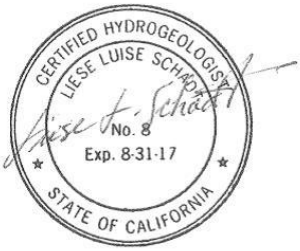
Technical Memorandum

DATE: April 26, 2017 PROJECT: 16-1-013

TO: Mr. Dan Reiff, CEMEX

FROM: Liese Schadt, Till Angermann

SUBJECT: **ESTIMATION OF AVERAGE LOW GROUNDWATER LEVELS CEMEX MADISON PLANT, YOLO COUNTY**



This Technical Memorandum supplements an earlier technical memorandum prepared by Luhdorff and Scalmanini, Consulting Engineers (LSCE) that provided the estimated average high groundwater (AHG) at the CEMEX Madison Plant area (the Plant), including description of the estimation methodology (LSCE, November 30, 2016). The earlier technical memorandum provided the areal AHG derived specifically for CEMEX Phases III, IV, and VI (Figures 1 and 2) toward meeting requirements of the Yolo County Off-Channel Surface Mining Reclamation Ordinance (Ordinance), Section 10-5.516, regarding the minimum separation between AHG and the surface of reclaimed below-grade agricultural lands.

In this current Technical Memorandum, the estimated average low groundwater (ALG) at the Plant is provided based on the same methodology, which incorporates the variations in climatic, hydrologic, and water supply conditions in the area. The areal ALG was derived for CEMEX Phases III, IV, and VI toward meeting requirements of the Ordinance, Section 10-5.530 regarding reclaimed wetpit slopes below the ALG. Discussion is also provided addressing the estimated pond levels in reclaimed wetpits under ALG conditions.

This Technical Memorandum describes herein background to the ALG estimation for the CEMEX Phases, the results of the areal ALG estimation, and discussion to provide context to those results.[1]

BACKGROUND

As part of the derivation of AHG for the CEMEX Phases (LSCE, November 30, 2016), a hydrologic base period was developed during which historical area precipitation and creek discharge are considered average and not biased toward overly wet or dry conditions. The base period was developed from analysis of cumulative departure of annual precipitation (Davis, California) and annual creek discharge (Cache Creek at Rumsey Bridge) from their respective historical mean values (Figures 3 and 4, respectively). The developed base period, from 1995 through 2014, serves as the basis for analyzing historical groundwater levels to estimate both AHG and ALG for the Plant area.

[1] A detailed description of methods is provided in LSCE (November 30, 2016).

Historical groundwater levels in the Plant area have fluctuated on a seasonal and long-term basis, with levels typically lowest each year during the summer months (Figure 5). Thus, estimation of areal ALG involved identifying the summer low groundwater level observed each year of the base period in each well surrounding the CEMEX Phases. Then, for each well, the average of the identified summer low groundwater levels was computed. For this analysis, well-specific ALG were computed for six wells surrounding CEMEX Phases III, IV, and VI, specifically monitoring wells OW-3, OW-4, OW-8d, OW-9, and OW-10, and shallow water supply well 10N/01W-36B02. These computed well-specific ALG were then utilized to estimate areal ALG for the CEMEX Phases in the form of a map of groundwater level contours constructed from historically observed groundwater levels that most closely compare to the computed well-specific AHG.

RESULTS

The monthly groundwater level record (1990-2000) for the Plant monitoring wells indicates that the summer low groundwater levels each year typically occur between late June and late August. In each Plant area well, the computed ALG elevation was compared to each year's observed summer low groundwater elevation in order to identify a specific year within the base period when the elevation difference (computed average vs. observed) for each well was the smallest (Figure 6). This comparison indicated that the groundwater elevations observed in each well during late June 2013 were closest to their respective computed ALG and, as such, the map of groundwater elevation contours for June 2013 represents the areal ALG for CEMEX Phases III, IV, and VI (Figure 7). Separate water level contour maps need not be generated for each of these three mining phases because this map comprehensively aggregates information specific to each of the mining phases. From west to east, areal ALG range from approximately 108 to 100 feet (NGVD29).[2]

Unlike the case of mined land reclaimed to below-grade agricultural land, for which reclamation can be based directly on AHG elevation contours, the reclamation of mined land to wetpit ponds requires additional evaluation of the ALG elevation contours. In the reclamation of mined land to wetpit pond, the resulting pond level can be expected to "equilibrate" to an elevation roughly the average of the groundwater elevations at upgradient and downgradient edges of the pond. As a result, at the CEMEX Plant, the average summer low pond elevation in any reclaimed wetpit will depend on the wetpit location and extent. Thus, the map of areal ALG (see Figure 7) is useful for providing the upgradient and downgradient groundwater elevation (average summer low) for any CEMEX wetpit pond based on its footprint; and the average of these elevations would equal the estimated wetpit pond elevation under summer low groundwater conditions.

[2] The computed well-specific ALG were not utilized to construct the areal ALG contour map because they are not observed values. Further, it cannot be assumed that a hydrologic condition has or ever would exist where groundwater levels in all six wells would exhibit their respective well-specific ALG at the same time.

It is important to note that the ALG condition established herein is not applicable to the mining phases west of Phase III (Phases I, II, and VII) because the analysis did not include groundwater level data from this area. Similarly, this ALG condition is not applicable to Phase V due to the absence of a downgradient groundwater level record.

CONTEXT

For the CEMEX Phases, comparison of the ALG developed herein to the AHG shows they differ by about five feet, with the areal ALG ranging from approximately 108 to 100 feet, and the areal AHG ranging from about 113 to 105 feet (NGVD29). Importantly, review of the historical groundwater level record for the CEMEX monitoring wells (see Figure 5) indicates that, during the base period, seasonal groundwater level fluctuations were of a similar magnitude, on the order of five to seven feet.

Since the statistical average is an estimator of central tendency, it should be expected that summer groundwater levels will periodically fall below the ALG established herein. Review of the historical groundwater elevation data from the CEMEX monitoring wells indicates that summer groundwater levels have fallen below the areal ALG several times during the approximate 25 years comprising the period of record (fall 1990 through present). Such conditions were most pronounced in the late summer months of drought years 1991, 1992, and, most recently, 2014. A map of contours of equal groundwater elevation for September 2014 illustrates the lowest groundwater levels observed during the period of record (Figure 8). The groundwater levels observed in September 2014 are lower than the areal ALG conditions by four to five feet. This suggests that periodic lowering of groundwater and wetpit pond levels below wetpit slopes reclaimed in compliance with Ordinance Section 10-5.530 is a possibility in years of prolonged drought.

Last, variations in agricultural irrigation practices (and associated percolation of irrigation water) on adjacent lands have likely affected groundwater levels beneath the CEMEX parcels over time. Following reclamation of wetpits, if conducted by the building of slopes with fine materials, additional effects on groundwater and wetpit pond levels may be expected due to the expected impedance of groundwater flow through the finer materials.

REFERENCES CITED

California Department of Water Resources, California Data Exchange Center (CDEC), 2016; Hourly Mean Stream Discharge Data, "Cache Creek at Rumsey" gauge, Water Years 1994-2016.

Luhdorff and Scalmanini Consulting Engineers, 2016; Estimation of Average High Groundwater Levels, CEMEX Madison Plant, Yolo County. Technical Memorandum, November 30, 2016.

Western Regional Climate Center, 2016; Monthly Precipitation Data, "Davis 2 Experimental Farm" and "Woodland" gauges, Water Years 1950-2016.

Yolo County Water Resources Information Database (WRID), 2016; Semi-annual Groundwater Level Data and Summary Well Information.

