City of Lancaster

Groundwater Recharge Feasibility Study

Prepared by:

RMC
Water and Environment

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Acknowledgements

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List of Abbreviations

ADA	Anti-degradation analysis
afy	Acre-feet per year
AGR	Agricultural Supply
AOP	Advanced Oxidation Process
AVSWCA	Antelope Valley State Water Contractors Association
ASR	Aquifer storage and recovery
AVEK	Antelope Valley-East Kern Water Agency
AVTTP	Antelope Valley Tertiary Treatment Plant
Basin Plan	Lahontan Basin Plan / Water Quality Control Plan
BPA	Basin Plan amendment
ccf	Hundred cubic foot
CCR	California Code of Regulations
CECs	Chemicals of Emerging Concern
CEQA	California Environmental Quality Act
CIP	Capital Improvement Program
City	City of Lancaster
County DHS	Los Angeles County Department of Health Services
CWC	California Water Code
LACSD	County Sanitation District of Los Angeles County
LACSD No. 14	County Sanitation District No. 14 of Los Angeles County
DDB	DDB Engineering, Inc.
DHS	California Department of Health Services
DWR	Department of Water Resources
DHS	Department of Health Services
EAFB	Edwards Air Force Base
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ft-msl	Feet above mean sea level
FRSH	Freshwater Replenishment
GAC	Granular Activated Carbon
GAVEA	Greater Antelope Valley Economic Alliance
GIS	Geographical Information System
gpd	Gallons per day
GV	Groundwater Vistas

GWR	Groundwater recharge
GWR-RW	Groundwater recharge using recycled water
GWRJPA	Groundwater Recharge Joint Powers Authority
HAA	Haloacetic acids
i	Groundwater gradient
IND	Industrial Service Supply
IEUA	Inland Empire Utilities Agency
JPA	Joint Powers Authority
K	Hydraulic conductivity
KCPD	Kern County Planning Department
LAFCO	Los Angeles County – Local Agency Formation Commission
Layer 1	Unconfined (upper) layer of MODFLOW groundwater model
LCID	Littlerock Creek Irrigation District
LWRP	Lancaster Water Reclamation Plant
mg/L	Milligrams per liter
mgd	Million gallons per day
msl	Mean sea level
LACFCD	Los Angeles County Flood Control District
LACSD	County Sanitation Districts of Los Angeles County
M&I	Municipal and industrial
MF	Microfiltration
MOU	Memorandum of Understanding
MUN	Municipal and Domestic Supply
n	porosity
N+N	Nitrate+Nitrite
NDN	Nitrification / Denitrification
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
NWIS	USGS National Water Information Service
O&M	Operations and maintenance
OAL	Office of Administrative Law
Psi	Pounds per square inch
PWRP	Palmdale Water Reclamation Plant
RA	Reservoir augmentation
RCSD	Rosamond Community Services District
RMC	RMC Water and Environment

RO	Reverse Osmosis
ROWD	Report of Waste Discharge
RWQCB	Regional Water Quality Control Board
RWWTP	Rosamond Wastewater Treatment Plant
SAT	Soil aquifer treatment
SCAG	Southern California Association of Governments
Study	Groundwater Recharge Feasibility Study
SWP	State Water Project
SWRCB	California State Water Resources Control Board
Task Force	Nitrogen/TDS Task Force
TDS	Total dissolved solids
TIN	Total inorganic nitrogen
THM	Trihalomethanes
TM	Technical memorandum
TOC	Total organic carbon
TSS	Total suspended solids
Title 22	Title 22 California Code of Regulations
URT	Underground retention time
USGS	U.S. Geological Survey
V_x	Average linear velocity
WDR	Waste Discharge Requirements
WDS	Western Development and Storage, Inc.
WEF	Water Education Foundation
WEI	Wildermuth Environmental, Inc.
WL	West Lancaster recharge area
WRP	Water Reclamation Plant
WRR	Water Recycling Requirements
WWD No. 40	Los Angeles County Department of Public Works, Waterworks District No. 40

Executive Summary

The Groundwater Recharge Feasibility Study (Study) was prepared by RMC Water and Environment (RMC), as a consultant to the City of Lancaster (City, or Lancaster). The purpose of the Study was to assess institutional, regulatory, technical, and financial opportunities and challenges associated with a groundwater recharge (GWR) project using recycled water (GWR-RW) as one of the water supplies in Antelope Valley (Valley). These opportunities and challenges were studied in sufficient detail to:

1. Evaluate the feasibility of using recycled water as part of a GWR project operation
2. Develop an implementation strategy
3. Provide local officials with the basis for making a decision on if and how the region should move forward with a GWR-RW project as part of the solution to the Valley's water resources management issues

Background

The Antelope Valley is a thriving area covering over 2,200 square miles of Los Angeles and Kern counties. In addition to benefiting from a historically dynamic farming community, the Valley is expecting its population in City of Lancaster, City of Palmdale, Town of Rosamond, and unincorporated areas to increase from an estimated 400,000 people in 2005 to roughly 740,000 in 2025 based on the 2006 Greater Antelope Valley Economic Alliance report.

The Valley is a desert environment that currently relies mostly on groundwater and surface water imported from other parts of the state through the California Aqueduct as part of the State Water Project (SWP). The Valley is a closed basin in that there is no outlet to the Pacific Ocean.

Need for Groundwater Recharge Projects

The Valley needs to tackle a number of major water resource issues to sustain its current economy as well as its projected growth. These water resource issues include:

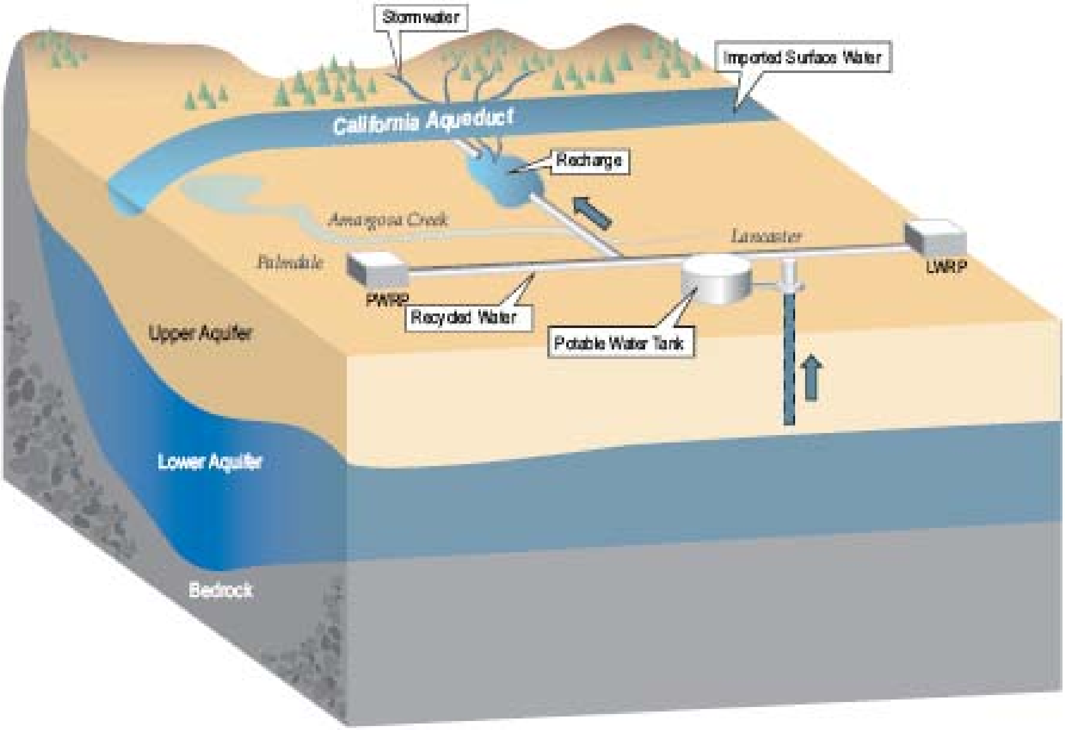
- An overdrafted groundwater basin, which limits the amount of water that can be economically and sustainably pumped in the long-term
- Uncertain future reliability of SWP water supplies due to factors such as climate change, levee breach, earthquake, power outage, or environmental and wildlife protection needs
- Limited local water treatment and conveyance capacity and increasingly stringent potable water quality standards, which will require significant capital improvements in the next 20 years
- Limited effluent management options and increasingly stringent wastewater discharge requirements, which will require significant capital improvements in the next 20 years

The entities in charge of water resources management in the Valley have been working on developing and implementing solutions to address these various issues. The solutions are at different stages of development and implementation; but there appears to be a consensus amongst stakeholders that GWR projects, including GWR-RW, will need to be part of the ultimate solution.

Why Groundwater Recharge Using Recycled Water?

The technique of using recycled water to replenish groundwater via surface spreading or direct injection has been successfully applied in other areas of the State. In Los Angeles County, the Montebello Forebay GWR Project, which serves the greater Los Angeles metropolitan area, uses roughly 50,000 acre-feet per year (afy) of recycled water for groundwater recharge of the Central Basin. Other examples include the Chino Basin Groundwater Recharge Project in Riverside County, which currently has authorization to use 8,000 afy with plans to ultimately use 22,000 afy of recycled water, and the Orange County Groundwater Replenishment System in Orange County, which plans to recharge 72,000 afy of recycled water starting in 2007. All of these projects use a blend of recycled water, imported water and/or stormwater for recharge. The concept of using recycled water as part of a GWR project is illustrated in **Figure ES-1**.

Figure ES-1: Concept of Groundwater Recharge Project Using Recycled Water in Antelope Valley



Implementing a regional GWR project would provide benefits such as avoiding and/or delaying the need for new imported water treatment facilities and provide a more reliable water supply (since water would be stored underground). Some of the key benefits that would result from using recycled water as part of the GWR projects being considered for implementation in the Valley are summarized in **Table ES-1**.

Table ES-1: Key Benefits of a GWR-RW Project in Antelope Valley

Benefit Category	Benefit Description [1]
Water Supply Reliability	Provides new source of water supply that is reliable, "drought-proof," and locally controlled
	Diversifies regional water portfolio
Effluent Management	Provides beneficial use project for winter recycled water flows and reduces recycled water storage needs
	Provides alternative effluent management mechanism
	Promotes highest beneficial use of recycled water
Integration/Synergies with Other Solutions	Supports other solutions being developed to address the limited availability of water supplies, including GWR and groundwater management projects
Consistency with State and Federal Goals and Objectives	Upholds State guidelines and policies relative to recycled water, including the California Water Code, Section 13510, and Section 461, and the 2005 California Water Plan Update, which promote diversification of regional water portfolio and encourage the use of recycled water

Notes:

1. Only identifies benefits of using recycled water as part of a GWR project; does not list all the benefits of implementing a GWR project.

Why Now?

Over 10 million gallons per day (mgd) of tertiary treated recycled water is anticipated to become available by 2010 as a result of the planned upgrades at the County Sanitation Districts of Los Angeles County's (LACSD's) Lancaster Water Reclamation Plant (LWRP). Additional tertiary treated recycled water should become available in 2010 as a result of the planned upgrades at LACSD's Palmdale Water Reclamation Plant (PWRP). Tertiary treated recycled water will also become available in the short term as a result of planned upgrades at the Rosamond Community Services District Wastewater Treatment Plant (RWWTP). The potential project partners must decide now how to optimize the use of this recycled water as well as imported water, which is the most likely blend supply.

Study Scope

Alternative strategies to achieve GWR-RW in the Valley were evaluated, taking into consideration related regional initiatives (including the GWR projects using imported water, the agriculture and urban use recycled water projects, and the wastewater treatment plant upgrades), regulatory approval pathways, water rights and other institutional issues, and cost implications.

The Study outcomes include a GWR-RW feasibility study for the Lancaster area, and an implementation plan that delineates how the baseline project could be built and how long it would take. The implementation plan serves as the documentation of the recommendations relative to if and how the region should move forward with using recycled water as one of the water supplies for GWR projects.

In developing the baseline project, six key assumptions were made that impact the project definition and implementation plan:

- **Lancaster Area vs. Palmdale Area Project** – This Study focuses on using recycled water from LWRP. PWD is currently conducting a study looking into GWR-RW from PWRP but the timing and more limited scope of that study is such that the results could not be simply integrated into this Study to develop one single regional GWR-RW project. The project considered in this Study is the Lancaster Area GWR-RW Baseline Project (baseline project).
- **"Preferred" vs. "Baseline" GWR-RW Project** – The objective of this Study is to develop a baseline project (as opposed to *the* preferred project) so that budgetary cost estimates and a detailed implementation plan can be developed. When a decision is made to move forward with a GWR-RW project, the "baseline" project should be refined during a subsequent facility planning phase to identify the preferred project for implementation.
- **Baseline vs. No Project Alternatives –** Implementing a GWR-RW project is one potential element of the overall solution to address the Valley's water resources issues. Other potential elements of the overall solution include developing GWR projects using water supplies other than recycled water only (such as imported water or stormwater), purchasing additional imported water, using recycled water for agricultural irrigation or urban uses such as park irrigation, and promoting water conservation.[1] These other elements should be considered by local officials prior to making a final decision on whether the region should move forward with a GWR-RW project. The current Integrated Regional Water Management Plan (IRWMP) process could be the forum for making this decision. This Study provides the information necessary to make an informed decision. It demonstrates that using recycled water is technically feasible and economically viable in comparison to a No Project alternative (i.e., GWR project that would solely rely on imported water).

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[1] These elements are considered in various documents, including *AVEK 2005 UWMP (AVEK, 2005), 2005 Integrated UWMP for the Antelope Valley (KJ, 2005), Antelope Valley Facilities Planning Report Recycled Water (KJ, 2005), Palmdale Water District 2005 UWMP (Carollo, 2005), LWRP 2020 Facilities Plan and EIR (ESA, 2004), PWRP 2020 Facilities Plan and EIR (LACSD, 2004), and City of Lancaster Recycled Water Facilities and Operations Master Plan (RMC, 2006).*

- **Regional vs. Local GWR Project** – The baseline project focuses on a large/regional project in the Lancaster area (as described in the previous bullet). Smaller/local projects (e.g., pilot project within Lancaster city limits) could be considered as a potential next step in the implementation plan.
- **LWRP Available Recycled Water Flows –** The baseline project was developed assuming that a "baseline" amount of 10,000 afy of recycled water would be available for GWR from the LWRP. This approach was used to provide local officials with one data point to compare the different elements of the solution to address the Valley's water resources issues and make a decision on whether to move forward with a GWR-RW project. This number should be refined during the facility planning phase.
- **Incidental vs. Planned Recharge –** The baseline project is a planned recharge project[2] rather than an incidental recharge project.[3] This approach was based on an evaluation of the potential advantages and disadvantages of incidental recharge and planned recharge conducted in response to stakeholder input. The evaluation concluded that incidental recharge did not appear to provide any significant advantage over planned recharge in the Lancaster area.

Stakeholder Involvement

A key objective of this Study was to meaningfully engage local agencies and stakeholders to obtain a broad spectrum of input and information transfer on a GWR-RW project. The Study was structured around a series of workshops that were attended by 20 to 30 stakeholders representing a wide array of socio-economic interests as illustrated in **Table ES-2**. Members of the public and stakeholders who were not directly contacted were also encouraged to ask questions at any time during the Study, although no extensive outreach was conducted. Increased public involvement is anticipated and recommended in subsequent phases of the project.

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[2] Project in which a sponsor applies for a permit to use recycled water for a project that has been designed, constructed, and is operated for the purpose of recharging a groundwater basin (by infiltration or injection) that is used as a source of domestic water supply.

[3] "Incidental" recharge occurs when water is added to a groundwater aquifer due to human activities, such as excess irrigation water or wastewater discharged to land or surface water. In the Antelope Valley setting, an incidental recharge project would consist of the discharge of recycled water to the dry bed of an intermittent stream or to disposal ponds. Some examples of incidental recharge include the Victor Valley Wastewater Reclamation Authority Regional Wastewater Treatment Plant that discharges treated effluent to percolation ponds and the unlined Mojave River, which provides incidental recharge to the Mojave Groundwater Basin, and the Santa Clarita Valley Sanitation District's Valencia and Saugus WRPs that discharge to Reaches 5 and 6 of the Santa Clara River in the Eastern Sub-basin. The Santa Clara River provides incidental recharge to the Piru Sub-basin, which underlies Reach 4 of the Santa Clara River. It should be noted that these discharges are regulated under the NPDES program.

Table ES-2: Stakeholder Involvement

Public Agencies	Regulatory Agencies
Antelope Valley - East Kern Water Agency	California Department of Health Services
City of Lancaster	Lahontan Regional Water Quality Control Board
City of Palmdale	Los Angeles County Department of Health Services
County Sanitation Districts of Los Angeles County	State Water Resources Control Board
Edwards Air Force Base	**Businesses**
Littlerock Creek Irrigation District	Agricultural Companies (e.g. Bolthouse)
Los Angeles County Department of Public Works	Los Angeles County Farm Bureau
Palmdale Water District	UC Cooperative Extension, High Desert Ag. Div.
Quartz Hill Water District	Unaffiliated Agricultural Representatives
Rosamond Community Services District	Water Companies (e.g. Sundale MWC)
Elected Officials	
County Supervisor - Michael D. Antonovich (Representative Attended)	Cities' Council Members/Agencies' Board Members/Officials

Lancaster Area GWR-RW Baseline Project

The Antelope Valley GWR setting was evaluated in terms of the regional hydrogeology, the expected recycled water availability and quality, the blend (diluent) water reliability and quality, and the current regional initiatives (including GWR projects using imported water). The current regulatory setting prescribed by the California Department of Health Services (DHS) and the Lahontan Regional Water Quality Control Board (RWQCB) was assessed, and constraints and potential regulatory pathways for a GWR-RW project were identified. These evaluations served as the basis for developing and analyzing potential GWR-RW project alternatives and selecting the Lancaster Area GWR-RW Baseline Project recommended herein for further evaluation.

Project Description & Operational Strategy

The baseline project would recharge 50,000 afy of blend water, on average, at a 4:1 ratio. The blend water would initially consist of 40,000 afy of imported water from the SWP and 10,000 afy of recycled water from LWRP. Up to 64,000 afy of imported would be recharged in wet years to take advantage less expensive water but the 5-year running average of imported water deliveries would be 40,000 afy. The blend might later include stormwater but this component is not part of the current project definition. The 4:1 blend ratio was constrained by DHS requirement included some key assumptions; particularly total organic carbon (TOC) removal through soil aquifer treatment (75% reduction) and initial TOC concentrations in recycled water (8 to 10 mg/L).

The baseline project would extract 48,000 afy[4] of recharged water, on average, via a new well field and deliver the water to wholesaler/retailer distribution system(s) and private agricultural users. **Table ES-3** summarizes the primary components of the baseline project. And, for comparison, Table ES-3 includes the "No Project alternative," which is a regional GWR project that recharges 50,000 afy, on average, of imported water only. **Figure ES-2** presents facilities locations, which were located to develop a detailed baseline project description for comparison with a regional GWR project, and, consequently, should be refined as project details are better defined. **Figure ES-3** presents the operational schematic. The baseline project assumes all facilities within the "Project Scope" area on Figure ES-3 would be owned and operated (and, perhaps, contracted) by a Groundwater Recharge Joint Powers Authority[5] (GWRJPA). This assumption should be refined as project planning progresses.

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[4] The baseline project assumes 2,000 afy of blend water is lost to evaporation while in the recharge basins.

[5] The Antelope Valley State Water Contractors Association (AVSWCA) is the most likely organization to fulfill the role of a GWRJPA. Information on the AVSWCA can be found at www.avswca.org.

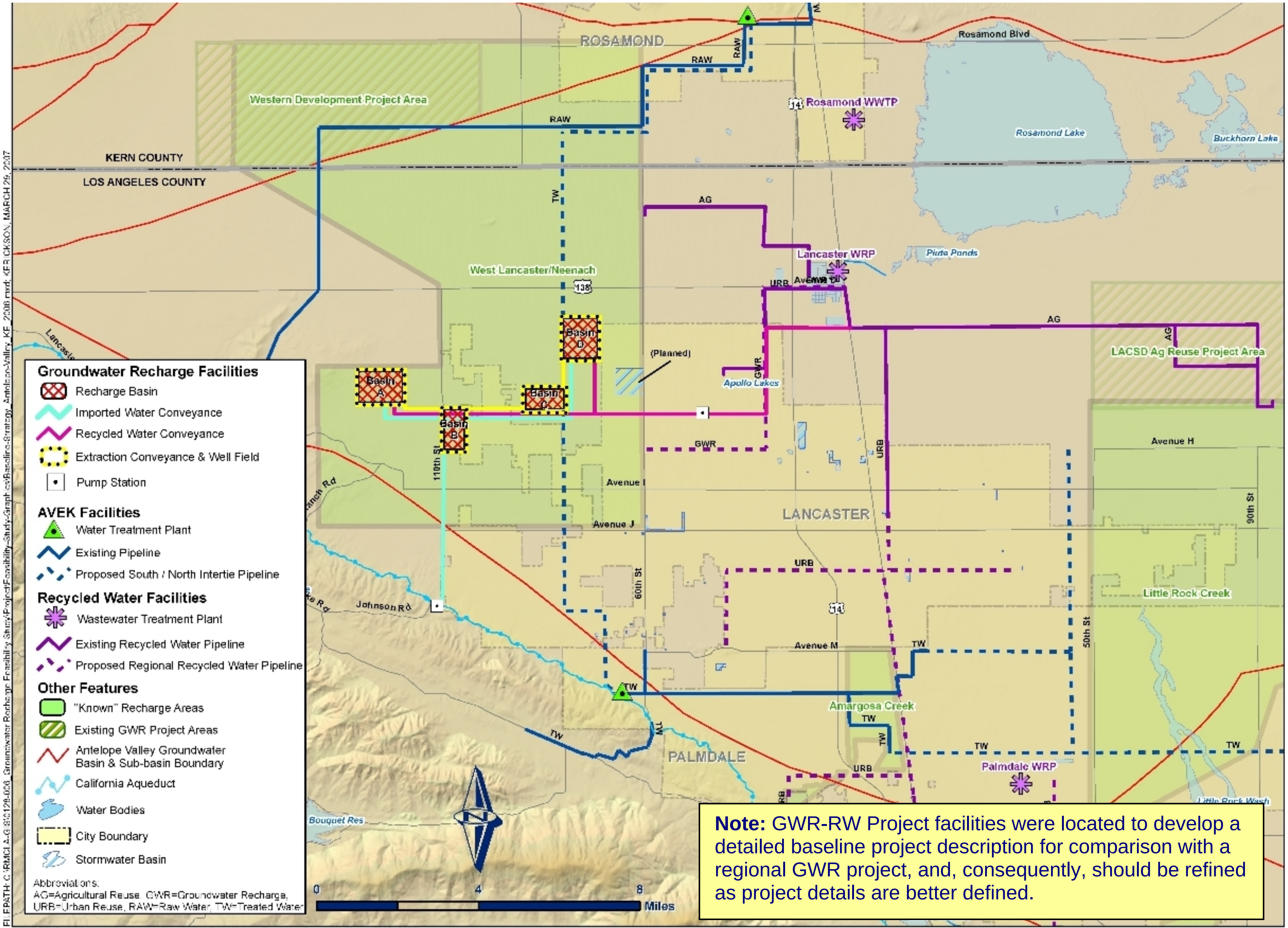
Table ES-3: Baseline Project - Concept & Facilities

Project Component	Concept	Operational Period	Flows			Facilities[1]
			Annual Average		Peak Day	
Lancaster Area GWR-RW Baseline Project			**afy**	**mgd**	**mgd**	
Recycled Water Facilities[2]	• No advanced treatment; 4:1 blend with imported water • New conveyance system • Opportunity for direct delivery to agricultural users	Jan – Dec	10,000	9	21	• 14 miles of 15" to 30" pipeline • 1,800 hp booster pump station along pipeline
Imported Water Facilities[3]	• 4:1 blend with recycled water • New conveyance system • Opportunity for direct delivery to agricultural users	Nov – Mar	40,000	86	139	• 11 miles of 36" to 66" pipeline • 6,400 hp pump station at California Aqueduct
Recharge Basins[4]	• West Lancaster area • Opportunity to use planned City stormwater basin(s)	Jan – Dec	50,000	36	160	• 4 basins over 1,100 acres • Infiltration rate of 0.5 ft/day
Extraction Facilities[5]	• New well field and conveyance facilities • Same as regional GWR project except for DHS well location requirements • Opportunity for direct delivery to agricultural users	Apr – Oct	48,000	25	45	• 6 miles of 30" to 48" pipeline • 50 wells @ 560 hp/well
Regional GWR Project / No Project Alternative (for comparison with GWR-RW Baseline Project)						
Imported Water Facilities	• No blending required • New conveyance system but larger than GWR-RW project	Jan – Dec	50,000	107	174	• 11 miles of 39" to 72" pipeline • 8,300 hp pump station at California Aqueduct
Recharge Basins	• Same area (West Lancaster) as GWR-RW project but larger basin acreage	Jan – Dec	50,000	36	174	• 1,200 acres • Same infiltration rate
Extraction Facilities	• Same as regional GWR project without DHS well location requirements	Apr – Oct	48,000	25	45	• 6 miles of 30" to 48" pipeline • 50 wells @ 560 hp/well

Notes:

1. Pipelines were sized based on a maximum velocity of 10 feet per second.
2. Recycled water is proposed to be delivered from LWRP to four recharge basins. Available flows vary from approximately 5 mgd in the summer to the peak of 21 mgd in the winter based on the following assumptions: 1) committed flows to Piute Ponds and Apollo Lakes continue; 2) planned urban uses are implemented through 2010; 3) LACSD agricultural reuse project is developed through 2010; and 4) all remaining flows could be made available for GWR-RW. Water quality goals from regulatory requirements will be met through a 4:1 blend with imported water (20 percent recycled water and 80 percent imported water) and no supplemental tertiary treatment from LWRP. Recycled water will be received at 120 psi from the LACSD Recycled Water Transmission Line and delivered to the recharge basins at atmospheric pressure.
3. Imported water from SWP is proposed to be delivered from the California Aqueduct to four recharge basins. Delivery flows vary based on hydrologic (wet/average/dry) year with above average deliveries in wet years and below average deliveries in dry years. Imported water will be delivered to the recharge basins at atmospheric pressure.
4. Recharge basins are proposed to be spread across a 20-square mile area to prevent mounding of recharge water. Limiting factors in design of the recharge basin were infiltration rate and getaway capacity. For this Study, the infiltration rate was based observations at an adjacent project (in an adjacent groundwater sub-basin) and getaway capacity was based on analytical modeling. Both values should be refined as site-specific data is collected.
5. Extraction facilities consist of wells to extract the recharge water and pipelines to deliver the water to AVEK's South/North Intertie (treated water) Pipeline, which will convey water to municipal and industrial customers. Wells will be required (by draft DHS GWR regulations) to be a minimum of 500 feet and six months travel time from the recharge basins. Depending on the basin size, 10 to 20 wells will surround each recharge basin to extract recharge water as it flows concentrically away from the recharge areas.

Figure ES-2: Baseline Project - Facilities Location



Note: GWR-RW Project facilities were located to develop a detailed baseline project description for comparison with a regional GWR project, and, consequently, should be refined as project details are better defined.

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SOURCE: See Appendix C of the Antelope Valley Groundwater Recharge Feasibility Study (RMC, 2006)

Figure ES-3: Baseline Project - Operational Schematic

① **LWRP – RECYCLED WATER**

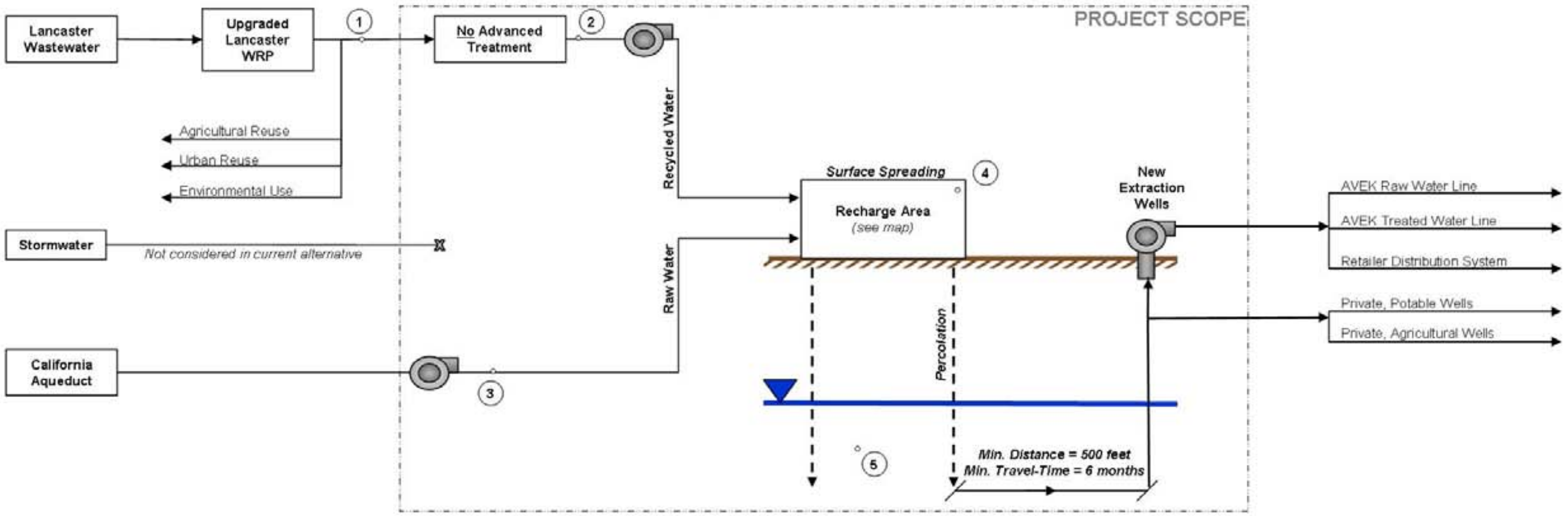
Water Quantity
- Annual Volume = 10,000 afy
- Peak Flow = 20.7 mgd

Water Quality (typical)
- TOC = 10 mg/L
- TDS = 570 mg/L (on average)
- Nitrate (N) = 9 mg/L
- THMs =Not Available

② **RECYCLED WATER FOR RECHARGE**

Water Quantity
Same as ①

Water Quality
Same as ①



③ **AVEK – IMPORTED RAW WATER**

Water Quantity
- Annual Volume = 40,000 afy
- Peak Flow = 139 mgd

Water Quality (typical)
- TOC = 4 mg/L
- TDS = 230 mg/L
- Nitrate (N) = 1 mg/L
- THMs = Not Available

④ **BLENDED WATER FOR RECHARGE**

Water Quantity
- Annual Volume = 50,000 afy
- Peak Flow = 160 mgd

Water Quality (estimated)
- TOC in RW = Not Applicable
- TDS = 300 mg/L (on average)
- Nitrate (N) = 2.6 mg/L
- THMs = Not Available

⑤ **RECHARGE WATER AFTER PERCOLATION**

Water Quality (estimated)
- TOC = 0.5 mg/L
- TDS = 300 mg/L
- Nitrate (N) = 1.7 mg/L
- THMs = Not Available

Budgetary Cost Estimate

Table ES-4 summarizes the estimated costs for the baseline project. These estimates are budgetary cost estimates and should be refined as project planning progresses. Most of the capital and operating and maintenance (O&M) costs are associated with facilities that would be part of the regional GWR project currently under development (recharge basins, imported water conveyance facilities, and extraction and delivery facilities). For comparison, the estimated cost for the No Project alternative (i.e., a regional GWR project using 50,000 afy of imported water, on average) is included in Table ES-4.

Table ES-4: Budgetary Cost Estimates

Baseline Project Components	GWR-RW Project Cost	No Project Alternative Cost
	($ Million; 2006 dollars) [1]	
Recharge Basins	$30 M	$30 M
Recycled Water Treatment Facilities	-	-
Recycled Water Conveyance Facilities	$30 M	-
Imported Water Conveyance Facilities	$70 M	$80 M
Extraction and Delivery Facilities	$70 M	$70 M
Capital Cost Subtotal	$200 M	$180 M
Annualized Capital Cost [2]	$15.0 M/yr	$13.2 M/yr
Operational & Maintenance Cost [3]	$22.0 M/yr	$23.6 M/yr
Total Annual Cost	**$37.0 M/yr**	**$36.8 M/yr**

Notes:

1. The cost estimate is based on a combination of recent local bid information, planning costs for other Southern California GWR projects, and generic unit costs for pipelines and pump stations. It includes a planning level contingency of 25 percent and a 20 percent contingency for planning, design, environmental documentation, administration costs. Capital and O&M costs are rounded the nearest ten million and hundred thousand, respectively.
2. Annualized at 6 percent over 30 years (A/P Factor = 0.073).
3. Includes the purchase price of imported water. The purchase price of recycled water was not included because negotiations are currently underway between LACSD and potential customers. The price could be up to $100 per af (RMC, 2006), which is equivalent to $1.0 million per year in incremental costs.

Benefits and Avoided Costs

Table ES-5 presents the major incremental costs and benefits (expressed as avoided costs) associated with the baseline project as compared to the No Project alternative.

The project would provide benefits beyond those identified in Table ES-5, such as diversifying the regional water portfolio or promoting highest beneficial use of recycled water. These benefits are listed in Table ES-1 but were not quantified.

Table ES-5: Major Incremental Costs vs. Avoided Costs [1]

Project Component	Benefit / Impact	Incremental Cost ($ M / year)	Avoided Cost ($ M / year)
Capital Costs [2]			
Recycled Water Conveyance	New pipeline and pump stations	$2.6	
Imported Water Conveyance	Reduced size of pipeline and pump station		$0.8
Recharge Basins [3]	Avoided acreage (100 ac) required for recharge		$0.2
LACSD Agricultural Reuse Project [4]	Avoided storage ponds, equipment, roads, etc.		$2.5
O&M/yr Costs			
Recycled Water Conveyance [5]	New pumping costs and recycled water purchase	$1.2 to 2.2	
Imported Water Conveyance [6]	Avoided pumping costs and imported water purchase		$2.8 to 7.3
LACSD Agricultural Reuse Project [4]	Avoided agricultural operations and lost revenue	$2.5	$1.7
Well Mitigation [7]	New water supply and/or well replacement/relocation	$0.5	-
Access to New Water Supply	New water supply available for use in proximity of pipelines	Not Quantified [8]	
Total		**$6.8 to 7.8**	**$8.0 to 12.5**

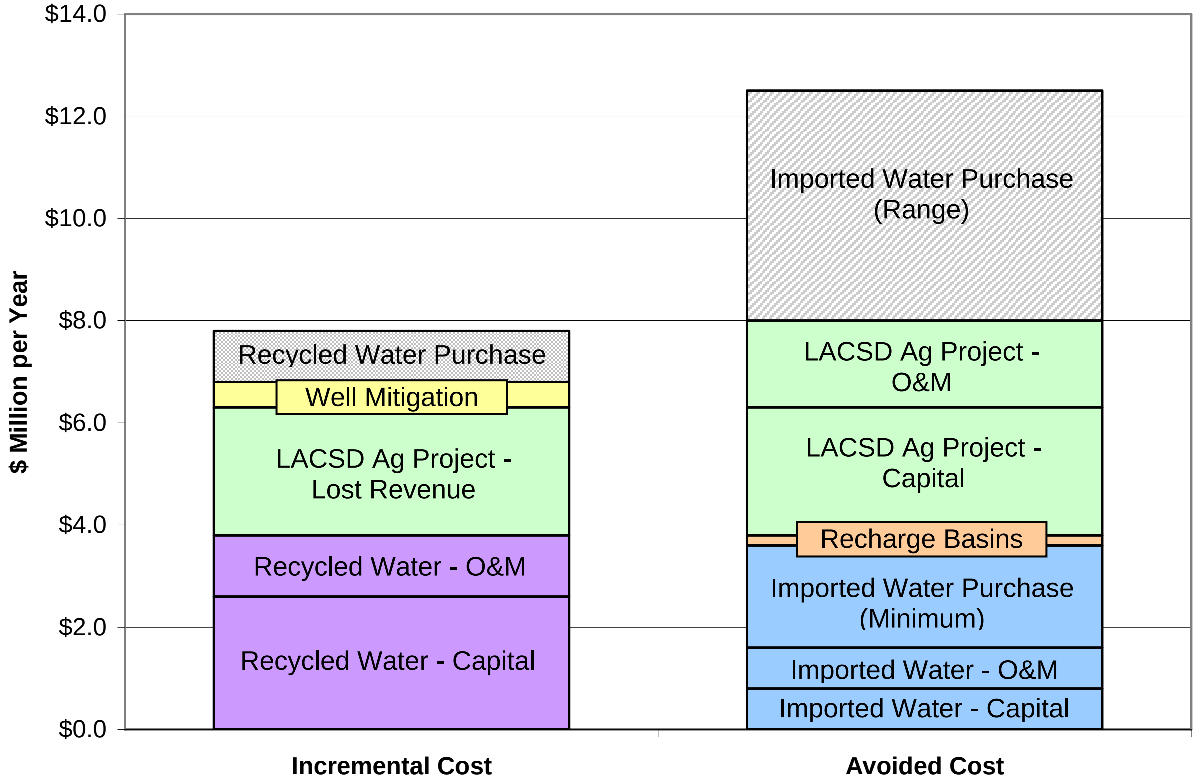
Notes:

1. GWR-RW project key incremental costs and avoided costs are in comparison to the No Project alternative (i.e., a 50,000 afy regional GWR project using imported water only).
2. Capital costs were annualized based on an interest rate of 6 percent over 30 years (A/P Factor = 0.073).
3. The GWR-RW project would require 100 less acres of recharge than a regional GWR project due to a lower blend water peak flow. The lower peak flow results from delivery of recycled water over the full year instead of imported water over five months during the wet season.
4. The incremental cost for the agricultural reuse project is based on the loss of $250/af of projected annual revenue once the project is operational. Avoided costs for the project are $33.8 million for the avoided construction of storage ponds, agricultural operation equipment, and roads/fences/culverts ($27.5, $2.6, and $3.7 million, respectively). Avoided costs also include $1.7 million per year of avoided O&M costs for agricultural operations. (Source: LACSD, personal communication, 2006 and 2007)
5. Recycled water O&M includes the purchase price of recycled water, which was not included in the baseline project because negotiations are currently underway between LACSD and potential customers for urban uses. Recycled water purchase price for GWR is typically less expensive than urban uses due to wet season storage avoidance benefits. To be conservative, the price could be up to $100 per af, which is equivalent to $1.0 million per year in incremental costs. The potential range of recycled water purchase price results in a range of incremental costs.
6. Imported water O&M includes the purchase price of imported water, which was assumed to be $200 per af based on current AVEK GWR rates but delivery of imported water via purchase of an entitlement could cost over $650 per af. The potential range of imported water purchase price results in a range of avoided costs.
7. Well mitigation assumes one well per recharge basin would need to be relocated and/or a new water supply would be provided to well owner.
8. Agricultural users in the vicinity of the imported water and recycled water pipeline alignment would have access to non-potable water for agricultural uses. This benefit is not quantified but could be significant in dry years if access to groundwater is limited due to adjudication.

A range of incremental costs and avoided costs were presented due to the range of future conditions, particularly regarding the cost and availability of imported water and benefits/costs for the LACSD Agricultural Reuse Project.

As shown in Table ES-5 and presented in **Figure ES-4**, the avoided costs associated with the baseline project are estimated to outweigh the incremental costs.

Figure ES-4: Comparison of Incremental Costs vs. Avoided Costs



Based on the favorable comparison of avoided and incremental costs, the baseline project is estimated to be economically feasible in addition to being technically feasible. Hence, it is recommended that the baseline project be further investigated and that the stakeholders move forward with the implementation plan presented below.

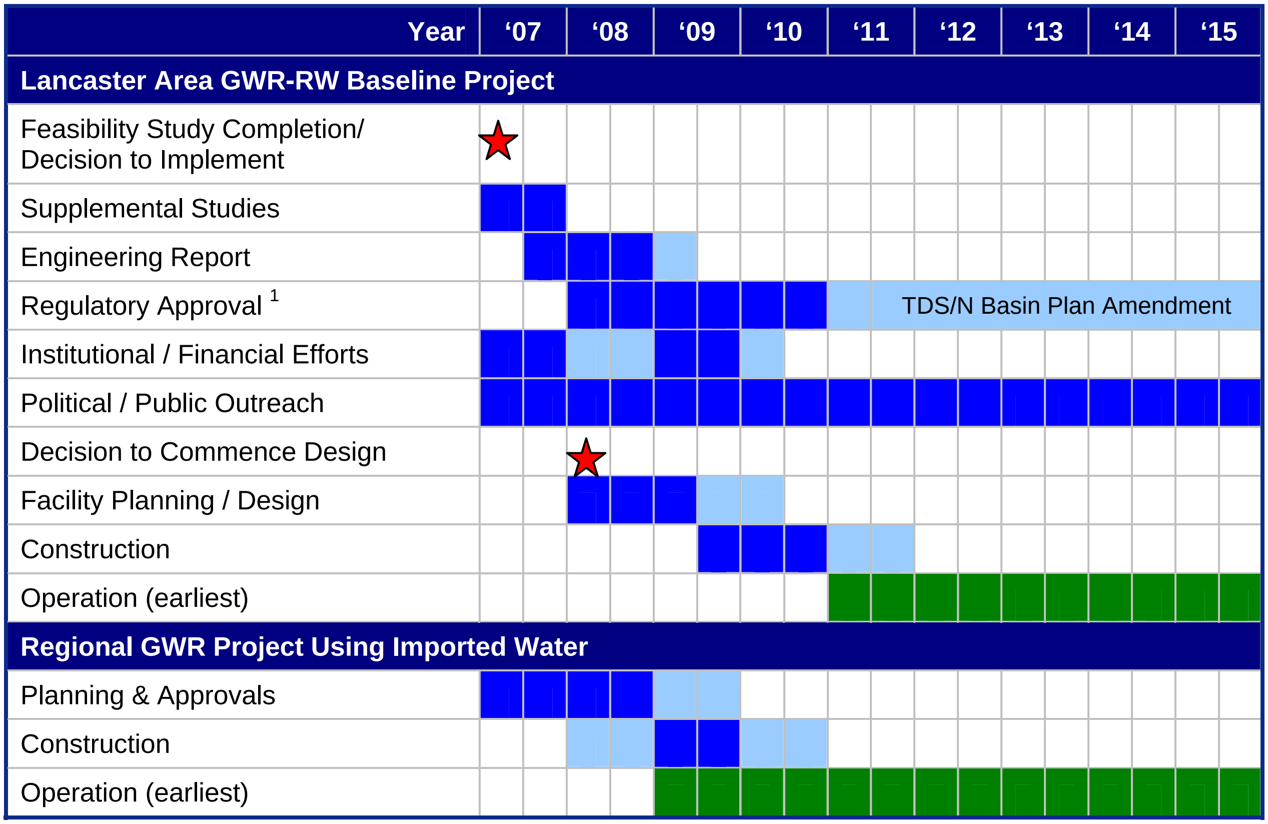
Implementation Plan

Figure ES-5 summarizes the recommended implementation activities for the baseline project and associated timeline. It also illustrates how the project implementation timeline would relate to the regional GWR project using imported water being developed by the GWRJPA, and highlights key decision points.

The timeline shows that it would take four to nine years after this Study is complete to start using recycled water as part of a GWR project operation.

The timeline assumes that a project champion/lead agency responsible for implementing the plan in coordination with all the stakeholders is identified immediately after this Study is complete. In the interim, the project champion/lead agency is assumed to be the GWRJPA.

Figure ES-5: Implementation Timeline



Year	'07		'08		'09		'10		'11		'12		'13		'14		'15	
Lancaster Area GWR-RW Baseline Project																		
Feasibility Study Completion/ Decision to Implement	★																	
Supplemental Studies	🟦	🟦																
Engineering Report		🟦	🟦	🟦	░													
Regulatory Approval [1]			🟦	🟦	🟦	🟦	🟦	🟦	░	░ TDS/N Basin Plan Amendment	░	░	░	░	░	░	░	░
Institutional / Financial Efforts	🟦	🟦	░	░	🟦	🟦	░											
Political / Public Outreach	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Decision to Commence Design			★															
Facility Planning / Design			🟦	🟦	🟦	░	░											
Construction						🟦	🟦	🟦	░	░								
Operation (earliest)									🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Regional GWR Project Using Imported Water																		
Planning & Approvals	🟦	🟦	🟦	🟦	░	░												
Construction			░	░	🟦	🟦	░	░										
Operation (earliest)					🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩

Note:

1. The duration of this task is dependent on many factors, particularly the magnitude of recycled water included in the initial phase(s) of the GWR-RW project and the related scope of an anti-degradation analysis. Also, a Salt / Nitrogen Basin Plan Amendment may be developed, which could take many years, but a GWR-RW project could be implemented in the interim.

🟦 Estimated Task Length
░ Potential Extension of Task Length
🟩 Project Operation

Specific strategies and activities were developed for the five key implementation activities that should be initiated prior to moving forward with project design. These strategies are briefly summarized below. A number of the recommended activities would also be required as part of the regional GWR project using imported water. Implementation activities for the regional GWR project using imported water and the baseline project should therefore be closely coordinated and/or merged.

Supplemental Studies

Table ES-6 summarizes the main recommendations for technical work recommended in the near-term to better define the baseline project and refine the budgetary cost estimate and implementation timeline.

Table ES-6: Primary Technical Recommendations

Project Component	Primary Technical Implementation Recommendations
Recycled Water Conveyance Facilities	• Evaluate use of recycled water between urban, agricultural, and groundwater recharge to identify highest beneficial use to the Valley through IRWMP process and/or update to Regional Recycled Water Master Plan
Recycled Water Treatment / Blending Assumptions	• Track progress of DHS draft GWR regulations and incorporate into project planning • Track progress of draft and final WRRs and WDRs from Lahontan and other RWQCBs and be prepared to incorporate into project planning • Solicit input at public meetings to determine preferred recycled water treatment alternative • Collect water quality samples for DHS and RWQCB regulated constituents from new LWRP treatment facilities to verify Study estimates
Imported Water Conveyance Facilities	• Coordinate design of regional GWR imported water system to ensure that the design does not exclude a GWR-RW project • Conduct imported water quality sampling for DHS and RWQCB regulated constituents that are not currently evaluated
Recharge Basins	• Conduct groundwater sampling in the area(s) of recharge • Conduct vadose zone monitoring via column testing, field tests at recharge sites, or other means • Conduct site-specific, hydrogeologic testing to determine range of infiltration rates and getaway capacities
Extraction Facilities	• Coordinate design of regional GWR extraction system to ensure that the design does not exclude a GWR-RW project • Confirm underground retention time estimates to support design suggestions for extraction system

Regulatory Strategy

The project to obtain regulatory approval includes three components: DHS / RWQCB Process; environmental documentation; and Salt / Nitrogen Basin Plan Amendment (TDS/N BPA).

It is recommended that the lead agency continue involving DHS and RWQCB in the project planning activities, a process that was started with this Study. It is also recommended that the lead agency initiate the regulatory process described below as soon as the technical information becomes available:

1. **Project Sponsor Submits Engineering Report (0.5 to 1.5 years):** All recycled water projects must submit engineering reports for DHS and RWQCB review. The specific topics that impact the timeline for completion of an engineering report are:
    - Hydrogeologic Characterization
    - Groundwater Quality Monitoring
    - Diluent Water Characterization
    - Contingency Plan
    - Long-Term Monitoring Plan
    - Vadose Zone Monitoring
    - Impact and Mitigation Analysis
2. **DHS and RWQCB Review Engineering Report (0.5 to 1.0 year):** There are no statutory or regulatory deadlines for when DHS and RWQCB must complete a review of an engineering report. In addition, for DHS, the review and subsequent revision of a report is typically a multiple

step process, with time gaps between providing comments to the project sponsor, the project sponsor revising and re-submitting the report, and the project sponsor receiving additional DHS feedback.

3. **DHS Holds Public Hearing (0.3 to 0.5 year):** Upon completion of the engineering report, DHS schedules and holds a public hearing prior to making a final determination on the public health aspects of a project.
4. **DHS Issues Findings of Facts/Conditions (0.3 to 0.5 year):** After the completion of the public hearing, DHS issues “Findings of Fact and Conditions.” Project sponsors have found that this process can be expedited if they volunteer to produce a draft document for DHS to use as a starting point for their own document production.
5. **RWQCB Holds Permit Hearing (0.5 to 2 years):** Once the “Findings of Fact and Conditions” have been finalized by DHS, the next step in the process is to obtain Waste Discharge Requirements (WDRs) and/or Water Recycling Requirements (WRRs) from the RWQCB. The project sponsor must submit a Report of Waste Discharge to the RWQCB.
6. **RWQCB Prescribes WDR or WRR (up to 1 year):** If there are no disputes over the permit after the RWQCB public hearing, the permit goes into effect almost immediately and no further approval is needed. However, the process would be extended if the permit is petitioned by the sponsor or an opponent.

The environmental (California Environmental Quality Act / National Environmental Policy Act) process could be conducted concurrently with the regional GWR project review process. It is recommended that a review under NEPA be conducted in addition to a CEQA review so that federal funding can be pursued.

It may be beneficial for all stakeholders to consider pursuing and funding a regional approach for salt and nitrogen management similar to the TDS/N BPA adopted by the Santa Ana RWQCB in 2004.[6] This BPA took almost nine years to develop and approve, and included the formation of a stakeholder Task Force and the completion of multi-million dollar studies. A comparable endeavor taking place in the Antelope Valley might require 6 to 10 years to complete and, therefore, it is recommended that efforts begin directly.

