RECLAMATION

Managing Water in the West

2015 Groundwater Status Report
Yuma Area
Arizona and California

Yuma Area Office
Lower Colorado Region

U.S. Department of the Interior
Bureau of Reclamation

September 2016

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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Cover Photo: Pumped groundwater from drainage wells SG-1, SG-12, and SG-2 in the South Gila Valley discharging into Drainage Pump Outlet Channel No. 1 (DPOC-1). Groundwater observation well in foreground at right with SG-2 in background. September 2014.

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Acronyms and Abbreviations

AAC	All-American Canal
cfs	cubic feet per second
ft	feet
bgs	below ground surface
amsl	feet above mean sea level
DTW	depth to water or depth to groundwater from land surface
GGMC	Gila Gravity Main Canal
NGVD-29	National Geodetic Vertical Datum 1929
SIB	Southerly International Boundary
Tape reading	depth measurement from a reference point at the top of a well casing to the water surface.
WMIDD	Wellton-Mohawk Irrigation and Drainage District
YAO	Yuma Area Office
YCWUA	Yuma County Water Users' Association
YDP	Yuma Desalting Plant
YMIDD	Yuma Mesa Irrigation and Drainage District

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Supervisory Review

This report has been reviewed and is believed to be in accordance with the standards of this profession.

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Introduction

Purpose and Scope

This report presents a summary description of the groundwater conditions in the Yuma area during 2015. This area includes the Yuma groundwater basin consisting of the North Gila Valley, Reservation Division, South Gila Valley, Yuma Valley, and Yuma Mesa, as well as the nearby Wellton-Mohawk area to the east (Figure B-1). The purpose of this report is to present groundwater data and related hydrogeological information for the study area, so that current conditions can be evaluated and compared to previous monitoring studies to assess changes over time.

Results of previous monitoring conducted in the Yuma area by the Bureau of Reclamation (Reclamation) are contained in annual Ground Water Status Reports dating from the 1960s through 1995.[1] This report summarizing monitoring data collected in 2015 marks a resumption of this annual reporting program. It provides a summary of depth-to-groundwater (DTW) measurements and calculated groundwater elevations. Data collected from the monitoring program are displayed in this report as contour maps of DTW and groundwater elevation for specific areas.

Work conducted for this groundwater monitoring program is based on the following authorizations:

- Reclamation Act of 1902, June 17, 1902 (Yuma Project approved by the Secretary of the Interior on May 10, 1904)
- P.L. 64-293, Yuma Auxiliary Project, January 25, 1917, as amended
- P.L. 68-292, Second Deficiency Appropriation Act for 1924, Section 4 (The Fact Finders Act), December 5, 1924 (Gila Project approved by the President on June 21, 1937)
- P.L. 68-585, Colorado River Front Work and Levee System, March 3, 1925 P.L. 70-642, Boulder Canyon Project Act, December 21, 1928
- P.L. 80-247, Interior Department Appropriation Act of 1948, July 30, 1947
- P.L. 88-25, Delivery of Water to Mexico, May 17, 1963
- P.L. 106-221, Wellton Mohawk Transfer Act, June 21, 2000
- P.L. 106-566, Conveyance to Yuma Port Authority, December 23, 2000

The projects were administratively consolidated into the Yuma Area Projects with the approval of the appropriations committee in 1957.

[1] U.S Bureau of Reclamation, Lower Colorado Region, Yuma Area Office; Ground Water Status Report, 1995, Yuma Area, Arizona and California.

Reclamation intends to prepare groundwater status reports for this program on an annual basis to document data collection and to assess changes in aquifer conditions over time. This report and future annual status reports will be posted on Reclamation's website to provide assess by water managers and interested parties.

Location and General Description

The Yuma area includes approximately 675 square miles of land located on the apex of the Colorado River delta in southwestern Arizona and southeastern California. Notable physiographic features include the Cargo Muchacho and Chocolate Mountains to the north and the Gila Mountains to the east. The Colorado River bisects the area and forms the international boundary between the United States and Mexico in the area west of the Yuma Valley (Figure 1).

The landscape in the Yuma area is characterized by the Colorado and Gila River valleys, river terraces or mesas, desert plains, and rugged mountains. Land surface elevations range from 75 feet at the Colorado River near San Luis, AZ, to a high point of 3,156 feet above mean sea level (amsl) at Sheep Mountain in the Gila Mountains. The climate is extremely arid with an average rainfall of about 3 inches per year.

Agriculture is by far the single largest industry in Yuma County generating approximately $2.8 billion in economic output in 2014.[2] The thriving agricultural economy is made possible by a steady supply of water from the Colorado River.

The Yuma area is divided into six subareas distinguished by natural geographic boundaries, irrigation districts, and hydrogeologic characteristics (Figure B-1 in Appendix B). The subareas comprise the North Gila Valley, Reservation Division, South Gila Valley, Yuma Mesa, Yuma Valley and the Wellton-Mohawk area, which lies to the east of the Gila Mountains along the Gila River. (Figure 1).

[2] Yuma County Agriculture Coalition. 2015. "A Case Study in Efficiency – Agriculture and Water Use in the Yuma, Arizona Area." [http://www.agwateryuma.com/]

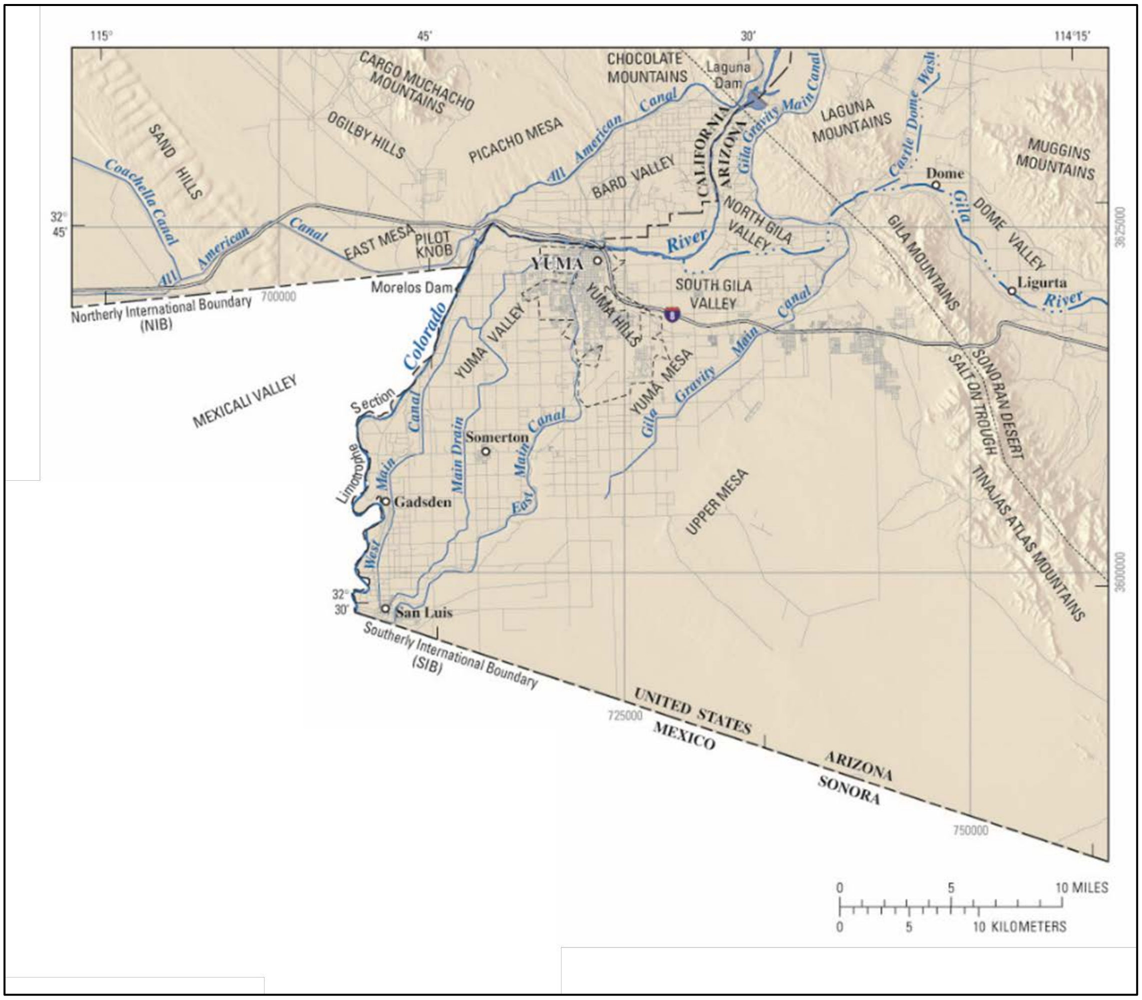

Figure 1: General map of the Yuma area
(Data source: U.S. Geological Survey, Scientific Investigations Report 2006-5135)

History of Development in the Yuma Area

Numerous events have occurred over time in the development of water resources to support agriculture in the Yuma area. Initial efforts began in 1857 with the building of the first canals to deliver agricultural irrigation water in Yuma Valley. Over time more infrastructure was added to manage water supplies, like the Laguna Diversion Dam in 1905, the Imperial Dam in 1938, and the All-American Canal (AAC) in 1940. Beginning in the 1950s, a system of high-capacity drainage wells was developed and maintained to help keep groundwater at acceptable levels for agriculture and other purposes in South Gila Valley and eastern Yuma Valley. In recent years, efforts have been made to use the pumped drainage water for supply. Appendix A provides a table that describes the chronology of significant events related to the development and management of water supplies in the Yuma area.

The Groundwater System

The following presents a summary of the hydrogeological characteristics for the Yuma area based on two publications from the U.S. Geological Survey, Professional Paper 486-H[3] and Scientific Investigations Report 2006-5135[4]. These documents provide a comprehensive summary of hydrogeological conditions in the area monitored for this program.

The Yuma area groundwater basin, also called the Yuma groundwater reservoir, is an aquifer system located in the upstream end of the Colorado River delta and includes alluvial deposits of the Yuma area and parts of the states of Baja California and Sonora, Mexico. The aquifer system developed in a sedimentary basin, formed by the interaction of Basin and Range tectonics and the Salton Sea trough. The basin is bounded on the north and east by impermeable bedrock outcrops. The western and southern boundaries of the system have not been defined, but it is believed that the aquifer extends for considerable distances west and south of the Yuma area into northern Mexico.

The aquifer system is comprised largely of Colorado and Gila River sediments that overlie Pliocene and older marine sediments, volcanic units or crystalline bedrock. Total thickness of the river sediments ranges from 0 feet near the mountain margins to over 2,500 feet in the southwestern parts of the Yuma area. The alluvium is divided into two main water bearing units that are composed of numerous stratified, heterogeneous materials.

Figure 2 shows major geologic structures that tend to affect the movement and direction of groundwater flow in the Yuma area. The Algodones fault trends northwest to southeast through the area along with other numerous parallel faults that offset the Bouse Formation. The map shows the alignment of three geologic sections A-A', B-B' and C-C', two of which are shown in Figure 3 and used in this report to illustrate the subsurface conditions that are described below.

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[3] Olmsted, F.H., Loeltz, O.J., and Irelan, B. 1973. Geohydrology of the Yuma Area, Arizona and California: U.S. Geological Survey Professional Paper 486-H, 227 pp.
[4] U.S. Geological Survey, Scientific Investigations Report 2006-5135. Hydrogeologic Framework Refinement, Ground-Water Flow and Storage, Water-Chemistry Analyses, and Water-Budget Components of the Yuma Area, Southwestern Arizona and Southeastern California, prepared in cooperation with the Bureau of Reclamation.

