THE SUSTAINABILITY OF IRRIGATED AGRICULTURE IN THE LOWER COLORADO RIVER REGION

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ABSTRACT

There are some 160,000 acres of irrigated agriculture in the region of the Lower Colorado River from below Imperial Dam to the Mexican border. Included in this region are seven irrigation districts, 6 in Arizona and 1 in California, and these districts presently operate on a run-of-the-river basis, diverting waters from the Colorado River and returning flows to the river through agricultural drains and groundwater flows.

Demand for water is increasing in the region due to urbanization, particularly the rapidly growing City of Yuma but also the cities of San Luis, Somerton and Wellton, Arizona. Mexico also diverts large volumes of surface water and increasingly relies on groundwater pumping to meet it water needs. The region presently has areas of groundwater excess, where drainage wells and open drains are needed to relieve high groundwater tables, and areas of declining groundwater tables, especially near the border areas with Mexico and potentially along the lower Gila River. Treaty requirements negotiated with Mexico regulate salinity of return flows to the river, resulting in much water being bypassed to the Santa Clara slough in Mexico and potentially being desalted on a large scale basis by the Yuma Desalting Plant in the future.

Sustainability of irrigated agriculture over the long term for this region will depend on many factors, including (1) the overuse of groundwater supplies, especially along the lower Gila River and along the Mexican border area; (2) the reduction in surface water supplies due to water conservation; (3) reduction in groundwater recharge as flood events on the Colorado and Gila Rivers become even more infrequent with continued construction of upstream flood control storage; and (4) general impacts on agriculture and water rights from conversion of agricultural lands to urban uses.

INTRODUCTION

Geographic Area

The Lower Colorado River area as used in this paper is the area in both Arizona and California from Imperial Dam, about 20 miles north of the city of Yuma, Arizona, to the southerly Mexican border about 20 miles south of Yuma (Figure 1.) Included in this Lower Colorado River area are the run-of-river irrigation districts that divert water from the Colorado River along with municipal users of Colorado River water and users of groundwater in the recharge area of the Colorado River.

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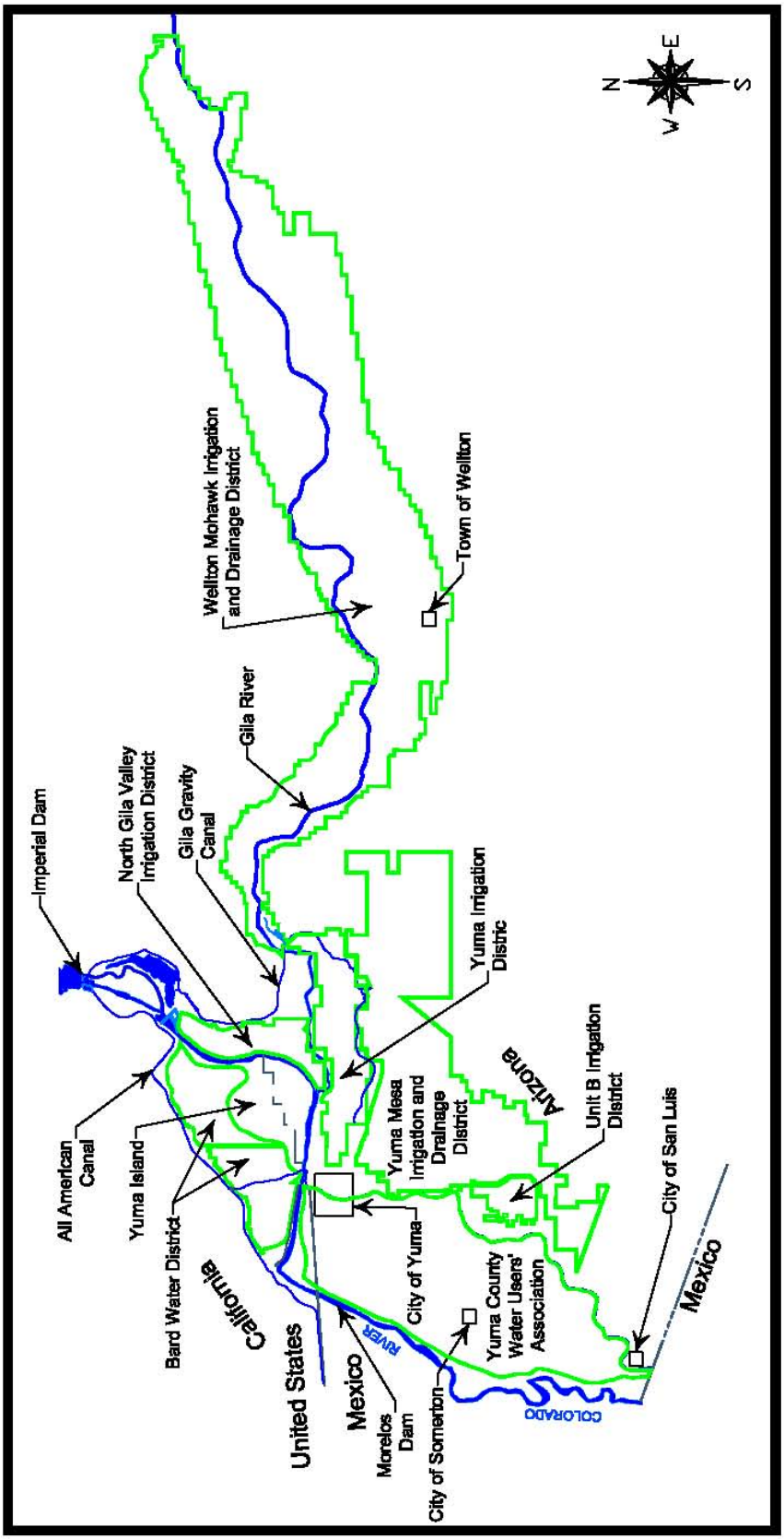

Figure 1. Location Map

Not fully included in the study area but of importance on the area wide hydrologic balance are the out-of-basin diversions of Colorado River water to Mexico and the Imperial Valley, eventually draining to the Salton Sink, and the run-of-river diversions to Mexico that are diverted in the study area but are linked hydrologically more to lands further south in the delta region of the Colorado River.

