MONITORING AND DATA COLLECTION PROTOCOLS

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UVRGA

Contents

Introduction

This document describes the standard protocols that Upper Ventura River Groundwater Agency (UVRGA) staff and consultants will follow for the collection and recording of geologic and hydrologic data within the Upper Ventura River Basin (UVRB) and surrounding areas within the Ventura River watershed. Pursuant to Groundwater Sustainability Plan (GSP) Emergency Regulations § 352.2, monitoring and data collection protocols are a required element of the GSP for the UVRB. This document is intended to satisfy this requirement and will also be utilized for pre-GSP monitoring and data collection activities. Pursuant to GSP Emergency Regulations § 352.2(c), the monitoring protocols contained in this document shall be reviewed at least every five years as part of the required periodic GSP evaluation. Additionally, this document should be updated, as needed, to provide protocols for monitoring or data collection activities not currently performed.

Pursuant to GSP Emergency Regulations § 352.2(b), the Agency may rely on monitoring protocols included as part of the best management practices (BMPs) developed by the Department of Water Resources (DWR), or may adopt similar monitoring protocols that will yield comparable data. Unless otherwise indicated, this document proposes to utilize the protocols presented in DWR's BMP titled *Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice*, dated December 2016 (herein referred to as the "DWR BMP") (DWR, 2016a).

The standard protocols addressed in this document are:

- Groundwater level monitoring

- Stream flow measurements

- Visual surface water flow observations

- Well construction procedures

- Water quality sampling procedures

- Groundwater Extraction Measurement

Relationship to GSP Monitoring Network Requirements

Pursuant to Subarticle 4 of the GSP Emergency Regulations, the GSP must include a monitoring network that includes monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network must be capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation. Suggested practices for developing the monitoring network are provided in DWR's BMP titled *Monitoring Networks and Identification of Data Gaps Best Management Practice*, dated December 2016 (DWR, 2016b).

The primary components of the monitoring network are:

1. Monitoring Objectives: The GSP must include a description of the monitoring network objectives for the basin, which will be developed in conjunction with the sustainable management criteria during the planning process. In general, the network will need to be capable of capturing data on a sufficient temporal frequency and spatial distribution to demonstrate short-term, seasonal, and long-term trends in basin conditions for each of the sustainability indicators, and provide enough information to evaluate GSP implementation. DWR's monitoring network and monitoring protocols BMPs suggest that GSPs using the Data Quality Objective (DQO) process laid out in the U.S. EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006) to develop the DQOs. Although strict adherence to this method is not required, it does provide a robust approach to consider and assures that data is collected with a specific purpose in mind, and efforts for monitoring are as efficient as possible to achieve the objectives of the GSP and compliance with the GSP Regulations. The monitoring objectives will be developed during the GSP planning process and will utilize a DQO process approved by the UVRGA Board of Directors.

2. Monitoring Protocols: Monitoring protocols are the subject of this document.

3. Data Reporting Requirements: Pursuant to GSP Emergency Regulations § 354.40, the Agency must store monitoring data in a data management system (DMS) that is capable of storing and reporting information relevant to the development or implementation of the GSP and monitoring of the basin. Monitoring data must be included in the required annual reports and submitted electronically on forms provided by DWR. The data management system will be created during the GSP development.

Training Requirements

An overarching requirement of the monitoring and data collection protocols is for all personnel to be fully trained and working under the supervision of a California Professional Geologist and Certified Hydrogeologist or Professional Civil Engineer (herein referred to as the "responsible professional") before performing any study or project-related activities. Minimum personnel requirements are established to assure that personnel performing the work meet the adequate qualifications and sufficient training to meet the data quality objectives. Similarly, laboratories utilized for chemical analysis of water samples shall be accredited by the CA Environmental Laboratory Accreditation Program (ELAP).

Training includes familiarity and understanding of the applicable protocols in this document, SGMA Requirements, UVRGA GSP and its predecessor preparatory documents, and the geography, hydrology, and geology of the watershed. Detailed written and verbal directions will be provided by the responsible professional to personnel working under their direct supervision. Manuals that include the applicable protocols in this document, field equipment instructions, equipment calibration protocols, safety manuals, and references are to be made available to all personnel performing monitoring or data collection activities.