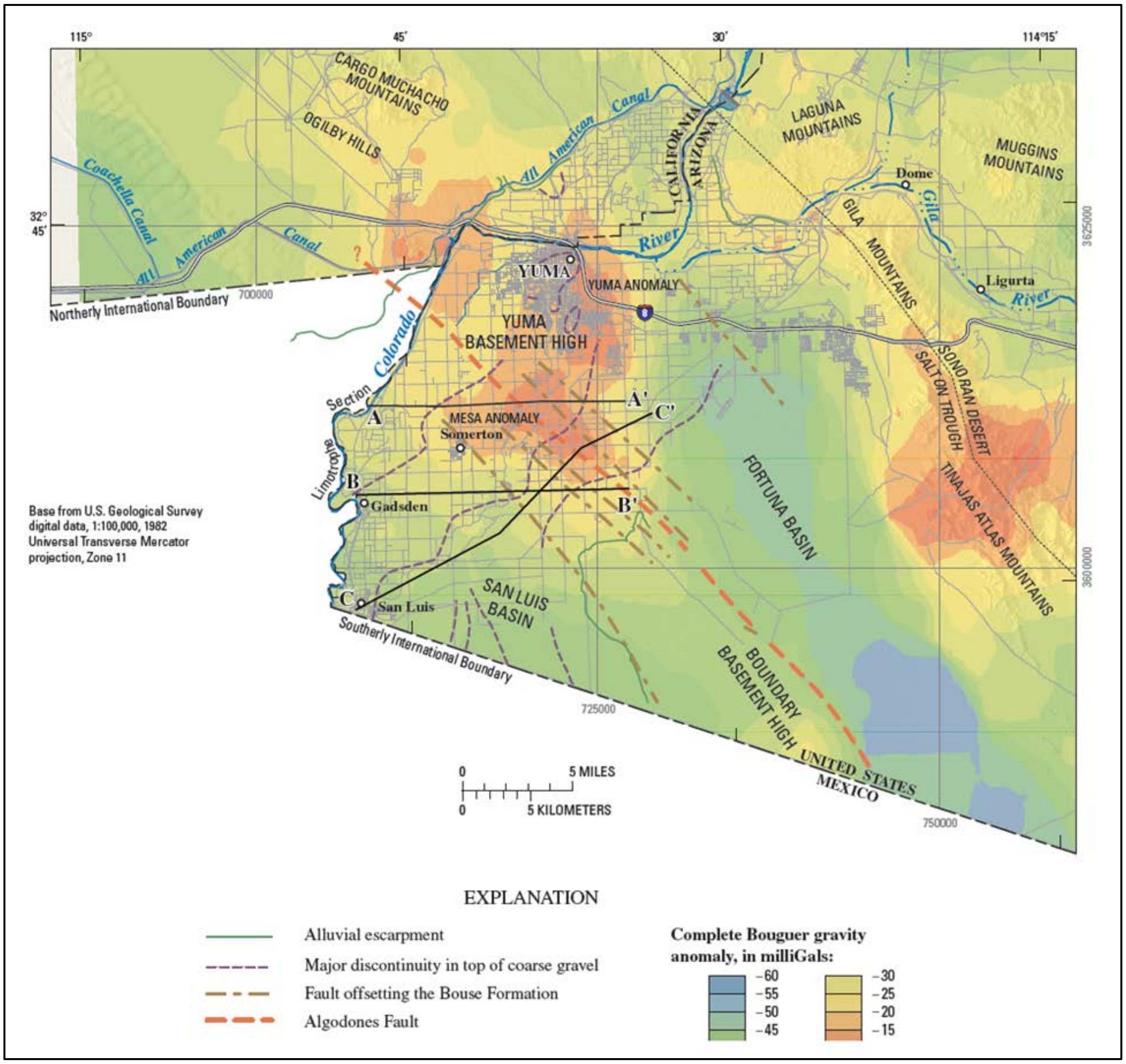

Figure 2: Structures Affecting Groundwater Flow in the Yuma Area and the Location of Geologic Sections (Data source: U.S. Geological Survey, Scientific Investigations Report 2006-5135)

The lower aquifer unit or transmissive layer, commonly referred to as the "wedge zone," (Olmsted and others, 1973, p. 66) consists of a series of fine to coarse grained alluvial deposits reaching a total thickness of over 2,000 feet. The wedge zone is typically encountered at depths of 200 feet or more below land surface and is labeled in Figure 3 as “undifferentiated lower units.” Because the lower transmissive layer accounts for about half of the transmissivity of the total alluvial thickness, it is considered to be a significant component of the groundwater system.

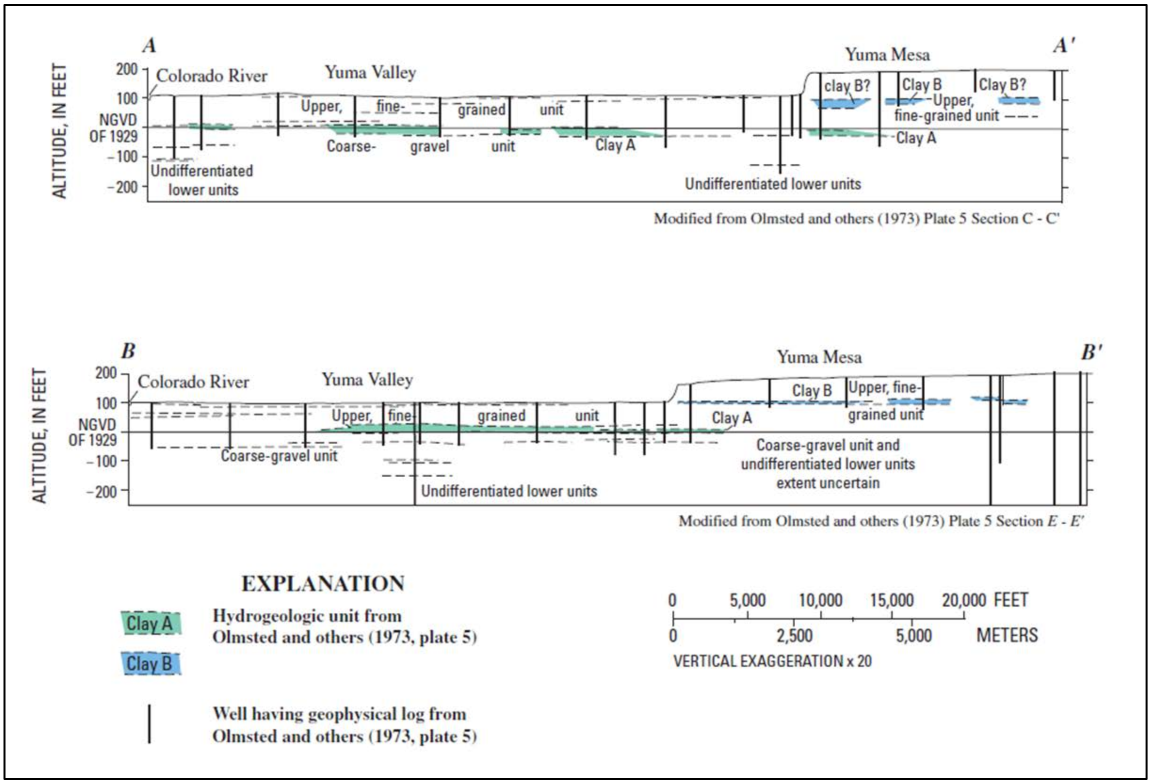

Figure 3: Cross-sections showing hydrogeological conditions in the Yuma Valley and Adjacent Yuma Mesa Areas (Data source: U.S. Geological Survey, Scientific Investigations Report 2006-5135)

The upper aquifer unit, or transmissive layer, consists of fine to coarse-grained sediments ranging in thickness from 0 to more than 200 feet, and is labeled in Figure 3 as the “Upper Fine-Grained Unit.” In the river valleys and parts of the adjacent terraces, or mesas, the basal member of the upper transmissive layer is composed largely of highly permeable Colorado and Gila River gravels having lesser amounts of interbedded sands. The total thickness of these gravels often exceeds 100 feet and is called the "coarse gravel zone" or the “coarse-gravel unit,” as shown in Figure B-3. This zone tends to be absent in mesa areas that are distal from the river valleys. However, in these mesa areas, the upper and lower transmissive layers are stratigraphically indistinguishable and the division between them is rather arbitrary, therefore they are considered to be hydraulically connected. The gravel beds of the upper transmissive layer are the most permeable of the sediments in the greater Yuma area and because the layer is relatively shallow most groundwater wells are completed in it.

The coarse gravel zone of the upper transmissive layer is overlain by finer-grained sediments ranging in thickness from 0 to more than 100 feet and includes two localized clay layers, which are labeled as “Clay A” and “Clay B” in Figure 3. In the river valley areas these sediments tend to form semi-confining layers, which tend to impede the vertical movement of groundwater. Near the mountain ranges, the upper sediments grade into coarse-grained alluvial fans and piedmonts, which have not been developed for water supply due to the greater DTW and remote location. Some domestic wells have been completed in the upper fine-grained sediments, but they produce relatively small quantities of water. Most groundwater discharge from the upper fine-grained sediments above the coarse gravel zone is through evapotranspiration to the atmosphere or through surface drains.

The basin sediments are largely saturated with the depth-to-groundwater ranging from land surface to over 500 feet. The regional groundwater gradient is to the southwest into Mexico, but locally is controlled by fault barriers and irrigation activities that have caused groundwater mounding on Yuma Mesa. Except for the Colorado and Gila River channels, the sedimentary basin is closed to the north and east causing subsurface inflows to be restricted. Virtually all recharge to the basin results from the irrigation application of Colorado River water to agricultural fields.

Groundwater Monitoring

Groundwater Measurements

The Yuma Area Office (YAO) operates and maintains an extensive groundwater monitoring program using more than 500 observation wells distributed throughout the Yuma area (Figure 4). As part of this program, YAO personnel, in collaboration with several water districts, take measurements of groundwater depth in the observation well network on a set schedule. Collaborating agencies involved with the program include Yuma County Water Users' Association (YCWUA), Wellton-Mohawk Irrigation and Drainage District (WMIDD), and the Yuma Mesa Irrigation and Drainage District (YMIDD). The following describes the methods and procedures used in the monitoring program.

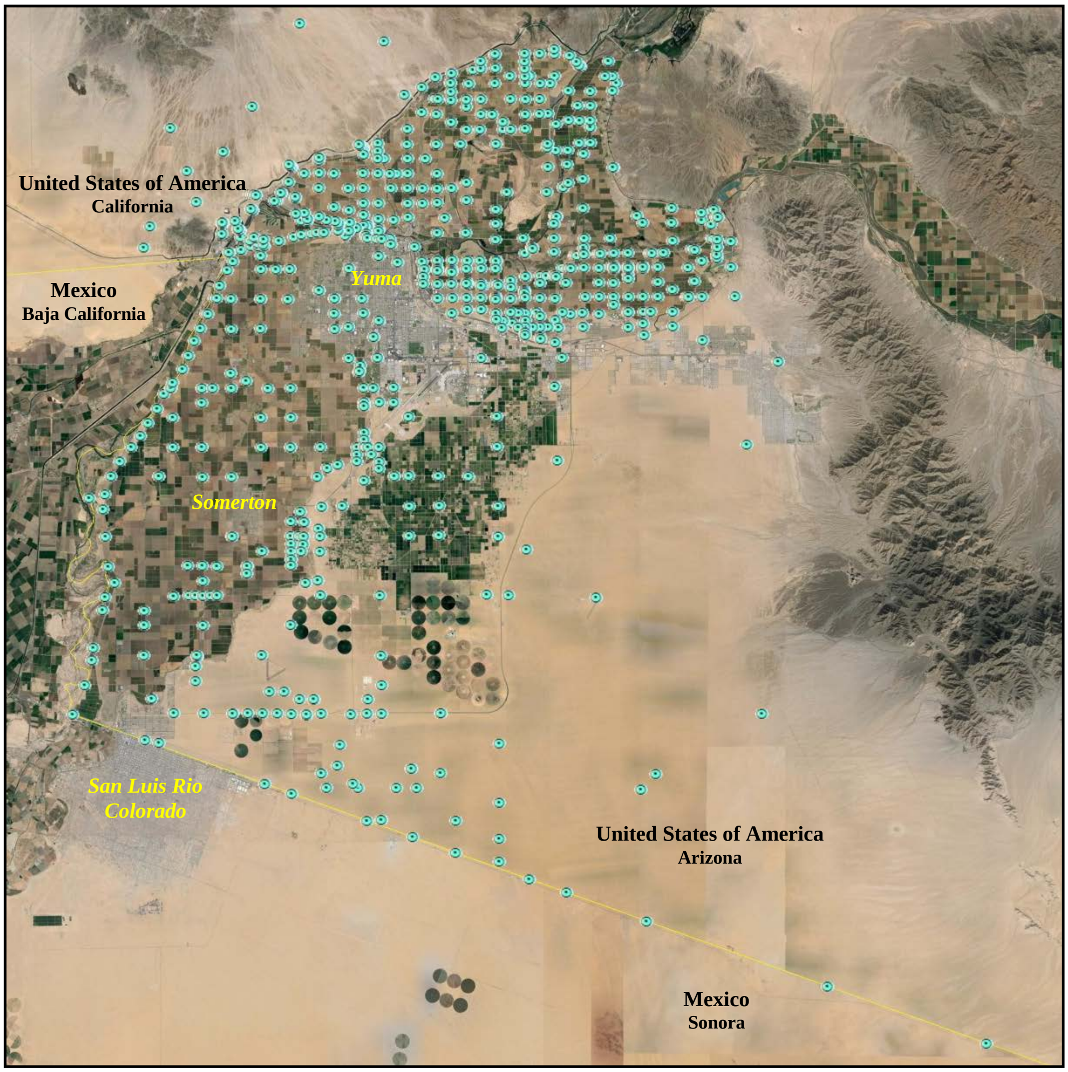

Figure 4: Map showing locations of YAO groundwater observation wells (blue dots) in the Yuma area.