The geographic area also includes the lower 50 miles of the Gila River, a major river draining much of central and southern Arizona, parts of western New Mexico and a area of northern Mexico. This stretch of the Gila River is irrigated with surface water diverted from the Colorado River.

Major Water Users of the Study Area

The seven principal irrigation districts in the study area are Bard Water District (BWD) in California and in Arizona the North Gila Valley Irrigation Drainage District (NGVID), Wellton-Mohawk Irrigation and Drainage District (WMIDD), Unit B Irrigation District (Unit B), Yuma Irrigation District (YID), Yuma Mesa Irrigation and Drainage District (YMIDD) and the Yuma County Water Users' Association (YCWUA). Between these seven districts some 160,000 acres of agricultural lands are irrigated by surface water diversions. Note that not all these are irrigation districts in the legal sense (for example, BWD is a State of California Water District and the YCWUA are organized as a Water Users' Association) but for the sake of simplicity they are all referred to as irrigation districts in this paper.

The major municipal water users in the study area are the City of Yuma, the City of San Luis, the City of Somerton, and the Town of Wellton, all in Arizona. Other municipal water users include the unincorporated town of Winterhaven in California, the Quechan Indian Reservation, mostly in California, the Cocopah Indian Reservation in Arizona (including the North, West and East Reservations) and various unincorporated area with residential, commercial or industrial developments. Water use by these users includes both the diversion of surface water from the Colorado River and the use of groundwater.

Diversions to California's Imperial Valley are made by the All-American Canal from Imperial Dam. While these are primarily out of basin flow, with any resulting return flows ending up in the Salton Sea, the canal itself loses flows to seepage as it passes by the Bard Valley and these seepage losses eventually contribute as return flows to the Colorado River.

Water use by Mexico consists of both surface water diversions at Morelos Dam, a diversion dam roughly due west of the City of Yuma, of groundwater pumping west of the Colorado River between the northerly and southerly Mexican borders (referred to as the Northerly International Border, NIB, and the Southerly International Border, SIB, with the Colorado River between the two referred to as the Limitrophe Section) for agricultural uses, and water pumping south of the SIB for agricultural and municipal uses. The surface water diversion are primarily used for agriculture in the Mexicali Valley, and as there exists a drainage divide within the Mexicali Valley, return flows

either go northerly via the New and Alamo Rivers to the Salton Sea (out of basin) or go southerly to return to the Colorado River as it nears the Gulf of California.

It should be noted that all United States diverters of surface flows of Colorado River water have water right entitlements with the US Bureau of Reclamation and the states of Arizona or California. Groundwater users may or may not have entitlements to Colorado River water.

Water Supply Sources

The major water surface water supply sources in the study area are the mainstream Colorado River and the flows of the Gila River. The Colorado River is regulated by the upstream dams (primarily Hoover and Glen Canyon Dams) and flows are normally released to the Yuma area based on water orders submitted to the US Bureau of Reclamation. Flood flows occur infrequently due to the release of upstream flow from the dams as they near capacities and also minor flood flows occur when local runoff enters the Colorado below Hoover Dam.

Water supply from the Gila River above the study area is the result of infrequent but often significant flood releases from upstream reservoirs in Central Arizona. These releases occur rarely, perhaps occurring only once a decade, but when they do occur, they often have a duration of many months and can result in significant recharge of the aquifers along the lower Gila River. The Gila River is not used as a surface water supply source.

Ground water supplies are available in the alluvial aquifers bordering the Colorado and Gila Rivers throughout the study area. These supplies are a combination of a base storage component that pre-dates the modern use of Colorado River water for irrigated agriculture and of a recharge component from surface water irrigation. Many studies of the hydrogeology of the Lower Colorado River area have been conducted, most recently by US Geological Survey as Scientific Investigations Report 2006–5135 (Dickinson, et al., 2006)

Return Flows

The return flows to the Colorado River in this area are an important part of the overall hydrologic accounting, being accredited to the entitlements of the various water right holders.

Return flows in the study area occur either through drainage canals and pipelines flowing directly to the Colorado River, drainage canals flowing to Mexico, or groundwater recharge that in turn eventually returns to the Colorado River or is used by other water users. There are many groundwater drainage wells that pump return flows to the drain systems. It should be noted that return flows in the study area, particularly groundwater return flows, are of higher total dissolved solids content than Colorado River water and thus return flows may not be productively used (such as flows to the Santa Clara Slough

as discussed below) or are delivered to Mexico in accordance with the requirements of the Mexican Treaty and thus are limited in quantity by the treaty.

CURRENT AGRICULTURAL WATER USE

The net agricultural water use by each of the seven irrigation districts in the study along with agricultural users outside of the irrigation districts varies considerably depending on many factors. The net use and the factors affecting this use are presented below for each of these districts and other major users.

In reviewing the agricultural water users, the first described are the two pure run-of-river districts, Bard Water District and North Gila Valley Irrigation District. These districts have relatively simple water supply and return flow regimes, both being fed from and draining directly to the Colorado River. Next the described are the interconnected districts of Yuma Irrigation District, Yuma Mesa Irrigation and Drainage District, Unit B Irrigation District and the Yuma County Water Users' Association. Two of these districts, Yuma Mesa and Unit B, are on mesa lands above the other two districts and contribute return flows to the two valley districts, Yuma Irrigation District and the Yuma County Water Users' Association. The Yuma County Water Users' water usage is also affected by their neighbor to the west and south, Mexico. Lastly, the Wellton-Mohawk Irrigation and Drainage District is perhaps the most self-contained of the districts, having both valley and mesa lands, handling its own drainage and return flows, and further having the potential for groundwater recharge from the Gila River should groundwater levels decline from excess use.

Water use and physical data about the irrigation districts cited below are primarily from the U.S. Bureau of Reclamation's project Yuma Project and Gila Project web sites (www.usbr.gov) and from the Arizona Department of Water Resources web site (www.azwater.gov). Water rights data is primarily from the summaries contained in "Updating the Hoover Dam Documents" (Nathanson, 1978).

