Madrona Marsh Preserve Assessment and Conceptual Restoration Plan

TECHNICAL MEMORANDUM

Prepared for:

The City of Torrance
3031 Torrance Boulevard
Torrance, California 90503

Prepared by:

Gannett Fleming
800 Leonard Street, Suite 1
Clearfield, PA 16830

Telluris, Inc.
1511 Lakeside Lane
Huntington Beach, CA 92648

Principal Investigators Kevin L. Hoover and Terry A. Rightnour
Current Contact Information: Water's Edge Hydrology, Inc. P.O. Box 868, Clearfield, PA, 16830. 814-592-2216.
trightnour@wehydro.com or khoover@wehydro.com – http://wehydro.com

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EXECUTIVE SUMMARY

The Madrona Marsh Preserve, located in the City of Torrance, is a 44 acre natural preserve containing of some of the last vernal wetlands in Los Angeles County, California. Hydrologic supply for the wetlands comes from surface runoff from surrounding developed areas and periodic pumping from an on-site stormwater detention basin known as the Maple/Sepulveda Sump. Because of this limited supply, the wetlands have suffered from increasing eutrophication over time. As part of its ongoing stewardship program for the site, the City commissioned a study to evaluate three options for increasing the influent volume to the wetlands and develop conceptual restoration and enhancement plans for the wetlands based on these results. The three influent options under consideration are: (1) increased pumping of the on-site Sump waters, (2) recycled water from the West Basin Municipal Water District, and (3) City of Torrance potable water.

The study plan consisted of water quality sampling for 45 parameters at four sample points within the wetland area, two sample points within the Sump, and samples each from the recycled water and potable water. Two sample rounds were conducted in 2004, one in June to represent early dry season conditions, and one in October at the start of wet season conditions. Additional data were taken from historic information sources to supplement the sampling program, yielding sample point data sets with between one and five records for each parameter. A comparative evaluation was conducted between the composite existing conditions in the wetlands and the results from the Sump, recycled, and potable waters. A qualitative assessment was made of the effect that the introduction of each influent option would have on the existing levels in the wetlands of each study parameter. Testing results show that: (1) the Sump waters are equal or better in quality than the wetlands for all parameters except possibly nitrate: (2) the potable water is acceptable except for possibly nitrate, sodium, and pH, with concerns about chlorine; and (3) there are concerns with the recycled water regarding the previously noted parameters as well as alkalinity, ammonia, boron, chloride, CO_2, phosphate, and sulfate.

Possible options determined from this evaluation are that: (1) the existing Sump water could be used for influent enhancement with possible passive pre-treatment by constructed wetlands; (2) the potable water could be used if activated carbon treatment were added to the pre-treatment process before constructed wetlands; and (3) use of the recycled water would require an active physiochemical process, such as reverse osmosis, in addition to possible activated carbon filtration and passive wetland treatment. It was concluded from this analysis that increased use of the Sump waters was the most practical influent option. The recommended approach to wetland area expansion is to develop a volumetric model for the wetlands based on topographic mapping in support of grading expansion plans. Plans should include/provide: (1) seasonal water turnover in the wetlands with at least one volume at the maximum inundation level being circulated for return discharge to the Sump; and (2) circulation patterns in the wetlands should be improved as much as possible. It is recommended that additional water sampling for selected parameters (at the Sump, recycled, and potable water points), topographic and construction constraint mapping, and vegetation and habitat mapping be completed before proceeding with more detailed planning of restoration and enhancement activities.

INTRODUCTION

The Madrona Marsh Preserve is a 44-acre tract of wetlands, grasslands, and dunes surrounded by residential and commercial development within the City of Torrance, California (Figure 1). It is one of the last examples of a vernal marsh system remaining in Los Angeles County and serves as a valuable environmental preserve in the otherwise urban setting. The City acquired the Preserve in the mid-1980s and now manages the site as a community resource with assistance from concerned citizens, such as the Friends of Madrona Marsh.

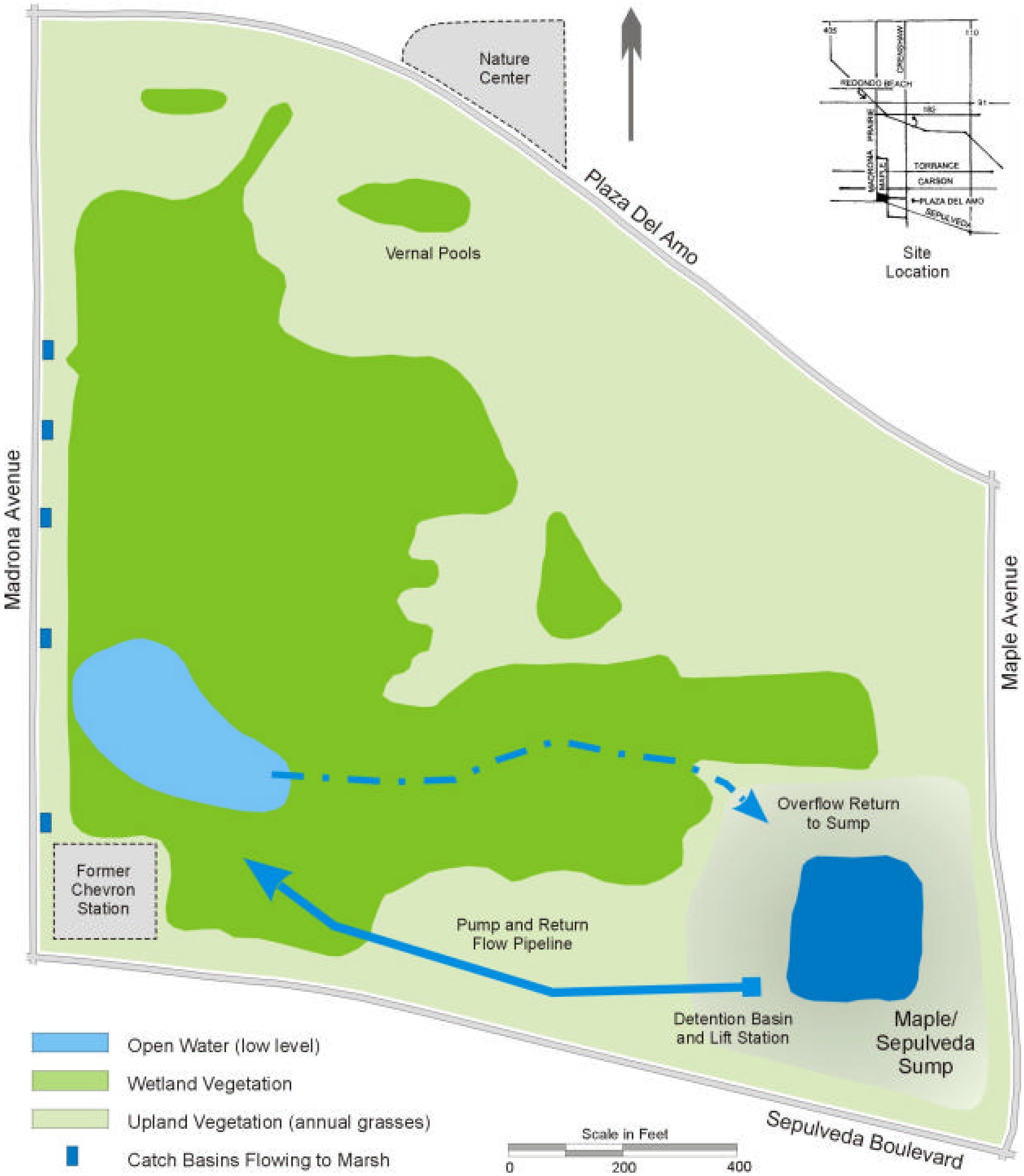
Because of its isolation within a developed area, the Preserve is largely dependent on human management of available water resources to maintain its viability. Existing hydrology comes primarily from internal site runoff, stormwater runoff from surrounding areas, and periodic pumping conducted by the City from the Maple/Sepulveda Sump, a large stormwater detention basin at the southeast corner of the site. It has become apparent over time that these sources alone may not be sufficient to prevent adverse impacts from urban runoff contaminants, stagnation, and eutrophication. Seeking to improve conditions in the wetland portion of the Preserve, the City undertook a study in 2003 and 2004 to assess the existing water quality conditions and to evaluate potential influent options to augment the available hydrology. These influent sources include increased pumping from the Sump, recycled water from the West Basin Municipal Water District (WBMWD), and City of Torrance potable water.

The study consisted of two water quality sample rounds collected during early dry season and early wet season conditions, with analyses for a broad range of parameters. Other recent studies and information sources were also reviewed to develop a composite picture of the current wetland conditions relative to the potential influent options. With this information, an assessment was made of the potential benefits and impacts of using the influent options, and a conceptual restoration plan was then developed including the preferred hydrologic enhancement alternative and other approaches for improving wetland conditions. The report includes background on the site, details of the study undertaken, results and findings of the analyses, and recommendations for conceptual influent enhancement and restoration plans.

Site Background

The Madrona Marsh Preserve is a remnant of a once extensive system of wetlands formed by geologic uplifting and alteration of the Los Angeles River flow patterns. More recent shifting of these river patterns in the 1800s and other human activities have since eliminated most traces of these wetlands. The Preserve owes its continued existence in part to its use as an oil field beginning in 1924. The last active oil wells on the site were recently decommissioned and restored. Portions of the site have also been used in the past for agriculture, and a Chevron service station formerly occupied the southwest corner.

Figure 1 – Madrona Marsh Preserve Existing Conditions



At the present time, the Preserve consists of about 17 acres of wetlands, 36 acres of upland grasslands, and the 1 acre Maple/Sepulveda Sump. The wetland currently has no source of hydrology other than surface runoff and is dependent on the impermeable nature of its soils to retain those waters that reach the wetland areas. The wetland area is fed by 36 acres of storm drain runoff from adjacent residential areas. Part of this existing supply comes from catch basins along Madrona Avenue. The Preserve wetlands are seasonal, with surface water present for five to nine months out the year, depending on the annual rainfall amount. In most years, the wetlands begin filling with the first winter rains and persist through mid-summer. Due to the highly variable annual rainfall of the Los Angeles basin, drought conditions can occur for several years at a time. The City currently manages the wetland hydrology by periodic pumping from the Sump. Other activities include summer mowing of all wetland vegetation except cattails and tules, and annual introduction of mosquitofish for mosquito control. The City also maintains a nature center along Plaza Del Amo for public outreach and education.

Restoration and Enhancement Goals

A number of restoration and enhancement opportunities have been identified within the Marsh Preserve, with corrective work either in the conceptual or active stages. This includes elimination of invasive plants and replacement with native species, debris removal, and removal of gopher populations. Specific to this study, hydrologic restoration and enhancement goals are as follows:

1. Reduce the degree of eutrophication in the wetlands by means of the selected influent option(s) and increased flow-through volume.

2. Expand the extent of the existing wetland areas by grading and/or increasing the water supply from one or more of the potential influent options.

3. Evaluate means to pre-treat influent options to better meet water quality improvement goals.

4. Evaluate the potential effects of the influent options relative to existing water quality conditions in the wetlands.

5. Address the quality of stormwater drainage from catch basins along Madrona Avenue, possibly by means of a bypass pipe or local passive treatment.

Potential Influent Options

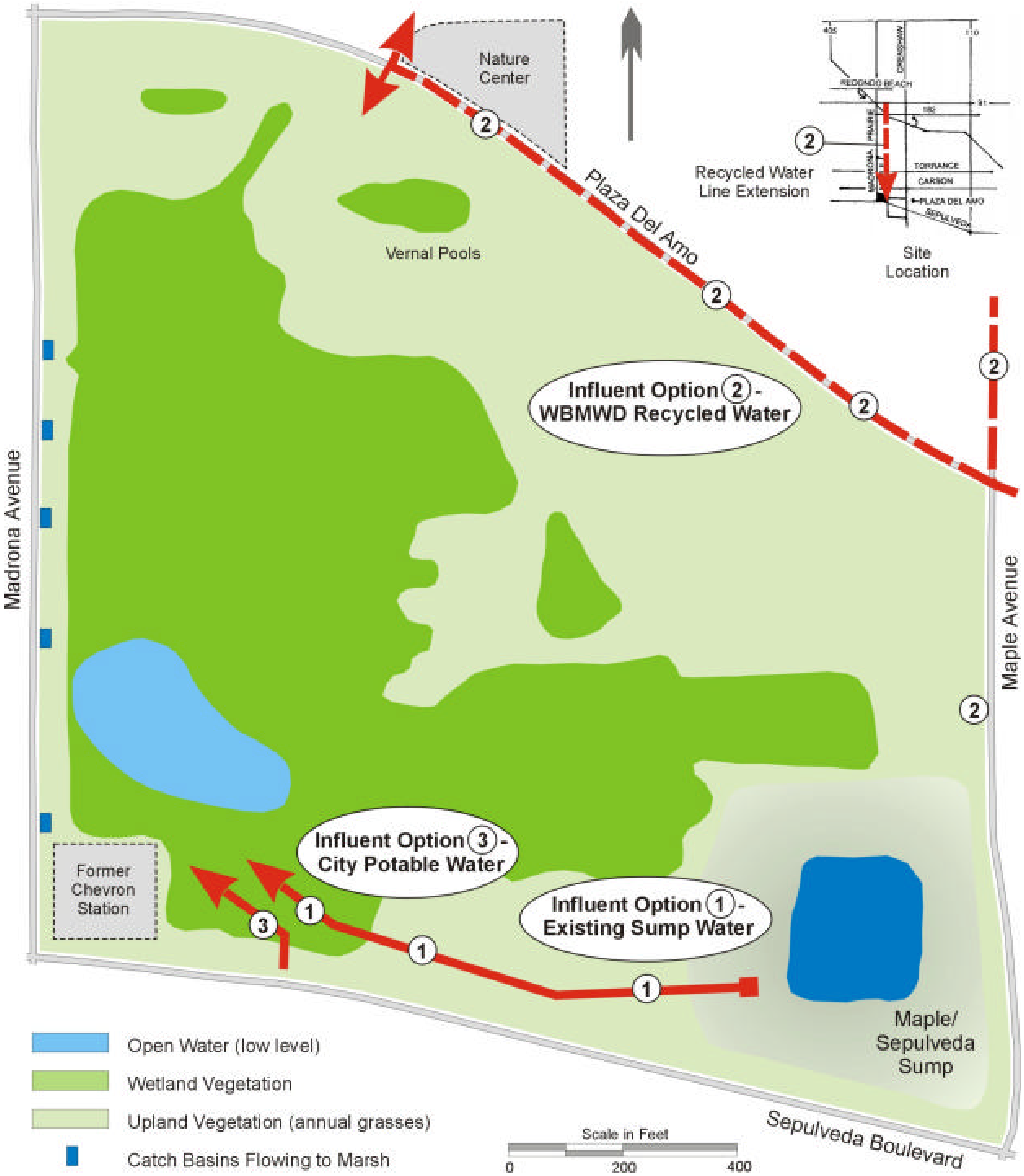
Part of this study includes an evaluation of whether the Madrona Avenue catch basins are suitable for continued use for hydrologic supply, or if they should be collected and diverted away from the seasonal wetlands. No other changes are currently envisioned to alter existing runoff patterns supplying the wetlands. Increased hydrologic supply is proposed to come from one or more of the potential influent options, as illustrated by Figure 2 and described in the following:

The Maple/Sepulveda Sump currently receives runoff from 183 acres within the City and overflow from the wetland area. Water collected in the Sump is usually allowed to infiltrate to groundwater, but is also occasionally pumped to the wetland area when direct surface runoff has not been sufficient to maintain existing wetland conditions as to support nesting or breeding species. A lift station and pumping line currently convey Sump waters to the southwest corner of the Preserve. Overflow from surface runoff or pumping is returned to the Sump through a surface channel. The Sump shows considerable water level variations in response to ambient runoff conditions, but seldom goes dry over the course of a year.

The WBMWD operates a large water recycling facility in the City of El Segundo, with a distribution system that services a number of users in the City of Torrance. Five grades of recycled water are generated, ranging from tertiary filtered and treated secondary wastewater for irrigation to ultra-pure reverse osmosis water for specialty industrial uses. The tertiary grade waters are under consideration as an influent source for the wetlands. Use of this water would require construction of a 2.5 mile pipeline along Maple Avenue to connect the existing distribution system to input sites around the Preserve.

