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Technical Memorandum

Prepared for: Monterey County Water Resources Agency

Project Title: Salinas River Groundwater Basin Investigation

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Technical Memorandum

Subject: Data Adequacy Assessment for Groundwater Modeling

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Section 1: Introduction

As part of the Salinas River Groundwater Basin Investigation, Brown and Caldwell (BC) was tasked with determining whether the data currently available within the Salinas River Groundwater Basin (the Basin) are adequate for the development of a numerical groundwater-surface water model. This Technical Memorandum (TM) presents the results of this analysis. This analysis is part of a larger investigation into the groundwater and surface water resources of the Basin that is discussed in a series of reports. As such, this TM will not provide an exhaustive description of the hydrogeologic background of the study area.

1.1 Scope and Purpose

The overall intent of the use of a three-dimensional (3D) groundwater model as part of a comprehensive 5-Year Study is to address Policy PS-3.1 c. objective 6. Specifically, the groundwater model will provide the basis for drawing conclusions regarding the total water demand designated in the General Plan for the year 2030 and the likelihood that "modeled demands" will exceed the 2030 projected demand. In addition, the study will discuss the likelihood of groundwater elevation fluctuations (e.g. declines) between now and the year 2030. Lastly, the model can address the likelihood of changes in the extent of seawater intrusion by the year 2030. To this end, a numerical model covering the entirety of Zone 2C is proposed with resolution appropriate for simulating conditions on both a regional (Basin-wide) and sub-regional scale (the subareas within Zone 2C) that can provide enough spatial and temporal granularity of simulated changes in groundwater storage and head elevations to address the balance of groundwater demand versus supply.

Under Task 3 of Project 2 in the BC scope of work is the development of a hydrogeologic conceptual model of Zone 2C. Task 6 in the BC scope of work is the construction and calibration of a groundwater-surface water model. This TM conducts a cursory assessment of available groundwater head elevation and streamflow data to determine their adequacy to: A) develop a hydrogeologic conceptual model [Task 3]; and B) construct and calibrate a numerical groundwater-surface water model [Task 6]. This analysis also compares the currently available groundwater head elevation and streamflow data collected in Zone 2C with other modeling investigations in California.

1.2 Previous Investigations

This TM discusses the adequacy of available data within the Basin for the construction of a numerical groundwater-surface water model. This discussion compares the available dataset to that recommended by Geomatrix (2001), and also to other existing model studies (sees Section 4). Additional information on the hydrogeology of the study area is available from numerous previous investigations that are discussed in other TMs and reports prepared for the Basin Investigation.

Section 2: Groundwater Head Elevations

This section outlines the types, locations, and quantity of groundwater head elevation data available in the study area that can contribute to a numerical groundwater-surface water interaction model. Typically, the most important result of a groundwater model is the calculated hydraulic head elevations that characterize groundwater flow in an aquifer system. The usefulness of a groundwater model depends on its ability to simulate hydraulic heads and their changes over times that match field measurements acceptably well. The process of modifying the parameters, initial conditions, and boundary conditions of a model to improve the match between simulated and measured groundwater head (or other variables such as streamflow) is called model calibration. Groundwater head elevation data are provided by a groundwater monitoring network.

Groundwater flows from higher head elevations to lower head elevations, either within an aquifer (due to the effect of a horizontally gradient) or between aquifers as inter-aquifer flow (due to the effect of a vertical gradient). Groundwater in the Salinas Valley generally flows from the southeast end of the Basin to the northwest towards the coast of the Monterey Bay, which is the lowest-elevation point of the Basin. North of about Chualar, groundwater flow is to the northeast, toward a groundwater head trough that has developed due to pumping in the East Side Subarea.

Groundwater head elevations are measured by MCWRA frequently at numerous wells throughout the study area. Figures 1 through 3 show the locations of 921 wells for which location information is available and in which groundwater head has been measured at some point since the beginning of Water Year 1967. Figure 1 shows the locations of wells screened in the shallower aquifers (Pressure 180-Foot, East Side Shallow, Forebay, and Upper Valley). Figure 2 shows the locations of wells screened in the deeper aquifers and those screened across multiple aquifers or for which the aquifer designation is not known (Pressure 400-Foot, Pressure Both, East Side Deep, East Side Both, and East Side). Figure 3 shows the locations of wells screened in the Pressure Deep Aquifer.