“Tape readings” are water level depth measurements, taken from a reference point at the top of a well casing, to the water surface. Tape readings for shallow observation wells are manually made by YAO field staff using a “popper” tape. For deeper wells, an electrical “sounding” meter is used (Figure 5).

A popper tape is a measuring device having a bell-shaped, brass “popper” attached to its end. The tape is lowered slowly into a well until the popper just contacts the water surface, thereby emitting a popping sound that can be heard at the ground surface. Once the sound is heard, the tape reading is taken. This measurement method is effective for relatively shallow measurements (i.e., less than about 50 ft.) where the water level is above the top of the screened interval in the well.

With the electrical sounding meter, an audible buzzing sound is emitted when two electrical contacts at the end of the tape touch the water surface, thereby closing the electrical circuit. This measurement method is most effective for water level depths greater than 50 feet. Both methods are used in the monitoring program to measure groundwater levels to the nearest hundredth of a foot (0.01 ft.).

Figure 5: Popper tape (left) and electrical sounding tape (right).

Benchmark surveys are used in the program to accurately measure the top-of-casing for use as reference elevations at each observation well for the calculation of groundwater elevations. The groundwater elevation at each measured well is computed by subtracting the tape reading from the top-of-casing reference elevation to provide groundwater elevations in feet amsl using the NGVD-29 vertical datum.

DTW measurements taken at wells, in general, represent depth to the water table below land surface and are given in the unit of feet below ground surface (bgs). For preparing contour maps of DTW in agricultural areas, the water table depth or DTW is computed by subtracting the groundwater surface elevation from the average elevation of the surrounding agricultural fields. Because adjacent agricultural fields are often at slightly different elevations across a field break, off-sets in DTW contours can develop in the contour maps.

Groundwater Maps

For the water level monitoring program, DTW contour maps are prepared by YAO for the following areas and schedules:

- **South Gila Valley and Yuma Valley** – maps prepared on a monthly basis.
- **Reservation Division –** maps prepared on a quarterly basis using data collected in March, June, September, and December.
- **Wellton-Mohawk area** - maps prepared on a quarterly basis using data collected in January, April, July, and October.

An example DTW contour map is provided as Figure 6. This map shows the DTW for a portion of Yuma Valley in December 2015. The area shown includes Morelos Dam, the City of Yuma, and a number of drainage wells (black triangles) and observation wells (blue circles). The observation well measurements and contour lines showing the approximate water table depth are given in feet bgs. The example map shows a broad ridge of shallow groundwater extending generally southwest from Yuma Mesa towards the Colorado River where the groundwater surface deepens.

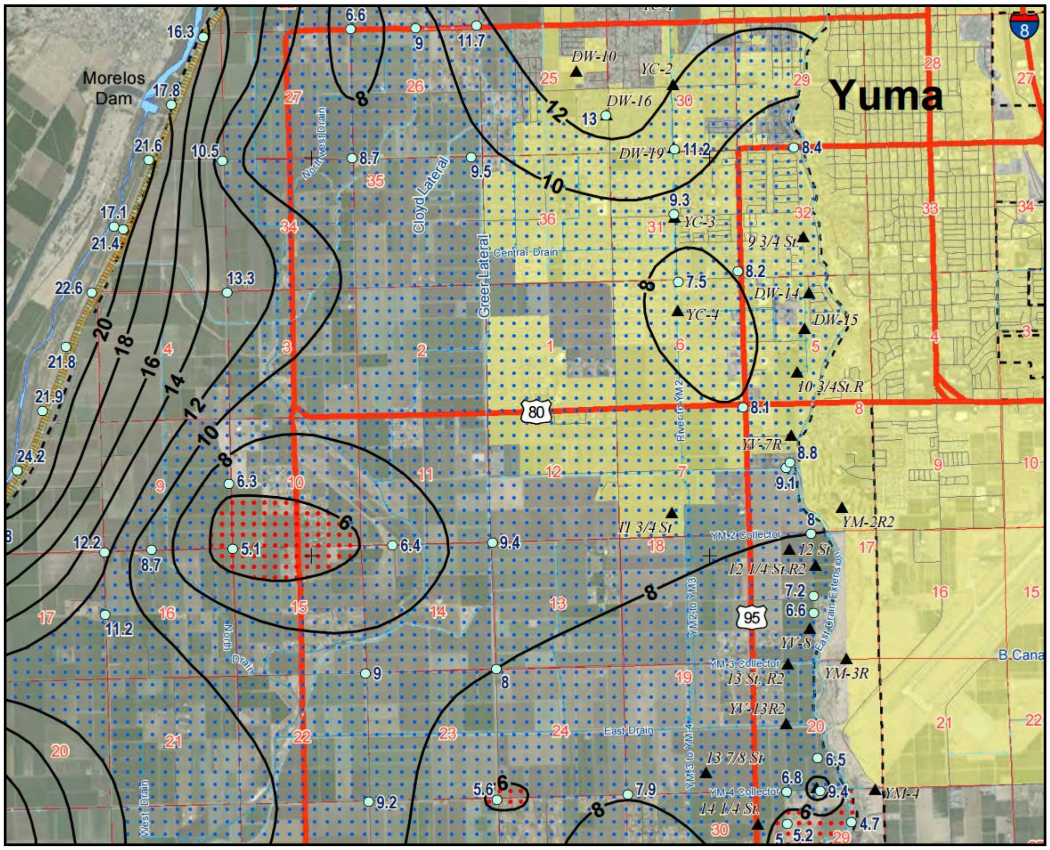

Figure 6: Portion of the December 2015 depth-to-groundwater map of the northern Yuma Valley.

Groundwater elevation contour maps for the entire Yuma area (not including the Wellton-Mohawk area) are prepared by YAO semi-annually in June and December. These maps show groundwater levels in reference to mean sea level. Both the June and December 2015 maps are provided in Appendix B as Figures B-2 and B-3, respectively. These maps can also be viewed at the Reclamation website:

http://www.usbr.gov/lc/yuma/programs/YAWMS/GROUNDWATER_maps.cfm

The June 2015 groundwater elevation contour map for the Yuma area (Figure B-2) shows lines of equal groundwater elevation in feet amsl. The contours describe the shape of the groundwater surface or water table for the upper portion of the aquifer system where unconfined aquifer conditions exist. Groundwater elevations range from a high of just over 170 feet amsl, south of the City of Yuma in the area of Yuma Mesa, to a low elevation of about 24 feet amsl near the Southerly International Boundary (SIB) with Mexico. The area of high groundwater elevations beneath Yuma Mesa is associated with a groundwater mound produced by recharge to the aquifer from the infiltration of agricultural irrigation water. Groundwater flows from areas of high hydraulic head (or water level in a well) to areas of low hydraulic head in a direction generally perpendicular to the groundwater elevation contours. Therefore, groundwater generally flows radially outward from the Yuma Mesa mound in all directions. In particular, it flows west to Yuma Valley and north to the South Gila Valley. Groundwater flow from the mound has tended to raise groundwater levels in these two valley areas and is part of the reason drainage pumping is necessary. In other areas of the map undulating contours (such as in northern and central Yuma Valley) indicate locations where the groundwater surface is nearly flat. Additionally, offsets in the contours southeast of the mound occur along the Algodones Fault suggesting that this fault is behaving as a hydraulic barrier to groundwater flow.

A comparison of the contour lines between the June 2015 (Figure B-2) and December 2015 (Figure B-3) maps indicate that the overall shape of the groundwater surface in the Yuma area is relatively consistent throughout the year with only subtle changes in shape and magnitude occurring between monitoring events.

Groundwater Basin Subareas

The Yuma area groundwater basin is divided into subareas distinguished by physical features and hydrologic characteristics. Subareas of the Yuma area groundwater basin include the North Gila Valley, Reservation Division, South Gila Valley, Yuma Mesa, and Yuma Valley areas (Figure 7). The Wellton-Mohawk area is technically not a part of the Yuma area basin, but is included in the monitoring program because of its close association to the basin (Figure B-1).

The following describes the features of each area and provides select groundwater contour maps from the 2015 monitoring program for discussion. These maps are considered to be representative for each area and are provided in Appendix B. All the maps prepared for the annual program can be located at the Reclamation website listed above.

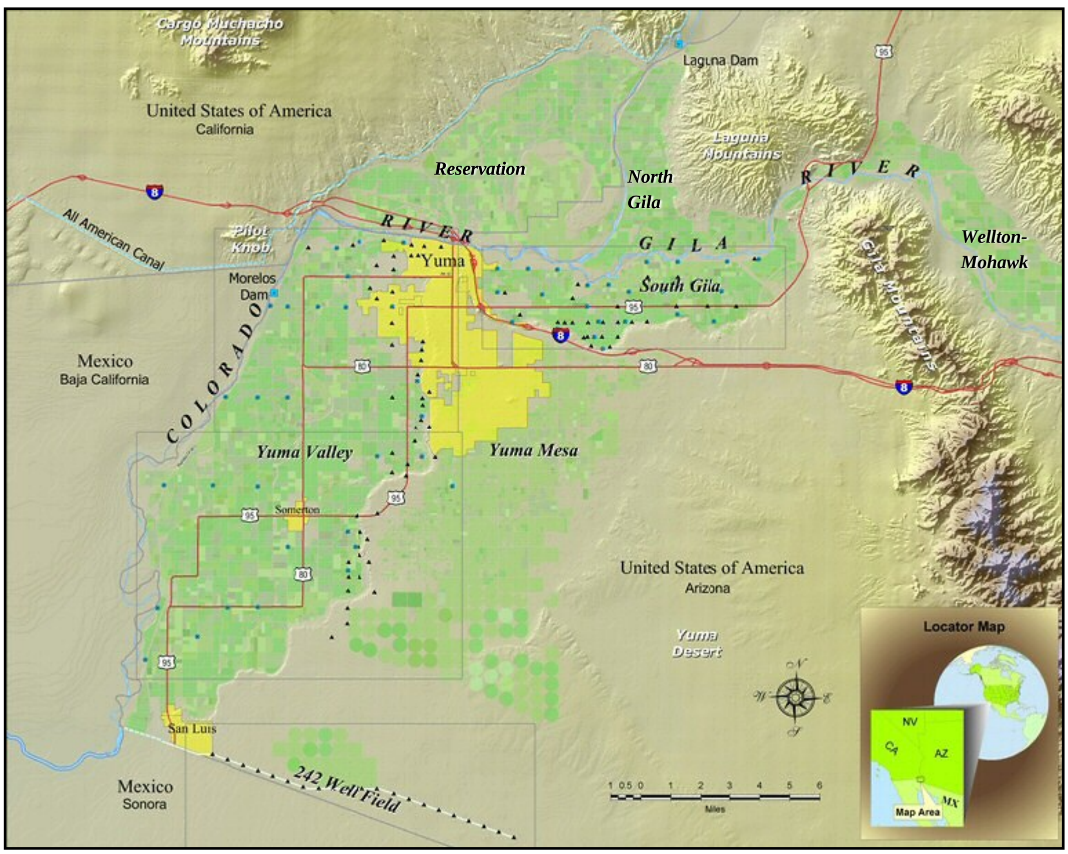

Figure 7: Map showing locations of groundwater basin subareas near Yuma, AZ.