The third potential influent source is the City potable water, administered by the Torrance Municipal Water Department (TMWD). The TMWD supply comes from a combination of well water pumped from the West Coast groundwater basin (12%) and other potable water purchased from the Metropolitan Water District (MWD) of Southern California (88%). Existing access to the City potable water is located along Sepulveda Boulevard at the southern edge of the Preserve. This source has previously been used to supply the wetlands, but to a far lesser degree than the Sump waters.

Figure 2 – Madrona Marsh Preserve Potential Influent Options



STUDY PLAN

Numerous water sampling programs have occurred in the wetland area for different purposes over time. Because these had varying sample locations and parameter lists specific to their individual needs, it was desired as part of this current study to conduct new sampling using a broad and consistent set of parameters, focusing on the potential influent options and points of interest for improvement within the wetlands.

During the initial project planning of early 2003, it was intended to collect a series of four water quality samples over a four month period from selected points in the seasonal wetlands and from the three influent options. However, during May and June of 2003 conditions were observed in the wetlands leading to concerns that a chemical/organic release of some nature had occurred and was affecting the stormwater runoff in the catch basins along Madrona Avenue. The project sampling was postponed at this time so as not to collect potentially unrepresentative conditions. A separate sampling program was initiated through URS Corporation to document conditions related to the suspected release. This sampling occurred between July 2003 and March 2004.

While the URS sampling was underway, modifications were made to the study sampling program to accommodate the necessary scheduling changes. With the additional data being collected by URS and other historical information from the potential influent options, it was decided in June 2004 that two sample rounds would be conducted for the study. These were collected during June 2004 towards the end of the summer hydroperiod and October 2004 during the start of the local wet season.

The final sampling program consisted of four points within the wetlands proper (Catch Basin 1, South Bay, East Fork, and the North Pond of South Pond), two points in the Maple/Sepulveda Sump (Sump East – In and Sump West – Out), and each of the WBMWD recycled water and City potable water. The locations of the sample points within the wetlands are shown on Figure 3. The recycled water was collected from the historic sampling point at the WBMWD facility.

The final sampling parameter list was developed with input from the City and project partners based on historic parameters of concern and the capabilities of the WBMWD analytical facility (United Laboratories). Associated Laboratories of Orange, CA was contracted to perform some of the specialty metals and high-volume bacteriological analyses. Telluris was responsible for sample collection using bottles and specifications provided by the two laboratories, and for collection of field parameters. Table 1 summarizes the final parameter list, including reporting units, detection limits, status as field or laboratory analytical results, and party responsible for the analysis.

Figure 3 – Study Plan Water Sampling Points

Table 1 – Summary of Final Sampling Plan Parameters

Parameter/ Abbreviation	Units	Detection Limit	Analysis Type	Responsible Party
Alkalinity	mg/L	2	Laboratory	United Labs
Aluminum	mg/L	0.02	Laboratory	United Labs
Ammonia	mg/L	0.1	Laboratory	United Labs
Arsenic	ug/L	1	Laboratory	United Labs
Bicarbonate	mg/L	2	Laboratory	United Labs
Boron	mg/L	0.01	Laboratory	United Labs
Biological Oxygen Demand (BOD_5)	mg/L	4	Laboratory	Associated Labs
Chemical Oxygen Demand (COD)	mg/L	10	Laboratory	United Labs
Cadmium	ug/L	0.5	Laboratory	United Labs
Calcium	mg/L	0.5	Laboratory	United Labs
Chloride	mg/L	1	Laboratory	United Labs
Chlorine	ppm	0.01	Field	Telluris
Coliform, Total	MPN	2	Laboratory	Associated Labs
Coliform, Fecal	MPN	2	Laboratory	Associated Labs
Conductivity	mS	1	Laboratory	United Labs
Copper	ug/L	1	Laboratory	United Labs
Dissolved CO_2	ppm	0.1	Field	Telluris
Dissolved O_2	ppm	0.1	Field	Telluris
Hardness	mg/L	3.3	Laboratory	United Labs
Hexavalent Chromium	ug/L	0.3	Laboratory	Associated Labs
Heterotrophic Plate Count (HPC)	CPU/cm	1	Laboratory	Associated Labs
Iron	mg/L	0.1	Laboratory	United Labs
Lead	ug/L	1	Laboratory	United Labs
Magnesium	mg/L	0.5	Laboratory	United Labs
MBAS	mg/L	0.04	Laboratory	Associated Labs
Mercury	ug/L	0.2	Laboratory	United Labs
Nickel	ug/L	1	Laboratory	United Labs
Nitrate	mg/L	0.1	Laboratory	United Labs
Nitrite	mg/L	0.1	Laboratory	United Labs
Oil & Grease	mg/L	5	Laboratory	Associated Labs
Ortho-Phosphate	mg/L	0.1	Laboratory	United Labs
Pesticides	ug/L	Varies	Laboratory	Associated Labs
pH	SU	0.01	Field	Telluris
Potassium	mg/L	0.5	Laboratory	United Labs
Selenium	ug/L	2	Laboratory	United Labs
Silica	mg/L	0.1	Laboratory	United Labs
Sodium	mg/L	0.5	Laboratory	United Labs
Sulfide	ppm	0.1	Field	Telluris
Sulfite	mg/L	1	Laboratory	Associated Labs
Sulfate	mg/L	2	Laboratory	United Labs
Total Dissolved Solids (TDS)	mg/L	10	Laboratory	United Labs
Total Suspended Solids (TSS)	mg/L	1	Laboratory	United Labs
Total Organic Carbon (TOC)	mg/L	0.5	Laboratory	United Labs
Vanadium	ug/L	10	Laboratory	United Labs
Volatile Organic Compounds (VOCs)	ug/L	Varies	Laboratory	Associated Labs
Zinc	ug/L	5	Laboratory	United Labs

RESULTS

Because the project sampling program was limited to two sampling events, up to three additional data sets were selected from historic information sources to provide a better representation of the potential range of variability that can occur. The additional historic data were limited to three sets to provide comparable quantities of data for each point, as some points only have this amount of information available. Historic data sources included recent studies and reported results closely corresponding to the sample point locations and timeframe of the study. The Preserve and Sump sampling points were augmented with results from the URS sampling events in July 2003, January 2004, and March 2004 (URS Documents A, B and C). Supporting data for the recycled water were taken from the WBMWD monthly reports for July, August, and September 2004 (WBMWD, 2004). The most recent historic data available for the City potable water were taken from the 2003 Water Quality Report (City of Torrance, 2003). This provided summary data for potable water delivered by the TMWD from its well source and purchased from the MWD. Results for 2003 were reported as amount detected and range (low – high). Because the MWD source represents the bulk of the delivered water, the amount detected, low, and high values for that source were assumed to represent the average, minimum, and maximum values for the potable water. The combined current and historic data sets for each sample point are contained in Appendix A, with the summary results presented in Table 2.

Average values in Table 2 represent the mean of the study sampling data and historic data with positive detection results. Where the number of non-detect results exceeds that of positive detections for a parameter, its average condition is interpreted to be non-detect (ND). The minimum and maximum observed levels are presented for each parameter below its average, along with the number of positive detections versus total data records for that parameter at the given sample point. A range-type comparison was selected for Table 2 because there is insufficient information for many parameters to develop a statistical assessment of variation, such as standard deviations.

In review of the wetland sample points, considerable variability is noted for several parameters, particularly the bacteriological tests and the metals aluminum, iron, lead, vanadium, and zinc. A large variation in bacteria counts can be expected because of the sensitivity of these populations to very localized conditions. The higher metals readings appear to correspond to elevated suspended solids (TSS) in individual samples. It is not unusual for metals to be entrained with sediment and show total mass readings greater than are actually present as dissolved concentrations. Entrainment of sediment can be unavoidable when sampling shallow or stagnant water, as was sometimes the case for the South Bay, East Fork, and North Pond points. Catch Basin 1, which is presumably flushed at times by storm flows, has much lower TSS readings and correspondingly lower metals concentrations. It is interpreted that the higher metals readings may not be representative of actual dissolved concentrations that would be obtained from filtered samples.

Aside from bacteriological parameters and metals concentrations possibly influenced by sediment, the wetland samples show reasonably overlapping ranges for individual parameters, suggesting that it would be valid for conceptual evaluation purposes to treat the four wetland sample points as a single data set. Similarly, the inlet and outlet sample points on the Sump show reasonably consistent values, although a degree of attenuation is noted for many parameters between the inlet and outlet points. It is reasoned that prolonged pumping on the Sump could draw its inlet waters towards its outlet point, so a composite of the two Sump data sets would be better representative of its conditions. As such, two composite data sets have been developed for the wetlands and Sump to simplify comparisons between the wetlands and the influent options. These composite data sets are contained in Appendix B, with the results discussed in the next section. Both the recycled and potable waters are single-source points with stand-alone data sets showing fairly low variability for parameters with long-term records.

Table 2 – Summary of Sampling Program Results Including Historic Data

Parameter	Units D.L.	Wetland Sampling Points				Potential Influent Source Points			
		Catch Basin 1	South Bay	East Fork	North Pond South Pond	Sump East (In)	Sump West (Out)	Recycled Water	Potable Water
Alkalinity	mg/L 2	**79** 30–128 [2]	**41** 36–45 [2]	**178** [1]	**55** [1]	**67** 33–125 [3]	**88** 52–123 [2]	**281** 267–296 [5]	**87** 73–112 [5]
Aluminum	mg/L 0.02	**0.171** 0.052–0.290 [2]	**3.3** 1.6–5 [2]	**9.9** [1]	**15** [1]	**0.18** ND–0.18 [2/3]	**0.063** 0.025–0.1 [2]	**0.51** 0.35–0.66 [2]	**1.43** 0.052–2.8 [2]
Ammonia	mg/L 0.1	**1.6** 1.1-2.4 [3]	**0.68** 0.36-0.88 [3]	**0.44** ND-0.44 [1/2]	**5** ND-5 [1/2]	**1.03** 0.26-2.4 [3]	**0.24** 0.18-0.3 [2]	**41** 37-45 [5]	**0.49** 0.48-0.50 [2]
Arsenic	ug/L 1	**1.9** ND-2.6 [2/3]	**24** ND-33 [2/3]	**24** ND-24 [1/2]	**8.6** ND-8.6 [1/2]	**1.4** 1.1-1.8 [3]	**1.5** 1.3-1.6 [2]	**3.9** 3.9-3.9 [2]	**1.9** 1.7-2.0 [2]
Bicarbonate	mg/L 2	**79** 30–128 [2]	**41** 36–45 [2]	**178** [1]	**55** [1]	**67** 33–125 [3]	**88** 52–123 [2]	**281** 267–296 [5]	**80** 78–82 [2]
Boron	mg/L 0.01	**0.14** 0.07–0.21 [2]	**0.36** 0.33–0.39 [2]	**0.49** [1]	**0.26** [1]	**0.14** 0.079–0.23 [3]	**0.18** 0.13–0.23 [2]	**0.52** 0.49–0.58 [5]	**0.15** 0.10–0.18 [5]
BOD_5	mg/L 4	**18** 4–34 [5]	**48** 8–120 [5]	**36** 7–120 [4]	**137** ND–260 [2/3]	**10** ND–18 [4/5]	**14** 5–25 [4]	ND ND–4 [1/5]	NA
COD	mg/L 10	**84** 31–160 [5]	**162** 29–340 [5]	**190** 36–470 [4]	**108** 43–190 [3]	**34** 21–67 [5]	**33** 24–41 [4]	**34** 29–39 [5]	**24** ND–24 [1/2]
Cadmium	ug/L 0.5	ND ND–0.51 [1/3]	ND ND–8.4 [1/3]	ND ND [0/2]	**5.8** ND-5.8 [1/2]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	ND ND [0/2]
Calcium	mg/L 0.5	**28** 13–43 [2]	**44** 20–68 [2]	**61** [1]	**32** [1]	**28** 20–44 [3]	**33** 22–43 [2]	**46** 42–50 [5]	**34** 23–56 [5]
Legend		Data Format **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]				ND – Non-Detect NA – Not Analyzed			

Table 2 – Summary of Sampling Program Results Including Historic Data (continued)

Parameter	Units D.L.	Wetland Sampling Points				Potential Influent Source Points			
		Catch Basin 1	**South Bay**	**East Fork**	**North Pond South Pond**	**Sump East (In)**	**Sump West (Out)**	**Recycled Water**	**Potable Water**
Chloride	mg/L 1	**77** 18–110 [3]	**53** 35–81 [3]	**99** 33–165 [2]	**47** 33–60 [2]	**67** 25–139 [3]	**89** 47–131 [2]	**198** 189–211 [5]	**71** 63–79 [2]
Chlorine	ppm 0.01	ND ND [0/2]	ND ND [0/2]	ND [0/1]	ND [0/1]	ND ND-0.02 [1/3]	**0.04** ND-0.04 [1/2]	**2.2** 2.2-2.2 [2]	**63** 1.8-105 [5]
Coliform, Total	MPN 2	**$6x10^6$** 1600–$3x10^7$ [5]	**$3x10^7$** 11–$2x10^8$ [5]	**439** 7–900 [4]	**1037** 11–2800 [3]	**$5x10^5$** 13–$2x10^6$ [5]	**$8x10^4$** ND–$2x10^5$ [3/4]	ND ND [0/2]	ND ND [0/3]
Coliform, Fecal	MPN 2	**$8x10^4$** ND–300000 [4/5]	**$6x10^5$** ND–$2x10^6$ [4/5]	**44** ND–80 [3/4]	**846** 39–1600 [3]	**$4x10^4$** ND–$2x10^5$ [4/5]	**$1x10^4$** ND–$2x10^4$ [2/4]	ND ND [0/2]	NA
Conductivity	mS 1	**490** 190–790 [2]	**550** 400–700 [2]	**960** [1]	**480** [1]	**487** 220–890 [3]	**630** 380–880 [2]	**1445** 1440–1450 [2]	**633** 500–890 [5]
Copper	ug/L 1	**23** ND–39 [2/3]	**70** ND–120 [2/3]	**15** ND–15 [1/2]	**42** ND–42 [1/2]	**10** 5–16 [3]	**8.4** 4.7–12 [2]	**6.4** 5.2–7.6 [2]	**8.7** 5.4–12 [2]
Dissolved CO_2	ppm 0.1	**20** 15–25 [2]	**47** 20–73 [2]	**20** [1]	**20** [1]	**6** 4–10 [3]	**6** 6–6 [2]	**65** 50–80 [2]	**4** [1]
Dissolved O_2	ppm 0.1	**1.9** ND–3.6 [4/5]	**5.6** ND–8.9 [4/5]	**6.7** 4.7–8.6 [3]	**6.4** 3.6–8.5 [3]	**8.4** 5.8–9.3 [5]	**8.8** 7–10 [4]	**4.9** 4.2–5.6 [2]	**8.3** [1]
Hardness	mg/L 3.3	**113** 46–180 [2]	**170** 76–263 [2]	**234** [1]	**115** [1]	**112** 76–185 [3]	**136** 88–184 [2]	**203** 188–221 [5]	**154** 106–258 [5]
Hex. Chromium	ug/L 0.3	ND ND [0/2]	ND ND [0/2]	ND [0/1]	ND [0/1]	ND ND-0.4 [1/3]	ND ND [0/2]	ND ND [0/2]	NA
Legend		Data Format **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]				ND – Non-Detect NA – Not Analyzed			

Table 2 – Summary of Sampling Program Results Including Historic Data (continued)

