Attachment 7

Technical Justification of Projects

Santa Ana One Water One Watershed IRWM Prop 84, Round 2
Implementation Proposal

Project A: Perris Desalination Program – Brackish Water Wells 94, 95 and 96 (Eastern Municipal Water District)

A tabular summary of physical benefits quantified for purposes of this proposal are presented in Table 9. These benefits include:

- Water Supply
- Reductions in Demand on the State Water Project
- Water Quality
- Energy Conservation, and
- Reductions in Greenhouse Gas Emissions

Recent and Historical Conditions; Water Shortages and Water Quality Problems

The Project is located in a rapidly growing area served by EMWD, consisting of six (6) cities (Hemet, Moreno Valley, portion of Murrieta, Perris, San Jacinto and Temecula) and some unincorporated areas of Riverside County. The 2012 population in the EMWD service area was approximately 660,000, and according to the Southern California Association of Government projections, the population is expected to reach approximately 890,000 by 2030.

EMWD is dependent on three (3) main water sources: Metropolitan Water District (MWD), local groundwater, and recycled water. EMWD's Urban Water Management Plan from 2010 identifies that approximately 75% of EMWD's potable water is imported and supplied by MWD.

On January 23, 1991, EMWD adopted Ordinance No. 72, (Water Conservation Plan) in response to the implementation of MWD's Incremental Interruption and Conservation Plan which was enacted due to statewide and local water supply shortages resulting from several years of drought conditions. Ordinance No. 72.25 (Water Use Efficiency Ordinance) was adopted on December 8, 2011 to provide for stricter water-use efficiencies with economic incentives (tiered rates) for improved conservation. A Water Shortage Contingency Plan for Domestic Water (Ordinance No. 117.1) was adopted on April 1, 2009 in accordance with State Water Code 10632 requirements. Several years of dry conditions and limitations on State Water Project (SWP) operations required MWD to implement a 10% regional shortage from July 2009 through April 2011. MWD's Regional Urban Water Management Plan indicates that MWD will have a reliable source of water to meet member agencies' needs through 2035 although demand reductions similar to that between 2009 and 2011 are anticipated.

Detailed technical information describing current conditions and groundwater basin objectives are presented in EMWD's West San Jacinto Groundwater Basin Groundwater Management Plan. EMWD's waste discharge requirements incorporate the Basin Plan Amendment, Resolution No. R8- 2004-0001, that has adopted new salt and nutrient objectives for the Groundwater Management Zones (GMZ) within the Santa Ana Region to include the San Jacinto River Watershed. The removal of nutrients through EMWD's desalinization system is the mitigation activity that has been approved to offset the excess mass loading of nutrients from reuse in the Lakeview/Hemet North GMZ. Desalination, basin reclamation, salt exportation, and water storage and recycling are central to local and regional resource management for supply and quality.

Estimates of Without-Project Conditions; e.g. Current and Future Physical Benefits

Water Supply - Without the proposed Project, EMWD will need to continue importing approximately 2,100 acre-feet per year (AFY) of potable water to meet existing demands. The Project will extract approximately 3,000 AFY of brackish groundwater and produce 2,100 AFY of drinking water after treatment. With the Project, this new/local supply will immediately be delivered into EMWD's distribution system. The cost of imported water is $847 per acre-foot (AF) in 2013. This rate is expected to increase to $890 in 2014 and continue rising at 5% through 2045. With various factors affecting the supply of imported water - such as competition for new supply, concerns for endangered species at water sources, and drought conditions – EMWD's service area will continue to face water reliability challenges; especially as new development takes place. There are currently no other projects planned that would produce similar results.

State Water Project – MWD supplies all EMWD's import requirements for potable water through the SWP.

Although there are other sources of supply including desalination of brackish groundwater and water recycling, these local sources are economically prohibitive without subsidy. Current importation and future increases will continue to be met through the SWP to the extent that water is available and the unit cost is less than that of desalination. The financing EMWD has secured to construct the Perris II Desalter Program provides this opportunity to replace 2,100 AFY of imported supply with local groundwater that otherwise would remain impaired and buried.

Water Quality – Without the Project, impaired groundwater will persist in the basin and continue migration to potable supply zones as the hydraulic gradient steepens. Other extraction wells operate in the area, however these wells are insufficient to draw down the contaminant plume sufficiently to stop migration and eventually potable supply wells will need to be abandoned. This benefit of preventing contaminant migration is not quantified in this proposal, however is noted here for background.

EMWD utilizes significant areas for recycled water (RW) storage. The RW ponds are unlined which allows percolation to the groundwater basin. Allowing recharge of high-TDS RW is allowed only though mitigation efforts to offset salt loading. The Project provides the necessary mitigation. Without the Project the recycled water would need to be treated through reverse osmosis.

Energy Conservation – Without the Project EMWD will continue importing 2,100 AFY of treated potable supply from MWD. Energy consumption to treat and deliver this water through the SWP and Mills Filtration Plant is estimated at 2.91 megawatt hours per AF (MWh/AF). Annual energy usage is then 6,111 MWh. Without the Project, the wells will not operate and the desalting facilities will not be utilized at ultimate design capacity. The energy necessary to operate the wells and desalter or 1,200 MWh/AF would not be required.

Greenhouse Gas (GHG) Emissions - Without the Project EMWD will continue importing 2,100 AFY of treated potable supply from MWD. GHG emissions associated with energy consumption to treat and deliver this water through the SWP and Mills Filtration Plant is estimated at 0.43 tons/AF. Without the Project, the wells will not operate and the desalting facilities will not be utilized at ultimate design capacity.

The Relationship of the Project to other Projects including Suite Benefits

The brackish water extraction wells are part of EMWD's South Perris Desalination Program which consists of 12 existing brackish water wells, up to seven proposed brackish water wells, two existing desalters (the Menifee and Perris I Desalters), a third desalter under construction (the Perris II Desalter), and a brine line brine line for exporting salts from the local area to the Pacific Ocean. The Perris II Desalter is on schedule to be constructed and operational in 2013. The feed water produced from the new wells may also supply the existing Menifee and Perris I Desalters with raw, brackish groundwater and thus help to increase the system's operational capacity (in parallel with construction of the iron and manganese pre-treatment facilities at the Menifee and Perris I Desalters).

The Project works in concert with Western Municipal Water District (WMWD) Phase I Chino Creek Well Fields Project, and SAWPA's Brine Line Reach IVB Project. Brine discharge from EMWD's desalter (900 AFY from the proposed Project) and WMWD's desalter will be conveyed to the SARI Line. Expansion of the SARI Line will provide needed capacity to accept brine discharge from the desalter facilities that accept, treat and deliver new potable water suppliers. These three projects work together and represent three of the thirteen projects that make up SAWPA's "suite of projects".

Description of Methods used to Estimate Physical Benefits

Quantified benefits are monetized in Table 15 - Annual Benefit. Table 15 summarizes monetized benefits, identifies units and unit values by year, and discounts dollar values by 6% annually using 2012 as the basis.

Water Supply (cost savings) – The Project will extract approximately 3,000 AFY of brackish groundwater and produce 2,100 AFY of drinking water as a new supply with full production starting in 2016. The new supply will reduce import demands by an equal amount. The current cost to produce the new supply is $591 per acre-foot based on EMWD cost data for existing Menifee and Perris I operations. EMWD's current cost of Tier 1 MWD water is $847 per acre-foot. Replacing the import supply with the new supply results in a $256 per acre-foot cost savings (2013 values). For the purposes of Table 15, local treatment costs are escalated by 4% per year and import supply costs are escalated by 5% per year.

State Water Project (implied value) – The Project will reduce demand on the SWP by 2,100 AF starting in 2016. The value claimed for this benefit is limited to the cost paid by MWD to secure water in the Sacramento Bay-Delta (2013 costs, per acre-foot):

Tier 1 Supply Rate	$140
System Access Rate	223
Water Stewardship Rate	41
Total	$404

The value of an item or service is at a minimum equal to the price a consumer is willing to pay. However, for the purposes of this application, the system power rate of $189 is not included. The unit value of $404 per acre-foot is escalated at 4% annually.

Water Quality (implied value/avoided cost) – The Project will pump and treat approximately 3,000 AFY from the basin, removing approximately 6,000 tons/year of salts and 25.5 tons/year of nutrients thereby reducing the overall salt/nutrient content of the basin. This extraction of contaminants is considered mitigation for the recharge of recycled water containing increased levels of TDS. Without the mitigation, EMWD would be required to line RW ponds or treat the RW with reverse osmosis. An elementary assignment of benefit value is the current cost of treatment through an existing facility or $591 per acre- foot. Each acre-foot of water yields 2 tons of salt therefore the value is $591/2=$296 (claimed unit value included in Table 15 for 2013, or $37.2 million over the life of the project in 2012 dollars). EMWD treatment costs are escalated at 4% per year.

A more accurate method for estimating value would be through avoided cost analysis. Table 16 is provided to describe this analysis for comparison purposes only assuming the benefit to basin recharge precludes the option of pond lining. Preliminary engineering has not been performed; however constructed capacity at $20,000 per acre-foot is reasonable. Estimating that the constructed facility would be financed at 6% for thirty years is also a reasonable assumption. The total present value using this analysis is $60 million. The claimed benefit is 62% of the estimated avoided cost.

The qualitative benefits of reduced salinity and other constituents in the aquifer include lower impacts on water users. These impacts range from degradation of appliances, pipes and other water infrastructure, to effects on water taste, lower crop yields and other environmental and public health/public acceptance impacts. These benefits are not independently quantified as they are assumed supportive of the policies and procedures upon which the desalination program was authorized.

Energy Conservation (cost savings) – Energy consumption to treat and deliver water through the SWP and is estimated at 2.91 MWh/AF or 6,111 MWh per year. With the Project, starting in 2016, this usage will be replaced with energy to operate the wells and desalter at 1.2 MWh/AF or 3,600 MWh per year. The Project will conserve 2,511 MWh annually. Assuming a value of $0.12 per kWh, the resulting annual cost savings would be $301,320 in 2013. Energy costs are escalated at 4% annually.

Greenhouse Gas (GHG) Emissions (implied value) – Energy conservation converts directly to a reduced carbon footprint. GHG emissions are calculated to be 1,228 pounds of CO_2 per MWh for the LADWP (import supply, 2007 CCAR), and 630 pounds of CO_2 per MWh for Southern California Edison (local supply, 2007 CCAR). Using with and without Project energy consumption amounts and considering the different energy sources, GHG emissions are reduced by 2,373 tons of CO_2 annually with Project implementation. Monetization of the value of a ton of CO_2 is based on the 2013 auction reserve price of $10.71 for the California Cap-and-Trade Program. The 2012 reserve price was set at $10. Regulation requires that the rate be increased by 5% per year plus the rate of inflation (2.16% in 2013). For the purposes of this proposal, the value of GHG emissions is escalated at 7% annually.

Facilities, Policies, and Actions required to Obtain the Physical Benefits

As previously discussed; most of the facilities, policies, and actions to obtain the physical benefits are in place. Perris II Desalter expansion is expected to be complete in 2018. All planning and preliminary designs are complete and the Project does not require land acquisition or extensive permitting. Construction financing, contractor selection and actual construction are about the only actions necessary to begin realization of the stated benefits.

Uncertainty of Benefits

The Project will construct three brackish water wells that are each expected to produce approximately 1,000 AF annually. This estimate is based on the production levels of adjacent wells, but may be an over- or under-estimation depending on the geology of the site and the final depth achieved. The cost estimates assume that the well will be approximately 350 feet deep. However, if the maximum depth of 520 feet is reached, the cost of the Project will increase. In order to avoid construction delays from increasing costs, EMWD will bid the Project assuming the maximum depth of 520 feet.

The costs used for treatment are based on average water quality found at the existing wells within the basin. Actual water quality found at the proposed well may vary from the average, and therefore affect the estimated cost of water treatment.

Technological advances will affect future benefit values. For example, brine flows may be reduced while product flows are increased. Conversely, power production will become more efficient thereby reducing benefits associated with energy savings and gas emissions. These changes will occur, however not in the near future and the impact on the benefit/cost analysis will be nominal. Hydrological studies indicate that the supply of brackish groundwater will outlast the Project's financial life. There is little risk that the benefits associated with the water supply and quality functions will not be achieved. It is anticipated that the core values contained herein will prove to be extremely conservative over time.

Description of any Adverse Effects

The Project will have one-time construction impacts, although mitigation provisions will be included in the specifications for the well and pipeline construction. The major adverse effect will be the loss of water through the brine stream. EMWD is working to increase process efficiencies to reduce brine volume.

Physical Benefits not Quantified

The benefits not quantified include:

a. Basin Reclamation
b. Existing Potable Supply Well Protection

EMWD has an aggressive water recycling program. This source of supply is critical to EMWD's abilities to manage shortages and meet future demands. Removing pollutants from the basin and reclaiming it for storage is an essential component of the water recycling plan. Insufficient data is available to quantify the value of this benefit as the salinity source is not fully understood.

Although private wells exist in the area of the proposed extraction wells, EMWD potable-supply wells are not located in close proximity to the impaired groundwater plume. It is possible that the plume could migrate to good-quality areas; however recent studies indicate that management efforts to-date has proven effective. It is beyond the scope of this proposal to define the groundwater dynamic with sufficient accuracy to quantify benefits.

Table 9 – Annual Project Physical Benefits			
Project Name: EMWD - Perris Desalination Program - Brackish Wells 94, 95 and 96_______________			
Type of Benefit Claimed: Water Supply_____________			
Measure of Benefit Claimed (Name of Units): Acre Feet per Year________			
Additional Information About this Measure: New water supply from brackish groundwater sub basin ________			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	1050	1050
2016	0	2100	2100
2017	0	2100	2100
2018	0	2100	2100
2019	0	2100	2100
2020	0	2100	2100
2021	0	2100	2100
2022	0	2100	2100
2023	0	2100	2100
2024	0	2100	2100
2025	0	2100	2100
2026	0	2100	2100
2027	0	2100	2100
2028	0	2100	2100
2029	0	2100	2100
2030	0	2100	2100
2031	0	2100	2100
2032	0	2100	2100
2033	0	2100	2100
2034	0	2100	2100
2035	0	2100	2100
2036	0	2100	2100
2037	0	2100	2100
2038	0	2100	2100
2039	0	2100	2100
2040	0	2100	2100
2041	0	2100	2100
2042	0	2100	2100
2043	0	2100	2100
2044	0	2100	2100
2045	0	2100	2100
Comments: Brackish production estimated at 1,000 AF/year/well. Brine stream estimated at 30% or 300 AF/year/well. New water supply estimated for 3 wells calculated at 2,100 acre-feet per year.			

Table 9 – Annual Project Physical Benefits			
Project Name: EMWD - Perris Desalination Program - Brackish Wells 94, 95 and 96____________			
Type of Benefit Claimed: Water Supply____________			
Measure of Benefit Claimed (Name of Units): Acre Feet per Year_______			
Additional Information About this Measure: Demand reduction on State Water Project _______			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	2100	2100	0
2013	2100	2100	0
2014	2100	2100	0
2015	2100	1050	1050
2016	2100	0	2100
2017	2100	0	2100
2018	2100	0	2100
2019	2100	0	2100
2020	2100	0	2100
2021	2100	0	2100
2022	2100	0	2100
2023	2100	0	2100
2024	2100	0	2100
2025	2100	0	2100
2026	2100	0	2100
2027	2100	0	2100
2028	2100	0	2100
2029	2100	0	2100
2030	2100	0	2100
2031	2100	0	2100
2032	2100	0	2100
2033	2100	0	2100
2034	2100	0	2100
2035	2100	0	2100
2036	2100	0	2100
2037	2100	0	2100
2038	2100	0	2100
2039	2100	0	2100
2040	2100	0	2100
2041	2100	0	2100
2042	2100	0	2100
2043	2100	0	2100
2044	2100	0	2100
2045	2100	0	2100
Comments: Benefit to State Water Supply estimated as equal offset from new supply.			

Table 9 – Annual Project Physical Benefits			
Project Name: EMWD - Perris Desalination Program - Brackish Wells 94, 95 and 96_____________			
Type of Benefit Claimed: Water Quality_____________			
Measure of Benefit Claimed (Name of Units): Tons per Year________			
Additional Information About this Measure: Salt removal from basin and watershed ________			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	3000	3000
2016	0	6000	6000
2017	0	6000	6000
2018	0	6000	6000
2019	0	6000	6000
2020	0	6000	6000
2021	0	6000	6000
2022	0	6000	6000
2023	0	6000	6000
2024	0	6000	6000
2025	0	6000	6000
2026	0	6000	6000
2027	0	6000	6000
2028	0	6000	6000
2029	0	6000	6000
2030	0	6000	6000
2031	0	6000	6000
2032	0	6000	6000
2033	0	6000	6000
2034	0	6000	6000
2035	0	6000	6000
2036	0	6000	6000
2037	0	6000	6000
2038	0	6000	6000
2039	0	6000	6000
2040	0	6000	6000
2041	0	6000	6000
2042	0	6000	6000
2043	0	6000	6000
2044	0	6000	6000
2045	0	6000	6000
Comments: Salt extraction is estimated at 2 tons per acre-foot based on current desalter operations with similar quality feed water.			

Table 9 – Annual Project Physical Benefits			
Project Name: EMWD - Perris Desalination Program - Brackish Wells 94, 95 and 96 ___________			
Type of Benefit Claimed: Environmental Enhancement ______________			
Measure of Benefit Claimed (Name of Units): Megawatt hours per year, MWh/yr________			
Additional Information About this Measure: Energy Conservation ________			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	6111	6111	0
2013	6111	6111	0
2014	6111	6111	0
2015	6111	4855.5	1255.5
2016	6111	3600	2511
2017	6111	3600	2511
2018	6111	3600	2511
2019	6111	3600	2511
2020	6111	3600	2511
2021	6111	3600	2511
2022	6111	3600	2511
2023	6111	3600	2511
2024	6111	3600	2511
2025	6111	3600	2511
2026	6111	3600	2511
2027	6111	3600	2511
2028	6111	3600	2511
2029	6111	3600	2511
2030	6111	3600	2511
2031	6111	3600	2511
2032	6111	3600	2511
2033	6111	3600	2511
2034	6111	3600	2511
2035	6111	3600	2511
2036	6111	3600	2511
2037	6111	3600	2511
2038	6111	3600	2511
2039	6111	3600	2511
2040	6111	3600	2511
2041	6111	3600	2511
2042	6111	3600	2511
2043	6111	3600	2511
2044	6111	3600	2511
2045	6111	3600	2511

Comments: Energy conservation is estimated using 2.91 MWh/AF for State Project Water and 1.2 MWh/AF for desalted water. The SWP reduction is 2,100 AF/year while the desalter processes 3,000 AF/year to generate 2,100 AF of product water.

Table 9 – Annual Project Physical Benefits			
Project Name: EMWD - Perris Desalination Program - Brackish Wells 94, 95 and 96 ___________			
Type of Benefit Claimed: Environmental Enhancement _____			
Measure of Benefit Claimed (Name of Units): Tons of CO2 per year______			
Additional Information About this Measure: Greenhouse Gas Reduction ________			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	3403	3403	0
2013	3403	3403	0
2014	3403	3403	0
2015	3403	2216.5	1186.5
2016	3403	1030	2373
2017	3403	1030	2373
2018	3403	1030	2373
2019	3403	1030	2373
2020	3403	1030	2373
2021	3403	1030	2373
2022	3403	1030	2373
2023	3403	1030	2373
2024	3403	1030	2373
2025	3403	1030	2373
2026	3403	1030	2373
2027	3403	1030	2373
2028	3403	1030	2373
2029	3403	1030	2373
2030	3403	1030	2373
2031	3403	1030	2373
2032	3403	1030	2373
2033	3403	1030	2373
2034	3403	1030	2373
2035	3403	1030	2373
2036	3403	1030	2373
2037	3403	1030	2373
2038	3403	1030	2373
2039	3403	1030	2373
2040	3403	1030	2373
2041	3403	1030	2373
2042	3403	1030	2373
2043	3403	1030	2373
2044	3403	1030	2373
2045	3403	1030	2373
Comments: GSG benefit considers LADWP production of 1227.89 lb CO2/MWh for SWP and SoCalEd production of 630.89 lb CO2/MWh for local service.			

Project B: Quail Valley Subarea 9 Phase 1 Sewer System Project (Eastern Municipal Water District)

A tabular summary of physical benefits quantified for purposes of this proposal are presented in Tables 9. These benefits include:

- Water Quality
- Water Supply
- Reductions in Demand on the State Water Project

Recent and Historical Conditions; Water Quality Problems

Quail Valley was developed in the 1920's as a hunting lodge. Casitas were located on the grounds with individual septic systems for seasonal guests. The lots were subdivided and sold, and almost 100-years later the septic systems are failing. These failing systems result in septic effluent running through the community and downstream to Canyon Lake. In wet weather conditions especially, this effluent containing "high pathogenic contamination" is floated to the surface and ponds in low lying areas. During a 2004/2005 investigation, county health workers observed children walking through "yards flooded with septic system effluent". Additionally, in some areas the shallow soil overlying the bedrock has become saturated with contaminated groundwater. Because the drinking water pipelines in Quail Valley were constructed approximately 40 years ago, the potential exists for contaminants to enter the potable distribution system.
The contaminated groundwater migrates toward Canyon Lake, and pollutes the supply source for privately owned local wells. Canyon Lake Reservoir is listed as an impaired water body by the federal government due to elevated levels of nitrates, phosphorus, and pathogens. The reservoir is a potable water supply source for Elsinore Valley Municipal Water District and a popular recreational facility. Canyon Lake has received considerable media attention for closures to swimming, wading, and water skiing due to high bacteria levels. The lake was closed 145 days to water contact recreation during the 2004/2005 investigation. The City of Canyon Lake conducted independent tests on incoming storm water from the Quail Valley drainage and found high levels of pathogens.
The 2004/2005 investigation prompted the Regional Water Quality Control Board, Santa Ana Region to adopt a Basin Plan Amendment (Resolution No. R8-2006-0024) "to include a waste discharge prohibition on the use of septic tank-subsurface disposal systems in the Quail Valley area of Riverside County" (see also State of California Regional Water Quality Control Board Santa Ana Region, Staff Report on Basin Plan Amendment, January 12, 2006). County of Riverside Ordinance No. 856 adopted August 29, 2006 establishes "a septic tank prohibition for specified areas of Quail Valley…requiring the connection of existing septic systems to sewer".
Quail Valley is a *Severely Disadvantaged Community* defined as having a median household income (MHI) of less than 60% of the statewide average. The Phase I Project establishes service opportunity for only 149 existing homes with an MHI of $31,650.

