Post-Flooding Numerical Model Update and Review

Technical Memorandum

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Upper Ventura River Groundwater Agency

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JULY 2024

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1.0 Background and Purpose

The Upper Ventura River Groundwater Basin (UVRGB) numerical model was developed in support of the Upper Ventura River Groundwater Agency's (UVRGA) Groundwater Sustainability Plan (GSP) (INTERA & Bondy, 2021; UVRGA, 2022a). The model was developed and calibrated from January 2005 through September 2018. A key component of the model is the representation of surface-groundwater interactions to assist with characterization of the depletion of Interconnected Surface Water (ISW) sustainability indicator for the GSP. While the ISW depletion minimum threshold is based on biological factors, determining whether the minimum threshold has been exceeded currently requires use of the numerical model, which is used to estimate depletion of ISW caused by groundwater extraction.

As explained further below, this memorandum presents the results of two model evaluation tasks:

1. Model Verification Using the Period October 1, 2018 through September 30, 2022.

2. Evaluation of the Effects of the January 2023 Channel Modifications on Model Calibration.

1.1 Model Verification

The UVRGB model has been extended annually each year since GSP adoption to complete the required GSP annual reports (UVRGA 2022b, UVRGA 2023, UVRGA 2024). The extended timeframe of the model between September 2018 and January 2023 was used for model verification. Model verification is the process of evaluating model calibration during a period in which the model was not calibrated. This technical memorandum presents the results of this verification exercise.

1.2 Effects of January 2023 Channel Modification Event on Model Calibration

A major storm event on January 10, 2023 resulted in approximately 7 inches of rain in just a single day. This event flooded the Upper Ventura River (UVR) with over 10,000 cubic feet per second (cfs) of streamflow measured at gages 602/602B and 604. This event was the second highest flow recorded over the last 98 years and only the third time measured flow has exceeded 10,000 cfs over the same span. This flooding event caused significant changes to the braided stream network that constitutes the Ventura River. It also removed significant areas of riparian vegetation.

Upon visual observation of the new UVR braided channel network following the January 2023 flood event, a revision to the UVRGB numerical model was recommended to address the potential impacts to predictive capability of the model for its use in estimating ISW depletions for GSP annual reporting and GSP implementation.. The model revision included the review and incorporation of collected LiDAR and satellite imagery data, the former executed by Rincon Consultants, Inc., and their subcontractors. This data was used to modify the existing streamflow and riparian vegetation representation in the UVRGB model. This technical memorandum documents the modifications to the channel exclusively and the corresponding impacts of the channel modification on the simulated results.

This memorandum documents the updated UVR braided channel network, the calibration status, and the resulting model implications. It includes the following sections:

- **Section 2**: A description of the differences of the new UVR channel characteristics and the methods used to update the channel representation in the UVRGB numerical model.
- **Section 3**: An assessment of the historical baseline model calibration.
- **Section 4**: An assessment of the updated channel's impact on the model results.
- **Section 5**: Findings and recommendations.

2.0 Channel Update

2.1 Methods

The new UVR channel geometry was evaluated through the interpretation of LiDAR data, satellite imagery, and field surveys. LiDAR data was collected between June 28th and July 6th, 2023, and was used to create a digital elevation model (DEM) that represents land surface elevation throughout the UVRGB. The DEM was used to identify the new location and elevation of the main UVR channel and secondary braids throughout the basin. Satellite imagery (taken post-flood July 2023) was also used to corroborate the location of the channel with the DEM.

This data was used to update the channel components in the Streamflow-Routing Package Version No. 2 (SFR2) package in MODFLOW-NWT, based on the same methodology for the original GSP model's braided channel network (UVRGA, 2021). The key components that were updated in the SFR2 package were the main channel and braid positions (model cells where the stream passes through), streambed elevations, and the routing throughout the basin as the flood event caused additions and deletions of channel braids where it splits and re-joins downstream. Streambed conductances and flow-depth-width relationships were not changed.

The changes in the channel characteristics generally depended on the location within the basin. The upstream areas were found to more likely increase in streambed elevations in response to sediment deposition and the downstream areas were more likely to observe decreases in streambed elevation in response to scour. To illustrate the stream modifications according to location, the results are presented by hydrogeologic areas, which were defined in the GSP (UVRGA, 2022). Figure 2.1 illustrates the hydrogeologic areas for the UVR channel (note that the Robles and Santa Ana Hydrogeologic areas are further subdivided into north and south areas in this memorandum).

Figures 2.2a-2.2f illustrate the pre- and post-flood channel location and elevation for each hydrogeologic area. For each figure, the map on the left shows the lateral position of the original (thick blue line) and updated (thick red line) channel within the hydrogeologic area. This map demonstrates how the new braided channel network in comparison to the original channel network. Thick dashed lines indicate secondary braids of the braided channel network. The thin blue lines represent tributaries and are not included in the evaluation as they are represented in the channel network through their inflow contributions to the main channel network alone (INTERA & Bondy, 2021). Production wells are also mapped in typically perennially flowing areas (Santa Ana South and Casitas Springs) where ISW usually exists. Showing the location of pumping in these areas provides further context for potential ISW depletions, since the channel proximity to high-production wells increases the susceptibility to ISW depletion. Production rates are mapped by well using the average modeled rates from 2005-2019 and have not been updated based on results from UVRGA's well registration process.

The graph on the right (for each figure within Figures 2.2a-2.2f) plots the original and updated channel network streambed elevation versus distance of the channel within each hydrogeologic area. This demonstrates where accretion or erosion may have occurred within each hydrogeologic area. The following subsections document the channel network adjustments by hydrogeologic area.

Kennedy

In the Kennedy hydrogeologic area, there was minimal change in the lateral position of the updated channel network's position in comparison to the original channel network. However, the streambed elevation increased by approximately four feet on average (Figure 2.2a), indicating significant sediment deposition in this area. The accretion within the channel network increases moving downstream, with a maximum elevation difference of over eight feet occurring at the most-downstream reach.

Robles North

In the Robles North hydrogeologic area, the lateral position of the channel was minimally changed in comparison to the original channel in the northern half of this area. A new braid was formed in the southern half of this area (Figure 2.2b). Similar to the Kennedy zone, the overall channel within the Robles N zone increased in elevation by up to approximately three to five feet in some areas..

Robles South

Within the Robles South hydrogeologic area, the lateral position of the updated channel network is generally in the same location as the original channel network (Figure 2.2c). However, the updated channel network is less tortuous than the original channel network. There is a small vertical change in the streambed elevation. On average, the updated channel network is approximately one foot lower than the original channel network. This zone represents a transition between sediment accretion in the upper portion of the basin and erosion in the lower portion of the basin.

Santa Ana North

In the Santa Ana North hydrogeologic area, the updated channel shifted both westward and eastward in different reaches of the stream in addition to the formation of new braids (Figure 2.2d). The stream location begins westward of the original channel in the upstream areas and then crosses over eastward of the original channel until roughly rejoining the original channel. The updated channel network is consistently around two feet lower than the original channel network in this area, indicating the overall erosion of the streambed.

Santa Ana South

In the Santa Ana South hydrogeologic area, the updated channel network position overall shifted westward due to the disappearance of a significant braid in the original channel network (Figure 2.2e). In the downstream portion of the Santa Ana South hydrogeologic area, the updated channel network position is generally consistent with the original channel network. There is not much groundwater production in this zone and no notable difference of the updated channel network proximity to extraction wells. The upstream component of the updated channel network elevation is up to nearly seven feet lower than the original channel network elevation with an average decrease of three feet. The downstream component of the updated channel network is nearly the same as the original channel network with an average decrease in elevation of nearly one foot. In total, the average change in streambed elevation is a decrease of approximately two feet relative to the original channel network.

Casitas Springs

In the Casitas Springs hydrogeologic area, the upstream portion of the updated channel network is significantly different from the original channel network. The original channel network upstream braid disappeared, and the updated channel network is relatively more eastward in position. In addition, a new braid is present in the downstream portion of this area. Overall, the updated channel network within the Casitas Springs zone is closer to active wells than the original channel network was. While some portions of the updated channel network are up to four feet lower or higher than the original channel network, the average elevation of the updated channel is the same as the original channel.

Summary

The updated channel network elevation increased mostly in the northern reaches, with accretion of over eight feet, relative to the original channel network elevation. Updated channel network elevations in downstream reaches decreased slightly relative to the original channel network, indicating some erosion. The updated channel network was also moved in the southern reaches, indicative of the erosion relocating the streambed more substantially than in the upstream areas where there was limited changes in the streambed location. In the southernmost Casitas Springs area, the updated channel network is closer to active wells which may increase direct depletion of ISW, all other factors equal.

3.0 Model Verification

The model verification is used to demonstrate how accurately the model represents measured data during a period other than used for model calibration and helps determine the significance of any changes in model results using the updated UVR channel network configuration.

The original GSP model was calibrated to measured data available from January 2005 through September 2018. The numerical model has not been recalibrated for the period after September 2018 so calibration statistics will be assessed for these two respective periods: 1) from January 2005 through September 2018 (i.e., through-WY 2018) and 2) from October 2018 through September 2022 (i.e., post-WY 2018). Previous annual model extensions (UVRGA, 2022b; UVRGA, 2023; UVRGA, 2024) did not address calibration. This verification compares the performance of the model since the last calibration effort up to WY 2018 with the performance of the model since WY 2018. The calibration is assessed up to WY 2022, prior to the flooding event of January 2023 for a direct understanding of model error before the flooding and change in channel geometry occurred.

The following subsections describe the calibration performance for measured groundwater level and streamflow data. Figure 3.1 shows the locations of streamflow gages and monitoring wells with measured data used to assess the calibration.

3.1 Streamflow

Streamflow calibration was assessed using measured flow at the Foster Park gage at the southern basin boundary (Figure 3.1). Figure 3.2 shows the simulated and observed flows at Foster Park from January 2005 through September 2022. The period from WY 2018 – WY 2022 represents the period of model extensions, in which recalibration was not performed and, therefore, can be used for verification. Key statistics indicative of model performance (quantifying the overall difference between simulated and observed data) are listed in the table in Figure 3.2 and include root mean squared error (RMSE[1]) and mean error (ME[2]). Low-flow conditions are critical for GSP implementation, so calibration statistics are listed only for conditions where flow is less than 10 cfs.

The model is biased toward overestimating streamflow when flows are less than 10 cfs ("low-flow conditions").The RMSE of low flows for the calibration and verification periods are 2.4 cfs and 5.0 cfs, respectively. The ME of low flows for the calibration and verification periods are 1.2 ft and 4.4 cfs, respectively. The increase in calibration metrics between both periods indicate a decrease in model calibration quality after WY 2018. This is reflected in Figure 3.2, where the differences between the observed and simulated streamflow increase after WY 2018. The increase in streamflow ME from 1.2 ft to 4.4 ft during low flow periods is significant because the increase error during the verification period is larger than the 2 cfs threshold for undesirable results included in the GSP.

[1] RMSE measures the standard deviation of the differences between the model's predicted values and the observed values. RMSE does not differentiate between overestimation and underestimation.

[2] ME measures the average difference between the model's predicted values and the observed values. A positive ME represents a positive model bias meaning predicted values are greater than the observed. A negative ME means that the model predicts lower values than observed on average.

3.2 Groundwater Levels

The calibration assessment for groundwater levels at calibration wells is also compared using RMSE and ME. Figures 3.3a-3.3e show the hydrographs of simulated and observed water levels, grouped by hydrogeologic area. No wells are shown for the Santa Ana South hydrogeologic area due to the lack of available data in this area during the modeling period (a monitoring well in this area was added to the monitoring network in May 2024). During the model calibration period, the region with the highest error is the Robles (North and South) area and the region with the lowest error is the Kennedy area. After WY 2018, the region with the highest error is still the Robles area, but the region with the lowest error is now the Casitas Springs area. Pressure transducer data for several wells did not become available until after 2018 so the previous calibration was not able to account for the more frequent measurements provided by the transducers. Table 3.1 lists the calibration statistics for all wells for through-WY 2018 and post-WY 2018 periods.

The average RMSE and ME across all calibration wells for the through-WY2018 period was 7.4 ft and 2.7 ft, respectively. From the post-WY 2018 period, the average RMSE and ME across all calibration wells was 11.1 ft and 5.1 ft, respectively. This is an increase of 50% and 91% for the RMSE and ME, respectively, relative to through-WY 2018 calibration metrics. Similar to the assessment of streamflow calibration, the increase in calibration metrics indicates a decrease in model calibration quality after WY 2018.

4.0 Assessment of Updated Channel Impact

The impact of the updated channel network on modeled streamflow and groundwater levels was assessed. The assessment consisted of comparing model runs through WY 2022 using the original channel and the updated channel . This allows for the direct comparison of model outputs between the original channel network and the updated channel network. Any differences in outputs can be attributed to the updated channel network configuration.

Both channel network configurations were used in baseline and no pumping model scenarios to allow for inspection of the impact on ISW depletions. The simulations were run for the period of January 2005 through September 2022.

4.1 Impact of Updated Channel on Simulated Streamflow

For each hydrogeologic area, modeled streamflow results were compared, and statistics were calculated to quantify the differences between the updated and original channel network simulations. The outputs compared between the two channel networks are undepleted flows, depleted flows, and depletions. Undepleted flows represent hypothetical streamflow with no pumping in the UVRGB (calculated by running the baseline historical model with all pumping turned off). Depleted flows represent streamflow with historical pumping in the UVRGB (calculated by running the baseline model under historical pumping conditions). Depletions represent the reductions in streamflow attributable to groundwater pumping. They are calculated by taking the difference in streamflow between the baseline historical simulation and the No-Pumping scenario simulation.

