3.0 ALTERNATIVES COMPARISON

3.1 INTRODUCTION

As discussed in Chapters 1 and 2, the City is currently facing several interdependent issues associated with wastewater discharge compliance. This chapter presents the development of a number of alternatives to address the issues, the criteria to evaluate the alternatives, and a relative ranking of the alternatives to determine the most desirable alternative(s) to move forward toward implementation. This summarizes the following aspects of the alternatives comparison:

- Preliminary alternative solutions developed by the City
- Additional alternative solutions developed by Malcolm Pirnie
- Evaluation criteria developed by the City and Malcolm Pirnie
- Ranking methodology for the alternative solutions
- Results of the alternative ranking evaluation

The analyses described in this chapter are planning-level. That is, they were conducted at a level of detail appropriate for understanding the likely positive and negative aspects of each candidate alternative, and their relevance to developing an overall water and wastewater quality strategy for the City. The information herein incorporates the information and analyses summarized in the previous two chapters and the Appendix A summary of efforts to date.

3.2 ALTERNATIVES CONSIDERED

The City developed several conceptual alternative solutions that may be implemented to address the potable water supply and wastewater effluent discharge/reuse issues facing the City.

- Do nothing

- Import treated water from a regional water treatment plant and blend it with existing groundwater supply

- Desalinate well water supply

- Desalinate wastewater (possibly for reuse application)

Malcolm Pirnie worked with the City and performed document reviews to understand work to date on these topics and develop those conceptual solutions into planning-level alternatives. Malcolm Pirnie also developed additional alternative solutions. Many of the following alternatives are not mutually exclusive (i.e., could be implemented in conjunction with each other) and in the following chapter of this report, combinations of the alternatives are considered to most efficiently meet effluent TDS standards and realize other benefits.

This section (3.2) briefly presents each alternative. The following section (3.3) discusses the criteria used to evaluate each alternative's relative attractiveness to the City. Finally, Section 3.4 presents the evaluation of each alternative, including conceptual-level costs for each, a comparison matrix for all alternatives, and a summary cost table.

1. **Do Nothing**

Under this alternative, the City would continue to treat and discharge wastewater into the Salinas River using the City's existing wastewater treatment plant, and rely entirely on its existing groundwater sources for its water supply. The "do nothing" alternative represents no change from the current condition.

2. **Achieve Greater Industrial and Commercial Discharge Quality Control**

The 2001 Salt Management Plan (Carollo, 2001b) indicated that reduction in TDS loading from the City's commercial facilities and industries was a possible method to reduce TDS concentrations in the City's treated wastewater discharge to the Salinas River. The City's four quarters of salt monitoring (City of El Paso de Robles, 2003b), which was conducted in response to one of Carollo's recommendations, confirmed that there are TDS concentrations in the City's wastewater collection system that exceed the City's Sewer Code limit of 1000 mg/L. Implementing this alternative involves the City successfully working with local businesses to reduce the TDS content of their discharges to consistently meet the City's existing Sewer Code limit (or better) to reduce TDS loading to the City's wastewater treatment plant.

3. **Participate in Nacimiento Project (Treated Water Option)**

This alternative calls for the City to participate in, and share the costs and benefits of, a regional project to transmit and treat water from Lake Nacimiento. The current level of City participation is planned to be 4,000 AF/yr of the 16,200 AF/yr available. The City would share in the design and construction of both the transmission infrastructure and a regional water treatment plant, and would receive deliveries of treated water.

The imported treated Lake Nacimiento water would be used to supplement the water produced by the City's existing groundwater wells. Based on the City's Water Master Plan (Boyle, 1995), there are three planned turnouts in the West Zone of the distribution system that would connect to the Nacimiento Project transmission line. For the East Zone of the City's distribution system, (an) additional turnout(s) may be necessary to equitably distribute the higher quality Lake Nacimiento treated water throughout the entire City. Hydraulic modeling to build on that performed by Boyle (1995) may be required to help the City define the need and location for any distribution system modifications in the East Zone.

4. **Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-owned Plant**

This alternative involves participating in the raw water option of the Nacimiento Project, and features a water treatment plant dedicated to serving the City of Paso Robles, as opposed to a regionally owned and operated plant serving multiple (or all) Project participants. Under the raw water alternative, Project participants would receive raw water deliveries and be responsible for treating and delivering, or otherwise using, the Project water. Either a regional or a City-dedicated water treatment plant would be capable of producing high-quality finished water suitable for blending with existing City groundwater supplies.

5. **Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-owned Plant**
This alternative is similar to #4 above, in that the City would be treating Lake Nacimiento water with its own treatment plant. However, this alternative assumes that the City cannot (or chooses not to) participate in the Nacimiento Project and its regional infrastructure. Therefore, under this alternative, the City would be paying for, and be responsible for, its own reservoir intake, transmission facilities, and treatment plant. This assumes that the City would have rights and access to 4,000 AF/yr of Lake Nacimiento water independent of the Nacimiento Project; this would have to be investigated if the City decides to move forward with this alternative.

6. **Participate in Nacimiento Project (Raw Water Option) to Recharge Salinas River Underflow**
This alternative involves participating in the Nacimiento Project and importing the planned amount of 4,000 AF/yr as raw (untreated) water from Lake Nacimiento. This was originally conceived as a first phase of a "phased approach" to City participation in the Nacimiento Project: importing raw water for local recharge for approximately 10 years prior to the implementation of a water treatment plant. Raw water would not be suitable for direct delivery to City customers or blending with existing groundwater supplies in the City's water system, but could be used to recharge the Salinas River Underflow groundwater supply.

7. **Desalinate Well Water Supply**
This alternative involves the desalination of a portion of the City's existing potable groundwater supplies so that the City's wastewater would contain lower TDS concentrations. As described in Chapter 1, the City currently pumps 100% of the City's potable water supplies from the City's Salinas River Underflow (shallow groundwater) and Paso Robles Groundwater Basin (deep groundwater). Under this alternative, wells that have the highest TDS concentrations would be treated using a reverse osmosis (RO) treatment process to lower TDS concentrations. Among the 16 wells that are currently in operation, Malcolm Pirnie evaluated RO treatment for the 7 wells that have TDS above 450 mg/L. For comparative purposes, this was done to achieve an average water system TDS concentration of approximately 350 mg/L, roughly equivalent to the water system TDS concentration if 4,000 AF/yr of Lake Nacimiento water were imported and blended with existing groundwater.

The entire flow from a well would not be treated by RO and delivered to the system because the low TDS, hardness, and alkalinity of RO treated water can be very aggressive in terms of corrosion and pipe-scale dissolution. To avoid issues from overly soft and aggressive RO treated water, this evaluation considered splitstream treatment, wherein a portion of the well water is by-passed and treated by RO to produce a blended water of 300 mg/L TDS from each selected well or well cluster. This would in turn be blended with the water from the remaining wells (the wells that would not be desalinated) to supply the distribution system.

Selectively desalinating a portion of the groundwater supply will reduce the TDS concentrations in the WWTP influent and effluent waters. Approximately 15 to 20 percent of the RO feed water will end up as reject or concentrate stream, which would need to be disposed of. There are several ways this might be accomplished. Evaporation ponds were considered throughout this evaluation (i.e., this alternative and all others featuring desalination) for comparative purposes. Evaporation pond size is a function of RO feed and reject flows. The evaporation ponds should have liners to prevent salt from leaching through the sub-surface. The cost for evaporating reject or concentrate stream water is fairly expensive. The RO reject or concentrate stream may not be put to the sewer because that would defeat the goal of desalting which is to lower the TDS in the WWTP influent water. However, another option may be to send the reject stream to the ocean. This option would require the installation of a piping network in the City to collect the reject water from each desalting location and the installation of a pipe that would transfer the reject water from the City to the ocean. Other San Luis Obispo County municipalities may be interested in working with the City to design and construct the transfer pipe to the ocean. Although this option is not considered in detail in this report, further investigation could be performed to determine the viability of the option.

Desalting can also be performed on clusters of wells that are physically located in close proximity. For example, instead of treating the Thunderbird wells individually, it is possible to bring them to a central location and treat at the clustered location. Costs for clustering treatment will be lower. From an operation standpoint too, it requires less labor to maintain one central treatment facility than to maintain several small treatment plants.

Three of the City's Salinas River Underflow wells ("Ronconi" wells) are currently off-line because they have been determined to be under the direct influence of surface water. Although water quality data from these wells was not available for review, they are likely relatively high in TDS (i.e., between 500 and 600 mg/L), based on TDS results from other City wells completed in the Underflow. If the City desires, these wells could be brought back on-line if adequate treatment were provided. Specifically, a process such as microfiltration would need to be implemented to provide the level of treatment necessary to address the wells' surface water regulatory designation. This would be prior to, and in addition to, the reverse osmosis or equivalent process necessary to reduce TDS from these wells as necessary to meet the system TDS target as discussed above.

Re-activating these Ronconi wells is possible, but was not considered in detail in this report for three main reasons. First, doing so does not allow the City to realize any benefit related to its main goal of improving the TDS quality of its treated effluent. These wells are likely high in TDS and would require TDS removal just like the other high-TDS City wells that are already in operation. Second, re-activating these wells would be more costly than treating the existing wells in operation because of the additional surface water treatment step. Third, the City has sufficient well and pumping capacity to meet its water supply needs, so there is not a need to bring additional wells on line at this time.

