ATTACHMENT 2
Water and Energy Savings and Greenhouse Gas Emission Reductions

Water and energy savings are summarized in the DWR provided spreadsheet included as **Appendix 2.1**. Additional details and discussions are provided below.

2.1 - Water Supply Benefits

The project consists of the lining 6,477 feet of earthen canal in the Cross Valley Canal Extension Pool No. 8 (CVC Pool No. 8), substantially reducing seepage in a major conveyance canal. The water savings are documented in the seepage calculations table (see **Appendix 2.2**), which is discussed below.

Baseline Conditions

Existing baseline water associated with the project includes:

Average water deliveries in CVC Pool No. 8 = 19,298 MG/year
Average seepage losses in CVC Pool No. 8 = 841 MG/year
Average water delivered to Henry C. Garnett Water Purification Plant = 19,298 – 841 = 18,457 MG/year

Seepage is directly measured as the difference in pumping at CVC Pumping Plant No. 7 (at the upstream end of Pool No. 8) and deliveries to the Henry C. Garnett Water Purification Plant, while also taking into account five different diversions along Pool No. 8. Evaporation from the canal and direct precipitation onto the canal were also considered in the analysis. It should be noted that Improvement District No. 4 (ID4) incurs all of the seepage losses in the CVC Extension.

These seepage losses are based on data from 2004 to 2013. Although the CVC Extension operations are not directly tied to hydrological conditions, this period had an average Kern River runoff of 92% of the long-term mean April to June snowmelt runoff. Additionally, the SWP allocation for this period averaged 62%, which compares relatively well to the 2013 SWP Delivery Reliability Report's long term future conditions estimate of 58% (DWR, 2013). Therefore, the period of 2004 to 2013 is considered close to a hydrologically average period.

Water Savings

A new concrete liner is estimated to reduce seepage by 80%. This factor is based on a 10-year study by the USBR on canal linings which included seepage reduction estimates. An excerpt of this study is included as **Appendix 2.3**. The data collected by USBR showed an effectiveness ranging from 60 to 90% with a long-term effectiveness

of about 70%. With a new concrete liner and the utilization of fiberglass reinforcement embedded in the concrete, cracking of the concrete would be reduced, improving water tightness. A factor of 80% has been used in this analysis and has been applied in the summary table.

The reduction in seepage losses is estimated to be 80% x existing seepage = 80% x 841 MG/year = 673 MG/year. The new seepage rate will be 841-673 = 168 MG/year. A comparison of pre and post project deliveries is shown below (these values are used in the tables in **Appendix 2.1**):

Water requirement to meet 18,457 MG/year baseline without lining = 18,457 + 841 seepage = 19,298 MG/year
Water requirement to meet 18,457 MG/year baseline with lining = 18,457 + 168 seepage = 18,625 MG/year

Canal seepage reduces the volume of water that reached the Henry C. Garnett Water Purification Plant and treated water distribution system. – All of the water lost to seepage is from the SWP, either delivered directly through the CVC, or delivered to Kern Fan area groundwater banks, stored, and later delivered to ID4. Reducing seepage will make more efficient and effective use of SWP water. The project will conserve water, increase water supply reliability and improve drought preparedness.

Life of Project
The USBR prepared a report in November 2002 entitled "*Canal-Lining Demonstration Project Year 10 Final Report*." The report states that "concrete and earth canal linings have a typical service life of about 50 years" (see **Appendix 2.3** for more details).

Without Project Conditions
The "Without-project" conditions are assumed to be similar to historical conditions for the last 10 years of operations (2004 to 2013), which is considered close to a hydrologically average period. Seepage would continue every year with total losses averaging 841 MG/year. No other CVC Extension capacity increases or changes to the delivery pattern are planned that would affect the without-project or with-project conditions.

2.2 - Energy Benefits

Potential energy benefits can be divided into two categories:

1. Energy embedded in the water saved for the project

2. Energy embedded in the imported water for its supply and conveyance to the system

Energy embedded in water saved for the project includes a reduction in Kern Fan area groundwater bank well pumping. The project conserves energy by eliminating seepage

and subsequent Kern Fan area groundwater bank pumping to recover the seeped water.

Energy is embedded in the imported water supply, both from the SWP and groundwater banks. Energy is utilized to pump and convey this water to ID4. However, the project will not eliminate the need for water conveyance energy usage, so this is not claimed as a benefit.

