APPENDIX A

FINAL REPORT

Summary of Existing Water/Wastewater Quality Information – Full Version

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CITY OF EL PASO DE ROBLES
WATER & WASTEWATER QUALITY CONCERNS – WATER QUALITY STRATEGY

PREPARED FOR:

City of El Paso De Robles
1000 Spring Street
Paso Robles, CA 93446

MARCH 2003

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SUMMARY OF EXISTING WATER/WASTEWATER QUALITY INFORMATION – FULL VERSION

CITY OF EL PASO DE ROBLES
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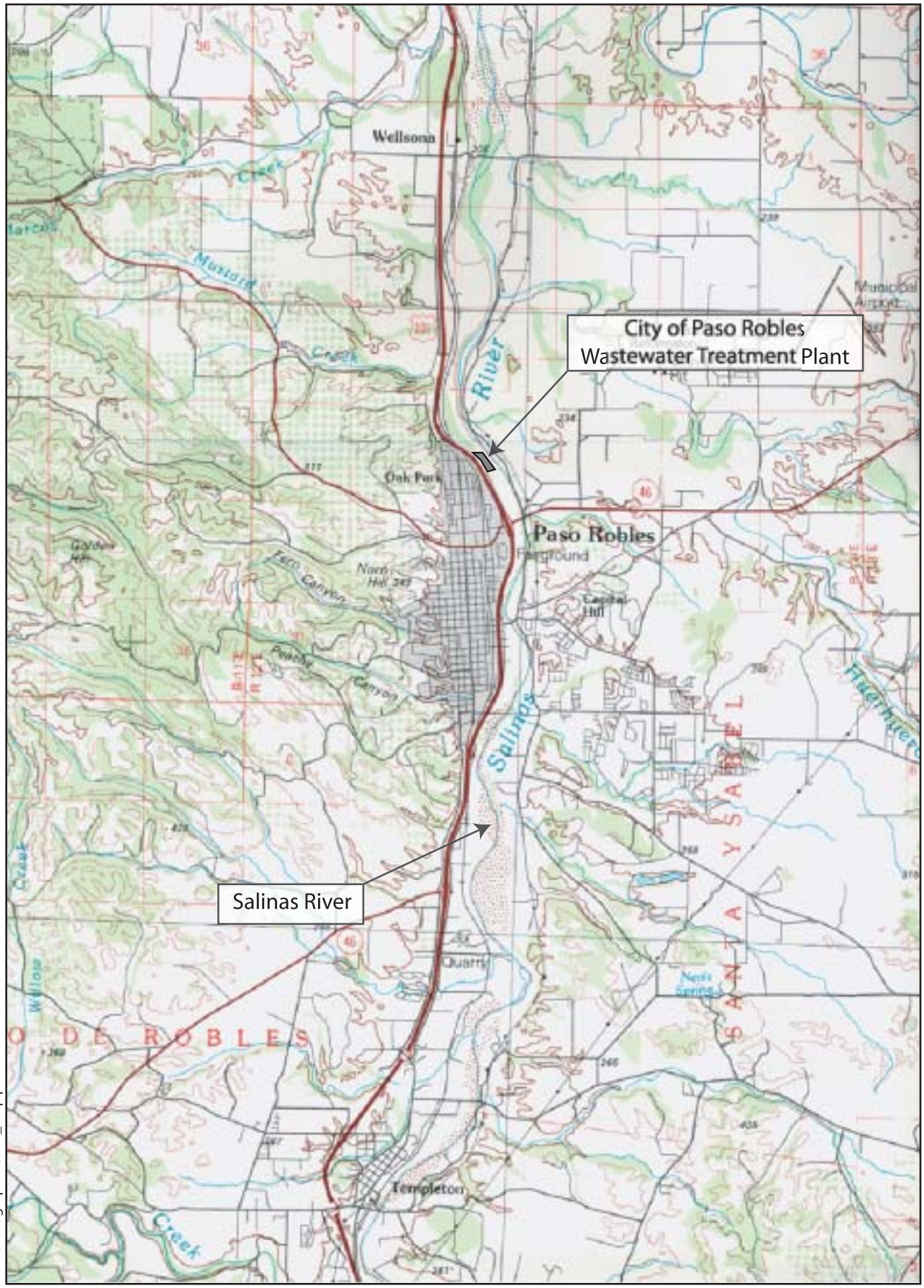
APPENDIX A

1.0 INTRODUCTION

This appendix is the complete version of Chapter 1 of this report, which provided a brief summary of available water and wastewater information pertinent to the development of a water/wastewater quality strategy for the City. Specifically, this section provides a more complete description of the City's current status with respect to:

- Discharge of treated wastewater to the Salinas River
- Characteristics of treated wastewater and compliance with limits for Total Dissolved Solids (TDS)
- Existing water system and delivered water quality
- Water rights, magnitude, quality, and reliability of the City's Salinas River Underflow (shallow groundwater) water supply source
- Water rights, magnitude, quality, and reliability of the City's Paso Robles Groundwater Basin (deep groundwater) water supply source
- Recycled water as a potential water supply source for the future
- Imported surface water as a potential water supply source for the future

This summary was developed by Malcolm Pirnie based on available reports and other documents provided by the City for review. The information presented herein is not intended to be an exhaustive discussion of the reports provided for our review. Instead, it is intended to provide a compilation and discussion of the information in previous documents that directly pertains to the development of a water/wastewater quality strategy. The summary information herein provides the foundation for the analyses conducted during this project, namely, the analysis of the potential effects of introducing treated surface water into the City's distribution system and the evaluation of various alternatives for the City to consider to address its water and wastewater quality issues. **Figure A-1** is a location map of the study area.



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Location Map
Paso Robles, California

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Figure A-1

2.0 CITY OF PASO ROBLES WASTEWATER DISCHARGE SUMMARY

This section summarizes available information on the quantity and quality of the City's treated wastewater as it pertains to the development of a water/wastewater quality strategy.

2.1 Average and Maximum Wastewater Flows

The average dry weather flow design capacity of the City's wastewater treatment plant is 4.9 million gallons per day (MGD). At the time of the development of the City's 1998 NPDES permit, flows averaged 2.8 MGD, and the 2001 Carollo Salt Management Study indicates an average flow of 2.9 MGD for 1999 (Carollo, 2001b). A 6% per year annual increase in City wastewater flow is indicated by data from 1994-1999 (Carollo, 2001a). The service area of the City's wastewater treatment plant includes the City of Paso Robles as well as the community of Templeton and the Paso Robles Boys School. The plant provides secondary treatment prior to discharge to polishing/percolation ponds and ultimately the Salinas River (RWQCB, 1998). Previous reports (Todd, 2000) indicate that the City's wastewater treatment plant capacity is sufficient to handle City growth for the next twenty years or more; however, the Central Coast Region of the California Regional Water Quality Control Board (RWQCB) has expressed concerns about the current hydraulic/treatment capacity of the plant (Briggs, 1999).

2.2 Discharge to the Salinas River

Currently the City's treated wastewater is discharged to the Salinas River under NPDES Permit 98-42 issued by the RWQCB. The RWQCB has required the City to investigate alternatives to continuing to discharge to the river, noting that the City is the only remaining municipal system discharging into the Salinas River. The City has been notified that the RWQCB generally encourages wastewater reclamation, and that prior to the February 2005 renewal of the City's NPDES permit, the RWQCB will closely review whether the City should be allowed to continue to discharge to the Salinas River (Briggs, 1999).

2.3 General Wastewater Treatment Process/Quality

The City's current wastewater treatment process consists of ferric chloride addition (to reduce hydrogen sulfide in the digester gas), screening, grit removal, primary clarification, biological treatment via trickling filters, secondary clarification, chlorination, discharge to polishing ponds (dechlorination occurs during the detention in the ponds), and discharge to the Salinas River. It is Malcolm Pirnie's understanding that there have historically not been any wastewater treatment upsets or significant problems.

Based on data provided in the 2001 Comprehensive Recycled Water Study (Carollo, 2001a), annual averages of the City's effluent five-day biochemical oxygen demand (BOD_5) and Total Suspended Solids (TSS) concentrations were 13 and 21 mg/L, respectively, during the 1994-1999 period, as compared to their monthly average NPDES effluent limitations of 25 mg/L and 30 mg/L. A review of the City's "Quarterly Constituent Reports" for the wastewater treatment plant from 1992-2002 (City of El Paso de Robles, 2002c) indicates consistent removals of suspended solids and BOD_5, generally equal or greater than 95%. Based on 1994-1999 data,

the City also appears to be well in compliance with permit limitations for selected metals (aluminum, boron, copper, iron, and zinc). The report also concludes that the City's wastewater discharge does not have a detrimental impact on the groundwater in the immediate vicinity of the plant (the Salinas River Underflow unit) based on dry weather (no river flow) monitoring data for TDS, sodium, chloride, and hardness. Regarding nitrogen, data are only available for 1992 and 1993 (City of El Paso de Robles, 2002b). Total Nitrogen was measured quarterly during those years, ranging from 2.1 to 14 mg/L, with a media value of 5.2 mg/L. The "Quarterly Constituent Reports" indicate that no effluent limitation is in place for nitrogen.

2.4 Total Dissolved Solids (TDS)

According to the RWQCB (Briggs, 1999), the City has historically had problems in complying with its effluent limitations for TDS. The precise reason for non-compliance is not stated in the 1999 correspondence; however, review of the 2001 Salt Management Study and the City's NPDES permit (Carollo, 2001b; RWQCB, 1998) indicates that the violations have been exceedances of the City's 1100 mg/L daily maximum TDS concentration limit. (Based on the permit provisions, the City is regulated for TDS on this daily maximum basis and not according to monthly average concentrations, weekly average concentrations, mass loading values, or any other basis.)

The TDS content of the City's treated wastewater is the result of four main factors: (1) the TDS content of the City's source water, which is currently 100% local groundwater; (2) the increase in TDS that typically results from municipal water use; (3) the TDS load from residential water softeners; and (4) the TDS input from industrial/commercial sources.

Table A-1 summarizes the TDS concentrations of the City's water and wastewater. In addition to the data in the table, Todd (2000) states that the average monthly TDS concentration in treatment plant effluent was 1,000 mg/L from 1994-1999, based on data compiled by Carollo Engineers in 2000. Sodium, chloride, and sulfate data are also included in the table. The 2001 Salt Management Study indicates the City also has difficulty consistently meeting NPDES effluent limitations for these constituents. The table illustrates the general increase in TDS from source water to effluent and that the City does not have a sufficient margin of safety with regards to compliance for TDS or the other three constituents shown. Available data indicate that, during the January 2000 monitoring event, concentrations of TDS, chloride, and sulfate were equal to or in excess of their respective daily maximum effluent limitations. A review of the City's "Quarterly Constituent Reports" for the wastewater treatment plant from 1992-2002 (City of El Paso de Robles, 2002c) confirms that the City's effluent is typically at or near its effluent limitations for these constituents.

