REPLACEMENT PAGES

APPENDIX A

RANGE OF DISCHARGE EVALUATION

15% option is assumed to exceed the numeric-based criteria and therefore the impact will be considered significant.

- Cyanide: The 5%, 10%, and 15% options will result in increases in cyanide in the Laguna compared to the 1% project. For both the 10% and 15% options (but not the 5% option), the amount of total cyanide will exceed the numeric-based criteria and therefore the impact will be significant. However, with proposed mitigation (Implementing a Cyanide Source Control Program), the impact for both the 10% and 15% options will be reduced to less than significant.

- Biostimulatory Substances (Benthic and Planktonic Algae): The 5%, 10% and 15% options will result in increases over the 1% project in adverse impacts for one or more months of the years in both the Laguna and/or Santa Rosa Creek. These impacts are considered significant for all discharge options, and no mitigation has been identified that will reduce the impact to less than significant. The 5%, 10%, and 15% options will also result in decreases compared to the 1% project in the beneficial impacts during one or more months of the year for the Russian River as well as for the Laguna and Santa Rosa Creek. However, the beneficial impacts under the 5%, 10%, and 15% options will still be considered significant.

- Turbidity: The 5% and 10% options were determined to have a less than significant impact on turbidity, and the 20% Laguna discharge alternative (Alternative 5B) was found to have a significant impact on turbidity (Merritt Smith Consultants 1996b). The impact of the 15% option was not specifically evaluated, therefore the impact is assumed to be significant.

- Waste Reduction Strategy: The 5%, 10%, and 15% options would result in decreased ability (compared to the 1% project) to meet the Regional Board goal for reduction in total nitrogen and nitrogen-ammonia in both the Laguna and Santa Rosa Creek. These impacts are considered less than significant for the 5% option and significant for the 10% and 15% option. However, the proposed mitigation (Implementing a Total and Ammonia Nitrogen Source Control Program) will reduce the impact for the 10% and 15% option to less than significant.

- Toxicity: The 5% and 10% options would cause toxicity to occur in the receiving water at a frequency that is less than the existing condition. Therefore, ~~T~~the 5% and 10% options were determined to have a less than significant impact on toxicity, and the 20% Laguna discharge alternative (Alternative 5B) was found to have a significant impact on toxicity (Merritt Smith Consulting~~ant~~ 1996b). Mitigation Measure 2.5.7 may nonetheless be imposed by the Regional Board if the 5% or 10%

– options are implemented because such discharges would not attain the Regional Board toxicity objective which prohibits toxicity in receiving water. Although, tThe impact of the 15% option was not specifically evaluated, interpolation suggests that the impact will be significant. Therefore, the impact of the 15% option is considered to be significant.

REPLACEMENT PAGES

APPENDIX B

LIST OF PREPARERS

(THERE ARE NO REPLACEMENT PAGES FOR THIS APPENDIX)

REPLACEMENT PAGES

APPENDIX C

LIST OF INDIVIDUALS WHO RECEIVED THE SCOPING REPORT AND LIST OF INDIVIDUALS THAT RECEIVED NOTIFICATION OF AVAILABILITY OF THE DRAFT EIR/EIS

(THERE ARE NO REPLACEMENT PAGES FOR THIS APPENDIX)

REPLACEMENT PAGES

APPENDIX D

DESCRIPTION OF EXISTING SYSTEM AND ALTERNATIVES

discharge would be different. Reclaimed water would mix in the reservoir and would therefore be released from the dam year-round.

Purpose and Need

This project does provide wastewater disposal and provides for beneficial reuse of reclaimed water by returning water to the Russian River.

Cost

Cost of constructing a project to pipe wastewater to Lake Sonoma would be about $70 million. Because of pumping costs, annual operations and maintenance costs for this options would be relatively high, at about $5 million per year. These costs are considerably higher than a 20% discharge direct to the Russian River, which has a $6 million capital cost and a relatively small operational cost of about $100,000 per year.

Technology

The technology for pipelines and pump stations is readily available.

Logistics

A pipeline and pump station could feasibly be located; however, this option would require long-term management of 26 miles of pipeline with 675 feet of lift. A closer discharge location would certainly be logistically preferable.

Summary

Lake Sonoma discharge is not being considered further because it is essentially equivalent to direct discharge to the Russian River, but costs are significantly higher. Two subalternatives for direct discharge to the Russian River are being evaluated: continued discharge through the Laguna, and a new pipeline direct to the river. Although other discharge locations such as Lake Sonoma might be possible, it is not feasible to evaluate every potential discharge point along the entire length of the river. Given the extreme difference in costs and logistics, this is not a reasonable alternative.

Community Separator Wetlands

This component was proposed during public workshops as a method for storing reclaimed water while providing a separation between Santa Rosa and surrounding communities. Although wetlands would not provide significant amounts of storage, it was agreed to evaluate this component in one of the project alternatives because wetlands consume wastewater, provide a land use benefit, and may also be used for polishing of wastewater.

Table 1

Property Potentially Affected by Acquisition

Project Component	Assessor's Parcel Number	Property Owner	Total Area of Parcel (Acres)	Only Easement Required
	68-080-02	Roche Joseph G & Genevieve	324.73	
	68-080-03	Roche Joseph G & Genevieve	606.77	
LAKEVILLE HILLSIDE	68-080-01	Cardoza John S Jr. & Mary L Tr. Et. Al	489.97	
	68-110-16	Marcucci Allen	23.00	
	68-110-17	Marcucci Allen	180.94	
	68-110-18	Henning Dorothy E Tr. Et Al	56.92	
	68-110-19	Henning Dorothy E Tr. Et Al	43.08	
	68-110-29	Manlove Inc. Et. Al.	199.63	
	68-110-33	Domaine Chandon Inc.	90.66	
	68-110-34	Namdar Hossein Et. Al.	122.29	
SEARS POINT	68-080-03	Roche Joseph G & Genevieve	606.77	
	68-090-01	Roche Joseph G & Genevieve	594.00	
	68-090-04	Roche Joseph G & Genevieve	550.69	
	68-090-10	Stefansky Nancy E Donnell	394.96	
	68-090-12	Stefansky Nancy E Donnell	21.68	
TWO ROCK (Including Inlet Pipeline)	22-010-04	Tresch Joe & Kathy ~~University of California~~	558.94	
	22-020-01	Mattos John A Jr. & Sandra Et. Al	381.60	
	24-080-01	Tunzi Lester N Life Est Et Al	110.98	Yes
	24-080-03	Gray Richard	306.00	
	24-080-19	County of Sonoma	389.05	
	24-090-16	Tunzi Lester N & Dolores S Et Al	202.00	Yes
	24-090-17	Tunzi Lester N & Dolores S Et Al	32.00	Yes
	24-090-26	Tresch Joe & Kathy~~University of California~~	348.67	
BLOOMFIELD	27-010-12	Benedetti Walter & Aloha	106.32	
	27-020-02	Claeyssens Paul	200.00	
	27-020-06	Briggs Colleen A Tr. Et Al	319.71	
	27-030-02	Briggs Colleen A Tr. Et Al	277.80	
	27-030-03	Briggs Colleen A Tr. Et Al	162.42	
	27-040-11	Dougan John A & Helen M Tr.	216.14	
	73-020-04	Boothe D P & Catherine	458.76	
CARROLL RD.	73-020-04	Boothe D P & Catherine	458.76	

to increased river discharge during periods when allowable river discharge rates would be exceeded. The following is a description of the various model components.

Reclaimed Water Inflow

Reclaimed water inflow is defined as treatment plant effluent that supplies the reclaimed water system. The Laguna treatment plant average daily flow (ADF) is adjusted for hydrologic conditions for each water year and converted into an annual flow volume. The annual flow volume is divided into monthly flow volumes based upon the estimated monthly reclaimed water flow distribution. The estimated monthly reclaimed water flow distribution was developed from influent flow data for 1981 to 1985 at the Laguna Treatment Plant and is discussed in TM-R-1, *Irrigation Expansion Feasibility*.

Distribution of Total Estimated Annual Flow to Each Month
For the Monthly Water Balance Model

Month	Distribution
October	0.0721
November	0.0743
December	0.0896
January	0.1141
February	0.0998
March	0.1095
April	0.0888
May	0.0772
June	0.0715
July	0.0705
August	0.0667
September	0.0659
Total	1.0000

Source: CH2M Hill’s Technical Memorandum No. R-1 (February 1989)

Irrigation Requirements

Irrigation requirements are subdivided into various categories depending upon land use. The land application areas and annual application rate requirements for each category are used to determine annual volume requirements. The annual volume requirements are further subdivided into monthly irrigation reuse flow volumes based upon the estimated monthly hydraulic loading distribution. This monthly distribution was also developed in TM-R-1. Irrigation application rates were held constant for each year as no attempt was made to adjust the irrigation requirements for annual temperature or precipitation variations. Irrigated area is one variable that can be adjusted in solving the water balance and achieving the required reliability.

Russian River Discharge

Allowable river discharge is the monthly volume of Russian River flow multiplied by the allowable discharge rate (1, 5, 10, or 20 percent of the river discharge rate). Actual river discharge is calculated by comparing water available for storage to the target storage volume. Target storage is defined as the accumulated volume desired in the storage system for any given month. Monthly target storage values are input to the model as a fraction of maximum storage. Collectively, the target storage values comprise the target storage curve, which is assumed as part of the model. Actual river discharge is calculated based on irrigation demand, reclaimed water inflow, and target storage. Actual river discharge is compared to allowable river discharge and any actual discharge in excess of the allowable is calculated and recorded by the model as "contingency volume."

Storage Requirements

The determination of storage requirements is an iterative process beginning with the actual river discharge calculation. After irrigation requirements are satisfied, actual river discharge is calculated based on target storage requirements, as described above. Preliminary storage volume (based on target storage), is compared to the maximum storage available to ensure that the maximum is not exceeded. Maximum available storage and the target storage curve are additional variables which can be adjusted in solving the water balance and achieving the required reliability.

Supplementary Water

"Supplementary water" is water that is required to meet irrigation demand when reclaimed water from storage and reclaimed water from the Laguna Plant are insufficient to meet that demand. The Water Balance Model calculates and records supplementary water requirements. Supplementary water is not required for the existing reclamation system and it was assumed that supplementary water should not be required for this project. Supplementary water requirements for all alternatives and at all discharge rates are zero.

Goal of the Model

The goal of the model is to minimize the required irrigation area and storage volume while maintaining a contingency volume frequency of 1 month in 20. The key variables to manipulate are the land application areas for the various irrigation categories (e.g., South County, West County, Sebastopol) and the maximum storage criteria. Increasing irrigation area or maximum storage capacity increases the reliability of the system by decreasing the frequency of contingency volumes. The objective is to bring the reliability number as close to 1 as possible.

WATER BALANCE MODEL REVISIONS

A number of revisions were made to the Water Balance Model received by Parsons ES. The major changes are summarized below.

Reclaimed Water Inflow Calculations

Reclaimed water inflows are calculated in the model using the Average Daily Flow (ADF) of wastewater to the treatment plant. The ADF is converted to an annual flow and distributed monthly according to the monthly flow distribution established in TM-R-1. In the original model, ADF determination is unclear. It appears that ADFs were hand-entered into the model, according to Russian River flows. The basic premise is that greater precipitation would increase both the Russian River flow and the ADF (due to infiltration and inflow). Instead of hand-entering ADF data, Parsons ES modified the model by establishing a relationship between total annual Russian River flow and total annual Laguna Plant flow. Actual river and plant flow data were entered into a regression model for the years 1986-1992 and ~~a~~ the following regression equation was derived:~~.~~

$$ADF = \text{River Volume} \times 3.5 \times 10^{-6} + ADWF$$

where:

ADF = average daily flow in MG

River Volume = Total Annual Russian River Volume in MG

ADWF = average dry weather flow = 21 mgd

The regression coefficient (r-squared value) for this equation is 0.85

The regression equation was entered into the Water Balance Model so that the ADF could be calculated automatically. This modification provides a more realistic variation of ADF in response to climatic conditions. Implicit in the use of the above equation to estimate future ADF is the assumption that I/I will remain constant. The agreement between the Subregional System partners requires that each entity spend at least 5 percent of the entities total operations and maintenance cost of sewage collection on I/I identification and control. This fraction was derived to control I/I at current levels. The City of Santa Rosa, spends up to 10 times the required amount.

ADF calculation is also dependent upon the Average Dry Weather Flow (ADWF). Theoretically speaking, the ADF is equivalent to the ADWF when Russian River flow is lowest, approaching zero. The y-intercept of the regression equation (based on actual plant and slightly from the water balance model allocation priorities." Allocation priorities refers to guidelines that determine how the water balance model chooses to distribute reclaimed water to storage, irrigation, and discharge. These guidelines are built into the water balance model and described in detail in a memo addressed to Robin Cort on 25 August 1995, regarding contingency volumes results for the monthly water balance model. In other words, if the model has the flexibility to store more reclaimed water (in contingency storage) during periods of low river flow and discharge to the river when flow conditions are more favorable, then fewer discharges in excess of the design discharge rate would occur.

Contingency Discharge

The discharge results for each design discharge rate are given in Table 1. The total contingency discharge represents the total discharge to the Russian River in excess of the design discharge rate over the 70-year period of record. Monthly or daily contingency discharges (depending upon the water balance model) were totaled to obtain this figure. The number of months in which the contingency discharges occur over the 70-year (840 month) period of record are shown. Daily water balance model results (i.e., number of days for which there were contingency discharges) were converted to represent the number of months which have daily contingency discharges. This conversion was performed to directly compare contingency discharge frequency results between two models with different time steps.

The maximum monthly discharge rate is the maximum percentage of wastewater flow as a percentage of Russian River flow. Discharge rates for the daily water balance model were also converted to monthly figures for direct comparison. It should be noted that daily rates predicted by the daily water balance model fluctuate about this average, and are sometimes much higher than the monthly average. Both monthly and daily maximums for the daily water balance model are shown in Table 1. For example, the maximum daily discharge rates (52.3 and 55.3 percent) for the 20 percent design discharge are much greater than the maximum monthly average discharge rates (25.0 and 22.0 percent). Cumulative frequency curves for daily discharge rates and monthly averages of daily discharge rates are shown in Figures 1-8. These curves further show the effects of monthly averaging on daily rates. There are two curves for each design discharge rate, one showing cumulative frequency between 0 and 100 percent and the other between 99 and 100 percent. Monthly averaging of daily results attenuates the peak discharge rates. This is most evident in Figures 2, 4, 6, and 8. Additional characterization of contingency discharges as simulated using the daily water balance model is provided in Table 2. The frequency with which the estimated discharge rate is less than or equal to the design discharge rate is summarized in Table 3. The values in Table 3 describe the x-value on Figures 1 through 8 at which the line is above the y-value corresponding to the design discharge rate.

The three contingency discharge parameters were chosen to compare the results between the daily and monthly water balance models and check for consistency. Because of differences in time-step and model construction, we would expect the daily and monthly water balance model results to be similar but not identical. The results are similar for the 5, 10, and 20 percent design discharge options but are noticeably different for the 1 percent option.

Monthly and daily contingency discharge results are compared in the “Monthly” and “Daily (1)” columns in Table 1 for each design discharge rate. Storage volume, curve type, and curve adherence are kept constant. Total contingency discharge, number of months with contingency discharge, and maximum monthly discharge rate are very similar for the 20

Table 2.

Characterization of Contingency Discharge Based on Daily Water Balance Model

Design Discharge	Year	Total Annual Contingency Discharge, MG	Total No. Months & Days in Year With Contingency Discharge (Mo/Day)
1%	1946	29	1 / 1
1%	1966	59	1 / 2
1%	1983	28	1 / 1
1%	1984	57	1 / 2
1%	1985	89	1 / 3
10%	1977	75	2 / 18
10%	1978	11	1 / 4
20%	1937	18	1 / 4
20%	1977	183	3 / 35
20%	1978	63	1 / 10

Table 3.

Percentage of Time That Estimated Discharge Rate is Less Than or Equal to Design Discharge Rate For Daily and Monthly Water Balance Model

Design Discharge Rate	**Daily**	**Monthly**
1	99.94 %	100 %
5	100 %	99.73 %
10	99.83 %	99.38 %
20	99.68 %	99.02 %

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Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
AMERICANO CREEK WATERSHED					
Residential Development Projects					
3 lots for minor subdivision	Valley Ford District	Sonoma County P&RMD			X
Solid Waste Projects					
Roblar Site - closure landfill improvements	Roblar Road	Sonoma County Public Works			X
STEMPLE CREEK WATERSHED					
Habitat Restoration/Environmental Mitigation Projects					
Watershed restoration project	Stemple Creek	U.S. Department of Agriculture; Natural Resources Conservation Service		X	
Solid Waste Projects					
Central landfill composting facility	500 Meacham Road, Petaluma	Integrated Waste Management Board			X
Central landfill recycletown	500 Meacham Road, Petaluma	Integrated Waste Management Board			
Central landfill improvements	Central Landfill, Meacham Road	Sonoma County Public Works			X
TOLAY CREEK WATERSHED					
Habitat Restoration/Environmental Mitigation Projects					
Watershed restoration project	Tolay Creek	U.S. Department of Agriculture; Natural Resources Conservation Service	X		
Environmental mitigation	Route 121, Hwy. 37 to Tolay Creek Bridge	Caltrans			X
Transportation Projects					
Roadway reconstruction	Route 121 from Route 37 to Tolay Creek Bridge	Caltrans			

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Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
Annexations					
4 lot SF minor subdivision, 2.2 acres	910 First St.	Sebastopol Planning		X	
4 parcels, 2.61 acres	6701 Montecito Blvd.	Santa Rosa Community Development			X
3 parcels	931 Middle Rincon Rd.	Santa Rosa Community Development			X
County Island, one parcel	350 Brey Rd.	Santa Rosa Community Development			X
23.6 acres	2278 Dutton Ave.	Santa Rosa Community Development			X
Navle Air Center, 17.5 acres	3842 Finley Center	Santa Rosa Community Development			X
200 acres	2853 S. Dutton Ave.	Santa Rosa Community Development			X
26 lots on 7 acres	3537 Bennett Valley	Santa Rosa Community Development			X
Annexation of Creekside Middle School	East of Snyder south of Keiser	Rohnert Park Community Development		X	
4,000 sq ft - 82 unit motel	Downtown Sebastopol	Sebastopol Planning Dept.			X
General Plan Amendments & Update					
Brooks Commercial (3.9 acres)	Los Amigos and Brooks Ave.	Windsor Planning Dept.			X
Yardbirds Center, 101,000 s. f. General Plan Amendment Rezoning	3200 Mendocino Ave.	Santa Rosa Community Development			X
Lovers Lane Specific Plan, plan outlines development of 990 to 1360 sf family, and multi family units and 2 acres of commercial development. General plan amendment and rezoning required.	North of the city of Ukiah	Mendocino Co. Planning			X
Residential development	5780 Old Redwood Hwy., Windsor District	Sonoma County P&RMD			X
17 lots for minor subdivisions	Sepastopol District	Sonoma County P&RMD			
General plan amendment for riparian setback ordinance	Russian River	Healdsburg Planning Dept.			
Agricultural zoning to commercial zoning 10 acres	South of The Forks, North State St.	County of Mendocino Planning and Building			X

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Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
Agricultural zoning to commercial zoning 24 acres	South of The Forks, North State St.	County of Mendocino Planning and Building			X
Remote residential 40 acres per unit to remote residential 20 acres per unit.	Redwood Valley	County of Mendocino Planning and Building			X
General Plan Update	City of Santa Rosa	Santa Rosa Community Development Dept.			
Update Airport Master Plan	Sonoma County Airport	Sonoma County Public Works			X
Windsor General Plan	Entire City of Windsor and expanded areas	Windsor Planning Dept.			X
Change general plan mapping from low to very low density, 12.5 acres.	3100 Chanate Rd.	Santa Rosa Community Development			X
Change residential low density to business park, one parcel.	818 Britain Lane	Santa Rosa Community Development			X
Shift residential density and establish shopping center designation	4600-4712 Sonoma Hwy.	Santa Rosa Community Development			X
Rohnert Park General Plan Update	City of Rohnert Park	Rohnert Park Planning Dept.			X
Commercial Development Projects					
Cary/Taylor Industrial Building, 10,000 Sq. Ft.	450 Aaron St.	Cotati Planning	X		
Lukens Industrial Building, 8,774 s.f.	711 Portal St.	Cotati Planning	X		
Discovery Office Systems, 36,261 s.f.	Houser St. at Redwood Dr.	Cotati Planning		X	
~~16 screen m~~Movie theater complex	80 Golf Course Dr.	Rohnert Park Community Development		X	
Allied Moving and Storage 15,500 s.f.	State Farm Dr. and Professional Dr.	Rohnert Park Community Development		X	
Next Level Communication, Electronics Manufacturing, three phases total 150,000 s.f.	State Farm Dr.	Rohnert Park Community Development		X	
Hewlett Packard, warehouse and office, 100,000 s.f.	Rohnert Park	Rohnert Park Community Development		X	
Construction of 8,765 s.f. Building	Larkfield District, 4601 Redwood Hwy.	Sonoma County P&RMD		X	
Four wholesale greenhouses	Philips Ave.	Sonoma County P&RMD		X	
25,900 s.f.	Various locations within city	Ukiah Planning Dept.			
Mendocino Brewing Company	Downtown Ukiah	City of Ukiah Planning Dept.	X		

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Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
211~~714~~ SF units, 80~~156~~ MF units, 1,727 acres.	Various locations within the City of Santa Rosa	Santa Rosa Community Development			X
11 SF units	Various locations within the City of Cotati	Cotati Planning	X		
36 SF units	Various locations within the City of Cotati	Cotati Planning		X	
4 lots for minor subdivision	Jenner District	Sonoma County P&RMD			X
13 lots for minor subdivision	Geyserville District	Sonoma County P&RMD			X
30 lots for minor subdivision	Windsor District	Sonoma County P&RMD			X
223 lots for major subdivision	Windsor District	Sonoma County P&RMD			X
7 lots for minor subdivision	Guerneville District	Sonoma County P&RMD			X
4 lots for minor subdivision	Rio Nido District	Sonoma County P&RMD			X
39 lots for major subdivision	Larkfield District	Sonoma County P&RMD			X
19 lots for minor subdivision	Twin Hills District	Sonoma County P&RMD			
Airport Improvement Projects					
Aircraft storage hangars (2)	Sonoma County Airport	Sonoma County Public Works			X
New general aviation runway	Sonoma County Airport	Sonoma County Public Works			X
Land acquisition for runway approach protection	Sonoma County Airport	Sonoma County Public Works			X
Airfield sfety and maintenance projects	Sonoma County Airport	Sonoma County Public Works			X
Resurface main runway	Sonoma County Airport	Sonoma County Public Works			X
Airport business park industrial, commercial and office	South of downtown at Airport Rd., Hwy. 101 and Talmage Rd.	Ukiah Public Works	X	X	
Drainage Projects					
Flood channel maint.	Pieta Creek Vineyards, Hopland	Mendocino Co. Planning and Building			X
Russian River breaching - obstruction removal and sandbar clearing	Jenner, Son. County	Sonoma County Public Works; Corps	X		
Retaining wall emergency repair	Healdsburg Dam	Sonoma County Water Agency; Corps			X
Big Sulphur Creek emergency watershed project	Big Sulphur Creek	Sonoma County Water Agency; Corps		X	

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Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
Pleasant Oak Park improvements	Pleasant Ave.	Windsor Planning Dept.	X		
Community park	South side of City on Muscat Creek	Cloverdale Public Works		X	
Healdsburg dam fish ladder and dam modifications	Healdsburg Dam on Russian River, north of Hwy. 101	Sonoma County Water Agency			X
Sewer System Projects					
Sewer line replacement	North High St.	City of Sebastopol Public Works		X	
Pump station construction	Morris St.	City of Sebastopol Public Works		X	
Graton treatment plant and reclamation improvements	West of Ross Rd along a tributary of Atascadero Creek, Graton	Sonoma County Water Agency			X
Forestville CSD Capital Replacement Program	Various Locations	Sonoma County Water Agency			X
Mirabel Heights Wastewater Collection and Treatment Facilities	Mirabel Heights area south of River Road at Mirabel Road	Sonoma County Water Agency			X
Occidental treatment plant improvements	South of Occidental Rd, Occidental	Sonoma County Water Agency			X
Occidental transfer station	4985 Stoetz Lane, Sebastopol, CA 95472	Integrated Waste Management Board			
Russian River CSD treatment plant and reclamation improvements	Guerneville	Sonoma County Water Agency			X
Airport treatment plant, storage and irrigation system improvements	At Santa Rosa Airport	Sonoma County Water Agency			X
~~Airport/Larkfield/Wickiup c~~Capital replacement program - repair/replace collection system, electrical and mechanical hardware.	Airport/Larkfield/Wickiup~~Various Locations~~	Sonoma County Water Agency			X
Camp Meeker Wastewater Collection and Treatment Facilities	Camp Meeker area along Bohemian Highway and Dutch Creek	Sonoma County Water Agency			X
Forestville CSD treatment plant improvements	South of Hwy. 116 along tributary of Green Valley Creek, Forestville	Sonoma County Water Agency			X

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Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
Geyserville treatment plant improvements	South of Hwy. 128 along Russian River, Geyserville	Sonoma County Water Agency			X
Geyserville capital replacement program	Various Locations	Sonoma County Water Agency			X
~~Russian River CSD capital replacement program~~	~~Guerneville~~	~~Sonoma County Water Agency~~			~~X~~
South Park CSD capital replacement program	Various Locations	Sonoma County Water Agency			X
24" sewer interceptor from Cotati to the Laguna Plant	Cotati to Laguna Treatment Plant	Cotati Public Works, Corps	X		
North trunks collector	Generally along NWP RR Tracks	Windsor Planning Dept.		X	
Southwest trunk collector	Southwest Area	Windsor Planning Dept.			X
Replace sewer main	Jefferson, Hoehl and Charles Streets	Cloverdale Public Works	X		
Sewer and water main replacement	Bonavita Heights	Santa Rosa Utilities Department		X	
Sewer and water main replacement	Burbank Gardens	Santa Rosa Utilities Department		X	
Water main installation and overlay	D St. to First St. Sonoma	Santa Rosa Utilities Department		X	
Sewer main replacement	Darla Dr.	Santa Rosa Utilities Department		X	
Sewer and water main replacement	E St., King St., 5th St., Royal St.	Santa Rosa Utilities Department	X		
Sewer and water main replacement	Julliard Park Neighborhood	Santa Rosa Utilities Department	X		
Sewer replacement	Sebastopol Rd. / Roseland Ave.	Santa Rosa Utilities Department		X	
Sewer main replacement	Clover, Wild Rose	Santa Rosa Utilities Department		X	
Sewer main replacement	5th St. Mendocino to B St.	Santa Rosa Utilities Department		X	
Sewer main replacement	Steven St. to Gordon Lane	Santa Rosa Utilities Department		X	
Sewer and water improvement	Bento St. and 13th	Santa Rosa Utilities Department		X	
Sewer and water main replacement	South A - Barham to Santa Rosa Ave.	Santa Rosa Utilities Department		X	
Water main replacement	Marlow Rd. - West Steele to Marsh	Santa Rosa Utilities Department	X		

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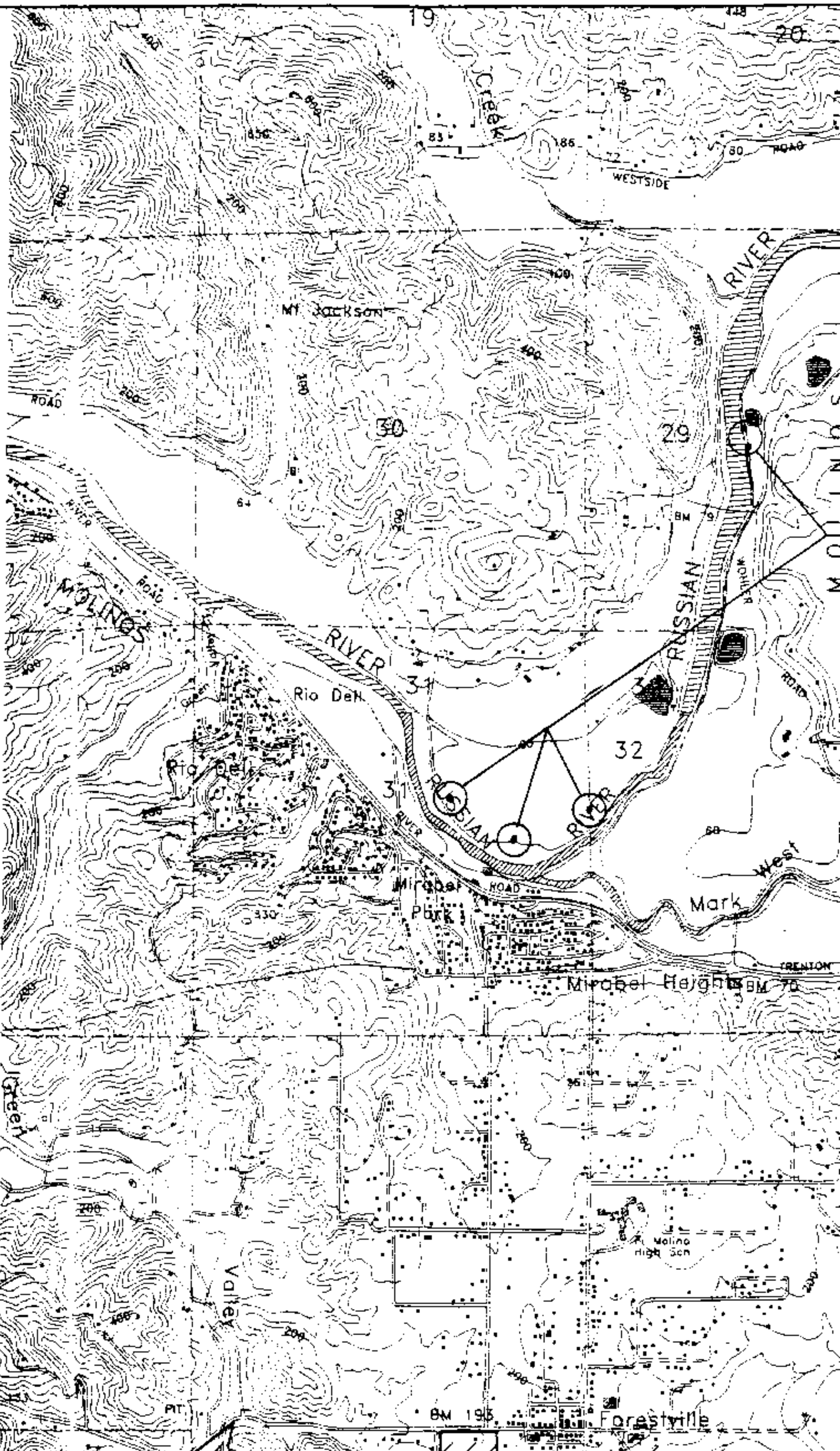
Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
Water main replacement	Sullivan Crt.	Santa Rosa Utilities Department		X	
Water main replacement	Extensions - East	Santa Rosa Utilities Department		X	
Water main replacement	Extensions - West	Santa Rosa Utilities Department		X	
Sewer and water main replacement	Grahn Dr. & Siesta Lane	Santa Rosa Utilities Department		X	
Rohnert Park Water Reuse Project	Laguna de Santa Rosa and Copeland Creek	Santa Rosa Utilities Department		X	
Sewage ponds upgrade	Ukiah	Ukiah Public Works; Corps	X		
Solid Waste Projects					
Cloverdale composting program	Cloverdale	Integrated Waste Management Board		X	
Healdsburg transfer station	166 Alexander Valley Road, Healdsburg, CA 95448	Integrated Waste Management Board		X	
Guerneville transfer station	13450 Pocket Dr., Guerneville, CA 95446	Integrated Waste Management Board			
Healdsburg site - closure & landfill gas collection	Alexander Valley Road	Sonoma County Public Works			X
~~Recycletown North~~	~~166 Alexander Valley Road, Healdsburg, CA 95448~~	~~Integrated Waste Management Board~~			
Larry's Materials recovery and drop off	7085 Gravenstein Highway, Cotati	Integrated Waste Management Board			
Recycle America - materials recovery and drop off	3400 Standish Ave., Santa Rosa	Integrated Waste Management Board			
Garbage Reincarnation drop off	3899 Santa Rosa Avenue, Santa Rosa	Integrated Waste Management Board			
Industrial Carting Materials Recovery Facility	3911 Santa Rosa Avenue, Santa Rosa	Integrated Waste Management Board			
Airport disposal site - closed landfill improvements	Airport Boulevard adjacent to Sonoma Co. Airport	Sonoma County Public Works			X
Guerneville enclosure building improvements	Pocket Drive, Guerneville	Sonoma County Public Works			X
Landfill expansion	Central City Landfill	City of Ukiah Public Works		X	

Appendix D-31

Cumulative Project List

Project Title/Description	Location	Reporting Agency	Appv. and Under Const.	Appv. and Not Under Const.	Not Appv.
RUSSIAN RIVER WATERSHED					
Early Warning System (EWS) - 3 monitoring stations to detect contaminants in the Russian River	Sta. 1 on Russian River north of Forestvillle; Sta 2 on Mark West Creek @ Trenton-Healdsburg Rd; Sta 3 on Russian River south of Healdsburg	Sonoma County Water Agency			X
Miscellaneous site improvements at the Mirabel site	South of Westside Road along the Russian River	Sonoma County Water Agency			X
Ozone treatment plants for emergency wells (3)	Well sites along the Russian River-Cotati Intertie	Sonoma County Water Agency			X
New Russian River well field	Between Mirabel Site and Wohler Road north of Russian River	Sonoma County Water Agency	X		X
~~Miscellaneous site improvements at the Wohler site~~	~~Wohler Road east of the Russian River~~	~~Sonoma County Water Agency~~			~~X~~
Potter Valley project	Mendocino and Lake Counties	Sonoma County Water Agency			X
Russian River Estuary Management Plan	Russian River from Duncans Mills to Jenner	Sonoma County Water Agency			X
Sweetwater Springs Water District improvement project	Hulbert Creek, Guerneville	Corps	X		
Dry Creek Wells: Municipal Water Wells, Healdsburg	Healdsburg Corporation Yard	Healdsburg Public Works			X
New wells and well rehabilitation	Bluebird Well Site	Windsor Planning Dept.		X	
New water main	Old Redwood Hwy. & Herb Rd.	Windsor Planning Dept.	X		
New water main	Russian River to Herb Rd.	Windsor Planning Dept.	X		
New water main	Starr Rd. to High School	Windsor Planning Dept.		X	
~~New water main~~	~~Old Redwood Hwy. to Lockwood~~	~~Windsor Planning Dept.~~		~~X~~	
New water main	Shiloh tanks to Fought Rd. and Pleasant Ave.	Windsor Planning Dept.		X	



NO.	DATE	REVISIONS	BY

		DATE
PROJECT NO.	723129	
DESIGNED BY	J. TRISLER, T. WOODING	8/95
DRAWN BY	L. FLUKER	8/95
CHECKED BY	R. MAURER	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES

PARSONS ENGINEERING SCIENCE

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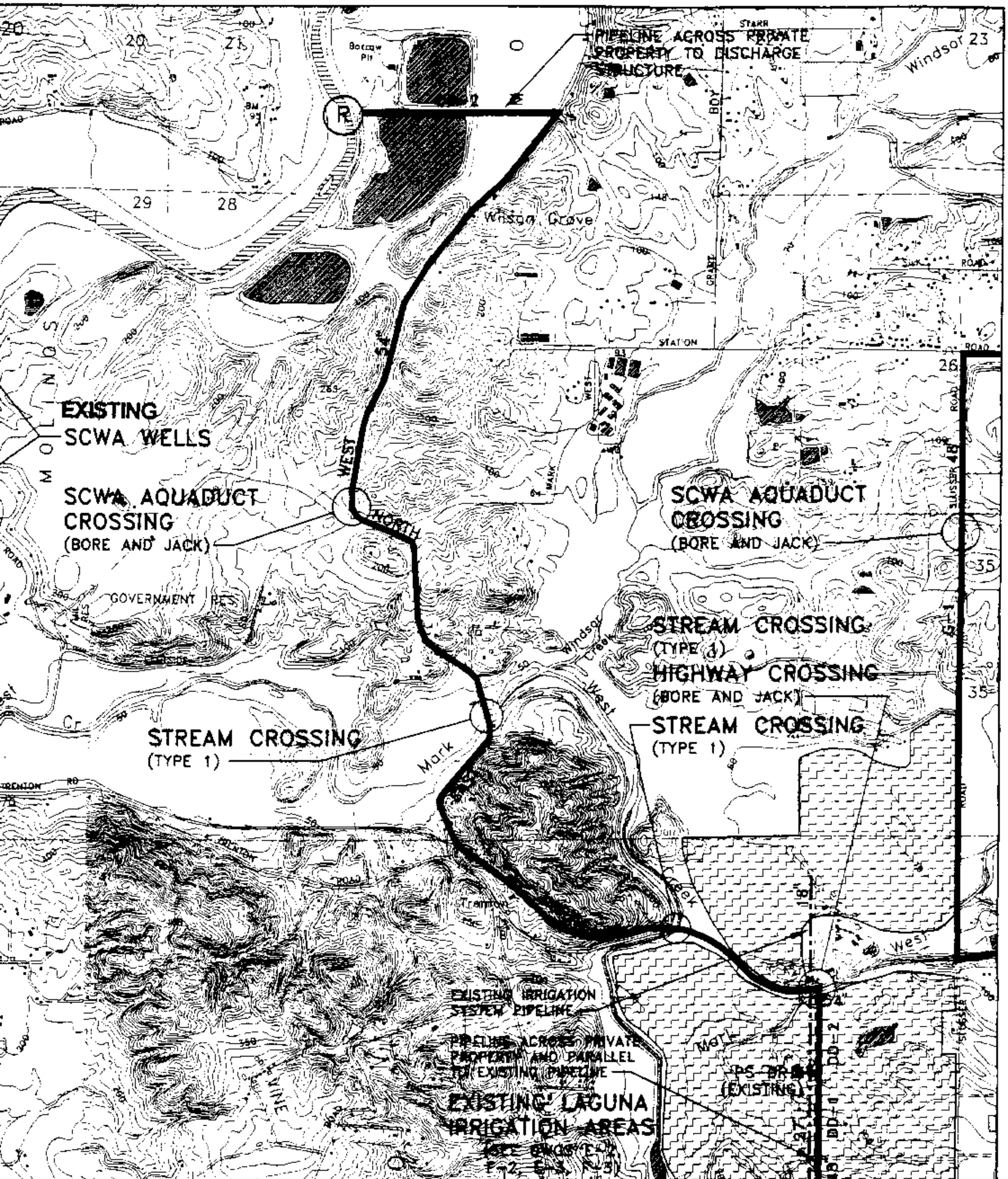

ANTA ROSA IONAL LONG-TERM EWATER PROJECT	1000' 0 1000' 2000' SCALE: 1" = 1000' CONTOUR INTERVAL: 40ft./20ft.	SHEET LOCATION	PROJECT OVERVIEW MAP STORAGE TRANSMISSION AND IRRIGATION DISTRIBUTION PIPELINES	AS SHOWN E-3B-P

FEB 07 1994

NO.	DATE	REVISIONS	BY

PROJECT NO.	723129	DATE
DESIGNED BY:	J. TRISLER, T. WOODING	8/95
DRAWN BY:	L. FLUKER	8/95
CHECKED BY:	R. MAURER	8/95

HARLAND BARTHOLOMEW AND ASSOCIATES

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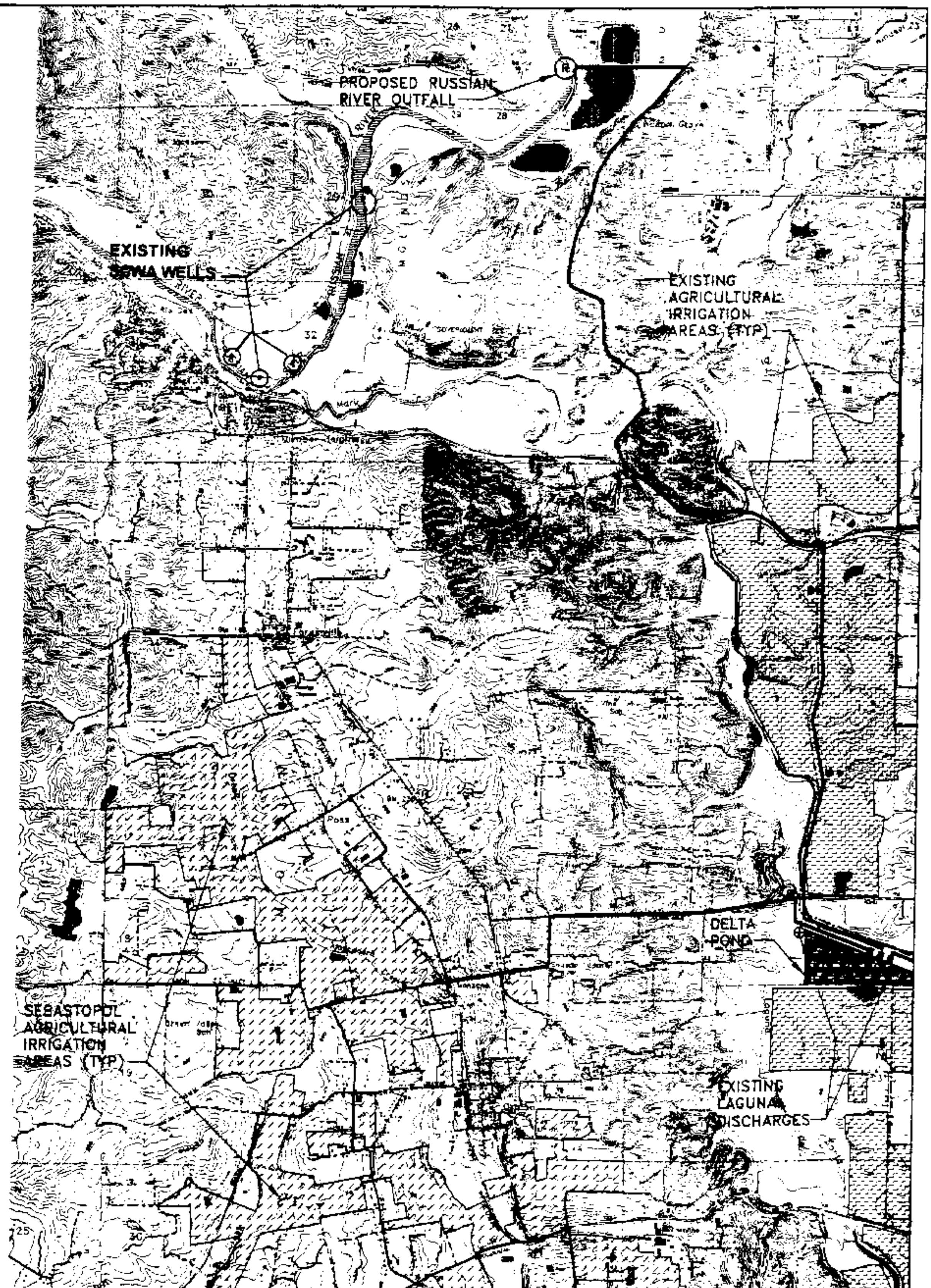


SANTA ROSA REGIONAL LONG-TERM WASTEWATER PROJECT	2000' 0 2000' 4000' SCALE: 1" =2000' CONTOUR INTERVAL: 40ft./20ft.	SHEET LOCATION	PROJECT OVERVIEW MAP	SCALE 1" = 2000'
			PROJECT FACILITIES ALTERNATIVES 1 – 5	SHEET NO. E-3

REPLACEMENT PAGES

APPENDIX E

AGRICULTURE

(THERE ARE NO REPLACEMENT PAGES FOR THIS APPENDIX)

REPLACEMENT PAGES

APPENDIX F

GEOLOGY, SOILS AND SEISMICITY

(THERE ARE NO REPLACEMENT PAGES FOR THIS APPENDIX)

REPLACEMENT PAGES

APPENDIX G

SURFACE WATER HYDROLOGY

velocity the hydraulic forces on the sediment are sufficient to lift the particles and move them downstream. The magnitude of the threshold velocity depends on the size of the sediment particles. For example, fine sand will be eroded at a lower velocity than gravel.

Merritt Smith Consulting obtained 14 sediment samples from the ~~bottom~~ bed and banks of the Laguna and 6 samples from the Russian River. Table 1 summarizes the particle size data. The measured particle size distribution indicates that in the upper reaches of the Laguna, sediments are more susceptible to erosion than in the reaches near the confluence with the Russian River. The Russian River contains more sands and gravels than the Laguna and is less susceptible to erosion.