Table 1. Wells in the Current Monitoring Network and in the 2001 Recommended Network

Subarea	GW Zone	Lithology	current GWEL[1]	current WQ[2]	current Both	current Total	2001 GWEL[3]	2001 WQ[3]	2001 Both[3]	2001 Total
Pressure	180 Ft	131	41	90	68	**199**				
	400 Ft	269	58	80	104	**242**				
	Both	15	3	0	2	**5**				
	Deep	18	1	4	11	**16**				
	Unknown[4]	56	0	0	0	**0**				
East Side	Shallow	37	14	2	17	**33**				
	Deep	125	19	6	8	**33**				
	Both	85	36	1	34	**71**				
	Unknown	101	9	26	1	**36**				
Forebay	Shallow	222	43	65	65	**173**				
Upper Valley	Shallow	226	24	67	22	**113**				
Total Shallow Wells (Figure 1)		**616**	**122**	**224**	**172**	**518**	84	57	281	422
Total Deep Wells (Figure 2)		**394**	**77**	**86**	**112**	**275**	20	31	146	197
Total "Both" Wells (Figure 2)		**100**	**39**	**1**	**36**	**76**	15	12	49	76
Total "Unknown" Wells (Figure 2)		**157**	**9**	**26**	**1**	**36**	--	--	--	--
Total Pressure Deep Wells, (Figure 3)		**18**	**1**	**4**	**11**	**16**	1	2	23	26
Total Wells		**1,285**	**248**	**341**	**332**	**921**	**120**	**102**	**499**	**721**

Note: 1 GWEL = Groundwater head elevation; wells with head measurements only
2 WQ = Water quality; wells with water quality measurements only
3 From "2001 recommended Monitoring Network", Geomatrix, 2001
4 Wells classified as "Unknown" do not have an aquifer specified. These are classified as either "Pressure" or "East Side" in the database.

Table 1 lists the number of wells (by subarea and aquifer) that both have available location information and have had head measurements collected. Head measurements are available at these wells as early as 1944, but the numerical model will not begin that early. Table 1 also lists the number of monitoring wells in the recommended monitoring network as documented in the “Final Report – Evaluation and Proposed Redesign of the Salinas Valley Ground Water Monitoring Network” (Geomatrix, 2001). The separation distance of wells in the current monitoring network is on average about half a mile to two miles (Figures 1 through 3). A similar range of well separations was recommended by Geomatrix (2001).

Section 3: Streamflow

The primary source of groundwater in the Basin is the percolation into the subsurface of precipitation runoff along streams. Streamflow data will be used to calibrate the surface water component of the groundwater-surface water model. Streamflow data in the Basin are available from the USGS, which operates numerous gauges located within Zone 2C and in the surrounding highlands. Figure 4 shows the locations of stream gauges within the watershed of the Salinas River and its tributaries. In total, 36 stream gauges have been active within the area, with 11 being currently active. The gauges have been active anywhere from 2 to 113 water years, averaging about 31 water years per gauge.

Section 4: Comparison to Other Modeling Studies

Data used in other existing numerical modeling studies were examined to demonstrate the adequacy of the existing data for this proposed model investigation.

4.1 Case Study 1: Antelope Valley Groundwater Flow Model

A numerical model was constructed to simulate groundwater flow and land subsidence in the Antelope Valley Groundwater Basin of southern California (Leighton and Phillips, 2003). The active model cells covered a land area of 921 square miles, discretized into 921 grid cells, each a square mile in area. The model consisted of 81 one-year stress periods, running from 1915 to 1995.

The Antelope Valley model was calibrated using 24 head measurement points at 20 different locations (two locations had nested piezometers, each screened at three different elevations within the aquifer). These 24 head measurement points had a total of about 1,890 measurements over the 81-year duration of the model, an average of about 80 measurements per location.

Because the model is regional in scope, its goal was to simulate groundwater head trends and groundwater movement on a regional scale, and did not seek to match highly localized conditions. Therefore, the sparse amount of calibration data was considered acceptable for this model.

