# Avra Valley Irrigation and Drainage District (AVIDD) Water and Energy Efficiency Improvement Program

## Funding Opportunity Announcement R13SF80003

**AVIDD**

**Marana, Arizona**

**2013**

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# Technical Proposal and Evaluation Criteria

## 1: Executive Summary

**Project Name:** Avra Valley Irrigation and drainage District (AVIDD) Water and Energy Efficiency Improvement Program
**Proposal Date:** January 17, 2013
**Applicant Name:** AVIDD
**City:** City of Tucson (nearby)
**County:** Pima County
**State:** Arizona

**Introduction:**

Avra Valley Irrigation and Drainage District (AVIDD) is a major groundwater users in Tucson Active Management Area (AMA) with a groundwater pumping rate of over 35,000 AFY. It has over 50 privately owned/leased irrigation wells, 27 of them are actively in service. Out of the 27 active wells, 14 wells are gas engine driven. Most of the wells were drilled in 50's and 60's with natural gas engines. A recent System Optimization Review (SOR), completed under Bureau of Reclamation (USBR) grant program (Grant Agreement No R11AP32070) indicated that the existing Caterpillar® natural gas engines are far exceeded their serviceable lives. These models are obsolete. The existing operating conditions of the pumping systems have changed significantly from the original design conditions and the system efficiencies have dropped dramatically below the desired range. **Modernizing the antiquating ground water pumping system is critical to the District and the region.** On the other hand, AVIDD gets renewable hydropower generated from Hoover Dam. Switching to electric motor will take better advantage of this clean hydropower. The SOR has recommended to replace the natural gas engines with electric motors, which will not only increase energy efficiency, reduce energy consumption, but also bring significant environmental benefits in Coronado National Monument west.

The SOR also evaluated the conditions of the canals and farm ditches associated to the irrigation wells via visual inspections. The existing farm ditches were in varying condition ranging from good to fair. Visual inspection revealed that most of the older ditches had multiple cracks and breakage. According to USBR's "Canal-lining Demonstration Project Year 10 Final Report", the effectiveness of seepage reduction for concrete along (good condition) is only 70% comparing to 90% for exposed geo-membrane. **Installing geo-membrane liners to the ditches will reduce seepage significantly.**

**Project Summary:**

The specific items in the proposed project and their contribution to meet the FOA goals are listed as followings:

1. Install geo-membrane (over 3 miles) to the distribution systems associated to two irrigation wells (Fox West and F19) – contributing to FOA goals: **(a) Water Conservation, Canal Lining; (b) Benefits to Endangered Species; (c) Water Market.**
2. Install flow meters to the discharge pipes of the pumps – contributing to FOA goal: **Water Conservation, Irrigation Water Measurement.**
3. Bring power to the sites – contributing to FOA goal: **Implementing Renewable Energy Projects Related to Water Management and Delivery.**
4. Replace two aging natural gas engines with electric motors, replace damaged pumps – contributing to FOA goal: **Increasing Energy Efficiency in Water Management**

The proposed budget for the entire project is $751,846. Within this budget, ditch lining is budgeted for $169,600, bringing power to the sites for $120,000 (TRICO cost) flow meters installation for $20,000, pumps/motors replacement for $320,000, engineering design and oversight for $68,150, and miscellaneous costs. Details can be found in the Project Budget Proposal under Tab E of the APPLICATION.

The proposed project is expected to be completed within 22 months after project kick-off (**Table 1-1**). The anticipated completion date is August/September 2014. This schedule will work really well allowing actual construction to happen in winter, when wells are not in use.

**Table 1-1: Tasks and Schedule**

| Tasks | FY 2013 | | | | | | FY2014 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Dec | Feb | Apr | Jun | Aug | Oct | Dec | Feb | Apr | Jun | Aug |
| Task 1: Project Management and Reporting | | | | | | | | | | | | |
| Task 2: Design | | | | | | | | | | | | |
| Task 3: Permitting and Coordination | | | | | | | | | | | | |
| Task 4: Bringing Electrical Utility Onsite | | | | | | | | | | | | |
| Task 5: Contract Solicitation | | | | | | | | | | | | |
| Task 6: Construction | | | | | | | | | | | | |
| Task7: Measuring Performance and Planning for Future Projects | | | | | | | | | | | | |

# 2: Background Data

## 2.1 Project Area and Geographic Location

AVIDD is located in Tucson Active Management Area, Southern Arizona (**Figure 2-1**). The District covers approximately 40 square miles (24,000 acres) along the Santa Cruz River and west of Interstate 10 in northern Pima County, approximately 25 miles northwest of Tucson, Arizona.

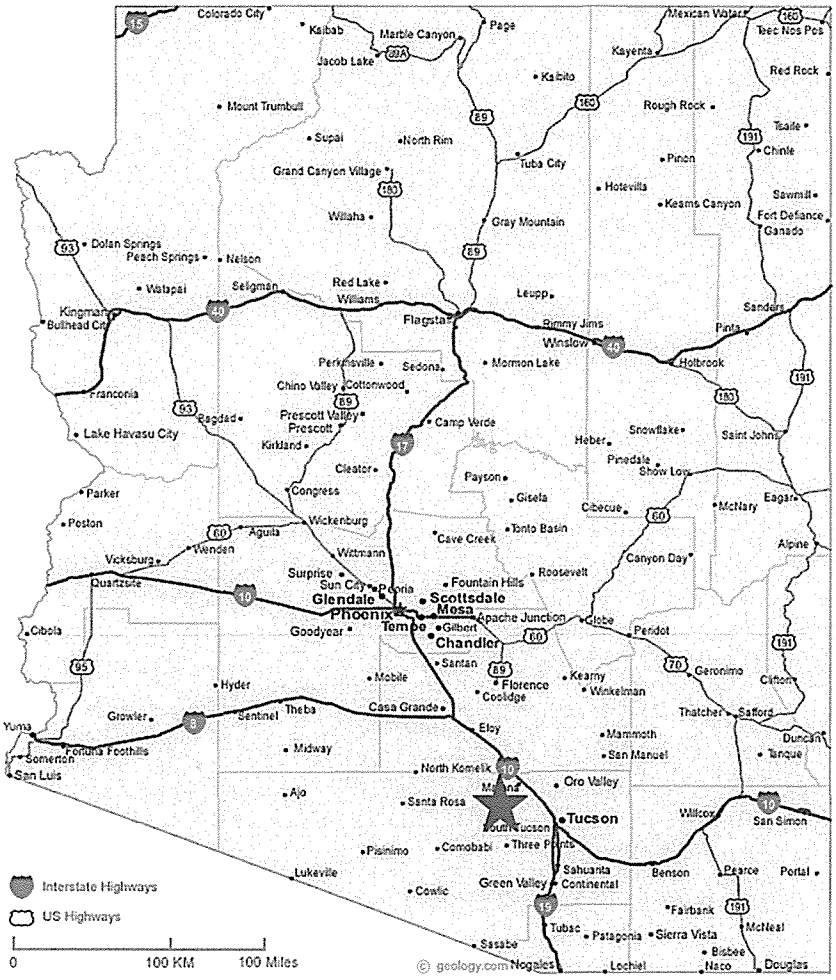



**Figure 2-1: Project Geographic Location**

## 2.2 Sources of Water and Energy Supply

### 2.2.1: Major Water Source: GroundWater

Groundwater is still the primary water source for irrigation in AVIDD, under Arizona Groundwater Rights – Irrigation Grandfathered Rights. An Irrigation Grandfathered Right confers the right to irrigate specific plots of land that had been irrigated with groundwater between 1975 and 1980 (ARS 45-462 A). The District has over 100 miles of canals/farm ditches and over 50

privately owned/leased irrigation wells with pumping capacities of 1,000 - 3,000 gallons per minute (gpm) each. In an average year, many of these pumps run approximately nine (9) months intermittently starting in January/February. Most of the wells in the District were drilled in 50's and 60's. The irrigation water demand of the District is over 35,000 AFY.

***Arizona Groundwater Management Act (GMA)***

Historically, Arizonans have pumped groundwater faster than it was replaced naturally - a condition known as "overdraft". Groundwater overdraft creates significant problems, including increased costs for drilling/pumping and the eventual loss of supply. Water quality also suffers because groundwater pumped from greater depths typically contains more salts and minerals. In areas of severe groundwater depletion, the earth's surface may sink, or "subside", causing cracks or fissures that can damage roads, building foundations, and other underground structures. Recognizing continued depletion of finite groundwater supplies as a threat to prosperity and quality of life, the Arizona Legislature created the framework to manage the state's water supply for the future.

The 1980 Groundwater Management Code (Code) has three primary goals, to:

1. Control severe overdraft occurring in many parts of the state.
2. Provide a means to allocate the state's limited groundwater resources to most effectively meet the changing needs of the state.
3. Augment Arizona's groundwater through water supply development.

To accomplish these goals, the Code set up a comprehensive management framework and established the Arizona Department of Water Resources (ADWR) to administer the Code's provisions.

In the Phoenix, Prescott, and Tucson AMAs, which include the large urban areas of the state, the primary management goal is to attain "safe-yield" by 2025. Safe-yield is defined as a long-term balance between the annual amount of groundwater withdrawn in the AMA and the annual amount of natural and artificial recharge. To reach safe yield by 2025, water users in the AMAs must offset all the groundwater uses that total more than the net natural recharge with renewable resources, like CAP water and treated wastewater effluent, or with artificial recharge. The ADWR administers the safe yield goal through a series of ten-year management plans for each AMA. The Tucson AMA is currently operating under the Third Management Plan and the Fourth Management Plan is under development. Despite positive progress toward attaining the safe yield goal, ADWR notes in its Third Management Plan: "given current projections, the AMA will **not** reach safe-yield by 2025." Although of critical importance, even if the safe yield goal were met, it would not solve

all the issues related to groundwater overdraft. Under the 1980 GMA, development may continue to mine groundwater through purchase of paper water recharge credits from CAP. State law allows for withdrawals in one part of the AMA to be offset by recharge in another, hydrologically disconnected location. Reducing groundwater mining is the best solution.

Replacing and rehabilitating aging equipment and infrastructure will Improve irrigation efficiency, prevent water loss, and eventually reduce groundwater pumping and help Tucson AMA to meet its safe-yield goal in 2025.

### 2.2.2 Secondary Water Source: Central Arizona Project (CAP) Water

***Central Arizona Project***

Central Arizona Project (CAP) (**Figure 2-2**) is designed to bring about 1.5 million acre-feet (AF) of Colorado River water per year to counties in Southern Arizona. CAP carries water from Lake Havasu near Parker to the southern boundary of the San Xavier Indian Reservation southwest of Tucson. It is a 336-mile long system of aqueducts, tunnels, pumping plants and pipelines. Is the largest single resource of renewable water supply in the State of Arizona. Water is provided to lands in Maricopa County, Pinal County, Pima County, and to several communities, including the metropolitan areas of Phoenix and Tucson.

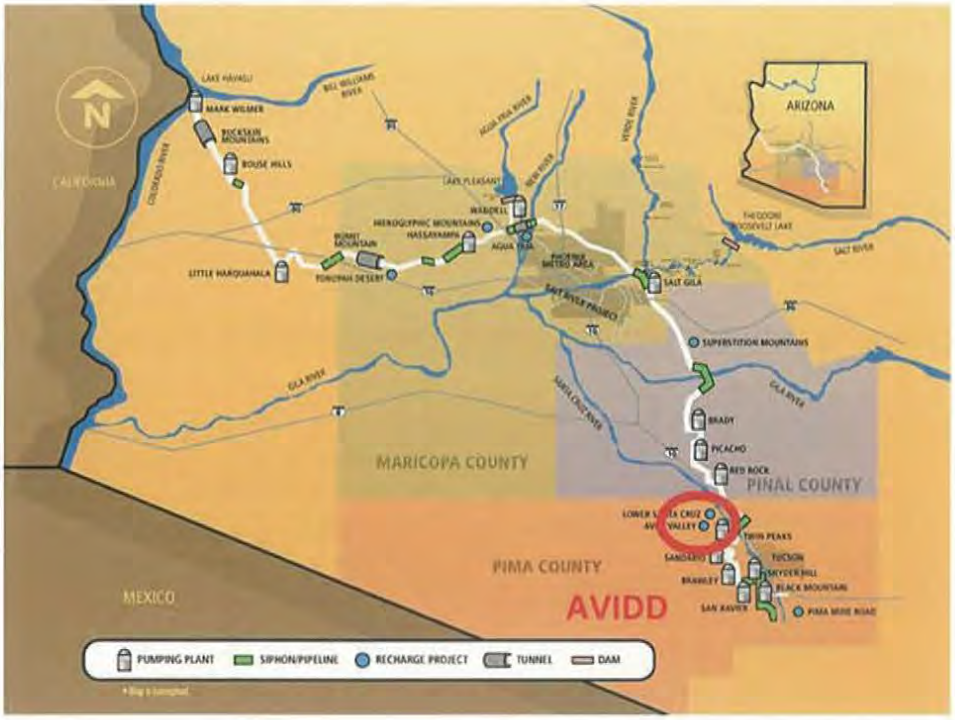



**Figure 2-2: CAP Map and the Location of AVIDD**

***CAP Water Recharge and Storage***

The current CAP allocations in the Tucson AMA are shown in **Table 2-1**. Although AVIDD has no direct contract for CAP water allocation, it has permitted as CAP water Groundwater Saving Facility (GSF) allowing CAP allocation holders to use AVIDD land to recharge and store CAP water to meet their groundwater replenishment obligation.

**Table 2-1: CAP Allocations in Tucson AMA**

Note: Please refer to: http://www.cap-az.com/Water/Allocations.aspx for more up-to-date allocation information.

| Allocation Holder | Current Allocations* |
|---|---|
| City of Tucson | 144,172 |
| Community Water Company (Green Valley) | 2,858 |
| Flowing Wells Irrigation District | 2,873 |
| Green Valley Domestic Water Improvement District | 1,900 |
| San Xavier District (Tohono O'odham Nation) | 50,000 |
| Schuk Toak District (Tohono O'odham Nation) | 16,000 |
| Pascua Yaqui Tribe | 500 |
| Town of Marana | 1,528 |
| Metropolitan Domestic Water Improvement District | 13,460 |
| Town of Oro Valley | 10,305 |
| Spanish Trail Water Company | 3,037 |
| Arizona State Land Department | 32,076 |
| Vail Water Company | 1,857 |
| Avra Water Co-op, Inc. | 808 |
| **Total** | **281,374** |

* Per CAP Subcontracting Status Report dated October, 2012

Due to the lack of surface water treatment capability in Tucson AMA, CAP water is used indirectly. While the community gradually increases its use of CAP water for potable supply, CAP water is recharged to the ground in order to accrue recharge credit so that it can be recovered from the ground storage to meet the potable water demand.

The GSF projects are farming operations that use CAP water to irrigate crops instead of pumping groundwater. Recharge credits are granted by ADWR commensurate with the volume of groundwater that is saved (not pumped) due to the use of Colorado River water for local farming. Most of the farm lands in AVIDD are permitted for CAP water recharge and storage. **Figure 2-3** and **Table 2-2** show the permitted GSFs in Tucson AMA. The permitted lands located in AVIDD are indicated in the red circle.