Institutional Arrangements

Currently there are several entities that either contribute to the volume of water in the basin or draw from it. An adjudication process began in 1999; however, there is no clear indication on what the result may be, and there may not be a conclusion for many years. Hence, agreements between stakeholders will need to be developed so that the project partners and/or participants can claim project benefits and implement GWR in the absence of conclusion to the adjudication process.

For this discussion, it is assumed that the GWRJPA will take the lead in developing and implementing a regional GWR program. GWRJPA would be responsible for conducting an inclusive process to address the issues of all stakeholders and developing policies for development, such as management of water volume, water quality, and monitoring. The specifics for policies will become clearer as the IRWMP process proceeds and other analytical work, such as groundwater monitoring and pilot studies, provide data.

Then, a set of criteria should be developed against which to measure any proposals for GWR or other project that would affect the quantity or quality of water in the basin. For a GWR-RW project, management of water quality and monitoring should be emphasized since use of recycled water instead of

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[6] Santa Ana RWQCB Resolution R8-2004-0001: Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated TDS and Nitrogen Management Plan for the Santa Ana Region Including Revised Groundwater Sub-basin Boundaries, Revised TDS and Nitrate-Nitrogen Quality Objectives for Groundwater, Revised TDS and Nitrogen Wasteload Allocations, and Revised Reach Designations, TDS and Nitrogen Objectives and Beneficial Uses for Specific Surface Waters. Available at: http://www.waterboards.ca.gov/santaana/pdf/04-01.pdf

imported water could raise concerns regarding water quality impacts. Finally, interagency agreements will be prepared to document the policies and criteria. Examples of these agreements include between:

- GWRJPA and AVEK/PWD/LCID for purchase of imported water
- GWRJPA and LACSD for purchase of recycled water
- GWRJPA and wholesalers/retailers for storage and/or purchase of recharge water
- GWRJPA and agricultural users for direct delivery of imported, recycled, and/or extracted water

Financial Approach

The first step in approaching financing is for the lead agency to work with project participants to determine the project costs and benefits to the participants. Preliminary benefits and costs were developed in this Study; but benefits and costs must be refined and the participation by the various agencies agreed upon. Based on the preliminary benefits and costs assessment, it is anticipated that key participants would be AVSWCA and LACSD. This step is closely related to the development of institutional arrangements and should therefore be completed simultaneously.

A second step will be for the lead agency and key participants to develop a funding strategy for their share of the project that would combine outside sources of capital funding and local funding:

- Several outside sources of capital funding could be available, which would be best pursued by the lead agency. Given the timing of the project, the most promising source of state or federal dollars is Proposition 84 dollars through the IRWMP process. The lead agency should therefore incorporate the project through the current IRWMP process. The lead agency should also start working with all water resources agencies in the Valley to develop a single federal funding request for water resources projects. The funding could come through Title XVI or direct appropriation.

- Realistically no outside source of funding would cover the entire capital cost and some form of local capital funding, such as a bond or certificates of participation, will be needed. The debt from local capital funding as well as O&M costs will likely be paid through revenue sources, which typically fall into the categories of connection fees, water availability standby charges, system charges, commodity rates, and property taxes. AVEK has been collecting development fees for projects identified in their 10-Year Capital Facilities Program. Some of the projects within this program relate to a regional GWR project. Many banking programs charge a volumetric (commodity) fee per af of storage per year; this is another option that the participants could consider. It is recommended that the lead agency and participants start developing a financial plan, which would establish the most appropriate source of local funding.

Public Acceptance Strategy

Successful GWR-RW projects such as the Orange County Water District Groundwater Replenishment Program and the Scottsdale [Arizona] Water Campus project have incorporated extensive public relations campaigns. These and other projects were case studies used in the preparation of the recommendations in the WateReuse Foundation study *Best Practices for Developing Indirect Potable Reuse Projects, Phase 1 Report*[7]and the related web site[8]. The recommended project, which is outlined below in three steps, is modeled on the recommendations of the aforementioned *Best Practices Report* and web site. Key recommendations include:

1. Understand and Support Policy Makers
    - Collaborate with Policy Makers

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[7] Best Practices for Developing Indirect Potable Reuse Projects: Phase 1 Report (WateReuse Foundation, 2004). Available at: www.watereuse.org/Foundation/researchreport.htm

[8] www.watereuse.org/Foundation/resproject/WaterSupplyReplenishmt/index.htm

  - Develop Foundation of Written Support
  - Develop Political Champions
2. Build Strong Relationships
  - Define Priority Relationships
  - Identify Early Supporters
  - Create Water Quality Confidence
  - Turn Conflict and Opposition into Assets
3. Communicate with Purpose and Diligence
  - Adopt a Collaborative Communication Style
  - Lead a Meaningful Dialog
  - Pay Attention to the Media
  - Understand Public Sentiments

The lead agency should immediately develop and implement a public outreach program building upon these recommendations. Outreach activities to be defined as part of the program are anticipated to include a 6-month to 1-year public outreach campaign on water resources issues to establish the need for solutions/projects. This campaign should take place immediately. The campaign would then evolve to focus on the solutions, including GWR-RW projects.

Pilot GWR-RW Program

Although large-scale GWR-RW within Antelope Valley shows high potential, timing of implementation depends on two processes unknowns: timing of large-scale groundwater banking and resolution of the groundwater adjudication process. Since it is important to move forward with the general concept of GWR-RW, a logical first step towards implementation could be the development of a local pilot GWR-RW program.

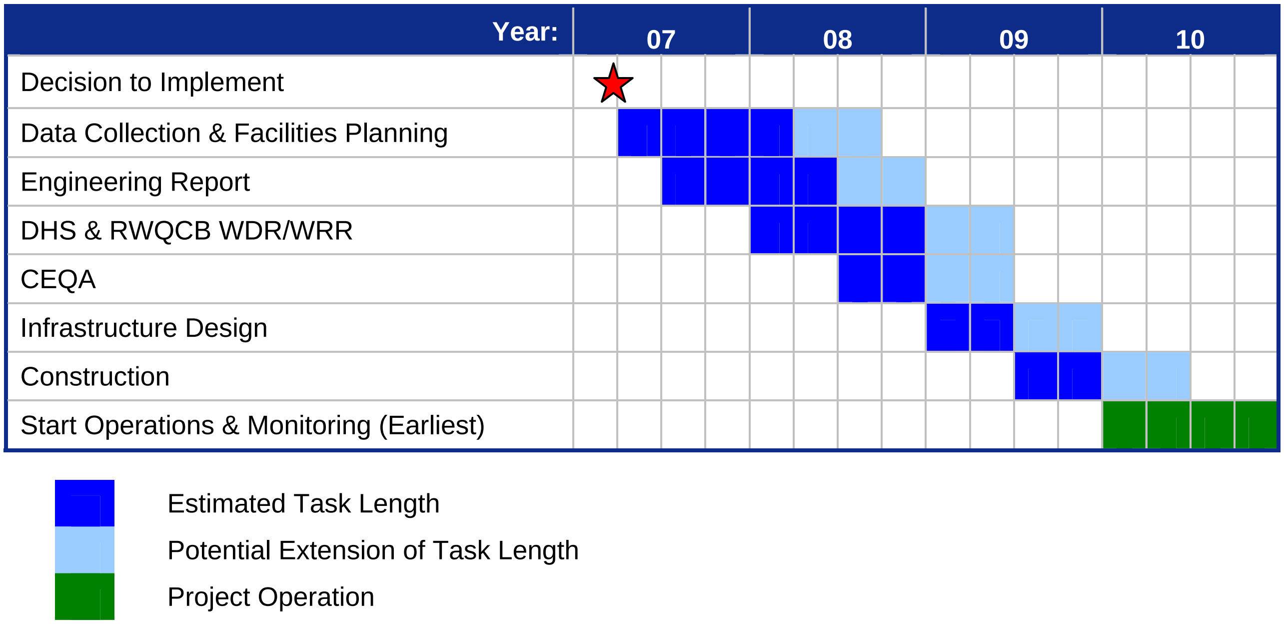
Site selection and design of the pilot program could incorporate stormwater basins that are used for recharge of stormwater. Recycled water could be available from LACSD (such as from the 1 mgd MBR facility that recently began operation at LWRP) and could be conveyed via existing or planned recycled water pipelines serving the urban areas with possible extensions to the recharge basin. Imported water could supplement stormwater as the blend supply.

Implementation of a pilot GWR-RW program would provide similar benefits and avoided costs to the program partners but on a smaller scale than a regional project. The pilot program would enhance the feasibility of implementing the regional GWR-RW project by:

- Providing water quality and reliability data that will help optimize the regional project definition
- Demonstrating attainment of regulatory requirements, while avoiding basin-wide issues such as salt and nitrogen management and Basin Plan Amendment
- Providing a forum to resolve institutional issues surrounding the regional project with a reduced number of partner agencies
- Providing a forum for public review

The total process should take three to four years, as shown in **Figure ES-7,** and could begin operations by 2009-2010 or 2010-2011 wet season.

Figure ES-7: Pilot GWR-RW Program Timeline



Year:	07				08				09				10			
Decision to Implement	★															
Data Collection & Facilities Planning		🟦	🟦	🟦	🟦	▨	▨									
Engineering Report			🟦	🟦	🟦	🟦	▨	▨								
DHS & RWQCB WDR/WRR					🟦	🟦	🟦	🟦	▨	▨						
CEQA							🟦	🟦	▨	▨						
Infrastructure Design									🟦	🟦	▨	▨				
Construction											🟦	🟦	▨	▨		
Start Operations & Monitoring (Earliest)													🟩	🟩	🟩	🟩

🟦 Estimated Task Length
▨ Potential Extension of Task Length
🟩 Project Operation

Immediate-Term Tasks

In summary, the interim lead agency (assumed to be the GWRJPA) should work with the participants and other stakeholders to complete the following tasks in 2007-2008:

- Confirm project champion/lead agency that will be responsible for implementing the plan, including incorporating the GWR-RW baseline strategy into the regional GWR project and promote GWR-RW project benefits relative to other water resource solutions in the Valley.
- Use the IRMWP process (or other planning processes) to refine the amount of recycled water that should be recharged (the baseline project assumes 10,000 afy).
- Complete technical tasks that will support pilot program implementation and allow refinement of the baseline project definition:
  - Document regional GWR project components, such as imported water supply plan and facilities recharge sites, and extraction facilities.
  - Collect water quality data for constituents not currently analyzed but required for an ADA, such as total nitrogen.
  - Commence hydrogeologic characterization for key attributes, such as groundwater quality, infiltration rate, getaway capacity, and underground retention time in preparation for development of an Engineering Report.
  - Identify ideal recharge basin sites and begin negotiations with land owners to determine willingness to sell development rights[9] and/or ownership of sites.
- Continue engaging with DHS and RWQCB regarding GWR projects in the Valley and determine if a regional TDS/N Management Plan would be beneficial to GWR-RW project implementation.

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[9] Purchase of development rights of agricultural land would allow for continued agricultural operations on a majority of the tract while using a portion to operate recharge basins. The recharge basin locations could be rotated in conjunction with rotating agricultural use of the land. This approach could foster a partnership between groundwater recharge proponents and the agricultural community by supporting continued agricultural operations in the Antelope Valley and provide an alternative revenue source for agricultural operators.

- Start developing a detailed financing plan. Incorporate the project into the current IRWMP process to position the project for Prop 84 grant funds. Start working with all water resources agencies in the Valley to develop a single federal funding request for water resources projects.
- Develop a long-term political/public outreach program. Conduct a 6-month to 1-year public outreach campaign on water resources issues to establish the need for solutions/projects.

As noted previously, a number of these tasks would also be required as part of a regional GWR project using imported water. These tasks should therefore be closely coordinated and/or merged with tasks associated with a regional GWR project implementation.

Chapter 1 Introduction

The Groundwater Recharge Feasibility Study (Study) was prepared by RMC Water and Environment (RMC), as a consultant to the City of Lancaster (City, or Lancaster).

Groundwater recharge (GWR) using recycled water (GWR-RW) could provide up to 30,000 acre-feet per year (afy) of new water supply to the Antelope Valley by 2025. The goal of the Study is to assess institutional, regulatory, technical, and financial opportunities and challenges associated with a GWR project using recycled water. These opportunities and challenges will be studied in sufficient detail to develop a detailed implementation plan, including a schedule, and provide local officials with the basis to decide if and how the region should move forward with GWR-RW.

This chapter provides background on the Study and discusses the Study purpose and scope as well as the stakeholder coordination process. For those readers who are not familiar with GWR-RW, 0 of this report provides an overview of this recharge technique.

1.1 Background

This section includes:

- A brief description of the Study area (additional information on the Antelope Valley setting is provided in Chapter 3)
- A discussion of the need for GWR-RW projects in the Study area
- A summary of the regional water resources initiatives relevant to this Study, including groundwater banking activities, recently completed or undertaken by the local entities

1.1.1 Study Area

The Antelope Valley is located in the southwestern portion of the Mojave Desert. The Study area encompasses the Lancaster, Buttes, and Pearland hydrogeologic subunits of the Antelope Valley groundwater basin, as illustrated in **Figure 1-1**.

The Study area is located 60 miles northeast of Los Angeles in the Antelope Valley. It was defined as the area within which a GWR project using recycled water would most likely be implemented given the location of water reclamation plants, jurisdictional boundaries of the potential project partners, potential recharge areas, and other existing or planned facilities. Hydrogeologic subunits boundaries were used to delineate the Study area since groundwater hydrogeology will be a primary driver in the project definition. The Antelope Valley is a closed basin with no outlet to the ocean, which presents particular regulatory challenges related to groundwater protection. All surface water flows naturally toward three dry lakes (Rogers, Rosamond, and Buckhorn) located on Edwards Air Force Base.

The Study area is located within the 25th Congressional District of California (Congressman Howard P. “Buck” McKeon), District 17 of the California State Senate (Senator George Runner), and District 36 of the California State Assembly (Assemblywoman Sharon Runner).[10] The County supervisors representing the Study area are Michael D. Antonovich for Los Angeles County and Don Maben for Kern County.

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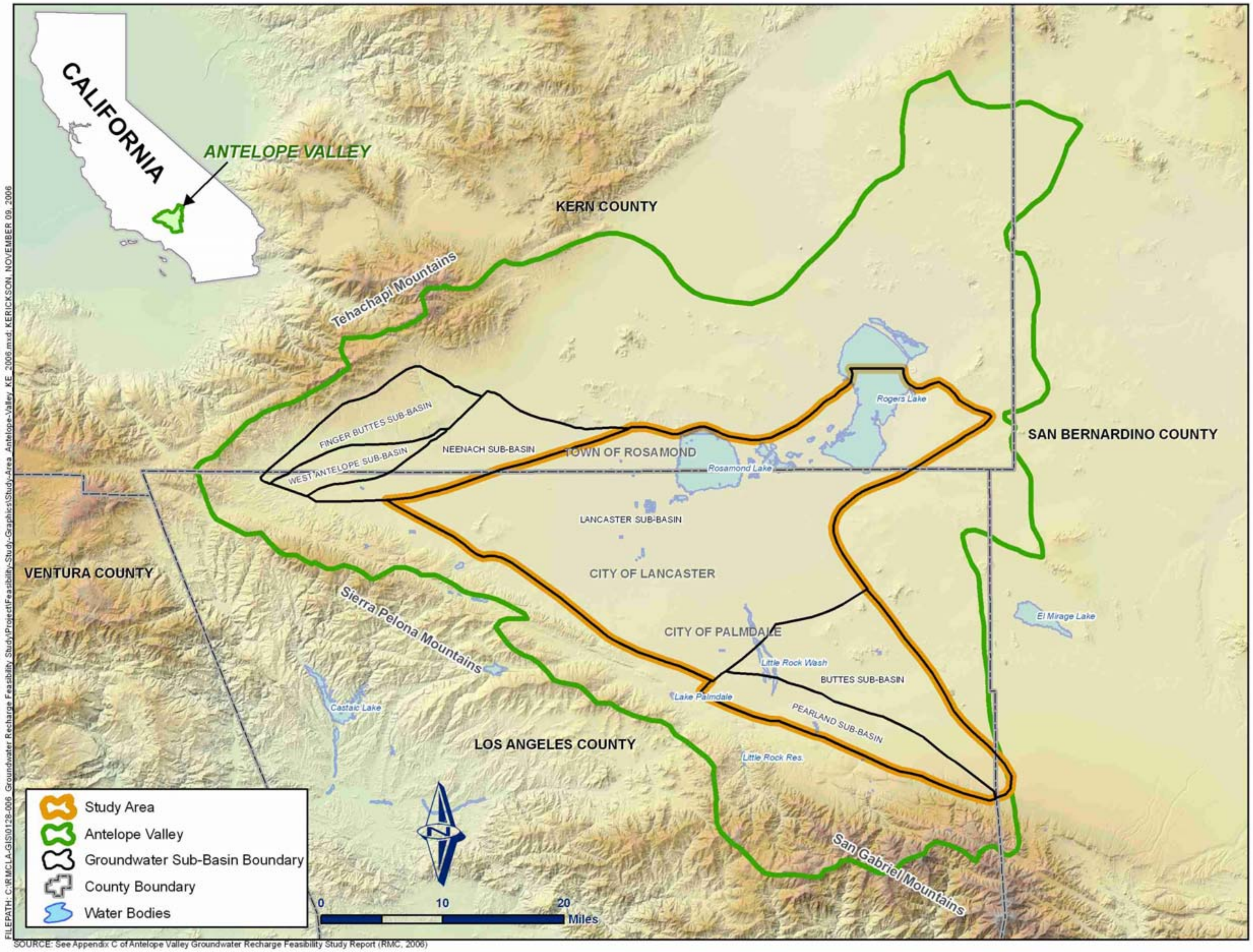
[10] The Study area includes portions of California State Assembly Districts 34 and 37 but most of the area, including Lancaster and Palmdale, are represented by District 36.

Figure 1-1: Study Area



SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

The major communities located in the Study area are Lancaster, Palmdale, Mojave, Boron, and Rosamond. Smaller communities in the valley include Littlerock, Quartz Hill, Pearblossom, Llano, and Pearland. Population in the Antelope Valley has steadily increased from just under 140,000 in 1980 to nearly 330,000 in 2000 (date of the last census), and is expected to increase significantly over the next 20 years. Population projections are shown in **Table 1-1.** Water demand in the Antelope Valley is projected to increase by almost 40 percent by 2025, as shown in **Table 1-2**. This demand covers both agricultural use and municipal and industrial (M&I) use.

Table 1-1: Projected Population in Study Area

	Projected Population				
	2005	2010	2015	2020	2025
City of Lancaster	142,000	168,000	191,900	215,500	238,000
City of Palmdale	146,000	176,500	218,100	259,700	298,500
Greater Rosamond	31,600	35,600	40,300	44,900	50,300
Unincorporated – LA County	80,100	96,000	114,900	133,700	150,500
Total	**399,700**	**476,100**	**565,200**	**653,800**	**737,300**

Source: 2006 Greater Antelope Valley Economic Alliance Report (GAVEA, 2006; http://www.aveconomy.org/)

Table 1-2: Projected Water Demand for the Study Area

Water Supplier	Projected Water Demand (afy)				
	2005	2010	2015	2020	2025
Palmdale Water District [1]	25,800	31,000	39,600	48,600	54,100
WWD No. 40, RCSD, QHWD [2]	62,300	74,800	85,300	95,500	106,300
Other AVEK [3]	36,200	29,000	29,600	30,300	30,900
Other Groundwater Users [4]	60,000	60,000	60,000	60,000	60,000
Total	**184,300**	**194,800**	**214,500**	**234,400**	**251,300**

Notes:

1. Source: 2005 Palmdale Water District Urban Water Management Plan (PWD, 2005)
2. Source: 2005 Integrated Urban Water Management Plan for the Antelope Valley (KJ, 2005)
3. Derived from total Antelope Valley East Kern Water Agency (AVEK) demand estimates less imported water demand from PWD, Los Angeles County Department of Public Works, Waterworks District No. 40 (WWD No. 40), Rosamond Community Services District (RCSD), and Quartz Hill Water District (QHWD). AVEK demand estimates less imported water demand from PWD, District No. 40, RCSD, and QHWD.
4. Rough estimate of demand supplied through other groundwater pumping in Antelope Valley, including non-metered use (KJ, 1995)

1.1.2 Need for Groundwater Recharge Projects

Developing GWR-RW capabilities is one potential element of the overall solution to address the Antelope Valley water resources issues described below.

Other potential elements of the overall solution include purchase of additional State Water Project (SWP) water, use of recycled water for agricultural irrigation or urban uses (such as park irrigation), and water conservation[11]. These other elements will need to be considered by local officials prior to making a

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[11] These elements are considered in various documents, including *AVEK 2005 UWMP (AVEK, 2005), 2005 Integrated UWMP for the Antelope Valley (KJ, 2005), Antelope Valley Facilities Planning Report Recycled Water (KJ, 2005), Palmdale Water District 2005 UWMP (Carollo, 2005), LWRP 2020 Facilities Plan and EIR (ESA,*

decision on whether the region should move forward with a GWR-RW project. The Antelope Valley Region Integrated Regional Water Management Plan (IRWMP) process, which was initiated by Los Angeles County Department of Public Works, Waterworks District No. 40 (WWD No. 40) in May 2006 and is anticipated to be adopted in July 2007, could be the forum where all these elements will be considered to develop a preferred solution to address the Antelope Valley water resources issues.

Water Resources Issues

Major water resources issues need to be tackled for the area to sustain its current population as well as the projected growth. These major water resources issues include:

- **Limited Local Groundwater Supply** – The groundwater basin is in overdraft, which limits the amount of water that can be pumped in the long-term. The U.S. Geological Survey (USGS) estimated that the sustainable yield of the Antelope Valley Groundwater Basin is approximately 40,000 afy whereas groundwater pumping is roughly 90,000 afy (USGS, 2003).
- **Uncertain Reliability of State Water Project Water Supplies** – The California Department of Water Resources (DWR) identified three general factors that determine water reliability (DWR, 2006): 1) availability of water from the source[12]; 2) availability of means of conveyance[13]; and 3) level and pattern of water demand in the delivery service area. Based on these factors, SWP deliveries are projected to vary between 4% and 100% of contractor entitlements (DWR, 2006) as shown in **Table 1-3**

Table 1-3: State Water Project Delivery Reliability, 2005 – 2025

SWP Delivery Reliability in % of Table A Amount [1]				
Average Year [2]	Maximum [2]	Minimum (Single Dry Year) [2]	5-Year Drought [3]	5-Year Wet [4]
68% - 77%	93% - 100%	4% - 5%	35%	72% - 93%

Notes:

1. Table A is the contractual method for allocating available SWP supply
2. From Table 5-2 (DWR, 2006)
3. Derived from 4-year and 6-year drought scenarios in Table 5-4 (DWR, 2006)
4. Derived from 4-year and 6-year wet scenarios in Table 5-6 (DWR, 2006)

- **Limited Water Treatment and Conveyance Capacity and Increasingly Stringent Potable Water Quality Standards –** To meet increasing water demands, water wholesalers and retailers need to expand their conveyance and treatment systems, requiring significant capital improvements by 2025. In addition, as drinking water standards become increasingly more stringent, water wholesalers and retailers will need to comply with those standards. This trend will be similar to the changes in standards that water agencies are currently facing for constituents such as arsenic and the trihalomethanes (THM). For example, arsenic is a particularly problematic issue due to high naturally-occurring arsenic levels in groundwater in certain areas of the country. The new arsenic standards have forced groundwater users to inactivate some wells,

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2004), PWRP 2020 Facilities Plan and EIR (LACSD, 2004), and City of Lancaster Recycled Water Facilities and Operations Master Plan (RMC, 2006).

[12] The availability of water from the source depends on annual rain and snow volumes as well as use of the water in the source area. The State Water Project Delivery Reliability Report – 2005 (DWR, 2006) analysis applies 73 years of historical rainfall and runoff records for future projections to address annual variability.

[13] Availability of means of conveyance is limited by facility and institutional limitations. Facility limitations include current and future infrastructure capacity and system failure (e.g. levee breach, earthquake, flood, power outage). Institutional limitations include legal, contractual and regulatory restrictions (e.g. flow decreases for environmental and wildlife protection).

blend high arsenic groundwater with better quality water, and/or provide treatment, all of which puts an additional constraint on already limited local groundwater supplies.

- **Limited Wastewater Treatment Capacity and Increasingly Stringent Wastewater Discharge Requirements** – As the population in the Antelope Valley expands so will the need to provide additional wastewater treatment capacity and alternatives for facilities to manage the wastewater. As shown in **Table 1-4,** the three existing wastewater treatment plants in the Antelope Valley will need to be expanded to accommodate increased wastewater flows. The primary issue facing these facilities will be how to cost effectively and feasibly manage the effluent. Given the physical setting of the Antelope Valley, options are more limited than other parts of the state and include land disposal/discharge, evaporation ponds, and water recycling.

Table 1-4: Wastewater Treatment Plants Current and Projected Flow Rates

Treatment Plant	2004 Average Flow Rate (mgd)	Current (2005) Discharge Capacity (mgd)	Projected Average Flow Rate (mgd)			
			2010	2015	2020	2025
Lancaster WRP[1]	12.8	16.0	17.8	NA	26.0	NA
Palmdale WRP[2]	9.4	15.0	13.2	16.4	19.5	22.4
Rosamond WWTP[3]	1.1	1.3	1.8	2.1	2.5	NA

NA Not Available

Sources:

1. Lancaster WRP 2020 Facilities Plan (LACSD, 2004)
2. Palmdale WRP 2025 Plan (LACSD, 2005a)
3. Facilities Plan Report, Antelope Valley Recycled Water Project (K/J, 2005)

In addition, any effluent management option selected faces increasingly stringent regulatory requirements that will in turn impact the level of treatment provided. For example, both the Lancaster Water Reclamation Plant (LWRP) and Palmdale Water Reclamation Plant (PWRP) are currently being upgraded to provide tertiary treatment and new effluent management practices are being implemented to meet the requirements of the Lahontan Regional Water Quality Control Board (RWQCB).

Potential Solutions

The entities in charge of water resources management in Antelope Valley have been working on developing and implementing solutions to tackle the various issues identified above. The solutions being developed are in different stages of development and implementation. **Figure 1-2** lists the major relevant regional water resources initiatives, including wastewater treatment plant upgrades, regional recycling projects, and water banking opportunities undertaken by various agencies in the Antelope Valley. It also identifies the lead agency and provides an approximate implementation schedule. This Study was coordinated with all these initiatives to the extent possible.

Figure 1-2: Relevant Regional Water Resources Initiatives

Water Resources Initiative (Lead Agency)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Antelope Valley Region Integrated Regional Water Management Plan (WWD No. 40)			■	■																		
Water Banking/Groundwater Recharge																						
Planning/Studies																						
Stormwater Reuse or GWR Feasibility Study (QHWD)		■																				
Recycled Water GWR Feasibility Study (Lancaster)			■																			
Recycled Water GWR Reconnaissance Study (PWD)			■																			
Recycled Water GWR Reconnaissance Study (RCSD)			■																			
Public Projects in Antelope Valley (Planned or Underway)																						
Imported Water ASR (WWD No. 40)		■	_ _	_ _	_ _	_ _	■															
"In-Lieu Recharge (AVEK, AVSWC)"		■	■	■																		
20-year CIP (AVEK)			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Imported Water Banking (GWRJPA)		■	■	■	■	■																
Private Projects in Antelope Valley (Planned or Underway)																						
Western Development and Storage (WDS) Antelope Valley Water Bank Project	■	■	■	■																		
Purchase Capacity from Private Banks (Evaluation Stage) (WWD No. 40; PWD)		■	■	■																		
Purchase Capacity from Private Banks (AVEK/RCSD)		■	■	■	■	■																
Outside Antelope Valley Projects (Planned or Underway)																						
Wheeler Ridge Maricopa Water Storage District (Evaluation Stage) (WWD No. 40)	_ _	■	■	■																		
Semitropic Water Banking and Exchange Program (Evaluation Stage) (WWD No. 40)	_ _	■	■	■																		
Purchase Capacity from Existing Banks (Evaluation Stage)	_ _	■	■	■																		
Treatment Plant Upgrades/Urban Recycled Water Use																						
Planning/Studies																						
Lancaster WRP 2020 Plan & EIR (LACSD)	■																					
Palmdale WRP 2025 Plan & EIR (LACSD)	■	■																				
City Recycled Water Master Plan (Lancaster)		■	_ _	■																		
Regional Recycled Water Facilities Planning & EIR (WWD No. 40)		■	■																			
Recycled Water Facility Plan & Environmental Documentation (RCSD)			■																			

Water Resources Initiative (Lead Agency)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<u>Antelope Valley Projects (Planned or Underway)</u>																						
Lancaster WRP Upgrade & Expansion (LACSD)	■	■	■	■	■	–	–	■	■	■	■											
Lancaster WRP Ag Reuse Project (LACSD)	■	■	■	■	■																	
Division Street Corridor Recycled Water Project (Lancaster)		■	■																			
Palmdale WRP Upgrade & Expansion (LACSD)		■	■	■	■	■	–	–	■	■	■	■										
Palmdale WRP Ag Reuse Project (LACSD)				■	■	■																
Regional Water Recycling Project - Phase 1B through Phase 4 (WWD No. 40)				■	■	■	■	■	■	■												
Local Recycled Water Distribution System (PWD)				■	■																	
RCSD WRP Upgrade & Expansion (incl. Satellite Treatment Plants) (RCSD)		■	■	■	–	■	■	–	–	–	–	–	–	–	■	■						
Local Recycled Water Distribution System (RCSD)				■	■	■	–	–	–	–	–	–	–	–	–	■	■					
Conservation																						
Planning/Studies (TBD)																						
Conservation Program (active, ongoing) (WWD No. 40, RCSD, PWD)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Institutional Activities																						
Groundwater Adjudication Process		■	■	■	■	■	■	■	■	■	■											
<u>JPA</u>																						
Water Banking JPA (GWRJPA)			■																			
Recycled Water JPA			■																			
Outside Funding Pursuit (multiple pursuits, on going)		■	■	■	■	■																

Significant to the Study are two key initiatives discussed below: Regional GWR projects and the Antelope Valley IRWMP, which was initiated WWD No. 40 in May 2006.

GWR projects currently being considered or in the planning stages are of great relevance to a potential GWR-RW project. The GWR projects are envisioned as a three-step initiative:

1. **In-Lieu Recharge** – Delivery of raw imported water to agricultural users in-lieu of use of groundwater. Then Antelope Valley-East Kern Water Agency (AVEK) has already started implementing this first step.
2. **Annual and Seasonal Banking** – Storage of imported water in wet year or season in the Lancaster groundwater basin for extraction during dry year or season. One project led by Western Development and Storage, Inc. (WDS) is in the final stages of implementation. Other projects led by AVEK, Palmdale Water District (PWD), and the Groundwater Recharge Joint Powers Authority (GWRJPA) are in the very early planning stages.
3. **Banking for External Clients** – Using additional groundwater basin capacity for annual or seasonal storage for out-of-basin entities. No specific project has been defined at this time.

The Antelope Valley IRWMP, which is being conducted in parallel with this Study, is anticipated to be completed in December 2007. The proposed goals for the IRWMP are to:[14]

- Develop a comprehensive plan to meet the Antelope Valley's future regional need for water supply reliability by evaluating opportunities for water recycling, water conservation, groundwater management, conjunctive use, water transfers, water quality improvement, stormwater capture and management, flood management, recreation and public access, and environmental and habitat protection and improvement;
- Foster coordination, collaboration and communication among public agencies in the Antelope Valley and other interested stakeholders to achieve greater water-use efficiencies, enhance public services, and build public support for vital projects; and
- Improve regional competitiveness for future State and Federal grant funding.

The proposed GWR-RW project complements these goals by combining water recycling, groundwater management, conjunctive use, water transfers, and, potentially, stormwater capture to provide multiple benefits to multiple public agencies.

Why Groundwater Recharge Using Recycled Water?

In the context described above, GWR-RW provides an opportunity to leverage the GWR projects currently underway to maximize the beneficial use of recycled water to be produced at the water reclamation plants. Implementing a regional GWR project would provide benefits such as avoiding and/or delaying the need for new imported water treatment facilities and provide a more reliable water supply (since water would be stored underground). Other GWR-RW project benefits would also result from using recycled water as part of the GWR projects as shown in **Table 1-5**. As local officials make a decision on whether the region should move forward with GWR-RW, all these benefits should be considered. These benefits are further quantified later in the report (see Section 6.1.4).

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[14] avwaterplan.org/

Table 1-5: Key Benefits of Groundwater Recharge Project Using Recycled Water in Antelope Valley

Benefit Category	Benefit Description [1]
Water Supply Reliability	Provides new source of water supply that is reliable, “drought-proof,” and locally controlled
	Diversifies regional water portfolio
Effluent Management	Provides beneficial use project for recycled water flows and reduces recycled water storage needs
	Provides alternative effluent management mechanism
	Promotes highest beneficial use of recycled water
Integration/Synergies with Other Solutions	Supports other solutions being developed to address the limited availability of water supplies, including GWR and groundwater management projects
Consistency with State and Federal Goals and Objectives	Upholds State guidelines and policies relative to recycled water, including the California Water Code (CWC), Section 13510, and Section 461, and the 2005 California Water Plan Update, which promote diversification of regional water portfolio and encourage the use of recycled water

Notes:

1. Only identifies benefits of using recycled water as part of a GWR project; does not list benefits of implementing a GWR project.

Why Now?

Over 10 mgd (11,000 afy) of tertiary treated recycled water is anticipated to become available by 2010 as a result of the planned upgrades at the LWRP. Additional tertiary treated recycled water should become available in 2010 as a result of the planned upgrades at the PWRP. Tertiary treated recycled water will also become available in the short term as a result of planned upgrades at the Rosamond Wastewater Treatment Plant (RWWTP). The potential project partners need to start planning now for the use of this recycled water within the Study area.

1.2 Study Purpose and Scope

The main purpose of the Study was to assess the institutional, regulatory, technical, and financial opportunities and challenges associated with a GWR-RW project. These opportunities and challenges were studied in sufficient detail to develop an implementation schedule and provide local officials with the basis for making a decision on if and how the region should move forward with implementing GWR-RW as part of the solution to the Antelope Valley’s water resources issues.

1.2.1 Important Issues to Be Addressed

In developing the Study scope, important issues to be addressed were identified based on RMC past experience and input from the stakeholders. **Table 1-6** summarizes the regulatory, institutional, financial, outreach, and technical issues as well as the proposed strategies to address these issues that were incorporated in the Study scope.

Table 1-6: Key Issues and Proposed Project

Topic	Issue/Concern [1]	Feasibility Study Project/Approach
Regulatory		
DHS	Application of DHS Recycling Regulations and Draft Recharge Regulations	• Addressed in Regulatory Analysis (Chapter 4) and Regulatory / Permitting Project (Section 6.2.2)
RWQCB	Application of water quality standards and the non-degradation policy	• Addressed in Regulatory Analysis (Chapter 4) and Regulatory / Permitting Project (Section 6.2.2)
Unregulated Chemicals	Potential for project delays due to the potential for a pollutant *de jour* to pop up during the project period	• Include source control program in implementation plan (Section 3.3.1) • Account for potential delays and develop realistic implementation schedule (Section 6.2) • Include outreach budget for addressing "issues de jour." (Section 6.2.2)
Institutional		
Stakeholder Support	Project implementation requires partnerships	• Build support for the project amongst key partners through identification of GWR-RW project benefits (Section 6.1.4)
Coordination with Regional Initiatives	Avoid duplication of efforts	• Identify current regional initiatives, their mission and timeline (see Section 1.1.2) • Make sure key stakeholders attend the workshops (Appendix A)
	Evaluation of other regional water resources solutions	• Lead project proponent to advocate GWR-RW project in evaluation (Section 6.2.3)
	Confusion due to numbers of ongoing initiatives	• Need to communicate clearly on how they fit together through a public outreach plan (Section 6.2.5)
Adjudication	Groundwater basin is not adjudicated	• Bring all stakeholders on board and identify benefits (Section 6.1.4) • Form a Groundwater Management Agency or Joint Powers Authority (Section 6.2.3)
Financial		
Project Costs	Outside funding will likely be needed to implement project while limiting impact on rate payer and developers	• Position project for upcoming state funding opportunity through Prop 50, Chapter 8 IRWMP and Prop 84 (Section 6.2.4) • Investigate future county, State and Federal funding opportunities and consider these opportunities in the development of the implementation plan (Section 6.2.4)

Topic	Issue/Concern [1]	Feasibility Study Project/Approach
Outreach		
Public Acceptance	Public acceptance of concept of using recycled water for GWR	• Current project is not to involve the general public in the Feasibility Study process because there are still too many unknowns. However, the implementation plan includes a public outreach plan (Section 6.2.5). • Rely on stakeholders engaged in the Feasibility Study to start building public and political support for the project during the Feasibility Study (Section 6.2.5).
Joint Powers Authority	Area covered by JPA is larger than area covered by this study; JPA does not involve LACSD	• Form JPA subcommittee in charge of GWR-RW in Antelope Valley. Agencies to decide whether to proceed with project (Section 6.2.3)
Technical		
Data needs	Extensive data collection by individual organizations but not much data integration	• Compile and review existing reports and data under Antelope Valley Setting Documentation (Chapter 3)
	Available data is of insufficient detail necessary for regulatory and technical evaluation	• Recommend next steps after Study to collect appropriate data (Section 6.2.6)
Recharge Sites	Identification of recharge sites	• Develop evaluation criteria and refine as project becomes better defined (Section 5.1)
Recycled Water	Availability of recycled water	• Update Regional Recycled Water Master Plan to incorporate GWR-RW project information from Study (Section 6.2.6)
Blend Water	Location and availability of raw imported water facilities	• Issue to be considered under Alternative Development & Evaluation (Sections 3.4 and 5.1.2)
Schedule	In-lieu recharge and other banking strategies can be implemented faster than GWR-RW	• In-Lieu recharge and GWR projects will address initial implementation issues and then a GWR-RW project can be incorporated into the regional GWR project by addressing project-specific issues (Section 6.2)

1.2.2 Scope of Work

The Study was designed to develop a GWR-RW project concept supported by the stakeholders, an implementation plan that delineated how the project would be built, a realistic implementation schedule, and a project funding project. Alternative strategies to achieve GWR-RW were evaluated, taking into consideration related regional initiatives, regulatory approval pathways, water rights and other institutional issues, and cost implications. Alternative strategies considered both water supply reliability and effluent management benefits deemed to be feasible.

Specific technical activities performed by RMC as part of this Study included:

- **Task 1:** Coordinated with the local agencies and stakeholders and start building support for the project with efforts focused around four workshops conducted bi-monthly.
- **Task 2:** Assessed the current regulatory setting and identify constraints and opportunities to be considered in the development of alternative projects.
- **Task 3:** Documented the water resource setting in Antelope Valley as it pertains to implementing a GWR project using recycled water.
- **Task 4:** Developed GWR-RW alternatives to be evaluated with input from the Advisory/ Stakeholder group within the structure of Task 1.
- **Task 5:** Evaluated the alternatives identified under Task 4 and gain concurrence on a baseline GWR-RW project.
- **Task 6:** Documented the recommended project plan and developed a detailed implementation plan.

The specific approach for each technical task and associated outcomes are presented in the different chapters of this report. Key assumptions that affect all chapters are listed in the section below. The Study was initiated in March 2006 and will be completed following a schedule similar the one provided in **Figure 1-3**.

Figure 1-3: Study Schedule

Task Name	2006										2007		
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Project Award / Kickoff	★												
Task 1 – Stakeholder Involvement and Outreach		■	■	■	■	■	■	■	■				
Task 2 – Regulatory Analysis		■	■	■									
Task 3 – Antelope Valley Setting Documentation		■	■	■									
Task 4 – Alternatives Development					■								
Task 5 – Alternatives Evaluation						■							
Task 6 – Recommended Plan Development							■	■					
Task 7 – Feasibility Study Report Preparation								■	■	■	-	■	■

1.2.3 Key Assumptions

In developing the baseline project, six key assumptions were made that impact the project definition and implementation plan:

- **Lancaster Area vs. Palmdale Area Project** – This Study focuses on using recycled water from LWRP. PWD is currently conducting a study looking into GWR-RW from PWRP but the timing and more limited scope of that study is such that the results could not be simply integrated into this Study to develop one single regional GWR-RW project. Given the Antelope Valley setting presented in Chapter 3 (including the location of LACSD's treatment plants, the potential recharge locations, and the availability of blending water sources), it is likely that the outcome of this Study and the PWD study will be two relatively independent GWR strategies using recycled water – one using recycled water from the LWRP, focusing on recharge locations in the West side of Antelope Valley and using imported water as the primary source of blend; and one using recycled water from the PWRP, focusing on recharge locations in the Amargosa and Little Rock Creek areas, and using both imported water and stormwater as sources of blend. To differentiate between the two GWR projects, the project considered in this Study is the Lancaster Area GWR-RW Baseline Project (baseline project). The other project is referred to as the Palmdale Area GWR-RW Baseline Project.

- **Preferred vs. Baseline GWR-RW Project** – The objective of this Study is to develop a baseline project (as opposed to *the* preferred project) so that budgetary cost estimates and a detailed implementation plan can be develope. When a decision is made to move forward with a GWR-RW project, the baseline project should be refined during a subsequent facility planning phase to identify the preferred project for implemenation. These refinements could include adjusting the size of the project, and reevaluating some of the treatment alternatives considered as part of the Study with additional public input. These steps are reflected in the implementation plan presented in Chapter 6.
- **Baseline vs. No Project Alternatives –** Implementing a GWR-RW project is one potential element of the overall solution to address the Valley's water resources issues. Other potential elements of the overall solution include developing GWR projects using water supplies other than recycled water only (such as imported water or stormwater), purchasing additional imported water, using recycled water for agricultural irrigation or urban uses such as park irrigation, and promoting water conservation.[15] These other elements should be considered by local officials prior to making a final decision on whether the region should move forward with a GWR-RW project. The current Integrated Regional Water Management Plan (IRWMP) process could be the forum for making this decision. This Study provides the information necessary to make an informed decision. It demonstrates that using recycled water is technically feasible and economically viable in comparison to a No Project alternative (i.e., GWR project that would solely rely on imported water).
- **Regional vs. Local GWR Project** – The baseline project focuses on a large/regional project in the Lancaster area (as described in the previous bullet). Smaller/local projects (e.g., pilot project within Lancaster city limits, use of recycled water from the RWWTP) could be considered as a potential next step in the implementation plan.
- **LWRP Available Recycled Water Flows –** The baseline project was developed assuming that a "baseline" amount of 10,000 acre-feet per year (afy) of recycled water would be available for GWR from the LWRP.

  As discussed above, this approach was used to provide local officials with one data point to compare the different elements of the solution to address the Valley's water resources issues and make a decision on whether to move forward with a GWR-RW project. Should a decision be made to move forward with a GWR-RW project, this number should be refined during the facility planning phase. These refinements would include adjusting the size of the project (i.e., refining the "baseline" amount of recycled water from the LWRP that would be recharged).

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[15] These elements are considered in various documents, including *AVEK 2005 UWMP (AVEK, 2005), 2005 Integrated UWMP for the Antelope Valley (KJ, 2005), Antelope Valley Facilities Planning Report Recycled Water (KJ, 2005), Palmdale Water District 2005 UWMP (Carollo, 2005), LWRP 2020 Facilities Plan and EIR (ESA, 2004), PWRP 2020 Facilities Plan and EIR (LACSD, 2004), and City of Lancaster Recycled Water Facilities and Operations Master Plan (RMC, 2006).*

- **Incidental vs. Planned Recharge –** The baseline project is a planned recharge project[16] rather than an incidental recharge project.[17] This approach was based on an evaluation of the potential advantages/disadvantages of incidental recharge and planned recharge conducted in response to stakeholder input. The evaluation concluded that incidental recharge did not appear to provide any significant advantage over planned recharge in the Lancaster area for three main reasons:
    - **Permitting** – The process for obtaining a permit from the Lahontan Regional Water Quality Control Board (RWQCB) for an incidental recharge project versus a planned recharge project would not be faster or less complicated.
    - **Other Permits** – An incidental recharge project would likely require additional regulatory consultation/approval from other agencies such as the California Department of Fish and Game (CDFG), which could add to the implementation timeline.
    - **Recovery of Recharged Water** – Incidental recharge provides less control over recharged water recovery, which could constitute a fatal flaw in project implementation.

  It is therefore recommended to move forward with developing a planned recharge project as the Lancaster Area GWR-RW Baseline Project and consider incidental recharge as an alternative only if a significant advantage can be identified as the project gets refined.

  This recommendation takes into consideration the possibility that the conditions for incidental recharge using recycled water from the other reclamation plants in the area might be more favorable but, as in this case, would require further assessment of the different opportunities, constraints and evaluation criteria. For example, it is conceivable that a project looking at discharging a blend of recycled water from the PWRP, stormwater and imported water into Little Rock Creek or Amargosa Creek could benefit from being defined as an incidental recharge project; however, without further evaluation, it would be premature to draw this conclusion at this time.

1.3 Stakeholder Coordination

A key objective of this Study is to meaningfully engage local agencies and stakeholders to obtain a broad spectrum of input, to build support for the Study outcomes, and to facilitate coordination with other regional initiatives. The Study was structured around a scoping meeting and a series of three workshops to facilitate this stakeholder coordination. Individual meetings were also held with critical project partners including AVEK and LACSD. Information obtained during the workshops and individual meetings were incorporated into this report.

1.3.1 Stakeholders

Table 1-7 lists the categories and specific stakeholder organizations that were identified and invited by phone or mail to join the scoping meeting and workshops. Appendix A provides the list of attendees at each meeting/workshop.

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[16] Project in which a sponsor applies for a permit to use recycled water for a project that has been designed, constructed, and is operated for the purpose of recharging a groundwater basin (by infiltration or injection) that is used as a source of domestic water supply.

[17] "Incidental" recharge occurs when water is added to a groundwater aquifer due to human activities, such as excess irrigation water or wastewater discharged to land or surface water. In the Antelope Valley setting, an incidental recharge project would consist of the discharge of recycled water to the dry bed of an intermittent stream or to disposal ponds. Some examples of incidental recharge include the Victor Valley Wastewater Reclamation Authority Regional Wastewater Treatment Plant that discharges treated effluent to percolation ponds and the unlined Mojave River, and the Santa Clarita Valley Sanitation District's Valencia and Saugus WRPs that discharge to Reaches 5 and 6 of the Santa Clara River in the Eastern Sub-basin. The Santa Clara River provides incidental recharge to the Piru Sub-basin, which underlies Reach 4 of the Santa Clara River.

Table 1-7: Stakeholder List

Public Agencies	Regulatory Agencies
Antelope Valley - East Kern Water Agency	California Department of Health Services
City of Lancaster	Lahontan Regional Water Quality Control Board
City of Palmdale	Los Angeles County Department of Health Services
County Sanitation Districts of Los Angeles County	State Water Resources Control Board
Edwards Air Force Base	**Businesses**
Littlerock Creek Irrigation District	Agricultural Companies (e.g. Bolthouse)
Los Angeles County Department of Public Works	Los Angeles County Farm Bureau
Palmdale Water District	UC Cooperative Extension, High Desert Ag. Div.
Quartz Hill Water District	Unaffiliated Agricultural Representatives
Rosamond Community Services District	Water Companies (e.g. Sundale MWC)
Elected Officials	
County Supervisor - Michael D. Antonovich (Representative Attended)	Cities' Council Members/Agencies' Board Members/Officials

Note: Members of the public, small, private water districts, environmental organizations, community groups, and the press were encouraged to ask questions at any time during the Study phase; but no extensive comprehensive outreach program was conducted. The City and its partners are planning on conducting a comprehensive outreach program during the next phase of the GWR project, after the Study is complete (see Section 6.2.5).

Up to thirty stakeholders attended each of the workshops with regular attendance by most public water and wastewater agencies, agricultural representatives, and regulatory agencies. The variety of stakeholders at the workshops and consistent attendance resulted in comments from a range of perspectives and valuable input to this Study. Members of the public and stakeholders who were not directly contacted were also encouraged to ask questions at any time during the Study, although no extensive outreach was conducted. Increased public involvement is anticipated and recommended in subsequent phases of the project.

1.3.2 Workshop Process

Table 1-8 summarizes the timeframe and specific objectives associated with each workshop. The scoping meeting and workshop summaries are included in Appendix A.

Table 1-8: Workshop Timeframe and Objectives

Workshop	Timeframe	Specific Objectives
Scoping Meeting	Mar 2006	• Review Study drivers, goals and objectives • Identify related activities, and key issues & opportunities to be considered • Present stakeholder process • Discuss approach and scope
1	May 2006	• Identify and quantify benefits • Discuss regulatory & engineering assessment
2	July 2006	• Present GWR project alternatives • Define evaluation criteria
3	Sep 2006	• Define preferred GWR project(s) • Discuss implementation issues

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Chapter 2 Recycled Water Groundwater Recharge Overview

CWC defines recycled water (alternatively called reclaimed water) as "water which, as a result of treatment of waste [water], is suitable for a direct beneficial use or a controlled use that would not otherwise occur." Essentially, recycled water is wastewater that has been highly purified and treated to strict standards set by the California Department of Health Services (DHS) to protect public health and ensure safety in water recycling practices. These standards are specified in the California Code of Regulations, Title 22, Division 4, Chapter 3 (Title 22) (DHS, 2001b). Recycled water is monitored by local, state, and federal regulatory agencies to ensure that it meets these strict standards.

Recycled water can be safely used for many applications that do not require drinking water quality, including landscape irrigation (e.g., golf course, parks, roadway medians, and cemeteries), cooling towers and other industrial uses, toilet flushing, wetlands restoration, decorative fountains, and irrigation of food crops.

Recycled water has been safely and widely used in California for more than 20 years. Recycled water is also used in an increasing number of other states, including Nevada, Arizona, Florida, and Texas, as well as in many other countries around the globe (e.g., Australia, Singapore). In 2002, over 540,000 acre-feet (af), or 176 billion gallons, of recycled water were used in California (SWRCB, 2002).

