

**CALIFORNIA STATEWIDE GROUNDWATER
ELEVATION MONITORING
(CASGEM)
MONITORING PLAN
FOR
DEPARTMENT OF WATER RESOURCES
GROUNDWATER SUBBASIN 4-11.01
THE SANTA MONICA SUBBASIN**

**BY
DEPARTMENT OF WATER RESOURCES
CITY OF SANTA MONICA**



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1. Introduction

This document has been prepared by the City of Santa Monica, Water Resources Division (the City) for use in the California Statewide Groundwater Elevation Monitoring Program (CASGEM). The City will assume the role as a monitoring entity for the Santa Monica Subbasin. The Department of Water Resources (DWR) has designated the Santa Monica Subbasin as Groundwater Basin 4-11.01 (DWR Bulletin 118).

The City has provided notification to DWR to establish itself as the monitoring entity for the Santa Monica Subbasin. The purpose of the monitoring plan is to provide background on the characteristics of the Santa Monica Subbasin, groundwater resources in the Santa Monica Subbasin, and to outline a monitoring plan and schedule. The monitoring program encompasses the entire Santa Monica Subbasin; however, it should be noted here, as it is in the notification, that the City only has monitoring wells under its jurisdiction in the Olympic, Charnock, and Arcadia Subbasins.

2. Santa Monica Subbasin Characteristics and Hydrogeology

The Santa Monica Subbasin is bounded by the Santa Monica Mountains to the north, the Newport-Inglewood Fault Zone to the east, the Ballona Escarpment and Baldwin Hills to the south, and the Pacific Ocean to the west (Kennedy/Jenks, 1992). Five subbasins comprise the greater DWR Bulletin 118 Santa Monica Subbasin: Arcadia, Coastal, Crestal, Charnock, and Olympic. The five subbasins are shown on Figure 1. Faults separate the subbasins; therefore, there is very little correlation between water levels measured in different subbasins.

Geologically the Santa Monica Subbasin is characterized predominantly by unconsolidated and semi-consolidated continental (fluvial) and marine earth materials of Tertiary and Quaternary age. These sediments, which are mostly comprised of gravels, sands, silts, and clays, reach a thickness of up to 5,000 feet in the deepest part of the basin. The coarse-grained gravels and sands units form the aquifers used for municipal water supply. Principle water-bearing formations in the basin include: the “50-foot gravel” (Holocene), Lakewood Formation (Upper Pleistocene), San Pedro Formation (Lower Pleistocene), Pico and Repetto Formations (Pliocene), and Monterey and Franciscan Formations (Miocene through Jurassic). The continental and marine sediments overly a basement complex comprised of pre-Tertiary metamorphic and igneous rocks (Figures 6A and 6B – Conceptual Groundwater Basin Model and Assessment of Available Groundwater Supplies – Santa Monica Groundwater Basin; report document uploaded to the CASGEM OS as supplemental information).

Recharge to the Santa Monica Subbasin is principally from subsurface flow from the Santa Monica Mountain watersheds, percolation of precipitation, and subsurface inflow from basin boundaries. Detailed information related to the complex aquifer systems in the Santa Monica Subbasin are presented in supplemental documentation the City of Santa Monica has provided to the CASGEM Online System – specifically, the “Charnock Semiannual Groundwater Monitoring Report, January 15, 2014” and the “Olympic Well Field Management Plan, June, 2013.”

3. Groundwater Resources in the Santa Monica Subbasin

The City pumps, treats, and distributes groundwater for drinking water purposes from the Santa Monica Subbasin. Within the Santa Monica Subbasin, there are three City well fields, the Arcadia Well Field located in the Arcadia Subbasin (3 groundwater production wells); the Santa Monica Well Field (this well field is also referred to as the Olympic Well Field) located in the Olympic Subbasin (2 groundwater production wells); and the Charnock Well Field located in the Charnock Subbasin (5 groundwater production wells).

The well fields in and around the City of Santa Monica have been well studied. Three comprehensive studies conducted to date include:

- California's Groundwater, Bulletin 118, October 2003, State of California, Department of Water Resources (DWR).
- Groundwater Assessment Study, Report Number 1308, A Status report on the Use of Groundwater in the Service Area of the Metropolitan Water District of Southern California, September 2007, MWD.
- City of Santa Monica Land Use and Circulation Element (LUCE) Environmental Impact Report, Appendix G – Water Supply Assessment, January 2010.

The Santa Monica Subbasin is an unadjudicated basin. The City is the primary producer of groundwater in the subbasin. Groundwater management in the Santa Monica Subbasin has centered primarily on the cleanup of groundwater contaminated by MTBE, most notably in the Arcadia and Charnock subbasins, and chlorinated solvents (PCE and TCE) in the Olympic Subbasin. Figure 1 provides an overview of the Santa Monica Subbasin (MWD 2007).