Parameter	Units D.L.	Wetland Sampling Points				Potential Influent Source Points			
		Catch Basin 1	**South Bay**	**East Fork**	**North Pond South Pond**	**Sump East (In)**	**Sump West (Out)**	**Recycled Water**	**Potable Water**
HPC	CPU 1	**$9x10^5$** 944-$3x10^6$ [5]	**$4x10^5$** 1400-$2x10^6$ [5]	**$3x10^4$** 1700-$1x10^5$ [4]	**$2x10^4$** 2000-$4x10^4$ [3]	**$5x10^4$** 2800-$2x10^5$ [5]	**$2x10^4$** 75-$8x10^4$ [4]	**48** 6-90 [2]	NA
Iron	mg/L 0.1	**0.35** 0.27–0.42 [2]	**12** 6.5–18 [2]	**25** [1]	**19** [1]	**0.22** ND–0.23 [2/3]	**0.14** 0.11–0.16 [2]	**0.35** 0.19–0.61 [5]	**1.3** ND–1.3 [1/2]
Lead	ug/L 1	**4.1** ND–6.4 [2/3]	**200** ND–220 [2/3]	**84** 8.2–160 [2]	**740** ND–740 [1/2]	**1.8** ND–2 [2/3]	**1.2** ND–1.2 [1/2]	**1.1** ND–1.1 [1/2]	**45** ND–45 [1/2]
Magnesium	mg/L 0.5	**11** 3.1–18 [2]	**15** 6.7–23 [2]	**20** [1]	**8.5** [1]	**11** 6.3–19 [3]	**13** 7.9–18 [2]	**21** 18–24 [5]	**16** 12–23.5 [5]
MBAS	mg/L 0.04	**0.38** 0.15–0.60 [2]	**0.34** 0.26–0.41 [2]	**0.76** [1]	**0.31** [1]	**0.19** 0.09–0.31 [3]	**0.16** 0.12–0.20 [2]	**0.13** 0.11–0.14 [2]	NA
Mercury	ug/L 0.2	ND ND [0/3]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	ND ND [0/2]
Nickel	ug/L 1	**10.6** ND–16.8 [2/3]	**31** ND–50 [2/3]	**11** ND–11 [1/2]	**18** ND–18 [1/2]	**4.3** 3.2–6.2 [3]	**4.3** 3.1–5.5 [2]	**8.2** 7.9–8.4 [2]	**2.7** 1.6–3.8 [2]
Nitrate	mg/L 0.1	ND ND–0.68 [1/5]	ND ND–0.63 [1/5]	ND ND [0/4]	ND ND-0.3 [1/3]	**0.76** ND–1.5 [3/5]	**0.6** ND–1.0 [2/4]	ND ND–0.61 [2/5]	**0.89** ND–1.4 [3/5]
Nitrite	mg/L 0.1	ND ND [0/3]	ND ND-0.29 [1/3]	ND ND [0/2]	ND ND [0/2]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	ND ND-0.5 [1/5]
Oil & Grease	mg/L 5	ND ND–9 [1/4]	**14** ND–20 [2/3]	**50** ND–50 [1/2]	**30** ND–30 [1/2]	ND ND–7 [1/3]	ND ND [0/2]	ND ND [0/2]	NA
Legend		Data Format **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]				ND – Non-Detect NA – Not Analyzed			

Table 2 – Summary of Sampling Program Results Including Historic Data (continued)

Parameter	Units D.L.	**Wetland Sampling Points**				**Potential Influent Source Points**			
		Catch Basin 1	**South Bay**	**East Fork**	**North Pond South Pond**	**Sump East (In)**	**Sump West (Out)**	**Recycled Water**	**Potable Water**
Ortho-Phosphate	mg/L 0.1	**1.6** 1.4–1.7 [2]	**1.3** 0.32–2.2 [2]	**0.81** [1]	**1.4** [1]	**1.0** 0.92–1.1 [3]	**0.95** 0.89–1.0 [2]	**4.9** 4.3–5.6 [5]	**0.16** 0.10–0.22 [2]
Pesticides	Var. Var.	ND ND [0/3]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	NA
pH	SU 0.01	**6.61** 6.24–6.82 [5]	**6.37** 6.14–6.75 [5]	**6.46** 6.28–6.70 [3]	**6.64** 6.28–6.83 [3]	**6.78** 6.44–7.19 [5]	**6.64** 6.27–7.05 [4]	**6.87** 6.65–7.00 [5]	**7.83** 6.84–8.25 [4]
Potassium	mg/L 0.5	**6.4** 5.3–7.5 [2]	**18** 17–18 [2]	**27** [1]	**19** [1]	**5.1** 3.7–6.2 [3]	**5.9** 5.6–6.1 [2]	**16** 15–17 [2]	**3.6** 2.7–4.2 [5]
Selenium	ug/L 2	**9.6** ND–18 [2/3]	**6.9** 2.5–14 [3]	**7.1** 5.1–9.1 [2]	**4.9** 2–7.8 [2]	ND ND–1.8 [1/3]	**1.4** ND–1.4 [1/2]	**4.5** 3.6–5.4 [2]	**3.1** 2.2–3.9 [2]
Silica	mg/L 0.1	**12** 4.9–19 [2]	**37** 34–39 [2]	**35** [1]	**50** [1]	**3.9** 3.2–4.5 [3]	**2.6** 1.5–3.6 [2]	**22** 20–24 [5]	**18** 15–21 [2]
Sodium	mg/L 0.5	**47** 14–79 [2]	**44** 36–52 [2]	**113** [1]	**44** [1]	**51** 20–102 [3]	**70** 40–100 [2]	**148** 135–158 [5]	**64** 49–87 [5]
Sulfide	ppm 0.1	ND ND [0/2]	ND ND [0/2]	ND [0/1]	ND [0/1]	ND ND [0/3]	ND ND [0/2]	ND ND [0/5]	NA
Sulfite	mg/L 1	ND ND [0/2]	ND ND [0/2]	ND [0/1]	ND [0/1]	ND ND [0/3]	ND ND [0/2]	ND ND [0/2]	NA
Sulfate	mg/L 2	**51** 22–105 [3]	**84** 1.4–240 [3]	**2.7** ND–2.7 [1/2]	**7.7** ND–7.7 [1/2]	**57** 26–104[3]	**78** 53–102 [2]	**120** 112–127 [5]	**61** 50–72 [2]
Legend		Data Format **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]				ND – Non-Detect NA – Not Analyzed			

Table 2 – Summary of Sampling Program Results Including Historic Data (continued)

Parameter	Units D.L.	Wetland Sampling Points				Potential Influent Source Points			
		Catch Basin 1	**South Bay**	**East Fork**	**North Pond South Pond**	**Sump East (In)**	**Sump West (Out)**	**Recycled Water**	**Potable Water**
TDS	mg/L 10	**406** 130–640 [3]	**393** 280–590 [3]	**450** 290–610 [2]	**275** 250–300 [2]	**311** 140–544 [3]	**390** 240–540 [2]	**698** 650–780 [5]	**362** 278–528 [5]
TSS	mg/L 1	**11** 3–26 [3]	**770** 210–1100 [3]	**1440** 780–2100 [2]	**416** 12–820 [2]	**14** 11–16 [3]	**14** 13–15 [2]	**6** 5–7 [5]	**230** ND-230 [1/2]
TOC	mg/L 0.5	**15** 10–20 [2]	**17** 15–19 [2]	**14** [1]	**16** [1]	**14** 11–18 [3]	**14** 12–16 [2]	**12** 11–13 [5]	**4.4** 1.7–8.5 [5]
Vanadium	ug/L 10	ND ND–2.7 [1/3]	**36** ND–50 [2/3]	**63** ND–63 [1/2]	**79** ND–79 [1/2]	ND ND–2.9 [1/3]	**2.4** ND–2.4 [1/2]	**5** ND–5 [1/2]	**11** ND–11 [1/2]
VOCs	ug/L Var.	ND ND-71 [1/3]	ND ND-168 [2/3]	ND ND-58 [2]	ND ND-10 [1/2]	ND ND [0/3]	ND ND [0/2]	ND ND-38 [1/2]	NA
Zinc	ug/L 5	**43** ND–47 [2/3]	**1647** ND–3200 [2/3]	**91** ND–91 [1/2]	**1400** ND–1400 [1/2]	**94** 15–180 [3]	**79** 17–140 [2]	**13** 7–18 [2]	**34** 19–49 [2]
Legend		Data Format **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]				ND – Non-Detect NA – Not Analyzed			

EVALUATION OF INFLUENT OPTIONS

The primary criterion for selection of an influent option is the chemical suitability of the source waters for introduction into the wetland environment. The first priority is to prevent the addition of constituents that could aggravate existing problems or cause new adverse impacts. Eutrophication and lack of circulation in the wetlands have caused many parameters to become elevated above desirable levels, so the selected influent option must possess lower concentrations of these parameters to have a positive benefit, or, at the least, have equal concentrations to prevent accelerated degradation. The assumption is made that the selected influent option will be used to the extent that dilution effects occur by means of flow-through circulation. With this assumption, a comparison can be made between the existing conditions in the wetlands and the characteristics of the influent options to evaluate potential water quality changes.

Comparison of Influent Options to Existing Wetland Conditions

The available information for some parameters in the recycled and potable waters is limited to the two sample rounds of the monitoring program, which are insufficient to allow a reliable statistical assessment of the range of variability that could occur in these influent options. The wetland and Sump composite data sets have more records (6 to 17 and 5 to 10, respectively), but both are subject to broad climatic variation, and the results from 2004 may not fully represent the range of conditions that may be observed in other years. Because of these limitations, it is not believed that parameter changes resulting from application of a given influent option can be quantitatively predicted with any reasonable accuracy at this time. There is, however, sufficient information to allow a qualitative assessment of potential changes, such as application of an influent option with a low concentration of a parameter will likely result in reduction of a higher concentration of that parameter in the wetlands through dilution.

To assess these potential qualitative changes, a goal-based matrix evaluation (Table 3) has been developed comparing the existing composite parameter values in the wetlands to those of the three influent options. The data presentation format is the same as in Table 2, but composite data sets have been used here for the existing wetland conditions and the Sump. In the Existing Wetland Composite column, a conceptual Enhancement Goal is shown for each parameter, with a downward arrow indicating a desired reduction in the existing parameter level, an upward arrow indicating a desired increase in the parameter level, and an open circle indicating that the parameter level is either currently acceptable or that no change is needed. Under the influent option columns, the effect of using an influent option on a given parameter is qualitatively compared to the Enhancement Goal for that parameter. A green circle indicates that use of the influent source could benefit the goal, a red circle indicates that this option use could adversely effect the goal, and an open circle indicates that the option would probably cause no change or otherwise have no effect on the goal. This format is intended to highlight parameters with potential adverse effects as a lead-in to the next discussions evaluating pre-treatment requirements for the influent options.

Table 3 – Evaluation of Existing Conditions and Potential Effects of Influent Options

Parameter	Units D.L.	Existing Wetland Composite	Enhancement Goal	Effect of Influent Option Use on Enhancement Goal						Comments
				Sump Composite	Potential Change	Recycled Water	Potential Change	Potable Water	Potential Change	
Alkalinity	mg/L 2	**79** 30–178 [6]	○	**75** 33–125 [5]	○	**281** 267–296 [5]	🔴	**87** 78–112 [5]	○	Recycled water has consistently high alkalinity, could alter existing balance.
Aluminum	mg/L 0.02	**5.31** 0.052–15 [6]	▼	**0.12** ND–0.18 [4/5]	🟢	**0.51** 0.35–0.66 [2]	🟢	**1.43** 0.052–2.8 [2]	🟢	Elevated aluminum in the wetlands likely due to stagnation and high TSS, could be reduced by any of the sources.
Ammonia	mg/L 0.1	**1.5** ND-5.0 [8/10]	▼	**0.7** 0.2-2.4 [5]	🟢	**41** 37-45 [5]	🔴	**0.49** 0.48-0.50 [2]	🟢	Decrease would be beneficial. Recycled water shows consistently high ammonia.
Arsenic	ug/L 1	**14** ND-33 [6/10]	▼	**1.4** 1.1-1.8 [5]	🟢	**3.9** 3.9-3.9 [2]	🟢	**1.9** ND-2.0 [3/5]	🟢	Elevated arsenic in the wetlands likely due to stagnation and high TSS, could be reduced by any of the sources.
Bicarbonate	mg/L 2	**79** 30–178 [6]	○	**75** 33–125 [5]	○	**281** 267–296 [5]	🔴	**80** 78–82 [2]	○	Alternative measure of alkalinity, same assessment applies.
Boron	mg/L 0.01	**0.29** 0.071–0.49 [6]	▼	**0.16** 0.079–0.23 [5]	🟢	**0.52** 0.49–0.58 [5]	🔴	**0.15** 0.10–0.18 [5]	🟢	Current conditions acceptable, but decrease beneficial. Recycled water higher than existing range.
BOD_5	mg/L 4	**47** ND–260 [16/17]	▼	**12** ND–25 [8/9]	🟢	ND ND–4 [1/5]	🟢	NA	🟢	Decrease would be beneficial. Potable water assumed to have low BOD.
COD	mg/L 10	**136** 29–470 [17]	▼	**33** 21–67 [9]	🟢	**34** 29–39 [5]	🟢	**24** ND–24 [1/2]	🟢	Decrease would be beneficial. All sources acceptable.
Cadmium	ug/L 0.5	ND ND–8.4 [3/10]	▼	ND ND [0/5]	🟢	ND ND [0/2]	🟢	ND ND [0/2]	🟢	Low concern due to few detections. All sources acceptable.
Calcium	mg/L 0.5	**40** 13–68 [6]	○	**30** 20–44 [5]	○	**46** 42–50 [5]	○	**34** 23–56 [5]	○	All sources compatible with existing range.
Legend		▲ - Goal is to Increase ○ - Acceptable Levels ▼ - Goal is to Decrease		🟢 - Potentially Beneficial to Goal, 🔴 - Potentially Adverse to Goal ○ - No Change - Acceptable or Beneficial						<u>Data Format</u> **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]

Table 3 – Evaluation of Existing Conditions and Potential Effects of Influent Options (continued)

Parameter	Units D.L.	**Existing Wetland Composite**	Enhancement Goal	**Effect of Influent Option Use on Enhancement Goal**						**Comments**
				Sump Composite	Potential Change	**Recycled Water**	Potential Change	**Potable Water**	Potential Change	
Chloride	mg/L 1	**68** 18–165 [10]	▼	**76** 25–139 [5]	○	**198** 189–211 [5]	● (red)	**71** 63–79 [2]	○	Decrease would be beneficial. Sump and potable water would cause no change, recycled water would increase.
Chlorine	ppm 0.01	ND ND [0/6]	○	ND ND-0.04 [2/5]	○	**2.2** 2.2-2.2 [2]	● (red)	**63** 1.8-105 [4]	● (red)	Trace amounts in Sump water. Recycled and potable could cause significant increase.
Coliform, Total	MPN 2	**$1X10^7$** $7–2x10^8$ [17]	▼	**$3x10^5$** $ND–2x10^6$ [8/9]	● (green)	ND ND [0/2]	● (green)	ND ND [0/3]	● (green)	Sump waters lower in bacteria, but susceptible to contamination.
Coliform, Fecal	MPN 2	**$2X10^5$** $ND–2X10^6$ [14/17]	▼	**$3x10^4$** $ND–1.6x10^5$ [6/9]	● (green)	ND ND [0/2]	● (green)	NA	● (green)	Recycled and potable water should have little or no fecal coliform.
Conductivity	mS 1	**587** 190–960 [6]	▼	**544** 220–890 [5]	○	**1445** 1440–1450 [2]	● (red)	**633** 500–890 [5]	● (red)	Surrogate measure of other parameters. Decrease normally beneficial, but not essential.
Copper	ug/L 1	**40** ND–120 [6/10]	▼	**9.5** 4.7–16 [5]	● (green)	**6.4** 5.2–7.6 [2]	● (green)	**8.7** 5.4–12 [2]	● (green)	Elevated copper in the wetlands likely due to stagnation and high TSS, could be reduced by any of the sources.
Dissolved CO_2	ppm 0.1	**29** 15–73 [6]	▼	**6** 4–10 [5]	● (green)	**65** 50–80 [2]	● (red)	**4** [1]	● (green)	Concentrations below 15 ppm desirable.
Dissolved O_2	ppm 0.1	**4.9** ND–8.9 [14/16]	▲	**8.6** 5.8–10 [9]	● (green)	**4.9** 4.2–5.6 [2]	● (green)	**8.3** [1]	● (green)	Increase desired to offset stagnation. All sources could improve this <u>with influent aeration.</u>
Hardness	mg/L 3.3	**152** 46–263 [6]	○	**122** 76–185 [5]	○	**203** 188–221 [5]	○	**154** 106–258 [5]	○	All sources within same range of hardness – parameter within acceptable limits.
Hex. Chromium	ug/L 0.3	ND ND [0/6]	○	ND ND-0.4 [1/5]	○	ND ND [0/2]	○	NA	○	Non-detect parameter
Legend		▲ - Goal is to Increase ○ - Acceptable Levels ▼ - Goal is to Decrease		● (green) - Potentially Beneficial to Goal, ● (red) - Potentially Adverse to Goal ○ - No Change - Acceptable or Beneficial						<u>Data Format</u> **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]