Data Collected by Others

Many monitoring programs already exist within and surrounding the Upper Ventura River Basin. DWR encourages, to the extent possible, the use of existing monitoring data and programs to meet the needs for characterization, historical record documentation, and continued monitoring for the SGMA program. For the UVRGA, this includes data collected by other local governmental agencies, non-governmental organizations (NGOs) and the State Water Resources Control Board (SWRCB). UVRGA does not have the authority to impose compliance with its monitoring protocols. DWR recognizes this reality and, as a result, the DWR BMP recommends building in flexibility among the various methodologies available to meet the objectives based upon professional judgment, local knowledge and conditions, project needs, access, and budgetary limitations. Where possible, UVRGA will evaluate existing monitoring data to assure the data being collected meets the data quality objectives, regulatory requirements, and data collection protocol described in this document. As such, review of others' data collection protocols is just one aspect of evaluating existing and ongoing data collected by others. Review of non-UVRGA data will be addressed in more detail in the DQO process for the monitoring network.

Data and Reporting Standards

Pursuant to GSP Emergency Regulations § 352.4, the following reporting standards shall be adhered to:

Units:

- Water volumes shall be reported in acre-feet.
- Surface water flow shall be reported in cubic feet per second
- Groundwater flow shall be reported in acre-feet per year.

Units and Accuracy:

- Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

Monitoring sites shall include the following information:

- A unique site identification number and narrative description of the site location (for wells – CASGEM well identification number if available);
- A description of the type of monitoring, type of measurement taken, and monitoring frequency;
- Location, elevation of the ground surface, and identification and description of the reference point.

Protocols

The following sections provide protocols for specific monitoring and data collection activities. Language taken directly from the DWR BMP is indicated by italic font.

Data Management and Quality Assurance/Quality Control

DWR provides the following data management BMP for measuring groundwater levels, which is adopted here in full and applied more generally to all forms of data that are stored in the DMS. *All data should be entered into the DMS as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for compliance with the data quality objectives.*

In addition to the DWR BMP for data management, UVRGA will be developing a data review process to provide data quality assurance and quality control.

Monitoring Site Information

Although not addressed in the DWR BMP, a log shall be maintained for each monitoring site that includes the following information:

- Access agreements to private property for areas not accessible as public lands, via prescriptive access easements, or commonly accessible open space land. Access agreements should include year-round site access to allow for increased monitoring frequency;
- Access instructions and point of contact (if necessary);
- Well construction information;
- Tracking and photographic documentation with date stamped images of all modifications to the monitoring site that could impact data collection activities and data quality. For wells, the reference point for groundwater level measurements should be carefully reviewed each visit and modifications noted in the log. For surface water flow measurement sites, the channel morphology should be inspected each visit and changes noted in the log.; and
- Any other information necessary to ensure accurate and repeatable data are collected, as determined by the responsible professional in charge of the monitoring or data collection activity.

Protocols for Measuring Groundwater Levels

The DWR BMP for measuring groundwater levels is adopted in full and is reprinted below, with minor additions or edits applicable to UVRGA's particular circumstances.

Groundwater levels are a fundamental measure of the status of groundwater conditions within a basin. In many cases, relationships of the sustainability indicators may be able to be correlated with groundwater levels. The quality of this data must consider the specific aquifer being monitored and the methodology for collecting these levels.

The following considerations for groundwater level measuring protocols should ensure the following:

- *Groundwater level data are taken from the correct location, well ID, and screen interval depth*
- *Groundwater level data are accurate and reproducible*
- *Groundwater level data represent conditions that inform appropriate basin management data quality objectives*
- *All salient information is recorded to correct, if necessary, and compare data*
- *Data are handled in a way that ensures data integrity*

General Well Monitoring Information

The following presents considerations for collection of water level data that include regulatory required components as well as those which are recommended.

Groundwater elevation data will form the basis of basin-wide water-table and piezometric maps and should approximate conditions at a discrete period in time. Therefore, all groundwater levels in a basin should be collected within as short a time as possible, preferably within a 1- to 2-week period.

Depth to groundwater must be measured relative to an established Reference Point (RP) on the well casing. The RP is usually identified with a permanent marker, paint spot, or a notch in the lip of the well casing. By convention in open casing monitoring wells, the RP reference point is located on the north side of the well casing. If no mark is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing. In UVRGA Area production wells, the lower lip of the northernmost sounding tube is used as a reference point, consistent with the water levels collected by the County of Ventura.

