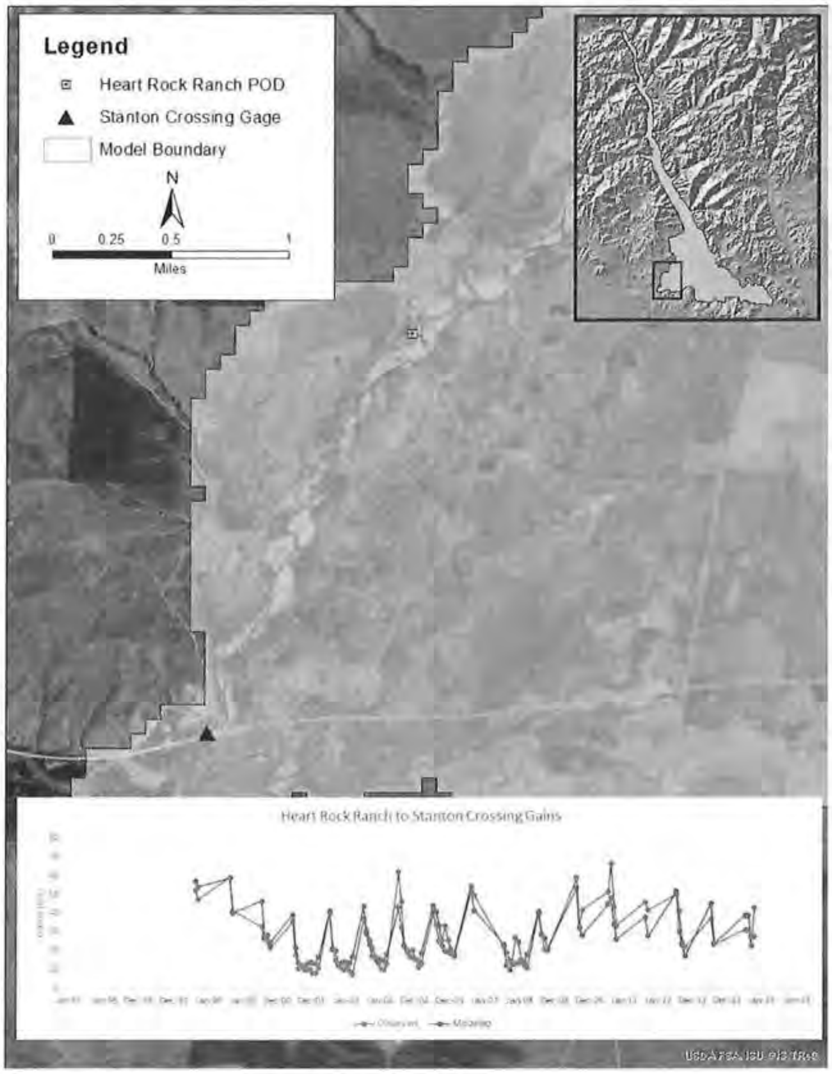
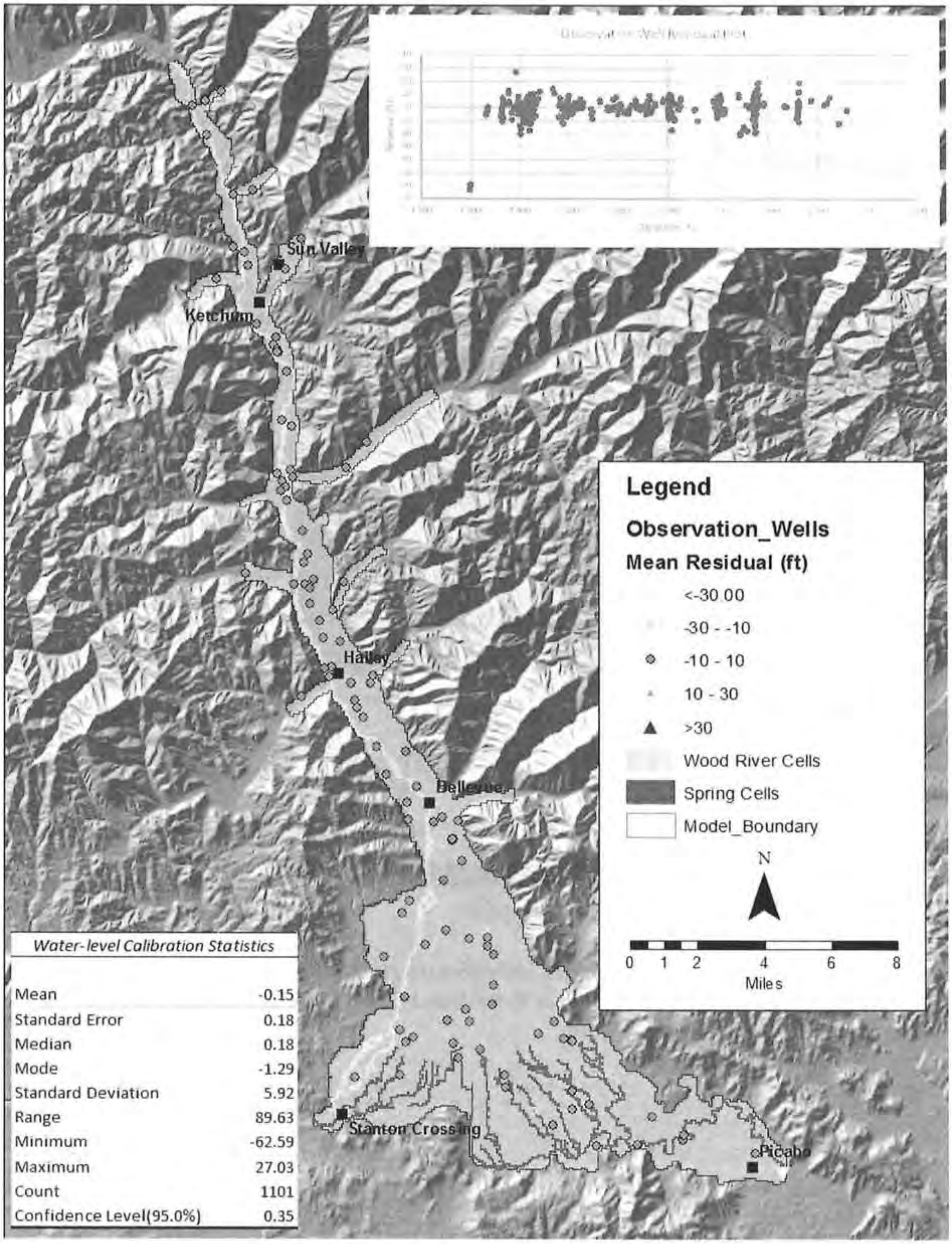


