CRESCENTA VALLEY COUNTY PARK
STORMWATER RECHARGE FACILITY STUDY PROJECT

Crescenta Valley, California

Final Report - Prepared for:

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Crescenta Valley Water District (CVWD)

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LIST OF ACRONYMS

AF	Acre-Feet
AFY	Acre-Feet/Year
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CVWD	Crescenta Valley Water District
DDW	State Water Resources Control Board, Division of Drinking Water
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FMWD	Foothill Municipal Water District
gpd/ft	gallons per day per foot
gpm	gallons per minute
LACDPW	Los Angeles County Department of Public Works
LACDPR	Los Angeles County Department of Parks and Recreation
LACFCD	Los Angeles County Flood Control District
MCL	California Maximum Contaminant Level
mg/L	milligrams per liter
msl	above mean sea level
NO_3	Nitrate as NO_3
NPDES	National Pollutant Discharge Elimination System
REC	relative error criterion
RWQCB	Regional Water Quality Control Board, Los Angeles Region
TDS	total dissolved solids
µg/l	micrograms per liter
ULARA	Upper Los Angeles River Area
USACOE	United States Army Corps of Engineers- Los Angeles Division
USFW	United States Fisheries and Wildlife Service
VOCs	volatile organic compounds

CRESCENTA VALLEY COUNTY PARK
STORMWATER RECHARGE FACILITY STUDY PROJECT

Crescenta Valley Water District (CVWD)

1.0 PROJECT BACKGROUND

Crescenta Valley Water District's (CVWD's) Crescenta Valley County Park Stormwater Recharge Facility Study (Project) is a grant-funded project to evaluate the feasibility of capturing stormwater and infiltrating it into the ground to augment local groundwater supplies. The Project is consistent with CVWD's long-term goal of increasing the recharge of stormwater into the Verdugo Groundwater Basin (Basin), thereby increasing the amount of groundwater available to CVWD's groundwater production wells and City of Glendale's groundwater production wells in the Basin. Recharging more stormwater would give CVWD access to more lower-cost local groundwater and help reduce the amount of more expensive imported water that CVWD must purchase.

Location of CVC Park

The Project is being funded, in part, by California Department of Water Resources (DWR) as a part of the Local Groundwater Assistance (LGA) grant program under the Local Groundwater Management Assistance Act of 2000 and funded by Proposition 84, The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Projection Bond Act of 2006. Specifically, the Project is an evaluation of the feasibility of installation of facilities to divert stormwater at various times from the Verdugo Wash Channel and/or from Dunsmuir Channel and for infiltrating this water via subsurface infiltration galleries installed beneath portions of Crescenta Valley County Park (CVC Park). Figure 1.1 shows the location of the park in the Crescenta Valley. Figure 1.2 shows the Project area. Figure 1.3 shows the locations of key features within CVC Park including flood control channels.

In late 2013, CVWD awarded a contract to AMEC Environment and Infrastructure, Inc., (now AMEC Foster Wheeler Environment and Infrastructure, Inc.) to support CVWD in completing the Project.

Key studies and previous work that were used to support the Project include:

- Data provided by CVWD including driller's logs, well casing information, well capacity, groundwater production and monitoring well water levels in the area,
- Verdugo Basin Groundwater Evaluation and Monitoring (CVWD Project E-696) prepared by Bookman-Edmonston, Inc. dated June 2004,
- *Verdugo Basin Groundwater Recharge Storage, and Conjunctive Use Feasibility Study* (CVWD Project E-713), Prepared by Geomatrix Consultants, Inc, dated May 2005,
- *Verdugo Basin Geophysical Evaluation Report* (CVWD Project E-760),prepared by Geomatrix Consultants, Inc, dated June 2006
- Quaternary Resource Investigations, LLC, 2008, *Stratigraphy of the Verdugo Basin in Glendale & La Crescenta, California, report to ATC Associates, Inc. for Resource Environmental, LLC,* dated May 2008,
- Geophysical studies of the surrounding area and CVC Park (see Sections 9.0 and 10.0 of this report for more information),
- Various environmental studies related to impacts to groundwater in the area from gasoline stations and other facilities and,
- *Annual Water Service in the Upper Los Angeles River Area, Los Angeles County, California – Water Year 2012-13 Report* prepared by Upper Los Angeles River Area Watermaster's office, dated December 2014.

1.1 PROJECT GOALS AND OBJECTIVES

As stated in the LGA grant application for the Project, the primary goal of the Project is to conduct a study to evaluate the feasibility of using portions of CVC Park to recharge stormwater runoff. The project included evaluating various engineering and environmental effects and benefits of implementation. The results of this Project support development of a cost-effective strategy for developing this potentially significant source of water for CVWD.

Specific objectives to accomplish the overall goal of the Project were:

- Installing surface water gauging stations in the storm drain channels in and adjacent to CVC Park;
- Monitoring the quality of surface water that would be diverted for groundwater recharge;
- Assessing soil and groundwater conditions for recharge, including performing infiltration tests and installing groundwater monitoring wells;
- Conducting a site and tree survey to identify site features that may be important to the design of recharge facilities, including buildings, channels, parking areas, and trees; and
- Establishing a Task Force to guide and support the Project.

1.2 PROJECT TASKS

The Project included several tasks which are listed below. Work accomplished and results, conclusions, and recommendations are provided in following sections of this report. The organization of this report generally follows Exhibit A, Project Work Plan, of California DWR Grant Agreement 460010339. Sections 2 through 10 summarize the task work performed. Deliverables related to each task are discussed in the report text and/or are presented in appendixes to this report.

- Task 1: Administration
- Task 2: Task Force Group
- Task 3: Environmental and Regulatory Compliance and Permit Review
- Task 4: Gauging & Verifying Surface Water Flows & Water Quality in Verdugo Wash
- Task 5: Drilling and Installing Monitoring Wells and Water Level Monitoring
- Task 6: Performing Infiltration Tests
- Task 7: Topographic Survey
- Task 8: Groundwater Modeling
- Task 9: Development of Stormwater Recharge Study

2.0 TASK 1: ADMINISTRATION

2.1 QUARTERLY REPORTS

The Project was administered by CVWD. Work performed by CVWD included coordination of consultants and contractors, monitoring project budget and schedule, preparation of quarterly progress reports, preparation of quarterly invoices with backup information and submittals to DWR.

2.2 FINAL PROJECT COMPLETION REPORT

CVWD will be submitting a final report to DWR that will include the final CVC Park Stormwater Recharge Facility Study, an executive summary of the project, summary of cost and disposition of funds, and additional project information with respect to proposed work verses actual work.

3.0 TASK 2: TASK FORCE GROUP

3.1 COORDINATION WITH TASK FORCE GROUP

The Project included development and outreach to local public agencies, regional stakeholders, the general public, and State agencies. During the course of the Project CVWD reached out to stakeholders by email and phone calls to encourage participation and collaboration. Agencies contacted included: City of Glendale Parks and Recreation (GPR), Glendale Water and Power (GWP), Los Angeles County Department of Parks and Recreation (LACDPR), Los Angeles County Department of Public Works (LACDPW), Los Angeles County Flood Control District (LACFCD), Los Angeles County Fire Department Forestry Division, Crescenta Valley Town

Council, the Council for Watershed Health, the Upper Los Angeles River Area (ULARA) Watermaster's office, Foothill Municipal Water District (FMWD), the Arroyo Seco Foundation, the TreePeople organization, Glendale-Crescenta Volunteers Organized in Conserving the Environment (V.O.I.C.E.), the Southern California Water Committee and Los Angeles County Supervisor Antonovich's Office. In addition interested members of the public were encouraged to attend.

3.2 TASK FORCE MEETINGS

During the course of the Project, CVWD held four (4) Task Force Group meetings[1]. Meetings were held at the CVC Park Community Center Building. At each meeting, participants were informed about the progress of the Project and agendas and handouts prepared and distributed. The meetings provided a format for discussion of the Project and participants were encouraged to interact and coordinate regarding findings and design considerations and to ask questions and discuss issues related to the Project. Meeting handouts, including agendas are included as Appendix A.

4.0 TASK 3: ENVIRONMENTAL AND REGULATORY COMPLIANCE AND PERMIT REVIEW

Task 3 work was to develop environmental and regulatory compliance documents and obtain permits necessary to complete Tasks 4, 5, and 6 (gauging flows and surface water sampling, monitoring well installations and infiltration testing, respectively).

4.1 CEQA – ENVIRONMENTAL CHECKLIST

Following detailed review of the scope of work, CVWD determined that the Task 4, 5, and 6 work did not require activities under the California Environmental Quality Act (CEQA). The specific permits and agreements required for Project activities are discussed in sections of this report that relate to Tasks 4, 5, and 6, and copies of permits are included in Appendix B. Information regarding specific types of permits is presented in the following report subsections.

4.2 CEQA – DOCUMENT

The original report called for CVWD to perform a CEQA Initial Study, however after further review of the 2014 CEQA statute and guidelines, it was determined that the monitoring well portion of the study was under Article 19 – Categorical Exemptions. CVWD determined that this project was exempt from the California Environmental Quality Act (CEQA) pursuant to Section 15306 of the CEQA Guidelines. This exemption covers gathering of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency

[1] Meetings were held on 7/11/2012, 9/26/2013, 9/24/2014, and 5/25/2016.

has not yet approved, adopted, or funded. A copy of the recorded Notice of Categorical Exemption is in Appendix B.

4.3 LOS ANGELES RWQCB – NPDES PERMIT

National Pollutant Discharge Elimination System (NPDES) permits for the Verdugo Basin area are issued by the California Regional Water Quality Control Board-Los Angeles Region (RWQCB).

The discharge water that was produced during the installation of the monitoring wells was contained on-site and discharged to an approved location, an NPDES permit was not required for the work performed.

4.4 LOS ANGELES COUNTY DEPARTMENT OF PUBLIC HEALTH PERMIT

A well drilling permit was obtained from the Los Angeles County Department of Public Health, Environmental Drinking Water Program. The permit is in Appendix B.

4.5 CITY OF GLENDALE, DEPARTMENT OF PUBLIC WORKS

Work for the project was entirely within the park boundaries (i.e. Los Angeles County property) and not in the streets, which are owned by the City of Glendale; therefore no permit was required for construction. However, a street use permit was required by the City of Glendale for storage of equipment on the street. A well permit was obtained from the City of Glendale. The permit is included in Appendix B.

4.6 CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE (CDFW)

Permits from the California Department of Fish and Wildlife (CDFW), such as a Streambed Alteration Agreement, were not required for the project work.

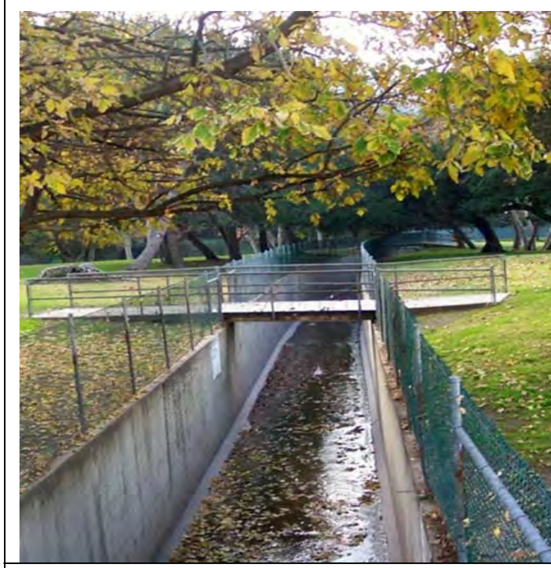
4.7 ADDITIONAL COMPLIANCE/PERMITTING

As part of Task 9: Development of Stormwater Recharge Study, a conceptual design for a diversion and infiltration system was developed. As discussed in Section 10.0 of this report, environmental and regulatory and permitting conditions related to the design and operation of such a system have been identified. In the future, as the conceptual design is developed, environmental considerations and permitting will be revisited and addressed. Such considerations will include environmental requirements related to CEQA, any state and federal requirements, and specific requirements related to agencies such as the ULARA Watermaster's office, LACDPR, and LACDPW.

5.0 TASK 4: GAUGING AND VERIFICATION OF SURFACE WATER FLOWS AND WATER QUALITY IN THE VERDUGO WASH

Two flood control channels traverse CVC Park, the Verdugo Wash Channel and the Dunsmuir Channel, which are concrete lined with vertical sides, as shown on Figures 1.2, 1.3, and 5.1. The Dunsmuir Channel, also known as the Dunsmuir Canyon Channel, was built in 1936 and is maintained by the LACFCD[2,3]. The Verdugo Wash Channel was built in 1967 and is maintained by the LACFCD[4].

The Verdugo Wash Channel extends northwest to southeast through the park and is approximately 26 feet wide where it traverses the park. The Dunsmuir Channel extends north to south across the central portion of the park, is approximately 10 feet wide, and is tributary to the Verdugo Wash Channel. Figure 5.2 shows the locations of the two channels and the watershed areas upgradient and including the park that are tributary to each channel. The watershed area tributary to the Verdugo Wash Channel including the eastern end of the park is approximately 2,393 acres. The watershed area tributary to the Dunsmuir Channel including the park is approximately 929 acres. The watershed for both channels lies within the Upper Los Angeles River Area Watershed.



Dunsmuir Channel

A key aspect of the Project was to collect data regarding the nature and volume of surface water flows in the Verdugo Wash and Dunsmuir flood control channels and the quality of water in the channels. The following report subsections summarize these data collection and evaluation activities.

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[2] The Dunsmuir Channel is shown on LACFCD Drawing No. 5-D2 and is Asset (MMS) number F02000049.

[3] Construction drawings for the Dunsmuir Channel and Verdugo Wash can be accessed via the LACFCD website: http://dpw.lacounty.gov/fcd/stormdrain/index.cfm

[4] Verdugo Wash is shown on LACFCD Drawing 10-D116 and is Asset (MMS) number F021876087 just upstream of the confluence with the Dunsmuir Channel and Asset number F02187092 downstream of the confluence with the Dunsmuir Channel.

5.1 Coordination and Agreement with LACDPW

The flood control channels in the vicinity of CVC Park are owned and operated by the County of Los Angeles. At the outset of the project, the LACDPW was contacted regarding access to the Verdugo Wash channel and the Dunsmuir Channel. CVWD received permits for access to the channels for installation and maintenance of the flow monitoring stations (stream gauges) and for collection of water quality samples. Appendix B presents the access permits obtained for the project.

5.2 Installation and Calibrating Channel Gauges

Figure 5.1 shows the locations of the two flow monitoring gauges installed for the Project. The upstream flow monitoring station (Station 1) was installed by CVWD at a pedestrian bridge that crosses Verdugo Wash near the CVC Park Community Building. This location is upstream of the intersection of the Verdugo Wash channel and the Dunsmuir Channel. The downstream flow monitoring station (Station 2) was installed by CVWD at the New York Avenue Bridge over the Verdugo Wash. This location is downstream of the confluence of the Verdugo Wash and Dunsmuir Channel and monitors the combined flows of the Verdugo Wash and the Dunsmuir Channel near the southeastern-most part of the park (i.e. furthest point downgradient or downstream in CVC Park).

Verdugo Wash Channel

CVWD coordinated with LACDPW regarding the types of instrumentation to be installed and other aspects of the installations. LACDPW's flow monitoring station specifications included use of Ametek USonic Ultrasonic level transmitters (look-down sensors or USonics), WaterLog H-500XL High-Level data loggers (H-500XL), and solar panels for power.

Flow Monitoring Station 1-
Verdugo Wash Upgradient

The look-down sensors continuously measure the vertical distance from the sensor to the top surface of the water flowing below the sensor. Data is transmitted to a data logger at 15-minute intervals.

CVWD setup the Water Log H-500XL record the data and the data was uploaded by CVWD personnel at various times during the study period. Photographs of the installed systems are presented in the Surface Water Flow Monitoring and Sampling Technical Memorandum included as Appendix C to this report.

CVWD staff performed the initial calibration and setup based on LACDPW guidance. The flow monitoring stations were operational starting in November 2014. In accordance with CVWD's Monitoring Plan, AMEC conducted asite visit on March 5, 2015 to collect manual measurements to be used to assist in the calibration of the electronic flow measurements. Based on the field readings, AMEC recommended adjustments to the flow station set up. CVWD relocated the flow meters and adjusted the calibration settings following the site visit.

Flow Monitoring Station 2-
Verdugo Wash Downgradient

In November 2015, CVWD had LACDPW assist with reviewing the calibration settings prior to the anticipated rain expected during the wet season. The flow monitoring stations were recalibrated before the data was downloaded. This resulted in a data gap in the electronic monitoring data between September 2015 and November 2015. AMEC conducted additional field visits on November 13, 2015, and May 11, 2016, and other additional visits during rain events and dry-weather conditions. During the monitoring period, CVWD took photographs and videos of the runoff in the channels.

In order to convert water levels to flow rates at the two monitoring stations, AMEC collected field measurements of the depth and nature of water flow in the Verdugo Wash Channel during the site visits, and a topographic survey of the channel bottom profile was completed by Starlight Surveying Company[5].

The field measurements of the channel cross sections and topographic data were used to develop a site-specific rating curve/lookup table, based on the Manning Equation, to convert the electronic water level measurements into flow rates. The rating curve/lookup table is presented at the end of Appendix C of this report.

[5] See Section 8 of this report for information on the topographic surveys performed for this study.

AMEC performed quality control review of the dataincluded field visits to manually measure flow and review of photographs and videos made by CVWD during precipitation events. The visual observations and field-verified data were used to level-adjust the dataset and remove some erroneous data spikes that appeared to be caused by debris in the channel at or near the flow measurement station locations[6].

5.2.1 Dry-Weather Flow Measurement:

Dry-weather flow measurement data were collected at the upstream and downstream stations in the Verdugo Wash for an approximate 19-month period from November 2014 through May 2016, with the exception of the brief data gap between September and November 2015.

Flow measurements (date, time, and water level reading) were collected at 15-minute intervals. Flow data and observations indicated that dry weather flows in the Verdugo Wash upstream of Dunsmuir Channel were negligible. Flow data and observations at the flow monitoring station in Verdugo Wash downstream of the confluence with Dunsmuir Channel (Station 2) indicated greater flow, on the order of 20 to as much as 160 gallons per minute (gpm).

5.2.2 Wet-Weather Flow Measurement:

Wet-weather flow measurement data were collected at the upstream and downstream stations in the Verdugo Wash between November 2014 and May 2016, with the exception of the brief data gap between September and November 2015. Flow measurements were recorded at 15-minute intervals. Field visits by CVWD were performed during several wet weather events, to collect photos and videos of site conditions that were used to assess accuracy of the flow readings. During the monitoring period, 18 separate rainfall events occurred. Average rainfall per event was 0.83 inches). Peak flows of up to approximately 1.3 million gpm (~2,900 cubic feet per minute) were recorded. AMEC developed hydrographs for several of the rain events to assess the potential to collect the flow at the upstream and/or downstream stations. The hydrographs are presented in Appendix C.

5.3 WATER QUALITY SAMPLING AND ANALYSIS

The goal of this Project was to determine if captured stormwater could be infiltrated to augment groundwater supply and monitoring the quality of surface water was an important component of the Project. Water quality analyses help in the assessment of the potential for negatively impacting groundwater quality by infiltrating storm water. As described in the following paragraphs, samples of dry weather and wet weather flow were collected and analyzed for a wide range of chemical constituents related to water quality standards. The standards considered were the California Water Resources Control Board Division of Drinking Water

[6] During low water flow periods, debris in the channel can affect the flow and the depth of water recorded by the look-down sensors.

(DDW) maximum contaminant levels (MCLs) for potable water supplies and applicable parts of the RWQCB Basin Plan[7].

Surface water samples were collected at the Verdugo Wash downstream station by CVWD field employees, in accordance with the monitoring plan provided to DWR. Collected samples were analyzed for the constituents listed in Tables 5.1 and 5.2, which include volatile organic compounds (VOCs), organochlorine and organophosphorus pesticides, chlorinated herbicides, oil and grease, total metals, nutrients, total dissolved solids (TDS) and other general monitoring parameters. Samples were collected during both high flow and dry weather conditions in the form of discrete grab samples. During collection of water samples for laboratory analysis, field personnel measured the pH and approximate flow rate of the surface water runoff.

Table 5.1 summarizes the results of the dry-weather flow sampling. One dry weather sample was collected on May 18, 2016. VOCs, pesticides, and herbicides were not detected in this sample. Metals were generally at low concentrations or were not detectable.

The nutrients nitrate and orthophosphate were not detected in the dry weather flow and the concentration of TDS was 340 milligrams per liter (mg/L).

For analyzed constituents with established drinking water maximum contaminant levels (MCLs), with the exception of arsenic and thallium, all were detected at concentrations below the MCL. These two constituents, although slightly above MCLs, are expected to be retained in the soil as the dry weather flow water is infiltrated[8]. Additionally, dry weather flows are a very small percentage of the total amount of water that will be recharged. Consequently, dry weather recharge will be greatly diluted and concentrations reduced. Laboratory results are presented in Appendix C.

Table 5.2 summarizes the results of the wet-weather flow sampling. Five wet weather samples were collected during the monitoring period. VOCs, pesticides, and herbicides were not detected in any of the samples. Chromium, copper, lead, nickel, thallium, and zinc were detected in at least one sample at a maximum concentration of 6.7, 40, 25, 4.7, 26, and 190 microgram/liter (µg/L), respectively. Nitrate (as N) and orthophosphate (as P) were detected at maximum concentrations of 1.1 and 0.21 mg/L, respectively. Concentrations of TDS ranged from 37 to 190 mg/L. With the exception of lead, which slightly exceeded the MCL in two of five wet weather samples and thallium, which exceeded the MCL in two of five wet weather samples, all constituents were reported at concentrations less than their MCL. Lead and thallium are known

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[7] RWQCB, 1994, *Water Quality Control Plan, Los Angeles Region, (Basin Plan),* Adopted June 13. Amendments to the Basin Plan can be found at the following website: http://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/wqs_list.shtml

[8] University of Minnesota, 2008, *Contamination of Soil and Groundwater, Due to Stormwater Infiltration Practices, A Literature Review*, St. Anthony Falls Laboratory, Engineering, Environmental and Geophysical Fluid Dynamics, Project Report No. 515, By: Peter T. Weiss, Greg LeFevre and John S. Gulliver, dated June 23.

to attenuate in soil as water infiltrates down to the water table[9]. Significant dilution will occur as recharged water mixes with groundwater. Laboratory results are presented in Appendix C.

Based on analysis of dry and wet weather flow samples, the quality of the surface water flows does not appear to be a constraint with respect to recharge of surface water into the underlying groundwater. With the exceptions noted, the surface water flows meet DDW potable water quality standards for groundwater as a source of potable water supply for the constituents analyzed[10].

With regard to surface water standards or regulations, the RWQCB has adopted a Basin Plan which includes Total Maximum Daily Load (TMDL) criteria for surface water in the area (which would include flows in the Verdugo Wash and Dunsmuir Channel) for bacteria, metals, trash, and nutrients. Through diversion of runoff from the channel and infiltration into groundwater, the loading of many of these pollutants to downgradient areas will be reduced. Reducing the occurrence of these pollutants within the downgradient area, which includes the Los Angeles River, is consistent with the Basin Plan and will be a benefit to the watershed.

5.4 COMPILING DATA

The compilation and analysis of the flow and water quality data are summarized in the Surface Water Flow Monitoring and Sampling Technical Memorandum which is included as Appendix C to this report.

In addition, this report analyzed the amount of runoff from the parking lot at CVC Park, which could be a potential site for collecting storm water. The parking lot, located in the northwest portion of the park is approximately 0.55 acres in area. Considering the median annual precipitation for the area and a runoff coefficient for parking lot areas, the estimated annual runoff from the parking lot area will be approximately 0.85 AF per year (AFY).

The quality of the water that will run off from the parking lot will vary depending on the time of year and time between runoff events. The main pollutants that are typically present in parking lot runoff are oil and grease, trash, and suspended solids. Also there are usually traces of metals (zinc, lead, iron, and copper) from tires and oil leaks from the vehicles. Concentrations are usually highest during the first-flush (i.e. the first portion of runoff that occurs after commencement of rainfall). The concentration of the constituents varies, but is generally not a concern for recharge to groundwater because of typical low initial concentrations and because the concentrations are decreased during infiltration through mechanical filtration and adsorption.

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[9] The Los Angeles and San Gabriel Rivers Watershed Council, 2005, *Los Angeles Basin Water Augmentation Study, Phase II Final Report,* Prepared with assistance from Geomatrix Consultants, Inc., August.

[10] Untreated surface water flows do not meet bacterial standards for potable water supplies. The results of the surface water laboratory analyses indicate that the surface water meets inorganic constituent standards for groundwater for the analytes tested.

5.5 STORMWATER FLOW AND QUALITY TECHNICAL MEMORANDUM

Following collection and evaluation of the flow and water quality data, a technical memorandum was prepared and included as Appendix C, the Storm Water Flow Monitoring and Sampling Technical Memorandum. Additional information regarding the data analyses and conclusions are also presented in Section 10 of this report.

6.0 TASK 5: DRILLING AND INSTALLING MONITORING WELLS AND WATER LEVEL MONITORING

The purpose of this task was to install two monitoring wells within CVC Park to assess the soil conditions, soil lithology or composition, depth to bedrock, and groundwater level. Additionally, the wells provide information regarding the vadose zone and aquifer conditions in the area and allow for monitoring of water levels and sampling for groundwater quality. Data from the wells, along with other available hydrogeologic, land use, and other data, were used to evaluate the optimal location for the infiltration galleries, to assess the amount of storage space available for recharged water and to better understand groundwater flow/movement in the area. Figure 6.1 shows the locations of the two new wells: MW16 and MW17.

