EXECUTIVE SUMMARY
Lower San Luis Rey River Valley GROUNDWATER STORAGE AND RECOVERY FEASIBILITY STUDY: PHASE 1

1.0 PURPOSE OF STUDY

This report summarizes the first phase of a planned three-phase study to evaluate the feasibility of Groundwater Storage and Recovery (GSR) projects in the Lower San Luis Rey River Valley in Northern San Diego County. The San Diego County Water Authority (Authority) is conducting this three-phase study as part of the 2030 Regional Water Facilities Master Plan.

The purpose of Phase 1 is to evaluate the feasibility of storing surface-water supplies in the Mission and Bonsall Groundwater Basins for subsequent recovery and use.

Conjunctive-use (i.e. groundwater storage and recovery projects) could enhance groundwater yields in the study area by providing artificial replenishment to the groundwater basins. The Authority is performing this study in conjunction with a similar effort in the southwest portion of its service area (San Diego Formation Aquifer Storage and Recovery Feasibility Study). Groundwater storage and recovery project alternatives may include, but are not limited to, the recharge, storage, and recovery of imported water, local-rainfall runoff, and/or recycled-municipal wastewater (reclaimed water).

a. ***Study Approach***

The Phase 1 scope of work includes the following general work tasks:

- Compilation of available water resources data and information regarding the study area;
- Development of Geographical Information System (GIS)-based mapping and data for the study area;
- Evaluation of hydrogeology and existing and planned groundwater use
- Evaluation of existing water systems engineering constraints to the implementation of groundwater storage and recovery projects;
- Conceptual design of alternative groundwater storage and recovery projects;
- Preliminary evaluation of permitting and environmental issues related to groundwater storage and recovery project concepts;
- Development of costs and benefits, and ranking criteria for groundwater storage and recovery project concepts; and
- Development of recommended Phase 2 work activities; and

Phase 1 is a "desktop" study, which is primarily based on existing data and information previously developed by others. The primary goal of Phase 1 was to develop candidate project concepts that warrant further study based on a preliminary estimate of costs and benefits.

Based upon the results of Phase 1 study and subsequent discussions with its member agencies, the Authority may elect to study selected project concepts further during Phases 2 and 3 of the study. Phase

2 will likely include additional refinement of Phase 1 project concepts, discussions with regulatory agencies regarding the Phase 1 project concepts, field investigations to obtain additional hydrogeologic data, and further analysis of the technical and political feasibility of selected project concepts.

Phase 2 field investigations could include subsurface explorations and groundwater modeling. The purpose of these activities would be to further evaluate specific assumptions regarding aquifer characteristics and behavior to enhance the study team's understanding of how groundwater storage and recovery projects might perform. Phase 3 would likely include additional engineering analysis to further refine project concept design, operational scenarios, and costs and benefits based on Phase 2 data.

Existing hydrogeologic information about the groundwater recharge and extraction potential of the Mission and Bonsall Basins in the Lower San Luis Rey River Valley was reviewed by the study team. In addition, information regarding existing and planned local water systems was gathered from both the Authority and its member agencies. This information was subsequently used to identify potential project concepts and possible recharge and extraction sites.

b. ***Study Area***

The study area is located in Northern San Diego County and within the Authority's service area. It includes the alluvial aquifers identified as the Mission and Bonsall Groundwater Basins and hydrologic units within Lower San Luis Rey River Valley (LSLRRV). The Mission Groundwater Basin (Mission Basin) lies almost entirely within the City of Oceanside. The Mission Basin extends upstream from the Pacific Ocean past the eastern boundary of City of Oceanside just west of the Bonsall Bridge (near the intersection of Highway 76 and S13) (Figure ES-1). The Bonsall Groundwater Basin (Bonsall Basin) is located east of the Mission Basin generally within unincorporated areas of San Diego County. The Bonsall Basin extends to a point about one mile west of the intersection of Rice Canyon Road and Highway 76.

Local retail water agencies, including Authority member agencies, that have an interest in the development of groundwater resources within these basins. Authority member agencies include Carlsbad Municipal Water District (CMWD), City of Oceanside, and Rainbow Municipal Water District (RMWD). Representatives of these agencies formed a Project Advisory Committee (PAC) for this project. The role of the PAC during the Phase 1 study was to review study findings and provide input to the study team on groundwater storage and recovery project alternatives.