Table A-1. Water and Wastewater Quality Summary

	Source Water for WWTP Service Area		Influent to WWTP		Effluent from WWTP	NPDES Permit Requirements
	avg.	*max.*	*avg.*	*max.*	*one monitoring event (January 2000)*	*daily max.*
TDS (mg/L)	612	730	992	1200	1100	1100
Sodium (mg/L)	122	280	220	280	200	225
Chloride (mg/L)	67	120	314	470	320	310
Sulfate (mg/L)	137	160	141	180	190	180

Compiled from Tables 2 and 3 in 2001 Salt Management Study (Carollo, 2001b); values represent January 1997 – January 2000 quarterly monitoring data, except as noted.

Based on available data, Carollo estimated that TDS loading to the City's wastewater treatment plant would need to decrease by 2,419 lb/day to meet permit limits. This was based on a 100-mg/L decrease in TDS concentration in the plant influent (i.e., reducing the 1997-2000 maximum TDS influent concentration of 1200 mg/L to the permit limit of 1100 mg/L). (The City would likely set a more ambitious target for TDS load reduction to provide a margin of safety in meeting their permit requirements.)

The data presented in the table demonstrate that the TDS increases in the City's service area are higher than average. Specifically, TDS concentrations in wastewater from typical municipal use can be expected to be 150-380 mg/L higher than the source water supplied to the area, as referenced in the 2001 Salt Management Study. Available TDS concentration data from 1997-2000 summarized in **Table A-1** indicates that TDS increases through City use appear to be quite a bit higher than typical municipal increases, as can be seen by the 380 and 470 mg/L increases in the average and maximum measured values, respectively. This is likely a reflection of the additional salt load from home treatment units employing ion exchange and/or industrial/commercial sources.

A number of alternatives were examined in the 2001 Salt Management Study to address the City's wastewater compliance issues and were presented in three main categories: source water management, residential water softener management, and industrial/commercial control. These are discussed in detail in the 2001 Salt Management Study and are briefly summarized here in **Table A-2**.

Table A-2. Summary of Previously Identified Salt Management Alternatives

Category	Alternative	Conclusion
Source Water Management	Preferentially Pump from Wells of Higher Water Quality	TDS improvement probably marginal. Counter-productive with respect to maintaining Salinas River Underflow water rights.
	Augment Well Water Supply with Treated Surface Water	Would bring effluent into compliance. Amount of imports and timing need to be considered.
	Desalinate Well Water	Would bring effluent into compliance. Amount to desalinate a function of water quality objectives and cost.
Residential Water Softener Management	Implement Rental Canister Units for New Developments	Not feasible to address TDS problem (e.g., timing, SB 1006, marginal benefits).
	Limit Residential Softening to Hot Water Uses in New Homes	Not feasible to address TDS problem (e.g., timing, SB 1006, marginal benefits).
	Implement Voluntary Conversion to Rental Canister Units in Existing Homes	Not feasible to address TDS problem (e.g., non-enforceable, still adds sodium).
Industrial and Commercial Control	Implement Salt Management Plans for Industrial/Commercial Facilities	Marginal effluent improvement but relatively easy to implement.
	Require Off-Site Disposal of Brines and Other TDS Wastes	Marginal effluent improvement; City could subsidize costs, or industries could pay.
	Implement Pre-Treatment Program	Possibly only marginal benefit; may not bring effluent into compliance.

Paraphrased from Table 6 of 2001 Salt Management Study (Carollo, 2001b).

The 2001 Salt Management Study identified two significant data gaps regarding the City's salt loadings and wastewater compliance:

- Monitoring of residential wastewater in the City's collection system had not been conducted; therefore, the residential contribution of salts to the City's wastewater could only be estimated at the time of the report.

- Only limited sampling data regarding industrial/commercial contributors were available, although three facilities had been identified as the largest potential contributors.

In response to Carollo's recommendations to further quantify salt contributions according to the various types of contributors to the City's wastewater collection system, the City's Wastewater Division conducted one year of salt monitoring in selected locations. One difference in the methodology of the City's program as compared to Carollo's recommendations was that the City used grab samples instead of composite samples (pers. comm., Columbo, 2003). The City performed monitoring at two locations representing residential discharge (one in the City's West Zone, and one in the East Zone), and at sixteen locations to characterize commercial/industrial discharges. Monitoring results were documented by the Wastewater Division in four quarterly reports (City of El Paso de Robles, 2003b). The reports provide concentration data, but do not include calculations of mass loadings (and therefore relative

contributions) to the City's wastewater treatment plant. Specific flow data would be necessary to perform these calculations. Nevertheless, useful findings can be developed from the reported salt concentration data alone. These are summarized below in addition to information provided by City Wastewater Division staff (pers. comm., Columbo, 2003).

- The year of salt monitoring (July 2001 – July 2002) confirmed that the City's wastewater discharge compliance difficulties for TDS are due to a combination of source water, residential, and commercial/industrial factors. The monitoring confirmed the known high TDS content of the City's source water (groundwater), and no particular industry or residential area, for example, appeared to be a single high contributor of TDS increases in the City.

- The City's monitoring documents increases above background (source water) TDS concentrations in residential areas ranging from 239 to 359 mg/L and averaging 290 mg/L. This is comparable to the typical municipal increase of 150-380 mg/L noted earlier in this section, which includes not only residential contributions, but industrial and other potentially high-salt dischargers as well. Therefore, the reported range of salt concentration increases from City residential use alone appears to be higher than average, consistent with the known high use of home water softeners in the area.

- The City's monitoring documents concentrations of TDS and related constituents in the collection system in excess of the City's Sewer Code Limits. This is shown in the table on page 3 of the Fourth Quarter Review Report, where maximum readings for three of the four quarters of monitoring (1,900, 2,100, and 1,400 mg/L of TDS) significantly exceed the stated City Sewer Code Limit of 1000 mg/L. As stated in the report, "All industrial sites still have a wide range of analytical results with all but a couple sites being in violation of the constituent's limits in both Sewer Code and plant discharge limits a majority of the time."

- Since the time of the four quarters of salt monitoring, the community of Templeton has brought their new wastewater treatment plant into service. One particular facility that previously discharged to the City's wastewater plant is now in the Templeton service area, and recent results of the City's wastewater influent monitoring for TDS and related constituents are lower than average. Whether this decrease is associated with the service area switch of the one facility cannot be confirmed based on available data.

It is important to note that concentration data alone are insufficient to develop relative salt loadings to the City's wastewater treatment plant from the City's source water and residential, commercial, and industrial dischargers. For example, TDS concentrations downstream of a particular industry may be in the thousands of milligrams per liter, but its discharge flow may be very small compared to the source water supplied to the City, or the flow from another type of TDS source. In a case such as this, the site in question may have an insignificant contribution to the salt loading to the City's wastewater plant when considered in context of the rest of the City. Relative mass loadings (e.g., in lbs/day) of salt from source water

and the types of salt contributors in the City could be calculated using the City's monitoring data discussed above along with (if available) measured or estimated flow contributions for each of the commercial/industrial contributors.

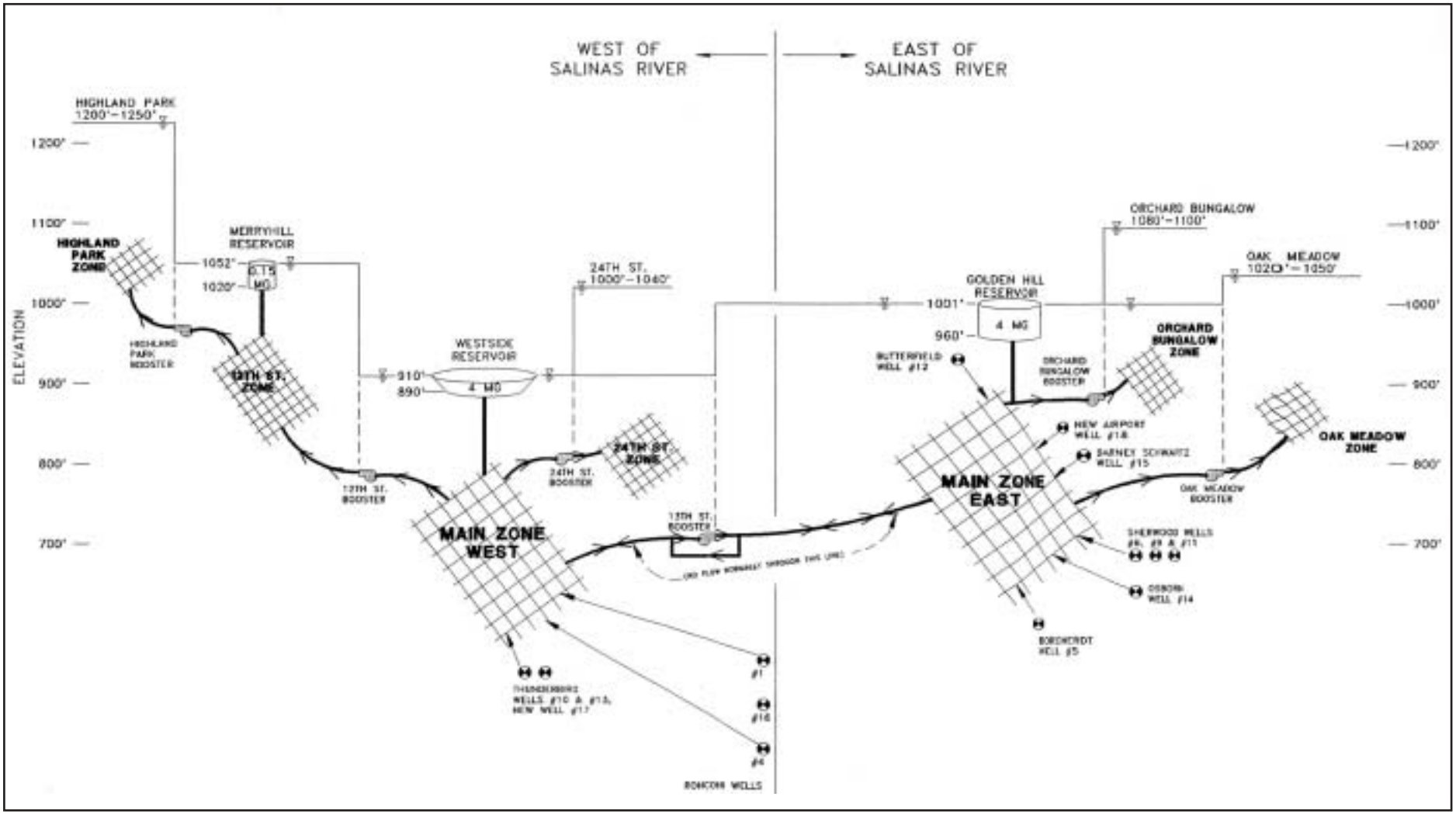
3.0 CITY OF PASO ROBLES WATER SUPPLY SUMMARY

This section summarizes available information on the City's water supply situation as it pertains to the development of a water/wastewater quality strategy. A brief description of the City's water system is provided, and current water supply sources are discussed. Potential future water supply sources are discussed in sections 4 and 5 of this appendix.