6.1 COORDINATION AND AGREEMENT

CVWD worked with Los Angeles County Department of Parks and Recreation (LACDPR) to amend CVWD's existing access agreement to include drilling of the new monitoring wells. The agreement is presented in Appendix B.

The monitoring wells were installed within the boundaries of the park and not on streets or other right of ways. Drilling of the wells, however, required parking or staging of drilling equipment in the street. Consequently, a street access permit was obtained from the City of Glendale. The drilling contractor obtained well construction permits from Los Angeles County Department of Public Health and the City of Glendale (see Appendix B).

6.2 PRELIMINARY DESIGN

A preliminary design for the two monitoring wells was developed by a California licensed Professional Geologist (PG) and California Certified Hydrogeologist (CHg) employed by AMEC. The locations for the wells were selected based on the locations of the existing monitoring wells, abandoned wells and CVWD's water production wells, available open space to avoid existing Oak trees, site access for the drilling equipment, and input from the LACDPR staff at CVC Park.

6.3 DESIGN PLANS AND SPECIFICATIONS AND BIDDING

CVWD and AMEC prepared technical specifications and bid documents for the installation of the monitoring wells, which included a request for bid for drilling the wells. The request, which included detailed specifications for well construction, is included in Appendix D.

The technical portion of the specifications, including the selection of well drilling and construction methods, and the well design were prepared by a California licensed Professional Geologist (PG) and Certified Hydrogeologist (CHg) employed by AMEC. The solicitation for a drilling contractor was performed in accordance with the Public Works Contracting Code. Following receipt of bids from California licensed C-57 well drilling contractors; CVWD selected Yellow Jacket Drilling, Inc., based on price and conformance to specifications for the installation of the monitoring wells.

6.4 CONSTRUCTION – TWO (2) MONITORING WELLS

Appendix D includes a Technical Memorandum summarizing the well drilling and installation work. The Technical Memorandum includes a certification by AMEC, which employed a California Licensed PG and CHg to certify that the wells were completed in general accordance with the specifications and that the completed monitoring wells comply with the applicable well standards and permit requirements. Prior to drilling the monitoring wells, specific locations were selected by CVWD and the contractor based on field conditions and access for the drilling equipment. Once selected, Underground Service Alert (USA), was contacted such each utility within the area of each drilling location located their underground utility facility.

The monitoring wells were drilled and installed during February and March 2015. During drilling for each well, the borehole was logged by AMEC, which employed a California licensed PG using industry-accepted procedures and techniques and in accordance with ASTM D2488. The soil materials encountered in the depth intervals where the monitoring wells were to be screened were relatively coarse. As a result, laboratory sieve analyses were not required for formation samples[11]. The well perforation size and gravel pack size were selected based on the coarse nature of the sediments and standard industry practice for monitoring well design and installation.

[11] ASTM designation D2487 applies to laboratory analyses of soil samples for classification for engineering purposes. Because soil formation samples did not require laboratory testing, testing in accordance with method D2487 was not required.

Drilling Rig - Borehole for Well
CVWD MW16

For each monitoring well, following completion of the borehole, the well design was finalized by AMEC, which employed a California licensed PG for this work. The wells were completed with 4-inch diameter Schedule 80 PVC well casing with 0.040-inch slot size for the perforated sections. The sand filter pack for the wells was a #8-mesh sand. Above the sand filter pack in each well, the well annulus was filled with a grout seal. The wells were completed in vault boxes and surrounding concrete pads flush with the ground surface.

Following installation, each monitoring well was developed by bailing, surging and pumping. Because the wells were drilled with air-rotary casing hammer and no drilling mud or fluids were used, the wells required very little development to complete the project.

The table below summarizes the well constru ctions. Detailed well logs, construction diagrams, California Department of Water Resources (DWR) well completion report forms (Form 188) are included in Appendix D.

Monitoring Well Construction

Well Number	Surveyed Top of Casing Elevation (feet above sea level)	Total Depth (feet)	Depth to Top of Perforations (feet)	Depth to Bottom of Perforations (feet)	Depth to Top of Sand Filter Pack/Bottom of Grout Seal (feet)
MW16	1355.84	55.0	30.1	55.0	25.0
MW17	1414.36	128.3	58.0	128.3	47.0

Following installation of the wells, water levels were monitored during the study period and groundwater from the wells was sa mpled, analyses results are shown in Appendix D. Water levels were taken at representative wet-season and dry-season intervals. The depth to water in well MW16 ranged from approximately 38 to 55 feet below ground surface. The depth to water in well MW17 ranged from approximately 60 to 123 feet below ground surface.

6.5 WATER QUALITY SAMPLING AND ANALYSES

Groundwater samples were collected from the monitoring wells for water quality analyses. The wells were sampled on March 16, 2015 after co nstruction was completed and, July 21, 2015, September 23, 2015, and February 9, 2016. For each sampling event, the wells were purged of at least three well casing volumes of water and until field monitoring parameters stabilized. The wells were sampled by and under the supervision of CVWD personnel using widely-accepted sample collection and handling procedures. Samples were submitted to BC Laboratories in Bakersfield, California. BC Laboratories are California ELAP[12] certified. Appendix D includes a Compact Disk (CD) of the laboratory results.

The groundwater samples were analyzed for California Code of Regulations, Title 22 constituents, including total dissolved solids (TDS), general mineral parameters, nitrate, oil and grease, volatile organic compounds (VOCs), and pesticides. The results of the analyses are presented in Tables 6.1, 6.2, and 6.3 and are summarized below.

The results of the analyses for Title 22 constituents indicate that the chemical nature of the groundwater in the two new monitoring wells are similar to that for nearby CVWD groundwater extraction wells CVWD1, CVWD7, and CVWD9. Overall the quality of groundwater, based on samples from the two new monitoring wells (named CVWD wells MW16 and MW17) are considered relatively good. The TDS of the groundwater ranged from 520 to 680 mg/L.

With the exception of nitrate and aluminum, concentrations of constituents tested were below State Water Resources Control Board, Division of Drinking Water (DDW) primary maximum contaminant levels (MCL) concentrations.

Nitrate concentrations ranged from 14 to 48 mg/L as measured as NO_3, with only one of seven samples exceeding the MCL of 45 mg/L nitrate. All other nitrate results were 17 mg/L or less. Nitrate is a known groundwater contaminant in the Verdugo Basin, and as appropriate, CVWD actively treats and blends extracted groundwater to reduce nitrate concentrations to below the MCL. Aluminum (total recoverable aluminum) was detected in the groundwater samples at concentrations ranging from approximately 1.7 mg/L to approximately 8.8 mg/L, which is above the MCL of 1.0 mg/L. The elevated aluminum concentrations may be related to suspended solids in the water samples that were not removed prior to laboratory analyses.

6.6 ANALYSIS OF DATA

The data collected from the installation and monitoring of the wells and water quality analyses were reviewed by qualified professional geologists, hydrogeologists, and engineers for quality control. The data and results were incorporated into the overall project and preliminary design of the proposed stormwater infiltration system.

6.7 MONITORING WELL TECHNICAL MEMORANDUMS

Technical memorandums related to the monitoring well installations include:

- <u>DWR Well Completion Report</u> which is included as Part 3 of Appendix D of this report.

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[12] Laboratory certified under the state of California Environmental Laboratory Accreditation Program (ELAP).

- Well Construction Technical Memorandum which is included as Part 2 of Appendix D of this report. Part 1 of Appendix D of this report is the Wells Bid Document prepared by CVWD for soliciting bids from drilling contractors for the installation of the monitoring wells.
- Water Level Monitoring Technical Memorandum. Water levels in the two new monitoring wells have been monitored periodically by CVWD since the wells were installed. Monitoring is ongoing, and as a result, the Water Level Monitoring Technical Memorandum will be prepared at a future date after additional water level data are collected and compiled. Water level measurements for the wells are summarized, however, in the Well Construction Technical Memorandum.

7.0 TASK 6: PERFORM INFILTRATION TESTS

Infiltration tests were performed at selected locations to evaluate the capacity of the soil and shallow sediments for infiltration of water. The following report subsections summarize the work related to the infiltration tests and the testing results.

7.1 COORDINATION AND AGREEMENT WITH LACDPW

CVWD worked with Los Angeles County Department of Parks and Recreation (LACDPR) to amend CVWD's existing access agreement to include installation of the test infiltration pits. Appendix B presents the access agreement. The tests were installed within the boundaries of the park and not on streets or other right of ways. Consequently, permitting by the City of Glendale or Los Angeles County Department of Public Works was not required.

7.2 PRELIMINARY DESIGN AND LOCATION

The design and locations for the infiltration tests were prepared, selected, and reviewed by AMEC, which employed a California Certified Hydrogeologist and Professional Engineer for this work. Three (3) tests were performed at representative locations shown on Figure 7.1. The tests were conducted in areas where future infiltration galleries might be located. Criteria for selecting the locations for the tests included:

- Locations within CVC Park,
- Open areas away from trees and buildings, and
- Locations where the elevation is low enough to allow for gravity feed of diverted stormwater to the area where infiltration galleries might be located.

The tests were performed to evaluate subsurface soils at a depth similar to that anticipated for the stormwater infiltration galleries. A well-established test method was utilized, as described in the Infiltration Test Preliminary Design Memorandum and the Infiltration Test Technical Memorandum, presented in Appendix E. The test method incorporates County of Los Angeles, Department of Health Services – Environmental Health, "*Procedures for Application for Approval of Private Sewage Disposal System Construction*" January 2000.

7.3 DESIGN PLANS AND SPECIFICATIONS AND BIDDING

Equipment and supplies for the infiltration tests were provided by CVWD. Consequently, an outside contractor was not required for the testing, and a bid package was not prepared for contractor bidding. A Preliminary Design Memorandum was prepared which described the test procedures to be used and the methods for calculation of infiltration rate. The Preliminary Design Memorandum is included in Appendix E.

7.4 CONSTRUCTION

As shown on Figure 7.1 three test pits were located in the eastern portion of the park, in the area of the two baseball fields, an open area away from trees and buildings. This area is also at a relatively low elevation within the park, which would allow for gravity flow of water that could be diverted from the Verdugo Wash Channel and/or the Dunsmuir Channel. The test pits were constructed by CVWD using a backhoe. Falling-head tests were conducted in each of the three approximately 8-foot deep pits.

Details regarding the tests, including descriptions of the materials encountered and photographs of the pits are presented in the Infiltration Testing Technical Memorandum presented in Appendix E.

7.5 FIELD WORK

The infiltration tests were performed by first saturating the soil in each test pit and then repeatedly filling each pit and monitoring the water level decline over time. A board placed across the top of each pit was used as a reference point for the water level measurements. The field tests were performed by AMEC, which employed a California licensed PG for this work and the work was overseen by a California Certified Hydrogeologist and Certified Engineering Geologist.

7.6 ANALYSIS OF DATA

The results of the infiltration tests were reviewed and analyzed and soil infiltration capacity calculations made by a California Licensed Professional Engineer and Professional Geologist. The test results indicate that the relatively coarse-grained soils in the areas tested have infiltration rates ranging from more than 9 feet/day to more than 100 feet per day. Infiltration rates greater than 10 feet per day (greater than 5 inches/hour) are considered to be very high[13]. The infiltration test results indicate a high potential for infiltration at the site because of the abundance of coarse textured soil. Specific test results are presented in Appendix E.

[13] US Department of Agriculture, Natural Resources Conservation Service, 2008, *Soil Quality Indicators,* June.

7.7 INFILTRATION TEST TECHNICAL MEMORANDUM

As previously mentioned, the results of the infiltration testing are presented in the Infiltration Testing Technical Memorandum presented in Appendix E. The technical memorandum includes figures and tables showing the locations of the tests, the test setup and the results of the testing. The technical memorandum also presents results and conclusions regarding the infiltration capacity of the soils.

8.0 TASK 7: TOPOGRAPHIC SURVEY

An important aspect of the Project was to identify key features in CVC Park that need to be considered in evaluating the potential for stormwater capture and groundwater recharge. A topographic survey of CVC Park, north of the Verdugo Wash was performed in February 2015.

8.1 COORDINATION AND AGREEMENT WITH LACDPW

CVWD worked with Los Angeles County Department of Parks and Recreation (LACDPR) to amend CVWD's existing access agreement to include a topographic survey of CVC Park. CVWD's permit with LACPW allowed access for surveying the channel bottom at two locations. The agreements with LACDPR and LACDPW are presented in Appendix B.

8.2 PRELIMINARY SITE INVESTIGATION

As part of the survey task, a field visit was made to verify the limits of the work, the general layout of the park, its facilities, trees, and other features. The surveyor that performed the work, Starlight Surveying, Inc., which employs licensed land surveyors and was aware of the property lines and easements, etc. related to the CVC Park.

8.3 AERIAL TOPOGRAPHIC SURVEY

Starlight Surveying, Inc., the surveyor selected for the project, arranged for aerial photographs of the park to be flown. Preparations for the aerial photography included layout of eight targets at CVC Park.

8.4 FIELD SURVEY

A field survey of the park was performed to further identify and locate features in the park. The field survey included identification of trees and key features north of the Verdugo Wash and east and west of the Dunsmuir Channel. The survey included:

- Review of tract and parcel maps for the area,
- Developing 1-foot topographic contours of the park area,
- Identification of parking areas, structures, and facilities, including surface water channels,
- Locating trees on the property,

- Flood control channel bottom cross-section survey at the locations of the two surface water monitoring stations installed for the Project, and
- Lateral and vertical coordinates of the two groundwater monitoring wells installed for the Project.

Figure 8.1 presents a topographic map of the CVC Park based on the topographic survey performed. The survey was performed by Starlight Surveying, Inc. of Irvine, California. Electronic files of the survey data and contour lines were provided to CVWD.

8.5 IDENTIFY AND CATALOG TREES

Trees are an important feature of CVC Park, and as such, need to be protected and considered in planning for a stormwater recharge program. The field survey included tree locations and, where possible, the type of tree, tree trunk diameter, and tree canopy area. Figures 1.3 and 8.1 show the locations of trees in the park and a more detailed larger-scale map of the park which shows the tree locations, trunk diameters for larger trees, and the tree types that were identified is included in Appendix F.

8.6 TOPOGRAPHIC SURVEY TECHNICAL MEMORANDUM

Appendix F presents a Topographic Survey Memorandum and a Tree Survey Memorandum prepared by Arbor Culture, LLC located in Montrose, CA, which further summarizes the work performed and the data produced, and detailed topographic maps for the park.

9.0 TASK 8: GROUNDWATER FLOW MODEL UPDATE

A groundwater flow model for the Verdugo Basin (Basin) was initially developed in 2004-2005 as part of the Verdugo Basin Groundwater Recharge, Storage and Conjunctive Use Feasibility Study[14]. Minor updates to the model, including revisions related to a basin-wide geophysical study[15], were made in 2006. The purpose of the model was to support CVWD's evaluation of groundwater conditions in the Basin, including the possibility of artificial recharge at one or more locations in the Basin. The model was further updated and used in the evaluation of the potential to recharge surface water within the boundaries of CVC Park. The update is summarized in the following report subsections and a 2016 Groundwater Model Update Technical Memorandum is included as Appendix G to this report.

9.1 INPUT UPDATED GEOLOGIC AND GROUNDWATER DATA

Since 2006, a number of additional groundwater-related studies have been performed in the Basin in relation to several gas stations and other environmental releases. These additional studies provided data used to update the model. Key studies included a geophysical evaluation

[14] Geomatrix Consultants, Inc. (now Amec Foster Wheeler), 2005, *Verdugo Basin Groundwater Recharge, Storage and Conjunctive Use Feasibility Study, CVWD Project E-713,* dated May 2005.
[15] Geomatrix Consultants, Inc. (now Amec Foster Wheeler), 2006, *Verdugo Basin Geophysical Evaluation Project*, CVWD Project E-760, June.

which included the CVC Park and surrounding area[16]. Data from the two monitoring wells installed for this Project and the results of the infiltration tests were also included in the data used to update the model. The data from the geophysical evaluation and other studies were used to revise the model inputs for aquifer permeability, depth to bedrock, the locations and nature of faults in the Basin, and other aspects of the model. CVWD provided groundwater level and pumping data for the period through late 2015 which were incorporated into the model. Details regarding the additional data inputs are included in the Model Update Technical Memorandum, presented as Appendix G.

9.2 UPDATED GROUNDWATER MODEL

The updated Verdugo Basin groundwater flow model was re-calibrated to 4,149 groundwater elevation observations in 11 CVWD production wells, seven (7) US Environmental Protection Agency (EPA) monitoring wells, and 43 monitoring wells installed since 2005 in the Basin.

As presented in the 2016 Groundwater Model Update Technical Memorandum, the model calibrated well, with a Scaled Root Mean Square (SRMS) error of 3.1 percent. Groundwater flow models with SRMS values of less than 10 percent are considered adequately calibrated[17].

The calibrated model was used to evaluate possible recharge scenarios including the degree of groundwater mounding that may occur and the movement of infiltrated water away from the recharge locations.

As presented in the Groundwater Model Update Technical Memorandum, a scenario was modeled whereby 300 acre-feet/year (AFY) of stormwater was recharged using two stormwater recharge galleries: one beneath the parking lot next to the existing dog park in the western part of CVC Park (Gallery 1), and one beneath the outfields of the two baseball fields in the eastern portion of the park (Gallery 2). Section 6.0 and figures 24 and 25 of the Model Update Technical Memorandum present details of the scenario modeled. Additional detailed information about the scenario and related groundwater mounding and other considerations is presented in Section 10 of this report.

9.3 GROUNDWATER MODELING TECHNICAL MEMORANDUM

As previously mentioned, Appendix G of this report presents the 2016 Groundwater Model Update Technical Memorandum prepared for this project. The Technical Memorandum includes a description of the work performed and tables and figures provide information on the scenario modeled and resulting groundwater flow outward from the recharge area.

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[16] Quaternary Resource Investigations, LLC, 2008, *Stratigraphy of the Verdugo Basin in Glendale & La Crescenta, California, report to ATC Associates, Inc. for Resource Environmental, LLC,* dated May 13.
[17] Zheng, C. and Neville, C., 1994, *Practical Modeling of Pump-and-Treat Systems Using MODFLOW, PATH3d and MT3D*, Short Course Notes. Chunmiao Zheng, Professor of Hydrogeology Department of Geological Sciences, University of Alabama, Tuscaloosa, AL 35487

10.0 TASK 9: DEVELOPMENT OF STORMWATER RECHARGE STUDY

Report sections 10.1 through 10.4, below; summarize the various Stormwater Recharge Study reports prepared. Report sections 10.5 through 10.10 provide information regarding the analyses performed and conclusions. Section 11 includes conclusions and recommendations for future steps for design and installation of stormwater recharge facilities at CVC Park.

10.1 THROUGH 10.4 STORMWATER RECHARGE STUDY REPORTS

This final report incorporates comments and edits to both the 50% and 100% draft Stormwater Recharge Study reports. Appendix H to this report includes comments and edits to the 50% and 100% draft versions of this report.

10.5 AMOUNT AND TIMING OF AVAILABLE SURFACE WATER FOR RECHARGE

The surface water flow data in the Verdugo Wash Channel and the Dunsmuir Channel were evaluated and the volume of water that could be recharged on an annual basis was estimated. The estimate was developed by comparing the observed flows in the Verdugo Wash and Dunsmuir Channel with surface water flow estimates developed using an existing LACDPW surface runoff model.

10.5.1 LACDPW SURFACE RUNOFF MODEL

The LACDPW surface runoff model (known as the LSPC model[18]) provides estimates of surface water discharge at locations that can be selected within different watersheds, including the Verdugo Basin and the area tributary to CVC Park. Locations corresponding to the upstream (Station 1) and downstream (Station 2) flow monitoring stations were selected and the corresponding model outputs were evaluated. The model simulates runoff using rainfall data, topography of the land, land use, and land cover. The two rain gauges used in the model simulations are La Crescenta (251C) and Briggs Terrace (373C), which are manual gauges belonging to LACDPW, with rainfall time series from 1996 through 2012.

The LSPC model was used to estimate hourly discharge in Verdugo Wash at the two flow monitoring stations (Station 1 and Station 2). A review of the modeling input data indicated that rainfall during the year 2000 (calendar year) is very close to the median rainfall within the Crescenta Valley based on long-term rainfall data (per La Crescenta Weather Station FC251 data for the period 1970-2016). The median rainfall is 19.4 inches and the total rainfall during calendar year 2000 was 19.44 inches.

[18] The model is described in the *User's Manual for the Loading Simulation Program in C++ (LSPC) Version 3.1*, LACDPW, December 11, 2009. Available at: County of Los Angeles Department of Public Works Watershed Management Division, 900 South Fremont Avenue, 11th Floor, Alhambra, CA 91803-1331.

10.5.2 COMPARISON OF MEASURED FLOWS TO LACDPW SURFACE RUNOFF MODEL RESULTS

The surface water flows recorded during the course of this Project within the Verdugo Wash were compared with LACDPW LSPC model results to assist in putting the recorded data in context with longer-term runoff estimates and to provide a basis for estimating the amount of stormwater available for recharge. The surface flow monitoring performed for this project and the LACDPW model represent different periods in time. Because flow monitoring was conducted from 2014 to 2016, and the LACDPW model estimates flow based on historical rainfall from 1996 through 2012, there was no direct comparison of estimated flows from these two sources. However, several flow events (both recorded and modeled) resulting from rainfall events with similar magnitude and duration could be compared.

For similar events, model flow estimates were generally much higher than observed conditions in terms of peak flow rate and volume. Because the model uses hourly rainfall data instead of 15-minute interval data, the peak flow data were difficult to compare. Modeled volumes were generally 4 to 5 times larger than comparable storm events recorded at the two monitoring stations installed for this study. In addition, dry weather flows estimated by the model were consistently higher than dry weather flow estimated from the recent flow monitoring.

Results of flow monitoring and the LSPC modeling both indicate that even small storms (about 0.1 inches in 1 hour) will produce periods of elevated flow within the Verdugo Wash. In estimating flow available for capture and infiltration, both flow during storm events and flow after an event are important considerations. For this Project, both aspects were considered. With respect to water that might be diverted for recharge, the duration of high flow after rainfall has ceased has a significant affect. The LSPC model-generated flow events appear to recess from high flows to approximate dry weather flows in approximately 2 days. The recession times for flow events measured as part of this study, however, were much shorter; only 5 or 6 hours long. As a result, the LSPC model may slightly over estimate flows.

Because they represent different periods of time and different hydrologic conditions, at this time and with the available data we cannot readily determine whether the measured or modeled flows are more accurate. It is possible that both sources provide reasonably accurate flow estimates, and that the differences are due primarily to the disparity in hydrologic conditions. The LACDPW model represents conditions over a 17-year period typical of historical norms for precipitation. Flow measurements conducted for this study, however, represent a period of extended drought when water conservation was being encouraged. It is plausible that during the period of flow monitoring for the Project, both wet and dry weather flows were near the low end of historical range. Consequently, flows observed during the Project could reasonably be expected to be lower than those produced by the LACDPW model.

10.5.3 ESTIMATES OF WATER VOLUME AVAILABLE FOR GROUNDWATER RECHARGE

Estimates of water available for recharge were developed considering the capacity of diversion and recharge facilities that could be put in place at CVC Park, and variations in flow over a certain time period. The following paragraphs summarize the development and evaluation of four (4) possible recharge scenarios.

CAPACITY OF DIVERSION AND GROUNDWATER RECHARGE FACILITIES

For estimating purposes, two (2) recharge galleries were assumed to be installed. The general locations of the galleries are shown on Figure 10.1. Based on the results of the infiltration testing (see Section 5 and Appendix C of this report) and other factors, each recharge gallery was assumed to have a maximum recharge capacity of 600 gpm[19], for a total capacity of 1,200 gpm. The assumed recharge galleries are as follows:

- One gallery would be located beneath the parking lot near the dog park in the western portion of CVC Park, referred to as Gallery 1. Water available to this gallery would come from flows represented by the upstream flow monitoring station (i.e. Verdugo Wash flows upstream of the confluence with Dunsmuir Channel).
- A second gallery would be located beneath the ball field outfield area in the central-eastern portion of the park referred to as Gallery 2. Water available to this gallery would be water in Verdugo Wash not diverted by the upstream gallery and water from Dunsmuir Channel. Additional details regarding the recharge galleries are provided in Section 10.8 of this report.

SURFACE WATER FLOWS

Regarding surface water flows, there are two components of flow that can contribute to water available for recharge to groundwater:

1. Flow related to precipitation events. For flows related to precipitation events, peak flow, which occurs during the precipitation period, is much greater than can be captured by an infiltration system installed at CVC Park. The duration of the peak flow and the subsequent period when flows are increased but regressing, represent the time period when runoff related to a rainfall event can be diverted for recharge, and
2. Dry weather flow. Dry weather flow occurs year round with the exception of precipitation events, which typically last only a few days per event.

RECHARGE SCENARIOS BASED ON SURFACE WATER FLOWS - For comparison purposes, four (4) stormwater recharge scenarios were developed using available measured and LSPC modeled

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[19] This estimate is based on a recharge gallery area of 80 feet x 80 feet and a soil infiltration rate of 20 feet/day for each gallery. This results in an infiltration rate of 128,000 ft^3/day or approximately 660 gallons-per-minute (gpm) flow. A conservative value of 600 gpm was used in developing the scenarios.

flow information. "High flow" refers to any period of time when flow exceeds the 600 gpm capacity of each recharge gallery. All flow up to a total of 1,200 gpm is assumed to be available for capture and infiltration. Figure 10.2 shows the monthly amount of water that could be recharged under each of the scenarios.

The following paragraphs summarize each scenario and related conclusions.

- **Scenario 1: Observed Flows**: This estimate was based on the flow monitoring measurements and observations from 2014 to 2016 for this study. Key observations used to develop this scenario are: small rain events (0.1 inch or less over 1 hour) that produced periods of high flow; recession from high flow to dry weather base flow occurred over approximately 5 to 6 hours; and dry weather flow in Verdugo Wash at the upstream gaging station was negligible during the study period. This scenario was based on calculations at 6- hour intervals.

