City of San José

San José/Santa Clara Water Pollution
Control Plant Master Plan

TASK NO. 4
PROJECT MEMORANDUM NO. 8
SCALPING PLANT ASSESSMENT

FINAL DRAFT
May 2010

in association with

CITY OF SAN JOSÉ

SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT MASTER PLAN

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SCALPING PLANT ASSESSMENT

1.0 INTRODUCTION

The purpose of this project memorandum (PM) is to examine whether one or more scalping plants might be sited to serve potential new customers within the planning horizon of the San Jose/Santa Clara Water Pollution Control Plant (WPCP) Master Plan. Operation of a new scalping plant was compared to the alternative of allowing WPCP to serve those new customers. This PM considers the available and projected capacities of the collection, treatment, and recycled water systems, along with potential new reuse customers that might be served during the master planning period.

The WPCP serves over 1.5 million people (City of San José, 2009a) in the San José area using a 2,200 mile sewer network (City of San José, 2009b). It is a centralized wastewater treatment plant that treats an average of 100 to 120 million gallons per day (mgd) of wastewater, or approximately two-thirds of its 167 mgd capacity (City of San José, 2009b). Of the total capacity, about 107 mgd is allocated to the City of San José (City of San José, 2007a). Raw wastewater undergoes primary and secondary treatment and pressure filtration at the main WPCP facilities. Most of the filtered effluent is discharged through the Artesian Slough to the San Francisco Bay, but on an annual basis approximately 10 percent is subjected to additional chlorine disinfection and sent to the South Bay Water Recycling (SBWR) Transmission Pump Station (TPS) where it is distributed to nearly 600 irrigation and industrial customers. (City of San José, 2009).

As stipulated in the City of San Jose “Green Vision Plan” for reuse of wastewater and confirmed by the Santa Clara Valley Water District’s “Ends Policy” for water supply, the community has a target of supplying approximately 40,000 acre-ft/yr to meet Silicon Valley’s water supply and effluent diversion needs by 2020 (City of San José, 2007b). Recycled water is piped from SBWR to 584 customers within the cities of San José, Santa Clara and Milpitas via 110 miles of pipeline (City of San José, 2007b). The recycled water is used for landscaping, agricultural irrigation, and industrial purposes to offset the demands for potable water.

2.0 FUTURE TREATMENT AT WPCP

Under current plans, the existing WPCP and SBWR facilities would meet the wastewater treatment and recycled water needs anticipated for the next 30 years. New customers would be connected to the existing sewer and recycled water networks so that raw wastewater would continue to be conveyed to the WPCP for treatment and recycled water returned for reuse. The treatment capacity of the WPCP primary and secondary systems (when operating in nitrification mode) is sufficient to meet the projected increased wastewater flows for the planning period as discussed in PM 3.5. However, SBWR recycled water system facilities have a maximum peak flow capacity of only about 50 mgd, limiting maximum daily average flows to about 25 mgd without additional storage. In addition, the system cannot meet the current minimum disinfection requirement of CT = 450 mg/L-min at flows greater than about 30 mgd. In order to fulfill the goals set by the City of San José's Green Vision (Goal 6) approximately 20 mgd of recycled water would be supplied by SBWR to new and existing reuse customers for nonpotable needs while an additional 20 mgd would be provided for some combination of additional reuse including indirect potable reuse (e.g., groundwater recharge and streamflow augmentation). (SBWR, 2008). The remaining treated effluent (60 mgd to 80 mgd, varying seasonally) would continue to be discharged to the Bay in order to maintain the quality of the receiving water habitat. A summary of the existing and future effluent uses is provided in Table 1.

Table 1 WPCP and SBWR Treatment and Discharge Summary
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Characteristic	Water Pollution Control Plant (WPCP)	South Bay Water Recycling (SBWR)
Total capacity	167 mgd	50 mgd (instantaneous maximum pumping capacity)
Current average inflow (WPCP) or discharge (SBWR)	100 – 120 mgd	11 mgd
Treatment level	Primary (settling tanks) Secondary (aeration tanks, clarifiers) Tertiary filtration	Tertiary with additional chlorine disinfection (CT=450 mg/L-min)
Effluent destination, current [1]	11 mgd to SBWR 90 – 110 mgd to Bay	11 mgd to reuse customers
Effluent destination, future (by 2022) [1,2]	40 mgd to SBWR Remaining effluent to Bay	20 mgd to reuse customers 20 mgd to indirect potable use, streamflow augmentation

Source: City of San José, 2009b.

