CITY OF MORRO BAY
WATER RECLAMATION FACILITY PROJECT

City of Morro Bay
Master Water Reclamation Plan

DRAFT March 2017

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List of Acronyms and Abbreviations

AADF	Average Annual Daily Flow
ADD	Average Daily Demand
AF	Acre-Foot
AFY	Acre-Feet per Year
AOP	Advanced Oxidation Process
AWWF	Average Wet Weather Flow
BOD	Biochemical Oxygen Demand
BOD_5	5-Day Biochemical Oxygen Demand
BWRO	Brackish Groundwater Reverse Osmosis
CCR	California Code of Regulations
CCWA	Central Coast Water Authority
cfs	Cubic feet per second
CIWQS	California Integrated Water Quality System
CMC	California Men’s Colony
CSD	Cayucos Sanitary District
DBP	Disinfection By Product
DDW	Department of Drinking Water
DNQ	Detected, Not Quantified
DPR	Direct Potable Reuse
DWR	Department of Water Resources
EC_W	Electrical Conductivity of the Water
FMP	Facility Master Plan
GIS	Geographic Information Systems
GRRP	Groundwater Replenishment Reuse Project
GSI	GSI Water Solutions, Inc.
hcf	Hundred cubic feet
IPR	Indirect Potable Reuse
JFR	John F. Rickenbach Planning and Environmental Consulting
LWA	Larry Walker and Associates
MBCSD	City of Morro Bay & Cayucos Sanitary District
MBR	Membrane Bioreactor
MCL	Maximum Contaminant Level
MDD	Maximum Daily Demand
mg/L	Milligrams per liter
MGD	Million Gallons per Day
mL	Milliliter
MKN	Michael K. Nunley and Associates
MMF	Maximum Monthly Flow
MPN	Most Probable Number
MWRP	Master Water Reclamation Plan
ND	Non Detectable
NOV	Notice of Violation
NPDES	National Pollution Discharge Elimination System
PDF	Peak Daily Flow
PHD	Peak Hourly Demand
PHF	Peak Hour Flow
PHDWF	Peak Hourly Dry Weather Flow
PHG	Public Health Goal
ppb	Parts per billion
ppm	Parts per million
PPWTP	Polonio Pass Water Treatment Plant
PSDWF	Peak Seasonal Dry Weather Flow
RO	Reverse Osmosis
RWC	Recycled Water Contribution
RWQCB	Regional Water Quality Control Board
SAR	Sodium Adsorption Ratio
SBR	Sequencing Batch Reactor
SNMP	Salt and Nutrient Management Plan
SRWS	Self Regenerating Water Softeners
SWP	State Water Project
SWRCB	State Water Resources Control Board
TOC	Total Organic Carbon
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TM	Technical Memorandum
TSS	Total Suspended Solids
UV	Ultraviolet
UWMP	Urban Water Management Plan
WDR	Waste Discharge Requirements
WPA	Water Planning Areas
WRF	Water Reclamation Facility
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

SECTION 1 INTRODUCTION

1.1 Purpose and Scope

Michael K. Nunley & Associates Inc. (MKN) was selected by the City of Morro Bay (City) to prepare a Master Water Reclamation Plan (MWRP) with partial funding being provided through the State Water Resource Control Board (SWRCB) Recycled Water Planning Grant Program. This MWRP follows the suggested outline identified in Appendix B of the “Water Recycling Funding Program Guidelines” amended June 16, 2015 and prepared by California State Water Resources Control Board. The scope of services for this project included the following work:

- Review existing and future water demands and wastewater flows
- Summarize existing wastewater influent and effluent quality characteristics
- Identify opportunities and project alternatives for recycled water use in the community
- Assess the treatment requirements for the future water reclamation facility for the project alternatives
- Describe water recycling and potable water supply alternatives evaluated
- Perform a market assessment and assess user requirements
- Perform alternatives analysis, including quantitative and qualitative benefits, facilities needed for each project, and comparative preliminary cost estimates
- Select recommended project and provide further development and evaluation
- Evaluate the recommended project environmental considerations, and for potential legal and institutional issues
- Develop construction financing plan

1.2 Data Collection and Review

The data collection and review effort involved working with City staff to collect the following information:

- Existing water supply permit from California State Water Resources Control Board, Division of Drinking Water
- Consumer Confidence Reports for the last five years
- Wastewater Treatment Plant (WWTP) influent, effluent, and receiving water monitoring results
- City water billing and production data, including State Water deliveries
- Current City Geographic Information Systems (GIS) data
- Central Coast Water Authority Information Concerning City of Morro Bay
- Past cost of water analyses

The following reports, studies, and other material were reviewed during preparation of this Recycled Water Study.

1. City of Morro Bay Cayucos Sanitary District WWTP NPDES Permit No. CA0047881 Order No. R3-2008-0065
2. San Luis Obispo County Master Water Report (Carollo Engineers, May 2012)

3. 2012 Recycled Water Feasibility Study Prepared for the City of Morro Bay and Cayucos Sanitary District Wastewater Treatment Plant Upgrade Project (Dudek, 2012)
4. Water Quality Control Plan for Ocean Waters of California (State Water Resources Control Board California Environmental Protection Agency, 2012)
5. Morro Bay New Water Reclamation Facility – Water Reuse Opportunities (MKN, Draft May 2014)
6. Regulatory Implications of Discharge Options for the Future City of Morro Bay Water Reclamation Facility (Larry Walker & Associates, October 2014)
7. Hydrologic evaluation of the potential benefits to the City water supply from increasing wastewater discharge to Chorro Creek, San Luis Obispo County (Cleath-Harris Geologists, Inc., November 2014)
8. Central Coast Water Authority 2015 Urban Water Management Plan (Central Coast Water Authority, 2015)
9. City of Morro Bay Water & Sewer Rate Studies (Bartle Wells Associates, May 2015)
10. Morro Bay Water Reclamation Facility Project Status of Salinity Source Identification and Control Plan (MKN, January 2016)
11. Water Quality Control Plan for the Central Coast Basin (Regional Water Quality Control Board Central Coast Region, March 2016)
12. City of Morro Bay 2015 Urban Water Management Plan (MNS Engineers, July 2016)
13. City of Morro Bay Salinity Control Program Development (Larry Walker & Associates, July 2016)
14. Effluent Disposal Feasibility Alternatives Study (GSI Water Solutions, July 2016)
15. Assessment of the Hydrogeologic Characteristics of the Chorro Valley (GSI Water Solutions, Inc., August 2016)
16. City of Morro Bay Draft Water Reclamation Facility Master Plan (Black & Veatch, November 2016)
17. Draft Lower Morro Valley Basin Screening-Level Groundwater Modeling for Injection Feasibility (GSI Water Solutions, Inc., January 2017)

1.3 Recycled Water Market Analysis and Alternatives Assessment

The City's proposed Water Reclamation Facility (WRF) Project could provide recycled water to customers within the Morro Bay service area for a number of uses, including urban irrigation, commercial uses, agricultural irrigation, and to augment groundwater supplies if feasible. This MWRP will investigate requirements for recycled water usage in the area and identify the best possible alternative for recycled water usage.

The City's Council has adopted Community Goals for the WRF which include:

- ❑ Produce tertiary, disinfected water in accordance with Title 22 requirements for unrestricted urban irrigation in a cost effective manner for all ratepayers
- ❑ Design to be able to produce reclaimed wastewater for potential users, which could include public and private landscape areas, agriculture, or groundwater recharge. A master water reclamation plan should include a construction schedule and a plan for bringing on recycled water customers in a cost effective manner.

- Allow for onsite composting.
- Design for energy recovery
- Design to treat contaminants of emerging concern in the future.
- Design to allow for other possible municipal functions, i.e. City Corporation Yard on site, as well as other uses such as a public park and education center.
- Ensure compatibility with neighboring land uses.
- Have a new WRF operational within five years.

These goals establish a minimum effluent quality for the WRF and indicate the WRF will be designed to be able to produce reclaimed wastewater. **Table 1-1** lists the community goals and how they relate to the WRF and recycled water projects. The market analysis and alternatives assessment will review previously identified recycled water opportunities, investigate additional potential opportunities (including utilizing recycled water in lieu of imported water for irrigation and/or commercial uses, and environmental uses), develop conceptual projects, and compare the conceptual projects using qualitative and quantitative criteria to identify the recommended project.

Table 1-1: WRF Project Community Goals

Community Goal	Applicability for WRF	Applicability for Recycled Water
Produce tertiary disinfected recycled water	WRF project is to be designed accordingly	Allows for multitude of recycled water uses and provides basis for advanced treatment
Produce reclaimed wastewater cost-effectively	Draft FMP considered costs in treatment evaluation	Project alternative assessment will include capital and operating costs and consider total amount of recycled water produced
Allow for onsite composting	Reviewed as part of Draft FMP. Onsite composting is not recommended, regional facility composting will be more cost effective and more compatible for neighbors	Not Applicable
Design for energy recovery	Draft FMP considered energy recovery for WRF	Project alternatives analysis will consider energy usage
Design to treat for contaminants of emerging concern (CECs)	Draft FMP included consideration in treatment evaluation	Advanced treatment would provide additional treatment for CECs
Allow for other municipal uses	Draft FMP considered for WRF site planning	Not Applicable
Ensure compatibility with neighboring land uses	Draft FMP considered for WRF site planning	Consideration for major infrastructure siting
Operational WRF within five years	WRF project is on schedule	Project alternatives analysis will consider potential challenges that could delay the project.

SECTION 2 STUDY AREA CHARACTERISTICS

This section provides an overview of the City's existing and future population estimates, land uses, and hydrologic conditions.

2.1 Service Area

The City of Morro Bay is a coastal City along Highway 1 located in western San Luis Obispo County. The City provides water treatment and distribution, as well as wastewater collection, treatment, and disposal services to residential and commercial customers within their service area. According to the 2015 City of Morro Bay Water and Sewer Rate Studies ("Rate Study", Bartle Wells Associates, May, 2015) the City currently provides 5,424 residential units, including 11 outside the City limits under legacy agreements, and 341 commercial units with water supply, treatment and distribution services and approximately 5,468 residential and 494 commercial units with wastewater collection and disposal services. The water and wastewater treatment facilities and service area are shown in **Figure 2-1**. The potential WRF location is currently outside the City limits and service area. The City is considering annexation of the property, in which case permitting would occur through the City. If the property is not annexed, permitting would be performed through the San Luis Obispo County's process. The City's General Plan Update, currently underway, will consider the proposed WRF property.

2.2 Population

The City of Morro Bay is a general law city with a potential buildout population of 12,200. According to the Rate Study, there are currently 4,200 single family dwellings, 308 condominiums, and 960 multi-family dwellings (Bartle Wells Associates, 2015). **Table 2-1** provides a summary of the estimated existing population served by the City. The City also has a high vacancy rate of 23.2 percent, which suggests many homes are vacation rentals with inconsistent occupation throughout the year.

Table 2-1: Estimated Existing Population Served by the City

Customer Base	Number of Residential Units	Estimated Population
Water	5,424	10,224
Wastewater	5,468	10,224

The Draft Facility Master Plan (FMP) for the WRF provided a population projection up to the year 2040 for the City's influent wastewater characteristics, flow projections, and effluent discharge requirements. Current and projected populations are listed in **Table 2-2** (Black & Veatch, November 2016). It is important to note that while vacancy rate is high, the occupancy of these homes is accounted for in the population projections.

Table 2-2: Current and Projected Population for Morro Bay

2015	2020	2025	2030	2035	2040
10,284	10,606	10,939	11,282	11,636	12,000

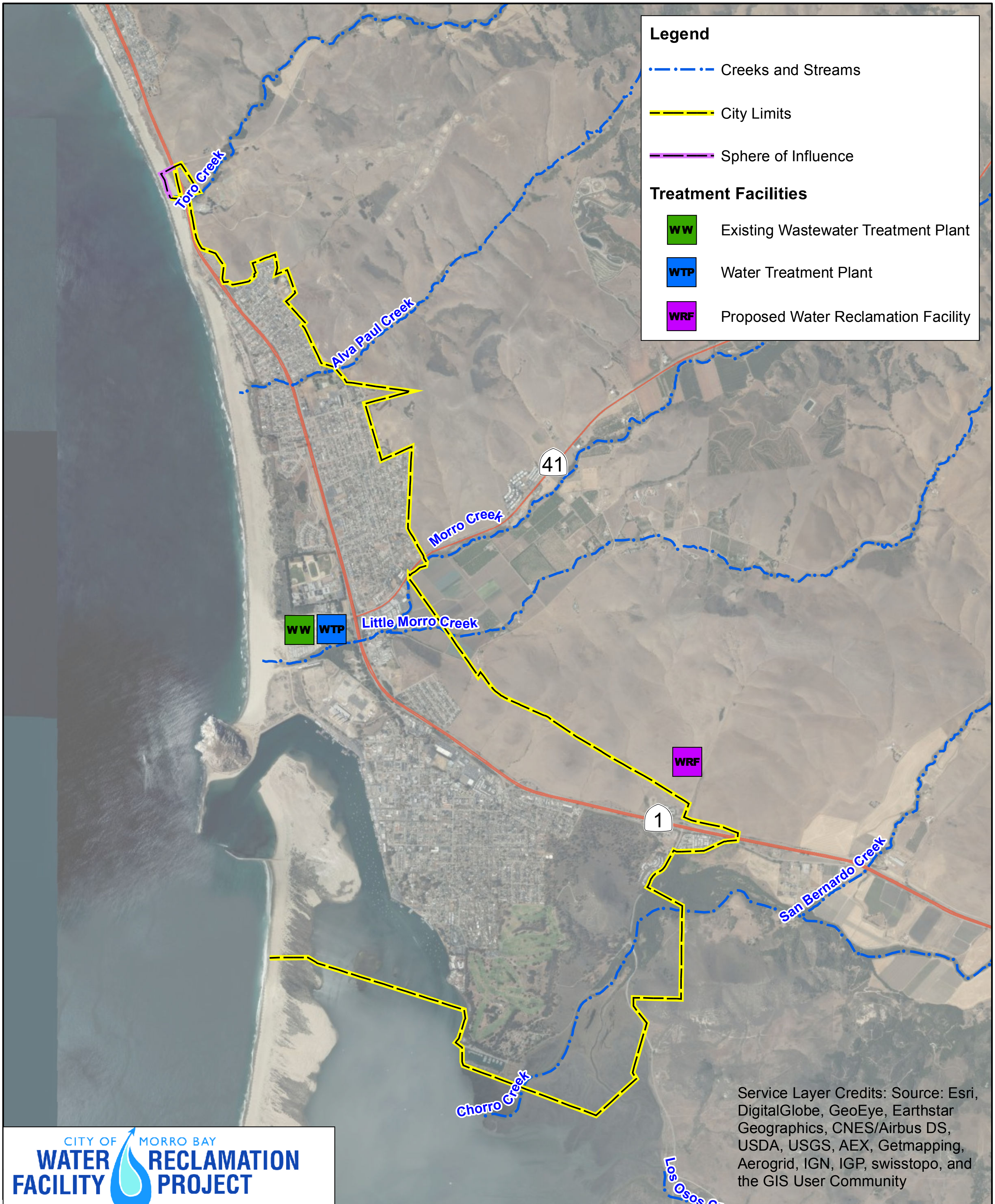

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Figure 2-1:
City Service Area and Existing Treatment Facilities

1 inch = 3,500 feet
0 3,500

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2.3 Land Use

The City's service area includes a variety of land uses. **Table 2-3** and **Figure 2-2** provide an overview of the existing land uses based on the City's available Geographic Information Systems (GIS) data. The City's 1988 General Plan is currently being updated.

Table 2-3: Land Use Designations within City Service Area	
Land Use	**Acres**
Agriculture	174.1
Coastal Development	99.6
Commercial / Recreational Fishing	20.2
Commercial District	79.9
Environmentally Sensitive Habitat	813.6
General	74.8
Harbor / Navigational Ways	402.9
High Density Residential	51.7
Low Density Residential	147.7
Medium Density Residential	285
Mixed Use	190.6
Moderate Density Residential	504.5
Open Space / Recreation	797.6
Public Facilities	74.4
Visitor Serving	74.3
Total	**3790.9**

Based on review of the City's historical growth, it is assumed that the existing overall land use pattern is likely to stay similar in the future.

2.4 Hydrologic Features

The County of San Luis Obispo Master Water Report (Carollo, May 2012) divides the County of San Luis Obispo into three sub-regions: North Coast, South Coast, and Inland; and 16 Water Planning Areas (WPA) to collect, organize and summarize information for existing/future water sources, supplies and demands for water purveyors throughout the County. The WPAs were delineated based on existing watershed boundaries, groundwater basin boundaries, urban growth boundaries and water supplies. The City is located within Morro Bay WPA 4 (North Coast Sub-Region). The City lies over two groundwater basins: Chorro Valley and Morro Valley. Both groundwater basins have been classified as shallow alluvial basins.

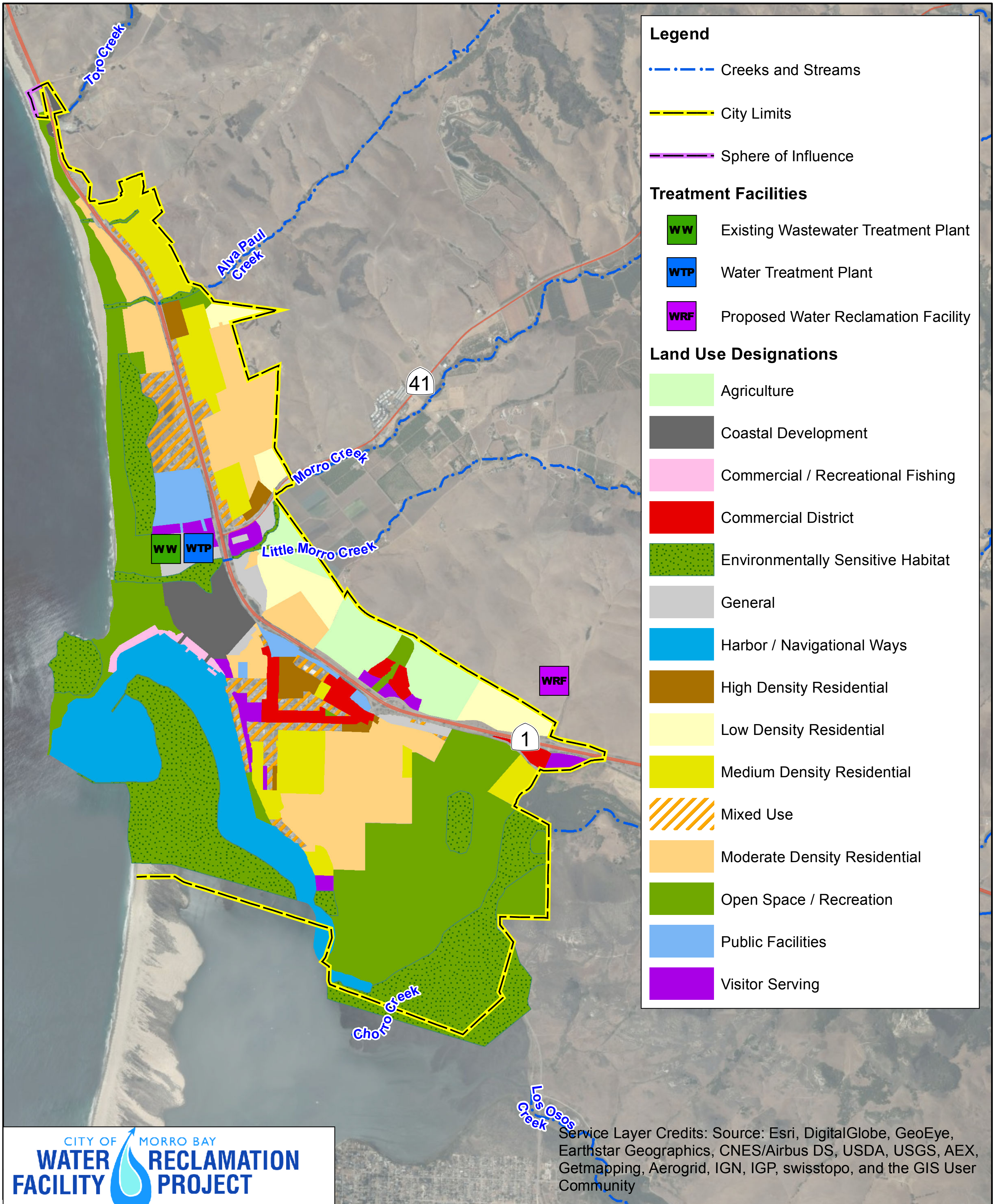
Treated effluent from the City's wastewater treatment system is discharged 2,900 feet offshore to Estero Bay and henceforth the Pacific Ocean.

Known beneficial uses of Estero Bay per the Water Quality Control Plans for Ocean Waters of California (the Ocean Plan) and Central Coast Basin (the Basin Plan) are as follows:

- Industrial Water Supply (IND)
- Water Contact and Non-Contact Recreation, including Aesthetic Enjoyment (Ocean Plan REC, Basin Plan REC-1 and REC-2)
- Navigation (NAV)
- Commercial and Sport Fishing (COMM)

- Mariculture (MARI)
- Preservation and Enhancement of Designated Areas of Special Biological Significance (ASBS)
- Rare and Endangered Species (RARE)
- Marine Habitat (MAR)
- Fish Migration (MIGR)
- Fish Spawning and Shellfish Harvesting (Ocean Plan SPWN, Basin Plan SHELL)

Figure 2-3 and **Figure 2-4** provide an overview of the topography and hydrologic features within and adjacent to the City's service area. Additional information about the City's water supply and water quality is included in **Section 3** of this report.



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Master Water Reclamation Plan
Figure 2-2:
Land Use Designations

1 inch = 3,500 feet
0 3,500

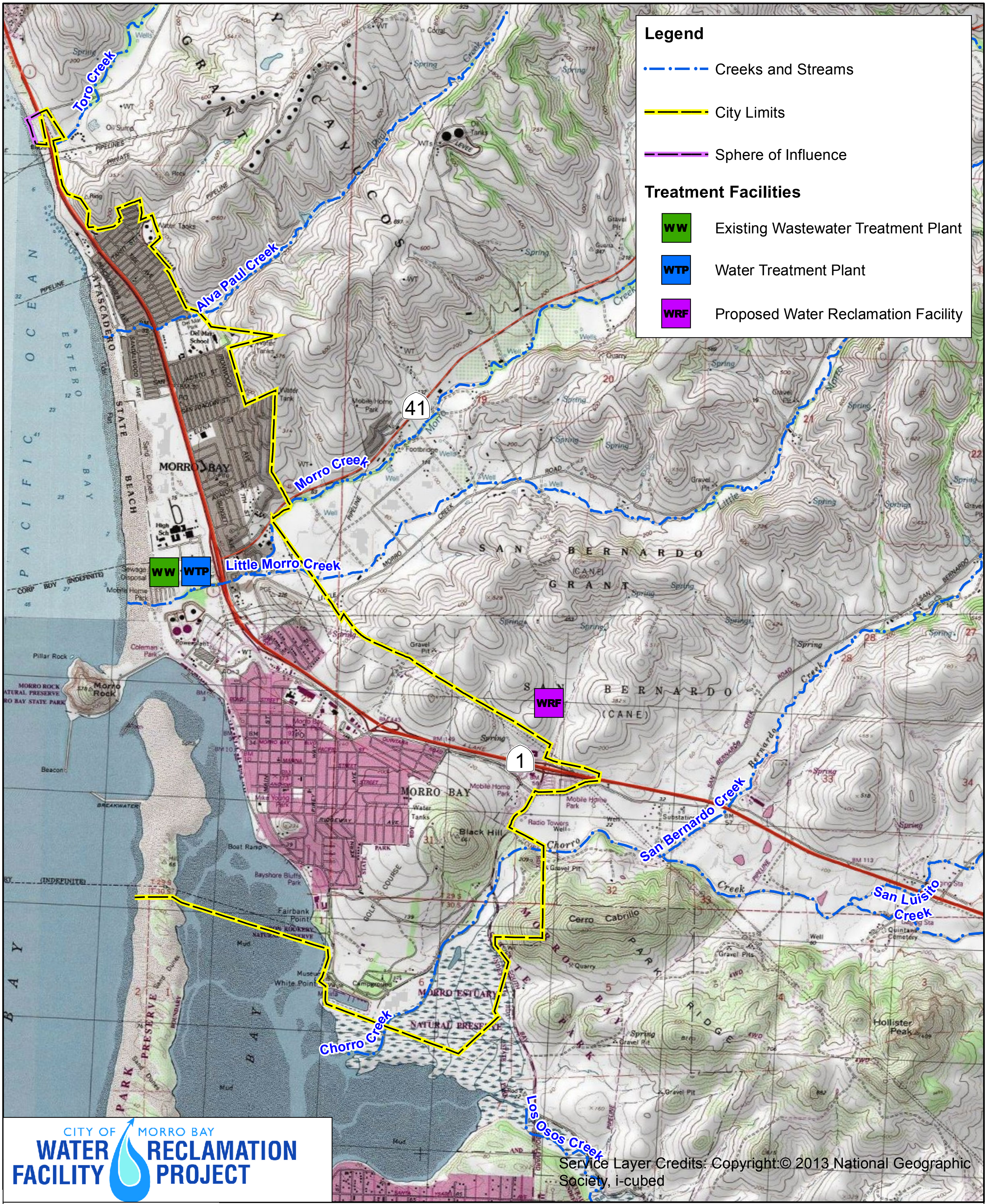

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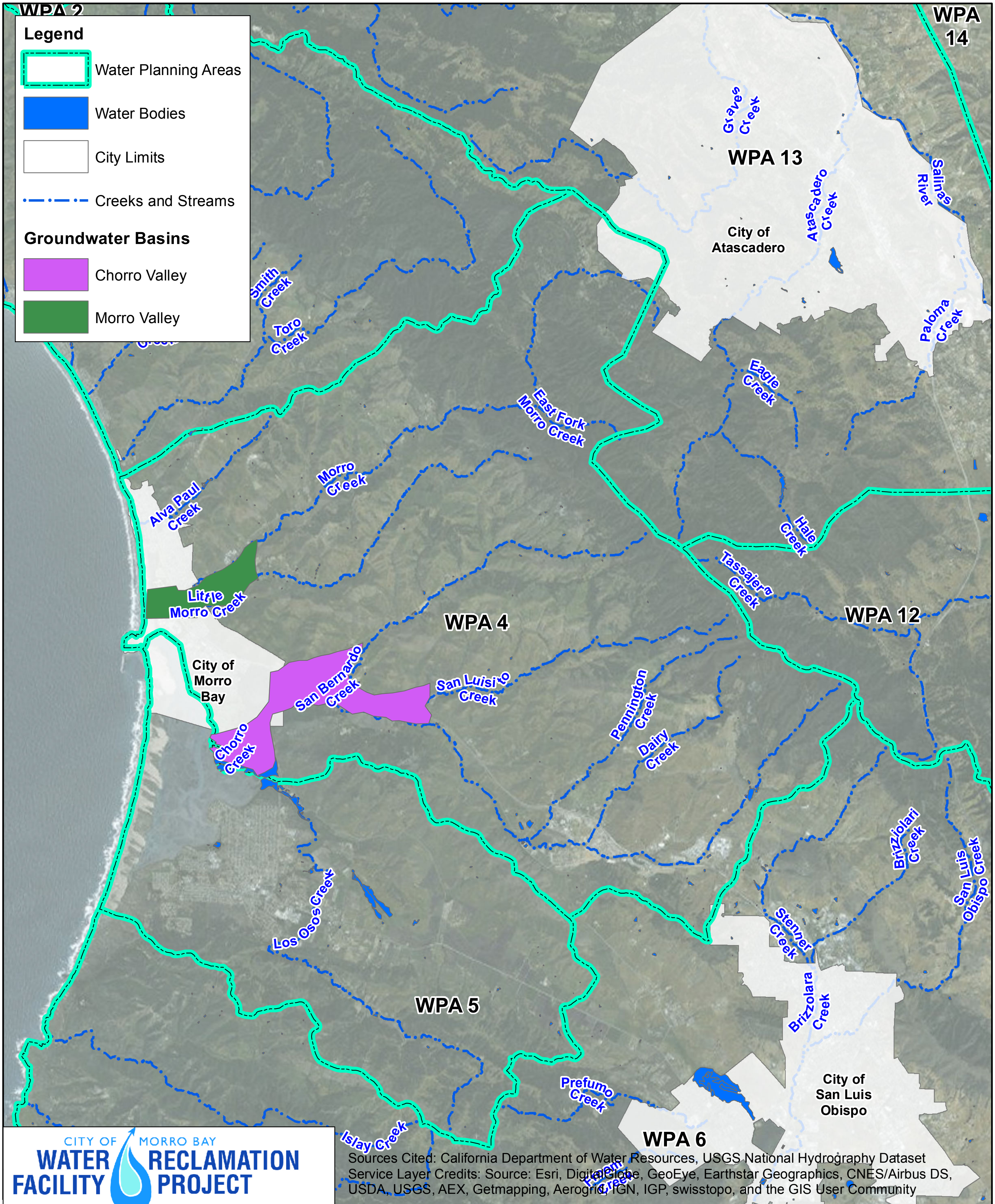
Figure 2-3:
Topographic Map



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Master Water Reclamation Plan
Figure 2-4:
Hydrologic Features

1 inch = 2 miles

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SECTION 3 WATER SUPPLY CHARACTERISTICS

This section provides an overview of the water supply, water quality, and existing and future projected water demands within the District's service area.

3.1 Water Supply

The City of Morro Bay water supply currently consists an appropriative permit to withdraw water from two local groundwater basins (associated with Morro Creek and Chorro Creek) and water imported by the State Water Project (SWP). The City also has the capability to supplement water supply with a seawater desalination facility. Both the local groundwater basins are high in nitrate due to the agricultural industry's over-application of nitrogen fertilizers within the watershed. Because of this contamination, the water must be treated by blending or processing through the City's brackish water reverse osmosis treatment system co-located at the City's desalination plant. Due to their relatively small size and number of users, the groundwater basins can reach overdraft conditions during droughts. According to the City's 2015 Water Quality Consumer Confidence Report, in 2014 87% of the City's water was supplied by the SWP and the remaining 13% was supplied from local groundwater via the City's Brackish Groundwater Desalination Plant. The City has contracted for a maximum of 1,313 acre-feet per year (AFY) of State Water from the San Luis Obispo Flood Control and Water Conservation District, plus an additional 174 percent "drought buffer" to ensure reliability during drought years. This additional drought buffer ensures that the City receives its full allowance of 1,313 AFY when the SWP deliveries are reduced by up to 36.5% due to drought conditions. In years of minimal delivery, which has been as low as 5% allocation from the SWP, the City receives 216 AFY. In order to satisfy demand, water is made up from SWP water in storage at San Luis Reservoir and treated local groundwater.

Prior to the SWP, the City relied on groundwater from the Morro Valley and Chorro Valley Groundwater Basins for its primary source of water. These basins are shallow alluvial basins that behave similar to an underground stream. Rainfall in the watershed percolates into the ground and flows underground to the ocean. Use of such water resources is controlled by the SWRCB. The SWRCB issued findings in 1972 that the Chorro Valley and Morro Valley Groundwater Basins are supplied by riparian underflow. The City of Morro Bay applied for appropriative water rights and the SWRCB approved rights in 1995 for withdrawal of up to 1723.5 AFY of groundwater. The City is allowed an instantaneous withdrawal of up to 1.2 cubic feet per second (cfs) and annual withdrawal of 581 AFY from the Morro Valley Groundwater Basin and up to 3.171 cfs and 1,142.5 AFY from Chorro Creek underflow. In accordance with the SWRCB permits, the City may pump up to only 1,150 AFY in severe drought years. Pumping from the Chorro Valley Groundwater Basin is limited to times when Chorro Creek has a minimum flow rate of 1.4 cfs. Additionally, groundwater from both basins can exceed the primary drinking water standard for nitrate. Groundwater pumped from the Morro Valley is treated at the City's Water Treatment Plant, but the infrastructure is not in place for treatment of Chorro Valley groundwater.

3.2 Water Production Facilities

As previously stated, the City receives the majority of its potable water from the SWP. The water delivered is diverted from the California Aqueduct through the Coastal Branch Extension where it is treated at the Central Coast Water Authority (CCWA) operated Polonio Pass Water Treatment Plant (PPWTP). Morro Bay receives the treated water from PPWTP via the Chorro Valley Pipeline.

Morro Bay's desalination plant, originally constructed in 1992, was intended to provide desalinated seawater in a drought emergency. The desalination treatment train is served from five seawater wells. The treatment system can produce up to 645 AFY, but has never produced this amount of water because of influent water quality issues and the expense of operating the treatment system. Seawater intake wells are currently being evaluated for well capacities. The plant served as a primary source of water for a few months in 2010 and currently is used on a very limited basis. In case of SWP supply reductions or service outages, the plant provides a backup and emergency water supply.

In 2009, the City modified the desalination plant to treat brackish groundwater. Groundwater from the Morro Valley groundwater basin that is pumped by the City is treated at the Brackish Water Reverse Osmosis (BWRO) plant. Chorro Valley groundwater cannot currently be treated at the BWRO facility. Groundwater in the Morro Valley and Chorro Valley basins can exceed primary drinking water standard for nitrates and is also high in total dissolved solids. The location of the wellfields make them potentially susceptible to seawater intrusion. The BWRO plant treatment train can produce up to 581 AFY, enough to treat the annual permitted allowance from the Morro Valley basin. The facility can currently only operate one treatment process (SWRO or BWRO) at a time, but the City may pursue upgrades to be able to bring both systems online simultaneously. In the future, planned upgrades could allow the plant to produce water at a rate of 1350 GPM from both supplies.

3.3 Water Quality

The City receives SWP water through the California Aqueduct diverted to the Coastal Branch Extension. The water is treated at the PPWTP before a portion flows through the Chorro Valley Pipeline to Morro Bay. Groundwater pumped from the Morro Valley basin by the City is treated through the BWRO plant. The City does not currently have the infrastructure (pipelines or treatment facilities) to treat groundwater from the Chorro Valley basin.

All drinking water must be in compliance with the following California Title 22 Code of Regulations, among other state and federal standards and requirements, including:

- Total Coliform Rule
- Lead and Copper Rule
- Safe Drinking Water Act
  - Primary Drinking Water Standards
  - Secondary Drinking Water Standards
- Stage 2 Disinfection Byproducts Rule

Groundwater aquifers in the area are vulnerable to seawater intrusion during dry periods and are subject to impacts from regional and agricultural operations, namely increased nitrate concentrations. The groundwater wells in the Morro Valley and Chorro Valley basins have experienced elevated levels of salinity during dry periods, with total dissolved solids (TDS) levels as high as 4,000 milligrams per liter (mg/L). The Morro Valley wells experience elevated nitrate concentrations as high as 110 mg/L as nitrate. The City's BWRO plant is designed to remove TDS and nitrate from groundwater pumped out of the Morro Valley groundwater basin. Water entering the plant is run through cartridge filters before entering reverse osmosis treatment. Permeate from the reverse osmosis process is remineralized through calcium carbonate contact to reduce corrosivity and is disinfected and sent to the distribution system. Concentrate is discharged to an ocean outfall separate from the existing WWTP outfall.