It was assumed that high flow (greater than 600 gpm) occurs for six hours related to each 6-hour period when at least 0.10 inches of rain falls[20], and for the entire (additional) 6-hour period following a 6-hour period meeting the minimum rainfall criterion. Flow during all other 6-hour periods is considered dry weather flow. Dry weather flows at the monitoring stations varied by month. Flow in Verdugo Wash at the upstream station was observed to be essentially zero during the summer months, and flow at the downstream station (which was essentially flow from Dunsmuir Channel) varied by month.

The annual precipitation recorded during the monitoring period was approximately 8 inches/year, or approximately 36% of the long-term normal rainfall of approximately 22 inches/year. As shown on Figure 10.2, Scenario 1 results, which represent the runoff observed during the period of this study, indicate that the maximum amount of recharge, approximately 20 to 25 acre-feet/month could be recharged in December through March. Recharge in other, drier, months would be less. The total amount of water recharged for this scenario would be approximately 180 AF in one year. Considering that Scenario 1 represents a very dry year after several drought years, recharge of approximately 180 AFY is considered a minimal annual amount that could be recharged (assuming the recharge gallery capacity mentioned above).

- **Scenario 2: LSPC Model Results-Not Adjusted**: This estimate and those for Scenarios 3 and 4 are based on LACDPW flow modeling results. Scenario 2 flows are an estimate based on the entire 1996 through 2012 simulation period for the LSPC model.

As previously mentioned, based on the conditions observed during this study, the model outputs have longer flow regression periods (approximately 2 days) than have been observed during this study (approximately 5 or 6 hours). Consequently, the model results for Scenario 2 may

[20] Rainfall is recorded at 15-minute intervals. The rainfall in a 6-hour period was calculated by adding together all the 15-minute rainfall values for the period.

over estimate flows in Verdugo Wash at the upstream station (Station 1). However, for Scenario 2, the model results were not adjusted to account for the possible over estimation of flows.

At the upstream flow monitoring station (Station 1), water available for diversion and recharge at Gallery 1 (located beneath the parking lot area) was assumed to be the entire estimated flow up to a maximum of 600 gpm. Considering that water will be diverted for recharge at Gallery 1, estimated flows for the downstream station (Station 2) were reduced by the amount of flow that was diverted for recharge at Gallery 1. The entire remaining flow, up to a maximum of 600 gpm, was assumed to be available for recharge at Gallery 2 (located beneath the ball fields).

Scenario 2 represents an average of the flows for the years in the LACDPW model (1996 – 2012). This scenario is considered much less conservative (i.e. estimates greater amounts of water available for recharge) because the model simulates regression periods of approximately two (2) days following each precipitation event when peak flows are receding. As previously mentioned, the regression periods observed during this study were much shorter, on the order of 5 to 6 hours rather than 2 days. Results of this scenario indicated that approximately 630 AF of water could be available for recharge in an average year.

- **<u>Scenario 3: Model Results- Year 2000 Not Adjusted</u>**: This estimate is based on LACDPW model results for year 2000 which was the median year for rainfall; approximately 19.4 inches. The flows were not adjusted for possible over estimating of flow regression periods by the model (see explanation under the description of Scenario 2).

Water available for recharge was calculated using the same method as for Scenario 2. All flow at the upstream station, up to a maximum of 600 gpm, is available for recharge. At the downstream station, the modeled hydrograph is reduced by the amount of water at the upstream station that was diverted for recharge using Gallery 1. The remaining flow, up to a maximum of 600 gpm, was considered available for recharge using Gallery 2.

Scenario 3 represents modeled conditions for the year 2000, when the annual rainfall of 19.4 inches was approximately equal to the longer-term mean precipitation of 21.8 inches and longer-term median precipitation of 19.4 inches. For this scenario, the model results were not adjusted to reduce the modeled regression flows (approximately two days per precipitation event). Consequently, the amount of water available for recharge under this scenario is approximately 610 AF of water in a year. As shown on Figure 10.2, the amount of water that would be recharged in March would be approximately 153 acre-feet since March 2000 was a very wet month.

The March 2000 estimated recharge is roughly equivalent to operating both recharge galleries at full capacity for the entire month. In terms of recharge, this scenario is also considered less-conservative in that it probably over-estimates the amount of water that could actually be available for recharge in a typical (median rainfall) year.

- **<u>Scenario 4: Model Results: Year 2000 Adjusted</u>:** This estimate is identical to Scenario 3, except that dry weather flows calculated by the model at the upstream station (which occurs commencing about 2 days following a rainfall event) were adjusted. The dry weather flows were assumed to be zero. This adjustment is based on the fact that dry weather flows at the upstream flow monitoring station during the 2014 to 2016 monitoring period[21] were observed to be zero.

Scenario 4 represents modeled conditions for the year 2000, with the precipitation event runoff adjusted to better represent conditions observed at the two flow monitoring stations. The dry-weather flow conditions at the upgradient monitoring station were set to zero, consistent with observations made for this study. With this scenario the amount of water available for recharge was estimated to be approximately 510 AF in a year. Based on this scenario which represents a year with near median average long-term runoff, recharge of approximately 500 AF in a year is considered reasonable for long-term average conditions.

CONCLUSIONS BASED ON SCENARIOS

The stormwater recharge scenarios developed were based, in part, on the assumption that the maximum rate of recharge of surface water to groundwater is 1,200 gpm. Based on the scenarios presented, estimates of the volume of water that could be recharged on an annual basis ranged from approximately 180 AFY to 630 AFY. Actual flow available for infiltration during any year will depend on the amount of rainfall and watershed condition.

The lower end of this range, 180 AFY, represents drought or dry-period conditions such as those in the last two years in the Verdugo Basin and surrounding area. During this period the watershed was very dry and local residents have been implementing water conservation measures that may reduce surface water runoff. The upper end of this range, 630 AFY, represents modeled conditions that are predicted to be somewhat higher than might actually be achieved, considering the assumptions regarding the size and locations of recharge galleries at CVC Park. Assuming that the Verdugo Basin watershed returns to long-term average precipitation and based on the scenarios developed and evaluated, the amount of water available for recharge is estimated to be between approximately 180 and 500 AFY.

10.6 WATER QUALITY CONSIDERATIONS

As presented and discussed in Section 5 of this report, the quality of surface waters are generally within DDW & RWQCB water quality standards, with minor MCL exceedances for metals observed in analyses of the samples collected and analyzed. For the dry weather flows, concentration of total dissolved solids (TDS) was 340 milligrams per liter (mg/L). For storm runoff flows, the TDS was lower, ranging from 37 to 190 mg/L.

[21] Dry weather flows at the upstream Verdugo Wash flow monitoring station were nil during the 2014 – 2016 monitoring period for this project.

Studies performed for the Los Angeles and San Gabriel Rivers Watershed Council (now the Council for Watershed Health) indicate that metals attenuate in vadose zone soils as surface water infiltrates down to the water table.[22]

As presented and discussed in Section 6 of this report, the quality of groundwater, based on samples from CVWD wells MW16 and MW17 at the park are within DDW & RWQCB water quality standards. The TDS of the groundwater ranged from 520 to 680 mg/L. With the exception of nitrate and aluminum, concentrations of containments tested were below MCL concentrations. Nitrate concentrations ranged from 14 to 48 mg/L, with only one of seven samples exceeding the MCL of 45 mg/L nitrate. All other nitrate results were 17 mg/L or less.

Nitrate is a known groundwater problem in the Verdugo Basin, and as appropriate, CVWD actively treats and blends extracted groundwater to reduce nitrate concentrations to below the MCL.

Aluminum (total recoverable aluminum) was detected in the groundwater samples at concentrations ranging from approximately 1.7 mg/L to approximately 8.8 mg/L, which is above the MCL of 1.0 mg/L. The reason for the relatively high aluminum concentrations is not readily apparent, as historical water quality data for groundwater wells in the area have not shown high aluminum concentrations.

Based on the water quality analyses performed for this study, the surface water that could be used for recharge of the underlying groundwater system is of better overall quality than the groundwater. The water quality results should be discussed with RWQCB and DDW as part of the final design of the project. The surface water does not appear to have chemical or other

constituent in it that would be harmful to groundwater quality. As a result, a recharge program at CVC Park should have a beneficial impact with respect to groundwater quality. Recharged water could help reduce the concentrations of both nitrate and aluminum in groundwater.

10.7 HYDROGEOLOGIC CONSIDERATIONS RELATED TO RECHARGE

Key hydrogeologic aspects of a stormwater recharge program include consideration of the ability to infiltrate water, mounding of recharged water, movement of recharged water away from the area of mounding, and the ability to recover the recharged water for beneficial use. The following report sections summarize the current understanding of the hydrogeologic conditions in the area as they relate to a possible recharge program.

10.7.1 VADOSE ZONE CONDITIONS

Vadose zone conditions are an important consideration related to the ability of using infiltrate water for groundwater recharge. The Vadose zone for the Verdugo Basin is considered the zone

[22] The Los Angeles and San Gabriel Rivers Watershed Council, 2005, Los Angeles Basin Water Augmentation Study, Phase II Final Report, Prepared with assistance from Geomatrix Consultants, Inc., August.

of unsaturated soil above the water table. The thickness of the vadose zone varies depending on the depth to groundwater in the area.

Data from the newly installed monitoring wells, CVWD's existing production wells, and previous studies in the area of CVC Park indicate that vadose zone soils at CVC Park and in the surrounding area are generally coarse grained, consisting primarily of sands and gravels[23,24,25,26].

Pits excavated for infiltration testing for the Project primarily encountered sands and gravels with minor amounts of silt. The infiltration capacity of the soils at the depths anticipated for the proposed recharge galleries indicate a high potential for infiltration with calculated infiltration values that range from more than nine feet/day to more than 100 feet/day. A conservatively low value of 20 feet/day was used in developing the infiltration capacity estimates for this study.

The thickness of the vadose zone and room for infiltrated water to create a mound of recharged water on the water table (or raise the water table, thereby reducing the thickness of the vadose zone) are also important considerations for developing stormwater recharge systems. Water level data for the two (2) new CVWD monitoring wells and existing CVWD monitoring well M-1 (located at the west end of CVC Park) suggests that the depth to the water table beneath CVC Park is currently and in recent years ranges from approximately 30 to 40 feet to more than 60 feet below finished ground, depending on location. Depths to ground water of approximately 30 feet or more could allow room within the Vadose Zone for periodic mounding of recharged stormwater while still maintaining a depth to water below ground surface that would not adversely impact overlying trees and structures.

Historical data for CVWD monitoring well M-1 indicate that the depth to water has varied from approximately 23 feet to 62 feet since the well was installed in 2001, with depths generally 30 feet or greater. The depth to groundwater beneath the nearby parking lots thought to be similar. The depth to groundwater at the time of this study (2014 to 2016) beneath the parking lot near the dog park near the west end of the park is estimated to be approximately 35 to 40 feet below ground surface.

The depth to groundwater beneath the ball field area at the time of this study is estimated to be approximately 45 feet below ground surface. Historical static water levels for CVWD production well CVWD 9, located across Honolulu Boulevard from the eastern portion of the park (i.e.

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[23] California State Water Rights Board, 1962, *Report of Referee*, volumes I and II, The City of Los Angeles, a Municipal Corporation, Plaintiff, vs. City of San Fernando, a Municipal Corporation, et.al. Defendants.

[24] Bookman-Edmonson, 2004, *Final Report, Verdugo Basin Groundwater Evaluation and Monitoring Report*, report prepared for CVWD.

[25] Geomatrix Consultants, Inc., 2005, *Verdugo Basin Groundwater Recharge, Storage, and Conjunctive Use Feasibility Study, CVWD Project E713,* May.

[26] Quaternary Research Investigations, Inc., 2008, *Stratigraphy of the Verdugo Basin in Glendale and La Crescenta, California,* Report to ATC Associates, Inc. for Resource Environmental, LLC, May 13.

located north of the ball field area) have ranged from approximately 40 to more than 100 feet below ground surface since approximately 1980.

Considering that current water levels reflect a drought period where water levels are deeper than average, water levels could be shallower beneath the parking lot and the ball field areas during wet periods.

The depth to water in production wells CVWD 7, and CVWD 1, which are located downgradient of CVC Park (east and southeast of the park), have historically ranged from approximately 50 feet to 120 feet below ground surface, depending on the season and year.

10.7.2 AQUIFER CONDITIONS

Aquifer conditions are another important consideration in evaluating a groundwater recharge program. In the Verdugo Basin, groundwater generally occurs in the alluvial sediments above bedrock. Groundwater is also thought to occur in the upper weathered portion of the bedrock that underlies the alluvial aquifer. The permeability of the weathered bedrock, however, is likely much lower than that for the overlying alluvial materials. More-detailed information about the aquifer conditions in the Verdugo Basin can be found in previous hydrogeologic reports for the area.[27,28,29]

AQUIFER THICKNESS AND MATERIALS

In general, recharged stormwater and groundwater may move more freely in areas where the alluvial aquifer is thicker. Although the depth to bedrock and the thickness of the overlying alluvial aquifer is not well defined in the CVC Park area, the wells installed for this study provide data to help better define the nature and thickness of the alluvial aquifer in the area. Bedrock has been encountered in several wells at and near the park. Figure 10.3 shows the depth to bedrock as estimated from well logs in the area, including wells installed for this study.

As shown on Figure 10.3, the depth to bedrock at well MW17 in the central northern part of the park is greater than 136 feet. At wells M-1 and MW16 located at the west and south east ends of the park, the depth to bedrock is shallower, at 60 and 55 feet, respectively. These two wells are closer to the Verdugo Hills mountain front, and the bedrock would be expected to be shallower than further north and east away from the mountain front. The depths to bedrock in wells CVWD 4, CVWD 9 and CVWD 7 are 140 feet or greater, indicating that the alluvial aquifer thickens to the north and east of the park.

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[27] Geomatrix Consultants, Inc. 2005, *Verdugo Basin Groundwater Recharge Storage, and Conjunctive Use Feasibility Study,* Prepared for CVWD, May.
[28] California State Water Rights Board Referee, 1962, *Report of Referee, Volume 1, Text and Plates,* The City of Los Angeles, Plaintiff, vs. City of San Fernando, Defendant.
[29] See also ULARA Watermaster Reports: http://ularawatermaster.com/

Geophysical studies performed in 2008 in the area of CVC Park[30], identified younger and older alluvial units that make up the alluvial aquifer in the Verdugo Basin. These materials consist primarily of sand and gravel mixtures with lesser amounts of finer sediments. The younger alluvial materials are considered Recent or Holocene in age and less consolidated than the older alluvial deposits. The older alluvial deposits (Pleistocene and Pliocene age) may be more consolidated than the younger alluvial units and as a result may be much less permeable. The geophysical studies also suggested the presence of a fault (the La Crescenta Valley Fault) in the park area that offsets bedrock and older alluvial deposits. Approximate locations of suspected faults in the area are shown on Figure 10.3.

The distribution of older and younger alluvial materials and the presence or absence of such a fault was not verified by the work performed for this Project.

AQUIFER PERMEABILITY

During the development and calibration of the groundwater flow model for the Verdugo Basin, an aquifer permeability of 65 feet/day was assumed, which is representative of sands and sandy materials[31]. Results of an aquifer test performed in well M-1 at the west end of the park indicated permeability (hydraulic conductivity) of approximately 5 feet/day[32]. Qualitative observations during installation of wells MW16 and MW17 regarding the permeability of the aquifer materials suggest that the shallow aquifer materials are relatively permeable in the central and eastern part of the park. Considering the lower permeability value indicated by the aquifer testing at well M-1, additional evaluation of the permeability of alluvial materials nearby in the parking lot area would be helpful in further developing the design of recharge facilities in the parking lot area.

10.7.3 GROUNDWATER MOUNDING

The updated groundwater flow model was used to evaluate the degree of mounding that might occur as a result of the stormwater recharge. A recharge scenario of approximately 300 AFY was developed and run using the model. The scenario included recharge of 44 AF per month for five months of the year, 10 AF per month for six months of the year, and 15 AF for one month of the year. Approximately 150 AFY was recharged at each of the recharge gallery locations (parking lot area and ball field area).

The recharge scenario was developed by running the calibrated model for the period over which it is calibrated (an approximate 34-year period: June 1981 through December 2015), while imposing the additional recharge at the two gallery locations.

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[30] Quaternary Resource Investigations, LLC, 2008, *Stratigraphy of the Verdugo Basin in Glendale & La Crescenta, California*, report to ATC Associates, Inc. for Resource Environmental, LLC, dated May 2008

[31] US Department of the Interior, Bureau of Reclamation, 1995, *Groundwater Manual,* US Government Printing Office.

[32] Bookman-Edmonston, 2004, *Final Report, Verdugo Basin Groundwater Evaluation and Monitoring*, CVWD Project E-696, June 24.

Because the model is calibrated over both extremely wet and dry periods, the modeled scenario provides information on how the Basin (including water levels in the CVC Park area) would respond during these various conditions. Figure 10.4 presents modeled hydrographs for the locations of the ball field recharge gallery (Gallery 1) and parking lot recharge gallery (Gallery 2).

The water level plots shown on Figure 10.4 (a) are modeled water levels for the ball field area. The blue line is the modeled water level without recharge and the gold line is the water level with recharge. The gold line shows annual fluctuations in response to seasonal recharge.

Figure 10.4 (b) shows a plot of the difference between the modeled water levels with and without recharge. The greatest mounding (water level increase) as a result of recharge occurs in approximately year 1992 when modeling suggests mounding would be approximately 24 feet beneath the recharge gallery. The year 1992 conditions correspond to a time when water levels in the area were relatively low. Overall the amount of mounding (increase in the elevation of the water table) directly beneath the ball field recharge gallery is estimated to range between 5 and 20 feet. That is, the elevation of the water table directly beneath the recharge gallery would be between 5 and 20 feet higher than it would be without water being recharged.

The water level plots on Figure 10.4 (c) show modeled water levels beneath the parking lot area which are similar to those for Figure 10.4 (a).

As shown on Figure 10.4 (d), mounding (increase in the elevation of the water table) beneath the parking lot recharge gallery would range from about 2 to 12 feet above the water table elevation without recharge. Similar to the ball field area, mounding was greatest for conditions corresponding to the year 1992.

Figure 10.5 shows the degree of groundwater mounding for the year 1992 conditions (maximum mounding). As shown, mounding beneath the ball field area could exceed 20 feet. At the park boundary mounding is approximately 18 feet or less along New York Avenue and approximately 17 feet or less along Honolulu Avenue. In the vicinity of CVWD Well 9 which is near the intersection of Honolulu Avenue and New York Avenue, mounding would increase water levels by approximately 16 feet. Mounding beneath the parking lot area for year 1992 conditions is approximately 14 feet. Along the park boundary (Honolulu Avenue) nearby mounding is approximately 12 feet or less.

As shown on Figure 10.5 mounding would extend to beneath the I-210 freeway, where mounding would be approximately 13 feet or less. Mounding would also occur beneath Dunsmuir and Verdugo Wash channels and, to a lesser degree, beneath homes surrounding the park.

Depending on water level conditions mounding could present a problem if water levels become too shallow. Additional discussion of mounding and shallow groundwater levels is presented in Sections 10.8.2 and 10.9 of this report.

Groundwater mounding as a result of recharge will help reduce groundwater pumping lifts at CVWD's groundwater pumping wells located east and southeast of the recharge areas. Reduced pumping lifts are a benefit to CVWD in the form of reduced pumping costs and higher well capacity or pumping yields.

10.7.4 GROUNDWATER FLOW

Groundwater modeling results indicate that recharged groundwater would flow outward from the recharge galleries. The general groundwater gradient in the area is to the east, and southeast, and the majority of the recharged water would flow in these directions. Figure 10.6 shows the percentage of recharged water in the area around CVC Park at the end of the recharge scenario (i.e. after approximately 34 years of recharge). Recharged water represents a portion of the groundwater in the vicinity of CVWD's pumping wells. Evaluation of the scenario results indicate that up to 88 percent of the recharged water is captured by CVWD's pumping wells and that only a small portion of the recharged water flows past CVWD's pumping wells. The small uncaptured portion of the recharged water may be recovered by other pumping wells in the lower part of the Verdugo Basin. The modeled scenario is based on historical pumping plus an increase in pumping equal to the amount of water recharged each year. Once the recharge galleries are in operation, CVWD may be able to modify pumping patterns from their wells to recover an even larger percent of the water recharged.

As part of the recharge scenario evaluation, a particle-tracking feature of the groundwater flow model was used to evaluate the flow of the recharged water. The red lines on Figure 10.7 show how recharged water may move southeasterly from the area of the recharge galleries towards CVWD's pumping wells where the water is extracted. More than 88% of the recharged water can be expected to be recovered by CVWD's pumping wells. Of the 1,636 particle-tracking lines, less than 50 (3% of the total) extend southeast past CVWD's pumping wells[33]. This supports the conclusion that the vast majority of the recharged water will be recovered by CVWD's wells.

10.8 PRELIMINARY DESIGN OF DIVERSION AND INFILTRATION SYSTEM

The following sections summarize the design and operation of the systems to divert and infiltrate water. During the development of the preliminary design, the LADCPW provided information regarding their existing diversion structures and operations. LACDPW operates stormwater diversion structures at several other locations in Los Angeles County. System components and operation of an infiltration system are described in the following paragraphs.

10.8.1 SYSTEM COMPONENTS

As mentioned in Section 10.5.3 of this report, two infiltration systems are proposed for the CVC Park as shown in Figure 10.1. Both infiltration systems would divert water from different

[33] See Figure 10.7 where fewer than 50 particle-tracking lines extend downgradient of CVWD pumping well number 8.

locations along the Verdugo Wash Channel. The location of the northern infiltration system, shown on Figures 10.1 and 10.8, is proposed adjacent to the dog park in the northern portion of CVC Park. This system would divert water from the Verdugo Wash Channel and infiltrate the storm water in a subsurface gallery (Gallery 1) underneath the parking lot south of the dog park. The southern infiltration system, shown on Figures 10.1 and 10.9, would be located downstream of the confluence of Verdugo Wash Channel and Dunsmuir Channel allowing the capture of storm water from both channels.

The diverted storm water from the southern infiltration system would infiltrate through a subsurface gallery (Gallery 2) located between the ball fields located in the southeastern portion of CVC Park.

Each infiltration systems will consist of three components:

1. In-channel diversion structure;
2. Conveyance piping, manholes, and a pretreatment structure; and
3. Infiltration gallery.

The two infiltration systems would be similar and schematic of the infiltration systems in profile is shown on Figure 10.10.

The in-channel diversion structure will consist of either an inflatable rubber dam or a pneumatic gate. The dam or gate would be approximately three feet in height and span the entire width of the Verdugo Wash Channel. The inflatable rubber dam or pneumatic gate would be operated by an air compressor system located adjacent and outside of the channel. The rubber dam or pneumatic gate would be designed such that LACDPW maintenance vehicles could drive over the structure if necessary without damaging it. The other component of the diversion structure would consist of a screened outlet that would penetrate through the vertical wall of the channel to allow water to exit the channel and enter the conveyance piping. The diversion structure would require moderate modification of the existing concrete channel in the immediate area of the diversion structure.

The subsurface conveyance piping for the infiltration system would utilize standard reinforced concrete pipe and manholes used for typical municipal storm water infrastructure. Pretreatment to remove sediment would be accomplished with a manufactured, subsurface vortex separator vault.

The final component of the infiltration system consists of a subsurface infiltration gallery. The infiltration gallery is constructed of large diameter, perforated pipes that distribute, store, and infiltrate the diverted storm water into the underlying alluvial soils.

The large diameter pipes will be installed upon a layer of coarse gravel and the area around, between, and over the pipes will also be backfilled with the same type of gravel.

The coarse gravel will also add some measure of storage within the void space of the gravel matrix and also allow water to be distributed more evenly over the area of the infiltration gallery.

All of the components, besides the diversion structure, will be below ground to allow full use of the overlying park. The subsurface infrastructure will be designed to allow occasional vehicle traffic for necessary park maintenance activities.

10.8.2 SYSTEM OPERATION

The infiltration system operates by detaining storm water behind the inflatable dam or gate allowing flow to be diverted into the conveyance piping.

When the flow capacity of the infiltration system is exceeded, storm water will flow over the crest of the inflatable dam or gate and proceed downstream. Diverted storm water would initially fill the infiltration gallery distribution pipes, then flow out of the perforations and infiltrate into the underlying gravel and aquifer. The inflatable dam or gate as well as the large diameter pipes making up the infiltration gallery provide some storage capacity for storm water, but the infiltration rate of the infiltration gallery will be the governing mechanism. For the conceptual design, each infiltration gallery covers an 80 foot by 80 foot area that would infiltrate up to an estimated 600 gpm when the system operates at full capacity.

Operation of the infiltration system would be during both dry weather and wet weather conditions. The inflatable dam or gate will remain inflated or in the active position for a majority of the time. The LACDPW conducts routine maintenance within the Verdugo Wash Channel. Upon notification of upcoming channel maintenance, the inflatable dam or gate will be lowered to allow maintenance full access to the channel. The inflatable dam and gates can be safely traversed by maintenance vehicles within the channel. The inflatable dam or gate will also periodically be lowered to flush sediment or accumulated debris as necessary.

The pretreatment vault would remove a certain percentage of the sediment load associated with the storm water to decrease the sediment entering the infiltration gallery. The pretreatment vault would require periodic sediment removal with a vacuum truck as necessary. The manholes would allow access to the infiltration gallery to assess sediment build up and conduct sediment removal using a vacuum truck or other methods.

