Final Report

Effluent Disposal Feasibility Alternatives Study of Morro Valley

Morro Bay, California

Prepared for

Michael K. Nunley & Associates and the City of Morro Bay

August 2016

Prepared by

GSI Water Solutions, Inc.
5855 Capistrano Avenue, Suite C
Atascadero, CA 93422
P: 805.460.4621
info@gsiws.com www.gsiws.com

Table of Contents

Introduction

This report presents the results of our screening-level evaluation of several potential projects to cost-effectively dispose of treated effluent in a manner that would enhance the City's water supply. These potential alternatives include:

1. Groundwater Recharge through Infiltration Basins
2. In-Lieu Recharge Program – Exchange for Reduced Groundwater Pumping
3. Injection and Recovery at City Pumping Wells
4. Injection for a Seawater Intrusion Barrier
5. Sale of Treated Effluent Directly to Growers
6. Continued Use of City's Brine Disposal Pipeline
7. Riparian Rights Agency Agreement and Exchange with Agricultural Users

The results of analyses performed for each of seven alternatives is presented on Table 1 (attached), and discussed below. The discussion constitutes a screening-level discussion and is meant to supplement the table, which generally provides a more complete summary of each alternative.

Treated Effluent Disposal Alternatives

1. Groundwater Recharge through Infiltration Basins Upstream of the Narrows

This alternative involves direct groundwater recharge through surface application (percolation ponds) into the alluvial aquifer within the Morro Valley above the narrows (east of Highway 1). The land use of the area upstream of the narrows is primarily agricultural with large fields of sufficient size for the construction of percolation pond facilities. Downstream of the narrows (west of Highway 1), the dominant land use is urbanized development, with little available area for percolation pond development. Conceptually, a percolation pond facility upstream of the narrows would recharge the local aquifer, bank the effluent as stored groundwater, and increase the volume of available groundwater in the alluvial system for extraction by City wells, which are located downstream, west of Highway 1.

The area available for percolation within the lower portion of Morro Valley above the narrows is approximately 110 acres for the area extending east from the confluence of Morro Creek and Little Morro Creek to a property line boundary approximately a half mile upstream. This area is within the overall Morro Creek Basin, which covers an area of 2,269 acres and is an average of 50 feet deep (Brown and Caldwell, 1981). The area considered for this assessment is roughly coincident with an area referred to as the Cabrillo property (Brown and Caldwell, 1981) bounded on the north by the Morro Creek along Atascadero Road / Highway 41 and on the south by Little Morro Creek.

The shallow geologic materials present in the area consist predominantly of two to eight feet of topsoil, described as silty clay loam that is deep and somewhat poorly drained (Fugro, 2016a; Ernstrom, 1984). The deeper materials have been documented in previous reports to consist of 10 to 18 feet of “clay” below the surface (Brown and Caldwell, 1981). Geologic cross sections through the area indicate that the clay materials are present at the surface throughout this area of interest. Below these clay layers are significant depths of sands in which wells located along the adjacent creeks are completed (refer to cross sections on Figures 6 and 7 of Fugro, 2016a). Active percolation would be significantly impeded by the thick clay layers at the surface, which would make recharge into percolation basins infeasible.

However, percolation within the active channel of Morro Creek (northern edge of the area) may be feasible. The area along the active Morro Creek adjacent to Atascadero Road covers an additional elongated area of approximately 10 acres, which was considered as a location for effluent disposal. Based on logs of wells completed along the southern bank of this creek, the channel materials consist of coarse sand from the ground surface to a depth of 10 to 15 feet, extending in places to a depth of up to 32 feet. Similar coarse materials are not present along Little Morro Creek. In this portion of Morro Creek, 45 acre-feet of total storage would be available in drought conditions with no storage available during wet conditions.

The residence time (groundwater travel time) for water percolated within the lower Morro Creek must be considered. Available well log records indicate that four water wells are known to exist along the lower portion of Morro Creek, to which the residence time varies with distance from the area of percolation. From approximately a half mile upstream of the narrows, the water would travel at a rate of roughly 2 feet / day, which would be in transit for up to four years before reaching the City’s wells. Percolated water would travel to closer wells more quickly. Although the City could conceivably serve the affected wells if necessary, such analysis is not considered for this alternative.