This comparison of simulated streamflow focuses on flows at Foster Park Gage because that is where depletions are calculated for the GSP, and flow measurements are available. The subsequent paragraphs describe the differences in model results for the original and updated channel networks at the Foster Park Gage.

Table 4.1 shows the statistical summary of differences between the original and updated channel networks for depleted and undepleted flows simulated at Foster Park Gage. Figures 4.1a-d depict graphs of the simulated streamflow and associated depletions at the Foster Park Gage for the original and updated channel networks. The top two charts of Figure 4.1 (a and b) show the simulated undepleted and depleted flows for streamflow conditions less than 10 cfs, to focus on the low-flow periods. These figures demonstrate that the differences in simulated flows (both under pumping and no-pumping conditions) between the original and the updated channel network are small (i.e., the red and blue lines are nearly identical). The statistics in Table 4.1 make this point as well. The average differences in both undepleted and depleted flow (at less than 10 cfs) are less than 0.1 cfs (<1% of average undepleted flows; <2% of average depleted flows). The standard deviation of the differences in depleted flows is 0.3 cfs and the standard deviation of the differences in undepleted flows is 0.4 cfs. These results show that the simulated flows and depletions are very similar consistently between the original and updated channel networks for the critical low flow conditions.

Figure 4.1c (lower left) shows the overall depletions when flows are less than 10 cfs. The difference in simulated depletions at the Foster Park Gage is 0.1 cfs for flow conditions at less than 10 cfs (2% of average original channel network depletions) (Table 4.2). The standard deviation of the differences in depletions is 0.2 cfs, which indicates that the depletions in both the updated channel and the original channel network are consistently very similar.

Figure 4.1d (lower right) illustrates streamflow depletion that exceeds the ISW minimum threshold as defined in the GSP. This “excess” depletion corresponds to the periods where depleted flow falls below 2 cfs, as indicated by the black line on the top two charts. The original channel simulated the occurrence of excess depletions for 407 days (1.1 years) and the updated channel simulated excess depletions for 446 days (1.2 years) out of the entire simulation period of 17.7 years. This is a 9% increase in the duration of ISW minimum threshold exceedance.

4.2 Impact of Updated Channel Network on Simulated Groundwater Levels

Table 4.3 summarizes the average differences in simulated groundwater levels between the original and updated channel networks for the baseline historical simulation at each of the calibration wells. Complementing the statistical summary, Figures 4.2a-4.2e present hydrographs at each of the calibration wells demonstrating the differences in simulated groundwater levels for the original and updated channel network models. Discussion for each hydrogeologic area is provided below.

Kennedy

Groundwater levels at calibration wells in the Kennedy hydrogeologic area increase by 4.7 ft on average when the updated channel network is implemented as compared to the original channel (Figure 4.2a). The greatest differences between levels occur during wet conditions. The higher simulated groundwater levels for the updated channel correspond to the average channel elevation being higher in the Kennedy area.

Robles North

Groundwater levels at calibration wells in the Robles North hydrogeologic area are essentially unchanged for the updated channel network results (Figure 4.2b). On average, between the two wells in the Robles N zone (04N23W09B01S and 04N23W04J01S), simulated groundwater levels increase by approximately 0.7 ft.

Robles South

Groundwater levels at calibration wells in the Robles South hydrogeologic area nearly match between using the updated channel and original channel (Figure 4.2c). The average simulated groundwater level decreased by 0.2 ft for the two calibration wells in this hydrogeologic area.

Santa Ana North

Groundwater levels at calibration wells in the Santa Ana North hydrogeologic area decreased by an approximate average of 0.5 ft for the updated channel network results (Figure 4.2d), similar to the Robles North and Robles South hydrogeologic areas.

Casitas Springs

Groundwater levels at calibration wells in the Casitas Springs hydrogeologic area decreased by 1.0 ft on average for the updated channel results (Figure 4.2e). Well 03N23W08B07S (right chart) consistently shows lower groundwater levels caused by the updated channel whereas Well 03N23W08B01S (left) shows varying differences in groundwater levels caused by the updated channel network. While the updated channel network resulted in lower groundwater levels at 03N23W08B01S by 0.3 ft on average, the difference in groundwater levels ranged from 2.8 ft lower to 4.5 ft higher than groundwater levels for the original channel network results. This variable difference corresponds to the variable streambed elevation changes (increasing and decreasing) found in the Casitas Springs area (see Section 2).

5.0 Conclusions and Recommendations

5.1 Model Verification

A model verification was performed using WY 2019 through WY 2022. The average model error in streamflow at Foster Park is 4.4 cfs during the verification period, compared with -1.2 cfs during the calibration period. The average model error in groundwater levels is 5.1 feet during the verification period, compared with 2.7 feet during the calibration period. The higher mean error during the verification period indicates that the model calibration quality decreases after the calibration period.

Notably, the average error for simulated streamflow during low (<10 cfs) conditions increased by 367% during the verification period. This increase is of concern, because the average error of 4.4 cfs during the verification period is larger than the 2 cfs threshold for undesirable results included in the GSP.

5.2 Effects of the January 2023 Channel Modifications on Numerical Model Calibration

The observed changes in the UVR channel network following the January 2023 flood generally increased streambed elevations in the north and decreased streambed elevations in the south. In addition, the channel network was relocated, and braids were either created or removed primarily in the southern areas of the basin.

The impact of the modified channel was assessed by comparing numerical model runs with the original and updated channel configurations through WY 2022. Model results for simulated streamflow were analyzed to evaluate how the updated channel network configuration affected simulated streamflow and ISW depletions. During low-flow events (streamflow less than 10 cfs), the average difference in simulated streamflow and depletions between the original and updated channel network configuration were both less than 0.1 cfs. This indicates that modeled streamflow in the Foster Park area does not appear to be sensitive to the types of channel changes observed following the January 2023 flooding event. While this analysis suggests the sensitivity of the model to river channel network modifications appears to be minimal, in contrast, modeled groundwater levels are sensitive to the channel modifications. The average simulated difference in groundwater levels for the updated channel network compared to the original channel network ranged from 0.2-5 ft. The largest differences in simulated groundwater levels were in the Kennedy area, where the simulated groundwater levels increased by 4.4 and 5 ft, on average.

5.3 Recommendations

It is recommended that the model be reviewed to determine potential cause(s) for the change in calibration quality after WY 2018. Raw data and pre-processed model inputs should be first re-checked for errors or discrepancies. As part of this process, the groundwater extraction inputs for the model should be updated based on information obtained from UVRGA's well registration and extraction reporting program. UVRGA and City of Ventura stream gauge data and data from UVRGA's expanded groundwater level monitoring network, which were unavailable during model calibration, should also be incorporated.

If the raw data and pre-processed model inputs are validated or any data/input corrections/updates do not address the post-WY 2018 calibration issues, the model should then be reviewed to determine potential causes for the decrease in calibration quality post WY 2018. This analysis should consider the possibility that the calibration during the pre-WY 2018 period could be “right for the wrong reasons.” Sensitivity analysis should be performed to determine the model parameters that exert the most control on simulated Ventura River flows at Foster Park, particularly during low flow periods. This work should include consideration of aquifer properties in addition to SFR2 parameters. After assessing potential causes and parameter sensitivity, the model calibration should be updated during the post-WY 2018 period (assuming, of course, that the preceding analysis does do not suggest that the pre-WY 2018 calibration was “better for the wrong reasons”). Additionally, simulated groundwater levels post-January 2023 should be inspected to assess whether the higher simulated groundwater levels associated with the new channel configuration are supported by post-January 2023 measured data.

6.0 References

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FIGURES

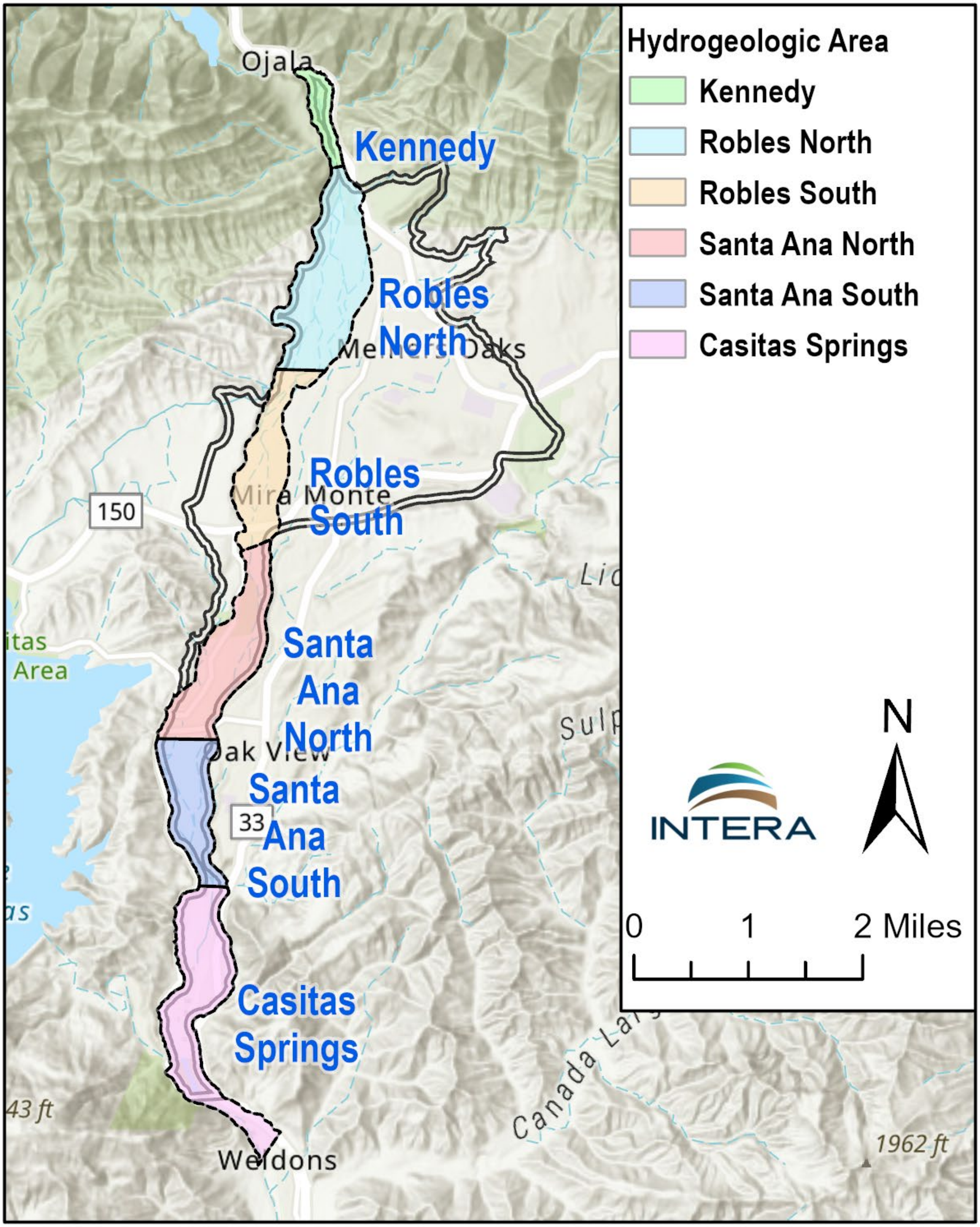

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Figure 2.1. Hydrogeologic Areas of Upper Ventura River Groundwater Basin