Table 3 – Evaluation of Existing Conditions and Potential Effects of Influent Options (continued)

Parameter	Units D.L.	Existing Wetland Composite	Enhancement Goal	Effect of Influent Option Use on Enhancement Goal						Comments
				Sump Composite	Potential Change	Recycled Water	Potential Change	Potable Water	Potential Change	
HPC	CPU 1	**$4x10^5$** $944\text{-}3x10^6$ [17]	▼	**$4x10^4$** $75\text{-}2x10^5$ [9]	🟢	**48** 6-90 [2]	🟢	NA	🟢	Sump waters lower in bacteria, but susceptible to contamination.
Iron	mg/L 0.1	**12** 0.27–25 [6]	▼	**0.18** ND–0.23 [4/5]	🟢	**0.35** 0.19–0.61 [5]	🟢	**1.3** ND–1.3 [1/2]	🟢	All sources essentially equal.
Lead	ug/L 1	**188** ND–740 [7/10]	▼	**1.6** ND–2.0 [3/5]	🟢	**1.1** ND–1.1 [1/2]	🟢	**45** ND–45 [1/2]	🟢	Potable Water results limited for lead; warrants further sampling.
Magnesium	mg/L 0.5	**13** 3.1–23 [6]	○	**12** 6.3–19 [5]	○	**21** 18–24 [5]	○	**16** 12–23.5 [5]	○	All sources within same range for magnesium – parameter within acceptable limits.
MBAS	mg/L 0.04	**0.42** 0.15–0.76 [6]	▼	**0.18** 0.09–0.31 [5]	🟢	**0.13** 0.11–0.14 [2]	🟢	NA	🟢	MBAS assumed absent in Potable Water. Reason for presence in Recycled Water is unknown.
Mercury	ug/L 0.2	ND ND [0/10]	○	ND ND [0/5]	○	ND ND [0/2]	○	ND ND [0/2]	○	Non-detect parameter
Nickel	ug/L 1	**19** ND–50 [6/10]	▼	**4.3** 3.1–6.2 [5]	🟢	**8.2** 7.9–8.4 [2]	🟢	**2.7** 1.6–3.8 [2]	🟢	Nickel locally present in the wetlands, but also some non-detects. Low concentration influent sources assumed to improve conditions.
Nitrate	mg/L 0.1	ND ND–0.68 [3/17]	▼	**0.7** ND–1.5 [5/9]	🔴	ND ND–0.61 [2/5]	○	**0.89** ND–1.4 [3/5]	🔴	Nutrient reduction desired; can be attenuated by passive treatment. More results needed for Potable Water.
Nitrite	mg/L 0.1	ND ND-0.29 [1/10]	○	ND ND [0/5]	○	ND ND [0/2]	○	ND ND-0.5 [1/5]	○	Essentially a non-detect parameter
Oil & Grease	mg/L 5	**23** ND–50 [5/10]	▼	ND ND–7 [1/5]	🟢	ND ND [0/2]	🟢	NA	🟢	Reductions in oil and grease more likely from runoff filtration measures than from dilution.
Legend		▲ - Goal is to Increase ○ - Acceptable Levels ▼ - Goal is to Decrease		🟢 - Potentially Beneficial to Goal, 🔴 - Potentially Adverse to Goal ○ - No Change - Acceptable or Beneficial						<u>Data Format</u> **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]

Table 3 – Evaluation of Existing Conditions and Potential Effects of Influent Options (continued)

Parameter	Units D.L.	Existing Wetland Composite	Enhancement Goal	Effect of Influent Option Use on Enhancement Goal						Comments
				Sump Composite	Potential Change	Recycled Water	Potential Change	Potable Water	Potential Change	
Ortho-Phosphate	mg/L 0.1	**1.3** 0.32–2.2 [6]	▼	**1.0** 0.89–1.1 [5]	○	**4.9** 4.3–5.6 [5]	● (red)	**0.16** 0.10–0.22 [2]	● (green)	Nutrient reduction desired.
Pesticides	Var. Var.	ND ND [0/10]	○	ND ND [0/5]	○	ND ND [0/2]	○	NA	○	Non-detect parameter
pH	SU 0.01	**6.51** 6.14–6.83 [16]	○	**6.72** 6.27–7.19 [9]	○	**6.87** 6.65–7.00 [5]	● (red)	**7.83** 6.84–8.25 [4]	● (red)	Small upward increase with Sump and Recycled Waters; possibly more with Potable Water - needs further results to determine.
Potassium	mg/L 0.5	**16** 5.3–27 [6]	▼	**5.4** 3.7–6.2 [5]	● (green)	**16** 15–17 [5]	○	**3.3** 2.6–4.0 [5]	● (green)	Nutrient reduction desired. Recycled Water probably no change.
Selenium	ug/L 2	**7.1** ND–18 [9/10]	▼	ND ND–1.8 [2/5]	● (green)	**4.5** 3.6–5.4 [2]	● (green)	**3.1** 2.2–3.9 [2]	● (green)	Lowest possible desirable to reduce bioaccumulation.
Silica	mg/L 0.1	**30** 4.9–50 [6]	▼	**3.4** 1.5–4.5 [5]	● (green)	**22** 20–24 [5]	● (green)	**18** 15–21 [2]	● (green)	No specific aquatic life criteria, but reduction is desirable.
Sodium	mg/L 0.5	**56** 14–113 [6]	▼	**59** 20–102 [5]	○	**148** 135–158 [5]	● (red)	**70** 49–89 [5]	● (green)	Reduction desired to prevent salinity buildup. Recycled water consistently higher than wetland range.
Sulfide	ppm 0.1	ND ND [0/6]	○	ND ND [0/5]	○	ND ND [0/5]	○	NA	○	Non-detect parameter
Sulfite	mg/L 1	ND ND [0/6]	○	ND ND [0/5]	○	ND ND [0/2]	○	NA	○	Non-detect parameter
Sulfate	mg/L 2	**52** ND–240 [8/10]	○	**65** 26–104 [5]	○	**120** 112–127 [5]	● (red)	**61** 50–72 [2]	○	Parameter within acceptable range for all sources.
Legend		▲ - Goal is to Increase ○ - Acceptable Levels ▼ - Goal is to Decrease		● (green) - Potentially Beneficial to Goal, ● (red) - Potentially Adverse to Goal ○ - No Change - Acceptable or Beneficial						<u>Data Format</u> **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]

Table 3 – Evaluation of Existing Conditions and Potential Effects of Influent Options (continued)

Parameter	Units D.L.	**Existing Wetland Composite**	Enhancement Goal	**Effect of Influent Option Use on Enhancement Goal**						**Comments**
				Sump Composite	Potential Change	**Recycled Water**	Potential Change	**Potable Water**	Potential Change	
TDS	mg/L 10	**385** 130–640 [10]	▼	**343** 140–544 [5]	○	**698** 650–780 [5]	🔴	**362** 278–528 [5]	🔴	Surrogate measure of other parameters. Decrease normally beneficial, but not essential.
TSS	mg/L 1	**606** 3–2100 [10]	▼	**14** 11–16 [5]	🟢	**6** 5–7 [5]	🟢	**230** ND-230 [1/2]	🟢	Elevated TSS partially due to low water level sampling conditions. High Potable Water reading is unusual.
TOC	mg/L 0.5	**16** 10–20 [6]	▼	**14** 11–18 [5]	○	**12** 11–13 [5]	🟢	**4.4** 1.7–8.5 [5]	🟢	TOC within normal wetland range, reduction beneficial but not essential.
Vanadium	ug/L 10	**43** ND–79 [5/10]	▼	**ND** ND–2.9 [2/5]	🟢	**5** ND–5 [1/2]	🟢	**11** ND–11 [1/2]	🟢	Elevated vanadium in the wetlands likely due to stagnation and high TSS, could be reduced by any of the sources.
VOCs	ug/L Var.	ND ND-160 [3/10]	▼	ND ND [0/5]	🟢	ND ND-38 [1/2]	🟢	NA	🟢	Sporadic detects in the wetlands. Trace levels in Recycled Water. Assumed absent in Potable Water.
Zinc	ug/L 5	**812** ND–3200 [6/10]	▼	**88** 15–180 [5]	🟢	**13** 7–18 [2]	🟢	**34** 19–49 [2]	🟢	Elevated zinc in the wetlands likely due to stagnation and high TSS, could be reduced by any of the sources.
Legend		▲ - Goal is to Increase ○ - Acceptable Levels ▼ - Goal is to Decrease		🟢 - Potentially Beneficial to Goal, 🔴 - Potentially Adverse to Goal ○ - No Change - Acceptable or Beneficial						<u>Data Format</u> **14.1** **Average Value** (average of positive detections*) ND-33 [6/10] Range: Lowest-Highest [No. Detects/Total No. Results]

Evaluation of Pre-Treatment Requirements

In review of Table 3, it is evident that the recycled water has the most potential adverse changes, and the Sump water the least. An evaluation of potential adverse changes for a parameter does not preclude an influent option from consideration, but does indicate that some form of pre-treatment or attenuation could be needed for that parameter. Additional sampling should be conducted for these parameters of concern to better refine their variability relative to the wetlands before any final decisions are made regarding the selection of an influent option or levels of modification necessary for its use.

If used singly, all of the influent options appear to require some degree of pre-treatment. Conceptual restoration plans for the wetlands included the use of passive wetland (PW) treatment to improve influent quality. Other options include semi-passive physiochemical treatment, such as activated carbon (AC) filters, or active physiochemical treatment, such as reverse osmosis (RO). Table 4 provides a summary of the influent option parameters with potential to cause adverse changes, and the conceptual means to treat them prior to discharge to the wetlands. The parameters bicarbonate, conductivity, and TDS are not included in Table 4 because they are surrogate measures of other parameters.

The majority of the parameters in Table 4 can be effectively treated by passive means in the concentration ranges observed for the three influent options. The most problematic parameter for passive treatment would be chlorine. Although chlorine removal has been reported in passive wetland systems, documentation is very limited, and no design criteria have been established. The effectiveness of treatment in wetlands would also depend on the form of the chlorine, which can travel either as the dissolved gas or as chloramine, depending on how it was introduced into the influent option. Dissolved chlorine will volatilize from water during detention and presumably during passage through wetlands, but rates are temperature dependent and difficult to reliably predict. Removal of chloramine in wetlands would require bacterial action, and decay rates have not been established in this environment. Because of the uncertainties of removing chlorine with passive treatment, it is not recommended that this approach be applied to the recycled or potable water without on-site pilot studies documenting its effectiveness. Activated carbon filtration is reliable for chlorine, chloramine, and ammonia. The remaining parameters of concern, boron, chloride, sodium, and sulfate, are not removed to any significant degree in wetlands and are problematic for activated carbon treatment. Active physiochemical processes, typically reverse osmosis, are required to reliably reduce these parameters.

In summary, the Sump waters appear to be chemically compatible with the existing wetland environment if delivered through a modest passive wetland pre-treatment system. The parameters in the potable water appear amenable to passive treatment except for chlorine, which may require an additional stage of activated carbon filtration prior to passive wetland treatment. The chloride, sodium, and sulfate levels in the recycled water may require physiochemical treatment, such as reverse osmosis, in addition to ammonia and chlorine removal by activated carbon and passive pre-treatment of residual parameters.

Table 4 – Evaluation of Conceptual Pre-Treatment Approaches for the Influent Options

Potentially Adverse Parameter	**Conceptual Pre-Treatment Approach**			**Comments**
	Sump Composite	Recycled Water	Potable Water	
Alkalinity		PW		Tends to be moderated by passive treatment, but may require chemical adjustment.
Ammonia		PW, AC?		Levels in Recycled water may require treatment in addition to passive wetlands.
Boron		PW, RO?		Some removal in passive systems, usually requires RO for significant reduction.
Chloride		RO		Removable by physiochemical processes only.
Chlorine		PW?, AC	PW?, AC	Removal unknown in wetlands, AC treatment effective.
Dissolved CO_2		PW		Moderated by volatilization or pH buffering in wetlands.
Nitrate	PW		PW	Nitrate levels suitable for attenuation by passive means.
Ortho-Phosphate		PW		Phosphate levels suitable for attenuation by passive means.
pH		PW	PW	Tends to be moderated by passive treatment, but may require chemical adjustment.
Sodium		RO		Removable by physiochemical processes only.
Sulfate		RO		Removable by physiochemical processes only.

PW – Passive Wetland Treatment, AC – Activated Carbon Treatment, RO – Reverse Osmosis Treatment

Combinations of Influent Options

Another approach to attenuating a parameter of concern is dilution by other waters containing more favorable levels of that parameter. One of the considerations of this study was to evaluate the potential benefits of using more than one of the influent options in combination to supplement the wetland hydrology. The Sump water pumping system is already in place, and a potable water tap is available at the south end of the site. The nearest distribution line for the recycled water is currently several miles from the Preserve, and the MBMWD is now extending this line into the vicinity to potentially service the Preserve and other customers. As such, there are no major obstacles to using more than one of the potential new influent sources, either through existing access or newly developed access.

The existing Sump waters appear to have the lowest degree of required pre-treatment, potentially satisfied by passive wetland treatment alone, and thus would constitute the diluting water for combination with either or both of the recycled or potable water sources. The primary constraints on diluting the recycled or potable waters are chlorine, ammonia, chloride, sodium, and sulfate. The USEPA freshwater aquatic life criterion for chlorine is 0.019 mg/L. Both the recycled and potable water appear to be over one hundred times this concentration, requiring a comparable dilution ratio using the Sump waters. It would not be cost effective to supplement the Sump waters with a hundredth or lesser volume of recycled or potable water, so activated carbon pre-treatment of chlorine would be required in place of dilution should either of these sources be used. It is also not certain that the ammonia levels in the recycled water can be fully removed by passive treatment, so dilution without activated carbon pre-treatment of this parameter is probably not an effective option either. The chloride, sodium, and sulfate levels in the Sump waters are essentially the same as the existing wetland conditions, so it would not be possible to dilute the concentrations of these parameters in the recycled or potable waters to the same levels as the wetlands. As such, it is concluded that dilution is not a viable means of avoiding pre-treatment beyond passive wetlands, and that other forms of pre-treatment may be required if either the recycled or potable waters are used.

Use of Catch Basins for Influent

Intuitively, it would be expected that the stormwater catch basins along Madrona Avenue would be a source of pollutants to the wetlands because of runoff from roads. The results from Catch Basin 1, however, show equal or better water quality than the other three wetland sample points for all but the bacteriological parameters. As discussed under the Results, it is suspected that some of the high metals readings at the other wetland sample points were due to suspended sediment. In most cases the Catch Basin 1 results more closely resemble those of the Sump, suggesting that wetland pre-treatment could also improve the road runoff quality sufficiently for continued use of the catch basins for influent. Constructed wetland forebays, for example, could be placed at the discharge of each catch basin to provide trapping of sediment and trash, and a moderate degree of passive treatment.

The primary argument against continued use of the catch basins is their susceptibility to spills or other chemical releases, as was suspected to have occurred in 2003. Even with wetland forebays, a release in the road area would quickly enter the wetland environment unless containment actions were taken immediately at the catch basins. The catch basins are also susceptible to initial flushing of higher concentration contaminants at the beginning of storm events. With the limited amount of sampling conducted for this study, it cannot be determined if the observed conditions are representative of such events, or if worse water quality could occur.

A conceptual alternative to wetland forebays is to install a drain line to convey the catch basin outfalls around the Preserve and into the Sump. The runoff area feeding the catch basins is considerably smaller than that collected by the Sump, so presumably dilution and attenuation of initial flushing events or releases would occur within the volume of the Sump. Also, in the event of a significant release, pumping from the Sump to the wetlands could be ceased until such time as acceptable water quality was restored. Once blended with the Sump waters, the catch basin discharges would pass through the selected pre-treatment system, with presumably greater contaminant removal efficiency that small forebays. A second option is to convey the catch basins to Ralphs Sump, which is located at the corner of Plaza del Amo and Madrona Avenue northwest of the Preserve. This would eliminate the possibility of a spill at the catch basins reaching either the wetlands or the Sump. Both options are considered to be preferable to the continued discharge of the catch basins to the wetlands.