8. Recharge WWTP Effluent (Without Desalination)

The City's treated wastewater could be directly recharged into local groundwater without any additional treatment such as desalination. This might be less costly than providing desalination of the City's effluent, but it would not provide the corresponding reduction in TDS load to local groundwater. Again, favorable locations for recharging based on local subsurface materials are generally in the flood plain of the Salinas River as previously reported (Carollo, 2001a) and therefore possibly difficult from a regulatory perspective U.S. Army Corps of Engineers (USACE) and possibly undesirably close to existing water supply wells. Appendix A contains more details on this issue.

9. Desalinate WWTP Effluent to Meet NPDES Discharge Limits

The effluent from the WWTP can be desalted using RO to satisfy the RWQCB discharge requirements for TDS. This alternative would require treatment of the secondary effluent using microfiltration (MF) to remove additional particulates and solids. It would only be necessary to desalinate a portion of the WWTP effluent to achieve effluent compliance. Desalinating a portion of the wastewater effluent to very low TDS levels and blending it back into the main waste stream is preferable to treating the whole flow to the target level. For comparative purposes, an 800-850 mg/L TDS target was selected, to be roughly equal to the WWTP effluent TDS that may result in the years following a potential import of Lake Nacimiento water. This target would be achieved by providing MF and RO treatment for roughly one-third of the City's wastewater flow (side-stream treatment) and recombining it with the remaining two-thirds of the secondary effluent for discharge to the river. An 800-850 mg/L TDS concentration is below the current NPDES permit requirement for TDS (1,100 mg/L) and would provide a reasonable margin of safety against non-compliance, based on historical WWTP effluent monitoring results. The RO waste stream would be sent to evaporation ponds.

Desalinating wastewater prior to discharge may also be necessary in conjunction with other alternatives to ensure that effluent standards are met. Specifically, as discussed in Chapter 2, importing treated surface water will provide a significant TDS benefit, but will not be operational for a number of years to allow for Nacimiento Project participant confirmation, design, construction, and startup. In the Chapter 2 scenarios, imported water was not expected to be on-line until 2007, for example. This alternative, to desalinate wastewater prior to discharge, could be implemented temporarily, to help ensure that effluent limits are met until the surface water project is operational.

10. Desalinate WWTP Effluent for Irrigation Reuse with Storage

In the Comprehensive Recycled Water Study (Carollo, 2001a), three potential reuse scenarios were developed, each requiring tertiary treatment, which can be achieved either by the unit processes presented in that report or by the MF/RO combination discussed in this report for wastewater effluent and well water applications. The scenarios were developed in detail in the Carollo study and are therefore not reproduced here. Appendix A (Table A-9) presents a summary of the reuse and other scenarios previously considered. Of the five main scenarios developed by Carollo and summarized in Appendix A, only the scenarios including wastewater disposal by evaporation are not considered further in this report, because the potential stakeholder concerns, land requirements, and lack of water supply benefits were considered to make these options relatively unattractive methods to cease river discharge as compared to the use and recharge scenarios developed. However, they still may be viable options. Briefly, the irrigation reuse with storage scenario enables the highest recycled water delivery volume per year of the scenarios considered, but is also the most expensive. It features additional wastewater treatment, recycled water distribution infrastructure, and a long-term storage basin to enable year-round ceasing of discharge to the river. Specifically, tertiary treated wastewater would be diverted into the storage reservoir during the non-irrigation season and put to use during the warmer months. This was the only reuse option developed by Carollo enabling the City to cease its Salinas River discharge year-round.

11. Desalinate WWTP Effluent for Irrigation Reuse with River Discharge

This scenario is very similar to the irrigation reuse with storage option, except that it includes a smaller storage option and therefore is not sufficient to cease river discharge year-round. The associated costs are significantly lower based on Carollo's evaluation.

12. Desalinate WWTP Effluents for Community-based Reuse with River Discharge

This is a similar scenario, but was developed for a different potential recycled water market. Like irrigation reuse with river discharge, storage capacity under this scenario is not sufficient to enable year-round avoidance of river discharge. This has a potentially lower recycled water volume delivered each year than the two reuse alternatives above, and Carollo indicates roughly the same capital costs as the irrigation reuse with storage option. Although this alternative requires less storage than alternative #10, capital costs have been estimated to be similarly high, due to the extensive recycled water distribution system necessary to deliver water to community-based reuse customers.

13. Desalinate WWTP Effluent for Recharge

As discussed above under alternative #6, recharging wastewater without desalination is theoretically possible, but likely infeasible because it would be difficult to demonstrate a benefit to the groundwater basin and gain approval for the project. Recharging desalinated wastewater, however, is an option that would be more feasible. Like the alternative involving desalination for river discharge, this alternative features side-stream treatment on the City's wastewater effluent to meet a target TDS level. As noted earlier in this section, the target TDS level for river discharge was set at 800-850 mg/L to provide an approximately equivalent alternative from a wastewater TDS perspective as imported surface water. For this recharge alternative to represent a benefit to the groundwater basin, the TDS concentration would likely have to be less than or equal to the average TDS concentration in area groundwater. TDS concentrations in the two main groundwater units underlying the City generally average between 450 and 550 mg/L, with the Salinas River Underflow unit generally showing higher TDS concentrations than the deeper Paso Robles Formation. Therefore, the minimum level of desalination considered for this alternative was that necessary to achieve a target of 450 mg/L[1].

14. Add East Site WWTP (Upstream Reclamation Plant)

This alternative would not directly address either of the primary project criteria (reduce TDS of all City WWTP discharge to below permit limits; cease discharge to the Salinas River) but would increase overall City WWTP capacity, allow discontinuation of wastewater pumping from the east side to the west side of the City, and would facilitate east side wastewater reuse/recharge if implemented as a tertiary treatment facility. This alternative was included here primarily for cost comparison purposes.

3.3 EVALUATION CRITERIA

Two primary criteria were used to evaluate each alternative: (1) whether or not the alternative reduced the TDS concentration at the City's treated wastewater to meet its existing effluent limit with a reasonable (~20%) margin of safety, and (2) whether or not the alternative would allow the City to cease discharge to the Salinas River year-round. To evaluate the relative attractiveness of each of the alternatives meeting one or both of these primary criteria, a number of secondary criteria were considered. Not all apply to each alternative, but they were selected to collectively cover all the major considerations from a planning-level pertinent to deciding to move forward with one or more of the identified alternatives. They are each described in this section, and then applied to each of the alternatives as described in Section 3.4 of this chapter.

[1] For the purposes of considering multiple or interim alternatives, RO treatment can be implemented modularly. That is, the City could install RO treatment to achieve the immediate 800-850 mg/L target for wastewater compliance for river discharge, then later add another module (e.g., 2 MGD) to remove additional TDS for recharge or reuse applications.

Water Supply Magnitude/Reliability

Although the immediate focus of the selected alternative will be to ensure the City's compliance with its wastewater effluent TDS limit, improving the City's water supply reliability may be a secondary benefit, depending on the alternative chosen. As noted in the Urban Water Management Plan (Todd, 2000), the City already has a certain amount of built-in "backup" – its wells are completed in two different aquifers, and are located in various spots throughout the City. If one well or well cluster experiences problems or needs to taken off-line, the City has numerous other wells and extra pumping capacity to continue to serve the City. As noted in the recent Groundwater Basin Study (Fugro, 2002), however, there are areas near the City experiencing water table depression. While the groundwater levels in the City's wells are currently stable, the nearby, localized decline in water levels indicates that the City's groundwater supplies are vulnerable to overdrafting. Importing surface water would serve to relieve the demand on local groundwater supplies, as well as add another level of system reliability. Therefore, those alternatives including importing surface water for water quality reasons were also viewed favorably in terms of their associated water supply reliability benefits. The degree to which each would increase water supply reliability was incorporated into the ranking of alternatives.

Groundwater Basin Levels

A criterion related to the water supply reliability discussion above involves ranking alternatives based on their ability to maintain or improve water levels in the Salinas River Underflow and/or Paso Robles Formation aquifers. Specifically, those alternatives that include augmenting existing groundwater supplies with surface water imports rate favorably in this area because they reduce the demand on local groundwater. Also, those alternatives featuring recharge benefit local groundwater basin levels by directly replenishing local groundwater. The degree to which each alternative would help to maintain or enhance current groundwater basin levels was taken into account during the ranking of alternatives.

Water Rights

Water rights are important to consider, not only in terms of the City's existing Salinas River Underflow rights, but also relative to alternatives featuring water recharge or recycling. Alternatives that would tend to preserve the City's existing Underflow water rights (i.e., continue current levels of pumping from Underflow wells) were considered more desirable than those that might jeopardize those water rights (i.e., decrease pumping from Underflow wells). As reported by Boyle (2002) and noted in Appendix A, if the Underflow 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. Therefore, those alternatives featuring recharge were considered beneficial from a water rights standpoint. Water recycling also introduces water rights considerations, though these are less well defined based on available information. For example, as noted in the

Comprehensive Recycled Water Study (Carollo, 2001a), ownership of effluent from a wastewater treatment plant where downstream users rely on the water is a current legal concern. Specifically, there are currently unresolved issues between dischargers and downstream water users regarding ownership of the water. Therefore, those alternatives that divert water from river discharge (although preferable from the RWQCB's point of view) were ranked as potentially problematic if downstream users were to claim ownership of the City's effluent.