Figure 16. Heart Rock Ranch to Stanton Crossing gains.

Aquifer head in observation wells

One thousand one hundred one water levels collected in the 129 wells shown in Figure 17 were used as calibration data. The wells were surveyed using a real-time kinematic and fast-static differential global positioning surveying system capable of sub-foot elevation accuracy. Water levels were collected using an electric measuring tape, a steel tape, a pressure gage, or a pressure transducer. The resulting water-level elevations are considered accurate to ±1.0 ft.

This carefully documented water-level dataset provides excellent calibration data. The water level calibration statistics are presented in the table in Figure 17. The mean difference between modeled and observed water levels is -0.15 feet, the median difference is 0.18 feet, and the standard deviation is 5.92 feet. The 95% confidence interval for the mean is ± 0.35 feet; thus the confidence interval extends from +0.20 to -0.50 and includes zero. Therefore the possibility that the mean residual is zero cannot be excluded.



Water-level Calibration Statistics	
Mean	-0.15
Standard Error	0.18
Median	0.18
Mode	-1.29
Standard Deviation	5.92
Range	89.63
Minimum	-62.59
Maximum	27.03
Count	1101
Confidence Level(95.0%)	0.35

Figure 17. Residual plot and calibration statistics for observation well data.

The residual-plot in Figure 17 is a graph of the difference between observed and modeled water levels plotted with the observed elevation on the X axis. Assuming a perfect match between measured and modeled water levels, the blue circles representing individual water level observations would all fall on the zero line. There are two significant deviations from the zero line, one at the elevation of 4,700 feet, which correlates to the yellow downward-pointing triangle east of Picabo in Figure 17. There are four observations in this well and the model is unable match them and match the observations in the well just north of Picabo with 19 observations. The other deviation shown in the residual-plot in Figure 17 is near the elevation of 4,900 feet. It corresponds to the purple upward pointing triangle near Stanton Crossing. The well is modeled as being completed in the unconfined aquifer and perhaps, in reality, it was completed in the confined aquifer.