Table 1

Stream Channel Sediment Particle Size Distribution

	Sediment Volume by Average Particle Size			
Location	**Gravel** 75 - 5 mm	**Sand** 5 - 0.08 mm	**Silt** 0.08 - 0.001 mm	**Clay** 0.08 - 0.001 mm
Laguna de Santa Rosa				
Upper Reaches	0%	30 - 40%	35%	25 - 30%
Lower Reaches (Nos. 7.2, 7.4 and 7.6)	0%	40- 50%	20 - 25%	30 - 35%
Russian River				
Near the Laguna Confluence	3%	70 - 80%	15 - 20%	5%
Near Guerneville	3%	95%	2%	0%

Source: Merritt Smith Consulting

Based on the sediment sampling data, it is apparent that the erosion velocity threshold varies between the Laguna and the Russian River. The finer grained material in the Laguna will erode at a lower streamflow velocity than the coarser material in the Russian River. For the purpose of evaluating potential erosion impacts associated with the discharge of reclaimed water, it was assumed that an increase in the stream power and the potential for erosion was only significant when the average streamflow velocity for the discharge condition was greater than the erosion threshold velocity for the reach. The sediment particle size distribution from Table 1 and typical scour velocities (ASCE, 1995 and Goldman et al., 1986) were used to develop a table of threshold velocities for each reach in the upper and lower Laguna and Russian River. The upper Laguna is defined here as those reaches located upstream of Santa Rosa Creek, and the lower Laguna is located downstream of Santa Rosa Creek. Table 2 on page 4 summarizes the estimated erosion...

REPLACEMENT PAGES

APPENDIX H

GROUNDWATER

2.0 RECLAIMED WATER QUALITY DATA

Numerical reclaimed water quality data are given in a series of tabular appendices to this report, as follows:

2.1 RECLAIMED WATER METALS, CYANIDE, AND CHLORIDE

Appendix 1 contains data on concentrations of 25 metals, as well as cyanide and chloride, (sampled at the treatment plant) as reported approximately quarterly from July 1988 through January 1995. Beginning in January 1990, total cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc were usually analyzed monthly. Dissolved metals, other total metals, and chloride were usually analyzed quarterly.

2.2 RECLAIMED WATER ORGANICS

Appendix 2 contains data on organic chemical species (sampled at the treatment plant) as reported approximately quarterly from January 1991 through January 1995. Data for 44 purgeable species (EPA Method 624/8260), 27 organochlorine pesticides and PCB's (EPA Method 608), and 56 base neutral extractable species (EPA Method 625) are reported. Data on eight chlorinated herbicides (EPA Method 515.1) and 12 organonitrogen /organophosphorus pesticides (EPA Method 507) are available for a single date only; and data on 26 congeners of dioxin and furan are available for three dates in 1994 and 1995.

2.3 RECLAIMED WATER ROUTINE CONSTITUENTS

A summary of routinely measured reclaimed water constituents (sampled at the treatment plant) is given in Appendix 3, as monthly minimum, maximum, and average values from January 1991 through January 1995. The constituents are ammonia, nitrite, nitrate, phosphate, alkalinity, total dissolved solids (TDS), biological oxygen demand (BOD), total suspended solids (TSS), pH, coliforms, and turbidity. Less frequently analyzed data on total organic carbon (TOC) (monthly from May 1994 through January 1995); enteric virus counts (seven dates); total Kjeldahl nitrogen (TKN) (two dates); and color, fluoride, sulfate and surfactants (1 date each) are included. Also included as Appendix 4 are Delta Pond data for ammonia, and organic nitrogen which are used in the *Water Quality Impact Analysis* Technical Report (MSC 1996).

2.4 SPECIAL RECLAIMED WATER STUDY

Some compounds of concern as constituents of drinking water are not required for analysis of Santa Rosa's reclaimed water or receiving waters and, therefore, are not routinely measured. In order to provide additional data on constituents in reclaimed water of concern for drinking water~~In order to provide additional data on reclaimed~~

~~water quality~~, a special reclaimed water study was conducted in late 1994. The results of this study are given in Appendix 5, and include analyses for seven inorganic substances, 170 organic species, radionuclides, two metals (beryllium and thallium), and eight pathogens, all conducted on composite treatment plant reclaimed water samples collected on four dates. Also included are pathogens from Delta Pond which were analyzed on one date. The study also included (on two dates) a tentatively identified compound (TIC) search for 76 organic species as part of a special alkylphenol study. The methods used to analyze for constituents in this study were selected to be consistent with the methods used for routine analyses by the Subregional System. These methods include the following:

Metals	**EPA 200.8, EPA 206.2, EPA 215.1, EPA 239.2, EPA 242.1, EPA 245.1, EPA 270.2, EPA 6010-200.7**
Organic Compounds	**EPA 547, EPA 548, EPA 549, EPA 1613, EPA 504, EPA 525.1, EPA 531.1, EPA 515.1, EPA 508, EPA 524.2**
Radiation	**EPA 900.0, EPA 903.0**
Biology (bacteria, viruses, protozoa)	**SM[1] 9510, SM 9711B, SM 9260J, SM 9260D, SM 9260E, SM 9251B, SM 9221B**
Other	**EPA/SM 335.3, EPA 160.1, EPA 160.2, SM 2340B, EPA 300.0, EPA 100.1**

[1] Sm = APHA, AWWA, WEF. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition.

2.5 Phthalate and Cyanide Special Study

A special collection and analysis for phthalates and cyanide in fresh reclaimed water (sampled at the treatment plant) and storage ponds was conducted. Appendix 6 contains data for six phthalate species, and for cyanide from composite reclaimed water samples collected on four dates in December 1995 and January 1996. Phthalates were included in the special study because they are a common laboratory contaminant. To control for this potential problem, trip/field blanks were included for all the reclaimed water collections and one of the Delta Pond samples. Diethyl phthalate was the only phthalate found in detectable concentrations. It was detectable in two of the four treatment plant reclaimed water samples and two of the four Delta Pond samples. It was also detectable in the Delta Pond blank, but none of the treatment plant reclaimed water blanks.

Cyanide was included in the special study because existing data collected by the City of Santa Rosa do not provide an estimate of potential effects of storage and complex formation on the concentration of total cyanide. In very pure water, the predominant form of cyanide is hydrogen cyanide (HCN) which is somewhat volatile and may be reduced through storage of reclaimed water. Additionally, in the presence of metals such as those found in reclaimed water, some of the cyanide forms metal complexes which are very stable and much less toxic than HCN. The City of Santa Rosa has measured cyanide in treatment plant effluent only, not in storage ponds. Therefore, the reclaimed water cyanide measurements may not be representative of the actual toxic fraction of cyanide present in reclaimed water discharged from storage ponds. To evaluate the effect of storage on cyanide, three types of cyanide analysis were conducted in the special study: total cyanide, amenable to chlorination cyanide, and weak acid dissociable cyanide. The amenable to chlorination and weak acid dissociable cyanide provide an estimate of the concentration of the toxic form of cyanide. Samples were collected from plant-collected reclaimed water and stored reclaimed water (Delta Pond).

The measurement of total cyanide, which is routinely measured in reclaimed water samples, is subject to interference from nitrate and nitrite. This interference causes artificially high cyanide results. The City of Santa Rosa routine cyanide results and the special study results may be affected by the interference. The Santa Rosa routine cyanide samples are being evaluated further to ascertain which data are subject to interference. The results of this evaluation will be presented in a supplementary report. For the special cyanide study, the analytical laboratory was requested to follow Standard Methods analytical procedures, which include a step to remove nitrate interference, but instead used the EPA methodology without this step. Therefore, the results of the special study total cyanide and amenable to chlorination cyanide are suspect and not included in this report. The weak acid dissociable cyanide method is not subject to nitrate interference. The data

3.0 RECLAIMED WATER QUALITY OVERVIEW

Table 1 provides a summary of the reclaimed water chemical constituents which have been detected in reclaimed water. Many other constituents were undetectable, and the data on both detectable and undetectable constituents are contained in the appendix tables. The table contains a list of chemical constituents of reclaimed water, along with information on their concentration, reporting (detection) limits, and the number of times that each has been detected. Mean concentrations given in these tables are calculated by assuming a value of half the detection limit for values below detection. For many of these constituents, numeric water quality objectives and guidelines (points of significance) have been promulgated by environmental regulatory agencies, including the U. S. EPA and Regional Water Quality Control Boards (RWQCB). These points of significance are also listed in Table 1. In cases where different regulatory agencies have promulgated different values for a given constituent, the lowest (i.e., most stringent) value is shown here. Notes explaining points of significance for each constituent are given in a separate technical report, *Development of Evaluation Criteria for Potential Water Quality Impacts*, (MSC 1996).

Several estimates of nitrate are available as follows:

- The overall average nitrate concentration from the Laguna Treatment Plant reclaimed water (16.3 mg-N/L)
- The average nitrate concentration in the treatment plant when the Laguna plant is nitrifying (18.1 mg-N/L)
- The expected nitrate concentration in the Laguna Treatment Plant efflluent after interim period plant upgrades are completed (14 mg-N/L) (estimated in a September 1995 memo by CH2M Hill and reported in the *Treatment Wetlands Evaluation* technical report (MSC 1996))
- The expected nitrate concentration in storage ponds after 14 mg-N/L is added to the pond and nitrification occurs in the pond (12 mg-N/L)

Table 2 provides a summary of the reclaimed water biological data (BOD, bacteria and enteric viruses) contained in the appendix tables. The human health implications of the data presented in this document are discussed in two separate technical reports: *Human Health Risks from Chemical and Biological Components of Reclaimed Water*, Parsons Engineering (Parsons ES 1995) and *Human Health Effects and Wildlife Effects of Environmental Estrogens* (Parsons ES 1995).

Table 2.

Biological Constituents of Reclaimed Water

Biological Constituent	Units	Concentration Range	Mean Concentration	Reporting Limits	Number of Detects	Number of Samples	Point of Significance
BOD	mg/L	1.5 - 19	3.4		49[1]	49[1]	none
Total Coliform	Mpn/ 100 ml	ND - 170	2.2	2.2	49[1]	49[1]	none
Enteric Virus	PFU/100 L	ND	N/A	1/~150 L	0	7	none
Giardia lamblia cysts	#cysts/ 100 L	ND - 13.8	4.7	1/~200 L	2	4	none
Cryptosporidium oocysts	#oocysts/ 100 L	ND	N/A	1/~200 L	0	4	none
Legionella sp.	Mpn/ 100 ml	ND	N/A	7840	0	4	none
Salmonella sp.	Mpn/ 100 ml	ND	N/A	2.2	0	4	none
Shigella	Mpn/ 100 ml	ND	N/A	2.2	0	4	none
Heterotrophic Plate Count	CFU/ml	ND - 2	1.25	2	1	4	none

N/A - not available
N.D. - not detected
Sources of significance points:
A - US EPA Freshwater Continuous
B - US EPA Saltwater Continuous
C - SF Bay RWQCB Freshwater 4-day average
D - SF Bay RWQCB Saltwater 4-day average
E - No. Coast RWQCB

[1] Numbers shown are the number of monthly averages; these constituents are routinely measured several times per month.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The results of chemical analyses of Santa Rosa's treatment plant final effluent made from February 1995 through February 1996 are similar to results obtained in the years 1988 through 1994. The data from 1988-1994 that were used as the basis for the EIR/S are representative of current effluent quality.

Giardia and *Cryptosporidium* values observed in 1996 are ~~much~~ greater than those observed previously and upon which the EIR/S analysis is based. However, the 1996 data are not considered representative of long-term reclaimed water quality because of a treatment plant malfunction that appears to have caused the elevated *Giardia* and *Cryptosporidium* values in 1996, with the exception of the detection of *Cryptosporidium* on one date after the filter malfunction was corrected. The implications of the *Giardia* and *Cryptosporidium* measurements of 1996 are described in the addendum to Appendix J-3.

Two instances of lethal effects to *Ceriodaphnia* in 20 tests and one instance of lethal effects to fish in 11 tests have been observed over 4 years. These toxicity data have been incorporated into the *Water Quality Impact Analysis* Technical Report (MSC 1996). Future toxicity testing on effluent storage pond water should include sterilization to eliminate biological effects, which can mask toxic effects.

REPLACEMENT PAGES

APPENDIX I

SURFACE WATER QUALITY

5. Improved, irrigated permanent pasture.

Since not every possible crop can be modeled, the crops selected for evaluation must serve as representative or benchmark crops indicative of a common level of management and likely water quality effect. Strawberries were selected as representative of specialty crops for water quality modeling for the Stemple and Americano Creek watersheds, and melons for Tolay Creek. Lettuce and potatoes were used as the benchmark vegetable crop for all three areas, and sudan grass was used as the benchmark for the forage crop, with irrigated pasture as the lowest intensity crop in all areas.

As described in the Tanji Technical Memorandum, a number of assumptions are made for each crop evaluated regarding typical nitrogen requirements, fertilizer and manure application rates and irrigation amounts. These are based on discussions with U.C. Cooperative Extension Service, records available from the Sonoma County Agricultural Commissioner's office, and consultation with the project agronomist, Vern Marble, Ph.D.

Based on management needs, a large number of new herbicides and pesticides (insecticides, fungicides, etc.) potentially could be used in the West or South County project areas. Two of the most common currently used in Sonoma County (the herbicide 2,4,D and the insecticide carbaryl [trade name Sevin]) were selected ~~as representative of possible water quality impacts. In part, their selection was~~ based on knowledge of their behavior, toxicity and modeling capabilities.

The modeling assumed that all areas of forage crops would have 2,4,D applied and all areas of specialty and vegetable crops would have carbaryl applied at common application rates. This represents a worst-case scenario. In reality, only a portion of the forage crop lands would likely need herbicide management in any year, and a wide variety of pesticides would be used, in addition to and instead of carbaryl. The modeling also assumes direct runoff of some irrigation water to the adjacent creeks (one to two percent). This is a worst case assumption that will largely be controlled by implementing the Irrigation Management Plan.

The results of the model integration indicate that the Medium Tech cropping scenario will have the greatest overall effect on nitrogen increases in the creeks, with summer increases of nitrate-nitrogen from two (2) to 3.7 mg/l, or about 75 percent. Improved management of manure in the West County watershed, which is not directly assessed in the Tanji model but is an important element of the Irrigation Management Plan, may actually result in reductions in overall nitrogen concentrations in surface water.

The herbicide 2,4,D, which is assumed in the modeling to be in widespread use in the watershed on forage crop lands, is predicted to exist at concentrations in the range of parts per trillion for the Medium Tech scenario. These concentrations would be below detection levels for routine field and laboratory monitoring, but possibly detectable in more sophisticated research laboratories. If it is assumed that 2,4,D or other similar herbicides will actually be applied in any cropping year to only about 25 percent of the forage crop lands, then the predicted herbicide concentration would likely be below detection limits achievable in research facilities. Similarly, even when the non-persistent insecticide carbaryl (Sevin) is assumed to be widely applied to all specialty crops and vegetables crops, the model predicts concentrations at or below the detection limits of research grade laboratory instruments.

The project will increase the quantity of ~~most significant increase predicted by the water quality modeling is in~~ salt that discharges to the estuaries. Increases of more than three times in the salt content of return flow irrigation tail water to surface water are predicted for all streams. While this may seem somewhat surprising given the high quality-low TDS of the reclaimed water, it is due to the concentration of salts that occurs from evapotranspiration of the applied water. Salts, which generally do ~~are~~ not accumulate~~d to any significant extent~~ in the growing crops and are relatively mobile in the soil environment, are easily transported through the watershed soils through rainfall and applied irrigation water. Virtually all salts added to the watershed eventually will be discharged to the estuaries. The~~is~~ effect of the predicted increase in the annual mass discharge of salts from project watershed lands ~~should be put into proper perspective. The salt discharge from watershed runoff and subflow represents a very small amount of salt (estimated less than one percent) compared to the salts entering the estuaries with tidal inflow. The effects of this are~~ on the esteros is discussed in the *Water Quality Impact Analysis Technical Report* (Meritt-Smith Consulting~~ants~~, July~~April~~, 1996).

5.0 MASS DISCHARGE

Mass discharge refers to the total discharge quantity of an element such as nitrogen, salts or pesticides, in kilograms, pounds or tons, reported on an annual basis. Basically, it represents the multiplication of concentration with volume. The point of interest is the discharge of these constituents to the Estero Americano, Estero de San Antonio and the mouth of Tolay Creek at San Pablo Bay. Using the Tanji model, mass discharges of nitrate-nitrogen and salt can be estimated for the existing conditions scenario and compared with the Low Tech, Medium Tech and High Tech cropping scenarios. The results of the mass loading analysis are summarized in **Tables 2** and **3** in Appendix A; the calculation sheets are included in tables in Appendix B.

The capability of the watershed's soil-hydrologic system to retain these compounds can also be approximated. This can be accomplished by comparing the total load applied to each watershed in irrigation water (for nitrates and salts) with the stream mass loading discharge (**Table 4**). The difference between the two is an approximation of watershed retention or concentration (some salts and N are added from fertilizers, manure and imported feeds). For nitrogen, over 99 percent of the irrigation applied load is retained in the soil or crop. Salts, being relatively soluble and mobile, are retained less in the watershed ~~to a much less significant extent~~ (84%±).

The greatest increase in mass loading are: 1) for the Medium Tech scenario for nitrogen, about a 10-percent increase; and 2) the High Tech scenario for salts, an approximately 300-percent increase. Existing conditions assume essentially no detectable herbicides/pesticides in the surface water.

3.0 METHODOLOGY AND APPROACH

The potential impacts of reclaimed water irrigation on surface and shallow zone groundwater were estimated using a water balance approach. This is sometimes referred to as a root-zone model. The water balance approach tracks water entering an agricultural field (rainfall and applied irrigation water) and divides water exiting the field into: 1) runoff, 2) evapotranspiration; and, 3) shallow zone groundwater. Constituents of interest, in this case trace metals, are assumed to move in a dissolved form with the water through the root zone hydrologic system. The model has been simplified since it does not consider metals associated with eroded soil particles, leaching of native soil metals, local surface water storage, deep groundwater percolation and groundwater usage by domestic wells. In addition, the model assumes that for the West County and Tolay Creek area, the shallow zone groundwater (from combined rainfall and irrigation) is entirely discharged after a one to four-month time lag, reflecting slow subflow movement through the soil to the nearby surface stream. During this time period, the metals content of the shallow zone soil-water (the water contained in pores in the soil and shallow aquifer materials from irrigation application) is concentrated somewhat by evapotranspiration losses, with some subsequent attenuation or dampening of this effect by various physical-chemical reactions during movement through the soils. Metals immobilization or retention in the soil occurs as a result of various adsorption, fixation and chemical reactions with organic matter, clay minerals and other naturally occurring substances in the soil (hydroxides, carbonates, sulfides).

For the South County area, surface storage and groundwater usage also are not considered and all applied water (irrigation and rainfall) in excess of evapotranspiration (ET) losses is assumed to percolate and enter the shallow zone groundwater as leachate or percolate where it mixes with existing or resident shallow zone groundwater. This resident groundwater represents recharge from the previous winter through rainfall infiltration. The quantity of the shallow zone groundwater is estimated based on net rainfall amounts entering the soil profile after adjustment for runoff and ET losses. Depending on the concentration of metals in the shallow zone groundwater, this comingling usually dilutes the metals concentrations of the reclaimed water that enters this lower zone as percolate or leachate. Concentrations of metals from deeper groundwater sample analyses were used to calculate the commingling/dilution effect. Over a long period of time (25+ years) and for a shallow aquifer of limited saturated thickness and storage capacity, this percolating water provides a very conservative estimate of the future quality of the irrigation affected aquifer water. In reality, aquifer dilution may be 100-fold or more in South ~~West~~ County aquifers, since the irrigation percolate will constitute less than one percent of the water volume of the aquifer.[1]

[1] The dilution provided by the volume of water in the aquifer is relative to the volume of water contributed by irrigation affected groundwater.

For the West County, it was assumed that the presence of shallow restrictive layers within five to six feet of the surface (clay pans and bedrock) serves to guide and direct the applied surface water through preferential flow paths at the soil-restrictive layer contact, and through permeable zones

2.0 FINDINGS

2.1 BACKGROUND

Americano Creek is about 16 kilometers (km) long and drains a 125 square kilometer (km^2) watershed in which the predominant land use is dairy and dairy pasture. Americano Creek discharges to Estero Americano, a 12 km long tidal embayment extending inland from Bodega Bay. The Estero is relatively narrow (1 meter to 200 meters) and shallow (depth at mean higher high water varies from 0.6 meters to 2.3 meters). Important features of Estero Americano include a sand bar at the mouth that somewhat restricts tidal exchange with the ocean, and a mud flat in the middle reach of the Estero that strongly limits exchange between the upper and lower Estero. Stemple Creek is a larger but otherwise similar watershed located immediately south of the Americano Creek watershed. Estero de San Antonio, the estero associated with Stemple Creek, also has a sand bar at the mouth but has no hydraulic equivalent to the Estero Americano mud flat.

The connection to Bodega Bay controls water quality and water movement in each Estero. Sand can accumulate in the inlet as a result of wind-induced turbulence <u>and littoral sand transport</u> in Bodega Bay. During spring tide conditions, ebb tide flows are typically sufficient to erode the accumulated sand. If sand accumulates during a neap (low amplitude) tide condition, outflow may be insufficient to erode the accumulated sand, and the inlet is blocked. Sand can continue to accumulate, hydraulically isolating the Esteros from Bodega Bay. The sand bar may remain until rainfall runoff accumulates in the Esteros behind the sand bar, and then overtops and quickly cuts through the sand bar. This process occurs most years in the Esteros, but not every year. Alternatively, local landowners report cutting through the sand bar to alleviate flooding of their land. The accumulation of sediment in the Esteros during the past 100 or so years has reduced the volume of tidal water moving between Bodega Bay and the Esteros, which likely results in more frequent bar closure than occurred prior to sediment accumulation. Bar closure is described in a report by the Marin County Resource Conservation District (MCRCD 1994).

Salinity is an important factor that affects the suitability of aquatic habitat for aquatic life. Salinity in the Esteros is influenced by the amount of freshwater inflow from the creeks, the amount of tidal inflow from Bodega Bay, and evaporation. During and after a large rainfall event, freshwater inflow can flush virtually all seawater from the Esteros. As inflow decreases, seawater has increasing dominance on the Estero. During summers when the bar is open and freshwater inflow is negligible, evaporation leads to salinity levels in excess of seawater (hypersalinity). During summers when the bar is closed, salinity is determined by salinity at the time of bar closure, any continued inflow, and evaporation. Freshwater inflow can float on top of seawater, and if the bar closes during a period of stratification, wind mixing of the two layers is also a factor controlling salinity. Hypersaline conditions were observed only during bar-open conditions. Under bar-closed conditions hyper saline conditions were not observed probably because fresh water was present when the bar closed and was retained in, rather than flushed from the Esteros by

3.0 CONCLUSIONS

The two esteros show many biological similarities, but they differ physically. Each consists of a downstream estuary-like section with eelgrass beds, and a narrow upper section with riverine properties. The downstream section in Estero Americano is much larger, and provides far more habitat for marine species when the bar is open. In contrast, the downstream section in Estero de San Antonio is very small, and most of the estero (including all of the part sampled regularly in 1989-1990) is narrow and riverine.

Both esteros were allowed to open and close "naturally" in the 1970's, and data gathered then indicate few differences in the biology of the systems between that time and the 1988-1990 period. During the later period, Estero Americano was artificially kept open, and biological sampling made near the mouth showed greater faunal diversity in the marine-influenced sections. Keeping the bar open also increases the likelihood of the occurrence of hypersaline conditions in the upper part of the tidal system. Estero de San Antonio was not kept open during this period. The stations sampled there did not differ much biologically between bar-open and bar-closed dates, but areas near the mouth (where tidal exchange would occur) were not sampled.

The current management of the Gulf of the Farallones National Marine Sanctuary is not to issue any permits to keep the bar open artificially. Therefore, the bar is likely to be closed during some times in the future. <u>The data at hand provide an indication of the distribution of biota in Estero Americano when the bar is closed. –No observations on Estero Americano were made under bar-closed conditions during the present study, but some speculations about how the estero might be expected to respond to bar closure may be made based on bar-closed observations in Estero de San Antonio.</u> Observations made in 1989-1990 in Estero de San Antonio would suggest that the upper riverine parts of Estero Americano will be less saline but probably not be much different biologically, since the dominant species in the upper parts are euryhaline. When the Estero Americano bar is closed, biota in the lower Estero will be similar to that in the upper Estero. Changes in the biota of the lower part of Estero Americano during bar-closed conditions will probably be related both to lowered salinity and lack of recruitment from coastal populations. Both of these factors can be expected to reduce, at least temporarily, the diversity of the biota there.

5.0 SUMMARY OF LAGUNA, SANTA ROSA CREEK, AND MARK WEST CREEK WATER QUALITY DATA

This section summarizes water quality data from the Laguna, Santa Rosa Creek, and Mark West Creek including the data described above and data from other sources including the NCRWQCB and the City of Santa Rosa Reclamation Staff.

5.1 Sources of Recent Data

5.1.1 Chemical Data

The Long-Term EIR/S Project Team conducted a Laguna water quality monitoring program which gathered data from seven Laguna stations and one Santa Rosa Creek station beginning in October 1990 and continuing through February 1995 (one Mark West Creek station was included from July 1992 through March 1994). On seven sampling dates each year, data were collected on nutrients (nitrate, total and un-ionized ammonia, total and dissolved phosphate) and other water quality constituents, including conductivity, DO, pH, turbidity, chlorophyll, phaeophytin, TDS, TOC, and DOC. These data were reported in annual technical memoranda (Roth and Smith, 1992, 1993, 1994; Reclamation Staff, 1995), and are tabulated in Appendix 2.

The NCRWQCB has also monitored water quality in the Laguna and its tributaries, and data supplied by them has been included in Appendices 3 and 4. Appendix 3-1 contains a suite of nutrients and other constituents comparable to those reported by the project team, collected between October 1989 and January 1992, with approximately weekly samples between January and June 1990. Appendix 3-2 contains phytoplankton and chlorophyll *a* data collected on some of the same dates in 1989 and 1990. The NCRWQCB conducted five dissolved oxygen diel studies in 1994 and 1995. These data are presented in Figures 2 and 6.

Metals, organic chemicals, nutrients, and other constituents were sampled by the NCRWQCB on four dates in 1985 and once in January of 1986 and 1992. These data are presented in Appendices 4-1 (Laguna stations), 4-2 (Santa Rosa Creek), and 4-3 (Mark West Creek).

The only detectable organic compound in the Laguna de Santa Rosa or its tributaries was gamma BHC (Lindane), which was found at a concentration of 1.1 µg/L on one occasion in Santa Rosa Creek at Stony Point Road.

5.1.2 Biological Data

Both wet- and dry-weather receiving water toxicity testing (EPA 3-species short-term sensitive life stage toxicity tests) has been done on water from the Laguna de Santa Rosa and Santa Rosa Creek. Water collected from the Laguna near Guerneville Road (i.e.

immediately below the confluence of the Laguna and Santa Rosa Creek) was tested in 1992 (Merritt Smith 1992). Santa Rosa Creek toxicity tests were done in 1994 (Merritt Smith 1994).

Algal Growth Potential (AGP) tests have been made on water collected at 3 Laguna and 1 Santa Rosa Creek station as part of the study team Laguna water quality monitoring program described above.

5.2 LAGUNA DE SANTA ROSA

Nutrients and other constituents in the Laguna are summarized in Table 6. These are listed by season for stations above the confluence with Santa Rosa Creek (Stony Point Road, Llano Road, Todd Road, Highway 12, Occidental Road, and directly above the confluence with Santa Rosa Creek) and below the confluence with Santa Rosa Creek (Guerneville Road, River Road, and Trenton-Healdsburg Road). For the purposes of this report, seasons are defined as: Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; and Fall = September, October, and November.

Nutrients are frequently depleted in Laguna water in summer, as was the case in July and August 1995 (see Table 5). However, the longer-term averages in Table 6 show that nutrients are not always depleted. The relationship between nutrient availability and algal growth potential is discussed below.

The results of the five diel dissolved oxygen studies are presented in Figures 2 through 6. During May 18 through 23, 1994 (Figure 2), dissolved oxygen concentrations in the Laguna at Trenton Healdsburg Road ranged from 5.3 mg/L to 7.3 mg/L. The Basin Plan dissolved oxygen instantaneous minimum for the Laguna of 7.0 mg/L was not attained during each night of the study.

Dissolved oxygen in the Laguna at Trenton Healdsburg Road in September 14 through 23, 1994 ranged from 4.5 mg/L to 7.0 mg/L (Figure 3). The Basin Plan minimum concentration is 7.0 mg/L.

Dissolved oxygen was measured at three locations in the Laguna during the March 3 through 8, 1995 diel: at Trenton Healdsburg Road and Occidental Road which are below Santa Rosa's discharge to the Laguna, and at Stony Point Road which is above Santa Rosa's discharge to the Laguna (Figure 4). Dissolved oxygen concentrations at Occidental and Stony Point were similar, ranging from 2.4 to 6.4 mg/L at Occidental Road and 2.9 to 6.9 mg/L at Stony Point Road. During this study dissolved oxygen in the Laguna at Occidental and Stony Point roads never exceeded the Basin Plan minimum of 7.0 mg/L. The similarity between the two locations indicates that dissolved oxygen is controlled by factors other than Santa Rosa's discharge, possibly runoff from nearby dairies. During this same time period, dissolved oxygen in the Laguna at Trenton

Healdsburg Road ranged from 6.4 to 8.5 mg/L. Dissolved oxygen fell below the Basin Plan minimum during most nights of this study.

Dissolved oxygen levels measured in the Laguna at Trenton Healdsburg Road, Occidental Road, and Stony Point Road during April 26 through May 8, 1995 were variable both on a daily basis and throughout the study (Figure 5). Dissolved oxygen in the Laguna at Trenton Healdsburg was the probably the least variable, but still ranged from 3.8 to 8.8 mg/L. Dissolved oxygen in the Laguna at Occidental Road was the most variable, ranging from 1.5 to 17.3 mg/L. Dissolved oxygen in the Laguna at Stony Point Road ranged from 2.5 to 7.1 mg/L. The dissolved oxygen concentrations at all three stations were frequently below the Basin Plan minimum.

Dissolved oxygen concentration in the Laguna at Occidental Road and Stony Point Road during the August 21 through 28 study were quite variable on a diel basis but fairly consistent throughout the study (Figure 6). Dissolved concentrations at these stations ranged from 2.4 to 8.5 mg/L at Occidental Road and 3.4 to 8.7 mg/L at Stony Point Road. Dissolved oxygen in the Laguna at Trenton Healdsburg Road (Figure 6) during this time period showed less diel variation and ranged from 4.1 to 7.5 mg/L. Dissolved oxygen at all three stations fell below the Basin Plan minimum during the night.

Table 6.

Average Water Quality in the Laguna de Santa Rosa

	Above Santa Rosa Creek				**Below Santa Rosa Creek**			
	Winter	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Conductivity (µmhos/cm)	565	670	733	634	328	417	598	534
Turbidity (FTU)	20.2	27.4	28.9	24.5	8.8	22.1	21. 8	5.7
Dissolved oxygen (mg/L)	7.5	8.3	7.1	6.8	9.1	7.3	6.1	6.5
Nitrate (mg-N/L)	4.23	1.60	0.25	0.52	1.95	0.95	1.06	0.59
Ammonia (mg-N/L)	1.72	1.49	0.24	0.24	0.28	0.08	0.12	0.12
TKN (mg /L)	2.62	5.13	2.27	2.05	no data	no data	1.07	no data
Dissolved orthophosphate (mg-P/L)	1.47	1.48	1.13	0.74	0.93	0.63	0.41	0.21
Chlorophyll *a* (mg/L)	0.042	0.096	0.232	0.059	0.013	0.048	0.055	0.006

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 2. Dissolved Oxygen in the Laguna de Santa Rosa at Trenton Healdsburg Road
May 18-23 1994

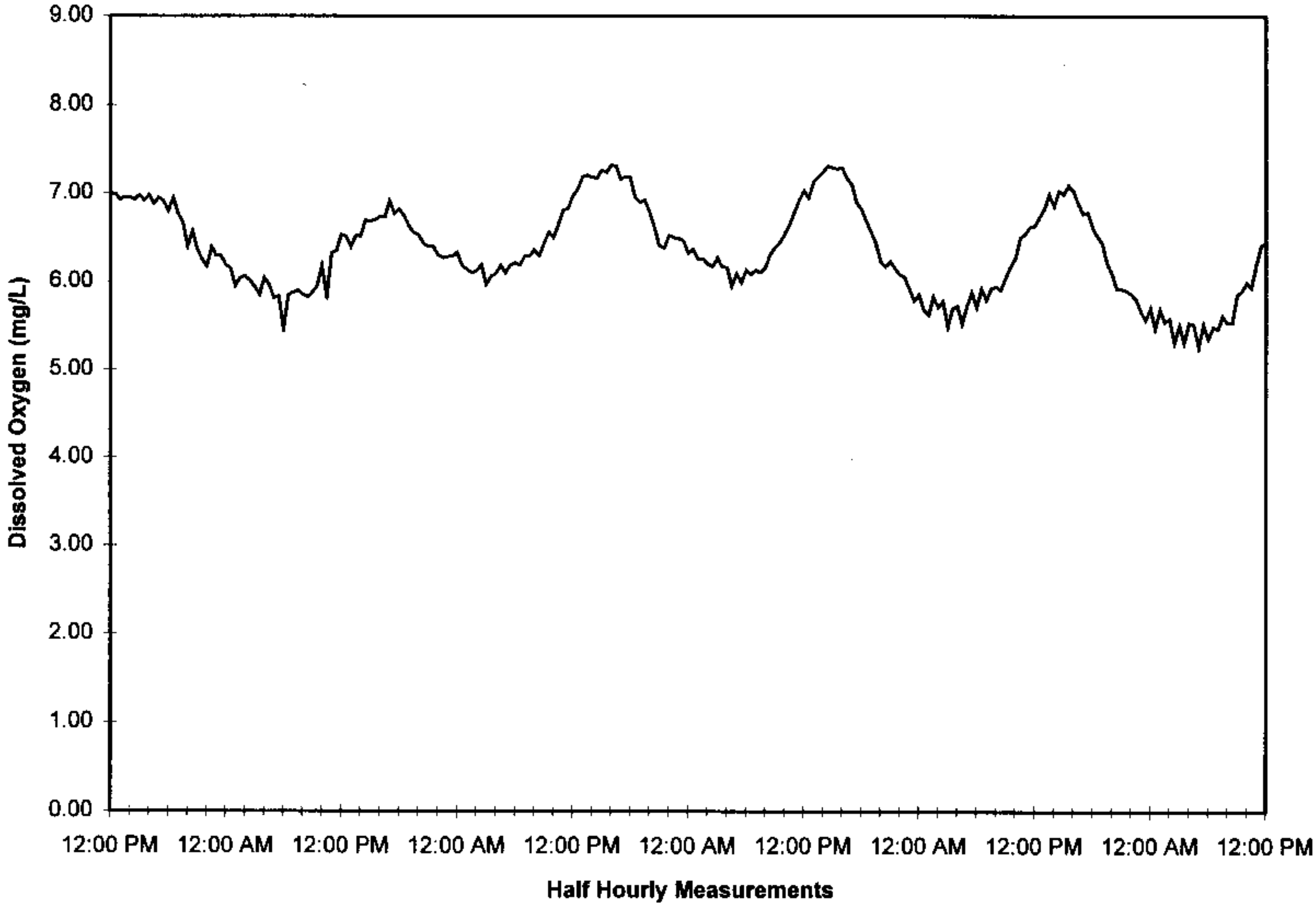


Figure 3. Dissolved Oxygen in the Laguna de Santa Rosa at Trenton-Healdsburg September 14-23 1994

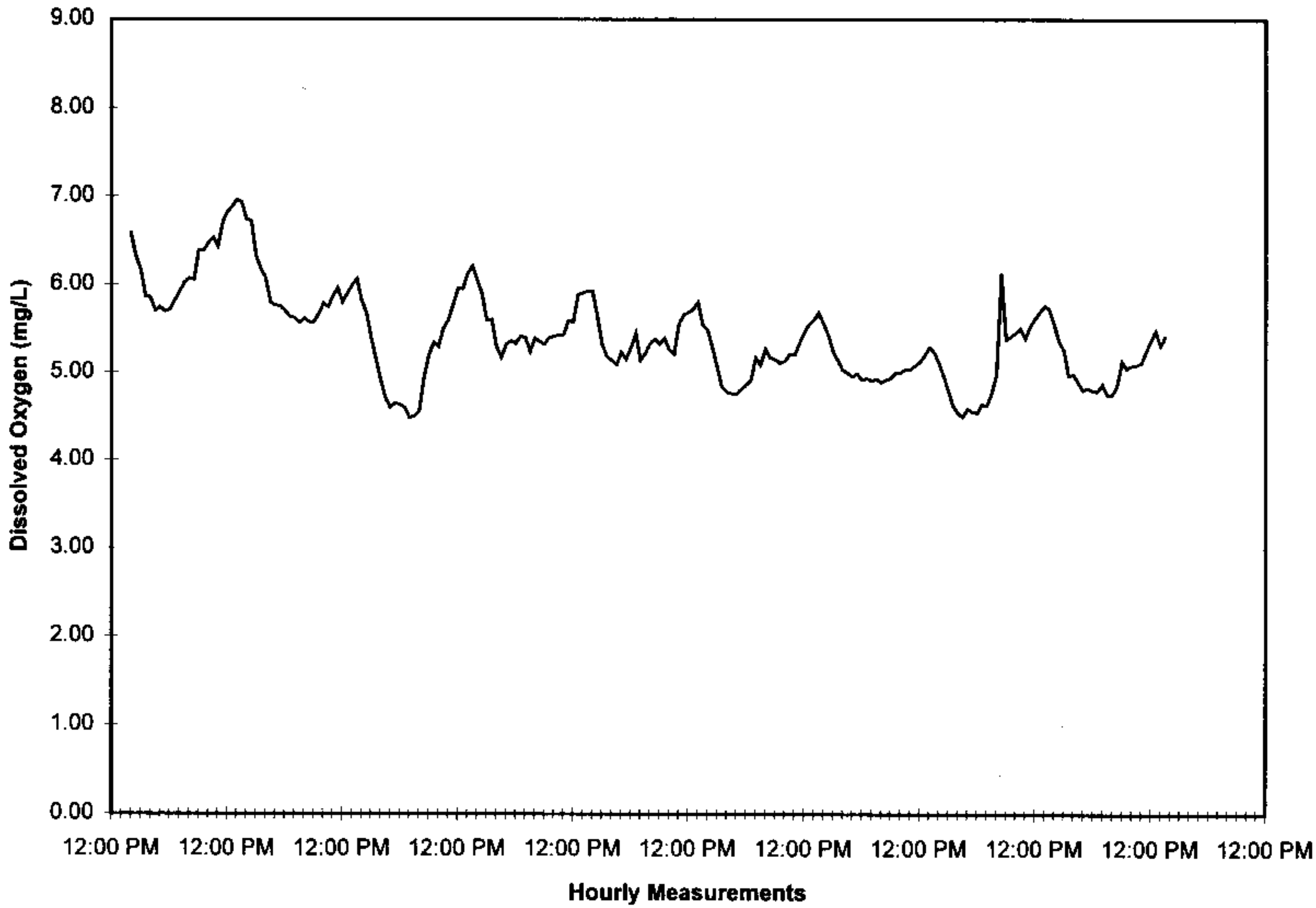


Figure 4. Dissolved Oxygen in the Laguna de Santa Rosa
March 3-8 1995

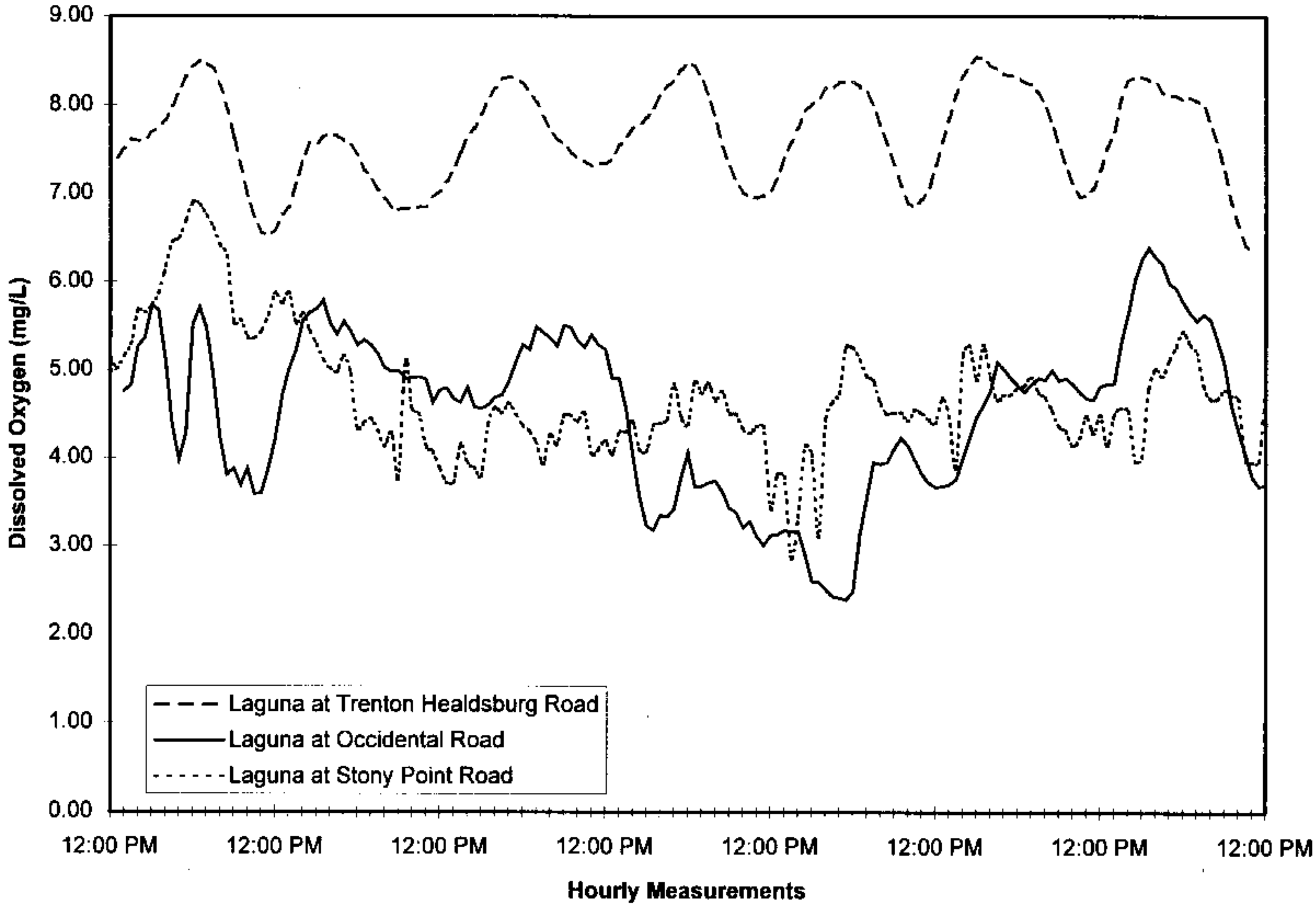


Figure 5. Dissolved Oxygen in the Laguna de Santa Rosa April 26 - May 8 1995

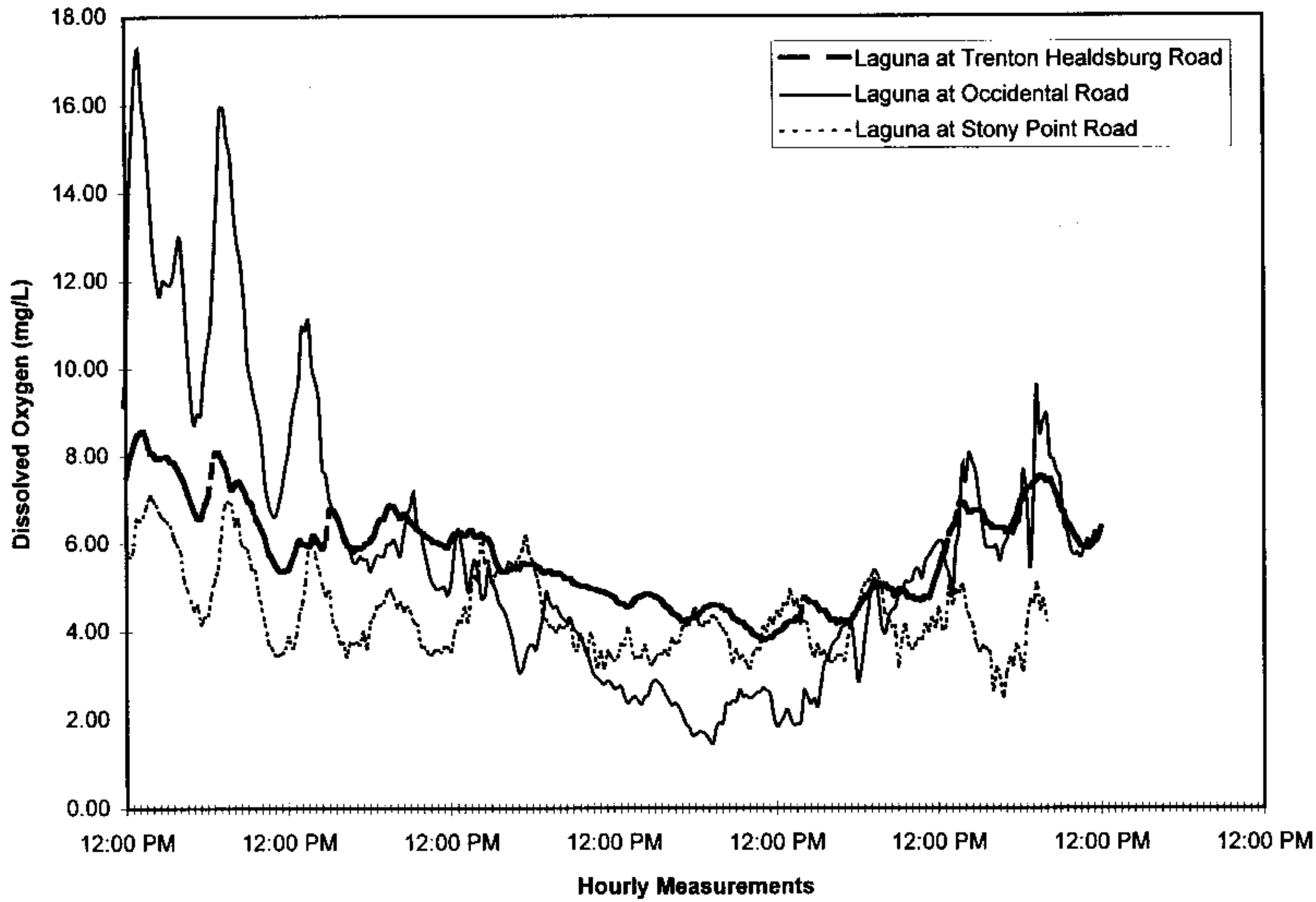
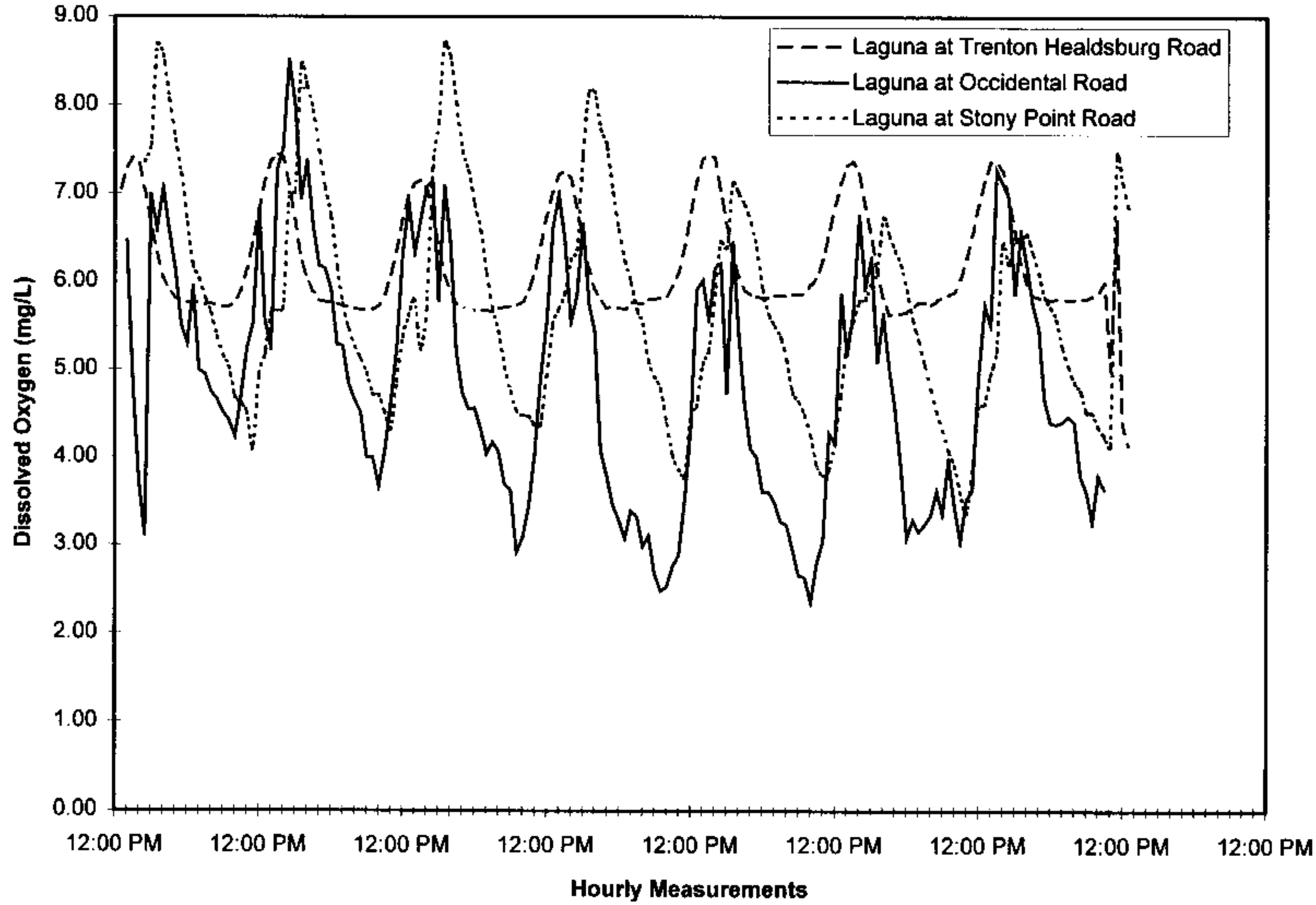


**Figure 6. Dissolved Oxygen in the Laguna de Santa Rosa
August 21 - 28 1995**



INTRODUCTION

PURPOSE

The purpose of this report is to characterize the aquatic plant biomass in the Russian River. Biomass data collected in the River will serve as a basis for describing existing conditions and provide input to a water quality model developed to evaluate alternatives for the Santa Rosa Long-Term Wastewater Project (the Project). This report summarizes summer conditions of biomass in the River over two years to provide baseline data for the model. Aquatic plant biomass in the Russian River is primarily influenced by the level of nutrients and other conditions (e.g., light, flow, etc.) in the water and substrate of the River. Plant biomass data, as it relates to the level of nutrients in the River, will allow for the modeling of impacts of nutrient additions to the River from the project alternatives.