The elevation of the RP of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less. Survey grade global navigation satellite system (GNSS) global positioning system (GPS) equipment can achieve similar vertical accuracy when corrected. Guidance for use of GPS can be found at USGS http://water.usgs.gov/osw/gps/. Hand-held GPS units likely will not produce reliable vertical elevation measurement accurate enough for the casing elevation consistent with the DQOs and regulatory requirements. County of Ventura RP elevations are recorded and hereby deemed acceptable reference points.

The sampler should remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure or vacuum release. If a release is observed, the measurement should follow a period of time to allow the water level to equilibrate.

Depth to groundwater must be measured to an accuracy of 0.1 foot below the RP. It is preferable to measure depth to groundwater to an accuracy of 0.01 foot. Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot and should only be used if it is not possible to use a water level meter. The method of measurement should be noted on the field log.

The water level meter should be decontaminated after measuring each well.

Measuring Groundwater Levels

Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot relative to the RP.

For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.

The sampler should calculate the groundwater elevation as:

GWE = RPE - DTW

Where:

GWE = Groundwater Elevation; RPE = Reference Point Elevation; DTW = Depth to Water

The sampler must ensure that all measurements are in consistent decimal units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.

Recording Groundwater Levels

The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. The field form provided in Appendix A shall be utilized for all groundwater level measurements.

The sampler should replace any well caps or plugs, and lock any well buildings, gates, or covers.

Pressure Transducers

Groundwater levels and/or calculated groundwater elevations may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. When installing pressure transducers, care must be exercised to ensure that the data recorded by the transducers is confirmed with hand measurements. Because many dataloggers and pressure transducers have evolved into one and the same, the terms are used interchangeably here; UVRGA currently utilizes Solinst Leveloggers and associated direct read cables in monitored wells.

The following general protocols must be followed when installing a pressure transducer in a monitoring well:

- *The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.*

- *The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.*

- *Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected is meeting the DQO and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.*

- *The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.*

- *Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.*

- *Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.*

- *The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.*

Protocols for Measuring Streamflow

The DWR BMP for measuring streamflow is adopted in full and is provided below, with minor additions or edits applicable to UVRGA's particular circumstances.

Monitoring of streamflow is necessary for incorporation into water budget analysis and for use in evaluation of stream depletions associated with groundwater extractions as well as gaining reaches associated with groundwater discharge. The use of existing monitoring locations should be incorporated to the greatest extent possible.

Establishment of new streamflow measurement sites should consider the existing network and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.

To establish a new streamflow monitoring station special consideration must be made in the field to select an appropriate location for measuring discharge. Once a site is selected, development of a relationship of stream stage to discharge will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages will be necessary to develop the ratings curve correlating stage to discharge. The use of Acoustic Doppler Current Profilers (ADCPs) can provide accurate estimates of discharge in the correct settings. Professional judgment must be exercised to determine the appropriate methodology. Following development of the ratings curve a simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis.

Key measurement locations within the UVRB include:

- Matilija Creek near Matilija Hot Springs (USGS, CMWD, Ventura County WPD)
- Camino Cielo Bridge (UVRGA, SWRCB)
- Robles Diversion (CMWD, USGS)
- Highway 150 Bridge (UVRGA)
- Santa Ana Road (County of Ventura WPD, UVRGA)
- San Antonio Creek at Highway 33 Bridge (County of Ventura WPD)
- Arroyo Mobile Home Park area (UVRGA)
- Coyote Creek at Casitas Vista Road (County of Ventura WPD)
- Casitas Vista Bridge (USGS)
- Other locations may be established, as needed to address DQOs

Many of the locations monitored by the UVRGA are measured via a current-meter measurement procedure long established by the USGS using modern equipment.

Streamflow measurements shall be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, Volume 1. – Measurement of Stage Discharge and Volume 2. – Computation of Discharge (Rantz, et al, 1982). This methodology is currently being used by both the USGS and DWR for existing streamflow monitoring throughout the State. A field data sheet for measuring surface water flow is presented as Appendix B).

The USGS procedures are summarized below.

The first step in making a current-meter measurement is to select a reach of stream containing the following characteristics:

1. A straight reach with the threads of velocity parallel to each other.

2. Stable streambed free of large rocks, weeds, and protruding obstructions such as piers, which would create turbulence.

