LOMR
VOLUME 1

For the

Upper Bound

Of the

Detailed Study Reach

Of the

CALABACILLAS ARROYO

Prepared for:

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January 2010

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Purpose and Scope

The purpose of this LOMR request is to convincingly demonstrate that the FIRM, adjacent to the upper reach of the Calabacillas Arroyo (see Figure 1 – Vicinity Map), should be revised to modify the limits of the designated flood areas on panels 35001C0103G & 0104G as depicted in Figure 2 – Revision Area. The owners/developers of the two residential subdivisions, Saltillo Subdivision on the north side and Anasazi Ridge Subdivision on the south side of the arroyo, want to fulfill their obligation to remove the floodplain from the developable lots and the bridge deck in accordance with their development agreements. Mark Goodwin and Associates, MGA, has the responsibility for the preparation and this submittal requesting a Letter of Map Revision. This submittal provides the supporting documents and references required by 44 CFR Ch. 1 to modify the designated flood zones in the request area to the limits proposed in this submittal. In addition, the CD included with the submittal contains a full copy of the submittal, spatial & model files, presentation graphics and all documents referenced.

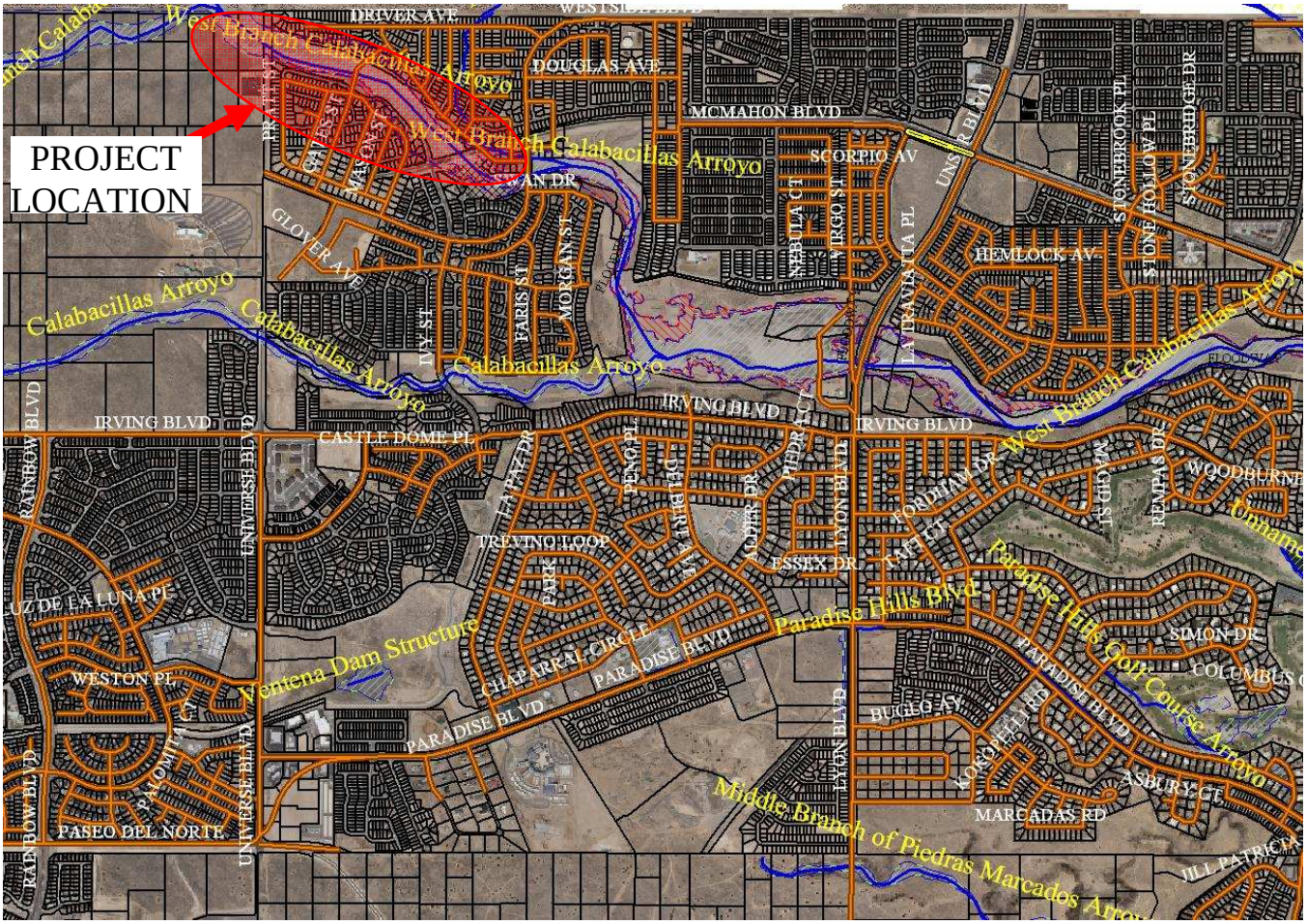

Figure 1 – Vicinity Map

The materials that are included show that the flood hazard condition within the following areas beyond the revised bank limits should be removed from the current effective maps, as shown in Figure 2. The revised bank limits are defined by the floodway boundary indicated on the Annotated FIRM, in APPENDIX A, and based on the results of the data included in this submittal. The removed areas are: 1) the areas beyond the limits to the north known as Saltillo Subdivision, 2) the areas beyond the limits of the floodway to the south beyond Anasazi Ridge Avenue., and 3) the McMahon Boulevard Bridge deck. .All of the floodplain revisions are based on improvements located about 5 miles upstream of the confluence of the Calabacillas Arroyo with the Rio Grande to the limits of the detailed study of the Calabacillas Arroyo. The lower limit of the revision is 25916.8. This reach of the arroyo has a length of approx.3000 feet and is a middle reach of the basin. The construction improvements within the floodway as shown in the studies, designs and modeling of the reach contained in this request demonstrates the validity of the LOMR request. The Flood Plain Administrator for the most affected community (Albuquerque) by the modifications has endorsed this request as shown on the concurrence form. The submittal has been forwarded through the Flood Plain Administrator for the City of Albuquerque to the Federal Emergency Management Administration, FEMA.

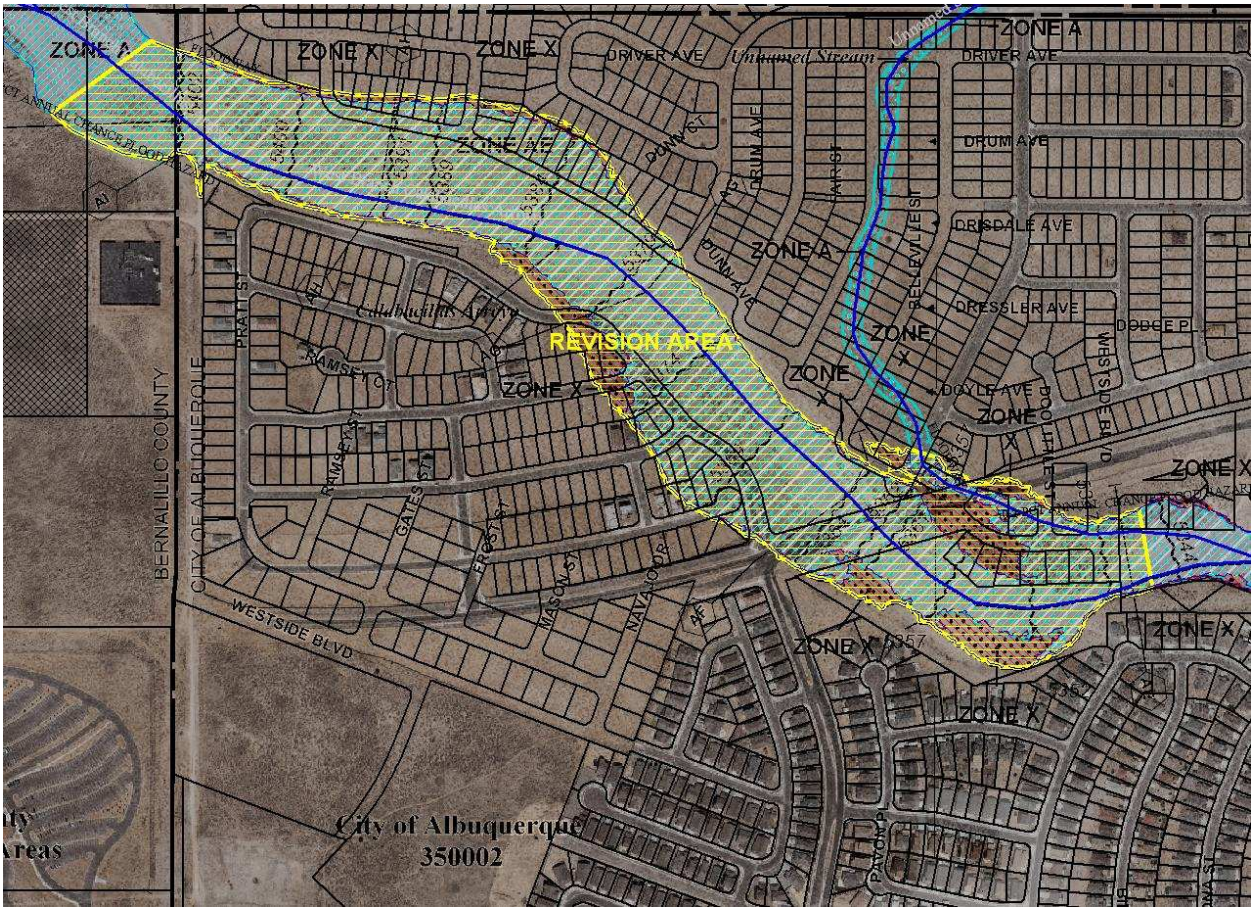

Figure 2 – Revision Area

Planning and Design of the Improvements

Master Drainage Management Plan

The engineering design began in 2001 when AMAFCA hired Mussetter Engineering to evaluate the stability of the arroyo. The evaluation was documented in the report titled "Hydraulic and Channel Stability Analysis and Designing Assistance for Main Branch Calabacillas Arroyo Upstream from Swineburne Dam". In that report, attached as *APPENDIX C*, design flows were established for the 64 square mile watershed. The assumption of this analysis was a design flow of development in the year 2036 as illustrated in Table 2.1 from that document . The 100-YR design flow was estimated to be 14,734 cfs including 598 cfs sediment which is more than double the 100-YR flow in the FIS of 7,071 cfs. However, based on historical flow data the report includes a rejection of the higher flows. Therefore the flows in the current FIS have been applied for this submittal.

Table 2.1. Summary of peak discharges and storm runoff volumes, Main Branch, Calabacillas Arroyo upstream of Swinburne Dam.

Recurrence Interval (years)	Pre-development Conditions			2036 Development Conditions		
	Peak Discharge (cfs)		Unbulked Runoff Volume (ac-ft)	Peak Discharge (cfs)		Unbulked Runoff Volume (ac-ft)
	Unbulked	Bulked		Unbulked	Bulked	
Node P28 - Just downstream of north bank tributary at Station 254+00 (66.5 mi^2)						
2	963	990	229	3,173	3,277	618
5	3,096	3,215	735	5,478	5,681	1,172
10	4,889	5,099	1,161	7,527	7,809	1,656
25	7,183	7,495	1,707	9,968	10,352	2,241
50	9,128	9,531	2,170	12,025	12,508	2,737
100	11,154	11,659	2,652	14,136	14,734	3,247

Figure 3 – Discharge Analysis

The study also included sediment transport analysis and concluded that this reach of the arroyo is both horizontally and vertically unstable. Initially the report recommended setting aside a 1500' wide corridor to accommodate lateral migration.