The data in this report are summarized for locations above and below the Laguna de Santa Rosa (Laguna) to facilitate evaluation of discharge of reclaimed water from the City of Santa Rosa. However, comparisons of data above versus below the Laguna have not been made because of the many physical differences (not addressed in this report) between those sections of the River that impact plant growth. The complete data which are summarized in this report are included in Appendices 1-3.

STUDY AREA

The Russian River (110 river miles) drains an area of nearly 1,500 square miles from its headwaters upstream of Ukiah, to its mouth at the Pacific Ocean. Large creek systems that flow from steep, mountainous land comprise the watershed of the River. These creeks drain to the flat, alluvial valleys of the upper and middle River, and to the lower canyon beginning at Wohler Bridge. The River reaches tidewater near Duncans Mills (river mile 7) and enters the ocean at Jenner (river mile 0)(Marcus 1992).

The study area for the Project begins in the River downstream of Healdsburg and upstream of the Sonoma County water collectors and Wohler Bridge (see Figure 1). Dry Creek, a large tributary that drains Lake Sonoma, flows into the River just below Healdsburg. Lake Sonoma serves as a water-supply and flood-control reservoir. Flow from the lake is regulated by Warm Springs Dam. Water releases in the summer and restrictions in the winter modify the hydrology of the River. Downstream movement of sediment in the River is greatly reduced by the reservoir (Florsheim 1993).

Other impacts to the River include treated wastewater discharges from the cities of Healdsburg, Santa Rosa, and others (the winter discharge from Santa Rosa flows from the Laguna de Santa Rosa into the River at Mirabel), gravel mining, summer check dams, water diversions, septic systems discharges, flooding, and urban and agricultural runoff. Vineyards and gravel operations line the banks of the River just downstream of

Healdsburg and more vineyards bound the River near Oddfellows Park. Gravel skimming operations occur at numerous gravel bars in the River bed (Teytaud 1994). Cattle are

APPENDICES

Appendix 1

Biomass of Attached Algae in the Russian River

Sampling Location*	River Feet	Sampling Date	Sampling Device	Sample Vol (ml)	Chlor *a* (mg/L)	Chlor *a* (mg/m^2)	Substrate Type**
Jenner	9500	9-Jun-94	quadrat	450	0.2	1.0	cobble
Hwy 1	14000	9-Jun-94	ponar	895	0.2	8.1	coarse sand
Farm/beach	22500	25-May-94	quadrat	755	2.2	17.9	cobble
Casini Ranch	39000	25-May-94	quadrat	555	2.7	16.1	cobble
A-frame	48000	26-May-94	ponar	905	0.5	20.8	gravel/cobble
Monte Rio	54500	26-May-94	quadrat	750	5.2	42.0	cobble
Johnsons Beach	80500	26-May-94	ponar	550	0.0	0.5	gravel/sand
Oddfellows	97500	26-May-94	quadrat	880	1.3	12.3	cobble
Burkes	123000	26-May-94	quadrat	940	5.9	59.7	cobble
Alder Rock	142000	7-Jun-94	quadrat	540	0.4	2.2	cobble
Alder Rock	142000	7-Jun-94	ponar	660	0.5	15.1	sand
Kaiser shore	149000	7-Jun-94	quadrat	350	0.4	1.5	gravel
Kaiser pool	149000	7-Jun-94	ponar	700	0.5	16.1	sand
Oddfellows	97500	9-Jun-94	quadrat	510	2.7	14.8	cobble
Jenner	9500	19-Jul-94	quadrat	670	0.2	1.4	cobble
Hwy 1	14000	20-Jul-94	ponar	900	2.6	101.3	sand
Farm/beach	22500	20-Jul-94	quadrat	810	6.7	58.4	cobble
Casini Ranch	39000	19-Jul-94	quadrat	710	1.6	12.2	cobble
A-frame	48000	19-Jul-94	ponar	880	0.6	21.3	gravel
Monte Rio	54500	19-Jul-94	quadrat	970	8.2	85.6	cobble
Johnsons Beach	80500	20-Jul-94	ponar	660	0.5	15.1	sand/gravel
rep2	80500	20-Jul-94	ponar	670	1.0	27.8	sand/gravel
rep3	80500	20-Jul-94	ponar	870	0.2	6.0	gravel
Oddfellows	97500	19-Jul-94	quadrat	1000	1.5	16.1	cobble
rep2	97500	20-Jul-94	ponar	1000	0.2	7.8	gravel/sand

Appendix 1

Biomass of Attached Algae in the Russian River

Sampling Location*	River Feet	Sampling Date	Sampling Device	Sample Vol (ml)	Chlor *a* (mg/L)	Chlor *a* (mg/m^2)	Substrate Type**
rep3	97500	20-Jul-94	quadrat	560	2.4	14.5	cobble
Burkes	123000	20-Jul-94	quadrat	640	0.9	6.3	cobble
Vineyard pump	133000	19-Jul-94	ponar	980	3.7	157.0	gravel
Alder Rock	142000	19-Jul-94	quadrat	720	0.3	2.2	cobble
Kaiser shore	149000	19-Jul-94	quadrat	780	0.2	1.7	gravel
Kaiser pool	149000	19-Jul-94	ponar	800	0.5	16.6	sand
Jenner	9500	13-Sep-94	quadrat	995	0.5	5.5	cobble
Hwy 1	14000	13-Sep-94	ponar	980	0.2	8.1	sand
Farm/beach	22500	13-Sep-94	quadrat	360	0.7	2.6	cobble
Casini Ranch	39000	13-Sep-94	quadrat	530	1.4	8.0	cobble
A-frame	48000	16-Sep-94	ponar	970	0.1	2.9	gravel
Monte Rio	54500	15-Sep-94	quadrat	690	4.0	29.7	cobble
Johnsons Beach	80500	15-Sep-94	ponar	550	0.8	17.9	sand/gravel
rep2	80500	15-Sep-94	ponar	590	0.1	3.1	sand/gravel
rep3	80500	15-Sep-94	ponar	730	0.4	11.1	gravel
Oddfellows	97500	15-Sep-94	quadrat	970	1.7	17.8	cobble
rep2	97500	15-Sep-94	quadrat	640	2.2	15.2	cobble
Burkes	123000	12-Sep-94	quadrat	885	2.4	22.9	cobble
Vineyard pump	133000	12-Sep-94	ponar	880	2.0	76.2	gravel
Alder Rock	142000	12-Sep-94	quadrat	680	0.6	4.7	cobble
Kaiser shore	149000	12-Sep-94	quadrat	720	0.2	1.7	gravel
Kaiser pool	149000	12-Sep-94	ponar	830	0.3	10.4	sand
Jenner	9500	11-May-95	quadrat	815	0.4	3.3	cobble
Casini Ranch	39000	10-May-95	quadrat	610	0.3	2.1	gravel/sand
Monte Rio	54500	10-May-95	quadrat	445	0.0	0.1	cobble/gravel
Oddfellows	97500	10-May-95	ponar	850	0.0	0.7	sand
Vineyard pump	133000	10-May-95	ponar	790	0.0	0.2	sand/gravel/cobble

Appendix 1

Biomass of Attached Algae in the Russian River

Sampling Location*	River Feet	Sampling Date	Sampling Device	Sample Vol (ml)	Chlor *a* (mg/L)	Chlor *a* (mg/m^2)	Substrate Type**
Kaiser shore	149000	10-May-95	ponar	840	0.0	0.2	sand/gravel
Jenner	9500	6-Jul-95	quadrat	700	1.3	9.8	cobble
Hwy 1	14000	6-Jul-95	ponar	1030	0.4	18.3	sand/silt
Farm/beach	22500	6-Jul-95	quadrat	640	1.4	9.6	gravel/sand
Casini Ranch	39000	6-Jul-95	quadrat	655	2.6	18.3	cobble
A-frame	48000	6-Jul-95	ponar	955	0.2	8.3	gravel
Monte Rio	54500	6-Jul-95	quadrat	440	2.1	9.9	cobble
Johnsons Beach	80500	6-Jul-95	ponar	1040	0.2	9.5	gravel
Oddfellows	97500	6-Jul-95	quadrat	880	0.6	5.8	cobble
Burkes	123000	6-Jul-95	quadrat	970	1.0	10.4	cobble/gravel
Vineyard pump	133000	5-Jul-95	ponar	2140	0.1	4.6	sand/gravel
rep 2	133000	5-Jul-95	quadrat	250	0.9	2.4	gravel/sand
Alder Rock	142000	5-Jul-95	quadrat	330	1.4	5.0	cobble/gravel/sand
rep2	142000	5-Jul-95	ponar	1420	3.1	190.6	sand/gravel
Kaiser shore	149000	5-Jul-95	quadrat	470	1.3	6.6	cobble/gravel/sand
Kaiser pool	149000	5-Jul-95	ponar	985	0.5	20.5	sand
Jenner	9500	9-Aug-95	quadrat	745	6.1	48.9	cobble
Hwy 1	14000	9-Aug-95	quadrat	240	3.1	8.0	cobble
Farm/beach	22500	9-Aug-95	ponar	730	1.1	34.8	sand/gravel/cobble
Casini Ranch	39000	9-Aug-95	quadrat	455	5.2	25.5	cobble
A-frame	48000	9-Aug-95	ponar	1020	0.3	14.1	sand/gravel
Monte Rio	54500	9-Aug-95	quadrat	390	0.8	3.4	cobble
Johnsons Beach	80500	10-Aug-95	ponar	930	0.4	14.5	sand/gravel
rep2	80500	10-Aug-95	ponar	820	0.4	14.6	sand/gravel
rep3	80500	10-Aug-95	ponar	940	0.3	12.2	silt/sand
Oddfellows	97500	10-Aug-95	quadrat	530	1.2	6.8	gravel/sand
rep2	97500	10-Aug-95	ponar	790	0.7	24.3	sand

Appendix 1

Biomass of Attached Algae in the Russian River

Sampling Location*	River Feet	Sampling Date	Sampling Device	Sample Vol (ml)	Chlor *a* (mg/L)	Chlor *a* (mg/m^2)	Substrate Type**
rep3	97500	10-Aug-95	ponar	1100	0.6	26.2	sand
Burkes	123000	10-Aug-95	quadrat	780	1.4	11.8	gravel/sand
Vineyard pump	133000	10-Aug-95	ponar	1030	0.3	13.4	sand/gravel
Alder Rock	142000	10-Aug-95	quadrat	790	0.5	4.5	cobble
rep2	142000	10-Aug-95	ponar	850	0.4	12.9	sand
Kaiser shore	149000	10-Aug-95	quadrat	770	0.2	2.0	gravel
Kaiser pool	149000	10-Aug-95	ponar	805	0.3	11.2	sand

* Replicates were collected at various locations to represent cross-sections of the river. These replicates appear as averages in the table for similar substrates.

** Substrate was defined for sampling locations as "sand" if only sand, as "gravel" if any gravel-sized rocks (<1-inch diameter) occurred with sand, and "cobble" if any cobble-sized rocks (>1-inch diameter) occurred with sand or gravel.

Appendix 2

Biomass of Submergent Macrophytes in the Russian River

Location	River Feet	Date	River Width (ft)	% Cover (percent)	Height (ft)	Wet Weight (g/m^2)
Hwy 1 Bridge	14000	9-Jun-94	280	1	0.33	no sample*
Farm/beach	22500	9-Jun-94	260	0.5		no sample*
Houses	25000	9-Jun-94	282	32		2480
rep 2	25000	9-Jun-94	282	32		2480
rep 3	25000	9-Jun-94	282	32		4400
Casini Ranch	39000	9-Jun-94	205	0		no sample*
Bridge Road	45500	9-Jun-94	310	16	3.5	3680
rep 2	45500	9-Jun-94	310	16	4	6480
Monte Rio	52000	9-Jun-94	195	9	1	2640
Hwy 1 Bridge	14000	13-Sep-94	360	16	various	2880
Farm/beach	22500	13-Sep-94	260	12	1	440
Houses	25000	13-Sep-94	280	16		4000
Casini Ranch	39000	13-Sep-94	200	50		no sample*
Bridge Road	45500	13-Sep-94	165	50		no sample*
Monte Rio	52000	13-Sep-94	195	51		3560
Guerneville	80500	16-Sep-94	160	11		2160
Oddfellows	94500	15-Sep-94	78	12		2520
Kaiser beach	149000	15-Sep-94	100	0		no sample*
Vineyard pump	183000	15-Sep-94	150	40		1160
Hwy 1 Bridge	14000	9-Aug-95	360	50	15	no sample*

June 9, 1994 sampling: no submerged macrophytes observed Monte Rio to Burkes.

September 13-16, 1994 sampling: few submerged macrophytes above Monte Rio.

May 8-11, 1995 sampling: no submerged macrophytes observed.

July 5-6, 1995 sampling: no submergents observed.

August 9-11, 1995 sampling: no submergents upstream of Hwy 1 bridge.

* samples not collected when biomass to low and/or filamentous algae too fine to collect

Appendix 3

Biomass of Emergent Macrophytes in the Russian River

		Relative to Laguna	Area of Emergents (sq ft)	
River section	**River feet**		**Jun-94**	**Sep-94**
Emergent Macrophytes - Russian River 1994				
Kaiser Beach to Alder Rock	149000-141000	above	2044	4495
Alder Rock to Vineyard Pump	141000-133000	above	210	1980
Vineyard Pump to Burkes	133000-123000	above	5738	9690
Burkes to Hacienda Bridge	123000-112000	below	2178	3075
Hacienda Bridge to Oddfellows	112000-98000	below	2778	9814
Oddfellows to Guerneville Bridge	98000-80000	below	1975	5548
Guerneville Bridge to Monte Rio Bridge	80000-54000	below	4330	11639
Monte Rio Bridge to Casini Ranch	54000-39000	below	22.5	172
Casini Ranch to Jenner	39000-0	below	0	0
Emergent Macrophytes - Russian River 1995				
Kaiser Beach to Alder Rock	149000-141000	above	3315	
Alder Rock to Vineyard Pump	141000-133000	above	3003	
Vineyard Pump to Burkes	133000-123000	above	3265	
Burkes to Hacienda Bridge	123000-112000	below	2872	
Hacienda Bridge to Oddfellows	112000-98000	below	3623	
Oddfellows to Guerneville Bridge	98000-80000	below	5202	
Guerneville Bridge to Monte Rio Bridge	80000-54000	below	7973	
Monte Rio Bridge to Casini Ranch	54000-39000	below	378	
Casini Ranch to Jenner	39000-0	below	0	

May 8-11, 1995 sampling: no emergents observed

July 5-6, 1995 sampling: no emergents observed

August 9-11, 1995 survey: vegetation all primrose with exception of 80 sq ft of *Scirpus*-like grass

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where P_f = preference, varying from 0 to 1, for ammonia over nitrate if concentrations of both are equal and N_3 = nitrate-nitrogen concentration (mg N L^{-1}). The value for p_{nh3} will also vary from 0 to 1. The preference for ammonia is derived from the concept that less energy is required for utilization of ammonia, than for nitrate, in cell synthesis.

2.3.4-3 Nitrate

Nitrate is also taken up by benthic algae during growth in relation to the preference for ammonia described above. Hence, the greater preference for ammonia, the less preference for nitrate. The uptake by benthic algae is given by the following relation.

$$\frac{dN_3}{dt} = \beta_2\left(1 - p_{nh3}\right)\mu_{ba}\,\frac{B}{z}$$

2.3.4-4 Dissolved Phosphorus

Similar to ammonia, dissolved phosphorus is produced by decay of organic sediments and taken up by benthic algae. The rate of both processes depends on the proportion of phosphorus in each constituent. The following relation describes these processes.

$$\frac{dP_1}{dt} = -\gamma_1 k_{osd} S_{os} \theta_1^{(T-20)} + \gamma_2 \mu_{ba}\,\frac{B}{z}$$

where P_1 = dissolved phosphorus content in the water column (mg P L^{-1}), γ_1 = proportion of phosphorus in organic sediment (gm P/gm Organic Sediment), and γ_2 = proportion of P in benthic algae (gm P/gm Benthic Algae).

2.3.5 Estimate of Agricultural Inputs

The simulated agricultural load included total nitrogen, ammonia nitrogen, BOD, and organic solids. Phosphates of dairy origin have not been included in the dairy analysis by MSC since phosphates are not a limiting nutrient during periods of dairy runoff. The total nitrogen load estimate was adjusted for the ammonia and the nitrogen component of organic solids.

i.e., Organic N = total N - NH_3 - N - [N_s *x* Organic solids]

where N_s is the nitrogen fraction of organic solids

Each of these parameters were input to the model by allocating the dairy loads to the background concentration of the appropriate local tributaries. The incremented tributary inflows were modeled just like any other input. The timing and magnitude of the dairy load was based on the assumption that:

1. the potential load would be the greatest at the beginning of the runoff season (due to accumulation over the summer months) and

2. the rate at which the material of dairy origin would wash-off the watershed more rapidly as the runoff rate increased.

The time dependent adjustment was:

$$F_t = (1 - 0.01 \, x \, d_{40})^2$$

where d_{40} was the number of days during the season when the runoff to the Laguna (excluding Santa Rosa and Mark West creeks) exceeded 40 cfs

The flow dependent adjustment was:

$$F_q = (q - 40)^{1.1}$$

where q was the total runoff to the Laguna (excluding Santa Rosa and Mark West creeks)

These factors were normalized as the fraction of the total load for each day when q exceeded 40 cfs. The inflow concentration was adjusted on a daily basis by:

$$C = C_0 + M \, x \, F_{tq} \, x \, R/Q$$

where;

C_o = inflow quality without dairy load

M = total seasonal dairy load

F_{tq} = normalized product of F_t and F_q

R = fraction of total load allocated to a particular tributary (based on limits of the watershed.

Q = flow rate

2.4 MODEL CONFIGURATION

Developing the model configuration for the Laguna - lower Russian River system involves describing the channel geometry and identifying locations of point inflows and withdrawals. The geometric description for the system was based on those developed for the 1990 Laguna model (Smith 1991) and the 1991 UCD Russian River model (UCD 1991). A schematic representation of the final model is shown in Figure 2.3.

A consistent set of assumptions was used in developing the hydrology for both the calibration and alternative analysis periods so that the calibration results would be indicative of the accuracy of the alternatives analysis. Both the observed data and the operations model output include the Russian River flow at Healdsburg, the Warm Springs Dam release, the SCWA withdrawal and the Russian River flow at Hacienda Bridge. By flow mass balance, the total incremental inflow to the Russian River system between Healdsburg and Hacienda Bridge can be computed. For the purposes of this study, the incremental inflow is defined as the total inflow to the Russian River between Healdsburg and Guerneville.

i.e., $Q_i = Q_{hb} + Q_{scwa} - Q_h - Q_{ws} - Q_{rw}$

~~$Q_i = Q_h + Q_{ws} - Q_{hb} - Q_{scwa} - Q_{rw}$~~

Where: Qi = incremental inflow

Q_h = Russian River flow at Healdsburg

Q_{ws} = Warm Springs Dam release to Dry Creek

Q_{hb} = Russian River flow at Guerneville (Hacienda Bridge)

Q_{rw} = Total reclaimed water discharge

Q_{scwa} = Sonoma County Water Agency withdrawal

For the calibration period, the recorded Laguna Plant and Delta Pond reclaimed water discharges were included in the mass balance. For the alternative analyses the reclaimed water discharge was not considered in the mass balance. A description of how the reclaimed water discharges are accounted for in the alternatives analysis is included in Section 4.3.

The total daily incremental inflow was apportioned to the individual tributaries and headwater inflow shown on Figure 2.3. The flow apportionment was based on the following:

- Stream flow measurements by MSC
- Dry Creek flow measurements for the gauge near Cloverdale
- Average annual rainfall as represented by the SCWA rainfall distribution map
- Estimates of annual infiltration based on watershed characteristics

The resulting fractions allocated to each tributary are listed in Table 2.1 and were used to allocate flow for both the calibration and alternative evaluations. The sum of the percentages for the first 12 tributaries (i.e., those above Guerneville) totals to 100 percent. The tributaries below Guerneville were not considered in the computation of the incremental inflow originating from the area between the two Russian River gauges. The inflows for the tributaries below Guerneville was determined as a function of drainage area, mean annual rainfall and infiltration assuming that unit runoff factors computed from the incremental inflow also apply to the tributaries below Guerneville.

matter, oxidation of nutrients, and respiration of algae remove D.O. from the water column and can lead to very low D.O. concentrations. Photosynthesis associated with algal growth increases the concentration of D.O. in the water column and can lead to super-saturation (concentrations of D.O. above the oxygen saturation concentration).

D.O. concentrations will vary over the diurnal cycle due to the changes in water temperature caused by warming during the day and cooling at night. In addition, the daily cycle of algal growth and respiration can lead to very large diurnal fluctuations in D.O. concentrations. This is particularly evident in the Laguna where reaeration is limited because of very low velocities during low flow periods. The seasonal variation in diurnal range is clearly seen in the time histories of D.O. at the four monitoring sites (Appendix Figures 3.20 - 3.23). During the high flow, winter periods there is very little diurnal temperature variation and low biological activity, thus there is virtually no diurnal variation in D.O. concentration. In the warmer, low flow period there are larger daily temperature fluctuations and significant biological activity leading to large diurnal variations in D.O.

At Occidental Road (Appendix Figure 3.20) the observed D.O. concentrations vary from nearly zero to over 17 mg/l (well above the oxygen saturation concentration). The observed diurnal range during the warmer low flow period varies from 2.7 to over 8 mg/l. Simulated D.O. concentrations show similar variation. The simulated D.O. concentrations vary from less than 1 mg/l to nearly 20 mg/l during the spring algae bloom. The diurnal range of the simulated concentrations during the warmer low flow periods is from 2 to 15 mg/l. At Trenton-Healdsburg Road, (Appendix Figure 3.21) neither the computed nor the observed D.O. concentrations vary as widely as at Occidental Road. The model over-estimates the D.O. concentration on the average of 2 mg/l, however the simulated and observed diurnal ranges are comparable, typically 2 mg/l during the warmer low flow periods.

The Laguna is a highly eutrophic environment which exhibits large variations in dissolved oxygen concentrations. Biological activity, particularly during warm weather, may rapidly deplete oxygen through decay and respiration or increase oxygen through photosynthesis. During periods of low wind velocity, low aeration rates allow larger departures from saturation. Eutrophic conditions persist in many of the tributaries to the modeled stream reaches so tributary loadings may also be quite variable. The variable nature of wind and loadings cannot be precisely described as boundary conditions. ~~The large variations in D.O. concentrations in the Laguna are principally a result of transient loadings that cannot be precisely described as boundary conditions for the model.~~ It is therefore unreasonable to expect the model to precisely match observed D.O. concentrations. The calibration results presented here are considered adequate because the range of simulated D.O. concentrations in the upper Laguna are comparable to the observed range, including periods of super-saturation and critically low D.O. And because the simulated and observed diurnal ranges are comparable, indicating that the impact of biological activity on D.O. is reasonably represented.

In the lower Russian River the seasonal and diurnal variations in D.O. are much smaller than in the Laguna due to the greater volume of water in the river. Also, the D.O. concentration is less dominated by biological activity as evidenced by the smaller diurnal range and absence of very low or very high D.O. concentrations. At Odd Fellows and Monte Rio (Appendix Figures 3.22 and 3.23) the observed D.O. concentrations vary from 7 to 10 mg/l. Simulated D.O. concentrations are within the range of the observed data. The diurnal variation of both the simulated and observed concentrations during the warmer low flow periods are on the order of 1.5 mg/l.

4.3.1 Reclaimed Water Production

The daily reclaimed water production is a function of the average dry weather flow (ADWF) plus an increment due to infiltration into the collection system. This increment is generally associated with wet weather. The incremental inflow used in the tributary inflow model is obviously related to rainfall. Therefore, a correlation between the recorded daily reclaimed water production and the daily incremental inflow was developed. The correlation was developed from plant operation data for the period between January 1, 1985 and September 30, 1992 and the corresponding SCWA estimates of incremental inflow.

The first step was to normalize the reclaimed water production data to a constant ADWF. The top half of Appendix Figure 4.1 shows the historical daily reclaimed water production and trend in ADWF. For the purpose of this analysis, the ADWF line was defined as 13.1 MGD on January 1, 1985 and a yearly increase of 0.427 MGD. The seasonal variation in reclaimed water production and the trend in ADWF is apparent in Appendix Figure 4.1.

The bottom half of Appendix Figure 4.1 shows the adjusted historical reclaimed water production and the model reclaimed water production. The adjusted historical reclaimed water production was calculated by scaling the actual production by the ratio of buildout ADWF to the ADWF (e.g., 21 / 13.1 on January 1, 1985) seen in the top half of Appendix Figure 4.1. This approach assumes that the relationship between wet weather flow (WWF) and ADWF will remain the same at buildout. The relationship between the model reclaimed water production and the incremental watershed inflow was developed using a regression fit between the adjusted historical reclaimed water production and incremental inflow. The following expression results in a root mean square error of 2.8 MGD. The following expression results in a root mean square error (standard deviation) of 2.8 MG, and has a correlation coefficient (r-squared value) of 0.88.

For $Q_I > 100$ cfs

$$Q_{ww} = 21 + 0.2973\,(Q_I - 100)^{1/2}$$

For $Q_I < 100$ cfs

$$Q_{ww} = 21$$

Where: Q_{ww} = Reclaimed water production in MGD

Q_I = Incremental watershed inflow in cfs

The annual reclaimed water production for the model is within +/- 3% of the adjusted historical records of production for all years.

4.3.2 Operation Assumptions

In the model, each reclaimed water disposal alternative is defined by a maximum discharge rate, available storage volume, discharge location, contingency operation options and irrigation acreage.

The maximum discharge rate was defined as a fraction of the total flow in the Russian River at Hacienda Bridge. This maximum rate was constrained by the capacity of the discharge and conveyance facilities. The hydraulic capacity of the Delta Pond and Laguna Plant discharges across the nonflooding range of Laguna flow conditions were 120 MGD

Table 4.2

Reclaimed Water Storage Objectives
End of Period Storage
Volume in MG

Project Condition	Contingency Storage (%)[a]	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May 15
Existing Cond.	0	210	520	910	1015	850	771	520	700
No Project	5	353	503	625	720	870	1101	1292	1360
Geysers	0	92	98	191	498	679	1045	1203	1184
1% Project	0	1352	1924	2392	2755	3328	4212	4940	5200
5% Project	5	1066	1517	1886	2173	2624	3321	3895	4100
10% Project	5	806	1147	1426	1642	1984	2511	2945	3100
20% Project	5	312	444	552	635	768	972	1140	1200
Russian R. (20%)	5	312	444	552	635	768	972	1140	1200

[a] contingency storage is expressed as a percentage of the monthly storage objective. For example, 5 percent contingency storage assumed for the 20 percent discharge means that in the month of October, storage would allowed to be 5 percent more than 312 MG.

4.3.3 Reclaimed Water Discharge

The goal of the operations model was to simulate operation of the various project alternatives to determine the location and rate of discharge of reclaimed water. The following computation sequence was used to compute the fate of the reclaimed water on a daily basis.

The first step was to compute the optimal reclaimed water discharge rate. This rate was defined as the reclaimed water production (computed as a function of incremental inflow) less the summer irrigation demands, incremental storage volume requirement and other demands, if any (e.g., export to the Geysers). Then the maximum allowable discharge rate was determined as a function of the previous day's Russian River average flow. Actual operation has historically been based on the previous day's peak flow, but this has been under review by the Regional Board during the time that these simulations were being conducted. In light of this uncertainty, average flow was used because simulated discharge (and thus water quality impact) on any given day would be generally less than if peak flow was used. This is considered conservative because impacts of project alternatives are being evaluated based on differences from existing conditions.

If the maximum allowable discharge exceeded the optimal reclaimed water discharge rate, the optimal discharge rate was assumed and the model proceeded to the next day. If the maximum allowable discharge rate was less than optimal reclaimed water discharge rate, the following steps were taken to reduce the discharge rate to the maximum allowed under the project specifications.

1. Allow the storage volume to exceed the target storage up to the contingency storage limit.

Table 2.

Water Quality Objectives (Conductivity, Total Dissolved Solids, and Dissolved Oxygen) for the North Coast Region

	Conductivity (µmhos/cm^2) at 77 °F		Total Dissolved Solids (mg/L)		Dissolved Oxygen (mg/L)		
	90% Upper Limit[a]	50% Upper Limit[b]	90% Upper Limit[a]	50% Upper Limit[b]	Min.	90% Lower Limit[a]	50% Lower Limit[b]
Russian River upstream of the Laguna	320	250	170	150	7.0	7.5	10.0
Russian River downstream of the Laguna	375	285	200	170	7.0	7.5	10.0
Laguna de Santa Rosa					7.0	7.5	10.0
Other waters designated warm, marine, or saline					5.0		
Other waters designated cold including Santa Rosa Creek					6.0		
Other waters designated spawning					7.0		
Other waters designated spawning during critical periods[c]					9.0		

Source: North Coast Regional Water Quality Control Board. 1994. Water Quality Control Plan for the North Coast Region.

[a] 90% upper and lower limits represent the 90th percentile values for a calendar year. 90 percent or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit for the water to be in attainment.

[b] 50% upper and lower limits represent the 50th percentile values of the monthly means for a calendar year. 50 percent or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit for the water to be in attainment. The 50th percentile upper limit point of significance ~~for conductivity~~ is more stringent than the 90th percentile upper limit point of significance. Therefore, compliance with the 50th percentile upper limit point of significance was evaluated. Compliance with the minimum dissolved oxygen point of significance was also evaluated.

[c] Critical periods are during spawning and egg incubation.

Table 6.

Summary of Narrative Water Quality Objectives and Evaluation Criteria

Narrative Objective or Policy	Source	Evaluation Criterion (Impact Significant If:)	Rationale for Evaluation Criterion
Turbidity. Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.	North Coast Basin Plan (3/24/94) page 3-3.00, Bay Basin Plan (9/16/92) page III-2	An impact is significant and adverse if monthly average turbidity increases more than 20 percent above estimated background levels as a result of the discharge . An impact is significant and beneficial if monthly average turbidity decreases more than 20 percent below estimated background levels as a result of the discharge.	Narrative Objective The narrative objective is intended to protect visual-related beneficial uses (i.e., aesthetics and fish feeding) from the effects of a reclaimed water discharge. Other project components that could affect turbidity (i.e., soil, streambed, and streambank erosion) are addressed in Sections 4.3 (soil) and 4.4 (streambed and bank)~~as described in the Sediment criterion Rationale~~. An evaluation criterion of 20 percent was established based on the Basin Plan ~~by professional judgment~~ to protect visual-related beneficial uses.

Table 1-1.

Summary of Significant Adverse and Beneficial Surface Water Quality Impacts[a]

Evaluation Criterion	Santa Rosa Creek	Laguna	Russian River	West Co. Creeks	Esteros	Tolay Creek	Petaluma River	Other Waters
Cyanide	~~10%, 20%, NP~~	~~20%, NP~~	None	None		None	None	None
Conductivity	Criterion not applicable		*20% River*	Criterion NA		Criterion not applicable		
Average Dissolved Oxygen	**20%, NP**	20%, **NP**	None	~~Storage~~		~~Storage~~	None	None
Hydrogen Sulfide	None	None	None	~~Storage~~	None	~~Storage~~	None	None
Lethal Toxicity	~~20%, NP~~	~~20%, NP~~		None	None	None	None	None
Waste Red. Strategy			Criterion not applicable					
Adverse								
Total Nitrogen	~~10%, 20%,~~ NP	~~10%, 20%, NP~~						
Ammonia	~~20%, NP~~	~~20%, NP~~						
Beneficial								
Total Nitrogen	1%, 5%, 20%River, G	1%, 5%, 20%River, G						
Ammonia	1%, 5%, 10%, 20% River, G	1%, 5%, 10%, 20% River, G						
Other criteria	None	None	None	None	See top note	None	None	None

[a] Components causing a significant adverse or beneficial impact are shown. Since impacts were evaluated for all months and three hydrologic years, both beneficial and adverse impacts can result for some parameters at different times from the same component. Overstriking indicates impact avoided with mitigation or measures that need to be considered by the city for the No Project component, italics indicates no mitigation proposed, bold indicates impacts that are significant after mitigation that are not significant before mitigation. Components are identified as follows:

1% = 1% design discharge component
5% = 5% design discharge component
10% = 10% design discharge component
20% = 20% design discharge component to Laguna
20% River = 20% design discharge component to River
Storage = Storage reservoir
NP = No Project discharge component
G = Geysers discharge component
Irrig = Irrigation e

Table 3-1.

Evaluation Criteria for the Protection of Aquatic and Benthic Life with Criteria of Significance - Surface Water Quality and Sediment Quality

Evaluation Criteria	Point of Significance			Justification[a]
	Fresh-water	Salt-water	As Measured By	
Sediment.	any increase	any increase	Suspended sediment in the waterways.	Basin Plans narrative criterion
Salinity. The discharge to San Pablo Bay or its tributaries may cause an increase in salinity.		any increase above background	ppt	Basin Plan narrative criterion
Temperature.	5 °F increase in monthly average temperature	4 °F increase in monthly average temperature in estuaries	° F	Basin Plans narrative criterion
Turbidity - Adverse.	20% increase	20% increase	Monthly average planktonic algal biomass as chlorophyll *a*	Basin Plans narrative criterion of 20%, ~~established by professional judgment,~~ is the criterion intended to protect visual-related beneficial uses (i.e., aesthetics and fish feeding).
Turbidity - Beneficial.	20% decrease	20% decrease	Monthly average planktonic algal biomass as chlorophyll *a*	20%, established by professional judgment, is the criterion intended to protect visual-related beneficial uses (i.e., aesthetics and fish feeding).

Key assumptions that were used in the evaluation are as follows:

- **Reclaimed Water Quality.** The average of treatment plant reclaimed water quality measurements made from 1991 (1988 for metals) through January 1995 (as summarized in the *Reclaimed Water Quality Monitoring Results* Technical Report, MSC 1996) is assumed to be representative of the quality of reclaimed water discharged from storage ponds. The large capacity of Laguna storage relative to discharge volume assures that variations in plant reclaimed water quality will be dampened and the quality of the discharge will be much more constant.
- **Ambient Water Quality.** Ambient water quality was estimated from data collected in Santa Rosa Creek, the Laguna de Santa Rosa, and the Russian River above and below the confluence with the Laguna as described in *Laguna de Santa Rosa Water Quality Monitoring Results* and *Russian River Water Quality Monitoring Results* Technical Reports (MSC 1996). Data used to calibrate the Russian River model are described in the *Russian River Water Quality Model* Technical Report, RMA 1996
- **Operations.** The Subregional System is operated to maximize discharge at Delta Pond before discharge occurs at Meadowlane Pond. The daily operations model was established to discharge up to the hydraulic capacity of the Delta Pond outfall each day. The balance of discharge was assumed to then be released at Meadowlane Pond. Discharge from other locations was not simulated since almost all reclaimed water discharge occurs from Delta and Meadowlane ponds.

Discharge impacts on water quality were evaluated using two methods, depending on the constituent. Each method is described below.

Constituents Affected by Biological Activity - Water Quality Simulation Model

The potential impacts of discharge on the Laguna de Santa Rosa and the Russian River were evaluated using a hydraulic and water quality model (see the *Russian River Water Quality Model* Technical Report, RMA 1996). Reclaimed water discharge as defined under the 1 percent design Laguna discharge alternatives (Alternatives 2 and 3), Laguna discharge associated with Geysers alternative (Alternative 4), 20 percent design River discharge alternative (Alternative 5a), and 20 percent design Laguna discharge alternative (Alternative 5b) was simulated on a daily time step for the 10th, 50th and 90th percentile water years (1976, 1961 and 1982, respectively). A "water year" starts in October of the previous year (e.g. the 1976 water year starts on 1 October 1975). The 10th percentile water year (1976) is the water year in which total annual Russian River flow (adjusted for future diversions) is less than 90 percent of the total annual Russian River flow values during the period of record (see Surface Hydrology section of EIR/S). The estimated return frequency of the total annual Russian River flows that occurred in 1976, 1961, and 1982 is 18.5, 2, and 14.5 years, respectively. Operations of the Subregional System, including reclaimed water discharge, for each of the discharge components cited above in this paragraph were assumed per the *Water Balance Model - Overall Summary and Results* and *Water Balance Contingency Plan*s (Parsons ES 1995). Daily flow estimates for 1976, 1961 and 1982 are based on actual River flow measurements that were adjusted to reflect future diversions, consistent with the method under the existing condition was not in attainment of the Regional Board's point of significance, then any further decrease of the monthly average dissolved oxygen concentration was considered a significant adverse impact.

Monthly average dissolved oxygen values were used in this evaluation to be consistent with the Regional Board's objective and for reasons related to model precision. The Regional Board's dissolved oxygen objective includes a component that is based on monthly means and a component that is based on an instantaneous minimum. ~~The instantaneous minimum dissolved oxygen concentration caused by any of the discharge components cannot be reliably assessed.~~ Model-predicted changes in dissolved oxygen of less than 0.5 mg/L were not considered significant due to model uncertainty.

Model estimates of the minimum dissolved oxygen (based on hourly estimates) were also evaluated for impacts. These minimum hourly concentrations for each month were evaluated for the same hydraulic years and locations as the monthly average dissolved oxygen. If any predicted minimum monthly dissolved oxygen concentration for the project alternatives was 1) 0.5 mg/L below the estimated existing monthly dissolved oxygen minimum and 2) below the point of significance for minimum dissolved oxygen, the impact was considered significant. This is consistent with the approach used for average dissolved oxygen, as described in the proceeding paragraph.

- **Ammonia**. Impact significance is being evaluated with respect to two ammonia criteria:

  - A numeric criterion for protection of aquatic organisms from potential toxic effects which applies to the Russian River. To evaluate for significant impacts, model estimates of the monthly maximum total ammonia for the stream reaches described above in 1976, 1961 and 1982 were determined. Since the numeric ammonia criterion is temperature and pH dependent, monthly maximum total ammonia concentrations were compared to the point of significance for the long-term average temperature and pH of the lower Russian River. An impact was considered significant if any monthly maximum total ammonia exceeded the total ammonia point of significance. In the Russian River below the confluence with the Laguna, the average temperature and pH in the water quality database (*Russian River Water Quality Monitoring* Technical Report, MSC 1996) are 16.7°C and 8.0, respectively. The EPA point of significance (CCC) for total ammonia (sensitive species present) for a temperature of 20°C and a pH of 8.0 is 0.76 mg-N/L.
  - A narrative waste load reduction criterion for ammonia which applies to the Laguna and Santa Rosa Creek. The impact of the proposed discharge components on ammonia load were evaluated by comparing the average annual ammonia load for each discharge component (calculated using the average annual discharge to the Laguna multiplied by the expected

concentration of ammonia in reclaimed water [1 mg-N/L]) to the estimated load in 1994 (56,610 pounds).

Algae. The monthly average benthic (attached) algae biomass (mass per area) and plankton density (mass per volume) was calculated in the stream reaches described above by averaging all of the estimates in the reach during the month. Thus, the monthly average is a temporally- and spatially-averaged value. The impact on benthic algae and planktonic algae are described in this report. If the estimated monthly average algae concentration resulting from a discharge component in any reach was more than 10 percent greater than that estimated to result from existing conditions, then the impact was considered to be significant. If the estimated monthly average algae concentration resulting from a discharge component in any reach was...

