Appendix C – Construction Sequencing

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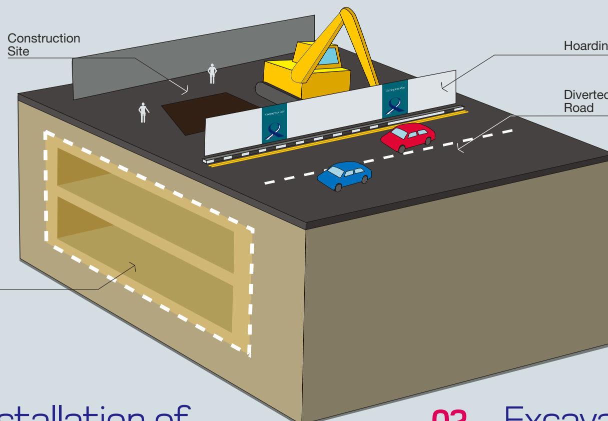
CONSTRUCTION OF SECANT PILE WALL

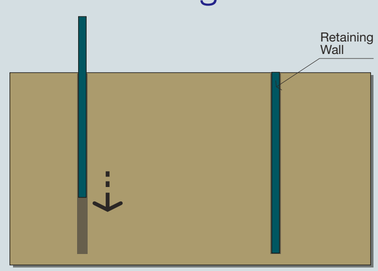
Land Transport Authority

The underground Rapid Transit System (RTS) stations and cut-and-cover tunnels are typically constructed by the "open-cut and bottom-up" method. In this method, the earth is excavated to the required depth with retaining walls and struts supporting the soil at the sides. Upon the completion of excavation to the required depth, the base slab of the underground structure is cast at the bottom-most level, followed by the side walls. Casting of concrete progresses upwards, level by level till the roof of the structure is completed. Ground is then backfilled and reinstated.

OPEN-CUT & BOTTOM-UP CONSTRUCTION METHOD

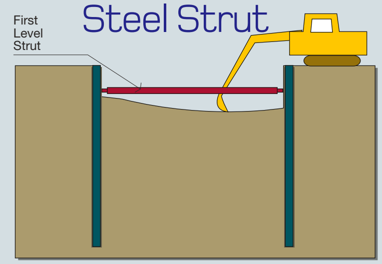


01. Installation of Retaining Wall



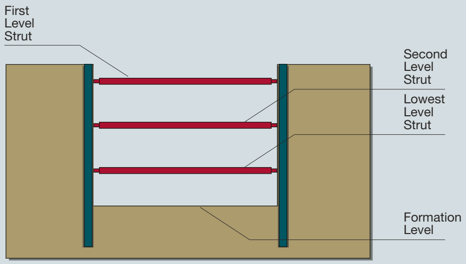
The underground retaining wall is installed before excavation commences. The retaining wall can be a concrete diaphragm wall, a concrete bored pile wall or a steel sheet pile wall; depending on the site condition, soil type and the excavation depth.

02. Excavation & Installation of Steel Strut



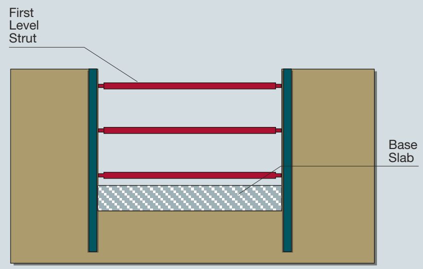
The soil is excavated to the first strut level. The first level strut is installed before the excavation proceeds further.

03. Excavation & Installation of Steel Strut



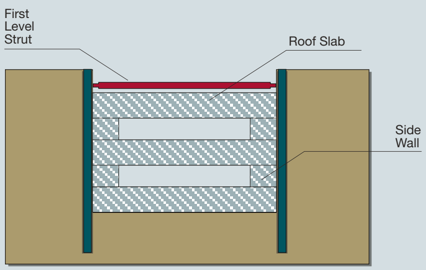
The soil is excavated to the next strut level and the second level strut is installed. It continues till the excavation reaches the final depth or formation level. The number of strut levels depends on the excavation depth.

04. Construction of Underground Structure



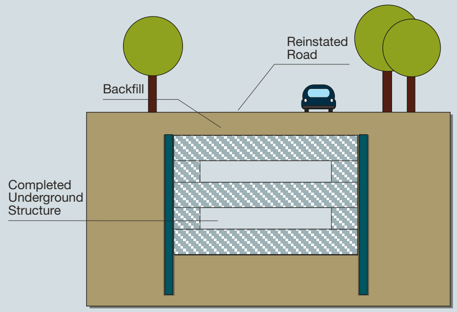
At formation level, the reinforced concrete slab or base slab is constructed, followed by the removal of the lowest level strut and the side walls are constructed.

05. Construction of Underground Structure



The next level of slab is constructed, followed by the removal of the strut near to that slab level. This process progresses upwards till the roof slab is constructed.

06. Backfilling & Reinstatement



After the roof slab is completed, the soil is backfilled to the first strut level before the first level strut is removed. This is followed by completely backfilling the top of the underground structure. If the retaining wall is a diaphragm wall or a bored pile wall, the top 2 metres of the wall will be removed. If it is a sheet pile wall, the sheet piles will be extracted.

While noise, dust and other inconveniences are inevitable during construction, LTA will work closely with the contractor to keep them to a minimum.

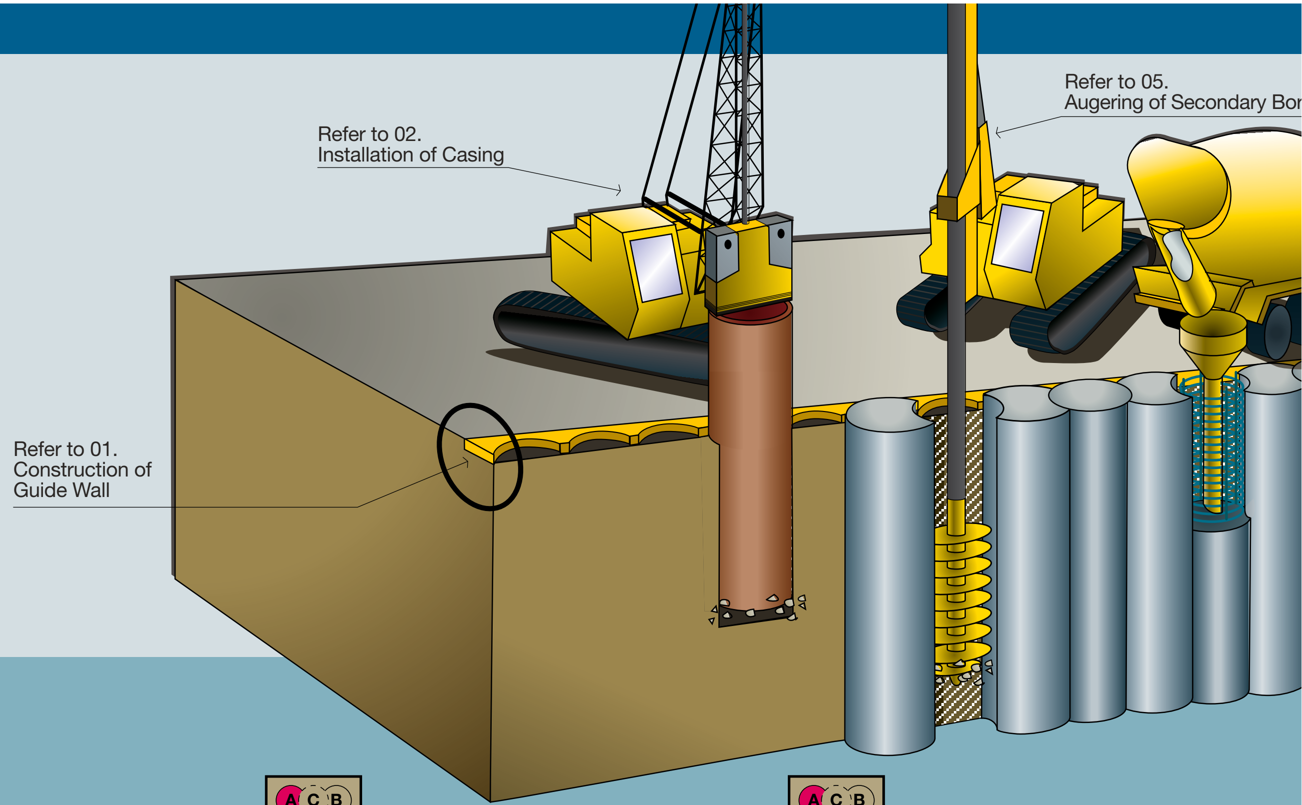
Land Transport Authority

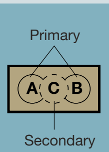
If you have any suggestions or feedback,
please call our Customer Service Line: 1800 – CALL LTA
1800 – 2255 582

October 2004 Designed & produced by C2 Design Studio Pte Ltd

CONSTRUCTION OF SECANT PILE WALL

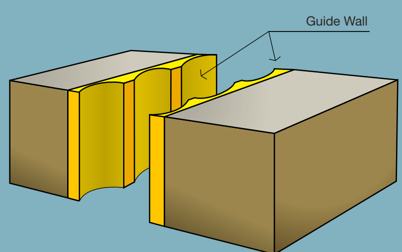
This pictorial guide illustrates the construction sequence of a Secant Pile Wall. This type of retaining wall was used for the construction of Chinatown Station on the North East Line (NEL).





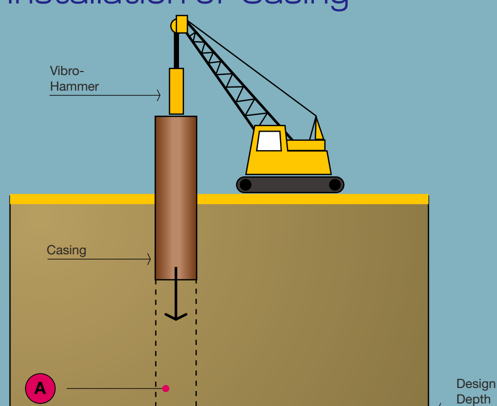
Plan (Top) View
A unit of secant pile wall consists of two primary bored piles and one secondary bored pile.

01. Construction of Guide Wall



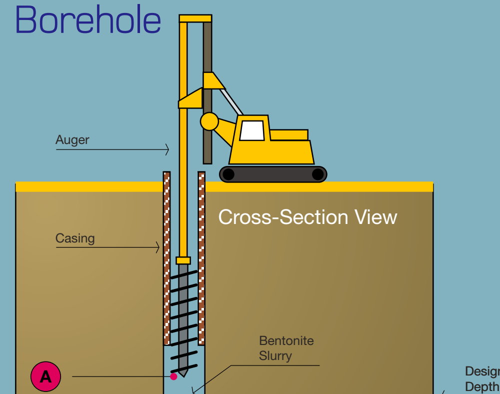
A guide wall is constructed to set out the position of the secant pile wall.

02. Installation of Casing



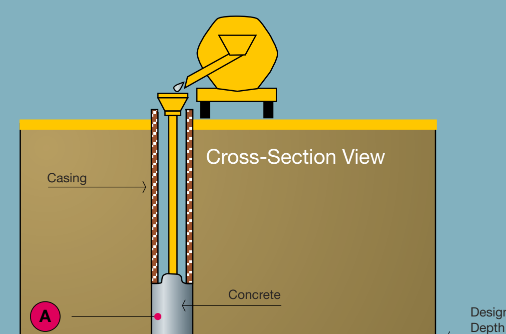
The vibro-hammer drives a casing into the ground, leaving about 1 metre length of the casing protruding from the ground.

03. Augering of Primary Borehole

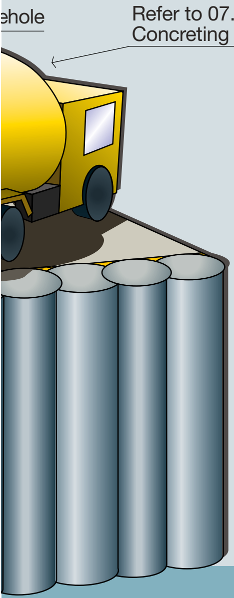


The auger, a drilling tool, cuts and removes the soil within the casing to form a primary borehole. The soil surrounding the borehole is supported by the casing. If the casing is not long enough to reach the required depth in the ground, bentonite slurry is used to support the soil below the casing.

04. Concreting of Primary Borehole



Concrete is poured into the borehole to form the primary bored pile.

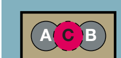


Safety Measures

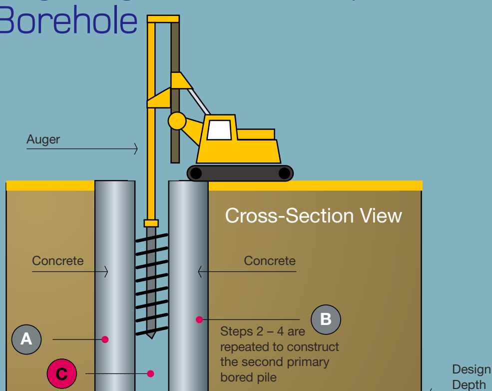
The Land Transport Authority (LTA) accords top priority to safety. Professional Engineers (PE) and Qualified Persons (QP) are engaged to carry out stringent checks on the temporary structures to ensure that they are installed correctly and safely before the excavation can proceed from one level to the next level. In addition, our engineers monitor the various stress and strain gauges installed on the temporary structures on a regular basis so as to be sure that the stresses fall within acceptable limits set by the design engineers. Likewise, instruments are extensively installed in the vicinity of the construction site to monitor vibrations, ground movements etc. This is so that the engineers are always in the know of the impact of the construction on the surrounding buildings and structures, thereby ensuring that they are safe.

Inconveniences

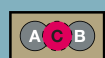
Noise and vibrations are generated when the casing is driven in and extracted from the ground by the vibro-hammer. Noise is also generated during the augering process. We will therefore try our best to schedule the work such that it creates minimal disruption to the public.



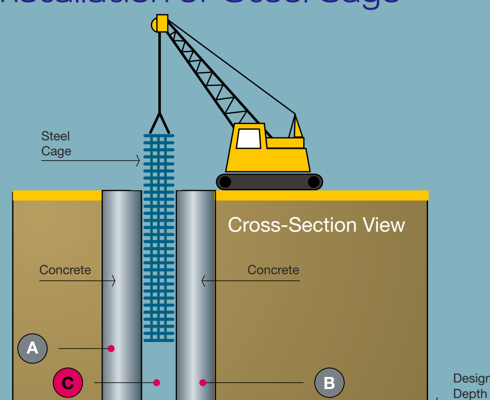
05. Augering of Secondary Borehole



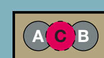
After the casings of the two primary bored piles are extracted by the vibro-hammer, the auger cuts and removes the soil in between the two primary bored piles to form a secondary borehole. The secondary borehole intersects with the adjacent primary bored piles.



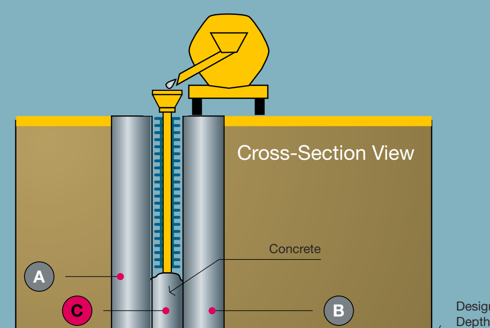
06. Installation of Steel Cage



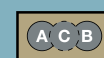
The crane lifts up the steel cage and places it within the secondary borehole.



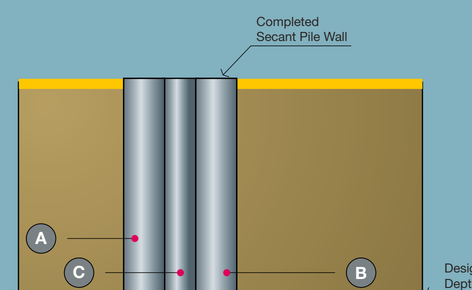
07. Concreting of Secondary Borehole



Concrete is poured into the borehole to form the secondary bored pile.



08. Repetition of Process



Steps 2 – 7 are repeated till the entire length of the secant pile wall construction is completed.

Appendix D

Terminal Island Water Reclamation Plan Opportunities TM

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Summary of Modifications to the Terminal Island Water Reclamation Plant Opportunities Technical Memorandum since Initial Publication on February 18, 2010

The Recycled Water Master Planning (RWMP) effort has spanned three years (April 2009 – March 2012). As is the nature of a planning project, assumptions are typically modified and refined as a project is further developed. The most recent assumptions related to the Long-Term Concepts master planning effort are presented in the Draft Long-Term Concepts Report (January 2012). Assumptions and conclusions presented in this report supersede assumptions included in this technical memorandum (TM). The following table summarizes the modifications applicable to all RWMP TMs and those specifically applicable to this TM are described following the table.

Assumption	Modified	Original
Applicable to all RWMP TMs		
Recycled Water Goal	59,000 AFY by 2035 This goal reflects the 2010 LADWP Urban Water Management Plan that was adopted in early 2011, after the original RWMP goals were drafted	50,000 AFY by 2019
Introduction Section	Ignore this section and refer to the Introduction Section of the RWMP Report.	This section was included in all initial TMs but the terms described have been replaced by the Introduction Section for each RWMP report.
NPR Projects Terminology	To avoid confusion related to LADWP's water rate structure, the terms "Tier 1" and "Tier 2" are superseded with the terms "planned" and "potential," respectively. Both planned and potential projects would be considered for implementation by 2035.	"Tier 1" for NPR projects that were originally planned for design and construction by the year 2015. "Tier 2" for NPR projects that were being originally evaluated in the NPR Master Planning Report for potential future implementation after the year 2015.
Name for MF/RO/AOP treatment plant	Advanced water purification facility (AWPF)	Advanced water treatment facility (AWTF)
Name for water produced by AWPF	Purified recycled water	Advanced treated recycled water, highly purified recycled water, etc.
Treatment Plant Acronyms	DCTWRP LAGWRP	DCT LAG

The following modifications are specific to this TM.

Universal

All references to "Recycled Water Master Plan" should be replaced with "Recycled Water Master Planning".

Cost estimates (page 5, 6, 36, 37)

The basis for the cost estimates included in this TM was subsequently revised, as documented in the Cost Estimating Basis for Recycling Water Master Planning TM (Appendix G in the LTCR).

This resulted in changes to unit costs for capital and O&M costs, construction contingencies, implementation factors, project financing rates, discount rates, and the Engineering News Record (ENR) Index.

Component	Initial	Updated
Estimated Capital Cost		
Project Option 1	$85.3M	$58.2M
Project Option 2	$128.8M	$92.5M
Estimated O&M Cost		
Project Option 1	6.7	6.8
Project Option 2	7.1	7.2
ENR Index	9,764 (December 2009)	10,000 (January 2011)
Equalization Cost	$4/gallon	$1.5/gallon

Table 5-1 – TIWRP Capital Cost Estimate (page 36) should be replaced with the following table:

Table 5-1 – TIWRP Capital Cost Estimate

Item	Project Option 1	Project Option 2
Cost Basis:	Standard	50% Redundancy
Total RW Production Capacity (mgd)	12.5	12.5
RW Production Capacity Added (mgd)	7.5	7.5
Storage/EQ Volume (MG)	2	2
Cost Estimate(1,2)	**($M)**	**($M)**
Permits, Inspection	0.3	0.3
Startup, Office Suppl., Training, Manuals	1.0	1.0
Site Conditions, Geotech, Survey	0.5	0.5
Mobilization, Demolition, Site Work	5.1	5.1
Deep Foundations/Vibrofloatation(3)	7.1	7.1
Structural, Mech., Plumb., Elec., Instr.	18.9	34.7
Reverse Osmosis	12.8	23.4
Microfiltration	9.5	17.4
Equalization (2 MG)(4)	3.0	3.0
Total	**58.2**	**92.5**
Cost per mgd of RW Production	7.8	12.3

(1) Projected capital costs are in January 2011 dollars.
(2) Based on original AWTF bid documents inflated from May 2001 dollars to January 2011 dollars.
(3) Original AWTF required deep structural foundations due to liquefaction potential. Similar construction requirements are assumed in this cost estimate.
(4) Equalization cost basis is $1.5/gallon of storage provided.
(5) Redundancy of 50% applies to total capacity (i.e., 50% of 12.5 mgd)

Table 5-2 – TIWRP O&M Annual Cost Estimate (page 37) should be replaced with the following table:

Table 5-2 – TIWRP O&M Annual Cost Estimate

Item	Project Option 1 ($M)	Project Option 2 ($M)
Power	3.4	3.4
Chemicals	1.2	1.2
Labor	0.8	0.8
Membrane Replacement	0.6	0.9
Compliance Monitoring	0.3	0.3
Plant Refurbishment	0.3	0.4
UV Lamp Replacement	0.1	0.1
Contract Maintenance	0.1	0.1
Total	**6.8**	**7.2**

(1) Costs are based on reported 2008 O&M costs for GWR System and scaled to January 2011.

Page 13, Section 2.3

First sentence of last paragraph should be replaced with:

"Although non-potable demand amounts to ~~only 4,830 AFY~~ 3,600 AFY for IPR and 1,230 AFY for NPR (4.3 mgd expressed as annual average recycled water production), groundwater replenishment and groundwater exchange demands could exceed the proposed 12.5 mgd production capacity at TIWRP."

Page 15, Section 3.1.2

Third sentence of first paragraph should be replaced with:

"However, the recovery rate could potentially be increased up to approximately 77 percent as the result of improvements in membrane technology, correction of existing membrane deficiencies, and implementation of appropriate membrane cleaning and replacement procedures."

Page 27, Section 4.1.1

First sentence of third paragraph, reference should be replaced with (LARWQCB Resolution 94-009, 1994).

Page 27, Section 4.1.1

Second bullet third sentence should be replaced with:

"A consultant study commissioned by BOE evaluated the potential for deep well injection of concentrate below the TIWRP site at depths ranging from 1,500 feet to 3,000 feet. "

Page 29, Section 4.1.3

Delete second bullet item and delete second row in Table 4-1. Palos Verdes Reservoir is not being considered for seasonal storage in the RWMP effort.

City of Los Angeles
Recycled Water Master Plan

Task 4

Terminal Island Water Reclamation Plant Opportunities Technical Memorandum

Prepared For:

Los Angeles Department of Water and Power

City of Los Angeles, Department of Public Works

Prepared By:

RMC in association with CDM

February 18, 2010

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Technical Memorandum

Title:	**Terminal Island Water Reclamation Plant Opportunities Technical Memorandum**
Version:	DRAFT
Prepared For:	John Hinds, Project Manager & Task 4a Lead, LADWP Doug Walters, Project Manager, BOS Lenise Marrero, Task 4a Co-Lead, BOS
Prepared by:	Brian Dietrick, Task 4 Project Engineer, RMC John Thayer, RMC Miluska Propersi, RMC
Reviewed by:	Steve Clary, Task 4 Lead, RMC Tom Richardson, Project Manager, RMC Heather Boyle VanMeter, Deputy Project Manager, CDM Marilyn Bailey, RMC Rachael Wark, RMC
Date:	February 18, 2010
Reference:	Task Order 4a: Concept Report for Maximizing Reuse Task 4.2 Identification of Projects Task 4.2.2 TIWRP Opportunities

1. Introduction

With imported water supplies becoming ever more unpredictable, the Los Angeles Department of Water and Power (LADWP) adopted the Mayor's vision of Securing LA's Water Supply in May 2008, calling for 50,000 acre-feet per year (AFY) of potable supplies to be replaced by recycled water by 2019. To meet this near-term challenge and plan for expanding reuse in the future, LADWP has partnered with the Department of Public Works to develop the Recycled Water Master Plan (RWMP). The RWMP includes seven major tasks:

- Groundwater Replenishment (GWR) Master Plan
- Non-Potable Reuse (NPR) Master Plan
- Groundwater Replenishment Treatment Pilot Study
- Max Reuse Concept Report
- Satellite Feasibility Concept Report
- Existing System Reliability Concept Report
- Training

The importance of additional water supply options for Los Angeles has become increasingly apparent with continuation of drought conditions, building contention for limited available water supplies both statewide and across the Southwest, and growing awareness of the critical nexus between quality of life/economic stability and available supplies of quality water.

This technical memorandum (TM) is a deliverable under Task 4a: Concept Report for Maximizing Reuse.

1.1 Task 4 Overview

The purpose of Task 4 is to research and identify project options that have the potential to maximize the beneficial reuse of effluent produced, or potentially produced, at three of the City of Los Angeles' (City's) existing treatment plants: Hyperion Treatment Plant (HTP), Los Angeles-Glendale Water Reclamation Plant (LAG), and Terminal Island Water Reclamation Plant (TIWRP). Specifically, Task 4 will identify potential opportunities that would increase the City's reuse beyond the 50,000 AFY goal established in Task 2. Opportunities to maximize reuse from the Donald C. Tillman Water Reclamation Plant (DCT) are covered under Task 1.

Task 4a identifies a wide array of potentially feasible wastewater diversion, flow equalization, and treatment expansion and/or upgrade projects that would maximize recycled water production from the existing treatment plants; identifies local and regional indirect potable reuse opportunities (including interconnections with neighboring agencies) that could provide a mechanism for beneficial reuse of the maximized recycled water; and identifies non-potable reuse projects that could be served by any remaining and expanded recycled water sources including interagency interconnections.

1.2 Purpose of TM

The TIWRP Opportunities TM identifies potentially feasible project options that would produce 12.5 mgd of injection barrier or high-quality industrial source water from TIWRP. It documents projected influent flows, available area for recycled water treatment processes at the TIWRP site, and previous findings with respect to GWR and NPR market demands in the vicinity of TIWRP.

The TM also documents the assumed treatment technologies, appropriate process capacities, and the facilities needed to deliver tertiary effluent to the recycled water treatment process and return residuals (i.e., concentrate and filtration reject/backwash flows) to TIWRP. It identifies concentrate management issues and preliminary strategies. It also includes a discussion of flow equalization needs, and recommended site layouts for treatment facilities. The TM concludes with a discussion of special issues (including discharges to the Harbor and operational challenges), preliminary conveyance routes, and an order of magnitude cost estimate for maximizing recycled water production.

Information developed in this TM will be used in Task 4b of the study to develop integrated system-wide recommendations regarding the amount of recycled water production that should be sited at TIWRP.

1.3 Related Technical Memoranda

Other related technical memoranda summarizing basic research for the Maximizing Reuse Concept Report include the following:

- Advanced Water Treatment Technology TM (Task 1.4)
- Existing and Tier 1 Recycled Water Systems (Task 2.1.1)
- Tier 2 Target Non-Potable Customers Overview TM (Task 2.2)
- Treatment Plant Review TM (Task 4.1.1)
- Regional Recycled Water System TM (Task 4.1.2)
- Regional Groundwater Assessment TM (Task 4.1.3)
- LA River Flow Assessment TM (Task 4.1.4)
- LAG Opportunities TM (Task 4.2.1)
- HTP Opportunities TM (Task 4.2.3)
- Wastewater Flow Projection TM (Task 5.1.1)
- Satellite Reuse Plant Options Admin Draft TM (Task 5.2.5)

1.4 Summary of Findings

This TM describes the development of 12.5 mgd of advanced treated recycled water production at TIWRP by expanding the treatment capacity to 16.2 mgd (the 2040 projected flow within the TIWRP sewershed). The two project options include preliminary layouts for facilities with and without 50 percent treatment redundancy, assuming two different scenarios for failsafe discharge of treated effluent as explained below.

The 12.5 mgd advanced treated recycled water production estimate is based on the following findings and assumptions:

1. Influent flows at TIWRP will remain relatively constant between 2009 and 2040. Consistent with this assumption, the average annual influent flows at TIWRP are projected to be 16.2 mgd in 2040.

2. In-plant uses at TIWRP are non-consumptive (i.e., spray-down water, tank cleaning water, and foam control for the aeration basins) and therefore total consumptive loss is assumed to be negligible. As such, 16.2 mgd would be available for advanced treatment by 2040.
3. Recommended improvements to plant operations will increase the recovery rate to 77 percent, thereby resulting in a recycled water production capacity of 12.5 mgd. It should be noted that the plant currently experiences a recovery rate of 71 percent, which would yield a production capacity of 11.5 mgd using an influent flow rate of 16.2 mgd.
4. Up to 12.5 mgd of recycled water production capacity can be located on-site at TIWRP. Production capacity is limited by influent flows.
5. Advanced treatment of the recycled water will be required to meet regulatory requirements for direct injection to a groundwater aquifer and/or specialized industrial uses. The assumed treatment process involves microfiltration (MF), reverse osmosis (RO), and advanced oxidation processes (AOP), collectively called advanced water treatment (AWT). AOP treatment removes potential constituents of emerging concern (CEC).
6. Recycled water production capacity will not be limited by concentrate disposal. It is assumed that concentrates and other residuals will be managed using one or more of the following: (1) the existing Harbor outfall, (2) the Los Angeles County Sanitation Districts (LACSD) ocean outfall, (3) a regional concentrate pipeline, or (4) deep well injection using abandoned oil wells on the TIWRP site. The maximum anticipated flow of concentrate and MF residuals would be approximately 3.7 mgd for facilities producing 12.5 mgd of recycled water.

Table 1-1 summarizes the potential recycled water production that could be implemented at TIWRP, assuming different concentrate discharge options and flow equalization.

The estimated capital cost of building AWT facilities for a total recycled water production capacity of 12.5 mgd is $85.3 million (or $128.8 million with 50 percent MF/RO treatment redundancy) in December 2009 dollars.

Table 1-1: Summary of Project Options

	Project Option 1	Project Option 2
Description	**Continued Use of Harbor Outfall**	**No discharge to Harbor Outfall**
Fail Safe Disposal Method	Harbor Outfall	Recycled Water Users
AWT Level of Redundancy	Standard	50%
Concentrate Disposal Option	Harbor Outfall	LACSD outfall, regional concentrate pipeline, or deep well injection
Water Quality Produced	MF/RO/AOP	MF/RO/AOP
Tertiary Effluent Flow, mgd(1)	16.2	16.2
Total MF/RO Feed Flow Rate, mgd(1)	16.2	16.2
Total RW Production, mgd(2)	12.5	12.5
Total Volume RW Produced, AFY	14,000	14,000
Total Equalization Volume Provided, MG	2	2
Estimated Capital Cost(3)	$85.3 million	$128.8 million
Estimated O&M Costs(4)	$6.7 million/year	$7.1 million/year

(1) Projected influent flow for 2040 is 16.2 mgd.
(2) Current recovery rate is 71% but assumed recovery rate with plant improvements is 77%.
(3) Estimated capital costs do not include pumping, conveyance, or seasonal storage.
(4) Includes power, chemicals, labor, membrane replacement, compliance monitoring, plant refurbishment, UV lamp replacement, and contract maintenance

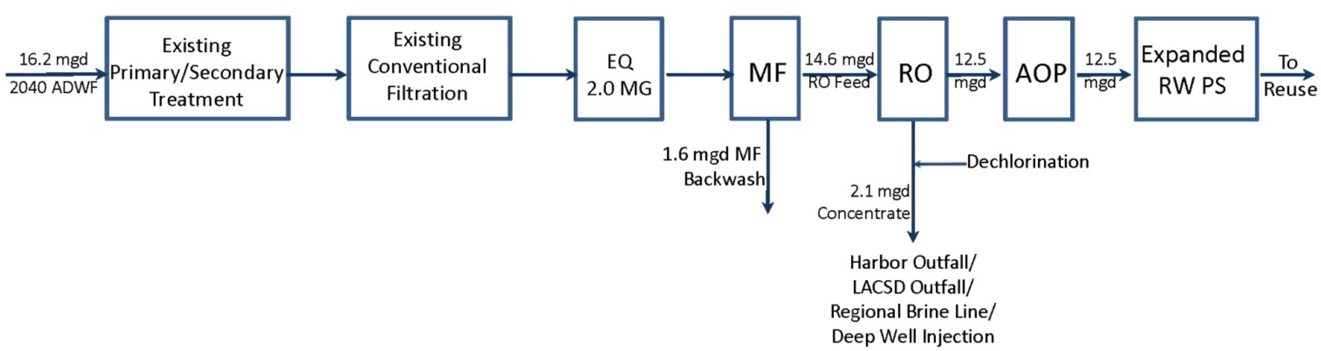
Other findings in this TM include:

- On-site available areas for equalization and AWT expansions include the area north of the existing microfiltration facility, east of the existing reverse osmosis facility and the chlorine contact basin. Other areas previously discussed in the 4.1.1 Treatment Plant Review TM are not needed to expand the total recycled water production capacity to 12.5 mgd.
- Recycled water production capacity exceeds the potential non-potable reuse demands in the vicinity of TIWRP. However, the production capacity could be fully-utilized if groundwater replenishment projects and/or groundwater exchanges are implemented.
- If discharge to the Harbor Outfall is not possible, adding 50 percent redundancy to the facilities would increase reliability and allow the recycled water to be distributed to potential users as an alternative failsafe disposal method. Construction of the redundant facilities would require multi-story construction of the MF/RO facilities.
- Assuming discharge is allowed to continue to the Harbor Outfall, increased concentrations of copper and lead (resulting from increased recycled water production to 12.5 mgd) will impact the ability to comply with NPDES permit limits.
- Reduced flows to the Harbor Outfall are not likely to impact the operation of the outfall itself unless flows to the outfall are reduced to approximately 1.5 mgd.

- TIWRP reliability issues with lime saturation, membrane fouling, and power outages will be resolved and the production capacity of the existing AWTF will be restored to 5.0 mgd before additional facilities are added to expand the production capacity to 12.5 mgd.
- Seasonal storage would only be necessary if industrial customers and groundwater replenishment demands approach the production capacity of the plant. Approximately 100 MG of seasonal storage volume could be required to supply the irrigation demands identified in Task 2 for the Harbor Area.
- Three preliminary conveyance alignments across the Harbor Channel are identified (1) west, towards to San Pedro, (2) northwest, under Vincent Thomas Bridge (3) north, parallel to the existing recycled water pipeline.

A schematic diagram of the projected water balance at TIWRP is shown in **Figure 1-1**.

Figure 1-1: TIWRP Projected (2009-2040) Water Balance



2. Summary of Background Information

2.1 Water Balance

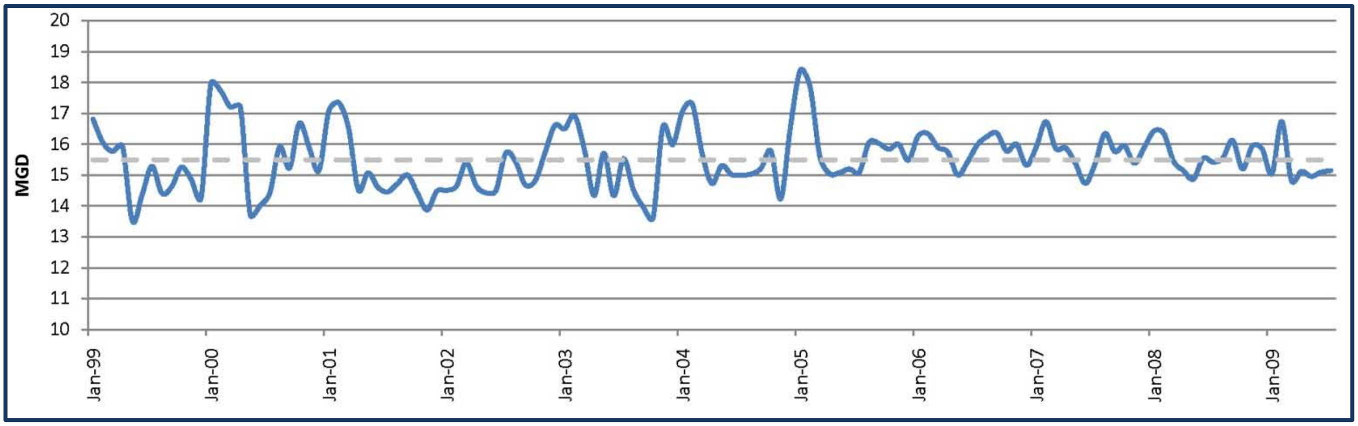
TIWRP is located on a 22-acre site on Terminal Island in the port area of San Pedro, within the City of Los Angeles, near the entrance to the Los Angeles Harbor. TIWRP has a permitted average dry weather flow (ADWF) tertiary treatment capacity of 30 mgd and is currently operating at an average influent flow rate of 15.4 mgd (May 2008 through July 2009). TIWRP treats raw sewage from the Terminal Island Service Area (TISA). The treatment plant discharges undisinfected tertiary effluent on a continuous basis through its permitted harbor outfall into the Los Angeles Harbor, which is hydraulically connected by the harbor entrance to the Pacific Ocean. TIWRP also has a 5.0 mgd capacity Advanced Wastewater Treatment Facility (AWTF), which consists of microfiltration membranes, reverse osmosis membranes, and disinfection with sodium hypochlorite. Advanced treated disinfected effluent from TIWRP is sent to Dominguez Gap Seawater Intrusion Barrier and Harbor Generating Station (HGS), while concentrates and other residuals are dechlorinated and then discharged through the Harbor Outfall to San Pedro Bay.

2.1.1 Historic and Current Flows

Historic Influent Flows Trends

Influent flow rates at TIWRP appear to be relatively consistent over time as shown in **Figure 2-1**. From January 1999 through July 2009, average influent flows, ranged from 13.5 mgd to 18.4 mgd with a ten-year overall average of 15.5 mgd, similar to the average influent of 15.4 mgd for May 2008 through July 2009.

Figure 2-1: Monthly Average Influent Flows
January 1999 through July 2009

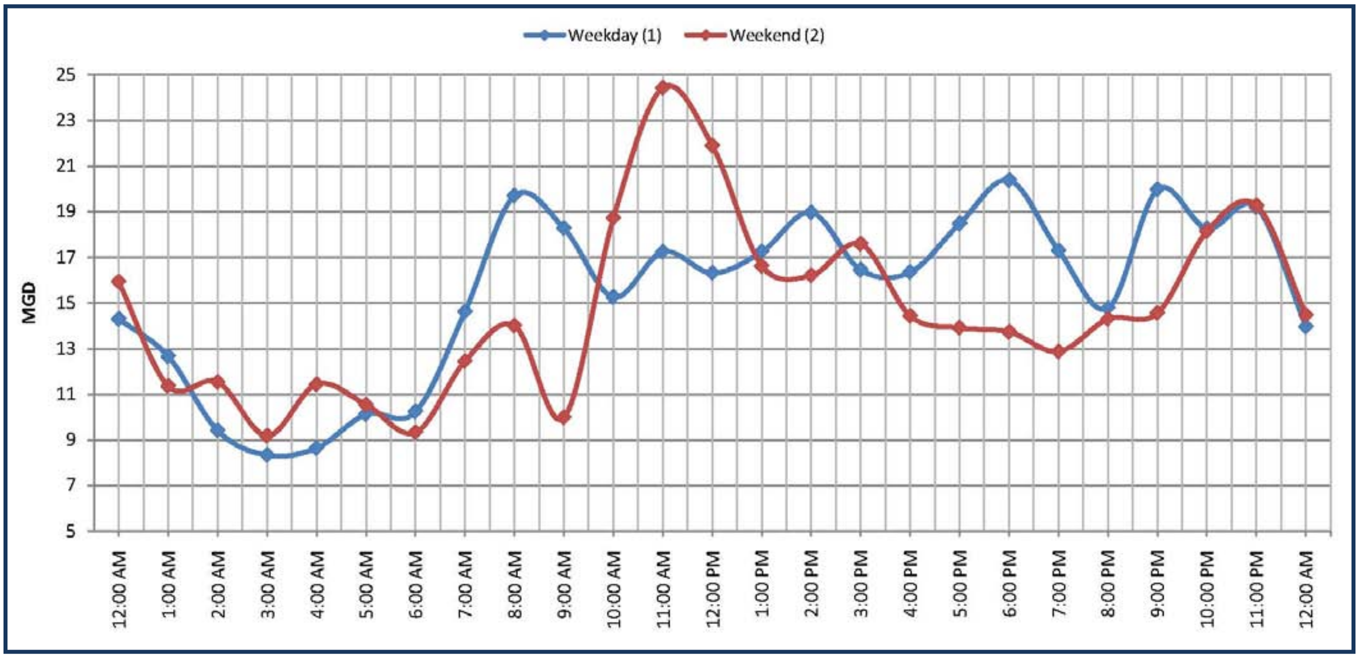


Source: City of Los Angeles, Bureau of Sanitation (BOS), 2009

Diurnal Influent Flows

Daily fluctuations in hourly influent flows (i.e., diurnal curves) are shown in **Figure 2-2** for weekdays and weekends in June and July of 2009. Because all of the influent enters the plant through pumped force mains, the diurnal variations are influenced by pump station operations. Minimum hourly flows for the months of June and July 2009 (8.3 mgd) occurred during the weekday period and maximum hourly flows for the months of June and July 2009 (24.4 mgd) occurred during the weekend period (RMC/CDM, 2009a). The nominal design peak wet weather capacity of TIWRP is 55 mgd (CH:CDM, 2005).

Figure 2-2: Diurnal Dry Weather Influent Flows



Source: BOS, TIWRP Operations Daily Log, Summary of Overall Treatment

(1) Weekday: Wednesday, June 10, 2009
(2) Weekend: Sunday, July 19, 2009

Effluent Flows and Current Water Balance

In-plant use of effluent at TIWRP is limited to spray-down water, tank cleaning water, and foam control for the aeration basins. None of these uses are continuous and therefore it is assumed that the amount of in-plant consumptive use is negligible.

The daily volume of flow discharged to the Harbor outfall consists of the tertiary effluent flow, concentrates and other residuals discharged from the reverse osmosis membranes, and a percentage of the advanced treated product water which is wasted back to the outfall for operational reasons. The average daily flow of tertiary effluent to the outfall is approximately 11.6 mgd (May 2008 through July 2009). Approximately 0.6 mgd of concentrates/residuals and approximately 0.5 mgd of AWT product water are discharged to the outfall as well, for a total of 12.7 mgd.

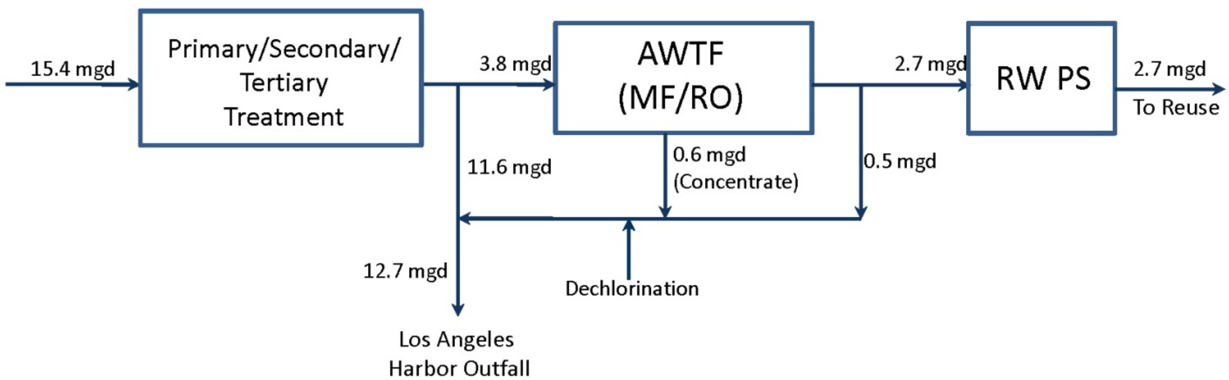
Advanced treated product water from the AWTF is pumped to injection wells that introduce the water into the Dominguez Gap Seawater Intrusion Barrier. The product water is also supplied to irrigation uses at Harbor Generating Station.

The product water from the MF/RO system is permitted for injection at the Dominguez Gap Barrier to control seawater intrusion under Order No. R4-2003-0134 and for irrigation and industrial uses under Order No. R4-2003-0025. The current permits allow LADWP and the Water Replenishment District of Southern California (WRD) to deliver approximately 5.0 mgd of RO-treated water to the Dominguez Gap Barrier as part of the Harbor Water Recycling Project – Dominguez Gap Barrier Project (Phase I), which began operating in 2003. The permit requires a

50/50 blend of recycled water and potable water over a five-year span from the initial delivery date (MWH, 2007).

Excess RO product water is dechlorinated and returned to the Harbor Outfall. **Figure 2-3** shows TIWRP's existing water balance.

Figure 2-3: TIWRP Current Water Balance (May 2008 through July 2009)



2.1.2 Anticipated Influent and Effluent Flows

<u>Influent Flows for 2040</u>

Wastewater flow projections for the entire TISA can be found in the Task 5.1.1 Wastewater Flow Projection TM, which predicts the change in collection system flow rates between now and 2040. For the Year 2040, the predicted population of the TISA is 197,000 inhabitants and the projected ADWF for TIWRP is 16.2 mgd. Projected flows are based on projected population (residential and commercial), groundwater infiltration and industrial flow (RMC/CDM, 2009b).

<u>Projected Effluent Flows for 2040</u>

Assuming no in-plant consumptive losses for the primary and secondary processes (BOS, 2009), approximately 16.2 mgd of tertiary effluent would be available for advanced treatment in 2040.

2.2 Area Available for New Recycled Water Facilities

2.2.1 Background

TIWRP is located on the west side of Terminal Island, an artificial island located west of the Port of Long Beach and south of San Pedro. Terminal Island is a fully-utilized container and bulk terminal owned by the Port of Los Angeles, and there is no room for the TIWRP site to expand in any direction. Instead, the City of Los Angeles, the Bureau of Sanitation (BOS) and the City of Los Angeles, Bureau of Engineering (BOE) have used the 22-acre site to continue to improve TIWRP from a small primary treatment plant to its current tertiary treatment capacity of 30 mgd, plus 5 mgd advanced treatment. All areas are occupied either with current active process facilities, administrative support facilities, maintenance and operational support facilities, or decommissioned (former) process facilities. Therefore, to determine space available for new recycled water facilities, the Consultant team worked with BOS and BOE staff to determine locations of "under-utilized" area at the TIWRP, which is defined as: (1) space with decommissioned process facilities; (2) currently-utilized space above which AWT facilities could be built; or (3) existing buildings inside of which new facilities could be built. It is important to note the distinction between below-grade available space and above-grade available space. Some areas can feasibly be used for both above and below-grade construction, and some areas are more suitable for only above-grade construction.

2.2.2 Available On-Site Areas

Figure 2-4 shows the locations of available under-utilized space on the TIWRP site, as identified by BOS and BOE staff. The figure also shows portions of the site that represent main utility corridors. At the January 19, 2010 meeting attended by numerous representatives of LADWP, BOE, BOS, and the Consultant team, these areas were specifically earmarked by BOS and BOE as potential candidates for siting future recycled water treatment infrastructure. **Table 2-1** summarizes these locations, which are described in more detail below:

- *North of Existing Microfiltration Facility* (approximate area: 25,200 ft^2, 0.6 acres): The existing MF facility is located in the southwestern area of the site. During design of the AWTF, this area was designated for future expansion of the MF system.
- *East of Existing Reverse Osmosis Facility and Chlorine Contact Basin* (approximate area: 10,800 ft^2, 0.3 acres): The existing RO building is located east of the MF building and west of the digesters. During design of the AWTF, this area was designated for future expansion of the RO system.
- *Future Process Stacking Above Chlorine Contact Basin* (approximate area: 3,000 ft^2, 0.1 acres): The chlorine contact basin is located northeast of the RO Facility.

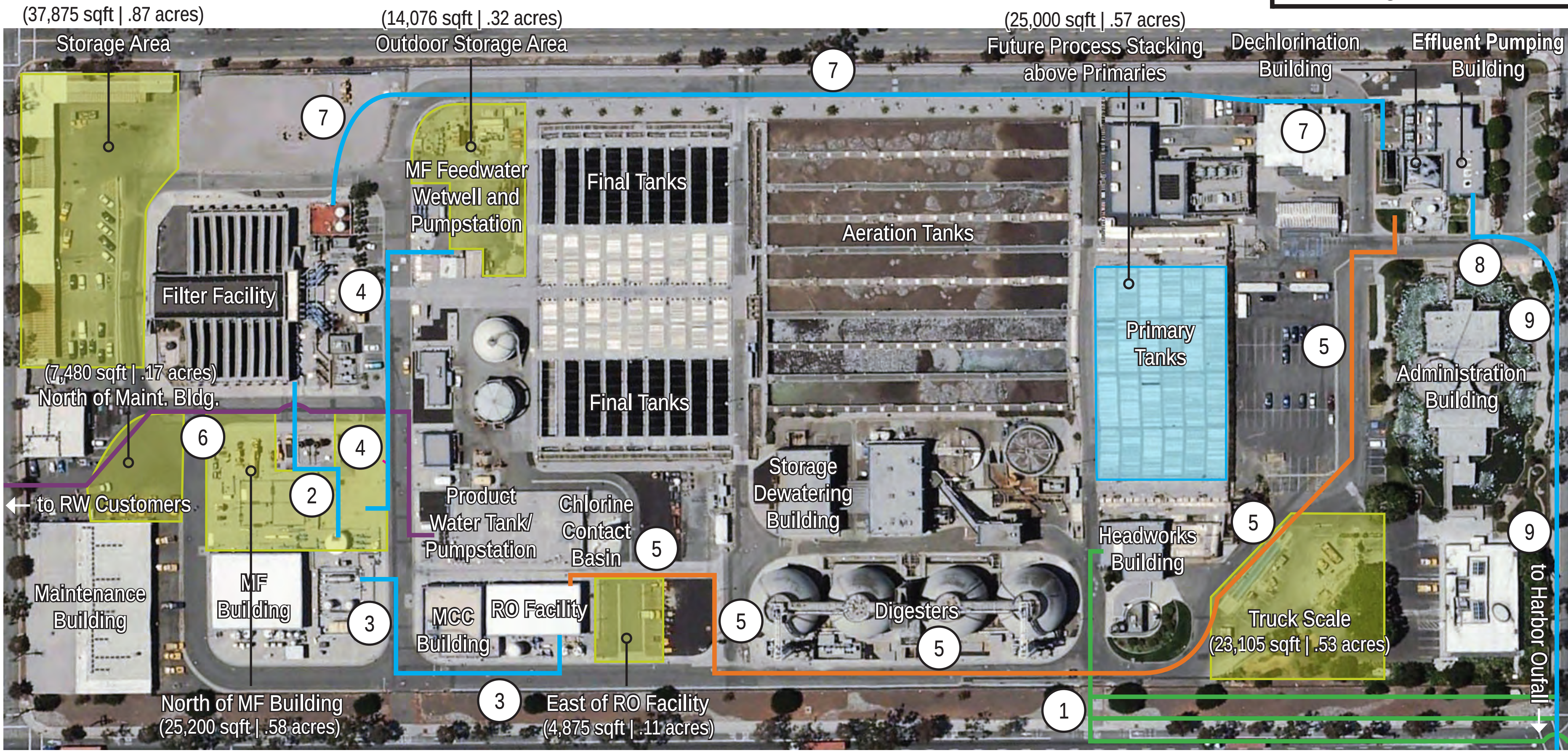
The various on-site available areas are summarized in **Table 2-1**. Approximately 1.0 acre is available, and of that area, approximately 0.3 acres are available for below-grade construction.

Table 2-1: TIWRP Potential Locations for Future Treatment Infrastructure

Location	Above-Grade Estimated Area		Below-Grade Estimated Area	
	acres	ft^2	acres	ft^2
North of Microfiltration Membranes	0.6	25,200		
East of RO and Chlorine Contact Basin	0.3	10,800	0.3	10,800
Future Process Stacking above Chlorine Contact Basin	0.1	3,000		
Total	**1.0**	**39,000**	**0.3**	**10,800**

Other available on-site areas were originally identified in the 4.1.1 Wastewater Treatment TM (also shown in Figure 2-4) by BOS at an earlier meeting, but are not needed to construct Project 1 and 2. These areas include the truck scale, the Construction Material and Hazardous Waste Storage Area, the area north of the Maintenance Building, the Outdoor Storage Area, and future process stacking above the primary tanks.

Terminal Island Treatment Plant Utilities Corridor
Figure No. 2-4



LEGEND

1. 54" Pretensioned Concrete Cylinder and Multiple Influent Forcemains
2. 3. 16" Microfiltration Filtrate
4. 24" Microfiltration Feed (Effluent)
5. 16" Reverse Osmosis Brine
6. 24" Product Water
7. Effluent Box Conduit
8. 48" Final Effluent Force Main Outfall
9. 30" Final Effluent

Note: Electrical Underground Utilities Not Shown

- Influent
- Tertiary Effluent
- Advanced Treated Effluent
- Brine
- Under-utilized Space/Potential Future Tertiary (Ground Level)
- Under-utilized Space/ Potential Future Tertiary (Process Stacking)

0 75' 150' 300'

City of Los Angeles
Recycled Water Master Plan

RMC in association with CDM

Source: Google Earth Pro, 2009

2.3 Potential Demands for Recycled Water from TIWRP

Currently, the average recycled water demand from TIWRP is approximately 3.2 mgd, and there are no identified Tier 1 demands (RMC/CDM, 2009c).

Potential future market demands for recycled water were identified in the Task 4.1.3 Regional Groundwater Assessment TM and the Task 2.2 Tier 2 Target Non-Potable Customers Overview TM. The total recycled water demands in the vicinity of TIWRP could potentially reach up to approximately 26,000 AFY (23 mgd expressed as annual average recycled water production). These demands are summarized in **Table 2-2** and are based on the following assumptions:

- Existing uses at the Dominguez Gap Seawater Intrusion Barrier (DGB) and Harbor Generating Station will continue (RMC/CDM, 2009c).
- Tier 1 NPR customers for the Harbor Area will be supplied by West Basin Municipal Water District and not from TIWRP (RMC/CDM, 2009c).
- Tier 2 NPR customers for the Harbor Area will be supplied by TIWRP (RMC/CDM, 2009d).
- TIWRP could provide additional recycled water to the DGB in the amount of approximately 4,000 AFY. TIWRP could also provide recycled water to industrial customers in the Harbor Area that currently use groundwater. These groundwater exchanges could potentially create demands for up to 17,000 AFY of recycled water (RMC/CDM, 2009d).

Table 2-2: Potential Future Demands for Recycled Water from TIWRP

Description	Potential Demand (AFY)	Annual Average RW Production (mgd)
Existing LADWP	3,600	3.2
LADWP Tier 1	0	0
LADWP Tier 2	1,230	1.1
Groundwater Replenishment	4,000	3.6
Potential Groundwater Exchanges	17,000	15.2
Total	**26,000**	**23**

Although non-potable demand amounts to only 4,830 AFY (4.3 mgd expressed as annual average recycled water production), groundwater replenishment and groundwater exchange demands could exceed the proposed 12.5 mgd production capacity at TIWRP. These combined demands could be at least partially supplied with the expanded treatment facilities described in Section 3.

3. Development of Projects

This section describes the two project options developed to maximize recycled water production at TIWRP:

- *Project Option 1*: This option provides treatment for all projected flows in the TIWRP sewershed (16.2 mgd) and assumes that the failsafe disposal method will be the Harbor Outfall.
- *Project Option 2:* This option provides the same treatment capacity as Project Option 1 but includes 50 percent treatment redundancy so that TIWRP may shift the failsafe disposal method from the Harbor Outfall to recycled water users.

3.1 Project Option 1

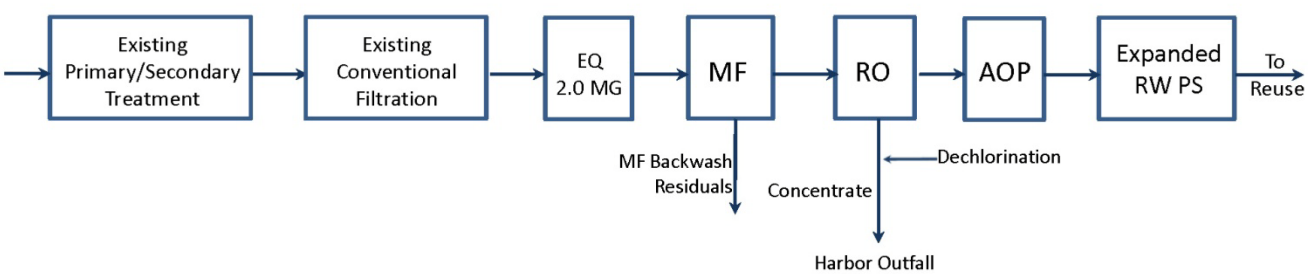
This section describes the assumed level of treatment, treatment facilities, site layout, equalization requirements, and concentrate disposal strategy to treat the projected 2040 flow within the TIWRP sewershed assuming continued use of the Harbor Outfall.

3.1.1 Assumed Level of Treatment

Consistent with a "maximum reuse" scenario and with the facilities developed in Task 1 of the RWMP, this Project Option involves a level of treatment at TIWRP that would allow for groundwater direct injection and/or specialized industrial uses. The nearby Edward C. Little Water Recycling Plant (ELWRP) and Orange County Groundwater Replenishment System (GWR System) facilities serve as the industry standard in Southern California for the production of recycled water suitable for groundwater injection. The process train used at these facilities consists of 2 MG of tertiary effluent equalization (see Section 3.1.4), Microfiltration (MF) to remove turbidity and suspended solids, followed by Reverse Osmosis (RO) to remove dissolved solids, followed by advanced oxidation (AOP) to remove CECs and provide disinfection of bacteria, viruses, and other waterborne pathogens. The MF/RO/AOP process also includes a post-stabilization step intended to raise the pH of the recycled water product water to within acceptable limits. Therefore, in assessing the production potential that could be sited at TIWRP, these processes were assumed. The proposed MF/RO/AOP treatment process flow is shown in **Figure 3-1**.

Even for traditional Title 22 uses, reverse osmosis treatment would likely be needed at TIWRP to reduce the Total Dissolved Solids (TDS) content of the secondary effluent. In 2008, the average influent TDS was 2,683 mg/L and maximum daily was 3,537 mg/L (RMC/CDM, 2009a). This TDS level would make tertiary-treated flows difficult or impossible to reuse. Some level of reverse osmosis treatment would be needed to reduce TDS to acceptable levels for customers.

Figure 3-1: Advanced Treatment Flow Diagram



3.1.2 Assumed Recovery/Production Rate

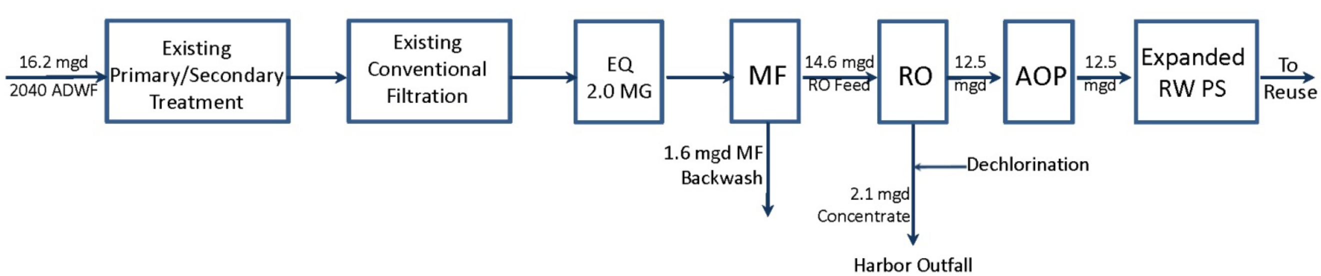
The existing average MF/RO recovery rate for TIWRP is 71 percent based on data from the eight-month period between December and July 2009. This recovery would yield a future recycled water production rate of 11.5 mgd with influent flows of 16.2 mgd. However, the recovery rate could potentially be increased up to approximately 77 percent as the result of improvements in membrane technology, correction of existing membrane deficiencies, and implementation of approximate membrane cleaning and replacement procedures. A 77 percent recovery rate would result in 12.5 mgd of advanced treated recycled water production. The site plans developed for this project option assume an overall target recycled water recovery rate of 77 percent (90% for MF and 85% for RO) based on pilot-scale data and membrane manufacturer claims.

It should be noted that the GWR System Treatment Plant, which is the largest MF/RO/AOP recycled water treatment facility currently operating in California, was designed for an overall worst-case recovery of 71 percent. Actual observed recoveries will depend on the generation of membrane technology used, the progression of membrane technology up to the point when TIWRP facilities are designed, and the water quality of the TIWRP tertiary effluent. The GWR System treatment facilities were constructed between 2005 and 2007, and the facilities went into operation in January 2008. While the GWR System facilities are still relatively new, there have been improvements to MF and RO technology since the GWR System was designed.

The target recovery rate of 77 percent for TIWRP is slightly lower than the recovery rate assumed for the Advanced Water Treatment Plant (AWTP) identified in Task 1 of the RWMP. As noted in TM (Task 1.4 Draft Advanced Water Treatment Technology Assessment), the recovery rate at DCT for the planned AWTP will be about 79 percent (93% for MF and 85% for RO). This is slightly higher than the recovery rate assumed for TIWRP due to the fact that DCT will be treating a lower salinity feed than the tertiary effluent used for source water at TIWRP (CDM, 2010). The Total Dissolved Solids (TDS) of the RO feedwater at TIWRP is approximately 2,868 mg/L whereas at DCT the influent TDS is approximately 583 mg/L. The lower water quality at TIWRP should result in a lower overall recovery compared to DCT.

Figure 3-2 shows the treatment process flow for Project Option 1, including 2 MGD of equalization.

Figure 3-2: Project Option 1 Water Balance



3.1.3 Site Layout

Figure 3-3 shows a preliminary conceptual layout for future MF/RO/AOP facilities to expand TIWRP from its existing production capacity of 5.0 mgd to 12.5 mgd. This is a layout of the facilities that would be required to produce advanced treated recycled water meeting the quality requirements for groundwater injection[1]. Calculations were performed to estimate the floor space requirements for each process component; recycled water production for each available area was maximized based on these calculations. It is assumed that multi-story construction is feasible. It is also assumedthat maximum reasonable excavation below grade for EQ, without resorting to exorbitantly costly construction measures, is approximately 40 feet below the ground surface (allowing for concrete slab thickness and over-excavation).

Available space would be utilized for Project Option 1 as follows:

- *MF Feed Pump Station*: This pump station is shown expanded from its current location east of the filters.
- *MF Membranes and Supporting Chemical Storage/Feed Facilities*: These facilities are expanded on the available space to the north and east of the existing MF membranes.
- *RO Membranes and Supporting Chemical Storage/Feed Facilities*: These facilities are expanded on the available space to the north and northeast of the existing RO membranes.
- *AOP and Post Treatment Chemical Storage Facilities*: These facilities are shown installed on the east and west sides of the existing chlorine contact tank. The UV and ancillary electrical facilities are shown installed on top of the existing chlorine contact tank. It is assumed that a structural canopy would cover the UV and electrical facilities.
- *RO Product Water Pump Station*: This pump station is shown expanded in its current location on top of the existing chlorine contact basin.
- *Equalization Basin*: The 2 MG equalization basin is a rectangular cast-in-place basin underneath the new RO Building, with the top slab at existing grade elevation. The same basin could provide secondary effluent equalization if the filters are bypassed, and secondary effluent is applied directly to the MF membranes without going through conventional filtration.

The design recycled water production of 12.5 mgd is equivalent to approximately 14,000 AFY of recycled water suitable for irrigation, industrial uses, groundwater injection and groundwater recharge. A portion of the RO facilities could be designed as dual-pass to meet select industrial uses requiring ultra-pure product water for various refinery and boiler feed applications, but a separate distribution pipeline would be required for those flows.

Although the existing membrane trains are covered only by structural canopies, BOS expressed a preference for enclosed buildings. This preference will not change the footprint of the treatment facilities in this conceptual analysis, but it would increase the cost estimates presented in Section 5 (which assume a level of structural improvements similar to the original AWTF).

[1] This layout also applies to a scenario serving non-groundwater demands (no AOP). Under this scenario, peroxide facilities would not be necessary and the UV dose and footprint would be smaller.

PLAN
APPROX SCALE: 1" = 80'-0"
(AT HALF SIZE)

0 40' 80'
APPROX SCALE: 1" = 80'-0"
(AT HALF SIZE)

LEGEND

TIWRP PRELIMINARY AWTF LAYOUT

1. EXISTING LIME SILO
2. PROPOSED LIME SILOS
3. EXISTING RO MEMBRANES
4. PROPOSED RO MEMBRANES AND RO ELECTRICAL ROOM. 2.0 MG EQ BASIN BELOW GRADE (60'x180'x25')
5. EXISTING MF MEMBRANES
6. PROPOSED MF MEMBRANES AND MF ELECTRICAL
7. PROPOSED CHEMICAL STORAGE/HYPOCHLORITE/ CITRIC/SULFURIC/BREAK TANK
8. PROPOSED CHEMICAL STORAGE AREA - SULFURIC/CITRIC/ HYPOCHLORITE/ THRESHOLD INHIBITOR
9. PROPOSED CHEMICAL STORAGE AREA - HYDROGEN PEROXIDE AND AMMONIA
10. UV UNITS PLUS UV ELECTRICAL ON TOP OF EXISTING CHLORINE CONTACT BASIN. INSTALL STRUCTURAL CANOPY OVER UV UNITS.
11. EXISITING PRODUCT WATER PUMP STATION
12. EXPANDED PRODUCT WATER PUMP STATION
13. EXISTING MF FEED PUMP STATION
14. EXPANDED MF FEED PUMP STATION
15. EXISTING MF/RO ELECTRICAL BLDG.

PROPOSED FACILITIES

PRELIMINARY

C:\RMC\(0214) LADWP\214-002 TASK 4-SUBTASK 2\TERMINAL ISLAND\EMAIL OUTBOX\TI SITE PLAN.DWG
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0" 1" VERIFY SCALES BAR IS ONE INCH LONG ON FULL SIZE DRAWING. IF NOT ONE INCH LONG ON THIS DRAWING, ADJUST SCALES ACCORDINGLY	RMC Water & Environment	REV / DATE / BY / APVD / DESCRIPTION	DESIGNED / DRAWN / CHECKED	SUBMITTED: RMC PROJ ENGR C____ APPROVED: RMC ENGR C____	**Figure 3-3** Terminal Island Water Reclamation Plant MF/RO/AOP Site Layout	DWG NO / SHEET NO 1 OF 1 / PROJ NO 0000-000 / DATE February 2010

3.1.4 Need for Flow Equalization

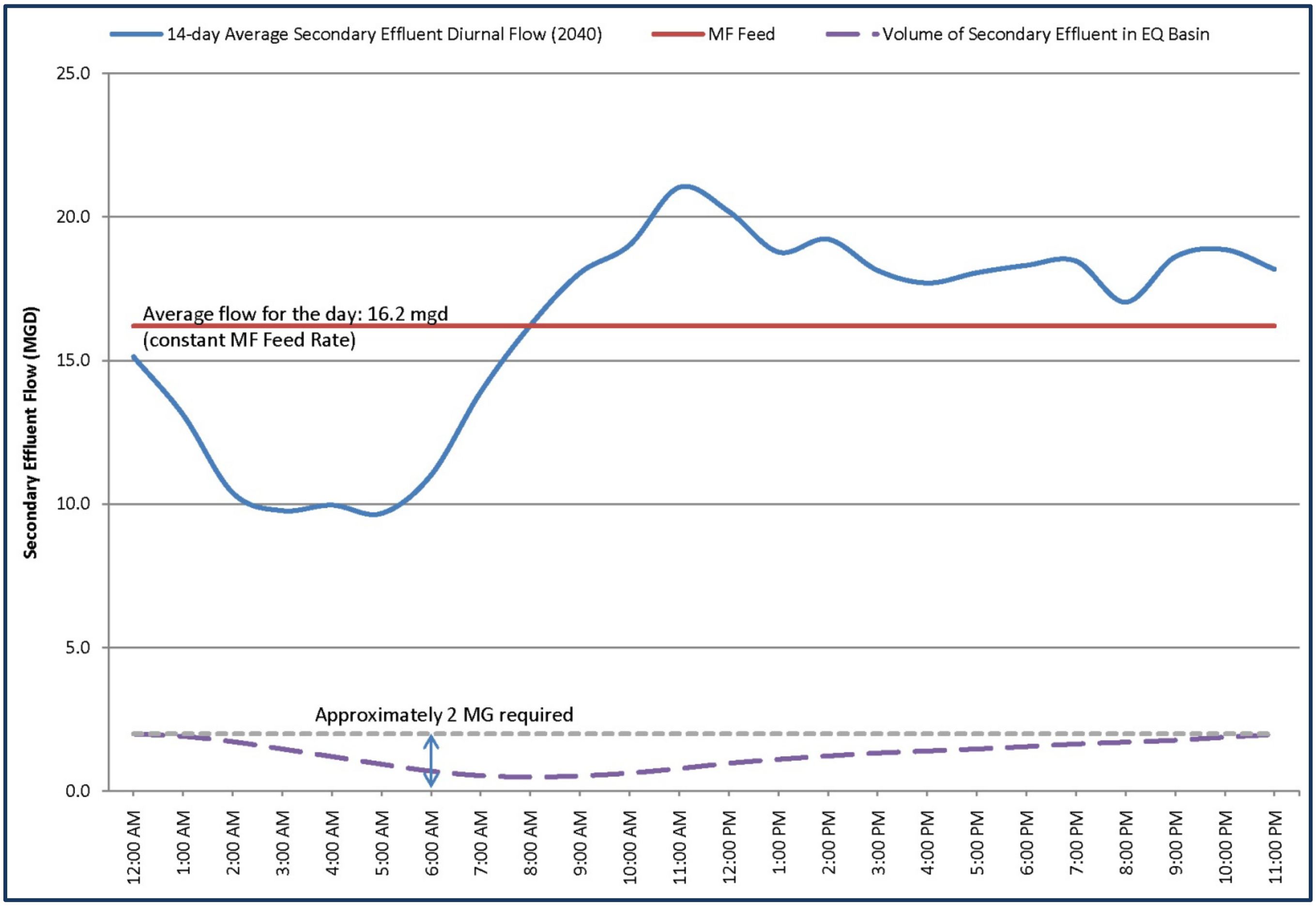
Equalization (EQ) for tertiary effluent (or secondary effluent) would provide a constant MF feed flow rate and maximize production of recycled water by capturing daytime diurnal flows that exceed the MF feed capacity.

EQ allows the MF/RO/AOP facility to continue producing recycled water at full capacity during the nighttime hours, when the drop in diurnal flow decreases the instantaneous supply of secondary effluent available. This would increase the percentage capture of secondary effluent for reuse and minimize discharge to the Harbor Outfall. Another benefit provided by EQ is the improved process performance and reliability gained by avoiding steep flow variations over the day. As shown by the diurnal flow curves in Figure 2-2, the influent flow rate is highly variable throughout the day. An EQ basin would improve the process performance of the membranes by avoiding steep flow variations and the need to take individual membrane trains out of service on a frequent basis.

Figure 3-4 shows a 14-day average diurnal secondary effluent flow during June and July 2009, the constant MF feed flow rate, and the EQ storage volume required to capture 100% of the available secondary effluent. Approximately 2 MG of EQ is required at TIWRP to equalize the tertiary effluent flow (or secondary effluent flow) except in rare cases when the diurnal influent flow fluctuates outside its typical range.

The site layout assumes that the EQ basin would be installed between the tertiary filters and the AWTF. Alternatively, EQ could be placed downstream of the primary tanks to achieve base loading of influent flows to the secondary aeration tanks; but this may be unnecessary since the existing secondary facilities have a rated capacity of 30 mgd, providing a significant buffer in maintaining nitrification/denitrification performance during diurnal peaks. Also, primary EQ could present operational challenges such as biosolids accumulation and odors.

Figure 3-4: TIWRP Equalization Storage Calculation



Note: Diurnal curve is based on hourly data from one week in June and one week in July 2009. The 14-day average was scaled to projected 2040 secondary effluent flows.

3.2 Project Option 2

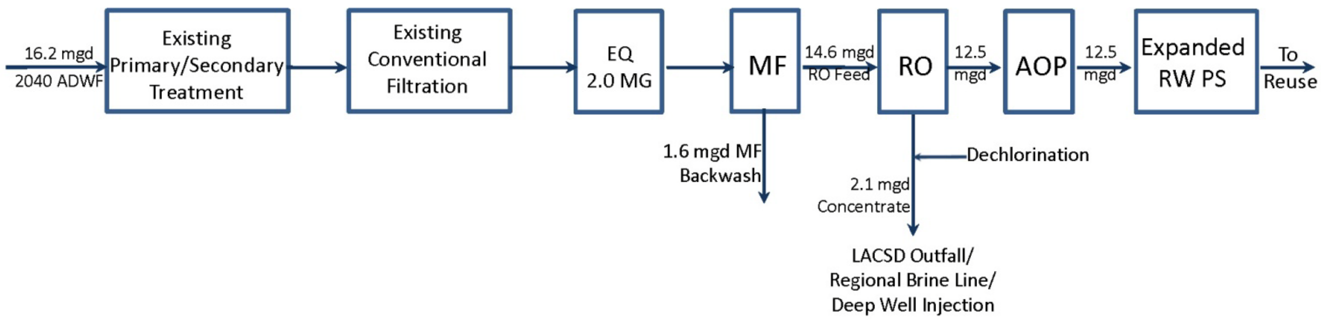
This section describes the assumed level of treatment, treatment facilities, site layout, equalization requirements, and concentrate disposal strategy to treat the projected 2040 flow within the TIWRP sewershed, assuming that the method of failsafe discharge is shifted from Harbor Outfall discharge to reuse customers. This shift may be necessary if the California Regional Water Quality Control Board, Los Angeles Region (RWQCB-LA) requires TIWRP to cease discharges of tertiary effluent to the Harbor as discussed in Section 4.1.1. To facilitate this shift and increase the reliability of the MF/RO/AOP system, Project Option 2 includes a 50 percent redundancy of the treatment facilities.

3.2.1 Assumed Level of Treatment and Recovery Rate

Project Option 2 assumes the same level of treatment as Project Option 1 (i.e., MF/RO/AOP with equalization), and assumes the same 77 percent recovery rate that results in a recycled water production rate of 12.5 mgd.

Figure 3-5 shows the treatment process flow for Project Option 2, including 2 MG of equalization.

Figure 3-5: Project Option 2 Water Balance



3.2.2 Redundancy of Treatment Facilities and Site Layout

TIWRP currently discharges to the Harbor Outfall; however, there is a permit requirement to discontinue tertiary discharges to the Harbor by 2020 (see Section 4.1.1). An alternative failsafe disposal method assumed for Project Option 2 is that the recycled water would be distributed to customers instead. In order for this to be a full-safe disposal method, additional redundancy is required. This additional redundancy would provide the extra benefit of improving reliability for potential industrial customers (e.g., power plants and oil refineries) that require a continuous source of water in terms of both quality and supply, 24 hours per day.

Project Option 2 includes 50 percent backup for the full 12.5-mgd production capacity of the MF/RO units. This redundancy would provide a higher degree of reliability for advanced treatment and would allow TIWRP to shift the failsafe disposal method from Harbor Outfall discharge to reuse customers. Concentrates and other residuals that are currently discharged to the Harbor Outfall would be managed by discharging to the LACSD outfall, to a regional concentrate pipeline, to deep well injection on-site, or to another disposal method[2].

The redundant MF/RO equipment would be constructed by stacking on the MF/RO equipment proposed in Project Option 1, as shown in Figure 3-3. The MF/RO facilities to provide 50 percent redundancy for the full 12.5-mgd production capacity can be accommodated within the footprint designated for the facilities in Project Option 1.

3.2.3 Need for Flow Equalization

Project Option 2 would also provide EQ for tertiary effluent (or secondary effluent) to maintain a constant MF feed flow rate and maximize production of recycled water by capturing daytime diurnal flows that exceed the MF feed capacity.

[2]BOS has expressed that discharge of RO concentrates and off-spec effluent to the Harbor Outfall may be possible under Order No. R4-2005-0024 after the year 2020 (RMC/CDM Meeting, 2010).

3.3 Summary of Project Options

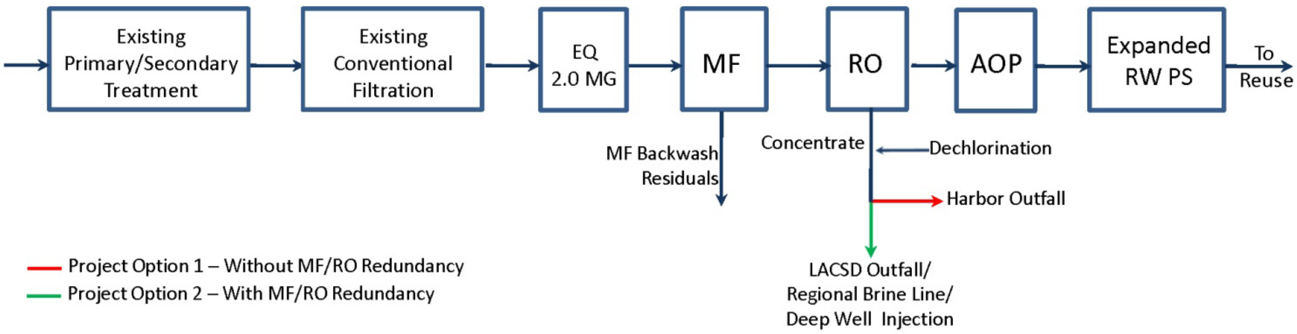
Two project options are summarized in **Table 3-1**, and illustrated in **Figure 3-6**.