During the Phase 1 study, three meetings were held with the PAC. The initial PAC meeting was held on October 27, 1998. At the meeting, study plans were introduced, data gathering and some preliminary project concepts developed by the study team (Authority and consultant staff) were discussed. Following this initial meeting between the PAC members and the study team, individual meetings were held with each PAC member to further discuss the study and data needs, and possible project concepts. The second PAC meeting was held on March 10, 1999 to introduce and discuss preliminary project concepts developed by the study team. Following this meeting, the study team refined the project concept operational scenarios, estimated capital and operating costs, and

developed a list of potential project benefits and institutional issues. These items were presented to the PAC at the third PAC meeting held on July 15, 1999.

c. ***Previous Studies***

The Mission and Bonsall groundwater basins have been the subject of numerous water resources management studies and project studies conducted by local agencies, the Authority, and other federal and state agencies. Many of these studies date back nearly 40 years and were performed to examine the water resources associated with the basins or implement specific potable and reclaimed water transmission, supply or storage programs, or drainage and flood control projects. Others that have studied water resources within the basins include the U.S. Geological Survey (USGS), California Department of Water Resources (DWR), California State or Regional Water Quality Control Board (State or Regional Board), California Department of Health Services (DHS), U.S. Army Corps of Engineers (COE), and the County of San Diego.

2.0 HYDROGEOLOGY

Hydrogeology of the Mission and Bonsall Groundwater Basins has been described by various federal, state, regional, and local agencies. The study team has used results from previous studies and investigations for its preliminary evaluation of the potential for groundwater storage and recovery in the study area.

a. *Description of the Mission Basin*

The Mission Basin is a shallow, alluvium-filled valley located at the western terminus of the San Luis Rey River. The river alluvium extends about nine miles from the narrow canyon at the western, or downstream end (adjacent to the Pacific Ocean), to the Bonsall (bedrock) Narrows near the Bonsall Bridge at the upstream or eastern end. Due to the generally coarse-grain character of river alluvium, it will readily yield water to wells.

The alluvium is unconsolidated and exceeds 200 feet in thickness in some places, (USGS, December 1985). The ground-surface elevation/ surface of the alluvium ranges from approximately 120-feet above mean sea level (amsl) at the east end of the Bonsall Basin (at Bonsall Narrows) to approximately 10-feet amsl in the canyon at the western end of the basin.

The maximum or "gross" groundwater storage capacity of the Mission Basin is estimated to be approximately 90,000 acre-feet. **The usable storage of the Mission Basin is estimated to be roughly 30,000 acre-ft.** Usable storage has been estimated based on records of historical low groundwater elevations, estimates of the total volume of alluvial materials, and the specific yield of those materials.

According to USGS investigations, groundwater in the Mission Basin is generally unconfined in the eastern part but generally semi-confined or confined in the western part. However, the horizontal extent, depth, and thickness of the confining layers have not been well defined throughout the basin.

Groundwater in the Mission Basin generally contains moderately high concentrations of Total Dissolved Solids (TDS), Chloride, and Sulfate. Analytical results of water quality samples collected by the USGS in Spring 1983 indicate the TDS concentrations ranged from 1,220 to 1,540 milligrams per liter (mg/l), Chloride concentrations ranged from 320 to 630 mg/l, and Sulfate concentrations ranged from 150 to 360 mg/l (USGS, December

1985). Analytical results of water quality samples collected from three pumping wells in 1991 and 1996 are consistent with these ranges (Oceanside, September 1991 and February 7, 1997(a).

The TDS, Chloride, and Sulfate concentrations have exceeded the recommended secondary standards for drinking water set by the State of California (500 mg/l for TDS and 250 mg/l for Chloride and Sulfate). High TDS concentrations in the western portion of the Mission Basin are thought to be the result of seawater intrusion that was reported to have occurred as early as the mid-1940's following a period of low rainfall and extensive groundwater pumping.

b. *Description of the Bonsall Basin*

The Bonsall Basin is located northeast and immediately upstream of the Mission Basin. It is a relatively shallow and narrow alluvium-filled river basin underlain by crystalline bedrock. The Bonsall Basin alluvium extends from the Bonsall (bedrock) Narrows (Bonsall Bridge) to Monserate (bedrock) Narrows, located east of I-15. The Bonsall Basin is approximately nine miles long with an average width of about one-half mile and a maximum width of approximately one-mile. Its thickness ranges from approximately 50 feet in the Bonsall Narrows area to 75 feet or more in the Monserate Narrows area (USGS, 1974). The ground surface elevation ranges from approximately 280-feet amsl in the Monserate Narrows area to approximately 120-feet amsl in the Bonsall Narrows area.

The maximum or "gross" groundwater storage capacity of the Bonsall Basin is reported to range from approximately 18,000 acre-feet (USGS, 19745) to 40,000 acre-feet (SDCWA Groundwater Feasibility Study, September 1995).

The usable storage of the Bonsall Basin is estimated to be about 9,000 acre-ft. Usable storage has been estimated based on historical records of low groundwater elevations, an estimate of the volume of alluvial materials in the basin, and the specific yield of those materials.