Upper Ventura River Groundwater Basin

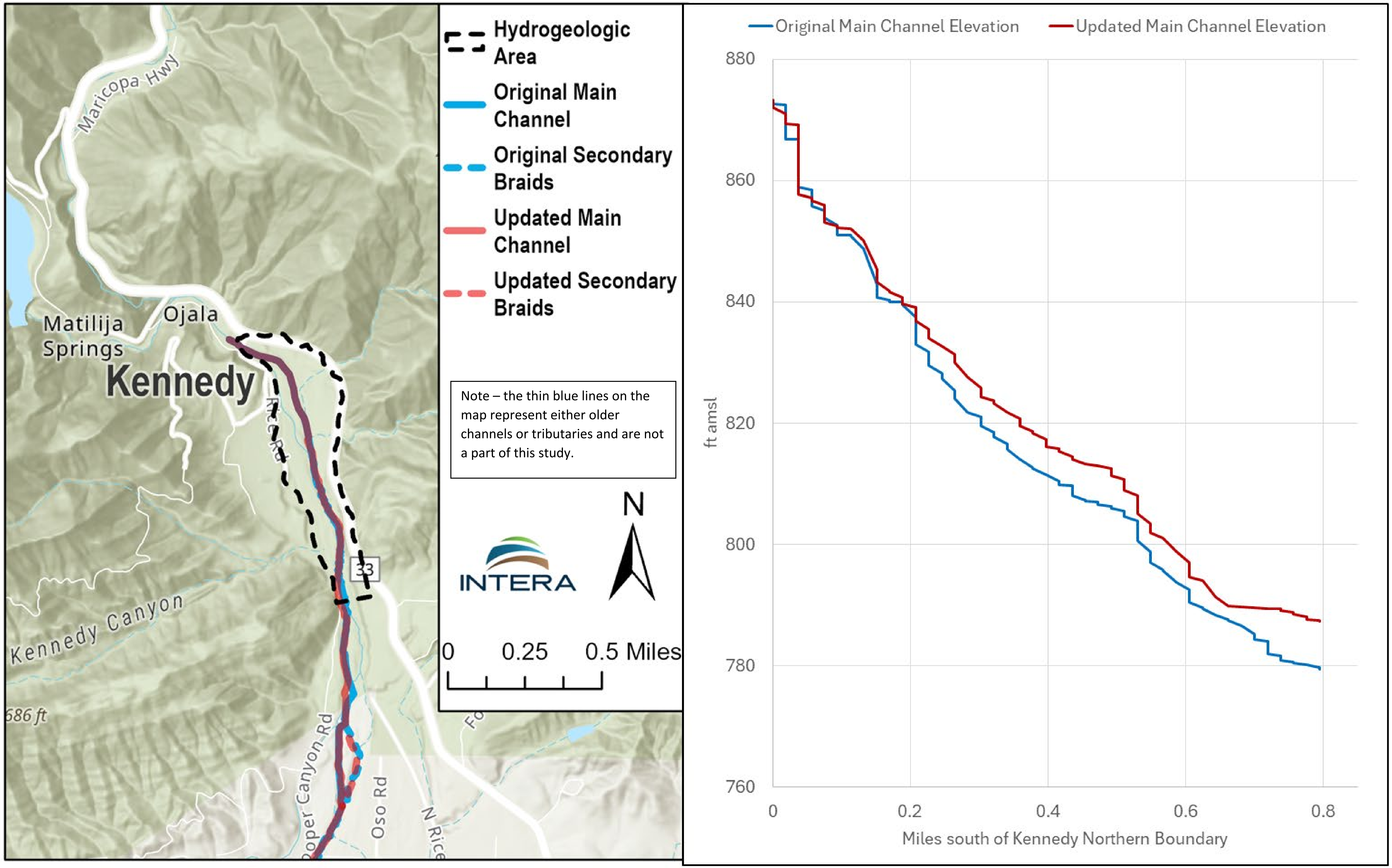


Figure 2.2a. Channel alterations in Kennedy Hydrogeological Area

Upper Ventura River Groundwater Basin

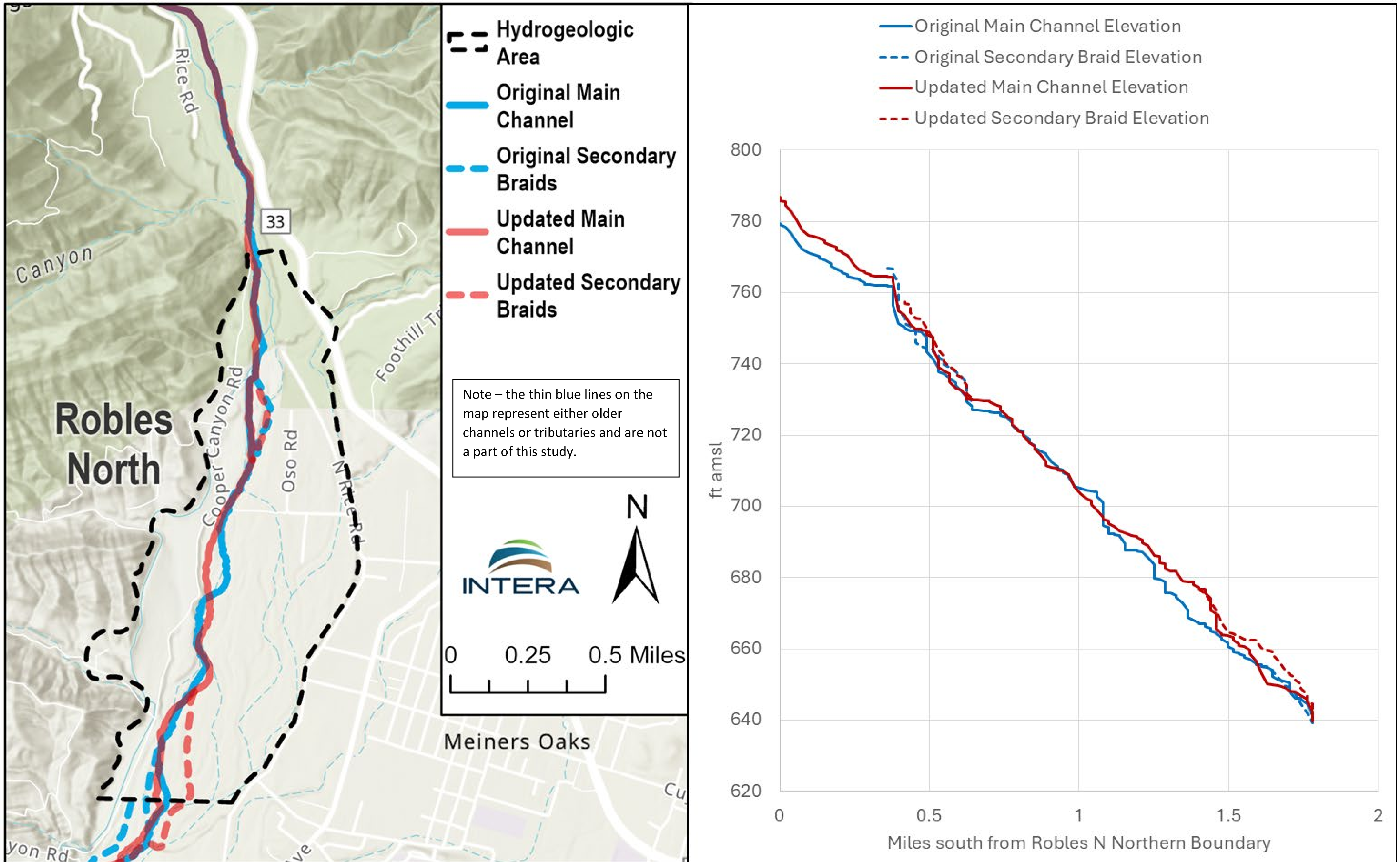
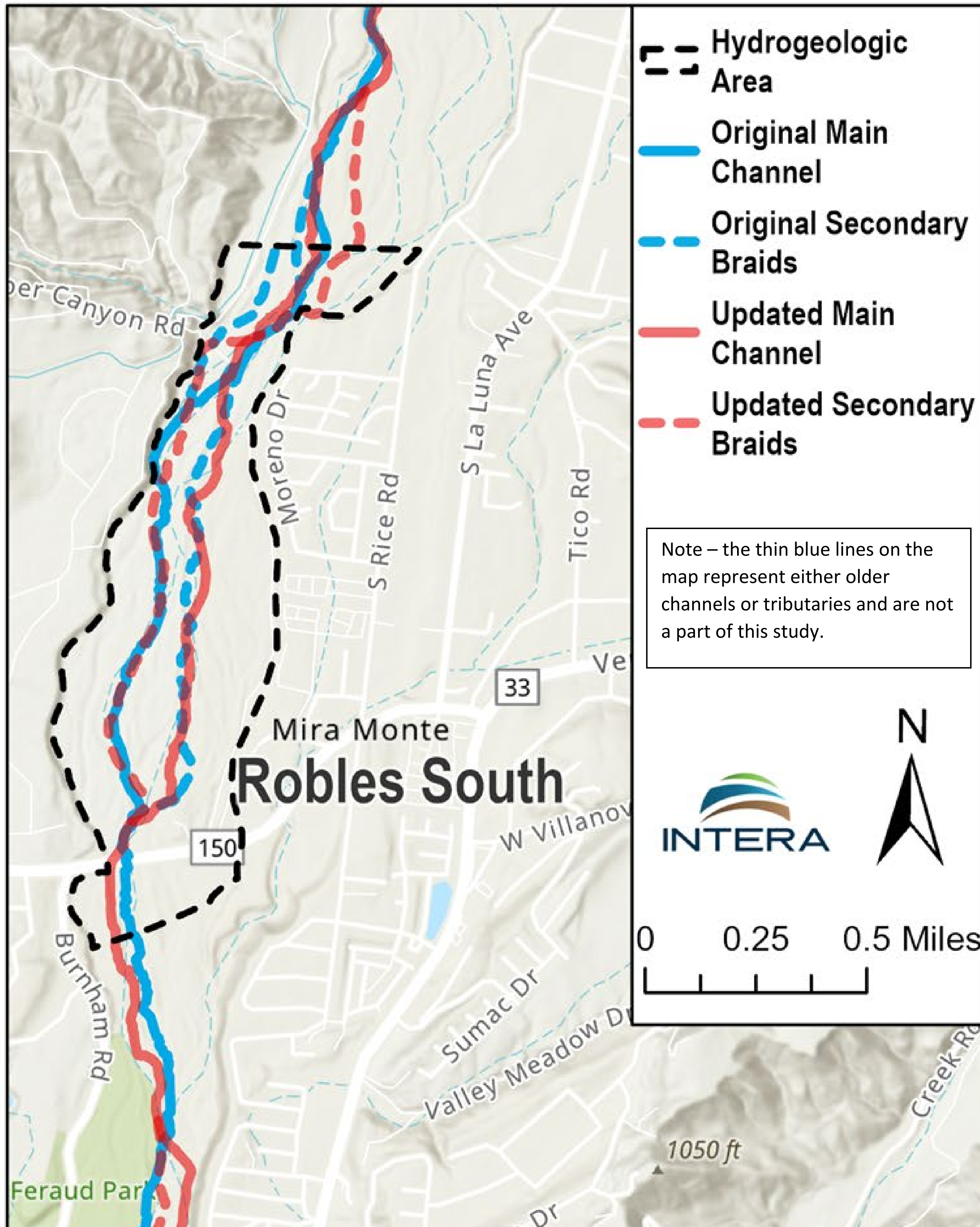


