

# Shallow Groundwater Area Monitoring Program

## Water Level Data Collection Procedures

### January 2019

#### Introduction

Groundwater level monitoring is conducted by the Pima County Regional Flood Control District (District) to evaluate the effects of climate and land use changes on local groundwater levels within various watersheds in Eastern Pima County. Monitored watersheds are characterized as those having significant natural resource values such as shallow groundwater (water levels above 50 feet below land surface), important riparian habitat, improved floodplain function and/or passive recreational interest. Water levels are measured in wells primarily owned by the District, but may also include privately owned wells and those managed by other public agencies. Data collection is by various methods including download from a local sensor (datalogger), manual sounding, accessing centralized databases and direct request to other parties.

#### Monitoring Locations

Groundwater levels are currently field measured by the District in five locations and one other watercourse is monitored using water level data supplied by the City of Tucson (Tucson Water) from their production wells. The five (5) areas field measured by District staff are:

- Santa Cruz River between Camino del Cerro and Avra Valley Road,
- Canada del Oro Wash in Catalina, Arizona,
- Santa Cruz River at Canoa Ranch,
- Cienega Creek and Davidson Canyon at the Cienega Creek Natural Preserve,
- San Pedro River near Bingham Cienega Natural Preserve (Redington, AZ).

Water level data supplied by the Tucson Water) is along Tanque Verde Creek from Wentworth Road to just downstream of Sabino Canyon Road. **Figures 1-6** display location maps for the wells along these watercourses.

#### Field Equipment

Field measurements of water level data include direct sounding of a well and downloading a datalogger if one is installed. The following equipment is needed for the site visits to perform these actions:

- Portable sounder or contact meter (w/ batteries)
- Laptop computer
- Direct Read USB cable reader
- USB docking station
- Tape measure or ruler

- Pipe wrench
- Master Lock Keys (2002, 0620 & A620)
- Field form(s)
- Cell Phone
- Calculator (cell phone has one)
- GPS Unit (to locate wells)
- Notebook with map site files
- Pen and/or pencil
- Datalogger operator's manual
- Large paper clip

The District currently has a Powers Well Sounder and a Stevens® Contact Meter for use in directly measuring water levels in wells. The Powers Well Sounder measures in units of feet, with numbers provided for every other foot (on the even numbers). A tape measure or ruler is needed to measure in between the one-foot marks. Note that the cable on the sounder has been broken and stretched – an error chart is located on the meter (one can also be provided) to determine the actual reading. The Stevens® Contact Meter measures in units of meters, so the reading will need to be divided by 3.28 to convert to feet. Make sure to have extra batteries on hand just in case the old ones run out of power.

Software for the dataloggers has been installed on two Toughbook laptop computers. CD ROM disks are available for download onto other computers if necessary or desired. All of the dataloggers have been deployed with a Direct Read cable. This allows the operator to directly connect the sensor to a computer, using the Direct Read USB cable reader, without having to remove the sensor from the well. However, there have been instances where a communication link could not be established (or maintained), thus the need for the USB docking station. The docking station requires the operator to remove the sensor from the well, as it will need to be disconnected from the cable and placed directly into the station.

A field form has been created to document the manual water level measurements taken during the site visits. A copy of the form is provided in **Attachment A**.

### Manual Water Level Measurement

Manual measurements should be taken at each well, including those equipped with dataloggers. The monitoring well caps have been modified with a number of designs that may require a key to remove a locking cap and/or a pipe wrench to remove a threaded pipe cap. Once the cap is removed, a direct measurement can be taken by simply dropping the probe of the sounder or contact meter down into the well; note that the Powers Sounder needs to be turned on before use. The **sounder** will make a repetitive beeping sound once the probe reaches the water level - the power level display on the meter should be at the maximum before taking the reading. Use your hand to mark the point of first water contact and the ruler/tape measure to determine the inches. Calculate the final reading in feet using a calculator and the error chart. The

**contact meter** will only light up once the probe reaches the water. This meter has a graduated tape measure that can be directly read at the point of first water contact. The reading is in meters, so divide by 3.28 to convert it into feet.