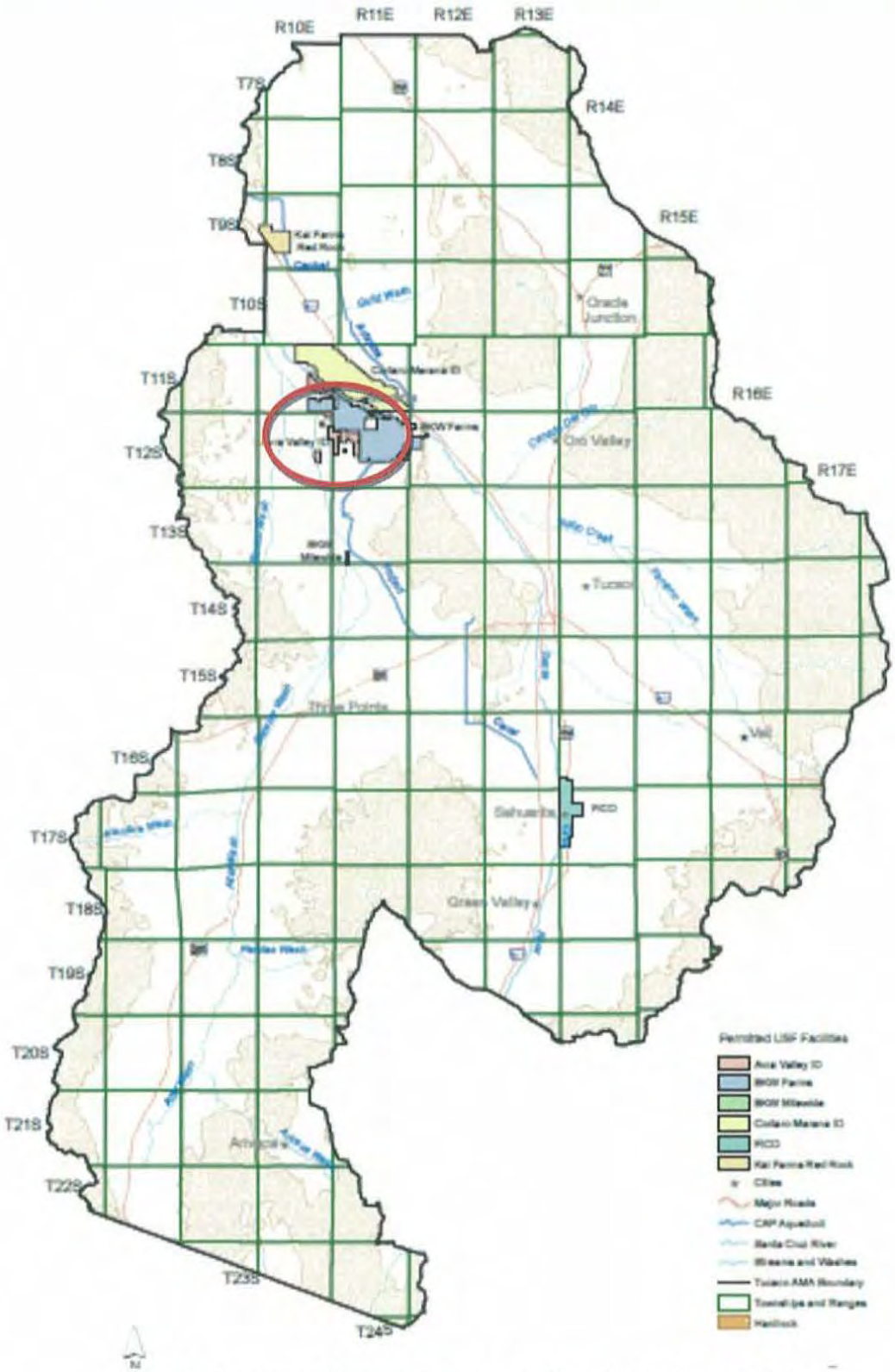



**Figure 2-3: Tucson AMA Permitted Ground Water Savings Facilities**

**Table 2-2: CAP Water Underground Storage Facilities and Groundwater Saving Facilities**

A. Underground Storage Facilities

| FACILITY NAME | FACILITY NUMBER | PERMITTEE NAME | FACILITY TYPE | PERMITTED AF/YEAR | WATER SOURCE |
|---|---|---|---|---|---|
| AVRA VALLEY | 71-564896.0001 | CAWCD | CONSTRUCTED | 11,000 | C |
| CENTRAL AVRA VALLEY STORAGE AND RECOVERY PROJECT (CAVSARP) | 71-578806.0001 | CITY OF TUCSON/TUCSON WATER | CONSTRUCTED | 80,000 | C |
| LOWER SANTA CRUZ CONSTRUCTED | 71-561366.0002 | PCFCD/CAWCD | CONSTRUCTED | 50,000 | C |
| LOWER SANTA CRUZ MANAGED | 71-591928.0000 | CITY OF TUCSON, MARANA, CMID, AVIDD, PIMA COUNTY, ET AL | MANAGED | 43,000 | E |
| MARANA HIGH PLAINS | 71-563876.0002 | PCFCD/TOWN OF MARANA | CONSTRUCTED | 600 | S,E |
| PIMA MINE ROAD | 71-577501.0001 | CAWCD | CONSTRUCTED | 30,000 | C |
| ROBSON RANCH QUAIL CREEK | 71-581379.0001 | ROBSON RANCH QUAIL CREEK | CONSTRUCTED | 2,240 | E |
| SANTA CRUZ MANAGED | 71-545944.0001 | CITY OF TUCSON/USBOR | MANAGED | 9,307 | E |
| SOUTHERN AVRA VALLEY STORAGE AND RECOVERY PROJECT (SAVSARP) | 71-211276.0000 | CITY OF TUCSON/TUCSON WATER | CONSTRUCTED | 60,000 | C |
| SWEETWATER | 71-520083.0000 | CITY OF TUCSON/TUCSON WATER | CONSTRUCTED | 6,500 | E |
| TOWN OF SAHUARITA WWTP | 71-595209.0000 | TOWN OF SAHUARITA | CONSTRUCTED | 896 | E |

B. Groundwater Savings Facilities

| PERMITEE/FACILITY NAME | FACILITY NUMBER | PERMITTED AF/YEAR | WATER SOURCE |
|---|---|---|---|
| BKW / MILEWIDE | 72-563502.0001 | 627 | C |
| BKW FARMS | 72-538133.0002 | 16,615 | C |
| CORTARO-MARANA IRRIGATION DISTRICT (CMID) | 72-538100.0004 | 20,000 | C |
| FARMERS INVESTMENT COMPANY (FICO) | 72-564465.0001 | 22,000 | C |
| KAI - AVRA | 72-564430.0001 | 12,513 | C |
| KAI FARMS - RED ROCK | 72-538093.0002 | 11,231 | C |

Notes:
C - CAP
E - Effluent
S - Surface Water
AVIDD - Avra Valley Irrigation and Drainage District
CAWCD - Central Arizona Water Conservation District
CMID - Cortaro-Marana Irrigation District
PCFCD - Pima County Flood Control District
USBOR - U.S. Bureau of Reclamation

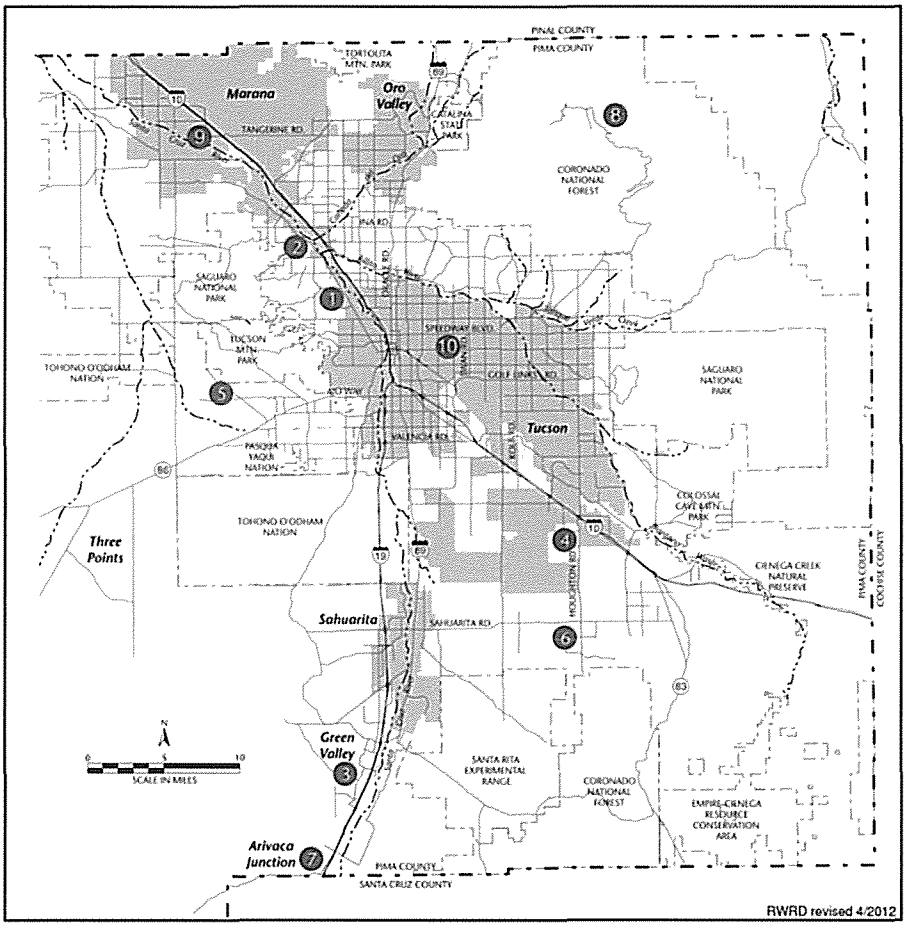
### 2.2.3 Potential Water Sources: Treated Wastewater Effluent

Pima County Regional Wastewater Reclamation Department (RWRD) owns and operates two regional wastewater reclamation facilities, Ina Road Wastewater Reclamation Facility (IRWRF) and Roger Road Wastewater Reclamation Facility (RRWRF) and eight smaller wastewater treatment plants scattered within Pima County (**Figure 2-4**). Both of the regional treatment facilities are located along Santa Cruz River. The effluents from both regional facilities are discharged into the River.

Treated wastewater effluent reuse through agricultural irrigation is designated to increase water sustainability and water conservation in AVIDD and the larger Tucson AMA as defined by ADWR. Santa Cruz River is an effluent dependent river running cross the northern boundary of AVIDD. It would be of great benefit to reuse the water in the river, which is primarily contributed by treated wastewater effluent from the two regional wastewater treatment plants in Pima County. Potentially using the treated wastewater effluent for agricultural irrigation will reduce groundwater pumping, relieve the District's groundwater dependence, and save cost on energy.

More importantly, USBR will be able to take full credits from the amount of water reused for agricultural irrigation. It will allow USBR to sell the credits to the communities, where water is needed for future development.

In 2010, RWRD treatment facilities produced a total of 68,817 AF of effluent. **Figure 2-5** shows the contributions to the total effluent by the facilities.




**Legend**

Treatment Facilities

1. Roger Road WWTP
2. Ina Road WPCF
3. Green Valley WWTP
4. Pima County Fairgrounds WWTF
5. Avra Valley WWTF
6. Corona de Tucson WWTF
7. Arivaca Junction WWTF
8. Mt. Lemmon WWTP
9. Rillito Vista WWTF
10. Randolph Park WRF

**Figure 2-4: Pima County Wastewater Treatment Facilities Location Map**

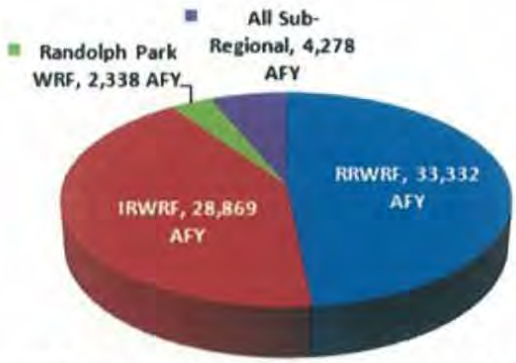



**Figure 2-5: Effluents from Pima County in 2010**
(http://www.pima.gov/wwm/about/trtmnt_map.htm)

### 2.2.4 Energy Sources – Hoover Dam Electricity and Natural Gas

***Electricity Generated from Boulder Canyon Project - Hoover Dam***

Hoover Dam is the highest and third largest concrete dam in the United States. The dam, power plant, and high-voltage switchyards are located in the Black Canyon of the Colorado River on the Arizona-Nevada state line. Lake Mead, the reservoir behind the dam, can hold the average two-year flow of the Colorado River. Hoover Dam's authorized purposes are: first, river regulation, improvement of navigation, and flood control; second, delivery of stored water for irrigation and other domestic uses; and third, power generation. Lake Mead also provides outstanding outdoor, water-based recreation opportunities, and is home to a myriad of wildlife.

The power plant is located at the toe of the dam, with wings that extend downstream 650 feet along each canyon wall. The turbines are designed to operate at heads ranging from 420 to 590 feet. The final generating unit, N-8, was installed at Hoover Dam in 1961, giving the dam a total of 17 commercial generating units. Installation of Unit N-8 brought the power plant's rated capacity to 1,850,000 horsepower. Two station-service units, rated at 3,500 horsepower each, increased the plant total to 1,857,000 horsepower. Between 1982 and 1993, the 17 commercial generating units were upgraded with new turbines, and new transformers and breakers were installed, raising the plant's capacity to its current levels of 2,991,000 horsepower.

AVIDD receives power through the Hoover Power Allocation Act (**Figure 2-6**). Hoover power is a vital power resource for consumers in Arizona, California, and Nevada. Over 29 million people rely on this **clean renewable source of energy**. Since its construction, Hoover Dam power has been allocated by Act of Congress. Hoover power was first allocated by Congress in the Boulder Canyon Project Act of 1928. In 1984, Congress again allocated Hoover power through contracts with state, municipal and utility contractors.


**Figure 2-6: Customers of Hoover Power**

***Natural Gas***

Natural gas is an important energy sources for the District. The District has over 50 irrigation wells. Most of them were drilled in 50's and 60's. The wells were originally equipped with oil lubricated, vertical turbine pumps driven by gas engines. Although, over the years, AVIDD has converted some of the natural gas engines to electric motors, the remaining are still driven by the original gas engines, which are way beyond their useful life.

One of the major objectives of this project is to modernize the ground water pumping systems, by replacing the aging natural gas engines either with new electric motors.

## 2.3 Water Use and Demand

In 2011, under a USBR grant program (No. R11AP32070), a System Optimization Review (SOR) was completed. For the purposes of the study, the entire District was generally divided in to seven sections. Geographically, Sections 1, 2, 3, 4, and 5 are closer to the Santa Cruz River, while Sections 6 and 7 are farther away from the River. The acreages of active farmlands in each section was estimated based on Pima County MapGuide® maps. Results were listed in **Table 2-3**. The land in the District is primarily used to grow cotton. Irrigation water demand was estimated under the assumption of four (4) AF water required per acre per season of cotton farming. Cotton farming season is generally nine months, from January to September. This preliminary study has shown

AVIDD currently has active farm land of 8,915 acres with an annual irrigation water demand of 35,659 AF.