3.1 City Water System Description

The City water system currently serves a population of 25,200 via approximately 8,422 service connections (City of El Paso de Robles, 2002b). The City currently has 18 municipal supply wells distributed throughout the service area, which are depicted in **Figure A-2**, adapted from the City's updated Water Master Plan (Boyle, 1995). City wells, which are completed in two major groundwater units as discussed below, range in total depth from 84 to 1,075 feet. Seven wells are located in the Salinas River Underflow where depth to groundwater has ranged from 8 to 44 feet over the last 20 years. The Underflow wells show no long-term trend with respect to groundwater levels. Three of the seven wells (Ronconi 1, 4 and 16) were found to be influenced by surface water and were abandoned in 1994 due to the City's difficulty in meeting more rigorous disinfection contact time requirements (based on the Surface Water Treatment Rule) than the original system design allowed. There are 11 municipal supply wells completed in the Paso Robles Formation, with one well on standby due to high sulfate levels and another well restricted to park irrigation due to high concentrations of iron and manganese. Depths to groundwater in the Paso Robles Formation ranged from 115 to 185 feet in 1999 and, based on data from the past ten years, have showed no declining or other trend. Extraction rates for wells in the Salinas River Underflow range from 813 to 1,300 gpm and, in the Paso Robles Formation (deeper groundwater), the extraction rates range from 400 to 1,150 gpm (Boyle, 1995). Based on monthly reports prepared by the City during 2001 and 2002 (City of El Paso de Robles, 2001 & 2002a), the percentage of water pumped from Underflow wells ranges from 40% to 70% of the City supply. Based on the 2001 and 2002 information, the ratio between the Underflow and the deeper Paso Robles Formation sources varies seasonally, with demand. Specifically, a higher fraction of water is drawn from the Underflow wells when demand is lower in the colder months, and production from the Formation wells is increased to meet the higher demand during the warmer months of the year. A summary of the City's wells is provided in **Table A-3**. Water quality information presented in the table is addressed in the sections following the table.

The City's water system consists of the West and East Zones, which are divided by the Salinas River and generally operate independently; however, a pipeline and a booster pump station are in place to allow the two Zones to exchange water in case of emergency (Boyle, 1995).



SOURCE: 1993 Water Master Plan - April 1995 Update, prepared by Boyle Engineering Corporation for the City of El Paso de Robles, April 1995

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City of El Paso de Robles
Existing Water System Schematic

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FIGURE A-2

Table A-3. Water Supply Well Summary

	Well Name	Well Number	Screened Interval (ft. bgs)	Reported Depth to Water (ft.)	Yield (gpm)	Total Pumped in 1999 (MG)	Total Pumped in 2001 (MG)	TDS (mg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Hardness (mg/L)	Status
Salinas River Underflow	Ronconi #1	-	-	15	839	-	-	-	-	-	-	-	off-line since 1994: under surface water influence
	Ronconi #4	-	-	15	813	-	-	-	-	-	-	-	off-line since 1994: under surface water influence
	Ronconi #16	-	-	15	1,000	-	-	-	-	-	-	-	off-line since 1994: under surface water influence
	Thunderbird #10	27S/12E-09M02	60-210	32	1,025	417	306	529	30	52	161	410	active
	Thunderbird #13	27S/12E-09M03	70-130	31	1,000	331	391	514	32	50	146	381	active
	Thunderbird #17	27S/12E-09M04	70-130	35	1,000	386	376	507	50	49	124	354	active
	Thunderbird #23	27S/12E-09M06	90-140	41	1,300	101	17	626	39	75	177	465	active
	Borcherdt #5	27S/12E-04K02	175-400	58	440	-	78	-	-	-	-	-	active
Paso Robles Formation	Sherwood #6	27S/12E-02D01	160-758	140	600	-	0	-	-	-	-	-	on standby due to high sulfate
	Sherwood #9	27S/12E-02E01	175-600	180	1,000	90	226	444	88	67	34	210	active
	Sherwood #11	27S/12E-02F02	275-592	160	1,150	287	225	407	70	57	31	226	active
	Butterfield #12	26S/12E-22J01	275-775	140	400	26	68	526	115	68	88	202	active
	Osborne #14	27S/12E-02L02	180-524	161	650	39	82	444	58	68	29	322	active
	B. Schwartz #15	26S/12E-26H02	260-340 400-660	120	800	-	-	-	-	-	-	-	off-line due to high manganese and surface water influence; high sodium also indicated
	Dry Creek #18	26S/12E-24D03	400-1075	102	1,000	102	151	528	142	57	143	134	active
	Tarr Well #19	26S/13E-18K01	350-885	158	400	4	14	369	60	67	29	206	active
	Royal Oak #20	27S/12E-02H01	290-370 410-430 470-590	175	800	160	182	472	58	107	29	324	active
	Fox Well #21	26S/12E-13N01	450-1060	200	800	59	66	415	57	70	47	234	active
	Cuesta Well #22	26S/12E-22L02	330-430	120	200	1	8	445	104	49	49	231	active

Table A-3 Notes

Well name, well number, screened interval, depth to water, yield data, and 2001 pumping information from City of Paso Robles Well Water Information table and attachments (City of El Paso de Robles, Undated). 1999 pumping information from Salt Management Study (Carollo, 2001b). Somewhat different values for well yields, depth-to-water values, and screened intervals from those indicated in the table above are reported in the Drinking Water Source Assessment (City of El Paso de Robles, 2002).

Aquifer designation (i.e., Salinas River Underflow or Paso Robles Formation) from Monthly Water Reports (City of El Paso de Robles, 2001 and 2002a). Per City designation, Thunderbird wells are West Side Wells while the rest of the active wells are East Side Wells (City of El Paso de Robles, 2001 & 2002a). (Borcherdt #5 is the only active well both designated as a Salinas River Underflow and an East Side well.)
Ronconi well information and notes re: off-line/standby wells are from Water Master Plan (Boyle, 1995), except indication of high sodium in B. Schwartz #15 (per 7/2/02 City Council agenda). Water Master Plan (1995) also indicates slightly different yields for some wells as compared to those indicated in the table above. Significantly shallower depth-to-water values for 3 wells are indicated in the Water Master Plan also – for Thunderbird #17, Dry Creek #18, and Tarr Well #19. (The rest of the depth-to-water values in the Water Master Plan agree with the values in the table above.)

Water quality data are average values per the Salt Management Study (Carollo, 2001b). The report suggests that these are 1999 averages, but does not state so. Hardness is assumed to be expressed as mg/L as $CaCO_3$.

Dashes indicate information not available or not reported.

Physical Barrier Effectiveness (PBE) assessments performed for the City Drinking Water Source Assessment (City of El Paso de Robles, 2002b) indicate “low” and “moderate” PBEs for active Salinas River Underflow wells and “high” PBEs for active Paso Robles Formation wells.

New well (#8) to be drilled near City airport (per 11/19/02 City Council agenda).

It is Malcolm Pirnie's understanding that the City service areas for water and wastewater are nearly the same. Water service is generally metered. Commercial/industrial sewer use is metered, while residential sewer charges are based on a fixed fee. The West Zone, which is roughly 100 feet higher than the East Zone, receives predominantly Salinas River underflow water from the City's shallow wells (relatively high TDS), while the East Zone receives predominantly deeper groundwater (lower TDS).

Like those of other cities, the City's distribution system consists of a network of pipelines with varying age, material, and condition. The City's oldest pipelines can be found in the West Zone, some of which date back to the 1900s. The oldest pipelines in the East Zone date back to the 1940s. The City's pipeline distribution system consists of asbestos cement (AC), cast iron (CI), ductile iron (DI), polyvinyl chloride (PVC), and steel. The majority of the pipelines are AC, which were installed from the 1950s through the mid-1980s. PVC has been the material of choice since the mid-1980s for replacing old pipelines and installing new ones. The use of steel pipelines has been minimal and has only been done for pipelines 4" or less in diameter. DI pipelines were used exclusively for main pumping lines starting in 1972. CI was installed prior to the late 1950s. This information is provided in the City's Water Master Plan (Boyle, 1995) and is supported by information in the City's Water Atlas (City of El Paso de Robles, 1996b).

3.2 Existing Delivered Water Quality

The City's water has consistently met drinking water standards and generally has not had problems with stagnant areas of the system, high coliform counts, or loss of chlorine residual (Dunham, 2002). A review of the City's annual Water Quality Reports (City of El Paso de Robles, 2002d) for the last decade generally confirms this. Only one positive coliform count was reported, in 1992. Additionally, no synthetic organic or volatile organic compounds (SOCs and VOCs) have been detected based on information reviewed. The water delivered represents a blend of water from the City's numerous wells. All well water is chlorinated, with a target residual of between 0.8 and 1.1 mg/L of free chlorine. **Tables A-4** through **A-6** on the following pages provide a summary of water quality monitoring results for 1992 through 2001.

3.3 Groundwater (Existing Water Supply Source)

The City currently relies on groundwater for 100% of its municipal water supply. There are two main sources of this groundwater: the Salinas River Underflow and deeper groundwater within the Paso Robles Groundwater Basin. The alluvium along the Salinas River is the unit containing the Salinas River Underflow, which refers to shallow groundwater flowing as a subterranean stream in direct connection with the Salinas River. Groundwater within the Paso Robles Formation is the most extensive area aquifer, consisting of 1800 feet of unconsolidated sand, silt, gravel, and clay. The Paso Robles Formation provides groundwater not only to the City of Paso Robles but also to other municipal, domestic, and agricultural users throughout the basin (Todd, 2000). Additional information regarding these two groundwater supply sources is provided in the subsections below.