Energy intensity is '*the energy consumption per unit volume of water through one or several consecutive segments of the water use cycle*'. Energy is needed to recover seeped water through operation of groundwater well pumps and four of the CVC pumping plants. The analysis below is based on 'System-specific' energy intensities in the ID4 water system. **Appendix 2.4** documents energy use for well pumps utilized by ID4, the average energy use is approximately 260 kWh/AF for a pump operating with 200 feet of total dynamic head (which is the long-term approximate average in the Kern Fan). This converts to 797 kWh/MG. Energy use at the CVC pumping plants is approximately 65 kWh/MG per plant. Each pumping plant has a similar hydraulic operating condition.

The resultant **annual average energy reduction** is estimated as:

(797 kWh + 4 x 64 kWh)/MG x 673 MG = (1057 kWh/MG) x 673 MG = 711,361 kWh

The resultant **total lifetime energy reduction** is estimated as:

711,361 kWh/year x 50 years = 35,568,050 kWh

2.3 - Greenhouse Gas Emission Reductions

The effects of climate change will likely make imported water supplies less reliable in the future. It will reduce the natural storage and re-regulation of local surface water supplies by lessening the snowpack, increasing the amount of precipitation that comes in the form of rainfall, and likely reduce the overall volume of precipitation falling on the region. The project will help to mitigate this impact by reducing greenhouse gas (GHG) emissions.

The reduction in energy required to pump water that has seeped from the canal will reduce GHG emissions. The local electrical utility, Pacific Gas and Electric (PG&E), could not provide a 'local total-output emission rate' and only provided general information on GHG emissions when local data was requested.

Appendix 2.5 is a January 2013 memorandum from the San Joaquin Valley Unified Air Pollution Control District (which covers the project location and project benefit area) discussing GHG emissions from electrical use. The memo states:

> "*each electricity supplier may purchase and provide electricity from a variety of power plants that can vary from day to day and year to year. Because of this variability, it would be impossible to establish a GHG emission factor for each electricity supplier*".

The paper provides an emission factor of 313 kg CO2e/MWh (or 0.313 kg CO2e/kWh) for use in estimating GHG emissions in the geographic area covered by the Air Pollution Control District, and states that this value is 'accepted as a reasonable estimate'. This value was therefore used in the GHG reduction calculations, and is considered the best available emission factor for the local system.

The energy savings quantified for the project is an average of 711,361 kWh/year or 35,568,050 kWh over the 50-year life of the project. This results in the following GHG emission reductions:

Annual GHG emission reductions = 711,361 kWh/year x 0.313 kg CO2e/kWh = **222,656 kg CO2e/year**

Project Lifetime GHG emission reductions = 35,568,050 kWh x 0.313 kg CO2e/kWh = **11,132,800 kg CO2e**

2.4 - Ancillary Benefits

The project will have several ancillary benefits that do not fall under the categories of water savings, energy savings or greenhouse gas emission reductions. These are briefly listed below:

1. **Prevention of Interrupted Service.** Lining CVC Pool No. 8 will reduce the risk of potential canal breeches, thereby reducing the risk of flooding, and protecting deliveries to the Henry C. Garnett Water Purification Plant on which much of the Metropolitan Bakersfield area relies for drinking water.

2. **Reduction in Damage from Canal Seepage.** Currently canal seepage is causing high groundwater levels and damage to adjacent pavement. With installation of the concrete lining it is anticipated that groundwater levels will decline and these problems will cease.

3. **Additional Operational Flexibility.** The canal lining will allow for steeper side slopes (2H:1V versus existing 3:H:1V) and increase the total storage capacity in Pool No. 8. The larger storage will increase flexibility in operations, reduce fluctuations in pool levels, and reduce the potential for overtopping.

2.5 - Regional Project Benefits.

The project will provide regional benefits by implementing a project listed in the Kern Integrated Regional Water Management Plan (IRWMP) that is also consistent with many of the regional goals provided in the Kern IRWMP (see **Attachment 1**). The

project will also provide regional benefits by conserving groundwater in the Kern Groundwater Sub-Basin, which is in a state of overdraft. The project involves conjunctive use of groundwater and surface water, which is at the heart of water management in Kern County and is the common basis for project integration and generating truly regional benefits. If a project benefits groundwater conditions in one area it almost certainly provides regional benefits in terms drought protection, reductions in conflicts, and groundwater quality improvement.

Appendices

2.1 - Estimate of Water Savings, Energy Savings, and GHG Emissions Reduction
2.2 - Canal Seepage Calculations
2.3 - USBR Canal Lining Report
2.4 - Well Power Calculation Sheet
2.5 - Air Pollution District Greenhouse Gas Emissions Memo