It is important to note that SWP water delivered to Morro Bay has seen an increase in TDS concentrations in recent history. In 2011, the average TDS concentration was 190 mg/L, in 2013 the concentration was 336 mg/L, and in 2014 the concentration was 428 mg/L. As the drought has reduced available water supply, water from lower elevations in SWP reservoirs, which tend to have higher salt concentrations, has been delivered. Increased salinity in source water results in increased salinity in the City's wastewater effluent, as conventional wastewater treatment technologies do not address salinity. Recycled water with high salinity content has limited uses, and would need further treatment to increase opportunities for reuse.

Table 3-1 below provides a summary of the City's historical water quality monitoring data from 2011 through 2015 as reported in the City's annual consumer confidence reports. During this time period the City drinking water was not in violation at any time other than missing a sampling deadline in 2014 for Hexavalent Chromium. The City had sampled for this constituent before the State of California issued a Maximum Contaminant Level (MCL) in July of 2014, but the previous testing missed the cut-off by a few months. The testing done in February 2014 yielded results well below the detection level of 10 parts per billion (ppb).

Table 3-1: Historical Water Quality Results

Constituent	Maximum Contaminant Level (MCL)	Public Health Goal (PHG)	Maximum Level Detected									
			SWP 2011	Well 2011[1,2]	SWP 2012	Well 2012 [2]	SWP 2013	Well 2013 [1,2]	SWP 2014	Well 2014 [1,2]	SWP 2015	Well 2015 [1,2]
Primary Drinking Water Standards												
Aluminum (ppm)	1	0.6	130	ND	0.12	0.01	0.15	0.01	0.069	0.01	0.11	0.01
Barium (mg/l)	1	2	ND	100	ND	0.128	ND	0.128	ND	0.128	ND	3.24
Fluoride (ppm)	2	1	ND	0.3	ND	0.2	ND	0.2	ND	0.2	ND	0.3
Nickel (ppb)	100	12			ND	10	ND	10	ND	10	ND	8
Nitrate (as Nitrogen) (ppm)	10	10	0.41	20.34	0.48	36.09	ND	37.41	0.08	36.09	0.43	35.70
Selenium (ppb)	50	30	ND	0.012	ND	13	ND	13	ND	13	ND	19
Secondary Drinking Water Standards												
Chloride (ppm)	500	n/a	78	64	146	162	136	162	170	162	205	1480
Color	300	n/a	ND	20	ND	ND	ND	ND	ND	ND		
Manganese (ppb)	50	n/a	ND	20					ND	NA	ND	30
Specific Conductance (microohms)	1600	n/a	467	1080	706	1490	715	1490	969	1490	1160	5050
Sulfate	500	n/a	38	93.9	71	121	36	121	120	121	97	149
Total Dissolved Solids (ppm)	1000	n/a	277	637	417	910	423	910	572	910	708	2870
Turbidity	5	n/a	0.1	11.2	0.1	1	0.17	1	0.11	1	0.14	11.7
Secondary Drinking Water Standards (Unregulated)												
Hardness (ppm)	None	None	96	533	156	585	15	585	182	585	206	1800
Sodium (ppm)	None	None	32	48.7	62	94	42	94	130	94	84	317

Table 3-1: Historical Water Quality Results							
Constituent	**Maximum Contaminant Level (MCL)**	**Public Health Goal (PHG)**	**2011**	**2012**	**2013**	**2014**	**2015**
Total Coliform Rule, Sampled from Distribution System							
Fecal Coliform	A routine sample and a repeat sample detect total coliform and either sample also detects fecal coliform or E. coli	0				No Exceedance	No Exceedance
Total Coliform Bacteria	More than 1 sample in a month with detection	0				No Exceedance	No Exceedance
Lead and Copper Rule, Sampled from Tap Water Throughout Distribution System, 90th Percentile							
Copper (ppm)	1.3 (Regulatory Action Level)	0.3	0.18	0.13	0.13	0.13	0.12
Lead (ppb)	15 (Regulatory Action Level	0.2	11	3.4	3.4	3.4	6.7
Stage 2 Disinfection Byproducts Rule, sampled from Distribution System							
Chloramines (as Cl2) (ppm)	4	4	2.2	2.2	2.2	2.2	2.2
Haloacetic Acids (HAA5) (ppb)	60	n/a	28	19	22	13	17
Total Trihalomethanes (TTHM) (ppb)	80	n/a	33	59.1	63.7	61.2	69.3
ND = Non detect, sampling from Well Water is from 2012. 1: Well Water results are from previous year. 2: Sampling from raw water prior to treatment or blending. 3: Tap water samples collected from homes throughout distribution system, 90th percentile presented							

3.4 Historical Water Demand

Metered water usage is outlined in both the City's Urban Water Management Plan ("UWMP", MNS Engineers, July 2016) and the 2015 Morro Bay Rate Study. **Table 3-2** and **Table 3-3** detail the historical water produced and metered usage. Due to conservation efforts mandated by the State of California, demand has decreased in recent years.

Table 3-2: Historical Water Production (Acre-Feet)

Year	Chorro Valley Basin	Morro Valley Basin	SWRO and BWRO	State Water	Total
2006	257	80	25	1009	1371
2007	276	35	19	1116	1446
2008	184	52	28	1175	1439
2009	235	80	64	1069	1448
2010	74	54	258	873	1259
2011	18	101	84	1144	1347
2012	Sampling water for testing only	109	70	1130	1310
2013		151	107	1139	1397
2014		59	41	1140	1240
2015			138	950	1088

Table 3-3: Historical Water Use (Acre-Feet)

Residential	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Single Family	615.8	583.1	603.6	615.4	624.7	410.0
Single Family Condo	19.7	21.8	22.6	22.9	22.9	14.5
Multi-Family	104.3	99.3	100.5	102.9	101.7	66.3
Single Family- Outside City	0.7	0.6	0.4	1.7	1.5	0.9
Non Residential	511.4	549.4	439.7	419.3	434.5	291.4
Total	1,251.9	1,254.3	1,166.8	1,162.1	1,185.2	783.0

Note: 2014 data only includes water usage between January and August
"Single Family Outside City" = single family residential units, located just outside of the City Limits with City water services.

3.5 Existing Water Demands

The City's UWMP included details on existing water demands in 2015. These details are shows in **Table 3-4**. Use of "Vacant Land", "Industrial", and "Hydrant Flushing/Testing" were less than 1 acre-foot (AF) and not included in this summary table. Based on the potable and raw water demands in 2015, the average daily demand (ADD) was determined to be 0.96 million gallons per day (MGD).

Table 3-4: Potable and Raw Water Demand in 2015 (Acre-Feet)	
Use Type	**Volume**
Single-Family	562
Multi-Family	128
Commercial	250
Institutional/Governmental	97
Losses	37
Total	1,074

3.6 Future Water Demands

Based on future population projections, the City prepared a Rate Study in 2015 for water and wastewater users in order to evaluate necessary customer rates to avoid deficit. **Table 3-5** presents the projected potable and raw water demands from the City's 2015 UWMP, which were used in the Rate Study to help determine future billing rates.

Table 3-5: Projected Demand for Potable and Raw Water (Acre-Feet)					
Use Type	**2020**	**2025**	**2030**	**2035**	**2040**
Single Family	683	699	718	738	759
Multi-Family	156	159	164	168	173
Commercial	304	311	320	328	337
Institutional/Government	118	121	124	127	131
Losses	37	37	37	37	37
Total	1,298	1,327	1,363	1,398	1,437
Projected use was scaled from 2013 demands based on future population projections relative to 2015 population					

3.7 Water Production Costs

The City's water production costs vary depending on the source. SWP costs are based on the City's contract with CCWA. The City's contract has take-or-pay stipulations which make it financially desirable to maximize use of State Water. According to City staff, the City will spend approximately $2,400,000 for 1,140 acre-feet of State Water in 2016/2017, which amounts to $2,100 per acre-foot. It is anticipated that State Water costs will increase due to inflation and additional infrastructure projects related to the State Water Project.

City staff estimate the cost for seawater desalination is estimated at $1,600/AF, which includes extraction of water through the seawater wells and treatment through the SWRO system. Total cost for extraction and treatment of Morro Valley groundwater is estimated to be $1,000/AF.

Table 3-6: Comparison of Water Production Costs by Source	
Source	**Current Estimated Cost ($ per AF)**
State Water Project	2,100[1]
Seawater Desalination	1,600
Morro Valley Groundwater	1,000
[1] SWP estimated cost is based on costs during 2015. SWP costs are variable and dependent on the amount delivered, but SWP has a high fixed cost.	

SECTION 4 WASTEWATER CHARACTERISTICS AND FACILITIES

This section provides an overview of the existing wastewater treatment and disposal systems and effluent water quality requirements, the anticipated new WRF treatment facilities, existing and future wastewater flows, and historical influent water quality.

4.1 Description of Existing Facilities

The existing WWTP is located on Atascadero Road, west of Highway 1 and serves the City and the Cayucos Sanitary District (CSD). The existing WWTP operates under a 301(h) modified National Pollutant Discharge Elimination System (NPDES) permit, which waives full secondary treatment requirements for biochemical oxygen demand and total suspended solids. The City' NPDES permit allows discharge of treated wastewater into Estero Bay through an ocean outfall/diffuser 2,900 feet offshore, which is owned by both the City and CSD. The City and CSD reached a settlement agreement with the RWQCB to upgrade the jointly-owned WWTP to full secondary treatment in anticipation of losing the 301(h) waiver for ocean discharge. The agreement allowed the City and District to pursue secondary treatment on a schedule that was mutually agreed up on by both agencies and the Regional Water Quality Control Board (RWQCB). The proposed upgraded facility at the current WWTP location was denied a Coastal Development Permit by the California Coastal Commission for various reasons including a failure to avoid coastal hazards such as tsunami, location within a designated sensitive view area, and failure to include a sizable recycled water component. Since then, both the City and CSD have independently investigated possibilities for WRFs. The existing treatment processes at the WWTP include:

Liquid treatment processes:

- ❑ Headworks fine screening
- ❑ Grit removal
- ❑ Primary clarifiers
- ❑ Trickling filters
- ❑ Secondary clarifiers
- ❑ Disinfection (sodium hypochlorite)

Solids treatment processes:

- ❑ Anaerobic digestion
- ❑ Drying beds and on-site composting

A process flow diagram illustrating the existing wastewater treatment technology can be seen below in **Figure 4-1**

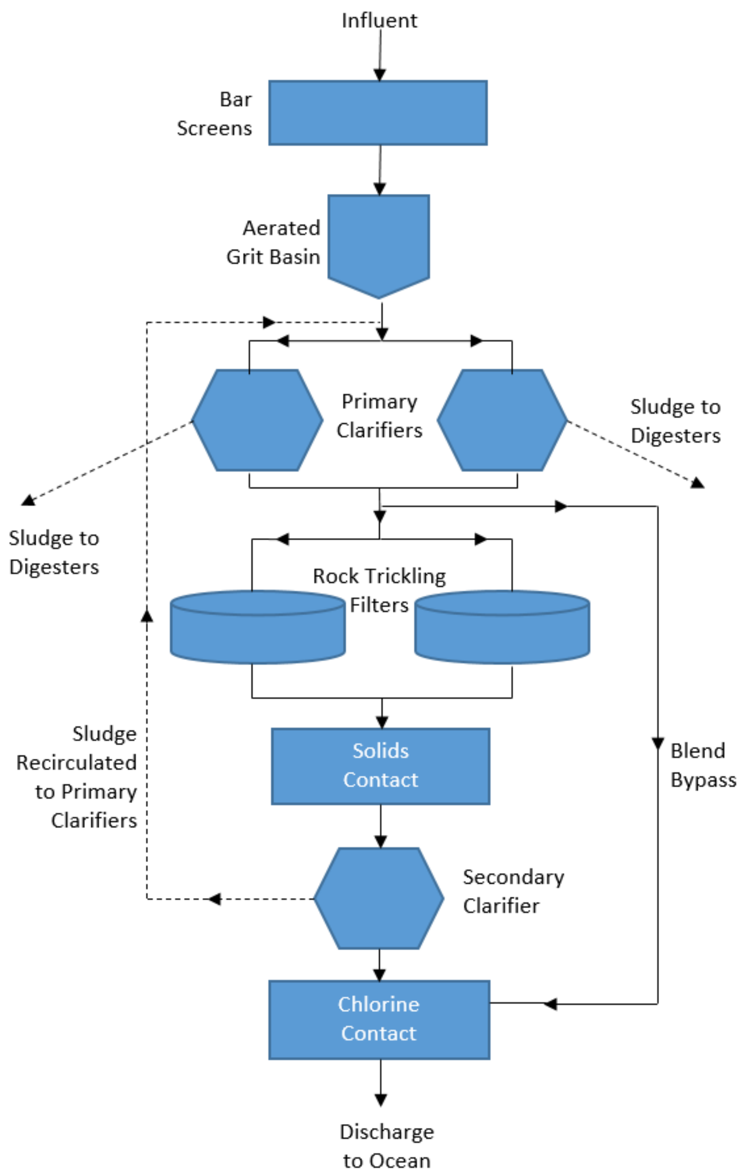


Figure 4-1: Existing City WWTP Treatment Train

4.2 Existing Effluent Limitations and Discharge Requirements

The City's WWTP discharge is permitted through the California RWQCB with Waste Discharge Requirements (WDR) Order No. R3-2008-0065 / NPDES Permit CA0047881 with full secondary treatment requirements for BOD_5 and total suspended solids (TSS) waived by a Clean Water Act Section 301 (h) waiver. The permit authorizes discharge of up to 2.36 MGD of treated wastewater on an average monthly basis to a 27-inch diameter ocean outfall ending in a 170-foot-long diffuser designed to achieve the required minimum dilution of 133 parts seawater for every part effluent. The diffuser is located 2,900 feet offshore under 50 feet of water.

Effluent limitations for total suspended solids (TSS), 5-day biochemical oxygen demand (BOD_5) and other monitored constituents are listed in **Table 4-1**. The Permit requires removal, as a 30-day average, of at least 75% of suspended solids and 30% of biochemical oxygen demand. The Permit also requires effluent pH to remain within 6.0 and 9.0 at all times. Effluent pH has been monitored daily since 1993, and has never gone below 6.9 or above 8.2.

Table 4-1: WDR Order No. R3-2008-0065 Effluent Discharge Requirements for Selected Pollutants							
Parameter	Units	Effluent Limitations					
		Average Monthly	Average Weekly	Maximum Daily	Instant. Minimum	Instant. Maximum	6-Month Median
5-day BOD	mg/L	120			180		
	lb/d	2,062			3,092		
	% removal	30					
Suspended Solids	mg/L	70			105		
	lb/d	1,203			1,804		
	% removal	75					
Grease and Oil	mg/L	25	40		75		
	lb/d	430	687		1,288		
Settleable Solids	ml/L	1.0	1.5		3.0		
Turbidity	NTU	75	100		225		
pH	S.U.						
Ammonia	mg-N/L			322		804	80.4
Total Residual Chlorine	ug/L lb/d			1.07		8.04	0.27
Chronic Toxicity	TUc			134			
Notes: BOD = biological oxygen demand; mg/L = milligrams per liter; lb/d = pounds per day; ml/L = milliliters per liter; NTU = nephelometric turbidity unit; mg-N/L = milligrams as nitrogen per liter; ug/L = microgram per liter; TUc = chronic toxicity unit							

In addition to the limits noted in the table above, the NPDES permit includes discharge limits for metals, cyanide, phenolic compounds, endosulfan, endrin, hexachlorocyclohexane, and radioactivity for the protection of marine aquatic life; and limits for carcinogens and non-carcinogens, regulated for the protection of human health.

The Permit also designates that the effluent must be essentially free of:

- Material that is floatable or will become floatable upon discharge.
- Substances that may form sediments or settleable material which will degrade aquatic life or benthic communities.
- Substances that will accumulate to toxic levels in marine waters, sediments, or biota.
- Substances that significantly decrease natural light available to benthic communities.
- Materials that result in undesirable discoloration of the ocean surface.

4.3 Description of Anticipated New WRF Treatment Facilities

It is anticipated that the City's proposed WRF will treat wastewater to provide tertiary disinfected recycled water based on the community project goals. Depending on the end use, this may include advanced treatment. At a minimum, the new WRF will provide full secondary treatment to meet the anticipated NPDES permit requirements. The City plans to maintain its ocean outfall but will be substantially increasing extent of treatment and, pending implementation of a recycled water project, will be reducing total volume discharged annually upon construction of the WRF. Recycled water produced from the WRF may initially all be diverted to the ocean outfall depending on the schedule of implementing recycled water project(s). To offset potable water use, it is in the City's best interest to maximize its use of recycled water and minimize the amount sent to the ocean outfall.

The Draft FMP evaluated potential liquid and solids treatment technologies and provides recommendations for the WRF (Sections 4 and 5 of the Draft FMP, respectively). Evaluation criteria, based on community project goals and feedback from City technical staff, included comparative capital and operating costs, odor mitigation, technical complexity, reliability, staff requirements, scalability, product water quality, beneficial reuse opportunities, flexibility for Title 22 redundancy, and visual impact/footprint.

The report recommends two liquid treatment process train options, with potential for future expansion to advanced treatment. One alternative (Option A) is a conventional treatment process option consisting of screening, grit removal, flow equalization, secondary treatment with sequencing batch reactor (SBR), tertiary treatment achieved through microfiltration, and disinfection by ultraviolet radiation. SBR is a well-established batch operation activated sludge technology, which has been widely used since the later 1970s. SBR technology is well-suited to smaller communities where flows can vary widely, and the units are relatively compact and energy efficient. The SBR provides clarification and biological steps. Subsequent filtration and disinfection processes are required to provide tertiary treatment. The basic process flow diagram for this option is provided in **Figure 4-2**.

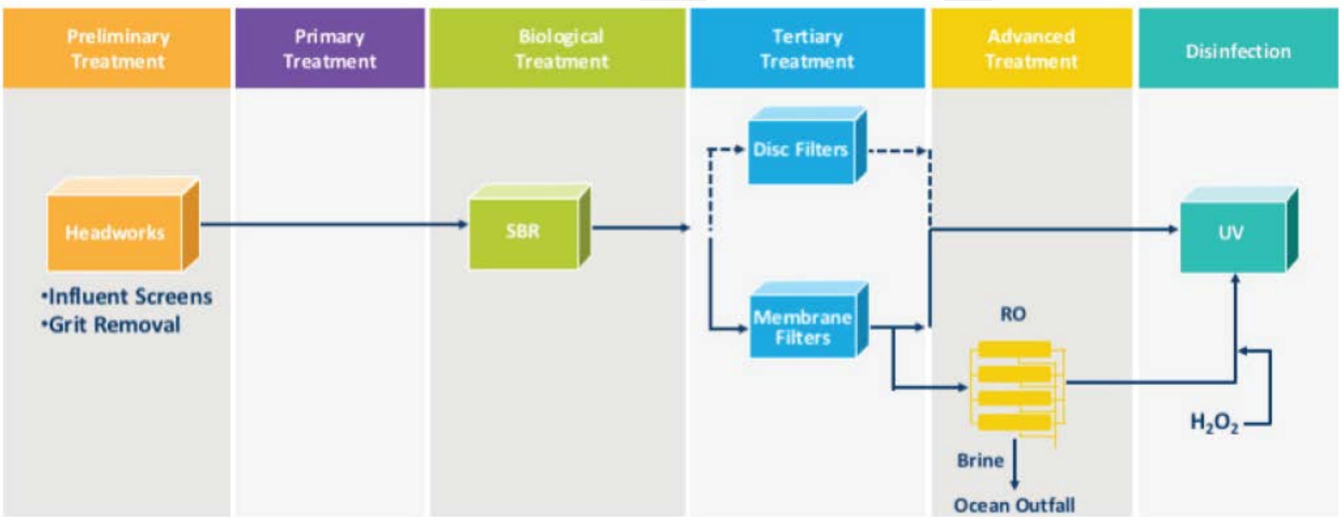


Figure 4-2 Conventional Treatment Alternative

The second alternative (Option B), a combined secondary and tertiary treatment option, involves screening, grit removal, flow equalization, secondary and tertiary treatment through a membrane bioreactor process, and disinfection by ultraviolet radiation. The membrane bioreactor (MBR) acts as both a biological treatment process and a filtration process. The MBR provides the primary biological, and filtration steps of the process, and is more compact than SBR since additional filters are not required. The basic process flow diagram for the MBR option is provided in **Figure 4-3**.

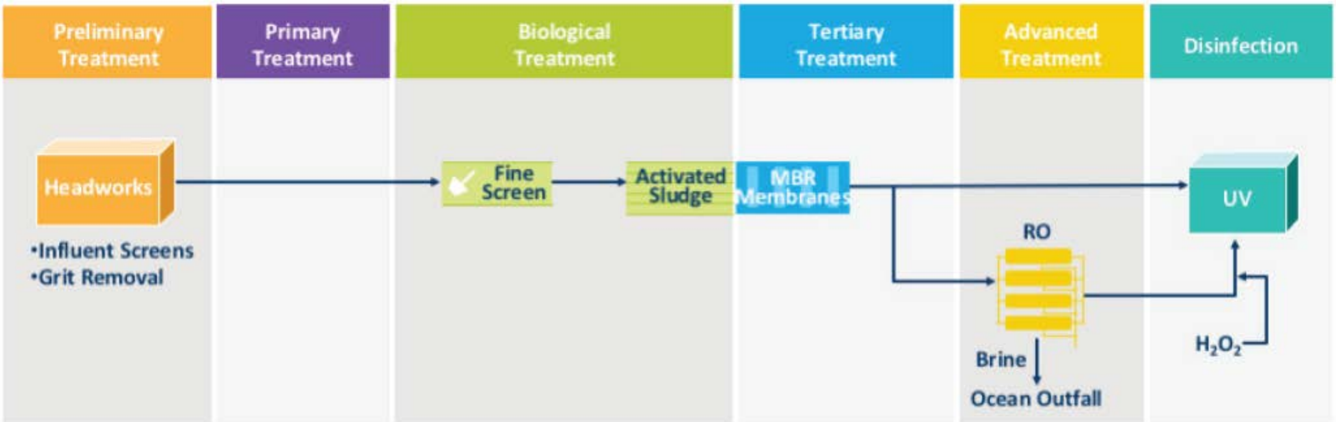


Figure 4-3 Combined Secondary/Tertiary Treatment Alternative

Advanced treatment will likely be required the recycled water projects under consideration, as discussed further in **Section 5**. Both systems would be adequate biological treatment for reverse osmosis, but the conventional treatment option would require addition of membrane filters as a pretreatment step to reverse osmosis. The ultraviolet disinfection process can also be coupled with hydrogen peroxide treatment to provide an advanced oxidation process (AOP). AOPs involve generation of highly reactive free radical intermediates which are applied for the destruction of various contaminants. An AOP is required for indirect potable reuse via groundwater injection, and are anticipated to be required by future direct potable reuse legislation.

Section 5 of the Draft FMP summarizes the evaluation and recommendations for solids management and treatment. Biosolids are produced in the liquid treatment process when solids and liquids are separated. These biosolids must be either disposed of in a landfill or composted and prepared for beneficial reuse. Biosolids handling includes collection from the liquid treatment process stream, and water separation to reduce weight and volume. Treatment is also involved, but may occur at offsite facilities. The Draft FMP evaluated the potential to perform composting or energy recovery using biosolids, but determined that it would not be cost effective. It is anticipated that the City will continue its current practice of hauling dewatered biosolids to a regional facility, Liberty Composting in Kern County, where the biosolids are further processed and sold for agricultural reuse.

4.4 Anticipated Future Effluent Limitations and Discharge Requirements

The City will be negotiating a new NPDES permit and WDR for the WRF and the ocean outfall is planned to be maintained for wet weather and brine disposal. The new permit for ocean discharge is expected to require full secondary treatment at a minimum. Additional effluent and/or discharge limitations will be included in the permit, depending on the type of discharge or end use for the effluent. The Draft FMP was prepared based on the community goals, including the goal to produce disinfected tertiary recycled water. Implementation of a recycled water project will require a Title 22 Engineering Report and inclusion of recycled water requirements in the City's NPDES permit and WDR.

The City examined probable regulatory stipulations for the ocean outfall, percolation ponds, and inland surface water discharge for the future WRF, as summarized in the technical memorandum titled "Regulatory Implications of Discharge Options for the Future City of Morro Bay WRF" (Larry Walker and Associates (LWA), 2014). The evaluation of discharge to percolation ponds and inland surface waters is summarized in **Section 5**.

The LWA report identified constituents detectable in the 2014 wastewater effluent that may require future effluent limitations for ocean discharge. These compounds were cadmium, copper, cyanide, nickel (salts), total zinc, and dioxin. Numeric limits for salts other than nickel salts will not be applied. It is important to note that for the existing ocean outfall, a dilution credit of 133 parts seawater to 1 part wastewater is currently granted. This value is very likely to remain the same or even increase in future permits. Effluent limits for the discharge are determined by applying the dilution factor of 133 to the water quality objectives outlined in the Basin Plan, Ocean Plan, Thermal Plan, and ultimately the NPDES permit. Effluent limits for pathogens, nutrients, and salts, are not expected to change. Historical treated effluent quality from the existing WWTP based on monthly and annual reports available on the California Integrated Water Quality System (CIWQS) is summarized in **Appendix A.**

Water quality requirements for reuse alternatives are included in **Section 5**.

4.5 Wastewater Treatment Plant Flows

Wastewater Flow Conditions

The Draft FMP reviews past studies, historical population, and flow and water quality data from the existing WWTP to provide baseline information and develop sizing criteria for the new WRF. Historical flows from the 2007 Facility Master Plan and the 2010 Facility Master Plan were reviewed and compared, and an independent analysis of historical flow data from 1995 through 2014 was performed. The flow conditions used to prepare preliminary design criteria for the WRF project as presented in the draft FMP are defined below.

Average Annual Daily Flow (AADF)

AADF is the average daily wastewater flow over the course of a year and is generally obtained by averaging the flows conveyed to a WWTP. The AADF was determined using annual average flows for 2002-2014. The existing AADF is estimated at 0.84 MGD. The ADF factor is defined as the gallons of wastewater generated per capita per day (gpcd). An ADF factor of 81 will be used to project the future ADF for the City.

Maximum Month Flow (MMF)

MMF is the average daily flow during the month with the maximum cumulative flow. MMF is often the regulated flow limit in a WWTP's discharge permit. The current waste discharge requirements for the District's WWTP limits plant effluent to a maximum month flow of 2.36 MGD. Using the flow from the max month of 2014 the existing MMF is estimated at 0.82 MGD based on plant flow records. An assessment of the MMF for 1995 through 2014 resulted in a 20-year average MMF peaking factor of 1.19.

Peak Seasonal Dry Weather Flow (PSDWF)

The PSDWF is the highest average monthly flow between the months of July and August, which encompass traditional peak tourist season for the City. Using data from calendar years 1995 to 2014, the existing PDDWF factor is 1.05, which will be used to project future PSDWF.

Peak Day Flow (PDF)

PDF is the maximum daily flow rate experienced at the WWTF and is used to design or evaluate hydraulic retention times for certain treatment processes. PDF factor is used as a multiplier to estimate PDF. The PDF factor was estimated using data from 2010-2014 to be 2.75. The City has reported that influent wastewater becomes surcharged during high flow events or during unusual operation situations which as a result does not provide accurate measurements during those periods. Due to these inaccuracies, the City should pursue flow measurements in the collection system upstream of the existing WWTP in coming months to gather data to determine PDF and PDF factor to be used during future system design.

Peak Hour Flow (PHF)

PHF is the maximum one-hour flow experienced by the system, and is typically used for sizing collection system piping, lift stations, flow meters, interceptors, and headworks systems. Peak hour flow is typically derived from WWTF influent records, flow monitoring, or empirical equations used to estimate PHF based on service area population. For this MWRP, a PHF factor of 8.37 which corresponds to previous high flow events. It is recommended that the City gather more data via flow monitoring to gather additional data.

4.5.1 Existing Wastewater Flows

Currently the City and CSD wastewater flows are both treated at the City WWTP. Historically, CSD has contributed on average 25% of the total flow through the facility. The WWTP is currently designed for an average annual daily flow of 1.5 MGD, average daily maximum flow in peak month of 2.9 MGD, and peak season dry weather flow of 2.7 MGD. The secondary treatment design capacity of the facility is 0.97 MGD. Flows in excess of 0.97 MGD receive primary treatment and are blended with secondary effluent, disinfected, and discharged to the Pacific Ocean. The current average annual daily flow is 1.25 MGD, therefore the majority of the WWTP effluent receives secondary treatment throughout most of the year.

4.5.2 Future Wastewater Flows

Projected design flows for the WRF as reported in the Draft FMP are presented in **Table 4-2**. The start-up flows were determined for a population of 10,542 people as the facility is expected to begin treatment between 2018 and 2020. Currently, the City and CSD are both individually pursuing WRFs in their respective service areas. With the absence of CSD contributing to the City's new WRF, initial projected flows are lower than current WWTP flows.

Table 4-2: Projected Wastewater Flows

Flow Condition	Start-Up WRF Flow Rate (MGD)	Buildout WRF Flow Rate (MGD)
Minimum 2 Hour Flow	0.28	0.32
Minimum Average Daily Flow	0.64	0.67
Annual Average Daily Flow (AADF)	0.85	0.97
Maximum Monthly Flow (MMF)	1.02	1.16
Peak Day Flow (PDF)	2.35	2.75
Peak Hour Flow (PHF)	6.16	7.03

4.6 Influent Wastewater Characteristics

Table 4-3 through **Table 4-5** summarize the biochemical oxygen demand (BOD), total suspended solids (TSS), and nitrogen loading analysis included in the Draft FMP for calendar years 2010 through 2014. BOD analyses were performed on 24-hour composite samples taken about once every eight days. In 2010 and 2012, samples were collected for three to four consecutive days over the holidays of Memorial Day, Fourth of July, and Labor Day. The loads on these days were usually above the average, which may influence analysis, albeit conservatively.

Table 4-3: Historical BOD Loading					
Year	Annual Average (lb/day)	Annual Max Month		Annual Max Day	
		Load (lb/day)	Peaking Factor	Load (lb/day)	Peaking Factor
2010	3,600	4,300	1.18	6,300	1.68
2011	3,200	4,300	1.32	4,900	1.52
2012	3,100	4,100	1.33	4,700	1.52
2013	2,600	3,400	1.28	4,700	1.79
2014	2,700	3,200	1.17	4,600	1.68
5-year	3,100	4,300	-	6,300	-

TSS was analyzed typically every eight days. It was also sampled for the three to four-day sampling periods on the same holidays as mentioned above.

Table 4-4: Historical TSS Loading					
Year	Annual Average (lb/day)	Annual Max Month		Annual Max Day	
		Load (lb/day)	Peaking Factor	Load (lb/day)	Peaking Factor
2010	4,000	5,400	1.36	9,700	2.46
2011	3,500	4,500	1.28	5,500	1.57
2012	3,700	5,100	1.40	7,000	1.90
2013	2,800	4,000	1.42	4,900	1.73
2014	2,900	3,500	1.18	5,400	1.84
5-year	3,400	5,400	-	9,700	-

There are currently no NPDES permit requirements for nitrogen species in the MBCSD WWTP influent. The influent Total Kjeldahl Nitrogen (TKN) load is estimated below in **Table 4-5** using the effluent ammonia concentration and various assumptions surrounding nitrogen removal mechanisms at the facility. The existing WWTP removes nitrogen exclusively via assimilation by heterotrophic biomass engaged in BOD oxidation. Using assumptions for amount of nitrogen assimilated per biomass produced by BOD oxidation, the Draft FMP provides nitrogen loading estimates.

Table 4-5: Historical Nitrogen Loading					
Year	Annual Average (lb/day)	Annual Max Month		Annual Max Day	
		Load (lb/day)	Peaking Factor	Load (lb/day)	Peaking Factor
2010	580	680	1.20	960	1.68
2011	510	680	1.32	750	1.52
2012	490	650	1.33	740	1.52
2013	420	540	1.28	750	1.79
2014	440	510	1.17	740	1.68
5-year	490	680	-	960	-

4.7 Projection of Future Influent Loads

Projected loads for BOD, TSS, and Total Kjeldahl Nitrogen (TKN) are presented in **Table 4-6** were established in the Draft FMP using peaking factors and projected population. TKN refers to the total concentration of organic nitrogen and ammonia.

Table 4-6: Projected Future Wastewater Loads

Parameter	Annual Average	Maximum Month	Maximum Day
Flow (mgd)	0.97	1.16	2.75
Biological Oxygen Demand (BOD)			
Concentration (mg/L)	440	470	-
Load (lb/d)	3,600	4,500	5,900
Load Peaking Factor	-	1.26	1.65
Total Suspended Solids (TSS)			
Concentration (mg/L)	490	540	-
Load (lb/d)	4,000	5,300	7,500
Load Peaking Factor	-	1.33	1.90
Total Kjeldahl Nitrogem (TKN)			
Concentration (mg/L)	70	74	-
Load (lb/d)	570	720	940
Load Peaking Factor	-	1.26	1.65

4.8 Salinity Control Program

As previously mentioned, salinity and TDS concentrations seen in both source water and wastewater have gradually increased in recent years. To facilitate reuse of future effluent for crop irrigation or other recycled water uses, the City is seeking to reduce the amount of salts discharged into the wastewater collection system. In 2015, the City conducted a Salinity Source Identification Study and determined that the two largest sources within the City's control were discharges from residential self regenerating water softeners (SRWS) and discharges from Culligan's water softening facility. To address these issues the City is developing a source control program focusing on these two sources. The main focus of the source control program is to reduce loading of salts and nutrients to the wastewater treatment facility to facilitate reuse of effluent for crop irrigation or other alternatives. Salts removal at the treatment plant is not cost effective as removal requires reverse osmosis or other costly treatment technologies. The study aims to identify sources of salinity in the community that can be managed or reduced.

The City evaluated salinity in the collection system in the Morro Bay Water Reclamation Facility Project Status of Salinity Source Identification and Control Plan (MKN, Draft January 4, 2016). The report determined that self-regenerating water softeners (SRWS) and brine discharge from the Culligan water softening facility were the main controllable contributors to salt in influent wastewater. Currently, the main motivation to use SRWS is due to the City's water supply having high hardness. Citizens use SRWS to prevent hardness deposits on water fixtures and to use less detergent when cleaning. The Culligan water softening facility regenerates water softeners that do not have the capability to self-regenerate. The facility has a low discharge flow of around 1,000 gallons per day but contributes around 14% of total salt load to the WWTP, according to the City of Morro Bay Salinity Control Program Development (Larry Walker and Associates, Draft August 2016). A breakdown of salinity sources in the wastewater stream is summarized in **Table 4-7**.

Table 4-7: Salinity Loads from Identified Sources		
	TDS	
Source	Lbs/yr	%
Water Supply	4,159	46
Residential and Commercial Uses	2,498	28
Self-Regenerating Water Softeners	1,118	12
Culligan Water Plant	1,269	14
Total	9,044	

Regulation of SRWS is being investigated as a possible option to reduce the use of SRWS and resulting salt loading to the collection system, or to remove them altogether. The City of Morro Bay Salinity Control Program Development (ibid) provides a detailed background on regulation of SRWS with various examples of regulation in California. The program is under development, but would likely include a phased local ordinance, implementation of a buyback or financial incentive program for decommissioning SRWS. While such a program would require the City to budget for said financial incentive, communities that have implemented this two-pronged approach, even with strictly voluntary buyback programs, have seen significant reduction of chloride in influent wastewater. The aforementioned Salinity Control Program Development (ibid) contains multiple case studies demonstrating efficacy of the two-pronged approach. A reduction in influent chloride concentrations could directly result in reduced capital and operating costs, by reducing overall advanced treatment requirements.