Bard Water District (BWD)

The Bard Valley is the floodplain land on the California side of the Colorado River from just a few miles below Imperial Dam and then north and west of the City of Yuma. Bard Water District is the operating agency for Reservation Division of the U.S. Bureau of Reclamation's Yuma Project. The Reservation Division consists of two units, the Bard Unit, an area of privately owned lands, and the Indian Unit, lands that are a part of the Quechan Indian Reservation. There are about 14,700 acres of irrigated land in Bard Water District.

BWD has Colorado River water rights with a priority date of 1905 for lands in the Bard Unit and 1884 for the Indian Unit. These water rights are beneficial use rights and thus not strictly quantified though the Bard Unit has listed for it a present perfected right of 21,162 acre-feet and the Indian Unit has water rights that were set at a diversion of 51,616 acre-feet but that are also still litigated.

Water use in district for the 2008 calendar year consisted of total diversions from the Colorado River of 89,914 acre-feet, total measured and unmeasured return flows of 44,680 acre-feet and total consumptive use of 45,234 acre-feet. Measured return flows are collected in open drains and are affected by All-American Canal seepage, seepage from agricultural lands, and in years of high Colorado River flows, the generally high water table caused by the river. Unmeasured return flows are generally bank flows seeping into the adjacent Colorado River.

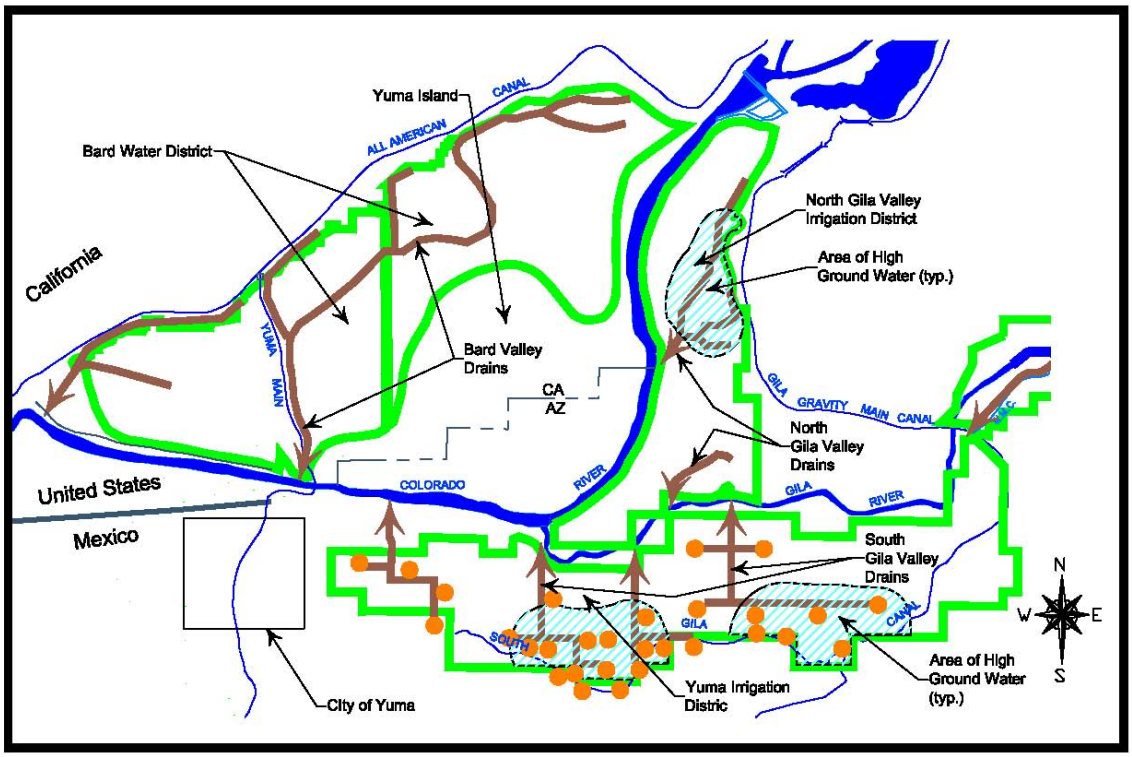

Figure 2. Bard Water District, North Gila Valley Irrigation District and Yuma Irrigation District

Within BWD is very little groundwater use and very little urban development. The small town of Winterhaven, California is included in the boundaries of the District but it has shown little growth, which is mostly attributable to being landlocked by the Quechan Indian Reservation. The development of the Quechan Reservation inside the BWD boundaries has been limited, also.

To the east of BWD but adjacent to it is what is known as the Yuma Island, an old cut off meander of the Colorado River that is substantially farmed. The Yuma Island, though now on the California side of the River, is about half in Arizona and half in California – a compromise by the two states. Most of the agriculture on the Island gets its water supply by pumping groundwater or pumping directly from the Colorado River, with one area (Ranch 5) receiving Colorado River water from the BWD delivery system. Water rights

are complicated for the Island water users, with Ranch 5 water use being accounted for directly to the Quechans and other water users having limited quantified rights.

North Gila Valley Irrigation District (NGVID)

The North Gila Valley is the land opposite the Bard Valley, lying east of the Colorado River and north of the Gila River. Originally constructed as a part of the Yuma Project, the district became the North Gila Unit of the Mesa Division of the Gila Project following the completion of the Gila Gravity canal in the 1940's. The District includes some 6500 irrigated acres.

NGVID has Colorado River water rights with a priority date of 1909. These water rights were originally beneficial use rights but have been quantified through Gila Project contracts such that NGVID has present rights to 29,650 acre-feet per year of consumptive use, including 2500 acre-feet that can be used for municipal uses.

Water use in NGVID for the 2008 calendar year consisted of total diversions from the Colorado River of 47,944 acre-feet, total measured and unmeasured return flows of 33,983 acre-feet and total consumptive use of 13,961 acre-feet. Measured return flows are collected in open drains and are affected by Gila Gravity Canal seepage, seepage from agricultural lands, and in years of high Colorado River flows, the generally high water table caused by the river. Unmeasured return flows are generally bank flows seeping into the adjacent Colorado River.

There is very little existing or planned urban development in the North Gila Valley and very minor groundwater use.

Adjacent to and east of the NGVID is the Gila Monster Ranch, an area of about 2800 acres with some 9000 acre-feet of Colorado River water rights of various priorities. The Gila Monster Ranch both diverts from the Gila Gravity Canal and uses groundwater, with substantial return flows similar to NGVID.