**Table 2-3: AVIDD Irrigation Water Demand**

| Sections | Area of Active Farm Lands | Average Annual Water Demand (AF)[1] | Farming Season Average Monthly Water Demand (AF)[2] |
|---|---|---|---|
| 1 | 1,089 | 4,355 | 484 |
| 2 | 1,000 | 4,002 | 445 |
| 3 | 912 | 3,649 | 405 |
| 4 | 2,236 | 8,943 | 994 |
| 5 | 2,413 | 9,654 | 1,073 |
| 6 | 517 | 2,068 | 230 |
| 7 | 747 | 2,989 | 332 |
| **Total** | **8,915** | **35,659** | **3,962** |

1. Calculated based on 4 AF per acre per season and one farming season per year.
2. Farming season is about nine months, from January to September.

## 2.4 System Description

The Districts wells and irrigation systems are located in the Avra Valley Sub-basin, which is an alluvial basin with a gently sloping plan (average surface slope is 18 feet per mile) that trends south to north. In the Sub-basin, abundant groundwater occurs in the basin-fill sediments. The alluvial fill may be as much as 2,000 feet thick and is composed of inter-fingering layers of silt, sand, and gravel (Travers, 1984) that, when saturated, may yield more than 3,000 gpm of water in properly constructed wells. The slope of the groundwater surface is primarily northeastward and then northward, conforming, in general, to the slope of the land surface.

**Figure 2-7: Photos of Existing Pumps in the District**

AVIDD has over 50 privately owned/leased irrigation wells with individual capacity of 1,000~3,000gpm. AVIDD utilizes total of over 100 miles of concrete-lined open ditch distribution systems. Each well has its own distribution system or shares one with nearby well(s). A map of the irrigation wells and their distribution system is provided in **Figure 2-7**. 27 of the District wells are currently active (**Figure 2-8**), while more than 20 other wells are inactive (pumps and/or motors have been removed). The farmland that served by these inactive wells are now irrigated with CAP water.

During the SOR study, the physical conditions of the 27 active wells were visually assessed. Among the 27 active wells, 13 wells have electric motors and the remaining well pumps are gas engine driven. Ten pumps were selected for field efficiency tests based on, types of power, pump horsepower, and owner's willingness. **Table 2-4**, summarized the test sites information.

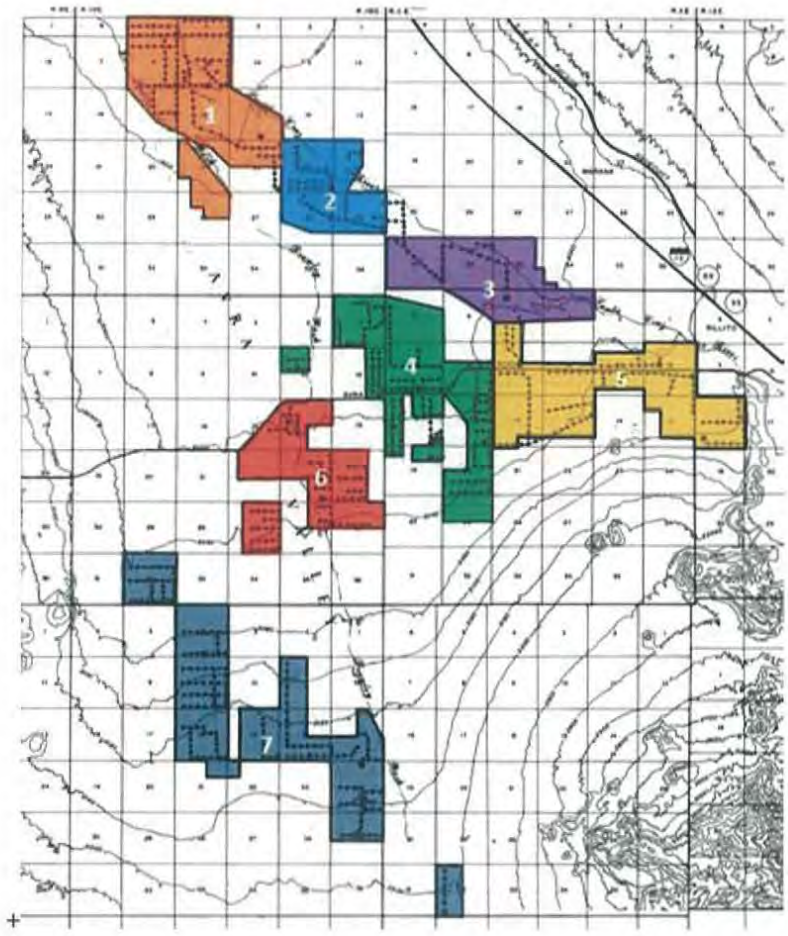



**Figure 2-8: AVIDD Existing Irrigation Wells and Distribution Systems Map**

**Table 2-4: Field-testing Sites Information**

| Well Name | ADWR Well No. (55-) | Power Type | Motor HP | Motors/Engines | Pump Model | Estimated Pump Age | Estimated Motor/Engine Age |
|---|---|---|---|---|---|---|---|
| DF East | 801333 | Electrical | 400 | US Motor | SJ14C-6 | < 1 year | >20 years |
| House Well | 615763 | Electrical | 150 | Westinghouse | SU12C-4 * | >30 years | ~ 25years after rewound |
| Hardin Road Well | 615762 | Electrical | 250 | US Motor | SJ14C-4 | ~12 years | ~ 4 years after rewound |
| Trico East | 615764 | Electrical | 250 | US Motor | SJ14C-4 | > 20 years | > 20 years |
| Trico West | 618386 | Electrical | 250 | US Motor | SG14C-4* | > 20 years | > 20 years |
| Fox West | 618382 | Natural Gas | 350 | Cat G353 | SG14C-5 | > 20 years | > 30 years |
| F72E | 618429 | Natural Gas | 375 | Cat G379 | SG14C-5 | ~5 years | > 30 years |
| F19 | 618431 | Natural Gas | 350 | Cat G353 | SG14C -6 | > 20 years | > 30 years |
| F17 E | 615837 | Natural Gas | 375 | Cat G379 | SD14C-5 | ~ 7 years | > 30 years |
| F17 W | 615838 | Natural Gas | 200 | Cat G342 | SJ14C-5 | > 25 years | > 30 years |

*Impeller trim for these sites was assumed based on available information

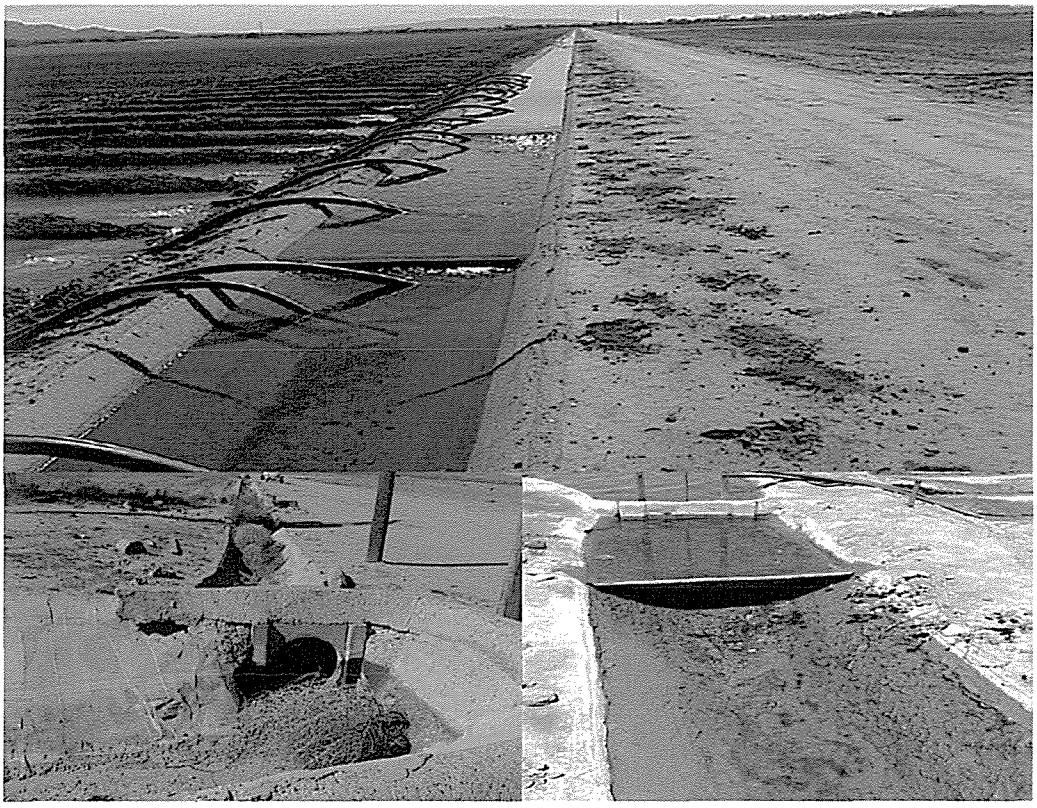


**Figure 2-9: Aging Irrigation Conveyance and Ditches**

Groundwater is typically supplied to concrete-lined farm ditches by wells and then applied to the field using siphon tubes. The observations and inspections of canals and farm ditches were made as part of the SOR. Most of the farm ditches are 24 inches with 12 inches bottom. The

conditions of the canal and ditches vary from good to fair (**Figure 2-9**). Some potions of a few ditches are in need of repair. Most of the older ditches had multiple cracks and breakage. Maintaining an older concrete ditch system is important to avoid excessive water losses during conveyance to the field. The water loss for an old ditch could be as high as 15% more compare to a ditch in good condition. Part of this proposed project is to install geo-membrane liner to distribution systems associated to the Fox West and F19.

The irrigation system in AVIDD is flood irrigation system. Flood irrigation systems are inherently inefficient due to the inability to apply low application rates. The goal of a good irrigation water management (IWM) practices is to narrow the gap of soil moisture replacement needs and application rates while maximizing crop yield. Better IWM systems will also be investigated and considered by some farms within the District.

## 2.5 Energy Efficiency Improvement and Potential Renewable Energy Sources

### 2.5.1: Improve Energy Efficiency by Replacing Old Groundwater Pumping Equipment

**Table 2-5: Field Date and estimated Pumping system Efficiency for Electric Motor Pumps**

| Site Name | HP | RPM | Flow, gpm | Head, ft | Amps | Metered Voltage, Volts | Power, KW | Power Factor | Estimated Pump Efficiency Existing, % |
|---|---|---|---|---|---|---|---|---|---|
| DF East | 400 | 1770 | 1878 | 428 | 1156 | 278 | 285 | 0.89 | 56 |
| House Well | 150 | 1770 | 1492 | 190 | 495 | 280 | 121 | 0.87 | 47 |
| Hardin Road Well | 250 | 1770 | 2427 | 196 | 771 | 276 | 182 | 0.86 | 52 |
| Trico East | 250 | 1770 | 2000 | 208 | 793 | 279 | 179 | 0.81 | 46 |
| Trico West | 250 | 1770 | 1742 | 205 | 554 | 275 | 123 | 0.81 | 58 |

**Table 2-6: Field Data and Estimated Pumping System Efficiency for Natural Gas Engine Driven Pumps**

| Site | HP | Flow, gpm | Head, ft | Gas used, therms per min | Fuel consumption in HP | Estimated Pumping Efficiency, % |
|---|---|---|---|---|---|---|
| Fox West | 350 | 1580 | 264 | 0.277 | 652 | 16 |
| F72E | 375 | 1200 | 258 | 0.276 | 651 | 12 |
| F19 | 350 | 1045 | 330 | 0.194 | 458 | 19 |
| F17 E | 375 | 1800 | 266 | 0.285 | 672 | 18 |
| F17 W | 200 | 1200 | 282 | 0.168 | 396 | 22 |

As mentioned above, most of the natural gas engines were original and installed when the well was drilled. Typical power requirements for the pumps are between 150hp to 400hp. The well

pumps, engines, electrical motors, and associated delivery systems are quite old and have far exceeded their useful lives. The operating conditions of the pumping systems have changed significantly from the original design conditions and the system efficiencies have dropped dramatically below the desired range.

The SOR have completed pumping efficiency testing for ten (10) prioritized sites (five electric and five natural gas) and provided recommendations for improvements. **Table 2-5 and 2-6** summarized the testing results. The overall pumping efficiencies of natural gas engine driven pumps (10-20%) are significantly less than the efficiencies of electric motors (45-60%). Old natural gas engines require much more maintenance than electric motors. For example, the engine requires a major overhaul every five years for over $20,000 each plus regular ware and tare and oil changes. On the contrary, electric motors require major service every ten years for $10,000 each and no need for regular oil change.

In addition, electric motors are more user-friendly and environmentally friendly. An old natural gas engine generates significant emissions of greenhouse gases. In addition, the engine oil spills and pollutes the surrounding grounds. Although these engines are not regulated under any air quality permits for agricultural purposes, replacing the engines with environmentally friendly electric motors is of great environmental benefits.

In this proposed project, the District would like to replace two existing natural gas or engines with electric motors. This change will increase the use of renewable hydropower generated at Hoover Dam. AVIDD receives power through the Hoover Power Allocation Act (**Figure 2-6**). Hoover power is a vital power resource for consumers in Arizona, California, and Nevada. Over 29 million people rely on this **clean renewable source of energy**.

## 2.6 Previous Work Relationship with Bureau of Reclamation

Established in 1984, AVIDD has long history of working with USBR both directly and indirectly. As illustrated previously, many of the AVIDD lands are permitted as GSFs to use CAP water for irrigation in lieu of groundwater. It allows CAP water rights holders to use the saved groundwater credits elsewhere within the Tucson AMA. AVIDD, together with USBR, is one of co-operators for the Lower Santa Cruz River Managed Recharge Project (LSCRMRP) as an Effluent Underground Recharge Facility (Permit No. 71-591928.0000).

AVIDD receives power from Hoover Dam Hydropower plant under Arizona Power Authority. Cover page of the power sales contract can be found in **Appendix A** of this APPLICATION. Both the Hoover Dam and CAP projects were authorized by Congress and Constructed by USBR.

In fiscal year 2011, under a grant agreement (No R11AP32070) with USBR, AVIDD completed a System Optimization Review (SOR) study to increase outdoor water conservation and improve irrigation pumping efficiency in the District, optimize District operation, reduce energy cost, and potentially reduce the agricultural dependence on the groundwater supply by improving irrigation efficiency. The improvements proposed here were recommended in the SOR.

# 3: Technical Project Description

## 3.1 Goals

The goals of the proposed project are to increase outdoor water conservation and improve irrigation pumping system energy efficiency in AVIDD, optimize District operations, reduce energy costs, and potentially reduce the agricultural demand on the groundwater supply by improving irrigation efficiency. The wells and their associated distribution systems under consideration this time are: Fox West and F19. The specific scope items are:

- Install HDPE lining in the water distribution ditches to reduce leaks.
- Replace old natural gas engines with new electric motors.
- Inspect well casing for its condition and structural integrity
- Pull and inspect the well pumps.
- Inspect well casing, perform well video logging and well brush and bail prior to installation of new well pumping equipment (optional).
- Replace the damaged well pumps.
- Install sounding tubes to the wells.
- Install new well discharge piping and install new water meter
- Verify water and energy savings.
- Planning and scheduling future project

## 3.2 Project Approach

The specific approach and methodology for the proposed project is described in the following tasks.