Thus, receiving water concentrations for all conservative constituents found in detectable concentrations in reclaimed water were calculated for each discharge alternative (1 percent, 5 percent, 10 percent, 20 percent Laguna discharge, 20 percent Russian River discharge, No Project, and Geysers discharge) and for the following combinations of percent reclaimed water and receiving water concentration:

- 50th percentile percent reclaimed water (average year) with average background concentration
- 95th percentile percent reclaimed water (maximum percent year) with average background concentration

Significance of impacts were determined for the following constituents that were not screened out as described above in the Screening of Evaluation Criteria section:

Aluminum
Dissolved Copper
Mercury
Dissolved Nickel
Dissolved Silver
Dissolved Zinc
Acrolein
Gamma BHC (Lindane)
Chlorpyrifos
Guthion
Malathion
Demeton
Parathion
Phthalate Esters
Toxaphene
Conductivity
Cyanide

Constituents in italics are organic compounds which are not detectable in reclaimed water but the reporting limit is greater than the point of significance.

All other constituents routinely measured in reclaimed water were screened out from the significant impacts evaluation because the impacts of their discharge on receiving waters were *a priori* determined not to be significant (as described in the Screening of Evaluation Criteria section).

The ranges of potential impacts of all conservative constituents for which Evaluation Criteria exist were estimated with the dilution model. This was done by estimating the concentration of each constituent in the receiving waters. A different approach was used to evaluate conductivity, nitrogen load, and toxicity, as described below.

Conductivity

The points of significance for conductivity, which apply only to the Russian River, are dependent on monthly mean conductivity and percentiles rather than an estimated maximum concentration. Average monthly conductivities in the Russian River at Oddfellows and Wohler Bridge were calculated and used as ambient conductivity. Simulated daily average reclaimed water concentrations, averaged for each month, for the 20 percent design discharge to the River component were used, selecting for each month the year (1961, 1976, 1981) with the highest average discharge concentration. Conductivity for each month was estimated using the average monthly conductivities and the average monthly

Table 4-2.

Estimated Daily Average Reclaimed Water Concentration

	Existing discharge	1 percent design discharge	5 percent design discharge	10 percent design discharge	20 percent design Laguna discharge	20 percent design Russian River discharge	No Project	Geysers
Santa Rosa Creek								
50th percentile[a]	19	0	6	11	35	0	29	0
95th percentile[b]	62	9[c]	49	67	81[c]	2[c]	75[c]	6
99th percentile[b]	71	13[d]	56	69	83[c]	4	79[c]	7
100th percentile[b]	79	14[d]	61	76	84[c]	36	81[c]	8
Laguna at River Rd								
50th percentile[a]	8	0	3	5	17	0	13	0
95th percentile[b]	38	4[c]	26	43	61[c]	0.6[c]	53[c]	2
99th percentile[b]	47	5[c]	32	45	64[c]	2	57[c]	3
100th percentile[b]	58	6[d]	35	52	65[c]	16	60[c]	4
Russian River at Oddfellows								
50th percentile[a]	1	0	0.3	0.6	3	2	2	0
95th percentile[b]	7	0.5[c]	5	10	15	10	10	0.4
99th percentile[b]	10	1[d]	5	10	19	11	11	0.6
100th percentile[b]	10	1[d]	6	11	20	11	11	1
Russian River at SCWA Wohler intakes								
50th percentile[a]						3		
95th percentile[b]						11		
99th percentile[b]						14		
100th percentile[b]						14		

[a] 50th percentile concentration in normal hydrologic year (1961) is given.
[b] The maximum of the three ~~95th percentile~~ concentrations (dry, normal, wet) at a particular percentile is shown. The maximum occurred in the dry year (1976) unless noted otherwise.
[c] highest ~~95th percentile~~concentration value occurred in 1961, not 1976
[d] No discharge was projected to occur in 1976 under the 1 percent design discharge. Value would occur in 1961.

Water Quality Simulation Model Results - Existing Conditions Baseline

The results of the water quality simulation model, using existing conditions as a baseline for benthic algae, planktonic algae, average and minimum dissolved oxygen, and ammonia are presented in this section. These results, except for minimum dissolved oxygen, are presented as changes from the existing conditions baseline which is presented in Table 4-3. The minimum dissolved oxygen existing conditions baseline concentrations are shown in Table 4-3A.

The water quality impacts of reclaimed water discharges on benthic algae, planktonic algae, average dissolved oxygen, and ammonia in Santa Rosa Creek, Laguna, Russian River above the confluence with the Laguna, and Russian River below the Laguna confluence are shown in Figures 4-13 to 4-17. The water quality impacts of reclaimed water on minimum dissolved oxygen are shown in Table 4-3A. Model results from the two reaches in which water range from a two percent decrease from baseline (April normal year) to an 8 percent increase from baseline (October normal year). The model predicts that with No Project discharge, there will be no significant decreases in planktonic algae in the Russian River below the confluence with the Laguna. No significant increases in planktonic algae are predicted to occur in the Santa Rosa Creek, the Laguna, or the Russian River below the Laguna with discharge associated with No Project alternative to the Laguna.

Geysers. Predicted impacts from discharge related to a Geysers alternative on planktonic algae in Santa Rosa Creek range from a two percent decrease from baseline (November dry year) to a seven percent increase from baseline (November wet year). Predicted impacts from Geysers discharge on planktonic algae in the Laguna de Santa Rosa range a seven percent decrease from baseline (May dry year) to a 0.7 percent increase from baseline (June dry year). Predicted impacts from discharge related to a Geysers alternative on planktonic algae in the Russian River below the confluence with the Laguna range from a seven percent decrease from the existing condition baseline (May dry year) to no change from baseline. No significant increases or decreases in planktonic algae are predicted to occur in Santa Rosa Creek, the Laguna, or the Russian River below the Laguna with Geysers related discharge to the Laguna.

Dissolved Oxygen

The predicted average monthly changes (in mg/L) from existing conditions baseline for dissolved oxygen for the different discharge alternatives are shown in Figure 4-15. The average monthly existing conditions baseline concentration for dissolved oxygen in Santa Rosa Creek are all less than 10 mg/L. In the Laguna, eleven out of twelve of the average monthly existing conditions baseline for dissolved oxygen are less than 10 mg/L. Since the Basin Plan 50th percentile point of significance for dissolved oxygen states that 50 percent or more of average monthly dissolved oxygen must exceed 10 mg/L, the existing baseline dissolved oxygen is not in compliance. Therefore the predicted decreases of greater than or equal to 0.5 mg/L (the minimum difference in dissolved oxygen that the water quality model can accurately distinguish is estimated to be 0.5 mg/L) would be a significant impact to the Laguna and Santa Rosa Creek. The 50th percentile point of significance is more stringent than the 90th percentile point of significance, therefore exceedances of the 90th percentile point of significance were not evaluated.

There are no significant decreases in average dissolved oxygen predicted with the 1, 5, and 10 percent design discharge components, 20 percent design discharge to the River, and design discharge components associated with No Project and Geysers alternatives.

The only discharge alternative that is predicted to cause decreases in average dissolved oxygen greater than or equal to 0.5 mg/L is the 20 percent design discharge to the Laguna (Figure 4-15). The predicted decrease in average dissolved oxygen in Santa Rosa Creek in January of a dry year is 0.5 mg/l. The predicted decrease in average dissolved oxygen in the Laguna in November is 0.5 mg/L in dry and normal years. All other decreases in dissolved oxygen predicted to occur with a 20 percent design discharge to the Laguna are less than 0.5 mg/L.

The predicted minimum monthly dissolved oxygen concentrations (in mg/L) for the different discharge alternatives are shown in Table 4-3A. No predicted minimum dissolved oxygen concentrations for the Project alternatives are more than 0.5 mg/L below existing conditions and less than the points of significance (6.0 mg/L for Santa Rosa Creek and 7.0 mg/L for the Laguna and Russian River). Therefore, no significant decreases in dissolved oxygen are predicted with the 1, 5, and 10 percent design discharge components, the 20 percent design discharge to the Laguna, the 20 percent design discharge to the River, and design discharge components associated with the No Project and Geysers alternatives.

Table 4-3A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Design Discharge (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			No Project			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Santa Rosa Creek																								
Oct	7.5	7.9	7.7	7.5	7.9	8.0	7.5	7.9	8.0	7.5	7.9	8.0	7.9	8.1	8.1	7.5	7.9	8.0	7.6	8.0	8.0	7.5	7.9	9.1
Nov	7.6	8.3	8.2	7.6	8.3	8.4	7.6	8.3	8.4	7.6	7.7	8.4	8.0	8.1	8.1	7.6	8.3	8.4	7.9	8.1	8.1	7.6	8.3	9.1
Dec	8.6	8.3	8.6	8.7	9.2	8.8	8.7	8.7	8.6	8.7	8.6	8.6	8.7	8.5	8.8	8.7	9.2	8.8	8.7	8.6	8.8	8.7	9.1	9.3
Jan	8.9	8.9	8.8	8.9	9.9	8.8	8.9	8.9	8.8	8.9	8.7	8.8	8.9	8.6	8.7	8.9	9.9	8.8	8.9	8.7	8.8	8.9	9.9	9.7
Feb	8.8	8.4	8.5	8.9	9.1	8.7	8.8	8.8	8.7	8.8	8.6	8.6	8.8	8.5	8.8	8.8	8.3	8.7	8.8	8.6	8.8	8.9	9.1	9.9
Mar	8.7	8.3	8.6	8.7	8.3	8.7	8.7	8.3	8.7	8.7	8.2	8.7	8.7	8.2	8.6	8.7	8.3	8.7	8.7	8.2	8.6	8.7	8.3	9.4
Apr	8.3	8.0	8.5	8.4	7.9	8.7	8.1	6.9	8.6	8.3	6.4	8.6	8.3	8.1	8.6	8.4	7.9	8.7	8.3	8.1	8.6	8.4	7.9	9.5
May	7.1	5.7	8.0	7.1	5.9	8.0	7.1	5.8	8.0	7.1	5.8	8.0	7.1	5.5	8.0	7.1	5.9	8.0	7.1	5.7	8.0	7.1	5.9	9.5
Jun	6.2	6.1	7.6	6.2	6.3	7.6	6.2	6.2	7.6	6.2	6.3	7.6	6.1	6.1	7.6	6.2	6.3	7.6	6.1	6.1	7.6	6.2	6.3	8.9
Jul	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	8.9
Aug	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	8.9
Sep	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	8.9
Laguna de Santa Rosa																								
Oct	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.1	8.1	8.1	8.2	8.2	8.2	8.0	8.1	8.0	8.2	8.2	8.2
Nov	8.2	8.8	8.2	8.2	8.8	8.2	8.2	8.8	8.2	8.2	8.8	8.2	8.2	8.5	8.2	8.2	8.8	8.2	8.2	8.5	8.2	8.2	8.8	8.2
Dec	9.0	8.1	9.0	9.1	8.1	9.1	9.0	8.1	9.0	9.0	8.1	9.0	9.0	8.1	9.0	9.0	8.1	9.0	9.0	8.1	9.0	9.0	8.1	9.0
Jan	9.2	10.1	9.2	9.2	10.2	9.2	9.2	10.1	9.2	9.2	10.0	9.2	9.2	9.9	9.2	9.2	10.2	9.2	9.2	10.0	9.2	9.2	10.2	9.2

Table 4-3A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Design Discharge (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			No Project			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Feb	9.1	7.2	9.1	9.1	7.2	9.1	9.1	7.2	9.1	9.1	7.2	9.1	9.2	7.2	9.2	9.1	7.2	9.1	9.2	7.2	9.2	9.2	7.2	9.2
Mar	8.7	7.0	8.7	8.7	7.0	8.7	8.7	7.0	8.7	8.7	7.1	8.7	8.7	7.1	8.7	8.7	7.0	8.7	8.7	7.1	8.7	8.7	7.0	8.7
Apr	8.5	7.4	8.5	8.5	7.2	8.5	8.5	7.3	8.5	8.5	7.3	8.5	8.5	7.3	8.5	8.5	7.2	8.5	8.5	7.3	8.5	8.5	7.2	8.5
May	7.8	6.7	7.8	7.8	7.0	7.8	7.8	7.0	7.8	7.8	7.0	7.8	7.8	6.8	7.8	7.8	7.0	7.8	7.8	6.8	7.8	7.8	7.0	7.8
Jun	7.5	6.6	7.5	7.5	6.8	7.5	7.5	6.7	7.5	7.5	6.7	7.5	7.5	6.6	7.5	7.5	6.8	7.5	7.5	6.6	7.5	7.5	6.8	7.5
Jul	7.4	6.5	7.4	7.4	6.5	7.4	7.4	6.5	7.4	7.4	6.5	7.4	7.4	6.5	7.4	7.4	6.5	7.4	7.4	6.5	7.4	7.4	6.5	7.4
Aug	7.3	6.6	7.3	7.3	6.6	7.3	7.3	6.6	7.3	7.3	6.6	7.3	7.3	6.6	7.3	7.3	6.6	7.3	7.3	6.6	7.3	7.3	6.6	7.3
Sep	7.6	7.3	7.6	7.6	7.3	7.6	7.6	7.3	7.6	7.6	7.3	7.6	7.6	7.3	7.6	7.6	7.3	7.6	7.6	7.3	7.6	7.6	7.3	7.6
Russian River above the Laguna																								
Oct	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.1	9.0	9.0	9.2	9.1	9.1	9.2	9.1	9.1
Nov	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.6	9.2	9.4	9.4	9.4	9.6	9.6	9.4	9.6	9.6
Dec	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.4	10.6	10.5	10.2	10.6	10.6	10.4	10.6	10.6	10.4	10.6
Jan	10.8	11.1	10.8	10.8	11.1	10.8	10.8	11.1	10.8	10.8	11.1	10.8	10.8	11.1	10.8	10.7	10.7	10.8	10.8	11.1	10.8	10.8	11.1	10.8
Feb	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.4	10.7	10.8	10.7	10.7	10.8	10.7	10.7
Mar	10.6	9.9	10.3	10.6	9.9	10.3	10.6	9.9	10.3	10.6	9.9	10.3	10.6	9.9	10.3	10.5	9.7	10.3	10.6	9.9	10.3	10.6	9.9	10.3
Apr	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	8.9	9.8	9.6	9.0	9.8	9.6	9.0	9.8
May	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8
Jun	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6

Table 4-3A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Design Discharge (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			No Project			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Jul	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5
Aug	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4
Sep	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5
Russian River below the Laguna																								
Oct	8.9	8.8	8.8	8.9	8.8	8.8	8.9	8.8	8.8	8.9	8.8	8.8	8.6	8.7	8.7	8.9	8.9	8.9	8.7	8.7	8.8	8.9	8.8	8.8
Nov	9.1	9.3	9.0	9.1	9.3	9.1	9.1	9.3	9.1	9.1	9.3	9.1	8.8	9.0	9.0	8.9	9.1	9.2	8.8	9.1	9.0	9.1	9.2	9.1
Dec	9.7	9.9	10.2	9.7	10.0	10.2	9.7	10.0	10.2	9.7	10.0	10.2	9.7	9.9	10.2	9.8	10.1	10.3	9.7	10.0	10.2	9.7	10.0	10.2
Jan	10.1	10.8	10.3	10.1	10.8	10.3	10.1	10.8	10.3	10.1	10.8	10.3	10.1	10.7	10.3	10.3	10.6	10.5	10.1	10.7	10.3	10.1	10.8	10.3
Feb	10.2	10.0	10.1	10.2	10.1	10.1	10.2	10.1	10.1	10.2	10.1	10.1	10.2	10.1	10.1	10.4	10.2	10.3	10.2	10.1	10.1	10.2	10.1	10.1
Mar	10.1	9.3	9.6	10.1	9.3	9.7	10.1	9.3	9.6	10.1	9.3	9.6	10.1	9.2	9.6	10.3	9.4	9.9	10.1	9.3	9.6	10.1	9.3	9.7
Apr	9.3	8.6	9.4	9.4	8.5	9.4	9.4	8.6	9.4	9.4	8.6	9.4	9.3	8.6	9.4	9.4	8.6	9.5	9.4	8.6	9.4	9.4	8.5	9.4
May	8.1	7.6	8.5	8.1	7.6	8.5	8.1	7.6	8.5	8.1	7.6	8.5	8.1	7.5	8.5	8.3	7.9	8.7	8.1	7.5	8.5	8.1	7.6	8.5
Jun	7.9	7.7	8.0	7.9	7.8	8.0	7.9	7.8	8.0	7.9	7.8	8.0	7.9	7.7	8.0	8.2	8.2	8.5	7.9	7.7	8.0	7.9	7.8	8.0
Jul	8.3	8.2	8.0	8.3	8.2	8.0	8.3	8.2	8.0	8.3	8.2	8.0	8.3	8.2	8.0	8.7	8.7	8.6	8.3	8.2	8.0	8.3	8.2	8.0
Aug	8.1	8.1	7.9	8.1	8.1	7.9	8.1	8.1	7.9	8.1	8.1	7.9	8.1	8.1	7.9	8.5	8.6	8.4	8.1	8.1	7.9	8.1	8.1	7.9
Sep	8.3	8.3	8.2	8.3	8.3	8.2	8.3	8.3	8.2	8.3	8.3	8.2	8.3	8.3	8.2	8.6	8.6	8.5	8.3	8.3	8.2	8.3	8.3	8.2
Lower Russian River																								
Oct	8.7	8.9	8.9	8.7	8.9	8.9	8.7	8.9	8.9	8.7	8.9	8.9	8.3	8.6	8.6	8.8	8.9	8.9	8.5	8.7	8.7	8.7	8.9	8.9

Table 4-3A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Design Discharge (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			No Project			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Nov	8.9	9.1	9.1	8.9	9.1	9.1	8.9	9.1	9.1	8.9	9.1	9.1	8.4	8.7	9.0	8.8	9.0	9.2	8.6	8.9	9.0	8.9	9.1	9.1
Dec	9.6	9.8	10.1	9.6	9.8	10.1	9.6	9.8	10.1	9.6	9.8	10.1	9.6	9.7	10.1	9.7	9.9	10.3	9.6	9.7	10.1	9.6	9.8	10.1
Jan	10.1	10.7	10.3	10.1	10.7	10.3	10.1	10.7	10.3	10.1	10.6	10.3	10.1	10.5	10.3	10.3	10.6	10.4	10.1	10.6	10.3	10.1	10.7	10.3
Feb	10.2	9.8	10.1	10.2	10.0	10.1	10.2	10.0	10.1	10.2	9.9	10.1	10.2	9.9	10.1	10.4	10.1	10.3	10.2	9.9	10.1	10.2	10.0	10.1
Mar	10.1	9.3	9.7	10.1	9.3	9.7	10.1	9.3	9.7	10.1	9.3	9.7	10.1	9.2	9.7	10.3	9.3	9.9	10.1	9.2	9.7	10.1	9.3	9.7
Apr	9.3	8.6	9.3	9.4	8.7	9.3	9.4	8.6	9.3	9.3	8.6	9.3	9.3	8.6	9.3	9.3	8.8	9.4	9.3	8.6	9.3	9.3	8.7	9.3
May	8.4	7.4	8.8	8.4	7.6	8.8	8.4	7.5	8.8	8.4	7.5	8.8	8.4	7.4	8.8	8.5	8.0	8.8	8.4	7.4	8.8	8.4	7.6	8.8
Jun	7.9	7.3	7.9	7.9	7.3	7.9	7.9	7.3	7.9	7.9	7.3	7.9	7.8	7.3	7.9	8.3	8.2	8.7	7.8	7.3	7.9	7.9	7.3	7.9
Jul	8.0	7.9	7.9	8.0	7.9	7.9	8.0	7.9	7.9	8.0	7.9	7.9	8.0	7.9	7.9	8.7	8.8	8.8	8.0	7.9	7.9	8.0	7.9	7.9
Aug	7.8	7.9	7.7	7.8	7.9	7.7	7.8	7.9	7.7	7.8	7.9	7.7	7.8	7.9	7.7	8.5	8.6	8.5	7.8	7.9	7.7	7.8	7.9	7.7
Sep	8.1	8.0	8.1	8.1	8.0	8.1	8.1	8.0	8.1	8.1	8.0	8.1	8.1	7.9	8.1	8.5	8.5	8.5	8.1	7.9	8.1	8.1	8.0	8.1

[a] Dissolved oxygen minima are based on hourly estimates.

mg-N/L. Therefore, no significant increases in ammonia are predicted to occur in the Russian River below the Laguna with discharge related to a No Project Alternative.

Geysers. Predicted impacts from discharge related to a Geysers alternative on ammonia in Santa Rosa Creek range from a 86 percent decrease from existing conditions baseline (February dry year) to a 66 percent increase from existing conditions baseline (November dry year). Predicted impacts from discharge related to a Geysers alternative on ammonia in the Laguna de Santa Rosa range from a 76 percent decrease from existing conditions baseline (May dry year) to a nine percent increase from existing conditions baseline (November normal year). Predicted impacts from discharge related to a Geysers alternative on ammonia in the Russian River below the confluence with the Laguna range from a 40 percent decrease (April normal year) to a four percent increase from existing conditions baseline. None of the predicted concentrations of ammonia in the Russian River exceed 0.76 mg-N/L. Therefore, no significant increases in ammonia are predicted to occur in the Russian River below the Laguna with discharge related to a Geysers alternative.

Turbidity

The range of impacts of the discharge components on turbidity due to planktonic algae is discussed above in the planktonic algae section (see also Figure 4-14, but note that the point of significance for turbidity is a 20 percent change and a 10 percent change for planktonic algae). The water quality model predictions for planktonic algae indicate that there will be no significant increases in planktonic algae induced turbidity in Santa Rosa Creek and the Laguna with any of the discharge rates examined. A 20 percent discharge to the Laguna is predicted to result in a significant decrease in turbidity in Santa Rosa Creek and the Laguna in November (dry and normal years). Discharge associated with a No Project alternative is also predicted to result in a significant decrease in turbidity in Santa Rosa Creek and the Laguna in November (dry and normal years). The decreases in turbidity are due to the flushing effect of the reclaimed water. A 20 percent discharge to the Russian River is predicted to result in a significant increase in turbidity in the Russian River above the confluence with the Laguna in April of a dry year. A 20 percent discharge to the Russian River is predicted to result in a significant decrease in turbidity in the Russian River below the confluence with the Laguna in April and May (dry year), June (all years), and July, August, and September (dry and wet years).

Temperature

The predicted average monthly changes in temperature from the existing conditions baseline for the different discharge alternatives are shown in Figure 4-17. The predicted maximum hourly changes in temperature each month (Maximum Monthly Temperature) from the existing condition baseline (maximum temperature) were also examined for the different discharge alternatives. The point of significance for temperature is a 5 °F increase. Therefore, any increases in temperature greater than or equal to 5 °F are considered significant. Little temperature change is expected since the storage ponds are normally unstratified and therefore approximate ambient temperature

One Percent Design Discharge. Predicted impacts from a 1 percent design discharge on temperature are less than a 1 degree change from the existing conditions baseline in Santa

Rosa Creek, the Laguna, and the Russian River below the confluence with the Laguna. Predicted maximum increases in maximum monthly temperature from a 1 percent design discharge are 3.2 degrees in Santa Rosa Creek, 1.2 degrees in the Laguna, and less than one degree in the Russian River. Therefore the model does not predict any significant impact to temperature from a one percent design discharge.

Rosa Creek, the Laguna, and the Russian River below the confluence with the Laguna. Therefore the model does not predict any significant impact to temperature from a one percent design discharge.

Five Percent Design Discharge. Predicted impacts from a 5 percent design discharge on temperature are less than a one degree change from the existing conditions baseline in Santa Rosa Creek, the Laguna, and the Russian River below the confluence with the Laguna. Predicted maximum increases in maximum monthly temperature from a 5 percent design discharge are 2.6 degrees in Santa Rosa Creek and less than one degree in the Laguna and in the Russian River. Therefore the model does not predict any significant impact to temperature from a 5 percent design discharge.

Ten Percent Design Discharge. Predicted impacts from a 10 percent design discharge on temperature are less than a one degree change from the existing conditions baseline in Santa Rosa Creek, the Laguna, and the Russian River below the confluence with the Laguna. Predicted maximum increases in maximum monthly temperature from a 10 percent design discharge are 2.6 degrees in Santa Rosa Creek and less than one degree in the Laguna and in the Russian River. Therefore the model does not predict any significant impact to temperature from a 10 percent design discharge.

Twenty Percent Design Discharge to the Laguna. Predicted impacts from a 20 percent design discharge to the Laguna on temperature in Santa Rosa Creek range from a 0.1 degree decrease from existing conditions baseline (January, February, March, and April dry year) to a 1.9 degree increase from existing conditions baseline (November normal year). Predicted impacts from a 20 percent design discharge on temperature in the Laguna de Santa Rosa range from a 0.3 degree decrease from existing conditions baseline (January dry year) to a 1.8 degree increase from existing conditions baseline (November normal year). Predicted impacts from a 20 percent design discharge on temperature in the Russian River below the confluence with the Laguna are all less than one degree. Predicted maximum increases in maximum monthly temperature from a 20 percent design discharge to the Laguna are 1.2 degrees in the Laguna and less than one degree in Santa Rosa Creek and in the Russian River. No significant impacts on temperature are predicted for Santa Rosa Creek, the Laguna, or the Russian River below the confluence with the Laguna with a 20 percent design discharge to the Laguna.

Twenty Percent Design Discharge to the Russian River. Predicted impacts from a 20 percent design discharge to the Russian River on temperature are less than a one degree change from the existing conditions baseline in Santa Rosa Creek, the Laguna, and the Russian River above and below the confluence with the Laguna. Predicted maximum increases in maximum monthly temperature from a 20 percent design discharge to the

Russian River are 3.2 degrees in Santa Rosa Creek, 1.2 degrees in the Laguna, and less than one degree in the Laguna and in the Russian River. Therefore the model does not predict any significant impact to temperature from a 20 percent design discharge to the Russian River.

No Project. Predicted impacts from discharge related to a No Project alternative on temperature in Santa Rosa Creek range from a 0.2 degree decrease from existing conditions baseline (January dry year) to a 1.8 degree increase from existing conditions baseline (November normal year). Predicted impacts from discharge related to a No Project alternative on temperature in the Laguna de Santa Rosa range from a 0.1 degree decrease from existing conditions baseline (May normal and wet years) to a 1.5 degree increase from existing conditions baseline (November normal year). Predicted impacts from a discharge related to a No Project alternative on temperature in the Russian River below the confluence with the Laguna are all less than one degree. No significant impacts on temperature are predicted for Santa Rosa Creek, the Laguna, or the Russian River below the confluence with the Laguna with discharge related to a No Project alternative. Predicted maximum increases in maximum monthly temperature from discharge related to a No Project alternative are 1.1 degrees in the Laguna and less than one degree in Santa Rosa Creek and in the Russian River.

Geysers. Predicted impacts from discharge related to a Geysers alternative on temperature are less than a one degree change from the existing conditions baseline in Santa Rosa Creek, the Laguna, and the Russian River below the confluence with the Laguna. Therefore the model does not predict any significant impact to temperature from discharge related to a Geysers alternative. Predicted maximum increases in maximum monthly temperature from discharge related to a Geysers alternative are 3.2 degrees in Santa Rosa Creek, 1.2 degrees in the Laguna, and less than one degree in the Laguna and in the Russian River.

Water Quality Simulation Model Results - Zero Discharge Baseline

Water quality conditions without Santa Rosa's discharge (zero discharge baseline conditions) were simulated, and the results of the simulation are summarized in Table 4-4. Water quality conditions relative to the zero discharge baseline are presented in this section for benthic algae, planktonic algae, dissolved oxygen, and ammonia.

Benthic Algae

The predicted average monthly percent changes from a zero discharge baseline for benthic algae for the different discharge alternatives are shown in Figure 4-18.

One Percent Design Discharge to the Laguna. Predicted impacts from a 1 percent design discharge on benthic algae in Santa Rosa Creek range from a 1 percent decrease from a zero discharge baseline (January wet year) to a 23 percent increase from a zero discharge baseline (April wet year). Predicted impacts from a 1 percent design discharge on benthic algae in the Laguna de Santa Rosa range from less than a 1 percent change (most months and years) to a two percent increase (April normal year). Predicted impacts from a 1 percent design discharge on benthic algae in the Russian River are less than a 1 percent change except in April of a normal year where a four percent increase is predicted.

Five Percent Design Discharge to the Laguna. Predicted impacts from a 5 percent design discharge on benthic algae in Santa Rosa Creek range from a 17 percent decrease from a zero discharge baseline (February dry year) to a 22 percent increase from a zero discharge baseline (April wet year). Predicted impacts from a 5 percent design discharge on benthic algae in the Laguna de Santa Rosa range from a nine percent decrease from a zero discharge baseline (February normal year) to a six percent increase from a zero discharge baseline (June dry year). Predicted impacts from a 5 percent design discharge on benthic algae in the Russian River below the confluence with the Laguna range from no change from a zero discharge baseline (several months, all years) to a 15 percent increase from a zero discharge baseline (April, normal year).

The estimated concentrations in the receiving waters of dissolved arsenic, copper, mercury, dissolved nickel, dissolved silver, dissolved zinc, halomethanes, chlorobenzene, chloroform, dichlorobenzene, methylene chloride, tetrachloroethene, toluene, aldrin, gamma BHC (Lindane), and conductivity (50^{th} percentile point of significance) are all less than their respective points of significance for all discharge components. Therefore, the impact of discharge of reclaimed water at the concentrations predicted for the 1 percent design discharge, 5 percent design discharge, 10 percent design discharge, 20 percent design discharge to the Laguna, 20 percent design discharge to the River, No Project, and Geysers components with respect to these compounds will be less than significant.

Conductivity, cyanide, phthalates, nitrogen load and toxicity are evaluated below.

Conductivity

Compliance with the 50th percentile criteria for conductivity requires that 50 percent or more of the monthly means must be less than or equal to the point of significance (285 µmhos/cm for the Russian River below the Laguna and 250 µmhos/cm for the Russian River above the Laguna). For the lower River, the average conductivity in the Russian River at Oddfellows for each month, the percent reclaimed water for each month for the 20 percent design discharge to the Laguna and the 20 percent design discharge to the River, and the average reclaimed water conductivity were used as input to a dilution model as described for other constituents. The resulting estimated conductivity was compared to the 50th percentile point of significance (Tables 4-4 through 4-12). Fewer than six months exceeded the 50th percentile point of significance for the lower River for both the 20 percent design discharge to the Laguna and 20 percent design discharge to the River. Therefore, all discharge components will have a less than significant impact on conductivity in the lower Russian River.

The average conductivity in the Russian River at Wohler Bridge ~~Oddfellows~~ for each month was ~~also~~ used as input to the dilution model as described above to evaluate conductivity impacts in the River above the Laguna. ~~There were insufficient conductivity data available for the upper River to calculate monthly averages. However, using the lower River conductivity is conservative in that the conductivity in the upper River is likely to be similar or lower.~~ The resulting estimated conductivity was compared to the 50th percentile point of significance (Table 4-12). More than six months exceeded the 50th percentile point of significance for the upper River with a 20 percent design discharge to the River component. Therefore, a 20 percent design discharge to the River component is considered to have a significant impact on conductivity in the upper Russian River.

Cyanide

A range of concentrations of cyanide due to direct discharge to Santa Rosa Creek and the Laguna cannot be determined because of lack of information of background receiving water cyanide concentrations. However, the concentration of cyanide in Santa Rosa Creek and the Laguna was predicted assuming a background receiving water concentration of

Table 4-12.

Estimated Conductivity in the Upper and Lower Russian River with 20 Percent Design Discharge to the Laguna and the River

	Lower Russian River (point of significance = 285 µmhos/cm)			Upper Russian River (point of significance = 250 µmhos/cm)	
	Existing Conditions Lower River	**20 Percent Design Discharge to the Laguna**	**20 Percent Design Discharge to the River**	**Existing Conditions Upper River**	**20 Percent Design Discharge to the River**
October	232	268	252	217	~~255~~ 240
November	227	273	260	232	~~266~~ 270
December	267	299	292	246	~~296~~ 276
January	280	337	319	251	~~325~~ 299
February	277	321	205	224	~~309~~ 260
March	233	269	259	240	~~264~~ 271
April	266	310	294	248	~~301~~ 285
May	255	269	262	253	~~263~~ 261
June	266	266	266	263	~~266~~ 263
July	239	239	239	210	~~239~~ 210
August	232	232	232	222	~~232~~ 222
September	238	238	238	224	~~238~~ 224

0.0 mg/L, which is a reasonable estimate. The actual concentrations may be higher if cyanide is present in the receiving water. Using a background concentration of 0 mg/L, thepredicted concentrations of total cyanide in Santa Rosa Creek exceed the point of significance (0.0052 mg/L) with the 10 percent design discharge, 20 percent design discharge to the Laguna, and discharge associated with a No Project alternative. Therefore, the 10 percent design discharge, 20 percent design discharge, and discharge associated with No Project will have a significant impact on cyanide in the Santa Rosa Creek. There may be significant impacts on cyanide in Santa Rosa Creek with the 1 percent design discharge, 5 percent design discharge, and discharge associated with the Geysers alternative if the concentration of cyanide in Santa Rosa Creek is greater than zero. The predicted concentration of cyanide in the Laguna exceeds the point of significance for cyanide with the 20 percent design discharge, and discharge associated with No Project. Therefore, the 20 percent design discharge, and discharge associated with No Project will have a significant impact on cyanide in the Laguna. There may be significant impacts on cyanide in the Laguna with the 1 percent design discharge, 5

The point of significance for an adverse impact to the waste reduction strategy is also 21,500 lbs/year. Thus, a reduction in ammonia nitrogen load less than 21,500 lbs/year is a adverse impact. It is predicted that the 20 percent design discharge to the Laguna and discharge related to a No Project alternative will cause reductions in ammonia nitrogen load to the Laguna of less than 21,500 lbs/year. Therefore, the 20 percent design discharge to the Laguna and discharge related to a No Project alternative will have a significant adverse impact on the Laguna.

Table 4-14 shows a reduced ammonia nitrogen load for the 10 and 20 percent design Laguna discharge despite the fact that more reclaimed water would be discharged than under existing conditions. This is because the NCRWQCB (1995) estimate of existing load was based on an ammonia nitrogen concentration of 2 mg/L, the long term concentration of ammonia nitrogen in plant effluent (when nitrifying). Recent data (see Appendix 4 of the *Reclaimed Water Quality* Technical Report, MSC 1996) show that the ammonia nitrogen concentration in reclaimed water discharged from storage ponds has decreased to 1 mg/L). Therefore, the loads shown in Table 4-14 are based on 1 mg/L.

Toxicity

Lethal toxicity was found once in 11 tests, or in 9 percent of the tests (see *Reclaimed Water Quality Update* Technical Report, MSC 1996), and the lowest, or worst-case NOEC of reclaimed water is 25 percent. Table 4-15 shows the frequency of days that daily average reclaimed water concentration would exceed 25 percent (the worst-case no-effects concentration) in Santa Rosa Creek (section of Laguna system subject to highest concentrations) using output of the water quality model (as described in *Russian River Water Quality Model* Technical Report, RMA 1996). These frequencies of potentially toxic concentrations are then multiplied by the worst-case toxicity frequency (9 percent), to give the expected occurrence of toxic conditions in Santa Rosa Creek. These calculations are given for a dry year, an average year, and a wet year. The impact is considered significant if the frequency that toxic conditions would occur in the receiving water is greater for a discharge component that for existing conditions. Thus, the impact of discharge on toxicity is considered to be significant for the 20 percent design Laguna discharge and the No Project discharge components. Table 4-15 shows that, in a wet year, reclaimed water seldom is greater than 25 percent, so the calculated frequency of a toxic effect (0.009 times this frequency) is also seldom. A toxic effect would occur in the receiving water on less than 2 percent of discharge days under any discharge component. In a dry year, the frequency that such conditions occur would be around 8 percent under some discharge components (20 percent Laguna discharge and No Project). The frequency would be 6.1 percent under existing conditions in a dry year.

Although not shown in Table 4-15, the concentration of reclaimed water in the Laguna would also exceed 25 percent for the 20 percent design Laguna discharge and No Project discharge components. However, the concentration of reclaimed water resulting from design discharge would not exceed 25 percent in the Russian River. ~~Thus,~~ T~~t~~he impact on toxicity in the Laguna is considered to be significant for the 15 and 20 percent Laguna discharge and No Project alternatives, and the impact on toxicity in the Russian River is considered to be less than significant for all alternatives. The 5 and 10 percent design Laguna discharge would cause toxicity to occur in the receiving water at a frequency that is less than the existing condition; therefore, the impact of these design discharge alternatives is considered to be less than existing conditions. However, such discharges would not be, and the existing condition is not, in attainment of the Regional Board toxicity objective which prohibits toxicity in receiving water, and mitigation could be required by the Regional Board.

Table 4-20

Significant Adverse and Beneficial Impacts of Each Design Discharge Component[a]

Constituent	Santa Rosa Creek	Laguna	Russian River Below Laguna	Russian River Above Laguna
Benthic Algae				
Adverse	1%, 5%, 10%, 20%, 20% River, NP, G	1%, 20%, 20% River, NP, G	20%, 20% River, NP	20% River
Beneficial	1%, 5%, 10%, 20% River, G	1%, 5%, 10%, 20% River, G	1%, 5%, 10%. 20% River, G	
Planktonic Algae				
Adverse		1%, 5%, 10%, 20% River	20%	20% River
Beneficial	20%, NP	20%, NP	20% River	
Turbidity				
Adverse				20% River
Beneficial	20%	20%	20% River	
Average Dissolved Oxygen		20%		
Conductivity				20% River
Cyanide	10%, 20%, NP	20%, NP		
Toxicity	20%, NP	20%, NP		
Waste Red. Strat.			Criterion applies only to Laguna system	
Adverse				
Total Nitrogen	10%, 20%, NP			
Ammonia	20%, NP			
Beneficial				
Total Nitrogen	1%, 5%, 20% River, G			
Ammonia	1%, 5%, 10%, 20% River, G			

[a] 1% = 1% design discharge component
20% = 20% design discharge component to Laguna
20% River = 20% design discharge component to River
NP = No Project discharge component
G = Geysers discharge component

water that is discharged to the Russian River has a higher average conductivity than does the River.

An impact that is considered significant would occur as a result of discharge to the Russian River above the Laguna as proposed. Alternatives for mitigation and avoidance of this potential impact were considered as follows:

Table 4-21.

Estimated Percent Daily Average Reclaimed Water Concentrations in Receiving Waters Resulting from Project and Mitigation Operations

	Existing	1 percent design discharge		5 percent design discharge		10 percent design discharge		20 percent design Laguna Discharge		20 percent design Russian River Discharge		No Project		Geysers	
		Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Measures for the City's Consideration	Project	Mitigation
Santa Rosa Creek															
50th percentile[a]	19	0	0	6	0	11	0	35	11	0	0	29	6	0	0
95th percentile[b]	62	9[c]	19[a]	49	54[a]	67	72[a]	81[c]	83	2[c]	61	75[c]	77	6	3.1[a]
99th percentile	71	13[d]	22	56	59	69	76	83[c]	87	4	82[c]	79[c]	79	7	6[d]
100th percentile	79	14[d]	26	61	64	76	79	84[c]	89	36	86	81[c]	84	8	7[d]
Laguna at River Rd															
50th percentile[a]	8	0	0	3	0	5	0	17	5	0	0	13	3	0	0

Table 4-21.

Estimated Percent Daily Average Reclaimed Water Concentrations in Receiving Waters Resulting from Project and Mitigation Operations

	Existing	1 percent design discharge		5 percent design discharge		10 percent design discharge		20 percent design Laguna Discharge		20 percent design Russian River Discharge		No Project		Geysers	
		Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Measures for the City's Consideration	Project	Mitigation
95th percentile[b]	38	4[c]	8[a]	26	31[a]	43	49[a]	61[c]	64	0.6[c]	37	53[c]	55	2	1[a]
99th percentile	47	5[c]	10[d]	32	34	45	52	64[c]	71	2	64[c]	57[c]	59	3	3[d]
100th percentile	58	6[d]	12[d]	35	39	52	58	65[c]	76	16	67	60[c]	64	4	3[d]
Russian River at Oddfellows															
50th percentile[a]	1	0	0	0.3	0	0.6	0	3	0.7	2	0.6	2	0.5	0	0

Table 4-21.

Estimated Percent Daily Average Reclaimed Water Concentrations in Receiving Waters Resulting from Project and Mitigation Operations

	Existing	1 percent design discharge		5 percent design discharge		10 percent design discharge		20 percent design Laguna Discharge		20 percent design Russian River Discharge		No Project		Geysers	
		Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Measures for the City's Consideration	Project	Mitigation
95th percentile[b]	7	0.5[c]	1	5	5	10	10	15	21	10	15	10	19	0.4	0.2[a]
99th percentile	10	1[d]	1	5	5	10	11	19	21	11	18[c]	11	26	0.6	0.5[d]
100th percentile	10	1[d]	1	6	6	11	11	20	22	11	19[c]	11	27	1	0.6[d]
Russian River at SCWA Wohler intakes															
50th percentile[a]	0	0	0	0	0	0	0	0	0	3	.8	0	0	0	0
95th percentile[b]	0	0	0	0	0	0	0	0	0	11	14	0	0	0	0

Table 4-21.

Estimated Percent Daily Average Reclaimed Water Concentrations in Receiving Waters Resulting from Project and Mitigation Operations

	Existing	1 percent design discharge		5 percent design discharge		10 percent design discharge		20 percent design Laguna Discharge		20 percent design Russian River Discharge		No Project		Geysers	
		Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Mitigation	Project	Measures for the City's Consideration	Project	Mitigation
99th percentile										14	14				
100th percentile										14	15				

[a] 50th percentile concentration in normal hydrologic year (1961) is given.

[b] The maximum of the three ~~95th percentile~~ concentrations (dry, normal, wet) at a particular percentile is shown. The maximum occurred in the dry year (1976) unless noted otherwise.

[c] Highest concentration~~95th percentile value~~ occurred in 1961, not 1976

[d] No discharge was projected to occur in 1976 under the 1 percent design discharge. Value occurred in 1961.

measures for the City's consideration to avoid impacts from discharge associated with the No Project alternative are also assessed.

Source Control Program

Cyanide

Cyanide sources are expected to be identifiable and controllable. Therefore, a cyanide control program is expected to fully mitigate the significant impact that may be identified if monitoring of stored effluent shows that stored effluent can cause exceedences of the point of significance in receiving waters.

Nitrogen

Nonpoint source control measures applicable to local conditions have been developed and tested (EPA 1993c, Gold Ridge RCD 1995). Implementation of control measures as needed to achieve the necessary Laguna nitrogen load reduction is considered feasible. Therefore, the adverse impacts of the 10 percent design discharge, 20 percent design Laguna discharge and the No Project discharge components would be considered insignificant if the mitigation is implemented.

Ammonia is a component of total nitrogen which would be reduced by implementing nitrogen control measures. In particular, focusing on nitrogen sources for which ammonia represents a particularly high proportion of the total ammonia (such as dairy agriculture) would increase the ammonia control benefit. The effectiveness of this mitigation is addressed below in the Discharge Management Strategy section.

Toxicity Control Program

The TIE/TRE process may be protracted and expensive, but the technology exists (as described in EPA 1989, EPA 1991b, EPA 1993a, b) to successfully identify and control toxicity-causing constituents in effluents exhibiting consistent toxicity. Therefore, this mitigation measure is considered to be effective.

Discharge Management Strategy

The mitigation operation strategy for biostimulatory substances would reduce, but not eliminate significant adverse impacts of discharge components on benthic algae, planktonic algae, and turbidity. The mitigation operations strategy would not eliminate the single occurrence of an average dissolved oxygen significant impact.

The potential water quality impacts, except for minimum dissolved oxygen, of the mitigation operating strategy for biostimulatory substances are compared in Figures 4-36 through 4-39 to the potential impact of project operations. Figures 4-36 through 4-39 compare the water quality impact of project and mitigation operations only for constituents and discharge components for which significant adverse impacts of project operations and/or project operations with mitigation were identified. Therefore, not all constituents are graphed for all discharge components. The predicted minimum dissolved oxygen concentrations for the discharge alternatives with the mitigation operating strategy for biostimulatory substances are shown in Table 25A. Tables 4-26 and 4-27 showsummarize the number of significant adverse and beneficial impacts, respectively, that were identified using the analysis approach described above and the number of significant adverse and beneficial impacts resulting from project and mitigation operations. The number of analyses is equal to the number stream segments in which impacts were summarized (3 for all discharge components except the 20 percent River discharge, in which case 4 reaches were considered) times the number of hydrologic conditions (3; dry, normal and wet years) times the number months in each year (12 months/year). Tables 4-26 and 4-27 show the number of adverse or beneficial impacts for benthic algae, planktonic algae, turbidity, and average dissolved oxygen potentially caused by each discharge component expressed as a percentage of the number of analyses. For example, the 1 percent discharge component caused exceedance of the benthic algae point of significance in 4 of 108 cases (4 percent). Table 4-26 does not include conductivity; exceedance would be caused in only one of six cases (in the Russian River above Laguna in a dry year). Tables 4-26 and 4-27 do not include conductivity, cyanide, toxicity or waste reduction strategy (total nitrogen and ammonia loads to the Laguna) because only one opportunity for exceedance (and beneficial impacts in the case of total nitrogen and ammonia loads) is possible, except for ammonia in the Russian River. No significant impacts of ammonia occurred in the Russian River. Table 4-28 describes the locations of significant adverse and beneficial impacts. Tables 4-26, 4-27, and 4-28 do not include minimum dissolved oxygen since no significant impacts are predicted to occur with design discharge or with the mitigation operations strategy for biostimulatory substances.