Preliminary & Hydraulic Design

In 2004, Mark Goodwin and Associates as the engineer for the owner of the affected property suggested that countermeasures be used to limit the lateral migration. Spurs and Bank Protection were recommended to limit lateral migration to a corridor that varied from 250' to 400' width. Grade Control Structures made out of 2' thick concrete were recommended to prevent excessive vertical incision that is expected to result from a decrease in sediment supply associated with the year 2036 development of the upstream watershed. In 2005 a comprehensive design analysis report was provided for the bridge, the grade control structures, the bank protection and the fill in the overbanks which provided 2' of freeboard for the 100-yr water surface elevation using the 2036 design flow. The project was then broken up into pieces for preparation of final construction documents.

Preliminary design was completed in March 2005 and is contained in two documents. The "Calabacillas Arroyo Stabilized Development Master Plan" dated 6/10/2004 by MGA, ,*APPENDIX B*, and "Hydraulic and Channel Stability Analysis and Design Assistance for the Main Branch of the Calabacillas Arroyo Upstream from Swinburne Dam" dated March 2005 by Mussetter Engineering Inc. *APPENDIX C*. (See the summary of the "Modified Design, Map 2" from Mussetter, 2005 below). On March 17 2005 a three way agreement between 1) the City of Albuquerque, COA, 2) the Albuquerque Metropolitan Arroyo Flood Control Authority, AMAFCA, and 3) Vista Arroyo LLC, VISTA, (then the owner of the land on both sides of the arroyo north of McMahon Boulevard) was assigned the responsibility for the construction of 3 grade control structures (#2, #3, and #4), the McMahon Boulevard Bridge together with its associated Bank Protection, and finally Spurs and Bank Protection on both sides of the arroyo for a distance of about 3,000 feet upstream from the bridge to protect the new subdivision(s) from possible long term lateral migration of the arroyo. AMAFCA agreed to accept maintenance of the spurs, bank protection, and grade control structures if constructed to their standards, and the COA took the bridge maintenance responsibility.

McMahon Boulevard Bridge Plans

The COA hired Wilson & Company to prepare the construction documents for the McMahon Boulevard Bridge. The plans included the bridge guide banks and grade control structures #2 and #3 downstream of the bridge. The construction of that project was completed and Wilson & Company provided as-built plans dated March 2007 (See *APPENDIX D* for Record Drawings with Certification dated 3-30-2007). The bridge deck is not in the floodplain and the guide banks further limit the floodplain for several hundred feet either side of the bridge. The newly constructed guide banks end abruptly below the bridge and the flood plain there spreads abruptly back to its natural width. The COA maintains the bridge, and AMAFCA maintains the bank protection and the grade control structures.

Anasazi Ridge Subdivision Plans

Grading of the south bank of the arroyo and Anasazi Ridge Road construction was completed in early 2007 and Record drawings were provided by Smith Engineering with Surveyor's Certification dated 3-21-2007 (See *APPENDIX G* for Record Drawings). Since then several houses have been constructed on the lots that were elevated above the floodplain on the south side. They are presently owned by separate individual residents, not the developer. (See 2008 orthographic-photo). The bank protection has not been constructed on the south side of the arroyo, and the fill needed to establish the top of bank in the location shown on those plans is not constructed. The road has been constructed more than 2' above the 500-yr water surface elevation as illustrated on the profile in the following section. In addition, the lots are higher than the road. The COA will maintain the road after that construction is accepted, and AMAFCA will maintain the bank protection after it has been constructed and accepted.

Saltillo Subdivision Plans

Construction of the north bank of the arroyo began in 2007. In 2009 the construction of the spurs and bank protection on the north side of the arroyo has been completed. Phase 2 of Saltillo fronts most of the 3000' length of the revised portion of the arroyo. It has been subdivided and graded but the roads and utilities in Phase 2 have not been constructed. (See *APPENDIX F* for Record Drawings).

Channelization, Spurs & Bank Protection

The "top of bank" for the left bank (looking downstream) has been constructed in accordance with the Construction Plans for the Calabacillas Arroyo Improvements – Saltillo Subdivision Spurs and Bank Protection with engineer's stamp dated 11-29-2007 (See APPENDIX E) as verified by field survey received from Surv-Tek Inc. on 1-25-2010. The "top of bank" for the right bank has been established at the north boundary of the right-of-way of Anasazi Ridge Avenue as depicted in the Construction Plans for the Anasazi Ridge Subdivision with engineer's stamp dated 6-27-2006 (See APPENDIX G) as verified by field survey received from Surv-Tek Inc. on 1-25-2010.. The "top of bank" has been constructed more than 2' above the 500-yr water surface elevation as illustrated in the profile view of the finished conditions on and the lots are higher in elevation than the "top of bank". AMAFCA will maintain the bank protection after it has been constructed and accepted.

Form 1 – Overview and Concurrence

Hydraulic Analysis Method

Duplicate Effective Model

FIS Data Request Case Z1006082 provided the base digital data used in this analysis. The data included the current effective HEC-RAS model, and shape files of cross section locations and horizontal mapping of Manning's n values, but no topography. The current effective HEC-RAS geometry file name is "Geom 01 by CodeH2 for Windows.g01" which is identical to "Floodway Flows.g02" because the encroachment height was set to Zero. The Current effective HEC-RAS model has two plan files titled "Floodway and Multiple" with similarly named flow files.

Corrected Effective Model

The Corrected Effective Model was copied from the effective model and supplemented with additional data. The model was supplemented with 2' contour interval topographic information from the year 2000 and 1' contour interval topographic information from the year 2004. The revised reach is shown in Figure 4a. The modified sections combined with the effective sections are shown in Figure 4b - Figure 4e on pages 4-3 thru 4-4. In addition, appropriate GIS locations were assigned to the two unreferenced cross sections, 25916.80 and 29751. The reach was also extended to station 30250.28. As determined from the flow profiles, the modifications produce an EGL that has a grade that is consistent with respect to the channel slope than the previous model.

Record Drawings

As-Built plans were obtained for two construction projects, the McMahon Bridge Record Drawings from Wilson & Company with Certification dated 3-30-2007 and the Anasazi Ridge Subdivision Record drawings from Smith Engineering with Surveyor's Certification dated 3-21-2007 as verification that the improvements had been constructed in accordance with the original design plans. Construction in accordance with the third plan set, Construction Plans for the Calabacillas Arroyo Improvements – Saltillo Subdivision Spurs and Bank Protection with engineer's stamp dated 11-29-2007, was verified by field survey from Surv-Tek Inc. James D Hughes visited the site to further verify as-constructed conditions.

All of the Record Drawings, Construction Plans and surveys are on NGVD 29. NGVD 29 elevations were converted to NAVD 88 elevations by adding 2.8 feet. All FEMA information is based on NAVD 88. Spatial files of the subdivision construction plans were transformed from the NAD 27 to NAD 88 projections in the central zone of the New Mexico State Plane Coordinate System and combined with spatial files from the D-FIRM and a 2008 ortho-photo. All spatial files have been adjusted to NAD 83 and NAVD 88 on the central zone of the New Mexico State Plane Coordinate System.