Table A-4. Delivered Water Quality Summary - Primary Regulated Substances (Part 1)

Water Quality	Aluminum (mg/L)		Antimony (σg/L)		Arsenic (σg/L)		Barium (mg/L)		Beryllium (mg/L)		Cadmium (σg/L)		Chromium (σg/L)		Cyanide (mg/L)		Fluoride (mg/L)		Gross Alpha Activity or Alpha Emitters (pCi/L)		Mercury (σg/L)	
Report Date	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
2001	0.005	ND - 0.068	NR	NR	5.36	ND - 20.9	0.06	ND - 0.2	NR	NR	NR	NR	NR	NR	NR	NR	0.25	ND - 0.81	2.5	ND - 5.1	NR	NR
2000	0.054	ND - 0.697	NR	NR	5.26	ND - 20.9	0.68	ND - 0.197	NR	NR	NR	NR	NR	NR	NR	NR	0.33	ND - 1.11	5.1	1.1 - 5.1	NR	NR
1999	0.066	ND - 0.7	NR	NR	15	ND - 15	0.55	ND - 0.27	NR	NR	NR	NR	NR	NR	NR	NR	0.48	0.08 - 1.1	5.1	1.1 - 5.1	NR	NR
1998	0.009	ND - 0.058	NR	NR	3.933	ND - 15	0.059	ND - 0.267	NR	NR	NR	NR	NR	NR	NR	NR	0.478	0.08 - 0.93	3.6	1.1 - 10.16	NR	NR
1997	ND	ND	ND	ND	4.94	ND - 15	0.056	ND - 0.267	ND	ND	ND	ND	ND	ND	ND	ND	0.475	0.26 - 0.93	2.4	0.7 - 4.35	ND	ND
1996	ND	ND	ND	ND	6.12	ND - 18	0.077	ND - 0.28	ND	ND	ND	ND	ND	ND	ND	ND	0.344	0.23 - 0.8	1.9	0.7 - 2	ND	ND
1995	ND	ND	ND	ND	6.12	ND - 18	0.077	ND - 0.28	ND	ND	ND	ND	ND	ND	ND	ND	0.344	0.23 - 0.8	1.87	0.7 - 2	ND	ND
1992	0.1	0.1 - 0.1	NR	NR	9	5 - 28	0.15	0.09 - 0.36	NR	NR	1	1 - 1	6	5 - 7	NR	NR	0.4	0.1 - 0.8	2.6	0.4 - 4.9	0.2	0.2 - 0.2

Table A-4. Delivered Water Quality Summary - Primary Regulated Substances (Part 2)

Water Quality	Nickel (mg/L)		Nitrate (mg/L as NO_3)		Nitrate + Nitrite (mg/L as N)		Nitrite (mg/L as N)		Selenium (σg/L)		Thallium (mg/L)		TTHMs (σg/L)		Turbidity (NTU)	
Report Date	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**
2001	NR	NR	8.54	ND-26	1.8	ND - 4.32	NR	NR	2.93	ND - 24	NR	NR	11.95	3.9 - 12.6	3	NR
2000	NR	NR	9.85	ND - 40.9	2.4	ND - 5.7	NR	NR	3.89	ND - 24	NR	NR	24.8	ND - 49.6	2	NA
1999	NR	NR	13.19	4.4 - 35.6	2.9	0.61 - 6.41	NR	NR	5.4	ND - 26.3	NR	NR	9.5	2.3 - 16	4.8	NA
1998	NR	NR	11.61	4.58 - 41.6	2.5	0.61 - 6.41	NR	NR	5.05	ND - 34.3	NR	NR	18.8	5.6 - 31.7	1.17	0.01 - 6.5
1997	ND	ND	11.17	2.7 - 28.4	2.3	0.6 - 6.4	ND	ND	6.53	ND - 34.3	ND	ND	7.5	ND - 20.5	1.73	0.1 - 6.5
1996	ND	ND	10.95	2.1 - 34.5	2.28	0.97 - 5.28	ND	ND	6.68	ND - 24	ND	ND	11.05	ND - 18.3	0.464	0.11 - 3
1995	ND	ND	11.11	2.0 - 35.9	2.3	0.97 - 5.28	ND	ND	6.68	ND - 24	ND	ND	18.78	3.9 - 36.7	0.464	0.11 - 3
1992	NR	NR	6.7	1.0 - 12.6	NR	NR	NR	NR	5	5 - 5	NR	NR	11.30	2 - 36	0.35	0.1 - 2

Table A-5. Delivered Water Quality Summary - Secondary Regulated Substances

Water Quality	Apparent Color (Color Units)		Chloride (mg/L)		Iron (σg/L)		Manganese (σg/L)		MBAS (mg/L)		Odor-Threshold (units)		Silver (σg/L)		Specific Conductance (σmhos/cm)		Sulfate (mg/L)		Total Dissolved Solids (TDS) (mg/L)		Zinc (σg/L)	
Report Date	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**
2001	NR	NR	68.22	45 - 120	16.43	ND - 230	2.21	ND - 31	NR	NR	1	1 - 1	NR	NR	842.36	686 - 1,200	85.59	26.3 - 182	486	369 - 720	NR	NR
2000	NR	NR	65.22	46.2 - 107	26.85	ND - 233	NR	NR	NR	NR	1	1 - 1	NR	NR	845.62	686 - 1,120	86.72	26.3 - 182	479.38	369 - 626	NR	NR
1999	1.15	0 - 5	64.37	48.5 - 107	26.85	ND - 233	NR	NR	NR	NR	1.15	1 - 2	NR	NR	860.38	670 - 1,120	83.62	28.9 - 177	480	370 - 630	NR	NR
1998	0.83	0 - 5	69.37	48.5 - 120	9.667	ND - 116	3.75	ND - 45	NR	NR	1.25	1 - 2	NR	NR	875.42	670 - 1,200	81.717	28.9 - 161	489.12	369 - 715	NR	NR
1997	3.3	0 - 5	67.57	50 - 120	39.2	ND - 270	3.8	ND - 45	ND	ND	1.2	0 - 2	ND	ND	888.1	670 - 1,200	92.77	29 - 161	517.63	369 - 715	ND	ND
1996	3.4	0 - 4	67.45	42.7 - 116	26	ND - 170	6.6	ND - 45	ND	ND	1.4	0 - 4	ND	ND	869.3	710 - 1,150	90.91	24 - 160	539.75	435 - 705	ND	ND
1995	3.4	ND - 4	67.45	42.7 - 116	26	ND - 170	6.6	ND - 45	ND	ND	1.4	0 - 4	ND	ND	869.3	710 - 1,150	90.91	24 - 160	539.75	435 - 705	ND	ND
1992	4.4	3 - 10	74	45.4 - 115.4	100	100 - 100	30	30 - 30	0.02	0.02 - 0.02	1.4	1 - 3	5	5 - 5	NR	NR	96.7	30.1 - 207.2	566	450 - 743	50	50 - 50

Table A-6. Delivered Water Quality Summary - Tap Water Samples and Unregulated Substances (Part 1)

Water Quality	Bicarbonate (mg/L)		Boron (ōg/L)		Calcium (mg/L)		Carbonate (CO_3) (mg/L)		Copper (mg/L)		Hydroxide (OH) (mg/L)		Lead (mg/L)		Magnesium (mg/L)	
Report Date	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Value**	**Range**	**Avg.**	**Range**	**Value**	**Range**	**Avg.**	**Range**
2001	305.6	256 - 430	266	ND - 740	64.4	16 - 110	NR	NR	0.29 (90th percentile)	NR	NR	NR	NR	NR	24.5	6.3 - 39.5
2000	303.46	256 - 351	NR	NR	66.58	31.20 - 135	NR	NR	1.1 (90th percentile)	NR	NR	NR	NR	NR	28.24	6.3 - 39.5
1999	307.21	260 - 354	NR	NR	66.3	30.1 - 135	NR	NR	1.1 (90th percentile)	NR	NR	NR	NR	NR	29.12	14.2 - 42.2
1998	313.81	260 - 400	NR	NR	61.89	30.1 - 101	NR	NR	1.08 (90th percentile)	NR	NR	NR	NR	NR	29.03	14.2 - 42.2
1997	317.4	260 - 400	NR	NR	57.99	30.1 - 104	ND	ND	ND	ND	ND	ND	ND	ND	30.42	14.2 - 56
1996	313.8	276 - 397	NR	NR	58.31	30 - 94	ND	ND	ND	ND	ND	ND	ND	ND	29.07	14.2 - 44
1995	313.8	276 - 397	NR	NR	58.31	30 - 94	ND	ND	ND	ND	ND	ND	ND	ND	29.07	14.2 - 44
1992	NR	NR	NR	NR	80.7	41.5 - 133.1	NR	NR	0.05	0.05 - 0.05	NR	NR	0.005	0.005 - 0.005	27.3	14.1 - 43.1

Table A-6. Delivered Water Quality Summary - Tap Water Samples and Unregulated Substances (Part 2)

Water Quality Report Date	pH (units)		Potassium (mg/L)		Sodium (mg/L)		Total Alkalinity (mg/L as $CaCO_3$)		Total Hardness (mg/L as $CaCO_3$)		Vanadium (σg/L)	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
2001	7.37	7.10 - 7.62	1.9	ND - 4.2	82.6	31.9 - 240	250.9	210 - 360	263.6	93 - 412	19	ND - 57
2000	7.41	7.16 - 7.73	1.69	ND - 3.4	70.88	31.9 - 146	249.08	210 - 288	284	128 - 465	NR	NR
1999	7.57	7.3 - 8.0	1.88	1.10 - 3.10	69.45	30.20 - 142	251.94	213 - 290	284.53	133.6 - 465	NR	NR
1998	7.56	7.3 - 8	2	1.1 - 3.9	79.13	30.2 - 190	257.27	213 - 328	267.75	133.6 - 410	NR	NR
1997	7.59	7.4 - 8	2.2	1.1 - 3.9	86.3	30.2 - 190	260	213 - 328	263.55	157 - 410	NR	NR
1996	7.61	7.4 - 8	2.23	1.5 - 3.4	86.5	37 - 184	253.8	219 - 335	265.26	133.6 - 408	NR	NR
1995	7.61	7.4 - 8	2.23	1.5 - 3.4	86.5	37 - 184	253.8	219 - 335	265.26	133.6 - 408	NR	NR
1992	7.71	7.57 - 7.91	2.04	1.3 - 3.4	71.4	31.4 - 165.5	NR	NR	285.6	50.8 - 509.6	NR	NR

Notes on Tables A-4 through A-6

Water Quality Reports are not available for 1993 and 1994.
There are no reported detections of either SOCs or VOCs so they are not indicated in the tables.
There are no reported detections of high coliforms, so they are not indicated in the tables (the only reported coliform was one positive sample out of 364 collected in 1992).
NR = Not Reported.
ND = Non Detected.
Aluminum has also a secondary standard in addition to its primary standard.