**Task1: Project Management and Federal Reporting**

The project team will provide the required Project Management for the successful completion of the proposed project. This will include periodic updates and meetings regarding project status, invoicing, and implementation of the various tasks. The project team will closely work with USBR project manager, District staff, property owners, and other stakeholders throughout the entire project. The project team will provide assistance to the District to meet USBR reporting requirements.

**Task 2: Design**

It is assumed that both well pumps will need replacement. In this phase, the project team (Designer) will provide:

- Basic well head design showing above grounding well piping including new appurtenances and instrumentation
- Electrical, instrumentation and controls design for the new electrical panels, if not provided by the motor manufacturer, including TRICO new electric service, transformer, meter, panel and other related electrical and instrumentation
- Design drawing will also include new well pump and motor specifications
- Review and selection of HDPE liner

Equipment specifications will be included on the design documents. Design documents will include design plans for well piping arrangement and electrical panel. Design documents will be reviewed by the District at 60% design. Comments will be addressed in the final design documents.

**Task 3: Permitting and Coordination**

Project team will assist the District to:

- Coordinate with power utility company (TRICO) regarding new power drop.
- Coordinate and obtain permits (if any) from the Pima County or Town of Marana Planning and Zoning to allow construction of power drop and electrical equipment.

**Task 4: Bringing Electrical Utility Onsite**

The District will work with TRICO to bring the electrical utility on site and coordinate with Designer as needed.

**Task 5: Contractor Solicitation**

This task is for the District to select a proper Contractor for constriction. The District will receive bid from Contractors. Project team will be responsible to answer RFIs, and assist the District during bid processes.

**Task 6: Construction**

Per engineering design, selected Contractor will install the specified equipment. For construction work related to well equipping, a preconstruction meeting will be held on-site followed by two on-site meetings during construction to inspect construction activities (one is in the middle and the other one is at the end of construction). Up to two additional site meetings will be conducted to inspect the installation of HDPE liner. Prior to construction, Designer will review and approve motor and pump submittals. The District is responsible for day to day construction site management and inspection. A minimum of one year construction warranty from the Contractor and standard equipment warranty from manufacturers are required.

**Task 7: Measuring Performance and Planning for Future Projects**

Contractor will conduct ponding tests before and after the installation of the membrane liners to verify the performance. Contractor shall also test the overall pumping efficiency for the rehabilitated well site. The testing procedure and results shall be reviewed by the project team. The project team will recommend future projects schedules.

### 3.3 Project Team

The project organizational chart is presented in **Figure 3-1**. The project team is consist of USBR project manager for overall project progress monitoring, AVIDD for providing management and field assistance, Apex Applied Technology, Inc. for day to day project management and reporting (Task 1), and Westland Resources, Inc. for design, and construction over sight.

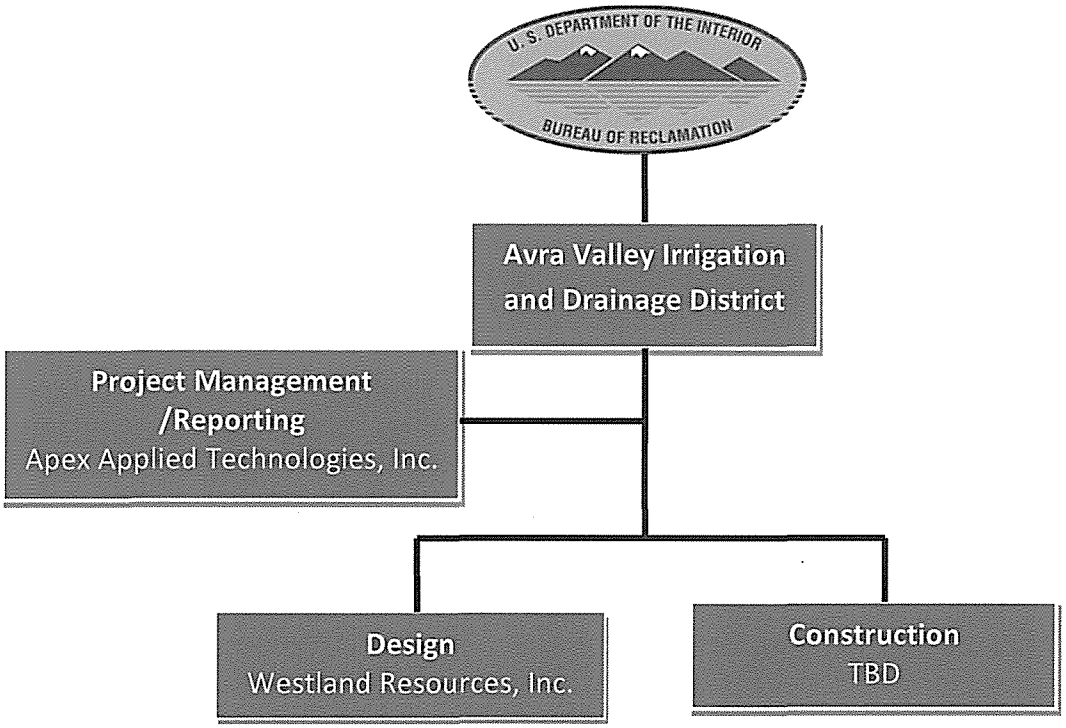



**Figure 3-1: Project Team Organization Chart**

Brief descriptions of the project team members:

**Jing Luo, PhD, PE**

-with Apex Applied Technology, Inc. will serve as project manager representing the District on this project. Jing has over 16 years of active experiences in the water and wastewater industry. She has

managed over fifty planning, design, and construction projects and has delivered total of $30M worth of projects for both public and private sectors.

**Kara Festa, PE**

-with Westland Resources, Inc. will serve as principal-in-charge of Westland's tasks. Kara has been working in the field of water and wastewater engineering since 1995. In addition to the day-to-day coordination of water and wastewater engineering issues, plan reviews, and master planning and system integration, Kara manages design, permitting, bidding, and construction projects for many types of infrastructure projects for these and other water companies, private developers, public sector, and mining clients. Her design and permitting experience includes project management and engineering design and specifications for numerous water distribution systems, booster stations, storage facilities, and wells. Kara is trained in the DOE's PSAT, which will be utilized for the analysis of electric-power well pumps in this SOR.

**Michael Caporaso**

Senior Project Manager from Westland Resources, Inc. will serve as project manager and provide oversight of Westland's tasks. Mr. Caporaso has been working in the field of hydrology, water resource management and conservation, agricultural irrigation system design, and regulatory water planning, permitting, and compliance for over 30 years. His experience includes performing agricultural irrigation system design and management for seven years with the USDA, Natural Resources Conservation Service (primarily at the Wellton-Mohawk Salinity Control Project), 15 years as the lead regulatory agricultural conservation program planner for the Arizona Department of Water Resources, and 12 years as a project manager with WestLand, specializing in water and wastewater engineering projects. Mr. Caporaso's experience includes the evaluation of agricultural irrigation system practices; the development and implementation of agricultural Best Management Practices; design, permitting, and construction of onsite wastewater treatment systems; lake design and pond lining systems; evaluation and use of reclaimed water, groundwater recharge and recovery projects; and water quality permitting and protection.

**Saqib Karori, P.E.**

-with Westland Resources, Inc. will perform the duties of project engineer. Mr. Karori has 12 years of experience in engineering services including well design, water system efficiency assessments, and construction management. He has a strong background and experience in water resources including water and wastewater system design and permitting; construction coordination and management of water treatment plants and water infrastructure; Water system energy assessments including pumping system field testing, determining upgrades to improve pumping efficiencies, efficient pump selection; profound understanding of surface and ground water

treatment process mechanics, design and costing; hands-on experience in distribution system water quality analysis and modeling; excellent bench, pilot and full scale testing work; strong technical analytical, writing and communication skills; and involvement in innovative project delivery methods. Mr. Karori has completed several short courses ranging from water system energy efficiency assessments to design and feasibility studies. He has also presented and authored technical papers and publications focusing on energy efficiencies, water treatment, infrastructure and related topics.

### 3.4 Tasks and Schedule

The District plans to complete this project in 22 months. The scope of work and the time line is outlined in **Table 3-1**. The detailed scope has been discussed previously in Section 3.2.

**Table 3-1: Tasks and Schedule**

| Tasks | FY 2013 | | | | | | FY2014 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Dec | Feb | Apr | Jun | Aug | Oct | Dec | Feb | Apr | Jun | Aug |
| Task 1: Project Management and Reporting | | | | | | | | | | | | |
| Task 2: Design | | | | | | | | | | | | |
| Task 3: Permitting and Coordination | | | | | | | | | | | | |
| Task 4: Bringing Electrical Utility Onsite | | | | | | | | | | | | |
| Task 5: Contract Solicitation | | | | | | | | | | | | |
| Task 6: Construction | | | | | | | | | | | | |
| Task7: Measuring Performance and Planning for Future Projects | | | | | | | | | | | | |

Note: Assuming project starts on October 1st, 2013.

## 4: Evaluation Criterion

### 4.1 Evaluation Criterion A: Water Conservation (28 points)

#### 4.1.1 Sub-criterion No. A.1.—Water Conservation (up to 20 pts)

#### (a)—Quantifiable Water Savings

**Describe the amount of water saved:**

***Q1: What is the applicant's average annual acre-feet of water supply?***

**A:** The District's average annual water supply is 35,000-40,000 AFY.

***Q2: Where is that water currently going (e.g., back to the stream, spilled at the end of the ditch, seeping into the ground, etc.)?***

**A:** The water currently is going to plants (primarily cotton) for agricultural production, evaporating to the atmosphere, and seeping into the ground. Safe-yield is defined as a long-term balance between the annual amount of groundwater withdrawn in the AMA and the annual amount of natural and artificial recharge. In order to reach safe-yield goal in Tucson AMA, the water extracted from ground must be offset by either natural recharge with renewable resources, like CAP water and treated wastewater effluent, or with artificial recharge.

***Q3: Where will the conserved water go?***
**A:** The conserved water will remain in ground as potable water source for future developments and other competing uses. There will be no pumping and no need for recharge to meet safe yield goal.

**Project Related Questions:**
**Canal Lining/Piping:**
Canal lining/piping projects can provide water savings when irrigation delivery systems experience significant losses due to canal seepage. The District is proposing to install 80-mil textured High Density Polyethylene (HDPE) liner to the distribution ditches of two groundwater wells (Fox West and F19). The total length of the irrigation systems is approximately 3.2 miles. General understanding, concrete lined canals may last 40-60 years (USBR, Canal-lining Demonstration Project Year 10 Final Report, 2003). With minimum maintenance provided by the District, many of the old ditches have deteriorated over the years.

***Q4: How has the estimated average annual water savings that will result from the project been determined? Please provide all relevant calculations, assumptions, and supporting data.***
**A:** According to the USBR's "Canal-lining Demonstration Project Year 10 Final Report", the seepage reduction effectiveness of concrete lining is 70%, assuming the lining is in good condition. As indicated in the "AVIDD System Optimization Review and Improvement Action Plan" (USBR Grant No. R11AP32070), a realistic estimate of conveyance water loss due to concrete lined ditches in fair to poor condition can range from 5 to 15% compare to a ditch in good condition. Considering the physical condition of the ditches in the District, 10% deterioration from a ditch in good condition is assumed for this estimate. Therefore, the effectiveness of the existing concrete lined ditches is calculated to be 63% (70% x 10% = 63%). One objective of this proposed project is to install 80-mil HDPE textured liner. The effectiveness of geo-membrane liner is 90%. Therefore, installing new HDPE liner over old concrete ditches will increase the seepage reduction effectiveness by 27% (90%-63%).

Total water delivered by Fox West and F19 is approximately 1,944 AFY. The estimated water saving is about 525 AFY, which is enough to supply a community of 3,200 residence at a water usage of 150 gallon per day per capita.

***Q5: How have average annual canal seepage losses been determined? Have ponding and/or inflow/outflow tests been conducted to determine seepage rates under varying conditions?***
**A:** As described in the previous question, the average annual canal seepage losses were estimated according to the empirical assumptions from USBR's Canal Lining Program study results (http://www.usbr.gov/pn/programs/wat/canal.html), the age, and the visual inspection results from the District's recent SOR. As part of the scope in this proposed project, ponding test(s) will be conducted before and after the lining installation to verify the conditions of the existing liners and to measure the performance of the new liners.

***Q6: What are the expected post-project seepage/leakage losses and how were these estimates determined (e.g., can data specific to the type of material being used in the project be provided)?***
**A:** The expected post-project seepage/leakage loss will be less than 10%. This is estimated according the USBR's Canal Lining Program study result for 80-mil textured HDPE liner. The anticipated life of this type of liner is 20-25 years.

***Q7: What are the anticipated annual transit loss reductions in terms of acre-feet per mile for the overall project and for each section of canal included in the project?***
**A:** The anticipated average annual transit loss reduction for the overall project is approximately 164 AFY/mile. The transit loss reduction for each section will vary from section to section. It will be verified by ponding tests of representative reaches in the section before and after the project.

***Q8: How will actual canal loss seepage reductions be verified?***
**A:** The seepage rate of a farm ditch can be estimated by conducting a ponding test with a typical section of the ditch prior to and after the project. A ponding test measures the rate at which the level of water ponded behind an earthen dam placed in the ditch drops over two (2) to twenty-four (24) hours. The area in the ditch that is wetted by the pond behind the dam must be measured. The seepage rate can be calculated as acre-feet per mile of ditch per day. The total quantity of water lost to seepage from the ditch is estimated by multiplying the seepage rate times the number of days per year the ditch is used to convey water. For example, a small farm ditch with a wetted perimeter of 5 feet and a length of 1/2 mile is found to have a seepage rate of 1.0 acre-feet per mile per day, assuming the ditch is used to carry irrigation water 40 days per year. The total seepage from the ditch is 20 acre-feet per year (1/2 x 1.0 x 40). To be accurate, evaporation need to be subtracted from the measured water loss. HDPE liners should have minimal seepage.

***Q9: Include a detailed description of the materials being used.***
**A:** 80-mil textured HDPE will be used. HDPE is special form of polyethylene that has longer carbon strings with less branching. The result is a more compactable molecule and a higher density. HDPE is available smooth or with texturing called Microspike® to increase the slip coefficient. HDPE is shipped in large rolls and mechanically deployed. All seams are made in the field using heat fusion or a tape designed for geosynthetics. HDPE is slightly less expensive than other materials, but has a higher cost of installation. It can be cost effective in large projects. HDPE should only be installed by qualified professionals.

- Standard Thicknesses: 12 mil, 20 mil, 30 mil, 40 mil, 60 mil, 80 mil, 100 mil (1 mil = 1/1000 inch)
- Maximum Panel Sizes: See HDPE Data Sheet (**Appendix C**) of this APPLICATION for roll sizes.
- Roll Width: 19' for 12 and 20 mil, 23' for all other thicknesses
- Seaming Methods: Heat Welding, Tape
- Standard Warranty: 1 Year, additional warranties available.

**Irrigation Flow Measurement:**

Irrigation flow measurement can provide water savings when improved measurement accuracy results in reduced spills and over-deliveries to irrigators. Currently, many irrigation pumps in the District have no flow meter. In this project, the District proposes to install propeller type of flow meters to the discharge pipes at their two old wells - Fox West and F19.

***Q10: How have average annual water savings estimates been determined? Please provide all relevant calculations, assumptions, and supporting data.***
**A:** Please refer to the answer for Q4.