GWR-RW is one type of application of recycled water and has been implemented in California for over 40 years (the Montebello Forebay GWR Project in Los Angeles County started operations in 1962). However, the projects are limited in number compared with more common applications, such as landscape irrigation. To date only six GWR projects using recycled water have been permitted and are in operation in California.

This chapter is intended to provide a general overview on GWR-RW. First, it provides a definition of GWR and GWR-RW. Second, it provides a definition of planned versus incidental GWR-RW projects. Finally, it briefly describes existing GWR-RW projects in California.

2.1 Definition

The groundwater within a basin is a limited resource. It must be replaced in the same quantity as it is extracted to be a sustainable resource. A basin typically recharges from precipitation (such as rain, snow) that percolates down to groundwater aquifers. However, activities, primarily groundwater pumping, can extract groundwater at a much higher rate than a basin can naturally recharge, and an increase in impervious ground surfaces can cause a decrease in percolation.

This situation has resulted in overdraft of numerous groundwater basins in California and the United States. In fact, groundwater in California is currently being depleted by an average of 425 billion gallons per year (WEF, 2003). Consequences of overdraft include increased pumping costs due to a lower groundwater table, subsidence, decreased groundwater quality, and, ultimately, loss of the groundwater resource. Conjunctive use of groundwater and non-groundwater sources has emerged as a method to counteract overdraft and to actively manage the groundwater basin as an underground storage reservoir.

Conjunctive use methods (commonly referred to as "groundwater recharge") include in-lieu use, GWR via spreading and infiltration, and GWR via injection (WEF, 2003):

- **In-Lieu Use** – In-lieu use is the use of water supplies other than groundwater, when available, in place of groundwater. For example, use of imported surface water in wet years (when more imported water is available and/or is less expensive than average or dry years) by users that would otherwise use groundwater.
- **Groundwater Recharge via Surface Spreading and Infiltration –** Surface spreading and infiltration is the recharge of water via gravity to convey water through an unsaturated zone (between the surface and groundwater table) to an unconfined aquifer. Permeable surface soils are

preferred to less permeable soils because the rate of recharge can be higher due to lower resistance to water traveling through the zone. Less prevalent but sometimes used are methods that recharge in excavated areas within the unsaturated zone, such as vadose zone wells / dry wells or trenches. The recharged groundwater becomes part of the aquifer system for extraction by public or private well owners.

- **Groundwater Recharge via Injection** – Injection occurs by pumping water under pressure through a well to a chosen aquifer. As with GWR via spreading and infiltration, the recharged groundwater becomes part of the aquifer system for extraction by public or private well owners. Aquifer storage and recovery (ASR) is a type of injection method where the well is designed to inject the recharge water and extract the same water at the same location. As a result, recharge water in ASR projects do not travel within the aquifer system but rather remain in the vicinity of the recharge location.

Imported water has historically been the primary non-groundwater source for GWR projects in Southern California. Recycled water is now increasingly being used as a non-groundwater source. The use of recycled water affects the GWR methods described above in different ways:

- **In-Lieu Use Using Recycled Water** – Using recycled water for in-lieu use is limited to only those uses approved under DHS water recycling criteria. The recycling criteria establish standards for the use of recycled water for landscape irrigation, agricultural irrigation, industrial processing/cooling, recreational impoundments, and other applications.
- **Groundwater Recharge via Surface Spreading and Infiltration Using Recycled Water –** When using recycled water, GWR via surface spreading is approved on a case-by-case basis by DHS with permits issued by a RWQCB. DHS is in the process of developing specific regulations for GWR-RW projects, and the draft GWR regulations are used as guidelines for establishing requirements for projects. The draft regulations include numeric requirements for recycled water quality, treatment process requirements, operational requirements, and treatment reliability requirements. The specific regulatory process and requirements that govern GWR-RW via surface spreading are further discussed in Chapter 4.
- **Groundwater Recharge via Injection Using Recycled Water** – Similar to GWR-RW via surface spreading, GWR-RW via injection must meet specific DHS and RWQCB requirements when using recycled water. The DHS requirements are stricter than those applied to surface spreading projects with regard to how the recycled water must be treated [typically microfiltration with reverse osmosis (MF/RO) at a minimum] and operational requirements. The specific regulatory process and requirements that govern GWR-RW via injection are further discussed in Chapter 4.

2.2 Recycled Water Groundwater Recharge Projects in California

Table 2-1 lists GWR-RW projects that have been considered or implemented to date in California. Both successful and unsuccessful projects are identified. Most of the unsuccessful projects faced some form of public opposition or lack of political support. A brief summary of each project is included in Appendix B.

Table 2-1: Groundwater Recharge Projects Using Recycled Water in California

Successful Projects			Unsuccessful Projects [1]		
Name	**Type**	**Operational Date**	**Name**	**Type**	**Termination Date**
Montebello Forebay GWR	SS	1962	Los Angeles Dept of Water and Power East Valley Water Reclamation Project	SS	2000
Chino Basin GWR, Phase 1	SS	2005	Dublin San Ramon Clean Water Revival Project	I	1998
Orange County GWR	SS	2007	San Diego Water Repurification Project	RA	1999 [3]
OCWD Water Factory 21	I	1975 [2]	**Project in Progress**		
West Coast Basin Barrier	I	1994	San Gabriel Valley GWR Project [4]	SS	Not Known
Alamitos Barrier	I	2006			
Dominguez Gap Barrier	I	2006			

Notes: SS: Surface spreading; I: Injection; RA: Reservoir augmentation

1. Most of the unsuccessful projects faced some form of public opposition or lack of political support.
2. Project was temporarily stopped in 2004 and will resume in 2007 as part of Orange County GWR.
3. Project is being re-evaluated.
4. The first effort to move forward with this project was defeated due to public opposition; it was reconfigured and is still being evaluated.

Table 2-2 provides a summary of the key characteristics for the three successful projects using surface spreading (Montebello Forebay, Chino Basin Phase 1, Orange County Groundwater Replenishment System), which are most relevant to a GWR project using recycled water in Antelope Valley. The table also summarizes the regulatory pathways that were employed for each project.

Table 2-2: Successful Groundwater Recharge Projects Using Surface Spreading

GWR-RW Project	Lead Agency	Basin Status; RWQCB	Blend Supply (afy)		Regulatory Pathway
			Recycled Water	**Diluent Water**	
Montebello Forebay	Water Replenishment District of Southern California	Adjudicated; Los Angeles	50,000 (35%)	100,000 (65%)	• Research Allowed Increase from 22 % RWC to 35% RWC • Grandfathered at Current RWC • Potential conversion to alternative disinfection methods
Chino Basin, Phase 1	Inland Empire Utilities Agency	Adjudicated; Santa Ana	8,000 (20%)	36,000 (80%)	• Blending with 20% RWC • Soil Aquifer Treatment “Credits” • Salt/Nitrogen Management Plan
Orange County	Orange County Water District	Managed; Santa Ana	72,000 (75%)	24,000 (25%)	• Blending with 75% RWC with phased approach to 100% RWC • Advanced Treatment • Track Record/Public Outreach

Chapter 3 Antelope Valley Groundwater Recharge Setting

Potential strategies for GWR-RW as well as implementation strategies are dependent on a combination of primary factors, including hydrogeology of the Study area (e.g., volume, quality, yield, and transmissivity), expected recycled water availability and quality, blend (diluent) water reliability and quality, and the adjudication proceedings.

Blend water is a necessary component of a GWR-RW project based on regulatory requirements. The primary source of blend water is anticipated to be imported SWP water. Another potential source of blend water could be stormwater. Two of the existing GWR projects using recycled water and spreading basins use stormwater as part of their blend supply (Montebello Forebay, Chino Basin Phase 1; see Chapter 2). In both cases the primary blend water source is untreated imported water from either the SWP or the Colorado Aqueduct. Both imported water and stormwater are considered in this Chapter, but the emphasis is placed on imported water because it is a more available and predictable blend water source, and GWR projects using imported water are further along in the planning process than GWR projects using stormwater in the Antelope Valley (see Chapter 1).

This chapter documents and analyzes the primary factors listed above. Potential strategies were developed based on this analysis of the GWR setting and the regulatory analysis documented in Chapter 4. The potential strategies are presented in Section 6.2.

3.1 Existing Reports and Data

Many relevant reports have been prepared over the past 10 years or are currently being developed by various agencies in Antelope Valley. These reports were reviewed to support this Study (reports completed before 1996 were not considered, unless they addressed the basin hydrogeology).

In addition to these reports, relevant data was obtained directly from the potential project partners. Readily available, and most current water quality, flow, and various other data was directly summarized or referred to in the text. Geographic Information System (GIS) data was used to develop the maps and figures included in this Study. Due to non-disclosure agreements signed with the partner agencies, the GIS data are not provided in electronic form in this report. Some GIS data was developed as part of this Study and information on all GIS data used to prepare this report are summarized in Appendix C.

Some data gaps were identified such as private well data that could be used to refine subsurface conditions outside of the areas where WWD No. 40 and PWD supplied well completion reports. These data would provide additional details on subsurface conditions and support assumptions made in our evaluation. These data gaps are not critical to complete this Study, but will need to be filled prior to the implementation phase. Therefore, no new data collection (e.g., water quality monitoring program) was initiated as part of this Study. However, new data collection is recommended as part of the implementation plan presented in Chapter 5.

3.2 Hydrogeology of the Study Area

The hydrogeologic characterization of the Lancaster, Buttes, and Pearland subunits, which constitute the Study area (Figure 1-1), is a critical technical step in the development of a GWR-RW project. For the purpose of this Study, the hydrogeologic characterization consisted of five tasks:

1. Piezometric Maps Development
2. Specific Yield Estimate
3. Storage Volume Review
4. Hydraulic Conductivity Review
5. Water Quality Review

Existing information described in Section 3.1 was relied upon to the maximum extent to minimize duplication of efforts. Reports that were most relied upon to complete this chapter are listed below:

- Bloyd, R.M., Jr., 1967. Water Resources of the Antelope Valley-East Kern Water Agency Area, California: U.S. Geological Survey Open-File Report 67-21.
- Christensen, A.H., 2005. Generalized Water-Level Contours, September-October 2000 and March-April 2001, and Long-Term Water-Level Changes, at the U.S. Air Force Plant 42 and Vicinity, Palmdale, California: USGS Scientific Investigations Report 2005-5074.
- Duell, L.F., 1987. Geohydrology of the Antelope Valley Area, California and Design for a Ground-Water-Quality Monitoring Network: USGS Water-Resources Investigations Report 84-4081.
- Durbin, T.J., 1978. Calibration of a Mathematical Model of the Antelope Valley Ground-Water Basin, California: USGS Water-Supply Paper 2046.
- Howle, J.F. et al, 2003. Determination of Specific Yield and Water-Table Changes Using Temporal Microgravity Surveys Collected During the Second Injection, Storage, and Recovery Test at Lancaster, Antelope Valley, California, November 1996 Through April 1997: USGS Water-Resources Investigations Report 03-4019.
- Johnson, H.R., 1911. Water Resources of Antelope Valley, California: USGS Water-Supply Paper 278.
- Kern County Planning Department, April 2006. Draft Environmental Impact Report for Antelope Valley Water Bank Project by Western Development and Storage, LLC (SCH #2005091117).
- Law Environmental (Law), November 1991. Water Supply Evaluation, Antelope Valley, California, prepared for Palmdale Water District.
- Leighton, D.A. and Phillips, S.P., 2003. Simulation of Ground-Water Flow and Land Subsidence, Antelope Valley Ground-Water Basin, California: USGS Water-Resources Investigations Report 03-4016.
- Stetson Engineers, Inc. (Stetson), September 2002. Final Report Study of Potential Recharge Sites in the Antelope Valley, prepared for Antelope Valley State Water Contractors Association.
- Weir, J.E. et al, 1965. A Progress Report and Proposed Test-Well Drilling Program for the Water-Resources Investigation of the Antelope Valley-East Kern Water Agency Area, California: USGS Open-File Report 65-172.

In addition, the USGS groundwater flow model of the Antelope Valley (Leighton, 2003) was obtained and run using several recharge scenarios to determine the underground retention time (URT) of recycled water recharged to the aquifer prior to reaching the nearest domestic supply well. This information is presented in Section 5.1.3.

Agencies in the Antelope Valley are moving forward with the development and implementation of GWR projects using imported water (see Figure 1-2). A number of activities relative to the hydrogeology of the basin are therefore underway related to these GWR efforts, although not documented in specific reports. Information relative to these activities was obtained to the extent possible through discussion with agency staff and considered herein.

3.2.1 Groundwater Levels

Understanding groundwater levels and level changes over time within a groundwater basin provide the foundation of a groundwater study. This information is used to determine groundwater flow direction and gradient, groundwater flow velocity, the volume of water in storage, and the volume of available (unused) storage. This, in turn, is used to estimate the potential water quality changes and impact to wells that can be expected as a result of GWR (see Section 5.2.3).

Approach

Groundwater elevation data was collected from numerous sources, including previous reports, WWD No. 40, PWD, and USGS. The data for selected time periods was analyzed to produce groundwater elevation maps that represented the extremes, intermediate, and current groundwater elevations within the Study area. These time periods were selected by analyzing the following available information:

- Groundwater elevation contour maps for 1915 (Durbin, 1978), 1961 (Durbin, 1978), 1979 (Duell, 1987), and 1988 (Law, 1991)
- Piezometric time histories for 42 WWD No. 40 wells (January 2001 through the present)
- Piezometric time histories for 24 PWD wells (January 1992 through the present)
- Piezometric time histories for approximately 160 wells within the USGS database (1920's through the present)

Results

The groundwater level mapping periods selected for this Study – 1915, 1961, 1979, 1988, and 2006 – are those periods with sufficient available data and that best represent the extremes of groundwater elevations measured within the Study area. The groundwater level map for 2006 is presented in **Figure 3-1** and all periods are included in Appendix D. Each of the periods was designated by the following:

- **High Water Level** - This Study assumes the period during which the highest water level elevations occurred within the Study area was prior to 1915; the period before significant groundwater production occurred. A groundwater elevation contour map for the period of 1915 (Durbin, 1978) was digitized to create the groundwater elevation contour map used in this study, and is presented in Appendix D.
- **Low Water Level -** The period during which groundwater storage was declining the fastest was during the period of heaviest groundwater production within the basin [approximately 300,000 afy in 1950, (Durbin, 1978)] and before the SWP began making surface water deliveries to the Antelope Valley in 1972. Based upon storage volume changes within the Study area, groundwater levels continued to decline until approximately 1979.

  A groundwater elevation contour map for the period of 1979 (Duell, 1987) was digitized to create the groundwater elevation contour map used in this study, and is presented in Appendix D.

  Although current groundwater elevations are actually lower in the heavily pumped urban areas of Lancaster and Palmdale, groundwater elevations in the east and west portions of the Lancaster sub-unit are increasing. Therefore, this study assumes the period during which the Study area storage volume was at its lowest, 1979, was also the period when overall groundwater elevations were at their lowest.
- **Intermediate Water Level 1 and 2 -** Groundwater elevation contour maps for the periods of 1961 (Durbin, 1978) and 1988 (Law, 1991) were digitized to create the groundwater elevation contour maps used in this study. The basin-wide groundwater elevations during these years were between the highest and lowest elevation years. The maps are presented in Appendix D.
- **Current Water Level -** The current water level map is for spring 2006 (Appendix D). Spring 2006 water level data was provided by PWD, WWD No. 40 and the USGS National Water Information System (NWIS) web service.[18] The groundwater elevations were calculated by subtracting the depth to water at each well location from the ground surface elevation. The ground surface elevation was obtained from a 30 meter digital elevation model[19] to standardize the reference point elevations for various well owners.

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[18] http://nwis.waterdata.usgs.gov/usa/nwis/gwlevels

[19] http://seamless.usgs.gov/

Groundwater levels within the Study area have changed since significant pumping began in the early 1900's. The changes are primarily groundwater level declines in response to extraction in excess of recharge. The changes, however, are not spatially or temporally uniform across the Study area. Within the eastern portion of the Buttes and Pearland sub-units the groundwater levels have remained relatively unchanged, with groundwater level declines of approximately 20 feet. Within the western portion of these sub-units groundwater levels have declined up to 100 feet. Within the Lancaster sub-unit the groundwater level declines are more dramatic and varied with land use. Groundwater levels in 1961 indicate agricultural pumping in the east and west of the Lancaster sub-unit resulted in water table depressions up to 200 feet below 1915 levels. As the valley became more urbanized and SWP water became available, the water table depressions stabilized within the east and west and increased towards the central portion of the basin near the cities of Lancaster and Palmdale.

Groundwater Movement

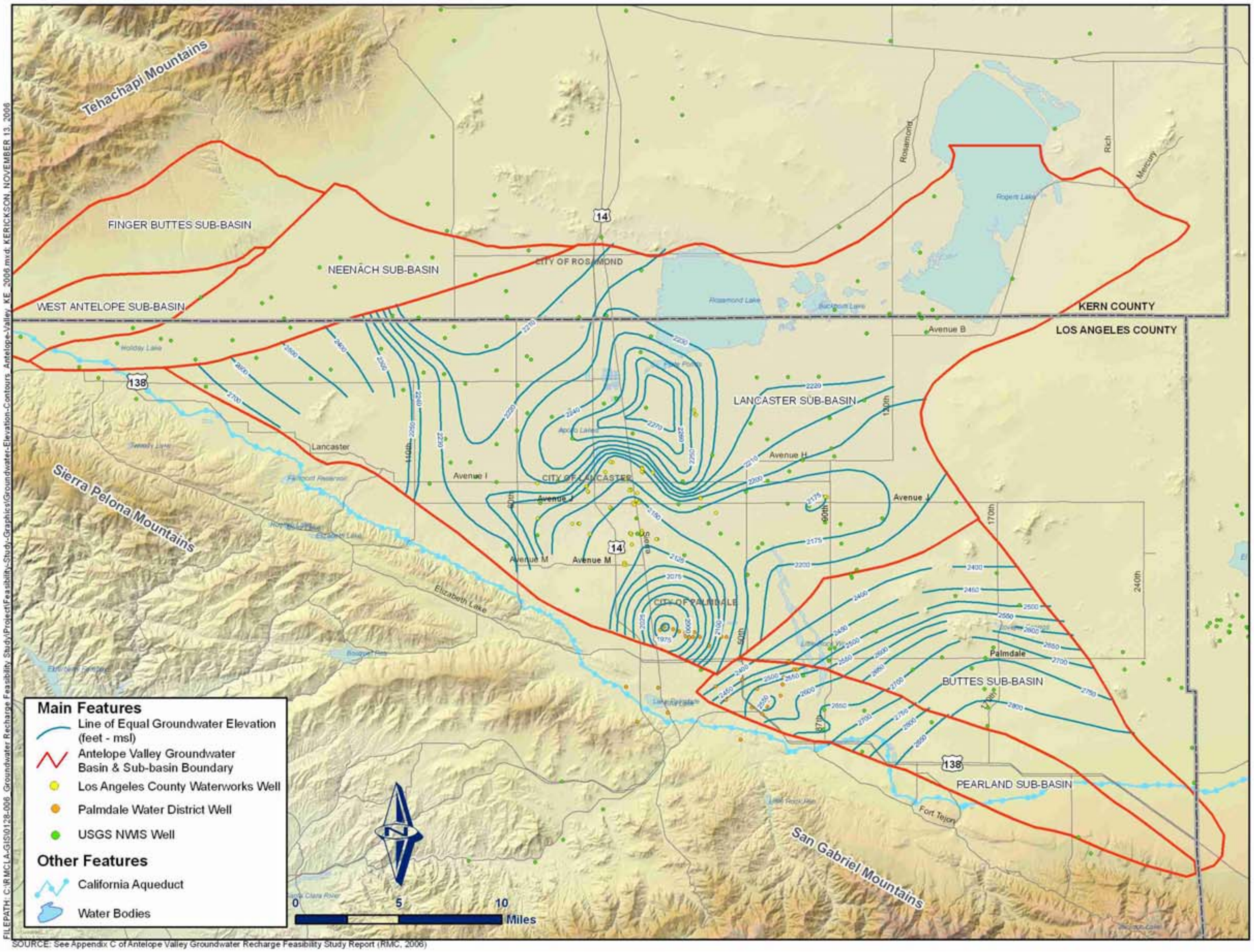
Groundwater movement within the Buttes and Pearland sub-units is primarily to the northwest and parallel to the San Andreas Fault zone. This has not significantly changed since pumping began in 1915. As groundwater production within these units' developed so did some local groundwater flow direction changes, but the overall flow direction remains to the northwest.

Groundwater movement within the Lancaster sub-unit has dramatically changed with the development of the groundwater basin. Under natural conditions, groundwater movement was from the high alluvial deposits along the San Gabriel Mountains (the primary source of groundwater recharge) towards the lower elevations of Rosamond and Rodgers dry lakes. With the onset of significant agricultural pumping within the east and west portions of the Lancaster sub-unit, pumping depressions developed and groundwater movement changed towards those depressions. Subsequently, as urbanization increased within the central and southern portions of the Lancaster sub-unit, additional pumping depressions developed, resulting in a general reversal in the groundwater flow direction towards the south-central portion of the basin, near the cities of Lancaster and Palmdale.

A ridge of relatively high groundwater exists within the west-central portion of the Lancaster sub-unit, extending from Rosamond Lake southwest toward Quartz Hill. As shown on the 1979 groundwater elevation contour map, a groundwater elevation high occurs beneath this area. As of spring 2006, this groundwater elevation high extends to the southwest towards the Apollo Lakes. As a result, groundwater west of the ridge flows toward the northwest and groundwater east of the ridge flows southeast, towards the cities of Lancaster and Palmdale. Others have suggested that water infiltrated at the Piute Ponds does not reach the regional groundwater table owing to the high clay content of the subsurface soils (Leighton, 2003). Some (Bloyd, 1967 and Duell, 1987) have suggested a regional perched water layer exists beneath this area, which may contribute to the relatively high groundwater elevations.

A significant pumping depression has developed within the southern portion of the Lancaster subunit, between the cities of Palmdale and Lancaster. This depression extends radially several miles from the lowest water level reading in the basin and is most likely due to concentrated groundwater pumping for municipal supplies.

Figure 3-1: Spring 2006 Groundwater Elevation Contours



SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

3.2.2 Storage Volume

The storage volume was calculated to determine the changes in groundwater conditions within the Study area and to assess the effects recharging water may have on groundwater quality beneath the recharge sites. Storage volume changes within the Study area are directly related to the volume of groundwater extracted for consumptive use. Significant groundwater production within the Antelope Valley began in 1915 and continues through today. Groundwater production has decreased from a high of over 300,000 afy in the 1950's (Durbin, 1978) to approximately 60,000 afy in 1995 (K/J, 2005).

Approach

The USGS groundwater model divides the Antelope Valley into three layers, each defined in terms of elevation. Layer 1, the uppermost layer, is the primary layer of concern for this Study and is defined as the zone from 1950 feet above mean sea level (ft-msl) to the water table. This layer is the primary concern of this Study because this is where water recharged through surface spreading will have the greatest impact.

Top and bottom elevations for Layers 2 and 3 are uniform at 1950 ft, 1550 ft and 1000 ft (unless bedrock is at an elevation greater than 1,000 ft), respectively. Aquifer information was extracted from the USGS MODFLOW model for the Antelope Valley (Leighton, 2003). Water level elevation surface grid systems were overlain on the USGS model grid and water level information was transferred to USGS model grids. A spreadsheet model was developed to calculate storage volume for each model grid cell and then to summarize the storage volume for each sub-basin.

The storage volume for each sub-unit of the Study area was calculated by multiplying the area (in acres) of the basin by the thickness of the saturated zone (in feet) and by the specific yield (S_y, %) of the saturated material. The extracted data included the active model grid cells; top and bottom elevations of USGS model Layer 1 and specific yield.

Water level maps were digitized and projected to real world coordinates. Areas with missing information were interpolated from adjacent areas or from earlier maps. For example, 1988 and 2006 water level maps do not include the water level information for the north-east portion of the Lancaster sub-unit. This missing data was supplemented with 1979 water level data. The digitized water level contour maps were converted to digital data and geo-statistical software was used to create water level surfaces.

Results

Table 3-1 shows the Layer 1 storage volumes and the changes in storage volume from 1915 to spring 2006 for each sub-basin of the Study area.

Table 3-1: Storage Volumes of Layer 1

Sub-basin	1915 (af)	1961 (af)	1979 (af)	1988 (af)	2006 (af)	1915 – 2006 Decrease (million af)
Lancaster	14,571,500	10,806,600	9,698,000	10,176,500	9,902,900	4.7 maf / 32%
Buttes	3,370,700	2,937,700	2,858,000	3,056,400	2,881,900	0.5 maf / 15%
Pearland	2,342,600	2,150,300	2,084,900	1,691,500	1,741,900	0.6 maf / 26%
Total	**20,284,800**	**15,894,700**	**14,640,900**	**14,924,400**	**14,526,700**	**5.8 maf / 28%**

The volume of groundwater in storage within the Study area declined between 1915 and spring 2006. The most significant decrease occurred between 1915 and 1979. Multiple factors may contribute to the leveling-off trend seen since 1979, including the reduction of groundwater pumping, the increase in SWP deliveries, and the latent effects of agricultural return flows reaching the water table. Within the context of the data analyzed to make these calculations, the changes seen in the overall volume of groundwater in storage in the Buttes and Pearland sub-units are insignificant.

3.2.3 Specific Yield

Understanding the specific yield[20] of the saturated materials underlying the Study area is necessary to calculate storage volumes and storage volume changes over time. Specific yield estimates were made by the USGS in their development of the MODFLOW model for the Antelope Valley (Leighton, 2003) and used in this Study. The specific yield estimates for the unconfined (upper) layer (Layer 1) ranged from 10 to 14 percent and are shown on **Figure 3-2**.

3.2.4 Hydraulic Conductivity

Understanding the hydraulic conductivity[21] of the materials underlying the Study area is necessary to estimate the rate at which recharged water will move through the vadose zone and aquifer towards pumping wells (further discussed in Section 5.1.3). Hydraulic conductivity estimates were made by the USGS in their development of the MODFLOW model for the Antelope Valley (Leighton, 2003). The hydraulic conductivity values for Layer 1 ranged from 2 to 30 feet per day and are shown on **Figure 3-3**.

3.2.5 Water Quality

Groundwater quality data for TDS, nitrate, and THMs within the Study area was obtained from the USGS records, PWD, WWD No. 40, and the Edwards Air Force Plant 42 Investigation (Geomatrix, 2005). The groundwater samples were collected from municipal and private domestic supply wells, private agriculture and industrial wells, and monitoring wells. The data reviewed range in dates from 1952 to 2006. **Table 3-2** shows the average TDS and nitrate concentrations within the Study area. Figures and tables summarizing available groundwater quality data and the source of the data can be found in Appendix E.

Table 3-2: Typical Groundwater Quality in Study Area

Constituent	Units	Range of Concentrations	Median Concentrations
TDS	mg/L	110 to 1,480	220
Nitrate (as N)	mg/L	Non-Detect to 15	0.8
THMs	µg/L	Non-Detect [1]	-

Source: see Appendix E

Note:

1. Limited THM data was available. PWD collected THM samples from the majority of wells during 2004 and all of the results were non-detect.

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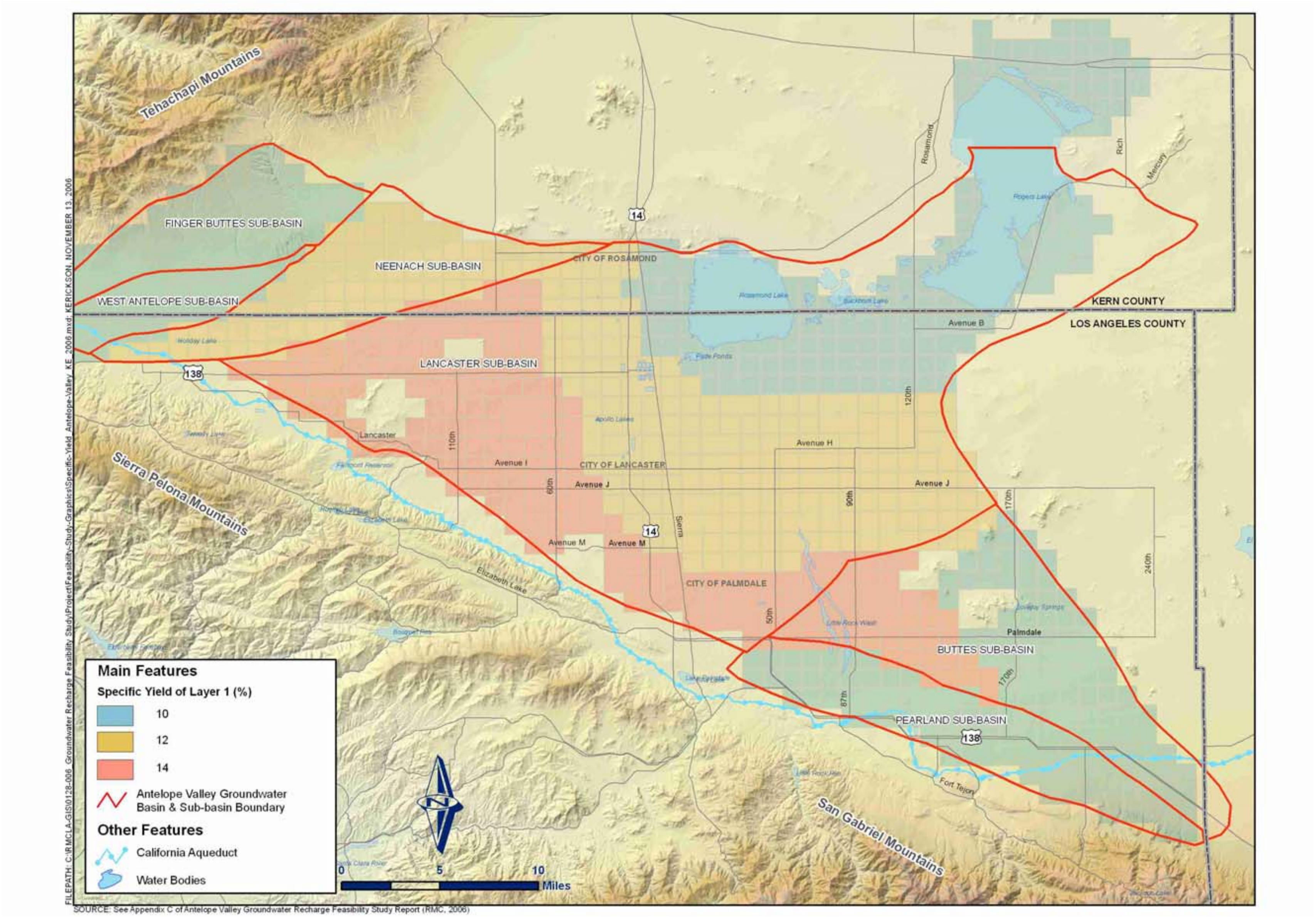
[20] Specific yield is the ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil, and is typically expressed as a percentage.

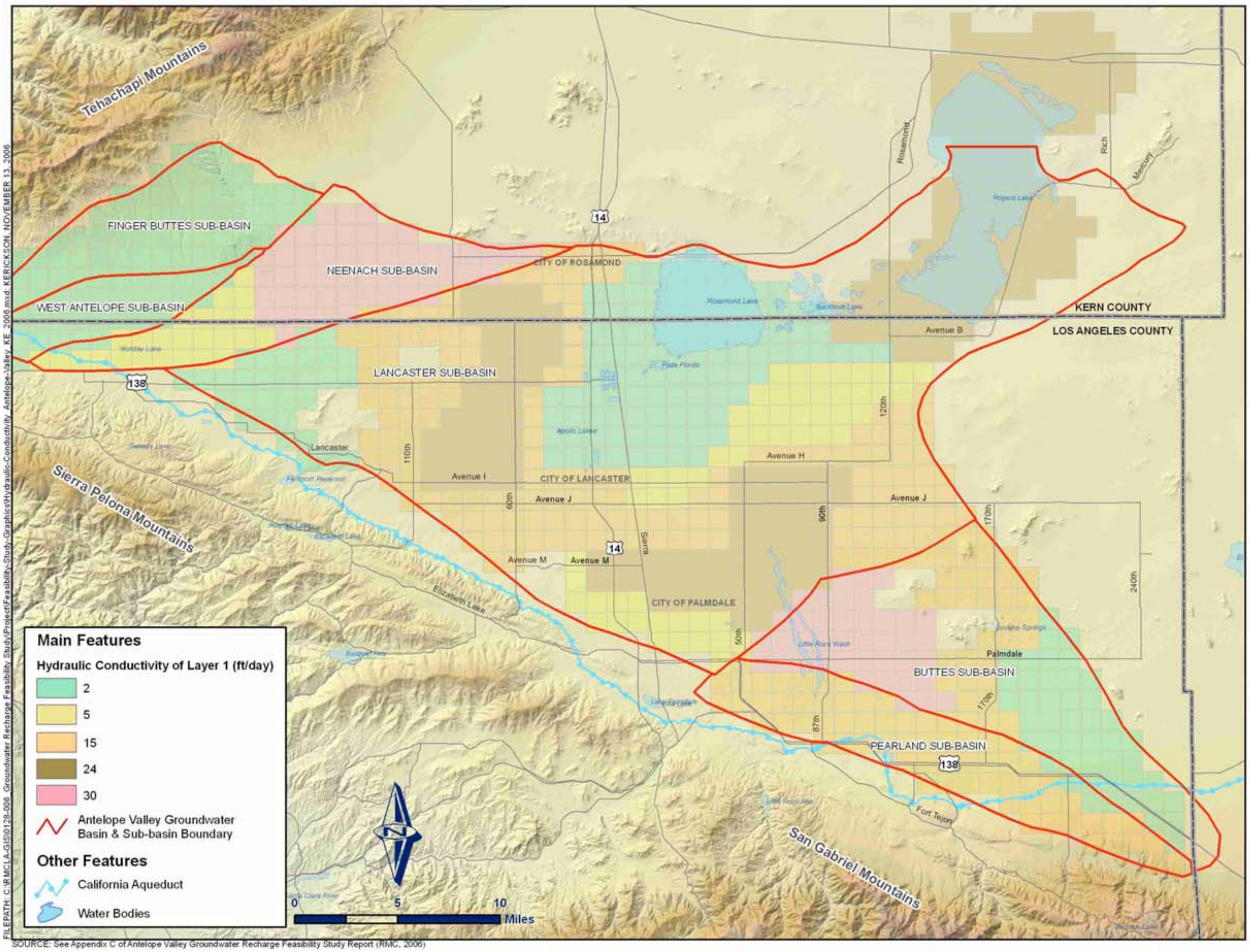
[21] Hydraulic conductivity is a coefficient of proportionality describing the rate at which water can move through a permeable medium.

Figure 3-2: Specific Yield of Layer 1, Antelope Valley Groundwater Basin



SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

Figure 3-3: Hydraulic Conductivity of Layer 1, Antelope Valley Groundwater Basin



SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

Average TDS concentrations in four wells within Lancaster, Buttes, and Pearland sub-basins exceed the secondary drinking water recommended MCL (500 mg/L). In the urbanized area of southern Lancaster sub-basin the average concentration of TDS in groundwater is near the MCL, with two wells exceeding the MCL. Within the northeast agricultural area of Lancaster sub-basin the average concentration of TDS in groundwater is also near the MCL, with one well exceeding the MCL. Groundwater in the northern end of Pearland sub-basin exhibits some detectable concentrations below the MCL with one station near 87th Street exceeding the MCL. Limited TDS data is available for the western and northern area of Lancaster sub-basin, Buttes sub-basin, and the southeast end of Pearland sub-basin, however, the limited existing data indicates concentrations are below the MCL in these areas.

Average nitrate concentrations within Lancaster, Buttes, and Pearland sub-basins exceed the primary drinking water MCL (10 mg/L as N) in three locations. In the urbanized area of southern Lancaster sub-basin, average concentrations of nitrate in groundwater are below the MCL, with one well exceeding the MCL near the northern end of the urban area. Elevated nitrate concentrations are seen near Edwards Air Force Plant 42 with concentrations as high as 15 mg/L (as N). The northern area of Pearland sub-basin contains average concentrations of nitrate in groundwater near and exceeding the MCL. Limited nitrate data is available for the western and eastern agricultural areas of Lancaster sub-basin, Buttes sub-basin, and the southeast end of Pearland sub-basin, however the limited existing data indicates low or non-detect concentrations.

3.3 Recycled Water Sources

There are currently three main existing or planned recycled water sources within the Study area: LWRP, PWRP, and RWWTP. LACSD has developed facilities plans for the LWRP and PWRP through the years 2020 and 2025, respectively, that show planned expansions of both facilities to accommodate flows. No additional water reclamation facilities have been considered for the area at this time. Thus, the LRWP, PRWP and the RWWTP were the main source of recycled water considered in the Study.

For the purpose of this Study, the key information necessary relative to the treatment plant is as follows:

- Capacity and Treatment Components
- Water Quality
- Source Control

This information is summarized below for the LRWP. Information for PRWP and RWWTP are available in the *Facilities Planning Report, Antelope Valley Recycled Water Project (KJ, 2006),* and was not documented herein since this report focuses on a GWR project in the Lancaster area. The existing and planned distribution system is also summarized at the end of this section.

3.3.1 Lancaster Water Reclamation Plant

LWRP is owned and operated by LACSD No. 14. Existing information described in Section 3.1 was relied upon to the maximum extent to minimize duplication of efforts. Reports that were most relied upon to complete this Section are listed below:

- *LWRP 2020 Facilities Plan and EIR (LACSD, 2004)*
- *2004 Annual Monitoring Report (LACSD, 2005b)*
- *City of Lancaster Recycled Water Facilities and Operations Master Plan (RMC, 2006)*
- *Facilities Planning Report, Antelope Valley Recycled Water Project (KJ, 2006)*

Capacity and Treatment Components

The LWRP is a secondary treatment plant with a permitted capacity of 16.0 mgd. Wastewater treatment consists of comminution, grit removal, primary sedimentation, oxidation (achieved with oxidation ponds), and solids processing (achieved with digestion tanks and drying beds). The recycled water produced at the LWRP is used to irrigate fodder crops at Nebeker Ranch, maintain a marsh-type habitat at Piute Ponds, and maintain the adjacent impoundment areas, which are used for seasonal duck hunting. A small side stream of the secondary-treated effluent undergoes tertiary treatment at the Antelope Valley Tertiary Treatment Plant (AVTTP) and is conveyed to Apollo Park for habitat enhancement of Apollo Lakes and landscape irrigation. The treatment capacity of the AVTTP is 0.5 mgd. Surplus secondary effluent is stored in four, 40-acre reservoirs, which are located on the LWRP site.

The recommended project resulting from the *LWRP 2020 Plan* will expand the treatment capacity at the LWRP from 16.0 mgd to 26.0 mgd by 2015, in two phases. Treatment modifications will include expanding existing primary treatment facilities, replacing secondary treatment oxidation ponds with conventional activated sludge, and adding tertiary treatment.

Subsequent to the completion of the LWRP 2020 Plan, LACSD elected to also construct a 1 mgd pilot tertiary Membrane Bioreactor (MBR) Plant. Effluent from the MBR Plant will be combined with unused AVTTP plant effluent for irrigation at an agricultural site.

Table 3-3 summarizes planned production capacity and associated tertiary treatment processes under the existing plant configuration, the LWRP 2020 Plan and the MBR pilot project. **Figure 3-4** provides a process schematic for the Phase 2 plant.

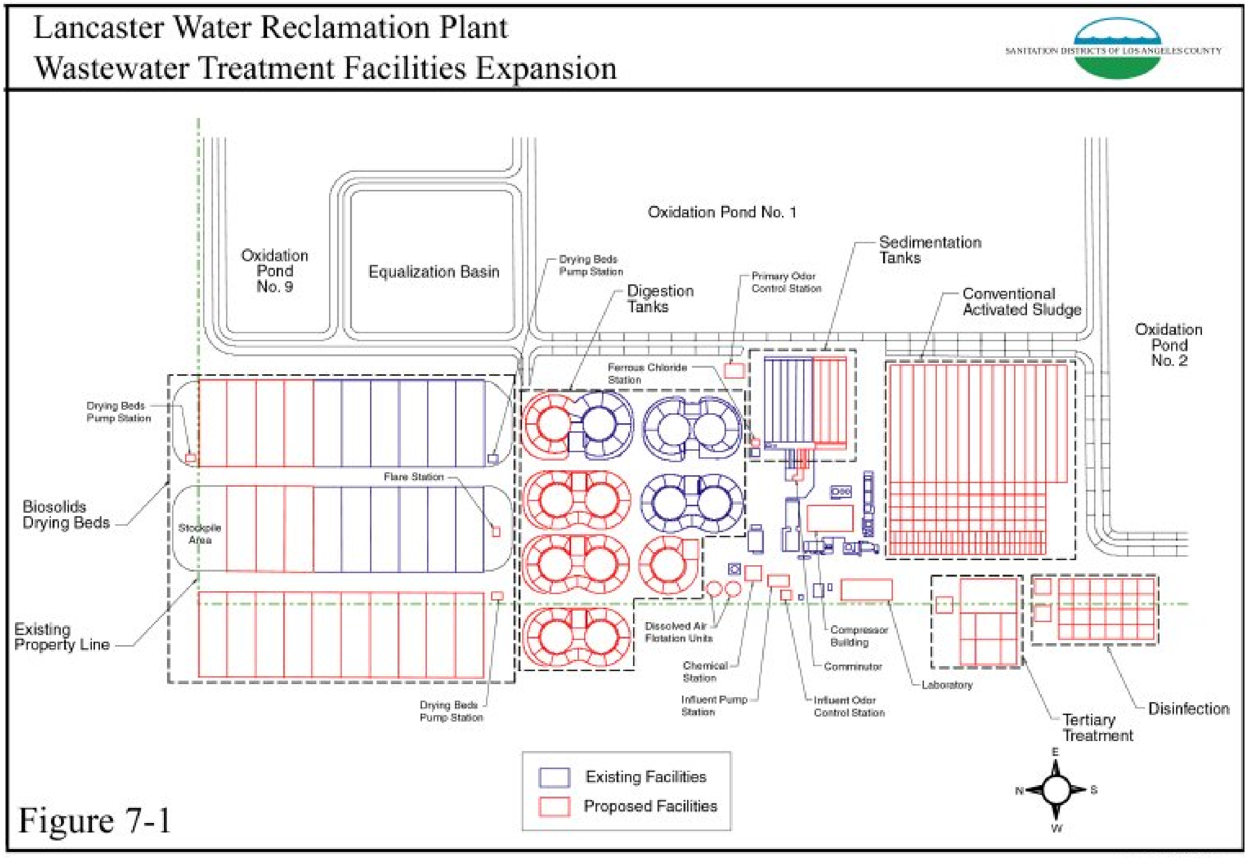
Table 3-3: Planned LWRP Recycled Water Production Capacity

LWRP Expansion Phase	Timing	Capacity (mgd)	Tertiary Treatment Process
Existing (AVTTP)	2004 - 2006	0.5	Coagulation/flocculation, sedimentation, dual-media gravity filtration, chlorination
Phase 1	2006 - 2010	1.5	Same as Existing plus 1.0 mgd of MBR with UV disinfection
Phase 2 (Stage V Expansion)	2011 - 2014	21	Mono-media filters, chlorination (planned); 1.5 mgd from Phase 1
Phase 3 (Stage VI Expansion)	2015 and beyond	26[2]	

Source: *LWRP 2020 Plan* (ESA, 2004) and personal correspondence with LACSD (June 2005 and May 2006).
Notes:

1. Proposed facilities and timing of expansion is planned to be reevaluated in 2010-2011 to respond to any changes in wastewater flow projections or other factors affecting the recommended project.
2. Proposed facilities and timing of expansion is planned to be reevaluated in 2010-2011 to respond to any changes in wastewater flow projections or other factors affecting the recommended project.

Figure 3-4: Planned Phase 2 LWRP Process Schematic



LWRP 2020 Plan

Some of the recycled water from the planned expansions has already been committed for other uses and thus will not be available for GWR-RW. This includes recycled water needed to maintain Piute Ponds. In addition, the City of Lancaster, in partnership with LACSD No. 14 and WWD No. 40, are developing the first phase of a local reuse project (RMC, 2006). The Division Street Corridor Recycled Water Project, which will approximately 1.0 mgd of tertiary effluent for landscape irrigation, dust control, and soil compaction is expected to be operational by 2007. The rest of the recycled water to be produced at LWRP is currently intended for agricultural use so that District No. 14 can meet its discharge requirements under Cease & Desist Order No. R6V-2004-0038. This Order was established by the RWQCB to discontinue overflows of effluent from Piute Ponds to Rosamond Dry Lake.

For the purpose of this Study, the following assumptions were made to estimate the quantities of recycled water that could be available for GWR-RW under each phase of LWRP expansion listed in Table 3-3:

- **Committed Flows -** Flows to Piute Ponds and Apollo Lake (existing recycled water users) must be maintained in the future.
- **Planned Urban Flows**– The proposed Phase 1 and Phase 2 projects described in the Lancaster RWMP (RMC, 2006) will be implemented. Implementation of GWR-RW is assumed to be more economical beyond that phase. This assumption will need to be verified after this Study is complete.
- **LACSD Agricultural Reuse Project Flows** – The agricultural reuse project identified in the *LWRP 2020 Plan* is developed to the extent assumed through 2010 (LACSD, 2004).

- **GWR-RW Flows** – In 2015, 10,000 afy of the agricultural reuse project water could be made available for GWR-RW use. This value was used as the basis to develop and evaluate the GWR-RW alternatives presented in Chapter 5.

Table 3-4 summarizes the quantities of recycled water that would be available for GWR under each phase of LWRP expansion under the assumptions listed above.

Table 3-4: Assumed Annual Use of LWRP Recycled Water

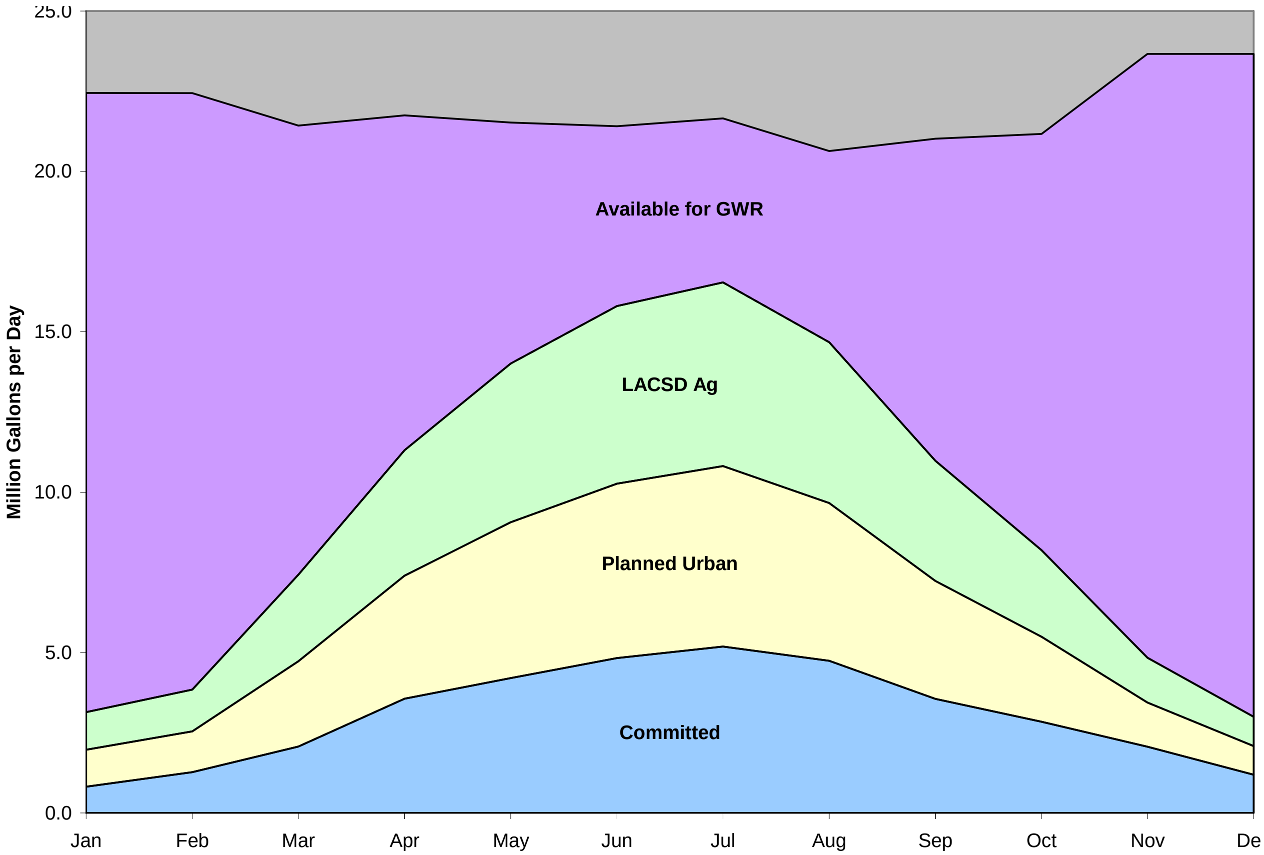
Recycled Water Use (all values in afy)	2010	2015	2020	2025
Committed Flows [1]	3,400	3,400	3,400	3,400
Planned Urban Flows [2]	3,600	3,600	3,600	3,600
LACSD Agricultural Reuse	12,900	7,500	12,100	15,000
Groundwater Recharge	-	10,000	10,000	10,000
Total [3]	**19,900**	**24,500**	**29,100**	**32,000**

Notes:

1. Committed flows include current flows to Piute Ponds and Apollo Lake (existing recycled water user) (LACSD, 2004)
2. Planned urban flows include all projects described in the Lancaster RWMP through Phase 2 (RMC, 2006)
3. Source of Total Flows: 2020 LWRP Plan (LACSD, 2004)

Figure 3-5 illustrates the projected monthly variations in recycled water flows under the 2015 scenario.