3. A flat streambed profile to eliminate vertical components of velocity.

It is usually not possible to satisfy all of these conditions. Select the best possible reach using these criteria and then select a cross section. After the cross section has been selected, determine the width of the stream. String a tag line or measuring tape for measurements made by wading, from a boat, from ice cover, or from an unmarked bridge. String the line at right angles to the direction of flow to avoid horizontal angles in the cross section. Next determine the spacing of the verticals, generally using about 25 to 30 partial sections. With a smooth cross section and good velocity distribution, fewer sections may be used. Space the partial sections so that no partial section has more than 10 percent of the total discharge in it. The ideal measurement is one in which no partial section has more than 5 percent of the total discharge in it, but this is very seldom the case when 25 partial or more sections are used. Equal widths of partial sections across the entire cross section are not recommended unless the discharge is well distributed. Make the width of the partial sections less as depths and velocities become greater. Space the verticals so the discharge in each vertical is about 5 percent of the discharge from the rating curve.

After the cross section has been selected and the stationing determined, assemble the appropriate equipment for the current-meter measurement and prepare the measurement note sheets to record the observations. Solo measurements may be recorded via digital audio media and transcribed at a later date. For each discharge measurement record the following information:

- Name of stream and location to correctly identify the established gaging station; or name of stream and exact location of site for a miscellaneous measurement.
- Date, party, type of meter suspension, and meter number.
- Time measurement was started using 24-hour format.
- Bank of stream that was the starting point (e.g., east or west).
- Control conditions.
- Gage heights and corresponding times.
- Water temperature.
- Other pertinent information regarding the accuracy of the discharge measurement and conditions which might affect the stage-discharge relation.

Identify the stream bank by either LEW or REW (left edge of water or right edge of water, respectively, when facing downstream). Record the time in the notes periodically, during the course of the measurement. This time usually should be synchronized with the time of punch on the digital recorder. This is important because if there is any appreciable change in stage during the measurement, the time is needed to determine the mean gage height for the measurement. When the measurement is completed, record the time and the bank of the stream where the section ends. After the equipment and the note sheet have been readied, begin the measurement. Indicate on the note sheet or voice recording the distance from the initial point to the edge of

the water. Measure and record the depth at the edge of water. After the depth is known and recorded, determine the method of velocity measurement. Normally the two-point method or the 0.6-depth method is used. Compute the setting of the meter for the particular method to be used at that depth. Record the meter position (as 0.8, 0.6, 0.2, . . .). After the meter is placed at the proper depth, permit it to become adjusted to the current before starting the velocity observation. The time required for such adjustment is usually only a few seconds if the velocities are greater than 1 fps, but for lower velocities, particularly if the current meter is suspended by a cable, a long period of adjustment is needed. After the meter has become adjusted to the current, record the flow velocity of the digital readout in accordance with manufacturer instructions. If the velocity is to be observed at more than one point in the vertical, determine the meter setting for the additional observation, time the revolutions, and record the data. Move to each of the verticals and repeat this procedure; record the distance from initial point, depth, meter-position depth, revolutions, and time interval, until the entire cross section has been traversed.

Current-meter measurements by wading are preferred, if conditions permit. Wading measurements offer the advantage over measurements from bridges and cableways in that it is usually possible to select the best of several available cross sections for the measurement.

When natural conditions for measuring are in the range considered undependable, modify the measuring cross section, if practical, to provide acceptable conditions. Often it is possible to build dikes to cut off dead water and shallow flows in a cross section, or to improve the cross section by removing the rocks and debris within the section and from the reach of stream immediately upstream from it. After modifying a cross section, allow the flow to stabilize before starting the discharge measurement. Stand in a position that least affects the velocity of the water passing the current meter. This position is usually obtained by facing the bank, with the water flowing against the side of the leg. Holding the wading rod at the tag line, stand from 1 to 3 inches downstream from the tag line and 18 inches or more from the wading rod. Avoid standing in the water if feet and legs would occupy a considerable percentage of the cross section of a narrow stream. In small streams where the width permits, stand on a plank or other support rather than in the water. Keep the wading rod in a vertical position and the meter parallel to the direction of flow while observing the velocity. During measurements of streams with shifting beds, the scoured depressions left by the hydrographer's feet can affect soundings or velocities. Generally, place the meter ahead of and upstream from the feet. Record an accurate description of streambed and water-surface configuration each time a discharge measurement is made in a sand-channel stream.

A quality control measure should be implemented at least twice per year, consisting of multiple independent flow measurements made concurrently by at least two trained personnel. If possible, concurrent measurements should also be made with other entities (such as the USGS) performing flow measurements in the basin.