Enclosures

Figure 1 Location Map

Figure 2 Mining Phases and Well Locations

Figure 3 Area (Davis) Historical Precipitation

Figure 4 Historical Stream Discharge, Cache Creek at Rumsey Bridge

Figure 5 Historical Groundwater Elevations, Phases III, IV, and VI

Figure 6 Difference Between Calculated Average Low and Observed Groundwater Levels

Figure 7 Contours of Equal Groundwater Elevation, Average Low Groundwater Conditions for Mining Phases III, IV, and VI

Figure 8 Contours of Equal Groundwater Elevation, Lowest Observed

Attachments

Area (Woodland) Historical Precipitation

Individual Groundwater Level Elevation Hydrographs

FIGURES

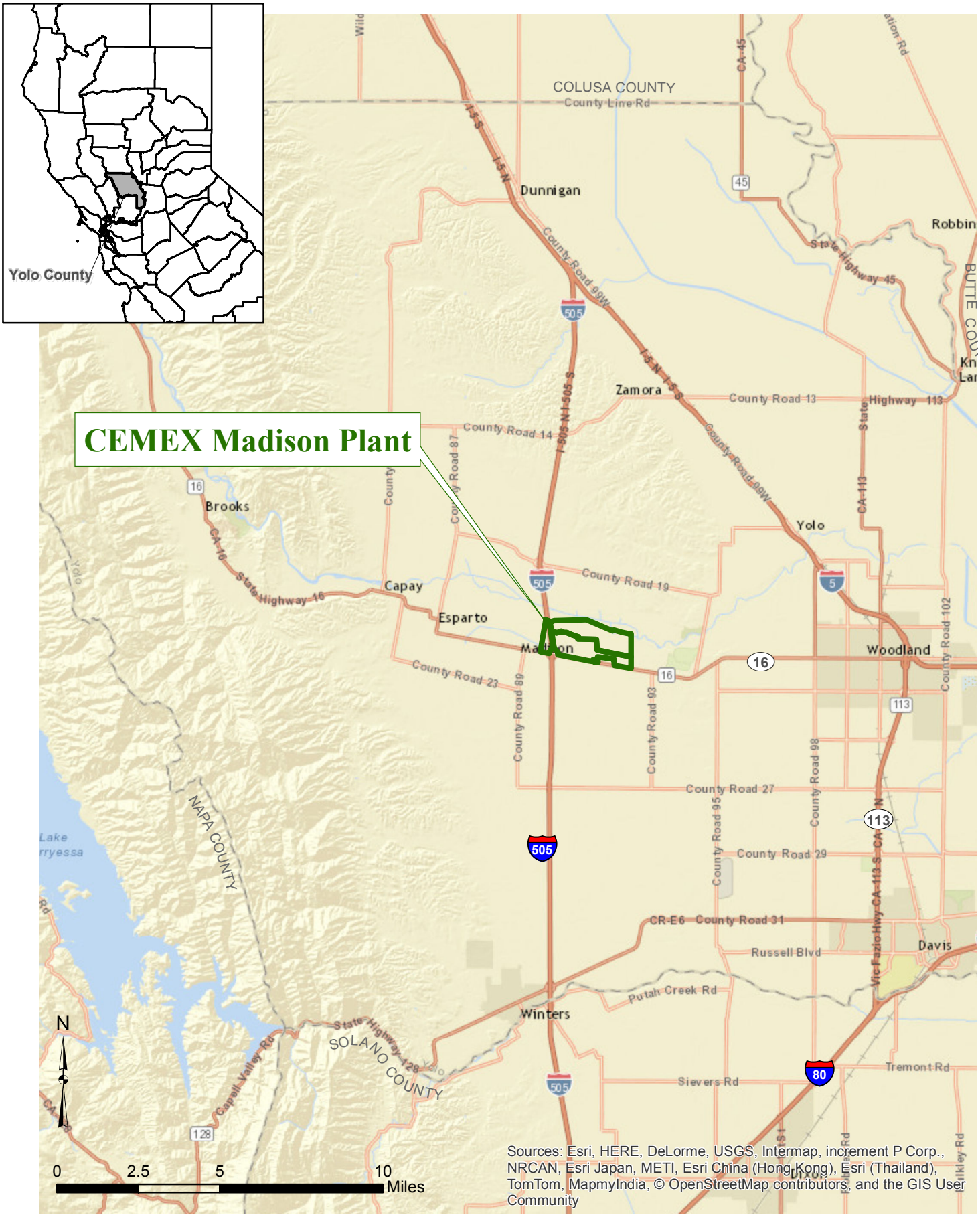


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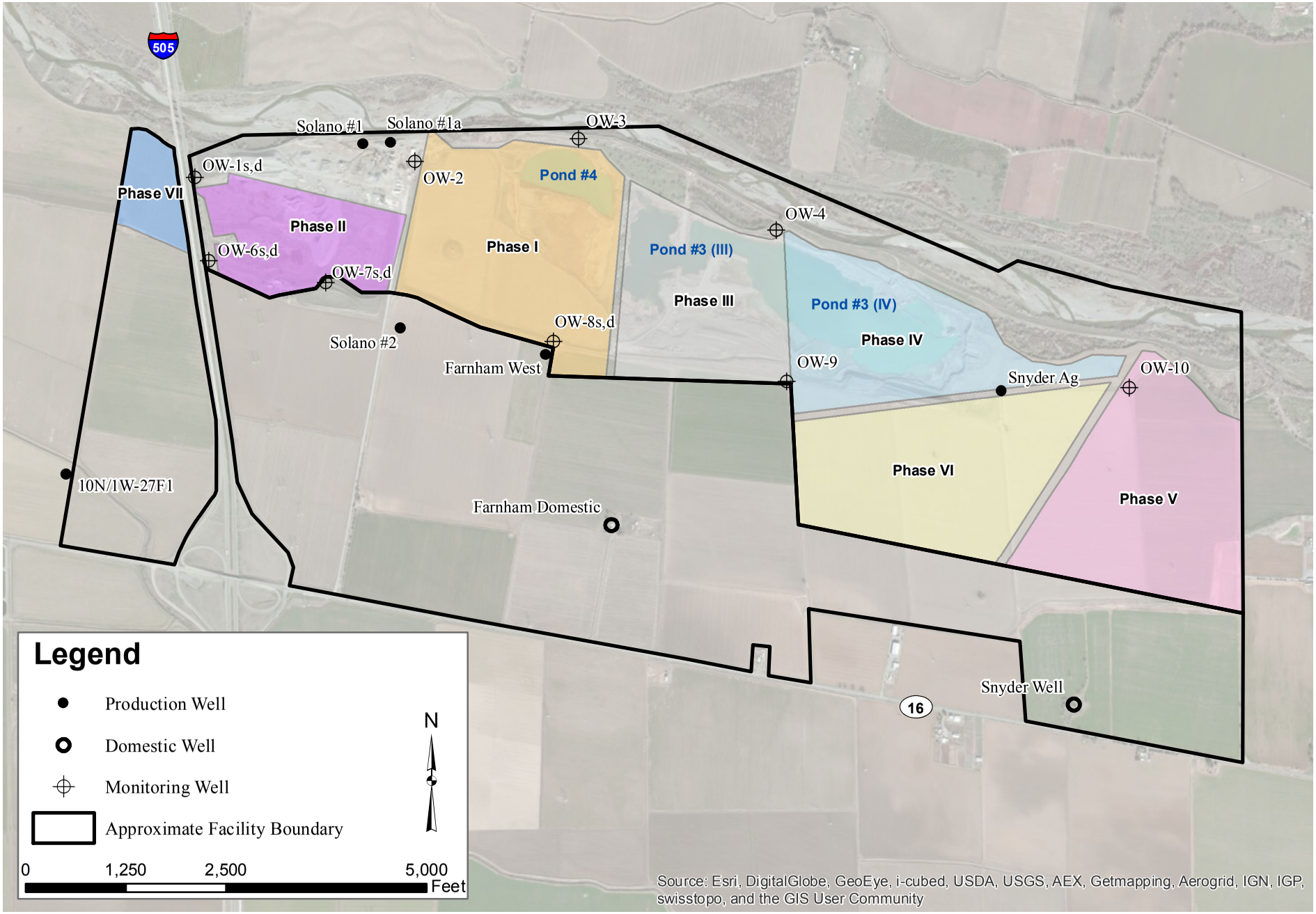
Figure 1
Location Map
CEMEX - Madison Plant



File: C:\Users\Dell\Desktop\GIS for Desktop\CEMEX\Figure 2 Mining Phases and Well Locations