Selection of the Preferred Alternative

Based on these evaluations, it appears that the Sump waters represent the best influent option in terms of water quality and level of effort for use. This water appears to equal or exceed the existing quality of the wetland waters for all parameters except nitrate, which is only slightly elevated. Passive wetland pre-treatment would readily address the nitrate levels and further improve the Sump water quality prior to discharge to the Preserve. The recycled and potable waters would both likely require activated carbon pre-treatment to remove chlorine, entailing supervision of the filtration system by City personnel. The recycled water additionally contains chloride, sodium, and sulfate at levels that could require reverse osmosis or other physiochemical methods, necessitating a higher level of mechanical supervision and technical competence by City personnel. The pumping and delivery system for the Sump waters is already in place and operated by the City, and passive wetland pre-treatment requires very minimal operational supervision. For these reasons, the Sump is considered to be the preferred alternative for increasing the water supply of the wetlands.

WATER MANAGEMENT PLAN

The conceptual water management plan for the wetlands has two basic goals: (1) to decrease the degree of internal eutrophication and stagnation, and (2) to increase the extent of the existing wetlands. Both of these goals can be addressed by a combination of excavation grading in uplands and supplying a greater volume of water to the wetlands, with the preferred influent source being the existing supply system from the Maple/Sepulveda Sump. This will require first establishing the desired and practical limits of wetland expansion on the site, and the consequent volume of annual influent addition necessary to maintain this expansion. A water routing strategy can then be developed to provide flow-through circulation to currently isolated areas of the wetlands to reduce eutrophication and stagnation.

Development of a final water management plan will require detailed topographic mapping that is not currently available for the site. This work is planned for the next phase of the restoration project and is beyond the scope of this report. However, a number of conceptual guidelines can be presented based on the available knowledge of the site, to be incorporated by the next phase design contractor in final plans and specifications. The following provides a discussion of these activities to develop the wetland expansion, water routing plan, pre-treatment plan, and operation and maintenance plan for the site. The locations of activities shown on the figures in the following discussions are for conceptual understanding only, and final locations will depend on the results of the topographic survey.

Conceptual Wetland Expansion Plan

The current wetland expansion plan envisions local excavation of adjacent uplands in combination with an increased water supply to account for the expanded area. The extent of wetland expansion will largely be dictated by existing topography. Following development of topographic mapping, grading expansion areas can be mapped versus existing or desired increased water levels in the wetlands. Other constrains, such as undesirable areas of vernal pool inundation, could also be mapped relative to potential new water levels. Figure 4 illustrates the conceptual grading and water level expansion areas currently envisioned for the wetlands.

Once the desired wetland expansion extent has been selected, the supporting water volume necessary to seasonally achieve this expansion can be determined based on topography. The minimum gross water volume needed by the wetlands would then be the inundating volume plus additional volume to account for evapotranspiration and leakage losses over the desired minimum period of seasonal inundation or saturation. Evapotranspiration and leakage rates may be initially estimated from local NOAA records and existing site soil studies, but it will likely be necessary to adjust influent addition rates over several years to arrive at an effective balance. The extent of saturated wetland fringe establishment is also very difficult to estimate, and it may be necessary to observe this effect over time as well to optimize the initial seasonal inundation level in the wetlands.

Figure 4 – Conceptual Wetland Expansion Areas by Grading and Water Level Increase

Conceptual Water Routing Plan

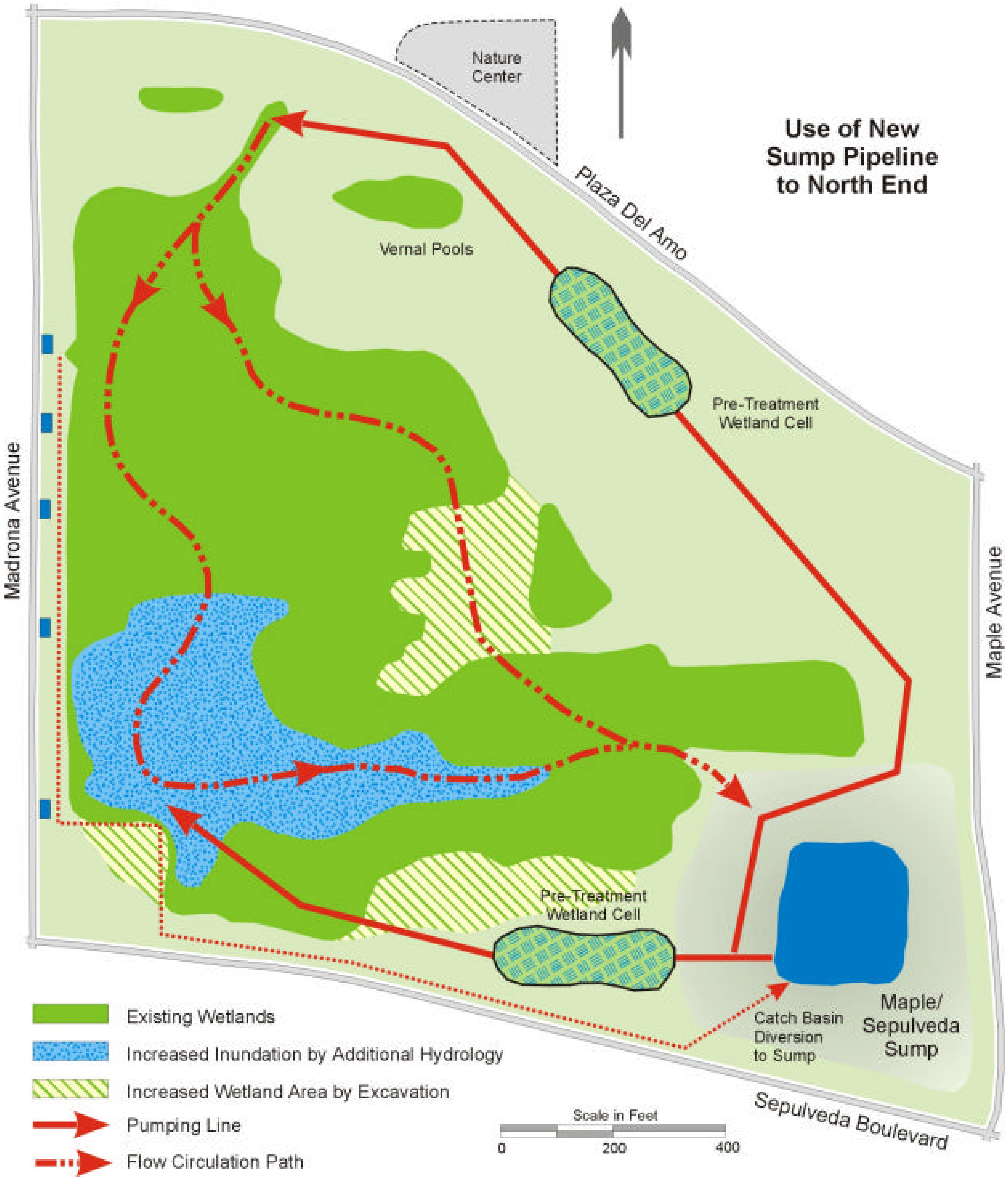
Because the wetlands are seasonal, there is a limit to the degree that inundation and flow-through water movement improvements can reduce eutrophication and stagnation effects. Inundation and flow-through movement cannot be maintained year-round without changing the fundamental nature of the wetlands, so water quality conditions will always decline in the drier months as areas become isolated and parameters in remaining waters are concentrated by evapotranspiration. There are, however, several water routing options that can improve the initial water quality conditions during the wet months and minimize the quantity of residual undesirable parameters during low water periods.

The first approach is to provide a degree of turnover in the standing water volume of the wetlands during maximum inundation conditions. The influent volume required to do this will require adjustment over time in conjunction with determining the volume necessary to maintain the wetland expansion area. As a starting point, the gross water volume input determined necessary for the expanded area could be pumped entirely from the Sump, with runoff from other sources providing an additional volume to be discharged as overflow back to the Sump. The Sump supply rate could then be varied until an optimum rate of turnover is established. Conceptually, it would be desirable to replace the maximum inundation volume of the wetlands with fresh input from the Sump at least once per growing season (i.e. the total volume of water entering the wetlands from the Sump and other runoff sources would be at least twice the gross water volume needed for expansion). Drainage of this replaced volume back to the Sump would progressively remove higher concentration zones of contaminants by diffusion and flushing, eventually equilibrating the inundated areas with the Sump water quality. The Sump receives runoff from a considerably larger area than the wetlands, and as such would serve as a diluting sink even if some of the overflow waters were returned to the wetland area during the pumping period.

In addition to volumetric turnover, it would be beneficial to establish more direct flow-through routes within the wetlands to deliver fresh Sump water to existing stagnant areas and promote flushing of high concentration waters back to the Sump. The degree to which this can be achieved will depend on the results of the topographic survey. Actions within the wetlands may involve a combination of local dikes and through-cuts to connect isolated areas to the dominant water movement courses. It may be possible to achieve acceptable flow patterns by these means using the existing discharge point of the Sump pumping line, as shown by Figure 5. Another approach may be to construct a new pump line to the northern end of the Preserve and operate two influent points, as shown by Figure 6. There are adjacent vernal pool areas within the Preserve that must be isolated from this flow pattern and cannot be improved by it.

Figure 5 – Conceptual Circulation Improvement with Existing Pump Line

Figure 6 – Conceptual Circulation Improvement with Existing and New Pump Lines



Pre-Treatment Plan

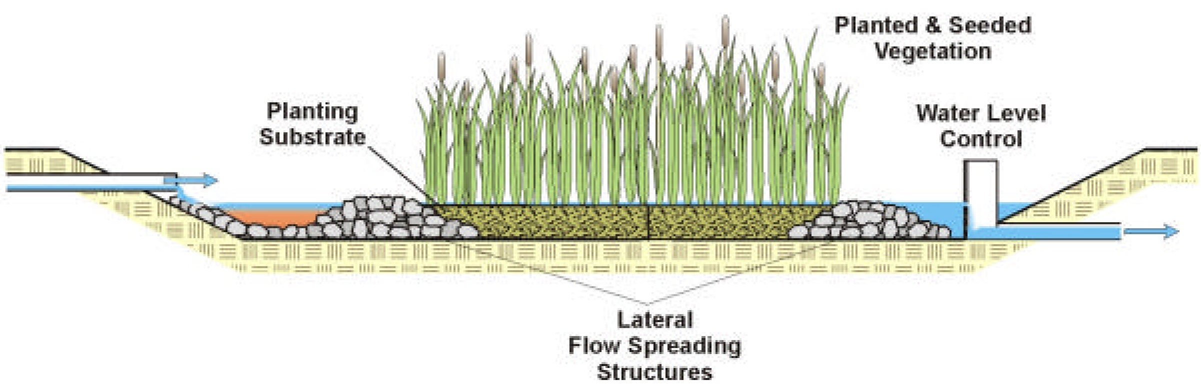
As discussed under the evaluation of influent options, except for possibly having slightly elevated nitrate levels, the Sump waters appear to be of equal or better quality than the existing wetland conditions. Low levels of pre-treatment, however, would be beneficial for the continued use of these waters. This level of pre-treatment can be provided passively by constructed wetlands. The recycled water or potable water would require a greater degree of pre-treatment with other physiochemical means. The goal of pre-treatment in this case is to further reduce nitrate and other undesirable parameters, rather than to achieve fixed discharge concentrations of these parameters.

Various approaches are available for sizing treatment wetlands. Systems for regulatory compliance often use area-based contaminant removal rates and/or hydraulic detention time as sizing criteria. For a non-specific contaminant reduction goal, these criteria would likely produce unnecessarily large wetland sizing requirements, and sizing for hydraulic capacity is more appropriate. The existing pumping rate for the Sump equates to approximately 100 gallons per minute. The recommended sizing criterion for hydraulic loading is to provide one foot of wetland substrate width perpendicular to flow for every one gallon per minute of average influent flow. Thus, a 100 gallon per minute influent rate would require a wetland cell about 100 feet wide. The length of the wetland cell should be longer than the width, with a length to width ratio of 3 to 1 having been found effective. A 100 foot wide wetland cell should then be about 300 feet long, or 30,000 square feet (0.7 acres). There appears to be sufficient area for this size of pre-treatment wetland along both the existing Sump pump line and the conceptual northern new pump line routes shown on Figure 6. Actual sites of the wetland cells will depend on the results of topographic surveying and ability to discharge by gravity to the wetland area. It is not recommended that wetland cells exceed 100 feet in width due to difficulties in maintaining uniform flow depth without short-circuiting. The total required width may be split into multiple parallel cells to reduce the individual cell widths.

The actual final required size of the pre-treatment wetlands will depend on the pumping rate determined to be necessary from the Sump to achieve wetland expansion and flow-through circulation goals. If the hydraulic sizing criteria produce a cell size requirement greater than can be accommodated on site, it may be possible to reduce the length to width ratio, such as using 2 to 1, but the pre-treatment effectiveness of such cells may not be as great. The width versus flow criterion should not be relaxed. Under normal operational conditions, it would be most advantageous to pass the entire pumped flow through the pre-treatment wetlands.

The wetland cells should be designed for shallow surface flow to maintain aerobic conditions, with between 3 and 6 inches of water depth. An aeration channel or similar structure should be included at the discharge point to additionally oxygenate the water before entering the constructed wetland area and again before discharging to the Preserve wetlands. The cells should be a blended substrate of soil and organic matter, with a bulk organic content of 10 to 20 percent. For maximum effectiveness, a level substrate is required. The substrate should be level-graded to assure flow spreading, and additional flow spreading structures, such as latitudinal rock berms, should be placed at the inlet and outlet ends. An adjustable water level control structure should be placed at the outlet of each cell to allow setting of initial water depths and adjustment over time in response to vegetative growth and interior water level changes. Figure 7 shows this basic cell layout section plan. This plan can be modified to some degree for visual conformity with existing vernal pools. The substrate should be planted and seeded with native plant species similar to or compatible with desired plant communities in the existing wetlands. The seeding and planting mix should favor thin-stemmed, grass-like native species over leafy species to improve flow spreading performance and surface contact of waters with stems and roots within the cells.

Figure 7 – Typical Aerobic Surface Flow Wetland Cell Longitudinal Section



Operation and Maintenance Plan

Initially, the greatest operational requirement for the new influent system will be adjustment of delivery rates to refine performance relative to the wetland expansion and water routing enhancement goals. Flow monitoring devices (i.e. flumes or weirs) should be installed at all influent points to the wetlands and at the effluent point for overflow to the Sump. A staff gage should also be placed in the lowest accessible portion of the Preserve to record inundation depths. Input and output volumes and staff gage readings should be monitored daily during initial seasons of operation to develop a volumetric behavior model for the wetlands over time. The contractor for the final design phase should prepare a monitoring and calibration plan for the model that will allow the City to determine required influent rates from the Sump based on inundation stage and season.

Ongoing maintenance requirements will primarily involve vegetative management to maintain the final established flow circulation paths and prevent redevelopment of significant isolated areas within the wetlands, exclusive of the vernal pools. The City already has an active vegetative maintenance program, and the final design contractor should identify where this program should be expanded based on the final project design. Changes in plant species communities and structure can be expected as the wetlands are expanded and local hydrologic regimes are altered. The final maintenance plan should address these changes and include provisions to exclude non-native and other undesirable species during the establishment period of the new hydrologic regimes. A routine inspection schedule and documentation form should also be developed based on these requirements.

Passive wetland pre-treatment cells may require more frequent inspection and vegetative management to maintain optimum function. It is recommended that the cells be inspected weekly for performance when in use. Vegetation should be thinned at the inlet and outlet ends on a regular basis to maintain even flow spreading. Preferential flow paths should be disrupted when identified to maintain flow spreading within the cells. Depending on the species selected to vegetate the cells, periodic thinning within the cells may also be necessary to maintain water levels and prevent backwater effects. To prevent excessive die-off and senescence of the vegetation, the cells should be maintained in a saturated state during periods of the year that direct pumping to the wetlands is not occurring. This can be achieved by minimal pumping from the Sump without discharge to the Preserve wetlands.