4.2 Case Study 2: Santa Rosa Plain GSFLOW Model

A numerical model was constructed to simulate groundwater flow and groundwater-surface water interaction in the Santa Rosa Plain watershed in northern California (Woolfenden and Nishikawa, 2014). This model covered an active area of about 262 square miles discretized into 16,741 grid cells; hence, each cell was about 10 acres in area. The model consisted of 432 monthly stress periods, covering Water Years 1975 to 2010.

This model was calibrated using both groundwater head and streamflow data. The model included 83 head measurement locations with 6,361 measurements, an average of about 80 per well. These head locations were used to calibrate the groundwater flow model. In addition, 12 stream gauge locations were used to calibrate the surface water model.

4.3 Case Study 3: Salinas Valley IGSM

A numerical model was constructed to simulate groundwater flow and groundwater-surface water interaction in the Salinas Valley, the Salinas Valley Integrated Groundwater-Surface Water Model (SVIGSM; MW, 1997). The model covered an active area of about 538 square miles (including parts of the aquifers beneath Monterey Bay) discretized into 1,615 grid cells, each about a third of a square mile in area (although the grid cell size is variable). The model consisted of 300 monthly stress period covering Water Years 1970 to 1994. The SVIGSM was calibrated using 73 calibration wells with 18,177 head measurements, an average of about 250 per well. In addition, 5 stream gauge locations were included.

Section 5: Summary and Recommendations

The current MCWRA monitoring network for groundwater head elevations and the USGS network of stream-flow gauges provide a robust dataset for characterization of groundwater and surface water at a regional (Basin-wide) and sub-regional (subarea) scale, as demonstrated by a comparison between the amount and density of data available within the study area and in the study areas considered for other modeling studies. The data collected historically and currently are sufficient to support the construction and calibration of a numerical groundwater model that encompasses the Zone 2C study area, with an aggregate average of about one and a half wells that could provide data per square mile (Table 2). The spatial density of wells (as depicted in Figures 1 to 3) is considered adequate, with the distance between monitoring network wells being about half a mile to two miles. This range of separation is the same as that recommended by Geomatrix (2001). The difference between the current monitoring network and the 2001 recommended network is that there are many more wells in the former (921) as compared to the latter (721). Streamflow data collected at 36 total and 11 active USGS gauging stations are also adequate to calibrate the surface water component of the model.

Table 2. Statistical Summary of Groundwater Head Elevation Data for Four Groundwater Modeling Investigations

Investigation	Model Area (mi^2)	Wells in Calibration	Wells per mi^2
Salinas River Groundwater Basin Investigation 2014	~600	921[1]	1.5
Antelope Valley Groundwater Flow Model	921	24	.02
Santa Rosa Plain GSFLOW Model	262	83	.30
Salinas Valley IGSM	538	73	.14

Note: 1 Not all 921 wells will be used for calibration.

This assessment of data adequacy is preliminary. Another assessment will be conducted on the adequacy of data available in specific localized areas on which the planned numerical model needs to focus. Further assessments of the 921 wells will determine subsets of these wells that have the appropriate time series data that can be used by the model to represent basin-wide and sub-regional groundwater conditions.

References

Geomatrix, *Evaluation and Proposed Redesign of the Salinas Valley Ground Water Monitoring Network, Salinas, California*, prepared for Monterey County Water Resources Agency by Geomatrix Consultants, Inc., September 2001.

Leighton, D.A. and S.P. Phillilps, *Sumulation of Ground-Water Flow and Land Subsidence in the Antelope Valley Ground-Water Basin, California*, U.S. Geological Survey Water-Resources Investigations Report 03-4016, 2003, 118p.

MW, *Salinas Valley Integrated Ground Water and Surface Model Update*, prepared for Monterey County Water Resources Agency by Montgomery Watson, May 1997, 189p.

Woolfenden, L.R. and T. Nishikawa, eds., *Simulation of Groundwater and Surface-Water Resources of the Santa Rosa Plain Watershed, Sonoma County, California*, U.S. Geological Survey Scientific Investigations Report 2014-5052, 2014, 292p.