3.3.1 Salinas River Underflow

The Paso Robles Groundwater Basin is composed of two main units: (1) a thin upper alluvium, which overtops (2) an extensive sedimentary basin. The upper alluvial deposit occurs beneath the flood plains of the rivers and streams within the groundwater basin and consists primarily of sand and gravel.

The thickness of the unit varies locally, reaching a maximum estimated depth of 80 feet near the confluence of the Salinas and Estrella rivers. Transmissivity of the alluvium is estimated to be 52,000 gpd/ft. Wells completed in the younger alluvium are present along the Salinas and Estrella rivers and the length of the Huer Huero Creek (Fugro, 2002). The portion of this thin upper alluvium along the Salinas River is known as the Salinas River Underflow.

3.3.1.1 Water Rights/Magnitude

The City of Paso Robles has water rights to a specific quantity of water from the Salinas River Underflow (shallow groundwater). Underflow is subject to appropriative water rights and is permitted by the State Water Resources Control Board. As of September 2000, the City had rights to an annual extraction of 4,600 acre-feet (AF) of the Underflow and in 1999 only used 3,800 AF. The City currently has the capacity to pump the entire volume. It was assumed during the development of the 2000 Urban Water Management Plan that use of the Underflow would gradually increase to account for the entire 4,600 AF (Todd, 2000). A somewhat larger allowable extraction from the Underflow is indicated in the Master Plan Update (Boyle, 1995): 8 cubic feet per second (cfs), which is equal to roughly 5,800 acre-feet per year (AF/yr). The 1941 Salinas River Withdrawal Permit is cited as the granting the City the 8 cfs from the wells adjacent to the Salinas River.

If the basin is recharged (e.g., with imported surface water), the amount of river underflow legally available to the City increases by the amount of recharge. It would not be necessary for the City to demonstrate that the additional water withdrawn from the basin is the same water that was recharged in order to realize this increase in allowable Underflow withdrawal (Boyle, 2002).

3.3.1.2 Quality

Wells screened within the Salinas River Underflow produce water with TDS concentrations between 300 and 800 mg/L (Todd, 2000). Based on TDS data compiled by Carollo for the Thunderbird wells (Carollo, 2001b), TDS concentrations in water produced by these wells average approximately 540 mg/L. This is somewhat higher than the average TDS in water produced by the City's deeper wells as discussed in the following subsections.

3.3.2 Paso Robles Groundwater Basin (Deep) Groundwater

Below the alluvium of the Paso Robles Groundwater Basin is the Paso Robles Formation, a sedimentary unit that extends from ground surface to more than 2000 feet below sea level. The Paso Robles Formation is a series of thin, often discontinuous sand and gravel layers interbedded with thicker layers of silt and clay. Transmissivity of the Paso Robles Formation is estimated to be 10,000 gpd/ft. The main aquifer for the City of Paso Robles is within the Paso Robles Formation and underlies the Salinas River alluvium. This unit then thins and deepens to the east, becoming the deep aquifer zone east of the Huer Huero Creek. This deep aquifer zone is

approximately 150 feet thick and occurs at an average depth of 700 feet below ground surface (bgs). Above and below this aquifer zone are thin lenticular production zones, with those above the deep zone tapped by domestic wells up to 400 feet deep. The deep aquifer zone is primarily used for deep irrigation wells and municipal supply wells (Fugro, 2002).

Underlying the Paso Robles Formation are several older geologic formations that typically have lower permeabilities and can act as reservoirs for geothermal water. One such unit is beneath the City of Paso Robles. The City of Paso Robles has historically been the site of hot springs. An investigation concluded that the source of these hot springs was the deep circulation of meteoric waters along faults, especially along the Rinconada fault. This groundwater is not considered part of the Paso Robles basin because the quality of the water produced is usually very poor. The groundwater here is often highly mineralized and characterized by elevated boron concentrations that restrict agricultural uses (Fugro, 2002).

3.3.2.1 Water Rights

As mentioned above, the groundwater of the Paso Robles Groundwater Basin is available to and appropriated by the City of Paso Robles as a source of water supply. The City extracted 2,300 AF from the Basin in 1999. This source of groundwater is not subject to explicit limitation. However, multiple users draw on this water source, and these demands are increasing (Todd, 2000).

3.3.2.2 Magnitude

The basin covers an area of approximately 790 square miles (505,000 acres), and the total watershed area is approximately 1,980 square miles. The total estimated groundwater in storage within the Paso Robles Groundwater Basin is approximately 30,500,000 AF. This value changes with time depending on the relative amounts of recharge and pumpage. The main area of groundwater recharge to the basin is where the shallow alluvial sand and gravel beds are in direct contact with the Paso Robles Formation. Near Paso Robles, the large aquifer in the Paso Robles Formation is in direct contact with the younger alluvium along the Salinas River channel (Fugro, 2002). Refer to Figure 27 of the Fugro (2002) report for a hydrogeologic cross section of the area.

According to Fugro (2002), perennial yield of the basin is defined as the rate at which water can be pumped over a long-term period (i.e., over several or more years) without decreasing the groundwater in storage. The perennial yield for the Paso Robles Groundwater Basin (which includes the Atascadero subbasin) has been calculated to be 94,000 AF/Y. Despite growth in the area, total net groundwater pumpage in the basin declined steadily from 1984 through 1998. Fugro (2002) did not specify why there was a decrease in pumping; however, reasons may include increased irrigation efficiency, residential water awareness/conservation, variations in rainfall, and/or other factors. In the following two years (1999 and 2000), it appeared that groundwater pumping was increasing, which may be the start of a new trend. In the year 2000, groundwater pumpage in the Paso Robles Groundwater Basin was approximately 82,600 AF. Fugro (2002) also noted that pumpage exceeded the perennial yield from 1980 through 1990. Only during the last decade has pumpage been less than the perennial yield. These trends should be further evaluated by considering the amount of recharge to the basin for a specific year in conjunction with pumpage (Fugro, 2002).

Water level data show that over the base period considered by Fugro (from July 1980 through June 1997) there is no definitive upward or downward water level trend for the basin except in the area near the City of Paso Robles where water levels have declined. Refer to Figures 32 and 33 in the Fugro (2002) report that present regional water surface maps for Spring 1980 and Spring 1997, respectively. Fugro (2002) estimated that this decrease that has occurred over the last 20 years is approximately 78,000 AF (about an 0.88% decrease). This decrease over time in the City of Paso Robles area is where Dry Creek flows northwesterly into Paso Robles. Dry Creek flows through an area where well yields are much lower than those generally found in the central part of the basin; this is likely due to the presence of older, less permeable sediments associated with uplift along the Creston anticlinorium. These less permeable sediments are also further away from the major recharge sources of the Huer Huero Creek and Estrella River. Refer to Figure 34 of the Fugro (2002) report for an illustration of the change in water surface elevation between Spring 1980 and Spring 1997. Coupled with less permeable sediments, this area is undergoing rapid development of rural residential housing, vineyards, and golf courses that currently rely entirely on groundwater for their water supply. Because of this recent demand on the groundwater, water levels have decreased, causing the groundwater flow patterns to shift and forcing the hydraulic gradient east of Paso Robles to steepen. Available data do not indicate any immediate impact on the City's wells; however, this localized groundwater level decline underscores the susceptibility of Basin water levels to increased groundwater use and the impacts to private wells near the City.

3.3.2.3 Reliability/Safe Yield Issues

As of September 2000, decreases in two City wells (Sherwood wells 9 and 11) were noted. These decreases could be related to local pumping in excess of natural recharge and again may highlight the susceptibility of groundwater levels in the area. Installation of additional City wells outside the City limits may not be possible. Todd (2000) suggested continued monitoring of local groundwater levels to evaluate whether overdraft conditions of the basin are beginning to be established. To offset the development of basin overdraft, it was suggested in the Urban Water Management Plan that conservation methods could be employed, and/or an additional surface water supply could be added to the City's groundwater supply (Todd, 2000).

As noted in the Urban Water Management Plan, the annual growth rate in the City is approximately 3%, and the population is estimated to reach approximately 34,400 by 2020. The ultimate population had been previously estimated at 70,700 (Boyle, 1995). It is Malcolm Pirnie's understanding that the differences in the City build-out population and associated water demand numbers in these documents are the result of differences in areas used. A build-out population of 60,000 or more generally includes both the City and outlying areas, is associated with the Planning Impact Area (PIA), and can be used as an estimate of the maximum number of people that a facility in the area may need to serve in the future. As of this writing (January 2003), the projected build-out population for the City can be assumed to be 42,000, with the potential to be somewhat higher depending on future annexation.

To support City growth, the total water demand was projected during the development of the Urban Water Management Plan to increase significantly from the

1999 demand of 6,025 AF/yr. Estimates of 2020 demand include 10,600 AF/yr and 11,130 AF/yr, although the assumptions used to develop these two different figures are not evident. The combined capacities of the City's Underflow wells (up to 4,600 AF/yr) and the basin wells (9,800 AF/yr) appear to meet the demands in the near future. However, the City may face groundwater supply shortages in the long-term. To address possible future groundwater supply shortages, the Urban Water Management Plan (Todd, 2000) considered three possible scenarios. The first of these is the continued use of groundwater alone, the second is the use of groundwater and imported surface water (Lake Nacimiento), and the third option is the use of groundwater in conjunction with recycled wastewater. The first of these three scenarios as explored in the Urban Water Management Plan is briefly summarized in the two paragraphs below. The other two are noted in later sections of this appendix.

In 2000, the total City water demand was 7,560 AF/yr, which was met by existing groundwater sources. Future water demands are expected to be nearly 150 percent of 2000 production as noted above. The Salinas River Underflow would provide 4,600 AF/yr, and the groundwater basin would provide the remaining 6,530 AF/yr. Although the current capacities of the City's wells appear to be sufficient to satisfy the future demand, the City could face water supply limitations. These limitations include competition for water supplies both on a local and regional level, inability to install and operate additional City wells beyond the current City limits, and the possibility of creating overdraft conditions in the basin (Todd, 2000).