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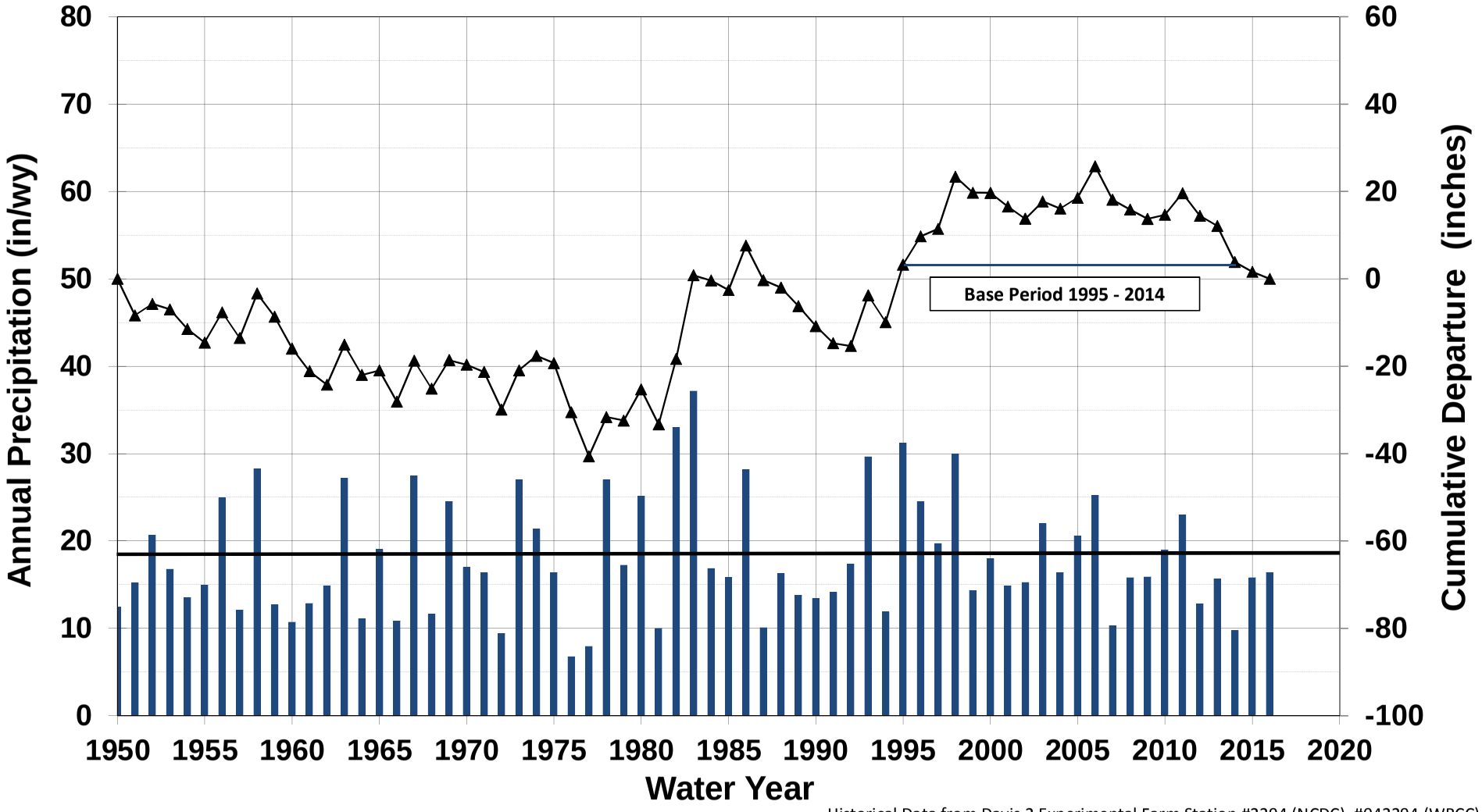
Figure 2
Mining Phases and Well Locations
CEMEX - Madison Plant Site



Historical Data from Davis 2 Experimental Farm Station #2294 (NCDC), #042294 (WRCC)

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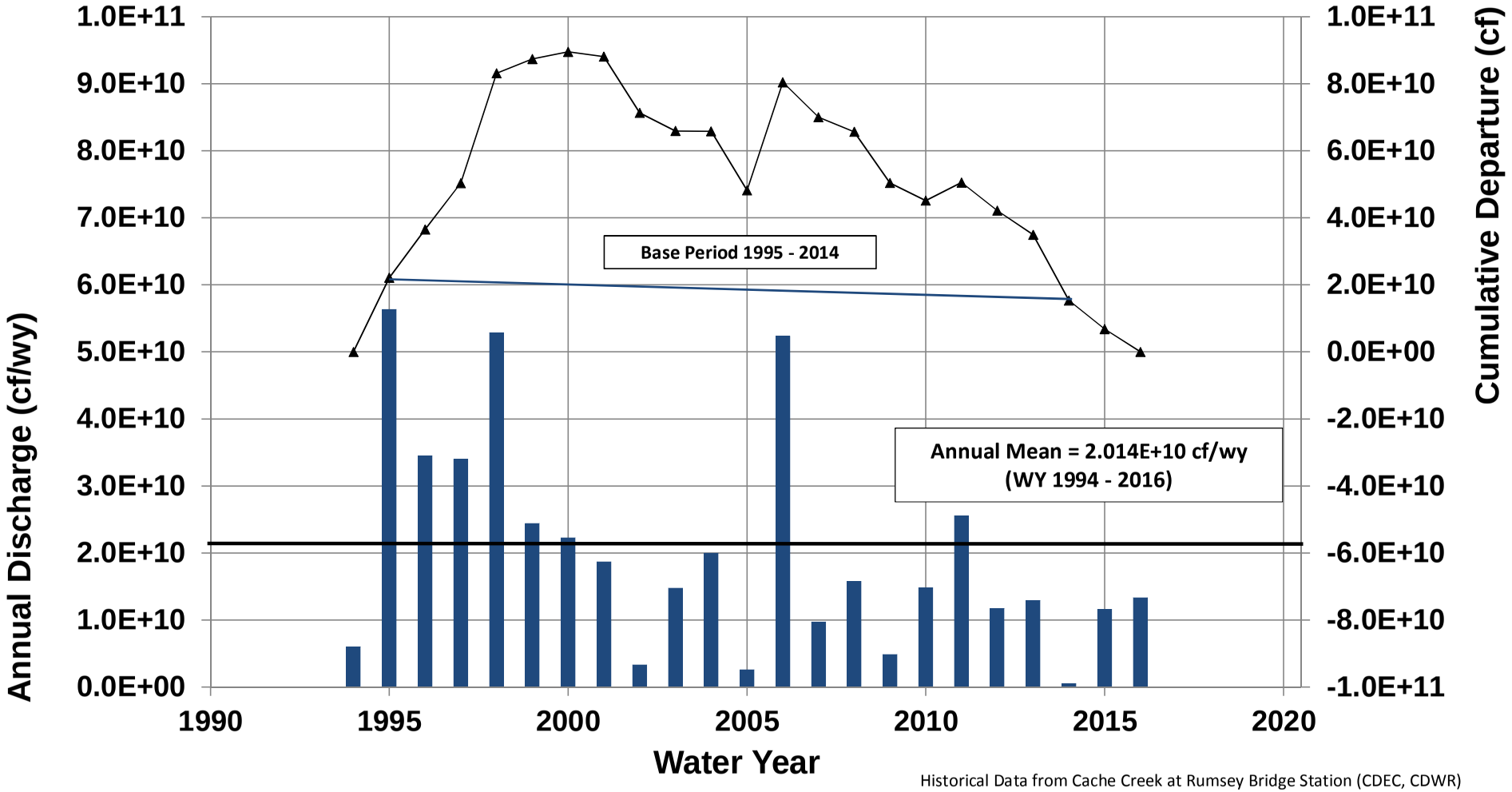
Figure 3
Area Historical Precipitation
CEMEX - Madison Plant Site



Historical Data from Cache Creek at Rumsey Bridge Station (CDEC, CDWR)

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Figure 4
Historical Stream Discharge, Cache Creek at Rumsey Bridge
CEMEX-Madison Plant Site