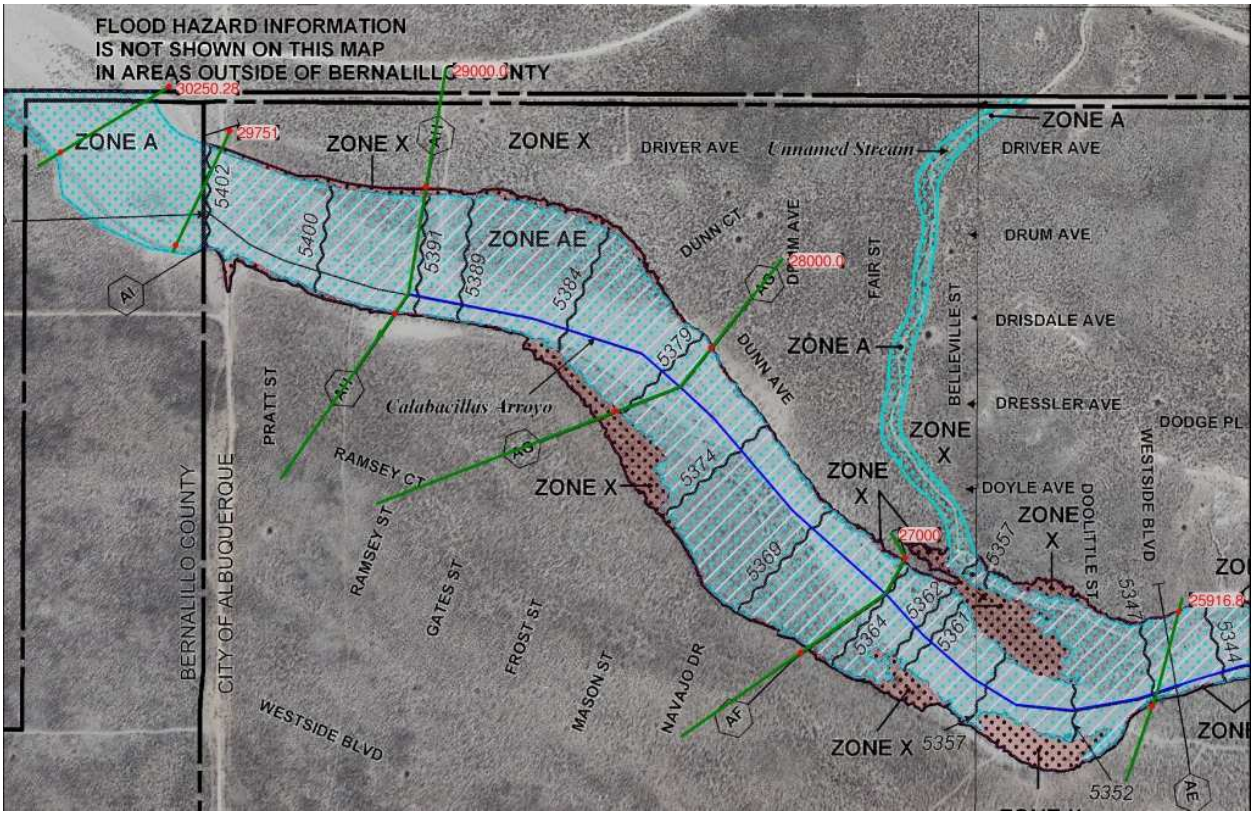

Figure 4a – Reach Schematic

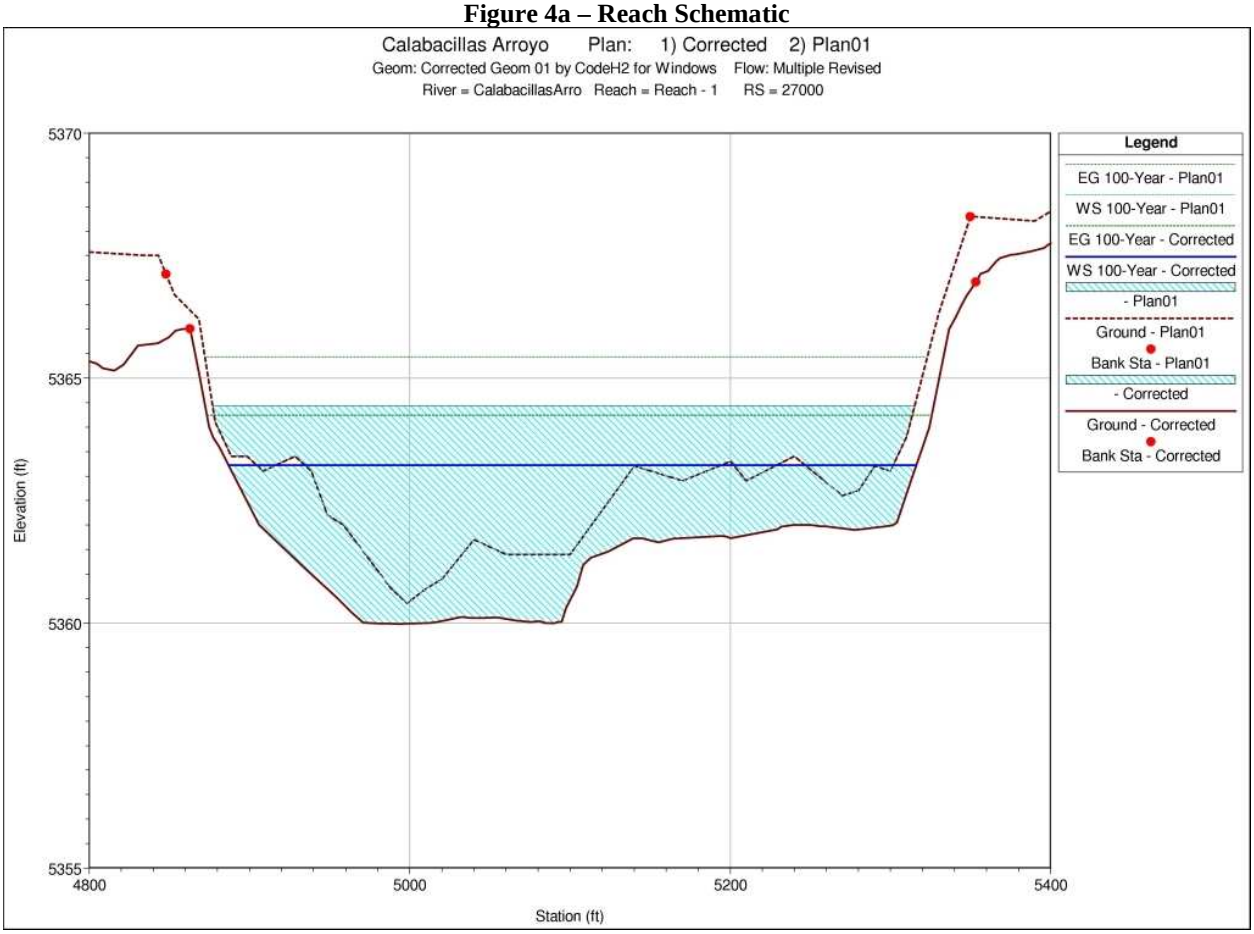

Figure 4b – Cross Sections

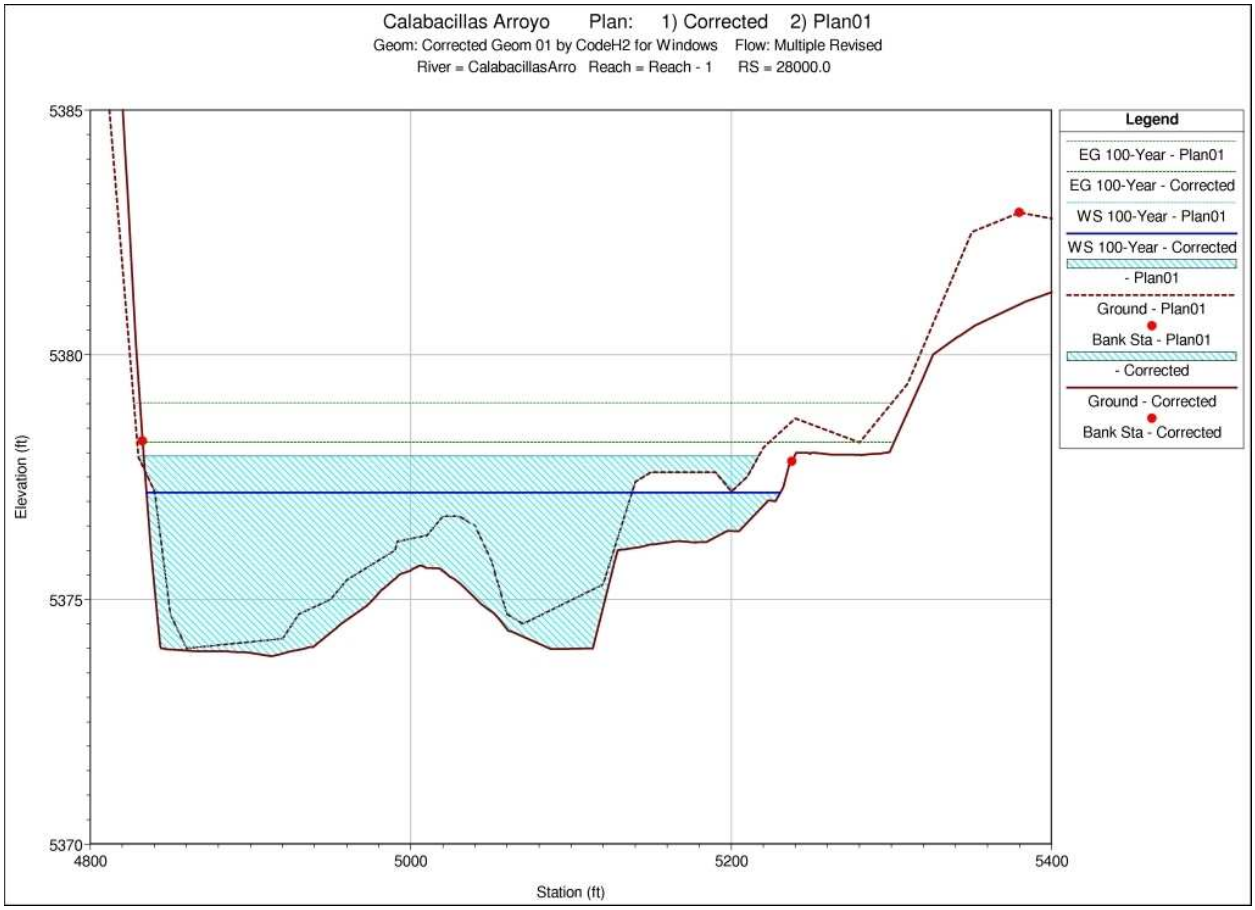

Figure 4c – Cross Sections

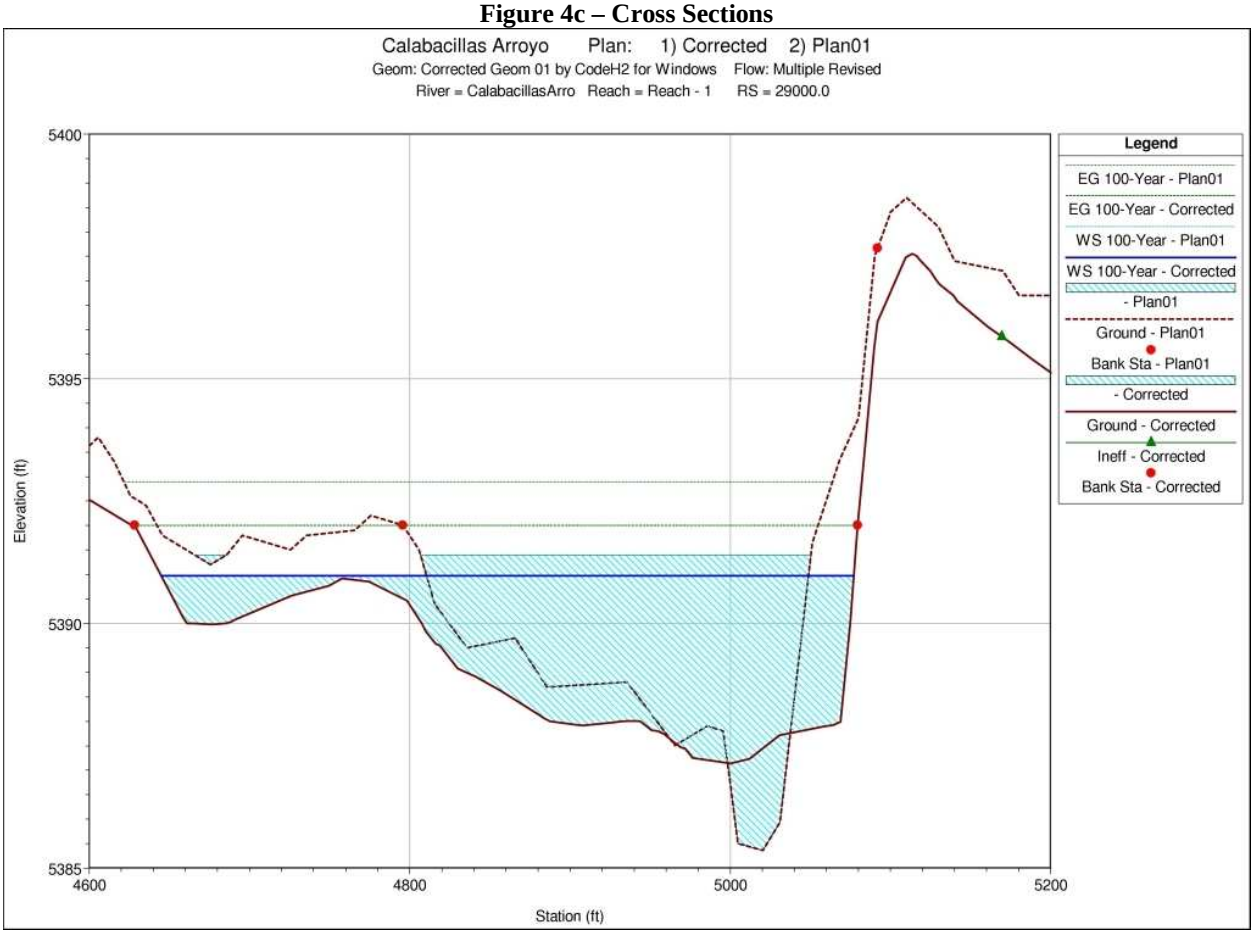

Figure 4d – Cross Sections

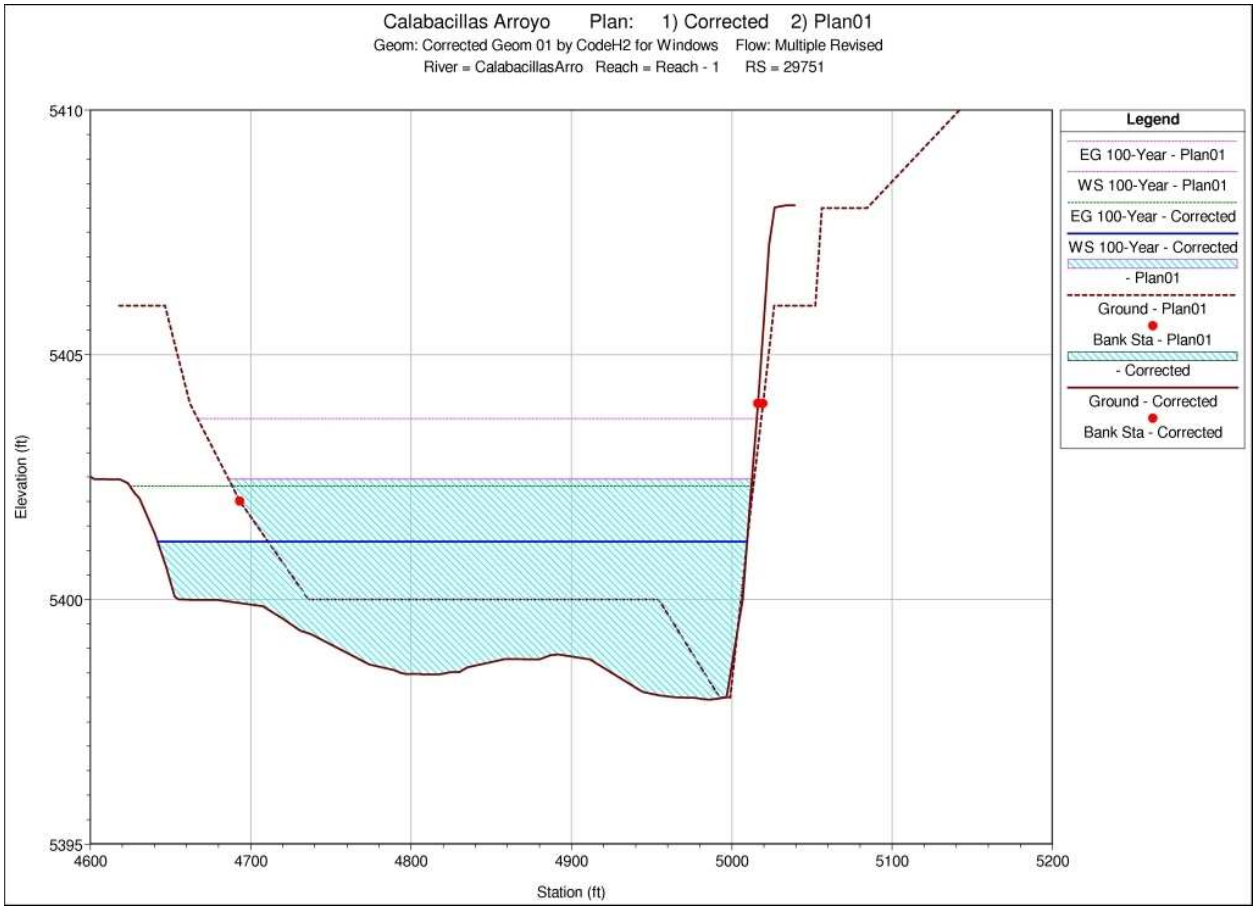

Figure 4e – Cross Sections

Plan Title	Geometry File	Flow Data File
Plan01 Corrected	Geom 01 by CodeH2 for Windows Corrected Model	Multiple Multiple Revised

River	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
CalabacillasArro	29751	100-Year	Plan01	7071.03	5398.00	5402.46	5402.46	5403.69	0.005232	8.92	794.29	327.73	1.00
CalabacillasArro	29751	100-Year	Correcte	7070.34	5397.95	5401.18	5401.18	5402.31	0.00593	8.53	829.19	367.75	1.00
CalabacillasArro	29000	100-Year	Plan01	7071.03	5385.36	5391.40	5391.40	5392.89	0.004978	9.79	723.81	263.94	1.00
CalabacillasArro	29000	100-Year	Correcte	7070.34	5387.14	5390.98	5390.98	5392.01	0.004255	8.15	867.55	432.34	1.01
CalabacillasArro	28000	100-Year	Plan01	7071.03	5374.00	5377.93	5377.93	5379.02	0.005473	8.39	843.17	387.16	1.00
CalabacillasArro	28000	100-Year	Correcte	7070.34	5373.84	5377.19	5377.12	5378.21	0.016728	8.12	870.66	395.47	0.96
CalabacillasArro	27000	100-Year	Plan01	7071.03	5360.40	5364.43	5364.43	5365.44	0.005638	8.06	877.78	438.13	1.00