Notes:

(1) Recycled water use currently 11 mgd; increased by year 2022 to meet City of San José Green Vision Goal 6 (City of San José, 2007b).

(2) Approximate breakdown of future recycled water use (SBWR, 2008).

3.0 SCALPING PLANT TREATMENT POTENTIAL

A scalping plant is a decentralized alternative to centralized wastewater treatment that can provide comparable treatment (e.g., secondary or tertiary) within a smaller facility. The liquid portion of the raw wastewater mined from the sewer would be treated and the solids returned to the sewer. Additionally, because reuse demands are mostly in the summer while peak wastewater flows are in the winter, the scalping plant would be designed for average dry weather flows. Peak wastewater flows would be redirected to the sewers for treatment at the WPCP. As a result, the scalping plant would not operate entirely independently of the treatment plant but would rely on the WPCP for treatment of solids as well as peak wet weather flows above its design capacity.

Scalping plants are most often consider in order (1) to avoid the capital costs of building new pipelines or (2) to avoid the capital cost of expanding the liquid handling capacity of an existing centralized treatment plant. However, because the WPCP has sufficient unused treatment capacity and comprehensive piping networks already in place for its sewer and recycled water systems, the potential for avoiding those capital costs does not exist. Operating the larger WPCP also provides economies of scale and reduced operations and maintenance (O&M) costs not available to a smaller treatment plant. However, where centralized treatment plants provide recycled water, another potential benefit provided by a scalping plant is to reduce the length of distribution pipe required to bring recycled water to a point of service.

The advantages of maintaining centralized treatment at the WPCP compared to the typical reasons scalping plant treatment would be used are discussed briefly here. Planning level construction and O&M costs for a new scalping plant are also provided in this section.

3.1 Typical Reasons for Scalping Plant Treatment

Because many of the benefits attributed to centralized treatment are already embodied at the WPCP, scalping plant treatment would not be suitable for meeting the future wastewater and recycled water needs identified at this time. Some of the key issues and how they would apply to the WPCP system are discussed below.

3.1.1 Flexible Location, Reduced Conveyance Infrastructure

Scalping plants are small and can be placed within a community to locally treat the wastewater. Therefore, one of the biggest advantages is that new or larger sewers and recycled water pipelines would not be needed for carrying increased flows to and from a central plant. However, this capital cost savings is not available since the WPCP piping systems (both sewer and recycled water) already extend throughout its service area in a comprehensive network with sufficient capacity to transport the anticipated future flows. Future customers would require relatively minimal new piping to tie into the existing networks. For example, the 15 mgd ten-mile Silver Creek recycled water pipeline (SCVWD, 2005) was recently constructed to extend the network and an existing 54-inch sewer in Blossom Hill currently operates at less than 10-inch full (City of San José, 2009c).

3.1.2 Additional Treatment Capacity, Decreased Load

Upstream wastewater scalping can provide additional comparable wastewater treatment capacity and reduce the raw wastewater BOD and solids load to a central plant (Allen and Vonghia, 2009), especially if influent wastewater quality or treatment capacity is an issue. WPCP has sufficient capacity in its primary and secondary treatment units to meet anticipated future demands. Under current permit conditions, no additional treatment capacity would be required. The mineral water quality (total dissolved solids) has also not been an issue for the current uses.

3.1.3 Proximity to Reuse Customers

Smaller more compact footprints increase placement flexibility, so a scalping plant producing recycled water can be located near large reuse customers (Allen and Vonghia, 2009). The SBWR recycled water network already reaches existing reuse customers within its service area. Other large users (Almaden Country Club, Boulder Ridge Golf Course, and Cinnabar Golf Course) have been identified outside the existing boundary, but connecting to them is currently beyond the 30-year planning horizon of the WPCP Master Plan. Also, it is not known at this time whether the upstream wastewater flow that could be captured and treated by a scalping plant would be sufficient to meet the needs of these irrigation customers.

The recycled water network is currently operating at about one-quarter of its capacity, so it has ample volume available to meet the recycled water demands of future customers and to fulfill Green Vision Goal 6. New reuse customers would tie into the existing recycled water network so a new scalping plant would not be needed for recycled water distribution.

3.1.4 Solids Handling

The solids generated at a scalping plant (waste activated sludge) would be returned to the sewer and would rely on the WPCP for solids treatment. In a satellite plant, as opposed to a scalping plant, the solids would be treated locally at the satellite plant.