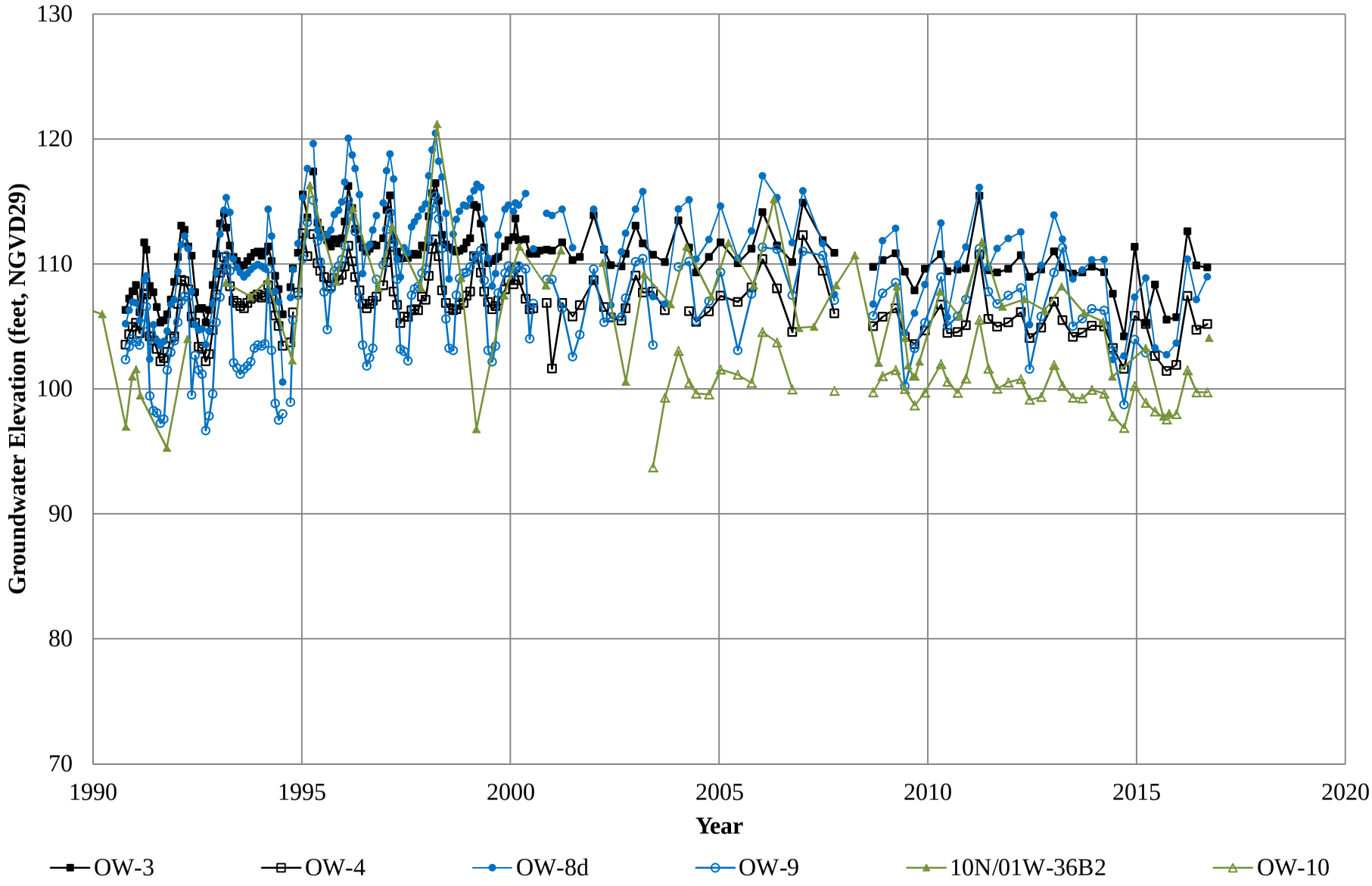

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Figure 5
Historical Groundwater Elevations, Phases III, IV, and VI
CEMEX - Madison Plant Site

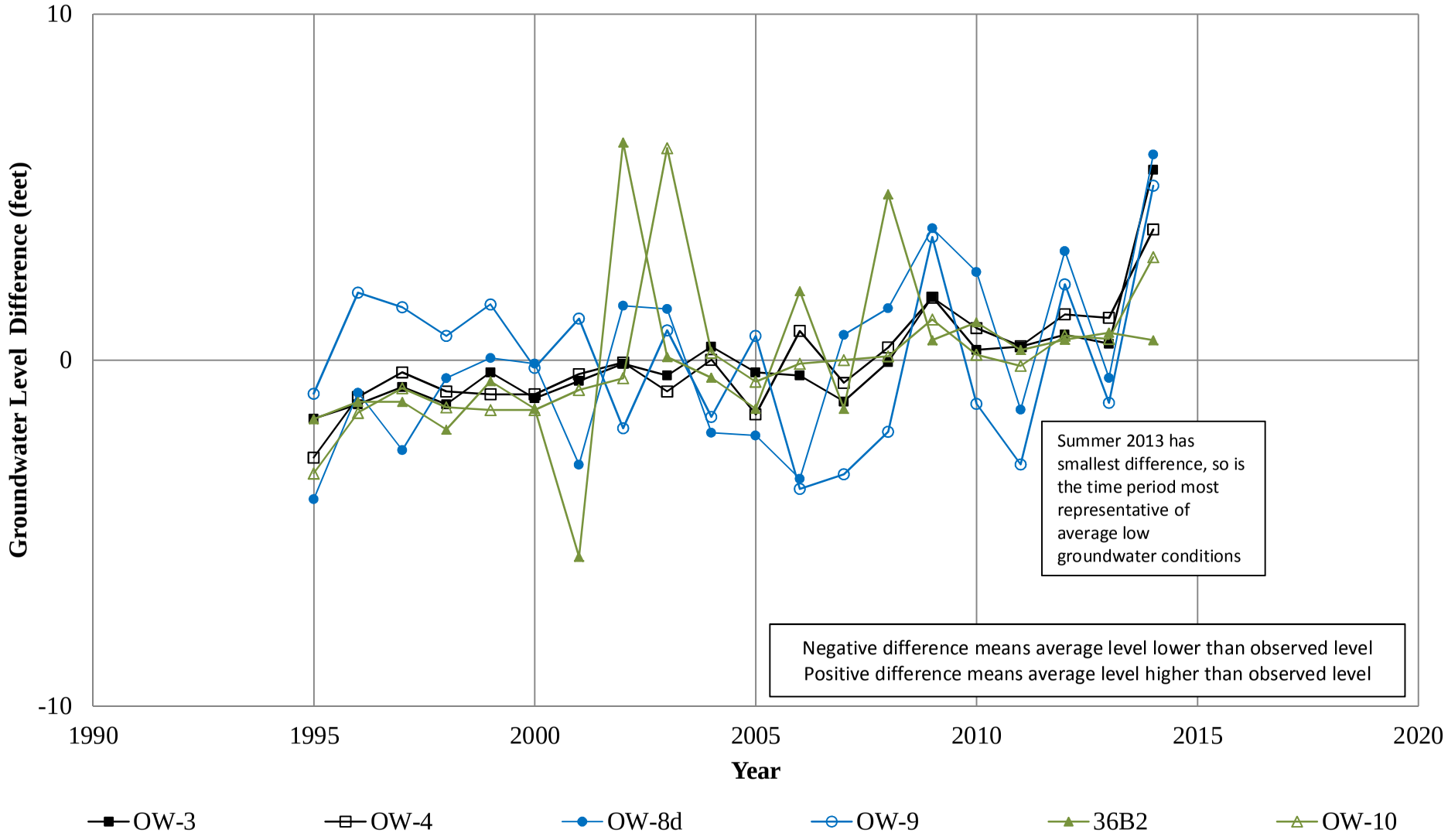

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Figure 6
Difference Between Calculated Average Low and Observed Groundwater Levels
CEMEX - Madison Plant Site