Figure 18a through 18c show hydrographs of modeled water levels with observed water levels for three wells. Hydrographs showing the modeled match with field observations for all wells with more than four field measurements are included in Appendix A.

Geolocated well driller water-levels

The Geolocated wells were all measured by a well driller after completing a well. The well locations were determined by either a hand-held GPS measurement provided by the driller, or an address for the lot on which the well was drilled (Figure 19). The land-surface elevation was determined from a digital elevation model. The method for obtaining the water level is unknown. The assumed accuracy for the Geolocated wells is ±7.0 ft. These water-levels were not collected with the documented accuracy of the Observation wells and none of the wells have repeated measurements. However, this dataset is useful because, as Figure 20 shows, it provides measurements during a time when the Observation well dataset is sparse. The mean difference between modeled and measured values is -4.00 feet, the median is -0.74 feet, and the standard deviation is 29.02 ft. The 95% confidence interval for the mean is ±3.92 feet; thus the 95% confidence interval extends from -0.08 to -7.92 ft.

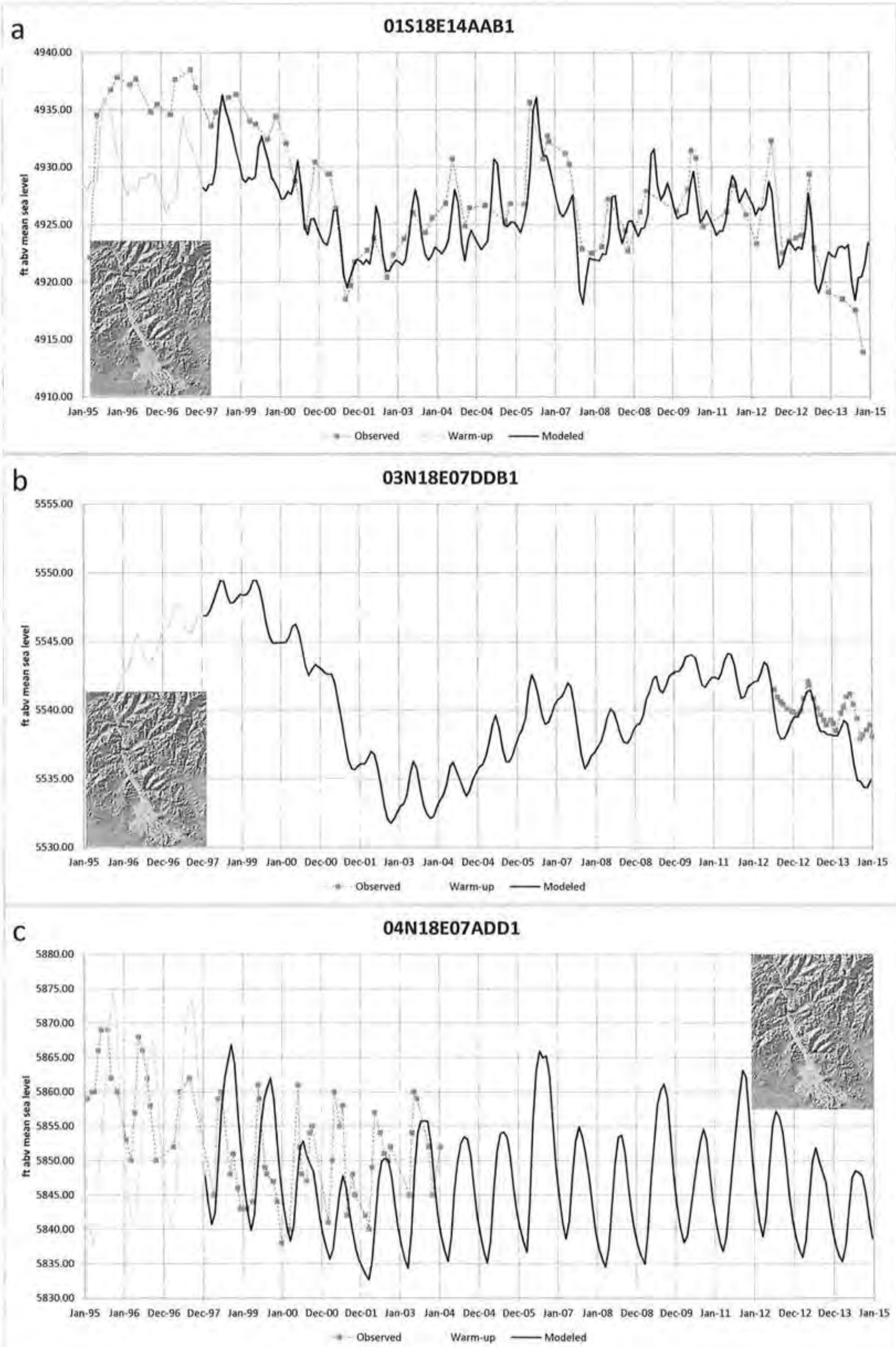


Figure 18. Match between modeled and observed water levels.