### Water Level Datalogger Download

The District has currently deployed In-Situ Rugged TROLL 200 and Rugged BaroTROLL dataloggers at selected sites shown in **Figures 1-6**. The Rugged Troll 200 dataloggers measure water levels with an accuracy of 0.1 percent and at ranges from 30 feet to 250 feet depending on the depth of deployment. Since the Rugged Troll 200 dataloggers are non-vented, no connection to the atmosphere, Rugged BaroTROLL dataloggers have been deployed to compensate for barometric pressure effects. A Rugged BaroTROLL can cover a network of Rugged Troll dataloggers within a 25-mile range.

Once the manual measurement has been obtained, the datalogger can be downloaded. Connect the Direct Read USB cable reader to the computer, turn the computer on and login to the system; note the user name and password are located on a note taped to the computer. Remove the cap from the Direct Read Cable and connect it to the reader. The sensor and cable do place a significant amount of weight on the connection, so you may want to use a large paper clip to hold it in place on top of the well monitoring port.<sup>1</sup>

After logging into the computer, click on the “Win-Situ 5” icon. The program will ask if you want to connect to the device, so press “yes”. The program may let you know that the device (sensor) is not synchronized with the local system (computer). If the computer’s time has been updated, go ahead and press “yes”. If not, press “no”; the device time is usually pretty accurate with real time. Once connected, the program will display the time and the sensor’s temperature, pressure and depth. Click the “Logging” icon (note pad with pencil) and then click on the latest log listed to highlight it (should be the one that is currently running). Click the arrow pointing downward near the bottom middle of the screen and then select “new data”. Once the data has been downloaded (~12 seconds), you can view the information on the data screen by selecting “yes” or go back to the logging screen by selecting “no”. Downloaded data will automatically be saved in a file within the Win-Situ directory folder under the log name.

**Please review the Operator’s Manual for the Rugged TROLL 100 and 200 and Rugged BaroTROLL Instruments for more details and step by step instructions (Pages 33-34).**

---

<sup>1</sup> Many of the dataloggers are secured to the well caps using locking caps, which may need to be removed to access the data port. **A security chain should already be attached to each cable to insure that the sensor does not fall into the well should the connectors be accidentally disconnected.**

Once finished, you can then disconnect from the sensor by selecting “File” and “Disconnect” (or hit the connection button in the bottom right-hand corner) and then exit the system by selecting “File” and “Exit”.

After exiting the program, turn off the computer and disconnect the cable reader from both the sensor and computer. Put the cap back onto the Direct Read Cable and place the well cap securely back onto the monitoring port. **Be sure to lock the cap or well casing before leaving the site.**

### Water Level Datalogger Setup

A new datalogger can be programmed in the office prior to the site visit or on-site. To program a new sensor or reprogram a used sensor, click on the “Logging” icon and then the “New” button (note with a star). The program will ask for the “Site Name”, which you can select from the dropdown list. If the sensor is for a new site, click the “Site” button (circle with a circling arrow), the “New” button, and enter the site name. The check mark button will save all changes. Next, select a name for the log using the current date (i.e., September 28 2018). Then click the right arrow button and select the measurement parameters, logging method, log interval, start/stop conditions, device memory and level reference – pressing the right arrow after each step. The measurement units are as follows: °F for temperature, mmHG for pressure and feet for depth. The logging method is Linear and the log interval is every 6 hours. The log start condition is set at the closest time to the regularly scheduled measurement intervals of 12:00 AM, 6:00 AM, 12:00 PM and 6:00 PM. Device memory is set to overlap data once the memory storage is full. The reference level is “Depth to Water”, with the number being the manual measurement collected using the sounder or contact meter. The final screen will summarize the log setup and, if all is correct, click the check mark button to save the information onto the sensor.

**Please review the Operator’s Manual for the Rugged TROLL 100 and 200 and Rugged BaroTROLL Instruments for more details and step by step instructions (Pages 29-31).**

### New Water Level Data Log

A sensor that is already deployed may need to be reprogrammed due to changing conditions or to recalibrate the depth to water measurement. Reprogramming a sensor is the same as described in the previous section (Datalogger Setup). Prior to writing a new log, the old one will need to be downloaded and then stopped. If there is more than one log in the sensor memory, you will need to delete one of the logs before proceeding to create a new one; the sensor only allows two logs in the memory at one time.