Table 3-1: Summary of Project Options

	Project Option 1	Project Option 2
Description	**Continued Use of Harbor Outfall**	**No discharge to Harbor Outfall**
Fail Safe Disposal Method	Harbor Outfall	Recycled Water Users
AWT Level of Redundancy	Standard	50%
Concentrate Disposal Option	Harbor Outfall	LACSD outfall, regional concentrate pipeline, or deep well injection
Water Quality Produced	MF/RO/AOP	MF/RO/AOP
TIWRP Influent Q, mgd(1)	16.2	16.2
In-Plant Consumptive Use, mgd(2)	0	0
Tertiary Effluent Flow, mgd(3)	16.2	16.2
Total MF/RO Feed Flow Rate, mgd(4)	16.2	16.2
Total EQ Volume Provided, MG(5)	2	2
Tertiary to Harbor Outfall, mgd(6)	0	0
RO Concentrate, mgd(7)	2.1	2.1
Total RW Production, mgd	12.5	12.5
Total Volume RW Produced, AFY	14,000	14,000

(1) Influent flows are based on 77% recovery rate with 12.5 mgd recycled water production
(2) In-plant uses are all non-consumptive (e.g., spray-down water, tank cleaning water, foam control)
(3) Total AWT Feed (Including existing AWT flow)
(4) Total AWT Feed (Including existing AWT flow)
(5) See Section 3.3
(6) TIWRP tertiary effluent equals feed flow minus recycled water production
(7) TIWRP concentrate flows are based on 77% recycled water production (85% RO) (see Section 3.4)

Figure 3-6: TIWRP Scenarios Evaluated



3.4 Preliminary Conveyance Alignments

This section identifies preliminary conveyance alignments to serve non-potable customers and/or groundwater replenishment projects in the vicinity of TIWRP. The potential pipelines have been sized and aligned with major transportation corridors. Specific review of alignments will be conducted in Task 4b. Non-potable distribution systems will be identified as part of Task 2b.

Potential conveyance routes for recycled water from TIWRP are shown in **Figure 3-7**. The figure highlights an area with a 1-mile radius from the center of the treatment plant and indicates existing LADWP and Metropolitan Water District (MWD) potable pipelines, BOS existing and abandoned sewer pipelines, LADWP recycled water pipelines, and Los Angeles County Department of Public Works (LACDPW) storm drains. Only pipelines greater than 8 inches in diameter are shown.

There are three potential corridors across the Harbor Channel:

- West, parallel to the LADWP existing 20-inch diameter sewer and 20-inch diameter potable pipelines
- Northwest, under Vincent Thomas Bridge and parallel to the LADWP existing 30-inch diameter sewer pipeline
- North, parallel to the existing 36-inch diameter recycled water pipeline

Expansion of the AWTF at TIWRP could produce up to 12.5 mgd of recycled water. To convey this amount of recycled water from TIWRP, one 30-inch diameter pipe or two 18-inch diameter pipes would be needed.

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Terminal Island Water Reclamation Plant Potential Conveyance Routes

Figure 3-7

- Potential Conveyance Routes

Existing Facilities

- MWD Potable System >8"
- LADWP Potable System > 8"
- LABOS Sewer System > 8"
- Abandoned Sewer Pipes >8"
- Recycled Water System
- Storm Drains
- 12 Denotes Pipeline Diameter

Other Features

- Major Road
- TIWRP Boundary

0 250 500 1,000
Feet

RMC in association with CDM

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Data Sources: RMC, USGS, LADWP

4. TIWRP Special Issues

This section discusses specific recycled water issues considered as part of the evaluation of maximizing production capacity at TIWRP, including requirements to cease discharges to the Harbor, operational issues, seasonal storage, NPDES permit limitations, power requirements, and low flow impacts to the ocean outfall.

4.1.1 Requirement to Cease Discharges to the Harbor

Under existing conditions, tertiary treated municipal effluent from TIWRP and concentrate waste streams from the AWTF are discharged to the Los Angeles Harbor. These discharges are permitted by the RWQCB-LA under Order No. R4-2005-0024 and NPDES Permit No. CA 0053856.

In 1974, the SWRCB called for the discharge of municipal wastewaters and industrial process waters to enclosed bays and estuaries to be phased out at the earliest practicable date under the Enclosed Bays and Estuaries Policy. On June 27, 1977, RWQCB-LA issued Order No. 77-133 requiring the City to phase out TIWRP discharge to the Los Angeles Harbor (which has been defined as an enclosed bay) at the earliest practicable date or to demonstrate that the discharge enhances the quality of the receiving water. As of 1985, the City had not been able to successfully demonstrate that the receiving water quality would be enhanced, and the RWQCB-LA required that discharge to the Los Angeles Harbor be phased out (Order No. 85-77). In response, the Los Angeles County Department of Public Works (LACDPW) and the LADWP jointly proposed to phase out discharge to the Los Angeles Harbor through implementation of a water recycling plan. The City's proposal was approved by the RWQCB-LA on October 31, 1994 with the issuance of Resolution No. 94-009. As part of this resolution, the RWQCB-LA performed a modeling study that indicated concentrates did not impact the water quality in the Los Angeles Harbor area.

The City established a goal for total reuse of the TIWRP effluent by 2020, provided that it is economically feasible to expand and there is a demand for recycled water in the Harbor area (MWD, 2007).

Selection of an alternate disposal method for the plant effluent will depend heavily on the following two issues:

- *Recommended disposal method for the tertiary effluent*. A consultant study by Montgomery Watson Harza (MWH)[3] considered the following alternatives: (1) extending the existing TIWRP harbor outfall to the open ocean, (2) connecting to a future new outfall that LACSD has been considering in its long-term planning, (3) discharging effluent to the Los Angeles River, and (4) other alternatives. This study did not identify a preferred alternative, but it did rank alternatives. Connection to the future LACSD outfall received the highest ranking.
- *Recommended concentrate disposal method*. TIWRP has an understanding the RWQCB seeks to disallow concentrate discharges to the Harbor Outfall after the year 2020[4]. A consultant study commissioned by LADWP[5] evaluated the potential for deep well injection of

[3] Terminal Island Treatment Plant, Future Utilization Concept Report – Volume I, Montgomery Watson Harza, July 2007.
[4] BOS has expressed that discharge of RO concentrates and off-spec effluent to the Harbor Outfall may be possible under Order No. R4-2005-0024 after the year 2020 (RMC/CDM Meeting, 2010).
[5] Terminal Island Water Reclamation Plant Brine Well Injection Feasibility Study, Draft Report, AECOM, January 2009.

concentrate below the TIWRP site at depths ranging from 1,500 feet to 3,000 feet. The concept is to inject the concentrate above the injection point for the Terminal Island Renewable Energy biosolids, which are injected directly below the TIWRP site at depths ranging between 3,800 and 5,300 feet.

4.1.2 Operational Issues at Existing AWTF

This section discusses the main operational issues experienced at the TIWRP that will need to be addressed as additional treatment facilities are planned. Operational issues which have historically prevented the plant from operating at its rated production capacity of 5.0 mgd have been the subject of several studies. Two studies[6] have identified the following AWTF issues:

- *Malfunctioning lime slurry injection system:* The process purpose of the lime system is to stabilize (raise) the pH of the advanced treated recycled product water following reverse osmosis. The two chief concerns appear to be caking in the lime feed system and effluent turbidity increases resulting from lime particulates in the product water. BOS has already completed full-scale testing of calcium chloride as an alternative to lime.
- *RO Membrane Lifespan*: Many of the RO membranes are nearing the end of their factory life and need to be replaced.
- *RO Membrane fouling*: It has been challenging to balance the Langlier Saturation Index (LSI)[7] with the Modified Fouling Index (MFI), a measure of the propensity of the water to plug the pores of membranes.
- *MF Membrane limitations*: In spite of the issues with the RO membranes, BOS staff considers the microfiltration (MF) membranes to be the flow-limiting factor in the AWTF process. There is a consultant study underway that has made some initial recommendations to resolve operational issues with the membranes.
- *Power Outages*: TIWRP has frequent voltage sags which can be attributed to the fact that the facility is located at the end of the electrical grid. The primary, secondary, and tertiary facilities (excluding advanced treatment) are on standby power, but currently the standby power is configured for manual initiation and manual re-start. The voltage sags have the effect of disabling motors throughout the plant. After a voltage sag lasting only a few seconds, it can take 4 to 6 hours to put the AWTF back on line. The voltage sags also shut down motors in the primary, secondary, and conventional tertiary facilities.

It is assumed that the production capacity of the existing AWTF will be restored to 5.0 mgd before additional facilities are added to expand the production capacity to 12.5 mgd.

4.1.3 Seasonal Storage of Recycled Water

Seasonal storage may be provided to accommodate fluctuating demands for recycled water between winter and summer months. It typically applies to irrigation customers.

[6] Terminal Island Advanced Wastewater Treatment Facility Membrane Optimization Study, Water Quality and Membrane Performance Evaluation, Draft Report, Carollo Engineers, July 2009.
Terminal Island Treatment Plant Advanced Wastewater Treatment Facility Equipment, Processes, and Procedures Evaluation Report, CH2MHill, Summer 2006.
[7] The LSI provides an indicator of the degree of saturation of water with respect to calcium carbonate. The LSI is another measure of the propensity of the membrane feed water to cause membrane scaling.

TIWRP is located in the densely industrial and commercial area of Los Angeles Harbor with few irrigation customers. According to the Task 2.1.1 Existing and Tier 1 Recycled Water Systems TM, over 98 percent of the existing demands for TIWRP recycled water are industrial. According to the Task 2.2 Tier 2 Target Non-Potable Customers Overview TM, approximately 47 percent of Tier 2 demands are for irrigation customers, with an average annual demand of approximately 1,200 AFY (1.1 mgd expressed as average annual recycled water production). The other identified potential demands for GWR and/or groundwater exchanges would be non-seasonal in nature. This estimate assumes that all Tier 2 irrigation customers are supplied by TIWRP, although some demands could actually be supplied by WBMWD from the Harbor Refineries Pipeline Project.

Assuming a summer peak month demand of two times the annual average (2.2 mgd), the recycled water production capacity at TIWRP (12.5 mgd) would likely be more than adequate to supply irrigation demands in the Harbor Area during future summer months.

In the event that demands for recycled water from TIWRP change dramatically in the future, two potential sites for seasonal storage reservoirs were identified within the TIWRP service area and in adjacent service areas (West Basin, Long Beach) using GIS. The following sites are summarized in Table 4-1 and described below. The sites are shown in **Figure 4-1** and are described below:

- *Machado Lake*: Machado Lake is located 2.3 miles from TIWRP existing recycled water pipeline. The lake is owned by City of Los Angeles, Department of Recreation and Parks (RAP). Using the entire site area and assuming a depth of ten feet, the total volume of an open surface reservoir at this site could be 148 MG. Machado Lake is currently a Tier 2 customer in Task 2a.
- *Palos Verdes Reservoir*: The Palos Verdes Reservoir is located about 3.9 miles west of TIWRP existing recycled water pipeline. The reservoir is maintained by the Metropolitan Water District (MWD) and could potentially contain 358 MG of recycled water. Currently Palos Verdes Reservoir is used for regulating the flow of the local potable water supply and not for long-term storage. The facility allows the district to meet local demand as it is needed; therefore it is only partially filled. The existing use would need to be discontinued for this to be a feasible seasonal storage site/facility. The reservoir is currently covered to address water quality issues (Faris, 1985).

The potential seasonal storage sites for TIWRP are summarized in **Table 4-1.** "Days of Storage" are calculated assuming two flow scenarios: (1) storage is provided for irrigation customers during summer months (2.2 mgd), and (2) storage is provided for the full plant capacity (12.5 mgd).

Table 4-1: TIWRP Potential Seasonal Storage Sites

Potential Site	Owner	Distance (miles)	Area (acres)	Potential Volume (MG)	Days of Storage[1] (2.2 mgd)	Days of Storage[2] (12.5 mgd)
Lake Machado	RAP	2.3	45.6	148[3]	67	12
Palos Verdes Reservoir	MWD	3.9	26.6	358[4]	163	29

1. Flow scenario that provides storage for irrigation customers in the Harbor area during summer months
2. Flow scenario that provides storage for full plant production capacity
3. Assumes 10 feet of depth
4. Assumes reservoir is completely filled

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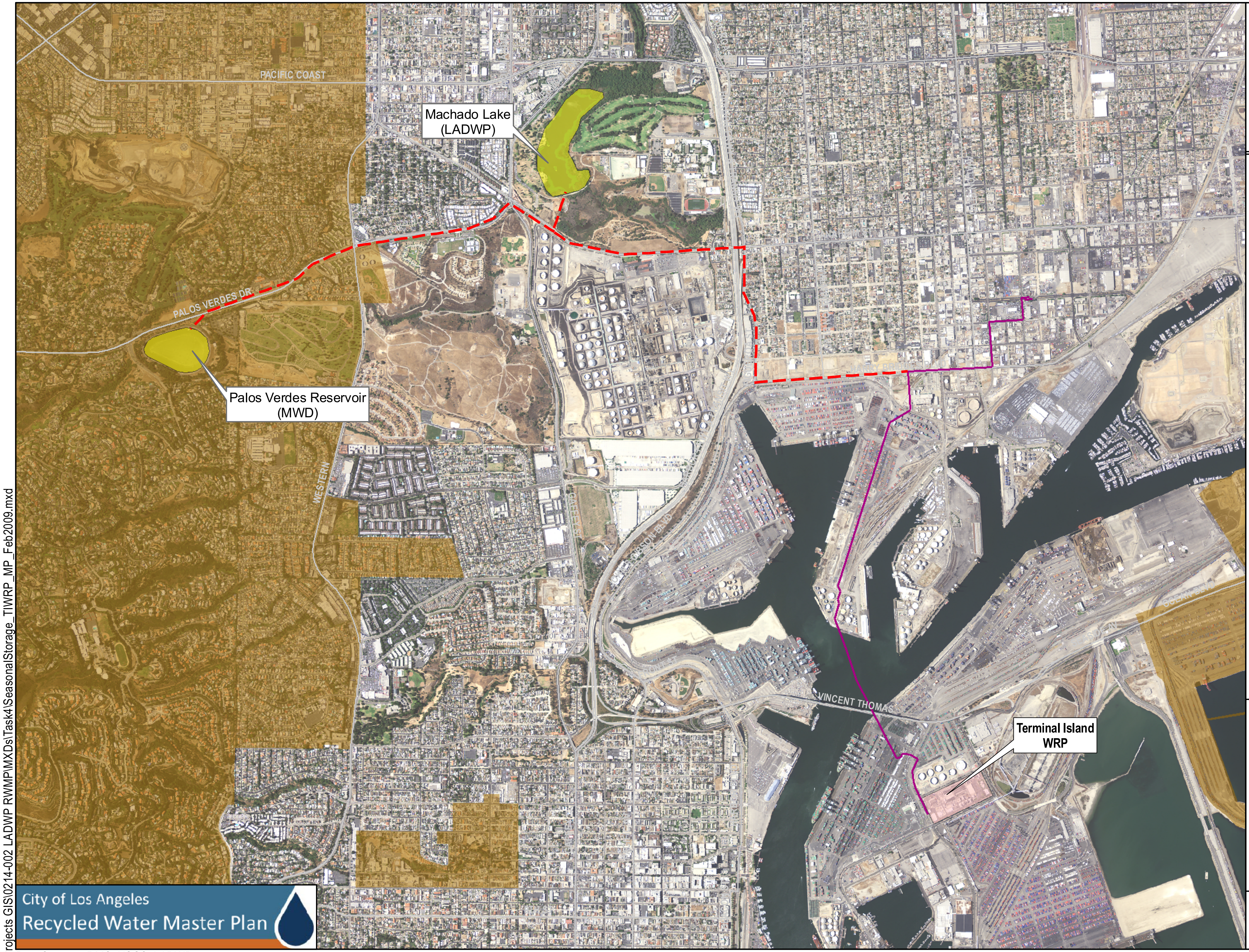

Terminal Island Water Reclamation Plant Potential Sites for Seasonal Storage

Figure 4-1

- Potential Pipeline Alignment
- Existing Recycled Water Pipeline
- Potential Storage
- TIWRP Boundary
- Non City of LA

N

0 1,000 2,000 4,000
Feet

RMC in association with CDM

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Data Sources: RMC, USGS, LADWP

4.1.4 Impacts to NPDES Permit from Project Option 1

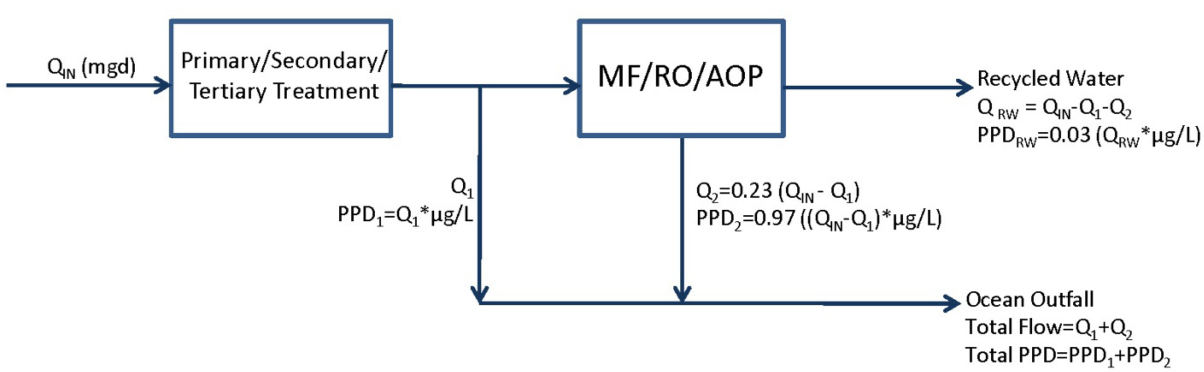
Project Option 1 may require modifications to TIWRP's NPDES permit (No. CA 0053856). As tertiary effluent is replaced by AWT effluent, and as more and more AWT effluent is reused, a greater and greater percentage of the discharge flow in the outfall will be composed of concentrates. Over time, mass loadings would remain relatively constant while flows decrease, and eventually some constituents could exceed the NPDES permit concentration limits. (TIWRP NPDES, 2005).

To determine if future NPDES violations would occur, an effluent concentration discharge analysis was conducted using the following assumptions:

- A plant influent flow of 16.2 mgd;
- An average rejection rate of 97% for permit constituents (RMC/CDM, 2009a)[8];
- Future influent concentrations of priority pollutants to the MF/RO facilities may be estimated by using tertiary effluent values reported in TIWRP's 2008 Annual Monitoring Report.

The influent concentrations for total suspended solids (TSS) and heavy metals were converted to units of pounds per day (PPD) using the mass balance shown in **Figure 4-2**. Once PPD was calculated, this value was divided by the total outfall flow to obtain the concentration of each constituent. The flow to the outfall was then decreased (and flow to reuse increased) until the concentration in the outfall exceeded the NPDES permit concentration limit.

Figure 4-2: NPDES Constituent Mass Balance



The results are presented in **Table 4-2**. As noted in the table, the limit for copper was exceeded in 2008 and will need to be addressed before recycled water production can be expanded. The only other concentration limit that would be impacted was for lead, which would be exceeded above recycled water production flows of approximately 11 mgd.

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[8] Rejection rate for specific metals and TSS is considerably higher than the overall rejection rate for MF/RO concentrates.

Table 4-2: Maximum Allowable Recycled Water Production Based on NPDES Discharge Constituents

Constituent	Unit	Current NPDES Permit Limit (Monthly Average)	Assumed Concentration of Influent to MF/RO[1]	Maximum RW Production Before Permit Limit is Violated (mgd)
TSS	mg/L	15	1	>12.5
Copper	µg/L	2.1	2.3	0
Lead	µg/L	6.6	2.1	11.1
Mercury	µg/L	0.051	0.01	>12.5
Nickel	µg/L	120	4.8	>12.5
Silver	µg/L	0.81	0.02	>12.5
Cyanide	µg/L	0.50	8.5	>12.5

1. Based on average tertiary effluent values from TIWRP 2008 RWQCB Annual Monitoring Report

4.1.5 Power Requirements

Additional power demands created by the proposed AWT are listed in **Table 4-3.** Further analysis of the available power supply at TIWRP will be required to determine the recycled water production rate that will trigger the need for additional power supply.

Table 4-3: TIWRP Estimated AWTF Power Demands

	Existing (MW)	Expansion (MW)	Total (MW)
RW Production (mgd)	5.0	7.5	12.5
MF	0.3	0.4	0.7
RO	0.8	1.1	1.9
UV	0.1	0.1	0.2
Recarbon. System	0.0	0.0	0.0
Misc	0.0	0.1	0.1
Total	**1.2**	**1.7**	**2.9**

Source: RMC, 2010

4.1.6 Low Flow Impacts to Ocean Outfall

This section discusses potential impacts of reduced flows through the Harbor Outfall. These impacts are only relevant if discharges of tertiary effluent, AWT water, concentrates, and other residuals are allowed to continue as in Project Option 1.

As recycling of TIWRP effluent increases, the amount of effluent discharged via the Harbor Outfall will decrease. The outfall discharge port consists of an 800-foot multiport diffuser consisting of 100, 4-inch ports (TIWRP NPDES, 2005). To avoid sea water intrusion into the outfall, minimum outfall flow rates of approximately 1.5 mgd will be needed throughout the day[9]. This minimum flow rate can be supplied by the discharge of the concentrate streams from the MF/RO treatment facilities. As shown in **Figure 3-2** and **Figure 3-5** such concentrate streams can supply more than 2 mgd of flow for the 2040 recycled water production of 12.5 mgd, assuming a 77 percent recovery rate. The flow schematic in **Figure 3-2** and **Figure 3-5** assumes flow equalization in order to provide a constant flow rate to the MF/RO facilities. This, in turn, has the advantage of providing fairly constant concentrate streams to the outfall throughout the day. The need to maintain minimum flow rates in the outfall should not limit the amount of flow that can be recycled at TIWRP, as long as the concentrate streams are returned to the outfall and flow equalization is used.

Project Option 2 assumes no discharges to the Harbor Outfall and thus minimum flows will not be maintained.

5. Cost Estimates

5.1 Cost of Project Option Phases

This section presents order of magnitude cost estimates for Project Options 1 and 2 described in Section 3 above. These cost estimates are preliminary and will be updated as part of the integrated alternatives analysis in Task 4b.

5.2 Capital Costs

This section estimates the total capital costs for AWT and EQ facilities at TIWRP. The estimate was developed based on the design summaries discussed in Section 3 and does not include costs for off-site pumping, conveyance facilities, concentrate management, or seasonal storage. The estimate is based on the bid documents for the original AWTF, constructed between 1999 and 2003, and costs are expressed in December 2009 dollars since an approximate construction date is not known. Once an approximate construction date is known, costs should be escalated to the construction mid-point date using an annual cost escalation in order to more accurately estimate costs at the time of construction.

A capital cost breakdown is shown in **Table 5-1**.

[9] At this flow rate the densimetric Froude number is greater than 1.0 which is considered the threshold to prevent seawater intrusion into a fresh water ocean outfall.

Table 5-1: TIWRP Capital Cost Estimate

Item	Project Option 1	Project Option 2
Cost Basis:	Standard	50% Redundancy
Total RW Production Capacity (mgd)	12.5	12.5
RW Production Capacity Added (mgd)	7.5	7.5
Storage/EQ Volume (MG)	2	2
Cost Estimate[1,2]	**($M)**	**($M)**
Permits, Inspection	0.3	0.3
Startup, Office Suppl., Training, Manuals	1.0	1.0
Site Conditions, Geotech, Survey	0.5	0.5
Mobilization, Demolition, Site Work	5.0	5.0
Deep Foundations/Vibrofloatation[3]	6.9	6.9
Structural, Mech., Plumb., Elec., Instr.	18.5	33.9
Reverse Osmosis	12.5	22.9
Microfiltration	9.3	17.0
Miscellaneous Other	2.6	2.6
Equalization (2 MG)[4]	9.0	9.0
Subtotal	**65.6**	**99.1**
Contingency (30% of Subtotal)	19.7	29.7
Total	**85.3**	**128.8**
Cost per mgd of RW Production	11.4	17.2

(1) Projected capital costs are in December 2009 dollars.
(2) Based on original AWTF bid documents inflated from May 2001 dollars to December 2009 dollars.
(3) Original AWTF required deep structural foundations due to liquefaction potential. Similar construction requirements are assumed in this cost estimate.
(4) Equalization cost basis is $4.5/gallon of storage provided.
(5) Redundancy of 50% applies to total capacity (i.e., 50% of 12.5 mgd)

The total construction cost estimate for Project Option 1 is $85.3 million, or approximately $11.4 million per mgd of recycled water production capacity added. The total construction cost estimate for Project Option 2 is $128.8 million, or approximately $17.2 million per mgd of recycled water production capacity added. The higher cost for Project Option 2 reflects the cost associated with providing failsafe production capacity that would allow a firm commitment to cease discharge of treated effluent to the Harbor Outfall.

5.3 O & M Costs

This section estimates O&M costs for AWT and equalization facilities at TIWRP using 2008 reported costs for the GWR System (GWR System, 2008). These O&M costs are assumed to be similar to those that can be expected for the TIWRP facilities. The GWR cost figures were converted to December 2009 dollars using ENR's CCI Index and are summarized in **Table 5-2**.

Table 5-2: TIWRP O&M Cost Estimate

Item	Project Option 1 ($M)	Project Option 2 ($M)
Power	3.3	3.3
Chemicals	1.2	1.2
Labor	0.8	0.8
Membrane Replacement	0.6	0.9
Compliance Monitoring	0.3	0.3
Plant Refurbishment	0.3	0.4
UV Lamp Replacement	0.1	0.1
Contract Maintenance	0.1	0.1
Total	**6.7**	**7.1**

(1) Based on 2008 reported O&M costs for GWR System.

Based on **Table 5-2**, the estimated annual O&M cost for Project Option 1 is $6.7 million in December 2009 dollars. This is approximately $893,000 per mgd of production capacity. The estimated annual O&M cost for Project Option 2 is $7.1 million, which is approximately $947,000 per mgd of additional capacity.

6. Next Steps

Information developed in this TM will be used in Task 4b of the study to develop more detailed recommendations regarding the amount of recycled water production that should be sited at TIWRP, preferred strategies for residuals/concentrate management, conveyance corridors, and reuse projects in the Harbor area.

References

CH:CDM, 2005: City of Los Angeles Integrated Resources Plan (IRP), Prepared by CH:CDM; Facilities Plan, Volume 1: Wastewater Management, July 2004, revised November 2005

Faris, 1985: Gerald Feris, MWD Hopes to Put Lid on Algae Growth at Reservoir, Los Angeles Times, August 25, 1985

MWH, 2007: Advanced Wastewater Treatment Facility Concept Report of July 2007, TIWRP Future Utilization Concept Report

RMC/CDM, 2009a: Draft Treatment Plant Review Technical Memorandum, Task 4a Concept Report for Maximizing Reuse, RMC/CDM, November 2, 2009

RMC/CDM, 2009b: Draft Wastewater Flow Projections Technical Memorandum, Task 5a Satellite Feasibility Concept Report, RMC/CDM, September 30, 2009

RMC/CDM, 2009c: Draft Existing and Tier 1 Recycled Water Systems Technical Memorandum, Task 2a Non-Potable Reuse Master Plan, RMC/CDM, December 14, 2009

RMC/CDM, 2009d: Draft Tier 2 Target Non-Potable Customers Overview Technical Memorandum, Task 2a Non-Potable Reuse Master Plan, RMC/CDM, January 19, 2010

RMC/CDM, 2009e: Draft Regional Groundwater Assessment Technical Memorandum, Task 4a Concept Report for Maximizing Reuse, RMC/CDM, November 25, 2009

RMC Meeting, 2010: Maximizing Reuse Coordination – LAG and TIWRP Site Planning – Task 4 Meeting Notes, January 19, 2009.

Trussell, 2010: Email/Phone Communications with Shane Trussell, January 2010

TIWRP NPDES, 2005: TIWRP Fact Sheet for Wastewater Discharge Requirements; Regional Board Order No. R4-2005-0024, January 2005

RMC/CDM Meeting, 2010: Monthly Management Meeting No. 7, Meeting Notes, February 17, 2010

Technical Memorandum

Title:	**Regional Recycled Water System Technical Memorandum**
Version:	DRAFT
Prepared For:	John Hinds, Project Manager & Task 4a Lead, LADWP Doug Walters, Project Manager, BOS Lenise Marrero, Task 4a Co-Lead, BOS
Prepared by:	Brian Dietrick, Task 4 Project Engineer, RMC
Reviewed by:	Tom Richardson, Project Manager, RMC Steve Clary, Task 4 Lead, RMC Heather Boyle VanMeter, Deputy Project Manager, CDM Rachael Wark, RMC Kris Helm, Kris Helm Consulting
Date:	October 20, 2009
Reference:	Task 4a: Concept Report for Maximizing Reuse Task 4.1: Basic Research Task 4.1.2: Overview of Regional Recycled Water Systems

Table of Contents

1. Introduction

With imported water supplies becoming ever more unpredictable, the Los Angeles Department of Water and Power (LADWP) adopted the Mayor's vision of Securing LA's Water Supply in May 2008, calling for 50,000 acre-feet per year (AFY) of potable supplies to be replaced by recycled water by 2019. To meet this near-term challenge and plan for expanding reuse in the future, LADWP has partnered with the Department of Public Works to develop the Recycled Water Master Plan (RWMP). The RWMP includes seven major tasks:

- Groundwater Replenishment Master Plan
- Non-Potable Reuse Master Plan
- Groundwater Replenishment Technology Pilot Study
- Max Reuse Concept Report
- Satellite Feasibility Concept Report
- Existing System Reliability Concept Report
- Training

The importance of additional water supply options for Los Angeles has become increasingly apparent with continuation of drought conditions, building contention for limited available water supplies both statewide and across the Southwest, and growing awareness of the critical nexus between quality of life/economic stability and available supplies of quality water. Significant attention has focused on the importance of indirect potable reuse given the multiple associated benefits, among them: local control; drought-resistant supplies; beneficial use of a critical, limited resource; sustained availability for future generations; existing infrastructure; lower investment and less environmental impact than other supply options; and demonstrated success nearby, across the nation and throughout the world.

This technical memorandum is a deliverable under Task 4a: Concept Report for Maximizing Reuse.

1.1 Background and Purpose

The purpose of Task 4 is to research and identify projects that have the potential to maximize the beneficial reuse of effluent produced, or potentially produced, at the following City treatment plants: Los Angeles Glendale Water Reclamation Plant (LAG), Terminal Island Water Reclamation Plant (TIWRP), and Hyperion Treatment Plant (HTP). Specifically, it is desired to identify potential reuse opportunities beyond those already identified to achieve the 50,000 AFY by 2019. Opportunities to maximize reuse from the Donald C. Tillman Water Reclamation Plant (DCT) are covered under Task 1.

One potential mechanism for expanding reuse by the City involves regional recycled water projects implemented in partnership with neighboring agencies (see **Figure 1-1** and **Figure 1-2**). As such, individual meetings were held with the agencies listed below in order to (1) understand current recycled water projects and studies, (2) assess willingness to pursue joint reuse projects, and (3) improve understanding of other agencies' perspectives on recycled water reuse and water management so that projects of mutual benefit can be developed:

- Burbank Water and Power (BWP)

- Central Basin Municipal Water District (CBMWD)
- Glendale Water and Power (GWP)
- Los Angeles County Sanitation Districts (LACSD)
- Las Virgenes Municipal Water District (LVMWD)
- Long Beach Water Department (LBWD)
- Los Angeles County Department of Public Works (LACDPW)
- Metropolitan Water District of Southern California (MWD)
- Pasadena Water and Power (PWP)
- Water Replenishment District of Southern California (WRD)
- West Basin Municipal Water District (WBMWD)

This TM documents the outcomes from these meetings, including a summary of (1) existing and planned recycled water systems; (2) intertie opportunities for supplementing recycled water flows available to LADWP as well as supplementing adjacent agency/system flows to potentially offset potable water that could be made available to LADWP; and (3) potential opportunities and issues associated with interagency partnerships.

Table 1-1: Summary of Regional Agency Meetings

Agencies	Type	Meeting Date	Attendees from Agency	Attendees from City of Los Angeles	RW Planning Document complete/under development
BWP	Purveyor	August 27, 2009	**Matt Elsner** Principal Civil Engineer Water Division **Bill Mace** Assistant GM Water Systems	Jim Yanotta (DWP) Paul Liu (DWP) Bob Sun (DWP)	2007 Recycled Water Master Plan
CBMWD	Wholesale/ Purveyor	September 4, 2009	**Art Aguilar** General Manager **David Hill** Water Resources and Planning Manager	Paul Liu (DWP) John Hinds (DWP) Doug Walters (BOS)	2008 Recycled Water Master Plan
GWP	Purveyor	August 20, 2009	**Raja Takidin** Senior Engineer **Rosanna Lau** Civil Engineering Asst.	Paul Liu (DWP) John Hinds (DWP) Doug Walters (BOS) Elisa Reynolds (DWP)	2006 Strategic Plan and Internal Recycled Water Expansion Program
LACSD	Wastewater Recycled Water	September 3, 2009	**Ray Tremblay** Assistant Department Head, Technical Services **Mike Sullivan** Division Engineer, Monitoring Section **Steven Highter** Supervising Engineer, Planning Section **Earle Hartling** Project Engineer **Andrew Hall** Project Engineer **Jodie Nygaard** Project Engineer	Paul Liu (DWP) John Hinds (DWP) Doug Walters (BOS)	1995 Plan for Beneficial Reuse of Reclaimed Water (currently being updated)
LVMWD	Purveyor	August 31, 2009	**David Lippman** Director, Facilities and Operations **John Zhao** Principal Engineer		2007 Update to Recycled Water Master Plan
LBWD	Purveyor	August 17, 2009	**Chris Pincherli** Senior Program Manager **Robert Verceles** Division Engineer	John Hinds (DWP) Patti Cruz (BOS) Elisa Reynolds (DWP) Lenise Marrero (BOS)	2002 Draft RW Master Plan (currently being updated)

Agencies	Type	Meeting Date	Attendees from Agency	Attendees from City of Los Angeles	RW Planning Document complete/under development
LACDPW	Public Works	September 17, 2009	**Mark Pestrella** Deputy Director **Christopher Stone** Assistant Deputy Director **Steve Sheridan** Assistant Division Engineer **Angela George** LA River Watershed Manager	Paul Liu (DWP) John Hinds (DWP) Patti Cruz (BOS) Lenise Marrero (BOS)	Condition Assessment Report (currently being drafted)
MWD	Wholesale	September 17, 2009	**Gordon Johnson** Chief Engineer **John Bednarski** Manager, Engineering Services Section **Greg de Lamare** Engineer, Facility Planning	Jim Yanotta (DWP) Paul Liu (DWP) John Hinds (DWP) Lenise Marrero (BOS)	N/A
PWP	Purveyor	September 9, 2009	**Brad Boman** Engineering Manager, Water Services Division **Roumiana Voutchkova** Engineer, Water Services Division **Michael Tse** Associate Engineer, Water Services Division	Paul Liu (DWP) John Hinds (DWP) Patti Cruz (BOS)	2007 CeLAC Study (RWMP job recently awarded)
WBMWD	Wholesale/ Purveyor	August 13, 2009	**Joe Walters** Manager of Recycled Water Program **Marc Serna** Manager of Engineering **Fernando Paludi** Manager of Planning and Water Resources	John Hinds (DWP)	2009 Recycled Water Master Plan (available soon)
WRD	Replenish-ment District	August 4, 2009	**Robert Siemak** Chief of Engineering and Planning **Ted Johnson** Chief Hydrogeologist **Hoover Ng** Water Quality Program Manager		Water Independence Now Strategic Plan

Figure 1-1: Regional Service Map 1

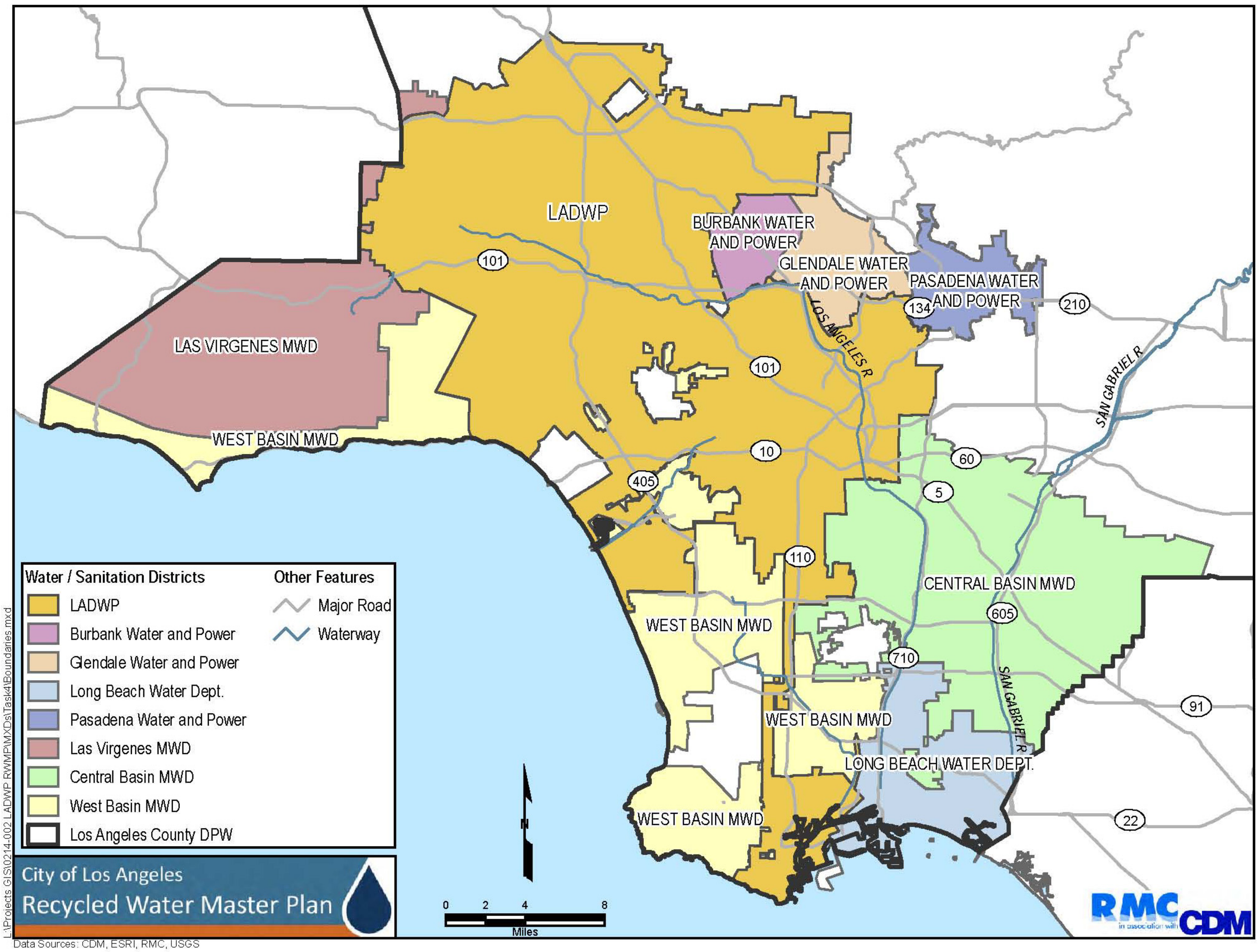
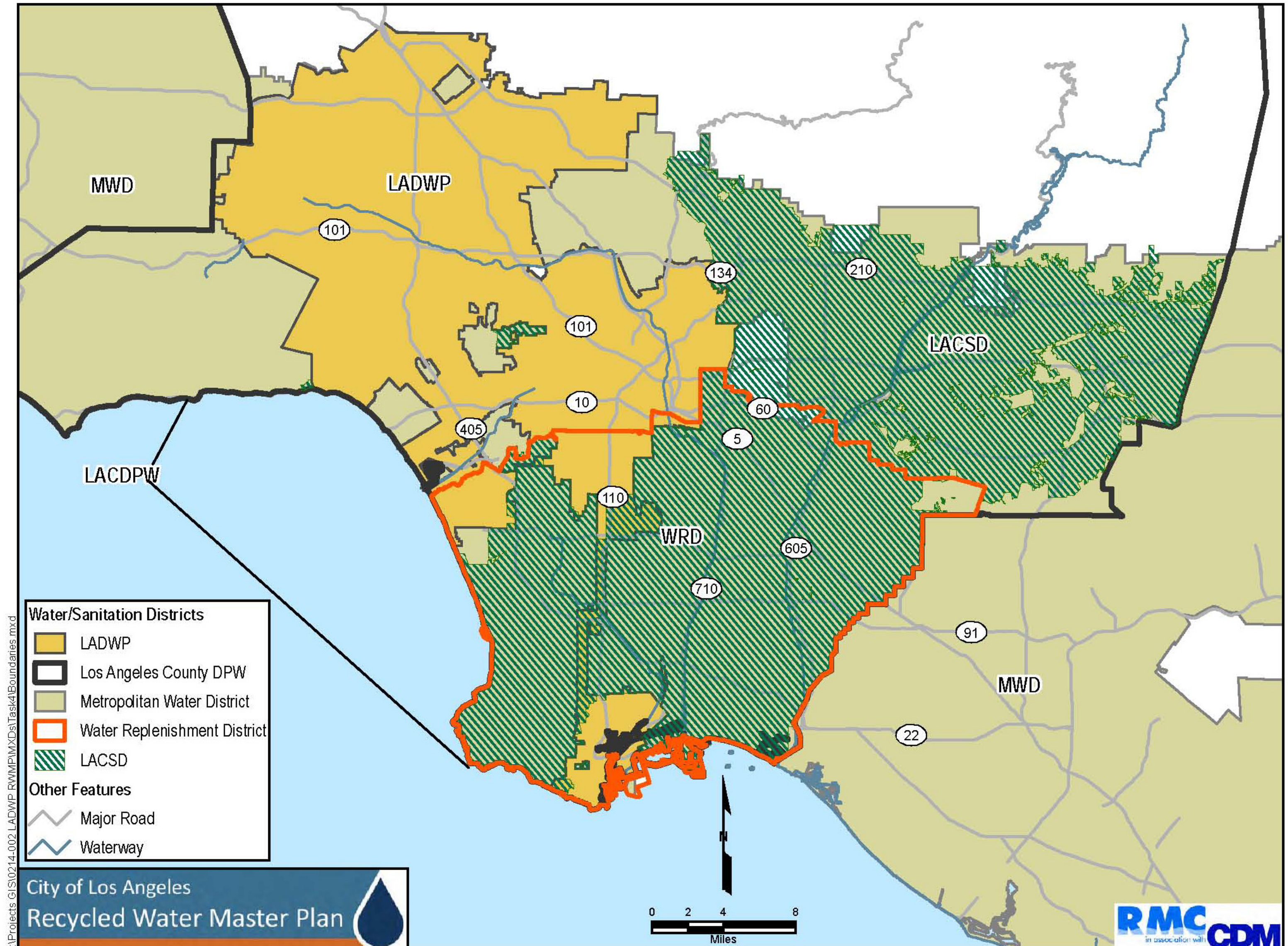


Figure 1-2: Regional Service Map 2



Data Sources: CDM, ESRI, RMC, USGS

1.2 Related Technical Memoranda

Other related technical memoranda, referenced in this TM, that provide additional information for the Maximizing Reuse Concept Report include the following:

- LADWP-Burbank Water and Power Interconnection Project (Task 2.4.2)
- Wastewater Treatment Draft TM (Task 4.1.1)
- Regional Groundwater Assessment Draft TM (Task 4.1.3)
- LA River Flow Assessment Draft TM (Task 4.1.4)
- Semi- and Direct Potable Reuse Draft TM (Task 4.1.5)
- Service and Reliability Goals and Criteria (Task 6.1.1)

2. Summary of Findings

Table 2-1 below summarizes the potential partnership opportunities for each agency. The current and planned AFY of recycled water reuse are also indicated, as well as whether the agency has identified a supply source.

There were several common themes expressed by the agencies interviewed:

Regional Collaboration is Critical – Every agency interviewed agreed that greater reliance on local sources benefits all water supply parties in the Los Angeles region. The situation in the California Delta, the drought on the Colorado River, the attention being given to energy and carbon footprint impacts, and the pressure for lower-cost solutions all drive collaboration and cooperation to increase recycled water reuse. Funding, particularly Federal, is easier to obtain when projects are conceived in regional collaboration. Other benefits include a unified public outreach message, combined resources and expertise to evaluate strategies and projects, and combined financial resources to plan, design, and construct regional projects. The agencies offered various suggestions for regional forums: IRWMP, RWAG, and a potential recycled water "working group". Several feel that collaboration has not been pursued strongly enough and wish to be included in future recycled water discussions pertaining to the RWMP. All agencies expressed interest in additional meetings with LADWP and in reviewing the findings of the RWMP.

Large Regional Recycled Water Projects are Already Being Considered – Other agencies are already planning large regional recycled water projects. MWD and LACSD are undertaking a joint study the potential for large, regional groundwater recharge projects using recycled water from their Joint Water Pollution Control Plant in Carson. The recycled water volume being contemplated (200,000 AFY) is similar in size to the ultimate max reuse goal for LADWP. MWD and LACSD both expressed a willingness to involve LADWP as "the other major recycled water entity in the region" so that the most practical regional solution can be implemented. Other large-scale recycled water projects include CBMWD's Southeast Water Reliability Project (SWRP) project, WRD's Groundwater Reliability Improvement Project (GRIP) project, and a concept project from LBWD for water augmentation in the Central Basin. Regional GWR projects are discussed in more detail in the Task 4.1.3– Regional Groundwater Assessment Draft TM.

Table 2-1: Potential Partnerships

Agency	Current RW Reuse (AFY)	Planned RW Reuse (FY)	Identified supply for planned reuse? (y/n)	Potential Partnerships
BWP	1,975	3,500	Y	• Supply users in LADWP's San Fernando Valley service area with RW from BWRP • Intertie at Griffith Park • Intertie at Equestrian Center • Intertie at Toluca Lake/Lakeside Golf Course Community • Intertie at Woodbury University • Supply RW to PWP from BWRP through GWP distribution system • Supplement LA River flows
CBMWD	5,000	22,000	Y	• SWRP intertie to serve LADWP Metro Area users • SWRP intertie to serve CBMWD users in western service area • Connect CBMWD groundwater users to recycled water
GWP	1,600	2,500	Y	• Supplement LA River flows
LACSD	59,360	109,360	Y	• Participate in LACSD/MWD Joint Water Purification Study • Coordinate plans for semi- and direct potable reuse • Engage legislative staff • Participate in LACSD Joint Outfall System Brine Study • Supply recycled water to Haynes Generating Station in Long Beach
LVMWD	6,500	6,500	Y	• LVMWD and LADWP intertie to improve reliability • Supplement LA River flows
LBWD	6,350	9,000	N	• Port of Long Beach intertie from TIWRP • Supply recycled water to LBWD in exchange for recycled water service to Haynes Generating Station • Collaborate on planning for water augmentation project in Central Basin
LACDPW	NA	NA	N	• Collaborate on regional recycled water planning • Collaborate on GWR infrastructure improvements • Collaborate on public outreach

MWD	NA	NA	N	• Participate in LACSD/MWD Joint Water Purification Study • Pursue funding for recycled water projects under LRP • Coordinate plans for semi- and direct potable reuse • Collaborate on public outreach • Collaborate on planning for water augmentation projects in Central and West Coast Basins
PWP	0	7,000	N	• Discuss formation of Regional Recycled Water "working group" • PWP Satellite Plant • Collaborate on planning for water augmentation project in Raymond Basin
WRD	NA	NA	N	• Increase recycled water contribution to Dominguez Gap Barrier • Collaborate on planning for water augmentation projects in Central and West Coast Basins, particularly at Montebello Forebay and the Los Angeles Forebay
WBMWD	35,000	70,000	Y	• Increase recycled water contributions at Dominguez Gap and West Coast Barriers • Collaborate on planning for water augmentation projects in West Coast Basin • Supply recycled water to West Side

Strong Interest in Semi- and Direct Potable Reuse – MWD expressed an interest in exploring semi- and direct potable reuse opportunities. They have already performed preliminary studies on direct potable and reservoir augmentation, though the reports were never finalized. Several other agencies also expressed support for the water supply potential of semi- and direct reuse projects but also expressed reservations about public acceptance. There was broad agreement that the water supply situation is creating the political will to investigate semi- and direct potable reuse. Semi- and direct potable reuse projects are discussed in more detail in the Task 4.1.5–Semi- and Direct Potable Reuse Draft TM.

Judgment Amendments Critical for Large-Scale GWR – The Judgment Amendments for the Central and West Coast Basin adjudications are widely seen as being necessary for large-scale water augmentation projects. These water augmentation projects may present the greatest potential for LADWP max reuse in the Central and West Coast Basins. These large-scale GWR projects are discussed in more detail in the Task 4.1.3 - Regional Groundwater Assessment Draft TM. Parties to the Judgment Amendments will need to work together to reach agreement on storage issues, water rights transfers, replenishment assessments, and water augmentation projects. Some parties currently support the Amendments and some oppose. The Judgment Amendments are discussed in further detail in the Task 4.7– Central and West Coast Basin Judgment Amendment Draft TM.

2.1 Recommended Next Steps

Based on the outcomes of these meetings, the following steps are recommended to further explore potential regional partnership opportunities:

- Formally invite all parties to participate in the RWAG meetings and/or Greater LA Basin IRMWP stakeholder meetings. Use these forums to discuss whether a separate recycled water "working group" is necessary to achieve the goal of optimizing regional recycled water reuse.
- Initiate joint discussions with MWD and LACSD regarding the "Joint Water Purification Study". Use the opportunity to share the findings of the Task 4.1.3– Regional Groundwater Assessment Draft TM and the Task 4.7– Central and West Coast Basin Judgment Amendments Draft TM. LADWP may consider participating in subsequent phases of the "Joint Water Purification Study" as a financial partner. LADWP is currently discussing a role for the RMC team in setting up the first joint meeting between LADWP, MWD, and LACSD as part of additional scope for Task 4a.
- Initiate joint discussions with MWD to share findings from semi- and direct potable reuse investigations. Provide a copy of the draft version of the Task 4.1.5 – Semi - and Direct Potable Reuse Draft TM for review and feedback from MWD. Request copies (or summaries) of previous draft reports completed by MWD.
- Initiate detailed planning with the LACSD on potential uses of the JWPCP in the Harbor Area for supply of recycled water and waste disposal from HTP and TIWRP.
- Initiate detailed planning efforts with LACSD on the future demands from the inland WRP's and the benefits/needs for supplemental supplies from LADWP systems.
- Conduct coordination meetings with the Upper San Gabriel Valley Municipal Water District (USGVMWD) and Main San Gabriel Basin Watermaster regarding future demands and potential for additional recharge/conjunctive use of the Main San Gabriel Basin.

- Conduct coordination meetings with the Raymond Basin Management Board regarding recharge aspects of the Arroyo project with Pasadena and additional recharge opportunities.
- Coordinate with the MWD staff on bringing LRP funding proposals to the MWD board for approval. LADWP will be pursuing funding of $12.5 million annually for its 50,000 AFY initial phase of reuse. MWD's potential to provide funding for expansions beyond this amount should be verified.
- Pursue a partnership with CBMWD to investigate a potential intertie with the SWRP pipeline. This work could be incorporated in the RWMP b-series for Task 5 and/or Task 4.2.3 – HTP Opportunities Draft TM, depending on the ultimate source of recycled water to be provided to the western CBMWD service area. Continued, regular meetings with CBMWD may also provide a constructive forum to discuss differences of opinion over MWD involvement in recycled water projects, public acceptance of GWR projects, and the controversial issues involved in the Central Basin Judgment Amendment. CBMWD may provide valuable expertise on public outreach challenges in the Central Basin. This coordination would also help to assess the existing and future demands within the City of Vernon.
- Pursue discussions with WBMWD regarding planned recycled water projects in the forthcoming 2009 RWMP. Set up a meeting with WBMWD staff to discuss supply issues from HTP, water quality, and expected secondary effluent demand for the Edward C. Little WRP. Also discuss ongoing work performed on the Task 4.6– HTP Special Issues Draft TM and projects being considered as part of work performed on Task 4.2.3 – HTP Opportunities Draft TM. If possible, a working group should be formed to develop consensus on future plans for development of new supplies from HTP, TIWRP and LACSD's JWPCP in the Harbor area.
- Initiate discussions with WRD, LBWD, City of Vernon, City of Southgate, Golden State Water Company, California Water Service Company and other major pumpers to investigate large-scale GWR with recycled water in the Central Basin.
- Develop definitive plans to supply recycled water to the Haynes Generating Station. Coordinate discussions with AES Alamitos Generating Station.
- Pursue partnerships to increase non-potable reuse and/or system reliability using interties with BWP, GWP, LBWD, LVMWD, and PWP. This work could be incorporated in the RWMP b-series for Task 2.
- Pursue partnerships to supplement recycled water flows to the LA River with BWP, GWP, and LVMWD. These potential interties will be discussed in further detail in the Task 4.1.4– LA River Flow Assessment Draft TM.
- Pursue an active role in Judgment Amendment deliberations. The Amendments are critical for water augmentation projects in both the Central and West Coast Basin. The Judgment Amendments are discussed in further detail in the Task 4.7– Central and West Coast Basin Judgment Amendments Draft TM.
- Participate, in some capacity, in the West Coast Optimization study being conducted by WRD, the Joint Outfall System Brine Study being conducted by LACSD, and the Condition Assessment Report being conducted by LACDPW.

3. Burbank Water and Power (BWP)

3.1 Background

BWP is a water and electricity utility that has been serving the City of Burbank since 1913. Under the city charter, BWP is administered by the City Manager and City Council. BWP is a member agency of MWD and delivers an annual average of 22,000 AFY of potable water to its customers from imported and local groundwater sources.

As shown in **Figure 1-1**, the BWP service area shares a border with the LADWP service area on the north, west, and south.

3.2 Existing and Projected Recycled Water System

3.2.1 Existing

The BWP recycled water system currently serves 35 customers through 100 meters. The largest existing customer is the Magnolia Power Plant, located on the BWP Campus and also operated by BWP. The Magnolia Power Plant is a 310 megawatt facility that provides electricity to Burbank, Anaheim, Glendale, Pasadena, Cerritos and Colton. Recycled water is the sole source of water used for the cooling towers and high purity industrial processes. Key landscape irrigation customers include Burbank Unified School District, De Bell Golf Course, City landfill, Bob Hope Airport, Chandler Bikeway, City Parks, Caltrans, Burbank Town Center, The Empire Center, and Media Studios North (KJ, 2007). The BWP existing recycled water system is depicted in

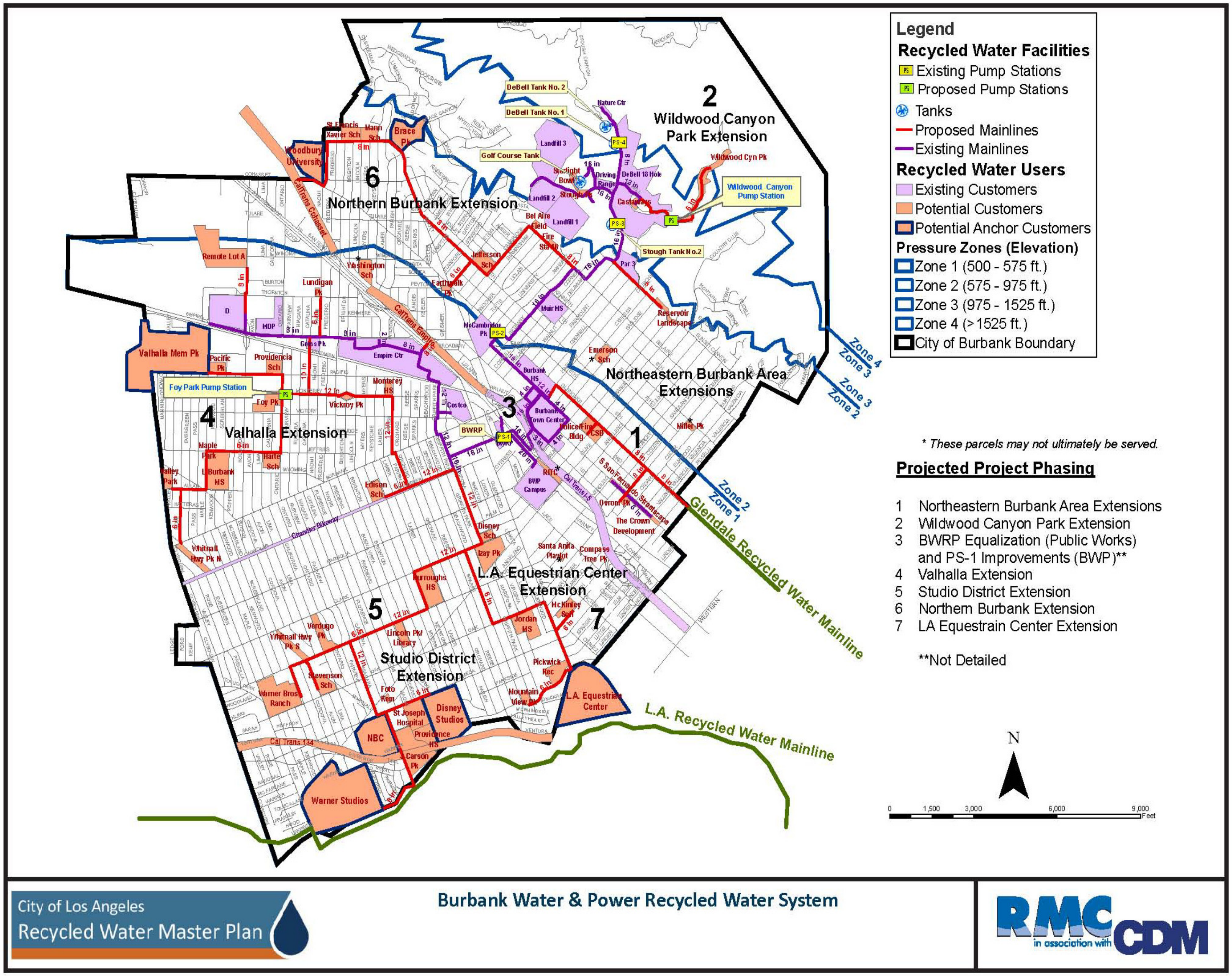
Figure 3-1.

The source of supply for this system is the city-owned Burbank Water Reclamation Plant (BWRP), which produces tertiary-treated recycled water. The Burbank Department of Public Works operates and maintains the BWRP, located near the intersection of Chestnut and Lake Streets, west of the Golden State Freeway (I-5). This facility has a capacity of 9.0 mgd and currently receives nearly 9.0 mgd of influent. Influent flows are as low as 4.0 mgd from midnight to 6:00 a.m. and flows during the daytime hours are as high as 13.0 mgd. BWP does not currently have a commitment to send water to the Los Angeles River; therefore, all plant effluent is available for reuse.

BWP operates and maintains the distribution system, consisting of approximately 9 miles of pipeline ranging from 4 to 16 inches in diameter, 4 pumping stations and corresponding pressure zones, and 4 reservoirs (KJ, 2007). The recycled water is delivered through two systems: (1) a 20-inch gravity flow pipeline that serves the plant yard, landscape irrigation, and HVAC system at Magnolia Power Plant, and (2) Pump Station 1 (PS-1) that serves recycled water to customers throughout the City (KJ, 2007).

During the 2008-2009 fiscal year, BWP's recycled water system delivered approximately 1,975 acre-feet (AF) to customers within the City of Burbank for landscape irrigation, industrial use, fire suppression, and HVAC systems. This leaves approximately 8,100 AFY of recycled water available which is currently discharged into the Los Angeles River.

Figure 3-1: City of Burbank Recycled Water System



Source: KJ, 2007

3.2.2 Projected

Figure 3-1 also shows future expansions of BWP's recycled water system. BWP's October 2007 RWMP projects that approximately 3,500 AFY will ultimately be supplied to recycled water customers (considered to be build out of the system), with approximately 6,500 AFY being discharged into the Los Angeles River. This surplus recycled water would potentially be available for other uses. The highest demand occurs during summer months when BWP's peak reuse is projected to be approximately twice the average demand.

BWP's recycled water planned projects are listed below:

- BWRP Upgrades and Expansions
  - Pump Station 1 Expansion - Pump Station 1 (PS-1) is located at the BWRP and with the exception of BWP Campus, virtually all of the system's recycled water is delivered through this facility. PS-1 is critical to the recycled water system and is currently operating at capacity to meet the existing recycled water demands. To meet the proposed increase in demand, PS-1 capacity must be expanded from approximately 1,350 gallons per minute (gpm) to 5,500 gpm (KJ, 2007).
  - Flow Equalization - Currently BWRP discharges flows at a variable rate. To expand the existing recycled water system, more night flow is required. With a flow equalization basin, the minimum output of BWRP is estimated to increase from approximately 3,640 gpm to 8,250 gpm (KJ, 2007).
- San Fernando Extension – The San Fernando Extension is currently under construction and should be in service by December 2009. The Extension connects to the existing recycled water line (east of the I-5) and heads southeast on Glenoaks Blvd. where it connects to GWP's recycled water system. The San Fernando Extension will provide 16 AFY of recycled water to streetscape, adjacent developments, City Parks and City of Glendale. The interconnection to the City of Glendale recycled water system would be used to supply recycled water in the event of a BWRP upset, instead of relatively expensive potable makeup water (KJ, 2007).
- Valhalla Extension – The Valhalla Extension is nearing design completion and will bid in October 2009. The new alignment extends from an existing pipeline northwest of the BWRP to the Valhalla Memorial Park and cemetery, then southerly to other customers. The Valhalla Memorial Park is a large "anchor" customer with over 400 AFY of current domestic water demand (from groundwater well). The total estimated demand for this extension is approximately 490 AFY.
- Studio District Extension – The Studio District Extension is nearing design completion for November 2009 and construction is scheduled to begin in mid-2010. It extends from an existing pipeline west of the BWRP to Burbank's southwest area which includes a number of entertainment industry studios and supporting facilities. The total estimated demand is approximately 310 AFY.

Currently, there are no plans for groundwater recharge (GWR) via spreading or injection. BWP might consider this option if BWRP is required to upgrade to nitrification and/or advanced treatment.

The Valhalla Extension and Studio District Extension are being evaluated under Task 2 (Non-Potable Reuse Master Plan).

3.3 Current and Potential Partnerships

LADWP does not currently have any inter-agency agreements with BWP related to recycled water. The following potential partnerships were discussed at the meeting with BWP held on August 27, 2009:

- BWP has indicated a general willingness to cooperate in the design and construction of requested extensions and interties to serve LADWP users. BWP would expect LADWP to reimburse BWP for the cost of the extensions and interties. Options for capital financing and purchase pricing are evaluated in the Task 2.4–Identification of Projects Draft TM.

- San Fernando Valley – Recycled water users with significant demands have been identified by LADWP along the 134 Freeway between the Los Angeles-Glendale Water Reclamation Plant (LAG) and Donald C. Tillman Water Reclamation Plant (DCT). These demands could be served by BWP from the Valhalla Extension or the Studio District Extension. Alternatives to upsize and expand BWP's Valhalla Extension or Studio District Extension to serve these additional customers is being investigated in the Task 2.4–Identification of Projects Draft TM. As an alternative to a purchase of recycled water by LADWP, BWP is interested in investigating the possibility of serving recycled water to LADWP users in exchange for groundwater rights in the San Fernando Basin.

    - Valhalla Extension - Connection to the Valhalla Extension would occur at the intersections of Burbank Boulevard and Clybourn Avenue and Chandler Boulevard and Clybourn Avenue. Some modifications to the Valhalla Extension have been made from what is presented in the BWP RWMP which may facilitate a possible connection with LADWP.

    - Studio District Extension - Connection to the Studio District Extension would occur at the intersection of Verdugo Avenue and Clybourn Avenue. The pipeline would have to be extended further west to Clybourn Avenue to facilitate a connection to LADWP, but this is currently not included in the design.

- Griffith Park intertie – Griffith Park and nearby areas are currently being served by LADWP with recycled water and are located south of Burbank. These areas could potentially be served from BWP's distribution system which would improve service reliability to these customers during peak demand months. The estimated average annual demand is 650 AFY.

- Equestrian Center intertie – The Los Angeles Equestrian Center is located to the south of and adjacent to the City of Burbank. The total center is 72 acres and has a potential demand of approximately 25 AFY. Currently, the Equestrian Center does not pay for water. Under an existing agreement, the City of Los Angeles Department of Recreation and Parks purchases potable water from LADWP and provides it at "no cost" to the Equestrian Center Though the agreement does not expire until 2025, another agreement could potentially allow this potable supply to be replaced with BWP's recycled water.

- Toluca Lake/Lakeside Golf Course Community intertie – Toluca Lake and Lakeside Golf Course are in LADWP's service area, but the lake make-up water is currently provided by potable water from BWP. LADWP is already supplying recycled water to the golf course for irrigation. The potable make-up water could be supplied as recycled water by either LADWP or BWP.

- Glendale/Burbank/Pasadena intertie – GWP, LADWP and/or BWP could each provide recycled water from BWP or GWP to PWP through the San Fernando Extension. PWP demands are yet to be defined but may be as high as approximately 7,010 AFY according to the 2007 CeLAC Study.

- Woodbury University intertie – Woodbury University is located northerly and adjacent to City of Burbank. A northern extension of BWP recycled system could supply 30 AFY to this user in LADWP's service area.

The Valhalla Extension and Studio District Extension are being evaluated under Task 2 (Non-Potable Reuse Master Plan).

There are two potential issues mentioned by BWP that could impact recycled water partnerships with LADWP. These issues will be examined further and alternative solutions will be presented in the Task 2.4–Identification of Projects Draft TM:

- LA City Charter – The LA City Charter restricts LADWP from selling potable and/or recycled water outside the City retail service area[1]. Further investigation is needed to determine actions needed by the City Council to approve the sale and distribution of recycled water to areas outside the City.

- Recycled Water Rate Structure – BWP's recycled water rate is 85 percent of the potable water rate. The Magnolia Power Plant, their largest customer, pays the recycled water rate and has a contract with the Southern California Public Power Authority which stipulates that the plant will receive any discount offered to other recycled water users. Therefore, this effectively prohibits the sale of discounted recycled water below the 85 percent rate. Currently, the recycled water rates at LADWP are higher than the rates at BWP. This discourages BWP from purchasing recycled water from LADWP, but it could allow LADWP to purchase recycled water from BWP at lower rates.

3.4 Potential Role for BWP in Max Reuse

LADWP could partner with BWP to expand non-potable reuse, offset LADWP potable water demand, and improve system reliability in the local BWP area and/or San Fernando Valley. BWP has intertie opportunities available at Griffith Park, the Equestrian Center, Toluca Lake, and Woodbury University, and larger opportunities may be available to supply users along the 134 Freeway and in the PWP service area. A partnership with BWP could also benefit LADWP's recycled water goals if discharges to the LA River from BWRP could be maintained in the future. If

[1] Sec. 680 of the Los Angeles Charter and Administrative Code states that the City Council may authorize LADWP by ordinance to provide utility service outside the City, but Sec. 680 goes on to state that : "Water service or products that would be provided outside the department's retail service area are specifically excluded from the provisions of this section."

these supplemental flows to the LA River could be maintained, they could potentially allow higher reuse for non-potable applications at DCT or LAG (for additional detail see the Task 4.1.4 – LA River Flow Assessment Draft TM). According to current expansion plans, at build-out BWP will have 6,500 AFY of recycled water available to offset potable demand or supplement discharges to the LA River in winter and 3,300 AFY in summer.

4. Central Basin Municipal Water District (CBMWD)

4.1 Background

CBMWD was established in 1954 to bring imported water to the region and enable reductions in over-pumping in the Central Groundwater Basin. CBMWD is a MWD member agency and delivers an average of approximately 61,000 AFY of imported water to supplement local groundwater production by municipalities, investor owned water companies, and mutual water companies and districts. CBWMD also supplies approximately 21,000 AFY of imported water to the WRD for recharge of the Central Basin via spreading. In addition to imported supplies, CBMWD distributes recycled water for applications such as landscape irrigation, commercial and industrial processes, and seawater barriers. Other agencies within CBMWD's service area distribute recycled water as well, including the City of Cerritos, City of Lakewood. WRD also purchases approximately 50,000 AFY of recycled water from the LACSD for spreading within the Central Basin, which blends with local surface runoff, groundwater underflow and imported water.

As shown in **Figure 1-1**, the CBMWD service area shares a border with LADWP on the west.

4.2 Existing and Projected Recycled Water System

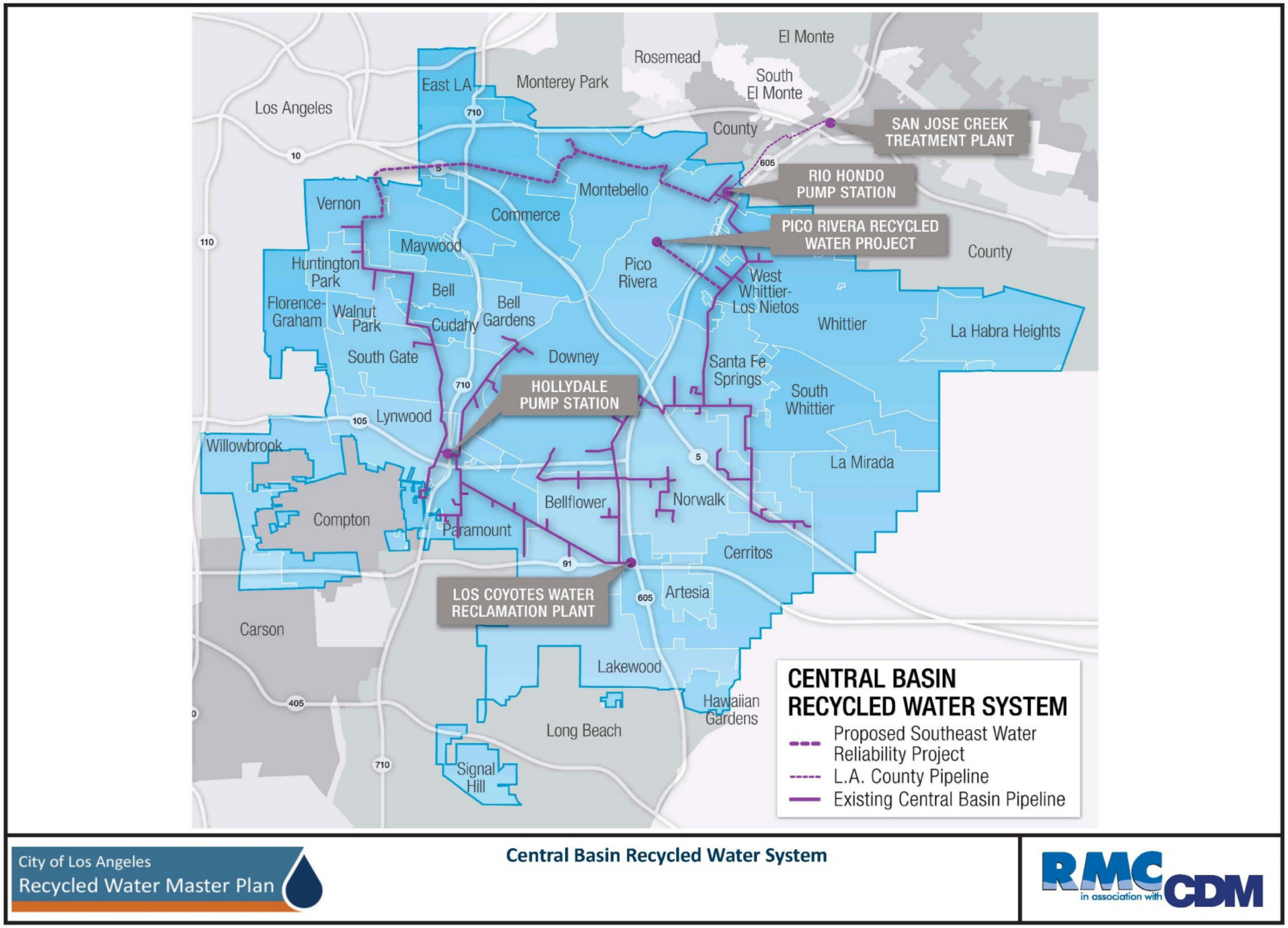
4.2.1 Existing

CBMWD currently serves 240 recycled water customers, including key anchor customers such as Tuftex Industries, Malburg Generating Station, Rio Hondo Golf Course, Rose Hills Memorial Park and Metropolitan State Hospital/Wheelabrator Industries. The CBMWD recycled water system is depicted in **Figure 4-1**.

CBMWD purchases recycled water from the LACSD Los Coyotes and San Jose Creek Water Reclamation Plants for distribution within its service area. The WRPs together produce approximately 100 mgd of tertiary-treated effluent, nearly 40% of which CBMWD and agencies within the service area reused in 2007-08 (LACSD, 2008).

Approximately 5,000 AFY is currently reused, approximately 90% from the San Jose Creek WRP which has lower total dissolved solids (TDS), and approximately 10% from the Los Coyotes WRP which CBMWD describes is used as a "backup supply".

Figure 4-1: Central Basin Municipal Water Basin Recycled Water System



Source: CBMWD, 2009

There are three existing booster pump stations within the service area:

- The 14,700 gpm Rio Hondo Booster Pump Station, located in the City of Pico Rivera, boosts water from the San Jose Creek WRP to the North Zone.
- The 9,800-gpm Cerritos Booster Pump Station, located in the City of Cerritos pumps water from the Los Coyotes WRP to the South Zone.
- The 1,400-gpm Lynwood Booster Pump Station, located in the City of Lynwood, pumps water from the South Zone to the North Zone.

There are about 66 miles of recycled water pipeline that range from 4-to 48-inches in diameter. The majority of the pipelines are 12 to 16-inches in diameter. There are no existing storage reservoirs (MWH, 2008).

Recycled water is wholesaled to CBMWD member agencies and by board policy is not to exceed 80% of the potable rate. The current average rate is $477/AF (65% of potable rate).

4.2.2 Projected

Since groundwater pumping has reached the maximum allowable production under the existing adjudication judgment for some purveyors in CBMWD's service area, recycled water is widely considered to be more reliable supply for growth.

CBMWD believes the existing system can be maximized at 7,000 AFY, depending upon the locations of demands, by expanding service to night time irrigation users. The total projected demand identified in the 2008 RWMP is 22,000 AFY. Potential new customers include La Mirada, LA County Parks and Recreation, and industrial users within South Gate and Vernon. Looping of the recycled water distribution system is needed to provide capacity to serve this demand.

The Southeast Water Reliability Project (SWRP), CBMWD's latest project that loops the distribution system, will be funded using the American Recovery and Reinvestment Act of 2009 and Title XVI. Construction is planned in two phases as described below.

- Phase 1, which is expected to begin construction in 2010, includes a twelve-mile pipeline from the existing Rio Hondo pump station to Montebello, approximately halfway to Vernon. Two power plants in Vernon were originally planned, in addition to the existing Malburg Generating Station, that would use 13,000 AFY combined. If both power plants move forward, a 42-inch pipeline is needed. If only one moves forward, a 30-inch is needed (6,500 AFY). Progress on both power plants is delayed by environmental concerns. Phase 1 includes a storage tank in Montebello Hills for reliability. CBMWD will construct some laterals and will set up a revolving fund for cities and other users to connect[2].

- Phase 2 will depend on customer locations; and will complete the loop of the existing system. After the system loop is complete, CBMWD plans to "fill in" remaining customers.

A potential interconnection between the CBMWD distribution system and LADWP's Metro Area may be evaluated under Task 2 (Non-Potable Reuse Master Plan).

[2] Since the meeting with CBMWD, the City of Vernon has filed an application with the California Energy Commission for a smaller power plant which would require approximately 4,000 AFY of recycled water.

4.3 Current and Potential Partnerships

LADWP does not currently have any inter-agency agreements with CBMWD related to recycled water. The following potential partnerships were discussed at the meeting with CBMWD held on September 4, 2009:

- CBMWD supports regional partnerships with other agencies.
- Funding – CBMWD believes that funding support from the Federal government will be more likely with regional projects.
- SWRP intertie – LADWP and CBMWD could consider a recycled water "phased exchange". In the short term, LADWP users (e.g., Exposition Park in the Metro Area) could be served by recycled water moving westward from the San Jose Creek WRP through the SWRP pipeline. In the long term, the SWRP pipeline could serve CBMWD users with recycled water moving eastward from the HTP or from a new Metro Area satellite plant. Reliability for both LADWP and CBMWD would be improved and pumping distances could potentially be reduced for both LADWP and CBMWD.
- GWR projects – CBMWD does not intend to play a role in groundwater recharge with recycled water beyond supplying imported water to WRD. They expressed more interest in basin storage of imported water. CBMWD has concerns about the proposed judgment amendment and about new groundwater recharge projects bringing attention to recycled water in an area that historically has had poor public outreach on controversial issues.
- Other potential partnerships mentioned as "under consideration" by CBMWD include:
    - Service from the Central Basin system to Municipal Water District of Orange County to serve non potable customers within Orange County.
    - WBMWD has discussed a potential pipeline through Compton that would connect WBMWD's recycled-water distribution system to CBMWD's distribution system.
    - The SWRP project could potentially serve users outside CBMWD's service area in the San Gabriel Valley.