North Gila Valley

The North Gila Valley is located in southwestern Arizona, northeast of the City of Yuma. The valley is situated east of the Colorado River, west of the Laguna and

Gila Mountains, south of Laguna Dam, and north of the Gila River. Irrigation water for the North Gila Valley is delivered through the Gila Gravity Main Canal (GGMC), which traverses the base of the mountains at the eastern edge of the valley. Land surface elevations range from 180 feet amsl along the GGMC to 130 feet amsl near the Colorado River at the southwestern corner of the valley.
For the North Gila Valley area, a total of 49 observation wells were used for groundwater monitoring in 2015, including 4 well clusters, each having a shallow, medium, and deep piezometer. Groundwater levels were measured quarterly in March, June, September, and December. DTW contour maps are not routinely prepared for this sub-area, but groundwater elevations for this area are contained within the regional groundwater elevation contour map for June and December, provided as Figures B-2 and B-3, respectively.

As summarized in Table 1, DTW measurements in 2015 ranged from 5.9 to 26.2 feet bgs with an average depth of 14.8 feet bgs. Groundwater elevations ranged from 119.1 to 153.5 feet amsl, with an average of 130.9 feet amsl.

Table 1 – Groundwater Depth and Elevation, North Gila Valley

2015 North Gila Valley Groundwater Depth (feet bgs)			
	Average	Minimum	Maximum
March	15.2	6.0	26.1
June	14.5	5.9	26.2
September	14.7	6.4	26.1
December	14.8	6.0	26.1
Annual Average	**14.8**	**6.1**	**26.1**

2015 North Gila Valley Groundwater Elevation (feet amsl)			
	Average	Minimum	Maximum
March	130.5	119.2	152.4
June	131.1	119.1	153.4
September	130.9	119.3	153.5
December	130.9	119.2	153.0
Annual Average	**130.9**	**119.2**	**153.1**

Figure 8 shows a water level hydrograph prepared for this subarea. The hydrograph provides groundwater elevation data from 2004 to 2015 for the well cluster “1 $\frac{3}{4}$N−5 $\frac{7}{16}$E” located along the Colorado River in the North Gila Valley. The cluster has shallow, medium, and deep piezometers constructed to depths of 25.7, 54.7, and 92.4 feet, respectively. The hydrograph shows that groundwater levels for the shallow and medium piezometers track closely and have a strong correlation. Groundwater levels in the deep piezometer track differently from the other two, probably because the deep piezometer is separated from the others by clayey/silty soils, which provides some hydraulic separation.

The hydrograph shows that the hydraulic head (or water level in the piezometer) increases with increasing depth. Since groundwater flows from high hydralic head to low hydraulic head, this indicates that there is a vertical component of upward flow at this location.

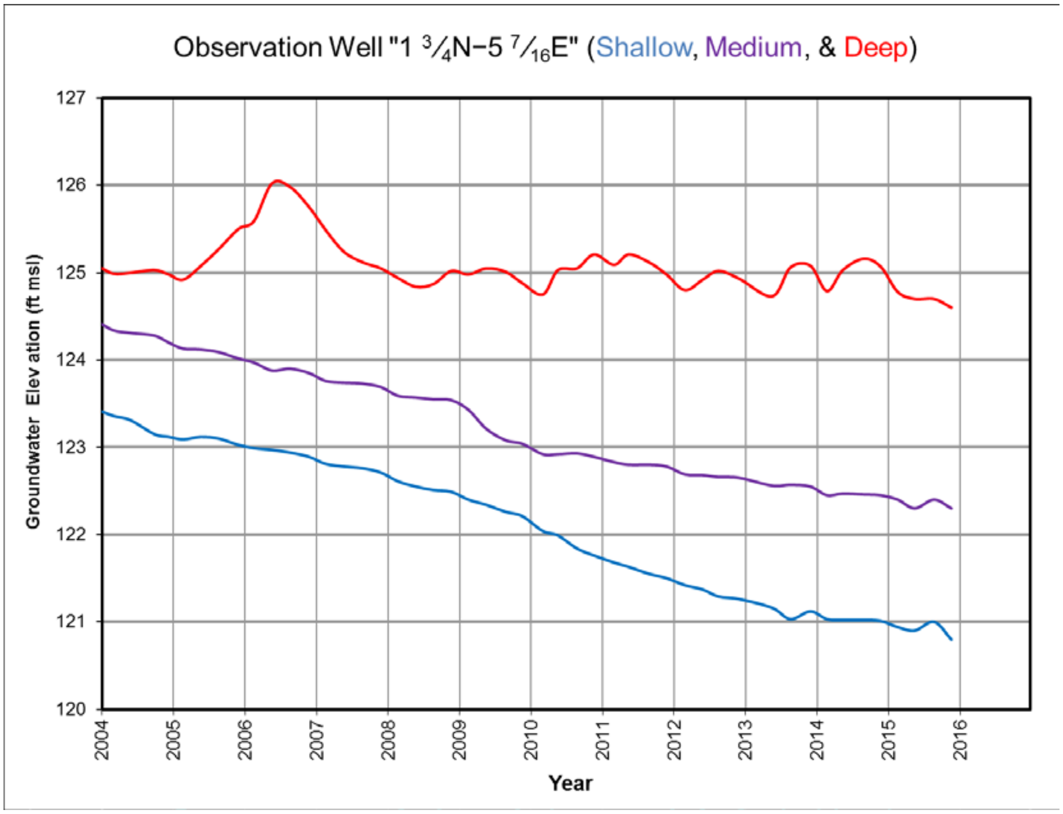

Figure 8: Hydrograph of cluster well "1 ¾N−5 7⁄16E" showing groundwater elevation in shallow, medium, and deep piezometers during 2004-2015.

Reservation Division

The Reservation Division is located in southeastern California north of the City of Yuma. The Reservation Division includes the Indian Unit, the Bard Water District, and for purposes of this report, the "Island." This agricultural valley is situated to the west and north of the Colorado River below Laguna Dam. The AAC flows south along the northwestern edge of the valley and delivers water to the various smaller canals and laterals of the Division.

The Reservation Division has a long history of water level monitoring with the first record of measurements taken in September 1911 using 12 observation wells. This early monitoring program was implemented to monitor hydrologic effects from the newly operational Yuma Main Canal (also referred to as the High Line Canal) that transported irrigation diversions from Laguna Dam to the Colorado

River Siphon. By 1915, there were 74 observation wells in the Reservation Division.

On June 7, 1920, flooding from the Colorado River breached the narrow meander neck near County Avenue 4E and the Reservation Levee Road. The avulsive flood event created what is now called the Island portion of the Reservation Division. As a result, two oxbow lakes formed in the abandoned river channel, Bard Lake and Haughtelin Lake. The larger Haughtelin Lake has been used as a source of off-stream pumping for irrigation in the Island. Observation wells were not established in the Island until the mid-1950s.

By 1937, water level measurements were being taken monthly in about 90 to 95 wells in the Reservation Division. Later that year 44 additional wells were installed to monitor the eventual operation of the AAC. By 1940, when the AAC became operational, the measurement frequency increased to three to four times per month until late 1943 and included 25 staff gages to measure flow (stage height) throughout the open-ditch drain network. The data during this time period were primarily displayed as north-south cross-sections starting at the AAC and having a ½-mile spacing. By December 1962, monthly water level measurements were being taken in about 175 wells.

For the 2015 monitoring period, there were a total of 134 observation wells available for monitoring in the Reservation Division. Measurements were performed quarterly in March, June, September, and December. As shown in Table 2, the 2015 depth-to-groundwater measurements ranged from 1.8 to 49.0 feet bgs with an average depth of 10.7 feet bgs. Groundwater elevations ranged from 110.1 to 144.8 feet amsl, with an average of 123.9 feet amsl.

Table 2 – Groundwater Depth and Elevation, Reservation Division

2015 Reservation Division Groundwater Depth (feet bgs)			
	Average	Minimum	Maximum
March	10.9	2.2	49.0
June	10.6	1.8	47.8
September	10.5	1.8	47.1
December	10.9	2.2	48.8
Annual Average	**10.7**	**2.0**	**48.2**

2015 Reservation Division Groundwater Elevation (feet amsl)			
	Average	Minimum	Maximum
March	123.4	110.1	137.8
June	123.9	110.1	140.5
September	124.4	110.1	144.8
December	123.9	110.5	140.7
Annual Average	**123.9**	**110.2**	**141.0**

Figure B-4 in Appendix B provides a representative DTW contour map for the Reservation Division. This map shows that the depth to the water table in March 2015 was generally about 6 to 18 feet bgs in most areas. Some undulations in the water depth contours occur due to the relatively flat gradient of the water surface. Subtle changes in the DTW contours are visible from quarter to quarter where shallow areas of groundwater expand and contract slightly or change shape (contrast Figure B-4 to B-5). But overall, the groundwater surface appears to be rather consistent.

South Gila Valley

The South Gila Valley is located in southwestern Arizona immediately east of the City of Yuma. The valley is situated south of the Colorado and Gila Rivers, west of the Gila Mountains, and north of the Yuma Mesa. Land surface elevations range from 180 feet amsl at the eastern edge of the valley to 120 feet amsl near the Colorado River at the Yuma East Wetlands. Irrigation water is conveyed southward to the area through the GGMC to the South Gila Main Canal, which traverses near the base of the Yuma Mesa. Drainage of excess irrigation water in South Gila Valley and groundwater inflow from the Yuma Mesa mound is achieved by extensive drainage pumping.

For the 2015 monitoring period, there were a total of 120 observation wells available for groundwater monitoring. These wells are measured during the first week of every month. As shown in Table 3, depth-to-groundwater measurements during 2015 ranged from 2.6 to 37.6 feet bgs with an average groundwater depth of 13.6 feet bgs. Groundwater elevations ranged from 116.0 to 151.8 feet amsl, with an average of 130.4 feet amsl.

Table 3 – Groundwater Depth and Elevation, South Gila Valley

2015 South Gila Valley Groundwater Depth (feet bgs)			
	Average	Minimum	Maximum
January	14.1	5.1	37.6
February	13.8	4.8	37.6
March	13.6	4.5	37.6
April	13.4	4.7	37.5
May	12.9	2.6	37.4
June	12.8	3.7	37.4
July	13.1	3.8	37.3
August	13.0	4.7	37.3
September	14.0	5.0	37.3
October	13.6	4.6	37.3
November	13.7	4.6	37.4
December	14.8	5.0	37.4
Annual Average	**13.6**	**4.4**	**37.4**

2015 South Gila Valley Groundwater Elevation (feet amsl)			
	Average	Minimum	Maximum
January	129.8	116.6	150.4
February	129.9	116.3	150.2
March	130.6	116.0	150.2
April	130.8	116.3	150.5
May	131.3	116.2	150.8
June	131.4	116.5	151.2
July	131.1	116.3	151.4
August	130.7	116.7	151.5
September	130.1	116.5	151.5
October	130.0	116.5	151.8
November	129.9	116.5	151.2
December	129.4	116.6	151.1
Annual Average	**130.4**	**116.4**	**151.0**

A representative DTW contour map for the South Gila Valley is provided in Appendix B as Figure B-6. This map shows that the depth to the water table in January 2015 was generally about 12 to 16 feet bgs in most areas. Some undulation in the contours is apparent due to the relatively flat gradient of the water surface. Offsets in the contours occur in some areas where the land surface abruptly changes by several feet at field breaks. Subtle changes in the DTW contours are visible from month to month, but the overall shape appears to be rather consistent.

Wellton-Mohawk Area

The Wellton-Mohawk area is located in southwestern Arizona along the Gila River floodplain. The town of Wellton is near the middle of the area, approximately 30 miles east of Yuma. Land surface elevations in this area range from 160 feet amsl near the western end of the agricultural area to about 330 feet amsl near the eastern end of the area.

Irrigation water is delivered by the GGMC through the Gila River Siphon to the Wellton-Mohawk Main Canal. Irrigation water is then lifted through a series of pump stations to reach the higher elevations at the eastern end of the agricultural area.

The WMIDD measures the depth-to-groundwater monthly in about 300 observation wells[5] throughout the area and provides the measurement data to YAO, which uses the data to produce depth-to-groundwater contour maps on a quarterly basis (January, April, June, and October). As shown in Table 4, DTW measurements taken in 2015 from the Wellton-Mohawk area ranged from a minimum of 1.0 feet bgs to a maximum of 16.8 feet bgs. The average DTW for the area was 9.1 feet. Groundwater elevations ranged from 198.8 to 307.0 feet amsl, with an average of 250.3 feet amsl.