## Barometric Pressure Compensation

All of the water level dataloggers are equipped with non-vented, Direct Read cables. To correct for changes in atmospheric pressure, a barometric datalogger has been deployed in each watershed location. The barometric sensor will cover a range of 25 miles from its deployment. Barometric dataloggers are set up in much the same way as the water level dataloggers, however the device will not need a level reference. Some are equipped with Direct Read cable, but others will require the USB docking station to download.

Once the device is downloaded, data from all water level dataloggers in the vicinity can be adjusted using the BaroMerge software program. Click on the Win-Situ Baro Merge icon and select "Use a Baro TROLL file". Click the button to the right of this selection and then click onto the barometric sensor file. Click the right arrow twice and then select all of the sensors whose data you wish to correct within the range of the barometric datalogger. The check mark will correct all the data for each level sensor selected and save it in a separate file with a BaroMerge extension.

## Centralized Database Review

The Arizona Department of Water Resources (ADWR) maintains a centralized database that displays information on all registered wells (and some unregistered wells) within Arizona, including water levels. This database can be accessed through ADWR's website via the Groundwater Site Inventory (GWSI). A Search Wizard will guide you through the process if you know the GWSI number or general location of the well. A Map can be used to locate all wells within a specific location in Arizona by zooming down to the area desired. Note that the Well Registry (Wells55) can also be used to locate wells with water level data, but you will need to click on the GWSI Site ID (if available) to access the data. Many of the wells have standard water levels that are directly inputted by ADWR staff, but there are some wells equipped with automated dataloggers that will measure water level data periodically and transmit it to the centralized database. Water levels can be reviewed and even downloaded onto a Microsoft Excel Spreadsheet. Note that automated water levels are highlighted in red on a separate tab within the database webpage. The ADWR websites for GWSI and Wells55 are as follows:

GWSI - <https://gisweb.azwater.gov/waterresourcedata/GWSI.aspx>

Wells55 - <https://gisweb.azwater.gov/waterresourcedata/WellRegistry.aspx>

## Direct Request of Data

Tucson Water regularly measures water levels in a number of their production and monitoring wells, keeping a record that may or may not be submitted to ADWR. Many of the wells in the Tanque Verde Creek location are equipped with dataloggers that are downloaded by Tucson Water staff during the Spring months (April-June). Tucson

Water will provide this data upon request – currently performed via an email to the most recent contact:

Mr. Michael Liberti, GIS Project Manager

[Michael.Liberti@tucsonaz.gov](mailto:Michael.Liberti@tucsonaz.gov)

(520) 837-2226

Pima County Natural Resources, Parks and Recreation measures water levels in the monitoring wells near Bingham Cienega Natural Preserve. This data is provided by Mr. Jess Barry on a quarterly basis (annually in July) through reports provided by the department within the County's network drive (V Drive) in the folder labelled Bingham Cienega – RFCD & NRPR. Direct data requests can be made to the current contact, Mr. Jess Barry: [Jess.Barry@pima.gov](mailto:Jess.Barry@pima.gov) or (520) 668-4980.

### Data Review and Management

The District's Water Resources Division (WRD) oversees management of the Shallow Groundwater Area Monitoring program. Mr. David Scalero (Principal Hydrologist) is currently responsible for all program activities including:

- Data collection and management,
- Datalogger purchase and installation, and
- Field measurements.

Microsoft Excel spreadsheets have been developed for each field measured well to track both manual and automated readings. These spreadsheets are located in the District's network drive: Z:Shared Data\_Division Files\_WRD\_Groundwater Monitoring Program\_Water Level Data. The files are organized by watershed. Hardcopies of the field forms are currently kept in a personal file folder, but may be moved to a centralized file folder for the Water Resources Division in the future.

A separate spreadsheet has been developed to track both monthly (1<sup>st</sup> day of the month) and annual (closest measurement to January 1) data. This spreadsheet also includes other data such as stream flow and pumping that are used in the annual report to evaluate causes for water level rises or declines. The spreadsheet and associated data is also available in the District's network drive: Z:Shared Data\_Division Files\_WRD\_Goundwater Monitoring Program.

