ATTACHMENT 7
Technical Justification of Projects

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7 Attachment 7 – Technical Justification of Projects

Attachment 7 is mandatory. See Exhibit C for detailed guidance on the preparation of this attachment. There is no page limitation for Attachment 7; however, applicants are encouraged to be specific, clear, and concise.

Scoring for Attachment 7 will be based solely on the technical justifications of project(s) with respect to the claimed physical benefits (i.e., technical basis of the project and capability of yielding the benefits). Documentation may include, but is not limited to: technical reports, feasibility studies, needs assessments, expert opinion or local knowledge, journals, etc. The magnitude of physical benefits will not be scored under this criterion. Please note that the magnitude of project benefits relative to costs will be evaluated based on the information provided in Attachment 8.

7.1 Urban Bakersfield Water Use Efficiency Project (UBAK)

7.1.1 Introduction

This attachment presents the technical justification for the Urban Bakersfield Water Use Efficiency Project (UBAK or Project). A project abstract and general discussion of the without-project baseline are followed by a discussion of each physically quantified benefit, and a summary of physically quantified benefits claimed.

The City of Bakersfield's (City) Domestic Water System serves retail customers within its service area. The City water system supplies water to approximately 35 percent of the City of Bakersfield. The remaining 65 percent of residents with the City are supplied from other retail water companies including Cal Water, East Niles Community Services District and Vaughn Mutual Water Company. Kern County Water Agency (KCWA) Improvement District No. 4 (ID4) is the wholesale water entity that supplies imported water to the metropolitan area of the City.

Cal Water maintains and operates the City Water System under contract. Cal Water also supplies water to its own customers within the City and is currently the largest municipal water supplier within the City. Cal Water's supply is a combination of groundwater (65%), Kern River Water (18%) and purchased imported water from KCWA (18%)

The Domestic Water System provides water primarily for residential uses and also for business, commercial, industrial, and public customers in, and adjacent to, the westerly portion of the City of Bakersfield area. In addition, the City operates the river channel and several canals through the City of Bakersfield as well as 2800 acres of groundwater recharge ponds along the Kern River. The City also wholesales Kern River water to two Cal Water Treatment Plants, which provide potable water to customers within the City's service area and Cal Water's service area within the City limits. Cal Water's service area includes areas inside and outside the city limits. The City's supply varies but for the purposes of this analysis is estimated to be a combination of groundwater (75%), Kern River Water (7%) and purchased imported water from KCWA (18%) which is consistent with their 2012 uses (City of Bakersfield, 2013)

The City of Bakersfield was among the nation's 25 fastest-growing cities between 2000 and 2008, according to estimates from the U.S. Census Bureau (Census). It is anticipated the population of the City's Domestic Water System's service area will grow an average of about 9.0 percent every five years until 2030.

An aggressive conservation program is essential to integrated regional water management by providing reliable and quantifiable demand reduction that improves the region's capacity to manage drought scenarios and other strains on regional water supplies. The proposed Urban Bakersfield Water Use Efficiency Project (UBAK or Project) will leverage and/or expand existing conservation incentive programs, municipal irrigation upgrades and education efforts. Conservation incentives and education efforts are targeted at the City's service area and supplement Cal Water's existing programs while the municipal irrigation upgrades will occur in parks in both the City and Cal Water service area. The Program is a comprehensive and complimentary suite of water conservation efforts designed to address the key water uses in the

City and assist the City and ID4 in meeting their state regulatory requirements identified by SBX7-7 and AB 1420. The Program includes a suite of program elements that promote high-efficiency devices and best water conservation practices to improve indoor and outdoor water use efficiency of the City's residential, commercial and municipal customers through both specific efficiency projects and educational opportunities.

In addition to reducing potable demand, the program provides secondary benefits, which include a reduction in energy consumption and associated indirect greenhouse gas emissions, a modest reduction in wastewater treatment as well as a reduction in non-point source pollution.

7.1.2 Project Abstract

UBAK includes a suite of program elements that promote high-efficiency devices and best water conservation practices to improve indoor and outdoor water use efficiency of the City's residential, commercial and municipal customers through both specific efficiency projects and educational opportunities.

Residential water use currently accounts for 75% of total water demand within the project area. Residential water use trends show a much higher consumption rate in hot summer months, when outdoor plants have a high evapotranspiration rate. Dedicated irrigation sites at large landscape areas such as parks, which account for 10% of water demand in the project area, have concentrated water usage among a relatively small number of locations.

UBAK proposes three programs:

1. Municipal Irrigation Controller Program (UBAK1):

   UBAK1 will upgrade the City Parks irrigation system to reduce runoff and total water usage through the design and installation of a smart irrigation control system that provides real-time information on irrigation water demand for 18 parks in the City. Implementation of this Project will also reduce dry-weather runoff, which carries pollution to storm water retention and detention basins, canals, and the Kern River main channel. The program is anticipated to reduce water use in the Parks by 30 percent (City of Bakersfield, 2013) and achieve 142 AFY of water savings or 2,135 AF in the estimated 15 year project life. As described in the Attachment 5 schedule, the project costs will be incurred starting in the middle of 2014 and concluding towards the end of 2016 for the UBAK1 program.

2. Residential and Commercial Rebate Program (UBAK2)

   UBAK2 provides incentives for a suite of devices that promote high-efficiency technologies and best water conservation practices to improve indoor and outdoor water use efficiency in the City. The program will leverage the existing administration and promotion of the Cal Water rebate program (https://www.calwater.com/conservation/index.php) and extend eligibility to residential and commercial customers served by the City. Currently City customers are not, and have never been, eligible to receive the rebates due to funding constraints.

   The nine specific incentives offered include:

Residential

- High-efficiency clothes washer (HEW) rebate
- Ultra/High-efficiency toilet (UHET/HET) rebate
- Smart Irrigation Controller rebate
- Showerheads, aerators

Commercial

- HEW rebate
- HET rebate
- High-efficiency urinal (HEU) rebate
- Smart Irrigation Controller rebate
- Large Landscape Water Use survey and report

The program is estimated to reduce water use by 656 AF over 25 years which is the maximum life of the devices to be installed. For UBAK2, project costs will be incurred over a 1 year implementation timeline to begin in early 2014 as shown on the schedule in Attachment 5.

3. Education Program (UBAK3)

The Education Program will expand existing water conservation outreach in the ID4 service area to provide a more comprehensive program. UBAK3 would develop California State Content Standards-based curriculum focused on urban water use efficiency for grades 7 -12; and hosting additional Project WET workshops for teachers of grades 7-12. There are no programs currently aimed at reaching that age group. For UBAK3, project costs start in mid 2014 and conclude in mid 2016, occurring over a 2 year timeframe.

7.1.3 Without-Project Baseline

As noted earlier, the City relies on a number of sources of water including local groundwater which has been recharged with imported SWP water, local surface water from the Kern River, as well as imported surface water that is delivered directly to the City both of which are treated at the City's two water treatment plants. The Region has experienced significant reductions in imported water supplies due to recent ongoing drought conditions and regulatory actions and court decisions that have reduced exports from the Sacramento-San Joaquin Delta. In addition, the effects of climate change may make imported water supplies less reliable in the future. The 2011 SWP Delivery Reliability projects SWP deliveries from 9 percent to 70 percent of the maximum contract amount over an 82-year simulation period under current conditions. Deliveries are expected to average 61 percent of maximum contract amount under current conditions, but decrease to approximately 35 percent of maximum contract amount over multiple dry years.

In addition to reductions in the availability of imported water, the City has to meet SBX7-7 and both the City and ID4 have to comply with AB1420 demand management measure (water conservation) requirements, but, due in part to recent economic conditions, there have been

limited financial resources to do so. For an area that was hard hit by the recession and has disadvantaged communities (DAC) but still has to meet SBX7-7, rebates provide an opportunity to aid residents in achieving demand reduction needs.

Without the UBAK project, customers will continue to use about 2,800 acre-feet (AF) of potable water through inefficient landscape practices, irrigation nozzles, toilets and clothes washers over the 25 years that these programs will realize water supply benefits. The City will keep supplying potable water to meet inefficient irrigation demands at 18 City Parks, to provide imported water to inefficient clothes washers, toilets and commercial and residential landscape and subsequently retreat that wastewater.

Without this project, over-irrigation at municipal, residential and commercial sites will continue. Runoff from inefficient urban irrigation systems will continue to increase the flow of pollutants such as pesticides, fertilizers, and bacteria through storm drains that eventually drain into the watershed.

7.1.4 Relationship of Project to Other Projects Included in the Proposal

There are two water conservation projects included in the Tulare Lake Basin Portion of Kern County grant proposal: this project (UBAK) is being implemented by the City of Bakersfield (City) to assist the City and ID4, while water use efficiency is being implemented by Tehachapi-Cummings County Water District (TCCWD). The two projects are independent of each other in that neither program depends on the other to achieve water conservation benefits. However, the programs outlined in both include elements designed to remove inefficient toilets and are both designed to achieve IRWM Plan and regional water goals. Also, the education programs are targeted to the entire service area so the consumer gets to understand the benefits of and take advantage of more incentives to conserve water. The projects are similar in promoting water use efficiency but are located in different parts of the IRWM region.

7.1.5 Description of Expected Physical Benefits

The following (quantifiable) physical benefits are expected from this project:

1. Water Supply Savings and associated Wastewater Treatment Savings Benefit
2. Greenhouse Gas Reduction

Each of these benefits are described in the narrative that follows.

Benefit 1: Water Supply and Wastewater Treatment Benefit

Annual Water Conservation Savings of 170 AFY and associated lifetime wastewater treatment savings of 30 AF

Annual water savings of about 170 AFY are expected as a result of this project, once the program's benefits are fully phased-in. This results in a total water savings of 2,828 AF due to increased efficiency over the 25-year life of the programs' benefits. Annual and total water

savings for the two quantifiable program components, UBAK1 and UBAK2 are presented in **Table 7.1-1**. Each program component is detailed in the narrative that follows:

Table 7.1-1: UBAK Program Water Savings

Program	Water Savings	
	AF/Year	Total (AF)
UBAK1	142	2,172
UBAK2	26	656
TOTAL	**169**	**2,828**

Water conservation incentivized through the UBAK programs will save over 2,800 AF of water over the lifetime of the project. Water efficiency benefits are realized as soon as project implementation begins. The component of water savings from indoor conservation activities such as high-efficiency washing machines, urinals and toilets, are estimated to provide a lifetime wastewater treatment savings of 30 AF once benefits from these activities have been fully phased-in.

UBAK1

Method Used to Estimate Benefit

Water saving estimates for UBAK1 are based on analysis of the 2009-2012 consumption of the 18 identified parks provided by the City (**Table 7.1-2**). The Maxicom system is projected to reduce consumption by about 30 percent.

Table 7.1-2: Estimated Water Savings from UBAK1

Priority	Park Name	Lot Size Acres	Water Usage (CCF) (2009-2012)	Water Use (AF) annual average	Estimated Water Savings (AF/Year)
1	Grissom Park	12	72,964	41.88	12.56
2	Campus Park North	8	64,181	36.83	11.05
3	Campus Park South	12	59,720	34.27	10.28
4	Seasons Park	10	57,595	33.05	9.92
5	University Park	11	57,666	33.10	9.93
6	Haggin Oaks Park	10	56,370	32.35	9.71
7	Kroll Park	4	34,675	19.90	5.97
8	Quailwood Park	6	46,742	26.83	8.05
9	Jastro Park	9	46,554	26.72	8.02
10	River Oaks Park	10	46,069	26.44	7.93
11	Stonecreek Park	6	41,535	23.84	7.15
12	Centennial Park	4	41,613	23.88	7.16
13	Garden Park	6	36,744	21.09	6.33
14	Wilderness Park	5	32,681	18.76	5.63
15	Wilson Park	8	34,895	20.03	6.01
16	Beale Park	7	32,763	18.80	5.64
17	MLK Center	13	32,573	18.69	5.61
18	Stiern Park	5	31,673	18.18	5.45
	TOTAL	**146**	**827,013**	**474.64**	**142.39**

UBAK2

Method Used to Estimate Benefits

Most fixture savings, lifetime and other assumptions are based on the California Urban Water Conservation Council water savings assumptions (http://www.cuwcc.org/committees/details.aspx?taxid=7444&parentid=1924). For the UBAK2 activities, a summary of savings by activity that will provide water savings, the number of customers receiving the benefit, and the savings estimates and when it will occur is presented in **Appendix 7.1-A**.

For Toilets: Water saving estimates for toilets in UBAK2 are based on analysis developed by Cal Water, who will be administering the program as an extension of its existing rebates efforts to provide incentives to customers that have previously had access to rebates in the past. . For toilets, unit savings are derived from Ultra Low Flow toilet (ULFT) savings equations published

by CUWCC (California Urban Water Conservation Council, 2004).[1] The reduced form equations are derived from empirical studies of ULFT savings prepared by A&N Technical Services and relate per toilet water savings to persons per household (PPH). The reduced form estimate of ULFT savings (in gallons per day) for single family toilets is:

$$S_{ULFT} = 6.693 \times PPH - 0.529 \times PPH^2 + 7.826$$

A scaling factor was then applied to each unit savings estimate to adjust the estimate to account for the fact that HETs would be expected to save about 13% more water per flush than ULFTs due to the lower flush volume. The scaling factor is calculated as:

$$K = \frac{GPF - GPF_{HET}}{GPF - GPF_{ULFT}} = \frac{4.0 - 1.28}{4.0 - 1.60} = 1.13$$

where GPF is the average gallons per flush of replaced toilets at the time the ULFT studies were conducted (set to 4 gpf), GPF_{ULFT} is the average gallons per flush of a ULFT (set to 1.6 gpf), and GPF_{HET} is the average gallons per flush of a HET (set to 1.28 gpf).

A second scaling factor was then applied to the scaled unit savings estimate to adjust the estimate to account for the fact that the average flush volume of toilets the program will replace is expected to be lower than the average flush volume of replaced toilets at the time the ULFT savings studies were completed. Based on data collected by Cal Water from home water surveys and toilet replacement from past programs, the average flush volume of existing non-efficiency toilets is now 3.1 gpf whereas at the time the ULFT studies were conducted it was 4 gpf. The second scaling factor is calculated as:

$$L = \frac{GPF_{now} - GPF_{HET}}{GPF - GPF_{HET}} = \frac{3.1 - 1.28}{4.0 - 1.28} = 0.67$$

where GPF_{now} is the average flush volume of toilets the program will replace and the other variables are as previously defined.

The final unit savings estimate (in gallons per day) for single family HET toilet rebates is:

$$S_{HET} = L \times K \times S_{ULFT}$$

This analysis is also scaled for UHET savings to adjust the estimate to account for the fact that the direct install UHETs would be expected to save about 33% more water per flush than ULFTs due to the lower flush volume.

For HET's useful life of 25 years is based on the average life of a residential toilet fixture, as reported in Vickers ((Vickers, 2002). Vickers' analysis included a savings decay after 10 years. The UHETs are relatively new with little long-term data available. For the purposes of this analysis, the UHET's were assumed to not experience a decay in savings.

For Clothes Washers: Unit savings (in gallons per year) are based on the difference between average water use for new washers, as forecasted by the United States Department of Energy,

[1] See page 2-58.

and Tier 3 (most energy efficient) washers with an average water factor of 3.5. Unit savings are calculated as:

$$S = \left(WF_{avg} - WF_{T3}\right) \times CU \times Cycles$$

where WF_{avg} is the average water factor of new washers, WF_{T3} is the water factor for Tier 3 washers, CU is the average capacity of new washers, and Cycles is the average number of washer cycles per single-family residence.

Average number of washer cycles per year is taken from EPA's Clothes washer Savings Calculator (U.S. Environmental Protection Agency, 2012).

The average water factor of new washers is derived from Department of Energy clothes washer market forecasts for top and front load clothes washers (U.S. Department of Energy, 2010).

Estimates for coin operated, single-family and multi-family clothes washers are subject to a similar analysis.

High Efficiency Pop-Up Nozzle: Source for unit savings is Metropolitan Water District of Southern California's Save Water Save A Buck program assumptions. The MWD estimate is reduced by 20% to account for distributed pop-up nozzles that do not get installed **(Table 7.1-3**)

Table 7.1-3: Assumed Irrigation Efficiency Improvement by Landscape Program

Landscape Water Savings Program	Irrigation Efficiency	
	Large Landscapes	Single Family
Baseline	61%	61%
Water Use Report	63%	NA
Surveys & Irrigation System Incentives	71%	66%
Weather Based Irrigation Controllers (WBICs)	71%	71%

Benefit Uncertainty

Water savings stemming from landscape improvements vary depending on the individual site's current water usage and potential for improvements. The estimates provided for UBAK1 are based on City staff's experience with the Maxicom system. The landscape benefits in UBAK2 are based on CUWCC estimates as adjusted by Cal Water's local data. Additionally, the lifetime expectancy of 15 years for the irrigation system is a lower-bound estimate – if the City continues to calculate water budgets annually and continues to implement the program, the effect can last longer than 15 years.

For the indoor savings estimates in UBAK2 the savings are based on commonly used assumptions from the CUWCC.

Finally, while education programs such as UBAK3 are considered foundational to utility efficiency efforts, there has been no documentation of actual savings. It is expected that there would be savings from these activities although they cannot be quantified at this time.

New Facilities Required to Achieve Benefit

No new facilities or expansion of current facilities are required to achieve water supply benefits for any of the UBAK programs.

Potential Adverse Physical Effects

No potential adverse physical effects are expected.

Summary of Benefit

As is shown in **Table 7.1-4,** at full implementation the UBAK1 and UBAK2 projects will result in a water savings ranging from 0.9 AFY up to 207.4 AFY. The City programs will conserve a total of 2,828 AF of water and wastewater over a 25-year span between 2014 and 2038. The UBAK1 program will save approximately 2,172 AF of water over 25 years and UBAK2 will conserve roughly 656 AF of water over 25 years. The water savings from the replacement of the interior fixtures (e.g. toilets and clothes washers), about 30 AF of water savings, will also be diverted from the wastewater treatment plant over the lifetime of the project.