UVRGA Protocols for Visual Surface Water Flow Observations

The DWR BMP does not address visual monitoring of surface water flow. The following protocols were developed based on past experience in the basin.

As with many watersheds in arid and tectonically active regions, the Ventura River Watershed exhibits a very dynamic and mobile, ephemeral and intermittent network of streams. Surface flow from most streams exits the headwaters and infiltrates into the subsurface as the streams enter the groundwater basins, namely the Ojai Basin and the Upper Ventura River Groundwater Basin. Given the cobble and boulder substrate of the river beds, gauging the flow is difficult except for where bridges or impoundments exist and have created an engineered river bottom of planar concrete. A network of gauges exists at many bridge locations, but these are at areas where flow is often absent while the live reaches flow over areas where measuring the flow can be difficult and inaccurate due to the mobile river bed gravels.

To accommodate this phenomenon, it is prudent to monitor the southern edges of surface water flow on the losing reaches and the northern edges of surface water flow on the gaining reaches in this generally north-to south flowing system. By conducting this mapping on an ongoing basis using GPS tools, a long-term database can be constructed. By correlating the latitudes of the daylighting groundwater with measured flow, the latitudes can be used as a rating-shifted proxy for river and stream flow, while reducing the uncertainty of measurements in the mobile substrate. Unique to each stream system, such a network can be used to graph the relationship between flow components and simplify the flow model of the stream system and interacting groundwater.

Currently Meiner's Oaks Water District (MOWD) (one of the UVRGA member agencies), maps the latitude and longitude of the southerly terminus of active surface water flow in the northern losing reach on a weekly basis. Typically, this is done on Friday afternoons when MOWD measures south end of surface flow at the losing reach of river to the north. Additionally, UVRGA has begun weekly monitoring of the starting point of active surface water flow at the northern edge the gaining reach. Optimal times to measure data will be selected as supported by detailed continuous flow migration measurements as described below.

Each weekly observation shall include documentation of the observation time and latitude and longitude of the active flow starting point (gaining reach) or terminus (losing reach) recorded as GPS Waypoints with photographic documentation of upstream and downstream views. The observation time will be selected based on the results of the high frequency readings study described in the following section. Because the DQO is to identify the active flow starting point (gaining reach) or terminus (losing reach), stagnant or non-surface flowing water will be considered ponded and not part of the flowing stream unless it its connected to flowing water without dry break. Because determination of the flow starting point or terminus is interpretive, a quality control measure should be implemented at least once per quarter, consisting of multiple independent observations made concurrently by at least two trained personnel. A practical check will be a video-logged record of the obviously flowing portion of the river followed upstream to the point of absent standing water in the gaining reach, and conversely downstream to the point of absent standing water in the losing reach. Videos will be time-stamped, saved and archived in UVRGA digital files.

Notes of wildlife should be recorded, as well as temperature, algae, and electrical conductivity of the water at first daylighting. The field form provided in Appendix C shall be utilized for all edge of surface flow field observation.

When locating the northern edge of the gaining reach, daylighting groundwater is typically anticipated to be north of the confluence of the Ventura River with San Antonio Creek. Most traverses will commence from the OVLC Confluence Preserve and work northward. During drier periods the assumed perennial flow would be over an outcrop of bedrock in the river just south of Casitas Vista Bridge. Under such conditions, traverses would commence at Foster Park. During wetter periods, the traverses will commence at Santa Ana Road bridge over the river.

High Frequency Readings

Owing to the potential for diurnal variability in the location of the Ventura River's north edge of the live reach, the weekly surveys should be augmented with at least one high-frequency survey to assess variability in the location of the active flow starting point throughout a twenty-four hour period that may be resulting from diurnal cycles in evapotranspiration and pumping. The results of the high-frequency survey(s) will be used to identify the optimal time of the day for the weekly monitoring, with the goal of ensuring consistent and representative observations.

The proper time for high-frequency surveys are after the full cross-basin flow has ceased, and the Robles reach has become dry (typically by late spring or early summer). This is to be a combination tape survey, pressure-logger and GPS based survey or the migration of the northern edge of the live reach when it is in a conveniently measureable location (e.g., just south of Santa Ana Road). At a convenient time, personnel will track and map the north edge of surface flow and map (via GPS and tape, as well as a datalogger in the downstream portion that will be saturated throughout this survey time period) to observe diurnal fluctuations over a 24-hour period.