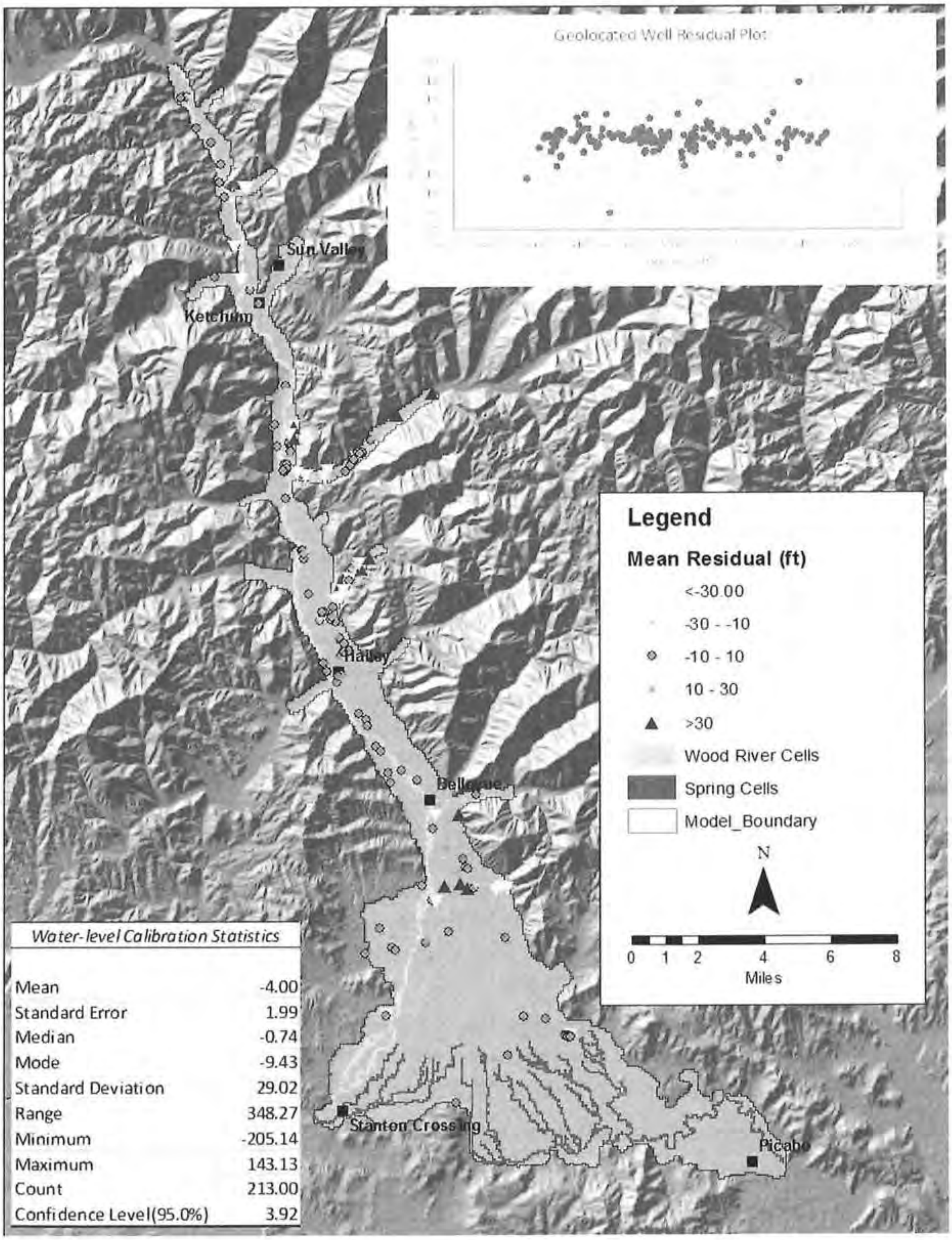


Figure 19. Residual plot and calibration statistics for geolocated well data.

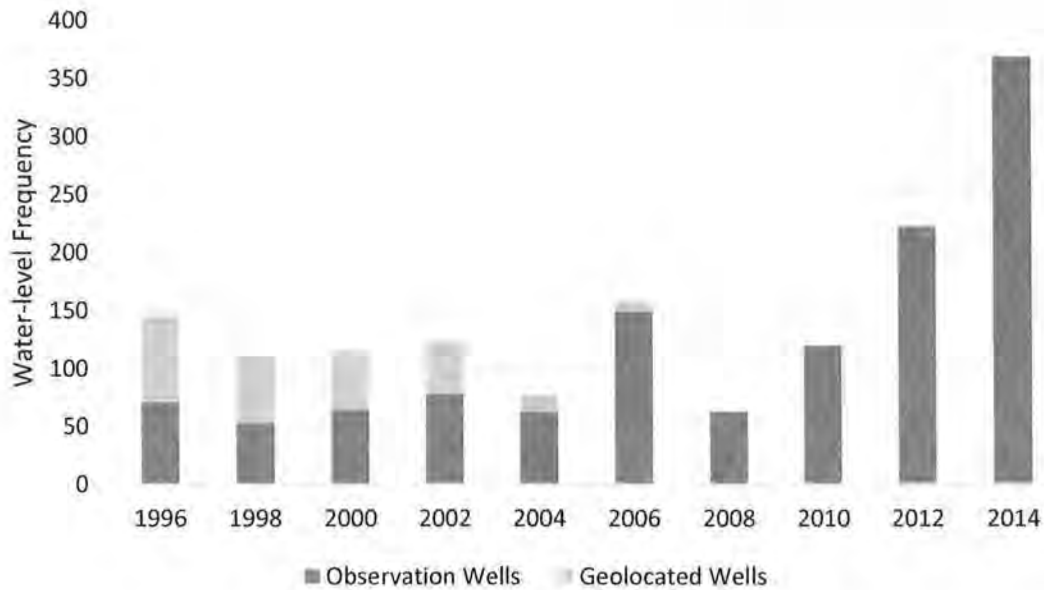


Figure 20. Frequency of water level observations through time.

Conclusions

This report documents the recalibration of the WRV Aquifer Model. WRV Aquifer Model Version 1.1 was calibrated to 16 years of data (1998-2014) as compared to 12 years for WRV Aquifer Model Version 1.0 (1998-2010). The Version 1.1 calibration period includes some of the driest years on record (2001, 2004 and 2007) and some of the wettest years on record (1996 and 2006). Calibration to data from a wide range of hydrologic conditions increases the likelihood that the model will accurately simulate the response of the river and aquifer system to a broad range of stresses.

The goal of this recalibration was to develop a more robust representation of the basin hydrogeology. Some of the improvements include an improved representation of the areal and temporal extent of reaches within the Big Wood River that seasonally go dry. Improved calibration data include a mass measurement conducted in 2012, 18 wells with pressure transducers, and the inclusion of the Heart Rock Ranch to Stanton Crossing reach-gain target.