Estimates of Without-Project Conditions; e.g. Current and Future Physical Benefits

<u>Water Quality</u> – Without the Project it is expected that septic systems will continue to fail at a higher rate with greater individual exposure to disease causing bacteria. The construction moratoriums in effect will result in lower land values and less impetus to maintain working septic systems or otherwise invest in property improvements. Secondary impacts will result in higher bacteria levels in Canyon Lake causing more closures. Increasing contaminant levels in local groundwater will force the abandonment of private domestic wells. The Project provides direct sewer service opportunity to 149 homes with an estimated wastewater yield of 44 acre-feet (AF) annually. Secondary benefits include improved service opportunity for the remaining 1,240-area homes through extension of the service main into the community. There currently are no other projects or actions planned to correct the health-risk problem.

<u>Water Supply</u> - Without the proposed Project approximately 44 AF of wastewater from the residences will continue flowing into the environment annually. This water will not be available for capture and treatment at its Perris Regional Water Reclamation Facility to augment EMWD's recycled water supply.

<u>State Water Project</u> – Without the Project, EMWD will not increase its recycled water supply by 44 AF annually. Without increased local supplies, EMWD will remain dependent on import supplies from MWD.

The Relationship of the Project to Other Projects Including Suite Benefits

The primary purpose of proposed Project is to benefit public health and provide assistance to a disadvantaged community. Environmental enhancements (water quality improvements) extend to Canyon Lake—a surface supply of potable water for Elsinore Valley Municipal Water District. Reclamation of the wastewater contributes to regional water recycling efforts.

Description of Methods used to Estimate Physical Benefits

Quantified benefits are monetized in Table 15 - Annual Benefit. Table 15 summarizes monetized benefits, identifies units and unit values by year, and discounts dollar values by 6% annually using 2012 as the basis.

Benefit Allocation – There are four program components necessary to achieve the annual benefits identified in Table 15. This narrative and the amounts contained in the tables reflect 100 percent of the benefits claimed for the purpose of simplification. It is also reasonable to base project evaluation on total benefits as this Project is fundamental not only to the physical processes, but it also reflects the institutional impetus for mitigating the public health risk while considering the needs of a disadvantage community.

Strict cost-benefit analysis requires that all program components be considered. The circumstances of this project emphasize the importance of considering related activities and ancillary costs. A more comprehensive financial analysis would allocate benefits for the proposed 149 service connections as follows:

	Project Cost	Abandonment / Hookup	Connect Fees	Treatment Costs	Program Total
Per EDU	37,584	5,500	7,451	7,919	58,454
Direct	5,600,000	819,500	1,110,199	1,179,978	8,709,677
2012 Dollars	4,666,700	649,044	879,277.61	1,179,978	7,374,999
Allocation	63%	9%	12%	16%	1

On average, each of the 149 residences to be served by the Project is considered an equivalent dwelling unit (EDU). Costs per EDU are calculated using the current (direct) cost estimates. The direct cost is converted to 2012 dollars using a discount rate of 6%. The cost allocation is based on present value. A more technically-accurate description of the Project benefits would be to reduce the amounts 37% and distribute the remaining amount over the various cost components. This has not been done in this application due to the significance of the problems being addressed and the administration of a solution set being conducted by EMWD and others as a direct component of the proposed Project.

The Project Cost represents the proposed Project to construct the sewer system making service available to the 149 homes in the Subarea 9 Phase I zone. This is a one-time charge and EMWD is working with various organizations to make this expense more affordable to the homeowner.

The homeowners would then be responsible for proper abandonment of the existing septic systems, and making the connection between the home and the new sewer pipeline. This cost is based on similar construction at the Enchanted Heights Community. This is a one-time charge and EMWD is working with various organizations to make this expense more affordable to the homeowner.

Connection fees are synonymous with Financial Participation Charges. These fees are paid by homeowners and developers for new service connections (both water and sewer, applied separately). The sewer connection fees are applied towards capital improvement costs associated with collection and treatment capacities. As such, the $7,451 per EDU fee assists with repayment of the existing capacity at the Perris Valley Regional Water Reclamation Facility. This is a one-time charge and EMWD is working with various organizations to make this expense more affordable to the homeowner.

The final cost element is the treatment cost (recycled-water system costs are not included). This is basically the O&M cost to operate the sewer system and treatment facility. Evaluation of EMWD's 2011/2012 Comprehensive Annual Financial Report indicates that the annual cost of operating the sewer and treatments systems is $1,623 per

AF. A more conservative estimate of $1,496 per AF is used for the Perris Valley service area. Treatment costs over 30 years are estimated at $7,919 per EDU (2012 dollars). This converts to a monthly homeowner expense of $22.00 which is very reasonable for regional sewer rates.

Water Quality (implied value/avoided cost) – The Project will provide sewer service to 149 residences in Quail Valley. This service is necessary to avoid risks to public health and improve the standard of living for a *Severely Disadvantaged Community*. The number of residences directly benefited (in the form of available sewer service) is not significant, and the Project does not address the local problem in its entirety. However, based on observations and studies, the Project does provided the greatest return on investment and creates the opportunity for future expansion at a more affordable cost.

The public health risks associated with failed septic systems is well documented. This proposal does not attempt to quantify public health risks but rather provides a simple method to monetize benefits through established public policy including the Clean Water and Safe Drinking Water Acts. Each of these environmental laws regulates exposure to pollutants based on economic justification. In this case, it is reasonable that the health risk and the associated financial exposure exceed the Project cost (net present value (2012) of $7,374,999 through 2046; see Table 19 – Annual Project Costs). The adjusted total project cost includes the cost of abandoning the existing septic system and connecting the individual residences to the sewer system ($5,500 per unit), and the connection fee (financial participation charge) of $7,451 per unit. Annual treatment costs are estimated at $1,496 per acre-foot escalated at 4%.

Water Supply (implied value) – The Project will produce approximately 44 AF per year of recycled water starting in 2017. The alternative for generating this new supply is typically through importation (i.e. imported water from MWD is delivered through the potable supply system and ultimately reclaimed for recycled use. Recycled water and water from other sources is typically used for irrigation and is not recycled.). Therefore, from an EMWD perspective, the new supply is valued as an equal reduction in import demand. EMWD's current cost for Tier 1 MWD water is $847 per acre-foot. For the purposes of Table 15, import supply costs are escalated by 5% per year.

State Water Project (implied value) – The Project will produce approximately 44 AF per year of recycled water starting in 2017. Use of the recycled water will reduce actual demand on the SWP by some amount less than the new water supply as recycled water is often retained in unlined storage ponds allowing for percolation and evaporation. For purposes of this application, the direct use efficiency of recycled water is assumed at 80%. Therefore, from the State perspective, although 44AF of new recycled water is produced, only about 80% or 36 AF is actually used to offset future SWP demands. The value claimed for this benefit is limited to the cost paid by MWD to secure water in the Sacramento Bay-Delta (2013 costs, per acre-foot):

Tier 1 Supply Rate	$140
System Access Rate	223
Water Stewardship Rate	41
Total	$404

The value of an item or service is at a minimum equal to the price a consumer is willing to pay. However, for the purposes of this application, the system power rate of $189 is not included. The unit value of $404 per acre-foot is escalated at 4% annually.

Facilities, Policies, and Actions required to Obtain the Physical Benefits

EMWD and others have invested years of study and investigation to correct the situation at Quail Valley. As previously discussed, the proposed Project will not achieve 100% of the benefits without additional construction and funding. The Project is limited to extending the regional sewer system to a portion of the community (Subarea 9-Phase I). To achieve full benefits, local homeowners will need to abandon their existing septic systems and connect to the sewer line. The homeowners will also be required to pay connections fees and treatment costs. Regulatory actions such as County of Riverside Ordinance No. 856 imposing a septic tank prohibition coupled with public outreach will probably be necessary to achieve ultimate private participation. Additional funding and financing programs will be necessary to achieve affordability. All planning and preliminary designs are complete and the Project does not require land acquisition or extensive permitting. Conventional actions associated with construction and operations are necessary to begin realization of the stated benefits.

Uncertainty of Benefits

The benefits claimed are estimates in terms of dollar value however are certain if Project funding can be achieved. Similar risks to public health will persist with less probability until additional projects can be identified to extend sewer service to the remainder of the community.

Description of any Adverse Effects

Project construction and implementation will adversely affect the financial condition of local residences. One-time program costs approach $50,000 per household where the median household income is $32,000. EMWD and others are working to mitigate this effect through grant funding and more favorable financing. The Project will have one-time construction impacts, although mitigation provisions will be included in the specifications for the sewer pipeline and lift station.

Physical Benefits not Quantified

The benefits not quantified include:

1. Surface Supply Quality (Canyon Lake)
2. Basin Reclamation
3. Existing Potable Well Protection
4. Recreation
5. Disadvantaged Community Assistance

Table 9 – Annual Project Physical Benefits Project Name: Quail Valley Subarea 9 Phase I Sewer System Project__________ Type of Benefit Claimed: Water Quality ____ Measure of Benefit Claimed (Name of Units): Acre Feet per Year________ Additional Information About this Measure: Wastewater Treatment ________			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	22	22
2017	0	44	44
2018	0	44	44
2019	0	44	44
2020	0	44	44
2021	0	44	44
2022	0	44	44
2023	0	44	44
2024	0	44	44
2025	0	44	44
2026	0	44	44
2027	0	44	44
2028	0	44	44
2029	0	44	44
2030	0	44	44
2031	0	44	44
2032	0	44	44
2033	0	44	44
2034	0	44	44
2035	0	44	44
2036	0	44	44
2037	0	44	44
2038	0	44	44
2039	0	44	44
2040	0	44	44
2041	0	44	44
2042	0	44	44
2043	0	44	44
2044	0	44	44
2045	0	44	44
Comments: Phase I Project, 149 units at 265 gpd average.			

Table 9 – Annual Project Physical Benefits Project Name: Quail Valley Subarea 9 Phase I Sewer System Project_________ Type of Benefit Claimed: Water Supply _____________ Measure of Benefit Claimed (Name of Units): Acre Feet per Year_______ Additional Information About this Measure: New Supply of Recycled Water _______			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	22	22
2017	0	44	44
2018	0	44	44
2019	0	44	44
2020	0	44	44
2021	0	44	44
2022	0	44	44
2023	0	44	44
2024	0	44	44
2025	0	44	44
2026	0	44	44
2027	0	44	44
2028	0	44	44
2029	0	44	44
2030	0	44	44
2031	0	44	44
2032	0	44	44
2033	0	44	44
2034	0	44	44
2035	0	44	44
2036	0	44	44
2037	0	44	44
2038	0	44	44
2039	0	44	44
2040	0	44	44
2041	0	44	44
2042	0	44	44
2043	0	44	44
2044	0	44	44
2045	0	44	44
Comments: Phase I Project, 149 units at 265 gpd average.			

Table 9 – Annual Project Physical Benefits Project Name: Quail Valley Subarea 9 Phase I Sewer System Project__________ Type of Benefit Claimed: Water Supply ______________ Measure of Benefit Claimed (Name of Units): Acre Feet per Year ________ Additional Information About this Measure: Demand reduction on State Water Project ________			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	36	36	0
2013	36	36	0
2014	36	36	0
2015	36	36	0
2016	36	18	18
2017	36	0	36
2018	36	0	36
2019	36	0	36
2020	36	0	36
2021	36	0	36
2022	36	0	36
2023	36	0	36
2024	36	0	36
2025	36	0	36
2026	36	0	36
2027	36	0	36
2028	36	0	36
2029	36	0	36
2030	36	0	36
2031	36	0	36
2032	36	0	36
2033	36	0	36
2034	36	0	36
2035	36	0	36
2036	36	0	36
2037	36	0	36
2038	36	0	36
2039	36	0	36
2040	36	0	36
2041	36	0	36
2042	36	0	36
2043	36	0	36
2044	36	0	36
2045	36	0	36
Comments: Assuming an 80% direct-use efficiency.			

Project C: Forest First-Increase Stormwater Capture and Decrease Sediment Loading through Forest Ecological Restoration (US Forest Service)

Water Quantity increased via reduced evapotranspiration

CardnoENTRIX Technical Memo (provided with Work Plan) gives a summary of literature indicating that removal of basal area of vegetation (thus reducing evapotranspiration) can be related to increased surface flow.

This paper describes the methodology and data used to estimate the expected economic benefits related to Santa Ana River Watershed water supplies of restoring forest health in the San Bernardino and Cleveland National Forests. Specifically, we describe methods to estimate the cost savings to the Santa Ana River Watershed that would result from two types of forest restoration projects: forest thinning to restore stand density and forest road retrofitting. The analysis is limited to estimating benefits related to water quantity and water quality; additional benefits related to avoided damage to infrastructure and private property, recreation, species habitat, and human health are not estimated.

Model 1: Water Quantity Benefits of Thinning: This model quantifies the relationship between thinning and increased stream flow volume due to reduced water use by vegetation (i.e., reduced evapotranspiration). The model then translates this increased stream flow into cost savings by water districts based on reduced requirement for imported water (increased use of natural stream flows results in less spending on water that would be purchased from outside the basin from such sources as the State Water Project).

There is significant uncertainty in both the ecological and economic benefits of restoration. Our understanding of natural ecosystems and their response to restoration efforts is still evolving. Furthermore, ecological responses can differ widely between sites due to differences in local conditions, such as weather, vegetation, stream flow, slope, and soil conditions. We have no available studies directly estimating the magnitude of restoration effects in our study area, and so our uncertainty is increased by the need to extrapolate from effects found in other locations.

Table 1 **Table 1: Key Inputs and Assumptions to Model 1: Water Quantity Benefits of Forest Thinning**

		Parameter Value Range Used in Model		
Model Parameter	Unit	Low	Most Likely	High
Stream flow % response to 1% reduction in stand density	%	0.5%	0.59%	0.81%
Minimum reduction in stand density for stream flow benefits	%		25%	
Target stand density in San Bernardino/Cleveland NF	Trees/Acre		150	
Stand density minimum for thinning to affect stream flow	Trees/Acre		200	

Studies summarized in: Marvin, Sarah, and Possible Changes in Water Yield and Peak Flows in Response to Forest Management, Vol. 3, and Chapter. 4, pp.153-199, United States Geological Survey, accessed online at http://pubs.usgs.gov/dds/dds-43/VOL_III/VIII_C04.PDF.

The Silviculture Specialist Report associated with the Bluff Mesa final NEPA analysis indicates the total trees per acre in the existing condition and the final target trees per acre after the implementation.

Treatment Type	Approximate Acres
Treatment Level 1 – Fuel break (intensive treatment)	85
Treatment Level 2 – Fuel break (less intensive treatment)	245
Treatment Level 3a – Forest Health	486
Treatment Level 3b – Forest Health	372
Treatment Level 3c – Plantation Thinning	17
Treatment Level 4a – Sensitive Areas: Sp, Owl PAC/Bald Eagle	65
Treatment Level 4b – Sensitive Areas: Sp. Owl HRC, Suitable Habitat	303
Treatment Level 4c – Sensitive Areas: Meadow	26
TOTAL	,600

Adapted from Tables 7 and 8 in Silviculture Specialist report

Treatment Level	Existing Condition	Proposed Action
Level 3a	Total live trees 74 Total dead trees 3	Total live trees 35 Total dead trees 2
Level 3b	Total live trees 107 Total dead trees 6	Total live trees 40 Total dead trees 3
Level 4a	Total live trees 226 Total dead trees 12	Total live trees 102 Total dead trees 8
Level 4b	Total live trees 210 Total dead trees 5	Total live trees 116 Total dead trees 5

Within Level 3a and 3b, trees greater than 6 inches diameter will be left at the 55-60% level, with all trees greater than 24 inch diameter left.

Within Level 4a, all trees greater than 6 inch diameter will be left.

Within Level 4b, 70% of all 6 inch or greater diameter trees will be left, with all trees greater than 24 inch diameter will be left.

Thinning would concentrate on the removal of weaker, smaller trees, thereby reducing tree density while maintaining uneven-aged structure that commonly developed with the historic fire regimes of montane-conifer forests. Thinning would increase growing space, availability of water, nutrients, and sunlight to residual trees allowing development of a fuller crown of foliage. This, in turn would increase individual diameter growth and vigor and allow trees to become better able to resist bark beetle attack.

Basal area reduction and volume of material removed will be compared to remaining levels of vegetation. The proposed action, taken across the treatment levels indicates a basal reduction on the order of 50%. Based on the literature summarized by the CardnoENTRIX report, this basal area reduction would coincide with an increase in surface flow of 15% from the treated acres.

http://www.fs.fed.us/rm/pubs/rmrs_gtr231.pdf
Elliot, William J.; Miller, Ina Sue; Audin, Lisa. Eds. 2010. **Cumulative watershed effects of fuel management in the western United States**. Gen. Tech. Rep. RMRS-GTR-231. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 299 p.

http://www.fs.fed.us/rm/pubs/rmrs_gtr231/rmrs_gtr231_126_148.pdf
Ch.7 – Fuel Management and Water Yield

There have been numerous studies worldwide demonstrating that changes in forest density can cause a change in water yield. Bosch and Hewlett (1982), Hibbert (1967), Stednick (1996) and Troendle and Leaf (1980) have summarized the findings from most of these studies. In general, as Hibbert (1967) observed, reducing forest cover increases water yield; establishing forest cover on sparsely vegetated land decreases water yield; and response to treatment is highly variable and, for the most part, unpredictable.

Although the first two of these conclusions are still accepted, the hydrologic response to changes in forest cover, although variable, is more predictable than Hibbert (1967) concluded (Bosch and Hewlett 1982; Stednick 1996; Troendle and Leaf 1980). This change in thinking results from the increased number of observations available with each successive review and an improved understanding of the factors influencing stream flow response. Stream flow response to a change in forest cover is strongly related to climate, species composition, and the percentage change in vegetation density (fig. 1). The data from 95 watershed experiments conducted in the United States show that, on average, annual runoff increases by nearly 2.5 mm for each 1 percent of watershed area harvested (Stednick 1996). Because runoff is quite variable from year to year, the general conclusion is that approximately 20 percent of the basal area of the vegetation must be removed before a statistically significant change in annual runoff can be detected (Bosch and Hewlett 1982; Hibbert 1967; Stednick 1996). However, as Bosch and Hewlett (1982) suggest, reductions in forest cover of less than 20 percent (fig. 1), particularly in more humid areas, may well produce statistically non-significant increases in stream flow that would presumably decrease to zero increase in stream flow at zero reduction in forest cover.

Much of our understanding about the effects of forest disturbance on water yield has come from paired watershed experiments. Unfortunately, very few of these catchment scale experiments provide data on the hydrologic response to fuel reduction since the vast majority of the treatments imposed a partial or complete clear cutting of the mature trees rather than a partial cut or thinning (Stednick 1996). Hence, much of our understanding of the hydrologic impacts of thinning and prescribed fire comes from inference supported by various plot and process studies.

Water Quality via reduced Fire intensity and post-fire erosion

http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_045471.pdf
The Grass Valley Fire started at approximately 0508 on October 22, 2007 in the mountains of the San Bernardino National Forest in Southern California about 60 miles east of Los Angeles. Weather conditions were warm and dry. Santa Ana winds (strong, dry winds) had been blowing for two days. Live vegetation and dead fuels were very dry. The fire spread to the south through wild land fuels and then transitioned to urban structural fuels where it destroyed or damaged approximately 199 structures. U.S. Forest Service, state, and local firefighters responded immediately after the initial report.
Most of the final fire area burned on the first day. The fire was contained on the 26th of October. According to firefighters, suppression actions were substantially enhanced by fuel treatments in and adjacent to the fire.
Fire behavior in fuel treatment areas was less rapid and less intense than in adjacent untreated wild land fuel and urban structural fuel. The reduced spread rate and intensity allowed suppression forces to concentrate on protecting structures and on preventing additional fire spread to the south.
Fuel treatments improved visibility enabling firefighters to engage the fire directly in places and to protect homes without jeopardizing their safety.

In untreated areas, there was an average of greater than 800 trees per acre. The treated areas had on average 100 trees per acre.

http://www.fs.fed.us/rm/pubs/rmrs_gtr231.pdf
Elliot, William J.; Miller, Ina Sue; Audin, Lisa. Eds. 2010. **Cumulative watershed effects of fuel management in the western United States**. Gen. Tech. Rep. RMRS-GTR-231. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 299 p.