CalabacillasArro	27000	100-Year	Correcte	7070.34	5359.98	5363.22	5363.22	5364.24	0.011844	8.1	872.71	429.29	1.00
CalabacillasArro	25916.8	100-Year	Plan01	7071.03	5343.00	5347.46	5347.46	5348.87	0.005155	9.54	741.41	268.17	1.01
CalabacillasArro	25916.8	100-Year	Correcte	7070.34	5343.00	5347.46	5347.46	5348.87	0.00514	9.53	742.07	268.19	1.01

Figure 5 – Effective vs. Corrected Water Surface Tables

Post Project Conditions Model

The revised HEC-RAS conditions model "Revised Conditions.p03" was completed utilizing the revised flow file from the effective model "Revised Multiple - CALABACILLAS ARROYO.f01 and the revised cross section geometries for River Stations 25916.8 – 30250.28, "Post Conditions Model - CALABACILLAS ARROYO.g03". The post reach schematic and spatial files were combined as shown in Figure 6. The current effective cross sections AH, AG, and AF at River Stations 29000, 28000, and 27000 respectively were superimposed on the on the Corrected Effective model as shown in Figure 6a – Figure 6f on the following pages. The McMahon Bridge was modeled by adding sections 26978.42 and 26866.42. Horizontal variations of Manning's 'n' value within the channel were replaced by a single value for the channel at all of the modified cross sections. The calculated water surface elevation is equal to critical depth at all cross sections so 'n' values have little effect.