Figure 3-5: 2015 Projected Monthly LWRP Recycled Water Flows



Notes:

1. Annual flow volumes based on 2015 values from Table 3-2
2. Monthly variations for committed flows are based on 2005 monthly flow data.
3. Monthly variations for planned urban and LACSD agricultural reuse flows are based on Lancaster evapotranspiration rates (RMC, 2006)
4. Monthly variations for total flows (sum of all uses) from 2005 monthly flow data obtained from LACSD

Influent to AVTTP is secondary effluent pumped from LWRP oxidation ponds. Under LWRP Expansion Phase 1 and Phase 2, recycled water could be produced on a constant basis (i.e., no diurnal variation) since oxidation ponds have a much greater capacity than tertiary treatment process. Under Phase 3, all wastewater influent to LWRP will be treated to tertiary levels. As a result, there will be diurnal variations in recycled water production that will be dictated by the diurnal variations in influent flow and design criteria of future treatment process (e.g., flow equalization, clearwell size, etc.). Thus, delivery of recycled water will require coordination as treatment plant upgrade design details are being developed since operating conditions at LWRP will likely affect operation of the distribution system for a project. For the purpose of this Study and the project definition, it was assumed that recycled water would be tapped from the LACSD Recycled Water Transmission Pipeline at the 36" turnout at approximately Sierra Highway and Ave E. Based on the City's Division Street Corridor project, a delivery pressure of approximately 120 pounds per square inch (psi) would be provided (LACSD, personal communication, 2005).

Recycled Water Quality

Recycled water quality is a fundamental driver in defining potential GWR-RW alternatives due to the need to meet regulatory requirements. This topic is therefore discussed separately as part of the regulatory analysis in Chapter 4 and concentrations of key constituents are summarized in **Table 3-**.

Table 3-5: Water Quality for Key Constituents of GWR Supplies

Constituents	Unit	Recycled Water [1]	Imported Water [2]	Stormwater [3]
Nitrate (as N)	mg/L	8	1	Not Available
Total Nitrogen	mg/L	10	Not Available	2.3
TDS	mg/L	570	230	90
TOC	mg/L	8 to 10	3.0 to 4.0	8.9

Notes:

1. Source: Discussion with LACSD staff in June 2006
2. Sources: Average value of 70 to 100 samples collected at SWP Station Check 41 between December 1997 and April 2006 (Available at wdl.water.ca.gov/wq-gst); SWP Water Quality Objectives (KJ, 2005)
3. Source: Median values from Title 22 Engineering Report for Phase II Chino Basin Recycled Water Groundwater Recharge Project (DDB & WEI, 2005)

Source Control

Based on the DHS draft GWR Regulations (DHS, 2004), any GWR-RW project must include the following source control provisions:

- An assessment of the fate of the specified contaminant compounds through the wastewater and recycled water treatment systems
- A source investigation and monitoring program focused on the specified contaminants
- An outreach program to industrial, commercial and residential communities within the sewage collection agency's service area to manage and minimize the discharge of compounds of concern at the source

- A program for maintaining an inventory of compounds discharged into the wastewater collection system so that new compounds of concern can be evaluated rapidly

LACSD conducts a thorough industrial waste pretreatment program that includes initial permitting and pretreatment requirements, field presence by inspection staff and monitoring crews, and aggressive enforcement actions (LACSD, 2005b). LACSD requires each company directly or indirectly discharging industrial wastewater to apply for an Industrial Wastewater Discharge Permit for each sewer outlet and any new industrial company must obtain a permit before its wastewater can be accepted for treatment.

An initial review of the LACSD source control program indicates the program meets the DHS GWR reuse regulations. For example, LACSD is *managing and minimizing discharge* of pharmaceuticals by focusing on minimizing sewer disposal of pharmaceuticals from hospitals and residences through development of a hospital disposal policy and public outreach program to residents (see Chapter 8, Section B; LACSD, 2005b). However, more detailed review of the program should be conducted during implementation of the GWR-RW project.

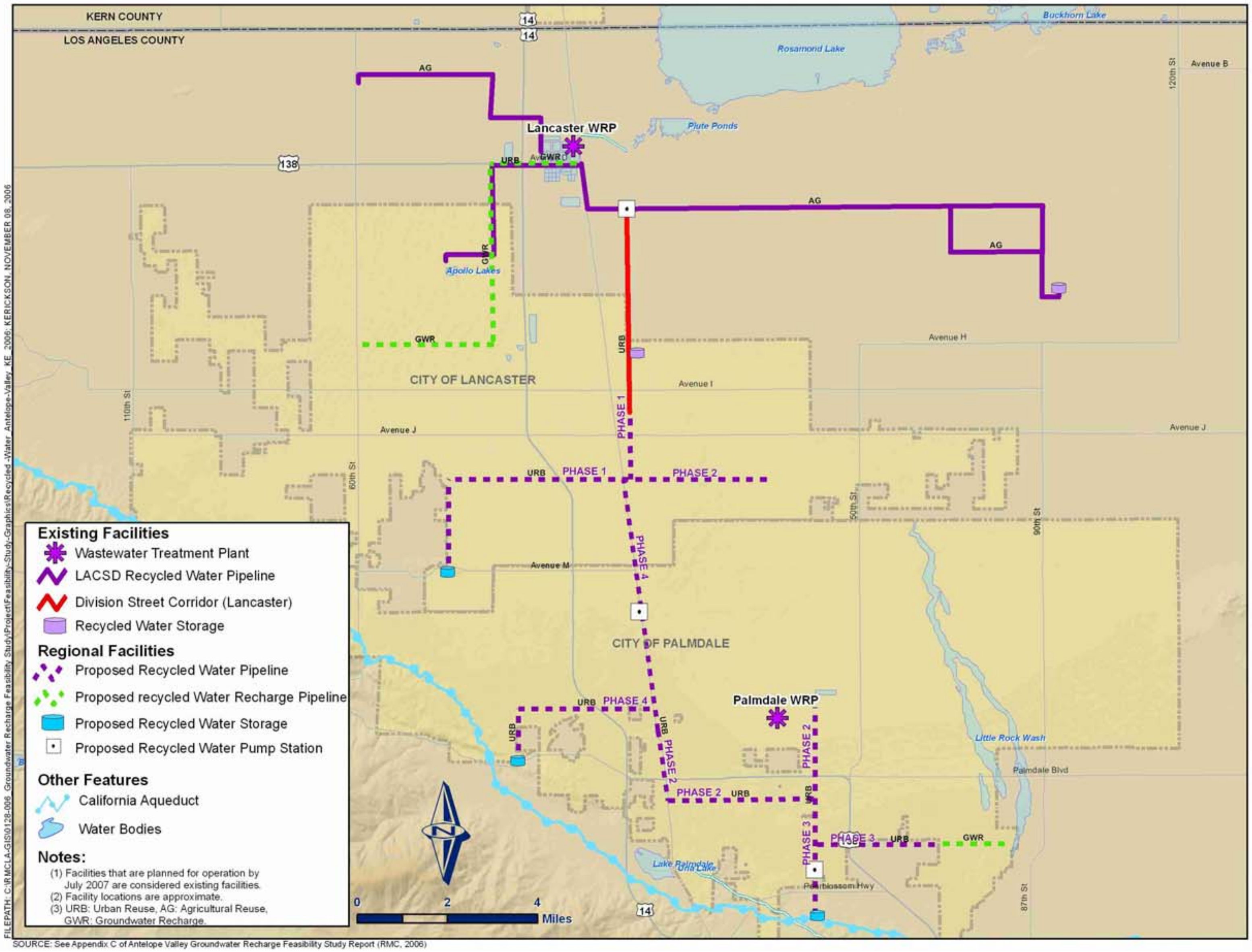
3.3.2 Recycled Water Distribution System

Existing information described in Section 3.1 was relied upon to the maximum extent to minimize duplication of efforts. Reports that were most relied upon to complete this Section are listed below:

- *City of Lancaster Recycled Water Facilities and Operations Master Plan (RMC, 2006)*
- *Facilities Planning Report, Antelope Valley Recycled Water Project (KJ, 2006)*

The existing recycled water distribution system, which serves Apollo Lakes and Nebeker Ranch, is currently being expanded for urban reuse as part of the Division Street Corridor Project. The expansion of the main conveyance facilities is currently planned to occur in three main phases over the next 10 years (laterals are not discussed herein as the laterals will likely not affect the GWR-RW project) as illustrated in **Figure 3-6.**

Figure 3-6: Proposed Recycled Water Distribution System for Agriculture and Urban Reuse



SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

3.4 Primary Blend Water Source – Imported Water

Imported water is provided to the Valley from the SWP primarily through AVEK and PWD. Littlerock Creek Irrigation District (LCID) is the third SWP contractor in Valley. **Table 3-6** lists the Table A[22] entitement for each SWP contractor. A graphic from the 2004 LAFCO Municipal Service Review Report that illustrates the High Desert Region water supply sources is provided in Appendix F.

Table 3-6: Antelope Valley State Water Project Wholesalers

Water District	State Water Project, Table A Amount
Antelope Valley-East Kern Water Agency	141,400 AF
Palmdale Water District	21,300 AF
Littlerock Creek Irrigation District	2,300 AF

Source: The State Water Project Delivery Reliability Report – 2005 (DWR, 2006)
Notes: Table A amount is the contractual method for allocating available SWP supply.

The Los Angeles Aqueduct also runs through the Valley but none of the agencies have any existing entitlement.[23]

It is expected that the majority of the blend water for a GWR-RW project in the Lancaster area would be provided by AVEK. Facilities from PWD and LCID could be used should the recharge area be located in the Palmdale area.

For the purpose of this Study, the key necessary information is as follows:

- GWR Projects and Project Concepts
- AVEK Facilities and Operations
- SWP Availability from AVEK
- SWP Water Quality

3.4.1 GWR Projects and Project Concepts

AVEK and other agencies in the Valley are at various stages of implementing “banking” of SWP water in the local groundwater basin, through GWR. These GWR projects include:

- **WWD No. 40 Aquifer Storage and Recovery Project** – This project injects up to 6,843 afy of treated SWP water from AVEK at with 15 injection wells at 5 sites in the City of Lancaster and Palmdale for storage in the upper aquifer of the Lancaster sub-basin and extraction of up to 13,282 afy. A pilot project was conducted in 1994 to identify suitable aquifer(s), TDS impact on groundwater, water levels, and hydrogeology. A demonstration project was completed in 1999 to determine aquifer properties and evaluate water quality, particularly the production, fate and transport of disinfection by-products. In 2004, WWD No. 40 received a Conditional Waiver of Waste Discharge Requirements (Resolution No. R6V-2004-0043) from the Lahontan RWQCB for the project. The waiver applied a series of conditions and expires on October 13, 2009.

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[22] Table A is the contractual method for allocating available SWP supply and the total of all maximum Table A amounts for delivery from the Delta is 4.133 million acre-feet per year (DWR, 2006).

[23] The Los Angeles Department of Water and Power, who owns and operates the Los Angeles Aqueduct, is currently planning on constructing a connection between the SWP and the Los Angeles Aqueduct in AVEK service area. The connection will involve construction of a pump station to pipe water from the SWRP up 80 feet to the Los Angeles Aqueduct. Construction is scheduled to be complete by mid-2007.

This project provides a good indication of the potential implementation issues to be faced by a GWR-RW project in the Valley; however a GWR-RW project would likely not be implemented within the same area and/or in coordination with this project. It is therefore not described further herein.

- **Antelope Valley Water Bank Project by Western Development and Storage, LLC** – WDS has proposed to implement the Antelope Valley Water Bank Project. Information presented herein is based on the April 2006 Draft Environmental Impact Report (SCH #2005091117) prepared by the Kern County Planning Agency (KCPD, 2006).

  The project would construct surface spreading facilities to recharge and store SWP water when available (in wet years) and recover the water using groundwater wells when needed. The project would recharge up to 100,000 afy with an instantaneous recharge capacity of 350 cfs. The project would extract up to 90 percent of the amount recharged (after losses due to evaporation, evapotranspiration) with a 250 cfs instantaneous recovery capacity using 30 to 40 new wells. The recharge basin area would comprise almost 1,500 acres of land. The recharge would occur during the winter and early spring each year. During the remainder of the year (approximately 8 months), the recharge basins would be used for organic farming.

  WDS is proposing to implement the project in two phases. Phase 1 would construct recharge and recovery facilities that connect to the AVEK West Feeder and be sized based on available capacity within the feeder. The project proposes to use an existing turnout (Van Dam Turnout) to deliver imported water from the West Feeder to the new project facilities. Phase 1 facilities would include 1,500 acres of recharge area, 4 miles of 84” diameter distribution/recovery pipeline, 7 miles of recovery pipelines, and 10 to 17 new wells. Phase 1 construction is proposed to begin by the end of 2006 and be completed by mid-2007.

  Phase 2 facilities would include 11 miles of recovery pipelines, up to 30 new wells, and a 9 mile pipeline that connects to the California Aqueduct. Imported water would be delivered directly from the California Aqueduct via the new pipeline to the recharge facilities. Phase 2 construction is proposed to start after at least one full year of Phase 1 operations and would take one year to complete.

  This project provides a good indication of the potential implementation issues to be faced by a GWR project using imported water in Antelope Valley. In particular, project operations could substantiate hydrogeological assumptions made in this report and demonstrate the feasibility of GWR in the West Lancaster area. Potential recharge locations that are closer to LWRP are evaluated in Section 5.1.3. However, as of the writing of this report, WDS was not coordinating with any other regional GWR projects so it is not described further herein.

- **Other GWR Projects** – AVEK is in the preliminary planning stages for implementing large GWR projects using imported water. At this time, there is no existing report that provides specific details about these projects.

Of the projects listed above, a GWR-RW project will most likely be implemented in coordination with one or more of the “Other GWR Projects”. Given the lack of existing details about these projects, a GWR project concept using imported water only must be defined as part of this Study to serve as a basis to evaluate the potential use of recycled water as an additional source of water supply. AVEK infrastructure and SWP availability and water quality are therefore essential knowledge for this Study.

3.4.2 AVEK Facilities and Operations

AVEK facilities include four primary conveyance facilities (West, Central/North, South and East Feeders) and four primary treatment plants. AVEK provides raw SWP water as a retailer to agricultural users and treated water to various entities as a wholesaler. AVEK plans to expand the conveyance abilities by increasing the capacity of existing conveyance facilities and constructing connectors between the feeders. Also, AVEK plans to expand the treatment capacity of their treatment plant to handle increased water demand from their customers. **Table 3-7** and **Table 3-8** summarize current and planned AVEK conveyance facilities and water treatment facilities, respectively. **Figure 3-7** presents AVEK existing and planned facilities.

Table 3-7: AVEK Major Conveyance Facilities

AVEK Facilities	Water Type	Pipeline Diameter
Existing Facilities		
West Feeder	Raw	60” to 33”
Central/North Feeder	Treated	36”
South Feeder	Treated	48” to 24”
60th Street West Lateral	Treated	36”
East Feeder	Treated	27”
South Feeder Parallel Pipeline	Treated	48” to 33”
Planned Facilities		**Implementation Date**
South/North Intertie	Treated	Prior to 2012
South/East Connector	Treated	Prior to 2012

Note: AVEK facilities on the south/west side of the California Aqueduct are not included here because they will not be used by the GWR project.

The West Feeder is the most likely facility to be used to convey imported water to recharge basins for GWR due to its location and capacity (see Figure 3-7). Based on discussions with AVEK, 80 cfs of capacity (approximately 14,400 af) in the West Feeder is available to convey imported water for GWR / blending from mid-November through mid-February.[24] Additional imported water conveyance facilities may need to be constructed to supplement and/or replace available capacity in the West Feeder depending upon the volume of imported water planned for GWR.

Table 3-8: AVEK Water Treatment Facilities

AVEK Facilities	Existing Capacity	Planned Capacity	Implementation Date
Rosamond WTP	14 mgd	28 mgd	Prior to 2025
Quartz Hill WTP	65 mgd	90 mgd (plus ozone)	Prior to 2025
Eastside WTP	10 mgd	25 mgd	Prior to 2025
Acton WTP	4 mgd	8 mgd	Prior to 2025
Westside WTP #1	-	15 mgd	Prior to 2025
Westside WTP #2	-	3 mgd	Prior to 2025

Note: AVEK facilities on the south/west side of the California Aqueduct are not included here because they will not be used by the GWR project.

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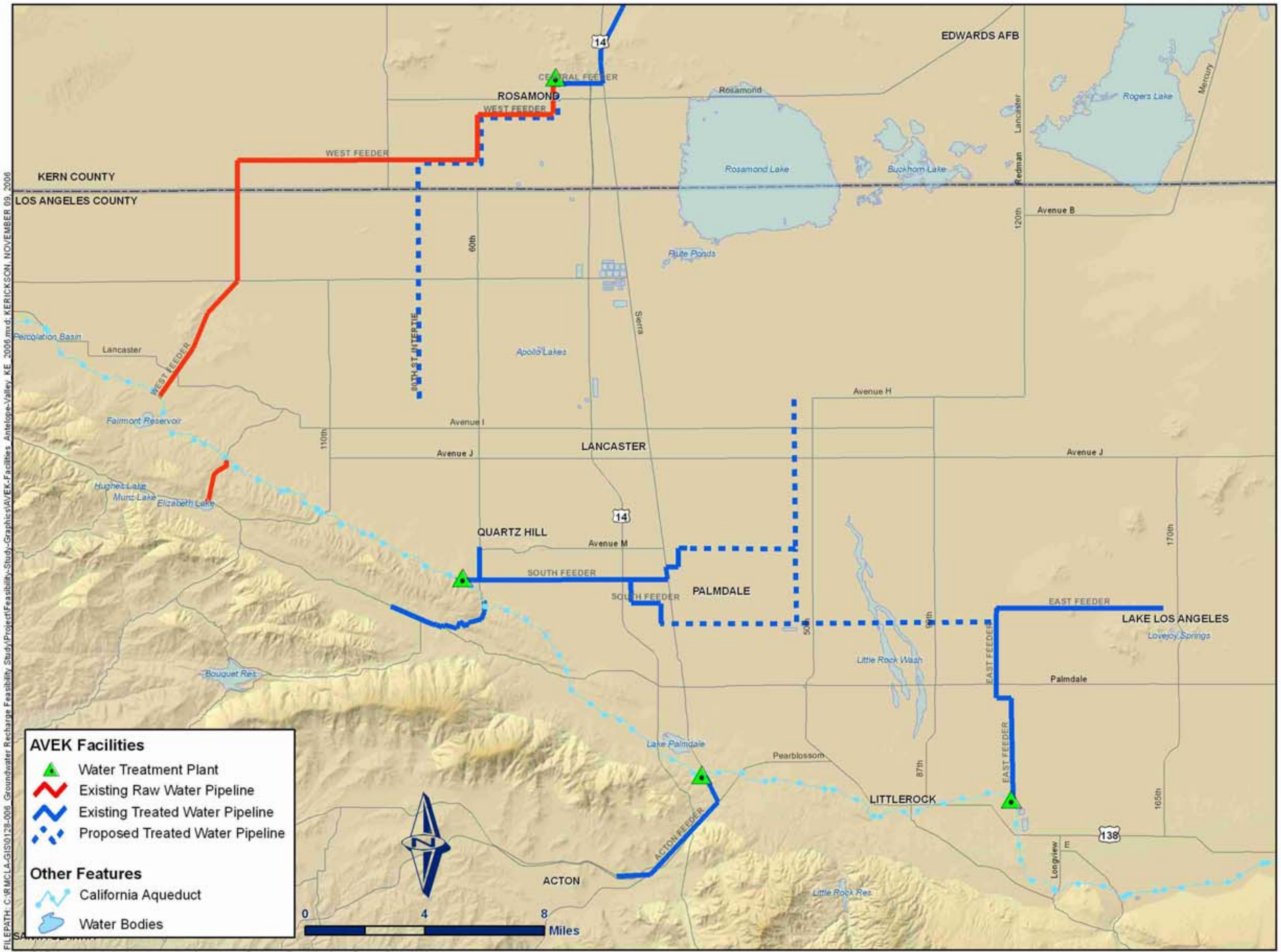
[24] From June 26, 2006 meeting with AVEK.

Figure 3-7: AVEK Major Conveyance and Water Treatment Facilities

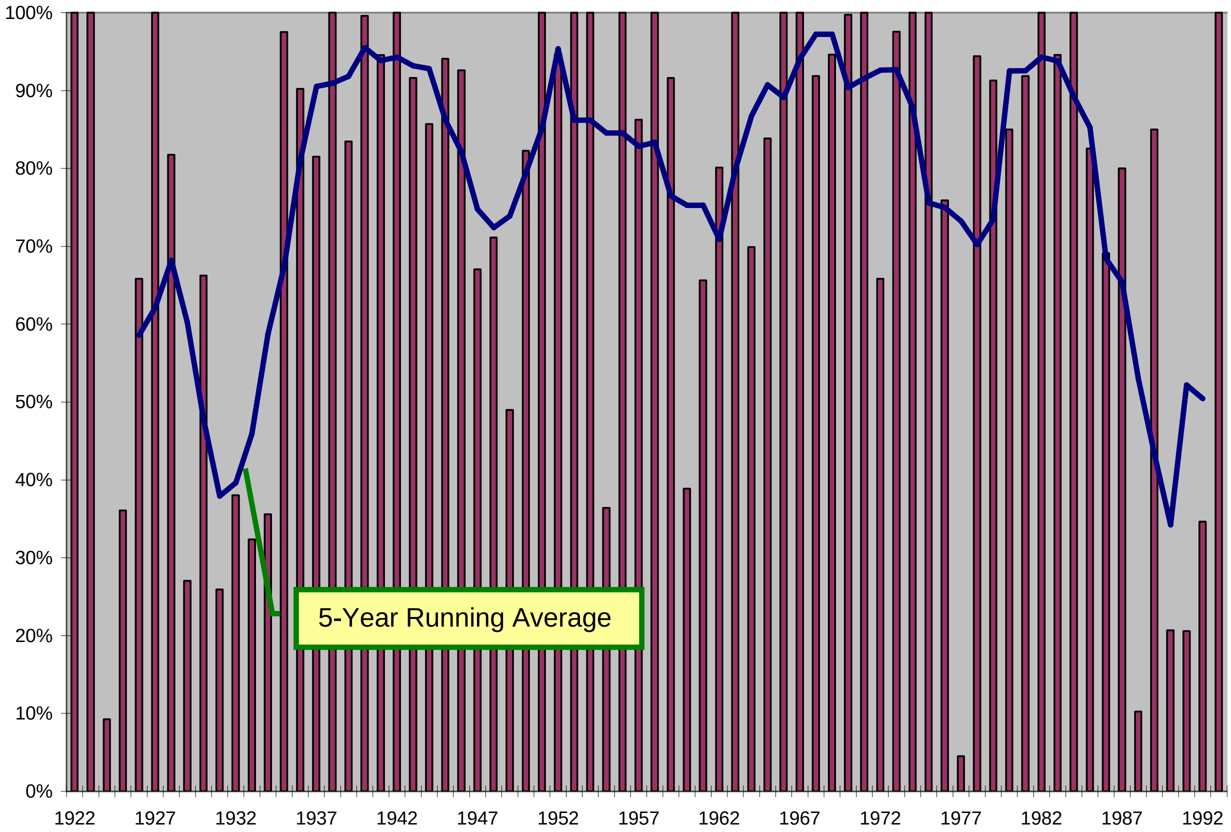


SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

3.4.3 SWP Availability from AVEK

Availability of SWP water varies from year to year, depending on a number of factors (precipitation, regulatory restrictions, legislative restrictions, and operational considerations), and is especially unreliable during dry years. **Figure 3-8** represents a simulation of SWP operations on a monthly basis over a 73-year historical record of rainfall and runoff (1922-1994) (DWR, 2006). The deliveries are documented by the percentage of Delta Table A contract delivered to contractors.

Figure 3-8: State Water Project Deliveries - Annual and 5-Year Running Average



Source: DWR, 2006

DWR projects that SWP deliveries, on average, will be 68 percent in 2005 and 77 percent in 2025. AVEK's Table A entitlement is equal to 141,400 afy and, as shown on **Table 3-9**, AVEK plans to use slightly more than the average SWP delivery for future supplies. AVEK must acquire new water rights, such as a SWP water entitlement, to be able to deliver their projections.

Table 3-9: AVEK State Water Project Deliveries

AVEK Customer	1999	2004	2010	2015	2020	2025
Rosamond Community Services District	1,512	1,111	2,080	2,138	2,197	2,256
Los Angeles County Waterworks Districts	31,794	38,581	72,227	74,261	76,296	78,330
Quartz Hill Water District	3,217	4,099	7,674	7,890	8,106	8,322
Total M&I Sales	45,800	53,627	100,394	103,222	106,050	108,878
Total Additional Water Uses and Losses [1]	26,405	8,626	10,637	10,722	10,806	10,891
Total Water Use	**72,205**	**62,353**	**111,031**	**113,944**	**116,856**	**119,769**
Percentage of Table A Entitlement	51%	44%	79%	81%	83%	85%

Source: AVEK 2005 Urban Water Management Plan; Tables 7 and 8 (AVEK, 2005)

Notes: All values are in acre-feet.

1. Includes raw water deliveries to agricultural users and unaccounted-for system losses.

3.4.4 State Water Project Water Quality

Similar to recycled water quality, SWP water quality is a fundamental driver in defining potential GWR alternative strategies due to the need to meet regulatory requirements. Key constituent concentrations are summarized in Table 3- and are discussed in relation to regulatory requirements as part of the regulatory analysis in Section 4.3.

3.5 Secondary Blend Water Source – Stormwater

For the purpose of this Study, the key information necessary is as follows:

- Water Quantity
- Infrastructure
- Water Quality

Reports that were reviewed to complete this section are listed below:

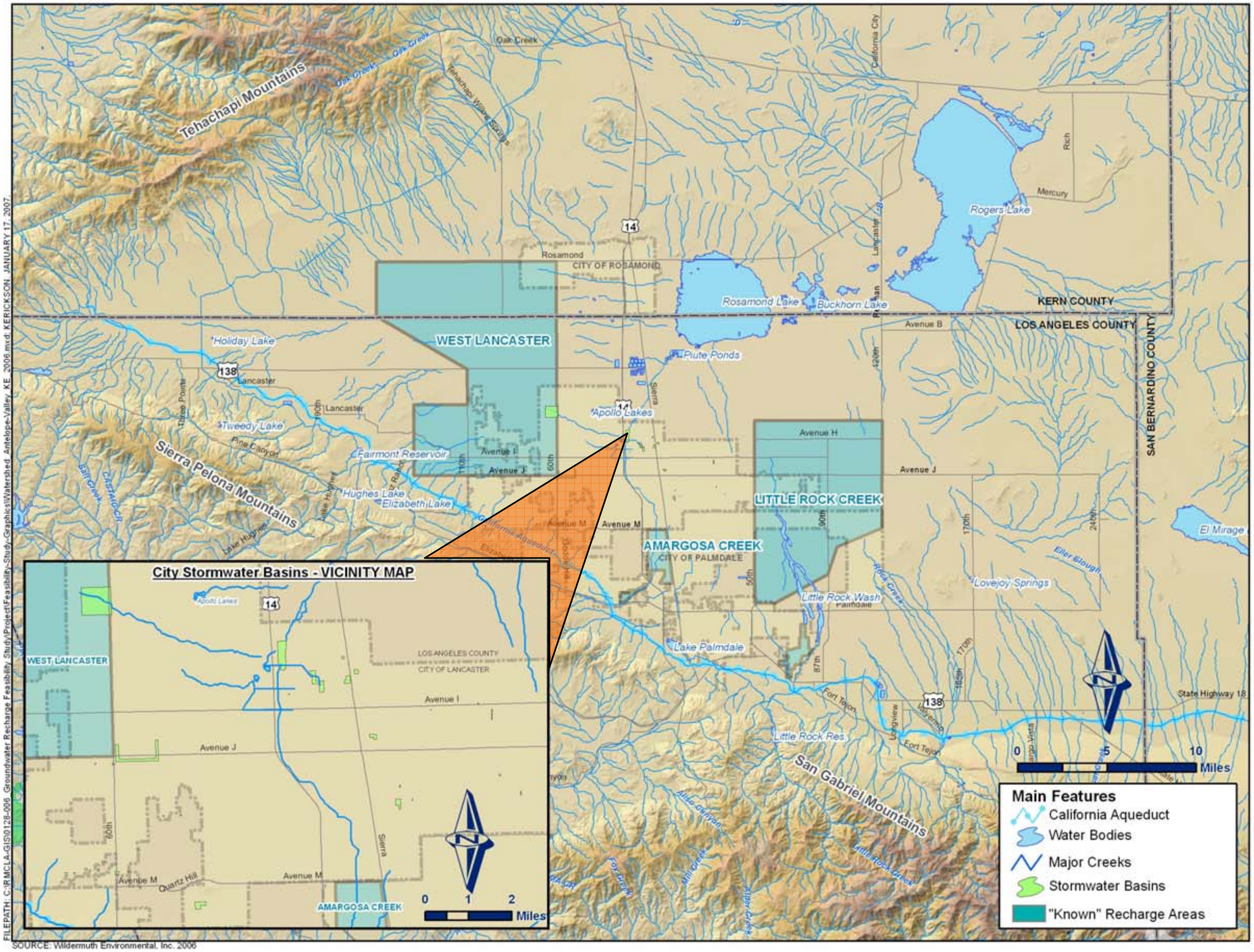
- *City of Lancaster Revised Master Plan of Drainage (Lancaster, 2005)*
- *Antelope Valley Water Resource Study (K/J, 1995)*
- *Antelope Valley Final Report on the Comprehensive Plan of Flood Control and Water Conservation (LACFCD, 1987)*

3.5.1 Water Quantity

There is very limited useable information on stormwater quantity in available documents. The major surface water bodies and information on total rainfall were therefore used as a general indication of stormwater water quantities in the Study area. **Figure 3-9** presents the major surface water bodies of the Antelope Valley. The surface water bodies location was used as a general indication of potential incidental recharge areas in the evaluation included in Appendix I.

Most surface water bodies are ephemeral since most rainfall occurs during the winter months. Average annual rainfall ranges from 5 inches at Edwards Air Force Base to 9 inches near the foothills and 19 inches in the San Gabriel Mountains (LACFCD, 1987). Rainfall has exceeded 40 inches in the San Gabriel Mountains and, though infrequent, flash floods can occur during the summer and fall (LACFCD, 1987).

Figure 3-9: Antelope Valley Watershed and Major Surface Water Bodies



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SOURCE: Wildermuth Environmental, Inc. 2006

3.5.2 Infrastructure

There is limited useable information on stormwater infrastructure in the documents that were reviewed, although, this information is being developed separately by the City of Lancaster, City of Palmdale and Los Angeles County. For example, the City of Palmdale is preparing a Watershed Management Plan to update their Master Drainage Plan and identify potential stormwater basins and those basins with recharge opportunities. The City of Lancaster and Los Angeles County have indicated their desire to create a similar plan for their respective jurisdictions to identify stormwater basins with potential for recharge but neither currently have one under development.

The City of Lancaster has existing stormwater basins and is investigating potential new stormwater basin sites. Of particular interest, is a 160-acre stormwater basin at Avenue F and 60th St West (just west of Fox Airfield) (see Figure 3-9). Based on recent discussions with the City, there are plans to drill borings in and around the basin site to determine if there is a potential for recharge of stormwater.

3.5.3 Water Quality

There is limited useable information on stormwater quality in the documents that were reviewed. In general, stormwater can be a good source of diluent water due to relatively low TDS and nitrogen concentrations as suggested by stormwater quality for the Chino Basin GWR Project (see Table 3-). It is therefore recommended that a stormwater quality monitoring program be implemented during the facility planning phase of a GWR project to better assess the potential use of stormwater as a source of diluent water.

3.6 Adjudication Proceedings

The right to groundwater, along with an established mechanism to account for “foreign” water such as recharged recycled water, is paramount to the implementation of a GWR-RW project.

The groundwater basin is not currently adjudicated or managed, and consequently there are no existing restrictions on pumping. Nor has the basin been deemed to be in overdraft by DWR.

Through a series of lawsuits starting with two large carrot growers in 1999 and 2001, and continuing with WWD No. 40 in 2004 and most recently the November 1, 2006 filing of a cross-complaint by RCSD, an adjudication process for Antelope Valley groundwater rights is underway.

The adjudication process will involve four main litigation topics:

1. Identify parties and basin boundaries (including decision to manage the basin by subunits or basin as a whole)
2. Definition of basin’s safe yield (current numbers vary between 40,000 to 60,000 afy per USGS and 100,000 afy per other parties)
3. Allocation of water
4. Development of physical solution

The process is currently addressing the first topic. Based on other adjudication process that have taken place in California, the process could take anywhere between 1 and 20 years or more to complete. It should be noted that in other settings (Beaumont Basin) the order of the topics was slightly different with Topic 4 preceding Topic 3.

Other jurisdictions in the State have also used a variety of strategies, other than adjudication, to manage groundwater basins. These alternative management strategies, including formation of a Groundwater Management Agency or formation of a Joint Powers Authority, have been considered in the development of the implementation plan for the Study.

Chapter 4 Regulatory Analysis

A GWR-RW project needs to meet a combination of public health and environmental objectives and evolving regulations set by DHS and the Lahontan RWQCB. Hence, the current regulatory setting was assessed and the constraints and potential regulatory pathways for a GWR-RW project were identified.

This chapter provides a regulatory and policy overview, discusses the relevance of precedential recharge permits, and presents the results of the water quality data analysis conducted as part of the Study. Finally, it provides a summary of the important conclusions and recommendations that are based on this data analysis, to be considered in the development of a GWR-RW project in the Antelope Valley area (see Chapter 5, and the development of the implementation plan (Chapter 6). The recommendations include additional analysis as part of preliminary design activities to substantiate conclusions drawn on the data analysis.

This chapter focuses on the use of recycled water from the LWRP and imported water from the SWP. This chapter (as well as subsequent chapters) also assumes that the GWR-RW project would be a "planned" recharge project as opposed to an "incidental" recharge project.

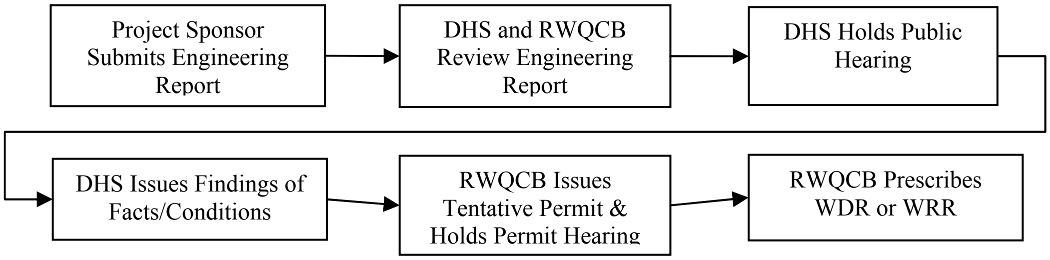
4.1 Regulatory and Policy Overview

The reuse of recycled water is regulated under several State laws and regulations:

- The California Water Code (CWC) contains requirements for the production, discharge and use of recycled water. In particular, CWC, Sections 13000 through 13999.19, include provisions that require DHS to establish water recycling criteria and give the RWQCBs responsibility for prescribing Water Recycling Requirements (WRR) or Waste Discharge Requirements (WDR) for water that is used or proposed to be used as recycled water.
- The CWC also requires the RWQCBs to adopt water quality control plans and establish water quality objectives in those plans to protect surface waters and groundwaters.
- Regulations for recycled water are contained in the California Code of Regulations (CCR), Titles 17 and 22.
- GWR-RW projects are also subject to policies developed by the SWRCB for protection of groundwater and drinking water.

Regulatory oversight of GWR-RW projects is carried out by the DHS and individual RWQCBs. **Figure 4-1** illustrates the general responsibilities of each agency through the regulatory process. The agency responsibilities[25] and associated regulatory requirements managed by each agency are discussed in the following sections.

Figure 4-1: Regulatory Process for GWR Projects Using Recycled Water (Simplified Version)



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[25] These responsibilities are also specified in a memorandum of agreement between the SWRCB and DHS.

4.1.1 Department of Health Services Requirements

The two major elements of DHS requirements are the Water Recycling Criteria (Title 22 CCR, Division 4, Chapter 3) and the draft GWR regulations[26], which, once finalized, will be incorporated in the Water Recycling Criteria.

Water Recycling Criteria

DHS has adopted Water Recycling Criteria under the CCR as mandated by CWC, Section 13521. The Water Recycling Criteria include general requirements for GWR of domestic water supply aquifers, including numeric requirements for recycled water quality, treatment process requirements, operational requirements, and treatment reliability requirements. For surface spreading projects, the regulations state that reclaimed water "shall be at all times of a quality that fully protects public health" and that DHS recommendations "will be based on all relevant aspects of each project, including the following factors:

- Treatment provided;
- Effluent quality and quantity;
- Spreading area operations;
- Soil characteristics;
- Hydrogeology;
- Residence time; and
- Distance to withdrawal."

As illustrated on Figure 4-1, all recycled water projects must submit engineering reports for DHS review.[27] RWQCBs must consult with and review recommendations from DHS on proposed projects, and permits issued by RWQCBs must be in conformance with the Water Recycling Criteria. The Water Recycling Criteria require that DHS hold a public hearing prior to making a final determination on the public health aspects of a project. Proposals to recharge groundwater by either surface spreading or injection are currently evaluated on a case-by-case basis with the draft GWR regulations guiding DHS decisions.

Draft Groundwater Recharge Regulations

Key elements of the draft GWR regulations for both surface spreading and injection are summarized in **Table 4-1** and a copy of the draft GWR regulations is provided in Appendix G. The draft regulations have gone through several iterations and, when finalized and subsequently adopted, will be included in the Water Recycling Criteria.

As shown in Table 4-1, the draft regulations include dilution requirements expressed as the "recycled water contribution." The recycled water contribution (RWC) is the fraction of total volume of recharge water that is recycled water. The draft regulations limit the RWC to a maximum average of 50 percent, with exceptions and increases granted under certain conditions. The allowable RWC, which is tied to total organic carbon (TOC) contributions, is a critical factor in determining how much recycled water can be used for a recharge project, and/or what additional control measures have to be undertaken.

In addition to the elements summarized in Table 4-1, the following elements of the draft regulations were noted for consideration in the project definition and implementation plan:

- The draft regulations will likely undergo future revisions prior to adoption, which could ultimately impact a project as it evolves.

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[26] California Department of Health Services, 2004; DRAFT Title 22, CCR, Division 4, Chapter 3. §60320 *et seq.*

[27] Title 22 CCR, Division 4, Chapter 3, section 60323.

- The draft regulations require entities that supply recycled water to a recharge project to administer a source control program.
- The draft regulations require the recycled water supplier to establish and monitor the recycled effluent stream for one year prior to initiating a project in addition to requiring on-going monitoring after the project is initiated to demonstrate compliance with the regulations summarized in Table 4-1.

Table 4-1: DHS Draft Groundwater Recharge Regulations Summary

Contaminant Type	Type of Recharge	
	Surface spreading	Subsurface injection
Pathogenic Microorganisms		
Filtration	≤ 2 NTU	
Disinfection	5-log virus inactivation a, ≤ 2.2 total coliform per 100 mL	
Underground Retention Time	6 months	12 months
Horizontal Separation [2]	150 m (500 ft)	600 m (2000 ft)
Regulated Contaminants		
Drinking Water Standards	Meet all drinking water MCLs (except nitrogen) and new Federal and State regulations as they are adopted (see Section 4.1.1)	
Total Nitrogen[3]	• Level specified by DHS for existing project with no RWC increase; • ≤5 mg/L (as N) for new project or increased RWC at existing project; or, • NO_2 and NO_3 consistently met in mound (blending allowed)	
Unregulated Contaminants		
TOC in Filtered Wastewater	TOC ≤ 16 mg/L in any portion of the filtered wastewater not subjected to RO treatment	
TOC in Recycled Water	No further treatment needed to achieve: • TOC level specified by DHS for existing project with no RWC increase [4] • Compliance point is in recycled water or mound[5] (no blending) RO treatment as needed to achieve: • TOC ≤ (0.5 mg/L)/RWC (new project or increased RWC at existing project) • Compliance point is in recycled water or mound[5] (no blending)	100% RO treatment of recycled water: • TOC level specified by DHS for existing project with no RWC increase [4] • TOC ≤ (0.5 mg/L)/RWC (new project or increased RWC at existing project)
Recycled Water Contribution	≤ 50% subject to above requirements > 50% subject to additional requirements	

Source: DHS, 2004; DRAFT Title 22 CCR, Division 4, Chapter 3, §60320 et seq

Notes:

1. The virus log reduction requirement may be met by a combination of removal and inactivation.
2. May be reduced upon demonstration via tracer testing that the required detention time will be met at the proposed alternative distance.
3. See Table 4-13 for further details.
4. Not applicable to the Antelope Valley setting
5. If mound monitoring is approved

Drinking Water Standards for Recharge Projects

As noted in Table 4-1, the recycled water must meet DHS drinking water standards, specifically:

- Primary Maximum Contaminant Levels (MCLs):
    - Inorganic chemicals in Title 22 CCR Table 64431-A (except for nitrogen compounds)
    - Organic chemicals in Title 22 CCR Table 64444-A
    - Radionuclides in Title 22 CCR Tables 64442 and 64443
- MCLs for disinfection byproducts in Title 22 CCR Section 644439
- Action levels for lead and copper in Title 22 CCR Section 64678
- Secondary MCLs for the constituents and characteristics in Title 22 CCR Tables 64449-A and B ("Upper" levels), except for color

Applicable DHS drinking water standards are listed in **Table 4-2** and **Table 4-3**. The limits for all of the constituents mentioned in Table 4-2 are provided in Appendix H. As a minimum, quarterly monitoring for primary MCLs, MCLs for disinfection byproducts, and action levels for lead and copper will be required after a project is initiated, while annual monitoring for secondary MCLs will be required.

Table 4-2: Applicable DHS Drinking Water Standards (DHS Section 64672.3)

Table from DHS Drinking Water Standards		Table # in Appendix G
Table #	Title of Table	
Table 64431-A	MCLs, Inorganic Chemicals	Table B-1
Table 64444-A	MCLs, Organic Chemicals	Table B-2
Table 64533-A	Disinfection Byproducts Regulations	Table B-3
Table 64449-A	Secondary MCLs Consumer Acceptance Contaminant Levels	Table B-4
Table 64449-B	Secondary MCLs Consumer Acceptance Contaminant Level Ranges	Table B-5
Table 64442	Gross Alpha Particle Activity, Radium-226, Radium-228, and Uranium MCLs	Table B-6
Table 64443	Beta Particle and Photon Radioactivity MCLs	Table B-7

Table 4-3: Lead and Copper Action Levels (DHS Section 64672.3)

Constituent	Action Level (90th percentile)
Lead	0.015 mg/L
Copper	1.3 mg/L

Other Monitoring Requirements for Recharge Projects

The draft GWR regulations require monitoring of the recycled water for constituents that do not have drinking water MCLs. These unregulated contaminants, chemicals with notification levels, and priority pollutants that need to be monitored are listed in **Table 4-4**, **Table 4-5** and **Table 4-6**, respectively. Monitoring will be at least quarterly for the first year of operation. Subsequently, DHS may allow monitoring to be reduced to annually, based on initial sample results. These monitoring requirements are reflected in the implementation plan and O&M costs. Further, findings of health-significant levels of monitored constituents could affect DHS decisions impacting the viability and operation of a project.

Table 4-4: Unregulated Chemicals (Draft DHS Table 64450)

Chemical (Synonyms / Acronyms)		
Boron	Ethyl-tert-butyl ether (ETBE)	tert-Butyl alcohol (TBA)
Chromium VI (Hexavalent chromium)	Perchlorate	1,2,3-Trichloropropane (TCP)
Dichlorodifluoromethane (Diflurorodichloromethane)	tert-Amyl-methyl ether (TAME)	Vanadium

Table 4-5: Chemicals with Notification Levels

Chemicals with Notification Levels[1]		
Boron	Ethylene glycol	Perchlorate
n-Butylbenzene	Formaldehyde	Propachlor
sec-Butylbenzene	HMX	n-Propylbenzene
tert-Butylbenzene	Isopropylbenzene	RDX
Carbon disulfide	Manganese	Tertiary butyl alcohol (TBA)
Chlorate	Methyl isobutyl ketone	1,2,3-Trichloropropane (1,2,3-TCP)
2-Chlorotoluene	Naphthalene	1,2,4-Trimethylbenzene
4-Chlorotoluene	N-Nitrosodiethylamine (NDEA)	1,3,5-Trimethylbenzene
Dichlorodifluoromethane	N-Nitrosodimethylamine (NDMA)	2,4,6-Trinitrotoluene (TNT)
1,4-Dioxane	N-Nitrosodi-n-propylamine (NDPA)	Vanadium

Source: DHS, 2004; DRAFT Title 22 CCR, Division 4, Chapter 3, §60320 et seq
Note:

1. Notification levels are health-based advisory levels established by DHS for chemicals in drinking water that lack MCLs and are not enforceable standards. If a chemical is detected above its notification level, certain requirements and recommendations apply.
2. See http://www.dhs.ca.gov/ps/ddwem/chemicals/AL/notificationlevels.htm, last updated May 2006.

Table 4-6: EPA Priority Pollutant List

Metals

1. Antimony
2. Arsenic
3. Beryllium
4. Cadmium
5a. Chromium (III)
5b. Chromium (VI)
6. Copper
7. Lead
8. Mercury
9. Nickel
10. Selenium
11. Silver
12. Thallium
13. Zinc

Miscellaneous

14. Cyanide
15. Asbestos (if requested)
16. 2,3,7,8-Tetrachlorodibenzo-P Dioxin (TCDD)

Volatile Organics

17. Acrolein
18. Acrylonitrile
19. Benzene
20. Bromoform
21. Carbon Tetrachloride
22. Chlorobenzene
23. Chlorodibromomethane
24. Chloroethane
25. 2-Chloroethyl Vinyl Ether
26. Chloroform
27. Dichlorobromomethane
28. 1,1-Dichloroethane
29. 1,2 Dichloroethane
30. 1,1-Dichloroethylene
31. 1,2-Dichloropropane
32. 1,3-Dichloropropylene
33. Ethylbenzene
34. Methyl Bromide
35. Methyl Chloride
36. Methylene Chloride
37. 1,1,2,2-Tetrachloroethane
38. Tetrachloroethylene
39. Toluene
40. 1,2-Trans-Dichloroethylene
41. 1,1,1-Trichloroethane
42. 1,1,2-Trichloroethane
43. Trichloroethylene
44. Vinyl Chloride

Acid Extractibles

45. 2-Chlorophenol
46. 2,4-Dichlorophenol
47. 2,4-Dimethylphenol
48. 2-Methyl-4, 6-Dinitrophenol
49. 2,4-Dinitrophenol
50. 2-Nitrophenol
51. 4-Nitrophenol
52. 3-Methyl-4-Chlorophenol
53. Pentachlorophenol
54. Phenol
55. 2,4,6 – Thrichlorophenol

Base/Neutral Extractibles

56. Acenaphthene
57. Acenaphthylene
58. Anthracene
59. Benzidine
60. Benzo (a) Anthracene
61. Benzo (a) Pyrene
62. Benzo (b) Fluoranthene
63. Benzo (g,h,i) Perylene
64. Benzo (k) Fluoranthene
65. Bis (2-Chloroethoxy) Methane
66. Bis (2-Chloroethyl) Ether
67. Bis (2-Chloroisopropyl) Ether
68. Bis (2-Ethylhexyl) Phthalate
69. 4-Bromophenyl Phenyl Ether
70. Butylbenzyl Phthalate
71. 2-Chloronaphthalene
72. 4-Chlorophenyl Phenyl Ether
73. Chrysene
74. Dibenzo (a,h) Anthracene
75. 1,2-Dichlorobenzene
76. 1,3-Dichlorobenzene
77. 1,4-Dichlorobenzene
78. 3,3'-Dichlorobenzidine
79. Diethyl Phthalate
80. Dimethyl Phthalate
81. Di-n-Butyl Phthalate
82. 2,4-Dinitrotoluene
83. 2-6 Dinitrotoluene
84. Di-n-Octyl Phthalate
85. 1,2-Dipenylhydrazine
86. Fluoranthene
87. Fluorene
88. Hexachlorobenzene
89. Hexachlorobutadiene
90. Hexachlorocyclopentadiene

Base/Neutral Ext. (cont.)

91. Hexachloroethane
92. Indeno (1,2,3-cd) Pyrene
93. Isophorone
94. Naphthalene
95. Nitrobenzene
96. N-Nitrosodimethylamine
97. N-Nitrosodi-N-Propylamine
98. N-Nitrosodiphenylamine
99. Phenanthrene
100. Pyrene
101. 1,2,4-Trichlorobenzene

Pesticides

102. Aldrin
103. Alpha BHC
104. Beta BHC
105. Delta BHC
106. Gamma BHC
107. Chlordane
108. 4,4' – DDT
109. 4,4' – DDE
110. 4,4' – DDD
111. Dieldrin
112. Alpha Endosulfan
113. Beta Endosulfan
114. Endosulfan Sulfate
115. Endrin
116. Endrin Aldehyde
117. Heptachlor
118. Heptachlor Epoxide
119. PCB 1016
120. PCB 1221
121. PCB 1232
122. PCB 1242
123. PCB 1248
124. PCB 1254
125. PCB 1260
126. Toxaphene

Revised: 7/7/2000

In addition to the above, DHS can require annual monitoring of the recycled water for pharmaceuticals, endocrine disrupting chemicals and other chemical indicators of municipal wastewater presence based on a review of the Engineering Report and the affected groundwater basin. Chemicals specified in the draft GWR regulations are presented in **Table 4-7**. These data are being collected for information purposes; there are no standards or advisory levels for the contaminants listed below. Standards or advisory levels are not anticipated to be developed in the foreseeable future.