3.1 Safe Yield

The safe yield of an aquifer is defined as the amount of groundwater that can be continuously withdrawn from a basin without adverse impact. Safe yield is expressed as gallons per minute (gpm) or AFY. One acre-ft is equal to 325,851 gallons (1 AFY equals 0.62 gpm). Depending on how it is applied, safe yield may be an annual average value, or may be calculated based on changed conditions each year. Although safe yield may be indicated by stable groundwater levels measured over a period of years, a detailed groundwater budget is needed to accurately estimate safe yield. Proper application of the safe yield concept requires that the value be modified through time to reflect changing practices within the basin. One of the common misconceptions is that safe yield is a static number. That is, once it has been calculated, the amount of water can be extracted annually from the basin without any adverse impacts. An example of a situation in which this assumption could be problematic is when land use changes (reduction in recharge) or pumping ceases (DWR 2003).

The safe yield of the entire Santa Monica Subbasin is roughly estimated to be 10,000 acre-feet per year (AFY) (LADWP 1991) and (Santa Monica 2005).

3.2 Santa Monica Subbasin Well Fields

3.2.1 Arcadia Well Field

There are three groundwater production wells located in the Arcadia Subbasin: Santa Monica #1, Arcadia #4 and Arcadia #5. Groundwater well SM#1 is located near 21st Street and San Vicente Boulevard in the City of Santa Monica. According to Mr. Robert Harvey, retired City of Santa Monica Water Production Supervisor for over 34 years, Santa Monica #1 originally operated at a production rate of 800 gpm. The current rate is closer to 250 gpm. A formal safe yield analysis was not located for this specific area of the Arcadia Subbasin. In 1992, Santa Monica #1 had a reported capacity of 350 AFY based on pumping records with a published high of 415 AFY in 1987 (Kennedy/Jenks 1992).

Arcadia wells #4 and #5 are located at the Santa Monica Water Treatment Plant, 1228 South Bundy Drive, in the City of Los Angeles. Arcadia #5 is designated as the primary pumping well and has a pumping capacity of approximately 400 gpm. Arcadia #4 has a pumping capacity of 100 gpm (SM Permit, 2002). A formal safe yield analysis was not located for this particular area of the well field. In 1992, Arcadia wells #4 and #5 had a combined reported capacity of 525 AFY. According to historical pumping records, the highest annual yield for Arcadia wells #4 and #5 was 408 AFY and 597 AFY, respectively for a total production of 1,005 AFY in 1974 (Kennedy/Jenks 1992).

In the 1980's several attempts were made by the City to find additional water in the area around Santa Monica #1 in the Arcadia Subbasin. Soil borings were drilled near 7th and San Vicente and near Harvard and Montana Avenue. All wells were dry. According to Mr. Harvey, a well was successfully installed at La Mesa and 26th Street. Water was found, but the Department of Health Services determined the well was too close to an active fuel line and would not permit its operation. This well (Santa Monica No. 1) is the well that has been proposed as a CASGEM monitoring well for the CASGEM program.

3.2.2 Santa Monica (Olympic) Well Field

There are two active groundwater production wells located in the Olympic Subbasin: SM #3 and SM #4. Both groundwater wells are located within Olympic Boulevard in the City. Since the 1970s, the City has been producing drinking water from the Olympic Subbasin at a rate of approximately 1,500 gpm. The 1,500 gpm rate was established by the City as a safe yield based on historic operational data (Kennedy/Jenks 1992). There is extensive soil and groundwater contamination originating from the former PaperMate manufacturing facility throughout the Olympic Subbasin. As such, the City has agreed to maintain the 1,500 gpm production rate to capture the groundwater contamination plume for treatment at the Santa Monica Water Treatment Plant (ICF 2010). The City maintains an extensive network of groundwater monitoring wells within the Olympic Subbasins. As indicated below, several of these wells have been selected for the monitoring CASGEM monitoring program.

In 2001, the perennial safe yield of the Coastal Subbasin (defined by the study authors as the Santa Monica Subbasin and the Arcadia Subbasin) was calculated based on a groundwater basin budget evaluation (i.e., the evaluation of individual recharge and discharge components). The maximum perennial yield estimate was reported as high as 10,455 AFY with a probable value of 4,225 AFY. A more recent safe yield analysis to explore higher pumping volumes has not been performed.

3.2.3 Charnock Well Field

There are five groundwater production wells located in the Charnock Subbasin: #13, #15, #16, #18, and #19. The five Charnock groundwater wells are located in the City of Los Angeles. Since the 1920's, The City of Santa Monica is the primary groundwater producer in the Charnock Subbasin. In 2002, the City acquired the water rights held by the Southern California Water Company (SCWC). The SCWC still owns land with two extraction wells (SCWC #9 and #10) and related facilities at 11607 Charnock Road, Los Angeles, CA.