Fire suppression in the last century has resulted in forests with excessive amounts of biomass, leading to more severe wildfires, covering greater areas, requiring more resources for suppression and mitigation, and causing increased onsite and offsite damage to forests and watersheds. Forest managers are now attempting to reduce this accumulated biomass by thinning, prescribed fire, and other management activities. These activities will impact watershed health, particularly as larger areas are treated and treatment activities become more widespread in space and in time. Management needs, laws, social pressures, and legal findings have underscored a need to synthesize what we know about the cumulative watershed effects of fuel management activities. To meet this need, a workshop was held in Provo, Utah, on April, 2005, with 45 scientists and watershed managers from throughout the United States. At that meeting, it was decided that two syntheses on the cumulative watershed effects of fuel management would be developed, one for the eastern United States, and one for the western United States. For the western synthesis, 14 chapters were defined covering fire and forests, machinery, erosion processes, water yield and quality, soil and riparian impacts, aquatic and landscape effects, and predictive tools and procedures. We believe these chapters provide an overview of our current understanding of the cumulative watershed effects of fuel management in the western United States.

http://www.firescience.gov/projects/08-1-1-19/project/08-1-1-19_final_report.pdf
Assessing fuels treatments in southern California National Forests in the context of climate change.
The Charlton-Chilao fuel treatment was effective in modifying the Station Fire
Behavior and protecting the Chilao Fire Station.

http://www.fs.fed.us/rm/pubs/rmrs_gtr292/2012_fule.pdf
Do thinning and/or burning treatments in western USA ponderosa or Jeffrey pine dominated
Forests help restore natural fire behavior?
We carried out a systematic review and meta-analysis of the effects of forest thinning and burning treatments on restoring fire behavior attributes in western USA pine forests. Ponderosa pine (Pinus ponderosa) and Jeffrey pine (Pinus jeffreyi), with co-occurring species, are adapted to a disturbance regime of frequent surface fires, but extended fire exclusion and other factors have led to historically uncharacteristically dense stands and high fuel loadings, supporting high-severity fires. Treatments to begin to reverse these changes and reduce fuel hazards have been tested experimentally and observations of wildfire behavior in treated stands have also been reported. Using a systematic review methodology, we found 54 studies with quantitative data suitable for meta-analysis. Combined treatments (thinning + burning) tended to have the greatest effect on reducing surface fuels and stand density, and raising modeled crowning and torching indices, as compared to burning or thinning alone. However, changes in canopy base height and canopy bulk density were not consistently related to treatment intensity, as measured by basal area reduction. There are a number of qualifications to the findings. First, because it is not feasible to subject treated areas to severe fire experimentally, inferences about potential fire behavior rely on imperfect modeling techniques. Second, research has not been carried uniformly over the ranges of the pine forests, although we found no significant differences in treatment effects between regions or forest types. Overall, however, meta-analysis of the literature to date strongly indicates that thinning and/or burning treatments do have effects consistent with the restoration of low-severity fire behavior.

http://www.fs.fed.us/rm/pubs_other/rmrs_2008_donovan_g001.pdf
Estimating the Avoided Fuel-Treatment Costs of Wildfire
Although the importance of wildfire to fire-adapted ecosystems is widely recognized, wildfire management has historically placed less emphasis on the beneficial effects of wildfire. We estimate the avoided fuel treatment cost for 10 ponderosa pine (Pinus ponderosa) stands on the Umatilla National Forest in the Pacific Northwest. Results show that fires in stands that show the greatest divergence from the archetypical ponderosa pine stand structure (large trees in an open,
Park like stand) tend to have higher avoided costs. This is a reflection of the higher cost of fuel treatments in these stands: treatments designed to restore a stand to a desired condition are normally more expensive than treatments to maintain a stand in a desired condition.

http://www.fs.fed.us/psw/programs/ecology_of_western_forests/projects/masticated_fuels
Pacific Southwest Research Station, Masticated Fuels Research - Dense flammable vegetation and seasonally extreme fire weather present a daunting fuels management challenge in the foothill and mountain regions of California and southern Oregon. Much of this area historically burned in relatively frequent low to moderate severity fires, helping to thin the forest understory and reduce the potential for severe wildfires. Fire suppression, timber

harvest, and unusually severe wildfires have all contributed to the dense thickets of shrubs and small trees common throughout the region. Prescribed fire is one means of reducing wildfire hazard, but it is unlikely to be applied over a large proportion of the area due to risks associated with the proximity to homes, air quality issues, and the lack of prescription burning opportunities. As a result, an increasing number of acres of shrubs and small trees are being treated with mechanical mastication to reduce fire hazard. However, little is known about the effectiveness of such activities for altering fire behavior, and about the fire behavior and fire effects of burning masticated fuel beds.

http://siteresources.worldbank.org/INTBIODIVERSITY/Resources/RunningPure2003+.pdf

Well managed natural forests provide benefits to urban populations in terms of high quality drinking water:

- Well managed natural forests almost always provide higher quality water, with less sediment and fewer pollutants, than water from other catchments
- Some natural forests (particularly tropical montane cloud forests and some older forests) also Increase total water flow, although in other cases this is not true and under young forests and some exotic plantations net water flow can decrease
- Impacts of forests on security of supply or mitigating flooding are less certain although forests can reduce floods at a local headwater scale
- As a result of these various benefits, natural forests are being protected to maintain high quality water supplies to cities
- Protection within watersheds also provides benefits in terms of biodiversity conservation, recreational, social and economic values
- However, care is needed to ensure that the rural populations living in watersheds are not disadvantaged in the process of protection or management for water quality

Maintaining high quality water supply is an additional argument for protection:

- Many important national parks and reserves also have value in protecting watersheds that provide drinking water to towns and cities
- Sometimes this is recognized and watershed protection was a major reason for establishing the protected area – here watershed protection has sometimes bought critical time for biodiversity, by protecting natural areas around cities that would otherwise have disappeared
- In other cases, the watershed values of protected areas have remained largely unrecognized and the downstream benefits are accidental
- Where forests or other natural vegetation have benefits for both biodiversity and water supply, arguments for protection are strengthened with a wider group of stakeholders
- In some cases, full protection may not be possible and here a range of other forest management options are also available including best practice management (for example through a forest management certification system) and restoration

The watershed benefits of forest protected areas could help to pay for protection:

- The economic value of watersheds is almost always under-estimated or unrecognized
- It is possible to collect user fees from people and companies benefiting from drinking water to help pay for the catchment protection benefits provided by protected area management – although only in certain circumstances
- Payment for water services can also be one important way of helping negotiations with people living in or using watersheds to develop land-use mosaics that are conducive to maintaining high quality drinking water supplies

Many of the world's largest cities rely on drinking water from protected areas:

- Around a third (33 out of 105) of the world's largest cities obtain a significant proportion of their drinking water directly from protected areas
- At least five other cities obtain water from sources that originate in distant watersheds that also include protected areas
- In addition, at least eight more obtain water from forests that are managed in a way that gives priority to their functions in providing water
- Several other cities are currently suffering problems in water supply because of problems in watersheds, or draw water from forests that are being considered for protection because of their values to water supply

http://www.fs.fed.us/rm/pubs/rmrs_gtr292/2009_safford.pdf
Effects of fuel treatments on fire severity in an area of wild land–urban interface, Angora Fire, Lake Tahoe Basin, California
The Angora Fire burned 1243 ha of Jeffrey pine and mixed conifer forest in the Lake Tahoe Basin between June 24 and July 2, 2007. The Angora Fire burned at unusually high severity due to heavy fuels; strong winds; warm, dry weather; and unseasonably low fuel moistures. The fire destroyed 254 homes, and final loss and suppression cost estimates of $160,000,000 make the Angora Fire one of the ten costliest wildfires in US history. The Angora Fire burned into 194 ha of fuel treatments intended to modify fire behavior and protect private and public assets in the Angora Creek watershed. The fire thus provides a unique opportunity to quantitatively assess the effects of fuel treatments on wildfire severity in an area of wild land–urban interface. We measured fire effects on vegetation in treated and adjacent untreated areas within the Angora Fire perimeter, immediately after and one year after the fire. Our measures of fire severity included tree mortality; height of bole char, crown scorch, and crown torch; and percent crown scorch and torch. Unlike most studies of fuel treatment effectiveness, our study design included replication and implicitly controlled for variation in topography and weather. Our results show that fuel treatments generally performed as designed and substantially changed fire behavior and subsequent fire effects to forest vegetation. Exceptions include two treatment units where slope steepness led to lower levels of fuels removal due to local standards for erosion prevention. Hand-piled fuels in one of these two units had also not yet been burned. Excepting these units, bole char height and fire effects to the forest canopy (measured by crown scorching and torching) were significantly lower, and tree survival significantly higher, within sampled treatments than outside them. In most cases, crown fire behavior changed to surface fire within 50 m of encountering a fuel treatment. The Angora Fire underlines the important role that properly implemented fuel treatments can play in protecting assets, reducing fire severity and increasing forest resilience.

ftp://frap.fire.ca.gov/pub/incoming/IMMP/Prop%201-E%20BCP%20Justification/Fuel%20Treatment%20valuation%20for%20BMP/Econ%20Benefits%20of%20reducing%20fire-related%20sediment%20in%20sw%20fire%20prone%20ecosystes.pdf
A multiple regression analysis of fire interval and resulting sediment yield (controlling for relief ratio, rainfall, etc.) indicates that reducing the fire interval from the current average 22 years to a prescribed fire interval of 5 years would reduce sediment yield by 2 million cubic meters in the 86.2 square kilometer southern California watershed adjacent to and including the Angeles National Forest. This would have direct cost savings to Los Angeles County Public Works in terms of reduced debris basin clean out of $24 million. The net present values of both 5- and IO-year prescribed fire intervals are positive. However, given other multiple use objectives of the USDA Forest Service, a 10-year prescribed fire interval may be more optimal than a 5-year fire
Interval.

In response to the increasing level and value of development in wild land-urban interface, public works departments have built and maintain debris basins to trap sediment and debris at the mouth of canyons. However, this is an increasingly expensive solution. In some watersheds,
Increased post fire erosion and debris have also added to water supply system costs. It has been increasingly common after fires for debris to end up in water supply reservoirs, as recently happened after the Buffalo Creek fire outside of Denver, Colorado. This necessitated an emergency clean out of debris from the reservoir. In addition, the added sediment results in lost reservoir water storage capacity and increased treatment costs [Martin and Moody, 2001; Holmes, 1988; Moore and McCall, 1987].

The recreation value at risk from fire is $26.8 million annually. This is quite substantial, and suggests avoiding recreation closures due to fire or post fire flooding is potentially an important benefit of avoiding catastrophic wildfires in our study area. In the next section, we incorporate
The benefits of avoiding wildfire closures into the benefit-cost analysis.

Water Quality via improved road system releasing less sediment

SEDIMENT PRODUCTION AND DELIVERY FROM FOREST ROADS IN THE SIERRA NEVADA, CALIFORNIA; THESIS; Drew Coe, 2006
Sediment production rates varied greatly between years and between road segments. Sediment production rates from native surface roads were 12-25 times greater than from rocked roads. On average, recently-graded roads produced twice as much sediment per unit of storm erosivity as roads that had not been recently-graded. Unit area erosion

rates were 3-4 times higher in the first wet season than in either of the following two wet seasons, as the first wet season had near normal precipitation and a higher proportion of rainfall. Road sediment production is best mitigated by rocking native surface roads, decreasing sediment transport capacity by improving and maintaining drainage, and avoiding sites where unusual soil characteristics increase road surface or ditch runoff.

Twenty-five percent of the surveyed road length was connected to the channel network. Stream crossings accounted for 59% of the connected road segments, and gullying accounted for another 35% of the connected road segments. The travel distance of sediment below road drainage outlets was controlled by the presence or absence of gullies, soil erodibility, traffic level, and road segment length. The amount of sediment delivered from episodic gully erosion below road segments (0.6 Mg km-1 yr-1) is comparable to the amount of sediment being delivered from the road surface (1.4 Mg km-1 yr-1).

An analysis of the data from this and other studies shows that road-stream connectivity is strongly controlled by mean annual precipitation and the presence or absence of engineered drainage structures ($R2=0.92$; $p<0.0001$). Road sediment delivery can be minimized primarily by reducing the number of stream crossings, rocking the approaches to stream crossings, reducing the length of roads draining to stream crossings, and minimizing gully formation below drainage outlets.

QUANTIFIYING FOREST NATURAL BACKGROUND AND ROAD SEDIMENT YEILD IN BIG BEAR LAKE, CALIFORNIA; THESIS; Mikaila Rimbenieks, 2011
Sedimentation of water bodies on the National Forest has become an issue of increasing concern, which is largely caused by exposed surface area created by forest roads (Walter and King, 2004). This study assesses sediment deposition on forest land by measuring the volume of sediment runoff from rocked and traditional forest roads. Samples were taken in the Big Bear Lake watershed due to the impaired status of the lake in addition to the extensive road system managed by the USDA Forest Service. The study, consisted of ten sample plots, utilizes silt fences as sediment deposition capture devices. Each plot has a silt fence which serves as a control paired with a sample silt fence located on both traditional and rocked roads. Sediment deposition volume was measured after each significant storm event and was compared to control values. The amount of sediment deposition was determined by comparing the rocked versus traditional forest road sediment volumes in addition to comparing these values with the determined control. Results indicate that sediment production is 2.3 times greater on traditional forest roads versus rocked roads. Excluding the burned area, the natural sediment background on the forest is zero, indicating that sediment from USDA Forest Service land is primarily attributed to dirt roads.

Non-market benefits to habitat, recreation, and public safety

http://www.ingentaconnect.com/content/saf/jof/2010/00000108/00000008/art00004
Loomis and Gonzales-Caban, 2010, Forest Service Use of Nonmarket Valuation in Fire Economics: Past, Present, and Future. Journal of Forestry, December.
The need for monetary benefits of protecting spotted owl old-growth forest habitat from fire in the early 1990s was the catalyst for application of nonmarket valuation techniques to fire management within the US Forest Service. Two large-scale general public surveys successfully established that the contingent valuation method (CVM) could be used to estimate both state-level and national-level benefits for fire prevention and fire suppression in endangered species critical habitat. By the late 1990s large-scale wild land– urban interface fires resulted in the need to measure what the general public would pay for prescribed burning and mechanical fuel reduction programs. To reduce the expense of conducting original surveys, we use past results to offer benefit transfer of the existing results as a plausible interim technique to provide nonmarket benefits the general public receives from fire prevention and suppression. We also offer some insights as to the next frontiers in CVM application to wild land fire.

The percent of those who said yes to the voter referendum CVM questions for each state and each program are instructive. The prescribed burning program consistently received 60% or higher Yes responses, ranging from a high of 84% among the Hispanic population in California to 60% among the white population in Montana. The mechanical fuel reduction program support was much lower among the white population, being only 34–50%, but 50–68% among the Hispanic population.

Many times public land managers have neither the time nor the budget to conduct their own original nonmarket valuation study to estimate economic values of their fuel reduction program specific to their geographic area.

Benefit transfer allows the application of past literature values to new geographic areas. The original voter referendum legit equations estimated in Loomis et al. (2008) can be reparameterized into WTP equations for reductions in acreage burned by following the procedure of Cameron (1988) to yield a straightforward WTP function for reducing acres burned. Using this reparameterization, we obtain WTP per household as a function of acres burned for white households in California, Florida, and Montana for the prescribed burning program:
WTP per household = $174.06 + 0.002578 (acre reduction)

http://onlinelibrary.wiley.com/doi/10.1111/j.1526-100X.2011.00788.x/abstract
A legacy of fire suppression and the impacts of climate change have induced a worsening pattern of large and severe forest fires across the western United States. This has spurred action to jump-start wildfire risk mitigation initiatives. Despite an increase in resources and attention, the persistence of economic impediments has forestalled the successful expansion of forest restoration to a landscape level. The failure to properly account for the full range of costs and benefits from restoration treatments has contributed to the asymmetry between needed action and actual implementation. The valuation of non-market ecosystem services such as carbon sequestration, along with the ability of ecological restoration to act as an agent of economic stimulus, should be incorporated into the policymaking process. We demonstrate how institutionalizing the economic benefits from both the process and products of forest restoration can strengthen policies for advancing long-term forest health.

Recognizing ecosystems as productive assets that generate numerous non-accounted ecosystem services can elevate the appeal of restoring dry forests and attract much-needed funding. Forests such as ponderosa pine provide numerous benefits, including aesthetic and recreational opportunities, erosion prevention, and microclimatic regulation (Frederici 2003). Restored forests enhance the value of surrounding real estate while making the region more attractive to high-quality labor (Kim & Wells 2005). A resilient forest ecosystem also provides the benefit of "insurance" from disturbances such as wildfire (Stephens et al. 2010). The combined economic
Value of this natural insurance along with a partial calculation of other services has been estimated at $3,500 per hectare [~$1420/acre] (Mason et al. 2006). Many of these ecosystem benefits are left unaccounted by market valuation and their absence in policy undermines efforts to expand restoration (Kline 2004). As studies show, it is often much more cost-efficient to restore fractured ecosystem services than to invest in man-made alternatives (Chichilnisky & Heal 1998).

http://www.sciencedirect.com/science/article/pii/S1104689912000207
Protection from natural hazards is the most important function of mountain forests from an ecological, economic and social point of view. This assertion has been widely debated in recent years by a number of authors. In this paper we focus on the economic aspects of the protective function of forests, developing a quick and simple estimation method that can be applied on a local scale. After having identified the main forest attributes directly or indirectly involved in protection, the economic value of the protective function for homogeneous zones was estimated by applying the replacement cost method. This value enables environmental concerns to be included in forest planning and political decision-making.

http://www.fs.fed.us/rm/pubs_other/rmrs_2010_stockmann_k001.pdf
Concern over increased wild land fire threats on public lands throughout the western United States makes fuel reduction activities the primary driver of many management projects. This single-issue focus recalls a management planning process practiced frequently in recent decades – a least-harm approach where the primary objective is first addressed and then plans are modified to mitigate adverse effects to other resources. In contrast, we propose a multiple-criteria process for planning fuel-treatment projects in the context of ecosystem management. This approach is consistent with policies that require land management activities be designed to meet multiple-use and environmental objectives, while addressing administrative and budget constraints, and reconciling performance measures from multiple policy directives. We present the process borrowing from the Trapper Bunkhouse Land Stewardship Project example to show the logic for conducting an integrated assessment of ecological and natural resource issues related to multiple management scenarios. The effects and trade-offs of the no-action scenario and proposed action alternatives are evaluated relative to silviculture, disturbance processes (including fire behavior), wildlife habitat, noxious weeds, water quality, recreation and aesthetics, and economic contributions. Advantages and challenges of this project planning approach are also discussed.

http://www4.ncsu.edu/~amdomans/waterquality/viscusi_and_huber_forthcoming_ERE.pdf
Stated preference values for water quality ratings based on the US Environmental Protection Agency National Water Quality Inventory ratings provide an operational basis for benefit assessment. Iterative choice survey results for a very large, nationally representative, Web-based panel imply an average valuation of $32 for each percent increase in lakes and rivers in the region for which water quality is rated "Good." Valuations are skewed, with the mean value more than double the median. Sources of heterogeneity in benefit values include differences in responses to average water quality information and the base level of water quality. Conjoint estimates are somewhat lower than the iterative choice values. The annual economic value of the decline in inland US water quality from 1994 to 2000 is over $20 billion.

http://www.fs.fed.us/psw/publications/2003_wildfires_report.pdf
The Old, Grand Prix, and Padua Wildfires: How much did these Fires Really Cost?
Ecosystems in Southern California have evolved and adapted to fire over the centuries, becoming resilient to these naturally recurring disturbances. However these ecosystems have changed dramatically over the last century and are experiencing large-scale wildfires that result in severe effects, such as those in 2003. These severe effects indicate a lack of ecosystem resiliency to wildfire. We define ecosystem resiliency as the ability of an ecosystem to experience a disturbance such as wildfire without experiencing severe and long-term negative effects. The high-severity and long-term nature of the effects resulting from the 2003 Old, Grand Prix, and Padua wildfire complex will be measured, in part, in socio-economic terms and will illustrate the ecosystem's current lack of resiliency. Below are some indicators that call into question the current resiliency of the ecosystem.

During the 2003 Old, Grand Prix, and Padua Fire Complex, approximately 100,000 residents were evacuated from communities during the height of the fires for up to a week (many did not return to their homes due to a lack of services for many weeks), 787 total losses and 3,860 partial losses of property were claimed by private citizens and businesses (CDI 2003), and a significant portion of the headwaters to the Santa Ana River watershed was burned: approximately125, 000 acres. This severe upper watershed disturbance continues to result in negative down-river water quality and flood impacts.

The costs from public, private, and non-profit sectors for this fire complex total approximately $1.2 billion to date. Keep in mind that these expenditures do not include such economic costs as the loss of income generating capacity, lost recreation opportunities, and degradation of ecosystem services such as clean water, as well as others.

Eighteen months have passed since the fires were extinguished; however local, regional, and national level repercussions are still being felt. Municipalities, water districts, government agencies, communities, and individuals continue to deal with the severe negative effects of the fires. Ongoing examples include: post-fire erosion, closures of burned areas on public land, and trauma to people impacted by the fires. Recovery services are still being provided by local non-profit organizations in the form of help to rebuild homes, deal with emotional distress, and facilitate general transition back to normal life. The American Red Cross estimates they will spend an additional $1.2 million in the process of closing open cases (Chris Baker, personal communication 2005). Additionally, the Federal Emergency Management Agency (FEMA) continues to provide reimbursements to governments for costs incurred as well as grants to individuals and businesses for recovery needs as a result of the fires.

Greenhouse Gas savings from reduced chance of high intensity wildfire

http://www.idahoforests.org/img/pdf/FCEMReport2Final3-6-08.pdf
GREENHOUSE GAS EMISSIONS FROM FOUR CALIFORNIA WILDFIRES: OPPORTUNITIES TO PREVENT AND REVERSE ENVIRONMENTAL AND CLIMATE IMPACTS

The purpose of this report is to provide estimates that illustrate the impact of wildfires on greenhouse gas emissions and the importance of thinning forests to protect forests and communities, and to prevent emissions from combustion and decay. It also focuses on the significance of removing dead trees and replanting to restore forests and recover greenhouse gases released by wildfire.

The Angora Fire of 2007 blackened 3,100 acres of forest and destroyed 254 homes in the Tahoe Basin because most of the forest was so dense. Using pre-fire data for the forest, FCEM estimates that combustion emissions could have been lowered from 46.2 tons per acre to 12 tons per acre if the density of trees had been reduced from 273 per acre to the more natural density of 60 per acre.

Wildfire	Greenhouse Gases* (tons)	Greenhouse Gases* (tons/acre)	GWP** Emissions (tons CO2e)	GWP** Emissions (tons CO2e/acre)
Angora Fire	143,129.0	46.2	156,169.7	50.4
Fountain Fire	3,196,172.2	53.4	3,489,198.2	58.3
Star Fire	1,240,688.5	76.7	1,354,463.2	83.8
Moonlight Fire	4,910,941.6	74.7	5,360,989.1	81.6

* Carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O).
** GWP means Global Warming Potential. CO2 is the baseline at a value of 1. CH4 has a GWP of 21x CO2, and N2O has a GWP of 321x CO2 (Houghton et al. 1996, U.S. Environmental Protection Agency 2002).

http://westinstenv.org/ffsci/2009/08/24/impacts-of-california-wildfires-on-climates-and-forests-a-study-of-seven-years-of-wildfires-2001-2007/
Thomas M. Bonnicksen. 2009. Impacts of California Wildfires on Climate and Forests: A Study of Seven Years of Wildfires (2001-2007). FCEM Report No. 3. The Forest Foundation, Auburn, CA.