Table 7.1-4: UBAK Annual Physical Benefits – Water Savings

Table 9a – Annual Project Physical Benefits

Project Name: Urban Bakersfield Water Use Efficiency Project

Type of Benefit Claimed: Water Savings

Measure of Benefit Claimed (Name of Units): AFY

Additional Information About this Measure:

(a)	(b)		(c)		(d)
	Physical Benefits				
Year	Without Project	With Project UBAK1	With Project UBAK2	Total Project Savings (UBAK1+UBAK2)	Change Resulting from Project (b) – (c)
2014	0	35.6	69.8	105.4	105.4
2015	0	71.2	65.3	136.5	136.5
2016	0	142.4	65.1	207.5	207.5
2017	0	142.4	65.0	207.4	207.4
2018	0	142.4	64.9	207.3	207.3
2019	0	142.4	62.3	204.7	204.7
2020	0	142.4	62.3	204.7	204.7
2021	0	142.4	62.3	204.7	204.7
2022	0	142.4	62.2	204.6	204.6
2023	0	142.4	62.2	204.6	204.6
2024	0	142.4	1.1	143.5	143.5
2025	0	142.4	1.1	143.5	143.5
2026	0	142.4	1.0	143.4	143.4
2027	0	142.4	1.0	143.4	143.4
2028	0	142.4	1.0	143.4	143.4
2029	0	106.8	1.0	107.8	107.8
2030	0	71.2	1.0	72.2	72.2
2031	0	35.6	1.0	36.6	36.6
2032	0	0.0	1.0	1.0	1.0
2033	0	0.0	1.0	1.0	1.0
2034	0	0.0	0.9	0.9	0.9
2035	0	0.0	0.9	0.9	0.9
2036	0	0.0	0.9	0.9	0.9
2037	0	0.0	0.9	0.9	0.9
2038	0	0.0	0.9	0.9	0.9

Comments: The savings from UBAK1 are based on a 30% reduction from current consumption levels. Savings from UBAK2 are based on standard assumption from the California Urban Water Conservation Council.

Benefit 2: Greenhouse Gas Reduction Benefit of Avoided Emission of 16.5 MT per Year of CO2

Reduced reliance on SWP and reduced groundwater pumping will provide avoided CO2 emissions (a Greenhouse Gas (GHG) which is associated with the energy production). In particular, reduced reliance on SWP water will avoid the energy requirements associated with transporting SWP water from Northern California to Kern County. Groundwater pumping also consumes energy, although on a significantly lower scale than imported water pumping.

Background and Historical Conditions

Based on estimates prepared by Provost and Pritchard Engineering Group (P&P), it is estimated the electricity required for the conveyance of 1 acre-foot of imported SWP water to Kern County 0.6 megawatt hours (MWh) (P&P, 2013).

Electricity used in California is generated within three different energy sub-regions [known as Western Electricity Coordinating Council (WECC) sub-regions]: California, the Northwest, and the Southwest (CEC, 2011). Almost 70% of California's electricity is generated within the state. The approximate breakdown of California's major sources of electricity is as follows: 45% is provided by natural gas, 18% is provided by nuclear power, 21% is provided by hydroelectric plants, 2% is provided by coal-fired power plants, and 14% comes from renewable sources (CEC, 2011).

CO2 emissions resulting from the production of electricity, measured as tons of CO2 per MWh, vary by energy source. Based on the current mix of energy sources for California, the CO2 emissions rate for energy used to transport SWP water to Kern County is estimated to be 0.354 MT/MWh.

Without-Project Conditions

Without the project, increased dependence on imported water supplies will result in increased energy use and CO2 emissions.

Methods Used to Estimate Benefits

To calculate energy savings associated with the project, we first multiplied the amount of energy required to transport 1 acre-foot of imported water by the amount of imported water that will be avoided as a result of the project (0.6 MWh per acre-foot). Groundwater pumping costs were estimated based on an estimated groundwater pumping depth of 250 feet and are estimated to be 0.43 MWh per acre-foot. Treatment costs are not available but are expected to be nominal when compared to the pumping costs.

Next, the CO2 emissions rate associated with energy use in California using 2009 U.S. Environmental Protection Agency (EPA) eGrid data was calculated by Stratus Consulting, a resource economic analysis firm. The California Energy Commission (CEC, 2011) reports that 70% of electricity used in California is generated in-state, 20% is generated in the WECC Southwest sub-region, and 10% is generated in the WECC Northwest sub-region. EPA publishes average CO2 emissions rates for these sub-regions based on the various energy sources used to generate electricity within them (e.g., natural gas, hydropower, etc.).

Table 7.1-5 shows the CO2 emissions rate for the three regions that produce the electricity used in California, and the average weighted rate for electricity used within the state. It is assumed that the mix of energy sources used by the state overall is representative of the mix of energy sources used by the SWP and in TCCWD.

Table 7.1-5 CO2 Emissions Rates for Energy Used in California by Regions that Produce Electricity

WECC Region	Emissions Rate (MT/MWh)	Percent of California Electricity Use
California	0.299	70%
Southwest	0.540	20%
Northwest	0.372	10%

Weighted average emissions rate for electricity used in California is 0.354 MT CO2/MWh
Source: U.S. EPA, 2012.

Given the calculated weighted average CO2 emissions rate of 0.354 MT of CO2 emitted per MWh, 0.21 MT of CO2 are produced for every acre-foot of SWP water delivered to the City service area (0.6 MWh per acre-foot multiplied by 0.354 MT/MWh). Similarly, the CO2 associated with groundwater pumping is estimated to be 0.15 MT/MWh (0.43 MWh per acre-foot multiplied by 0.354 MT/MWh).

By eliminating use of an average of 19.6 AFY of imported water (18% of water saved) and 81.5 AFY of groundwater (75% of water saved), the project will avoid emissions of about 16.5 MT of CO2 per year or 428 MT of CO2 over the life of the project. The water that flows from gravity from the Kern River (about 7% of all of the water delivered) is not included because it requires no conveyance energy. Likewise, the energy required to treat the imported water to customers is not included, therefore this is a conservative estimate of CO2 emissions.

Benefit Uncertainty

There is uncertainty that the customers receiving incentives represent receiving 18% imported water and 75% groundwater. If the imported water proportion is greater, then the CO2 emissions are understated and are overstated if the groundwater proportion is greater.

In addition, some uncertainty exists with the carbon emissions rate calculated based on the average mix of electricity sources in California. Local electricity production may use a slightly different mix of sources (e.g., more hydropower, less natural gas, or less imported electricity, etc.). This could result in a slightly higher or lower emissions rate, depending on the mix of sources used.

New Facilities Required to Achieve Benefit

No new facilities are required to achieve the benefits although all of the activities/devices need to be installed.

Potential Adverse Physical Effects

Energy savings and associated CO2 emissions reductions due to avoided use of imported water and pumping groundwater are not expected to result in any potential adverse physical effects.

Summary of Benefit

As is shown in **Table 7.1-6**, the project will result in an estimated reduction in CO2 emissions of 16.5 MT per year which is associated with an average energy savings of 46.5 MWh per year. Given the schedule for project implementation (with benefits beginning to accrue in 2014), the project will result in a net energy savings of 1,208 MWh and a net CO2 emissions reduction of 428 MT over the 25-year project life.

Table 7.1-6: UBAK Annual Physical Benefits – Reduced CO2 Emissions

Table 9b – Annual Project Physical Benefits Project Name:Urban Bakersfield Regional Water Use Type of Benefit Claimed: Reduced CO2 Emissions Measure of Benefit Claimed (Name of Units): MT CO2 Additional Information About this			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Projects UBAK1+UBAK2	Change Resulting from Project (b) – (c)
2014	16	0	16
2015	21	0	21
2016	31	0	31
2017	31	0	31
2018	31	0	31
2019	31	0	31
2020	31	0	31
2021	31	0	31
2022	31	0	31
2023	31	0	31
2024	22	0	22
2025	22	0	22
2026	22	0	22
2027	22	0	22
2028	22	0	22
2029	16	0	16
2030	11	0	11
2031	6	0	6
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
Last Year of Project Life	0	0	0
		Total =	428
Comments:			

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7.2 Tehachapi Regional Water Use Efficiency Project

7.2.1 Introduction

This attachment presents the technical justification for the Tehachapi Regional Water Use Efficiency Project (Project). A project abstract and general discussion of the without-project baseline is followed by a discussion of each physically quantified benefit, and a summary of physically quantified benefits claimed.

The TCCWD provides imported water supplies (SWP) for direct delivery and groundwater recharge and flood control management in the region through several improvement districts in the Tehachapi Basin. The three groundwater basins managed by TCCWD include the Brite, Cummings and Tehachapi Basins. TCCWD imports supplemental water through the California Aqueduct, and sells this SWP water as a wholesaler to several community services districts (Bear Valley CSD, Golden Hills CSD, and Stallion Springs CSD), the City of Tehachapi (City), and California Department of Corrections and Rehabilitation's Correctional Institution in Tehachapi (CCI) within TCCWD through conjunctive use. SWP water provided through conjunctive use to these communities is considered the marginal water needed to meet water demands beyond these agencies' existing groundwater rights.

The proposed Tehachapi Regional Water Use Efficiency Project (Project) will reduce demand in the Tehachapi-Cummings County Water District, Golden Hills CSD, Stallion Springs CSD, Bear Valley CSD and the City of Tehachapi service areas. One of most significant challenges in the Region and the State is the uncertainty of imported water supplies. In addition to recent and ongoing drought conditions, recent regulatory and judicial decisions related to endangered species in the Delta have reduced the imported SWP supplies since 2008 with ongoing uncertainties related to climate change and drought. The Tehachapi Regional Urban Water Management Plan (RUWMP) shows that the Region is planning for a single-year SWP allocation of 6 percent. Deliveries are expected to average 61 percent of maximum contract amount under current conditions, but decrease to about 25 percent of maximum contract amount over multiple dry years. Thus, the Region needs to increase the utilization of local water supplies and reduce dependency on imported water in order to provide a base level of water supply reliability for their customers.

7.2.2 Project Abstract

The Project provides quantifiable and sustainable water savings and promotes high-efficiency devices and best water conservation practices to improve indoor water use efficiency of the residential and commercial customers in the project service area. There are two elements to the project, both focus primarily on replacement of inefficient toilets:

1. Low-Income Direct Install Toilet Replacement and Audit (TCCWD1)

TCCWD-1 will replace 1,000 existing high volume toilets, 3.5 gallons per flush (gpf) or more, with Niagara's 0.8 gallon per flush Stealth™ ultra high-efficiency toilet (UHET) or the Western

Model 822 1.28 gallons per flush High Efficiency Toilet (HET) to low-income customers in the disadvantaged community (DAC) of the City of Tehachapi. The toilets and showerheads will be available for installation in both single-family and multi-family homes. In addition to the direct-install element, the program will provide customers with free water conservation inspections, as well as a water conservation kit with fixtures such as aerators, shut-off valves, and leak-detecting dye tablets.

2. Toilet Rebate (TCCWD2)

The Toilet rebate program provides incentives for the replacement of 950 toilets —that flush at 3.5 gpf or more with 900 tank-type and 50 flush-valve HET models that use 1.28 gpf or less. The project guidelines will specify that the models eligible for rebate will be required to meet the US EPA WaterSense standard and meet minimum Maximum Performance (MaP) flush performance scores of 600.

7.2.3 Without-Project Baseline

One of most significant challenges in the Region and the State is the uncertainty of imported water supplies. In addition to recent and ongoing drought conditions, recent regulatory and judicial decisions related to endangered species in the Delta have reduced the imported SWP supplies since 2008 and this trajectory is exacerbated by ongoing uncertainties related to climate change and drought. The Tehachapi RUWMP shows that the Region is planning for a critical single-dry- year SWP allocation of 6 percent. Deliveries are expected to average 61% of maximum contract amount under current conditions, but decrease to approximately 22, 27 and 26 (average 25) percent of the maximum contract amount over multiple dry years. Thus, the Region needs to increase the utilization of local water supplies and reduce dependency on imported water. About 52% of the water used in the TCCWD service area is imported water whether it is delivered directly or used for recharge, the remaining 48% is pumped groundwater.

Without the project, the participating retail water agencies included in the project will continue to provide potable water to meet the interior demands, including toilet flushing from the 1,000 toilets that are not replaced in disadvantaged communities with the direct install program and 950 toilets that are not replaced with the rebate program. Wastewater treatment will have to be provided to the additional wastewater that is produced by lower efficiency toilets.

7.2.4 Relationship of Project to Other Projects Included in the Proposal

There are two water conservation projects included in this Proposal: this project implemented by TCCWD, and the other implemented by the City of Bakersfield and Improvement District No. 4 (ID4). The two projects are independent of each other in that neither program depends on the other to achieve water conservation benefits. However, the programs outlined in both water conservation projects include elements designed to remove inefficient toilets and are designed to achieve regional water goals. Also, the education program in the City of Bakersfield/ID4

project is targeted to the entire service area so the consumer gets to understand the benefits of and take advantage of more incentives to conserve water. The projects are similar in promoting water use efficiency but are located in a different geographic region relative to other projects.

7.2.5 Description of Expected Physical Benefits

The following (quantifiable) physical benefits are expected from this project:

1. Water Supply Benefit and equivalent Wastewater Treatment Savings Benefit
2. Greenhouse Gas Reduction Benefit

Each of these benefits is described in the narrative that follows.

Benefit 1: Water Supply and Wastewater Treatment Benefit

Annual Water Conservation Savings of 109 AFY

Average annual water savings of 109 AFY are expected as a result of this project, once the program's benefits are fully phased-in. This means that total water savings of 2,775 AF due to increased efficiency over the 25-year life of the programs' benefits (**Table 7.2-1**). Since these savings are all indoors, they translate to an equivalent reduction in wastewater treatment.

Table 7.2-1: TCCWD Program Savings

Program	Average Annual Savings (AFY)	Lifetime Savings AF
TCCWD1 (Low Income Direct Install)	81	2042
TCCWD2 (Toilet Rebate)	28	733
Total	**109**	**2775**

Water conservation incentivized through the programs will save approximately 2,775 AF of water over the lifetime of the project as detailed in **Appendix 7.2-A**. Because water efficiency benefits are realized as soon as project implementation begins, project benefits will accrue to beneficiaries beginning with project implementation. It should be noted that total annual water savings vary from year to year as the program elements are implemented over time and some decay in savings occurs in future years.

Background and Assumptions

Toilets have an estimated water savings lifespan of 25 years (the performance of HETs are estimated to start degrading after 10 years, while the UHETs do not) (http://www.cuwcc.org/committees/details.aspx?taxid=7444&parentid=1924). Because benefits

phase in during one year at the beginning of project implementation and phase out at the end of the program lifetime, benefits from UHETs will accrue over 25-years in total.

Both project costs and project implementation are expected to be distributed evenly over the three-year project implementation period for the rebate program (TCCWD2) and one-year Low income direct install program (TCCWD1). Full project benefits are realized when the project is in its second year of implementation.

Methods Used to Estimate Benefits

Fixture savings, lifetime and other assumptions are based on the California Urban Water Conservation Council water savings assumptions (http://www.cuwcc.org/committees/details.aspx?taxid=7444&parentid=1924).
Water saving estimates for TCCWD1 and TCCWD2 are based on analysis developed by Cal Water in the Bakersfield area, which is nearby and therefore relevant to this analysis. For toilets, unit savings are derived from ULFT savings equations published by CUWCC (California Urban Water Conservation Council, 2004).

The reduced form equations are derived from empirical studies of ULFT savings prepared by A&N Technical Services and relate per toilet water savings to persons per household (PPH). The reduced form estimate of ULFT savings (in gallons per day) for single family toilets is:

$$S_ULFT=6.693\times PPH-0.529\times 〖PPH〗^2+ 7.826$$

A scaling factor was then applied to each unit savings estimate to adjust the ULFT estimate to account for the fact that HETs would be expected to save about 13% more water per flush than ULFTs due to the lower flush volume. The scaling factor is calculated as:

$$K=(GPF- 〖GPF〗_{HET})/(GPF- 〖GPF〗_{ULFT})=(4.0-1.28)/(4.0-1.60)=1.13$$

where GPF is the average gallons per flush of replaced toilets at the time the ULFT studies were conducted (set to 4 gpf), GPFULFT is the average gallons per flush of a ULFT (set to 1.6 gpf), and GPFHET is the average gallons per flush of a HET (set to 1.28 gpf).

A second scaling factor was then applied to the scaled unit savings estimate to adjust the estimate to account for the fact that the average flush volume of toilets the program will replace is expected to be lower than the average flush volume of replaced toilets at the time the ULFT savings studies were completed. Based on data collected by Cal Water from home water surveys and toilet replacement from past programs, the average flush volume of existing non-efficiency toilets is now 3.1 gpf whereas at the time the ULFT studies were conducted it was 4 gpf. The second scaling factor is calculated as:

$$L=(〖GPF〗_{now}- 〖GPF〗_{HET})/(GPF- 〖GPF〗_{HET})=(3.1-1.28)/(4.0-1.28)=0.67$$

where GPF_{now} is the average flush volume of toilets the program will replace and the other variables are as previously defined.

The final unit savings estimate (in gallons per day) for single family HET toilet rebates is:

$$S_HET=L\times K\times S_ULFT$$

The analysis was performed for both single and multi family estimates. For UHETs, a scaling factor was also applied to each unit savings estimate to adjust the estimate to account for the fact that the direct install UHETs would be expected to save about 33% more water per flush than ULFTs due to the lower flush volume.

For HETs a useful life of 25 years was assumed, based on the average life of a residential toilet fixture, as reported in Vickers (Vickers, 2002). Vickers' analysis included a savings decay after 10 years. The UHETs are relatively new with little long-term data available. For the purposes of this analysis, the UHET's were assumed to not experience a decay in savings.

The savings estimate for TCCWD1 is derived from the toilet and showerhead replacement project alone and excludes any potential benefits from the inspections and kits.

Benefit Uncertainty

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In this analysis, the main uncertainties are associated with assumptions of the savings and lifetime associated with UHETs, which have not been on the market as long as HETs and have therefore undergone less analysis. The HETs are assumed to degrade after 10 years, while the UHET savings do not have a degradation factor; both assume a 25 year life. For both UHETs and HETs actual savings could differ from the assumptions developed by the CUWCC. The showerheads are assumed to have a lifespan of 8 years and begin to degrade after 4 years.

Because these savings are derived from replacing inefficient toilets, they are considered and are not contingent on behavior changes. In addition, they do not take into account the water savings benefits derived from audits which have been documented by other entities.

New Facilities Required to Achieve Benefit

No new facilities are required to achieve the benefits although all of the TCCWD1 toilets are to be directly installed and those that receive the rebates (TCCWD2) must be installed by the property owner.

Potential Adverse Physical Effects

Water use reductions are not expected to result in any potential adverse physical effects.

Summary of Benefit

As is shown in **Table 7.2-2**, at full implementation the project will result in a water savings of ranging from 69 AFY up to 123.8 AFY. The TCCWD programs will conserve a total of 2,775 AF of water and wastewater over a 25-year span between 2014 and 2038. The TCCWD1 program will save approximately 2,042 AF of water over 25 years and TCCWD2 will conserve about 733 AF of water over 25 years. Because all of the water savings from the replacement of the toilets are indoor, the entire water savings will also be diverted from the wastewater treatment plant. The wastewater treatment savings of about 109 AFY are expected from indoor water use savings found in the table with a total wastewater treatment savings over the lifetime of the project of 2,775 AF.