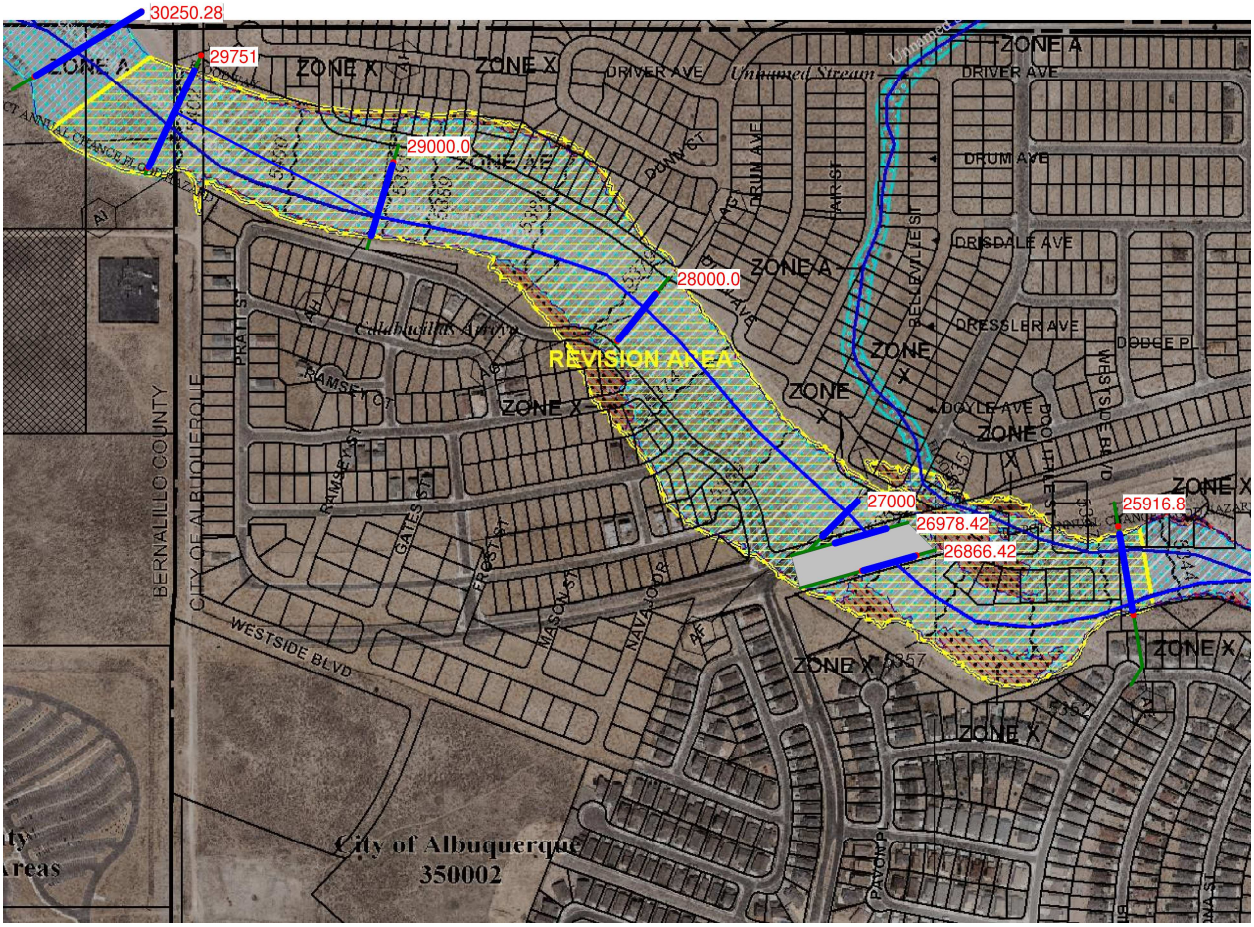

Figure 6a – Reach Schematic

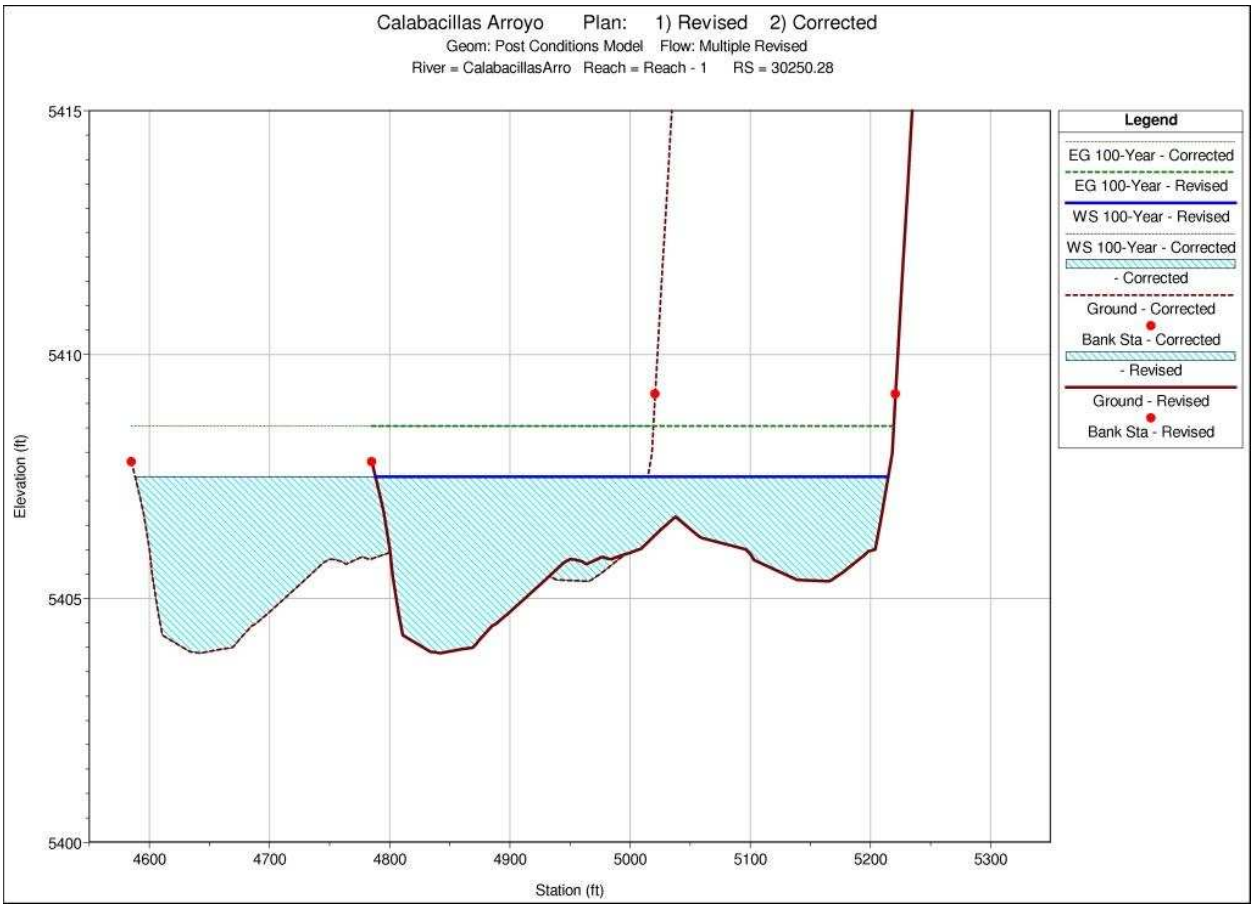

Figure 6b – Corrected vs. Revised Cross Sections

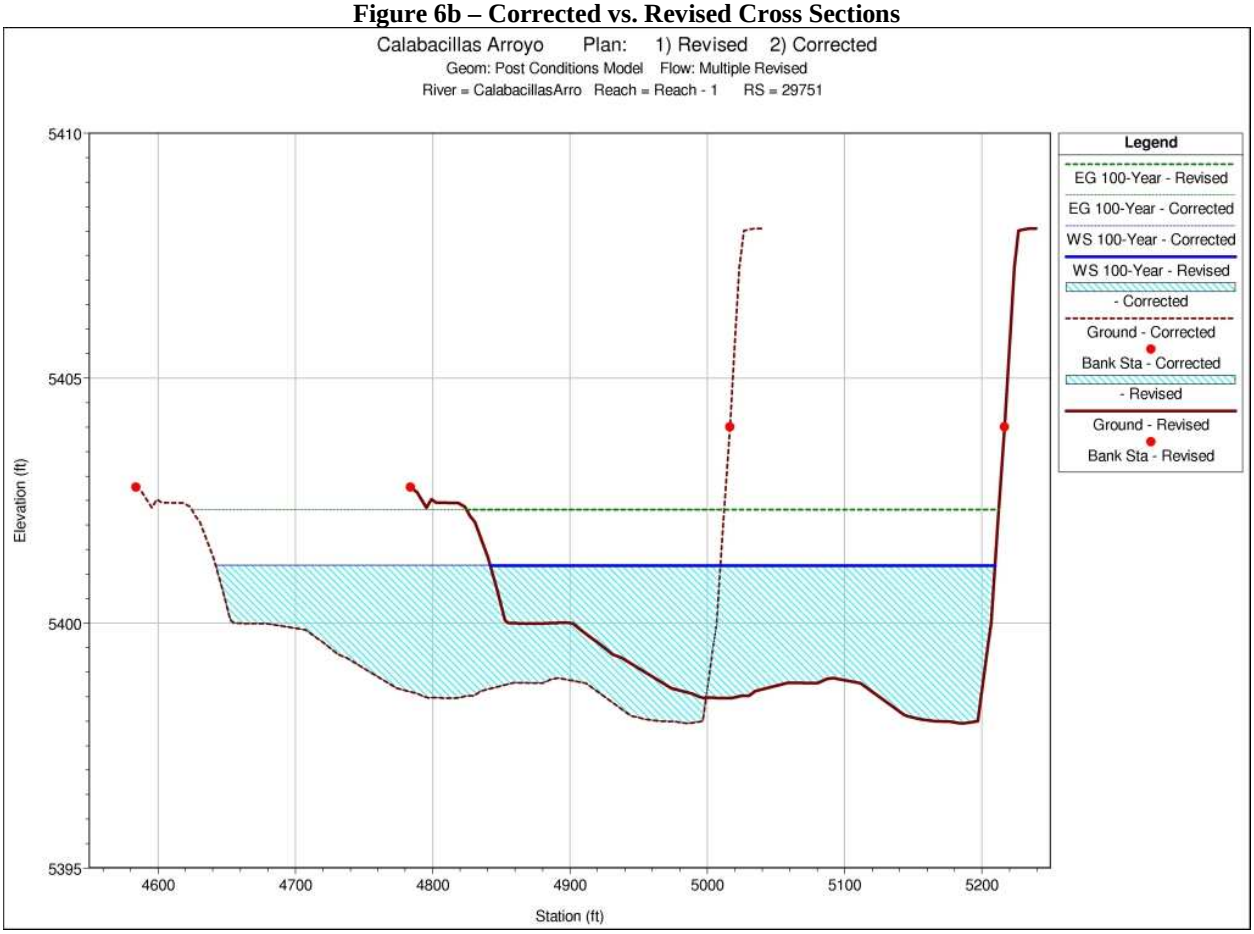

Figure 6c – Corrected vs. Revised Cross Sections

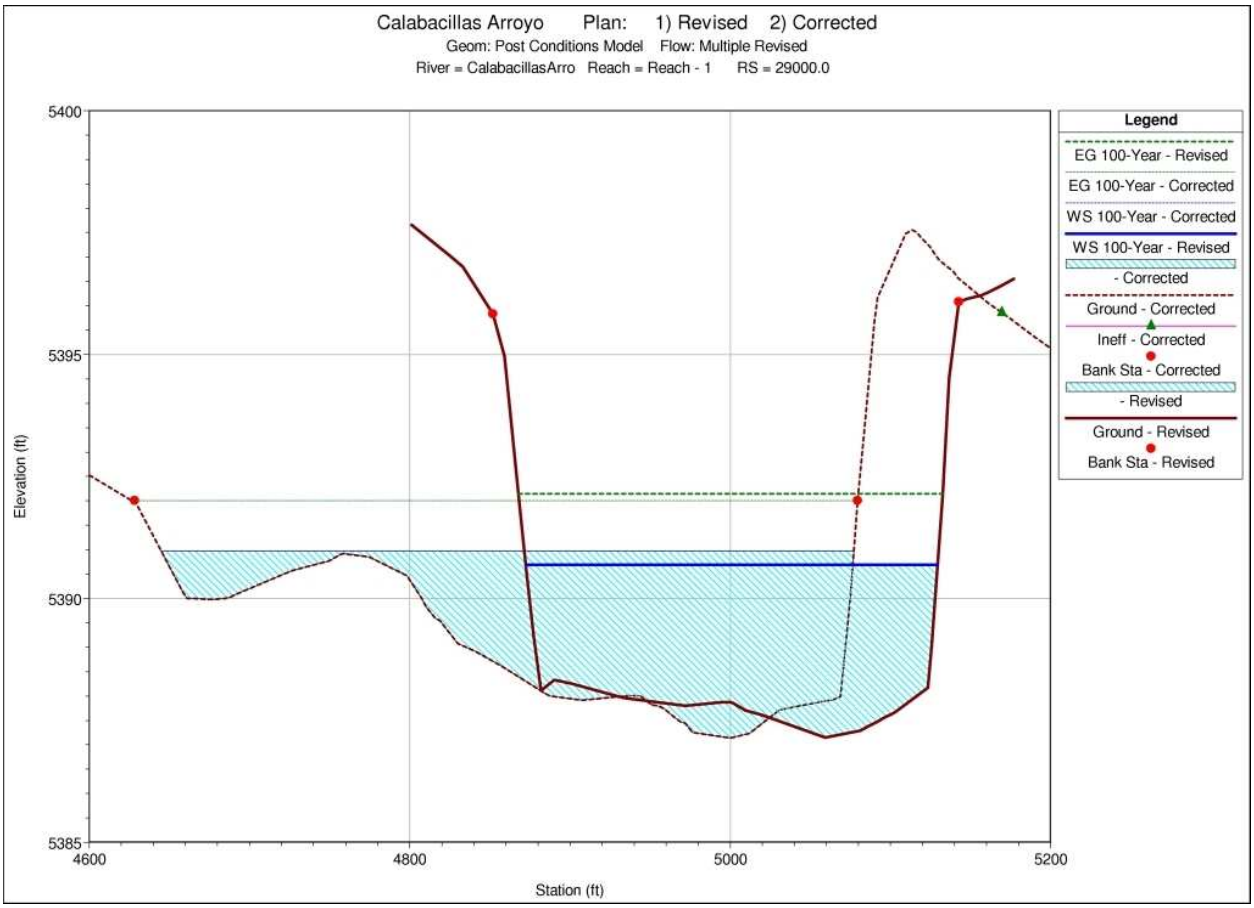

Figure 6d – Corrected vs. Revised Cross Sections

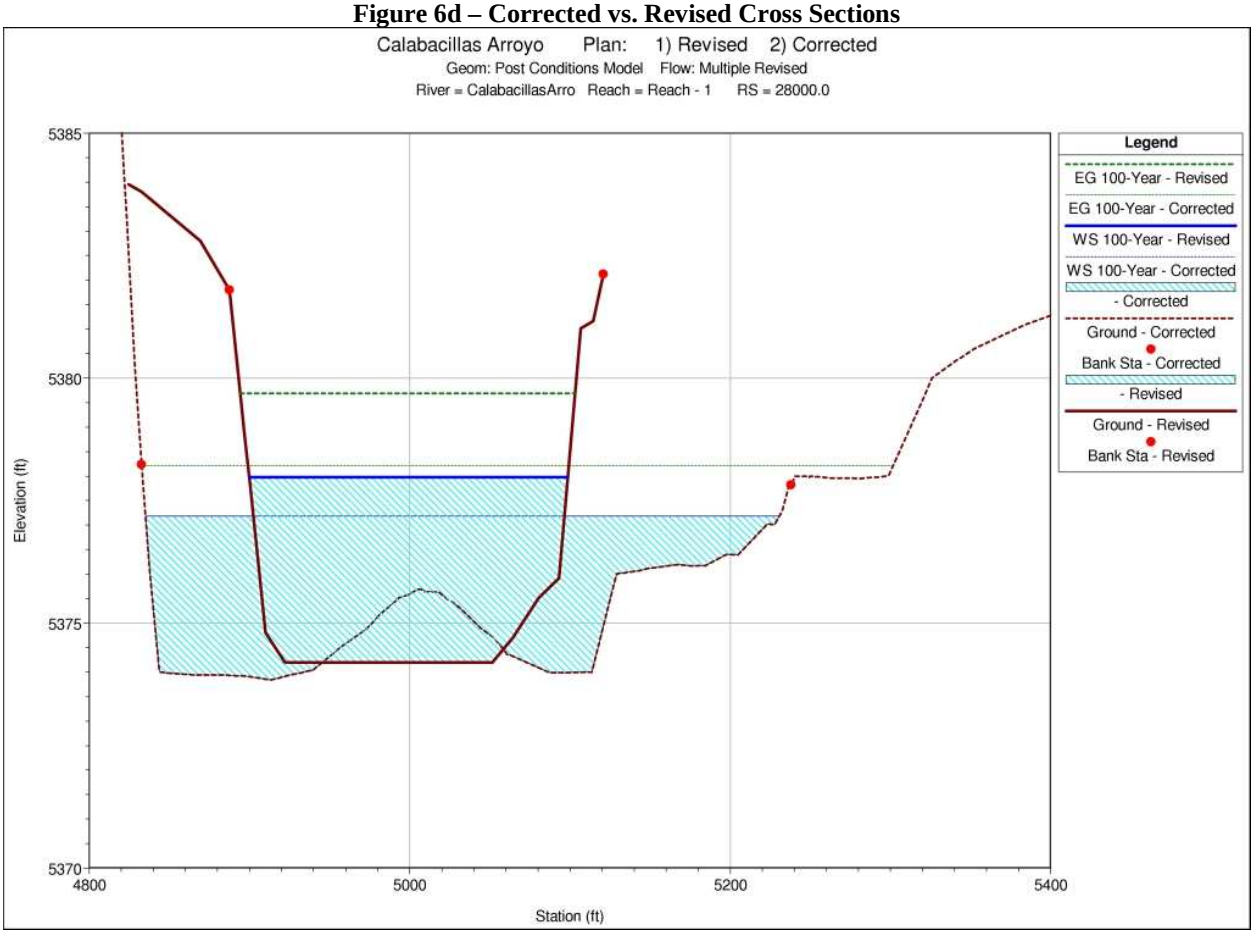

Figure 6e – Corrected vs. Revised Cross Sections