The City is currently exploring the option to allow discharge of a water softener exchange tank regeneration (Culligan) facility brine as non-domestic waste such that it could bypass the main treatment of the wastewater treatment facility and be discharged through the outfall. The City will need to obtain clearance from the Coastal Commission for this discharge and may have to conduct studies showing the combined discharge is not toxic nor will impair beneficial uses in Estero Bay.

SECTION 5 WATER QUALITY GOALS FOR DISCHARGE AND REUSE

This section provides an overview of the water quality and regulatory requirements for potential recycled water opportunities for the City. **Section 6** summarizes the market assessment of the various alternatives and **Section 7** evaluates the resulting recycled water project alternatives.

5.1 Potential Recycled Water Opportunities

MKN has investigated a variety of alternatives for use of the City's recycled water. One of the main objectives when analyzing the best alternative or alternatives was net benefit to potable water source for the City. This is due to the unreliability of SWP water and environmental impacts to groundwater basins during drought periods and periods of high demand due to crop irrigation and tourism. Based on previous studies and current research, possible recycled water project alternatives considered for this study include the following:

- Discharge using existing ocean outfall (No recycled water project alternative)
- Agricultural irrigation
- Urban reuse (commercial uses, irrigation of parks, schools, and playground)
- Delivery of recycled water to agricultural users in exchange for reduced groundwater pumping (in-lieu recharge program)
- Delivery of recycled water to agricultural users in exchange for riparian rights to withdraw groundwater
- Delivery of recycled water to agricultural users in exchange for pumped groundwater delivered to the City
- Indirect potable reuse: Groundwater replenishment using surface application (percolation basins)
- Indirect potable reuse: Groundwater replenishment using subsurface application at the Narrows (injection wells)
- Indirect potable reuse: Groundwater replenishment using subsurface application near bike path adjacent to Lila Keiser Park (injection wells)
- Streamflow augmentation at Morro Creek, Little Morro Creek, or Chorro Creek
- Groundwater injection for seawater intrusion barrier

The City prepared the Effluent Disposal Feasibility Alternatives Study (October 2016, GSI Water Solutions) to assess different reuse alternatives. Information from this study is included in the analysis of alternatives below. Water Quality Goals for Discharge to Ocean Outfall (No Recycled Water Project Alternative)

5.2 Water Quality Goals for Discharge to Ocean Outfall (No Recycled Water Project Alternative)

As previously mentioned, the NPDES permit will change for the new WRF. Discharge requirements from the existing NPDES permit are summarized in **Table 5-1**. Included in the NPDES permit are regulations based on the Ocean Plan, Basin Plan, and Thermal Plan. A. It is anticipated that the requirements for ocean discharge will be more stringent in the future, and full secondary treatment will be required at a minimum.

Table 5-1: WDR Order No. R3-2008-0065 Effluent Discharge Requirements for Selected Pollutants							
		Effluent Limitations					
Parameter	Units	Average Monthly	Average Weekly	Maximum Daily	Instant. Minimum	Instant. Maximum	6-Month Median
5-day BOD	mg/L	120			180		
	lb/d	2,062			3,092		
	% removal	30					
Suspended Solids	mg/L	70			105		
	lb/d	1,203			1,804		
	% removal	75					
Grease and Oil	mg/L	25	40		75		
	lb/d	430	687		1,288		
Settleable Solids	ml/L	1.0	1.5		3.0		
Turbidity	NTU	75	100		225		
pH	S.U.						
Ammonia	mg-N/L			322		804	80.4
Total Residual Chlorine	ug/L lb/d			1.07		8.04	0.27
Chronic Toxicity	TUc			134			
Notes: BOD = biological oxygen demand; mg/L = milligrams per liter; lb/d = pounds per day; ml/L = milliliters per liter; NTU = nephelometric turbidity unit; mg-N/L = milligrams as nitrogen per liter; ug/L = microgram per liter; Tuc = chronic toxicity unit							

In addition to the limits noted in the table above, the NPDES permit includes discharge limits for metals, cyanide, phenolic compounds, endosulfan, endrin, hexachlorocyclohexane, and radioactivity for the protection of marine aquatic life; and limits for carcinogens and non-carcinogens, regulated for the protection of human health.

Receiving water limits, based on the Ocean Plan, are also specified in the existing NPDES permit, including bacterial limits and the requirements that parameters such as temperature, pH, sulfides, organics, and sediment are not changed significantly from ambient conditions.

5.3 Overview of Title 22 Requirements for Reuse Alternatives

The California Code of Regulations (CCR) Title 22, Division 4, Chapter 3, Sections 60301 through 60355 lists regulations pertaining to recycled wastewater. Requirements are administered by California Department of Health Services and RWQCB. In the City's case, Title 22 regulations and the Basin plan are the main regulatory documents pertaining to reuse of recycled water. Title 22 requirements describe acceptable uses of recycled water, acceptable area uses and set-backs for the use of recycled water, groundwater replenishment requirements for surface and subsurface applications, sampling and analysis requirements, engineering design, and reliability requirements. The recycled water requirements are implemented by the State Water Resources Control Board and the local Regional Water Quality Control Boards.

Four treatment levels are defined in Title 22 for various recycled water uses in California: disinfected tertiary recycled water, disinfected secondary-2.2 recycled water, disinfected secondary-23 recycled water, and undisinfected secondary recycled water. These are summarized in **Table 5-2** along with allowable irrigation uses as examples.

Table 5-2: Title 22 Recycled Water Types and Allowable Uses				
Recycled Water Type	**Required Treatment**	**Median Total Coliform (MPN/100 mL)[1]**	**Maximum Total Coliform (MPN/100 mL)[2]**	**Allowable Irrigation Uses**
Disinfected Tertiary	Oxidized, Coagulated[3], Filtered, Disinfected	2.2	23[4]	Surface irrigation for food crops including edible portion, parks and playgrounds, schoolyards, unrestricted access golf courses, roadway landscaping, and residential & commercial landscaping
Disinfected Secondary-2.2	Oxidized, Disinfected	2.2	23	Irrigation of food crops where edible portion is above ground and not contacted by recycled water (ex. Drip irrigation is used)
Disinfected Secondary-23	Oxidized, Disinfected	23	240	Irrigation of cemeteries, freeway landscaping, restricted access golf courses, pasture for milk animals
Undisinfected Secondary	Oxidized	NA	NA	Irrigation for orchards and vineyards where edible portion does not contact recycled water (ex. Drip irrigation is used), non-food bearing trees, fodder crops and fiber crops, seed crops not eaten by humans, ornamental nursery stock

Notes:

1. Based on bacteriological results of the last 7 days for which analyses were completed.
2. Does not exceed in more than one sample in any 30 day period
3. Coagulation is not typically required if membrane filtration is used and/or turbidity requirements are met.
4. No sample shall exceed 240 MPN/100 mL.
5. Reference: California Code of Regulations, Title 22, Division 4, July 16, 2015 Edition

5.4 Water Quality Goals for Reuse Alternatives

Various options are being considered for immediate water reuse upon the completion of the City's WRF, including groundwater recharge, or supplementing the water supply (indirect potable reuse), agricultural exchange and agricultural reuse for irrigation, urban irrigation and commercial reuse, streamflow augmentation, and injection to produce a seawater intrusion barrier. Water quality objectives vary for different uses, as summarized in the following sections.

5.4.1 Water Quality Goals for Agricultural Irrigation

There have been multiple studies to determine constituents of concern in reclaimed water used for irrigation. Suitability of water for irrigation is directly related to the concentration and kind of chemical constituents present. Some water constituents that most commonly affect recycled water suitability for irrigation include electrical conductivity of the irrigation water (ECw), sodium adsorption ratio (SAR), bicarbonates, chlorides, and boron. General irrigation water quality guidelines from the Basin Plan are shown in **Table 5-3**.

Table 5-3: Water Quality Guidelines for Irrigation				
Problem and Related Constituent	**References**	**No Problem**	**Increasing Problems**	**Severe Problems**
Salinity[1]				
EC_w of irrigation water (mmhos/cm)	1,2	<0.75	0.75 - 3.0	>3.0
TDS (mg/l) or (ppm)	2	<450	450 - 2000	>2000
Permeability				
EC_w of irrigation water (mmhos/cm)	1	>0.5	<0.5	<0.2
adj.SAR[2]	1	<6.0	6.0 - 9.0	>9.0
Specific ion toxicity from root absorption[3]				
Sodium (evaluated by adj. SAR)	1,2	<3.0	3.0 - 9.0	>9.0[4]
Chloride (meq/l)	1	<4	4.0 - 10.0	>10
Chloride (mg/l)	1,2	<142	142 - 355	>355
Boron (mg/l)	1	<0.5	0.5 - 2.0	2.0 - 10.0
Specific ion toxicity from foliar absorption[5] (sprinkler irrigation)				
Sodium (meq/l)	1	<3.0	>3.0	--
Sodium (mg/l)	1,2	<69	>69	--
Chloride (meq/l)	1	<3.0	>3.0	--
Chloride (mg/l)	1	<106	>106	--
Miscellaneous[6]				
Total Nitrogen (NH_4-N + NO_3-N) (mg/l)	1,2	<5	5 - 30	>30
(The following apply only for irrigation by overhead sprinklers)				
Bicarbonate (HCO_3) (meq/l)	1	1.5	1.5 - 8.5	>8.5
Bicarbonate (HCO_3) (mg/l)	1,2	<90	90 - 520	>520
Residual Chlorine (mg/l)	2	<1.0	1.0 - 5.0	>5.0
pH	1,2		Normal range = 6.5-8.4	

[1]Assumes water for crop plus needed water for leaching requirement will be applied. Crops vary in tolerance to salinity.
[2]adj.SAR (adjusted sodium absorption ratio) is calculated form a modified equation developed by U.S. Salinity Laboratory to include added effects of precipitation or dissolution of calcium in soils and related to CO_3 + HCO_3 concentrations. Permeability problems related to low EC or high adj.SAR of water can be reduced if necessary by adding gypsum.
[3]Most tree crops and woody ornamentals are sensitive to sodium and chloride. Most annual crops are not sensitive.
[4]Shrinking-swelling type soils (montmorillonite type clay minerals); higher values apply for others.
[5]Leaf areas wet by sprinklers may show a leaf burn due to sodium or chloride absorption under low-humidity / high-evaporation conditions. (Evaporation increases ion concentration in water films on leaves between rotations of sprinkler heads.)
[6]Excess N may affect production of quality of certain crops (i.e., sugar beets, citrus, avocados, apricots, and grapes).
HCO_3 with overhead sprinkler irrigation may cause a white carbonate deposit to form on fruit and leaves.
Reference 1: Ayers, Robert S., Quality of Water for Irrigation, Journal of the Irrigation and Drainage Division, ASCE, June 1977. (Table 1, page 136)
Reference 2: Irrigation with Reclaimed Municipal Wastewater – A Guidance Manual, California State Water Resources Control Board, Report Number 84-1 WR, July 1984. (Table 3-4, page 3-11)
Note: Interpretations are based on possible effects of constituents on crops, soils or both. Guidelines are flexible and should be modified when warranted by local experience or special conditions of crop, soil, and method of irrigation.

A summary of the treated effluent quality from the existing WWTP is presented in **Table 5-4**. It is assumed the mineral content of the new WRF will resemble that of the existing treatment facility since a higher level of secondary and tertiary treatment will have a negligible impact on those parameters. Relative salt tolerance of various agricultural crops is presented in **Table 5-5**.

The Basin Plan outlines water quality specifications for Agricultural Supply water. The guidelines for water quality of water for irrigation are listed above in **Table 5-3**, as interpreted from the University of California Agricultural

Extension Service guidelines. The purpose of the limits in **Table 5-3** are to preserve agricultural beneficial use. Additional constraints for irrigation and livestock watering are listed below in **Table 5-6**.

Table 5-4: Existing Morro Bay/Cayucos Sanitary District WWTF Effluent Quality

Constituent	Units	1999 Effluent Quality[1]	2011/2012 Effluent Quality[2]	Comparison to Quality Guidelines presented in Table 5-5 [3]
Bicarbonate	mg/L	294	330	Increasing problems for carbonate deposits on fruit and leaves
Boron	mg/L	0.5	0.4	Low end of increasing problems for salinity
Chloride	mg/L	300	369	Increasing problems for root and foliar absorption
Total Nitrogen	mg/L	36.7	37.5	Potential for severe quality production problems for certain crops, including citrus, avocados, apricots, and grapes
pH	--	7.6	NA	Within normal range
TDS	mg/L	887	942	Increasing problems for salinity
EC	mmhos/cm	1.7	NA	Increasing problems for salinity; no problems for permeability
Sodium	mg/L	210	223	Increasing problems for foliar absorption

NA = Data not available
1 Averages based on data collected July 8 through 15, 1999 (Carollo Engineers, 1999)
2 Data was obtained from lab results from six 24-hour composite samples taken between February 8, 2012 and February 14, 2012. Tests were conducted by FGL Environmental and Agricultural Analytical Chemists. (Dudek, 2012)
3 Crops vary in tolerance to the constituents above in Table 5-5. Table 5-4 summarizes general irrigation water guidelines as published by the quoted references. Care should be taken in interpretation and application of this data.

The majority of crops in the immediate vicinity of the City are avocado with limited orange groves, all of which are sensitive to salts. Dilution by blending with a water source of lower salinity of salts reduction through microfiltration and reverse osmosis will likely be required to provide the appropriate quality of water for irrigation of these salt-sensitive crops. Based on the recorded chloride tolerance for the most sensitive avocado varierty, a TDS target of 300 mg/L is expected to be sufficient to avoid crop damage (Dudek, 2012).

Table 5-5: Relative Salt Tolerance of Agricultural Crops				
Crop Type	**Tolerant**	**Moderately Tolerant**	**Moderately Sensitive**	**Sensitive**
Fibre, Seed, and Sugar Crops	Barley, Cotton, Jojoba, Sugarbeet	Cowpea, Oats, Rye, Safflower, Sorghum, Soybean, Triticale, Wheat, Durum Wheat	Broad, Castorbean, Maize, Flax, Millet (foxtail), Groundnut/Peanut, Rice (paddy), Sugarcane, Sunflower	Bean, Guayule, Sesame
Grasses and Forage Crops	Alkali grass (nuttall), Alkali sacaton, Bermuda grass, Kallar grass, Saltgrass (Desert), Wheatgrass (fairway crested), Wheatgrass (tall), Wildrye (altai), Wildye (Russian)	Barley (forage), Brome (mountain), Canary grass (reed), Clover (hubam), Clover (Sweet), Fescue (meadow), Fescue (tall), Harding grass, Panis grass (blue), Rape, Rescue grass, Rhodes grass, Ryegrass (Italian), Ryegrass (perennial), Sudan grass, Trefoil (narrowleaf), birdsfoot, Trefoil (broadleaf), Wheat (forage), Wheatgrass (various), Wildrye (beardless & Canadian)	Alfala, Bentgrass, Bluestem (Angleton), Brome (smooth), Buffelgrass, Burnet, Clover (various), Corn (forage), Cowpea (forage), Dallis grass, Foxtail (meadow), Grama (blue), Lovegrass, Mulkvetch (Cicer), Oatgrass (tall), Oats (forage), Orchard grass, Rye (forage), Sesbania, Siratro, Spharophysa, Timothy, Trefoil (big), Vetch (common)	
Vegetable Crops	Asparagus	Artichoke, Beet (red), Zucchini squash	Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Celery, Corn (Sweet), Cucumber, Eggplant, Kale, Kohlrabi, Lettuce, Muskmelon, Pepper, Potato, Pumpkin, Radish, Spinach, Squash (scallop), Sweet Potato, Tomato, Turnip, Watermelon	Bean, Carrot, Okra, Onion, Parsnip
Fruit and Nut Crops	Date Palm	Fig, Jujube, Olive, Papaya, Pineapple, Pomegranate	Grape	Almond, Apple Apricot, Avocado, Blackberry, Boysenberry, Cherimoya, Cherry (sweet), Cherry (sand), Currant, Gooseberry, Grapefruit, Lemon, Lime, Loquat, mango, Orange, Passion fruit, Peach, Pear, Persimmon, Plum (prune), Pumello, Rose, Apple, Sapote (white), Strawberry, Tangerine

1 Reproduction of table presented in Water Quality for Agriculture FAO Irrigation and Drainage Paper 29 Rev 1 (Ayers and Westcot, Reprinted 1989 and 1994). Data taken from: Maas E.V. 1984 Salt tolerance of plants. In: The Handbook of Plant Science in Agriculture. B. R. Christie (ed). CRC Press, Boca Raton, Florida.
2 These data serve only as a guide to the relative tolerance among crops. Absolute tolerances vary with climate, soil conditions, and cultural practices.

According to CCR Title 22 Section 60304, recycled water used for irrigation is required to be treated to tertiary disinfected standards for food crops including all edible root crops where the recycled water comes into contact with the edible portion of the crop. If the edible portion of the food crop is not contacted by the recycled water, the treatment requirement is at least disinfected secondary—2.2 recycled water. Orchards and vineyards where recycled water does not come into contact with the edible portion of the crop, vineyards where recycled water does not come into and food crops that must undergo commercial pathogen-destroying processing before being consumed by humans can be irrigated with undisinfected secondary water.

Table 5-6: Basin Plan Requirements for Irrigation and Livestock Watering

Element	Maximum Concentration (mg/L)	
	Irrigation Supply	Livestock Watering
Aluminum	5.0	5.0
Arsenic	0.1	0.2
Beryllium	0.1	--
Boron	0.75	5.0
Cadmium	0.01	0.05
Chromium	0.1	1.0
Cobalt	0.05	1.0
Copper	0.2	0.5
Fluoride	1.0	2.0
Iron	5.0	--
Lead	5.0	0.1
Lithium	2.5	--
Manganese	0.2	--
Mercury	--	0.01
Molybdenum	0.01	0.5
Nickel	0.2	--
Nitrate + Nitrite	--	100
Nitrite	--	10
Selenium	0.02	0.05
Vanadium	0.1	0.10
Zinc	2.0	25

Pasture for animals producing milk for human consumption must be irrigated with at least disinfected secondary-23 recycled water. Fodder crops, fiber crops, and pasture for animals not producing milk for human consumption may be irrigated with water treated to at least undisinfected secondary recycled water standards. Water used for livestock watering must also conform with the requirements in **Table 5-3** and **Table 5-6**.

5.4.2 Water Quality Goals for Urban Reuse

According to CCR Title 22 Section 60304, all recycled water used for irrigation of parks, playgrounds, schoolyards, residential landscaping, and unrestricted access golf courses must be treated to disinfected tertiary recycled water standards. Recycled water used to irrigate cemeteries, freeway landscaping, restricted access golf courses, ornamental nursery stock and sod farms with unrestricted access, and nonedible vegetation with controlled access so the area cannot be used as if it were a park, playground or schoolyard must be treated to at least disinfected secondary-23 recycled water standards. Non food-bearing trees and ornamental nursery stock, provided no irrigation with recycled water occurs for period of 14 days prior to harvesting, retail sale, or allowing access by general public, can be irrigated by recycled water treated to at least undisinfected secondary recycled water standards.

Regulations for unrestricted urban use are primarily driven by public safety and suitability for application. Title 22 requirements include standards for effluent coliform concentrations and usage restrictions. Usage restrictions include pipeline distance from potable water pipelines, proximity to groundwater, prevention of cross-connection between potable and non-potable systems, and restrictions near eating facilities/drinking fountains. In order to comply with these requirements, potential customers may need to reconfigure either their irrigation or potable water systems.

There are other uses for water in the urban setting other than irrigation. Some of such uses include structural firefighting, decorative fountains, consolidation of backfill around potable water pipelines, and commercial car washes where the general public is excluded from the washing process. These uses require disinfected tertiary recycled water. Other uses include nonstructural firefighting, backfill consolidation around nonpotable piping, soil compaction, mixing concrete, dust control, cleaning of roads, sidewalks, and outdoor work areas, all of which require recycled water treated to at least disinfected secondary-23 recycled water.

5.4.3 Water Quality Goals for Groundwater Recharge

One recycled water project alternative that has the potential to augment the City's potable water supply is indirect potable reuse (IPR) via groundwater recharge. IPR involves taking highly treated wastewater and passing it through an environmental barrier, in this case the groundwater aquifer's soil, and removing the water after a period deemed safe by the SWRCB Department of Drinking Water (DDW) to be withdrawn for treatment and distribution as potable water. The environmental buffer provides opportunity for water purveyors to address public health concerns if problems occur in the wastewater treatment process, as well as diluting the treated wastewater with naturally occurring water sources. This section outlines general water quality goals for IPR, including specific water quality criteria for surface application and subsurface application methods.

Articles 5.1 and 5.2 of CCR Title 22 pertain to groundwater replenishment through both surface and subsurface application, respectively. Both of the alternatives fall under the distinction of Groundwater Replenishment Reuse Projects (GRRPs), which require permitting from the SWRCB DDW. Prior to operation of a GRRP, the project sponsor (in this case, the City), shall obtain DDW approval of the plan describing steps that the project sponsor will take to provide an alternative source of drinking water supply to all users of a producing drinking water well or a Department approved treatment mechanism the project sponsor will provide to all owners of a producing drinking water well that as a result of the GRRP's operation violates a California or federal drinking water standard, has been degraded to the degree that is no longer a safe source of drinking water, or receives water that fails to meet pathogenic microorganism standards. In the City's case, State Water or desalinated seawater could serve as the alternative water supply.

Groundwater replenishment using recycled water requires the recycled water source, in this case the WRF, have industrial pretreatment and source control programs. For the Morro Valley and Chorro Valley groundwater basins this would be especially important as elevated nitrate and TDS concentrations are already issues. The City is in the process of developing a Salinity Control Program to address source water dissolved solids and other constituents relevant to recycled water projects.

Pathogen Removal

Recycled water used for groundwater replenishment must also demonstrate removal of pathogens through log removal values (LRV). LRV is defined as follows:

$$LRV = \log\left(\frac{initial\ pathogen\ concentration}{final\ pathogen\ concentration}\right)$$

One LRV, or 1-log reduction is equivalent to 99% reduction, two LRV, or 2-log reduction is equivalent to 99.9% reduction, and so on. Title 22 requires that GRRPs achieve LRVs of at least 12-log enteric virus reduction, 10-log giardia cyst reduction, and 10-log cryptosporidium oocyst reduction. The treatment train must also have at least three separate treatment processes and meet the minimum recycled water treatment level listed below. Each separate treatment process may be credited for no more than 6-log reduction, with at least three processes each being credited with no less than 1.0-log reduction. Dependent on the type of study performed to estimate retention time to the nearest drinking well, specific log-removal credits are granted per month the recycled water is retained underground. Log reduction credits are outlined below in **Table 5-7**.

Table 5-7: Title 22 Table 60320.108, Virus Log Reduction Credit Specifications

Method Used to Estimate Retention Time to the Nearest Downgradient Drinking Water Well	Virus Log Reduction Credit per Month
Tracer study utilizing an added tracer	1.0 log
Tracer study utilizing an intrinsic tracer	0.67 log
Numerical modeling consisting of calibrated finite element or finite difference models using validated and verified computer codes used for simulating groundwater flow	0.50 log
Analytical modeling using existing academically-accepted equations such as Darcy's law to estimate groundwater flow conditions based on simplifying aquifer assumptions	0.25 log

Response Retention Time

Underground retention time is an important parameter, not just for log removal of viruses and other pathogenic organisms, but also to allow sufficient time to identify treatment failure and implement actions required for protection of public health. Retention time required must be approved by DDW, and shall be no less than two months. Demonstration of retention time is performed by a tracer study or by modeling, much like for the virus log reduction credit. If numerical modeling is used to estimate retention time, the response time credit is 0.5 months. Therefore a minimum of four months retention time must be demonstrated. The allocation of response time credits allowed for various methods is outlined in **Table 5-8**.

Table 5-8: Title 22 Table 60320.124, Response Time Credit Specifications	
Method Used to Estimate Retention Time	**Response Time Credit per Month**
Tracer study utilizing an added tracer	1.0 month
Tracer study utilizing an intrinsic tracer	0.67 month
Numerical modeling consisting of calibrated finite element or finite difference models using validated and verified computer codes used for simulating groundwater flow	0.50 month
Analytical modeling using existing academically-accepted equations such as Darcy's law to estimate groundwater flow conditions based on simplifying aquifer assumptions	0.25 month

Nitrogen Removal

Recycled water applied for groundwater recharge cannot contain more than 10 mg/L of total nitrogen.

Other Regulated Contaminants

Selected organic and inorganic chemicals, radionuclides, disinfection byproducts, and secondary drinking water MCLs are regulated and should be monitored in a GRRP.

Additional Monitoring

Monitoring for California priority toxic pollutants, any constituents specified by the DDW based on the prepared engineering report, and emerging contaminant indicators must be performed. It should be noted that GRRP projects require substantial testing, modeling, reporting and development of operating and monitoring plans prior to operating a GRRP. The groundwater basin, proposed recycled water treatment processes, and proposed diluent water (if used) must be thoroughly studied and demonstrated to DDW as meeting the regulatory requirements through reports prior to approval and operation.

5.4.4 Groundwater Recharge Using Surface Application

Minimum Treatment

Recycled water used for surface application must be at minimum tertiary disinfected recycled water.

Pathogen Removal

Recycled water that is treated to disinfected tertiary standards or has undergone advanced treatment outlined in **Section 5.4.3** of this MWRP that also demonstrates at least 6 months of retention underground will be credited with 10-log Giardia cyst reduction and 10-log Cryptosporidium oocyst reduction.

Recycled Water Contribution (RWC)

The recycled water contribution (RWC), defined as the fraction of volume of recycled water used in surface application calculated from the total volume of recycled water and diluent water used, for surface application differs from subsurface application. DDW ultimately determines the allowable RWC, but initially the RWC is typically no greater than 0.20. The RWC can be increased if either the project can be demonstrated to achieve total organic carbon (TOC) concentrations no greater that 0.5 mg/L divided by the proposed RWC or if in the last 52 weeks, the 20 week running average of TOC has not exceeded 0.5 mg/L divided by the proposed maximum RWC.

Soil Aquifer Treatment

Soil-aquifer treatment involves a combination of physical, chemical, and biological processes that naturally occur in groundwater environments. The main objective of soil aquifer treatment is to remove residual organic material, nutrients, and pathogens. In surface applications of recycled water, it is especially important if advanced treatment technologies are not specifically required. By mandate, soil aquifer treatment is required to reduce concentrations of three indicator compounds specified by the project sponsor by 90% between the point of application and a location no more than 30 days downgradient. The initial TOC concentration in the water upon application must be below 0.5 mg/L divided by the running monthly average RWC.

5.4.5 Groundwater Recharge Using Subsurface Application

Minimum Treatment

If recycled water is to be injected into the groundwater aquifer for intents of indirect potable reuse, it must first be treated to disinfected tertiary standards and undergo full advanced treatment including reverse osmosis and an advanced oxidation process. The reverse osmosis process must meet the requirement that each reverse osmosis element achieves rejection of sodium chloride no less than 99 percent and average rejection of no less than 99.2 percent. Also, no more than 5% of samples during the first twenty weeks of operation may have TOC concentrations above 0.25 mg/L.

The AOP chosen must demonstrate 0.5 log removal of 1,4 dioxane or removal of select indicator compounds outlined in **Table 5-9**.

Table 5-9: Advanced Oxidation Process Removal Criteria

0.5 Log Removal of Indicator Compound for Each Group	0.3 Log Removal of Indicator Compound for Each Group
Hydroxy Aromatic	Saturated Aliphatic
Amino/Acylamino Aromatic	Nitro Aromatic
Nonaromatic with carbon double bonds	
Deprotonated Amine	
Alkoxy Prolyaromatic	
Alkoxy Aromatic	
Alkyl Aromatic	

Recycled Water Contribution (RWC)

The RWC allowable for subsurface application can be up to 100% if TOC concentrations are less than 0.5 mg/L, and with approval from DDW.

5.4.6 Water Quality Goals and Potential Regulation for Streamflow Augmentation

While the water quality requirements and goals for landscape and agricultural irrigation are relatively well defined, the potential requirements for stream augmentation can be difficult to predict. Surface water discharges are regulated through the NPDES permitting process based on protection of existing and potential future beneficial uses as defined in the RWQCB Basin Plan. The Basin Plan is an ever-changing document with amendments made yearly and updates (at a minimum every three years) required through the Clean Water Act and California Water Code. The implementation of SNMPs is expected to further update water quality requirements for sub-basins.

A relevant example for potential regulatory implications for streamflow augmentation is the California Men's Colony (CMC) WWTP which currently produces recycled water for the Dairy Creek Golf Course and discharges effluent to Chorro Creek. The permit for the CMC WWTP was updated in 2012, and was reviewed to provide insight on recent requirements for discharge to Chorro Creek. Effluent Limitations include organics, solids, oil and grease, chlorine residual, toxics, and nitrogen compounds. The permit includes limitations for the receiving water (Chorro Creek), which requires monitoring stations upstream and downstream of the discharge point. Receiving water limitations for several parameters are set based on amounts or concentrations that cause a nuisance or adversely affect beneficial uses. Some of the parameters include coloration, taste or odor-producing substances, floating material, suspended material, settleable material, oils, greases, waxes, biostimulatory substances, suspended sediment, toxic metals, and inorganic chemicals. The permit specifies limits for changes in turbidity, pH, and temperature based on the natural levels in the receiving water, and specifies that dissolved oxygen concentrations shall not be reduced below 7.0 mg/L at any time. There are also limitations regarding salinity based on agricultural beneficial uses and water quality objectives defined for Chorro Creek in the Basin Plan. In addition to influent and effluent monitoring, CMC monitors five points along Chorro Creek, from just downstream of the reservoir dam to just upstream of the discharge into Morro Bay Estuary.

Regulations for discharge into streams and other inland surface waters are expected to increase, especially in the realm of nutrients. In wadeable streams, eventual thresholds for nitrogen may be as low as 1.0 mg/L as total nitrogen and limits for phosphorous may be as low as 0.1 mg/L. Scientific work produced by the Southern California Coastal Water Research Project suggests that future nutrient thresholds would not be attainable without the use of reverse osmosis processes ("Regulatory Implications of Discharge Options for the Future City of Morro Bay WRF" (Discharge Options), LWA, 2014).

Additionally, diverting treated effluent from a surface water to another application has its own implications. Changes to discharges that decrease flow in a watercourse must be approved by the SWRCB Division of Water Rights via a Change Petition. A Change Petition would involve providing sufficient evidence that the change would not injure any other legal user of water and would not impact fish and wildlife. Relevant local examples of this is the San Luis Obispo (SLO) WRF, which must dedicate a portion of its effluent to maintain a minimum flow of 2.5 cfs in SLO Creek; and CMC WWTP must continuously discharge a minimum continuous flow rate of 0.75 cfs to Chorro Creek. If the City were to discharge recycled water from the WRF to Chorro Creek or Morro Creek, future use of that water may be restricted to surface water discharge depending on the NPDES permit.

Chorro Creek and Morro Creek are assigned the beneficial use of Municipal and Domestic Supply (MUN) in the Basin Plan which requires Title 22 MCLs be met for any discharge to the water body. The Discharge Options report investigated effluent data from the current City WWTP between January 2010 and January 2014 for conformity with Basin plan, California Toxics Rule, and Title 22 objectives. Concentrations of ten constituents in the effluent were found to be above the lowest applicable water quality objective. Concentration of Ammonia-N exceeded the total nitrogen limit for the 2012 CMC permit. Criteria for the California Toxics Rule were updated in 2014 for 90 constituents. Only three of the updated constituents that are monitored in the City WWTP effluent were detected, two of which exceeded the updated criterion. The concentration of these two constituents, cyanide and bis (2-ethylhexyl) phthalate, exceeded the criteria before its update in 2014. The current WWTP receives a significant dilution credit for its effluent via the ocean outfall and diffuser. This dilution credit will likely not carry over to inland surface water discharges therefore treatment to address constituents listed above will be necessary for discharge to Chorro Creek or Morro Creek.

Discharging to Chorro Creek requires the most regulatory involvement. The creek has TMDLs defined in the Basin Plan for nutrients, sediment, and bacteria. The nutrient TMDL for Chorro Creek contained a reopener provision that gives opportunity for regulators to implement new restrictions from state policy on nutrients and biointegrity. Salt and Nutrient Management Plan development for the Chorro Valley Basin may also complicate discharge requirements as a large number of stakeholders, including regulatory agencies such as NOAA Fisheries and California Department of Fish and Wildlife would be involved. Chorro Creek itself is named as critical habitat for federally listed Steelhead trout and California red-legged frog. The Creek discharges into state-protected estuarine habitat that provides for dozens of federally listed species. Accordingly, permitting for discharge to Chorro Creek or changes to the discharge in the future could be heavily scrutinized by state and federal agencies.

Discharging to Morro Creek involves many of the same regulatory implications as Chorro Creek. Toxicity, nutrient, and bacteria policies pertaining to Chorro Creek will also apply to Morro Creek, as well as the biological integrity assessment. Since Morro Creek does not discharge into a sensitive estuary it is not expected to be as heavily scrutinized as Chorro Creek by state and federal agencies. There are also no TMDLs for Morro Creek in the Basin Plan that can potentially be reopened and revised with new goals for discharges.

5.4.7 Water Quality Goals for Injection for Seawater Intrusion Barrier

If used to augment the City's water supply it is very likely that water quality goals for a Seawater Intrusion Barrier would match that of a GRRP using subsurface application.

5.4.8 Water Quality Goals for Future Direct Potable Reuse

Direct potable reuse (DPR) differs from IPR by removing the environmental buffer involved, but typically requiring a higher degree of treatment. DPR can be achieved by either introducing advanced treated wastewater into a raw water supply immediately upstream of a drinking water treatment facility or by introducing the water directly into the potable water distribution system, downstream of the water treatment facility. The lack of the environmental barrier must be made up by the use of treatment technologies that address a broad variety of contaminants. Reverse osmosis technology is frequently used, and often produces effluent of higher quality than conventionally treated drinking water in terms of TOC, TDS, and trace contaminants. The need for rapid adjustment and redundancy in the treatment train is also paramount.

DPR is not currently permitted in the State of California. It is possible that regulations may change in the future, as DPR projects in other parts of the United States and the world are currently operating successfully. One such project, operational since spring of 2013, is presented in the Draft FMP. The system is located in Big Spring, Texas and treats filtered secondary treated effluent using microfiltration, reverse osmosis, and an ultraviolet advanced oxidation process. The treated water is blended with raw water supplies in a transmission line to one of several drinking water facilities before it is distributed. This project, as well as another DPR project in Texas, received approval on a case-by-case basis without the benefit of all-encompassing resources addressing any issues related to DPR.