Table 7.2-2: TCCWD Annual Physical Benefits – Water Savings

Table 9a – Annual Project Physical Benefits				
Project Name:Tehachapi Regional Water Use Efficiency Project				
Type of Benefit Claimed: Water Savings and Wastewater Treatment Savings				
Measure of Benefit Claimed (Name of Units): AFY				
Additional Information About this Measure: HET/UHET result in water savings that are also direct flow reductions to wastewater collection and treatment facilities over older, low efficiency toilets				
(a)	(b)		(c)	(d)
	Annual Physical Benefit			
Year	Without Project	With Project TCCWD1	With Project TCCWD2	Change Resulting from Project (b) – (c)
2014	0	52.7	16.3	69.0
2015	0	52.7	16.3	69.0
2016	0	92.7	31.1	123.8
2017	0	92.7	31.1	123.8
2018	0	92.7	31.1	123.8
2019	0	90.8	31.1	121.9
2020	0	89.0	31.1	120.1
2021	0	87.2	31.1	118.3
2022	0	85.4	31.1	116.5
2023	0	83.6	31.1	114.7
2024	0	82.9	30.6	113.5
2025	0	82.7	30.5	113.2
2026	0	82.5	30.5	113.0
2027	0	82.3	30.4	112.7
2028	0	82.1	30.3	112.4
2029	0	81.9	30.3	112.2
2030	0	81.7	30.2	111.9
2031	0	81.5	30.1	111.6
2032	0	81.3	30.1	111.4
2033	0	81.1	30.0	111.1
2034	0	80.9	29.9	110.8
2035	0	80.7	29.9	110.6
2036	0	80.5	29.8	110.3
2037	0	80.3	29.7	110.0
2038	0	80.1	29.7	109.8
				2775.4
Comments:				

Benefit 2: Greenhouse Gas Reduction Benefit of Avoided Emission of 1,091 MT per Year of CO2

Reduced reliance on SWP will provide avoided CO2 emissions (a Greenhouse Gas (GHG) which are associated with the energy production). In particular, reduced reliance on SWP water will avoid the energy requirements associated with transporting SWP water from Northern California to Kern County.

In addition the imported water must be pumped from the valley floor up about 3,000 feet to the TCCWD service area, particularly in BVCSD where one-third of the water rate reflects the pumping costs for the high elevation areas. Reduced water consumption in these locations will directly reduce the energy requirements for pumping and related GHG emissions. For the purposes of this analysis, it is assumed that the water saved is imported water as it is the marginal source of water for the Tehachapi communities needed to meet demands beyond the available water rights in the groundwater basin.

Background and Historical Conditions

Based on estimates prepared by Provost and Pritchard Engineering Group (P&P), it is estimated that the electricity required for the conveyance of 1 acre-foot of imported SWP water to Kern County is approximately 0.6 megawatt hours (MWh) (P&P, 2013). In addition, the water must be pumped about 3,000 feet more in elevation to the TCCWD, which requires an additional 14.7 MWh (50 MMBTU) for every acre-foot of SWP water delivered (TCCWD, 2013). This totals about 15.3 MWh/AF to pump from the Delta to the TCCWD service area.

Electricity used in California is generated within three different energy sub-regions [known as Western Electricity Coordinating Council (WECC) sub-regions]: California, the Northwest, and the Southwest (CEC, 2011). Almost 70% of California's electricity is generated within the state. The approximate breakdown of California's major sources of electricity is as follows: 45% is provided by natural gas, 18% is provided by nuclear power, 21% is provided by hydroelectric plants, 2% is provided by coal-fired power plants, and 14% comes from renewable sources (CEC, 2011).

CO2 emissions resulting from the production of electricity, measured as tons of CO2 per MWh, vary by energy source. Based on the current mix of energy sources for California, the CO2 emissions rate for energy used to transport SWP water to Kern County is estimated to be 0.354 MT/MWh.

Without-Project Conditions

Without the project, continued dependence on imported water supplies will result in continued energy use and CO2 emissions.

Methods Used to Estimate Benefits

To calculate energy savings associated with the project, we first multiplied the amount of energy required to transport 1 acre-foot of imported water by the amount of imported water that will be

avoided as a result of the project (15.3 MWh per acre-foot) for an estimated energy usage of 3,083 MWh/year.

Next, the CO2 emissions rate associated with energy use in California using 2009 U.S. Environmental Protection Agency (EPA) eGrid data was calculated by Stratus Consulting, a resource economic analysis firm. The California Energy Commission (CEC, 2011) reports that 70% of electricity used in California is generated in-state, 20% is generated in the WECC Southwest subregion, and 10% is generated in the WECC Northwest subregion. EPA publishes average CO2 emissions rates for these subregions based on the various energy sources used to generate electricity within them (e.g., natural gas, hydropower, etc.). **Table 7.2-3** shows the CO2 emissions rate for the three regions that produce the electricity used in California, and the average weighted rate for electricity used within the state. It is assumed that the mix of energy sources used by the state overall is representative of the mix of energy sources used by the SWP and in TCCWD.

Table 7.2-3 CO2 Emissions Rates for Energy Used in California by Regions that Produce Electricity

WECC Region	Emissions Rate (MT/Mwh)	Percent of California Electricity Use
California	0.299	70%
Southwest	0.540	20%
Northwest	0.372	10%

Weighted average emissions rate for electricity used in California0.354
Source: U.S. EPA, 2012.

Given the calculated weighted average CO2 emissions rate of 0.354 MT of CO2 emitted per MWh, 5.4 MT of CO2 are produced for every acre-foot of SWP water delivered to TCCWD service area (15.3 MWh per acre-foot multiplied by 0.354 MT/MWh). By eliminating use of an average of 109 AFY of imported water, the project will avoid emissions of about 591 MT of CO2 per year or 14,988 MT of CO2 over the life of the project. This does not include the energy required to treat the imported water to customers.

Benefit Uncertainty

There is uncertainty that each of the individual customers of the five participating agencies will achieve the anticipated water savings and therefore the energy and CO2 emissions reduction. If the waters savings are overstated then the CO2 emissions is reduced.

In addition, some uncertainty exists with the carbon emissions rate calculated based on the average mix of electricity sources in California. Local electricity production may use a slightly different mix of sources (e.g., more hydropower, less natural gas, or less imported electricity, etc.). This could result in a slightly higher or lower emissions rate, depending on the mix of sources used.

New Facilities Required to Achieve Benefit

No new facilities are required to achieve the benefits although all of the toilets directly installed and those that receive the rebates must be installed.

Potential Adverse Physical Effects

Energy savings and associated CO2 emissions reductions due to avoided use of imported water are not expected to result in any potential adverse physical effects.

Summary of Benefit

As is shown in **Table 7.2-4**, the project will result in an average estimated reduction in CO2 emissions of 1,074 MT per year associated with an average energy savings of 3,083 MWh per year. Given the schedule for project implementation (with benefits beginning to accrue in 2014), the project will result in a net energy savings of 77,084 MWh and a net CO2 emissions reduction of 27,288 MT over the 25-year project life.

Table 7.2-4: TCCWD Annual Physical Benefits – Avoided CO2 Emission

Table 9b – Annual Project Physical Benefits			
Project Name:Tehachapi Regional Water Use Efficiency Project			
Type of Benefit Claimed: Reduced CO2 Emissions			
Measure of Benefit Claimed (Name of Units): MT CO2 Emissions			
Additional Information About this Measure:_____			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Projects TCCWD1+TCCWD2	Change Resulting from Project (b) – (c)
2014	372	-	372
2015	372	-	372
2016	669	-	669
2017	669	-	669
2018	669	-	669
2019	658	-	658
2020	649	-	649
2021	639	-	639
2022	629	-	629
2023	619	-	619
2024	613	-	613
2025	611	-	611
2026	610	-	610
2027	609	0.0	609
2028	607	0.0	607
2029	606	0.0	606
2030	604	-	604
2031	603	-	603
2032	601	-	601
2033	600	-	600
2034	599	-	599
2035	597	-	597
2036	596	-	596
2037	594	-	594
2038	593	-	593
		Total=	14988

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7.3 Snyder Well Intertie Pipeline for Irrigation and Nitrate Removal

7.3.1 Introduction

The City of Tehachapi (City) provides potable water to residential, commercial and public customers located in Tehachapi. Water supplied to customers is pumped from the Tehachapi Groundwater Basin, an adjudicated basin with limited groundwater supplies. The City currently has six wells available to meet demands. A seventh well, the Snyder Well, has elevated nitrates concentrations that are above the MCL. The California Department of Public Health (CDPH) has requested that the City remove this well from their potable water supply system.

TCCWD provides an imported SWP water supply for agricultural use and urban use (through conjunctive use) in the Tehachapi area. TCCWD has a raw-water pipeline located approximately ¼ mile away from the Snyder Well that delivers irrigation water to nearby fields.

7.3.2 Project Abstract

The Snyder Well Project consists of the construction of an intertie pipeline that will connect the Snyder Well with TCCWD's raw water distribution system. Water from the Snyder Well would then be used to irrigate the Jacobson Junior High School athletic fields located adjacent to the proposed pipeline and will provide agricultural water to other TCCWD customers. The athletic fields have historically been served potable water by other City wells. The construction of the intertie pipeline will remove the irrigation water demand for the athletic fields from the City's potable demand and provide Tehachapi Unified School District (TUSD) with a less expensive source of irrigation water.

Additionally, through pumping, the project will remove nitrate-laden groundwater from the Tehachapi Basin aquifer and apply to the athletic fields and crops where it can be put to beneficial use at agronomic rates.

7.3.3 Without-Project Baseline

Without the project, the Snyder Well will continue to be unused by the City, and the athletic fields will continue to receive potable water from other City wells for irrigation. The City's potable water demands will continue to grow at their projected rate with no reduction from using an alternative water source to irrigate the athletic fields.

Additionally, in the without-project scenario the elevated nitrates in the groundwater aquifer will not be removed through the Snyder Well and applied at agronomic rates to the area's athletic fields and crops. Without remediation of the high nitrates in the groundwater aquifer, the Snyder Well is expected to continue to have high nitrate levels above the MCL, and other nearby wells may stay at current levels or increase in concentration.

7.3.4 Relationship of Project to Other Projects Included in the Proposal

The Snyder Well Project can be integrated with the Tehachapi Regional Water Use Efficiency Project. Both projects work to provide the City with adequate water supplies to meet demand. Both projects also reduce the potable water demands for the City. The Tehachapi Regional Water Use Efficiency Project will reduce water use by the City's residents by providing water conservation tools to them. While the Snyder Well Intertie Pipeline Project will remove the athletic field's irrigation water demand from the City's potable water system. Both projects will help reduce costs of water to customers of this disadvantaged community. Both projects also contribute toward meeting the IRWMP Objectives and Water Management Strategies. Although the projects work together to meet a common goal, they both add value without requiring coordinated implementation or operation.

7.3.5 Description of Expected Physical Benefits

The technical justifications of the physical benefits provided by the project are presented in this section. As a summary, the physical benefits of the project include the following:

Project Benefit	**Result**
Reduced City potable water demands to be used to meet future water demands.	Water demand of approximately 65 AF per year to be used for future potable water demands and at a higher water rate to produce more revenue.
Reduced City potable pumping capacity for maximum day demands.	Delay the need for constructing new well to meet peak day water demands. The City will delay its need for a new well by 1 year. As a secondary benefit, TCCWD will have added groundwater pumping capacity redundancy.
Removal of nitrate from the aquifer and beneficial re-use on turf grass and other crops.	About 1,000 pounds of Nitrogen removed from the groundwater aquifer and applied for irrigation of crops resulting in a lower quantity of purchased fertilizer being applied.
Reduction in the water cost for the TUSD.	TUSD will pay about $45,000 less for non-potable water versus potable water from the City.

Benefit 1: Reduced Annual Potable Water Demands

Serving the Jacobson Junior High School athletic fields with the Snyder Well non-potable water in lieu of the City's potable water supply will reduce the annual City potable water demands by about 65 AF per year. The reduction in potable water demand from the school will increase available water supply capacity for the City to meet future customers' potable water demands.

Background and Assumptions

The City's past and future water deliveries without-project were obtained from the 2010 Tehachapi Regional Urban Water Management Plan and are presented in **Table 7.3-1**. Total deliveries for the City are expected to increase into the future due to population growth and the associated increased water demands.

Table 7.3-1: City of Tehachapi Past, Current and Planned Water Deliveries (AFY)

	2005	2010	2015	2020*	2025	2030	2035	2040
Metered Deliveries	1,563	1,810	1,886	1,851	2,043	2,256	2,491	2,750
Total Potable Demand	1,563	1,810	1,886	1,851	2,043	2,256	2,491	2,750
System Losses	270	148	154	151	167	184	204	225
Total Deliveries	*1,833*	*1,958*	*2,040*	*2,002*	*2,211*	*2,441*	*2,695*	*2,975*

Source: 2010 Tehachapi Regional Urban Water Management Plan
*(*Note that the lower demands in 2020 are due to the demand reduction targets set for 2015 and 2020)*

The projected delivery information for the City provides a baseline for comparison between the with-project and the without-project alternatives.

Without-project conditions

The without-project conditions assume that the athletic fields will continue to be served by the City's potable water distribution system. The projected City water use will not be reduced if this project is not implemented.

Methods Used to Estimate Benefits

To generate the with-project alternative, the annual water demands for the athletic fields were determined. The three water meters that were used in the analysis (Account #008, #009, and #0012) primarily serve the water demands of the athletic fields. However, some potable water connections are also served through these same laterals; this generates an estimated baseline of 80,000 gallons per month of potable demand based on historical data. **Table 7.3-2** displays the total potable water meter readings for 2012, the estimated potable water demand baseline, and the estimated athletic fields demand per month. The total estimated athletic field demand is approximately 65 AFY.

Table 7.3-2: Jacobson Junior High School Estimated Athletic Field Water Consumption

Month	**Monthly Water Demands for 3 Meters in 2012** (1,000 gal)	**Baseline Potable Water Demand** (1,000 gal)	**Estimated Athletic Field Demand** (1,000 gal)	**Estimated Athletic Fields Demand** (AF)
January	80	80	0	0.0
February	101	80	21	0.1
March	411	80	331	1.0
April	2294	80	2214	6.8
May	2343	80	2263	6.9
June	3971	80	3891	11.9
July	3543	80	3463	10.6
August	3872	80	3792	11.6
September	2776	80	2696	8.3
October	2369	80	2289	7.0
November	388	80	308	0.9
December	85	80	5	0.0
Annual Total	**22,233**	**960**	**21,273**	**65**

Therefore, the overall City water demands could be reduced by 65 AFY and can be re-purposed for meeting future water demands.

A cross check of this calculation was performed using the estimated applied water for irrigation of turf grass and resulted in similar results.

Benefit Uncertainty

The projected City demand reduction calculations are based on available data and assumptions as discussed. As a result, there may be some uncertainties regarding the variable water use of the school depending upon weather conditions. The past two years. In this analysis, the primary uncertainties are due to estimating the school's athletic field irrigation water demands based on typical irrigation practices and climate. The actual irrigation efficiency of the school's sprinkler system and the timing of the irrigation events may not be accurately represented based on these assumptions. However, based on a cursory review of the schools total water use, the applied water amounts determined above are within reason.

New Facilities Required to Achieve Benefit

The construction of the intertie pipeline between the Snyder Well and the TCCWD raw water system is required to achieve these results. The pipeline will have metered laterals that serve the athletic field irrigation systems. With the proposed pipeline system, accurate flow rates will be recorded to help the maintenance staff to better manage the irrigation of the fields. This data will also be utilized in monitoring the actual annual water demand reduction to the City.

Potential Adverse Physical Effects

Water use reductions are not expected to result in any potential adverse physical effects.

Summary of Benefit

The Snyder Well project will remove 65 AFY of annual demand from the City's water system. A summary of with- and without- project annual demand is shown in **Table 7.3-3**.

Table 7.3-3: Snyder Well Intertie - City Potable Water Demand reduction.

Table 9a – Annual Project Physical Benefits Project Name: Snyder Well Intertie Pipeline Type of Benefit Claimed: City Water Demand Reduction Measure of Benefit Claimed: AFY			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2014	2,024	1,959	65
2015	2,040	1,975	65
2016	2,032	1,967	65
2017	2,025	1,960	65
2018	2,017	1,952	65
2019	2,010	1,944	65
2020	2,002	1,937	65
2021	2,444	2,379	65
2022	2,886	2,821	65
2023	3,329	3,263	65
2024	3,771	3,706	65
2025	2,211	2,146	65
2026	2,257	2,192	65
2027	2,303	2,238	65
2028	2,349	2,284	65
2029	2,395	2,330	65
2030	2,441	2,376	65
2031	2,492	2,427	65
2032	2,543	2,477	65
2033	2,593	2,528	65
2034	2,644	2,579	65
2035	2,695	2,630	65
2036	2,751	2,686	65
2037	2,807	2,742	65
2038	2,863	2,798	65
2039	2,919	2,854	65

Table 9a – Annual Project Physical Benefits Project Name: Snyder Well Intertie Pipeline Type of Benefit Claimed: City Water Demand Reduction Measure of Benefit Claimed: AFY			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project**
2040	2,975	2,910	65
2041	3,031	2,966	65
2042	3,087	3,022	65
2043	3,143	3,078	65
2044	3,199	3,134	65
2045	3,255	3,190	65
2046	3,311	3,246	65
2047	3,367	3,302	65
2048	3,423	3,358	65
2049	3,479	3,414	65
2050	3,535	3,470	65
2051	3,591	3,526	65
2052	3,647	3,582	65
2053	3,703	3,638	65
2054	3,759	3,694	65
2055	3,815	3,750	65
2056	3,871	3,806	65
2057	3,927	3,862	65
2058	3,983	3,918	65
2059	4,039	3,974	65
2060	4,095	4,030	65
2061	4,151	4,086	65
2062	4,207	4,142	65
2063	4,263	4,198	65
2064	4,319	4,254	65
		Total=	**3330**
Comments:			

Benefit 2: Reduced City Potable Pumping Capacity for Maximum Day Demand

Serving the Jacobson Junior High School athletic fields with the Snyder Well water in lieu of the City's potable water supply will also reduce the City's peak day water demands by about 105 gallons per minute (gpm). The reduction in water demand from the school will increase available groundwater pumping capacity for the City's potable water system to provide for future potable water demands.

Background and Assumptions

The City's historical peak monthly water deliveries were obtained from the City's records. and are presented in **Table 7.3-4**. The City's peak demand generally occurs during July or August each year.

Table 7.3-4: City of Tehachapi Historical Peak Month Deliveries

Year	Month	Acre-Feet (AF)	Gallons per Day (gpd)
2008	July	300	3,160,117
2009	July	304	3,202,252
2010	Aug	295	3,107,449
2011	Aug	297	3,128,516
2012	July	301	3,170,651

Maximum Monthly Demand	3,202,252	gpd
Maximum Daily Demand Peaking Factor	1.5	
Maximum Daily Demand	4,803,378	gpd
Required Supply Capacity	3,336	gpm

Maximum monthly demands are adjusted using appropriate peaking factors to arrive at maximum daily demands. Using the growth factors from the projected annual demands in the 2010 Tehachapi Regional Urban Water Management Plan, the City's required supply capacity was projected.