The project should include a routine water quality monitoring program in conjunction with operation and maintenance activities. Recommended sampling points include the Sump waters at the pump intake point, the discharge of any pre-treatment wetlands, and the overflow route to the Sump. Additional sample points within the wetlands may be warranted at the discretion of the City. The final design contractor should develop a schedule of water quality goals and action levels based on the final water management plan.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this study, it is concluded that the Maple/Sepulveda Sump is the influent option that best meets the water supply increase needs of the wetlands with the minimum of pre-treatment effort. Collecting the Madrona Avenue catch basins and conveying the stormwater runoff to the Sump could also improve conditions and better protect the wetlands from accidental releases, although the option of routing these waters to Ralphs Sump should also be examined. The pre-treatment needs of the Sump waters can be addressed by constructed wetlands sized to meet the hydraulic capacity requirements of the final determined maximum pumping rate from the Sump. Use of the WBMWD recycled water or City potable water is also possible, but will require a greater degree of pre-treatment by physiochemical means.

The desired and achievable degree of wetland expansion will depend primarily on site topographic constraints. The goal of reducing eutrophication and stagnation can be attained by increasing the quantity of flow-through volumetric turnover and improving flow circulation patterns to interconnect isolated areas of the wetlands, exclusive of areas designated as vernal pools. The existing Sump pumping and conveyance system can be used for this purpose provided that circulation can be extended into the northern wetland areas of the site. Potentially better results could be achieved by adding a new pipeline segment to a discharge point at the northern end of the Preserve.

Prior to committing to a final course of action, it is recommended that more detailed site information be collected to confirm the feasibility of the conceptual plans presented in this report. The following basic activities should be conducted in support of the next stage in project planning:

- Conduct additional sampling for the parameters of concern identified in Tables 3 and 4 to better define pre-treatment requirements relative to proposed influent volumes, and to provide sufficient information for statistical prediction of potential water quality changes in the wetlands. Sample points should include at the minimum the Sump – Out, recycled water, and City potable water, with at least one additional round for the wetland sample points. The frequency and duration of sampling will depend on the level of needed statistical confidence determined by the final design contractor.

- Develop detailed topographic mapping of the site to allow determination of basin volumetrics for wetland area expansion and to identify improved flow routing patterns.

- Locate utilities and other potential constraints on inundation area expansion, construction, and pipeline placement.

- Conduct a wetland, habitat, and plant species cover delineation to document existing conditions and allow evaluation of potential community pattern changes resulting from wetland expansion.

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APPENDIX A

Monitoring Program Results and Historic Water Data

Madrona Marsh Preserve Assessment
and Restoration Plan
TECHNICAL MEMORANDUM
Preliminary Draft 1/3/05

Catch Basin 1 - Madrona Marsh Preserve

Parameter	Units - DL	Historic Samples*			Study Samples		Min.	Ave.	Max.
		7/15/03	1/27/04	3/10/04	6/28/04	10/18/04			
Alkalinity	mg/L - 2				128 u	30 u	30	79	128
Aluminum	mg/L - 0.02				0.052 u	0.290 u	0.052	0.171	0.290
Ammonia	mg/L - 0.1	2.4 n			1.1 u	1.2 u	1.1	1.6	2.4
Arsenic	ug/L - 1	ND n			1.2 u	2.6 u	ND	1.9	2.6
Bicarbonate	mg/L - 2				128 u	30 u	30	79	128
Boron	mg/L - 0.01				0.21 u	0.071 u	0.071	0.14	0.21
BOD	mg/L - 4	34 n	20 n	17 n	4 a	16 a	4	18	34
COD	mg/L - 10	160 n	78 n	57 n	31 u	96 u	31	84	160
Cadmium	ug/L - 0.5	ND n			ND u	0.51 u	ND	ND	0.51
Calcium	mg/L - 0.5				43 u	13 u	13	28	43
Chloride	mg/L - 1	110 n			104 u	18 u	18	77	110
Chlorine	ppm - 0.01				ND f	ND f	ND	ND	ND
Coliform, Total	MPN - 2	*1600* n	1600 n	160000 n	16000 a	30000000 a	1600	6035840	30000000
Coliform, Fecal	MPN - 2	*1600* n	ND n	220 n	240 a	300000 a	ND	75515	300000
Conductivity	mS - 1				790 u	190 u	190	490	790
Copper	ug/L - 1	ND n			6.5 u	39 u	ND	23	39
Dissolved CO_2	ppm - 0.1				25 f	15 f	15	20	25
Dissolved O_2	ppm - 0.1	ND n	1.5 n	3.6 n	1 f	1.4 f	ND	1.9	3.6
Hardness	mg/L - 3.3				180 u	46 u	46	113	180
Hex. Chromium	ug/L - 0.3				ND a	ND a	ND	ND	ND
HPC	CPU - 1	880000 n	2600000 n	5600 n	944 a	940000 a	944	885309	2600000
Iron	mg/L - 0.1				0.27 u	0.42 u	0.27	0.35	0.42
Lead	ug/L - 1	ND n			1.8 u	6.4 u	ND	4.1	6.4
Magnesium	mg/L - 0.5				18 u	3.1 u	3.1	11	18
MBAS	mg/L - 0.04				0.15 a	0.6 a	0.15	0.38	0.6
Mercury	ug/L - 0.2	ND n			ND u	ND u	ND	ND	ND
Nickel	ug/L - 1	ND n			4.4 u	16.8 u	ND	10.6	16.8
Nitrate	mg/L - 0.1	ND n	ND n	ND n	ND u	0.68 u	ND	ND	0.68
Nitrite	mg/L - 0.1	ND n			ND u	ND u	ND	ND	ND
Oil & Grease	mg/L - 5	9 n		ND n	ND a	ND a	ND	ND	9
Ortho-P	mg/L - 0.1				1.4 u	1.7 u	1.4	1.6	1.7
Pesticides	Var.	ND n			ND a	ND a	ND	ND	ND
pH	SU - 0.01	6.77 n	6.52 n	6.24 n	6.72 f	6.82 f	6.24	6.61	6.82
Potassium	mg/L - 0.5				7.5 u	5.3 u	5.3	6.4	7.5
Selenium	ug/L - 2	18 n			1.2 u	ND u	ND	9.6	18
Silica	mg/L - 0.1				19 u	4.9 u	4.9	12	19
Sodium	mg/L - 0.5				79 u	14 u	14	47	79
Sulfide	ppm - 0.1				ND f	ND f	ND	ND	ND
Sulfite	mg/L - 1				ND a	ND a	ND	ND	ND
Sulfate	mg/L - 2	26 n			105 u	22 u	22	51	105
TDS	mg/L - 10	640 n			448 u	130 u	130	406	640
TSS	mg/L - 1	26 n			3 u	4 u	3	11	26
TOC	mg/L - 0.5				10 u	20 u	10	15	20
Vanadium	ug/L - 10	ND n			2.7 u	ND u	ND	ND	2.7
Zinc	ug/L - 5	ND n			47 u	38 u	ND	43	47
VOCs: Acetone	ug/L - 100				ND a	ND a	ND	ND	ND
VOCs: Benzene	ug/L - 1	ND n			ND a	ND a	ND	ND	ND
VOCs: Ethylbenzene	ug/L - 5	27 n			ND a	ND a	ND	ND	27
VOCs: Toluene	ug/L - 5	7.2 n			ND a	ND a	ND	ND	7.2
VOCs: Xylene	ug/L - 5	37 n			ND a	ND a	ND	ND	37

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*URS Corp. Samples: 7/15/03 - SW-SP-030715, 1/27/04 - SW-SP-1, 3/10/04 - SW-SP-1

South Bay - Madrona Marsh Preserve

Parameter	Units - DL	Historic Samples*						Study Samples				Min.	Ave.	Max.
		7/15/03		1/27/04		3/10/04		6/28/04		10/19/04				
Alkalinity	mg/L - 2							36	u	45	u	36	41	45
Aluminum	mg/L - 0.02							5	u	1.6	u	1.6	3.3	5
Ammonia	mg/L - 0.1	0.8	n					0.36	u	0.88	u	0.36	0.68	0.88
Arsenic	ug/L - 1	ND	n					15	u	33	u	ND	24	33
Bicarbonate	mg/L - 2							36	u	45	u	36	41	45
Boron	mg/L - 0.01							0.33	u	0.39	u	0.33	0.36	0.39
BOD	mg/L - 4	17	n	11	n	7.8	n	85	a	120	a	8	48	120
COD	mg/L - 10	160	n	83	n	29	n	200	u	340	u	29	162	340
Cadmium	ug/L - 0.5	ND	n					ND	u	8.4	u	ND	ND	8.4
Calcium	mg/L - 0.5							20	u	68	u	20	44	68
Chloride	mg/L - 1	35	n					81	u	43	u	35	53	81
Chlorine	ppm - 0.01							ND	f	ND	f	ND	ND	ND
Coliform, Total	MPN - 2	*1600*	n	11	n	1600	n	5000	a	1.7E+08	a	11	34001642	1.7E+08
Coliform, Fecal	MPN - 2	30	n	ND	n	7	n	900	a	2400000	a	ND	600234	2400000
Conductivity	mS - 1							400	u	700	u	400	550	700
Copper	ug/L - 1	ND	n					19	u	120	u	ND	70	120
Dissolved CO_2	ppm - 0.1							20	f	73	f	20	47	73
Dissolved O_2	ppm - 0.1	ND	n	7.6	n	8.9	n	4	f	1.8	f	ND	5.6	8.9
Hardness	mg/L - 3.3							76	u	263	u	76	170	263
Hex. Chromium	ug/L - 0.3							ND	a	ND	a	ND	ND	ND
HPC	CPU - 1	30000	n	1400	n	1800	n	25400	a	1940000	a	1400	399720	1940000
Iron	mg/L - 0.1							18	u	6.5	u	6.5	12	18
Lead	ug/L - 1	ND	n					220	u	180	u	ND	200	220
Magnesium	mg/L - 0.5							6.7	u	23	u	6.7	15	23
MBAS	mg/L - 0.04							0.41	a	0.26	a	0.26	0.34	0.41
Mercury	ug/L - 0.2	ND	n					ND	u	ND	u	ND	ND	ND
Nickel	ug/L - 1	ND	n					12	u	50	u	ND	31	50
Nitrate	mg/L - 0.1	ND	n	ND	n	ND	n	0.63	u	ND	u	ND	ND	0.63
Nitrite	mg/L - 0.1	ND	n					0.29	u	ND	u	ND	ND	0.29
Oil & Grease	mg/L - 5	7.4	n					20	a	ND	a	7.4	14	20
Ortho-P	mg/L - 0.1							0.32	u	2.2	u	0.32	1.3	2.2
Pesticides	Var.	ND	n					ND	a	ND	a	ND	ND	ND
pH	SU - 0.01	6.14	n	6.37	n	6.26	n	6.75	f	6.31	f	6.14	6.37	6.75
Potassium	mg/L - 0.5							18	u	17	u	17	18	18
Selenium	ug/L - 2	14	n					4.2	u	2.5	u	2.5	6.9	14
Silica	mg/L - 0.1							39	u	34	u	34	37	39
Sodium	mg/L - 0.5							52	u	36	u	36	44	52
Sulfide	ppm - 0.1							ND	f	ND	f	ND	ND	ND
Sulfite	mg/L - 1							ND	a	ND	a	ND	ND	ND
Sulfate	mg/L - 2	1.4	n					11	u	240	u	1.4	84	240
TDS	mg/L - 10	310	n					280	u	590	u	280	393	590
TSS	mg/L - 1	1000	n					1100	u	210	u	210	770	1100
TOC	mg/L - 0.5							15	u	19	u	15	17	19
Vanadium	ug/L - 10	ND	n					50	u	22	u	ND	36	50
Zinc	ug/L - 5	ND	n					93	u	3200	u	ND	1647	3200
VOCs: Acetone	ug/L - 100							7.7	a	ND	a	ND	7.7	7.7
VOCs: Benzene	ug/L - 1	ND	n					ND	a	ND	a	ND	ND	ND
VOCs: Ethylbenzene	ug/L - 5	160	n					ND	a	ND	a	ND	ND	160
VOCs: Toluene	ug/L - 5	ND	n					ND	a	ND	a	ND	ND	ND
VOCs: Xylene	ug/L - 5	ND	n					ND	a	ND	a	ND	ND	ND

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*URS Corp. Samples: 7/15/03 - SE-SP-030715, 1/27/04 - SE-SP-2, 3/10/04 - SE-SP-2

East Fork - Madrona Marsh Preserve

Parameter	Units - DL	Historic Samples*			Study Samples		Min.	Ave.	Max.
		7/15/03	1/27/04	3/10/04	6/28/04	10/18/04			
Alkalinity	mg/L - 2				178 u	Dry	178	178	178
Aluminum	mg/L - 0.02				9.9 u		9.9	9.9	9.9
Ammonia	mg/L - 0.1	ND n			0.44 u		0.44	0.44	0.44
Arsenic	ug/L - 1	ND n			24 u		24	24	24
Bicarbonate	mg/L - 2				178 u		178	178	178
Boron	mg/L - 0.01				0.49 u		0.49	0.49	0.49
BOD	mg/L - 4	8.8 n	6.6 n	9.8 n	120 a		7	36	120
COD	mg/L - 10	160 n	95 n	36 n	470 u		36	190	470
Cadmium	ug/L - 0.5	ND n			ND u		ND	ND	ND
Calcium	mg/L - 0.5				61 u		61	61	61
Chloride	mg/L - 1	33 n			165 u		33	99	165
Chlorine	ppm - 0.01				ND f		ND	ND	ND
Coliform, Total	MPN - 2	900 n	7 n	350 n	500 a		7	439	900
Coliform, Fecal	MPN - 2	23 n	ND n	30 n	80 a		ND	44	80
Conductivity	mS - 1				960 u		960	960	960
Copper	ug/L - 1	ND n			15 u		15	15	15
Dissolved CO_2	ppm - 0.1				20 f		20	20	20
Dissolved O_2	ppm - 0.1	4.7 n	6.8 n	8.6 n			4.7	6.7	8.6
Hardness	mg/L - 3.3				234 u		234	234	234
Hex. Chromium	ug/L - 0.3				ND a		ND	ND	ND
HPC	CPU - 1	16000 n	5500 n	1700 n	98400 a		1700	30400	98400
Iron	mg/L - 0.1				25 u		25	25	25
Lead	ug/L - 1	8.2 n			160 u		8.2	84	160
Magnesium	mg/L - 0.5				20 u		20	20	20
MBAS	mg/L - 0.04				0.76 a		0.76	0.76	0.76
Mercury	ug/L - 0.2	ND n			ND u		ND	ND	ND
Nickel	ug/L - 1	ND n			11 u		11	11	11
Nitrate	mg/L - 0.1	ND n	ND n	ND n	ND u		ND	ND	ND
Nitrite	mg/L - 0.1	ND n			ND u		ND	ND	ND
Oil & Grease	mg/L - 5	ND n			50 a		50	50	50
Ortho-P	mg/L - 0.1				0.81 u		0.81	0.81	0.81
Pesticides	Var.	ND n			ND a		ND	ND	ND
pH	SU - 0.01	6.70 n	6.41 n	6.28 n			6.28	6.46	6.7
Potassium	mg/L - 0.5				27 u		27	27	27
Selenium	ug/L - 2	9.1 n			5.1 u		5.1	7.1	9.1
Silica	mg/L - 0.1				35 u		35	35	35
Sodium	mg/L - 0.5				113 u		113	113	113
Sulfide	ppm - 0.1				ND f		ND	ND	ND
Sulfite	mg/L - 1				ND a		ND	ND	ND
Sulfate	mg/L - 2	2.7 n			ND u		ND	2.7	2.7
TDS	mg/L - 10	290 n			610 u		290	450	610
TSS	mg/L - 1	780 n			2100 u		780	1440	2100
TOC	mg/L - 0.5				14 u		14	14	14
Vanadium	ug/L - 10	ND n			63 u		ND	63	63
Zinc	ug/L - 5	ND n			91 u		ND	91	91
VOCs - Acetone	ug/L - 100				49 a		49	49	49
VOCs - Benzene	ug/L - 1	ND n			ND a		ND	ND	ND
VOCs - Ethylbenzene	ug/L - 5	4.5 n			ND a		ND	4.5	4.5
VOCs - Toluene	ug/L - 5	ND n			9.2 a		ND	9.2	9.2
VOCs - Xylene	ug/L - 5	ND n			ND a		ND	ND	ND