Yuma Irrigation District (YID)

The South Gila Valley is the valley land between the Yuma Mesa to the south and the Gila and Colorado Rivers to the north. Originally irrigated by an extensive system of wells, YID was formed in 1962, entering into a contract with the US Bureau of Reclamation as the South Gila Valley Unit of the Mesa Division of the Gila Project. There are about 10,600 acres of irrigated land in Yuma Irrigation District.

YID has Colorado River water rights as a part of the Gila Project contracts such that YID has present rights to 47,700 acre-feet per year of consumptive use plus 5,000 acre-feet that can be used for municipal uses.

Water use in the district for the 2008 calendar year consisted of total diversions from the Colorado River of 69,686 acre-feet, total measured and unmeasured return flows of

30,149 acre-feet and total consumptive use of 39,537 acre-feet. Measured return flows are collected by deep drainage wells and pipeline or open channel drains and are affected by the Gila Gravity Canal seepage, seepage from agricultural lands, and in years of high Colorado River flows, the generally high water table caused by the river. In addition, as YID is located at a lower elevation than the Yuma Mesa to the south of it, the deep percolation from irrigation on the Yuma Mesa flows into the South Gila Valley. These groundwater flows from the Yuma Mesa are substantial and are the cause of needing to use deep drainage wells to lower the groundwater table.

YID continues to use groundwater wells to supplement its surface water diversions. In addition, some adjacent lands are irrigated using wells.

There is a moderate level of urban activity in the YID boundaries. The City of Yuma is encroaching into the western end of the district and scattered urban developments are found in various areas of the District.

Yuma Mesa Irrigation and Drainage District (YMIDD)

The Yuma Mesa is the higher land between the Gila and Yuma Valleys, stretching from the City of Yuma south to Mexico. The lands on the Yuma Mesa are about 50 to 100 feet above the valley lands, thus requiring a pumping plant to deliver irrigation flows. Its sandy soils are well suited to citrus and hay cultivation. The two irrigation districts on the Yuma Mesa are Yuma Mesa Irrigation and Drainage District and the Unit B Irrigation District, which is adjacent to and west of YMIDD. YMIDD is the Mesa Unit of the Yuma Mesa Division of the Gila Project. It can irrigate 20,000 acres of land within its boundaries.

YMIDD, authorized as a part of the Gila project in 1937, has Colorado River water rights to 104,000 acre-feet per year of consumptive use plus 10,000 acre-feet that can be used for municipal uses. As with the other Yuma Mesa Division projects, it also has the potential for supplemental water use.

Water use in the district for the 2008 calendar year consisted of total diversions from the Colorado River of 191,796 acre-feet, total measured and unmeasured return flows of 107,056 acre-feet and total consumptive use of 84,740 acre-feet. Measured return flows are collected by the USBR drainage facilities (drainage wells and pipelines) along the western edge of the Yuma Mesa and in the Gila and Yuma Valleys. With the generally sandy soils of the Yuma Mesa lands, the deep percolation component of water use is significant and over time there has developed a significant body of groundwater under the Yuma Mesa, the Yuma Mesa groundwater mound. Groundwater flows are not only to the Yuma and Gila Valleys but to the south towards Mexico, where they are intercepted by both the U.S. Bureau of Reclamation's 242 Wellfield system (named after Minute 242 of the Mexican Treaty) and by well fields in Mexico.

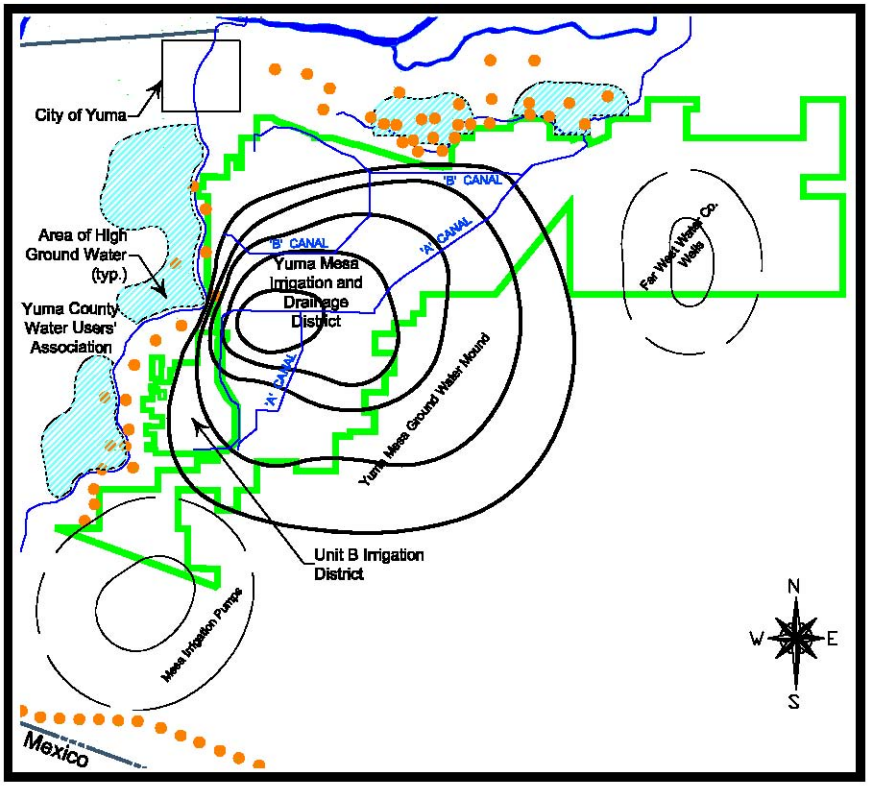

Figure 3. Yuma Mesa Irrigation and Drainage District and Unit B Irrigation District

Urban and suburban development occurs throughout YMIDD. In the northern part of the district the City of Yuma is growing at a fairly rapid rate. This includes industrial lands around the Marine Corps Yuma Air Station and Yuma International Airport. In scattered areas throughout the district are developments known locally as ranchettes, typically two acre residential parcels that may or may not use irrigation water. It should be noted that arable land is available to the south of the present agricultural lands of the District to allow expansion of the District to replace urbanized lands. There are a fair number of groundwater wells within the District boundaries and adjacent to it.