Without-project conditions

The without-project conditions assume that the athletic fields will continue to be served by the City's potable water distribution system. None of the projected pumping capacity reductions from this project will be achieved if the project is not constructed.

Methods Used to Estimate Benefits

Table 7.3-5 provides the previous two years of school water demands for the peak water use month (Maximum Month Demand, or MMD). As discussed previously, the base load of 80,000 gallons per month of potable demands was removed to obtain the deliveries to the athletic fields. Based on discussions with school maintenance staff, during the summer month's an additional 50% volume of water is applied during the warmest days of the month to the football

field. Based on this factor the estimated peaking factor for the maximum day of the month is 1.20. The total maximum daily demand for the athletic fields is estimated to be 105 gpm.

Table 7.3-5: Jacobson Junior High School Peak Month Water Demands

Maximum Month	MMD Total (1,000 gallons)	MMD Athletic Fields (1,000 gallons)
Jul-11	3992	3912
Jul-12	3971	3831
Maximum	**3992**	**3912**

Maximum Daily Demand Peaking Factor	1.2	
Maximum Daily Demand	151,432	gpd
Maximum Daily Demand	105	gpm

Removing the football field and other demands associated with the Snyder meter from the City's water delivery system will decrease potable demand by about 105 gpm.

Benefit Uncertainty

The projected City demand reduction calculations are based on the available data and assumptions provided above. In this analysis, the primary uncertainties are due to estimating the school's demand using a peaking factor and historical records. The operation of the school's sprinkler system and the timing of the athletic field irrigation may not be accurately represented by these assumptions. However, based on experience with irrigation systems, the parameters used in this analysis are typical of irrigation system design.

New Facilities Required to Achieve Benefit

The construction of the intertie pipeline between the Snyder Well and the TCCWD raw water system is required to achieve these results. The pipeline will have metered laterals that serve the athletic field irrigation systems. This data will also be utilized in monitoring the actual pumping capacity reduction to the City.

Potential Adverse Physical Effects

Water use reductions are not expected to result in any potential adverse physical effects.

Summary of Benefit

The Snyder Well project will reduce the City's pumping capacity requirement by about 105 gpm (maximum daily demand). A summary of with- and without- project peak daily demands are provided in **Table 7.3-6.**

Table 7.3-6: Snyder Well Intertie - City Potable Pumping Capacity for MDD

Table 9b – Annual Project Physical Benefits Project Name: Snyder Well Intertie Pipeline Type of Benefit Claimed: Reduced City Potable Pumping Capacity for MDD Measure of Benefit Claimed: gpm			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2014	2,279	2,173	105
2015	2,317	2,212	105
2016	2,308	2,203	105
2017	2,300	2,194	105
2018	2,291	2,186	105
2019	2,282	2,177	105
2020	2,274	2,169	105
2021	2,321	2,216	105
2022	2,369	2,264	105
2023	2,416	2,311	105
2024	2,464	2,358	105
2025	2,511	2,406	105
2026	2,563	2,458	105
2027	2,616	2,510	105
2028	2,668	2,563	105
2029	2,720	2,615	105
2030	2,772	2,667	105
2031	2,830	2,725	105
2032	2,888	2,783	105
2033	2,945	2,840	105
2034	3,003	2,898	105
2035	3,061	2,956	105
2036	3,124	3,019	105
2037	3,188	3,083	105
2038	3,252	3,146	105
2039	3,315	3,210	105

Table 9b – Annual Project Physical Benefits

Project Name: Snyder Well Intertie Pipeline
Type of Benefit Claimed: Reduced City Potable Pumping Capacity for MDD
Measure of Benefit Claimed: gpm

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project
2040	3,379	3,274	105
2041	3,442	3,337	105
2042	3,506	3,401	105
2043	3,570	3,464	105
2044	3,633	3,528	105
2045	3,697	3,592	105
2046	3,760	3,655	105
2047	3,824	3,719	105
2048	3,888	3,782	105
2049	3,951	3,846	105
2050	4,015	3,910	105
2051	4,078	3,973	105
2052	4,142	4,037	105
2053	4,206	4,100	105
2054	4,269	4,164	105
2055	4,333	4,228	105
2056	4,396	4,291	105
2057	4,460	4,355	105
2058	4,524	4,419	105
2059	4,587	4,482	105
2060	4,651	4,546	105
2061	4,714	4,609	105
2062	4,778	4,673	105
2063	4,842	4,737	105
2064	4,905	4,800	105

Comments:

Benefit 3: Removal of Nitrate from the Aquifer and Beneficial Use on Turf Grass and Other Crops

The use of the water from the Snyder Well for irrigation of the athletic fields will remove nitrate-laden groundwater from the aquifer. To determine the total amount of nitrates removed from the groundwater, nitrate loading for the athletic fields was calculated and compared to groundwater nitrate levels.

Background and Assumptions

UC Davis on behalf of the California State Water Resources Control Board prepared technical reports that address California's drinking water nitrate issues. In Technical Report 5: Groundwater Remediation and Management for Nitrate, an evaluation of groundwater remediation options was performed. Options analyzed in the report included pump and treat, phytoremediation, in situ bioremediation/in situ redox manipulation and pump and fertilize. The report concluded that pumping groundwater and accounting for the fertilizer it contains is one of the most promising actions that will improve groundwater quality long-term.

To successfully utilize the nitrates removed from the aquifer through pumping and ensure that deep percolation that occurs from the athletic field does not return appreciable nitrate to the aquifer, the commercial fertilizer applications to the athletic field should account for the nitrates applied through the groundwater. To achieve this, nitrate concentrations from the Snyder Well and water applications to the athletic fields will be tracked and loading calculations will be performed for the athletic fields.

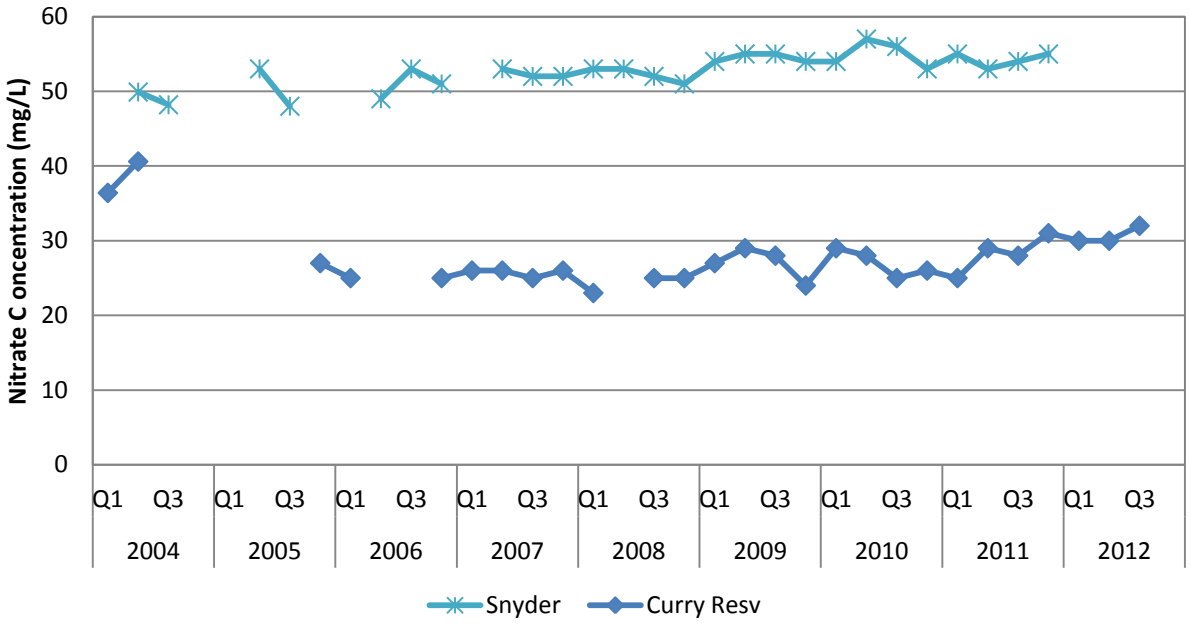
Without-project conditions

The without-project conditions assume that no additional nitrates will be removed from the aquifer. None of the projected nitrate benefits will be achieved if the project is not constructed.

Methods Used to Estimate Benefits

Nitrate concentrations from historical sampling results for the Snyder Well and City water system were used to calculate the average nitrate concentration of the groundwater produced by the well and the average nitrate concentration of the City's water supply. The average NO3-N concentration from the Snyder Well and City water system were calculated and used to determine the with-project and without-project nitrogen loading calculation. A graph of the Snyder Well and City system nitrate concentrations is provided in **Figure 7-1**.

Figure 7-1 Snyder Well and City System Nitrate Concentration Graph



The average nitrate concentration for Snyder well is 54.6 mg/L. To calculate the total amount of nitrate removed by the project, the nitrate concentrations were converted from Nitrate (NO_3) to Nitrate Nitrogen (NO_3-N). The average NO_3-N is 12.3 mg/L which can be compared to the Title 22 drinking water maximum contaminant level of 10 mg/L.

At the City's primary tank site where the water supply wells blend together, the average NO_3 concentration of the City water deliveries is 26.9 mg/L, which converts to an average NO_3-N provided by the City's potable water system of 6.1 mg/L.

The total nitrogen removal achieved by the project is the difference of the nitrate applied the athletic fields applied with-project compared to the nitrate applied for the without-project alternative.

The nitrate removal was calculated using the average NO_3-N concentration, applied water results and athletic field acreage. A summary table presenting the results of the analysis is provided below.

Table 7.3-7: Nitrogen Removal Comparison

With-Project		Without -Project	
NO3-N Removal		NO3-N Removal	
Concentration 12.3 mg/l		Concentration 6.1 mg/l	
Applied		Applied	
(lbs/ac)	Total (lbs)	(lbs/ac)	Total (lbs)
1	8	0	4
1	10	0	5
3	42	1	21
15	235	7	117
15	240	8	119
26	407	13	202
19	308	10	153
16	257	8	127
14	226	7	112
14	226	7	112
3	40	1	20
1	8	0	4
63	**2,007**	**63**	**996**

Benefit Uncertainty

The projected City nitrate reduction calculations are based on available data and assumptions as mentioned above. For the analysis, the primary uncertainty is the fluctuating nitrate levels over time. However, based on the graph provided as **Figure 7.3-1** the levels do not fluctuate in a manner that would change the analysis significantly.

New Facilities or Actions Required to Achieve Benefit

The construction of the intertie pipeline between the Snyder Well and the TCCWD water system is required to achieve these results. The pipeline will be tied into the athletic field irrigation system.

As a part of the proposed Project Monitoring Plan (PMP) (Task 3.2 of the Work Plan), an estimate of the recommended fertilizer application will be prepared based on the actual nitrate concentration at the well. This information will be provided to school district maintenance staff for implementation to maintain fertilizer application at agronomic rates to the fields.

Potential Adverse Physical Effects

It is understood that based on discussions with TUSD maintenance personnel that the athletic fields (except the football field) are typically under-fertilized to save on costs to the District. Because of this factor, the likelihood of over-application (and potential deep percolation of nitrates) of fertilizer is relatively low. From these discussions, it is understood that TUSD desires to reduce fertilizer costs even more; this project will help them achieve that objective.

Summary of Benefit

Total nitrate removal from the aquifer through the use of the Snyder Well to irrigate the athletic fields is about 1,000 lbs per year as summarized in **Table 7.3-8**.

As mentioned above, there is an economic benefit of utilizing nitrate rich groundwater for irrigation of fields by reducing the amount of commercial fertilizer that must be purchased. The UC Davis report cited that nitrogen fertilizer costs can exceed $0.50-0.75/lb N. Using the 1,000 lbs of nitrogen applied through irrigation water calculated above, the resulting savings for the school district could be up to $750 per year.

Table 7.3-8: Snyder Well Intertie – Removal of Nitrate (as Nitrogen) from the Aquifer

Table 9c – Annual Project Physical Benefits Project Name: Snyder Well Intertie Pipeline Type of Benefit Claimed: Removal of Nitrate (as Nitrogen) from the Aquifer and Use for Crops Measure of Benefit Claimed: pounds/year			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2014	1,083	2,183	-1,100
2015	1,083	2,183	-1,100
2016	1,083	2,183	-1,100
2017	1,083	2,183	-1,100
2018	1,083	2,183	-1,100
2019	1,083	2,183	-1,100
2020	1,083	2,183	-1,100
2021	1,083	2,183	-1,100
2022	1,083	2,183	-1,100
2023	1,083	2,183	-1,100
2024	1,083	2,183	-1,100
2025	1,083	2,183	-1,100
2026	1,083	2,183	-1,100
2027	1,083	2,183	-1,100
2028	1,083	2,183	-1,100
2029	1,083	2,183	-1,100
2030	1,083	2,183	-1,100
2031	1,083	2,183	-1,100
2032	1,083	2,183	-1,100
2033	1,083	2,183	-1,100
2034	1,083	2,183	-1,100
2035	1,083	2,183	-1,100
2036	1,083	2,183	-1,100
2037	1,083	2,183	-1,100
2038	1,083	2,183	-1,100
2039	1,083	2,183	-1,100

Table 9c – Annual Project Physical Benefits Project Name: Snyder Well Intertie Pipeline Type of Benefit Claimed: Removal of Nitrate (as Nitrogen) from the Aquifer and Use for Crops Measure of Benefit Claimed: pounds/year			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project**
2040	1,083	2,183	-1,100
2041	1,083	2,183	-1,100
2042	1,083	2,183	-1,100
2043	1,083	2,183	-1,100
2044	1,083	2,183	-1,100
2045	1,083	2,183	-1,100
2046	1,083	2,183	-1,100
2047	1,083	2,183	-1,100
2048	1,083	2,183	-1,100
2049	1,083	2,183	-1,100
2050	1,083	2,183	-1,100
2051	1,083	2,183	-1,100
2052	1,083	2,183	-1,100
2053	1,083	2,183	-1,100
2054	1,083	2,183	-1,100
2055	1,083	2,183	-1,100
2056	1,083	2,183	-1,100
2057	1,083	2,183	-1,100
2058	1,083	2,183	-1,100
2059	1,083	2,183	-1,100
2060	1,083	2,183	-1,100
2061	1,083	2,183	-1,100
2062	1,083	2,183	-1,100
2063	1,083	2,183	-1,100
2064	1,083	2,183	-1,100
		Total=	**-56100**

Tertiary Benefit: Reduction in the Cost of Water for the TUSD

The Snyder Well project will reduce the school's annual water costs. In lieu of paying the City water rates for potable water, the school will pay at TCCWD raw water rates. This analysis quantifies the savings that TUSD would receive. These savings benefit this school district in this disadvantaged community by reducing costs that could fund educational programs and needs. This analysis is a side benefit of the project that affects TUSD but does not factor into the Benefit-Cost analysis in Attachment 8

Background and Assumptions

To determine the cost savings, the invoices from the school's water meters for 2012 were compared with the water usage for the irrigation of the athletic fields.

The with-project costs are based on the TCCWD raw water cost of $456/AF for the 65 AF of water delivered to irrigate the athletic fields annually.

The without-project costs are based on the City potable water costs using the 2013 Zone A potable water rates provided by the City. **Table 7.3-9** provides the current Zone A rate structure.

Table 7.3-9: 2013 City of Tehachapi Zone A Rates

Minimum Plus					**$**	**20.41**	**Base Cost**
Over	4,000	gallons	up to	10,000	$	0.65	per 1,000 gal
Over	10,000	gallons	up to	20,000	$	0.96	per 1,000 gal
Over	20,000	gallons	up to	40,000	$	2.05	per 1,000 gal
Over	40,000	gallons	up to	60,000	$	2.50	per 1,000 gal
Over	60,000	gallons	up to	80,000	$	2.97	per 1,000 gal
Over	80,000	gallons	up to	100,000	$	3.40	per 1,000 gal
Over	100,000				$	3.70	per 1,000 gal

Note: A customer bill would be calculated using the Base Cost of $20.41 plus the volumetric cost of the purchased water

Without-project conditions

The without-project conditions assume that the school continues to pay City Zone A rates. The schools water usage would likely stay the same as historical rates. No expansions of the school's athletic fields are planned.

Methods Used to Estimate Benefits

To determine the reduced cost of water, a spreadsheet-based water rate model was prepared to analyze the without-project and with-project estimated cost of water. A summary of the results is included in **Table 7.3-10**. The model uses the current 2013 Zone A rates for estimating the

"2013" potable water costs. The without project costs are estimated to be about $80,000 per year.

As discussed previously there is a base load of 80,000 gallons of potable demands that will remain on the City's water system and be charged at the City's water rates. With these assumptions the overall athletic field demand is 65 AF, which compares well with the applied water estimate previously discussed. Using the 2013 rate structures, the total estimated savings is approximately $45,000 per year.

Benefit Uncertainty

Uncertainties in the projected benefits include potential variability in the City Zone A and TCCWD water rates over time and variations in the annual school water use. At this point, no significant changes to either rate structure are expected. However, TCCWD's water rates are vulnerable to the cost of natural gas as a significant portion of the rate is for the energy cost associated with lifting the water up the Tehachapi Mountains. Because of this unknown factor, TCCWD water rates are assumed to remain constant over time to be conservative. In regards to the water use for the school, it is anticipated to remain stable with no additional athletic fields planned.

New Facilities and Actions Required to Achieve Benefit

The construction of the intertie pipeline between the Snyder Well and the TCCWD raw water system is required to achieve these results. The pipeline will be tied into the athletic field irrigation system.

TUSD will have to coordinate with TCCWD and setup an irrigation account prior to connecting to the water system.

Potential Adverse Physical Effects

This benefit will result in a temporary reduction of revenue for the City of Tehachapi. However, future potable water demands will increase the revenue to the City because future water users will be on Zone B rates.

Summary of Benefit

TUSD will decrease their annual water costs by approximately $45,000.