Considering that groundwater mounding and relatively shallow water levels in the vicinity of the recharge galleries may be a concern, groundwater levels would be monitored in conjunction with operation of the galleries. In the event that groundwater levels beneath or near the galleries reached a pre-determined minimum depth below ground surface, the amount of stormwater recharge could be reduced to allow recharged water to flow away from the galleries, thereby reducing the degree of mounding and allowing groundwater levels beneath and near the galleries to decline. Recharge would resume when groundwater levels declined to pre-determined levels.

10.9 ENVIRONMENTAL AND SAFETY CONSIDERATIONS

There are a number of environmental and safety considerations related to collection and infiltration of stormwater at CVC Park. A specific consideration for the facilities is the potential impact on oak trees in CVC Park. If recharge were to raise groundwater levels to the degree that the roots of oak trees in the area were flooded, the trees could be adversely affected. The areas identified for construction of the recharge facilities are located away from existing oak trees and other trees and as a result, construction impacts related to trees are considered to be minimal.

Evaluation of groundwater mounding using the groundwater flow model updated for this project indicates that mounding should not occur to the degree that the higher groundwater levels would impact the trees; i.e. the depth to water beneath oaks and other trees would be greater than 10 to 15 feet. Discussions with a local arborist, Mr. Craig Crotty of Arbor Culture, LLC in Verdugo City, California indicate that at a depth of 10 to 15 feet (approximately) below ground surface, mounded groundwater would not adversely impact the trees. There is a potential for the trees to benefit from the additional below-grade moisture.

A generalized map of the area prepared by the state of California indicates that the CVC Park area is in an area with potential for liquefaction.[34] Specific studies are not thought to have been performed in the park area and the potential for liquefaction is therefore not fully known.

The recharge facilities will also involve ponding of water in theVerdugo Wash channel and there may be safety concerns related to the ponded water. Detailed design of the diversion facilities has not been performed at this time, however, the maximum depth of ponded water in the channel is assumed to be on the order of three feet or less. Storm flows in the channel, which would result in more water being ponded, occur only for brief periods during and immediately after storms. The vast majority of theyear, dry-weather low-flows occur, and the amount of water ponded would probably be two feet deep or less. Overall the channel is not open to public access and is surrounded by a chain link fence. Additionally, the ponded water would be in a portion of the channel away from high-use areas of the park. Consequently, the potential for access by the public, and related ponded-water safety issues, is considered low.

An additional issue related to ponded water is the potential for mosquitos and West Nile virus. Although issues related to mosquitos are not anticipated, LACDPW operates several other rubber dam projects, and this and related issues should be discussed with LACDPW to determine if mosquitos have posed a significant problem at other water ponding locations in channels. If a potential mosquito problem is identified, LACDPW's current systems and activities to alleviate the problem should be identified and evaluated. As appropriate, similar measures could be incorporated into the diversion structures at CVC Park.

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[34] California Department of Conservation, Division of Mines and Geology, 1998, *Seismic Hazard Zone report for the Burbank 7.5-minute Quadrangle, Los Angeles County, California.*

10.10 PERMITTING AND AGREEMENTS

Several types of permits and necessary agreements will be required for the recharge facilities. Permits that may be required were divided into two categories: 1) environmental permitting and 2) other permitting. These two permitting categories and general agreements are discussed in the following subsections.

10.10.1 ENVIRONMENTAL PERMITTING

Environmental permits will be required to construct and operate the facilities. The following is a list of key processes/agencies and related permitting information:

CEQA. CEQA review will be required and its scope should be evaluated as part of the development of a detailed design for the project. It is anticipated that CEQA review would be limited to an Initial Study followed by a Negative Declaration or Mitigated Negative Declaration.

US Army Corps of Engineers (USACOE). The USACOE regulates the discharge of fill material into jurisdictional waterways under Section 404 of the Clean Water Act. They likely have jurisdiction over these concrete lined waters and construction of diversion structures within the waterway would require a Section 404 Permit. The project may meet the requirements of some of the USACOE nation-wide permits (NWPs), including: NWP18-Minor Discharges (less than 25 CY of material discharged into the waterway), NWP33-Temporary Construction, Access, and Dewatering, NWP 41 – Reshaping Existing Drainage Ditches, or NWP 43 – Stormwater Management Facilities. For NWPs, the USACOE Los Angeles Division would review information regarding the project, provide confirmation that the project qualifies for the required permit and any permit requirements.

RWQCB. The RWQCB regulates potential impacts to water quality under Section 401 of the Clean Water Act (providing Water Quality Certification for projects that require a 404 permit). The process for obtaining this permit would be to submit an application to the RWQCB, providing information on the water diversions and the potential for impact (positive or negative) to downgradient water quality. The RWQCB would review and provide a 401 Certification.

CDFW. CDFW probably will require a Streambed Alteration Agreement (under Section 1602 of the State Fish and Game Code) for diversion of water from the Verdugo Wash Channel. Although it is concrete lined in the area of CVC Park, a portion of the channel downgradient is unlined at the Verdugo Debris Basin and water diversions have the potential to impact downstream habitat for wildlife. CDFW evaluates projects in waterways with respect to wildlife along the channel, including downgradient of the diversions. The process for obtaining the agreement is to notify CDFW and provide them with information regarding the proposed diversions, including potential for impact to listed or otherwise sensitive species (birds, fish, mammals, etc.). CDFW would then provide the Agreement with any permit requirements.

10.10.2 OTHER PERMITTING

Other permitting may include building permits and encroachment permits. CVWD already has good working relationships with the parties that may be involved in construction and operation permitting including LADCPW, LACDPR, and the City of Glendale. Permits related to construction and modification of the Verdugo Wash Channel will be related to the LACDPW which owns and operates the Verdugo Wash Channel.

By consulting with LACDPW during the more-detailed design process for the diversion structures, the permitting process for construction and operation in the channel should proceed in a timely manner.

The conveyance piping, sediment pre-treatment vaults, and infiltration galleries will be constructed in the park, which is LACDPR property and an amendment to CVWD's existing agreement with LACDPR will be required.

10.10.3 AGREEMENTS

Access agreements will be needed for construction and operation of the diversion and operation of the facilities. CVWD has an existing access agreement with LACDPW and LACDPR for the current Project. It may be possible to amend the agreements to allow for construction and long-term operation of the diversion and recharge facilities. If not, CVWD will need to obtain new agreements with these agencies for construction and long-term operations.

11.0 CONCLUSIONS AND RECOMMENDATIONS

The surface water flow monitoring, sampling, infiltration testing, groundwater monitoring and other components of the Project provide a good basis for CVWD to move forward with planning and implementation of a recharge project. The work to date indicates that a recharge program is viable for the CVC Park.

11.1 CONCLUSIONS

The Project allowed development of a number of significant conclusions. Conclusions are grouped in appropriate categories and are summarized below:

11.1.1 SURFACE WATER AVAILABILITY AND QUALITY:

- During the period of this project, dry weather flows in Verdugo Wash Channel were very low and flow in Dunsmuir Channel ranged from approximately 20 to 160 gpm.
- During periods when precipitation is more reflective of long-term average conditions, dry weather flows will be greater. It is assumed that when the current water drought conditions return to normal water conditions, water conservation measures for the local community will be reduced and the watershed will also return to more normal conditions. At that time, dry weather flows are expected to increase.

- Assuming an overall infiltration capacity of 1,200 gpm within the two infiltration gallery systems, it is assumed that a minimum of 180 AFY of water could be recharged in dry years. During normal (non-drought) periods, up to 500 AFY (or more) could be recharged during the wet-weather flows.

- An infiltration capacity of 1,200 gpm was assumed for this study. If a larger infiltration capacity were assumed (i.e. larger infiltration gallery areas or more infiltration galleries) from a water availability standpoint, greater amounts of stormwater water could be recharged into the Verdugo Basin. As described in the Hydrogeologic Conditions section below, shallow water levels and groundwater mounding need to also be considered as a constraint.

- Surface water quality is relatively good based on water quality data, and recharge of surface water could improve the overall quality of groundwater in the area.

11.1.2 INFILTRATION CAPACITY:

- Review of the well logs and infiltration testing data results from this study indicates that shallow soils in the area are relatively permeable and have a high infiltration capacity. The infiltration test results indicate permeability ranging from approximately 10 to 100 feet/day for soils in the eastern portion of the park. Shallow soils in other portions of the park are thought to be similar permeability with respect to infiltration capacity. Overall infiltration capacity should not be a significant constraint for the proposed stormwater recharge program at CVC Park.

11.1.3 HYDROGEOLOGIC CONDITIONS:

- Review of existing hydrogeologic studies in the Basin and in the vicinity of the park indicates that the alluvial aquifer in the area is relatively permeable. One geophysical study indicates the possible presence of a fault beneath the park. If present the fault may offset older (less permeable) alluvium and bedrock in the area. The potential for the fault to affect groundwater flow is not known at this time. A review of available water level data, however, does not suggest that faulting of alluvial units or bedrock has an effect on water levels or groundwater flow.

- The depth to groundwater beneath the park at the time of this Project ranges from approximately 30 to more than 60 feet below finished ground, depending on location and time of the year. Historical data for CVWD monitoring well M-1 at the west end of the park (near the parking lot) and production well CVWD 9 near the northeastern corner of the park indicate that water levels in the past have been shallower, approximately 20 to 40 feet higher than today's well levels, respectively, at these well locations.

- During wet periods when the groundwater Basin is relatively full, the data shows that groundwater levels beneath and near CVC Park will be shallower than observed during this study. Depending on the depth to groundwater, recharge may need to be limited to avoid raising groundwater levels to such a degree that groundwater mounding could impact structures or trees.

- Results of a groundwater modeling simulation for recharge of 150 AFY for each of two recharge galleries (one beneath the parking lot at the west end of the park and one beneath the ball field area) indicate that recharge of 300 AFY would result in mounding generally ranging from 5 to 20 feet below finished grade beneath the ball field area and from 2 to 12 feet below finished grade beneath the parking lot area.

- Mounding would vary seasonally, with the greatest mounding in winter months and less in summer and fall months. During non-drought periods when dryweather flows may be greater, increasing the infiltration of dry weather flows would spread the recharge out more evenly throughout the year and allow for greater amounts of recharge without significant increases in groundwater mounding.

- Groundwater mounding and resulting shallow water levels represent a constraint to how much stormwater could be recharged into the Verdugo Basin.

- Mounding of groundwater also could be reduced or re-distributed by modifying the shapes and locations of the recharge galleries. For this study, rectangular recharge galleries 80 feet x 80 feet in area were modeled. More-linear recharge galleries or galleries further north in the park area where the depth to groundwater is greater may help to reduce mounding and allow for more recharge during periods where water levels beneath the park are shallower.

- Results of the groundwater modeling scenario indicate that pumping at existing CVWD pumping wells will capture the vast majority of the recharged water. A small portion of the recharged water may flow past CVWD's pumping wells, but this water would likely be captured by City of Glendale groundwater pumping wells located further south and east in the Verdugo Basin.

- Groundwater mounding could help to reduce pumping lifts and increase production of water from CVWD's pumping wells.

- Groundwater quality could be improved by the addition of recharged stormwater into the Verdugo Basin.

11.2 RECOMMENDATIONS

As part of this report, additional work is recommended to further develop the design for diversion and infiltration of surface water beneath CVC Park. Recommendations are grouped in appropriate categories and are summarized below.

11.2.1 ADDITIONAL DATA COLLECTION:

- Continued surface water flow monitoring is recommended. Future monitoring of the flow monitoring stations will provide additional flow data for conditions more typical of long-term precipitation in the area. In addition, when the non-drought conditions return to the area and local water conservation measures are eased, more dry-weather flows could be available for stormwater recharge. With additional data, the evaluation of water available for recharge would be updated and the information will be used to determine the effectualness of the infiltration system.

- Continued groundwater level monitoring at monitoring wells at CVC Park is recommended. Regular monitoring of water levels, on a monthly basis for wells M-1, MW16 and MW17 at the park will provide data on the depth to groundwater and groundwater flow directions over time. This information will help in further evaluating how much water can be recharged over time beneath the park.

- Further evaluation of groundwater mounding and water level conditions is recommended. Since mounding is directly related to the permeability of the aquifer, short-duration (24 hours or less) pumping tests to determine aquifer transmissivity and permeability are recommended for new wells MW16 and MW17 and also for CVWD pumping well CVWD9. Aquifer permeability and transmissivity data (and groundwater level data) could be used to update the groundwater flow model in the vicinity of CVC Park.

- After the above recommendations are implemented, additional updating of the Verdugo Basin groundwater flow model for conditions beneath and near the park is recommended. This update would focus on the area around CVC Park and CVWD's water production wells. The hydraulic conductivity of the aquifer beneath and near the park would be updated using the pumping test results and most recent water level data from the monitoring wells. Currently the groundwater model utilizes a 100-foot by 100-foot nodal grid to simulate conditions and with the additional data, the grid size in the park area could be reduced to provide better resolution of modeled water levels.

- If additional areas of the park are identified for recharge galleries, one or more soil borings in these areas is recommended to confirm soil conditions.

11.2.2 ADDITIONAL DESIGN AND PERMITTING:

- Recommend to complete the final design of the infiltration system based on the preliminary design of this report. An initial step in the final design would be to meet with LADCPW to further discuss their specific design requirements.

- As the final design of an infiltration system is refined, further interactions with environmental agencies is recommended so that conditions or considerations required by permitting agencies can be considered and addressed in the system design phase.

- Development of a cost estimate for the systems is recommended. The cost estimate will allow CVWD to evaluate funding for construction, including various grants that may be available from the state of California.

TABLES

TABLE 5.1. Dry Weather Surface Water Sampling Results
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Analyte	Analytical Procedure	MCL	Units	MDL	Result (05-18-16)
Volatile Organic Analysis					
Benzene	EPA Method 624	1	ug/L	0.0500	ND
Bromodichloromethane	EPA Method 624	0.2	ug/L	0.0810	ND
Bromoform	EPA Method 624	N/A	ug/L	0.1100	ND
Bromomethane	EPA Method 624	N/A	ug/L	0.1600	ND
Carbon tetrachloride	EPA Method 624	0.5	ug/L	0.0500	ND
Chlorobenzene	EPA Method 624	70	ug/L	0.0500	ND
Chloroethane	EPA Method 625	N/A	ug/L	0.0630	ND
Chloroform	EPA Method 624	N/A	ug/L	0.0500	ND
Chloromethane	EPA Method 624	N/A	ug/L	0.0900	ND
DibroChloromethane	EPA Method 624	N/A	ug/L	0.0770	ND
1,2-Dichlorobenzene	EPA Method 624	600	ug/L	0.0720	ND
1,3-Dichlorobenzene	EPA Method 624	N/A	ug/L	0.0500	ND
1,4-Dichlorobenzene	EPA Method 624	5	ug/L	0.0500	ND
1,1-Dichloroethane	EPA Method 624	5	ug/L	0.0500	ND
1,2Dichloroethane	EPA Method 624	0.5	ug/L	0.1300	ND
1,1-Dichloroethene	EPA Method 624	N/A	ug/L	0.0750	ND
trans-1,2-Dichloroethane	EPA Method 624	N/A	ug/L	0.0750	ND
1,2-Dichloropropane	EPA Method 624	5	ug/L	0.0950	ND
cis-1,3-Dichloropropane	EPA Method 624	N/A	ug/L	0.0500	ND
trans-1,3-Dichloropropane	EPA Method 624	N/A	ug/L	0.0630	ND
Ethylbenzene	EPA Method 624	300	ug/L	0.0540	ND
Methylene chloride	EPA Method 624	N/A	ug/L	0.4100	ND
Methyl t-butyl ether	EPA Method 624	13	ug/L	0.0950	ND
1,1,2,2-Tetrachloroethane	EPA Method 624	1	ug/L	0.0960	ND
Tetrachloroethane	EPA Method 624	N/A	ug/L	0.0770	ND
Toluiene	EPA Method 624	150	ug/L	0.0700	ND
1,1,1-Trichloroethane	EPA Method 624	200	ug/L	0.0720	ND
1,1,2-Trichloroethane	EPA Method 624	5	ug/L	0.1400	ND
Trichloroethane	EPA Method 624	N/A	ug/L	0.0870	ND
Trichloroflurometħane	EPA Method 624	150	ug/L	0.1200	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA Method 624	1200	ug/L	0.0500	ND
Vinyl chloride	EPA Method 624	0.5	ug/L	0.0680	ND
Total Xylenes	EPA Method 624	N/A	ug/L	0.1600	ND
p- & m-Xylenes	EPA Method 624	N/A	ug/L	0.1000	ND
o-Xylene	EPA Method 624	N/A	ug/L	0.0510	ND
Organochlorine Pesticides					
Aldrin	EPA Method 8081B	N/A	ug/L	0.0020	ND
alpha-BHC	EPA Method 8081B	N/A	ug/L	0.0018	ND
betha-BHC	EPA Method 8081B	N/A	ug/L	0.0038	ND
delta-BHC	EPA Method 8081B	N/A	ug/L	0.0017	ND
gamma-BHC (Lindane)	EPA Method 8081B	N/A	ug/L	0.0019	ND
Chlordane (Technical)	EPA Method 8081B	0.1	ug/L	0.0850	ND
4,4'-DDD	EPA Method 8081B	N/A	ug/L	0.0018	ND
4,4'-DDE	EPA Method 8081B	N/A	ug/L	0.0018	ND
4,4'-DDT	EPA Method 8081B	N/A	ug/L	0.0018	ND
Dieldrin	EPA Method 8081B	N/A	ug/L	0.0025	ND
Endosulfan I	EPA Method 8081B	N/A	ug/L	0.0027	ND
Endosulfan II	EPA Method 8081B	N/A	ug/L	0.0025	ND
Endosulfan sulfate	EPA Method 8081B	N/A	ug/L	0.0024	ND
Endrin	EPA Method 8081B	2	ug/L	0.0033	ND
Endrin aldehyde	EPA Method 8081B	N/A	ug/L	0.0036	ND
Heptachlor	EPA Method 8081B	0.01	ug/L	0.0032	ND
Heptachlor epoxide	EPA Method 8081B	0.01	ug/L	0.0048	ND
Methoxychlor	EPA Method 8081B	30	ug/L	0.0035	ND
Toxaphene	EPA Method 8081B	3	ug/L	0.2000	ND

TABLE 5.1. Dry Weather Surface Water Sampling Results
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Analyte	Analytical Procedure	MCL	Units	MDL	Result (05-18-16)
OrganoPhosphorus Pesticides					
Azinphos methyl	EPA Method 8041B	N/A	ug/L	0.0620	ND
Bolstar	EPA Method 8041B	N/A	ug/L	0.1300	ND
Chlorpyrifos	EPA Method 8041B	N/A	ug/L	0.1000	ND
Coumaphos	EPA Method 8041B	N/A	ug/L	0.1400	ND
Demeton O/S	EPA Method 8041B	N/A	ug/L	0.1300	ND
Diazinon	EPA Method 8041B	N/A	ug/L	0.0600	ND
Dichlorvos	EPA Method 8041B	N/A	ug/L	0.0860	ND
Disulfoton	EPA Method 8041B	N/A	ug/L	0.1100	ND
Ethoprop	EPA Method 8041B	N/A	ug/L	0.0250	ND
Fensulfothion	EPA Method 8041B	N/A	ug/L	0.1300	ND
Fenthion	EPA Method 8041B	N/A	ug/L	0.0500	ND
Merphos	EPA Method 8041B	N/A	ug/L	0.0910	ND
Methyl parathion	EPA Method 8041B	N/A	ug/L	0.0950	ND
Mevinphos	EPA Method 8041B	N/A	ug/L	0.1200	ND
Naled	EPA Method 8041B	N/A	ug/L	0.1100	ND
Phorate	EPA Method 8041B	N/A	ug/L	0.1300	ND
Ronnel(Fenchlorphos)	EPA Method 8041B	0.01	ug/L	0.0970	ND
Stirophos (Tetrachlovinophos)	EPA Method 8041B	0.01	ug/L	0.0940	ND
Tokuthion (Prothiofos)	EPA Method 8041B	N/A	ug/L	0.0590	ND
Trichloronate	EPA Method 8041B	N/A	ug/L	0.0660	ND
Chlorinated Herbicides					
2,4-D	EPA Method 8151A	70	ug/L	0.0570	ND
2,4-DB	EPA Method 8151A	N/A	ug/L	0.2600	ND
Dalapon	EPA Method 8151A	200	ug/L	0.3300	ND
Dicamba	EPA Method 8151A	N/A	ug/L	0.0680	ND
Dichloroprop	EPA Method 8151A	N/A	ug/L	0.1300	ND
Dinoseb	EPA Method 8151A	7	ug/L	0.0340	ND
2,4,5-T	EPA Method 8151A	N/A	ug/L	0.0350	ND
2,4,5-TP (silvex)	EPA Method 8151A	50	ug/L	0.0170	ND
Oil and Grease	EPA Method 1664	N/A	mg/L	0.7600	1.00
Water Analysis (General Chemistry)					
Nitrate as N	EPA-300.0	45	mg/L	0.0220	ND
Electrical conductivity	EPA-210.1	N/A	uS/cm	1.0000	412
Total Dissolved Solids @ 180 C	SM-2540C	N/A	mg/L	20.0000	340
Total Suspended Solids	SM-2540D	N/A	mg/L	0.5000	7.2
Ammonia as N	EPA-350.1	N/A	mg/L	0.0250	0.11
ortho-Phosphate as P	EPA-365.1	N/A	mg/L	0.0170	ND
Metals (Total Recoverable)					
Antimony	EPA Method 200.7	6	ug/L	5.0000	ND
Arsenic	EPA Method 200.7	10	ug/L	7.8000	13
Beryllium	EPA Method 200.7	4	ug/L	0.7700	ND
Cadmium	EPA Method 200.7	5	ug/L	1.1000	ND
Chromium	EPA Method 200.7	50	ug/L	1.2000	3.4
Copper	EPA Method 200.7	1300	ug/L	1.2000	ND
Lead	EPA Method 200.7	15	ug/L	3.5000	ND
Nickel	EPA Method 200.7	100	ug/L	2.3000	ND
Selenium	EPA Method 200.7	50	ug/L	27.0000	34
Silver	EPA Method 200.7	N/A	ug/L	1.3000	ND
Thallium	EPA Method 200.7	2	ug/L	11.0000	11
Zinc	EPA Method 200.7	N/A	ug/L	1.3000	13

Abbreviation(s)
ND = Not Detected at the method detection limit
N/A = Not Applicable
MCL = California Maximum Contaminant Level
MDL = Method Detection Limit
ug/L = micrograms per liter
mg/L = milligrams per liter