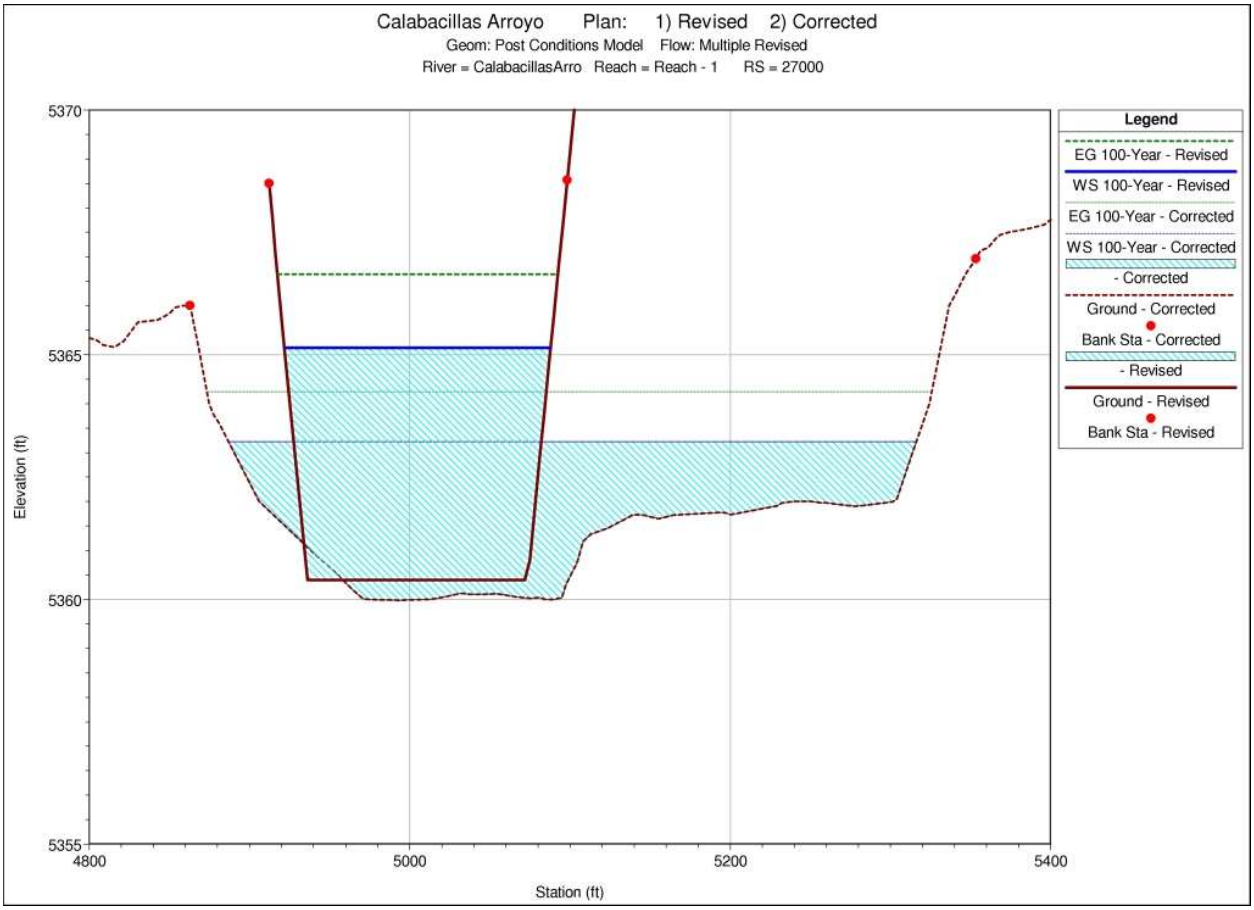

Figure 6f – Corrected vs. Revised Cross Sections

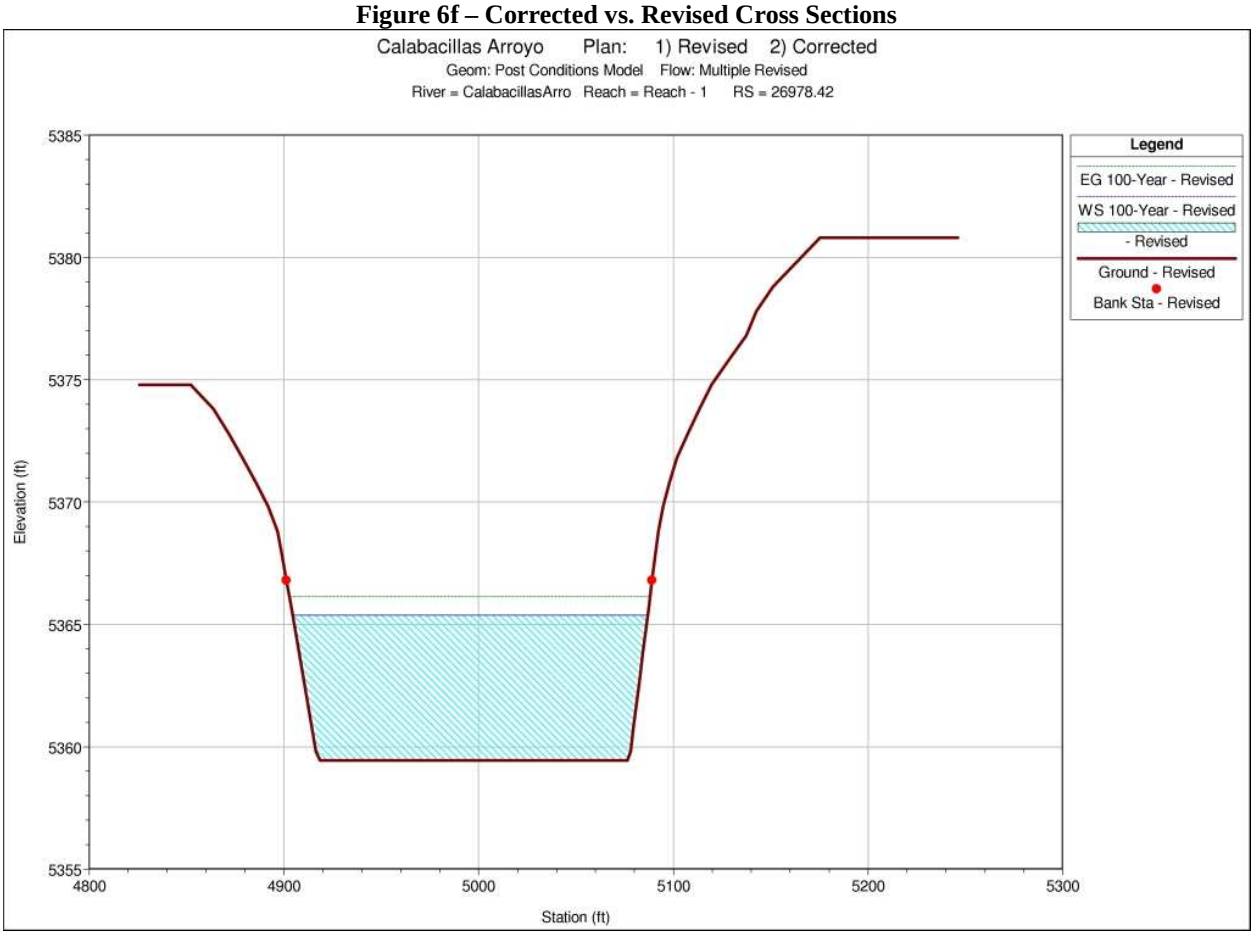

Figure 6g – Corrected vs. Revised Cross Sections

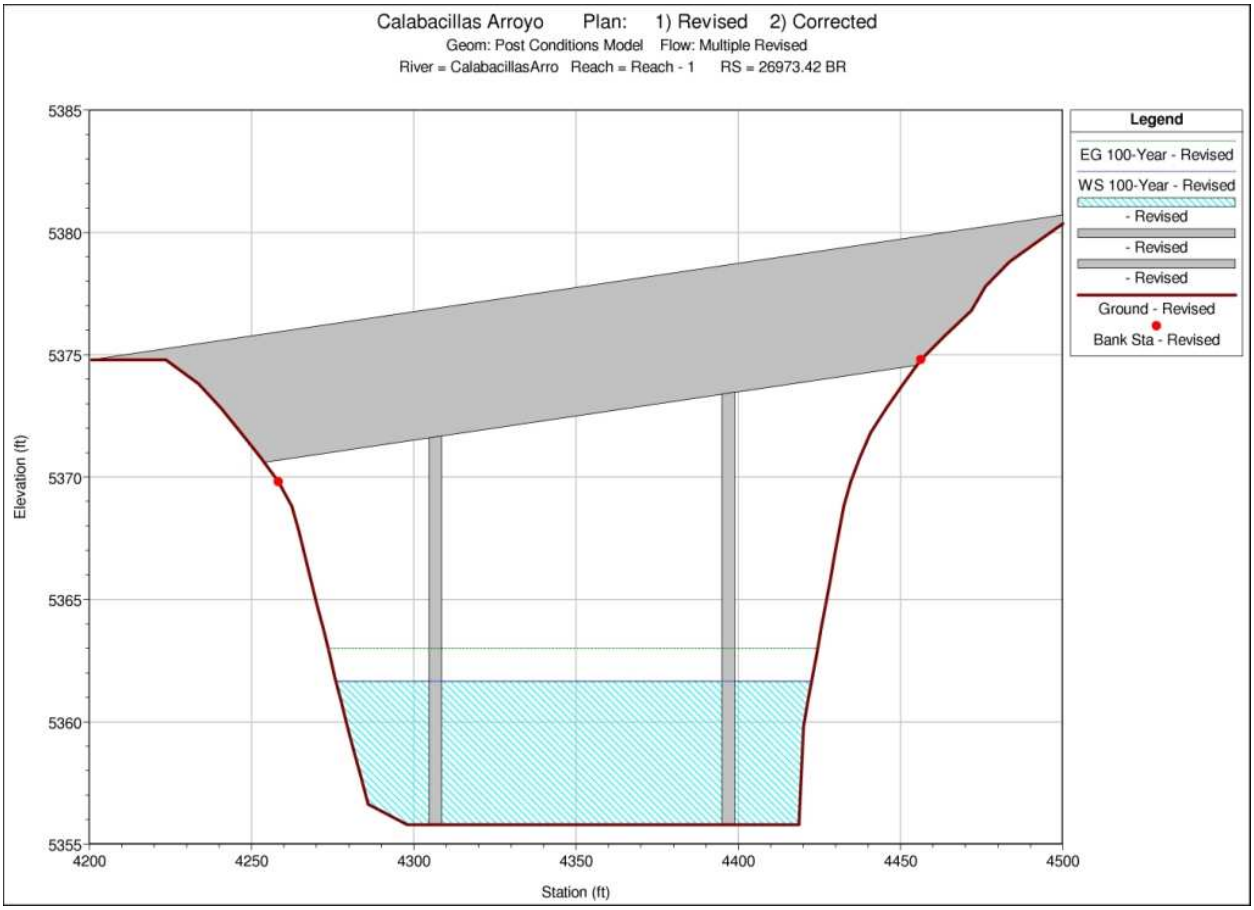

Figure 6h – Corrected vs. Revised Cross Sections

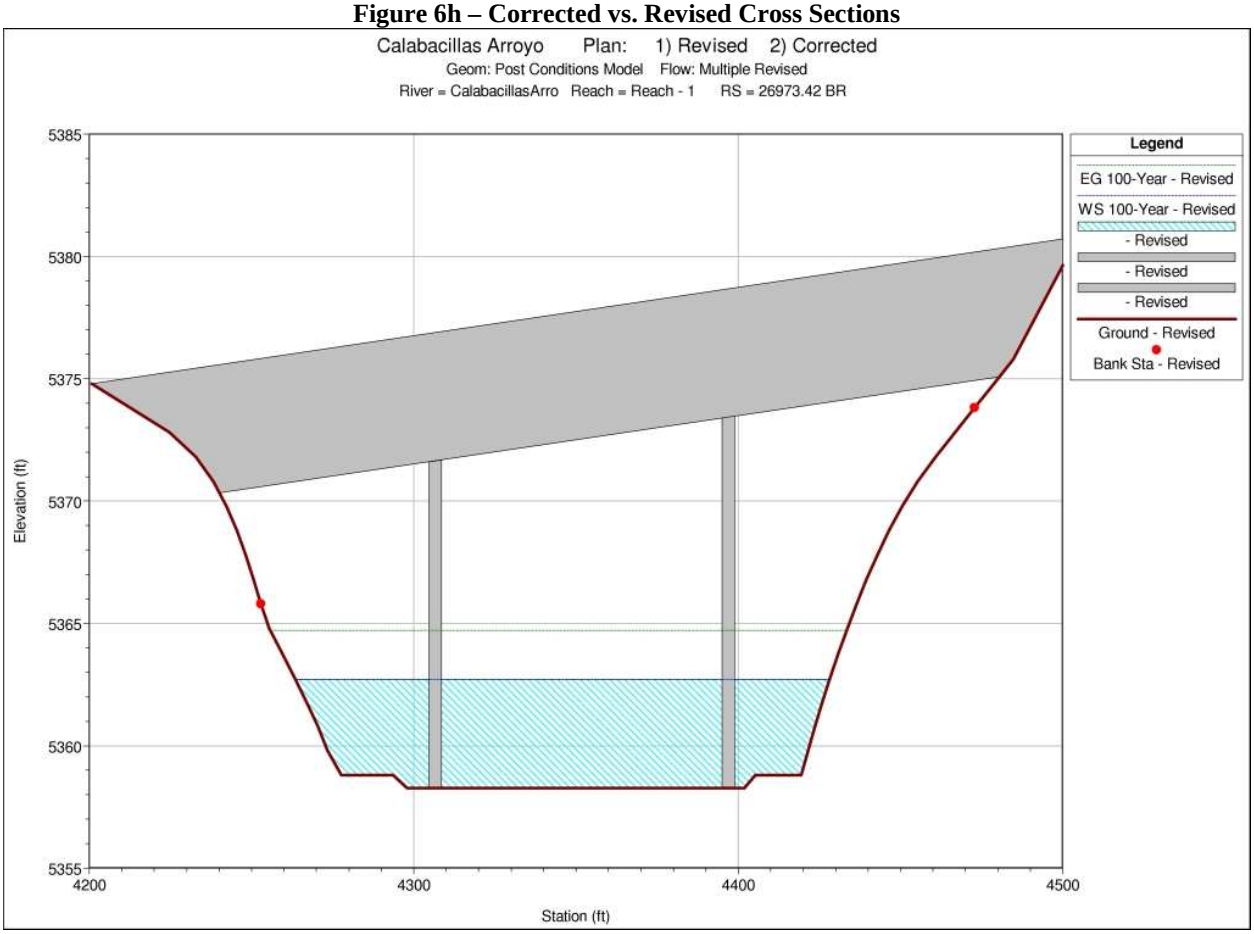

Figure 6i – Corrected vs. Revised Cross Sections

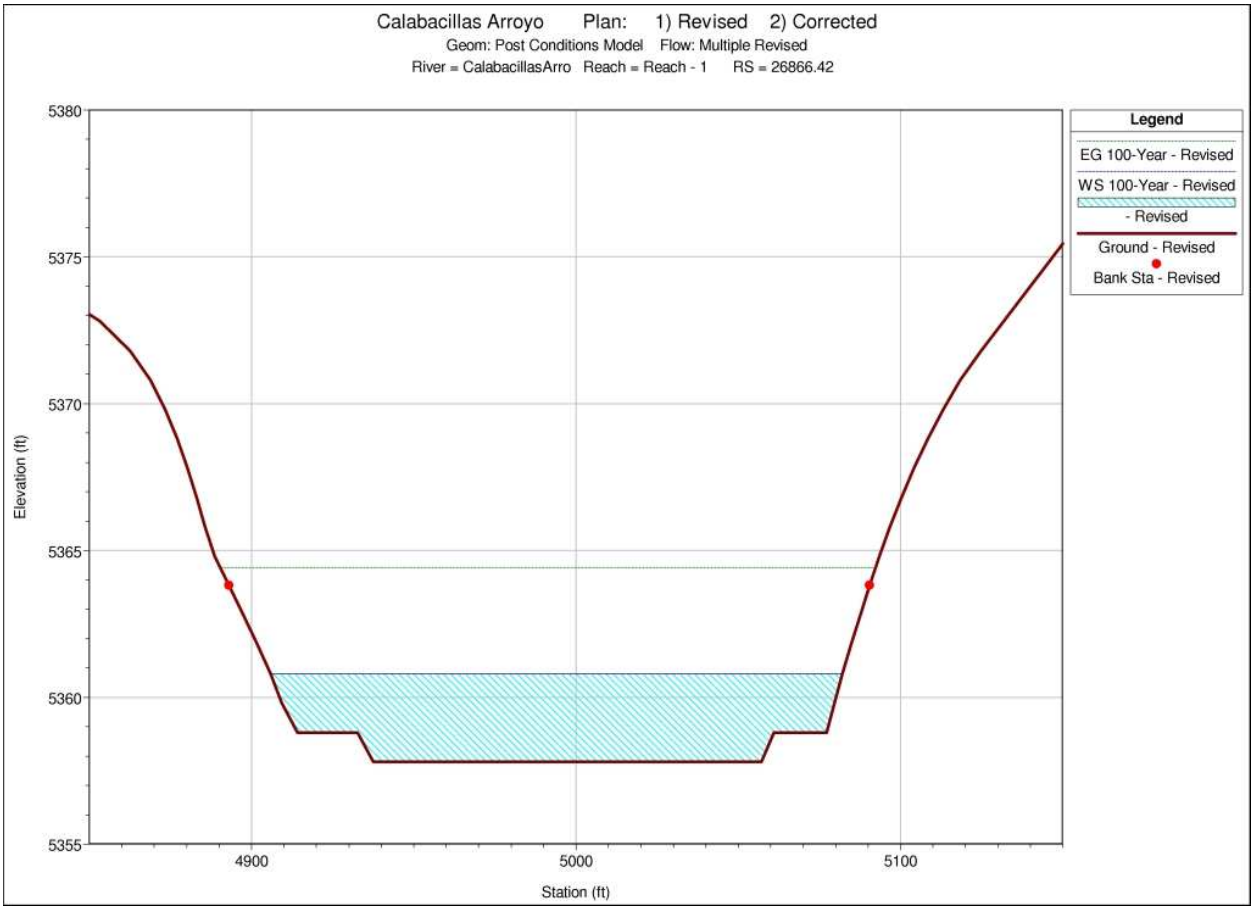

Figure 6j – Corrected vs. Revised Cross Sections