Table 7.3-10: Without-Project and With-Project Water Costs for TUSD

	Without Project		With Project					
Month	2012 Total Potable Demand (1,000 gallons)	2013 Costs	Est. Potable Water Demand Base Load (1,000 gallons)	Est. Athletic Field Raw Water Demand (1,000 gallons)	Est. Athletic Field Raw Water Demand (AF)	TCCWD Water Cost	2013 City Water Cost	Total Water Cost
January	80	$ 184	80	0	0.0	$ -	$ 184	$ 184
February	101	$ 230	80	21	0.1	$ 29	$ 184	$ 214
March	411	$ 1,282	80	331	1.0	$ 463	$ 184	$ 648
April	2294	$ 7,960	80	2214	6.8	$ 3,099	$ 184	$ 3,283
May	2343	$ 8,137	80	2263	6.9	$ 3,167	$ 184	$ 3,351
June	3971	$ 14,031	80	3891	11.9	$ 5,445	$ 184	$ 5,630
July	3543	$ 12,481	80	3463	10.6	$ 4,846	$ 184	$ 5,031
August	3872	$ 13,672	80	3792	11.6	$ 5,307	$ 184	$ 5,491
September	2776	$ 9,705	80	2696	8.3	$ 3,773	$ 184	$ 3,957
October	2369	$ 8,231	80	2289	7.0	$ 3,203	$ 184	$ 3,388
November	388	$ 1,207	80	308	0.9	$ 431	$ 184	$ 615
December	85	$ 188	80	5	0.0	$ 7	$ 184	$ 191
Annual Total	**22,233**	**$ 77,309**	**960**	**21,273**	**65**	**$ 29,772**	**2,212**	**$ 31,983**
							Total Estimated Savings:	**$ 45,326**

7.3.6 Annual Project Physical Benefits

The Snyder Well Intertie Pipeline Project will help decrease demands on the City's potable water supply by shifting a portion of the irrigation demand from the Jacobson Junior High School to the Snyder Well. Constructing the intertie pipeline will provide the capability of delivering non-potable water from the Snyder Well or TCCWD's raw water system to the Jacobson Junior High athletic fields. The benefits of this project consist of: removing 65 AF annually and 105 gpm of peak daily demand from the City's potable system. In addition, approximately 1,000 pounds of nitrates will be removed from the aquifer. Furthermore, as a tertiary benefit TUSD will save approximately $45,000 annually on their water rates.

The new pipeline will be constructed with safeguards to protect the City's potable system from potential contamination from raw water backflow. Backflow prevention and cross connection control will be built into the system to ensure that the City's potable water system is not affected by the intertie pipeline.

7.3.7 References

2010 Tehachapi Regional Urban Water Management Plan, 2010

Addressing Nitrate in California's Drinking Water. Technical Report 5 – Groundwater Remediation and Management for Nitrate, University of California, Davis, July 2012.

City of Tehachapi correspondence with Kirk Gilbert, Director of Maintenance at TUSD (661-822-2120)

Nitrate Concentrations from City Wells from 2004-2012, City of Tehachapi

City of Tehachapi, E-mail Communication, March 22, 2013. 2012 and 2013 Water Rate Schedules

City of Tehachapi, E-mail Communication, March 21, 2013. TUSD Jacobson Junior High Water Use for 2012 and 2011

TCCWD, E-mail Communication, March 21, 2013. TCCWD Water Delivery Rates

7.4 Kern Water Bank Recharge and Recovery Enhancement Project

7.4.1 Introduction

Successful Construction and Operation of the Kern Water Bank

Successful construction and operation of existing Kern Water Bank facilities described in Attachment 3 (Workplan) is perhaps the strongest technical justification for the Project. Much of the data and information utilized in this section was provided by Jon Parker, Kern Water Bank Authority General Manager and a Registered Geologist and Certified Hydrogeologist, and Ken Bonesteel, Kern Water Bank Authority Facilities Manager, a Registered Civil Engineer. They can be reached at (661) 398-4900 or JParker@KWB.org or KBonesteel@KWB.org. According to Mr. Parker, to date approximately 2,000,000 acre-feet have been recharged, and approximately 1,000,000 acre-feet recovered , leaving a balance of approximately 1,000,000 acre-feet. Other facts and figures attributed to Mr. Parker and/or Mr. Bonesteel are so noted below.

Additional information regarding the Kern Fan Area were gained from Rick Iger, a Registered Civil Engineer with Provost & Pritchard Consulting Group and former Engineering Services Manager of the Kern County Water Agency. Mr. Iger was involved in the development and operation of the Kern Water Bank and other water banking projects on the Kern Fan. Mr. Iger can be reached at (661) 616-5900 or RIger@ppeng.com. Facts and figures attributed to Mr. Iger are so noted below.

Much technical information supporting this section can be found in **Attachment 7.4-A** 2005-2006 Kern Fan Area Operations and Monitoring Report, which was prepared by the Kern Fan Monitoring Committee (KFMC), which monitors the Kern Water Bank and adjoining entities. This is the most recently finalized report of the KFMC, and there are several others covering KWB operations since 1995.

Background

The Kern Water Bank Authority (KWBA) currently provides groundwater banking services to its Member Participants (Members) as described in prior Sections of this Proposal. All of those Members have their principal water supplies from the State Water Project (SWP), and also purchase available supplemental water available from California's water market to the extent it can be delivered via the California Aqueduct to meet Member needs at an affordable price to Member customers. According to KWBA's Memorandum of Understanding with its Adjoining Entities, Adjoining Entities purchase four percent (4%) of the water recharged by KWBA for overdraft correction. Also by the same MOU, KWBA can only recover a maximum of 90% of previously banked water.

KWBA currently has 84 wells and about 7,000 acres of recharge basis on its existing property (which has previously planned areas to add additional wells and recharge ponds). Periodically, additional surface water supplies are available to KWBA Members that exceed current recharge

basin capacity. Also periodically, requests for recovery from KWBA exceed the capacity of the existing wells. Previously banked water by KWBA is available for recovery by KWBA, amounting to about 1 Million acre-feet.

7.4.2 Project Abstract

The Project will add a net of 189 additional acres of recharge ponds connected to existing KWBA conveyance facilities that will allow KWBA to receive more wet period water from a number of sources. The Project will also add three additional wells with associated equipment, recovery pipelines, and connections to larger existing KWBA conveyance facilities which allow recovery of more water to KWBA members via the California Aqueduct and existing exchange mechanisms.

Without the project, dry period water demands of KWBA Members will be unmet, and those Members will turn to the California Water Market for an alternative to KWBA's banked water at times when market prices are typically very high.

Additionally, in the without-Project scenario, Adjoining Entity overdraft conditions would be exacerbated and those entities would purchase and deliver more wet period water for their customers in wet periods to reduce groundwater overdraft conditions. Without the project, there also would be less water stored in the Kern Water Bank and Kern Fan area.

7.4.3 Relationship of Project to Other Projects Included in the Proposal

The Project has an integration element with Urban Bakersfield WUE Project in that KCWA ID4 is a common participant. Although the projects work together to meet a number of IRWMP objectives, they both add value without requiring coordinated implementation or operation.

7.4.4 Description of Quantifiable Expected Physical Benefits

The Project's Primary Physical Benefit will be increased dry year water supplies (acre-feet per year) for KWBA Members during the Project's useful life (assumed to be 50 years), which correlate to annual volumes recovered from the Project's wells. Also, water recharged but not recovered for KWBA Members results in two other Physical Benefits. Firstly under the KWB MOU, adjoining districts purchase 4% of total water recharged in the ponds for overdraft correction, and this overdraft correction water (acre-feet per year) is another Physical Benefit. Then, at the end of the Project's useful life, the amount of water recharged, but not recovered by KWBA Members, nor lost to evaporation or purchased by adjoining districts for overdraft correction (in total acre-feet) would still be stored underground, and have a remaining value to KWBA Members and others in the Basin for dry year supplies. All of these benefits have been included in the Monetized Benefits Analysis Tables for the Project.

The technical justifications of the quantifiable physical benefits provided by the project are presented in this section. As a summary, the quantifiable physical benefits of the project include the following:

Project Benefit	Result
Increased Dry Period Water Supply	Volumes of water delivered to KWBA Members over the course of 50 years to meet their dry period demands..
Increased Overdraft Correction Water	Periodic volumes of water recharged in adjoining entity overdraft correction accounts.
Increased Groundwater Storage that can be Recovered during Later Dry Periods	A volume of water remaining in storage at the end of the analysis period.

Benefit 1: Increased Dry Period Water Supply

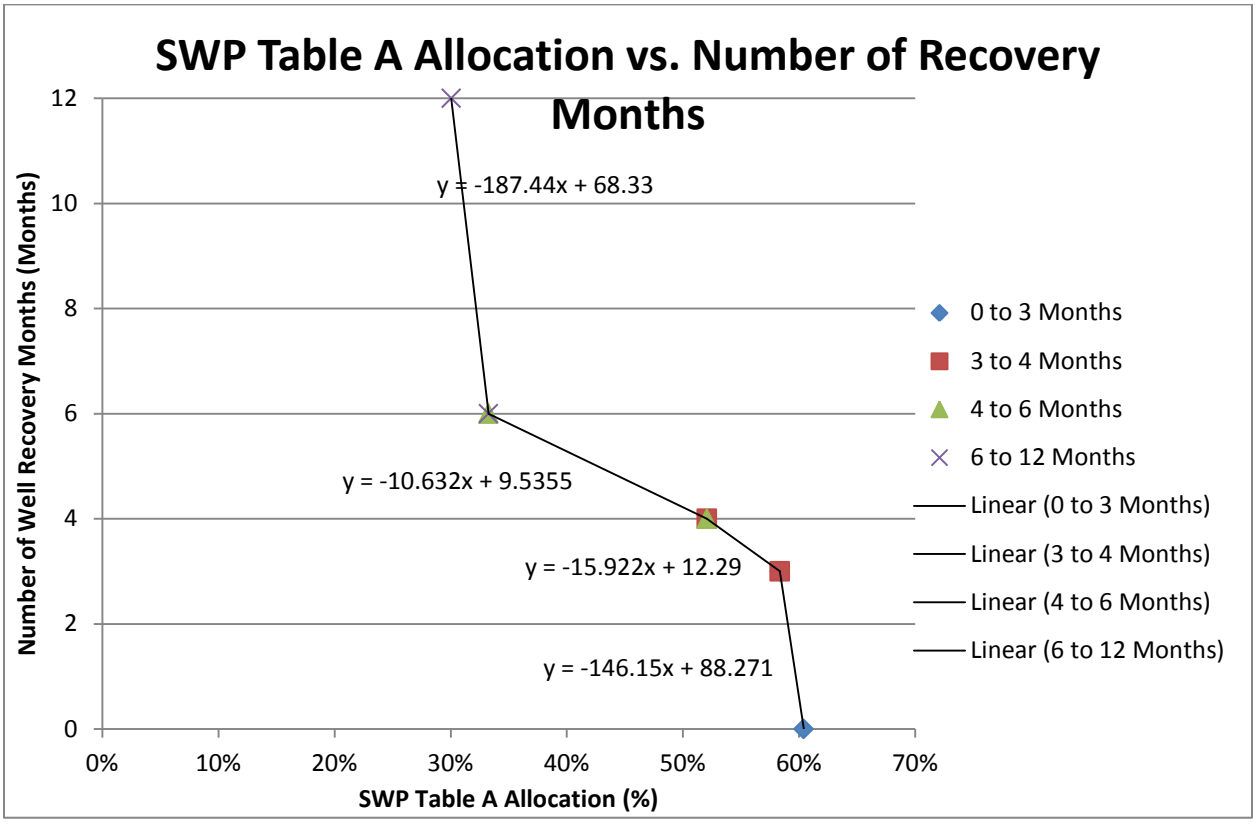
Increased dry period water results from the availability of the Project's three new wells to recover previously banked water from the Kern Water Bank.

Background and Assumptions

In the past, there have been many times that KWBA Member requests for dry period water exceed the capacity of the current wells. From records of KWBA operations provided by Ken Bonesteel, and from discussions with Mr. Bonesteel, the additional capacity provided from three new wells would have been used to meet unfulfilled Member requests from 1995 through 2012 as follows:

Year	SWP % Table A	Number of Months New Wells Would be Used
1995	45%	0
1996	53%	0
1997	55%	0
1998	39%	0
1999	61%	0
2000	65%	0
2001	33%	6
2002	61%	3
2003	72%	0
2004	56%	3
2005	67%	0
2006	66%	0
2007	56%	9
2008	30%	12
2009	25%	10
2010	39%	4
2011	80%	0
2012	65%	4

From this data, a broken linear relationship was developed between SWP Table A allocation and number of recovery months from the new wells as follows:



Sources of Recharge Water

A wide variety of water sources are available for recharge on the Kern Water Bank (KWB). These sources include: State Water Project (SWP) Entitlement, SWP Article 21 Water, unregulated Central Valley Project (CVP) water from the Friant-Kern Canal (Section 215 water), unregulated water from northern California, Kern River water, imported floodwaters, and water purchased or transferred from other sources. All of these sources have been utilized by Kern Water Bank participants in the past, and are considered as sources of water for the proposed Project.

State Water Project Water

Consistent with existing conditions governing diversions of water from the Sacramento-San Joaquin Delta, including the Bay-Delta Accord and State Board Orders implementing the same and biological opinions issued by the United States Fish & Wildlife Service (USFWS), it is anticipated that regular entitlement, interruptible entitlement water, and Article 21 water from the SWP will be available for banking and recharge in the Project facilities when those supplies are in excess of their current needs.

All of the KWB Members have contracts for SWP entitlement either directly, as in the case of Dudley Ridge Water District, or indirectly through the Kern County Water Agency (Wheeler Ridge-Maricopa Water Storage District, Improvement District No.4, Semitropic Water Storage District and Tejon Castaic Water District) or through other member units of the Kern County Water Agency. Consequently, all of the participants have the right to receive and bank SWP water, including Article 21 water when available, and in excess of their needs at the time.

A list of State Water Contractors, including Kern County Water Agency and Dudley Ridge Water District, and more information about them can be found at: http://www.swc.org/about-us/member-agencies-list. Member Units of Kern County Water Agency are listed at http://www.kcwa.com/about_kcwa/districts.shtml.

Central Valley Project Water

In the past, water from the CVP via the Friant-Kern Canal has been banked in the Kern Water Bank through Section 215 contracts with the Bureau of Reclamation, and that is expected to continue for the proposed Project. This is because Section 215 water results from the on-going need to provide critical flood protection to areas below Friant Dam, including the urban Fresno/Clovis metropolitan area. San Joaquin River Restoration Project models described at www.**restore**sjr.net/program.../05.../**Steiner**_Expert%20Report.pdf predict continued, but somewhat reduced availability of Section 215 water to non long-term Friant contractors (like KWBA).

Kern River Water

In wetter years, Kern River flows exceed the ability of the Kern River water rights holders to utilize their rights. In addition to this, Kern County Water Agency's Hacienda Water Rights on the Kern River are also sometimes available for banking by KWBA Members. Between 1995 and 2012, large quantities of Kern River water were banked by KWBA, as documented in the Kern Fan Monitoring Committee's various Report of Operations. Chapter 3 C in Attachment 7a is an example.

Other Eastside Floodwaters

Delta Lands Reclamation District No. 770 pumps floodwaters of the Kings, Kaweah, and Tule River systems into the Friant-Kern Canal to reduce farmland flooding in Tulare Lake Bed. This water flows into Kern County and is released into the Kern River, Cross Valley Canal, or other associated channels, and is recharged in the Kern Water Bank. This water is also assumed to continue, as the needs for flood protection in the Tulare Lake bed continue. An Environmental Assessment done by the USBR in 2012 allowing continued pumping into the Friant-Kern Canal can be seen at: www.usbr.gov/mp/nepa/documentShow.cfm?Doc_ID=8923.

Westside CVP Section 215 Water

From time to time, Westside CVP Section 215 water has also been banked in the Kern Water Bank, and that is assumed to continue. Westside CVP water results when floodwaters reaching the Delta exceed water rights holders' diversion rights, and capacity exists to transport it to Kern County.

Duration that New Ponds Could Have Been Used

According to Mr. Bonesteel, from 1995 to 2012, there were periodic times that recharge water was available from the above-described sources in sufficient quantities, and with sufficient capacity in existing conveyance facilities to fill the new ponds. This information was combined with historical records for total State Water Project Article 21 Water Availability and Kern River Runoff numbers as follows:

Year	SWP Article 21 (taf)	Kern River Flow at First Point % of Average	Number of Months of Recharge in New Ponds
1995	64	196	8
1996	29	126	12
1997	21	120	7
1998	20	240	12
1999	158	53	5
2000	309	65	0
2001	48	53	0
2002	43	45	0
2003	60	69	0
2004	219	47	0
2005	731	244	11
2006	632	226	12
2007	310	53	1
2008	3	109	0
2009	6	99	0
2010	8	188	3
2011	0	283	12
2012	0	NA	1

From this data, a relationship was developed in the form of:
Months of Recharge = m1 * Kern River % + m2* SWP Art. 21+ b
Where: m1, m2, and b are constants determined by regression/best fit analysis

Estimated Quantities of Water Available for Recharge

In calculating the quantity of water available for recharge in Project facilities, consideration was made to not “double count” water that would be recharged in the Kern Water Bank’s existing recharge facilities. Consequently, the approach used historic KWBA records from 1995 to 2012 provided by Mr. Bonesteel along with his projections for how many months existing ponds were full, but when additional recharge water and conveyance capacity was available for the proposed new ponds. Development of this relationship is described later

Recharge Rates

Mr. Parker and Mr. Bonesteel report that data from KWBA operations of existing ponds surrounding the new ponds in similar soils, and from past flooding of portions of the proposed ponds, indicates variable recharge rates; but long term average rates of 0.3 acre-feet per wetted acre per day can conservatively be used for planning purposes. Thus, 0.3 acre-feet per wetted acre per day was adopted in Project Benefit calculations.

Losses

The only significant losses that result from project operations are recharge losses. Surface water discharges, losses to basin outflow, and losses from the target aquifer are not expected. The basin is closed on three sides, and bounded by a groundwater trough to the north (see groundwater elevation map in Attachment 7c). As such, no water will migrate out of the basin. Groundwater will migrate away from the recharge areas toward both southeast and northwest, but all but a fraction will be recaptured during recovery periods. Past Hydrologic Profiles (See Figure 4C-1 in Attachement 7a) have recorded the mounding and recapture effect of prior KWB operations.

With respect to recharge losses, the Department of Water Resources developed a comprehensive approach to the analysis of recharge losses on the Kern Water Bank that considered pond surface evaporation, phreatophyte evapotranspiration, and soil evaporation (DWR, 1990). This analysis predicted that total losses would probably range from 4% in the winter to 7% in the summer. Given the results of this analysis, the *Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program* (KWB MOU) established a conservative 6% loss factor to all surface water recharged on the Kern Water Bank. An analysis of recharge activities confirmed that the 6% value is indeed conservative. The approach developed by DWR was applied to recharge activities from 1995 through 1999, and the results indicate cumulative losses through the 5-year period were actually about 4.2%. Thus, the use of the conservative recharge loss factor has resulted in a significant benefit to overdraft correction in the basin.

Without-project conditions

The without-project conditions assume that KWBA Members would have no additional dry period water to meet demands, and would then purchase additional water from the California Water Market for delivery via the California Aqueduct.

Methods Used to Estimate Benefits

To generate the with-Project alternative a number of assumptions were made.

A fifty year analysis period was assumed, corresponding to the approximate length of time a number of existing groundwater recharge projects in Kern County have successfully operated recharge ponds. This includes North Kern Water Storage Project, Arvin-Edison Water Storage District, and the City of Bakersfield. Wells, however, were only assumed to last 40 years before replacement, based upon typical well life observed in the Kern Fan area, and reported by Mr. Parker and Mr. Iger.