### Schedule

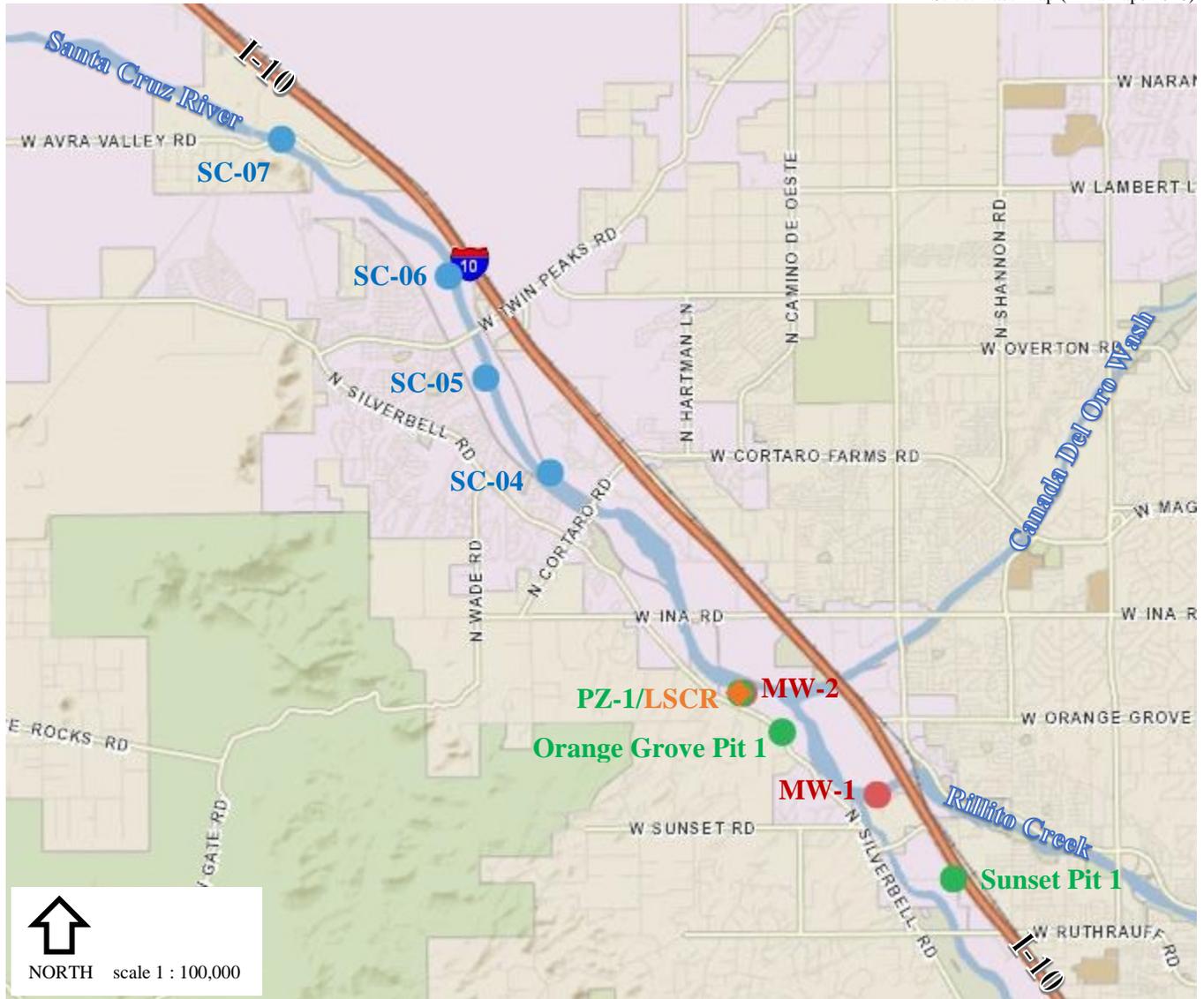
Data collection and reporting coincides with environmental updates by the District for the County's Sustainability Action Plan (SAPCO) and by the Office of Sustainability and Conservation (OSC) for the Multi-species Conservation Plan (MSCP) under the federal "Section 10" permit. Water levels are typically field collected at all sites in **January** and **June** of each year. City of Tucson staff are contacted in **June** to request data from their

wells in the Tanque Verde Creek shallow groundwater areas. ADWR's centralized database is periodically queried to obtain data from the wells they monitor.