TABLE 5.2. Wet Weather Surface Water Sampling Results
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Analyte	Analytical Procedure	MCL	Units	MDL	Result (12-02-14)	Result (12-12-14)	Result (12-16-14)	Result (02-23-15)	Result (03-07-16)
Volatile Organic Analysis									
Benzene	EPA Method 624	1	ug/L	0.0830	ND	ND	ND	ND	ND
Bromodichloromethane	EPA Method 624	0.2	ug/L	0.2400	ND	ND	ND	ND	ND
Bromoform	EPA Method 624	N/A	ug/L	0.2600	ND	ND	ND	ND	ND
Bromomethane	EPA Method 624	N/A	ug/L	0.1200	ND	ND	ND	ND	ND
Carbon tetrachloride	EPA Method 624	0.5	ug/L	0.1200	ND	ND	ND	ND	ND
Chlorobenzene	EPA Method 624	70	ug/L	0.0630	ND	ND	ND	ND	ND
Chloroform	EPA Method 624	N/A	ug/L	0.1200	ND	ND	ND	ND	ND
Chloromethane	EPA Method 624	N/A	ug/L	0.1200	ND	ND	ND	ND	ND
DibroChloromethane	EPA Method 624	N/A	ug/L	0.1300	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	EPA Method 624	600	ug/L	0.1300	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	EPA Method 624	N/A	ug/L	0.0720	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	EPA Method 624	5	ug/L	0.1100	ND	ND	ND	ND	ND
1,1-Dichloroethane	EPA Method 624	5	ug/L	0.0590	ND	ND	ND	ND	ND
1,2Dichloroethane	EPA Method 624	0.5	ug/L	0.1100	ND	ND	ND	ND	ND
1,1-Dichloroethene	EPA Method 624	N/A	ug/L	0.0920	ND	ND	ND	ND	ND
trans-1,2-Dichloroethane	EPA Method 624	N/A	ug/L	0.0700	ND	ND	ND	ND	ND
1,2-Dichloropropane	EPA Method 624	5	ug/L	0.1400	ND	ND	ND	ND	ND
cis-1,3-Dichloropropane	EPA Method 624	N/A	ug/L	0.1300	ND	ND	ND	ND	ND
trans-1,3-Dichloropropane	EPA Method 624	N/A	ug/L	0.1400	ND	ND	ND	ND	ND
Ethylbenzene	EPA Method 624	300	ug/L	0.0710	ND	ND	ND	ND	ND
Methylene chloride	EPA Method 624	N/A	ug/L	0.0770	ND	ND	ND	ND	ND
Methyl t-butyl ether	EPA Method 624	13	ug/L	0.4800	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	EPA Method 624	1	ug/L	0.1100	ND	ND	ND	ND	ND
Tetrachloroethane	EPA Method 624	N/A	ug/L	0.1700	ND	ND	ND	ND	ND
Toluiene	EPA Method 624	150	ug/L	0.0950	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	EPA Method 624	200	ug/L	0.0670	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	EPA Method 624	5	ug/L	0.1100	ND	ND	ND	ND	ND
Trichloroethane	EPA Method 624	N/A	ug/L	0.1500	ND	ND	ND	ND	ND
Trichlorofluromethane	EPA Method 624	150	ug/L	0.0720	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA Method 624	1200	ug/L	0.0790	ND	ND	ND	ND	ND
Vinyl chloride	EPA Method 624	0.5	ug/L	0.1200	ND	ND	ND	ND	ND
Total Xylenes	EPA Method 624	N/A	ug/L	0.2200	ND	ND	ND	ND	ND
p- & m-Xylenes	EPA Method 624	N/A	ug/L	0.1700	ND	ND	ND	ND	ND
o-Xylene	EPA Method 624	N/A	ug/L	0.0500	ND	ND	ND	ND	ND
Organochlorine Pesticides									
Aldrin	EPA Method 8081B	N/A	ug/L	0.0013	ND	ND	ND	ND	ND
alpha-BHC	EPA Method 8081B	N/A	ug/L	0.0011	ND	ND	ND	ND	ND
betha-BHC	EPA Method 8081B	N/A	ug/L	0.0021	ND	ND	ND	ND	ND
delta-BHC	EPA Method 8081B	N/A	ug/L	0.0014	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	EPA Method 8081B	N/A	ug/L	0.0009	ND	ND	ND	ND	ND
Chlordane (Technical)	EPA Method 8081B	0.1	ug/L	0.3800	ND	ND	ND	ND	ND
4,4'-DDD	EPA Method 8081B	N/A	ug/L	0.0017	ND	ND	ND	ND	ND
4,4'-DDE	EPA Method 8081B	N/A	ug/L	0.0019	ND	ND	ND	ND	ND
4,4'-DDT	EPA Method 8081B	N/A	ug/L	0.0008	ND	ND	ND	ND	ND
Dieldrin	EPA Method 8081B	N/A	ug/L	0.0012	ND	ND	ND	ND	ND
Endosulfan I	EPA Method 8081B	N/A	ug/L	0.0016	ND	ND	ND	ND	ND
Endosulfan II	EPA Method 8081B	N/A	ug/L	0.0014	ND	ND	ND	ND	ND
Endosulfan sulfate	EPA Method 8081B	N/A	ug/L	0.0026	ND	ND	ND	ND	ND
Endrin	EPA Method 8081B	2	ug/L	0.0008	ND	ND	ND	ND	ND
Endrin aldehyde	EPA Method 8081B	N/A	ug/L	0.0032	ND	ND	ND	ND	ND
Heptachlor	EPA Method 8081B	0.01	ug/L	0.0012	ND	ND	ND	ND	ND
Heptachlor epoxide	EPA Method 8081B	0.01	ug/L	0.0010	ND	ND	ND	ND	ND
Methoxychlor	EPA Method 8081B	30	ug/L	0.0011	ND	ND	ND	ND	ND
Toxaphene	EPA Method 8081B	3	ug/L	0.4200	ND	ND	ND	ND	ND
OrganoPhosphorus Pesticides									
Azinphos methyl	EPA Method 8141B	N/A	ug/L	0.0620	N/A	N/A	N/A	N/A	ND
Bolstar	EPA Method 8141B	N/A	ug/L	0.1300	N/A	N/A	N/A	N/A	ND
Chlorpyrifos	EPA Method 8141B	N/A	ug/L	0.1000	N/A	N/A	N/A	N/A	ND
Coumaphos	EPA Method 8141B	N/A	ug/L	0.1400	N/A	N/A	N/A	N/A	ND
Demeton O/S	EPA Method 8141B	N/A	ug/L	0.1300	N/A	N/A	N/A	N/A	ND
Diazinon	EPA Method 8141B	N/A	ug/L	0.0600	N/A	N/A	N/A	N/A	ND
Dichlorvos	EPA Method 8141B	N/A	ug/L	0.0860	N/A	N/A	N/A	N/A	ND
Disulfoton	EPA Method 8141B	N/A	ug/L	0.1100	N/A	N/A	N/A	N/A	ND
Ethoprop	EPA Method 8141B	N/A	ug/L	0.0250	N/A	N/A	N/A	N/A	ND
Fensulfothion	EPA Method 8141B	N/A	ug/L	0.1300	N/A	N/A	N/A	N/A	ND
Fenthion	EPA Method 8141B	N/A	ug/L	0.0500	N/A	N/A	N/A	N/A	ND
Merphos	EPA Method 8141B	N/A	ug/L	0.0910	N/A	N/A	N/A	N/A	ND
Methyl parathion	EPA Method 8141B	N/A	ug/L	0.0950	N/A	N/A	N/A	N/A	ND
Mevinphos	EPA Method 8141B	N/A	ug/L	0.1200	N/A	N/A	N/A	N/A	ND
Naled	EPA Method 8141B	N/A	ug/L	0.1100	N/A	N/A	N/A	N/A	ND
Phorate	EPA Method 8141B	N/A	ug/L	0.1300	N/A	N/A	N/A	N/A	ND
Ronnel(Fenchlorphos)	EPA Method 8141B	0.01	ug/L	0.0970	N/A	N/A	N/A	N/A	ND
Stirophos (Tetrachlovinophos)	EPA Method 8141B	0.01	ug/L	0.0940	N/A	N/A	N/A	N/A	ND
Tokuthion (Prothiofos)	EPA Method 8141B	N/A	ug/L	0.0590	N/A	N/A	N/A	N/A	ND
Trichloronate	EPA Method 8141B	N/A	ug/L	0.0660	N/A	N/A	N/A	N/A	ND

TABLE 5.2. Wet Weather Surface Water Sampling Results
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Analyte	Analytical Procedure	MCL	Units	MDL	Result (12-02-14)	Result (12-12-14)	Result (12-16-14)	Result (02-23-15)	Result (03-07-16)
Chlorinated Herbicides									
2,4-D	EPA Method 8151A	70	ug/L	0.0630	ND	ND	ND	ND	ND
2,4-DB	EPA Method 8151A	N/A	ug/L	0.1500	ND	ND	ND	ND	ND
Dalapon	EPA Method 8151A	200	ug/L	0.1000	ND	ND	ND	ND	ND
Dicamba	EPA Method 8151A	N/A	ug/L	0.0430	ND	ND	ND	ND	ND
Dichloroprop	EPA Method 8151A	N/A	ug/L	0.0480	ND	ND	ND	ND	ND
Dinoseb	EPA Method 8151A	7	ug/L	0.0570	ND	ND	ND	ND	ND
2,4,5-T	EPA Method 8151A	N/A	ug/L	0.0250	ND	ND	ND	ND	ND
2,4,5-TP (silvex)	EPA Method 8151A	50	ug/L	0.0530	ND	ND	ND	ND	ND
Oil and Grease	EPA Method 1664	N/A	mg/L	1.2000	1.8	ND	ND	1.2000	ND
Water Analysis (General Chemistry)									
Nitrate as N	EPA-300.0	45	mg/L	0.0180	0.42	0.82	0.42	2.1	1.1
Nitrite as N	EPA-353.2	1000	ug/L	10.0000	24	30	29	59	ND
Total Dissolved Solids @ 180 C	SM-2540C	N/A	mg/L	10.0000	37	150	50	97	190
Total Suspended Solids	SM-2540D	N/A	mg/L	1.8000	140	130	170	81	11
Ammonia as N	EPA-350.1	N/A	mg/L	0.0330	0.073	0.2	0.3	0.97	0.11
ortho-Phosphate as P	EPA-365.1	N/A	mg/L	0.0057	0.13	0.14	0.11	0.21	0.0081
Metals (Total Recoverable)									
Antimony	EPA Method 200.7	6	ug/L	5.0000	ND	ND	ND	ND	ND
Arsenic	EPA Method 200.7	10	ug/L	7.8000	ND	ND	ND	ND	ND
Beryllium	EPA Method 200.7	4	ug/L	0.7700	ND	ND	ND	ND	ND
Cadmium	EPA Method 200.7	5	ug/L	1.1000	ND	ND	ND	ND	ND
Chromium	EPA Method 200.7	50	ug/L	1.2000	6.7	5.2	6.1	5	ND
Copper	EPA Method 200.7	1300	ug/L	1.2000	28	18	40	27	9.2
Lead	EPA Method 200.7	15	ug/L	3.5000	25	13	21	12	ND
Nickel	EPA Method 200.7	100	ug/L	2.3000	4.5	3	4.7	2.5	ND
Selenium	EPA Method 200.7	50	ug/L	27.0000	ND	ND	ND	ND	ND
Silver	EPA Method 200.7	N/A	ug/L	1.3000	ND	ND	ND	ND	ND
Thallium	EPA Method 200.7	2	ug/L	11.0000	ND	ND	ND	15	26
Zinc	EPA Method 200.7	N/A	ug/L	1.3000	140	95	190	110	38

Abbreviation(s)
ND = Not Detected at the method detection limit
N/A = Not Applicable
MCL = California Maximum Contaminant Level
MDL = Method Detection Limit
ug/L = micrograms per liter
mg/L = milligrams per liter

Table 6.1 Groundwater Sampling Results - General Mineral and Miscellaneous Analytes
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Well No.	Sample Date		Laboratory Report Number	Total Recoverable Calcium	Total Recoverable Magnesium	Total Recoverable Sodium	Total Recoverable Potassium	Bicarbonate	Carbonate	Hydroxide	Alkalinity as CaCO3	Chloride	Fluoride	Nitrate as N	Sulfate	Total Cations	Total Anions	Hardness as CaCO3	pH	Electrical Conductivity @ 25 C	Total Dissolved Solids @ 180 C	Color	Odor	Turbidity	MBAS	Nitrite as N	Perchlorate
				E200.7	E200.7	E200.7	E200.7	A2320	A2320	A2320	CALC	E300.0	E300.0	E300.0	E300.0	CALC	CALC	CALC	E150.1	A2510B	A2540C	A2120B	A2150B	E180.1	A5540C	E353.2	E314.0
				mg/L[2]	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L[3]	meq/L	mg/L	pH Units	umhos/cm[4]	mg/L	Color Unit	Odor Units	NT Units	mg/L	mg/L	ug/L
MW-16	3/16/2015		1506349	100	39	64	6.9	280	ND (5)	ND (2.8)	230	110	0.24	--	130	11	11	410	7.13	1000	680	2	No Obs Odo	51	0.025	17	ND (1.3)
	3/16/2015	D	1506349	106	42	69	7.4	--	--	--	--	112	0.19	--	131	--	--	--	--	--	--	2	--	51	--	17	ND (1.3)
	7/21/2015		1517870	110	37	66	4.5	280	ND (5)	ND (2.8)	230	110	0.19	--	130	11	11	410	7.42	1040	650	ND (1)	8	29	ND (0.015)	ND (10)	ND (1.3)
	7/21/2015	D	1517870	121	41	75	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	72	32	58	3.9	220	ND (2.5)	ND (1.4)	180	110	0.2	3.2	120	8.9	9.4	310	7.07	901	640	ND (1)	No Obs Odo	25	ND (0.03)	ND (0.01)	ND (0.72)
MW-17	3/16/2015		1506349	81	34	50	5.8	160	ND (2.5)	ND (1.4)	130	81	0.12	--	92	9.2	7.6	340	6.8	731	520	2	ND (1)	120	0.12	11	ND (1.3)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	82	37	66	5.1	210	ND (2.5)	ND (1.4)	170	110	0.22	3.3	120	10	9.5	360	6.9	905	640	ND (1)	No Obs Odo	21	0.05	0.011	ND (0.72)

Notes:
1. µg/L = micrograms per liter.
2. mg/L = milligrams per liter.
3. meq/L = milliequivalents per liter
4. umhos/cm = micromhos per centimeter
ND () = not detected to the value in parentheses
-- = not analyzed
D = duplicate sample

Table 6.2 Groundwater Sampling Results - Metals
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Well No.	Sample Date		Laboratory Report Number	Hexavalent Chromium	Total Recoverable Aluminum	Total Recoverable Antimony	Total Recoverable Arsenic	Total Recoverable Barium	Total Recoverable Beryllium	Total Recoverable Boron	Total Recoverable Cadmium	Total Recoverable Chromium	Total Recoverable Copper	Total Recoverable Iron	Total Recoverable Lead	Total Recoverable Manganese	Total Recoverable Mercury	Total Recoverable Nickel	Total Recoverable Selenium	Total Recoverable Silver	Total Recoverable Thallium	Total Recoverable Vanadium	Total Recoverable Zinc
				E218.6	E200.7	E200.8	E200.8	E200.7	E200.8	E200.7	E200.8	E200.7	E200.7	E200.7	E200.8	E200.7	E245.1	E200.7	E200.8	E200.7	E200.8	E200.8	E200.7
				ug/L[1]	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	ND (0.055)	3100	0.31	2.6	100	ND (0.14)	130	ND (0.11)	6	15	5100	3.9	220	0.22	4.9	ND (0.19)	ND (1.3)	ND (0.1)	10	31
	3/16/2015	D	1506349	--	3310	--	--	107	--	143	--	6.39	16.13	5467	--	237	--	5.73	--	ND (1.3)	--	--	33.5
	7/21/2015		1517870	0.6	1300	0.21	1.5	99	ND (0.14)	86	ND (0.11)	3.8	4.2	2300	2.3	120	0.12	3.9	ND (0.19)	ND (1.3)	ND (0.1)	11	19
	7/21/2015	D	1517870	--	1731	--	--	113	--	97	--	4.30	5.44	3208	--	144	--	3.17	--	ND (1.3)	--	--	23.9
	2/9/2016		1604008	ND (0.034)	2700	0.29	1.2	160	ND (0.14)	81	0.17	5.3	4.6	4700	3.4	140	ND (0.023)	4.4	0.46	ND (1.3)	ND (0.1)	9.6	45
MW-17	3/16/2015		1506349	0.47	8800	0.31	5	250	0.38	55	0.16	20	38	12000	5.9	120	0.17	6.3	0.46	ND (1.3)	ND (0.1)	23	64
	7/21/2015	D	1517870	--	--	ND (0.11)	1.411	--	ND (0.14)	--	0.115	--	--	--	2.603	--	0.20	--	ND (0.19)	--	ND (0.1)	11.8	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.034)	2800	0.3	1.3	160	ND (0.14)	79	0.14	5.4	6	5100	2.7	170	ND (0.023)	4.4	0.76	ND (1.3)	ND (0.1)	11	54

Notes:
1. µg/L = micrograms per liter.
ND () = not detected to the value in parentheses
-- = not analyzed
D = duplicate sample

Table 6.3 Groundwater Sampling Results - Organic Compounds
Crescenta Valley County Park Stormwater Recharge Facility Project
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Well No.	Sample Date		Laboratory Report Number	1,2-Dibromo-3-chloropropane	Ethylene dibromide	Aldrin	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC (Lindane)	Chlordane (Technical)	4,4'-DDD	4,4'-DDE	4,4'-DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulfate	Endrin	Endrin aldehyde	Heptachlor	Heptachlor epoxide
				E504.1	E504.1	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E508
				ug/L[1]	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	ND (0.0046)	ND (0.0044)	ND (0.0065)	ND (0.0055)	ND (0.01)	ND (0.007)	ND (0.0047)	ND (0.5)	ND (0.0085)	ND (0.0095)	ND (0.0038)	ND (0.006)	ND (0.008)	ND (0.007)	ND (0.013)	ND (0.0041)	ND (0.016)	ND (0.006)	ND (0.005)
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	ND (0.0035)	ND (0.0034)	ND (0.0022)	ND (0.0019)	ND (0.0036)	ND (0.0024)	ND (0.0016)	ND (0.17)	ND (0.0029)	ND (0.0033)	ND (0.0013)	ND (0.0021)	ND (0.0028)	ND (0.0024)	ND (0.0045)	ND (0.0014)	ND (0.0055)	ND (0.0021)	ND (0.0017)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.0015)	ND (0.0041)	ND (0.00053)	ND (0.0025)	ND (0.0019)	ND (0.0012)	ND (0.0011)	ND (0.048)	ND (0.0029)	ND (0.0014)	ND (0.0011)	ND (0.00078)	ND (0.00086)	ND (0.0018)	ND (0.0012)	ND (0.0025)	ND (0.0017)	ND (0.0005)	ND (0.0008)
MW-17	3/16/2015		1506349	ND (0.0046)	ND (0.0044)	ND (0.0065)	ND (0.0055)	ND (0.01)	ND (0.007)	ND (0.0047)	ND (0.5)	ND (0.0085)	ND (0.0095)	ND (0.0038)	ND (0.006)	ND (0.008)	ND (0.007)	ND (0.013)	ND (0.0041)	ND (0.016)	ND (0.006)	ND (0.005)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.0015)	ND (0.0041)	ND (0.00053)	ND (0.0025)	ND (0.0019)	ND (0.0012)	ND (0.0011)	ND (0.048)	ND (0.0029)	ND (0.0014)	ND (0.0011)	ND (0.00078)	ND (0.00086)	ND (0.0018)	ND (0.0012)	ND (0.0025)	ND (0.0017)	ND (0.0005)	ND (0.0008)

Table 6.3 Groundwater Sampling Results - Organic Compounds
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Well No.	Sample Date		Laboratory Report Number	Methoxychlor	Toxaphene	PCB-1016	PCB-1221	PCB-1232	PCB-1242	PCB-1248	PCB-1254	PCB-1260	Total PCB's (Summation)	Bentazon	2,4-D	2,4-DB	Dalapon	Dicamba	Dichloroprop	Dinoseb	MCPA	MCPP
				E508	E508	E508	E508	E508	E508	E508	E508	E508	E508	E515.1	E515.1	E515.1	E515.1	E515.1	E515.1	E515.1	E515.1	E515.1
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	ND (0.0055)	ND (2.1)	ND (0.22)	ND (0.35)	ND (0.4)	ND (0.32)	ND (0.42)	ND (0.38)	ND (0.3)	ND (0.5)	ND (0.13)	ND (0.065)	ND (0.32)	ND (2.4)	ND (0.037)	ND (0.012)	ND (0.04)	ND (0.29)	ND (0.3)
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	ND (0.0019)	ND (0.72)	ND (0.078)	ND (0.12)	ND (0.14)	ND (0.11)	ND (0.15)	ND (0.13)	ND (0.1)	ND (0.17)	ND (0.13)	ND (0.065)	ND (0.32)	ND (2.4)	ND (0.037)	ND (0.012)	ND (0.04)	ND (0.29)	ND (0.3)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.0017)	ND (0.32)	ND (0.061)	ND (0.2)	ND (0.12)	ND (0.15)	ND (0.06)	ND (0.06)	ND (0.051)	ND (0.1)	ND (0.11)	ND (0.15)	ND (0.3)	ND (1.2)	ND (0.041)	ND (0.096)	ND (0.066)	ND (8.8)	ND (8.8)
MW-17	3/16/2015		1506349	ND (0.0055)	ND (2.1)	ND (0.22)	ND (0.35)	ND (0.4)	ND (0.32)	ND (0.42)	ND (0.38)	ND (0.3)	ND (0.5)	ND (0.13)	ND (0.065)	ND (0.32)	ND (2.4)	ND (0.037)	ND (0.012)	ND (0.04)	ND (0.29)	ND (0.3)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.0017)	ND (0.32)	ND (0.061)	ND (0.2)	ND (0.12)	ND (0.15)	ND (0.06)	ND (0.06)	ND (0.051)	ND (0.1)	ND (0.11)	ND (0.15)	ND (0.3)	ND (1.2)	ND (0.041)	ND (0.096)	ND (0.066)	ND (8.8)	ND (8.8)

Table 6.3 Groundwater Sampling Results - Organic Compounds
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Well No.	Sample Date		Laboratory Report Number	2,4,5-T	2,4,5-TP (Silvex)	Benzene	Bromodichloromethane	Bromoform	Carbon tetrachloride	Chlorobenzene	Chloroform	Dibromochloromethane	1,2-Dichlorobenzene	1,4-Dichlorobenzene	Dichlorodifluoromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,2-Dichloropropane	1,3-Dichloropropane
				E515.1	E515.1	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	ND (0.012)	ND (0.016)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	ND (0.012)	ND (0.016)	ND (0.083)	ND (0.14)	ND (0.27)	ND (0.18)	ND (0.093)	ND (0.12)	ND (0.13)	ND (0.072)	ND (0.062)	ND (0.099)	ND (0.11)	ND (0.17)	ND (0.18)	ND (0.085)	ND (0.15)	ND (0.13)	ND (0.086)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.026)	ND (0.032)	ND (0.083)	ND (0.14)	ND (0.27)	ND (0.18)	ND (0.093)	ND (0.12)	ND (0.13)	ND (0.072)	ND (0.062)	ND (0.099)	ND (0.11)	ND (0.17)	ND (0.18)	ND (0.085)	ND (0.15)	ND (0.13)	ND (0.086)
MW-17	3/16/2015		1506349	ND (0.012)	ND (0.016)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.026)	ND (0.032)	ND (0.083)	ND (0.14)	ND (0.27)	ND (0.18)	ND (0.093)	ND (0.12)	ND (0.13)	ND (0.072)	ND (0.062)	ND (0.099)	ND (0.11)	ND (0.17)	ND (0.18)	ND (0.085)	ND (0.15)	ND (0.13)	ND (0.086)

Table 6.3 Groundwater Sampling Results - Organic Compounds
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Well No.	Sample Date		Laboratory Report Number	cis-1,3-Dichloropropene	trans-1,3-Dichloropropene	Total 1,3-Dichloropropene	Ethylbenzene	Methylene chloride	Methyl t-butyl ether	Styrene	1,1,2,2-Tetrachloroethane	Tetrachloroethene	Toluene	1,2,4-Trichlorobenzene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Trichlorofluoromethane	1,2,3-Trichloropropane	1,1,2-Trichloro-1,2,2-trifluoroethan	Vinyl chloride	Total Xylenes
				E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E524.2
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	--	--	--	--	--	ND (0.11)	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	ND (0.14)	ND (0.079)	ND (0.21)	ND (0.098)	ND (0.48)	ND (0.11)	ND (0.068)	ND (0.17)	ND (0.13)	ND (0.093)	ND (0.19)	ND (0.11)	ND (0.16)	ND (0.085)	ND (0.13)	ND (0.24)	ND (0.15)	ND (0.12)	ND (0.36)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.14)	ND (0.079)	ND (0.21)	ND (0.098)	ND (0.48)	ND (0.11)	ND (0.068)	ND (0.17)	ND (0.13)	ND (0.093)	ND (0.19)	ND (0.11)	ND (0.16)	ND (0.085)	ND (0.13)	ND (0.24)	ND (0.15)	ND (0.12)	ND (0.36)
MW-17	3/16/2015		1506349	--	--	--	--	--	ND (0.11)	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	ND (0.11)	--	--	ND (0.13)	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.14)	ND (0.079)	ND (0.21)	ND (0.098)	ND (0.48)	ND (0.11)	ND (0.068)	ND (0.17)	ND (0.13)	ND (0.093)	ND (0.19)	ND (0.11)	ND (0.16)	ND (0.085)	ND (0.13)	ND (0.24)	ND (0.15)	ND (0.12)	ND (0.36)

Table 6.3 Groundwater Sampling Results - Organic Compounds
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Well No.	Sample Date		Laboratory Report Number	Total Trihalomethanes	t-Amyl Methyl ether	t-Butyl alcohol	Ethyl t-butyl ether	p- & m-Xylenes	o-Xylene	Acenaphthylene	Alachlor	Anthracene	Atraton	Atrazine	Benzo[a]anthracene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Benzo[g,h,i]perylene	Benzyl butyl phthalate	delta-BHC
				E524.2	E524.2	E524.2	E524.2	E524.2	E524.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	--	ND (0.25)	--	ND (0.18)	--	--	ND (0.058)	ND (0.074)	ND (0.054)	ND (0.14)	ND (0.036)	ND (0.075)	ND (0.077)	ND (0.072)	ND (0.093)	ND (0.042)	ND (0.092)	ND (0.007)
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	ND (0.63)	ND (0.25)	ND (9.4)	ND (0.18)	ND (0.28)	ND (0.082)	--	--	--	--	ND (0.036)	--	--	--	--	--	--	ND (0.0024)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.63)	ND (0.25)	ND (9.4)	ND (0.18)	ND (0.28)	ND (0.082)	ND (0.051)	ND (0.16)	ND (0.05)	ND (0.11)	ND (0.12)	ND (0.029)	ND (0.03)	ND (0.087)	ND (0.076)	ND (0.048)	ND (0.083)	ND (0.0012)
MW-17	3/16/2015		1506349	--	ND (0.25)	--	ND (0.18)	--	--	ND (0.058)	ND (0.074)	ND (0.054)	ND (0.14)	ND (0.036)	ND (0.075)	ND (0.077)	ND (0.072)	ND (0.093)	ND (0.042)	ND (0.092)	ND (0.007)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	ND (0.25)	ND (9.4)	ND (0.18)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.63)	ND (0.25)	ND (9.4)	ND (0.18)	ND (0.28)	ND (0.082)	ND (0.051)	ND (0.16)	ND (0.05)	ND (0.11)	ND (0.12)	ND (0.029)	ND (0.03)	ND (0.087)	ND (0.076)	ND (0.048)	ND (0.083)	ND (0.0012)

Table 6.3 Groundwater Sampling Results - Organic Compounds
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Well No.	Sample Date		Laboratory Report Number	gamma-BHC (Lindane)	bis(2-Ethylhexyl)phthalate	Bromacil	Chrysene	Diazinon	Dibenzo[a,h]anthracene	Di(2-ethylhexyl)adipate	Dimethoate	Dimethyl phthalate	Di-n-butyl phthalate	Fluorene	Hexachlorobenzene	Hexachlorocyclopentadiene	Indeno[1,2,3-cd]pyrene	Methoxychlor	Metolachlor	Metribuzin	Molinate	Phenanthrene
				E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	ND (0.0047)	ND (0.37)	ND (0.17)	ND (0.087)	ND (0.077)	ND (0.079)	ND (0.13)	ND (0.53)	ND (0.053)	ND (0.11)	ND (0.039)	ND (0.038)	ND (0.26)	ND (0.07)	ND (0.0055)	ND (0.081)	ND (0.082)	ND (0.057)	ND (0.048)
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	ND (0.0016)	--	--	--	--	--	--	--	--	--	--	--	--	--	ND (0.0019)	--	--	--	--
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.0011)	5.6	ND (0.12)	ND (0.045)	ND (0.11)	ND (0.15)	ND (0.052)	ND (0.063)	ND (0.05)	ND (0.043)	ND (0.054)	ND (0.11)	ND (0.33)	ND (0.083)	ND (0.0017)	ND (0.065)	ND (0.14)	ND (0.12)	ND (0.036)
MW-17	3/16/2015		1506349	ND (0.0047)	ND (0.37)	ND (0.17)	ND (0.087)	ND (0.077)	ND (0.079)	ND (0.13)	ND (0.53)	ND (0.053)	ND (0.11)	ND (0.039)	ND (0.038)	ND (0.26)	ND (0.07)	ND (0.0055)	ND (0.081)	ND (0.082)	ND (0.057)	ND (0.048)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.0011)	6.4	ND (0.12)	ND (0.045)	ND (0.11)	ND (0.15)	ND (0.052)	ND (0.063)	ND (0.05)	ND (0.043)	ND (0.054)	ND (0.11)	ND (0.33)	ND (0.083)	ND (0.0017)	ND (0.065)	ND (0.14)	ND (0.12)	ND (0.036)

Table 6.3 Groundwater Sampling Results - Organic Compounds
Crescenta Valley County Park Stormwater Recharge Facility Project
Crescenta Valley Water District

Well No.	Sample Date		Laboratory Report Number	Prometon	Prometryn	Pyrene	Secbumeton	Simazine	Terbutryn	Thiobencarb	Endothal	Diquat
				E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E525.2	E548.1	E549.2
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW-16	3/16/2015		1506349	ND (0.15)	ND (0.15)	ND (0.05)	ND (0.22)	ND (0.078)	ND (0.07)	ND (0.079)	ND (7.6)	ND (0.38)
	3/16/2015	D	1506349	--	--	--	--	--	--	--	--	--
	7/21/2015		1517870	--	--	--	--	ND (0.078)	--	ND (0.079)	ND (0.76)	ND (0.38)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.11)	ND (0.11)	ND (0.043)	ND (0.058)	ND (0.24)	ND (0.098)	ND (0.068)	ND (0.75)	ND (0.38)
MW-17	3/16/2015		1506349	ND (0.15)	ND (0.15)	ND (0.05)	ND (0.22)	ND (0.078)	ND (0.07)	ND (0.079)	ND (7.6)	ND (0.38)
	7/21/2015	D	1517870	--	--	--	--	--	--	--	--	--
	9/23/2015		1524268	--	--	--	--	--	--	--	--	--
	2/9/2016		1604008	ND (0.11)	ND (0.11)	ND (0.043)	ND (0.058)	ND (0.24)	ND (0.098)	ND (0.068)	ND (0.75)	ND (0.38)

Notes:

1. µg/L = micrograms per liter.