Regulations have not been specifically developed for DPR projects at either the state or federal level. California Water Code Section 13560-13569, enacted in February 2009, directs the SWRCB DDW to investigate and report on feasibility of developing uniform water recycled criteria for DPR and IPR. IPR regulations have already been developed and gone into effect for surface and subsurface applications to groundwater. The DDW convened an Expert Panel and tasked them with advising DDW on technical, scientific, and public health issues regarding development of water recycling criteria for IPR through surface water augmentation as well as investigating feasibility of developing uniform recycling criteria for DPR. Uniform water recycling criteria for IPR through surface water augmentation was to be adopted before December 31, 2016. The feasibility of developing recycling criteria for DPR will also be reported before the same date. The report on DPR feasibility was anticipated to incorporate: availability of treatment technologies necessary to protect public health, treatment processes that may be appropriate for DPR applications, any information on health effects associated with DPR, mechanisms to protect public health if problems are found in the recycled water being used as a potable water supply, monitoring needs for protection of public health, and other scientific or technical issues.

The DDW Expert Panel published a report titled, "Evaluation of the Feasibility of Developing Uniform Water Recycled Criteria for Direct Potable Reuse" in August 2016. The report found that it is feasible to develop uniform water recycling criteria for DPR that would provide a degree of public health protection better or equal than conventional drinking water supplies, IPR using groundwater replenishment, and proposed IPR using surface water augmentation. DPR projects will not incorporate an environmental buffer as IPR project do, so this discrepancy in level of protection must be addressed by other means such as reliability of mechanical systems or plant performance. The report includes recommendations for additional research that is needed to establish uniform water regulatory criteria for DPR, and recommended approach for accomplishing the additional research that is needed.

The Draft FMP outlines critical elements that are anticipated as necessary to develop a DPR program in the future using disinfected tertiary effluent from the proposed Morro Bay WRF. These elements include: a multi-barrier process train that removed contaminants and pathogens, redundant processes that consist of multiple unit operations which target removal of a given contaminant or pathogen such that if one process fails the integrity of treatment remains intact, and a robust and resilient treatment train designed to achieve removal of a wide variety of contaminants and pathogens, including pharmaceuticals and emerging contaminants. A wide range of technologies are available to achieve these treatment requirements, such as RO and AOPs which are widely used in IPR projects.

SECTION 6 RECYCLED WATER MARKET ASSESSMENT

6.1 Market Assessment Procedures

The recycled water market assessment performed in this MWRP analyzes the feasibility of utilizing recycled water to reduce the City's potable water demand or augment the City's potable water supply. The City's 2012 Recycled Water Feasibility Study prepared by Dudek identified various recycled water opportunities around the City. At the time the study was prepared, the City and CSD were jointly pursing upgrades to the existing WWTP, so the analysis encompasses opportunities for reuse in Cayucos as well. The proposed upgrades to the facility at the time included filtration and disinfection to meet Title 22 disinfected tertiary treated recycled water with the upgrades having 0.4 MGD capacity. Advanced treatment including RO and AOPs was also considered. Potential recycled water users that were identified in the Dudek study were further investigated as part of this MWRP, and considered in conjunction with the new WRF.

The methodology used to determine review potential recycled water opportunities is described below:

- ❑ Identification of recycled water uses for investigation
- ❑ Review of proximity to the proposed WRF site near the intersection of HWY 1 and South Bay Boulevard
- ❑ Review of past and present property owners interested in receiving recycled water. Various potential users were identified in the 2012 Dudek study and updated in "Morro Bay New Water Reclamation Facility – Water Reuse Opportunities" (MKN, 2014)
- ❑ Evaluation of nearby water supplies for recharge or augmentation. These potential opportunities would include the Chorro Valley and Morro Valley groundwater basins as well as Chorro Creek and Morro Creek.
- ❑ Feasibility to serve each potential recycled water user based on the following criteria:
    - o Regulatory requirements
    - o Water quality requirements
    - o Water demand
    - o Ability to offset potable water supply
    - o Reliability

6.2 Potential Uses of Recycled Water

As described in **Section 5**, there are various allowable uses of recycled water for the City, including agricultural and urban uses, and augmentation of groundwater and surface water supplies. Information from various reports prepared for the City, including Effluent Disposal Feasibility Alternatives Study (GSI Water Solutions, Inc.), Morro Bay Recycled Water Feasibility Study (Dudek, 2012), and the Cayucos/Morro Bay Comprehensive Recycled Water Study (Carollo Engineers, 1999) is summarized in this section to describe each potential opportunity.

Potential reclamation opportunities were considered in conjunction with the siting studies performed for the new WRF and summarized in the draft technical memorandum "Morro Bay New Water Reclamation Facility – Water Reuse Opportunities" (MKN, May 8, 2014) (**Appendix C**). At this time, the location of the new WRF was undetermined and several sites were under consideration. The memorandum reviewed reclamation opportunities identified in previous reports, developed a comprehensive map of the opportunities, and a summary of the potential demands and general water quality requirements. Once the planned new WRF location was determined, the results of this Technical Memorandum became the starting point for refreshing the market assessment described herein.

Recycled water project opportunities in the Chorro Valley were reviewed and summarized in the report "Assessment of the Hydrogeologic Characteristics of the Chorro Valley" (GSI Water Solutions, Inc., August 2016). Groundwater in the Chorro Valley basin is high in nitrates and the City wells that draw from the basin are susceptible to seawater intrusion. The City does not currently have the infrastructure, including a nitrate removal facility and pipelines, to treat and deliver water from the Chorro Valley groundwater basin. The report concluded the most feasible opportunities were percolation in the active channels of Chorro Creek and/or tributaries and in-lieu recharge exchange with agricultural users. The report also noted the legal and water rights issues that could arise if the City recharges Chorro Valley groundwater directly or receives a water supply benefit through in-lieu exchange. There are many agricultural users that could extract that water with no assurance the City wells would physically be capable of withdrawing the full recycled water portion deposited even though it can be presumed the City has rights to most of the water it recharges. Unlike the lower Morro Valley groundwater basin, the aquifer is not constrained and many property owners could extract the City's recycled water. Preventing the loss of this water would require active basin wide groundwater management and agreements among users.

Another report titled "Hydrologic evaluation of the potential benefits to the City water supply form increasing wastewater discharge to Chorro Creek, San Luis Obispo County" by Cleath-Harris Geologists, Inc. in 2014 found that the annual water supply benefit of discharging to Chorro Creek and recovering at existing City wells during a normal year would be up to 515 acre feet (AF) and during years of exceptional drought, the water supply benefit would reach as high as 900 AF. The project evaluated would involve discharging into Chorro Creek upstream of the City wells in the Chorro Valley and withdrawing Chorro Creek underflow using the City wells. The report did not take into account any regulatory issues, which are significant in evaluating a recycled water alternative. As previously stated in Section 5.4.6, if the City were to discharge into Chorro Creek, a minimum flowrate would need to be met in Chorro Creek before being able to divert any additional recycled water to other applications. Permitting would include an NPDES permit from RWQCB, and recycled water requirements from DDW as the alternative would likely be considered an indirect potable reuse project since it aims to augment the potable water supply. Finally, the long-term benefit of recycled water opportunities in the Chorro Valley would not be guaranteed as future agricultural development or environmental regulation could limit the amount of water available to withdraw from the aquifer both physically and legally. It is anticipated that agricultural development will occur between the City's two wellfields in Chorro Valley. Due to these reasons, previously identified recycled water uses in the Chorro Valley were not investigated further.

Recycled water project opportunities in the Morro Valley were reviewed and summarized in the report "Effluent Disposal Feasibility Alternatives Study" (GSI Water Solutions, Inc., July 2016). The City extracts and treats groundwater from the Morro Valley groundwater basin to supplement potable supply, so implementing a recycled water project in the Morro Valley basin would more directly impact potable water supply. In addition, the City has existing wells and an existing treatment system that can remove nitrate. Other than the City, there are no other users in the lower Morro Valley groundwater basin.

A summary of the potential reuse opportunities reviewed is included in **Table 6-1**. Projects evaluated further are indicated and brief comments on the feasibility and anticipated efficacy of each alternative are provided. More complete descriptions of each alternative and the rationale are included below in **Sections 6.2.1-6.2.13**.

Table 6-1: Summary of Reuse Opportunities

Alternative	Evaluated Further	Comments
No Recycled Water Project	✓	No water supply benefit to the City Lowest treatment requirements of all alternatives
Urban Reuse	✓	Distribution system to urban irrigation opportunities within the City Limits would need to be constructed by the City Potential to offset City potable water demand and fertilizer costs Generally lower treatment requirements than agricultural irrigation

Table 6-1: Summary of Reuse Opportunities		
Alternative	Evaluated Further	Comments
Agricultural Irrigation		Costly distribution system would need to be constructed by the City Does not increase City's potential water supply, only increases likelihood of withdrawing full allocation from Morro Valley Initial outreach indicated general unwillingness to participate Additional treatment for removal of salts necessary
Exchange of Recycled Water with Agricultural Users in Exchange for Reduced Groundwater Pumping		Distribution system to Morro Valley would need to be constructed by the City Basin-wide groundwater management plan would be required to receive full benefit Does not increase City's potential water supply, only increases likelihood of withdrawing full allocation from Morro Valley Initial outreach indicated general unwillingness to participate Additional treatment for removal of salts necessary
Exchange of Recycled Water with Agricultural Users for Riparian Rights to Withdraw Groundwater		Distribution system to Morro Valley would need to be constructed by the City Complex legal issues surrounding Riparian Rights Initial outreach indicated general unwillingness to participate Additional treatment for removal of salts necessary
Exchange of Recycled Water with Agricultural Users in Exchange for Pumped Groundwater Delivered to the City	✓	Distribution system to Morro Valley and return pipeline to water treatment facilities would need to be constructed by the City Initial outreach indicated agricultural users would only be interested if delivered water was less expensive than their current costs or higher quality Additional treatment for removal of salts necessary
Indirect Potable Reuse, Groundwater Replenishment Using Surface Application		Limited water supply benefit, especially during wet years City must acquire land for percolation ponds City must staff and maintain percolation ponds Higher treatment requirements than all alternatives but groundwater injection
Indirect Potable Reuse, Groundwater Replenishment Using Subsurface Application at the Narrows	✓	Injection wells at the Narrows Pilot testing and additional modeling required for permitting and refined supply benefit estimates Highest mandated treatment requirements of all alternatives Highest potential water supply benefit
Indirect Potable Reuse, Groundwater Replenishment Using Subsurface Application at the Narrows Near Bike Path Adjacent to Lila Keiser Park	✓	Injection wells near the bike path near Lila Keiser Park Pilot testing and additional modeling required for permitting and refined supply benefit estimates Highest mandated treatment requirements of all alternatives Highest potential water supply benefit

Table 6-1: Summary of Reuse Opportunities		
Alternative	Evaluated Further	Comments
Groundwater Injection for Seawater Intrusion Barrier		City would likely need to install new injection wells Limited water supply benefit as majority of injected water lost to ocean Highest mandated treatment requirements of all alternatives
Streamflow Augmentation		Regulatory challenges in present and future Long term or permanent commitment to dedicated stream discharge Requires expansion of water treatment facilities to treat surface water Majority of streamflow in Chorro Creek goes to ocean with minimal percolation
Direct Potable Reuse		Not currently legal in California Future regulatory challenges

6.2.1 No Recycled Water Project Alternative

The No Recycled Water Project Alternative would consist of constructing a new WRF and either deferring or removing the recycled water component from the overall project. A treated effluent discharge pipeline would be constructed from the WRF to the existing ocean outfall. This line would be installed with any of the project alternatives, as it is planned for operational or wet weather discharge, during times when recycled water could not be delivered, and to transport brine discharge from reverse osmosis treatment.

6.2.2 Urban Reuse

Water quality regulations (CCR Title 22) require that unrestricted irrigation of commercial landscapes, parks, and playgrounds must be tertiary disinfected recycled water. Some of the commercial uses may only require secondary disinfected recycled water. However, the required treatment will be dictated by the highest quality required for the recycled water users. It is anticipated that salts removal (reverse osmosis) will be needed to reduce chlorides and other dissolved solids. The use of recycled water for public landscaping and other urban applications can reduce City expenditures on water and fertilizer. Since recycled wastewater commonly has nutrient content that can be beneficial to landscaping and turf grass, use of recycled water can achieve optimum growth without contributing to potable water demand or purchase of fertilizer. Statewide, nearly 20% of recycled water use is attributed to landscape irrigation involving parks, playgrounds, golf courses, freeway landscaping, open space, and various other applications. This alternative would require the installation of a separate recycled water distribution system.

6.2.3 Agricultural Irrigation – Not Evaluated Further

Agricultural irrigation has been recognized as one of the most promising recycled water opportunities for the area due to the number of irrigated agricultural properties concentrated along Highway 41, just east of the City. However, these properties are outside the City's service area and currently irrigate using existing private groundwater wells. While it is conceivable that delivery of recycled water could decrease groundwater pumping in the Morro Valley, without contracts with the recycled water users to do so (so the City will realize a water supply benefit), such a project could be treated as a supplemental water source and increase agricultural cultivation. Recent outreach has indicated general unwillingness to enter into contracts to reduce groundwater pumping. Additionally, pricing recycled water to be competitive with existing groundwater pumping costs would require that the project be subsidized by the City. This alternative does not provide substantial water supply benefit to the City and was not evaluated further in this study.

6.2.4 Exchange of Recycled Water with Agricultural Users in Exchange for Reduced Groundwater Pumping (In-Lieu Groundwater Recharge) – Not Evaluated Further

This alternative would provide agricultural users in the mid- and upper-Morro Valley with a constant irrigation supply of recycled water in exchange for reduced pumping. Such a reduction in pumping could conceivably result in a greater volume of groundwater available to the City by extraction from the existing downstream City wells. However, such a program would require a valley-wide basin management plan with cooperation agreement by virtually all growers, whether or not they were receiving recycled water. Currently, many of the growers only reduce pumping when their wells begin to dry up. Based on outreach to the agricultural community to date, there is little or no interest in entering into agreements with the City to reduce groundwater pumping. In addition, the City's groundwater pumping rights would not likely change as a result of this alternative. The current allowable withdrawal of 581 AFY from the Morro Valley basin would not meet the City's potable water demands without SWP deliveries even if groundwater levels and quality would allow for regular extraction. This alternative also requires an extensive distribution system to growers in the Morro Valley. Consequently, this alternative is considered not feasible due to water rights concerns, lack of benefit to agricultural users for reduced pumping, and no guaranteed water supply benefit to the City.

6.2.5 Exchange of Recycled Water with Agricultural Users for Riparian Rights to Withdraw Groundwater – Not Evaluated Further

Exchange of recycled water for riparian water rights would involve providing recycled water to landowners with riparian water rights in exchange for rights to pump groundwater. To take advantage of the pumping rights, the City would require agricultural groundwater pumpers to name the City as a trustee to their water rights as a part of this alternative. As with the previously discussed alternative, this project would require significant participation by agricultural growers in the Morro Valley in order to see any potable water supply benefit. Based on outreach to the agricultural community to date, there is little or no interest in entering into agreements with the City to assign or share users' pumping rights. This alternative also requires an extensive distribution system to growers in the Morro Valley.

6.2.6 Exchange of Recycled Water with Agricultural Users in Exchange for Pumped Groundwater Delivered to the City

Exchanging recycled water with agricultural users for delivery of groundwater pumped from their private wells is an opportunity that could benefit the City by augmenting water supply while also reducing groundwater pumped for irrigation. It is anticipated that the City would receive a fraction of the volume of recycled water delivered in return Advantages of this alternative include in lieu groundwater recharge by agricultural users in the Morro Valley, increasing the available groundwater supply for users and growers in the lower regions of the aquifer near the Narrows. The existing City wells also lie near this area, so it is possible that they could also see higher groundwater elevations resulting in lower pumping costs and a severely reduced risk of overdrafting the aquifer or inducing seawater intrusion. For irrigation applications, it is expected that the recycled water will undergo reverse osmosis treatment to achieve suitable TDS concentrations. In contract to the other agricultural irrigation alternatives, this project could provide potable water supply benefit to the City with participation from one to three major water users in the Morro Valley.

6.2.7 Indirect Potable Reuse, Groundwater Replenishment Using Surface Application (Percolation Ponds) – Not Evaluated Further

Groundwater replenishment using surface application (percolation ponds) involves acquisition of large plots of land to use as infiltration basins. The optimal location would be upstream of the "Narrows", east of the City near HWY 41 where Morro Creek and Little Morro Creek converge. It is estimated that the City could gain a water supply benefit in the range of 100 to 300 AFY during drought conditions, and less to none during wet weather conditions (GSI Water Solutions, July 2016). Since this is significantly lower than the amount of water being produced, particularly during average or wet years, as well as the ability for other pumpers to extract this water without it reaching City wells, this alternative was not preferred.

6.2.8 Indirect Potable Reuse, Groundwater Replenishment Using Subsurface Application at the Narrows (Injection Wells)

This alternative involves injection of recycled water at the Narrows for recovery at the City's potable water wells. Preliminary groundwater modeling by GSI Water Solutions presented in "Draft Lower Morro Valley Basin Screening-Level Groundwater Modeling for Injection Feasibility" (GSI Water Solutions, Inc. January 2017) suggests that all recycled water (up to 825 AFY) could be injected and volume equal to the full annual State Water allocation could be withdrawn from the City wells with little risk of seawater intrusion. Recycled water would be conveyed to the injection wells via a recycled water pipeline alignment that lays along the east side of Highway 1.

6.2.9 Indirect Potable Reuse, Groundwater Replenishment Using Subsurface Application Near Bike Path Adjacent to Lila Keiser Park (Injection Wells)

This alternative involves injection of recycled water near the bike path adjacent to Lila Keiser Park for recovery at the City's potable water wells. Preliminary groundwater modeling by GSI Water Solutions presented in "Draft Lower Morro Valley Basin Screening-Level Groundwater Modeling for Injection Feasibility" (GSI Water Solutions, Inc. January 2017 suggests that all recycled water (up to 825 AFY) could be injected and volume equal to the full annual State Water allocation could be withdrawn from the City wells with little risk of seawater intrusion. Recycled water would be conveyed to the injection wells via a recycled water pipeline alignment that lays along the west side of Highway 1. Depending on recycled water project schedule, it may be possible for the recycled water pipeline to the injection wells to be installed during installation of the raw influent and brine disposal pipelines as the alignments generally follow the same path.

6.2.10 Groundwater Injection for Seawater Intrusion Barrier – Not Evaluated Further

Groundwater injection to develop a seawater intrusion barrier would consist of injecting recycled water into either the existing coastal seawater wells located along the Embarcadero, or into new injection wells somewhere between there and the City's existing potable water wells in the Morro Valley. The injected water would create a fresh water barrier and prevent seawater intrusion during periods of increased pumping from the City's wells, and thereby increase the volume that the City can withdraw from their wells without inducing seawater intrusion. However, a considerable quantity of the water would be lost to the ocean and prevention of seawater intrusion could also be achieved by a groundwater recharge and extraction system.

6.2.11 Streamflow Augmentation – Not Evaluated Further

Streamflow augmentation did not prove to be a preferred alternative from both the regulatory and water supply benefit perspectives. The primary concern regarding this alternative is that committing a portion of flow to the stream would be ultimately binding in the long term, meaning the City would need to maintain its contribution regardless if a much more beneficial recycled water opportunity were to arise (Larry Walker and Associates, October, 2014). Along with the long term commitment, potential future regulations are expected to be very restrictive to discharge of treated wastewater to surface waters, resulting in additional advanced treatment requirements and costs. Additionally, during average and wet years most of the streamflow in Chorro Creek and Morro Creek goes out to the ocean with minimal percolation into the groundwater aquifers, which does not help to offset potable water use. Also the City does not currently treat surface water so the main potential benefit would be percolation to groundwater for increased supply. Alternatively, it is possible the City could use recycled water discharge to Chorro Creek to maintain the minimum required stream flow of 1.4 cfs, which would allow additional seasonal pumping from the Chorro wells. However, as described in the report by Cleath (ibid.) it is not anticipated to significantly increase the amount of water the City would have rights to extract and additional treatment infrastructure would be required for the high-nitrate groundwater in the Chorro Valley. Additionally, permitting would likely require both RWQCB for the surface water discharge and DDW, since it may be considered indirect potable reuse (IPR). With the level of treatment required for IPR, it is economically advantageous to maximum amount of water reclaimed. Due to these reasons, this alternative is not preferred.

6.2.12 Direct Potable Reuse – Not Evaluated Further

Since DPR is not currently legal in California, it is not assessed in depth in this study as a project alternative. Relevant information for potential DPR regulations can be found in **Section 5.4.8**. It is expected that regulations will be coming forth in the next few years, as the DDW Expert Panel found that it is feasible to develop uniform water recycling criteria for DPR that meets or exceeds a degree of public health protection than what is currently provided.

6.2.13 Summary of Feasible Reuse Opportunities

The reuse opportunities that appear feasible and are further analyzed herein include urban reuse (commercial and irrigation uses), agricultural exchange, and indirect potable reuse.

6.3 Evaluation of Potential Users

Based on the discussion in **Section 6.2**, the list of reclamation opportunities was narrowed to three main options: urban reuse (irrigation and commercial use), exchange of recycled water for delivery of pumped groundwater from agricultural wells, or indirect potable reuse via groundwater injection. A summary of water quality guidelines for each of these alternatives is included below in **Table 6-2**. As discussed in previous sections, minimum treatment levels required to meet regulation may be less than the water quality required for a specific use. This pertains mainly to crops irrigation opportunities for reuse in which the crops to be watered are sensitive to salts. Consequently, some applications may require water treated by reverse osmosis or blending to achieve the desired salinity content.

Table 6-2: Water Quality Requirements for Top Reuse Alternatives

	Indirect Potable Reuse: Groundwater Recharge via Injection (Either Location)	Exchange of Recycled Water for Agricultural Delivery	Urban Reuse (Irrigation and Commercial Use)
Anticipated Timing	5 years		
Governing Permits	Waste Discharge Requirements	Waste Discharge Requirements	Waste Discharge Requirements
Governing Regulations	Basin Plan, Title 22 (GRRP)	Basin Plan, Title 22 (Irrigation)	Basin Plan, Title 22 (Unrestricted Reuse)
Nitrate (mg/L as N)[1]	10		
Selected Metals[2]	Title 22 MCLs or CTR values		
Selected Organics[2]	Title 22 MCLs or CTR values		
7 day median Total Coliforms	2.2 MPN/100 mL		
Anticipated TDS goal (mg/L)	NA (full advanced treatment required)	300	300 - 900

1. Future Salt and Nutrient Management Plan (SNMP) and TMDLs may limit nutrient content in irrigation water
2. Constituents regulated by the California Toxicity Regulation (CTR) are also Title 22 MCLs. Some CTR limits are lower than Title 22 MCLs and vice versa.

In addition to the water quality requirements notes above, several future potential regulatory actions may impact permitting requirements for some of the potential reuse opportunities, including new Toxicity and Control Policy, Bacteria Policy for marine and fresh water discharges, and revised USEPA Human Health Criteria. Specific effluent requirements cannot be anticipated, making flexibility of treatment process selections an important consideration.

A comprehensive list of potential urban and agricultural recycled water users from previous studies was reviewed and updated. The list includes opportunities for agricultural irrigation in both the Chorro Valley and Morro Valley, landscape irrigation, commercial and industrial uses, streamflow augmentation, and other miscellaneous uses. These users were evaluated based on the following criteria to determine feasible alternatives for reuse, potential required recycled water facilities and infrastructure, and potential future recycled water projects:

- Required salts removal or blending for recycled water use
- Suitability of pipeline alignment from the anticipated WRF site
- Estimated recycled water demand, including seasonal variability
- Potential for expansion of recycled water use in proximity to user's location

Recycled water demand estimates were refined from the amounts listed in the previously published recycled water studies via additional interviews with potential users and groundwater modeling. Ten potential recycled water stakeholders were contacted for interviews and the program management team met with seven individually. The stakeholders included agricultural landowners holding parcels ranging from 8 up to 30 irrigated acres in the Morro Valley. It should be noted that none of the agricultural growers interviewed are among the largest growers by acreage in the Morro Valley.

In general, the agricultural landowners who were interviewed indicated whether they were interested in receiving recycled water and how much water they currently use from onsite wells. Water use ranged from just under 4 AFY to 90 AFY. The landowners also expressed that salt removal would be a critical requirement for their participation. In general, growers were not interested in giving up their water rights, and some would not even consider entering formal agreements of any kind. Some interviewed may consider limiting pumping in exchange for water, but others are simply seeking additional water supply for irrigation. Based on current outreach, agricultural irrigation demand would be at least 136 AFY and potentially more than the total amount of recycled water that the WRF can produce (approximately 825 AFY). It should be noted that solely delivering water for agricultural irrigation will not bring a potable water supply benefit to the City. The amount of water given to the City in exchange will likely not be at a 1:1 ratio to the water delivered, and that would be determined as part of the City's negotiations with growers for exchange.

A database of potential users along with water quality requirements to meet regulations and demand estimates has been provided to the City.

SECTION 7 PROJECT ALTERNATIVE ANALYSIS

Based on the market assessment and hydrogeological screenings, the project alternatives that appear feasible and are further analyzed herein are summarized in **Table 7-1**.

Table 7-1: Summary of Project Alternatives

Alternative #	Title	Brief Description
0	No Recycled Water Project (Discharge to existing ocean outfall)	With no recycled water project, the City would continue discharging treated effluent to the existing ocean outfall.
1	Urban Reuse	Recycled water pipeline from WRF to City with turnouts to various urban commercial and landscape irrigation users for potential potable water offset, and recycled water to Morro Bay Golf Course.
2	Delivery of recycled water to agricultural users in exchange for pumped groundwater delivered to the City – “Agricultural Exchange”	Recycled water pipeline to properties in the Morro Valley along Hwy 41 to deliver recycled water for agricultural irrigation in exchange for groundwater sent back to the City. Alternative would include potable water pipeline from upper Morro Valley to City.
3	Indirect potable reuse: Groundwater replenishment using subsurface application at the Narrows (injection wells) – “Indirect Potable Reuse – East”	Recycled water pipeline to new groundwater injection wells east of Hwy 1 and south of Hwy 41, near the Narrows, for groundwater replenishment. Groundwater extracted from existing City wells in the Morro Valley would be treated at the City’s existing water treatment plant.
4	Indirect potable reuse: Groundwater replenishment using subsurface application near the bike path (injection wells) – “Indirect Potable Reuse – West”	Recycled water pipeline to new groundwater injection wells west of Hwy 1 and south of Hwy 41, near the bike path adjacent to Lila Keiser Park, for groundwater replenishment. Groundwater extracted from existing City wells in the Morro Valley would be treated at the City’s existing water treatment plant.

7.1 Evaluation Criteria

In order to evaluate the various recycled water alternatives, evaluation criteria were defined based on the WRF Project Community Goals adopted by City Council. The WRF project community goals and applicability comments from **Section 1** are included again in **Table 7-2** for reference. These project goals were the focus for the Draft FMP and were used to evaluate technologies and processes for the WRF. It should be noted that any recycled water project would be required to submit a Title 22 Report to the RWQCB and SWRCB DDW for review and approval and obtain agreements and contracts with recycled water users prior to project implementation.

Table 7-2: WRF Project Community Goals		
Community Goal	**Applicability for WRF**	**Applicability for Recycled Water**
Produce tertiary disinfected recycled water	WRF project is to be designed accordingly	Allows for multitude of recycled water uses and provides basis for advanced treatment
Produce reclaimed wastewater cost-effectively	Draft FMP considered costs in treatment evaluation	Project alternative assessment will include capital and operating costs and consider total amount of recycled water produced
Allow for onsite composting	Reviewed as part of Draft FMP. Onsite composting is not recommended, regional facility composting will be more cost effective and more compatible for neighbors	Not Applicable
Design for energy recovery	Draft FMP considered energy recovery for WRF	Project alternatives analysis will consider energy usage
Design to treat for contaminants of emerging concern (CECs)	Draft FMP included consideration in treatment evaluation	Advanced treatment would provide additional treatment for CECs
Allow for other municipal uses	Draft FMP considered for WRF site planning	Not Applicable
Ensure compatibility with neighboring land uses	Draft FMP considered for WRF site planning	Consideration for major infrastructure siting
Operational WRF within five years	WRF project is on schedule	Project alternatives analysis will consider potential challenges that could delay the project.

The recycled water project alternatives were evaluated based on the following criteria, aligning with the community project goals:

- Comparative capital and operating costs
- Compatibility with neighboring land uses and impact during construction
    - Total pipeline length
    - Land acquisition
- Reliability of recycled water uses and potential for schedule delays
- Potential to benefit the City's potable water supply (as described below)

This evaluation also considers the potential to benefit the City's potable water supply, either by offsetting potable water demand through delivery and use of recycled water or by a more direct method of supplementing the City's groundwater supply using injection wells (indirect potable reuse). The City currently relies on imported water from the SWP as the primary source of water. During times of low deliveries, or when the annual SWP maintenance occurs, the City utilizes brackish groundwater from the Morro Valley Groundwater Basin, treated through the BWRO at the Water Treatment Plant. Currently, only groundwater from the City's Morro Valley wells can be treated at the BWRO facility, and there is no treatment available for the Chorro Valley wells, which have also been high in nitrates and TDS. Reducing dependence on imported water by offsetting demand or supplementing with recycled water would increase reliability of the City's water supply and could reduce long-term costs. The SWP consists of a complex network of reservoirs, aquaducts, powerplants and pumping plants. Increasing the City's local supply of water provides additional resiliency and reduces the risk of interruption of an imported water supply due to damage caused by earthquakes, climate change, or some other natural disaster. The costs of SWP are anticipated to rise with required improvements as facilities age and critical projects are identified. The City may be able to maintain their SWP allocation, and arrange contracts to transfer their allocation of water to other SWP customers.

7.2 Planning and Design Assumptions

City records and various reports were used to develop the basis for design assumptions for the recycled water project alternatives. **Section 2** and **Section 3** detail the historical water produced and imported as well as the metered usage. Conservation efforts mandated by the State of California have resulted in a substantial reduction in demand in recent years. The City's main source of water is the SWP which has become increasingly unreliable in recent years due to drought conditions.

Preliminary design criteria for the WRF from the Draft FMP were used to develop planning and design assumptions in the comparison of the recycled water alternatives. The City identified one of the main goals of the WRF project is to produce disinfected tertiary recycled water. To best achieve this level of treatment using industry standard technologies, the Draft FMP identified two liquid treatment alternatives, with potential for future expansion to advanced treatment. One alternative was a conventional treatment option consisting of screening, grit removal, flow equalization, secondary treatment with sequencing batch reactor, tertiary treatment achieved through microfiltration, and disinfection by ultraviolet radiation. The other alternative, a combined secondary and tertiary treatment option, involved screening, grit removal, flow equalization, secondary and tertiary treatment through a membrane bioreactor process, and disinfection by ultraviolet radiation. The membrane bioreactor acts as both a biological treatment process and a filtration process. A brief discussion and process flow diagrams for the treatment alternatives is provided in **Section 4.3**.

Advanced treatment will likely be required for the recycled water projects under consideration, and will be discussed in a later section. Both treatment systems would provide adequate biological treatment for reverse osmosis, but the conventional treatment option would require addition of membrane filters as a pretreatment step to reverse osmosis. The ultraviolet disinfection process can also be coupled with hydrogen peroxide treatment to provide an advanced oxidation process (AOP).

WRF influent flows and anticipated recoveries of the treatment technologies outlined in the Draft FMP used to develop the preliminary design criteria for recycled water pipelines, storage, and advanced treatment facilities for each alternative are listed in **Table 7-3.**

Table 7-3: Anticipated Recoveries and WRF Influent Flow Rate	
Average Annual Flow – WRF Influent at Buildout	0.97 MGD / 1087 AFY
Microfiltration Recovery	95%
Membrane Bioreactor Recovery	95%
Reverse Osmosis Recovery	80%
Reverse Osmosis salt rejection	98%
Estimated Future Annual Production from WRF at Buildout	825 – 1087 AFY
Note: Volume of recycled water depends on the amount of advanced treatment required.	

Table 7-4 summarizes the preliminary design criteria used for sizing the recycled water pipelines and pump stations for the various alternatives.

Table 7-4: Preliminary Hydraulic Design Criteria	
Parameter	Criteria
Minimum Service Pressure for Spray Irrigation	45 PSI
Minimum Service Pressure for Drip Irrigation	15 PSI
ADD Pipeline Velocity	< 5 fps
PHD Pipeline Velocity	< 10 fps
Hazen-Williams Roughness Coefficient	130

7.3 Project Alternative 0: No Recycled Water Project

Project Alternative 0: No Recycled Water Project would consist of constructing a new WRF and either deferring or removing the recycled water component from the overall project. A treated effluent discharge pipeline would be constructed from the WRF to the existing ocean outfall. This line would be installed with any of the project alternatives, as it is planned for operational or wet weather discharge, during times when recycled water could not be delivered, and to transport brine discharge from reverse osmosis treatment. Due to the need to provide for full discharge flow during wet weather events, the preliminary sizing for the discharge pipeline is the same under each project alternative scenario.

The anticipated water quality requirements for ocean discharge are described in **Section 5.4**. A new NPDES permit will be prepared for the WRF and the effluent limitations are expected to require full secondary treatment at a minimum.