From 2001 to 2007, fires burned more than 4 million acres and released an estimated 277 million tons of greenhouse gases into the atmosphere from combustion and the post-fire decay of dead trees. That is an average of 68 tons per acre.

http://discover.tudelft.nl:8888/recordview/view?recordId=Elsevier%3Aelsevier%3ACXT0205A%3A03781127%3A02510003%3A07004331&language=en
*Narayan C, Fernandes PM, Van Brusselen J, Schuck A. 2007. Potential for CO_2 emissions mitigation in Europe through prescribed burning in the context of the Kyoto Protocol. Forest Ecology and Management **251**: 164–173*

The current paper analyses the potential for prescribed burning techniques for mitigating carbon dioxide (CO2) emissions from forest fires and attempts to show quantitatively that it can be a means of achieving a net reduction of carbon emissions in the context of the Kyoto Protocol. The limited number of available studies suggests that significant reductions in CO2 emissions can be obtained and that prescribed burning can be a viable option for mitigating emissions in fire-prone countries. The present analysis shows that the potential reduction attained by prescribed burning as a percentage of the reduction in emissions required by the Kyoto Protocol varies from country to country. Out of the 33 European countries investigated, only in one the requirements of the Kyoto Protocol could potentially be achieved by applying prescribed burning, while three other nations showed a potential net CO2 emissions reduction of about 4–8% of the Kyoto requirements and the majority showed a reduction of less than 2%. This implies that prescribed burning can only make a significant contribution in those countries with high wild land fire occurrence. Over a 5-year period the emissions from wildfires in the European region were estimated to be approximately 11 million tones of CO2 per year, while with prescribed burning application this was estimated to be 6 million tones, a potential reduction of almost 50%. This means that for countries in the Mediterranean region it may be worthwhile to account for the reduction in emissions obtained when such techniques are applied.

http://www.ncbi.nlm.nih.gov/pubmed/17976229
Estimates of CO2 from fires in the United States: implications for carbon management

Fires emit significant amounts of CO2 to the atmosphere. These emissions, however, are highly variable in both space and time. Additionally, CO2 emissions estimates from fires are very uncertain. The combination of high spatial and temporal variability and substantial uncertainty associated with fire CO2 emissions can be problematic to efforts to develop remote sensing, monitoring, and inverse modeling techniques to quantify carbon fluxes at the continental scale. Policy and carbon management decisions based on atmospheric sampling/modeling techniques must account for the impact of fire CO2 emissions; a task that may prove very difficult for the foreseeable future. This paper addresses the variability of CO2 emissions from fires across the US, how these emissions compare to anthropogenic emissions of CO2 and Net Primary Productivity, and the potential implications for monitoring programs and policy development.

Bluff Mesa Air Quality Resource Report

Table 8 displays estimated emissions generated from proposed activities. Also calculated are the emissions that would result in a wildfire consuming much of the 1,600-acre project area.

This result further enforces the need to apply the "best available control measures" as suggested in the South Coast AQMD Smoke Management Plan. The calculated emissions, however, are based on the assumption that all areas proposed for burning would have continuous fuels across the ground, that all piles under burn units were burned at once, and an average emission factor for flaming and smoldering fuels. Because of these assumptions, these estimates are high. Actual emissions would likely be much less, especially in the commercial thinning area, because much of the fuels are planned for removal. Nonetheless, California Environmental Quality Act requires public notification of projects that exceed the significance thresholds for air quality.

Documentation of this project's public notification process and scoping procedures would address this requirement.

Table 8. Approximate tons of pollutants generated from burning activities under the Proposed Action compared with Wildfire.

Activity	PM_{10}	$PM_{2.5}$	CO	VOC	NO_X
Proposed Action					
Pile Burning	152.0	110.4	1472.8	66.6	23.5
Broadcast Burning	237.0	237.0	2,297.4	103.9	18.8
Total Tons	**389.0**	**347.5**	**3,770.3**	**170.6**	**42.3**
Annual Tons (totals divided by 5)	**77.8**	**69.6**	**754.0**	**34.0**	**8.5**
Wildfire					
Wildfire	765.8	556.5	7,421.9	335.8	118.4

Table 9 – Annual Project Physical Benefits			
Project Name: _Forest First______			
Type of Benefit Claimed: _Water Quantity______			
Measure of Benefit Claimed (Name of Units): __acre-feet per year______			
Additional Information About this Measure:______			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	181	-181.25
2015	0	363	-362.5
2016	0	544	-543.75
2017	0	725	-725
2018	0	725	-725
2019	0	725	-725
2020	0	725	-725
2021	0	725	-725
2022	0	725	-725
2023	0	725	-725
2024	0	725	-725
2025	0	725	-725
2026	0	725	-725
2027	0	725	-725
2028	0	725	-725
2029	0	544	-544
2030	0	363	-363
Last Year of Project Life	0	181	-181

Table 9 – Annual Project Physical Benefits			
Project Name: _Forest First_______________ Type of Benefit Claimed: _Water Quality_______________ Measure of Benefit Claimed (Name of Units): __cubic yards sediment produced from treatment areas_______________ Additional Information About this Measure:_Sediment reduced by reduced risk from high intensity wildfire and improved roads			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	281553	281553	0
2013	281553	281553	0
2014	281553	257017	24536
2015	281553	232482	49071
2016	281553	207929	73624
2017	281553	138490	143063
2018	281553	138490	143063
2019	281553	138490	143063
2020	281553	138490	143063
2021	281553	138490	143063
2022	281553	138490	143063
2023	281553	138490	143063
2024	281553	138490	143063
2025	281553	138490	143063
2026	281553	138490	143063
2027	281553	138490	143063
2028	281553	138490	143063
2029	281553	207929	73624
2030	281553	232482	49071
Last Year of Project Life	281553	257017	24536
Comments: If a wildfire occurs on these areas prior to treatment, modeling indicates that over 4 million cubic yards would be generated. In a given year, a USGS study indicates a 6.3% chance of a high magnitude debris flow occurring.			

Table 9 – Annual Project Physical Benefits			
Project Name: _Forest First_			
Type of Benefit Claimed: _Greenhouse Gas reduction_			
Measure of Benefit Claimed (Name of Units): __metric tons CO2e per year_reduced_			
Additional Information About this Measure:_			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	36366	36366	0
2013	36366	36366	0
2014	36366	32236	4130
2015	36366	28106	8260
2016	36366	23966	12400
2017	36366	19836	16530
2018	36366	19836	16530
2019	36366	19836	16530
2020	36366	19836	16530
2021	36366	19836	16530
2022	36366	19836	16530
2023	36366	19836	16530
2024	36366	19836	16530
2025	36366	19836	16530
2026	36366	19836	16530
2027	36366	19836	16530
2028	36366	19836	16530
2029	36366	23966	12400
2030	36366	28106	8260
Last Year of Project Life	36366	32236	4130
Comments: For the Angora Fire, FCEM estimates that combustion emissions could have been lowered from 46.2 tons per acre to 12 tons per acre if the density of trees had been reduced from 273 per acre to the more natural density of 60 per acre. Bluff Mesa density ranges from 77-238 per acre with project reducing to 37-121 per acre. Based on these averages, without project is estimated at 22 tons per acre; with project at 12 tons per acre			

Table 9 – Annual Project Physical Benefits Project Name: _Forest First_______ Type of Benefit Claimed: _Habitat restored for wildlife and recreational benefits_______ Measure of Benefit Claimed (Name of Units): __acres improved_______ Additional Information About this Measure:_______			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	413	-413
2015	0	826	-826
2016	0	1240	-1240
2017	0	1653	-1653
2018	0	1653	-1653
2019	0	1653	-1653
2020	0	1653	-1653
2021	0	1653	-1653
2022	0	1653	-1653
2023	0	1653	-1653
2024	0	1653	-1653
2025	0	1653	-1653
2026	0	1653	-1653
2027	0	1653	-1653
2028	0	1653	-1653
2029	0	1653	-1653
2030	0	1653	-1653
Last Year of Project Life	0	1653	-1653

Project D: Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades (Inland Empire Utilities Agency)

The Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades project will achieve the following benefits:

1. 1,500 acre-feet per year (AFY) of Water supply for customer use
2. 3,000 AFY for ground water recharge
3. 4,600 AFY Storm Water capture and storage
4. 5,000 AFY imported water recharge to meet desalter replenishment obligations and water banking for dry years
5. 10,000 tons of salt removal
6. 2 mgd treated non-point sources reduction
7. 50 % Year Reduction for TMDL and other Pollutant
8. 45.9 Acres of wetlands
9. 45.9 acres natural hydrology restoration
10. 4,766 metric tons of $CO2e$/year Green House Gas

This is accomplished by the combination of the project components:

- Wineville Regional Pipeline
- Recycled Water Retrofits
- Groundwater Recharge System Upgrades

The technical justification for each of the quantifiable benefit is summarized below with the corresponding number as stated in the paragraph above.

1. **1,500 AFY of water supply for customer use:** Selected public facility customers located along the pipeline alignment will be retrofitted with "purple pipe" as part of the project to enable the site to be converted from potable water to recycled water. The direct use customers along the alignment have the potential to use approximately 500 AFY in the City of Ontario and 1,800 AFY in the City of Fontana, based on potable water consumption for the sites provided by the respective retail water agencies. The potable water consumption was adjusted by the retail agencies to provide estimates for the industrial and irrigation uses. With a maximum potential direct use benefit of **2,300 AFY,** the project is claiming to provide **1,500 AFY** of recycled water for direct non-potable use. Fontana Water Company, the retail provider for City of Fontana (Josh Swift) and City of Ontario (Dennis Mejia) provided the information for the project's beneficial direct re-use numbers. The project complexity is primarily having the commitment from the end use customers in having the sites converted, and the associated costs of the conversion. For this project, the majority of the customers identified are public and industrial sites, so there is a high potential that the conversions will be completed to meet the project benefit.

2. **3,000 AFY of groundwater recharge:** The Wineville Regional Pipeline will build the backbone distribution system to deliver water to the RP-3 and Declez basins, whereby an additional 3,000 AFY of recycled water recharge is anticipated as the project benefit. The rates derived for the basin infiltration are derived from the current basin infiltration capacities as observed with stormwater capture. Provided below in Tables 1 and 2 are the rates of infiltration that has been observed at the RP-3 and Declez Basins for the last three years, since 2009.

Table 1 – RP-3 Basin Infiltration Data Summary (2009- 2012)

	Basin Avg Infiltration Rate	Top of Basin before spillway	Area at top of Basin	Cumulative Infiltration Rate		
	Feet/day	feet	acres	AF/day	cfs	AF/month
RP-3 Basin 1	2.34	4.50	8.99	21	10.62	631
RP-3 Basin 2	1.95	4.50	3.20	6	3.15	187
RP-3 Basin 3	2.24	4.50	6.17	14	6.99	415
RP-3 Basin 4	1.44	4.50	7.42	11	5.37	319
				Total (max)	**26.13**	**1552**
				Average (1+3)	**17.62**	**1,047**
				Average (1+4)	**16.00**	**950**

Table 2 – Declez Basin Infiltration Data Summary (2009 – 2012)

	Basin Average Infiltration Rate (feet/day)	Max Basin Ht (feet)	Area (acres)	Infiltration Rate		
				AF/day	cfs	AF/month
Declez 1	0.78	8	6.95	5.40	2.73	162
Declez 2	0.46	8	4.78	2.21	1.12	67
Declez 3	0.51	8	4.21	2.15	1.09	65
Declez 2&3	**0.63**	**8**	**9.00**	**4.36**	**2.21**	**132**
Declez Total	**0.52**	**8**	**15.94**	**9.76**	**4.94**	**294**
Notes: Basin 1 does not infiltrate well - usually gets a lot of debris. Therefore do not include in design criteria						

RP-3's maximum infiltration capacity is 630 acre-feet per month to 1,500 acre-feet per month. Declez's maximum infiltration capacity is 150 acre-feet per month. These could potentially be the best infiltration rates that can be achieved, and there is potential for the basin performance to be degraded once continuous recharge occurs at the site. As a result, the maximum infiltration capacity per month between the two basins that can be conservatively estimated would be 763 acre-feet. (This assumes that only Basin 1 of RP-3 is operating, and only Basins 2 and 3 of Declez are operating.) Assuming four months of operation, **3,052 AFY** recycled water recharge can be achieved, and the project is claiming improved recharge capacity conservatively with **3,000 AFY.** The challenges in this portion of the project are the actual consistent basin performance when it is continually recharged, and receiving the required diluent water in order to make the target goal of recycled water recharge.

3. **4,600 acre-feet per year of storm capture:** The SCADA System Upgrades Project is critically needed in order to manage the Chino groundwater recharge basins. The existing communication network is overburdened by large data streams through a technologically archaic and sluggish system that can no longer support operations. The existing SCADA Systems need to be migrated to a new communication network backbone to allow the Operations Staff to maintain reliable and opportune control of the facilities. IEUA has been informed that the manufacture will no longer support the current system nor guarantee the supply of parts when the system breaks

down. Over time, this will result in outages throughout the system and will reduce the amount of storm water capture and recharge.

The SCADA System Upgrades Project will prevent the erosion of groundwater recharge capacity. As shown in Table 3, in FY11/12, a total of **9,266 AFY** of storm water was captured and recharged at the Chino groundwater recharge basins. With the SCADA System Upgrades completed, it is assumed that, in future years, roughly the same amount of storm water (about **10,000 AFY**) will be recharged on average. Without the project, it is assumed that a minimum of 50 percent of that capacity for storm water recharge would be lost in the near term (the next 5-10 years) by having to operate the system in a manual mode. The time to replace equipment, in the event of communication equipment failure, in an emergency mode would be close to twelve months. Therefore, the project benefit is estimated at **4,600-5,000 acre-feet** of storm water capture per year.

Table 3 – FY2011/12 Summary of IEUA Groundwater Recharge

Source	Acre-Feet	Percent
Stormwater	9,266	23%
Recycled Water	8,634	21%
Imported Water (SWP)	22,560	56%
Total	40,460	100%

4. **5,000 acre-feet per year of imported water recharge for conjunctive use:** Imported Water conjunctive use provides a more sustainable water supply by banking imported water in wet years for use in dry years. The Chino Basin groundwater recharge program is designed to recharge a mix of recycled water, storm water and imported water to meet the water supply and salt management goals of the region. Figure 1 shows the amounts of imported water, recycled water and storm water recharged over the last five fiscal years, with greater amounts of imported water being recharged in wet years.

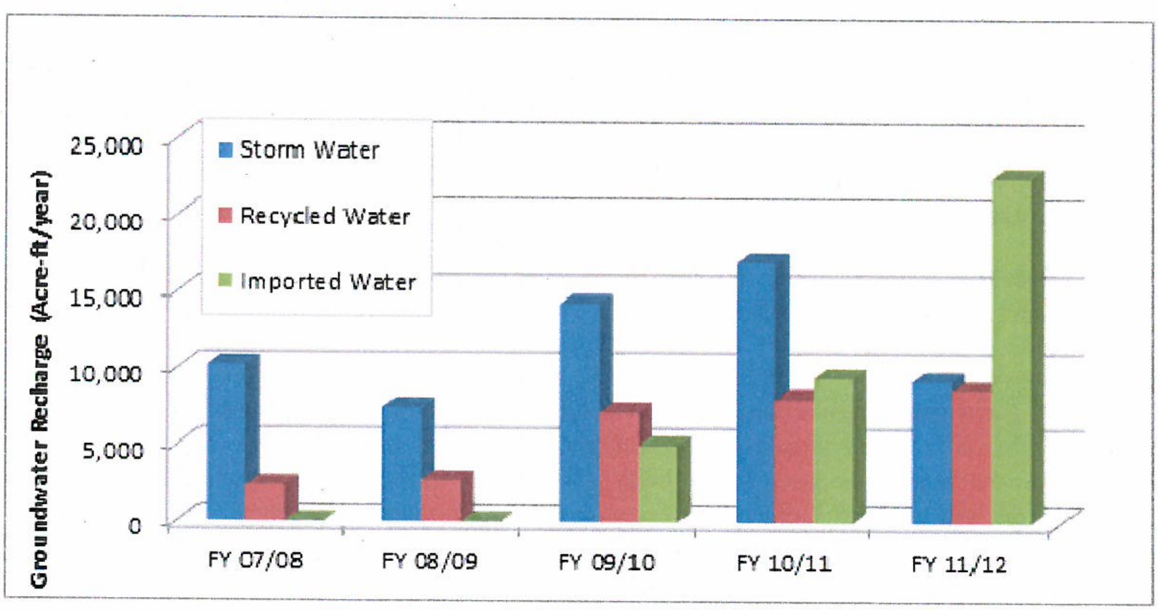

Figure 1: Historical Groundwater Recharge Data

The SCADA system is the automatic control and monitoring system that manages the recharge of all three types of water through a series of imported water and recycled water turnouts, inflatable rubber dams, gates, valves and monitoring equipment. The SCADA system electronics, telemetry and computer interfaces allow IEUA operators to remotely control the delivery of water to the 18 basins in the recharge program. Without the SCADA system, it would not be possible to deliver as much water because the 18 basins are too spread out for manual operation to be effective.

The SCADA System Upgrades Project will prevent the erosion of imported recharge capacity. Since FY05/06, IEUA has on average recharged **29,680 AFY** of storm, imported and recycled water. A realistic expectation or assumption for future years is **30,000 AFY** on average, assuming the necessary SCADA System Upgrades are completed. That would be comprised of approximately **10,000 AFY** of each type of water (1/3 imported, 1/3 recycled, and 1/3 storm water). Without the project, we can expect the recharge quantities to be gradually decreased due to equipment downtime and communication failures. Consistent with the assumptions for storm water capture, it is assumed that without the project, there would be a minimum of 50 percent reduction of imported water recharge, or **5,000** acre-feet, in the near term (the next 5-10 years). Therefore, one of the expected project benefits is **5,000 acre-feet** of imported water recharge for conjunctive use.

5. **10,000 Tons salt removed:** One of the benefits of the SCADA System Upgrades Project is our ability to operate a desalter program that currently removes almost **20,000 tons per year** of salt from the watershed. That is because the groundwater recharge program provides the replenishment water to balance the water that is pumped by the desalter program. So, there is a one-to-one benefit in terms of recharge capacity and salt removal ability. Instead of the current **20,000 tons per year** of salt removal, we would be entitled to remove only **10,000 tons per year** if, as predicted, we lose 50% of recharge capacity in the next 5-10 years due to SCADA system outages and failures. Therefore, one of the expected project benefits is **10,000 tons** of salt removal.

   To explain more fully, the Chino Basin groundwater recharge program is part of the Optimum Basin Management Program (OBMP) for Chino Basin. The OBMP manages the salt balance in the watershed while allowing recycled water use. The OBMP is implemented through agreements between the Chino Basin Watermaster Parties, Orange County Water District and the Santa Ana Regional Water Quality Control Board. The OBMP has several goals, including:

   - Maximizing the use of local resources, including recycled water, in order to provide water supply reliability and reduce dependence on imported water;
   - Improving the water quality in Chino Basin by utilizing desalters to pump salt from degraded areas of the basin (degraded due to historical agricultural practices);
   - Utilizing the desalter wells to provide a hydraulic barrier to prevent the migration of salts to downstream water basins in Orange County; and
   - Providing a water balance in Chino Basin using the groundwater recharge program to replenish the water removed by the desalters.

In order to remove salt from the watershed, the OBMP relies on a combination of two Non-reclaimable Waste (NRW) Systems (brine lines) and a series of desalters. As shown in Table 4, there is currently one desalter with 14 MGD capacity that is removing almost **20,000 tons per year** of salt from the basin. The desalter program is continuing to expand to meet the goals set by the Regional Water Quality Control Board, which will eventually almost double the salt removal capacity and creating a "replenishment obligation" of 30,000 AFY. This replenishment obligation cannot be reliably met without the SCADA System Upgrades Project.

Table 4 – FY11/12 Summary of Salt Removal from Chino Basin

	Million Gallons/Year	TDS (mg/L)	Tons/Year

North NRW System	1,244	2,587	13,419
South NRW System	127	12,336	6,549
Desalter 1 (14 MGD)	834	5,573	19,386
Total	**2,205**	**4,280** (Flow-Weighted) **Average)**	**39,354**

6. **2 MGD treated non-point sources reduction:** The recharge basins are located on streams or channels that pass through urban areas that contribute nuisance runoff in the summer, containing high non-point source pollutant levels. The recharge basins capture and treat approximately 4 MGD or 6 cubic feet per second (cfs) of dry weather nuisance runoff. The treatment is through the fact that there is no dry-weather release from the basins, so all the nuisance water stays in the basins and gets natural soil-aquifer treatment. The SCADA system upgrades will allow this benefit to continue and will improve it even further by providing better control of inlet gate control operation and the opportunity to use remote water quality monitoring devices to trigger the inlet gate controls. Currently, the SCADA system allows us to capture nearly 100% of dry weather nuisance flow. The estimated loss of 50% of recharge efficiency would translate to being able to capture and recharge only half of that or 2 MGD. So, an expected project benefit is **2 MGD** of treated non-point source reduction.

7. **50% Reduction for TMDL and other Pollutant:** The Middle Santa Ana River has a bacteria TMDL due to violations of water quality objectives. The recharge basins are located on tributaries to the Middle Santa Ana River, and generally these tributaries are impaired by bacteria levels that exceed the water quality objectives and the TMDL. The recharge basins capture virtually 100% of the dry weather nuisance runoff and remove the bacteria through soil-aquifer treatment. Without the project, the estimated loss of 50% of recharge efficiency would translate being able to capture and treat only 50% of the flow and bacteria, which would cause more water quality violations and MS4 Compliance challenges. Also, with the SCADA Project, we may be able to install more monitoring equipment in basins to monitor turbidity and tell us when the first flush has passed. Right now, we have to make a very conservative assumption that the first two hours of the storm are too turbid to capture. With automatic monitoring, we may be able to have real-time data and therefore reduce the amount of first flush bypassed and pollutants bypassed downstream. We are planning a pilot program to try it out. The percentage that the benefit would be attributed would be the dry weather flow of 6 cfs or 4 MGD.