As presented on Table 1, the storage available throughout the subject area during drought conditions ranges from approximately 100 to 180 acre-feet. Seasonal constraints would be high; during the wet season and all non-drought times, this storage decreases to near zero as the coarse aquifer materials become fully saturated.

The alternative would require Regional Water Quality Control Board (RWQCB) permitting for effluent disposal and California Department of Drinking Water (DDW) for compliance with residence time and Total Organic Carbon (TOC) removal requirement.

Agreements with private well owners in the vicinity of the Narrows would be required, if the residence time is short enough that direct serve agreements must be implemented. Significant property acquisition would be required for infiltration sites.

The City currently has a permit to extract 581 acre-feet per year (AFY) of underflow from Morro Creek. The current beneficial use of groundwater in the area of consideration is 50 - 100 AFY. Active recharge upstream of the City's wells would likely increase the City's right and ability to pump underflow by an equal volume, minus some calculated loss factor.

Water quality of produced groundwater from City wells would slowly and eventually improve through recycled aquifer flushing of better quality water than native groundwater, which would likely take many years.

The advantages of this alternative are that it would create a mechanism to dispose of at least 100 to 180 acre feet (AF) of effluent to as much as 250 to 300 AF during drought, which would, in turn, increase the City's water supply by adding groundwater to the underflow eventually recharging the City's wells.

However, the alternative would require high land acquisition costs and would reuse 20% to 30 % of effluent because of geology and seasonality constraints. Furthermore, the alternative could create a potential for shallow groundwater conditions in the lower valley and creates potential residence time constraints because of proximity to nearby private wells. Lastly, the alternative creates potential need to serve private landowners with City water outside of City boundaries because of residence time limitations.

Analysis of this alternative, following discussions of the limitations and constraints with City staff, suggests that the alternative of Groundwater Recharge through Infiltration Basins is likely not feasible.

2. In-Lieu Recharge Program – Exchange for Reduced Groundwater Pumping

An in-lieu recharge program would provide valley growers with an irrigation water supply in exchange for a reduction in groundwater pumping. The treated effluent would be delivered to growers located in the mid- to upper reaches of Morro Valley for direct application to crops in exchange for reduced groundwater pumping. Such reduction in pumpage would conceivably result in a greater volume of groundwater available to the City by extraction from the downstream City wells.

The principal advantage of the alternative is that, depending on the location of growers/customers and their willingness to participate, there is the potential to utilize the full wastewater flow volume, if seasonality constraints and/or wet weather storage can be resolved. Furthermore, an in-lieu exchange program is generally the most effective means to maintain water levels (groundwater in storage) in a basin, and can be particularly effective at increasing groundwater in storage.

There are a large number of unknowns relative to the potential benefits to the City. The potential benefit depends on where the in-lieu growers are located in the valley and their willingness to exchange groundwater pumping for in-lieu water. Currently, in the absence of an adequate groundwater management plan, many of the growers only stop pumping when their wells dry up, the time of which would extend before their wells dry up with an in-lieu program.

An in-lieu program would require a valley-wide basin management plan, with cooperation agreements by virtually all growers, whether or not they received in-lieu water. All growers would have to cooperate in order for the City to realize a water supply benefit at the downstream end of the valley. The management plan and cooperation agreements would likely result in reduced demand, management constraints, and possibly in a valley-wide Water Supply Analysis.

To feasibly accept water during wet weather, significant off-stream storage would be required to mitigate the seasonality constraints.

Numerous water rights issues may exist related to this alternative. It is likely that the City would be able to claim credit for the exchanged water, then pump it from their underflow wells, and thereby exceed their State permit which allows 581 AFY of pumpage. While most of the growers pump according to riparian rights, some may also have a State permit to pump underflow. If so, these growers would likely be unwilling to reduce their pumping for fear of losing that established right. If the growers don't stop (or reduce) pumping, little to no benefit to the City would be created.

There are numerous significant constraints to the effectiveness of this alternative in enhancing the City's water supply. Obstacles may include a requirement of the creation of a basin-wide groundwater management plan, which would include all growers and pumpers in the basin, not just the recipients of the in-lieu water. A plan would have to be developed that would result in a net reduction in groundwater pumping by the private users in order for the City to realize a water supply benefit at the downstream end of the basin. Lastly, an extensive distribution system would be required to deliver the in-lieu water to each individual grower.