Numerous safe yield analyses have been conducted on the Charnock Subbasin. They include:

- 8,000 - 9,000 AFY based on City Pumping Records (LADWP 1991)
- 7,580 AFY based on literature review (DWR 2003)
- 5,500 – 7,000 AFY based on statistical analysis of groundwater level versus extraction data (Kennedy/Jenks 1992)
- 1,190-9,940 AFY based on a groundwater basin budget evaluation data (Kennedy/Jenks 1992)
- 9,244 AFY based on a Direct Correlation Approach (KOMEX 2001)
- 9,077 AFY based on historical production rates (KOMEX 2001)
- 8,200 AFY based on groundwater flow model (KOMEX 2001)

According to a City of Santa Monica letter, dated August 9, 1951, during the time period of 1946 through 1950, the City produced an average of over 10,000 AFY from the Charnock wells with a high of 10,460 AFY in 1949 (Santa Monica 1951).

Since the Charnock Subbasin has a relatively large storage capacity, short term fluctuations in recharge that occur over a few to several years are damped out and do not appear to affect the overall production capabilities or the average safe yield of the subbasin. Two separate groundwater modeling numerical simulations suggest that overdraft production can be maintained for a significant period of time without adversely impacting the basin. An overdraft of 30 percent (10,660 AFY) could be sustained for up to 7.5 years according to modeling results obtained from a 2001 study (KOMEX 2001). A second groundwater modeling study was conducted with two withdrawal scenarios: a 5000 gpm production scenario and a 7000/5000 gpm scenario. In the 5000 gpm production scenario, the five Charnock wells are assumed to operate at a steady withdrawal rate totaling 5000 gpm. In the second scenario, the wells are initially simulated at a total withdrawal of 7000 gpm and then withdrawal is reduced to 5000 gpm and held steady until the model-simulated water table elevation drops to the approximate elevation of the bottom of the Upper Silverado Aquifer (USA) in the well field area. It takes approximately 4½ years in the simulation for the water table to drop to this elevation (Geotrans 2006).

The groundwater quality in the Charnock Well Field has been impacted by releases of methy-tert butyl ether (MTBE) and other gasoline-related compounds. An extensive network of groundwater monitoring wells have been installed to monitor water levels and water quality. A number of these monitoring wells have been selected for the CASGEM monitoring program.

Currently, the groundwater extraction rate from the Charnock Subbasin is restricted due to treatment plant limitations. The City is restricted to pumping 5,000 gpm of groundwater with 3,000 gpm to be treated in the newly operational Charnock Treatment Plant. Once all 5,000 gpm of extracted groundwater is free from MTBE contamination, then the scenarios of over pumping the basin can be fully explored.

4. Proposed CASGEM Monitoring Program

The City has an extensive network of groundwater monitoring wells in the Olympic and Charnock subbasins. Water levels are routinely measured in these wells to meet Regional Water Quality Control Board (RWQCB) groundwater monitoring requirements. Most wells are monitored quarterly, but some are only monitored semi-annually. The City does not have groundwater monitoring wells under its jurisdiction in the Arcadia, Coastal, or Crestal subbasins. However, water level data from one production well in the Arcadia Subbasin may be included in the monitoring program. The details of the monitoring program are provided in the following sections.

4.1 Monitoring Well Network

The City intends to use selected wells from its extensive monitoring well network located in the Charnock and Olympic subbasins. Due to the presence of faults and other hydrostratigraphic conditions, water levels between subbasins cannot be correlated. However, water level data within each subbasin can be used to record and monitor water levels trends over time. It should also be noted that the proposed monitoring well networks within each subbasin are not necessarily spatially distributed. This is an artifact of the original purpose of the monitor wells, which was to assess and monitor the distribution of groundwater contamination. Thus, the existing network of monitoring wells is preferentially clustered around known sources of contamination. To the extent feasible, we have selected wells that will provide representative water levels in multiple water-bearing zones in each of the three subbasins. The details for the proposed monitoring wells is provided in Table 1.

The location of the wells selected for the inclusion in the CASGEM monitoring programs in the Arcadia, Charnock, and Olympic subbasins, are respectively shown on Figures 2, 3, and 4. An index map showing the locations of the wells in the context of the broader Sana Monica area is shown on Figure 5.

4.2 Monitoring Schedule

The wells listed in Table 1 are monitored on quarterly or semi-annual basis. For the purpose of the CASGEM monitoring program the City proposes to collect water level measurements in late April/early May and late November/early December to capture the seasonal high and low water level trends. These time periods roughly correspond to our second and fourth quarter groundwater monitoring programs. We anticipate that water level data would be uploaded to the CASGEM online database in June and January of each year.

4.3 Field Methods

Groundwater level gauging at traditional monitoring wells (denoted “single” in Table 1) will be performed using a Solinst down-hole electronic water level sounder with a graduated tape accurate to 0.01 feet. Groundwater level gauging at continuous multi-channel tubing (CMT) monitoring wells will be performed using a Solinst down-hole electronic water level sounder with a graduated tape accurate to 1 foot and a graduated tape measure accurate to 0.01 feet. Prior to gauging, each well will be opened for a few minutes. During that period, the surface condition of each well will be evaluated and recorded and necessary well box maintenance will be performed. A sample field form that summarize the measurements and monitoring performed during groundwater gauging activities is presented as Attachment 1.