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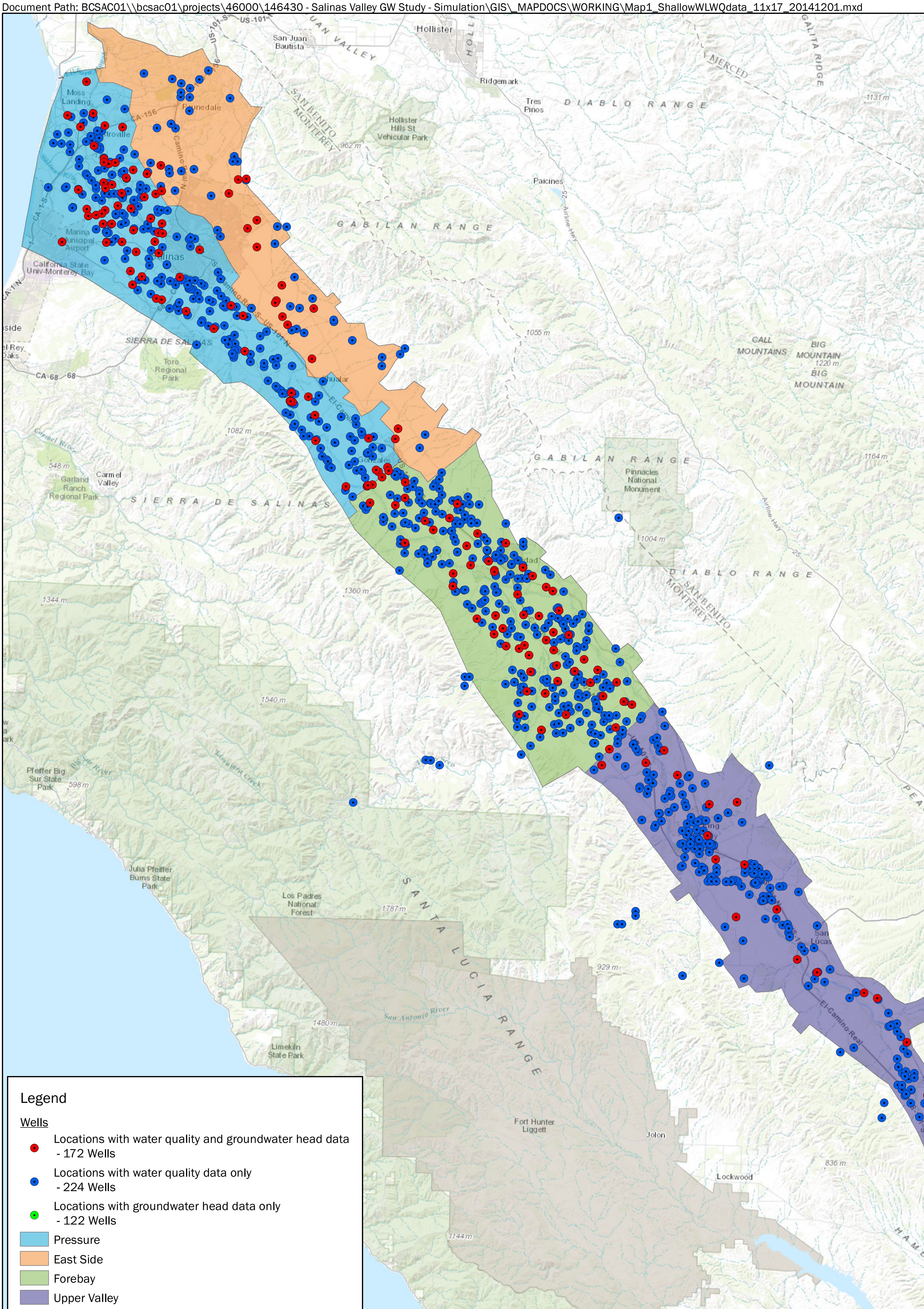