Figure 2.2b. Channel alterations in Robles North Hydrogeological Area

Upper Ventura River Groundwater Basin



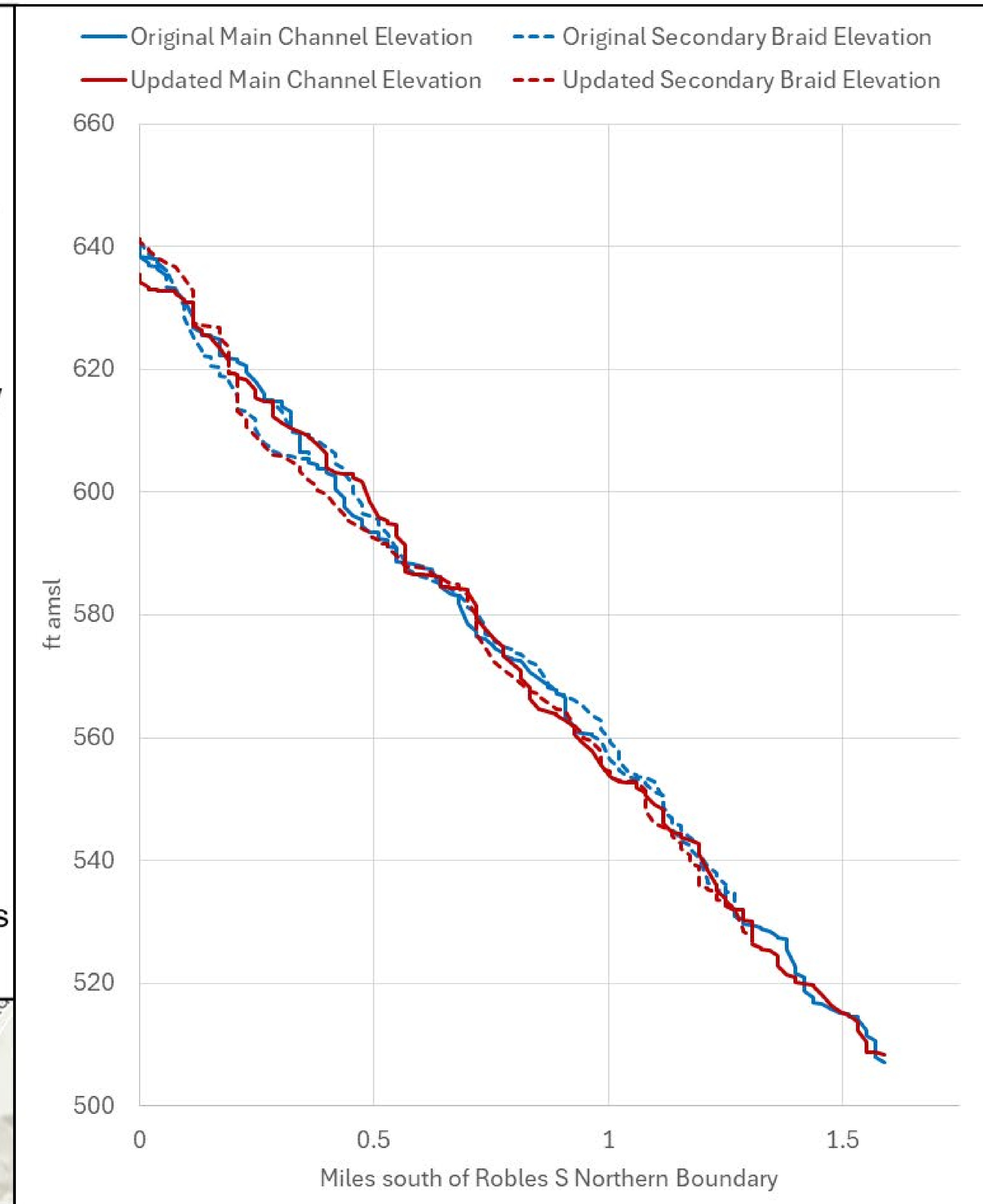


Figure 2.2c. Channel alterations in Robles South Hydrogeological Area

Upper Ventura River Groundwater Basin

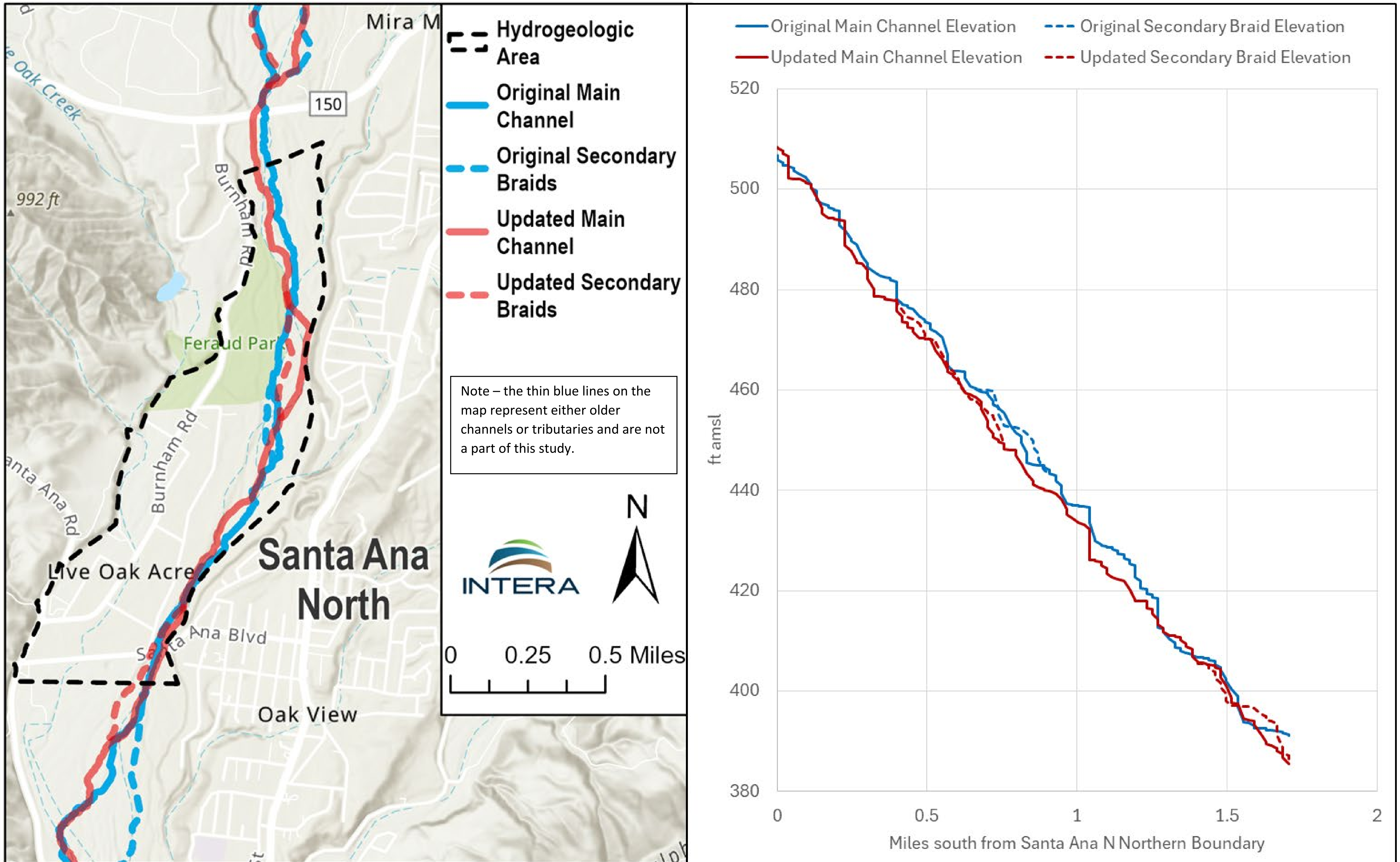


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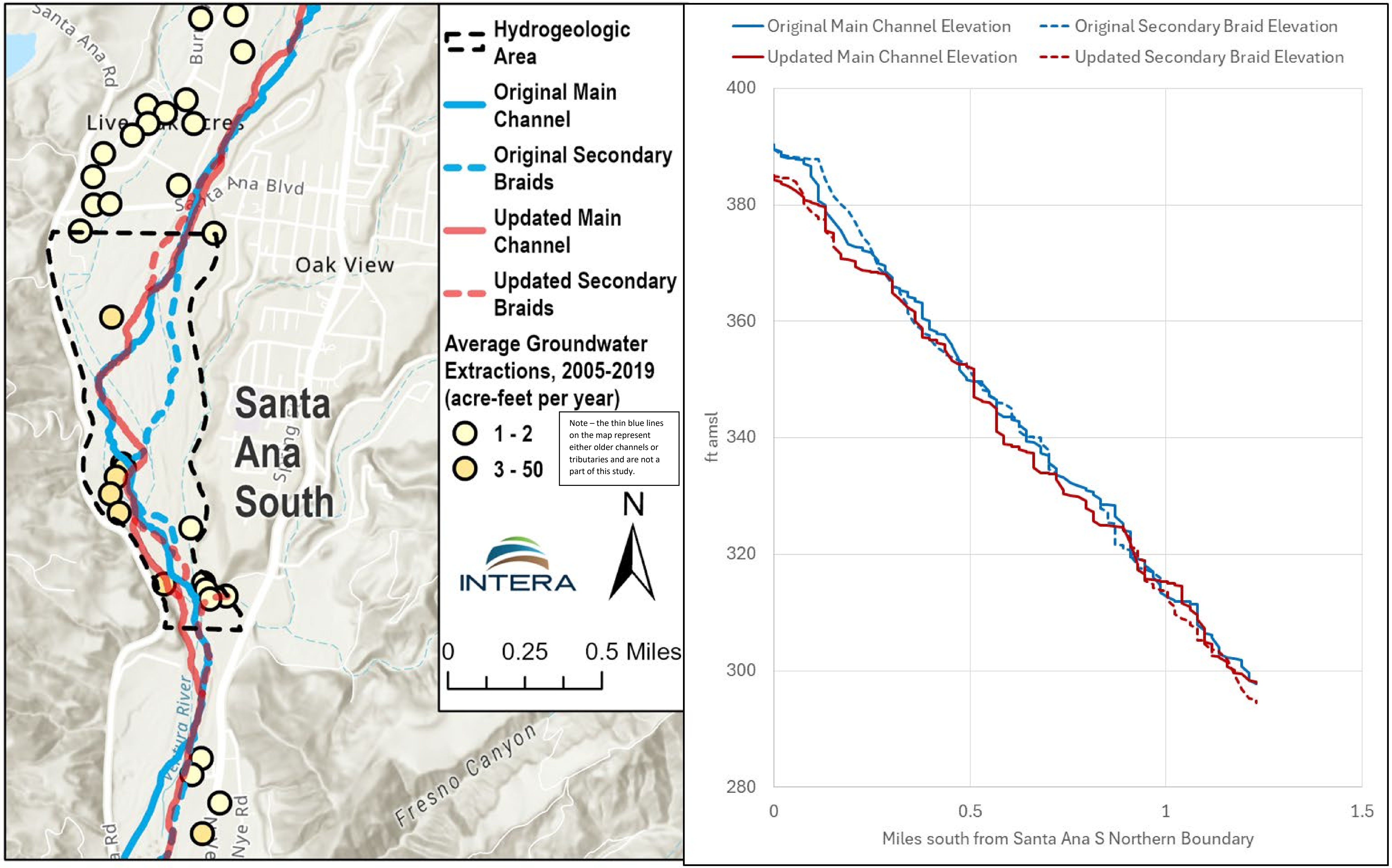
Figure 2.2d. Channel alterations in Santa Ana North Hydrogeological Area

Upper Ventura River Groundwater Basin



INTERA **Figure 2.2e. Channel alterations in Santa Ana South Hydrogeological Area**