Drinking Water Quality

Some of the alternatives under consideration will have no effect on the quality of the City's delivered water, while others will likely improve it. The clearest cases of this are the alternatives including imported treated surface water. They will result in the City's water becoming lower in both TDS and hardness, while maintaining relatively low concentrations of DBPs in the City's system as discussed in Chapter 2. Based on the water quality characteristics of Lake Nacimiento water and the City's existing groundwater supplies, blending the waters will not have any adverse water quality impacts provided corrosion control and disinfectant issues are properly addressed. Those alternatives that feature recharge of desalinated wastewater also offer a drinking water quality benefit, although less immediate. They will serve to reduce the concentration of TDS in water recharging local groundwater, and therefore would be expected to yield a net long-term benefit in regards to the quality of the City's pumped groundwater. The effect each alternative might have on the quality of the water in the City's water system was closely considered, and those alternatives that maintain or enhance the high quality of the City's drinking water were ranked favorably for this criterion.

Security/Vulnerability Position (U.S. Environmental Protection Agency [USEPA] Vulnerability Assessment Requirement)

An important overall water system feature considered during USEPA-required Vulnerability Assessments is redundancy of supplies. This was taken into account when ranking alternatives. Importing surface water or (to a lesser degree) implementing a reuse program would diversify the City's water supply sources and therefore reduce its risk of service disruption.

Capital and Operating Cost Competitiveness

Both capital and operating costs were considered for each alternative. In addition, life-cycle costs based on the net present value of each alternative were developed in order to enable direct comparisons among alternatives. To represent typical public works financing terms, a 20-year evaluation period and 7% discount rate were assumed for all alternatives. Sensitivity analyses using a longer evaluation period (30 years) and one-half percent interest rate fluctuations were also performed. Those costs that were incorporated from previous studies (e.g., Nacimiento Project costs, recycled water alternative costs) were modified if necessary so that this report presents all costs on equal bases and allows direct comparisons. The methodology used by others to develop previous cost estimates was not reviewed; cost estimates presented in other reports were assumed to be of high quality and incorporated directly here. Estimated costs presented in this report are necessarily not at the level of detail sufficient for final design and construction, but were developed for planning-level use and to enable comparison among alternatives, to help the City select the alternative(s) with which to move forward.

Regulatory Issues (Other Than Water or Wastewater Quality)

The main focus of this project includes complying with one regulation in particular: the City's current NPDES permit terms, which include TDS limits of 1,100 mg/L (an immediate concern), and the RWQCB's likely future directive to the City to cease its discharge to the Salinas River. As noted in Chapter 1, the City has difficulty consistently meeting its TDS, sodium, chloride, and sulfate limits[2]. Alternatives that do not address this critical regulatory issue are presented in this report, but not evaluated in any more detail than is appropriate. There are a host of other regulatory considerations associated with the various alternatives discussed in this report. The major ones are listed below, and others may be identified when one or more particular alternatives are moved forward toward implementation.

- NPDES Permit – the City's NPDES permit contains many other provisions besides effluent limits for TDS and related constituents. Any alternative selected will have to be consistent with all the terms of the City's NPDES permit, including its renewal, which was originally expected in February 2005, but is now imminent (Spring 2003).

- Water Supply Permit – a permit will be required from the California Department of Health Services if the City receives water from a new water source.

- Environmental Impact Report – environmental planning and documentation is required for any project with potentially significant impacts.

- Drinking Water Standards – the City must continue to comply with federal and state drinking water standards, and may need to meet surface water treatment requirements depending on the alternative(s) selected. In California, the Department of Health Services is the "primacy agency" responsible for implementing the drinking water program.

[2] In terms of water quality measurements and treatment technologies, TDS includes the three other constituents (sodium, chloride, and sulfate) of particular concern in the City's wastewater effluent. Therefore, for the purposes of discussing blending effects and the evaluation of alternatives in this report, the term "TDS" is used alone, although it is understood that the City's wastewater permit also addresses specific components of a TDS measurement.

- Brine Regulations – if the City selects an alternative involving brine evaporation or disposal, applicable requirements would need to be met. This would most likely involve ensuring the evaporation facility met RWQCB requirements for surface impoundments.

- Flood Plain Construction Regulations – as discussed in the Comprehensive Recycled Water Study (Carollo, 2001a), the USEPA would be involved if the City selects a recharge alternative that involves construction in the Salinas River flood plain.

- Water Recycling Regulations - as discussed in the Comprehensive Recycled Water Study (Carollo, 2001a), several agencies including the CA DHS, the State Water Resources Control Board, and the RWQCB have jurisdiction over recycled water projects in California. If the City decides to move forward with a recycling project, it will likely work through the RWQCB as the permitting agency.

Time Required to Implement

Because the City already has difficulty meeting its current effluent limits for TDS, this is a key consideration. Alternatives were evaluated in general terms for how many months or years from the present until they would be implemented and the City would be realizing the associated benefit. The time required for such common steps as coordination with other agencies, planning, pre-design, design, construction, and startup of the alternatives were considered, as well as any time constraints specific to each alternative.

Customer/Stakeholder Acceptance

In addition to all the technical criteria involved in selecting the alternative(s), its acceptability to the City's customers and other stakeholders must be considered. These were considered on a case-by-case basis and are often multi-faceted. For example, recharging treated wastewater would rate favorably in terms of the City's relationship with the RWQCB, one of its key stakeholders. Customer acceptance, may be difficult, however, if the public has negative perceptions of any type of wastewater recharge or reuse programs. Considering these types of issues was necessarily a subjective exercise, but was nevertheless important to help rank alternatives and identify potential delays or obstacles to implementation of the candidate alternatives. The main customers and stakeholders considered included:

- City drinking water customers
- City Council members
- Regional Water Quality Control Board
- Environmental groups
- Communities along the proposed Nacimiento Project alignment

- City residents in the vicinity of any new infrastructure (e.g., City-dedicated water treatment plant, wellhead treatment system, recharge basin)
- Local commercial and industrial businesses

3.4 EVALUATION OF ALTERNATIVES

This section describes the evaluation performed by Malcolm Pirnie of each alternative solution presented in Section 3.2. This section includes a summary of the evaluation/ranking methodology, the results of the evaluation, including the alternatives comparison matrix, and a cost summary. This evaluation incorporates and is intended to build on previous conclusions and recommendations, for example, the salt management alternatives presented in Table 6 of the Salt Management Study (Carollo, 2001b).

3.4.1 Ranking Methodology

Each of the alternatives presented in Section 3.2 were first considered in relation to whether they addressed the two primary wastewater regulatory criteria for this project (lowering effluent TDS concentrations and allowing the City to cease discharging to the Salinas River). Those alternatives addressing one or both of these criteria were then considered further in relation to the remainder of the evaluation criteria described in Section 3.3. Therefore, each alternative was assigned a "yes" or "no" designation for the wastewater regulatory criteria, and then assigned a series of numerical scores, one for each of the remaining evaluation criteria discussed in Section 3.3. The numerical scores are relative rankings intended to reflect the often multi-faceted aspects for each ranking. For example, when ranking the Lake Nacimiento Project alternatives in terms of water rights, a clear benefit is that they result in new rights to a surface water supply. However, a potential negative impact of importing water, with respect to water rights, is the associated decrease in groundwater pumping and potential jeopardizing of existing Underflow water rights. Such interrelated factors were considered in the development of the relative scores indicated for each alternative in the matrix that follows the narrative evaluations below.

3.4.2 Evaluation Results

The following sections describe the results of the alternatives evaluation, which are summarized in the comparison matrix at the end of this chapter. The comparison matrix summarizes the alternative ranking results based on whether each alternative meets the two primary project wastewater criteria, then based on water supply and other criteria. The following descriptions are intended to summarize the results of the evaluation based on key criteria for each alternative.

1. Do Nothing

The City's current groundwater supplies have relatively high concentrations of total dissolved solids (TDS) that directly impact the City's treated wastewater quality. As noted by the RWQCB (Briggs, 1999), the wastewater that the City discharges into the Salinas River does not consistently meet the TDS requirements specified in the National Pollutant Discharge Elimination System

(NPDES) permit for the City's wastewater treatment plant. In addition, the City is also facing compliance issues with respect to TDS component constituents sodium, chloride, and sulfate. As a result of the City's non-compliance with the NPDES permit, the "do nothing" alternative is not a viable option.

The RWQCB has indicated they are going to closely review whether the City should be allowed to continue discharging wastewater treatment plant effluent to the Salinas River (Briggs, 1999). The City is the only remaining municipal system discharging into the Salinas River. The RWQCB has required the City to investigate alternatives for discharging the wastewater treatment plant effluent. This is a reason why the "no action" alternative is not a viable solution for the City's treated wastewater discharging needs.

As discussed in Chapter 2, the City is also required to meet a significant increase in future water demand from population growth. Over the next 20 years, the City's water demand is expected to increase from approximately 7,500 AF/yr (current demand) to approximately 13,000 AF/yr (2023 projected demand). Attempting to meet this increased water demand entirely with groundwater from City wells may result in localized overdraft conditions and therefore not be sustainable. From a long-term water supply standpoint, it would be prudent for the City to secure additional supplies to supplement their existing water resources over the next 20 years. This is yet another reason why the "no action" alternative is not a viable solution for the City.

2. Achieve Greater Industrial and Commercial Discharge Quality Control

As previously identified (Carollo, 2001b), a salt management alternative to consider is reduction of TDS discharge from commercial and industrial businesses in the City's wastewater service area. At the time of the Salt Management Study, there was only limited salt monitoring data within the City's wastewater collection system and the relative contributions of residential areas and commercial/industrial facilities were not quantified.