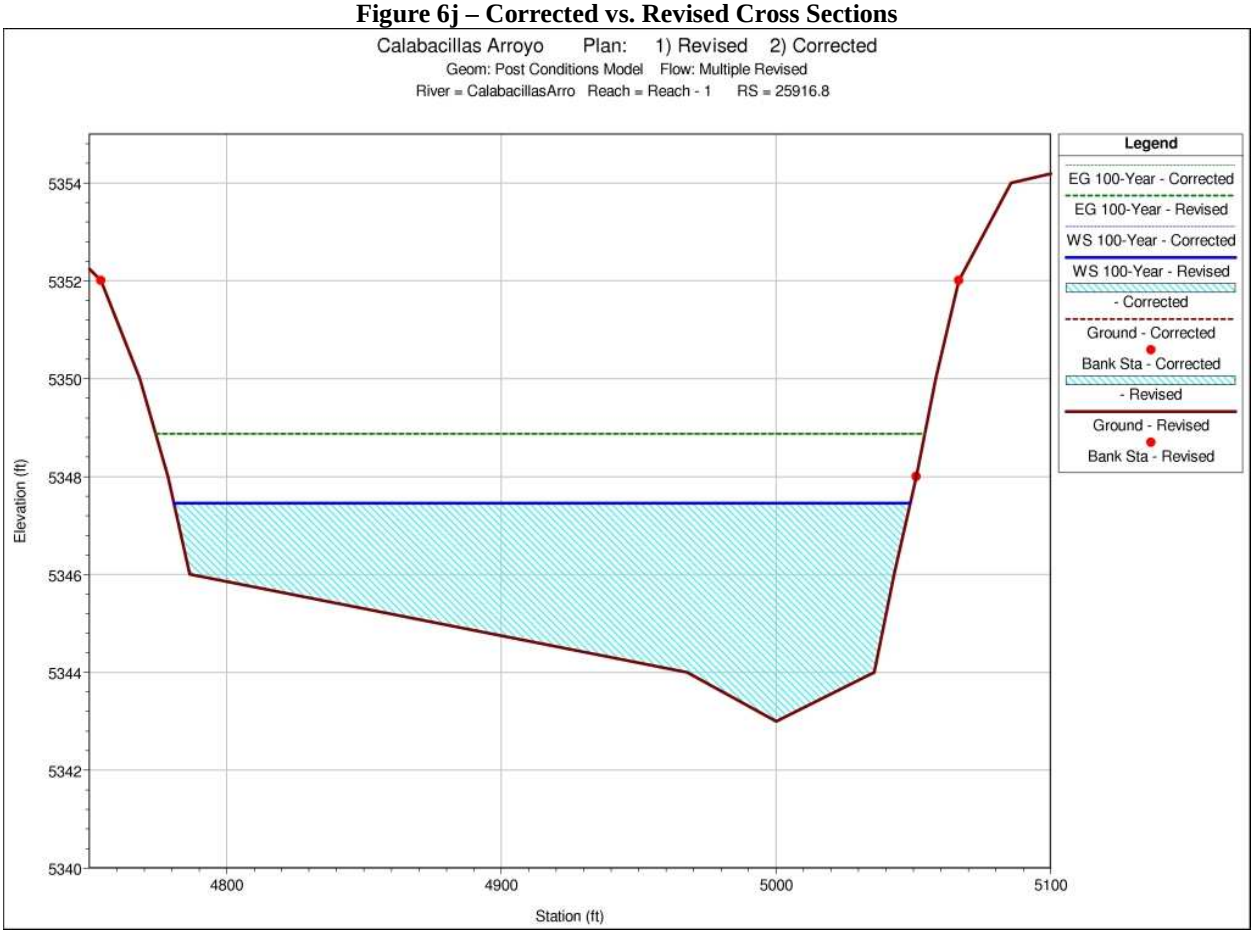

Figure 6k – Corrected vs. Revised Cross Sections

Hydraulic Results and Summary

As shown in the profile, Figure 8, there is no change to the water surface elevations or to the horizontal flood plain limits at river station 29855 on the upstream end and at 25916.8 on the downstream end. The results of the HEC-RAS models and their comparison are in the following tables.