Table 4-7: Additional Monitoring Requirements

Constituent Category	Constituents	
Hormones	• Ethinyl estradiol • 17-β estradiol	• Estrone
"Industrial" Endocrine Disruptors	• Bisphenol A • Nonylphenol • polyethoxylate	• Octylphenol • polyethoxylate • Polybrominated diphenyl ethers
Pharmaceuticals and Other Substances	• Acetaminophen • Amoxicillin • Azithromycin • Caffeine • Carbamazepine • Ciprofloxacin • ethylenediamine tetra-acetic acid (EDTA)	• Gemfibrozil • Ibuprofen • Iodinated contrast media • Lipitor • Methadone • Morphine • Salicylic acid • Triclosan

4.1.2 Regional Board Requirements

The primary responsibility for the protection of water quality in California rests with the State Water Resources Control Board (SWRCB) and nine RWQCBs, including the Lahontan RWQCB, which has jurisdiction over the Antelope Valley. The SWRCB sets statewide policy for the implementation of state and federal laws and regulations. The RWQCBs adopt and implement Water Quality Control Plans (Basin Plans), which establish beneficial uses and water quality objectives for waters within their regions.

As illustrated in Figure 4-1, the CWC requires any person who proposes to recycle or to use recycled water to file with the RWQCB an engineering report on the proposed use.[28] After receiving the report, and consulting with and receiving recommendations from DHS, and any necessary evidentiary hearing, the RWQCB must prescribe WRRs or WDRs for the use.[29] The requirements may be placed on the person recycling the water, the user, or both.[30]

The key regulatory challenges faced in obtaining WRRs or WDRs for a GWR project are meeting the Basin Plan requirements, including the State's Anti-degradation Policy.

Basin Plan Considerations

In evaluating a proposed project (long-term or pilot) it will be necessary to assess how it complies with both the numeric and narrative water quality standards in the Basin Plan. Water quality standards consist of beneficial uses of water bodies and the applicable water quality objectives to protect the uses. Water

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[28] CWC section 13522.5
[29] CWC section 13523
[30] CWC section 13523

quality objectives can be numeric or narrative. How a RWQCB interprets narrative objectives for toxics substances can often result in challenging issues for recycled water projects, depending on what level of protection a RWQCB considers to be acceptable. In addition, the Basin Plan has generic prohibitions related to pollution and the creation of nuisance, in addition to other criteria.

Beneficial Uses

Four existing or potential[31] beneficial uses have been assigned to the groundwater in the Antelope Valley as shown in **Table 4-8**.

Table 4-8: Antelope Valley Groundwater Beneficial Uses

Applicable Regulations / Key Issues	Description
MUN - Municipal and Domestic Supply	Beneficial uses of waters used for community, military, or individual water supply systems including, but not limited to, drinking water supply
AGR - Agricultural Supply	Beneficial uses of waters used for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, and support of vegetation for range grazing
IND - Industrial Service Supply	Beneficial uses of waters used for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, geothermal energy production, hydraulic conveyance, gravel washing, fire protection, and oil well re-pressurization
FRSH - Freshwater Replenishment	Beneficial uses of waters used for natural or artificial maintenance of surface water quantity or quality (e.g., salinity)

Source: Water Quality Control Plan for the Lahontan Region[32]

Water Quality Objectives

In the Lahontan Basin Plan, water quality objectives for groundwaters are divided into two categories:

1. Objectives that apply to all groundwaters
2. Objectives that apply to specific groundwater basins

The water quality objectives that apply to groundwater consist primarily of narrative objectives combined with a limited number of numerical objectives. These objectives define the upper concentration or other limit that the RWQCB considers protective of beneficial uses. The objectives apply to all groundwaters, rather than only at a wellhead, at a point of consumption, or at point of application of a discharge. The objectives that apply to the Antelope Valley are shown in **Table 4-9**.

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[31] Per the Basin Plan, in the tables of beneficial uses (Tables 2-1 and 2-2), an "X" indicates an existing or potential use, and the distinction is not made. In addition, the placing of an "X" in Table 2-2 does not indicate that all of the groundwaters in that particular location are suitable (without treatment) for a designated beneficial use. However, all waters are designated as MUN unless they have been specifically exempted by the RWQCB through adoption of a Basin Plan amendment after consideration of substantial evidence to exempt such waters.

[32] See www.waterboards.ca.gov/lahontan/BPlan/Bplan.pdf

Table 4-9: Antelope Valley Groundwater Objectives

Category	Numeric Objectives	Narrative Objectives
Bacteria, Coliform	**MUN** – Median concentration of coliform organisms over any seven-day period shall be less than 1.1/100 ml	
Chemical Constituents	**MUN** – Primary and secondary MCLs per Title 22 of the CCR	Groundwaters shall not contain concentrations of chemical constituents that adversely affect the water for beneficial uses. **AGR** – Shall not contain concentrations of chemical constituents in amounts that adversely affect the water for beneficial uses.
Radioactivity	**MUN** – Table 4 of Section 64443 of Title 22 of the CCR	Not present in concentrations which are deleterious to human, plant, animal, or aquatic life nor result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or aquatic life.
Taste and Odor	**MUN** – Secondary MCLs per Title 22 of theCCR	Ground waters shall not contain taste or odor-producing substances in concentrations that cause nuisance or that adversely affect beneficial uses.

Source: Water Quality Control Plan for the Lahontan Region[33]

For AGR beneficial uses there is also a statement in the Basin Plan that in determining compliance with objectives, the RWQCB will refer to water quality goals and recommendations from sources such as the Food and Agriculture Organization of the United Nations (Ayres, 1976), University of California Cooperative Extension, Committee of Experts, and “Water Quality Criteria” by McKee and Wolf (1963).

There are no numeric objectives or guidelines for IND or FRSH. The application of narrative objectives would have to be applied on a case-by-case basis.

Non-Degradation Objective

The Basin Plan also incorporates the State’s Anti-degradation Policy[34] as part of the water quality objectives section. Application of the Policy has recently become one of the significant challenges encountered when trying to implement water recycling projects. Anti-degradation, as defined in state policy, is the lowering of water quality in rivers, streams or groundwater, which is allowed if the change is consistent with providing a maximum benefit to the people of the State and does not unreasonably affect present and anticipated beneficial uses of the State’s waters.

In some cases, some RWQCBs have taken an extreme interpretation of the Policy to not allow any changes in water quality above natural concentrations, even though the change still allows water to meet State water quality and health standards. In other cases, some RWQCBs are saying that no chemicals can be detected in a water or can only be allowed at levels where there is no risk created by the presence of the chemical as a result of a recycled water project, including the application of DHS Notification Levels.[35] The inclusion of Notification Level-based limits in permits has also been justified by one

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[33] See www.waterboards.ca.gov/lahontan/BPlan/Bplan.pdf

[34] Resolution 68-16: “Statement of Policy with Respect to Maintaining High Water Quality in California.”

[35] Notification Levels (Health & Safety Code Section 116455) are health-based advisory levels established by DHS for chemicals in drinking water that lack maximum contaminant levels. When chemicals are found at concentrations greater than their notification levels, certain requirements and recommendations apply.

RWQCB through the application of a Basin Plan's narrative objectives.[36] In the later case, the SWRCB issued a precedential Order (2006-0001) that concluded that based on the policies favoring reclamation and reuse of water, it was inappropriate for the RWQCB to include DHS Notification Levels as effluent limitations in the WRRs/WDRs for an indirect potable reuse project.[37] The order also included important policy deliberations and statements by the SWRCB regarding the application of limitations in permits for indirect potable reuse projects as shown in **Table 4-10.**

Table 4-10: Key SWRCB Policy Statements Water Quality Order 2006-0001 Related to Indirect Potable Reuse Projects

Statement	Basis
Effluent limitations can be based on criteria that have not been adopted as water quality standards, so long as appropriate findings are made.	• WQ 95-4 • WQO 2001-16 • WQO 2002-0015
Since the sanctions for violation of effluent limitations in the CWC are significant, the additional potential liability for violating the limitations can appropriately be considered in weighing the policy issues.	
Notification levels are likely to change over time; such a "moving target" poses practical problems if used as an effluent limitation.	
RWQCB should follow DHS recommendations on the appropriate use of its Notification Levels; DHS did not recommend the use of Notification Levels for limitations.	• WQO 2005-0007
Concerning the healthfulness of the injected water, it is subject to extensive treatment, blended with imported water, and must, of course, meet all drinking water requirements prior to being pumped up and served to customers.	

In 2005, the SWRCB prepared a draft guidance document for implementing State statutes, regulations, and policies for recycled water projects that was intended to provide further insight into the application of the Anti-degradation Policy. In 2006, the SWRCB elected to not move forward with the guidance document, but rather to develop a state Policy pursuant to the CWC.[38] When completed, the Policy would be adopted by the SWRCB by resolution. It is expected that the Policy will be ready for adoption in 2007.

In the interim, the RWQCB is still the primary interpreter of anti-degradation. Under the Basin Plan's Non-degradation Objective, the RWQCB embraces the position of no changes from background levels by stating that until the conditions in the state Anti-degradation Policy that allow degradation are met, "background water quality concentrations (the concentrations of substances in natural waters which are unaffected by waste management practices or contamination incidents) are appropriate water quality goals to be maintained."[39] This approach was applied to a WRR/WDR issued to LACSD No. 14 in September 2006 for the LWRP agricultural irrigation project.[40] In that case, in the absence of an anti-degradation analysis (ADA), the tentative permit included receiving water limits for nitrate and TDS in groundwater underlying the irrigation site. Provision I.B.5 states that:

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[36] Los Angeles Basin Plan: "Ground waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use."

[37] SWRCB Order 2006-0001 for the Alamitos Barrier Project.

[38] CWC Section 13140 provides that the SWRCB shall formulate and adopt State Policy for Water Quality Control; Section 13142(c) provides that State Policy for Water Quality Control shall consist of principles and guidelines deemed essential by the SWRCB for water quality control; Section 13240 provides that Basin Plans shall conform to any State Policy for Water Quality Control.

[39] Section 3 of the Basin Plan, *Water Quality Objectives*, page 3-2.

[40] Board Order No. R6V-2006-0035.

> *Nitrate and TDS (Eastern Agriculture Site No. 1) – Use of recycled water at Eastern Agriculture Site No. 1 shall not cause: (i) nitrate concentrations in groundwater in excess of 3.4 mg/L as N, and (ii) TDS concentrations in groundwater at a given monitoring point to exceed existing concentrations at that point (concentration limit) as determined by an approved intra well statistical method (See Finding No. 13).*

This provision was a significant modification of the language in the original tentative Order that stated "Ground waters underlying the proposed Agriculture Site No. 1 shall not contain concentrations of nitrate in excess of a naturally occurring background concentration of 3.4 mg/L as N." In either case the limitation is based on the naturally occurring background water quality. It should be noted that a comprehensive ADA would have to be conducted for a GWR project and certainly the results of that analysis would factor into any permit conditions established by the RWQCB also taking into consideration policies favoring reclamation or maximum benefit to the State.

The LACSD permit also contains prohibitions per the Basin Plan (see next section) that can be construed to apply the same approach to all other constituents in groundwater. However, given the outcome of the SWRCB Water Quality Order 2006-0001, there may be more discretion given to indirect potable reuse projects in terms of applying anti-degradation requirements. In addition, the Basin Plan amendment (BPA) adopted by the Santa Ana RWQCB related to anti-degradation and salt and nitrogen management in groundwater may also have ramifications for a proposed project (as discussed in later in this section under "Other Basin Plan Considerations").

When discussing anti-degradation, it is important to remember that the Lahontan RWQCB is not only concerned about the impacts of individual projects, but also the cumulative effects of all projects in the region. At Workshop 1, RWQCB staff noted that the proponents for this project should conduct detailed alternative analyses so the RWQCB can make informed decisions (see Appendix A for Workshop 1 Summary). The genesis of this comment is that the RWQCB is receiving many individual "degradation requests" for discharge projects, but the cumulative degradation of these projects is not being addressed. The net result of this situation is that it is likely that the RWQCB will take a more conservative approach when approving projects unless a coordinated approach is undertaken. The RWQCB staff member noted that the TDS and Nitrogen Management Plan approved by the Santa Ana RWQCB is an example of a helpful plan to address cumulative degradation (as discussed in later in this section under "Santa Ana Basin Plan Amendment").

Finally, when discussing anti-degradation, it is also important to acknowledge that another related challenge is the allocation of assimilative capacity. Assimilative capacity is defined as the amount of a contaminant that can be discharged to a specific water body without exceeding water quality standards or criteria. In the case of groundwater, this would be the difference between the background concentration of a contaminant and a water quality objective. When assessing permit limits for a project, the RWQCB may consider the available assimilative capacity of the groundwater basin. However, pursuant to the CWC, the RWQCB is not obligated to authorize the utilization of the assimilative capacity of the groundwater.[41] Should this approach be taken, it could result in very stringent permit requirements, which could further impact control measures needed for project approval.

Prohibitions

The Basin Plan contains waste discharge prohibitions, including those that apply to the entire region and those that apply to specific areas. There are no specific prohibitions for the Antelope Valley; however, the region-wide prohibitions apply. For recycled water projects, the three critical prohibitions are:

1. The discharge of waste which causes violation of any narrative water quality objective contained in the Basin Plan, including the Non-degradation Objective, is prohibited

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[41] CWC section 13263(b).

2. The discharge of waste which causes violation of any numeric water quality objective contained in the Basin Plan is prohibited
3. Where any numeric or narrative water quality objective contained in the Basin Plan is already being violated, the discharge of waste which causes further degradation or pollution is prohibited

In the last case, this could be an issue if any of the potential GWR-RW sites have groundwater with natural constituent levels in excess of water quality objectives. These prohibitions could be critical if the RWQCB should take a position not allowing any degradation of groundwater quality for any or specific constituents as a result of a GWR-RW project. However, the Basin Plan does include language allowing for exemptions from discharge prohibitions. In the case of recycled water projects, the Basin Plan specifically cites that the need to develop and use recycled water is one factor the RWQCB will evaluate when considering exemption requests to waste discharge prohibitions.[42]

Other Basin Plan Considerations

In assessing Basin Plan requirements, RWQCB may require recycled water to comply with water quality objectives at the point of discharge. There are a number of precedential SWRCB orders that can be used to counter balance this approach. For example, the SWRCB has ruled that when setting permit limits, the RWQCB can consider the effects of attenuation and/or dilution that occur during the recharge process if the water recycler has demonstrated with a documented analysis that these processes will prevent groundwater objectives from being exceeded at a specified distance from the discharge.[43] Also, in Water Quality Order 2006-0001, the SWRCB affirmed that the recycled water must meet all drinking water requirements after treatment and blending with imported water and prior to being pumped up and served to customers.

Should compliance with water quality objectives be an issue, it is possible to amend a Basin Plan to revise the groundwater quality objectives so long as they are still protective of designated beneficial uses. It is also possible to refine or de-designate the groundwater beneficial uses through a BPA, which may allow for the application of less stringent objectives. Any such amendments must be consistent with CWC Section 13241 and the Anti-degradation Policy. However, while these actions are possible, in practice they are not politically popular and difficult to effectuate.

One worthy exception to consider is the BPA adopted by the Santa Ana RWQCB related to anti-degradation and salt/nitrogen management in groundwater.

Santa Ana Basin Plan Amendment

In January 2004, the Santa Ana RWQCB amended the Basin Plan to incorporate new revised boundaries for groundwater sub-basins (called management zones), new nitrate and TDS objectives for the management zones, and TDS management strategies applicable to surface water and groundwater.[44]

The genesis of this effort were concerns over groundwater quality objectives for TDS and nitrate-nitrogen and the RWQCB's Nitrogen/TDS management plan (to satisfy the 1994 amendments to the Basin Plan that incorporated a revised total inorganic nitrogen (TIN) wasteload allocation). A principal underlying concern was that the 1994 updates to the Basin Plan resulted in inappropriate constraints on wastewater recycling opportunities. Since reuse of recycled water was a critical component of many agencies' plans to meeting rapidly increasing water demands in the region, the Santa Ana RWQCB agreed to review the objectives. A Nitrogen/TDS Task Force (Task Force) was formed in 1995-96 to conduct studies regarding the TDS and nitrate-nitrogen objectives and other components of the N/TDS management plan. The Task Force was comprised of 22 water supply and wastewater agencies throughout the region. The BPAs that

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[42] Section 4.1 of the Basin Plan, *Waste Discharge Prohibitions*, page 4-8.

[43] SWRCB Order WQ 81-5 at pp. 6-7; SWRCB Order WQ 73-4 at p.7.

[44] Resolution No. R8-2004-001; this was approved by the SWRCB on September 30, 2004, and the Office of Administrative Law on December 23, 2004, after which the groundwater-related components became effective.

were adopted in 2004 were the culmination of multi-year, multi-million dollar (approximately $3.5 million) studies conducted by the Task Force to review groundwater TDS and nitrate-nitrogen objectives, groundwater sub-basin boundaries, the TIN and TDS wasteload allocations and other components of the N/TDS management plan.

As part of the 2004 update of the N/TDS management plan in the Santa Ana Basin Plan, several agencies proposed that less stringent TDS and/or nitrate-nitrogen water quality objectives be adopted for specific groundwater management zones and surface waters. In general, the new groundwater management zone boundaries were defined on the basis of:[45]

1. Separation by impervious rock formations or other groundwater barriers, such as geologic faults
2. Distinct flow systems defined by consistent hydraulic gradients that prevent widespread intermixing, even without a physical barrier
3. Distinct differences in water quality

Groundwater flow, whether or not determined by a physical barrier, was the principal characteristic used to define the management zones. In addition to these technical considerations, water and wastewater management practices and goals for the Chino Basin were considered and used to define an alternative set of management zone boundaries for that area. These proposals were based on additional consideration of the factors specified in CWC Section 13241 and the requirements of the State's Anti-degradation Policy. Since the less stringent objectives would allow a lowering of water quality, the agencies were required to demonstrate that their proposed objectives would protect beneficial uses, and that water quality consistent with maximum benefit to the people of the state would be maintained.

Another interesting aspect to the approach taken by the Santa Ana RWQCB was how the objectives were established. The TDS and nitrate objectives specified in the 1975 and 1984 Santa Ana Basin Plans, and initially in the 1995 Basin Plan, were based on an evaluation of groundwater samples from the five year period 1968 through 1972. This time period is typical for how most RWQCBs established objectives based on historical background conditions. However for the 2004 amendment, for the most part, the TDS and nitrate water quality objectives for each management zone were based on historical concentrations of TDS and nitrate from 1954 through 1973 and are referred to as the "anti-degradation" objectives. The 1954-1973 period brackets 1968, when the SWRCB adopted the state's Anti-degradation Policy. For determining assimilative capacity, current ambient water quality was defined as the 20-year average of TDS and nitrate-nitrogen data for each management zone from 1978 through 1997 and was compared to the water quality objectives for the groundwater management zones to determine whether there was TDS and/or nitrate-nitrogen assimilative capacity in each of the management zones.

Appropriate beneficial use protection and maximum benefit demonstrations were made by a number of agencies to justify alternative "maximum benefit" objectives for the Chino North, Cucamonga, Yucaipa, Beaumont and San Timoteo groundwater management zones. These "maximum benefit" proposals entailed commitments by the agencies to implement specific projects and programs.[46] To address circumstances that might impede or preclude these commitments, the BPA included both the "anti-degradation" and "maximum benefit" objectives for the groundwater management zones. The "anti-

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[45] The specific technical basis for distinguishing each groundwater Management Zone was provided in the report entitled "TIN/TDS Study – Phase 2A Final Technical Memorandum," Wildermuth Environmental, Inc., July 2000.

[46] Water and wastewater purveyors and other parties in the watershed have implemented, and propose to implement, facilities and programs designed to address salt problems in the groundwater of the region, including the construction of brine lines and groundwater desalters, implementation of programs to enhance the recharge of high quality stormwater and imported water, where available, and re-injection of recycled water to maintain salt water intrusion barriers in coastal areas.

degradation" objectives are more stringent than the "maximum benefit objectives."[47] As long as these agencies' commitments are met, then the agencies have demonstrated maximum benefit and the "maximum benefit" objectives included in the 2004 Basin Plan apply for regulatory purposes. However, if the RWQCB finds that these commitments are not being met and that "maximum benefit" is not demonstrated, then the "anti-degradation" objectives for the waters will apply.

The BPA also includes permitting provisions. Agencies are required to implement measures to improve effluent TDS quality when the 12-month running average effluent concentration exceeds specified thresholds for three consecutive months, or when the 12-month running average TIN concentration exceeds a specified threshold for any month. For recycled water recharge permits, TDS limitations are 5-year running average concentrations equal to or less than the "maximum benefit" TDS objective.

To further the Basin Plan approach to salt, the Santa Ana RWQCB is also considering adopting General WDRs for the discharge of salts through injection/percolation of SWP water, Colorado River water or imported well water to recharge groundwater management zones within the Santa Ana Region. To date, the RWQCB has not regulated GWR projects using these waters, even where the concentrations of nitrogen, TDS (or other) constituents exceeded relevant Basin Plan objectives and/or current ambient quality. However, given the increased number and magnitude of the water recharge projects being contemplated, and in view of the extensive commitments that have been and will be made by dischargers and other stakeholders in the region to develop and implement the new TDS and N objectives, the Santa Ana RWQCB wants to ensure that imported water GWR projects do not cause or contribute to violations of applicable water quality standards and anti-degradation requirements by adopting the General WDRs (Order No. R8-2006-0005). The discharge limits in the General Order for TDS and TIN are based on 5-year averages. A Salinity Management and Imported Water Recharge Workgroup (Workgroup) has been formed to pursue enforceable alternatives to the imposition of a WDR. The Workgroup is developing a draft "Cooperative Agreement to Protect Water Quality and Encourage the Conjunctive Use of Imported Water in the Santa Ana River Basin" that if executed would create, implement, coordinate and enforce an integrated regional water management program that achieves compliance with the Basin Plan salinity objectives.

Water Code Considerations & State's Anti-degradation Policy

The CWC contains provisions related to waste wells[48] that prohibit the use of any waste well that extends into a water bearing stratum that is, or could be, used as a water supply for domestic purposes. But an exception can be provided if the RWQCB finds that water quality considerations do not preclude the direct injection and if DHS, after a public, hearing finds that the recharge will not degrade the quality of the aquifer as a source of water supply for domestic purposes. In making its finding on degradation, DHS must consider the State's Anti-degradation Policy.[49] While these provisions are typically interpreted to apply to recharge by injection, DHS and some RWQCBs also apply this statute to surface spreading projects. Consequently, assessment of a GWR project must also consider such statutory requirements.

A section on water reclamation requirements in the CWC states that a RWQCB may not deny issuance of water reclamation requirements to a project that violates only a salinity standard in a basin plan.[50] In 1988, soon after this provision was added to the CWC, the SWRCB's Office of Chief Counsel issued a legal opinion concluding that this requirement applied to WRRs, but not to WDRs. The Lahontan RWQCB in practice has elected to issue joint WRRs/WDRs for non-potable reuse projects, and would probably take the same approach for a GWR-RW project. Thus, the permit for a GWR-RW project would

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[47] For example, for the Beaumont groundwater management zone, the maximum benefit objective for TDS is 330 mg/L compared to the anti-degradation objective of 230 mg/L; similarly the maximum benefit objective for nitrate-nitrogen is 5 mg/L compared to the anti-degradation objective of 1.5 mg/L.

[48] CWC section 13540.

[49] Ibid.

[50] *See* Water Code section 13523.5.

contain limits on discharges of salts if necessary to meet water quality objectives or otherwise protect beneficial uses.

4.2 Relevance of Precedential Recharge Permits

At the present time, there are only a handful of GWR-RW projects that have been permitted in California as shown in **Table 4-11**.

Table 4-11: Permitted GWR Surface Spreading Projects Using Recycled Water [1]

Project	Start Date	Level of Treatment to Secondary Effluent	Amount of Recycled Water (RW Contribution)	RWQCB
Montebello Forebay GWR Project (Central Groundwater Basin)	1962	Tertiary	50,000 afy (35%) [2]	Los Angeles
Phase I Chino Basin Recycled Water GWR Project [3]	2005	Tertiary	8,000 afy (20%) [4]	Santa Ana
Groundwater Replenishment System (Orange County Groundwater Basin)	2007	Advanced Treatment: MF, RO, & AOP [5]	Up to 72,000 afy (75%)	Santa Ana

Notes:

1. This list does not include indirect potable reuse projects that use injection as the means of recharging groundwater or creating salt water intrusions barriers, such as West Coast Basin Barrier Project, Harbor Water Recycling Project B Dominguez Gap Barrier Project, Interim Water Factory 21 - Talbert Barrier Project, and the Alamitos Barrier Project.
2. The project can go up to 60,000 AF in any single year or 50% recycled water provided the 3 year running average is 50,000 AFY or 35% recycled water. Diluent water is a combination of potable water, stormwater and subsurface flow from the San Gabriel Basin.
3. The ultimate project intends to use an additional 15,000 afy of recycled water and 72,000 afy of diluent water.
4. Diluent water is a combination of 28,000 afy of potable water and 8,000 afy stormwater.
5. AOP for this project includes hydrogen peroxide addition and UV irradiation, pH adjustment.

All three projects listed in Table 4-11 are practiced in a groundwater basin that has been adjudicated or is part of a statutory management program. Of the three projects, the one most applicable to the Study is the Phase I Chino Basin Recycled Water Groundwater Recharge Project (Phase I Chino Basin Project).

The Phase I Chino Basin Project is part of a comprehensive water supply enhancement program jointly sponsored by the Inland Empire Utilities Agency (IEUA), Chino Basin Watermaster, Chino Basin Water Conservation District, and the San Bernardino County Flood Control District. The WRR (R8-2005-0033) was adopted by the Santa Ana RWQCB in 2005 based on the most recent DHS draft GWR regulations. The Phase I Chino Basin Project consists of three major components:

1. Wastewater treatment and water recycling facilities
2. Recharge basins
3. Conveyance systems to deliver the various water supplies from their sources to the recharge basins

The Phase I Chino Basin Project is replenishing the Chino Basin via spreading with a targeted blend of approximately 20 percent recycled water and 80 percent water of non-wastewater origin, based on a 60-month running average. A phased approach is being used to achieve the targeted blend of 20 percent over a two-year period. The RWC is 0.10 during the initial year of operation, 0.15 during the second year of operation and 0.20 during the third and subsequent years. Diluents are stormwater and SWP water.

The Chino Groundwater Basin is a closed basin with a deep vadose zone, very much like the Antelope Valley basin. As a result the WRRs include requirements that may be of significance to a permit potentially issued to an Antelope Valley GWR project:

- The effluent limits and other requirements in the WRRs pertain to the "maximum benefit" and "anti-degradation" groundwater quality objectives in the Santa Ana Basin Plan (per the previous discussion in Section 4.1.1).
- As part of the maximum benefit commitments, IEUA has agreed to implement measures to assure that the combined effluent quality from all of its plants does not exceed 550 mg/L TDS and 8 mg/L TIN on a 12-month running average; and that the blend of recycled water and other recharge sources is done to assure that the 5-year running average of TDS does not exceed 420 mg/L and the nitrate-nitrogen does not exceed 5 mg/L.
- Because of the deep vadose zone and absence of a defined groundwater mound, IEUA is being allowed to demonstrate compliance with the permit's TOC requirements using a lysimeter system that has been approved by DHS. This lysimeter system is also an option for determining compliance with limits based on MCLs.

4.3 Preliminary Data Analysis

A preliminary data analysis was conducted based on the regulatory and policy issues presented in sections 4.1 and 4.2, their applicability to the GWR-RW project, and water quality data collected from the various agencies that would be involved in the GWR-RW project. The preliminary data analysis focused on recycled water from the LWRP and untreated SWP water. The primary objective of the preliminary analysis was to identify constraints and potential regulatory pathways for this Study. The identified pathways were in turn considered in the development of project alternatives, project definition, and project implementation plan.

4.3.1 DHS Draft Groundwater Recharge Regulations

Based on the data collected, an assessment was conducted of how the GWR-RW project would comply with the DHS draft GWR regulations summarized in Table 4-1. Unregulated contaminants, which are regulated on the basis of TOC, are discussed before the regulated contaminants because the RWC that will be established based on TOC affects compliance with regulated contaminant (including total nitrogen) requirements.

Pathogenic Microorganisms

Turbidity and microbial requirements specified in the DHS regulations in association with the filtration and disinfection processes will be readily met via the addition of tertiary treatment at the LWRP and, therefore, is not further discussed here.

Requirements in the draft regulations associated with retention time underground and horizontal separation are not related to the recycled water or blend water quality and are therefore not discussed further here but are discussed in Section 5.1.3.

Unregulated Contaminants

When the LWRP is upgraded to activated sludge, nitrification/denitrification (NDN), tertiary filtration, and chlorination, TOC in the recycled water is anticipated to range between 8 mg/L and 10 mg/L.[51] Such

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[51] Based on discussion with LACSD staff in June 2006.

concentrations would satisfy the requirement that the weekly maximum TOC in filtered wastewater be less than 16 mg/L.

A concentration of 10 mg/L was used to estimate the TOC concentration of wastewater origin after percolation through the vadose zone and the allowable RWC, thereby providing a conservative estimate for determination of the allowable RWC should concentrations be more typically in the 8 mg/L range.

At IEUA, which has vadose zone depths similar to those in the Antelope Valley, monitoring in 2005 has indicated the following:

- The recycled water TOC averaged approximately 8 mg/L.
- The average TOC removal through the vadose zone via soil aquifer treatment (SAT) at Banana Basin, Hickory Basin West Cell, and Hickory Basin East Cell were 69, 64, and 75 percent, respectively at the 25-foot lysimeter level.
- TOC removal efficiency varies based on initial TOC concentration and basin operation. IEUA has observed differences in TOC removal performance in two similar adjacent basins: Hickory East and West. The TOC removal was poorer for Hickory West. This has been attributed to differences in basin operation with Hickory West, which was temporarily out of service to repair a breached berm due to storm damage. IEUA believes that the given identical operations, the results would have been the same.[52] Data from IEUA indicate slightly different TOC removal efficiencies for recycled water and diluent water, with slightly higher TOC removal efficiency in the recycled water. This may be due to “recalcitrant” TOC in diluent water that is not removed or degraded in the vadose zone.

In the Antelope Valley, it was assumed that the maximum TOC concentrations in treated imported water from the SWP would be a representative measure of the “recalcitrant” TOC that might be present in the recycled water. Based on 2005 Kern system data, TOC in treated water varies between 1.3 and 2.5 mg/L and averages 1.8 mg/L. Based on 2005 Los Angeles system data, TOC in treated water varies between 1.3 and 2.7 mg/L and averages 2 mg/L.

Given a maximum recycled water TOC concentration estimated at 10 mg/L, a TOC removal of 73 percent to 75 percent would need to be observed through the vadose zone before reaching a 2.5 to 2.7 mg/L concentration that would correspond to the “recalcitrant” TOC levels in recycled water. Based on IEUA data shown above (TOC removals ranging from 75% to 65%), it was assumed that such removal could be achieved for an Antelope Valley project. This range of TOC removals was used for assessing allowable RWCs for an Antelope Valley GWR-RW project.

As indicated in **Table 4-12**, the maximum allowable RWC would be 20 percent if the initial recycled water TOC concentration is 10 mg/L and TOC removal of 75 percent can be achieved in the vadose zone through SAT. The maximum allowable RWC would drop to approximately 15 percent if the initial recycled water TOC concentration is 10 mg/L and TOC removal in the vadose zone is only 65 percent.

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[52] Personal communication with Andy Campbell, IEUA.

Table 4-12: Blending Requirements Based on Recycled Water TOC of 10 mg/L

TOC Removal in Vadose Zone	TOC in Recycled Water after Percolation Through Vadose Zone	Maximum Allowable Recycled Water Contribution [1]	Blending Requirements (Diluent:RW)
50%	5.0 mg/L	10.0%	9:1
55%	4.5 mg/L	11.1%	8:1
60%	4.0 mg/L	12.5%	7:1
65%	3.5 mg/L	14.3%	6:1
70%	3.0 mg/L	16.7%	5:1
75%	2.5 mg/L	20.0%	4:1
80%	2.0 mg/L	25.0%	3:1

Notes: The RWC values are average values based on a 60-month running average; they are not single sample maximum allowable limits.

Regulated Contaminants

Drinking Water Standards

For those constituents that have been sampled in the effluent at the existing LWRP (see Appendix H), existing data generally indicates that the water quality requirements are being met. Compliance for the constituents of concern that have not been sampled (see Table 4-14) could not be determined at the present time.

Although data from existing surface spreading projects (e.g., Montebello Forebay GWR Project and Phase I Chino Basin Project) indicates that all drinking water standards can be met after tertiary treatment and percolation through a vadose zone, there is no assurance that similar water quality will be achieved by a similar project in Antelope Valley, as all wastewater and recharge area soil characteristics are site dependent.

Total Nitrogen

The DHS draft GWR regulations include three options to control nitrogen compounds, as summarized in **Table 4-13**. As indicated in Table 4-13, the nitrogen requirements apply to recycled water or a blend of recycled water and diluent water. The compliance point and standards vary according to which option is chosen.

Unlike the TOC requirements, nitrogen limits apply to all recharge waters under Option a(1) and Option a(2), i.e., recycled water or blended water must meet nitrogen requirements. Since compliance with the blend water requirements is generally more favorable, Option a(1) and Option a(2) for the blend water is considered here:

- Planned upgrades to the LWRP include NDN and tertiary treatment. When these upgrades are complete, recycled water will present an average total nitrogen concentration of about 10 mg/L (as N). Of this total, the nitrate+nitrite concentration is expected to be 8 mg/L (as N), the ammonia concentration 1 mg/L (as N), and the organic nitrogen 1 mg/L (as N).[53] The organic nitrogen is considered to be refractory or only partially biodegradable, and at least one RWQCB (Santa Ana) sets limits on TIN, not total nitrogen. Although ammonia has the potential to vaporize in the atmosphere prior to reaching the vadose zone in a surface spreading setting, it is reasonable to assume that 9 mg/L (as N) (i.e., 8 mg/L of nitrate-nitrite and 1 mg/L of ammonia

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[53] Based on input from LACSD staff in June 2006.

converted to nitrate/nitrite in the vadose zone) has the potential for impacting the GWR-RW project.

- For the purpose of this Study, it is assumed that untreated SWP water will be used as the main source of diluent water. Untreated SWP water contains approximately 1 mg/L nitrate (as N) (AVEK, 2005). No data was readily available on the concentrations of total nitrogen or nitrite.

Table 4-13: DHS Draft Groundwater Recharge Regulations for Control of Nitrogen Compounds

	Control of Nitrogen Compounds		
	Option (a)(1)	Option (a)(2)	Option (a)(3)
Compliance Point	Recycled water, or a blend of recycled water and diluent water, in or above the mound	• Total N: Recycled water, or a blend of recycled water and diluent water, in or above the mound • Ammonia, Organic Nitrogen, Nitrite, and DO in excess of the BOD: Recycled water, or recharge water in or above the mound, as required • Groundwater down-gradient of the recharge area for DO as required	Groundwater down-gradient of the recharge area
Standard(s)	• 5 mg/L total N as an average • 10 mg/L total N at a maximum frequency	Total N : 10 mg/L; • As established by the engineering report for: • Total N at some level <10 mg/L when used as part of a comprehensive nitrogen control scheme • Ammonia, nitrite, and/or organic nitrogen • Minimum DO in excess of BOD • Minimum DO	MCLs for NO_2 and NO_3[1]
Frequency of Sampling	2 per week	As established by the engineering report	2 per month

Source: California Department of Health Services, 2004; DRAFT Title 22, CCR, Division 4, Chapter 3. §60320 et seq
Note:

1. The MCLs for nitrite and nitrate are 1 mg/L and 10 mg/L as N, respectively.

Thus, there is inadequate information to determine the total nitrogen (i.e., ammonia, nitrate, nitrite, and organic nitrogen) level in the diluent water. For purposes of determining nitrogen requirements, a conservative approach was therefore taken, assuming that the total nitrogen concentration in the diluent water would be 10 mg/L or less. A concentration of approximately 4-5 mg/L is more likely but cannot be supported by actual data.

- If both the recycled and diluent waters have total nitrogen levels of 10 mg/L or less, any removal through the vadose zone will lower the total nitrogen concentration to less than 10 mg/L in the blended water. Sampling at IEUA indicated average total nitrogen reduction of 32, 49, and 51 percent through the vadose zone for the three basins that received recycled water. If similar removal can be achieved in the Antelope Valley and total nitrogen concentration in recycled water or diluent water does not exceed 10 mg/L, compliance with Option a(1) requirements could potentially be achieved.

As indicated in Option a(3) in Table 4-13, an exception may be made to the need to comply with either Option a(1) or Option a(2) if it can be shown to the satisfaction of DHS that the MCLs for NO_2 and NO_3 are met in groundwater downgradient of the spreading area. Compliance based on meeting Option a(3) may be readily achievable depending on both the RWC and nitrogen removal through the vadose zone, although nitrate and nitrite data on removal in the groundwater aquifer currently are not available to estimate whether MCLs can be met in the groundwater downgradient of the spreading area. Hence, groundwater sampling during project operation would need to be performed to demonstrate compliance with Option a(3).

4.3.2 RWQCB Requirements

As discussed in Section 4.1.2, the key regulatory requirements that the GWR-RW project would have to meet are the groundwater quality objectives and non-degradation objective in the Basin Plan. These requirements would be translated into effluent or groundwater limitations in a permit issued by the RWQCB. For the purposes of this discussion, it is important to recognize the distinction between water quality objectives and "effluent limitations." The effluent limitations are established in permits both to protect water for beneficial uses within the area of the discharge, and to meet or achieve water quality objectives. Since there are no numeric objectives or guidelines for IND or FRSH uses, this evaluation is solely based on MUN and AGR beneficial uses.

Numeric and Narrative Water Quality Objectives

MUN Water Quality Objectives

For compliance with MUN water quality objectives, it is likely that a permit would include effluent limitations whereby the "discharge" will not cause a violation of the groundwater quality objectives for bacteria, chemical constituents, radioactivity, and taste and odors.

For bacteria, it is probably reasonable to assume that if the effluent meets the Title 22 criteria for coliform, then the discharge will not cause the rolling seven-day median coliform concentration in groundwater to exceed the water quality objective of 1.1/100 mL.

For chemical constituents, a simplistic initial way of determining whether these conditions impose potential regulatory challenges for a GWR-RW project using recycled water is to compare the objectives to the quality of the LWRP effluent and make the assumption that if the effluent concentrations are equal to or less than the objectives, the discharge would not violate the objectives. This approach does not consider the possible mitigating effects of attenuation and/or dilution that could occur during the recharge process, or the possible effects of blending the recycled water with diluent water or providing additional treatment.

An assessment was conducted for the chemical water quality objectives based on MUN beneficial uses as shown in Appendix H. The results are summarized in **Table 4-14**.

Table 4-14: Evaluation of Chemical Groundwater Objectives

Category	Compliance	Comments	Data Not Available For:
Primary MCLs			
Inorganic	Yes with qualification	$N0_3$+$N0_2$ – current effluent > 10 mg/L; however, when LWRP is converted to activated sludge with NDN, LACSD expects the $N0_3$+$N0_2$ to be 7-8 mg/L	• Asbestos and Fluoride
Organic	Yes with qualification	Detection limits not sufficiently sensitive enough for: • 1,2,4-Trichlorobenzene • Di(2-ethylhexyl) phthalate • Hexachloro-benzene • Pentachlorophenol	• cis-1,2-Dichloroethylene • 1,2-Dichloroethane • Styrene • Trichlorofluoromethane • 1,1,2-Trichloro-1,2,2-Trifluoroethane • Atrazine • Bentazon • Carbofuran • 2,4-D • Dalapon • Dibromochloropropane • Di(2-ethylhexyl)adipate • Dinoseb • Diquat • Endothall • Ethylene Dibromide • Glyphosate • Methoxychlor • Molinate • Oxamyl • Picloram • Polychlorinated Biphenyls • Simazine • Thiobencarb • 2,3,7,8-TCDD (Dioxin) • 2,4,5-TP (Silvex)
Disinfection Byproduct	Yes with qualification		• Bromate • Chlorite
Secondary MCLs			
Consumer Acceptance Limits	Yes with qualification		• Color • Odor • Thiobencarb
Ranges	Yes with qualification	TDS – between recommended and upper range	• Specific Conductance

For THMs, there is very limited data that is representative of the future LWRP. Data for the AVTTP indicates that there are occasions when the THMs and haloacetic acids (HAAs) in the disinfected tertiary effluent can exceed MCLs; however, that has only occurred under conditions when ammonia is not present and chlorine residuals are high. It is believed this situation can be mitigated by disinfection control strategies. The other qualification is that there is an absence of data for many constituents with MCLs. That situation has occurred because most wastewater management agencies evaluate priority pollutants in their effluent, and this list of analytes does not match those with corresponding MCLs.

Thus, effluent quality meets MCLs where data is available but there are a number of data gaps that will need to be filled before conducting a further assessment. However, LACSD has information on compliance with MCLs for its three plants in its Joint Outfall System that provide recycled water for the Montebello Forebay GWR Project. The treatment systems for these plants will be the same system used for the modified LWRP; however, the LWRP will have a lower proportion of industrial wastes than the three Joint Outfall System plants. Data collected for the three LACSD WRPs demonstrate that the plants are essentially in compliance with MCLs.[54] One caveat is that for a few compounds (Endothall, Dinoseb, and Thiobencarb) the detection limits for some or all of the samples are higher than the MCLs, making it difficult to conclusively determine compliance.

It is reasonable to presume that if the upgraded LWRP treatment performances are similar to the Joint Outfall System plants, the LWRP recycled water will comply with MCLs prior to recharge. Moreover, inasmuch as the SWP water is also in compliance with MCLs (AVEK, 2006), then any blend of the two water sources will also be in compliance with MCLs[55]. Thus, one can conclude that the discharge will not cause a violation of the MUN objectives for bacteria, chemical constituents, radioactivity, and taste and odors.

AGR Water Quality Objectives

For compliance with AGR water quality objectives, it is likely that a permit would include effluent limitations whereby the "discharge" will not impact groundwater to the extent it cannot be used for AGR uses. Again, a simplistic comparison of irrigation water quality guidelines to the quality of the LWRP effluent can be made to see if there are any potential constituents of concern. The results of this assessment are presented in **Table 4-15**.

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[54] Memo dated January 6, 2006 From Earle Hartling, Recycling Coordinator, Water Quality and Soils Engineering Section, to Vicki Conway, Assistant Department Head, Technical Services entitled "Montebello Forebay Compliance with MCLs and NLs for Monitored and Non-monitored Compounds."

[55] Since THM formation occurs during disinfection as part of the treatment process, untreated SWP water should have very low levels of THMs with the exception of specific times when chlorine may be added to conveyance systems for maintenance. That is what has been observed for untreated SWP used at the Montebello Forebay GWR project. However this statement would need to be verified in the future using AVEK data.

Table 4-15: Comparison of Effluent Quality to Irrigation Water Quality Standard Guidelines

Issue	Related Constituents	Units	No Problems	Increasing Problems	Severe Problems	2005 Effluent Quality		
						Mean	Max	Min
Salinity [1]	TDS	mg/L	< 750	750 - 3,000	> 3,000	570	733	454
Permeability	TDS	mg/L	> 500	500 - 200	< 200	570	733	454
Specific Ion Toxicity	SAR	Ratio	< 3	3.0 - 9.0	> 9.0	NDA		
	Chloride	mg/L	< 142	142 - 355	> 355	139	175	116
	Boron	mg/L	< 0.5	0.5 - 2.0	2.0 - 10	0.47	0.59	0.34
Specific Ion Toxicity from Foliar Absorption	Sodium	mg/L	< 69	> 69	N/A	145	194	104
	Chloride	mg/L	< 106	> 106	N/A	139	175	116
Miscellaneous	Ammonia / Nitrate [2]	mg/L	< 5	5 - 30	> 30	13.1 [3]	23.3 [3]	1.5 [3]
	Bicarbonate, HCO_3	mg/L	< 90	90 – 520	> 520	198	248	132
	pH	pH	6.5 to 8.46	< 6.5 or > 8.46	N/A	8	9	7.3

Source: Adapted from Ayres and Westcott, 1976.

Notes:

1. Plants vary in tolerance to salinity
2. For sensitive crops
3. When LWRP is converted to activated sludge with NDN, LACSD expects the $N0_3+N0_2$ level to be 7 to 8 mg/L, and the ammonia to be less than 2 mg/L

NDA No data available

Water salinity is the most important parameter in determining the suitability of water for irrigation. As salinity increases in irrigation water, the probability for certain soil, water, and cropping problems increases. The data in Table 4-15 indicate that, unless properly managed, there could be potential problems associated with irrigation of crops if the groundwater impacted by the recharge project directly resembled the quality of recycled water produced at the LWRP. In most cases, the recycled water is within the range of "increasing problems," relative to the concentration of the given parameter. Concentrations of sodium and chloride in recycled water are relatively high and may potentially be damaging to some plants after repeated applications. However, this can be managed with common farming practices. The salinity of recycled water produced at the LWRP is also somewhat elevated. Plants tend to vary widely with respect to their tolerance to salinity, and provision of adequate soil drainage and irrigation management practices will help alleviate potential problems associated with the salinity of irrigation water. The high bicarbonate level and the relatively high pH, which are not unusual even for agricultural water, may also be a concern. They will not impact the groundwater, but the combination will provide challenges for infiltration during irrigation events. This may be mitigated with application of amendments onto the soil or in the irrigation water.

Another way to look at the impacts would be to assume that the proposed GWR-RW project was capped at a 20 percent RWC and 80 percent diluent water (4:1 ratio). One scenario might assume that the diluent water was low in salt and nitrogen (such as stormwater). In this case, the blended recharge would help insure that the agricultural guidelines were met or minimized in the underlying groundwater. For a second scenario, the diluent water could be SWP water. In that case, the average TDS concentration of the diluent water would be 230 mg/L, the chloride concentration is approximately 60 mg/L, the sodium concentration is approximately 66 mg/L, and the nitrate concentration is approximately 1 mg/L as N.[56] The blend would again help insure that the agricultural guidelines were met or minimized in the underlying groundwater since the resulting TDS concentration would be 300 mg/L; the chloride concentration would be 80 mg/L; the sodium concentration would be 82 mg/L, and the nitrate concentration would be approximately 2 mg/L as N.

Non-Degradation Objectives

For the anti-degradation objective, it is not the purpose of this Study to conduct a preliminary ADA. Any such undertaking would be premature at this stage of the project since there are no specific project alternatives to assess in terms of recycled water blend or treatment, there are no specific project sites that have been identified, and there are no site-specific groundwater data for a proposed site to evaluate changes in natural background conditions and/or assimilative capacity. A complete analysis would be conducted as part of the Engineering Report for a pilot or full-scale GWR project.

Nevertheless, based on a general understanding of groundwater quality in the Antelope Valley and previous permits issued by the Lahontan RWQCB, it is likely that there will be at least three primary constituents that are of concern for anti-degradation purposes: TDS, nitrate and disinfection by-products, including the THMs.[57] There may also be areas of the basin where arsenic levels or other constituent levels exceed numeric water quality objectives, which could trigger the narrative prohibition[58] and anti-degradation requirements. The RWQCB may also have concerns related to the leaching or dissolution of naturally occurring arsenic, chromium and selenium in soils as a result of recharge activities.

Based on recent practice in light of permits issued between 2003 and 2006, the Lahontan RWQCB has used different approaches when dealing with anti-degradation requirements in WDRs or WRRs for percolation pond/land disposal projects, aquifer storage and recovery projects, unlined storage ponds, or recycled water irrigation projects.

In one case, while there was knowledge that an effluent might contain higher concentrations of constituents than underlying groundwater, there was no mention of anti-degradation requirements in the permit and no inclusion of anti-degradation limitations either numeric or narrative.[59] In another case, the underlying groundwater exceeded water quality objectives, yet the use of recycled water for irrigation, which contained the constituents of concern, was considered by the RWQCB as a means to mitigate the adverse ground water quality effects, and the RWQCB determined that the project conformed to the State Anti-degradation Policy.[60]

In other cases, ADAs were completed and showed that even though groundwater concentrations of constituents of concern might increase as a result of the discharges, the projects were allowed to proceed or given a waiver.[61] In the case of the aquifer storage project which used SWP water, the RWQCB deemed the degradation to be "temporary" and restricted to a defined area, and the permit included provisions that required the groundwater to be restored to original background levels after the project was completed.

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[56] SWP water quality numbers are the average value of 70 to 100 samples collected at SWP Check 41 between December 1997 and April 2006 (Available at wdl.water.ca.gov/wq-gst);\.

[57] The RWQCB may also want to evaluate total nitrogen for anti-degradation purposes.

[58] Where any numeric or narrative water quality objective contained in the Basin Plan is already being violated, the discharge of waste which causes further degradation or pollution is prohibited.

[59] Board Order No. R6V-2004-0018 Hilton Creek Community Services District.

[60] Board Order No. R6V-2004-0005 Ft. Irwin National Training Center.

[61] Board Order No. R6V-2003-028 Victor Valley Wastewater Reclamation Authority and Board Order No. R6V-2004-0043 County of Los Angeles Department of Public Works Lancaster Sub-Basin Full-Scale Aquifer Storage and Recovery Project.