The direct exchange of treated wastewater in-lieu of reduced pumping is considered not feasible due to water rights concerns, a lack of benefit to the growers for reduced pumpage, and a likely limited to nil enhancement to the City's water supply.

3. Injection and Recovery at City Pumping Wells

This alternative considers the feasibility of injection of the treated effluent into the lower permeable horizons of the aquifer for storage and subsequent extraction by the City's water supply wells.

Based on somewhat intermittent water level data for the period of 1994 to present during which the City wells were not pumped extensively, this alternative could potentially benefit the City's water supply by as much as 1,000 AFY during drought, although this volume would decrease to zero during wet periods as the aquifer is normally filled to capacity. This calculated volume is based on conditions when the City wells were inactive; an active well field would draw down the aquifer, thereby increasing the available storage capacity of the aquifer, and potentially increasing the benefit to the City.

The alternative would require high capital costs and high operations and maintenance costs. Furthermore, injection may cause flooding and high groundwater in the lower basin. Lastly, residence time and TOC removal requirements may limit the feasibility of the alternative.

The area available in the lower portion of Morro Valley downstream of the narrows is approximately 300 acres. From this basin, the City currently has a permit to extract 581 AFY of underflow from Morro Creek. Active injection in this basin surrounding the City's wells would likely increase the City's right and ability to pump underflow by an equal volume, minus some calculated loss factor. This analysis is preliminary and will be refined with further analysis with the use of an analytical groundwater model as a screening analysis.

The basin in this area consists of beach and dune sands with lagoonal fine grained sediments. The thickness of sand in the area varies somewhat, but is 25 to 28 feet thick in the area of MB-3 and MB-1. Currently, the City's well field is capable of pumping 1,340 AFY, which is a facilities constraint, excluding nearby seawater wells.

Water levels during wet periods are generally near ground surface to near sea level and the lowest water levels on record were approximately 23 feet below sea level during drought. Based on observed data, water level fluctuations varied narrowly within a range of approximately 23 feet without pumping of City wells. Assuming that this range constitutes the volume available for injection of treated wastewater, we estimated that the maximum volume available was as much as 1,000 acre-feet. However, the range of water levels was usually narrower: between 5 and 11 feet of thickness, which would allow only 220 to 480 acre-feet of injection capacity in the aquifer. During wet periods, no storage would be available.

Therefore, the estimated net benefit to the City's water supply during drought would be a maximum of 1,000 acre-feet (even with no significant extraction by the City) and would only be available at these volumes during extreme drought periods. The net benefit appears to be more in the range of 200 and 500 acre-feet during average conditions and zero during wet periods (based on non-pumping conditions).

The water quality of produced groundwater from City wells would slowly and eventually improve through recycled aquifer flushing of better quality water than native groundwater. This would likely take many years, however, particularly because upstream recharge may continue to be high in nitrates if an associated alternative in that area is not pursued. Assumptions could be made through comparison of anticipated quality of effluent with native groundwater and mass volume calculation and/or water quality model to simulate long-term changes to water quality.

The alternative would require Regional Water Quality Control Board (RWQCB) permitting for effluent disposal and California Department of Drinking Water (DDW) for compliance with residence time and Total Organic Carbon (TOC) removal requirements.

Further consideration of injection and extraction from City wells is warranted and is being explored further with consideration of creation of an analytical groundwater model.

4. Injection for a Seawater Intrusion Barrier

This alternative considers the development of a seawater intrusion barrier by injection of treated effluent. It differs from the Injection and Recovery alternative in that this method would inject the water either into the existing coastal seawater wells located along the Embarcadero and west toward Morro Rock, or somewhat between those wells and the City's wells. The injected effluent would create a fresh water barrier, presumably recharging the aquifer and preventing seawater intrusion during periods of increased pumping from the City's wells, thereby increasing the volume of groundwater that the City wells can pump without inducing seawater intrusion.

The alternative may result in a potential benefit to the City's water supply by as much as 1,000 AFY during drought periods. The primary disadvantages are high capital costs and high operations and maintenance costs. Furthermore, development of an injection barrier may cause flooding and high groundwater in the lower basin, as well as the potential for short-term degradation of the water quality in the receiving aquifer as the seawater intrusion barrier develops and the native brackish water is forced landward (this condition, if it occurred, would be temporary). Lastly, residence time and TOC removal requirements may limit the method.