***Q11: Are flows currently measured at proposed sites and if so what is the accuracy of existing devices? How has the existing measurement accuracy been established?***
**A:** At present time, the irrigation flow rates are not measured at the subject well sites. During the SOR study, the flow rated was measured in the irrigation channel. The accuracy is believed to be ±50%.

***Q12: Provide detailed descriptions of all proposed flow measurement devices, including accuracy and the basis for the accuracy.***
**A:** Mc Propeller flow meter, or proved equal, is proposed to be used in this application. McCrometer® has set the standard for liquid flow measurement performance, ease-of-use and value in the agricultural and turf markets since 1955. Unlike traditional propeller meters, the Mc Propeller uses a flexible drive-train and sealed ball bearings. Its unique design makes it easy to service in the field and requires no external power or batteries. The Mc Propeller is designed to comply with AWWA C704-08. Standard features include an instantaneous flow rate indicator and six-digit totalizer. There are no tight tolerances in the Mc Propeller. It handles solids suspended in water without clogging. With its high accuracy, this flow meter is also a water management tool, helping to reduce water costs, preventing over-irrigation and reducing leaching of chemicals and fertilizers into the ground. The Mc Propeller is a uniquely-designed propeller meter good for both clean and dirty water flows, and is the top-selling flow meter in the US for agriculture and turf irrigation applications.

Specifications and design features (http://www.mccrometer.com/products/product_mcpropeller.asp#):

- Accuracy: +/-2%
- Repeatability: +/-0.25%
- Turndown: up to 15:1
- Very low permanent head loss
- Mechanical instantaneous flow rate indicator and totalizer standard
- Optional electronic digital register available
- Unique magnetic coupling system, isolates register from flow
- Needs 5-10 diameters upstream, 1-2 diameter downstream
- Straightening veins to generate optimum flow profiles
- Epoxy-coated carbon steel body; all stainless available

- Pre-calibrated, corrosion-resistant polymer impeller
- AWWA approved for cold water use
- Register options: forward/reverse flow; test hand/index wheel; anti-reverse totalizer; custom scale; extended digit totalizer
- Impeller options: high temperature resistant; acid and caustic resistant
- Line sizes: from 2" to 96"

***Q13: How will actual water savings be verified upon completion of the project?***
**A:** Currently, there are no flow measurement devices at the subject wells. Therefore, the District has no way to accurately quantify water uses/savings. After the flow meters are installed, the District will monitor the pumping flow rate and run time, and then calculate the annual water use, or use totalizer. Actual water saving will be verified by the reduction of water use after the completion of the entire project comparing to historic water use data.

### (b)—Improved Water Management (up to 5 pts)

This proposed project will significantly improve water management for the District by replacing aging natural gas engines with electrical motors, which allow Variable Frequency Drives (VFD) to be installed in the future. These will allow the District to better manage (better measurement and control) the use of valuable groundwater.

**Describe the amount of water better managed:**
***Q14: For projects that improve water management but which may not result in measurable water savings, state the amount of water expected to be better managed, in acre-feet per year and as a percentage of the average annual water supply.***
**A:** The average annual water supply is the amount actually diverted, pumped, or released from storage, on average, each year. The District's average annual water demand is 35,659 AF (**Table 2-3**). The amount of water better managed is about 1,944 AF per year. Based on the following formula:

$$\frac{\text{Estimated Amount of Water Better Managed}}{\text{Average Annual Water Supply}} = \frac{1{,}944}{35{,}659} = 5.5\%$$

### 4.1.2 Sub-criterion No. A.2.—Percentage of Total Supply (4 pts)

***Q15: Provide the percentage of total water supply conserved:***
**A:** District's total average annual water supply is 35,659 AFY. Based on the following formula:

$$\frac{\text{Estimated Amount of Water Conserved}}{\text{Average Annual Water Supply}} = \frac{525}{35{,}659} = 1.5\%$$

Due to the limitation of available funding, this APPLICATION is only to modernize a small portion of the District's entire pumping and irrigation systems. If the District modernizes the entire system, it would potentially conserve over 9,500 AFY of groundwater and save over $380,000/year of

pumping cost (at $40/AF). Lots of work needs to be done. Therefore, this proposed project is extremely critical for the District.

### 4.1.3 Sub-criterion No. A.3.—Reasonableness of Costs (4 pts)

***Q16: Please include information related to the total project cost, annual acre-feet conserved (or better managed), and the expected life of the improvement.***

**A:** The reasonableness of the costs was calculated based on the following formula:

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The results are summarized in **Table 4-1**. According to USBR's Canal Lining Program study results, the expected life for HDPE liner is 20-25 years (http://www.usbr.gov/pn/programs/wat/canal.html). The specification of the material can be found in **Appendix C** of this APPLICATION. 300hp vertical electric motor from US Motor® (http://www.usmotors.com/) is proposed in this project. US Motors® brand vertical motors have been a standard in the pumping industry since 1922. These motors are recognized for their longevity, reliability and ease of use. The motors are constructed of high quality materials and are manufactured in a state-of-the-art, ISO9000-2000 facility. Innovative, performance-focused design makes this motor the most trusted in the industry. Most of electric motors currently used in the District are products of US Motor®. Typical life expectancy of these motors is 25 year. Many motors in the District have been in service for over 20 years.

**Table 4-1: Reasonableness of Costs**

| Proposed Improvements | Estimated Costs ($) | Life (years) | Water Conserved/Better Managed (AFY) | Reasonableness of Cost = Estimated Cost/(Water Saved or Better Managed X Year) |
|---|---|---|---|---|
| Install HDPE Liner for approx. 3,2 miles | $169,600 | 25 | 525 | $12.92 |
| Replace two natural gas engines/pumps with new eletrical motors/pumps | $330,000 | 25 | 1,944 | $6.79 |

Features of US Motors:

- Horsepower: 3 – 5000
- Speeds: 3600-400 rpm
- Design Voltages: 208-6900 VAC/3Phase/50 or 60Hz
- Enclosures: Weather Protected Type I, Weather Protected Type II, Totally Enclosed Fan Cooled, and Hazardous Location
- Efficiency Levels: Standard Efficient, Energy Efficient, and Premium
- Solid and hollow shaft designs for use in agriculture, turf, municipal and industrial applications.

- Normal, Medium, High and Extra High thrust capacity motors are available.

## 4.2 Evaluation Criterion B: Energy-Water Nexus (16 points)

### 4.2.1 Sub-criterion No. B.1.—Implementing Renewable Energy Projects Related to Water Management and Delivery

As described in Section 2.2.4, AVIDD receives renewable hydropower authorized by the Hoover Power Allocation Act under Arizona Power Authority. Along with over 29 million people, AVIDD is entitled to this **clean renewable source of energy**. However, many pumps in the Districts are currently driven by natural gas engines. Although, natural gas is a relatively low cost fuel, the existing engines are dated having very low efficiency (10-20%). Lots of fuel has been actually wasted. The engines also generate significant amount of emissions and cause unnecessary air pollution. In this APPLICATION, the District plans to convert two natural gas engines/pumps to electric motors/pumps in order to take the most benefit of the hydropower from Hoover Dam. Switching to electric power will also open to the opportunities of other renewable energy, such as solar or wind, when it is deemed to be cost effective.

***Q17: Describe the amount of energy capacity.***

**A:** Converting to electric motors (300hp or 223kW each), the District will increase its capacity of using Hoover Power by 446kW. Assuming the effective run time for each pump is 4 months (24 hours a day and 7 days a week), these pumps will consume over 1,280,000 kWh of hydroelectric energy per year. In another word, over 1,280,000 kWh of energy produced by fossil fuel will be substituted by hydropower.

***Q18: Describe the amount of energy generated.***

**A:** No major energy generation facility is proposed in this APPLICATION. However, the proposed improvements/modifications will enable the District to use the clean and renewable Hoover Power and open to other forms of renewable energy when it is deemed to be cost effective.

***Q19: Describe any other benefits of the renewable energy project.***

**(a) Expected environmental benefits of the renewable energy system**

**A:** Electric motors are much more user and environmentally friendly than the existing natural gas engines. (i) Most of the engines in the District have far exceeded their serviceable lives and became obsolete. The manufacturer has stopped making the model. The farmers have to purchase parts and conduct expensive overhaul every 5 years, which is not required for electric motor. (ii) Electric motor produces much less noise than the engines. (iii) Electric motors do not generate carbon emission, at the site, like the engines. (iv) Using renewable power from hydropower facility reduces overall carbon footprint.

**(b) Any expected reduction in the use of energy currently supplied through a Reclamation project**

**A:** It is anticipated that the overall energy consumption will be reduced due to the improved efficiency of the system.

**(c) Anticipated beneficiaries, other than the applicant, of the renewable energy system**
**A:** The irrigation water in AVIDD is primarily supplied by groundwater. AVIDD is one of the largest irrigation water users in Tucson AMA. Increased demand from irrigation and other types of water use may cause occasional shortfalls causing major environmental and economic impacts to the region, which is much larger than the District. Improving water sustainability and energy efficiency in the District will ultimately benefit the City of Tucson, Pima County, Town of Marana, Town of Oro Valleys, and other water and irrigation districts in Tucson AMA.

**(d) Expected water needs of the renewable energy system**
**A:** There is no additional water need for the renewable energy system.

### 4.2.2 Sub-criterion No. B.2.—Increasing Energy Efficiency in Water Management

***Q20: Describe any energy efficiencies that are expected to result from implementation of the water conservation or water management project*** *(e.g., reduced pumping).*
**A:** In this proposed project, the District plans to replace two old and inefficient natural gas engines/pumps (Fox West and F19) with efficient electric motors/pumps. Indicated in **Table 4-3**, existing pumping efficiencies for the subject natural engine pumps are below 20%. The efficiency of a new electric pump can easily be as high as 60%. It is expected that the overall energy consumption will decrease due to both reduced pumping and improved efficiency.

**(a) Please provide sufficient detail supporting the calculation of any energy savings expected to result from water conservation improvements. If quantifiable energy savings are expected to result from water conservation improvements, please provide sufficient details and supporting calculations. If quantifying energy savings, please state the estimated amount in kilowatt hours per year.**

**A:** The estimated energy savings are presented in **Table 4-2**. Water conservation improvements and energy efficiency improvements combined will contribute to energy saving of 2,635,918 kWh per year, while water conservation alone will reduce 906,461kWh per year and energy efficiency improvement along will reduced 2,369,118 kWh per year. **Tables 4-3 and 4-4** provide the details of how the energy savings were estimated.

**Table 4-2: Anticipated Energy Savings**

| Annual Energy Savings (kWh) | | Water Conservation Improvement | |
|---|---|---|---|
| | | Yes | No |
| Energy Efficiency Improvement | Yes | 2,635,918 | 2,369,118 |
| | No | 906,461 | 0 |

**Table 4-3: Energy Saving Estimates for Energy Efficiency Improvement**

| Sites | Irrigated Acreage (AC) | Water Demand (AFY) | Power (hp) | Flow (gpm) | Run Time per Year (min) | Gas Consumption (therms/min) | Existing Pumping Efficiency (%) | Total Energy Consumed per Year (therms) | Total Energy Consumed per Year (kWh) | Effective Energy (kWh) | Target Efficiency for Electrical Motors (%) | Total Energy Consumed by Electric Motor (kWh) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fox West | 224 | 896 | 350 | 1580 | 184,786.4 | 0.277 | 16% | 51,185.8 | 1,499,744.8 | 239,959.2 | 60% | 399,932.0 |
| F19 | 262 | 1048 | 350 | 1045 | 326,786.5 | 0.194 | 19% | 63,396.6 | 1,857,519.6 | 352,928.7 | 60% | 588,214.5 |
| | | | | | | | | Total: | 3,357,264.4 | | Total: | 988,146.5 |

**Table 4-4: Energy Saving Estimates for Water Conservation (reduced pumping) and Energy Efficiency Improvements**

| Sites | Irrigated Acreage (AC) | Water Demand (AFY) | Power (hp) | Flow (gpm) | Run Time per Year (min) | Gas Consumption (therms/min) | Existing Pumping Efficiency (%) | Total Energy Consumed per Year (therms) | Total Energy Consumed per Year (kWh) | Effective Energy (kWh) | Target Efficiency for Electrical Motors (%) | Total Energy Consumed by Electric Motor (kWh) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fox West | 224 | 654.08 | 350 | 1580 | 134,894.1 | 0.277 | 16% | 37365.6559 | 1,094,813.7 | 175,170.2 | 60% | 291,950.3 |
| F19 | 262 | 765.04 | 350 | 1045 | 238,554.1 | 0.194 | 19% | 46279.4981 | 1,355,989.3 | 257,638.0 | 60% | 429,396.6 |
| | | | | | | | | Total: | 2,450,803.0 | | Total: | 721,346.9 |

**(b) Please describe the current pumping requirements and the types of pumps (e.g., size) currently being used. How would the proposed project impact the current pumping requirements?**

**A:** Fox West Well Pump: Irrigates about 224 acres. It is required to pump approximately 896 AF per year of ground water. The make and model is unknown to the current farmer. Based on the output flow, the pumping water level, other irrigation pumps installed in the District, and the common use of the same pump model within AVIDD, it is believed that the well pump is a Simflo® Model SG 14C, 5 stage pump with full impeller trim (11.5 inches). The natural gas engine is a 350hp Caterpillar® Model G 353. The manufacturer has stopped making the model.

F19 Well Pump: Irrigates about 262 acres. It is required to pump approximately 1,048 AF per year of ground water. The pump installed in the well is Simmons (currently Simflo®) Model SM14L-6 pump. The pump was installed in 1987. The natural gas engine is a 300hp Caterpillar® Model G 353. The manufacturer has stopped making the model.

After HDPE lining is installed, the pumping requirements should be reduced by 27%. After the engine driven pumps are replaced by electric pumps, pumping the same amount of water will require much less energy.

**(c) Please indicate whether you energy savings estimate originates from the point of diversion, or whether the estimate is based upon an alternate site of origin.**

**A:** The energy saving estimate originates from the point of diversion.

**(d) Does the calculation include the energy required to treat the water?**

**A:** No water treatment is required for irrigation purposes.

**(e) Will the project result in reduced vehicle miles driven, in turn reducing carbon emissions? Please provide supporting details and calculations.**

**A:** The proposed project will certainly result in vehicle mile driven, man power reduction and carbon emission reduction, due to much less maintenance required by electric pumps versus natural gas pumps. In general, electric motor requires major reconditioning every ten year, while the existing natural gas engines require major overhaul ever five years. The estimated maintenance cost of electric motor is about $1,000 per year, while $4,000-$5,000 per year for natural gas engine.

**(f) Describe any renewable energy components that will result in minimal energy savings/production (e.g., installing small-scale solar as part of a SCADA system).**

**A:** Small-scale solar application will be evaluated whenever possible. However, it is not clear at this point of time.

### 4.3 Evaluation Criterion C: Benefits to Endangered Species (12 points)

***Q 21: For projects that will directly benefit federally-recognized candidate species, please include the following elements:***

***(a) What is the relationship of the species to water supply?***

**A:** Historically, water users in the Tucson AMA have relied heavily on groundwater. Continued groundwater mining has caused substantial damage to riparian environments, with an estimated loss of 85 to 95% of quality riparian habitat during the last century. AVIDD is one of the major groundwater users in Pima County. The District is fully aware of the Federal and the State listed threatened and endangered species (**Table 4-5**) that may existing in the lower Colorado River basin, within Pima County. Many of these species live in riparian areas.