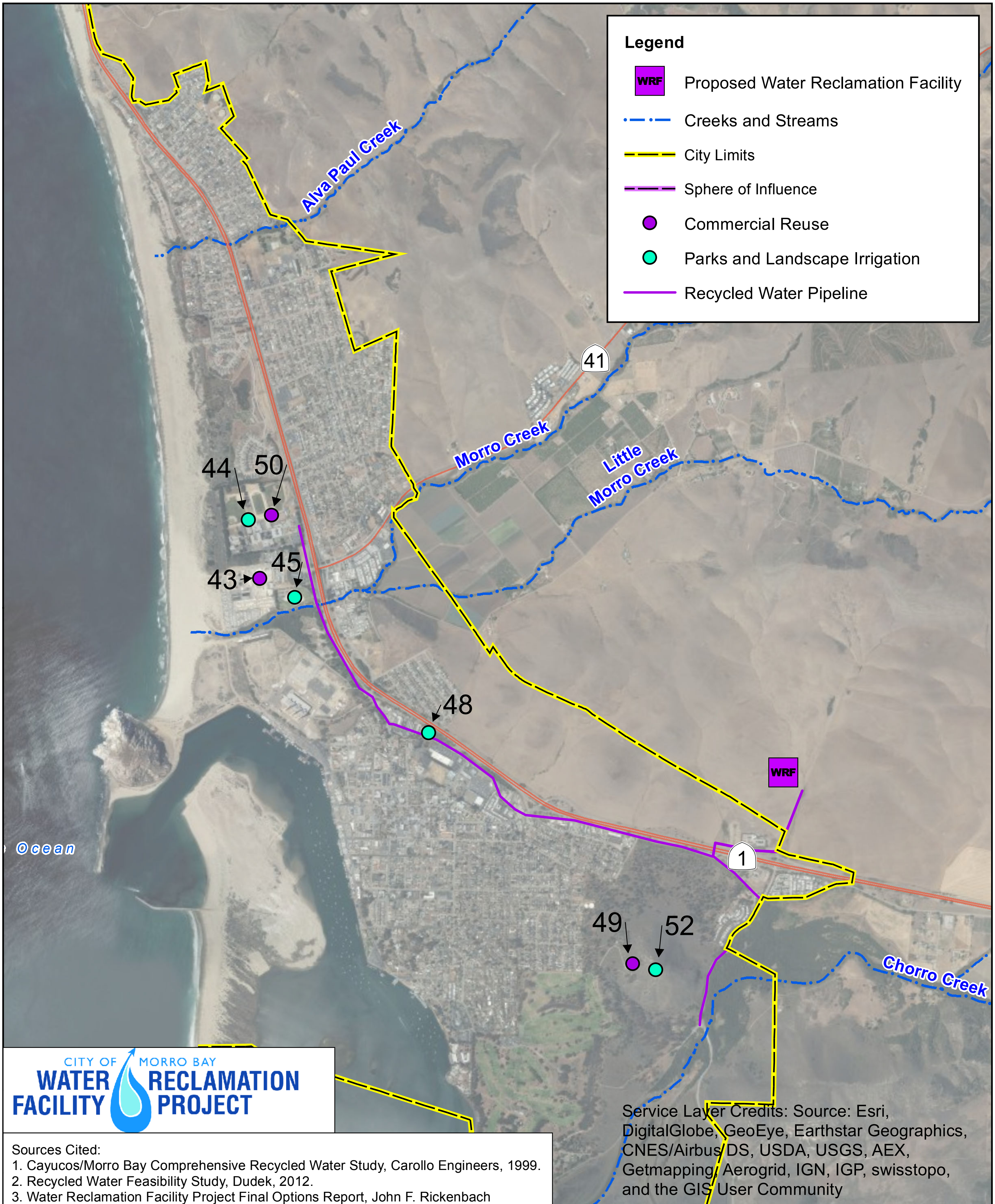
The Draft FMP evaluated two treatment process trains for the WRF based on the community goals for the project: an SBR process (Option A) and an MBR process (Option B). Membrane filters would be installed downstream of the SBR to allow tertiary treatment, and both process alternatives would include disinfection. The Draft FMP provided budgetary-level cost opinions for each alternative. If Alternative 0 is pursued, and the WRF is designed for full secondary treatment instead of treatment to produce disinfected tertiary recycled water, then a SBR plant without the membrane filters would provide full secondary treatment. Assuming membrane filtration and UV disinfection are not required, and disinfection is provided by a chlorine contact basin instead, a full secondary plant is anticipated to cost approximately $12 million less, as summarized in **Table 7-5**. Though full secondary treatment does not meet the Community project goal of producing tertiary disinfected recycled water, it is anticipated that this treatment level would be required for ocean discharge. Therefore, the cost estimate was developed for this report to provide a basis for evaluation of alternatives and relative cost of a recycled water project.

Table 7-5: Cost Opinion for Alternative 0 No Recycled Water Project Alternative		
	Tertiary Disinfected Treatment	Full Secondary Treatment Only (No recycled water)
Estimated Construction Cost Opinion	$118,600,000	$106,400,000
Notes: Estimated cost opinions based on information presented in the Draft FMP for “Option A”, SBR process, and includes the WRF lift station, pipelines, and treatment plant without any recycled water components, engineering and design, and 25% construction contingency. Estimated cost for Option B –MBR with tertiary treatment and disinfection is approximately $120,300,000. This cost opinion does not include additional program costs, such as construction management, property acquisition, and demolition of the existing WWTP. (See Table 7-19 for estimated full WRF program costs).		

This project alternative would not provide recycled water. Production of recycled water is a community goal defined for the WRF project, and the City has long held a goal to produce and utilize recycled water. The Local Coastal Plan sets reclaimed water as the City's second highest priority for its water supply, next to State Water; and states that water reclamation should be pursued when funded by a potential user, required as part of a wastewater plant upgrade or permit condition, or when it is shown as cost effective for City use. Whether it is cost effective to produce and distribute recycled water will need to be determined. This alternative is presented to assist with that evaluation. Alternative 0 is anticipated to be the least expensive alternative that would meet discharge requirements.

7.4 Project Alternative 1: Urban Reuse

Project Alternative 1: Urban Reuse consists of providing recycled water to urban commercial and landscape irrigation uses in the City and to the Morro Bay Golf Course as shown in **Figure 7.1**.



Sources Cited:
1. Cayucos/Morro Bay Comprehensive Recycled Water Study, Carollo Engineers, 1999.
2. Recycled Water Feasibility Study, Dudek, 2012.
3. Water Reclamation Facility Project Final Options Report, John F. Rickenbach

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Figure 7-1:
Alternative 1: Urban Irrigation

1 in = 2,500 feet
0 2,500 5,000
N

7.4.1 Preliminary Design Assumptions

Water quality regulations (CCR Title 22) require that unrestricted irrigation of commercial landscapes, parks, and playgrounds must be tertiary disinfected recycled water. Some limited commercial uses, such as the High School bus facility and the City maintenance yard, may only require secondary disinfected recycled water. However, the required treatment will be dictated by the highest quality required for the recycled water users. It is anticipated that salts removal (reverse osmosis) will be needed to reduce chlorides and other dissolved solids. However, for this alternative, a side stream of the WRF effluent would be treated by reverse osmosis and blended back with the tertiary disinfected recycled water to achieve the target TDS and chloride concentrations.

The majority of the urban recycled water uses identified are for landscape irrigation of grasses, which are primarily sensitive to chloride concentration in varying degrees, depending on the type of grass. Based on the water quality guidelines for irrigation, chloride concentrations of less than 142 mg/L represent no problem for irrigation, and concentrations between 142 and 355 mg/L represent increasing problems. This study assumes chloride is removed proportionally to TDS, and chloride concentrations between 142 and 355 mg/L are approximately equal to TDS concentrations between 387 and 914 mg/L. A mass balance was performed assuming a tertiary disinfected effluent TDS concentration (influent to the advanced treatment system) of 942 mg/L and a final TDS concentration target of 600 mg/L to estimate the size of the reverse osmosis system. As shown in **Figure 7-2**, this blending scenario would yield a TDS concentration slightly lower than 600 mg/L for planning purposes.

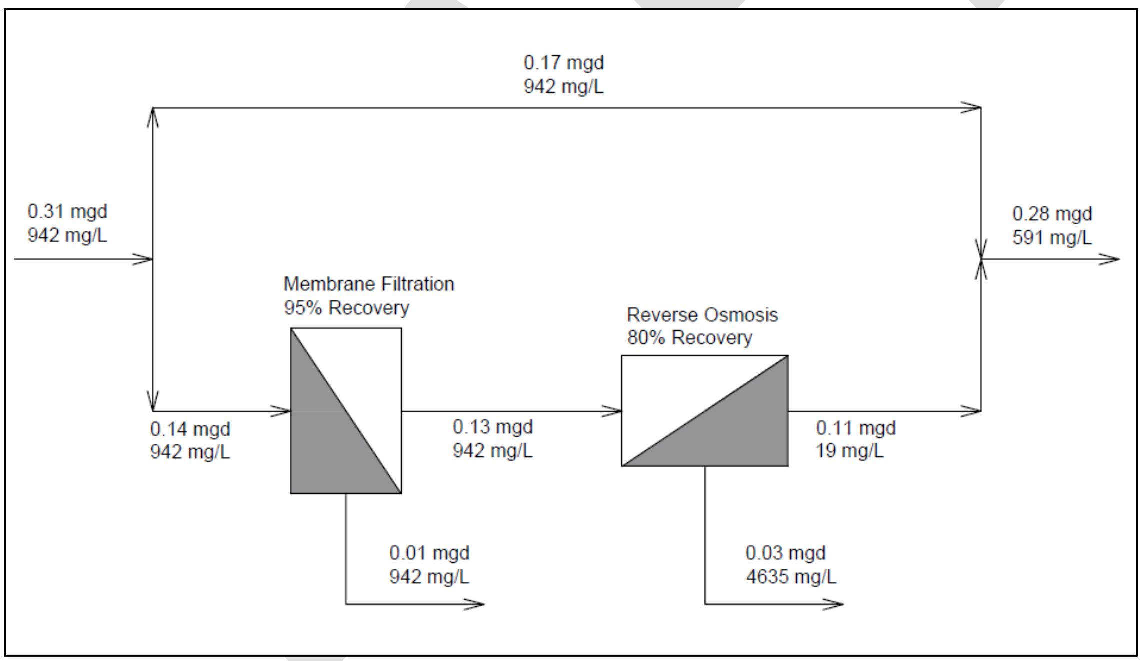


Figure 7-2: Blending Scenario for Alternative 1: Urban Reuse

The preliminary design assumptions for Alternative 1 are summarized in **Table 7-6**. The recycled water opportunities identified for this alternative represent a water demand that is less than half of the estimated recycled water available. To allow for future expansion as additional opportunities are secured, this alternative assumes that the recycled water pipeline from the WRF to the City will be sized for the future potential flow rate. The advanced treatment system is also sized for future potential demands with two trains, providing one redundant train for current demands. It is assumed the recycled water pump station will be sized for current demands and upgraded if/when future opportunities are identified. A recycled water tank at the WRF is recommended to provide operational storage for approximately 20 hours of average day production at buildout.

Table 7-6: Alternative 1 Urban Reuse Preliminary Design Assumptions	
Advanced Treatment	
Process	Reverse Osmosis
Recycled water quality target	600 mg/L TDS
RO permeate flow rate (current)	100 gpm
RO permeate flow rate (future)	200 gpm
RO Influent TDS	942 mg/L
RO permeate TDS	18 mg/L
Recycled water flows	
Average Annual Flow (current/future)	351.4 AFY/ 703 AFY
Average Day Flow (current/future)	0.31 MGD / 0.62 MGD
Peak Hour Flow (current/future)	0.93 MGD / 1.86 MGD
Recycled water pump station (current)	
Estimated Total Dynamic Head (TDH)	Approx. 100 feet TDH
Estimated horsepower required	25 HP
Configuration	(2) 30 HP pumps (1 duty, 1 standby)
Recycled water pipeline	
Material	PVC
Diameter	12-inch
Length	19,140 linear feet
Recycled water storage tank volume	500,000 gallons

7.4.2 Recycled Water Usage

The anticipated recycled water users for Alternative 1 are shown on **Figure 7-1** and summarized in the table below. The four potential users in the City make up an estimated 45.4 AFY of water demand, which could be offset by recycled water. These users were chosen because they are near or directly along the anticipated pipeline route for the WRF project, and represent the bulk of the recycled water market. Additional potential recycled water opportunities within the City have been identified in the past, and may be added at some point in the future if the alternative is pursued. The Morro Bay Golf Course may use up to 306 AFY. However, since the golf course does not currently utilize City water, this total would not offset potable water use for the City. It is important to note that nearly 99 percent of the usage for this alternative is for irrigation of landscape. During period of wet weather very little recycled water will be utilized. It is assumed the WRF will discharge to the existing ocean outfall during the wet weather months.

Table 7-7: Urban Reuse Recycled Water Opportunities			
Site ID	Reuse Opportunity	Reuse Type	Estimated Annual Demand (AFY)
43	City Maintenance Yard	Industrial	1.5
44	Morro Bay High School	Landscape	24.2
45	Lila Keiser Park	Landscape	6.2
48	South side of Highway 1	Landscape	10.0
50	Morro Bay High School Bus Facility	Commercial	3.5
Annual Demand Subtotal (Potential City potable water offset)			**45.4**
49	Morro Bay Golf Course	Landscape	300
52	Morro Bay State Park/Golf Course	Commercial	6.0
Annual Demand Total (City plus golf course)			**351.4**
Demand Estimates taken from Morro Bay New Water Reclamation Facility – Water Reuse Opportunities (MKN, 2014); Outreach by John F Rickenbach Planning and Environmental Consulting and RRM Design Group; and City Billing Data (1/2015-9/2016)			

7.4.3 Preliminary Cost Opinion

A preliminary opinion of probable cost was developed for general guidance to the City in preparing a planning-level budget and evaluating alternatives. Assumptions have been included based on the information available and preliminary design criteria described above. **Table 7-8** summarizes the opinion of probable construction cost and annual operating and maintenance costs. Appendix B summarizes the methodology and assumptions used to develop the cost opinion.

Table 7-8: Cost Opinion for Alternative 1 Urban Reuse				
Recycled Water Project Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Estimated Cost**
Reverse Osmosis System	1	LS	$1,000,000	$1,000,000
Recycled water pump station	1	LS	$400,000	$400,000
Recycled water pipeline (Open Area)	0.3	MI	$1,452,000	$435,600
Recycled water pipeline (Open Area + Sidewalk/trees)	1.1	MI	$1,557,600	$1,713,400
Recycled water pipeline (Road/City)	2.3	MI	$1,716,000	$3,946,800
Highway crossing (jack and bore)	400	LF	$650	$260,000
Storage Tank	500,000	GAL	$2	$1,000,000
			Subtotal Capital Cost	**$8,755,800**
Escalation (2%)				$175,116
Engineering and Administration (30%)				$2,627,000
Project Contingency (25%)				$2,189,000
			Total Capital Cost	**$13,800,000**
Annualized Project Cost (SRF Loan, 3% Interest, 30-year period; A/P = 0.051)				**$710,000**

Table 7-8: Cost Opinion for Alternative 1 Urban Reuse	
Annual Operation and Maintenance Cost	
Description	**Estimated Cost**
Advanced Treatment O&M	$70,000
Recycled Water Pumping Electricity	$20,000
Repair and Replacement (1% of capital)	$87,558
Staffing	$96,000
Monitoring and Reporting	$48,000
Total Annual O&M Cost	**$322,000**
Anticipated Cost Per Acre-Foot of Water Supply Benefit	
Total Anticipated Annual Cost	$1,032,000
Estimated Total Recycled Water Demand (AFY)	351.4
Estimated Water Supply Benefit (AFY)	45.4

Notes:

1. Cost opinion does not include service connections or recycled water onsite costs (adjustments to irrigation systems, cross-connection control, etc.)
2. Cost opinion includes the recycled water project only, and does not include costs for the WRF.

7.4.4 Preliminary Alternative Evaluation

The total estimated recycled water demand for Alternative 1 is approximately 40% to 45% of the estimated recycled water available. The majority of the potential recycled water use under this alternative is allocated to the Morro Bay Golf Course. Since the golf course does not use City water, the potential water supply benefit for this alternative is limited to up to 45.4 AFY (approximately 5% of the recycled water available).

The capital and estimated annual operating costs are relatively low compared to the other options. However, the annual cost per acre-foot of potential water supply benefit is very high, due to the low benefit to potable water supplies.

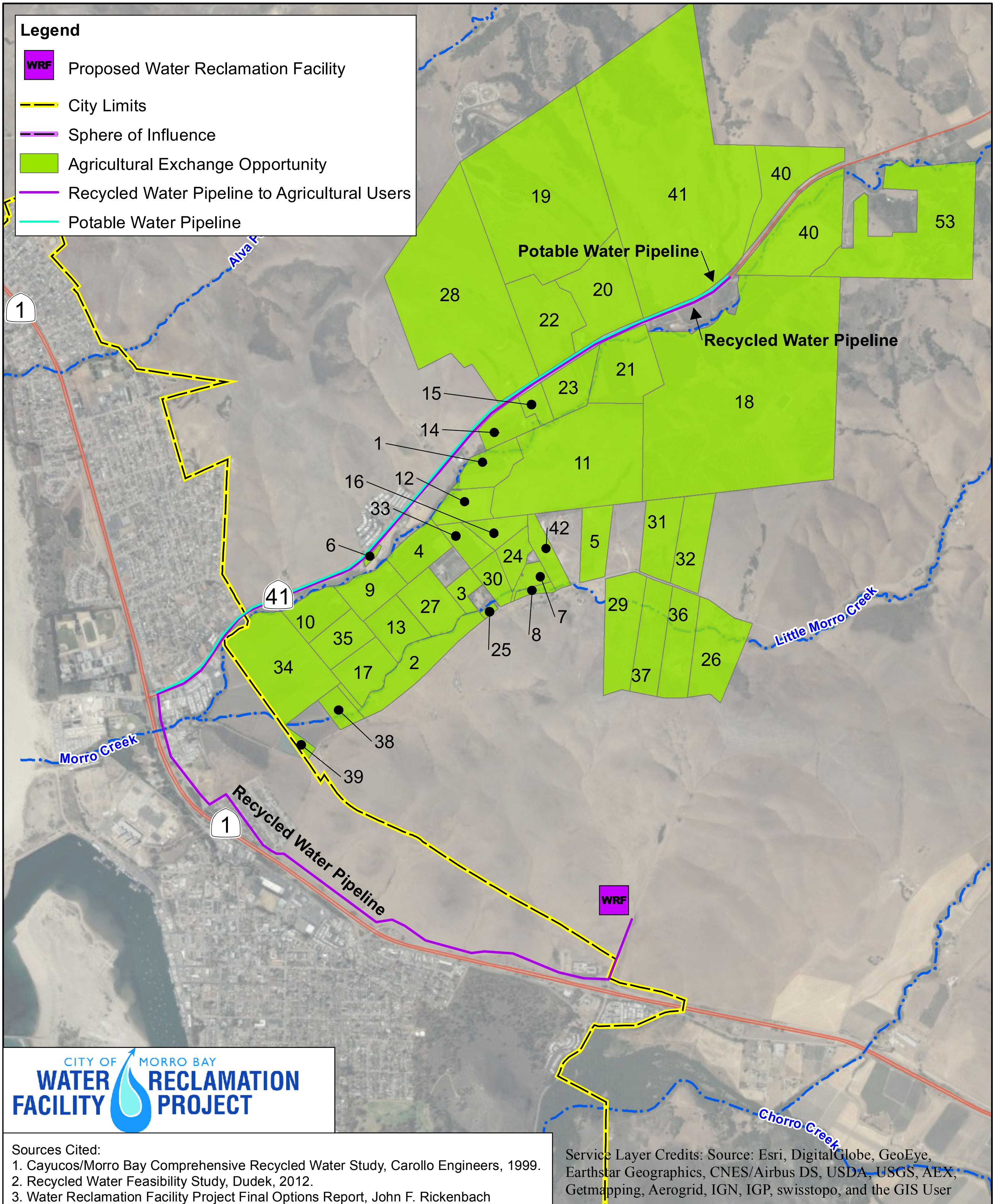
Each recycled water customer would require a service lateral and flow meter, and onsite retrofits for cross connection control between recycled water and potable water plumbing. Service connections and onsite retrofits vary in size, complexity, and cost; therefore, these costs are not reflected in the preliminary cost opinion above.

The energy use for this alternative is relatively low, with an estimated 15% of the effluent requiring advanced treatment (for current identified opportunities) and approximately 25 hp pumps required for recycled water delivery.

Design of onsite irrigation systems will be required to limit the potential for human contact and have signs posted to clearly indicate the use of recycled water. All major above-grade infrastructure for the project will be contained at the WRF site. Compatibility with neighbors is considered to be favorable for this alternative.

7.5 Project Alternative 2: Agricultural Exchange

Project Alternative 2: Agricultural Exchange consists of delivering recycled water to agricultural properties for the purposes of irrigation in exchange for groundwater pumped and delivered to the City. Major project components and potential agricultural exchange opportunities are shown in **Figure 7-3**. Demands associated with each property are referenced in the figure by site number and can be seen in **Table 7-10**. For the scenario to be attractive to the agricultural community, it is assumed the volume of groundwater delivered back to the City would be less than the volume of recycled water provided. The City would install and operate a new well pump at the landowner's existing well and a potable water pipeline back to the City's system. Alternatively, a branch from the land owner's existing wellhead and a booster pump station could be installed to feed the potable water line back to the City. If the groundwater is extracted from the upper Morro Valley, the quality may be such that additional treatment (beyond disinfection) is not required.



Sources Cited:
1. Cayucos/Morro Bay Comprehensive Recycled Water Study, Carollo Engineers, 1999.
2. Recycled Water Feasibility Study, Dudek, 2012.
3. Water Reclamation Facility Project Final Options Report, John F. Rickenbach

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Figure 7-3
Alternative 2: Agricultural Exchange

1 inch = 2,500 feet
0 5,000
N

7.5.1 Preliminary Design Assumptions

To evaluate the alternative, this study assumes one to three landowners in the upper Morro Valley will participate. Negotiations and contracts would need to be developed with the individual land owners, but for the purposes of this study, it is assumed that the contracts would outline a two-to-one ratio of recycled water delivered to groundwater returned.

Based on the water quality regulations (CCR Title 22), undisinfected secondary recycled water could be used to irrigate orchards where the edible portion does not contact the recycled water. However, due to the chloride sensitivity of avocado trees, advanced treatment (reverse osmosis) will be needed.

Reverse osmosis systems require a high quality influent to maintain reasonable costs for membrane operation and maintenance. Additionally, one of the WRF Project Community Goals is to produce disinfected tertiary recycled water. Both treatment process trains described in the Draft FMP would provide tertiary disinfected recycled water quality, and adequate treatment for a reverse osmosis system.

For this alternative, a side stream would be treated by the reverse osmosis system and blended back with the tertiary disinfected recycled water to achieve the target TDS and chloride concentrations. The majority of the agricultural irrigation in the Morro Valley is for avocado crops, which are primarily sensitive to chloride concentrations. This study assumes a target chloride concentration goal of less than 80 mg/L. Unfortunately, existing analyses of WWTP effluent do not include chloride analysis, so an estimate of chloride concentration was made by assuming bicarbonate concentration of 350 mg/L, sulfate of 40 mg/L, and hardness of about 200 mg/L (as $CaCO_3$). Using these values and TDS of 942 mg/L, sodium chloride concentration is estimated at 482 mg/L, giving chloride concentration of 258 mg/L. This chloride concentration is consistent with the collection system testing performed in June and July of 2016 as part of the Salinity Source Identification and Control Program, which found average daytime and nighttime chloride concentrations of 172 mg/L and 319 mg/L, respectively. Reverse osmosis (RO) performance projections using this assumed water quality predict permeate chloride concentration of 3.5 mg/L. Mass balance calculations indicate that a blended water TDS concentration of about 300 mg/L will provide the desired chloride concentration of 80 mg/L. This blend consists of about 75 percent RO permeate and 25 percent effluent. With RO recovery of 80 percent and effluent flow of 0.97 MGD, blended irrigation water production will be about 0.79 MGD (**Figure 7-4).**

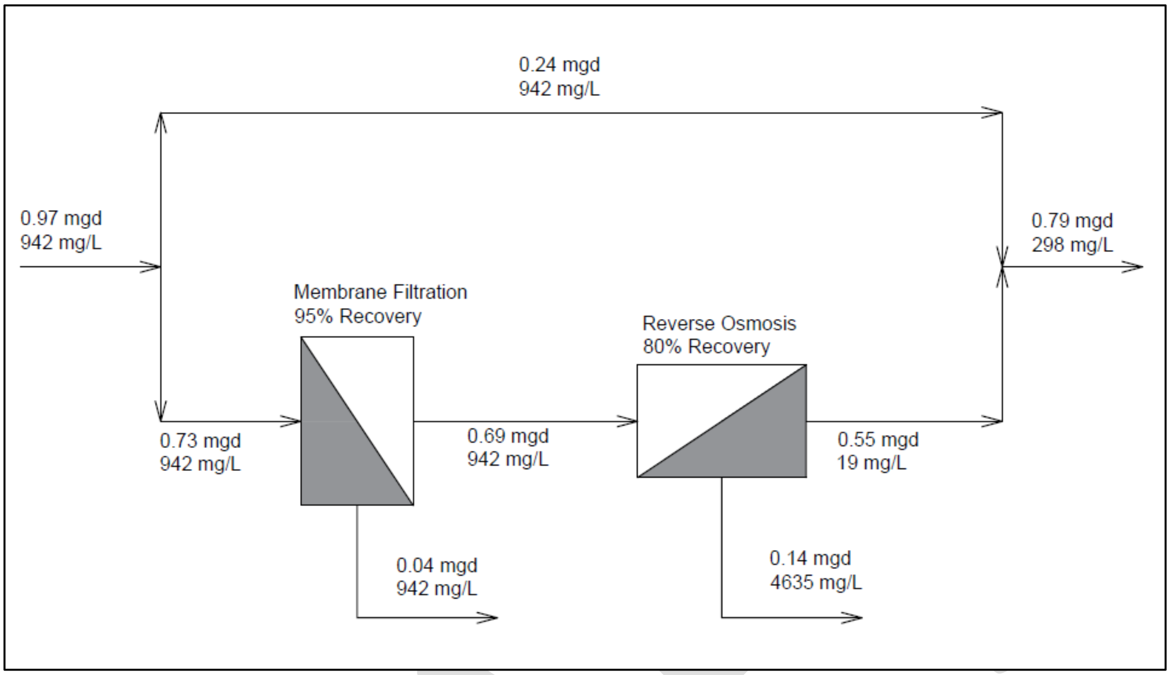

Figure 7-4: Blending Scenario for Alternative 2: Agricultural Exchange

The preliminary design assumptions for Alternative 1 are summarized in **Table 7-9**. A recycled water tank at the WRF is recommended to provide operational storage, which might not be required if the recycled water users are able to provide adequate operational storage. This study assumes a constant delivery rate equal to the average daily flow.

Table 7-9: Alternative 2 Agricultural Exchange Preliminary Design Assumptions	
Advanced Treatment	
Process	Reverse Osmosis
Recycled water quality target	80 mg/L chloride
RO permeate flow rate	385 gpm
RO Influent chloride	258 mg/L
RO permeate chloride	3.5 mg/L
Recycled water flow rate	
Average Day Flow	0.79 MGD
Average Annual Flow	885 AFY
Recycled water pump station	
Estimated Total Dynamic Head (TDH)	Approx. 260 feet TDH
Estimated horsepower	45 HP
Configuration	(2) 50 HP pumps (1 duty, 1 standby)
Recycled water pipeline	
Material	PVC
Diameter	12 inch
Length	28,240 linear feet
Recycled water storage tank volume	500,000 gallons
Potable water pipeline	
Material	PVC
Diameter	8 inch
Length	14,770 linear feet
Average annual potable water supply	442 AFY

7.5.2 Recycled Water Usage

This study assumes one to three large landowners will participate in a program to receive the full amount of recycled water available at a constant rate in exchange for groundwater at a two to one ratio, respectively. Based on the anticipated treated effluent flow rates from the Draft FMP and the water quality requirements for the recycled water, a mass balance was developed as described above, estimating approximately 885 AFY of recycled water will be available. From initial discussions with potential users, the assumed potential water supply benefit to the City is half this amount, 442 AFY.

A preliminary list of potential users and preliminary water demand estimates is included below in **Table 7-10**. Preliminary demand estimates assume 2.5 feet per year per acre of irrigated area. Site numbers correlate with opportunities presented in **Figure 7-3**.

Table 7-10: Anticipated Recycled Water Demands from Agricultural Exchange Users			
Site #	**Size (Acres)**	**Estimated Irrigated Acreage**	**Average Demand Estimate (AFY)**
1	18.1	9.8	24.4
2	33.2	33.2	82.9
3	9.9	8.9	22.3
4	20.0	17.4	43.4
5	19.7	17.0	42.4

Table 7-10: Anticipated Recycled Water Demands from Agricultural Exchange Users			
Site #	Size (Acres)	Estimated Irrigated Acreage	Average Demand Estimate (AFY)
6	1.3	0.4	1.0
7	6.3	4.7	11.9
8	3.4	1.8	4.5
9	19.2	17.6	12.0
10	21.1	20.0	50.0
11	126.7	17.2	43.1
12	17.1	13.5	33.7
13	20.1	18.9	47.2
14	15.7	14.2	35.4
15	7.9	6.4	15.8
16	12.3	3.8	3.7
17	23.3	23.3	58.2
18	349.5	248.1	620.3
19	186.6	56.0	140.0
20	50.6	50.1	125.1
21	38.4	36.4	91.1
22	46.0	34.5	86.2
23	23.6	20.5	51.3
24	11.1	10.0	25.0
25	1.3	1.0	2.6
26	40.0	2.4	6.0
27	19.6	19.2	47.9
28	176.4	7.9	19.8
29	38.6	10.4	26.1
30	10.8	9.7	24.3
31	25.7	7.7	19.3
32	27.0	1.4	3.4
33	12.0	6.9	17.3
34	62.0	58.3	145.8
35	20.1	20.1	50.3
36	29.1	7.9	19.6
37	31.4	12.9	32.1
38	9.8	8.8	22.1
39	5.7	5.2	13.0
40	98.4	37.7	94.2
41	350.9	14.4	30.9
42	12.2	4.0	10.0
53	111.7	29.3	90.0
Note: Demands estimated by owner or by assuming 2.5 feet/year/irrigated acre			

7.5.3 Preliminary Cost Opinion

A preliminary opinion of probable cost was developed for general guidance to the City in preparing a planning-level budget and evaluating alternatives. Assumptions have been included based on the information available and preliminary design criteria described above. **Table 7-11** summarizes the opinion of probable construction cost and annual operating and maintenance costs. Appendix B summarizes the methodology and assumptions used to develop the cost opinion.

Table 7-11: Cost Opinion for Alternative 2 Agricultural Exchange				
Recycled Water Project Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Estimated Cost**
Reverse Osmosis System	1	LS	$1,700,000	$1,700,000
Recycled water pump station	1	LS	$500,000	$500,000
Recycled water pipeline (Open Area)	1.6	MI	$1,452,000	$2,323,200
Recycled water pipeline (Open Area + Trees)	0.3	MI	$1,557,600	$467,300
Recycled water pipeline (Road/City)	3.6	MI	$1,716,000	$6,177,600
Stream crossings (assume 100 ft HDD each)	3	EA	$65,000	$195,000
Potable water pipeline (Road/City)	3.6	MI	$1,584,000	$5,702,400
Storage Tank	500,000	GAL	$2	$1,000,000
			Subtotal Capital Cost	**$18,070,000**
Escalation (2%)				$361,400
Engineering and Administration (30%)				$5,421,000
Project Contingency (25%)				$4,518,000
			Total Capital Cost	**$28,400,000**
Annualized Project Cost (SRF Loan, 3% Interest, 30-year period; A/P = 0.051)				**$1,450,000**
Annual Operation and Maintenance Cost				
Description				**Estimated Cost**
Advanced Treatment O&M				$130,000
Recycled Water Pumping Electricity				$75,000
Repair and Replacement (1% of capital)				$180,700
Staffing				$96,000
Monitoring and Reporting				$30,000
Total Annual O&M Cost				**$511,700**
Anticipated Cost Per Acre-Foot of Water Supply Benefit				
Total Anticipated Annual Cost				$1,961,700
Estimated Water Supply Benefit (AFY)				442

Notes:

1. Cost of groundwater pump or potable water booster station and associated piping, electrical, and instrumentation is not included in this cost opinion. Cost opinion includes the recycled water project only, and does not include costs for the WRF.
2. Cost opinion assumes new potable water pipeline will tie to the City's system east of Hwy 1 and no highway crossing would be required.

7.5.4 Preliminary Alternative Evaluation

This analysis assumes Alternative 2 could utilize the full amount of recycled water available and provide a potable water supply benefit to the City of 442 AFY, approximately half of the recycled water delivered.

When compared to Alternative 1, the capital and estimated annual operating costs are higher. However, the annual cost per acre-foot of potential water supply benefit is much lower than Alternative 1, due to the greater estimated water supply benefit.

Each recycled water customer would require a turnout and a flow meter, and onsite retrofits for cross connection control may be required. Service connections and onsite retrofits vary in size, complexity, and cost. It is assumed the individual landowners will be responsible for compliance with the regulations and associates costs for recycled water usage and systems within their properties. For example, retrofits to existing irrigation systems may be required to ensure compliance with the regulations, which include application at agronomic rates and no runoff or overspray from the property.

The energy use for this alternative is moderate, compared to the other alternatives, with an estimated 70 percent of the effluent requiring advanced treatment and approximately 45 horsepower required for recycled water pumping.

All major above-grade infrastructure for the project will be contained at the WRF site. With regard to infrastructure and potential visual, odor, or noise impacts, compatibility with neighbors is not considered to be significant for this alternative. However, there has been some concern expressed by agricultural landowners in the Morro Valley regarding the potential impact to crop value and private drinking water wells from irrigation with recycled water on adjacent or nearby properties. Title 22 requires no runoff of recycled water from property edges, and a minimum 100-foot setback of recycled water irrigation and recycled water impoundments from any domestic water supply wells. A well survey and Title 22 report would be required to ensure proper setbacks from drinking water wells.

To date, the City has not entered into any agreements with landowners in the Morro Valley to receive recycled water. There is limited interest in utilizing recycled water, and general unwillingness to enter into a contract with the City to reduce pumping or provide groundwater, with the exception of a few Morro Valley landowners who have expressed interest in developing a memorandum of understanding for a mutually beneficial exchange arrangement. To date, discussions with these landowners have been preliminary and the terms have not been negotiated. Any changes to the water quality requirements, amount of recycled water delivered, and/or amount of potable water for the City would affect the cost opinion and assessment. Should the City wish to pursue this alternative, the legal rights associated with the users delivering water outside of their property would need to be explored.

7.6 Project Alternative 3: Indirect Potable Reuse – East

Project Alternative 3: Indirect Potable Reuse – East involves conveying recycled water to four separate injection wells near the Narrows where it will be used to replenish the groundwater basin as shown in **Figure 7-5**. The water will be extracted from existing City wells and treated at the City's existing BWRO treatment facility for potable use. The recycled water pipeline would run along the eastern side of Highway 1 to Bolton Drive, east on Radcliff Avenue, north on Main Street, and West down Errol Street. At this point in time the City has not acquired land or investigated potential right of way acquisition to construct the injection wells and a siting study would be required to identify and evaluate potential injection well locations.

7.6.1 Preliminary Design Assumptions

Title 22 requires any GRRP using subsurface application to treat the recycled water using full advanced treatment. The accepted technology for full advanced treatment is reverse osmosis and an AOP. General injection and recovery well locations were derived using hydraulic modeling, and driven by residence time requirements set by the California DDW As described in **Section 5.5**, residence time credits are granted through evidence of retention through groundwater modeling or pilot testing.

A storage tank of 500,000 gallons was assumed for this alternative to provide operation storage for equipment maintenance or precipitation events which may inhibit the ability to add water to the aquifer. The tank will allow for at least two days of operating volume for two injection wells. The preliminary design assumptions for Alternative 3 are summarized in **Table 7-12**.

Table 7-12: Alternative 3 Indirect Potable Reuse – East Preliminary Design Assumptions	
Advanced Treatment	
Process	Reverse Osmosis and Advanced Oxidation
Average Flow rate	560 gpm
Recycled water flow rate	
Average Day Flow	0.74 MGD
Average Annual Flow	825 AFY
Recycled water pump station	
Estimated Total Dynamic Head (TDH)	Approx. 150 feet TDH
Estimated horsepower	27 HP
Configuration	(2) 30 HP pumps (1 duty, 1 standby)
Recycled water pipeline	
Material	PVC
Diameter	12 inch
Length	15,100 linear feet
Recycled water storage tank volume	500,000 gallons
Number of injection wells	4
Average Injection well capacity	206 AFY
Number of pumping wells	5 (existing City wells)
Travel time between injection and extraction	Approx. 4 months

CITY OF MORRO BAY WATER RECLAMATION FACILITY PROJECT

Sources Cited:
1. Lower Morro Valley Basin Screening Level Groundater Modeling for Injection Feasibility (GSI Water Solutions, Inc. 2016)

mkn WATER - WASTEWATER - REUSE

Master Water Reclamation Plan
Figure 7-5:
Alternative 3: Indirect Potable Reuse - East

1 inch = 2,500 feet

0 5,000

N

7.6.2 Recycled Water Usage

Preliminary hydraulic modeling summarized in the report, "Lower Morro Valley Basin Screening-Level Groundwater Modeling for Injection Feasibility" (Draft January 30, 2017, GSI Water Solutions, Inc.) concluded that an injection and pumping configuration of four new injection wells near the narrows and extraction from five existing City wells could achieve injection of the full volume of recycled water (up to 825 AFY) and could support extraction of 943 AFY. According to the model, total amount of extraction is limited by seawater intrusion. The City's existing wells would not require any updates in order to capture the recycled water. The modeling also concluded that additional wells may be needed depending on how often the injection wells clog. To verify the results of the model and begin permitting discussion with DDW, pilot scale testing is recommended and DDW should be involved in the planning and implementation thereof. Since the residence time demonstrated in the groundwater models was close to the required four months of residence time, permitting would likely not move forward based on the model results alone. Pilot testing will allow the City to refine preliminary assumptions, design criteria, and budgetary cost opinion.