In the most restrictive case to date, as discussed in Section 4.1.2, the RWQCB has issued a tentative permit that has proposed groundwater limitations whereby the effluent percolation to groundwater underlying an irrigation site is limited to an amount that does not cause nitrate in excess of naturally occurring background concentrations.[62] However, in that case, an ADA had not yet been conducted for the irrigation site. For the same tentative permit, the RWQCB established groundwater limits that allowed for some degradation underneath effluent storage reservoirs based on the results of an ADA. There is also a permit that was issued in 2002 that is worthy of notice. In that case, the groundwater limits were set for a date 4 years following completion of plant modifications and allowed for attenuation and blending of wastewater with native groundwater at a downstream compliance point.[63]

Many of these anti-degradation decisions may need to be carefully reconsidered for a GWR-RW project in light of SWRCB Water Quality Order 2006-0001 which provided important guidance on the weight that should be given to policies favoring reclamation and reuse of water when issuing WDRs or WRRs. For a GWR project, a comprehensive ADA would have to be conducted, and certainly the results of that analysis would factor into any permit conditions established by the RWQCB, in addition to satisfying the requirements in the Non-degradation Objective.

From this baseline assessment, it is possible to speculate that if a proposed GWR project using recycled water was capped at a 20 percent RWC and the diluent water was low in salt and nitrate (such as stormwater), then the likelihood of compliance with the non-degradation objective would increase. If SWP water was used as the diluent water, there may be degradation issues with salts, nitrate and disinfection by-products that require further evaluation and assessment in term of the State Anti-degradation Policy.

Nitrate

For nitrate, the estimated concentration of a 4:1 blend of untreated SWP and recycled water is approximately 2 mg/L as N (see discussion regarding compliance with AGR). Data on the average nitrate concentrations in groundwater for the study area is presented in Section 3.2.5 and Appendix E. The data indicates that median nitrate concentrations in the wells sampled was below 1 mg/L as N.[64] Thus, the use of recycled water and SWP water for recharge could increase the nitrate concentration in groundwater above ambient levels. However, this assessment does not take into consideration the attenuation via SAT and dilution in the groundwater. Nor does it take into consideration allocation of any assimilative capacity, since the change in nitrate in groundwater will be below the MUN groundwater objective. Based on the resulting concentration, the impacts on groundwater are not expected to unreasonably affect present or anticipated beneficial uses. In addition, given the ruling pursuant to Water Quality Order 2006-0001 related to indirect potable reuse projects, it is likely that the project would meet the requirements of the State's Anti-degradation Policy and the Basin Plan. This determination will require further evaluation of site specific groundwater data and consultation with the RWQCB on this project and the cumulative impacts of other projects in the region.

Total Dissolved Solids/Salts

For TDS, the estimated concentration of a 4:1 blend of SWP and recycled water is 300 mg/L (see discussion regarding compliance with AGR). Data on the average TDS concentrations in groundwater for the study area is presented in Section 3.2.5 and Appendix E. The data indicate that the median TDS concentration in the wells sampled was 220 mg/L. As shown in Appendix E, there are some localized areas with TDS at higher concentrations. There is also likely to be considerable variability in groundwater TDS concentrations even within relatively short spatial distances.[65] Thus, the use of recycled water and

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[62] Board Order No. R6V-2006-0035, County Sanitation District No. 14 of Los Angeles County.

[63] Board Order No. R6T-2002-0030Tahoe-Truckee Sanitation Agency.

[64] As shown in Appendix E, there are some localized areas with nitrate at higher concentrations.

[65] Personal communication from LACSD based on groundwater monitoring studies outside the study area.

SWP water for recharge could increase the TDS concentration in groundwater above ambient levels. However, this assessment does not take into consideration possible mitigating affects of dilution in the groundwater. Nor does it take into consideration allocation of any assimilative capacity, since the change in TDS in groundwater will be below the MUN groundwater objective. Since the impacts on groundwater are not expected to unreasonably affect present or anticipated beneficial uses, and given the ruling pursuant to Water Quality Order 2006-0001 related to indirect potable reuse projects, it is likely that the project would meet the requirements of the State's Anti-degradation Policy and the Basin Plan. This determination will require further evaluation of site-specific groundwater data, determination if potential leaching of TDS during percolation has any impacts on groundwater quality, and consultation with the RWQCB on this project and the cumulative impacts of other projects in the region. The likelihood of compliance with the non-degradation objective would also decrease for TDS if the RWC was greater than 20 percent. Under this scenario, it is assumed that supplemental treatment would have to be provided to the water to meet DHS draft GWR criteria for TOC.

Disinfection By-Products

For the disinfection by-products, we do not currently have definitive data on what the concentrations will be in the LWRP. The SWP water showed THM levels ranging from 44 to 64 μg/L and HAAs ranged from 25 to 28 μg/L in the distribution system (AVEK, 2005). Concentrations might be lower if untreated SWP water is used for the blend. As shown in Appendix E, THM levels in wells sampled in the Study area were below detection. Thus, the recharge of a 4:1 blend of recycled water and SWP water will elevate THM and HAA concentrations above ambient levels in groundwater, but below the drinking water MCLs. However, this assessment does not take into consideration the affects of attenuation via SAT and/or dilution in the groundwater. Nor does it take into consideration allocation of any assimilative capacity, since the change in disinfection by-product levels in groundwater will be below the MUN groundwater objectives. Since the impacts on groundwater are not expected to unreasonably affect present or anticipated beneficial uses, and given the ruling pursuant to Water Quality Order 2006-0001 related to indirect potable reuse projects, it is likely that the project would meet the requirements of the State's Anti-degradation Policy and the Basin Plan. This determination will require further evaluation of site-specific data and consultation with the RWQCB regarding this project and the cumulative effects of other projects in the region. The likelihood of compliance with the non-degradation objective would also increase for the disinfection by-products if the RWC was greater than 20 percent. Under this scenario, it is assumed that additional treatment would have to be provided to the water to meet DHS draft GWR criteria for TOC using supplemental treatment that reduces organic carbon.

The issue of degradation using SWP water has been addressed for the WWD No. 40 Lancaster Sub-Basin Full-Scale Aquifer Storage and Recovery Project, and its outcome is instructive for the purposes of this project. Based on the anti-degradation analysis conducted for the project, WWD No. 40 concluded that the levels of TDS and THMs introduced to the groundwater by the proposed project would not violate water quality objectives or unreasonably affect present or anticipated beneficial uses because the anticipated water quality resulting from discharges associated with this project were still suitable for all the beneficial uses.[66] It should be noted that for this injection project, it was determined that there was no THM removal during the application of water. However, for a proposed GWR project, some THM removal would be expected as a result of SAT. As previously noted, the RWQCB elected to issue a Waiver of Water Discharge Requirements for the project because the degradation was consistent with the State's Anti-degradation Policy and Basin Plan.[67] The waiver included conditions for "not to exceed" concentrations for disinfection by-products in SWP water and the groundwater as follows:

1. THMs in excess of a maximum concentration of 72 μg/L or a monthly running average of 40 μg/L;

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[66] WWD No. 40 Aquifer and Storage Project Anti-degradation Analysis, September 2004.

[67] Waiver No. R6V-2004-0043.

2. Total HAAs in excess of 25 µg/L as a monthly running average; or
3. Bromate in excess of a maximum concentration of 10 µg/L;
4. Chlorite in excess of a maximum concentration of 1.0 mg/L; or
5. TOC in excess of an annual (calendar-year) average of 4.0 mg/L.

The waiver also requires that the treated SWP water not contain TDS in excess of 350 mg/L. If these same conditions were applied to a GWR project with a 4:1 blend of SWP water and recycled water, the project would likely meet those requirements.

4.4 Conclusions and Recommendation

The following summarizes the important conclusions/recommendations regarding meeting DHS Water Recycling Criteria and draft GWR regulations based on this preliminary data analysis:

1. The primary constraint relative to meeting DHS requirements is the TOC content of recycled water. A secondary constraint is the total nitrogen content of the blend water.
2. Assuming that TOC concentrations in recycled water can be reduced from an anticipated initial concentration of 8 to 10 mg/L at the LWRP to 2.5 mg/L in the vadose zone through SAT, the project could move forward with a 4:1 blend of untreated SWP water and recycled water without treatment beyond that planned at the LWRP. This blend ratio is equivalent to a 20 percent RWC. The blend requirement would increase to 6:1 if TOC concentrations in recycled water can only be reduced to 3.5 mg/L in the vadose zone from an anticipated initial concentration of 10 mg/L.

   The TOC removal assumption corresponds to a 65% to 75% reduction in TOC based on the anticipated initial concentrations of 8 to 10 mg/L at the LWRP. This assumption appears to be reasonable at the feasibility study level given TOC removal observed for the Phase 1 Chino Basin GWR project, vadose zone depth in Antelope Valley, and measured TOC concentrations in treated SWP water. More accurate estimates of TOC removal will need to be determined during the facility planning or pre-design phase of the GWR-RW project via column testing, field tests at recharge sites, or other means.
3. To increase the RWC beyond 20 percent, the project would need to either demonstrate a higher level of SAT to reduce TOC concentrations in the vadose zone or to include an advanced treatment component (such as activated carbon or reverse osmosis) to reduce TOC concentration in recycled water.
4. Based on Conclusions #1 through #3, two regulatory pathways to meet TOC requirements are recommended for consideration in the development of the GWR-RW project alternatives:
   a. Plan the first phase of the project for a maximum blend ratio of 4:1. Assume that the RWC could be increased in future phases after TOC removal in the vadose zone is demonstrated; or,
   b. Plan the first phase of the project for a maximum blend ratio of 1:1 (50 percent recycled water from LWRP and 50 percent diluent water) with no credit applied for TOC removal through the vadose zone via SAT. This approach would necessitate inclusion of advanced treatment of recycled water to reduce TOC concentrations to 1 mg/L.
5. For developing and evaluating project alternatives, it can be assumed that nitrogen requirements specified in the DHS draft GWR regulations can be met without advanced treatment, under the following assumptions:
   a. Blend ratio of 4:1 will be needed to meet TOC requirements (see Conclusion #2)
   b. Total nitrogen in untreated SWP water is less than 10 mg/L
   c. Total nitrogen removal of 30 to 50 percent can be achieved through the vadose zone

An effort should be made to determine typical total nitrogen concentration in untreated SWP water (the primary diluent water) as soon as possible to confirm the validity of Conclusion #6, since no data was readily available.

In addition, while total nitrogen removal of 30 to 50 percent in the vadose zone through SAT appears to be a reasonable assumption at the feasibility study level (given anticipated nitrate removal observed at IEUA and vadose zone depth in Antelope Valley), more accurate estimates of total nitrogen removal will need to be determined during the facility planning or pre-design phase of the GWR project via column testing, field tests at recharge sites, or other means.

6. For developing and evaluating project alternatives, it can be assumed that all drinking water standards specified in the DHS draft GWR regulations can be met without advanced treatment.

   However, a monitoring program will need to be undertaken to confirm that all drinking water standards specified in the draft regulations can be met. This program can be part of the 1-year monitoring program required in the draft regulations prior to initiating the project. The program will need to be done using recycled water to be produced at the upgraded LWRP (or equivalent; i.e., activated sludge secondary treatment with NDN, filtration, and chlorine disinfection). This 1-year monitoring program was considered in the Study's implementation plan, particularly the project schedule.

The following summarizes the important conclusions/recommendations regarding meeting RWQCB requirements based on the preliminary data analysis:

7. The key regulatory challenge that a GWR project will face to obtain WRRs or WDRs is to address the Basin Plan requirements (including the State's Anti-degradation Policy) for three primary constituents: TDS, nitrate and disinfection by-products, including THMs.[68] The RWQCB may also have concerns about leaching and/or dissolution of naturally occurring arsenic, chromium and selenium via percolation of recharge water.
8. The use of recycled water from the LWRP for GWR is not expected to cause a violation of the MUN groundwater quality objectives based on effluent data alone.
9. While the recycled water is within the range of "increasing problems" relative to the concentration of the given parameters, based Ayres and Westcott (1967), a 4:1 blend of untreated SWP water and recycled water (see Conclusion #2) would help ensure that the AGR objectives are met or that impacts are minimized in the underlying groundwater.
10. Based on a general understanding of groundwater quality in the Antelope Valley and previous permits issued by the Lahontan RWQCB, it is likely that there will be at least three primary constituents of concern in terms of meeting the anti-degradation requirements: TDS, nitrate and disinfection by-products. Assuming a 4:1 blend of SWP and recycled water (see Conclusion #2), the GWR project could increase the concentration of these constituents in groundwater above ambient levels. However, since the changes in groundwater quality would be below numeric objectives and the impacts on groundwater are not expected to unreasonably affect present or anticipated beneficial uses, it is likely that the project would meet the requirements of the State's Anti-degradation Policy and the Basin Plan. This determination will require further evaluation of site-specific data, completion of an ADA and consultation with the RWQCB, particularly in regard to their concern relative to the cumulative impacts of multiple projects in the region.
11. With regard to the issue of the leaching and/or dissolution of naturally occurring metals in local soils, this issue will require further evaluation by looking at studies that have specifically addressed this issue, by possibly conducting soil column research, or looking the behavior of these compounds during a pilot demonstration project. This issue was considered in the implementation plan but is not anticipated to affect the feasibility of the project.

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[68] The RWQCB may also want to evaluate total nitrogen for anti-degradation purposes.

12. The likelihood of compliance with the non-degradation objective for TDS and disinfection by-products would increase if the RWC was greater than 20 percent because it would likely require additional treatment of the recycled water (see Conclusion #3) to meet TOC requirements, which would also reduce TDS and THM levels.
13. Given Conclusion #10, it may be beneficial for all stakeholders to consider pursuing a regional approach for salt and nitrogen management similar to the plan adopted by the Santa Ana RWQCB in 2004 to provide long-range cost effective solutions for the protection of water quality in the Antelope Valley (see Section 4.1.2). However, this may not be necessary for a specific project if there are no significant anti-degradation concerns.

Chapter 5 Baseline Project Development

The baseline project was developed for the Lancaster area consistent with the key assumptions presented in Chapter 1.

This Chapter documents the alternatives associated with the three main components of the GWR-RW project (i.e., treatment process, water supply plan and recharge location) and how the baseline alternative was selected. The Chapter then describes the other components of the GWR-RW project (i.e., recycled water conveyance, imported water conveyance, and groundwater extraction). No alternative was evaluated for these components.

5.1 Alternative Evaluation

Table 5-1 presents the general evaluation criteria that were discussed during Workshop 2. These criteria were used to guide development of specific evaluation criteria for the three main components of the baseline GWR-RW project as presented in the following sections.

Table 5-1: General Evaluation Criteria

Criteria	Description
Costs	• What are the estimated capital costs? • What are the estimated O&M costs? • What are the estimated life cycle costs?
Benefits	• How much new local water supply is created? • How does the project help with wastewater discharge compliance? • What are other benefits (e.g., promotion of groundwater banking initiative, promotion of farming activities)?
Implementation	• How quickly can the project be implemented (i.e., when will the benefits be fully realized?) o Ease with which project can be phased[1] o Ease with which project can be designed, permitted and constructed o Potential to attract outside funding o Ease with which cost sharing mechanism can be defined (tie back to clear benefits for each stakeholder)
Negative Impacts	• What are potential environmental impacts? • What are other potential negative impacts for which mitigation costs are not included in the estimated life cycle costs?

Notes:

1. Phasing has multiple benefits, such as: providing flexibility to meet changes conditions in growth, regulatory requirements, and technological advances; and realizing some of benefits sooner.

5.1.1 Supplemental Treatment

Four treatment alternatives were evaluated following three-step evaluation process:

1. Develop a set of applicable evaluation criteria, including a scoring scale.
2. Develop each alternative.
3. Evaluate each alternative against the set of evaluation criteria and score the alternatives. Rank alternatives, discuss ranking and select the supplemental treatment component of the baseline GWR-RW project.

Evaluation Criteria

Criteria applicable to the treatment alternative analysis were selected from the list of general criteria and refined as shown in **Table 5-2.**

Table 5-2: Supplemental Treatment Analysis Evaluation Criteria

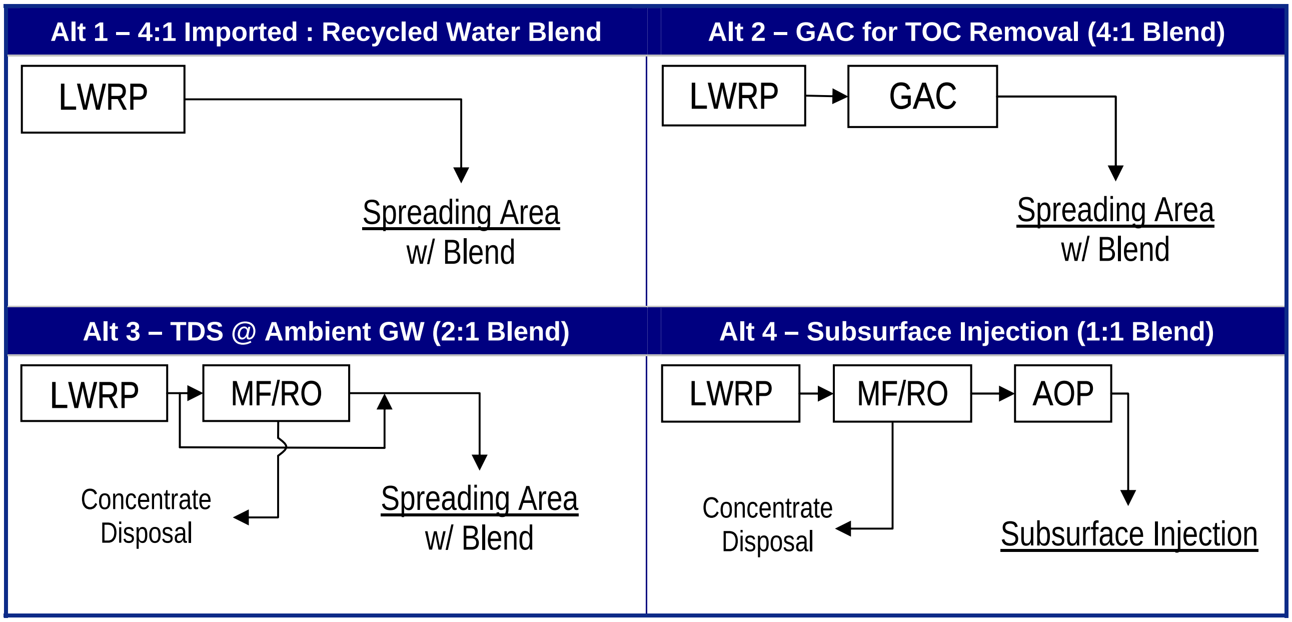
Criteria	Description	Scoring
Cost Criterion		
Estimated Costs	Lifecycle cost per acre-foot of water delivered	5 = < \$100/af 4 = < \$250/af 3 = < \$500/af 2 = < \$750/af 1 > \$750/af
Benefits Criterion		
Project Benefits	Amount of new water supply (recycled water) created. 10,000 afy is available but some processes produce less treated water.	5 = 10,000 afy 4 < 10,000 afy 3 = < 8,000 afy 2 = < 6,000 afy 1 = < 4,000 afy
Project Implementation Criteria		
Regulatory Approval	Likelihood of approval by DHS and RWQCB as well as expected level of effort to achieve approval	5 = Both DHS & RWQCB approval is likely with minimal efforts 4 = Both DHS & RWQCB approval is likely with significant efforts (i.e. TDS/N Management Plan) 3 = Either DHS or RWQCB approval is likely with minimal efforts 2 = Either DHS or RWQCB approval is likely with significant efforts 1 = Both DHS & RWQCB approval is unlikely
Public Acceptance	Anticipated degree of public support for the project	5 = Public acceptance is likely with little outreach 4 = Public acceptance is likely with 'typical' outreach activities 3 = Public acceptance will require significant outreach efforts 2 = Public acceptance is unlikely with 'typical' outreach efforts 1 = Public acceptance is unlikely regardless of outreach efforts
Chemicals of Emerging Concern (CECs)	Ability of treatment process to address CECs, particularly NDMA and 1,4-dioxane	5 = Treatment process removes CECs without SAT 4 = Treatment process removes CECs but is partially dependent on SAT 3 = Treatment process removes CECs but is fully dependent on SAT 2 = Treatment process removes some but not all CECs 1 = Treatment process does not remove CECs
Imported Water Independence	Reliance of alternative on imported water as a blend supply	5 = < 10,000 afy of imported water is required 4 = < 20,000 afy 3 = < 30,000 afy 2 = < 40,000 afy 1 > 40,000 afy

Criteria	Description	Scoring
Negative Impacts		
Concentrate Disposal	Handling of concentrate from treatment processes is a liability	5 = Negligible 4 = < 750 afy 3 = < 1,500 afy 2 = < 2,250 afy 1 > 2,250 afy
Energy Use	Required energy use (measured in million kWh/yr) to treat recycled water	5 = Negligible 4 = < 1.0 M kWh/yr 3 = < 2.0 M kWh/yr 2 = < 3.0 M kWh/yr 1 > 3.0 M kWh/yr

Alternative Development

Four treatment alternatives were defined based on the regulatory analysis presented in Chapter 4. They are illustrated in **Figure 5-1**. The alternatives were developed using the planning level design criteria and assumptions in **Table 5-3**.

Figure 5-1: Supplemental Treatment Alternatives Overview



AOP	Advanced oxidation process
GAC	Granular activated carbon
MF	Microfiltration
RO	Reverse Osmosis

Table 5-3: Supplemental Treatment Design Criteria and Assumptions

Planning Level Design Criteria	Value	Assumptions
For All Four Alternatives		
Average Annual Flow	10,000 AFY (8.9 mgd)	• Annual volume identified in Section 3.3.1
Maximum Daily Flow	20.7 mgd	• Equal to average monthly flow from LWRP in December (peak month) • No daily or hourly peaking factor is included based on the assumption that upstream treatment processes would equalize flows
Facility Location		• Construction on County property in close vicinity of LWRP
For Alternative 3 and 4		
Concentrate Flow	25% of MF/RO Flow	• Concentrate produced from MF/RO treatment only • Disposal of concentrate in evaporation ponds[1] • Concentrate pipeline sized for 25% of MF/RO flow
Total Dynamic Head for MF/RO	400 feet	• Feed water minimum pressure required for recycled water with TDS concentration up to 1,000 mg/L

Notes:

1. Evaporation ponds are assumed for concentrate disposal based on a cursory assessment due to relatively inexpensive land and relatively high evapotranspiration rates in the Study area. Alternatives that would need to be considered further at the facility plan level include liquid disposal (ocean outfall or deep well injection), crystallization (evaporation ponds, misters, forced circulation crystallizer), concentrators (membrane process, vibratory shear enhanced processing membrane system (VSEP), electrodialysis reversal, mechanical evaporation) prior to selected disposal mechanism, and zero liquid discharge.

Alternative 1 – Blending Only (4:1 blend)

Alternative 1 is based on the recommendations of the regulatory analysis, which is to use a 4:1 blend ratio (80 percent diluent water and 20 percent recycled water from LWRP; RWC = 20 percent) and SAT to meet DHS TOC requirements. The RWC could be increased in future phases if enhanced TOC removal in the vadose zone (greater than 75%) is demonstrated from monitoring.

Under this alternative, TDS and nitrogen levels in blend water would not be reduced below ambient levels. But a regional approach to salt and nitrogen management similar to the plan adopted by Santa Ana RWQCB in 2004 (see Chapter 4) could improve implementation of the alternative and may be required by the RWQCB for full-scale GWR projects with or without recycled water.

Figure 5-2 presents the process schematic for Alternative 1 and **Table 5-4** includes flow and water quality estimates.

Figure 5-2: Alternative 1 Process Schematic

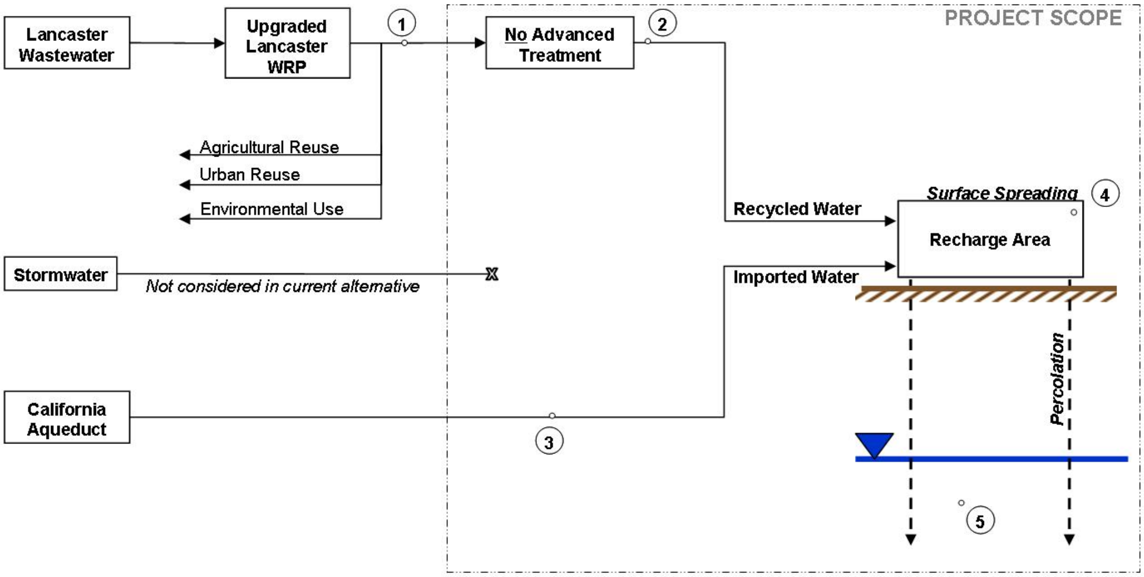


Table 5-4: Alternative 1 Water Quantity and Quality Estimates

Point on Schematic	①	②	③	④	⑤
Elements	LWRP Recycled Water	Recycled Water for Recharge	AVEK Imported Raw Water	Blended Water 4:1 Ratio	Recharge Water after Percolation
Water Quantity					
Average Flow (afy)	10,000	10,000	40,000	50,000	–
Peak Flow (mgd)	20.7	20.7	139	160	–
Average Water Quality [% Removal] [1]					
TOC (mg/L)	10	10	4	Not Applicable[2]	0.5
TDS (mg/L)	570	570	230	300	300 [0%]
Nitrate (as N) (mg/L)	9	9	1	2.6	1.8 [30%]
THMs (µg/L)	Not Available [3]				

Notes:

1. Source for % Removal estimate: Ng et al, 2005.
2. TOC regulatory requirements are for concentrations in recycled water prior to blending.
3. There is limited THM data that is representative of the future LWRP and no data for raw SWP water. For further discussion, see Section 4.3.

Alternative 2 – GAC for TOC Removal (4:1 blend)

Alternative 2 is intended to supplement TOC removal by SAT with granular activated carbon (GAC) treatment based on the assumption that DHS and/or the RWQCB would not agree with the SAT removal levels presumed in Chapter 4 for TOC (e.g., 65 to 75). Alternative 2 is estimated to remove 50 percent of TOC, which will reduce recycled water TOC concentrations to less than 5 mg/L prior to SAT. Even with a 4:1 blend ratio (80 percent diluent water and 20 percent recycled water from LWRP), some TOC removal by SAT would still required meet regulatory requirements.

Similarly to Alternative 1, TDS and nitrogen levels in blend water would not be reduced below ambient levels. But a regional approach to salt and nitrogen management similar to the plan adopted by Santa Ana RWQCB in 2004 (see Section 4.1.2) could improve implementation of the alternative and may be required by the RWQCB for full-scale GWR projects with or without recycled water.

Figure 5-3 presents the process schematic for Alternative 2 and **Table 5-5** includes flow and water quality estimates.

Figure 5-3: Alternative 2 Process Schematic

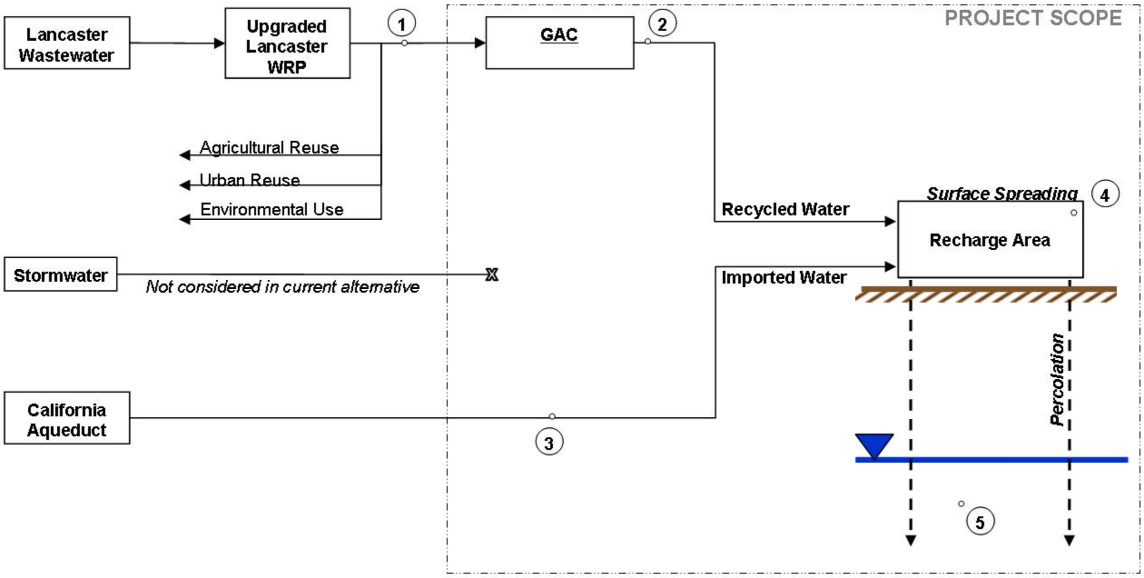


Table 5-5: Alternative 2 Water Quantity and Quality Estimates

Point on Schematic	①	②	③	④	⑤
Elements	LWRP Recycled Water	Recycled Water for Recharge	AVEK Imported Raw Water	Blended Water 4:1 Ratio	Recharge Water after Percolation
Water Quantity					
Average Flow (afy)	10,000	10,000	40,000	50,000	–
Peak Flow (mgd)	20.7	20.7	139	160	–
Average Water Quality [% Removal] [1]					
TOC (mg/L)	10	5 [50%]	4	Not Applicable[2]	0.5
TDS (mg/L)	570	570 [0%]	230	300	300
Nitrate (N) (mg/L)	9	9 [0%]	1	2.6	1.8 [30%]
THMs (µg/L)	Not Available [3]				

Notes:

1. Sources for % Removal estimate: EPA, 2004; Angelotti et al, 2005; Ng et al, 2005.
2. TOC regulatory requirements are for concentrations in recycled water prior to blending.
3. There is very limited THM data that is representative of the future LWRP and no data for raw SWP water. For further discussion, see Section 4.3.

Alternative 3 – MF/RO for TDS Reduction to Ambient GW Levels (2:1 blend)

Alternative 3 is designed to provide microfiltration / reverse osmosis (MF/RO) treatment as needed to reduce the TDS in the blend water below ambient or allowable levels in groundwater. A TDS target of 290 mg/L was assumed for the purpose of this Study based on the average groundwater concentration in the Study area (Section 3.2.5). To achieve this target, Alternative 3 would process 40% of the 10,000 afy of tertiary effluent from the LWRP, and assumes that this level of treatment achieves 99% removal of TDS in the water treated. The recycled water would be blended with diluent water to achieve a 2:1 blend ratio (66 percent diluent water and 33 percent recycled water). In addition, MF/RO would reduce the TOC in recycled water to approximately 6.5 mg/L, assuming 95 percent removal. As in the previous alternatives, some SAT is necessary to meet regulatory requirements. Also, nitrogen concentrations are reduced by MF/RO, but not below ambient groundwater levels so, as in previous alternatives, a regional approach to salt and nitrogen management may be needed.

Figure 5-4 presents the process schematic for Alternative 3 and **Table 5-6** includes flow and water quality estimates.

Figure 5-4: Alternative 3 Process Schematic

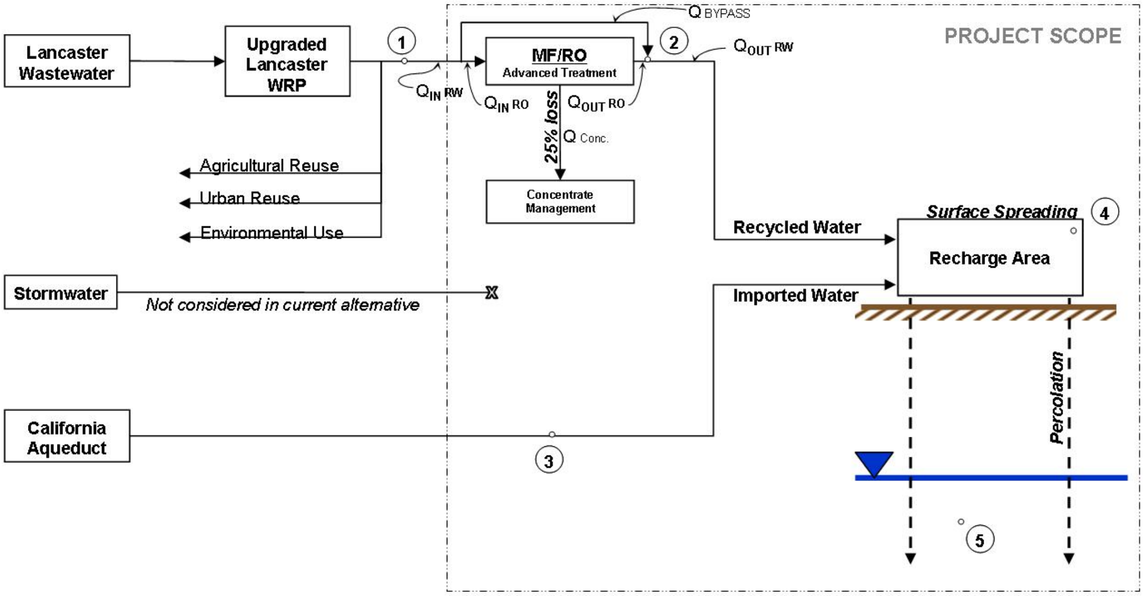


Table 5-6: Alternative 3 Water Quantity and Quality Estimates

Point on Schematic	①	②	③	④	⑤
Elements	**LWRP Recycled Water**	**Recycled Water for Recharge**	**AVEK Imported Raw Water**	**Blended Water 2:1 Ratio**	**Recharge Water after Percolation**
Water Quantity					
$Q_{RW,\ IN}$ Average (afy)	10,000	10,000	18,000	27,000	–
$Q_{RW,\ IN}$ Peak (mgd)	20.7	20.7	70	91	–
Q_{BYPASS} Average (afy)	–	6,000	–	–	–
Q_{BYPASS} Peak (mgd)	–	12.6	–	–	–
$Q_{RO,\ IN}$ Average (afy)	–	4,000	–	–	–
$Q_{RO,\ IN}$ Peak (mgd) [1]	–	3.6 [1]	–	–	–
Q_{CONC} Average (afy)	–	1,000	–	–	–
Q_{CONC} Peak (mgd)	–	6.3	–	–	–
$Q_{RW,\ OUT}$ Average (afy)	–	9,000	–	–	–
$Q_{RW,\ OUT}$ Peak (mgd)	–	18.9	–	–	–
Average Water Quality [% removal] [2,3]					
TOC (mg/L)	10	6.5 [95%] [2]	4	Not Applicable [4]	0.5
TDS (mg/L)	570	340 [99%] [2]	230	270	300 [0%]
Nitrate (N) (mg/L)	9	5.8 [90%] [2]	1	2.6	1.8 [30%]
THMs (µg/L)	Not Available [5]				

Notes:

1. To reduce treatment system costs, peak flow value assumes 4,000 afy is treated evenly over 12 months instead of 40% of flow through the year, which would result in a higher peak flow.
2. Percent removal is for portion of total recycled water flow (40%) that passes through MF/RO treatment.
3. Sources for % Removal estimate: EPA, 2004; Vernon et al, 2004; Ng et al, 2005.
4. TOC regulatory requirements are for concentrations in recycled water prior to blending.
5. There is very limited THM data that is representative of the future LWRP and no data for raw SWP water. For further discussion, see Section 4.3.

Alternative 4 – Advanced Treatment for Subsurface Injection (1:1 blend)

Alternative 4 applies MF/RO and advanced oxidation (AOP) treatment to all 10,000 afy of recycled water flows from LWRP for direct injection. The maximum blend ratio of 1:1 (50 percent recycled water from LWRP and 50 percent diluent water) is assumed; however, the RWC could be increased in future phases after recharge water and groundwater quality is documented. Also, AOP would be required by the draft DHS GWR regulations to increase the RWC over 50 percent.

Figure 5-5 presents the process schematic for Alternative 4 and **Table 5-7** includes flow and water quality estimates.

Figure 5-5: Alternative 4 Process Schematic

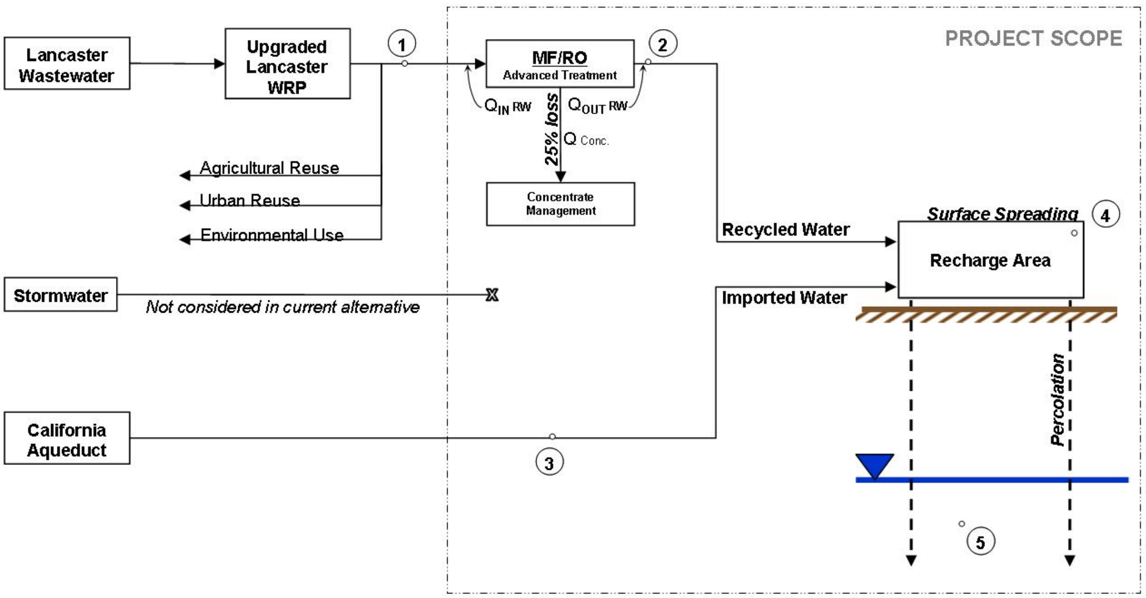


Table 5-7: Alternative 4 Water Quantity and Quality Estimates

Point on Schematic	①	②	③	④	⑤
Elements	**LWRP Recycled Water**	**Recycled Water for Recharge**	**AVEK Imported Raw Water**	**Blended Water 1:1 Ratio**	**Recharge Water after Injection**
Water Quantity					
$Q_{RW,\ IN}$ Average (afy)	10,000	10,000	7,500	15,000	–
$Q_{RW,\ IN}$ Peak (mgd)	20.7	20.7	35	46	–
Q_{CONC} RO Average (afy)	–	2,500	–	–	–
Q_{CONC} RO Peak (mgd)	–	5.3	–	–	–
Q_{OUT} Average (afy)	–	7,500	–	–	–
Q_{OUT} Peak (mgd)	–	15.8	–	–	–
Average Water Quality [% removal] [1]					
TOC (mg/L)	10	0.5 [95%]	4	Not Applicable[2]	0.5
TDS (mg/L)	570	10 [99%]	230	120	120 [0%]
Nitrate (N) (mg/L)	9	0.9 [90%]	1	1.0	1.0 [0%]
THMs (µg/L)	Not Available [3]				

Notes:

1. Source for % Removal estimate: EPA, 2004; Vernon et al, 2004.
2. TOC regulatory requirements are for concentrations in recycled water prior to blending.
3. There is very limited THM data that is representative of the future LWRP and no data for raw SWP water. For further discussion, see Section 4.3.

Evaluation Results

Table 5-8 summarizes the recycled water supplemental treatment alternative evaluation results. **Table 5-9** provides a numerical evaluation of the alternatives based on the discussion in Table 5-8 and scoring scale in Table 5-2. It also shows the alternative ranking.

Table 5-8: Supplemental Treatment Alternatives Evaluation Results

Criteria [1]	Alternative 1 – Blend Only	Alternative 2 – GAC	Alternative 3 – 40% MF/RO	Alternative 4 – 100% MF/RO
Costs [2]				
Capital	-	$13,00,000	$28,00,000	$140,000,000 [3]
O&M	$200,000/yr	$1,300,000/yr	$1,200,000/yr	$5,600,000/yr [3]
Lifecycle	$200,000/yr	$2,200,000/yr	$3,200,000/yr	$16,00,000/yr [3]
$/AF of New Water Supply	$20/af	$200/af	$400/af	$2,100/af [3]
Benefits				
New Water Supply	Approximately 10,000 afy	Approximately 10,000 afy	Approximately 9,000 afy	Approximately 7,500 afy
Implementation				
DHS Approval	DHS TOC and N requirements are met by blending and SAT, assuming DHS accepts the level of treatment established for SAT.	DHS TOC and N requirements are met by treatment, blending and SAT, assuming DHS accepts the level of treatment established for SAT.	DHS TOC and N requirements are met by treatment & blending; some SAT removal must be approved by DHS.	DHS TOC and N requirements are met by treatment.
RWQCB Approval	Each alternative would reduce TDS and N below MCLs; however, RWQCB approval would be dependent on acceptance of TDS and N anti-degradation analysis because N reduction below ambient groundwater concentrations would be dependent on SAT; also approval would be dependent upon ambient background concentrations and the application of the Anti-degradation Policy. For Alternative 3, TDS would not be an issue because the blend water TDS concentration would be below ambient groundwater levels.			This alternative would reduce TDS and N in recycled water at or below ambient groundwater levels.

Criteria[1]	Alternative 1 – Blend Only	Alternative 2 – GAC	Alternative 3 – 40% MF/RO	Alternative 4 – 100% MF/RO
Public Acceptance	Public acceptance would be based on the fact that all public health and anti-degradation concerns are addressed by the project.	Public acceptance would be more likely for Alternative 2 than Alternative 1 due to the additional TOC treatment and, thus, perceived reduced public health risk.	Public acceptance would be more likely than Alternative 1 due to a higher level of treatment but less than Alternative 2 because only 40% of the flow addresses TOC removal. MF/RO removal of TOC allows for a lower blend	Public acceptance would be highest due to advanced treatment process used at other GWR projects and high quality of effluent. Although, direct injection could raise concerns relative to surface spreading due to no SAT.
CECs[4]	Most CECs should be addressed by SAT.	Removal of CECs with a combination of GAC and SAT provides an additional barrier in the 'multi-barrier' approach to treatment. This alternative would be preferred over Alternative 1 and 3 because 100% of the flow is treated by both GAC and SAT.	40% of the flow is subjected to MF/RO but Alternative 3 does provide an additional barrier similar to Alternative 2. CECs would be addressed with SAT.	Treatment reliability has been demonstrated with other injection projects (see Table 2-1) but does remove the SAT barrier.
Imported Water Independence	40,000 afy, on average		18,000 afy, on average	7,500 afy, on average
Negative Impacts				
Concentrate Disposal	Not applicable		1,000 afy of concentrate; 60 ac of evaporation ponds	2,500 afy of concentrate; 550 ac of evaporation ponds
Energy Use	Negligible	Approximately 0.2 M kWh/yr	Approximately 2.3 M kWh/yr	Approximately 5.6 M kWh/yr

Notes:

1. Some criteria from Table 5-1 were not included in this table because each alternative had similar description for that criterion.
2. Detailed cost estimates are in Appendix J. Costs are based on ENR Los Angeles Construction Cost Index from August 2006 (= 8570). Capital costs are annualized over 30 years @ 6 percent (A/P Factor = 0.073).
3. Cost estimate assumes lifecycle costs of injection / extraction wells are equivalent to the lifecycle costs for recharge basins. In general, the capital costs for injection / extraction wells would likely be smaller due to the smaller footprint and, thus, lower land purchase costs. On the other hand, O&M costs would likely be higher to due higher pressure requirements at the point of injection, which would require larger pump stations and more pumping.
4. Sources: Snyder, 2005 and EPA, 2004.

Table 5-9: Supplemental Treatment Alternatives Ranking

Criteria	Alt 1	Alt 2	Alt 3	Alt 4
Costs	***5***	***4***	***3***	***1***
Cost per AF	5	4	3	1
Benefits	***5***	***5***	***3***	***2***
New Water Supply	5	5	3	2
Implementation	***2.3***	***3***	***3.5***	***4.5***
Regulatory Approval	3	4	4	4
Public Support[1]	2	3	3	4
Emerging Contaminants	3	4	4	5
Imported Water Independence	1	1	3	5
Negative Impacts	***5***	***4.5***	***2.5***	***1***
Concentrate Disposal	5	5	3	1
Energy Use	5	4	2	1
Total (out of 20) [2]	**17.3**	**16.5**	**12.0**	**8.5**
Ranking	**1**	**2**	**3**	**4**

Notes: Based on scoring scale defined in Table 5-2 and discussion provided in Table 5-8.

1. Scoring is not based on direct public input but rather is based on anticipated public support from experience.
2. Total is sum of scores for each primary criteria category, which are calculated by averaging the scores for items within each category.

Baseline Alternative

Alternative 1 was selected for the baseline project based on its ranking. Alternative 1 presents the lowest cost, highest benefits and least negative impacts of all alternatives; and this ranking is not likely to change. But Alternative 1 could become less desirable than the other alternatives depending on three implementation elements: regulatory approval, public support, and imported water dependence:

1. Regulatory approval is dependent on DHS' and RWQCB's acceptance of SAT and ADA assumptions. This acceptance is expected; however, during Workshop 1 the RWQCB stated a preference to judge individual projects in the context of all other water resources projects in the Valley and, therefore, may request a salt and nitrogen management plan to implement *any* project with groundwater degradation potential.

   It is therefore recommended that the agencies work with RWQCB to evaluate the concept of a salt and nitrogen management plan for the Valley.

2. The public would more likely accept a GWR-RW project that includes additional treatment as a precautionary step, regardless of cost implications.

   It is therefore recommended that public outreach be done to communicate on the safety of Alternative 1 and the decision making process leading to Alternative 1 selection. This effort should allow building support for Alternative 1. However, the agencies should also be open to reconsidering the preferred treatment alternative (which would increase the project cost).

3. The feasibility of Alternative 1 depends on imported water supply plans, including the implementation of GWR projects in the Valley. Should GWR project plans be scaled down,

Alternative 1 could still be preferred if (1) the RWC can be increased based on demonstration of enhanced TOC removal through SAT (greater than 75%) thereby maintaining the project size, or (2) the project size is reduced. Given the current GWR project context, this condition is considered unlikely.

5.1.2 Water Supply Plans

A water supply plan defining the source of diluent water is a necessary component of the baseline project. As discussed in Chapter 3, the primary diluent supply in the Lancaster area is imported water from the SWP; the secondary diluent supply is stormwater.

Imported Water

The 4:1 blend ratio (40,000 afy of diluent water for 10,000 afy of recycled water) recommended as the supplemental treatment alternative must be achieved, on average, over five years per the DHS draft GWR regulations.

Because the operating details of GWR projects in the Valley have yet to be developed, there is no basis for defining a logical plan on how to provide an average of 40,000 afy of imported water over a five-year period for blending.

A plan that could apply to future GWR projects had therefore to be selected. The plan selected herein was developed in coordination with AVEK. It should be refined by the GWRJPA as the operating details of GWR projects are developed.

Four plan alternatives were developed considering two elements:

- **Contractual sources of SWP imported water supply -** Contractual sources of SWP water include use of current AVEK[69] Table A entitlement, purchase of Table A entitlement from another SWP contractor, and purchase of water on the 'open market.' Of these options, new entitlement purchase is likely the most expensive with an estimated water rights cost of $3,000/af to $5,000/af (Water Strategist, Feb 2006; AVEK, personal communication, 2006). This cost is equivalent to $200/af to $350/af once the purchase price is annualized. It represents the cost to own the right to the water and does not include the cost to deliver this water via the SWP system, which is approximately $180/af (AVEK, personal communication, 2006).

  The least expensive option is most likely 'open market' purchase of SWP water in wet hydrologic years. The cost of wet year water varies but is estimated at $80/af plus SWP transport costs (AVEK, personal communication, 2006). However, this option is less reliable because delivery is dependent on the presence of a wet year, whereas a Table A entitlement will get at least 4 percent of contracted supply in a dry year. In comparison, use of the current AVEK entitlement provides the most reasonable price since most system investments occurred many years ago but could conflict with alternative uses of SWP water.
- **Conveyance facilities for SWP imported water supply -** The primary conveyance facilities necessary to transport imported water from the California Aqueduct to the recharge basins would be a pump station and pipeline. The cost of these facilities is a function of the peak flow that must be delivered since higher peak flows require larger pipe diameters and pump station capacity, which are more expensive. As a result, various supply scenarios require a tradeoff between the cost of the water and the cost of the conveyance facilities. For example, wet year purchases are cheaper than the other alternatives but require larger conveyance facilities because more water must be delivered to the recharge basin in wet years and less would be delivered in dry years to meet average delivery requirements.

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[69] AVEK is used for the imported water plan component of the baseline GWR-RW project because they are the primary SWP contractor in the West Lancaster area; however, the GWR project would be lead by the GWRJPA, which includes the other Antelope Valley SWP contractors: PWD and LCID.