3.1.5 Economies of Scale

Centralizing treatment operations to one location allows the WPCP to take advantage of economies of scale, which reduces the required labor, number of treatment units, and operation and maintenance costs as compared to operating multiple plants. Constructing a small scalping plant would not have the same potential for cost savings.

3.1.6 System Redundancy

Multiple plants can provide redundancy, so that a failure at one plant would not cause a failure of the entire wastewater system (Allen and Vonghia, 2009). The WPCP has minimized this concern by employing multiple process units. Individual units could be offline for repair or maintenance and the WPCP would continue to operate normally. Additionally, since the WPCP serves thousands of customers over a huge geographical area, one or two scalping plants would not have sufficient capacity to offer a significant amount of backup treatment during an emergency. One future consideration for distributed treatment could be sea level rise (beyond the current planning horizon).

3.1.7 Treatment Flexibility

Treatment at a scalping plant can be tailored to local or regional needs (Allen and Vonghia, 2009), such as an industrial inflow with high concentrations of a pollutant. Because future raw wastewater quality is anticipated to be similar to current conditions, individualized treatment is not a current concern.

3.2 Scalping Plant Costs

Planning level costs were determined for a membrane bioreactor (MBR)-based scalping plant to compare the cost of constructing and operating a new plant versus connecting to the WPCP. MBRs consist of an anoxic-aerobic activated sludge process that uses ultrafiltration membranes to filter out wastewater solids, organic materials, and pathogens larger than the membrane pore size (Allen and Vonghia, 2009). Treated permeate is drawn through the membranes using a vacuum, leaving the solids behind. Sludge can be digested directly within the bioreactors (Allen and Vonghia, 2009). Essentially, the membranes would take the place of the secondary clarifiers and tertiary filters (Allen and Vonghia, 2009) that are used at the WPCP and SBWR. The effluent would be disinfected and then discharged to the existing reuse system.

Estimated construction costs for an MBR plant at three sizes are presented in Table 2. There is little economies of scale achieved as facility size increases, so the cost per wastewater volume treated ($/gpd) decreases only slightly from the 2-mgd to the 10-mgd sized plant. Total plant footprint depends on the orientation of the MBR and placement of auxiliary buildings, but the overall area consists mostly of the MBR system.

Table 2 Estimated Construction Costs by MBR Plant Size ($ million)
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Plant Component	2 mgd (1)	5 mgd (2)	10 mgd (2)
MBR system	3.5	8.4	15.9
Concrete	2.3	5.5	8.6
Equipment	5.9	14.2	17.2
Mechanical	2.9	7.0	9.8
Electrical	1.9	4.6	12.7
Other components	3.3	7.9	15.9
Total Construction Cost ($ M)	**$19.8**	**$47.6**	**$80.1**
Unit Construction Cost ($/gpd of capacity)	**9.9**	**9.5**	**8.0**
MBR system footprint (3)	100 ft x 100 ft	115 ft x 190 ft	213 ft x 290 ft

Note: Estimated costs are in 2009 dollars. Cost of land not included.
(1) Brown and Caldwell, 2009.
(2) Carollo, 2009.
(3) Coombs-Hopkins, 2009.

Estimated annual O&M costs by MBR plant size are provided in Table 3. Economies of scale cost savings are apparent as the plant size increases from 2-mgd to 10-mgd. Annual O&M costs for WPCP and SBWR treatment (raw wastewater to finished tertiary effluent) are approximately $961/MG treated, or $42 million annually to treat 120 mgd of wastewater. The $961/MG cost includes sludge treatment and handling (estimated at 25 percent of the operating costs) and pumping of influent flows and equalization basin flows. As a result, the comparable cost of liquid treatment only is on the order of $680/MG. Although it initially appears that O&M costs are comparable for a scalping plant, the estimated costs are not all-inclusive like the WPCP value. Because the scalping plant would rely on the WPCP for solids handling and treatment of the wastewater peak flows, actual O&M costs would be higher than the Table 3 values.

Table 3 Estimated Annual O&M Costs by MBR Plant Size ($000)
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Cost Components	2 mgd [(2)]	5 mgd [(1)]	10 mgd [(2)]
Electrical power	217	486	847
Chemical	36	80	139
Membrane replacement	167	372	649
Equipment repairs and replacement	102	227	396
Labor	49	109	189
Annual O&M cost ($ K/yr)	**$570**	**$1,274**	**$2,221**
O&M cost ($/MG treated)	**781**	**698**	**608**

Note: Estimated costs are in 2009 dollars. Solids handling costs not included.
(1) DeCarolis et al, 2007.
(2) Estimated as a proportion of 5-mgd sized plant costs. O&M cost multipliers determined using data from WEFTEC 2007 paper (DeCarolis et al, 2007) and Coombs-Hopkins MBR estimate (Coombs-Hopkins, 2009).