Table 4 – Groundwater Depth and Elevation, Wellton-Mohawk Area

2015 Wellton-Mohawk Area Groundwater Depth (feet bgs)			
	Average	Minimum	Maximum
January	8.6	1.0	15.8
February	10.7	6.1	15.8
March	9.4	3.8	15.8
April	10.4	3.8	15.8
May	8.0	3.8	12.7
June	7.9	3.8	12.7
July	8.1	3.8	12.7
August	8.2	3.8	12.7
September	8.1	3.8	12.7
October	10.5	3.8	16.5
November	10.1	1.2	16.8
December	9.6	6.6	12.7

[5] http://www.wmidd.org/irrigation.html

Annual Average	9.1	3.8	14.4
2015 Wellton-Mohawk Area Groundwater Elevation (feet amsl)			
	Average	Minimum	Maximum
January	270.0	192.2	314.3
February	247.1	192.2	305.0
March	238.0	192.2	305.0
April	244.4	192.2	305.0
May	249.8	206.1	305.0
June	268.0	219.4	305.0
July	243.3	206.1	305.0
August	254.8	206.1	305.0
September	239.3	202.2	305.0
October	254.5	206.1	311.9
November	255.7	174.1	312.4
December	238.5	196.9	305.0
Annual Average	**250.3**	**198.8**	**307.0**

Figure B-7 in Appendix B provides a representative DTW contour map for the Wellton-Mohawk area. This map shows that the depth to groundwater in January 2015 is generally about 6 to 18 feet bgs in most areas. Some undulations in the water depth contours occur due to the relatively flat gradient of the water surface. In the eastern portion of the valley, narrowly-spaced groundwater depth contours indicate relative deepening of the water table away from the agricultural fields towards areas of elevated ground. Subtle changes in the DTW contours are visible from quarter to quarter, but the overall shape appears to be rather consistent.

Yuma Mesa

Yuma Mesa is located to the east and south of the City of Yuma, and consists of mixed urban, suburban, agricultural, and undeveloped desert landscapes. The mesa is the largest subarea in the Yuma area groundwater basin and is topographically higher than the nearby valleys. Yuma Mesa is situated south of the South Gila Valley, west of the Gila Mountains, and extends south to the U.S.-Mexico international border. Land surface elevations range from 150 feet amsl near the 242 Wellfield to about 500 feet amsl near the base of the Gila Mountains. The developed portion of Yuma Mesa is underlain by a sizable groundwater mound resulting from the infiltration of agricultural water primarily used for the irrigation of citrus orchards. The groundwater mound is estimated to contain approximately 600,000 acre-feet of water storage above the predevelopment water levels.[6] As noted previously, groundwater flows radially outward from the mound to areas of lower groundwater elevation.

In 2015, a total of 102 observation wells were available for groundwater monitoring on the Yuma Mesa with measurements taken quarterly in March, June, September, and December. DTW contour maps were not prepared for this area in 2015, but groundwater elevations for this area are contained in the regional groundwater elevation contour map for June and December 2015, which are provided as Figures B-2 and B-3, respectively.

For the Yuma Mesa area the YMIDD measures 22 wells and YAO measures 80 wells. As shown in Table 5, depth-to-groundwater measurements in the Yuma Mesa area varied greatly from a minimum of 12.4 feet bgs in agricultural areas to a maximum of 498.2 feet bgs along the U.S.-Mexico border about 30 miles east of San Luis, AZ. The average depth-to-groundwater on the Yuma Mesa was 112.7 feet bgs in 2015. Groundwater elevations ranged from 24.0 to 172.9 feet amsl, with an average of 84.2 feet amsl.

Table 5 – Groundwater Depth and Elevation, Yuma Mesa

2015 Yuma Mesa Groundwater Depth (feet bgs)			
	Average	Minimum	Maximum
March	107.8	13.5	328.3
June	113.2	13.2	498.2
September	116.9	12.4	328.8
December	112.8	13.7	498.2
Annual Average	**112.7**	**13.2**	**413.4**

2015 Yuma Mesa Groundwater Elevation (feet msl)			
	Average	Minimum	Maximum
March	86.8	25.5	170.2
June	87.6	26.7	170.7
September	85.2	24.1	173.0
December	85.6	24.0	172.9
Annual Average	**84.2**	**25.1**	**171.7**

Yuma Valley

The Yuma Valley is situated to the west and southwest of the City of Yuma in the historic, predevelopment Colorado River floodplain. The Yuma Valley is

[6] Dickinson, et al. 2006. Hydrogeologic Framework Refinement, Ground-Water Flow and Storage, Water-Chemistry Analyses, and Water-Budget Components of the Yuma Area, Southwestern Arizona and Southeastern California: U.S. Geological Survey Scientific Investigations Report 2006-5135, 90 pp.

bounded on the north and west by the Colorado River, on the east by Yuma Mesa, and to the south by the U.S.-Mexico international border. Land surface elevations in the Yuma Valley range from about 90 feet amsl near San Luis to 130 feet amsl near the City of Yuma.

Colorado River water is provided to the Yuma Valley by diversion from the AAC to the Yuma Main Canal. Irrigation water deliveries in Yuma Valley are managed by the YCWUA through a system of canals and laterals.

The water table in Yuma Valley is relatively shallow throughout all but the southernmost part of the valley. The shallow water table is the result of the extensive irrigation, abundant discontinuous clay layers in the shallow subsurface, and westward groundwater flow from the Yuma Mesa. Drainage wells and deep-cut drainage ditches are typically used to collect shallow groundwater from irrigated areas throughout the valley to aid in controlling the water table depth. The drains generally flow from north to south through the valley and terminate at the Boundary Pumping Plant at the Southerly International Boundary (SIB) near San Luis, AZ. The drain water is then pumped into the Sanchez Mejorada Canal and delivered to Mexico for use as agricultural water.

During 2015, a total of 149 observation wells were available for monthly groundwater monitoring in the Yuma Valley with measurements taken during the first week of each month. For the Yuma Valley area, the YCWUA measures water levels in 69 wells and YAO measures water levels in 80 wells.

As shown in Table 6, depth-to-groundwater measurements ranged from a minimum of 0.1 feet above ground surface to a maximum depth of 56.2 feet bgs in the Colorado River limitrophe near the SIB. In 2015, the average depth-to-groundwater for the Yuma Valley was 14.1 feet bgs. Groundwater elevations ranged from 34.7 to 115.1 feet amsl, with an average of 97.5 feet amsl.

Table 6 – Groundwater Depth and Elevation, North Gila Valley

2015 Yuma Valley Groundwater Depth (feet bgs)			
	Average	Minimum	Maximum
January	14.2	4.2	51.7
February	14.4	4.2	52.6
March	14.3	3.7	53.8
April	14.0	1.3	55.2
May	13.6	-0.1	56.2
June	13.6	2.0	52.1
July	13.8	2.7	52.9
August	13.8	2.4	53.4
September	14.2	3.8	54.1
October	14.2	4.7	53.2
November	14.2	4.1	53.9
December	14.3	3.3	54.5
Annual Average	**14.1**	**3.0**	**53.6**

2015 Yuma Valley Groundwater Elevation (feet msl)			
	Average	Minimum	Maximum
January	97.4	39.2	115.0
February	97.3	38.4	114.9
March	97.4	37.1	114.8
April	97.7	35.7	114.8
May	97.8	34.7	114.6
June	98.0	38.8	114.8
July	97.7	38.0	115.1
August	97.7	37.5	115.0
September	97.2	36.8	114.8
October	97.4	37.8	114.8
November	97.4	37.1	114.4
December	97.1	36.4	114.6
Annual Average	**97.5**	**37.3**	**114.8**

Figure B-8 in Appendix B provides a representative DTW contour map for the Yuma Valley area. This map shows that the depth to the water table in January 2015 was generally over 8 feet bgs in most areas with small isolated pockets of shallower groundwater in agricultural areas. A large area of shallow groundwater occurs just south and southwest of the City of Yuma, which deepens rapidly in the direction of the Colorado River. The deepest water levels of about 30 feet bgs occur just north of the Town of San Luis.

A comparison of the water level depth contour lines between each month in 2015 indicates that the overall shape of the groundwater surface is relatively consistent throughout the year with subtle changes in the shape and magnitude occurring between monitoring events. However, in some months, primarily April through August, pockets of isolated shallow groundwater appear to enlarge and become more shallow approaching depths of 4 feet bgs or less in some areas. Figure B-9 shows groundwater conditions in June 2015 when areas of shallow groundwater have enlarged and coalesced.

Conclusion

This Annual Groundwater Monitoring Report documents water level monitoring data collected in 2015 by YAO staff and the program partners for use in evaluating groundwater conditions. Over 500 observation wells are monitored for the program and groundwater contour maps are routinely prepared to show current groundwater conditions for assisting water managers and agricultural districts in the Yuma area. The groundwater basin subareas included in the monitoring program are comprised of the North Gila Valley, Reservation Division (including the Island), South Gila Valley, Yuma Mesa, and Yuma Valley areas. For purposes of the report, the Wellton-Mohawk area, a nearby agricultural area, is also included in the monitoring program.

During 2015, the average depth-to-groundwater in the Reservation Division and Wellton-Mohawk area were relatively shallow at 10.7 and 9.1 feet bgs, respectively. The groundwater surfaces in the North Gila Valley, South Gila Valley, and the Yuma Valley subareas were somewhat deeper at 14.8, 13.3 and 14.1 feet bgs, respectively. However, the Yuma Mesa area generally had a much greater depth-to-groundwater, averaging 112.7 feet bgs, primarily due to deepening of the groundwater surface away from the Yuma Mesa recharge mound towards the Mexico border.

Areas of shallow groundwater monitored by the program are of concern to irrigation districts and other water users. The DTW maps prepared under this program are helpful for locating areas of shallow groundwater that could impact agricultural or construction activities and for the planning of dewatering or drainage operations.

During the 2015 monitoring program, DTW contour maps were prepared for the Reservation Division (quarterly), South Gila Valley (monthly), Wellton-Mohawk Valley (quarterly), and the Yuma Valley (quarterly). Although DTW maps are not routinely prepared for the North Gila Valley and Yuma Mesa areas, groundwater conditions for these areas are included in the groundwater elevation contour maps for the greater Yuma area. These maps show contours of equal groundwater elevation for evaluating the shape and magnitude of the groundwater surface. Although subtle changes in water depth do occur over time in response to pumping and irrigation practices, the contour DTW and elevation maps show that conditions are relatively consistent throughout the year.

One groundwater level hydrograph for the North Gila Valley was included in the 2015 Annual Report to show the hydrologic separation between the shallow and deeper portions of the aquifer in this area. The hydrograph shows a decreasing water level trend for the upper portions of the aquifer of about 2 feet since 2004, which is not apparent for the deeper part of the aquifer. Hydrographs for other subareas will be included in future reports to further assess aquifer changes over time that are not readily apparent on the groundwater contour maps.

References Cited

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Appendix A

Chronology of Significant Events

TABLE A-1
HISTORY OF DEVELOPMENT IN THE YUMA AREA

Date	Significant Events
1857	First attempt to build canals in Yuma Valley.
1890	Small private irrigation developments in Yuma Valley.
1892	Small acreage on Yuma Mesa planted to citrus.
1902	Reclamation Act signed. Reclamation Service began survey of Yuma Project.
1904	Yuma Project authorized.
1905	Construction began on Laguna Dam. Reclamation delivered water to Valley Division (Yuma Valley) by pumping from Colorado River.
1908	Diversion of Colorado River water to Reservation Division began.
1909	Laguna Dam completed. Diversion of Colorado River water to North Gila Valley began.
1911	First groundwater observation wells constructed in Yuma Valley and Reservation Division. First groundwater map of Yuma Valley published.
1912	Colorado River siphon completed and began delivering water to Yuma Valley. First observation wells constructed in North Gila Valley.
1913	Construction of open drains began in Reservation Division.
1915	First irrigation well constructed in South Gila Valley.
January 22, 1916	Colorado/Gila flood flows at Yuma reached 220,000 cfs.
1916	Construction of open drains began in Yuma Valley.
1917	Yuma Auxiliary Project (Unit B) authorized.
1918	North Gila Valley Irrigation District established.
1919	Boundary Pumping Plant started operating. Yuma Irrigation District established in South Gila Valley.