A potential interconnection between the CBMWD distribution system and LADWP's Metro Area may be evaluated under Task 2 (Non-Potable Reuse Master Plan).

4.4 Potential Role for CBMWD in Max Reuse

LADWP can partner with CBMWD to expand non-potable reuse and improve system reliability. A partnership with CBMWD would likely include LACSD, as the recycled water producer. CBMWD is a large, influential MWD member agency and a large recycled water distributor in the Central Basin area. The agency expressed a strong commitment to expanding the use of recycled water, backed by support from LA County Supervisor Don Knabe. They also expressed openness to a potential partnership with LADWP to serve recycled water users in the Metro Area and western CBMWD service area.

CBMWD expressed hesitation about the MWD/LACSD MOU and joint study, thinking that MWD should pursue water augmentation projects through its member agencies. CBMWD also opposes the Central Basin Judgment Amendment in its current draft form, citing concerns about partial privatization of the aquifer, water rights transfers, and the need for separate Replenishment Assessment calculations for Central and West Coast Basin.

CBMWD expressed that they are not interested in expansion of groundwater recharge projects using recycled water. They are interested in storage projects using imported water.

To summarize, there are four types of conceptual projects in which CBMWD and LADWP could partner to advance LADWP's goals in water recycling:

- CBMWD recycled water pipelines could be extended into the LADWP service area to serve Metro Area demands.
- LADWP could assist CBMWD by serving recycled water to users that are presently served with groundwater. These would include large industrial users in the City of Vernon and South Gate. The groundwater displaced by this recycled water service could be transferred via sale or lease to LADWP reducing use of imported water by LADWP.
- LADWP could supply the CBMWD distribution system with recycled water either from HTP directly or from a satellite plant on the LADWP collection system. This would reduce CBMWD's use of water from the LACSD plants and potentially create a water allocation for LADWP from these plants. That water could be developed for recharge of the Central Basin for LADWP's use or for the benefit of WRD or others.
- LADWP could participate in construction of the SWRP pipeline to allow flow in the reverse direction to further augment supplies presently available from the LACSD's inland treatment plants.

5. Glendale Water and Power (GWP)

5.1 Background

GWP provides water and electric service to the City of Glendale. A five-member Water & Power Commission, appointed by the City Council, oversees the activities of the GWP. The fiscal year 2008-2009 annual water consumption for the City of Glendale was 32,000 AFY, from two basic sources: local groundwater from the San Fernando Valley and Verdugo Basins, and imported surface water from MWD (GWP, 2009). GWP also provides recycled water for reuse.

As shown in **Figure 1-1**, the GWP service area shares a border with the LADWP on the north and south.

5.2 Existing and Projected Recycled Water System

5.2.1 Existing

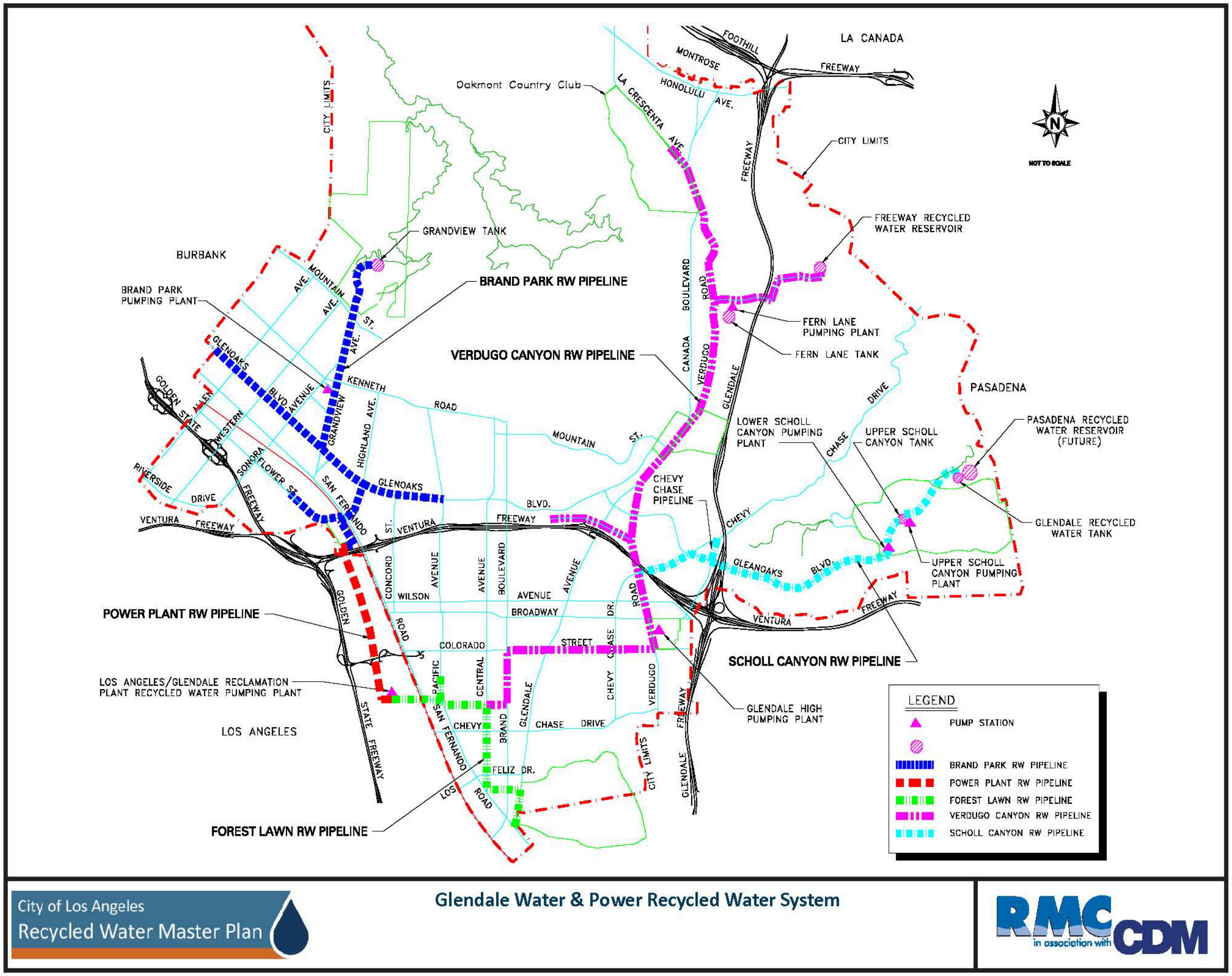
GWP currently delivers approximately 1,600 AFY to 40 customers including the following key anchor users:

- Glendale Power Plant Project – Recycled water has been delivered to the Glendale Power Plant for use in the cooling towers since the late 1970s. A 24-inch pipeline from LAG to the power plant crosses Highway 134.
- Forest Lawn Project – This joint project with the City of Los Angeles serves Forest Lawn Memorial Park with recycled water for irrigation via a 30-inch diameter pipe. Recently, GWP began irrigating street medians on Brand Blvd. and Los Feliz Blvd.
- Verdugo Canyon/Scholl Canyon Pipeline – This project delivers recycled water to the Oakmont Country Club and Scholl Canyon Golf Course for irrigation. It also delivers recycled water to the Scholl Canyon Landfill for dust control and to Caltrans for irrigation.
- Brand Park Project – This project consists of a pumping plant, storage tanks, and pipeline connections to service the Glendale Power Plant. The line extends to a tank above Brand Park. The pipeline delivers recycled water for irrigation to Brand Park, Grandview Cemetery and along the street medians on Glenoaks Blvd. Pipe was installed in Glenoaks Blvd., Grandview Ave., and Highland Ave.
- Connection with Burbank Water and Power – This project connects the 6-inch recycled water line in Glenoaks Blvd. with BWP's 8-inch pipeline at the Burbank/Glendale City border. This connection is only planned for use as an emergency back-up supply. BWP has "extra" water and that surplus could be provided to GWP and/or LADWP.
- Community garden – This facility was recently connected. The property is owned by the City of Glendale.
- LADWP currently receives recycled water from GWP at the city boundary near San Fernando Road, south of Glendale. Recycled water service from LAG is conveyed through GWP's distribution system. This recycled water is supplied to Forest Lawn Cemetery.

The GWP recycled water system is depicted in

Figure 5-1.

Figure 5-1: Glendale Water and Power Recycled Water System



Source: GWP, 2005

The source of recycled water for GWP is LAG, operated by the City of Los Angeles Bureau of Sanitation (LABOS). Approximately 1,600 AF of recycled water was served to customers in the GWP service area in 2008-2009 (GWP, 2009). The remaining 8,400 AFY is discharged to the LA River.

Under Agreement No. 10943, GWP is entitled to 50% of any effluent produced at the 20-mgd LAG, owned jointly by the City of Glendale and the City of Los Angeles. This amounts to approximately 10,000 AFY of recycled water from LAG. Of GWP's 50% entitlement, Pasadena Water and Power has contracted for 6,000 AFY (equivalent to 60% of GWP's 10,000 AFY entitlement). The Reclaimed Water System Participation Agreement No. 15,075 between City of Pasadena and City of Glendale terminates on December 31, 2017, but PWP has the right to extend the agreement term for an additional 25 years. PWP does not currently take any recycled water but plans to design their Phase 1 system in 2010 and construct the system in 2011.

The GWP recycled water system is comprised of 20 miles of pipeline, 5 storage tanks, and 6 pumping plants. Approximately 70% of recycled water demand in the GWP system occurs at night and 30% is continuous, including the power plant. GWP has multiple small storage tanks used by individual customers for daily equalization.

5.2.2 Projected

GWP is not currently operating under a RWMP, but uses the planning efforts of LADWP to provide information about recycled water expansions. GWP also uses an internal Recycled Water Expansion Program and the 2009 Strategic Plan for planning purposes. The goals of the Strategic Plan are to serve 2,500 AFY of recycled water by 2013 and reduce water usage by 7% over the 2006 base year by 2014 (GWP2, 2009). There are no plans for further expansion within the Glendale city limits beyond 2013.

- GWP has an agreement with PWP to provide up to approximately 6,000 AFY of recycled water from LAG. PWP does not currently take any recycled water but plans to design their Phase 1 system in 2010 and construct the system in 2011.
- GWP has an interest in implementing GWR projects but no recharge sites inside city limits. GWP has pumping rights and participates in management of the San Fernando Valley groundwater basin.
- GWP has not connected its dual plumbed customers due to lack of reliability of recycled water service. GWP suggested that a potable backup be installed at the Griffith Park tank in the future to provide this reliability.

5.3 Current and Potential Partnerships

Current agreements between LADWP and GWP include:

- Agreement No. 10943 – GWP is entitled to 50% of any effluent produced at the 20-mgd LAG, owned jointly by the City of Glendale and the City of Los Angeles.
- The Central Los Angeles County Regional Recycled Water Project (CeLAC) is a partnership between GWP, LADWP, PWP, and Foothill MWD to develop project concepts to reuse a total of 13,500 AFY of recycled water.

The following potential partnerships were discussed at the meeting between LADWP and GWP held on August 20, 2009:

- LADWP and GWP plan to partner to develop GWP's distribution system hydraulic model.
- LADWP and GWP plan to partner on installation of a new effluent flow meter that measures GWP's recycled water use near LAG.
- LADWP expressed that it is interested in taking excess recycled water from LAG during the summer months if available.

5.4 Potential Role for GWP in Max Reuse

LADWP can partner with GWP to expand non-potable reuse in the San Fernando Valley. There were no intertie opportunities mentioned, nor any plans for GWR projects. However, a partnership with GWP could benefit LADWP's recycled water goals mainly by providing supplemental flows to the LA River that could potentially allow higher reuse for non-potable applications at DCT or LAG (for additional detail see the Task 4.1.4– LA River Flow Assessment Draft TM). According to current expansion plans, GWP will have between 1,500 AFY and 7,500 AFY available for discharge to the LA River, depending on how much of PWP's contract entitlement of 6,000 AFY is used.

6. Los Angeles County Sanitation Districts (LACSD)

6.1 Background

LACSD is a partnership of 24 independent special districts that provide wastewater and solid waste management services to about 5.3 million people in Los Angeles County. The agency is not a water purveyor but presently provides recycled water via contract to regional water supply agencies. LACSD constructs, operates, and maintains facilities to collect, treat, recycle, and dispose of wastewater and industrial wastes. Individual districts operate and maintain their own portions of the collection system. Local jurisdictions are responsible for the collection of wastewater through local sewers and the collection of solid waste. LACSD also provides for the management of solid wastes including disposal, transfer operations, materials recovery, and energy recovery.

The LACSD service area covers approximately 800 square miles and encompasses 78 cities and unincorporated territory within the County. LACSD is governed by a Board of Directors made up of the mayors of the cities within each district and the Los Angeles County Board of Supervisors for unincorporated area. In the Los Angeles basin area, LACSD operates six upstream satellite plants and one large ocean discharge treatment plant that accepts solids from the upstream plants.

As shown in **Figure 1-2**, the LACSD service area is located east and south of the majority of the LADWP service area. The Harbor area lies between LACSD's South Bay districts and the Long Beach district.

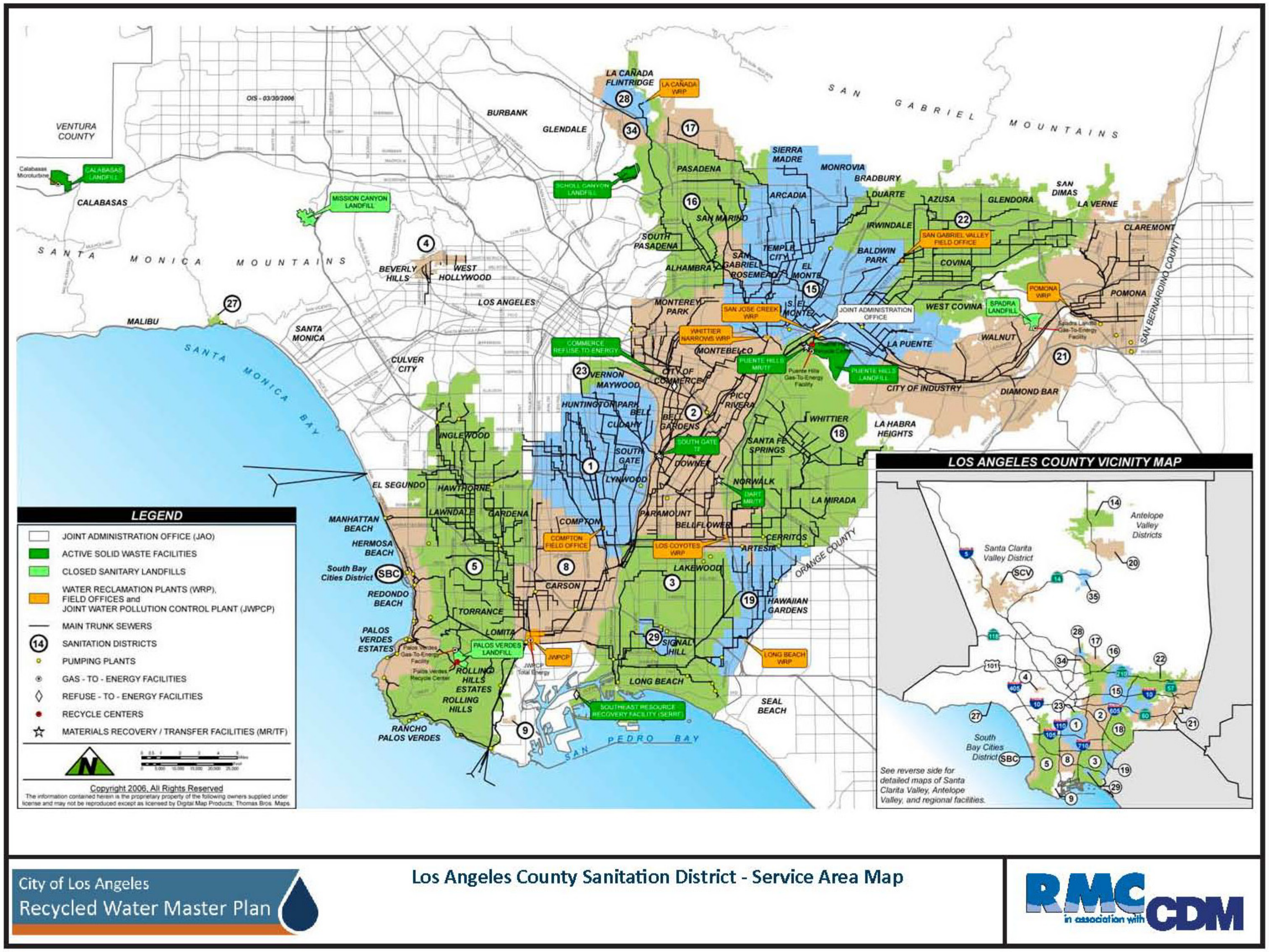
6.2 Existing and Projected Recycled Water System

6.2.1 Existing

The LACSD service area is depicted in **Figure 6-1**. LACSD is currently updating its Recycled Water Master Plan. They are operating under the 1995 "Plan for Beneficial Reuse of Reclaimed Water" that is currently being updated by staff.

Recycled water is currently produced at several inland wastewater treatment plants (see **Table 6-1**). LACSD has more recycled water demand than supply. LACSD does not sell recycled water directly to users but instead relies on water purveyor partners to advance recycled water projects.

Figure 6-1: LACSD Sewer System



Source: LACSD, 2009

Table 6-1: LACSD WRPs Located in the vicinity of LADWP

WRP	Design Capacity (mgd)	Treatment Level	RW Delivered (mgd)	RW Contracted (mgd)	Additional Information
La Canada	0.2	Disinfected secondary	0.1	0.1	• Supplies Country Club golf course lakes and irrigation
Los Coyotes	37.5	Tertiary	6.0	10.8	• Currently treats 25.8 mgd • Supplies multiple municipal distribution systems as well as CBMWD • 8,000 contracted to CBMWD • Reuse includes irrigation, greenbelts; and industrial
Long Beach	25.0	Tertiary	5.6	25.0	• Currently treats 16.0 mgd •
Joint Water Pollution Control Plant	400	Secondary	0	0	• Treats 300 mgd to secondary level and discharges through ocean outfalls • Currently, no treated effluent is reused
Pomona	15.0	Tertiary	3.6	15.0	• Currently treats 8.8 mgd • Supplies Pomona Water Department, Walnut Valley Water District, Rowland Water District and LACSD Spadra Landfill • Remaining recycled water is discharged into the San Jose Creek and San Gabriel River
San Jose Creek	100	Tertiary	31.0	72.7	• Currently treats 73.5 mgd • Supplies irrigation, greenbelts and GWR • 37,500 AFY contracted to WRD • 15,000 AFY contracted to CBMWD • Remaining recycled water is discharged into the San Gabriel River
Whittier Narrows	15.0	Tertiary	6.7	14.2	• Currently treats 7.2 mgd • 11,200 AFY contracted to WRD • 4,600 AFY contracted to USGVMWD • 25,000 AFY bypasses WRP • No plans for expansion; located on USACE property

Source: LACSD, 2008

6.2.2 Projected

LACSD estimates that approximately 50,000 AFY of new recycled water reuse could be implemented in its Joint Outfall System service area, based on planned projects by other agencies (LACSD, 2008). LACSD does not have any WRP expansions planned for the near future given that effluent flows in the Joint Outfall System have been decreasing in recent years due to conservation efforts and economic conditions. San Jose Creek WRP would likely be the first plant to require expansion, but this is not anticipated until after 2020. Instead, LACSD is planning to participate in treatment upgrades, changes to operations, and investigations as listed below:

- MOU between LACSD and MWD to cooperatively fund a Joint Water Purification Study
  - A copy of the Board Letter is available on the MWD website (MWD, 2009).
- Joint Water Purification Study – The Board Letter proposes a jointly-funded Water Purification Study that will examine demands for regional GWR and conveyance costs. Basin managers will be contacted and planning will be coordinated with LADWP and other recycled water agencies for efficiency and for CEQA purposes. The MOU signifies a potential "policy shift" for MWD with respect to involvement in recycled water. The timeline for the study is early to mid 2010, which parallels Phase "b" of the RWMP project. The primary goal of the study is to investigate ways to reuse up to 200,000 AFY of secondary effluent from the Joint Water Pollution Control Plant (JWPCP) in Carson. For additional detail on the Joint Water Purification Study, see Section 10.2.2 of this technical memo.
  - The MOU will be presented to MWD board in late 2009
  - Carbon Footprint – Preliminary calculations of the carbon footprint indicate that greenhouse gas emissions from pumping recycled water from JWPCP to Central Basin are comparable to importing water from the California Delta.
- Groundwater Reliability Improvement Program (GRIP) – LACSD has offered to "host" advanced treatment facilities on their property to support GWR projects in the Central Basin and Main San Gabriel Basin. Construction and O & M costs will be paid by other agencies.
  - Existing Partnership – LACSD, WRD, Upper San Gabriel Valley Municipal Water District (USGVMWD), and San Gabriel Valley Municipal Water District (SGVMWD) have partnered on GRIP. The goal is to eliminate the need for imported replenishment water in spreading basin operations (approximately 25,000 AFY in the Main San Gabriel Basin and 21,000 AFY in the Central Basin).
  - LADWP Role – LACSD is investigating LADWP land behind the San Jose Creek WRP that could be used to build the advanced treatment facilities for GRIP.
  - Raymond Basin – Recycled water could be supplied to Raymond Basin from San Jose Creek WRP via the proposed GRIP pipeline to the Santa Fe Dam spreading grounds (extended to the Raymond Basin). Recycled water could also potentially be supplied from LAG. The CeLAC Study proposed 6,000 AFY for GWR in the Raymond Basin during winter months and irrigation at Griffith Park during summer months based on PWP's contract with GWP (see Section 5).
- Other Montebello Forebay Recharge Operations:

  - Winter Recharge at Spreading Grounds – LACSD has proposed that WRD shift to non-summer-only spreading (9 months) of recycled water so that more is available for irrigation uses in the summer (3 months). WRD will complete a formal review of the 9-month spreading concept.
  - Continued use of Tertiary Effluent – LACSD advocates the continued use of tertiary water for spreading operations, but political issues, environmental justice concerns, and blend requirements for imported water are creating pressure for higher levels of treatment.
  - Contract with WRD – LACSD provides nearly 50,000 AFY to WRD from the Whittier Narrows and San Jose Creek WRPs. The recycled water rate is $5 - $7/AF. The contracts with WRD for replenishment do not use the current rate formula, which averages $100/AF based on alternative water supply (with minimum and maximum rates set at 30% and 100% of O&M costs). LACSD has considered implementing a tiered rate structure with the top tier (e.g., MF/RO) being guaranteed as un-interrupted and the lower tier being provided "as available".
- Long Beach WRP – Under contract, all effluent produced by the LACSD Long Beach WRP is owned by the City of Long Beach. Long Beach WRP currently provides recycled water to LBWD. During the summer months, there is no recycled water surplus available. Therefore, LBWD cannot provide additional water to WRD for expansion of the VanderLans treatment project for injection into the Alamitos Seawater Intrusion Barrier. WRD could potentially obtain additional recycled water from the Los Coyotes WRP or from LADWP. LBWD is also seeking Proposition 50/84 funds to build facilities for extra spreading of winter recycled water in the Montebello Forebay.
- LACSD Brine Study – A LACSD Brine Study will examine brine sources (including GRIP), regulatory pathway, and alternative strategies for TDS management: (1) use current distribution system as-is, (2) further separation of high TDS and low TDS flows in upstream collection system, (3) brine pipeline to JWPCP (downstream from treatment), (4) deep well injection.
- Clearwater Program – The Clearwater Program is a Los Angeles basin-wide facilities plan/EIR for LACSD facilities through 2050. This is not a recycled water master plan, but includes recycled water elements such as upstream WRP expansions and potential expansions to IPR. The Clearwater Program examines conveyance, treatment, biosolids, and effluent management for all wastewater facilities in the Joint Outfall System (facilities in the LA basin). The program includes investigation of a new tunnel and ocean outfall, and upstream recycling is unlikely to reduce the need for a new tunnel. The tunnel is a major component because the two existing tunnels are over 50 years old and cannot be inspected. LACSD commented that they have been in discussions with BOS and Port of Los Angeles regarding potential alignments through the Port of Los Angeles. LACSD's primary concern is a large storm event similar to 1995. Conservation efforts have made expansion of existing upstream capacity unnecessary until 2020-2030 (projected flows for 2050 are similar to previously projected flows for 2010). Upstream treatment is preferred to downstream treatment with pumping, but there are no plans to expand upstream treatment capacity at this time.

- LACSD Discharges to San Gabriel River – LACSD is monitoring any possible limitations on minimum flows to the San Gabriel River. LACSD expressed interest in the findings of the LADWP RWMP related to minimum flow requirements on the LA River.
- Other Needs—LACSD does not presently have adequate flow to meet the potential future uses of recycled water from its inland plants. Future uses include potential recharge projects in the Main San Gabriel Basin and Central Basin, power plant cooling water for the LADWP Haynes Generating Station and the AES Alamitos Generating Station and expansion of recycled water service into Eastern Orange County.

6.3 Current and Potential Partnerships

LADWP does not currently have any inter-agency agreements with LACSD related to recycled water. LADWP and LACSD partnered on a study in the 1980s known as Orange and Los Angeles Counties Water Reuse Study (OLAC), which investigated regional recycled water opportunities. This study detailed numerous potential recycled water distribution system projects, many of which were constructed in the LACSD service area and elsewhere.

The following potential partnerships were discussed at the meeting between LADWP and LACSD held on September 3, 2009:

- LACSD/MWD Joint Water Purification Study – LACSD expressed a willingness to invite LADWP to participate in the Joint Water Purification Study with MWD. LACSD also expressed support for a practical, regional approach to recycled water supply throughout the LA Basin. LACSD believes large recycled water producers like LACSD and LADWP should provide recycled water according to geographic location and cost-effectiveness and not necessarily according to established service areas. For additional detail on the Joint Water Purification Study, see Section 10.2.2 of this technical memo.
- Legislative Cooperation – LACSD recommended that their legislative staff could work in partnership with the LADWP legislative staff to acquire grant and bond funding for projects that increase local water supplies in LA Basin.

6.4 Potential Role for LACSD in Max Reuse

LADWP can partner with LACSD to help meet regional groundwater replenishment goals in the Central and West Coast Basins and the Main San Gabriel and Raymond Basins, and to obtain funding. LACSD is undertaking a joint study with MWD to examine the potential for large, regional groundwater recharge projects using recycled water from their Joint Water Pollution Control Plant in Carson. The recycled water volume being contemplated (200,000 AFY) is similar in size to the ultimate max reuse goal for LADWP. LACSD management is aware of the potential for "competition" between LACSD and LADWP for storage space and water augmentation space. But they also expressed a willingness to proceed with investigations jointly so that the most practical regional solution can be implemented. LADWP could benefit from a three-way meeting with LACSD and MWD and from participating in follow-up meetings with these agencies to discuss regional recycled water projects.

Moreover, there is a need to coordinate on potential plans for semi- and direct potable reuse.

The Joint Water Pollution Control Plant presently provides brine disposal from WBMWD's Juanita Millender-McDonald Water Treatment Facility. It is also being investigated as a supply of recycled water in the Harbor Area to supplement the supply of HTP and Terminal Island Water Reclamation Plant (TIWRP) effluent for reuse projects by the LADWP and WBMWD. Detailed planning is needed to determine optimal use of the water supply and waste disposal capabilities of the JWPCP in the context of maximum reuse in the Harbor Area.

The LADWP Haynes Power Plant and the AES Alamitos Power Plant (both in Long Beach) have a potential need for recycled water for cooling to replace once-through cooling operations and comply with potential new State regulations discouraging use of this cooling method.

7. Las Virgenes Municipal Water District (LVMWD)

7.1 Background

LVMWD provides water, sanitation, and recycled water services to the cities of Agoura Hills, Calabasas, Hidden Hills, and Westlake Village as well as unincorporated portions of Los Angeles County. LVWMD purchases its potable water supplies from MWD; there are no local supply sources. LVMWD pumps groundwater but does not have well head treatment. Instead, the groundwater is pumped into the sewer system for treatment at Tapia to supplement recycled water supplies.

The Joint Powers Authority (JPA) of LVMWD and Triunfo Sanitation District (TSD) provides tertiary treated recycled water. LVMWD provides retail recycled water service directly to customers within the LVMWD service area. The JPA provides wholesale recycled water to TSD, which then wholesales the water to Calleguas Municipal Water District for service to retail agencies, who in turn provide retail service to customers within Ventura County (Boyle, 2007).

As shown in **Figure 1-1**, the LVMWD service area shares a border with the LADWP service area along the eastern edge.

7.2 Existing and Projected Recycled Water System

7.2.1 Existing

The LVWMD currently provides 6,500-7,000 AFY of recycled water to customers. Anchor customers include Pepperdine University and Calabasas Golf Course. On peak days, demand for recycled water can exceed supply by 30 percent or higher. The difference is made up using well and potable water. This improves reliability, but the groundwater contains high manganese and iron concentrations. A majority of the customers are landscape irrigation, therefore demand decreases in the winter and increases in the summer.

The LVMWD recycled water system is depicted in **Figure 7-1**. Recycled water is generated at the 16.1-mgd Tapia Water Reclamation Facility (WRF) on Malibu Canyon Road. The Tapia WRF currently generates approximately 10,000 AFY of recycled water; treated effluent that is not reused is currently discharged to Malibu Creek. Tapia WRF is prohibited from discharging to Malibu Creek between April 15 and November 15 of each year unless a storm event occurs. The Tapia

Effluent Alternatives Study was conducted to identify means to eliminate discharge to the creek. Alternatives to winter discharges included seasonal storage, exporting recycled water to other watersheds or direct discharge to the Los Angeles River. However none of these were deemed economically feasible at the time. The Tapia WRF supply ranges from 11,900 AFY in summer months to 13,200 AFY in winter months.

Transmission pipelines for the recycled water system range from 14-24 inches in diameter. The system also has five pumping stations with a cumulative capacity of 22,400 gpm, six reservoirs with capacities ranging from 0.13 to 14 MG, and four pressure reducing stations.

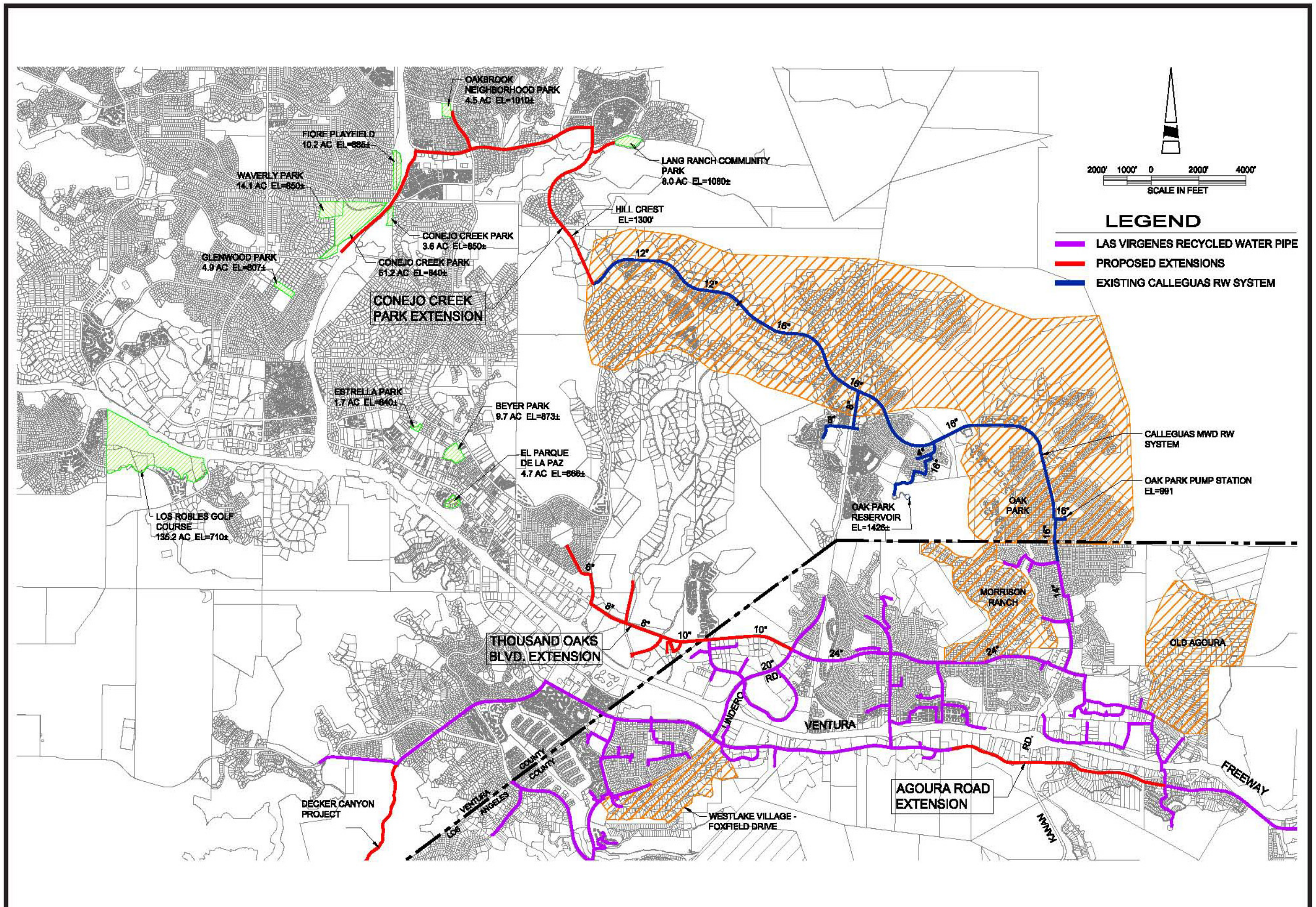
7.2.2 Projected

The agency updated their RWMP in 2007, and the primary goals of the RWMP were to update the model of the recycled water system, pumping stations, storage reservoirs, and pressure-reducing stations and evaluate various infrastructure improvements to address customer needs. Multiple future projects have been identified for LVWMD's recycled water system:

- The Decker Canyon Project would connect the Malibu Country Club Golf Course to the existing system via construction of approximately 25,000 LF of pipe as well as pumping and storage facilities. This project is a priority for the District because Malibu Country Club Golf Course is the largest potable water user with an average day demand of 298 AFY.
- The Thousand Oaks Boulevard Extension Project would connect Westlake High School and Elementary School, Baxter, Russell Park and other commercial and residential users along Thousand Oaks Blvd to the existing system via construction of 17,000 LF of pipe. The estimated maximum day demand is 548 AFY.
- The Calabasas City Center Project would connect Calabasas High School, the City Center median landscape, Stelle Middle School and Freedom Park to the existing system. The maximum day demand for these customers would be 48 AFY. LVMWD wants to extend this project further to serve the Motion Picture Hospital and Woodland Hills Course (Boyle, 2007)
- LVMWD is also considering installing dual plumbing to individual residential parcels.

A potential interconnection between the LVMWD distribution system and LADWP's West San Fernando Valley area may be evaluated under Task 2 (Non-Potable Reuse Master Plan).

Figure 7-1: Las Virgenes MWD Recycled Water System



City of Los Angeles
Recycled Water Master Plan

Las Virgenes Municipal Water District Recycled Water System

Source: Boyle, 2007

7.3 Current and Potential Partnerships

LADWP does not currently have any inter-agency agreements with LVMWD related to recycled water. The following potential partnerships were discussed at the meeting with LVMWD held on August 31, 2009:

- LVMWD and LADWP intertie – LVMWD could be connected to LADWP's recycled water distribution system at the western edge of the San Fernando Valley. The surplus recycled water from LVMWD's system during winter months could be supplied to non-potable users or groundwater recharge in the LADWP service area. This could potentially provide an alternative to current effluent management practices. Recycled water could be delivered from LADWP to LVMWD during summer months when additional recycled water is needed for irrigation. Staff at LVMWD believe that an intertie between the two systems is essential to maximizing recycled water usage throughout the year and offsetting potable water usage.
- LVMWD supplement LA River flows – LVMWD currently pumps tertiary effluent to the LA River as a "lowest priority" effluent management practice. This practice could be made more consistent under contract if supplemental flows are needed in the LA River for downstream beneficial uses as recycled water reuse is maximized at DCT. However, LVMWD expressed concerns that this could establish a precedent that LVMWD would not be able to reverse in the future if additional recycled water demands emerged in their service area.

7.4 Potential Role for LVMWD in Max Reuse

LADWP could partner with LVMWD to expand non-potable reuse and improve system reliability in the San Fernando Valley. This could take the form of using LVMWD intertie opportunities to offset demands for potable water in LADWP's service area during winter months. In turn, LADWP could provide supplemental recycled water to LVMWD during high-demand summer months. A partnership with LVMWD could also benefit LADWP's non-potable reuse goals by providing supplemental flows to the LA River that could potentially allow higher reuse for non-potable applications at DCT or LAG (for additional detail see the Task 4.1.4– LA River Flow Assessment Draft TM). According to current expansion plans, LVMWD will have up to 13,200 AFY available for discharge to the LA River in winter and none in summer because demands exceed supply. This may or may not be compatible with LADWP demands, which are also higher during summer months.

8. Long Beach Water Department (LBWD)

8.1 Background

The LBWD provides drinking water, recycled water, and sewer service to the City of Long Beach. The agency has a 5-member Board of Directors that has full jurisdiction over the distribution of water and sewer service (LBWD, 2005). LBWD is a MWD member agency and delivers an average of approximately 69,900 AFY of imported and local groundwater. LBWD has the largest Allowable Pumping Allocation in the Central Basin adjudication (32,684 AFY).

As shown in **Figure 1-1**, the LBWD service area shares a border with the LADWP on the west.

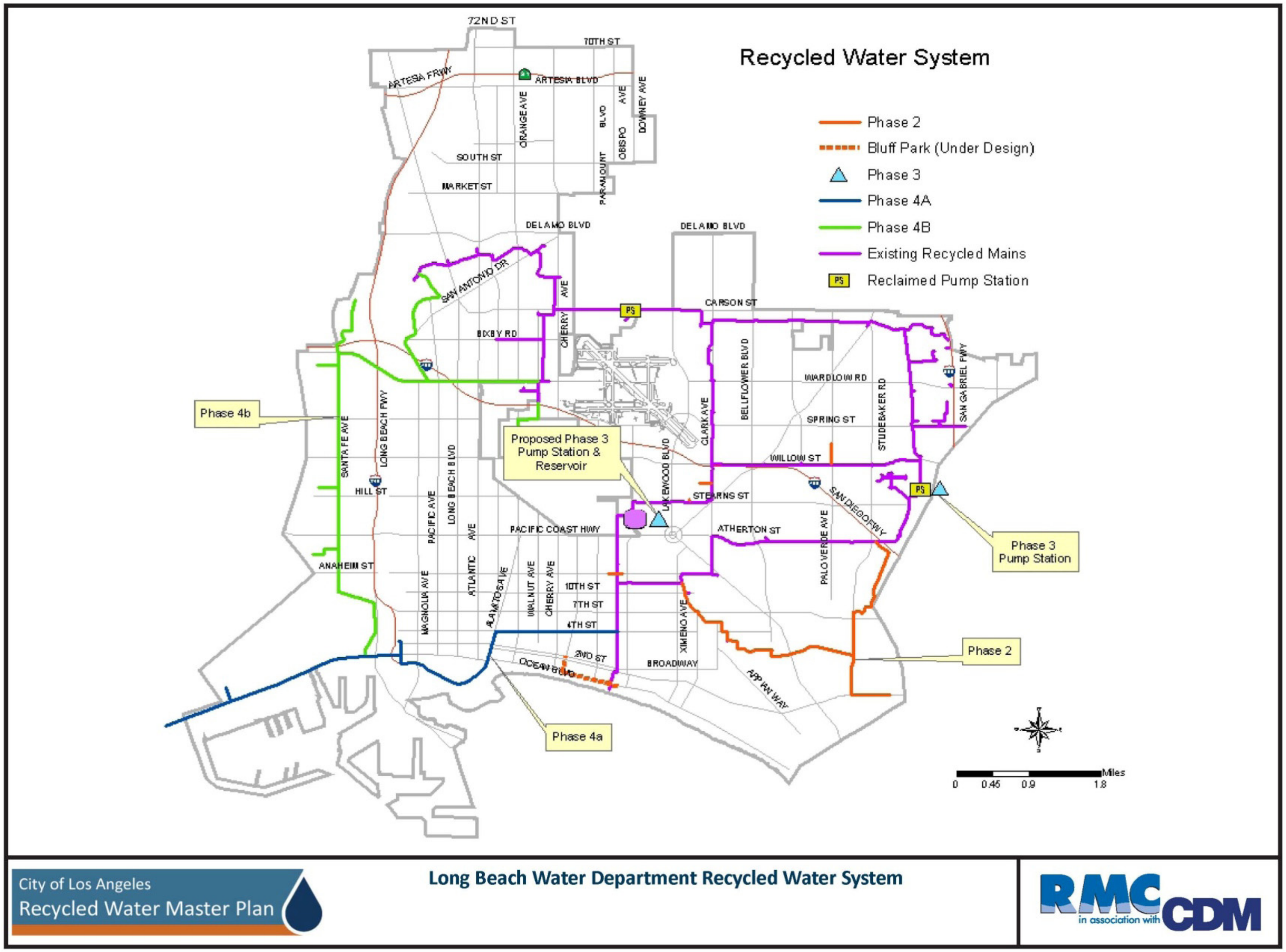
8.2 Existing and Projected Recycled Water System

8.2.1 Existing

During the 2007-08 fiscal year, LBWD served 6,349 AFY of recycled water to 55 customers in Long Beach, including approximately 1,200 AFY to WRD's Leo J. Vander Lans Treatment Facility, an MF/RO plant that provides advanced treated water with UV disinfection to the Alamitos Seawater Intrusion Barrier. The existing system also serves other anchor users such as THUMS Island, Lakewood Golf Course, Virginia Country Club, and El Dorado Park East. The latest customers to be connected are Bluff, Stearns, and Bixby parks, in 2007. The majority of customers are landscape irrigation; therefore seasonal demand fluctuates from high in the summer to low in the winter. However LBWD has industrial and recharge customers that use water year round. Typically, irrigation demand is too high during summer months to provide recycled water to the seawater barrier

The LBWD recycled water system is depicted in **Figure 8-1**.

Figure 8-1: Long Beach Water Department Recycled Water System



Source: LBWD, 2005

LBWD's recycled water source is the Long Beach WRP, operated by LACSD. Wastewater flows average 20 mgd in winter (24 mgd peak) and 15 mgd in summer. Planned shutdowns and maintenance can lower summer flows to as low as 10 mgd. The water reclamation plant has three chlorine contact tanks, two connect to the recycled water pump station and one has a weir that overflows to the San Gabriel River. The de-chlorination system must have a minimum continuous flow of 1.5 mgd to maintain operations and send effluent to the San Gabriel River. If 100% reuse of the effluent is guaranteed for an extended period of time (e.g. several summer months), the de-chlorination system can be taken offline.

Three converted water storage tanks on Signal Hill store recycled water to equalize diurnal flows. They only provide one day of storage and maintain the same pressure as the pump station (60 psi).

The recycled water system currently has 32.5 miles of piping ranging from 6-24 inches.

Long Beach has two levels of recycled water pricing. For customers who use recycled water during the night time, the rate is 70% of potable price. For 24-hr use, the rate is 50% of potable price. This dual price structure is to encourage continuous use.

8.2.2 Projected

The agency operates under a draft 2002 Recycled Water Master Plan that was never released in final form. The 2002 RWMP identified phases to bring the LBWD recycled water demand to approximately 9,000 AFY. The agency plans to update the RWMP in 2010. The plan will not identify new customers or update demands. It will focus solely on identifying how much source water is available for recycling and how to maximize use of available wastewater from the Long Beach WRP.

The RWMP update will include discussion of contact tank connections/plant modifications. The following bullets list the progress of each distribution system phase from the 2002 RWMP:

- Phase 3 system – proposed pump station and reservoir at Signal Hill
- Phases 4a and 4b connect users in the west edge and southwest corner of the City, including the Harbor, they are conceived for 2020-2025; Phase 4a includes 1,500 AFY for two power plants on west side of Long Beach
- Phase 5 – concept only; may tie the Phase 4 pipelines in with CBMWD for groundwater recharge; could precede 4a and 4b if funding obtained
- Possible 1,500 AFY increase in capacity at THUMS
- Alamitos Barrier – currently uses 4.0 mgd RW @ 50% blend; plans to eventually increase to approx. 8.0 mgd @ 100% blend
- LBWD is considering pumping additional recycled water to the Montebello Forebay for use in spreading basins. This is part of a long-term strategy to maximize groundwater pumping ability.

8.3 Current and Potential Partnerships

LADWP does not currently have any inter-agency agreements with LBWD related to recycled water. The following potential partnerships were discussed at the meeting with LBWD held on August 17, 2009:

- Port of Long Beach intertie
  - The 2002 RWMP included a potential intertie with LADWP in the Port of Long Beach. This could be an opportunity for LADWP water from TIWRP to supply users in West Long Beach.
  - LBWD is considering pumping additional recycled water to the Montebello Forebay for use in spreading basins. If recycled water is needed to supplement supply currently provided to users in the LBWD service area, this could be provided by LADWP through a potential connection from LADWP. LBWD is seeking Proposition 50/84 funds to build these facilities.

8.4 Potential Role for LBWD in Max Reuse

LADWP could partner with LBWD to expand non-potable reuse and improve system reliability in the Harbor area, and could potentially partner in a regional indirect potable reuse project. LBWD intertie opportunities in the Port of Long Beach could be used to maximize reuse of effluent from TIWRP. LBWD may also require additional recycled water for recharge opportunities at the Montebello Forebay. LBWD is the largest pumper in the Central Basin adjudication and could be a partner in water augmentation projects in the Central Basin.

The Long Beach Harbor area presently uses approximately 2,000 AFY of potable water from the City of Los Angeles. The LADWP Haynes Generating Station may require large volumes of recycled water for cooling in the future. The LBWD system could potentially be interconnected with a distribution system from TIWRP. There have been discussions of possible water exchanges between LADWP and LBWD wherein LADWP would serve recycled customers within Long Beach in exchange for recycled water service to the Haynes Generating Station.

The proposed judgment amendments to the Central Basin groundwater adjudication decree would allow "water augmentation projects". LBWD and LADWP have similar goals for water augmentation. LBWD's proposed evaluation of new sources of recycled water for spreading in the Montebello Forebay should be coordinated with LADWP evaluations of projects to provide supplemental recycled water for this purpose. In order to utilize additional groundwater resources created by a water augmentation project, LBWD may need to develop new conveyance capability to pump groundwater in the Forebay areas and transport that groundwater into Long Beach. Planning efforts with LBWD should include evaluation of cooperative means to develop new groundwater pumping capabilities. Additional detail may be found in the Task 4.1.3– Regional Groundwater Assessment Draft TM.

The challenges faced by LBWD in supplying recycled water in the summer to the VanderLans treatment plant are being evaluated by LBWD, LACSD and WRD. LADWP has multiple options to create a supply for this use which need further evaluation.

9. Los Angeles County Department of Public Works (LACDPW)

9.1 Background

The LACDPW headquarters is located in Alhambra and has 77 field facilities throughout Los Angeles County. The agency is responsible for the design, construction, operation, maintenance, and repair of roads, bridges, airports, sewers, water supply, flood control, water quality, and water conservation facilities and for the design and construction of capital projects. LACDPW is governed by the Los Angeles County Board of Supervisors.

As shown in Figure 1-2, the LACDPW service area encompasses the LADWP service area.

9.2 Existing and Projected Recycled Water System

LACDPW does not produce nor distribute recycled water, and therefore does not have a recycled water distribution system.

LACDPW conserves (i.e., returns to the aquifer) an average of 220,000 acre-feet of local storm water runoff each year in Los Angeles County. The water flows to 27 groundwater recharge areas, or spreading grounds, consisting of natural river bottoms and spreading basins and pits. During non-storm periods, the artificial recharge program is supplemented by spreading almost 75,000 acre-feet of untreated imported water and 50,000 acre-feet of recycled water.

LACDPW also operates and maintains three seawater barriers in Los Angeles County. These barriers inject treated imported water into the freshwater aquifers along coastal areas to prevent the intrusion of salt water inland. The aquifers protected by the barriers supply nearly 20 percent of the water used in Los Angeles County (LADWP, 2009).

Recycled water has not historically been a priority for LACDPW. The Flood Control District was formed in 1915 with the dual mission of flood control and water conservation. LACDPW recognizes the importance of water conservation, including recycled water, but has not utilized its resources for these projects.

Water Management Objectives for LACDPW (from September 17, 2009 meeting notes):

- Dry urban runoff – LACDPW seeks to capture and reuse urban runoff as a water resource.
- Los Angeles River – LACDPW has no specific objectives for minimum flow requirements in the LA River, but they realize that flows are decreasing and that an integrated approach to river management is needed.
- San Fernando Valley Groundwater Basin– Groundwater contamination is a problem.
- Seawater Intrusion Barriers – Condition Assessment is under way. The first report will assess current conditions and needed upgrades/expansions. The second report will assess deficiencies in barrier performance. Collectively, the Condition Assessment will lay out a program for the future needs of the barriers. LACDPW is relying on WRD to identify demands.

9.3 Current and Potential partnerships

Current agreements between LADWP and LACDPW include:

- Big Tujunga Dam – San Fernando Basin Groundwater Enhancement Project - LACDPW currently has an MOU with LADWP for a recharge project at the Tujunga Spreading Basin. In September 2007, the LADWP Board approved Agreement No. 47717 to provide $9 million to the Los Angeles County Flood Control District for the construction of the Big Tujunga Dam Project – an effort to seismically retrofit the dam, increase its water storage capacity, improve its reliability as a supply source, enhance flood protection measures, and green the environment (ClimateLA, 2008).

The following potential partnerships were discussed at the meeting with LACDPW held on September 17, 2009.

- Regional Recycled Water Planning
    - LACDPW is interested in being included in future meetings that include discussion of regional recycled water planning.
    - IRWMP – LACDPW commented that the LA Basin IRWMP stakeholder group could be a constructive forum for discussions about regional recycled water projects.
    - LA River – LACDPW recommends regional partnerships as an effective regulatory strategy with respect to river discharges from treatment plants.
- Infrastructure Improvements – LACDPW is open to infrastructure improvements that provide water recycling benefits, but they would expect financial partners. LACDPW believes the timing for recycled water projects is good because imported supplies have been reduced. Potential infrastructure partnerships:
    - Maintain the existing seawater intrusion barriers.
    - Modify dams or spreading grounds – LACDPW plans to complete improvements at Tujunga, Pocoima, and Devil's Gate spreading grounds within the next twelve months. LADWP could provide recycled water from a small satellite advanced treatment plant to the Tujunga spreading grounds. There may also be capacity in the flood control network for recharge at other existing spreading basins.
- Public outreach
    - LACDPW recommended sharing public outreach language across agencies to ensure a unified message.
    - LADWP's ongoing public outreach efforts include the formation of a Recycled Water Advisory Group (RWAG), Community Roundtables, and Neighborhood Council workshops. LADWP is also meeting with City Council members one-on-one. LADWP recommended that LACDPW participate in the RWAG and agreed to provide a scope for the RWAG.

9.4 Potential Role for LACDPW in Max Reuse

LADWP could partner with LACDPW to expand indirect potable reuse opportunities. LACDPW expressed a desire to begin an ongoing dialogue for regional recycled water planning, specifically with respect to spreading basins and injection wells (all existing infrastructure is operated by LACDPW). LACDPW's forthcoming Condition Assessment will provide valuable information that can be used for facilities planning and design, and the operational expertise of LACDPW may be used to make recommendations for future spreading basins, injection wells, or both. LACDPW should be consulted for all projects conceived under the Task 4.1.3– Regional Groundwater Assessment Draft TM. LADWP and LACDPW should continue to collaborate on regional recycled water solutions in IRWMP stakeholder meetings and in RWAG meetings, and the two agencies should partner on public outreach efforts related to recycled water reuse.

10. Metropolitan Water District of Southern California (MWD)

10.1 Background

MWD is an imported water provider composed of 26 member agencies, including the City of Los Angeles and 13 other cities, 11 municipal water districts, and the San Diego County Water Authority. MWD's service area covers the Southern California coastal plain and receives water from both the State Water Project and the Colorado River Aqueduct System. MWD is a water wholesaler with no retail customers. The agency provides treated and untreated water directly to its member agencies.

Approximately 35% of Los Angeles County is in the MWD service area, which includes 92% of Los Angeles' population (Table 1-1, MWD UWMP, 2005). LADWP, BWP, GWP, LBWD, PWP, CBMWD, and WBMWD are among MWD's 26 member agencies.

As shown in **Figure 1-2**, the MWD service area encompasses all of LADWP's service area.

10.2 Existing and Projected Recycled Water System

10.2.1 Existing

MWD does not produce nor distribute recycled water.MWD currently supports recycled water projects undertaken by its member agencies with funding assistance only. The Local Resource Program (LRP) provides funding for the development of water recycling and groundwater recovery supplies that replace an existing demand or prevent a new demand on MWD's imported water supplies, either through direct replacement of potable water or increased groundwater production. MWD is currently seeking to develop 174,000 AFY of additional yield to meet a regional goal of 779,000 AFY of recycled water by year 2025. Financial incentives between $0 and $250 per acre-foot produced over 25 year terms are offered annually, contingent upon approval by MWD's Board of Directors. The LRP can be considered an essential source of funding for LADWP's existing and future water reuse projects

10.2.2Projected

MWD supply sources are becoming less reliable. Both the Colorado River Aqueduct and the State Water Project are experiencing drought and habitat issues. There is ongoing debate among member agencies about the role MWD should play in recycled water projects. As LADWP contemplates large-scale reuse projects, the role that MWD will play, either through continued funding under the LRP or in some expanded role is of critical importance to the success of those efforts.

MWD and LACSD began detailed discussions six months ago regarding an MOU for a joint study to investigate regional GWR projects. The purpose of the MOU is to formalize a relationship between MWD and LACSD for cost-sharing on the "Joint Water Purification Study". The MOU was announced at MWD's Special Committee on Desalination and Recycling meeting in August 2009.

The Joint Water Purification Study is composed of two parts:

- Part 1 analyzes the major groundwater basin capacities and parameters: seasonal constraints, water demands of member agencies, adjudication and institutional issues (including the ongoing Judgment Amendments), and fatal flaw questions. They anticipate beginning the study in early 2010. This corresponds to the scope and schedule of LADWP's RWMP Task 4.1.3– Regional Groundwater Assessment Draft TM. The scope of Part 1 of the Joint Water Purification Study includes:
    - Preliminary basin operational capacity –The capacity for continuous recharge/withdrawal in the West Coast, Central, Raymond, and San Gabriel Basins may be approximately 100,000 AF combined.
    - Preliminary infrastructure – MWD predicts that both injection wells and additional spreading basins will be necessary to maximize reuse in the basins.
    - Preliminary regulatory analysis –The early 1990 draft regulations for reservoir augmentation would be the "starting point" for a discussion of regulatory pathway for regional GWR projects.
    - Preliminary treatment requirements – MWD is assuming a treatment "starting point" equivalent to the Orange County Groundwater Replenishment System. Additional treatment may be required because LACSD trunk lines to the JWPCP contain some concentrated brines from industrial waste.
    - Brine disposal – The preliminary estimate of 200,000 AFY of reuse from the JWPCP assumes that the remaining flow contains the most concentrated brine allowable for ocean discharge.
    - Study cost – MWD expects that the costs for the Study will be approx. $1M (50/50 staff and consultant costs). The costs are to be shared by LACSD and MWD.
- Part 2 of the Joint Water Purification Study will analyze potential pump station and distribution systems to various regional basin locations and/or reservoirs. MWD expects Part 2 to begin sometime in late 2010.

10.3 Current and Potential Partnerships

Current agreements between LADWP and MWD include:

- Agreement No. 10748 – The Los Angeles Greenbelt Water Reclamation Project will supply 1,600 AFY of recycled water for landscape irrigation from the LAG to Forest Lawn Memorial Park, Mt. Sinai Memorial Park, Lakeside Country Club and Universal City.
- Agreement No. 26554 – Harbor Water Recycling Project Local Resources Program (LRP).
- Agreement No. 69874 – Sepulveda Basin Water Recycling Project – MWD will provide LADWP $125/AF for up to 546 acre-feet of eligible water delivered by the Sepulveda Basin Water Recycling Project Phase 4. The agreement will automatically terminate in June 2029.
- Agreement No. 94259 – Taylor Yard Park Water Recycling Project – The first phase of the Central City/Elysian Park Water Recycling System, the Taylor Project will connect to City of Glendale's existing 30-inch recycled water pipeline and serve about 150 AFY of recycled water in the northeast section of LADWP's service.

The following potential partnerships were discussed at the meeting with MWD held on September 17, 2009:

- LADWP participation in MWD/LACSD Joint Water Purification Study – The possibility of LADWP's participation in the MOU was discussed and the following actions items were decided:
  - MWD expressed support for LADWP becoming a signatory to the MOU. At the time of the meeting, the presentation of the MOU to the MWD Board of Directors had been delayed to December, allowing enough time for this potential change to be considered by all boards. MWD acknowledged that LADWP's participation would make the Study a "more regional" effort[3].
  - The RMC team will remain in contact with MWD to discuss the findings of the Task 4.1.3 – Regional Groundwater Assessment technical memo as compared to Part 1 of the Joint Water Purification Study.
  - The RMC team will set up a follow-up meeting with MWD, LACSD, and LWDWP to discuss the MOU and cooperative efforts on the Joint Water Purification Study.
- Cooperative Public Outreach – LADWP is planning public outreach efforts with regard to recycled water, including the formation of a Recycled Water Advisory Group (RWAG). RWAG would meet 6-10 hours per month. MWD was encouraged to participate in RWAG as soon as the first meeting is organized.
- Semi- and Direct Potable Reuse – MWD expressed at the meeting that they have examined reservoir augmentation and semi- and direct potable concept projects, but they currently do not have finalized reports. LADWP commented that one obstacle to direct potable is the need for real-time monitoring. Current systems take 24-48 hours for results. MWD commented that in five years, all five MWD water treatment plants will have ozone disinfection similar to that provided at the Los Angeles Aqueduct Filtration Plant. Ozone disinfection effectively removes many of the constituents of emerging concern (CECs). MWD expressed a desire to have the opportunity to review the RWMP Task 4.1.5 –Semi- and Direct Potable Reuse Draft TM.

[3] LADWP management has since decided not to participate in the regional GWR discussion as a signatory to the MOU.

10.4 Potential Role for MWD in Max Reuse

The funding that MWD currently provides and would provide in the future under the LRP subsidy program is a significant source of operating revenues for the reuse initiatives of LADWP. The continued availability of these subsidy payments is a key consideration in the economic feasibility of water recycling for LADWP. Moreover, the economic value of recycling is largely realized by avoiding future purchases of imported water from MWD and investing those avoided costs in water recycling capital and operating costs. As LADWP contemplates even larger projects toward the goal of maximum reuse, partnerships with MWD should be carefully evaluated.

In whatever form, LADWP could partner with MWD to help meet regional indirect potable reuse goals in the Central and West Coast Basins and elsewhere, to obtain funding, and to pursue semi- and direct potable reuse projects. MWD's undertaking of a joint study with LACSD to examine the potential for large, regional groundwater recharge projects using recycled water from the LACSD Joint Water Pollution Control Plant in Carson may signal a re-evaluation of how MWD wishes to participate in projects involving groundwater recharge. The recycled water volume being contemplated (200,000 AFY) is similar in size to the ultimate max reuse goal for LADWP. MWD expressed a willingness to proceed with investigations jointly so that the most practical regional solution can be implemented. LADWP should initiate a three-way meeting with LACSD and MWD and should participate in follow-up meetings with these agencies to discuss regional recycled water projects. It is essential that the engineering evaluations of LADWP and MWD be coordinated. Similarly, it is essential that the institutional strategy for cooperative funding of these projects be defined.

LADWP should also remain in regular contact with MWD to share the findings of the RWMP Task 4.1.3– Regional Groundwater Assessment Draft TM as compared to the findings of Phase 1 of the Joint Water Purification Study, and LADWP should invite MWD to review the findings of the RWMP Task 4.1.5–Semi- and Direct Potable Reuse Draft TM.

MWD's plans for allocation of imported water during drought conditions include consideration of agency needs based upon the development of recycled water. As LADWP considers the economics of water recycling compared to continued reliance on imported water supplied by MWD, the future allocation policies of MWD may determine how drought related benefits of water recycling are retained by LADWP and/or shared with other agencies that depend upon imported water from MWD. Definition of the procedures to share benefits of water recycling among the MWD member agencies may greatly influence LADWP's plans for implementing maximum reuse.

11. Pasadena Water and Power (PWP)

11.1 Background

PWP is responsible for providing the residents of the City of Pasadena with power, potable water and recycled water. The agency is governed by the Pasadena mayor and city council. The total amount of potable supplied is approximately 38,600 AFY. Wastewater treatment is provided by the LACSD at the Whittier Narrows WRP.

In 1993, PWP and GWP signed *Reclaimed Water System Participation Agreement No. 15,075*. This contract entitled PWP to 6,000 AFY of recycled water at an instantaneous maximum rate of 6,255 gpm and defined LAG as the source of this water. The contract terminates on December 31, 2017; however, PWP has the right to extend the agreement terms for an additional 25 years.

As shown in **Figure 1-1**, the PWP service area shares a border with the LADWP service area along a small section of the western edge.

11.2 Existing and Projected Recycled Water System

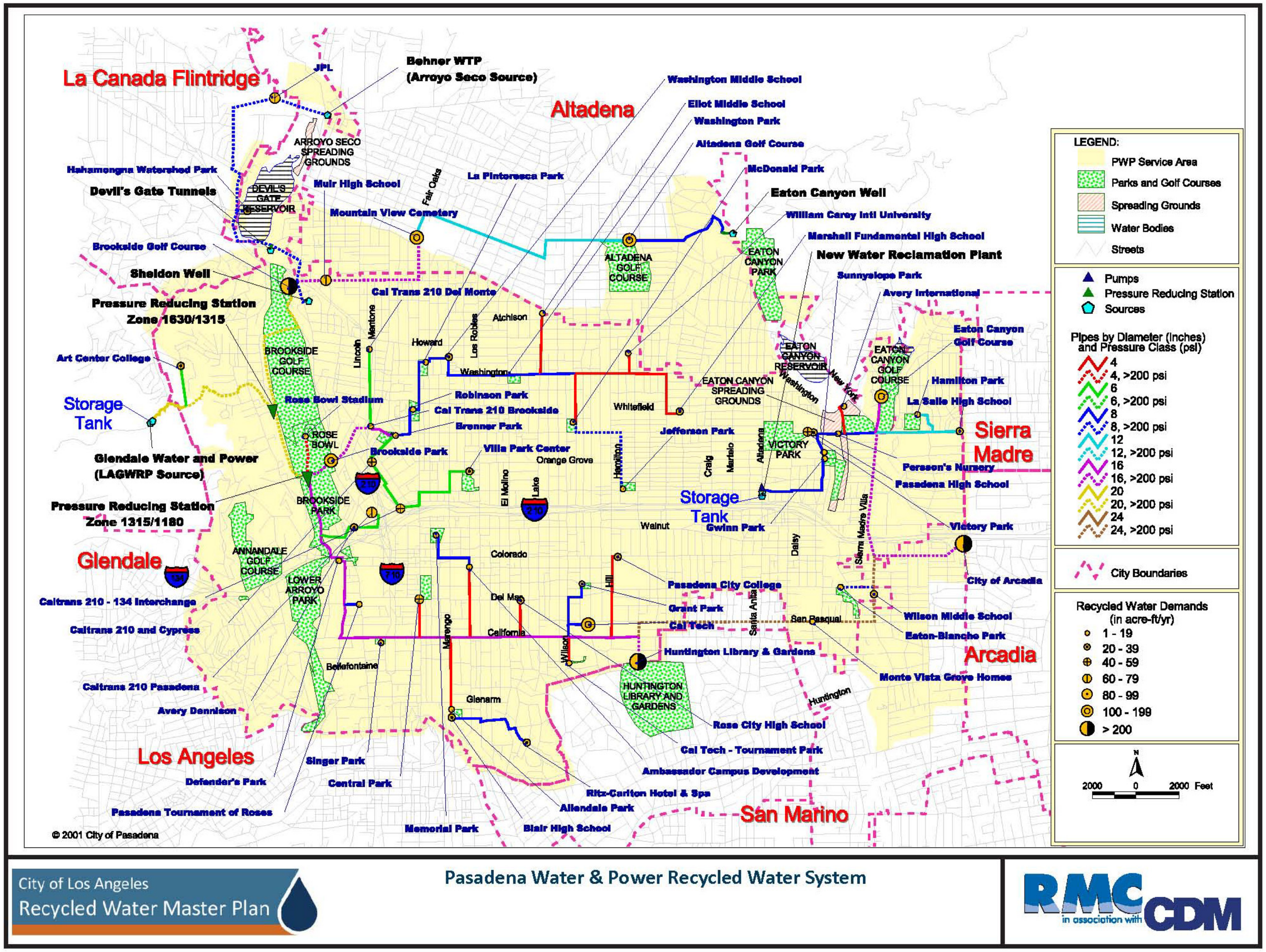
11.2.1 Existing

PWP does not currently have any recycled water facilities. However, PWP plans to design their Phase 1 recycled water system in 2010 and complete construction by 2011.

11.2.2 Projected

- The Central Los Angeles County Regional Recycled Water Project (CeLAC) is a partnership between GWP, LADWP, PWP, and Foothill MWD to develop project concepts to reuse 13,500 AFY of recycled water (**Figure 11-1**). Three phases were developed for PWP that would develop reuse of between 730 to 7,010 AFY (RMC, 2007).
    - Phase 1 – planned for 2010 – serve Arroyo Seco Area (730 AFY)
    - Phase 2 – planned for 2015 – serve Arroyo Seco groundwater recharge, Huntington and Spurs, Mountain View, and Devil's Gate area (3,110 AFY)
    - Phase 3 – planned for 2020 – serve Eaton Wash and Altadena Golf Course (3,170 AFY)
- The Arroyo Seco area was identified as a core area to deliver recycled water in the 2005 Recycled Water Feasibility Study. This would serve nearly 700 AFY to four customers – Brookside Golf Course, Rose Bowl Stadium, Brookside Park, and Defenders Park. It would involve the construction of a 5-mile long pipeline from the connection to the Glendale recycled water system to the Arroyo Seco area (MWH, 2005; RMC, 2007).
- Other potential recycled water customers include Arcadia (e.g., the LA County Arboretum, race track, and county park golf course) and San Marino (e.g., Huntington Gardens).

Figure 11-1: Pasadena Water and Power Recycled Water System



Source: MWH, 2005

11.3 Current and Potential Partnerships

LADWP does not currently have any inter-agency agreements with PWP related to recycled water. PWP signed an agreement with GWP: *Water System Participation Agreement No. 15,075,* entitling PWP to 6,000 AFY of recycled water at an instantaneous maximum rate of 6,255 gpm. LAG was defined as the source of this water.

The following potential partnerships were discussed at the meeting between LADWP and PWP held on September 9, 2009:

- Regional Recycled Water "working group" – PWP recommends forming a regional recycled water working group that could promote projects, conduct public outreach, and seek funding opportunities. To be beneficial, the group should be a collective and not a single, pre-existing water supply entity (e.g., MWD).

- PWP Satellite Plant – PWP expressed interest in partnering with LADWP (or LACSD) on a local satellite plant that could provide recycled water to PWP's service area. A potential benefit to LADWP from this type of project would be an exchange of groundwater and/or imported water that could be used to offset potable demand in LADWP's service area.

- Promote Acceptance of Multi-Purpose Pipelines – PWP expressed a strong preference for multi-purpose pipelines (i.e., raw imported, local runoff, and recycled water combined into one pipeline) for GWR projects because they could potentially avoid duplicating capital costs. PWP stated that pipe construction costs are the largest impediment to recycled water projects, but current regulations prohibit using the same pipe for different water sources.

- GWR Recreation Areas – Another possible recycled water opportunity is groundwater recharge underneath recreation areas. These projects would minimize infrastructure (i.e. summer irrigation and winter GWR are in same location) and land requirements, but they would also require separate permits under existing regulatory rules.

11.4 Potential Role for PWP in Max Reuse

LADWP could partner with PWP to expand non-potable reuse and potentially offset LADWP potable water demand. PWP expressed a strong desire to partner with LADWP and other agencies in a recycled water "working group" to promote projects, conduct public outreach, and seek funding opportunities. PWP is interested in innovative project ideas and seeks regulatory reform of recycled water laws that prohibit innovative projects from being implemented.

As the largest water rights holder in the Raymond Basin and an influential member of the Raymond Basin Management Board, PWP may have a key role in determining plans for recharge of the Raymond Basin with recycled water. As evaluations of possible recharge of the Raymond Basin proceed, LADWP should continue close coordination with PWP.

12. Water Replenishment District (WRD)

12.1 Background

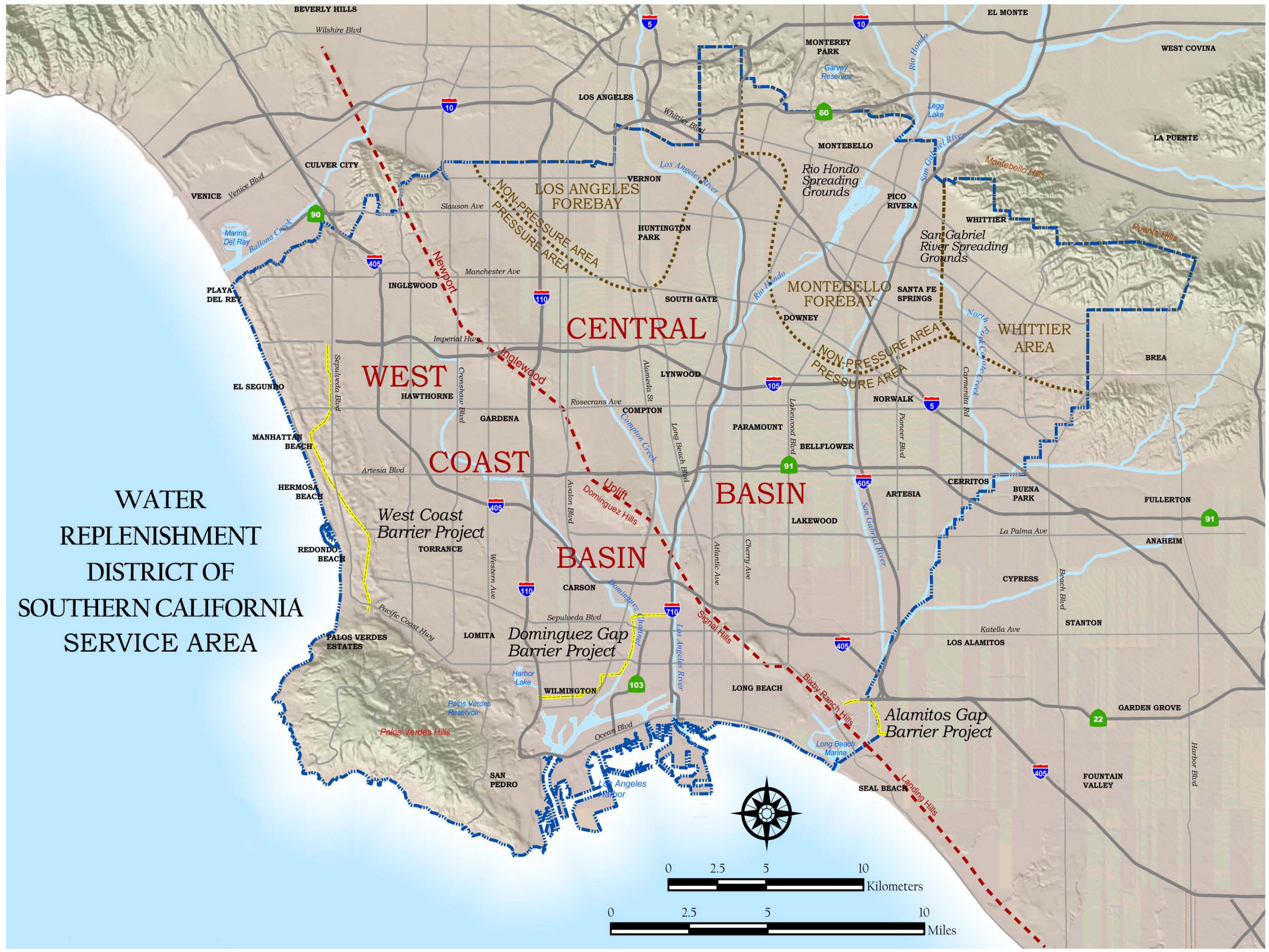
The WRD is the regional groundwater management agency for two of the most utilized groundwater basins in California: Central and West Coast Basins. WRD's role in the groundwater basins is to replenish groundwater, address water quality issues, and administer storage.

WRD manages groundwater for nearly four million residents in 43 cities of southern Los Angeles County. The 420 square mile service area uses about 250,000 acre-feet of groundwater per year, which equates to nearly 40% of the total demand for water. The remaining 60% is imported water from Northern California, the Colorado River and recycled water from local municipal wastewater treatment plants.

MWD has created a series of programs that agencies such as WRD can leverage to offset costs and provide independence from imported water during disruptions or droughts. MWD has created incentive and credit programs for groundwater storage, water conservation and water recycling that are available through its member agencies such as the cities of Los Angeles, Long Beach, Compton, and the Central and West Basin Municipal Water Districts, all of which are within the WRD service area (WRD, 2009).

As shown in **Figure 1-1**, the WRD service area overlaps the southern portions of the LADWP service area that include the Central and West Coast Basins. **Figure 12-1** shows WRD's service area in greater detail.

Figure 12-1: Water Replenishment District Recycled Water System



Water Replenishment District of Southern California Service Area

City of Los Angeles
Recycled Water Master Plan

RMC in association with CDM

Source: WRD, 2007

12.2 Existing and Projected Recycled Water System

WRD owns the Leo J. Vander Lans Water Treatment Facility which receives recycled water from the LBWD and provides advanced microfiltration and reverse osmosis treatment and UV disinfection for injection into the Alamitos Seawater Intrusion Barrier. This barrier project provides seawater intrusion protection to the Central Basin and adjacent Orange County Basin. Additionally, recycled water is purchased by WRD from LACSD and WBMWD and delivered to facilities owned and operated by LACDPW for groundwater replenishment in spreading basins and injection wells. WRD also purchases imported "blend" water for these replenishment facilities from WBMWD and CBMWD.

WRD participates in a planning effort known as the Water Independence Network (WIN). WIN is a network of local facilities and education efforts which would help the quality of life and economy of southern Los Angeles County if potable water becomes unavailable. MWD has created a series of programs that local agencies such as WRD can leverage to offset costs and provide true independence from imported water during disruptions or droughts. MWD has created incentive and credit programs for groundwater storage, water conservation and water recycling that are available through its member agencies such as the cities of Los Angeles, Long Beach, Compton, and the Central and West Basin Municipal Water Districts, all of which are within the WRD service area (WRD, 2009):

- Storage – Basin Amendments
- GRIP project
- VanderLans Expansion
- Dominguez Gap Barrier
- West Coast Basin Barrier

Additional details are provided in the Task 4.1.3– Regional Groundwater Assessment Draft TM.

12.3 Current and Potential Partnerships

WRD purchases water for recharge of the Dominguez Gap Barrier from LADWP. The current contract provides for purchase of 50% of the injection demand for the barrier or approximately 4,000 AFY to be supplied from TIWRP. WRD is seeking additional recycled water to eventually supply 100% of the barrier demands.

The following potential partnerships were discussed at the meeting between LADWP and WRD held on August 4, 2009:

- Offset Imported Water Supplies – WRD expressed a long-term interested in replacing imported MWD water with recycled water to improve reliability. WRD's long-term goal is to eliminate use of imported water. In the short-term, expanded recycled water facilities will be able to replace reductions to imported water due to Delta cutbacks, loss of snowpack, and drought on the Colorado River.

- Prefer Spreading Basins for GWR – WRD emphasized the advantages of spreading basins over injection wells as the best way to expand recycled water recharge. Spreading basins require less energy, generate a smaller carbon footprint, and provide organic trace contaminant removal with soil aquifer treatment. Currently, spreading grounds are used to replenish the Central Basin with 50,000 AF annually while injection wells are used to prevent sea water intrusion at the Alamitos Barrier in Central Basin and at the Dominguez Gap and West Coast Barriers in the West Coast Basin.