Preparation of an annual report begins at the end of the County's fiscal year (**June 30**), with a delivery date for the final report at the end of the Calendar Year (**December 31**). A table of water levels and graphics displaying hydrographs for wells in the CCNP and Tanque Verde areas are prepared and delivered to Mr. Greg Saxe (District) for SAPCO reporting in **July**. Reports and data are also provided to other departments and agencies throughout the year upon request.

**Figure 1. Lower Santa Cruz River Monitoring Wells**

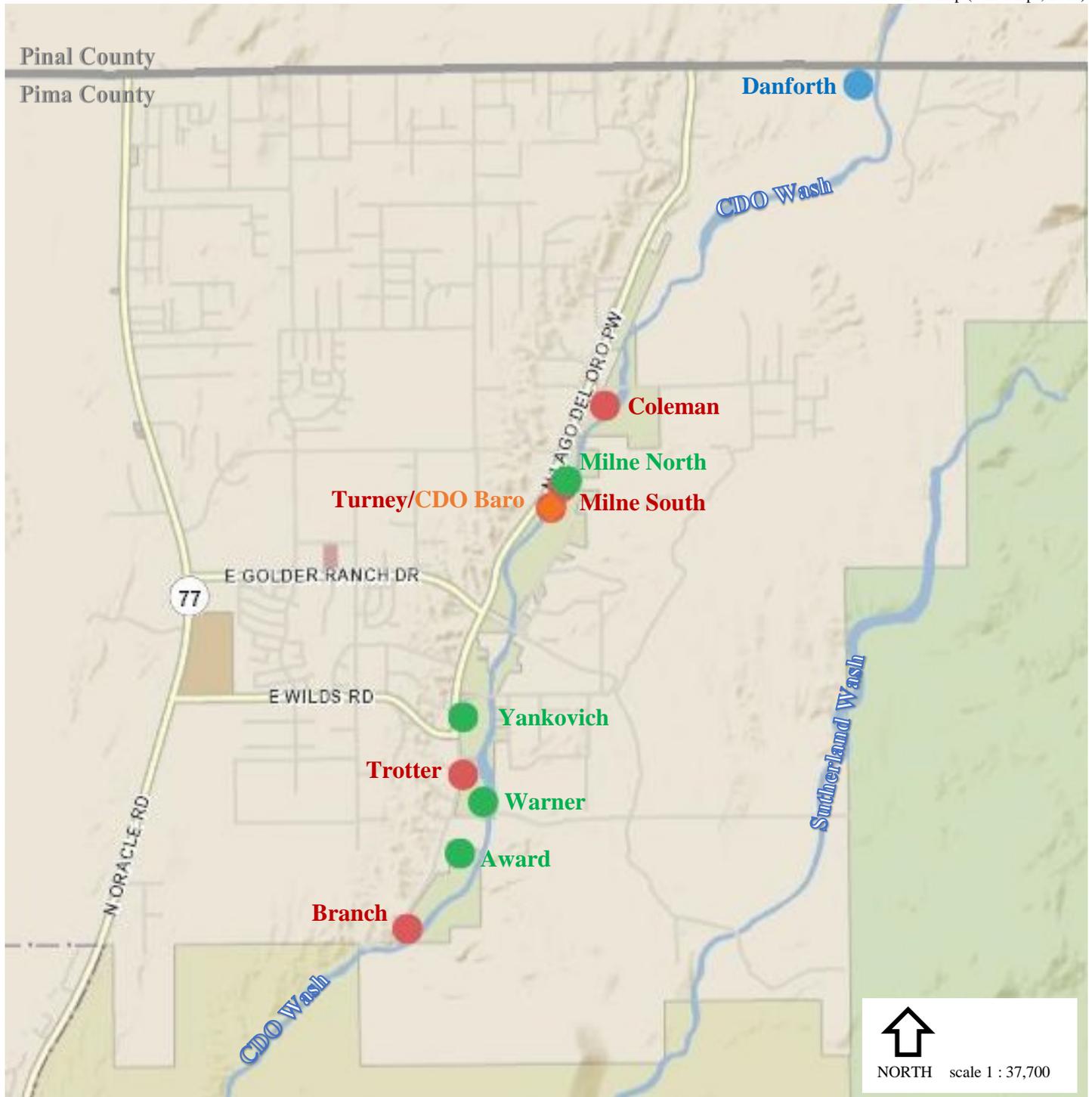
Street Base Map (PimaMaps 2018)