It is assumed that the groundwater extracted from the City wells will be treated at the existing water treatment plant through the BWRO system. Groundwater from the Morro Valley is high in nitrates and TDS. Over time, these concentrations may become lower with the influence of the highly treated recycled water. The BWRO system currently has an efficiency of 80%, with 20% of the product lost as concentrate. In addition to pilot testing, it is recommended that the City perform an assessment of the additional treatment than may be required for the groundwater. It is possible that acceptable quality could be achieved by treating a portion of the groundwater through the BWRO and blending with the rest, thereby reducing the amount of water lost through treatment.

7.6.3 Preliminary Cost Opinion

A preliminary opinion of probable cost was developed for general guidance to the City in preparing a planning-level budget and evaluating alternatives. Assumptions have been included based on the information available and preliminary design criteria described above. **Table 7-13** summarizes the opinion of probable construction cost and annual operating and maintenance costs. **Appendix B** summarizes the methodology and assumptions used to develop the cost opinion.

Table 7-13: Cost Opinion for Alternative 3 Indirect Potable Reuse - East

Recycled Water Project Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Estimated Cost**
Advanced Treatment, RW pump station, and RW pipeline to Quintana (2900 LF)	1	LS	$10,580,755	$10,580,755
Recycled water pipeline (Open Area)	1.3	MI	$1,452,000	$1,887,600
Recycled water pipeline (Open Area + Trees)	0.3	MI	$1,557,600	$467,300
Recycled water pipeline (Road/City)	0.9	MI	$1,716,000	$1,544,400
Stream crossings (assume 100 ft HDD each)	3	EA	$65,000	$195,000
Injection well, piping and appurtenances	4	EA	$210,000	$840,000
Electrical, instruments and controls at injection well	4	EA	$70,000	$280,000
Monitoring well	8	EA	$84,000	$672,000
Storage tank	500,000	GAL	$2	$1,000,000
			Subtotal Capital Cost	**$17,467,055**

Table 7-13: Cost Opinion for Alternative 3 Indirect Potable Reuse - East	
Escalation (2%)	$349,341
Engineering and Administration (30%)	$5,241,000
Project Contingency (25%)	$4,367,000
Total Capital Cost	**$27,500,000**
Annualized Project Cost (SRF Loan, 3% Interest, 30-year period; A/P = 0.051)	**$1,410,000**
Annual Operation and Maintenance Cost	
Description	**Estimated Cost**
Advanced Treatment O&M	$160,000
Recycled Water Pumping Electricity	$30,000
Repair and Replacement (1% of capital)	$174,382
Staffing	$120,000
Monitoring and Reporting	$78,000
Extraction and Treatment ($1000/AF)	$943,000
Total Annual O&M Cost	**$1,510,000**
Anticipated Cost Per Acre Foot of Water Supply Benefit	
Total Anticipated Annual Cost	$2,920,000
Estimated Water Supply Benefit (AFY)	943
Notes: 1. Cost opinion does not include property research, land acquisition, or pilot testing. Cost opinion includes the recycled water project only, and does not include costs for the WRF.	

7.6.4 Preliminary Alternative Evaluation

Alternative 3 would utilize the full amount of recycled water available and provide an estimated potable water supply benefit to the City of 993 AFY. This would be a significant addition to the City's potable water portfolio, representing nearly 90% of the City's potable water demand, based on the 2015 value (1,074 AF). As described in **Section 3**, the City currently participates in the State Water Project (SWP) through a contract with Central California Water Authority (CCWA). With an allocation of 1,313 AFY, take-or-pay stipulations, and unpredictable availability, the annual cost of State Water varies. The City's State Water cost is estimated at $1,600 per AF at full allocation. The cost for 2016/17 fiscal year was $2,100 per AF.

When compared to Alternatives 1 and 2, the capital and estimated annual operating costs are higher. However, the annual cost per acre-foot of potential water supply benefit is lower than the first two alternatives, due to the greater estimated water supply benefit.

Alternative 3 has greater reliability than the first two alternatives due to no additional recycled water customers to coordinate with or contracts to negotiate.

The energy use for this alternative is high compared to the other alternatives, with the full volume of recycled water requiring advanced treatment, although recycled water pumping requirements are relatively low at a motor size of approximately 30 hp.

The major above-grade infrastructure for the project will be contained at the WRF site, with the exception of the injection and monitoring wells. Potential impacts of the injection and monitoring wells are considered minor. The injection wells should require a relatively small site, with some manifold piping, a motorized flow control valve and flow meter, and electrical and controls panels. No pumps or motors will be needed at the wells.

7.7 Project Alternative 4: Indirect Potable Reuse – West

Project Alternative 4: Indirect Potable Reuse - West involves conveying recycled water to 4 separate injection wells near the bike path north of the power plant where it will be used to replenish the groundwater table as shown in **Figure 7-6**. The water will be extracted from existing City wells for treatment at the City BWRO treatment facility. The recycled water pipeline would run along the western side of Highway 1 along Quintana Road to Main Street where it would generally follow the bike path to the injection wells. At this point in time the City has not acquired land or investigated potential right of way acquisition to construct the injection wells and a siting study would be required to identify and evaluate potential injection well locations.

7.7.1 Preliminary Design Assumptions

Title 22 requires any GRRP using subsurface application to treat the recycled water using full advanced treatment. The accepted technology for full advanced treatment is reverse osmosis and an AOP. General injection and recovery well locations were derived using hydraulic modeling, and driven by residence time requirements set by the California DDW. As described in **Section 5.4.5**, residence time credits are granted through evidence of retention through groundwater modeling or pilot testing.

A storage tank of 500,000 gallons was assumed for this alternative to provide operation storage for equipment maintenance or precipitation events which may inhibit the ability to add water to the aquifer. The tank will allow for at least two days of operating volume for two injection wells. The preliminary design assumptions for Alternative 4 are summarized in **Table 7-14**.

Table 7-14: Alternative 4 Indirect Potable Reuse – West Preliminary Design Assumptions

Advanced Treatment	
Process	Reverse Osmosis and Advanced Oxidation
Flow rate	560 gpm
Recycled water flow rate	
Average Day Flow	0.72 MGD
Average Annual Flow	804 AFY
Recycled water pump station	
Estimated Total Dynamic Head (TDH)	Approx. 60 feet TDH
Estimated horsepower	10 HP
Configuration	(2) 15 HP pumps (1 duty, 1 standby)
Recycled water pipeline	
Material	PVC
Diameter	12 inch
Length	15,200 linear feet
Recycled water storage tank volume	500,000 gallons
Number of injection wells	4
Average Injection well capacity	206 AFY
Number of pumping wells	4 (existing City wells)
Travel time between injection and extraction	Approx. 4 months

Sources Cited:
1. Lower Morro Valley Basin Screening Level Groundater Modeling for Injection Feasibility (GSI Water Solutions, Inc. 2016)

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User

mkn WATER - WASTEWATER - REUSE

Master Water Reclamation Plan
Figure 7-6:
Alternative 4: Indirect Potable Reuse - West

1 inch = 2,500 feet
0 5,000
N

7.7.2 Recycled Water Usage

Preliminary hydraulic modeling summarized in the report, “Lower Morro Valley Basin Screening-Level Groundwater Modeling for Injection Feasibility” (Draft January 30, 2017, GSI Water Solutions, Inc.) concluded that an injection and pumping configuration of four new injection wells near the bike path and power plant property and four existing wells pumping could achieve injection of nearly the full volume of recycled water (804 AFY) and could support extraction of 1,119 AFY. The City’s existing wells would not require any updates in order to capture the recycled water. The modeling also concluded that additional wells may be needed depending on how often the injection wells clog.

To verify the results of the model and begin permitting discussion with DDW, pilot scale testing is recommended and DDW be involved in the planning and implementation thereof. Since the residence time demonstrated in the groundwater models was close to the required four months of residence time, permitting would likely not move forward based on the model results alone. Pilot testing will allow the City to refine preliminary assumptions, design criteria, and budgetary cost opinion.

It is assumed that the groundwater extracted from the City wells will be treated at the existing water treatment plant through the BWRO system. Groundwater from the Morro Valley is high in nitrates and TDS. Over time, these concentrations may become lower with the influence of the highly treated recycled water. The BWRO system currently has an efficiency of 80%, with 20% of the product lost as concentrate. In addition to pilot testing, it is recommended that the City perform an assessment of the additional treatment than may be required for the groundwater. It is possible that acceptable quality could be achieved by treated a portion of the groundwater through the BWRO and blending with the rest, thereby reducing the amount of water lost through treatment.

7.7.3 Preliminary Cost Opinion

A preliminary opinion of probable cost was developed for general guidance to the City in preparing a planning-level budget and evaluating alternatives. Assumptions have been included based on the information available and preliminary design criteria described above. **Table 7-15** summarizes the opinion of probable construction cost and annual operating and maintenance costs. **Appendix B** summarizes the methodology and assumptions used to develop the cost opinion.

Table 7-15: Cost Opinion for Alternative 4 Indirect Potable Reuse - West

Recycled Water Project Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total cost**
Advanced Treatment, RW pump station, and RW pipeline to Quintana (2900 LF)	1	LS	$10,580,755	$10,580,755
Recycled water pipeline (Open Area)	0.3	MI	$1,452,000	$435,600
Recycled water pipeline (Open Area + Sidewalks/Trees)	0.6	MI	$1,557,600	$934,600
Recycled water pipeline (Road/City)	1.6	MI	$1,716,000	$2,745,600
Highway crossing (jack and bore)	400	LF	$650	$260,000
Injection Well, piping and appurtenances	4	EA	$210,000	$840,000
Electrical, instruments and controls at injection well	4	EA	$70,000	$280,000
Monitoring Wells	8	EA	$84,000	$672,000
Storage Tank	500,000	GAL	$2	$1,000,000
			Subtotal Capital Cost	**$17,748,555**
Escalation (2%)				$354,171
Engineering and Administration (30%)				$5,325,000

mkn WATER - WASTEWATER - REUSE

Table 7-15: Cost Opinion for Alternative 4 Indirect Potable Reuse - West	
Project Contingency (25%)	$4,438,000
Total Capital Cost	**$27,870,000**
Annualized Project Cost (SRF Loan, 3% Interest, 30-year period; A/P = 0.051)	**$1,430,000**
Annual Operation and Maintenance Cost	
Description	**Estimated Cost**
Advanced Treatment O&M	$160,000
Recycled Water Pumping Electricity	$15,000
Repair and Replacement (1% of capital)	$177,486
Staffing	$120,000
Monitoring and Reporting	$78,000
Extraction and Treatment ($1000/AF)	$1,119,000
Total Annual O&M Cost	**$1,670,000**
Anticipated Cost Per Acre Foot of Water Supply Benefit	
Total Anticipated Annual Cost	$3,100,000
Estimated Water Supply Benefit (AFY)	1119
Notes: 1. Cost opinion does not include property research, land acquisition, or pilot testing. Cost opinion includes the recycled water project only, and does not include costs for the WRF.	

7.7.4 Preliminary Alternative Evaluation

Alternative 4 would utilize the full amount of recycled water available and provide an estimated potable water supply benefit to the City of 1,119 AFY. This would be a significant impact to the City's potable water portfolio, fulfilling all of the City's current potable water demand, based on the 2015 value (1,074 AF). As described in **Section 3,** the City currently participates in the State Water Project (SWP) through a contract with Central California Water Authority (CCWA). With an allocation of 1,313 AFY, take-or-pay stipulations, and unpredictable availability, the annual cost of State Water varies. The City's State Water cost is estimated at $1600 per AF at full allocation. The cost for the 2016/17 fiscal year was $2,100 per AF.

When compared to other alternatives, the capital and estimated annual operating costs are highest. However, the annual cost per acre-foot of potential water supply benefit is lowest, due to the greatest estimated water supply benefit.

Alternative 4 has greater reliability than the first two alternatives due to no additional recycled water customers to coordinate with or contracts to negotiate.

The energy use for this alternative is high compared to the other alternatives, with the full volume of recycled water requiring advanced treatment; though recycled water pumping requirements are the lowest of the three alternatives, at approximately 10 horsepower.

The major above-grade infrastructure for the project will be contained at the WRF site, with the exception of the injection and monitoring wells. Potential impacts of the injection and monitoring wells are considered minor. The injection wells should require a relatively small site, with some manifold piping, a motorized flow control valve and flow meter, and electrical and controls panels. No pumps or motors will be needed at the wells.

7.8 Summary of Project Alternatives

A qualitative comparison of the four recycled water project alternatives is summarized in **Table 7-16** based on the community project goals. Alternative 0 is not included, since it would not provide a recycled water project. **Table 7-17** contains the qualitative ranking with 1 being low and 4 being high.

Table 7-16: Recycled Water Project Qualitative Comparison

Criteria	Alternative 1 Urban Reuse	Alternative 2 Agricultural Exchange	Alternative 3 IPR East	Alternative 4 IPR West
Potential City water supply benefit (AFY)	Limited: 45.4	Half the amount of recycled water available: 442	More than recycled water amount: 943	More than recycled water amount: 1,119
New pipeline length (LF)	19,200	43,000	15,100	15,200
Land acquisition	No additional easements	Several Easements required	Land required for siting new injection wells near the Narrows	Land required for siting new injection wells near power plant property
Reliability	Only interest expressed from golf course; relies on contracts with potential users	Limited interest based on outreach to date; relies on contracts with potential users	City controlled	City controlled

Table 7-17: Comparative Qualitative Ranking

Criteria	Alternative 1 Urban Reuse	Alternative 2 Agricultural Exchange	Alternative 3 IPR East	Alternative 4 IPR West
Potential City water supply benefit	1	2	4	4
Pipeline length	2	1	4	3
Land acquisition	4	3	1	2
Reliability	1	1	3	3
Total	**8**	**7**	**12**	**12**

A summary of the project alternative capital and annual costs and potable water supply benefit is provided in **Table 7-18**. The capital costs include the WRF lift station, pipelines, and treatment facilities, and the recycled water advanced treatment, pump station, storage tank, injections wells, pipelines, engineering and design, and construction contingency. Additional program costs associated with the project are described in **Table 7-19**.

Table 7-18: Summary of Recycled Water Project Alternatives Cost and Water Supply Benefit

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	Urban Reuse	Agricultural Exchange	IPR East	IPR West
Estimated Recycled Water Project Capital Construction Cost	$13,800,000	$28,400,000	$27,500,000	$27,870,000
Annualized Recycled Water Project Cost Payment[1]	$710,000	$1,450,000	$1,410,000	$1,430,000
Estimated Recycled Water Annual O&M Cost	$322,000	$511,700	$1,510,000	$1,670,000
Total Estimated Recycled Water Project Annual Cost	$1,032,000	$1,961,700	$2,920,000	$3,100,000
Estimated Water Supply Benefit (AFY)	45.4 [2]	442	943	1119

Notes:
1) Annualized Project Cost (SRF Loan, 3% Interest, 30-year period; A/P = 0.051)
2) Estimated water supply benefit for Alternative 1 does not include Morro Bay Golf Course and State Park (306 AFY demand) as they currently use a non-potable well.
3) Alternative 0 is not included here, as the estimated capital construction cost for recycled water project would be $0 and there would be no water supply benefit.
4) Estimated Recycled Water Annual O&M Costs and Total Estimated Recycled Water Project Annual Costs for Alternatives 3 and 4 include $1000 per acre-foot (for 943 acre-feet and 1119 acre-feet, respectively) for extraction and treatment of groundwater at the existing water treatment plant.
5) Additional program costs, such as construction management, property acquisition, and demolition of the existing WWTP, are not reflected here. See Table 7-19.

7.9 Conclusions from Project Alternatives Evaluation

The recycled water project alternatives were evaluated based on the community goals for the project. Evaluation criteria include capital cost, operating cost, neighborhood compatibility, reliability, and potential water supply benefit. The following main conclusions can be made:

- The highest water supply benefit would be realized through indirect potable reuse (IPR) (Alternatives 3 and 4). Based on preliminary modeling, it appears Alternative 4 could support the majority, if not all, of the City's current water demand with an estimated water supply benefit of over 1100 AFY. This could significantly reduce or eliminate reliance on imported water.
- The least expensive alternative is no recycled water project (Alternative 0), followed by urban reuse (Alternative 1). Alternative 0 provides no water supply benefit and Alternative 1 provides the least, an estimated 45.4 AFY water supply benefit.
- The capital costs for agricultural exchange (Alternative 2) and IPR (Alternatives 3 and 4) are similar, but IPR has significantly higher water supply benefit if a higher exchange rate is not possible for Alternative 2. Agricultural exchange relies on successful contract negotiations with landowners, adding some uncertainty.

Based on the analyses presented herein, the recommended recycled water project is IPR, Alternative 3 or 4, with the main difference consisting of the locations for injection and extraction wells. The IPR alternative provides the highest potential water supply benefit. Supplementing the potable water supply with highly treated recycled water is the highest form of allowable beneficial reuse, and will allow the City to reduce or eliminate reliance on imported water.

To further refine the project assumptions and costs, the recommended next steps are summarized as follows:

- Rate study update
- Consultation with DDW
- Siting study for injection wells
- Pilot study for injection and extraction
- Groundwater modeling update (after/with pilot study)
- Assessment of groundwater treatment and blending options at existing WTP
- Design of recycled water system, including advanced treatment, injection wells, pumps and pipelines

The City is planning to construct the new WRF within the next five years. If a recycled water project is pursued, there could be significant savings realized by completing the construction at the same time as the WRF. The estimated total program capital costs for Alternatives 0 through 4 are summarized in **Table 7-19**. The total program costs include the total cost for the WRF as presented in the Facility Master Plan; additional estimated program costs including decommissioning of the existing WWTP, property acquisition for the WRF, permitting and environmental mitigation, and construction management; and estimated recycled water project costs as presented earlier in this section.

Alternative 0 (No Recycled Water Project) presents a WRF that produces secondary disinfected effluent which is discharged to the ocean for an estimated total program cost of approximately $124 million. Alternatives 3 and 4, the recommended recycled water project, consists of a WRF and full IPR recycled water program for an estimated total cost of approximately $167 million.

Table 7-19: Comparison of Total Estimated Program Costs					
	Alternative 0	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No Recycled Water Project (Secondary only)	Urban Reuse	Agricultural Exchange	IPR East	IPR West
WRF Capital Costs					
Estimated WRF Capital Construction Cost	$79,350,000	$89,710,000	$89,710,000	$89,710,000	$89,710,000
Engineering/Design (WRF)	$7,730,000	$8,740,000	$8,740,000	$8,740,000	$8,740,000
Procurement (4% WRF)	$3,174,000	$3,588,400	$3,588,400	$3,588,400	$3,588,400
Project Admin & CM (12% WRF)	$9,522,000	$10,765,200	$10,765,200	$10,765,200	$10,765,200
Permitting, monitoring, and mitigation (1% WRF)	$793,500	$897,100	$897,100	$897,100	$897,100
Existing WWTP Demolition	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000
Property Acquisition (WRF)	$300,000	$300,000	$300,000	$300,000	$300,000
Recycled Water Project Capital Costs					
Estimated Recycled Water Project Capital Construction Cost	$0	$8,940,000	$18,440,000	$17,820,000	$18,110,000
Engineering/Admin (RW)	$0	$2,630,000	$5,430,000	$5,250,000	$5,3230,000
Subtotal Program Capital Cost Opinion (rounded)	**$104,200,000**	**$128,900,000**	**$141,700,000**	**$140,400,000**	**$140,700,000**
Construction Contingency	$19,320,000	$24,040,000	$26,370,000	$26,220,000	$26,290,000
Total Program Capital Cost Opinion	**$123,520,000**	**$152,940,000**	**$167,570,000**	**$166,620,000**	**$166,990,000**

Notes:

1) Estimated WRF Capital Construction Cost includes the WRF Project (lift station, pipelines, and treatment plant) without any recycled water components, based on costs presented in the Draft FMP, not including construction contingency or engineering/design, which are shown separately.
2) Cost assumptions for Alternative 0 are based on secondary treatment only, SBR option as described in **Section 7.3**. Alternative 0 does not fulfill the community project goals to produce tertiary disinfected wastewater or to produce reclaimed water.
3) WRF costs for Alternatives 1 – 4 assume the MBR option from the Draft FMP. Based on estimates in the Draft FMP, the total program capital cost opinion for Alternatives 1 – 4 would be approximately $2M less with the SBR option.
4) Construction contingency consists of 25% of construction cost subtotal(s).

7.10 Environmental Considerations

An Environmental Impact Report (EIR) is currently being prepared for the proposed WRF and related actions, including the Master Water Reclamation Plan. The scope of the EIR is based on the Notice of Preparation (NOP) that was publicly distributed on August 8, 2016. In addition, there was a public workshop held on August 16, 2016, to take further input on the scope of the EIR. Because an EIR is being prepared, no Initial Study was required or prepared. Instead, the NOP identifies the following issues areas for comprehensive review in the EIR, consistent with most of the issues included in the CEQA Initial Study Checklist:

- Aesthetics
- Agricultural and Forestry Resources
- Air Quality
- Biological Resources
- Cultural and Paleontological Resources
- Geology, Soils and Seismicity
- Greenhouse Gas Emissions
- Hazards and Hazardous Materials
- Hydrology and Water Quality
- Land Use and Recreation
- Noise
- Population and Housing/Growth Inducement
- Public Services
- Traffic and Transportation
- Utilities and Energy
- Cumulative Impacts

The NOP, included as Appendix D, contains a complete discussion of each of these issues, and how the analysis of each will be framed within the EIR. The Draft EIR is expected to be publicly available in August 2017, with the Final EIR likely to be completed and certified in November 2017.

SECTION 8 CONSTRUCTION FINANCING PLAN AND REVENUE PROGRAM

8.1 Financing Plan Overview

The City plans to fund the WRF and recycled water project through low-cost financing, such as a Clean Water State Revolving Fund (SRF) construction loan, and use sewer enterprise rates to cover the debt service. The City's grant and loan consultant and federal lobbyist are working to investigate and pursue appropriate grant and loan opportunities.

The City has been awarded an SRF Planning Loan for $10.375M and a Recycled Water Feasibility Planning Study grant from SWRCB for $75,000.

A 30-year loan at 3% annual interest rate was assumed in the 2015 Water and Sewer Rate Study (5/25/2015, Bartle Wells Associates). If this were applied to the recommended project ($167M), this would result in debt service of $8,520,000 that would begin one year after construction is completed (June 2022 assuming June 2021 completion).

It should be noted that implementing the recommended project would result in an estimated reduction of $XXXX in State Water Project costs, assuming a supplemental water supply (in addition to Morro Valley Groundwater) is available to provide redundancy.

8.2 Current Sewer Rates and Rate Study Update

The City Council approved a rate increase in May 2015 based on the 2015 Water and Sewer Rate Study. The rates were developed to cover water and sewer operating costs and planned capital improvements, including the WRF project. Based on the preliminary evaluations available at the time, the City anticipated moving forward with design and construction of a $75 million wastewater treatment plant at the Rancho Colina site in the Morro Valley. The assumption was that Cayucos Sanitary District would fund 25% of the costs and the plant would be "reclamation ready," so no advanced treatment or recycled water distribution system was included. The rate study developed 10-year financial projections to evaluate annual revenue requirements and project sewer rate increases.

Proposed rate increases were scheduled over five years, from fiscal year 2015-2016 to 2019-2020. Residential customers pay a fixed monthly charge per dwelling unit with reduced charges for multi-family and condominium dwelling units. Non-residential customers pay a charge based on customer class and metered water consumption, subject to a minimum charge set at the reduced charge per multi-family dwelling unit. The current approved sewer rates, based on the 2015 Water and Sewer Rate Study are presented in **Figure 8-1**.

Sewer Rates/ Effective Dates

	Previous Rate	7/1/2015	7/1/2016	7/1/2017	7/1/2018	7/1/2019
Residential Sewer Rates						
(Fixed monthly charge per residential dwelling unit)						
Single Family	$ 45.59	$ 55.00	$ 62.50	$ 70.00	$ 77.00	$ 83.00
Multiple Family/Condo	$ 45.59	$ 45.59	$ 50.00	$ 56.00	$ 61.60	$ 66.40
Non-Residential Sewer Rates						
(Billed per 100 cubic feet of metered water use ($/hcf))						
Class A- Low Strength	$ 4.63	$ 6.50	$ 7.95	$ 9.37	$ 10.57	$ 11.40
Class B- Domestic Strength	$ 5.82	$ 7.98	$ 9.65	$ 11.29	$ 12.67	$ 13.61
Class C- Moderate Strength	$ 8.03	$ 10.19	$ 11.86	$ 13.50	$ 14.89	$ 15.82
Class D- Mod-High Strength	$ 10.45	$ 12.55	$ 14.18	$ 15.78	$ 17.13	$ 18.03
Class E- High Strength	$ 13.38	$ 15.89	$ 17.84	$ 19.75	$ 21.36	$ 22.46
Minimum Monthly Charge	*$ 51.77*	*$ 45.59*	*$ 50.00*	*$ 56.00*	*$ 61.60*	*$ 66.40*

1 hcf=100 cubic feet=748 gallons

Class A- Low Strength includes schools, laundromats, carwashes, city and public facilities, & water softener accounts

Class B- Domestic Strength includes professional offices, retail stores, mobile home parks, and all other standard-strength commercial accounts.

Class C- Moderate Strength includes motels, retirement homes with dining facilities, and mortuaries.

Class D- Mod-High Strength includes hotels with dining rooms or restaurants, and mixed-use accounts where high-strength sewage accounts for between an estimated 25% to 75% of toal wastewater flow.

Class E- High Strength includes restaurants, bakeries, and seafood processors.

Note: The City reserves the right to estimate wastewater strength and assign customer class.

Figure 8-1 Current Approved Sewer Rates

With the Draft Facility Master Plan and this Master Water Reclamation Plan, refined budgets have been developed for the WRF and recycled water project alternatives, as described in this report. The WRF Project cost is now anticipated to be more than previously assumed (> $75M). Therefore, the current approved rates will not be sufficient to support the project. A rate study update is currently underway to develop financial projections and sewer rate recommendations to support the various WRF Project alternatives. The rate study will review financing alternatives, including bonds, SRF loans, and other financing options. WRF project alternatives will likely include secondary treatment and advanced treatment with IPR. The City will follow the Proposition 218 process before implementing an increase in sewer rates. It is currently anticipated that the draft Rate Study Update analyses will be presented to City Council in April 2017.

Appendix A:
Historical Effluent Wastewater Quality

Appendix A: MBCSD WWTP Historical Effluent Quality

MKN reviewed historical treated effluent quality based on monthly and annual reports available on the California Integrated Water Quality System (CIQWS), presented below in **Table A-1**, **Table A-2**, and **Table A-3**. Since the City is planning on constructing a new WRF, the future effluent quality will be different than historical effluent quality, though some of the characteristics may be considered during NPDES permit negotiations.

Table A-1: 2015 MBCSD WWTP Effluent

Month	BOD5 (mg/L)	TSS (mg/L)	Oil and Grease (mg/L)	Settlable Solids (mL/L)	Turbidity (NTU)	pH (SU)	Ammonia (mg/L as N)	Total Coliform (MPN/100 mL)
January	42.3	25.4	1.4	0.1	28.3	7.5	41	2
February	64.3	32.4	0	0.1	29.7	7.5	38	2
March	45.2	31.8	0	0.1	30.8	7.5	19	2
April	45.8	28.1	1.7	0.1	29.9	7.5	50	2
May	49.3	36	0	0.1	29.3	7.6	49	2
June	52.8	35.7	0	0.1	30.8	7.6	43	6
July	42.2	26	0	0	30.5	7.6	50	2
August	51.3	25.1	0	0.1	28.8	7.5	49	2
September	54	21	1.9	ND	24.8	7.5	45	2
October	42.8	29.9	ND, DNQ	0.1	27.9	7.6	65	2
November	44.8	39.1	ND, DNQ	ND	27.9	7.5	37	2
December	52.6	38.8	ND, DNQ	ND	34.2	7.5	49	2

Notes: All values presented as average monthly, except for Ammonia and Total Coliform which are presented as maximum daily and 30-day median, respectively. ND = Not Detected, DNQ = Detected, Not Quantified

There were very few effluent violations in recent history, all of which were having to do with total chlorine residual exceeding the discharge limit. The first violation in the period examined was in December of 2014, where a faulty sodium bisulfite dosing pump used for dechlorination was malfunctioning. The pump was immediately replaced and the chlorine residual responded accordingly. The second violation was in April of 2015, where the chlorine contact tank was taken offline for repair to ensure safe and reliable future operation. The final and most recent violation was in December of 2015 where the circuit in which the sodium bisulfite pumps were operating on had its circuit breaker tripped by a sump pump operating on the same circuit. The City is pursing isolated and dedicated circuits for the sodium bisulfite pumps in order to avoid future occurrences.

Table A-2: Historical Effluent Quality BOD and TSS Concentrations

	2011		2012		2013		2014		2015	
Month	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)
January	27	17	57	26	44	30	72	30	42	25
February	46	21	58	25	44	29	46	26	64	32
March	44	25	47	23	70	33	44	27	45	32
April	88	30	45	27	48	32	48	37	46	28
May	57	37	64	331	57	37	47	27	49	36

Table A-2: Historical Effluent Quality BOD and TSS Concentrations										
	2011		2012		2013		2014		2015	
Month	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	TSS (mg/L)
June	45	22	60	28	58	26	50	30	53	36
July	52	33	52	26	54	25	52	25	42	26
August	57	32	48	28	52	21	50	28	51	25
September	52	32	40	33	53	28	56	22	54	21
October	45	27	46	32	54	28	48	33	43	30
November	50	24	42	28	59	32	51	38	45	39
December	56	21	42	27	76	36	51	29	53	39
Annual Average	52	27	50	27	56	30	51	29	49	31
NPDES Limit (Average Monthly)	120	70	120	70	120	70	120	70	120	75

The City also performs daily sampling for Chlorine residual, weekly sampling of Oil/Grease, Settlable Solids, and pH, and monthly sampling for ammonia. Chronic Toxicity is tested twice annually and Total Coliforms are sampled 5 consecutive days a week. A wide variety of other chemicals monitored for protection of marine aquatic life and protection of human health, which are specified in the NPDES permit, are analyzed annually and semi-annually.

Table A-3: MBCSD Historical Effluent Data								
Parameter	**Average Monthly Limit**	**Maximum Daily Limit**	**Sampling Frequency**	**2011**	**2012**	**2013**	**2014**	**2015**
Oil & Grease (mg/L)	25	75	Weekly	4	5	4.4	4	1.7
Settlable Solids (mL/L)	1	3	Weekly	0.1	0.1	0.1	0.1	0.1
pH (s.u.)	6-9 at all times		Weekly	7.6	7.6	7.5	7.5	7.5
Chlorine (mg/L)	0.27 [1]	1.07	Daily	<0.05	<0.05	<0.05	<0.05 [3]	<0.05 [3]
Ammonia (as N) (mg/L)	80.4	322	Monthly	<34	<42	<64	<65	<65
Chronic Toxicity (TU)[4]	--	134	2/year	17.9	17.9	31.2	17.9	17.9
Total Coliform (organisms/mL)	30-day median of 23	2,400 MPN/ 100 mL	5 days/ week	<2	<2	<2	<2	<2 [2]
1) Total Chlorine Residual is regulated as a Six-Month Median concentration. 2) Peak running-median value applicable to 30-day median values 3) Levels ND excluding violating discussed in this section. 4) Highest measured toxicity value for each year reported								

Appendix B:

Construction Cost Opinion Notes

Appendix B – Recycled Water Project Alternative Analyses Cost Opinion Assumptions

Costs for various Recycled Water Alternative components were derived using various references including City Consultant studies and reports, previous construction bids, and engineering estimates.

The annualized project cost payments were estimated assuming an SWRCB State Revolving Fund (SRF) loan at 3% interest and a 30-year term (A/P = 0.051) as considered in the City's 2015 Water and Sewer Rate Study.

Advanced Treatment Components – The Draft FMP prepared by Black and Veatch for the City included costs for an advanced water purification facility (AWPF). The WRF costs were broken into two phases: phase one would achieve treatment for tertiary disinfected recycled water and phase two would involve bringing the reverse osmosis and advanced oxidation process online. These Phase 2 advanced treatment component costs from the MBR Option were used for Alternatives 3 and 4, not including escalation, engineering and design, or construction contingency, as these costs are estimated as a percentage of the subtotal capital cost.

Alternatives 1 and 2 are expected to require reverse osmosis systems for a side stream of the effluent to achieve the required water quality. Assumptions for extent of advanced treatment were made based on chloride and TDS removal as described for each alternatives. The cost opinions for the RO systems were based on the following assumptions:

- Two trains are provided. The two trains allow for the option of shutting one train down when influent flows are reduced. Having two trains also allows the plant to continue producing water when one train is taken out of service for cleaning or maintenance.
- Each of the two trains is equipped with cartridge filter, feed pump, membrane array, and associated piping, valves, controls, and instrumentation.
- No carbon dioxide stripping tower is included. Blending the permeate with the high-alkalinity influent stream provides sufficient buffering that CO2 stripping is not required.
- Building cost is not included. It is assumed that the RO equipment is installed in an existing building. It could also be installed outdoors.
- Clean-in-place (CIP) and scale inhibitor feed and storage facilities are included.
- The RO system will require a space of about 20 feet by 30 feet.

Considering these assumptions and the expected capacities of the treatment systems, the expected installed cost of the RO treatment equipment is about $3.50 per gallon-per-day of permeate capacity.

Conveyance Facilities – Recycled water pipeline construction costs are based on 12 inch diameter, PVC pipeline, approximately 3 feet below grade. Costs are divided by terrain sections, "Open Area", "Open Area with Sidewalk or Trees", or "Road/City Area". The cost for the installed pipeline was estimated as $275 per linear foot (LF) for open area, $295 per LF for open areas with trees or sidewalks, and $325 per LF for road areas.

Costs for injection wells and necessary monitoring equipment were derived from recent bid responses and construction cost opinions for similar systems.

Operation and Maintenance – The Draft FMP included an appendix on operation and maintenance costs for the WRF. Since all alternatives would achieve tertiary disinfected recycled water, that was considered the baseline cost. Additional operation and maintenance costs including chemical, power, and repair and replacement were included in cost ranges provided in the Draft FMP. The cost ranges were based on the percentage of total flow going through the AWPF. Planning level estimates of 15%, 75%, and 100% were assumed for urban irrigation, agricultural irrigation, and IPR. The Draft FMP provided a range of estimated costs for both recommended WRF treatment processes (sequencing batch reactor and membrane biofiltration). For purposes of this study, the highest range for the more expensive option (membrane biofiltration) was chosen and the baseline WRF estimated annual operating cost was subtracted to provide an estimated annual operating cost for the advanced treatment.