- Central Basin GWR opportunities discussed at the meeting:
  - Montebello Forebay– Additional spreading of recycled water in the forebay provides an opportunity to divert more recycled water from LACSD and possibly LADWP. WRD plans to interconnect the San Gabriel and Rio Hondo spreading basins which are the existing major spreading grounds for recharge of the Montebello Forebay as part of WRD's WIN program. The Montebello Forebay describes the unconfined area of the Central Basin south of Whittier Narrows. It has highly permeable soils which allow deep percolation of surface waters. Current operations at these recharge facilities conserve an average of approximately 150,000 acre-feet of 80,000 AFY local, 21,000 AFY imported, and 50,000 AFY recycled water annually.
  - Los Angeles Forebay – This forebay is the other major unconfined area of the Central Basin and is located west of the Los Angeles River, near Vernon and Huntington Park. It may be difficult to find available land for surface spreading, but land north of Vernon could be developed to create a multi-purpose spreading basin, green space, community area, and/or Los Angeles River revitalization project. WRD expressed that subsurface injection could be performed anywhere in the Central Basin; however, the Los Angeles Forebay area has higher soil transmissivity and unused storage space and could possibly allow recharge via shallow or dry wells.
- West Coast Basin GWR opportunities discussed at the meeting:
  - Increase Recycled Water Contribution – The West Coast Barrier is currently supplied with 75% recycled water and 25% imported water. Converting the barrier to 100% recycled water could offset potable water demands and save energy compared to imported water from MWD. Both seawater barriers in the West Coast Basin (e.g. the West Coast Barrier and the Dominguez Gap Barrier) are moving toward a 100% recycled water goal which could be supplied by LADWP or West Basin MWD from wastewater sources of the City of Los Angeles[4].
  - Inject Additional Recycled Water Mid-Basin – WRD suggested investigating a project that would "fill up" the West Coast Basin and flatten or reverse the existing hydraulic gradient that allows seawater intrusion. This could reduce or eliminate the need to operate barrier pumps/wells as well as minimizing energy use and carbon footprint. Shifting groundwater pumping from the West Coast Basin to the Central Basin could then stabilize the West Coast

4 There may be interest in similar projects from LACSD to offset the need for a new ocean outfall. LACSD is concurrently drafting a Master Facilities Plan called the Clearwater Program that will, in part, analyze alternatives for recycled water reuse.

Basin. These and other concepts for enhanced management of the West Coast Basin warrant more detailed evaluation.

- Increase conjunctive use with recycled water storage and recovery.
- Participate in "West Coast Basin Optimization Study".

12.4 Potential Role for WRD in Max Reuse

LADWP could partner with WRD to help meet regional indirect potable reuse goals in the Central and West Coast Basins. WRD expressed a desire to maintain an ongoing dialogue for regional recycled water planning, specifically with respect to spreading basins and injection wells. LADWP should pursue additional meetings with WRD. LADWP should also remain in regular contact with WRD to share the findings of RWMP Task 4.1.3 technical memo.

WRD is seeking immediate supply of recycled water from LADWP to supply remaining demands of the Dominguez Gap Barrier presently served with imported water (4,500 AFY).

LADWP, WRD and a majority of rights holders in the Central and West Coast Basin are sponsoring amendments to the adjudications which would enable large scale water augmentation projects utilizing recycled water for recharge of the basins (see the RWMP Task 4.1.3– Regional Groundwater Storage Draft TM and the Task 4.7– Central and West Coast Basin Judgment Amendments Draft TM. These amendments provide a mechanism to approve new projects to recharge the basins with recycled water without a specific limit as to amount. WRD would play a key role in evaluating and approving new recharge projects.

LADWP previously had WRD manage the design and construction of new groundwater wells on the LADWP system. The maximum reuse concepts in the Central and West Coast Basins include options to increase recharge of the groundwater basins with recycled water and service of recycled water to industrial customers presently served with groundwater. WRD may be able to assist LADWP with the design and construction of wells to produce additional groundwater supplies created by these efforts.

The consultant team anticipates that the proposed judgment amendments will motivate many agencies to contemplate projects for additional spreading of recycled and/or imported water at the Montebello Forebay. WRD manages the delivery of supplemental water to the spreading grounds and would have a key role in determining the availability of spreading capacity to accommodate new recharge projects. WRD also has a groundwater model of the Central and West Coast Basins which is a critical evaluation tool for any contemplated recharge projects.

WRD has done extensive evaluations of the Los Angeles Forebay. The WRD General Manager has expressed interest in partnering with LADWP to perform technical evaluations of the possible development of the Los Angeles Forebay.

13. West Basin Municipal Water District (WBMWD)

13.1 Background

The WBMWD was established in 1947 to annex into Metropolitan areas overlying the West Coast groundwater basin outside the boundaries of Los Angeles and Torrance. WBMWD was created to supply supplemental imported water to enable reductions in over-pumping in the West Coast Groundwater Basin and to supply imported water for recharge of the groundwater basin via the seawater intrusion barriers. WBMWD wholesales potable water to WRD for recharge and to 17 cities, mutual water companies, investor-owned utilities, water districts and private companies in the region. WBMWD also provides recycled water to these same entities for seawater barrier injection, municipal, commercial, and industrial use.

WBMWD is governed by a five member elected Board of Directors from within the service area of the District. In 2005, the total water served for WBMWD's service area was 183,900 AF. (WBMWD, 2005) WBMWD serves multiple southwestern LA County cities such as Culver City, Inglewood, Manhattan Beach, Lawndale, Palos Verdes Estates, and Carson.

As shown in Figure 1-1, the WBMWD service area is located south of the majority of LADWP's service area and in the same general vicinity as the Harbor area (WBMWD, 2005).

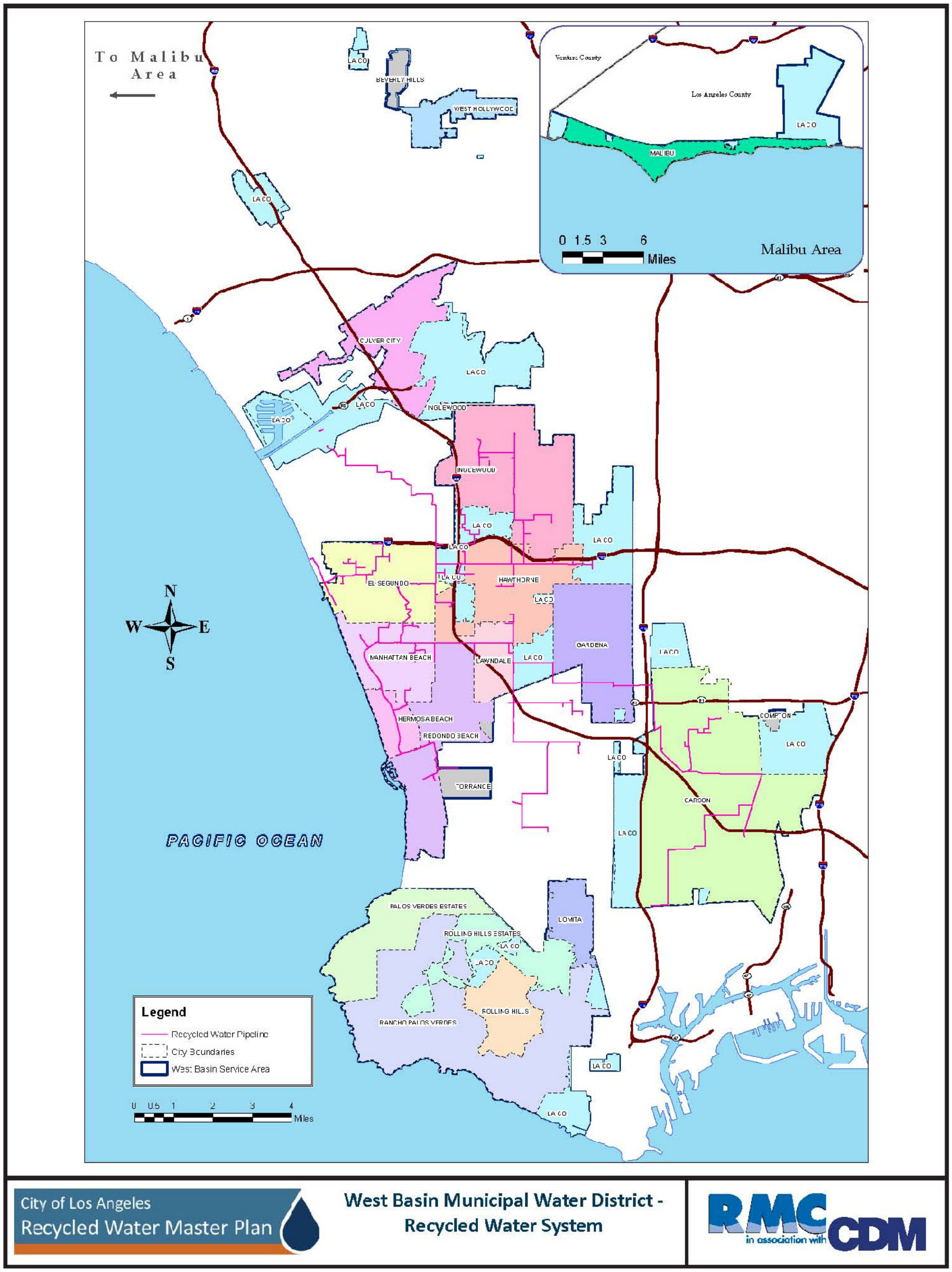
13.2 Existing and Projected Recycled Water System

13.2.1 Existing

WBMWD currently provides approximately 35,000 AFY to users in the service area. WBMWD's customers include: 50% refineries, 33% barrier, 17% other Municipal & Industrial.

As shown in **Figure 13-1**, the recycled water distribution system serves customers from El Segundo to Carson.

Figure 13-1: WBMWD Recycled Water System



Source: WBMWD, 2005

WBMWD purchases secondary effluent from the HTP and further treats it to tertiary standards for multiple uses at the Edward C. Little Water Recycling Plant in El Segundo, CA. The 56-mgd El Segundo Plant has the capability to produce five different levels of advanced treatment:

- Tertiary Water (Title 22) for industrial and irrigation uses
- Nitrified water for industrial cooling towers
- Softened reverse osmosis water: Secondary treated wastewater purified by micro-filtration (MF), followed by reverse osmosis (RO), and disinfection for injection to the West Coast Seawater Intrusion Barrier
- Pure Reverse Osmosis Water for refinery low-pressure boiler feed water
- Ultra-Pure Reverse Osmosis Water for refinery high-pressure boiler feed water

The output of Title 22 tertiary facilities is currently reduced to 30 mgd (limited by the capacity of the high-rate influent clarifiers). Currently, 12.5 mgd goes to the West Coast Barrier.

WBWMD also operates multiple satellite plants, which further treat Title 22 water from the Edward C. Little plant including the Chevron Nitrification Plant (5 mgd), the Exxon-Mobil Nitrification and Reverse Osmosis Plant (6 mgd), and the Juanita Millender-McDonald Water Treatment Facility (JMMWTF, 3.5 mgd). The JMMWTF provides nitrification, separate microfiltration, and reverse osmosis. WBMWD owns and operates a pump station at HTP with a 60 mgd capacity. Other existing recycled water facilities are summarized below:

13.2.2 Projected

WBMWD's 1999 Recycled Water Master Plan with LADWP is being updated, and is anticipated to be distributed in late October 2009. The "Water Reliability 2020" program is currently guiding recycled water planning and has the overall goal of reducing imported supplies from 66% to 33% by 2020. Conservation, groundwater storage, and ocean desalination will also play a role.

The updated RWMP predicts that recycled water use will increase to approximately 70,000 AFY by 2020 (50,000 AFY within the service area) under the "Water Reliability 2020" program. WBMWD currently serves 10% of the total HTP secondary effluent supply as recycled water. This amount could expand to 20% with all identified customers in the updated 2009 RWMP. WBMWD seeks to increase the amount of recycled water service even further but may be limited by the pipeline capacity from HTP to the Edwards C. Little WRF.

WBMWD has identified additional recycled water supply sources listed below:

- WBMWD Effluent Pump Station – Increase capacity from 60 to 115-120 mgd.

- Joint Water Pollution Control Plant – This 400-mgd capacity ocean discharge plant is operated by LACSD. WBMWD has potential plans to operate a 7-mgd tertiary plant to serve the nearby BP refinery. The tertiary plant would provide nitrification, microfiltration, and partial reverse osmosis advanced treatment to supplement water from the JMMWTF. This project concept is driven by the excessive cost to construct a parallel pipeline from the Edwards C. Little WRF to Carson. WBMWD has been in discussions with LACSD regarding this project opporutnity.

- Chevron Nitrification Plant – Planned expansion from 5.0 mgd to 5.58 mgd capacity.

- JMMWTF – In addition to a 12.5 MGD expansion of the plant (described below) to serve LADWP there is a planned expansion from 3.5 mgd to 4.5 mgd capacity to serve BP's Los Angeles Refinery. WBMWD's expansion may be even larger and include an upgrade to include ultraviolet disinfection and advanced oxidation so that additional advanced treated recycled water may be provided to the Dominguez Gap Barrier.

- West Coast Barrier – Expand recycled water use in injection wells from 11,000 AFY (75% blend) to 15,000 AFY (100%).

Non-Potable reuse expansion projects in the Harbor, Westside, and Northern Westside areas will be analyzed under Task 2 (Non-Potable Reuse Master Plan).

13.3 Current and Potential Partnerships

LADWP and WBMWD currently have a 25-year agreement that expires in 2016. WBMWD purchases secondary-treated effluent from HTP at $7.50/AF. The agreement includes a LADWP right to purchase up to 25,000 AFY of recycled water from WBMWD at a price not to exceed WBMWD's actual costs of treatment and distribution. Currently, LADWP buys approximately 500 AFY for non-potable reuse customers on the Westside. Tier 1 of LADWP's non potable reuse development includes purchase of 12.5 MGD of recycled water from the JMMWTF to serve 9,300 AFY of demands in the Harbor area.

The following potential partnerships were discussed at the meeting with WBMWD held on August 13, 2009.

- Harbor Refineries Pipeline Project – This project will supply recycled water from the upgraded JMMWTF to several refineries and irrigation users in the Harbor area. WBMWD will receive additional secondary-treated effluent from HTP at the El Segundo WRP, which in turn will provide tertiary-treated water to the JMMWTF, which will provide nitrified recycled water to LADWP. An agreement for this project is scheduled for LADWP Board action in November 2009. The EIR for the project is expected to be certified by the Board in October 2009. This project will offset 9,300 AFY of potable water demands from LADWP.
- Effluent Pump Station – LADWP and WBMWD are discussing an agreement to expand the pump station at HTP from 60 mgd to 120 mgd of capacity. There are also discussions underway about possible improvements in the secondary treatment provided at HTP to be paid for by WBMWD as a means to improve water quality.

13.4 Potential Role for WBMWD in Max Reuse

LADWP could partner with WBMWD to expand non-potable reuse and improve system reliability. System reliability benefits may depend on WBMWD obtaining a second source of recycled water, such as the JWPCP in Carson operated by LACSD. There may be opportunities to offset potable demand in LADWP's service area as well. WBMWD is a large, influential MWD member agency and a large recycled water distributor in the West Coast Basin area. The agency expressed a strong commitment to expanding the use of recycled water.

WBMWD currently provides WRD with the imported blend water for spreading basin operations at the West Coast Barrier and the Dominguez Gap Barrier. These barriers supply recharge water within both the LADWP and WBMWD service areas. As imported water contributions to the injection well operations are gradually replaced with recycled water, WBMWD could potentially have more imported water available for distribution or storage. A potential partnership could include provisions for additional potable supplies to be provided to LADWP from WBMWD in exchange for the recycled water supply (for additional detail see the Task 4.1.3– Regional Groundwater Assessment Draft TM).

Discussions are needed between WBMWD and LADWP on the preferred method of servicing demands at the Dominguez Gap barrier project. It is possible to serve these demands from either TIWRP or from HTP via the JMMWTF.

Expansion of the Harbor area treatment facilities (TIWRP, JMMWTF, and/or the JWPCP) will be needed to serve recycled water to the refineries to satisfy demands presently served with groundwater. These opportunities exist for both the WBMWD and LADWP service areas. LADWP should review plans by WBMWD to develop supplies from the JWPCP. LADWP should also allow WBMWD to review plans for development of water from the TIWRP included in the LADWP RWMP.

LADWP may ask WBMWD to provide supplemental treatment to produce high-purity and ultra-pure water suitable for boiler makeup at the refineries within LADWP's service territory.

The proposed judgment amendments may create additional recharge demands via injection in either the seawater barriers or via new mid-basin injection wells. WBMWD may provide treatment to supply a portion of these demands. Planning for facilities to service these new demands should be closely coordinated with WBMWD. LADWP may also consider having WBMWD provide new treatment services to create recycled water from HTP effluent as a source of supply for other uses under the concept of maximum reuse (additional details may be found in the Task 4.1.3– Regional Groundwater Assessment and Draft TM in the Task 4.7– Central and West Coast Basin Judgment Amendments Draft TM).

Future facilities to accomplish maximum reuse would include a combination of new advanced treatment at DCT, LAG, BWRP and potential new satellite treatment plants plus new treatment facilities at HTP. The design, construction and operation of these new facilities will impact the quantities and quality of effluent available at HTP. This warrants careful coordination with WBMWD to ensure that new reuse options do not impact existing and planned reuse by WBMWD.

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Appendix F

Regional Groundwater Assessment TM

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Summary of Modifications to the Regional Groundwater Assessment Technical Memorandum since Initial Publication on November 25, 2009

The Recycled Water Master Planning (RWMP) effort has spanned three years (April 2009 – March 2012). As is the nature of a planning project, assumptions are typically modified and refined as a project is further developed. The most recent assumptions related to the Long-Term Concepts master planning effort are presented in the Draft Long-Term Concepts Report (January 2012). Assumptions and conclusions presented in this report supersede assumptions included in this technical memorandum (TM). The following table summarizes the modifications applicable to all RWMP TMs and those specifically applicable to this TM are described following the table.

Assumption	Modified	Original
Applicable to all RWMP TMs		
Recycled Water Goal	59,000 AFY by 2035 This goal reflects the 2010 LADWP Urban Water Management Plan that was adopted in early 2011, after the original RWMP goals were drafted	50,000 AFY by 2019
Introduction Section	Ignore this section and refer to the Introduction Section of the RWMP Report.	This section was included in all initial TMs but the terms described have been replaced by the Introduction Section for each RWMP report.
NPR Projects Terminology	To avoid confusion related to LADWP's water rate structure, the terms "Tier 1" and "Tier 2" are superseded with the terms "planned" and "potential," respectively. Both planned and potential projects would be considered for implementation by 2035.	"Tier 1" for NPR projects that were originally planned for design and construction by the year 2015. "Tier 2" for NPR projects that were being originally evaluated in the NPR Master Planning Report for potential future implementation after the year 2015.
Name for MF/RO/AOP treatment plant	Advanced water purification facility (AWPF)	Advanced water treatment facility (AWTF)
Name for water produced by AWPF	Purified recycled water	Advanced treated recycled water, highly purified recycled water, etc.
Treatment Plant Acronyms	DCTWRP LAGWRP	DCT LAG

The following modifications are specific to this TM.

Universal

All references to "Recycled Water Master Plan" should be replaced with "Recycled Water Master Planning".

All references to "Metropolitan" or "Metropolitan Water District" should be replaced with "MWD".

Page 6, Section 2.1

First sentence of last paragraph should be replaced with:

~~Thus, the greatest water supply benefit derives~~ A benefit exists from options to deliver recycled water to recharge groundwater basins and/or serve demands not presently supplied by LADWP that would in turn increase its supply of groundwater.

Page 7 and 11, Section 2.1.2

Since the time this TM was submitted, additional information has been obtained on projects in the Central Basin. The table below describes the recharge potential from the 4.1.3 TM and explains how these numbers are used to arrive at the 115,000 AFY of estimated combined recharge potential for the West Coast and Central Basin that is assumed in the Long-Term Concepts Report.

To clarify the recharge capacity of the West Coast Basin (and the total recharge capacity of all basins), the following table should be added to 4.1.3 TM Section 2.1.2 Long-Term Opportunities. Other recharge capacity numbers for the West Coast Basin (shown in Figure 1 and on page 11, second bullet) should be updates as follows.

Basin	Recharge Potential Assumed in 4.1.3 TM (AFY)	Recharge Potential Assumed in LTCR (AFY)	Notes
Raymond	5,000 - 10,000	*5,000 – 10,000*[1]	Though recharge capacity may be available, the recharge potential is supply-limited because supplies from DCTWRP and LAGWRP will be utilized in the San Fernando Basin. It is assumed in the LTCR that project concepts in the Raymond and San Fernando Basins are mutually exclusive.
West Coast	50,000	50,000	Up to 50,000 AFY of recharge capacity is available through mid-basin injection wells or a combination of mid-basin wells and increased injection at seawater barriers and recovery through additional pumping.
Central	77,000	65,000	The previous estimate for Central Basin included surface recharge at Montebello Forebay (12,000 AFY), injection wells at LA Forebay (40,000 AFY) and additional recharge and recovery in the Montebello Forebay (25,000 AFY). Since that time, it has become clear that the 12,000 AFY of surface recharge capacity at Montebello Forebay will be utilized for a non-City recharge project. The remaining Central Basin capacity is 65,000 AFY.
Total	**132,000 – 137,000**	**115,000**[1]	

1. It would be possible to substitute project concepts in the Raymond Basin for project concepts in the San Fernando Basin. The total value for recharge potential does not include the Raymond Basin because these projects would be mutually exclusive with projects in the San Fernando Basin.

Page 31, Section 4.2

Under the "Individual Storage Accounts" bullet, "APA" stands for "Allowable Pumping Allocation".

Page 31, Section 4.2

Second sentence of last paragraph should be replaced:

As such, LADWP ~~should~~ could take appropriate steps to demonstrate support for both the amendments as well as implementation of the storage framework.

Page 36, Section 4.3

Under "Water Supply Implications", first sentence of third paragraph should be replaced with:

In the future, LADWP ~~should~~ could consider providing additional recycled water to the WCBBP for the purpose of augmenting water supply in the West Coast Basin.

Page 38, Section 4.3

Under "Water Rights and Institutional Implications", the list should be replaced with the following:

1. LADWP could ~~can~~ acquire and produce water rights that are presently unused. This new groundwater pumping would be sustained by increased injection of recycled water either at the barriers or via mid-basin injection.
2. LADWP could ~~can~~ acquire water rights which would be displaced by the delivery of recycled water to the major refineries. The new pumping by LADWP would not increase demands for injection of water into the basin but would instead be sustained by the delivery of surface recycled water to the refineries.
3. LADWP could ~~can~~ sponsor a water augmentation project under the proposed judgment amendments. Under this scenario LADWP's new groundwater production would be sustained by injection of additional recycled water either at the barriers or via mid-basin injection.

Page 39, Section 4.3

The third sentence in the second paragraph should be replaced with:

However, LADWP would need to ~~must~~ become pro-active in planning with the other MWD member agencies and the sub-agencies of West Basin MWD who have the potential to use groundwater.

Page 60, Section 8

The second sentence in the second paragraph should e replaced with:

But there may be ~~are more~~ efficient solutions employing interconnections of existing recycled water systems of LADWP and other agencies.

Page 61, Section 8

First bullet under the second should be replaced with:

MWD is updating ~~will~~ update its Integrated Resources Plan.

Page 62, Section 8.1

Last sentence under the fourth paragraph should be deleted:

The potential also exists to serve the new power plant in Vernon in conjunction with a project to serve other potential demands in Vernon and enable Vernon to transfer groundwater rights to LADWP. Thus Vernon is an independent decision maker and a valuable player in developing new supplies of wastewater on the Central Basin system and for regional uses within Central Basin. Since the power plant would be required by the California Energy Commission (CEC) to develop a recycled water supply and not compete with other uses of recycled water it could contribute in a unique way to an optimal solution. Moreover, the CEC policy encourages power plants to employ zero liquid discharge whenever possible. ~~Recognizing that City of LA has historically opposed a power plant in Vernon due to environmental justice concerns, the discussions between City of Los Angeles and Vernon regarding the water supply to the power plant are particularly complicated.~~

Page 64, Section 8.3

Last sentence in the first paragraph should be deleted:

WRD has important resources which could benefit LADWP. WRD has in the past developed new wells for LADWP. The expertise on new wells is useful to LADWP. Also, WRD has a groundwater model which is needed for evaluation of all new basin management strategies and would be central to CEQA evaluations of new recharge and production facilities. WRD would have to approve any new projects proposed by LADWP under the judgment amendments. WRD has built an effective relationship with the major pumpers within the basin. The opinions of WRD's staff are important to formulating any service proposal for spreading water or injection water. WRD is service oriented and wants to help LADWP in the basin. It would consider new institutional programs such as revised in-lieu or special pumping assessments. It would consider new recharge mechanisms for its use in advance of the judgment amendment approvals. It has invited LADWP's participation in the GRIP project. ~~LADWP needs to show a commitment to WRD to avail itself of the WRD resources and cooperation.~~

Technical Memorandum

Title: **Regional Groundwater Assessment Technical Memorandum**

Version: DRAFT

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Date: November 25, 2009

Reference: Task Order 4a: Concept Report for Maximizing Reuse
Task 4.1: Basic Research
Task 4.1.3: Regional Groundwater Assessment

1. Introduction

With imported water supplies becoming ever more unpredictable, the Los Angeles Department of Water and Power (LADWP) adopted the Mayor's vision of Securing LA's Water Supply in May 2008, calling for 50,000 acre-feet per year (AFY) of potable supplies to be replaced by recycled water by 2019. To meet this near-term challenge and plan for expanding reuse in the future, LADWP has partnered with the Department of Public Works to develop the Recycled Water Master Plan (RWMP). The RWMP includes 7 major tasks:

1. Groundwater Replenishment Reuse Master Plan,
2. Non-Potable Reuse Master Plan,
3. Groundwater Replenishment Treatment Pilot Study,
4. Max Reuse Concept Report,
5. Satellite Feasibility Concept Report,
6. Existing System Reliability Concept Report, and
7. Training.

The importance of additional water supply options for Los Angeles has become increasingly apparent with continuation of drought conditions, building contention for limited available water supplies both statewide and across the Southwest, and growing awareness of the critical nexus between quality of life/economic stability and available supplies of quality water.

This technical memorandum (TM) is a deliverable under Task 4a: Concept Report for Maximizing Reuse, and focuses on groundwater replenishment opportunities

1.1 Task Order Background

The purpose of Task 4 is to research and identify projects that have the potential to maximize the beneficial reuse of effluent produced, or potentially produced, at the following treatment plants: Los Angeles Glendale Water Reclamation Plant (LAG), Terminal Island Water Reclamation Plant (TIWRP), and Hyperion Treatment Plant (HTP). Specifically, it is desired to identify potential reuse opportunities beyond those already identified to achieve the 50,000 AFY by 2019. Opportunities to maximize reuse from the Donald C. Tillman Water Reclamation Plant (DCT) are covered under Task 1.

Task 4a will identify a wide array of potentially feasible wastewater diversion, flow equalization, and treatment expansion and/or upgrade projects that would maximize recycled water production from the existing treatment plants. This includes (1) identification of local and regional groundwater replenishment opportunities (including interconnection with neighboring agencies) that could provide a mechanism for beneficial reuse of the maximized recycled water; (2) identification of non-potable reuse projects that could be served by any remaining and expanded recycled water sources including interagency interconnections; and (3) a preliminary screening of these projects and opportunities to identify potentially feasible projects.

1.2 Purpose

This Regional Groundwater Assessment TM summarizes existing and planned groundwater replenishment opportunities, including seawater intrusion barriers and estimates of basin replenishment potential, for the following basins:

- West Coast Basin
- Central Basin
- Raymond Basin
- San Gabriel Basin

Potential replenishment of the San Fernando Valley Groundwater Basin is documented under Task 1a.

1.3 Outline of this TM

This TM is organized in the following sections:

- Section 1 – Introduction
- Section 2 – Conclusions and Recommendations
- Section 3 – Regional Groundwater Overview
- Section 4 - West Coast Basin Opportunities
- Section 5 – Central Basin Opportunities
- Section 6 – Raymond Basin Opportunities
- Section 7 – San Gabriel Basin Opportunities
- Section 8 – Regional Planning and Cooperation

1.4 Related Technical Memoranda

Other related technical memoranda summarizing basic research for the Maximizing Reuse Concept Report include the following:

- Wastewater Treatment TM (Task 4.1.1)
- Regional Recycled Water System TM (Task 4.1.2)
- LA River Flow Assessment TM (Task 4.1.4)
- Semi- and Direct Potable Reuse TM (Task 4.1.5)
- Central and West Coast Basin Judgment Amendments TM (Task 4.7.1)

2. Conclusions and Recommendations

A wide range of opportunities for expanded recycled water use exist in the West Coast Basin and Central Basin, as well as recycled water opportunities in the Raymond Basin. The opportunities include:

- Expanded uses of recycled water for seawater barrier injection and surface recharge to replace imported water at current levels

- Long term water augmentation programs that would increase both recharge with recycled water and recovery through increased groundwater production
- Indirect reuse concepts where expanded recycled water use for non-potable needs could free up additional groundwater production rights.

Some of the options considered rely upon amendments that have been proposed to the judgments that would allow for a variety of water augmentation, storage and recovery programs. The West Coast Basin judgment amendments may be approved by the court soon, while the Central Basin judgment amendments face additional challenges and a less-certain near term future. For additional information on the Central and West Coast Basin Judgment Amendment, see Task 4.7.1 Final Draft TM.

The options identified herein will be prioritized in later stages of the Recycled Water Master Plan. That prioritization will include evaluations of cost and feasibility and will consider the priorities that the City of LA has for using wastewater from particular sources and the extent to which the options improve the reliability of LADWP's water supplies.

Nonetheless, these opportunities are described in detail in this Technical Memorandum. They are summarized in the following text and in **Table 1**. A map illustrating these opportunities is shown in **Figure 1**.

2.1 Near and Long Term Opportunities

The following hierarchy of benefits is useful in judging the relative merits of various recycled water opportunities:

- The most benefit is derived when LADWP develops recycled water and reduces its own use of Metropolitan supplied water.
- A lesser benefit is likely derived when LADWP delivers recycled water to another agency and receives a delivery of non-Metropolitan supplied water in exchange.
- A lesser benefit is derived when the agency receiving recycled water delivers Metropolitan-supplied water in exchange.
- A lesser benefit is derived when LADWP delivers recycled water to another agency without any exchange of water and that recycled water use displaces a Tier 1 use of Metropolitan-supplied water.
- A lesser benefit is derived when LADWP delivers recycled water to meet the groundwater replenishment demands of another agency which is not part of the agency's allocation of Metropolitan-supplied water but LADWP benefits from that replenishment operation.
- The least benefit of all options would seem to be selling recycled water to displace current replenishment deliveries which are not part of an agency's allocation of Metropolitan supplied water and the replenishment does not sustain groundwater production within the City of Los Angeles

Thus, the greatest water supply benefit derives from options to deliver recycled water to recharge groundwater basins and/or serve demands not presently supplied by LADWP that would in turn increase its supply of groundwater. Since the these options require LADWP to install new groundwater production facilities, prioritizing these opportunities requires the evaluation of new well locations and how to integrate these well supplies into the distribution system of LADWP. The least benefit is derived from the delivery of recycled water for spreading water to a groundwater basin in which LADWP does not operate and has no legal standing. In such cases LADWP would need to negotiate a formal agreement with one or more of the parties to for sale or recycled water or other indirect benefit. The opportunities identified below incorporate these principles.

2.1.1 Near Term Opportunities

Several key opportunities are currently being planned by LADWP and LABOS, or they should be considered for possible action as soon as possible. These include:

- **West Coast Basin Barrier (already planned)** - Expansion of the use of recycled water to 100 percent of current demands at the West Coast Basin Barrier which would use an additional 3,900 AFY at current basin conditions. Water would continue to be provided to West Basin Municipal Water District (WBMWD) for advanced treatment and delivery to the Water Replenishment District of Southern California (WRD) for injection in the Barrier. LADWP should investigate means of sharing with WBMWD the imported water which is conserved by the delivery of recycled water.
- **Dominguez Gap Barrier (already planned)** - Expansion of the use of recycled water from Terminal Island WRP at the Dominguez Gap Barrier Project which would use an additional 4,000 AFY at current basin conditions. LADWP and LABOS should continue actively working with WRD to secure an agreement to supply more water from TIWRP. LADWP should also investigate means of sharing with WBMWD the imported water which is conserved by the delivery of recycled water.
- **Groundwater exchange (recommended)** - LADWP should consider supplying recycled water to the major refineries in exchange for acquiring water rights which would be displaced by the delivery of the recycled water. The new pumping by LADWP would not increase demands for injection of water into the basin but would be offset by the delivery of surface recycled water to the refineries in lieu of refinery pumping.
- **Begin installing new production wells in the West Coast Basin (recommended)** – LADWP may exercise its unused pumping rights and rights of others presently unused. This new production would increase demands for recycled water at the two seawater intrusion barriers. The new wells would also be useful to recover water recharged in the West Coast Basin under future water augmentation projects allowed under the amended judgment.

2.1.2 Long Term Opportunities

Most of the remaining opportunities may take longer time periods (likely 10 years or longer) to develop into actual projects. These are summarized below.

L:\Projects GIS\0214-002 LADWP RWMP\MXDs\Task4\RegionalMap-Groundwater_LA_DF_2009.mxd

Data Sources: CDM, ESRI, RMC, USGS

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Table 1- Summary of Future IPR opportunities

Groundwater Basin	General Location and Method of Replenishment	Existing RW Use? - Source	Potential Future RW Opportunities			Institutional Setting - Exisiting/Potential					Applicable Judgment and Key Provisions				Additional Studies Recommended	Discussion/Observations
			Brief Description of Opportunities	Possible New/Additional Quantity	Source(s) of Recycled Water	Basin Replenishment	Watermaster	Injection or Spreading Basin Operation	Reycled Water Source/Producer	Imported Water Purveyor(s)	Judgment	LADWP Adjudicated Water Rights	Current Provisions	With Proposed Amendments		
West Coast Basin	Injection at WCBBP	Yes - HTP and WBMWD	Expand injection from 75% to 100% recycled water	3,800 AFY	HTP through WBMWD ELWRF	WRD	DWR	LACDPW	LABOS/LADWP/WBMWD	WBMWD	West Coast Basin Judgment	1,503 AFY	Replenishment Water covered under current provisions regardless of source. No direct provision for storage and recovery.	Various provisions for developing storage and recovery allotments either as LADWP or in conjuction with others (e.g. MWD) for regional and recovery projects	Existing studies and monitoring programs adequate	Expansion to 100% RW planned after further monitoring, evaluation, and review by IAP.
			Increase total barrier injection beyond current levels	See mid-basin injection											More detailed studies of expanded storage and recovery options - quantity and quality issues	Evaluate benefits of increased injection on overall water levels and storage for injection at barriers vs. mid-basin injection
	Injection at DGBP	Yes - TIWRP	Expand injection from 50% to 100% recycled water	4,000 AFY	Terminal Island Treatment Plant				LABOS/LADWP, LABOS/LADWP/WBMWD, or LACSD						Existing studies and monitoring programs continue, may need feasibility analysis of best source of rw	Future expansion possible. Requires monitoring, project evaluation, review by IAP, and expansion of AWT at the TIWRP.
	Mid-basin or increased barrier injection	No	Construct new inland injection wells	Up to 50,000 AFY recharge through mid-basin injection wells or combination of mid-basin and increased injection at barriers and recovery through pumping.	HTP through WBMWD ELWRF			Current - none; Potential - LADWP	Current - none; Potential LABOS/LADWP				No direct storage and recovery provisions		More detailed studies of expanded storage and recovery options - quantity and quality issues	Evaluate benefits of increased injection on overall water levels and storage for mid-basin injection vs. at barriers
Central Basin	Surface recharge at Montebello Forebay	Yes - LACSD Whitier Narrows, San Jose Creek and Pomona WRPs	Supplement current replenishment supplies with more recycled water - make up current deficit and gradually replace imported water	12,000 AFY	LACSD Whittier Narrows, San Jose Creek and/or Los Coyotes Treatment Plants; LACSD Carson Plant (future); HTP: new City of LA satellite plant.	WRD	DWR	LACDPW	Current - LACSD; Future - LACSD, potential LABOS/LADWP	CBMWD	Central Basin Judgment	15,000 AFY	Replenishment Water covered under current provisions regardless of source. No direct provision for storage and recovery.	Various provisions for developing storage and recovery allotments either as LADWP or in conjuction with others (e.g. MWD) for regional and recovery projects	No new investigations - issues well understood and documented.	Substantial opportunity to make up current deficit and over long-term substantially reduce imported water
	Injection (shallow) at LA Forebay	No	Add new recharge wells in LA Forebay area that could be larger capacity design, shallower wells. Alternative is to consider taking land out of commercial/industrial use and creating spreading basins, but very expensive and may be surface contamination.	Unknown-assume up to 40,000 AFY	HTP (or new satellite treatment plant) with AWT at HTP or satellite plant			Current - none; Potential - LADWP	Current - none; Potential LABOS/LADWP				No direct storage and recovery provisions		Investigations of methods,locations and sources of recycled water.	Good opportunity. Unconfined portion of basin, but highly developed and heavily industrialized area, so surface recharge opportunity very limited or possibly infeasible due to possible surface contamination. Injection wells could be shallow, high capacity wells.
	Injection at Alamitos Barrier	Yes - LACSD Long Beach WRP via LBWD	Expand injection from 50% to 100% recycled water	3,400 AFY	LACSD Long Beach WRP			LACDPW	LACSD				Replenishment Water covered under current provisions regardless of source.		None	Too far from LADWP facilities - can be supplied from LACSD Long Beach WRP

Groundwater Basin	General Location and Method of Replenishment	Existing RW Use? - Source	Potential Future RW Opportunities			Institutional Setting - Exisiting/Potential					Applicable Judgment and Key Provisions				Additional Studies Recommended	Discussion/Observations
			Brief Description of Opportunities	Possible New/Additional Quantity	Source(s) of Recycled Water	Basin Replenishment	Watermaster	Injection or Spreading Basin Operation	Reycled Water Source/Producer	Imported Water Purveyor(s)	Judgment	LADWP Adjudicated Water Rights	Current Provisions	With Proposed Amendments		
Raymond Basin	Surface recharge	No	Supplement current local replenishment supplies with recycled water.	5,000 - 10,000 AFY	LAG or San Jose Creek WRP	Replenishment of local surface water by specific pumpers	Raymond Basin Advisory Board	Various parties	Current - none; Potential - Glendale, Bubank, LABOS/LADWP	City of Pasadena, Foothill MWD, Upper San Gabriel Valley MWD, San Marino	Raymond Judgment	None	Contains provisions for storage and recovery. Does not address recycled water.	None Pending	Investigations of methods,locations and potential permitting issues.	Conjunctive storage of MWD water has been studied. Recycled water storage has not been evaluated.
	Injection	No	Supplement current local replenishment supplies with recycled water.	5,000 - 10,000 AFY	LAG or San Jose Creek WRP										Investigations of methods,locations and potential permitting issues.	Conjunctive storage of MWD water has been studied. Recycled water storage has not been evaluated.
San Gabriel Basin	Surface recharge	No	Supplement current local replenishment supplies with recycled water.	Replace up to 46,000 AFY of imported water	San Jose Creek WRP	Upper San Gabriel Basin Watermaster	Upper San Gabriel Basin Watermaster	Various parties	Current - none; Potential - LACSD	Upper San Gabriel Valley MWD; TVMWD	Main San Gabriel Basin Judgment	None				Likely too far for LADWP, potential for LACSD

West Coast Basin

- **Continue the installation of new wells in the basin and acquire and develop unused rights in the basin** - With up to 20,000 AFY of unused pumping rights currently available, this use of groundwater would substantially increase the demands for injection at the two barriers. Depending upon location of the new pumping wells, this increase could be between approximately 14,000 to 18,000 AFY at the West Coast Basin Barrier and between one and four thousand AFY at the Dominguez Gap Barrier
- **Develop water augmentation projects within the West Coast Basin** - These projects would involve the delivery of additional recycled water for injection to build storage for subsequent recovery and delivery for potable use in the West Coast Basin through mid-basin injection wells or a combination of mid-basin wells and further increases in injection at the barriers. Total potential injection and recovery could potentially be as high as 30,000 AFY. Water would likely be supplied from Hyperion Treatment Plant (HTP) via AWT treatment by WBMWD and from TI WRP AWT treatment. This would require court approval of the current pending West Coast Basin Judgment amendment.
- **Work with other potable water uses within the basin** – Projects with these groundwater producers (i.e., Torrance, Long Beach and West Basin sub-agencies) could be used to develop new production capacity to recover water from water augmentation projects described above.

Central Basin

- **Replace imported water with recycled water at Montebello Forebay -** Provide a supply of additional recycled water to WRD via direct or indirect means in place of imported water in the Montebello Forebay. Under current Central Basin production patterns and with the implementation of near term planned projects by WRD and others, the unmet Forebay replenishment requirements are anticipated to generally be approximately 12,000 AFY based on long term average pumping, but could be higher if future pumping is closer to full adjudicated rights. While it may not be practical to supply additional recycled water to the Montebello Forebay from City of LA/LADWP sources due the distance from any City facilities and the proximity to Los Angeles County Sanitation Districts (LACSD) Water Reclamation Plants (WRPs), LADWP could potentially supply recycled water to offset non-potable demands currently being met by the City of Long Beach or Central Basin Municipal Water District (CBMWD) which would free up additional water from the LACSD plants.
- **Supply recycled water to non-potable users in western Long Beach** - While it does not appear practical to supply additional recycled water to the Alamitos Gap Barrier Project (AGBP) from city of LA/LADWP sources due the distance from any City facilities and the proximity to the Long Beach and Los Coyotes WRPs, LADWP could potentially supply recycled water to offset non-potable demands currently being met by the City of Long Beach or CBMWD which would free up additional water from the LACSD plants. Demands at the AGBP are approximately 3,000 AFY

  Develop Groundwater Recharge (GWR) in Los Angeles Forebay - Construct new injection or possibly surface recharge (potentially major challenges would be involved) in the Los Angeles Forebay portion of the Central Basin either as a substitute for recharge of the Montebello Forebay or for subsequent recovery and delivery for potable use through increased LADWP pumping under a water augmentation program. Total potential recharge and recovery could be as high as 40,000 AFY. Water could be supplied from various sources[1]:

- HTP and expanded AWT at WBMWD
- HTP with a separate City of LA AWT facility located closer to the areas of recharge
- City of LA satellite treatment plant with AWT in the southeast portion of the City for the treatment of raw sewage
- City of LA satellite treatment plant with AWT in the southeastern portion of the City for the further treatment of upstream effluent discharged into the LA River

- **Increase pumping up to allocated limit** - Further develop and use the approximately 5,000 AFY of LADWP pumping rights that have gone unutilized. Perhaps more reliably, LADWP could potentially increase its pumping rights by supplying recycled water to users within Central Basin who are supplied with well water. There are opportunities to develop recycled water customers within the City of Vernon and Southgate on the order of 5,000 AFY which in conjunction with acquisition of these rights by LADWP could increase LADWP's pumping rights within the Central Basin by 5,000 AFY to a total of approximately 20,000 AFY.
- **Partner with WRD and other agencies in regional planning** - WRD has contemplated in the past a regional groundwater recovery program in the Montebello Forebay which would pump new recharge water from the Forebay and distribute that water to the southern end of the basin to large purveyors including the City of Long Beach. Initially a project of 25,000 AFY pumping was contemplated.

Raymond Basin Opportunities

- **Exchange recycled water for imported supply** - Supply of recycled water to City of Pasadena or other parties in the Raymond Basin for storage and recovery in the Raymond Basin in exchange for an equivalent amount of imported water supply. Estimated maximum potential is 5,000 – 10,000 AFY. This would require agreements with a party or parties to the Raymond Basin Judgment and the Raymond Basin Management Board.

2.1.3 Regional Planning and Cooperation

As noted above, there are significant opportunities to serve recycled water to meet the regional replenishment requirements within the Central, West Coast, and Raymond groundwater basins. Moreover, there are opportunities to serve recycled water to users who rely upon groundwater and to customers of water purveyors who rely upon groundwater from the three basins. These opportunities provide a market for recycled water originating from wastewater sources of the City of Los Angeles and can also serve to improve the adequacy of water sources for the LADWP.

The delivery systems to serve recycled water can be stand-alone systems originating from wastewater sources of the City of Los Angeles. However, more efficient solutions are possible if the existing recycled water systems of LADWP and other agencies are planned and used in an

[1] Any of these larger-scale options would require court approval of the proposed Central Basin Judgment amendment

integrated manner. The utility of integrating these systems can be fully realized only when the benefits of the region, as well as, to the City of Los Angeles are considered. Also, the physical operation of these systems must consider how to integrate wastewater sources from the City of Los Angeles with other wastewater sources. Key agencies with whom close cooperation and coordination is essential for the various opportunities noted above include:

- WBMWD
- CBMWD
- WRD
- LACSD
- City of Long Beach
- Raymond Basin Watermaster
- City of Pasadena

Further discussion on specific regional planning and cooperation activities is provided in Section 8.

2.2 Additional Studies Needed to Confirm, Refine, and/or Implement the Above Opportunities

The various parties involved in the planning for expansion of recycled water use at the West Coast Basin Barrier Project (WCBBP) and Dominguez Gap Barrier Project (DGBP) are involved in activities related to those projects. LABOS and LADWP are directly part of these efforts as well. No additional studies are identified under this Technical Memorandum for the near term opportunities.

For each of the long term opportunities, there are a range of technical, financial, institutional and legal issues that will need further development and investigation. Nearly all of these opportunities will involve multiple parties and therefore LADWP will need to be actively engaged with various agencies and stakeholders to further explore each option and make strategic decisions at appropriate times. A basic overview of additional issues to be studied is summarized in Table 2.

Many of the options contained in this memorandum involve the production of additional groundwater by LADWP from the Central and West Coast Basin. LADWP should begin evaluations of potential new well production facilities in both basins. These investigations would include hydro-geologic studies and distribution system integration evaluations to determine how new well water supplies could be utilized in the LADWP system.

Because it appears that the West Coast Basin Judgment amendments may be accepted soon by the Court, a high priority would be to continue cooperative investigations with WRD and other parties of expanded storage through injection or recycled water and recovery of production in the West Coast Basin. Also, LADWP should develop relationships and partner further with Raymond Basin parties. Additional technical investigations at a feasibility level could be initiated in conjunction with WRD and others to address the potential for storage and recovery in the Los Angeles Forebay. Similarly, additional studies are warranted for new water augmentation projects in the Montebello Forebay and via injection in the pressure areas of Central Basin. These studies should remain closely aligned with ongoing legal actions related to the proposed Central Basin Judgment amendments. Moreover, the studies should consider the environmental checklist for future

California Environmental Quality Act (CEQA) evaluations of these options.

3. Regional Groundwater Overview

This section describes the physical characteristics of the major groundwater basins in the Los Angeles region that have existing groundwater replenishment programs or have the potential for such programs. These basins, shown in **Figure 2,** include the West Coast, Central, Raymond and San Gabriel Basins.

The West Coast and Central Basins are within Los Angeles County, and underlie the City of LA and surrounding areas. The Raymond and San Gabriel Basins are also in Los Angeles County but farther east in the San Gabriel Valley, and are thus slightly farther away from LADWP facilities.

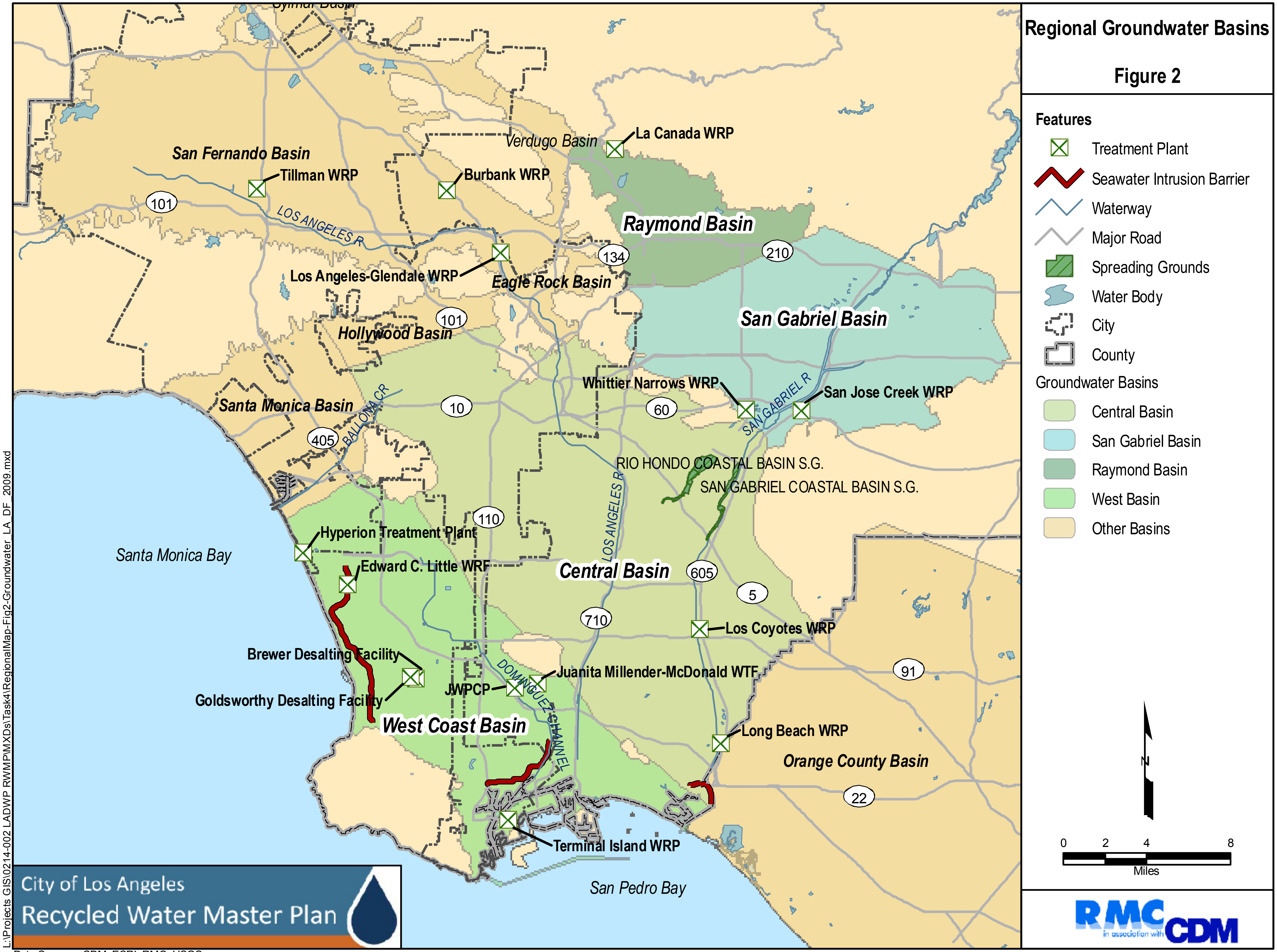
3.1 Physical Characteristics of the West Coast Basin

The West Coast Basin is a sub basin of the Coastal Plain of the Los Angeles Basin. As shown in **Figure 3**, the basin lies along the coast in western Los Angeles County, and at the surface covers 142 square miles, a significant portion of which underlies the City of Los Angeles. The cities of El Segundo, Manhattan Beach, Hermosa Beach, Redondo Beach, Torrance, Inglewood, Hawthorne, Gardena, Lomita, Carson and Long Beach also overlie the basin.

Basin Boundaries. The West Coast Basin is bounded on the north by the Ballona Escarpment, which is an ancient erosional channel of the Los Angeles River. The eastern boundary is separated from the Central Basin by the Newport-Inglewood uplift/fault zone, which is comprised of several faults, many of which limit flow between the Central Basin and the West Coast Basin. To the southeast of the basin is San Pedro Bay, and to the southwest are the Palos Verdes Hills. The western boundary of the West Coast Basin is the Pacific Ocean (DWR Bulletin 118).

Groundwater Inflow and Outflow. The Los Angeles River crosses through the southeastern part of the West Coast Basin, but provides minimal recharge to the underlying aquifers because the river is fully concrete lined throughout the lower reaches (DWR Bulletin 118). Although annual precipitation of approximately 12 inches per year provides some recharge to the basin's shallow aquifers (WCB WM 2009), extensive low permeability layers result in limited recharge of the deeper layers where most groundwater pumping occurs.

Although the basin is (effectively) considered to be a fully confined basin as there is no significant unconfined forebay area as is present in the adjacent Central Basin, limited groundwater inflow and outflow does occur. Limited groundwater inflow enters the basin through portions of the Newport Inglewood Fault Zone on the eastern boundary of the basin. Historically, inflow across the Newport Inglewood Fault zone was substantial, but it was reduced by pumping in the Central Basin. Conversely, groundwater flow also occurs eastward across other portions of the fault zone with possible limited net outflow typical. The primary additional sources of inflow are from the West Coast Basin Barrier and Dominguez Gap Barrier projects that supply water to maintain hydraulic heads near the coastal areas to prevent or minimize seawater intrusion. Groundwater levels are below mean sea level throughout most of the basin (MWD 2007), and ocean water infiltration into the West Coast Basin can occur near the depth of the Silverado aquifer along the Santa Monica and San Pedro Bays (MWD 2007). Other than the limited flow across the Newport-Inglewood Fault, all other outflow effectively occurs only through pumping.



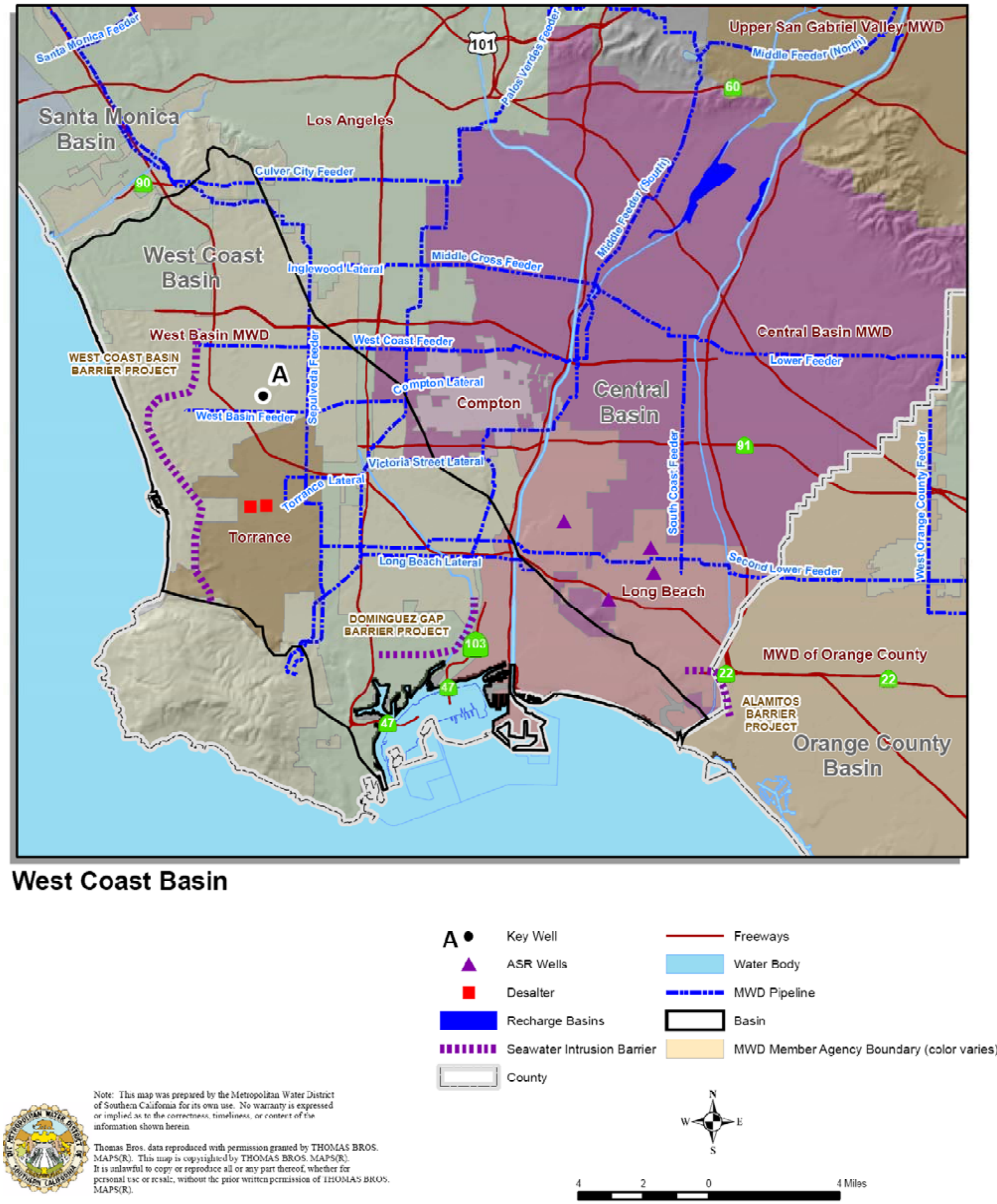
Regional Groundwater Basins

Figure 2

L:\Projects GIS\0214-002 LADWP RWMP\MXDs\Task4\RegionalMap-Fig2-Groundwater_LA_DF_2009.mxd

Data Sources: CDM, ESRI, RMC, USGS

Figure 3: West Coast Basin Map (MWD 2007)



Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

Basin Geology. The aquifer structure in the West Coast Basin is similar to that of the adjacent Central Basin, which is separated by the Newport Inglewood Fault Zone. Several aquifers are present throughout the soil column, each separated by aquitards (see **Figure 4**). The Semiperched aquifer, which extends through both the West Coast and Central Basins, is an unconfined aquifer near the ground surface that is characterized by poor water quality and a low yield. Below this aquifer, The Bellflower aquiclude serves as a vertical barrier from percolation down to more productive aquifers in deeper, confined layers. The most productive aquifer in the West Coast Basin is the Silverado Aquifer in the San Pedro Formation, providing between 80 and 90 percent of the groundwater extracted from the West Coast Basin (DWR Bulletin 118). Near the coast, some of these aquifers begin to merge, such as the Sunnyside and Silverado aquifers.

The United States Geological Survey (USGS) conducted a hydrogeologic study of the West Coast and Central Basins in 2002, which included numerical modeling. **Figure 4** shows the stratigraphy of the West Coast and Central Basins, and also groups the aquifers by geologic formation. This grouping formed the basis for identifying vertical model layers for the USGS study.

Details on existing storage, pumping and recharge operations for the West Coast Basin are discussed in Section 4.

Figure 4: "Geologic formations, aquifers, aquifer systems, and model layers in the Central and West Coast Basins, Los Angeles County, California." USGS, 2003.

AGE	FORMATION	AQUIFER	AQUIFER SYSTEMS	MODEL LAYER
HOLOCENE	ACTIVE DUNE SAND	SEMIPERCHED GASPUR	RECENT AQUIFER SYSTEM (Upper Aquifer Systems)	1
UPPER PLEISTOCENE	OLDER DUNE SAND *LAKEWOOD FORMATION* (California Dept. of Water Resources, 1961) *(UNNAMED UPPER PLEISTOCENE,* Poland and others 1956, 1959)	BALLONA EXPOSITION ARTESIA GARDENA GAGE (200 FOOT SAND)	LAKEWOOD AQUIFER SYSTEM (Upper Aquifer Systems)	2
LOWER PLEISTOCENE	*SAN PEDRO FORMATION*	HOLLYDALE JEFFERSON LYNWOOD (400 FOOT GRAVEL) SILVERADO	UPPER SAN PEDRO AQUIFER SYSTEM (Lower Aquifer Systems)	3
		SUNNYSIDE LOWER SAN PEDRO	LOWER SAN PEDRO AQUIFER SYSTEM (Lower Aquifer Systems)	4
UPPER PLIOCENE	*PICO FORMATION*		Pico unit	

Modified from California Department of Water Resources, 1961; Ponti, 1989

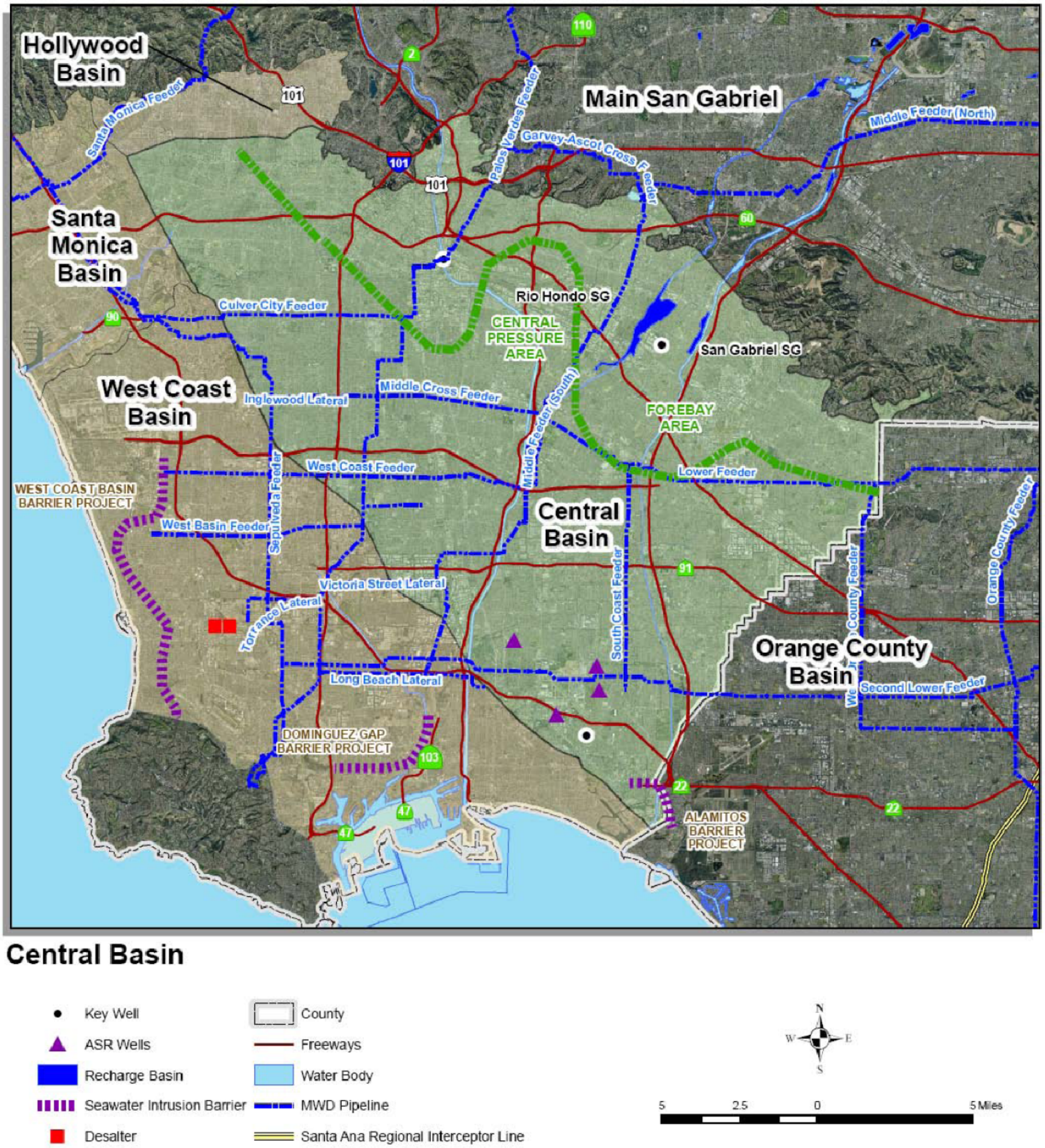
EXPLANATION

Lower Aquifer Systems { Aquifer systems grouping for geochemical analysis

3.2 Physical Characteristics of the Central Basin

As shown in **Figure 5**, the Central Basin underlies the Coastal Plain of Los Angeles Sub basin and covers a surface area of 277 square miles in Los Angeles County. The cities of Artesia, Bellflower, Cerritos, Compton, Downey, Huntington Park, Lakewood, Los Angeles, Long Beach, Montebello, Paramount, Pico Rivera, Norwalk, Santa Fe Springs, Signal Hill, South Gate, Vernon and Whittier overlie the basin.

Figure 5: Central Basin Map (MWD 2007)



Basin Boundaries. The Central Basin is bounded by the Elysian, Repetto, Merced and Puente Hills to northeast and east. The less permeable tertiary rocks that make up these hills create a physical barrier separating the groundwater basin from adjacent areas. The exception to this is the Whittier Narrows through which groundwater enters the basin from the San Gabriel Basin to the northeast. There is no physical barrier between the Central Basin and the Orange County Basin to the southeast. But the boundary is established by Coyote Creek. The basin is bounded to the southwest by the Newport/Inglewood fault system that creates a partial barrier between the Central Basin and the West Coast Basin as discussed in Section 3.1. The northern boundary of the Central Basin is La Brea High, which is a system of folded, uplifted and eroded tertiary basement rocks (DWR Bulletin 118).

Groundwater Inflow and Outflow. Rivers passing over the Central Basin include the Los Angeles River and San Gabriel River, both of which terminate at the Pacific Ocean. Storm flow from the San Gabriel River provides a substantial source of recharge for the Central Basin whereas the Los Angeles River is fully paved across the Central Basin and provides minimal recharge. Although precipitation averages 12 inches/yr, a near-surface aquiclude (the Bellflower aquiclude) prevents recharge throughout most of the basin. The exception to this is in the far northern portion of the basin where the Montebello Forebay is located. Significant natural recharge enters the aquifer system from surface flows through the Whittier Narrows into the Montebello Forebay where there are extensive land areas both along the river and in well developed artificial spreading grounds underlain by highly permeable soils. Recharge in the Los Angeles Forebay is much more restricted due to the high intensity of impervious development and the paved bottom of the Los Angeles River.

The Whittier Narrows conducts both surface and subsurface outflows from San Gabriel Valley to the Central Basin area. Many smaller faults run parallel to the flow through the Narrows, allowing passage of subsurface flow into the Central Basin. General regional groundwater flow patterns are to the south and west. Flow exits the Central Basin across the Newport/Inglewood fault system.

Basin Geology. The Central Basin is characterized by a region of forebays to the north and east, and pressure areas to the south and west. The Los Angeles and Montebello Forebays are the portions of the basin where deep aquifers merge and become unconfined. Aquifers in the forebay regions are unconfined and interconnected, and extend to depths of between 1,600 and 2,200 feet.

The Los Angeles Forebay is located in the northern part of the Central Basin where the Los Angeles River enters the Central Basin through the Glendale Narrows from the San Fernando Groundwater Basin. Both the Los Angeles and San Gabriel River forebays have unconfined groundwater conditions and relatively interconnected aquifers that extend up to 1,600 feet deep to provide recharge to the aquifer system of this sub-basin (DWR 1961). The specific yield[2] of deposits in the sub-basin range up to 23 percent in the Montebello forebay, 29 percent in the Los Angeles forebay, and 37 percent in the Central Basin pressure area (DWR 1961).

A profile of the aquifers in the Central and West Coast Basins is shown in **Figure 6**. As noted in this figure, the aquifers in the West Coast Basin extend into the Central Basin. The pressure areas in the west and south of the Central Basin are structurally similar to the West Coast Basin, and in these areas the aquifers are more vertically isolated than in the forebays. These aquifers are separated from each other by aquitards and as a result are confined, and are also largely protected from surface contamination (MWD, 2007).

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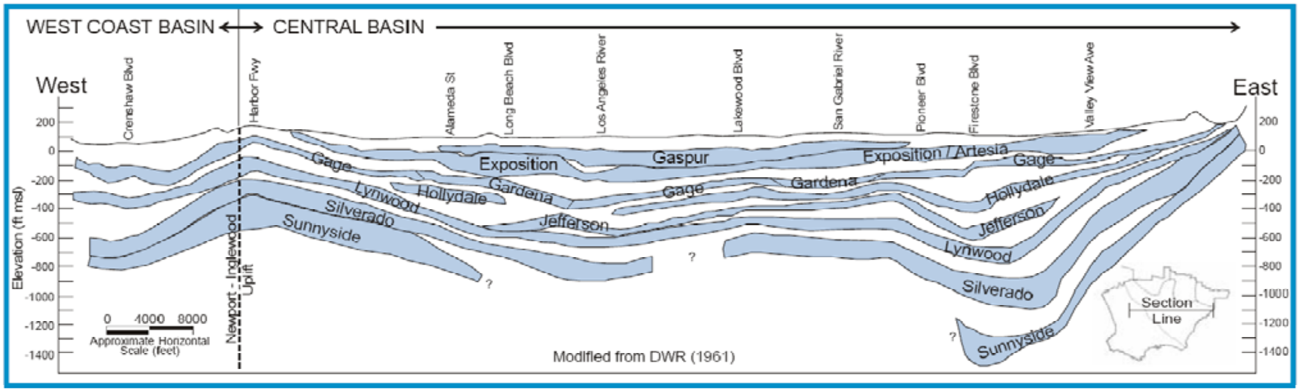
[2] Specific yield is defined as the volume of water that a saturated rock or soil will yield by gravity or pumping per unit area of soil per unit change in water table elevation.

Figure 6: Aquifer Cross Section going East-West through Central and West Coast Basin (WRD 2005).



Above the Bellflower aquiclude lies the Semiperched aquifer, which is characterized by low yields and poor water quality (USGS 2003). The higher yield aquifers within the Central Basin are in deeper, older soil of the San Pedro Formation, which is predominantly Lower Pleistocene soil. These aquifers include the Lynwood, Silverado, and Sunnyside aquifers. Shallower, lower yield aquifers in the Lakewood (Upper Pleistocene) and more recent formations include the Gaspur, Exposition, Gardena, Gage Hollydale and Jefferson aquifers (MWD, 2007).

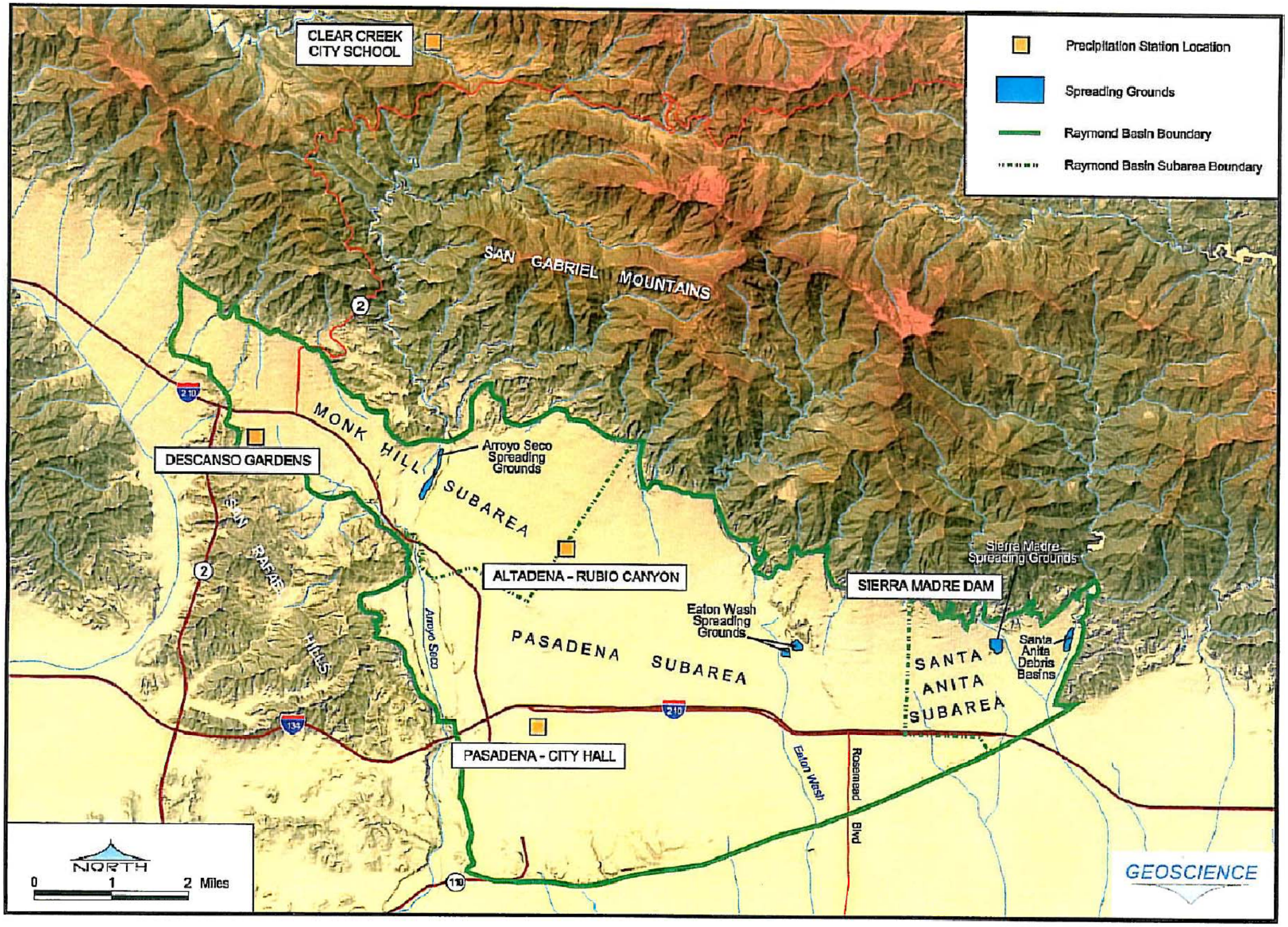
Details on existing storage, pumping and recharge operations are discussed in Section 5.

3.3 Physical Characteristics of the Raymond Basin

The Raymond Basin, shown in **Figure 7**, is located in the northwest part of the San Gabriel Valley. Its total overlying surface area is 40 square miles, and it contains three sub basins: Monk Hill, Pasadena, and Santa Anita. The Raymond Basin underlies the communities of Sierra Madre, Arcadia, Pasadena, La Cañada Flintridge and unincorporated areas of Los Angeles County.

Basin Boundaries. The Raymond Basin is bordered on the north and east by the San Gabriel Mountains, to the South by the Raymond Fault, and to the southwest and west by the San Rafael Hills (DWR Bulletin 118). While the western portion of the Raymond Fault serves as a barrier separating the Raymond and San Gabriel Basins, flow from the Raymond Basin into the San Gabriel Basin is unrestricted east of the Eaton Wash. The Raymond Basin is therefore sometimes considered part of the San Gabriel Basin.

Figure 7: Raymond Basin Boundaries and Spreading Grounds (RBMB 2007).



Groundwater Inflow and Outflow. Natural recharge enters the Raymond Basin from surface water and groundwater. Runoff from the San Gabriel Mountains enters the basin mostly via the Arroyo Seco, Eaton Wash and the Santa Anita Creek. Rainfall over the area tributary to the basin averages 21 inches per year which includes both the valley floor and the San Gabriel Mountain watersheds. Groundwater enters the basin through underflows from the San Gabriel Mountains. (MWD 2007). Water exits the basin by crossing the eastern portion of the Raymond Fault into the San Gabriel Basin, and also from groundwater extraction.

Within the basin, the Eaton Wash Fault is a divide that runs parallel to the Eaton Wash; this divide separates east and west flows for both groundwater and surface waters (DWR Bulletin 118, RBMB 2007). General regional flow patterns are towards the south and east.

Basin Geology. Soil in the Raymond Basin is largely unconsolidated alluvial gravel, sand & silt from the San Gabriel Mountains to the north. Younger alluvium is present near active streambeds, in layers less than 150 feet thick. Older alluvium is up to 1,140 feet thick around Pasadena, but thins to 200 feet at the Raymond Fault. Farther from the San Gabriel Mountains, a finer clast is present. Groundwater in the Raymond Basin is mostly unconfined, but is confined in some areas near the fault (DWR Bulletin 118).

Details on existing storage, pumping and recharge operations are discussed in Section 6.

3.4 Physical Characteristics of the San Gabriel Basin

The San Gabriel Basin, shown in **Figure 8**, is a 255-square mile area in eastern Los Angeles County. Overlying communities include: Arcadia, Azusa, Baldwin Park, Bradbury, Covina, Duarte, El Monte, Glendora, Industry, Irwindale, La Puente, Monrovia, Rosemead, San Gabriel, San Marino, South El Monte, South Pasadena, Temple City, and West Covina.