Considering the Paso Robles Groundwater Basin as a whole, agricultural pumpage currently accounts for 69% of total basin pumpage. Depending on new trends (e.g., continued addition of vineyards) or additional water demand exerted by the agricultural industry, the basin pumpage could approach or exceed the perennial yield in the near future. Domestic demand (municipal, small community systems, and rural domestic) has increased at a steady rate since 1980, and this trend is expected to continue. Fugro (2002) indicated future water demands for the area (based on domestic and agricultural growth as developed in the 1998 San Luis Obispo County Master Water Plan Update) to be 120,620 AF/yr by the year 2020. If and when this future water demand exceeds the perennial yield of the Paso Robles Groundwater Basin, an additional water supply source for the area will be required if basin overdrafting is to be prevented.

3.3.2.4 Quality

In water produced by the deep Paso Robles Groundwater Basin wells, TDS concentrations generally range from 300 to 1000 milligrams per liter (mg/L), averaging 450 mg/L (Todd, 2000). The corresponding range for Salinas River Underflow well water is 300 to 800 mg/L, with a somewhat higher (540 mg/L) average (Carollo, 2001b).

According to Fugro (2002), the quality of the groundwater in the basin is relatively good with a few areas of poor quality. They identified six major water quality degradation trends for the basin as a whole as listed below. In some cases, only one well was used to determine the trend indicated, so additional data would, in most cases, be needed to confirm that they were representative of more widespread conditions. The trends identified are:

- Increasing TDS and chlorides in shallow Paso Robles Formation deposits along the Salinas River in the central Atascadero subbasin. The most visible trend of water quality deterioration is in a shallow well (105 ft deep) located in the Salinas River valley, approximately one mile downstream of the City of Atascadero wastewater percolation ponds. Available data from this well (28S/12E-14K01) indicate TDS concentrations increasing by approximately 10 mg/L per year.

- Increasing chloride concentrations in the deep, historically artesian aquifer in the area northeast of Creston.

- Increasing TDS and chlorides near San Miguel.

- Increasing nitrates in the Paso Robles Formation in the area north of Highway 46, between the Salinas River and the Huer Huero Creek.

- Increasing nitrates in the Paso Robles Formation in the area south of San Miguel.

- Increasing TDS and chloride concentrations in deeper portions of the aquifer near the confluence of the Salinas and Nacimiento Rivers.

In a report authored by the DWR in 1981, they concluded that the salt loading of the Salinas River Underflow was attributable to mineralized flows from wells and springs and to the City of Paso Robles wastewater treatment plant discharges. Recently, Fugro (2002) concluded, however, that the deep geothermal waters are not deteriorating the quality of the groundwater near the City of Paso Robles. Through their study they found that there is no increase in concentration of TDS, sodium, or chloride with increased well depth. However, their conclusions were based upon limited data and recommend that additional data be collected over time to verify their conclusions. Figure 50 from the Fugro (2002) report illustrates TDS concentrations across the Paso Robles Groundwater Basin. In general, elevated concentrations of TDS are present downgradient of both wastewater treatment plants, as well as throughout the Groundwater Basin. The widespread presence of elevated TDS concentrations is indicative of other TDS sources (anthropogenic or natural) in addition to wastewater discharges.

4.0 RECYCLED WATER (POTENTIAL FUTURE SOURCE)

4.1 Water Rights

The 2001 Comprehensive Recycled Water Study (Carollo, 2001a) provided the City with a detailed evaluation of the City's water recycling options and associated project scenarios and estimated costs. Relative to water rights, the report makes several points:

- Ownership of effluent from a wastewater treatment plant is a current legal concern. When treated wastewater is discharged to a surface water, as it is in Paso Robles, there are currently unresolved issues between dischargers and downstream water users regarding the ownership of the water.
- When either the purpose of use or point of discharge of treated wastewater is changed, approval must be obtained.
- If a municipality discharging to a surface water body desires to obtain an equal amount of water downstream of the point of discharge, water rights must be considered.
- Adoption of a groundwater management plan may introduce other water rights issues.

The report also mentions that many farmers fear that accepting recycled water would force them to give up existing groundwater or surface water rights. However, some water rights protection is provided under the Water Code for recycled water users.

4.2 Recycled Water Alternatives/Magnitude

The City currently does not recycle any of its treated wastewater. Wastewater recycling has been noted as a means to address possible future groundwater supply shortages (Todd, 2000) and has also been investigated in detail (Carollo, 2001a) to address a RWQCB requirement.

Groundwater recharge was investigated in the 2001 Comprehensive Recycled Water Study as a potential alternative to river discharge of treated wastewater, and the major findings are summarized below:

- Two main groundwater recharge methods are currently recognized and regulated by the California Department of Health Services: spreading basins and direct injection. Other types of wastewater disposal (e.g., evaporation/percolation ponds) that may incidentally result in groundwater recharge, but are not designed for it, are not considered recharge facilities.

- Surface spreading facilities would not be easily located, because the suitable soils for recharge are located near the Salinas River, and are, therefore, too close to existing water supply wells.

- Direct injection facilities would be difficult to site because of similar issues: it would be difficult to site injection facilities both sufficiently far away from existing water supply wells and in a favorable hydrogeologic location.

- For both types of groundwater recharge projects, a benefit to the groundwater would have to be demonstrated, and this would be complicated by the generally high TDS content of the wastewater plant effluent.

The 2001 Comprehensive Recycled Water Study identified over 50 potential recycled water customers of various types (e.g., industries, parks, golf courses). This information is summarized in Table 4.1 of the study report (Carollo, 2001a). Two of the identified industries in the area were considered potential recycled water users. The majority of potential recycled water uses in the area are irrigation (landscape and agriculture). Of these, 45 sites were identified as potential recycled water users for landscape irrigation and include a cemetery, parks, golf courses, schools, land developments, and others. Four potential agricultural sites were identified (three vineyards and one farm).

Although it is not stated specifically in the 2001 Comprehensive Recycled Water Study, it appears that the potential recycled water demand is high enough to allow all of the City's treated wastewater flow to be applied to recycled water uses during the warmer months. A treated wastewater flow of 2.9 MGD is roughly equivalent to 270 AF/mo. Over the roughly 900 acres of potential landscape irrigation applications, this is approximately equal to 3.6 inches of precipitation, less than the irrigation demand for the April-October time period indicated in Table 4.3 of the study. Recycled water demand could exceed the wastewater flow for more months throughout the year if agricultural areas and vineyards participate as well. Their potential acreage is much higher than that of irrigated landscaped areas.

The study discusses effluent disposal alternatives in addition to potential recycled water applications. Even with a large number/high acreage of recycled water participants, recycled water would not be needed for irrigation during the generally rainy winter months. The study's findings regarding these disposal alternatives are summarized in **Table A-7** below. Wetlands habitat creation as a method of wastewater disposal was also considered but ruled out due to the unsuitability of area soils.

Table A-7. Summary of Effluent Disposal Alternatives

Disposal Alternative	Summary of Findings
Continued River Discharge	City already implementing. Required shallow monitoring well data indicate no water quality impact on local groundwater.
Evaporation Ponds	Siting relatively easy but impermeable soils (low percolation) require large ponds.
Percolation Ponds	Siting difficult - favorable soils for percolation typically located in flood plain.
Evaporation/Percolation Ponds	Gypsum may be used to aid percolation in clay areas and allow a pond to be located out of the flood plain area, but with a smaller size than an essentially evaporation-only pond.

Information from Sections 2 and 3 of 2001 Comprehensive Recycled Water Study (Carollo, 2002a)

4.3 Quality

Different levels of water quality are required for different recycled water uses. Generally, the level of treatment required increases with the degree to which humans will be in contact with the recycled water application. For example, the water quality standards and treatment levels for recycled water to be used for spray irrigation of food crops are significantly higher than those set for landscape irrigation in areas of limited public access. Tables 2.2 and 2.4 of the 2001 Comprehensive Recycled Water Study summarize the existing and proposed recycled water treatment regulations, respectively. **Table A-8** summarizes the report's conclusions regarding potential recycled water applications in the City of Paso Robles according to recycled water types (quality/treatment levels).

Table A-8. Summary of Recycled Water Types and Compatibility of City Facilities

Recycled Water Type	Compatibility of City Wastewater Treatment Facilities
Disinfected Tertiary	Would require significant facility upgrades (e.g., the addition of a solids contact basin, tertiary filtration, and chlorine contact basin upgrades).
Disinfected Secondary – 2.2	Would likely require filtration and has no proposed matching uses. Was not considered further.
Disinfected Secondary – 23	City nearly meets criteria with existing level of treatment. Would likely only require increased chlorine dose.
Undisinfected Secondary	(not evaluated in report – suggests that City effluent already meets or exceeds criteria)

Information from Sections 2 and 3 of 2001 Comprehensive Recycled Water Study (Carollo, 2002a)

Given the disposal alternatives and compatibility of existing City facilities with recycled water types, five alternative scenarios for treated wastewater reuse and disposal were developed in the 2001 Comprehensive Recycled Water Study. These scenarios described project requirements, siting considerations, and costs. They are discussed in detail in the study and are summarized in **Table A-9**.

4.4 Regulatory Drivers/Requirements

As noted in Section 2 of this appendix, the City's treated wastewater is currently discharged to the Salinas River. The RWQCB has required the City to investigate alternatives to continuing to discharge to the river, noting that the City is the only remaining municipal system discharging into the Salinas River. The City has been notified that the RWQCB generally encourages wastewater reclamation, and that prior to the February 2005 renewal of the City's NPDES permit, the RWQCB will closely review whether the City should be allowed to continue to discharge to the Salinas River (Briggs, 1999). Therefore, although the City is not currently under a requirement to cease its treated wastewater disposal to the river, it appears that this will become a regulatory requirement.