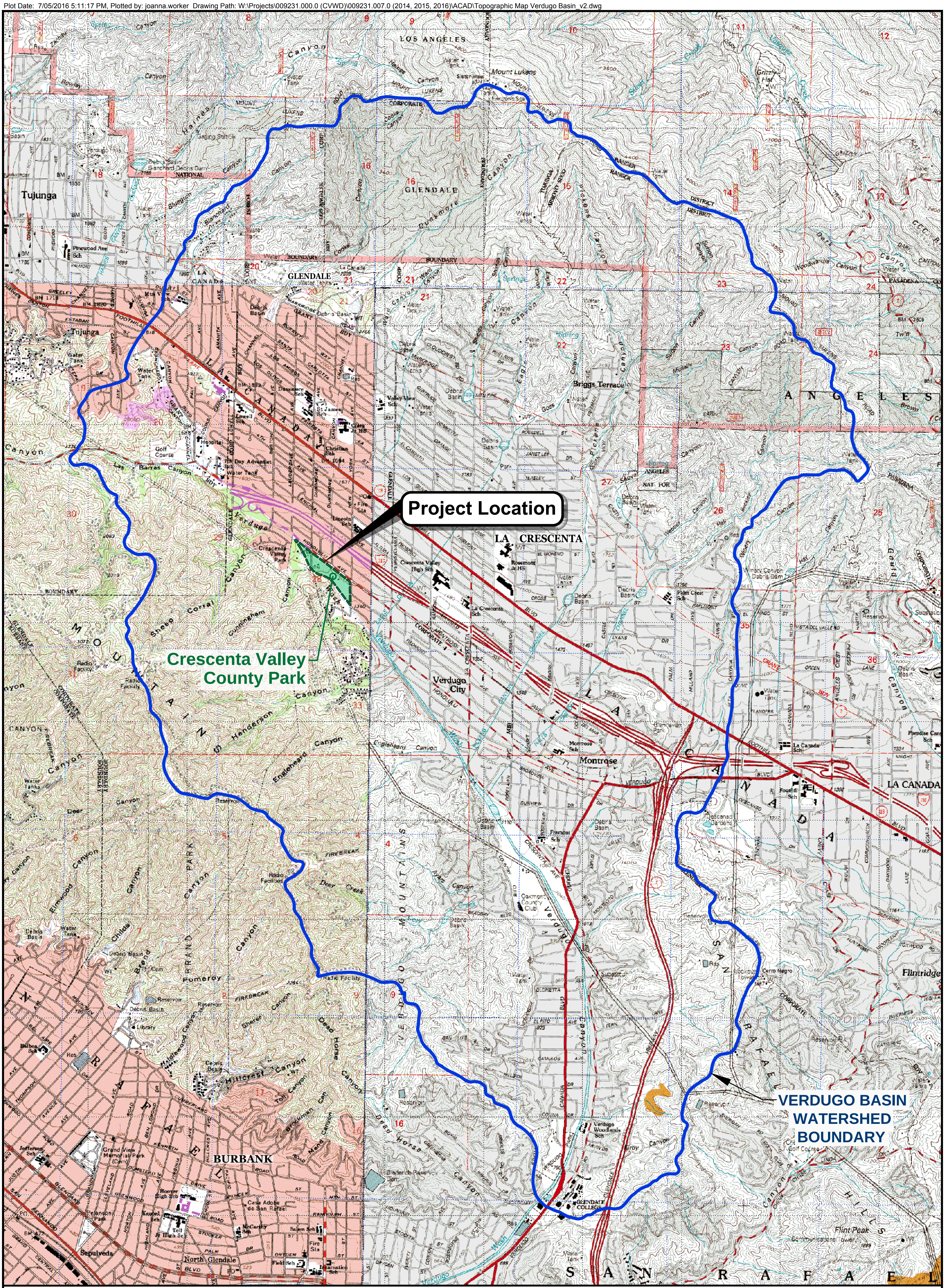
ND () = not detected to the value in parentheses

-- = not analyzed

D = duplicate sample

FIGURES

Plot Date: 7/05/2016 5:11:17 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\Topographic Map Verdugo Basin_v2.dwg



Sources: J.A. Jones Environmental Services McLaren-Hart/Jones Division; Keith Company; U.S.G.S. DEM

Explanation

Project Area

Approximate location of watershed boundary

Approximate scale in feet
0 1,500 3,000
0 450 900
Approximate scale in meters

PROJECT LOCATION MAP
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 07/05/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	1.1

Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Off Leash Dog Park boundary
- Crescenta Valley County Park existing parking area
- L.A. County Maintenance Yard
- Verdugo Wash
- Dunsmore Channel

Note:

All locations are approximate.

N

Approximate scale in feet: 0, 150, 300

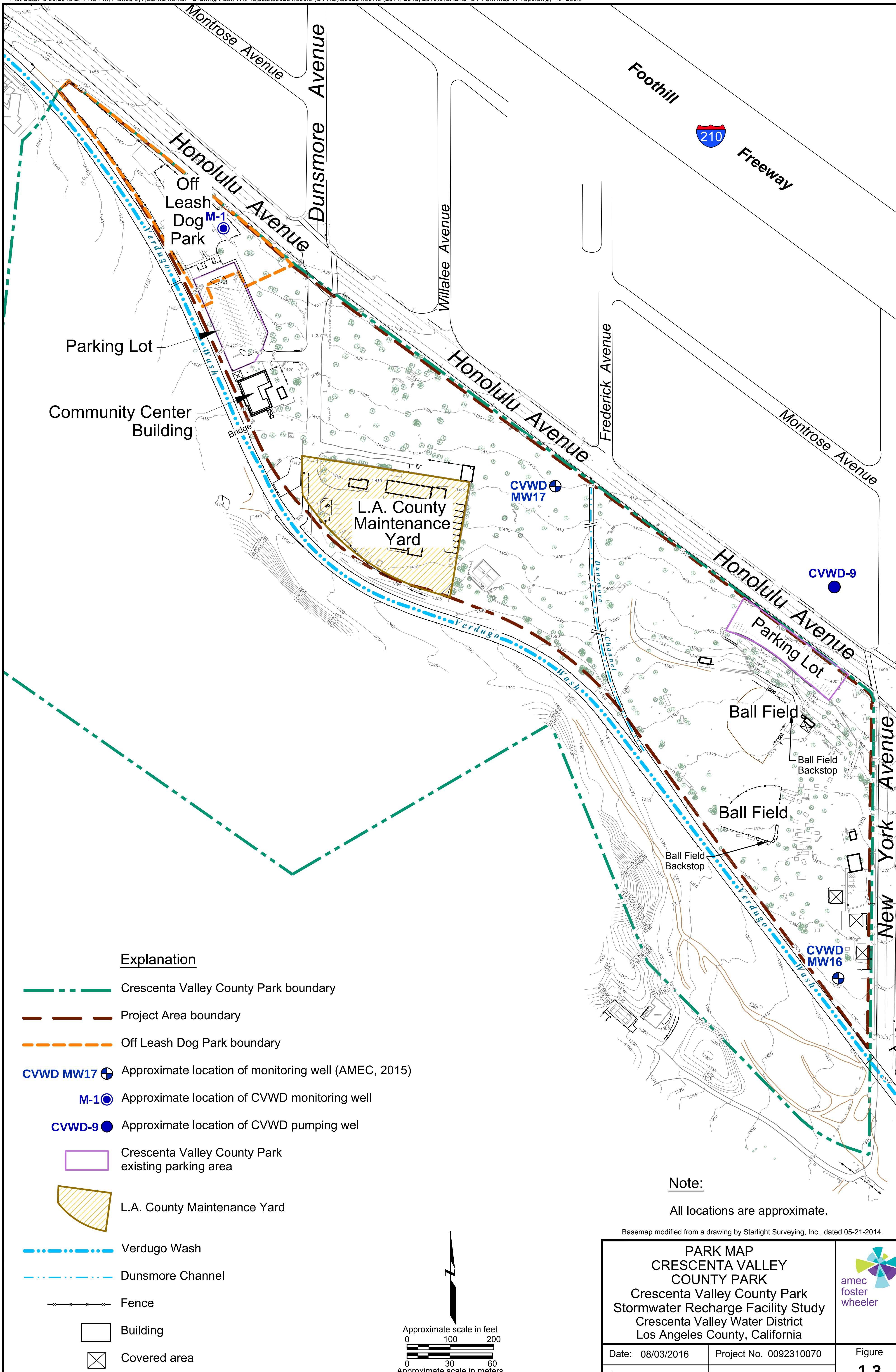
Approximate scale in meters: 0, 45, 90

Basemap modified from an aerial photo from BING Maps, © 2015 Microsoft Corporation, © 2015 Nokia, dated April 2014, a drawing by County of Los Angeles Department of Parks and Recreation, Sheet No. L-0.1, "Off Leash Dog Park Site Plan", dated 08/01/11, and a survey by Starlight Surveying, Inc. dated 03-06-2015.

PROJECT AREA CRESCENTA VALLEY COUNTY PARK Crescenta Valley County Park Stormwater Recharge Facility Study Crescenta Valley Water District Los Angeles County, California		amec foster wheeler
Date: 08/03/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	1.2

Plot Date: 8/03/2016 2:05:18 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\CV Park Site W Wells_v2.dwg, ProjectArea

Plot Date: 8/03/2016 2:17:45 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_CV Park Map W Topo.dwg, 1in-200ft



Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Off Leash Dog Park boundary
- L.A. County Maintenance Yard
- Verdugo Wash
- Dunsmore Channel
- CVWD MW17 — Approximate location of monitoring well (AMEC, 2015)
- CVWD-9 — Approximate location of CVWD well
- M-1 — Approximate location of existing monitoring well
- CVWD-4 — Approximate location of destroyed CVWD well

Note:

All locations are approximate.

Approximate scale in feet: 0, 150, 300
Approximate scale in meters: 0, 45, 90

Basemap modified from an aerial photo from BING Maps, © 2015 Microsoft Corporation, © 2015 Nokia, dated April 2014, a drawing by County of Los Angeles Department of Parks and Recreation, Sheet No. L-0.1, "Off Leash Dog Park Site Plan", dated 08/01/11, and a survey by Starlight Surveying, Inc. dated 03-06-2015.

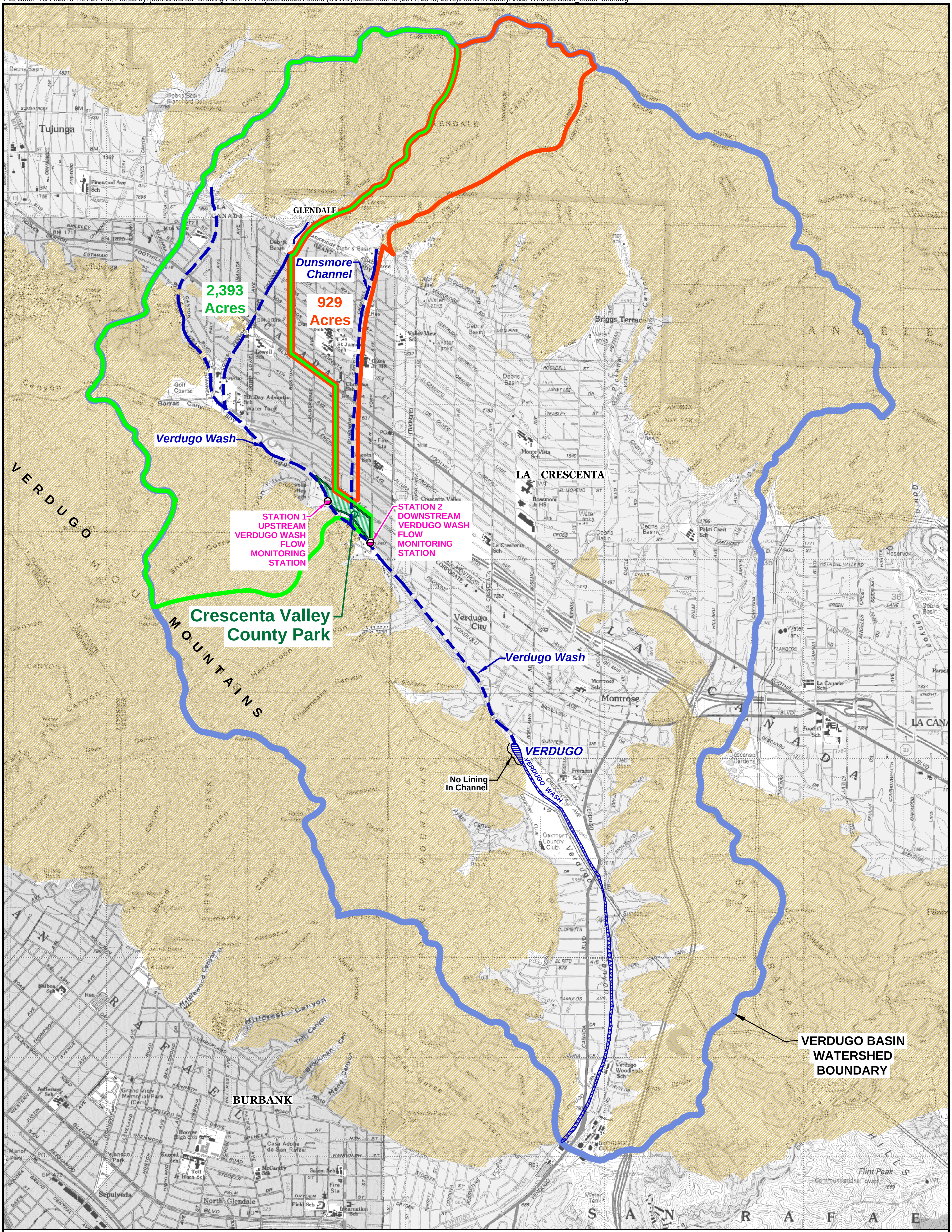
FLOW MONITORING STATIONS
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/14/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	5.1

Plot Date: 10/14/2016 3:58:45 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\CV Park Site W Wells_v2.dwg, FlowMon Stns

Plot Date: 10/14/2016 4:01:27 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\TributaryAreas-Wtrshed Basin_StatePlane.dwg



REFERENCE:

U.S.G.S. 7.5 Minute Quadrangle Maps PASADENA & SUNLAND, California, 1995, BURBANK, California, 1966, photorevised 1972, minor revisions, 1994.

Sources: J.A. Jones Environmental Services McLaren-Hart/Jones Division; Keith Company; U.S.G.S. DEM

Explanation

- Project Area
- VERDUGO — Approximate location of debris basin
- Approximate location of channel
- Approximate boundary of Verdugo Basin Watershed
- Areas of surrounding hills and mountains

Approximate scale in feet: 0 — 1,500 — 3,000

Approximate scale in meters: 0 — 450 — 900

N

TRIBUTARY AREAS WITHIN THE VERDUGO BASIN WATERSHED Crescenta Valley County Park Stormwater Recharge Facility Study Crescenta Valley Water District Los Angeles County, California		amec foster wheeler
Date: 10/14/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	5.2

Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Off Leash Dog Park boundary
- L.A. County Maintenance Yard
- Verdugo Wash
- Dunsmore Channel
- CVWD MW17 — Approximate location of monitoring well (AMEC, 2015)
- CVWD-9 — Approximate location of CVWD pumping well
- M-1 — Approximate location of existing monitoring well
- CVWD-4 — Approximate location of destroyed CVWD well
- ft bgs — feet below ground surface

Note:

All locations are approximate.

Approximate scale in feet: 0, 150, 300

Approximate scale in meters: 0, 45, 90

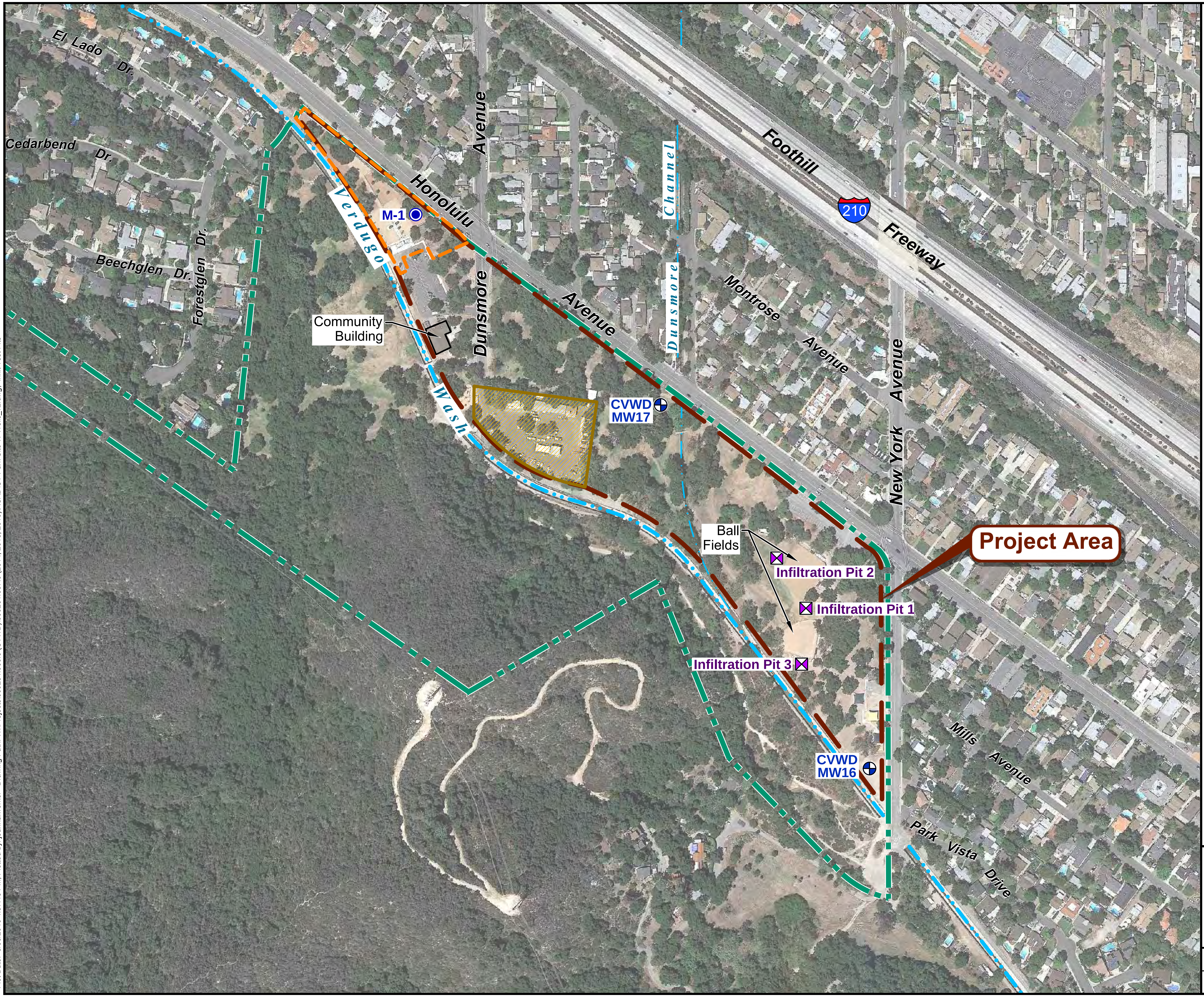
Basemap modified from an aerial photo from BING Maps, © 2015 Microsoft Corporation, © 2015 Nokia, dated April 2014, a drawing by County of Los Angeles Department of Parks and Recreation, Sheet No. L-0.1, "Off Leash Dog Park Site Plan", dated 08/01/11, and a survey by Starlight Surveying, Inc. dated 03-06-2015.

MONITORING WELL LOCATIONS
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 08/04/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	6.1

Plot Date: 8/04/2016 8:58:58 AM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\CV Park Site W Wells_v2.dwg, Mon Wells



Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Off Leash Dog Park boundary
- L.A. County Maintenance Yard
- Verdugo Wash
- Dunsmore Channel
- Infiltration Pit 3 — Infiltration test pit
- CVWD MW17 — Approximate location of monitoring well (AMEC, 2015)
- M-1 — Approximate location of existing monitoring well

Note:

All locations are approximate.

Approximate scale in feet
0 150 300
0 45 90
Approximate scale in meters

Basemap modified from an aerial photo from BING Maps, © 2015 Microsoft Corporation, © 2015 Nokia, dated April 2014, a drawing by County of Los Angeles Department of Parks and Recreation, Sheet No. L-0.1, "Off Leash Dog Park Site Plan", dated 08/01/11, and a survey by Starlight Surveying, Inc. dated 03-06-2015.

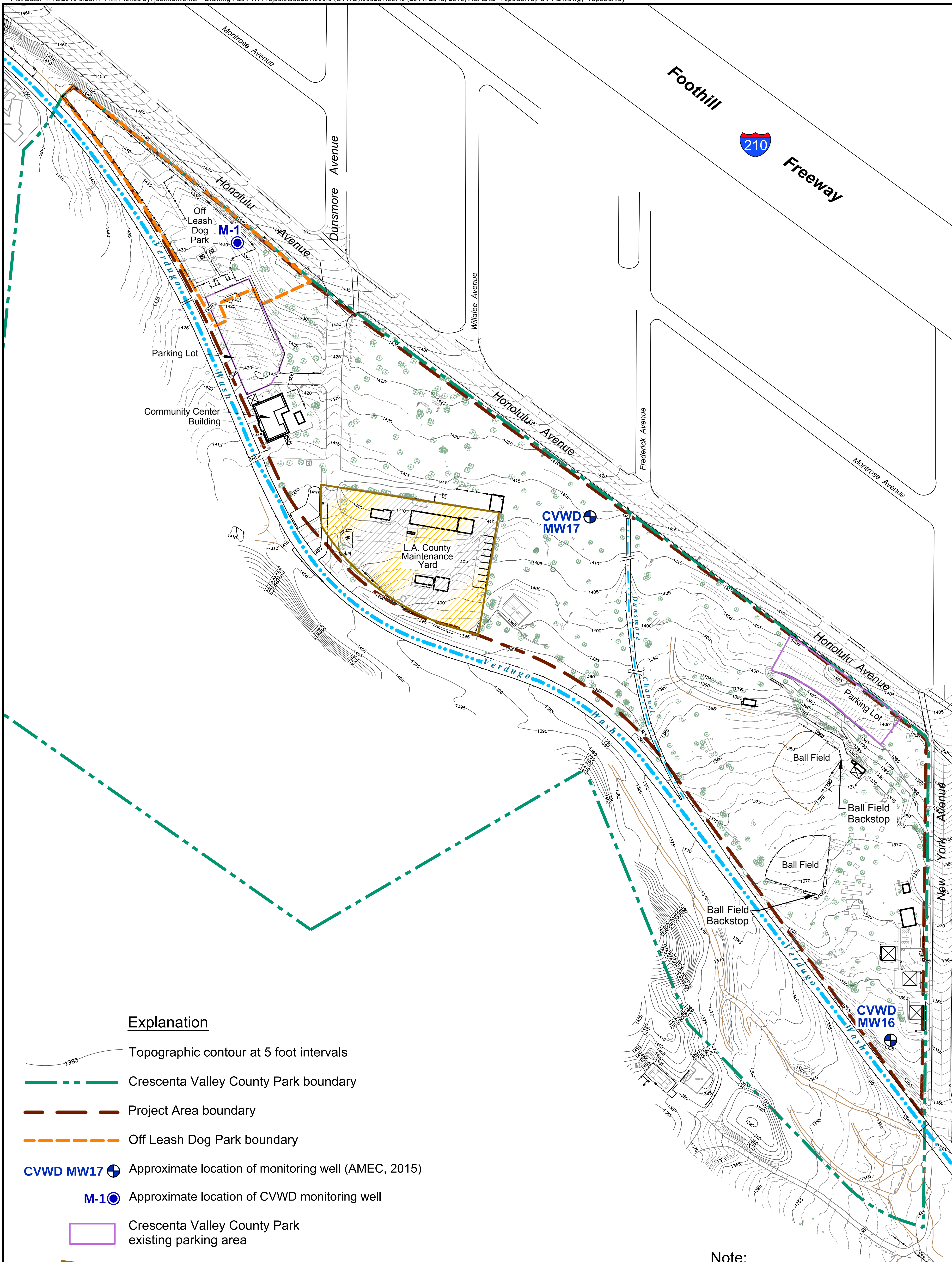
INFILTRATION TEST PIT LOCATIONS
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 08/03/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	7.1

Plot Date: 8/03/2016 4:37:43 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\CV Park Site W Wells_v2.dwg, Infilt Test Pits

Plot Date: 7/15/2016 3:28:17 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_TopoSurvey CV Park.dwg, TopoSurvey



Explanation

Topographic contour at 5 foot intervals

Crescenta Valley County Park boundary

Project Area boundary

Off Leash Dog Park boundary

CVWD MW17 Approximate location of monitoring well (AMEC, 2015)

M-1 Approximate location of CVWD monitoring well

Crescenta Valley County Park existing parking area

L.A. County Maintenance Yard

Verdugo Wash

Dunsmore Channel

Fence

Building

Covered area

Approximate scale in feet: 0, 100, 200

Approximate scale in meters: 0, 30, 60

Note:

All locations are approximate.