Unit B Irrigation District (Unit B)

Also on the Yuma Mesa and adjacent to the YMIDD, Unit B Irrigation District is the smallest of the Irrigation Districts in the study area with 3,305 acres that can be irrigated. Unit B was originally authorized in 1917 and constructed as a part of the Yuma Project. It has unquantified Colorado River water rights, with 6800 acre-feet of those rights considered present perfected rights.

Water use in the district for the 2008 calendar year consisted of total diversions from the Colorado River of 26,894 acre-feet, total measured return flows of 13,172 acre-feet (no unmeasured return flows were credited to it) and total consumptive use of 13,722 acre-feet. Measured return flows are primarily from the groundwater pumped to the U.S. Bureau of Reclamation's Yuma Mesa Conduit along the western edge of the Yuma Mesa. As with YMIDD, the generally sandy soils of the Yuma Mesa lands result in significant

deep percolation and contribute to the Yuma Mesa groundwater mound. Groundwater flows are primarily to the Yuma Valley and south to Mexico.
Much of Unit B has been developed into 2-acre ranchettes and as a result the overall agricultural production and water use in the District has declined.

Yuma County Water Users' Association (YCWUA)

The oldest irrigation district (actually a Water Users' Association rather than an Irrigation District) in the Arizona portion of the study area is the Yuma County Water Users' Association, formed in 1903 to contract with the U.S. Bureau of Reclamation for the construction of the Yuma Project. The YCWUA operate and maintain the Valley Division of the Yuma Project, which consists of about 53,415 irrigable acres, of which about 43,000 are currently in agriculture.

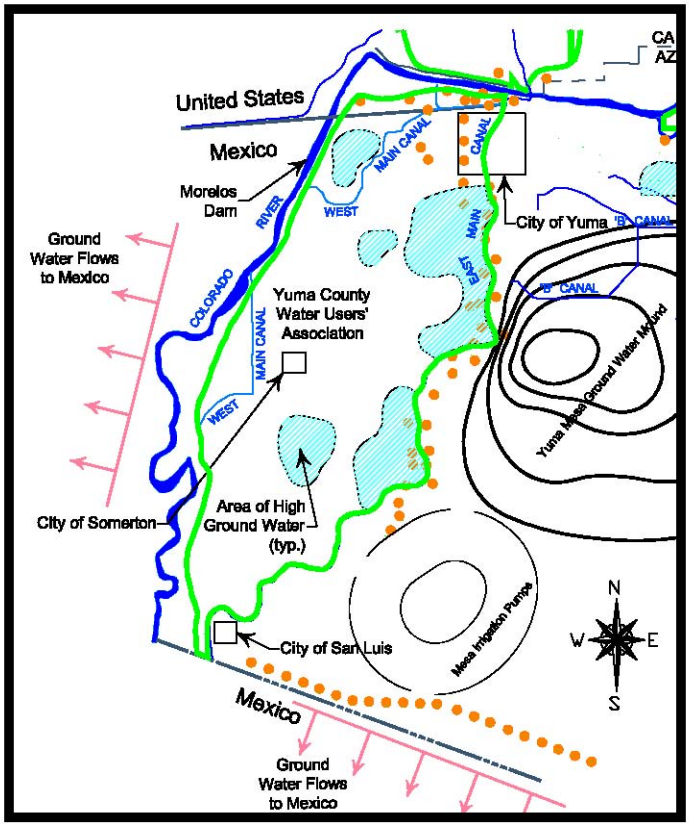

Figure 4. Yuma County Water Users' Association

The water rights of the YCWUA are individual beneficial use water rights of which 254,200 acre-feet are present perfected Colorado River water rights and additional unquantified priority 2 water rights. These water rights date from the 1890's.

Water use in the Association for the 2008 calendar year consisted of total diversions from the Colorado River of 348,121 acre-feet, total measured and unmeasured return flows of 95,418 acre-feet and total consumptive use of 252,703 acre-feet. Measured return flows are collected in open drains and by groundwater drainage wells. Groundwater sources to

the Yuma Valley include seepage from the Colorado River from above Morelos Dam (and from below Morelos in years of high river flows) and groundwater flows from the Yuma Mesa groundwater mound, as wells as from percolation from water applied to the lands of the Yuma Valley. Unmeasured return flows include groundwater that percolates from the Yuma Valley to the normally mostly dry Colorado River below Morelos Dam and groundwater that is pumped from under the Yuma Valley by groundwater supply wells in Mexico (the wells in Mexico pump a combination of water lost from the Colorado River and water percolating from Yuma Valley lands.)

There is significant urban development within the lands of the YCWUA, including the City of Yuma to the north, the City of Somerton in the central part of the Yuma Valley and the City of San Luis at the southerly Mexican border. Each of these cities is growing but overall growth is slower in the valley lands than it is on the adjacent mesa lands. The East, West and North Cocopah Indian Reservations are within or adjacent to the YCWUA and the reservation lands are a mix of agricultural and urban developments and they also have their own water rights. There are also several small water right contractors adjacent to the YCWUA, including, for example the USBR Yuma Area Office, Yuma Union High School District, and several private water contractors.

The City of Yuma has an individual water right contract for Colorado River Water rights but also has a water conversion contract with the YCWUA such that they can deliver water from lands with water rights as municipal or industrial water rather than as agricultural water. The City's of San Luis and Somerton have or are developing similar conversion contracts.

Wellton-Mohawk Irrigation and Drainage District (WMIDD)

The Wellton-Mohawk Irrigation and Drainage District is the most geographically and operationally distinct of the Yuma area irrigation districts. It is the Wellton-Mohawk Division of the Gila Project and includes land along both sides of the Gila River from about the Gila Mountains east to the Mohawk Mountains. WMIDD can provide irrigation water to 65,000 acres, including both the valley lands along the Gila River and adjacent mesa lands to the south of the Gila. WMIDD, as a part of the Gila project, has Colorado River consumptive use water rights to 278,000 acre-feet per year.