4.4 Data Gaps

Twenty-one CASGEM wells are proposed by the City for the CASGEM program. The wells are owned by the City and subsequently full well construction information (total well depth and perforated intervals) is available. This reduces potential data gaps with respect to available well construction information.

Because the CASGEM wells proposed are consolidated in the Charnock and Olympic Well Field sites (Figures 3, 4 and 5), spatial data gaps exist in the greater Santa Monica Subbasin. Using the five subbasins within the Santa Monica Subbasin (Figure 1) as reference points, there are data gaps to the southwest in the Coastal Subbasin; to the north and east in parts of the Charnock Subbasin; and the entire Crestal Subbasin. The City has one CASGEM well proposed in the central portion of the Arcadia Subbasin. The east and west portions of the Arcadia Subbasin remain a spatial data gap. No additional monitoring well sites are available at this time in the remainder of the greater Santa Monica Subbasin to reduce spatial data gaps.

The City of Santa Monica will continue to evaluate and improve the monitoring network. However, there is currently no funding to install dedicated monitoring wells in the subbasin (or subbasins within) where there are no wells monitored or where data gaps exist.

Figures 2, 3, 4, and 5 illustrate the water level monitoring network for the Santa Monica Groundwater Subbasin and Table 1 is a list of proposed CASGEM monitoring wells as per CASGEM requirements.

4.5 Future Modifications

Some of the wells identified for inclusion in the CASGEM monitoring program may be subject to abandonment due to their location on private property. If it is necessary for wells to be abandoned, the City will recommend replacement wells, if reasonably located replacement wells are available.

References

- California's Groundwater, Bulletin 118, October 2003, State of California, Department of Water Resources.
- City of Santa Monica Land Use and Circulation Element (LUCE) Environmental Impact Report, Appendix G – Water Supply Assessment, January 2010.
- City of Santa Monica Domestic Water Supply Permit Amendment No 04-16-02PA-000, May 2002, California State Department of Health Services.
- Development of the Santa Monica and Hollywood Groundwater Basins as a Water Supply Source for the City of Los Angeles, April 1991, Los Angeles Department of Water and Power (LADWP).
- Estimates of Safe Yield for the Charnock Sub-Basin, KOMEX, August 2001.
- Groundwater Assessment Study, Report Number 1308, A Status report on the Use of groundwater in the Service Area of the Metropolitan Water District of Southern California, September 2007, MWD.
- Meeting with Mr. Robert Harvey, Retired City of Santa Monica Water Production Supervisor for 34 years, November 2010.
- PSCM Update, GW monitoring activities and Operation Basin Management Practices Technical Memorandum, ICF International, April 2010
- Santa Monica, Department of Public Works letter, dated August 1951, submitted to California State, Department of Public Work, and Division of Water Resources.
- Santa Monica Groundwater Management Plan, Charnock and Coastal Sub-Basins, June 1992, Kennedy/Jenks Consultants.
- Santa Monica Urban Water Management Plan, November 2005.
- Transport Model Calibration and revised Predictions (Groundwater Modeling Task 21.7), September 2006, Geotrans, Inc.

Figures

Santa Monica Subbasin (4-11.01)
CASGEM Groundwater Level Monitoring Basin Boundary