Table 4-26 suggests that mitigation operations for biostimulatory substances do not reduce the number of significant impacts for the 1, 5 and 10 percent design discharge components, and that mitigation operation substantially reduces the incidence of significant benthic algae impacts for the other discharge components. Furthermore, the number or incidence of significant impacts for the 1, 5 and 10 percent design discharge components is considered to be low (four percent or less). Therefore, mitigation operations for biostimulatory substances are recommended only for the 20 percent Laguna, 20 percent River, Geysers and No Project design discharge components. Table 4-27 shows that mitigation operations generally increase the number of beneficial impacts of these same discharge components.

Table 4-26 shows the single significant adverse impact on turbidity, which would occur in the River above the Laguna as a result of the 20 percent design discharge to the River. Mitigation operations for biostimulatory substances would avoid this impact.

Table 4-25A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Mitigation Operations for Biostimulatory Substances (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Santa Rosa Creek																					
Oct	7.5	7.9	7.7	7.5	7.9	8.0	7.5	7.9	8.0	7.5	7.9	8.0	7.5	7.9	8.0	7.5	7.9	8.0	7.5	7.9	8.0
Nov	7.6	8.3	8.2	7.6	8.3	8.4	7.6	8.3	8.4	7.6	8.3	8.4	7.6	7.0	6.8	7.6	8.2	8.4	7.6	8.3	8.4
Dec	8.6	8.3	8.6	8.7	9.2	8.7	8.7	8.9	8.6	8.6	7.2	8.6	8.3	8.4	8.7	8.4	8.9	8.7	8.7	9.2	8.8
Jan	8.9	8.9	8.8	8.8	9.6	8.5	8.8	8.9	8.5	8.6	8.6	8.5	8.3	8.4	8.5	7.2	8.6	8.4	8.9	9.9	9.0
Feb	8.8	8.4	8.5	8.8	8.9	8.7	8.9	8.6	8.7	8.9	8.4	8.7	8.8	8.3	8.5	8.9	8.1	8.6	8.9	9.0	8.9
Mar	8.7	8.3	8.6	8.7	8.3	8.7	8.7	8.3	8.7	8.7	8.3	8.7	8.1	6.1	8.7	8.7	8.3	8.7	8.7	8.3	8.7
Apr	8.3	8.0	8.5	8.4	7.9	8.7	8.4	7.9	8.7	8.4	7.9	8.7	8.3	7.8	8.7	8.4	7.9	8.7	8.4	7.9	8.7
May	7.1	5.7	8.0	7.1	5.9	8.0	7.1	5.9	8.0	7.1	5.9	8.0	7.1	5.9	8.0	7.1	5.9	8.0	7.1	5.9	8.0
Jun	6.2	6.1	7.6	6.2	6.3	7.6	6.2	6.3	7.6	6.2	6.3	7.6	6.2	6.3	7.6	6.2	6.3	7.6	6.2	6.3	7.6
Jul	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5	6.4	6.0	7.5
Aug	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4	6.3	5.9	7.4
Sep	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9	6.7	6.8	7.9
Laguna de Santa Rosa																					
Oct	7.9	8.2	8.2	7.9	8.2	8.2	7.9	8.2	8.2	7.9	8.2	8.2	7.9	8.2	8.2	7.9	8.2	8.2	7.9	8.2	8.2

Table 4-25A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Mitigation Operations for Biostimulatory Substances (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Nov	8.0	8.8	8.2	8.0	8.8	8.2	8.0	8.8	8.2	8.0	8.8	8.2	8.0	8.8	8.2	8.0	8.8	8.2	8.0	8.8	8.2
Dec	8.0	8.1	9.0	8.0	8.1	9.0	8.0	8.1	9.0	8.0	8.1	9.0	8.0	8.1	9.0	8.0	8.1	9.0	8.0	8.1	9.0
Jan	8.8	10.1	9.2	8.8	10.2	9.1	8.8	10.1	9.1	8.8	9.9	9.1	8.8	9.6	9.1	8.8	9.9	9.1	8.8	10.2	9.2
Feb	8.9	7.2	9.1	8.9	7.2	9.1	9.0	7.2	9.2	9.0	7.3	9.2	8.9	7.3	9.1	8.9	7.2	9.1	8.9	7.2	9.2
Mar	8.9	7.0	8.7	8.9	7.1	8.7	8.9	7.1	8.7	8.9	7.3	8.7	8.8	7.1	8.7	8.9	7.0	8.7	8.9	7.0	8.7
Apr	8.5	7.4	8.5	8.7	7.2	8.5	8.7	7.2	8.5	8.7	7.3	8.5	8.7	7.2	8.5	8.7	7.2	8.5	8.7	7.2	8.5
May	7.4	6.7	7.8	7.4	7.0	7.8	7.4	7.0	7.8	7.4	7.0	7.8	7.4	7.0	7.8	7.4	7.0	7.8	7.4	7.0	7.8
Jun	7.0	6.6	7.5	7.0	6.8	7.5	7.0	6.8	7.5	7.0	6.8	7.5	7.0	6.8	7.5	7.0	6.8	7.5	7.0	6.8	7.5
Jul	6.9	6.5	7.4	6.9	6.5	7.4	6.9	6.5	7.4	6.9	6.5	7.4	6.9	6.5	7.4	6.9	6.5	7.4	6.9	6.5	7.4
Aug	6.8	6.6	7.3	6.8	6.6	7.3	6.8	6.6	7.3	6.8	6.6	7.3	6.8	6.6	7.3	6.8	6.6	7.3	6.8	6.6	7.3
Sep	7.3	7.3	7.6	7.3	7.3	7.6	7.3	7.3	7.6	7.3	7.3	7.6	7.3	7.3	7.6	7.3	7.3	7.6	7.3	7.3	7.6
Russian River above the Laguna																					
Oct	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1	9.2	9.1	9.1
Nov	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.6	9.4	9.6	9.5	9.4	9.6	9.6
Dec	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.4	10.6	10.6	10.2	10.6	10.6	10.4	10.6

Table 4-25A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Mitigation Operations for Biostimulatory Substances (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Jan	10.8	11.1	10.8	10.8	11.1	10.8	10.8	11.1	10.8	10.8	11.1	10.8	10.8	11.1	10.8	10.7	10.6	10.8	10.8	11.1	10.8
Feb	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.7	10.7	10.8	10.4	10.7	10.8	10.7	10.7
Mar	10.6	9.9	10.3	10.6	9.9	10.3	10.6	9.9	10.3	10.6	9.9	10.3	10.6	9.9	10.3	10.5	9.5	10.3	10.6	9.9	10.3
Apr	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8	9.6	9.0	9.8
May	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.4	8.8	8.6	8.5	8.8	8.6	8.4	8.8
Jun	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.5	8.6	8.6	8.4	8.5	8.6
Jul	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5
Aug	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4	8.5	8.6	8.4
Sep	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5	8.6	8.7	8.5
Russian River below the Laguna																					
Oct	8.9	8.8	8.8	8.9	8.8	8.8	8.9	8.8	8.8	8.9	8.8	8.8	8.9	8.8	8.8	9.1	9.0	9.0	8.9	8.8	8.8
Nov	9.1	9.3	9.0	9.1	9.3	9.1	9.1	9.3	9.1	9.1	9.3	9.1	9.1	9.3	9.0	9.3	9.4	9.3	9.1	9.3	9.1
Dec	9.7	9.9	10.2	9.7	10.0	10.2	9.7	10.0	10.2	9.7	10.0	10.2	9.7	9.9	10.1	9.8	10.1	10.3	9.7	10.0	10.2
Jan	10.1	10.8	10.3	10.1	10.8	10.3	10.1	10.8	10.3	10.0	10.8	10.3	10.1	10.7	10.3	10.3	10.6	10.4	10.1	10.8	10.3
Feb	10.2	10.0	10.1	10.2	10.1	10.1	10.2	10.0	10.1	10.2	10.0	10.1	10.2	10.1	10.1	10.4	10.2	10.3	10.2	10.1	10.1

Table 4-25A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Mitigation Operations for Biostimulatory Substances (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
Mar	10.1	9.3	9.6	10.1	9.3	9.7	10.1	9.3	9.6	10.1	9.3	9.6	10.1	9.3	9.6	10.3	9.3	9.9	10.1	9.3	9.7
Apr	9.3	8.6	9.4	9.4	8.5	9.4	9.4	8.5	9.4	9.4	8.5	9.4	9.4	8.5	9.4	9.4	8.7	9.5	9.4	8.5	9.4
May	8.1	7.6	8.5	8.1	7.6	8.5	8.1	7.6	8.5	8.1	7.6	8.5	8.1	7.6	8.5	8.3	8.0	8.7	8.1	7.6	8.5
Jun	7.9	7.7	8.0	7.9	7.8	8.0	7.9	7.8	8.0	7.9	7.8	8.0	7.9	7.8	8.0	8.2	8.3	8.5	7.9	7.8	8.0
Jul	8.3	8.2	8.0	8.3	8.2	8.0	8.3	8.2	8.0	8.3	8.2	8.0	8.3	8.2	8.0	8.7	8.7	8.6	8.3	8.2	8.0
Aug	8.1	8.1	7.9	8.1	8.1	7.9	8.1	8.1	7.9	8.1	8.1	7.9	8.1	8.1	7.9	8.5	8.6	8.4	8.1	8.1	7.9
Sep	8.3	8.3	8.2	8.3	8.3	8.2	8.3	8.3	8.2	8.3	8.3	8.2	8.3	8.3	8.2	8.6	8.6	8.5	8.3	8.3	8.2
Lower Russian River																					
Oct	8.7	8.9	8.9	8.7	8.9	8.9	8.7	8.9	8.9	8.7	8.9	8.9	8.7	8.9	8.9	9.0	9.0	9.0	8.7	8.9	8.9
Nov	8.9	9.1	9.1	8.9	9.1	9.1	8.9	9.1	9.1	8.9	9.1	9.1	8.9	9.1	9.1	9.1	9.3	9.3	8.9	9.1	9.1
Dec	9.6	9.8	10.1	9.6	9.8	10.1	9.6	9.8	10.1	9.6	9.8	10.1	9.6	9.8	10.1	9.7	9.9	10.3	9.6	9.8	10.1
Jan	10.1	10.7	10.3	10.1	10.7	10.3	10.1	10.7	10.2	10.0	10.6	10.2	10.1	10.5	10.2	10.3	10.6	10.4	10.1	10.7	10.3
Feb	10.2	9.8	10.1	10.2	9.9	10.1	10.2	9.8	10.1	10.2	9.9	10.1	10.2	9.9	10.1	10.4	10.1	10.3	10.2	10.0	10.1
Mar	10.1	9.3	9.7	10.1	9.3	9.7	10.1	9.3	9.7	10.1	9.3	9.7	10.1	9.2	9.7	10.3	9.3	9.9	10.1	9.3	9.7
Apr	9.3	8.6	9.3	9.3	8.7	9.3	9.3	8.7	9.3	9.3	8.7	9.3	9.4	8.7	9.3	9.4	8.9	9.4	9.3	8.7	9.3

Table 4-25A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Mitigation Operations for Biostimulatory Substances (in mg/L)

	Existing Conditions			1 Percent			5 Percent			10 Percent			20 Percent to the Laguna			20 Percent to the Russian River			Geysers		
	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year	Normal Year	Dry Year	Wet Year
May	8.4	7.4	8.8	8.4	7.6	8.8	8.4	7.6	8.8	8.4	7.6	8.8	8.4	7.6	8.8	8.5	8.1	8.8	8.4	7.6	8.8
Jun	7.9	7.3	7.9	7.9	7.3	7.9	7.9	7.3	7.9	7.9	7.3	7.9	7.9	7.3	7.9	8.3	8.2	8.7	7.9	7.3	7.9
Jul	8.0	7.9	7.9	8.0	7.9	7.9	8.0	7.9	7.9	8.0	7.9	7.9	8.0	7.9	7.9	8.7	8.8	8.8	8.0	7.9	7.9
Aug	7.8	7.9	7.7	7.8	7.9	7.7	7.8	7.9	7.7	7.8	7.9	7.7	7.8	7.9	7.7	8.5	8.6	8.5	7.8	7.9	7.7
Sep	8.1	8.0	8.1	8.1	8.0	8.1	8.1	8.0	8.1	8.1	8.0	8.1	8.1	8.0	8.1	8.5	8.5	8.5	8.1	8.0	8.1

[a] Dissolved oxygen minima are based on hourly estimates

Table 4-26.

Number of Significant Adverse Impacts of Project and Mitigation Operations (percent of the total number of analyses)

Discharge Component	No. Analyses[a]	Benthic Algae		Planktonic Algae		Turbidity		Average Dissolved Oxygen	
		Project	Mitig	Project	Mitig	Project	Mitig	Project	Mitig
1%	108	4%	6%[b]	1%	1%	0%	0%	0%	0%
5%	108	1%	1%	1%	1%	0%	0%	0%	0%
10%	108	1%	1%	1%	1%	0%	0%	0%	0%
20%	108	46%	11%	1%	0%	0%	0%	1%	2%[c]
20% River	144	24%	11%	2%	1%	1%	0%	0%	0%
Geysers	108	9%	4%	0%	0%	0%	0%	0%	0%
No Project[d]	108	45%	0%	0%	0%	0%	0%	0%	11%[b]

a This column shows the maximum number of significant impacts that could be identified using the evaluation approach described in this report (108 = 3 stream segments *x* 3 types of years *x* 12 months/year, 144 = 4 stream segments x 3 types of years x 12 months/year).

b Increases in benthic algae with mitigation probably a result of increased reclaimed water concentrations in one month (March).

c Decreases in average dissolved oxygen concentration with mitigation as a result of decreases in oxygen-producing benthic algae.

d For No Project, shown are number of significant adverse impacts of project and measures for the City's consideration.

Table 4-28

Significant Adverse and Beneficial Impacts of Each Design Discharge Component[a] After Mitigation[b]

Constituent	Santa Rosa Creek	Laguna	Russian River Below Laguna	Russian River Above Laguna
Benthic Algae				
Adverse	1%, 20%, 20% River, G	1%, 20% 20% River, G	20%, 20% River	20% River
Beneficial	1%, 20%, 20% River, G, NP	1%, 20%, 20% River, G, NP	1%,20%, 20% River, G, NP	
Planktonic Algae				
Adverse		1%, 20% River	20%	20% River
Beneficial	20%	20%, NP	20% River	
Average Dissolved Oxygen	20%, NP	20%, NP		
Turbidity				
Adverse				
Beneficial				
Conductivity				20% River
Cyanide				
Toxicity				
Waste Red. Strat.			Criterion applies only to Laguna system	
Adverse				
Total nitrogen				
Ammonia				
Beneficial				
Total nitrogen	1%, 20% River, G			
Ammonia	1%, 20% River, G			

[a] 1% = 1% design discharge component
20% = 20% design discharge component to Laguna
20% River = 20% design discharge component to River
NP = No Project discharge component
G = Geysers discharge component
Since impacts were evaluated for all months and three hydrologic years, both beneficial and adverse impacts can result for some parameters at different times from the same component.

[b] Mitigation of benthic algae, planktonic algae, and average dissolved oxygen involves revising discharge operations to minimize discharge during fall and spring. Mitigation for cyanide involves a source identification and control program. Mitigation for waste reduction strategy (total nitrogen load and ammonia load) is to reduce nitrogen load to the Laguna at appropriate sources. No mitigation for conductivity impacts is identified.

Removal of nitrogen from reclaimed water down to a total inorganic nitrogen concentration of 2 mg/L with mitigation operations for biostimulatory substances was evaluated as an alternative to mitigation operations for biostimulatory substances alone to mitigate for impacts of project operations. A comparison of mitigation operations to mitigation operations with nitrogen removal is provided in Table 4-29. Table 4-29 does not include waste reduction strategy (total nitrogen and ammonia loads to the Laguna) because only one opportunity for exceedance (and beneficial impacts in the case of total nitrogen and ammonia loads) is possible, except for ammonia in the Russian River. No significant impacts of ammonia occurred in the Russian River. Nitrogen removal for purposes of reducing significant impacts is not recommended for the following reasons:

- The incidence of significant impacts is low with implementation of mitigation operations for biostimulatory substances alone. For example, the incidence of significant impacts on benthic algae for the 20 percent design discharge to the Laguna is 12/108 or 11 percent. Mitigation operations without nitrogen removal can be implemented at no cost.
- Nitrogen removal from reclaimed water does not avoid significant impacts. The 11-percent incidence of significant benthic algae impacts is reduced only slightly to 5 percent. The estimated capital cost of nitrogen removal is up to $21.5 million (see *Treatment Wetlands Evaluation*, September 1995). The water quality benefit of nitrogen removal is considered insufficient to justify the cost.

Table 4-29.

Number of Significant Adverse Impacts of Mitigation Operations and Mitigation Operations With Nitrogen Removal (percent of the maximum)

Discharge Component	Max. No.[a]	Benthic Algae		Planktonic Algae		Average Dissolved Oxygen	
		Mitig.	Mitig-N	Mitig.	Mitig-N	Mitig.	Mitig-N
1%	108	6%	4%	1%	0	0	0
5%	108	1%	1%	1%	0	0	0
10%	108	1%	1%	1%	0	0	0
20%	108	11%	6%	0	0	2	2%
20% River	144	11%	8%	1%	1	0	0
Geysers	108	4%	3%	0	0	0	0
No Project[b]	108	0	0	0	0	12	11%

a This column shows the maximum number of significant impacts that could be identified using the evaluation approach described in this report (108 = 3 stream segments x 3 types of years x 12 months/year), 144 = 4 stream segments x 3 types of years x 12 months/year).

b For No Project shown are number of significant adverse impacts of measures for the City's consideration.

exceed their respective points of significance. An analysis of the impact of contingency discharge was not conducted for waste load reduction to the Laguna since the waste load reduction strategy is based on a long-term annual average. Contingency discharge would not enter into the long-term annual average since contingency discharge would occur infrequently.

Algae, Dissolved Oxygen, Temperature and Ammonia

The distribution of daily average reclaimed water concentration in Santa Rosa Creek, the Laguna de Santa Rosa, and the Russian River during a very dry year (1977) is shown in Figures 4-40 through 4-43. These figures show daily average reclaimed water concentrations for discharge components which include contingency discharge. These distributions are very similar to what the distribution of reclaimed water concentration for a 1977 design discharge would be because contingency discharges take place only on a few dates in 1977. Concentrations under mitigation operations are also shown.

The results of the water quality impact evaluation for benthic and planktonic algae, average dissolved oxygen, ammonia, and temperature are shown in Figures 4-44 through 4-58 for the 10 percent, 20 percent, and 20 percent River components. Water quality impacts of design discharge alone and design plus contingency discharge are shown. The effects of design plus contingency discharge under mitigation operations is also shown. The predicted minimum dissolved oxygen with design plus contingency discharge are given in Table 4-30A. For all parameters in Figures 4-44 through 4-58 and Table 30A, a~~A~~ll months in the simulated year (1977) are shown, but contingency discharge would only occur in January and February under the 10 percent component, and only in January, February, and April under the 20 percent and 20 percent River discharge components. Significant adverse impacts of contingency discharge are listed in Table 4-31. No beneficial impacts of contingency discharge were identified. These impacts are only listed for months during contingency discharge. Except for ammonia (discussed below), an impact is indicated if the simulation for design and contingency discharges resulted in a significant increase. Therefore a significant impact as shown is not necessarily due to the incremental effect of contingency discharge above design discharges. In fact, Figures 4-44 through 4-58 show that the effects of design discharge and design plus contingency discharge are about the same.

Table 4-30A

Predicted Minimum[a] Dissolved Oxygen Concentrations of Contingency Discharge and Contingency Discharge with Mitigation Operations for Biostimulatory Substances[b] (in mg/L)

		Contingency Discharge			Contingency Discharge with Mitigation Operations for Biostimulatory Substances		
	Existing Conditions	10 Percent	20 Percent to the Laguna	20 Percent to the River	10 Percent	20 Percent to the Laguna	20 Percent to the River
Santa Rosa Creek							
Oct	7.6	6.8	7.7	6.8	6.8	6.8	6.8
Nov	7.0	7.2	8.0	7.2	7.2	7.2	7.2
Dec	6.9	7.5	8.2	8.7	7.8	8.3	6.7
Jan[c]	8.5	8.5	8.4	8.3	8.5	8.3	6.7
Feb[c]	8.4	8.5	8.4	8.2	8.5	8.3	8.1
Mar	8.2	8.2	8.2	8.2	8.2	6.3	6.2
Apr[c]	5.7	7.9	8.0	7.4	7.4	7.4	7.4
May	5.4	5.4	5.3	5.4	5.4	5.4	5.4
Jun	5.2	5.1	5.0	5.1	5.1	5.1	5.1
Jul	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Aug	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Sep	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Laguna de Santa Rosa							
Oct	7.4	7.3	7.5	7.3	7.3	7.3	7.3
Nov	8.0	7.9	8.2	7.9	7.9	7.9	7.9
Dec	8.3	8.3	8.4	8.2	8.3	8.3	7.9
Jan[c]	7.6	7.9	7.8	7.1	7.9	8.2	8.1
Feb[c]	9.3	9.3	9.3	9.1	9.2	9.2	9.2
Mar	5.4	4.9	5.3	4.3	5.9	6.5	5.2
Apr[c]	7.9	7.6	7.9	6.8	6.9	6.9	6.8
May	6.5	6.4	6.3	6.3	6.4	6.4	6.3
Jun	5.6	5.5	5.4	5.5	5.6	5.6	5.5
Jul	5.7	5.6	5.7	5.6	5.6	5.7	5.6
Aug	5.9	5.9	5.9	5.9	5.9	5.9	5.9

Table 4-30A

Predicted Minimum[a] Dissolved Oxygen Concentrations of Contingency Discharge and Contingency Discharge with Mitigation Operations for Biostimulatory Substances[b] (in mg/L)

		Contingency Discharge			Contingency Discharge with Mitigation Operations for Biostimulatory Substances		
	Existing Conditions	10 Percent	20 Percent to the Laguna	20 Percent to the River	10 Percent	20 Percent to the Laguna	20 Percent to the River
Sep	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Russian River above the Laguna							
Oct	8.8	8.8	8.8	8.7	8.8	8.8	8.8
Nov	8.9	8.9	8.9	8.7	8.9	8.9	8.9
Dec	10.2	10.2	10.2	9.9	10.2	10.2	10.0
Jan[c]	10.7	10.7	10.7	10.3	10.7	10.7	10.2
Feb[c]	10.4	10.4	10.4	10.2	10.4	10.4	10.1
Mar	9.8	9.8	9.8	9.6	9.8	9.8	9.5
Apr[c]	8.9	8.9	8.9	8.7	8.9	8.9	8.9
May	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Jun	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Jul	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Aug	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Sep	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Russian River below the Laguna							
Oct	8.1	8.3	8.1	8.2	8.3	8.3	8.3
Nov	8.3	8.5	8.3	8.3	8.5	8.5	8.5
Dec	8.9	8.8	8.9	8.8	8.8	8.9	8.8
Jan[c]	8.8	8.7	8.8	8.7	8.7	8.8	8.8
Feb[c]	9.8	9.8	9.8	9.7	9.8	9.8	9.7
Mar	6.6	6.6	6.8	6.8	6.6	6.9	6.8
Apr[c]	8.4	8.6	8.5	8.3	8.3	8.3	8.3
May	7.4	7.4	7.4	7.4	7.4	7.5	7.4
Jun	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Jul	7.5	7.5	7.5	7.5	7.5	7.5	7.5

Table 4-30A

Predicted Minimum[a] Dissolved Oxygen Concentrations of Contingency Discharge and Contingency Discharge with Mitigation Operations for Biostimulatory Substances[b] (in mg/L)

		Contingency Discharge			**Contingency Discharge with Mitigation Operations for Biostimulatory Substances**		
	Existing Conditions	**10 Percent**	**20 Percent to the Laguna**	**20 Percent to the River**	**10 Percent**	**20 Percent to the Laguna**	**20 Percent to the River**
Aug	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Sep	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Lower Russian River							
Oct	8.0	8.2	7.9	8.1	8.2	8.2	8.2
Nov	8.0	8.3	7.9	8.1	8.3	8.3	8.3
Dec	9.1	9.1	8.9	9.0	9.1	9.0	9.0
Jan[c]	7.4	7.4	7.4	7.4	7.4	7.5	7.5
Feb[c]	9.4	9.4	9.4	9.4	9.4	9.4	9.5
Mar	4.2	4.2	4.5	4.6	4.3	4.6	4.6
Apr[c]	9.1	9.2	9.1	9.1	8.9	8.9	8.9
May	7.1	7.1	7.0	7.0	7.1	7.1	7.1
Jun	6.6	6.6	6.6	6.6	6.7	6.7	6.7
Jul	6.8	6.8	6.8	6.8	6.9	6.9	6.9
Aug	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Sep	7.4	7.4	7.4	7.4	7.4	7.4	7.4

[a] Dissolved oxygen minima are based on hourly estimates.

[b] Minimum dissolved oxygen concentrations which are more than 0.5 mg/L below the estimated existing concentration and below the point of significance (6.0 mg/L for Santa Rosa Creek and 7.0 mg/L for the Laguna and Russian River) are shown in bold for months in which contingency discharge will occur.

[c] Contingency discharge would only occur in January and February under the 10 percent component and only in January, February, and April under the 20 percent and 20 percent River discharge components.

The 20 percent River contingency discharge component would result in a significant increase in benthic algae in Santa Rosa Creek; increases in benthic algae, and planktonic algae in the Russian River above the Laguna; and an increase in planktonic algae in the Laguna. Both the 10 percent and 20 percent Laguna discharges would also increase the planktonic algae biomass in the Laguna. All of these impacts are adverse. No beneficial impacts of contingency discharge on these constituents are predicted by the model.

Contingency discharges would not significantly affect average dissolved oxygen concentrations or temperature in any of the stream zones. With 20 percent contingency discharge to the Russian River, predicted minimum dissolved oxygen in the Laguna de Santa Rosa was 6.8 mg/L in April (Table 4-30A), which is below the point of significance for minimum dissolved oxygen in the Laguna. Therefore, a significant impact on dissolved oxygen in the Laguna is predicted to occur with 20 percent contingency discharge to the Laguna. The predicted minimum dissolved oxygen in the Laguna in April 1977 with 20 percent discharge to the River and no contingency discharge is also 6.8 mg/L. Therefore, the effect on minimum dissolved oxygen is the same for design discharge and design plus contingency discharge. Since no discharge is entering the Laguna with a 20 percent design plus contingency discharge to the River, the effect on dissolved oxygen is not directly due to discharge but to removal of discharge. A likely explanation is that the reduced flow in the Laguna relative to existing conditions which include Laguna discharge, reduces the flushing effect of increased flow. This increases phytoplankton density which leads to increased dissolved oxygen fluctuations and, thus, a lower minimum dissolved oxygen concentration. Because reduced flows in the Laguna appear to cause the significant decrease in minimum dissolved oxygen concentrations, the decrease in dissolved oxygen can be avoided by discharging to the Laguna during a very dry year such as 1977.

Simulated ammonia concentrations in the Russian River above the Laguna under the 20 percent River component (Figure 4-55) show large (approximately 200 percent) increases, but this is because baseline concentrations were near zero during this period. Actual concentrations simulated would increase from around 0.1 to 0.4 mg/L.

Ammonia was evaluated for significant impacts as described in Section 4.1.4 Impact Evaluation Approach. Most predicted maximum total ammonia concentrations in the Russian River with contingency discharge were less than 0.76 mg-N/L, and thus represent no significant impact of contingency discharge on ammonia. The few predicted total ammonia concentrations in the Russian River with contingency discharge greater than 0.76 mg-N/L were all within five percent of the existing conditions. Thus the impact of contingency discharge on ammonia in the Russian River is considered to be less than significant.

Contingency discharge has no effect on average annual ammonia load. Therefore, contingency discharge has no impact on ammonia in the Laguna and Santa Rosa Creek.

Table 4-32 shows the number of significant adverse impacts of contingency discharge under project and biostimulatory substances mitigation operations. Approximately one-third of the possible impacts on planktonic algae would be adverse under all three contingency discharge components. Mitigation operations would reduce the number of adverse impacts only in a single case.

Table 4-31

Significant Adverse and Beneficial Impacts of Contingency Discharge[a]

Constituent	Santa Rosa Creek	Laguna de Santa Rosa	Russian River below Laguna	Russian River above Laguna
Benthic Algae				
Adverse	20% River			20% River
Beneficial				
Planktonic Algae				
Adverse		10%, 20%, 20% River		20% River
Beneficial				
Average Dissolved Oxygen				
Adverse				
Minimum Dissolved Oxygen				
Adverse		20 % River		
Ammonia				
Cyanide	10%, 20%	10%, 20%		
Conductivity				20% River
Toxicity	20%	20%		

[a] 10% = 10 percent design discharge scenario component 20% = 20 percent design discharge scenario component to Laguna 20% River = 20 percent design discharge scenario component to River. Since impacts were evaluated for all months and three hydrologic years, both beneficial and adverse impacts can result at different times from the same component.

Table 4-32

Number of Significant Adverse Impacts of Contingency Discharge Under Project and Mitigation Operations

Discharge Component	Max. No.[a]	Benthic Algae		Planktonic Algae		Average Dissolved Oxygen		Minimum Dissolved Oxygen		Ammonia		Temperature	
		Proj	Mit	Proj	Mit	Proj	Mit	Proj	Mit	Proj	Mit	Proj	Mit
10%	6[b]	0	0	2	2	0	0	0	0	0	0	0	0
20%	9[c]	3	3	2	2	0	0	0	0	0	2~~1~~	0	0
20%R	12[d]	0	0	4	3	0	0	1	3	0	0	0	0

a This column show the maximum number of significant impacts that could be identified using this evaluation approach.
b 6 = 3 stream segments x 1 type of year x 2 months/year that include contingency discharges.
c 9 = 3 stream segments x 1 type of year x 3 months/year that include contingency discharges.
d 12 = 4 stream segments x 1 type of year x 3 months/year that include contingency discharges.

Significant adverse impacts after biostimulatory substances mitigation operations are listed in Table 4-33. The mitigation discharge operating scenario was developed to reduce design discharge impacts by minimizing discharge in fall and spring and maximizing discharge in winter. Simulations show that this strategy is an effective means of mitigating design discharge impacts, but the strategy causes a slight increase in the frequency of contingency discharge. Nonetheless, mitigation operations would have little effect on the impact of contingency discharge scenarios, in part because mitigation operations that involve decreased discharges would not occur during months when contingency discharges take place. The significant increase in planktonic algae in the Russian River above the Laguna would be mitigated by mitigation operations (see Figure 4-49), but a significant increase in benthic algae in Santa Rosa Creek under the 10 percent component would also result from mitigation operations (Figure 4-44). Biostimulatory substances mitigation operations with contingency discharge is predicted to cause significant decreases in minimum dissolved oxygen concentrations with all three discharge alternatives (10 percent contingency discharge, 20 percent contingency discharge to the Laguna, and 20 percent contingency discharge to the River).

Ammonia concentrations in the Russian River below the confluence with a 20 percent contingency discharge to the Laguna and biostimulatory substances mitigation operations are predicted to exceed the point of significance for ammonia in two ~~one~~ months (January and February). This increase in ammonia is greater than five percent above existing conditions. Therefore, the impact of a 20 percent contingency discharge to the Laguna and biostimulatory substances mitigation operations is considered to be significant.

Table 4-33

Significant Adverse and Beneficial Impacts of Contingency Discharge After Biostimulatory Substances Mitigation[a]

Constituent	Santa Rosa Creek	Laguna de Santa Rosa	Russian River below Laguna	Russian River above Laguna
Benthic Algae				
Adverse	**10%**, 20% River			20% River
Beneficial				
Planktonic Algae				
Adverse		10%, 20%, 20%R	**20% River**	~~20% River~~
Beneficial				
Average Dissolved Oxygen				
Adverse				
Minimum Dissolved Oxygen				
Adverse		20% River		
Ammonia			**20%**	
Cyanide				
Conductivity				~~20% River~~
Toxicity				

[a] Design components shown in ~~strikethrough~~ indicate project impacts removed by mitigation operations; **Boldface** indicate that project impacts are caused by mitigation operations; others remain under mitigation operations.

Cyanide

The concentrations of cyanide in receiving waters resulting from direct contingency discharge were calculated using a dilution model as described in the Impact Evaluation Approach section for conservative constituents. The 95th percentile daily average reclaimed water concentration in Santa Rosa Creek, the Laguna at River Road, and the Russian River at Oddfellows for contingency discharge associated with a 10 percent design discharge and a 20 percent design discharge to the Laguna are shown in Table 4-34.

20 percent contingency discharge to the River are less than the point of significance and are, therefore, considered to be less than significant.

The concentration of cyanide after cyanide mitigation (storage and/or source detection and control) cannot be calculated but is predicted to be less than significant.

Table 4-35.

Estimated Cyanide Concentration with Contingency Discharge (mg/L)

	10% Contingency Discharge		**20% Contingency Discharge to the Laguna**		**20% Contingency Discharge to the River**	
	Project Operation	Biostim. Substances Mitigation Operation	Project Operation	Biostim. Substances Mitigation Operation	Project Operation	Biostim. Substances
Santa Rosa Creek	0.0065	0.0065	0.0080	0.0084	0.0000	0.0043
Laguna at River Road	0.0040	0.0042	0.0056	0.0065	0.0000	0.0023
Russian River at Oddfellows Road	0.0033	0.0033	0.0041	0.0046	0.0033	0.0037
Russian River above the Laguna	0.0000	0.0000	0.0000	0.0000	0.0035	0.0039

Conductivity

Predicted conductivity in the Russian River below the confluence with the Laguna with a 10 percent contingency discharge, a 20 percent contingency discharge to the Laguna, and a 20 percent contingency discharge to the River was evaluated as described in the Impact Evaluation Approach section. These values are shown in Table 4-36. For all contingency discharges, the average conductivities in the Russian River below the confluence are predicted to be less than the 50^{th} percentile upper limit point of significance for conductivity (285 µmhos/cm) in six or more months. Since the criterion states that 50 percent (six) or more of the monthly means must be less than or equal to the point of significance, the impacts of a 10 percent contingency discharge, a 20 percent contingency discharge to the Laguna, and a 20 percent contingency discharge to the River on conductivity in the Russian River below the confluence are considered to be less than significant. ~~The results in the River below the confluence are the same for contingency discharge as for contingency discharge with mitigation operations.~~ Predicted conductivity in the River above the confluence for contingency discharge with biostimulatory substances mitigation operations are less than the 50^{th} percentile upper limit point of significance for conductivity in six months. Therefore, the impact of a 20 percent contingency discharge to the River on conductivity in the Russian River above the confluence with the Laguna is considered to be less than significant.

The average conductivities in the Russian River above the confluence with the Laguna with a 20 percent contingency discharge to the River are predicted to be less than the 50th percentile upper limit point of significance for conductivity (250 µmhos/cm) in only three months. Therefore. the impact of a 20 percent contingency discharge to the River on conductivity in the Russian River above the confluence with the Laguna are considered to be significant. The results in the River above the confluence are the same for contingency discharge as for contingency discharge with biostimulatory substances mitigation operations.

Table 4-36

Conductivity in the Russian River (in μmhos/cm with Contingency Discharge and Contingency Discharge with Mitigation Operations

	Russian River Below the Confluence with the Laguna						Russian River Above the Confluence with the Laguna		Existing Conditions	
	10% Contingency Discharge		20% Contingency Discharge to Laguna		20% Contingency Discharge to River		20% Contingency Discharge to River			
	Project Oper.	Mitig. Oper.	Project Oper.	Mitig. Oper.	Project Oper.	Mitig. Oper.	Project Oper.	Mitig. Oper.	Lower River	**Upper River**
Oct	232	232	278	232	251	232	~~256~~241	~~232~~217	232	217
Nov	227	227	321	240	275	232	~~287~~292	~~234~~239	227	232
Dec	300	272	357	381	311	326	~~324~~306	~~342~~324	267	246
Jan	318	313	351	369	318	332	~~330~~304	~~338~~312	280	251
Feb	322	314	356	388	316	335	~~330~~283	~~349~~304	277	224
Mar	258	276	288	319	263	285	~~274~~280	~~293~~299	233	240
Apr	294	268	337	266	298	266	~~309~~ 293	~~266~~248	266	248
May	257	255	272	255	263	255	~~264~~261	~~255~~ 253	255	253
Jun	266	266	266	266	266	266	~~266~~ 263	~~266~~263	266	263
Jul	239	239	239	239	239	239	~~239~~210	~~239~~210	239	210
Aug	232	232	232	232	232	232	~~232~~222	~~232~~222	232	222
Sep	238	238	238	238	238	238	~~238~~224	~~238~~224	238	224

Toxicity

Lethal toxicity was found once in 11 tests, or in 9 percent of the tests (see *Reclaimed Water Quality Update* Technical Report, MSC 1996), and the lowest, or worst-case NOEC of reclaimed water is 25 percent. Table 4-37 shows the frequency of days that reclaimed water concentration would exceed 25 percent (the worst-case no-effects concentration) in Santa Rosa Creek in the very dry year with contingency discharge (as described in *Russian River Water Quality Model* Technical Report, RMA 1996). These frequencies of potentially toxic concentrations are then multiplied by the worst-case toxicity frequency (9 percent), to give the expected occurrence of toxic conditions in Santa Rosa Creek. The impact is considered significant if the frequency that toxic

- Using a water quality model to simulate biological interactions with reclaimed water constituents.

Dilution Model

The method for identifying impacts of design discharge with respect to many of the numeric-based evaluation involved using estimates of reclaimed water dilution (95[th] percentile daily average reclaimed water concentration in a dry year), constituent concentration in reclaimed water, and the background constituent concentration in Santa Rosa Creek/Laguna to estimate the potential Subregional system project impact on constituent concentration. Design discharge was not predicted to cause numeric points of significance to be exceeded for any constituents in reclaimed water except conductivity and cyanide. No point of significance exists for conductivity in the Laguna or Santa Rosa Creek. No cumulative projects have been identified that would change background water quality conditions in the Laguna or Santa Rosa Creek, The Laguna and Santa Rosa Creek are not affected by any wastewater discharges except that of the Subregional System and the City of Windsor. The City of Windsor discharges to the Laguna at Trenton Healdsburg Road, but no change in its maximum discharge rate (because of Basin Plan restrictions) or quality (because of pretreatment regulations) are included in cumulative projects. ThusSince no cumulative projects have been identified that would change background water quality conditions in the Laguna or Santa Rosa Creek (including the City of Windsor discharges), the Subregional System project cannot cause an exceedence, or cause the magnitude of an existing exceedence (e.g. cyanide) to increase in the Laguna or Santa Rosa Creek other than those identified for the Subregional System Project alone., despite any impacts of cumulative projects on water quality.

In the Russian River, no significant impacts from dilution model constituents in Santa Rosa's reclaimed water were identified, with the exception of conductivity in the Russian River above the Laguna. This means that the Project discharge would not cause water quality objectives to be exceeded. Additional discharges of 4 mgd or 6.5 cfs (see Table 4-41) to the River from cumulative projects are expected during a normal year, but not in a dry year. The total of 6.5 cfs does not include Cloverdale and Healdsburg because these discharge to groundwater and do not affect Russian River quality during the dry season when impacts are otherwise most likely to occur in the River. All of the other discharges in Table 4-41 are currently constrained by a 1 percent discharge limitation, so growth in these communities is not expected to result in higher reclaimed water concentration in the Russian River during a dry year when River flows remain low. Based on pretreatment regulations and the Regional Board requirement that these discharges be maintained at or upgraded to tertiary level, the quality of these discharges (except for conductivity, which is addressed below) is expected to remain constant. Thus, in a normal hydrologic year, an incremental wastewater flow of 6.5 cfs (relative to the minimum River flows of about 400 to 600 cfs that would occur in a normal year discharge season) is considered to be negligible and not expected to affect Russian River quality with regard to dilution model constituents. Therefore, the cumulative impacts analysis will not address any of the constituents evaluated using the dilution method, other than conductivity, in the Russian River.

The Subregional System design discharge alternatives caused an exceedance of the conductivity point of significance in the Russian River above the Laguna, and conductivity in the Russian River is potentially affected by other discharges. The potential for cumulative projects to cause significant conductivity impacts in the River above and below the Laguna has been evaluated as described below.

Conductivity Evaluation Above The Laguna

For purposes of this analysis, the incremental (cumulative projects) discharge from other communities was assumed not to lower the baseline conductivity in the Russian River above the Laguna, and will probably cause conductivity to increase. This assumption is based on the fact that Ukiah, Cloverdale, and Healdsburg derive much of their water supply from the Russian River. The remaining water comes from wells with conductivity and/or TDS concentrations that equal or exceed that found in the Russian River (pers. comm. Frank Noyd, City of Ukiah; Tony Villa, City of Cloverdale; and Dick Pusick, City of Healdsburg). As it passes through the treatment system, water cannot decrease in conductivity without the use of reverse osmosis, and none of these communities have reverse osmosis capability. Therefore, although conductivity is not measured in their treated effluent (pers. comm. Frank Noyd, City of Ukiah; Tony Villa, City of Cloverdale; and Dick Pusick, City of Healdsburg), the future incremental discharge from Ukiah, Cloverdale, and Healdsburg is expected to result in equal or higher conductivity than the baseline conductivity in the Russian River above the Laguna. Since the 20 percent design discharge to the Russian River above the Laguna is estimated to cause a significant impact on conductivity, this impact of cumulative projects would also be considered significant.

Conductivity Evaluation Below The Laguna

The impact of cumulative projects on conductivity in the Russian River below the Laguna was assessed by assuming that all the conductivity in the River is due to reclaimed water (a conservative approach). The flow in the River in each month of an average year (1961) was obtained from the monthly water balance model, and the proportion of the monthly flow that will be due to the incremental flow from non-Santa Rosa reclaimed water discharge (Table 4-41) was determined then multiplied by the existing monthly conductivity to get a predicted monthly increase in conductivity due to non-Santa Rosa reclaimed water discharge. The estimated incremental monthly conductivity value was

	Estimate[a]	Growth[b]	Flow[c]		
Ukiah	3.4	0.14	3.54	2.4	1.14
Cloverdale	2.00	0	2	0.5	1.5
Healdsburg	1.80	0	1.8	1.0	0.8
Windsor	2.7	2.1	4.8	1.1	3.7
Forestville	0.12	0	0.12	0.05	0.07
Graton	0.14	0	0.14	0.08	0.06
Guerneville	0.71	0	0.71	0.35	0.36
Occidental	0.05	0	0.05	0.02	0.03

[a] General Plan projections reported in (1994)
[b] Based on proposed general plan changes since 1994
[c] Sum of two column to the left
[d] Based on reports submitted by discharges to RWQCB, also summarized in Table 4.6-9 in the EIR/S
[e] Flow used for cumulative impacts analysis

The NCRWQCB has established total nitrogen and ammonia load reduction goals for the Laguna watershed to improve Laguna water quality (NCRWQCB 1995). The total target load reductions for urban, non-irrigated, septic, and open space sources were evaluated for cumulative impacts.

The nutrient/algae/dissolved oxygen interactions that occur in the Laguna and Russian River as a result of reclaimed water discharges and other discharges and as a result of non-Subregional System waste load reductions were evaluated with the water quality model that was used to evaluate design discharge (see in Section 4.1.4 Impact Evaluation Approach - Constituents Affected by Biological Activity). The same approach was used to evaluate the cumulative projects impacts with the following exceptions:

- Cumulative projects impacts were evaluated for a normal hydrological year (1961). Design Subregional System project discharges were evaluated in a dry (1976), normal (1961) and wet (1982) year simulation.
- Cumulative projects impacts were evaluated for significance relative to existing conditions, and the potential cumulative impacts are also described relative to impacts of design discharge.
- The potential impacts of cumulative discharge on benthic algae, planktonic algae, average and minimum dissolved oxygen, and ammonia in Santa Rosa Creek, the Laguna de Santa Rosa, and the Russian River were evaluated as for design discharge. Cumulative projects impacts on temperature, however, were not evaluated using the model. The temperature point of significance is that a 5 °F increase in monthly average temperature would be considered significant. The greatest effect of the Santa Rosa discharge on receiving water temperature occurs in Santa Rosa Creek, and any downstream effects attenuate rapidly (see Figure 4-17). None of the cumulative projects are expected to affect temperature. Thus, since no significant impacts of design discharge components would occur (see Figure 4-17), no significant impacts of the cumulative projects would occur either.