SITE

Salinas River Groundwater Basin Investigation

TITLE

Shallow Wells with Groundwater Head & Water Quality Data

Brown AND Caldwell

DATE 12/01/14

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FIGURE 1

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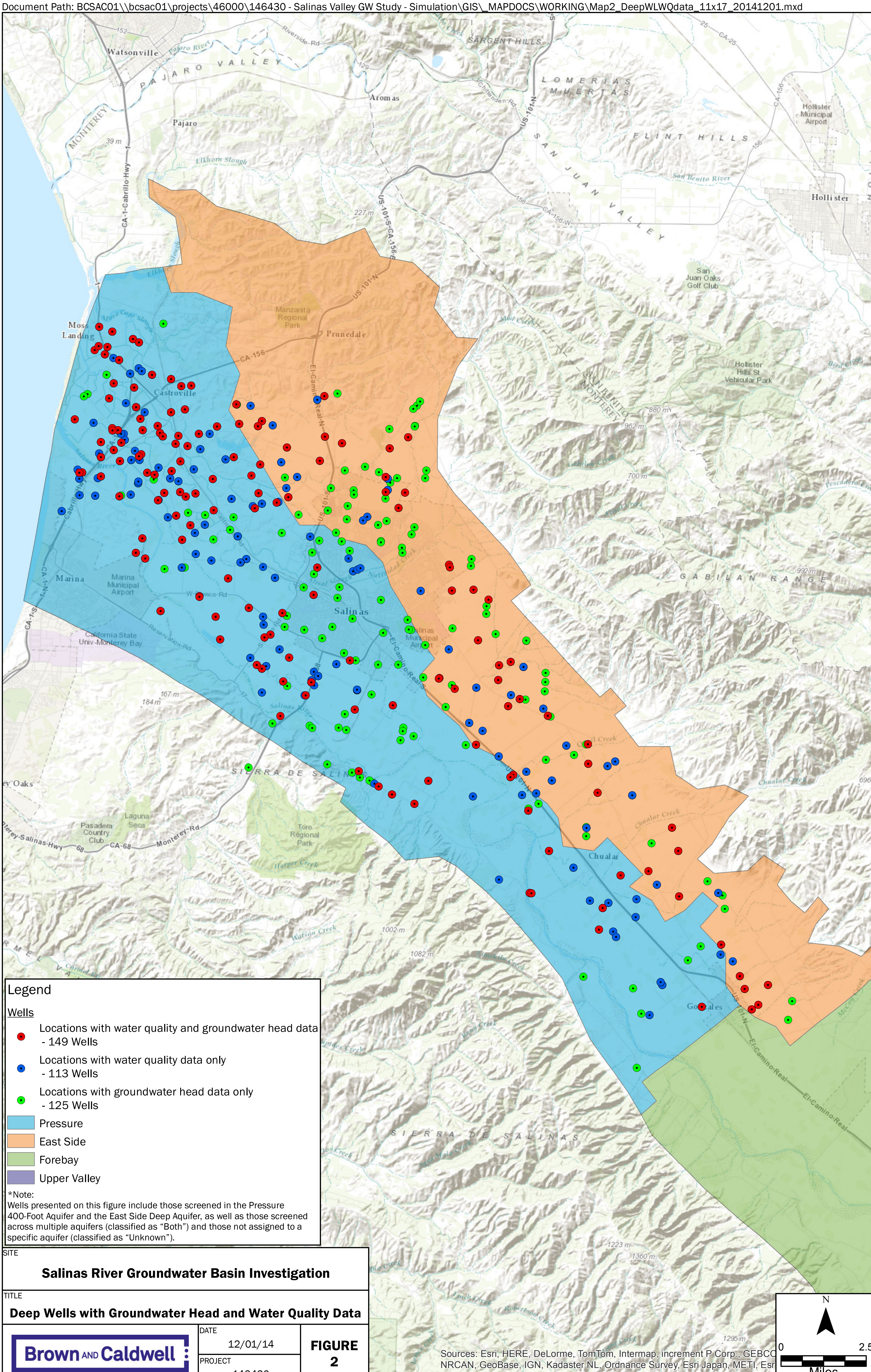