The City has conducted four quarters of salt monitoring data in response to recommendations in the 2001 Salt Management Plan. Although they provide useful concentration data, there are significant limitations that preclude their use in determining relative mass loading estimates and therefore potential benefits of control measures. City staff (pers. comm., Columbo, 2003) have also provided additional information regarding this topic.

One limitation is that grab samples were used instead of the suggested flow-weighted composites. Therefore, there is a greater uncertainty associated with the sample results – they may reflect short-term low or high TDS values and may not necessarily be representative of average conditions necessary to understand mass loadings. A more significant limitation is that flows have not been quantified, in particular, the flows from commercial/industrial facilities. This information is difficult to develop, even with water use data known, because of the differences from facility to facility regarding the percentage of water used that is discharged to the wastewater system.

Available information is insufficient to quantify the magnitude of residential or commercial/industrial sources, and therefore insufficient to estimate the potential benefits of reducing TDS concentrations from these sources.

Nevertheless, City monitoring results (City of El Paso de Robles, 2003b) indicate that there are TDS concentrations in the City's wastewater collection system well in excess of the City's Sewer Code limit of 1,000 mg/L. As noted above, these are grab sample results and may be representative of short-term slugs of high TDS concentration wastewater in the system as opposed to long-term average conditions. Conversations with City staff indicate that the City has been working with local industry for some time to reduce the TDS load from their operations, and many facilities do not have the capability of making the process changes necessary to reduce their TDS discharges beyond their existing levels (pers. comm., Columbo, 2003). Therefore, the potential TDS benefits to the City's wastewater discharge associated with commercial/industrial control cannot be quantified without more data, and may be limited. Regarding residential salt contribution, the limitations inherent in reducing residential TDS load have been presented previously (Carollo, 2001b), although home water softener use may decline with the introduction of a blend of softer water to the City as discussed in the alternatives addressing imported surface water. Implementing this alternative alone would provide no water supply or drinking water quality benefits, but be relatively low in cost.

3. Participate in Nacimiento Project (Treated Water Option)

This alternative would allow the City to meet the current NPDES wastewater limit for TDS of 1100 mg/L. As estimated in Chapter 2, importing treated Lake Nacimiento water at 4,000 AF/yr (and implementing no other alternatives) will reduce the City's treated wastewater effluent TDS concentrations from 1,000-1,100 mg/L to 800-850 mg/L. Over time, effluent TDS concentrations will gradually climb with increasing groundwater use, but not reach existing levels if surface water imports continue.

This alternative would also provide the City with significant water supply benefits. Specifically, by adding Nacimiento Project water to the City's current water supplies, the City will be able to meet future water demands without relying completely on groundwater supplies. By adding a new water supply, the City would conserve its limited local groundwater resources because less water would be pumped from the local groundwater aquifers. This alternative would also increase the City's overall water supply reliability by adding a new source to the City's supply. In addition, Lake Nacimiento would provide the City with a higher quality of water supply, with TDS and hardness concentrations that are significantly lower than the City's groundwater.

This alternative would require the City to pay for its portion of a regional project to treat and transmit Nacimiento water to the City. Planning-level cost estimates for this alternative have already been developed (e.g., Carollo, 2002). Estimated capital costs for the City's participation in this project range from approximately $35.0 to $59.6 million, the operation and maintenance would cost approximately $1.41 million for the first year (the O&M costs would increase annually based on inflation), and the resulting total approximate annual costs (debt service plus annual O&M costs) would be $4.44 to $7.04 million. Malcolm Pirnie calculated the debt service assuming a 7% interest rate and a 20-year term. The low end of the cost estimates are based on a "railroad" approach, where the total capital cost of the project is distributed proportionally by reach for those participants who benefit from the facilities within the reach. The high end of the estimates are based on proportional allocation of capital costs between all Project participants, where the total capital cost of the project is distributed in direct proportion to each participant's requested entitlement. For conservative comparative purposes, the high-end estimates are incorporated into the cost summary at the end of this chapter. Debt service and total annualized costs were calculated similarly for all alternatives.

4. Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-owned Plant

This alternative would meet the current NPDES wastewater limit for TDS of 1100 mg/L and provide similar water supply/quality benefits to the regional treated water option discussed above. Slightly less water supply reliability and potential water rights benefits would be associated with this alternative, because a smaller, City-dedicated plant may not offer the flexibility to increase lake imports if other Project participants drop out or if other changes occur.

In addition, this alternative would also allow the City to have full control of the water treatment plant while relying on the regional raw water project for raw water transmission. Instead of participating in a regional water treatment plant, the City would have complete control of its own water treatment plant. That would allow the City to manage/control long-term planning for the water treatment plant, repair and replacement schedules, staffing, water quality management (i.e., the ability to manage the treatment processes according to the blending needs in the City), budgeting, and so forth. Conversely, this alternative requires the City to provide more direct oversight of the water treatment plant, and will require the City to allocate and manage resources accordingly.

Malcolm Pirnie developed cost estimates for four packaged water treatment systems that would be capable of processing 4,000 AF/yr of Lake Nacimiento water per the City's expected level of Project participation. The packaged treatment systems included the following process trains: conventional treatment with chloramines for disinfection; conventional treatment with a GAC post-filter adsorber and free chlorine for disinfection; microfiltration treatment with chloramines for disinfection; and microfiltration treatment with a GAC post-filter adsorber and free chlorine for disinfection. Finished water reservoir and disinfection costs were added to the package treatment system costs. **Table 3-1** below and the cost summary table at the end of this chapter indicate the estimated cost of selecting this alternative.

Another cost the City may incur under this alternative and others involving importing surface water is for converting the disinfection of the City's well water from free chlorine to chloramine to match disinfectants if necessary as discussed in Chapter 2. Based on a typical chlorine to ammonia ratio of 4.1, upgrade costs (ammonia storage and feed systems) at all the City's existing operational wells/well clusters were estimated. These conceptual-level capital and O&M costs for ammonia addition are $1.2 million and $95,000 per year, respectively.

Table 3-1. Conceptual Cost Estimate of Alternative 4: Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-owned Plant[1]

Capital Cost Item	Capital ($)
Conventional Treatment	$1,580,000
Finished Water Reservoir	$ 300,000
GAC Process Cost	$1,485,000
Disinfection with Chlorine	$88,000
Subtotal Process Costs	***$3,453,000***
Direct Capital Cost[2]	**$6,906,000**
Raw Water Transmission System[3]	$46,219,000
Pilot Scale Testing	$50,000
Operator Training	$10,000
Indirect Capital Costs	**$46,279,000**
Total Capital Cost	**$53,185,000**

O&M Cost Item	O&M ($/yr)
Conventional Treatment[4]	$203,500
GAC[4]	$240,600
Chlorine	$21,500
Power Cost for Water Transmission[5]	$390,000
Power Cost for Booster Pumps	$20,400
Total Annual O&M	**$876,000**

1. This alternative assumes that the City-owned plant would consist of conventional treatment with GAC post-filter adsorber and chlorine for disinfection (Scenario 1B). Of the four scenarios presented in Chapter 2, this is the highest cost scenario by approximately 10% and is indicated here for a conservative estimate of treatment costs.

2. Direct capital cost is estimated by multiplying the subtotal process costs by a capital cost multiplier of two. The capital cost multiplier includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.

3. This estimate is based on the total capital cost for the raw water option presented in Table 2.2 of the "Updated Draft: EIR Preparation Phase Engineering Report, Nacimiento Project" (Carollo, 2002). Paso Robles' portion was estimated based on peaking values. The raw water cost includes recharge facilities for Paso Robles, which will not be necessary if Paso Robles chooses to treat the raw water at a City-owned plant. However, the cost of the recharge facilities is estimated to be minimal relative to the overall cost of the project and within the accuracy range of the cost estimates.

4. Includes chemicals, labor, power, and materials.

5. This estimate is based on the regional pump stations (Intake Pump Station, Inline Booster Station, and Happy Valley Pump Station) indicated for the Lake Nacimiento project (Carollo, 2002). The variable frequency drive (VFD) pumps were assumed to operate on average at 50% power throughout the year or, equivalently, operate 50% of the time at full power. Paso Robles' portion of the electrical cost was calculated using their proportional allocation based on peaking values (5,200/16,449). Paso Robles' cost would decrease if costs were allocated based on participants' actual pumping requirements ("railroad approach"). This estimate is based on a long-term average rate of $0.08/kWh.

5. Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-owned Plant

This alternative would be similar to #4 above in terms of overall water supply, drinking water quality, and wastewater quality benefits to the City. However, a somewhat lesser degree of water supply reliability, potential benefit to local groundwater levels, and water rights benefits are associated with this alternative as compared to the two previous alternatives featuring participation in the regional project—either the raw or treated water options. If this option is implemented and the City does not participate in a regional water supply project (or one is not implemented), the flexibility associated with regional infrastructure is lost. Specifically, there would not be the same extra treatment and transmission capacity available, which the City could potentially use in the case of other participants decreasing or eliminating their participation.

This alternative is also less desirable that the other Nacimiento alternatives from a schedule and regulatory standpoint because to date, only the regional project has been seriously considered for use of Lake Nacimiento as a drinking water source, and a new EIR process would have to be started (the regional EIR is already near final). **Table 3-2** on the following page and the cost summary table at the end of this chapter indicate the estimated cost of selecting this alternative.