4.5.4 Results of Cumulative Impacts Assessment

Significant adverse and beneficial impacts of the cumulative projects (projects listed in Table 4-40 plus the Subregional System reclaimed water discharge) are summarized in

Tables 4-42 through 4-45. Table 4-42 presents the frequency of adverse impacts (as a percentage of the total possible adverse impacts) of the cumulative projects and cumulative projects plus mitigation for biostimulatory substances. Table 4-43 presents the frequency of beneficial impacts (as a percentage of the total possible beneficial impacts) of the cumulative projects and the cumulative projects plus mitigation for biostimulatory substances. Table 4-44 presents the net number of impacts (the number of significant beneficial impacts minus the number of significant adverse impacts). Tables 4-42 through and 4-44 do not include conductivity, cyanide, toxicity because only one opportunity for exceedance is possible, except for ammonia in the Russian River. No significant cumulative projects impacts of ammonia occurred in the Russian River and no significant cumulative projects impacts of minimum dissolved oxygen occurred in Santa Rosa Creek, the Laguna or the Russian River, so these constituents are not included in Tables 4-42 through 4-44. No significant adverse impacts are estimated to occur as a result of the cumulative projects that are not also estimated to occur as a result of the Subregional System reclaimed water design discharge alone. However, the combination of the cumulative projects (which in the Laguna involves substantial nutrient load reduction) and mitigation of the Subregional System operations avoids all significant water quality impacts of the 20% Laguna design discharge. Impacts are further described below.

Benthic Algae

The impact of the cumulative projects on benthic algae biomass during a normal hydrological year is estimated to be similar to that of the Subregional System design discharge project, as shown in Figure 4-59. The number of significant adverse impacts estimated to result from the cumulative projects is the same as that from the Subregional System project for each discharge component except for the Geysers, in which case the cumulative projects caused two fewer significant impacts than that estimated for the Subregional System project alone (8 percent of the total possible impacts with the Subregional System project alone versus 3 percent for the cumulative projects). Table 4-42 shows that the predicted frequency of significant adverse impacts on benthic algae of the cumulative projects range from zero to 58 percent of the total number of possible significant adverse impacts, depending on discharge scenario. As is the case for the Subregional System project impacts, mitigation reduces the frequency of impacts for cumulative discharge scenarios except for the 1% discharge scenario. In contrast to the mitigated Subregional System project impact (which caused significant impacts after mitigation, depending on discharge scenarios), the cumulative projects with mitigation of Subregional System impacts would cause no significant benthic algae impacts for the 5%, 10%, 20% Laguna alternatives. Impacts persist in the Laguna even with mitigation for the 20% to the Russian River, Geysers and 1% due to reduced flow relative to existing condition. Reduced flow favors benthic algal growth.

The number of significant beneficial impacts estimated to result from the cumulative projects is the same as from the Subregional System project for each discharge component except in the Russian River below the Laguna for the 5 percent and 10 percent discharge to the River (Figure 4-49). In each of these cases, the number of significant beneficial impacts have been reduced from one (3 percent of the total) to zero.

The predicted frequency of significant beneficial impacts of the cumulative projects on benthic algae range from zero to 8 percent of the total number of possible significant beneficial impacts (Table 4-43). The frequency of significant beneficial impacts on benthic algae increases with mitigation for the 10 percent, 20 percent and Geysers design discharges.

Planktonic Algae

The impact of the cumulative projects on planktonic algae biomass during a normal hydrological year is estimated to be similar to that of the Subregional System design discharge project (see Figure 4-60). The single significant adverse impact estimated to result from the cumulative projects (on the Russian River below the Laguna with a 20 percent design discharge to the Laguna) is the same as that from the Subregional System project. Mitigation for biostimulatory substances is predicted to reduce the single adverse impact on benthic algae resulting from the cumulative projects to less than significant levels. (Table 4-42).

The number of significant beneficial impacts estimated to result from the cumulative projects is the same as that from the Subregional System project for each discharge component, except the 20 percent River discharge component in the lower Russian River and the 20 percent Laguna discharge component to the Laguna. In the lower Russian River with a 20 percent River discharge, the number of significant beneficial effects of the Subregional System project is reduced by the cumulative projects from seven (19 percent of the total possible impacts) to zero. In the Laguna with a 20 percent Laguna discharge, the frequency of significant beneficial effects of the Subregional System project is reduced by the cumulative projects from 4 to 3 (from 11 percent to 8 percent of the total possible impacts in the normal year). The beneficial impacts on planktonic algae resulting from the cumulative projects are predicted to be reduced by mitigation to below significance (Table 4-43).

Table 4-42.

Frequency of Significant Adverse Impacts of the Cumulative Projects and Mitigation Operations (percent of the total number of analyses)

Discharge Component	No. Analyses[a]	Benthic Algae		Planktonic Algae		Turbidity		Average Dissolved Oxygen	
		Project	Mitig	Project	Mitig	Project	Mitig	Project	Mitig
No Project	36	55%	-	0%	-	0%	-	0%	-
1%	36	3%	6%	0%	0%	0%	0%	0%	0%
5%	36	3%	0%	0%	0%	0%	0%	0%	0%
10%	36	0%	0%	0%	0%	0%	0%	0%	0%
20%	36	58%	0%	3%	0%	0%	0%	3%	0%
20% River	48	27%	15%	0%	0%	0%	0%	0%	0%
Geysers	36	3%	3%	0%	0%	0%	0%	0%	0%

[a] This column shows the maximum number of significant impacts that could be identified using the evaluation approach described in this report (36 = 3 stream segments *x* 12 months/year, 48 = 4 stream segments x 12 months/year).

Table 4-45

Significant Adverse and Beneficial Impacts of the Cumulative Projects for Each Discharge Component[a]

Constituent	Santa Rosa Creek	Laguna	Russian River Below Laguna	Russian River Above Laguna
Benthic Algae				
Adverse	**1%,** ~~20%~~, **20% River,** NP	1%, ~~5%~~, ~~20%~~, 20% River, NP, G	~~20%~~ , ~~20% River,~~ NP	20% River
Beneficial	1%, 5%, **10%, 20%,** ~~20% River~~, **G**	**10%, 20%**	1%, 5%, **10%, 20%, 20% River,** G	
Planktonic Algae				
Adverse			~~20%~~	
Beneficial	~~20%,~~ NP	~~20%,~~ NP		
Turbidity				
Adverse				
Beneficial	~~20%,~~ NP	~~20%,~~ NP		
Average Dissolved Oxygen		~~20%~~		
Minimum Dissolved Oxygen				
Ammonia				
Conductivity				*20% River*

[a] Components causing a significant adverse or beneficial impact are shown. Cumulative projects impacts were evaluated for a normal hydrologic year. Since impacts were evaluated for all months, both beneficial and adverse impacts can result for some parameters at different times from the same component. Overstriking indicates impact avoided with mitigation or measures that need to be considered by the city for the No Project component, italics indicates no mitigation proposed, bold indicates impacts that are significant after mitigation that are not significant before mitigation. Impacts of mitigation on the No Project component were not analyzed. Components are identified as follows:
1% = 1% design discharge component
20% = 20% design discharge component to Laguna
20% River = 20% design discharge component to River
G = Geysers discharge component

Turbidity

The impact of the cumulative projects on turbidity during a normal hydrological year is estimated to be similar to that of the Subregional System project (see Figure 4-60). The cumulative projects is not predicted to cause significant adverse impacts on turbidity (Table 4-42). Significant beneficial impacts of the cumulative projects are predicted to occur with the 20 percent design discharge to the Laguna (Table 4-43). These beneficial impacts are reduced by mitigation to below significance.

Dissolved Oxygen

The impact of the cumulative projects on average dissolved oxygen during a normal hydrological year is estimated to be similar to that of the Subregional System design discharge project (see Figure 4-61). The cumulative projects is estimated to cause exceedance of the point of significance (> 0.5 mg/L decrease) just once (3 percent of the total possible impacts), and this would occur in the Laguna as a result of the 20 percent Laguna design discharge. This significant adverse impact of the cumulative projects is reduced by mitigation for biostimulatory substances to below significance (Table 4-42). The predicted minimum dissolved oxygen concentrations for cumulative projects are shown in Table 4-45A. No predicted minimum dissolved oxygen concentrations for project alternatives are more than 0.5 mg/L below the existing conditions and less than the points of significance (6.0 mg/L for Santa Rosa Creek and 7.0 mg/L for the Laguna and Russian River). Therefore, no significant decreases in dissolved oxygen are predicted to occur with cumulative projects.

Table 4-45A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Cumulative Projects (in mg/L)

		1 Percent		5 Percent		10 Percent		20 Percent to the Laguna		20 Percent to the Russian River		Geysers		No Project
	Existing Conditions	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	
							Santa Rosa Creek							
Oct	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.9	7.5	7.5	7.5	7.5	7.5	7.6
Nov	7.6	7.6	7.6	7.6	7.6	7.6	7.6	8.0	7.6	7.6	7.6	7.6	7.6	7.9
Dec	8.6	8.7	8.7	8.7	8.7	8.6	8.6	8.7	8.4	8.7	8.4	8.7	8.7	8.7
Jan	8.9	8.9	8.9	8.9	8.8	8.9	8.6	8.9	8.3	8.9	7.6	8.9	8.9	8.9
Feb	8.8	8.9	8.9	8.9	8.9	8.9	8.9	8.8	8.8	8.9	8.9	8.9	8.9	8.8
Mar	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.1	8.7	8.7	8.7	8.7	8.7
Apr	8.3	8.4	8.4	8.1	8.4	7.8	8.4	8.3	8.4	8.4	8.4	8.4	8.4	8.3
May	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Jun	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.1	6.2	6.2	6.2	6.2	6.2	6.1
Jul	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Aug	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3

Table 4-45A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Cumulative Projects (in mg/L)

		1 Percent		5 Percent		10 Percent		20 Percent to the Laguna		20 Percent to the Russian River		Geysers		No Project
	Existing Conditions	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	Proj.	Mitig.	
Sep	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Laguna de Santa Rosa														
Oct	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.8	7.9	7.9	7.9	7.9	7.9	7.7
Nov	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Dec	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Jan	8.8	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Feb	8.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Mar	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	9.0	8.9
Apr	8.5	8.7	8.7	8.6	8.7	8.6	8.7	8.6	8.7	8.7	8.7	8.7	8.7	8.6
May	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3	7.4	7.4	7.4	7.4	7.4	7.3
Jun	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Jul	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Aug	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Sep	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Russian River above the Laguna														
Oct	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.1	9.2	9.2	9.2	9.2
Nov	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.2	9.4	9.4	9.4	9.4
Dec	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.5	10.6	10.6	10.6	10.6
Jan	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.7	10.7	10.8	10.8	10.8
Feb	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
Mar	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.5	10.5	10.6	10.6	10.6
Apr	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
May	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Jun	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Jul	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Aug	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Sep	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6

Table 4-45A

Predicted Minimum[a] Dissolved Oxygen Concentrations with Cumulative Projects (in mg/L)

		1 Percent		**5 Percent**		**10 Percent**		**20 Percent to the Laguna**		**20 Percent to the Russian River**		**Geysers**		**No Project**
	Existing Conditions	**Proj.**	**Mitig.**	**Proj.**	**Mitig.**	**Proj.**	**Mitig.**	**Proj.**	**Mitig.**	**Proj.**	**Mitig.**	**Proj.**	**Mitig.**	
Russian River below the Laguna														
Oct	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.6	8.9	8.7	8.9	8.9	8.9	8.8
Nov	9.1	9.1	9.1	9.1	9.1	9.1	9.1	8.8	9.1	8.8	9.1	9.1	9.1	8.9
Dec	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
Jan	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Feb	10.2	10.2	10.2	10.2	10.2	10.2	10.3	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Mar	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Apr	9.3	9.4	9.4	9.4	9.4	9.4	9.4	9.3	9.4	9.3	9.4	9.4	9.4	9.3
May	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Jun	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Jul	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Aug	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Sep	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Lower Russian River														
Oct	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.4	8.7	8.5	8.7	8.7	8.7	8.6
Nov	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.4	8.9	8.6	8.9	8.9	8.9	8.7
Dec	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
Jan	10.1	10.1	10.1	10.1	10.1	10.1	10.0	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Feb	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Mar	10.1	10.2	10.2	10.2	10.2	10.2	10.2	10.1	10.1	10.1	10.1	10.2	10.2	10.2
Apr	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
May	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Jun	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.8	7.9	7.8	7.9	7.9	7.9	7.8
Jul	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Aug	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Sep	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1

[a] Dissolved oxygen minima are based on hourly estimates

Ammonia-Nitrogen Concentration

The impact of the cumulative projects on the concentration of ammonia nitrogen during a normal hydrological year is estimated to be similar to that of the Subregional System project (see Figure 4-62). No significant impacts are expected from the cumulative projects or from cumulative projects with mitigation for biostimulatory substances.

Conductivity

Russian River Above The Laguna

The 20 percent design discharge to the Russian River above the Laguna is estimated to cause a significant impact on conductivity. With the assumption that the cumulative projects will not lower and may increase baseline conductivity, the impact of the cumulative projects on conductivity in the River above the Laguna would also be considered significant.

Russian River Below The Laguna

Attainment of the evaluation criterion for conductivity requires that the median of 12 monthly average conductivity values must be less than or equal to the point of significance, which is 285 µmhos/cm for the Russian River below the Laguna). The monthly average conductivity values estimated to occur with cumulative projects (Table 4-46) were compared to the point of significance. The median of the 12 estimated monthly average conductivity values did not exceed the point of significance for the lower River for either the 20 percent design discharge to the Laguna or the 20 percent design discharge to the River. Therefore, the cumulative projects is expected to have a less than significant impact on conductivity in the lower Russian River.

Streams Technical Report (RMA 1996). Impacts to the Esteros are all indirect since no reclaimed water will be discharged directly into either Estero.

Under each combination of watershed, hydrologic condition, and inflow condition, Estero water quality was simulated for bar-open and bar-closed conditions. The dynamics of the sand bar at the inlet of each Estero are described in Section 4.6 of the EIR/S (Water Quality Affected Environment (Setting) section).

Impact Evaluation Results

The effect of a 1 percent irrigation project on water quality in the Esteros is considered significant according to the evaluation criteria described in Section 3 because water quality conditions would be affected by the project. Figures 6-1 through 6-5 illustrate potential project effects on total dissolved solids, ammonia, planktonic algae, benthic algae, and dissolved oxygen. Tables 6-11 through 6-15 summarize the impacts described in each of Figures 6-1 through 6-5, respectively. Figures 6-1 through 6-5 show the estimated daily average, daily minimum and daily maximum values for existing conditions and project conditions for each inflow condition (spring and summer), hydrologic condition (dry, average, wet years), and inlet condition (open and closed). The simulations presented in Figures 6-1 through 6-5 show that water quality in the Esteros would be changed by irrigation or by irrigation with storage, although the effect is slight in many cases. Irrigation and storage effects on total dissolved solids, ammonia, planktonic algae, benthic algae, and dissolved oxygen, metals and temperature are described below for irrigation scenarios other than winter (contingency) irrigation. Winter irrigation impacts are evaluated separately in the Contingency irrigation section below.

Figures 6-1 through 6-5 do not show the full range of water quality conditions that can occur in the Esteros because inflow conditions other than those simulated occur. The particular inflow and season conditions that were simulated were selected because the watershed model indicated that the project would have the greatest impact on stream flow and quality under the conditions that were selected.

Tables 6-11 through 6-15 are each structured such that each cell relates to one of 24 sheets of each of Figure 6-1 through 6-5. In cases where the same description applies to more than one irrigation condition (and thus more than one figure), table cells have been merged. For example, the first data cell of Table 6-11 describes Figures 6-1.1, 6-1.2, and 6-1.3. The second data cell in Table 6-11 describes Figures 6-1.4, and 6-1.5, and the third data cell describes only Figure 6-1.6. The numeric values that are included in the cells of Table 6-11 through 6-15 describe the *difference* between existing and project conditions, and these values are approximate.

The evaluation criterion for impacts in the esteros (which is part of the Sanctuary) is that any water quality change is considered significant because of the Sanctuary's interpretation of Sanctuary regulations. Were it not for this policy-based evaluation criterion, some of the water quality changes in the Sanctuary (such as increased dissolved oxygen and decreased manure load) would be considered beneficial.

Total Dissolved Solids

Effects of irrigation and storage on total dissolved solids in the Esteros are summarized in Table 6-11 and Figure 6-1. Total dissolved solids would be increased in both Esteros under all scenarios considered. This would occur in spring because inflows are expected to be reduced as a result of the storage and improved watershed management (*Aquatic Biological Resources Impacts Analysis* Technical Report, MSC 1996). The increased total dissolved solids would occur in summer because the total dissolved solids in the creeks would increase as a result of deficit-mode irrigation.

REPLACEMENT PAGES

APPENDIX J

PUBLIC HEALTH AND SAFETY

TABLE OF CONTENTS

3 RISK FROM BIOLOGICAL COMPONENTS

This section presents the human health risk from biological components in reclaimed water from the Subregional Wastewater Project. It addresses the potential human health risks resulting from discharge of final treated effluent from the treatment plant to surface water and the subsequent use of surface water as a source of potable water as well as other purposes (e.g., irrigation). Appendix G of this report updates the analysis of impacts in this section.

The risk assessment follows the standard framework used for chemical risk assessment, which consists of:

- Biological components of reclaimed water
- Hazard identification
- Dose-response assessment
- Exposure Assessment
- Risk Characterization

3.1 BIOLOGICAL CONTAMINATION

Final effluent was sampled for microorganisms over a 3-month period from October through December 1994 and analyzed according the Field Sampling and Quality Assurance Plan for this study (Merritt Smith Consulting 1995a). Four samples were taken of fresh final effluent over this period and one sample was taken from Delta Pond of stored final effluent. Delta Pond is a large open impoundment adjacent to Santa Rosa Creek. These data are summarized in Tables 3.1-1 and 3.1-2. Table 3.1-1 presents the data for concentrations of pathogenic bacteria in the treated effluent. Table 3.1-2 presents the data for protozoa and viral agents. Four samples were also taken from the Russian River at Kaiser Beach, 5 miles upstream of the point of entry of the Laguna de Santa Rosa to the River. These data are included in the tables for comparison purposes.

The data in Table 3.1-1 include specific test results for *Salmonella*, *Shigella*, and *Legionella*, as well as results of tests for indicator organisms, including total coliform and heterotrophic bacteria. The term “indicator organism,” as used in water microbiology, means a microorganism whose presence is evidence that pollution (associated with fecal contamination from man or other warm-blooded animals) has occurred. Indicator organisms may be accompanied by pathogens, but do not necessarily cause disease themselves (NRC 1977). Indicators have the following general characteristics: they are absent from unpolluted waters, are present in greater numbers than pathogenic organisms, have greater survival time than pathogens, and their detection is more reliable and less time-consuming.

APPENDIX G

This addendum is an amplification and clarification of potential project impacts on the density of pathogens in the Russian River and on the potential need for additional drinking water treatment facilities. The addendum is different from the Section 3 of Appendix J-3 in two ways:

- This addendum takes into account the presence of *Cryptosporidium* in effluent that was detected after Appendix J-3 was prepared (as noted on Appendix H-3 page 14).
- This addendum takes into account the City's decision to convert from chlorine to ultra-violet light disinfection that was made after the Draft EIR/EIS was prepared.

This addendum provides a description of the regulatory background, a summary of pathogens in reclaimed water, a description of the existing receiving water conditions, and an updated evaluation of potential- impacts.

Regulatory Background

Coliform is the only pathogen for which a maximum contaminant level (MCL) has been established. The standard established by the California Department of Health Services is described on page 4.7-28: a maximum of five percent of samples each month may be positive for total coliform, and no re-tests may be positive. The State of California's Surface Water Filtration and Disinfection Treatment regulations (Title 22, Sections 64650 - 64666) as the equivalent EPA's Surface Water Treatment Rule (SWTR) establish a treatment standard for *Giardia*, which requires a 3-log removal (1,000 fold reduction) through filtration and chemical disinfection. The SWTR applies to surface waters and groundwaters considered by the California Department of Health Services to be under the direct influence of surface waters. Groundwater under the direct influence of surface water is defined in Title 22 Section 64651.50 as "any water beneath the surface of the ground with significant occurrence of insects or other microorganisms, algae or large diameter pathogens such as *Giardia lamblia*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions."

The EPA has proposed the Enhanced Surface Water Treatment Rule (Enhanced SWTR - *Federal Register* 38832, July 29, 1994) wherein several regulatory options are identified as follows:

1. No change from the existing SWTR;
2. Require additional (greater than 1,000 fold) *Giardia* removal depending on *Giardia* cyst density in the source water;

3. Require *Cryptosporidium* removal depending on *Cryptosporidium* oocyst density in the source water; or

4. Two and three above.

The Proposed Enhanced SWTR states that the Final Enhanced SWTR will not be promulgated until after water utilities provide information to EPA on the density of *Cryptosporidium* and *Giardia* in their source and finished waters pursuant to the Information Collection Rule. Data collection has been delayed and is currently scheduled to begin in mid-1997. The date of Final Enhanced SWTR promulgation is not known. The Proposed Enhanced SWTR does not include MCLs for *Cryptosporidium* or *Giardia*. The Proposed Enhanced SWTR applies to surface waters and groundwaters considered by the Department of Health Services to be under the influence of surface waters. The Proposed Enhanced SWTR (beginning of Section II) also states "the Groundwater Disinfection Rule, which is currently under development, will add further protection for systems using ground water." EPA has not yet issued a Proposed Groundwater Disinfection Rule for public review or comment.

The Sonoma County Water Agency and Sweetwater Springs Water District are the only two drinking water suppliers within Department of Health Services jurisdiction that are potentially affected by the project discharge components. District wells are located away from the River and have an overall water quality that differs significantly from the River. Department of Health Services expects that the filtration characteristics of River sediments will not change in a manner that would affect the wells' status under the SWTR (Bruce Burton, Department of Health Services, October 29, 1996, personal communication). The Water Agency's Intake No. 5 is the only drinking water intake in the Russian River project area that is considered by the Department of Health Services to be under the direct influence of surface water and thus subject to SWTR and any Final Enhanced SWTR. The four other water agency intakes and District wells are considered by the Department to be not under the direct influence of surface water according to the SWTR. The Department of Health Services considers the "not under the direct influence" status of the four Water Agency intakes to be subject to periodic review because of the potential that the filtration characteristics of River sediments may change or the quality of the River would be degraded.

The Department of Health Services currently has the authority to require more than 1,000 fold *Giardia* removal for any intakes found to be under the direct influence of surface water. Current operating procedures used for the Sonoma County Water Agency's Intake No. 5 are considered to be an alternative to filtration technologies identified in Title 22 Section 64653(a), as defined in Section 64653(f). Pursuant to Section 64653(h), performance standards may be established for such alternative filtration technologies by the Department for individual systems, such as Intake No. 5. In addition, California Health and Safety Code Section 4014 states that the Department may impose additional treatment requirements that “it deems necessary to assure a reliable and adequate supply of water at all times which is pure wholesome, potable, and does not endanger the health of consumers.” Thus, the Department can impose additional treatment requirements on any of the Water Agency intakes if it finds that the project would adversely affect the health of consumers. The treatment performance standard that the Department of Health Services would require is described in the Department’s *Surface Water Treatment Staff Guidance Manual* (May 15, 1991) Appendix B: *Guidelines for Determining When Surface Waters Will Require More Than The Minimum Levels of Treatment Defined in the Surface Water Treatment Regulations.* If the Department were to determine that additional treatment is required for either of the reasons cited above (change in the filtration characteristics of River sediments or the degraded River water quality), the required *Giardia* cyst removal/inactivation is based on source (River) water cyst and coliform density as shown in Table 1:

Table 1

Required *Giardia* Cyst Removal

	If cyst or coliform density is:		
Allowable daily average cyst density /100L (geometric mean in source water)	<1	>1 - 10	>10 - 100
Allowable Total Coliform Density /100 mL	<1,000	>1,000 - 10,000	>10,000 - 100,000
	The Cyst Removal is:		
Required *Giardia* cyst removal	3-log (1,000 fold)	4-log (10,000 fold)	5-log (100,000 fold)

This data in Table 1 means that if, for example, the measured daily average *Giardia* cyst density in the River is between 1 and 10 per 100 liters (L) or the measured median monthly total coliform density is between 1,000 and 10,000 MPN per 100 milliliters (mL), DOHS could require 4-log (10,000-fold reduction) *Giardia* cyst removal instead of 3-log (1,000 fold) cyst removal. The River would be considered the source water if the intakes are found to be under the influence of surface water.

Existing regulations do not address *Cryptosporidium*, but the Proposed Enhanced SWTR includes options for performance standards which recognize that chlorine disinfection is not effective, and removal by filtration and inactivation by non-traditional methods (i.e., ozonation) is effective.

No information about the potential future regulation of groundwater under the Groundwater Disinfection Rule is available on which to base an evaluation of impacts.

Reclaimed Water Quality

Pathogens in reclaimed water are summarized below. A project to convert the disinfection system from chlorine disinfection to ultra-violet light is being implemented, and the impact on pathogens is addressed below.

Measurements of Pathogens in Reclaimed Water

Appendices H-2 and H-3 describe density of pathogens in reclaimed water that were available at the time that the Draft EIR/EIS was issued. The *Cryptosporidium* and *Giardia* density values collected through 14 May 1996 were reported in Appendix 4 of Appendix H-3, and are based on Standard Methods (18th ed.) method 9711B (FA), which reports presumptive values. The City of Santa Rosa has continued to collect protozoan data since 14 May 1996, but has used EPA's Information Collection Rule method exclusively since then. The change to the EPA method occurred for two reasons:

- EPA promulgated the Information Collection Rule method in approximately May 1996.

- The EPA method involves a more detailed analysis that confirms presumptive cyst density data. Thus, data from the EPA method are considered to be more accurate.

- The water and wastewater industry switched to the EPA method to be consistent with the Information Collection Rule requirements. Use of the EPA by the City of Santa Rosa would provide data that are comparable to other studies.

Since then, additional *Cryptosporidium* and *Giardia* data have been collected. A total of 34 *Cryptosporidium* and *Giardia* measurements in plant effluent have been made after 14 May 1996 through 6 January 1997, and these are summarized in Table 2. The data are provided in Table 3. Of the 34 samples, four were confirmed positive for *Giardia* and one was confirmed positive for *Cryptosporidium*.

Table 2

Summary of *Cryptosporidium* and *Giardia* in Laguna Plant Effluent (cysts/100 L)

Cryptosporidium		*Giardia*	
Median	**Range**	**Median**	**Range**
≤6.6	≤1.6 - 9.6	≤8.5	≤1.6 - 37

Source: City of Santa Rosa, Initial Study and Negative Declaration for Conversion to Ultra-Violet Disinfection (February, 1997).

Table 3

Density of *Cryptosporidium* and *Giardia* in Laguna Plant Effluent From May 23, 1996, through January 6, 1997 (cysts/100 L)

Date	*Crypto*	*Giardia*	Reporting Limit	Date	*Crypto*	*Giardia*	Reporting Limit
23-May-96	ND	ND	3	16-Sep-96	ND	ND	27
28-May-96	ND	ND	5.3	23-Sep-96	ND	ND	12
4-Jun-96	ND	ND	2.5	30-Sep-96	ND	ND	22
13-Jun-96	ND	ND	1.6	7-Oct-96	ND	ND	4.3
19-Jun-96	ND	ND	13	15-Oct-96	ND	ND	7.4
26-Jun-96	ND	ND	6.6	21-Oct-96	ND	ND	12
2-Jul-96	ND	ND	2.6	28-Oct-96	ND	ND	6.6
11-Jul-96	ND	ND	6.6	4-Nov-96	ND	ND	6.5
18-Jul-96	ND	ND	51.4	12-Nov-96	ND	ND	19
24-Jul-96	ND	ND	43.5	18-Nov-96	ND	ND	16
31-Jul-96	ND	ND	6.6	25-Nov-96	ND	ND	37
8-Aug-96	ND	ND	3.3	2-Dec-96	ND	ND	5.4
15-Aug-96	ND	ND	5.4	9-Dec-96	ND	ND	9.5
22-Aug-96	ND	ND	3.3	16-Dec-96	ND	ND	2.7
27-Aug-96	ND	ND	60	23-Dec-96	ND	ND	13
3-Sep-96	ND	ND	3.2	30-Dec-97	ND	ND	
9-Sep-96	ND	ND	14	6-Jan-97	ND	ND	2.8

Source: Laguna Treatment Facility

1 ND means that the pathogen was not found in the sample at the indicated reporting limit. for example, *Giardia cyst density on May 1996is unknown but is less than 3 cysts per 100L. The reporting limit varies because it is affected by water sample cahracteristics (e.g., the amount of particulate matter in the sample).*

The median of protozoan density values reported Appendix H-3 is higher and the range is broader. This is because Appendix H-3 values are presumptive (not confirmed) and because data include a period in which the filters were not functioning properly.

Filter medium loss results from routine filter operation. Construction activities at the Laguna Plant necessitated unusual filter operations which greatly accelerated filter medium loss. The loss of filter medium that occurred in late 1995 was identified immediately by treatment plant staff, and staff took steps to obtain additional medium to replace that which was lost. Medium replacement was delayed by approximately three months due to the normal purchasing and delivery process, and then was delayed for another three months due to unusually high flows in the Laguna Plant. A filter must be taken off line to add the filter medium, and high flows during early 1996 necessitated keeping all filters that were present at that time on line at all times until early April 1996. Since that time the City has instituted a policy to store filter medium on site to avoid delays related to acquiring medium. The policy also requires evaluation and correction of filter medium depth prior to the rainy season when treatment plant flows would further delay problem correction. Based on the solution that has already been implemented, impacts are evaluated below using pathogen density data from the period of routine filter operation.

Effect of UV Disinfection on Pathogen Density

The City of Santa Rosa is currently implementing the Conversion to Ultra-Violet Disinfection Project, which replaces the existing chlorine disinfection process with one that uses ultra-violet light. The ultra-violet conversion project was not addressed in the Draft EIR/EIS because the City of Santa Rosa had not yet decided to implement the conversion prior to issuance of the Draft EIR/EIS. Since then, however, the City has committed to the ultra-violet conversion project and has described potential impacts in a separate CEQA document (*Initial Study and Negative Declaration for Conversion to Ultra-Violet Disinfection* (February, 1997)). The *Initial Study and Negative Declaration for Conversion to Ultra-Violet Disinfection* is based on confirmed values from 23 May 1996 through 6 January 1997, which are described in Tables 2 and 3.

The City of Santa Rosa's *Initial Study and Negative Declaration for Conversion to Ultra-Violet Disinfection* determined that ultra-violet disinfection is equally effective as chlorine for kill of bacteria and viruses in filtered reclaimed water. The ultra-violet Initial Study/Negative Declaration also found no change in kill of *Cryptosporidium*; neither disinfection method is believed to inactivate *Cryptosporidium* oocysts. Chlorine is capable of 0.5-log *Giardia* reduction, but ultra-violet light is not considered capable of inactivating *Giardia* cysts. The Initial Study/Negative Declaration concludes that changing to ultra-violet disinfection would not affect protozoan pathogen levels in the receiving water because:

- Filtration at the Laguna Plant and settling in storage provide 4- to 5-log (10,000 to 100,000-fold) removal of *Cryptosporidium* and *Giardia*; and

- The density of protozoan pathogens in reclaimed water is low relative to background levels in receiving waters.

The Initial Study/Negative Declaration concluded that ultra-violet disinfected reclaimed water will continue to meet the Title 22 standards for unrestricted reuse.

Effect of Storage on Pathogen Density

The Initial Study/Negative Declaration cited above estimated that natural die-off, settling, and predation of *Cryptosporidum* and *Giardia* in storage ponds to predominate over additions of *Cryptosporidium* and *Giardia* to storage ponds. Thus, the density of *Cryptosporidium* and *Giardia* is estimated to decrease as a result of storage from the values in Table 2 by 1 log (10-fold) to 2 log (100-fold).

Coliform levels in ponds routinely increase, but no reason exists to assume that the coliform level in Delta Pond reflects a problem with human fecal contamination. Low numbers of total coliform provide a good indication that bacteria have been removed by filtration and disinfection. The regulations that specify no more than 23 coliforms per 100 mL are for fresh effluent and the point of compliance is at the end of chlorine contact at the Laguna plant. Higher total coliform numbers in storage ponds are primarily a reflection of inputs from waterfowl and other wildlife and are not necessarily reflective of human pathogens.

Measurements of total coliform in storage facilities detect the presence of five genera of bacteria: *Escherichia* (the genus of *E. coli*), *Klebsiella*, *Citrobacter*, *Enterobacter*, and lactose positive species of *Aeromonas*. Many of these do not cause illness in humans. For example, *Aeromonas* is a naturally occurring freshwater organism that is only pathogenic to cold-blooded animals such as frogs. *Enterobacter* includes several strains of nitrogen fixing bacteria that are widely present in water and soil, and are not characteristic intestinal inhabitants. Thus, the fact that total coliform levels in ponds are higher than levels measured at the treatment plant is not an indicator of human health risk. Typical total coliform levels in surface water routinely measure 1,000 or more, but most of the organisms that are detected in a total coliform analysis are likely to be non-pathogenic organisms. In fact, because it detects so many non-pathogenic organisms, EPA no longer recommends use of total coliform as an indicator for surface water. Analysis of either *enteroccocci* or *E. coli* is recommended to determine safety of surface waters for water contact recreation. (Dufour, A.P., Health Effects Criteria for Fresh Recreational Water, U.S. Environmental Protection Agency, EPA 600/1-84-004, Cincinnati, Ohio, 1984.)

Pathogens in Receiving Water

Sonoma County Water Agency's *Russian River Demonstration Study* (July 1993) reports that 48 samples were collected in the Russian River near the Water Agency intakes from April 1992 through May 1993 and analyzed for *Cryptosporidium* and *Giardia*. Three samples were positive for *Giardia* and one sample was positive for *Cryptosporidium*. The data are summarized in Table 4.

Table 4

Density of *Cryptosporidium* and *Giardia* in Russian River
(cysts/100 L)

Cryptosporidium		***Giardia***	
Median	**Range**	**Median**	**Range**
<1	<1 - 2.7	<1	<1 - 13.8

Source: SCWA's Russian River Demonstration Study
(July 1993)

Project Impacts

Table 5 compares the density of *Cryptosporidium* and *Giardia* cysts in storage pond discharge to existing background conditions in the River. Table 5 shows that the median density in storage pond discharge and in the River are both less than the limit of detection. The range of *Giardia* cyst density in storage pond discharge overlaps, but is generally lower than that in the River. The range of *Cryptosporidium* oocyst density in storage pond discharge is less than to that of the River. The Table 5 data show that discharge at any rate would have no apparent effect on *Cryptosporidium* or *Giardia* cyst density in the Russian River. These data further indicate that discharge at any rate would not measurably increase risk of exposure to protozoan pathogens and that discharge at any rate would not measurably degrade water quality or lead to imposition of additional treatment requirements on the Sonoma County Water Agency by the Department of Health Services. Therefore, the impact of discharge alternatives using chlorine or ultra-violet disinfection is considered less-than-significant for exposure of humans to bacterial and protozoan pathogens. Because of the medium values less than detection limit, a more definitive analysis is not possible.

Table 5

Comparison of *Cryptosporidium* and *Giardia* in River and Reclaimed Water (cysts/100 L)

	Cryptosporidium		***Giardia***	
	Median	**Range**	**Median**	**Range**
Discharge From Storage Pond[1]	<0.06 - <0.6[3]	<0.1 - <14.1[43]	<0.08 - <0.8[3]3	<0.401 - 41[43]
Background in River[2]	<1	<1 - 2.7	<1	<1 - 13.8

1 Source: City of Santa Rosa, Initial Study and Negative Declaration for Conversion to Ultra-Violet Disinfection (February, 1997).

2 Source: Sonoma County Water Agency's Russian River Demonstration Study (July 1993), see Table 4

3 The range is based on the median value from Table 2 divided by 10 and 100, which is the estimated attenuation due to die-off, settling and predation in storage.

4 The maximum value is the maximum treatment plant effluent value (Table 2) divided by 10 and 100, which is the estimated multiplied by the density attenuation due to die-off, settling and predation in storage. Storage will also dampen the magnitude of cyst density variation, as described in Response to Comment 82-200. This effect is not reflected in the range given in Table 5. The range will therefore be less than that shown in Table 5.

REPLACEMENT PAGES

APPENDIX K

TERRESTRIAL BIOLOGICAL RESOURCES

ADOBE ROAD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
Birds	
Scrub jay	*Aphelocoma coerulescens*
Great horned owl	*Bubo virginianus*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
California quail	*Callipepla californica*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Turkey vulture	*Cathartes aura*
Swainson's thrush	*Catharus ustulatus*
Wrentit	*Chamaea fasciata*
Killdeer	*Charadrius vociferus*
Northern flicker	*Colaptes auratus*
Western wood-pewee	*Contopus sordidulus*
American crow	*Corvus brachyrhynchos*
Steller's jay	*Cyanocitta stelleri*
White-tailed kite	*Elanus leucurus*
Brewer's blackbird	*Euphagus cyanocephalus*
Merlin	*Falco columbarius*
American kestrel	*Falco sparverius*
Varied thrush	*Ixoreus naevius*
Dark-eyed junco	*Junco hyemalis*
Acorn woodpecker	*Melanerpes formicivorus*
Plain titmouse	*Parus inornatus*
Savannah sparrow	*Passerculus sandwichensis*
Nuttall's woodpecker	*Picoides nuttallii*
California towhee	*Pipilo crissalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Bushtit	*Psaltriparus minimus*
Ruby-crowned kinglet	*Regulus calendula*
Allen's hummingbird	*Selasphorus sasin*

ADOBE ROAD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Western bluebird	*Sialia mexicana*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
American robin	*Turdus migratorius*
Mourning dove	*Zenaida macroura*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Mammals	
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
Western gray squirrel	*Sciurus griseus*
California ground squirrel	*Spermophilus beecheyi*
Reptiles	
Gopher snake	*Pituophis melanoleucus*
Western fence lizard	*Sceloporus occidentalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

LAKEVILLE HILLSIDE WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Bullfrog	*Rana catesbeiana*
Birds	
Red-winged blackbird	*Agelaius phoeniceus*
Golden eagle	*Aquila chrysaetos*
Great horned owl	*Bubo virginianus*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
Anna’s hummingbird	*Calypte anna*
House finch	*Carpodacus mexicanus*
Turkey vulture	*Cathartes aura*
Northern flicker	*Colaptes auratus*
Common raven	*Corvus corax*
Yellow-rumped warbler	*Dendroica coronata*
White-tailed kite	*Elanus leucurus*
Brewer’s blackbird	*Euphagus cyanocephalus*
American kestrel	*Falco sparverius*
Dark-eyed junco	*Junco hyemalis*
Nuttall’s woodpecker	*Picoides nuttallii*
California towhee	*Pipilo crissalis*
Ruby-crowned kinglet	*Regulus calendula*
Black phoebe	*Sayornis nigricans*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Mourning dove	*Zenaida macroura*
Golden-crowned sparrow	*Zonotrichia atricapilla*
White-crowned sparrow	*Zonotrichia leucophrys*
Mammals	
Coyote	*Canis latrans*
Black-tailed jackrabbit	*Lepus californicus*
Striped skunk	*Mephitis mephitis*

LAKEVILLE HILLSIDE WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Raccoon (tracks)	*Procyon lotor*
California ground squirrel	*Spermophilus beecheyi*
Reptiles	
Western fence lizard	*Sceloporus occidentalis*
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

SEARS POINT WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Birds	
Cooper's hawk	*Accipiter cooperii*
White-throated swift	*Aeronautes saxatalis*
Red-winged blackbird	*Agelaius phoeniceus*
Mallard	*Anas platyrhynchos*
Scrub jay	*Aphelocoma coerulescens*
Golden eagle	*Aquila chrysaetos*
Great horned owl	*Bubo virginianus*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
California quail	*Callipepla californica*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Turkey vulture	*Cathartes aura*
Killdeer	*Charadrius vociferus*
Lark sparrow	*Chondestes grammacus*
Northern harrier	*Circus cyaneus*
Rock dove	*Columba livia*
Olive-sided flycatcher	*Contopus borealis*
Western wood-pewee	*Contopus sordidulus*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Steller’s jay	*Cyanocitta stelleri*
Horned lark	*Eremophila alpestris*
Brewer’s blackbird	*Euphagus cyanocephalus*
Merlin	*Falco columbarius*
American kestrel	*Falco sparverius*
Cliff swallow	*Hirundo pyrrhonota*
Barn swallow	*Hirundo rustica*
Northern oriole	*Icterus galbula*

SEARS POINT WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Dark-eyed junco	*Junco hyemalis*
Song sparrow	*Melospiza melodia*
Brown-headed cowbird	*Molothrus ater*
Ash-throated flycatcher	*Myiarchus cinerascens*
Plain titmouse	*Parus inornatus*
House sparrow	*Passer domesticus*
Nuttall’s woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
California towhee	*Pipilo crissalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Bushtit	*Psaltriparus minimus*
Black phoebe	*Sayornis nigricans*
Allen’s hummingbird	*Selasphorus sasin*
Western bluebird	*Sialia mexicana*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*Tachycineta thalassina*
Bewick’s wren	*Thyromanes bewickii*
House wren	*Troglodytes aedon*
American robin	*Turdus migratorius*
Western kingbird	*Tyrannus verticalis*
Mourning dove	*Zenaida macroura*
Mammals	
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
Western gray squirrel	*Sciurus griseus*
Audubon’s cottontail	*Sylvilagus audubonii*
Reptiles	
Western fence lizard	*Sceloporus occidentalis*
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

TOLAY WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Bullfrog	*Rana catesbeiana*
Birds	
Cooper's hawk	*Accipiter cooperii*
Red-winged blackbird	*Agelaius phoeniceus*
Tricolored blackbird	*Agelaius tricolor*
Northern shoveler	*Anas clypeata*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Golden eagle	*Aquila chrysaetos*
Great blue heron	*Ardea herodias*
Red-tailed hawk	*Buteo jamaicensis*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
Pine siskin	*Carduelis pinus*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Purple finch	*Carpodacus purpureus*
Great egret	*Casmerodius albus*
Turkey vulture	*Cathartes aura*
Hermit thrush	*Catharus guttatus*
Wrentit	*Chamaea fasciata*
Killdeer	*Charadrius vociferus*
Northern harrier	*Circus cyaneus*
American crow	*Corvus brachyrhynchos*
White-tailed kite	*Elanus leucurus*
Horned lark	*Eremophila alpestris*
Brewer's blackbird	*Euphagus cyanocephalus*
American coot	*Fulica americana*
Cliff swallow	*Hirundo pyrrhonota*
Barn swallow	*Hirundo rustica*

TOLAY WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Northern oriole	*Icterus galbula*
Dark-eyed junco	*Junco hyemalis*
Lincoln's sparrow	*Melospiza lincolnii*
Song sparrow	*Melospiza melodia*
Brown-headed cowbird	*Molothrus ater*
Plain titmouse	*Parus inornatus*
Fox sparrow	*Passerella iliaca*
Double-crested cormorant	*Phalacrocorax auritus*
California towhee	*Pipilo crissalis*
Allen’s hummingbird	*Selasphorus sasin*
Western bluebird	*Sialia mexicana*
Western burrowing owl	*Speotyto cunicularia hypugea*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Violet-green swallow	*Tachycineta thalassina*
Greater yellowlegs	*Tringa melanoleuca*
American robin	*Turdus migratorius*
Western kingbird	*Tyrannus verticalis*
Mourning dove	*Zenaida macroura*
Mammals	
Coyote (scat)	*Canis latrans*
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
California ground squirrel	*Spermophilus beecheyi*
Audubon’s cottontail	*Sylvilagus audubonii*
Reptiles	
Northwestern pond turtle	*Clemmys marmorata marmorata*
Western fence lizard	*Sceloporus occidentalis*
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

BLOOMFIELD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Bullfrog	*Rana catesbeiana*
Birds	
Cooper's hawk	*Accipiter cooperii*
Red-winged blackbird	*Agelaius phoeniceus*
Cinnamon teal	*Anas cyanoptera*
Mallard	*Anas platyrhynchos*
Scrub jay	*Aphelocoma coerulescens*
Great blue heron	*Ardea herodias*
Great horned owl	*Bubo virginianus*
Bufflehead	*Bucephala albeola*
Red-tailed hawk	*Buteo jamaicensis*
California quail	*Callipepla californica*
Anna’s hummingbird	*Calypte anna*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Turkey vulture	*Cathartes aura*
Killdeer	*Charadrius vociferus*
Lark sparrow	*Chondestes grammacus*
Western wood-pewee	*Contopus sordidulus*
Common raven	*Corvus corax*
Steller’s jay	*Cyanocitta stelleri*
Yellow-rumped warbler	*Dendroica coronata*
Brewer’s blackbird	*Euphagus cyanocephalus*
American kestrel	*Falco sparverius*
Barn swallow	*Hirundo rustica*
Northern oriole	*Icterus galbula*
Dark-eyed junco	*Junco hyemalis*
Loggerhead shrike	*Lanius ludovicianus*
Lincoln's sparrow	*Melospiza lincolnii*
Song sparrow	*Melospiza melodia*