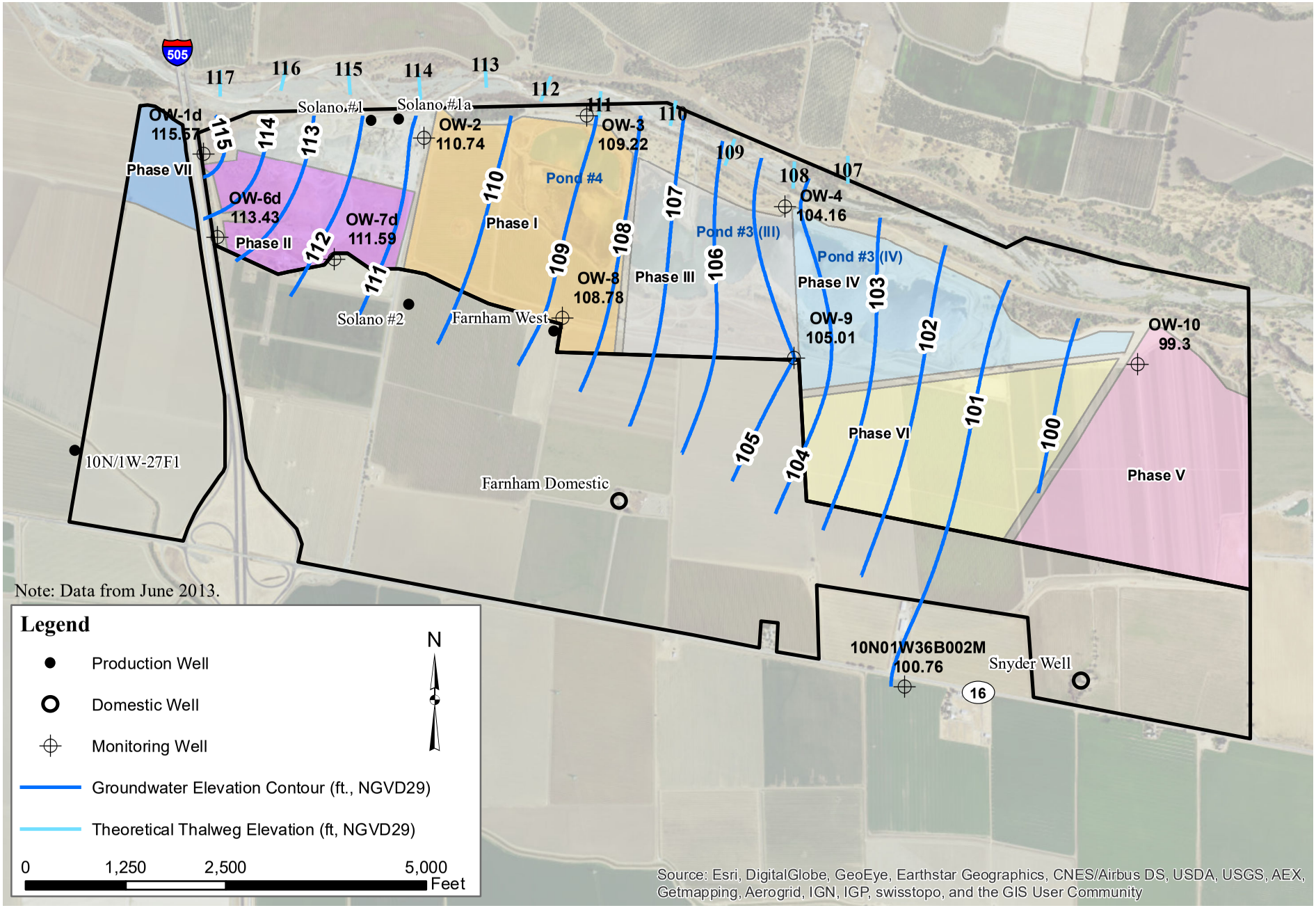

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Figure 7
Contours of Equal Groundwater Elevation,
Average Low Groundwater Conditions
CEMEX - Madison Plant Site

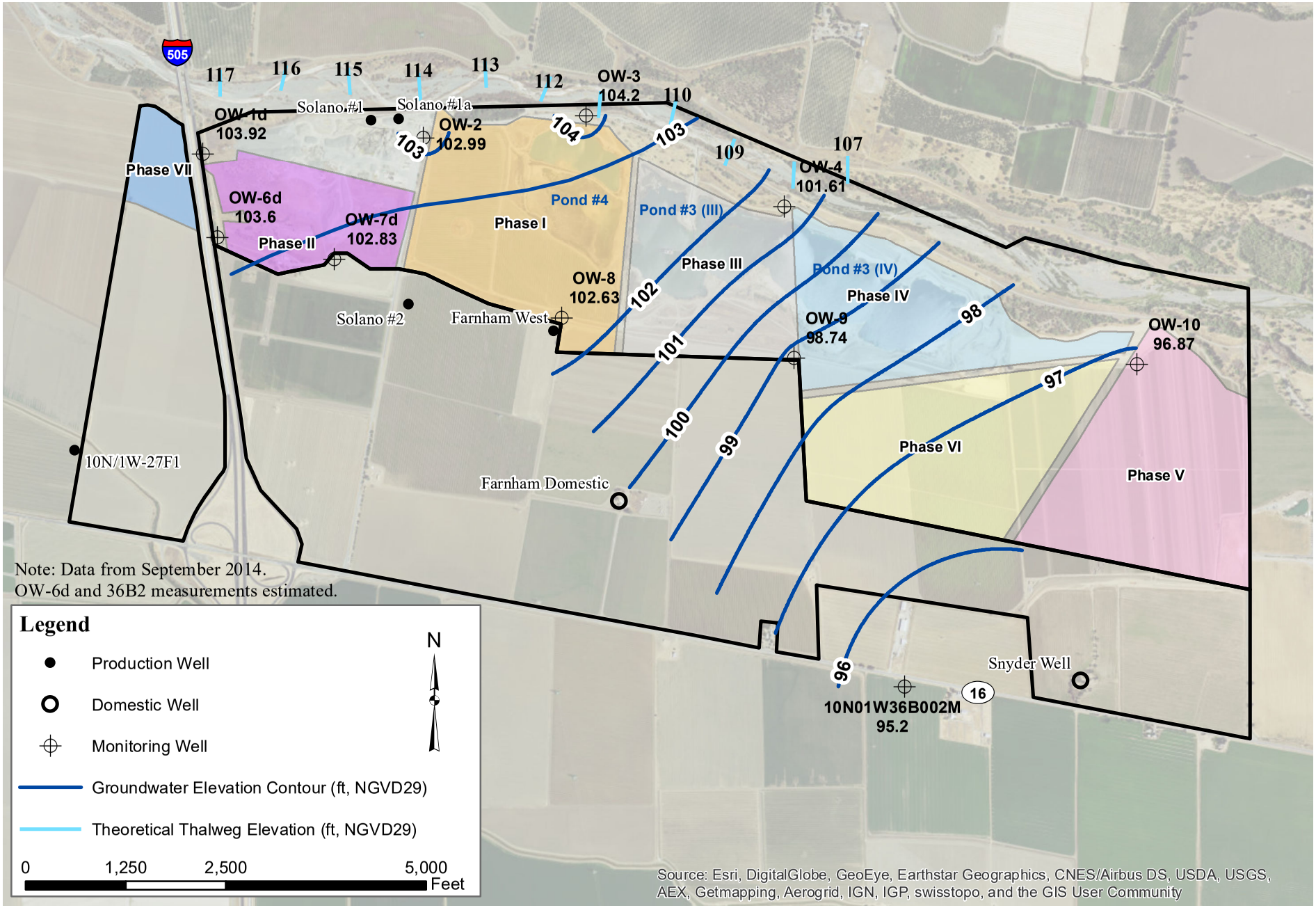

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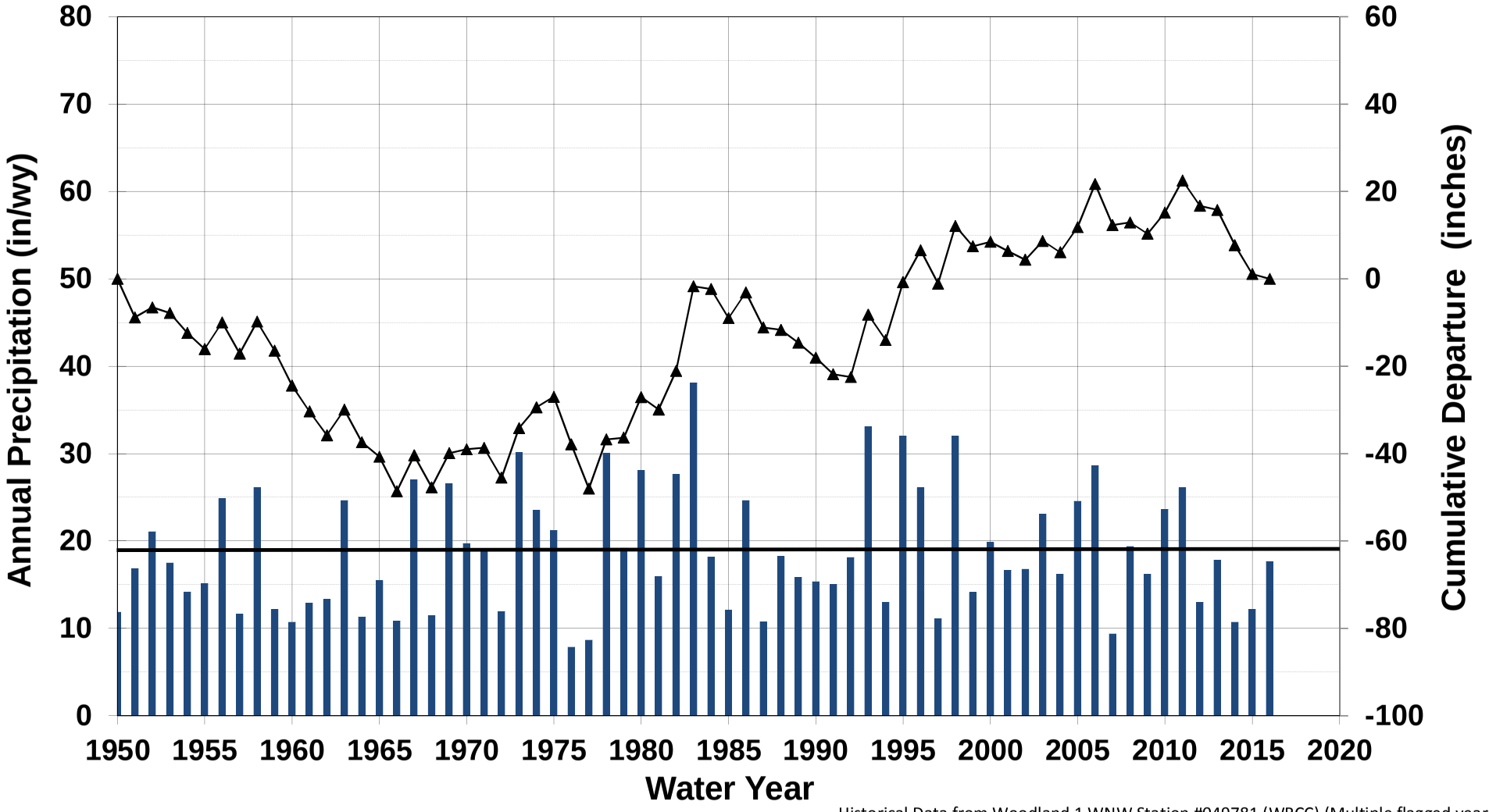
Figure 8
Contours of Equal Groundwater Elevation, Lowest Observed
CEMEX - Madison Plant Site