***(b) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species?***

**A:** Due to the water shortage in the region, human activity is always competing with nature over the finite water resource. Water conservation projects have special meaning to the habitat of threatened and endangered species. This project will increase water conservation that is in general beneficial to the habitat of the threatened, endangered species as well as other wild lives in the area. All the design and construction work within the proposed project will take into consideration of threatened and endangers species protection.

The electric pumps cause to much less greenhouse gas emission. In addition, they produce much less noise than engines. In general, the electric pumps are much more environmentally friendly and have much less adverse affect to the wild lives in the surrounding areas.

**Table 4-5 Threatened and Endangered Species in Lower Colorado River Basin**

| Group | Name | Status | Recovery Plan Name |
|---|---|---|---|
| Amphibians | Chiricahua leopard frog (Rana chiricahuensis) | Threatened | Chiricahua Leopard Frog Recovery Plan |
| Birds | Masked bobwhite (quail) (Colinus virginianus ridgwayi) | Endangered | Masked Bobwhite Recovery Plan, Second Revision |
| Birds | American peregrine falcon (Falco peregrinus anatum) | Recovery | |
| Birds | California least tern (Sterna antillarum browni) | Endangered | Revised California Least Tern Recovery Plan |
| Birds | Yellow-billed Cuckoo (Coccyzus americanus) | Candidate | |
| Birds | Mexican spotted owl (Strix occidentalis lucida) | Threatened | Final Recovery Plan for the Mexican Spotted Owl, First Revision (Strix occidentalis lucida) |
| Birds | Southwestern willow flycatcher (Empidonax traillii extimus) | Endangered | Final Recovery Plan for the Southwestern Willow Flycatcher |
| Fishes | Gila topminnow (incl. Yaqui) (Poeciliopsis occidentalis) | Endangered | Draft Revised Recovery Plan for the Gila Topminnow |
| Fishes | Gila topminnow (incl. Yaqui) (Poeciliopsis occidentalis) | Endangered | Gila/Yaqui Topminnow (2 ssp.) |
| Fishes | Gila chub (Gila intermedia) | Endangered | |
| Fishes | Desert pupfish (Cyprinodon macularius) | Endangered | Desert Pupfish (Cyprinodon macularius) Recovery Plan |
| Flowering Plants | Acuna Cactus (Echinomastus erectocentrus var. acunensis) | Proposed Endangered | |
| Flowering Plants | Nichol's Turk's head cactus (Echinocactus horizonthalonius var. nicholii) | Endangered | Nichol's Turk's-head Cactus |
| Flowering Plants | Kearney's blue-star (Amsonia kearneyana) | Endangered | Kearney's Blue-star |
| Flowering Plants | Pima pineapple cactus (Coryphantha scheeri var. robustispina) | Endangered | |
| Flowering Plants | Huachuca water-umbel (Lilaeopsis schaffneriana var. recurva) | Endangered | |
| Mammals | Sonoran pronghorn (Antilocapra americana sonoriensis) | Endangered | Sonoran Pronghorn Recovery Criteria and Estimates of Time for Recovery Actions for the Sonoran Pronghorn: A Supplement and Amendment to the Final Revised Sonoran Pronghorn Recovery Plan |
| Mammals | Sonoran pronghorn (Antilocapra americana sonoriensis) | Endangered | |
| Mammals | Jaguar (Panthera onca) | Endangered | Recovery Outline for the Jaguar |
| Mammals | Ocelot (Leopardus (=Felis) pardalis) | Endangered | Ocelot (Leopardus pardalis) Recovery Plan, Draft First Revision |
| Mammals | Lesser long-nosed bat (Leptonycteris curasoae yerbabuenae) | Endangered | Lesser Long-nosed Bat |
| Reptiles | Northern Mexican gartersnake (Thamnophis eques megalops) | Candidate | |
| Reptiles | Sonoyta mud turtle (Kinosternon sonoriense longifemorale) | Candidate | |
| Reptiles | Tucson shovel-nosed Snake (Chionactis occipitalis klauberi) | Candidate | |
| Reptiles | Sonoran desert tortoise (Gopherus morafkai) | Candidate | |
| Snails | Rosemont talussnail (Sonorella rosemontensis) | Candidate | |

***Q 22: For projects that will directly accelerate the recovery of threatened or endangered species or address designated critical habitats, please include the following elements:***

***(a) How is the species adversely affected by a Reclamation project?***

**A:** The District does not expect the proposed project to bring any negative impact to the habitat of any the protected species.

***(b) Is the species subject to a recovery plan or conservation plan under the Endangered Species Act?***
**A:** The recovery plans of the threatened and endangered species are listed in **Table 4-5**.

***(c) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species?***
**A:** The proposed project will likely improve the status of the species that are in the neighborhood due to the reduction of air pollution and carbon emission.

### 4.4 Evaluation Criterion D: Water Marketing (12 points)

***Q 23: Briefly describe any water marketing elements included in the proposed project. Include the following elements:***
**A:** Arizona's Groundwater Management Act, passed in 1980 has a mandate that, by 2025, groundwater mining should cease in the most populous parts of the State. The law also defined safe yield as the condition, where water pumped out of the aquifer is in balance with water entering the aquifer, whether naturally or artificially. Natural recharge into many aquifers in Arizona is very limited and must be augmented by adding renewable water through specially constructed recharge facilities.

The current renewable water sources in Tucson AMA include CAP water, and treated wastewater effluent, as described in Section 2.2. Reducing groundwater pumping in the District will allow the recharge credits generated by artificial recharge of either CAP or wastewater treated effluent be marketed as potable water source for future development in the region.

***(a) Estimated amount of water to be marketed***
**A:** After the implementing the project, approximately 524 AFY of groundwater will be freed up to be market.

***(b) A detailed description of the mechanism through which water will be marketed (e.g., individual sale, contribution to an existing market, the creation of a new water market, or construction of a recharge facility)***

**A:** Groundwater is a major water source for potable water supply in Tucson AMA. Central Arizona Groundwater Replenishment District (CAGRD) was created by the State legislature to allow development to occur in areas without access to renewable water resources, by requiring that replenishment of water occur at different location from where the pumping is. New CAGRD rate schedule, effective on June 21, 2012, has indicated the approved rate in Tucson AMA is $474/AF firm for FY 12/13 and $530/AF provisional for FY 13/14.

***(c) Number of users, types of water use, etc. in the water market***
**A:** It is anticipated that the stakeholders of this water marketing opportunities are Town of Marana, City of Tucson, Metro Water, Pima County, and USBR.

***(d) A description of any legal issues pertaining to water marketing (e.g., restrictions under Reclamation law or contracts, individual project authorities, or State water laws)***
**A:** It is not expected to have restriction, because, in this case, the conserved water will be marked in an existing market – CAGRD.

***(e) Estimated duration of the water market***
**A:** After the completion of the proposed project, the water will be available all year around.

### 4.5 Evaluation Criterion E: Other Contributions to Water Supply Sustainability (14 points)

***Q24: Points may be awarded for projects that will help to expedite future on-farm irrigation improvements, including future on farm improvements that may be eligible for NRCS funding. Please address the following:***

**A:** The proposed project will certainly expedite future on-farm irrigation improvements, including those potentially qualify for other Federal funding. In fact, the District is already considering applying for NRCS funding under Environmental Quality Incentive Program (EQIP) to improve some of their irrigation systems.

***(a) Include a detailed listing of the fields and acreage that may be improved in the future.***
**A:** AVIDD has over 8,500 acres of active farmland subject to on-farm irrigation improvements. **Figure 2-8** shows the District's existing farm land, irrigation wells and distribution systems and **Table 2-3** listed the acreage of each section in the District.

***(b) Describe in detail the on-farm improvements that can be made as a result of this project. Include discussion of any planned or ongoing efforts by farmers/ranchers that receive water from the applicant.***
**A:** Water is a scarce resource in the Southwest regions of the county. In FY 2012, the District conducted a SOR (sponsored by USBR). Through the study, the farmers in the District started realizing the importance of water and energy conservation. Right now, the District is considering improving the irrigation system for a ~200 acres farmland using NRCS funding.

***(c) Provide a detailed explanation of how the proposed WaterSMART Grant project would help to expedite such on-farm efficiency improvements.***
**A:** This proposed WaterSMART Grant project will implement some of the recommendations from the SOR. If get funded, these proposed improvements will become great demonstration projects to attract more famers in the region to participate in on-farm water and energy efficiency improvement program.

***(d) Fully describe the on-farm water conservation or water use efficiency benefits that would result from the enabled on-farm component of this project. Estimate the potential on-farm water savings that could result in acre-feet per year. Include support or backup documentation for any calculations or assumptions.***

**A:** As described in the answers to Q4 and Q20, the proposed project will reduce groundwater pumping by 525 AFY and reduce energy consumption of 2,635,918 kWh. This project is only to improve water and energy efficiency of 2 out of the total of 27 active irrigation pumps in the District. Potentially if all the 27 pumps will be improved, the potential water savings will be in the neighborhood of 7,000 – 8,000 AFY. The energy consumption will also be reduced significantly.

***(e) Projects that include significant on-farm irrigation improvements should demonstrate the eligibility, commitment, and number or percentage of shareholders who plan to participate in any available NRCS funding programs. Applicants should provide letters of intent from farmers/ranchers in the affected project areas.***

**A:** A letter of intent from Mr. Tom Glover, farmer of the land affected by project area can be found in **Tab D** of this APPLICATION. He also stated that he is planning to participate in available NRCS funding programs to improve irrigation efficiency.

***(f) Describe the extent to which this project complements an existing or newly awarded AWEP project.***

**A:** Presently, there is no known existing or new AWEP project in the area.

***Q25: Points may be awarded for projects that include other benefits to water supply sustainability.***

***(a) Will the project make water available to address a specific concern? For example:***

***i. Will the project address water supply shortages due to climate variability and/or heightened competition for finite water supplies (e.g., population growth or drought)? Is the river, aquifer or other source of supply over-allocated?***

**A:** There is no doubt that this proposed project will improve water supply sustainability in the region. Historically, Arizonans have pumped groundwater faster than it was replaced naturally - a condition known as "overdraft". Groundwater overdraft creates significant problems, including increased costs for drilling and pumping and the eventual loss of supply. Water quality also suffers because groundwater pumped from greater depths typically contains more salts and minerals. In areas of severe groundwater depletion, the earth's surface may sink, or "subside", causing cracks or fissures that can damage roads, building foundations, and other underground structures.

Without artificial recharge/replenishing, groundwater is a finite water source. Improving water conservation, reducing groundwater mining will preserve groundwater supplies and

providing adequate water for population growth in the Town, the City, and the County in Tucson AMA

***ii. Will the project market water to other users? If so, what is the significance of this (e.g., does this help stretch water supplies in a water-short basin)?***

**A:** The District does not directly market water to other users. However, the proposed project will help stretch water supplies in the water-short Lower Colorado River basin indirectly. Due to the requirement of "safe yield", reduced groundwater pumping also reduces the requirement of groundwater recharge/replenishment.

***iii. Will the project make additional water available for Indian tribes?***

A: Yes. The project will benefit Indian tribes, which are close to the project area in Low Colorado River Basin.

***iv. Will the project help to address an issue that could potentially result in an interruption to the water supply if unresolved? (e.g., will the project benefit an endangered species by maintaining an adequate water supply)? Are there endangered species within the basin or other factors that may lead to heightened competition for available water supplies among multiple water uses?***

**A:** The project will help to address water shortage issue that could potentially result in an interruption to the water supplier. According to Pima County report, Continued groundwater mining has caused substantial damage to riparian environments, with an estimated loss of 85 to 95% of quality riparian habitat during the last century. AVIDD is one of the major groundwater users in Pima County. Many of threatened/endangered species live in riparian habitat. Reduce groundwater use will leave more water available for the need of riparian habitat, among multiple other water uses, in the region.

***v. Will the project generally make more water available in the water basin where the proposed work is located?***

**A:** Yes.

***(b) Does the project promote and encourage collaboration among parties?***

***i. Is there widespread support for the project?***

**A:** This project received widespread support. District has received support letter from Town of Marana and Pima County Regional Wastewater Reclamation Department. Please find the letters in **Tab D** of this APPLICATION.

***ii. What is the significance of the collaboration/support?***

**A:** The scope of improving water supply sustainability is always beyond one single agency. It is critical to collaborate with other government agencies. In SOR phase, we have got lots of support from Town of Marana, City of Tucson, and Pima County.

***iii. Will the project help to prevent a water-related crisis or conflict?***
**A:** Water is a very precious resource in this region. This project will definitely prevent water related crisis.
***iv. Is there frequently tension or litigation over water in the basin?***
**A:** Yes. There is frequently tension or litigation over water issue in the basin. For example, Town of Marana and Pima County are having unsettled lawsuits regarding the wastewater services and ownership of a local wastewater treatment plant. It has been on for over seven years.

***v. Is the possibility of future water conservation improvements by other water users enhanced by completion of this project?***
**A:** There are other irrigation districts in the area. AVIDD hopes to set a good example. The success of this project will certainly encourage other districts to improve water conservation.

***(c) Will the project increase awareness of water and/or energy conservation and efficiency efforts?***

***i. Will the project serve as an example of water and/or energy conservation and efficiency within a community?***
**A:** Yes. The proposed project will set a great example within the community.

***ii. Will the project increase the capability of future water conservation or energy efficiency efforts for use by others?***
**A:** Yes. AVIDD is willing to share good experience with other farming agencies/users.

***iii. Does the project integrate water and energy components?***
**A:** Yes. This project has both water and energy components.

## 4.6 Evaluation Criterion F: Implementation and Results (10 points)

### 4.6.1 Sub-criterion No. F.1.—Project Planning

***Q26: Does the project have a Water Conservation Plan, System Optimization Review (SOR), and/or district or geographic area drought contingency plans in place? Does the project relate/have a nexus to an adaptation strategy developed as part of a WaterSMART Basin Study)? Provide the following information regarding project planning:***

***(a) Identify any district-wide, or system-wide, planning that provides support for the proposed project. This could include a Water Conservation Plan, SOR, Basin Study, or other planning efforts done to determine the priority of this project in relation to other potential projects.***
**A:** AVIDD has developed a SOR and Improvement Action Plan (**Appendix D**)

***(b) Identify and describe any engineering or design work performed specifically in support of the proposed project.***

**A:** District has been planning on improving water conservation and energy efficiency for about two years. The SOR was conducted by professional engineering consultants. The three well pumps selected to be improved was found to be the ones with the worst physical conditions and lowest efficiency. Preliminary sizing and cost estimate was provided in the final report.