Groundwater in the Bonsall Basin has experienced similar water quality problems of the Mission Basin. Analytical results of water samples collected in Spring 1984 (EarthInfo Inc., 1996) indicate the TDS concentrations ranged from 694 to 2,330 mg/l, Chloride concentrations ranged from 120 to 580 mg/l, and Sulfate concentrations ranged from 210 to 760 mg/l. The best groundwater quality is found in the eastern portion of the basin. The poorest quality groundwater is found in the central part of the Bonsall Basin (USGS, December 1985). Analytical results of water quality samples collected from two production wells in 1995 are consistent with these ranges (RMWD, January 1996).

3.0 ENVIRONMENTAL REGULATIONS

Implementation of Groundwater Storage and Recovery project concepts in the Mission and Bonsall Basins will require careful consideration of potential environmental issues and permitting requirements related to sensitive habitats and the use of reclaimed water. Projects could result in impacts to local wetland or riparian habitats. California and federal environmental laws require project impact analysis and sometimes mitigation to protect listed threatened and endangered species. The California Department of Fish and Game (DFG) and the US Fish and Wildlife Service (USFWS) are the

primary agencies responsible for the enforcement of laws that are intended to protect endangered and sensitive species and their habitats. The U.S Army Corps of Engineers (USACOE) is responsible for regulating activities that may affect flood control. Aspects of a GSR program that these agencies might be interested in reviewing include:

- the construction of facilities;
- potential project impacts to surface water flow or quality;
- potential project impacts to the salinity of the San Luis Rey River estuary;
- potential project impacts on depths to groundwater; and
- potential project impacts to terrestrial and aquatic habitats.

An environmental impact report (EIR) will likely be required before implementation of groundwater projects in the Lower San Luis Rey River Valley. The EIR would detail potential impacts to environmentally sensitive areas. Implementation of groundwater project components may potentially impact wetlands, waters of the U.S. or critical habitat/species. If potential impacts to endangered species are identified, the regulatory agencies may require mitigation habitat to be developed and maintained as a condition of project approval. Other agencies that may require permits/approvals include:

- USEPA
- California Regional Water Quality Control Board - San Diego Region

Permit Requirements for the Protection of Human Health

The California Department of Health Services (DHS) and the County of San Diego Environmental Health Services Department (SDEHS) regulate activities that could potentially impact the public health. These activities include water well construction, use of reclaimed water, and drinking water treatment. In addition to the construction of the recharge/extraction component of a groundwater project, appurtenant facilities include conveyance pipelines, electrical services, protective fencing, and treatment facilities. Construction management aspects are regulated by several local entities such as the City of Oceanside Engineering Department and County Department of Public Works and Real Property Division.

Local Construction and Zoning Permit Requirements

In addition to local ordinances, an applicable federal regulation is Government Code 53091, which states that building, and "zoning ordinances of a county or city shall not apply to the location or construction of facilities for the production, generation, storage, or transmission of water." Under this regulation, groundwater wells are typically exempt from local jurisdictional zoning and building permit requirements. This code, however, does not apply to the engineering permit requirements within a local jurisdiction. Local engineering department permit requirements typically concern public right-of-way encroachments and connections to existing public facilities.

4.0 PROJECT CONCEPTS

Groundwater Storage and Recovery project concepts developed in this Phase 1 feasibility study could provide a constant yield that will be sustained with artificial replenishment provided on a seasonal basis.

The need for constant yield projects is driven by the anticipated need to demineralize stored groundwater upon extraction. It is assumed that water used to replenish either the Mission or Bonsall Basin will mix with poor quality groundwater currently stored in these basins and be degraded to the point that it will require demineralization. For both economic and operational reasons, it is assumed that the demineralization treatment facilities will need to be operated constantly (as opposed to facilities that could be available on a standby basis).

It should be noted that proposed facilities referred to in this report are in addition to those currently required for the planned Oceanside's 6.37-MGD expansion of the Mission Basin Desalter. In addition, it is important to note that the use of Oceanside facilities has been assumed. Besides the existing Mission Basin Desalter facility site, those facilities include existing wells, recharge sites, and conveyance facilities owned by the City of Oceanside, as well as some of the City's other planned facilities. As such, implementation agreements with the City of Oceanside would be an integral component of any Groundwater Storage and Recovery Project in the Mission Basin.

Project concepts have been sized based upon each basin's estimated usable storage potential, or in the case of concept 1, the amount of reclaimed-water recharge that is projected to be available.