Water use in WMIDD for the 2008 calendar year consisted of total diversions from the Colorado River of 402,373 acre-feet, total measured return flows of 107,056 acre-feet and total consumptive use of 145,204 acre-feet. Being the only irrigation district in its geographic area, WMIDD has no direct unmeasured return flows – all water lost to seepage contribute directly to the groundwater table or to the Gila River, and Gila River flows, both surface and subsurface, are measures as they leave the WMIDD project area.

Measured return flows are collected by drainage facilities (drainage wells and drainage channels) throughout the project area and the collected drainage flows, due to their relatively high salinity, are conveyed by the USBR's Main Outlet Drain and Main Outlet Drain extension along the Gila and Colorado Rivers, past YID and the YCWUA, and into

Mexico to the Santa Clara Slough. The lands in WMIDD were for many years irrigated by well water and thus accumulated excessive salts in the soils which were then leached out in the early years of receiving Colorado River water. While salt concentrations in drainage flows have declined from their early peaks, the drainage waters are still bypassed to the Santa Clara Slough as such allows the U.S. to comply with the salinity requirements agreed to with Mexico. The Yuma Desalting Plant, located in the northern Yuma Valley, is designed to desalt the WMIDD drainage flows during times when treaty obligations cannot be met through river flows, but since its construction it has not been needed.

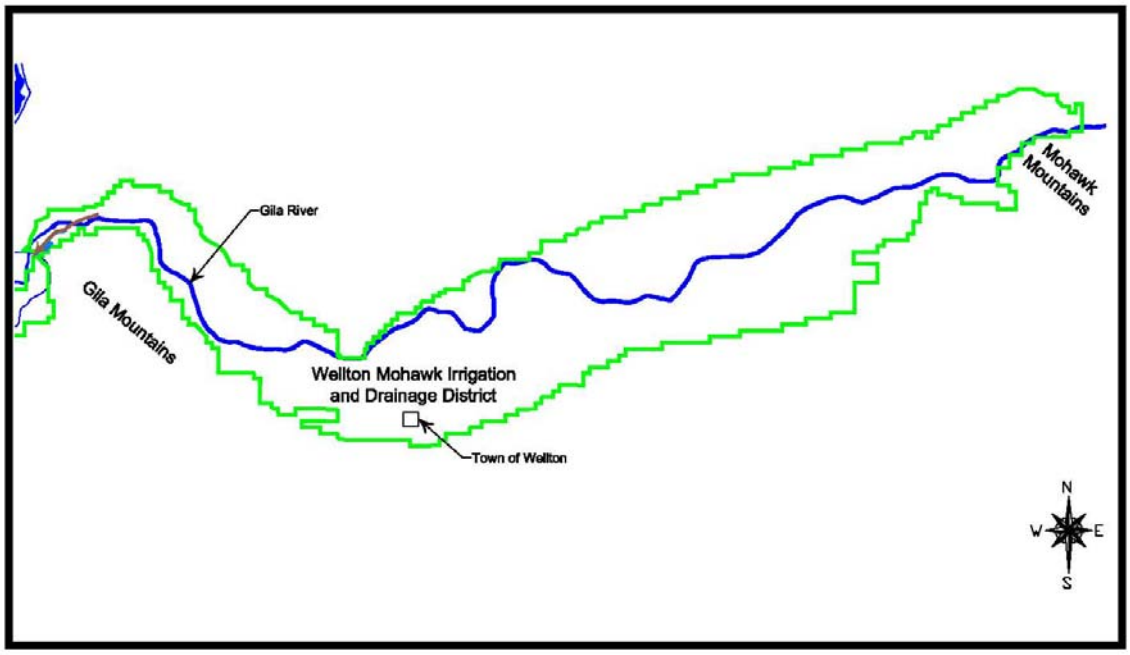

Figure 5. Wellton-Mohawk Irrigation and Drainage District

Groundwater recharge in WMIDD is typically from the percolation of irrigation water. The groundwater drainage wells in the area are operated to maintain the groundwater table at acceptable levels for farming in the valley areas. The Gila River is normally dry upstream of WMIDD but can contribute significant regional groundwater recharge during years when it flows, which due to the release criteria of Painted Rock Dam, the upstream flood control dam, are designed to minimize flood damage along the Gila River and result in Gila River flows through the project area last many months.

There is some urban development occurring in the mesa areas of WMIDD, notably around the Town of Wellton, but such development is still relatively minor in comparison to the acreage in the district. There are some groundwater wells pumped for municipal, industrial and agricultural uses, primarily on the mesa lands to the south of the Gila River.

SUSTAINABILITY OF AGRICULTURAL IN THE LOWER COLORADO RIVER AREA

The Lower Colorado River area has at present an agricultural economy that encompasses some 160,000 acres of farm land and agriculture produces some $1 billion in economic activity in the area. The area supplies much of the United States winter produce, in particular lettuce, and also produces much citrus, field crops and livestock. Currently agriculture in Lower Colorado River has sufficient land and water to thrive but it is also potentially threatened in the future by urbanization and water supply and water quality issues. Each of these issues is discussed below with regards to their effects on the long term sustainability of agriculture in the Lower Colorado River area.

Urbanization

Urbanization, as used herein to generically describe the increase in non-agricultural land uses including residential, commercial and industrial land uses and their associated water use demands, is having and will continue to have an overall significant impact on agricultural lands along the Lower Colorado River. The effects of urbanization on individual irrigation districts in the area will vary greatly, from having almost no effect to having a very significant impact on agriculture.

It is not anticipated that urbanization will have a significant impact at all in the Bard Water District or in the North Gila Valley Irrigation District. There are very little existing urban land uses in these districts now and both have farm economies that are presently profitable and are expected to remain that way. Neither area has much in the way of urban infrastructure, and while the Quechan population in the Indian Unit of BWD will continue to grow, the overall land use of such growth should be relatively minor. In addition relatively high groundwater levels in both valleys and lack of certified flood control levees in the North Gila Valley are detriments to any large scale developments.