Despite these enhancements our understanding of the WRV Aquifer System remains imperfect and more work needs to be done. Several significant gaps in data or in the understanding of the underlying hydrologic system have become apparent during this project. Suggestions for future work include:

a) Install transducers in as many tributary valley wells as possible,

b) Monitor several of the ephemeral streams in the tributary valleys above Hailey to determine the duration of spring runoff,

c) Monitor and archive recharge events within the WRV,

d) Continue annual fall seepage studies on Trail Creek and Warm Springs Creek,

e) Continue stream gaging at the Big Wood River near Ketchum, Big Wood River at Hailey, Big Wood River at South Broadford Bridge, Big Wood River at Stanton Crossing, North Fork Big Wood River near Sawtooth National Recreation Area, Trail Creek Near Sun Valley, Trail Creek at Ketchum, Warm Springs Creek at Gates Road, Warm Springs Creek near Ketchum, East Fork Big Wood River at Gimlet, Willow Creek near Spring Creek Ranch, and Silver Creek at Sportsman Access,

f) Continue Big Wood River stage measurements at Hulen Road Bridge, at Ketchum, at Gimlet, at Glendale Bridge, and at Wood River Ranch,

g) Continue monitoring a minimum of 45 observation wells in the WRV, and

h) Continue annual (at a minimum) gaging of Silver Creek at the North Picabo Road Bridge.

Although every groundwater model is a simplification of a complex hydrologic system, WRV Aquifer Model Version 1.1 is the best available tool for evaluating the interaction between groundwater and surface water in the Wood River Valley. The science underlying the production and calibration of the WRV Aquifer Model Version 1.1 reflects the best knowledge of the aquifer system available at this time. The WRV Aquifer Model Version 1.1 was calibrated to 1,314 aquifer water-level measurements and 1,026 river gain-and loss-calculations. Calibration statistics indicate a good fit to the observed data, providing confidence that the updated model provides an acceptable representation of the hydrologic system in the Wood River Valley.

With the Eastern Snake Plain Aquifer Model, the length of the Snake River in hydraulic communication with the Eastern Snake Plain Aquifer remains nearly constant through time allowing the development of a numerical superposition version of that model. However, in the WRV, the length of the Big Wood River in hydrologic connection with the aquifer system varies seasonally, thus a numerical superposition model based on the WRV Aquifer Model should not be developed (Hubbel and others, 1997). All analyses with the WRV Aquifer Model should be conducted using a fully populated transient model.