The project concepts developed by the study team are briefly identified as follows:

1. Mission Basin 1.63-MGD Desalter with seasonal recharge of reclaimed water.
2. Mission Basin 6.70-MGD Desalter with provisions to supply Carlsbad MWD, and facilities for groundwater storage and recovery of both reclaimed and discounted-imported water.

2A. Mission Basin 10.0-MGD Desalter with provisions to supply Carlsbad MWD, and facilities for groundwater storage and recovery of both reclaimed and discounted-imported water.

3. Mission Basin 6.70-MGD Desalter with facilities for groundwater storage and recovery of reclaimed and discounted-imported water, plus expansion and regional use of City of Oceanside's Weese Filtration Plant (WFP).

3A. Mission Basin 10.0-MGD Desalter with facilities for groundwater storage and recovery of reclaimed and discounted-imported water, plus expansion and regional use of City of Oceanside's Weese Filtration Plant (WFP).

4. Bonsall Basin 3.60-MGD Desalter with facilities for groundwater storage and recovery of discounted-imported water.

4A. Bonsall Basin 4.60-MGD Desalter with facilities for groundwater storage and recovery of discounted-imported water.

1. *Mission Basin 1.63 MGD Desalter Project*

The project would supply an additional 1.63 MGD (1825 acre-ft/year) to the City of Oceanside. This concept would operate as a constant yield /seasonal storage project to supply a portion of the City of Oceanside's local demands in its 320-pressure zone. It is thought to be a feasible next step expansion in the City's groundwater program, if the City's

reclaimed water facilities are expanded. Project capacity is based upon the artificial recharge that could be provided by Title 22 reclaimed water from the City's San Luis Rey WWTP.

2/2A. ***Mission Basin 6.70/10.0 MGD Desalter project with provisions to supply Carlsbad MWD and Seasonal and/or Carryover Storage Operations***

The project would supply an additional 6.70 /10.0 MGD (7504 /11,200 acre-ft/year) of potable water to City of Oceanside, Carlsbad MWD, and other member agencies connected to the Authority's North County Distribution Pipeline.

Project concept No. 2 is based on a continuous extraction and a three-year outage of imported-water replenishment, while Project Concept 2A is based on a two-year outage for imported water replenishment.

This project concept(s) could provide a constant yield and use both carryover and seasonal storage groundwater. Oceanside would use the water to supply either its 320 or 511-pressure zones and Carlsbad MWD could supply either its 255 or 490-pressure zones. Other agencies that are connected to the NCDP at the Oceanside 6/VID 11/Rainbow 12 FCF could also receive Mission Basin groundwater through a new connection and pump station at that location.

Artificial recharge could be provided by Title 22-reclaimed water from the City's San Luis Rey WWTP and unfiltered imported water from the Authority's Second Aqueduct. However, if the imported water recharge supply is curtailed, such as after an earthquake or during a prolonged drought, it is assumed that water in carryover storage in the Mission Basin could be extracted to maintain production of the groundwater demineralization facility.

The extent to which the Basin can be drafted and how much storage in the basin can be utilized by the project are unknown. The availability of storage needs to be evaluated further during subsequent field investigations and modeling studies and ultimately addressed by a groundwater management plan. However, for the purposes of this conceptual description, it is assumed that all usable storage in Basin could be extracted. It is assumed that groundwater in (carryover) storage could extracted and then replenished following restoration of imported water service.

A seawater-intrusion barrier is also assumed in this concept since it is assumed that he Basin would be overdrafted during when replenishment water was unavailable. Advanced Tertiary reclaimed water from the San Luis Rey WWTP, a more reliable source of replenishment water, would be used for the seawater-intrusion barrier. When the basin is nearly full, the reclaimed water could be directed away from the seawater-intrusion barrier and into a recharge pond further inland. The reclaimed water for the seawater barrier could be injected at the Mission Basin narrows near Interstate 5. It is assumed nanofiltration would be performed on the reclaimed water before injection, although the need for this will be further evaluated in subsequent phases of the study.

3/3A. ***Mission Basin 6.70/10.0 MGD Desalter with Regional use of the Weese Water Filtration Plant***

This project would supply an additional 6.70 /10.0 MGD (7504 /11,200 acre-ft/year) of potable water to City of Oceanside and Carlsbad MWD, and an equal amount of treated water to other

Authority member agencies located south of the Weese Filtration Plant. This project concept proposes to expand Mission Basin groundwater production by either 6.70-MGD (Project Concept 3) or 10.0-MGD (Project Concept 3A) and construct a corresponding increment of additional treatment capacity at the City of Oceanside's Weese Filtration Plant. The expanded Weese Plant capacity could be used by the Authority to serve member agencies south of the plant's location in Northern San Diego County.

During periods when imported-water replenishment is not available, the basin could be overdrafted, as discussed under Concept No. 2, until such time as the replenishment supply again becomes available.