The typical survey shall consist of monitoring over a 24-hour period, minimum, with a full-time observer placed near the northern edge of daylighting groundwater. Equipment may include field note book, GPS unit, 300-ft long fiberglass tape with decimal feet gradations, timepiece, telephone, camera, whistle, headlamps, shade structure, chair, and food/drinking water supplies. Upon arrival to the designated point, the observer shall lay out the 300-ft tape with half (0-150 ft) in the submerged portion of the river and half upstream (150 to 300 ft) in the dry portion at the time of arrival. The datalogger shall be set in a flowing portion of the river downstream of the “0” mark on the tape where flow is anticipated to be continuous throughout the survey. The logger shall be placed on the stream bed, and weighted with cobbles to ensure stationarity throughout the survey. Its GPS position shall be recorded in the field notes.

The observer shall record at 10-minute intervals:

- Time of observation
- Footage reading on fiberglass tape at time
- Latitude of daylighting point
- Longitude of daylighting point
- Temperature of daylighting water

Following the survey, the following data will be compiled:

- Flow at Casitas Vista Bridge
  https://waterdata.usgs.gov/nwis/uv?site_no=11118500
- Flow at Matilija Creek near Matilija Hot Springs
  https://waterdata.usgs.gov/nwis/uv?site_no=11114495

Any relief personnel shall follow the protocol, with overlapping time of 30 minutes (three measurements) to check compatibility and consistency of data collection during a shift change. All data will be entered into an excel spreadsheet such that a diurnal chart of the latitude of daylighting groundwater on the surveyed date can be generated. Flows into and out of the basin, at a minimum, as available from the USGS websites presented above, will be recorded on the data sheets in cfs.

New Monitoring Well Construction

The DWR BMP for new monitoring well construction is adopted in full and is reprinted below, with minor additions or edits applicable to UVRGA's particular circumstances.

Where existing wells do not meet the base standard as described in the GSP Regulations new monitoring wells may need to be constructed to meet the DQOs of the GSP. The design, installation, and documentation of new monitoring wells must consider the following:

- *Construction consistent with California Well Standards as described in Bulletins 74-81 and 74-90* and County of Ventura and UVRGA permitting requirements.

- *Logging of borehole cuttings under the supervision of a California Professional Geologist and described consistent with the Unified Soil Classification System methods according to ASTM standard D2487-11.*

- *Written criteria for logging of borehole cuttings for comparison to known geologic formations, principal aquifers and aquitards/aquicludes, or specific marker beds to aid in consistent stratigraphic correlation within and across basins.* For UVRGA, this generally means differentiating between alluvium and bedrock units, which shall be noted based on drilling rate, rig behavior, and visual observation of cuttings or core samples, including rock type, mineralogy, and color. Where possible, the field geologist shall attempt to differentiate between recent and older alluvium.

- *Geophysical surveys of boreholes to aid in consistency of logging practices. Methodologies should include resistivity, spontaneous potential, spectral gamma, or other methods as appropriate for the conditions. Selection of geophysical methods should be based upon the opinion of a professional geologist or professional engineer and address the DQOs for the specific borehole and characterization needs.*

- *Prepare and submit State well completion reports according to the requirements of §13752. Well completion report documentation should include geophysical logs, detailed geologic log, and formation identification as attachments. DWR well completion reports can be filed directly at the Online System for Well Completion Reports (OSWCR) http://water.ca.gov/oswcr/index.cfm.*

Protocols for Sampling Groundwater Quality

The DWR BMP for groundwater quality sampling is adopted in full and is reprinted below, with minor additions or edits applicable to UVRGA's particular circumstances. The field form provided in Appendix D shall be utilized when collecting groundwater quality samples.

All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The specific analytical methods are beyond the scope of this document, but should be commiserate [sic] *with other programs evaluating water quality within the basin for comparative purposes.*

The following points are general guidance in addition to the techniques presented in the USGS National Field Manual for the Collection of Water Quality Data (Wilde, 2005).

Standardized protocols include the following:

- *Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.*

- *Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.*

- *In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.*

- *The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.*

- *The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.* It is understood that it may not be possible to measure the groundwater level in pumping wells.

- *For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary.*

- *Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to*

sampling. Measurements of pH should only be measured in the field, lab pH analysis are typically unachievable due to short hold times. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for meeting DQOs of GSP and assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.