The MBR plant costs (Tables 2 and 3) do not take into account a specific plant location, which would determine conveyance and land costs. Two future developments, Almaden and Coyote Valley, and a potential diversion pipeline project at Curtner and Almaden Expressway were considered as potential locations for a future scalping plant (City of San José, 2009c). However, they were not suitable for a detailed assessment because it was uncertain if development of the Almaden and Coyote Valley communities would be delayed until after the master planning period, and few reuse customers were identified near the diversion pipeline project.

If potential plant or future customer locations are identified later, an estimate of the capital cost for tying it into the existing pipe networks would be $30 per inch diameter of lineal feet of pipe (City of San Jose, 2009c). For example, the installed cost of 1000 feet of 8 inch diameter pipe would be approximately $240,000. Scenarios that could trigger future reconsideration of scalping plants would include:

- A new demand for 2 mgd or more of recycled water for an industry,
- A demand to irrigate 600 acres or more of landscape, assuming 300 acres/mgd of demand, or
- An avoided cost of $10 million in new recycled water pipeline, or a combination of the conditions.

In addition to the construction and O&M costs presented, significant regulatory and permitting costs would also be required to implement and operate a scalping plant in the San Jose area. For this planning level analysis, a detailed regulatory review was not pursued.

4.0 CONCLUSIONS

Because the WPCP has sufficient unused treatment capacity in its primary, secondary (nitrification mode), and tertiary process units to meet the demand increases anticipated over the 30-year master planning period, an upstream scalping plant is not needed for the WPCP service area. The system's existing extensive sewer and recycled water networks can transport raw wastewater to the plant and distribute tertiary treated water to existing and future reuse customers projected to be served through the master planning period. Some improvements may be required in order to operate the SBWR recycled water system at capacity and new piping would be needed to connect new reuse customers, but utilizing the currently unused capacity would be more efficient and cost effective than constructing and integrating a new scalping treatment plant. Alternatives for scalping treatment plants are not recommended to be carried forward in the WPCP Master Plan development.

REFERENCES

REFERENCES

1. Allen, Chris and Enrico Vonghia. 2009. Sustainable Development through Decentralized Water Reuse Technology. WateReuse Conference, California Section. March.

2. Brown and Caldwell. 2009. MBR Scalping Plant Options, Summary Estimate Report with Mark-ups Allocated. July 8.

3. Carollo. 2009. Construction cost estimates for 5-mgd and 10-mgd sized MBR plants. Provided via text edits to draft version of this memorandum. July.

4. City of San José. 2007a. Draft Environmental Impact Report, Coyote Valley Specific Plan, Volume I. March.

5. City of San José. 2007b. San José's Green Vision. October 5.

6. City of San José. 2009a. San José/Santa Clara Water Pollution Control Plant Website, http://www.sanjoseca.gov/esd/wastewater/water-pollution-control-plant.asp July.

7. City of San José. 2009b. San José/Santa Clara Water Pollution Control Plant, Plant Master Plan Website, http://www.piersystem.com/go/site/1823/ July.

8. City of San José. 2009c. San José/Santa Clara Water Pollution Control Plant Master Plan, Satellite Recycled Water Study Meeting Minutes. June 10.

9. Coombs-Hopkins Company. 2009. MBR Quotes, Zenon System Footprint and Plant Cost Estimate. June 22.

10. DeCarolis, James, Samer Adham, William R. Pearce, Zakir Hirani, Stephen Lacy, and Roger Stephenson. 2007. Cost Trends of MBR Systems for Municipal Wastewater Treatment. Water Environment Federation, WEFTEC 2007 Conference.

11. Hoang, Mary. 2009. Legal, Policies, and Regulatory Issues for San José Water Company, an Investor-owned Public Utility, to Invest in Recycled Water. WateReuse Conference, California Section. March.

12. Santa Clara Valley Water District (SCVWD). 2005. Urban Water Management Plan 2005. December 20.

13. South Bay Water Recycling (SBWR). 2008. South Bay Water Recycling, Presentation to Transportation and Environment Committee. September 8.