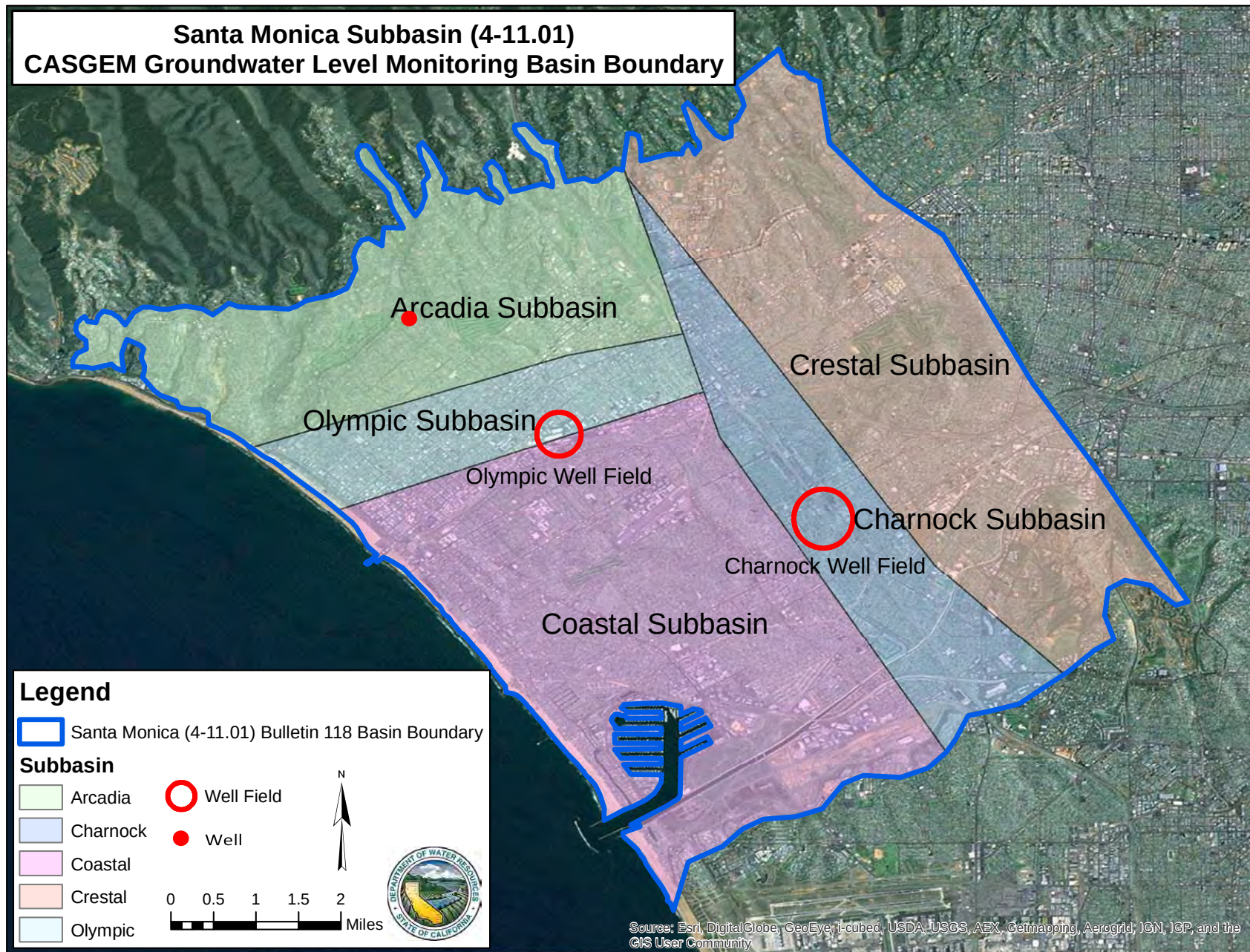


Figure 1
Santa Monica Subbasin