- SC Monitoring Wells (RWRD) - dataloggers in SC-06 & SC-07
- CTRDN Wells (RFCD) - manual readings
- MW Monitoring Wells (RFCD) w/dataloggers
- ◆ LSCR Baro (RFCD) - barometric pressure sensor

**Figure 2. Canada Del Oro Wash (CDO) Monitoring Wells**

Street Basemap (PimaMaps, 2018)



- Private Well - Manual readings
- Monitoring Wells (RFCDD) - Manual readings
- Monitoring Wells (RFCDD) w/dataloggers
- ◆ LSCR Baro (RFCDD) - barometric pressure sensor

**Figure 3. Canoa Ranch Monitoring Wells**

Street Basemap (PimaMaps, 2018)



- Monitoring Wells (ADWR) w/ dataloggers
- Monitoring Wells (RFCD) - manual readings
- Monitoring Wells (RFCD) w/dataloggers
- ◆ Canoa Baro (RFCD) - barometric pressure sensor

**Figure 4. Cienega Creek Natural Preserve Monitoring Wells**

Street Basemap (PimaMaps, 2018)

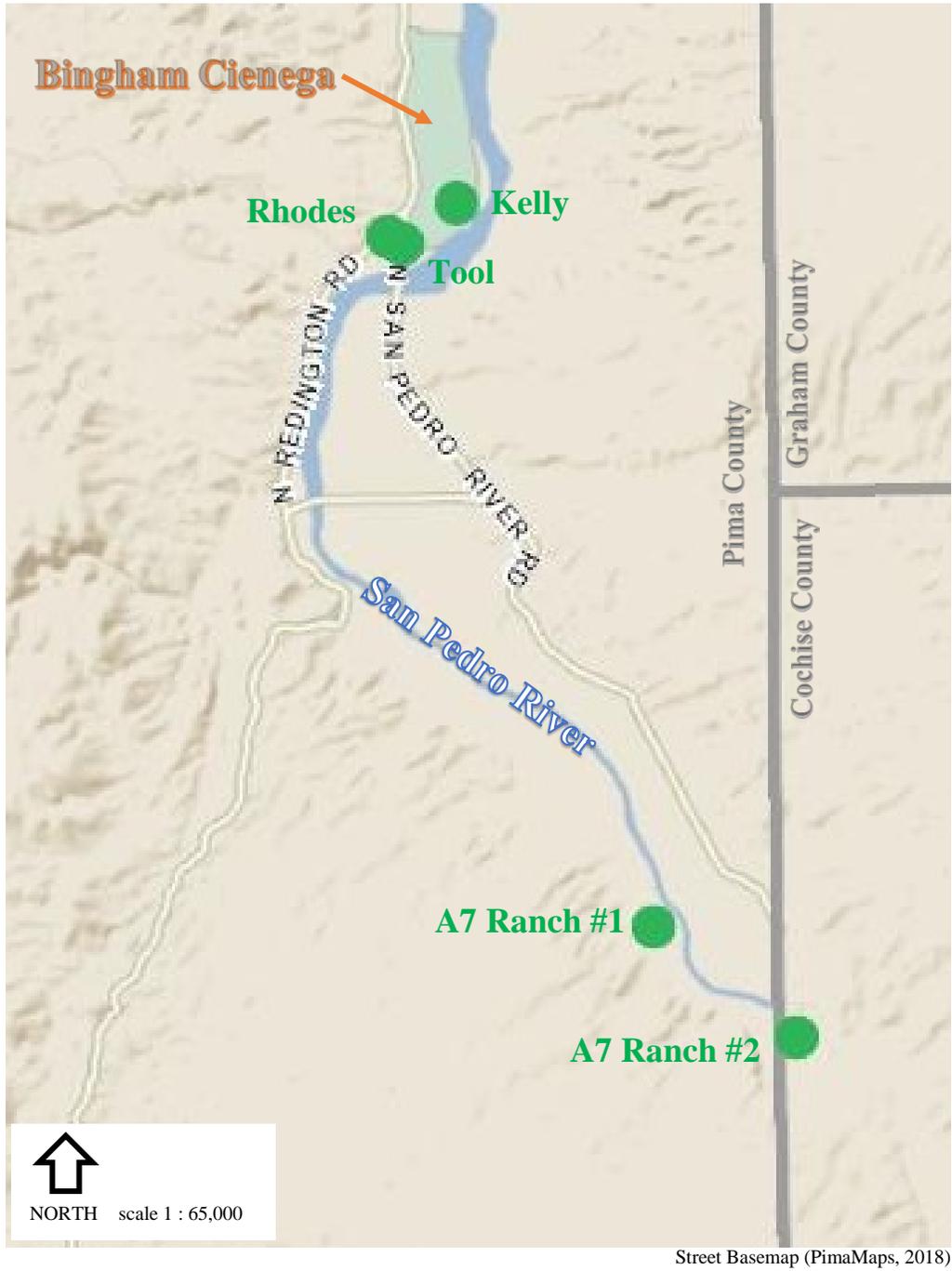


- Monitoring Wells (ADWR) w/dataloggers
- Monitoring Wells (RFCD) - manual readings
- Monitoring Wells (RFCD) w/dataloggers
- ◆ CCNP Baro (RFCD) - barometric pressure sensor



NORTH scale 1 : 140,000

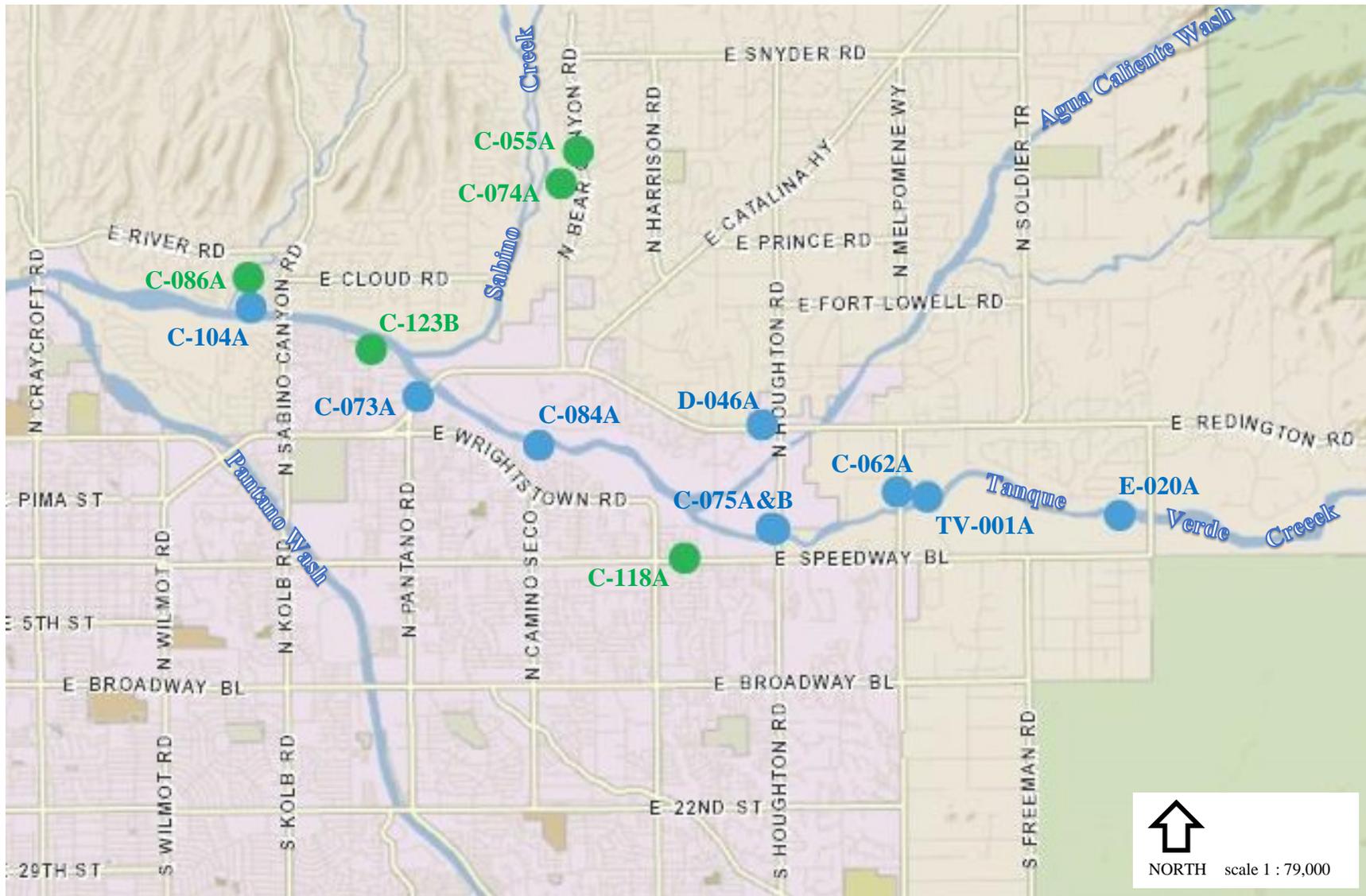
Figure 5. San Pedro River Monitoring Wells