The four alternatives are presented in **Table 5-10** and are analyzed below.

Table 5-10: Imported Water Supply Plan Alternatives Overview

Schedule		Maximum Annual Delivery	Annual Source(s) of Imported Water [1]		
			AVEK Entitlement	Wet Year, Open Market	New Entitlement
1	AVEK Entitlement Only	64,000 af	40,000 af	-	-
2	AVEK & Wet Year	80,000 af	20,000 af	20,000 af	
3	Wet Year Only	80,000 af	-	40,000 af	-
4	New Entitlement	52,000 af	-	-	40,000 af

Note:

1. The values are for average volume over various hydrologic years so that the 5-year running average is 40,000 afy.

- Alternative 1 assumes AVEK directly delivers to customers up to 77,200 af. The remaining water would be used for GWR. The largest delivery requirement is 64,000 af. This number should be the basis for sizing conveyance facilities. The price of water from AVEK is established at $200/af, based on the 2006 rate for SWP water for GWR.
- Alternative 2 is similar to Alternative 1 but assumes AVEK directly delivers up to the average delivery volume (108,900 af) and wet year purchases occur to average 40,000 afy over 5 years. As a result of wet year purchases, the largest delivery requirement increased by over 20 percent to 80,000 af. Alternative 2 would require more expensive conveyance facilities than Alternative 1, but water would be less expensive.
- Alternative 3 assumes no deliveries from AVEK's entitlement; instead, all water will be purchased on the open market in wet years. Water would be cheaper than Alternative 2 while the cost of conveyance facilities would be similar. Alternative 3 may be less expensive than Alternatives 1 and 2 but is much more dependent on the occurrence of wet years and, therefore, is not recommended.
- Alternative 4 assumes that a new Table A entitlement averaging at least 40,000 afy is purchased from another SWP contractor. Water would be more expensive than all other alternatives but conveyance facilities would be cheaper because the largest annual flow would be 52,000 af. In addition, Alternative 4 would provide the most dependable water since blend water would be available every year.

Alternative 1 was selected as the imported water supply plan component of the baseline GWR-RW project because it provides the most reliable cost and delivery projections at this stage in the Study.

Further investigation into the cost of acquiring new entitlements and wet year supplies should be undertaken as part of GWR projects planning to refine the water supply plan selection.

Stormwater

The baseline project does not include a stormwater component due to lack of readily available planning documentation. The baseline project definition should be refined in the future in coordination with local (cities) and regional (counties) stormwater planning efforts to potentially incorporate a stormwater supply component.

Lancaster's stormwater planning efforts are incorporating recharge of stormwater in stormwater basins. Of particular interest, Lancaster is planning to drill borings in and around a 160-acre stormwater basin at Avenue F and 60th St West (just west of Fox Airfield) (see Figure 3-9).

5.1.3 Recharge Options

The recharge options considered herein assume surface spreading, consistent with the baseline supplemental treatment alternative. Injection wells would need to be considered should surface spreading be deemed impractical or infeasible for such reasons as low recharge rates, insufficient spreading surface or institutional opposition to surface spreading.

The following three-step process was used to create and evaluate alternatives:

1. Develop set of applicable evaluation criteria
2. Develop each alternative
3. Evaluate each alternative against the set of evaluation criteria, discuss evaluation and select recharge option component of the baseline GWR-RW project

Evaluation Criteria

Table 5-11 presents the siting criteria that were used to evaluate basin suitability for GWR-RW. They are listed in order of importance. The following sections discuss each criterion.

Table 5-11: Recharge Site Analysis Evaluation Criteria

Criteria [1]	Description
Costs	
Proximity to: • LWRP • California Aqueduct • South/North Intertie	Proximity to sources of blend water determine the cost of piping required to supply blend water to the recharge basins
Implementation	
Hydrogeology Characteristics	Primary hydrogeologic criteria include: • Primary aquifer characteristics • Presence of near surface impermeable layers • Groundwater flow direction • Groundwater depth • Groundwater quality • Groundwater barriers
Current and Planned Land Use	The current and planned land use of the recharge site as well as adjacent areas will influence the viability of the site. For example, current and planned agricultural use is beneficial because recharge operations can occur in conjunction with agricultural operations. In contrast, current or planned housing developments would likely reject siting of a recharge area adjacent to their property.

Note:

1. For description of each criterion, see the following sections.

Proximity to Water Supply and Extraction Facilities

The proximity of the basin to recycled water, imported water, and extraction facilities was considered to minimize costs associated with the delivery of blend water to the recharge basins and extraction of recharge water. Proximity was evaluated based on distance between the recharge area and the selected reference facilities and corresponding pipeline capital cost (O&M costs, such as pumping, were not considered to simplify the evaluation):

- For recycled water, the reference facility was the LWRP. The current recycled water pipelines from LWRP to Apollo Lakes and Nebeker Ranch were not considered because their capacity was limited and use of pipelines would provide a relatively low cost reduction to consider in this Study.
- For imported water, the reference facility was the California Aqueduct at W 110th St. The site was selected based on input from AVEK that the site could be a potential new SWP extraction site (AVEK, personal communication, 2006). The current AVEK conveyance facilities (West Feeder pipeline and pump station) were not considered due to limited capacity (see Section 3.4.2).
- For recharge water extraction, the proposed South/North Intertie pipeline was used as the reference facility.

Local Hydrogeology

An evaluation of the hydrogeologic data was conducted. Data was provided by local agencies and the USGS include well completion reports, groundwater levels, groundwater quality, and local groundwater knowledge. In addition, reports summarizing general geologic and hydrogeologic conditions within the Valley were reviewed. This data was used to assess regional and local hydrogeologic conditions for areas being considered for surface spreading. The primary hydrogeologic evaluation criteria include:

1. **Primary Aquifer Characteristics** (hydraulic conductivity and specific yield) – These values were obtained from the USGS groundwater model (USGS, 2003). In general, the materials represented by these values range from silts and clayey sands to coarse gravels.
2. **Presence of Near Surface Impermeable Layers** – Areas within and around Rosamond Lake, Buckhorn Lake and Rogers Lake were not considered, as these areas are underlain by a substantial clay layer that would prohibit adequate infiltration of recharged water to the aquifer. In addition, areas with exposed bedrock were avoided.
3. **Groundwater Depth** – Groundwater depth was considered to assure the vadose zone was sufficiently thick to receive recharged water.
4. **Groundwater Quality –** Groundwater quality was considered to ensure that recharged water would not be spread in areas where water quality had been degraded to below drinking water standards.
5. **Groundwater Barriers** – Groundwater barriers were considered to ensure that recharged water would not be hindered in travel towards recovery (pumping) areas.

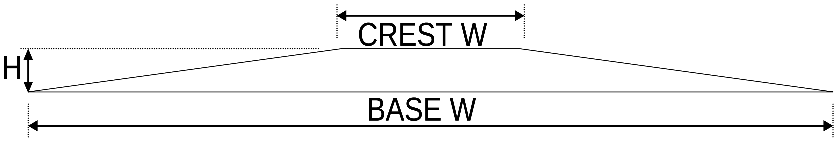
Current and Planned Land Use

Setting includes land use consistency, permitting requirements and land ownership. These criteria will be considered as the final basis for recharge basin site selection as they are institutional in nature and could be modified through local agency petitioning. They will, however, be initially considered when deciding between multiple basins that meet the above siting criteria.

Alternative Development

The alternatives were developed based on the planning level design criteria and assumptions in **Table 5-12**.

Table 5-12: Recharge Basins Planning Level Design Criteria and Assumptions

Planning Level Design Criteria	Value	Assumptions
Average recharge rate	0.5 feet/day	• Based upon previous studies (KCPD, 2006); to be confirmed by field tests as project planning progresses
Average berm height (H)	4 feet	
Average berm crest width (CREST W)	12 feet	
Average berm base width (BASE W)	24 feet	
Freeboard	2 feet	• Based on professional experience
Footprint		• Land required for recharge basins includes berms
Material		• All berm material to come from excavated material

The following paragraphs describe selection of the baseline project recharge site(s) in three steps:

1. Review "known" recharge areas
2. Identify "typical" sites within selected area
3. Analytical modeling of "typical" sites

"Known" Recharge Areas

To help narrow the search for potential recharge basins, "known" recharge areas were identified. These are locations within the Study area that have been anecdotally identified for possessing positive GWR potential by AVEK, PWD and local drillers based upon criteria such as available land, proximity to existing water banking efforts (such as WDS), the GWRJPA recommendations, and previous reports. **Figure 5-6** shows the "known" recharge areas, which include:

- **West Lancaster -** This recharge area is within the Lancaster sub-unit. The recharge area was identified by AVEK as a potential GWR and water banking area (AVEK, written communication, 2006). AVEK is considering using this area for banking of SWP water (AVEK, personal communication, 2006). WDS is currently conducting GWR testing in the northwest portion of this area for private water banking purposes (KCPD, 2006).
- **Upper and Lower Little Rock Creek -** The Upper Little Rock Creek recharge area is wholly within the Pearland sub-unit. This area has been considered by PWD for GWR within former aggregate mining pits (PWD, personal communication, 2006). It has also been identified by GWRJPA as a potential recharge area (Stetson, 2002). The Lower Little Rock Creek recharge area is on the eastern portion of the Lancaster sub-unit with its southern boundary within the Buttes sub-unit. This is an area identified by AVEK for GWR efforts on the east side of the Antelope Valley (AVEK, written communication, 2006).
- **Upper and Lower Amargosa Creek -** The Upper Amargosa Creek recharge area is wholly outside of the Antelope Valley groundwater basin, and south of the Lancaster sub-unit. The Lower Amargosa Creek recharge area is wholly within the Lancaster sub-unit. Both of these areas have been considered by GWRJPA as potential GWR sites (Stetson, 2002).

The West Lancaster area was selected for further consideration due to its relative proximity to LWRP compared with the proximity of the Little Rock Creek and Amargosa Creek areas to PWRP. In addition, the West Lancaster area overlaps considerably the potential GWR areas identified by AVEK / GWRJPA.

"Typical" Recharge Sites in West Lancaster

The West Lancaster area covers roughly 60,000 acres. 1,100 acres are estimated to be needed for the baseline GWR-RW project. Three alternative recharge sites were identified in three distinct locations within the West Lancaster area and are illustrated on **Figure 5-7**. The sites are referred to as:

- West Lancaster 1 (WL-1)
- West Lancaster 2 (WL-2)
- West Lancaster 3 (WL-3)

Evaluation Results

The three alternative recharge sites were evaluated based on the criteria identified in Table 5-11.

Table 5-13 presents an estimate of the pipeline costs associated with each alternative recharge site.

Table 5-13: Proximity to Water Supply and Extraction Facilities

Facility (Equivalent Pipe Diameter for Cost) [1]	WL-1		WL-2		WL-3	
	Distance (miles)	Capital Cost	Distance (miles)	Capital Cost	Distance (miles)	Capital Cost
LWRP (21")	14	$15.5m	8	$8.9m	13	$14.4m
CA Aqueduct (51")	11	$29.6m	9	$24.2m	6	$16.2m
South/North Backbone (39")	3	$6.2m	1	$2.1m	4	$8.2m
Total Est. Capital Cost	**$51.3 million**		**$35.2 million**		**$38.8 million**	

Note:

1. Equivalent pipe diameters were developed by estimating the average pipe diameter for each of the baseline project facilities because each set of facilities (i.e. recycled water, imported water, and extraction) have a different range of pipeline diameters based on location in the system.

Table 5-14 summarizes the hydrogeological characteristics of each alternative recharge site.

Table 5-14: Alternative Recharge Sites Hydrogeological Characteristics

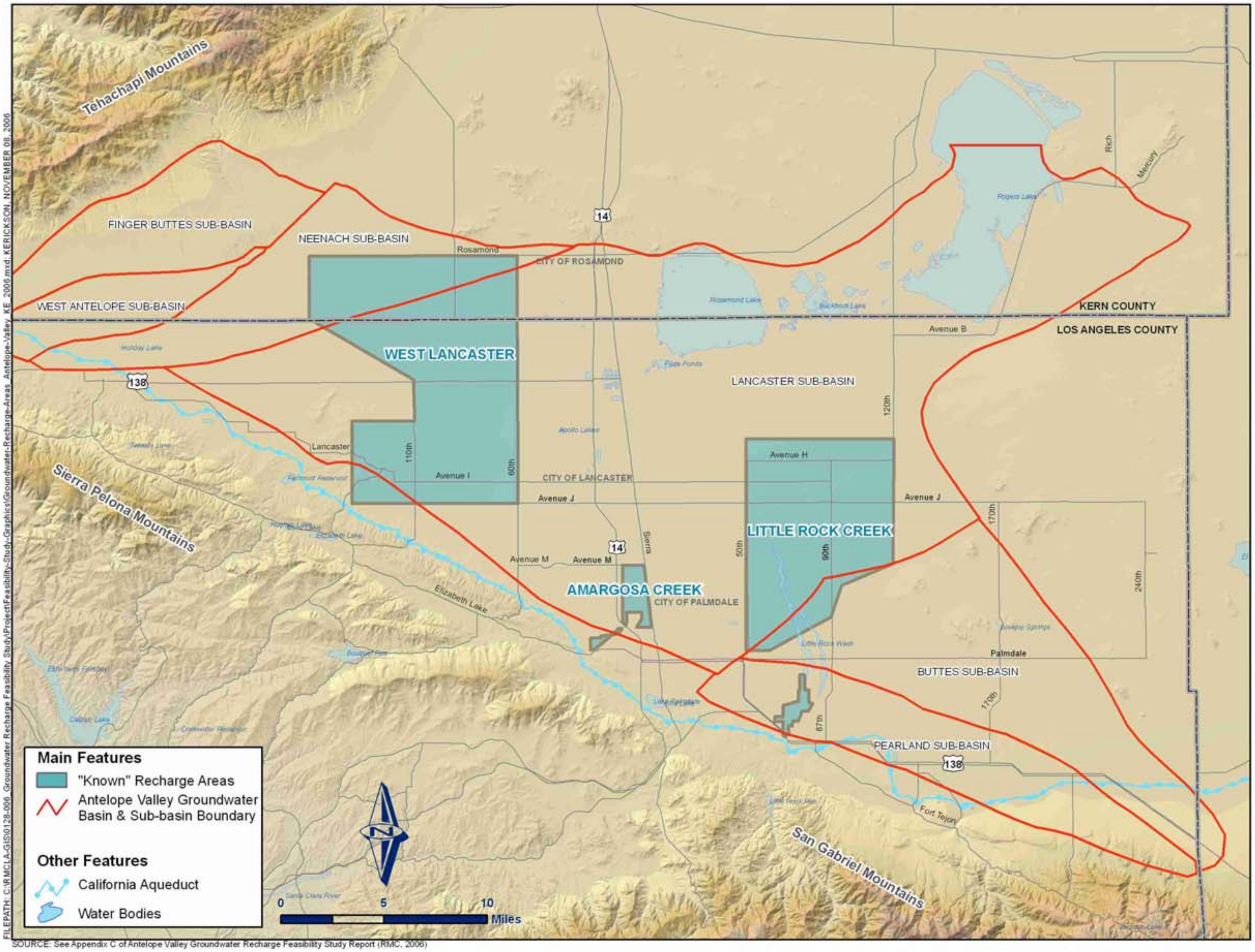
Basin	Sy [1] (%)	K_h (ft/day)	K_v (ft/day)	Depth to GW [2] (ft-bgs)	Transmissivity (ft^2/day)	TDS [4] (mg/L)	Nitrate [5] (mg/L)
WL-1	12-14	10-30	1-3	250	4,200-6,000	250-350	< 10
WL-2	14	24	2.4	150	6,720	300-400	< 10
WL-3	14	2-10	0.2-1	160-260	5,250- 8,250	300-400	< 10

Notes:

1. USGS has modeled this area.
2. Calculated using spring 2006 groundwater elevations.
3. Limited data exists on the groundwater quality beneath this recharge area. The USGS database was queried for TDS and nitrate in wells within the Study area to supplement data provide by PWD and WWD No. 40.
4. Very little data exists for those areas outside of the Lancaster and Palmdale areas, but literature (Duell, 1987) nitrate concentrations below the MCL (10 mg/L).

The hydrogeological characteristics reveal some variation between each recharge site but no significant differences are evident. The analysis is limited due to limited site-specific hydrogeological data available.

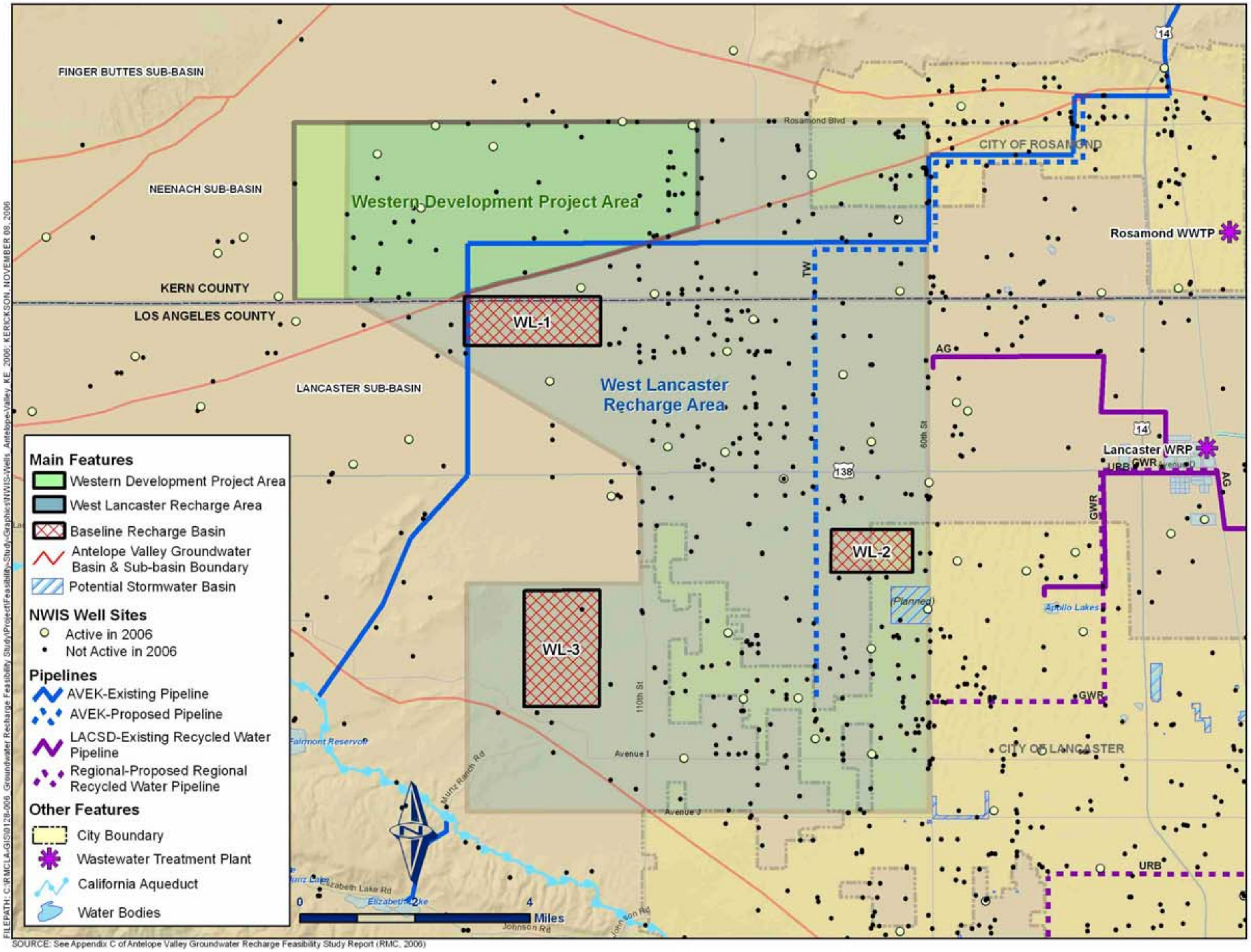
Figure 5-6: Antelope Valley “Known” Recharge Areas



FILEPATH: C:\RMCLA-GIS\0128-006_Groundwater Recharge Feasibility Study\Project\Feasibility-Study-Graphics\Groundwater-Recharge-Areas_Antelope-Valley_KE_2006.mxd; KERICKSON, NOVEMBER 08, 2006

SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

Figure 5-7: Potential Recharge Sites in West Lancaster



FILEPATH: C:\RMCLA-GIS\0128-006_Groundwater Recharge Feasibility Study\Project\Feasibility-Study-Graphics\NWIS-Wells_Antelope-Valley_KE_2006; KERICKSON, NOVEMBER 08, 2006

SOURCE: See Appendix C of Antelope Valley Groundwater Recharge Feasibility Study Report (RMC, 2006)

Additional hydrogeological data collection and evaluation is recommended as part of the implementation plan (see Section 6.2).

For example, Duell (1987) has shown the approximate extent of a regional perched groundwater body resulting from a low permeability deposit beneath WL-2. Verification of this feature is necessary before moving forward with subsequent planning for this recharge site. Also, WL-1 has a barrier to groundwater movement along the northern edge due to the Neenach fault, which separates the Lancaster and Neenach sub-units. The fault should not be a concern for GWR operations except to note that each sub-unit is hydrologically separated and, as a result, have separate characteristics. And the WDS GWR project is in the Neenach sub-basin.

Regarding current and planned land use, the current land use of each recharge site is agricultural use and/or open space. Planned land use for each site is not known based on available planning documents. The only concern would be the relative proximity of WL-2 to residential areas and the potential for these areas to expand. Incorporating future land use plans into the ultimate recharge basin siting selection is included as part of the implementation plan (see Section 6.2).

Based on hydrogeological characteristics and current land use, no alternative clearly stands out. So, based on the information available for this evaluation, the primary evaluation criterion is the cost to deliver and extract water from each site. Based on the cost criterion, WL-2 and WL-3 would be preferred over WL-1. Since there is a concern with WL-2 subsurface conditions related to impermeable boundaries and surrounding land use, WL-3 was selected for the baseline project recharge basin.

Baseline Project

WL-3 was identified for the baseline project but analytical modeling (see Appendix K) concluded that multiple, smaller basins would be required to recharge 50,000 afy in the West Lancaster area. The use of multiple basins was due to limited getaway capacity in the aquifer below the recharge basins, which causes recharge water to build up to the surface of the recharge basin over a period of years. As a result, four basins of 200 to 400 acres, including WL-2 and WL-3, are recommended for the baseline project. The four basins were sited in coordination with common facilities (discussed in the following section) and designated as ‘A’ through ‘D’ in Chapter 6.

One must consider the numerous assumptions were made during the evaluation of the recharge sites, including the following:

- **Infiltration rates** - Infiltration rates were assumed to be 0.5 ft/day, based upon previous studies (KCPD, 2006) and are appropriate at the feasibility study level. These values would need to be confirmed by field tests as project planning progresses to properly size the recharge facilities.
- **Subsurface conditions** - Subsurface hydrogeologic conditions were obtained through the USGS groundwater flow model for the Valley and are approximations of actual conditions. Subsequent evaluations of actual conditions beneath each proposed recharge site should be made as project planning progresses to better understand the behavior of the recharged water and its effect on the groundwater and nearby wells. These could include installation of deep soil borings and wells, and subsequent aquifer tests.
- **Groundwater elevations -** Groundwater elevation contours for the Study area were made using data from wells with very little information on how the wells were constructed and from what portions of the aquifer the wells are screened. This approach can have a significant impact on how the groundwater elevation contours are portrayed. Subsequent steps should obtain private well information from the DWR, to the extent possible, to verify the construction of the wells from which groundwater level data was obtained.

5.2 Common Facilities

The project facilities for which no alternative was evaluated are recycled water conveyance facilities, imported water conveyance facilities, and extraction facilities.

5.2.1 Recycled Water Conveyance

Under 2015 conditions, as presented in Section 3.3.1, the recycled water conveyance system would convey 10,000 af of recycled water from LWRP to West Lancaster area recharge basins. **Table 5-15** lists the planning level design criteria and assumptions used to develop the recycled water conveyance portion of the baseline GWR-RW project and, particularly, the cost estimates.

Table 5-15: Recycled Water Delivery Facilities Planning Level Design Criteria and Assumptions

Planning Level Design Criteria	Value	Assumptions
Average Annual Flow	10,000 af	• Equal to value assumed for recycled water treatment alternatives (see Table 5-3)
Peak Daily Flow	20.7 MGD	• Equal to value assumed for recycled water treatment alternatives (see Table 5-3)
Head Loss	7 ft / 1,000 ft	• Head loss calculated using Hazen-Williams equation coefficient of 130 • Minor head loss is 5% of velocity head loss
Maximum Velocity	10 fps	• Based on AVEK standards
Maximum System Pressure	185 psi	• Based on AVEK standards
Receipt Pressure	120 psi	• Water will be received under pressure from LACSD Recycled Water Transmission Pipeline • Value is based input from LACSD staff
Delivery Pressure [1]	Atmosphere	• Water will be discharged to recharge basins under atmospheric pressure
Right-of-Way		• Construction will occur in existing City and/or County right-of-way so no land purchase is required

Notes:

1. Delivery of recycled water to users, such as agricultural, prior to the recharge basins may require booster stations at the point of discharge to meet desired operational pressure.

5.2.2 Imported Water Conveyance

As presented in Section 5.1.2, 40,000 afy of imported water is required on average and up to 64,000 afy would be recharged in wet years. This water will be delivered from the California Aqueduct to the recharge basins over a five-month period in the winter when more imported water supplies are available. **Table 5-16** lists the planning level design criteria and assumptions used to develop the imported water conveyance portion of the baseline GWR project and, particularly, the cost estimates.

Table 5-16: Imported Water Delivery Facilities Planning Level Design Criteria and Assumptions

Planning Level Design Criteria	Value	Assumptions
Imported Water Conveyance Facilities		
Average Annual Flow	40,000 af	• Equal to value assumed for imported water supply plan
Maximum Daily Flow	96,600 gpm	• Up to 64,000 af over 5 months
Head Loss	7 ft / 1,000 ft	• Head loss calculated using Hazen-Williams equation coefficient of 130 • Minor head loss is 5% of velocity head loss
Maximum Velocity	10 fps	• Based on AVEK standards
Maximum System Pressure	185 psi	• Based on AVEK standards
Delivery Pressure [1]	Atmosphere	• Water will be discharged to recharge basins under atmospheric pressure
Right-of-Way		• Construction will occur in existing City and/or County right-of-way so no land purchase is required
Imported Water Pump Station		
Average Annual Flow	40,000 af	• Same as for imported water conveyance facilities
Maximum Daily Flow	96,600 gpm	• Same as for imported water conveyance facilities
Pump efficiency	75%	• Typical value for pump efficiency at feasibility study level
Minimum # of standby pumps	1	• No back-up power supply
Footprint	¼ acre	• Construction on private property adjacent to California Aqueduct

Notes:

1. Delivery of imported water to users, such as agricultural, prior to the recharge basins may require booster stations at the point of discharge to meet desired operational pressure.

5.2.3 Extraction and Delivery Facilities

The extraction and delivery facilities will produce up to 74,000 af over seven months during dry years, based on the maximum volume of recharge in wet years. **Table 5-17** lists the corresponding planning level design criteria and assumptions used to develop the extraction and delivery facilities portion of the baseline GWR-RW project and, particularly, the cost estimates.

Table 5-17: Extraction Facilities Planning Level Design Criteria and Assumptions

Planning Level Design Criteria	Value	Assumptions
Extraction Well Field		
Depth to Groundwater	200 ft	• See Table 5-14
Average well yield	1,500 gpm	• Based on average flow for potable supply well in West Lancaster area, which range from 500 to 2,500 gpm
Peak hourly flow	80,000 gpm	• Peak hourly flow based on extraction of 74,000 af over 7 months
Number of new wells	50	• Some existing wells will be used for extraction • # of wells includes 2 backups
Sphere-of-influence	500 ft	• Based on typical value for wells operating at 1,500 gpm and aquifer characteristics • Value should be refined with pump tests
Distance Between Wells	800 ft	• Value is used to estimate required piping for delivery • Value should be refined based on pump tests
Maximum Velocity	10 fps	• Based on AVEK standards
Well Footprint	50' x 50'	• Well will be located on private land so land purchase is necessary
Conveyance of Extracted Water		
Average Annual Flow	48,000 afy	• 50,000 afy of blend water less 2,000 afy, on average, of losses to evaporation
Peak Hourly Flow	80,000 gpm	• Same flow as for extraction well field
Maximum Velocity	10 fps	• Based on AVEK standards
Maximum System Pressure	185 psi	• Based on AVEK standards
Head loss	7 ft / 1000 ft	• Head loss calculated using Hazen-Williams equation coefficient of 130 • Minor head loss is 5% of velocity head loss
Delivery Pressure	120 psi	• Based on AVEK estimates
Right-of-Way	N/A	• Construction in existing City and/or County right-of-way so land purchase is not required
Storage	N/A	• Water will be delivered directly into AVEK facilities so no storage facilities are required

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Chapter 6 Recommended Plan

Should the City and partner agencies decide to move forward with a GWR-RW project, numerous tasks will need to be undertaken prior to starting operations; hence the necessity to develop a realistic project implementation timeline.

This chapter documents the Lancaster Area GWR-RW Baseline Project that was developed in Chapter 5. The chapter then presents the recommended implementation strategies and anticipated implementation timeline.

6.1 Lancaster Area GWR-RW Baseline Project

Table 6-1 summarizes the basic Lancaster Area GWR-RW Baseline Project concept.

Table 6-1: Baseline Project – Basic Concept

Project Component	Summary Description
Recycled Water Supply	• No advanced treatment • Blend with imported water as primary source of diluent supply • 10,000 afy by 2015
Blend Supply	• 40,000 afy, on average, and up to 64,000 afy of imported water from AVEK • Opportunity for direct delivery to agricultural users • Stormwater, as stormwater facilities are developed and are available (secondary source of supply)
Recharge Location	• Recharge basins to be located in the West Lancaster area • 1,000 acres of total recharge area plus 100 acres of facilities (berms, fencing, etc.) • Four basins of 200 to 400 acres sited in coordination with supply facilities
Extraction	• New well field extracting up to 74,000 afy in dry years and 48,000 afy on average • Extract and convey recharge water to AVEK South/North Intertie treated water line • Opportunity for direct delivery to or direct extraction by agricultural users

6.1.1 Facility Description

Table 6-2 describes the major facilities sizes. **Figure 6-1** illustrates the approximate location of major facilities. Key facilities were defined based on the feasibility study level design criteria presented in Chapter 5. The baseline project facilities were located to develop a detailed baseline project description for comparison with a regional GWR project, and, consequently, should be refined as project details are better defined.

Table 6-2: Baseline Project – Major Facilities

Project Component	Summary Description	
Recycled Water Conveyance	Average Annual Flow	10,000 af over the full year
	Peak Daily Flow	14,400 gpm / 20.7 mgd
	Range of Pipe Diameter	15” to 30”
	Pipe Length	14 miles
	Booster Pump	1,800 hp
Imported Water Conveyance	Average Annual Flow	40,000 af from Nov. to Mar.
	Maximum Annual Flow	64,000 af from Nov. to Mar.
	Peak Daily Flow	100,000 gpm / 140 mgd
	Range of Pipe Diameter	36” to 66”
	Pipe Length	11 miles
	Pump Station	14,500 hp
Recharge Basins	Average Annual Inflow	50,000 af over the full year
	Maximum Annual Flow	74,000 af over the full year
	Peak Daily Flow	115,000 gpm / 160 mgd
	Total Area	1,100 acres
	Average Losses to Evaporation	2,000 afy
	Recharge Rate	0.5 feet / day
Extraction Facilities	Average Annual Flow	48,000 af from Apr. to Oct.
	Max Annual (Dry Year) Flow	74,000 af from Apr. to Oct.
	Peak Daily Flow	80,000 gpm / 110 mgd
	Average Well Flow	1,500 gpm
	Number of wells	50 wells with 560 hp each
	Range of Pipe Diameter	30” to 48”
	Pipe Length	6 miles

The design criteria used in this Study are sufficient to analyze the feasibility of the baseline project but they should be refined and optimized as the project planning process progresses and the details of the regional GWR project are developed. Examples of refinement to be considered include the following:

- Using some recycled water storage at LWRP (which will be constructed for the agricultural reuse project) during the winter to reduce peak flows, which would reduce the size and cost of pipeline, pump stations, and, if necessary, treatment facilities
- Recharge of imported water over 12 months instead 5 months would reduce the size and cost of the pipeline and pump station but the cost of water could increase, depending upon the ultimate imported water supply plan

In addition, the regional GWR project should consider design restrictions that a GWR-RW project would entail, such as extraction wells a minimum of 500 feet from the recharge site.

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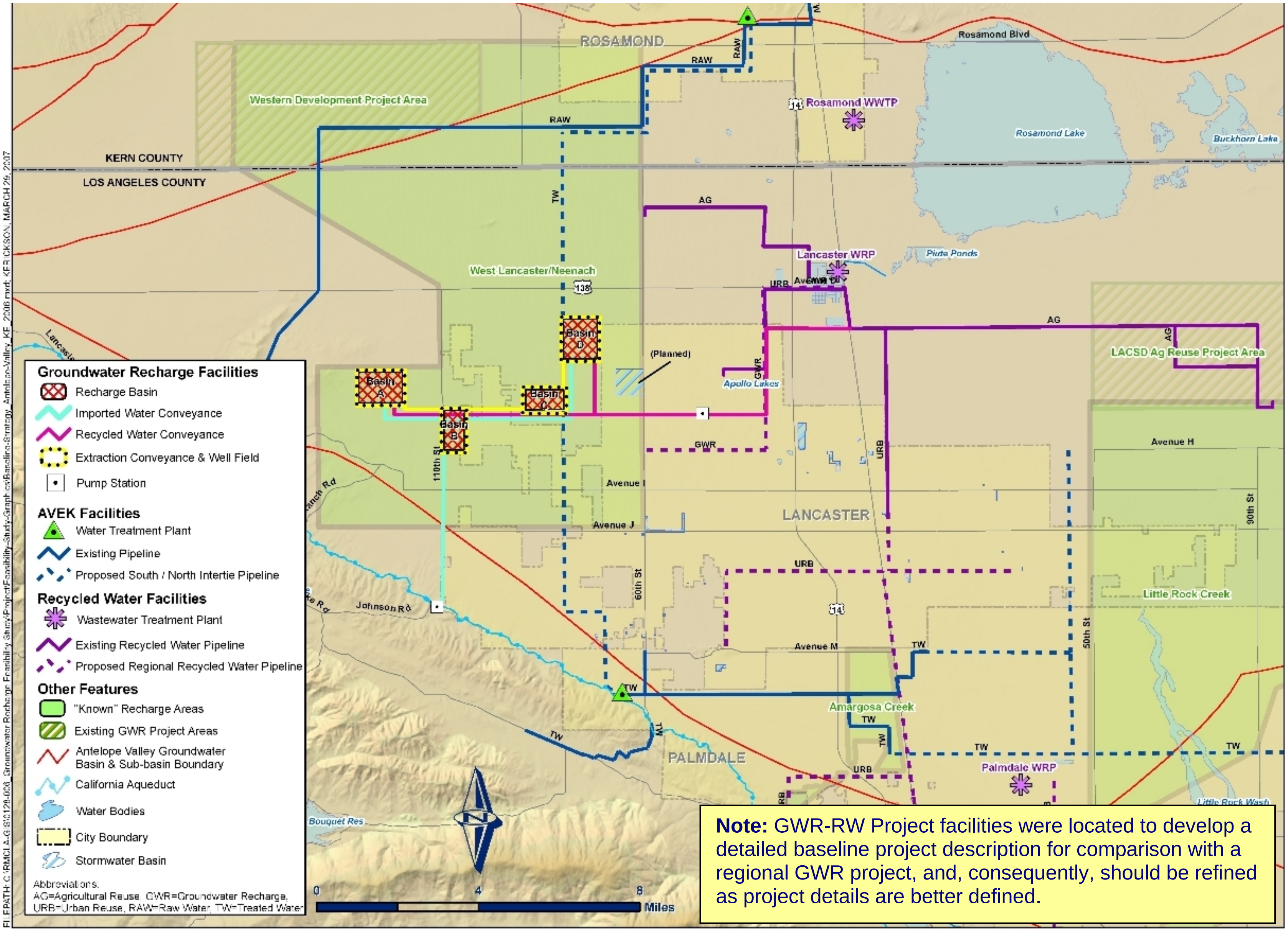
Figure 6-1: Baseline Project – Major Facilities Location



Note: GWR-RW Project facilities were located to develop a detailed baseline project description for comparison with a regional GWR project, and, consequently, should be refined as project details are better defined.

SOURCE: See Appendix C of the Antelope Valley Groundwater Recharge Feasibility Study (RMC, 2006)

6.1.2 Facility Operation

Figure 6-2 provides a schematic representation of the conceptual operational strategy for the baseline project. The baseline project assumes all facilities within the “Project Scope” area on Figure 6-2 would be owned and operated by the GWRJPA (perhaps via contract). This operational strategy should be refined as the project planning process progresses and the details of the regional GWR projects are developed.

For example, per DHS draft GWR regulations, a 4:1 blend ratio of imported water to recycled water is required on a five year running average. The imported water supply plan component of the baseline project assumes annual imported water volume would vary based on hydrologic year. This approach was used to adapt to the annual variation in imported water availability as well as the related cost of the imported water. So, the baseline project operational strategy could be adjusted based on the imported water supply plan developed by the regional GWR project as long as minimum blending requirements are met.

Similarly, the extraction facilities were sized assuming seven months of operation. The schedule was based on the need for alternative water supplies and delivery mechanisms during the higher demand periods of the spring, summer, and fall. The extraction schedule could be altered to operate over 12 months as a baseline water supply and non-GWR water supply facilities could increase use to meet the higher demand periods.

Finally, new raw imported water and recycled water could be directly delivered to users located in the vicinity of the conveyance and extraction pipeline alignments. The non-potable supplies of raw imported water and recycled water could be appealing to agricultural users, who would have an alternative source of water for agricultural operations. Currently, the baseline project definition does not account for direct deliveries but a slight alteration to facilities and operational plans with limited impact on cost could allow direct deliveries.

Figure 6-2: Baseline Project – Operational Schematic

① LWRP – RECYCLED WATER

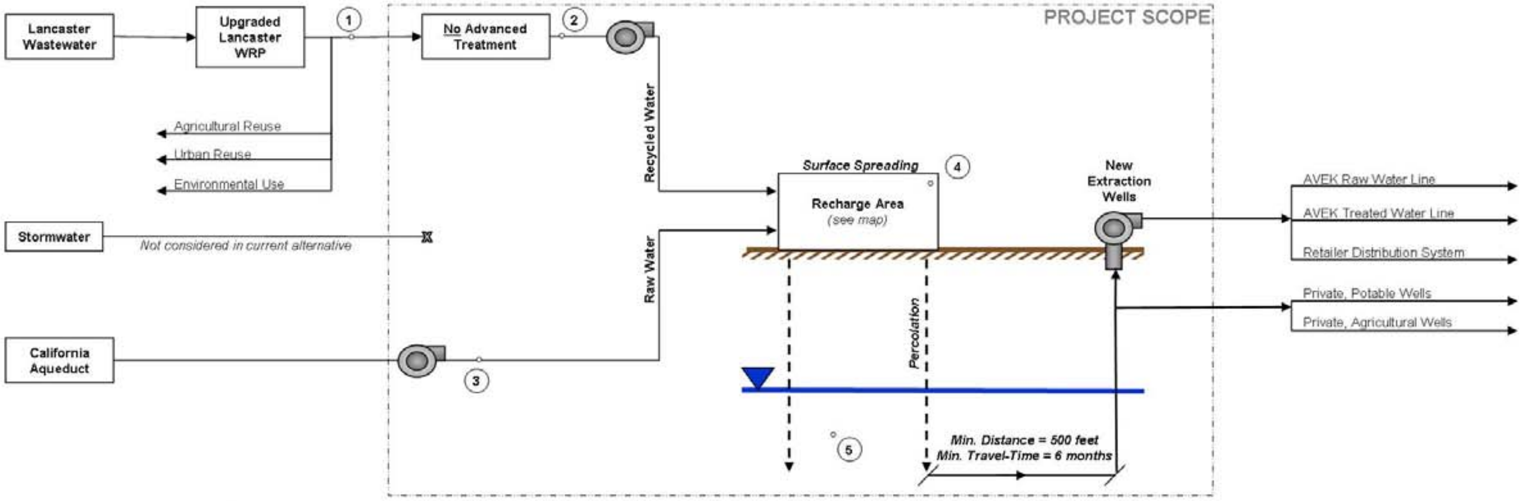
Water Quantity
- Annual Volume = 10,000 afy
- Peak Flow = 20.7 mgd

Water Quality (typical)
- TOC = 10 mg/L
- TDS = 570 mg/L (on average)
- Nitrate (N) = 9 mg/L
- THMs =Not Available

② RECYCLED WATER FOR RECHARGE

Water Quantity
Same as ①

Water Quality
Same as ①



③ AVEK – IMPORTED RAW WATER

Water Quantity
- Annual Volume = 40,000 afy
- Peak Flow = 139 mgd

Water Quality (typical)
- TOC = 4 mg/L
- TDS = 230 mg/L
- Nitrate (N) = 1 mg/L
- THMs = Not Available

④ BLENDED WATER FOR RECHARGE

Water Quantity
- Annual Volume = 50,000 afy
- Peak Flow = 160 mgd

Water Quality (estimated)
- TOC in RW = Not Applicable
- TDS = 300 mg/L (on average)
- Nitrate (N) = 2.6 mg/L
- THMs = Not Available

⑤ RECHARGE WATER AFTER PERCOLATION

Water Quality (estimated)
- TOC = 0.5 mg/L
- TDS = 300 mg/L
- Nitrate (N) = 1.7 mg/L
- THMs = Not Available

6.1.3 Estimated Cost

Table 6-3 summarizes the estimated costs for the baseline project. These estimates are budgetary cost estimates and should be refined as project planning progresses. Most of the capital and operating and maintenance (O&M) costs are associated with facilities that would be part of the regional GWR project currently under development (recharge basins, imported water conveyance facilities, and extraction and delivery facilities). For comparison, the estimated cost for the No Project alternative (i.e., a regional GWR project using 50,000 afy of imported water, on average) is included in Table 6-3.

Table 6-3: Baseline Project – Cost Estimate

Elements	GWR-RW Project	No Project Alternative
Capital Cost [1]		
Recharge Basins – Land Purchase	$9.9 M	$10.9 M
Recharge Basins – Construction	$11.9 M	$12.4 M
Recycled Water Conveyance Facilities	$26.1 M	-
Imported Water Conveyance Facilities	$44.8 M	$51.9 M
Extraction and Delivery Facilities	$49.6 M	$49.6 M
Construction Cost Subtotal	**$142.4 M**	**$124.8 M**
Construction Cost Contingency (25%)	$35.6 M	$31.2 M
Engineering, Environmental Documentation, etc. (20%)	$28.5 M	$25.0 M
Capital Cost Subtotal	**$206.5 M**	**$181.0 M**
Operational & Maintenance Cost		
Recharge Basins	$0.1 M/yr	$0.1 M/yr
Recycled Water Conveyance Facilities	$1.2 M/yr	-
Recycled Water Purchase	- [2]	-
Imported Water Conveyance Facilities	$3.2 M/yr	$4.0 M/yr
Imported Water Purchase	$8.0 M/yr	$10.0 M/yr
Extraction and Delivery Facilities	$9.5 M/yr	$9.5 M/yr
O&M Cost Subtotal	**$22.0 M/yr**	**$23.6 M/yr**
Lifecycle Cost		
Annualized Capital Cost [3]	$15.1 M/yr	$13.2 M/yr
Annual O&M Cost	$22.0 M/yr	$23.6 M/yr
Total Annual Cost	**$37.1 M/yr**	**$36.8 M/yr**

Notes:

1. Costs based on ENR Los Angeles Construction Cost Index from August 2006 (= 8570).
2. The purchase price of recycled water was not included because negotiations are currently underway between LACSD and potential customers. The price could be up to $100 per af, which is equivalent to $1.0 million per year in incremental costs.
3. Annualized at 6 percent over 30 years (A/P Factor =0.073).

The budgetary cost estimate presented above should be refined as project planning progresses. Adjustments in some of the key assumptions made in this Study could significantly affect this cost estimate:

- **Recharge Basins:** Siting of the recharge basins was based on limited hydrogeologic and land use planning data so site-specific information could significantly affect the minimum recharge area and, thereby, land acquisition cost. Variation in the land cost can also significantly affect the land acquisition cost (the baseline strategy assumes the purchase of 1,100 acres of land at $9,000 per acre). Acquiring the land in advance of the project could potentially reduce the effect of price escalation on project cost. An alternative strategy to land acquisition for the recharge basins is to buy the development rights[70] to agricultural land. This strategy would entail continuing active agricultural practices on the land by the owner while rotating a portion of the land for recharge operations.
- **Recycled Water Treatment Facilities:** The baseline strategy assumes that no supplemental treatment facilities will be required to meet regulatory requirements; however, regulatory agencies may require and/or the general public may be willing to pay for additional treatment prior to recharge. This could have a cost impact of over $100 million in capital costs plus significant energy inputs if MF/RO/AOP is added.
- **Recycled Water Conveyance Facilities:** The baseline strategy assumes that the recycled water conveyance facilities must transport a peak design flow of 20.7 mgd. The peak design flow could be reduced, and cost of conveyance facilities decreased, by coordinating deliveries to the various recycled water users and using available storage at LWRP. Therefore, coordination with LACSD operations is recommended to optimize recycled water operations and facilities sizing.
- **Imported Water Conveyance Facilities:** The baseline strategy assumes that the imported water conveyance facilities must transport a peak design flow of 139 mgd. A refinement of the imported water supply plan, which balances the costs of facilities, water purchase, and pumping, could alter the cost of imported water conveyance facilities.
- **Extraction and Delivery Facilities:** The baseline strategy assumes that the extraction and delivery facilities must transport a peak design flow of 113 mgd. A refinement of the extraction and delivery plan, which balances the costs of facilities with dry season supply requirements, could reduce the cost of the facilities.
- **Operations and Maintenance:** O&M costs primarily included energy use for pumping and purchase of imported water. The future cost of imported water supplies is tough to predict, except that they will most likely increase due to increased SWP demand combined with stagnant and/or decreased SWP supply. Therefore, the cost of imported water purchases, whether they be temporary purchase in a wet year or purchase of an entitlement, is likely to increase.

6.1.4 Benefits and Costs

Table 6-4 presents the main incremental costs and benefits/avoided costs associated with the baseline project. A series of incremental costs and avoided costs were presented due to the range of future conditions, particularly regarding the cost and availability of imported water and benefits or costs for the LACSD Agricultural Reuse Project.

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[70] Purchase of development rights of agricultural land would allow for continued agricultural operations on a majority of the tract while using a portion to operate recharge basins. The recharge basin locations could be rotated in conjunction with rotating agricultural use of the land. This approach could foster a partnership between groundwater recharge proponents and the agricultural community by supporting continued agricultural operations in the Antelope Valley and provide an alternative revenue source for agricultural operators.