ATTACHMENTS



Historical Data from Woodland 1 WNW Station #049781 (WRCC) (Multiple flagged years)

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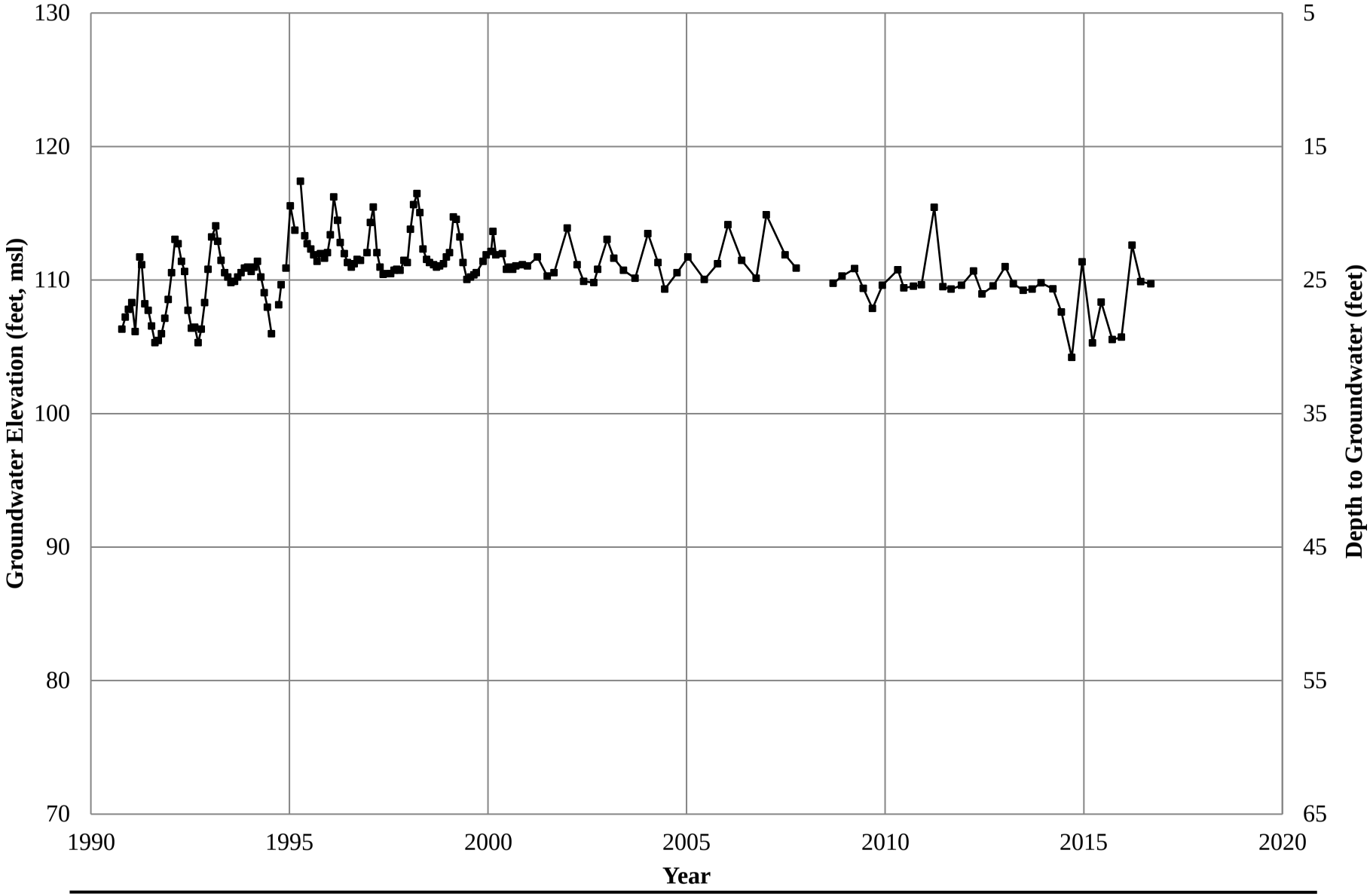
Area (Woodland) Historical Precipitation
CEMEX - Madison Plant Site



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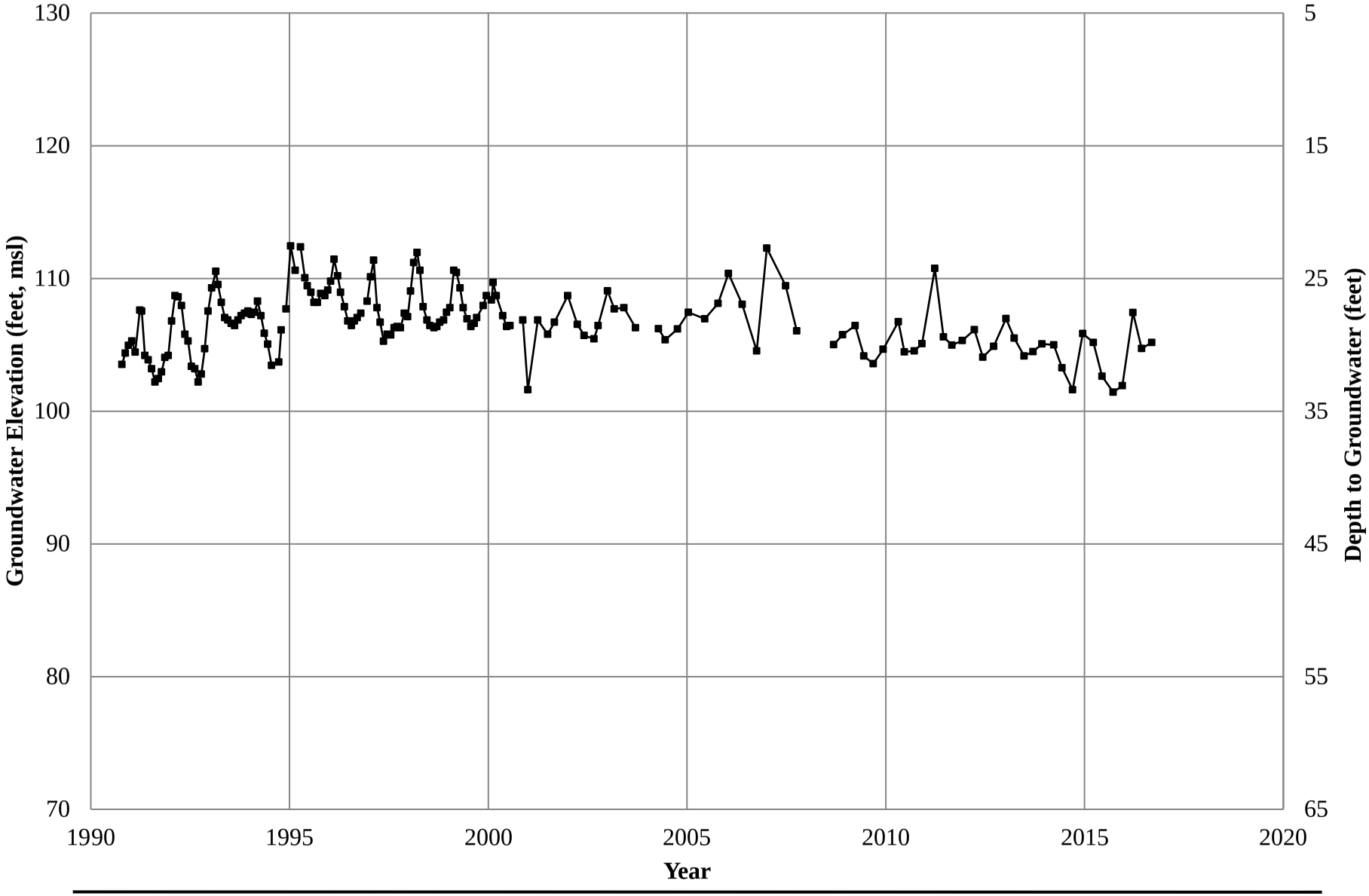
CEMEX - Madison, Yolo County, CA
Observation Well OW-3