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Appendix A

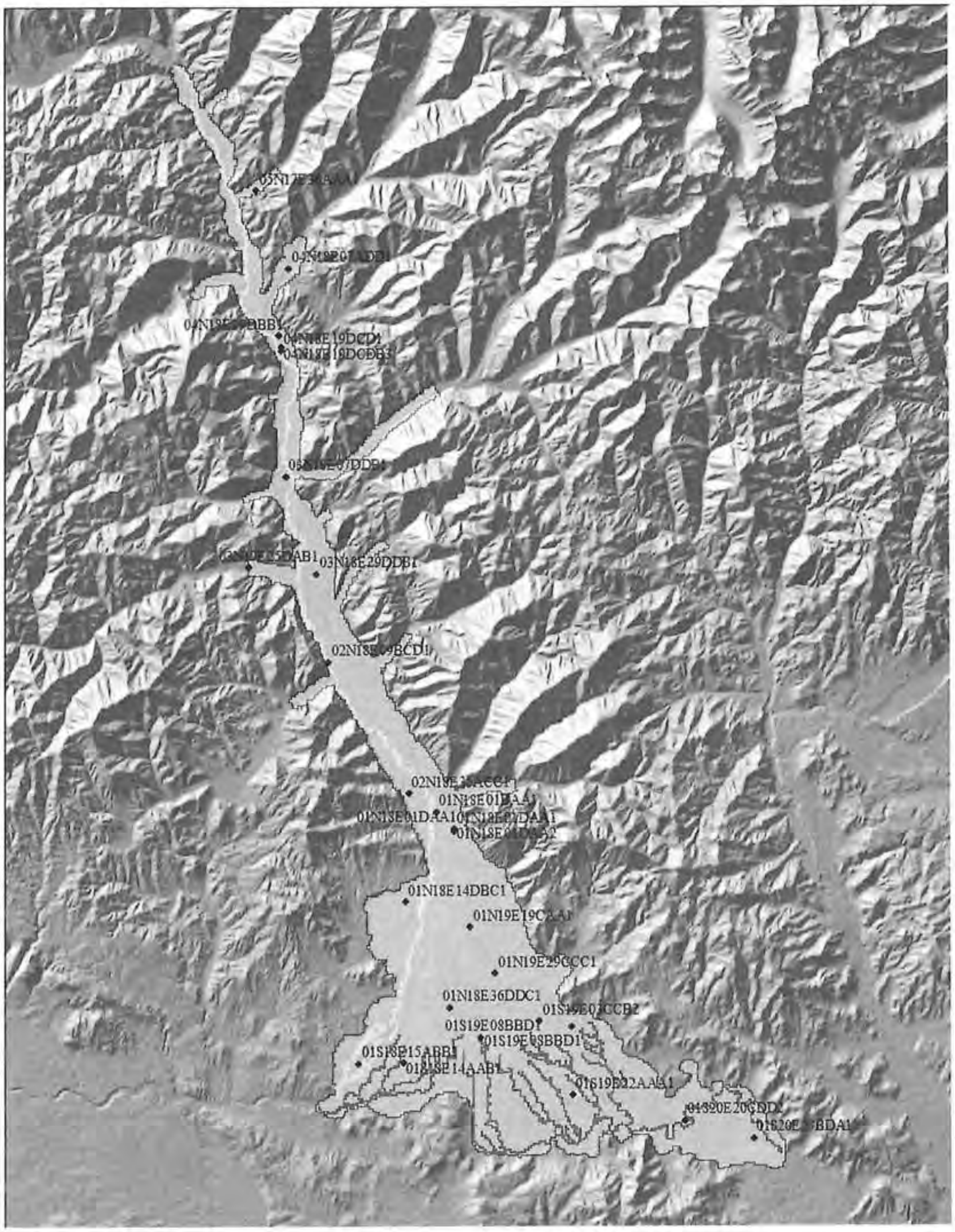
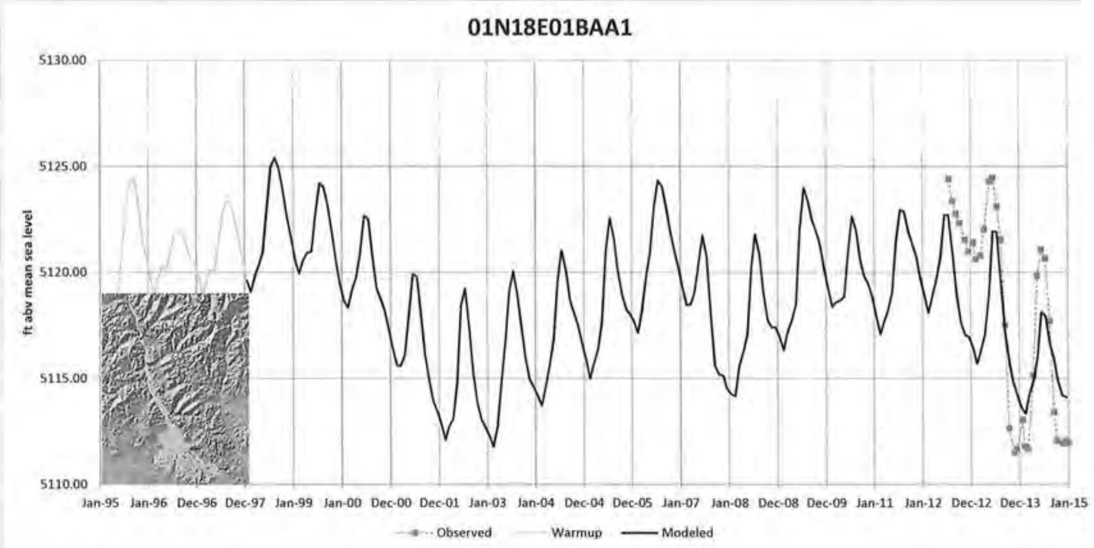