TABLE A-1
HISTORY OF DEVELOPMENT IN THE YUMA AREA

Date	Significant Events
June 7-8, 1920	Avulsive change in the Colorado River created the "Yuma Island." Cut-off was near the present Gila and Colorado River confluence. Peak discharge estimated at 175,000 cfs.
1922	B-Lift Pumping Plant completed and began delivering water to Yuma Auxiliary Project on the Yuma Mesa.
1934	Construction began on All-American Canal.
1935	Hoover Dam completed diminishing flood threat in Yuma area and providing a controlled supply of Colorado River water.
1937	Yuma Mesa Division of Gila Project authorized.
1938	Imperial Dam completed. Parker Dam completed.
1940	All-American Canal completed.
1941	Lake Mead filled.
1942	Early field tests and observation wells for the Coachella Canal.
1943	Gila Gravity Main Canal completed. First observation wells constructed in South Gila Valley.
1944	Yuma Mesa Pumping Plant completed and began delivering water for irrigation of the Yuma Mesa.
1944	The United States and Mexico adopted a treaty allotting 1.5 million acre-feet of water per year to Mexico from the Colorado River.
1947	First drainage wells constructed in Yuma Valley. First observation wells constructed on Yuma Mesa. Gila Project Reauthorization Act established the present Gila Project.
1948	Coachella Canal became operational.
1950	Diversions began at Morelos Dam.
1952	Delivery of Colorado River water to Wellton-Mohawk area began.
1955	The Mexican government authorized the drilling of 281 wells in the Mexicali Valley to augment Colorado River water supplies.

TABLE A-1
HISTORY OF DEVELOPMENT IN THE YUMA AREA

Date	Significant Events
1957	The Mexican government authorized the drilling of an additional 100 wells in the Mexicali Valley to augment Colorado River water supplies.
1957	Pilot Knob power plant operational.
1958	Groundwater pumping in Mexicali Valley.
1960	Discharge of Wellton-Mohawk Division drainage water began. Painted Rock Dam completed.
1960	The first nine drainage wells constructed in South Gila Valley.
1964	Twelve additional drainage wells and three supply wells constructed in South Gila Valley. Distribution system completed in South Gila Valley providing delivery of Colorado River water.
1966	Six Reclamation drainage wells constructed in Yuma Valley. Gila River flood water from Painted Rock Dam reached Colorado River.
1967	Twelve drainage wells constructed on Yuma Mesa for future use.
1972	Yuma Mesa Wellfield became operational. Mexico's San Luis Mesa Well Field became operational. Three additional drainage wells constructed in South Gila Valley.
1973	The United States and Mexico adopt Minute 242 of the 1944 Water Treaty establishing a limit on the salinity of water delivered to Mexico.
1977	Construction began on the Protective and Regulatory Pumping Unit (“242 Wellfield”). The Bypass Drain became operational carrying drainage well water from the Wellton-Mohawk Valley to the Gulf of California.
1981	242 Wellfield became operational.
1983	Colorado River high flows. Peak Yuma gage elevation was 130.5 feet on July 4. The peak flow was 32,400 cfs on August 19. Replacement of drainage well YM-2R completed.
1984	Eleven drainage wells completed in northern Yuma Valley (DW-1, DW-2, DW-4, DW-5, DW-7, DW-8, DW-9, YC-1, YC-2, YC-3, YC-4) and one in the South Gila Valley (DW-3).
1988	Groundwater drainage wells DW-17 and DW-18 completed.
1989	Groundwater drainage wells DW-10, 11, 12, 13, 16, and 19 completed.

TABLE A-1
HISTORY OF DEVELOPMENT IN THE YUMA AREA

Date	Significant Events
1990	Groundwater drainage wells DW-14 and 15 completed.
1992	The Yuma Desalting Plant (YDP) began operation with the first desalted water produced in March and desalted water released to the Colorado River on May 6. Operation was terminated after about 9 months.
March 5, 1993	The Gila River flooded resulting in a peak discharge of 24,800 cfs at the Yuma gage and a stage of 124.5 ft msl.
Mar-93	Replacement of South Gila drainage well SG-10R completed. October. Replacement of Yuma Valley drainage well YV-13R2 completed.
April 1994	Replacement of Yuma Mesa drainage well YM-3R completed.
November 1994	Replacement of Yuma Valley drainage well YV-23R2 completed. This is the 2nd replacement well at this site.
December 1994	Replacement of Yuma valley drainage well YV-7R completed. This well site is about 0.2 miles north of the original YV-7.
July 1996	New drainage well SG-14 in the South Gila Valley completed using cable-tool. Final well constructed by Larry Hood.
November 1996	New drainage well in Yuma Valley completed. This well was situated to provide shallow groundwater relief to Padre Rancitos near County 13th St. and the East Main Canal.
December 1996	Replacement well DW-8R completed as a water supply well for the Yuma Desalting Plant and is located in the northwest corner of the facility. The existing well had fallen off in production.
February 1997	Replacement well SG-9R completed in the South Gila Valley. Replacement well YM-7R completed on the Yuma Mesa, but the well failed and was capped.
March 1997	YCWUA completed drainage well YCWUA 14 ½ St. Original well (YCWUA 14 ⅝ St.) was located about ¼ mile west and ⅛ mile south.
March 1997	Replacement well YV-28R completed in the Yuma Valley.
April 1997	YCWUA replaced YCWUA 12 ¼ St. well.
January 1998	YCWUA replaced YCWUA 13th St. well. This is the second replacement well at this site.
February 1998	YCWUA replaced drainage well YCWUA 10 ¾ St. This is the third replacement well at this site.

TABLE A-1
HISTORY OF DEVELOPMENT IN THE YUMA AREA

Date	Significant Events
September 2000	YCWUA installed a new Yuma Valley drainage well (YCWUA 16th St.) at County 16th St. and the East Main Canal.
June 2002	Replacement well YM-2R2 completed; the third well at this site.
September 2003	YCWUA installed a new Yuma Valley drainage well (YCWUA 12th St.) at County 12th St. about 0.1 mile west of the Yuma Main Canal.
February 2004	YCWUA installed a new Yuma Valley drainage well (YCWUA 11 ¾ St.) at Avenue B ½ at the head of an open-ditch drain.
May 2004	YCWUA installed new drainage wells YCWUA 13 ⅞ St. at Ave. B ½ just north of County 14th St. and YCWUA 16 ½ St. at County 16 ½ St. and the Yuma Main Canal.
June 2004	YCWUA installed a new Yuma Valley drainage well (YCWUA 17 1/4 St.) near County 17 St. and the Yuma Main Canal.
2009	Completion of the All-American Canal Lining Project from Pilot Knob to Drop 3.
April 4, 2010	Magnitude 7.2 earthquake shook the Yuma area and destroyed about 1/3 of the irrigation canals in the Mexicali Valley.
May 3, 2010	Pilot run of the YDP began and operated continuously for about 11 months.
October 2012	Pilot holes LCWSP-3 (660 ft) and LCWSP-4 (620 ft) drilled along the AAC in the Imperial Dunes for future production well sites.
November 2012	Groundwater drainage well YM-3R3 completed to replace the existing drainage well.
January 2013	Replacement of well YCWUA-14th St. completed for YCWUA.
April 2013	Replacement of drainage well YM-8R3 completed. Well site moved east and closer to the Yuma Mesa Conduit.
May-June 2013	Eight additional relief wells completed along the base of Senator Wash Dam between the existing relief wells: RW-3 ½, RW-4 ½, RW-5 ½, RW-6 ½, RW-7 ½, RW-8 ½, RW-9 ½, and RW-10 ½.
August 2013	Replacement well 242-2R completed in the 242 Wellfield.
October 2013	Water supply well LCWSP-1R in the Imperial Dunes was completed to a deeper level (550 ft) with extended pump chamber and screened interval to replace existing well.

TABLE A-1
HISTORY OF DEVELOPMENT IN THE YUMA AREA

Date	Significant Events
November 2013	An additional production well (INWR-3) used for native fisheries was drilled for Imperial National Wildlife Refuge.
February 2014	Replacement well 242-3R completed in the 242 Wellfield.
March 23, 2014	Minute 319 pulse flow water delivered to the Colorado River delta in accordance with Minute 319 of the U.S.-Mexico water treaty. The pulse flow flooded riparian areas throughout the delta and reached the Gulf of California during high tide on May 15.
May 2014	Replacement well 242-4R completed in the 242 Wellfield.
July 2014	Replacement of Yuma Mesa drainage well YM-11R completed.
October 2014	Replacement of South Gila drainage well SG-2R completed.
November 2014	Replacement of Yuma Mesa drainage well YM-9R completed. Existing well had collapsed the previous month.
January 2015	Replacement of Yuma Mesa drainage well YM-2R3 completed. This is the fourth drainage well drilled at this site and was drilled deeper (395 ft) than any of the previous wells.
March 2015	Replacement of South Gila drainage well SG-12R3 completed.
April 2015	Replacement of South Gila drainage well SG-10R2 completed.
June 2015	Replacement well 242-22R completed in the 242 Wellfield.
August 2015	Replacement well 242-21R completed in the 242 Wellfield.
October 2015	Replacement well 242-18R completed in the 242 Wellfield.
December 2015	Report of the Reservation Division observation well resurvey and reconciliation project completed.
December 29, 2015	Replacement of South Gila drainage well SG-714R3 completed to a depth of 685 ft. This experimental deep well produces water with half of the total dissolved solids (1,080 ppm) of its predecessor shallower drainage well.