BLOOMFIELD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Northern mockingbird	*Mimus polyglottos*
Brown-headed cowbird	*Molothrus ater*
Plain titmouse	*Parus inornatus*
Chestnut-backed chickadee	*Parus rufescens*
Savannah sparrow	*Passerculus sandwichensis*
California towhee	*Pipilo crissalis*
Bushtit	*Psaltriparus minimus*
Ruby-crowned kinglet	*Regulus calendula*
Black phoebe[1]	*Sayornis nigricans*
Western bluebird	*Sialia mexicana*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*Tachycineta thalassina*
Bewick's wren	*Thyromanes bewickii*
American robin	*Turdus migratorius*
Western kingbird	*Tyrannus verticalis*
Mourning dove	*Zenaida macroura*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Mammals	
Long-tailed weasel	*Mustela frenata*
Black tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
California ground squirrel	*Spermophilus beecheyi*
Reptiles	
Southern alligator lizard	*Gerrhonotus multicarinatus*
Western fence lizard	*Sceloporus occidentalis*
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

CARROLL ROAD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
Bullfrog	*Rana catesbeiana*
Rough-skinned newt	*Taricha granulosa*
Birds	
Sharp-shinned hawk	*Accipiter striatus*
Red-winged blackbird	*Agelaius phoeniceus*
Scrub jay	*Aphelocoma coerulescens*
Cedar waxwing	*Bombycilla cedrorum*
Great horned owl	*Bubo virginianus*
Bufflehead	*Bucephala albeola*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
Pine siskin	*Carduelis pinus*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Purple finch	*Carpodacus purpureus*
Turkey vulture	*Cathartes aura*
Belted kingfisher	*Ceryle alcyon*
Killdeer	*Charadrius vociferus*
Lark sparrow	*Chondestes grammacus*
Northern flicker	*Colaptes auratus*
Rock dove	*Columba livia*
Western wood-pewee	*Contopus sordidulus*
American crow	*Corvus brachyrhynchos*
Yellow-rumped warbler	*Dendroica coronata*
Brewer's blackbird	*Euphagus cyanocephalus*
American kestrel	*Falco sparverius*
Barn swallow	*Hirundo rustica*
Northern oriole	*Icterus galbula*
Dark-eyed junco	*Junco hyemalis*

CARROLL ROAD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Loggerhead shrike	*Lanius ludovicianus*
Song sparrow	*Melospiza melodia*
Northern mockingbird	*Mimus polyglottos*
Brown-headed cowbird	*Molothrus ater*
House sparrow	*Passer domesticus*
Savannah sparrow	*Passerculus sandwichensis*
Nuttall's woodpecker	*Picoides nuttallii*
California towhee	*Pipilo crissalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Pied-billed grebe	*Podilymbus podiceps*
Bushtit	*Psaltriparus minimus*
Ruby-crowned kinglet	*Regulus calendula*
Black phoebe	*Sayornis nigricans*
Allen's hummingbird	*Selasphorus sasin*
Western bluebird	*Sialia mexicana*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*Tachycineta thalassina*
American robin	*Turdus migratorius*
Barn owl	*Tyto alba*
Mourning dove	*Zenaida macroura*
Golden-crowned sparrow	*Zonotrichia atricapilla*
White-crowned sparrow	*Zonotrichia leucophrys*
Mammals	
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
California ground squirrel	*Spermophilus beecheyi*
Audubon's cottontail	*Sylvilagus audubonii*
Reptiles	
Northwestern pond turtle	*Clemmys marmorata marmorata*
Western fence lizard	*Sceloporus occidentalis*

CARROLL ROAD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

HUNTLEY WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
California slender salamander	*Batrachoseps attenuatis*
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Bullfrog	*Rana catesbeiana*
Birds	
Red-winged blackbird	*Agelaius phoeniceus*
Mallard	*Anas platyrhynchos*
American pipit	*Anthus rubescens*
Scrub jay	*Aphelocoma coerulescens*
Canada goose	*Branta canadensis*
Great horned owl	*Bubo virginianus*
Bufflehead	*Bucephala albeola*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
Pine siskin	*Carduelis pinus*
American goldfinch	*Carduelis tristis*
Turkey vulture	*Cathartes aura*
Northern flicker	*Colaptes auratus*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Yellow-rumped warbler	*Dendroica coronata*
Horned lark	*Eremophila alpestris*
Brewer's blackbird	*Euphagus cyanocephalus*
American kestrel	*Falco sparverius*
Dark-eyed junco	*Junco hyemalis*
Loggerhead shrike	*Lanius ludovicianus*
Song sparrow[1]	*Melospiza melodia*
Chestnut-backed chickadee	*Parus rufescens*
California towhee	*Pipilo crissalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*

HUNTLEY WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Bushtit	*Psaltriparus minimus*
Black phoebe	*Sayornis nigricans*
Allen's hummingbird	*Selasphorus sasin*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
American robin	*Turdus migratorius*
Mourning dove	*Zenaida macroura*
Golden-crowned sparrow	*Zonotrichia atricapilla*
White-crowned sparrow	*Zonotrichia leucophrys*
Mammals	
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
California ground squirrel	*Spermophilus beecheyi*
Audubon's cottontail	*Sylvilagus audubonii*
American badger (digs/burrow)	*Taxidea taxus*
Reptiles	
Northwestern pond turtle	*Clemmys marmorata marmorata*
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

TWO ROCK WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Bullfrog	*Rana catesbeiana*
California newt	*Taricha torosa*
Birds	
Red-winged blackbird	*Agelaius phoeniceus*
Grasshopper sparrow	*Ammodramus savanarum*
Mallard	*Anas platyrhynchos*
Scrub jay	*Aphelocoma coerulescens*
Golden eagle	*Aquila chrysaetos*
Great blue heron	*Ardea herodias*
Cedar waxwing	*Bombycilla cedrorum*
Great horned owl	*Bubo virginianus*
Red-tailed hawk	*Buteo jamaicensis*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Purple finch	*Carpodacus purpureus*
Turkey vulture	*Cathartes aura*
Swainson's thrush	*Catharus ustulatus*
Wrentit	*Chamaea fasciata*
Lark sparrow	*Chondestes grammacus*
Northern flicker	*Colaptes auratus*
Rock dove	*Columba livia*
Western wood-pewee	*Contopus sordidulus*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Steller's jay	*Cyanocitta stelleri*
Yellow warbler	*Dendroica petechia*
Pacific-slope flycatcher	*Empidonax difficilis*
Horned lark	*Eremophila alpestris*

TWO ROCK WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Brewer's blackbird	*Euphagus cyanocephalus*
American kestrel	*Falco sparverius*
American coot	*Fulica americana*
Common moorhen	*Gallinula chloropus*
Cliff swallow	*Hirundo pyrrhonota*
Barn swallow	*Hirundo rustica*
Northern oriole	*Icterus galbula*
Dark-eyed junco	*Junco hyemalis*
California gull	*Larus californicus*
Song sparrow	*Melospiza melodia*
Northern mockingbird	*Mimus polyglottos*
Brown-headed cowbird	*Molothrus ater*
Ash-throated flycatcher	*Myiarchus cinerascens*
Black-crowned night-heron	*Nycticorax nycticorax*
Plain titmouse	*Parus inornatus*
Chestnut-backed chickadee	*Parus rufescens*
House sparrow	*Passer domesticus*
Fox sparrow	*Passerella iliaca*
Lazuli bunting	*Passerina amoena*
Nuttall's woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
California towhee	*Pipilo crissalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Western tanager	*Piranga ludoviciana*
Pied-billed grebe	*Podilymbus podiceps*
Bushtit	*Psaltriparus minimus*
Black phoebe	*Sayornis nigricans*
Allen's hummingbird	*Selasphorus sasin*
Mountain bluebird	*Sialia currucoides*
Western bluebird	*Sialia mexicana*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*

TWO ROCK WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*Tachycineta thalassina*
Bewick's wren	*Thyromanes bewickii*
House wren	*Troglodytes aedon*
American robin	*Turdus migratorius*
Western kingbird	*Tyrannus verticalis*
Barn owl	*Tyto alba*
Orange-crowned warbler	*Vermivora celata*
Warbling vireo	*Vireo gilvus*
Hutton's vireo	*Vireo huttoni*
Wilson's warbler[1]	*Wilsonia pusilla*
Mourning dove	*Zenaida macroura*
Mammals	
Striped skunk	*Mephitis mephitis*
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
California ground squirrel	*Spermophilus beecheyi*
Western gray squirrel	*Sciurus griseus*
Reptiles	
Northwestern pond turtle	*Clemmys marmorata marmorata*
Southern alligator lizard	*Gerrhonotus multicarinatus*
Western fence lizard	*Sceloporus occidentalis*
California red-sided garter snake	*Thamnophis sirtalis infernalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

VALLEY FORD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Amphibians	
Western toad	*Bufo boreas*
Pacific tree frog	*Pseudacris regilla*
California red-legged frog	*Rana aurora draytoni*
Bullfrog	*Rana catesbeiana*
Rough-skinned newt	*Taricha granulosa*
Birds	
Sharp-shinned hawk	*Accipiter striatus*
Red-winged blackbird	*Agelaius phoeniceus*
Mallard	*Anas platyrhynchos*
Scrub jay	*Aphelocoma coerulescens*
Great blue heron	*Ardea herodias*
Red-tailed hawk	*Buteo jamaicensis*
California quail	*Callipepla californica*
Lesser goldfinch	*Carduelis psaltria*
House finch	*Carpodacus mexicanus*
Turkey vulture	*Cathartes aura*
Killdeer	*Charadrius vociferus*
Northern harrier	*Circus cyaneus*
Northern flicker	*Colaptes auratus*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Yellow-rumped warbler	*Dendroica coronata*
Brewer's blackbird	*Euphagus cyanocephalus*
Prairie falcon	*Falco mexicanus*
American kestrel	*Falco sparverius*
Loggerhead shrike	*Lanius ludovicianus*
Savannah sparrow	*Passerculus sandwichensis*
Nuttall's woodpecker	*Picoides nuttallii*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Pied-billed grebe	*Podilymbus podiceps*
Black phoebe	*Sayornis nigricans*
Western bluebird	*Sialia mexicana*

VALLEY FORD WILDLIFE SPECIES LIST*

Common Name	Scientific Name
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Greater yellowlegs	*Tringa melanoleuca*
Western kingbird	*Tyrannus verticalis*
Mourning dove	*Zenaida macroura*
Mammals	
Coyote (scat)	*Canis latrans*
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon (tracks)	*Procyon lotor*
Reptiles	
Northwestern pond turtle	*Clemmys marmorata marmorata*
Gopher snake	*Pituophis melanoleucus*
Western fence lizard	*Sceloporus occidentalis*

Notes:
* = Species observed at each reservoir site during surveys conducted in support of the Draft EIR/EIS.

300 feet downstream from the spillway. The spillway is intended for emergency release of water only in the event of upstream flow from a severe storm entering the reservoir when it is full.

All proposed borrow areas, which will provide the basic fill material for construction of the dam, are located within the reservoir footprints. However, all reservoirs will require some imported materials.

Vegetative Communities Plant Communities

Acres of vegetative plant communities potentially affected by construction and maintenance of the proposed reservoir storage facilities are presented in Table 5-1.

Table 5-1

Acreage of vegetative plant communities and mapped features potentially affected by the project components.

Vegetative Communities/ Mapped features	WestSouth County					SouthWest County				
	Bloomfield	Carroll Rd	Huntley	Valley Ford	Two Rock	Adobe Rd	Lakeville Hillside	Sears Pt	Tolay A	Tolay C
Annual grassland	306.16	273.16	268.64	307.3	235.11	265.36	168.36	387.85	350.98	294.17
* Buckeye	.	.	.	.	.	.	.	.	.75	.75
CLO/ILO woodland	.	.	.		.	16.83	.	6.19		.
Cropland	.	.	.	.	.	.	.	.	605.94	245.9
* Cypress	.	.	.	.	.49	.	.	.		.
Drainage		.65		2.82	.44		.48	1.2	6.14	3.
Eucalyptus	6.	18.19	17.8	2.07	1.81	.	13.65	3.45	.05	2.59
Excavated ditch	.	.	.	.	.	.	.	.	10.34	4.91
Freshwater marsh	.	.	.	.	.41	.	.	.		.
Freshwater pond	.78	2.44	.51	3.	6.75	2.39	.19	.	9.77	1.55
Freshwater seep	.	.19	2.36	1.78	23.93	.73	.56	.4	.48	.32
* Lombardy poplar	.	.	.	.	.	.	.72	.		.
Mixed riparian	1.01	.	1.07	.	8.26	60.22	.	43.7	4.37	4.37
Native grassland	.	1.	2.05	.	1.25	.	.56	.	24.78	23.92
Non-wooded riparian	13.6	1.08	2.54	3.17	2.95	3.87	7.97	6.35	19.	18.91
Northern coastal scrub	4.58	2.9	.	.	.	.		.		.
Oak-Bay-Madrone woodland	.63	.	.	.96	58.28	.	.	.		.
* Redwood	.	.07	.	.	.	.	.	.		.
Seasonally wet vegetation	.		8.33	46.51	1.02	.	.	.73	13.89	1.39
Urban	.	.	.	.	.	.	.	.	8.24	.1
Vineyard	.	.	.	.	.	.	28.21	.	10.71	.
Willow riparian woodland	8.7	17.35	3.51	8.87	7.43	.	10.54	15.38	2.42	2.56
Communities per Site	**8**	**10**	**9**	**9**	**13**	**6**	**10**	**9**	**15**	**14**
Elevation of Site (feet)										
Minimum	80	80	80	40	160	180	80	20	190	190
Maximum	400	300	340	220	480	450	240	260	360	360
Size of Site (Acres)	341.46	317.03	306.81	376.48	348.13	349.4	231.24	465.25	1067.86	604.44

* Small stands of trees; not vegetative communities.

REPLACEMENT PAGES

Appendix L

Aquatic Biological Resources

first caught moving upstream, was recaptured moving downstream 10 days later. A hatchery fish was first caught moving downstream, not having spawned; then was recaptured moving upstream, still not having spawned, 26 days later. Another adult was first caught moving upstream on 29 January (not having spawned), and was recaptured 56 days later, spawned out.

Out of seven recaptured fish only two went up ripe and came down spawned out. The interval between the two events was 56 days and 33 days.

Conclusions Concerning Catches of Downmigrating Steelhead. The capture of post-spawned steelhead returning downstream in the three creeks demonstrates that a critical phase in the life cycle is being successfully completed. More fish were captured moving downstream than upstream, which demonstrates that the number of adults in the spawning run of each creek is larger than the number captured moving upstream. The number of downmigrants is likely also underestimated by data collected in this study since these fish (like upmigrants) tended to move during high-flow periods, when fyke nets usually could not be deployed. Fyke nets deployed in the Lower Laguna (see below) showed that even in low-flow periods these nets do not capture all adults (or smolts) which pass.

Steelhead Smolts

Capture of steelhead smolts migrating to the sea for the first time is good evidence that the freshwater phase of the life cycle has been successfully completed. Fyke net counts of juvenile salmonids cannot be assumed to represent the whole population of juveniles passing through the stream. Smolts, like adults, move during high flows associated with rain when fyke nets often cannot be deployed. Inferences drawn from recapture of smolts in the lower Laguna (discussed below) suggest that fyke net catches underestimate smolt numbers even in relatively low-flow periods.

Santa Rosa Creek. A total of 653 juvenile steelhead were captured in the Santa Rosa Creek fyke net moving downstream, and 218 juveniles were captured moving upstream (Table 3-6). Figure 3-11 shows the juvenile steelhead catch for each day; rainfall is plotted on the same figure. In Figure 3-11, juveniles moving downstream are shown as solid bars, and those moving upstream as open bars. Catches of juvenile steelhead tended to be largest just after rains, as was the case with adults and half-pounders. Some juveniles were captured in Santa Rosa Creek virtually every fishing day. A net movement in the downstream direction was nearly always observed. Fish caught moving upstream early in the season are probably not traveling from very far downstream, since little summer habitat is available downstream (see Chapter IV). Such fish were probably displaced downstream by high flows following rains, and if these fish were not ready to smolt, they moved back upstream. Catches of downmigrants following rains in mid-December were about three dozen fish per day. Later on it was more typical to trap one to two dozen per day after rains.

Juvenile fish catches reported below are the counts of fish caught on each day in each net. Juveniles were not marked throughout the study, so it is possible that a given fish could have been counted more than once. However, this is assumed not to be a significant source of error for the following reason. Early in the study juveniles captured in fyke nets were marked. Very few juveniles were ever recaptured, regardless of whether they were first caught moving up- or downstream. Thus no evidence was found that a significant number of young steelhead were milling back and forth in the vicinity of the fyke nets. Counting the downstream-moving fish only (and ignoring the upstream-moving counts, as is done below) probably gives a conservative estimate of smolt numbers, for the following reason. A few downstream-moving fish may be caught twice, but it is probable that a larger number of the fish caught moving upstream (which probably also eventually went out to sea) may not have been included in the downstream count (for example because such fish may have passed the net site while the nets were not set or not fishing effectively). Marking of juvenile salmonids was resumed in conjunction with the lower Laguna fyke netting, as described on page 16.

During December and January, only one-half to two-thirds of the juveniles had clearly developed into smolts. By mid-February, nearly all juveniles had the appearance of typical smolts (i.e., slender body shape, no parr marks, silvery deciduous scales). By early March capture of juveniles in the upstream trap was negligible.

Mark West Creek. A total of 317 juvenile steelhead were captured moving downstream in Mark West Creek; 104 were captured moving upstream (Table 3-6). Figure 3-12 shows the juvenile catch in Mark West Creek. Unlike in Santa Rosa Creek, in Mark West Creek most of the juveniles caught before mid-February were moving upstream. These were probably fish not ready to smolt which had been displaced downstream by rains and

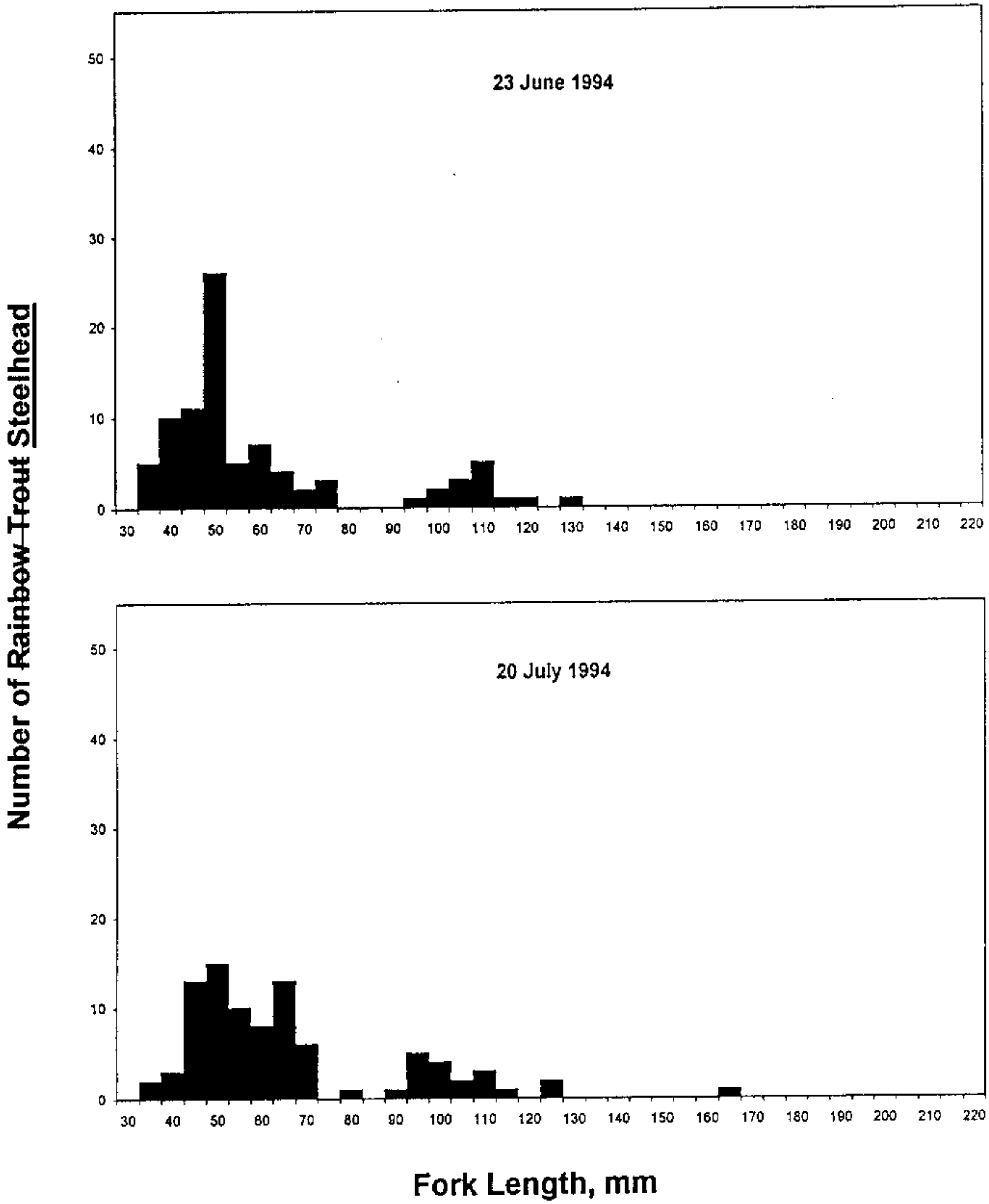


Figure 4-2. Length Frequency Distribution of Juvenile Steelhead
Upper Santa Rosa Creek, June vs. July 1994 – Units 1 and 3

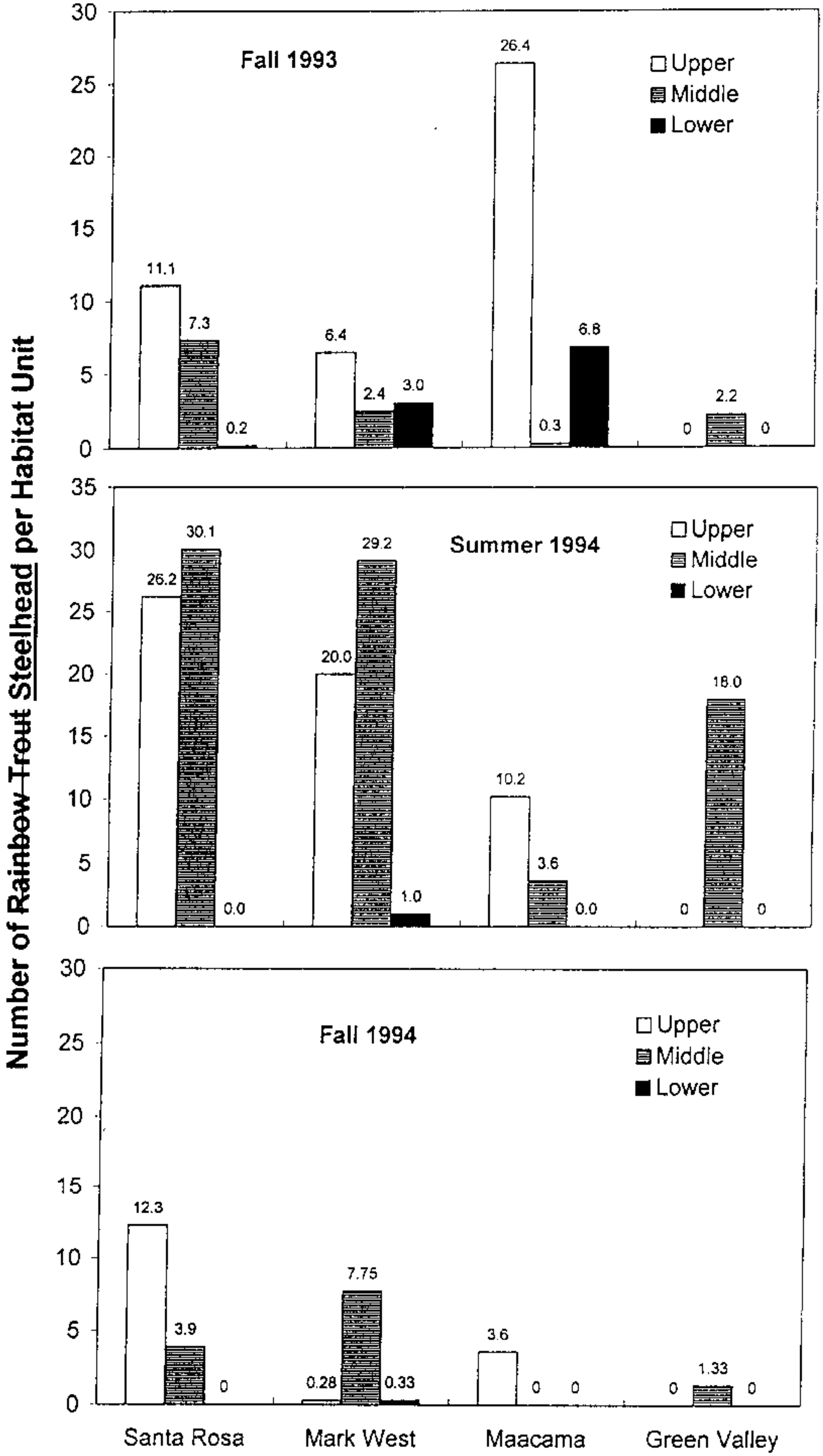


Figure 4-4. Juvenile Steelhead Abundance

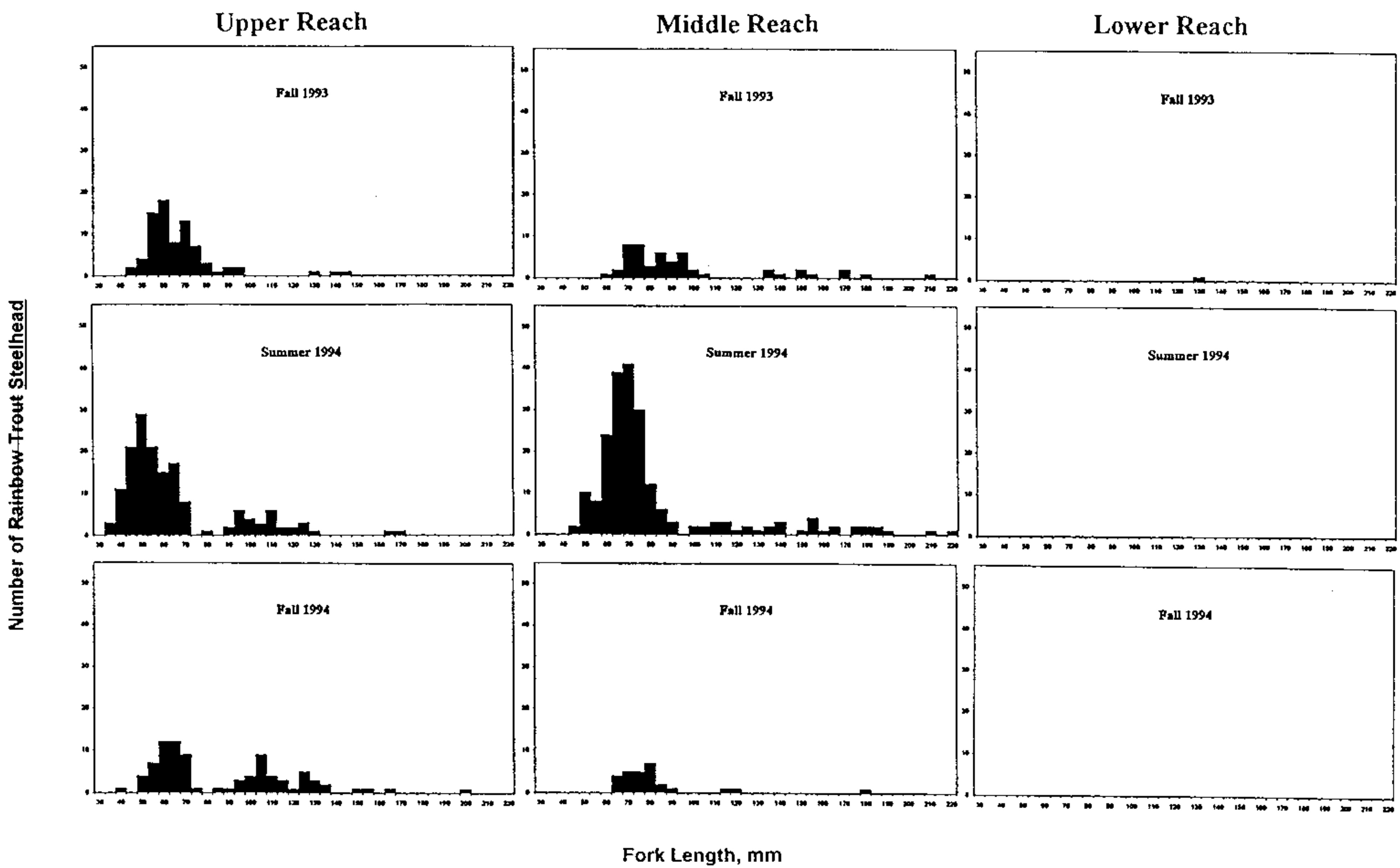


Figure 4-5. Length Frequency Distribution of Juvenile Steelhead
Santa Rosa Creek

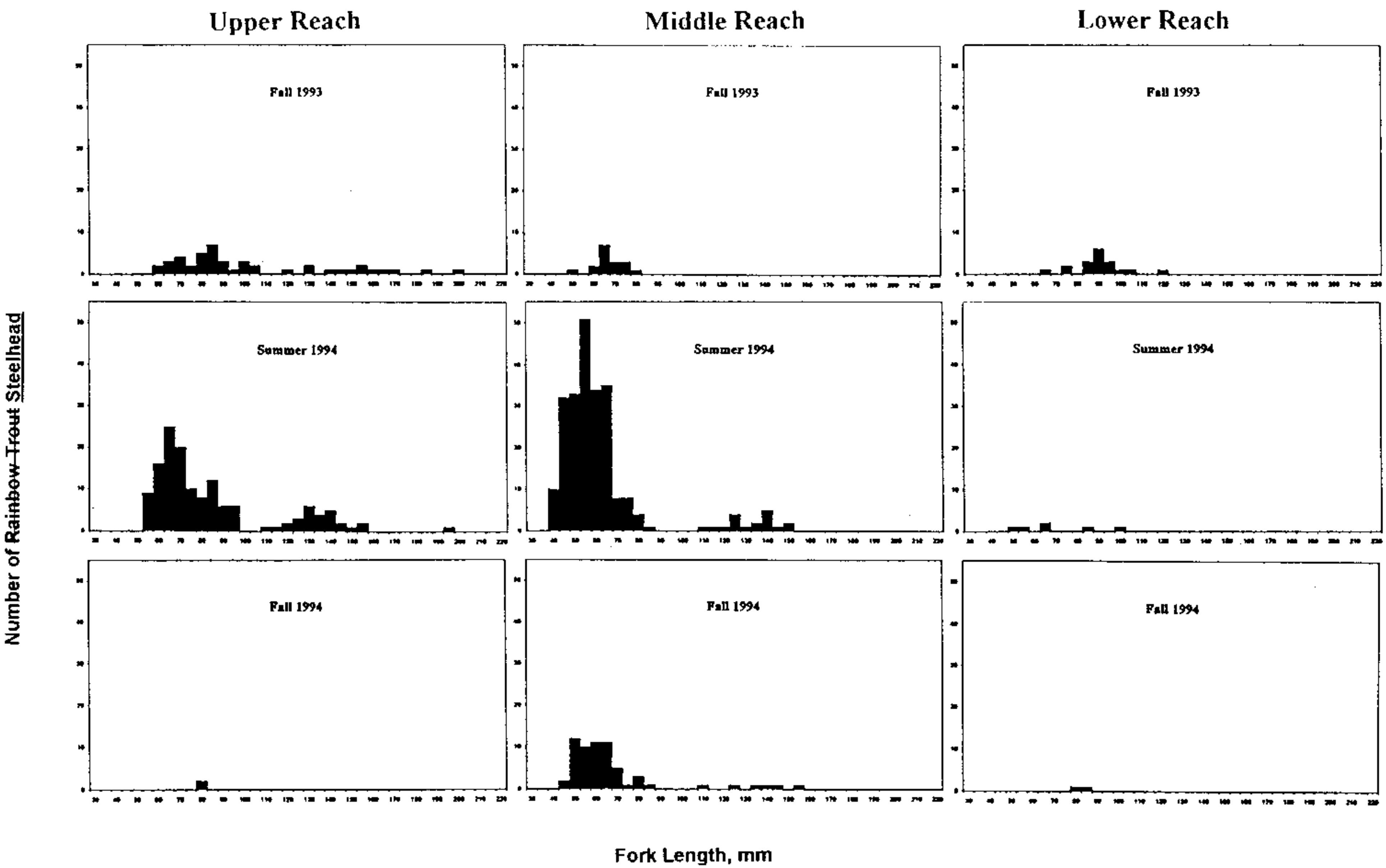


Figure 4-6. Length Frequency Distribution of Juvenile Steelhead
Mark West Creek

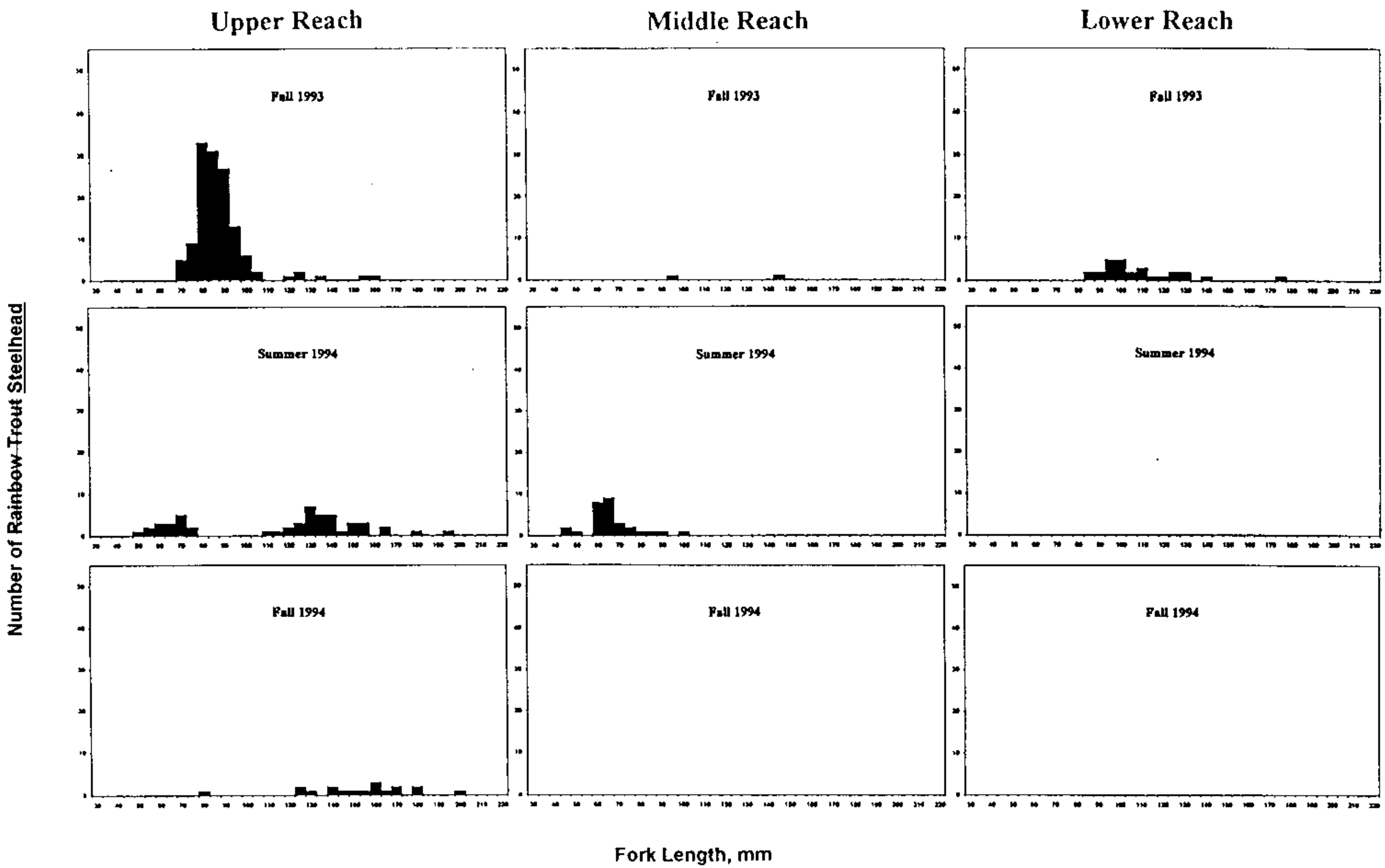


Figure 4-7. Length Frequency Distribution of Juvenile Steelhead
Maacama Creek

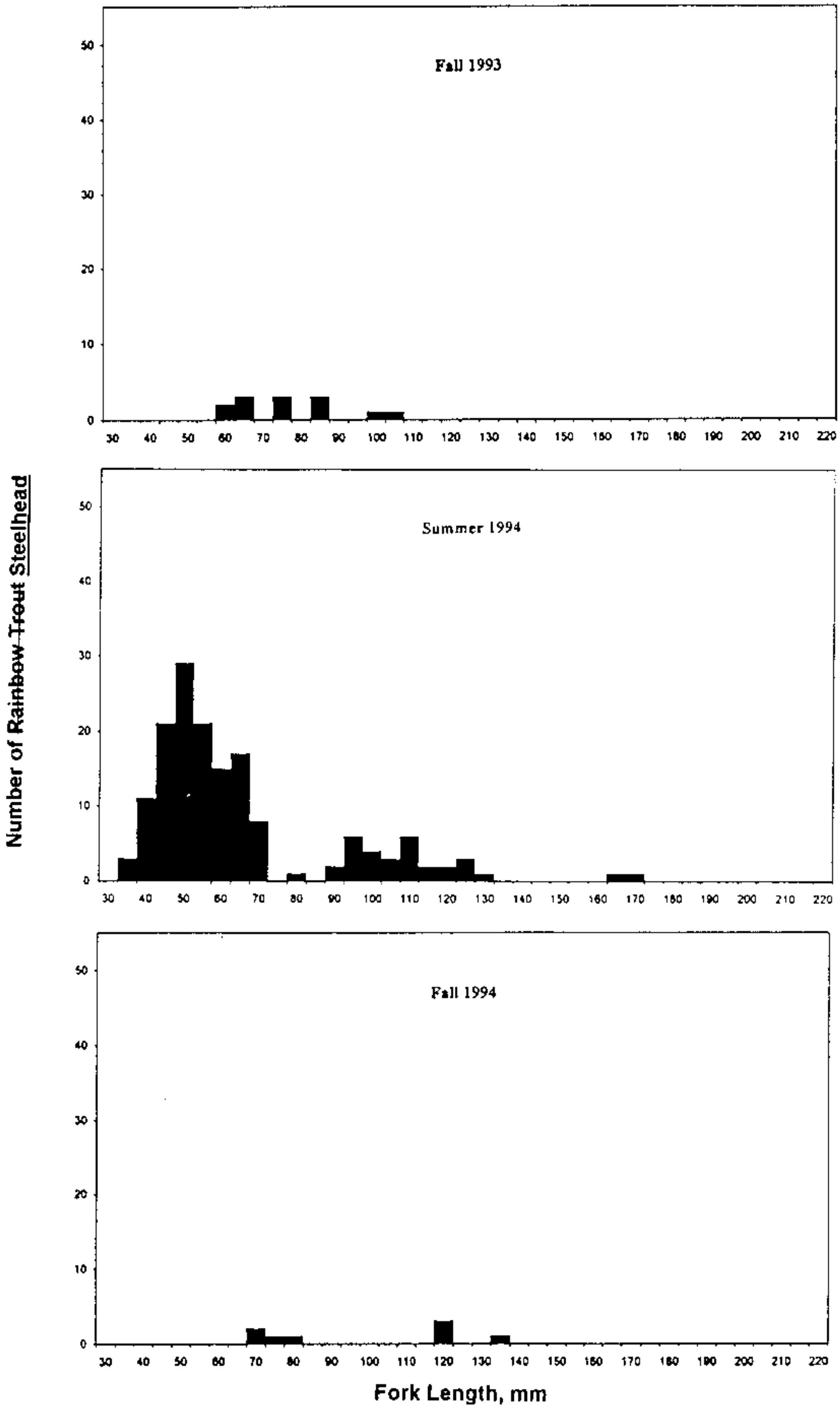


Figure 4-8. Length Frequency Distribution of Juvenile Steelhead
Green Valley Creek

Appendix 4-3-1. Santa Rosa Creek Juvenile Abundance Data.

Upper Santa Rosa Creek (Cougar Lane)									
		Fall 1993 survey		Summer 1994 survey				Fall 1994 survey	
Habitat Unit	Habitat Type	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead
1(lower)	pool	11-Nov-93	22	23-Jun-94	32	20-Jul-94	27	24-Oct-94	20
1(upper)	pool	11-Nov-93	19	23-Jun-94	31	20-Jul-94	30	24-Oct-94	16
2	riffle	11-Nov-93	0					24-Oct-94	0
3	pool	11-Nov-93	17	23-Jun-94	24	20-Jul-94	33	24-Oct-94	14
4	riffle	11-Nov-93	0			20-Jul-94	2	24-Oct-94	1
6(upper)	pool	11-Nov-93	13			20-Jul-94	25	24-Oct-94	14
6(lower)	pool	11-Nov-93	7			20-Jul-94	40	24-Oct-94	21

Middle Santa Rosa Creek (fish ladder to Hwy 12 bridge)							
		Fall 1993 survey		Summer 1994 survey		Fall 1994 survey	
Habitat Unit	Habitat Type	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead
1	pool	8-Nov-93	19	21-Jul-94	141	28-Oct-94	15
2+3	riffle/pool	8-Nov-93	3	21-Jul-94	12	28-Oct-94	1
5	pool	8-Nov-93	0	21-Jul-94	1	28-Oct-94	4
6	pool	8-Nov-93	12	21-Jul-94	24	28-Oct-94	3
19	pool	8-Nov-93	4	21-Jul-94	9	28-Oct-94	2
34	riffle/pool	9-Nov-93	0	21-Jul-94	0	28-Oct-94	0
35	pool	9-Nov-93	13	21-Jul-94	24	28-Oct-94	2

Lower Santa Rosa Creek (above and below Willowside bridge)							
		Fall 1993 survey		Summer 1994 survey		Fall 1994 survey	
Habitat Unit	Habitat Type	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead
1	glide/pool	3-Nov-93	0	27-Jul-94	0	26-Oct-94	0
8(upper)	pool	13-Nov-93	0			26-Oct-94	0
18	riffle			27-Jul-94	0	26-Oct-94	0
22	riffle/glide	2-Nov-93	0	27-Jul-94	0	26-Oct-94	0
24A	riffle/glide	2-Nov-93	0	27-Jul-94	nh	26-Oct-94	0
24	riffle/glide	2-Nov-93	0	27-Jul-94	0	26-Oct-94	nh
32(upper)	glide/pool			27-Jul-94	0	26-Oct-94	0
34	glide/pool	2-Nov-93	1	27-Jul-94	0	26-Oct-94	0

Appendix 4-3-2. Mark West Creek Juvenile Abundance Data.

Upper Mark West Creek (Alpine Road)							
		Fall 1993 Survey		Summer 1994 Survey		Fall 1994 Survey	
Habitat Unit	Habitat Type	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead
1	glide	12-Nov-93	0	18-Jul-94	nh	26-Oct-94	0
2	riffle	12-Nov-93	0	18-Jul-94	nh	26-Oct-94	0
3	pool	12-Nov-93	5	18-Jul-94	42	26-Oct-94	0
5	pool/glide	13-Nov-93	1	18-Jul-94	22	26-Oct-94	0
7	pool	13-Nov-93	1	18-Jul-94	nh	26-Oct-94	0
7A	pool	13-Nov-93	1	18-Jul-94	nh	26-Oct-94	0
8	pool	13-Nov-93	37	18-Jul-94	76	26-Oct-94	2

Middle Mark West Creek (downstream from Mark West Lodge)							
		Fall 1993 Survey		Summer 1994 Survey		Fall 1994 Survey	
Habitat Unit	Habitat Type	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead
12	pool/glide	9-Nov-93	1	25-Jul-94	25	21-Oct-94	10
18	glide	9-Nov-93	7	25-Jul-94	55	21-Oct-94	11
20	pool	10-Nov-93	1	25-Jul-94	20	21-Oct-94	2
22	pool			25-Jul-94	55	21-Oct-94	13
24	pool/glide	10-Nov-93	1	25-Jul-94	28	21-Oct-94	8
26(middle)	glide	10-Nov-93	6	25-Jul-94	17	21-Oct-94	1
26(upper)	pool	10-Nov-93	1	25-Jul-94	34	21-Oct-94	17
26A	pool	10-Nov-93	0	25-Jul-94	nh	21-Oct-94	0

Lower Mark West Creek (River Road Bridge to Cunningham Ranch)							
		Fall 1993 Survey		Summer 1994 Survey		Fall 1994 Survey	
Habitat Unit	Habitat Type	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead	Date Sampled	Total ~~Trout~~ Steelhead
27	pool	30-Oct-93	6	26-Jul-94	2	20-Oct-94	2
28 (lower)	riffle	30-Oct-93	0	26-Jul-94	1	20-Oct-94	0
28 (upper)	riffle	30-Oct-93	2	26-Jul-94	0	20-Oct-94	0
32	glide	30-Oct-93	2	26-Jul-94	3	20-Oct-94	0
34	glide	30-Oct-93	2	26-Jul-94	0	20-Oct-94	0
36	pool	30-Oct-93	6	26-Jul-94	0	20-Oct-94	0

Appendix 4-3-3. Maacama Creek Juvenile Abundance Data.