Figure 21. Locations of wells with more than four observations.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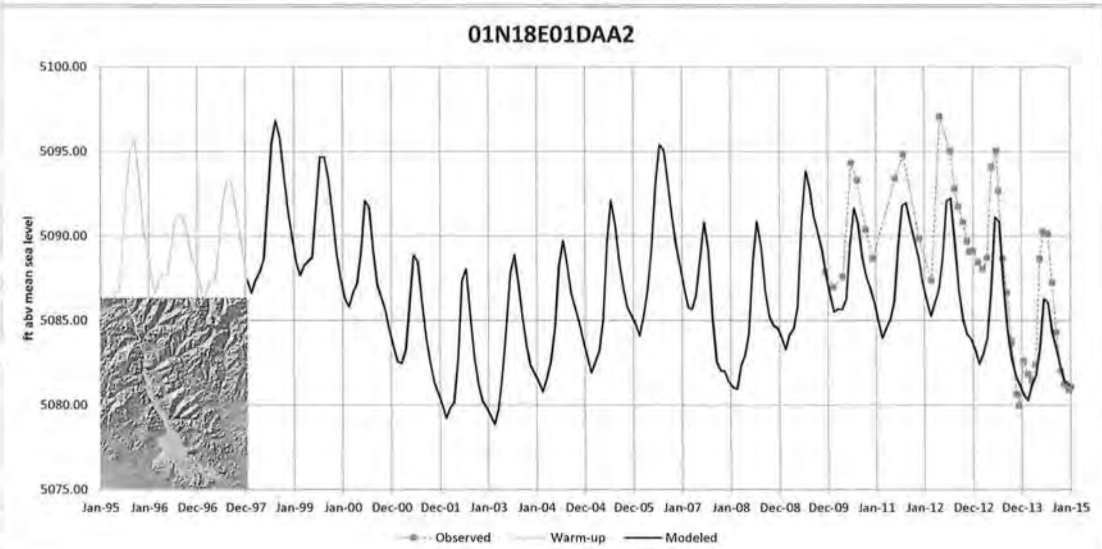
ft abv mean sea level
5130.00
5125.00
5120.00
5115.00
5110.00
Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11 Jan-12 Dec-12 Dec-13 Jan-15
Observed
Warmup
Modeled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ft abv mean sea level
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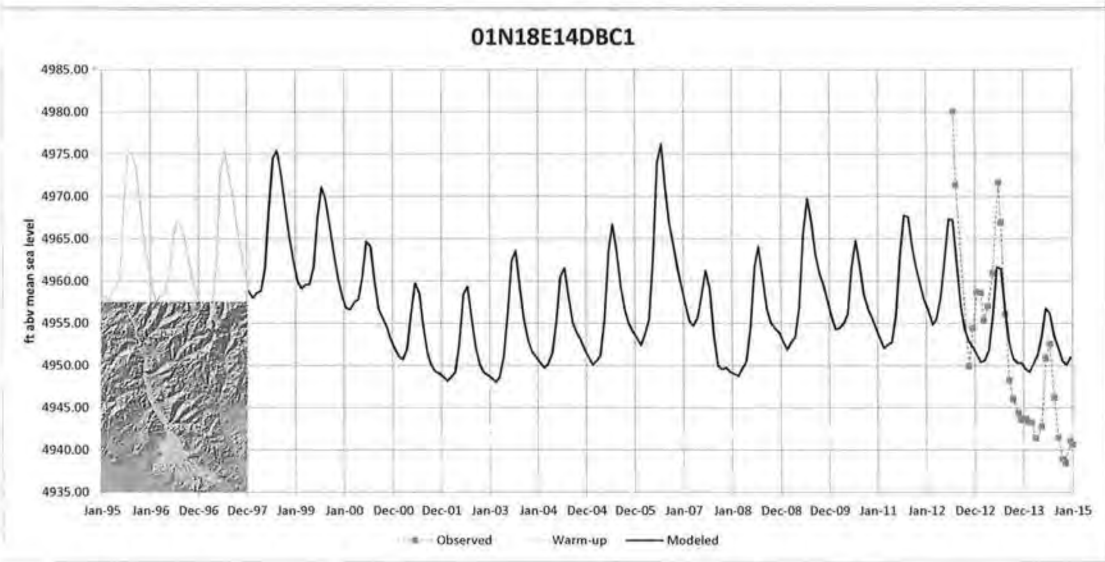
5095.00
5090.00
5085.00
5080.00
5075.00
Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11 Jan-12 Dec-12 Dec-13 Jan-15
Observed
Warm-up
Modeled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4975.00
4970.00
4965.00
4960.00
4955.00
4950.00
4945.00
4940.00
4935.00
Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11 Jan-12 Dec-12 Dec-13 Jan-15
Observed
Warm-up
Modeled