- *Sample containers should be labeled prior to sample collection. The sample label must include: sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.*

- *Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.*

- *Samples should be collected according to appropriate standards such as those listed in the Standard Methods for the Examination of Water and Wastewater, USGS National Field Manual for the Collection of Water Quality Data, or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.*

- *All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.*

- *Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.*

- *Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.*

- *Instruct the laboratory to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels.*

- *Special Protocols for Low-Flow Sampling Equipment: In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the following protocols derived from EPA's Low-flow (minimal drawdown) ground-water sampling procedures (Puls and Barcelona, 1996). These protocols apply to low-flow sampling equipment that generally pumps between 0.1 and 0.5 liters per minute. These protocols are not intended for bailers.*

- *Special Protocols for Passive Sampling Equipment: In addition to the protocols listed above, passive diffusion samplers should follow protocols set forth in USGS Fact Sheet 088-00.*

Groundwater Extraction Measurements

UVRGA has undertaken an aerial survey and is evaluating water deliveries to identify private groundwater users and develop initial estimates of their pumping for the purposes of evaluating a potential initial regulatory fee to fund the Agency's activities. Looking ahead, it is anticipated that the UVRGA will identify method(s) for measuring or estimating groundwater extractions. The DWR BMP does not provide protocols for measuring or estimating groundwater extractions from wells. This document will be updated at a later date to add protocols for the groundwater extraction measurement or estimation methods selected the Agency.

References

California Department of Water Resources, 2016a. Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice, December 2016

https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-1-Monitoring-Protocols-Standards-and-Sites.pdf

California Department of Water Resources, 2016b. Monitoring Networks and Identification of Data Gaps Best Management Practice, December 2016.

https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-and-Identification-of-Data-Gaps.pdf

Rantz, S.E., and others, 1982. Measurement and computation of streamflow; U.S. Geological Survey, Water Supply Paper 2175. http://pubs.usgs.gov/wsp/wsp2175/#table

U.S. Environmental Protection Agency, 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, February 2006. https://www.epa.gov/sites/production/files/documents/guidance_systematic_planning_dqo_process.pdf

Wilde, F.D., January 2005. Preparations for water sampling (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A1, http://water.usgs.gov/owq/FieldManual/compiled/NFM_complete.pdf

Appendix A – Groundwater Level Field Form

Upper Ventura River
GROUNDWATER AGENCY
SUSTAINABLE MANAGEMENT

GROUNDWATER LEVEL MEASUREMENT FIELD DATA SHEET

A	B	C	D	E	F	G	H
WELL ID	DATE	TIME	RPE (ft amsl)	RPH (ft agl)	DTW (ft)	GWE (ft amsl)	Notes
Researched	*Record*	*Record*	*Researched*	*Measured*	*Measured*	*D-F*	

Appendix B – Surface Water Flow Measurement Field Form

Page _____ of _______
Section Area.:____________________
Latitude - Longitude: ____
Date:___________________________
Personnel:_________________________ Weather:____________________________________

Upper Ventura River
GROUNDWATER AGENCY
SUSTAINABLE MANAGEMENT

SURFACE WATER FLOW MEASUREMENT DATA SHEET

A	B	C	D	E	F
Cumulative Section length (ft)	Depth (ft)	Flow Velocity (ft/sec)	Sectional flow (cfs)	Cumulative flow (cfs)	Notes
Recorded	*Measured*	*Measured*	*(An-Ao)XBXC*	*Sum Dn:Do*	

Appendix C – Daylighting Groundwater Observation Field Form

Page _____ of _______
Section Area.:____________________

Upper Ventura River
GROUNDWATER AGENCY
SUSTAINABLE MANAGEMENT

Personnel:_________________________ Weather:____________________________________

EDGE OF SURFACE FLOW FIELD OBSERVATION SHEET

A Date	B Time	C Latitiude	D Longitude	E Ft from RP (ft N/S)	F Temp	G EC (uS/cm)	H Notes

Appendix D – Groundwater Quality Sampling Field Form

Page _____ of _______
Section Area.:____________________

Upper Ventura River
GROUNDWATER AGENCY
SUSTAINABLE MANAGEMENT

____

Personnel:_________________________ Weather:____________________________________

GROUNDWATER QUALITY SAMPLING FIELD FORM

A	B	C	D	E	F	G	H
Date	Time	Well ID	Temp	EC	pH	Rate (gpm)	Notes