***(c) Describe how the project conforms to and meets the goals of any applicable planning efforts, and identify any aspect of the project that implements a feature of an existing water plan(s).***
**A:** The proposed project is to implement some recommendations from the AVIDD SOR and Improvement Action Plan. In addition, this project will help meeting the goals of other water agencies in the region, such as:

- City/County 2011-2015 Action Plan for Water Sustainability
- Town of Marana 2010 General Plan
- 2010 Potable Water Master Plan

### 4.6.2 Sub-criterion No. F.2.—Readiness to Proceed

*Points may be awarded based upon the extent to which the proposed project is capable of proceeding upon entering into a financial assistance agreement.*

**Q27:** ***Describe the implementation plan of the proposed project. Please include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates. (Please note, under no circumstances may an applicant begin any ground-disturbing activities—including grading, clearing, and other preliminary activities—on a project before environmental compliance is complete and Reclamation explicitly authorizes work to proceed).***
***Please explain any permits that will be required, along with the process for obtaining such permits.***
**A:** The detailed project approach/plan is described in Section 3.2 and the proposed schedule including major tasks is outlined in Section 3.3. Assuming the notice-to-proceed will be issued before October 1, 2013. District plans to take 22 months to complete this project. The actual construction is scheduled in winter time when no farming activities are ongoing. There is no intent to start the project before the completion of environmental compliance and USBR authorizing to start. As described in Section 3.2, project team will coordinate with TRICO for power connection permit and any other permits required for this project.

### 4.6.3 Sub-criterion No. F.3.—Performance Measures

***Q 28: Provide a brief summary describing the performance measure that will be used to quantify actual benefits upon completion of the project (e.g., water saved, marketed, or better managed, or energy saved).***
**A:** As described in Section 3.2, **Task 7 Measuring Performance and Planning for Future Projects** is to measure performance and quantify actual project benefits.
For canal lining, Ponding tests will be conducted before and after the farm ditch lining. Evaporation data will also be collected and subtracted from the total water loss measured. At

least two pre-project ponding tests will be preformed. One will be in August/September, which is the end of irrigation season. And the other will be in February/March which is the beginning of the irrigation season. The post ponding test will be performed after the completion of the project.

For measuring device, this project will install flow meters to the discharge pipes of the two irrigation wells, where no flow meters are exist currently. Pre-project condition, irrigation water consumption is estimated based on historic data and farmer's experience. Post-project, water consumption will be measured accurately. Post-project Water consumption data will be compared with pre-project consumption. Any rate structure changes made possible by installing the meters will be documented.

For renewable energy improvement, old natural gas engines will be replaced with new electric motors. The electricity in the District is supplied by renewable hydropower from Hoover Dam. The reduction of natural gas consumption is a great measurement of using renewable energy to replace fossil fuel.

For increasing energy efficiency in water management, the overall pumping efficiency will be tested after the completion of this project. The baseline data was collected during the SOR. The post-project pumping efficiency will be compared to the baseline data. The amount of kWh savings will be documented to the final report.

Other environmental benefits will also be measured (if possible) and documented in the final report to USBR.

### 4.7 Evaluation Criterion G: Additional Non-Federal Funding (4 points)

$$\frac{Non-Federal\ Funding}{Total\ Project\ Cost} = 60.13\%$$

### 4.8 Evaluation Criterion H: Connection to Reclamation Project Activities (4 points)

***Q 29: How is the proposed project connected to Reclamation project activities?***

**A:** Section 1.4 explains the long-standing relationship between AVIDD and USBR. In general, AVIDD is located in the Lower Colorado River basin and Central Arizona Project (CAP) service area as shown in **Figure 2-2** and **Figure 2-3**. The District has many lands permitted as CAP water underground storage facilities and GDF. AVIDD is also contracted with and utilizing the hydroelectric power generated from Hoover Dam for the irrigation well pumps powered by electrical motors.

***Q 30: Does the applicant receive Reclamation project water?***

**A:** Yes. The District receives CAP water for agricultural use and recharge.

***Q 31 Is the project on Reclamation project lands or involving Reclamation facilities?***

**A:** No. The proposed project does not directly address CAP project facility or CAP project land. However, AVIDD is right adjacent to the CAP project land.

***Q 32 Is the project in the same basin as a Reclamation project or activity?***
**A:** Yes. AVIDD is located in the same basin as the CAP service area in Tucson AMA.

***Q 33 Will the proposed work contribute water to a basin where a Reclamation project is located?***
**A:** Yes. The improvements proposed here are to reduce groundwater withdrawal in the CAP service area within the Tucson AMA.

### 5: Performance Measures

Performance measures are detailed in the answer to Q28. It will be accomplished as a stand-alone task (Task 7 in Section 3.2) in the project scope.

---The End of Technical Proposal---

# Tab C
# § Environmental and Cultural Resources Compliance
# § Required Permits and Approvals

## ENVIRNMENTAL AND CULTURAL RESOURCES COMPLIANCE

- The activities associated with the proposed project will have no expected adverse impact to the surrounding environment.
- It is not certain that any endangered species exist in the project area. However, none of the activities associated to the proposed project will potentially affect them in any adverse manner.
- The proposed project activities will not affect any wetland inside the project area.
- It is not anticipated the project activities will involve modification or affect the individual features of the water systems.
- There are no known buildings, structures, or features in the project area listed or eligible for listing on the National Register of Historic Places.
- Provided the rich archeological activities in the area, it is likely there are archeological sites in the area of the proposed project area. However, the project activities will only associate existing well site. A clearance letter will be obtained from the State Historic Preservation Officers (SHPO) before the start of the construction.

# REQUIRED PERMITS AND APPROVALS

Permits and approvals will be obtained during Design Phase, prior to Construction Phase.

# Tab D
§ Letters of Project Support
§ Official Resolution


TOWN OF MARANA
WATER DEPARTMENT

January 9, 2013

Bureau of Reclamation
Acquisition Operations Group
Mail Code: 84-27810
P.O. Box 25007
Denver, CO 80225

Dear Bureau of Reclamation,

The Town of Marana Utilities Department strongly supports the Avra Valley Irrigation and Drainage District (AVIDD) Water and Energy Improvement Program.

As an incorporated town in rural Pima County, the Town of Marana promotes and encourages the importance of water and energy conservation within the Lower Colorado River basin. Large area of the AVIDD is located within the Town of Marana. The Town and the District are close partners on many projects. Both Town of Marana and the District have registered underground storage facilities and groundwater saving facilities for CAP water in the Tucson AMA.

As the Town of Marana and AVIDD work cooperatively on the above activities, the importance of water conservation in our basin continues to be evident. We fully understand that water and energy are precious resources and both the Town and the District are working to conserve these important commodities. This proactive conservation project will assist the Town and the region in its long term sustainability.

Sincerely,

John P. Kmiec
Utilities Director
Town of Marana, AZ

5100 W. INA ROAD ■ TUCSON, ARIZONA 85743 ■ PH: (520) 382-2570 ■ FAX: 382-2590 ■ TTY: 382-3499

**PIMA COUNTY**
**REGIONAL WASTEWATER RECLAMATION DEPARTMENT**
201 NORTH STONE AVENUE
TUCSON, ARIZONA 85701-1207

**JACKSON JENKINS**
DIRECTOR

PH: (520) 740-6500
FAX: (520) 620-0135

January 9, 2013

Bureau of Reclamation
Acquisition Operations Group
Mail Code: 84-27810 P.O. Box 25007
Denver, CO 80225

To Whom It May Concern:

I am writing this letter to express my strong support for Avra Valley Irrigation and Drainage District's (AVIDD) WaterSMART program proposal. Pima County Regional Wastewater Reclamation Department (PCRWRD) owns and operates ten wastewater reclamation facilities and a conveyance system including over 3,000 miles of sewer main and over 30 pump stations within Pima County. PCRWRD has always worked with Avra Valley Irrigation and Drainage District on various issues.

PCRWRD, a major Department of Pima County, is very concerned about groundwater conservation. Historically, water users in the Tucson AMA have relied heavily on groundwater. Over the past 30 years, the use of renewable supplies has increased; the use of reclaimed water has also increased. However, continued groundwater mining has caused substantial damage to riparian environments, with an estimated loss of 85 to 95% of quality riparian habitat during the last century. In 2010, the City of Tucson Mayor and Council and the Pima County Board of Supervisors initiated a multi-year study of water and wastewater infrastructure and developed 2011 -2015 action plan for water sustainability. The ultimate goal of these efforts are to assure a sustainable community water source given continuing pressure on water supplies caused by population growth and the environment.

The Avra Valley Irrigation and Drainage District (AVIDD) is one of the major groundwater users in Pima County. AVIDD pumps over 30,000 AFY to meet its irrigation needs. The WaterSMART program from the Bureau of Reclamation provides an excellent assistance to the irrigation districts, such as AVIDD, to identify, prioritize, and implement projects that will reduce groundwater pumping, increase efficiency, and achieve "water-safe" in the Lower Colorado River Basin. We believe this grant will provide invaluable assistance to the District and the water users in the region.

Your consideration in the matter is greatly appreciated.

Sincerely,

Jackson Jenkins, Director
Pima County Regional Wastewater Reclamation Department

BOR re: Avra Valley Irrigation and Drainage District-182.jj

Mr. Tom Glover
P O Box 232
Marana, AZ 85653

1/14/2013
Bureau of Reclamation
Acquisition Operations Group
Mail Code: 84-27810
P.O. Box 25007
Denver, CO 80225

Dear Ms. Michelle Maher,

This is Tom Glover. I am a board member of the Arva Valley Irrigation and Drainage District (AVIDD). I am also the farmer of the land, which will be directly affected by the project. I am writing this letter to support the submission of this grant application.

Water is a valuable resource, especially in Arizona. It has special meaning to farmers like us. Water shortage is a serious problem that all the farmers in the State are facing. Fox West and F19 are two major wells, which we use to irrigate a total of 500 acres of farm land. Both of the well pumps were driven by natural gas engines. The existing pumps were installed over 20 years ago and the engines are at least 30 years old. These natural gas engines are so old that the manufacturers do not make them anymore. We have to buy parts and perform an overhaul every 5 years. It costs over $20,000 each time. I am looking forward to having these pumps replaced.

I am also very interested in upgrading our existing irrigation systems to produce more commodities using less water. I would like to participate in on-farm improvement for water and energy conservation through programs like EQIP, AWEP, or REAP if they make economic sense.

Your consideration is greatly appreciated.

Best Regard,

Tom Glover

Tom Glover

AVRA VALLEY IRRIGATION AND DRAINAGE DISTRICT
P O BOX 2305

CORTARO, ARIZONA 85652

**Resolution G-001**

Now therefore, be it resolved that the Board of Directors of the Avra Valley Irrigation and Drainage District (AVIDD) agrees and authorizes that:

1. The Board of Directors of AVIDD has reviewed and supports the proposal submitted;

2. The AVIDD hereby is capable of providing the amount of funding and/or in-kind contributions, specified in the funding plan; and

3. If awarded for a WaterSMART grant, AVIDD will work with the Bureau of Reclamation to meeting established deadlines for entering into a cooperative agreement.

Dates: January 14, 2013.

John Kai, Jr., President

# Tab E

## § Project Budget Proposal:

### Funding Plan and Letters of Commitment
### Budge Proposal
### Budge Form SF-424D

# PROJECT BUDGET PROPOSAL

## 1. Funding Plan and Letter of Commitment

**(1) How you will make your contribution to the cost share requirement, such as monetary and/or in-kind contributions and source funds contributed by the applicant (e.g., reserve account, tax revenue, and/or assessments).**

**A:** The non-reclamation share of the project will be contributed as a combination of monetary ($396,460) and in-kind ($38,152).

**(2) Describe any in-kind costs incurred before the anticipated project start date that you seek to include as project costs. Include:**

**A:** No in-kind cost incurred before the anticipated project start date will be included as project costs.

**(3) Provide the identity and amount of funding to be provided by funding partners, as well as the required letters of commitment.**

**A:** The non-Reclamation share of the project cost will be raised by the District. No third party fund is planned at current time.

**(4) Describe any funding requested or received from other Federal partners. Note: other sources of Federal funding may not be counted towards your 50 percent cost share unless otherwise allowed by statute.**

**A:** No funding has been requested from other Federal agencies on this project.

**(5) Describe any pending funding requests that have not yet been approved, and explain how the project will be affected if such funding is denied.**

**A:** Currently, there is no pending funding request.

**Table 1: Summary of non-Federal and Federal funding sources**

| Funding Sources | Funding Amount |
|---|---|
| Non-Federal Entities: | |
| AVIDD | $406,460 |
| AVIDD (in-kind)* | $38,152 |
| Non-Federal Subtotal: | $452,056 |
| | |
| Other Federal Entities: | |
| | $0 |
| Other Federal Subtotal: | $0 |
| Required Reclamation Funding: | $299,790 |
| Total Project Funding: | $751,846 |

# 2. Budget Proposal

**Table 2: Funding Sources**

| Funding Sources | Percent of Total Project Cost | Total Cost by Source |
|---|---|---|
| Receipient Funding | 60.13% | $452,056 |
| Reclamation Funding | 39.87% | $299,790 |
| *Other Federal Funding | 0.00% | $0 |
| Total: | 100.00% | $751,846 |

**Table 3: Budget Proposal**

| BUDGET ITEM DESCRIPTION | COMPUTATION | | Quantity Type | Total Cost | USBR Costs | District Costs |
|---|---|---|---|---|---|---|
| | $/Unit | Quantity | (hours/days) | | | |
| SALARIES AND WAGES | | | | | | |
| District Project Manager (in-kind) | $46.00 | 220 | hours | $10,120 | | $10,120 |
| District Personnel (in-kind) | $38.00 | 440 | hours | $16,720 | | $16,720 |
| FTINGE BENEFITS - 30% | | | | | | |
| District Project Manager (in-kind) | $13.80 | 220 | hours | $3,036 | | $3,036 |
| District Personnel (in-kind) | $11.40 | 440 | hours | $5,016 | | $5,016 |
| TRAVEL | | | | | | |
| Trip 1- Visit USBR Office | $3,000.00 | 2 | People | $6,000 | | $6,000 |
| EQUIPMENT | | | | | | |
| SUPPLIES/MATERIAL | | | | | | |
| Office Supplies | | | | $1,500 | | $1,500 |
| CONTRACTUAL/CONSTRUCTION | | | | | | |
| Apex Applied Technology, Inc. | $80.00 | 160 | hours | $12,800 | $12,800 | |
| Westland Resources, Inc. | $135.00 | 410 | hours | $55,350 | $55,350 | |
| TRICO | | | | $120,000 | $31,200 | $88,800 |
| Contractor 1 -Liner | | | | $169,600 | $67,840 | $101,760 |
| Contractor 2 - Pump/Motor, flow meter | | | | $340,000 | $132,600 | $207,400 |
| OTHER | | | | | | |
| Permitting | | | | $1,000 | | $1,000 |
| Reporting (in-kind) | $49.40 | 66 | hours | $3,260 | | $3,260 |
| TOTAL DIRECT COSTS | $3,373.60 | | $0.00 | $744,402 | $299,790 | $444,612 |
| INDIRECT COST -1 % | | | | $7,444 | | $7,444 |
| TOTAL PROJECT COST | | | | $751,846 | $299,790 | $452,056 |

## 3. Budget Narrative

**A. Personnel** – The District President will manage the project. District manager and staff will be required to participate for design review and construction management and inspection.

---

**B. Fringe Benefits** – Fringe benefits are average 30% of salary costs and include basic health, insurance, and vacation/sick time allowance costs.

---

**C. Travel** – Travel is expected to be in the normal course of daily business. One trip of two District staff is budgeted to visit USBR Denver Office.

---

**D. Equipment** – The proposed project is a typical design and construction project. No equipment is required in the design phase. All the equipment required in the construction phase will be provided by the selected Contractors.

---

**G. Consultants/Contracts** – Two consulting firms will be obtained to complete the proposed project. Budget break down by task is detailed in Table 3 above.