Upper Ventura River Groundwater Basin

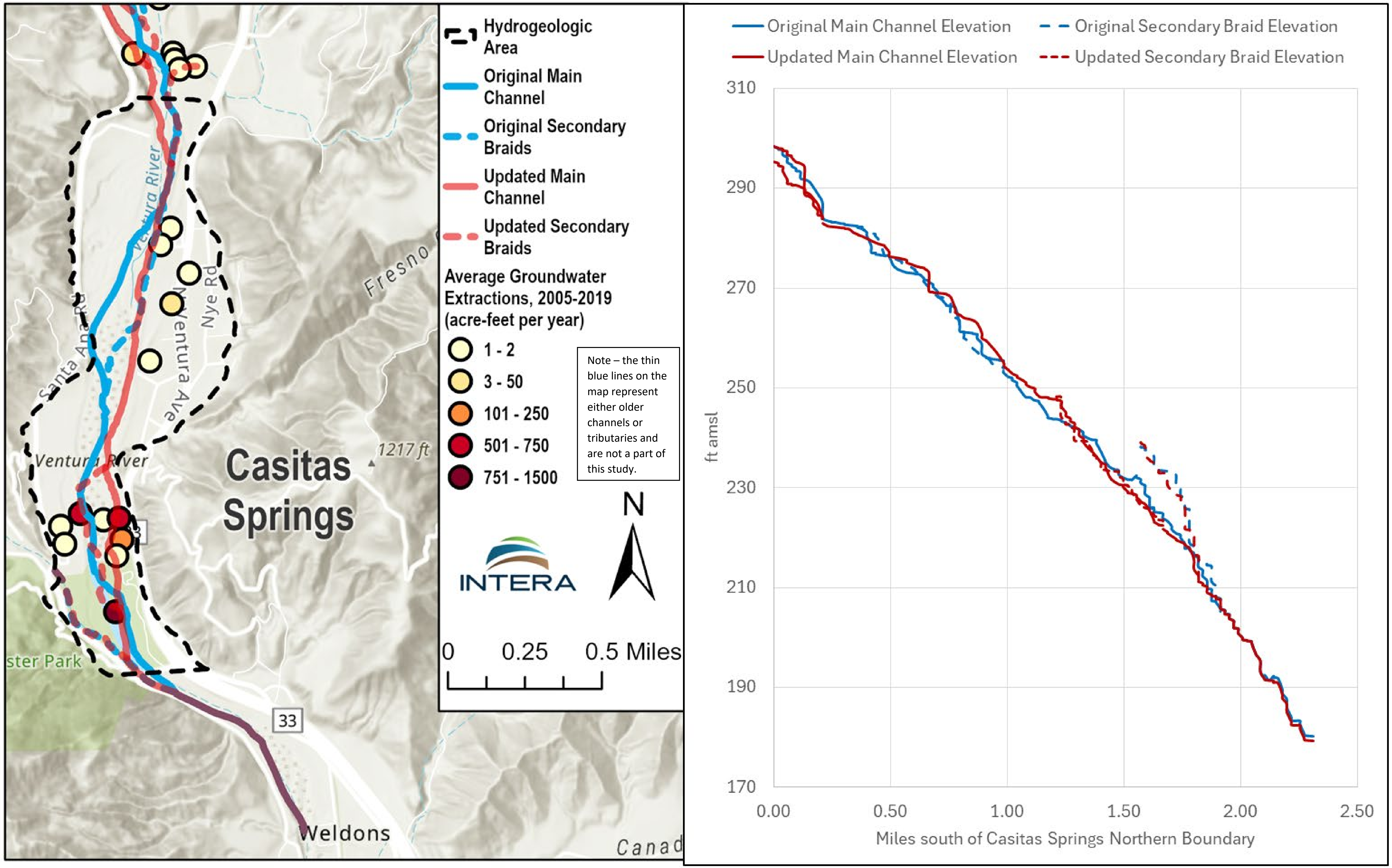


Figure 2.2f. Channel alterations in Casitas Springs Hydrogeological Area

Upper Ventura River Groundwater Basin

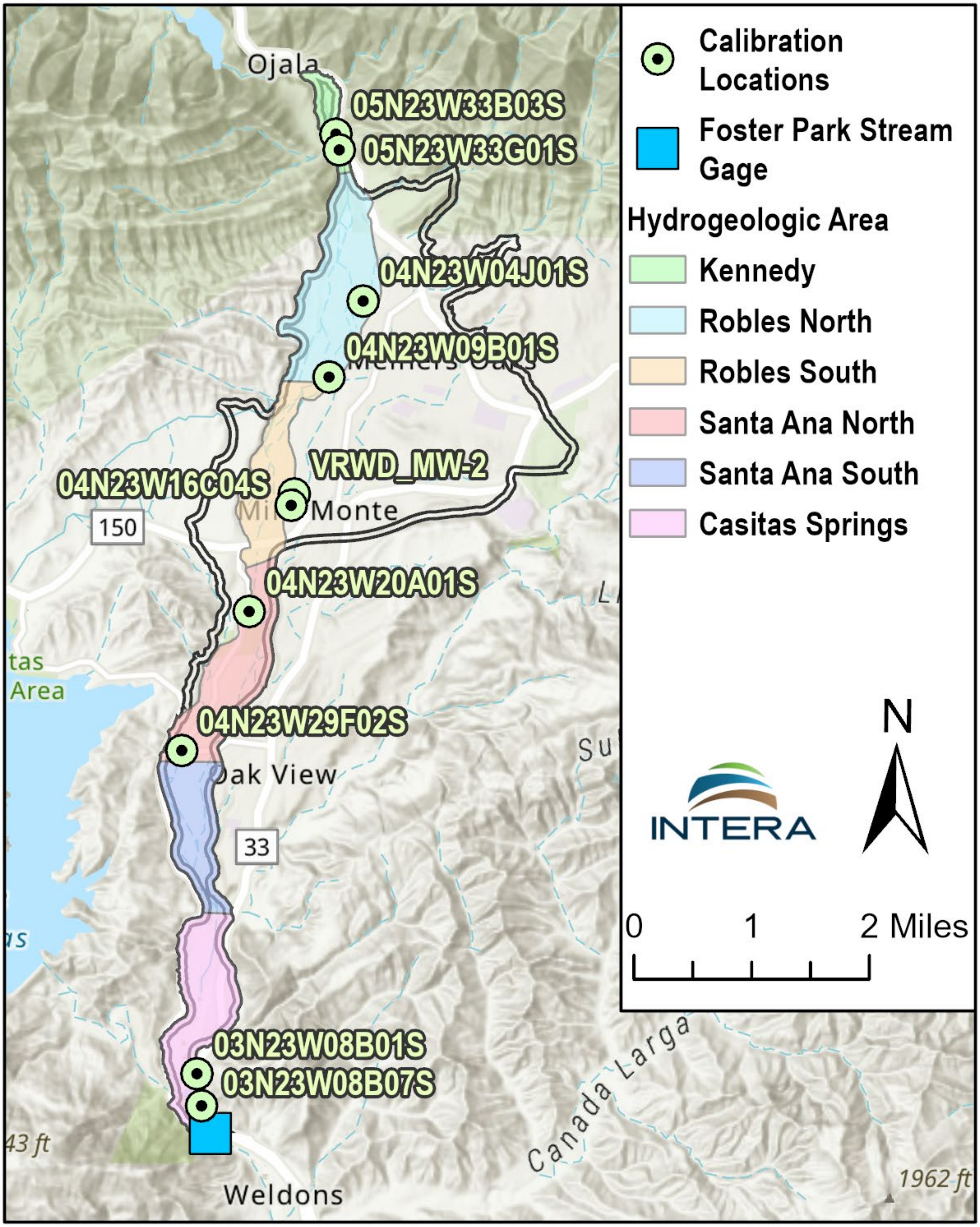


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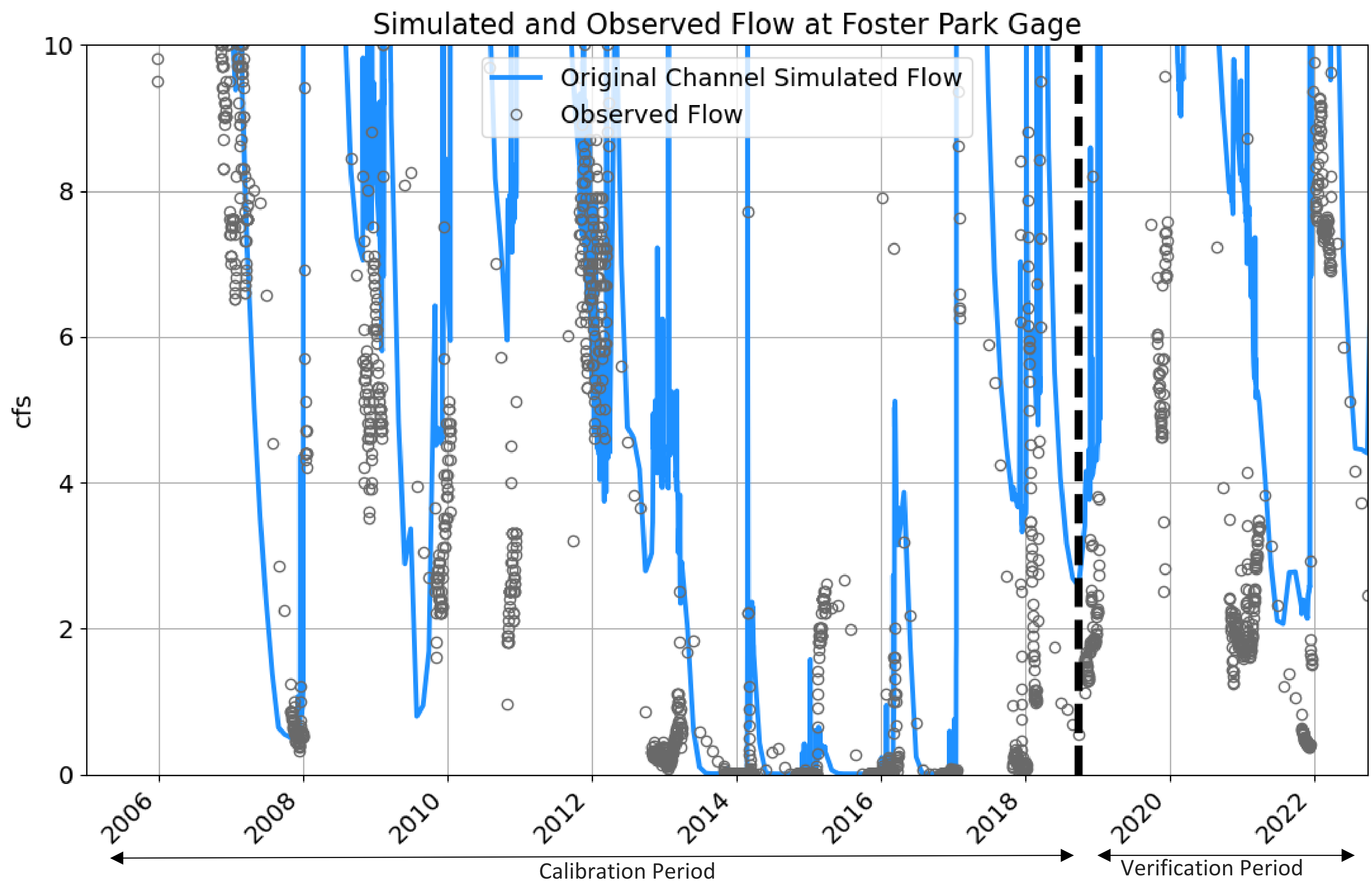
Figure 3.1. Calibration Well Locations

Upper Ventura River Groundwater Basin



	Jan2005-WY 2018	WY 2018-WY 2022
RMSE	2.4 cfs	5 cfs
ME	1.2 cfs	4.4 cfs

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Figure 3.2. Observed versus Simulated Streamflow at Foster Park Gage from 2005-2022 (Thick dashed black line represents end of WY 2018)

Upper Ventura River Groundwater Basin

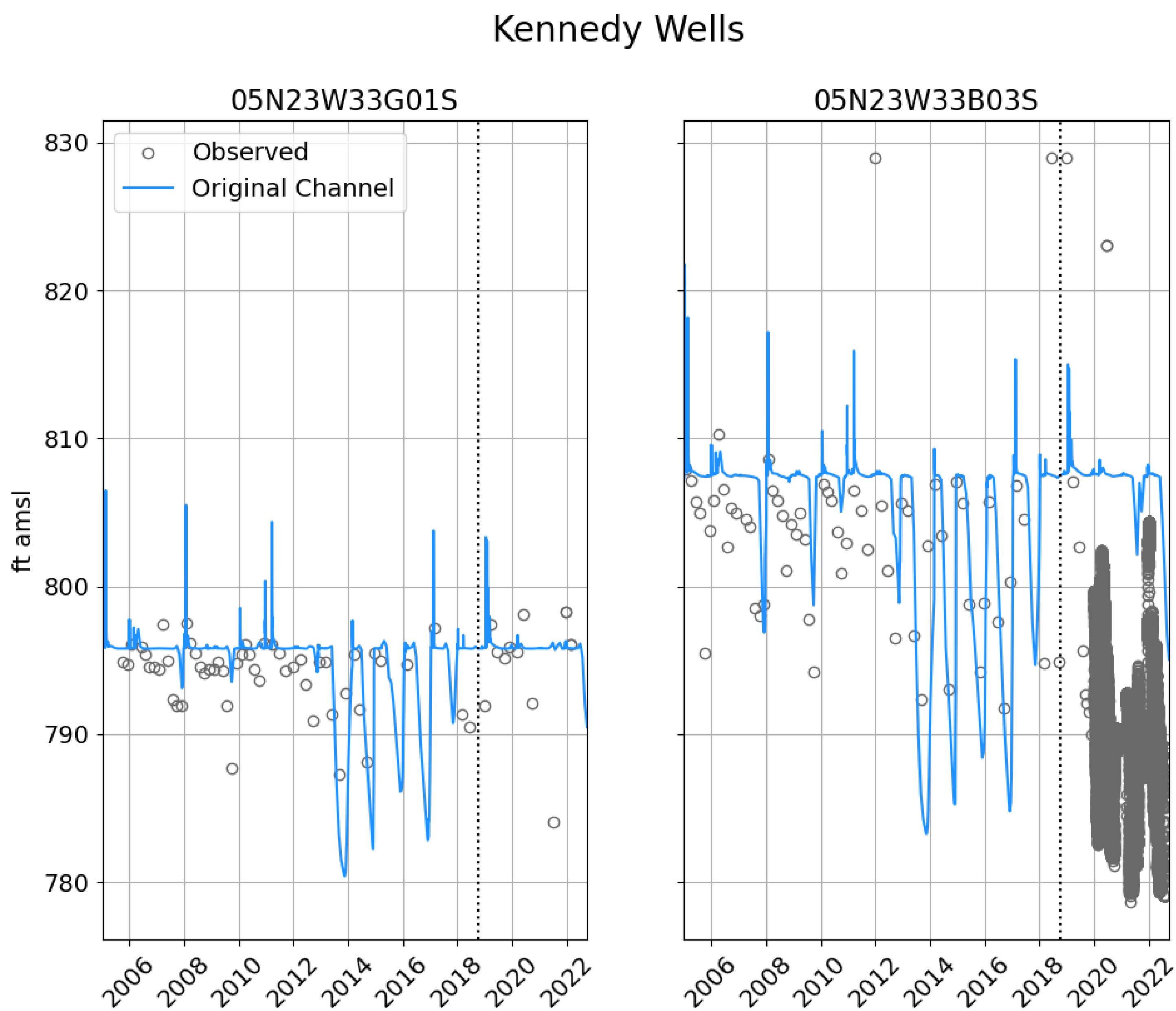

Figure 3.3a. Observed versus Simulated Groundwater Levels at Calibration Well Locations in the Kennedy Hydrogeologic Area

Upper Ventura River Groundwater Basin

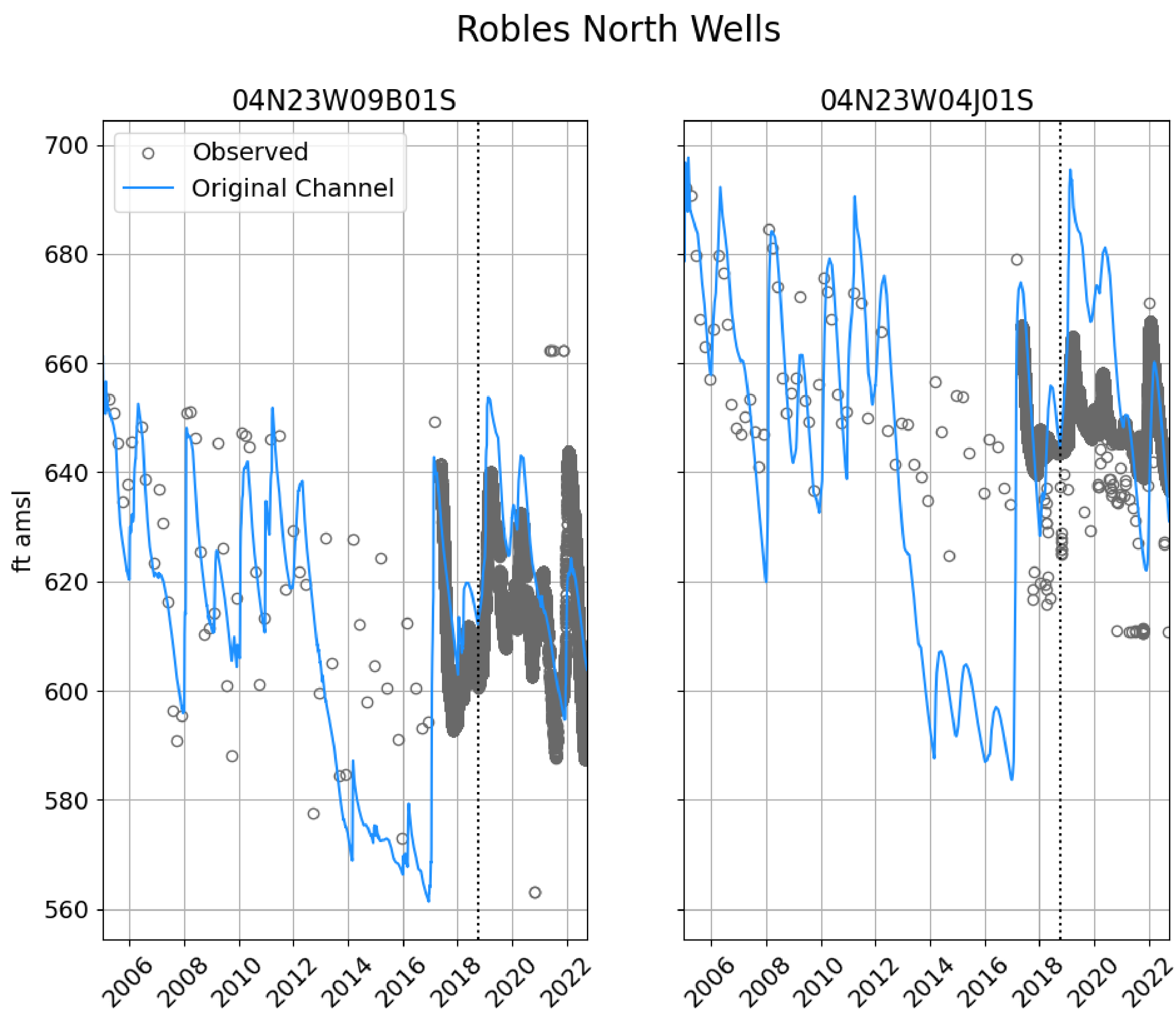

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Figure 3.3b. Observed versus Simulated Groundwater Levels at Calibration Well Locations in the Robles North Hydrogeologic Area