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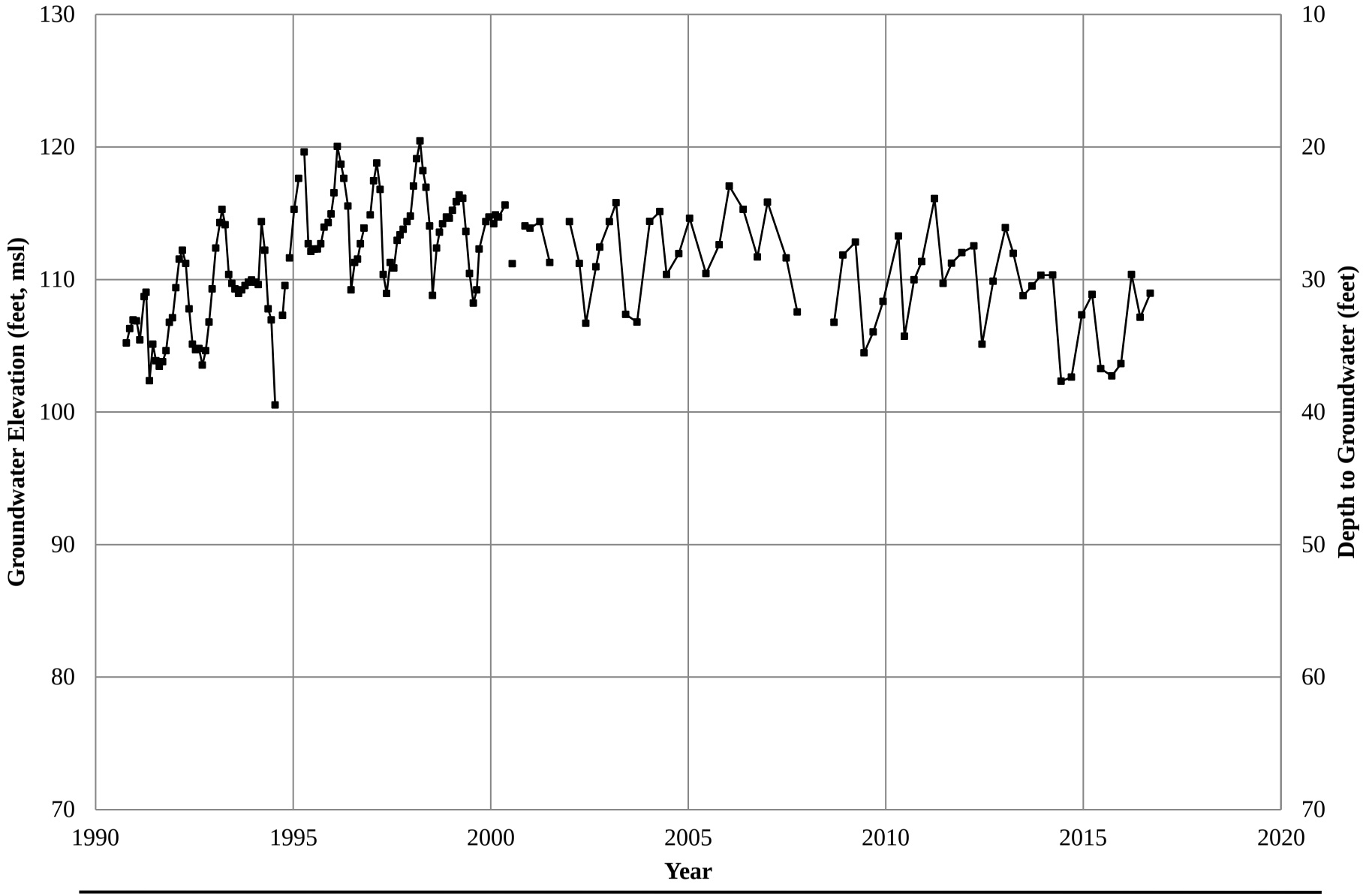
CEMEX - Madison, Yolo County, CA
Observation Well OW-4



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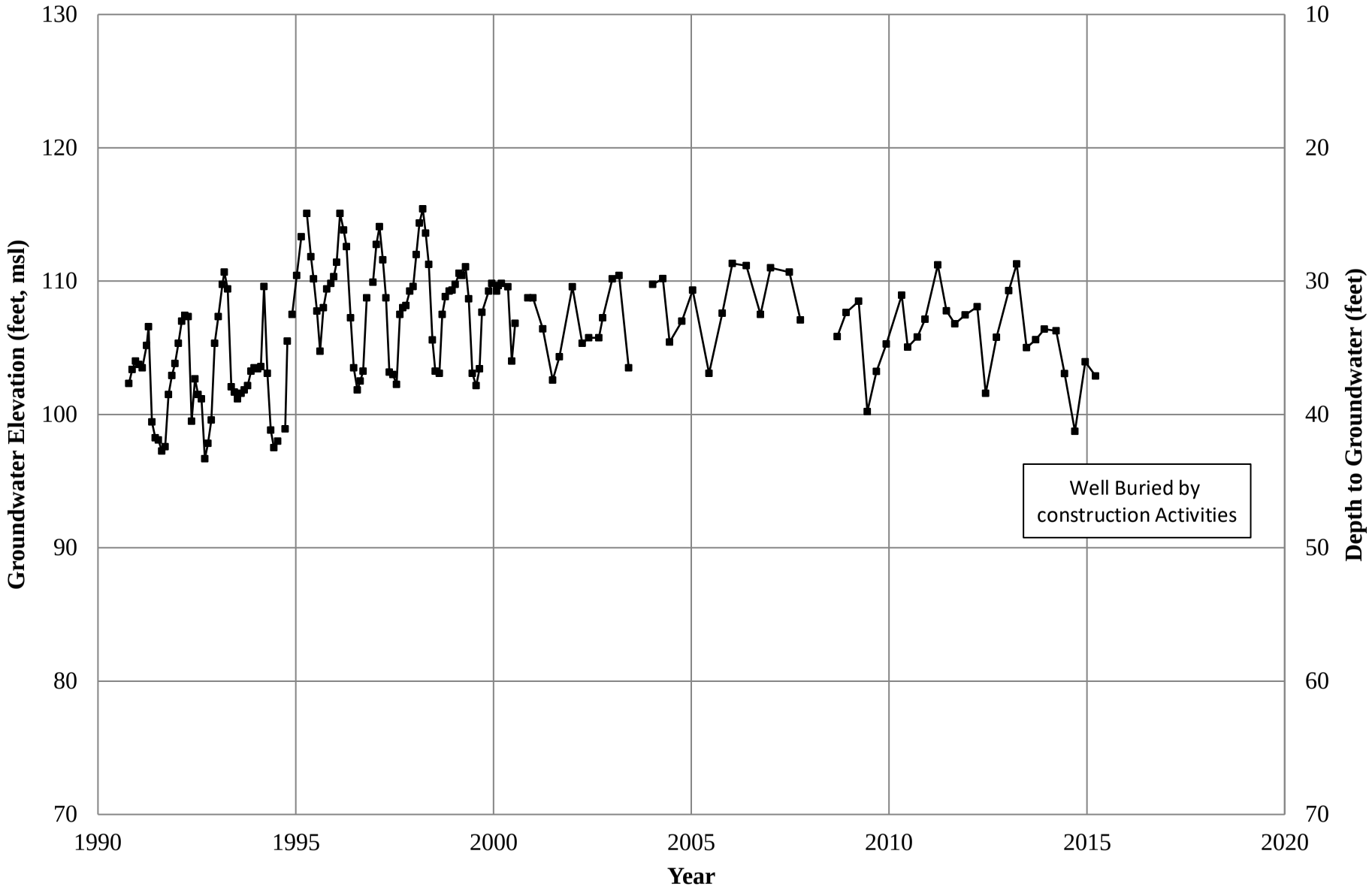
CEMEX - Madison, Yolo County, CA
Observation Well OW-8d