Table A-9. Reuse and Disposal Scenarios

Scenario	Selected Features	Water Delivered	Capital Cost	Annual O&M Cost	Cost
#1 – Irrigation reuse with storage	∉# avoids river discharge ∉# requires new treated wastewater long-term storage reservoir (~4,500 AF) ∉# requires tertiary treatment and distribution facilities for delivery to irrigation users	10,305 AF/yr	$54.6 M	$3.1 M/yr	$610/AF
#2 – Irrigation reuse with river discharge	∉# river discharge still required for non-irrigation season and when treated wastewater flow exceeds reuse demand ∉# requires short-term storage basin (~1.3 MG) ∉# requires tertiary treatment and distribution facilities for delivery to irrigation users	4,369 AF/yr	$12.5 M	$1.3 M/yr	$470/AF
#3 – Community-based reuse with river discharge	∉# river discharge still required for non-irrigation season/times and when treated wastewater flow exceeds reuse demand ∉# requires short-term storage basin (~2.6 MG) ∉# requires tertiary treatment and distribution facilities for delivery to community-based (generally accessible to the public) uses	2,912 AF/yr	$54.6 M	$1.4 M/yr	$1,570/AF
#4 – Evaporation ponds in highlands	∉# avoids river discharge ∉# requires ~80 acres of evaporation ponds ∉# #4a requires gypsum addition to aid percolation (~1,500 lb/day) and ~15 acres of ponds	4,369 AF/yr	$8.5 M	$98,000/yr	$140/AF
#4a - Evaporation/perc. ponds with chemical addition			$4.3 M	$258,000/yr	$120/AF
#5 – Percolation ponds in lowlands	∉# requires ~ 9 acres of percolation ponds in flood plain (RWQCB and Army Corps of Engineers approval)	4,369 AF/yr	$3.6 M	$46,000/yr	$60/AF

Information from Sections 5 and 6 of 2001 Comprehensive Recycled Water Study (Carollo, 2002a)

The 2001 Comprehensive Recycled Water Study notes that implementation of a reuse project would require compliance with California Water Code Title 22 and possibly the Groundwater Recharge Guidelines from the Department of Health.

4.5 Recycled Water Conclusions

The main conclusion of the 2001 Comprehensive Recycled Water Study is that traditional reasons for a municipality to consider water recycling are not in place in the City of Paso Robles. The reasons cited are:

- The City currently meets its NPDES permit
- There is no imminent shortage of potable water
- All irrigation demands are currently being met with groundwater
- The cost for reuse water exceeds the cost of other water supply options

It should be noted that based on information available, the first bullet above is not accurate; the City has been out of compliance with its effluent limitations for TDS, chloride, and sulfate, as noted in Section 2 of this appendix.

Other concluding points made include:

- Analyses of recycled water projects should be conducted based on costs, but also consider non-economic factors, including water supply reliability, political considerations, and public perception.

- Agreements between the City and the recycled water users are required.

- Depending on the application, water quality concerns such as salinity and nitrogen need to be considered in addition to the typical regulatory parameters (e.g., BOD_5, coliform) governing recycled water.

Todd (2000) also notes that Salinas River Underflow is used for municipal water supply by San Miguel and for irrigation downstream, and that reducing effluent discharge to the river if a reuse project were implemented would decrease recharge to groundwater and diminish available water for reuse downstream.

5.0 SURFACE WATER (POTENTIAL FUTURE SOURCE)

To address the City's possible future groundwater supply shortages, the Urban Water Management Plan (Todd, 2000) considered three possible scenarios. The first of these is the continued use of groundwater alone, the second is the use of groundwater and imported surface water (Lake Nacimiento), and the third option is the use of groundwater in conjunction with recycled wastewater. Regarding the second option, Todd (2000) concluded that it would be prudent for the City to consider Lake Nacimiento as a supplemental water source to increase water supply reliability and to ensure long-term sustainability of the City's water supply. The Urban Water Management Plan also briefly addressed the City's potential to import California State Water Project water from the California Aqueduct, noting that the SWP is already unable to fulfill its maximum entitlements to its existing contractors.

The San Luis Obispo County (SLO County) Flood Control and Water Conservation District has a 17,500 AF/yr entitlement from the Nacimiento Reservoir (Lake Nacimiento) based on an agreement executed with Monterey County in 1959 (Carollo, 2002). SLO County has been considering the transmission and distribution of this entitlement water to North and South SLO County water purveyors for many years. Of the 17,500 AF/yr, 16,200 AF/yr have been allocated for future use by North and South SLO County water purveyors, and the remaining 1,300 AF/yr have been reserved for local lakeside use (Carollo, 2002). When water purveyors were asked to submit requests for water from the Nacimiento Reservoir, the City of El Paso de Robles (City) submitted a request for 4,000 AF/yr (3.57 mgd, 5.52 cfs) on average with a peaking factor of 1.3 to be delivered at three locations in the City system (Carollo, 2002). The amount of water requested by the City and fourteen other purveyors totaled 13,575 AF/yr, leaving 2,625 AF/yr of the 16,200 AF/yr available as contingency for SLO County (Carollo, 2002).

According to Todd (2000), if the Nacimiento water supply is added, it will not be used or will not be ready until 2010. Therefore, a combination of Underflow and Basin groundwater would continue to be the City's water source until 2010. After 2010, Lake Nacimiento water would supply 4,000 AF, and the remaining projected supply (5,345 AF) would come from a combination of Salinas River Underflow and deeper groundwater. Therefore, excess groundwater production capacity would exist, which would allow some low-yield wells to be destroyed, if desired, and would allow for an emergency supply to build up in the basin.

Todd (2000) notes that the City of Paso Robles would benefit in several ways if they did use the surface water supply from Lake Nacimiento:

- The imported surface water supply would be independent of the local groundwater supply. By using an imported source of water, the aquifer is allowed to replenish, allowing groundwater levels to recover. This would be very important especially if the basin is considered to be in overdraft.

- The TDS for Lake Nacimiento water averages 150 to 300 milligrams per liter (mg/L). If this source of water were blended with the groundwater, the quality of the water served to the City customers would improve with respect to TDS. In addition, introducing a relatively low TDS water source to the City would result in lower wastewater discharge TDS concentrations and an increased ability of the City to meet its effluent discharge requirements.

There are two basic ways that the City could begin participation in the transmission and distribution of water from Lake Nacimiento ("Nacimiento Project"): either (1) by importing raw (untreated) water from the lake or (2) by receiving treated lake water.

Raw water would not be suitable for direct delivery to City customers or blending with existing groundwater supplies, but could be used to recharge the Salinas River Underflow groundwater supply. The potential benefits to this approach are that (1) City costs to help construct a water treatment plant are deferred, while the City is only accepting raw water, perhaps for 10 years, and (2) water storage and water rights associated with the Salinas River Underflow supply are enhanced by the addition of the imported surface water. A drawback to importing raw water for recharge is that the City would not realize the full benefit of the relatively low-TDS lake water, both in terms of drinking water quality and wastewater effluent quality. That is, if the low-TDS lake water is recharged into the Salinas River Underflow, it will mix with the existing high-TDS shallow groundwater and likely only partially be recovered in City wells completed in that zone. It is Malcolm Pirnie's understanding that this Project participation option (importing raw water) was introduced a number of years ago before water and wastewater quality issues were considered as critical as they are today.

The second of the two options (the City participating in the implementation of a regional drinking water treatment plant and receiving treated water deliveries) would require the City to bear the costs of the water treatment plant sooner than the first option. However, it would result in the delivery of finished potable water suitable for direct delivery to customers or blending in the distribution system with existing groundwater supplies, provided the potential water quality effects of blending are addressed. It is Malcolm Pirnie's understanding that the Nacimiento Project Environmental Impact Report (EIR) is still in draft form and may be finalized during the first quarter of 2003. The City needs to make a decision regarding its participation in the Nacimiento Project by Spring 2003.

5.1 Water Rights

Based on available information, the City has not executed an agreement for Nacimiento water with SLO County, nor has it secured water rights for any Nacimiento water. The City currently participates in the Nacimiento Participants Advisory Committee to work on issues common to the potential Project participants.

5.2 Magnitude

Per the City's request, SLO County is planning to provide the City 4,000 AF/yr of Nacimiento Project water on average with a peaking factor of 1.3 to be delivered at three locations in the City system (Carollo, 2002). Of the fifteen purveyors that requested water from SLO County, the City requested the greatest amount. Other requests ranged from 30 to 3,380 AF/yr.

5.3 Quality

5.3.1 Raw Water Quality

Tables A-10 to A-13 present Lake Nacimiento raw water quality data as compiled by Boyle (2002), along with the corresponding finished drinking water quality standards. The time period that these raw water data represent is not reported except where noted; however, based on the temperature data, they appear to include both winter and summer values. All lake monitoring results are exactly as reported by Boyle (2002); however, some of the finished drinking water standards and comments were edited for the following tables for clarity.

Table A-10. Lake Nacimiento Inorganic Mineral Water Quality

Parameter	Measured Values	Finished Drinking Water Standards
Calcium	19 to 30 mg/L	
Magnesium	9 to 13 mg/L	
Sodium	6 to 10 mg/L	
Chloride	8 to 12 mg/L	500 mg/L[2]
Bicarbonate	70 to 110 mg/L	
Nitrate	< 2 mg/L	45 mg/L (as NO_3^-)[1]
Iron	0.08 to 1.24 mg/L	0.30 mg/L[2]
Manganese	0.01 to 2.8 mg/L	0.05 mg/L[2]
Alkalinity (as $CaCO_3$)	90 to 134 mg/L	
Hardness (as $CaCO_3$)	84 to 128 mg/L	
TDS	150 to 300 mg/L	500 mg/L[2]
pH	7.3 to 8.9 units	6.5 to 8.5[2]
Temperature	9°C to 23°C	
Langelier Index	-1.2 to 0.9	> 0 (non-corrosive)[2]

adapted from Boyle (2002)

Notes:
[1] Primary Maximum Contaminant Level
[2] Secondary Maximum Contaminant Level

Table A-11. Other Lake Nacimiento Water Quality Parameters

Parameter	Measured Values			Finished Drinking Water Standard/Required Treatment
	Min	Avg	Max	
Total Organic Carbon (TOC)	3.3 mg/L	4.1 mg/L	5.2 mg/L	15 to 35% removal depending on alkalinity[1]
Turbidity	1.4 NTU	10.5 NTU	25.8 NTU	0.5 NTU (95% of the time)[2]
Color Units (CU)	7 CU	19 CU	33 CU	15 CU[3]

adapted from Boyle (2002)
Notes:
[1] Stage 1 Disinfectant/Disinfection By-Products Rule
[2] Primary Maximum Contaminant Level
[3] Secondary Maximum Contaminant Level

Table A-12. Lake Nacimiento Water THM Test Results

Chlorine Residual	THMs Formed* Depth of Water Sample	
	5 feet	80 feet
0 mg/L	< 1 σg/L	< 1 σg/L
1	33	28
3	129	125
4	160	175
5	180	186
6	201	227

adapted from Boyle (2002)

* Note that the formation of THMs observed is based on the chlorination of *raw* water. Disinfection with chlorine would likely occur after the coagulation, flocculation, and filtration processes have removed a significant portion of the THM precursors in the form of TOC. Much lower THM formation would, therefore, be expected during treatment of Lake Nacimiento water.