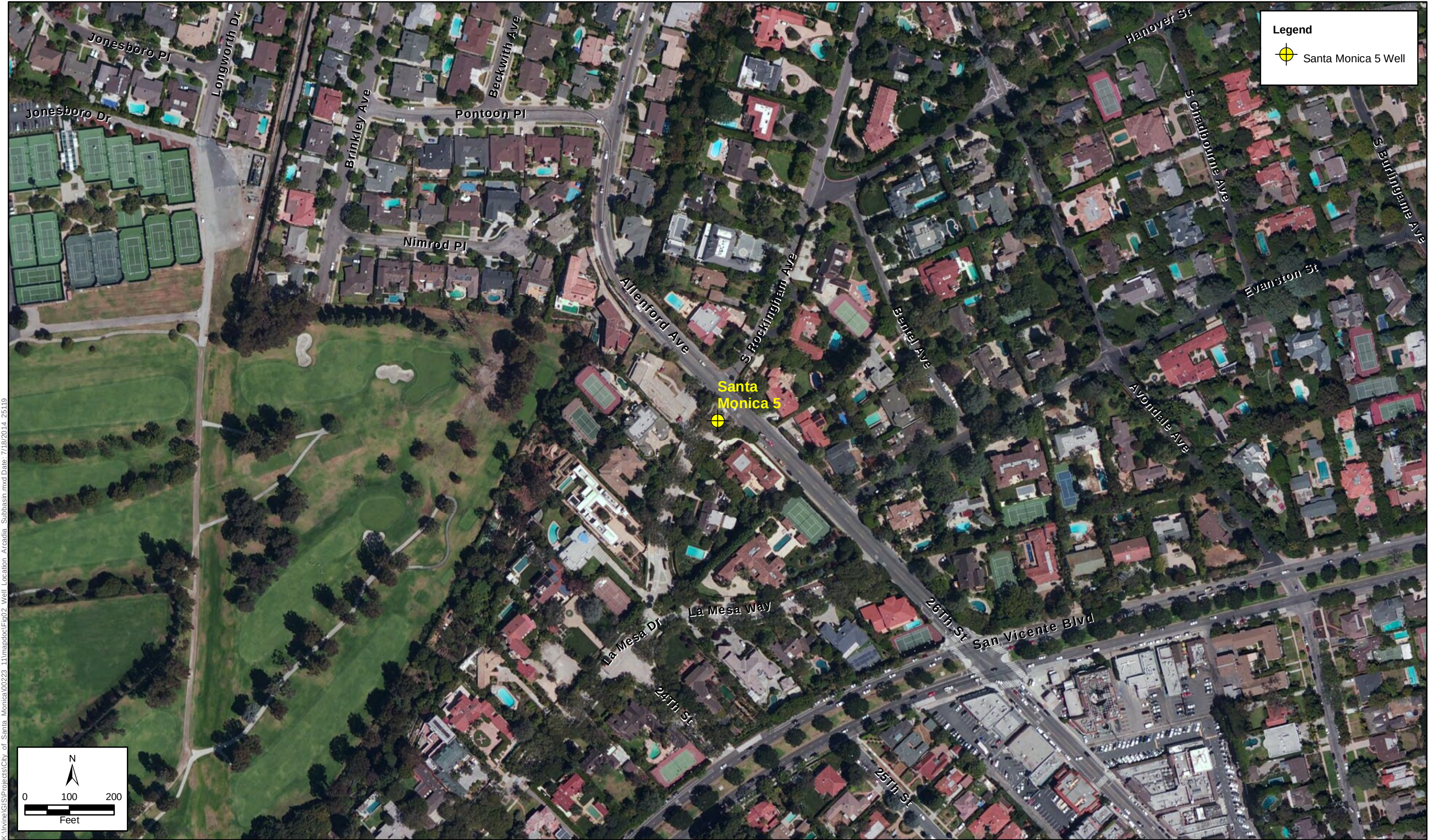