8. **45.9 Acres of wetlands:** RP-3 and Declez Basins provide 37.8 acres of open water surface that become waterfowl habitat when they are filled with storm water in the winter. With the Wineville Recycled Water Pipeline, recycled water will be supplied to the basins, providing open water habitat in drier periods and helping to offset the stress of climate change on wildlife. In addition, RP-3 has a separate created wetland area that is 8.1 acres. The project will provide recycled water and a permanent irrigation system for the created wetland habitat to ensure its success. So total area preserved/restored is computed as 37.8 plus 8.1 equals 45.9 acres.

9. **Natural hydrology restored**: Capturing water in soft-bottomed recharge basins reduces peak stream flows and infiltrates more water to better simulate pre-development conditions. During development, most of the stream channels were paved for flood control reasons. The recharge basins divert some of the stream flow from these concrete channels into soft-bottomed basins that restore the natural hydraulic connection between surface and groundwater. Also, concrete paving increased water velocities and created hydrologic conditions of concern (HCOCs) downstream where the concrete ended (sedimentation or scouring). By capturing some of the peak flows, the recharge basins help to reduce downstream velocities and HCOCs may be reduced.

10. **4,766 metric tons of CO2e/year Green House Gas:** Increasing the use of recycled water reduces statewide energy consumption due to not having to pump water from the Bay-Delta over the Tehachapi Mountains and into Southern California. IEUA estimates that it requires 2,657 kWh less electricity to deliver one acre-foot of recycled water than it does to deliver one acre foot of water from the State Water Project. According to the information provided in the study "The Role of Recycled Water in Energy Efficiency and Greenhouse Gas Reduction", for every MWh of energy required, 879 pounds of greenhouse gases (GHGs) as CO2 equivalents are produced and 2,205 pounds of GHGs equal 1 metric ton. So, the Project with a benefit of 4,500 afy would require 11,956 MWh less of energy and would reduce GHGs by an estimated 4,766 metric tons/yr of GHGs (as CO2eq).

Table 9 – Annual Project Physical Benefits

Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades
Type of Benefit Claimed: _______Water Supply for Customer Use
Additional Information About this Measure:__________Acre feet per year

Additional Information About this Measure:____________________

Year	Physical Benefits		
	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	1500	1500
2016	0	1500	1500
2017	0	1500	1500
2018	0	1500	1500
2019	0	1500	1500
2020	0	1500	1500
2021	0	1500	1500
2022	0	1500	1500
2023	0	1500	1500
2024	0	1500	1500
2025	0	1500	1500
2026	0	1500	1500
2027	0	1500	1500
2028	0	1500	1500
2029	0	1500	1500
2030	0	1500	1500
2031	0	1500	1500
2032	0	1500	1500
2033	0	1500	1500
2034	0	1500	1500
2035	0	1500	1500

2036	0	1500	1500
2037	0	1500	1500
2038	0	1500	1500
2039	0	1500	1500
2040	0	1500	1500
2041	0	1500	1500
2042	0	1500	1500
2043	0	1500	1500
2044	0	1500	1500
2045	0	1500	1500
2046	0	1500	1500
2047	0	1500	1500
2048	0	1500	1500
2049	0	1500	1500
2050	0	1500	1500
2051	0	1500	1500
2052	0	1500	1500
2053	0	1500	1500
2054	0	1500	1500
2055	0	1500	1500
2056	0	1500	1500
2057	0	1500	1500
2058	0	1500	1500
2059	0	1500	1500
2060	0	1500	1500
2061	0	1500	1500
2062	0	1500	1500
2063	0	1500	1500
2064	0	1500	1500
Comments: Recycled Water system has a 50 years project life ending in 2064			

Table 9 – Annual Project Physical Benefits			
Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades			
Type of Benefit Claimed: _______Stormwater Capture and Storage____			
Additional Information About this Measure:__________Acre feet per year ________________________________			
Additional Information About this Measure:____			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	9266	0	0
2013	9266	0	0
2014	9266	0	0
2015	4633	9266	4633
2016	4633	9266	4633
2017	4633	9266	4633
2018	4633	9266	4633
2019	4633	9266	4633
2020	4633	9266	4633
2021	4633	9266	4633
2022	4633	9266	4633
2023	4633	9266	4633
2024	4633	9266	4633
Comments: SCADA system has 10 years project life ending in 2024			

Table 9 – Annual Project Physical Benefits			
Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades			
Type of Benefit Claimed: _______Imported Water Recharge			
Additional Information About this Measure:__________Acre feet per year ___________________________________			
Additional Information About this Measure:____			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	10000	0	0
2013	10000	0	0
2014	10000	0	0
2015	5000	10000	5000
2016	5000	10000	5000
2017	5000	10000	5000
2018	5000	10000	5000
2019	5000	10000	5000
2020	5000	10000	5000
2021	5000	10000	5000
2022	5000	10000	5000
2023	5000	10000	5000
2024	5000	10000	5000
Comments: SCADA 10 years project life ending in 2024			

Table 9 – Annual Project Physical Benefits Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades Type of Benefit Claimed: _______Salt Removal Additional Information About this Measure:__________Acre feet per year ________________________ Additional Information About this Measure:________________________			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	20000	0	0
2013	20000	0	0
2014	20000	0	0
2015	10000	20000	10000
2016	10000	20000	10000
2017	10000	20000	10000
2018	10000	20000	10000
2019	10000	20000	10000
2020	10000	20000	10000
2021	20000	20000	10000
2022	20000	20000	10000
2023	20000	20000	10000
2024	20000	20000	10000
Comments: The SCADA system has a 10 year project life ending in 2024			

Table 9 – Annual Project Physical Benefits Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades Type of Benefit Claimed: _______Non-Point Source Reduction Measure of Benefit Claimed (Name of Units): ______Million Gallons per Day - Acre feet per year Additional Information About this Measure:_4 million gallons per day treated = 12.28 AF per day = 4,482 AFY			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	4482	0	0
2013	4482	0	0
2014	4482	0	0
2015	2241	4482	2241
2016	2241	4482	2241
2017	2241	4482	2241
2018	2241	4482	2241
2019	2241	4482	2241
2020	2241	4482	2241
2021	2241	4482	2241
2022	2241	4482	2241
2023	2241	4482	2241
2024	2241	4482	2241
Comments: Scada system has 10 years project life ending in 2024			

Table 9 – Annual Project Physical Benefits			
Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades			
Type of Benefit Claimed: _______Reduction of TMDL			
Measure of Benefit Claimed (Name of Units): ______Million Gallons per Day - Acre feet per year			
Additional Information About this Measure:_4 million gallons per day treated = 12.28 AF per day = 4,482 AFY			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	4482	0	0
2013	4482	0	0
2014	4482	0	0
2015	2241	4482	2241
2016	2241	4482	2241
2017	2241	4482	2241
2018	2241	4482	2241
2019	2241	4482	2241
2020	2241	4482	2241
2021	2241	4482	2241
2022	2241	4482	2241
2023	2241	4482	2241
2024	2241	4482	2241
Comments: SCADA system has a 10 years project life ending in 2024			

Table 9 – Annual Project Physical Benefits Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades Type of Benefit Claimed: _______Preservation and Restoration Additional Information About this Measure:__________Acres Additional Information About this Measure:_______Total area preserved is 45.9 acres______			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	45.9	45.9
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
2024	0	0	0

2025	0	0	0
2026	0	0	0
2027	0	0	0
2028	0	0	0
2029	0	0	0
2030	0	0	0
2031	0	0	0
2032	0	0	0
2033	0	0	0
2034	0	0	0
2035	0	0	0
2036	0	0	0
2037	0	0	0
2038	0	0	0
2039	0	0	0
2040	0	0	0
2041	0	0	0
2042	0	0	0
2043	0	0	0
2044	0	0	0
2045	0	0	0
2046	0	0	0
2047	0	0	0
2048	0	0	0
2049	0	0	0
2050	0	0	0
2051	0	0	0
2052	0	0	0
2053	0	0	0
2054	0	0	0
2055	0	0	0
2056	0	0	0
2057	0	0	0
2058	0	0	0
2059	0	0	0
2060	0	0	0
2061	0	0	0
2062	0	0	0
2063	0	0	0
2064	0	0	0
Comments: 50 years project life ending in 2064			

Table 9 – Annual Project Physical Benefits Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades Type of Benefit Claimed: _______Natural Hydrology Restoration Additional Information About this Measure:__________Acres Additional Information About this Measure:______Total area preserved is 45.9 acres____________________________			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b)+(c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	45.9	45.9
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
2024	0	0	0
2025	0	0	0
2026	0	0	0
2027	0	0	0
2028	0	0	0
2029	0	0	0
2030	0	0	0
2031	0	0	0
2032	0	0	0
2033	0	0	0
2034	0	0	0
2035	0	0	0
2036	0	0	0
2037	0	0	0
2038	0	0	0
2039	0	0	0
2040	0	0	0
2041	0	0	0
2042	0	0	0
2043	0	0	0
2044	0	0	0
2045	0	0	0
2046	0	0	0
2047	0	0	0
2048	0	0	0

2049	0	0	0
2050	0	0	0
2051	0	0	0
2052	0	0	0
2053	0	0	0
2054	0	0	0
2055	0	0	0
2056	0	0	0
2057	0	0	0
2058	0	0	0
2059	0	0	0
2060	0	0	0
2061	0	0	0
2062	0	0	0
2063	0	0	0
2064	0	0	0
Comments: 50 years project life ending in 2064			

Table 9 – Annual Project Physical Benefits

Project Name: _Wineville Regional Recycled Water Pipeline and Groundwater Recharge System Upgrades
Type of Benefit Claimed: _______Green house gases___________________________________
Measure of Benefit Claimed (Name of Units): ______metric tons of CO2e per year___________________________
Additional Information About this Measure:____

Year	Physical Benefits		
	Without Project	With Project	Change Resulting from Project (b) + (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	4766	4766
2016	0	4766	4766
2017	0	4766	4766
2018	0	4766	4766
2019	0	4766	4766
2020	0	4766	4766
2021	0	4766	4766
2022	0	4766	4766
2023	0	4766	4766
2024	0	4766	4766
2025	0	4766	4766
2026	0	4766	4766
2027	0	4766	4766

2028	0	4766	4766
2029	0	4766	4766
2030	0	4766	4766
2031	0	4766	4766
2032	0	4766	4766
2033	0	4766	4766
2034	0	4766	4766
2035	0	4766	4766
2036	0	4766	4766
2037	0	4766	4766
2038	0	4766	4766
2039	0	4766	4766
2040	0	4766	4766
2041	0	4766	4766
2042	0	4766	4766
2043	0	4766	4766
2044	0	4766	4766
2045	0	4766	4766
2046	0	4766	4766
2047	0	4766	4766
2048	0	4766	4766
2049	0	4766	4766
2050	0	4766	4766
2051	0	4766	4766
2052	0	4766	4766
2053	0	4766	4766
2054	0	4766	4766
2055	0	4766	4766
2056	0	4766	4766
2057	0	4766	4766
2058	0	4766	4766
2059	0	4766	4766
2060	0	4766	4766
2061	0	4766	4766
2062	0	4766	4766
2063	0	4766	4766
2064	0	4766	4766
Comments: Recycled Water System has a 50 years project life ending in 2064			

Project E: Plunge Creek Water Recharge and Habitat Improvement (San Bernardino Valley Water Conservation District)

Physical Benefits of the Plunge Creek Water Recharge and Habitat Conservation Project

- Groundwater Management-through recharge 1,250 acre feet per year average increased recharge
- Water Recharge Enhancement-Through increased permeable area of the stream bottom and widened braided stream course in Plunge Creek by up to 110 acres
- Habitat Conservation and Enhancement for the San Bernardino Kangaroo Rat (SBKR), an endangered species as listed in Jan 1998 by the US Fish & Wildlife Service
- Reduction in Greenhouse gases-estimated at over 1,250 metric tons of CO_2 per year from reduced water imports
- Flood Management Benefits-supporting a more natural stream hydrologic function which may eventually improve flood management downstream

Narrative Descriptions of Physical Benefits

1. Groundwater Management and Recharge Enhancement - In 2009, the San Bernardino Valley Water Conservation District adopted the Upper Santa Ana River Wash Plan Management and Conservation Plan http://www.sbvwcd.dst.ca.us/projects/WashPlan with multiple agencies in the area to join forces for joint habitat and water conservation uses on the same geographic areas. A Project Partner agency, the San Bernardino Valley Municipal Water District (SBVMWD), did a study that assessed all watershed streams in the Bunker Hill Basin to expand recharge. The results of this effort were documented in a January 2012 report called the Active Recharge and Constraints Study http://www.sbvwcd.dst.ca.us/reports-data. Plunge Creek was one of the creeks they documented having potential for added recharge. Their report indicates that the annual average flow is 6,122 acre feet per year based on historic flows from 1934-2008. SBVMWD proposed recharge facilities downstream from the District owned area. Recharge estimated for these basins assuming storm water capture like the historic period from 1934-2008, was 3,729 acre feet per year. This was based on the flows that occur, the high hydraulic conductivity of the site at 6.7 feet per day as measured in 2011 and the size of the recharge ponds proposed. SBVMWD proposed recharge facilities downstream from the District Owned area in Sections 9 and 10. Recharge estimated for these basins assuming stormwater capture like the historic period from 1934-2008, was 3,729 acre feet per year (Report Figure 92). This was based on the flows that occur, the high hydraulic conductivity of the site at 6.7 feet per day as measured in 2011 (Report Figure 66) and the size of recharge ponds proposed. The area of the recharge basins proposed on District land are likely to be smaller than the 160 acres (Report Figure 83)

2. The area of the recharge proposed on District land is smaller and uses native natural areas and so the resulting recharge is estimated at 1250 additional acre feet per year average. The recharge from this project in the upper watershed is seasonal. It benefits downstream users by storing the water during higher flow times for use later by upstream users; a majority of which will be discharged back to the river on a non-seasonal basis and is available to downstream users. Additionally, recharge of native water in the upper basin has both water quality and water supply benefits which make more water available for downstream users and ensures high quality water is discharged after use, available to downstream users.

3. Habitat Conservation and Enhancement - The San Bernardino kangaroo rat (SBKR), a subspecies of the Merriam's kangaroo rat, typically is found in Riversidian alluvial fan sage scrub (RAFSS) and sandy loam soils, alluvial fans and flood plains, and along washes with nearby sage scrub (McKernan 1997 as cited in USFWS 1998). RAFSS within the Santa Ana River floodplain is comprised of three primary seral stages of alluvial fan sage scrub: pioneer, intermediate, and mature phases. The vegetation of the pioneer phase is relatively open (less than 50 percent canopy cover) and, along with the intermediate phase, supports the highest densities of the SBKR (McKernan 1997 cited from FR 73 61935). In areas along Plunge Creek, the vegetation and ground cover is dense. With the removal/thinning of vegetation focusing on clearing all non-native grasses down to soil substrate and widely spacing shrubs would allow an increase in foraging and movement habitat for SBKR. A draft Habitat Conservation Plan (HCP) was prepared in 2011 as a mitigation program for a larger Wash Plan project of the Upper Santa Ana River Wash including the City of Highland, City of Redlands, County of San Bernardino, San Bernardino Valley Water Conservation District (SBVWCD), SBVMWD, East Valley Water District, BLM, and the San Bernardino County Flood

Control District. This mitigation program proposed to improve and /or restore the historic breakout channels from past episodic flood events in the Santa Ana River (SAR) to serve as movement corridors for SBKR. The breakout channels provide an opportunity for establishing movement corridors for SBKR that would provide connectivity for the Plunge Creek and SAR populations. The SBVWCD proposes to include in the HCP a combined SBKR Habitat and Water Recharge Enhancement activity that will provide habitat improvements above the mitigation requirements for impacts to SBKR resulting from implementation of the Wash Plan.

The combined habitat and water recharge enhancement project is designed with USFWS Biologists to create additional habitat on approximately 110 acres of District lands along the east-west reach of Plunge Creek. As part of the biological work conducted for the HCP, a US Fish and Wildlife Service biologist and a consulting biologist working for the District established over nearly 200 plots in 2012 throughout the 4600 acre Wash Plan area to assess more finite habitat parameters of SBKR habitats. Field survey work done by USFWS and RBF Engineering biologists (Dr. Tom McGill, biologist, tmcgill@rbf.com) evaluated the entire Wash Plan area and specifically the Plunge Creek area shown in this 2012 map: (http://www.sbvwcd.dst.ca.us/reports-data)

The enhancement activity would consist of vegetation removal/thinning through hydraulic scour creating a refreshed and wider stream course toward the south. The stream enhancement is anticipated to extend approximately one-half mile to the west. Widening of the stream course, in conjunction with very low density vegetative cover, will allow for increased SBKR habitat values as well as additional water percolation. This enhancement project builds on the previously completed Wash Plan and Environmental Impact Report (http://www.sbvwcd.dst.ca.us/projects/washplan) as well as the proposed Habitat Conservation Plan (HCP) that is currently in draft. The proposed enhancement project will add a recharge component to the Wash Plan vegetation management mitigation by spreading native water flows in Plunge Creek through increased surface area of suitable substrate for percolation.

4. The project provides a reduction in water imported from the Delta due to a small but positive benefit to water supply availability through its enhancement of recharge capability to the Bunker Hill Groundwater Basin. The estimated reduction of over 1,250 metric tons of CO_2 per year from reduced water imports is based on the reduction in the required electricity to import water; thus causing the reduction of greenhouse gases estimated at 1.1 metric ton per acre foot. These positive effects of the project are consistent with San Bernardino County's and the State of California's objectives.

5. This project was designed in coordination with San Bernardino County Flood Control and Water Conservation District Integrated flood management and their flood plain management efforts. Depending on final design elements the project could reduce sediment buildup in Plunge Creek above the outlet of the Elder Creek Channel. And although there are very limited benefits and flood management is not a significant goal of the project, the project will work with the County Flood to estimate the physical benefits of the project. Additionally wider more natural braided stream characteristics are associated with reduced downstream flooding in high flow events or extreme weather conditions. Once the hydraulic and hydrology study is finished and the design completed, the benefit to flood management can be better estimated.

Project F: Prado Basin Sediment Management Demonstration Project (Orange County Water District)

Table 9 – Annual Project Physical Benefits			
Project Name: Prado Basin Sediment Management Demonstration Project Type of Benefit Claimed: Water supply reliability, stormwater capture, storage and groundwater recharge and management Measure of Benefit Claimed (Name of Units): Acre feet Additional Information About this Measure: Additional water supply storage created by the sediment management			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	
2013	0	0	
2014	0	0	
2015	0	0	
2016	0	150	150
2017	0	300	300
2018	0	300	300
2019	0	300	300
2020	0	300	300
2021	0	300	300
2022	0	300	300
2023	0	300	300
2024	0	300	300
2025	0	300	300
2026	0	300	300
2027	0	300	300
2028	0	300	300
2029	0	300	300
2030	0	300	300
2031	0	300	300
2032	0	300	300
2033	0	300	300
2034	0	300	300
2035	0	300	300
2036	0	300	300
Comments: OCWD is using a conservative estimate of the amount of water supply to be created by the sediment management. Depending on the hydrological condition in the project area, it is possible that additional water supply storage could be created (such as in the event of a wet winter season). OCWD has had a lot of success in capturing stormwater flows from the Santa Ana River and recharging into its percolation facilities or basins located in the Forebay area. This project will demonstrate the ability to reverse sediment trends within Prado Basin and restore the flow of sediment to the lower reach of Santa Ana River. Method used to estimate water supply physical benefit includes the physical removal of sediment from the pool area (expressed as cubic yards) and the calculation of water storage volume to capture storm water flow (in acre feet).			

Table 9 – Annual Project Physical Benefits

Project Name: Prado Basin Sediment Management Demonstration Project

Type of Benefit Claimed: Water quality improvement

Measure of Benefit Claimed (Name of Units): Tons of salts removed per year

Additional Information About this Measure: Salt concentrations are measured as total dissolved solids (TDS) and the method of TDS determination is fully described in the Standard Methods for the Examination of Water and Wastewater.

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	
2013	0	0	
2014	0	0	
2015	0	0	
2016	0	68.8	68.8
2017	0	137.6	137.6
2018	0	137.6	137.6
2019	0	137.6	137.6
2020	0	137.6	137.6
2021	0	137.6	137.6
2022	0	137.6	137.6
2023	0	137.6	137.6
2024	0	137.6	137.6
2025	0	137.6	137.6
2026	0	137.6	137.6
2027	0	137.6	137.6
2028	0	137.6	137.6
2029	0	137.6	137.6
2030	0	137.6	137.6
2031	0	137.6	137.6
2032	0	137.6	137.6
2033	0	137.6	137.6
2034	0	137.6	137.6
2035	0	137.6	137.6
2036	0	137.6	137.6

Comments: The water quality improvement is determined based on the TDS concentrations of stormwater in the project area (200 mg/L as documented in OCWD's Technical memorandum entitled "Salt and Nitrate Projections for Orange County Management Zone.") and imported water from MWD (572 mg/L) in the project area. Water storage capacity created by the sediment management allows the capture of storm water (a low TDS concentration water). OCWD is confident that the water quality benefit claimed herein can be achieved.

Project G: San Sevaine Ground Water Recharge Basin (Inland Empire Utilities Agency)

The San Sevaine Groundwater Recharge Basin project will achieve the following benefits:

1. 4,500 AFY Recycled Water Reuse
2. 350 acre-feet per year Storm Water capture and storage
3. 120 AFY imported water recharge to meet desalter replenishment obligations and water banking for dry years
4. 126 Tons salt removal over ten years
5. 25.5 Acres of preservation and restoration
6. 4,766 metric tons of CO2e/year Green House Gas

The technical justification for each of the quantifiable benefit is summarized below with the corresponding number as stated in the paragraph above.