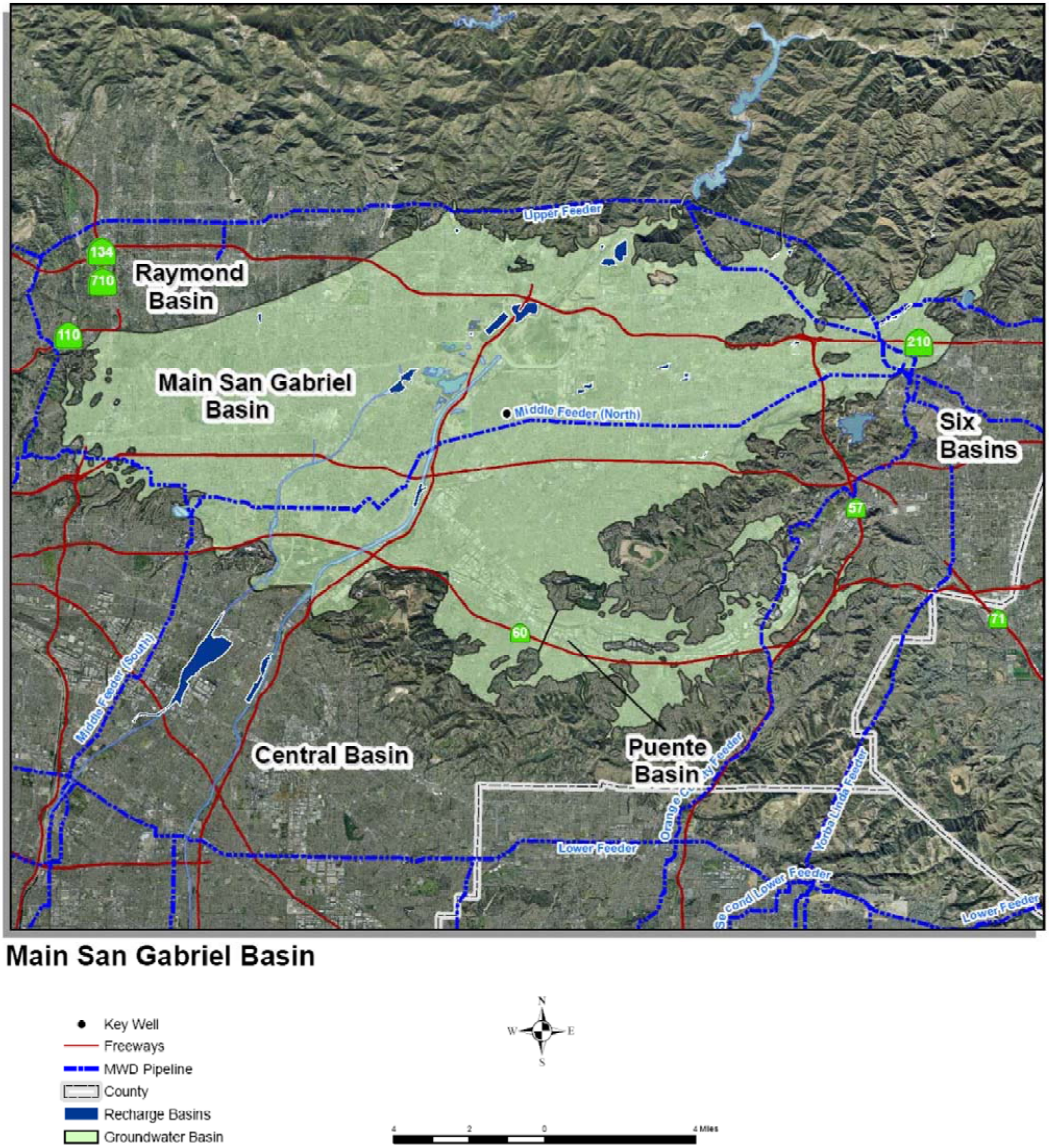
Basin Boundaries. The San Gabriel Basin is bordered to the north by the Raymond Fault that separates it from the Raymond Basin, as well as by the San Gabriel Mountains. The Chino and San Jose Faults form the eastern boundary of the basin and the southern and western boundary is comprised of the Repetto, Merced, and Puente Hills.

Groundwater Inflow and Outflow. Groundwater enters the San Gabriel Basin across permeable sections of the Raymond and Chino Basins, and from runoff in the San Gabriel Mountains. The unconfined alluvium aquifer structure also allows for recharge through rainfall infiltration. Groundwater exits the San Gabriel Basin from the Whittier Narrows, a gap between the Merced and Puente Hills, into the Central Basin (DWR Bulletin 118).

Basin Geology. The water-bearing materials of the basin are made up of unconsolidated to semi-consolidated alluvium deposited by streams flowing out of the San Gabriel Mountains. These deposits include Pleistocene and Holocene alluvium and the lower Pleistocene San Pedro Formation.

The San Gabriel Basin contains 8.6 million AF of storage.

Figure 8: San Gabriel Basin Map (MWD 2007)



4. West Coast Basin Opportunities

This section describes current operating conditions, basin water rights governance, and existing/planned water recycling activities for the West Coast Basin. Governance structures and proposed changes therein that are relevant to existing or potential recycled water recharge activities are also discussed.

4.1 Current Operational Conditions

Current operational conditions set the stage for understanding water rights governance, and also for identifying potential future recycled water projects. In this section basin storage, natural recharge, groundwater extraction, recycled water sources, existing recharge and barrier projects, and water quality and treatment are discussed.

4.1.1 Groundwater Basin Storage

Total aquifer storage capacity in the Silverado aquifer of the West Coast Basin is estimated at 6.5 MAF. As shown in **Figure 9**, 1.1 MAF of this storage is estimated as unused and of this 120,000 AF is estimated to be available for groundwater storage assuming that additional storage in the aquifer is allowed up to within 75 feet of the ground surface (MWD 2007). There are currently no groundwater storage projects in place in the basin (MWD 2007). This is the same quantity identified in the proposed amendments to the West Basin Judgment.

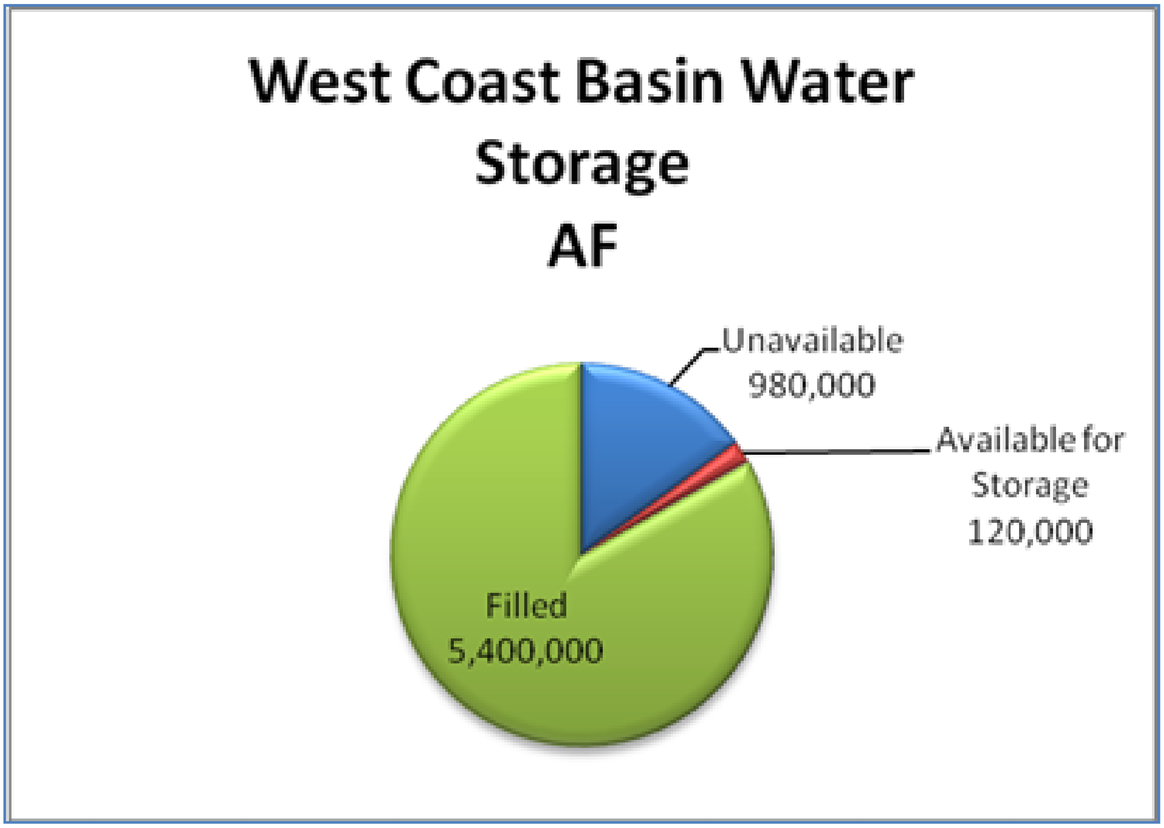
4.1.2 Recharge to Groundwater

The sources of recharge to the West Coast Basin include limited subsurface inflow from the Central Basin, some surface inflow into the uppermost aquifers from rainfall, water introduced through the two injection barriers and some seawater intrusion. The natural safe yield of the West Coast Basin, which represents the yield available from the basin as a result of native inflows alone, has been estimated by Water Replenishment District of Southern California (WRD) to be approximately 26,300 AFY (WRD, 2006e), of which approximately 7,100 AFY is from seawater intrusion (WRD, 2006e). The managed safe yield of West Coast Basin is equal to the 64,468 AFY (the adjudicated production limit discussed below), which is substantially higher than the natural safe yield. This yield is available because of the addition of artificial recharge to the basin through two injection projects owned and operated by the County of Los Angeles Department of Public Works with replenishment water provided by WRD.

4.1.3 Groundwater Extraction

Currently 64,468 AFY of annual extraction is allowed for the West Coast Basin, which was adjudicated in 1961. Average annual extraction for the period between 1985 and 2004 was 48,797 AFY (MWD 2007), and extractions for FY 2008-09 totaled 42,566 AF. Some parties lease their pumping allocations, but there is no long-term storage accounting in the basin under the current Judgment provisions (see Section 4.2.2 for proposed Judgment amendments). The City of Los Angles has 1,503 AFY of adjudicated rights in the West Coast Basin but has not produced any water from the basin in recent years. If a producer under pumps its rights in a given year, it can carry over up to 20 percent of the rights into the following calendar year.

Figure 9: Storage in the West Coast Basin, AF

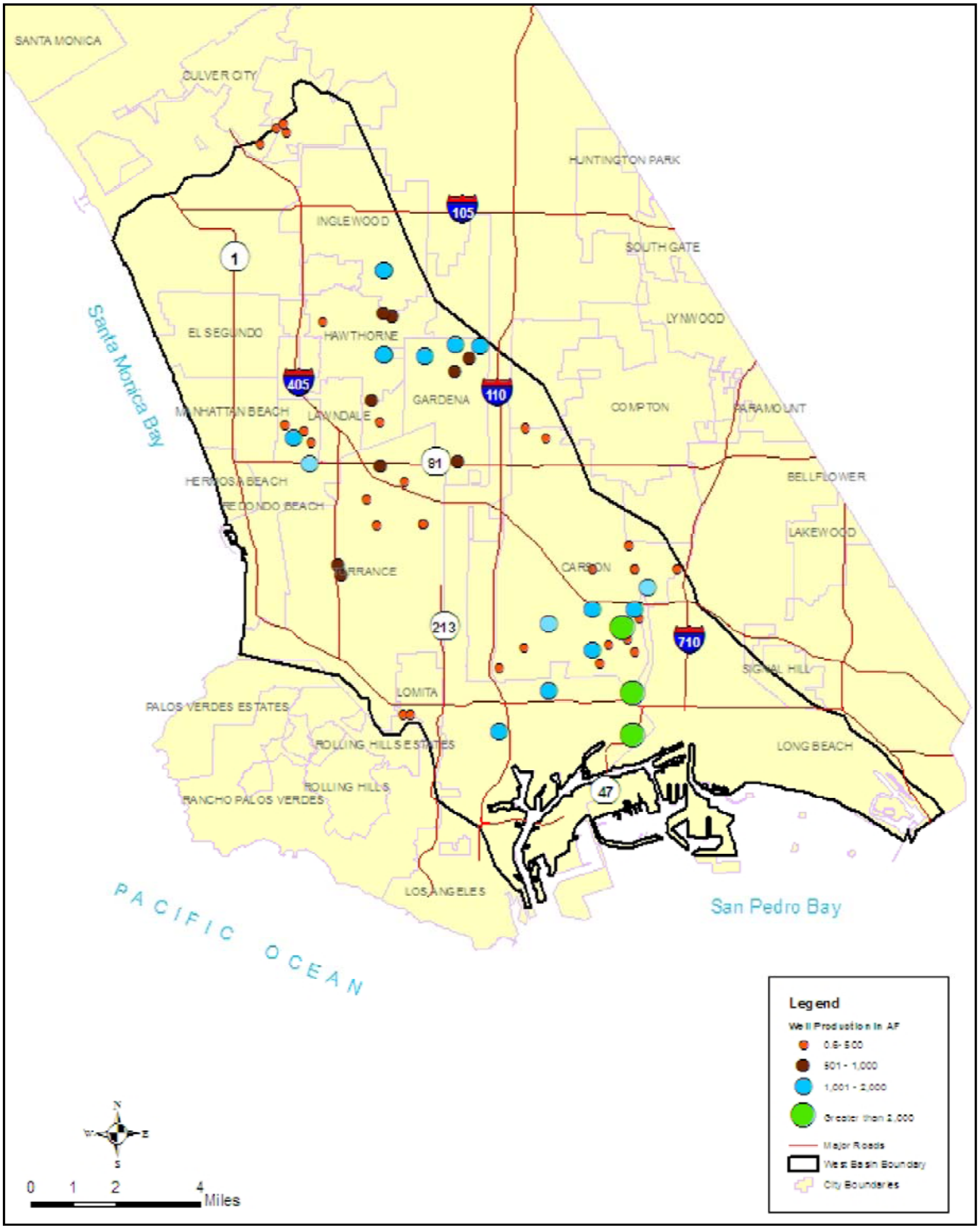


In the West Coast Basin, there are 123 extraction wells on record with the Watermaster as reported in the 2008-2009 Watermaster Report, 78 of which had active production recorded in 2008-2009. These wells are distributed among 26 active pumping parties with the largest users being the Golden State Water Company (14,335 AF in FY 2008-09) and California Water Service Company in the Rancho Dominguez District (7,870 AF in FY 2008-09). Significant pumping occurs near the outlet to San Pedro Bay south of I-405. All wells pumping more than 2,000 AFY in the West Coast Basin are located in this area. Another concentrated locale of pumping occurs in an east-west band between northern parts of Redondo Beach and Gardena. The spatial pattern of recent pumping is shown in **Figure 10**.

4.1.4 Recharge Projects

WRD operates an in-lieu water replenishment program. From 1985 through 2004, 9,800 AFY has been added to the West Coast Basin on average. In recent years, including 2008 and 2009, in-lieu water has not been made available by MWD due to water shortages. Although there are no spreading basins within the West Coast Basin, some recharge is accomplished via spreading basins within the Central Basin. Water spread in the Central Basin helps maintain water levels in that basin and therefore contributes to the amount of water entering the West Coast Basin through the Newport Inglewood Fault Zone. Further discussion on recharge in the Central Basin is provided in Section 5.1.2.

Figure 10: Recent Pumping in the West Coast Basin (West Coast Basin Watermaster)



4.1.5 Barrier Projects

Along the coasts of Santa Monica Bay and San Pedro Bay, there is ocean water infiltration into the

West Coast Basin. Ocean water entering the West Coast Basin averages 7,100 AFY (MWD 2007). Two barrier projects, consisting of injection wells along each coast line, are in place to halt further infiltration. A total of 247 injection wells and 532 monitoring wells are associated with the West Coast (Santa Monica Bay) and Dominguez Gap (San Pedro Bay) Barrier Projects (MWD2007, WC WM2009). The two projects consist of a line of injection wells running parallel to the coastline (see **Figure 1**).

- The **Dominguez Gap Project** extends from the Dominguez Channel to the 110 Freeway in Carson. The project has been in operation since 1971 (MWD 2007), and was expanded eastward in 2004 (WM 2009). The Dominguez Barrier Project consists of 94 injection wells and 221 observation wells (MWD 2007). Water is injected into the "200-foot sand", "400-foot gravel", and Silverado aquifers. Since 2006, WRD and LADWP have been injecting recycled water into the barrier project.
- The **West Coast Basin Barrier Project** started in 1953 (MWD 2007). The project extends from the Palos Verdes Hills up to the LA Airport. It consists of 153 injection wells and 302 observation wells, and is operated and owned by the LA County Department of Public Works. Imported and recycled water is injected into the "200-foot sand" and Silverado aquifers (WM 2009).

From 1985 through 2004, average total injection between the two projects was 24,400 AFY (MWD 2007). During FY 2007-08 and 2008-09, an average of 20,475 AF was injected into the West Coast Basin via barrier projects, including both imported and recycled water (WM 2009).

4.1.6 Groundwater Quality and Treatment

The two barrier projects have been in place for many years to minimize seawater infiltration. Seawater infiltration that primarily occurred prior to full operation of the two barrier projects has left chloride and total dissolved solids (TDS) concerns in some places. Inland of the barriers, chloride concentrations as high as 2,500 mg/L have been measured in some locales, and TDS concentrations as high as 11,000 mg/L in limited areas have been measured. The California Water Service Company operates the 1.5 MGD C. Marvin Brewer Desalter Treatment Facility (Brewer Desalter) to treat brackish water, and WRD operates the Robert W. Goldsworthy Desalter (Goldsworthy Desalter). The two plants treated an average of 2,500 AFY as of FY 2004-05 (MWD 2007).

Nitrate levels up to 12 mg/L have been measured in some monitoring wells due to local infiltration/leaching in the uppermost aquifer zones. However, nitrate concentrations in production wells have all been below 3 mg/L (MWD 2007).

Nearly one-third of all production wells in the northwestern portion of West Coast Basin have concentrations that exceed the secondary Maximum Contaminant Level (MCL) for iron (MWD 2007). In addition, 17 of 30 production wells tested had concentrations above the secondary MCL for manganese (MWD 2007).

4.2 Basin Water Right Governance

4.2.1 Existing West Coast Basin Summary

The West Coast Basin Judgment was entered in 1961 (California Water Service Company et al. v. City of Compton, Case No. 506806). Under the decree, each party's right to extract water from the basin is limited to an annual specified amount that is monitored by the Department of Water Resources (DWR), the appointed Watermaster of the basin. The adjudicated amount, totaling 64,468.25 AFY, exceeds the natural yield of the Basin, and the decree recognizes that WRD artificially replenishes the Basin to make up the difference. To recover its replenishment costs, WRD charges pumpers a Replenishment Assessment (RA) based on the volume of water each pumps per year. The RA encompasses replenishment costs in both the West Coast and Central Basins as is divided amongst the pumpers in both basins.

In addition to assigning pumping rights, the West Coast Basin Judgment includes provisions for how pumpers may exercise those rights. These provisions include:

- **Carryover:** Pumpers that do not exercise their full pumping rights in a particular year are allowed to carryover up to 20 percent into the following year.
- **Over-pumping:** Pumpers are allowed to pump up to 110 percent of their adjudicated right provided that any over production is made up by under production in the following year. In addition, the Judgment allows for up to 10,000 AFY of emergency over-pumping under certain conditions.
- **Lease:** Pumpers are able to lease their rights. Terms of the leases can vary including whether or not to include carryover.
- **Sales:** Pumpers are able to sell their rights.
- **Exchange pool:** The West Coast Basin Judgment creates an exchange pool through which pumpers who have access to supplemental imported water can make their pumping rights available to pumpers who do not, for a price (not to exceed the cost of the supplemental imported water). The exchange pool operates on an annual pooled basis as compared to leasing of rights which is between specific parties and can be for extended terms.

As written, the West Coast Basin Judgment does not preclude additional recharge of the groundwater basin for replenishment or storage. However, the Judgment does not recognize the right to stored water nor does it give pumpers the legal mechanism to pump more than their rights as provided in the Judgment. In addition, any water pumped from the groundwater basin could currently be subject to the Replenishment Assessment even if it could be shown to have been recharged outside the confines of the Judgment. In effect, these restrictions essentially preclude pumpers from operating the basin to generate additional water supply yield for themselves and operating outside of these restrictions could invite legal challenges from other pumpers. The proposed judgment amendments allow parties to recharge and recover water over and above the limits of the adjudication.

To summarize, pumping is less than adjudicated rights. Increased pumping within adjudicated rights would increase recharge demands at barriers which would lead to recycled water use. Also, pumping by refineries sustains non-potable uses which could be replaced with recycled water.

Most water is pumped without treatment but large scale increases could require treatment including desalination. To operate within the existing judgment, any extraction beyond LADWP's current pumping right would require LADWP to either lease or acquire rights from other pumpers in the basin.

4.2.2 Proposed Judgment Amendments

The judgment amendments seek to provide opportunities for groundwater recharge and storage in the Basins that are not possible under the current adjudication decrees. The amendments, as proposed, contain four principal elements that impact the types of projects that LADWP could pursue in achieving its recycled water goals. They also define the water agencies with whom LADWP will need to interact if these projects are to be implemented. These principal elements are summarized below and are described in additional detail in the Task 4.7.1 – Central and West Coast Basin Judgment Amendments Draft Technical Memorandum (September 30, 2009).

- **New Management Agencies** – The court-appointed Watermasters for the Basins do not currently administer unused storage space or approve new groundwater recharge projects. The judgment amendments, as proposed, would create a Storage Panel for each basin, made up of a Basin Administrator (WRD) and a Water Rights Panel (five groundwater producers), to review and approve discretionary projects. Discretionary projects would be those that construct new facilities, require CEQA review, and/or use more than 120 percent of the adjudicated pumping rights within each basin. New groundwater recharge and recovery projects would be considered discretionary.

  The rules for the selection, terms, and rotation procedures of the Water Rights Panel have yet to be determined. LADWP will need effective institutional relationships with WRD and the major groundwater producers if it is to realize its goals of maximizing water reuse.
- **Storage Space** – The current adjudication decrees do not contain provisions for use of unused storage space in the Basins. The amendments, as proposed, would declare that "available dewatered space" exists and would divide this space into the allotments shown in **Table 2** below.

Table 2: Summary of Storage Allotments Provided in Judgment Amendments

Storage Allotment	West Coast Basin	Central Basin
Basin Operating Reserve	49,100	125,000
Adjudicated Storage Space		
Individual Storage Accounts	25,800	87,000
Community Storage Pool	35,500	95,000
Regional Storage Projects	9,600	23,000
Sub-Total Adjudicated Storage Space	70,900	205,000
Total Available Dewatered Space	120,000	330,000

Briefly, each of these categories is defined as follows:

- **Basin Operating Reserve**: Reserved for use by WRD in order to more effectively achieve its mandate of providing replenishment to meet adjudicated pumping rights.

However, it is envisioned that Water Augmentation projects (described below) would utilize space within this allotment.

- **Individual Storage Accounts:** Each party to the judgments is assigned storage rights of 40 percent of its adjudicated right (West Coast Basin) or APA (Central Basin) for its exclusive use.
- **Community Storage Pool:** Once a party "fills" its Individual Storage Account, it may access the Community Storage Pool on a first come first-served basis. There are provisions that require parties to turn over their storage and provide access to other parties.
- **Regional Storage Projects:** This category is meant to provide access to or implementation of projects by non-parties to the proposed amendments. Projects would need to be designed to provide various benefits to those that are parties to the amendments (e.g., reducing the Replenishment Assessment).

Rules for the use of these allotments would be established for parties and nonparties to the adjudications. Though these provisions are primarily intended for conjunctive use, LADWP may facilitate maximum reuse projects by (1) providing recycled water to fill both its own storage allotment and the allotment of others instead of using imported water to replenish water removed from storage; (2) working with Metropolitan Water District (MWD) to develop a Regional Storage Project; and (3) developing a water augmentation project to utilize the storage set aside for the Basin Operating Reserve.

- **Water Rights Transfers** – The current adjudication decrees do not allow water rights transfers between the Basins. The amendments, as proposed, would allow each party to transfer up to 5,000 acre-feet per year (AFY) from the West Coast Basin to the Central Basin to increase groundwater production in the Central Basin. Total transfers less than 20,000 AFY would be considered a non-discretionary project. Under these proposed rules, LADWP may facilitate reuse projects by transferring its 1,503 AFY pumping right from West Coast Basin to Central Basin. LADWP could also potentially transfer leased pumping rights from West Coast Basin to Central Basin. Then the pumping rights may be exercised in Central Basin and recycled water could be used to replenish the pumped water[3].
- **Water Augmentation** – The current adjudication decrees establish fixed annual pumping rights for the parties. The amendments, as proposed, would allow parties to increase their production rights by recharging the basins with new water supplies via water augmentation projects. These projects are envisioned to increase yield from the basins by more or less matching recharge and extraction volumes on a regular basis (i.e., every 1-3 years). As such, the projects would not be considered storage (i.e., to be reserved for dry year supply) and thus would not require a party to utilize adjudicated storage space and the restrictions attached to that space. This type of project represents the largest potential for maximizing

[3] The court has issued a minute order approving all elements of the judgment amendments except for the transfer of pumping rights from West Coast Basin to Central Basin. The judge has suggested that WRD may have statutory authority to approve those transfers separate from the judgment itself. LADWP needs to discuss with WRD the future plans if any to allow transfers of pumping rights from West Basin to Central Basin. The judge has delayed issuing final judgment to hear arguments from Tesoro Refining in opposition to the amendments. Tesoro filed objections on November 17, 2009. The judge has scheduled a hearing and could issue a final ruling on the amendments as early as November 25, 2009.

the reuse of recycled water. LADWP may develop water augmentation projects with other regional partners.

In summary, the proposed judgment amendments that create the storage framework for the West Coast and Central Basins, if accepted by the Court, would create multiple ways through which LADWP could provide tens of thousands of AF of recycled water for both storage and supply augmentation. As such, LADWP should take appropriate steps to demonstrate support for both the amendments as well as implementation of the storage framework. The latest court hearing on the amendments at which the oral arguments will be heard will be on November 25, 2009 and the judge could issue a final ruling or schedule more deliberations at that time.

4.3 Existing Recycled Water Activities and Potential Opportunities

4.3.1 West Coast Basin Barrier Project

Current Recycled Water Use

The West Coast Basin Barrier Project (WCBBP), operated by Los Angeles County Department of Public Works (LACDPW), contains 153 injection wells and 302 observation wells along nine miles of coastline. Recycled water was first injected into this barrier in 1994, and since then an average of about 6,300 AFY of recycled water has been injected each year (approximately 43 percent of the total recharge). The recycled water, originating as secondary-treated effluent from the HTP, is pumped from HTP to West Basin Municipal Water District's (WBMWD) Edward C. Little Water Recycling Facility (ECLWRF), also known as the West Basin Water Reclamation Plant (WBWRP), where it is treated using microfiltration, reverse osmosis, and ultraviolet light oxidation/disinfection (MF/RO/UV or "advanced water treatment [AWT]") and lime stabilization. From the WBWRP, the water is pumped to the barrier injection wells and blended at different points with potable water provided from MWD. Brine from the WBWRP is discharged through the HTP ocean outfall under a separate NPDES permit (Order No. R4-2006-0067).

The initial project to use recycled water for barrier injection was authorized under Los Angeles RWQCB Order No. 95-014 that approved the use of 5,600 AFY of advanced treated recycled water and 5,600 AFY of imported water. The permit is jointly issued to WBMWD and LACDPW. In 1997, WBMWD received authorization (RWQCB Order No. 97-069) to expand the project to 8,400 AFY of AWT recycled water, which represented 50 percent of the total water injected at that time. In 2006, the project was authorized under WDRs (Order No. R4-2006-0009) to increase the amount of recycled water up to 14,000 AFY, which represents 75 percent of the total water injected and takes into account recycled water total organic carbon (TOC) and a five-year averaging period. The project is subject to a complex water quality monitoring and compliance program that assesses (1) all of the waters used for replenishment and (2) the groundwater system.

To make use of the increased recycled water contribution authorized by the revised WDRs, WRD subsequently entered into an agreement with WBMWD. This agreement enables WRD to purchase up to 12,500 AFY of recycled water for the WCBBP. To determine the amount of barrier water needed for the ensuing year, WRD obtains an estimate from LACDPW, reviews the estimate, and makes adjustments as necessary. For FY 2009/2010, WRD made no adjustments to the LACDPW estimate for 15,200 AF of water, including 11,400 AF of recycled water (75 percent) and 3,800 AF of imported water.

The WDRs currently require an underground retention time of at least 12 months before the water is extracted for drinking purposes and a minimum horizontal separation of 2,000 feet between the injection site and the nearest drinking water well.

Planned Recycled Water Use

The 2006 WDRs also included provisions that would allow the amount of recycled water injected into the barrier to increase to 19,600 AFY (which represents 120 percent of current barrier demands), following successful completion of an "initial operating period". During this period, which is currently underway, WBMWD must demonstrate fulfillment of all CDPH requirements and show that the injection of blended water has reached at least one barrier monitoring well for at least one year with an average of at least 60 percent RO recycled water, based on injection at the maximum average of 75 percent. Approval of the increase is also subject to a review by an expert panel and requires a demonstration that the project has not caused levels of endocrine disrupting chemicals, pharmaceuticals, or other constituents of interest to CDPH to increase above the levels in the RO recycled water.

The 2006 WDRs were based on Findings of Fact and Conditions issued by California Department of Public Health (CDPH) in 2004 that applied the 2004 Draft Groundwater Recharge Regulations. Prior to 2006, the RWQCB on its own authority included permit limits based on Notification Levels (NLs). Notification Levels are health-based advisory levels for chemicals in drinking water that are established for chemicals for which there are no formal regulatory standards (Maximum Contaminant Levels, or MCLs). These limits were removed from the permit via RWQCB Order No. R4-2006-0069, in response to the State Water Resource Control Board's (SWRCB) decision to disallow the imposition of NL-based permit limits for the Alamitos Barrier Project. The WDRs also included provisions for a collaborative arrangement between the City and WBMWD related to source control. The City agreed to work cooperatively with WBMWD to develop the Source Control Implementation Plan (SCIP) for increased source control investigation via a Memorandum of Agreement (MOA) between the agencies. This MOA specifies responsibilities for the SCIP and, under the WDRs, must be executed prior to the injection of 100 percent recycled water. As of the date of this TM, the MOA has not been signed.

WBMWD has convened an Independent Advisory Panel (IAP) that has evaluated all aspects of the current treatment and injection practices. The IAP issued findings and recommendations in May 2001, which were re-evaluated in 2008 with revised recommendations. The IAP's primary charge was to determine if it was in the best interests of public health to modify the source of water for injection into the seawater barrier from 75 percent to 100 percent recycled water. The IAP recommended that WBMWD (1) continue its comprehensive monitoring program, (2) verify the travel times of recycled water, and (3) execute the draft MOA between the City and WBMWD for the SCIP. The IAP intended for the recommendations to be complete before increasing recycled water use to 100 percent. Other recommendations addressed an assessment of the integrity of the seawater barrier, an assessment of groundwater reduction-oxidation conditions, monitoring for constituents of emerging concern in the recycled water, microbiological monitoring of the recycled water, an assessment of calcium carbonate stability, and identification of sources of formaldehyde in the product water.

WRD and WBMWD are in the process of making final arrangements to provide 100 percent advanced treated recycled water to the WCBBP. The two agencies signed an agreement in April 2009 for WRD to purchase up to 17,000 AFY from WBMWD. However, currently WRD estimates the total need for water at the barrier will remain at the current 15,200 AFY. At this quantity, the additional requirement for recycled water at 100% supply would be 3,900 AFY. The additional 4,500 AFY is subject to a separate pricing structure than the initial 12,500 AFY. Under the previous structure, WRD agreed to pay a set price subject to an annual percentage increase. Under the latest agreement, WRD will pay WBMWD the actual cost to produce the water, not to exceed 95 percent of MWD's Tier 1 rate, the rate for the imported supply currently used at the barrier.

Beyond the current plan to deliver 100 percent recycled water to the WCBBP, WRD is in the process of developing a West Coast Basin Optimization Plan to improve the utilization of the groundwater basin. The plan, which will be developed in collaboration with WBMWD and the groundwater producers, is expected to be developed in early 2010. The plan will consider ways to further augment groundwater replenishment including expanding deliveries to the barrier injection wells for supply augmentation as well as consideration of improvements to the barrier injection wells themselves.

Water Supply Implications

The existing and planned uses of recycled water for the WCBBP provide a direct benefit to WBMWD by reducing the amount of Tier 1 water from MWD needed to supply the barrier.

With regard to LADWP, the current arrangement of providing recycled water from HTP protects the West Coast Basin groundwater supply, to which LADWP has production rights, and by additional Tier 1 water available within the MWD system. In addition, by providing an alternative source of water for barrier injection, the overall regional demand for imported water is reduced by an equivalent amount, thereby providing benefits and increasing reliability for all MWD member agencies.

In the future, LADWP should consider providing additional recycled water to the WCBBP for the purpose of augmenting water supply in the West Coast Basin. By augmenting supplies, LADWP would be able to utilize the additional water directly for water supply reliability either by pumping from the West Coast Basin or by transferring rights to the Central Basin for subsequent pumping. This would require LADWP to work with WBMWD, WRD as well as groundwater producers under the recently conditionally-approved judgment amendment. To effectively engage in this process, LADWP should partner with WBMWD and WRD in the upcoming West Coast Basin Optimization Plan development.

In summary, under current West Coast Basin Production patterns, the barrier requirements are anticipated to generally remain at the current 15,200 AFY which would result in an increase of an additional 3,900 AFY of recycled water at 100% use and a corresponding decrease in imported water use. The potential to increase barrier demands and recycled water use beyond this quantity is discussed further under Section 4.3.3.

4.3.2 Dominguez Gap Barrier Project

Current Recycled Water Use

The Dominquez Gap Barrier (DGB) contains 94 injection wells and 232 observation wells along a length of 4.3 miles length near the coast between the Los Angeles Harbor and the Long Beach Harbor. Recycled water was first injected into this barrier in 2005, and since then an average of about 1,900 AFY of recycled water has been injected each year. Like the WCBBP, the barrier is operated by LACDPW.

Recycled water is provided to the DGB from the Harbor Water Recycling Project Advanced Wastewater Treatment Facility (HWRP/AWTF) at the Terminal Island Water Reclamation Plant (TIWRP). The HWRP/AWTF receives tertiary effluent from the TIWRP and provides MF, RO, lime stabilization, and disinfection using chlorine and ammonia. Brine is discharged through the TIWRP's outfall under an existing permit. The source control program requirements are included in the NPDES permit for the TIWRP (Order No. R4-2005-0024). The project is subject to a complex water quality monitoring and compliance program that assesses all of the waters used for replenishment and the groundwater system. Additional water quality requirements, which include turbidity and modified fouling index (MFI), must also be met to minimize potential fouling of injection wells. The Bureau of Sanitation is responsible for operating the treatment facility, LADWP is responsible for delivery, and WRD is responsible for groundwater monitoring compliance.

The project is authorized to use 5,600 AFY of advanced treated recycled water. Up to 50 percent recycled water can be used based on the total blended water injected over a five year averaging period; the TOC cannot exceed 0.5 mg/L. The permit includes a requirement for an underground retention time of at least 12 months for the recycled water in the groundwater basin before the water is extracted for drinking purposes and a minimum horizontal separation of 2,000 feet between the injection site and the nearest drinking water well.

Under an agreement with LACDPW, WRD obtains estimates for the expected demand at the barriers and makes adjustments as necessary. For FY 2009/2010, no adjustments were made to the LACDPW estimates for 8,000 AF, with 4,000 AF coming from recycled water and 4,000 AF from imported water.

Currently, water supply to the barrier wells is split, with recycled water from the HWRP/AWTF serving the wells in the western half of the barrier and MWD water provided by WBMWD serving the eastern half. Through its permit, the RWQCB acknowledged its desire for recycled water and imported water to be blended prior to injection. It established a requirement that, within five years, an above-ground blending facility would be constructed for this purpose. WRD is currently developing preliminary plans for this facility.

Planned/Potential Recycled Water Use

At this time, WRD is completing preliminary plans to expand the use of recycled water at the DGB to 100 percent of the supply. At current operating levels for the DGB, this would represent an additional 4,000 AFY of recycled water. WRD will need to work with the RWQCB and the CDPH to obtain the necessary permit modifications. It is expected that new permit requirements would be similar to those now providing for the 100 percent recycled water supply at the WCBBP. Depending upon timing of approval, it is possible that this could eliminate the need for an expensive imported water/recycled water blending facility required by the RWQCB discussed in the preceding section as well as eliminate the use of imported water at the DGB.

Additional recycled water supply for the DGB could come from three possible sources: expanded use of recycled water from TIWRP, supply from WBMWD that originates from the WBWRP/ELWRF, or construction an AWTF at the Sanitation Districts of Los Angeles County (LACSD) Joint Water Pollution Control Plant (JWPCP). Expanding the AWTF at the TIWRP would build upon the existing facilities and would help to reduce discharges to the Harbor area. Supply from WBMWD may be possible and could build upon existing facilities; however, it will likely require further expansion of the ELWRF and expansion of the delivery pipeline. Supply from the JWPCP may also be possible, but at this time no facilities currently exist. LACSD and MWD are expecting to begin a joint study in early 2010 that will examine developing an AWTF at the JWPCP for possible large-scale groundwater replenishment of up to 200,000 AFY. It is expected that a portion of the study will examine other nearby demands for recycled water, including the DGB.

Water Supply Implications

As with the WCBBP, the existing and planned uses of recycled water for the DGB provides a direct benefit to WBMWD by reducing the amount of Tier 1 water from MWD needed to supply the barrier.

LADWP currently sells recycled water from the HWRP/AWTF to WRD for injection into the DGB. The arrangement protects the West Coast Basin groundwater supply to which LADWP has pumping rights, and makes additional Tier 1 water available within the MWD system, of which LADWP is a member.

In the future, LADWP should consider providing additional recycled water to the DGB with the purpose of augmenting water supply in the West Coast Basin. By augmenting supplies, LADWP would be able to utilize the additional water directly either by pumping from the West Coast Basin or transferring pumping rights to the Central Basin. To do so will require LADWP to work with WBMWD and WRD as well as pumpers subject to the recent conditionally-approved Judgment Amendment. To effectively engage in this process, LADWP should join with WBMWD and WRD as a partner in the upcoming West Coast Basin Optimization Plan development.

In summary, under current West Coast Basin Production patterns, the barrier requirements are anticipated to generally remain at the current 8,000 AFY which would result in an increase of an additional 4,000 AFY of recycled water at 100% use and a corresponding decrease in imported water use. The potential to increase barrier demands and recycled water use beyond this quantity is discussed further under Section 4.3.3.

4.3.3 Increased West Coast Basin Injection and Production

Current Recycled Water Use

Because aquifers in the West Coast Basin are confined, injection wells would be required if additional augmentation of groundwater supplies was contemplated. Currently, all existing augmentation involving recycled water occurs only at the barrier locations; there are no inland injection wells for any water sources.

Potential Recycled Water Use

Barriers

There are approximately 20,000 AFY of pumping rights which are presently unused in the West Coast Basin. If these rights are exercised, this use of groundwater would substantially increase the demands for injection at the two barriers. Depending upon location of the new pumping wells, this increase could be between approximately 14,000 to 18,000 AFY at the West Coast Basin Barrier and between one and four thousand AFY at the Dominguez Gap Barrier.

Mid Basin Injection

In planning scenarios which involve increased groundwater production from the West Coast Basin, mid-basin injection of recycled water may be beneficial compared to reliance on the seawater intrusion barriers as the sole source of replenishment within the basin. The quantities of mid basin injection are entirely dependent upon an overall basin management strategy, but the use is conceptually large in the context of potential water augmentation or regional storage projects within the basin

There are locations within the basin where it may be both possible and desirable to inject advanced treated recycled water to enhance water supply. In the past, up to 45,000 AFY of imported water was injected at the WCBBP to replenish the groundwater basin after substantial overdraft. Since only 15,000 AFY is typically used today, primarily due to reduced production, it may be possible to inject up to 30,000 AFY or more of additional water into the West Coast Basin. If injection volumes were increased, increased extraction would be possible to recover the water. Historical peak extraction was approximately 100,000 AFY, whereas today, pumping is approximately 40,000 AFY. This suggests that it is physically possible to increase extraction capacity by at least 60,000 AFY. Based on this information and the experience of WRD staff with operating the basin, the additional conjunctive use storage and recovery capacity of the West Coast Basin could be on the order of 50,000 AFY.

To implement a mid-basin injection project using recycled water, it is anticipated that requirements would be similar to those required for 100 percent use of recycled water at the WCBBP. This includes a requirement for an underground retention time of at least 12 months for the recycled water in the groundwater basin before the water is extracted for drinking purposes and a minimum horizontal separation of 2,000 feet between the injection site and the nearest drinking water well. These requirements will likely limit the number of locations where recycled water could be injected.

In addition, the West Coast Basin contains a trapped plume of intruded seawater with elevated levels of total dissolved solids in the south-central portion of the basin. The presence of the plume has limited production in this portion of the groundwater basin to facilities with advanced treatment capabilities including two desalters, the Brewer Desalter (owned by WBMWD) and the Goldsworthy Desalter (owned by WRD), that currently tap this saline plume. A mid-basin injection project would have to address the interaction between injection-extraction mechanics and the saline plume.

WBMWD recently developed a conceptual plan to implement up to 10,000 AFY of mid-basin injection of recycled water. Facilities would include 10 injection wells (1,000 AFY injection capacity per well), expansion of the ELWRF to provide a greater capacity of advanced treatment, and an extensive dedicated conveyance pipeline. The plan presumes that sufficient pumping capacity would exist to be able to pump this additional supply from the basin. If greater injection capacity were installed, this would need to be matched by equivalent pumping capacity either from existing inactive wells or new wells.

Water Augmentation – New injection Demands 15- 20,000 AFY

The judgment amendments would allow water augmentation projects in the West Coast Basin which could be sustained with increased injection of water into the West Coast Barrier. This could result in increased use of recycled water of perhaps 10-20 thousand AFY via either the seawater intrusion barriers or via new mid-basin injection wells.

Water Rights and Institutional Implications

Under the existing West Coast Basin Judgment, it is not clear that LADWP would be able to exercise a right to extract injected water beyond its limited pumping rights. However, under the proposed Judgment Amendment, LADWP could utilize the water augmentation provision to develop a mid-basin injection project.

To implement a mid-basin injection project, LADWP would need to work closely with WRD, other West Coast Basin pumpers, and likely WBMWD to develop the delivery capacity, the injection wells, and the extraction capacity. LADWP should participate in WRD's upcoming West Coast Basin Optimization Study, which is expected to address many of these issues.

There are three institutional vehicles for LADWP to increase its supply of well water from the West Coast Basin; all of which are linked to an increase use of recycled water:

1. LADWP can acquire and produce water rights that are presently unused. This new groundwater pumping would be sustained by increased injection of recycled water either at the barriers or via mid-basin injection.
2. LADWP can acquire water rights which would be displaced by the delivery of recycled water to the major refineries. The new pumping by LADWP would not increase demands for injection of water into the basin but would instead be sustained by the delivery of surface recycled water to the refineries.
3. LADWP can sponsor a water augmentation project under the proposed judgment amendments. Under this scenario LADWP's new groundwater production would be sustained by injection of additional recycled water either at the barriers or via mid-basin injection.

The West Coast Basin Watermaster report suggests that the total water use by LADWP overlying the West Coast Basin is approximately 35,000 AFY. Of this amount LADWP development of additional recycled water would apparently reduce this use by approximately 9,000 AFY, and development for the barriers at current levels of non-potable water service would further reduce this potable water use. Thus, the vehicles to create a new well water supply for LADWP originating from recycled water development likely exceed the quantities of water that LADWP could beneficially use from the West Coast Basin. But in order to maximize the benefits to LADWP from recycled water development under all of the scenarios described above, it is essential for LADWP to determine the maximum quantities of water that LADWP can produce from the West Coast Basin. These evaluations include determinations of possible well locations, water treatment requirements to reliably produce potable water from these wells and evaluations of the distribution system integration necessary to maximize use of groundwater. Moreover these evaluations need to consider future reductions in potable water use resulting from deliveries of non-potable recycled water to customers of LADWP.

Maximized reuse within the West Coast Basin via increased use of unused and displaced groundwater rights apparently requires increased groundwater pumping by member agencies of West Basin MWD (notably Golden State Water Company and California Water Service Company) and by the cities of Torrance and Long Beach. In this regard, the studies of future use of the West Coast Basin sponsored by the WRD provide one vehicle for LADWP to participate in planning. However, LADWP must become pro-active in planning with the other Metropolitan member agencies and the sub-agencies of West Basin MWD who have the potential to use groundwater. Moreover, the large-scale changes in the management of the West Coast Basin under these concepts of maximized water reuse can dramatically affect WRD's replenishment costs which are paid by users within the Central Basin. The specific strategies to maximize reuse within the West Coast Basin must carefully consider financial and political issues within the Central Basin.

Additionally, the judgment amendments would allow regional agencies such as Metropolitan to develop new groundwater production and recharge within the basin. The scale of these projects is essentially limited only by the physical capacity of the basin to sustain new recharge and pumping since Metropolitan's distribution system could accept even larger quantities of water from the basin.

The current replenishment operations via the two seawater intrusion barriers sustain groundwater supplies within Los Angeles, West Basin MWD and the City of Torrance. Yet all of the imported water historically and presently supplied to these barrier projects is supplied by West Basin MWD. In the past when the recycled water supplies to the barrier project were developed, there was no explicit plan to share the conserved imported water between Metropolitan, West Basin MWD and City of Los Angeles. Additionally, when LADWP served recycled water to the Dominguez Gap Barrier project, LADWP sold the water to WRD without regard to the loss of net-revenues to West Basin MWD from a reduction in its potable water sales to WRD.

As the barriers are converted to 100 percent recycled water use, there should be a more careful consideration of these issues. More significantly, as large-scale changes in the use of groundwater within the West Coast Basin occur, these questions require even more careful examination. For example, as recycled water supplies increase to the barriers, perhaps West Basin MWD could begin delivering imported water to the LADWP to sustain the imported water deliveries presently made within City of Los Angeles via the seawater intrusion barriers. Alternatively, the purchase commitments and allocations of Metropolitan's waters between LADWP and West Basin could be adjusted.

5. Central Basin Opportunities

This section describes current operating conditions, basin water rights governance, and existing/planned water recycling activities for the Central Basin. Governance structures and proposed changes therein that are relevant to existing or potential recycled water recharge activities are also discussed.

5.1 Current Operational Conditions

Current operational conditions set the stage for understanding water rights governance, and also for identifying potential future recycled water projects. In this section basin storage, natural recharge, groundwater extraction, recycled water sources, existing recharge and barrier projects, and water quality and treatment are discussed.

5.1.1 Groundwater Basin Storage

The total aquifer storage capacity in the Central Basin is estimated at 13.8 million AF. As shown in **Figure 11**, the unused portion of this storage space is estimated at 1.1 million AF (MWD, 2007). Of the unused storage, 330,000 AF is estimated to be available for storage, assuming additional storage is available up to within 75 feet of the ground surface (MWD 2007). This is the same quantity identified in the proposed amendments to the Central Basin Judgment. Some parties lease their pumping allocations, but there is no long-term storage accounting in the basin under the current Judgment provisions (see Section 4.2.2 for proposed Judgment amendments).

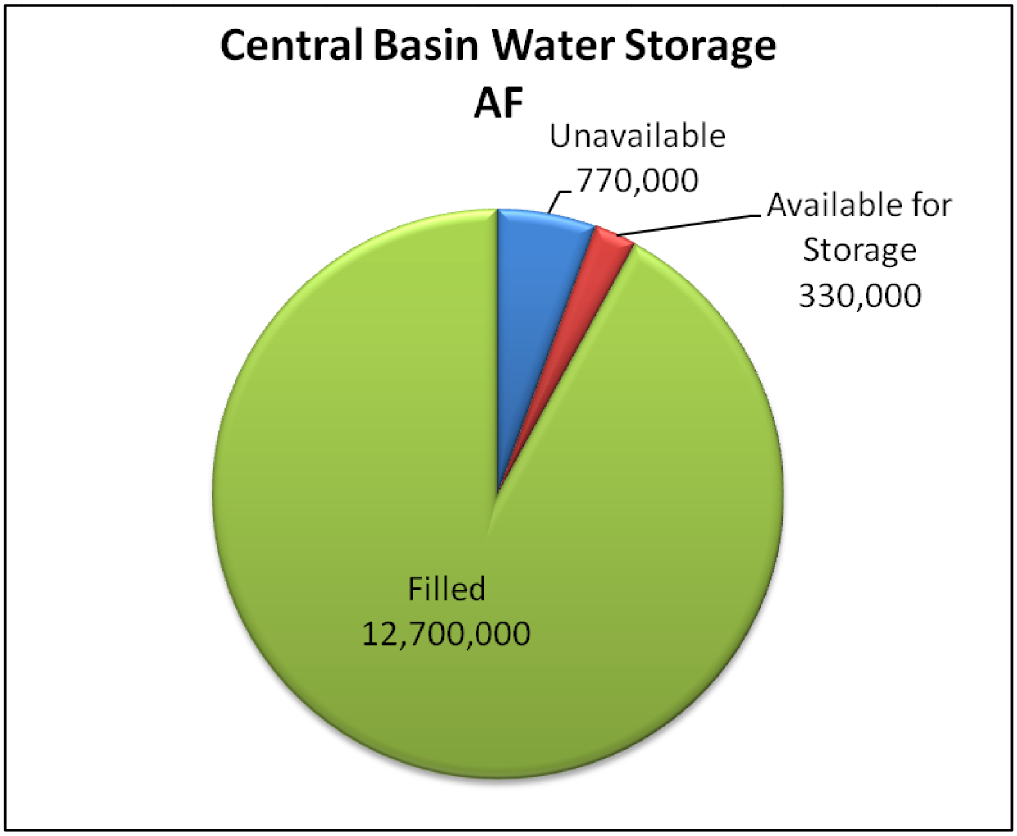
5.1.2 Natural Groundwater Recharge

The Central Basin is naturally recharged by precipitation, major recharge of surface flows from the San Gabriel and Rio Hondo Rivers in the Montebello Forebay area, minor recharge in the Los Angeles and Montebello Forebay areas, losses from the Los Angeles and San Gabriel rivers and subsurface inflow from the San Gabriel Basin through the Whittier Narrows.

5.1.3 Groundwater Extractions

The annual allocated extractions in the Central Basin for Water Year 2008-09 totaled 217,367 AF, and the actual reported extractions were 199,931 AFY (WM 2009). The decrease in production is related to water conservation and compartmentalized pumping of rights. From 1985 through 2005, average production was 189,597 AFY. There were seventy three parties actively pumping from 311 wells in the Central Basin in 2008-2009. The largest pumping parties in 2008-09 were the City of Long Beach (35,335 AF), Golden state Water Company (21,377 AF), and the City of Downey (17,220 AF). The City of Los Angeles produced 11,937 AF from the Central Basin of an allowed pumping allocation of 15,000 AFY (plus an additional allowed carry-over allocation of 3,000 AFY) in 2008-2009.

Figure 11: Storage in the Central Basin, AF

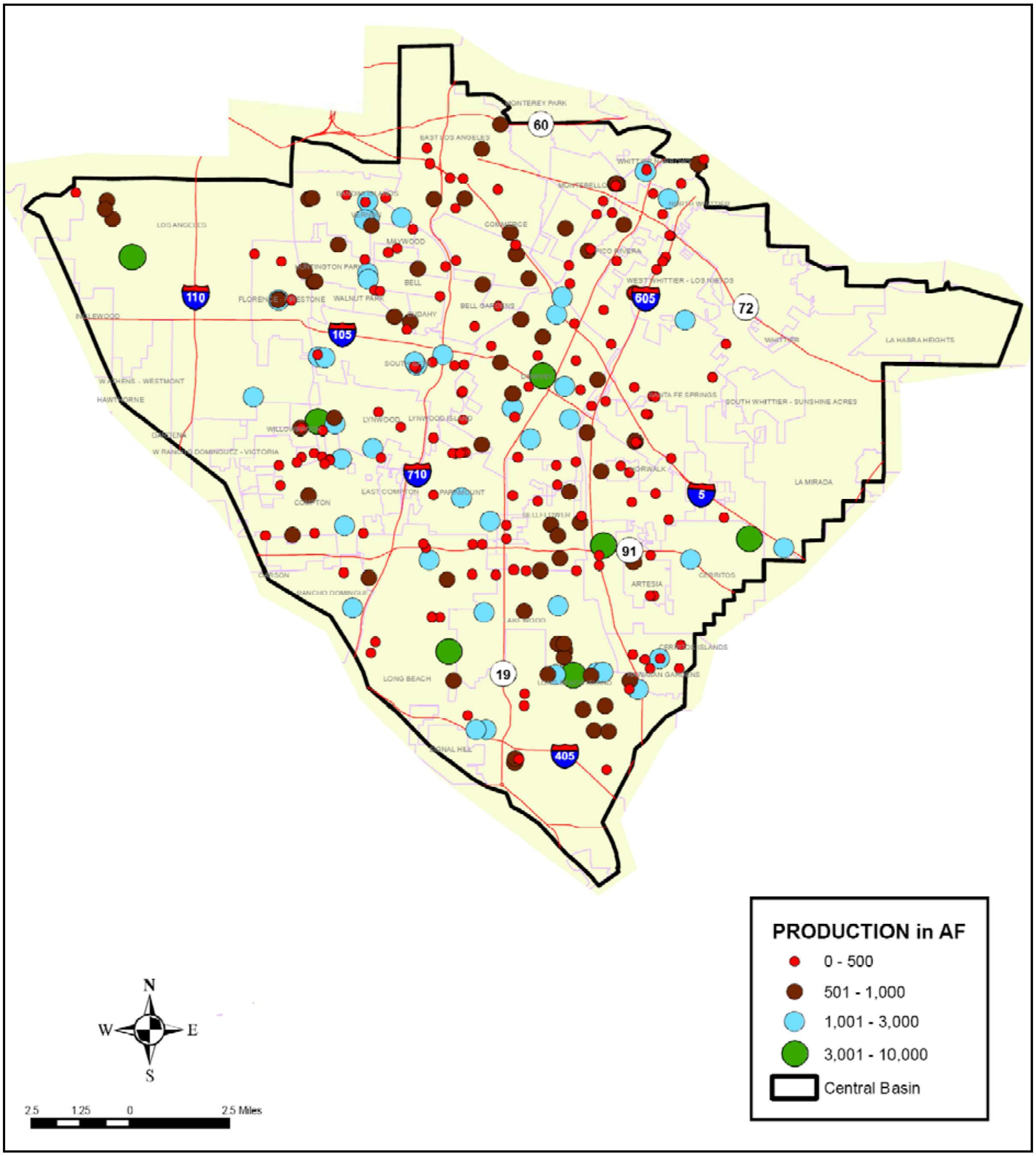


If a producer under pumps its rights in a given year, it can carry over up to 20 percent of the rights into the following calendar year. Groundwater replenishment requirements vary with pumping patterns. Long term average replenishment requirements have been 80,000 AFY, but more could be required if pumping trended up toward full adjudicated rights.

Very little pumping occurs in the far west and east corners of the basin. However, pumping is dense and evenly distributed over the north-south stretch of the basin that is bounded by I-110 and I-605, as shown in **Figure 12**.

Over-extractions for FY 2008-09 totaled 20,841 AF. This includes minor over-extractions by several producers and accumulated extractions over a number of years by the State of California (Caltrans) as a result of remediation activities. In addition, Caltrans has been pumping approximately 1,900 AFY for the last decade, which is not within the decree of the judgment. The Watermaster seeks to resolve this issue (Central Basin Watermaster Report, 2009).

Figure 12: Production Pumping in Central Basin



5.1.4 Recharge Projects

Spreading operations currently take place in the Montebello Forebay. The LA County Department of Public Works spreads a combination of recycled water, stormwater runoff, and imported water to replenish basin water. The four primary spreading areas in the Central Basin are the Rio Hondo Spreading Grounds, the San Gabriel River Spreading Basins, underlined portions of the San Gabriel River and the reservoir behind the Whittier Narrows Dam. In 1991, the maximum allowable spreading of reclaimed water in the Montebello Forebay was set at 60,000 AFY, not to exceed

150,000 AF over three years. These rules were amended in 2009 to allow annual reclaimed water contributions greater than 60,000 AFY as long as the three-year total remains below 150,000 AF.

From Fiscal Years 1985/86 through 2004/05, the average annual spreading was approximately 140,000 AFY (MWD, 2007). Between recycled water spreading and local runoff, 80,623 AF was replenished to the Central Basin in FY 2008-09 (WM 2009), which is 13 percent lower than the previous year. Further discussion of spreading operations in the Montebello Forebay is provided in Section 5.3.1.

WRD currently purchases approximately 30,000 AFY of spreading water from Central Basin MWD. WRD is seeking to develop approximately 9,000 AFY of additional flow from the San Gabriel River to reduce this spreading requirement to 21,000 AFY. WRD is seeking this 21,000 AFY from recycled water sources. LACSD has indicated an ability to supply 9,000 AFY of this demand from existing sources via a new AWT. Thus WRD has an apparent unmet need for 12,000 AFY of AWT quality recycled water (16,000 AFY prior to AWT treatment)

An in-lieu replenishment program is also practiced in the Central Basin. Between water years 1985/86 and 2004/05, average in-lieu replenishment was 22,000 AFY (MWD 2007). The program was not administered for the 2008-2009 (WM 2009).

5.1.5 Barrier Projects

Sea water intrusion at the mouth of the San Gabriel River (the "Alamitos Gap") threatens the Sunnyside and Silverado aquifers in the Central Basin. The Alamitos Gap Barrier Project has been in operation since 1965 to contain the sea water intrusion in this area. The project consists of 43 injection wells, 226 observation wells and four extraction wells. The extraction wells help lower water levels on the seaward side of the barrier thereby reducing the quantity of injection water required. During water year 2008-09, 7,936 AF was injected into the Alamitos Barrier Project including both imported water and recycled water.

5.1.6 Water Quality and Treatment

Seawater intrusion impacts water quality in the coastal area of the basin. In addition, volatile organic compounds (VOCs) have been detected in a number of wells. The WRD's Safe Drinking Water Program provides wellhead treatment equipment that keeps contaminated pumping wells online (MWD 2007). As in the West Coast Basin, MCLs for iron and manganese are exceeded in some wells in the Central Basin. Treatment is in place for iron and manganese removal in some areas (MWD 2007).

Groundwater in the Long Beach area typically has a reddish color from peat in soils. This is alleviated by treatment and blending with imported water.

5.2 Basin Water Right Governance

The Central Basin Judgment was entered in 1965 (Central and West Basin Water Replenishment District v. Adams, Case No. 786656). Similar to the West Coast Basin Judgment, each party's right to extract water from the basin is limited to an annual specified amount. However, the Central Basin Judgment establishes adjudicated rights totaling 267,900 AFY but limits pumping to an Allowable Pumping Allocation (APA) of approximately 80 percent of this amount (217,367 AFY). Both amounts exceed the natural yields of the basin, and the decree recognizes that WRD artificially replenishes the basin to make up the difference. To recover its replenishment costs, WRD charges pumpers a Replenishment Assessment based on the volume of water each pumps per year. The RA encompasses replenishment costs in both the West Coast and Central Basins and is divided amongst the pumpers in both basins collectively.

In many aspects, the Central Basin Judgment and its rights, provisions and restrictions mirror those described above for the West Coast Basin Judgment. For the Central Basin, the Judgment provides the following:

- **Carryover:** Pumpers are allowed to carryover up to 20 percent of their APA into the following year.
- **Over-pumping:** Pumpers are allowed to pump up to 120 percent of their APA (or 20 AF, whichever is greater) provided that any over production is made up by under production in the following year. Under certain circumstances, parties may over-extract in greater amounts; however, prior approval by the Watermaster must be obtained.
- **Lease:** Parties are able to lease their rights. Terms of the leases can vary including whether or not to include carryover. In the Central Basin, 57 leases totaling 30,300 AF were made involving 53 parties, the largest for 7,326 AF.
- **Sales:** Parties are able to sell their rights.
- **Exchange pool:** The Central Basin Judgment creates an exchange pool similar to the West Basin Judgment as previously discussed through which pumpers who have access to supplemental imported water can make their pumping rights available to pumpers who do not for a price not to exceed the cost of the supplemental imported water.

Outside of the Central Basin Judgment, WRD adopted a set of Interim Storage Rules that were designed to establish a framework and process through which pumpers could begin to store and extract water from conjunctive use projects. These Interim Storage Rules were developed at the request of a number of pumpers and under the premise held by many that WRD has the authority to develop and implement such rules under its legislative mandate. The Interim Storage Rules have been developed and are supported by many of the pumpers. However, they have not been implemented because of the concern of legal challenges that pumpers may face.

However, it is important to note that the Judgment does not recognize the right to stored water nor does it give pumpers the legal mechanism to pump more than their rights as provided in the Judgment. The annual Watermaster's Report prepared by DWR tracks the claimed storage amounts but explicitly states that it does so "without acknowledging their legal standing under the Judgment." In addition, any water pumped from the groundwater basin could currently be subject to the Replenishment Assessment even if it could be shown to have been recharged outside the confines of the Judgment. In effect, these restrictions essentially preclude pumpers from operating the basin to generate additional water supply yield for themselves and operating outside of these restrictions could invite legal challenges from other pumpers.

In summary, the conclusions regarding the current institutional framework for LADWP to use additional recycled water for groundwater recharge and extraction in the Central Basin are essentially the same as those for the West Coast Basin. Any extraction beyond LADWP's current pumping right would require LADWP to either lease or acquire rights from other pumpers in the basin. Also, additional pumping could be subject to a Replenishment Assessment even if LADWP bore substantially the costs of recharging the water. LADWP could request prior approval from the Watermaster to extract water beyond its current adjudicated right. However, the Watermaster appears reluctant to grant such approval as it would signal an endorsement of storage which currently is outside its authority. In addition, operating outside of the judgment could subject LADWP to legal action by another pumper.

The judgment amendments would provide definitive rules governing storage and recovery. If not adopted, there will likely be litigation to resolve these questions.

5.3 Existing Recycled Water Activities and Potential Opportunities

5.3.1 Central Basin – Montebello Forebay Spreading

Current Recycled Water Use

The Montebello Forebay recycled water recharge project is the oldest and best-characterized recycled water groundwater recharge project in California. The project is the joint responsibility of LACSD, WRD, and LACDPW. Since 1962, recycled water provided by the LACSD has been used to replenish the Central Groundwater Basin as part of the Montebello Forebay Project. Other sources of replenishment water are storm water and imported water (Colorado River Water and State Project Water) supplied by MWD. Water is applied at two spreading grounds: the Rio Hondo Coastal Spreading Grounds and the San Gabriel Coastal Spreading Grounds. In addition, the San Gabriel River channel itself is unlined (soft natural bottom) and is also used for recharge. Each spreading ground is subdivided into a system of smaller ponds that can be filled or dried alternately to allow maintenance.

Recycled water is supplied by the Whittier Narrows Water Reclamation Plant (WNWRP), San Jose Creek Water Reclamation Plant (SJCWRP), and Pomona Water Reclamation Plant (PWRP). WRD purchases water from the WNWRP and SJCWRP; water from the PWRP is considered incidental recharge and is not purchased by WRD. The purification system consists of primary treatment, nitrification/denitrification (NdN) activated sludge biological treatment, granular media filtration, disinfection using sequential chlorination, and dechlorination. The change from chloramination to sequential chlorination has occurred over the past few years in response to the goal of minimizing disinfection byproduct formation. Sequential chlorination involves the application of chlorine to fully nitrified secondary effluent upstream of the granular media filters (to form free available chlorine), and subsequent addition of chloramines (ammonia followed by chlorine) downstream of the filters.

The current recycled water spreading requirements for the Montebello Forebay established by the RWQCB are detailed in Order No. 91-100 adopted on September 9, 1991, and amended in April 2009 via Order No. R4-2009-048. The permit was jointly issued to LACSD, WRD, and LACDWP. The permit requirements are largely based on the results of the Health Effects Study (see below) and the review of the study by the 1986 Scientific Advisory Panel. In 1987, a permit was issued allowing the project to expand the use of recycled water from 32,500 AFY to 50,000 AFY, and thus did not reflect the requirements in the 1988 CDPH draft groundwater recharge regulations. The permit was amended in 1991 and essentially "grandfathered in" the project's existing requirements with the exception of allowing up to 60,000 AFY of recycled water to be used for recharge and up to 50 percent recycled water in any one year as long as the running 3-year total did not exceed 150,000 AFY or 35 percent recycled water. The recycled water percentage was based on the combined total inflow to both spreading grounds such that total inflow included all spreading waters, rainfall, and underflow from the San Gabriel Valley Groundwater Basin. There is no recycled water TOC, minimum retention time, or minimum separation requirements in the permit. The recycled water must meet drinking water MCLs for heavy metals and toxic contaminants and CDPH Title 22 guidelines on filtration and coliform levels. The amount of recycled water has averaged 50,000 AFY over the years of project operation. WRD plans on maximizing its allowable use of recycled water because it is a reliable and replenishment source.

In April 2009, the permit was amended to change the averaging period for the calculation of the recycled water allowance as a percentage of total recharge from all sources and provide other revisions to increase the flexibility of long term blending provisions. The amendment was intended to ensure that an adequate and reliable source of groundwater was available due to the lack of imported water that could be used for replenishment. Imported water has not been available for replenishment for more than a year and a half, and MWD has predicted that replenishment water may only be available for three out of every 10 years. WRD normally recharges 21,000 AFY of imported water. The 2009 permit amendment allows an increase in the annual amount of recycled water by removing the running 3-year allowable annual quantity limit and annual volume caps of recycled water but maintains the same long-term blend ratios. It allows the maximum quantity of recycled water spread to be 35 percent based on the combined total inflow to both spreading grounds during a period of five years instead of three years and thus will allow for additional recycled water to be spread to account for wet years and to provide more flexibility in operations. This change in the averaging period for the percentage of recycled water was supported by CDPH given the current water crisis and was based on the recycled water provisions in the 2008 draft groundwater recharge regulations.

The recharge project is subject to a complex water quality monitoring and compliance program that assesses all of the waters used for replenishment and the groundwater system. The monitoring program has been complemented by ongoing research to address water quality and public health issues. This research has included the Health Effects Study, which evaluated the health effects of using treated wastewater for groundwater recharge. Additional health studies have been conducted for the Montebello Forebay Project by the Rand Corporation as part of an ongoing effort to monitor the health of those consuming recycled water in Los Angeles County for the time period 1982-93. These studies examined health outcomes for 900,000 people living in the Central Groundwater Basin area who receive some recycled water in their household water supplies. To compare health characteristics, a control area of 700,000 people was selected that had similar demographic and socioeconomic characteristics, but did not receive recycled water. The results from these studies indicate that after almost 30 years of groundwater recharge, there is no association between recycled water and higher rates of cancer, mortality, infectious disease, or adverse birth outcomes (Sloss et al., 1993; Sloss et al., 1996). Additional research evaluated the ability of soil to treat recycled water as it percolates to groundwater via the soil aquifer treatment (SAT) process. The study found that SAT is an effective and sustainable process to remove organic compounds such as pharmaceuticals, personal care products, and endocrine-disrupting compounds (EDCs) (Fox et al., 2001; Fox et al, 2006).

Potential Recycled Water Use

WRD is continuing to explore new ways to increase the supply of recycled water to the Montebello Forebay. The primary effort is the Groundwater Reliability Improvement Program (GRIP). The GRIP is a partnership between WRD, the Upper San Gabriel Valley Municipal Water District (USGVMWD) and LACSD to develop alternative supplies to ultimately replace up to 46,000 AFY of imported water now used for groundwater replenishment in the Main San Gabriel Basin and the Central Basin. A conceptual design has been developed to build an AWTF at the SJCWRP to initially provide 18,000 AFY to the program; 9,000 AFY would be provided to the USGVMWD while the other 9,000 AFY would be used by WRD for recharge in the Montebello Forebay. The partnership is now embarking on an alternatives evaluation to determine the appropriate mixture of projects to achieve the 46,000 AFY replenishment goal. The study will include not only evaluating the initial conceptual project but alternatives as to where the additional supplies will be provided.

As a part of the study, recycled water options which WRD expects to consider include:

- **Expanding SJCWRP**: LACSD has evaluated whether sufficient modifications could be made in the collection system to divert more flows to the SJCWRP. In addition, LACSD has evaluated the ability to expand the SJCWRP at the existing site. However, given that wastewater flows in general are trending downward, coupled with major capital costs, it is not clear that this would provide a sufficiently reliable supply for replenishment. Currently, all recycled water from SJCWRP is contracted to other agencies, but less than half the water is actually reused by those agencies.
- **Providing supply from the Los Coyotes WRP**: The LCWRP currently has un-contracted recycled water and LACSD has evaluated delivering as much as 25,000 AFY to an AWTF at the SJCWRP. While sufficient recycled supply may be available, substantial conveyance facilities would be required.
- **Providing supply from HTP:** While HTP has a sufficient supply of secondary-treated effluent, treatment, conveyance issues, and cost are significant issues. LADWP, WRD and others would likely partner to develop a project broader than the objectives of the GRIP to provide replenishment water and/or water augmentation supply from HTP. A water augmentation project would need to be planned in conjunction with the proposed Central Basin Judgment Amendments or another legal framework to provide institutional certainty over the supply.
- **Providing supply from JWPCP**: LACSD and MWD are expected to enter into an agreement in December 2009 to study the use of up to 200,000 AFY of recycled water from the JWPCP for groundwater replenishment in multiple groundwater basins, including the Central Basin via the Montebello Forebay. As with providing supply from HTP, treatment, conveyance and cost issues are expected to be significant. An additional consideration is the fact that the quality of recycled water available at JWPCP is generally of much higher TDS levels than that at HTP, which could lead to higher costs per AF of water treated to produce replenishment water of equivalent quality.
- **Providing supply from a new satellite plant that would divert flows upstream of Hyperion**: A concept being considered is to construct a new satellite wastewater plant closer to downtown Los Angeles and the Montebello Forebay to capture flows higher in the watershed to serve both non-potable users as well as groundwater recharge. Rather than

divert water directly into the Montebello Forebay, LADWP could instead provide recycled water into Central Basin MWD's Southeast Water Recycling Project (SWRP) which is currently served by the SJCWRP. In exchange, Central Basin MWD would make their recycled water from SJCWRP available for groundwater replenishment.

In considering these alternative sources of supply, a key issue that will need to be addressed is the type of recycled water to be used for additional replenishment. At this time, it is expected that some level of advanced treatment could be needed to meet water quality and permitting requirements. However, using a blend of advanced treated and tertiary treated recycled water for groundwater replenishment has not yet been permitted in California. WRD is currently undertaking a study with the Colorado School of Mines to examine potential water quality and operational issues associated with blending recycled waters of two different qualities.

Another key issue associated with replenishment in the Montebello Forebay beyond existing requirements of WRD is recharge and storage capacity. WRD anticipates that augmentation recharge will be constrained in the near future unless additional extraction capacity is provided in the forebay area. WRD has proposed a project that would extract an additional 25,000 AFY via new wells in the Montebello Forebay and deliver it to customers elsewhere in the Central Basin to help alleviate this bottleneck.

As WRD, USGVMWD and LACSD undertake the alternatives evaluation for GRIP, LADWP should work closely with the partnership to further evaluate and promote opportunities for LADWP to provide recycled water not only to help meet the goals of GRIP, but to also provide water supply augmentation beyond those goals.

Water Rights Implications

If under any of the above mentioned projects, LADWP supplies recycled water for replenishment in the Montebello Forebay, it would likely need to be done once the proposed Judgment Amendments have been approved. Without the Judgment Amendments or other approved legal position, LADWP could be at risk as it would have no clear legal basis for extracting groundwater beyond its current APA in the Central Basin. It could provide recycled water for replenishment purposes to WRD for a price (such as for the DGB in the West Coast Basin), but LADWP would not be able to realize any direct water supply benefit. The primary indirect benefit would again be reduced use of imported water for replenishment which makes that supply available to other MWD member agencies in the region.

Under the proposed Judgment Amendments discussed previously, LADWP would no longer be constrained to pump within its APA. By using the water augmentation provisions, LADWP would be able to either extract directly, or through exchange with other pumpers, recover virtually all recycled water it could provide.

In summary, under current Central Basin Production patterns and with the implementation of near term planned projects by WRD and others, the unmet Forebay replenishment requirements are anticipated to generally be approximately 12,000 AFY based on long term average pumping, but could be higher if future pumping is closer to full adjudicated rights.

5.3.2 Central Basin - Alamitos Gap Barrier Injection

Current recycled water use

The Alamitos Gap Barrier Injection Project (AGBP) is authorized to use up to 3,360 AFY of advanced treated recycled water (MF/RO/UV with pH adjustment using sodium hydroxide) produced at the Leo J. Vander Lans Water Treatment Facility (LVLWTF). The recycled water is blended with 3,360 AFY of imported water to inject into the Alamitos Gap Seawater Intrusion Barrier. The LVLWTF, which currently produces 3,000 AFY, was designed and constructed 8 years ago. The maximum recycled water use for this project is 50 percent based on the total blended water injected, recycled water TOC, and a five year averaging period. The permit includes a requirement for an underground retention time of at least 12 months for the recycled water in the groundwater basin before the water is extracted for drinking purposes and a minimum horizontal separation of 2,000 feet between the injection site and the nearest drinking water well. The barrier is operated by LACDPW.

The LVLWTF is owned by WRD and operated by the Long Beach Water Department (LBWD). Water is supplied through an agreement between WRD and the LBWD and utilizes a portion of recycled water that is provided to LBWD through its agreement with LACSD. It receives disinfected tertiary effluent from LACSD's Long Beach WRP. The pretreatment requirements for the project are included in the NPDES permit for the Long Beach WRP. In addition, LACSD and WRD have entered into a Memorandum of Agreement with respect to the administration of the source control program. The agreement ensures that LACSD's industrial wastewater pretreatment and source control program will be consistent with the most recent recommendations and regulations issued by CDPH with respect to pretreatment and source control requirements for groundwater recharge projects. Brine from the LVLWTF is discharged to LACSD's sewer system, and is subject to an LACSD pretreatment permit. The sewer discharge is tributary to LACSD's ocean discharge plant, the Joint Water Pollution Control Plant in Carson. The project is subject to a complex water quality monitoring and compliance program that assesses all of the waters used for replenishment and the groundwater system.

Planned/Potential Recycled Water Use

WRD is developing plans to expand the LVLWTF to provide up to 6,000 AFY for the AGBP which is expected to meet 100 percent of the barrier demands. Expansion will provide advanced wastewater treatment for the production of recycled water through a process train that will include some combination of microfiltration, reverse osmosis, and advanced oxidation. The product water will then be delivered to the AGBP to replace the existing imported water demand. Much of the piping and site preparation for this expansion is already in place. Following expansion to 6,000 AFY, the LVLWTF will operate in the same manner as the existing facility. The LBWD will continue to be responsible for operation and maintenance of the treatment plant under contract with WRD.

For the expansion, key issues that need to be resolved include whether or not LBWD will be able to provide sufficient recycled water as well as brine discharge capacity. If not, WRD is considering using available recycled water from the Los Coyotes WRP located approximately 7 miles upstream along the San Gabriel River.

It does not appear practical to supply additional recycled water to the AGBP from city of LA/LADWP sources due the distance from any City facilities and the proximity to the Long Beach and Los Coyotes Creek WRPs. LADWP could potentially supply recycled water to offset non-potable demands currently being met by the City of Long Beach or CBMWD which would free up additional water from the LACSD plants, as discussed further in Section 8.