The aquifer materials in the area of the "seawater wells" extend to greater depths than at the City's main production wells with depths of up to 87 feet, of which more than 70 feet are composed of coarse materials. Water levels in these wells are not well-documented so total available storage is not known at this time. The combined pumping capacity of the existing seawater well field is reportedly approximately 1,300 gallons per minute.

The alternative would require Regional Water Quality Control Board (RWQCB) permitting for effluent disposal and California Department of Drinking Water (DDW) for compliance with residence time and Total Organic Carbon (TOC) removal requirements.

The feasibility of this alternative will be explored further through development of an analytical groundwater model.

5. Sale of Treated Effluent Directly to Growers

This alternative involves the direct sale of the treated effluent to growers located up-valley, which would result in a potential effluent disposal program but does not enhance the City's water supply.
The alternative has no direct goal of benefiting the City's water supply.

While the principal advantage of this alternative is that it could potentially dispose of a large volume of treated effluent, the principal disadvantage is that it has no foreseeable benefit to the City's water supply. The cost of the distribution system could potentially be greater than water sale revenue. The alternative also has higher capital and operations and maintenance cost than the continued use of City's existing ocean outfall, which is the other alternative with no water supply benefit to the City. Once in place, this alternative would be relatively easy to implement and operate.

The method may have significant seasonality constraints in the absence of offsite storage. Without such storage, the sale of water to customers would only be possible during irrigation season.

This alternative would not require any water rights issues to be addressed, nor would it have any significant impact on either water quality or foreseeable environmental issues.

The sale of treated effluent directly to growers is not feasible due to the lack of benefit to the City's water supply, and higher capital costs compared to other alternatives that also do not have a benefit to the City's supply.

6. Continued Use of City's Brine Disposal Pipeline

The default alternative being considered is simply the continued use of the City's offshore brine disposal pipeline. The alternative has the advantage of being capable of receiving the full volume of effluent. The principal disadvantage of using the existing pipeline is that the method offers no enhancement to the City's water supply capacity. The method requires no further regulatory nor permitting requirements and is the easiest alternative to implement and operate. It constitutes the least cost alternative.

Although the continued use of the brine disposal pipeline is possible, it is not considered beneficial to the City's water supply, and therefore may be considered infeasible for this analysis. However, if the other alternatives are rejected, this default alternative will be used nonetheless.

7. Riparian Rights Agency Agreement and Exchange with Agricultural Users

The final alternative considered involves the delivery of treated effluent directly to growers that currently pump underflow as a riparian rights operator, in exchange for City's right to pump the delivered amount of groundwater from the City wells. The City would act as trustee to the user for operation of their riparian water rights, which would benefit both the growers and City water supply.

Although the quantity of potential benefit is not known at this time, it is presumed that a large portion of the quantity of treated wastewater could be delivered to a few large landowners within the Morro Valley. The alternative could offer a significant water supply benefit to the City – likely the greatest benefit of all alternatives. The alternative is relatively easy to implement and operate, but has significant seasonality and wet-weather storage constraints. The agricultural user does not "lose" his right to pump riparian water because the City is exercising that right as the user's trustee.

The disadvantages are that the alternative are seasonality and wet weather storage constraints, it would require installation of a distribution system to each user who participates in program, and it would require separate riparian rights agency agreements with each user (which would require significant water rights attorney involvement).

The alternative would have no foreseeable environmental nor water quality impacts.

Although the exchange of treated water with agricultural users is potentially beneficial to the City water supply, the seasonality and wet weather storage constraints coupled with the potential water rights issues make this alternative infeasible.

Summary

Of the alternatives considered, a single alternative warrants further analysis:

- Injection and Recovery at City Pumping Wells, and

This alternative will be in a considered in more detail with a forthcoming groundwater model. This consideration of using multiple alternatives of wastewater disposal will likely be required to satisfy the goals of the City of disposing of the wastewater in a manner that maximizes the benefit to the City's water supply.

References

Brown and Caldwell, 1981. *Groundwater Evaluation of the Cabrillo Property in Morro Creek Basin*, consultant report prepared for the City of Morro Bay, June.

Cleath-Harris Geologists, Inc., 1994. *Analysis and Recommendations for a Water Management Plan*, consultant report prepared for the city of Morro bay, March.

------, 2014. *Hydrologic evaluation of the potential benefits to the City water supply from reclaimed water use in the Morro Valley, San Luis Obispo County*, consultant report prepared for the City of Morro Bay, November 7.