Plan Title		Geometry File					Flow Data File					
Multiple		Geom 01 by CodeH2 for Windows					Multiple					
River	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
CalabacillasArro	29751	100-Year	7071.03	5398.00	5402.46	5402.46	5403.69	0.005232	8.92	794.29	327.73	1.00
CalabacillasArro	29000	100-Year	7071.03	5385.36	5391.40	5391.4	5392.89	0.004978	9.79	723.81	263.94	1.00
CalabacillasArro	28000	100-Year	7071.03	5374.00	5377.93	5377.93	5379.02	0.005473	8.39	843.17	387.16	1.00
CalabacillasArro	27000	100-Year	7071.03	5360.40	5364.43	5364.43	5365.44	0.005638	8.06	877.78	438.13	1.00
CalabacillasArro	25916.8	100-Year	7071.03	5343.00	5347.46	5347.46	5348.87	0.005155	9.54	741.41	268.17	1.01

River	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
CalabacillasArro	29751	100-Year	5403.69	5402.46	1.23	3.89	0.03	1.63	7069.40		327.73
CalabacillasArro	29000	100-Year	5392.89	5391.40	1.49	5.22	0.12	2.12	7068.91		263.94
CalabacillasArro	28000	100-Year	5379.02	5377.93	1.09	5.55	0.03		7071.03		387.16
CalabacillasArro	27000	100-Year	5365.44	5364.43	1.01	5.84	0.04		7071.03		438.13
CalabacillasArro	25916.8	100-Year	5348.87	5347.46	1.41	4.68	0.00		7071.03		268.17

Plan Title		Geometry File					Flow Data File					
Revised Conditions		Post Conditions Model					Multiple Revised					
River	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
CalabacillasArro	29751	100-Year	7071.03	5398.00	5402.46	5402.46	5403.69	0.005232	8.92	794.29	327.73	1.00
CalabacillasArro	29000	100-Year	7071.03	5385.36	5391.40	5391.4	5392.89	0.004978	9.79	723.81	263.94	1.00
CalabacillasArro	28000	100-Year	7071.03	5374.00	5377.93	5377.93	5379.02	0.005473	8.39	843.17	387.16	1.00
CalabacillasArro	27000	100-Year	7071.03	5360.40	5364.43	5364.43	5365.44	0.005638	8.06	877.78	438.13	1.00
CalabacillasArro	25916.8	100-Year	7071.03	5343.00	5347.46	5347.46	5348.87	0.005155	9.54	741.41	268.17	1.01

River	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
CalabacillasArro	29751	100-Year	5403.69	5402.46	1.23	3.89	0.03	1.63	7069.40		327.73
CalabacillasArro	29000	100-Year	5392.89	5391.40	1.49	5.22	0.12	2.12	7068.91		263.94
CalabacillasArro	28000	100-Year	5379.02	5377.93	1.09	5.55	0.03		7071.03		387.16
CalabacillasArro	27000	100-Year	5365.44	5364.43	1.01	5.84	0.04		7071.03		438.13
CalabacillasArro	25916.8	100-Year	5348.87	5347.46	1.41	4.68	0.00		7071.03		268.17

Plan Title		Geometry File		Flow Data File	
Multiple Revised		Geom 01 by CodeH2 for Windows Post Conditions Model		Multiple Multiple Revised	
River	River Sta	Profile	Plan	Q Total	Min Ch El
				(cfs)	(ft)
CalabacillasArro	29855	100-Year	Revised	7071.03	5397.95
CalabacillasArro	29751	100-Year	Revised	7071.03	5398.00
CalabacillasArro	29751	100-Year	Multiple	7071.03	5398.00
CalabacillasArro	29000	100-Year	Revised	7071.03	5387.15
CalabacillasArro	29000	100-Year	Multiple	7071.03	5385.36
CalabacillasArro	28000	100-Year	Revised	7071.03	5373.94
CalabacillasArro	28000	100-Year	Multiple	7071.03	5374.00
CalabacillasArro	27000	100-Year	Revised	7071.03	5360.40
CalabacillasArro	27000	100-Year	Multiple	7071.03	5360.40
CalabacillasArro	26978.42	100-Year	Revised	7071.03	5359.45
CalabacillasArro	26973.42			Bridge	
CalabacillasArro	26866.42	100-Year	Revised	7071.03	5357.80
CalabacillasArro	25916.8	100-Year	Revised	7071.03	5343.00
CalabacillasArro	25916.8	100-Year	Multiple	7071.03	5343.00

River	River Sta	Profile	Plan	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
CalabacillasArro	29855	100-Year	Revised	5403.63		5403.88	0.000476	4.04	1749	383.23	0.33
CalabacillasArro	29751	100-Year	Revised	5402.45	5402.45	5403.68	0.005298	8.89	795.73	327.67	1.00
CalabacillasArro	29751	100-Year	Multiple	5402.46	5402.46	5403.69	0.005232	8.92	794.29	327.73	1.00
CalabacillasArro	29000	100-Year	Revised	5390.70	5390.70	5392.14	0.007941	9.65	732.69	256.96	1.01
CalabacillasArro	29000	100-Year	Multiple	5391.40	5391.40	5392.89	0.004978	9.79	723.81	263.94	1.00
CalabacillasArro	28000	100-Year	Revised	5378.32	5378.32	5380.02	0.015851	10.46	675.86	200.96	1.01
CalabacillasArro	28000	100-Year	Multiple	5377.93	5377.93	5379.02	0.005473	8.39	843.17	387.16	1.00
CalabacillasArro	27000	100-Year	Revised	5365.25		5366.68	0.003529	9.59	737.23	166.75	0.80
CalabacillasArro	27000	100-Year	Multiple	5364.43	5364.43	5365.44	0.005638	8.06	877.78	438.13	1.00
CalabacillasArro	26978.42	100-Year	Revised	5365.43	5363.31	5366.17	0.003538	6.9	1024.12	182.48	0.51
CalabacillasArro	26973.42										
CalabacillasArro	26866.42	100-Year	Revised	5361.87	5361.87	5363.68	0.015583	10.79	655.25	183.40	1.01
CalabacillasArro	25916.8	100-Year	Revised	5347.46	5347.46	5348.87	0.005176	9.55	740.5	268.14	1.01
CalabacillasArro	25916.8	100-Year	Multiple	5347.46	5347.46	5348.87	0.005155	9.54	741.41	268.17	1.01

Figure 7 – Corrected vs. Revised Water Surface Tables

Figure 8 below shows the revised 100-yr, 500-yr HEC-RAS water surface profiles and the bank elevations. The bank elevations correspond to the post project conditions floodway delineation. The limits of the flood hazard areas are the Anasazi Ridge Avenue profile on the south side of the arroyo and to the "Top of Bank" on the north side of the arroyo. More than 2' of freeboard on the 500-yr water surface elevations to the bank stations was noted throughout. The limits of the revised floodway and water surface elevations are shown on the Annotated FIRM's included in *APPENDIX A*

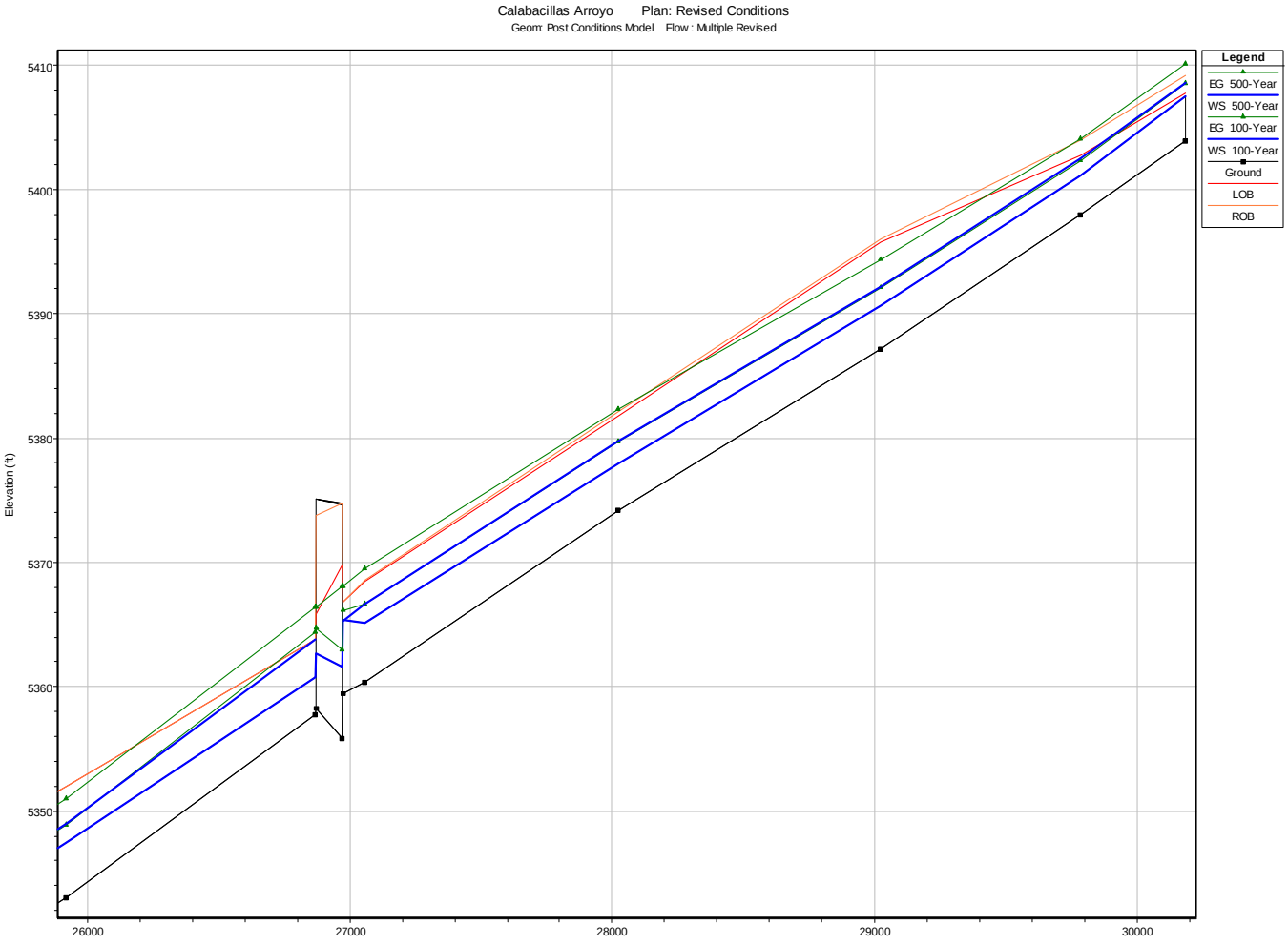

Figure 8 – Water Surface Profiles

Form 2 – Riverine Hydrology and Hydraulics

Summary of Riverine Structures

On March 17 2005 a three way agreement between 1) the City of Albuquerque, COA, 2) the Albuquerque Metropolitan Arroyo Flood Control Authority, AMAFCA, and 3) Vista Arroyo LLC, VISTA, (then the owner of the land on both sides of the arroyo north of McMahon Boulevard) assigned responsibilities for the construction of 3 grade control structures (#2, #3, and #4), the McMahon Boulevard Bridge together with its associated Bank Protection. Grade control structures #2 and #3 area downstream of the bridge.

The placement of the spurs upstream from the McMahon Bridge was established to coincide with the existing bank line. To reduce the amount of earthwork, a smooth channel alignment was developed between the spurs and grade control structures, and the nose of the spurs was set to coincide with the design 2H:1V bank slopes to limit the amount of projection into the channel.

The design of top-of-bank profiles along the reach was established using the hydraulic model of post conditions with a freeboard minimum of 2 feet.

Form 3 – Riverine Structures

APPENDIX A

Effective FIRM's 35001C0103G & 35001C0104G

LOMR 08-06-2956P-350002 & 350146

Annotated FIRM's 35001C0103G & 35001C0104G

APPENDIX B

Stabilized Development Master Plan

APPENDIX C

Hydraulic and Channel Stability Analysis and Designing Assistance for Main Branch Calabacillas Arroyo Upstream from Swinburne Dam

APPENDIX D

As Built Plans for McMahon Bridge

APPENDIX E

As-Built Plans for North Bank Channelization, Spurs & Bank Protection

APPENDIX F

As-Built Plans for Northern Bank Surface

APPENDIX G

As-Built Plans for Southern Bank Surface

APPENDIX H

Plans for South Bank Channelization, Spurs & Bank Protection