1. **4,500 AFY of recycled water recharge:** The San Sevaine Basins were originally constructed for flood control but are now operated for multiple purposes including groundwater recharge under a Four Party Agreement between San Bernardino County Flood Control, Chino Basin Watermaster, IEUA, and Chino Basin Water Conservation District. Millions of dollars have been spent on improvements to the basins by the Four Parties. The basins are used to recharge imported water, stormwater and recycled water in a conjunctive use program. IEUA performs the actual operation and maintenance of the basins for recharge purposes in cooperation with the Flood Control District. There are five, soft-bottomed basins located in series along San Sevaine Channel, comprising about 93 acres with the potential to recharge up to 8,500 AFY of recycled water. However, as the facility currently operates, recycled water is delivered only to the lower basin, Basin 5, which has a lower infiltration rate compared to the upper basins, enabling a current recharge of approximately 500 AFY.

   In order to fully realize the valuable potential of the basin, it is proposed to build approximately 5,000 feet of pipeline to deliver water (recycled and stormwater) to the upper basins, which have higher infiltration rates. The project includes: (1) small pump station that could pump either recycled water or stormwater to the upper basins; (2) 2,000-foot pipeline from basin 5 to basin 3; (3) geophysical investigation to determine if poor inflitration rates in basin 5 can be improved; (4) flow control and internal berms to route water between basin 1 and basin 2 and keep a minimum amount of water depth throughout the summer to help with vector control; (5) internal berms in basin 5 to deepen water and alternate wet and drying cycles to control insect issues.

   The rates derived for the basin infiltration are derived from the current basin infiltration capacities as observed with stormwater and recycled water capture with the current facilities. Provided below in Table 1 is the rates of infiltration that has been observed at the San Sevaine Basin. The project assumes that the infiltration rate of Basin 5 can be improved from 0.15 feet per day to 0.45 feet per day, which results in an increase in recharge by 290 acre-feet per month. In addition, if the recycled water pipeline is extended to Basin 3, an additional 270 acre-feet per month can be achieved, increasing the total recharge capacity by 560 acre-feet per month; assuming recharge is conducted for nine months of the year, an increase recharge can be attributed to the project at 4,500 AFY.

Table 1 – San Sevaine Infiltration Data Summary (2009- 2012)

	Average (ft/day)	Max Spill Ht (ft)	Area (acres)	Inf (AF/day)	Inf (cfs)	AF/month
San Sevaine 1	1.84	4	8	14.94	7.55	226
San Sevaine 2	2.14	5	8	17.13	8.65	259
San Sevaine 3	1.72	5	5	9.11	4.60	273
San Sevaine 4				0.00	0.00	0
San Sevaine 5	0.15	11	35*	10.33	5.22	157
				Total	**26.01**	**915**

Note: * Approximately half of San Sevaine Basin 5 is occupied by half million cubic yard of material by SBCFCD and is not known if the entire basin of 69 acres will be available for recharge. This amounts to approximately 35 acres not available for recharge.

2. **350 acre-feet per year of storm water recharge:** An increase in the amount of storm water recharge can be achieved by improving the distribution of storm water within the five basins. Installing a pump to raise water from Basin 5 to Basin 3 will allow storm water as well as recycled water to be pumped to the higher basin, which has a higher infiltration rate. Currently (FY11/12 data), 176 acre feet per year of storm water was captured in Basin 5. If the infiltration rate were to be increased by the project from 0.15 feet per day to 0.45 feet per day, the potential additional storm water capture would be 350 acre feet per year.

3. **120 acre-feet of imported water recharge:** Imported Water is recharged in San Sevaine Recharge Facility as well as recycled water and storm water, as part of a conjunctive use program. The program allows basin managers to bank water in wet years for use in dry years as well as to help meet Chino Basin Desalter replenishment obligations. In FY11/12, 1,228 AFY of imported water was recharge in San Sevaine Basins 1-4. With implementation of the project's improvements to flow controls and internal berms within Basins 1-4, it is conservatively estimated that an overall 10% increase in recharge will result, or approximately **120 AFY.** This additional imported water capture would be a result of not shutting down recharge due to vector control issues that would be mitigated with the internal berms within the basins for better water routing and infiltration.
4. 126 Tons per day salt removal: The project is expected to result in the recharge of an additional 4,970 AFY of water (4500 RW, 350 SW, and 120 IW). The average TDS concentration would be approximately 440 mg/l if the water were blended in those proportions. So, the project would introduce about 10 tons per day of salt into the Chino groundwater aquifer. On the other hand, the recharged water will be used to offset the replenishment obligation for the Chino Basin Desalter program and as such will allow an equal amount of high-salinity water to be pumped from the degraded areas of Chino Basin (degraded by past agricultural practices). The average TDS of the desalter well water is 5,129 mg/l, so the project will allow 126 tons per day of salt to be removed. The project will help better the aquifer's water quality by the improved TDS that will be recharged into the ground. Based on the above, for each MGD that is recharged, 4,680 mg/L of TDS less is introduced into the groundwater table (or 17 tons per day less per MGD).

   The project will help fulfill the agreements made by the Chino Basin Watermaster Parties, Orange County Water District and the Santa Ana Regional Water Quality Control Board as part of the Optimum Basin Management Plan. The OBMP allows use of recycled water in the area, protects water quality and provides hydraulic control to keep high-salt groundwater from migrating to Orange County. It maximizes the use of local resources in order to reduce dependence on imported water and provide water supply reliability. It is also helps the salt balance of the watershed by providing replenishment water to meet the desalter pumping obligation.

5. **25.5 Acres of preservation and restoration:** The project involves using flood control facilities for multiple purposes, including groundwater recharge and habitat. Maintaining soft-bottom recharge basins helps restore the natural connectivity of the surface water and groundwater. Capturing stormwater in the recharge basins reduces peak stream flows and infiltrates more water to better simulate pre-development conditions. It is a better imitation of the historical natural processes to infiltrate stormwater high in the watershed in the alluvial fans where the TDS and other pollutants in the stormwater are the lowest. San Sevaine basins 1, 2 & 3 will have more water on a more year-round basis with the project. When wet, they provide 25.5 acres of open water and shoreline habitat for birds. Keeping the basins wet with pools for mosquito fish will also control mosquitos.

6. **4,766 metric tons of CO2e/year Green House Gas:** Increasing the use of recycled water reduces statewide energy consumption due to not having to pump water from the Bay-Delta over the Tehachapi Mountains and into Southern California. IEUA estimates that it requires 2,657 kWh less electricity to deliver one acre-foot of recycled water than it does to deliver one acre foot of water from the State Water Project. According to the information provided in the study "The Role of Recycled Water in Energy Efficiency and Greenhouse Gas Reduction", for every MWh of energy required, 879 pounds of greenhouse gases (GHGs) as CO2 equivalents are produced and 2,205 pounds of GHGs equal 1 metric ton. So, the Project with a benefit of 4,500 AFY would require 11,956 MWh less of energy and would reduce GHGs by an estimated 4,766 metric tons/yr of GHGs (as CO2eq).

Table 9 – Annual Project Physical Benefits Project Name: _San Sevaine Ground Water Recharge Basin Type of Benefit Claimed: _______Water Recycling/Reuse Additional Information About this Measure:__________ Acre feet per year ____ Additional Information About this Measure:____			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	500	0	0
2013	500	0	0
2014	500	0	0
2015	500	5000	4500
2016	500	5000	4500
2017	500	5000	4500
2018	500	5000	4500
2019	500	5000	4500
2020	500	5000	4500
2021	500	5000	4500
2022	500	5000	4500
2023	500	5000	4500
2024	500	5000	4500
2025	500	5000	4500
2026	500	5000	4500
2027	500	5000	4500
2028	500	5000	4500
2029	500	5000	4500
2030	500	5000	4500
2031	500	5000	4500
2032	500	5000	4500
2033	500	5000	4500
2034	500	5000	4500
2035	500	5000	4500
2036	500	5000	4500
2037	500	5000	4500
2038	500	5000	4500
2039	500	5000	4500
2040	500	5000	4500
2041	500	5000	4500
2042	500	5000	4500
2043	500	5000	4500
2044	500	5000	4500
2045	500	5000	4500
2046	500	5000	4500
2047	500	5000	4500
2048	500	5000	4500
2049	500	5000	4500
2050	500	5000	4500
2051	500	5000	4500
2052	500	5000	4500
2053	500	5000	4500
2054	500	5000	4500
2055	500	5000	4500
2056	500	5000	4500

2057	500	5000	4500
2058	500	5000	4500
2059	500	5000	4500
2060	500	5000	4500
2061	500	5000	4500
2062	500	5000	4500
2063	500	5000	4500
2064	500	5000	4500
Comments: 50 years project life, ending in 2064			

Table 9 – Annual Project Physical Benefits

Project Name: _San Sevaine Ground Water Recharge Basin
Type of Benefit Claimed: _______
Stormwater Capture and Storage____
Additional Information About this Measure:__________
Acre feet per year ____
Additional Information About this Measure:____

	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2012	176	0	0
2013	176	0	0
2014	176	0	0
2015	176	526	350
2016	176	526	350
2017	176	526	350
2018	176	526	350
2019	176	526	350
2020	176	526	350
2021	176	526	350
2022	176	526	350
2023	176	526	350
2024	176	526	350
2025	176	526	350
2026	176	526	350
2027	176	526	350
2028	176	526	350
2029	176	526	350
2030	176	526	350
2031	176	526	350
2032	176	526	350
2033	176	526	350
2034	176	526	350
2035	176	526	350
2036	176	526	350
2037	176	526	350
2038	176	526	350
2039	176	526	350
2040	176	526	350
2041	176	526	350
2042	176	526	350
2043	176	526	350
2044	176	526	350

2045	176	526	350
2046	176	526	350
2047	176	526	350
2048	176	526	350
2049	176	526	350
2050	176	526	350
2051	176	526	350
2052	176	526	350
2053	176	526	350
2054	176	526	350
2055	176	526	350
2056	176	526	350
2057	176	526	350
2058	176	526	350
2059	176	526	350
2060	176	526	350
2061	176	526	350
2062	176	526	350
2063	176	526	350
2064	176	526	350
Comments: 50 years project life, ending in 2064			

Table 9 – Annual Project Physical Benefits

Project Name: _San Sevaine Ground Water Recharge Basin
Type of Benefit Claimed: _______Imported Water Recharge
Additional Information About this Measure:__________
Acre feet per year ______________________________
Additional Information About this Measure:______________________________

	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	1228	0	0
2013	1228	0	0
2014	1228	0	0
2015	1228	1348	120
2016	1228	1348	120
2017	1228	1348	120
2018	1228	1348	120
2019	1228	1348	120
2020	1228	1348	120
2021	1228	1348	120
2022	1228	1348	120
2023	1228	1348	120
2024	1228	1348	120
2025	1228	1348	120
2026	1228	1348	120
2027	1228	1348	120
2028	1228	1348	120
2029	1228	1348	120
2030	1228	1348	120
2031	1228	1348	120
2032	1228	1348	120

2033	1228	1348	120
2034	1228	1348	120
2035	1228	1348	120
2036	1228	1348	120
2037	1228	1348	120
2038	1228	1348	120
2039	1228	1348	120
2040	1228	1348	120
2041	1228	1348	120
2042	1228	1348	120
2043	1228	1348	120
2044	1228	1348	120
2045	1228	1348	120
2046	1228	1348	120
2047	1228	1348	120
2048	1228	1348	120
2049	1228	1348	120
2050	1228	1348	120
2051	1228	1348	120
2052	1228	1348	120
2053	1228	1348	120
2054	1228	1348	120
2055	1228	1348	120
2056	1228	1348	120
2057	1228	1348	120
2058	1228	1348	120
2059	1228	1348	120
2060	1228	1348	120
2061	1228	1348	120
2062	1228	1348	120
2063	1228	1348	120
2064	1228	1348	120
Comments: 50 years project life, ending in 2064			

Table 9 – Annual Project Physical Benefits

Project Name: _San Sevaine Ground Water Recharge Basin

Type of Benefit Claimed: _______Salt Removal

Additional Information About this Measure:__________

Acre feet per year ____

Additional Information About this Measure:____

	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	48.27	0	0
2013	48.27	0	0
2014	48.27	0	0
2015	48.27	174.27	126
2016	48.27	174.27	126
2017	48.27	174.27	126
2018	48.27	174.27	126
2019	48.27	174.27	126
2020	48.27	174.27	126

2021	48.27	174.27	126
2022	48.27	174.27	126
2023	48.27	174.27	126
2024	48.27	174.27	126
2025	48.27	174.27	126
2026	48.27	174.27	126
2027	48.27	174.27	126
2028	48.27	174.27	126
2029	48.27	174.27	126
2030	48.27	174.27	126
2031	48.27	174.27	126
2032	48.27	174.27	126
2033	48.27	174.27	126
2034	48.27	174.27	126
2035	48.27	174.27	126
2036	48.27	174.27	126
2037	48.27	174.27	126
2038	48.27	174.27	126
2039	48.27	174.27	126
2040	48.27	174.27	126
2041	48.27	174.27	126
2042	48.27	174.27	126
2043	48.27	174.27	126
2044	48.27	174.27	126
2045	48.27	174.27	126
2046	48.27	174.27	126
2047	48.27	174.27	126
2048	48.27	174.27	126
2049	48.27	174.27	126
2050	48.27	174.27	126
2051	48.27	174.27	126
2052	48.27	174.27	126
2053	48.27	174.27	126
2054	48.27	174.27	126
2055	48.27	174.27	126
2056	48.27	174.27	126
2057	48.27	174.27	126
2058	48.27	174.27	126
2059	48.27	174.27	126
2060	48.27	174.27	126
2061	48.27	174.27	126
2062	48.27	174.27	126
2063	48.27	174.27	126
2064	48.27	174.27	126
Comments: 50 years project life, ending in 2064			

Table 9 – Annual Project Physical Benefits Project Name: _San Sevaine Ground Water Recharge Basin Type of Benefit Claimed: _______Preservation and Restoration Additional Information About this Measure:__________Acres Additional Information About this Measure:Project will provide 25.5 acres of preservation and restoration			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	25.5	25.5
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
2024	0	0	0
2025	0	0	0
2026	0	0	0
2027	0	0	0
2028	0	0	0
2029	0	0	0
2030	0	0	0
2031	0	0	0
2032	0	0	0
2033	0	0	0
2034	0	0	0
2035	0	0	0
2036	0	0	0
2037	0	0	0
2038	0	0	0
2039	0	0	0
2040	0	0	0
2041	0	0	0
2042	0	0	0
2043	0	0	0
2044	0	0	0
2045	0	0	0
2046	0	0	0
2047	0	0	0
2048	0	0	0
2049	0	0	0
2050	0	0	0
2051	0	0	0
2052	0	0	0
2053	0	0	0
2054	0	0	0
2055	0	0	0
2056	0	0	0

2057	0	0	0
2058	0	0	0
2059	0	0	0
2060	0	0	0
2061	0	0	0
2062	0	0	0
2063	0	0	0
2064	0	0	0
Comments: 50 years project life, ending in 2064			

Table 9 – Annual Project Physical Benefits Project Name: _San Sevaine Ground Water Recharge Basin Type of Benefit Claimed: ______Green house gases Measure of Benefit Claimed (Name of Units): ______metric tons of CO2e per year Additional Information About this Measure:__________			
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	4766	4766
2016	0	4766	4766
2017	0	4766	4766
2018	0	4766	4766
2019	0	4766	4766
2020	0	4766	4766
2021	0	4766	4766
2022	0	4766	4766
2023	0	4766	4766
2024	0	4766	4766
2025	0	4766	4766
2026	0	4766	4766
2027	0	4766	4766
2028	0	4766	4766
2029	0	4766	4766
2030	0	4766	4766
2031	0	4766	4766
2032	0	4766	4766
2033	0	4766	4766
2034	0	4766	4766
2035	0	4766	4766
2036	0	4766	4766
2037	0	4766	4766
2038	0	4766	4766
2039	0	4766	4766
2040	0	4766	4766
2041	0	4766	4766
2042	0	4766	4766
2043	0	4766	4766
2044	0	4766	4766
2045	0	4766	4766

2046	0	4766	4766
2047	0	4766	4766
2048	0	4766	4766
2049	0	4766	4766
2050	0	4766	4766
2051	0	4766	4766
2052	0	4766	4766
2053	0	4766	4766
2054	0	4766	4766
2055	0	4766	4766
2056	0	4766	4766
2057	0	4766	4766
2058	0	4766	4766
2059	0	4766	4766
2060	0	4766	4766
2061	0	4766	4766
2062	0	4766	4766
2063	0	4766	4766
2064	0	4766	4766
Comments: 50 years project life, ending in 2064			

Project H: Corona/Home Gardens Well Rehabilitation and Multi-Jurisdictional Water Transmission Line Project (City of Corona)

Physical Benefits The primary physical benefit of the project is the establishment of a new local water source created by replacing two non-functioning wells in Home Gardens. The new local water produced will then be transported via new pipelines to be treated and distributed to customers. Test wells will be drilled to confirm the quantity of the groundwater to be produced. However, it is estimated that each replacement well will produce 1600-1800 AFY. A January 2013 Technical Memorandum prepared by AKM Consulting Engineers estimates the replacement wells combined will produce up to 3600 AFY. For the purposes of this estimate a range of water production amounts is being utilized. The actual water production (benefit) will be measured using well-head flow meter readings.

Recent and Historical Conditions The Corona/Home Gardens region experienced a prolonged drought from 1987 through 1992 and again in 2007 through 2009. The City of Corona was able to meet its customers' needs through careful conjunctive management of groundwater and local reservoir supplies, and by investing in water conservation and water recycling. However, these droughts further reinforced that the City needs to develop alternative water sources to be self-reliant in the future.

Groundwater Production The City of Corona pumped about 62% of its water supply from the ground in 2010, roughly 24,551 AFY. The project is estimated to add 1,600-3,600 AFY to local groundwater production. This will lessen Corona's reliance on imported water sources, such as the State Water Project *and* provide a new water source to help sustain predicted growth. Corona and Home Gardens are located in Riverside County where explosive growth is predicted. Riverside County is projected to grow the most of any California county by 2060 to become the second-most populated in the state, according to a demographic report from the California Department of Finance in January 2013. The county's population will almost double to reach 4,216,816 — a number second only to Los Angeles County.

Factors of Uncertainty A number of unpredictable factors impact groundwater production amounts. Rainfall amounts, drought, and snow melt can all have a significant effect on the amount of water that is produced by a well. In addition, the depth of the well can be a factor in water production. For example a shallow depth well may be more sucseptable to drought or overdraft conditions than a well pumping from greater depths. Given these hydrologic conditions a range was provided to reflect the minimum estimated production of one well (1,600 AFY) to the estimated maximum production of both wells (3,600 AFY) combined.

Table 9 – Annual Project Physical Benefits

Project Name: Corona Home Gardens Well Rehabilitation and Multi-jurisdictional Water Transmission Line

Type of Benefit Claimed: New Local Water Supply Produced

Measure of Benefit Claimed (Name of Units): Acre Feet Per Year

Additional Information About this Measure: Two new Home Gardens well-head flow meters will provide readings.

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2014	24,551	26,151-28,151	Corona DWP Groundwater production will increase by 1,600-3,600 AFY every year in which the wells and transmission lines are operational. This range of groundwater production is expected every year in the project life based upon average hydrologic conditions.
2015	24,551	26,151-28,151	
2016	24,551	26,151-28,151	
Etc.	24,551	26,151-28,151	
2064 Last Year of Project Life			The project life is estimated to be 50 years.

Project I: Enhanced Stormwater Capture and Recharge along the Santa Ana River (San Bernardino Valley Municipal Water District)

Table 9 – Annual Project Physical Benefits

Project Name: Enhnaced Stormwater Capture and Recharge along the Santa Ana River
Type of Benefit Claimed: Increase capture and use of local stormwater
Measure of Benefit Claimed (Name of Units): acre-feet
Additional Information About this Measure:________________________

(a) Year	(b) Without Project	(c) With Project	(d) Change Resulting from Project (c) – (b)
2015	0	1,600	1,600
2016	0	500	500
2017	0	200	200
2018	0	1,000	1,000
2019	0	12,000	12,000
2020	0	28,500	28,500
2021	0	1,700	1,700
2022	0	72,000	72,000
2023	0	11,000	11,000
2024	0	4,600	4,600
2025	0	3,700	3,700
2026	0	13,300	13,300
2027	0	1,700	1,700
2028	0	2,000	2,000
2029	0	3,300	3,300
2030	0	1,300	1,300
2031	0	34,000	34,000
2032	0	28,000	28,000
2033	0	47,300	47,300
2034	0	2,400	2,400

2035	0	4,000	4,000
2036	0	45,900	45,900
2037	0	6,000	6,000
2038	0	1,700	1,700
2039	0	2,300	2,300
2040	0	800	800
2041	0	750	750
2042	0	1,600	1,600
2043	0	200	200
2044	0	1,600	1,600
2045	0	1,800	1,800
2046	0	56,000	56,000
2047	0	2,100	2,100
2048	0	40,100	40,100
2049	0	1,700	1,700
2050	0	1,700	1,700
2051	0	33,000	33,000
2052	0	1,700	1,700
2053	0	1,600	1,600
Last Year of Project Life	Unknown, the current facilities have been operating since 1930		

Comments: The benefits of this project are for a "snapshot in time" and will vary with hydrology. Actual amounts could be higher or lower.