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*URS Corp. Samples: 7/15/03 - E-SP-030715, 1/27/04 - SE-SP-3, 3/10/04 - SE-SP-3

North Pond of South Pond - Madrona Marsh Preserve

Parameter	Units - DL	Historic Samples*			Study Samples		Min.	Ave.	Max.
		7/15/03	1/27/04	3/10/04	6/28/04	10/18/04			
Alkalinity	mg/L - 2				55 u	Dry	55	55	55
Aluminum	mg/L - 0.02				15 u		15	15	15
Ammonia	mg/L - 0.1	ND n			5 u		ND	5	5
Arsenic	ug/L - 1	ND n			8.6 u		ND	8.6	8.6
Bicarbonate	mg/L - 2				55 u		55	55	55
Boron	mg/L - 0.01				0.26 u		0.26	0.26	0.26
BOD	mg/L - 4	ND n		14 n	260 a		ND	137	260
COD	mg/L - 10	91 n		43 n	190 u		43	108	190
Cadmium	ug/L - 0.5	ND n			5.8 u		ND	5.8	5.8
Calcium	mg/L - 0.5				32 u		32	32	32
Chloride	mg/L - 1	33 n			60 u		33	47	60
Chlorine	ppm - 0.01				ND f		ND	ND	ND
Coliform, Total	MPN - 2	300 n		11 n	2800 a		11	1037	2800
Coliform, Fecal	MPN - 2	39 n		1600 n	900 a		39	846	1600
Conductivity	mS - 1				480 u		480	480	480
Copper	ug/L - 1	ND n			42 u		ND	42	42
Dissolved CO_2	ppm - 0.1				20 f		20	20	20
Dissolved O_2	ppm - 0.1	7.2 n		8.5 n	3.6 f		3.6	6.4	8.5
Hardness	mg/L - 3.3				115 u		115	115	115
Hex. Chromium	ug/L - 0.3				ND a		ND	ND	ND
HPC	CPU - 1	3900 n		2000 n	42400 a		2000	16100	42400
Iron	mg/L - 0.1				19 u		19	19	19
Lead	ug/L - 1	ND n			740 u		ND	740	740
Magnesium	mg/L - 0.5				8.5 u		8.5	8.5	8.5
MBAS	mg/L - 0.04				0.31 a		0.31	0.31	0.31
Mercury	ug/L - 0.2	ND n			ND u		ND	ND	ND
Nickel	ug/L - 1	ND n			18 u		18	18	18
Nitrate	mg/L - 0.1	ND n		ND n	0.3 u		ND	ND	0.3
Nitrite	mg/L - 0.1	ND n			ND u		ND	ND	ND
Oil & Grease	mg/L - 5	ND n			30 a		30	30	30
Ortho-P	mg/L - 0.1				1.4 u		1.4	1.4	1.4
Pesticides	Var.	ND n			ND a		ND	ND	ND
pH	SU - 0.01	6.81 n		6.28 n	6.83 f		6.28	6.64	6.83
Potassium	mg/L - 0.5				19 u		19	19	19
Selenium	ug/L - 2	7.8 n			2 u		2	4.9	7.8
Silica	mg/L - 0.1				50 u		50	50	50
Sodium	mg/L - 0.5				44 u		44	44	44
Sulfide	ppm - 0.1				ND f		ND	ND	ND
Sulfite	mg/L - 1				ND a		ND	ND	ND
Sulfate	mg/L - 2	ND n			7.7 u		ND	7.7	7.7
TDS	mg/L - 10	250 n			300 u		250	275	300
TSS	mg/L - 1	12 n			820 u		12	416	820
TOC	mg/L - 0.5				16 u		16	16	16
Vanadium	ug/L - 10	ND n			79 u		ND	79	79
Zinc	ug/L - 5	ND n			1400 u		ND	1400	1400
VOCs: Acetone	ug/L - 100				7.4 a		7.4	7.4	7.4
VOCs: Benzene	ug/L - 1	ND n			ND a		ND	ND	ND
VOCs: Ethylbenzene	ug/L - 5	ND n			ND a		ND	ND	ND
VOCs: Toluene	ug/L - 5	ND n			2.9 a		ND	2.9	2.9
VOCs: Xylene	ug/L - 5	ND n			ND a		ND	ND	ND

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*URS Corp. Samples: 7/15/03 - E-NP-030715, 1/27/04 - Not Sampled, 3/10/04 - E-NP-5

Maple/Sepulveda Sump East (Influent)

Parameter	Units - DL	Historic Samples*				Study Samples**						Min.	Ave.	Max.
		1/27/04		3/10/04		6/28/04		10/18/04		10/20/04				
Alkalinity	mg/L - 2					125	u	44	u	33	u	33	67	125
Aluminum	mg/L - 0.02					ND	u	0.17	u	0.18	u	ND	0.18	0.18
Ammonia	mg/L - 0.1					0.26	u	0.43	u	2.4	u	0.26	1.03	2.4
Arsenic	ug/L - 1					1.8	u	1.4	u	1.1	u	1.1	1.4	1.8
Bicarbonate	mg/L - 2					125	u	44	u	33	u	33	67	125
Boron	mg/L - 0.01					0.23	u	0.11	u	0.079	u	0.079	0.14	0.23
BOD	mg/L - 4	ND	n	11	n	6	a	18	a	6	a	ND	10	18
COD	mg/L - 10	25	n	25	n	33	u	67	u	21	u	21	34	67
Cadmium	ug/L - 0.5					ND	u	ND	u	ND	u	ND	ND	ND
Calcium	mg/L - 0.5					44	u	20	u	20	u	20	28	44
Chloride	mg/L - 1					139	u	38	u	25	u	25	67	139
Chlorine	ppm - 0.01					0.02	f	ND	f	ND	f	ND	ND	0.02
Coliform, Total	MPN - 2	*13*	*n*	1600	n	*900*	a	2400000	a	1300	a	13	480763	2400000
Coliform, Fecal	MPN - 2	ND	*n*	350	n	500	a	160000	a	800	a	ND	40413	160000
Conductivity	mS - 1					890	u	350	u	220	u	220	487	890
Copper	ug/L - 1					5	u	16	u	9.8	u	5	10	16
Dissolved CO_2	ppm - 0.1					4	f	4	f	10	f	4	6	10
Dissolved O_2	ppm - 0.1	5.8	n	9	n	8.8	f	9.3	f	9.3	f	5.8	8.4	9.3
Hardness	mg/L - 3.3					185	u	76	u	76	u	76	112	185
Hex. Chromium	ug/L - 0.3					ND	a	ND	a	0.4	a	ND	ND	0.4
HPC	CPU - 1	9300	n	2800	n	3900	a	240000	a	5800	a	2800	52360	240000
Iron	mg/L - 0.1					ND	u	0.23	u	0.21	u	ND	0.22	0.23
Lead	ug/L - 1					ND	u	2	u	1.6	u	ND	1.8	2
Magnesium	mg/L - 0.5					19	u	6.3	u	6.3	u	6.3	11	19
MBAS	mg/L - 0.04					0.09	a	0.31	a	0.17	a	0.09	0.19	0.31
Mercury	ug/L - 0.2					ND	u	ND	u	ND	u	ND	ND	ND
Nickel	ug/L - 1					3.2	u	6.2	u	3.6	u	3.2	4.3	6.2
Nitrate	mg/L - 0.1	ND	n	0.28	n	ND	u	1.5	u	0.5	u	ND	0.76	1.5
Nitrite	mg/L - 0.1					ND	u	ND	u	ND	u	ND	ND	ND
Oil & Grease	mg/L - 5					ND	a	ND	a	7	a	ND	ND	7
Ortho-P	mg/L - 0.1					1.1	u	1.1	u	0.92	u	0.92	1.0	1.1
Pesticides	Var.					ND	a	ND	a	ND	a	ND	ND	ND
pH	SU - 0.01	6.44	n	6.63	n	7.12	f	6.51	f	7.19	f	6.44	6.78	7.19
Potassium	mg/L - 0.5					6.2	u	5.5	u	3.7	u	3.7	5.1	6.2
Selenium	ug/L - 2					1.8	u	ND	u	ND	u	ND	ND	1.8
Silica	mg/L - 0.1					3.2	u	4.5	u	4.1	u	3.2	3.9	4.5
Sodium	mg/L - 0.5					102	u	32	u	20	u	20	51	102
Sulfide	ppm - 0.1					ND	f	ND	f	ND	f	ND	ND	ND
Sulfite	mg/L - 1					ND	a	ND	a	ND	a	ND	ND	ND
Sulfate	mg/L - 2					104	u	40	u	26	u	26	57	104
TDS	mg/L - 10					544	u	250	u	140	u	140	311	544
TSS	mg/L - 1					11	u	16	u	14	u	11	14	16
TOC	mg/L - 0.5					12	u	18	u	11	u	11	14	18
Vanadium	ug/L - 10					2.9	u	ND	u	ND	u	ND	ND	2.9
Zinc	ug/L - 5					15	u	180	u	88	u	15	94	180
VOCs: Acetone	ug/L - 100					ND	a	ND	a	ND	a	ND	ND	ND
Benzene	ug/L - 1					ND	a	ND	a	ND	a	ND	ND	ND
Ethylbenzene	ug/L - 5					ND	a	ND	a	ND	a	ND	ND	ND
Toluene	ug/L - 5					ND	a	ND	a	ND	a	ND	ND	ND
Xylene	ug/L - 5					ND	a	ND	a	ND	a	ND	ND	ND

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*URS Corp. Samples: 1/27/04 - Sump In, 3/10/04 - Sump In **10/20/04 - Sump East Influent City sample point

Maple/Sepulveda Sump West (Effluent)

Parameter	Units - DL	Historic Samples*			Study Samples		Min.	Ave.	Max.
			1/27/04	3/10/04	6/28/04	10/18/04			
Alkalinity	mg/L - 2				123 u	52 u	52	88	123
Aluminum	mg/L - 0.02				0.025 u	0.1 u	0.025	0.063	0.1
Ammonia	mg/L - 0.1				0.18 u	0.3 u	0.18	0.24	0.3
Arsenic	ug/L - 1				1.6 u	1.3 u	1.3	1.5	1.6
Bicarbonate	mg/L - 2				123 u	52 u	52	88	123
Boron	mg/L - 0.01				0.23 u	0.13 u	0.13	0.18	0.23
BOD	mg/L - 4		5.4 n	18 n	9 a	25 a	5	14	25
COD	mg/L - 10		31 n	24 n	34 u	41 u	24	33	41
Cadmium	ug/L - 0.5				ND u	ND u	ND	ND	ND
Calcium	mg/L - 0.5				43 u	22 u	22	33	43
Chloride	mg/L - 1				131 u	47 u	47	89	131
Chlorine	ppm - 0.01				0.04 f	ND f	ND	ND	0.04
Coliform, Total	MPN - 2		ND n	170 n	22 a	240000 a	ND	80064	240000
Coliform, Fecal	MPN - 2		ND n	2 n	ND a	24000 a	ND	12001	24000
Conductivity	mS - 1				880 u	380 u	380	630	880
Copper	ug/L - 1				4.7 u	12 u	4.7	8.4	12
Dissolved CO_2	ppm - 0.1				6 f	6 f	6	6	6
Dissolved O_2	ppm - 0.1		7 n	10 n	8.7 f	9.3 f	7	8.8	10
Hardness	mg/L - 3.3				184 u	88 u	88	136	184
Hex. Chromium	ug/L - 0.3				ND a	ND a	ND	ND	ND
HPC	CPU - 1		4500 n	2700 n	75 a	80000 a	75	21819	80000
Iron	mg/L - 0.1				0.11 u	0.16 u	0.11	0.14	0.16
Lead	ug/L - 1				ND u	1.2 u	ND	1.2	1.2
Magnesium	mg/L - 0.5				18 u	7.9 u	7.9	13	18
MBAS	mg/L - 0.04				0.12 a	0.2 a	0.12	0.16	0.2
Mercury	ug/L - 0.2				ND u	ND u	ND	ND	ND
Nickel	ug/L - 1				3.1 u	5.5 u	3.1	4.3	5.5
Nitrate	mg/L - 0.1		0.2 n	ND n	ND u	1 u	ND	0.6	1
Nitrite	mg/L - 0.1				ND u	ND u	ND	ND	ND
Oil & Grease	mg/L - 5				ND a	ND a	ND	ND	ND
Ortho-P	mg/L - 0.1				0.89 u	1 u	0.89	0.95	1
Pesticides	Var.				ND a	ND a	ND	ND	ND
pH	SU - 0.01		6.48 n	6.76 n	7.05 f	6.27 f	6.27	6.64	7.05
Potassium	mg/L - 0.5				6.1 u	5.6 u	5.6	5.9	6.1
Selenium	ug/L - 2				1.4 u	ND u	ND	1.4	1.4
Silica	mg/L - 0.1				1.5 u	3.6 u	1.5	2.6	3.6
Sodium	mg/L - 0.5				100 u	40 u	40	70	100
Sulfide	ppm - 0.1				ND f	ND f	ND	ND	ND
Sulfite	mg/L - 1				ND a	ND a	ND	ND	ND
Sulfate	mg/L - 2				102 u	53 u	53	78	102
TDS	mg/L - 10				540 u	240 u	240	390	540
TSS	mg/L - 1				15 u	13 u	13	14	15
TOC	mg/L - 0.5				12 u	16 u	12	14	16
Vanadium	ug/L - 10				2.4 u	ND u	ND	2.4	2.4
Zinc	ug/L - 5				17 u	140 u	17	79	140
VOCs: Acetone	ug/L - 100				ND a	ND a	ND	ND	ND
VOCs: Benzene	ug/L - 1				ND a	ND a	ND	ND	ND
VOCs: Ethylbenzene	ug/L - 5				ND a	ND a	ND	ND	ND
VOCs: Toluene	ug/L - 5				ND a	ND a	ND	ND	ND
VOCs: Xylene	ug/L - 5				ND a	ND a	ND	ND	ND

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*URS Corp. Samples: 1/27/04 - Sump Out, 3/10/04 - Sump Out