SITE

Salinas River Groundwater Basin Investigation

TITLE

Deep Wells with Groundwater Head and Water Quality Data

Brown AND Caldwell

DATE 12/01/14

PROJECT 146430

FIGURE 2

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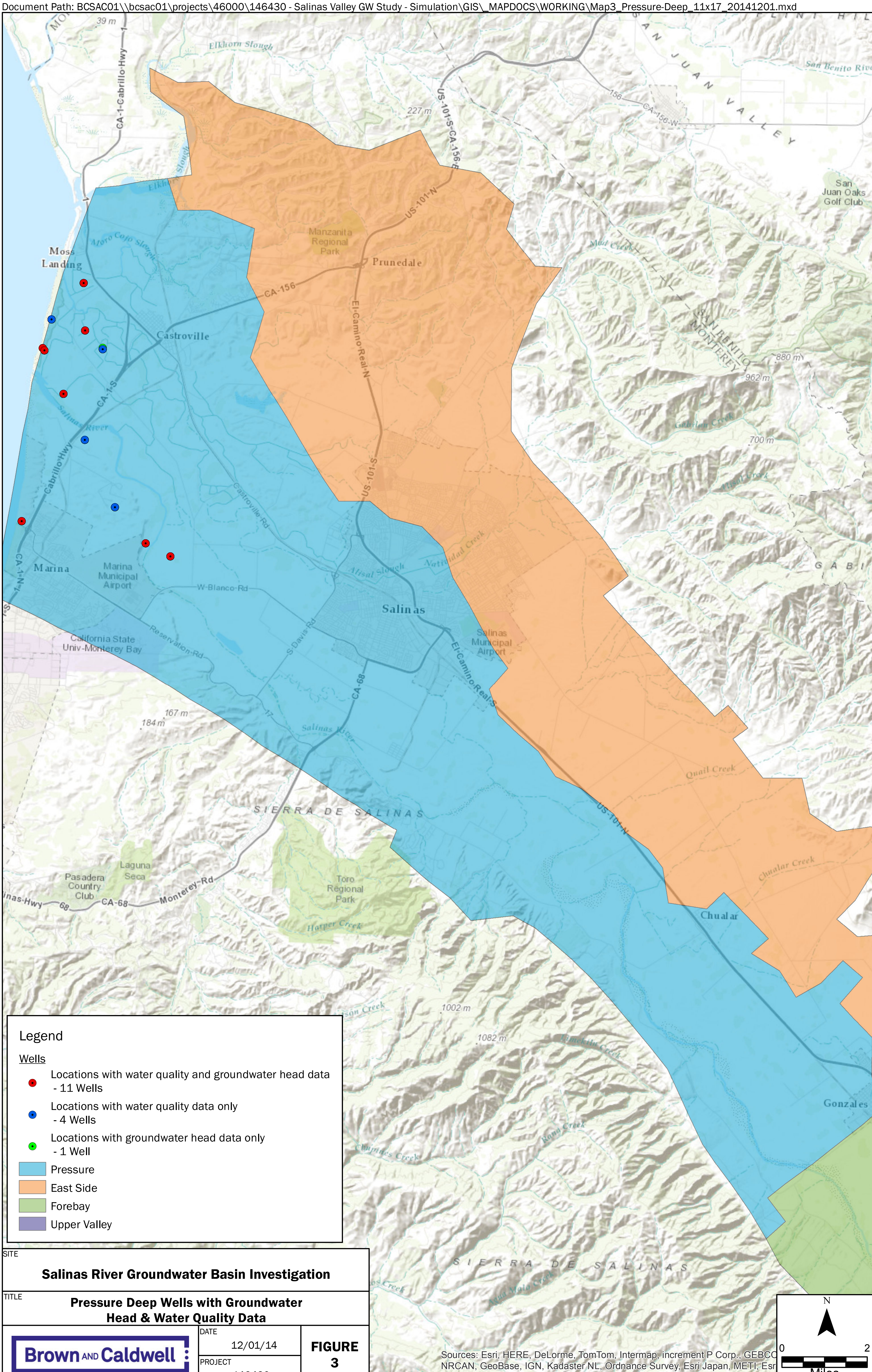

Legend

Wells

- Locations with water quality and groundwater head data - 11 Wells
- Locations with water quality data only - 4 Wells
- Locations with groundwater head data only - 1 Well