Table 9 – Annual Project Physical Benefits Project Name: Enhnaced Stormwater Capture and Recharge along the Santa Ana River			
Type of Benefit Claimed: Reduction in energy use Measure of Benefit Claimed (Name of Units): metric tons CO2e/year Additional Information About this Measure: Savings of using local stormwater as compared to imported water			
(a)	(b)	(c)	(d)
Year	Without Project	With Project	Change Resulting from Project (c) – (b)
2015	3,520	-	(3,520)
2016	1,100	-	(1,100)
2017	440	-	(440)
2018	2,200	-	(2,200)
2019	26,400	-	(26,400)
2020	62,700	-	(62,700)
2021	3,740	-	(3,740)
2022	158,400	-	(158,400)
2023	24,200	-	(24,200)
2024	10,120	-	(10,120)
2025	8,140	-	(8,140)
2026	29,260	-	(29,260)
2027	3,740	-	(3,740)
2028	4,400	-	(4,400)
2029	7,260	-	(7,260)
2030	2,860	-	(2,860)
2031	74,800	-	(74,800)
2032	61,600	-	(61,600)
2033	104,060	-	(104,060)
2034	5,280	-	(5,280)
2035	8,800	-	(8,800)

2036	100,980	-	(100,980)
2037	13,200	-	(13,200)
2038	3,740	-	(3,740)
2039	5,060	-	(5,060)
2040	1,760	-	(1,760)
2041	1,650	-	(1,650)
2042	3,520	-	(3,520)
2043	440	-	(440)
2044	3,520	-	(3,520)
2045	3,960	-	(3,960)
2046	123,200	-	(123,200)
2047	4,620	-	(4,620)
2048	88,220	-	(88,220)
2049	3,740	-	(3,740)
2050	3,740	-	(3,740)
2051	72,600	-	(72,600)
2052	3,740	-	(3,740)
2053	3,520	-	(3,520)
Last Year of Project Life			

Comments: The benefits of this project are for a "snapshot in time" and will vary with hydrology. Actual amounts could be higher or lower. Greenhouse gas savings assumes that the captured stormwater is offsetting the need for a like amount of imported water which may, or may not, be true.

Project J: Regional Residential Landscape Retrofit Program (Inland Empire Utilities Agency)

The project identified within this application will result in up to 1,000 acre-feet per year of a reduction in potable water use, 1,940 CO2 per year, and 3,300,000 KwH per year and corresponding reductions per year of imported water from northern California. All potable water not pumped from the Chino Basin will later be pumped and beneficially reused as a new local water supply.

The 1,000 acre-feet per year of savings is estimated from the landscape upgrades of residential sites. The estimated water savings for this program is based on a program completed by Three Valleys Municipal Water District (TVMWD). The project was completed and the savings has been compiled that demonstrate significant water use savings for the targeted residential water customers who participated. The water savings are quantifiable through the examination of water use records pre- and post-survey/retrofits. All participating customers must agree to allow their water agency to review their water use records and report that water use accordingly.

SURVEY ONLY	SURVEY & SPRINKLER RETROFIT ONLY	SURVEY & CONTROLLER RETROFIT ONLY	SURVEY & SPRINKLER & CONTROLLER RETROFITS	PRE-SURVEY WATER USE (average per month-gals.)	AFTER SURVEY WATER USE (average per month-gals.)	AVERAGE SAVINGS per SITE per BILLING CYCLE (gals.)
16				118,053	109,203	8,850
	4			128,526	94,721	33,805
		23		90,593	52,462	38,131
			24	116,080	83,415	32,665

As shown in the table above, the average water savings per residential site, per month is 28,363 gallons. With these averages alone, the savings represents 1.04 acre-feet of water saved per residential site per year. However, the savings increases substantially when looking at larger lot sizes and higher water users. The TVMWD pilot program used data from the sites upgraded in the Walnut Valley Water District and City of La Verne service areas. The discrepancy in lot sizes makes an obvious difference. The residential sites in the Walnut Valley Water District's service area saved approximately 2.3 acre feet per year, per residential site and the City of La Verne's savings was 0.30 acre-feet per residential site per year. The discrepancy between the average gallons saved is due to lot size differences. Overall, the percentages for each of the service areas results in an average savings of 26%.

Considering that our goal is to survey and upgrade at least 600 sites, the estimated water reduction may result in more than 10,000 acre-feet of water saved over a ten year period. This is a target figure, and is a conservative estimate. TVMWD's experience with this program showed that lot sizes made the biggest impact in time and budget.

An average of 2.3 acre-feet/year saved (WVWD) and 0.30 acre-feet/year (La Verne) = 1.3 acre-feet/year per residential site.

To determine the 10-year projected water savings, we have used a conservative figure of melding both the Walnut Valley Water District's and City of La Verne's average monthly water savings associated with this program, to come up with a composite figure of 1.3 acre-feet per year, per site, or a 26% reduction in monthly water use.

The ten year lifespan of savings is what the California Urban Water Conservation Council (CUWCC) and the Metropolitan Water District of Southern California (MWD) use to determine the savings for this type of program and landscape retrofits.

SUPPORTING DOCUMENTS

California Single Family Water Use Efficiency Study
http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-California-Single-Family-Water-Use-Efficiency-Study.pdf

USBR Summary of Smart Controller Water Savings Studies
http://www.usbr.gov/waterconservation/docs/WaterSavingsRpt.pdf

Evaluation of California Weather Based "Smart" Irrigation Controller Programs
http://www.aquacraft.com/sites/default/files/pub/Aquacraft-%282009%29-Evaluation-of-California-Weather-Based-Smart-Irrigation-Controller-Programs.pdf

Water Conservation Potential of Landscape Irrigation Smart Controllers
Michael D. Dukes, Ph.D., P.E

Performance and Water Conservation Potential of Multi-Stream, Multi-Trajectory Rotating Sprinklers for Landscape Irrigation

http://wallawallasprinkler.com/asabe_paper_published.pdf

Toro Precision Series Spray Nozzles-Third Party Study
http://www.pacificwatermanagement.com/precision-nozzle-study.pdf

Table 9 – Annual Project Physical Benefits

Project Name: Regional Residential Landscape Retrofit Project
Type of Benefit Claimed: Water Savings
Measure of Benefit Claimed (Name of Units): acre feet per year
Additional Information About this Measure: Approximate 1.67 average AFY per residence

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	167	167
2015	0	584.5	584.5
2016	0	1000	1000
2017	0	1000	1000
2018	0	1000	1000
2019	0	1000	1000
2020	0	1000	1000
2021	0	1000	1000
2022	0	1000	1000
2023	0	1000	1000
2024	0	833	833
2025	0	417.5	417.5

Comments: First year of project expect to retrofit 100 residences, 2nd year 250 residences, 3rd year 250 residences. Decline of benefit at end is because of the staggering of installation. Products have an estimated 10 year life from the date products are installed.

Table 9 – Annual Project Physical Benefits

Project Name: _Regional Residential Landscape Retrofit Project

Type of Benefit Claimed: _______Green house gases

Measure of Benefit Claimed (Name of Units): ______metric tons of CO2e per year

Additional Information About this Measure:

(a)	(b)	(c)	(d)

Table 9 – Annual Project Physical Benefits

Project Name: _Regional Residential Landscape Retrofit Project

Type of Benefit Claimed: _______Green house gases

Measure of Benefit Claimed (Name of Units): ______metric toms of CO2e per year

Additional Information About this Measure:__AFY of water savings per installed retrofits X 1.297

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012	0	0	0
2013	0	0	0
2014	0	216.6	216.6
2015	0	584.9	584.9
2016	0	1,297.0	1,297.0
2017	0	1,297.0	1,297.0
2018	0	1,297.0	1,297.0
2019	0	1,297.0	1,297.0
2020	0	1,297.0	1,297.0
2021	0	1,297.0	1,297.0
2022	0	1,297.0	1,297.0
2023	0	1,297.0	1,297.0
2024	0	1,080.4	1,080.4
2025	0	712.1	712.1

Comments: First year of project expect to retrofit 100 properties, 2nd year 250 properties, 3rd year 250 properties, retrofit has an approximate 10 year life which is staggered based on when the retrofit occurs

Based on a total estimate of 1000 AFY of water savings per year after all retrofits are completed, the CO2e is equal to 1,297 metric tons of CO2e per year. This was calculated using the following formula:

Metric Tons CO2/Year GHG reduction = (AFY year of water savings)*3,400 kWH/AF*(1 MWH/1000 kWh)*(0.4207 short tons CO2/MWH)*(2000 lbs /short ton)*(1 metric ton/2,205 lbs)

=AFY*1.297

The source of the above formula is http://carbonfund.org/

Project K: Canyon Lake Hybrid Treatment Process (Lake Elsinore & San Jacinto Watersheds Authority)

Project Physical Benefits

Physical benefits of the proposed Project are related to elimination of nutrient related impairments of beneficial uses in Canyon Lake. Reduction in algal blooms and low DO conditions facilitate more efficient treatment of water by EVMWD, prevention of fish kills, and improved aesthetics and recreational use potential for residents of Canyon Lake. The following sections describe how the use of alum additions, in the first phase of the Canyon Lake Hybrid Treatment Project, will provide reductions to nutrient related water quality impairments.

Generally, algal blooms in Canyon Lake occur at similar times of year (Figure 1) and are primarily a function of nutrient loading trends. For this reason, the alum applications will be timed to reduce seasonal chlorophyll-a concentrations. The first algal bloom occurs around February and is caused by the presence of nutrient rich external loads in dissolved or suspended particulate form that remain in Canyon Lake at the end of the wet season, coincident with increasing daylight hours and water temperatures. The second algal bloom occurs around October and is caused by turnover of the lake, which brings nutrient enriched water from the hypolimnion to the photic zone where it serves as a food source for algae. This source of nutrients comes from internal loads released from bottom sediments into the hypolimnion during the period of thermal stratification (roughly March through October). The presence of anoxic conditions in the hypolimnion increases the rate of nutrient flux from bottom sediments and subsequent loading of nutrients to photic zone at turnover. To address both periods of enhanced algal growth, alum applications to Canyon Lake are proposed twice per year, once in February, and again in September.

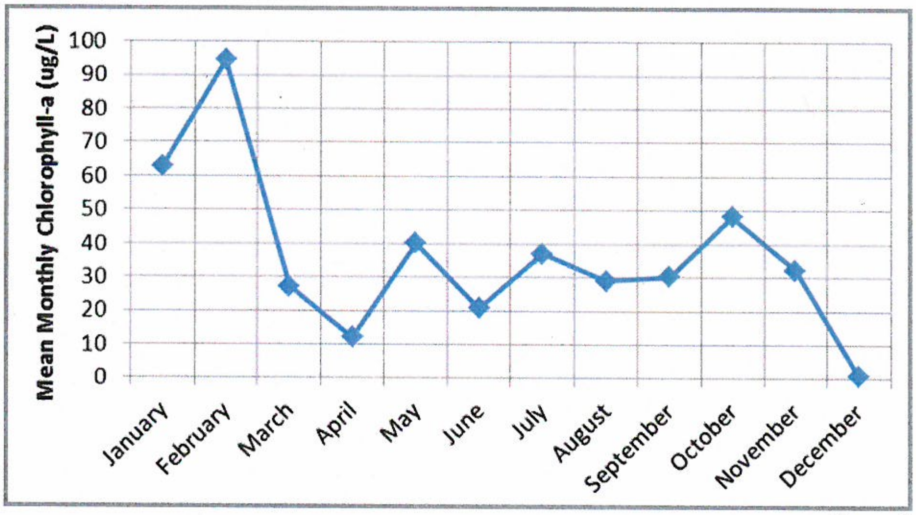

Figure 1

Mean Monthly Chlorophyll-a in Main Body of Canyon Lake

A one dimensional lake water quality model, DYRESM-CAEDYM, was developed by the Task Force for use in evaluating nutrient management strategies for Canyon Lake and Lake Elsinore. The analysis of in-lake nutrient management alternatives also accounts for estimated load reductions from watershed BMPs included in the CNRP, AgNMP, and from expectation of continued improvement to vehicle emissions as a result of more stringent federal and state air quality standards (State Implementation Plan, South Coast Air Quality Management District).

The CL/LE TMDL Task Force has completed detailed evaluations of aeration, oxygenation, and chemical addition (for references, see http://www.sawpa.org/collaboration/projects/lake-elsinore-canyon-lake-tmdl-task-force/). Based on these evaluations, the Task Force has determined that chemical addition, using aluminum sulfate (alum), is the most effective in-lake nutrient control strategy to address nutrient related impairments. When alum is added to a waterbody, an aluminum hydroxide precipitate known as floc is formed. The floc binds with phosphorus in the water column to form an aluminum phosphate compound which will settle to the bottom of the lake or reservoir. Once precipitated to the bottom of the reservoir, the floc will also act as a phosphorus barrier. It binds any phosphorus released from the sediments during normal nutrient cycling processes that occur primarily under anoxic conditions such as those found in much of the hypolimnion at Canyon Lake. The aluminum phosphate compounds are insoluble in water under most conditions, including those in Canyon Lake, and will render all bound phosphorus unavailable for nutrient uptake by aquatic organisms. It is through the reduction of bioavailable phosphorus that alum additions reduce the growth of algae in Canyon Lake, as measured by chlorophyll-a concentration in water samples.

Chlorophyll-a

Algae need both nitrogen and phosphorus for growth. The limiting nutrient is the one that is completely used for algal growth while some of the other still remains in its bioavailable form. Thus, only reductions of the limiting nutrient would be expected to generate reductions in algal growth. A Redfield ratio of TN to TP of greater than 7 suggests the waterbody in phosphorus limited, while a ratio less than 7 suggests the waterbody in nitrogen limited. Historical water quality data for Canyon Lake shows that the system is weakly nitrogen limited; however, alum additions are only effective for addressing phosphorus. Thus, Canyon Lake alum additions are designed to reduce phosphorus sufficiently to create a condition of phosphorus limitation before generating any positive results toward reducing nutrient related impairments.

The DYRESM-CAEDYM model was used to estimate the reduction of bioavailable phosphorus that would be needed to limit algae growth, and maintain average annual chlorophyll-a concentration at less than 25 ug/L in all hydrologic years. Adsorption isotherms were then used to estimate the required dose of alum needed to reduce phosphorus from current levels to the target concentration. Results showed that a dose of 10 mg/L of alum (~1 mg/L as Al) would effectively reduce 10-year averages of chlorophyll-a from ~35 ug/L to less than ~5 ug/L by reducing TP from ~0.31 mg/L to ~0.15 mg/L. The model predicted a significant reduction in chlorophyll-a despite average TP concentrations being above the TMDL numeric target of 0.1 mg/L. The reason for this is that the reduction accounts for most of the bioavailable pool of phosphorus (i.e. dissolved orthophosphate form). At a relatively low dose of 10 mg/L, alum forms a less than typical floc size or "microfloc", which has a longer residence time as it settles through the water column. The longer residence time allows for chemical processes needed to bind dissolved forms of phosphorus relative to heavier doses (50-100 mg/L) that largely only provide physical entrainment of particulates as a larger floc settles through the water column (Moore et al., 2009). EVMWD conducted jar tests to determine the reduction of TP that could be achieved at varying doses of alum. Jar test results from the two Main Body monitoring locations (CL07 and CL08) showed that a dose of 10 mg/L alum would result in a TP reduction of ~0.15 mg/L, which presumably is mostly in the form of dissolved orthophosphate.

The one dimensional DYRESM-CAEDYM model simulates a lake wide average vertical profile of water quality, therefore areas of relatively greater concern for chlorophyll-a are averaged with areas of typically better water quality. Of a particular interest to the Task Force is the East Bay of Canyon Lake. The East Bay is shallower than the Main Body, receives runoff from a different subwatershed, has higher nutrient concentrations, more dense and persistent algal blooms, and experiences minimal lateral mixing with the Main Body of the lake. A separate analysis using CDM Smith's Small Lake Assessment Model (SLAM) was completed for this zone of Canyon Lake to assess whether alum can be effective for reducing chlorophyll-a (CDM Smith, 2012). Once calibrated using historical nutrient and chlorophyll-a data (2007 – 2010), SLAM was used to test the effect of reduced water column TP on chlorophyll-a. SLAM results suggest that TP would need to be reduced to ~0.05 mg/L to reduce seasonal chlorophyll-a concentrations to below the numeric target of 25 ug/L (Figure 2). This differs from the DYESM-CAEDYM results, because SLAM does not partition dissolved and particulate forms of phosphorus. The alum application in the East Bay is heavier than in the Main Body and will therefore not act as a microfloc targeting primarily dissolved orthophosphate as is planned for the Main Body. Thus, simulation of total phosphorus is appropriate for the East Bay as additional removal of particulate phosphorus will occur.
EVMWD jar test results from the two East Bay monitoring locations (CL09 and CL10) showed that a dose of 30 mg/L alum would result in a TP of ~0.05 mg/L, therefore a heavier dose of 30 mg/L alum (~3 mg/L as Al) was selected for East Bay alum applications.

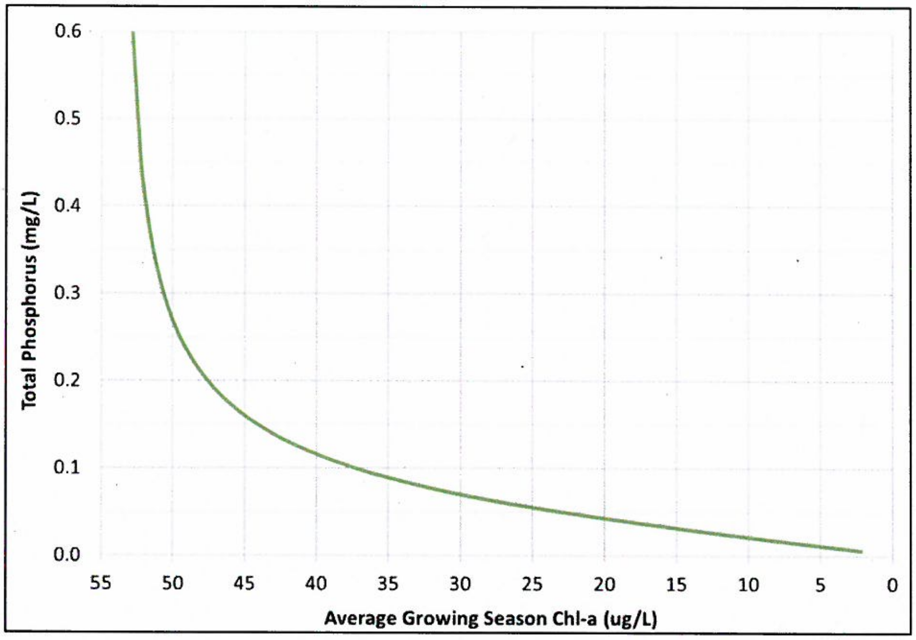

Figure 2
SLAM Results Showing Chlorophyll-a for Varying Reductions in Total Phosphorus during Growing Seasons

Dissolved Oxygen

The combination of watershed BMPs and alum additions will not directly increase dissolved oxygen within Canyon Lake; however, over time, the indirect benefit of reduced algal growth and die-off/settling will reduce sediment oxygen demand, and therefore reduce anoxic conditions at sediment-water interface. In turn, more oxic conditions at the sediment-water interface will reduce the flux of nutrient from bottom sediments to the water column, which would provide additional reductions in algal growth and die-off/settling. Figure 3 shows that implementation of watershed BMPs and alum additions over a 10-year period would be expected to provide significant progress toward returning exceedence frequency of WQOs to pre-development levels. However, these indirect benefits will not be realized immediately, given that the half-life of settled nutrients in Canyon Lake is estimated to be approximately 10 years (Anderson, 2012).

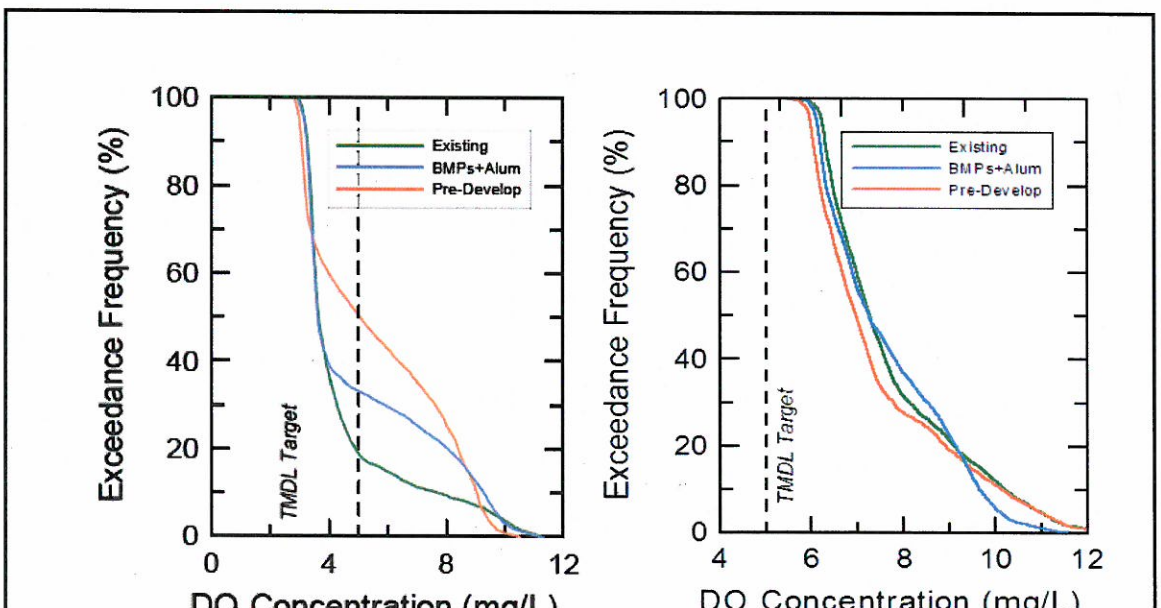

Figure 3
Cumulative Frequency of Daily Average DO in hypolimnion (left) and epilimnion (right) for DYRESM-CAEDYM Simulations of Existing, Pre-development, and with CNRP Implementation Scenarios

Uncertainty is greatest when it comes to the ability for alum to achieve the final DO response target for the hypolimnion, even after accounting for the potentially uncontrollable exceedences associated with a predevelopment condition in the watershed. The DYRESM-CAEDYM results showed a reduction in exceedence frequency from 80 to 65 percent of the time, attributable to the indirect benefits of reduced nutrient cycling and associated sediment oxygen demands. Such benefits may continue to accrue over several decades, but there is much uncertainty as to the ultimate potential for DO conditions in the hypolimnion. Consequently, the Project proponents have developed adaptive management in the form of a hybrid treatment approach. In 2016, the Project proponents will evaluate the effectiveness of alum applications for DO in the hypolimnion and determine whether a supplemental in-lake project for DO, such as aeration or oxygenation, would be needed to address remaining controllable nutrient related impairments.