5.3.3 Central Basin – Los Angeles Forebay Recharge

Current Recycled Water Use

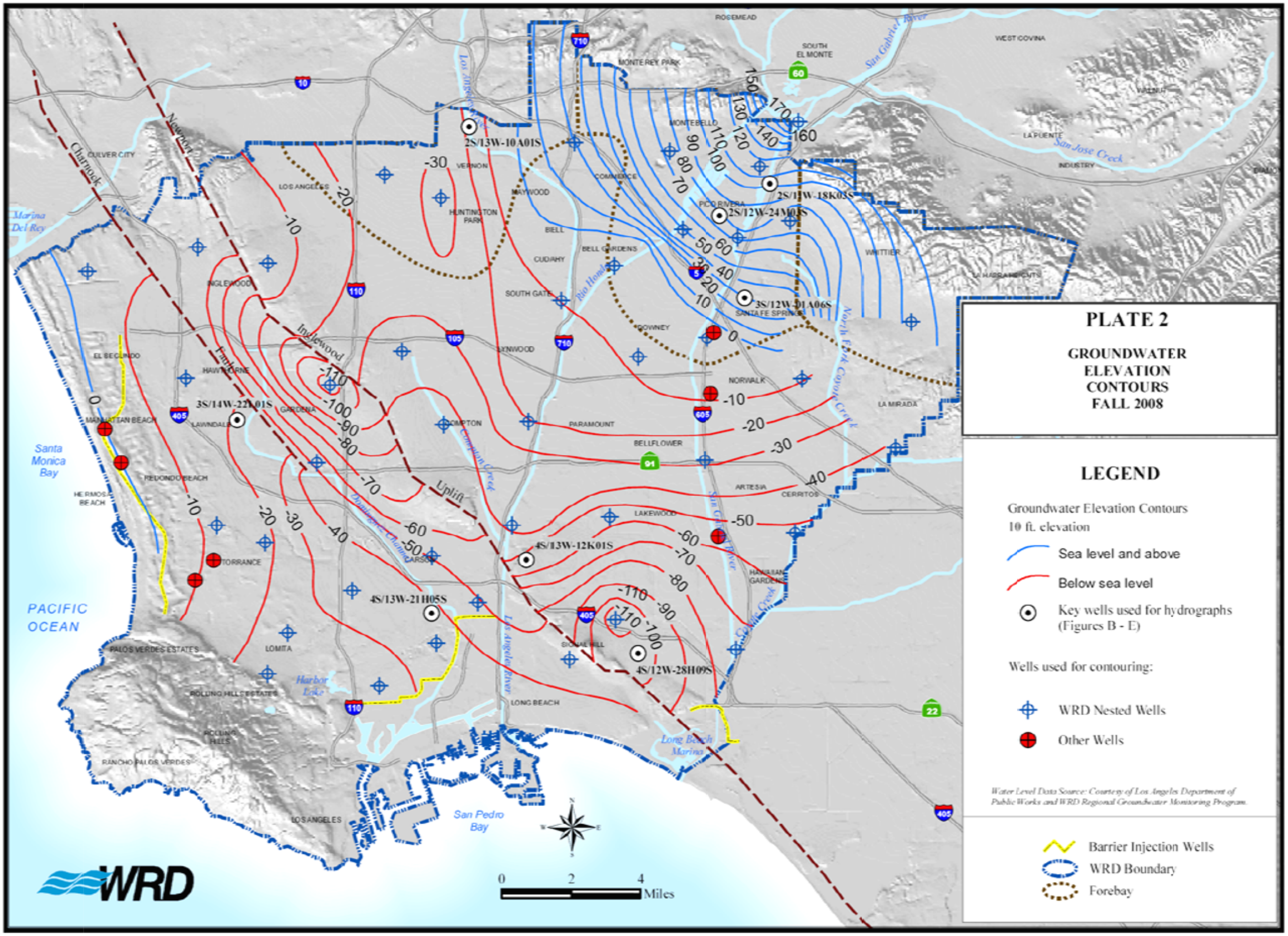
Prior to widespread urbanization and the lining of the Los Angeles River, the Los Angeles Forebay was an area of significant surface recharge. Currently there is no direct recharge of any water sources in the Los Angeles Forebay area other than from overlying percolation of precipitation and returns from overlying use. Since percolation from precipitation and returns from use are now very restricted as a result of intense urbanization at the surface and the lining of the river, the Forebay is a good candidate area for supplemental recharge. Because there is significant groundwater production in the area, water levels can decline during average or below average hydrologic periods, and recharge in the Montebello Forebay alone is not sufficient to maintain water levels in the Los Angeles Forebay. Based on Fall 2008 water level elevation data, water levels in the middle of the Forebay are 10-15 feet lower than surrounding areas as shown in **Figure 13** (WRD, 2009).

Potential Recycled Water Use

Unlike the Montebello Forebay, there is no open area for potential surface spreading basins in the Los Angeles Forebay. It is conceivable that previously developed land area could be acquired, cleared and converted into a surface recharge area, but this would likely be very costly. In addition, because much of the land use in the Forebay area is in older industrial uses, there is the possibility that there could be contamination in the near surface layers beneath some of the property that would need to be identified and fully remediated if surface recharge were to be considered. Based on water quality data published by WRD (WRD, 2009), water quality in the Forebay, particularly in the majority of production wells and at lower depths in monitoring wells is generally good; however, there are indications of higher concentrations of a number of constituents including TDS, hardness, Trichloroethylene (TCE), and Total Chromium in shallower depths, particularly toward the western side of the Forebay. For these reasons, is it is presumed that significant surface recharge is not practical.

Conversely, injection of recycled water has significant potential for this area. Conventional injection wells similar to those used at the Barriers are feasible, and would typically have the capacity to inject 1-2 cubic feet per second (cfs) per well. A potential alternative, given the relatively high permeability throughout the depth of the Forebay, would be to consider dry wells that potentially have capacity to recharge greater quantities of water per well.

Figure 13 – Groundwater Elevation Contours in the West Coast and Central Basin (WRD 2009)



Artificial recharge wells or injection wells have been typically used in the Southern California area to inject water into the groundwater basin to mitigate seawater intrusion. Recharge wells pump water into the aquifer instead of pumping the water out of the aquifer as a typical well would do. The recharge wells target specific water bearing zones in the aquifer. Typical injection wells can vary in depth from 50 to 1000 feet or more in depth, depending upon the aquifer depth to be recharged. Well diameters can vary from 4 inches to 20 inches or more in diameter. The total cost of the well increases with increased diameter and depth. The amount of water that these wells can inject into the groundwater basin varies and is dependent upon the hydraulic conductivity of the materials that are being recharged. Typically the well can inject the amount of water that an extraction well would be able to pump out. Injection wells require regular maintenance to sustain the injection rates as particles, microbial growth and chemical precipitates tend to clog the well screens and or gravel pack. One advantage of a recharge well is that the well has a relatively small footprint and can be installed in areas where available land is scarce.

More recently water production wells have been used to recharge the groundwater basin. These wells are called Aquifer Storage and Recovery (ASR) wells. ASR wells typically recharge the groundwater basin when the water is not needed for consumptive use and then when needed the water is pumped out and used for drinking water. ASR wells would not be appropriate for injecting and recovering recycled water for potable use but could potentially be used for initiating injection of blending water.

Dry wells are wells installed in the vadose zone that can be used to recharge unconfined aquifers. A dry well is typically 30 to 165 feet in depth and about 40 to 60 inches in diameter. Dry wells are less expensive to install than the typical recharge well and would have higher capacity. A dry well is similar to recharge shafts or recharge pits which also can be used to recharge groundwater. Because the well is installed in the vadose zone, it is difficult to remediate clogging of the well. Therefore, it is important to install the well carefully to minimize clogging and to treat the water prior to recharging to remove suspended solids, microorganisms, nutrients and other constituents.

Recent production in the Los Angeles Forebay is approximately 15,000 AFY, with significant additional pumping to the south, east and west in the confined areas of the basin. The City of Los Angeles's current Central Basin production is primarily focused in the confined layers to the immediate south and west of the Forebay.

The amount of recharge possible through some form of subsurface injection is difficult to predict without significant investigation. It is possible to conceptualize a relatively large potential given the characteristics of the aquifer in the Forebay, with an estimate as high as 30,000 – 40,000 AFY used for preliminary planning purposes. This estimate depends upon a number of key issues including:

- The ability to meet current or future recycled water draft of final regulations with respect to recycled water blend and travel time to closest wells since there are a number of existing production wells in the area. This will require significant investigation and understanding of this portion of the aquifer.
- Better understanding of the hydrogeology and modeling of the basin for such strategies.

There are several potential sources of recycled water that could be brought to the area for recharge, including:

- Secondary effluent from HTP treated at an expanded ECLWRF and delivered to the Forebay area;
- Construction of a satellite plant in southeast Los Angeles to intercept wastewater from the HTP service area with both secondary plus advanced treatment to produce water for injection;
- Interception of base flow from the Los Angeles River in southeast Los Angeles which includes a blend of upstream tertiary effluent and base dry weather flow and construction of an AWT facility in the vicinity to treat the base flow.

Water Rights Implications

LADWP could supply recycled water for replenishment in the Los Angeles Forebay to meet a portion of the existing replenishment demands of WRD. However a greater benefit to LADWP could be derived from recharge of the LA Forebay after the proposed Judgment Amendments have been approved.

Under the proposed Judgment Amendment, LADWP would no longer be constrained to pump within its APA. By using the water augmentation provisions (see Section 4.2 for further detail), LADWP would be able to either extract directly, or through exchange with other pumpers, recover virtually all recycled water it could provide.

Under the third concept for recycled water sources, diversion from the Los Angeles River, there are additional issues that would have to be resolved including surface water rights and diversion issues.

5.3.4 Other Central Basin Opportunities

Transfer Rights Under Existing Judgment Decree 5-10,000 AFY

Presently, most of the pumping rights within the Central Basin are fully utilized. Most of the unused rights in 2008-2009 were from LADWP's under pumping of its 15,000 AFY right. In recent history more than 5,000 AFY of pumping rights have gone unutilized. Perhaps more reliably, LADWP could potentially increase its pumping rights by developing new service of recycled water to users within Central Basin who are supplied with well water. There are opportunities to develop recycled water customers within the City of Vernon and Southgate on the order of 5,000 AFY which in conjunction with acquisition of these rights by LADWP could increase LADWP's pumping rights within the Central Basin by 5,000 AFY to a total of approximately 20,000 AFY.

Amendments to the Judgment Decree in Central Basin – 50-100,000 AFY new replenishment demands.

The proposed amendment to the Central Basin judgment summarized in Section 4.2 would allow parties such as LADWP to undertake water augmentation projects within the basin. Water augmentation would involve the increased recharge of the basin and the granting of new production rights equivalent to the amounts recharged. This offers a large scale opportunity for use of recycled water for new recharge of the basin. Also, the amendments would allow "regional storage projects" within the basin wherein large-scale recharge, storage and recovery of water by nonparties to the judgment such as Metropolitan could develop new production wells sustained with recharge from recycled water sources. Observationally, the largest opportunities for recharge and new pumping within the basin exist within the two "Forebay" areas of the basin because of the much larger recharge capacity of these areas, the substantial water-bearing or storage potential of these areas and the much higher well yields in these areas.

City of Los Angeles Demands – New Replenishment 20-30,000 AFY

If the judgment amendments are approved it is reasonable for LADWP to pursue one or more projects within the basin to develop additional recharge within the basin and maximize groundwater pumping. According to the Watermaster reports, City of Los Angeles demands overlying the Central Basin are on the order of 40,000 AFY. After use of LADWP's 15,000 AFY pumping right this would leave approximately 25,000 AFY in potential demand for new groundwater production. The Central City Demands of LADWP are much larger than this and it may be possible to distribute water to areas of the city which do not overlie the basin. The City's well field at 99th street is well situated within the basin near the edge of the Los Angeles Forebay. The City had historic "Soto St." wells which were apparently in the Los Angeles Forebay. Thus it seems reasonable to assume that LADWP could increase its production of groundwater from the basin by at least 25,000 AFY and possibly more. Detailed evaluations are needed of the potential new well locations within the basin and the means to integrate those wells into the distribution system of LADWP. Consideration of the legal and political questions concerning the use of water to supply non-overlying demands is warranted.

While the judgment amendments conceptually allow LADWP to develop its own recharge and recovery projects within the Central Basin, those projects require careful consideration of the needs and objectives of other agencies. The City of Long Beach is the largest water rights holder in the Central Basin and has an imported water demand of nearly 30,000 AFY. The City of Compton has an imported demand of more than 2,000 AFY. Within Central Basin MWD, Golden State Water, California Water Service Company and Park Water Company make up the bulk of the 50,000 AFY imported water demand, but there is also a substantial demand by the Cities of Paramount and Santa Fe Springs. In addition to LADWP's potential demand from the basin the other purveyors within the basin could potentially increase use of groundwater by 50-80 thousand acre-feet per year and this production could be sustained via recharge with recycled water.

The largest potential recharge and recovery within the basin is in the Montebello Forebay, but the overlying demands are much more concentrated in the lower end of the basin. WRD has contemplated in the past a regional groundwater recovery program in the Montebello Forebay which would pump new recharge water from the Forebay and distribute that water to the southern end of the basin to large purveyors including the City of Long Beach. Initially a project of 25,000 AFY pumping was contemplated. WRD obtained a Federal authorization for such a project but has not received an appropriation.

6. Raymond Basin Opportunities

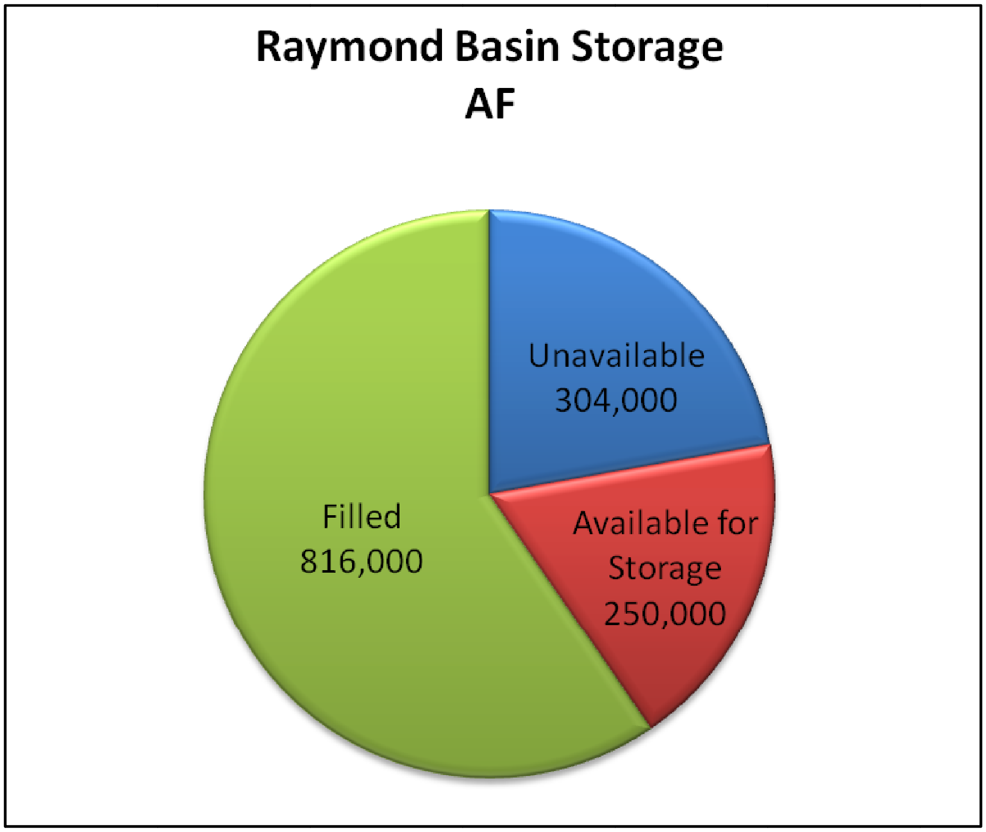
6.1 Current Operational Conditions

6.1.1 Groundwater Basin Storage

Total aquifer capacity is 1.37 million AF (MWD 2007), and the estimated unused storage space is 570,000 AF, based on a 2003 estimate. Of the unused storage space, only 250,000 AF is available

(MWD, 2007) to maintain maximum water levels sufficiently below the ground surface. The judgment's "decreed right" extraction total for the basin is 30,622 AF, which was deemed the safe yield for the basin in a 1955 court ruling (MWD, 2007). Estimated storage potential for the Raymond Basin is shown in **Figure 14**.

Figure 14: Raymond Basin Storage, AF



6.1.2 Groundwater Extractions

There are 45 wells in the Raymond Basin, and all water production in the basin is for municipal use. Average groundwater production from 1985 through 2004 was 33,000 AFY. Total extractions for FY 2006-07 (the most recent period for which an Annual Watermaster Report is available) were 35,000 AF, of which 1,800 AF was exported. Approximately 1,000 AF of additional surface water was diverted to water producers from streams in the basin (MWD 2007). Most significant pumping occurs in the Pasadena sub-area along Interstate 210. Extraction also takes place in the Santa Anita Subarea near the recharge basins, and also near the Arroyo Seco in the Monk Hill Subarea. In FY 2006-07, Lincoln Avenue Water Company over extracted by 273.5 AF. No other over extractions occurred. A map of the basin showing production 2006-2007 is shown in **Figure 15** (Raymond Basin Management Board, September 2007)

LADWP has no standing or rights to production in the basin. The Department would need to work through one of the parties with production rights as described below.

6.1.3 Storage Accounts

The Raymond Basin Management Board had 96,500 AF of storage leased in July 2007 (RBMB 2007) in long-term storage accounts. Storage accounts are approved by the Raymond Basin Management Board. All addition and removal of water from long-term storage accounts is independent of adjudicated water extraction. Because some water exits the Raymond Basin across the Raymond Fault, a loss of 1 percent is taken from all storage accounts each year (RBMB 2007).

Within the Raymond Basin, the Foothill MWD participates in a Conjunctive Use Program (CUP) with the Metropolitan Water District. Foothill MWD stores up to 9,000 AF of Metropolitan water in the Raymond Basin, and in exchange Metropolitan can extract as much as 3,000 AFY in the future. Foothill MWD recharge for this program includes in-lieu replenishment, injection and in-lieu replenishment (RBMB 2007). In 2007, Foothill MWD and Metropolitan were considering a larger CUP in conjunction with the City of Pasadena. This project would involve storage of 66,000 AF (MWD, 2007).

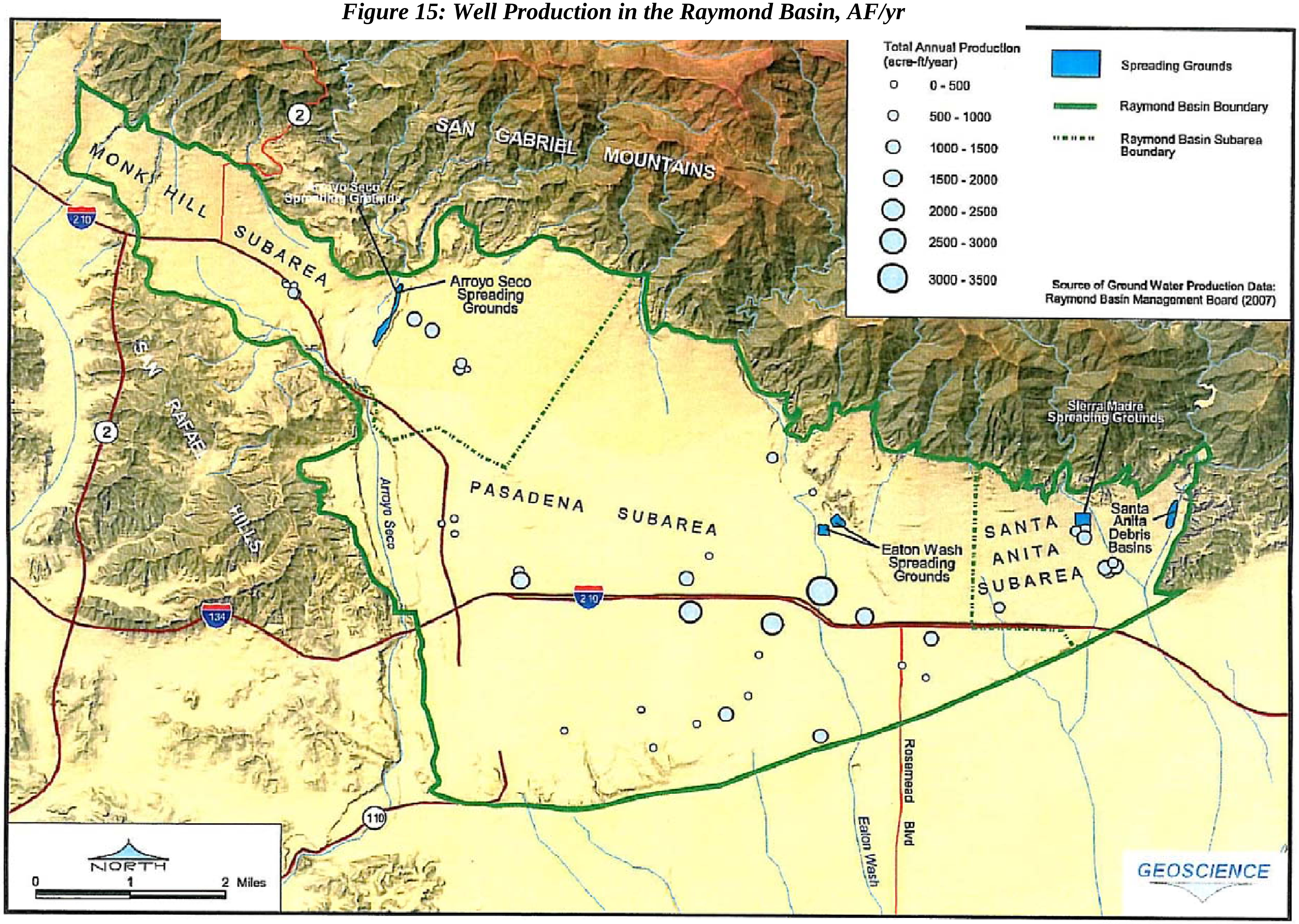
6.1.4 Recharge Projects

Recharge operations in the Raymond Basin include spreading basins and injection wells. Recharge of local and imported water takes place at the Arroyo Seco Spreading Grounds, the Eaton Wash Spreading Grounds, Sierra Madre Spreading Grounds, and Santa Anita Debris Basins. These major spreading grounds are shown in **Figure 15**. To a lesser degree, spreading also takes place at the Millard Canyon, Pasadena Glen, Pasadena Sludge Ponds and Rubio Canyon Spreading Basins. The average recharge from 1985 to 2004 was 10,000 AFY, including both spreading and injection. In FY 2006-07, 2,515 AF of spreading occurred (down from 10,972 from the previous year). The total spreading capacity in the Raymond Basin is estimated at 40,500 AFY. Three producers, Valley Water Company, the City of Pasadena, and Foothill MWD, also have facilities to inject water through dual extraction/injection wells, with a combined total injection capacity of 10,500 AFY (MWD 2007).

6.1.5 Groundwater Quality and Treatment

There is a Superfund site located at the NASA Jet Propulsion Laboratory (JPL) in Pasadena. Perchlorate and VOCs have been found in groundwater near the site. Perchloroethylene (PCE) and Tetrachloroethylene (TCE) have both been detected above their MCLs in seven wells in Monk Hill, Pasadena and Santa Anita. While treatment for VOCs and perchlorate is online in Monk Hill, seven wells in Monk Hill and Pasadena are inactive at present because of perchlorate levels. The Lincoln Avenue Water Company operates a 2,000 gpm water treatment facility for removal of VOCs and perchlorate. In 2007, another 10 MGD facility was planned for the City of Pasadena.

Figure 15: Well Production in the Raymond Basin, AF/yr



Other water quality concerns in the Raymond Basin include elevated nitrate levels in some locales; concentrations above the MCL have been detected at twelve wells in the basin. Concentrations are highest in shallow regions of the basin where previous extensive agricultural activities have taken place. The well injection program has improved nitrate levels in recent years, but some wells in Monk Hill are still blended with imported water to dilute nitrate levels.

Existing water quality issues may limit recharge opportunities in some parts of the Raymond Basin.

6.2 Basin Water Rights Governance

The Raymond Basin was adjudicated in 1955, and was the first adjudicated groundwater basin in the state of California. The current Watermaster is the Raymond Basin Management Board (RBMB). DWR, as the initial Watermaster, determined allocations among the producers according to the judgment before it was amended to name the RBMB as Watermaster in 1984.

The RBMB approves of all activities related to storage, pumping and recharge within the Raymond Basin. The Raymond Basin management Board Records and Approves the following activities:

- **Adjudicated Extractions**: The RBMB maintains records of all pumping parties and extraction wells in the basin. Allowable extractions are increased by parties that participate in spreading and injection recharge activities. Unused allowable extractions are carried over to the next year.

  Producers of Raymond Basin water include sixteen parties, the largest of which for 2006-07 were the Cities of Pasadena (13,664.3 AF extracted), Sierra Madre (3,417.8 AF extracted) and Arcadia (4,196.5 AF extracted). Other extractions over 1,000 AF were from Lincoln Avenue Water Company, Rubio Canon Land & Water Association and the California-American Water Company.
- **Storage**: Long-term Storage Accounts are maintained by the RBMB. All new accounts must be approved by the RBMB, as well as all additions to and extractions from the accounts.
- **Decreed Right Transfers and Leases**: Both storage account and extraction rights can be either leased or transferred to other parties.
- **Conjunctive Use Programs**: The RBMB participates in a Conjunctive Use program with Foothill MWD and Metropolitan Water District in which Foothill stores up to 9,000 AF of MWD water. In the future, MWD is permitted to extract up to 3,000 AFY from the basin. The RBMB has indicated support for additional Conjunctive Use Programs with MWD in the future.

The governance structure is in place in the Raymond Basin to facilitate storage of recycled water in the basin. This could potentially be accomplished through a long-term storage account established with the RBMB or leased from another party. It may also be possible to establish a conjunctive use program similar to the existing Metropolitan program. Either course of action would require interaction with the RBMB.

6.3 Existing/Planned Groundwater Replenishment Activities

No recycled water is currently used to recharge the basin and no projects are in the active planning stage. All recharge in the basin accomplished with either native runoff or imported water (MWD 2007). In 2007, the RWQCB approved water quality standards for recharge in the Raymond Basin.

Any recycled water used to recharge the basin would need to meet these standards. However, if AWT recycled water were to be used, it should be straightforward to meet water quality requirements. Existing perchlorate and VOC contamination issues in the basin may also limit recharge/extraction opportunities

According to the 2007 Metropolitan Water District Groundwater Assessment Study, the Raymond Basin's recharge capacity is under-utilized. Recycled water recharge may be possible either via:

- Conjunctive use agreements,
- Leased Long-term Storage Account space, or
- An Independent Long-term storage account.

The formalization of any arrangement would need to involve one or more parties to the Judgment and be approved by the Raymond Basin Management Board. LADWP would need to work with the Raymond Basin Management Board through one of the parties such as the City of Pasadena.

Recycled water could be supplied to Raymond Basin from LAG via a proposed pipeline or from SJCWRP via a leg of the proposed GRIP pipeline (i.e., beyond the Santa Fe Dam spreading grounds) followed by the proposed Foothill pipeline. The Central Los Angeles County Regional Recycled Water Project (CeLAC) proposes to reuse 13,500 AFY of recycled water as a partnership between Glendale Water and Power, LADWP, Pasadena Water and Power, and Foothill MWD. Approximately 6,000 AFY is planned for GWR in the Raymond Basin during winter months and irrigation at Griffith Park during summer months. The CeLAC projects were ranked highly in the Greater LA IRWMP application for Proposition 84 funding. Burbank WRP also has surplus recycled water which could be used for GWR.

Supplying recycled water to one or more parties to the Judgment for storage and recovery could be accommodated through one or more of the methods listed above.

The City of Pasadena has also indicated interest in partnering with LADWP and/or LASCD on a local satellite plant to provide recycled water to Pasadena's service area. This in-lieu replenishment would then provide LADWP with water rights in the basin. Other agencies that may be interested in a similar arrangement include the Cities of Arcadia and San Marino.

7. San Gabriel Basin Opportunities

Imported/external water spreading is limited in the San Gabriel Basin because space in the spreading basins is reserved for storm water runoff (MWD 2007); spreading is not permitted unless groundwater levels are below 250 feet MSL (MWD 2007). In addition, contamination from various chlorinated solvents and high nitrate levels limits the usability of the basin's groundwater. There are four Superfund Sites in the San Gabriel Basin (DWR Bulletin 118). Trichloroethylene, Perchloroethylene, and Carbon Tetrachloride contaminate the Whittier Narrows, Puente basin, Baldwin Park and El Monte areas of the basin (DWR 1998).

While it is unlikely that LADWP would provide recycled water to the San Gabriel Basin area, limited discussion is included in the Technical Memorandum because there are plans to provide recycled water from LACSD to the basin under the Groundwater Reliability Improvement Program (GRIP). The GRIP is a partnership between WRD, the Upper San Gabriel Valley Municipal Water

District (USGVMWD) and LACSD to develop alternative supplies to ultimately replace up to 46,000 AFY of imported water now used for groundwater replenishment in the Main San Gabriel Basin and the Central Basin. To the extent that some recycled water from LACSD is delivered to the San Gabriel Basin area, this potentially opens up more opportunity and needs for additional supply of recycled water to meet needs identified in the Central Basin as discussed below.

8. Regional Planning and Cooperation

As noted in the preceding sections, there are significant opportunities to serve recycled water to meet the regional replenishment requirements within the Central, West Coast, Main San Gabriel and Raymond groundwater basins. Moreover, there are opportunities to serve recycled water to users who rely upon groundwater and to customers of water purveyors who rely upon groundwater from the two basins. These opportunities provide a market for recycled water originating from wastewater sources of the City of Los Angeles and can also serve to improve the adequacy of water sources for the LADWP. These potential benefits derive in different ways depending upon the strategies employed.

The delivery systems employed to serve recycled water can be conceptualized as stand-alone systems originating from wastewater sources of the City of Los Angeles. But there are more efficient solutions employing interconnections of existing recycled water systems of LADWP and other agencies. The utility of these systems can only be fully described in the context of a strategy to maximize regional benefits and the specific benefits to the City of Los Angeles. Also, the physical operation of these systems must consider how to integrate wastewater sources from the City of Los Angeles with other wastewater sources.

Since the LACSD plants along the San Gabriel River produce substantial volumes of recycled water and supply multiple existing delivery systems, the potential demands for LADWP recycled water in the Central Basin and Main San Gabriel Basin areas are conceptualized as a portion of the total recycled water demand which cannot be met from existing sources. The adequacy of these sources depends upon future management of the wastewater collection system of LACSD and management of competing demands between surface delivery systems and between non potable water reuse and indirect potable reuse via replenishment delivery. The LACSD and Metropolitan are also investigating the feasibility of developing new sources of high quality water from the LACSD's Joint Water Pollution Control Plant (JWPCP). Therefore the opportunities to develop recycled water uses from wastewater sources of the City can only be described in the context of a regional plan which articulates both LACSD future recycled water uses and the future uses of the City's wastewater sources.

Articulation of a plan for the maximized use of the City's wastewater outside the boundaries of the current LADWP delivery system and outside the boundaries of the San Fernando Basin can only be accomplished through close coordination with the planning efforts of other agencies. Moreover, implementation of these strategies will require an unprecedented level of interagency cooperation.

The relative water reliability benefits to LADWP of various alternatives are listed below, from most benefit to least benefit:

- LADWP develops recycled water reuse and reduces its own use of imported water
- LADWP delivers recycled water to another agency and receives a delivery of non-imported

water in exchange

- LADWP delivers recycled water to another agency and the agency delivers imported water in exchange
- LADWP delivers recycled water to another agency without any exchange of water and that recycled water use displaces imported water
- LADWP delivers recycled water to meet the groundwater replenishment demands of another agency that is not part of the agency's allocation of imported water, but LADWP benefits from that replenishment operation
- LADWP delivers recycled water to displace current replenishment deliveries that are not part of an agency's allocation of imported water, but the replenishment does not sustain groundwater production within the City of Los Angeles (i.e., it does not benefit LADWP)

Thus, the most secure water supply benefit from options to deliver recycled water to serve demands not presently supplied by LADWP is derived when LADWP increases its supply of groundwater from the delivery of recycled water. The least secure water supply benefit is derived from the delivery of spreading water to a groundwater basin in which LADWP does not operate and has no legal standing. In such cases LADWP would need to negotiate a formal agreement with one or more of the parties to for sale or recycled water or other indirect benefit. Since the most secure options require LADWP to install new groundwater production facilities, prioritizing these opportunities requires the evaluation of new well locations and the integration of these well supplies into the distribution system of LADWP.

In order to evaluate and prioritize options, it will be necessary to develop specific plans and cost estimates for new production wells in the Central and West Coast Basins. It will also be necessary to develop a better understanding of the Metropolitan Water District (MWD) policies. There are several important venues in which this will occur:

- MWD will update its Integrated Resources Plan. This should reflect the plans of LADWP and West Basin for maximized reuse and will also include Metropolitan's aims for reuse from its study with the LACSD. The IRP will form the planning basis of numerous water policies of MWD. There are fundamental questions regarding MWD's role in maximized reuse of wastewater and its role in securing imported water for present and future demands.
- LADWP and West Basin MWD will seek LRP funding from MWD to subsidize costs for LADWP's Tier 1 development in the Harbor Area, West Basin's expansions of non potable service in the Harbor Area, and for the expansion of recycled water service to the two seawater barriers. Together these commitments would total approximately 17,000 AFY, qualifying for $4.25 million in annual subsidies, a net present value of approximately $58 million.
- LADWP and West Basin MWD would seek LRP funding for maximized reuse concepts on the order of 40,000 AFY or a $10 million annual subsidy with a net-present value of nearly $140 million.
- All member agencies will renew purchase commitments to MWD in 2013. These purchase commitments may form the basis of future drought allocations of MWD's water supplies.
- Drought allocations and water pricing structures of MWD are the subject of ongoing review

in a variety of policy venues.

- MWD may consider a regional storage project within the Central, West Coast or Main San Gabriel basins, which could be of very large scale and require substantial volumes of recycled water for recharge.

8.1 Coordination with Central Basin MWD

It is possible for LADWP to develop a supply of recycled water for recharge of the Los Angeles Forebay from its own wastewater sources via a scalper wastewater treatment plant. This plant could conceptually be large enough to supply recharge to enable Los Angeles to pump 40,000 AFY from the basin and satisfy all in-city overlying demands. It is also possible to purchase water from Central Basin MWD for an AWT to supply at least a portion of this demand.

One of the most immediate ways in which a new source of wastewater from City of Los Angeles could meet the potential future demands in Central Basin (and USGVMWD) is to connect the Central Basin MWD distribution system to a new scalper plant in the vicinity of Vernon. When such a supply would be usable from a regional perspective is uncertain. In the immediate term it may be possible to connect uses within the City of Los Angeles Metro area to the Central Basin system and supply water from the LACSD plants into the City of Los Angeles. In a later development, this supply of water could be supplemented with a new scalper plant. In a potential next step, the combined systems could be expanded to serve a new AWT for recharge of the Los Angeles Forebay. In later phases the scalper plant could supply all of the Central Basin MWD demands freeing up LACSD water for recharge projects. In the ultimate step, LADWP wastewater could be served not only to sustain the Central Basin demands but also to backfeed the Central Basin MWD system and supply water directly to the spreading areas in the Montebello Forebay and to the intake of the USGVMWD recharge system.

The timing of the new scalper plant conceptualized in this scenario could be greatly accelerated if more immediate use of recharge within the Los Angeles Forebay were pursued and if additional large users in Southgate and Vernon were connected to the Central Basin MWD system. In particular the new power plant in Vernon represents such a substantial demand that its development could dictate timing for a new scalper project. Indeed the Vernon Power Plant has a unique potential. The power plant could substantially benefit from higher quality water from an AWT, such a quality of water would allow the power plant to economically convert to zero liquid discharge and eliminate the need for an industrial discharge to the LACSD system. There would be substantial economies involved in building an AWT to serve the power plant at the same time as building an AWT to serve recharge uses in the Los Angeles Forebay.

The potential also exists to serve the new power plant in Vernon in conjunction with a project to serve other potential demands in Vernon and enable Vernon to transfer groundwater rights to LADWP. Thus Vernon is an independent decision maker and a valuable player in developing new supplies of wastewater on the Central Basin system and for regional uses within Central Basin. Since the power plant would be required by the California Energy Commission (CEC) to develop a recycled water supply and not compete with other uses of recycled water it could contribute in a unique way to an optimal solution. Moreover, the CEC policy encourages power plants to employ zero liquid discharge whenever possible. Recognizing that City of LA has historically opposed a power plant in Vernon due to environmental justice concerns, the discussions between City of Los

Angeles and Vernon regarding the water supply to the power plant are particularly complicated.

Central Basin MWD is currently contemplating award of a contract for a major portion of its recycled water system, the SWRP. Thus there is an immediate need for coordination with Central Basin MWD to develop potential supplies of recycled water for the Metro Area of LADWP. The discussions should also concern future potential. Indeed the sizing of the SEWRP is an issue in that a 42″ pipeline as originally contemplated offers substantially greater flexibility for integration with City of LA's system but a 30″ pipeline is currently out for bid.

Separate from the potential to integrate the Central Basin physical system as a part of LADWP's system to maximize future reuse of LA wastewater, Central Basin MWD is opposed to the WRD's GRIP project and is formally fighting the judgment amendments in Central Basin. The member agencies of Central Basin MWD who support the judgment amendments are planning their future uses of the groundwater basin without regard to any role for Central Basin MWD. LADWP's interests in coordinating on planning development of the groundwater basin with these entities and exploring potential projects for indirect potable reuse of City wastewater via recharge of the Central Basin for the benefit of these entities is in conflict with Central Basin MWD. At a minimum, Central Basin MWD believes that all coordination between LADWP and Central Basin MWD member units such as Golden State Water Company and California Water Service Company should be done through Central Basin MWD.

8.2 Coordination with City of Long Beach

LADWP should coordinate its recycled water planning with City of Long Beach on several levels. It is likely uneconomical for LADWP to supply recycled water from the TIWRP all the way to its Haynes Power Plant or to the Alamitos Barrier. However it is possible to connect to the City of Long Beach recycled water distribution system and potentially make water available for these uses. In particular it may be most feasible to connect the THUMS oil island demand to the TIWRP or West Basin MWD system and supply recycled water to these uses which would benefit the City of Los Angeles.

There is also consideration being given to piping water from the LACSD Los Coyotes WRP to the City of Long Beach. There is apparently 25,000 AFY of available supply from the Los Coyotes WRP which is more than adequate to meet the WRD demands at the Alamitos Barrier and potentially adequate to serve the cooling demands of the Haynes Generating Station and the AES Alamitos Generating Station.

Also, Long Beach is interested in an exchange wherein LADWP would serve recycled water demands within the Port of Long Beach and Long Beach would supply recycled water to the Haynes Generating Station. Moreover, Long Beach is perhaps the leading advocate of the Central Basin judgment amendments. LADWP's long-term aims at developing maximum potential reuse through recycled water recharge of the Central Basin are closely aligned with the interests of City of Long Beach.

There is therefore a potentially broad scope for future cooperation between the City of Long Beach and City of Los Angeles. Long Beach could potentially benefit from up to 25,000 AFY of indirect potable reuse within the Central Basin and could be critical to the supply of recycled water for LADWP's Haynes Generating Station.

8.3 Coordination with WRD

WRD has important resources which could benefit LADWP. WRD has in the past developed new wells for LADWP. The expertise on new wells is useful to LADWP. Also, WRD has a groundwater model which is needed for evaluation of all new basin management strategies and would be central to CEQA evaluations of new recharge and production facilities. WRD would have to approve any new projects proposed by LADWP under the judgment amendments. WRD has built an effective relationship with the major pumpers within the basin. The opinions of WRD's staff are important to formulating any service proposal for spreading water or injection water. WRD is service oriented and wants to help LADWP in the basin. It would consider new institutional programs such as revised in-lieu or special pumping assessments. It would consider new recharge mechanisms for its use in advance of the judgment amendment approvals. It has invited LADWP's participation in the GRIP project. LADWP needs to show a commitment to WRD to avail itself of the WRD resources and cooperation.

While the regulatory structure for additional recharge of the Central Basin is not clear it is reasonable to assume that all new recharge water would require state of the art AWT treatment. It is likely that new recharge in LA Forebay would require blending water for a period of time. Also, new mid-basin wells in the West Coast Basin could require freshwater for blending for a period of time. LADWP may want to consider ASR wells to inject freshwater for blending and as recovery wells for the longer term. Other concepts in Central Basin could include LADWP providing additional treatment of existing spreading water as a source of reducing existing wastewater influences to water quality.

Under the concepts of maximized reuse, conceptual CEQA requirements are complicated by the potential installation of new recharge facilities and new pumping facilities. In these basins, there are multiple parties who could be impacted by recharge water or new pumping. The evaluations of these impacts will require substantial time to complete. It may not be necessary to wait until the judgment amendments are approved to begin CEQA on incremental projects. It is clearly not too soon to begin groundwater modeling and initial studies related to environmental impacts of larger projects. Careful consideration of a CEQA strategy is warranted.

Incremental development of the basin under the structure that exists today may hasten future development if the amendments are approved. For example, the amendments allow recharge to fill storage without review if the facilities to accomplish recharge already exist. Creating new recharge facilities now in the Los Angeles Forebay to serve existing replenishment demands of WRD may reduce the scope of the project and the extent of CEQA review if in the future water augmentation is approved and these facilities become useful to that program. Similarly, new wells to allow increased use of well water during peak demands may in the future allow additional pumping on a more continuous basis if water augmentation is approved.

8.4 Coordination with LACSD

The LACSD supplies all recycled water presently used in areas overlying the Central Basin. The adequacy of these sources to meet the potential future needs is uncertain. In the summer months when the surface water distribution demands of the Long Beach, Cerritos, Lakewood, and Central Basin systems are highest, there is apparently inadequate supply to serve the demands of WRD and USGVMWD to meet demands for replenishment water to supplant the imported water currently used. Evaluations are underway to determine if increasing recharge uses in the winter months and discontinuing recharge in the summer would sustain these future demands.

Determination of the potential demands from LADWP wastewater sources is thus complex. Evaluation of the potential uses of LADWP supplies is best done in conjunction with an evaluation of the total uses of wastewater from existing sources. Moreover, describing the demands in AFY belies the seasonal fluctuations in demands and supplies which complicate a thorough analysis.

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Personal communication MWD with Ted Johnson, Water Replenishment District of Southern California

Appendix G

Cost Estimating Basis for Recycled Water Master Planning TM

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Technical Memorandum

Title: **Cost Estimating Basis for Recycled Water Master Planning**

Date: March 2012

Table of Contents

Attachments

Tables

Figures

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1. Introduction

The purpose of this Technical Memorandum is to describe a cost estimating basis used for the analysis of options and alternatives being developed under the City of Los Angeles Department of Water and Power's (LADWP) Recycled Water Master Plan (RWMP) for Task 1 (Groundwater Replenishment), Task 2 (Non-Potable Reuse)[1], Task 4 (Maximizing Reuse), Task 5 (Satellite Treatment), and Task 6 (Existing System Reliability). Unit costs for the following types of facilities are included in this TM:

- Treatment
- Pipelines
- Pump Stations
- Storage
- Pressure Regulating Stations
- Groundwater Wells
- Water Purchases
- Land Acquisition

For components not included in the TM, a unit cost or other estimating tool was developed.

[1] The cost estimating assumptions for non-potable customer conversions were developed under a separate TM.

2. Cost Estimating Criteria

2.1 Cost Estimate Class

The classes of cost estimates shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, are prepared for guidance in project evaluation and implementation and use the information available at the time of the estimate. The final costs of the project and resulting feasibility will depend on a variety factors, including but not limited to, actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personal, engineering, and construction phases. Therefore, the final project costs will vary from the estimate developed using the information in this document. Because of these factors, project feasibility, benefit cost/ratios, alternative evaluations, project risks, and funding needs must be carefully reviewed, prior to making specific financial decisions or establishing project budgets, to help ensure project evaluation and adequate funding.

As described in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* (PMI, 2008), cost estimates are a prediction based on information known at a given point in time and should be refined during the course of the project to reflect additional detail as it becomes available. The accuracy of the estimate should increase as the project progresses.

2.1.1 American National Standards Institute Standard Z94.0

In the late 1960s, the Association for the Advancement of Cost Engineering international (AACE) developed a guideline for cost estimate classification for the process industries. A three-part simplified version was adopted as an *American National Standards Institute (ANSI)* Standard Z94.0 in 1972. Those guidelines and standards enjoy reasonably broad acceptance within the engineering and construction communities and within the process industries. These cost estimate classes will be used for the financial and economic analysis (CH:CDM, 2003):

- Order of Magnitude Estimate
- Budget Level Estimate
- Definitive Estimate

Order of Magnitude Estimate. An order-of-magnitude estimate is made without detailed engineering data. An example includes an estimate based on cost-capacity curves.

Typically, an order-of-magnitude estimate is prepared during the design concept finalization phase, which represents a design at approximately 5 to 20 percent complete. In general, actual project costs can be expected to range from 50 percent more than to 30 percent less than the Order of Magnitude Cost Estimate.

Budget Level Estimate. The preparation of a budget estimate requires, at a minimum, the use of flow sheets, layouts, and major equipment quantity, type, and sizing details. Some examples include:

- An estimate using sketches or drawings to quantify specific facilities or processes
- An estimate using equipment cut sheets as the basis for vendor equipment quotes
- An estimate using lists of material quantities

Typically, a budget estimate is prepared at the end of the preliminary design phase, which represents a level of project definition at approximately 15 to 45 percent complete. Actual project cost can be expected to range from 30 percent more than to 15 percent less than the Budget Level Cost Estimate.

Definitive Estimate. A definitive estimate is prepared from very well defined engineering data. At a minimum, the estimator requires 85 to 95 percent complete plans and elevations, piping and instrumentation diagrams, one line electrical diagrams, equipment data sheets, vendor quotations, structural sketches, soil data, drawings of major foundations and buildings and a complete set of specifications. Some examples include:

- An estimate using equipment cut sheets as the basis for vendor equipment quotes
- An estimate using vendor or subcontractor quotes for equipment and services

Typically, a definitive estimate is prepared toward the end of the construction documents preparation (final design) phase. Actual project cost can be expected to range from 15 percent more than to 5 percent less than the Definitive Cost Estimate.

The accuracy range for each of the three cost estimate classes based on ANSI Standard Z94.0 are summarized in **Table 1**.

Table 1: ANSI Standard Z94.0 Estimate Accuracy Range

Category	Accuracy Range
Order of Magnitude	-30% to +50%
Budget Level	-15% to +30%
Definitive Cost Estimate	-5% to + 15%

Unit costs presented in this TM and RWMP cost estimates are generally Order of Magnitude estimates while Budget Level estimates will be prepared when sufficient information is available and the increased level of effort to prepare an estimate was appropriate. Unit costs developed for most of the expected project components are discussed below. In some cases, project definitions may require cost estimates for project components not identified in this TM and efforts will be made to develop a similar level of estimate based on the available information and within the scope of this study.

2.2 Cost Contingencies and Factors

2.2.1 Project Contingency

Project or program contingencies are defined as unknown or unforeseen costs. In general, higher contingencies should be applied to projects of high risk or with significant unknown or uncertain conditions. Such unknown and risk conditions for construction cost estimates could include project scope, level of project definition, occurrence of groundwater and associated dewatering uncertainties, unknown soil conditions, unknown utility conflicts, etc. Unknown conditions for operation and maintenance (O&M) cost estimates could include future energy or chemical costs. The amount of contingency applied to an estimate is typically based on the level of project definition. For planning studies, typical project contingencies can range between 20 and 50 percent for construction cost estimates and up to 30 percent for O&M cost estimates.

It is recommend an additional 30 percent for contingencies be applied to construction cost estimates based on Budget Level and Order of Magnitude estimates. No contingencies are included for O&M cost estimates since they are based off of similar LADWP facilities in operation; although, the potential for future rise in energy costs should be noted.

2.2.2 Implementation Factors

Cost factors are included to try to capture the entire capital costs associated with the implementation of the project. While these costs can vary greatly from project to project and from component to component, it is most common to assume a standard factor on the estimated construction costs across all projects and project types when analyzing alternatives and project options. In addition, it is necessary to allow for many uncertainties associated with conceptual level project definitions by applying appropriate contingencies. The following defines the typical efforts and factors for these additional services and contingencies:

- **Planning, Environmental Documentation, and Permits.** These services include the early conceptual planning, environmental documentation and permits that are often required of capital improvement projects. This factor includes pre-construction fees that may be required. The amount of effort for such services can vary greatly depending on the type, scale, and location of the project. Typical costs for such services can vary from 2 to 10 percent of the construction costs.
- **Engineering Services (Pre-Construction).** Engineering design services cover the preliminary investigations, site and route surveys, foundation exploration, and preliminary and final design phases. These services also includes plan processing (agency review and approval), and may also include the preparation of detailed cost estimates and construction/phasing schedules. The typical costs for these services vary between 8 and 15 percent of the construction costs.
- **Engineering Services during Construction.** Engineering construction support services typically include submittal and shop drawing reviews as well as minor design modifications. The typical costs for these engineering construction support services vary between 5 and 10 percent of the construction costs.
- **Construction Management and Inspection.** Costs for these services can vary greatly with project size and whether an agency performs this work with in-house staff or through a consultant. Regardless of the staffing, the costs for these services should still be accounted for and applied to the overall capital costs of the project. Typical costs for such services can vary from 5 to 10 percent of the construction costs.
- **Legal and Administrative Services.** These costs include such items as legal fees, financing expenses, general administration, and interest during construction. Typical costs for these items can vary from 1 to 15 percent of the construction costs depending on the size, complexity, and type of project.
- **Field Detail Allowance**. The Field Detail Allowance is used to account for miscellaneous and small costs that are not otherwise included in a summary of major costs components for an estimate. This factor is a specific construction cost allowance that is often applied to a

specific project component and not necessarily a project or program contingency. For the preliminary phases of a project, this factor can range from 5 to 15 percent, depending on the complexity of the project and the perceived number of individual construction components that cannot be individually accounted for at this level.

- **Market Adjustment Factor.** This factor is intended to account for the variable of cost estimating in volatile markets. This factor often varies in the same location for different type of work depending on the availability and work load for specialty contractors. Typical ranges for this factor are up to 10 percent. Issues that can affect the Market Adjustment Factor, include:
  - Busy contractors
  - Contractors selectively bidding jobs
  - Contractors selectively choosing which owners they want to do jobs for
  - Premium wages to keep skilled workers and management staff
  - Availability of crafts/trades
  - Immigration impacts and uncertainty
  - Abnormal fuel impacts and uncertainty
  - Public relations/communications, especially critical for recycled water projects
  - Availability of specialty equipment and materials
  - Local material supply availability or conditions
  - Prevailing wage/Project Labor Agreement requirements

Due to the variability in the project types, a wide range of costs is likely to exist. In addition, the services may vary from project to project depending on a variety of factors, including project complexity and need. Using the factors and contingencies listed previously, estimation of implementation costs could vary from as low as 25 percent of the estimated project construction cost to as high as 85 percent. For this study, a factor of 30 percent of the estimated project construction costs is used to account for these additional services, as summarized in **Table 2**.

Table 2: Non-Construction Cost Factor Summary

Type of Factor	Low Estimate	High Estimate
Planning, Environmental Documentation, and Permits	2%	10%
Engineering Services (Pre-Construction)	8%	15%
Engineering Services during Construction	5%	10%
Construction Management and Inspection	5%	10%
Legal and Administrative Services	1%	15%
Field Detail Allowance	5%	15%
Market Adjustment Factor	--	10%
Total	**26%**	**85%**
Recommended Implementation Factor	**30%**	

2.2.3 Other Costs

Several additional components may be needed to support the development of major recycled water supply facilities. Because most of these items are unique and project specific, they should be applied on a project-by-project basis. Therefore, no costs were included in the cost estimates identified above for the following items:

- **Maintenance Road Access.** The construction cost of maintenance roads greatly depends on the amount of cut and fill needed to complete grading and if new construction will be conducted at an existing site. Therefore, maintenance road costs should be considered if a new pump station or tank site is being developed.
- **Power Transmission Lines.** The cost of these to support a major pumping or treatment facility is often on a shared cost basis with the power utility.
- **Overall Program Management.** If the sheer magnitude of the capital cost program exceeds the capacity of agency or district staff to manage all of the work, then the services of a program management team may be required.
- **Public Information Program.** Depending on the relative public acceptability of a major facility or a group of facilities, there may be a need for a public information program, which could take many different shapes. Public Information Programs are typically handled by an agency or district's internal staff and therefore are often considered as an overhead expense. However, in some cases, outside consultants may be necessary to support a major program or project.
- **"Other" Costs.** These costs might be necessary on some projects and could include environmental mitigation and permitting costs; special legal, administrative, or financial assistance; easements or rights-of-way; expediting costs such as separate material procurement contracts. These "other" costs may be typically in the 5 to 15 percent of construction cost range.

In addition, some projects will require the purchase of land to site facilities but others are already to be located within City-owned property. For example, within the existing footprint of a treatment plant. For the RWMP, the cost to purchase land was based on recent (January 2011) sales records of vacant properties in the project area using Loopnet (www.loopnet.com). In general, a cost of $2.0 million per acre was applied if no other information was available. This was based on initial searches on Loopnet and consultation with LADWP staff. If appropriate, the LADWP Real Estate Division could provide more accurate estimates.

2.2.4 Application of Contingencies and Factors

Table 3 shows an example of how to apply the cost contingencies and markups.

Table 3: Example Application of Cost Factors

Items	Calculation	Planning Estimate
Capital Cost Factors		
A. Estimated Construction Cost Subtotal		$1,000,000
B. Construction Contingency Cost Factor (30%)	0.3 * (A)	$300,000
C. Total Construction Cost Subtotal	(A) + (B)	$1,300,000
D. Implementation Cost Factor (30%)	0.3 * (C)	$390,000
E. Total Capital Cost	**(C) + (D)**	**$1,690,000**

2.3 Engineering Economics

The following sections discuss the necessary engineering economic factors utilized as part of developing the unit costs and that will be used to analyze the estimated costs for each of the alternatives and project options. Items covered in this section are:

- ENR Index
- Inflation / Escalation
- Planning Period
- Project Financing and Discount Rate
- Useful Life of Facilities
- Lifecycle Cost Approach

2.3.1 ENR Index

To develop unit costs for the various project components, it is common to utilize previous unit cost information as well as recent project data for calibration of the derived cost curves. These historical cost data must be converted to current price levels to develop project cost estimates. The best available barometer of these changes is the *Engineering News Record's* (ENR) Construction Cost Index (CCI). This index is computed from prices of construction materials and labor and is based on a value of 100 in year 1913. Cost indices vary geographically and are dependent upon multiple variables, including labor and material markets. Los Angeles was the most applicable CCI for the RWMP. The costs in this report reflect the ENR Los Angeles CCI for January 2011 of 10,000.30.

Estimated project costs should be increased from this January 2011 dollar base to the appropriate year for future construction based on the inflation, interest, and discount rates described in the next sub-sections.

2.3.2 Inflation / Escalation

Escalation of capital and O&M costs is based on the average of annual Consumer Price Index for the last 10 years (2001 to 2011) for Los Angeles, Riverside, and Orange County, California as noted on the Bureau of Labor Statistics website on January 2011, at 2.8 percent. Escalation of recycled water purchase prices was assumed to be higher than the historical inflation rate due to several factors, including increasing scarcity and new capital investment requirements. The rates for these factors are shown in **Table 4**.

Table 4: Escalation Rates

Type of Factor	Rate
Capital and O&M Escalator	3.0%
Recycled Water Purchase Escalator	4.0%

2.3.3 Planning Period

Two planning periods are necessary for the RWMP: 1) near-term alternatives and 2) long-term alternatives. The planning period is assumed to be 50 years. The base year for near-term alternatives for the purposes of the calculations will be 2015, which is anticipated to be the start of implementation of near-term projects. The base year for long-term alternatives for the purposes of the calculations will be 2036, which is immediately after implementation of near-term projects is expected to be completed in 2035. **Table 5** summarizes the planning periods for the alternatives analysis.

Table 5: Planning Periods

Type	Duration	Period
Near-Term Alternatives	50	2015 - 2064
Long-Term Alternatives	50	2036 - 2085

2.3.4 Project Financing and Discount Rate

There are two different sets of project financing assumptions applied for near-term and long-term alternatives. The financing components include the rate to borrow money (interest rate), the payback period, and the discount rate.

Historically, LADWP has funded its recycled water projects without borrowing money. This is called the "pay-as-you-go" method that provides funding during each of the project's planning, design, and construction phases, and also for ongoing O&M costs. The near-term alternatives are also assumed to be financed by the pay-as-you-go method. No borrowing will be necessary and, therefore, there is no interest rate or payback period. However, recently LADWP decided to consider funding a portion, if not a majority, of the costs for the potential NPR projects by borrowing money through long-term financing. This will allow LADWP to leverage borrowed money to fund the program that could potentially reduce impacts to the LADWP customer's water rates. For long-term alternatives, LADWP's typical financing rate of 5.5 percent over 25 years will be applied.

The discount rate is used to bring future dollars back to a present value, reflecting the time value of money. The discount rate is generally equal to the borrowing interest rate when projects require debt financing. Since near-term alternatives require no borrowing, the discount rate was set to equal inflation only. For long-term alternatives the discount rate was set to equal the borrowing interest rate since it is anticipated that debt financing will be needed. The financing terms for near-term and long-term alternatives are shown in **Table 6**.

Table 6: Financing Terms

Type of Estimate	Interest Rate	Payback Period	Discount Rate
Near-Term Alternatives[1]	N/A[1]	N/A[1]	3%[1]
Long-Term Alternatives	5.5%	25 years	5.5%

Note:

1. The near-term alternatives were evaluated by the pay-as-you-go method considering financing with borrowing. Therefore, there is no interest rate or payback period. The inflation rate (see Section 2.3.2) will be used as the discount rate since no borrowing will occur. However, LADWP is also considering financing near-term alternatives by borrowing money long-term. This is further discussed in the NPR and GWR Master Planning Reports.

2.3.5 Useful Life of Facilities

The useful life of facilities will vary based on several factors, including: type of facility, operating conditions, design life, and maintenance upkeep. Structural components of most facilities are typically designed to last 50 years or longer. However, mechanical and electrical components tend to have a much shorter lifespan and typically require replacement or rehabilitation at regular intervals. Based on typical operating conditions and maintenance practices, an estimated percentage for each facility type is used to distinguish between the structural portions (50-year) and the mechanical and electrical portions (20-year) typical of each facility type.

Based on the 50-year planning period for facilities, components with a 20-year useful life will be replaced at 20 and 40 years and at the end of the planning period will have 10 years of useful life remaining (20 years life expectancy minus 10 years remaining planning period). **Table 7** presents the assumed useful life period splits for each type of facility.

Table 7: Useful Life of Facilities

Type of Facility	% of Capital Cost for 50-Year Life (for Structural Components)	% of Capital Cost for 20-Year Life (for Mechanical and Electrical Components)
Treatment Plant	50%	50%
Pump Station	50%	50%
Storage	90%	10%
Pipeline	100%	--
Wells – Injection and Extraction	75%	25%
Pressure Reducer	50%	50%

Note: More refined estimates of the useful life of treatment plant facilities and wells were applied when reliable information was available

2.3.6 Lifecycle Cost Approach

It is important that the selection of an engineering alternative is not based solely on the lowest initial or capital cost, but also considers all future costs over the useful life of all projects in that alternative. Lifecycle costs analysis is a standard technique used in engineering economic analyses for comparing cost-effectiveness of alternatives. It reflects both capital and O&M costs over the useful life of the alternatives. It reflects not only future inflation, but the time value of money. Because of these factors, lifecycle costs analysis was selected as the economic method to compare the costs of the alternatives.

Costs of the various alternatives will be compared by using the calculated unit lifecycle costs, which is the present value (PV) of the capital plus O&M costs over the planning period divided by the project yield over the planning period. The steps described below are used to calculate the unit lifecycle cost. Note that near-term alternative and long-term alternative have different project financing assumptions so the lifecycle cost approach. An example lifecycle cost calculation for a near-term alternative and a long-term alternative can be found in Appendix A.

Step 1: Capital Expenditures

Capital costs are estimated based on the assumptions described in Section 3 and, if applicable, may include "other costs" described in Section 2.2.3. Next, the cost contingencies and implementation factors, described in Sections 2.2.1 and 2.2.2, respectively, are applied. Capital costs are then escalated from today's (2011) dollars to the year of expenditure at the assumed annual inflation rate of 3% (per Section 2.3.2).

For near-term alternatives, the capital costs for each alternative will be spread across the assumed construction period for each project that makes up the alternative.

To simplify the number of assumptions to be made for long-term alternatives, all of the initial capital costs are assumed to be financed in Year 1 (2031). The annual payments for the initial capital will occur as defined by the borrowing rate for 25 years.

Step 2: Finance

The capital costs are financed based on the applicable terms defined in Section 2.3.4. For near-term alternatives, there is no financing since all capital and O&M costs will paid when they occur (i.e., "pay-as-you-go"). For long-term alternatives, the standard DWP borrowing rate of 5.5% for 25 years. For long-term alternatives, annual payments for capital will be estimated using the formula (PMT formula in Excel):

$$PMT = P\,\frac{r(r+1)^n}{(1+r)^n - 1}$$

Where:
PMT is the annual payment
r is the annual interest rate (in decimals, not percent). Based on interest rate above, this is equal to 0.055
n is the number of periods, equal for us to 25

Note that, if applicable, pay-as-you-go may be applied for long-term alternatives instead of borrowing capital funds.

Step 3: Replacement of Facilities

For replacement of facilities after the end of useful life, escalate the cost of replacement to the year when it's needed and apply the applicable financing terms per Step 2 (Finance).

Step 4: O&M Costs

Escalate projected O&M costs annually at the escalation rate of 3% (defined in Section 2.3.2).

Step 5: Salvage Value

Include salvage value of capital facilities in Year 50. As discussed in Section 2.3.3, facilities with a 20-year useful life will have 10 years of useful life remaining at the end of a 50-year planning period, which is 50% of its useful life. Therefore, the salvage value will be 0.5 times the capital cost in Year 50. Salvage values will be discounted from the year they are estimated with the discount rate.

Step 6: Discount Costs

Discount all costs with the discount rate (defined in Section 2.3.2) of 3% for near-term alternatives and 5.5% for long-term alternatives.

Step 7: Present Value

Calculate the PV for the project. For the PV calculations, the following formula will be applied to the series of annual payments of capital and annual O&M separately (PV formula in Excel):

$$PV = \sum_{t=1}^{T} \frac{R_t}{(1+i)^t}$$

Where:
PV is the present value
i is the discount rate (in decimals, not percent). Based on rates above, this is equal to 0.03 for near-term alternatives and 0.055 for long-term alternatives that use capital financing.
t is the sequential number of year (i.e., 2011 = 1; 2012 = 2; 2013 = 3; etc.)
R is the annual amount (annual capital payment or annual O&M expenses)

Step 8: Project Yield

Project yield is the amount of recycled water recharged or reused over the planning period. Calculate the project yield by summing the annual yield over the planning period.

Step 9: Unit Lifecycle Cost

Unit lifecycle cost ($/AF) is the present value divided by the project yield and is calculated by the formula:

$$Unit\ Lifecycle = \frac{Present\ Value}{Total\ Yield}$$

3. Construction and O&M Unit Cost Basis

Construction costs are estimated for each component based on experience with similar projects as well as standard engineering planning cost curves. Where possible, unit costs have been calibrated with historical LADWP construction estimates and cost data. Definitions of the project components are derived from the capacity information, GIS data, hydraulic model results, and other preliminary engineering available at the time of the analysis and formation of the alternatives. Basic construction costs cover the materials, equipment, labor, and services necessary to build the proposed projects or components. In addition, all unit construction costs include contractor overhead and profit, bonds & insurance, and mobilization. Unit costs given herein are not intended to present the lowest prices that can be achieved for each type for work but rather are intended to represent median prices submitted by responsible bidders or the cost of installation by LADWP or BOS crews.

Operation and Maintenance (O&M) costs are derived from experience on similar projects and standard engineering planning methods and cost curves. Where possible, costs have been calibrated using existing City of Los Angeles Bureau of Sanitation (BOS) and LADWP data, including data on power costs, labor rates, etc. Operating costs are defined as labor, material, equipment, and outside services necessary for routine operating functions. Outside services include electric power and chemicals. Maintenance expenses include all costs associated with the routine servicing and repair of facilities required on an annual basis.

Unit costs for the following types of facilities are included in this TM:[2]

- Treatment Plants
  - Tertiary Treatment – Conventional Filtration
  - Tertiary Treatment – Membrane Bioreactor
  - Advanced Treatment – Microfiltration, Reverse Osmosis, Advanced Oxidation
  - Advanced Treatment After MBR – Reverse Osmosis, Advanced Oxidation
- Pipelines
- Pump Station
  - Product Water
  - Influent Wastewater
- Storage Facilities
  - Distribution System Tanks
  - Wastewater Equalization Basins
- Pressure Regulating Stations
- Groundwater Wells – Injection and Production
- Water Purchases - Imported and Recycled

[2] The cost estimating approach for non-potable customer conversions was developed under a separate TM.

All facilities are expected to be constructed under the traditional contracting approach of design-bid-build. Facilities constructed by LADWP crews would not require the bid step.

References for both construction and O&M costs are identified for each type of facility. A common resource throughout cost estimating was CDM Constructors, Inc. (CDMCI). CDMCI is the construction contracting arm of CDM. They employ estimators that have a database of costs from previous projects, quotes from vendors, etc.

3.1 Treatment Plants

Costs will be developed for expansion of existing facilities and construction of new tertiary treatment facilities with influent raw wastewater. For the purposes of the RWMP, expansion of existing facilities assume use of similar conventional filtration processes and construction of new (satellite) tertiary treatment plants assumes the use of membrane bioreactors (MBR). Tertiary treatment plant development assumes the intake of raw wastewater so the cost estimates include wastewater intake, primary treatment, and secondary treatment in addition to tertiary treatment.

Costs will be developed for expansion of existing and construction of new advanced water purification facilities (AWPF). For the purposes of the RWMP, an AWPF is assumed to take secondary or tertiary product and treat with microfiltration (MF) followed by reverse osmosis (RO), disinfection with ultraviolet light (UV), and advanced oxidation with hydrogen peroxide (AOP). If the AWPF source water is from MBR, then the MF step can be excluded.

Layouts for treatment plant expansions at existing City plants considered existing site constraints and, when appropriate, costs were added for items such as building demolition and multi-story facility construction. New treatment plants assumed the purchase of land. Land costs were discussed in Section 2.2.3.

Note that this section does not address product water pump stations and equalization storage.

3.1.1 Tertiary Treatment – Conventional Filtration

Construction Costs

The unit construction costs for the expansion of tertiary treatment plants primarily referenced the following:

- Novato Sanitary District (NSD) Treatment Plant bid results (2009): Upgrade existing 7 million gallon per day (mgd) wastewater treatment facilities. Upgrades included influent pump station, headworks, primary sedimentation, activated sludge process, UV disinfection, gravity belt thickeners, anaerobic digestion, odor control, electrical distribution system, and SCADA control system.

Expansion of existing tertiary treatment plants will use existing facilities to support new production capacity to the greatest extent possible. Therefore, cost estimates for the expansion will include line items for the necessary components to achieve new production capacity. These components include headworks, influent pump station, primary sedimentation tanks, aeration tanks and blowers, secondary clarifiers, tertiary media filtration, and UV disinfection. The processes are sized to be consistent with existing treatment plant operations. The primary unit construction cost basis for these estimates is the NSD Treatment Plant bid results.

O&M Costs

The conventional treatment plant O&M unit cost is based on the Los Angeles-Glendale WRP actual operating costs, escalated to January 2011, and is approximately $0.28 per gallon of production capacity.

3.1.2 Tertiary Treatment – Membrane Bioreactor

New satellite treatment plant construction assumes MBR technology. The construction costs for the new MBR plants primarily referenced CDMCI, which is the construction contracting arm of CDM.

Construction Costs

The unit cost of MBR varies based on size of the plant with economies of scale realized with bigger plants. Based on a survey of MBR construction costs and CDMCI, the following production capacity unit costs were developed for a satellite MBR plant:

- Less than 1 MGD: $12 per gallon
- Between 1 and 10 MGD: $10 per gallon
- Greater than 10 MGD: $8 per gallon

In addition, CDMCI will develop cost estimates for ancillary facilities such as buildings, yard piping, pumps, etc. when necessary on a project-specific basis.

O&M Costs

The MBR O&M costs are based on average costs of existing MBR plants from CDMCI, escalated to January 2011, which are approximately $0.30 per gallon of production capacity.

3.1.3 Advanced Treatment – Microfiltration, Reverse Osmosis, Advanced Oxidation

The unit costs estimates for the construction and operation of AWPFs or Advanced Water Treatment Facilities (AWTFs) (MF/RO/AOP) primarily referenced:

- Orange County Water District (OCWD) Groundwater Replenishment System (GWRS) Advanced Water Purification Facility (AWPF) bid results (March 2004): The AWPF produces up to 70 mgd of product water after treating secondary wastewater with MF/RO/UV. Referenced O&M costs were from 2008.
- Donald C Tillman Water Reclamation Plant (DCT) Advanced Treatment System Basis of Design Criteria and Cost Estimate TM (CH:CDM, June 2006): Prepared for a 15.6 mgd AWPF at DCT using the CH2M HILL Parametric Cost Estimating System.
- Terminal Island Water Reclamation Plant (TIWRP) Advanced Water Treatment Facility (AWTF) bid results (May 2001): The TIWRP AWTF receives tertiary water with higher than typical TDS (~3,000 mg/L) and applies MF/RO, lime, and chloramination. The design capacity is 5 mgd.

The cost references were used as applicable to the various proposed sites for AWPFs and AWTFs. For example, the DCT estimate was used for DCT AWPF alternatives and TIWRP estimate was applied for TIWRP AWTF alternatives.

Construction Costs

The OCWD GWRS AWPF bid results, escalated to January 2011, resulted in a unit cost of approximately $4.1 per gallon of product water capacity, excluding buildings, structural, architectural, excavation/backfill/ compaction items for buildings and structures. This estimate is the starting basis for new AWPFs at HTP.

The DCT Cost Estimate TM, escalated to January 2011, resulted in a unit cost of approximately $5.3 per gallon of product water capacity for a generic site layout. This estimate is the basis for new AWPF at DCT and VGS. Development of site-specific AWPFs at DCT and VGS may require the addition of building demolition, new buildings, and additional yard piping.

The TIWRP AWTF bid results excluding equalization, escalated to January 2011, resulted in a unit cost of approximately $7.4 per gallon of product water capacity. This estimate is used as the basis for expanding the AWTF at TIWRP. The unit construction cost was higher than the other estimates due to the need for deep foundations / vibroflotation and lack of economies of scale. To be conservative, the relatively high unit cost will be applied as the AWTF expansion unit cost until the initial AWTF components that could benefit an expanded TIWRP are identified.

CDMCI will develop cost estimates for ancillary facilities such as buildings, yard pipe, pumps, etc. that were not included in the referenced projects when necessary on a project-specific basis.

O&M Costs

The OCWD GWRS AWPF actual annual operating costs, escalated to January 2011, are approximately $0.54 per gallon of treatment capacity, which is equivalent to $1.61 per 1,000 gallons of product water assuming a 92 percent online factor. This estimate is used for the new AWPF at HTP and for expanding the AWTF at TIWRP.

The DCT Cost Estimate TM, escalated to January 2011, resulted in an annual O&M cost of approximately $0.40 per gallon of treatment capacity, excluding power costs, which is equivalent to $1.19 per 1,000 gallons of product water assuming a 92 percent online factor. This estimate is the basis for new AWPF at DCT and VGS. Once power costs were added to the base O&M costs, the total O&M is approximately $0.57 per gallon of treatment capacity, which is equivalent to $1.70 per 1,000 gallons of product water assuming a 92 percent online factor. O&M cost for the AWPF at VGS is slightly higher at $0.59 per gallon of treatment capacity, which is equivalent to $1.76 per 1,000 gallons of product water assuming a 92 percent online factor, due to higher levels of NMDA formation as a result of longer traveling time.

3.1.4 Advanced Treatment after MBR – Reverse Osmosis, Advanced Oxidation

Construction Costs

Construction costs for a satellite AWTF located downstream of an MBR facility are assumed to not include additional MF treatment since the MBR process already includes an MF step. Therefore, the DCT Cost Estimate TM, excluding line items associated with MF, is used as the basis for satellite AWTF. This reduces the unit cost to $3.7 per gallon, which is approximately a 30% reduction compared to treating water from a secondary or conventional tertiary treatment plant.

O&M Costs

The DCT Cost Estimate TM is used as the O&M cost basis for satellite AWTF, which is $0.57 per gallon, which is equivalent to $1.70 per 1,000 gallons of product water assuming a 92 percent online factor. However, O&M cost should be lower than an AWPF facility with MF/RO/AOP since MF treatment is not required at the satellite AWTF because it is downstream of an MBR facility.

3.2 Pipelines

3.2.1 Construction Costs

Costs for pipe sizes ranging from 6 to 60 inches in diameter and 96 inches diameter and greater were developed for use in the study. The construction costs are estimated for a wide range of conditions that exist in the study area. Costs are developed for trenched pipelines (6" to 60" diameter) as well as tunneled pipelines (96" diameter and greater).

The unit costs represent both open-cut and trenchless pipelines constructed mostly in normal soils, with depths of cover typically less than 10 feet. They are consistent with construction that includes only minor surface restoration and minor surface and subsurface interference. These unit costs assume that the pipelines will be operating at pressures up to about 200 pounds per square inch (psi). These cost estimates include material and installation, normal appurtenances, and paving replacement.

Pipeline unit cost varies based on size with economies of scale realized with bigger pipes (in the range considered). Based on representative LADWP projects, the following unit costs were developed for pipeline installed via open-cut construction:

- $24/inch-diameter/LF for 6" and 8" diameter pipe
- $20/inch-diameter/LF for 10" and 12" diameter pipe
- $18/inch-diameter/LF for 16" and 20" diameter pipe
- $16/inch-diameter/LF for 24", 30", 36", 42", 54", and 60" diameter pipe

LADWP projects consist of both open-cut and trenchless construction methods (boring and jacking, directional drilling, and bridge hanging). Pipeline costs can be extremely varied depending on pipe size and site conditions. These costs include crossing of freeways, highways, major intersections, railroads, rivers, streams, and canals.

Tunneling is assumed for pipelines with 96" diameter or greater at a unit cost of $35/diameter inch/linear foot. Tunneling costs include casings as well as shafts. This unit cost is based on cost estimates from the East Bay Municipal Utility District's Wet Weather Infrastructure Improvements Studies TM (RMC/MWH, 2007).

Note that no land-acquisition costs are included as it is assumed that the pipelines would generally be constructed within the public street right-of-ways, which would not require any land acquisition.

3.2.2 O&M Costs

The O&M costs account only for the annual inspection and maintenance of the pipelines within the distribution system. The costs for pipelines up to 60" diameter are estimated to be approximately $0.6 per LF on an annual basis based on representative LADWP projects.

Annual O&M costs for tunneling pipelines, greater than 90" diameter, are assumed to be 0.5 percent of construction costs.

3.3 Pump Stations

3.3.1 Product Water Pump Station

Construction Costs

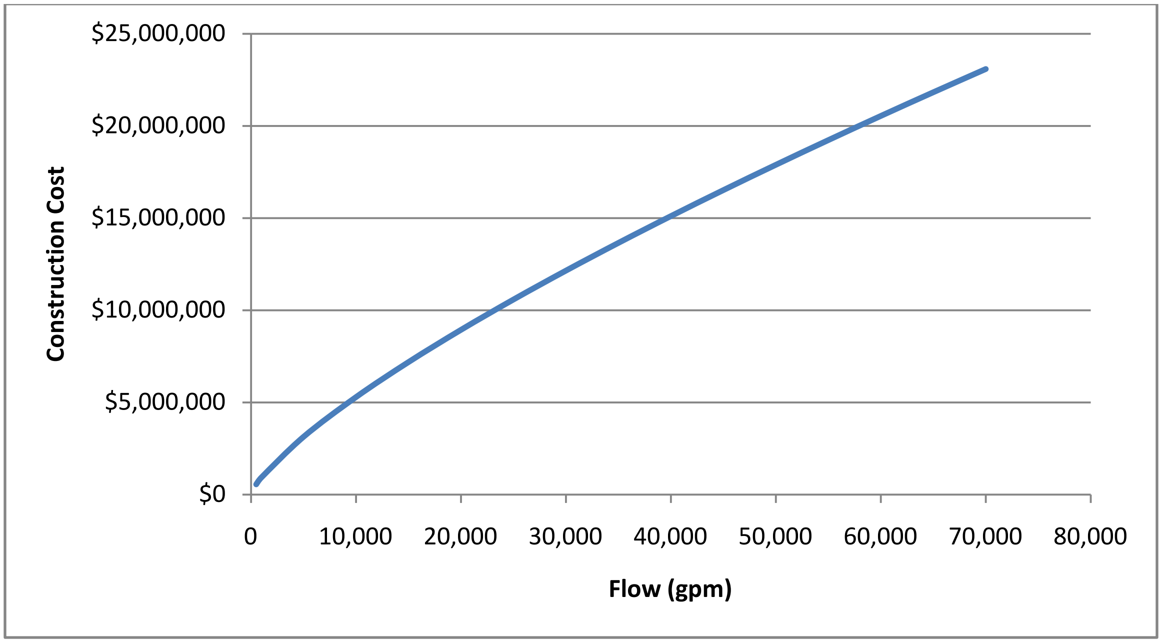
The pump stations cost curve shown in **Figure 1** was developed using the construction cost curves from Pumping Station Design (Sanks et al., 1989). The original Sanks equation has a reference ENR CCI of 4,500 and was modified with an ENR factor of 10,000.3 to determine the estimated cost in January 2011 dollars. The curve was also adjusted based on recent engineering bids for representative LADWP Recycled Water projects.

Pump Station Project Cost ($) = 3.12 x 10^(0.7583*log(Q)+3.1951)

Where:
Q = Flow rate in gallons per minute (gpm); Maximum flow rate

Costs for stations can vary greatly depending on the architectural design, pump type, location, pumping head, and station capacity. As many of these factors will not be defined during this phase of the study, this unit cost curve will apply to all stations. However, note that land acquisition and easement costs are not included.

Figure 1: Pump Stations Construction Cost Curve



O&M Costs

O&M costs include labor, equipment replacement, and electrical power usage.