Staffing costs were estimated based on extent of anticipated man-hour requirements for each alternative. IPR alternatives were considered to have higher staffing needs as they require more extensive monitoring and reporting as well as have more mechanical equipment requiring maintenance and upkeep.

Monitoring and reporting costs were estimated based on the end application of recycled water. Since water delivered for agricultural exchange would not come in contact with the general public, the monitoring and reporting comments were considered less than for the other alternatives. Monitoring and reporting requirements may require a greater effort for urban irrigation due to the higher number of potential recycled water users, and the IPR alternatives will require the greatest monitoring and reporting effort.

Appendix C:

Draft Technical Memorandum: Morro Bay New Water Reclamation Facility – Water Reuse Opportunities (MKN, 2014)

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TECHNICAL MEMORANDUM

To: John Rickenbach

From: Michael Nunley

Date: 5/8/2014

Re: Morro Bay New Water Reclamation Facility – Water Reuse Opportunities

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INTRODUCTION

Michael K. Nunley & Associates, Inc., and John F. Rickenbach Consulting (JFR) are providing project management support for the City of Morro Bay's new Water Reclamation Facility (WRF). One of the City Council's goals for the new WRF is production of recycled water. The purpose of this memorandum is to identify the potential water reuse opportunities and demands from prior City reports, develop a comprehensive map of the previously-identified potential reuse areas, and provide a summary of the general water quality requirements for these various uses.

MKN reviewed previous recycled water studies for the City of Morro Bay (City) and Cayucos Sanitary District (CSD) Wastewater Treatment Plant (WWTP), including

- Cayucos/Morro Bay Comprehensive Recycled Water Study, Carollo Engineers, October 1999
- 2012 Recycled Water Feasibility Study, Dudek, Draft March 9, 2012

These reports investigated the feasibility of implementing a recycled water program. Both studies included identification of potential water reuse opportunities in the Cayucos and Morro Bay areas and review of the water demands and water quality requirements.

The cost of a recycled water system can vary significantly. The treatment processes, pumping stations, pipelines, and storage facilities depend on the end user or final destination of the recycled water. Depending on the usage type(s), different regulatory requirements will apply. The water quality required for various individual users may result in the need for a higher level of treatment than would be required to meet the regulations. For example, if irrigation of avocados is a significant reuse opportunity salts removal may be required.

RECYCLED WATER QUALITY REGULATIONS AND GOALS

The California Code of Regulations (CCR) Title 22, Division 4, Chapter 3, Sections 60301 through 60355 regulate recycled wastewater and requirements are administered jointly by California Department of Health Services (CDHS) and RWQCB.

Four treatment levels are defined in the regulations for various recycled water uses in California: disinfected tertiary recycled water, disinfected secondary-2.2 recycled water, disinfected secondary-23 recycled water and undisinfected secondary recycled water. These are summarized in Table 1.

Table 1 – Title 22 Recycled Water Types and Allowable Uses (California Code of Regulations)

Recycled Water Type	Required Treatment	Median Total Coliform (MPN/100 mL)[1]	Maximum Total Coliform (MPN/100 mL)[2]	Allowable Uses
Disinfected Tertiary	Oxidized, Coagulated[3], Filtered, Disinfected	2.2	23[4]	Surface irrigation for food crops including edible portion, parks and playgrounds, schoolyards, unrestricted access golf courses, roadway landscaping, and residential & commercial landscaping
Disinfected Secondary-2.2	Oxidized, Disinfected	2.2	23	Irrigation of food crops where edible portion is above ground and not contacted by recycled water (ex. drip irrigation is used)
Disinfected Secondary-23	Oxidized, Disinfected	23	240	Irrigation of cemeteries, freeway landscaping, restricted access golf courses, pasture for milk animals
Undisinfected Secondary	Oxidized	NA	NA	Irrigation for orchards & vineyards where edible portion does not contact recycled water (ex. drip irrigation is used), non-food bearing trees, fodder crops and fiber crops, seed crops not eaten by humans, ornamental nursery stock

Notes:

1. Based on bacteriological results of the last 7 days for which analyses were completed.
2. Does not exceed in more than one sample in any 30 day period
3. Coagulation is not typically required if membrane filtration is used and/or turbidity requirements are met.
4. No sample shall exceed 240 MPN/100 mL.
5. Reference: California Code of Regulations, Title 22, Division 4, June 2001 Edition

Water quality objectives vary for different uses. Water quality for unrestricted urban use (ex. irrigation of parks are schools) is primarily driven by public safety and suitability for application. Safety assurances are written into Title 22 requirements through standards for effluent coliform concentrations and usage restrictions, such as pipeline distance from potable water pipelines, proximity to groundwater, prevention of cross-connection between potable and non-potable systems, and restrictions near eating facilities and drinking fountains. Potential customers may need to reconfigure either irrigation or potable water systems in order to comply with these requirements.

There have been multiple studies to determine constituents of concern in reclaimed water used for irrigation. Suitability of water for irrigation is directly related to the concentration and kind of chemical constituents present. Some water constituents that most commonly affect recycled water suitability for irrigation include electrical conductivity of the irrigation water (ECw), sodium adsorption ratio (SAR), bicarbonates, chlorides, and boron. General irrigation water quality guidelines are shown on Table 2. A summary of the treated effluent quality from the existing Morro Bay / Cayucos CSD

Wastewater Treatment Facility (WWTF) is presented in Table 3. It is assumed the mineral content of the new WRF will resemble that of the existing treatment facility since a higher level of secondary and tertiary treatment will have a negligible impact on those parameters. Relative salt tolerance of various agricultural crops is presented in Table 4.

Table 2 - Water Quality Guidelines for Irrigation

Problem and Related Constituent	References	No Problem	Increasing Problems	Severe Problems
Salinity[1]				
EC_w of irrigation water (mmhos/cm)	1,2	<0.75	0.75 - 3.0	>3.0
TDS (mg/l) or (ppm)	2	<450	450 - 2000	>2000
Permeability				
EC_w of irrigation water (mmhos/cm)	1	>0.5	<0.5	<0.2
adj.SAR[2]	1	<6.0	6.0 - 9.0	>9.0
Specific ion toxicity from root absorption[3]				
Sodium (evaluated by adj.SAR)	1,2	<3.0	3.0 - 9.0	>9.0[4]
Chloride (meq/l)	1	<4	4.0 - 10.0	>10
Chloride (mg/l)	1,2	<142	142 - 355	>355
Boron (mg/l)	1	<0.5	0.5 - 2.0	2.0 - 10.0
Specific ion toxicity from foliar absorption[5] (sprinkler irrigation)				
Sodium (meq/l)	1	<3.0	>3.0	--
Sodium (mg/l)	1,2	<69	>69	--
Chloride (meq/l)	1	<3.0	>3.0	--
Chloride (mg/l)	1	<106	>106	--
Miscellaneous[6]				
Total Nitrogen (NH_4-N + NO_3-N) (mg/l)	1,2	<5	5 - 30	>30
(The following apply only for irrigation by overhead sprinklers)				
Bicarbonate (HCO_3) (meq/l)	1	1.5	1.5 - 8.5	>8.5
Bicarbonate (HCO_3) (mg/l)	1,2	<90	90 - 520	>520
Residual Chlorine (mg/l)	2	<1.0	1.0 - 5.0	>5.0
PH	1,2	Normal range = 6.5-8.4		

[1]Assumes water for crop plus needed water for leaching requirement will be applied. Crops vary in tolerance to salinity.
[2]adj.SAR (adjusted sodium absorption ratio) is calculated form a modified equation developed by U.S. Salinity Laboratory to include added effects of precipitation or dissolution of calcium in soils and related to CO_3 + HCO_3 concentrations. Permeability problems related to low EC or high adj.SAR of water can be reduced if necessary by adding gypsum.
[3]Most tree crops and woody ornamentals are sensitive to sodium and chloride. Most annual crops are not sensitive.
[4]Shrinking-swelling type soils (montmorillonite type clay minerals); higher values apply for others.
[5]Leaf areas wet by sprinklers may show a leaf burn due to sodium or chloride absorption under low-humidity / high-evaporation conditions. (Evaporation increases ion concentration in water films on leaves between rotations of sprinkler heads.)
[6]Excess N may affect production of quality of certain crops (i.e., sugar beets, citrus, avocados, apricots, and grapes). HCO_3 with overhead sprinkler irrigation may cause a white carbonate deposit to form on fruit and leaves.
Reference 1: Ayers, Robert S., Quality of Water for Irrigation, Journal of the Irrigation and Drainage Division, ASCE, June 1977. (Table 1, page 136)
Reference 2: Irrigation with Reclaimed Municipal Wastewater – A Guidance Manual, California State Water Resources Control Board, Report Number 84-1 WR, July 1984. (Table 3-4, page 3-11)

Note: Interpretations are based on possible effects of constituents on crops, soils or both. Guidelines are flexible and should be modified when warranted by local experience or special conditions of crop, soil, and method of irrigation.

Table 3 Existing Morro Bay /Cayucos CSD WWTF Effluent Quality

Constituent	Units	1999 Effluent Quality[1]	2011/2012 Effluent Quality[2]	Comparison to Quality Guidelines presented in Table 2[3]
Bicarbonate	mg/L	294	330	Increasing problems for carbonate deposits on fruit and leaves
Boron	mg/L	0.5	0.4	Low end of increasing problems for salinity
Chloride	mg/L	300	369	Increasing problems for root and foliar absorption
Total Nitrogen	mg/L	36.7	37.5	Potential for severe quality production problems for certain crops, including citrus, avocados, apricots, and grapes.
pH	--	7.6	NA	Within normal range
TDS	mg/L	887	942	Increasing problems for salinity
EC	mmhos/cm	1.7	NA	Increasing problems for salinity; no problems for permeability
Sodium	mg/L	210	223	Increasing problems for foliar absorption

NA = Data not available
1 Averages based on data collected July 8 through 15, 1999 (Carollo Engineers, 1999)
2 Data was obtained from lab results from six 24-hour composite samples taken between February 8, 2012 and February 14, 2012. Tests were conducted by FGL Environmental and Agricultural Analytical Chemists. (Dudek, 2012)
3 Crops vary in tolerance to the constituents above in Table 3. Table 2 summarizes general irrigation water guidelines as published by the quoted references. Care should be taken in interpretation and application of this data.

Electric Conductivity/TDS

Salinity can be indirectly measured by electrical conductivity. The units of conductance are typically decisiemens per meter (dS/m), which is equivalent to millimhos per centimeter (mmhos/cm). Multiple devices and protocols exist for the monitoring/measuring of electrical conductivity, including in-office and in-field measurements.

EC_w is the electrical conductivity of the irrigation water. It is a measure of the total salt content of the irrigation water and is used to quantify its salinity. The existing WWTP effluent salinity (measured as EC) is within the "Increasing Problems" range as shown in Table 2. Salts reduction measures or intensive irrigation management may be required in order to control soil salinity levels. Adequate rainfall can assist the salt leaching process and help to mitigate the accumulation of soluble salts in the soil profile.

Sodium Adsorption Ratio

The sodium adsorption ratio (SAR) is the most reliable index of sodium hazard to crops and soils. A moderately high SAR will not generally result in a toxic effect to most plants. However, some crops are sensitive to excess sodium. Foliar toxicity may exist due to elevated sodium concentrations but it is site- and crop-specific.

A reduction in soil permeability is a major problem that occurs with high-sodium irrigation water. Applying water with an SAR below 6 does not usually result in permeability problems. If the SAR is between 6 and 9, permeability problems can occur on fine-textured soils. An SAR above 9 will likely result in permeability problems on all mineral soils except coarse, sandy soils.

Bicarbonates and Adjusted Sodium Adsorption Ratio (SAR_{adj})

Bicarbonates in irrigation water applied to the soil will precipitate calcium from the cation exchange complex as relatively insoluble calcium carbonate. As exchangeable calcium is lost from the soil, the relative proportion of sodium is increased with a corresponding increase in the sodium hazard (SAR). Bicarbonates in the irrigation water contribute to the overall salinity, but, more importantly, they may result in a previously calcium-dominant soil becoming sodium dominant by precipitating the exchangeable calcium, which, in turn, will reduce soil permeability.

A measure of the bicarbonate hazard in irrigation water can be expressed as the adjusted SAR (Table 2). The adjusted SAR takes into account the concentration of bicarbonates in irrigation water in relation to their effect on potential increases in soil SAR. When the adjusted SAR is less than 6, soil permeability problems generally do not occur. If the adjusted SAR is between 6 and 9, permeability problems can occur on fine-textured soil. An adjusted SAR above 9 will likely result in permeability problems in mineral soils except course, sandy soils, where adverse impacts to soil permeability are not a major concern. Periodic soil treatment (i.e. deep ripping or disking) or water treatment may be required to maintain favorable water infiltration characteristics in project soils.

Bicarbonates in irrigation water may also cause potential problems in micro-irrigation systems as a result of lime precipitation, which can cause emitter plugging. These potential problems are accentuated in alkaline irrigation water.

Chlorides

Chlorides are necessary for plant growth in relatively small amounts. However, high concentrations of chlorides can inhibit growth and result in toxicity to foliage if applied by sprinkler irrigation. Chlorides in irrigation water are toxic to some plant species. The chloride concentration of the existing treatment plant effluent (see Table 3) is within the range of increasing problems for root and foliar absorption when compared to the guidelines in Table 2. If a sprinkler wets the leaf areas, foliage toxicity (leaf burn) problems may also be apparent as a result of the effluent having a slightly higher-than-desired chloride concentration level (Table 2).

Boron

Boron in irrigation water does not have an effect on soil physical conditions, but in high concentrations it can have a toxic effect on some plants. The boron concentration of the existing treatment plant effluent (see Table 3) is at the low end of increasing problems for salinity when compared to the guidelines in Table 2.

Table 4 Relative Salt Tolerance of Agricultural Crops

Crop Type	TOLERANT	MODERATELY TOLERANT	MODERATELY SENSITIVE	SENSITIVE
Fibre, Seed and Sugar Crops	Barley, Cotton, Jojoba, Sugarbeet	Cowpea, Oats, Rye, Safflower, Sorghum, Soybean, Triticale, Wheat, Durum Wheat	Broad, Castorbean, Maize, Flax, Millet (foxtail), Groundnut/Peanut, Rice (paddy), Sugarcane, Sunflower	Bean, Guayule, Sesame
Grasses and Forage Crops	Alkali grass (Nuttall), Alkali sacaton, Bermuda grass, Kallar grass, Saltgrass (Desert), Wheatgrass (fairway crested) Wheatgrass (tall), Wildrye (altai), Wildrye (Russian)	Barley (forage), Brome (mountain), Canary grass (reed), Clover (hubam), Clover (Sweet), Fescue (meadow), Fescue (tall), Harding grass, Panic grass (blue), Rape, Rescue grass, Rhodes grass, Ryegrass (italian), Ryegrass (perennial), Sudan grass, Trefoil (narrowleaf), birdsfooot, Trefoil, broadleaf, Wheat (forage), Wheatgrass (various), Wildrye (beardless & Canadian)	Alfalfa, Bentgrass, Bluestem (Angleton), Brome (smooth), Buffelgrass, Burnet, Clover (various), Corn (forage), Cowpea (forage), Dallis grass, Foxtail (meadow), Grama (blue), Lovegrass, Milkvetch (Cicer), Oatgrass (tall), Oats (forage), Orchard grass, Rye (forage), Sesbania, Siratro, Sphaerophysa, Timothy, Trefoil (big), Vetch (common)	
Vegetable Crops	Asparagus	Artichoke, Beet (red), Zucchini squash	Broccoli, Brussels sprouts, Cabbage, Cauliflower, Celery, Corn (Sweet), Cucumber, Eggplant, Kale, Kohlrabi, Lettuce, Muskmelon, Pepper, Potato, Pumpkin, Radish, Spinach, Squash (scallop), Sweet potato, Tomato, Turnip, Watermelon	Bean, Carrot, Okra, Onion, Parsnip

Crop Type	TOLERANT	MODERATELY TOLERANT	MODERATELY SENSITIVE	SENSITIVE
Fruit and Nut Crops	Date palm	Fig, Jujube, Olive, Papaya, Pineapple, Pomegranate	Grape	Almond, Apple, Apricot, Avocado, Blackberry, Boysenberry, Cherimoya, Cherry (sweet), Cherry (sand), Currant, Gooseberry, Grapefruit, Lemon, Lime, Loquat, Mango, Orange, Passion fruit, Peach, Pear, Persimmon, Plum (prune), Pummelo, Rose apple, Sapote (white), Strawberry, Tangerine

1 Reproduction of table presented in Water Quality for Agriculture FAO Irrigation and Drainage Paper 29 Rev 1 (Ayers and Westcot, Reprinted 1989 and 1994). Data taken from: Maas E.V. 1984 Salt tolerance of plants. In: The Handbook of Plant Science in Agriculture. B.R. Christie (ed). CRC Press, Boca Raton, Florida.
2 These data serve only as a guide to the relative tolerance among crops. Absolute tolerances vary with climate, soil conditions and cultural practices.

STREAM AUGMENTATION QUALITY REGULATIONS AND GOALS

While the water quality requirements and goals for landscape and agricultural irrigation are relatively well defined, the potential requirements for stream augmentation can be difficult to predict. Surface water discharges are regulated through the State Water Resources Control Board's (SWRCB) National Pollutant Discharge Elimination System (NPDES) based on protection of existing and potential future beneficial uses as defined in the Regional Water Quality Control Board (RWQCB) Basin Plan. The Basin Plan is an ever-changing document with amendments made yearly and updates (at a minimum every three years) required through the Clean Water Act and California Water Code. The implementation of Salt and Nutrient Management Plans (SNMPs) is expected to further update water quality requirements for sub-basins. The City has applied for a grant to prepare a SNMP through the San Luis Obispo County's Integrated Water Resources Management Plan.

The permit for the California Men's Colony (CMC) wastewater treatment plant (WWTP) was updated in 2012, and was reviewed to provide insight on recent requirements for discharge to Chorro Creek. The CMC WWTP produces recycled water for the Dairy Creek Golf Course and discharges to Chorro Creek. Effluent limitations include organics, solids, oil and grease, chlorine residual, toxics, and nitrogen compounds. The permit includes limitations for the receiving water (Chorro Creek), which requires monitoring stations upstream and downstream of the discharge point. Receiving water limitations for several parameters are set based on amounts or concentrations that causes a nuisance or adversely affects beneficial uses. Some of the parameters include coloration, taste or odor-producing substances, floating material, suspended material, settleable material, oils, greases, waxes, biostimulatory substances, suspended sediment, toxic metals and inorganic chemicals. The permit specifies limits for changes in turbidity, pH, and temperature based on the natural levels in the receiving water, and dissolved oxygen concentrations shall not be reduced below 7.0 mg/L at any time. There are also limitations regarding salinity based on agricultural beneficial uses and water quality objectives defined for Chorro Creek in the Basin Plan. In addition to influent and effluent monitoring, CMC monitors five points along Chorro Creek, from just downstream of the reservoir dam to just upstream of the discharge into Morro Bay Estuary.

RECYCLED WATER OPPORTUNITIES

The previously identified potential water reuse opportunities are compiled in Table 5 (attached). Irrigated agricultural parcels and other potential reuse opportunities in the Morro Valley and Chorro Valley, not identified in prior studies, were identified as summarized in Table 6 (attached). Additional opportunities may become available in the future as growth occurs and land uses change. The potential reuse sites are shown with potential new WRF sites in Figure 1 (attached).

The majority of crops in the Morro Valley region are avocado, with some limited orange groves, all of which are sensitive to salts. Dilution by blending with a water source of lower salinity or salts reduction through microfiltration and reverse osmosis will likely be required to provide the appropriate quality of water for irrigation of these salt-sensitive crops. The Recycled Water Feasibility Study estimated a TDS target of 300 mg/L based on the recorded chloride tolerance for the most sensitive avocado variety (Dudek, 2012).

Assuming the new WRF were designed to produce disinfected tertiary recycled water with a TDS concentration of less than 300 mg/L and a future maximum monthly flow rate of 2.2 million gallons per day (MGD), the advanced treatment system (including microfiltration and reverse osmosis) should be sized to treat approximately 90% of the flow (1.9 MGD)[1]. Due to the cost of advanced treatment, it's common to design these systems to treat a portion of the secondary effluent and subsequently blend it back to achieve the desired water quality in the final effluent. At approximately $7 for every gallon per day of capacity (Dudek, 2012), an advanced treatment system of this size is estimated to cost over $13,000,000[2]. This scenario has a production efficiency of approximately 75% and on an annual basis would be estimated to produce approximately 0.85 MGD, or 949 AFY, of disinfected tertiary recycled water.

[1] Assumes TDS concentration of 1106 mg/L in the secondary effluent, 90% efficiency for tertiary filtration system, 92% efficiency for microfiltration system, and 70% efficiency and 90% removal for the reverse osmosis system.

[2] Cost estimate includes microfiltration and reverse osmosis systems only. The upcoming City's Master Planning effort will develop costs for the rest of the treatment system, lift stations, transmission mains, and other project elements to assess costs for the overall project and ultimately the community's rates. The Master Plan will also identify the costs and revenue potential associated with production of recycled water.

Table 5. Water Reuse Opportunities Identified for Morro Bay / Cayucos CSD WWTP in Prior Studies

Site #	Use Type	Irrigation Type / Potential Benefit for Creek Aug	Site Description	Size (Acres)	Location	Treatment Level Required to Meet Regulations	Salt Removal or Blending Required	Effluent TDS Target (mg/L)	Current Water Source	Average Demand Estimate (AFY)	Comments
0	Industrial		WWTP Onsite/Maintenance Yard	--	Morro Bay	Disinfected Secondary-23	No		State Water	1.46	
1	Landscape	Grass	Hardie Park & School	1	Cayucos	Disinfected tertiary	No		Untreated Well	1.9	Already has reliable non-potable water
2	Ag	Oranges, snow peas, avocados, pasture	Cayucos Creek Road	--	Cayucos	Disinfected tertiary	Yes	300	Wells	N/A	Multiple small parcels; acreage & demand unknown; uncertainty of multiple owner interest. Irrigation type may impact treatment level requirement. See Note 1.
3	Landscape	Grass	Paul Andrew Park	0.25	Cayucos	Disinfected tertiary	No		Domestic Water Supply	1.29	
4	Ag	Grass/Hill	S/W of Whale Rock Reservoir	5	Cayucos	Undisinfected secondary	No		Private Well	12.5	Acreage/demand unknown; uncertainty of multiple owner interest
5	Landscape	Grass	Cayucos-Morro Bay Cemetary	4	Cayucos	Disinfected Secondary-23	No		Whale Rock Reservoir	17.7	
6	Ag	Oranges, avocados	Old Creek Road	100-300	Cayucos	Disinfected tertiary	Yes	300	Creek Before Reservoir	500	Acreage/demand unknown; uncertainty of multiple owner interest. Irrigation type may impact treatment level requirement. See Note 1.
7	Landscape	Grass/landscape	Highway 1 median	2	Cayucos	Disinfected Secondary-23	Unknown		No Current Source	5	Does not currently irrigate
8	Ag	Winter Wheat, grass	Toro Creek Road	200-400	Cayucos	Undisinfected secondary	No		Unknown	N/A	Acreage/demand unknown; uncertainty of multiple owner interest
9	Landscape	Grass	Del Mar Park	9	Morro Bay	Disinfected tertiary	No		State Water	8.68	
10	Landscape	Grass, LS medians	The Cloisters Development	34	Morro Bay	Disinfected tertiary	No		State Water	5.98	
11	Landscape, Ag	Grass, horticulture, farm animals	Morro Bay High School	14	Morro Bay	Disinfected tertiary	Unknown		State Water, Untreated Private Well	61.78	
12	Landscape	Grass	Keiser Park	9	Morro Bay	Disinfected tertiary	No		State Water, Untreated Private Well	6.21	
13	Ag	Fields, Orchards (mainly avocado), Crops	Atascadero Rd. East of Hwy 1 (aka Hwy 41 Agricultural Corridor)	200	Unincorporated County of SLO	Disinfected tertiary	Yes	300	Private Well	500	Irrigation type may impact treatment level requirement. See Note 1.
14	Landscape	Pasture	Miscellaneous Pasture Area	10	Morro Bay	Disinfected Secondary-23	No		No Current Source	25	Does not currently irrigate
15	Landscape	Grass/landscape	Del Mar Elementary	6	Morro Bay	Disinfected tertiary	Unknown		State Water	6.97	
16	Landscape	Grass/landscape	S Side of Highway 1	4	Morro Bay	Disinfected Secondary-23	Unknown		No Current Source	10	Does not currently irrigate
17	Landscape	Grass/landscape	Morro Bay Elementary School	4	Morro Bay	Disinfected tertiary	Unknown		State Water	4.46	
18	Landscape	Grass/landscape	City Park	0.8	Morro Bay	Disinfected tertiary	Unknown		State Water	1.05	
19	Landscape	Grass	Monte Young Park	0.25	Morro Bay	Disinfected tertiary	No		State Water	0.43	
20	Landscape	Grass/landscape	Bayshore Bluffs Park	3	Morro Bay	Disinfected tertiary	Unknown		State Water	1.12	On outskirts of service area, may be considered for secong phase
21	Landscape	Grass/Greens	Morro Bay Golf Course	110	Morro Bay	Disinfected Secondary-23	No		Chorro Creek, Recycled Water from CMC	275	Already has reliable non-potable water
22	Ag	Native	Chorro Flats Enhancement Project	45	Morro Bay	Disinfected Secondary-23	No		No Current Source	0	Lack of project need - "Dry farming"
23	Creek Aug	Ag Crops, Riparian Habitat	Cayucos Creek	--	Cayucos	Disinfected tertiary +	Unknown				Significant treatment likely required, unstable road, may be economically infeasible
24	Creek Aug	Possible Potable Offset	Old Creek		Cayucos	Disinfected tertiary +	Unknown				Significant treatment likely required, may be economically infeasible
25	Creek Aug	Ag Crops, Riparian Habitat	Willow Creek		Morro Bay	Disinfected tertiary +	Unknown				Significant treatment likely required, unstable road, may be economically infeasible
26	Creek Aug	Riparian Habitat	Toro Creek		Morro Bay	Disinfected tertiary +	Unknown				Not seen as having primary benefit for flow enhancement or potable water supply replacement

Table 5. Water Reuse Opportunities Identified for Morro Bay / Cayucos CSD WWTP in Prior Studies

Site #	Use Type	Irrigation Type / Potential Benefit for Creek Aug	Site Description	Size (Acres)	Location	Treatment Level Required to Meet Regulations	Salt Removal or Blending Required	Effluent TDS Target (mg/L)	Current Water Source	Average Demand Estimate (AFY)	Comments
27	Creek Aug		Alva Paul Creek		Morro Bay	Disinfected tertiary +	Unknown				Determined nonbeneficial because of no flow for majority of the year
28	Creek Aug	Ag Crops, Riparian Habitat	Morro Creek		Morro Bay	Disinfected tertiary +	Unknown				Not seen as having primary benefit for flow enhancement or potable water supply replacement
29	Creek Aug	Ag Crops, Riparian Habitat	Little Morro Creek		Morro Bay	Disinfected tertiary +	Unknown				Significant treatment likely required, may be economically infeasible
30	Creek Aug	Wetlands	Morro Bay Estuary		Morro Bay	Disinfected tertiary +	Unknown				Significant treatment likely required, may be economically infeasible
31	Creek Aug	Municipal Supply, Estuary, Irrigation, CRL Frogs, fish	Chorro Creek		Morro Bay	Disinfected tertiary +	Unknown				Significant treatment likely required, may be economically infeasible
32	Other: Bus Facility		Morro Bay High School Bus Facility		Morro Bay	Disinfected Secondary-23	No		State Water	3.5	
33	Other: Commercial Laundry		Mission Linen Supply (Commercial Laundry)		Morro Bay	Disinfected tertiary	Unknown		State Water	13.93	
34	Other: Nursery		Newton (Tropicana) Nursery		Morro Bay	Disinfected Secondary-23	Yes		State Water	0.64	
35	Other: Boat Dock		Morro Bay Fuel Dock		Morro Bay	Disinfected tertiary	No		State Water	0.18	Water use minimal, far from other users
36	Other: wash down, sewer flushing		City of Morro Bay Maintenance Yard		Morro Bay	Disinfected Secondary-23	No		State Water	0.3	
37	Other: Cart washing		Morro Bay State Park/Golf Course		Morro Bay	Disinfected tertiary	No		State Water	0.28	
38	Other: Concrete mixing		Hanson Sand & Gravel (Concrete Mixing)		Morro Bay	Disinfected Secondary-23	Unknown		State Water, Untreated Well	0.34	
39	Landscape	Native	N of Cayucos; Along Highway 1	--	Cayucos	Undisinfected secondary	No		None	0	Does not currently irrigate. See Note 2.
40	Landscape	Native	Coleman Park	--	Morro Bay	Disinfected tertiary	No		No Current Source	0	Does not currently irrigate. See Note 2.
41	Landscape	Grass/landscape	Tri-Development Area	--	Morro Bay	Disinfected tertiary	Unknown		No Current Source	0	Does not currently irrigate
42	Creek Aug	Water Supply to Whale Rock Reservoir	Cottontail Creek		Cayucos	Disinfected tertiary +	Unknown				Water supply to Whale Rock Reservoir. See Note 2.
-	Recharge		Direct Groundwater Recharge		Morro Bay / Cayucos	Disinfected tertiary + 100% MF/RO + adv Oxidation	Yes				Retention times difficult to achieve, advanced treatment req'd, may be economically infeasible, physical constraints for several basins

Notes 1. The required water quality to meet regulations is Disinfected tertiary for food crops where reycled water contacts edible portion of crop, including all root crops, and Disinfected Secondary-2.2 for food crops where edible portion is produced above ground and not contacted by recycled water, except orchards and vineyards with no contact between edible portion and recycled water where the water quality required to meet regulations is Undisinfected Secondary. Additional treatment may be needed to achieve quality required for specific use.
2. Reuse opportunity was identified in prior reports, but was not numbered.
Sources: 1) Cayucos/Morro Bay Comprehensive Recycled Water Study, Carollo Engineers, October 1999. 2) 2012 Recycled Water Feasibility Study, Dudek, Draft March 9, 2012.