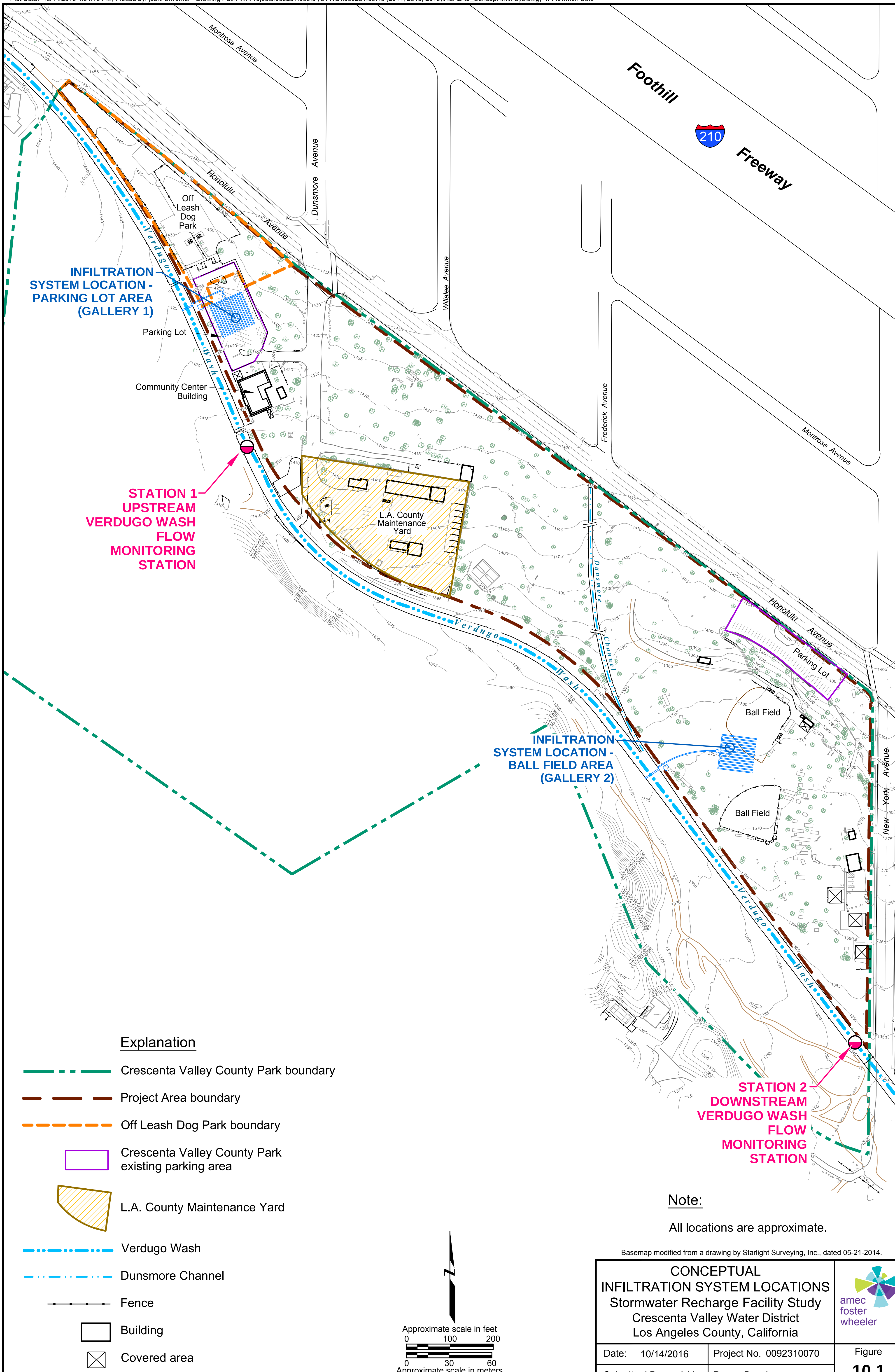
Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014.

TOPOGRAPHIC SURVEY OF CRESCENTA VALLEY COUNTY PARK
Crescenta Valley County Park Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 07/15/2016	Project No. 0092310070	Figure
Submitted By: wgh	Drawn By: jrw	8.1

Plot Date: 10/14/2016 4:04:18 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_Concept Infilt Sys.dwg, w FlowMon Stns



Note:

All locations are approximate.

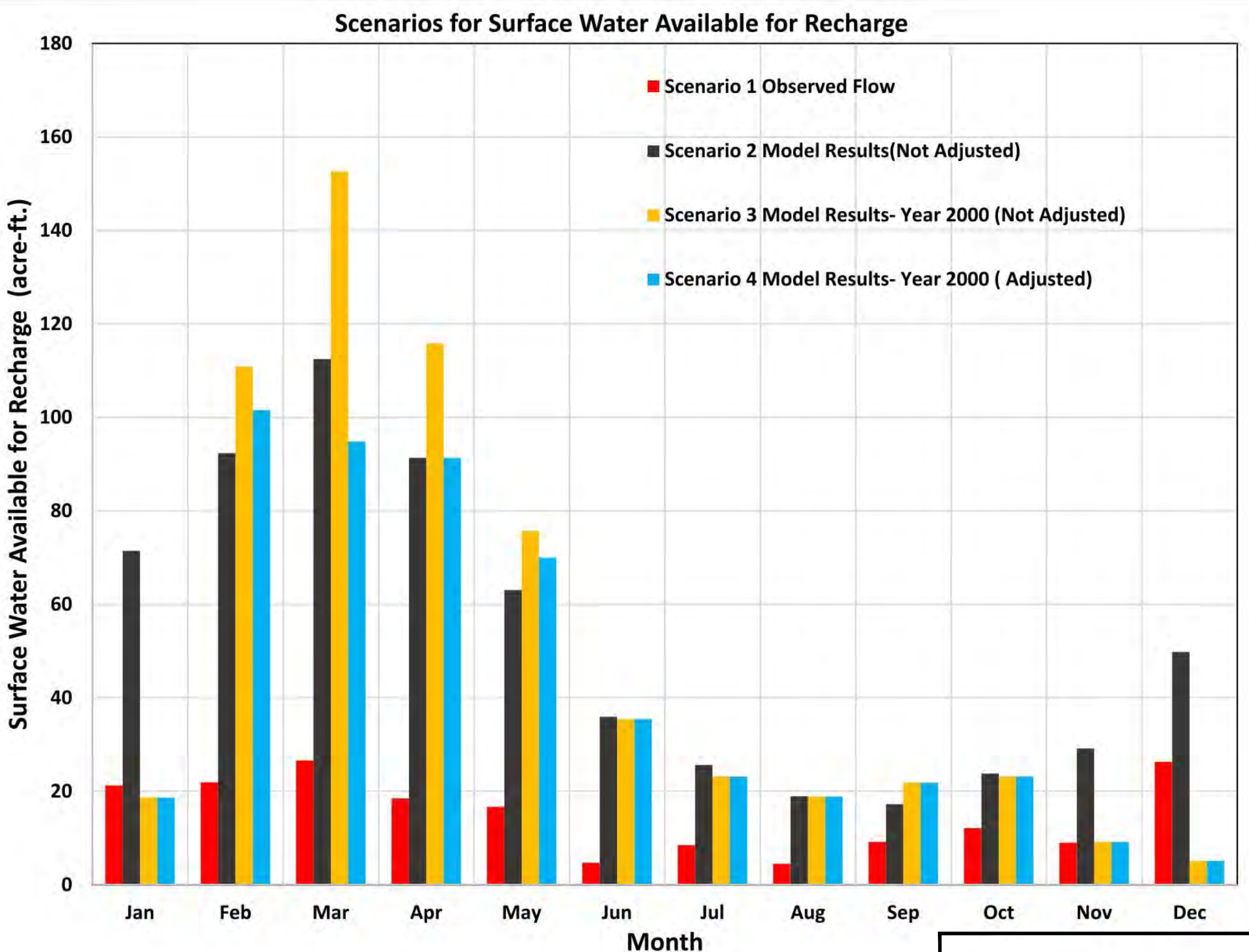
Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014.

CONCEPTUAL INFILTRATION SYSTEM LOCATIONS
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/14/2016	Project No. 0092310070	Figure
Submitted By: wgh/ds	Drawn By: jrw	10.1

Plot Date: 7/29/2016 2:46:48 PM , Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\Scenarios-SurfaceWtr For Recharge.dwg



SCENARIOS FOR SURFACE WATER AVAILABLE FOR RECHARGE
Storm Water Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

Date: 07/29/2016	Project No. 0092310070	Figure 10.2
Submitted By: wgh	Drawn By: jrw	

Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Off Leash Dog Park boundary
- L.A. County Maintenance Yard
- Verdugo Wash
- Dunsmore Channel
- CVWD MW17 — Approximate location of monitoring well (AMEC, 2015)
- CVWD-9 — Approximate location of CVWD pumping well
- M-1 — Approximate location of existing monitoring well
- CVWD-4 — Approximate location of destroyed CVWD well
- ft bgs — feet below ground surface
- La Tuna Canyon Fault
- La Crescenta Valley Fault

Notes:

1. Fault locations are approximate and the locations shown on this figure are based on locations presented in the report: 2008, *Stratigraphy of the Verdugo Basin in Glendale and La Crescenta, California*, Report by Quaternary Research Investigations, Inc. to ATC Associates, Inc. for Resource Environmental, LLC, May 13, 2008.
2. All locations are approximate.

Basemap modified from an aerial photo from BING Maps, © 2015 Microsoft Corporation, © 2015 Nokia, dated April 2014, a drawing by County of Los Angeles Department of Parks and Recreation, Sheet No. L-0.1, "Off Leash Dog Park Site Plan", dated 08/01/11, and a survey by Starlight Surveying, Inc. dated 03-06-2015.

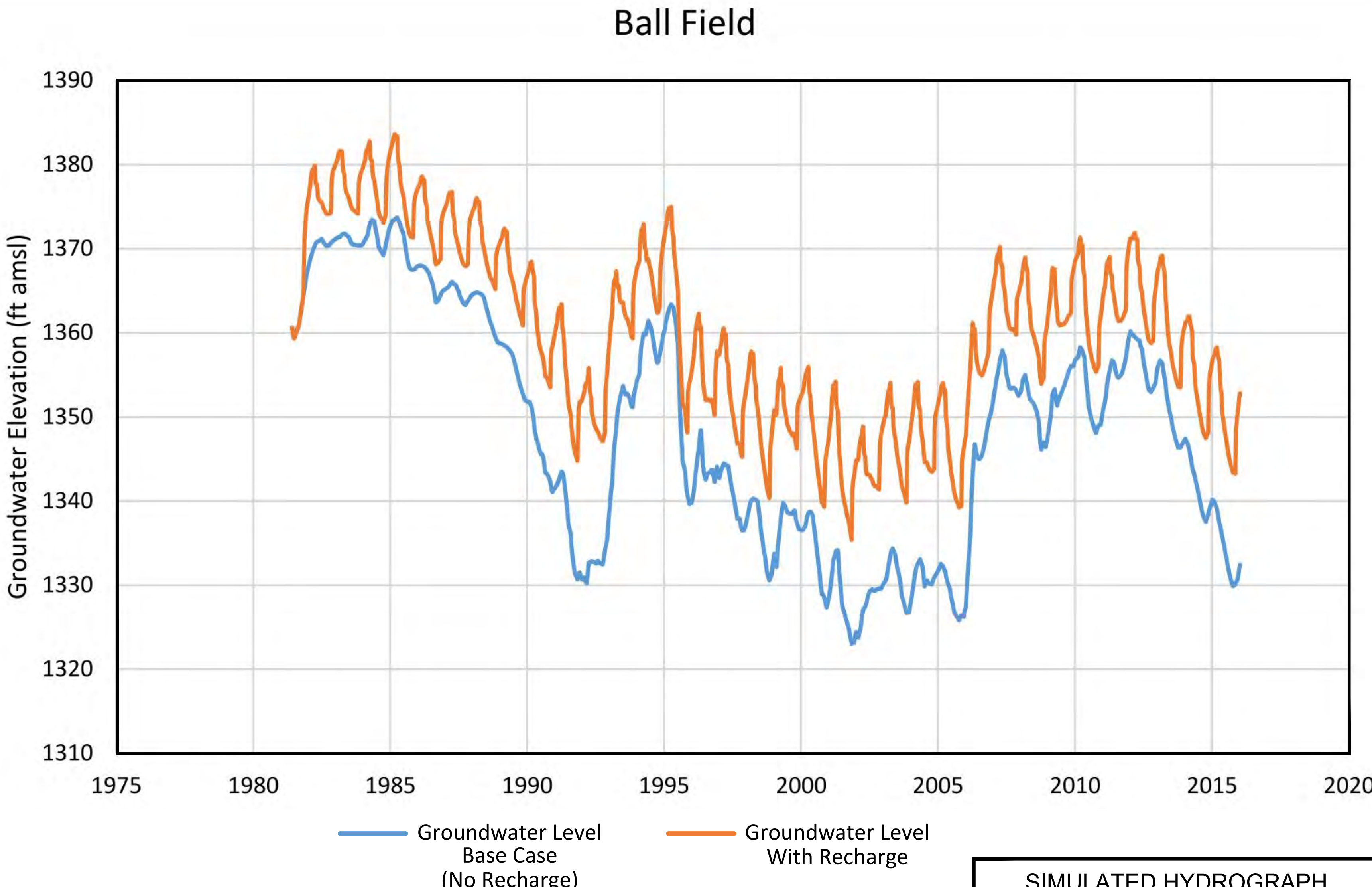
DEPTH TO BEDROCK AT WELLS
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/17/2016	Project No. 0092310070	Figure 10.3
Submitted By: wgh	Drawn By: jrw	

Plot Date: 10/17/2016 9:46:16 AM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\CV Park Site W Wells_v2.dwg, Depth Bedrock-Wells

Plot Date: 10/14/2016 4:17:41 PM , Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\Simulated Hydrographs.dwg



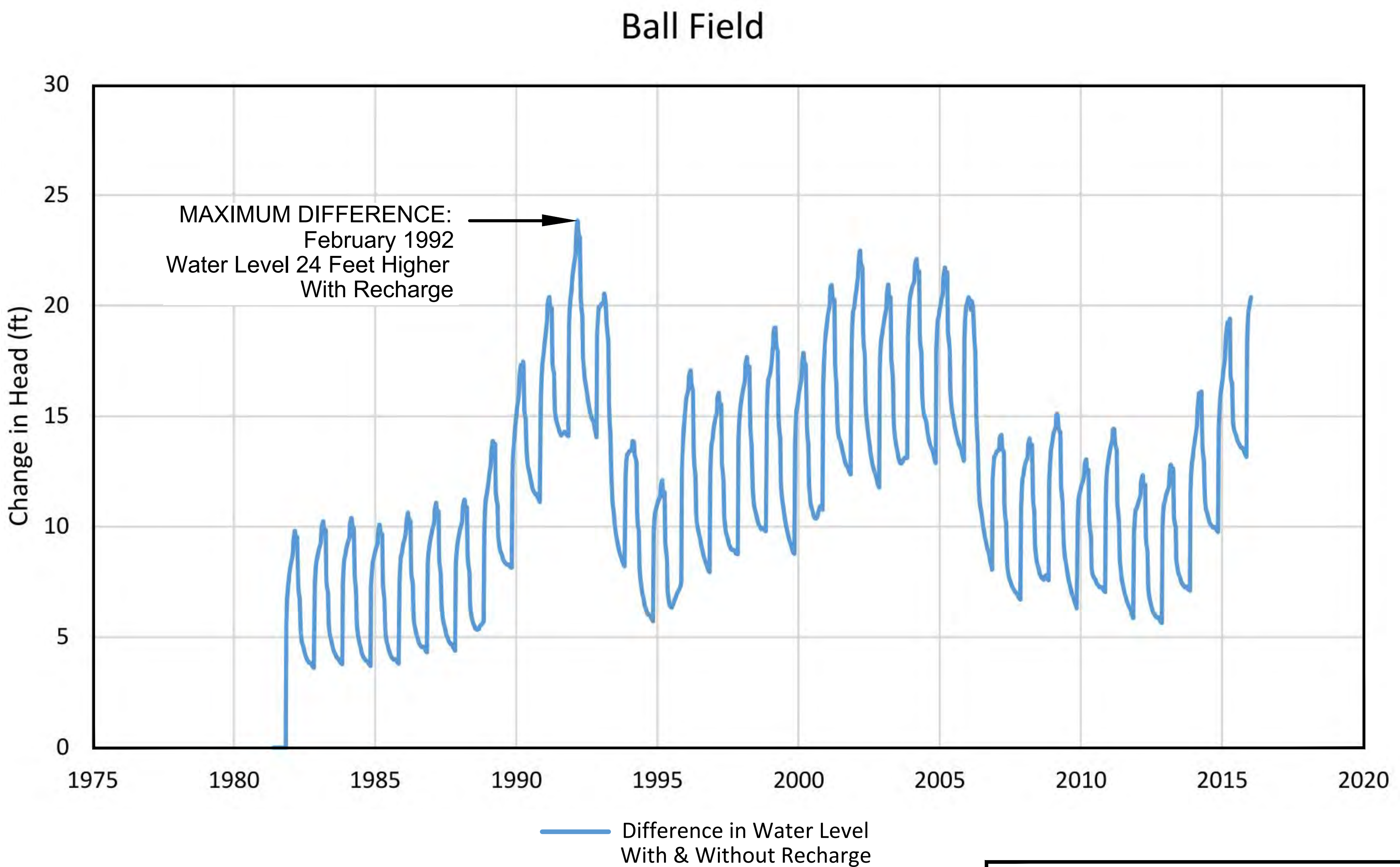
Notes:

1. Recharge gallery infiltration systems are 80'x80' and consist of perforated pipe.
2. Annual recharge amount is approximately 300 acre feet per year.

SIMULATED HYDROGRAPH
AT BALL FIELD (GALLERY 2)
RECHARGE AREA
GROUNDWATER ELEVATIONS
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/14/2016	Project No. 0092310070	Figure 10.4a
Submitted By: wgh/db	Drawn By: jrw	

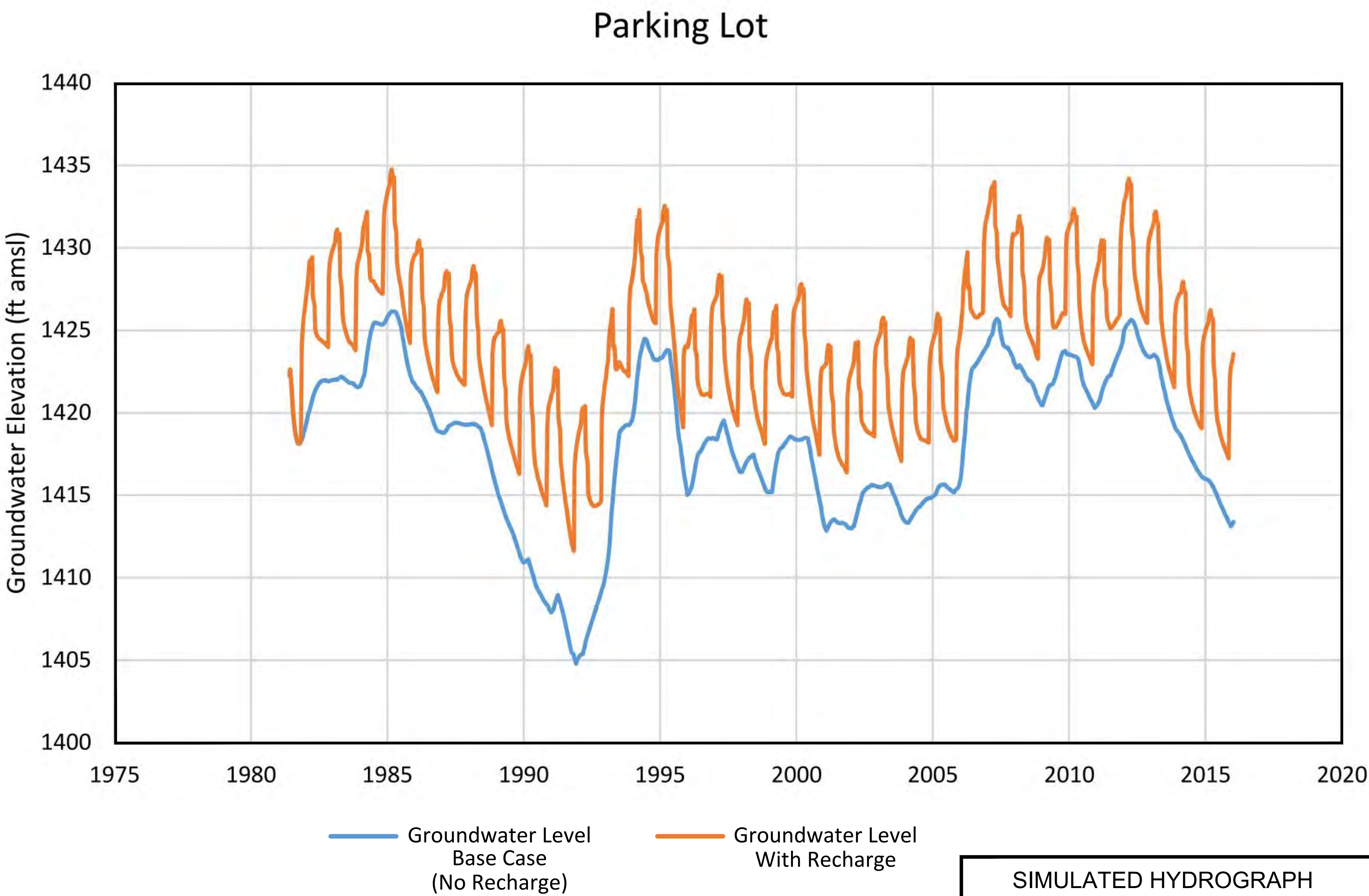


Notes:

1. Recharge gallery infiltration systems are 80'x80' and consist of perforated pipe.
2. Annual recharge amount is approximately 300 acre feet per year.