- Monitoring Wells (NRPR & RFCD) - manual readings

**\*All wells are monitored by Pima County Natural Resources, Parks and Recreation. Data are available in their quarterly reports to RFCD (Network V Drive) or upon request.**

Figure 6. Tanque Verde Creek Monitoring Wells



- Monitoring Wells (COT) w/ dataloggers
- Monitoring Wells (COT) - manual readings

Street Basemap (PimaMaps, 2018)

**Attachment A. Pima County Water Level Form – Wells**

Date: \_\_\_\_\_ Watershed: \_\_\_\_\_

Sampler(s): \_\_\_\_\_

-----  
Well Registry #55- \_\_\_\_\_ Well Name: \_\_\_\_\_ Arrival/Departure Time: \_\_\_\_\_

Depth to Water \_\_\_\_\_ (meters) Powers Sounder \_\_\_\_\_ (feet) Adjusted DTW\* \_\_\_\_\_ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: \_\_\_\_\_

-----  
Well Registry #55- \_\_\_\_\_ Well Name: \_\_\_\_\_ Arrival/Departure Time: \_\_\_\_\_

Depth to Water \_\_\_\_\_ (meters) Powers Sounder \_\_\_\_\_ (feet) Adjusted DTW\* \_\_\_\_\_ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: \_\_\_\_\_

-----  
Well Registry #55- \_\_\_\_\_ Well Name: \_\_\_\_\_ Arrival/Departure Time: \_\_\_\_\_

Depth to Water \_\_\_\_\_ (meters) Powers Sounder \_\_\_\_\_ (feet) Adjusted DTW\* \_\_\_\_\_ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: \_\_\_\_\_

-----  
Well Registry #55- \_\_\_\_\_ Well Name: \_\_\_\_\_ Arrival/Departure Time: \_\_\_\_\_

Depth to Water \_\_\_\_\_ (meters) Powers Sounder \_\_\_\_\_ (feet) Adjusted DTW\* \_\_\_\_\_ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: \_\_\_\_\_

-----  
Well Registry #55- \_\_\_\_\_ Well Name: \_\_\_\_\_ Arrival/Departure Time: \_\_\_\_\_

Depth to Water \_\_\_\_\_ (meters) Powers Sounder \_\_\_\_\_ (feet) Adjusted DTW\* \_\_\_\_\_ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: \_\_\_\_\_