4/4A. *Bonsall Basin 3.60/4.60-MGD Desalter with Groundwater Storage and Recovery Operations*

This project could supply an additional 3.60 /4.60 MGD (4032 /5152 acre-ft/year) of potable water to Rainbow MWD and offset filtered-water aqueduct deliveries. This project concept could supply a constant yield and use both the carryover and seasonal storage capacity of the Bonsall Basin. Project capacity of 3.6-MGD is based on a three-year extraction period without replenishment, and the 4.6-MGD is based upon a two-year extraction period without replenishment.

Artificial recharge could be provided by imported water from the Authority's Second Aqueduct. However, if the imported-water recharge supply is curtailed, such as after an earthquake or during an extended drought, it is assumed that water in carryover storage in the Bonsall Basin would be utilized to supply the District. The extent to which the Basin can be drafted is unknown and needs to be further evaluated during subsequent phases of the study.

Available data indicates historic-low groundwater levels equate to a usable storage of approximately 9,000 acre-ft. As the case with the Mission Basin concepts, it is assumed this volume could be extracted from storage over either a two or three-year period, and then replenished over a corresponding period following restoration of imported-water service.

5.0 PROJECT COSTS AND BENEFITS

Project Costs

Project costs were calculated and converted to unit costs in dollars per acre-ft of potable water a project could produce. The total unit costs consist of three primary elements:

- Unit cost for amortized capital for facilities construction
- Unit cost for amortized Operation & Maintenance costs
- Unit cost for amortized recharge water costs

These were organized into subcategories including Replenishment and Extraction Costs, Treatment Costs, Distribution Costs, and Replenishment Water Costs for both seasonal/carryover and seasonal-only operations.

Costs were calculated for the following operating scenarios:

- Mission Basin 1.63-MGD desalter expansion project concept. This includes seasonal recharge with reclaimed water from the City of Oceanside's San Luis Rey WWTP over a six-month period every year and does not include carryover storage extraction or replenishment.

- Mission Basin 6.70 /10.0-MGD desalter expansion project concepts. Both concepts include seasonal recharge with seasonally-discounted water over a six-month period every year and do not include carryover extraction or replenishment.
- Mission Basin 6.70 /10.0-MGD desalter expansion project concepts. Replenishment could typically be performed on a seasonal basis (as in the previous concept), however; replenishment could be performed using long-term-storage imported water. During periods when the long-term-storage water is unavailable, the project would maintain production by extracting groundwater from carryover storage.
- Mission Basin 6.70 /10.0-MGD desalter expansion with Regional use of WFP. These concepts would operate very similar to the concept described above in terms of the schedule for groundwater recharge and extraction. It has been assumed that the WFP would operate continuously without regard to the groundwater recharge schedule.
- Bonsall Basin 3.60/ 4.60-MGD desalter project concepts. Again, replenishment could be performed on a seasonal basis, however; recharge would be performed using long-term-storage imported water. During periods when the long-term-storage water is unavailable, the project would maintain production by extracting groundwater from carryover storage.
- Bonsall Basin 3.60 /4.60 MGD desalter project concepts with replenishment using seasonally-discounted imported water only.

Unit costs for the various project concepts range from $715 to $1,283/acre-ft of potable water produced. It should be noted that for completeness these costs include distribution costs, which are typically not included in the evaluation of new water supply alternatives. Without distribution costs, the unit costs to produce water range from $589 to $1,047/acre-ft. **A cost summary for each project is shown in Table ES-1**.

Table ES-1
Cost Summary

CATEGORY	Mission Basin 1.63 MGD Desalter Unit Cost ($/acre-ft)	Mission Basin 6.70 MGD Desalter w/Provisions to Supply Carlsbad MWD Unit Cost ($/acre-ft)	Mission Basin 10.0 MGD Desalter w/Provisions to Supply Carlsbad MWD Unit Cost ($/acre-ft)	Mission Basin 6.70 MGD Desalter w/Regional use of Weese Filtration Plant Unit Cost ($/acre-ft)	Mission Basin 10.0 MGD Desalter w/Regional use of Weese Filtration Plant Unit Cost ($/acre-ft)	Bonsall Basin 3.60 MGD Desalter Unit Cost ($/acre-ft)	Bonsall Basin 4.60 MGD Desalter Unit Cost ($/acre-ft)
REPLENISHMENT AND EXTRACTION COSTS	$141	$217	$162	$109	$81	$92	$88
TREATMENT COSTS	$277	$381	$319	$258	$227	$272	$273
DISTRIBUTION COSTS	$95	$236	$213	$129	$120	$340	$319
REPLENISHMENT WATER COSTS (Reclaimed (Mission Basin only) and LTS Discount Imported Water) (SEASONAL/CARRYOVER)	--	$377	$392	$406	$419	$225	$279
REPLENISHMENT WATER COSTS (Reclaimed (Mission Basin only) and Seasonal Discount Imported Water) (SEASONAL ONLY)	$202	$449	$476	$442	$455	$292	$343
TOTAL (Seasonal Only):	***$715***	***$1,047***	***$1,170***	***$938***	***$883***	***$995***	***$1,023***
TOTAL (Seasonal Only): (w/o distribution costs)	***$620***	***$1,047***	***$957***	***$808***	***$763***	***$656***	***$704***
TOTAL (Seasonal/Carryover):	---	***$1,211***	***$1,086***	***$902***	***$847***	***$928***	***$959***
TOTAL (Seasonal/Carryover): (w/o distribution costs)	---	*$975*	*$873*	*$772*	*$727*	*$589*	*$640*