Furthermore, the analysis period utilized modeled State Water Project Water availability from DWR's 2010 State Water Project Reliability Report Table 6 from 1922 to 1971, which includes relatively restrictive Delta operations criteria and effects of forecasted climate change. The 1922 to 1971 period was determined to be representative, as the average SWP Table A allocation during that period matched the full 80 year analysis average. Kern River % of average of First Point Runoff measurements (from Kern River Watermaster records from 1922 to 197) were also used. These were not adjusted for climate change, as increased need for storage for Kern River water in the future (due to more rain and earlier snow melt) was assumed to balance the impact in reduced runoff.

Since this Project is a small fraction of the overall Kern Water Bank (which has approximately 1 Million acre-feet in its Member storage accounts), recovery is allowed from the new wells from the beginning of the analysis period.

As mentioned above KWBA participant's bank accounts are overseen by the KFMC pursuant to the KWB MOU, the quantity of surface water delivered to the Water Bank is carefully measured, and appropriate losses of 10% are deducted. Under no circumstances are the participants allowed to extract more water than they have recharged into these accounts. Therefore, a check was made of modeled recovery to assure it exceeds 90% of total recharge.

Because SWP water is the primary surface water supply of KWBA members, the number of months that KWBA recoveries from the new wells were forecast to meet future additional Member demands was assumed to match the correlation with SWP Table A Entitlement developed above. Recovery volumes in each year of the analysis were then calculated by multiplying that number of months by new well recovery capacity (assumed to be 5 cubic feet per second (cfs), which is 9.9 acre-feet per day or 302 acre-feet per month per well). Mr. Parker and Mr. Bonesteel report that 5 cfs is a conservative long-term average recovery capacity of KWB's existing wells that KWBA staff have calculated and used successfully for planning its projects and operations to date.

To generate the without-Project alternative, it was assumed that no additional dry period water would be available to KWBA Members from KWBA.

Benefit Uncertainty

The first benefit is fairly certain, because KWBA member's needs for dry period water in the future is relatively easy to assume, and recovery assumptions are based on demonstrated factors from historic Kern Water Bank operations.

New Facilities Required to Achieve Benefit

Construction of the additional recharge ponds, three new wells, and associated facilities shown on the Project's 30% Construction Plans are needed to achieve the Project Benefits.

It should be noted that Article 21 water and Westside CVP Section 215 Water will be conveyed to the Project from the California Aqueduct, Cross Valley Canal (with flow from west to east), and KWB Canal to the project facilities. All of the participants have the contractual right, directly

or indirectly, to convey water in the California Aqueduct and Cross Valley Canal (which is a bi-directional facility).

Kern River Water and Friant CVP Section 215 Water can be delivered from the Cross Valley Canal (with flow from east to west) or the Kern River to the KWB Canal.

Water recovered from project wells will flow through new and existing pipelines to the Kern Water Bank Canal, and thence back to the California Aqueduct where it is returned to KWBA Members via operational exchanges by DWR.

Losses associated with conveyance are minimal, as the Cross Valley Canal is lined, and seepage losses in the KWB Canal return to groundwater, and can be recovered by KWBA.

Potential Adverse Physical Effects

Adverse physical effects are not expected, as the KWB MOU, Kern Fan Monitoring Committee, and KWBA's HCP require monitoring and mitigation of any adverse physical effects.

Summary of Benefit

The Project will recover a total of 123,161 acre-feet over 50 years (2,463 acre-ft per year) to meet dry year needs of KWBA members. These were assumed to be available for recovery beginning in the year 2015 (per the Project Schedule). A summary of with- and without- project annual increased dry period water to meet Member demands are provided in **Table 7.4-1**.

Table 7.4-1: KWBA Additional Recovery to Meet Dry Period Needs of KWBA Members Summary Table

Project Name: Kern Water Bank Authority - Recharge and Recovery Enhancement Project			
Type of Benefit Claimed: Increased Dry Period Water Supply			
Measure of Benefit Claimed (Name of Units): Ac-ft			
Additional Information About this Measure: This Benefit is Realized by KWBA Members			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2013	0	0	0
2014	0	0	0
2015	0	10,867	10,867
2016	0	3,622	3,622
2017	0	3,622	3,622
2018	0	0	0
2019	0	0	0
2020	0	3,622	3,622
2021	0	3,622	3,622
2022	0	10,867	10,867
2023	0	3,622	3,622
2024	0	3,622	3,622
2025	0	5,433	5,433
2026	0	0	0
2027	0	0	0

Project Name: Kern Water Bank Authority - Recharge and Recovery Enhancement Project			
Type of Benefit Claimed: Increased Dry Period Water Supply			
Measure of Benefit Claimed (Name of Units): Ac-ft			
Additional Information About this Measure: This Benefit is Realized by KWBA Members			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2028	0	0	0
2029	0	0	0
2030	0	3,622	3,622
2031	0	0	0
2032	0	0	0
2033	0	0	0
2034	0	0	0
2035	0	2,717	2,717
2036	0	0	0
2037	0	0	0
2038	0	2,717	2,717
2039	0	0	0
2040	0	2,717	2,717
2041	0	0	0
2042	0	0	0
2043	0	0	0
2044	0	0	0
2045	0	0	0
2046	0	3,622	3,622
2047	0	0	0
2048	0	0	0
2049	0	0	0
2050	0	3,622	3,622
2051	0	3,622	3,622
2052	0	3,622	3,622
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
Comments:			

Benefit 2: Increased Overdraft Correction Water

Overdraft Correction water (purchased by Adjoining Entities) in acre-feet each year is calculated by multiplying Project annual Recharge figures by 0.04 (4% corresponding to KWB MOU).

Without-Project Conditions

Without the Project, Adjoining Entities are assumed to have 0 acre-feet of Increased Overdraft Correction Water from KWBA.

Methods Used to Estimate Benefits

Groundwater overdraft in the Tulare Lake Basin has been estimated by Michael Day of Provost & Pritchard Consulting Group [phone (661) 616-5900, e-mail or mday@ppeng.com] at 1.6 Million Acre-feet per year, utilizing data from the most recent California Water Plan Update. The Kern County Sub-basin contributes to a portion of that overdraft, but estimates of that portion vary, and very much in dispute. What isn't in dispute is that the Kern basin as a whole is in a critical state of overdraft. See article in Bakersfield Californian at: http://www.bakersfieldcalifornian.com/columnists/lois-henry/x1925193948/LOIS-HENRY-A-good-water-idea-bubbles-up-right-here-in-Kern).

Pursuant to the terms of KWB MOU paragraph 2.b.(10)(b)), adjoining water districts have always opted to purchase four percent of the water recharged in Kern Water Bank (at KWBA's cost to bank it) each year since 1995 to help correct their overdraft conditions This provides an economical means for the surrounding districts to augment their water supplies and help eliminate overdraft in the basin.

In practice, the MOU requirements have resulted in significant overdraft reduction benefits.

Therefore, this Overdraft Correction Benefit has been projected forward in the 50 year analysis period, with recharge beginning in 2015 after ponds are constructed per the Project Schedule. This benefit was calculated each year as equal to four (4%) of the total water recharged. Total water recharged was determined by multiplying assumed recharge of 906 acre-feet of total recharge for each month the ponds could be used, and employing the historically derived relationship between Article 21 water availability and % of Average Kern River Runoff at First Point versus the number of months the pond would be used.

Benefit Uncertainty

Since adjoining entities have always purchased 4% of the water KWBA recharges, overdraft conditions are expected to persist and worsen due to increased completion for water supplies and climate change this benefit is highly likely.

New Facilities Required to Achieve Benefit

Construction of the Project Facilities previously described, and on-going compliance with KWB MOU and KFMC monitoring are required to achieve the Benefit.

Potential Adverse Physical Effects

As discussed for Benefit 1, adverse physical effects are not expected.

Summary of Benefit

The Project will increase Overdraft Correction water to Adjoining Entities as shown in the following table. The quantities purchased by Adjoining Entities are shown in acre-feet each year, and were calculated by multiplying Project annual Recharge figures by 0.04 (4% corresponding to KWB MOU).

Without the Project, Adjoining Entities were assumed to have 0 acre-feet each year, of increased overdraft correction water from KWBA.

Table 7.4-2: KWBA Adjoining Entity Increased Overdraft Correction Water Summary Table

Project Name: Kern Water Bank Authority - Recharge and Recovery Enhancement Project			
Type of Benefit Claimed: Increased Overdraft Correction Water			
Measure of Benefit Claimed (Name of Units): Ac-ft			
Additional Information About this Measure: Benefit is to KWBA Adjoining Entities for Overdraft Correction			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2013	0	0	0
2014	0	0	0
2015	0	414	414
2016	0	759	759
2017	0	69	69
2018	0	69	69
2019	0	69	69
2020	0	621	621
2021	0	69	69
2022	0	0	0
2023	0	690	690
2024	0	621	621
2025	0	552	552
2026	0	69	69
2027	0	69	69
2028	0	552	552
2029	0	69	69
2030	0	0	0
2031	0	69	69
2032	0	0	0
2033	0	69	69
2034	0	69	69
2035	0	69	69
2036	0	621	621
2037	0	138	138
2038	0	69	69
2039	0	0	0
2040	0	69	69

Project Name: Kern Water Bank Authority - Recharge and Recovery Enhancement Project			
Type of Benefit Claimed: Increased Overdraft Correction Water			
Measure of Benefit Claimed (Name of Units): Ac-ft			
Additional Information About this Measure: Benefit is to KWBA Adjoining Entities for Overdraft Correction			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2041	0	138	138
2042	0	621	621
2043	0	0	0
2044	0	138	138
2045	0	69	69
2046	0	69	69
2047	0	759	759
2048	0	138	138
2049	0	138	138
2050	0	69	69
2051	0	69	69
2052	0	0	0
2053	0	0	0
2054	0	138	138
2055	0	69	69
2056	0	69	69
2057	0	69	69
2058	0	69	69
2059	0	69	69
2060	0	276	276
2061	0	483	483
2062	0	69	69
Comments:			

Benefit 3: Increased Groundwater Storage

Because the Project recharges much more water than is projected to be either recovered for KWBA members and accounted to Overdraft Correction Benefit, as described for Benefits 1 and 2 above, there is an Increased Groundwater Storage Benefit from the Project.

Background and Assumptions

Gross recharge volumes, recharge accounted to KWBA Members, and recharge volumes accounted to Adjoining Entities calculated for each year of the fifty year analysis period, as described for the first two benefits above, were also used in calculating Benefit 3.

Without-project conditions

The without-Project conditions assume that no increase in groundwater storage would occur. None of the projected increased groundwater storage would occur if the Project is not constructed and operated as described previously.

Methods Used to Estimate Benefits

Increased Groundwater Storage is calculated in the last year of the analysis period after calculating ninety percent (90%) of the total volume recharged during the analysis period (which the KWB MOU allows for recovery by KWBA), then deducting from that result the sum of: Increased Dry Period Supplies for KWBA Members and Increased Overdraft Correction Water for Adjoining Entities. This then captures the amount of water in groundwater storage that KWBA can recover (or sell to others in the Kern Fan area under existing agreements for "in-ground banked water sales). Thus this benefit is not "stranded".

Benefit Uncertainty

This certainty of this benefit is similar to Benefits 1 and 2 described above (highly likely).

New Facilities or Actions Required to Achieve Benefit

The construction of the Project facilities described above, and continuing KWB MOU compliance and KFMC monitoring and reporting are necessary to achieve these results.

Potential Adverse Physical Effects

As described above, the Kern Fan MOU and KFMC monitoring and reporting assure no adverse physical effects of the Project.

Summary of Benefit

A total of 127,000 acre-feet of Increased Groundwater Storage was estimated at the end of the fifty year analysis period.

Table 7.4-3: KWB Project Increased Groundwater Storage at End of Life

Project Name: Kern Water Bank Authority - Recharge and Recovery Enhancement Project			
Type of Benefit Claimed: Increased Groundwater Storage			
Measure of Benefit Claimed (Name of Units): Ac-ft at end of Analysis Period			
Additional Information About this Measure: Benefit accrues to KWBA Members			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
2013	0	0	0
2014	0	0	0
2015	0	0	0
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

Project Name: Kern Water Bank Authority - Recharge and Recovery Enhancement Project			
Type of Benefit Claimed: Increased Groundwater Storage			
Measure of Benefit Claimed (Name of Units): Ac-ft at end of Analysis Period			
Additional Information About this Measure: Benefit accrues to KWBA Members			
(a)	**(b)**	**(c)**	**(d)**
	Physical Benefits		
Year	**Without Project**	**With Project**	**Change Resulting from Project (b) – (c)**
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	126,695	126,695
Comments: Note - KWBA has right to sell stored groundwater "in-basin" to other Kern Fan agencies earlier than assumed			

7.4.5 Non-Monetized Benefits

A number of other Physical Benefits were difficult to quantify monetarily, and were treated as Non-monetized benefits (see Attachment 8). These include:

- Increased intermittent wetland habitat for endangered and other waterfowl associated with periodic use of the new ponds.

- Improved water quality of Kern Fan groundwater.
- Reduced demand for net diversions for the regions from the Delta, because banking of local (non-Delta) wet period water which will offset without Project purchases from the Delta.
- Groundwater banking is a long-term solution versus short term annual water market purchases.
- Water supply reliability for KWBA Members will also be improved by the added flexibility the new ponds and recovery wells give KWBA in the location of recharge and recovery activities, reducing potential for conflicts with adjoining entities.
- Flood damage reduction to developed areas that would otherwise be flooded by water recharged in the new ponds.

Water Quality

The project will be operated under the requirements of the KWB MOU, which stipulates water quality is to be at the least maintained and, where possible, enhanced. Some of the measures prescribed in the KWB MOU to protect water quality include: 1) giving recharge priority to the best quality water available, 2) removing more salts than are recharged, 3) controlling the migration of poor quality water, and 4) extracting poorer quality groundwater where practicable (and where blending with excellent quality water from elsewhere in the project results in the water quality objectives of downstream users being met). Under these operational mandates, the proposed program will improve the quality of water in the aquifer.

The extensive monitoring conducted on the Kern Water Bank has established that baseline water quality in the project area is generally excellent. TDS concentrations average 291 mg/l in 84 recovery wells (see spreadsheet). Through the life of the project, excellent quality SWP, Kern River, and CVP water (TDS ≈95 to 250 mg/l) will be recharged. This recharge, and subsequent groundwater recovery, will result in a reduction in TDS levels in the aquifer.

Groundwater Monitoring

Extensive monitoring has been used to establish baseline groundwater quality and ensure that groundwater problems are not developing. This monitoring consists of two elements: 1) the regular sampling of dedicated monitoring wells (see Page 1-8 of **Appendix 1.3-D**) for several potential constituents of concern, and 2) the sampling of all recovery wells according to a Monitoring Schedule developed by the Department of Health Services. The sampling of the monitoring wells is mandated by the KWB MOU. Under this program water levels are measured at least semiannually and water samples are analyzed for several potential constituents of concern at least annually. The results of this monitoring are reported to and reviewed by the KFMC to ensure that excellent groundwater quality is maintained.

Habitat Benefits

Land use within the Project site is governed by the Kern Water Bank Habitat Conservation Plan / Natural Community Conservation Plan, executed with United States Fish & Wildlife Service and California Department of Fish & Game (now called the California Department of Fish and Wildlife) on October 2, 1997. Copies of the implementation agreements are included in **Appendix 3.5-A**. The HCP is based on three principals: (1) the project is self-mitigating; (2) the areas surrounding the recharge basins will be managed to provide habitat for Covered Species; and (3) adaptive management techniques will be used for operations and habitat management. Under the HCP, KWBA is responsible for establishing and maintaining habitat preserves, carrying out site-specific mitigation measures, and for monitoring and reporting results of management activities to the Wildlife Agencies. **Appendix 3.5-C** is a copy of KWBA's HCP 2011 Compliance Report and 2012 Management Plan.

Flood Protection Benefits

Low lying developed areas in the San Joaquin Valley periodically are inundated by flood waters, which is the topic of DWR's Central Valley Flood Protection Studies, and for the Tulare Lake Basin, part of what is covered in "Floods and Droughts in the Tulare Lake Basin (http://tularebasinwatershed.org/sites/default/files/sites/all/default/files/pdf/Floods-Droughts-Tulare-Lake-Basin_JAustin_20130109.pdf). The Tulare Lake area in particular is the recipient of floodwaters from the Kings, Kaweah, Tulare, Kern Rivers, and a number of smaller streams. **Figure 7-2** shows a map of farmland in the Tulare Lake area flooded in 1997, the most recent wet year which overwhelmed the Tulare Lake area's ability to fight floods. A portion of the water recharged in the Kern Water Bank otherwise would have contributed to flooding of low-lying improved lands in Kern County near the Kern River Flood Channel, Kings County (Tulare Lake Bed), and other areas further North (adjacent to the San Joaquin River and Delta). However, the amounts are difficult to quantify because of the complexity of various floodwater pathways, impact location, and degree of impacts to developed lands.