Upper Ventura River Groundwater Basin

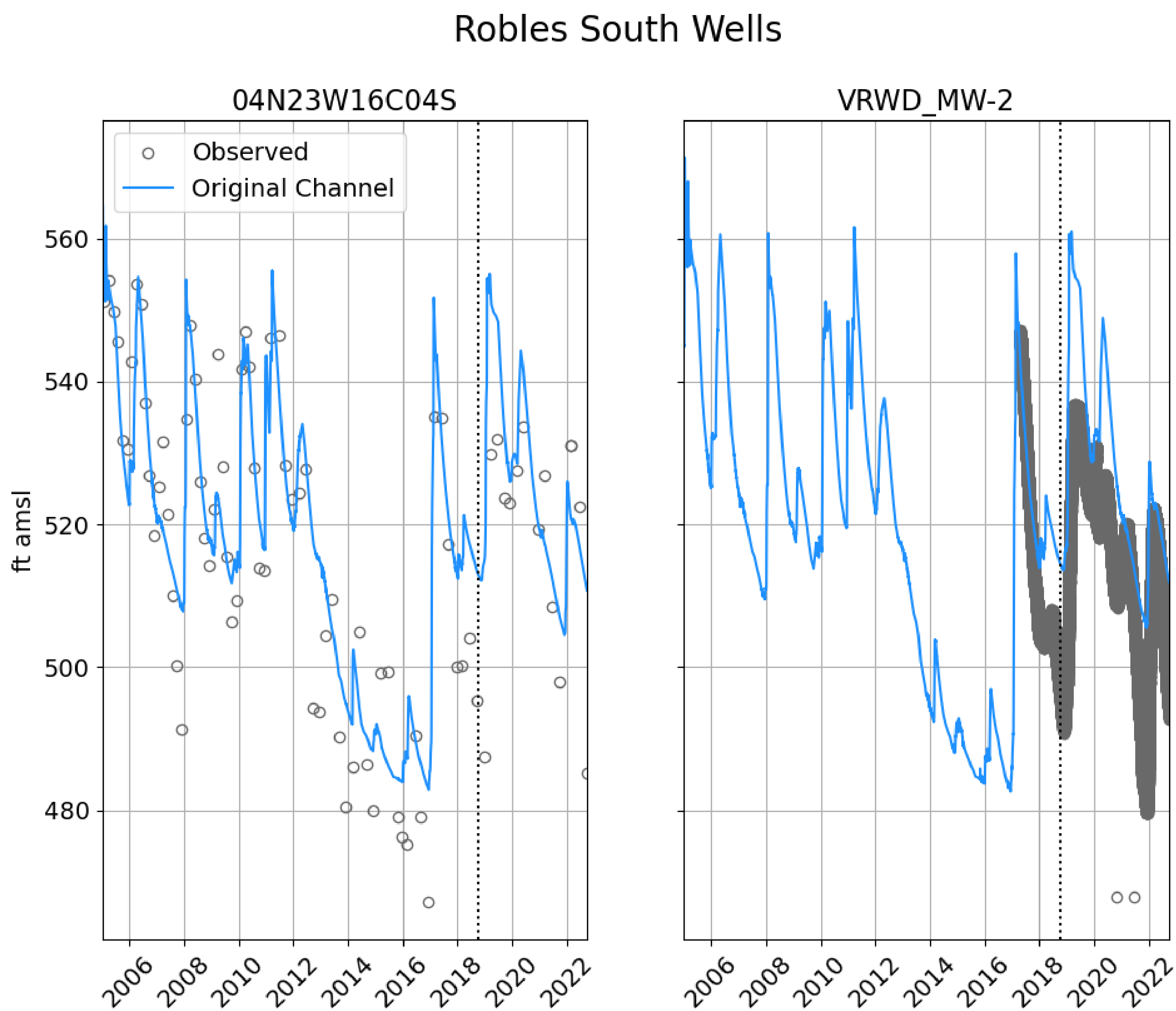

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Figure 3.3c. Observed versus Simulated Groundwater Levels at Calibration Well Locations in the Robles South Hydrogeologic Area

Upper Ventura River Groundwater Basin

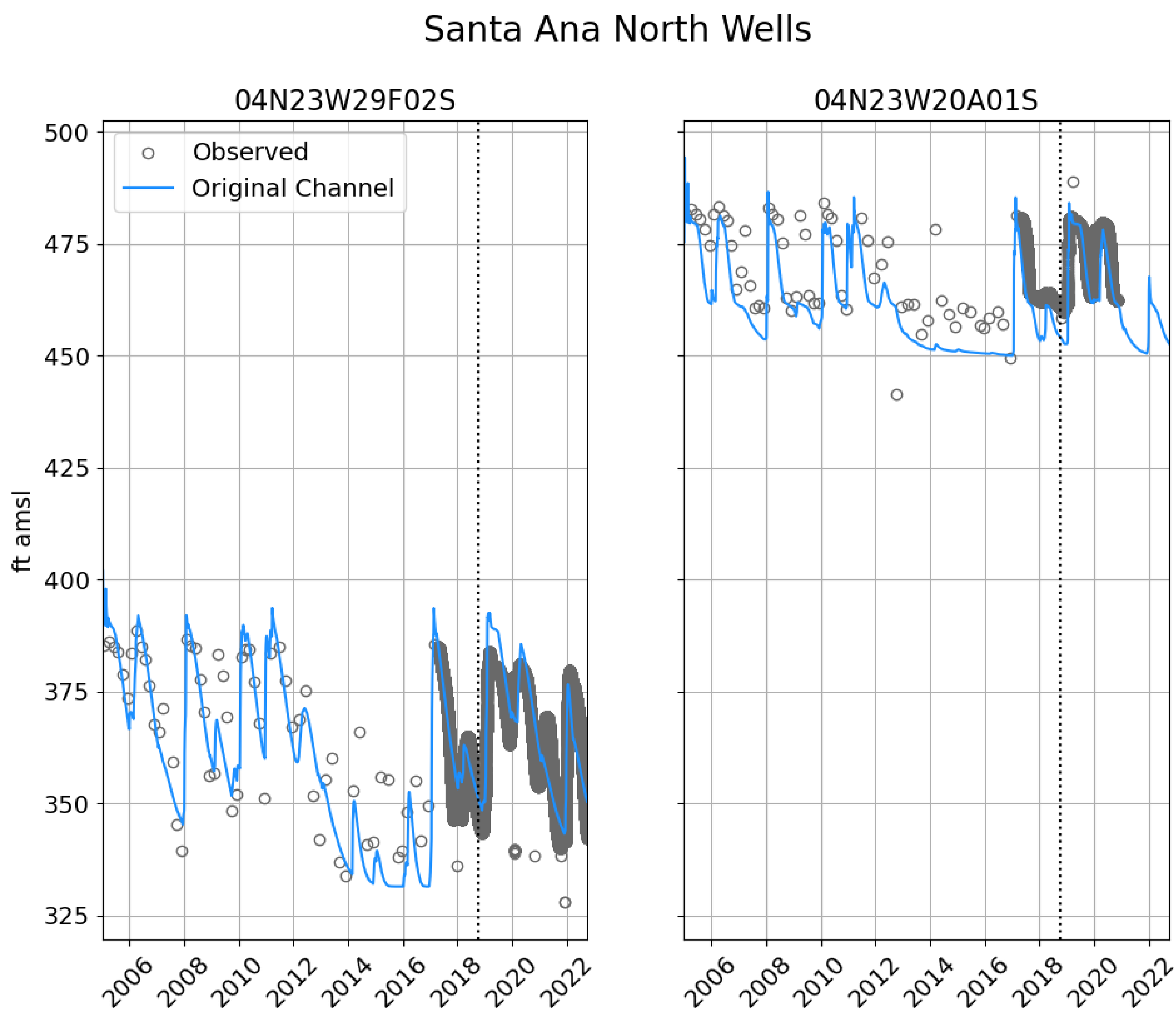

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Figure 3.3d. Observed versus Simulated Groundwater Levels at Calibration Well Locations in the Santa Ana North Hydrogeologic Area

Upper Ventura River Groundwater Basin

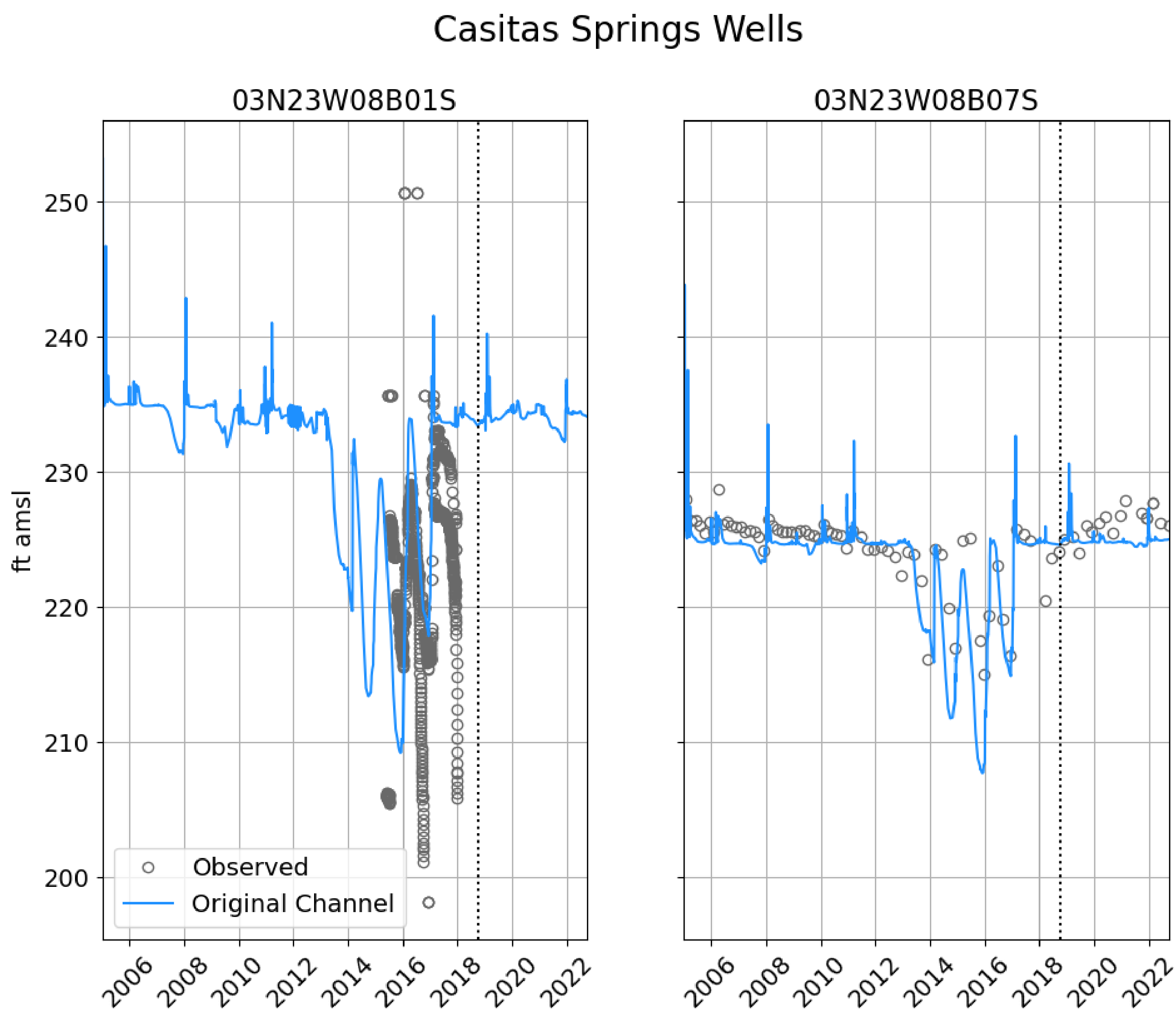

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Figure 3.3e. Observed versus Simulated Groundwater Levels at Calibration Well Locations in the Casitas Springs Hydrogeologic Area