The irrigation districts on the Yuma Mesa, YMIDD and Unit B, are probably most at risk due to urbanization. YMIDD will most likely continue to see increases in urbanization in the north end of the district as the City of Yuma grows and it will see increased development of ranchettes as long as zoning rules stay the same. As YMIDD does have the ability to expand the District's boundaries to the south (provided the City of San Luis does not grow too quickly to the north), irrigated agriculture can expand away from the northerly development provided that the irrigation delivery infrastructure can be extended economically. At some point in the future though, whether it is 25 years or 50 years or more from now, the reality of YMIDD being in the path for urban growth will be realized and it can be projected that YMIDD will be mostly urbanized. For water right purposes, the ability for YMIDD to convert their agricultural water rights to M&I water rights will need to be maintained and potentially exercised.

The urbanization of Unit B is in some ways well along at present with the existing development of the residential ranchettes. The remaining cultivated lands will over time

come under pressure for further development, either as additional ranchettes or as higher intensity uses such as industrial use. The City of Somerton has expanded its corporate boundaries to Unit B and the adjacent East Cocopah reservation is also developing and so over time it can be anticipated that commercial agriculture in Unit B will be minimal, though small scale agriculture on the ranchettes will continue.

The valley districts to the east and south of the City of Yuma, Yuma Irrigation District and the Yuma County Water Users' Association, will both face urbanization but with significant agricultural infrastructure in these areas based on the profitable produce crops grown in the valleys, the pace of urbanization should be more moderate. Urbanization of these valleys will also be somewhat slowed by land use planning currently favorable to agriculture and by the generally higher cost of urban land development in the valleys due to high groundwater tables and poor soils for infrastructure. Generally it can be said that urbanization of these valleys will be gradual as long as farming in the valleys remains profitable.

For the Wellton-Mohawk Irrigation and Drainage District, present day urban development is limited almost fully to the mesa lands around the towns of Wellton and Tacna. Very little development occurs in the Gila River valley area and as long as protection from flooding remains an issue, little future development in the valley area should occur. Future development of the mesa lands in and adjacent to WMIDD should be gradual for the near future but at some point – for example after growth from the Yuma side of the Gila Mountains moves east or if a significant development project (such as a now proposed oil refinery) becomes reality – growth could become rapid. With regards to current farm economics, the mesa lands are currently the least profitable, being in citrus and hay primarily, while the valley lands are more profitable with their produce crops and so one would expect the valley lands to be the last to be developed.

Water Supply Issues

The Colorado River is one of the most heavily used rivers in the United States, and in fact is in most years fully diverted for water supply to the various states along its length. Much of the last century has been spent in developing compacts and agreements (the "Law of the River") governing use of Colorado River water and it can be anticipated, especially in times of shortage, to see continued negotiations and litigation in the future.

The Colorado River is an interstate and international river, and as such, it use is regulated by both federal agencies, primarily the U.S. Bureau of Reclamation (USBR), and by the states. Water rights for Colorado River water are a combination of federal and state rights, with the states having limits as to how much water they can use in total and regulating the use within the state and with the USBR entering into water right contracts with individuals and public entities. The USBR acts as water master for the river and is closely watched by the states and other federal agencies.

Irrigation District Water Supplies The irrigation districts in the Lower Colorado Region have in general senior water rights. Colorado River water rights are given priorities of 1

through 6, with 6 being the junior rights. The seven irrigation districts discussed in this paper generally have either priority 1 (present perfected rights) or priority 2 or 3 rights (contracted prior to 1968 and co-equal to each other).

While good water rights are of first importance in having a secure future water supply, good stewardship of the water that is used is also critical. Colorado River water must be put to beneficial use. The standard of what is beneficial, however, changes over time and especially changes in times of water shortages. As large metropolitan areas such as Phoenix, Los Angeles and Las Vegas enact ever more stringent water conservation measures in order to stretch their water supplies for their growing populations, it becomes politically difficult to not show water conservation efforts in the use of water for agricultural purposes.

Overall, while the irrigation districts in the study area have some of the best water rights on the Colorado River, they must also be prepared to defend those rights through good stewardship of them in order to keep them sustainable.

Non-Irrigation District Water Supplies The other users of Colorado River water in the study area have various quantified and unquantified water rights that have varying levels of problems with their long term sustainability.

The City of Yuma is the largest non-agricultural water right holder, with some present perfected rights and the remainder of their rights priority 3. There are also about 8000 acre-feet of priority 2 and 3 water right holders, most of these being either small agricultural acres outside of the irrigation districts (with the Gila Monster Ranch in the North Gila Valley being the largest of these) or else municipal water users such as cemeteries and schools.

Priority 4, 5 and 6 water right holders include the Cocopah Indian Reservation and about 10 smaller contractors, including the City of Somerton and various M&I and agricultural users.

Unquantified water right holders and those water users without water rights are primarily the groundwater pumpers along the Colorado River (especially on the Yuma Island adjacent to Bard Water District) and those with groundwater wells on the mesa lands and in other area. It should be noted here that water use in the Gila River drainage area is not a part of the Colorado River apportionment of water. No Colorado River water rights are required for use of groundwater or Gila River water in the Gila River drainage area (which is essentially in the WMIDD area.)

The long term sustainability of non-irrigation district water supplies in the study area is a function of the priority of the existing water rights, if any, and the use of the water, whether for M&I purposes or for agricultural purposes. In general, the M&I water users benefit from the long term use that M&I water is put to once it is put to use, i.e., on farm water use of course has significant infrastructure built to support it but at the same time its use can often be curtailed for a season in times of shortage, whereas water put to use

to directly support say residential development must be used continuously as long as the residential development exists. Therefore it is expected that users such as the cities of Yuma, San Luis, Somerton and Wellton will, due to the nature of their water use, be able to count on long term water supplies regardless of their water right priorities. Even the City of San Luis, which now relies almost exclusively on unquantified groundwater rights, should be able to exercise its rights for the foreseeable future (while the City of San Luis pumps Colorado River water, if they did not that water would be pumped by Mexico and lost to the United States.)

The greatest threat to long term sustainability of water supply in the Lower Colorado River region is probably to those users of Colorado River water that either do not have a water right (primarily those that pump groundwater) and those users that do not exercise their rights. Much study of the source of groundwater in the study area has been conducted in recent years by the U.S. Geological Survey and the U.S. Bureau of Reclamation for the ultimate purpose of further regulating the use of subsurface Colorado River water and ultimately curtailing its use without water right contracts.