Appendix B

Project Vicinity Map

And

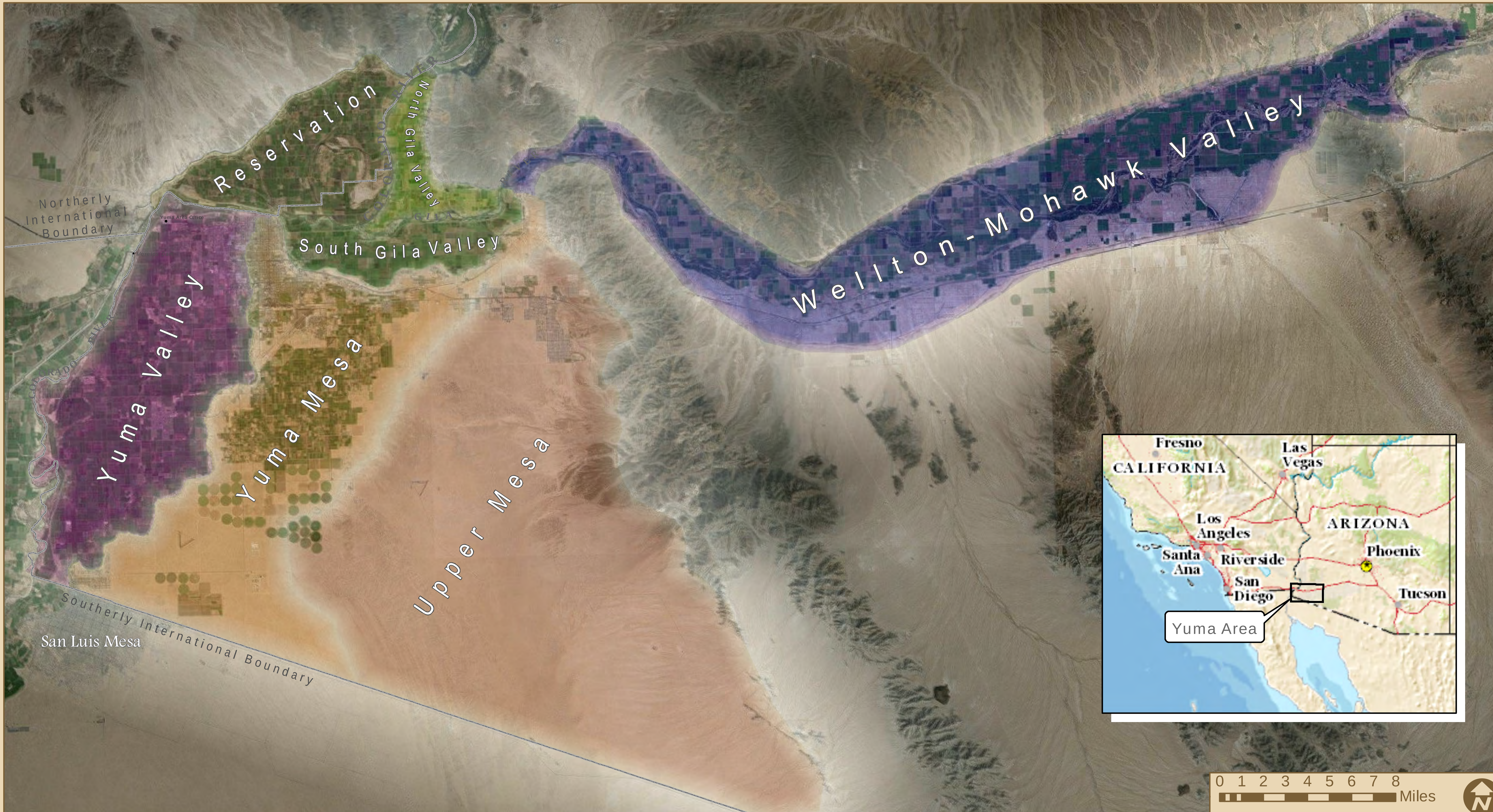
Groundwater Contour Maps

RECLAMATION

Figure B-1

U.S. Department of the Interior
Bureau of Reclamation

Yuma Area

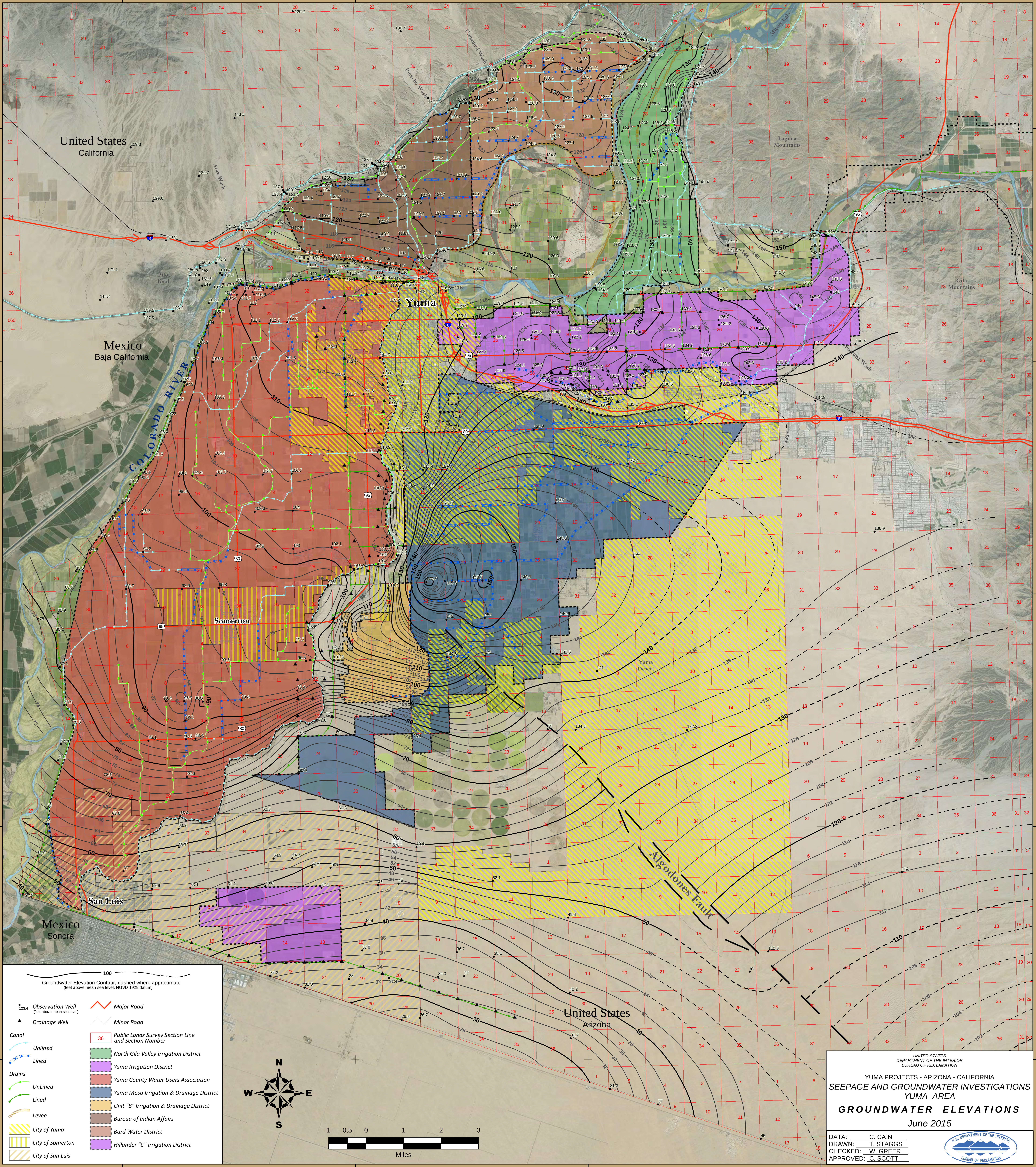


T. Staggs - YAOGIS2016-0060

RECLAMATION
Managing Water in the West

Figure B-2

U.S. Department of the Interior
Bureau of Reclamation



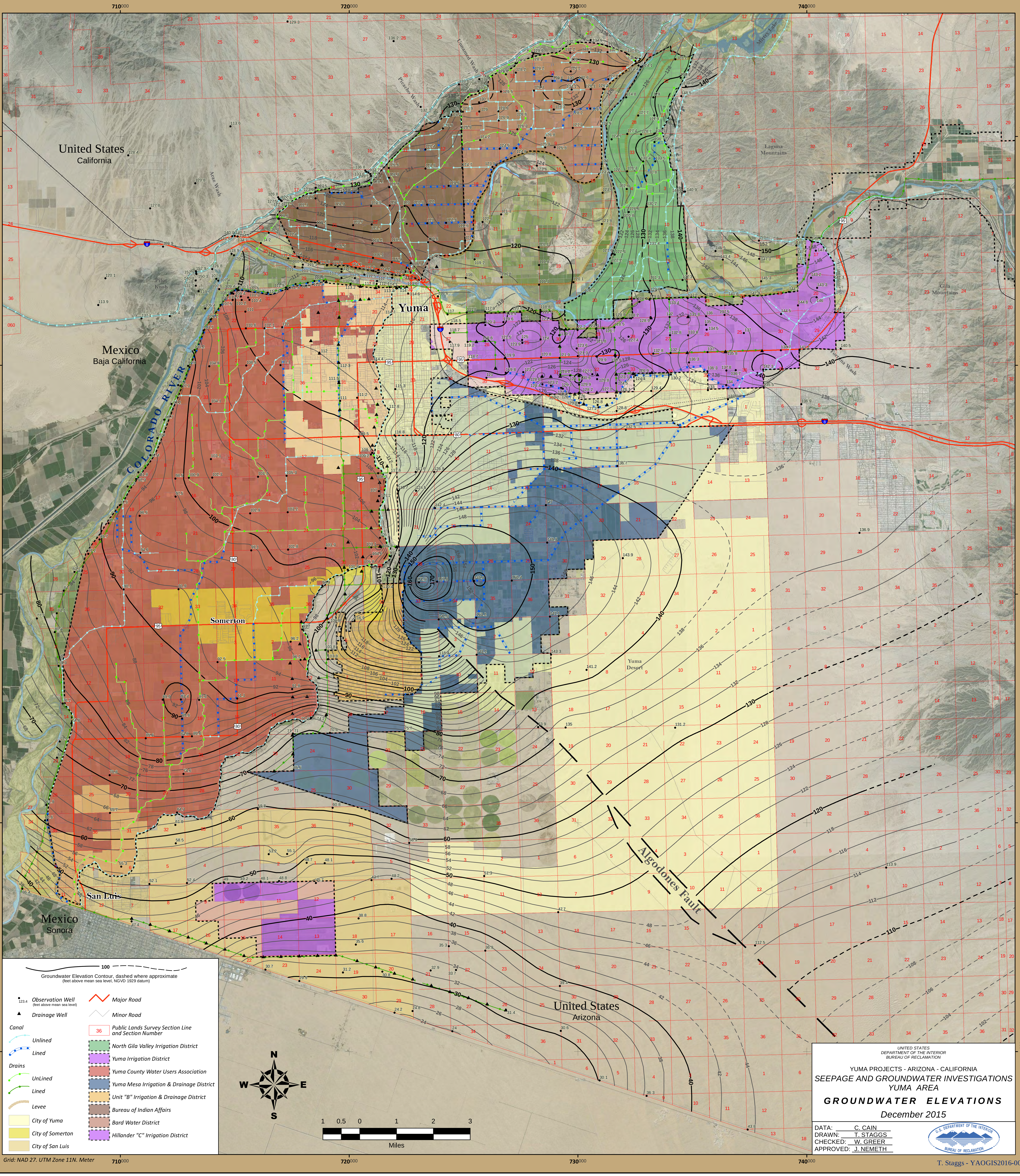
Grid: NAD 27. UTM Zone 11N. Meter

T. Staggs - YAOGIS2015-0086

RECLAMATION
Managing Water in the West

Figure B-3

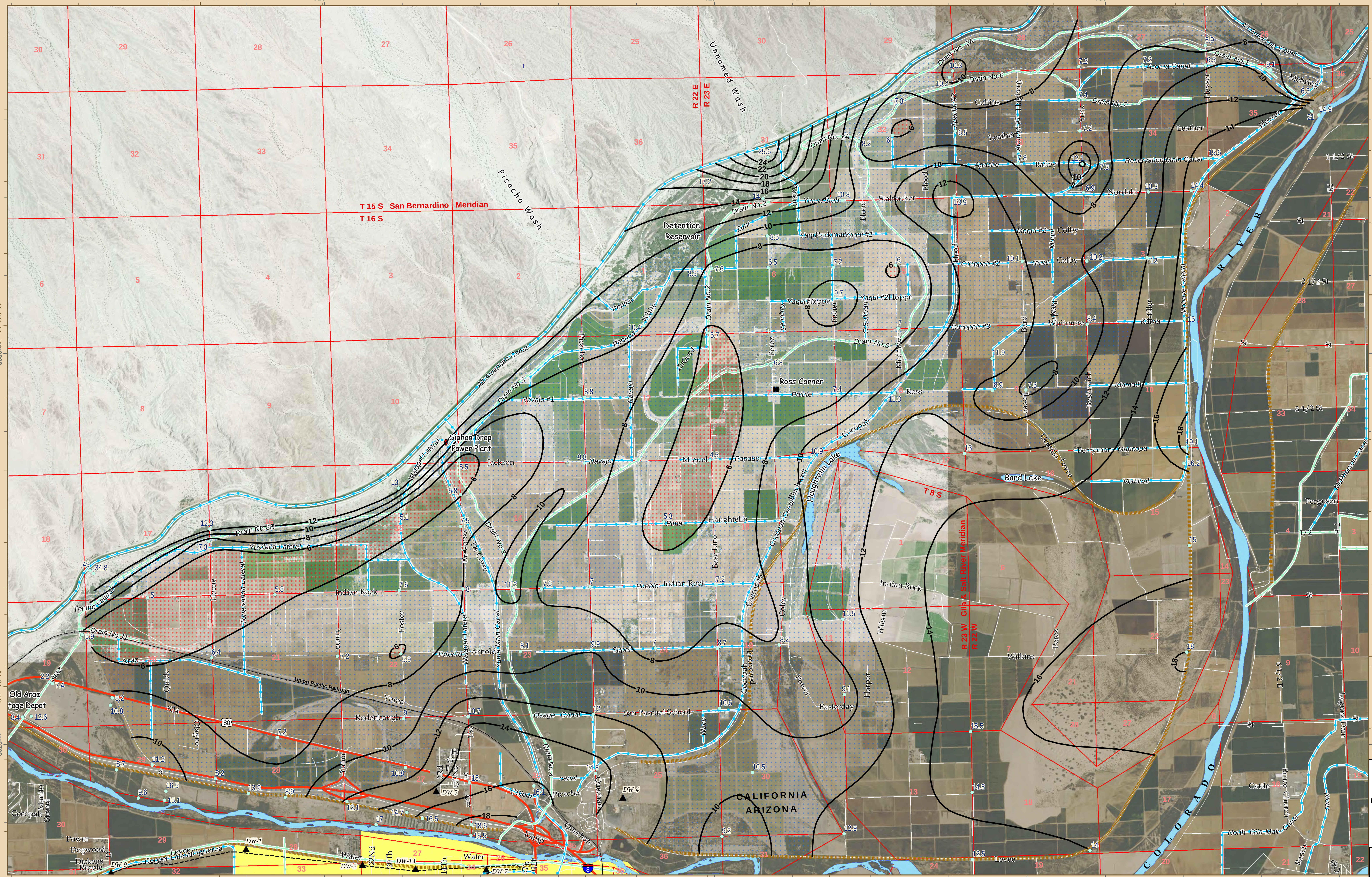
U.S. Department of the Interior
Bureau of Reclamation