Project Benefits

Direct economic measurement of a regional storage benefit is difficult at best given the current level of understanding of how future costs may be allocated. It is apparent, however, that any measure of additional storage or treated-water capability is a benefit to the region given the future uncertainty regarding reliability of imported water supplies and the region's projected growth.

The Phase 1 study has not allocated costs for the project concepts, rather, has identified the total cost a given concept would incur to produce water.

In general, the availability of local water supplies provides increased system-wide reliability and may allow deferral of future projects to expand treated-water delivery and local treatment capacity. The Phase 1 study has developed a benefit ranking and scoring procedure that was applied to each project concept.

Benefits that have been identified and considered by the Phase 1 study include:

- Additional increment of regional treated water supply
- Increased supply reliability during a shortage
- Beneficial use of reclaimed water
- Increased capture of local runoff
- Basin management
- Public acceptance
- Regulatory, environmental and legal issues
- Interagency agreement compatibility

Each project concept was evaluated and ranked according to the above criteria and a corresponding ranking scale as discussed in Chapter 6 of the study report.

The ranking system consists of assigning a numerical scope to each concept for each benefit/ranking criterion. **A summary of project rankings is provided as Table ES-2.**

Table ES-2
Project Concept Benefit Summary

Benefit		Project Concept						
		1	**2**	**2A**	**3**	**3A**	**4**	**4A**
1	Additional increment of regional treated supply	2	3	4	4	4	2	3
2	Increased supply reliability during a shortage	4	3	2	4	4	3	2
3	Beneficial use of reclaimed water	2	2	2	2	2	1	1
4	Increased capture of rainfall runoff and San Luis Rey River return flow	1	2	3	2	3	2	3
5	Basin management	2	3	4	3	4	3	4
6	Public acceptance	1	3	3	3	3	2	2
7	Regulatory, environmental and legal issues	2	3	3	3	3	2	2
8	Interagency agreement compatibility	4	3	3	2	2	4	4
	Totals	**18**	**22**	**24**	**23**	**25**	**19**	**21**

6.0 ANALYSIS OF COSTS & BENEFITS

All of the groundwater project concepts developed during the Phase 1 study offer benefits to the region. As mentioned previously, the current understanding of the issues associated with project implementation does not allow for a direct economic comparison of how costs and benefits are realized. At this time, the study team believes that a non-economic water management benefits framework is more appropriate to determine priorities for pursuing various projects.

Each project concept provides for some measure of groundwater storage, and an opportunity to replenish the groundwater basins using discounted imported water or reclaimed water. In addition, several project concepts have been configured to supply several member agencies. In the case of the project concepts that propose Authority construction and use of additional capacity at the Weese Filtration Plant, a substantial portion of the Authority's service area can be provided with an additional increment of treated water due to expanded groundwater production in the Mission Basin.

The Phase 1 study's benefit ranking process gave Project Concept 3A - Mission Basin 10.0-MGD Desalter with Regional use of the Weese Water Filtration Plant the highest score (25). This project produces the most potable water and makes more potable water available to more agencies than any of the other concepts. It also had the second lowest total unit cost of producing water ($727/acre-ft for seasonal/carryover operation, and $763/acre-ft for seasonal-only operation).

Project Concepts 2A (Mission Basin 10.0-MGD Desalter with provisions to supply Carlsbad MWD) and 3 (Mission Basin 6.70-MGD Desalter with Regional use of the Weese Water Filtration Plant) scored next highest each with scores of 24 and 23, respectively. Both projects make treated water available to multiple agencies with total unit costs to produce water ranging from $772 per acre-ft (for seasonal/carryover operation of concept 3) to $957 per acre-ft (for seasonal-only operation of concept 2A). Both projects can continue to produce during an imported water shortage or emergency.