---

**H. Other Costs** – Office suppliers of $1,500 has been budgeted. It includes the expenses in the office for the purposes of this project. It includes printing, postage, express mail, etc.
We don't expect any environmental permitting is required for this project.

---

**I. Indirect Costs** – We have budget 1% of indirect costs. This involves some unexpected indirect expenditures.

---

# 4. Budget Form

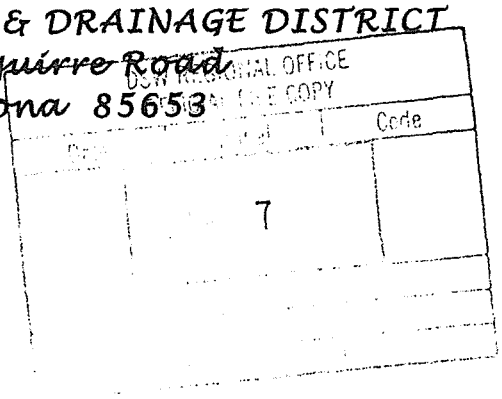
**SF-424 D is under Tab A**

# Tab F
# § Appendixes

# APPENDIX A

## Power Sales Contract

AVRA VALLEY IRRIGATION & DRAINAGE DISTRICT
14901 North Aguirre Road
Marana, Arizona 85653




January 27, 2005

Mr. J. Tyler Carlson
Regional Manager - Desert Southwest Region
Western Area Power Administration
Post Office Box 6457
Phoenix, Arizona 85005-6457

Re: Comments on Parker-Davis Project - Post 2008 Resource Pool Procedures and Supplement to Application for 1 Megawatt of Parker-Davis Project Power

Dear Mr. Carlson:

The Avra Valley Irrigation and Drainage District, Pima County, Arizona, (District) is a political subdivision of the State, organized and existing under the laws and the Constitution of the State of Arizona. It is a qualified applicant which comes under Paragraph II of General Eligibility Criteria set forth in the Federal Register concerning the Post 2008 marketing of the Parker-Davis Project Resource Pool. It is a distributor of electric energy to the irrigation pumps of its landowners through its agent, Trico Electric Cooperative and is a utility.

The District believes that having given first consideration under II(B) to entities who do not have a contract with Western for federal power resources or are not a member of a parent entity with such a contract, that Western amend its criteria and reserve the right to take into account special circumstances and unique considerations that may justify consideration to other classes of qualified applicants. The District believes it has special circumstances justifying an allocation of one megawatt of Parker Davis Project power to it to maintain the economic viability of its irrigation pump owner customers. Currently, the District receives only 610 kW of hydropower, and cannot serve five (5) of is twelve (12) customers.

The District generally agrees with the criteria set forth in under Paragraph III - General Allocation Criteria in the Federal Register publication.

Concerning Paragraph IV General Contract Principles, except for the following, the District believes those are acceptable.

a. Payment in Advance: It should be clearly stated in the Contract that any payment in advance will be payment of the monthly power bills no more than two (2) months in advance, and will not be a blank check for Western to require additional payments.

b. General Power Contract Provisions: Concerning the GPCPs and standard provisions in the sales contracts, particularly the concept of Section 12 in the proposed Parker-Davis Contract, those provisions should be worded so that it is clear that before any power is taken from a contractor or an allocation under contract is reduced that the contractor has sufficient notice, opportunity to comment and participate in a discussion, and has an

opportunity to cure any defects and to exhaust any appeals before losing any power resource under contract.

c. General Allocation Criteria - The economic viability of irrigated agriculture within the District is threatened by the lack of Federal power for use by all of the landowner pumps in the District. The cost of gas as an alternative fuel supply is prohibitive and uneconomical and threatens continued survivability of District agriculture. The District landowners have fifteen (15) pumps which are served with natural gas. The price of gas makes irrigated agriculture by these fifteen (15) pumps not economically viable. An additional one (1) megawatt of Federal Power is needed and the District requests an allocation of at least one (1) megawatt of Parker-Davis Project power from the pool.

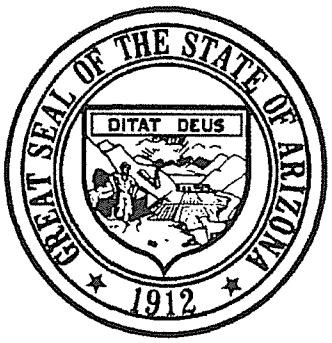
Sincerely,

AVRA VALLEY IRRIGATION & DRAINAGE DISTRICT

By _____

# APPENDIX B

## CAP Recharge Permit




# ARIZONA DEPARTMENT OF WATER RESOURCES

# GROUNDWATER SAVINGS FACILITY PERMIT

PERMIT NO. 72-216383.0000

STATE OF ARIZONA )ss.
)
COUNTY OF MARICOPA )

This is to certify that I have examined Application No. 72-216383.0000 and have determined that it meets the requirements of Title 45, Chapter 3.1, Article 2, for a Groundwater Savings Facility Permit. This permit amends and renews groundwater savings facility permit no. 72-564430.0000. The Director hereby grants authority to the Permittee to operate a groundwater savings facility, subject to the following limitations and conditions.

## Permit Limitations

Permittee:

Herb Kai
P. O. Box 550
Rillito, Arizona 85654-0550

| | |
|---|---|
| Recipients: | Holder or lessors of the Grandfathered Groundwater Rights listed on Attachment A of this permit, currently the following persons:<br><br>Herb Kai<br>P. O. Box 550<br>Rillito, Arizona 85654-0550<br><br>Thomas B. Glover<br>P.O. Box 6<br>Marana, Arizona 85238<br><br>James E. Glover<br>P.O. Box 6<br>Marana, Arizona 85238<br><br>Andrew Bowden<br>6301 North Anway<br>Marana, Arizona 85653 |
| Management Area: | Tucson |
| Sub basin: | Avra Valley |
| Grandfathered Groundwater Rights under which Groundwater Withdrawals will be curtailed: | See Attachment A |
| Wells operated by Recipient from which Groundwater Withdrawals will be Curtailed: | See Attachment B |
| Maximum Savings at Facility: | 9709.46 acre-feet per annum, subject to Condition 10 of this Permit |
| Permit Effective Date: | January 5, 2010 |
| Permit Expiration Date: | January 5, 2015 |

## Permit Conditions

1. The permittee shall deliver in lieu water to the Recipients, who have agreed to use the water delivered to the facility directly in lieu of groundwater on a gallon-for-gallon substitute basis.

2. The facility shall be operated pursuant to the documents comprising the Plan of Operation included in the Application for Groundwater Savings Facility Permit, dated May 2, 1997, and the Addendum to Application "Kai - Avra Groundwater Savings Facility," dated November 19, 1997, which are incorporated into this permit; however, to the extent that the Plan and the Addendum are inconsistent with the limitations and conditions of this permit, the limitations and conditions override the Plan of Operation and the Addendum.

3. The in lieu water delivered to the facility shall be measured with measuring devices approved by the Arizona Department of Water Resources.

4. The facility shall continue to meet the requirements of A.R.S. § 45-812.01 during operation of the facility.

5. The annual report shall be submitted no later than March 31 following the end of each completed annual reporting period. The first annual reporting period shall be from January 1, 2009 through December 31, 2009. Subsequent annual reporting periods shall be January 1 through December 31. The annual report shall include a copy of each Recipient's Annual Groundwater Withdrawal and Use Report indicating each Recipient's total groundwater pumping for the year and the amount of groundwater pumped by each well operated by each Recipient.

6. The annual report shall also include the following information:

   a. The amount of groundwater, the amount of in lieu water and the total amount of water used pursuant to each of the Grandfathered Groundwater Rights listed on Attachment A during the calendar year.

   b. The total amount of water used at the facility during the calendar year.

   c. The total amount of any source of water other than in lieu and groundwater delivered to and used at the facility.

7. The Plan of Operation incorporated into this permit may be subject to modification, depending upon the water storage permits that become affiliated with this storage facility permit and upon other circumstances.

8. For each year during the duration of this permit, if a recipient uses no more water than is specified for the Grandfathered Groundwater Right on Attachment A to this permit, the

Department will presume that the in lieu water used pursuant to that right has replaced groundwater use on a gallon-for-gallon basis at the facility. If one recipient uses water pursuant to more than one Grandfathered Groundwater Right listed on Attachment A during the year in a unified agricultural operation, the amounts specified on Attachment A for those rights shall be added, and if no more water is used in the unified agricultural operation than the sum for those rights, the Department will presume that in lieu water used pursuant to those rights has replaced groundwater on a gallon-for-gallon substitute basis at the facility.

9. In determining the volume of non-groundwater supplies used at the facility during a year that is eligible for storage, NIA pool water, in the volume defined below, shall be considered reasonably available. The reasonably available volume is defined as that amount of the NIA pool water allocated to the recipients by CAWCD for the year, not to exceed the volume set in CAWCD's *Supplemental Policy for Marketing of Excess Water for Non-Indian Agricultural Use – 2004 through 2030* and *Program for Allocation of the Ag Pool and Associated Conditions for Participation as a Groundwater Savings Facility,* adopted by the CAWCD Board of Directors on December 5, 2002. Additional NIA pool water made available by CAWCD through an annual reallocation process and used by the recipients shall not increase the total allowable water use.

If, during the year, all or a portion of the reasonably available NIA pool water is declined by the recipients, a volume of in-lieu water equal to the declined portion of the reasonably available NIA pool water shall be deemed ineligible for storage. In-lieu water delivered to the recipients during the year in excess of the declined portion shall be eligible for storage so long as it replaced groundwater that otherwise would have been pumped, and meets all other requirements and limitations set forth in this permit.

10. The Department will issue long-term storage credits in an amount equal to the amount of in lieu water that is presumed under paragraph 8 to have been used on a gallon-for-gallon substitute basis for groundwater, except as provided in paragraph 9. For in lieu water delivered to the facility that exceeds the amount that is presumed under this permit to have been used on a gallon-for-gallon substitute basis for groundwater, no long-term storage credits shall be issued, unless it is established to the satisfaction of the Director through additional evidence presented by the permit holder that an additional amount of in lieu water replaced groundwater pumping at the facility.

*Witness my hand and seal of office this 5th day of January, 2009.*

Sandra Fabritz-Whitney, Assistant Director

## Attachment A

| **Groundwater Rights Within External Boundaries Of Facility Under Which Groundwater Withdrawals Will Be Curtailed:** | **Total Allowable Water Use (All sources)** |
|---|---|
| 58-107034.0000 | 161.70 AF/Annum |
| 58-107035.0000 | 1597.44 AF/Annum |
| 58-112041.0000 | 727.05 AF/Annum |
| 58-112042.0000 | 320.76 AF/Annum |
| 58-109175.0000 | 652.32 AF/Annum |
| 58-108941.0002 | 1428.00 AF/Annum |
| 58-109179.0002 | 4595.40 AF/Annum |
| 58-109115.0003 | 226.79 AF/Annum |

## Attachment B

| **Wells operated by Recipients from which Groundwater Withdrawals will be curtailed:** | | |
|---|---|---|
| **Well Registration Number** | **Location** | **Owner** |
| 55-615837 | D 12-11 17 ADD | AZ State Land Department |
| 55-615838 | D 12-11 17 BDD | AZ State Land Department |
| 55-618382 | D 12-10 12 DCD | John & Herbert Kai |
| 55-618383 | D 12-10 12 DDA | John & Herbert Kai |
| 55-618389 | D 12-10 01 CCD | Herbert Kai |
| 55-618390 | D 12-10 01 DCC | Herbert Kai |
| 55-618429 | D 12-11 07 CDD | John & Herbert Kai |
| 55-618430 | D 12-11 20 ADD | Avra Plantations, Inc |
| 55-618431 | D 12-11 18 CBB | John & Herbert Kai |
| 55-618432 | D 12-11 19 BBC | John & Herbert Kai |
| 55-621363 | D 12-10 23 DC0 | J. B. White, Jr |
| 55-621364 | D 12-10 23 AC0 | J. B. White, Jr |
| 55-621668 | D 12-11 19 ACC | J. E. Glover, Jr |
| 55-622101 | D 12-11 18 DBC | T. B. Glover |

# APPENDIX C

## HDPE Specification Sheet

AccuGeo

SPECIFICATION SHEET

Toll Free (800) 955-4637 www.AccuGeo.com
Ph. (661) 321-0447 Fax (661) 321-0449
321 Industrial St. Bakersfield, CA 93307

# High Density Polyethylene (HDPE)- Microspike®

| Property | Test Method | Values | | | |
|---|---|---|---|---|---|
| Thickness (mils nominal) | ASTM 5199 | 40 | 60 | 80 | 100 |
| Thickness (mils minimum) | ASTM 5199 | 38 | 57 | 76 | 95 |
| Asperity Height (mils nominal) | GRI GM12 | 16 | 16 | 16 | 16 |
| Density (g/cm^3 minimum) | ASTM D792, Method B | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Strength at Yield (lbs/in. width) | ASTM D6693, Type IV - 2 in./minute | 88 | 132 | 176 | 220 |
| Tensile Strength at Break (lbs/in. width) | ASTM D6693, Type IV | 88 | 132 | 176 | 220 |
| Elongation at Yield (%) | ASTM D6693, Type IV | 13 | 13 | 13 | 13 |
| Elongation at Break (%) | ASTM D6693, Type IV | 350 | 350 | 350 | 350 |
| Tear Resistance (lbs) | ASTM D 1004 | 30 | 45 | 60 | 72 |
| Puncture Resistance (lbs) | ASTM D4833 | 90 | 120 | 150 | 180 |
| Carbon Black Content (%) | ASTM D4218 | 2 - 3 | 2 - 3 | 2 - 3 | 2 - 3 |
| Carbon Black Dispersion (Category) | ASTM D5596 | 10 views: 9 views in Cat. 1 or 2 and 1 view in Cat. 3 | | | |
| Stress Crack Resistance (Single Point NCTL) | ASTM D 5397, Appendix | 300 hrs | 300 hrs | 300 hrs | 300 hrs |
| Oxidative Induction Time (minutes) | ASTM D3895, 200°C, 1atm $O_2$ | ≥100 | ≥100 | ≥100 | ≥100 |
| Melt Flow Index (g/10 minutes) | ASTM D1238, 190°C, 2.16kg | ≤1.0 | ≤1.0 | ≤1.0 | ≤1.0 |
| Oven Aging<br>with HP, OIT, (% retained after 90 days) | ASTM D5721<br>ASTM D5885, 150°C, 500psi 02 | 80 | 80 | 80 | 80 |
| UV Resistance<br>with HP, OIT, (% retained after 1,600 hrs) | GRI GM11<br>ASTM D5885, 150°C, 500psi $0_2$ | 20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C<br>50 | | 50 | 50 |

## Supply Information (Standard Roll Dimensions)

| Thickness (mils) | Width (ft) | Length (ft) | Approximate Area (SqFt) |
|---|---|---|---|
| 40 | 23 | 710 | 16,330 |
| 60 | 23 | 505 | 11,615 |
| 80 | 23 | 385 | 8,855 |
| 100 | 23 | 310 | 7,130 |

*NOTES: 1.) All rolls are supplied with two slings. 2.) All rolls are fitted with a 6 inch ID HDPE core. 3.) Special roll lengths are available upon request. 4.) All roll lengths and widths have a tolerance of ±1%.*

# APPENDIX D

## AVIDD System Optimization Review (SOR)