Table 6. Irrigated Agricultural Parcels and Other Potential Reuse Opportunities in Morro Valley and Chorro Valley

Site #	APN	Site Description	Size (Acres)	Owner	Estimated % Irrigated	Irrigated Area (Acre)	Irrigated Crop	Treatment Level Required to Meet Regulations	Average Demand Estimate[4] (AFY)	Comments
43	073-032-005	Irrigated Ag, Morro Vlly	7.55	William Limon et al	88.0%	6.64	Orchard	Disinfected Tertiary	16.6	1
44	073-032-004	Irrigated Ag, Morro Vlly	4.53	William Limon et al	98.0%	4.44	Orchard	Disinfected Tertiary	11.1	1
45	073-032-003	Irrigated Ag, Morro Vlly	1.97	William Limon et al	100.0%	1.97	Orchard	Disinfected Tertiary	4.9	1
46	073-031-027	Irrigated Ag, Morro Vlly	18.09	Teri A. Keyser	54.0%	9.77	Orchard	Disinfected Tertiary	24.4	1, 2
47	073-051-058	Irrigated Ag, Morro Vlly	33.15	Susan Beasley et al	100.0%	33.15	Orchard	Disinfected Tertiary	82.9	1, 2
48	073-051-055	Irrigated Ag, Morro Vlly	9.89	Steven B. Victor et al	90.0%	8.9	Orchard	Disinfected Tertiary	22.3	1, 2
49	073-051-031	Irrigated Ag, Morro Vlly	19.96	Steve J. and Barbara J. Erden	87.0%	17.37	Orchard	Disinfected Tertiary	43.4	1, 2
50	073-111-012	Irrigated Ag, Morro Vlly	19.7	Scott T. Mather et al	86.0%	16.94	Orchard	Disinfected Tertiary	42.4	1, 2
51	073-085-022	Irrigated Ag, Morro Vlly	1.3	Ronald L. Kennedy et al	30.0%	0.39	Orchard	Disinfected Tertiary	1.0	1, 2
52	073-051-025	Irrigated Ag, Morro Vlly	6.32	Richard P. Sauerwein et al	75.0%	4.74	Orchard	Disinfected Tertiary	11.9	1
53	073-051-023	Irrigated Ag, Morro Vlly	3.38	Richard P. Sauerwein et al	53.0%	1.79	Orchard	Disinfected Tertiary	4.5	1
54	073-031-017	Irrigated Ag, Morro Vlly	9.04	Richard Lyons	42.0%	3.8	Orchard	Disinfected Tertiary	9.5	1, 2
55	073-051-053	Irrigated Ag, Morro Vlly	19.19	Richard B. Kitzman et al	92.0%	17.65	Orchard	Disinfected Tertiary	44.1	1, 2
56	073-051-050	Irrigated Ag, Morro Vlly	21.06	Randy & Joanne Kann	95.0%	20.01	Orchard	Disinfected Tertiary	50.0	1, 2
57	073-031-009	Irrigated Ag, Morro Vlly	126.73	Paul Madonna et al	13.6%	17.24	Row crop	Disinfected Tertiary	43.1	1, currently fallow
58	073-031-026	Irrigated Ag, Morro Vlly	17.07	Paul Madonna et al	79.0%	13.49	Row crop	Disinfected Tertiary	33.7	1, currently fallow
59	073-051-040	Irrigated Ag, Morro Vlly	20.1	Patrick N. Nagano et al	94.0%	18.89	Orchard	Disinfected Tertiary	47.2	1, 2
60	073-085-029	Irrigated Ag, Morro Vlly	15.74	Patricia L. Kennedy et al	90.0%	14.17	Orchard	Disinfected Tertiary	35.4	1, 2
61	073-085-028	Irrigated Ag, Morro Vlly	7.92	Patricia L. Kennedy et al	80.0%	6.34	Orchard	Disinfected Tertiary	15.9	1, 2
62	073-051-049	Irrigated Ag, Morro Vlly	12.26	Norman A. & Angia M. Martignoni	31.0%	3.8	Orchard	Disinfected Tertiary	9.5	1, 2
63	073-051-052	Irrigated Ag, Morro Vlly	23.28	Neil R. Nagano et al	100.0%	23.28	Row crops	Disinfected Tertiary	58.2	1
64	073-031-030	Irrigated Ag, Morro Vlly	349.46	Morro Ranch Co. LLC	71.0%	248.12	Orchard	Disinfected Tertiary	620.3	1
65	073-069-009	Irrigated Ag, Morro Vlly	186.62	Morro Creek Ranch	30.0%	55.99	Orchard	Disinfected Tertiary	140.0	1, 2
66	073-069-020	Irrigated Ag, Morro Vlly	50.56	Morro Creek Ranch	99.0%	50.05	Orchard	Disinfected Tertiary	125.1	1, 2
67	073-069-021	Irrigated Ag, Morro Vlly	38.35	Morro Creek Ranch	95.0%	36.43	Orchard	Disinfected Tertiary	91.1	1, 2
68	073-069-018	Irrigated Ag, Morro Vlly	45.95	Morro Creek Ranch	75.0%	34.46	Orchard	Disinfected Tertiary	86.2	1, 2
69	073-069-019	Irrigated Ag, Morro Vlly	23.59	Morro Creek Ranch	87.0%	20.52	Orchard	Disinfected Tertiary	51.3	1, 2
70	073-051-046	Irrigated Ag, Morro Vlly	11.11	Merriam J. Urquhart et al	90.0%	10	Orchard	Disinfected Tertiary	25.0	1, 2
71	073-051-016	Irrigated Ag, Morro Vlly	1.28	Mary Nagano et al	80.0%	1.02	Orchard	Disinfected Tertiary	2.6	1
72	073-011-043	Irrigated Ag, Morro Vlly	43.69	Mary Flavan	75.0%	32.77	Orchard	Disinfected Tertiary	81.9	1, 2
73	073-111-019	Irrigated Ag, Morro Vlly	40	Margaret G. French	6.0%	2.4	Orchard	Disinfected Tertiary	6.0	1, 2
74	073-051-041	Irrigated Ag, Morro Vlly	19.57	Manuel S. & Amparo G. Haber	98.0%	19.18	Orchard	Disinfected Tertiary	48.0	1, 2
75	073-085-018	Irrigated Ag, Morro Vlly	176.35	Lyle C. Foster et al	4.5%	7.94	Orchard	Disinfected Tertiary	19.9	1, 2
76	073-111-016	Irrigated Ag, Morro Vlly	38.61	Larry Johnson et al	27.0%	10.42	Orchard	Disinfected Tertiary	26.1	1, 2
77	073-011-056	Irrigated Ag, Morro Vlly	15.15	Kurt E. Steinmann	25.0%	3.79	Orchard	Disinfected Tertiary	9.5	1, 2
78	073-051-047	Irrigated Ag, Morro Vlly	10.79	Kenneth H. Macintyre et al	90.0%	9.71	Orchard	Disinfected Tertiary	24.3	1, 2
79	073-011-032	Irrigated Ag, Morro Vlly	36.09	Kathleen E. Cirone et al	45.5%	16.42	Orchard	Disinfected Tertiary	41.1	1, 2
80	073-011-047	Irrigated Ag, Morro Vlly	66	Judith E. Hull	25.0%	16.5	1/2 Row crop; 1/2 Orchard	Disinfected Tertiary	41.3	1, 2
81	073-011-048	Irrigated Ag, Morro Vlly	47.91	Judith E. Hull	10.0%	4.79	Orchard	Disinfected Tertiary	12.0	1, 2
82	073-111-031	Irrigated Ag, Morro Vlly	25.72	Joseph M. Spellacy	30.0%	7.72	Orchard	Disinfected Tertiary	19.3	1, 2
83	073-111-032	Irrigated Ag, Morro Vlly	27.01	Joseph M. Spellacy	5.0%	1.35	Orchard	Disinfected Tertiary	3.4	1, 2

Table 6. Irrigated Agricultural Parcels and Other Potential Reuse Opportunities in Morro Valley and Chorro Valley

Site #	APN	Site Description	Size (Acres)	Owner	Estimated % Irrigated	Irrigated Area (Acre)	Irrigated Crop	Treatment Level Required to Meet Regulations	Average Demand Estimate[4] (AFY)	Comments
84	073-051-048	Irrigated Ag, Morro Vlly	11.96	John J. Heitzenrater et al	58.0%	6.94	Orchard	Disinfected Tertiary	17.4	1, 2
85	073-031-020	Irrigated Ag, Morro Vlly	111.65	James Shanley et al	26.2%	29.25	Orchard	Disinfected Tertiary	73.1	1, 2
86	073-011-007	Irrigated Ag, Morro Vlly	361.98	James M. Dunn Family Ranches	4.5%	16.29	Orchard	Disinfected Tertiary	40.7	1, 2
87	073-051-059	Irrigated Ag, Morro Vlly	62.04	Howard H. Hayashi	94.0%	58.32	Row crops	Disinfected Tertiary	145.8	1
88	073-051-051	Irrigated Ag, Morro Vlly	20.1	Howard H. Hayashi	100.0%	20.1	Row crops	Disinfected Tertiary	50.3	1
89	073-111-018	Irrigated Ag, Morro Vlly	29.1	Gregory J. Frye et al	27.0%	7.86	Orchard	Disinfected Tertiary	19.7	1, 2
90	073-011-057	Irrigated Ag, Morro Vlly	151.3	Gary H. Evans	10.0%	15.13	1/2 Row crop; 1/2 Orchard	Disinfected Tertiary	37.8	1
91	073-111-017	Irrigated Ag, Morro Vlly	31.35	Frederick Harpster Sr.	41.0%	12.85	Orchard	Disinfected Tertiary	32.1	1, 2
92	073-011-042	Irrigated Ag, Morro Vlly	38.32	Evangeline D. Parker	50.0%	19.16	Orchard	Disinfected Tertiary	47.9	1, 2
93	073-011-041	Irrigated Ag, Morro Vlly	8.26	Evangeline D. Parker	50.0%	4.13	Orchard	Disinfected Tertiary	10.3	1, 2
94	073-051-056	Irrigated Ag, Morro Vlly	9.81	Eileen M. Giannini	90.0%	8.83	Row crop	Disinfected Tertiary	22.1	1
95	073-051-036	Irrigated Ag, Morro Vlly	5.73	Eileen M. Giannini	91.0%	5.21	Row crop	Disinfected Tertiary	13.0	1
96	073-031-033	Irrigated Ag, Morro Vlly	98.43	Dwain Davis et al	38.3%	37.7	Orchard	Disinfected Tertiary	94.3	1, 2
97	073-031-035	Irrigated Ag, Morro Vlly	350.87	Dwain Davis et al	4.1%	14.39	Orchard	Disinfected Tertiary	36.0	1, 2
98	073-111-008	Irrigated Ag, Morro Vlly	12.15	Dana & Valerie Putnam	33.0%	4.01	Orchard	Disinfected Tertiary	10.0	1, 2
99	073-211-002	Irrigated Ag, Chorro Vlly	438.93	State of California	32.0%	140.46	Row crop	Disinfected Tertiary	351.1	1
100	073-121-009	Irrigated Ag, Chorro Vlly	303.67	Morro Bay Ranch	85.0%	258.12	Row crop	Disinfected Tertiary	645.3	1
101		Dairy Creek Golf Course					NA	Disinfected Tertiary	62	Total est. demand = 250 AFY, est. average 188 AFY supplied by CMC WWTP
102		Botanical Gardens					NA	Disinfected Tertiary		Salt removal/ blending likely required due to plant variety

Comments:

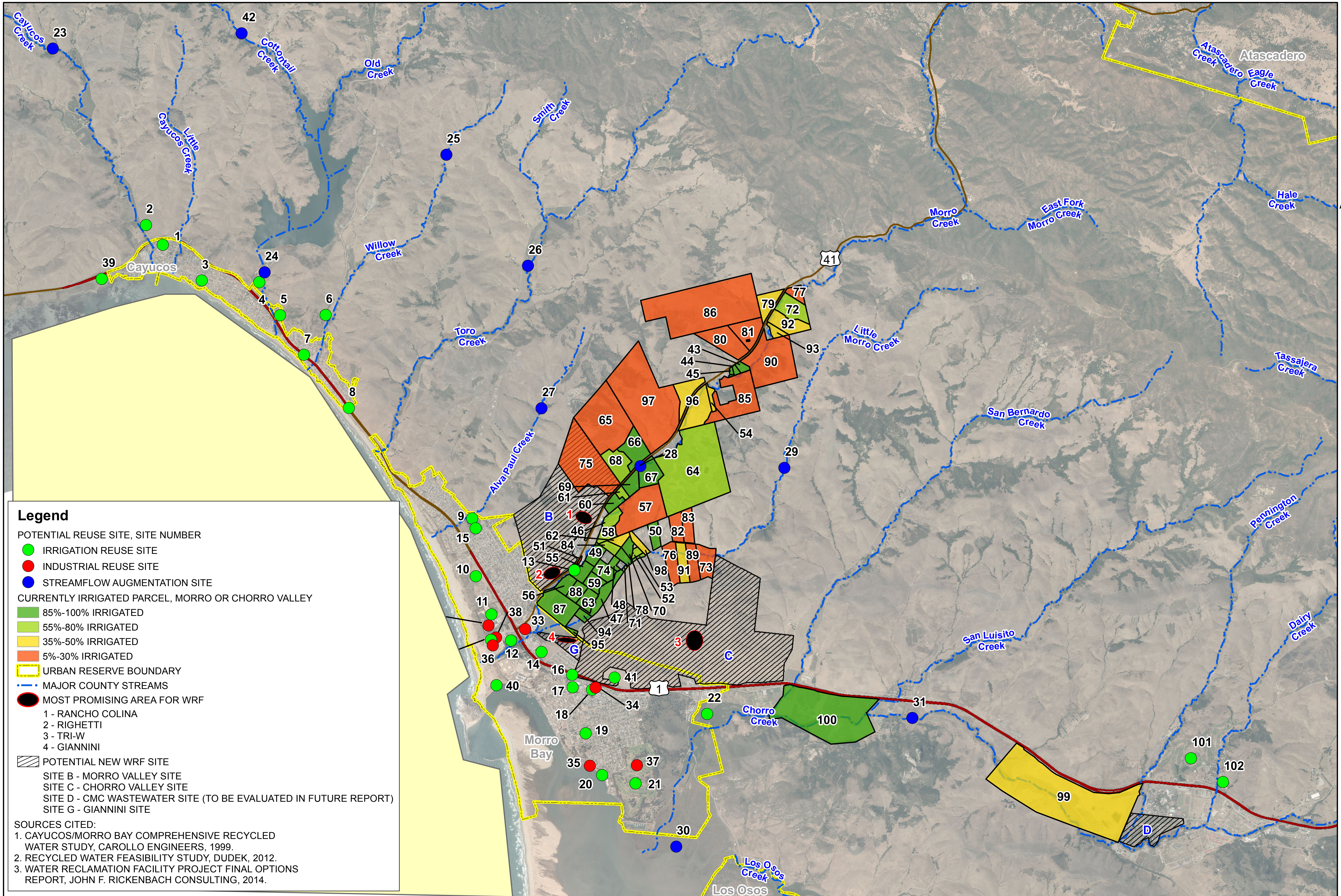
1. The required water quality to meet regulations is Disinfected Tertiary for food crops where reycled water contacts edible portion of crop, including all root crops, and Disinfected Secondary-2.2 for food crops where edible portion is produced above ground and not contacted by recycled water, except orchards and vineyards with no contact between edible portion and recycled water where the water quality required to meet regulations is Undisinfected Secondary. Additional treatment may be needed to achieve quality required for specific use.
2. Many citrus, stone fruit and nut trees are sensitive to salts. Salt removal/blending to reduce salinity of agricultural irrigation water may be required.

Notes:

3. Most orchards on the potential reuse sites in the Morro Valley are avocados, though there are also limited citrus groves.
4. Average Demand Estimate for irrigated agricultural properties based on 2.5 feet per year per acre of irrigated area, consistent with previous studies (Carollo, 1999 & Dudek, 2012).
5. Previously identified Site 13 in Table 5 includes some of the Morro Valley parcels shown here in Table 6. It is unclear which parcels were included previously for Site 13.

City of Morro Bay New Water Recycling Facility

Reuse Opportunities and Irrigated Ag Users in the Morro Valley and Chorro Valley



1 inch:5,000 feet

MAP NOTES:
2011 AERIAL PHOTO PROVIDED BY COUNTY OF SAN LUIS OBISPO.
MAP PUBLISHED APRIL 2014.

MKN

SUMMARY

The purpose of this memorandum is to summarize the available information regarding potential water reuse for the City of Morro Bay with respect to the new WRF. Several potential reuse opportunities were identified in previous studies. Based on the City's goal to produce recycled water, these opportunities may become a factor in siting the new WRF during the master planning process. Locating the new WRF near these opportunities will minimize capital and operation/maintenance costs for recycled water distribution. A summary of the potential reuse sites and estimated water demands by region is provided in Table 7.

Table 7 Estimated Water Use by Region

			Estimated Average Demand (AFY)					
Region	Main Use Type	No. of Sites	Disinfected Tertiary	Disinfected Secondary-2.2	Disinfected Secondary-23	Un-disinfected Secondary	Total	Comments
Cayucos	L, A	9	503	--	23	13	538	500 AFY is estimated to require salts removal or blending.
Morro Bay	L, C	23	111	--	316	--	427	Overall requirements for salt removal or blending is unknown.
Morro Valley	A	56	2736	--	--	--	2736	Overall requirements for salt removal or blending is unknown.
Chorro Valley	A, GC	4	1058	--	--	--	1058	Overall requirements for salt removal or blending is unknown. Demand for Botanical Gardens undefined.

Notes: L = Landscape Irrigation; A = Agricultural Irrigation; C = Commercial; GC = Golf Course

1. Does not include stream augmentation sites.
2. See Table 5, Table 6 and Figure 1 for additional details.
3. The required water quality to meet regulations is Disinfected Tertiary for food crops where recycled water contacts edible portion of crop, including all root crops, and Disinfected Secondary-2.2 for food crops where edible portion is produced above ground and not contacted by recycled water, except orchards and vineyards with no contact between edible portion and recycled water where the water quality required to meet regulations is Undisinfected Secondary. Additional treatment may be needed to achieve quality required for specific use.
4. Most orchards on the potential reuse sites in the Morro Valley are avocados, though there are also limited citrus groves.
5. Average Demand Estimate for irrigated agricultural properties based on 2.5 feet/year per acre of irrigated area.

The minimum treatment level required to meet the regulations may be less than the water quality needed for a specific use. For example, the minimum treatment required per Title 22 is undisinfected secondary for orchards where the edible portion of the crop does not contact the recycled water. However, Tables 2, 3, and 4 indicate that many fruit and nut crops are sensitive to salts and the existing WWTP effluent quality has higher salts concentrations, within a range that may cause increasing problems for irrigation. It is anticipated that the influent salts concentrations for the new WRF will be similar to the existing. Salts removal or blending may be required to produce a recycled water appropriate for irrigation of sensitive crops. Additionally, disinfection is typically recommended to reduce the potential for bacteriological growth in the pipelines and storage facilities.

A more detailed analysis of the existing WWTP effluent quality is recommended to identify water-quality related challenges or constraints for use in agricultural irrigation. It's recommended that the City also consider developing collection system salt management strategies, including a review and enhancement of current industrial pretreatment requirements, to reduce the salts load on the wastewater plant. These efforts should be performed in conjunction with or prior to the beginning of the City's Recycled Water Master Plan.

Appendix D:

Notice of Preparation of an Environmental Impact Report for the City of Morro Bay WRF Project

(August 5, 2016)

NOTICE OF PREPARATION

Date: August 5, 2016

To: California Office of Planning and Research, Responsible and Trustee Agencies, and Other Interested Parties

Subject: Notice of Preparation of an Environmental Impact Report

Project: Morro Bay Water Reclamation Facility

Lead Agency: City of Morro Bay

Review Period: August 8, 2016 to September 7, 2016 (30 days)

This Notice of Preparation (NOP) has been prepared to notify agencies and interested parties that the City of Morro Bay as the Lead Agency will prepare an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act (CEQA) for the proposed Morro Bay Water Reclamation Facility (WRF or proposed project). The proposed project will provide wastewater treatment services for the City and potentially additional nearby customers. The proposed project is intended to provide opportunities for the City to produce and beneficially reuse advanced treated recycled water and would meet or exceed all wastewater treatment requirements of the State Water Resources Control Board. The proposed project includes all necessary pipeline collection and conveyance infrastructure needed to support the treatment facility itself. The existing Morro Bay-Cayucos Wastewater Treatment Plant (WWTP) would be replaced by the proposed WRF, and its eventual decommissioning is also considered part of the proposed project. Additional information about the proposed project is included in Attachment A to this NOP.

Project Location: The Morro Bay WRF would be constructed on an approximately 10-acre area within a 396-acre parcel (APN 073-101-017) located in unincorporated San Luis Obispo County, adjacent to the City boundary and north of State Highway 1 at South Bay Boulevard (see Figure 1). The City intends to create a new parcel using the “Public Lot process” and pursue annexation of the City facility parcel. The proposed project also would include a pump station at or in the vicinity of the existing WWTP to convey raw wastewater to the WRF site and pipelines to transport raw wastewater from the existing WWTP to the WRF site; treated recycled water from the WRF site to end use locations; and brine or wet weather discharges to the existing outfall. Pipelines would be located primarily within rights-of-way of existing City streets.

Public Comments: The City of Morro Bay is soliciting the views of responsible and trustee agencies as well as interested persons as to the scope and content of the environmental information to be included in the EIR. In accordance with CEQA, agencies are requested to review the project description provided in this NOP and provide comments on environmental issues related to the statutory responsibilities of the agency. The EIR will be used by the City of Morro Bay when considering approval of the proposed project as well as any related discretionary approvals.

All comments to the NOP are due no later than **September 7, 2016**. Please send your comments to the mailing address or email addresses shown below. Include a return address or email address and a contact name for your agency or group with your comments.

Email comments to:	**Mail comments to:**
John Rickenbach Deputy Program Manager City of Morro Bay jrickenbach@morrobayca.gov and Jennifer Jacobus EIR Project Manager jjacobus@esassoc.com	John Rickenbach Deputy Program Manager City of Morro Bay 955 Shasta Avenue Morro Bay, CA 93442

Scoping Meeting: The City will hold a public meeting to receive comments and suggestions about the issues to be included in the EIR. The scoping meeting will include a brief presentation, providing an overview of the proposed project. After the presentation, oral comments will be accepted. Comment forms will be supplied for those who wish to submit comments in writing at the scoping meeting; written comments may also be submitted anytime during the 30-day NOP review period. The scoping meeting will be held as follows:

Tuesday, August 16, 2016, 4:00 p.m.
Veterans Memorial Building
209 Surf Street
Morro Bay, CA 93442

Document Availability: Copies of the NOP and project documents are available on the Morro Bay WRF web page (http://morrobaywrf.com/); at the Morro Bay Public Library (625 Harbor Street, Morro Bay); at City Hall (595 Harbor Street, Morro Bay); and in the Public Services Department (955 Shasta Avenue, Morro Bay).

SOURCE: ESRI 2015

Morro Bay Water Reclamation Facility Project. 150412

Figure 1
Project Location

Attachment A

Introduction and Background

The Morro Bay-Cayucos Wastewater Treatment Plant (WWTP) is currently located at 160 Atascadero Road in Morro Bay (Figure 1). The WWTP is jointly owned by the City of Morro Bay and the Cayucos Sanitary District (CSD). The WWTP provides primary and secondary treatment to all wastewater effluent produced in Morro Bay and Cayucos, with a capacity of 2.36 million gallons per day (MGD) for peak seasonal dry weather flow. The WWTP currently operates under a modified discharge permit, which allows a disinfected blend of primary and secondary treated effluent to be discharged through the ocean outfall, which terminates approximately 2,900 feet offshore into the Pacific Ocean.

The Federal Water Pollution Control Act Amendments of 1972, or Clean Water Act (CWA), required that publicly-owned wastewater treatment works (POTWs) like the WWTP achieve secondary treatment capability by 1977. Section 402 of the CWA established the National Pollutant Discharge Elimination System (NPDES) permit program to implement this requirement by regulating point source discharges, such as discharges from POTWs, into waters of the U.S. An NPDES permit sets specific limits for pollutants in point source discharges and establishes monitoring and reporting requirements.

Section 301(h) was added to the CWA in 1977 to allow POTWs that discharge into marine waters to apply for a variance from secondary treatment requirements if they could meet specific discharge criteria. It was determined that secondary treatment might not be necessary for ocean discharges due to greater dilution and dispersal potential relative to discharges into freshwater systems. Section 301(h) allowed the U.S. Environmental Protection Agency (EPA) to review and grant variances from secondary treatment requirements on a case-by-case basis.

In accordance with Sections 301(h) and 402 of the CWA, the existing WWTP is operated under a modified NPDES Permit No. CA0047881 issued by the U.S. EPA and the Central Coast Regional Water Quality Control Board (RWQCB). Based on an agreement with the RWQCB, the City of Morro Bay and CSD had previously pursued bringing the existing facility to full secondary treatment in place of continued requests for a 301(h) modified discharge permit. The agreement allowed the City and CSD to pursue secondary treatment on a schedule that was mutually agreed upon by both agencies and the RWQCB. In January 2011, the City as the CEQA Lead Agency certified the Final EIR for the WWTP Upgrade Project, which would have upgraded the existing WWTP to provide full secondary treatment for all effluent discharged through the ocean outfall and tertiary treatment for 1.5 MGD peak season dry weather flow. Subsequently, the City prepared a Coastal Development Permit (CDP) application for the WWTP Upgrade Project, which was appealed to the California Coastal Commission (CCC). At its January 10, 2013 meeting, the CCC voted to deny the CDP for construction of an upgraded WWTP at its existing location. In summary, the basis for denial included consistency with the Local Coastal Plan’s zoning provisions, failure to avoid coastal hazards, failure to include a sizable reclaimed water component, and project location within an LCP-designated sensitive view area.

Following the CCC decision, the City began a robust effort to identify and analyze potential alternative sites for a new Water Reclamation Facility (WRF). The CSD is pursuing future options for wastewater treatment for its service area independently of the City. The City solicited input from the public through stakeholder outreach, stakeholder interviews, multiple public workshops, and multiple City Council meetings. Using alternative screening analyses that had been done in 2011 as a starting point, combined with the input received from stakeholders and the public, the City considered 17 sites for the proposed WRF, documented in six reports[1] that can found on a dedicated web site established specifically for the proposed project: http://morrobaywrf.com. The sites were systematically compared and ranked repeatedly based on a number of criteria, including opportunities and constraints, environmental and physical site issues, and regulatory and permitting issues. The Morro Bay City Council selected the South Bay Boulevard Site, shown in Figure 1, as the proposed location for the new WRF to be carried forward and evaluated during the CEQA process.

Project Need and Objectives

With implementation of the proposed project, operation of the Morro Bay WRF would meet future NPDES permit requirements as determined by the Central Coast RWQCB. The proposed project also would protect all beneficial uses and water quality objectives for Estero Bay as defined by the California Ocean Plan.

The proposed project objectives are as follows:

- Produce tertiary, disinfected wastewater in accordance with the California Code of Regulations (CCR) Title 22 requirements for unrestricted urban irrigation.
- Design to be able to cost-effectively produce reclaimed wastewater for potential users, which could include public and private landscape areas, agriculture, or groundwater recharge.
- Design to treat contaminants of emerging concern in the future.
- Design for optimal energy recovery.
- Design to allow for other possible municipal functions at the WRF site.
- Ensure compatibility with neighboring land uses.

Project Components

The proposed project would be implemented in two phases. Phase 1 would build a 1.2 MGD (approximate maximum month flow or MMF) treatment facility at the WRF site that would produce tertiary-treated, disinfected water. Phase 1 would allow the City to meet the RWQCB requirements and timeline for upgrading to at least full-secondary treatment, and would exceed this minimal requirement through development of a tertiary treatment facility with disinfection. Implementation of Phase 1 would allow for the decommissioning of the existing WWTP. During operation of Phase 1, tertiary-treated and disinfected recycled wastewater may be discharged through the existing ocean outfall until recycled water

[1] Rough Screening Report (2011); Fine Screening Report (2011); Options Report (December 2013); Report on Reclamation and Council Recommended WRF Sites (May 2014); Comparative Site Analysis (December 2014); Report to City Council on Potential WRF Sites (April 2016)

facilities are implemented. Additionally, peak flows above the capacity of the reclamation capacity (e.g. wet weather) may be discharged to the Pacific Ocean utilizing the jointly-owned ocean outfall.

Phase 2 of the proposed project would be implemented once the City has determined the ultimate beneficial end uses for recycled water to be produced at the WRF. Timing may coincide with construction of Phase 1 or shortly thereafter. Implementation of Phase 2 would include construction and operation of an advanced water treatment facility (AWTF) at the WRF site and associated infrastructure to convey advanced-treated recycled water to the ultimate end uses. The objective of the facility is to cost-effectively reuse as much water as possible, but sizes of facilities will depend on delivery opportunities and costs to treat and convey water. Such facilities will be described in the Master Reclamation Plan currently being prepared by the City. The City will make every effort to accelerate Phase 2 to coincide with Phase 1, if possible, but it is assumed that pursuit of grants and funding, agreements with potential users, hydrogeologic studies, and water rights procurement could realistically take longer than the City Council's expedited schedule goal for construction of a new WRF.

Treatment Facility

The Phase 1 and Phase 2 treatment facilities would be built on approximately 10 acres within the proposed WRF site and would have a total treatment capacity of 1.2 MGD MMF. The specific layout and site area needs will be determined through the Facility Master Plan (FMP), which is currently being prepared. Since the WRF site is located in unincorporated San Luis Obispo County, the proposed project would include annexation of the WRF site into the City of Morro Bay. The specific treatment method, technologies, and design of the facilities are currently in progress. The facilities associated with Phase 1 will be described in the FMP, including processes to produce disinfected tertiary water, handle residual solids, and advanced treatment alternatives for a range of possible water reuse alternatives. The FMP will be completed approximately December 2016. Phase 2 will be addressed in detail in the Master Reclamation Plan, and will involve an evaluation and selection of the advanced treatment processes presented in the Facility Master Plan based on the various water reuse alternatives developed through the Master Reclamation Plan process. The draft Master Reclamation Plan will be completed approximately March 2017.

Force Main and Pump Station

The proposed project will require some minor modifications to the existing sewer collection system. Generally, however, all wastewater would continue to flow to, or near to, the existing WWTP site, where new facilities would be built to connect the existing wastewater infrastructure to the proposed WRF site. As part of Phase 1, a new force main would be built, beginning at or near the existing WWTP site and likely traveling east within the rights-of-way (ROWs) of existing streets to the new WRF site. A new pump station would be built at the existing WWTP site to pump raw wastewater uphill through the force main to the new WRF site. The City will also implement modifications of other lift stations to tie into the new force main and divert flows on the east side of town from the gravity collection system.

Recycled Water Pipeline

Under Phase 1, tertiary-treated water would temporarily be discharged through the existing ocean outfall, similar to existing conditions, until a recycled water distribution system is constructed and commissioned.

The size and capacity of the outfall is sufficient to accommodate the proposed project. Thus, a pipeline would be built to convey recycled water from the WRF site back to the existing WWTP to connect to the ocean outfall. Flow through the pipeline would likely be gravity driven based on topography. The pipeline would be designed to handle full capacity flow from the WRF, although discharges through the pipeline and outfall are intended to decrease with implementation of Phase 2 as advanced-treated recycled water is diverted elsewhere for beneficial reuse.

Reclamation and Reuse

Under Phase 2, a recycled water distribution system would be built to convey water to users in the City or possibly to locations within either the Morro Valley or Chorro Valley, based on users to be determined through the Master Reclamation Plan. Phase 2 facilities may include, but not be limited to, additional pipelines, pump stations, injection wells and monitoring wells. One of the proposed project's ultimate goals is to enhance the City's water supply portfolio. Potential opportunities for recycled water use include:

- Direct reuse and "in-lieu" groundwater recharge through delivery to landscape irrigation, open space irrigation, and agricultural irrigation.
- Exchange of recycled water and groundwater with agricultural users.
- Groundwater recharge through injection wells.
- Seawater intrusion barrier.
- Other permitted beneficial uses per CCR Title 22.

Each of these opportunities may require storage, distribution, pumping, turnouts, and delivery facilities. Phase 2 may incorporate any combination of the uses and facilities summarized above. Although Phase 2 would result in decreased discharges of recycled water through the ocean outfall, brine produced during the advanced treatment process at the AWTF would be discharged through the outfall.

Potential Environmental Impacts

The EIR will assess and disclose the reasonably foreseeable direct, indirect, and cumulative impacts that would likely result from the construction and operation of the proposed project. Potential impacts to resources listed in Appendix F and Appendix G of the CEQA Guidelines are summarized below. The EIR will identify mitigation measures if necessary to avoid, minimize, and offset potentially significant impacts of the project. The EIR also will describe the alternatives screening analysis conducted for the proposed project, evaluate alternatives to the proposed project that would avoid, minimize, and offset potentially significant impacts of the project.

Aesthetics

The proposed project would be located near State Highway 1 (approximately 1,700 feet northerly of the Highway at its closest point), which is a scenic highway and relatively near the coastline. Potential direct and indirect visual impacts could occur both during construction and after the treated water facilities and related infrastructure are built and operating. The EIR will identify the visible changes to scenic resources, scenic vistas, and visual character of the project area due to development of the treatment facilities, pump station, and force main and associated pipelines within the viewshed.

Agricultural Resources

The proposed WRF would be located on agricultural land and rangeland. The proposed project would require construction of facilities and pipelines that could disturb, displace, or impact existing agricultural resources. The EIR will assess the potential for the proposed project to conflict with agricultural land uses and zoning.

Air Quality

Construction and operation of the proposed project could result in additional air emissions associated with ground disturbance during construction, material hauling, vehicle trips associated with construction worker commutes, and operational vehicle trips due to facility operation and maintenance. The EIR will estimate pollutant emissions from construction and operational activities and evaluate emission levels against federal, state, and local standards and thresholds.

Biological Resources

The proposed project could affect wildlife habitat and special-status species during construction or operation. The proposed project could potentially affect biological resources in either the Morro Creek or Chorro Creek drainages. The EIR will evaluate the potential for construction and operation of the proposed project to affect biological resources and will discuss local ordinances and state and federal regulations governing biological resources. In particular, consistency with any designated Environmental Sensitive Habitat Area (ESHA) per the County's Local Coastal Program will be discussed in the EIR.

Cultural and Paleontological Resources

The proposed project would require ground disturbance to construct facilities and pipelines and thus could disturb known or unknown archeological sites, paleontological resources, and/or human remains where groundbreaking activities occur. The EIR will assess the potential effects of the proposed project on cultural resources, including archaeological, historic, paleontological, and Native American resources (Tribal cultural resources).

Geology, Soils and Seismicity

The project area is located within a region of California that is seismically active. The proposed project would require construction of wastewater treatment facilities on sloped terrain that could be subject to potential seismic and geologic hazards, including ground shaking, liquefaction, soil instability, soil erosion, expansive soils, and landslides. The EIR will describe local and state-wide building codes and policies that would apply to the project that could mitigate or avoid potentially significant effects to infrastructure and public safety.

Greenhouse Gas Emissions

Implementation of the proposed project could result in the generation of greenhouse gas (GHG) emissions associated with construction and operations. The EIR will estimate construction-related emissions and long-term operational emissions, including total CO_2-equivalent emissions for evaluating the effects of GHGs. The EIR will examine the project's effects on global climate change and evaluate consistency of the project with the State's GHG emissions reduction goals and the Morro Bay Climate Action Plan.

Hazards and Hazardous Materials

Construction activities associated with the proposed project could result in the release of hazardous materials. Also, excavation activities could result in uncovering of contaminated soils or hazardous substances that could pose a substantial risk to human health in the environment, such as serpentine rock. The EIR will evaluate whether the proposed project would be located on sites identified by the California State Water Resources Control Board (SWRCB) GeoTracker and the California Department of Toxic Substances Control (DTSC) Envirostor databases as hazardous release sites. The EIR also will evaluate the potential for the project to result in the release of hazardous materials during construction and operation.

Hydrology and Water Quality

The proposed project may change local drainage patterns at construction sites, which could impact the water quality, volume, and rates of surface runoff and eventually the local surface water resources. The EIR will describe relevant federal, state, and local regulations and agencies, including provisions of the federal Clean Water Act, the state Porter-Cologne Water Quality Control Act, and the permitting and regulatory authority of the RWQCB and SWRCB. The EIR will identify potential flood hazard zones in the project area, as well as stormwater quality protection measures required during construction and operation of proposed facilities.

The EIR will describe the potential end uses for recycled water produced at the proposed WRF. The EIR will evaluate the potential for groundwater recharge and surface irrigation to adversely affect groundwater quality and groundwater levels in the underlying Morro Valley Groundwater Basin and Chorro Valley Groundwater Basin. The EIR will also describe the effects associated with temporarily or initially discharging advanced treated water through the existing ocean outfall, and eventually reducing discharge through the outfall.

Land Use and Recreation

The EIR will evaluate the proposed project's consistency with land use and zoning designations and existing land uses. In particular, the EIR will discuss the project's consistency with the City's existing General Plan and Local Coastal Plan (LCP) and consistency with the City's General Plan Update that is currently in progress. It will also consider consistency with the County's General Plan and LCP to the extent those documents could apply to portions of the project that may traverse areas that remain within unincorporated areas.

Implementation of the proposed project is unlikely to affect demand of recreational parks or facilities. However, the EIR will identify any recreational facilities that could be adversely affected by the proposed project, including bike paths or trails, and identify any benefits to recreational opportunities.

Noise

Implementation of the proposed project would require construction and operation of project components that would potentially generate noise and vibration. Construction activities that could be a significant source of noise and vibrations include trucking operations, use of heavy construction equipment (e.g., drill rigs, graders, cranes, and frontend loaders), and pile driving activities. During project operations, fixed sources of noise could be established. The EIR will describe the local noise policies and ordinances. The EIR will quantify potential noise and vibration levels associated with construction and operation of the proposed project for comparison to standards and thresholds established in local noise policies and ordinances.

Population and Housing/Growth Inducement

The proposed project would replace the existing WWTP and continue to provide wastewater treatment for the existing and planned population within the City of Morro Bay. The EIR will evaluate the potential for the project to induce or accommodate growth as planned per the Morro Bay GP/LCP. The EIR will also identify current population, employment projections, and local planning jurisdictions with the authority to approve growth and mitigate secondary effects of growth.

Public Services

The proposed project would construct a new wastewater treatment facility, but is unlikely to affect demand for other public services or to require new or expanded facilities. The EIR will assess the potential for the proposed project to affect police and fire protection services, schools, and parks.

Traffic and Transportation

Construction of the proposed project could affect traffic on local roadways as a result of vehicle trips associated with hauling of material and equipment, pipeline installation within roadway ROWs, increased demand for parking to serve construction workers, and increase in traffic hazards caused by construction activities. In addition, operation of the proposed project would introduce vehicle trips at the new WRF due to employee commuter trips, operation and maintenance vehicles, and truck trips for solids disposal. The EIR will evaluate the potential impact to traffic and circulation due to construction-related vehicle trips, lane closures or road closures during pipeline installation, and operational vehicle trips on local and regional roadways.

Utilities and Energy

The EIR will assess the project’s potential to affect utilities and regional energy supplies. The EIR will describe the existing water, wastewater, electricity, telecommunications, and gas utilities serving the local community. Utility easements cross the proposed WRF site and existing utilities can occur within roadway ROWs. Decommissioning of the existing WWTP affects wastewater treatment service in Morro

Bay and Cayucos. The EIR will explain the CSD’s treatment project as well, and the steps needed to coordinate the decommissioning of the existing WWTP that serves both communities. The EIR will estimate the project’s energy usage and evaluate potential impacts to local and regional energy supplies.

Cumulative Impacts

The EIR will evaluate whether impacts associated with the proposed project for all environmental topics are cumulatively considerable when considered together with other past, present, and reasonably-foreseeable related projects in the area. The EIR will identify planned projects in the area including planned development, water supply, and wastewater treatment projects.