Thus it can be said that long term sustainability of water supplies for irrigated agriculture outside of the irrigation districts will be subject to increasing legal scrutiny in the coming years. With that said, the argument can be made that groundwater use may have no greater consumptive use than native vegetation in the valley areas (where native vegetation is plentiful) but it is thought that eventually groundwater pumping without a Colorado River water right contract could be substantially curtailed. Those water users with water right contracts should have a better time defending their usage, but as discussed above, should still strive to improve their stewardship of the water that they use.

Water Quality Issues

As stated at the beginning of this paper, the water use in the Lower Colorado River area is primarily ‘run-of-the-river’, meaning that water is diverted from the river as water supply and water is returned to the river as return flows. As such, as long as adequate return flows exist their can be something of an equilibrium existing in water quality. Salts and other water quality constituents are concentrated due to evapo-transpiration during application and flushed to some extent as soils are drained.

The Colorado River has high total dissolved solids (TDS) levels upstream of the study area due to both naturally occurring flows and due to upstream agriculture and other water uses. With the additional return flows and salinity added in this area, water quality became a major concern of Mexico’s in the 1960’s and the treaty between the United States and Mexico was amended to include water quality criteria for delivery of Colorado River Water to Mexico. While water quality had long been a concern of Mexico’s, the 1960’s saw the completion of the Gila Project and especially the increase in return flows from lands formerly irrigated by well water (with irrigation by well water essentially recycling groundwater supplies, increasing the salinity incrementally over time with each reuse.) Much of the new drainage from the Gila Project lands, especially from the

Wellton-Mohawk area, where wells were extensively used for a long period of time, was diverted in a separate drainage channel, around the South Gila and Yuma Valleys to Mexico near the delta of the Colorado River at what is known as the Santa Clara Slough.

Since the 1960's water quality of return flows, as measured by TDS, has been fairly constant and in some areas, such as the WMIDD drainage flows, have actually improved as previously accumulated salts are leached out. Groundwater quality from shallower wells (less than about 200 feet) is essentially the same as return flow quality but depending more on the recharge source, whether from deep percolation from agriculture or from recharge by river flows. Deeper wells often produce better quality if water unaffected by agriculture is pumped, though the local soil formation can have significant negative effects on the quality.

The sustainability of the current water quality levels in the area depends to a great deal on maintaining the current status quo of water deliveries, groundwater usage, and groundwater recharge. Increases in groundwater use for agriculture, whether caused by declines in surface water deliveries or simply increases in overall water use, will cause increases in TDS as the more saline groundwater is applied to the land and further concentrated.

Similarly, decreases in groundwater recharge due to river flows will result in increased salinity as the river flows, whether from the Colorado River or Gila River (except those flows from the Gila that are subject to significant evaporation as Painted Rock Dam is drained) are of lesser TDS content than agricultural percolation.

Water Conservation and Environmental Issues

The generally accepted concept is that water conservation is beneficial to both the manmade environment and to the natural environment. For example, to the extent that water conservation reduces water logging of agricultural lands, such water conservation is beneficial to the manmade environment. Similarly, if water conservation increases in-stream flows by reducing diversions, such is also beneficial to the natural environment. Water conversation by definition affects an areas water balance and as such it affects the sustainability of water use in an area.

In the Lower Colorado River Region, however, water conservation, whether locally or outside the region, can have negative effects. Potential water conservation practices and their potential effects on the region include the following.

- Increases in on-farm water use efficiency, resulting in less deep percolation of irrigation water. To the extent that crop production is increased, this can benefit the area. To the extent that less water is recharged but with the same salt level, the effect is to increase the TDS of groundwater and return flows, thus lowering their usefulness.
- Increases in on-farm and delivery system efficiencies, resulting in a decrease in return flows to agriculture drains and a decrease in operational

discharges from canal systems. These conservation measures decrease base flows in the Colorado River and Gila River channels (especially the Gila River in the WMIDD area, as return flows are typically its only water supply, thus keeping the riparian area alive.)

- Better operation of the mainstream Colorado River delivery system such as to reduce inadvertent over deliveries to the Yuma area results in less flows released below Morelos Dam and less groundwater recharge in the limitrophe section of the Colorado. Thus groundwater pumping will further lower the groundwater table, reducing the areas of wetlands and riparian vegetation that depend on groundwater.
- Increased upstream water storage capacity resulting in less frequent flood events on the Colorado and Gila Rivers. Especially on the Gila River, the long duration floods that occur now about every 10 years or so result in significant groundwater recharge of aquifers along the river. Reduction in that recharge would result in the overall lowering of the groundwater table and loss of riparian wetlands and vegetation. Similar effects would occur in the limitrophe section of the Colorado.

Also a water conservation issue is the operation of the Yuma Desalting Plant (YPD). The YDP was constructed to improve the quality of Colorado River water delivered to Mexico by desalting drainage flows from the WMIDD drains. Since its construction, however, the drainage flows have been delivered to the Santa Clara Slough in Mexico, creating a significant wetland there. Future operation of the plant, which will increase available Colorado River Water for lower priority users, will result in decreases in the size of the Santa Clara Slough (though there are arguments that not all of the water delivered to the Slough is needed.)

Overall, water conservation efforts affecting the Lower Colorado River have the potential to reduce the sustainability of agriculture in the area. While possibly counter-intuitive, the present status quo of the area can be characterized as very water rich environment (it is near the delta of a major river system). Continued water conservation will reduce flows to the agricultural drains, resulting in a new groundwater regime which will show up as diminished riparian areas and as degraded groundwater quality.

SUMMARY

In the area between the Imperial Dam and the Mexican border along the Lower Colorado River, the existing uses of Colorado River water for irrigated agriculture has allowed the development of some 160,000 acres of farmland. The seven irrigation districts in area along with the irrigated areas outside of the irrigation districts are presently in a sustainable mode, having operated in much the same way since their development, beginning in early 1900’s and into the 1960’s.

With increasing basin wide demands being placed on the Colorado River’s resources and with the urban growth occurring in the study area, the current status quo of water use will change in the future. While maintaining the status quo would be preferable for most all

water users and the environment (though perhaps with alleviating drainage problems in some areas of excess groundwater), if such cannot be maintained then awareness of the changes and appropriate planning may mitigate changes to the area, allowing irrigated agriculture to thrive for many years into the future.

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