Table 3-2. Conceptual Cost Estimate of Alternative 5: Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-owned Plant[1]

Capital Cost Item	Capital ($)
Conventional Treatment	$1,580,000
Finished Water Reservoir	$ 300,000
GAC Process Cost	$1,485,000
Disinfection with Chlorine	$88,000
Subtotal Process Costs	***$3,453,000***
Direct Capital Cost[2]	**$6,906,000**
Permitting	$104,000
Land	$1,036,000
Operator Training	$10,000
Multi-Port Tunnel Reservoir Intake[3]	$4,800,000
Pipeline Installation	$12,545,000
Booster Pump Installation	$1,480,000
Pilot Scale Testing	$50,000
Indirect Capital Costs	**$20,025,000**
TOTAL CAPITAL COST	**$26,931,000**

O&M Cost Item	O&M ($/yr)
Conventional Treatment[4]	$203,500
GAC[4]	$240,600
Chlorine	$21,500
Power Cost for Water Transmission[5]	$370,000
Power Cost for Booster Pumps	$20,400
TOTAL ANNUAL O&M COST	**$856,000**

1. This alternative assumes that the City-owned plant would consist of conventional treatment with GAC post-filter adsorber and chlorine for disinfection (Scenario 1B). Of the four scenarios presented in Chapter 2, this is the highest cost scenario by approximately 10% and is indicated here for a conservative estimate of treatment costs.

2. Direct capital cost is estimated by multiplying the subtotal process costs by a capital cost multiplier of two. The capital cost multiplier includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.

3. The capital cost of the reservoir intake is based on that indicated in the "EIR Preparation Phase Engineering Report" (Carollo, 2002), which references original cost estimates prepared by the Harza Engineering Company of California in 1996. Malcolm Pirnie adjusted the original cost estimate to 2003 dollars by applying a 3% annual escalation rate. The estimate presented here was developed for a reservoir intake sized for the regional Lake Nacimiento project. Many of the component costs are common to any size intake; however, since a smaller intake would be required to deliver water to Paso Robles only, the cost of the reservoir intake can be expected to be somewhat less than the $4.8 M indicated.

4. Includes chemicals, labor, power, and materials.

5. This estimate is based on an assumed modification of the two regional pump stations (Intake Pump Station and Inline Booster Station) indicated for the Lake Nacimiento project (Carollo, 2002). The number of pumps was reduced to account for the reduced pumping requirement to deliver water to Paso Robles only. The variable frequency drive (VFD) pumps were assumed to operate on average at 50% power throughout the year or, equivalently, operate 50% of the time at full power. This estimate is based on a long-term average rate of $0.08/kWh.

6. Participate in Nacimiento Project (Raw Water Option) to Recharge Salinas River Underflow

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, and (2) water storage and water rights associated with the Salinas River Underflow supply may be enhanced by the addition of the imported surface water.

Under this scenario, the City would still have to pay their proportional share of the Nacimiento Project facilities to transmit raw water from the lake to the City. The most important drawback relative to the City's water quality strategy, however, is that under the raw water scenario, 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.

7. Desalinate Well Water Supply

With regards to the primary project criteria, this alternative is capable of meeting the most immediate one: reducing the TDS concentration in the City's wastewater effluent to meet the current NPDES effluent limit of 1100 mg/L. Like the other alternatives, the conceptual design and costs were developed to allow equivalent comparisons; that is, the TDS benefit of this and other desalination alternatives were set to approximately equal the TDS benefit if treated Lake Nacimiento water were imported and blended with the City's existing groundwater supply. With regards to the more long-term of the two key project criteria, this alternative offers no direct benefit with respect to the City ceasing its discharge to the Salinas River.

With regards to water supply reliability and water rights, this alternative has little effect as compared to the current condition. It allows continued use of the City's existing wells, and is therefore positive in that it does not pose any threat to existing Salinas River Underflow water rights. However, it does not secure any new water sources or water rights, and therefore provides little benefit or change as compared to the City's current water reliability situation. It has little short-term effect on groundwater basin levels, as it calls for continued use of the City's existing wells according to current operational strategy. However, over the long-term with the projected population and water demand increases, implementing this alternative alone puts the City at risk of (1) inducing local overdraft conditions, and (2) not being able to meet the water demand of its build-out population.

This alternative would be expected to provide a benefit with respect to drinking water quality for the City's customers relative to current conditions. This is because the RO process would decrease TDS and also hardness, and provide customers with a water blend of a more moderate TDS and hardness content. As noted in Chapter 2 and similar to importing surface water, the decrease in delivered water hardness would likely not be enough that residential customers would stop using or uninstall their home water softeners, but the collective brine discharge resulting from a softer water in the City system would be expected to be somewhat less than the current amount. This makes the wastewater TDS benefits associated with lower-TDS source water alternatives (both this one and the surface water alternatives) slightly conservative; that is, somewhat greater TDS benefits would be expected than indicated by simple proportional calculations. This is discussed more fully in Chapter 2.

The most important regulatory issue associated with this alternative relates to brine disposal. Depending on the method selected, regulatory issues could be significant. The scenario considered in this report was disposal by an evaporation pond, which would need permitting prior to construction, as well as evaporate disposal (albeit only once every several years). Therefore, this alternative was ranked lower than other alternatives that did not involve brine disposal, and lower than the regional treated water surface water import alternative, where significant progress has already been made in terms of environmental permitting and documentation. Regarding drinking water regulations, the City would likely need to work with the California Department of Health Services to have the process change approved, but due to the water quality benefits stated above, this is not expected to pose a problem. The RO units would be installed at the City's existing well sites and pose a relatively low land acquisition (and time requirement) problem in that regard. However, an evaporation pond site would likely need to be acquired; this would take more time than alternatives with no land acquisition constraints, but not be as significant an issue as alternatives with larger recharge ponds or, for example, the irrigation reuse with storage option considered in the Comprehensive Recycled Water Study (Carollo, 2001a). A conceptual design summary indicating target TDS, necessary evaporation pond size(s), and other key parameters is provided in **Table 3-3** on the following page. Key design considerations and cost information for this alternative are summarized in **Table 3-4** and in the cost summary table at the end of this chapter.

Table 3.3. Conceptual Design Summary of Alternative 7: Desalinate Well Water Supply

(Desalination of Selected [>450 mg/L TDS] Wells)							
	Thunderbird #10	**Thunderbird #13**	**Thunderbird #17**	**Thunderbird #23**	**Butterfield #12**	**Dry Creek #18**	**Royal Oak #20**
Total Design Flow (mgd)[1]	1.48	1.44	1.44	1.87	0.58	1.44	1.15
Average TDS (mg/L)[1]	529	514	507	626	526	528	472
Target TDS (mg/L)[2]	≤300	≤300	≤300	≤300	≤300	≤300	≤300
RO Treatment Capability (~90% removal) for TDS (mg/L)	≤50	≤50	≤50	≤50	≤50	≤50	≤50
Design Flow to be Desalinated (%)	52	50	49	61	52	52	45
Flow to be Desalinated (mgd)	0.8	0.7	0.7	1.1	0.3	0.8	0.5
Reject from RO Process (%)	15	15	15	15	15	15	15
Reject (Brine) Flow (mgd)	0.1	0.1	0.1	0.2	0.04	0.1	0.1
Net Evaporation Rate (inches/year)[3]	59	59	59	59	59	59	59
Evaporation Pond Size (acres)[4]	23	22	21	37	9	22	16

[1] Based on available flow and TDS data by well as presented in Appendix A.
[2] Target TDS of ≤300 mg/L set for these wells to result in average water system TDS of 350-400 mg/L when blended with the remaining wells: for comparative purposes, a roughly equivalent TDS benefit to importing surface water.
[3] Net evaporation rate of 59”/year used throughout report based on a gross evaporation rate of 72”/year (average of evaporation rates measured at Lake Nacimiento and Santa Margarita Lake per information provided by the City (pers. comm., Deakin, 2003) and an assumed precipitation rate of 13”/year.
[4] Evaporation pond requirements shown specific to each well for illustrative purposes. Evaporation facilities for wells close to each other would likely be combined (e.g., 100 acres total for the four Thunderbird wells indicated).

Table 3-4. Conceptual Cost Estimate of Alternative 7: Desalinate Well Water Supply

Well Name	Yield (gpm)	Average Well Usage[1] (gpm)	TDS (mg/L)	RO Treatment Equipment Size (gpm)	Treatment Capital Cost[2] ($1000)	Evap. Pond Capital Cost[3] ($1000)	Total O&M Cost[2 4] ($1000/yr)
Thunderbird #10	1,025	688	529	532	$822	$2,280	$104
Thunderbird #13	1,000	687	514	502	$791	$2,150	$101
Thunderbird #17	1,000	725	507	493	$781	$2,120	$102
Thunderbird #23	1,300	112	626	787	$1,231	$3,380	$121
Butterfield #12	400	89	526	206	$367	$880	$42
Dry Creek #18	1,000	241	528	518	$812	$2,220	$78
Royal Oak #20	800	325	472	358	$589	$1,540	$65
Borcherdt #5	440	148	--	--	--	--	--
Sherwood #6	600	193	--	--	--	--	--
Borcherdt #9	1,000	301	444	--	--	--	--
Sherwood #11	1,150	487	407	--	--	--	--
Osborne #14	650	115	444	--	--	--	--
B. Schwartz #15	800	258	--	--	--	--	--
Tarr Well #19	400	17	369	--	--	--	--
Fox Well #21	800	119	415	--	--	--	--
Cuesta Well #22	200	9	445	--	--	--	--
				Total Cost	**$5,400**	**$14,600**	**$610**

[1] Based on annual well usage indicated for 1999 and 2001 per Appendix A.
[2] Includes ammonia feed costs for chloramine disinfection if necessary to match imported chlorinated surface water.
[3] Includes costs for purchasing additional land at $20,000 per acre.
[4] Includes costs for maintaining evaporation ponds.