Upper Ventura River Groundwater Basin

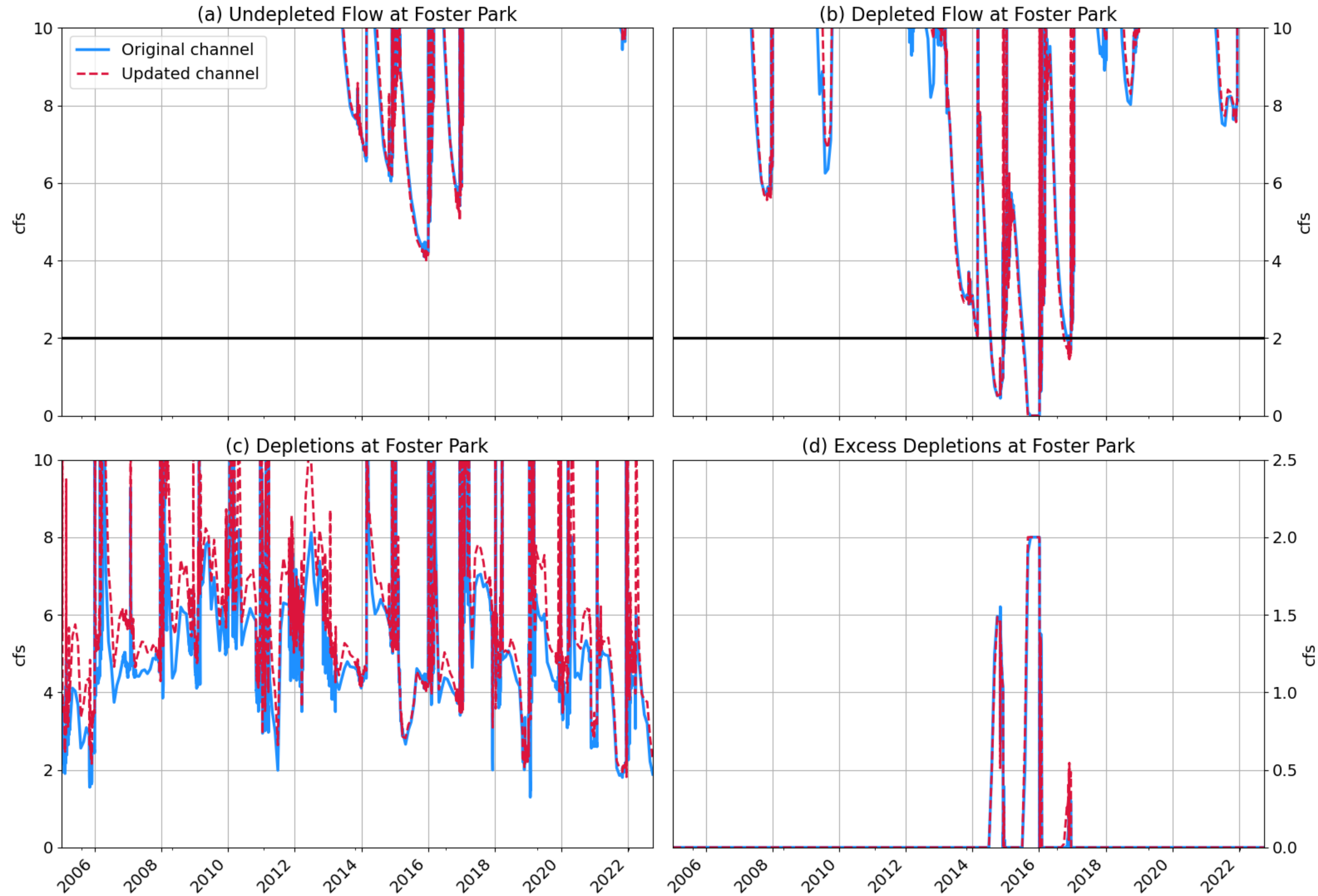


Figure 4.1. Simulated Streamflow Comparison at Foster Park Gage

Upper Ventura River Groundwater Basin

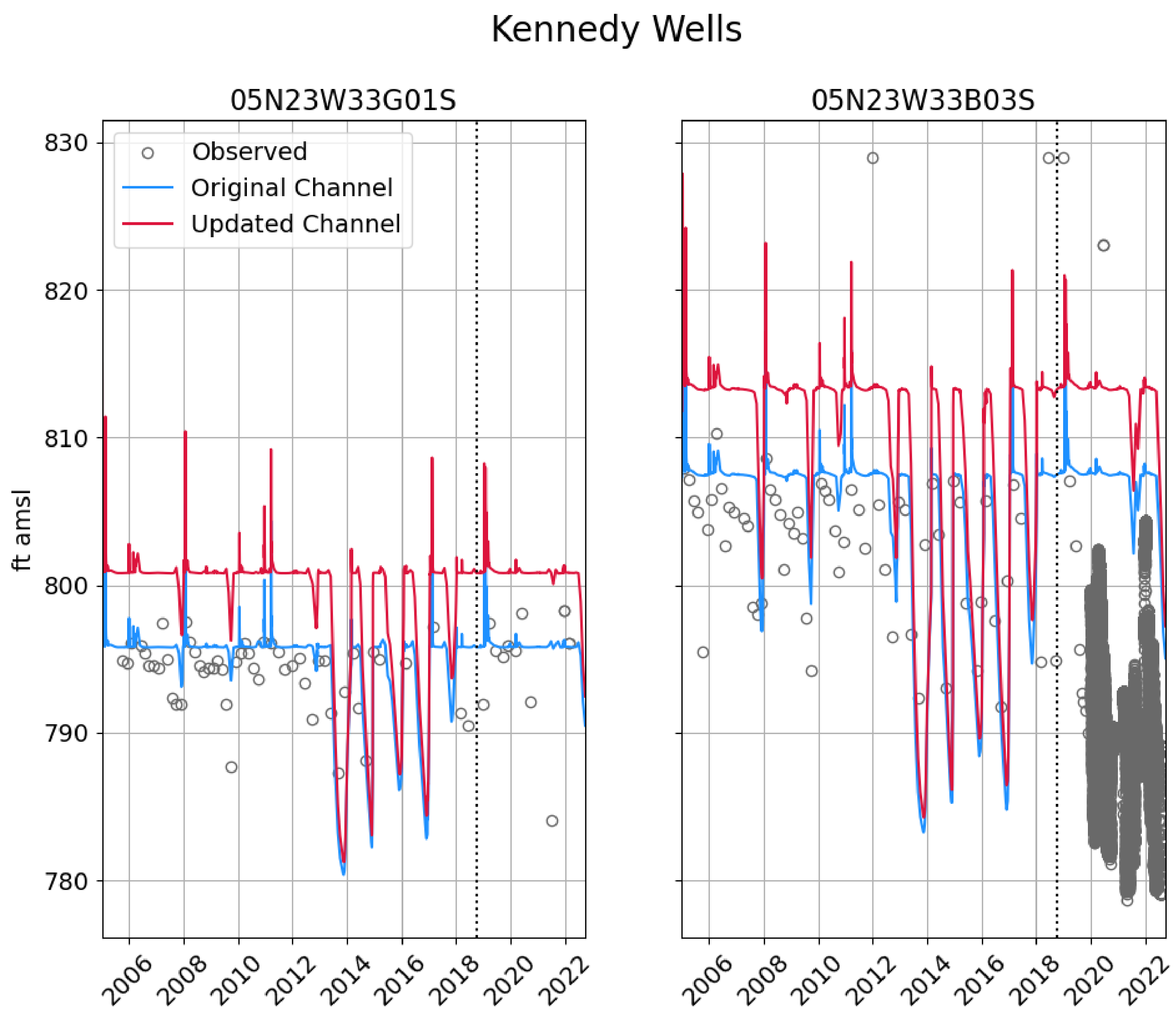
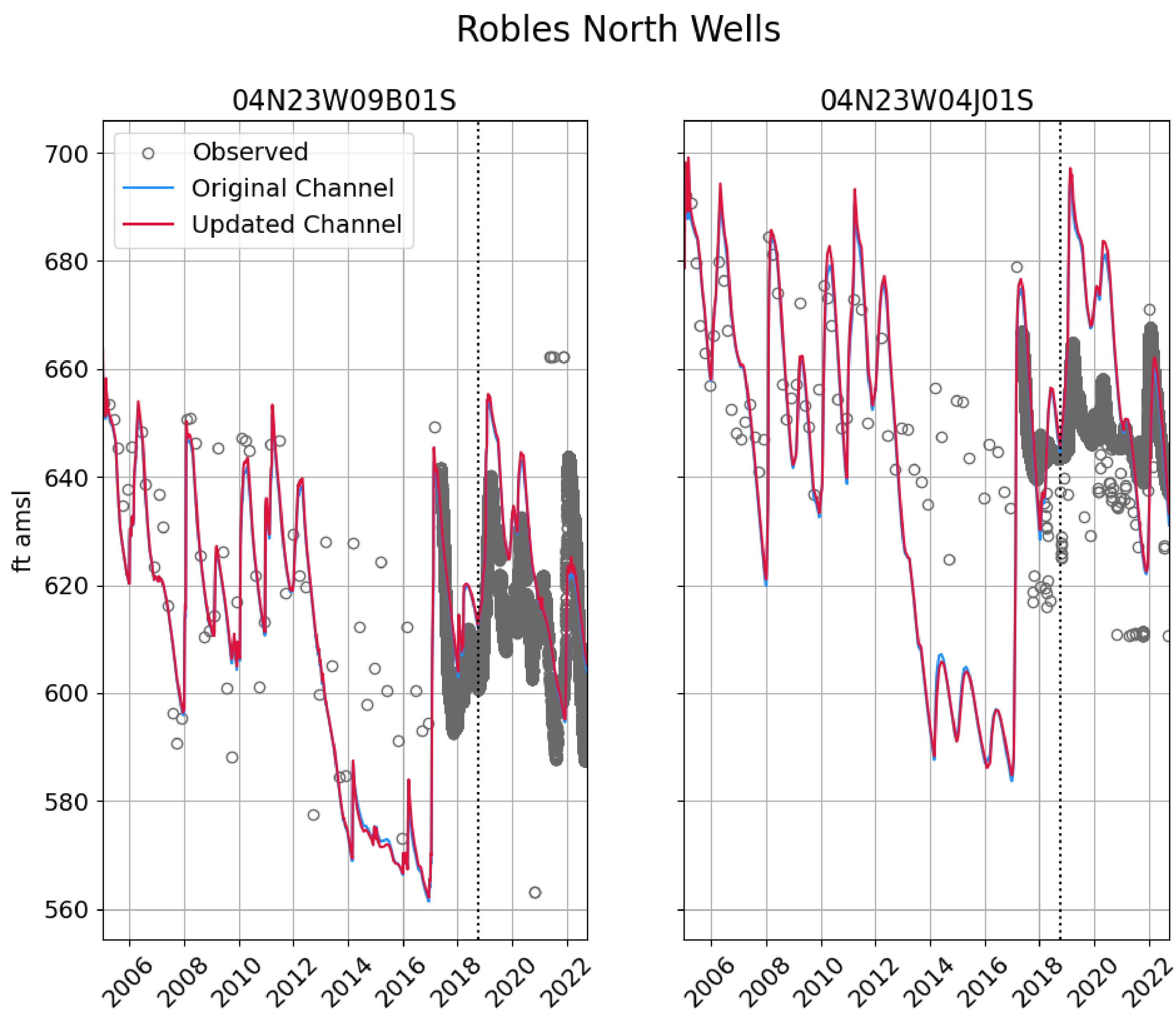


Figure 4.2a. Comparison of Simulated Groundwater Levels at Calibration Well Locations in the Kennedy Hydrogeologic Area

Upper Ventura River Groundwater Basin



INTERA

Figure 4.2b. Comparison of Simulated Groundwater Levels at Calibration Well Locations in the Robles North Hydrogeologic Area