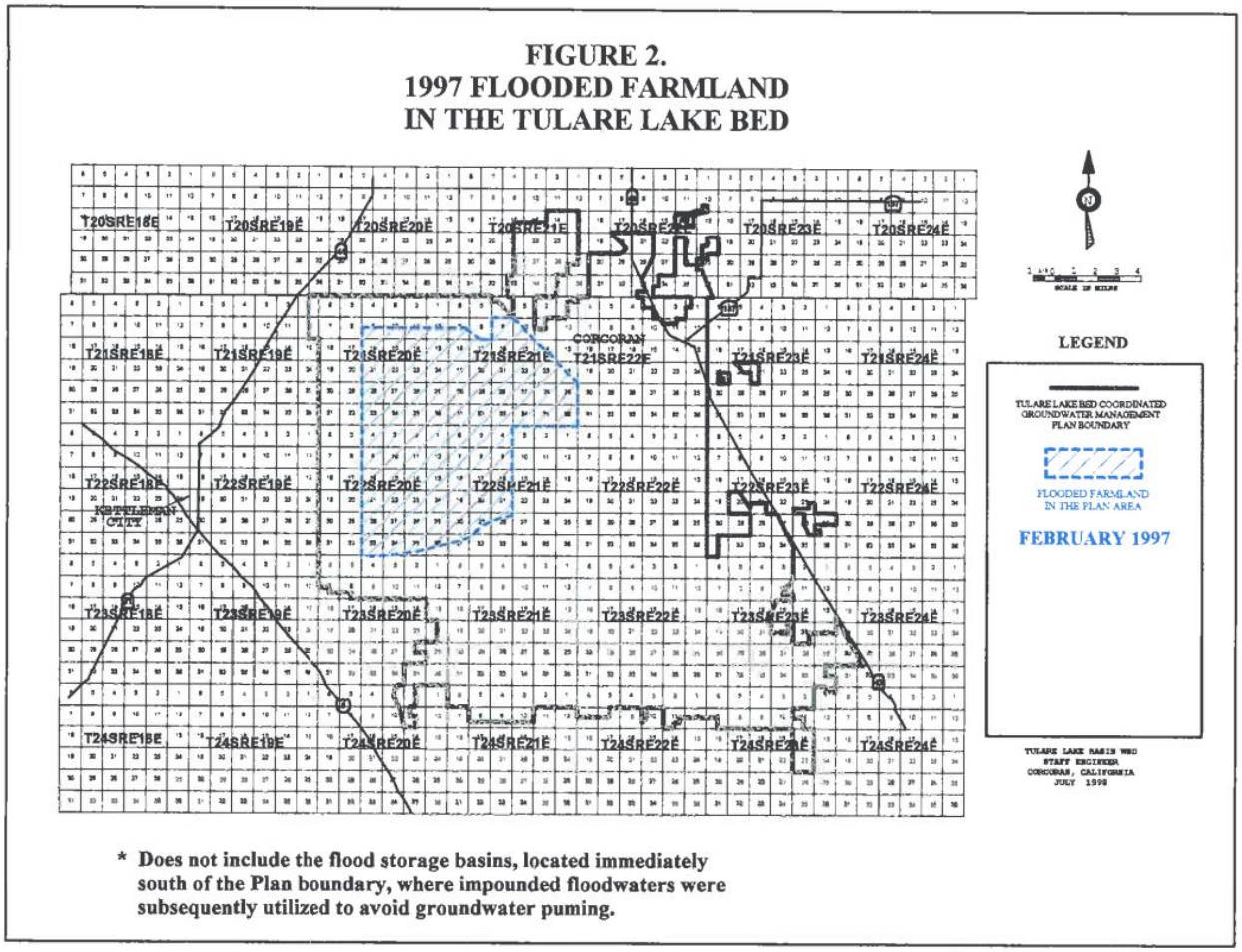


Figure 7-2: Tulare Lake Bed Flooded Farmland (1997)

7.4.6 References

Refer to **Appendix 3.5-D**

7.5 Sycamore Road Flood Reduction Project

7.5.1 Introduction

This attachment has been prepared to document that by completing the City of Arvin's Sycamore Road Flood Reduction Project (Sycamore Road Project), measurable physical benefits will be accrued. In order for this project to be completed as intended, the City of Arvin requires grant funding to provide the capital resources to implement a project of this magnitude. The City of Arvin (City) is a Central Valley community with a median household income (MHI) of about $29,740 which at 48% of the statewide MHI is below the 60% MHI that characterizes "severely disadvantaged communities". The sections below will provide a summary of the project, state the physical benefits of the project, provide a narrative description of all the expected physical benefits, summarize the "with project" and "without project" conclusions, and provide tables that depict the annual project physical benefits.

7.5.2 Project Abstract

Stormwater management has been a critical issue for the City due to historical flooding that has impacted its community and homes. To reduce flooding that occurs in multiple locations in Arvin, City staff has worked with consultants to develop a Master Grading/Drainage Plan which has identified multiple stormwater management facilities for implementation. The most critical project from this Plan involves storm drains and a retention basin to reduce flooding along Sycamore Road.

Flooding within the City has been documented along the approximately quarter-mile stretch of Sycamore Road between Comanche Drive, Walnut Drive, and Meyer Street. Some flooding occurs annually with more damage occurring when heavy rainfall from less frequent storms results in greater extents of flooding. At the low point in the area, this portion of Sycamore Road receives flow not only from local drainages but also receives flow from a larger region of almost 277 acres of commercial and residential properties when upstream facilities are overwhelmed. In addition, the City is topographically flat and can experience rainfall of up to 1.8 inches per day (as occurred in December 2010), resulting in significant flooding for long durations as the water cannot efficiently drain. In addition, Sycamore Road is a main east-west thoroughfare within the City of Arvin and the intersection with Meyer Road is a low point in the City. This intersection can have as much as 3415 per Kern Council of Governments traffic counts performed February 6, 2013.

While the City of Arvin contains some newer developments, much of the City has aging infrastructure that does not effectively convey stormwater off of roads and away from both private and public property. In the case of the proposed Sycamore Road Project area, runoff from the northern side of Sycamore Road, a mobile home park, and a housing tract are conveyed to undersized local detention ponds which can fill up quickly and then are no longer able to receive stormwater from the public roads, even on annual events. While there are localized mounds of soil and a concrete masonry unit (CMU) privacy fence that impedes some

flows, there is no formal flood protection berm to the north of Sycamore Road to protect mobile home properties from flood depths that can potentially damage crawl spaces, storage, and outdoor areas as a result of local flooding. The flooding of the crawl space can result in structural damage to the mobile home foundation, a sagging floor due to rotting wood, mold development with potential harmful spore allergens, and damage to personal property stored in the crawl space. Each of these issues can lead to expensive repair and renovation costs that would be borne by mobile home owners who are typically low income residents.

The current conveyance system, utilizing the surface flows on the road surface, ponds during frequently occurring storms and is grossly insufficient for the estimated flows from local events. Flooding of up to 2-feet occurs annually at the Meyer Street/Sycamore Road intersection requiring the closure of Meyer Street including the north lane of Sycamore Road Photographs and estimated flooding extents from a storm as recent as March 8, 2013 are provided on **Figure 7-3**.

During some larger storm events, as occurred in December 2010, the City of Arvin has had to rent 3-inch and 4-inch trash pumps (in addition to available City owned portable pumps) to pump stormwater from the local detention basins across Sycamore Road to the undeveloped parcel to the south. The rental invoice from Rain for Rent is provided in **Appendix 7.5-A**. Under without project conditions, road flows from small storms enter the local detention basin for infiltration/evaporation. On large events, local detention basin pumping is necessary for the road to drain. Pumping has been known to last in excess of four days to reduce the inundation in and along the roadway. Rainfall totals and estimated return intervals for a rain gauge at the Arvin-Edison Water Storage District Office (both of which are found in **Appendix 7.5-B**) for this event are summarized below.

Date	Daily Rainfall Total	Estimated Return Interval for 24-Hour and 3-Day Event
Dec 18, 2010	1.8 inches	> 10 year
Dec 19, 2010	1.08 inches	2 year
Dec 20, 2010	0.92 inches	< 2 year
Total 3 day-rainfall	3.8 inches	>100 year

While individual daily rainfall totals may not convey the severity of the event, the 3-day total, as well as the significant flooding at the project location, indicates the significance of this and similar events. This event was likely in the 2-year to 10-year return interval range when analyzed from a daily rainfall perspective but could be as large as a 100-year event when analyzed from a 3-day rainfall perspective. This event caused flooding of two homes located at the north-west intersection of Meyer Street and Sycamore Road. These parcels are essentially undevelopable because of the threat of flooding thereby reducing local property values.

The Sycamore Road Project is being proposed to update and improve an inefficient surface drainage system with sub-surface stormwater and flood water infrastructure that is intended to meet multiple IRWM Plan objectives. In addition to protecting public and private property from flood damage and improving regional flood management, the project will increase public safety,

and reduce operation and maintenance costs for this severely economically disadvantaged community.

The Sycamore Road Project will effectively convey stormwater from surrounding neighborhoods and public roadways that contribute to flooding along Sycamore Road, nearby intersections, and threatens the mobile home park. This stormwater will be conveyed by 2.4 miles of sub-surface reinforced concrete storm drain piping of 21-inch to 48-inch diameter, 31 manholes and 8 catch basins that will carry the water to a proposed 36 acre-foot capacity regional retention basin to the south. A detailed description of the project and project map can be found in Attachment 3. The retention basin is sized to store a 10 year storm per Kern County Hydrology Manual Requirements. Percolation values from the Soil Conservation Service mapping which indicates that this area is underlain by Group A soils which have good infiltration. These facilities will reduce or eliminate the accumulation of flood water along Sycamore Road, reduce potential flood damage to homes, vehicles, and roadways, and increase public safety and property values.

7.5.3 Without-Project Baseline

Without this project, localized street flooding and associated public safety risks from 1- year return interval precipitation events that have the probability of occurring annually will continue. In addition to causing street flooding, without this project, flooding for larger storms events will have the potential to enter up to 29 mobile homes and cause damage to personal property and isolate residents in this severely disadvantaged community. More detailed description of without project baseline is discussed in Section 7.5.5.

7.5.4 Relationship of Project to Other Projects Included in the Proposal

The Sycamore Road Flood Reduction Project is independent of the other four projects but the five projects will collectively achieve IRWM Plan objectives and regional water goals. The Sycamore Road Project provides the benefits of providing flood control, and helping to meet the critical water supply and water quality needs of disadvantaged communities as does the Snyder Well Intertie Pipeline project and the Tehachapi Regional Water Conservation Project. The other four projects add other benefits such as including increasing water supply and reliability, increasing water conservation, improving operational efficiency, improving water quality and promoting resource stewardship.

7.5.5 Description of Project Physical Benefits for the Sycamore Road Flood Reduction Project

Primary Benefit - Flood Damage Reduction (FDR)

Flood Damage Reduction will be achieved by connecting the Sycamore Road drainage area to a 36 acre-foot capacity detention basin via sub-surface storm drains, thus providing a conveyance for local and regional stormwater from Sycamore Road which is prone to flooding.

The primary physical benefit of the Sycamore Road Project is the reduction in physical damage that has been caused by past flood events and that continues to be a threat to the residential area in Arvin near the project location.

Method of Estimating Flood Damage

To document the potential extent of flood damage in the area, a global positioning system (GPS) survey of the project location was performed by Provost & Pritchard Consulting Group (P&P) to obtain existing elevation data. These data were combined with photographs of past events to "calibrate" the analysis and storm event calculations to understand flood scenarios associated with the Sycamore Road Project and damages that can occur "with project" and "without project." As noted earlier, Sycamore Road and its shoulders are at a topographic low point in the regional drainage and collect both local drainage and overflows from the regional drainage system in larger events. In addition, the crown of Sycamore Road functions as a weir such that stormwater above the crown of the road can flow to the south and infiltrate in the adjacent unimproved lands.

Pre-project flood depths were estimated based on historic events. Firsthand accounts of the December 2010 flood event were used to correlate precipitation data from the Bakersfield weather station to observed water surface elevations. The 2010 event set the upper limit (100 year reoccurrence interval) for the water surface elevation used in the analysis. The lower limit (1 year reoccurrence interval) was set by establishing a water surface elevation that caused minor flooding along Sycamore Drive. Minor flooding occurs nearly every year per conversations with City of Arvin staff. Water surface elevations for various reoccurrence intervals were calculated by linearly interpolating between the water surface elevations established in the December 2010 event and the lower limit event. A field survey was performed on March 2013. The survey data was used to establish the flooded boundary for a given water surface elevation. Post-projects flood depths were established by reducing the pre-project water surface elevations proportionally to the capacity of the post-project storm drainage system and the post-project calculated peak flood flows. The March 2013 survey data was then used to establish flooded boundary for post-project conditions.

Three flood events were considered for the analysis, the 1-year, 50-year, and 100-year storm events. The flood reduction benefits include external damage to property especially in the crawl spaces of mobile homes, cleanup costs, the reduction of operation and maintenance costs for City of Arvin staff to run and operate pumps during storm events, and the reduced damage to roadways.

<u>Flood Event 1:</u> The first flood event used in the Flood Damage Reduction benefit analysis was a local 1-year return interval event. An example of this occurred recently in March of 2013. Based on available local precipitation data and the precipitation depth frequency curve for this area, this storm event had a precipitation of about 0.81" in a 24-hour period and was estimated to be somewhat less than a 1-year return interval (~0.85-year). The runoff and flood water generated from this frequent event is typical for the project location and happens annually. **Figure 7-3** shows the flooding from the March 2013 event that is typical of these frequent storms. In these cases, traffic must be re-routed away from the flooded area as it closes

intersections. Children walking to and from the El Camino Real Elementary School to the south are forced to cross Sycamore Road at locations that do not have crosswalks. This flooding creates an unsafe situation for these children as not only are the roads and crossings flooded but visibility is also likely to be poor. The City of Arvin did not have to rent and operate pumps as a result of this storm; however the inundation in affected areas can last up to two days.

In the "without project" scenario, the current flooding occurs, causing road and intersection closures, altering school children's routes to and from school, and being a nuisance for local and commercial traffic along this highly-traveled arterial roadway, as shown on **Figure 7-3**. It is estimated that there will be 0.22 miles of Sycamore Road, an arterial road, inundated in 1-year flood events

The "with project" scenario would utilize the newly implemented stormwater conveyance system to convey the entire volume of runoff at the project location and no road flooding will occur.

SYCAMORE ROAD FLOODING 1 YEAR RECURRENCE INTERVAL (ACTUAL FLOODING EXTENT MARCH 2013)

SCALE: 1"=100'

PHOTO 1 – SYCAMORE AND WALNUT

PHOTO 3 – SYCAMORE ROAD

PHOTO 5 – SYCAMORE ROAD

PHOTO 6 – SYCAMORE ROAD

PHOTO 2 – SYCAMORE ROAD

PHOTO 4 – SYCAMORE AND MEYERS

EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

SYCAMORE ROAD FLOOD REDUCTION PROJECT

KERN IRWM GROUP
CITY OF ARVIN

PRE–PROJECT 1–YR RECURRENCE INTERVAL

Figure 7-3: Sycamore Road March 2013 Flooding (equivalent 1-Yr Return Interval)

Flood Event 2: The second event used in the Flood Damage Reduction Benefit analysis was a local, 50-year recurrence interval event. The local undersized retention basins for the adjacent development and mobile home park will reach capacity and will no longer be able to receive stormwater from these residential areas or from the public roadways without pumping for several days. Flood waters will reach farther north impacting an estimated 19 mobile home properties with a conservatively estimated maximum inundation depth of 1-foot. The mobile homes are assumed to have finished-floor elevation 2.0-feet above ground level, and although the water may not enter the mobile homes, crawls spaces, storage, and outdoor areas will be affected by such flooding. These depths will result in external property damages such as personal goods stored underneath the mobile home and the potential for mold and structural damage as well as flooding of low-clearance vehicles and cleanup costs. Sycamore Road intersections at Walnut Drive and Meyer Street will be flooded across the roadway as shown on and traffic will likely be diverted until the inundation recedes. Safety concerns arise for pedestrians and school children that use the crosswalks at these intersections as they will be forced to cross at unsafe locations under low-visibility conditions.

The “without project” scenario, as shown on **Figure 7-4**, would result in the higher floodwater depths stated previously, with the possibility of causing damage to 19 mobile home properties. The inundation time would be greater without the proposed project, and if water is not pumped from the local retention basins by City of Arvin staff, inundation time could be longer. It is estimated that 0.27 miles of Sycamore Road, an arterial road, will occur in a 50-year flood event.

The “with project” scenario as estimated hydraulically in **Appendix 7.5-C** and shown on **Figure 7-5**, shows that the proposed stormwater conveyance system will be able to eliminate much of the runoff. The duration of the event will dictate whether the volume of floodwater generated can be fully conveyed away from the roadway and the residential areas. The newly installed storm drainage system will likely convey stormwater for a longer duration storm with minimal inundation depths. The new system may reach capacity for a shorter duration 50-year storm and will result in some flooding as local drainage systems in California are generally not designed to convey these large events. The water which cannot be conveyed may cause flooding that could affect approximately 3 mobile home properties and cause flooding along Sycamore Road, however, the conveyance of stormwater will be continuous, and the inundation duration is likely to be lowered from 4 day to 3 days. As noted previously, the retention basin is designed for a storm event larger than a 10-year event. Should the retention basin located away from the Sycamore Road area fill to the maximum level, the excess stormwater will spill and sheet flow and percolate onto the City’s 80 acre parcel and ultimately excess stormwater would continue southwest of the city and sheet flow south toward the Malaga Slough.