8. Recharge WWTP Effluent (Without Desalination)

This alternative would result in meeting the primary project criteria. However, as noted in Chapter 1 and discussed in Appendix A, the City investigated groundwater recharge options in the 2001 Comprehensive Recycled Water Study. The investigation indicated that if the City decided to perform a groundwater recharge project, then the City would have to demonstrate that the recharged groundwater would benefit existing groundwater conditions. Unfortunately, due to the generally high TDS content of the wastewater treatment plant effluent, recharged groundwater would not be considered a benefit to the existing groundwater conditions. The investigation also indicated that both of the two main groundwater recharge methods that are currently recognized and regulated by the California Department of Health Services (spreading basins and direct injection) would be very difficult to site facilities in the City without impacting water supply wells. As a result, it appears that the City is not able to recharge wastewater without providing additional treatment to the wastewater treatment effluent, so this alternative is not evaluated further in this report.

9. Desalinate WWTP Effluent to Meet NPDES Discharge Limits

This alternative would result in meeting the most immediate of the two primary project criteria. However, this alternative alone does not provide any benefits to the City with regards to water supply. Specifically, this alternative alone does not provide the City with additional water resources, increase water supply reliability, preserve groundwater basin levels, or improve City drinking water quality. However, it is a very efficient way to meet the immediate TDS effluent limit criteria, as the desalination facilities would be sited in one location. There are other potential benefits to this alternative, such as preparing the City to meet future discharge regulations. For example, the desalination facility could be modified to meet more stringent future NPDES permit standards for TDS or to meet requirements for wastewater reuse or recharge applications. Regulatory issues include brine disposal, although generating brine from only one location (the WWTP) instead of multiple ones (wells/well clusters) makes this issue relatively attractive and cost-effective from this perspective. A conceptual design summary for this alternative including target TDS, necessary evaporation pond size, and other parameters is provided in **Table 3-5**. **Table 3-6** and the cost summary table at the end of this chapter summarize the costs for this alternative.

Table 3-5. Conceptual Design Summary of Alternative 9: Desalinate WWTP Effluent to Meet NPDES Discharge Limits

Total Design Flow (mgd)	4.9
Design Influent TDS (mg/L)[1]	1,200
Target TDS (mg/L)	Ω850
RO Treatment Capability (~90% removal) for TDS (mg/L)	Ω100
Design Flow to be Desalinated (%)	32
Flow to Be Desalinated (mgd)	1.6
Reject from RO Process (%)	15
Reject (Brine) Flow (mgd)	0.2
Net Evaporation Rate (inches/year)	59
Evaporation Pond Size (acres)	45

[1] Target of Ω850 mg/L set for comparative purposes (to provide approximately equivalent TDS benefit as importing surface water) and to provide 20-25% margin of safety against current NPDES limit.

Table 3-6. Conceptual Cost Estimate of Alternative 9: Desalinate WWTP Effluent to Meet NPDES Discharge Limits

Capital Cost Item	Capital ($)
MF Pretreatment System	$1,015,000
RO Treatment System	$823,000
Subtotal Process Cost	***$1,838,000***
Capital Cost (Subtotal Process Cost x Capital Cost Multiplier)[3]	**$3,676,000**
Membrane Housings	
MF	$195,000
RO	$165,000
Bench/Pilot-Scale Testing	$120,000
Permitting (at 3% of Process Cost)	$55,000
Land (at 1% of Capital Cost)	$37,000
Operator Training	$6,000
MF Backwash Discharge Pipeline	$6,000
RO Reject Evaporation Pond[1, 2]	$4,469,000
Indirect Capital Costs	**$5,053,000**
TOTAL CAPITAL COST	**$8,730,000**

O&M Cost Item	O&M ($/yr)
MF	$61,000
RO	$88,000
Evaporation Pond	$65,000
TOTAL ANNUAL O&M	**$210,000**

[1]Evaporation pond was sized assuming net evaporation rate of 59 inches per year.
[2]Evaporation pond costs include costs for purchasing land at $20,000 per acre.
[3]Capital cost multiplier of 2 includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.

10. Desalinate WWTP Effluent for Irrigation Reuse with Storage

This alternative has the potential to meet both of the two primary wastewater regulatory goals of this project. As discussed in the Comprehensive Recycled Water Study (Carollo, 2001a), there are various reuse options that the City can consider, specifically, irrigation reuse with storage, irrigation reuse with river discharge, and community-based reuse with river discharge (Scenarios 1 through 3 in that study). This alternative is the only one of the three that enables avoidance of river discharge year-round, due to the market considered and the large recycled water storage requirement. With regards to water supply reliability, none of the wastewater reuse alternatives offers the benefit of a new surface water supply source. However, implementing any of the three reuse options will offer the benefit of reducing City groundwater pumping, and therefore help to preserve basin groundwater levels and stave off potential overdraft conditions.

None of the three-reuse alternatives would have a direct effect on City drinking water quality. They do not offer the benefits of softer or lower-TDS water associated with the surface water import alternatives. However, there may a long-term drinking water quality benefit associated with desalinating water for reuse and using it within the basin. Specifically, that portion of the reuse water that makes its way to the groundwater basin would be of lower TDS concentration than the City's current wastewater effluent, a portion of which replenishes the groundwater basin via the Salinas River channel under current operations. Capital and operating costs for the irrigation reuse with storage alternative are relatively unfavorable, as indicated in the Carollo study and summarized in Table A-9 of Appendix A. For example, this alternative features a $55 million capital cost, largely due to the level of treatment, storage, and distribution facilities required. Significant regulatory approval is required for all three of these alternatives, as described in the Carollo study. None are expected to be prohibitive, but the combination of complying with water reuse regulations in addition to those associated with brine disposal rank these alternatives as relatively burdensome from a regulatory standpoint as compared to others considered in this report. The time to implement would be expected to be relatively long due to the significant water marketing, planning, engineering/design, permitting, siting, and construction required as compared to other alternatives. Water supply and treatment projects require many of the same steps, but the planning and environmental work for the regional plant and Nacimiento Project is already underway and was therefore ranked higher. Customer/stakeholder acceptance for reuse is difficult to rate at this time due to the variety of stakeholders. The RWQCB, for example, would look on such a project very favorably, while some others (e.g., City residents, potential reuse customers) might have a negative opinion of the concept of reusing wastewater, especially for unrestricted use. The irrigation reuse with storage option ranks higher than the other reuse options because it enables the City to cease river discharge year-round.

11. Desalinate WWTP Effluent for Irrigation Reuse with River Discharge

With regards to water supply reliability, drinking water quality, and groundwater basin levels, this alternative is similar to irrigation reuse with storage. It might yield slightly less water supply reliability benefit, because some water will be "lost" from the basin due to river discharge; however, this is a difficult difference to quantify at this time and would depend on how each project is implemented. The effect each reuse scenario has on water rights is also difficult to estimate based on available information and the unknowns identified in the Comprehensive Recycled Water Study (Carollo, 2001a) and summarized in Appendix A. The irrigation reuse with storage option was ranked slightly lower with respect to water rights than this alternative and the alternative discussed below, because if implemented as described, it would result in all, not just a portion, of the City's wastewater being reused in the area as opposed to flowing down the Salinas River or replenishing the Salinas River Underflow. If effluent ownership and related water rights concerns become contentious, this and the community-based alternative discussed below (which also still features river discharge) would pose less of a problem to the City than the irrigation reuse with storage option. Stakeholder acceptance for this alternative scenario is indicated as lower than the previous alternative because it would not result in year-round ceasing of river discharge and therefore be less attractive to the RWQCB.

12. Desalinate WWTP Effluent for Community-based Reuse with River Discharge

With regards to the criteria pertinent to this water/wastewater quality strategy, this alternative ranks very similarly to the irrigation reuse with river discharge scenario. The only significant difference pertinent to the comparison in this report is the much higher capital cost (~$55M) associated with this alternative as compared to the irrigation reuse option with river discharge. This capital cost is comparable to that indicated for alternative #10 and in this case is due to the extensive recycled water distribution network required to serve the community-based reuse market (Carollo, 2001a). There may be differences in customer/stakeholder acceptance give the different reuse market considered; however, these are difficult to quantify at this time.

13. Desalinate WWTP Effluent for Recharge

From a water supply reliability perspective, this alternative does not offer the same level of benefit as the alternatives involving importing surface water supplies. No new types of water sources are secured for the City under this alternative alone. However, it does serve to help maintain existing groundwater levels in the area and therefore maintain the viability of the City's existing groundwater supplies and help to prevent potential overdraft conditions. With regards to drinking water quality, this alternative would not have a direct effect on City drinking water quality. It does not offer the benefits of softer or lower-TDS water associated with the surface water import or supply well desalination alternatives. However, there is a long-term drinking water quality benefit associated with recharging desalinated water within the basin as compared to current conditions. Specifically, the recharged water would be of lower TDS concentration than the City's current wastewater effluent, a portion of which replenishes the groundwater basin via the Salinas River channel under current operations. Over the long term, this alternative may serve to decrease TDS concentrations in the basin and therefore in the City's groundwater supplies.