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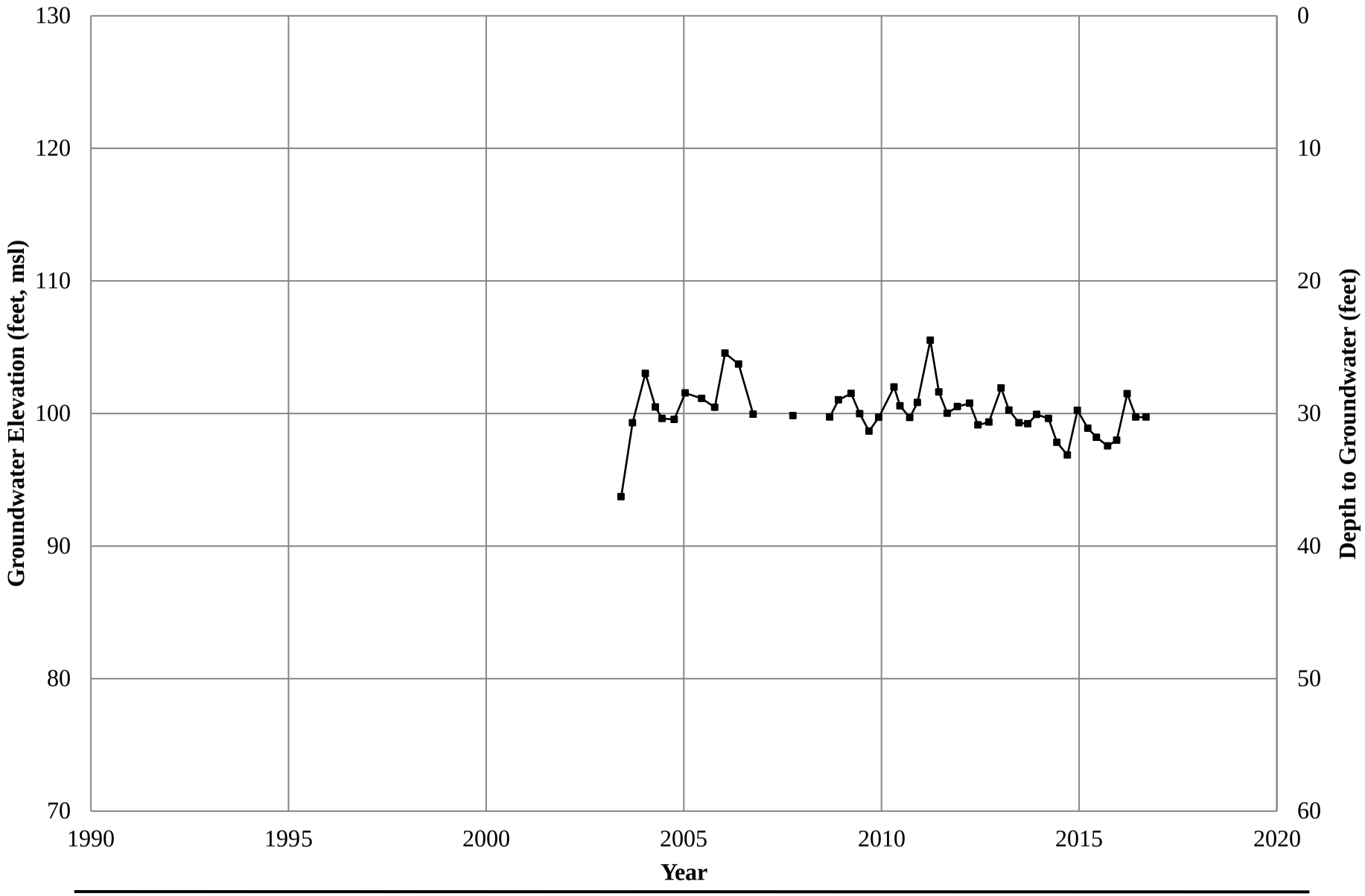
CEMEX - Madison, Yolo County, CA
Observation Well OW-9



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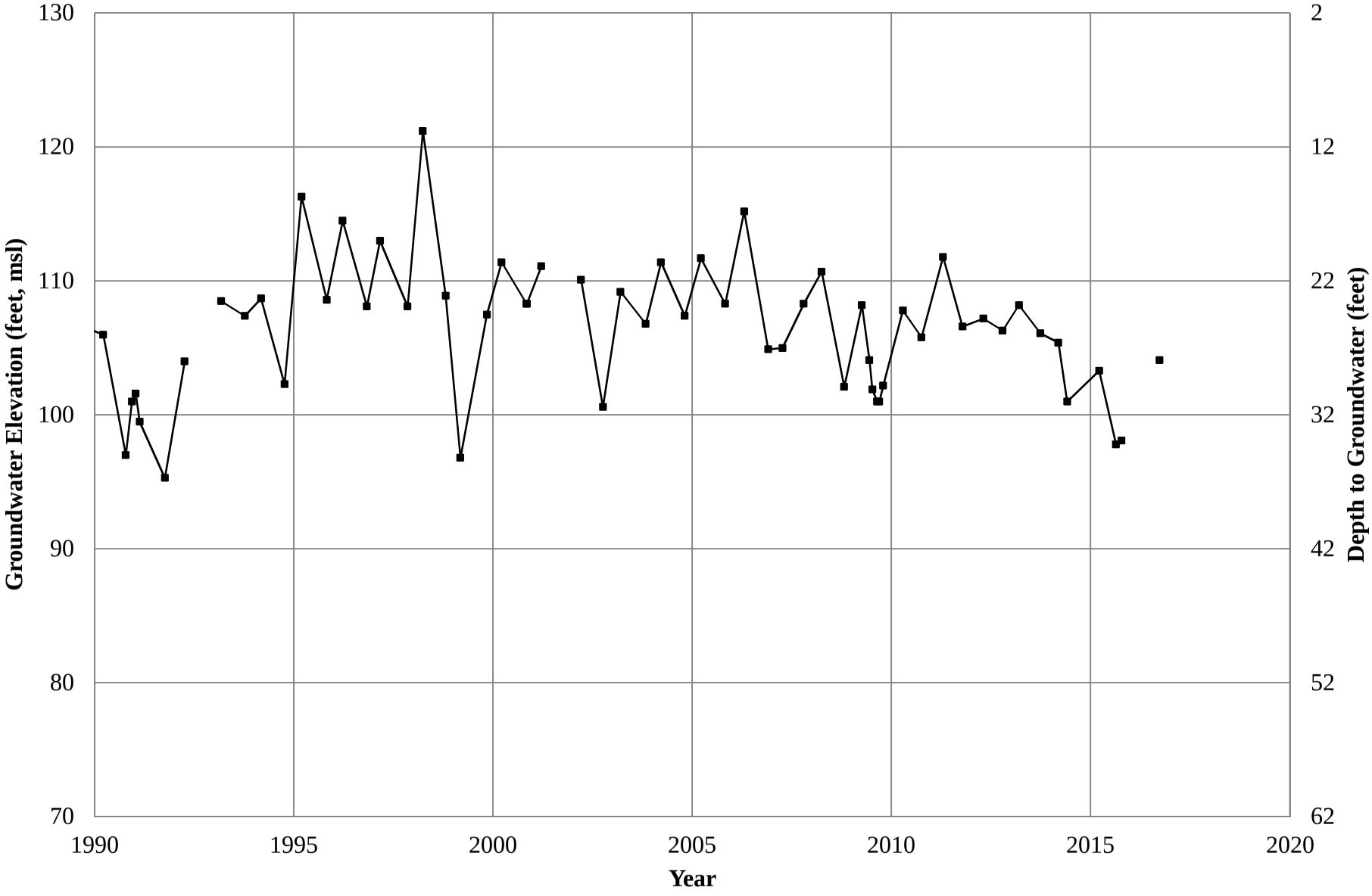
CEMEX - Madison, Yolo County, CA
Observation Well OW-10



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CEMEX - Madison, Yolo County, CA
Water Supply Well SWN 10N/01W-36B2