WBMWD Recycled Water

Parameter	Units - DL	Historic Samples*			Study Samples		Min.	Ave.	Max.
		Jul-04	Aug-04	Sep-04	6/28/04	10/19/02			
Alkalinity	mg/L - 2	273 u	296 u	281 u	287 u	267 u	267	281	296
Aluminum	mg/L - 0.02				0.35 u	0.66 u	0.35	0.51	0.66
Ammonia	mg/L - 0.1	42 u	42 u	40 u	37 u	45 u	37	41	45
Arsenic	ug/L - 1				3.9 u	3.9 u	3.9	3.9	3.9
Bicarbonate	mg/L - 2	273 u	296 u	281 u	287 u	267 u	267	281	296
Boron	mg/L - 0.01	0.49 u	0.54 u	0.58 u	0.49 u	0.51 u	0.49	0.52	0.58
BOD	mg/L - 4	ND u	ND u	ND u	4 a	ND a	ND	ND	4
COD	mg/L - 10	29 u	39 u	34 u	34 u	32 u	29	34	39
Cadmium	ug/L - 0.5				ND u	ND u	ND	ND	ND
Calcium	mg/L - 0.5	45 u	45 u	49 u	42 u	50 u	42	46	50
Chloride	mg/L - 1	199 u	189 u	211 u	197 u	192 u	189	198	211
Chlorine	ppm - 0.01				2.2 f	2.2 f	2.2	2.2	2.2
Coliform, Total	MPN - 2				ND a	ND a	ND	ND	ND
Coliform, Fecal	MPN - 2				ND a	ND a	ND	ND	ND
Conductivity	mS - 1				1440 u	1450 u	1440	1445	1450
Copper	ug/L - 1				7.6 u	5.2 u	5.2	6.4	7.6
Dissolved CO_2	ppm - 0.1				*50* f	80 f	50	65	80
Dissolved O_2	ppm - 0.1				5.6 f	4.2 f	4.2	4.9	5.6
Hardness	mg/L - 3.3	188 u	205 u	221 u	192 u	210 u	188	203	221
Hex. Chromium	ug/L - 0.3				ND a	ND a	ND	ND	ND
HPC	CPU - 1				6 a	90 a	6	48	90
Iron	mg/L - 0.1	0.19 u	0.27 u	0.3 u	0.37 u	0.61 u	0.19	0.35	0.61
Lead	ug/L - 1				1.1 u	ND u	ND	1.1	1.1
Magnesium	mg/L - 0.5	18 u	23 u	24 u	21 u	21 u	18	21	24
MBAS	mg/L - 0.04				0.14 a	0.11 a	0.11	0.13	0.14
Mercury	ug/L - 0.2				ND u	ND u	ND	ND	ND
Nickel	ug/L - 1				7.9 u	8.4 u	7.9	8.2	8.4
Nitrate	mg/L - 0.1	ND u	ND u	ND u	0.61 u	0.57 u	ND	ND	0.61
Nitrite	mg/L - 0.1				ND u	ND u	ND	ND	ND
Oil & Grease	mg/L - 5				ND a	ND a	ND	ND	ND
Ortho-P	mg/L - 0.1	4.6 u	5.6 u	5.5 u	4.5 u	4.3 u	4.3	4.9	5.6
Pesticides	Var.				ND a	ND a	ND	ND	ND
pH	SU - 0.01	7 u	7 u	7 u	6.65 f	6.72 f	6.65	6.87	7.00
Potassium	mg/L - 0.5	16 u	17 u	16 u	15 u	17 u	15	16	17
Selenium	ug/L - 2				3.6 u	5.4 u	3.6	4.5	5.4
Silica	mg/L - 0.1	20 u	22 u	23 u	22 u	24 u	20	22	24
Sodium	mg/L - 0.5	135 u	158 u	154 u	146 u	147 u	135	148	158
Sulfide	ppm - 0.1	ND u	ND u	ND u	ND f	ND f	ND	ND	ND
Sulfite	mg/L - 1				ND a	ND a	ND	ND	ND
Sulfate	mg/L - 2	123 u	112 u	127 u	113 u	123 u	112	120	127
TDS	mg/L - 10	700 u	680 u	780 u	680 u	650 u	650	698	780
TSS	mg/L - 1	7 u	5 u	7 u	6 u	5 u	5	6	7
TOC	mg/L - 0.5	11 u	13 u	12 u	12 u	13 u	11	12	13
Vanadium	ug/L - 10				5 u	ND u	ND	5	5
Zinc	ug/L - 5				7 u	18 u	7	13	18
VOCs: Acetone	ug/L - 100				37 a	ND a	ND	37	37
VOCs: Benzene	ug/L - 1				ND a	ND a	ND	ND	ND
VOCs: Ethylbenzene	ug/L - 5				ND a	ND a	ND	ND	ND
VOCs: Toluene	ug/L - 5				1 a	ND a	ND	1	1
VOCs: Xylene	ug/L - 5				ND a	ND a	ND	ND	ND

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*WBMWD Title 22 Product Water Report monthly samples for 2004

City of Torrance Potable Water

Parameter	Units - DL	Historic Samples* Low	Historic Samples* Reported	Historic Samples* High	Study Samples 6/28/04	Study Samples 10/18/04	Min.	Ave.	Max.
Alkalinity	mg/L - 2	73	91	112	82 u	78 u	73	87	112
Aluminum	mg/L - 0.02				2.8 u	0.052 u	ND	1.426	2.8
Ammonia	mg/L - 0.1				0.5 u	0.48 u	0.48	0.49	0.5
Arsenic	ug/L - 1				1.7 u	2 u	ND	1.85	2
Bicarbonate	mg/L - 2				82 u	78 u	78	80	82
Boron	mg/L - 0.01	0.1	0.14	0.16	0.18 u	0.16 u	0.1	0.148	0.18
BOD	mg/L - 4								
COD	mg/L - 10				24 u	ND u	ND	24	24
Cadmium	ug/L - 0.5				ND u	ND u	ND	ND	ND
Calcium	mg/L - 0.5	24	37	56	29 u	23 u	23	34	56
Chloride	mg/L - 1				79 u	63 u	63	71	79
Chlorine	ppm - 0.01	67	80	105		1.8 f	1.8	63	105
Coliform, Total	MPN - 2	ND	ND	ND			ND	ND	ND
Coliform, Fecal	MPN - 2	ND	ND	ND			ND	ND	ND
Conductivity	mS - 1	518	675	890	580 u	500 u	500	633	890
Copper	ug/L - 1				12 u	5.4 u	5.4	8.7	12
Dissolved CO_2	ppm - 0.1					4 f	4	4	4
Dissolved O_2	ppm - 0.1					8.3 f	8.3	8.3	8.3
Hardness	mg/L - 3.3	109	164	258	132 u	106 u	106	154	258
Hex. Chromium	ug/L - 0.3								
HPC	CPU - 1								
Iron	mg/L - 0.1				1.3 u	ND u	ND	1.3	1.3
Lead	ug/L - 1				45 u	ND u	ND	45	45
Magnesium	mg/L - 0.5	12	17.5	23.5	15 u	12 u	12	16	23.5
MBAS	mg/L - 0.04								
Mercury	ug/L - 0.2				ND u	ND u	ND	ND	ND
Nickel	ug/L - 1				3.8 u	1.6 u	1.6	2.7	3.8
Nitrate	mg/L - 0.1	ND	0.55	1.4	0.73 u	ND u	ND	0.89	1.4
Nitrite	mg/L - 0.1				ND u	ND u	ND	ND	ND
Oil & Grease	mg/L - 5								
Ortho-P	mg/L - 0.1				0.22 u	0.1 u	0.1	0.16	0.22
Pesticides	Var.								
pH	SU - 0.01	8.02	8.20	8.25		6.84 f	6.84	7.83	8.25
Potassium	mg/L - 0.5	2.6	3.2	4.0	3.8 u	2.7 u	2.6	3.3	4
Selenium	ug/L - 2				2.2 u	3.9 u	2.2	3.1	3.9
Silica	mg/L - 0.1				21 u	15 u	15	18	21
Sodium	mg/L - 0.5	55	69	87	58 u	49 u	49	64	87
Sulfide	ppm - 0.1								
Sulfite	mg/L - 1								
Sulfate	mg/L - 2				72 u	50 u	50	61	72
TDS	mg/L - 10	278	386	528	340 u	280 u	278	362	528
TSS	mg/L - 1				230 u	ND u	230	230	230
TOC	mg/L - 0.5	1.7	2.1	2.7	7 u	8.5 u	1.7	4.4	8.5
Vanadium	ug/L - 10				11 u	ND u	ND	11	11
Zinc	ug/L - 5				49 u	19 u	19	34	49
VOCs: Acetone	ug/L - 100								
VOCs: Benzene	ug/L - 1								
VOCs: Ethylbenzene	ug/L - 5								
VOCs: Toluene	ug/L - 5								
VOCs: Xylene	ug/L - 5								

DL - Detection Limit a - Associated Labs, u - United Labs, n - American Analytics, f - Field Test Parameters in *italics* greater than reported.

*Amount Detected and Range (Low-High) for Metropolitan Water District of Southern California, City of Torrance 2003 Water Quality Report.

APPENDIX B

Composite Data Sets
Existing Wetland Conditions and Sump

Madrona Marsh Preserve Assessment
and Restoration Plan
TECHNICAL MEMORANDUM
Preliminary Draft 1/3/05

Existing Marsh Conditions Composite

Parameter	Catch Basin 1					South Bay					East Fork					North Pond				Min	Ave	Max
Alkalinity				128	30				36	45				178	Dry			55	Dry	30	79	178
Aluminum				0.052	0.290				5	1.6				9.9				15		0.052	5.31	15
Ammonia	2.4			1.1	1.2	0.8			0.36	0.88	ND			0.44		ND		5		ND	1.5	5.0
Arsenic	ND			1.2	2.6	ND			15	33	ND			24		ND		8.6		ND	14	33
Bicarbonate				128	30				36	45				178				55		30	79	178
Boron				0.21	0.071				0.33	0.39				0.49				0.26		0.071	0.29	0.49
BOD	34	20	17	4	16	17	11	7.8	85	120	8.8	6.6	9.8	120		ND	14	260		ND	47	260
COD	160	78	57	31	96	160	83	29	200	340	160	95	36	470		91	43	190		29	136	470
Cadmium	ND			ND	0.51	ND			ND	8.4	ND			ND		ND		5.8		ND	ND	8.4
Calcium				43	13				20	68				61				32		13	40	68
Chloride	110			104	18	35			81	43	33			165		33		60		18	68	165
Chlorine				ND	ND				ND	ND				ND				ND		ND	ND	ND
Coliform, Total	*1600*	1600	2.E+05	2.E+04	3.E+07	*1600*	11	1600	5000	2.E+08	900	7	350	500		300	11	2800		7	11776016	170000000
Coliform, Fecal	*1600*	ND	220	240	3.E+05	30	ND	7	900	2.E+06	23	ND	30	80		39	1600	900		ND	193262	2400000
Conductivity				790	190				400	700				960				480		190	587	960
Copper	ND			6.5	39	ND			19	120	ND			15		ND		42		ND	40	120
Dissolved CO_2				25	15				20	73				20				20		15	29	73
Dissolved O_2	ND	1.5	3.6	1	1.4	ND	7.6	8.9	4	1.8	4.7	6.8	8.6			7.2	8.5	3.6		ND	4.9	8.9
Hardness				180	46				76	263				234				115		46	152	263
Hex. Chromium				ND	ND				ND	ND				ND				ND		ND	ND	ND
HPC	9.E+05	3.E+06	5600	944	9.E+05	3.E+04	1400	1800	3.E+04	2.E+06	2.E+04	5500	1700	1.E+05		3900	2000	4.E+04		944	387944	2600000
Iron				0.27	0.42				18	6.5				25				19		0.27	12	25
Lead	ND			1.8	6.4	ND			220	180	8.2			160		ND		740		ND	188	740
Magnesium				18	3.1				6.7	23				20				8.5		3.1	13	23
MBAS				0.15	0.6				0.41	0.26				0.76				0.31		0.15	0.42	0.76
Mercury	ND			ND	ND	ND			ND	ND	ND			ND		ND		ND		ND	ND	ND
Nickel	ND			4.4	16.8	ND			12	50	ND			11		ND		18		ND	19	50
Nitrate	ND	ND	ND	ND	0.68	ND	ND	ND	0.63	ND	ND	ND	ND	ND		ND	ND	0.3		ND	ND	0.68
Nitrite	ND			ND	ND	ND			0.29	ND	ND			ND		ND		ND		ND	ND	0.29
Oil & Grease	9		ND	ND	ND	7.4			20	ND	ND			50		ND		30		ND	23	50
Ortho-P				1.4	1.7				0.32	2.2				0.81				1.4		0.32	1.3	2.2
Pesticides	ND			ND	ND	ND			ND	ND	ND			ND		ND		ND		ND	ND	ND
pH	6.77	6.52	6.24	6.72	6.82	6.14	6.37	6.26	6.75	6.31	6.70	6.41	6.28			6.81	6.28	6.83		6.14	6.51	6.83
Potassium				7.5	5.3				18	17				27				19		5.3	16	27
Selenium	18			1.2	ND	14			4.2	2.5	9.1			5.1		7.8		2		ND	7.1	18
Silica				19	4.9				39	34				35				50		4.9	30	50
Sodium				79	14				52	36				113				44		14	56	113
Sulfide				ND	ND				ND	ND				ND				ND		ND	ND	ND
Sulfite				ND	ND				ND	ND				ND				ND		ND	ND	ND
Sulfate	26			105	22	1.4			11	240	2.7			ND		ND		7.7		ND	52	240
TDS	640			448	130	310			280	590	290			610		250		300		130	385	640
TSS	26			3	4	1000			1100	210	780			2100		12		820		3	606	2100
TOC				10	20				15	19				14				16		10	16	20
Vanadium	ND			2.7	ND	ND			50	22	ND			63		ND		79		ND	43	79
Zinc	ND			47	38	ND			93	3200	ND			91		ND		1400		ND	812	3200
VOCs																						
Acetone				ND	ND				7.7	ND				49				7.4		ND	21	49
Benzene	ND			ND	ND	ND			ND	ND	ND			ND		ND		ND		ND	ND	ND
Ethylbenzene	27			ND	ND	160			ND	ND	4.5			ND		ND		ND		ND	ND	160
Toluene	7.2			ND	ND	ND			ND	ND	ND			9.2		ND		2.9		ND	ND	9.2
Xylene	37			ND	ND	ND			ND	ND	ND			ND		ND		ND		ND	ND	37

Parameter	Sump East					Sump West					Min	Ave	Max	Sump Composite
Alkalinity			125	44	33				123	52	33	75	125	
Aluminum			ND	0.170	0.180				0.025	0.1	ND	0.12	0.18	
Ammonia			0.26	0.4	2.4				0.18	0.3	0.2	0.7	2.4	
Arsenic			1.8	1.4	1.1				1.6	1.3	1.1	1.4	1.8	
Bicarbonate			125	44	33				123	52	33	75	125	
Boron			0.23	0.11	0.079				0.23	0.13	0.079	0.16	0.23	
BOD	ND	11	6	18	6		5.4	18	9	25	ND	12	25	
COD	25	25	33	67	21		31	24	34	41	21	33	67	
Cadmium			ND	ND	ND				ND	ND	ND	ND	ND	
Calcium			44	20	20				43	22	20	30	44	
Chloride			139	38	25				131	47	25	76	139	
Chlorine			0.02	ND	ND				0.04	ND	ND	ND	0.04	
Coliform, Total	*13*	1600	900	2.E+06	1300		ND	170	22	2.E+05	ND	330501	2400000	
Coliform, Fecal	*ND*	350	500	2.E+05	800		ND	2	ND	2.E+04	ND	30942	160000	
Conductivity			890	350	220				880	380	220	544	890	
Copper			5	16	9.8				4.7	12	4.7	9.5	16	
Dissolved CO_2			4	4	10				6	6	4	6	10	
Dissolved O_2	5.8	9	8.8	9.3	9.3		7	10	8.7	9.3	5.8	8.6	10	
Hardness			185	76	76				184	88	76	122	185	
Hex. Chromium			ND	ND	0.4				ND	ND	ND	ND	0.4	
HPC	9300	2800	3900	2.E+05	5800		4500	2700	75	8.E+04	75	38786	240000	
Iron			ND	0.23	0.21				0.11	0.16	ND	0.18	0.23	
Lead			ND	2	1.6				ND	1.2	ND	1.6	2	
Magnesium			19	6.3	6.3				18	7.9	6.3	12	19	
MBAS			0.09	0.31	0.17				0.12	0.2	0.09	0.18	0.31	
Mercury			ND	ND	ND				ND	ND	ND	ND	ND	
Nickel			3.2	6.2	3.6				3.1	5.5	3.1	4.3	6.2	
Nitrate	ND	0.28	ND	1.5	0.5		0.2	ND	ND	1	ND	0.7	1.5	
Nitrite			ND	ND	ND				ND	ND	ND	ND	ND	
Oil & Grease			ND	ND	7				ND	ND	ND	ND	7	
Ortho-P			1.1	1.1	0.92				0.89	1	0.89	1.0	1.1	
Pesticides			ND	ND	ND				ND	ND	ND	ND	ND	
pH	6.44	6.63	7.12	6.51	7.19		6.48	6.76	7.05	6.27	6.27	6.72	7.19	
Potassium			6.2	5.5	3.7				6.1	5.6	3.7	5.4	6.2	
Selenium			1.8	ND	ND				1.4	ND	ND	ND	1.8	
Silica			3.2	4.5	4.1				1.5	3.6	1.5	3.4	4.5	
Sodium			102	32	20				100	40	20	59	102	
Sulfide			ND	ND	ND				ND	ND	ND	ND	ND	
Sulfite			ND	ND	ND				ND	ND	ND	ND	ND	
Sulfate			104	40	26				102	53	26	65	104	
TDS			544	250	140				540	240	140	343	544	
TSS			11	16	14				15	13	11	14	16	
TOC			12	18	11				12	16	11	14	18	
Vanadium			2.9	ND	ND				2.4	ND	ND	ND	2.9	
Zinc			15	180	88				17	140	15	88	180	
VOCs														
Acetone			ND	ND	ND				ND	ND	ND	ND	ND	
Benzene			ND	ND	ND				ND	ND	ND	ND	ND	
Ethylbenzene			ND	ND	ND				ND	ND	ND	ND	ND	
Toluene			ND	ND	ND				ND	ND	ND	ND	ND	
Xylene			ND	ND	ND				ND	ND	ND	ND	ND	