Capital and operating costs for this alternative were developed based on the recharge alternative for secondary wastewater developed by Carollo (2001a), coupled with treatment costs developed by Malcolm Pirnie to meet the TDS target as noted above. A conceptual design summary developed by Malcolm Pirnie of the desalination and brine disposal aspects of this alternative is provided in **Table 3-7** on the following page. Anticipated regulatory issues associated with this alternative are somewhat less favorable that most other alternatives. Specifically, they are expected to be somewhat less burdensome than reuse alternatives for the reasons described in those sections. However, as noted in the Comprehensive Recycled Water Study (Carollo, 2001a), siting would be relatively difficult for a recharge project in the area. The only suitable locations appear to be along the Salinas River channel, where the USACE has jurisdiction. Also, finding a site sufficiently distant from existing water supply wells would require more investigation. Because of these complications, this alternative ranks somewhat unfavorably in terms of regulatory constraints, time to implement, and overall stakeholder acceptance, although it would likely be viewed favorably by the RWQCB because it would enable the City to cease discharge to the Salinas River.

Table 3-7. Conceptual Design Summary of Desalination Components of Alternative 13: Desalinate WWTP Effluent for Recharge

Total Design Flow (mgd)	4.9
Design Influent TDS (mg/L)	1200
Target TDS (mg/L)[1]	Ω450
RO Treatment Capability (~90% removal) for TDS (mg/L)	Ω100
Design Flow to be Desalinated (%)	68
Flow to Be Desalinated (mgd)	3.3
Reject from RO Process (%)	15
Reject (Brine) Flow (mgd)	0.5
Net Evaporation Rate (inches/year)	59
Evaporation Pond Size (acres)	105

[1] Target of Ω450 mg/L set per Table 4-4 of the Comprehensive Recycled Water Study (Carollo, 2001a) and to provide demonstrable TDS benefit to groundwater basin.

Table 3-8 on the following page and the cost summary table at the end of this chapter summarize the costs for this alternative. The costs indicated are essentially the sum of previously developed costs for secondary wastewater recharge (Carollo, 2001a) and Malcolm Pirnie cost estimates to treat the City’s effluent to 450 mg/L TDS or lower.

Table 3-8. Conceptual Cost Estimate of Alternative 13: Desalinate WWTP Effluent for Recharge

Capital Cost Item	Capital ($)
MF Pretreatment System	$1,829,000
RO Treatment System	$1,413,000
Subtotal Process Cost	***$3,242,000***
Capital Cost (Subtotal Process Cost x Capital Cost Multiplier)[3]	**$6,484,000**
Membrane Housings	
MF	$455,000
RO	$385,000
Bench/Pilot-Scale Testing	$120,000
Permitting (at 3% of Process Cost)	$97,000
Land (at 1% of Capital Cost)	$65,000
Operator Training	$6,000
MF Backwash Discharge Pipeline	$6,000
Evaporation Pond[1, 2]	$10,428,000
Recharge/Percolation Ponds[4]	$3,600,000
Indirect Capital Costs	**$15,162,000**
TOTAL CAPITAL COST	**$21,650,000**

O&M Cost Item	O&M ($/yr)
MF	$163,000
RO	$162,000
Evaporation Pond	$151,000
Recharge/Percolation Ponds[4]	$50,000
Total Annual O&M	***$530,000***

[1]Evaporation pond was sized assuming net evaporation rate of 59 inches per year.
[2]Evaporation pond costs include costs for purchasing land at $20,000 per acre.
[3]Capital cost multiplier of 2 includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.
[4] Per alternative #5 of the Comprehensive Recycled Water Study (Carollo, 2001a).

14. Add East Side WWTP (Upstream Reclamation Plant)

As discussed in Section 3.2, a new wastewater treatment plant on the east side of the City would add treatment capacity, eliminate east side to west side wastewater pumping, and facilitate reuse/recharge projects on the east side of the City if a tertiary plant were constructed. However, this alternative alone does not directly address this project's two main criteria regarding City wastewater compliance and was included in our evaluation primarily for cost comparison purposes.

The design and average capacities of the existing Paso Robles Wastewater Treatment Plant (WWTP) are approximately 4.9 MGD and 3 MGD, respectively. Approximately 1.9 MGD of this flow is from the east side of Paso Robles (including Templeton) and the remaining 1.1 MGD is produced by the west side (City of El Paso De Robles, 2001). The potential future WWTP considered here would treat current and projected wastewater flow from the east side, while the current facility would continue to treat the flow from the west side.

Assuming a current population of 28,900 contributing to the existing wastewater treatment facility, the per-capita wastewater generation is 104 gallons-per-day (GPD). This per capita wastewater generation of 104 GPD was used to project the citywide wastewater flows over the next twenty years, consistent with the population and water demand projections discussed in Chapter 2 of this report. This is shown in **Table 3-9** below.

Table 3.9. Approximate Projected Wastewater Production Rates for the Next 20 Years

Year	Templeton (population served)	West Zone Population Paso Robles	East Zone Population Paso Robles	West Zone Projected WW Flow MGD	East Zone Projected WW Flow MGD
2003	2,907	10,400	15,600	1.08	1.92
2004	2,907	10,584	16,196	1.40	1.98
2005	2,907	10,769	16,815	1.42	2.05
2006	2,907	10,953	17,458	1.44	2.11
2007	2,907	11,138	18,126	1.46	2.18
2008	2,907	11,322	18,819	1.48	2.25
2009	2,907	11,506	19,539	1.50	2.33
2010	2,907	11,691	20,286	1.51	2.41
2011	2,907	11,875	21,061	1.53	2.49
2012	2,907	12,059	21,865	1.55	2.57
2013	2,907	12,244	22,698	1.57	2.66
2014	2,907	12,428	23,562	1.59	2.75
2015	2,907	12,613	24,457	1.61	2.84
2016	2,907	12,797	25,385	1.63	2.94
2017	2,907	12,981	26,346	1.65	3.04
2018	2,907	13,166	27,341	1.67	3.14
2019	2,907	13,350	28,372	1.69	3.25
2020	2,907	13,535	29,440	1.71	3.36
2021	2,907	13,719	30,544	1.73	3.47
2022	2,907	13,903	31,688	1.74	3.59
2023	2,907	14,088	32,871	1.76	3.71

Based on projected wastewater flows shown in the table, a new east side WWTP would be expected to receive an average flow of 4 MGD upon City build-out in twenty years, provided the existing WWTP continues to serve the west side of the City. The presumed location of the new WWTP is on the east side of the Salinas River adjacent to the City's Lift Station #1, opposite the current WWTP. Conceptual-level costs for two plants were developed, as shown in **Table 3-10** on the following page. The first set of costs is for construction of a secondary treatment facility similar to the current WWTP. The second set of costs includes filtration to reduce turbidity for water reclamation. Desalination would represent a cost in addition to those shown in the table, in the order of $10 million (capital) and $250,000/yr (O&M).

Table 3-10. Conceptual Cost Estimate of Alternative 14: Add East Side WWTP (Upstream Reclamation Plant)

Wastewater Effluent Type:	**Secondary**	**Reclaimed**
Site Work and Landscaping	$ 1,400,000	$ 1,400,000
Preliminary Treatment Facility	$ 5,200,000	$ 5,200,000
Aeration Facility	$ 5,000,000	$ 5,000,000
Secondary Sedimentation Facility with RAS Pump	$ 2,300,000	$ 2,300,000
Filtration	N/A	$ 1,300,000
Disinfection Facilities	$ 800,000	$ 800,000
Non-Potable Water Pump Station	$ 400,000	$ 400,000
Solids Handling Facility	$ 5,600,000	$ 5,600,000
Odor Control	$ 900,000	$ 900,000
Operations Building	$ 1,000,000	$ 1,000,000
Instrumentation, Electrical, and Controls	$ 1,200,000	$ 1,300,000
Subtotal Capital/Construction Cost	**$23,800,000**	**$25,200,000**
Administration, Legal, Planning, Design, And Construction Management (35%)	$ 8,330,000	$ 8,820,000
EIR	$ 500,000	$ 500,000
Estimated Total Project Capital Cost	**$32,630,000**	**$34,520,000**
$/gal (based on construction cost)	**$ 6.0**	**$ 6.3**
$/gal (including EIR, admin, legal, etc.)	**$ 8.2**	**$ 8.6**
Power	$ 270,000	$ 280,000
Chemicals	$ 80,000	$ 80,000
Maintenance	$ 100,000	$ 110,000
Subtotal	**$ 450,000**	**$ 470,000**
Estimated Contingency (20%)	$ 90,000	$ 90,000
Estimated Total O&M Cost	**$ 540,000**	**$ 560,000**

Preliminary treatment would include headworks facilities to provide screening and grit removal, followed by flow equalization. After flow equalization, wastewater would enter an aeration facility where activated sludge with biological nutrient removal (BNR) processes would reduce biological oxygen demand (BOD_5), total suspended solids (TSS), and total nitrogen. After aeration, secondary clarifiers in the secondary sedimentation process would produce an effluent to meet the performance goals for a secondary treatment facility. Return activated sludge (RAS) produced in the sedimentation process would be pumped back to the aeration facility, while waste activated sludge (WAS) would be transferred to a thickener, digested in an aerobic digester, and dewatered.