Project Concept 2 (Mission Basin 6.70-MGD Desalter with provisions to supply Carlsbad MWD) scored next highest at 22. This project had a total unit cost of producing water of $975 per acre-ft for seasonal/carryover replenishment operation, and $1,047/acre-ft for seasonal-only replenishment operation. The project will supply 3.47-MGD to City of Oceanside and 3.23-MGD to Carlsbad and can continue to produce during an imported water shortage or emergency. The project is also configured to alternatively supply 3.23-MGD to the NCDP agencies.

Project Concept 4A (Bonsall Basin 4.60-MGD Desalter) scored next highest at 21. This project had a total unit cost of producing water of $640 per acre-ft for seasonal/carryover replenishment operation, and $704 per acre-ft for seasonal-only replenishment operation. The project will offset 4.60-MGD (5,152 acre-ft/year) of treated water aqueduct deliveries to Rainbow MWD and can continue to produce during an imported water shortage or emergency.

Project Concept 4 (Bonsall Basin 3.60-MGD Desalter) scored next highest with a score of 19. Project Concept 1 (Mission Basin 1.63-MGD Desalter) rounded out the projects with a score of 18. These projects would supply one agency each with total unit costs to produce water ranging from $589/acre-ft (for seasonal/carryover replenishment operation of concept 4) to $656/acre-ft (for seasonal-only replenishment operation of concept 4). Both

projects can continue to produce during an imported water shortage or emergency.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- There is potential for an estimated 39,000 acre-ft of storage to be developed in the Lower San Luis Rey River Valley (Mission and Bonsall Basins) if a groundwater replenishment program is implemented.
- Groundwater storage and recovery projects in the Mission and Bonsall Basins provide the opportunity to purchase imported water at a discount.
- Mission and Bonsall Basins can provide an additional increment of treated water within the Authority's service area.
- If groundwater in the Lower San Luis Rey River Valley is replenished during the wet winter seasons and when seasonally-discounted or long-term-storage water is available, a portion of the region's treated water demand can be supplied during peak-demand periods or during prolonged droughts and relief some of the burden on the region's imported water system and surface water resources.
- Implementation of groundwater storage and recovery projects in the Mission and Bonsall Basins could also provide the opportunity to capture additional local runoff in the basins and thereby reduce the need to purchase discounted imported water for artificial replenishment. The extent to which additional local runoff could be captured by the Phase 1 project concepts has not been quantified.
- With the modification of existing water supply systems and construction of additional pipelines and pump stations, it is possible to supply Mission Basin groundwater to City of Oceanside, Carlsbad MWD and several of the NCDP agencies (Vallecitos WD and Vista Irrigation District).
- Expansion of Mission Basin groundwater production, coupled with a replenishment program, creates a potential for an in-lieu arrangement with the City of Oceanside. Such an agreement would allow the Authority to use of a portion of the Weese Filtration Plant to provide additional treated water to the majority of the Authority's service area.
- Additional groundwater production from the Bonsall Basin (used by Rainbow MWD) coupled with groundwater replenishment would offset aqueduct deliveries during periods of peak demands and extended droughts.
- Direct economic measurement of a regional storage benefit is difficult at best given the current level of understanding of how future costs may be allocated among the Authority and its member agencies. However, it apparent that any measure of storage or additional local treated water capability is a benefit to the region given the future uncertainty regarding imported water supplies and the region's projected population growth.

Recommendations

It is recommended that the Authority proceed with Phase 2 of the Lower San Luis Rey River Valley Groundwater Storage and Recovery Feasibility Study.

The study team recommends the following project concept priorities:

1. Project Concept No.3A- 10.0 MGD Mission Basin Desalter with 10.0 MGD expansion to Weese WFP
2. Project Concept No. 2A – 10.0 MGD Mission Basin Desalter
3. Project Concept No. 3 - 6.70 MGD Mission Basin Desalter with 6.70 MGD expansion to Weese WFP
4. Project Concept No. 2 - 6.70 MGD Mission Basin Desalter
5. Project Concept No. 4A – 4.6 MGD Bonsall Basin Desalter
6. Project Concept No 4 - 3.60 MGD Bonsall Basin Desalter
7. Project Concept No. 1 – 1.63 MGD Mission Basin Desalter

Project concepts with higher yields are preferred over those with lower yields in light of the potential benefit to the region's water supply system.

It is recommended that additional discussions be conducted with the City of Oceanside, Carlsbad MWD, and Rainbow MWD before developing a detailed scope of work for Phase 2. Phase 2 studies may include some additional project concept development as well as field investigations. Field investigations may include such activities as a water well survey, aquifer-performance testing, infiltration tests, groundwater and geochemical modeling, and geophysical surveys to further evaluate aquifer characteristics and geology.