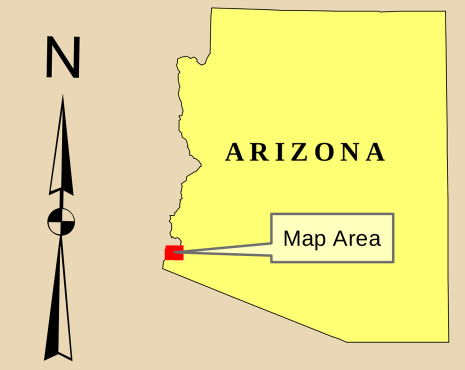


RECLAMATION
Managing Water in the West

Figure B-4

U.S. Department of the Interior
Bureau of Reclamation





Observation Well Reading (ft.)
Drainage Well
Groundwater Contour
Public Lands Survey Section Line and Section Number
State Border
Irrigation District Boundary
Levee
Drains
Canal
Major Road
Road

Depth To Groundwater Color Explanation

0' - 6'
6' - 12'
No shading over 12'

0 0.5 1 Mile

Depth To Groundwater Acreage:

0' to 4' = 0 Acres
0' to 6' = 1,364 Acres
0' to 8' = 7,028 Acres
Groundwater Readings taken:
March 19 to 22, 2015

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YUMA PROJECT - RESERVATION DIVISION
BARD AND INDIAN UNITS - ARIZONA - CALIFORNIA

DEPTH TO GROUNDWATER
March 2015

DATA: C. CAIN
DRAWN: T. STAGGS
CHECKED: A. MARSHALL
APPROVED: C. SCOTT

YAOGIS2015-0052

RECLAMATION
Managing Water in the West

Figure B-5

U.S. Department of the Interior
Bureau of Reclamation

Depth To Groundwater Acreage:

0' to 4' = 130 Acres
0' to 6' = 4,322 Acres
0' to 8' = 11,271 Acres
Groundwater Readings taken:
September 4 to 7, 2015

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YUMA PROJECT - RESERVATION DIVISION
BARD AND INDIAN UNITS - ARIZONA - CALIFORNIA

DEPTH TO GROUNDWATER
September 2015

DATA: C. CAIN
DRAWN: T. STAGGS
CHECKED: W. GREER
APPROVED: C. SCOTT

YAOGIS2015-0111

RECLAMATION
Managing Water in the West

Figure B-6

U.S. Department of the Interior
Bureau of Reclamation

Field Breaks and Wells

A field break is where ground elevation changes, approximately, by more than two feet in a twenty foot distance.

A field break well is not a physical well. It is used to extrapolate more accurate depth to groundwater levels in the vicinity of a field break, where significant changes in the surface elevation will make significant changes in the depth to groundwater level.

Actual wells and field break wells may be located on either the higher elevation or the lower elevation of a field break.

An assumption is made that the change in groundwater level in the near vicinity (1000 ft. distance) of a physical well is insignificant (less than 1/10 ft).

In some locations, the actual well is located within the field break area and field break wells are used on both sides on the field break.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

GILA PROJECT - YUMA MESA DIVISION
SOUTH GILA UNIT - ARIZONA

DEPTH TO GROUNDWATER
January 2015

DATA: T. FOX
DRAWN: T. STAGGS
CHECKED: A. MARSHALL
APPROVED: C. SCOTT

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

YAOGIS2015-0022

Note: The Grid used on this map was established in 1911 by the Bureau of Reclamation to designate observation wells and other structures. It is not the City or County Grid used to identify roads.

RECLAMATION
Managing Water in the West

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Figure B-7

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WELLTON-MOHAWK VALLEY
ARIZONA

DEPTH TO GROUNDWATER
January 2015

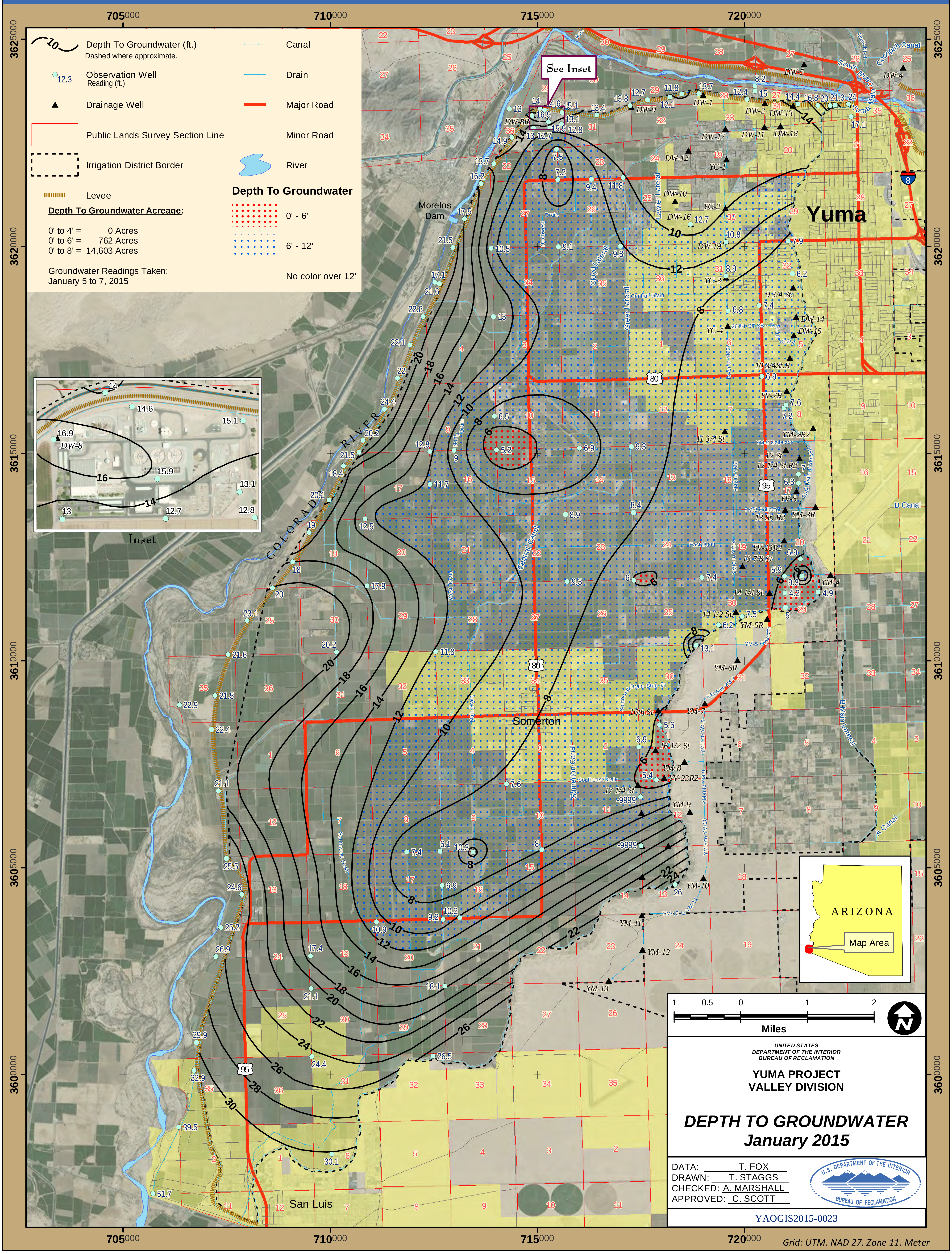
DATA: WMIDD
DRAWN: T. STAGGS
CHECKED: A. MARSHALL
APPROVED: C. SCOTT

YAOGIS2015-0047

RECLAMATION
Managing Water in the West

Figure B-8

U.S. Department of the Interior
Bureau of Reclamtion



RECLAMATION
Managing Water in the West

Figure B-9

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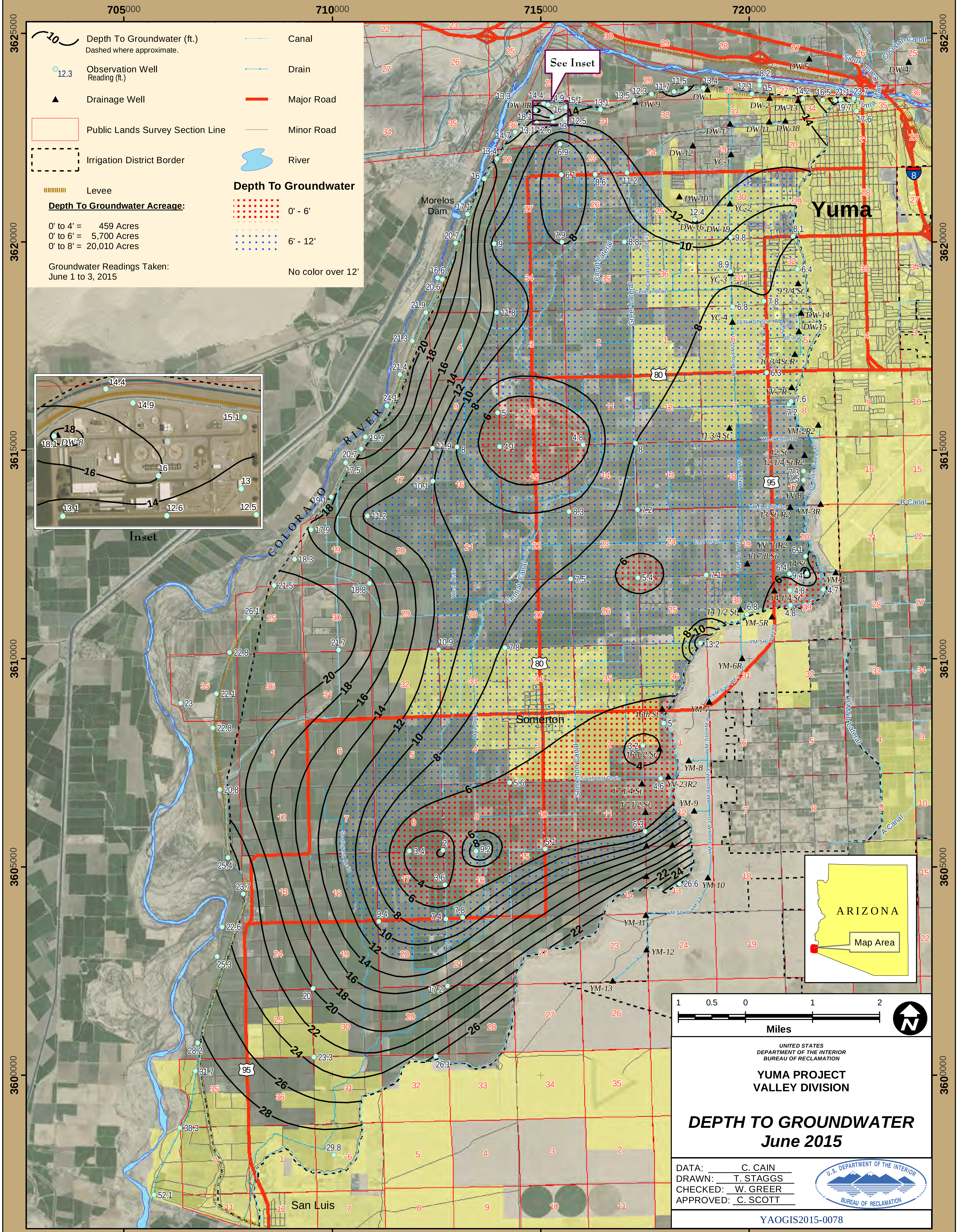

Grid: UTM. NAD 27. Zone 11. Meter