Figure 7-4 – 50-Year Pre-Project

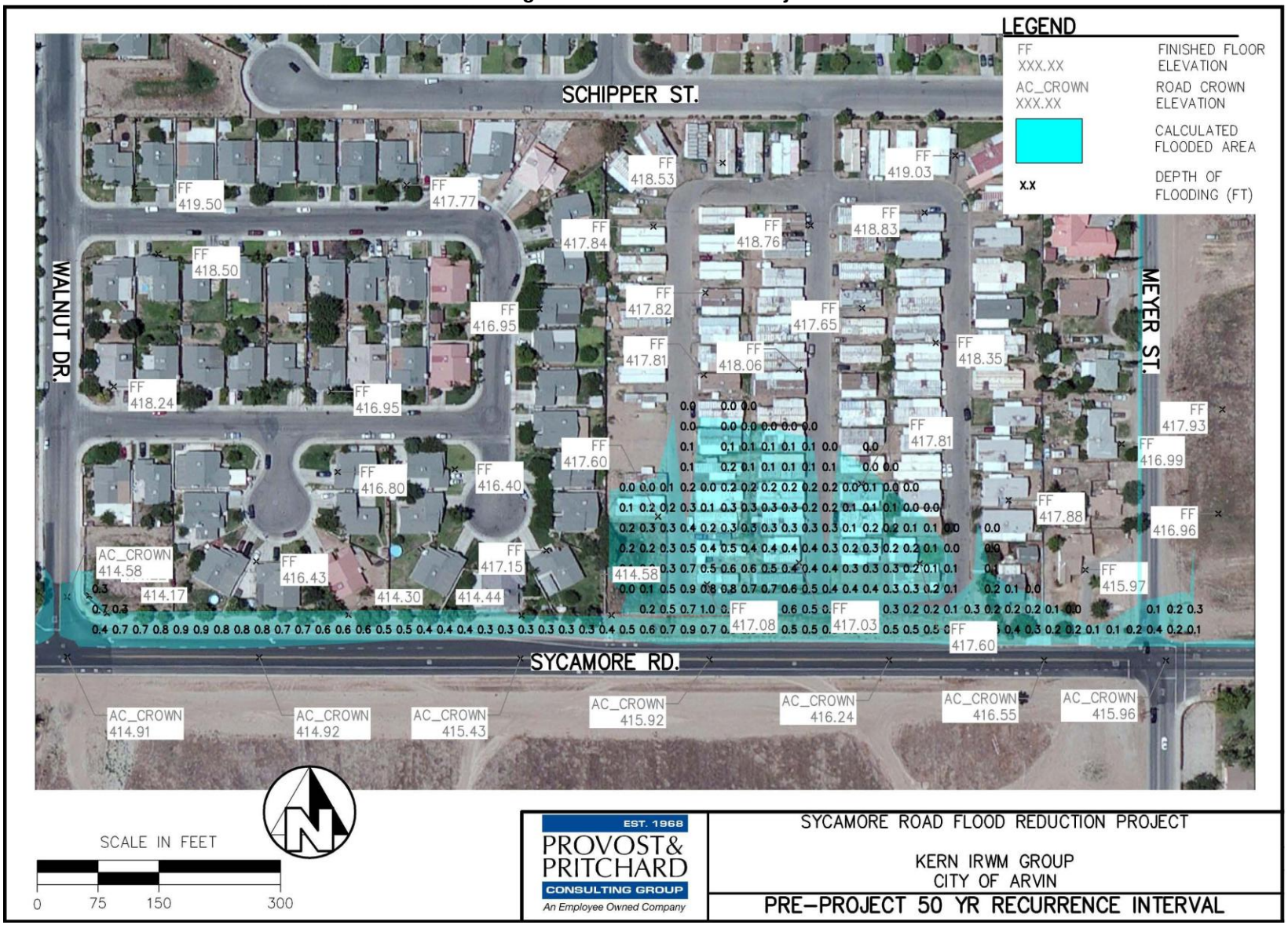
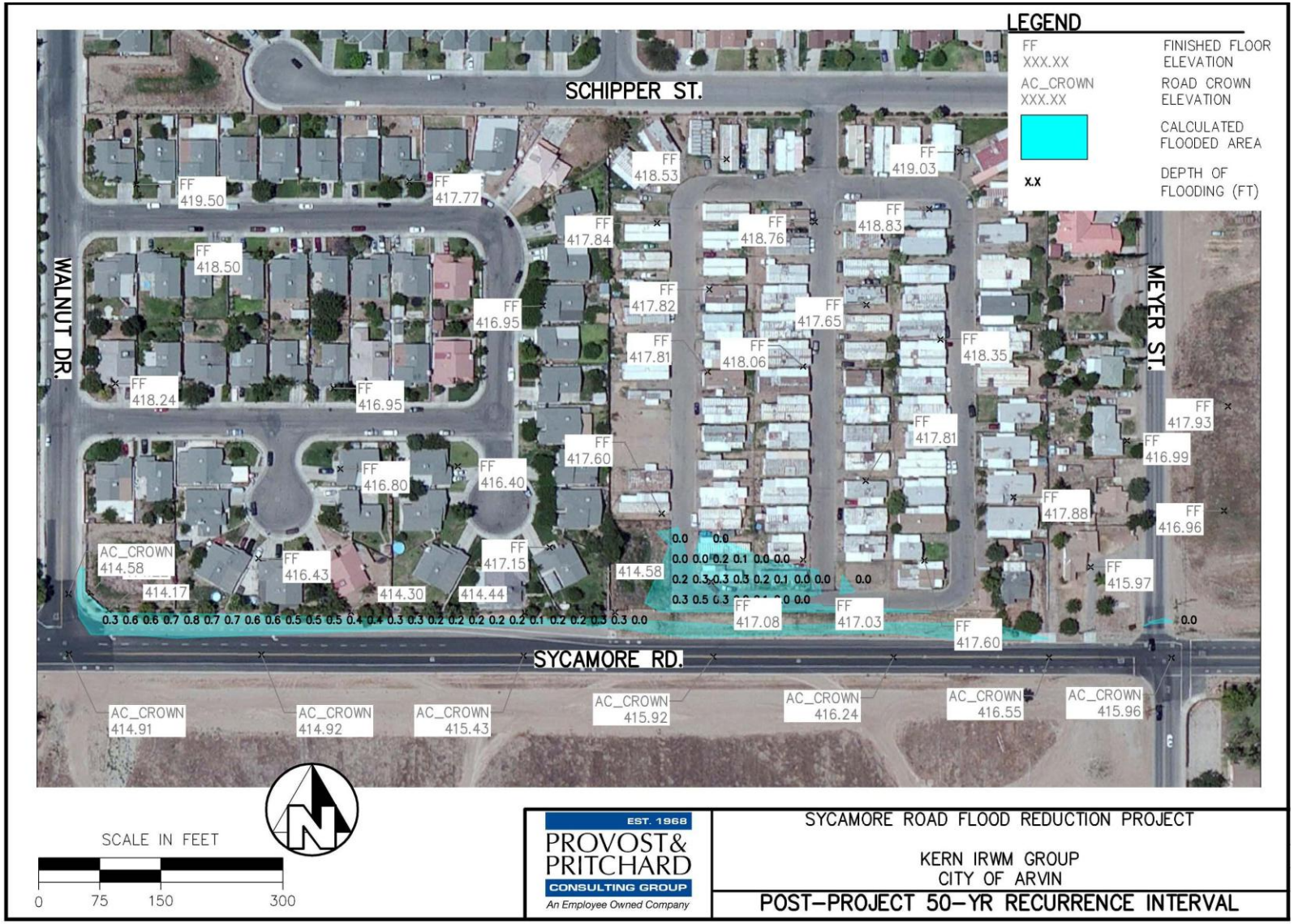


Figure 7-5 – 50-Yr Post-Project



Flood Event 3: The third event used in the Flood Damage Reduction Benefit Analysis was a local, 100-year recurrence interval event. This event has been modeled to show that flood inundation depths near the mobile homes are around 1-foot, and that the area of flooding extends even farther to the north into the mobile home park along Sycamore Road than the 50-year event (this is conservative as discussed previously). Modeling shows that 29 mobile homes can be impacted by this flooding. The flooding is somewhat limited to the crown of Sycamore Road, so depths are not expected to be much higher, but this 100-year return interval event will cause a severe nuisance to the residents of the mobile home park, and will result in private property damages. Since the finished-floor elevations are typically 2-feet above the existing ground surface, flood waters will likely cause damages to crawl spaces, outdoor storage, gardens, and other external property such as low clearance vehicles as well as increasing the probability of mold and foundation damage. The flood area is likely to be inundated for four days, which will restrict residents' access to and from their homes, threatening the habitability of their homes. Additionally, the flooding will cause traffic to be re-routed around flooded intersections and traffic lanes, and force school children and other pedestrians to cross Sycamore Road at non-designated spots during low visibility conditions. Safety concerns arise because a significant number of children that use the crosswalk at the corner of Sycamore Road and Meyer Street to get to and from the El Camino Elementary School. This resulting flooding also adds additional operations and maintenance costs for the City of Arvin because they must rent and operate pumps for an extended period of time to convey flood water to the south of Sycamore Road.

In the "without project" scenario as shown on Figure 7-d, the local flooding will be extensive and almost half of the mobile home park area will have some level of flooding with associated property damage similar to that of the 50-year event. Inundation duration would be much greater, and if the City cannot rent and operate pumps to convey the water to the south of Sycamore Road, inundation time can be even longer. Intersections and traveled ways would be flooded creating a hazard for traffic as well as pedestrians, and alternate routes would need to be used. Inundation over these longer durations will continue to accelerate degradation of the road surfaces which will result in the City having to repair and replace the roadways more frequently. As in a 50-year event, about 0.27 miles of Sycamore Road, an arterial road, will also be flooded during a 100-year flood event.

The "with project" scenario as shown on Figure 7-e would limit the extent of flooding by conveying a high volume of water through the sub-surface storm drain system to the newly constructed retention pond to the south. Flood depth will be decreased so that only 5 mobile home properties could expect to have any flooding. The inundation time would decrease from 4 days to 3 days, however, roadways, intersections, and crosswalks will likely to be re-opened sooner. A significant amount of external damage and cleanup costs would be avoided if the proposed project is implemented.

Figure 7-6 – P&P 100-Year Flood Model – Pre-Project

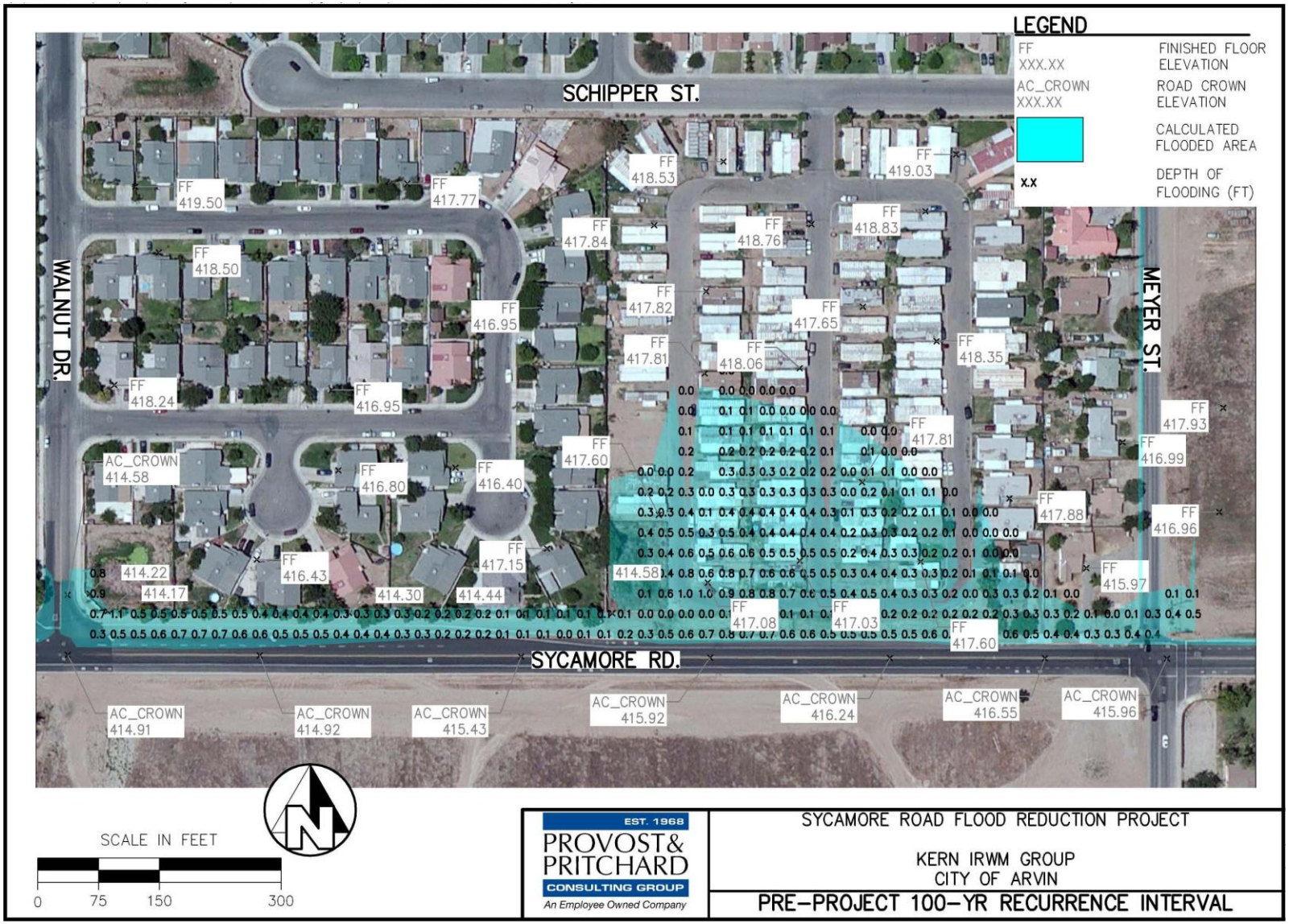
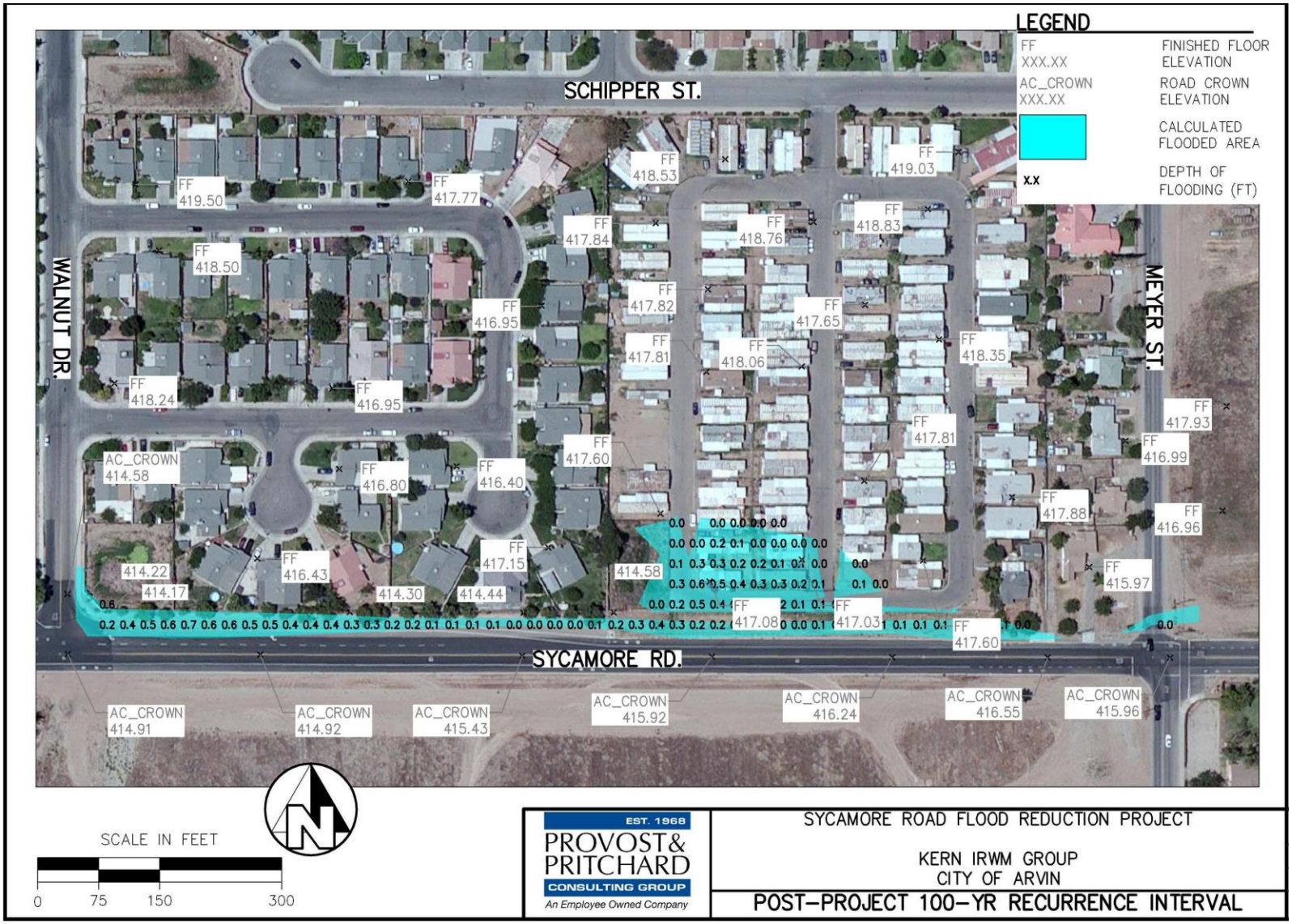


Figure 7-7 – P&P 100-year Flood Model – Post-Project



Benefit Uncertainty

The modeled flood depths for this analysis are conservative because the estimated flood elevation was assumed to have constant ponded water surface elevation as opposed to being analyzed through a hydraulic model where backwater affects would be taken into account. The presence of backwater effects was made apparent during the March 2013 event. The 50 year and 100 year event maps show that flood depths north of Meyers St. are less 0.4 feet. Based on the actual measurements at this location for the March 2013 event the depth was approximately 0.8 feet at the low point. This was observed to be the result of water backing up behind a small culvert that is located under a drive approach just west of the corner of Meyers and Sycamore. With the limited budget available from the City, a more rigorous model of the system could not be performed to achieve results closer to actual conditions.

Potential flooding impacts from a 50-year (or 100-year) event could be greater than the model estimated based on the actual results March 2013 event. Flooding could impact the nearby apartment complex on the northeast corner of Sycamore Road and Meyer Street. The following photograph from the March 2013 event shows the water surface in relation to the apartment complex; this water surface is greater than estimated through the model.

7.5.6 Secondary Benefits

There are a number of secondary, qualitative benefits from this project which are summarized below and described in greater detail in Attachment 8.

Increased Public Safety

Eliminating the flood hazard during a broad range of flood events provides a significant public safety benefit to the approximately 880 local pre-kindergarten through sixth grade school children at El Camino Real Elementary School that either walk to school or travel by vehicle through the flooded area under low-visibility conditions.

Increased local property values

Local property values are anticipated to increase as a result of the reduced flood risk with the construction of the Sycamore Road Flood Reduction Project as the occurrence and duration of inundation is significantly reduced. The parcels that flooded from the 2010 event should increase in property value as the lots will now be developable.

Protection of existing road infrastructure

Extended saturation of road ways from standing water that currently occurs in flood events will increase the rate of deterioration of the asphalt and road base. By reducing the inundation of the road way, the road surface will return to a typical life cycle reducing the frequency of repairs and ultimate replacement of the road surface.

7.5.7 Annual Project Physical Benefits

Table 7.5-1 that follows (PSP Table 9) presents the physically quantifiable annual benefits of the Sycamore Road Flood Reduction Project. The table has been completed using the information for roadway inundated for the 1-year return interval event described above because this is the event that has the probability of occurring annually.

Table 7.5-1: Sycamore Road Storm Drainage Project Annual Physical Benefits

Table 1 – Annual Project Physical Benefits Project Name: Sycamore Road Flood Reduction Project Type of Benefit Claimed: Major Road Inundated Measure of Benefit Claimed (Name of Units): Miles Additional Information About this Measure: None			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2012			
2013			
2014			
2015	0.22	0	-0.22
2016	0.22	0	-0.22
2017	0.22	0	-0.22
2018	0.22	0	-0.22
2019	0.22	0	-0.22
2020	0.22	0	-0.22
2021	0.22	0	-0.22
2022	0.22	0	-0.22
2023	0.22	0	-0.22
2024	0.22	0	-0.22
2025	0.22	0	-0.22
2026	0.22	0	-0.22
2027	0.22	0	-0.22
2028	0.22	0	-0.22
2029	0.22	0	-0.22
2030	0.22	0	-0.22
2031	0.22	0	-0.22
2032	0.22	0	-0.22
2033	0.22	0	-0.22
2034	0.22	0	-0.22
2035	0.22	0	-0.22
2036	0.22	0	-0.22
2037	0.22	0	-0.22
2038	0.22	0	-0.22
2039	0.22	0	-0.22

Table 1 – Annual Project Physical Benefits			
Project Name: Sycamore Road Flood Reduction Project			
Type of Benefit Claimed: Major Road Inundated			
Measure of Benefit Claimed (Name of Units): Miles			
Additional Information About this Measure: None			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2040	0.22	0	-0.22
2041	0.22	0	-0.22
2042	0.22	0	-0.22
2043	0.22	0	-0.22
2044	0.22	0	-0.22
2045	0.22	0	-0.22
2046	0.22	0	-0.22
2047	0.22	0	-0.22
2048	0.22	0	-0.22
2049	0.22	0	-0.22
2050	0.22	0	-0.22
2051	0.22	0	-0.22
2052	0.22	0	-0.22
2053	0.22	0	-0.22
2054	0.22	0	-0.22
2055	0.22	0	-0.22
2056	0.22	0	-0.22
2057	0.22	0	-0.22
2058	0.22	0	-0.22
2059	0.22	0	-0.22
2060	0.22	0	-0.22
2061	0.22	0	-0.22
Comments: It is assumed that the project is completed in 2014 with the benefits accruing starting in 2015 and has a 50-year life starting in 2012. Sycamore Road is assumed to be a major road.			

7.5.8 References

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