Upper Ventura River Groundwater Basin

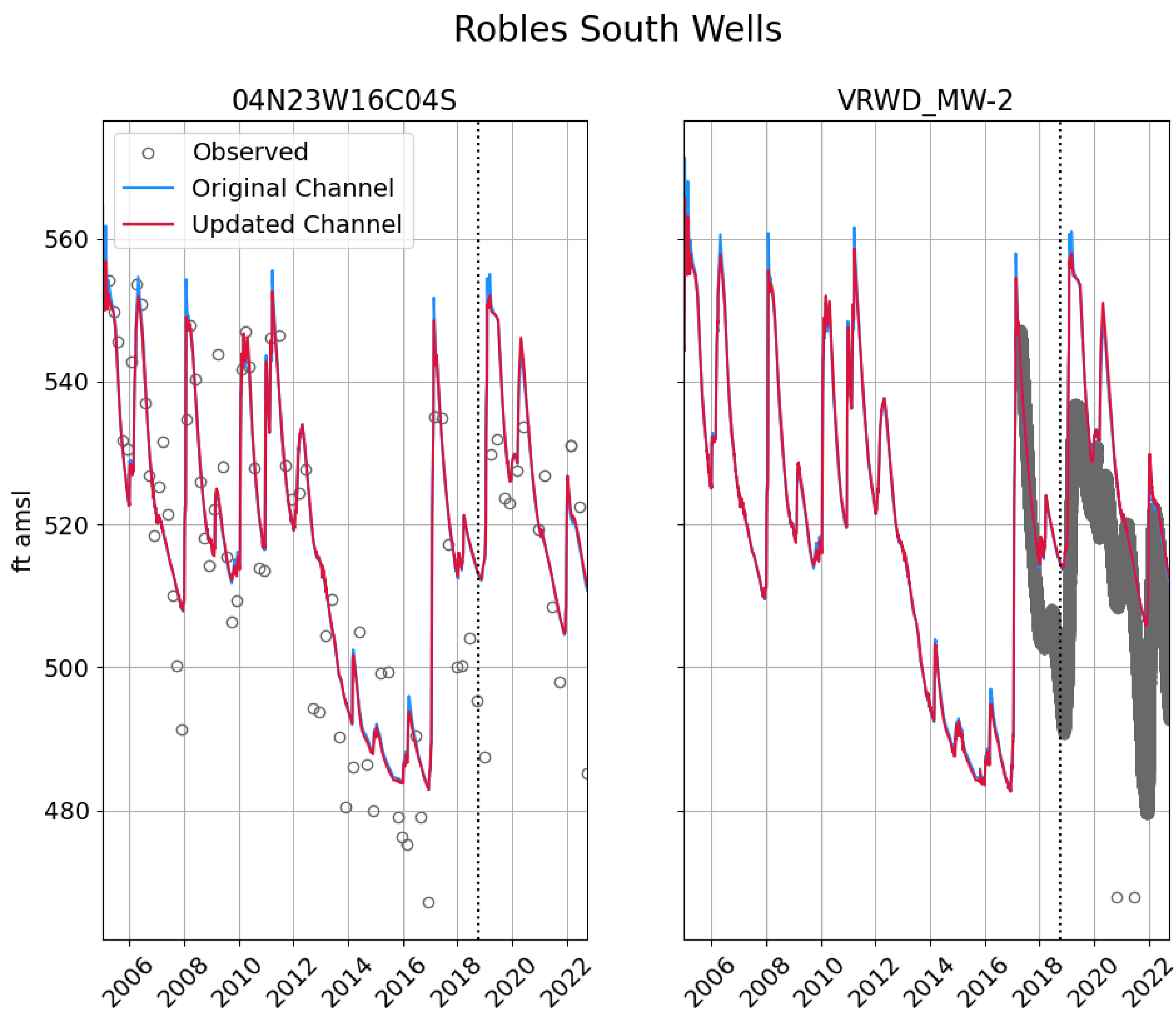
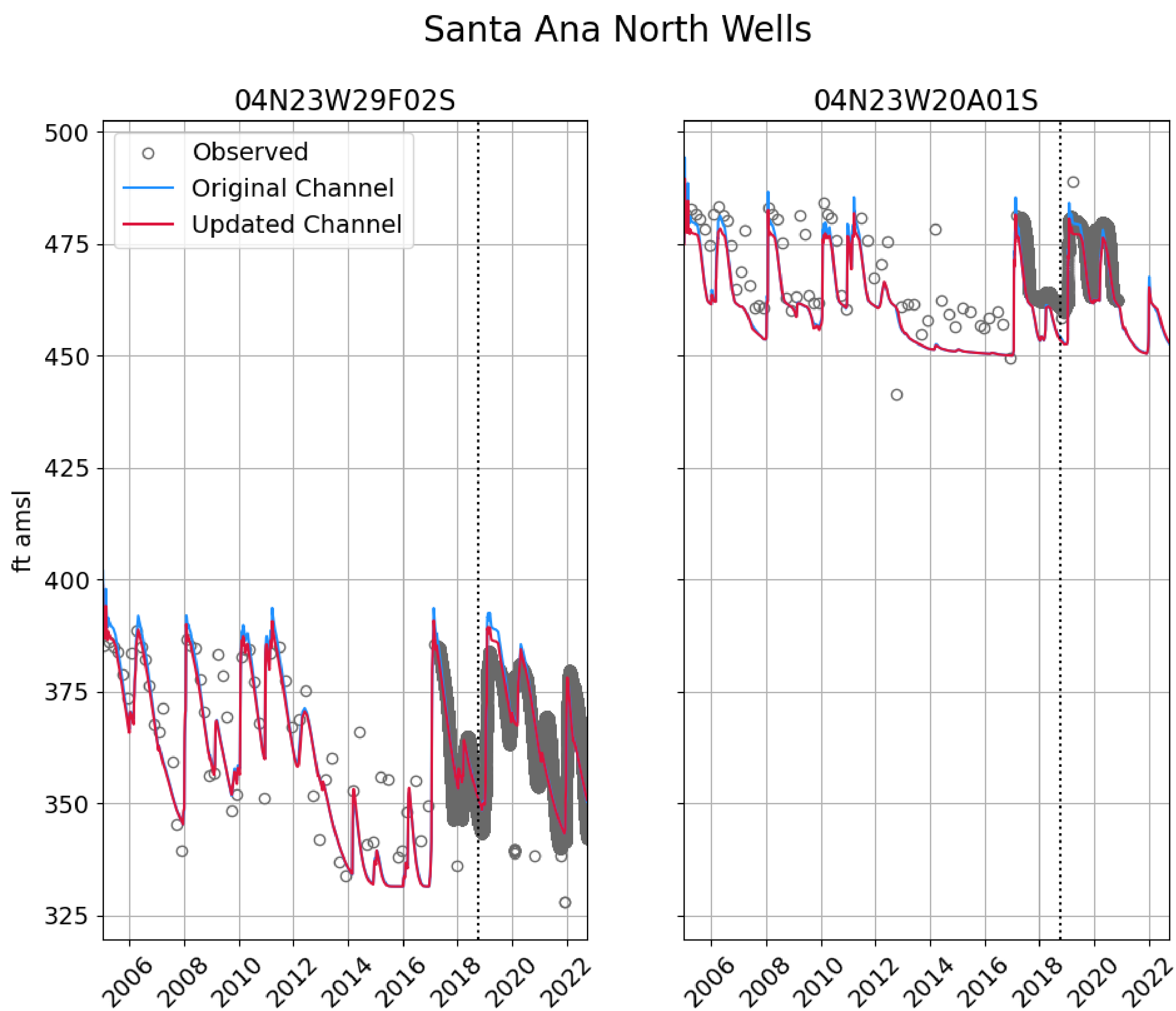


Figure 4.2c. Comparison of Simulated Groundwater Levels at Calibration Well Locations in the Robles South Hydrogeologic Area

Upper Ventura River Groundwater Basin



INTERA

Figure 4.2d. Comparison of Simulated Groundwater Levels at Calibration Well Locations in the Santa Ana North Hydrogeologic Area

Upper Ventura River Groundwater Basin

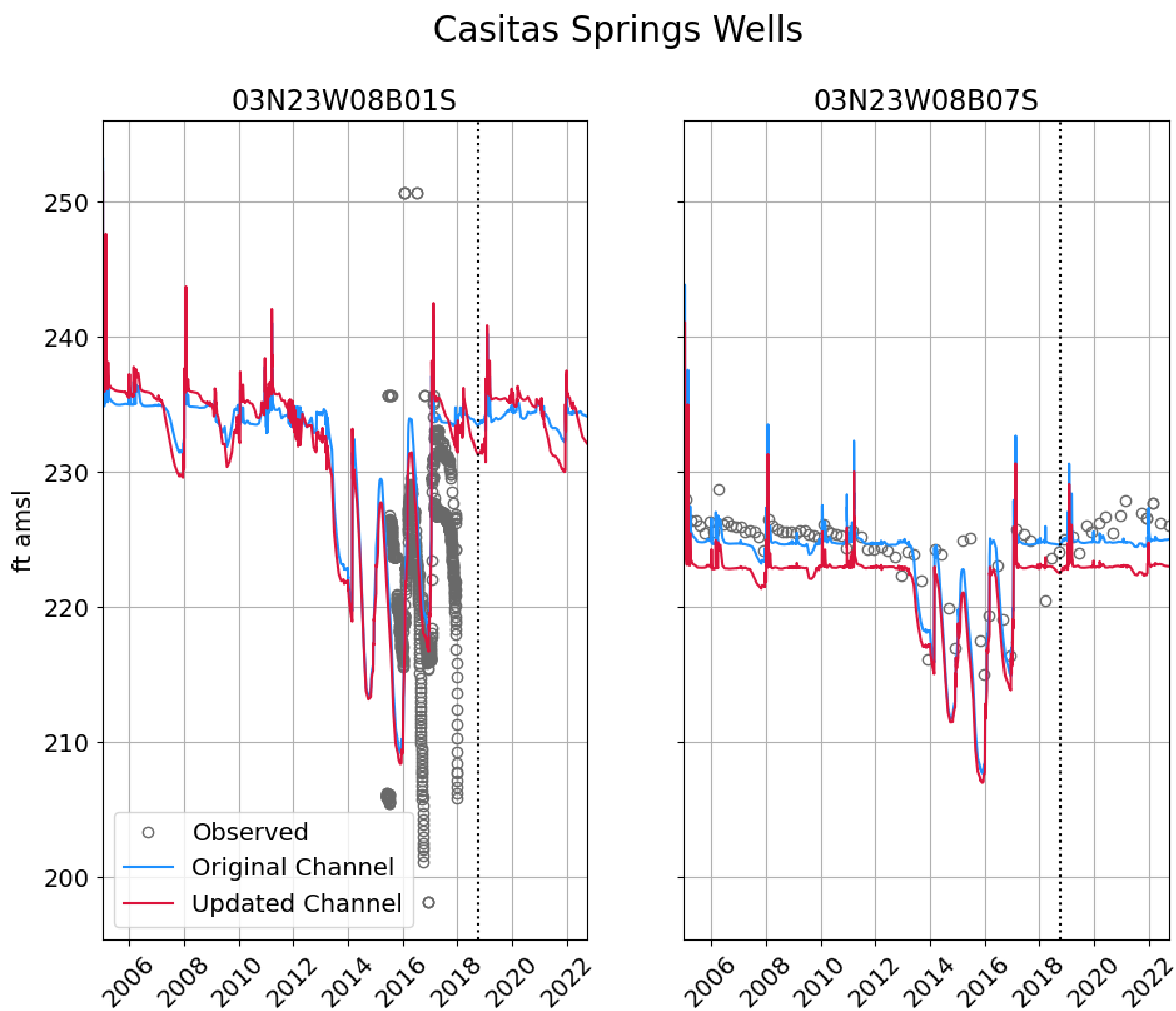


Figure 4.2e. Comparison of Simulated Groundwater Levels at Calibration Well Locations in the Casitas Springs Hydrogeologic Area

Upper Ventura River Groundwater Basin

TABLES

Table 3.1: Calibration Statistics for Calibration Wells

Well	Hydrogeologic Zone	Pre-WY2018		Post-WY2018	
		RMSE (ft)	ME (ft)	RMSE (ft)	ME (ft)
05N23W33G01S	*Kennedy*	2.8	1.0	3.9	0.9
05N23W33B03S	*Kennedy*	6.8	1.5	17.9	17.3
04N23W09B01S	*Robles N*	11.6	9.5	13.7	4.4
04N23W04J01S	*Robles N*	9.7	3.2	18.5	7.8
04N23W16C04S	*Robles S*	9.3	2.6	13.6	6.1
VRWD_MW-2	*Robles S*	10.8	8.4	16.6	14.1
04N23W29F02S	*Santa Ana N*	4.5	0.5	7.1	0.7
04N23W20A01S	*Santa Ana N*	7.2	-6.4	6.6	-4.3
03N23W08B07S	*Casitas Springs*	2.4	-1.1	1.8	-1.4
03N23W08B01S	*Casitas Springs*	8.9	7.5	N/A	N/A
Average		7.4	2.7	11.1	5.1

Table 4.1: Comparison of Simulated Flows at Foster Park[i]

Simulated Undepleted Flows less than 10 cfs			
Average Original Channel	**Average Updated Channel**	**Average Difference**	**Standard Deviation of Difference**
7.0	7.0	0.0	0.3
Simulated Depleted Flows less than 10 cfs			
Average Original Channel	**Average Updated Channel**	**Average Difference**	**Standard Deviation of Difference**
4.6	4.6	0.0	0.4

[i] All values in cfs. Difference in flows is calculated as Updated Channel Flows minus Original Channel Flows.

Table 4.2: Comparison of Simulated Depletions at Foster Park[i]

Simulated Streamflow Depletions at Foster Park for Conditions where Undepleted Flow is Less than 10 cfs				
Flow Conditions	**Average Depletion (Original Channel)**	**Average Depletion (Updated Channel)**	**Average Difference**	**Standard Deviation of Difference**
Undepleted Flow < 10 cfs	4.5	4.6	0.1	0.2

[i] All values in cfs.

Table 4.3: Differences in Groundwater Levels by Calibration Well

Well	Hydrogeologic Zone	Average Difference in Simulated Groundwater Levels (Updated minus Original; 2005-2022; ft)
05N23W33G01S	*Kennedy*	5.0
05N23W33B03S	*Kennedy*	4.4
04N23W09B01S	*Robles N*	0.7
04N23W04J01S	*Robles N*	0.7
04N23W16C04S	*Robles S*	-0.2
VRWD_MW-2	*Robles S*	-0.2
04N23W29F02S	*Santa Ana N*	-0.5
04N23W20A01S	*Santa Ana N*	-0.5
03N23W08B07S	*Casitas Springs*	-1.7
03N23W08B01S	*Casitas Springs*	-0.3
Average		1.4