SIMULATED HYDROGRAPH AT BALL FIELD (GALLERY 2) RECHARGE AREA CHANGE IN HEAD Crescenta Valley County Park Stormwater Recharge Facility Study Crescenta Valley Water District Los Angeles County, California		amec foster wheeler
Date: 10/14/2016	Project No. 0092310070	Figure
Submitted By: wgh/db	Drawn By: jrw	10.4b

Plot Date: 10/14/2016 4:29:56 PM , Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\Simulated Hydrographs.dwg

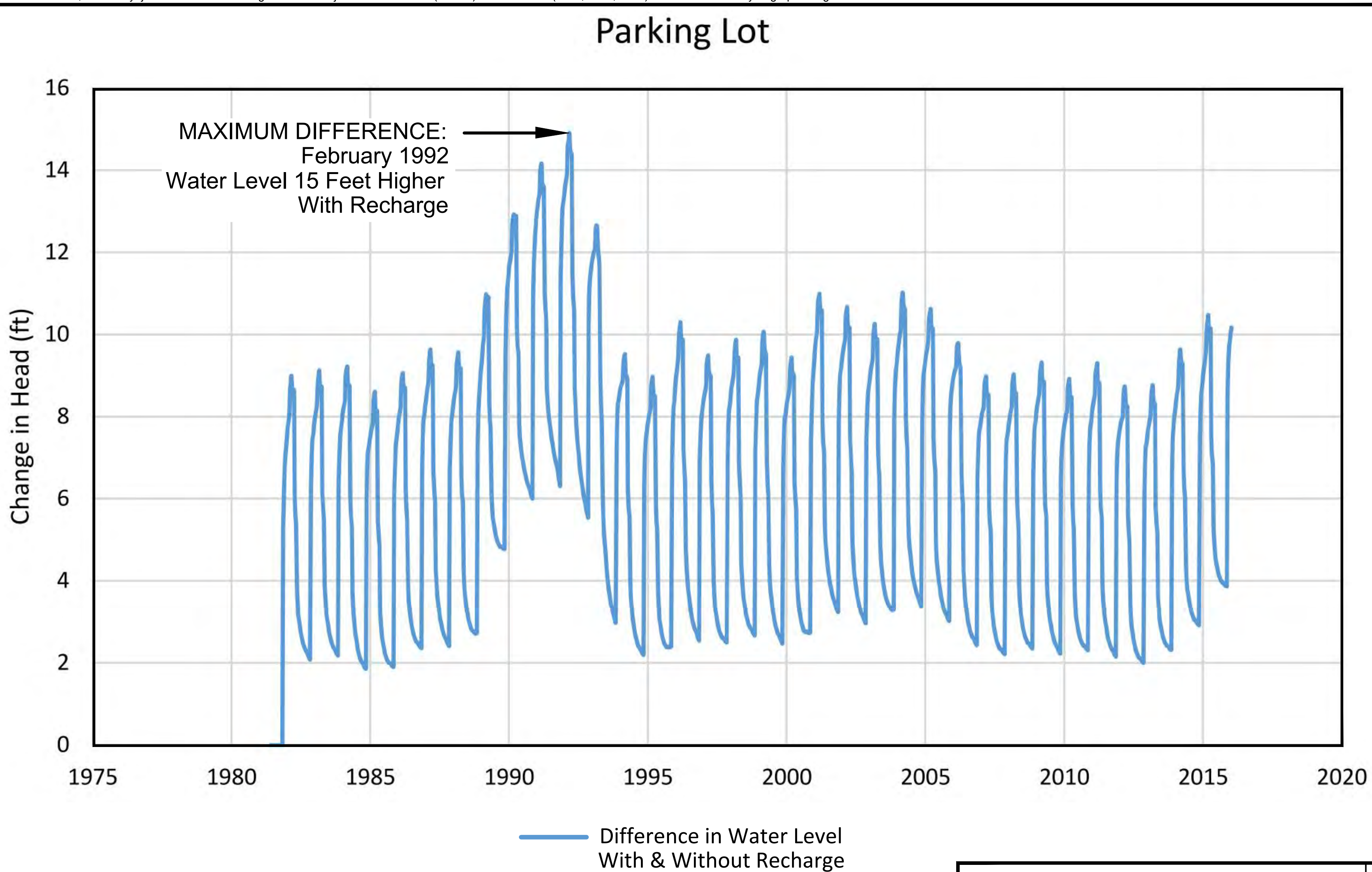


Notes:

1. Recharge gallery infiltration systems are 80'x80' and consist of perforated pipe.

2. Annual recharge amount is approximately 300 acre feet per year.

SIMULATED HYDROGRAPH AT PARKING LOT (GALLERY 1) RECHARGE AREA GROUNDWATER ELEVATIONS Crescenta Valley County Park Stormwater Recharge Facility Study Crescenta Valley Water District Los Angeles County, California		amec foster wheeler
Date: 10/14/2016	Project No. 0092310070	Figure **10.4c**
Submitted By: wgh/db	Drawn By: jrw	



Notes:

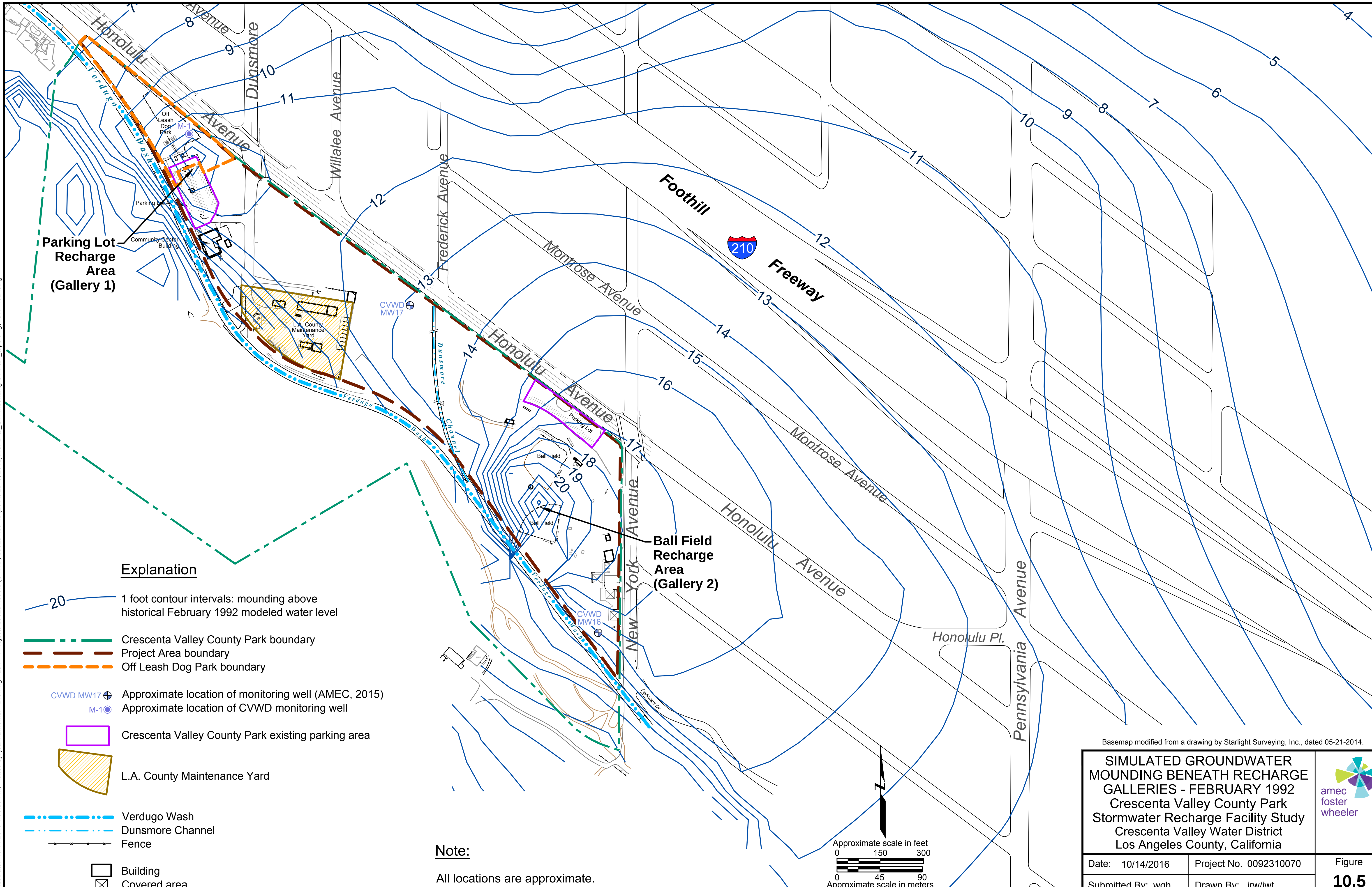
1. Recharge gallery infiltration systems are 80'x80' and consist of perforated pipe.

2. Annual recharge amount is approximately 300 acre feet per year.

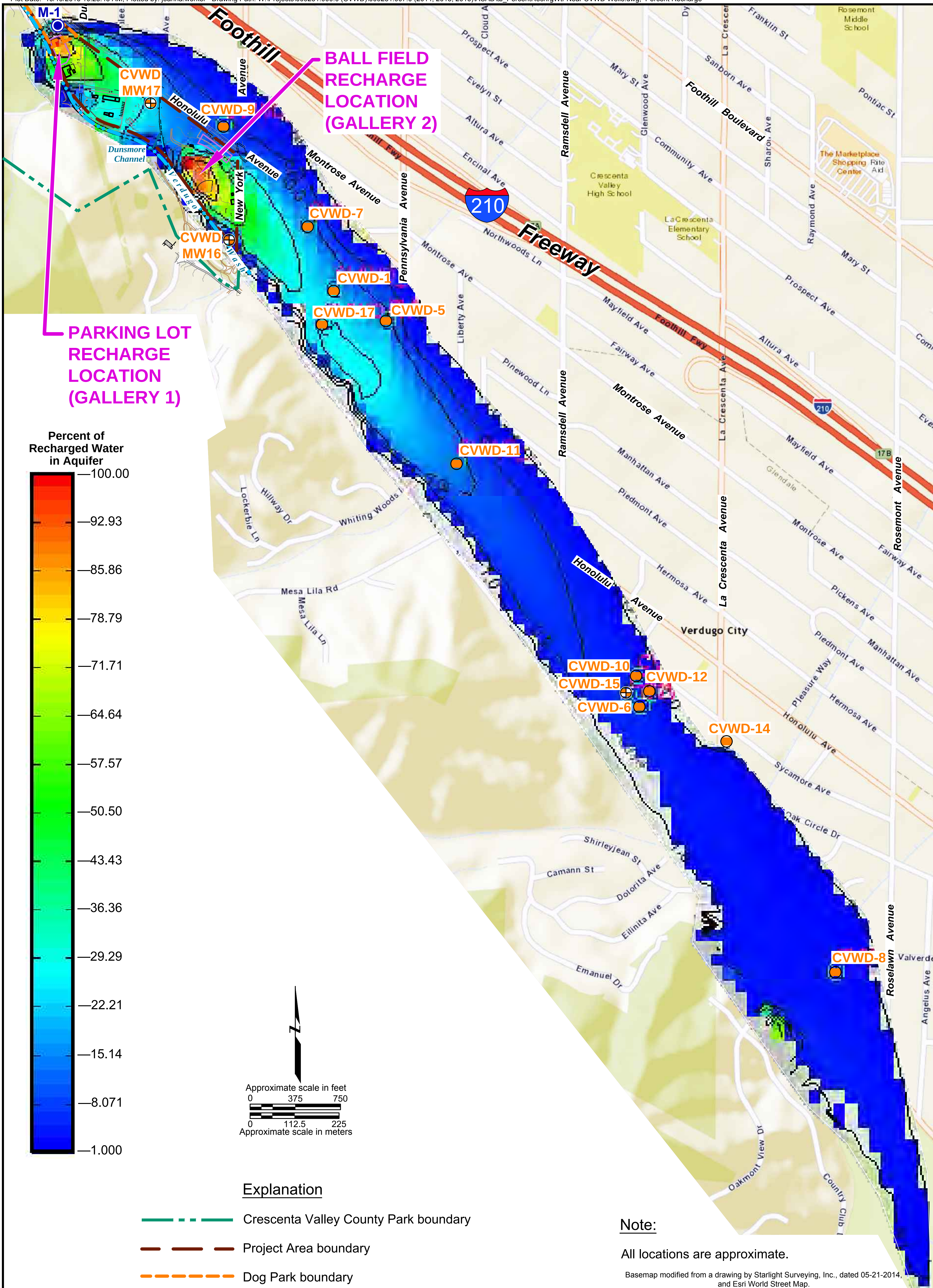
SIMULATED HYDROGRAPH
AT PARKING LOT (GALLERY 1)
RECHARGE AREA
CHANGE IN HEAD
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/14/2016	Project No. 0092310070	Figure
Submitted By: wgh/db	Drawn By: jrw	10.4d


Foothill Freeway
210
Honolulu Avenue
Montrose Avenue
Dunsmore Avenue
Willalee Avenue
Frederick Avenue
New York Avenue
Pennsylvania Avenue
Honolulu Pl.
Verdugo Wash
Dunsmore Channel
Off Leash Dog Park
M-1
CVWD MW17
CVWD MW16
L.A. County Maintenance Yard
Community Center Building
Ball Field
Parking Lot
Parking Lot Recharge Area (Gallery 1)
Ball Field Recharge Area (Gallery 2)
Explanation
1 foot contour intervals: mounding above historical February 1992 modeled water level
Crescenta Valley County Park boundary
Project Area boundary
Off Leash Dog Park boundary
Approximate location of monitoring well (AMEC, 2015)
Approximate location of CVWD monitoring well
Crescenta Valley County Park existing parking area
L.A. County Maintenance Yard
Verdugo Wash
Dunsmore Channel
Fence
Building
Covered area
Note:
All locations are approximate.
Approximate scale in feet
0 150 300
0 45 90
Approximate scale in meters
Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014.
SIMULATED GROUNDWATER MOUNDING BENEATH RECHARGE GALLERIES - FEBRUARY 1992
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California
amec foster wheeler
Date: 10/14/2016
Project No. 0092310070
Submitted By: wgh
Drawn By: jrw/jwt
Figure
10.5

Plot Date: 10/19/2016 10:28:43 AM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_PercentRechrgWtr Near CVWD Wells.dwg, Percent Recharge



Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Dog Park boundary
- CVWD MW17 — Approximate location of monitoring well (AMEC, 2015)
- CVWD-14 — Approximate location of CVWD pumping well
- M-1 — Approximate location of CVWD monitoring well
- Verdugo Wash
- Dunsmore Channel

Note:

All locations are approximate.

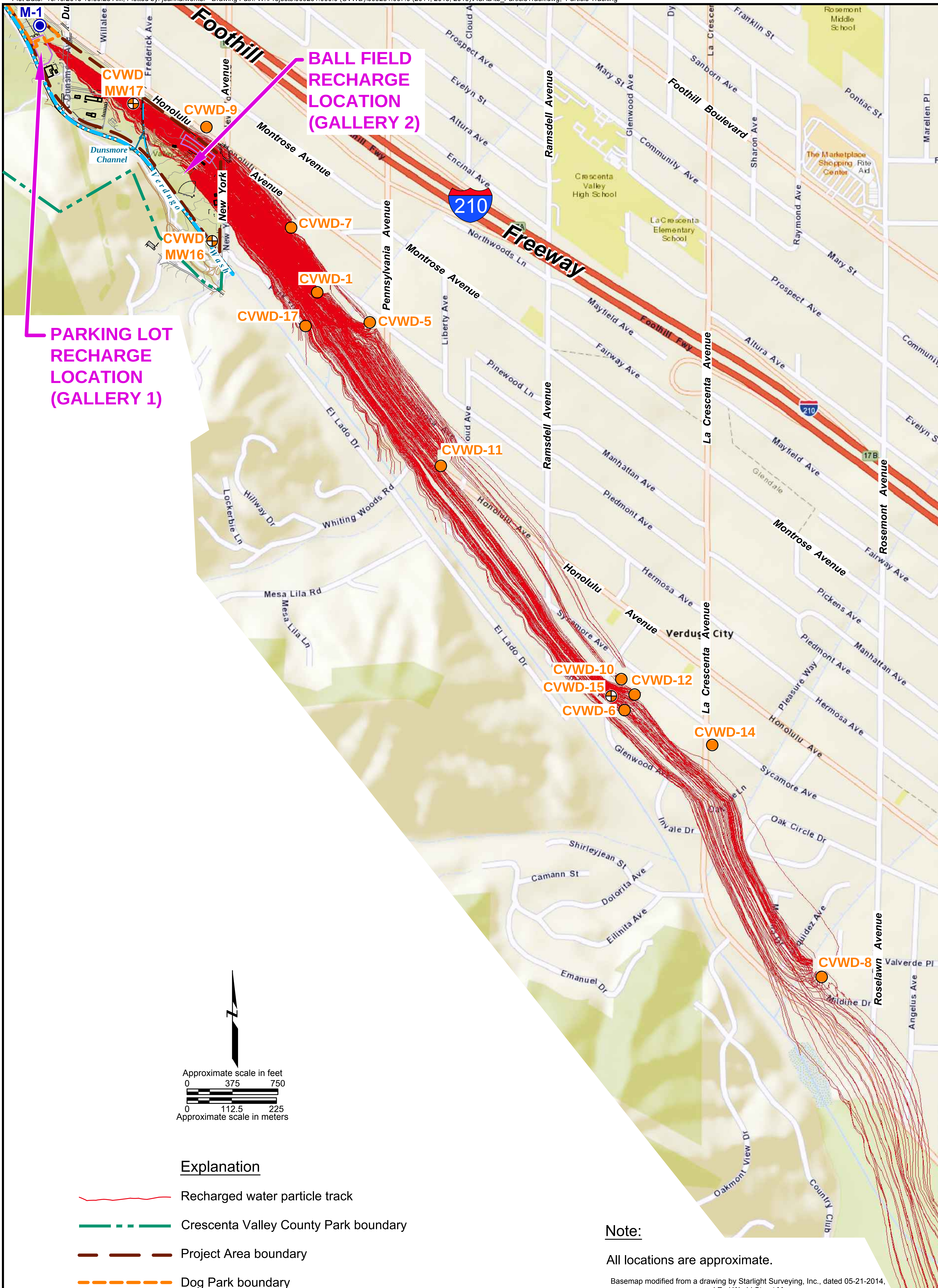
Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014, and Esri World Street Map.

PERCENT OF RECHARGED WATER IN VICINITY OF CVWD PUMPING WELLS
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/19/2016	Project No. 0092310070	Figure
Submitted By: db/wgh	Drawn By: jrw	10.6

Plot Date: 10/19/2016 10:39:28 AM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_ParticleTrack.dwg, Particle Tracking



Explanation

- Recharged water particle track
- Crescenta Valley County Park boundary
- Project Area boundary
- Dog Park boundary
- CVWD MW17 — Approximate location of monitoring well (AMEC, 2015)
- CVWD-14 — Approximate location of CVWD pumping well
- M-1 — Approximate location of CVWD monitoring well
- Verdugo Wash
- Dunsmore Channel

Note:

All locations are approximate.

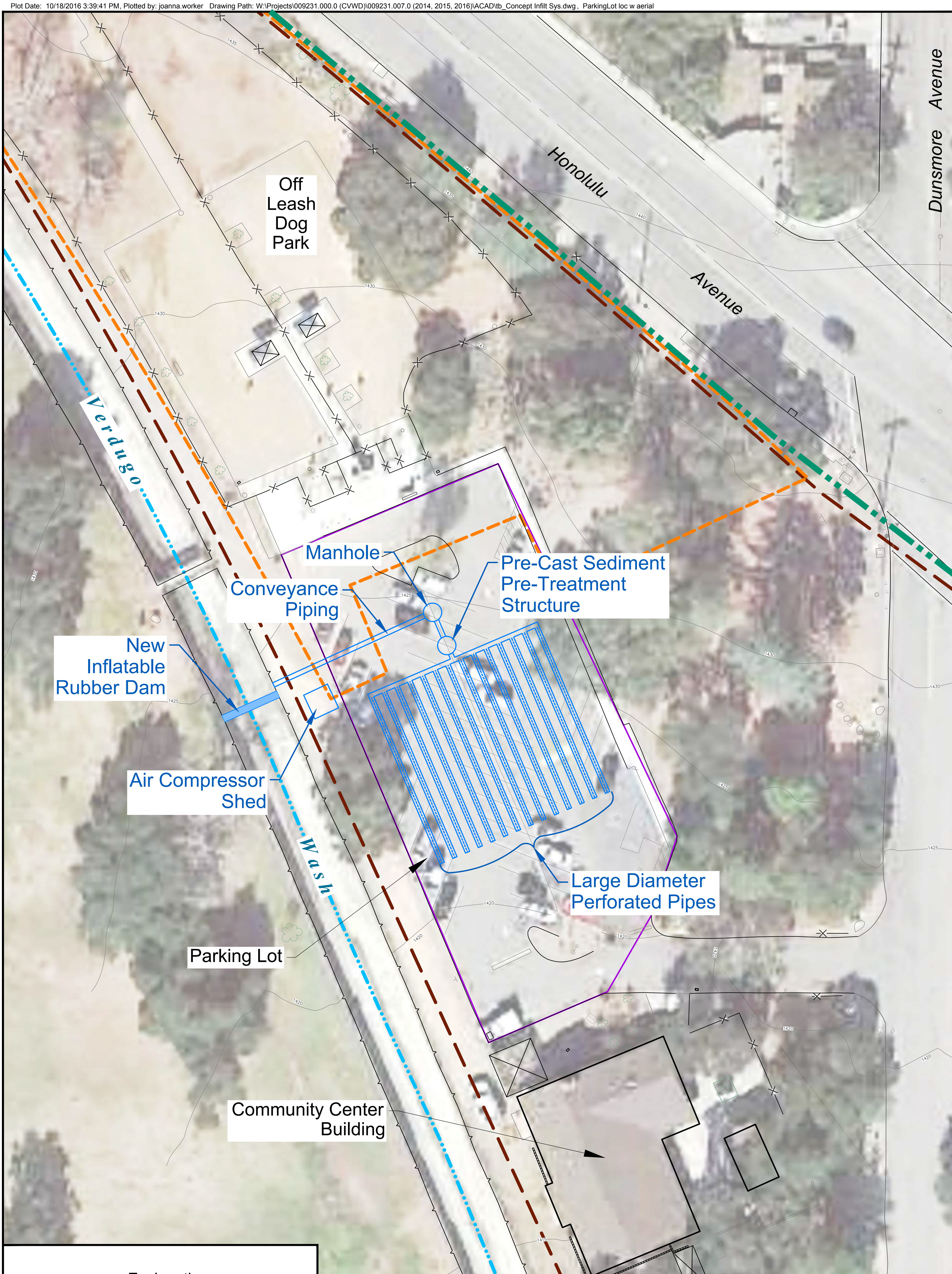
Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014, and Esri World Street Map.

RECHARGED WATER PARTICLE TRACKING
Crescenta Valley County Park
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/19/2016	Project No. 0092310070	Figure
Submitted By: db/wgh	Drawn By: jrw	10.7

Plot Date: 10/18/2016 3:39:41 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_Concept Infilt Sys.dwg, ParkingLot loc w aerial



Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Off Leash Dog Park boundary
- Crescenta Valley County Park existing parking area
- Verdugo Wash

N

Approximate scale in feet: 0, 20, 40
Approximate scale in meters: 0, 6, 12

Note:

All locations are approximate.

Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014, and an aerial photo from Google™ Earth, dated 2-2-2016 .

INFILTRATION SYSTEM LOCATION - PARKING LOT (GALLERY 1)
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/18/2016	Project No. 0092310070	Figure
Submitted By: wgh/ds	Drawn By: jrw	10.8

Plot Date: 10/18/2016 3:40:15 PM, Plotted by: joanna.worker Drawing Path: W:\Projects\009231.000.0 (CVWD)\009231.007.0 (2014, 2015, 2016)\ACAD\tb_Concept Infilt Sys.dwg, Ball Field loc w aerial

Explanation

- Crescenta Valley County Park boundary
- Project Area boundary
- Crescenta Valley County Park existing parking area
- Verdugo Wash
- Dunsmore Channel

N

Approximate scale in feet: 0, 20, 40
Approximate scale in meters: 0, 6, 12

Note:

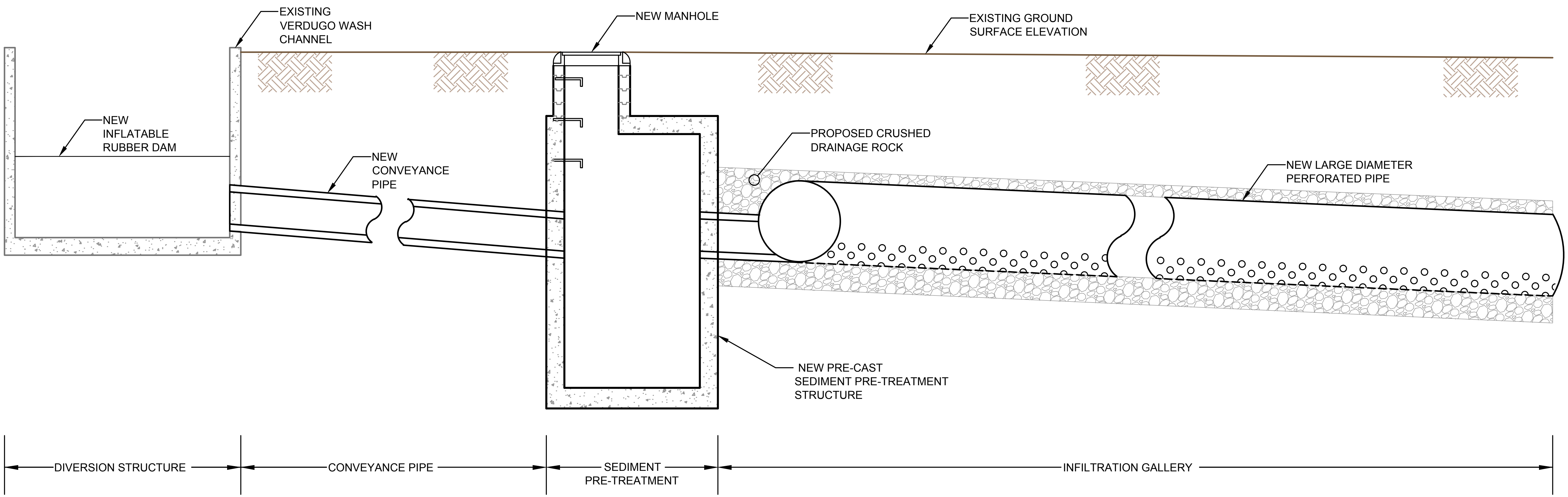
All locations are approximate.

Basemap modified from a drawing by Starlight Surveying, Inc., dated 05-21-2014, and an aerial photo from Google™ Earth, dated 2-2-2016 .

INFILTRATION SYSTEM LOCATION - BALL FIELD AREA (GALLERY 2)
Stormwater Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/18/2016	Project No. 0092310070	Figure
Submitted By: wgh/ds	Drawn By: jrw	10.9



CHANNEL DIVERSION AND INFILTRATION SYSTEM

DRAWING NOT TO SCALE

INFILTRATION SYSTEM
SCHEMATIC
Storm Water Recharge Facility Study
Crescenta Valley Water District
Los Angeles County, California

amec foster wheeler

Date: 10/18/2016	Project No. 0092310070	Figure
Submitted By: wgh/ds	Drawn By: jrw	**10.10**