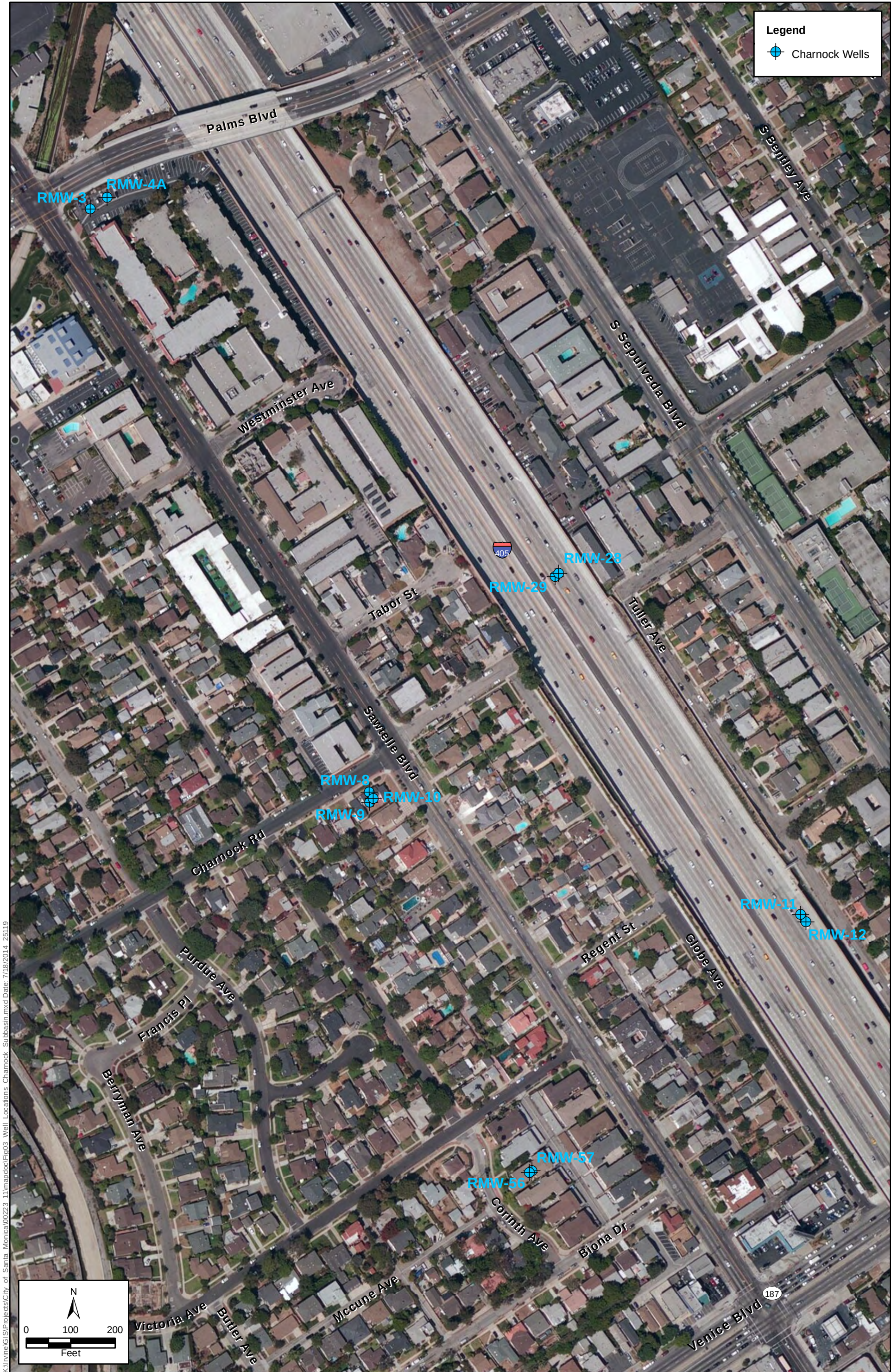
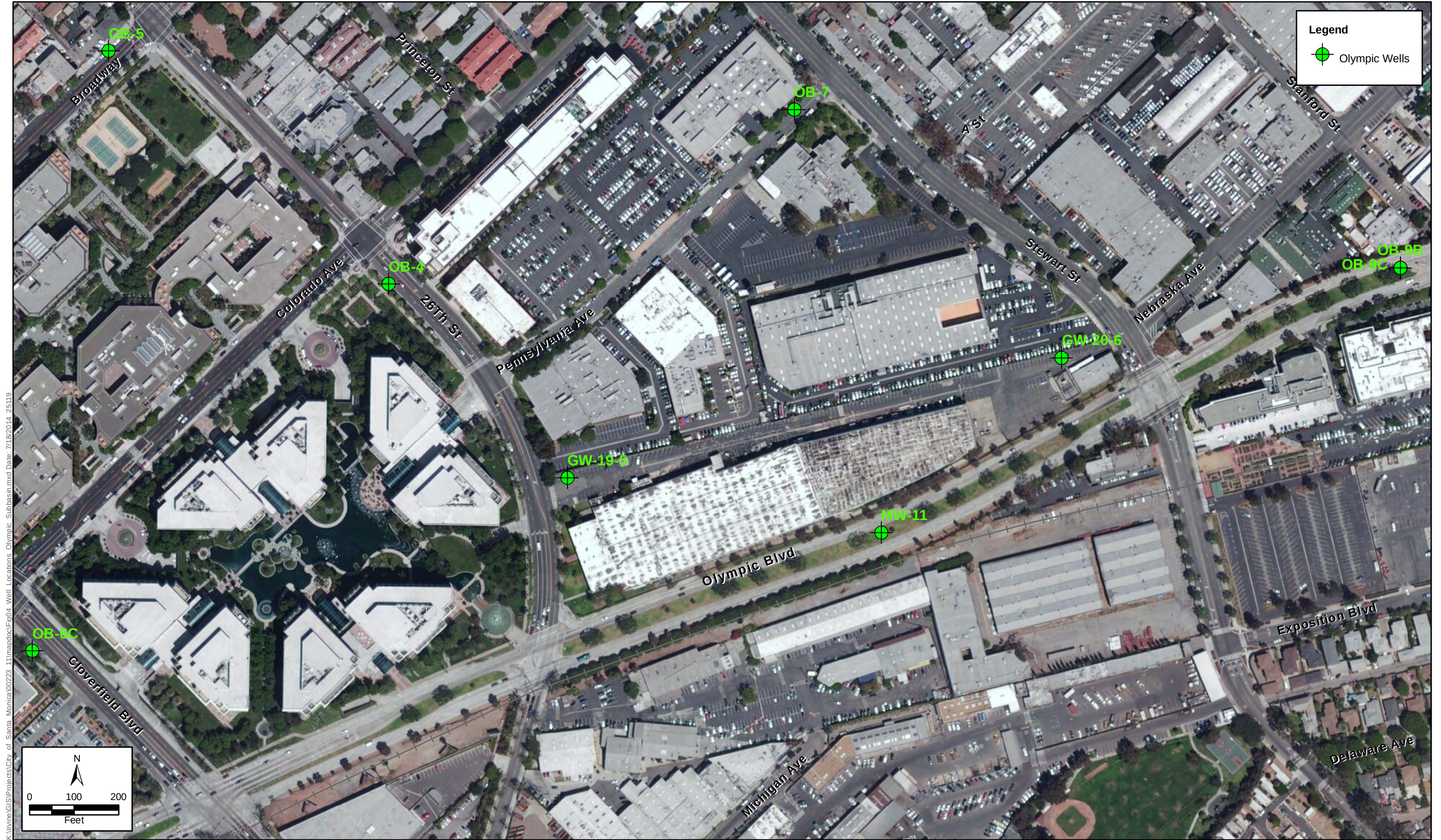