Table 9 – Annual Project Physical Benefits

Project Name: Canyon Lake Hybrid Treatment Project
Type of Benefit Claimed: Reduction in annual average chlorophyll-a and reduction in numeric target exceedences for DO in hypolimnion (epilimnion is currently above WQO of 5 mg/L DO most days in most years)

Measure of Benefit Claimed (Name of Units): ug/L chlorophyll-a; annual number of hypolimnetic DO target exceedence days
Additional Information About this Measure:________________________________

(a)	(b)	(c)	(d)
Annual Average Chlorophyll-a (ug/L)	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2013	35	5	30
2014	35	5	30
2015	35	5	30
2016	35	5	30
Dissolved oxygen in hypolimnion (days/yr less than 5 mg/L)	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2013	296	244	52
2014	296	244	52
2015	296	244	52
2016	296	244	52

Project L: 14th Street Groundwater Recharge and Storm Water Quality Treatment Integration Facility (City of Upland)

The proposed project will protect 220 acres against flooding during medium to large storm events by capturing, conveying and recharging approximately 400 acre-feet per year of high quality rainstorm to the groundwater basin. Without it, this volume would otherwise be lost to the storm drain system and, ultimately, the Pacific.

Doing so eventually reduces the amount of imported water through Metropolitan Water District of Southern California, thus reducing greenhouse gases associated with pumping and transporting the imported water from the Delta.

It is estimated that approximately 690 metric tons of CO_2 per year will be eliminated based on the Natural Resources Defense Council, pumping 1 ac-ft of State Water Project water to southern California requires 3,000 kWh and pumping 1 ac-ft of Colorado River Aqueduct water to the region requires about 2,000 kWh. As a result, using both sources, on average, requires 2,500 kWh for 1 ac-ft volume. The EPA estimated an emission factor of 6.8956×10^{-4} metric tons of CO_2 per kWh. Therefore, for an estimated 400 ac-ft per year, the proposed project will eliminate 690 metric tons of CO_2 each year.

This project provides an opportunity for future recycled water recharge, by utilizing the captured storm water as blending medium. This opportunity is futuristic and will need to be further evaluated.

All relevant technical reasons and benefits are presented in Attachments 3 and 8.

Project M: Customer Handbook to using Water Efficiently in the Landscape (Western Municipal Water District)

Please see attached.

Responses of Landscape Groundcovers to Minimum Irrigation[1]

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Abstract

Four irrigation regimes based on percentages of real-time reference evapotranspiration (ET_0) were applied to six widely used species of landscape groundcovers (*Baccharis pilularis* 'Twin Peaks', *Drosanthemum hispidum*, *Vinca major*, *Gazania rigens* v. *leucolaena* 'Yellow Cascade', *Potentilla tabernaemontanii*, and *Hedera helix* 'Needlepoint') during a 17-month period in Irvine, CA. Irrigation treatments (50%, 40%, 30% and 20% of ET_0) were applied when accumulated real-time $ET_0 \times$ treatment percentage reached 4.0 cm (1.6 in). Although the response to irrigation treatment was species dependent, *Baccharis*, *Drosanthemum*, and *Hedera* maintained at least minimally acceptable visual quality with applied water equal to 20% ET_0, while *Vinca* required a minimum of 30% ET_0. Acceptable visual quality of *Gazania* and *Potentilla* were not maintained at any treatment. Visual quality of *Potentilla* was better at ET_0 greater than or equal to 30% ET_0, but visual quality of *Gazania* was not improved with more water.

Index words: water conservation, evapotranspiration, landscape management, root systems, xeriscape.

Species used in this study: coyote bush (*Baccharis pilularis* DC. 'Twin peaks'); pink iceplant [*Drosanthemum hispidum* (L.f.) Schwant.]; Gazania [*Gazania rigens* (L.) Gaertn. v. *leucolaena* (*DC.*) Roessler 'Yellow Cascade']; English ivy (*Hedera helix* L. 'Needlepoint'); spring cinquefoil (*Potentilla tabernaemontanii* Asch.); periwinkle (*Vinca major* L.).

Significance to the Nursery Industry

Groundcovers are often recommended as turfgrass substitutes in irrigated landscapes of the southwestern United States based on the presumption that they require less water to maintain high visual quality. Turfgrass performance has been evaluated under experimental conditions, and irrigation amounts have been established for optimum, deficit, and survival management strategies. However, this kind of information has not been determined for groundcover species. In this study, we observed the performance of six groundcover species, representing a range of growth habits and potential adaptations to drought, at irrigation levels equal to or less than those suggested for turfgrasses. Overall, we found that groundcovers varied widely and unpredictably in their responses to irrigation. Four species (*Vinca major*, *Baccharis pilularis*, *Drosanthemum hispidum*, and *Hedera helix*) were able to maintain acceptable visual quality when given irrigation equal to or less than that needed by warm-season turfgrasses. Other species (*Potentilla* and *Gazania*) were not able to withstand any drought and appear to have minimum water needs similar to cool-season turfgrasses. Thus, the idea that groundcovers in general require less water than turfgrass to remain aesthetically appealing in the landscape is not entirely true. In order to achieve significant water conservation, the groundcover species must replace and have acceptable performance at levels of irrigation less than those suggested for cool-season turfgrass. In addition, we found that reference evapotranspiration (ET_0) information can be easily used to schedule groundcover irrigation, but further research is needed to determine schedules that most effectively conserve water in groundcovers.

[1]Received for publication November 8, 2000; in revised form February 14, 2001. This research was funded in part by **The Horticultural Research Institute, 1250 I Street, NW, Suite 500, Washington DC 20005**, and the Metropolitan Water District of Southern California.

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Introduction

Landscape groundcovers are a diverse group of trailing or spreading species that naturally form a continuous soil covering. They typically range in height from 7.5 cm (3.0 in) to nearly 1.0 m (3.3 ft) tall and may be woody, herbaceous, or succulent. In irrigated landscapes of the southwestern United States, where water conservation and water costs are high, these plants are increasingly viewed as substitutes for general-use, non-trafficked turfgrass based on the presumption they require less irrigation water to maintain a similar level of visual quality. Unlike turfgrass, much of the information describing groundcover irrigation needs is anecdotal and non-quantitative (2, 4, 10, 12); thus, there has been no objective basis for comparing water requirements of turfgrass and groundcovers or for scheduling groundcover irrigation.

Irrigation requirements of numerous agricultural crops and turfgrass have been experimentally determined in relationship to (generally expressed as a percentage of) reference evapotranspiration (ET_0) (5, R.L. Snyder, 1989 personal communication). These quantities have been determined under experimental conditions where irrigation application losses were minimized and ET_0 information was computed from local weather stations. While a relationship between irrigation and yield has been developed in many crops, irrigation of turfgrass and landscape plants is more appropriately related to their minimum and optimum appearance or their survival. In California, the minimum and optimum annual average irrigation requirements of commonly used warm-season turfgrasses have been quantified experimentally as 36% and 60% of ET_0, respectively (8, 11). For cool-season turfgrasses, the minimum and optimum requirements are 64% and 80% of ET_0 (8, 11).

A few studies on non-turf groundcover water needs have evaluated their ability to cover soil and their visual quality with respect to irrigation amounts. Two species of *Atriplex* and several non-turf type grasses demonstrated the capability to cover the ground in southern California when irrigated at 12% of ET_0 and mowed regularly (9). Staats and Klett (16) determined that visual quality of *Cerastium tomentosum* L. (snow-in-summer) and *Sedum acre* L. (goldmoss) were not greatly affected when irrigated as low as 25% ET_0, while visual quality of *Potentilla tabernaemontanii* (spring cinquefoil) was unacceptable in late summer if irrigated at or below 50% ET_0. They concluded that *Cerastium* and *Sedum* required less irrigation than the cool-season turfgrass *Poa pratensis* L. (Kentucky bluegrass). Unfortunately, these species are not commonly used in southwestern landscapes.

In an earlier single-season study, we found there was no significant loss in visual quality of six commonly used groundcovers when they were irrigated at 50% vs 100% ET_0 from May through October (13). Three of the species also performed well when irrigated at 25% ET_0.

Objectives of this study were to determine the minimum irrigation amounts required to maintain acceptable visual quality of established, commonly used, non-turf groundcovers and to evaluate the appropriateness of real-time ET_0-based irrigation scheduling for groundcovers.

Materials and Methods

The study was conducted at the University of California South Coast Research and Extension Center in Irvine, CA, which is 64 km (40 mi) southeast of Los Angeles. The site is in the south coastal plain of California and has a maritime, Mediterranean climate. Soil at the study site is a San Emigdio sandy loam [coarse-loamy, mixed (calcareous), thermic Typic Xerofluvent] with pH 6.9 and EC_e 1.0 dS m^{-1}. Its laboratory-determined moisture release characteristics are field capacity (FC) 23% and permanent wilting point (PWP) 9%. Six groundcovers that are commonly planted in southern California landscapes, representing a range of growth habits and potential adaptations to drought, were selected for the study. They were *Baccharis pilularis* 'Twin Peaks', *Drosanthemum hispidum*, *Vinca major*, *Gazania rigens* v. *leucolaena* 'Yellow Cascade', *Potentilla tabernaemontanii*, and *Hedra helix* 'Needlepoint'.

The treatment design was a two-factor factorial, and the experimental design was a split-plot in a randomized complete block with four blocks. Main plot treatments consisted of four irrigation levels, 50%, 40%, 30%, and 20% of real-time ET_0, randomly assigned to the main plots in each block, and the sub-plot treatment was the six groundcovers listed above, randomly assigned to the sub-plots in each main plot. Sub-plots measured 3.7 × 4.6 m (12 × 15 ft) with a 60 cm (2 ft) border and were established in March 1988 by transplanting rooted cuttings from flats at 30 × 30 cm (1 × 1 ft) spacing. Ammonium phosphate fertilizer (16–20–0) was pre-plant incorporated at 49.0 kg N ha^{-1} (1.0 lb N/1000 ft^2), and plots were treated with oryzalin [2.2 kg AI ha^{-1} (2.0 lb AI/acre)] two days after planting to inhibit weed growth. Additional nitrogen fertilizer was applied in May 1989 at 49.0 kg N ha^{-1} (1.0 lb N/1000 ft^2) and in April 1990 at 37.0 kg N ha^{-1} (0.75 lb N/1000 ft^2). Oryzalin was reapplied in November 1989 at 2.2 kg AI ha^{-1} (2.0 lb AI/acre) to inhibit weed invasion before the experiment began.

Each sub-plot was irrigated by fixed-spray shrub sprinkler heads (Rainbird 1800 Series), one in each corner and one at the midpoint of the long sides of a plot. The irrigation system had a distribution uniformity of 70%. Irrigation for each main plot was controlled by a solenoid valve connected to a programmable electronic controller. Valves were individually programmed to apply water according to the respective treatment. To verify irrigation amounts, an Engler analogue clock was wired to each valve circuit to record its actual cumulative run time in 6-second increments. Irrigation was applied three times/week during the one-year establishment period to maintain soil moisture at field capacity in the upper 61 cm (24 in) of soil.

Irrigation treatments were continuously scheduled on all species May 1990 through September 1991 using daily ET_0 estimates calculated by an on-site California Irrigation Management Information System (CIMIS) automated weather station employing a modified Penman equation (5, 6, 15). Daily real-time ET_0 values were multiplied by the fraction of ET_0 assigned for each treatment (0.5, 0.4, 0.3, 0.2, respectively) and accumulated. When the accumulated amount reached 4.0 cm (1.6 in), an irrigation of 4.0 cm (1.6 in) was applied to the plots of that treatment. This amount of water was approximately 50% of available water held in the top 61 cm (24 in) of soil determined by moisture release calculations. No adjustment factors were employed, and no additional water was applied to compensate for non-uniformity of the sprinkler irrigation system. Rainfall of 25 mm (0.1 in) or more per day was subtracted from the cumulative amount of each treatment. Irrigation scheduling by this method resulted in different intervals between applications and different amounts of water applied over a season among the treatments, but similar penetration of water into the root zone at each irrigation event. Compared to the traditional approach, where different amounts and depths of water (different percentages of ET_0) are applied simultaneously at a preset interval, more of the root zone is utilized and a better evaluation of species' responses to water stress is possible (3).

Visual quality ratings of groundcover appearance were recorded monthly by averaging the ratings given by members of a three-member panel. A 1 to 9 scale was used where 1 = dead or dying plants, 6 = minimally acceptable appearance in a landscape, and 9 = optimum appearance. Ratings were based on the density, vigor, color, uniformity, and incidence of pests. Visual quality ratings were averaged for each two-month period to smooth the results, and analysis of variance was done on the bimonthly averages to test main effects of irrigation level and groundcover species and the interaction. Analysis of variance was also done for each ground cover separately, and irrigation levels were compared with Fisher's protected LSD test at $P = 0.05$.

Soil moisture content (SMC) was monitored using a neutron probe (CPN 503-DR Hydroprobe) immediately before and within 72 hours after irrigation. A single neutron probe (NP) access tube was installed 1.5 m (5.0 ft) deep in each species and irrigation treatment plot in 2 of the 4 blocks for a total of 48 locations. NP data were calibrated to the volumetric SMC of samples taken during access tube installation.

Root growth and distribution were observed using clear acrylic minirhizotron tubes installed 1.2 m (4.0 ft) deep at a 60° angle in one treatment block (1). Video recordings of root systems were made periodically.

From May through October 1989, plantings were subjected to a preliminary trial with irrigation treatments of 100%, 75%, 50%, and 25% ET_0. Results were reported (13) and used to refine irrigation scheduling methods, develop data collection methods, and set the final range of ET_0 treatment levels. By April 1990, all species were established and attained 100% canopy cover in each plot. Frequent and deep irrigation was applied during April 1990 to ensure the soil water profile was full at the onset of the 17-month study. Similarly, winter rainfall in 1990–91 refilled the soil water profile between growing seasons during the study.

When the irrigation treatments began in 1990, visual quality of all groundcover species was at or near optimum and the SMC of the soil profile was near field capacity (Figs. 1 and 2). Minirhizotron observations showed that root systems of all species were developed and growing at least 60 cm (24 in) deep at this time (data not shown).

Results and Discussion

ET_0, rainfall, and irrigation data for the 17-month study period are summarized in Table 1. Real-time ET_0 was 10% greater than the historical average in 1990 and about equal to the average in 1991. During the principal growth and irrigation season from May to August, irrigations were infrequent for all treatments ranging from about 3 weeks apart in the 50% ET_0 treatment to more than 6 weeks apart in the 20% ET_0 treatment. Rainfall was minimal during these months in both years. However, a series of heavy, closely spaced rains occurred in February and March 1991 that completely filled the soil profile. Based on the site's soil physical properties and the precipitation rates of these rains, 50% of the rainfall was considered effective and included in irrigation scheduling calculations. The remainder was judged as lost to runoff or deep percolation beyond the root zone of the groundcovers.

The visual quality rating main effects ANOVA for irrigation level and groundcover species (Table 2) shows that the interaction of irrigation and species treatments was significant in each 2-month period. All species' visual quality ratings were higher in the spring-summer and lower in the fall-winter (Fig. 1).

The general response patterns of individual species to irrigation treatment were: (a) higher visual quality with more irrigation (*Vinca*, *Potentilla*); (b) higher visual quality with less irrigation (*Baccharis*); and (c) similar visual quality regardless of irrigation amount (*Drosanthemum*, *Gazania*, *Hedera*) (Fig. 1). The visual quality of *Vinca* and *Potentilla* was highest when they were irrigated at or above 30% ET_0. However, *Potentilla* quality was continuously unacceptable (visual quality rating below 6) at all treatments after the first summer, while *Vinca* was satisfactory with 30% ET_0 or more except in late summer. Conversely, *Baccharis* visual quality ratings were significantly lower at irrigation treatments above 30% ET_0. Among the species unaffected by irrigation amount, *Drosanthemum* quality was very high all year but *Gazania* quality was unacceptable after August of 1990. *Hedera* quality peaked in early summer then declined and was unacceptable in mid-winter largely due to the onset of dormancy and leaf spot disease. Thus, within typical seasonal fluctuations, *Baccharis*, *Drosanthemum*, and *Hedera* irrigated at 20% ET_0 and *Vinca* at 30% ET_0 provided acceptable or higher aesthetic quality nearly all year. However, *Gazania* and *Potentilla* failed to maintain acceptable visual quality at any irrigation treatment after the middle of the first summer.

NP data showed that the SMC among treatments within species generally followed the same trend as the irrigation treatments (Fig. 2). Each season, irrigation treatments, rainfall, and stored soil moisture contributed to the evapotranspiration (ET) of the groundcovers until soil moisture was depleted, after which only applied water from irrigation treatments was available to the groundcovers for summer ET. However, reduced irrigation resulted in earlier and more rapid soil water depletion and, in most cases, lower SMC in both years. The 20% and 30% ET_0 treatments resulted in extreme drying of the soil profile for long periods between irrigations, so the drought tolerances of the species were thoroughly tested.

The SMC data combined with the groundcover performance data are useful in the determination of irrigation recommendations. A reduction in SMC over time indicates that under-irrigation took place while a gain in SMC over time indicates over-irrigation occurred unless the plant material was unhealthy, damaged or sparse. NP data indicates that SMC was declining in all species at all irrigation treatments with the exception of *Baccharis* at the 50% ET_0 treatment. The 50% ET_0 treatment also resulted in increased SMC in *Vinca*, *Gazania*, and *Hedera* species but this had little impact on groundcover visual quality.

Differences in irrigation treatments (applied water) had greater effects on groundcover visual quality during July and August as daily ET_0 increased and stored soil moisture was depleted. For *Potentilla* and *Gazania*, the general decline of visual quality in 1990 closely followed the decline in SMC across treatments, indicating that these species were under-irrigated at all treatments. They were seriously injured once

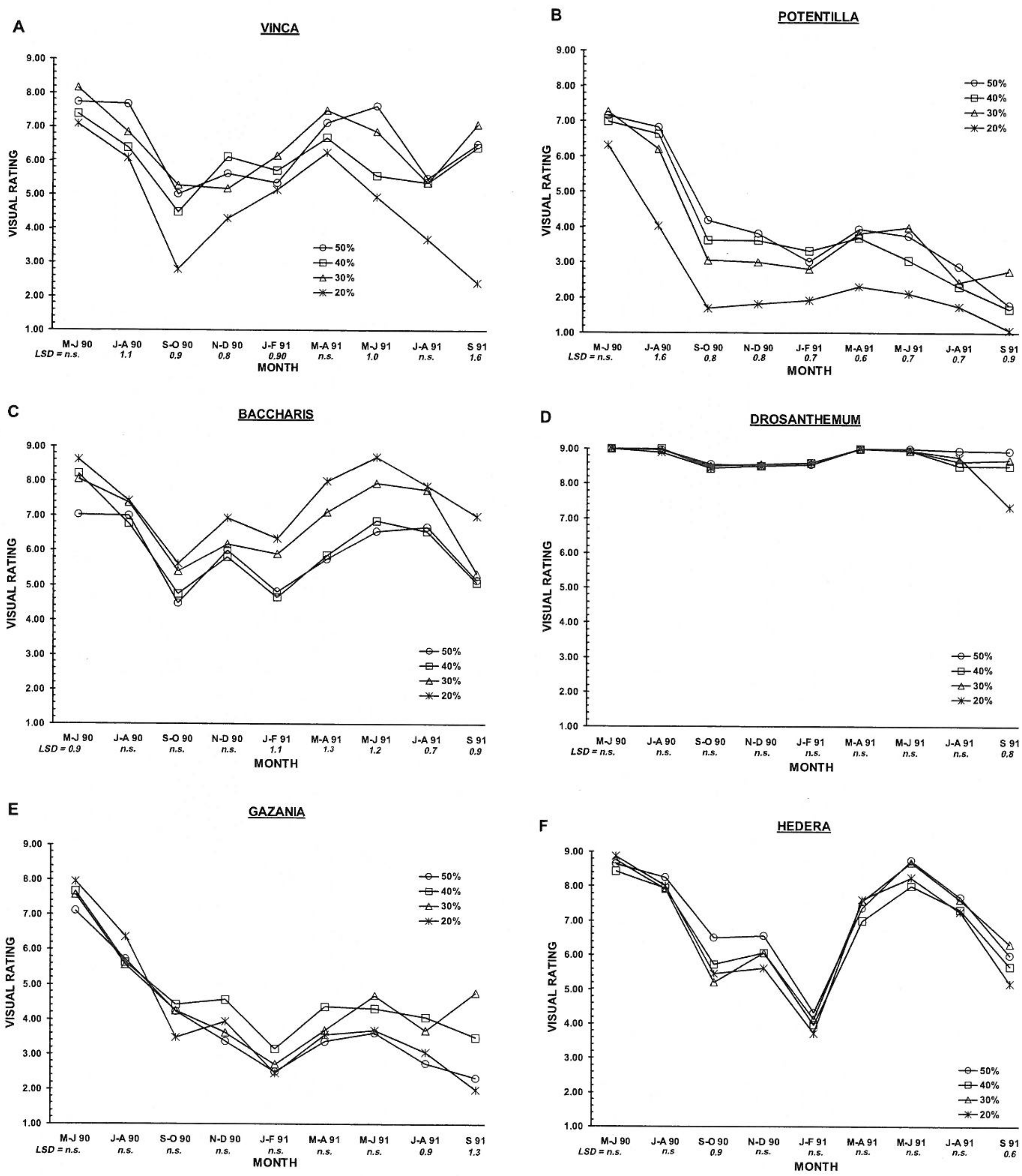

Fig. 1. **Mean visual quality ratings of six groundcover species at four irrigation levels from May 1990 through September 1991 (1 = dead, 6 = minimally acceptable, 9 = optimum). The value for Fischer's protected LSD test at P = 0.05 appears under each date.**

SMC approached PWP and did not recover to acceptable visual quality even when SMC later increased. The large fluctuations in SMC for these species after September 1990 was probably due to ineffective use of available water caused by low canopy densities and poor plant vigor. It appears that *Potentilla* and *Gazania* have a minimum water requirement greater than 50% ET_0 and similar to that of cool-season turfgrass (8, 11). These findings are consistent with Staats and Klett (16) who found that *Potentilla* requires 50% to 75% ET_0 to maintain acceptable visual quality. The perfor-