Pressure

East Side

Forebay

Upper Valley

SITE

Salinas River Groundwater Basin Investigation

TITLE

Pressure Deep Wells with Groundwater Head & Water Quality Data

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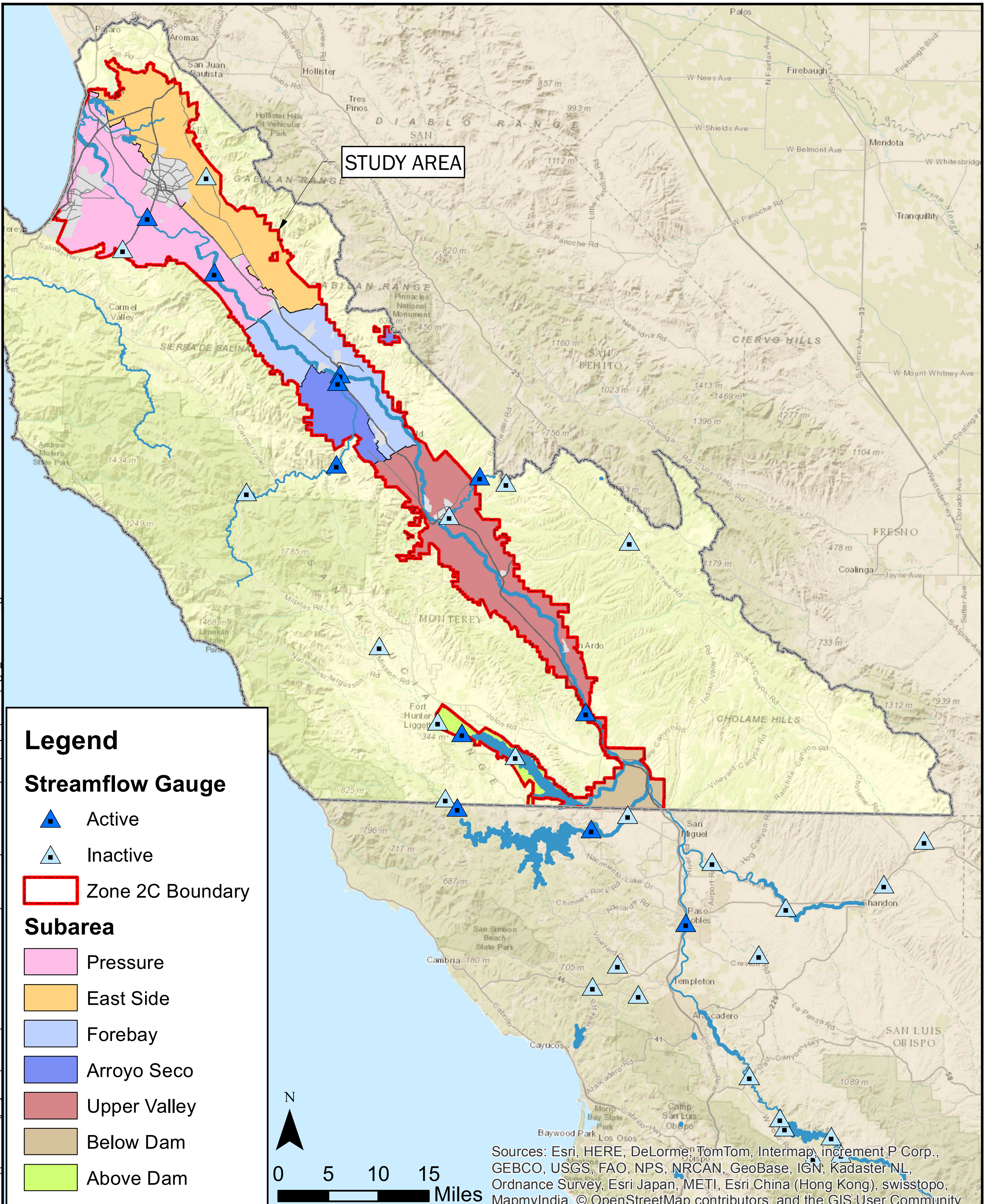

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Salinas River Groundwater Basin Investigation

TITLE

Locations of USGS Streamflow Gauges

Figure 4

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