Figure 2
Well Located in Arcadia Subbasin



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Figure 3
Wells Located in Charnock Subbasin



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Figure 4
Wells Located in Olympic Subbasin



Figure 5
Index Map for Wells Located in Santa Monica Subbasin

Table

Table 1: Monitoring Well Data - City of Santa Monica

Subbasin	Local Well Name	Well Category	Latitude (Decimal Degrees - NAD83)	Longitude (Decimal Degrees - NAD83)	State Well Number	Reference Point Elevation (feet above mean sea level)	Reference Point Description	Ground Surface Elevation (feet above mean sea level)	Total Depth of Casing (feet below ground surface)	Perforated Interval (feet below ground surface)	Well Use	Well Completion Type	Monitoring Frequency	Water-Bearing Zone Monitored (Aquifer)	Comments
Charnock	RMW-8	CASGEM	34.014607	-118.422688	N/A	92.56	Top of Casing	92.56	271.5	240.0 - 269.5	Monitoring	Single	Biannual	Lower Silverado	WCR #521734
Charnock	RMW-9	CASGEM	34.014547	-118.422701	N/A	92.64	Top of Casing	92.64	184.0	164.0 - 184.0	Monitoring	Single	Biannual	Upper Silverado	WCR #521735
Charnock	RMW-10	CASGEM	34.014593	-118.422622	N/A	92.53	Top of Casing	92.53	137.5	116.5 - 136.0	Monitoring	Single	Biannual	Shallow	WCR #521719
Charnock	RMW-57	CASGEM	34.012269	-118.421470	N/A	93.67	Top of Casing	93.67	145.0	130.0 - 145.0	Monitoring	Single	Biannual	Shallow	
Charnock	RMW-56	CASGEM	34.012252	-118.421515	N/A	93.51	Top of Casing	93.61	168.5	153.0 - 168.0	Monitoring	Single	Biannual	Upper Silverado	
Charnock	RMW-12	CASGEM	34.013917	-118.419497	N/A	108.42	Top of Casing	109.22	148.0	114.5 - 144.5	Monitoring	Single	Biannual	Shallow	WCR #521720
Charnock	RMW-11	CASGEM	34.013938	-118.419527	N/A	108.85	Top of Casing	108.48	181.5	166.5 - 180.5	Monitoring	Single	Biannual	Upper Silverado	WCR #521737
Charnock	RMW-4A	CASGEM	34.018353	-118.424577	N/A	105.01	Top of Casing	105.80	148.5	108.0 - 148.0	Monitoring	Single	Biannual	Shallow	WCR #539246
Charnock	RMW-3	CASGEM	34.018266	-118.424782	N/A	104.61	Top of Casing	105.19	202.0	179.5 - 199.5	Monitoring	Single	Biannual	Upper Silverado	
Charnock	RMW-29	CASGEM	34.016029	-118.421267	N/A	102.34	Top of Casing	102.64	152.0	136.0 - 151.0	Monitoring	Single	Biannual	Shallow	
Charnock	RMW-28	CASGEM	34.016056	-118.421202	N/A	102.43	Top of Casing	102.73	174.0	157.0 - 172.0	Monitoring	Single	Biannual	Upper Silverado	
Olympic	OB-5	CASGEM	34.031798	-118.473111	N/A	155.66	Top of Casing	156.00	176.0	145.9 - 175.9	Monitoring	Single	Quarterly	B-Zone	
Olympic	OB-4	CASGEM	34.030364	-118.471022	N/A	153.30	Top of Casing	153.64	191.3	161.3 - 191.3	Monitoring	Single	Quarterly	B-Zone	
Olympic	OB-7	CASGEM	34.031440	-118.468014	N/A	157.08	Top of Casing	157.45	245.7	215.0 - 246.0	Monitoring	Single	Quarterly	B-Zone	
Olympic	OB-9B	CASGEM	34.030468	-118.463530	N/A	156.87	Top of Casing	157.17	222.2	202.15 - 222.15	Monitoring	Dual-completion	Quarterly	B-Zone	
Olympic	MW-11	CASGEM	34.028829	-118.467383	N/A	156.13	Top of Casing	156.50	140.5	120.0 - 140.0	Monitoring	Single	Quarterly	B-Zone	
Olympic	OB-9C	CASGEM	34.030468	-118.463530	N/A	156.82	Top of Casing	157.17	335.3	305.33 - 335.33	Monitoring	Dual-completion	Quarterly	C-Zone	
Olympic	OB-6C	CASGEM	34.028051	-118.473689	N/A	148.83	Top of Casing	149.23	176.0	145.9 - 175.9	Monitoring	Dual-completion	Quarterly	C-Zone	
Olympic	GW-19-5	CASGEM	34.029141	-118.469727	N/A	157.09	Top of Casing	157.61	205.5	190.15 - 190.45	Monitoring	Multi-Channel	Quarterly	C-Zone	
Olympic	GW-20-6	CASGEM	34.029887	-118.466023	N/A	152.52	Top of Casing	152.82	263.8	262.95 - 263.25	Monitoring	Multi-Channel	Quarterly	C-Zone	
Arcadia	Santa Monica No. 5	CASGEM	34.049807	-118.494066	01S15W30P001S	360.00	Ground Surface	360.00	255.0	145 - 235	Monitoring	Single	Monthly	Upper Silverado	WCR #093782 Also called the La Mesa Well