Ernstrom, D.J., 1984. *Soil survey of San Luis Obispo County, California, coastal part*. USDA-SCS. U.S. Gov. Print. Office, Washington, DC.

Fugro, 2016a. *Morro Valley Groundwater Reconnaissance Study*, consultant report prepared for the City of Morro Bay, January.

GSI Water Solutions, Inc.

Table 1 -- Effluent Disposal Feasibility Alternatives Study of Morro Valley
City of Morro Bay

Goal: Cost-effectively dispose of 2.75 acre-feet per day (1,000 acre-feet per year, AFY) of treated effluent in a manner that will enhance the City's water supply
All units in AFY unless stated otherwise

Alternative	Volume of Wastewater Managed	Net Water Supply Benefit	Regulatory and Permitting Requirements	Cooperation Agreements Required	Seasonality Constraints	Available Storage	Water Rights Issues	Environmental Impacts	Water Quality Impacts	Capital and O&M Cost	Advantages	Disadvantages
1) Groundwater Recharge Through Infiltration Basins	Drought: 0 - 180 AFY Wet: None	150-300 AFY	RWQCB for effluent disposal, DDW for residence time	Well owners for residence time and property acquisition	Significant. No storage in wet season	45 AF in Morro Creek w/in 0.5 mile of narrows, 0-180 in lower valley	Could increase right/ability to pump underflow	Potential shallow groundwater / flooding of lower valley	Gradual improvement of lower valley	High	Disposal of 100-300 AFY during drought Increases supply to City wells	High land acquisition costs Disposes of maximum of 20-30% of effluent
2) In-Lieu Recharge Program - Exchange for Reduced Groundwater Pumping	Unknown (pending customers and seasonality constraints)	Limited		Valley-wide basin management plan & extensive agreements	Significant. Dependent on crops and irrigation schedules	Wet-weather, off-steam storage required	Numerous and potentially complicated.	Little to none	Little to none	High	Generally most effective means to maintain groundwater levels	Numerous constraints: basin plan, agreements, wet-season storage, water rights. Distribution system req.
3) Injection and Recovery at City Pumping Wells	Unknown pending modeling Drought: 1,000 AF ? Normal: 200-500 ? Wet: None	Up to 1,000 AFY, depending on results of modeling	SWRCB (RWQCB and DDW)	High School wells only ?	Significant. Potentially no storage in wet season	Unknown pending modeling Drought: 1,000 AF ? Normal: 200-500 ? Wet: None	Could increase City's right to pump beyond current limit of 581 AFY	Potential for shallow groundwater / flooding will require mitigation and monitoring to prevent flooding risk. Modeling effort will better define potential risk for flooding.	Gradual improvement	High	Would increase water supply benefit by 0 to 1,000 AFY	High capital / operations cost. Seasonality constraints Potential flooding
4) Injection for a Seawater Intrusion Barrier	Unknown. Modeling required	Unknown. Modeling required	SWRCB (RWQCB and DDW)	None	Significant. Potentially no storage in wet season	Unknown pending modeling Drought: 1,000 AF ? Normal: 200-500 ? Wet: None	None	Potential for shallow groundwater / flooding will require mitigation and monitoring to prevent flooding risk. Modeling effort will better define potential risk for flooding.	Possible temporary degradation as barrier forms, pushing native brackish water eastward	High	Could increase water supply benefit by 0 to 1,000 AFY	
5) Sale of Treated Effluent Directly to Growers	Unknown (pending customers and seasonality constraints)	None	None?	None	Significant. Dependent on crops and irrigation schedules	N / A	None	None	None	Mod	Relatively easy to implement and operate Potentially able to dispose of large volume for most of year.	No water supply benefit. Cost potentially higher than revenue. Need for wet-weather storage. Distribution system req.
6) Continued Use of City's Brine Disposal Pipeline	Full volume	None	None	None	None	N / A	None	None	None	Low	Easiest to implement. Least cost alternative.	No water supply benefit.
7) Riparian Rights Agency Agreement and Exchange with Agricultural Users	Unknown pending water rights investigation and determination of demand volume by landowners	Potentially very high	None	Separate agreements with each user	Significant	N / A	Riparian rights trustee agreements	None	None	Mod	Relatively easy to implement. Potentially dispose of entire volume for most of year.Benefits City supply. User does not lose right.	Distribution system required to each user.