O&M Excluding Electricity

Annual expenditures for labor and equipment replacement are based on the initial construction cost of the pump station. The following equation is used to estimate the annual O&M labor and equipment replacement costs ($O\&M_{LE}$) for each pump station:

Annual $O\&M_{LE}$ = $10,000 + 5 percent of construction costs

Electrical Costs

Electrical costs for pumping are estimated by applying the average flow for the network over a 24-hour period of operation. Many of the demands are landscaping areas where water is applied during the night hours when electrical rates are lower. In addition, some demands, like surface reservoirs, groundwater basins, and large industrial users, would receive water on a continuous basis throughout the day. Electrical costs are computed assuming an electricity cost of $0.12/kilowatt-hour (kw-hr) and by using the following equations:

$$\text{Annual electrical cost} = \$0.12 \times hp_{ave} \times 24 hrs/day \times 365 days/year \times 0.7457 \frac{kw-hr}{hp}$$

Where:

$$hp_{ave} = \text{the average brake horsepower} = \frac{Q_{avg}\left[AFY\right]/1.613 \times (H)}{3956} \times \frac{1}{0.75}$$

Where:

Q_{avg} = annual average flow in AFY
H = total head (including friction loss) in feet

3.3.2 Influent Wastewater Pump Station

Construction Costs

Construction costs for an influent wastewater pump station were estimated using the Novato Sanitary District Wastewater Facility Upgrade influent pump station 95 percent cost estimate. The influent pump station was designed for a peak flow capacity of 47 mgd with a discharge head of 42 feet. Total construction costs of $1.8M includes site work, concrete, metals, finishes, equipment, mechanical, and tax on materials. The total cost does not include contractor's overhead/profit, construction staging contingency, or design contingency. This cost estimate was prepared using January 2005 ENR CCI.

Based on this reference cost, escalated to January 2011, the unit cost is $41,000 per MG of capacity.

O&M Costs

For the purposes of the RWMP, annual O&M costs for influent pump stations are assumed to be the same as product water pump station. Refer to the O&M Costs section under Section 3.3.1 for influent pump stations O&M costs.

3.4 Storage Facilities

3.4.1 Distribution System Tank

Construction Costs

Typical recycled water storage capacities range from 0.50 million gallons (MG) to 5 MG. Based on representative LADWP projects, the following unit costs were developed for storage:

- Less than 0.75 MG: $4 per gallon
- Between 0.75 and 1.5 MG: $3 per gallon
- Greater than 1.5 MG: $2 per gallon

LADWP projects include mobilization, architectural features, structural components, coatings, concrete foundation, typical site improvements including minor grading, and mechanical, electrical, and instrumentation requirements. Tanks are assumed to be concrete and partially buried. Costs due to extensive grading, blasting, rock removal, and special construction related to unusual seismic conditions are not included and should be considered as part of the project contingencies without further information.

3.4.2 O&M Costs

Annual O&M costs for diurnal storage tanks are estimated to be approximately $75,000 per tank based on representative LADWP projects.

3.4.3 Wastewater Equalization Basins

Construction Costs

The cost for wastewater equalization basins was estimated as $1.50 per gallon based on cost estimates from East Bay Municipal Utility District's Wet Weather Infrastructure Improvements Studies TM (RMC/MWH, 2007). This includes mobilization, excavation, sheeting and shoring, dewatering, cast in place concrete, piles, piping/appurtenances, pump station, 84" force main and traffic control.

The size, shape, and depth of the storage basins were pre-designed and costs included excavation, concrete, and mechanical costs from several recent bids. Costs assume a structural load bearing roof to allow parking, etc.

3.4.4 O&M Costs

Annual O&M costs for equalization basins are assumed to be 0.5 percent of construction costs.

3.5 Pressure Regulating Stations

3.5.1 Construction Costs

Unit construction costs for pressure regulating stations were based on professional experience since no comparable estimates were available from LADWP and are shown in **Table 8**. These costs include the station vault, grading, miscellaneous piping and valves, fencing, landscaping, instrumentation, controls and the pressure regulating valve.

Table 8: Unit Construction Costs for Pressure Regulating Stations

Sizes by Diameter (in)	$/Station
8 or less	$220,000
9 to 12	$300,000
13 to 24	$350,000
25 to 32	$600,000

3.5.2 O&M Costs

The O&M costs account only for the annual inspection and maintenance of the pressure regulating stations. These costs are estimated to be approximately $20,000 per year based on representative LADWP projects.

3.6 Groundwater Wells

Construction and O&M costs were developed for both groundwater injection and production wells.

3.6.1 Construction Costs

The construction costs for groundwater injection production wells were estimated at $2 million per well for a depth of 1,000 feet and capacity of 1,000 gpm. Construction costs includes drilling the new well, installing pumping equipment, pressure reducing valves, pump control and relief valves, and flow meters. The estimate is based on professional experience and was substantiated by Water Replenishment District staff. LADWP has not installed any wells recently so unit costs were not available from that organization.

3.6.2 O&M Costs

A traditional well rehabilitation/redevelopment includes the following steps: pulling and inspecting the pump; video log; spinner log; zone sample; mechanical rehabilitation; chemical rehabilitation; pump to waste; another video log; re-install the original pump; disinfection; and waste disposal. Costs can be highly variable, from several tens of thousands of dollars to over $100,000, depending on the amount of rehabilitation (WRD, 2005).

Based on professional experience and comparison with recently installed facilities, injection wells are assumed to have a pump maintenance cost of $75,000 per well every ten years and a redevelopment cost of $100,000 per well every five years. A pump is needed in the injection wells to regularly pump waste and clean the well. This is usually performed once a day to once a week and is necessary to maintain injection rates. As a result of this usage, injection wells have a frequent redevelopment schedule of once every five years.

Based on professional experience and comparison with recently installed facilities, production wells are assumed to have a pump maintenance cost of approximately $100,000 every 10 years and a redevelopment cost of $100,000 per well every ten years.

3.7 Water Purchases

Water purchase costs were developed for imported water from Metropolitan Water District of Southern California (MWD) and for recycled water from purveyors outside of the City. In addition, revenues from the sale of recycled water to purveyors outside the City were developed. The estimated costs are described in the following sections.

3.7.1 Imported Water Purchases

LADWP purchases imported water from MWD under both Tier 1 and Tier 2 treated water rates. MWD sells a limited amount of Tier 1 imported water to each of its contractors (such as LADWP) and, once this allotment is met, the contractor must purchase more expensive Tier 2 supplies. Based on LADWP's Urban Water Management Plan (UWMP) (May 2011), LADWP plans to stay within their Tier 1 allotment throughout the projected period (through 2035). As a result, the three alternatives for expanding recycled water to 50,000 AFY were compared to the cost of MWD Tier 1 imported water and subsequently to achieve the UWMP goals of 59,000 AFY. For the purpose of this comparison, LADWP developed water purchase costs for MWD Tier 1 imported water.

MWD rates have increased significantly over the last 10 years. The increases are highly volatile, ranging from a low of 2.3% to a high of over 21%. This makes estimating rates into the future very difficult. Additionally, MWD only provides rate forecasts to 2020 and we need to plan well beyond that, into the 2060s.

Recent discussions between LADWP and MWD established that the most realistic estimate of future costs of MWD water, beyond current MWD rate projections through 2020, would escalate an average of 5%. This then established a present value unit cost of $1,370 per AF for near-term projects and $1,800/af for long-term projects.

3.7.2 Recycled Water Purchases

Table 9 presents the costs to purchase or acquire recycled water from other agencies that are being considered as part of the alternatives analysis. These costs shown are the current known costs for year 2010 only. Purchase water costs for LADWP from many of these agencies could increase in the future, depending on contract terms and conditions.

Table 9: Recycled Water Purchase Costs

Entity	Treatment Plant	Unit Cost ($/AF)	Notes
Burbank WP	Burbank WRP	$0	Based on LADWP purchase agreement with Burbank Water and Power; includes exchange of groundwater rights
Central Basin MWD	San Jose Creek WRP	$500	Based on preliminary meetings between LADWP and Central Basin WMD staff
Las Virgenes MWD	Tapia WRF	$500	Based on preliminary pending discussions with Las Virgenes MWD regarding service conditions and the need for facility upgrades / additions
West Basin MWD – Nitrified	Carson Regional WRF	$800	Based on LADWP purchase agreement with West Basin MWD
West Basin MWD – Tertiary	Edward Little WRF	$728	Based on West Basin MWD FY 2010-11 Water Rates and Charges

4. Summary Tables

Table 10 and **Table 11** summarize the unit construction and O&M costs.

Table 10: Construction Costs Summary

Category		Item	Unit Construction Cost
Treatment Plants			
	Tertiary - Conventional Filtration	To be developed by component	
	Tertiary - MBR	< 1 MGD	$12/gallon
		1 - 10 MGD	$10/gallon
		> 10 MGD	$8/gallon
	AWTF (MF/RO/AOP)	DCT Reference	$5.2/gallon
		OCWD Reference	$4.1/gallon
		TIWRP Reference	$7.4/gallon
	AWTF (RO/AOP)	Downstream of MBR	$3.7/gallon
Pipelines			
	By Diameter	6" and 8"	$24/in-dia/LF
		10" and 12"	$20/in-dia/LF
		16" and 20"	$18/in-dia/LF
		24", 30", 36", 42", 54", 60"	$16/in-dia/LF
		96" and greater	$35/in-dia/LF
Pump Stations			
	Product Water	Cost based on formula (Section 3.2)	
	Influent Wastewater	Capacity (mgd)	$40,900/mgd
Storage Facilities			
	Distribution System Tanks	< 0.75 MG	$4/gallon
		0.75 – 1.5 MG	$3/gallon
		> 1.5 MG	$2/gallon
	Wastewater Equalization Basin		$1.5/gallon
Pressure Regulating Stations			
		8" or less	$220,000/Station
		9" to 12"	$300,000/Station
		13" to 24"	$350,000/Station
		25" to 32"	$600,000/Station
Groundwater Wells			
	Injection Well		$2M/well
	Production Well		$2M/well
Water Purchases			N/A
Land Acquisition			$2M/acre

Note: All costs are in January 2011 dollars

Table 11: O&M Costs Summary

Category	Unit O&M Cost	
Treatment Plants		
Tertiary – Conventional Filtration	$0.28/gallon of treatment capacity	
Tertiary – MBR	$0.30/gallon of treatment capacity	
AWTF (MF/RO/AOP)	$0.54 to $0.59/gallon of treatment capacity	
AWTF (RO/AOP)	$0.57/gallon of treatment capacity	
Pipelines		
Up to 60" Diameter	$0.6/LF	
Tunneling (≥ 96" Diameter)	0.5% of construction costs	
Pump Stations		
O&M	$10,000 + 5% of construction costs	
Electricity	$0.12/KW-hr	
Storage Facilities		
Distribution System Tanks	$75,000 per tank	
Wastewater Equalization Basin	0.5% of construction costs	
Pressure Regulating Stations		
All sizes	$20,000 per station	
Groundwater Wells	Injection Wells	Production Wells
Pump Maintenance	$75,000 every 10 yrs	$100,000 every 10 yrs
Redevelopment of Wells	$100,000 every 5 yrs	$100,000 every 10 yrs
Water Purchases		
Imported Water	(See Section 3.7.1)	
Recycled Water	(See Section 3.7.2)	
Land Acquisition	N/A	

Note: All costs are in January 2011 dollars

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Attachment A

Example Lifecycle Cost Calculations

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ASPECT:	**Near-Term Alternatives Evaluation**	Date:	January 18, 2012
DESCRIPTION:	**Net Present Value Estimate**		**Annual Yield**
SUPPLY:	**EXAMPLE FOR COST ESTIMATING BASIS TM**		9,650

Item	Qty	Units	Unit Cost	Cost
Capital Costs				
Capital Facilities				
AWTF				
NPR Pump Station				$ 5,400,000
NPR Storage				$ 14,600,000
NPR Pipeline				$ 95,500,000
NPR Customers				$ -
			Construction Subtotal	**$ 115,500,000**
		Contingency Costs	30%	$ 34,700,000
			Construction Total	**$ 150,200,000**
		Implementation Costs	30%	$ 45,100,000
			Total Capital Cost (January 2011)	**$ 195,300,000**
20-Year Useful Life				
AWTF			estimated	
NPR Pump Station			50%	$ 2,700,000
NPR Storage			10%	$ 1,460,000
			Construction Subtotal	**$ 4,160,000**
		Contingency Costs	30%	$ 1,200,000
			Construction Total	**$ 5,360,000**
		Implementation Costs	30%	$ 1,600,000
			Total Capital Cost (January 2011)	**$ 6,960,000**
Post-Construction O&M Costs ($ / Year)				
AWTF				
NPR				$ 1,400,000
GWR Groundwater Extraction	15,000	AFY	$0	$ -
GWR GW Extraction & Treatment	15,000	AFY	$0	$ -
			O&M Cost Subtotal	**$ 1,400,000**
		Contingencies	0%	$ -
			Total O&M	**$ 1,400,000**
Recycled Water Purchase ($ / Year)				
			Purchase Cost Total	**$ 3,100,000**

PV Calculations			
Inflation / Discount Rate		50-Year Life	$ 188,140,000
Construction Escalator	3.0%	20-Year Life	$ 6,960,000
Water Purchase Escalator	4.0%		
Discount Rate	3.0%	Annual O&M	$ 1,400,000
Financing Costs		Annual Purchase	$ 3,100,000
Interest Rate	**PAY-GO**	Annual Yield (AFY)	9,650
Period	50	Total Yield (AF)	381,175

No.	Calendar Year	Capital Finance 1	O&M Cost	Purchase Cost	Total Cost	Total Yield (AF)
0	2011	0	0	0	0	0
9	2020	25,456,125	0	0	25,456,125	0
10	2021	26,219,809	188,148	458,876	26,866,833	965
11	2022	27,006,403	387,585	954,462	28,348,450	1,930
12	2023	27,816,595	598,820	1,488,960	29,904,374	2,895
13	2024	28,651,093	822,379	2,064,691	31,538,163	3,860
14	2025	29,510,626	1,058,813	2,684,098	33,253,537	4,825
15	2026	30,395,944	1,308,693	3,349,755	35,054,392	5,790
16	2027	31,307,823	1,572,612	4,064,369	36,944,804	6,755
17	2028	32,247,057	1,851,189	4,830,793	38,929,040	7,720
18	2029	33,214,469	2,145,066	5,652,028	41,011,563	8,685
19	2030	0	2,454,908	6,531,232	8,986,141	9,650
20	2031	0	2,528,556	6,792,482	9,321,037	9,650
21	2032	0	2,604,412	7,064,181	9,668,593	9,650
22	2033	0	2,682,545	7,346,748	10,029,293	9,650
23	2034	0	2,763,021	7,640,618	10,403,639	9,650
24	2035	0	2,845,912	7,946,243	10,792,155	9,650
25	2036	0	2,931,289	8,264,093	11,195,382	9,650
26	2037	0	3,019,228	8,594,656	11,613,884	9,650
27	2038	0	3,109,805	8,938,443	12,048,247	9,650
28	2039	0	3,203,099	9,295,980	12,499,079	9,650
29	2040	0	3,299,192	9,667,820	12,967,011	9,650
30	2041	0	3,398,167	10,054,532	13,452,700	9,650
31	2042	0	3,500,112	10,456,714	13,956,826	9,650
32	2043	0	3,605,116	10,874,982	14,480,098	9,650
33	2044	18,460,253	3,713,269	11,309,981	33,483,504	9,650
34	2045	0	3,824,667	11,762,381	15,587,048	9,650
35	2046	0	3,939,407	12,232,876	16,172,283	9,650
36	2047	0	4,057,590	12,722,191	16,779,781	9,650
37	2048	0	4,179,317	13,231,079	17,410,396	9,650
38	2049	0	4,304,697	13,760,322	18,065,019	9,650
39	2050	0	4,433,838	14,310,735	18,744,572	9,650
40	2051	0	4,566,853	14,883,164	19,450,017	9,650
41	2052	0	4,703,858	15,478,491	20,182,349	9,650
42	2053	0	4,844,974	16,097,630	20,942,604	9,650
43	2054	0	4,990,323	16,741,535	21,731,859	9,650
44	2055	0	5,140,033	17,411,197	22,551,230	9,650
45	2056	0	5,294,234	18,107,645	23,401,879	9,650
46	2057	0	5,453,061	18,831,950	24,285,012	9,650
47	2058	0	5,616,653	19,585,228	25,201,881	9,650
48	2059	0	5,785,153	20,368,638	26,153,790	9,650
49	2060	0	5,958,707	21,183,383	27,142,090	9,650
50	2061	0	6,137,468	22,030,718	28,168,187	9,650
51	2062	0	6,321,592	22,911,947	29,233,540	9,650
52	2063	0	6,511,240	23,828,425	30,339,665	9,650
53	2064	(180,253,641)	6,706,577	24,781,562	(148,765,501)	9,650
	PV	**$ 159,642,718**	**$ 53,689,320**	**$ 165,581,250**	**$ 378,913,289**	**381,175**

Total PV	**$ 378,913,289**
Project Yield (AF)	**381,175**
Unit Cost ($/AF)	**$990**

ASPECT:	**Long-Term Project Concepts Evaluation**	Date:	January 18, 2012	
DESCRIPTION:	**Net Present Value Estimate**		**Annual Yield**	
SUPPLY:	**EXAMPLE FOR COST ESTIMATING BASIS TM**		50,000	

Item		Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
HTP (Phase 1-2 completed)		50,000	AFY	$5,200	$ 260,000,000	
EQ Storage		0	gallons	$1.5	$ -	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
HTP to WCB	54	31,680	in-dia*LF	$16	$ 27,400,000	
Pump Station						
Pump Station at HTP		31,000	gpm	formula	$ 12,400,000	
Pump Station at WCB Wells		31,000	gpm	formula	$ 12,400,000	
Land Purchase		0.5	acres	$2,000,000	$ 1,000,000	Land purchase assumed for all off-site PS
Groundwater Recharge						
Injection Wells at WB		35	wells	$2,000,000	$ 70,000,000	
Land Purchase		4.0	acres	$2,000,000	$ 8,100,000	
Production Wells						
Production Wells at WB		35	wells	$2,000,000	$ 70,000,000	
Land Purchase		4.0	acres	$2,000,000	$ 8,100,000	
Well Head Treatment		50,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
WCB Wells later:	10	35,000	in-dia*LF	$20	$ 7,000,000	
WCB to DWP	54	21,120	in-dia*LF	$16	$ 18,200,000	
				Construction Subtotal	**$ 494,600,000**	
			Contingency Costs	30%	$ 148,400,000	
				Construction Total	**$ 643,000,000**	
			Implementation Costs	30%	$ 192,900,000	
				Total Capital Cost (Jan 2011)	**$ 835,900,000**	
20-Year Useful Life						
Treatment (Product Water)				63%	$ 164,400,000	
EQ Storage				10%	$ -	
Conveyance				0%	$ -	
Pump Station				50%	$ 12,400,000	
Groundwater Recharge Equipment				25%	$ 17,500,000	
Production Wells Equipment				25%	$ 17,500,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 211,800,000**	
			Contingency Costs	30%	$ 63,500,000	
				Construction Total	**$ 275,300,000**	
			Implementation Costs	30%	$ 82,600,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 357,900,000**	
O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
HTP (Phase 1-2 completed)		50,000	AFY	$480	$ 24,000,000	
EQ Storage		$0	LS	0.5%	$ -	
Distribution Storage		0	LS	$75,000	$ -	
Conveyance		31,680	LF	$0.60	$ 19,000	
Pump Station						
Pump Station at HTP		$10,000	LS	5.0%	$ 630,000	
Electrical Cost		5,577,100	kWh (Qavg)	$0.12	$ 669,000	
Pump Station at WCB Wells		$10,000	LS	5.0%	$ 630,000	
Electrical Cost		2,466,300	kWh (Qavg)	$0.12	$ 296,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost						
Power West Coast		50,000	AFY	$102	$ 5,117,000	Pumps to 100 psi (tb confirmed)
Distribution						
WCB Wells lateral		35,000	LF	$0.60	$ 21,000	
WCB to DWP		21,120	LF	$0.60	$ 13,000	
				Total Annual O&M	**$ 31,400,000**	

Item	Qty	Units	Unit Cost	Cost	Notes
10-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Pump Maintenance	35	wells	$75,000	$ 2,625,000	
Production Wells					
Pump Maintenance	35	wells	$100,000	$ 3,500,000	
Redevelopment of Wells	35	wells	$100,000	$ 3,500,000	
			Total 10-Year O&M	**$ 9,625,000**	
5-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Redevelopment of Wells	35	wells	$100,000	$ 3,500,000	
			Total 5-Year O&M	**$ 3,500,000**	
Recycled Water Purchase ($ / Year)					Assumes no blend requirement at project startup
	50,000		**Purchase Cost Total**	**$ -**	

NPV Calculations

Inflation / Discount Rate		Initial Capital Cost	$ 835,900,000
Construction/O&M Escalator	3.0%	20-Year Life	$ 357,900,000
Water Purchase Escalator	4.0%	Annual O&M	$ 31,400,000
Discount Rate	5.5%	10-Year O&M	$ 9,625,000
Financing Costs		5-Year O&M	$ 3,500,000
Interest Rate	**5.5%**	Annual Purchase	$ -
Period	25	Annual Yield (AFY)	50,000
Yield Period	50	Total Yield (AF)	2,500,000

No.	Calendar Year	Capital Finance 1	Capital Finance 2	Capital Finance 3	O&M Annual Cost	O&M 10-Year Cost	O&M 5-Year Cost	Total Cost
1	2011	$ -	$ -	$ -	0	0	0	0
25	2035	$ -	$ -	$ -	0	0	0	0
26	2036	$ 134,389,719	$ -	$ -	67,716,966	0	0	202,106,685
27	2037	$ 134,389,719	$ -	$ -	69,748,475	0	0	204,138,194
28	2038	$ 134,389,719	$ -	$ -	71,840,929	0	0	206,230,648
29	2039	$ 134,389,719	$ -	$ -	73,996,157	0	0	208,385,876
30	2040	$ 134,389,719	$ -	$ -	76,216,042	0	0	210,605,761
31	2041	$ 134,389,719	$ -	$ -	78,502,523	0	8,750,281	221,642,523
32	2042	$ 134,389,719	$ -	$ -	80,857,599	0	0	215,247,318
33	2043	$ 134,389,719	$ -	$ -	83,283,326	0	0	217,673,045
34	2044	$ 134,389,719	$ -	$ -	85,781,826	0	0	220,171,545
35	2045	$ 134,389,719	$ -	$ -	88,355,281	0	0	222,745,000
36	2046	$ 134,389,719	$ -	$ -	91,005,939	27,895,929	10,143,974	263,435,562
37	2047	$ 134,389,719	$ -	$ -	93,736,118	0	0	228,125,837
38	2048	$ 134,389,719	$ -	$ -	96,548,201	0	0	230,937,920
39	2049	$ 134,389,719	$ -	$ -	99,444,647	0	0	233,834,366
40	2050	$ 134,389,719	$ -	$ -	102,427,987	0	0	236,817,706
41	2051	$ 134,389,719	$ -	$ -	105,500,826	0	11,759,646	251,650,192
42	2052	$ 134,389,719	$ -	$ -	108,665,851	0	0	243,055,570
43	2053	$ 134,389,719	$ -	$ -	111,925,827	0	0	246,315,546
44	2054	$ 134,389,719	$ -	$ -	115,283,601	0	0	249,673,320
45	2055	$ 134,389,719	$ -	$ -	118,742,109	0	0	253,131,828
46	2056	$ 134,389,719	$ 103,924,493	$ -	122,304,373	37,489,796	13,632,653	411,741,033
47	2057	$ 134,389,719	$ 103,924,493	$ -	125,973,504	0	0	364,287,716
48	2058	$ 134,389,719	$ 103,924,493	$ -	129,752,709	0	0	368,066,921
49	2059	$ 134,389,719	$ 103,924,493	$ -	133,645,290	0	0	371,959,502
50	2060	$ 134,389,719	$ 103,924,493	$ -	137,654,649	0	0	375,968,861
51	2061	$ -	$ 103,924,493	$ -	141,784,288	0	15,803,981	261,512,762
52	2062	$ -	$ 103,924,493	$ -	146,037,817	0	0	249,962,310
53	2063	$ -	$ 103,924,493	$ -	150,418,952	0	0	254,343,444
54	2064	$ -	$ 103,924,493	$ -	154,931,520	0	0	258,856,013
55	2065	$ -	$ 103,924,493	$ -	159,579,466	0	0	263,503,958
56	2066	$ -	$ 103,924,493	$ -	164,366,850	50,383,151	18,321,146	336,995,639
57	2067	$ -	$ 103,924,493	$ -	169,297,855	0	0	273,222,348
58	2068	$ -	$ 103,924,493	$ -	174,376,791	0	0	278,301,284
59	2069	$ -	$ 103,924,493	$ -	179,608,095	0	0	283,532,587
60	2070	$ -	$ 103,924,493	$ -	184,996,337	0	0	288,920,830
61	2071	$ -	$ 103,924,493	$ -	190,546,228	0	21,239,229	315,709,949
62	2072	$ -	$ 103,924,493	$ -	196,262,614	0	0	300,187,107
63	2073	$ -	$ 103,924,493	$ -	202,150,493	0	0	306,074,986
64	2074	$ -	$ 103,924,493	$ -	208,215,008	0	0	312,139,500
65	2075	$ -	$ 103,924,493	$ -	214,461,458	0	0	318,385,951
66	2076	$ -	$ 103,924,493	$ 187,699,194	220,895,302	67,710,741	24,622,088	604,851,817
67	2077	$ -	$ 103,924,493	$ 187,699,194	227,522,161	0	0	519,145,847
68	2078	$ -	$ 103,924,493	$ 187,699,194	234,347,825	0	0	525,971,512
69	2079	$ -	$ 103,924,493	$ 187,699,194	241,378,260	0	0	533,001,947
70	2080	$ -	$ 103,924,493	$ 187,699,194	248,619,608	0	0	540,243,295
71	2081	$ -	$ -	$ 187,699,194	256,078,196	0	28,543,748	472,321,138
72	2082	$ -	$ -	$ 187,699,194	263,760,542	0	0	451,459,736
73	2083	$ -	$ -	$ 187,699,194	271,673,358	0	0	459,372,552
74	2084	$ -	$ -	$ 187,699,194	279,823,559	0	0	467,522,753
75	2085	$ -	$ -	$ (1,454,869,554)	288,218,266	0	0	(1,166,651,288)
	NPV	**$ 472,727,293**	**$ 125,289,118**	**$ 13,959,713**	**$ 496,173,513**	**$ 11,742,741**	**$ 9,721,820**	**$ 1,129,614,198**
								$450

Appendix H

Long-Term Project Concepts Costs Details

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ASPECT:	**Long-Term Project Concepts Evaluation**	Date:	March 21, 2012
DESCRIPTION:	**Net Present Value Estimate**		**Annual Yield**
SUPPLY:	**Va - LVMWD to DCTWRP to SF Basin Spreading Grounds**		2,000

	Item	Qty	Units	Unit Cost		Cost	Notes
Capital Costs							
Capital Facilities							
Treatment (Product Water)							
DCTWRP AWP (Cost TM)		4,000	AFY	$4,600	$	18,400,000	Source flow only occurs during 6 months of winter. This equals 5,000 AFY of source water and 4,000 AFY of yield for 6 months, a peaking factor of 2 for the annual yield
EQ Storage		0	gallons	$1.5	$	-	
Distribution Storage							
No Tank is needed		0	MG	$0	$	-	
Conveyance	Diam (in)	Length (ft)					
LVMWD to DCTWRP	16	42,240	in-dia*LF	$18	$	12,200,000	Assumes flow (5,000 AFY) occurs over 6 months only.
DCTWRP to SF Basin S.G.	16	42,240	in-dia*LF		$	-	Have capacity in Ex. 54" Assumes flow (4,000 AFY) occurs over 6 months only.
Pump Station							
Pump Station at LVMWD Connection		0	gpm	formula	$	-	Assumes flow provided at City boundary at pressure; assumes flow (5,000 AFY) occurs over 6 months only.
Pump Station at DCTWRP		2,480	gpm	formula	$	1,800,000	Assumes flow (4,000 AFY) occurs over 6 months only.
Groundwater Recharge							
Spreading Grounds		0	acre	$23,900	$	-	Existing SG
Land Purchase		0	acre	$1,000,000	$	-	
Production Wells							
Production Wells		2	wells	$2,000,000	$	4,000,000	Assumes flow (2,000 AFY) occurs over 12 months.
Land Purchase		0.2	acre	$1,000,000	$	200,000	
Well Head Treatment		2,000	AFY	$0	$	-	
Distribution	Diam (in)	Length (ft)					
SF Basin S.G. to DWP	10	2,000	in-dia*LF	$20	$	400,000	
				Construction Subtotal	**$**	**37,000,000**	
			Contingency Costs	30%	$	11,100,000	
				Construction Total	**$**	**48,100,000**	
			Implementation Costs	30%	$	14,400,000	
				Total Capital Cost (Jan 2011)	**$**	**62,500,000**	
20-Year Useful Life							
Treatment (Product Water)				50%	$	9,200,000	
EQ Storage				10%	$	-	
Conveyance				0%	$	-	
Pump Station				50%	$	900,000	
Groundwater Recharge Equipment				25%	$	-	
Production Wells Equipment				25%	$	1,000,000	
Distribution				0%	$	-	
				Construction Subtotal	**$**	**11,100,000**	
			Contingency Costs	30%	$	3,330,000	
				Construction Total	**$**	**14,430,000**	
			Implementation Costs	30%	$	4,300,000	
				Total 20-year Capital Cost (Jan 2011)	**$**	**18,730,000**	

O&M Costs					
Annual O&M Costs ($/Year)					
Treatment (Product Water)					
DCTWRP AWP (Cost TM)	2,000	AFY	$500	$ 1,000,000	Assumes flow (2,000 AFY) occurs over 12 months.
EQ Storage	0	LS	0.5%	$ -	
Distribution Storage	0	LS	$75,000	$ -	
Conveyance	84,480	LF	$0.60	$ 51,000	
Pump Station					
Pump Station at LVMWD Connection	$10,000	LS - base cost	5.0%	$ -	
Electrical Cost	0	kWh (Qavg)	$0.12	$ -	
Pump Station at DCTWRP	$10,000	LS - base cost	5.0%	$ 100,000	
Electrical Cost	962,000	kWh (Qavg)	$0.12	$ 115,000	Assumes flow (2,000 AFY) occurs over 12 months.
Groundwater Recharge Land Cost					
Spreading Grounds	0	LS	$100,000	$ -	Assumes ongoing existing maintenance
Production Wells Land Cost					
Power Valley	2,000	AFY	$102	$ 205,000	Assumes flow (2,000 AFY) occurs over 12 months.
Distribution					
SF Basin S.G. to DWP	2,000	LF	$0.60	$ 1,000	
			O&M Cost Subtotal	**$ 1,470,000**	
		Contingencies	0%	$ -	
			Total Annual O&M	**$ 1,470,000**	
10-Year Periodic O&M Costs ($/Year)					
Production Wells					
Pump Maintenance	2	wells	$100,000	$ 200,000	
Redevelopment of Wells	2	wells	$100,000	$ 200,000	
			Total 10-Year O&M	**$ 400,000**	
5-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Redevelopment of Wells	0	well	$100,000	$ -	
			Total 5-Year O&M	**$ -**	

Recycled Water Purchase ($ / Year)				
DCTWRP		AFY	$0	$ -
LAGWRP		AFY	$0	$ -
HTP		AFY	$0	$ -
West Basin - Nitrified (Harbor)		AFY	$800	$ -
West Basin - Tertiary (West/Metro)		AFY	$550	$ -
West Basin - AWP		AFY	$1,000	$ -
Central Basin MWD		AFY	$500	$ -
San Gabriel Valley MWD		AFY	$600	$ -
Burbank WP		AFY	$0	$ -
Las Virgenes MWD	2,500	AFY	$500	$ 1,250,000
	2,500		**Purchase Cost Total**	**$ 1,250,000**

Recycled Water Sell ($ / Year)				
DCTWRP - Tertiary		AFY	$500	$ -
DCTWRP - AWP		AFY	$1,000	$ -
LAGWRP - Tertiary		AFY	$500	$ -
	-		**Selling Cost Total**	**$ -**

Economic Cost Summary				
Present Value Calculations		PV Factor		
Initial Capital Cost	$ 62,500,000	0.566	$ 35,345,682	
20-Year Capital Costs	$ 18,730,000	0.389	$ 7,287,317	
Annual O&M Costs	$ 1,470,000	15.802	$ 23,228,505	
10-Year Periodic O&M	$ 400,000	1.220	$ 488,010	
5-Year Periodic O&M	$ -	2.778	$ -	
Recycled Water Purchase	$ 1,250,000	24.782	$ 30,977,638	
Recycled Water Sell	$ -	-24.782	$ -	
		Total PV	**$ 97,327,153**	
		50-year Project Yield (AF)	**100,000**	Assumes no blend requirement at project startup
		Unit Cost ($/af)	**$970**	

ASPECT:	**Long-Term Project Concepts Evaluation**	Date:	March 21, 2012
DESCRIPTION:	**Net Present Value Estimate**		**Annual Yield**
SUPPLY:	**Vb - Burbank to DCTWRP to SF Basin Spreading Grounds**		4,000

	Item	Qty	Units	Unit Cost		Cost	Notes
Capital Costs							
Capital Facilities							
Treatment (Product Water)							
DCTWRP AWP (Cost TM)		8,000	AFY	$4,600	$	36,800,000	Source flow only occurs during 6 months of winter. This equals 10,000 AFY of source water and 8,000 AFY of yield for 6 months, a peaking factor of 2 for the annual yield.
EQ Storage		0	gallons	$1.5	$	-	
Distribution Storage							
No Tank is needed		0	MG	$0	$	-	
Conveyance	Diam (in)	Length (ft)					
Upsize		26,400	in-dia*LF	$0	$	-	Upsize 16" to 24" From XX to XX Assumes flow (10,000 AFY) occurs over 6 months only.
BWP to DCTWRP	24	42,240	in-dia*LF	$16	$	16,200,000	Assumes flow (10,000 AFY) occurs over 6 months only.
DCTWRP to SF Basin S.G.	24	52,800	in-dia*LF		$	-	Assumes flow (8,000 AFY) occurs over 6 months only. Have capacity in Ex. 54"
Pump Station							
Pump Station at BWP Connection		0	gpm	formula	$	-	Assumes flow provided at City boundary with pressure
Pump Station at DCTWRP		4,960	gpm	formula	$	3,100,000	Assumes flow (8,000 AFY) occurs over 6 months only.
Groundwater Recharge							
Spreading Grounds		0	acre	$23,900	$	-	Existing SG
Land Purchase		0	acre	$1,000,000	$	-	
Production Wells							
Production Wells		3	wells	$2,000,000	$	6,000,000	Assumes flow (4,000 AFY) occurs over 12 months.
Land Purchase		0.3	acre	$1,000,000	$	300,000	
Well Head Treatment		4,000	AFY	$0	$	-	
Distribution	Diam (in)	Length (ft)					
SF Basin S.G. to DWP	10	3,000	in-dia*LF	$16	$	500,000	
				Construction Subtotal	**$**	**62,900,000**	
			Contingency Costs	30%	$	18,900,000	
				Construction Total	**$**	**81,800,000**	
			Implementation Costs	30%	$	24,500,000	
				Total Capital Cost (Jan 2011)	**$**	**106,300,000**	
20-Year Useful Life							
Treatment (Product Water)				50%	$	18,400,000	
EQ Storage				10%	$	-	
Conveyance				0%	$	-	
Pump Station				50%	$	1,600,000	
Groundwater Recharge Equipment				25%	$	-	
Production Wells Equipment				25%	$	1,500,000	
Distribution				0%	$	-	
				Construction Subtotal	**$**	**21,500,000**	
			Contingency Costs	30%	$	6,500,000	
				Construction Total	**$**	**28,000,000**	
			Implementation Costs	30%	$	8,400,000	
				Total 20-year Capital Cost (Jan 2011)	**$**	**36,400,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
DCTWRP AWP (Cost TM)	4,000	AFY	$500	$	2,000,000	
EQ Storage	0	LS	0.5%	$	-	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	95,040	LF	$0.60	$	57,000	
Pump Station						
Pump Station at BWP Connection	$10,000	LS	5.0%	$	-	
Electrical Cost	0	kWh (Qavg)	$0.12	$	-	
Pump Station at DCTWRP	$10,000	LS	5.0%	$	165,000	
Electrical Cost	3,847,900	kWh (Qavg)	$0.12	$	462,000	
Groundwater Recharge Land Cost						
Spreading Grounds	0	LS	$100,000	$	-	Assumes ongoing existing maintenance
Production Wells Land Cost						
Power Valley	4,000	AFY	$102	$	409,000	Assumes flow (4,000 AFY) occurs over 12 months.
Distribution						
SF Basin S.G. to DWP	3,000	LF	$0.60	$	2,000	
			O&M Cost Subtotal	**$**	**3,100,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**3,100,000**	
10-Year Periodic O&M Costs ($/Year)						
Production Wells						
Pump Maintenance	3	wells	$100,000	$	300,000	
Redevelopment of Wells	3	wells	$100,000	$	300,000	
			Total 10-Year O&M	**$**	**600,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	0	well	$100,000	$	-	
			Total 5-Year O&M	**$**	**-**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP		AFY	$0	$	-	
HTP		AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP	10,000	AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	10,000		**Purchase Cost Total**	**$**	**-**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	
Economic Cost Summary						
Present Value Calculations			PV Factor			
Initial Capital Cost	$ 106,300,000		0.566	$	60,115,936	
20-Year Capital Costs	$ 36,400,000		0.389	$	14,162,217	
Annual O&M Costs	$ 3,100,000		15.802	$	48,985,283	
10-Year Periodic O&M	$ 600,000		1.220	$	732,015	
5-Year Periodic O&M	$ -		2.778	$	-	
Recycled Water Purchase	$ -		24.782	$	-	
Recycled Water Sell	$ -		-24.782	$	-	
			Total PV	**$**	**123,995,452**	
			50-year Project Yield (AF)		**200,000**	project startup
			Unit Cost ($/af)		**$620**	

ASPECT:	**Long-Term Project Concepts Evaluation**	Date:	March 21, 2012
DESCRIPTION:	**Net Present Value Estimate**		**Annual Yield**
SUPPLY:	**Vc - LAGWRP to DCTWRP to SF Basin Spreading Grounds**		22,000

	Item	Qty	Units	Unit Cost		Cost	Notes
Capital Costs							
Capital Facilities							
Treatment (Product Water)							
LAGWRP Existing		10,000	AFY	$3,000	$	30,000,000	Source flow only occurs during 6 months of winter.
LAGWRP Expansion 1		8,000	AFY	$3,000	$	24,000,000	Source flow occurs during all year.
LAGWRP Expansion 2		14,500	AFY	$3,000	$	43,500,000	Source flow occurs during all year.
DCTWRP AWP (Cost TM)		25,000	AFY	$4,600	$	115,000,000	Source flow includes 6 months of winter. This equals 32,500 AFY of source water and 25,000 AFY of yield for 6 months.
EQ Storage		0	gallons	$1.5	$	-	
Distribution Storage							
No Tank is needed		0	MG	$0	$	-	
Conveyance	Diam (in)	Length (ft)					
LAGWRP to DCTWRP	42	79,200	in-dia*LF	$16	$	53,200,000	Assumes flow (32,500 AFY) occurs over 6 months only.
DCTWRP to SF Basin S.G.	24	52,800	in-dia*LF		$	-	Assumes flow (25,000 AFY) occurs over 6 months only. Have capacity in Ex. 54"
Pump Station							
Pump Station at LAGWRP		20,150	gpm	formula	$	9,000,000	Assumes flow (32,500 AFY) occurs over 6 months only.
Pump Station at DCTWRP		15,500	gpm	formula	$	7,400,000	Assumes flow (25,000 AFY) occurs over 6 months only.
Groundwater Recharge							
Spreading Grounds		0	acre	$23,900	$	-	Existing SG
Land Purchase		0	acre	$1,000,000	$	-	
Production Wells							
Production Wells		16	wells	$2,000,000	$	32,000,000	Assumes flow (22,000 AFY) occurs over 12 months.
Land Purchase		1.8	acres	$1,000,000	$	1,800,000	
Well Head Treatment		22,000	AFY	$0	$	-	
Distribution	Diam (in)	Length (ft)					
SF Basin S.G. to DWP	10	16,000	in-dia*LF	$20	$	3,200,000	
				Construction Subtotal	**$**	**319,100,000**	
			Contingency Costs	30%	$	95,700,000	
				Construction Total	**$**	**414,800,000**	
			Implementation Costs	30%	$	124,400,000	
				Total Capital Cost (Jan 2011)	**$**	**539,200,000**	
20-Year Useful Life							
Treatment (Product Water)				50%	$	106,300,000	
EQ Storage				10%	$	-	
Conveyance				0%	$	-	
Pump Station				50%	$	8,200,000	
Groundwater Recharge Equipment				25%	$	-	
Production Wells Equipment				25%	$	8,000,000	
Distribution				0%	$	-	
				Construction Subtotal	**$**	**122,500,000**	
			Contingency Costs	30%	$	36,800,000	
				Construction Total	**$**	**159,300,000**	
			Implementation Costs	30%	$	47,800,000	
				Total 20-year Capital Cost (Jan 2011)	**$**	**207,100,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
LAGWRP Existing	27,500	AFY	$260	$	7,150,000	
DCTWRP AWP (Cost TM)	22,000	AFY	$500	$	11,000,000	
EQ Storage	0	LS	0.5%	$	-	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	132,000	LF	$0.60	$	79,000	
Pump Station						
Pump Station at LAGWRP	$10,000	LS	5.0%	$	460,000	
Electrical Cost	17,273,300	kWh (Qavg)	$0.12	$	2,073,000	
Pump Station at DCTWRP	$10,000	LS	5.0%	$	380,000	
Electrical Cost	12,025,300	kWh (Qavg)	$0.12	$	1,443,000	
Groundwater Recharge Land Cost						
Spreading Grounds	0	LS	$100,000	$	-	
Production Wells Land Cost						
Power Valley	22,000	AFY	$102	$	2,251,000	Assumes flow (22,000 AFY) occurs over 12 months.
Distribution						
SF Basin S.G. to DWP	16,000	LF	$0.60	$	10,000	
			O&M Cost Subtotal	**$**	**24,850,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**24,850,000**	
10-Year Periodic O&M Costs ($/Year)						
Production Wells						
Pump Maintenance	16	wells	$100,000	$	1,600,000	
Redevelopment of Wells	16	wells	$100,000	$	1,600,000	
			Total 10-Year O&M	**$**	**3,200,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	0	well	$100,000	$	-	
			Total 5-Year O&M	**$**	**-**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP	27,500	AFY	$0	$	-	
HTP		AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	27,500		**Purchase Cost Total**	**$**	**-**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	
Economic Cost Summary						
Present Value Calculations			PV Factor			
Initial Capital Cost	$ 539,200,000		0.566	$	304,934,270	
20-Year Capital Costs	$ 207,100,000		0.389	$	80,576,789	
Annual O&M Costs	$ 24,850,000		15.802	$	392,672,351	
10-Year Periodic O&M	$ 3,200,000		1.220	$	3,904,080	
5-Year Periodic O&M	$ -		2.778	$	-	
Recycled Water Purchase	$ -		24.782	$	-	
Recycled Water Sell	$ -		-24.782	$	-	
			Total PV	**$**	**782,087,490**	
			50-year Project Yield (AF)		**1,100,000**	Assumes no blend requirement at project startup
			Unit Cost ($/af)		**$710**	

ASPECT:	Long-Term Project Concepts Evaluation	Date:	March 21, 2012	
DESCRIPTION:	Net Present Value Estimate		Annual Yield	
SUPPLY:	Vd - LAGWRP to AWP to Raymond Basin New Wells		22,000	*Assumes imported offset can be arranged.*

	Item	Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
LAGWRP Existing		10,000	AFY	$3,000	$ 30,000,000	Source flow only occurs during 6 months of winter.
LAGWRP Expansion 1		8,000	AFY	$3,000	$ 24,000,000	Source flow occurs during all year.
LAGWRP Expansion 2		14,500	AFY	$3,000	$ 43,500,000	Source flow occurs during all year.
Advanced Treatment (Cost TM)		25,000	AFY	$4,600	$ 115,000,000	Source flow includes 6 months of winter. This equals 32,500 AFY of source water and 25,000 AFY of yield for 6 months.
EQ Storage		3,240,000	gallons	$1.5	$ 4,860,000	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
LAGWRP to AWP	42	42,240	in-dia*LF	$16	$ 28,400,000	Assumes flow (32,500 AFY) occurs over 6 months only.
AWP to Raymond Basin	24	15,840	in-dia*LF	$16	$ 6,100,000	Assumes flow (25,000 AFY) occurs over 6 months only.
Pump Station						
Pump Station at LAGWRP		20,150	gpm	formula	$ 9,000,000	Assumes flow (32,500 AFY) occurs over 6 months only.
Pump Station at AWP		15,500	gpm	formula	$ 7,400,000	Assumes flow (25,000 AFY) occurs over 6 months only.
Groundwater Recharge						
Injection Wells		18	wells	$2,000,000	$ 36,000,000	Injection wells must handle slightly higher flows in winter.
Land Purchase		2.1	acres	$1,000,000	$ 2,100,000	
Production Wells						
Production Wells		16	wells	$2,000,000	$ 32,000,000	Production wells handle constant flows all year around.
Land Purchase		1.8	acres	$1,000,000	$ 1,800,000	
Well Head Treatment		22,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
RB to DWP	10	16,000	in-dia*LF	$20	$ 3,200,000	
				Construction Subtotal	**$ 343,360,000**	
			Contingency Costs	30%	$ 103,008,000	
				Construction Total	**$ 446,368,000**	
			Implementation Costs	30%	$ 133,900,000	
				Total Capital Cost (Jan 2011)	**$ 580,268,000**	
20-Year Useful Life						
Treatment (Product Water)				50%	$ 106,300,000	
EQ Storage				10%	$ -	
Conveyance				0%	$ -	
Pump Station				50%	$ 8,200,000	
Groundwater Recharge Equipment				25%	$ 9,000,000	
Production Wells Equipment				25%	$ 8,000,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 131,500,000**	
			Contingency Costs	30%	$ 39,450,000	
				Construction Total	**$ 170,950,000**	
			Implementation Costs	30%	$ 51,300,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 222,250,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
LAGWRP Existing	27,500	AFY	$260	$	7,150,000	
Advanced Treatment(Cost TM)	22,000	AFY	$500	$	11,000,000	
EQ Storage	4,860,000	LS	0.5%	$	24,000	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	58,080	LF	$0.60	$	35,000	
Pump Station						
Pump Station at LAGWRP	$10,000	LS	5.0%	$	460,000	
Electrical Cost	19,986,300	kWh (Qavg)	$0.12	$	2,398,000	
Pump Station at AWP	$10,000	LS	5.0%	$	380,000	
Electrical Cost	3,480,000	kWh (Qavg)	$0.12	$	418,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost				.		
Power Valley	22,000	AFY	$102	$	2,251,000	Assumes flow (22,000 AFY) occurs over 12 months.
Distribution						
RB to DWP	16,000	LF	$0.60	$	10,000	
			O&M Cost Subtotal	**$**	**24,130,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**24,130,000**	
10-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Pump Maintenance	18	wells	$75,000	$	1,350,000	
Production Wells						
Pump Maintenance	16	wells	$100,000	$	1,600,000	
Redevelopment of Wells	16	wells	$100,000	$	1,600,000	
			Total 10-Year O&M	**$**	**4,550,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	18	wells	$100,000	$	1,800,000	
			Total 5-Year O&M	**$**	**1,800,000**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP	32,500	AFY	$0	$	-	
HTP		AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	32,500		**Purchase Cost Total**	**$**	**-**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	

Economic Cost Summary						
Present Value Calculations			PV Factor			
Initial Capital Cost	$	580,268,000	0.566	$	328,159,493	
20-Year Capital Costs	$	222,250,000	0.389	$	86,471,229	
Annual O&M Costs	$	24,130,000	15.802	$	381,295,123	
10-Year Periodic O&M	$	4,550,000	1.220	$	5,551,114	
5-Year Periodic O&M	$	1,800,000	2.778	$	4,999,793	
Recycled Water Purchase	$	-	24.782	$	-	
Recycled Water Sell	$	-	-24.782	$	-	
			Total PV	**$**	**806,476,753**	
			50-year Project Yield (AF)		**1,100,000**	Assumes no blend requirement at project startup
			Unit Cost ($/af)		**$730**	

ASPECT:	**Long-Term Project Concepts Evaluation**			Date:	March 21, 2012		
DESCRIPTION:	**Net Present Value Estimate**				**Annual Yield**		
SUPPLY:	**MWa - HTP to WCB Wells**				50,000		

	Item	Qty	Units	Unit Cost	Cost		Notes
Capital Costs							
Capital Facilities							
Treatment (Product Water)							
HTP (Phase 1-2 completed)		50,000	AFY	$5,200	$	260,000,000	
EQ Storage		0	gallons	$1.5	$	-	
Distribution Storage							
No Tank is needed		0	MG	$0	$	-	
Conveyance	Diam (in)	Length (ft)					
HTP to WCB	54	31,680	in-dia*LF	$16	$	27,400,000	
Pump Station							
Pump Station at HTP		31,000	gpm	formula	$	12,400,000	
Pump Station at WCB Wells		31,000	gpm	formula	$	12,400,000	
Land Purchase		0.5	acres	$2,000,000	$	1,000,000	Land purchase assumed for all off-site PS
Groundwater Recharge							
Injection Wells at WB		35	wells	$2,000,000	$	70,000,000	
Land Purchase		4.0	acres	$2,000,000	$	8,100,000	
Production Wells							
Production Wells at WB		35	wells	$2,000,000	$	70,000,000	
Land Purchase		4.0	acres	$2,000,000	$	8,100,000	
Well Head Treatment		50,000	AFY	$0	$	-	
Distribution	Diam (in)	Length (ft)					
WCB Wells lateral	10	35,000	in-dia*LF	$20	$	7,000,000	
WCB to DWP	54	21,120	in-dia*LF	$16	$	18,200,000	
				Construction Subtotal	**$**	**494,600,000**	
			Contingency Costs	30%	$	148,400,000	
				Construction Total	**$**	**643,000,000**	
			Implementation Costs	30%	$	192,900,000	
				Total Capital Cost (Jan 2011)	**$**	**835,900,000**	
20-Year Useful Life							
Treatment (Product Water)				63%	$	164,400,000	
EQ Storage				10%	$	-	
Conveyance				0%	$	-	
Pump Station				50%	$	12,400,000	
Groundwater Recharge Equipment				25%	$	17,500,000	
Production Wells Equipment				25%	$	17,500,000	
Distribution				0%	$	-	
				Construction Subtotal	**$**	**211,800,000**	
			Contingency Costs	30%	$	63,500,000	
				Construction Total	**$**	**275,300,000**	
			Implementation Costs	30%	$	82,600,000	
				Total 20-year Capital Cost (Jan 2011)	**$**	**357,900,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
HTP (Phase 1-2 completed)	50,000	AFY	$480	$	24,000,000	
EQ Storage	$0	LS	0.5%	$	-	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	31,680	LF	$0.60	$	19,000	
Pump Station						
Pump Station at HTP	$10,000	LS	5.0%	$	630,000	
Electrical Cost	5,577,100	kWh (Qavg)	$0.12	$	669,000	
Pump Station at WCB Wells	$10,000	LS	5.0%	$	630,000	
Electrical Cost	2,466,300	kWh (Qavg)	$0.12	$	296,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost						
Power West Coast	50,000	AFY	$102	$	5,117,000	Pumps to 100 psi
Distribution						
WCB Wells lateral	35,000	LF	$0.60	$	21,000	
WCB to DWP	21,120	LF	$0.60	$	13,000	
			O&M Cost Subtotal	**$**	**31,400,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**31,400,000**	
10-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Pump Maintenance	35	wells	$75,000	$	2,625,000	
Production Wells						
Pump Maintenance	35	wells	$100,000	$	3,500,000	
Redevelopment of Wells	35	wells	$100,000	$	3,500,000	
			Total 10-Year O&M	**$**	**9,625,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	35	wells	$100,000	$	3,500,000	
			Total 5-Year O&M	**$**	**3,500,000**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP		AFY	$0	$	-	
HTP	50,000	AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	50,000		**Purchase Cost Total**	**$**	**-**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	

Economic Cost Summary					
Present Value Calculations			PV Factor		
Initial Capital Cost	$	835,900,000	0.566	$	472,727,293
20-Year Capital Costs	$	357,900,000	0.389	$	139,248,831
Annual O&M Costs	$	31,400,000	15.802	$	496,173,513
10-Year Periodic O&M	$	9,625,000	1.220	$	11,742,741
5-Year Periodic O&M	$	3,500,000	2.778	$	9,721,820
Recycled Water Purchase	$	-	24.782	$	-
Recycled Water Sell	$	-	-24.782	$	-
			Total PV	**$**	**1,129,614,198**
			50-year Project Yield (AF)		**2,500,000**
			Unit Cost ($/af)		**$450**

ASPECT: Long-Term Project Concepts Evaluation — Date: March 21, 2012
DESCRIPTION: Net Present Value Estimate — Annual Yield 180,000
SUPPLY: MWb - HTP to CB Wells

	Item	Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
HTP (Phase 1-4 completed)		180,000	AFY	$5,000	$ 900,000,000	
EQ Storage		21,000,000	gallons	$1.5	$ 31,500,000	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
HTP to CB	150	79,200	in-dia*LF	$36	$ 425,500,000	Tunneling. Shafts included in unit cost.
Pump Station						
Pump Station at HTP		111,590	gpm	formula	$ 33,000,000	
Distribution Pump Station at CB		111,590	gpm	formula	$ 33,000,000	
Land Purchase		0.5	acres	$2,000,000	$ 1,000,000	Land purchase assumed for all off-site PS
Groundwater Recharge						
Injection Wells at CB		124	wells	$2,000,000	$ 248,000,000	
Land Purchase		14.3	acres	$2,000,000	$ 29,000,000	
Production Wells						
Production Wells at CB		124	wells	$2,000,000	$ 248,000,000	
Land Purchase		14	acres	$2,000,000	$ 29,000,000	
Well Head Treatment		180,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
CB Wells laterals	10	124,000	in-dia*LF	$20	$ 24,800,000	
CB to DWP 1 (54")	54	31,680	in-dia*LF	$16	$ 27,400,000	
CB to DWP 2 (54")	54	15,840	in-dia*LF	$16	$ 13,700,000	
CB to DWP 3 (60")	60	5,280	in-dia*LF	$16	$ 5,100,000	
				Construction Subtotal	**$ 2,049,000,000**	
			Contingency Costs	30%	$ 614,700,000	
				Construction Total	**$ 2,663,700,000**	
			Implementation Costs	30%	$ 799,100,000	
				Total Capital Cost (Jan 2011)	**$ 3,462,800,000**	
20-Year Useful Life						
Treatment (Product Water)				63%	$ 569,100,000	
EQ Storage				10%	$ 3,200,000	
Conveyance				0%	$ -	
Pump Station				50%	$ 33,000,000	
Groundwater Recharge Equipment				25%	$ 62,000,000	
Production Wells Equipment				25%	$ 62,000,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 729,300,000**	
			Contingency Costs	30%	$ 218,800,000	
				Construction Total	**$ 948,100,000**	
			Implementation Costs	30%	$ 284,400,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 1,232,500,000**	

O&M Costs					
Annual O&M Costs ($/Year)					
Treatment (Product Water)					
HTP (Phase 1-4 completed)	180,000	AFY	$480	$ 86,400,000	
EQ Storage	$31,500,000	LS	0.5%	$ 158,000	
Distribution Storage	0	LS	$75,000	$ -	
Conveyance	$ 425,500,000	LS	0.5%	$ 2,128,000	Tunneling
Pump Station					
Pump Station at HTP	$10,000	LS	5.0%	$ 1,660,000	
Electrical Cost	56,333,400	kWh (Qavg)	$0.12	$ 6,760,000	
Distribution Pump Station at CB	$10,000	LS	5.0%	$ 1,660,000	
Electrical Cost	1,710,700	kWh (Qavg)	$0.12	$ 205,000	
Groundwater Recharge Land Cost					*See 10 Year Periodic below*
Production Wells Land Cost					
Power Central Basin	180,000	AFY	$102	$ 18,421,000	Pumps to 100 psi
Distribution					
CB Wells laterals	124,000	LF	$0.60	$ 74,000	
CB to DWP 1 (54")	31,680	LF	$0.60	$ 19,000	
CB to DWP 2 (54")	15,840	LF	$0.60	$ 10,000	
CB to DWP 3 (60")	5,280	LF	$0.60	$ 3,000	
			O&M Cost Subtotal	**$ 117,500,000**	
		Contingencies	0%	$ -	
			Total Annual O&M	**$ 117,500,000**	
10-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Pump Maintenance	124	wells	$75,000	$ 9,300,000	
Production Wells					
Pump Maintenance	124	wells	$100,000	$ 12,400,000	
Redevelopment of Wells	124	wells	$100,000	$ 12,400,000	
			Total 10-Year O&M	**$ 34,100,000**	
5-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Redevelopment of Wells	124	wells	$100,000	$ 12,400,000	
			Total 5-Year O&M	**$ 12,400,000**	
Recycled Water Purchase ($ / Year)					
DCTWRP		AFY	$0	$ -	
LAGWRP		AFY	$0	$ -	
HTP	180,000	AFY	$0	$ -	
West Basin - Nitrified (Harbor)		AFY	$800	$ -	
West Basin - Tertiary (West/Metro)		AFY	$550	$ -	
West Basin - AWP		AFY	$1,000	$ -	
Central Basin MWD		AFY	$500	$ -	
San Gabriel Valley MWD		AFY	$600	$ -	
Burbank WP		AFY	$0	$ -	
Las Virgenes MWD		AFY	$500	$ -	
	180,000		**Purchase Cost Total**	**$ -**	
Recycled Water Sell ($ / Year)					
DCTWRP - Tertiary		AFY	$600	$ -	
DCTWRP - AWP		AFY	$0	$ -	
LAGWRP - Tertiary		AFY	$500	$ -	
	-		**Selling Cost Total**	**$ -**	

Economic Cost Summary			
Present Value Calculations		PV Factor	
Initial Capital Cost	$ 3,462,800,000	0.566	$ 1,958,320,456
20-Year Capital Costs	$ 1,232,500,000	0.389	$ 479,531,110
Annual O&M Costs	$ 117,500,000	15.802	$ 1,856,700,249
10-Year Periodic O&M	$ 34,100,000	1.220	$ 41,602,855
5-Year Periodic O&M	$ 12,400,000	2.778	$ 34,443,020
Recycled Water Purchase	$ -	24.782	$ -
Recycled Water Sell	$ -	-24.782	$ -
		Total PV	**$ 4,370,597,689**
		50-year Project Yield (AF)	**9,000,000**
		Unit Cost ($/af)	**$490**

ASPECT:	**Long-Term Project Concepts Evaluation**		Date:	March 21, 2012	
DESCRIPTION:	**Net Present Value Estimate**			**Annual Yield**	
SUPPLY:	**MWc - HTP to CB Spreading Grounds**			100,000	

Item		Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
HTP (Phase 1-4 completed)		100,000	AFY	$5,200	$ 520,000,000	
EQ Storage		15,000,000	gallons	$1.5	$ 22,500,000	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
HTP to Montebello (CB)	120	105,600	in-dia*LF	$36	$ 453,900,000	Tunneling. Shafts included in unit cost.
Pump Station						
Pump Station at HTP		62,000	gpm	formula	$ 21,100,000	
Distribution Pump Station at Cb (MB FB)		62,000	gpm	formula	$ 21,100,000	
Land Purchase		0.5	acres	$2,000,000	$ 1,000,000	Land purchase assumed for all off-site PS
Groundwater Recharge						
Spreading Grounds		0	acre	$0	$ -	Existing SG
Land Purchase		0.0	acre	$2,000,000	$ -	
Production Wells						
Production Wells at CB		69	wells	$2,000,000	$ 138,000,000	
Land Purchase		7.9	acres	$2,000,000	$ 15,900,000	
Well Head Treatment		100,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
CB Wells lateral	10	69,000	in-dia*LF	$20	$ 13,800,000	
CB to DWP 1 (54")	54	110,880	in-dia*LF	$16	$ 95,800,000	This cost includes 21 miles total of 54" pipeline.
CB to DWP 2 (36")	36	10,560	in-dia*LF	$16	$ 6,100,000	
				Construction Subtotal	**$ 1,309,200,000**	
			Contingency Costs	30%	$ 392,800,000	
				Construction Total	**$ 1,702,000,000**	
			Implementation Costs	30%	$ 510,600,000	
				Total Capital Cost (Jan 2011)	**$ 2,212,600,000**	
20-Year Useful Life						
Treatment (Product Water)				63%	$ 328,800,000	
EQ Storage				10%	$ 2,300,000	
Conveyance				0%	$ -	
Pump Station				50%	$ 21,100,000	
Groundwater Recharge Equipment				25%	$ -	
Production Wells Equipment				25%	$ 34,500,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 386,700,000**	
			Contingency Costs	30%	$ 116,000,000	
				Construction Total	**$ 502,700,000**	
			Implementation Costs	30%	$ 150,800,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 653,500,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
HTP (Phase 1-4 completed)	100,000	AFY	$480	$	48,000,000	
EQ Storage	$22,500,000	LS	0.5%	$	113,000	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance			0.5%	$	2,270,000	
Pump Station						
Pump Station at HTP	$10,000	LS	5.0%	$	1,065,000	
Electrical Cost	30,807,500	kWh (Qavg)	$0.12	$	3,697,000	
Distribution Pump Station at Cb (MB FB)	$10,000	LS	5.0%	$	10,000	
Electrical Cost	38,432,900	kWh (Qavg)	$0.12	$	4,612,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Spreading Grounds	1	LS	$100,000	$	100,000	
Production Wells Land Cost				.		
Pump	0	kWh (Qavg)	$0.12	$	-	
Power West Coast	100,000	AFY	$102	$	10,234,000	Pumps to 100 psii
Distribution						
CB Wells lateral	69,000	LF	$0.60	$	41,000	
CB to DWP 1 (54")	110,880	LF	$0.60	$	67,000	
CB to DWP 2 (36")	10,560	LF	$0.60	$	6,000	
			O&M Cost Subtotal	**$**	**70,220,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**70,220,000**	
10-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Pump Maintenance	0	well	$75,000	$	-	
Production Wells						
Pump Maintenance	69	wells	$100,000	$	6,900,000	
Redevelopment of Wells	69	wells	$100,000	$	6,900,000	
			Total 10-Year O&M	**$**	**13,800,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	0	well	$100,000	$	-	
			Total 5-Year O&M	**$**	**-**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP		AFY	$0	$	-	
HTP	100,000	AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	100,000		**Purchase Cost Total**	**$**	**-**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	

Economic Cost Summary				
Present Value Calculations		PV Factor		
Initial Capital Cost	$ 2,212,600,000	0.566	$	1,251,293,704
20-Year Capital Costs	$ 653,500,000	0.389	$	254,258,483
Annual O&M Costs	$ 70,220,000	15.802	$	1,109,595,672
10-Year Periodic O&M	$ 13,800,000	1.220	$	16,836,346
5-Year Periodic O&M	$ -	2.778	$	-
Recycled Water Purchase	$ -	24.782	$	-
Recycled Water Sell	$ -	-24.782	$	-
		Total PV	**$**	**2,631,984,206**
		50-year Project Yield (AF)		**5,000,000**
		Unit Cost ($/af)		**$530**

ASPECT:	**Long-Term Project Concepts Evaluation**			Date:	March 21, 2012	
DESCRIPTION:	**Net Present Value Estimate**				**Annual Yield**	
SUPPLY:	**MWd - WBMWD to WCB Wells**				10,000	

	Item	Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
Advanced Treatment		10,000	AFY	$4,600	$ 46,000,000	Double ck
EQ Storage		0	gallons	$1.5	$ -	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
WB to WCB Wells	24	5,280	in-dia*LF	$16	$ 2,000,000	Open Cut Congested Area
Pump Station						
Pump Station at Plant		6,200	gpm	formula	$ 3,700,000	
Groundwater Recharge						
Injection Wells at WB		7	wells	$2,000,000	$ 14,000,000	
Land Purchase		0.8	acre	$2,000,000	$ 1,600,000	
Production Wells						
Production Wells		7	wells	$2,000,000	$ 14,000,000	
Land Purchase		0.8	acre	$2,000,000	$ 1,600,000	
Well Head Treatment		10,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
WB Wells to DWP	10	7,000	in-dia*LF	$20	$ 1,400,000	Open Cut Congested Area
				Construction Subtotal	**$ 84,300,000**	
			Contingency Costs	30%	$ 25,000,000	
				Construction Total	**$ 109,300,000**	
			Implementation Costs	30%	$ 32,800,000	
				Total Capital Cost (Jan 2011)	**$ 142,100,000**	
20-Year Useful Life						
Treatment (Product Water)				50%	$ 23,000,000	
EQ Storage				10%	$ -	
Conveyance				0%	$ -	
Pump Station				50%	$ 1,900,000	
Groundwater Recharge Equipment				25%	$ 3,500,000	
Production Wells Equipment				25%	$ 3,500,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 31,900,000**	
			Contingency Costs	30%	$ 10,000,000	
				Construction Total	**$ 41,900,000**	
			Implementation Costs	30%	$ 12,600,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 54,500,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
Advanced Treatment	10,000	AFY	$200	$	2,000,000	
EQ Storage	$0	LS	0.5%	$	-	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	5,280	LF	$0.60	$	3,000	
Pump Station						
Pump Station at Plant	$10,000	LS	5.0%	$	195,000	
Electrical Cost	72,100	kWh (Qavg)	$0.12	$	9,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost						
Pump	0	kWh (Qavg)	$0.12	$	-	
Power West Coast	10,000	AFY	$102	$	1,023,000	Pumps to 100 psi
Distribution						
Pump	0	kWh	$0.12	$	-	
WB Wells to DWP	7,000	LF	$0.60	$	4,000	
			O&M Cost Subtotal	**$**	**3,230,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**3,230,000**	
10-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Pump Maintenance	7	wells	$75,000	$	525,000	
Production Wells						
Pump Maintenance	7	wells	$100,000	$	700,000	
Redevelopment of Wells	7	wells	$100,000	$	700,000	
			Total 10-Year O&M		**$1,925,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	7	wells	$100,000	$	700,000	
			Total 5-Year O&M	**$**	**700,000**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP		AFY	$0	$	-	
HTP		AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP	10,000	AFY	$1,000	$	10,000,000	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	10,000		**Purchase Cost Total**	**$**	**10,000,000**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	
Economic Cost Summary						
Present Value Calculations			PV Factor			
Initial Capital Cost	$ 142,100,000		0.566	$	80,361,943	
20-Year Capital Costs	$ 54,500,000		0.389	$	21,204,418	
Annual O&M Costs	$ 3,230,000		15.802	$	51,039,505	
10-Year Periodic O&M	$ 1,925,000		1.220	$	2,348,548	
5-Year Periodic O&M	$ 700,000		2.778	$	1,944,364	
Recycled Water Purchase	$ 10,000,000		24.782	$	247,821,107	
Recycled Water Sell	$ -		-24.782	$	-	
			Total PV	**$**	**404,719,886**	
			50-year Project Yield (AF)		**500,000**	
			Unit Cost ($/af)		**$810**	

ASPECT: Long-Term Project Concepts Evaluation
DESCRIPTION: Net Present Value Estimate
SUPPLY: MWe - Metro Satellite to CB Wells

Date: March 21, 2012

Annual Yield
50,000

Item		Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
Metro Satellite Plant:						
MBR Plant		50,000	AFY	$7,100	$ 355,000,000	Costs based on Cost TM
RO/AOP Plant		50,000	AFY	$3,300	$ 165,000,000	
Land Purchase		54	acres	$2,000,000	$ 108,000,000	Included in treatment costs
EQ Storage		0	gallons	$1.5	$ -	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
Metro Satellite to CB Wells	54	15,840	in-dia*LF	$16	$ 13,700,000	
Pump Station						
Pump Station at Plant		30,998	gpm	formula	$ 12,400,000	
Distribution Pump Station at CB		30,998	gpm	formula	$ 12,400,000	
Land Purchase		0.5	acres	$2,000,000	$ 1,000,000	Land purchase assumed for all off-site PS
Groundwater Recharge						
Injection Wells at CB		35	wells	$2,000,000	$ 70,000,000	
Land Purchase		4.0	acres	$2,000,000	$ 8,100,000	
Production Wells						
Production Wells		35	wells	$2,000,000	$ 70,000,000	
Land Purchase		4.0	acres	$2,000,000	$ 8,100,000	
Well Head Treatment		50,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
CB Wells Laterals	10	35,000	in-dia*LF	$20	$ 7,000,000	
CB to DWP	54	5,280	in-dia*LF	$16	$ 4,600,000	
				Construction Subtotal	**$ 835,300,000**	
			Contingency Costs	30%	$ 250,600,000	
				Construction Total	**$ 1,085,900,000**	
			Implementation Costs	30%	$ 325,800,000	
				Total Capital Cost (Jan 2011)	**$ 1,411,700,000**	
20-Year Useful Life						
Treatment (Product Water)				50%	$ 314,000,000	
Distribution Storage				10%	$ -	
Conveyance				0%	$ -	
Pump Station				50%	$ 12,900,000	
Groundwater Recharge Equipment				25%	$ 17,500,000	
Production Wells Equipment				25%	$ 17,500,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 361,900,000**	
			Contingency Costs	30%	$ 108,600,000	
				Construction Total	**$ 470,500,000**	
			Implementation Costs	30%	$ 141,200,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 611,700,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
Metro Satellite Plant:						
MBR Plant	50,000	AFY	$200	$	50,500,000	Based on cost TM
RO/AOP Plant	50,000	AFY	$500	$	50,500,000	
EQ Storage	$0	LS	0.5%	$	-	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	15,840	LF	$0.60	$	10,000	
Pump Station						
Pump Station at Plant	$10,000	LS	5.0%	$	-	Included in treatment O&M
Electrical Cost	0	kWh (Qavg)	$0.12	$	-	
Distribution Pump Station at CB	$10,000	LS	5.0%	$	630,000	
Electrical Cost	360,500	kWh (Qavg)	$0.12	$	43,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost						
Power Central	50,000	AFY	$102	$	5,117,000	Pumps to 100 psi
Distribution						
CB Wells Laterals	35,000	LF	$0.60	$	21,000	
CB to DWP	5,280	LF	$0.60	$	3,000	
			O&M Cost Subtotal	**$**	**106,820,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**106,820,000**	
10-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Pump Maintenance	35	wells	$75,000	$	2,625,000	
Production Wells						
Pump Maintenance	35	wells	$100,000	$	3,500,000	
Redevelopment of Wells	35	wells	$100,000	$	3,500,000	
			Total 10-Year O&M	**$**	**9,625,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	35	wells	$100,000	$	3,500,000	
			Total 5-Year O&M	**$**	**3,500,000**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP	50,000	AFY	$0	$	-	
HTP		AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD		AFY	$500	$	-	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD		AFY	$500	$	-	
	50,000		**Purchase Cost Total**	**$**	**-**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	

Economic Cost Summary				
Present Value Calculations		PV Factor		
Initial Capital Cost	$ 1,411,700,000	0.566	$	798,359,994
20-Year Capital Costs	$ 611,700,000	0.389	$	237,995,278
Annual O&M Costs	$ 106,820,000	15.802	$	1,687,938,048
10-Year Periodic O&M	$ 9,625,000	1.220	$	11,742,741
5-Year Periodic O&M	$ 3,500,000	2.778	$	9,721,820
Recycled Water Purchase	$ -	24.782	$	-
Recycled Water Sell	$ -	-24.782	$	-
		Total PV	**$**	**2,745,757,881**
		50-year Project Yield (AF)		**2,500,000**
		Unit Cost ($/af)		**$1,100**

ASPECT:	Long-Term Project Concepts Evaluation	Date:	March 21, 2012
DESCRIPTION:	Net Present Value Estimate		Annual Yield
SUPPLY:	MWf - CBMWD to AWPF to CB Wells		5,000

Item		Qty	Units	Unit Cost		Cost	Notes
Capital Costs							
Capital Facilities							
Treatment (Product Water)							
Advanced Treatment (MF/RO/AOP)		10,000	AFY	$4,600	$	46,000,000	Assumes flow (10,000 AFY) occurs over 6 months only. Flow from CBMWD is tertiary treated. Cost is for DCTWRP at VGS (longtravel time)
Land Purchase		12	acres	$2,000,000	$	24,000,000	
Distribution Storage							
No Tank is needed		0	MG	$0	$	-	
Conveyance	Diam (in)	Length (ft)					
CBMWD to AWP	30	42,240	in-dia*LF	$16	$	20,300,000	
AWP to CB Wells	24	5,280	in-dia*LF	$16	$	2,000,000	
Pump Station							
Pump Station at CB		0	gpm	formula	$	-	Assumes flow provided with pressure at City boundary
Pump Station at AWP		6,200	gpm	formula	$	3,700,000	Assumes flow (10,000 AFY) occurs over 6 months only.
Groundwater Recharge							
Injection Wells at CB		7	wells	$2,000,000	$	14,000,000	
Land Purchase		0.8	acre	$2,000,000	$	1,600,000	
Production Wells							
Production Wells		4	wells	$2,000,000	$	8,000,000	
Land Purchase		0.5	acre	$2,000,000	$	900,000	
Well Head Treatment		5,000	AFY	$0	$	-	
Distribution	Diam (in)	Length (ft)					
CB Wells to DWP	10	4,000	in-dia*LF	$20	$	800,000	
				Construction Subtotal	**$**	**121,300,000**	
			Contingency Costs	30%	$	36,400,000	
				Construction Total	**$**	**157,700,000**	
			Implementation Costs	30%	$	47,300,000	
				Total Capital Cost (Jan 2011)	**$**	**205,000,000**	
20-Year Useful Life							
Treatment (Product Water)				50%	$	23,000,000	
Distribution Storage				10%	$	-	
Conveyance				0%	$	-	
Pump Station				50%	$	1,900,000	
Groundwater Recharge Equipment				25%	$	3,500,000	
Production Wells Equipment				25%	$	2,000,000	
Distribution				0%	$	-	
				Construction Subtotal	**$**	**30,400,000**	
			Contingency Costs	30%	$	9,100,000	
				Construction Total	**$**	**39,500,000**	
			Implementation Costs	30%	$	11,900,000	
				Total 20-year Capital Cost (Jan 2011)	**$**	**51,400,000**	

O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
Advanced Treatment (MF/RO/AOP)	10,000	AFY	$200	$	2,000,000	
Distribution Storage	0	LS	$75,000	$	-	
Conveyance	47,520	LF	$0.60	$	29,000	
Pump Station						
Pump Station at CB	$10,000	LS	5.0%	$	-	
Electrical Cost	0	kWh (Qavg)	$0.12	$	-	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost						
Pump	0	kWh (Qavg)	$0.12	$	-	
Power Central	10,000	AFY	$102	$	1,023,000	Pumps to 100 psi
Distribution						
Pump	0	kWh	$0.12	$	-	
CB Wells to DWP	4,000	LF	$0.60	$	2,000	
			O&M Cost Subtotal	**$**	**3,050,000**	
		Contingencies	0%	$	-	
			Total Annual O&M	**$**	**3,050,000**	
10-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Pump Maintenance	7	wells	$75,000	$	525,000	
Production Wells						
Pump Maintenance	4	wells	$100,000	$	400,000	
Redevelopment of Wells	4	wells	$100,000	$	400,000	
			Total 10-Year O&M	**$**	**1,325,000**	
5-Year Periodic O&M Costs ($/Year)						
Groundwater Recharge						
Redevelopment of Wells	7	wells	$100,000	$	700,000	
			Total 5-Year O&M	**$**	**700,000**	
Recycled Water Purchase ($ / Year)						
DCTWRP		AFY	$0	$	-	
LAGWRP		AFY	$0	$	-	
HTP		AFY	$0	$	-	
West Basin - Nitrified (Harbor)		AFY	$800	$	-	
West Basin - Tertiary (West/Metro)		AFY	$550	$	-	
West Basin - AWP		AFY	$1,000	$	-	
Central Basin MWD	6,500	AFY	$500	$	3,250,000	
San Gabriel Valley MWD		AFY	$600	$	-	
Burbank WP		AFY	$0	$	-	
Las Virgenes MWD	-	AFY	$500	$	-	
	6,500		**Purchase Cost Total**	**$**	**3,250,000**	
Recycled Water Sell ($ / Year)						
DCTWRP - Tertiary		AFY	$500	$	-	
DCTWRP - AWP		AFY	$1,000	$	-	
LAGWRP - Tertiary		AFY	$500	$	-	
	-		**Selling Cost Total**	**$**	**-**	
Economic Cost Summary						
Present Value Calculations			PV Factor			
Initial Capital Cost	$ 205,000,000		0.566	$	115,933,838	
20-Year Capital Costs	$ 51,400,000		0.389	$	19,998,295	
Annual O&M Costs	$ 3,050,000		15.802	$	48,195,198	
10-Year Periodic O&M	$ 1,325,000		1.220	$	1,616,533	
5-Year Periodic O&M	$ 700,000		2.778	$	1,944,364	
Recycled Water Purchase	$ 3,250,000		24.782	$	80,541,860	
Recycled Water Sell	$ -		-24.782	$	-	
			Total PV	**$**	**268,230,088**	
			50-year Project Yield (AF)		**250,000**	
			Unit Cost ($/af)		**$1,070**	

Appendix I

Sensitivity Analysis and Results

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Sensitivity analyses were performed, but were not used to evaluate the long-term project concepts. The sensitivity analysis was used for the near-term alternatives to verify the robustness of the initial project concept rankings. A total of six sensitivity runs were conducted. The variations in objectives weightings for the sensitivity runs were developed based on input from the RWAG and the City. The six sensitivity runs are summarized below. Similar runs were also conducted for the long-term project concepts.