Upper Maacama/Redwod Creek (Redwood Cr.,Hwy 128 to Yellowjacket)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head
1L	pool	19-Nov-93	0	14	19-Jul-94	0	4	27-Oct-94	0	0
2L	glide	19-Nov-93	0	5	19-Jul-94	0	1	27-Oct-94	0	1
3L	pool	19-Nov-93	43	101	19-Jul-94	3	18	27-Oct-94	0	10
1	glide	19-Nov-93	1	2	19-Jul-94	0	2	27-Oct-94	0	0
3	pool	19-Nov-93	11	10	19-Jul-94	0	26	27-Oct-94	0	7

Middle Maacama/Redwood Creek (Camp Maacama)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head
2(lower)	pool	20-Nov-93	0	0	22-Jul-94	nh	nh	27-Oct-94	0	0
2(upper)	pool	20-Nov-93	0	1	22-Jul-94	0	22	27-Oct-94	0	0
3	glide	20-Nov-93	0	0	22-Jul-94	0	7	27-Oct-94	0	0
5	pool	20-Nov-93	0	1	22-Jul-94	0	0	27-Oct-94	0	0
9A	pool	20-Nov-93	0	0	22-Jul-94	nh	nh	27-Oct-94	0	0
10(upper)	glide	20-Nov-93	0	0	22-Jul-94	nh	nh	27-Oct-94	0	0
20(lower)	pool	20-Nov-93	0	0	22-Jul-94	0	0	27-Oct-94	0	0
20(upper)	pool	20-Nov-93	0	0	22-Jul-94	0	0	27-Oct-94	0	0

Lower Maacama/Redwood Creek (Chalk Hill Road)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head
1	pool	17-Nov-93	0	2	22-Jul-94	nh	nh	27-Oct-94	nh	nh
7	pool/glide	17-Nov-93	0	1	22-Jul-94	0	0	27-Oct-94	nh	nh
8(upper)	pool	18-Nov-93	0	3	22-Jul-94	nh	nh	27-Oct-94	nh	nh
9	pool				22-Jul-94	0	0	27-Oct-94	nh	nh
13	pool/glide	18-Nov-93	0	21	22-Jul-94	0	0	27-Oct-94	nh	nh

Appendix 4-3-4,.Green Valley Creek Juvenile Abundance Data.

Middle Green Valley Creek (Allen Ranch)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head	Date Sampled	Total Coho	Total ~~Trout~~ Steel-head
6	pool	22-Nov-93	1	0	28-Jul-94	1	12	31-Oct-94	1	2
13(lower)	pool	22-Nov-93	0	2	28-Jul-94	0	15	31-Oct-94	0	0
13(upper	pool	22-Nov-93	3	0	28-Jul-94	0	16	31-Oct-94	0	0
14	pool	22-Nov-93	0	0	28-Jul-94	0	5	31-Oct-94	0	6
15	pool	22-Nov-93	0	11	28-Jul-94	0	20	31-Oct-94	0	0
17(lower)	pool	22-Nov-93	0	0	28-Jul-94	0	40	31-Oct-94	0	0

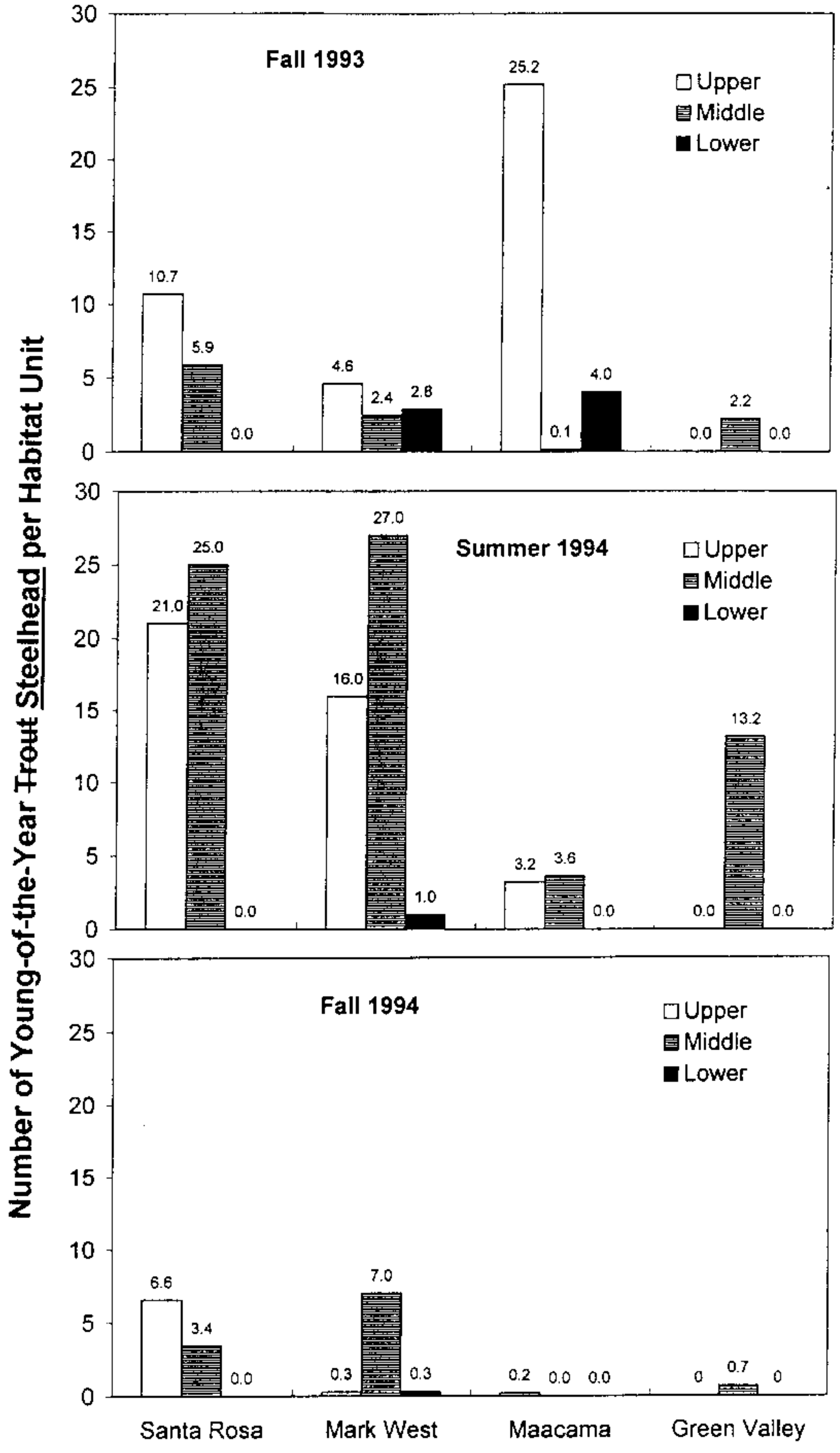
Appendix 4-3-5. Summary of ~~Rainbow Trout~~ Steelhead Abundance by Stream Reach and Age Class, Fall 1993, Summer 1994, and Fall 1994.

All juvenile ~~Rainbow Trout~~ Steelhead, number per habitat unit												
	SRC			MWC			MAAC			GVC		
	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994
Upper	11.1	26.2	12.3	6.4	20.0	0.28	26.4	10.2	3.6			
Middle	7.3	30.1	3.9	2.4	29.3	7.75	0.3	3.6	0	2.2	18.0	1.33
Lower	0.2	0.0	0	3.0	1.0	0.33	6.8	0.0	0			

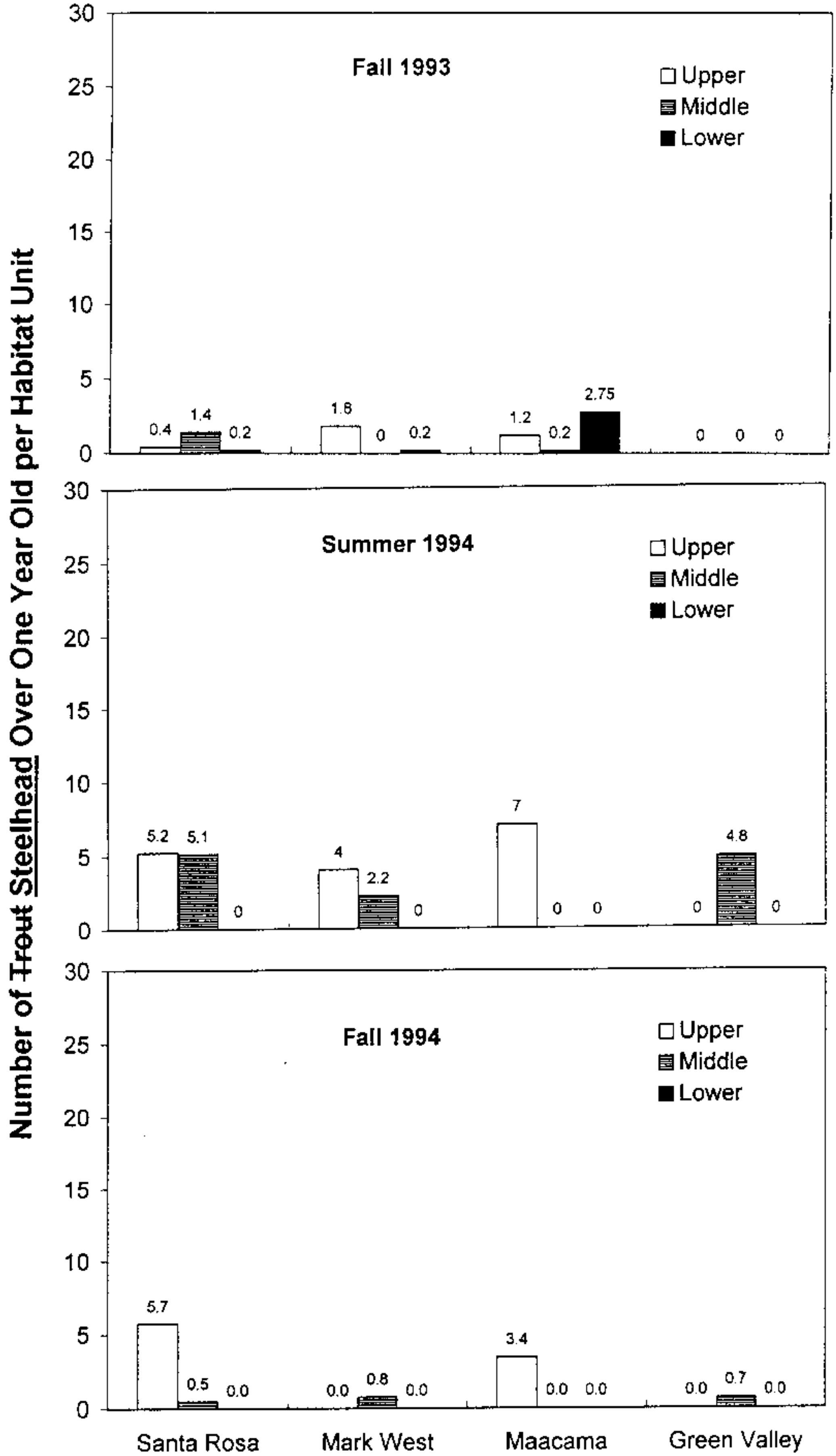
Young-of -the-year ~~Rainbow Trout~~ Steelhead, number per habitat unit												
	SRC			MWC			MAAC			GVC		
	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994
Upper	10.7	21.0	6.6	4.6	16.0	0.3	25.2	3.2	0.2			
Middle	5.9	25.0	3.4	2.4	27.0	7.0	0.1	3.6	0.0	2.2	13.2	0.7
Lower	0.0	0.0	0.0	2.8	1.0	0.3	4.0	0.0	0.0			

Appendix 4-3-6. Fork Lengths of Young-of-the-year ~~Rainbow Trout~~ Steelhead, Fall 1993, Summer 1994, and Fall 1994.

Young-of-the-year ~~Rainbow Trout~~ Steelhead													
		SRC			MWC			MAAC			GVC		
		Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994
Upper	N	75	126	46	32	112	2	126	16	1			
	F.L., mm	66.7	55.7	63.5	83.8	73.8	83.5	87.5	67.1	80.0			
	sd	10.6	9.3	7.0	12.3	10.9	0.7	7.3	7.4				
Middle	N	41	175	24	17	216	56	1	29	0	13	79	4
	F.L., mm	83.2	74.7	77.7	68.9	58.4	62.3	95	68.2		78.4	65.9	75.8
	sd	11.1	8.9	6.7	7.4	9.3	8.8		12.1		14.6	6.4	6.2
Lower	N	0	0	0	17	6	2	16	0	0			
	F.L., mm				86.9	71.8	85.0	98.1					
	sd				8.8	18.9	5.7	6.2					



Appendix 4-3-7. Young-of-the-Year Steelhead Abundance



Appendix 4-3-8. Abundance of Juvenile Steelhead Over One Year Old

4.0 MONITORING PLAN

A field sampling and quality assurance project plan was developed prior to implementation of sampling. This plan is included in Appendix 1.

Samples were collected from the Kelly Farm Demonstration Wetland Cell 3 during August 1994. The sample collection plan is described in Table 1. Samples of sediment, bulrush seeds, cattail rhizomes, crayfish, and mosquitofish were collected.

4.1 SEDIMENT SAMPLING

Three to four composite sediment samples were collected to analyze for the constituents shown in Table 1. The dense nature of the vegetation in Cell 3 prevented the use of standard sampling devices so repeated grabs of sediment were collected by gloved hand. Samples from the top 2-3 inches of sediment were collected. Every effort was made during sample collection to preclude contamination and cross-contamination of the samples. Each sample was composed of 5 subsamples taken from widely spaced locations throughout the pond. Sediment sampling was done prior to biological sampling and shore subsamples were collected prior to offshore samples to minimize disturbance to the sediment. Sediment samples were placed into glass jars which were then put into an ice chest and cooled to 4°C. The metal content of the sediment samples was analyzed using a strong acid extraction method.

Table 1.

Sample Collection Plan

Tissue	# Samples	Constituent
Sediment	4 composite	moisture, pH, TOC, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides, acid volatile sulfides
Bulrush seeds	3 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides
Cattail rhizomes	3 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides
Crayfish	3 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides
Mosquitofish	4 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides

6.0 COMPARISON OF 1994 RESULTS WITH 1991 RESULTS

In this section the results of the 1994 bioaccumulation/magnification KFDW study are compared to the results obtained in the 1991 KFDW study. Replicate samples were taken in 1994 but not in 1991 so assessment of changes in concentrations cannot be evaluated statistically. The 1991 KFDW samples were collected in October 1991. A summary of the sampling plan for the 1991 collections in KFDW can be found in Table 4 of CH2M Hill et al. (1992).

6.1 TRACE ELEMENTS

The concentrations of trace elements in KFDW tissues and sediment in the 1991 and the 1994 studies are presented in Tables 5 through 15.

6.1.1 Aluminum

Table 5.

Concentration (ppm dry weight) of aluminum in KFDW tissue and sediment

	1994		
Sample Type	**Mean[a]**	**Range**	**1991**
Cattail Rhizomes	1183	317-2420	2000
Bulrush Seeds	35.4	32.9-37	45.1
Crayfish	449	387-556	725
Mosquitofish	1232	626-1630	397
Sediment	18500	14400-20900	26200

[a] For concentrations below the reporting limit, the reporting limit was used for averages

Most tissue types and sediment show a decrease in aluminum concentration in 1994 with respect to the 1991 samples. The exception to this decrease in aluminum is in mosquitofish which greatly increased in aluminum concentration since 1991. The minimum value of aluminum in mosquitofish for any of the four replicate samples in 1994 was 626 ppm. This minimum is higher than the 1991 concentration of aluminum, indicating that the difference between years may be genuine.

Table 17. cont.

Concentration of Metals in Sediments and Organism Tissues of Kelly Farm Demonstration Wetlands

	Concentration in Sediments (mg/kg)	Tissue Concentration (mg/kg)			
		Wetland Vegetation		Aquatic Fauna	
		Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish
Mercury					
1994, average concentration[a]	0.089	< 0.040 ~~<0.038~~	0.017	0.050	0.110
1991, single sample[b]	<0.050	<0.150	<0.03	0.110	0.270
Change relative to 1991	Increased	-	-	-55%	-59%
Nickel					
1994, average concentration[a]	97.1	7.1	3.6	4.5	4.9
1991, single sample[b]	124.0	22.3	3.7	14.5	7.3
Change relative to 1991	-22%	-68%	-2%	-69%	-33%
Selenium					
1994, average concentration[a]	<0.7	< 0.40 ~~<0. 38~~	0.20	0.59	0.84
1991, single sample[b]	<0.5	<1.54	<0.35	<0.97	<0.85
Change relative to 1991	-	-	-	-	-
Silver					
1994, average concentration[a]	<3.3	0.92	0.80	0.60	1.36
1991, single sample[b]	0.59	<0.38	<0.09	0.29	<0.21
Change relative to 1991	-	Increased	Increased	107%	-
Zinc					
1994, average concentration[a]	63.8	15.4	5.0	62.2	142.2
1991, single sample[b]	139.0	41.5	10.2	91.8	128.0
Change relative to 1991	-54%	-63%	-51%	-32%	11%

[a] Average of four composite samples of sediment and three composite samples of organisms collected in August 1994.
[b] Concentration for single grab sample collected in October 1991.

Table 18.

Average Concentration of trace elements (ppm) in reclaimed water[a]

Constituent	1991	1992	1993	1994
Aluminum	0.024	0.045	0.030	0.037
Arsenic	0.0030	0.0018	0.0019	0.0015
Cadmium	0.0005	0.0009	0.0011	0.0004
Chromium	0.0020	0.0028	0.0022	0.0021
Copper	0.014	0.013	0.011	0.012
Lead	0.0013	0.0085	0.0094	0.0024
Mercury	0.0004	0.0004	0.0004	0.0004
Nickel	0.0051	0.0045	0.0038	0.0049
Selenium	0.0005	0.0005	0.0005	0.0005
Silver	0.0012	0.0013	0.0009	0.0006
Zinc	0.042	0.028	0.020	0.022

[a] Averages were calculated using half the reporting limit for samples that were below detection.

A comparison of crayfish data showed that, similarly to sediments and vegetation, aluminum, nickel and zinc concentrations were lower in 1994 than in 1991 (32 to 69 percent reduction), while concentration increases were detected for silver and copper in 1994 (89 to 107 percent increase). Crayfish data differed from vegetation data in the decrease of mercury and increase of lead concentrations from 1991 to 1994. Temporal changes in the content of arsenic, cadmium, chromium, and selenium in crayfish tissues could not be documented because tissue concentrations reported in 1991 were below analytical detection limits (Table 17).

Temporal trends in metals concentration for mosquitofish largely mirrored those observed in crayfish tissues for mercury and nickel (lower concentrations in 1994 than in 1991), and for copper, lead, and silver (increased concentrations in 1994). Aluminum concentration in mosquitofish, unlike crayfish data, increased in 1994 relative to the previously collected data. Temporal trends in metals concentration for mosquitofish largely mirrored those observed in crayfish tissues for mercury and nickel (lower concentrations in 1994 than in 1991), and for copper, lead, and silver (increased concentrations in 1996). Aluminum and chromium concentrations in mosquitofish, unlike crayfish, increased in 1994 relative to the previously collected data. The above explanation for aluminum and chromium changes in sediment would also apply to biota. The lead concentration increased in both mosquitofish and crayfish, and may be the result of the slight increased lead concentration in reclaimed water from 1991 to 1994.

Table 19.

Potential Bioaccumulation of Metals in Organism Tissues Of Kelly Farm Demonstration Wetlands

	Concentration in Sediments (mg/kg)	Ratio of Tissue Concentration to Sediment Concentration[a]				Tissue Concentration (mg/kg)			
		Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish	Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish
Aluminum	18,500	0.06	< 0.01	0.02	0.07	1,183	35	449	1,232
Arsenic	3.38	0.09	< 0.02	0.23	0.10	0.30	< 0.06	0.77	0.33
Cadmium	< 0.36	-	-	-	-	< 0.20~~2~~	< 0.06	< 0.15	< 0.26~~0.28~~
Chromium	63.5	0.06	< 0.01	0.03	0.08	4.09	0.30	1.88	4.94
Copper	24.6	0.30	0.18	3.48	0.28	7.38	4.35	85.7	6.79
Lead	11.1	0.11	0.02 ~~< 0.01~~	0.08	0.10	1.24	0.27 ~~0.03~~	0.94	1.06
Mercury	0.089	-	0.19	0.56	1.24	< 0.040~~< 0.038~~	0.017	0.050	0.110
Nickel	97.1	0.07	0.04	0.05	0.05	7.1	3.6	4.5	4.9
Selenium	< 0.7	-	-	-	~~>~~ < 1.0	< 0.40~~< 0.38~~	0.20	0.59	0.84
Silver	< 3.6	-	-	-	-	0.92	0.80	0.60	1.36
Zinc	63.8	0.24	0.08	0.97	2.23	15.4	5.0	62.2	142.2

[a] Ratio of average concentration in tissues (3 replicates) relative to the average concentration in sediments (4 replicates). Data for cadmium, selenium, and silver are unavailable (sediment concentrations below analytical detection limits).

8.0 COMPARISON TO REFERENCE STUDIES

8.1 WETLAND STUDIES

8.1.1 Wetland Vegetation

Two recent wetlands studies were used to evaluate concentration levels of metals in sediments and vegetation of the Kelly Farm wetland demonstration project. The first study analyzed the content of copper, lead, and zinc in sediments and vegetation of Crandall Creek marsh in Fremont, California (Demgen 1993). The 55-acre constructed marsh is a demonstration project for the treatment of contaminated urban runoff. The second study, conducted in the Milltown Reservoir in western Montana, evaluated the content of five metals (arsenic, cadmium, copper, lead, and zinc) in soils and vegetation of wetlands receiving metal-contaminated sediments from a mining district (Linder et al. 1994). Data for the two reference studies are summarized in Table 20. Sediments of Kelly Farm and Crandall Creek marsh had similar concentrations of copper, lead, and zinc, and comparable bioaccumulation factors for those metals in roots and rhizomes of vegetation (Table 20). In both wetlands, metals concentrations in plant tissues were less than 41 percent of those detected in the sediments.

Compared to the Milltown Reservoir wetlands, Kelly Farm wetlands had lower concentrations of arsenic, cadmium, copper, lead, and zinc, both in sediments and organism tissues (Table 20). Bioaccumulation factors (except for zinc) were also lower at Kelly Farm, which had values from 0.09 to 0.56~~0.61~~. At Milltown Reservoir, the vegetation content of cadmium and lead was similar or exceeded the concentration measured in the sediments. At Milltown Reservoir, zinc levels in vegetation were very elevated relative to Kelly Farm, but the bioaccumulation factor was low due to the high concentration of the metal sediments of the Milltown Reservoir. This suggests that physiological regulation of zinc may occur in emergent plants.

8.1.2 Aquatic Fauna

Few reference studies are available that relate metals bioaccumulation in aquatic organisms to concentrations in wetland sediments. For evaluation of the potential bioaccumulation of metals in aquatic organisms of Kelly Farm wetlands, a recent study of the Clark Fork River (Western Montana) at six locations exhibiting a well-defined gradient of metals concentrations was selected. This study provided data on metals accumulation in the aquatic amphipod *Hyallela azteca* from sediments (Ingersoll et al. 1994). The bioaccumulation evaluation was a component of a multidisciplinary evaluation of potential effects to aquatic and terrestrial organisms in a stream segment where mining activities have resulted in sediments with elevated content of arsenic, cadmium, copper, lead, manganese, and zinc.

Table 20.

Comparison of Metals concentrations In Wetland Vegetation

Concentration (mg/kg)	Kelly Farm Wetlands, CA	Crandall Creek Marsh, CA	Milltown Reservoir Wetlands, MT
Arsenic			
Sediments	3.38	-	15.0
Roots of vegetation	0.30	-	4.2
Cadmium			
Sediments	0.36	-	3.0
Roots of vegetation	0.20~~0.22~~	-	5.4
Copper			
Sediments	24.6	50.3	50.0
Roots of vegetation	7.4	16.1	21.9
Lead			
Sediments	11.1	8.0	22.0
Roots of vegetation	1.2	3.2	22.9
Zinc			
Sediments	63.8	99.5	930.0
Roots of vegetation	15.4	40.8	73.8
Bioconcentration Factors			
Arsenic	0.09	-	0.28
Cadmium	0.56 ~~0.61~~	-	1.79
Copper	0.30	0.32	0.44
Lead	0.11	0.40	1.04
Zinc	0.24	0.41	0.08

1. Kelly Farm: August 1994 average values for sediments and cattail rhizomes (this report).
2. Crandall Creek: data for marsh sediments and cattail roots (*Typha latifolia*) (Demgen 1993).
3. Milltown Reservoir: data for soils and below ground tissues of aquatic vegetation at sites where the minimum contamination levels were detected (Linder et al. 1994).

For comparison to the Kelly Farm data, results of the three sites at Clark Fork River with the lowest detected concentrations of metals were used: a reference site located upstream of the mining area (CF-06), and two sites where sediments exhibited moderately elevated metals concentrations (CF-05 and CF 04). Sediment and organism tissue data for these

Table 23.

Potential Risk for Adverse Effects on Terrestrial Fauna from Metals in Organism Tissues At the Kelly Farm Demonstration Wetlands

Tissue Concentration at KFDW (mg/kg)	Diet Source				
	Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish	Dietary Benchmark[a] (mg/kg)
Arsenic	0.30	0.06	0.77	0.33	Not Applicable (NA)
Cadmium [b]	0.20 ~~0.22~~	0.06	0.15	0.26 ~~0.28~~	NA
Chromium	4.09	0.30	1.88	4.94	NA
Copper	7.38	4.35	85.7	6.79	NA
Lead	1.24	0.27	0.94	1.06	NA
Mercury	0.040 ~~0.038~~	0.017	0.050	0.110	NA
Nickel	7.1	3.6	4.5	4.9	NA
Selenium	0.40 ~~0.38~~	0.20	0.59	0.84	NA
Silver	0.92	0.80	0.60	1.36	NA
Zinc	15.4	5.0	62.2	142.2	NA

These threshold percentages are based on our professional judgment of the relative importance of these habitat types within the region of the project area. Since *coolwater-A* and *coolwater-B* habitat is critically important to salmon and steelhead, and in short supply throughout the region, the threshold is set at 0 percent loss for these types. The threshold of significance of *warmwater-A* loss is 15 percent. For *warmwater-B* and *ponds*, the threshold is 25 percent loss.

The fractional watershed evaluation approach described above is considered to be appropriate because watersheds are a key factor affecting the distribution of aquatic organisms and habitat and to be consistent with resource agency policy promoting identification of impacts and mitigation within project watersheds. The fractional watershed approach has several limitations as follows that are important to understand when evaluating results.

- The fractional watershed approach creates a bias against project components (e.g., a storage reservoir) located in a small watershed (e.g., Lakeville) when they are being compared with in a much larger watershed (e.g., Stemple Creek).
- This approach also does not include in the evaluation of significance the amount of a particular habitat that is present throughout the region. For example, the impact of a particular component is evaluated in terms of the fraction of the watershed total amount, not regional total amount, of a particular habitat.

2.2.2 Barriers to Movement

In the case of potential barriers to movement of migratory species, the threshold value for significance is set at 0 barriers (i.e., any barrier would represent a significant impact).

2.2.3 Changes in Salinity

Potential effects on the existing salinity regimes of estuaries within the Gulf of the Farallones National Marine Sanctuary (Estero Americano and Estero de San Antonio) are also addressed in this report. In estuaries, the salinity regime is usually the major determinant of the distribution and abundance of aquatic plants and animals. Typically, an estuary has a region of high salinity near the mouth, with a biotic community composed of a mixture of marine and estuarine species. The central portion of a typical estuary features variable salinity dependent on tidal conditions and freshwater runoff, and a community dominated by estuarine species of plants and animals: pickleweed (*Salicornia sp*.) and cordgrass (*Spartina sp*.) in shallow mudflats around the edges, beds of eelgrass (*Zostera marina*) subtidally, and many species of bivalves, crustaceans, worms, and fishes that spend all, or nearly all, of their lives in the estuarine environment. The upper ends of estuaries usually have brackish, or low salinity water, but may be entirely freshwater during high runoff events, or hypersaline in the dry season (if runoff stops and tidal exchange is limited). ~~The biotic community in the brackish area may have a mixture of freshwater and estuarine plants and animals, but may also have a few species adapted only to the brackish environment. In the Estero de San Antonio and Estero Americano, one~~

~~such species that can live only in the brackish environment is the endangered tidewater goby.~~ The biotic community in the brackish area may have a mixture of freshwater and estuarine plants and animals, but also have a few species which characteristically occur only in the brackish environment. In the Estero de San Antonio and Estero Americano, one species characteristic of the brackish environment is the endangered tidewater goby (*Eucyclogobius newberryi*). This species succeeds in the brackish zone not because it is specifically adapted to low salinities, but because it can tolerate the wide range of salinities from fresh to 50 ppt (Moyle et al. 1995), and can breed at salinities from fresh to normal seawater (Worcester and Lea 1996).

Under the NOAA regulations applicable to Estero de San Antonio and Estero Americano (15 CFR 922), any change to existing habitat or aquatic life in a marine sanctuary constitutes a significant impact. Therefore, the significant impact threshold for salinity change in the two estuaries is 0 percent change.

2.2.4 Changes in Stream Flow

Project components have potential impacts on the flow of streams in the project area. Storage reservoirs will intercept streamflow during the wet season, such that flow immediately downstream from the dam may be greatly reduced or eliminated. Further downstream from a dam, groundwater discharge and discharge from lateral tributaries will restore flow depending on local geology, amount of rainfall, and other factors (see Questa Engineers 1996a). In the dry season, average flow downstream from a dam is likely to be increased relative to existing conditions, because of leakage from the base of the dam, irrigation runoff, and other factors. The extent to which flow may be affected at different locations downstream from a reservoir site will also depend on other variables, including meteorological conditions in a given year (e.g., dry vs. wet years, cool vs. hot summers), irrigation practices, and the amount of reclaimed water discharged to the Russian River (which will affect the remaining amount that must be disposed of by other means). The impacts of irrigation and storage on streamflow that were estimated in RMA (1996a) are used in this technical report to estimate associated impacts on aquatic life. The results from RMA (1996a) were used to generate tables showing the expected flow at different locations in each affected watershed under different project scenarios and combinations of the variables discussed above. The complete tables are provided in Appendices B through D and are discussed in detail in later sections of this report.

The thresholds chosen to represent significant impacts to aquatic life vary with habitat type and season. If the change is positive (increased flow), it is considered a beneficial impact; if negative (decreased flow), a detrimental impact. In the case of *coolwater-A* or *coolwater-B* habitat, any project-related change in flow is considered a significant impact due the flow-limited conditions in the project area. For *warmwater-A* and *warmwater-B*, the threshold value is a 50 percent change during the wet season, and a 0 percent change for *warmwater-A* in the dry season, based on the following rationale.

In the wet season, ~~the main effect of any~~ project storage reservoir**s** ~~is to~~ will intercept flow~~,~~ and decrease ~~so~~ flow ~~will be decreased~~ below the dam. A change from 30 cfs to 25 cfs would probably have no measurable impact on resident aquatic life in streams. However, a 50 percent decrease from 30 cfs to 15 cfs could reasonably be expected to result in measurable impacts on stream habitat, sediment transport, and minimum flows necessary for fish movement in some cases. In salmonid streams, average wet season flow may just be enough to allow passage of large adult spawners in a few cases, so any decrease in flow is considered significant.

Streams in the project area are marginally perennial or seasonal. Therefore sSummer flows in project area streams are considered to be ~~generally much more~~ critical to aquatic ~~life than are the wet season flows~~. A flow of 0.1 cfs during the dry season may mean the difference between *warmwater-A* habitat which can support a variety of fishes, amphibian larvae, and other aquatic life through the dry period, and *warmwater-B* habitat which is either totally dry in the dry season, or stagnant and overheated, and cannot support fishes and most other aquatic animals. Therefore, any project-related *decrease* in summer flow must be considered a significant impact. Any *increase* in summer flow within project area streams would be considered a beneficial impact for aquatic life. A 50 percent increase in summer flow is conservatively considered the point at which a significant beneficial impact occurs.

The threshold values for changes in stream flow that would result in significant impacts to aquatic life are summarized in Table 1.

Table 1.

Stream Flow Thresholds of Significance

Habitat Type	Threshold of Significance
Coolwater-A	0 percent decrease at any time
Coolwater-B	0 percent decrease at any time
Warmwater-A	50 percent decrease in wet season
Warmwater-A	0 percent decrease in dry season
Warmwater-B	50 percent decrease in wet season
Warmwater-B	Not applicable in dry season

2.2.5 Stream Bed Alteration

Evaluation criteria for assessing impacts from pipelines and discharges on aquatic habitat are similar to the narrative-based criteria established for surface water quality (see MSC 1996b). Stream beds may be altered when suspended sediment is introduced into streams or scoured from streams, and changes in substrate texture can affect the type and amount of benthic biota. These impacts may result from construction of the pipelines, from a rupture of a pipeline along a geologic fault, or from reclaimed water discharges. In time, stream beds will likely recover the original type of substrate owing to upstream sources of either sediment or scouring flows (unless upstream sources are blocked by diversions or dams). However, the timing of this recovery may be critical for certain aquatic life to sustain their populations in their original locations.

Benthic organisms are specialized in their feeding and other behaviors and require a consistent substrate for survival. Changing the substrate with the introduction or loss of

Operation and Maintenance

Streams

Operation of the proposed storage reservoirs could result in impacts to aquatic life downstream of the reservoirs through changes in stream hydrology. In the wet season, the reservoirs would be expected to cause a reduction in average and peak flows downstream, because the dams would intercept all flow coming from upstream areas, except in cases where runoff causes the reservoir to fill beyond its capacity. If such an event occurs, water would spill to downstream waters via a spillway. The frequency of such events is extremely rare and has not been estimated. A spill would be rare because two conditions must be coincident before a spill can occur: An extremely large (and infrequent) runoff event must occur at the time that the reservoir is nearly at nominal reclaimed water storage capacity (which would occur in spring when extremely large storms are especially infrequent).

Post-construction, wet season flow downstream of the dams would be supplied by lateral tributaries and groundwater discharge, but peak and average flows would be somewhat reduced relative to pre-construction flows. During the dry season, storage reservoirs would intercept base flows, but reservoir seepage could partially offset the downstream flow reduction caused by the dams. However, seepage has been identified as the cause of an adverse water quality impact (Merritt Smith Consulting 1996b), and capture and return of the seepage to the reservoir is identified as mitigation. If such mitigation is implemented, reservoir seepage would not offset the downstream flow reduction caused by the dams. Any reclaimed water quality-related impacts to aquatic life caused by dam leakage are addressed in Parsons ES (1996).

Predicted average wet (December through March) and dry (June through September) season flows at various locations in the Americano Creek watershed are provided in Appendix A. The locations are shown in the Appendix of MSC (1996a), and the method for estimating these flows is described in RMA 1996a and MSC 1996b. The predicted flows in Appendix A include the combined effects of both the storage reservoirs and irrigation-related groundwater incremental discharge to surface waters. The effects of irrigation and storage are separated only in the cases of “No Storage” (i.e., no storage reservoir in the watershed) scenarios and at the sites immediately downstream from the bases of proposed dams (AVF2, ACR2, AB2). Using the change in flow criteria for significant impacts to aquatic life, the data in Appendix A have been reduced (see Table 3) to show only the cases where a significant impact would be expected. Table 3 shows that only the Bloomfield Reservoir would result in a significant impact on flow (an increase in the dry season) in the mainstem of Americano Creek (Location A1), whereas, each of the reservoirs would cause a significant decrease in wet season flow in their respective tributaries. The increased dry season flow at site A1 resulting from operation of the Bloomfield Reservoir would be a significant beneficial impact, whereas the decreases in wet season flow would be negative impacts. The magnitude of the predicted project impact depends on the proportion of the watershed upstream of the particular location that would be irrigated (RMA 1996a). As the proportion that would be irrigated increases, so does the magnitude of the predicted flow impact.

Stemple creek watershed flows are provided in Appendix B and the significant impacts are shown in Table 4. In the Stemple Creek watershed, irrigation without any reservoirs would result in significant increases in dry season flow at sites S1, S2, S3, S4, S5, and STR1. The Huntley Reservoir and associated irrigation would result in a significant increase in dry weather flow at site S1 and a significant decrease in wet season flow only at site SH2, just below the base of the dam. The Two Rock reservoir would cause significant increases in dry season flow at sites S1, S2, and S3, and a significant decrease in wet season flow only at site STR2, just downstream from the dam.

The flow estimates in Appendices A and B do not reflect the effect of the reservoir water quality mitigation. Interception of the seepage to avoid a water quality impact would reduce the estimated flows in Appendices A and B by an amount equivalent to the estimated seepage rate, which is as follows (from Parsons ES 1996b):

Reservoir	**Estimated Seepage Rate (cfs)**
Valley Ford	0.038
Carroll Road	0.052
Bloomfield	0.079
Huntley	0.019
Two Rock	0.010

Interception of the seepage would not alter any findings of significance in Table 3 or 4, except those at Site A1. A significant dry season flow increase was identified at Site A1 (see first row of Table 3), but interception of seepage would eliminate this beneficial impact.

Esteros

Predicted wet and dry season flows at various locations in the Americano Creek and Stemple Creek watersheds under different project components are discussed above. Any project-related flow changes in tributaries of Estero Americano or Estero de San Antonio could potentially result in changes in the salinity regime in the esteros. Any project-related change in salinity in either estero would constitute a significant impact (see Evaluation Criteria above).

Predicted effects of project components on salinity at different locations in Estero Americano and Estero de San Antonio are analyzed in detail MSC (1996b). The general result is that all of the West County project components analyzed would lead to increases of up to 2.5 parts per thousand (ppt) in salinity in the upper reach of the esteros during summer. Increases in salinity would occur both in the wet season and in the dry season, although for different reasons. In the dry season, inflow to the esteros would be slightly increased relative to the existing condition, but salinity would be greatly increased (up to 2.5 ppt) because of the elevated TDS of the inflowing water. Irrigation is the cause of the predicted elevated TDS of the inflowing water. In the wet season, estero inflow would be slightly decreased, and estero salinity would increase because there would be less fresh water available to dilute the sea water entering from the mouths of the esteros.

Thus, each of the West County project alternatives analyzed would result in impacts to biological resources of Estero Americano and/or Estero de San Antonio that would be considered significant under the zero percent change in salinity threshold. The actual ecological effect would be to change the physical distribution of the salinity and thus aquatic organisms in the esteros. While this change is not necessarily adverse, it is considered significant under the strict evaluation criteria that have been established in recognition of the esteros' status as a marine sanctuary.

represented in Appendix C by the difference between the “No Storage” flows and flows under other conditions.

Table 6 shows that the Tolay A reservoir would result in significant decreases in wet season flow at all of the locations analyzed, under each of the hydrological conditions that were evaluated. Tolay A reservoir would reduce downstream flows even though runoff from upstream of the reservoir and the western shore of the reservoir would be diverted around the reservoir. Interception by the reservoir of the runoff from the eastern shore is estimated to cause the reduced downstream flow. In contrast to the West County analysis, the effect of different discharge rates to the Laguna de Santa Rosa (which determines irrigation acreage requirement) has not been included in the Tolay watershed analysis. This is because the amount of suitable acreage available for irrigation in the Tolay watershed is less than that necessary for even the 10 percent discharge scenario (which would require the least irrigation area). This approach was taken because it provides a conservative estimate of potential irrigation impact.

The flow estimates in Appendix C do not reflect the effect the reservoir water quality mitigation that would need to be implemented at Tolay and Sears Point. (Such mitigation is not needed at the Adobe Road or Lakeville Hillside sites). Interception of the seepage to avoid a water quality impact would reduce the estimated flows in Appendix C by an amount equivalent to the estimated seepage rate for the Tolay and Sears Point dams, which is 0.004 and 0.003 cfs, respectively (from Parsons ES 1996b). This is a small impact and would not result in additional significant impacts on flow.

The Sears Point reservoir would cause no significant flow changes. The Lakeville reservoir would result in significant decreases in wet weather flow downstream from the dam at locations LV1 and LV2 as shown in Table 6. An Adobe Road reservoir (with its runoff diversion structure) would not result in any significant changes in stream flow at sites AD1 and AD2.

The analysis of aquatic biological impacts of South County project components is restricted to the non-tidal portions of the watersheds, because it is judged that any project effects on the salinity regimes of San Pablo Bay (Tolay watershed) or the Petaluma River (which would potentially be affected by Bayflats irrigation or storage in the Lakeville and Adobe Road watersheds) would be so small and localized as to have no significant impacts on biological resources.

Merritt Smith Consulting 1996e. *Laguna Water Quality Monitoring Results* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Merritt Smith Consulting 1996f. *Russian River Algae and Macrophytes* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Merritt Smith Consulting 1996g. *Russian River Water Quality Monitoring Results* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Tidewater Goby *Eucyclogobius newberryi* (Girard), pp. 235-239, *In*: Fish Species of Special Concern in California, 2nd ed. California Department of Fish and Game, Sacramento, CA. 272p.

NOAA 15 CFR 922. Marine Sanctuary regulations in the United States Code of Federal Register

Parsons ES 1996. *Ecological Risk Assessment* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Parsons ES 1996b. *Dam Seepage Evaluation, Santa Rosa Subregional Long-Term Wastewater Project.* Memorandum from Fred Kintzer to Dave Smith. January 17, 1996.

Questa Engineering 1995. *Irrigation Management Guidelines* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Questa Engineering 1996a. *Baseline Hydrology and Irrigation Drainage Evaluation for West and South County Reclamation Alternatives* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Questa Engineering 1996b. *Hydrologic/Water Quality Evaluation of Irrigation of Baylands (Reyes Soils) with Reclaimed Water* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Questa Engineering 1996c. *Hydrologic and Water Quality Impacts from Irrigation Component* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Resource Management Associates 1996a. *Water Quality and Flow Model for Irrigation/Storage Area Streams* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Resource Management Associates 1996b. *Russian River Water Quality Model* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.

Roth, J. C., M. L. Commins, and M. H. Fawcett 1991. Steelhead Trout Migration in Mark West Creek and Santa Rosa Creek, 1991. Laguna de Santa Rosa Intensive Monitoring Program, Technical Memorandum.

Roth, J. C., M. L Commins, and M. H. Fawcett 1992. Steelhead Trout Migration in Mark West Creek and Santa Rosa Creek, 1992. Laguna de Santa Rosa Intensive Monitoring Program, Technical Memorandum.

Roth, J. C., M. L Commins, M. H. Fawcett, and R. W. Maddox 1993. Steelhead Trout Migration in Mark West Creek and Santa Rosa Creek, 1991-1993. Laguna de Santa Rosa Intensive Monitoring Program, Technical Memorandum.

Smith D. W., M. L. Commins, M. H. Fawcett, A. J. Horne, and J. C. Roth 1989. Preliminary Estero Americano Discharge Criteria, Long-term Detailed Wastewater Reclamation Studies. Santa Rosa Subregional Water Reclamation System. Technical Memo E5.

Winegar, J. J. 1977a. Camp Creek Channel Fencing -- Plant, Wildlife, Soil and Water Response, Rangeman's Journal, 4(1): 10-12.

Worcester, K. R., and R. N. Lea. 1996. Observations on tidewater goby habitat utilization and laboratory maintenance during the California drought (Abstract). *In:* Swift, C. Tidewater goby Symposium. Southern California Academy of Science, Annual Meeting.

REPLACEMENT PAGES

APPENDIX M

JURISDICTIONAL WETLANDS RESOURCES

(THERE ARE NO REPLACEMENT PAGES FOR THIS APPENDIX)

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APPENDIX N

TRANSPORTATION

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AIR QUALITY

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CULTURAL RESOURCES AND PALEONTOLOGY

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PUBLIC SERVICES, UTILITIES, AND RECREATION

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NEPA/CEQA REQUIRED SECTIONS

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APPENDIX U

FINAL SCOPING REPORT

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APPENDIX V

COMMENTS ON THE DRAFT EIR/EIS

(THERE ARE NO REPLACEMENT PAGES FOR THIS APPENDIX)

APPENDIX W

APPENDIX X