Costs for producing a higher quality effluent for water reclamation include filtration facilities to reduce turbidity after secondary sedimentation. Depending on filter performance goals, it may be necessary to provide chemical addition to the secondary effluent prior to filtration.

Following filtration (or secondary sedimentation for a secondary treatment facility), the effluent would be disinfected in a chlorine contact chamber using sodium hypochlorite.

3.4.3 Alternatives Comparison Matrix and Cost Summary

The Alternatives Comparison Matrix on the following page summarizes the results of the evaluation described in Section 3.4 above. **Table 3-11**, which follows the matrix, summarizes the cost information for those alternatives that address one or both of the primary project criteria and have significant capital and/or operating costs. Specifically, the only viable alternative not shown in this table is #2 in the matrix ("Achieve Greater Industrial and Commercial Discharge Quality Control"). There would be City staff labor costs and possibly relatively minor equipment costs associated with this alternative, but these were considered negligible in relation to the costs of other alternatives considered, which each call for significant capital improvements. This table is the basis for the relative "Capital Cost Competitiveness" and "Operating Cost Competitiveness" scores in the matrix.

CITY OF EL PASO DE ROBLES
Water and Wastewater Quality Concerns - Water Quality Strategy

ALTERNATIVES COMPARISON MATRIX

Relative Ranking Key for Each Alternative/Criterion

1 = unfavorable
2 = somewhat unfavorable
3 = neutral
4 = somewhat favorable
5 = significantly favorable
TBD = to be determined

Water/Wastewater Strategy Alternatives

		Relative Ranking Criteria													
		Primary Criteria - Wastewater Regulatory Drivers		Water Supply Criteria					Common Criteria						
		Does Alternative Achieve Effluent TDS Compliance?	**Does Alternative Cease Discharge to Salinas River?**	Water Supply Magnitude/Reliability	Groundwater Basin Levels	Water Rights	Drinking Water Quality	Security/Vulnerability Position (U.S. EPA Vulnerability Assessment Requirement)	Capital Cost Competitiveness	Operating Cost Competitiveness	Regulatory Issues (Other than Water and Wastewater Quality)	Time to Implement	Customer/Stakeholder Acceptance	OVERALL RANKING	Comments
1	**Do Nothing**	No	No	X	X	X	X	X	X	X	X	X	X	X	Does not address either primary criteria - alternative not considered further.
2	**Achieve Greater Industrial and Commercial Discharge Quality Control**	TBD	No	3	3	3	3	3	5	5	4	4	2	3.5	Insufficient information to quantify TDS benefit at this time - can only be considered as a supplement to other alternatives.
3	**Participate in Nacimiento Project (Treated Water Option)**	Yes	No	5	5	5	4	5	1	3	4	3	4	3.9	Would provide the City with a base flow of 4,000 AF/yr of treated surface water via regional transmission line and treatment plant.
4	**Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-Owned Plant**	Yes	No	5	5	5	4	5	1	4	4	3	4	4.0	Would provide the City with a base flow of 4,000 AF/yr of raw surface water via regional transmission pipe - City would own and operate its own treatment plant.
5	**Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-Owned Plant**	Yes	No	4	4	4	4	5	3	4	3	2	3	3.6	Would likely only be implemented if regional project does not materialize and City can obtain Lake Nacimiento water alone - requires City-owned reservoir inlet and all transmission/treatment infrastructure.
6	**Participate in Nacimiento Project (Raw Water Option) to Recharge Salinas River Underflow**	No	No	X	X	X	X	X	X	X	X	X	X	X	Does not address either primary criteria - alternative not considered further.
7	**Desalinate Well Water Supply**	Yes	No	3	3	3	4	3	3	4	2	3	3	3.1	Level of well water desalination to achieve TDS benefit equivalent with surface water imports considered for comparative purposes.
8	**Recharge WWTP Effluent (Without Desalination)**	Yes	Yes	2	4	4	2	3	4	5	X	2	2	X	Would theoretically address two primary project criteria but was considered infeasible due to difficulty in demonstrating benefit to groundwater basin by recharging high-TDS water.
9	**Desalinate WWTP Effluent to Meet NPDES Discharge Limits**	Yes	No	3	3	3	3	3	4	5	2	4	3	3.3	Level of WWTP effluent desalination to achieve TDS benefit equivalent with surface water imports considered for comparative purposes.
10	**Desalinate WWTP Effluent for Irrigation Reuse with Storage**	Yes	Yes	4	4	2	3	4	1	1	1	1	2	2.3	Based on Scenario #1 of Comprehensive Recycled Water Study (Carollo, 2001a).
11	**Desalinate WWTP Effluent for Irrigation Reuse with River Discharge**	Yes	No	4	4	3	3	4	4	3	1	1	3	3.0	Based on Scenario #2 of Comprehensive Recycled Water Study (Carollo, 2001a).
12	**Desalinate WWTP Effluent for Community-Based Reuse with River Discharge**	Yes	No	4	4	3	3	4	1	3	1	1	3	2.7	Based on Scenario #3 of Comprehensive Recycled Water Study (Carollo, 2001a).
13	**Desalinate WWTP Effluent for Recharge**	Yes	Yes	4	5	4	3	3	3	4	2	2	3	3.3	Based on Scenario #5 of Comprehensive Recycled Water Study (Carollo, 2001a) and Malcolm Pirnie desalination analysis to achieve TDS reduction sufficient to demonstrate benefit to groundwater basin.
14	**Add East Side WWTP (Upstream Reclamation Plant)**	No	No	X	X	X	X	X	X	X	X	X	X	X	Does not directly address either primary criteria. However, alternative would add City wastewater treatment capacity and was considered in this report for cost comparison reasons.

Table 3-11. Cost Summary for Alternatives That Address Primary Project Criteria

Alternative[a]	Total Capital Cost	Total Annual Capital Debt Service[b]	Total Annual O&M for Year 1[c]	Total Annual Costs (Debt Service + O&M)[c]
3. Participate in Nacimiento Project (Treated Water Option)[d]	$59.6	$5.63	$1.41	$7.04
4. Participate in Nacimiento Project (Raw Water Option) and Treat Water With City-Owned Plant	$53.2	$5.02	$0.88	$5.90
5. Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water With City-Owned Plant	$26.9	$2.54	$0.86	$3.40
7. Desalinate Well Water Supply	$20.0	$1.93	$0.61	$2.54
9. Desalinate WWTP Effluent to Meet NPDES Discharge Limits	$8.73	$0.83	$0.21	$1.04
10. Desalinate WWTP Effluent for Irrigation Reuse with Storage[e]	$54.6	$5.15	$3.10	$8.25
11. Desalinate WWTP Effluent for Irrigation Reuse with River Discharge[e]	$12.5	$1.18	$1.30	$2.48
12. Desalinate WWTP Effluent for Community-Based Reuse with River Discharge[e]	$54.6	$5.15	$1.40	$6.55
13. Desalinate WWTP Effluent for Recharge	$21.7	$2.05	$0.53	$2.58
14. Add East Side WWTP (Upstream Reclamation Plant)	$34.5	$3.26	$0.56	$3.82

Table 3-11 Notes

a. Numbering of alternatives is per accompanying report text and report text and Alternatives Comparison Matrix – only those alternatives with significant capital costs that are viable alternatives to address one or both primary criteria are included in this table.
b. Annual capital debt service payments include principal and interest on the total capital costs for 20 years at a fixed 7% interest rate.
c. Future O&M costs would include adjustments for inflation.
d. This estimate is based on the total capital cost for the treated water option presented in Table 2.1 of the "Updated Draft: EIR Preparation Phase Engineering Report, Nacimiento Project" (Carollo, 2002). Paso Robles' portion was conservatively estimated using a proportional allocation (non-railroad approach) based on peaking values (5,200/16,449 acre-feet/yr). Cost spreadsheets developed by Boyle Engineers dated April 8, 2002 provided to Malcolm Pirnie by the City were also reviewed. However, the costs incorporated in this report and Table 3-11 reflect the slightly higher estimates provided in the referenced EIR Engineering Phase report – to be conservative and to allow direct comparison among costs for Nacimiento Project alternatives.
e. Costs for alternatives 10, 11, and 12 are from Scenarios 1, 2, and 3, respectively, of Comprehensive Recycled Water Study (Carollo, 2001).

For each alternative, the total annual capital debt service payments were calculated based on a loan with a 20-year period and a fixed 7% interest rate. These values were selected as typical municipal public works financing parameters. However, actual interest rate(s) and/or loan period(s) used to finance the elected alternative(s) may be higher or lower. This provides a brief discussion of how annual and total payments for a given alternative would vary with changes in these parameters. The annual debt service payments and the total payment over the loan period will change in value if the loan period and/or interest rate change. Given a fixed interest rate, increasing the loan period results in smaller annual debt service payments and a higher total payment over the loan period. Given a fixed loan period, increasing the interest rate results in higher annual debt service payments and a higher total payment over the loan period. Using a 20-year, 7 % interest rate loan as a baseline, annual debt service payments and total payments can vary as shown in **Table 3-12**. The two scenarios presented provide reasonable boundaries on the potential cost variation.

Table 3-12. Example Boundaries on Annual and Total Payments According to Variations in Interest Rates and Loan Periods

Interest Rate	Loan Period (Years)	Annual Debt Service Payments as % of Baseline
5%	30	69%
8%	20	108%
Interest Rate	**Loan Period (Years)**	**Total Payment as % of Baseline**
5%	20	85%
8%	30	141%