Table A-13. Variations of Langelier Index, Temperature, and Iron and Manganese Concentrations by Depth in Lake Nacimiento

Parameter	Water Depth in Feet		Comments
	5 feet	80 feet	
Langelier Index	+0.1 to +0.5	-0.7 to –1.2	<0 values indicate corrosive water
Temperature (^oC)	12 to 23	8 to 9	
Manganese (mg/L)	<0.005 to 0.017	0.012 to 0.042	0.05 mg/L[1]
Iron (mg/L)	0.08 to 1.02	0.28 to 2.80	0.30 mg/L[1]
Dissolved Oxygen (DO)	8.5 mg/L[a] 12.9 mg/L[c]	0.2 mg/L[b] 7.5 mg/L[d]	a. September 1993, 17.8^oC b. September 1993, 7.8^oC c. March 1993, 11.7^oC d. March 1993, 9.2^oC, 100 feet

adapted from Boyle (2002)

Note:
[1] Secondary Maximum Contaminant Level

Note that the Boyle (2002) report does not indicate the source of the water quality data, nor in most cases the sample collection dates. In order to perform a complete evaluation of a potential water supply, the range of water quality parameters under various hydrologic conditions (average, pre-drought, drought, and post-drought) should be well understood, since this could have a significant impact on the feasibility and cost of treatment and, consequently, the value of a water supply. Based on conversations with SLO County staff, Lake Nacimiento water quality data from 1993 to 2002 are available from SLO County and can be reviewed and summarized by Malcolm Pirnie upon the City's request.

- The Lake Nacimiento water is of suitable quality for use as a drinking water source provided appropriate treatment is practiced.

- TDS and hardness are relatively low and should not adversely affect treated water quality or treatment of the water.

- Problems might be experienced with iron, and possibly, manganese.

- The Langelier Index data indicate that the water has corrosive tendencies and may require corrosion control for drinking water use.

- The Langelier Index, temperature values, and iron and manganese concentrations vary somewhat with depth based on sample data provided.

- The DO concentrations in the Lake also vary considerably with respect to depth and temperature.

Based on available information, Malcolm Pirnie generally agrees with Boyle's conclusions regarding the quality of Lake Nacimiento water. Below are examples of additional issues to consider:

- Conclusions regarding the suitability of Lake Nacimiento water for drinking water are limited to the parameters for which water quality data are available. For example, the Boyle data does not include data on synthetic organic compounds, algal concentrations or other taste-and-odor causing compounds, or others that may affect the suitability of the lake for water supply use in addition to the ones summarized.

- The apparent seasonal stratification of the Lake can affect the quality of the water supply from the Lake. Various engineering solutions (e.g., multi-level intake ports, hypolimnetic oxygenation[1]) are available to address this issue.

- Based on a TOC concentration range from 3.3 to 5.2 mg/L and an alkalinity (as $CaCO_3$) concentration range from 90 to 134, the TOC removal requirement would range from 15 to 35% based on USEPA requirements.

- Concentrations of disinfection by-products (DBP) in delivered water would be expected to increase with increased distance between the treatment plant and each participating municipality, due to the increased detention time available for DBP formation.

[1] The three most viable intake options considered in the EIR Preparation Phase Engineering Report (Carollo, 2002) take this water quality variation with depth into account. Two of the options have multi-port intakes that allow the selection of water release elevations; the third option combines a single-port intake with a recommended study of stratification at the Lake.

5.3.2 Treated Water Quality

If a water treatment plant is constructed to treat Lake Nacimiento water, the treated water quality would be subject to all applicable laws, rules, and regulations related to drinking water quality at the federal and state levels. Under the Federal Safe Drinking Water Act (SDWA), the United States Environmental Protection Agency (USEPA) is responsible for setting all federal drinking water standards; however, the USEPA is also authorized to grant primacy to individual states, allowing them to administer and enforce the SDWA. A state with primacy must adopt and enforce every standard that the USEPA adopts, but the state also has the option of setting even more stringent standards than those of the USEPA and setting additional standards, if warranted. In California, a state with primacy, the agency responsible for the monitoring of drinking water quality and the enforcement of drinking water regulations is the Department of Health Services (DHS). Enforceable drinking water standards are called Maximum Contaminant Levels (MCLs), which are based on a chemical's health risk, detectability, treatability, and costs of treatment. Boyle (2002) also provides additional details regarding the state and federal regulations, including the Safe Drinking Water Act and its rules (e.g., Surface Water Treatment Rule) that apply to drinking water quality.

For treatment of surface water sources, such as Lake Nacimiento, the microbiological quality of the treated drinking water supply is often the primary concern. Therefore, the pre-design of the proposed water treatment plant prepared by Boyle focuses on an evaluation of the filtration process to be applied to Lake Nacimiento water, since this will determine the ability of the plant to meet microbiological and turbidity requirements. Filtration processes have varying levels of ability to remove/inactivate the microorganisms of primary concern, namely *Giardia*, viruses, and *Cryptosporidium*, as reflected by the different removal "credits" (measured by # of *log* removals) assigned by the DHS to different filtration processes. The following filtration processes were considered by Boyle (2002) for the water treatment plant to treat Lake Nacimiento water:

- Conventional treatment – a sequence of processes including rapid mixing, flocculation, sedimentation, and gravity filtration through either dual media or deep bed granular activated carbon (GAC) filters;

- Actiflo® Process with Conventional Filtration – proprietary system that involves the addition of "Microsand" to accelerate settling of particles, thus resulting in reduced detention time and area requirements relative to conventional filtration; and

- Membrane treatment – uses thin polymeric films with very small pores that exclude solids with large diameters, such as *Giardia* and *Cryptosporidium* cysts.

The first two technologies are granted the same removal credits by the DHS, while membrane treatment has a higher removal credit for *Giardia*. For example, while membrane filtration can consistently achieve 6-log removal of *Cryptosporidium* oocysts and *Giardia* cysts (which is much higher than the minimum 3-log removal/inactivation required for *Giardia* and the minimum goal of 2-log removal/inactivation for *Cryptosporidium* oocysts), conventional rapid-rate filtration typically only achieves the 2 to 3-log removal required.

Disinfection of Lake Nacimiento water is also a key consideration in the design of the water treatment plant since: 1) water quality regulations require that disinfection be used as one

of the primary barriers against *Giardia* and viruses[2] that are not removed by other treatment processes, and 2) a disinfectant residual concentration is required in the distribution system. Compliance with the D/DBP Rule is one of the key factors to consider in selecting treatment technologies to both achieve microbial control and produce sufficiently low concentrations of disinfection by-products. Four of the most commonly-used disinfectant chemicals and the potentially most problematic regulated by-products associated with each are shown in **Table A-14**. (Trihalomethanes and haloacetic acids are indicated for both free chlorine and chloramines, although it is understood that for a given water, chloramine disinfection will tend to result in significantly lower by-product concentrations than will free chlorine.)

Table A-14. Disinfection Chemicals and Their Regulated By-Products [3]

Disinfectant	Maximum Residual Disinfectant Level Goal	Critical Regulated By-Products	By-Product MCL (D/DBP Rule)
Chlorine	4.0 mg/L	THM HAA_5	80 σg/L 60 σg/L
Ozone	-	Bromate	10 σg/L
Chlorine Dioxide	0.8 mg/L	Chlorite Chlorate	1.0 mg/L
Chloramine	4.0 mg/L	THM HAA_5	80 σg/L 60 σg/L

Given its TOC levels, Lake Nacimiento water has the potential to form THM and HAA_5 levels in excess of the current MCLs upon chlorination. The potential for bromate formation with ozonation is unknown since levels of bromide ions, which react with ozone to form bromate, are unavailable. Many major water purveyors (including the Metropolitan Water District, East Bay Municipal Utility District, and the San Francisco Public Utilities Commission) have turned to or will be turning to chloramination as a primary means of disinfection in order to meet the D/DBP Rule, since the use of chloramine significantly reduces the formation of THMs and HAAs. For this reason, chloramine is an attractive choice for disinfecting Lake Nacimiento water; however, the use of chloramine would preclude the blending of Lake Nacimiento water with water disinfected with chlorine. The blending of chlorine- and chloramine-disinfected water results in erratic disinfectant residuals and, therefore, should be avoided. Given Lake Nacimiento water's role as a supplemental supply likely to be mixed with water from other sources disinfected with chlorine (e.g., the City's groundwater and river underflow supply), the use of chloramine is generally not advisable (Boyle, 2002).

In its report, Boyle (2002) proposes the use of UV technology for primary disinfection, with chlorine as a secondary disinfectant. To avoid excess formation of THMs and HAA_5, precursors (TOC) are proposed to be removed using GAC.

As discussed above, a variety of treatment process options are available to produce treated Lake Nacimiento water that meets all of the applicable drinking water regulations. The characteristics of the finished water may vary somewhat depending on the type of process selected.

[2] *Cryptosporidium* inactivation is presently not required but is likely to be required in the near future.
[3] Stage 1 Disinfectant/Disinfection By-products Rule

When considering blending waters from different sources, careful consideration must be given to water chemistries, blending proportions, distribution system and residential plumbing materials, and water quality goals before implementation. Other communities (e.g., Tucson, Arizona) have experienced significant water quality and aesthetic problems when introducing new water sources into their distribution systems without full prior consideration of the possible effects. Paper studies (such as this water/wastewater quality strategy project) provide valuable information, but typically bench-scale and/or pilot-scale studies are required to follow up the paper studies before the source water switch/blend is implemented. This is because the complex interactions of water chemistry, microbiology, and pipe materials are highly specific and should be investigated as such to prevent adverse water quality and aesthetic problems.

5.4 Costs

The capital costs of providing raw and treated Lake Nacimiento water to SLO County water purveyors were estimated by Carollo (2002) to be $146.2 M and $188.5 M, respectively. Because these are conceptual-level cost estimates, Carollo cautions that the actual costs may range from 50% higher to 30% lower than estimated costs. The treated water supply alternative assumed includes: 64 miles of 8-inch to 36-inch diameter pipeline, a multi-port intake at the Nacimiento Reservoir, a water treatment plant, three pump stations, three storage reservoirs, and a connection to the Chorro Valley pipeline. The raw water supply alternative includes all of the above facilities except for the water treatment plant. The City will be responsible for all facilities beyond the turnout(s) to its system from the transmission pipeline carrying raw or treated water. It is Malcolm Pirnie's understanding that the City of Paso Robles is an active member of the Nacimiento Participants Advisory Committee, which is continuing to work on potential Project costs and distribution of costs among participants.

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