The regulatory agencies identified in Chapter 5 should be contacted following further evaluation and screening of concepts identified in this study. Early consultation and planning with all the permitting agencies will be useful in identifying additional study tasks and can ultimately expedite the permit process. The detailed requirements and constraints identified during these initial consultations can reduce the level of potential environmental impact of a given project by understanding what design elements need to be adjusted.

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4. Earth Info., 1996. USGS Quality of Water, West 1 Ground. Boulder, Colorado.
5. USGS, October 1984. Hydrologic on Salt Balance Investigations Using Digital Models, Lower San Luis Rey River Area, San Diego County, California. Water Resources Investigations 24-74.

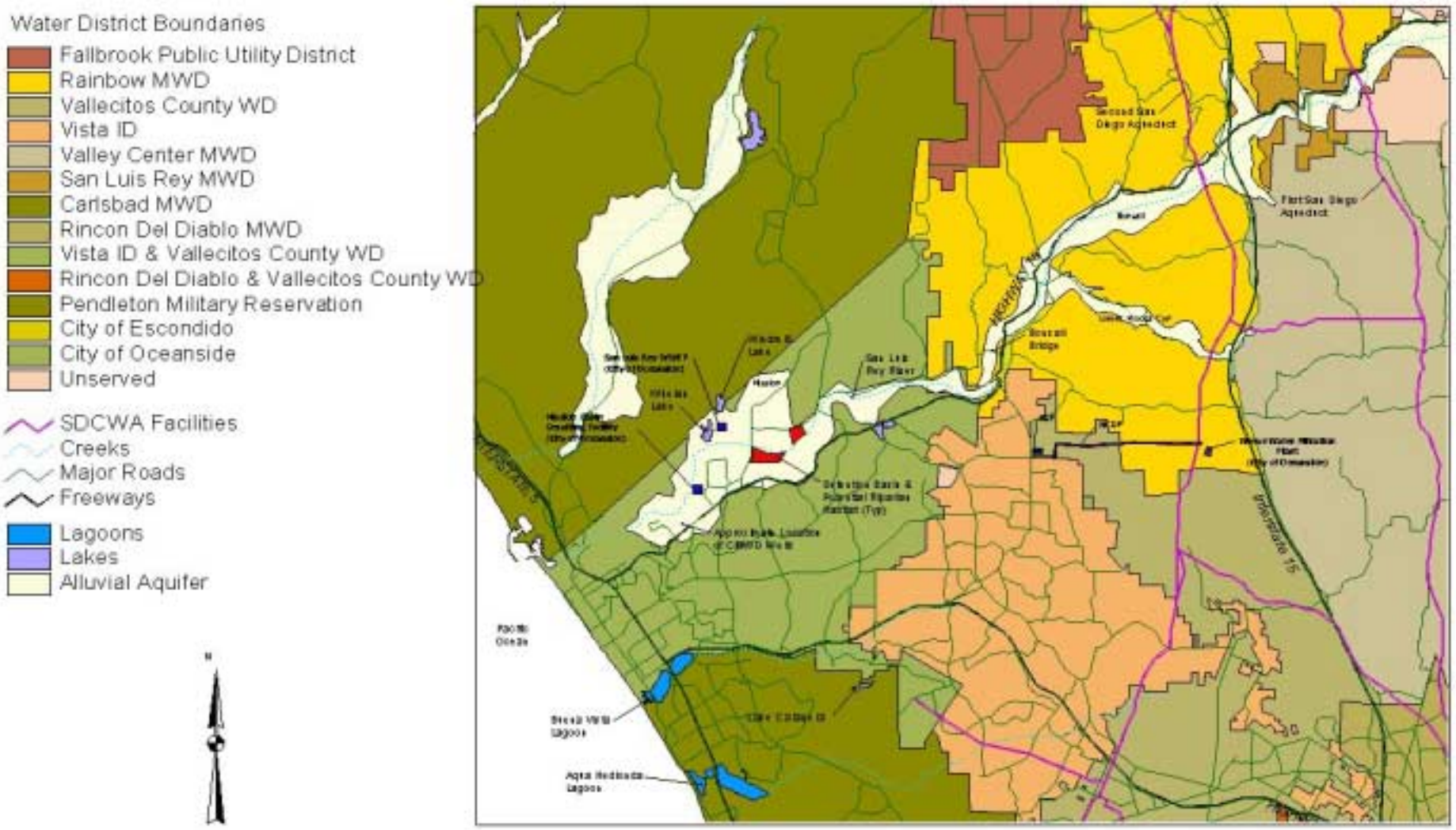

Figure ES-1
Project Study Area