Table 6-4: Incremental Costs vs. Avoided Costs [1]

Project Component	Benefit / Impact	Incremental Cost	Avoided Cost
Capital Costs [2]		**($ M / year)**	
Recycled Water Conveyance	New pipeline and pump stations	$2.6	
Imported Water Conveyance	Reduced size of pipeline and pump station		$0.8
Recharge Basins [3]	Avoided acreage (100 ac) required for recharge		$0.2
LACSD Agricultural Reuse Project [4]	Avoided storage ponds, equipment, roads, etc.		$2.5
O&M/yr Costs		**($ M / year)**	
Recycled Water Conveyance [5]	New pumping costs and recycled water purchase	$1.2 to 2.2	
Imported Water Conveyance [6]	Avoided pumping costs and imported water purchase		$2.8 to 7.3
LACSD Agricultural Reuse Project [4]	Avoided agricultural operations and lost revenue	$2.5	$1.7
Well Mitigation [7]	New water supply and/or well replacement/relocation	$0.5	-
Access to New Water Supply	New water supply available for use in proximity of pipelines	Not Quantified [8]	
Total		**$6.8 to 7.8**	**$8.0 to 12.5**

Notes:

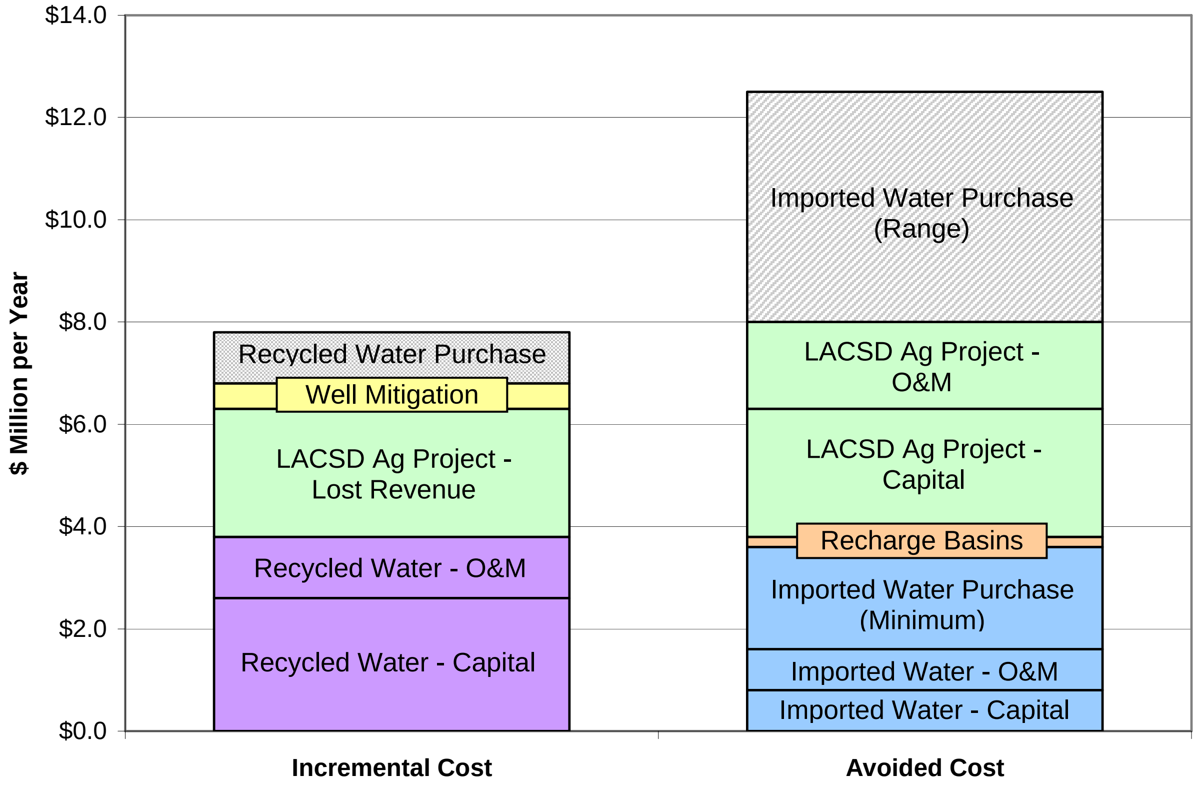
1. GWR-RW project key incremental costs and avoided costs are in comparison to the No Project alternative (i.e., a 50,000 afy regional GWR project using imported water only).
2. Capital costs were annualized based on an interest rate of 6 percent over 30 years (A/P Factor = 0.073).
3. The GWR-RW project would require 100 less acres of recharge than a regional GWR project due to a lower blend water peak flow. The lower peak flow results from delivery of recycled water over the full year instead of imported water over five months during the wet season.
4. The incremental cost for the agricultural reuse project is based on the loss of $250/af of projected annual revenue once the project is operational. Avoided costs for the project are $33.8 million for the avoided construction of storage ponds, agricultural operation equipment, and roads/fences/culverts ($27.5, $2.6, and $3.7 million, respectively). Avoided costs also include $1.7 million per year of avoided O&M costs for agricultural operations. (Source: LACSD, personal communication, 2006 and 2007)
5. Recycled water O&M includes the purchase price of recycled water, which was not included in the baseline project because negotiations are currently underway between LACSD and potential customers for urban uses. Recycled water purchase price for GWR is typically less expensive than urban uses due to wet season storage avoidance benefits. To be conservative, the price could be up to $100 per af, which is equivalent to $1.0 million per year in incremental costs. The potential range of recycled water purchase price results in a range of incremental costs.
6. Imported water O&M includes the purchase price of imported water, which was assumed to be $200 per af based on current AVEK GWR rates but delivery of imported water via purchase of an entitlement could cost over $650 per af. The potential range of imported water purchase price results in a range of avoided costs.
7. Well mitigation assumes one well per recharge basin would need to be relocated and/or a new water supply would be provided to well owner.
8. Agricultural users in the vicinity of the imported water and recycled water pipeline alignment would have access to non-potable water for agricultural uses. This benefit is not quantified but could be significant in dry years if access to groundwater is limited due to adjudication.

Other benefits of the project that were not quantified include:

- Provides new source of water supply that is reliable, “drought-proof,” and locally controlled
- Diversifies regional water portfolio
- Provides alternative wastewater management mechanism
- Promotes highest beneficial use of recycled water
- Supports other solutions being developed to address the limited availability of water supplies, including GWR and groundwater management projects

As shown in Table 6-4, and presented in **Figure 6-3**, the avoided costs associated with the baseline project are estimated to outweigh the incremental costs.

Figure 6-3: Comparison of Incremental Costs vs. Avoided Costs



Based on the favorable comparison of avoided and incremental costs, the baseline project is estimated to be economically feasible in addition to being technically feasible. Hence, it is recommended that the baseline project be further investigated and that the stakeholders move forward with the implementation plan presented below.

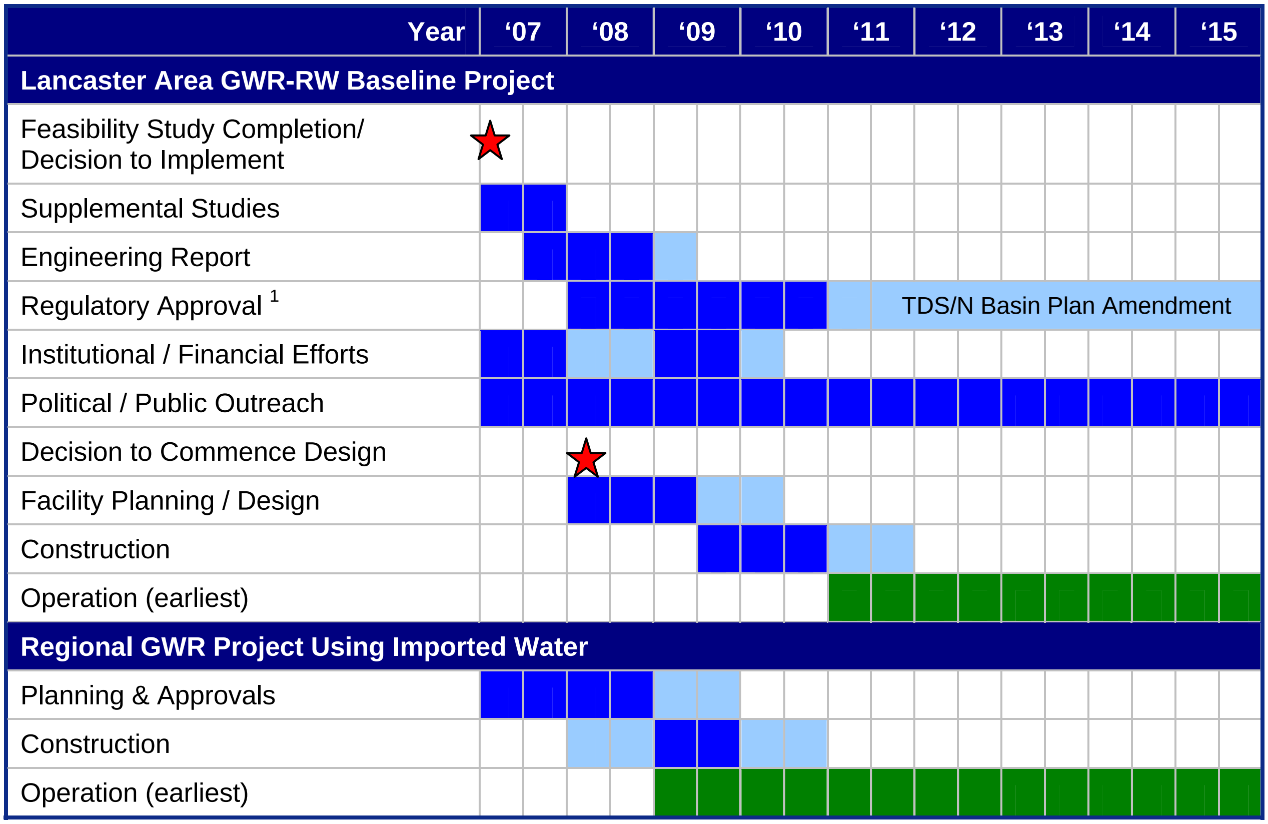
6.2 Implementation Strategies

Figure 6-4 summarizes the recommended implementation activities for the proposed project and associated timeline. It also illustrates how the project implementation timeline would relate to the regional GWR-RW project(s) using imported water, currently underway, and highlights key decision points.

This timeline shows that it would take four to nine years after this Study is complete to start using recycled water as part of a GWR project operation.

The timeline assumes that a project champion/lead agency responsible for implementing the plan in coordination with all the stakeholders is identified immediately after this Study is complete. In the interim, the project champion/lead agency is assumed to be the newly formed GWRJPA.

Figure 6-4: Baseline Project – Anticipated Implementation Timeline



Year	'07		'08		'09		'10		'11		'12		'13		'14		'15	
Lancaster Area GWR-RW Baseline Project																		
Feasibility Study Completion/ Decision to Implement	★																	
Supplemental Studies	🟦	🟦																
Engineering Report		🟦	🟦	🟦	▨													
Regulatory Approval [1]			🟦	🟦	🟦	🟦	🟦	🟦	▨	TDS/N Basin Plan Amendment	▨	▨	▨	▨	▨	▨	▨	▨
Institutional / Financial Efforts	🟦	🟦	▨	▨	🟦	🟦	▨											
Political / Public Outreach	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Decision to Commence Design			★															
Facility Planning / Design			🟦	🟦	🟦	▨	▨											
Construction						🟦	🟦	🟦	▨	▨								
Operation (earliest)									🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Regional GWR Project Using Imported Water																		
Planning & Approvals	🟦	🟦	🟦	🟦	▨	▨												
Construction			▨	▨	🟦	🟦	▨	▨										
Operation (earliest)					🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩

Note:

1. The duration of this task is dependent on many factors, particularly the magnitude of recycled water included in the initial phase(s) of the GWR-RW project and the related scope of an anti-degradation analysis. Also, a Salt / Nitrogen Basin Plan Amendment may be developed, which could take many years, but a GWR-RW project could be implemented in the interim.

🟦	Estimated Task Length
▨	Potential Extension of Task Length
🟩	Project Operation

Specific strategies and activities were developed for the five key implementation activities that should be initiated prior to moving forward with project design. These strategies are briefly summarized below. A number of the recommended activities would also be required as part of the regional GWR project using imported water. Implementation activities for the regional GWR project using imported water and the baseline project should therefore be closely coordinated and/or merged.

6.2.1 Supplemental Studies

The baseline project included numerous technical assumptions required to develop a project concept to a feasibility study level of detail. **Table 6-5** summarizes the main recommendations for technical work required in the near-term to better define the baseline project as well as refine the budgetary cost estimate and implementation timeline.

Table 6-5: Implementation Strategies for Technical Considerations

Project Component (Cross-Ref)	Assumption	Potential Impact	Items to Resolve / Actions to Take
Recycled Water			

Annual Availability for GWR (Section 3.3.1)	Assumptions were made regarding future recycled water uses to derive an availability of 10,000 afy of recycled water in 2015 and this volume drives the overall size of the project.	Deviation from this level of usage would affect the overall size of the project	• Determine start date for GWR-RW project (if not 2015)
			• Determine recycled water demand in 2015 for:
			  • Urban reuse
			  • Agricultural reuse
			• Determine use of recycled water after 2015, as more is available

Seasonal availability for GWR (Section 3.3.1)	Monthly demand of projected recycled water uses were estimated for each source with minimal use in the winter, which left 20.7 mgd for GWR.	Optimization of the use of recycled water in the winter, such as use of LACSD Agricultural Reuse Project storage could reduce recycled water treatment and conveyance facility size	• Define monthly use of recycled water by various reuse options • Update amount of storage volume constructed by 2015 and its availability in the winter
Recycled Water Quality (Section 3.3.1)	Water quality values in this report were estimated based on new treatment facilities and compared with similar LACSD facilities.	Changes in water quality could affect proposed treatment process and/or regulatory requirements	• Determine water quality of recycled water from new LWRP treatment facilities
Draft DHS GWR Regulations (Section 4.1.1)	Draft DSH GWR regulations could change during design and/or operation of the GWR-RW project.	Any change to the draft DSH GWR regulations could positively or negatively impact the design and/or operation of the GWR-RW project.	• Track progress of draft regulations and incorporate into project planning
Precedential RWQCB WRRs / WDRs (Section 4.2)	The Lahontan RWQCB policy is evolving and is becoming better defined as more recycled water and/or recharge projects are attempting to be permitted.	Conditions identified in these permits would likely be starting points for a GWR-RW project in the Antelope Valley.	• Track progress of draft and final WRRs and WDRs from Lahontan and other RWQCBs. Be prepared to incorporate into project planning

Project Component (Cross-Ref)	Assumption	Potential Impact	Items to Resolve / Actions to Take
Supplemental Treatment (Section 5.1.1)	The Lahontan RWQCB policy is evolving and is becoming better defined as more recycled water and/or recharge projects are attempting to be permitted.	Conditions identified in these permits would likely be starting points for a GWR-RW project in the Antelope Valley.	• Educate the public regarding GWR-RW through an outreach effort • Solicit input at public meetings to determine preferred recycled water treatment alternative
Imported Water			
Imported Water Quality (Section 3.4.4)	More extensive constituent list is needed for imported water quality data is needed to complete an Engineering Report and ADA.	New data could alter the recommended baseline project	• Conduct imported water sampling for DHS and RWQCB regulated constituents that are not currently evaluated
Imported Water Conveyance (Section 5.2.2)	The imported water component of the baseline project was developed in absence of detailed plans for the regional GWR project	The GWR-RW project would ultimately use the regional GWR project imported water system.	• Coordinate design of regional GWR imported water system to ensure that the design does not exclude a GWR-RW project
Stormwater			
Stormwater Infrastructure (Section 3.5)	Information from stormwater master plans are needed to included stormwater as a diluent source	Availability of stormwater could decrease the volume of imported water required for blend or increase opportunity of recycled water recharge	• Coordinate with Lancaster and Los Angeles County stormwater planning efforts
Stormwater Quality (Section 3.5.3)	Stormwater quality is suitable as a diluent source but no stormwater quality data was available for this Study	Dependable and extensive water quality data in the project area is needed to complete an Engineering Report	• Conduct groundwater sampling for in the area(s) of recharge
Groundwater / Hydrogeology			
Groundwater Quality (Section 3.2.5)	Limited groundwater quality data is available in addition to WWD No. 40 production wells, which are primarily located within the City of Lancaster.	Dependable and extensive water quality data in the project area is needed to complete an Engineering Report and ADA.	• Conduct groundwater sampling for in the area(s) of recharge

Project Component (Cross-Ref)	Assumption	Potential Impact	Items to Resolve / Actions to Take
SAT performance (Section 4.3)	More accurate estimates of TOC and nitrogen removal will need to be determined to determine if removal in the vadose zone assumed is achievable.	More accurate estimates would allow for more precise planning assumptions and substantiate regulatory and technical analyses.	• Conduct vadose zone monitoring via column testing, field tests at recharge sites, or other means
Infiltration Rate and Getaway Capacity (Section 5.1.3)	The assumed infiltration rate of 0.5 ft/day was based on limited tests in an adjacent groundwater sub-basin and hearsay. The getaway capacity was determined from hydrogeologic data that covers large areas and can vary within the area.	Infiltration rate and getaway capacity (see next item) are the two key inputs to determining recharge basins size and location requirements.	• Collect data from implemented projects • Conduct pilot projects to collect data • Conduct site-specific, hydrogeologic testing to determine range of infiltration rates and getwaway capacities
Recharge Basins			
Future Land Use (Section 5.1.3)	The current and planned land use of the recharge site as well as adjacent areas will influence the viability of the site.	Current and planned agricultural use is beneficial because recharge operations can occur in conjunction with agricultural operations. In contrast, current or planned housing developments would likely reject siting of a recharge area adjacent to their property.	• Contact and begin discussion with landowners willing to sell development or property rights
Extraction System			
Regional GWR Project System (Section 5.1.2)	The GWR-RW project would ultimately use the regional GWR extraction system.	The regional GWR extraction system must meet GWR-RW requirements such as 500 feet between recharge area and extraction well location.	• Coordinate design of regional GWR extraction system to ensure that the design does not exclude a GWR-RW project.
Underground Retention Time (Section 5.1.3)	The analytical modeling results showed that URT of recycled water was not a limiting factor in extraction system design, such as extraction well locations since travel time in the vadose and saturated zones were small.	Shorter URT Could affect the distance between recharge area and extraction wells.	• Confirm URT estimates to support design suggestions for extraction system
Cost Estimates (Appendix J)			

Project Component (Cross-Ref)	Assumption	Potential Impact	Items to Resolve / Actions to Take
Infrastructure	The cost estimates were based on a combination of previous bid and planning costs for other Southern California GWR projects as well as generic unit costs for pipelines and pump stations. Also, a 25 percent contingency was included to account for the wide range of unknowns.	Fluctuations in unit prices would increase or decrease overall project cost.	• Update unit costs to reflect current construction market • Reduce contingency percentage as project becomes better defined
Land Purchase	The project may require purchase of over 1,000 acres of land for recharge basins	Fluctuations in prices would increase or decrease overall project cost.	• Update unit cost of land purchase to avoid price shocks • Emphasize purchase of development rights instead of land ownership to lower costs and engage the agricultural community
Imported Water	In addition to delivery reliability, the contractual source and related purchase price of imported water is a key input to determining the avoided cost of using 10,000 afy of recycled water.	The purchase price could increase annual costs by $6.0 million, based on up to $500/af.	• Coordinate development of imported water supply plan for the regional GWR project to update cost benefit analysis for GWR-RW
Recycled Water	The purchase price of recycled water was not included.	The purchase price could increase annual costs by $1.0 million, based on up to $100/af.	• Include the 'value' of reliability when comparing the use of imported water and recycled water for recharge

6.2.2 Regulatory Strategy

Components and timelines required to obtain regulatory approval to proceed with the development of a GWR-RW project in the Antelope Valley were developed based on the regulatory analysis conducted for the Study (see Chapter 4), and input received from stakeholders at the Study workshops conducted in May, July, and September 2006. As noted in the regulatory analysis, authorization of a GWR-RW project in the Antelope Valley would be the responsibility of the California DHS and the Lahontan RWQCB.

DHS and RWQCB Process

A simplified schematic of the regulatory process for obtaining a permit was shown in Figure 4-1. Within each main component of this process there are typically additional steps that contribute to the effort and time needed for project approval. In many cases, definitive time frames cannot be predicted since they are dependent on the determinations and rulings of each regulatory agency. Each component is discussed below with estimates of the time needed to complete each step.

Step 1. Project Sponsor Submits Engineering Report (0.5 to 1.5 years)

All recycled water projects must submit engineering reports for DHS and RWQCB review (see Section 4.1). These are comprehensive reports that present the results of an extensive evaluation of the project, its impacts on the existing and potential uses of the impacted groundwater basin, and the proposed means for complying with applicable regulations. Section 60320.080 of the December 2004 DHS Draft GWR Regulations would be used as guidelines for the preparation of a report. The specific topics contained within an engineering report are:

- **Hydrogeologic Characterization**: The hydrogeologic characterization would include:
    - Hydrogeologic study on the impacted groundwater basin that addresses individual and cumulative impacts of the GWR-RW project and other GWR projects on domestic groundwater sources
    - Description of the pre-project groundwater quality in the impacted groundwater basin; identification of all wells that will be impacted by a proposed project
    - Estimated or measured shortest recycled water URT and horizontal separation, along with the methods for obtaining these
    - Description of any existing or anticipated flows into the basin that could affect the quality of water in the monitoring wells or drinking water wells downgradient of the project
- **Groundwater Quality Monitoring:** The results of one year of quarterly monitoring of the recycled water proposed for use for TOC, BOD, SS, total coliforms, and total nitrogen; all regulated and unregulated chemicals in Title 22; priority pollutants; chemicals with state Notification Levels. A list of endocrine disrupting chemicals and pharmaceuticals identified in the wastewater, as well as data on the levels where measurable.
- **Diluent Water Characterization:** For any diluent waters proposed for use, a source water assessment, and a quantitative and qualitative characterization of the water quality must be conducted, including temporal variations.
- **Contingency Plan:** A contingency plan for diversion of recycled water when required.
- **Long-Term Monitoring Plan:** A plan for monitoring recycled water, diluent water, mound water and groundwater flow and quality in the impacted groundwater basin, including a map of the locations of monitoring wells in the spreading basin and groundwater basin, details on their construction, and a rationale for their siting.
- **Vadose Zone Monitoring:** For projects using vadose zone or mound monitoring, a description of the vadose zone or mound monitoring program and, potentially, a demonstration project to

determine if the program satisfies DHS requirements. There are no specific guidelines as to what constitutes a demonstration project.

- **Impact and Mitigation Analysis:** An analysis of the project impact that includes a determination of the possible violations or situations that could occur that might pose a risk to public health and a plan with associated costs for mitigating each along with the financial assurance mechanism that would be utilized.

Much of this information should be developed during the supplemental studies phase of project implementation so the preparation of an engineering report is expected to take about 0.5 years. However, this effort could take at least 1.5 years if additional information must be collected, particularly if new monitoring wells need to be constructed or if the project sponsor determines that it wishes to conduct an ADA at this point in the process[71] to satisfy RWQCB requirements (see Section 4.1.2). It is difficult to predict how long an ADA will take to complete as there are no guidelines on how to conduct the evaluation and the RWQCB may require additional analyses or evaluations as results are presented.

Step 2. DHS and RWQCB Review Engineering Report (0.5 to 1.5 year)

There are no statutory or regulatory deadlines for when DHS and RWQCB must complete a review of an engineering report. In addition, for DHS, the review and subsequent revision of a report is typically an iterative process, with time gaps between providing comments to the project sponsor, the project sponsor revising and re-submitting the report, and the project sponsor receiving additional DHS feedback. For most projects this back and forth takes at least two iterations, and it is difficult to predict when the review will be completed and the report deemed satisfactory. This will depend on the availability of DHS staff time and the responsiveness of the report to DHS needs. This step in the process can take from 6 months to 1.5 years to complete.

Step 3. DHS Holds Public Hearing (0.3 to 0.5 year)

Upon completion of the engineering report, DHS schedules and holds a public hearing prior to making a final determination on the public health aspects of a project. It typically takes 4 to 6 months to arrange the hearing and comply with public noticing requirements.

Step 4. DHS Issues Findings of Facts/Conditions (0.3 to 0.5 year)

After the completion of the public hearing, DHS issues “Findings of Fact and Conditions.” Project sponsors have found that this process can be expedited if they volunteer to produce a draft document for DHS to use as a starting point for the agency’s own document production. This process also may involve several iterations between the project sponsor and DHS before a final document is produced. This step usually takes 6 to 9 months to complete.

Step 5. RWQCB Holds Permit Hearing (0.5 to 2 years)

Once the “Findings of Fact and Conditions” have been finalized by DHS, the next step in the process is to obtain WDRs and/or WRRs from the RWQCB. The project sponsor must submit a Report of Waste Discharge (ROWD) to the RWQCB.[72] The ROWD form requires that that the project sponsor provide a complete characterization of the discharge with regard to quantity, quality, and disposal method. If an ADA was not done as part of the engineering report, it is expected that the RWQCB would require the submittal of an ADA with or subsequent to the submittal of the ROWD. The ROWD also requests information on the status of the project’s California Environmental Quality Act (CEQA) process, and includes a specific notice encouraging communication with RWQCB staff before starting the CEQA documentation since there are Basin Plan issues vital to the CEQA effort. After receiving the ROWD, the RWQCB would then prepare a tentative permit for public review and comment. In some cases, a project

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[71] An anti-degradation analysis can also be conducted as part of the permitting process.

[72] See http://www.waterboards.ca.gov/sbforms/form200.pdf

sponsor may be able to review and comment on a preliminary version of the tentative permit before a permit is sent out for public review.

It is difficult to predict how long it might take for the RWQCB to issue a tentative permit. Typical schedule drivers include staffing, policy issues with the project, and completion of a successful ADA. It is possible that it can take anywhere from 6 months to 1.5 years to receive a tentative permit. The tentative permit is then sent out for public review and comment and, for WDRs and WRRs, the review period is typically 30 days. Once comments are received, the RWQCB will schedule a public hearing for the project, prepare a response to comments, and possibly revise the tentative permit. Again, it is difficult to predict how long this might take depending on whether substantive changes need to be made to the permit and the RWQCB's Board meeting schedule/calendar. It is possible that this can take from 3 to 9 months. That said, this step is estimated to take from 9 months to over 2 years to complete.

Step 6. RWQCB Prescribes WDR or WRR (up to 1 year)

If there are no disputes over the permit after the RWQCB public hearing, the permit goes into effect almost immediately and no further approval is needed. The process would be extended if the permit is petitioned by the sponsor or an opponent. Petitions must be filed within 30 days of the RWQCB action to the SWRCB. After filing, the SWRCB must act on the petition within 270 days unless a hearing is held and then the agency has 330 days to act on the petition or within 120 days of the close of the hearing, whichever is later. If the SWRCB does not act within these time limits the petition is deemed denied. If the SWRCB holds a hearing, it may elect to issue its own order, which then takes effect or it may elect to remand the permit to the RWQCB for revisions, and the whole process for issuing a revised tentative permit and hearing at the RWQCB level resumes. If the petitioner is not satisfied with the SWRCB outcome, the next course of action is litigation, which has an uncertain time line. However, for the purposes of this discussion, there would be no remand or litigation, and this step is estimated to take up to 1 year.

CEQA / NEPA Documentation

It is envisioned that the CEQA / National Environmental Policy Act (NEPA) process would take about 1 year to complete and could be conducted concurrently with the permitting process. A certified NEPA document would be required to be eligible for federal funding, such as the Title XVI program (see Section 6.2.4).

Basin Plan Amendment for Salts and Nitrogen

One of the conclusions of the regulatory analysis was in order to provide long-range cost effective solutions for the protection of water quality in the Antelope Valley, it may be beneficial for all stakeholders to consider pursuing and funding a regional approach for salt and nitrogen management similar to the TDS/N BPA adopted by the Santa Ana RWQCB in 2004.[73] This BPA took almost nine years to develop and approve, and included the formation of a stakeholder Task Force and the completion of multi-million dollar studies. The BPA process consists of the preparation of an amendment package and resolution, which is submitted to the public for review and comment, after which the RWQCB holds a public hearing. If there is no opposition, the package is sent to the SWRCB for approval, and then to the Office of Administrative Law (OAL) for review and approval, after which it goes into effect. Once a package has been prepared, it typically can take from 2 to 3 years to achieve OAL approval. This process is considerably longer if petitions are filed or if OAL finds fault with the amendment. The process for

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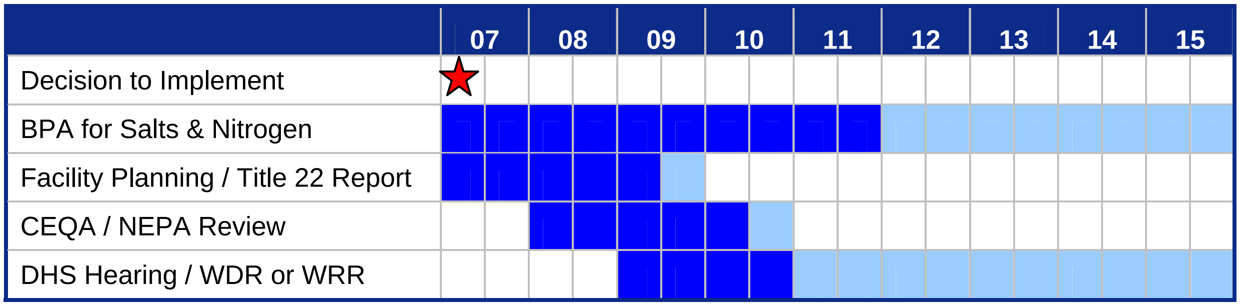
[73] **Santa Ana RWQCB Resolution R8-2004-0001**: Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated TDS and Nitrogen Management Plan for the Santa Ana Region Including Revised Groundwater Sub-basin Boundaries, Revised TDS and Nitrate-Nitrogen Quality Objectives for Groundwater, Revised TDS and Nitrogen Wasteload Allocations, and Revised Reach Designations, TDS and Nitrogen Objectives and Beneficial Uses for Specific Surface Waters.
Available at: http://www.waterboards.ca.gov/santaana/pdf/04-01.pdf

developing an amendment package depends on the complexity of the project and any potential controversy. Thus, one could assume that for an effort of this kind to take place in the Antelope Valley, it could take from 6 to 10 years to complete, and could be conducted concomitantly with the permitting process.

Summary

Obtaining regulatory approval for the baseline project is estimated to take at a minimum of four years (assuming no opposition or no key policy issues to be resolved) to at least eight years as shown in **Figure 6-5**.

Figure 6-5: Regulatory / Permitting Project Timeline



	07	08	09	10	11	12	13	14	15
Decision to Implement	★								
BPA for Salts & Nitrogen	■■	■■	■■	■■	■■	▨▨	▨▨	▨▨	▨▨
Facility Planning / Title 22 Report	■■	■■	■▨						
CEQA / NEPA Review		■■	■■	■▨					
DHS Hearing / WDR or WRR			■■	■■	▨▨	▨▨	▨▨	▨▨	▨▨

■ Estimated Task Length

▨ Potential Extension of Task Length

6.2.3 Institutional Arrangements

Currently there are several entities that recharge and/or withdraw water from the basin. An adjudication process to establish groundwater rights began in 1999; however, there is no clear indication on what the result may be, and there may not be a conclusion for many years. Hence, agreements between stakeholders will need to be developed so that the project partners and/or participants can claim project benefits and implement GWR in the absence of conclusion to the adjudication process.

For this discussion, it is assumed that the GWRJPA[74] will take the lead in developing and implementing a regional GWR program. GWRJPA would be responsible for conducting an inclusive process to address the issues of all stakeholders and developing policies for development, such as management of water volume, water quality, and monitoring. The specifics for policies will become clearer as the IRWMP process proceeds and other analytical work, such as groundwater monitoring and pilot studies, provide data.

Policies that may be considered for development should include the following topics:

- **Basin Management:** The adjudication process will most likely determine a safe yield for the groundwater basin, either as a whole, or by sub-basins. Policies on volume management would relate to maintaining the groundwater level within certain minimum and maximum limits.
- **Water Quality Management:** For this issue, non-degradation and anti-degradation policies would apply. Salt management would also be an issue so policies would need to be directed toward the amount of salt that could be placed in the basin.
- **Rights and Responsibilities:** There will be time periods when water can be stored or banked in the basin. During dry years this water will be available to meet demands. An example policy

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[74] The Antelope Valley State Water Contractors Association (AVSWCA) is the most likely organization to fulfill the role of a GWRJPA. Information on the AVSWCA can be found at www.avswca.org.

would simply be to have each agency or party that extracts water be responsible for replenishing it at the next reasonable opportunity.

- **Monitoring Policy:** In order to manage the water in the basin, knowledge of inputs and outputs must be obtained. Hence, policies directed toward the metering of all flows, in or out, would be necessary, and would support the above policies.

The specifics for policies will become clearer as the IRWMP process proceeds and other analytical work, such as groundwater monitoring and pilot studies, provide data. Then, a set of criteria should be developed against which to measure any proposals for GWR or other project that would affect the quantity or quality of water in the basin. For a GWR-RW project, management of water quality and monitoring should be emphasized since use of recycled water instead of imported water could raise concerns regarding water quality impacts.

Finally, interagency agreements will be prepared to document the policies and criteria. Examples of these agreements include between:

- GWRJPA and AVEK/PWD/LCID for purchase of imported water
- GWRJPA and LACSD for purchase of recycled water
- GWRJPA and wholesalers/retailers for storage and/or purchase of recharge water
- GWRJPA and agricultural users for direct delivery of imported, recycled, and/or extracted water

Table 6-6 lists the major stakeholders that may participate in the agreements and the functions they provide.

Table 6-6: Institutional Stakeholder Functions

Stakeholders	Functions
AVEK	• State Water Project contractor • Purchase water for blending • Conveyance for blending water • Conveyance for extracted water • Utilization of current and future system capacity to transport water
City Lancaster Public Works	• Stormwater management for use in recharge • Land use policies in Lancaster • Implementing retail recycled water program
City of Palmdale Public Works	• Stormwater management for use in recharge • Land use policies in Palmdale
Edwards Air Force Base	• Interested in minimizing runoff from the region onto the dry lake bed
GWRJPA	• Manage GWR program
LACSD	• Construct and operate supplemental water recycling facilities
LCID	• State Water Project contractor • Retail water agency • Utilizes ground water
PWD	• State Water Project contractor • Retail water agency • Utilizes ground water
Private Agricultural Well Users	• Utilization of groundwater • Ag return flow management
Los Angeles County Flood Control District	• Stormwater management for use in recharge • Land use policies for unincorporated areas
QHWD	• Retail water agency • Utilizes ground water
WWD No. 40	• Retail water agency • Utilizes ground water
Western Development and Storage, Inc.	• Working on a water banking program

6.2.4 Financial/Funding Strategies

Cost-Benefit Analysis

The first step in approaching financing is for the lead agency to work with project participants to determine the project costs and benefits to the participants, as presented in Section 6.1.4. This will most likely be a negotiated process among the participants.

Preliminary benefits and costs were developed in this Study; but benefits and costs must be refined as more detailed studies are completed and the extent of participation by the various agencies is defined. It is anticipated that the key participants for the project would be AVSWCA and LACSD (see Operational

Strategy). This step is closely related to the development of institutional arrangements and should therefore be completed simultaneously.

The hydrogeologic results of this study indicate that over the short term, say up to 3 years, recharge operations can be localized, which implies that those entities with wells distant from the recharge zone do not necessarily need to participate financially because they will not see any immediate benefit. However, if the ultimate policy is to progressively increase storage in the entire basin, then there would be a regionalized benefit that would call for regional cost sharing.

Sources of Capital Funding

A second step will be to determine the sources of capital funding. This step should be undertaken by the lead agency and the project participants. Several sources could be available:

- Grants & Loans
- Pay-as-you-go
- Municipal Revenue Bonds
- Loan Revenue Bonds

Grants & Loans

Grant funds and loans may be available from State or Federal agencies for eligible projects. **Table 6-7** summarizes potential GWR-RW project grant funding sources. **Table 6-8** summarizes potential GWR-RW project loan sources.

Table 6-7: Example of Potential GWR Project Grant Funding Sources

Program	Agency	Status	Summary
Prop 50, Chapter 8: IRWMP	DWR & SWRCB	Active	Groundwater recharge and recycled water construction projects can be included as part of an IRWMP grant proposal.
Prop 84	DWR & SWRCB	Under Development	Prop 84 includes similar projects as Prop 50, Chapter 8: IRWMP
Local Groundwater Assistance	DWR	No Funds Available	Grants up to $250,000 for groundwater data collection, modeling, monitoring and management studies.
Groundwater Storage Construction	DWR	No Funds Available	Grants for conjunctive use feasibility studies, pilot projects and construction.
Water Recycling Fund Program – Planning	SWRCB	Active	$75,000 for facility planning grants for recycled water facilities and distribution system projects. $5 million grants for construction of recycled water facilities and distribution system projects.
Title XVI	USBR	Awaiting reauthorization	Up to $20 million grant for construction of recycled water demonstration and construction projects. Construction funds only for projects specifically authorized by U.S. Congress.

Table 6-8: Example of Potential GWR Project Loan Sources

Program	Agency	Status	Summary
New Local Water Supply	DWR	Active	Non-subsidized loans for up to $500,000 for feasibility studies and $5M for projects that increase local supply.
Groundwater Recharge	DWR	No Funds Available	Loans up to $5M for GWR, salinity intrusion barrier projects.
Clean Water SRF Program	SWRCB	Active, oversub-scribed	Up to $15M in subsidized construction loans for recycled water facilities and distribution system projects.

The SRF Loan Program provides low-interest loan funding for construction of publicly-owned wastewater treatment facilities, local sewers, sewer interceptors, water reclamation facilities, as well as, expanded use projects, such as implementation of non-point source projects or programs and stormwater treatment. Amounts available range from $200 to $300 million annually. Loans with a 20-year term carry an interest rate equal to one-half the most recent State General Obligation Bond Rate, typically 2.5% to 3.5%. The application process is continuous.

Pay-As-You-Go

The Pay-As-You-Go method of funding requires adequate water sales or other fee revenue generation and reduces the overall costs by avoiding the costs associated with arranging debt financing (costs for bond issue, legal advisers, and financial advisers). With a program that will take many years to permit and construct, the project proponent has the opportunity to develop a rate structure to provide excess revenues that can be reserved for future capital improvements.

Municipal Revenue Bonds

Municipal Revenue Bonds are long-term debt obligations for which the revenue of the issuer is pledged for payment of principal and interest. The security pledged is that the project will be operated in such a way that sufficient revenues will be generated to meet debt service obligations.

Typically, issuers provide assurances to bondholders that funds will be available to meet debt service requirements through two mechanisms: provision of a debt service reserve fund or a surety and a pledge to maintain a minimum coverage ratio on the outstanding revenue bond debt. To the extent that the borrower can demonstrate achievement of coverage ratios higher than required, the marketability and interest rates on new issues may be more favorable.

State Revenue Bonds

Whereas this is a long term plan, and there is interest in the California State Legislature to support water recycling through State Bonds, there will likely be additional State Bond money that will be available at a future date. For example, Proposition 84, which was passed in the November 2006, allocates up to $1 billion to IRWMP projects. Hence, the agencies should inform their state legislators of the project plan to gain their political support.

Revenue Sources

Revenue sources typically fall into the categories of connection fees, water availability standby charges, system charges, property taxes, and commodity rates.

Connection fees are a commonly used funding source that are paid by developers or individual new connections for the equivalent cost of constructing new water facilities to serve other users to offset the demand created by the development. Connection fees are determined by the overall costs, the allocation to these costs to various benefit zones and the number of new connections expected in each of the benefit zones.

For example, AVEK is currently collecting a development fee for projects identified in their 10-Year Capital Facilities Improvement Program. There is a possibility that these funds could be applied to recharge basins since SAT could replace the function of a water treatment plant, assuming disinfection occurs after groundwater extraction. Also, new imported water conveyance to and from the recharge basins could replace expansion of raw and treated water conveyance facilities.

If the lead agency has taxing authority, another approach to supplement income is to establish a water availability standby charge. This is a levy of a minor amount on a per acre basis, for example, $10 per acre or per parcel for land less than an acre. It is imposed on the basis that the property receives benefit from the agency regardless of whether the parcel is currently receiving service and should therefore participate in the cost of making the capital improvements necessary to make service available.

Commodity rates are the per volume unit rates the purveyor charges for supplying water. For this project it is likely that a water extraction fee would be established for removing water from the recharged groundwater. Also, many banking programs charge a volumetric (commodity) fee per af of storage per year. This then would be passed along to ultimate consumers by the retailing agency.

Summary

Given the timing of the project, the most promising source of State or Federal dollars is Proposition 84 dollars through the IRWMP process. The lead agency should therefore line up the project through the current IRWMP process. The lead agency should also start working with all water resources agencies in the Valley to develop a single Federal funding request for water resources projects. The funding could come through Title XVI or direct appropriation.

Realistically no outside source of funding would cover the entire capital cost so some form of local funding, such as a bond or certificates of participation will be needed. The most appropriate source of local funding would need to be established through the development of a financial plan by the lead agency and project participants. The debt from capital funding as well as O&M costs would be paid through revenue sources, which typically fall into the categories of connection fees, water availability standby charges, system charges, commodity rates, and property taxes. AVEK has been collecting development fees for projects identified in their 10-Year Capital Facilities Improvement Program. Some of the projects relate to a regional GWR project. Many banking programs charge a volumetric (commodity) fee per af of storage per year; this is another option that the participating agencies could consider.

6.2.5 Public Acceptance Strategy

Successful projects such as the Orange County Water District Groundwater Replenishment Program and the Scottsdale [Arizona] Water Campus project have conducted extensive public relations campaigns. These and others were case studies used in the preparation of the recommendations in the WateReuse Foundation study *Best Practices for Developing Indirect Potable Reuse Projects, Phase 1 Report*[75]and the related web site.[76]

It is assumed that the proponent will have on staff or retain expertise in public and intergovernmental relations. The primary responsibility would be to coordinate translating the technical information from the planners and designers to a form that can be understood and considered by the public and the policy makers.

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[75] Best Practices for Developing Indirect Potable Reuse Projects: Phase 1 Report (WateReuse Foundation, 2004). Available at: www.watereuse.org/Foundation/researchreport.htm.

[76] www.watereuse.org/Foundation/resproject/WaterSupplyReplenishmt/index.htm

Key recommendations outlined below are modeled on the recommendations of the aforementioned *Best Practices Report* and web site.

Step 1: Understand and Support Policy Makers

- **Collaborate with policy makers:** The policy makers are those board or city council members who adopt policy and their staff members who draft and recommend policy. The influential organizations have been identified as the stakeholders who participated in this study. Land use policy makers are also important to the program.
- **Develop Foundation of Written Support:** The objective of this activity is to document support. The form would be a catalog of letters from agencies and individuals. These collectively build a mutually understood foundation that can be cross referenced between politicians and organizations. Operationally, the project proponent would inform each organization or individual about the project and solicit letters of support or a resolution of support from a governing body for the project. In those cases where there is dissent, additional efforts would be needed to determine the reasoning behind the position, and work to developing informed consent for the project.
- **Develop Political Champions:** Because there are multiple agencies involved in the project, the project proponent should develop political champions within each of the key agencies. These would be individuals who understand the project and are genuinely interested in promoting it to their peers and constituents. They would also be go-to resources for media.

Step 2: Build Strong Relationships

- **Define Priority Relationships:** Research has shown that one-on-one discussion with individuals ultimately yields a high degree of understanding and support for this type of project. However, it is not possible to reach everyone. Identify the organizations and individuals who are most likely to oppose the program, provide them with information, and provide an avenue such as organized meetings or presentations to their organization that allows for them to express their concerns. Provide feedback on actions taken as a result of their input.
- **Identify Early Supporters:** Early in the outreach process, obtain written support from those most familiar with the project. The organizations in the stakeholders list are the best place to begin.
- **Create Water Quality Confidence:** Member agencies of the GWRJPA have developed a reputation in the services they deliver. This needs to be leveraged by emphasizing their reputation and ability to deliver a quality product.
- **Turn Conflict and Opposition into Assets:** The public affairs manager and the leaders in the members of the GWRJPA and the other organizations that will benefit from the program must seek out existing or potential conflict. Create events designed to find opponents early.

Step 3: Communicate with Purpose and Diligence

- **Adopt a Collaborative Communication Style:** It is essential to focus on listening and learning what the key issues are. In getting to root opinions, it may be necessary to ask “why” many times to probe deeply enough to find the ultimate foundation of the opinion. In many cases, there will be an emotional response.
- **Lead a Meaningful Dialog:** This is a water supply project that has the opportunity to incorporate recycled water. Communications must emphasize the overall water availability and storage issue, the fact that the proponent is the best agency to solve the problem, and the agency’s commitment to solving the problem.

- **Pay Attention to the Media:** Develop relationships with the Antelope Valley Press and the Los Angeles Times, and other newspapers where unfavorable news may be of concern. Typically, there is a beat reporter that follows issues.
- **Understand Public Sentiments:** Establish a system to document all feedback from audiences during all meetings. The person responsible for this would be the public relations director. The information should be compiled and analyzed for trends, recurring issues that need to be addressed, and potentials for conflict.

The lead agency should immediately develop and implement a public outreach program building upon these recommendations. Outreach activities to be defined as part of the program are anticipated to include a 6-month to 1-year public outreach campaign on water resources issues to establish the need for solutions/projects. This campaign should take place immediately. The campaign would then evolve to focus on the solutions, including GWR-RW projects.

6.2.6 Pilot GWR-RW Program

Although large-scale GWR-RW within Antelope Valley shows high potential, timing of implementation depends on two processes unknowns: timing of large-scale groundwater banking and resolution of the groundwater adjudication process. Since it is important to move forward with the general concept of GWR-RW, a logical first step towards implementation could be the development of a local pilot GWR-RW program.

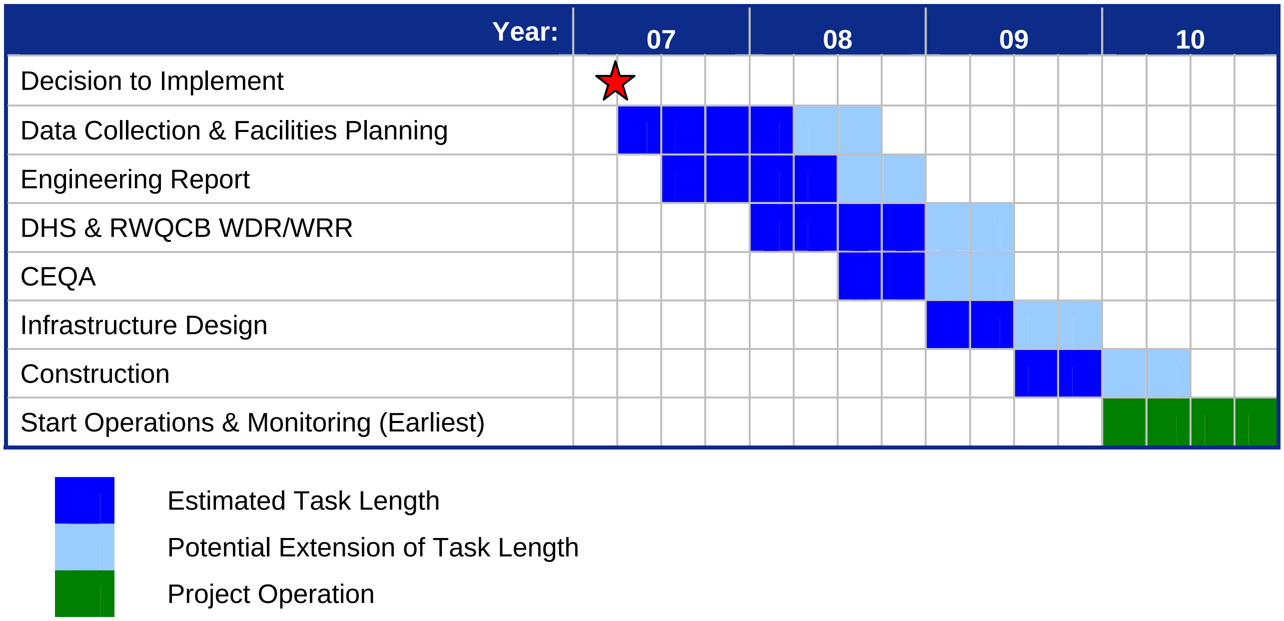
Site selection and design of the pilot program could incorporate stormwater basins that are used for recharge of stormwater. Recycled water could be available from LACSD (such as from the 1 mgd MBR facility that recently began operation at LWRP) and could be conveyed via existing or planned recycled water pipelines serving the urban areas with possible extensions to the recharge basin. Imported water could supplement stormwater as the blend supply.

Implementation of a pilot GWR-RW program would provide similar benefits and avoided costs to the program partners but on a smaller scale than a regional project. The pilot program would enhance the feasibility of implementing the regional GWR-RW project by:

- Providing water quality and reliability data that will help optimize the regional project definition
- Demonstrating attainment of regulatory requirements, while avoiding basin-wide issues such as salt and nitrogen management and Basin Plan Amendment
- Providing a forum to resolve institutional issues surrounding the regional project with a reduced number of partner agencies
- Providing a forum for public review

The total process should take three to four years, as shown in **Figure ES-7,** and could begin operations by 2009-2010 or 2010-2011 wet season.

Figure 6-6: Pilot GWR-RW Program Timeline



Year:	07				08				09				10			
Decision to Implement	★															
Data Collection & Facilities Planning		🟦	🟦	🟦	🟦	▨	▨									
Engineering Report			🟦	🟦	🟦	🟦	▨	▨								
DHS & RWQCB WDR/WRR					🟦	🟦	🟦	🟦	▨	▨						
CEQA							🟦	🟦	▨	▨						
Infrastructure Design									🟦	🟦	▨	▨				
Construction											🟦	🟦	▨	▨		
Start Operations & Monitoring (Earliest)													🟩	🟩	🟩	🟩

🟦 Estimated Task Length

▨ Potential Extension of Task Length

🟩 Project Operation

6.2.7 Immediate-Term Tasks

A number of the GWR-RW project implementation tasks would be completed as part of the regional GWR project implementation. Examples of such tasks include defining the imported water supply plan, conducting hydrogeologic characterization, collecting imported water quality data, identifying recharge basins, developing a GWR regulatory strategy, pursuing outside funding and developing a public outreach program.

This following outlines immediate-term tasks required to implement the baseline project and support a pilot program in addition to those required to be completed as part of the regional GWR project:

- **Identify Lead Project Proponent:** Identify lead entity to incorporate the baseline GWR-RW project into the regional GWR project and promote GWR-RW project benefits relative other water resource solutions in the Valley.
- **Complete Implementation Decision Process:** Determine appropriate subsequent efforts needed to select a GWR-RW project as a viable solution to the Valley's water resources issues, such as updating the Regional Recycled Water Master Plan.
- **Define GWR Project Components:** Incorporate GWR-RW requirements for GWR project components, such as imported water supply plan and facilities recharge sites, and extraction facilities, so that components of the baseline project can be better defined.
- **Refine GWR-RW Project Components:** Document GWR-RW project-specific components, such as recycled water supply plan and facilities.
- **Incorporate Stormwater Planning:** Continue to develop stormwater master plans for the Valley that incorporate recharge and coordinate with the GWR-RW project.
- **Conduct Hydrogeologic Characterization:** Include URT in hydrogeologic characterization efforts in preparation for development of an engineering report.
- **Collect Imported Water Quality Data:** Incorporate imported water quality data collection in preparation for development of an engineering report.

- **Identify Recharge Basins:** Incorporate siting of recharge basins relative to potable wells and potential mitigation measures for relocation of potable wells.
- **Implement Regulatory Project:** Commence regulatory elements specific to GWR-RW projects in parallel to GWR project efforts and determine if a regional TDS/N Management Plan would be beneficial to GWR-RW project implementation.
- **Implement Funding / Financial Project:** Identify potential funding opportunities for GWR-RW project planning and investigate financing project to build upon regional GWR project.
- **Implement Public Outreach Program:** Build upon public outreach program for the regional GWR project (once established) to develop a comprehensive public outreach program that includes recycled water.

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