Sensitivity Runs 1 through 6: Modified Objectives Weighting

Sensitivity Runs 1 through 4 were developed based on input from the RWAG. At the first RWAG workshop on December 9, 2009, the members completed a survey about the weightings for the RWMP objectives to reflect their interests. Based on the input from the RWAG, the following sensitivity runs were developed by the RWMP team:

1. *Average Weights*: an average of the inputs on weightings from all RWAG members.
2. *Environmental Emphasis*: weightings based on the inputs of RWAG members who felt the environment was their primary concern.
3. *Social Emphasis*: weightings based on the inputs of RWAG members who felt that social issues were their chief concern.
4. *Cost Emphasis*: weighting based on the inputs of RWAG members who felt that cost issues were their chief concern.

Sensitivity Runs 5 and 6 were developed by the RWMP team to test the project concept rankings:

1. *Equal Weights:* equal weighting for all objectives to see if the results change if none of the objectives are weighted higher than the others.
2. *No Cost:* cost receives 0 percent weighting to see if the results change if cost is not an issue.

The modified objectives weightings for Sensitivity Runs 1 through 6 are summarized in **Table I -1**. These sensitivity runs involved altering the objectives weightings. If the project concepts rankings change with the sensitivity runs, then this means that the project concept was sensitive to that particular element that was emphasized in the sensitivity run.

Table I-1: Modified Objectives Weightings for Sensitivity Analysis for Long-Term

Sensitivity Run Number		1	2	3	4	5	6
	Base Condition	RWAG Average Weights	RWAG Environmental Emphasis	RWAG Social Emphasis	RWAG Cost Emphasis	Equal Weights	No Cost
Promote Cost Efficiency	30%	19.8%	0%	11.9%	50%	16.7%	0%
Achieve Supply & Operational Goals	20%	23.3%	50%	14.3%	20%	16.7%	28.6%
Protect the Environment	10%	17.6%	50%	23.8%	10%	16.7%	14.3%
Maximize Implementation	20%	15.5%	0%	11.9%	10%	16.7%	21.4%
Promote Economic & Social Benefits	10%	11.4%	0%	28.6%	0%	16.7%	14.3%
Maximize Adaptability & Reduce Risk	10%	12.4%	0%	9.5%	10%	16.7%	21.4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure I-1: Modified Objectives Weightings for Sensitivity Analysis for Long-Term

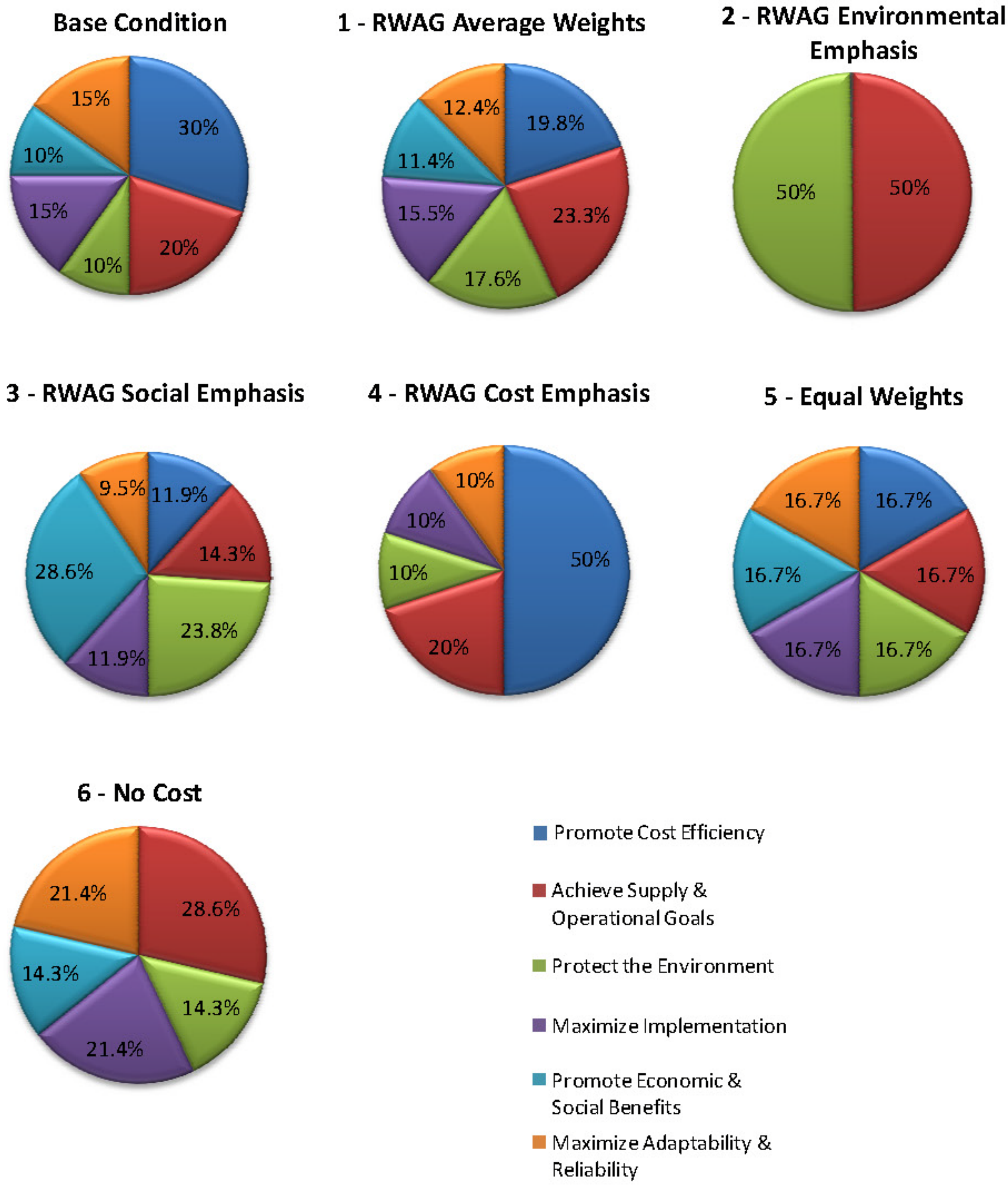


Table I-2 summarizes the number of times that each project concept was chosen as the highest ranked project concept. The ideal situation would be that the sensitivity runs had no effect on the highest ranked project concept, signifying that the choice of the project concept was not sensitive to differing viewpoints expressed in the varying weightings.

Table I-2: Summary of Long-Term Project Concepts for the Base Run and Sensitivity Runs

CDP Rankings without Groundwater Purification Cost										
	MWa	MWb	MWc	MWd	MWe	MWf	Va	Vb	Vc	Vd
0 Base	1	2	3	4	9	10	8	6	5	7
1 RWAG Average Weights	1	2	3	4	8	10	9	6	5	7
2 RWAG Environmental Emphasis	4	1	2	5	3	6	7	10	8	9
3 RWAG Social Emphasis	2	1	3	4	5	9	6	10	8	7
4 RWAG Cost Emphasis	1	3	2	4	10	8	9	6	7	5
5 Equal Weights	2	1	3	4	5	7	8	10	9	6
6 No Cost	2	1	3	5	4	7	9	10	8	6
Average Ranking	1.9	1.6	2.7	4.3	6.3	8.1	8.0	8.3	7.1	6.7
Total Number of Times Ranked No.1	3	4	0	0	0	0	0	0	0	0

Color Coding of Rankings:

1	2	3	4	5	6	7	8	9	10

Highest Ranked → → Lowest Ranked

The following figures show the graphical results of the sensitivity runs summarized in Table I-2.

Figure I-2: Recycled Water Cost Results RWAG Average Weights

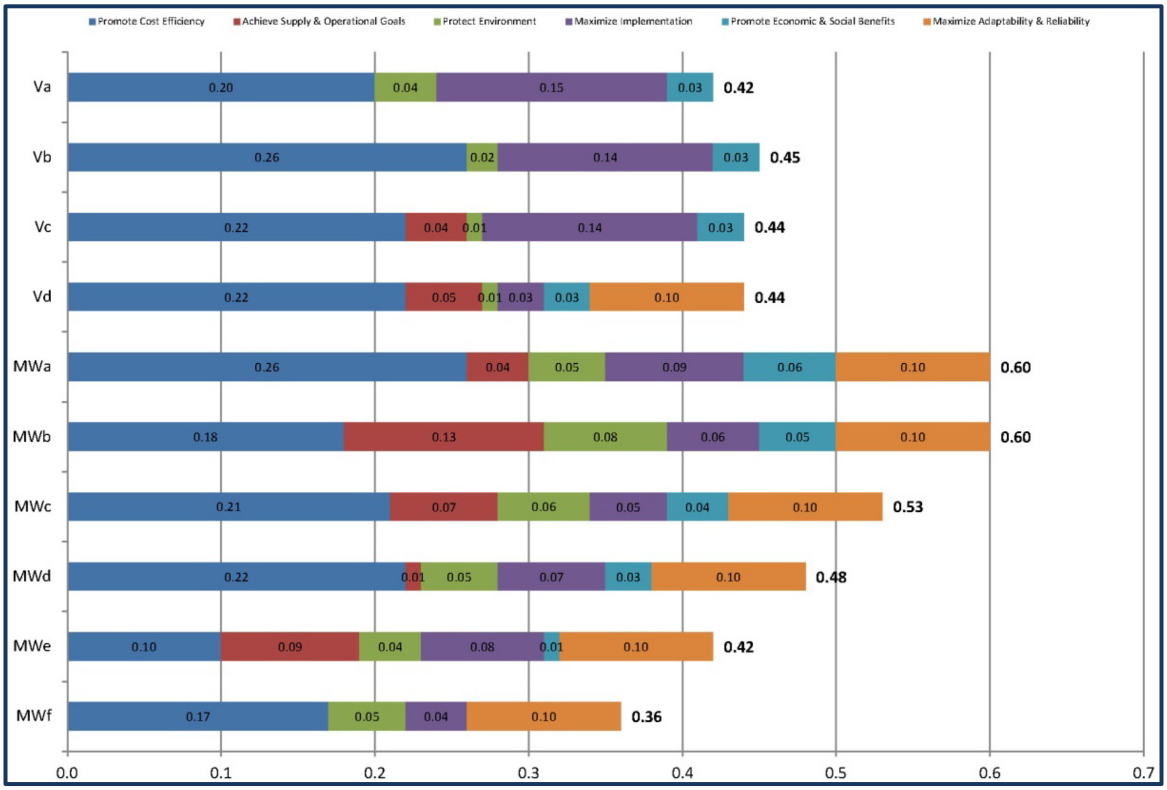


Figure I-3: Recycled Water Cost Results RWAG Environmental Emphasis

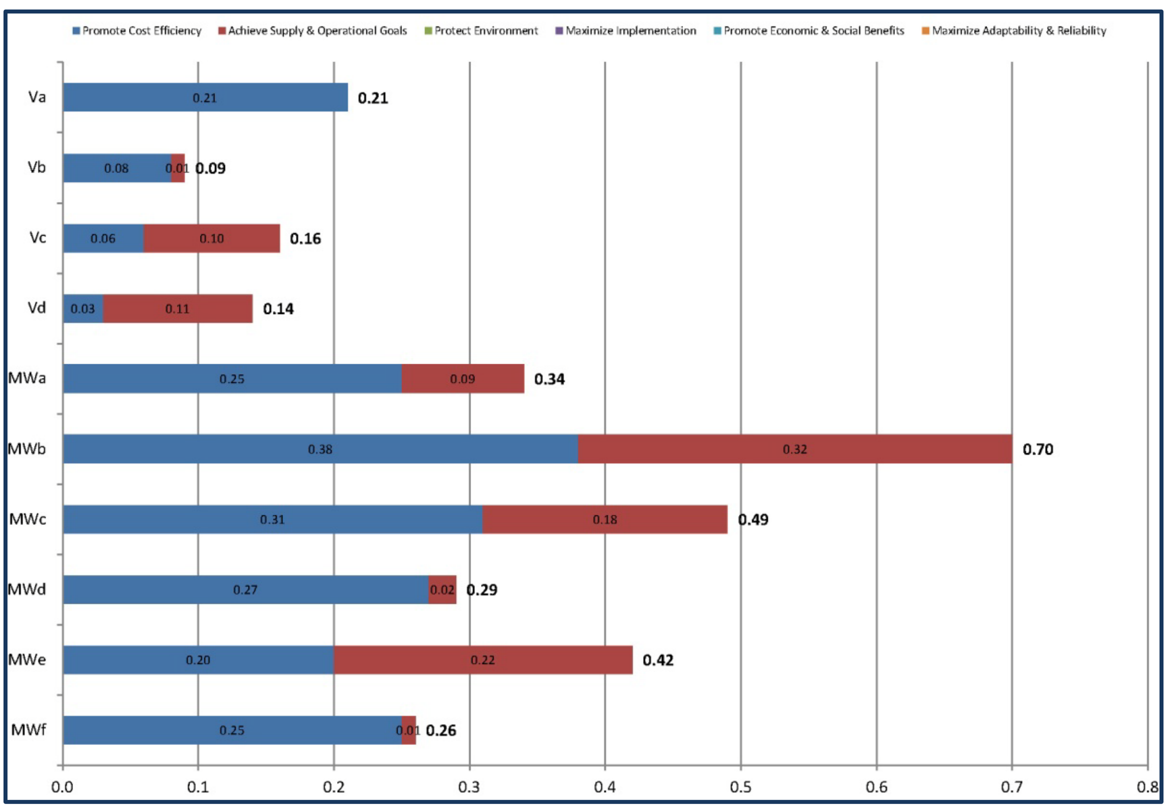


Figure I-4: Recycled Water Cost Results RWAG Social Emphasis

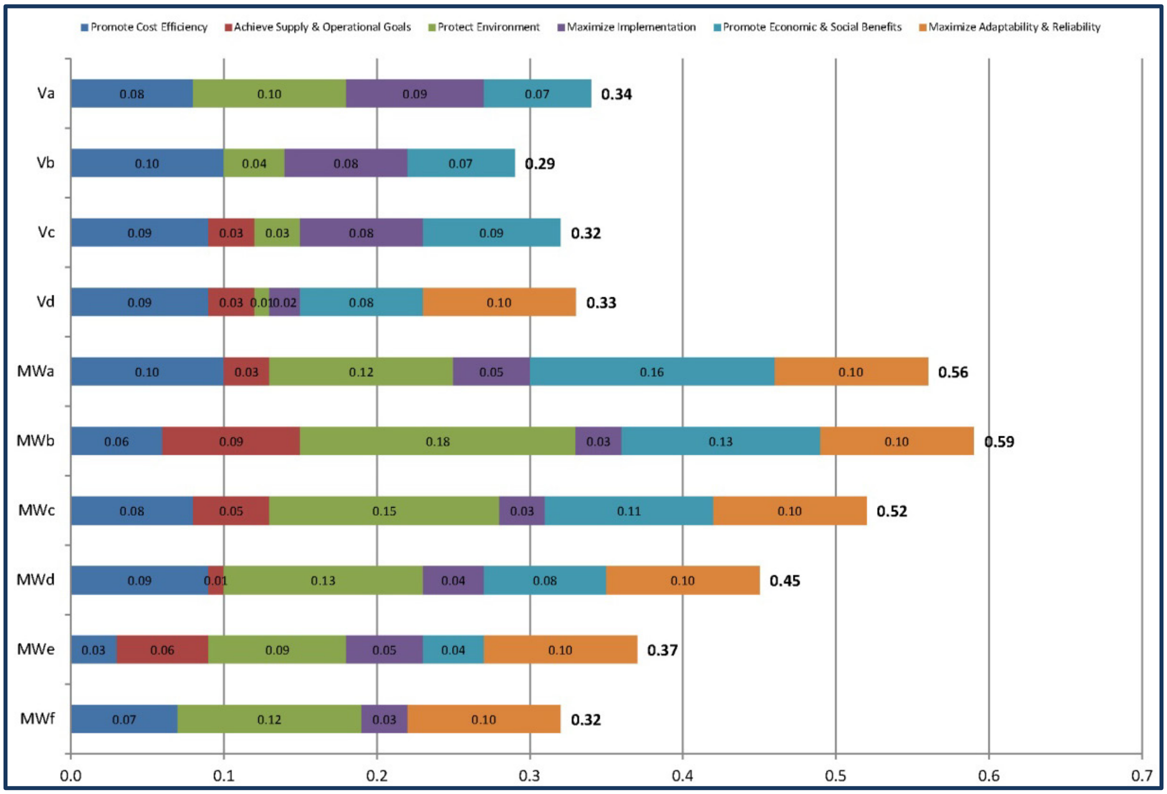


Figure I-5: Recycled Water Cost Results RWAG Cost Emphasis

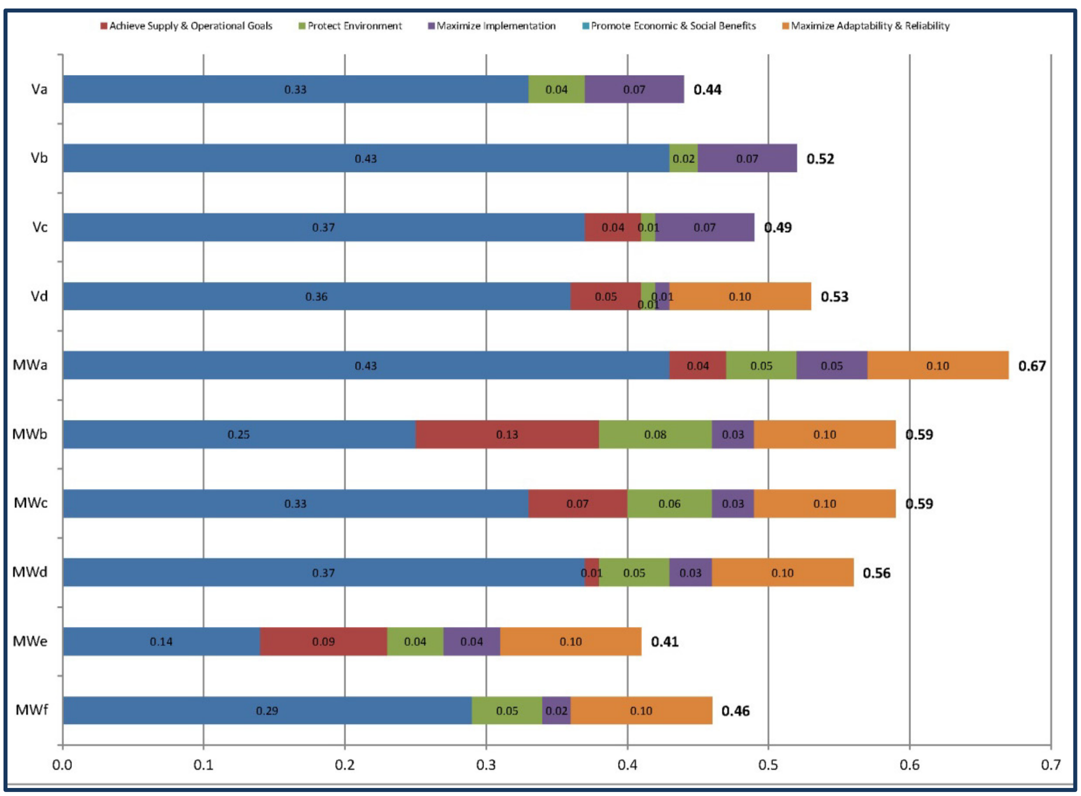


Figure I-6: Recycled Water Cost Results Equal Weights

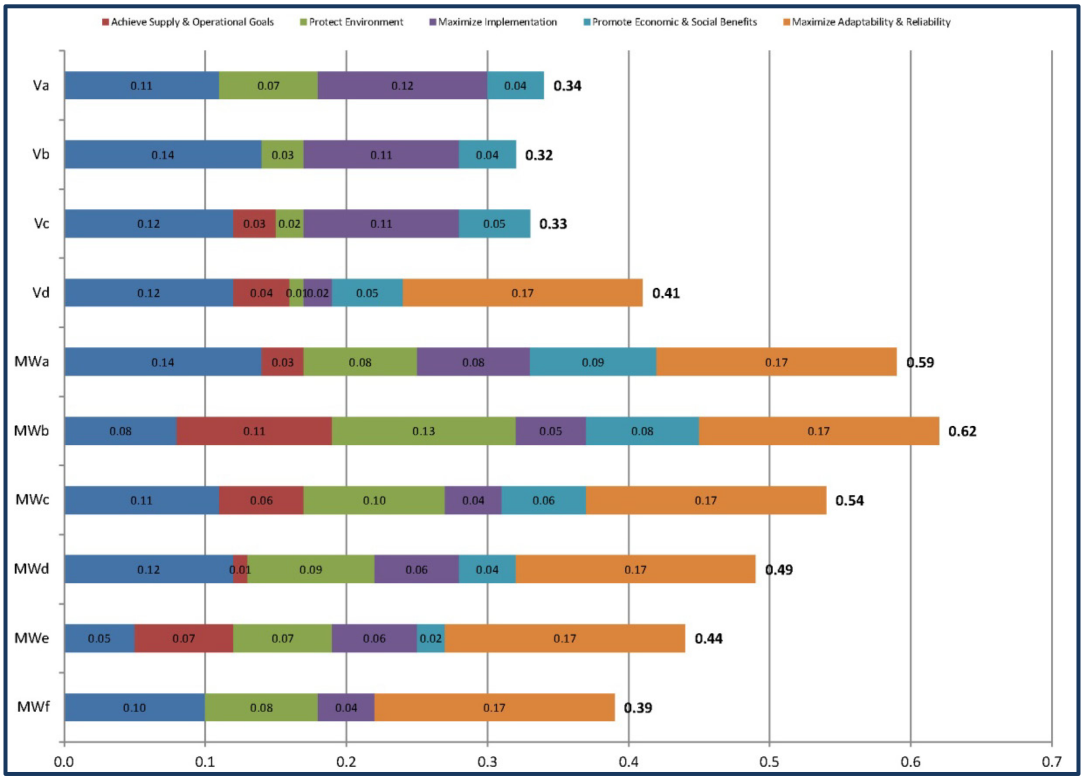
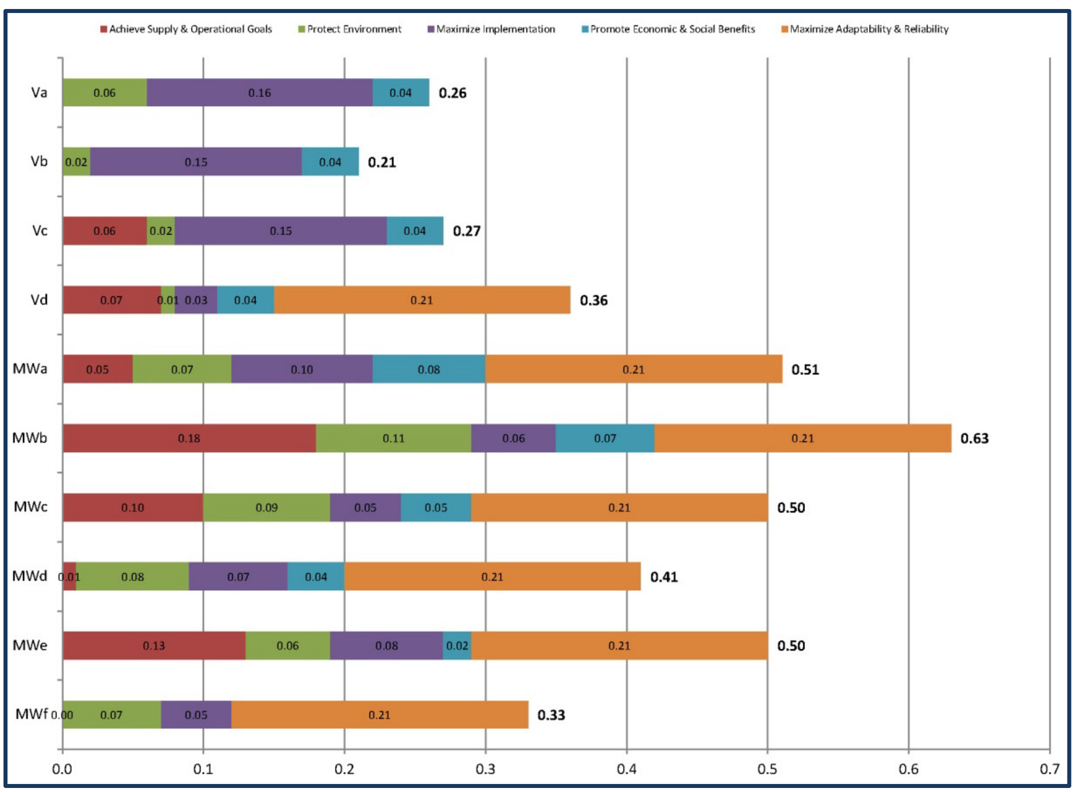


Figure I-7: Recycled Water Cost Results No Cost



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Appendix J

Regulatory, Permitting and Institutional Requirements

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Project Concepts Regulatory, Permitting and Institutional Requirements

Concept Project	Regulatory/Permitting	Institutional	Related Technical Memoranda	Scoring 1 (low) – 5 (high)
Proposed Valley options				
Va - LVMWD System	**CEQA/NEPA:** • LADWP- for transmission infrastructure, AWP expansion, spreading/injection/extraction facilities **CWC 1211 petitions:** • LVMWD - for change in discharge to the LA River from Tapia • LVMWD – for change in discharge to Malibu Creek from Tapia **GWR Project Permit Amendment**[1] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – modifications to GWR project for increase in RW use, higher recycled water contribution (RWC), and AWP expansion **HTP NPDES Permit:** • Bureau of Sanitation (BOS) – additional brine disposal to the HTP outfall **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **US Army Corp of Engineers (USACE) Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **Air Quality Management District (AQMD) Permits:** • BOS/LADWP – for AWP facility **Local Construction Permits/Easements:** • LADWP	**Sales Agreement** (MOU or contract between LADWP and LVMWD): 1. Conditions for the sale of RW from LVMWD 2. LVMWD compliance with the GWR Project Permit (e.g., monitoring, O&M, source control, etc.) 3. Infrastructure for transmission of RW to City boundary **Watermaster:** Resolution of any potential issues regarding inter-basin transfer of recycled water Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12) Development of Projects; Los Angeles River Regulatory Support TM (Task 4.8.1)	3-4
Vb – BWP System	**CEQA/NEPA:** • LADWP- for transmission infrastructure, AWP expansion, spreading/injection/extraction facilities **CWC 1211 petition:** • Burbank – for change related to decrease in discharge to the Burbank Western Channel, tributary to LA River **GWR Project Permit Amendment**[1] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – modifications to GWR project for increase in RW use, higher RWC, and AWP expansion **HTP NPDES Permit:** • BOS – additional brine disposal to HTP outfall **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for AWP facility	**Sales Agreement** (MOU or contract between LADWP and Burbank): 1. Conditions for the sale of RW from Burbank 2. Burbank compliance with the GWR Project Permit (e.g., monitoring, O&M, source control, etc.) 3. Infrastructure for transmission of RW to City boundary **Watermaster:** Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12) Development of Projects; Los Angeles River Regulatory Support TM (Task 4.8.1)	3-4

[1] The RWQCB may elect to issue Water Recycling Requirements (WRRs) and/or Waste Discharge Requirements (WDR) for the groundwater recharge project. The existing recharge projects all have WRRs. The permit(s) is typically issued to the entity that operates the water recycling facility, the entity that operates spreading or injection facilities (in this case the Los Angeles County Department of Public Works), and any other entity that would be involved with the project, such as operation of extraction or monitoring wells.

Concept Project	Regulatory/Permitting	Institutional	Related Technical Memoranda	Scoring 1 (low) – 5 (high)
	Local Construction Permits/Easements: • LADWP **California Department of Fish and Game (CDFG) Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)			
Vc – LAGWRP Expansion to DCTWRP	**CEQA/NEPA:** • LADWP – for transmission infrastructure, AWP expansion, spreading/injection/extraction facilities • BOS & Glendale – LAGWRP expansion **CWC 1211 petition:** • BOS & Glendale – for change in discharge to LA River (if there is a decrease from the existing NPDES permit as a result of the project) **Los Angeles-Glendale (LAGWRP) NPDES Permit Amendment :** • BOS & Glendale – LAGWRP expansion **GWR Project Permit Amendment**[2] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – modifications to GWR project for increase in RW use, higher RWC, and AWP expansion **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for AWP facility **Local Construction Permits/Easements:** • LADWP	**Revisions to existing Agreement No.** 32272 & 42257: 1. Resolution of ownership of LAGWRP expansion & RW capacity 2. BOS & Glendale compliance with GWR Project Permit (e.g., monitoring, O&M, source control, etc.) 3. Infrastructure for transmission of RW from LAGWRP to AWP facility **Watermaster:** Changes to adjudication agreement to allow for additional pumping rights for new extraction wells? **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12) Development of Projects; Los Angeles River Regulatory Support TM (Task 4.8.1)	4
Vd – LAGWRP Expansion to PWP	**CEQA/NEPA:** • BOS & Glendale – LAGWRP expansion • PWP – New AWP facility, distribution infrastructure, spreading/injection/extraction facilities **CWC 1211 petition:** • BOS & Glendale – for change in discharge to LA River (if there is a decrease from the existing NPDES permit as a result of the project) **NPDES Amendment:** • BOS & Glendale – LAGWRP expansion **GWR Project Permit**[3] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • PWP (and other sponsors) – new GWR project **LACDPH or CDPH Drinking Water Permits:** • PWP - new production wells	**Revisions to existing Agreement No.** 32272 & 42257: Resolution of ownership of LAGWRP expansion & RW capacity **Sales Agreement** (MOU or contract between LADWP,BOS, Glendale, & PWP): 1. Conditions for the sale of RW from LAGWRP 2. Glendale & BOS compliance with the GWR Project Permit (e.g., monitoring, O&M, source control, etc.) 3. Infrastructure for transmission of RW to PWP boundary	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12) Development of Projects; Los Angeles River Regulatory Support TM (Task 4.8.1)	1

[2] The RWQCB may elect to issue Water Recycling Requirements (WRRs) and/or Waste Discharge Requirements (WDR) for the groundwater recharge project. The existing recharge projects all have WRRs. The permit(s) is typically issued to the entity that operates the water recycling facility, the entity that operates spreading or injection facilities (in this case the Los Angeles County Department of Public Works), and any other entity that would be involved with the project, such as operation of extraction or monitoring wells.
[3] The RWQCB may elect to issue Water Recycling Requirements (WRRs) and/or Waste Discharge Requirements (WDR) for the groundwater recharge project. The existing recharge projects all have WRRs. The permit(s) is typically issued to the entity that operates the water recycling facility, the entity that operates spreading or injection facilities (in this case the Los Angeles County Department of Public Works), and any other entity that would be involved with the project, such as operation of extraction or monitoring wells.

Concept Project	Regulatory/Permitting	Institutional	Related Technical Memoranda	Scoring 1 (low) – 5 (high)
	LACDPH Well Construction Permit: • PWP – new production wells **USACE Permit:** • PWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • PWP – for AWP facility **Local Construction Permits/Easements:** • PWP **CDFG Streambed Alteration Agreement:** • PWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)	**Watermaster:** Resolution of any potential issues regarding inter-basin transfer of recycled water? Changes to adjudication agreement to allow for additional pumping rights for new extraction wells? **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.		
Proposed Metro Options				
MWa	**CEQA/NEPA:** • LADWP- for AWP at HTP, transmission infrastructure, injection/extraction facilities, connection to drinking water system **HTP NPDES Permit:** • BOS – additional brine disposal to HTP outfall **GWR Project Permit** (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – new GWR project **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for AWP facility **Local Construction Permits/Easements:** • LADWP **CDFG Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed). Permitting information for projects this far in the future is speculative.	**City of LA:** BOS compliance with GWR Project Permit (e.g., monitoring, O&M, source control, etc.) **Watermaster:** Resolution of any potential issues regarding inter-basin transfer of recycled water Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12)	3
MWb	**CEQA/NEPA:** • LADWP- for AWP at HTP, transmission infrastructure, injection/extraction facilities, connection to drinking water system **Local Jurisdiction Excavation Permit(s)** (for tunnel): • LADWP **Occupational Health and Safety Administration (OHSA) Authorization** (for the tunnel - mining operation): • LADWP **HTP NPDES Permit:** • BOS – additional brine disposal to HTP outfall	**City of LA:** BOS compliance with GWR Project Permit (e.g., monitoring, O&M, source control, etc.) **Watermaster:** Resolution of any potential issues regarding inter-basin transfer of recycled water Changes to adjudication agreement to allow for additional pumping rights for new extraction wells	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12)	2

Concept Project	Regulatory/Permitting	Institutional	Related Technical Memoranda	Scoring 1 (low) – 5 (high)
	GWR Project Permit[4] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – new GWR project **CDPH Drinking Water Permits:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for AWP facility **Local Construction Permits/Easements:** • LADWP **CDFG Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)	**Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.		
MWc	**CEQA/NEPA:** • LADWP- for AWP at HTP, transmission infrastructure, extraction facilities, connection to drinking water system **Local Jurisdiction Excavation Permit(s)** (for tunnel): • LADWP **OSHA Authorization** (for the tunnel - a mining operation): • LADWP **HTP NPDES Permit:** • BOS – additional brine disposal to HTP outfall **GWR Project Permit**[4] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – new GWR project **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for AWP facility **Local Construction Permits/Easements:** • LADWP **CDFG Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)	**City of LA:** BOS compliance with GWR Project Permit (e.g., monitoring, O&M, source control, etc.) **LA County Department of Public Works (DPW)**: MOU between LADWP and DPW for use/operation of Central Basin spreading basins **Watermaster:** Resolution of any potential issues regarding inter-basin transfer of recycled water Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12)	2
MWd	**CEQA/NEPA:** • WBMWD - for transmission of HTP to AWP and AWP expansion	**Sales Agreement** (MOU or contract between LADWP and WBMWD): 1. Conditions for the sale of RW from	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment	2

[4] The RWQCB may elect to issue Water Recycling Requirements (WRRs) and/or Waste Discharge Requirements (WDR) for the groundwater recharge project. The existing recharge projects all have WRRs. The permit(s) is typically issued to the entity that operates the water recycling facility, the entity that operates spreading or injection facilities (in this case the Los Angeles County Department of Public Works), and any other entity that would be involved with the project, such as operation of extraction or monitoring wells.

Concept Project	Regulatory/Permitting	Institutional	Related Technical Memoranda	Scoring 1 (low) – 5 (high)
	• LADWP- for other transmission infrastructure, injection/extraction facilities, connection to drinking water system **WBMWD NPDES Permit:** • WBMWD – additional brine disposal to connection to HTP outfall **GWR Project Permit**[5] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP & WBWMD (and other sponsors) – new GWR project **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • WBMWD – for AWP facility **Local Construction Permits/Easements:** • LADWP **CDFG Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)	WBMWD AWP facility 2. WBMWD compliance with the GWR Project Permit (e.g., monitoring and O&M) 3. Infrastructure for transmission of RW to City boundary **City of LA:** BOS compliance with GWR Project Permit (e.g., monitoring, O&M, source control, etc.) **Watermaster:** Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12)	
MWe	**CEQA/NEPA:** • BOS or/and LADWP - for treatment facilities, including AWT • LADWP - for transmission infrastructure, injection/extraction facilities, connection to drinking water system **HTP NPDES Permit:** • BOS – additional brine disposal to HTP outfall **GWR Project Permit**[5] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – new GWR project **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for treatment facility **Local Construction Permits/Easements:** • LADWP **CDFG Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)	**City of LA:** BOS compliance with GWR Project Permit (e.g., monitoring, O&M, source control, etc.) **Watermaster:** Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12)	3

[5] The RWQCB may elect to issue Water Recycling Requirements (WRRs) and/or Waste Discharge Requirements (WDR) for the groundwater recharge project. The existing recharge projects all have WRRs. The permit(s) is typically issued to the entity that operates the water recycling facility, the entity that operates spreading or injection facilities (in this case the Los Angeles County Department of Public Works), and any other entity that would be involved with the project, such as operation of extraction or monitoring wells.

Concept Project	Regulatory/Permitting	Institutional	Related Technical Memoranda	Scoring 1 (low) – 5 (high)
MWf	**CEQA/NEPA:** • BOS or/and LADWP (?)- for treatment facilities, including AWT • LADWP - for transmission infrastructure, injection/extraction facilities, connection to drinking water system **CWC 1211 petitions:** • LACSD - for change in discharge to CBMWD from LACSD **HTP NPDES Permit:** • BOS – additional brine disposal to HTP outfall **GWR Project Permit**[6] (Includes Engineering Report, CDPH hearing, RWQCB permit hearing): • LADWP (and other sponsors) – new GWR project **LACDPH or CDPH Drinking Water Permits:** • LADWP - new production wells **LACDPH Well Construction Permit:** • LADWP – new production wells **USACE Permit:** • LADWP – for work on structures in, over or under navigable waters of the U.S. **AQMD Permits:** • BOS/LADWP – for treatment facility **Local Construction Permits/Easements:** • LADWP **CDFG Streambed Alteration Agreement:** • LADWP (potential if a GWR project impacts natural river flow, changes a river or stream channel, bed, or bank, or uses material from a streambed)	**Sales Agreement** (MOU or contract between LADWP and Central Basin): Conditions for the sale of RW **Los Angeles County Sanitation Districts (LACSD)** (MOU or contract between LADWP and LACSD for compliance with the GWR Project Permit (e.g., source control, monitoring and O&M) **Watermaster:** Changes to adjudication agreement to allow for additional pumping rights for new extraction wells **Outside agency recycled water rights:** Must resolve rights to use recycled water as stipulated in service agreements.	Regulatory Assessment TM (Task 1.1) Groundwater Replenishment Operational Scenarios TM (Task 1.3) Groundwater Assessment Support TM (Task 1.12)	2

[6] The RWQCB may elect to issue Water Recycling Requirements (WRRs) and/or Waste Discharge Requirements (WDR) for the groundwater recharge project. The existing recharge projects all have WRRs. The permit(s) is typically issued to the entity that operates the water recycling facility, the entity that operates spreading or injection facilities (in this case the Los Angeles County Department of Public Works), and any other entity that would be involved with the project, such as operation of extraction or monitoring wells.

Appendix K

Potential Impacts of Brine-Concentrate Discharges

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1. Potential Impacts of Brine-Concentrate Discharges

This appendix describes analyses conducted to estimate the potential impacts of brine-concentrate discharges from the various advanced treatment options. To assess these potential impacts, a spreadsheet model was developed to calculate the flows and discharges for the various long-term options being considered. These options included expansion of the City's existing treatment plants to provide advanced treatment, construction of new satellite plants, and local and regional indirect potable reuse.

Advanced treatment processes for recycled water typically involve a RO process, which produces concentrated waste streams. These brine-concentrate discharges typically contain high concentrations of total dissolved solids (TDS), heavy metals, and other constituents. Discharging the brine-concentrate flows into existing sewer lines can have impacts on the treatment processes of downstream wastewater treatments plants, recycled water quality, and/or effluent discharge water quality.

For this analysis, only TDS and biochemical oxygen demand (BOD) levels were analyzed. TDS levels were analyzed because of the potential impacts to the WBMWD's ELWRF, which has been receiving increased TDS levels in secondary effluent from the HTP in recent years. There is potential concern that brine-concentrate flow discharges into the Hyperion sewershed system could further increase the TDS concentrations received at the ELWRF, which could impact both WBMWD and LADWP recycled water customers that are served from the plant. BOD levels are also analyzed to assess the potential impacts to the BOD loading at HTP, which could affect the existing treatment processes.

Previous studies have examined the existing ocean discharge requirements at HTP. Several discharge water quality parameters, including copper, could be impacted by the implementation of additional upstream water recycling that increases brine-concentrate flows to the sewer. However, these were not analyzed as part of this study. Additional data would be required to determine the existing levels in each upstream sewershed and to ascertain whether these constituents are affected or concentrated by the MF/RO processes.

1.1 Overview of Model

The purpose of the spreadsheet model is to project the TDS concentration and BOD load on the HTP for different scenarios of treatment plant expansions and new satellite plants. The model performs mass balance calculations based on the projected flows in and out of each plant.

Flows are determined by the projected sewer flows within the Hyperion sewershed and by the projected recycled water treatment level for each plant, based on the defined scenarios. TDS levels are based on the existing TDS concentrations in the Hyperion sewershed and an assumed RO concentration factor for the advanced treatment plants producing recycled water under each scenario.

Because BOD is removed by primary and secondary processes, BOD levels are not significantly concentrated by MF/RO systems; however, as result of treatment plant expansions and new satellite plants, the BOD load to the HTP would change under the various scenarios. The BOD load to the HTP would decrease if a new upstream treatment plant were constructed because the additional primary and secondary processes would reduce some of the BOD load that is currently treated at HTP.

While set up for analysis of only TDS and BOD, the spreadsheet model could easily be adapted to determine the concentration levels of other water quality parameters such as copper, ammonia, ***N*-**Nitrosodimethylamine (NDMA), and arsenic. Additional information on the existing sewer concentration levels for these parameters and the amount of additional concentration that occurs in the MF/RO processes would be required to conduct such analyses.

1.2 Analysis Framework

This analysis includes the wastewater flows into and out of Hyperion Service Area, including the wastewater flows into the DCTWRP, the VSL/FA sewershed, the LAGWRP sewershed, the Hyperion Tunnel sewershed, the Hyperion Coastal sewershed, and the Hyperion Metro sewershed. Currently all the wastewater flow generated in the Hyperion Service Area is treated at three existing treatment plants: DCTWRP, LAGWRP, and HTP. HTP receives all the biosolids return flows from DCTWRP and LAGWRP.

The spreadsheet model uses currently available flow and TDS data from 2008-2009. Future sewer flows are based on the 2040 projections identified in the Task 5.1.1 Wastewater Flow Projections Technical Memorandum.

1.2.1 Assumptions

To project the future wastewater flows and the TDS concentrations associated with future wastewater flows, the following assumptions were made as part of the analysis:

1. The total average day 2040 Hyperion Service Area sewershed flow is 412.9 mgd. Only the average day flows are considered in the analysis. Wet weather or seasonal peak flows are assumed not to be available for recycled water use as they would require additional treatment capacity and would occur during off-peak seasonal demand periods. Additional analysis would be required to assess the feasibility of adding additional treatment or seasonal storage to utilize the peak flows for recycled water.
2. Average influent TDS level at each of the existing plants or sources is:
    - DCTWRP Tertiary Supply- 597 mg/l
    - LAGWRP Tertiary Supply - 832 mg/l
    - LVMWD Tertiary Supply - 827 mg/l
    - CBMWD Tertiary Supply – 509 mg/l
    - BWP Tertiary Supply – 634 mg/l
3. TDS concentrations in wastewater flows remain the same even though the flow increases. This is assuming the proportion and water quality of wastewater will remain the same.
4. Total Suspended Solids flows are 5.5 percent of the total sewage flow.
5. All AWP processes include MF/RO.

6. MF treatment processes have a backwash reject flow of 7 percent and RO treatment processes have a reject flow of 15 percent. Both the MF reject flow and the RO reject flow are considered to constitute the brine-concentrate flow.
7. The TDS removal rate of RO treatment process is 98 percent.
8. No TDS removal occurs as part of the primary and secondary treatment processes.
9. A minimum discharge of 27 mgd will be maintained from the DCTWRP to the Los Angeles River.
10. No minimum discharge from the LAGWRP to the Los Angeles River is required.
11. Title 22 recycled water volumes from the DCTWRP and LAGWRP plants include only the existing and planned users. No expansion of potential uses is assumed for either plant in any scenario.
12. According to WBMWD's recently completed Recycled Water Master Plan (2010), the existing average day secondary effluent demand at the ELWRP is 20.5 mgd, allowing the AWP facilities to produce 9.5 mgd of AWP water. Brine-concentrate from this plant is returned to HTP's ocean outfall. The long-term future average day secondary effluent demand is 58.0 mgd, which would allow the AWP facilities to produce 15.0 mgd of AWP water.

1.2.2 Scenarios

Six 2040 projection scenarios were developed as part of the long-term reuse options with the Hyperion Service Area (**Table 1-1**). These scenarios range from a minimal increase in recycled water use to a "max reuse" approach to recycled water.

Table 1-1: 2040 Project Scenarios

No.	Scenario	Description
1	**2040 Baseline**	The baseline scenario is based on 2040 wastewater flow projections along with only existing and Tier 1 recycled water uses. It is assumed that no advanced treatment processes are added to the existing treatment plants in the Hyperion Service Area and no new satellite plants are constructed. For this scenario, it is assumed that all the tertiary recycled flow generated from DCTWRP and LAGWRP is utilized either for recycled water customers or as discharge to the Los Angeles River.
2	**With DCTWRP**	This scenario includes the 2040 wastewater flows and Title 22 recycled water use projections indicated in Scenario No.1. In addition, 29.3 mgd of advanced treatment process to the DCTWRP plant is also included as part of the groundwater recharge project.
3	**With LAGWRP**	This scenario includes the flow projections in Scenario No. 2 along an expansion of the tertiary process at the LAGWRP plant. All excess Title 22 recycled water not utilized for existing and Tier 1 users at the LAGWRP plant is conveyed to the DCTWRP for advanced treatment as part of an expanded groundwater recharge project.
4	**With Metro Satellite**	This scenario includes all the flow conditions set forth in Scenario No. 3 and adds a new Metro Satellite Plant. The Metro Satellite Plant is sized to produce 50,000 AFY of advanced treated recycled water flow.
5	**With Other Agencies**	This scenario includes all the flow conditions indicated in Scenario No. 4 and adds additional advanced treatment capacity at the DCTWRP and Metro Satellite Plants. Additional tertiary water to supply the increased advanced treatment capacity at the DCTWRP plant is provided by supplies from BWP and LVMWD. Additional flow to the Metro Satellite Plant is supplied from the CBWMD.
6	**With AWP at HTP**	This scenario includes all the flow conditions indicated in Scenario No. 5 with the addition of advanced treatment processes at HTP. For this scenario, all remaining secondary treated flow from HTP will be conveyed to the new advanced treatment plant for use in groundwater recharge in the Central Basin or elsewhere. This scenario would utilize all available average day flows to the HTP, such that only brine-concentrate waste streams from this new plant and from WBMWD's ELWRF would be discharged to the City's ocean outfall.

1.2.3 Inputs

The model consists of two types of inputs. The first type are constant and do not change for different scenario runs. The second type are variable and change based on different the scenario.

The constant inputs include the following:

1. Tertiary flow delivery to Los Angles River (LAR) – 27 mgd
2. Internal tertiary reuse at DCTWRP – 2 mgd
3. Existing/Tier 1 Title 22 Reuse from DCTWRP – 8.8 mgd (9,834 AFY)
4. Existing/Tier 1 Title 22 Reuse from LAGWRP – 5.3 mgd (5,900 AFY) for LA Customers
5. Committed capacity from LAGWRP to Glendale Water and Power system – 10 mgd

The variable inputs are the main inputs for the analysis, and they varied depending on the scenario. The variable inputs for each scenario are shown in **Table 1-2** through **Table 1-7**.

Scenario No. 1 Inputs

Scenario No. 1 is the baseline scenario and assumes no change in the treatment processes at the wastewater treatment plants in the Hyperion Service Area. The purpose of this scenario is to estimate the TDS concentration of the HTP influent for the 2040 wastewater flow projection, with only existing and Tier 1 recycled water users connected.

Table 1-2: Scenario No. 1 Inputs

Plant/Source (Usage)	Flow Type	2040 Projection Scenario (Average Daily Flow)	
		Baseline[1]	
		MGD	AFY
DCTWRP			
Internal Reuse	Tertiary RW Usage	2.0	2,240
Min. Tertiary Reuse	Tertiary RW Usage	8.8	9,834
Delivery to LAR	Tertiary RW	27.0	30,244
LAGWRP			
LAGWRP (Inflow)	Inflow (ADWF)	20.0	22,403
WBMWD-ECL Plant			
Tertiary	Tertiary RW Feed	20.5	22,963
RO	AWP RW Product	9.5	10,641

1. Baseline is the 2040 projection with only existing and Tier 1 recycled water users connected and no expansion of upstream WRPs.

Scenario No. 2 Inputs

Scenario No. 2 includes implementation of advanced treatment at DCTWRP. This scenario assumes the advanced treatment plant at DCTWRP will be sized for the available tertiary recycled water flow at DCTWRP after serving the tertiary recycled water demands and the LAR delivery of 27 mgd.

Table 1-3: Scenario No. 2 Inputs

Plant/Source (Usage)	Flow Type	2040 Projection Scenario (Average Day Flow)	
		MGD	AFY
DCTWRP			
Internal Reuse	Tertiary RW Usage	2.0	2,240
Min. Tertiary Reuse	Tertiary RW Usage	8.8	9,834
Delivery to LAR	Tertiary Water	27.0	30,244
DCTWRP (RO)	AWP RW Usage	29.3	32,820
LAGWRP			
LAGWRP (Inflow)	Inflow (ADWF)	20.0	22,403
WBMWD-ECL Plant			
Tertiary	Tertiary RW Feed	58.0	64,968
RO	AWP RW Product	15.0	16,802

Scenario No. 3 Inputs

This scenario includes conveying tertiary treated water from LAGWRP to DCTWRP for advanced treatment. This scenario assumes that LAGWRP will be expanded to produce tertiary recycled flow up to 44 mgd. The excess tertiary recycled water produced at LAGWRP will be conveyed to DCTWRP for advanced treatment and reused for groundwater recharge.

Table 1-4: Scenario No. 3 Inputs

Plant/Source (Usage)	Flow Type	2040 Projection Scenario (Average Day Flow)	
		MGD	AFY
DCTWRP			
Internal Reuse	Tertiary RW Usage	2.0	2,240
Min. Tertiary Reuse	Tertiary RW Usage	8.8	9,834
Delivery to LAR	Tertiary RW	27.0	30,244
DCTWRP (RO)	AWP RW Usage	29.3	32,820
LAGWRP Tertiary	Feed to RO	Max. Avail. Flow.	Max. Avail. Flow.
LAGWRP			
LAGWRP (Inflow)	Inflow (ADWF)	44.0	49,286
WBMWD-ECL Plant			
Tertiary	Tertiary RW Feed	58.0	64,968
RO	AWP RW Product	15.0	16,802

Scenario No. 4 Inputs

Scenario No. 4 assumes all the process upgrades described in the previous scenario along with construction of a new Metro Satellite Plant. The Metro Satellite Plant will have capacity to produce advanced treated recycled water up to 50,000 AFY.

Table 1-5: Scenario No. 4 Inputs

Plant/Source (Usage)	Flow Type	2040 Projection Scenario (Average Day Flow)	
		MGD	AFY
DCTWRP			
Internal Reuse	Tertiary RW Usage	2.0	2,240
Min. Tertiary Reuse	Tertiary RW Usage	8.8	9,834
Delivery to LAR	Tertiary RW	27.0	30,244
DCTWRP (RO)	AWP RW Usage	29.3	32,820
LAGWRP Tertiary	Feed to RO	Max. Avail. Flow.	Max. Avail. Flow.
LAGWRP			
LAGWRP (Inflow)	Inflow (ADWF)	44.0	49,286
Metro Satellite Plant			
Metro (RO)	AWP RW Usage	44.6	50,000
WBMWD-ECL Plant			
Tertiary	Tertiary RW Feed	58.0	64,968
RO	AWP RW Product	15.0	16,802

Scenario No. 5 Inputs

This scenario assumes additional advanced treatment plant expansion at DCTWRP. Additional tertiary recycled water flow from BWP and LVMWD will be conveyed to DCTWRP for advanced treatment. For this scenario, it is assumed that DCTWRP will receive 2,500 AFY of tertiary recycled water flow from LVMWD and 5,000 AFY of tertiary recycled water flow from BWP. This scenario also includes 5,000 AFY of the tertiary recycled water flow from CBMWD to the new Metro Satellite Plant.

Table 1-6: Scenario No. 5 Inputs

Plant/Source (Usage)	Flow Type	2040 Projection Scenario (Average Day Flow)	
		MGD	AFY
DCTWRP			
Internal Reuse	Tertiary RW Usage	2.0	2,240
Min. Tertiary Reuse	Tertiary RW Usage	8.8	9,834
Delivery to LAR	Tertiary RW	27.0	30,244
DCTWRP (RO)	AWP RW Usage	29.3	32,820
LAGWRP Tertiary	Feed to RO	Max. Avail. Flow.	Max. Avail. Flow.
LVWMD Tertiary	Feed to RO	2.2	2,500
BWP Tertiary	Feed to RO	4.5	5,000
LAGWRP			
LAGWRP (Inflow)	Inflow (ADWF)	44.0	49,286
Metro Satellite Plant			

Metro (RO)	AWP RW Usage	44.6	50,000
CBMWD (RO)	Feed to RO	4.5	5,000
WBMWD-ECL Plant			
Tertiary	Tertiary RW Feed	58.0	64,968
RO	AWP RW Product	15.0	16,802

Scenario No. 6 Inputs

This scenario includes addition of advanced treatment plant at HTP to treat all the secondary treated recycled water flow into the plant. This scenario will reduce the secondary discharge flow to the HTP ocean outfall such that it only contains brine-concentrate from this new advanced treatment plant and from WBWMD's ELWRF.

Table 1-7: Scenario No. 6 Inputs

Plant/Source (Usage)	Flow Type	2040 Projection Scenario (Average Day Flow)	
		MGD	AFY
DCTWRP			
Internal Reuse	Tertiary RW Usage	2.0	2,240
Min. Tertiary Reuse	Tertiary RW Usage	8.8	9,834
Delivery to LAR	Tertiary RW	27.0	30,244
DCTWRP (RO)	AWP RW Usage	29.3	32,820
LAGWRP Tertiary	Feed to RO	Max. Avail. Flow.	Max. Avail. Flow.
LVWMD Tertiary	Feed to RO	2.2	2,500
BWP Tertiary	Feed to RO	4.5	5,000
LAGWRP			
LAGWRP (Inflow)	Inflow (ADWF)	44.0	49,286
Metro Satellite Plant			
Metro (RO)	AWP RW Usage	44.6	50,000
CBMWD (RO)	Feed to RO	4.5	5,000
AWP at HTP			
RO	AWP RW Feed	Max. Avail. Flow.	Max. Avail. Flow.
WBMWD-ECL Plant			
Tertiary	Tertiary RW Feed	58.0	64,968
RO	AWP RW Product	15.0	16,802

1.3 Analysis Results

The model analyzes the following:

- Total recycled water usage for different scenarios
- TDS concentration for HTP influent if no brine line constructed
- Separate brine-concentrate flows and non-brine-concentrate flows at the influent of HTP if a brine line is constructed

- Brine-concentrate flows and non-brine-concentrate flows at the influent of HTP if the Valley Groundwater Purification Project is implemented
- BOD concentrations in the HTP influent flow for each scenario

1.3.1 Total Recycled Water Reuse

The model projects the tertiary and advanced treated recycled water uses at the different treatment plants for each scenario. The recycled water reuse projections are shown in **Table 1-8**. For DCTWRP, it is assumed that tertiary recycled water usage will remain constant and the advanced treated recycled water flow will increase as additional flows are conveyed from other treatment plants to DCTWRP.

Table 1-8: Recycled Water Usage Summary

Treatment Plant/ Parameter	Average Annual Flows (AFY)					
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6
	Baseline[1]	With DCTWRP	With LAGWRP	With Metro Satellite	With Other Agencies	With AWP at Hyp.
DCTWRP						
Total Tertiary Reused	9,834	9,834	9,834	9,834	9,834	9,834
Total Advanced Water Reused[2,3]	0	32,820	56,916	56,916	62,845	62,845
Total Reuse	9,834	42,654	66,750	66,750	72,679	72,679
LAGWRP						
Total Tertiary Reused	5,900	5,900	5,900	5,900	5,900	5,900
Total Advanced Water Reused	0	0	0	0	0	0
Total Reuse	5,900	5,900	5,900	5,900	5,900	5,900
Metro Satellite Plant						
Total Tertiary Reused	0	0	0	0	0	0
Total Advanced Water Reused[2]	0	0	0	50,000	53,953	53,953
Total Reuse	0	0	0	50,000	53,953	53,953
AWP at HTP						
Total Advanced Water Reused	0	0	0	0	0	155,796
Totals						
Total Tertiary Reused	15,734	15,734	15,734	15,734	15,734	15,734
Total Advanced Water Reused[3]	0	32,820	56,916	106,916	116,798	272,594
Total Reuse	15,734	48,554	72,650	122,650	132,531	288,328

Note:

1. Baseline is the 2040 projection with only existing and Tier 1 recycled water users connected and no expansion of upstream WRPs.
2. Includes tertiary flow from CBMWD to the Metro Satellite Plant for advanced treatment in Scenarios 5 and 6.
3. Includes tertiary flows from BWP and LVMWD to DCTWRP for advanced treatment in Scenario 6 and from LAGWRP in Scenarios 3 through 6.

1.3.2 HTP TDS Levels - No Brine Line Option

As the total amount of reuse increases in Scenarios 1 through 6, the HTP influent flow decreases from 356 mgd to 265 mgd. The increase in the advanced treated recycled water reuse results in increased brine-concentrate discharges with higher TDS concentrations into the Hyperion Service Area. The LARWQCB permit limits for WBMWD currently stipulate a maximum TDS level of 800 mg/l (Order No. 01-043, March 19, 2001).

Mitigation of TDS increases may be required to serve future Title 22 recycled water customers. **Table 1-9** shows the projected HTP influent and effluent flows, the TDS concentration in the influent and effluent flows, and the flow and TDS concentration to the City's ocean outfall. Since WBMWD has a separate outfall permit, the outfall values include both the HTP-only outflows and the combined (LA and WBMWD) outflows.

Table 1-9: HTP Average Daily Flow and TDS Summary

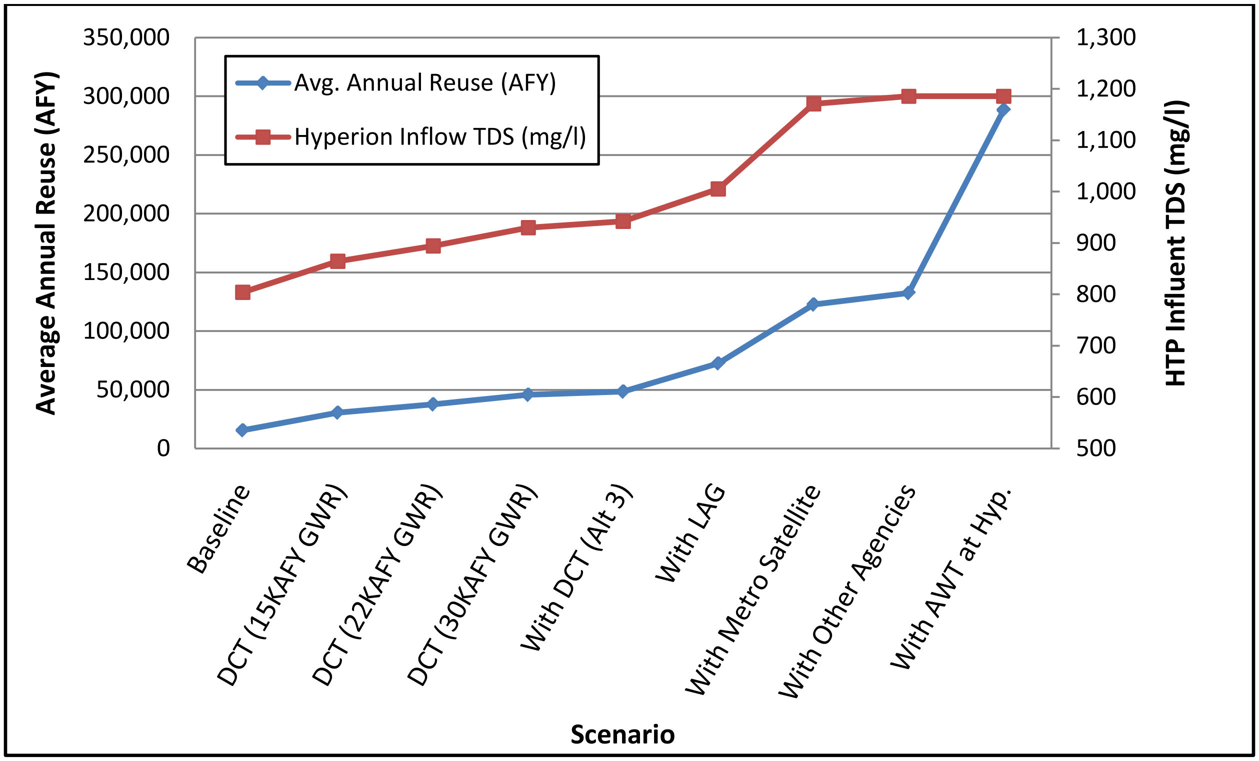
Parameter	Average Daily Flows and TDS Levels					
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6
	Baseline[1]	With DCTWRP	With LAGWRP	With Metro Satellite	With Other Agencies	With AWP at HTP
HTP Inflow (mgd)	356	327	310	265	268	268
HTP Inflow TDS (mg/l)	804	943	1,005	1,171	1,186	1,186
HTP Outflow (Not including WBMWD return flows) (mgd)	304	232	216	174	176	37
HTP Outflow TDS (Not including WBMWD return flows) (mg/l)	804	943	1,005	1,171	1,186	5,557
HTP Outfall (Including WBMWD) (mgd)	307	236	220	178	180	41
HTP Outfall TDS (Including WBMWD) (mg/l)	829	1,001	1,072	1,267	1,283	5,557

Note:

1. Baseline is the 2040 projection with only existing and Tier 1 recycled water users connected and no expansion of upstream WRPs.

As shown in **Table 1-9**, the HTP influent TDS levels increase from around 800 mg/l currently to over 1,200 mg/l with additional advanced treatment occurring upstream of the HTP. Additional analysis was conducted to examine the potential TDS impacts under an indirect potable reuse groundwater recharge project from the DCTWRP plant. Under these conditions, as in Scenario 1, no other reuse projects beyond the existing and Tier 1 customers were included. Three level of groundwater recharge were evaluated: 15,000, 22,000, and 30,000 AFY. **Figure 1-1** shows a graph of the long-term and near-term recycled water levels and the projected HTP Influent TDS levels. As shown in the graph, there is a consistent impact on TDS as upstream advanced treatment reuse projects are increased.

Figure 1-1: Recycled Water Usage vs. TDS Levels at HTP



1.3.3 HTP TDS Levels – Brine Line Option

Constructing a brine line to convey the brine-concentrate flow separately from sewer flows is considered an alternative option for brine-concentrate disposal. It would prevent increasing TDS concentrations from limiting the expansion of the upstream or downstream treatment plants. **Table 1-10** shows the total non-brine-concentrate and brine-concentrate flows for the different long-term scenarios under consideration.

This option assumes that all brine-concentrate flows will be conveyed separately from the sewer flow. By separating the brine-concentrate flow, the TDS concentration of the influent flow to the HTP will increase by minimal amounts. The reason the TDS levels increase is because the DCTWRP, LAGWRP, and New Metro Satellite plants are pulling lower TDS sewerage water from the Hyperion Service Area. Thus, the average TDS level in the flows going to the HTP increase due to the higher TDS levels in the sewersheds downstream of the DCTWRP, LAGWRP, and Metro Satellite plants.

Table 1-10: HTP Average Daily Flow and TDS Summary

With Brine Line Bypass (MF and RO Reject Streams Only, No Biosolids)						
Parameter	Average Daily Flows and TDS Levels					
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6
	Baseline[1]	With DCTWRP	With LAGWRP	With Metro Satellite	With Other Agencies	With AWP at Hyp.
Flow into HTP (Non-Brine-Concentrate Flows)						
HTP Inflow (mgd)	~~319~~	319	296	240	240	240
HTP Inflow TDS (mg/l)	~~898~~	898	908	926	928	928
Brine Line Flows						
HTP Inflow (mgd)	0	8	13	25	28	28
HTP Inflow (gpm)	0	5,392	9,352	17,567	19,190	19,190
TDS (mg/l)	N/A	2,797	3,147	3,497	3,431	3,431
Total Flows (Non-Brine Line + Brine Line)						
HTP Baseline TDS (mg/l)	900	900	900	900	900	900
Secondary Effluent (mgd)	~~269~~	232	216	174	176	0
Secondary Effluent TDS (mg/l)	~~898~~	943	1,005	1,171	1,186	N/A

Note:

1. Baseline is the 2040 projection with only existing and Tier 1 recycled water users connected and no expansion of upstream WRPs.

1.3.4 HTP TDS Levels - Valley Groundwater Purification Option

The Valley Groundwater Purification Project is another potential future brine-concentrate generating project that the City is currently considering. This project is projected to produce 8.6 mgd of brine-concentrate waste with an average TDS of 4,040 mg/l. As part of this project, the City is considering conveying the brine-concentrate generated from the cleanup project into a separate brine line that would convey the flows to the HTP's ocean outfall. Brine-concentrate flows from the advanced treatment process at DCTWRP and the New Metro Satellite plants would also be conveyed in this brine line from the Valley Groundwater Cleanup Project. The brine-concentrate flows from the expansion of upstream treatment plants and the Valley Groundwater Purification Project are listed in **Table 1-11**. Implementation of this brine line would avoid increases in TDS at the HTP.

Table 1-11: Brine Line and Non-Brine Line Flows with Groundwater Cleanup Brine Line

Parameter	Average Daily Flows and TDS Levels					
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6
	Baseline[1]	With DCTWRP	With LAGWRP	With Metro Satellite	With Other Agencies	With AWP at Hyp.
Brine Line Flows						
Brine Line Flows (mgd)	0	9	9	9	9	9
Brine-Concentrate TDS	N/A	4,040	4,040	4,040	4,040	4,040
Flow into HTP (Non-Brine-Concentrate Flows)						
HTP Inflow (mgd)	~~319~~	319	296	240	240	240
HTP Inflow TDS (mg/l)	~~898~~	898	908	926	928	928
Brine Line Flows						
HTP Inflow (mgd)	0	16	22	34	36	36
HTP Inflow (gpm)	0	11,392	15,352	23,567	25,190	25,190
TDS (mg/l)	N/A	3,451	3,496	3,635	3,576	3,576
Total Flows (Non-Brine Line + Brine Line)						
HTP Baseline TDS (mg/l)	900	900	900	900	900	900
Secondary Effluent (mgd)	~~269~~	232	216	174	176	0
Total Secondary Effluent TDS (mg/l)	~~898~~	943	1,005	1,171	1,186	N/A

Note:

1. Baseline is the 2040 projection with only existing and Tier 1 recycled water users connected and no expansion of upstream WRPs.

1.3.5 BOD Analysis Results

The impacts of increasing reuse at upstream treatment plants can slightly reduce BOD loading at the downstream HTP. This is due to conversion of some BOD to carbon dioxide during primary and secondary treatment process at the upstream treatment plants. Although the BOD loading (lbs. per day) in the HTP influent flow decreases under these scenarios, the concentration of BOD in the HTP influent will increases because the influent flow is reduced as upstream reuse increases. The BOD loading and concentration for the different long-term scenarios are shown in **Table 1-12**.

Table 1-12: HTP Influent BOD Loadings

Parameter	Average Daily Flows and BOD Levels					
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6
	Baseline1	With DCTWRP	With LAGWRP	With Metro Satellite	With Other Agencies	With AWP at HTP
HTP Inflow (mgd)	~~319~~	327	310	265	268	268
Influent BOD (lbs/day)	980,486	980,486	955,266	892,475	892,475	892,475
Influent BOD (mg/l)	330	360	370	403	400	400

Note:

1. Baseline is the 2040 projection with only existing and Tier 1 recycled water users connected and no expansion of upstream WRPs.

1.4 Long-Term Brine-Concentrate Management Options

Maximizing the recycled water production by expanding the City's existing treatment plants to provide advanced treatment or constructing a new satellite plant generates a large amount of brine-concentrate flows with high TDS concentrations. Section 1.3 analyzes and presents the possible impacts these brine-concentrate flows may have on the HTP influent flows and the subsequent product water sent to the WBMWD's ELWRF.

There are several possible options for mitigating the increased TDS to the HTP. These include the previously discussed brine line, as well as blending of advanced treated water with tertiary or secondary flows, separation of high TDS from low TDS sewershed systems that inflow to the HTP, and zero liquid discharge (ZLD).

1.4.1 New Brine Line(s)

As discussed in Sections 4.4.3 and 4.4.4, constructing of a separate brine line would reduce the TDS concentration of the HTP influent flow. This option includes building a brine line(s) from the MF/RO processes at the DCTWRP and Metro Satellite plants to the existing HTP ocean outfall. This line would bypass the HTP treatment processes. A separate ocean discharge permit similar to WBMWD's could be obtained to offset the concentrated discharges.

Another possibility under this option would be to utilize the existing tunnel between DCTWRP and HTP for brine-concentrate disposal. Currently, sewer flow from DCTWRP can be conveyed through a sewer line that bypasses the LAGWRP plant or through the existing tunnel. This option considers the possibility of converting the tunnel for brine-concentrate flow conveyance only. This option may require analysis of the capacity and reliability of alternative sewer piping and modifications to the existing sewer connections that are tied directly to the tunnel. This option would likely require extension of this sewer line to HTP where it would connect directly to the ocean outfall. A separate lateral from any New Satellite Plant(s) would need to be constructed to tie into this line, or directly to the ocean outfall.

1.4.2 Redirection and Separation of High TDS Inflows to HTP

This option would involve redirection or elimination of high TDS sewersheds or brine-concentrate discharges into the Hyperion sewershed from the upstream plants. The coastal sewershed in the Hyperion Service Area has relatively higher TDS levels. With some infrastructure improvements, it might be possible to route these flows and/or the sewer lines that would convey the brine-concentrate from the MF/RO processes into separate treatment trains at HTP and avoid their contribution to the ELWRF. However, this option could be extremely difficult to implement because of the infrastructure improvement costs and the need to create separate treatment trains at the HTP. In addition, in some scenarios, that sewerage flow may be needed to fully meet WBMWD's secondary flow needs. This option is not likely to be feasible compared to other options, including a dedicated brine line.

1.4.3 Sidestream RO Treatment at HTP or WBMWD

To mitigate the increased TDS levels to the WBMWD's WRP, this option would provide a small advance treatment facility at HTP to blend with secondary flows to WBMWD. This would provide for a lower and more consistent TDS concentration in the flow to ELWRF. A variation of this option involves WBMWD expanding its advanced treatment capacity to blend down the TDS levels in tertiary recycled water to acceptable customer and permit levels. This would create more brine-concentrate discharge from WBMWD and might require WBMWD to request modification of its current ocean discharge permit.

1.4.4 Send Brine-Concentrate to Joint Water Pollution Control Plant

Conveyance of some or all of the brine-concentrate flow to the Sanitation Districts of Los Angeles County's Joint Water Pollution Control Plant (JWPCP) in Carson would reduce TDS concentrations at HTP and WBMWD. This may not be practical for the advanced treatment plant at the DCTWRP, but such a brine line from a new Metro Satellite plant could be feasible.

1.4.5 Brine-Concentrate Reduction and Zero Liquid Discharge Technologies

Along with the above mentioned brine-concentrate disposal options, there are other technologies available that could be used to reduce or eliminate the brine-concentrate flows from the upstream advanced treatment plants. Concentrating technologies such as electrodialysis/electrodialysis reversal (ED/EDR), VSEP membrane systems, precipitative softening (PS)/RO, vertical tube falling film evaporation (VTFFE), and HERO membrane system (HERO) can reduce the brine-concentrate disposal stream and provide additional recovery of recycled water. However, these processes only reduce the flow, and hence the TDS and other constituents are concentrated even further. This would further impact the water quality of the inflow to the HTP.

Such volume reducing technologies might be considered in conjunction with a brine line as the brine line size could be reduced. This cost savings would need to be evaluated in comparison to the high capital and often very high operation and maintenance costs of the volume reduction technologies. Wetlands and evaporation ponds can also be used to reduce or even eliminate liquid residual flows. However, they require a very large space for even smaller flows. Given the urban environment of the Los Angeles area and the potentially large brine-concentrate flows, such technologies are not likely to be feasible.

Therefore, the only feasible ZLD technologies would include one or more volume reduction processes that would treat the MF/RO reject streams followed by a crystallizer. A crystallizer would eliminate the remaining liquid stream and produce a dry salt that would require landfill disposal. The ZLD options are extremely expensive to construct, expensive and often challenging to operate and maintain, require additional space, and not all ZLD options may be permissible in some areas due to their height or other potential permitting restrictions. Such options would need to be evaluated in comparison to a brine line.

1.4.6 Deep Well Injection

The other possible brine-concentrate disposal option is deep well injection. Such an option has only been implemented in very saline groundwater basins or in oil well fields that are either abandoned or have available capacity. It is not likely that such options could be considered in the Los Angeles Basin or in the San Fernando Valley because of the deep groundwater basins.

1.5 Capital Cost Estimates

Table 1-13 shows a preliminary estimate of the order-of-magnitude costs for two of the potential brine-concentrate management options. This includes the brineline and sidestream RO options. A more extensive analysis of the HTP treatment processes and sewage networks would be necessary to develop a cost estimate for the option to redirect and separate the brine-concentrate flows at HTP.

Table 1-13: Brine-Concentrate Management Options Cost Summary

Brine-Concentrate Management Option	Estimated Capital Costs					
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6
	Baseline [1]	With DCTWRP	With LAGWRP	With Metro Satellite	With Other Agencies	With AWT at HTP
Brineline options from DCTWRP and Metro Satellite Plants to HTP						
1. Construct New Tunnel	N/A	$128 M	$144M	$182M	$192M	$192M
2. Use Existing Tunnel[2]	N/A	$107M	$120M	$159M	$166M	$166M
Sidestream RO Treatment of West Basin Supply at Hyperion	N/A unless TDS rises	$95M	$128M	$198M	$203M	$203M

Note:

1. Baseline is the 2040 projection with only existing and planned recycled water users connected and no expansion of upstream WRPs.
2. Potential additional costs for diverting existing sewer flows out of the Hollywood Hills tunnel are unknown and would likely increase the cost of these options.

The brineline options would involve two separate options for construction of brinelines from the DCTWRP to the HTP and where applicable, from the Metro Satellite plant to HTP. The first sub-option includes the cost of a completely new brineline from DCTWRP to HTP. The second sub-option might be possible if enough sewage flow was diverted for reuse at DCTWRP and/or could be diverted out of the existing tunnel through the Hollywood Hills and into the BOS's existing and proposed sewers that extend westward out of the San Fernando Valley. More extensive analyses would be necessary to determine the peak flows and projected sewer capacities for this option to work. Additional effort to divert and isolate the existing tunnel from the existing and/or proposed sewer lines may be necessary to convert the tunnel section to a brine only line.

The order-of-magnitude cost estimates for the brinelines and the sidestream RO options were developed based on the Cost Estimating TM and include implementation (30%) and construction contingency (30%) cost factors.

Based on these preliminary cost estimates, the sidestream RO option is the lower in capital cost for scenarios where the amount of advanced treated recycled water (and hence brine-concentrate production) is lower (Scenarios 2 and possibly 3). However, as the amount of brine-concentrate treatment is increased, it is likely that the brineline option could be lower in capital costs. In the short-term it may be more cost-effective to install a sidestream RO plant to reduce any potential high TDS levels in the supply of water to West Basin. In the long-term, dedicated brinelines may be more cost effective as larger advanced treated recycled water projects are implemented. As noted above, additional analysis is recommended to further evaluate these options in more detail to better assess the implementation issues and specific infrastructure needs of each option.

1.6 Conclusions

In the near term, it is not likely that implementation of upstream advanced treatment at the DCTWRP will impact the influent TDS of the HTP or of secondary effluent conveyed to WBMWD's ELWRF and recycled water conveyed to customers, which include LADWP customers. This is particularly true in light of recent variability experienced at the HTP and ELWRF plants due to changes in regional water supplies and ongoing customer water conservation efforts. However, as additional long-term advanced treatment capacities are increased at DCTWRP or other facilities, there could be a significant impact to the TDS levels at HTP and ELWRF.

No simple solution exists to address this potential problem. Several possible solutions were analyzed or discussed, and include advanced treatment polishing of HTP secondary flows to ELWRF, dedicated brine lines, and ZLD disposal options. These will need to be further evaluated based on the potential of future advanced recycled water treatment projects. Additional water quality parameters will be concentrated as a result of upstream advanced treatment and brine-concentrate discharges to the Hyperion Service Area. These should be looked at in more detail as part of any future study assessing additional advanced treatment options to ensure that the City's ocean discharge permit will not be violated or that it can be adjusted to reflect the increased parameter concentrations that result from additional reuse.

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