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Hydrology • Hydraulics • Sediment Transport

SEDIMENTATION STUDY FOR A MATERIAL EXTRACTION ACTIVITY IN THE RIO MARIN PATILLAS, PUERTO RICO

PREPARED FOR:

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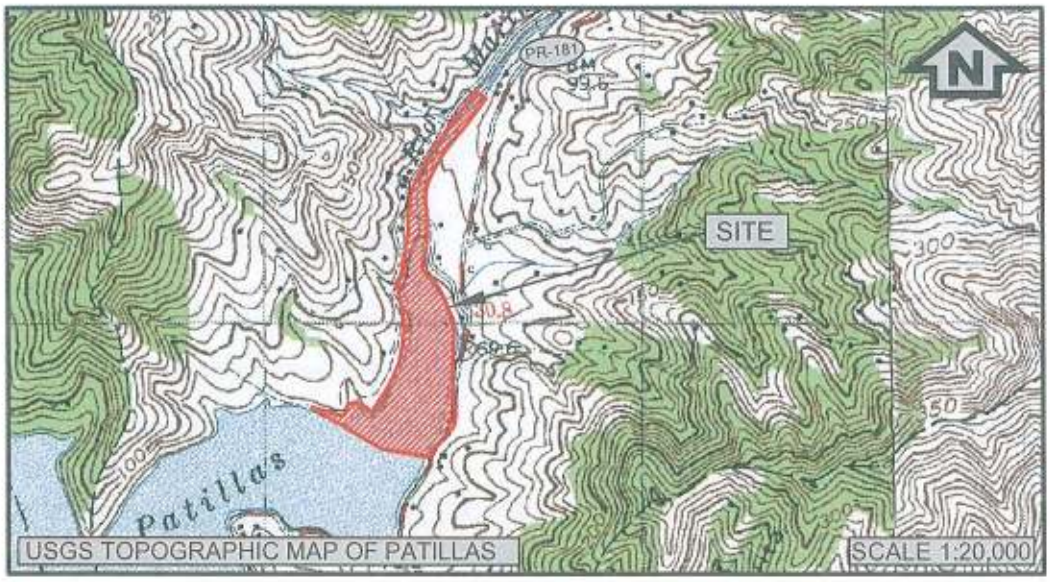

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SEDIMENTATION STUDY FOR A MATERIAL EXTRACTION ACTIVITY IN THE RÍO MARÍN PATILLAS, PUERTO RICO

Menar Hydrosystems Engineering, PSC
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I. INTRODUCTION

General

Mr. Carlos González Morales, project promoter, is currently undergoing the process to get a permit for a material extraction activity in a reach located on Río Marín upstream from Lago Patillas.

The studied reach on Río Marín is located at Km. 30.8 of the State Road PR-181, within the Municipality of Patillas, Puerto Rico. The reach length is approximately 1,014 meters, and the extraction length is 599 meters. Figure 1 shows the location plan of the concerned river reach on the USGS topographic map of Patillas, published by the US Geological Survey [1982].

The reach is located within the flooding zone of the Río Marín, as indicated in the FEMA's Flood Insurance Rate Map (FIRM) No. 1770H. Figure 2 show the studied reach location on the partial copy of this map published by the Federal Emergency Management Agency [FEMA, 2005].

The zone is classified as Zone A, because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones. For this reason a Hydrologic and Hydraulic analysis (HH) will be performed to determine the existing flooding levels and limits for the 100-year rainfall event along the studied reach in Río Marín. The existing water surface elevations must be not increase by the proposed extraction activity.

The proposed extraction activity should comply with the requirements of section number 3.2, paragraphs 19b and 22b, of the "*Reglamento para Regir la Extracción, Excavación, Remoción y Dragado de Los Componentes de la Corteza Terrestre*" [DRNA, 2004].

This report summarizes the results of the Hydrologic, Hydraulic and Sedimentation analysis performed to determine the impact of the proposed extraction activity on the existing water surface elevations and, on the equilibrium sediment transport rate along the analyzed reach. Recommendations of the maximum depths of material extraction for the analyzed reach are given based on the hydraulic analysis.

Authorization

Mr. Carlos González Morales, promoter of the extraction activity, authorized this study through an agreement with Mr. Miguel Menar Figueroa, P.E., representative of Menar Hydrosystems Engineering, P.S.C.

Scope of Work

The scope of work for the Hydrologic, Hydraulic and Sediment Transport studies includes the following tasks at the concerned reach of the Río Marín.

- Site visit to determine the river bed channel conditions.
- Hydrologic modeling of the existing condition.
- Hydraulic modeling of the existing and proposed conditions.
- Determine the hydraulic profile for the 100-year flood for the existing and proposed conditions.
- Sediment transport modeling for the existing and proposed conditions for frequent and non frequent events.
- Analysis of the resulting channel bed elevation change and sediment transport rates according to the proposed extraction at the river channel for the frequent and non frequent events.
- Recommendation of the maximum depth of material extraction within the river channel according to the impact on the equilibrium sediment transport rate.

II. HYDROLOGIC ANALYSIS

Peak Flow Discharge for the 100-yr Event

Methodology

A hydrologic analysis was performed to determine the peak flow discharge corresponding to the 100-year (100-yr) rainfall event for the watershed discharging into the analyzed reach. This analysis employed the Unit Hydrograph methodology developed by the U.S. Soil Conservation Service (SCS) and implemented in the June 1998 edition of the HEC-1 computer program (version 4.1) [USACE, 1998]. Discharge was computed for the existing condition.

Watershed Description

The watershed for Río Marín was delimited using the USGS topographic maps of Patillas and Yabucoa. One sub-basin was delimited; which was named ***Rio Marin*** (***RM***). Figure 3 shows the drainage watershed limits established for Río Marín upstream from the studied reach limit.

Rainfall Data

Average point rainfall depths for the 100-year event were taken from the Frequency Data Server available online and developed by NOAA's National Weather Services in NOAA Atlas 14 Volume 3, Version 4.0 [U.S. Department of Commerce, et. al 2006]. This data is included in Appendix B. Frequency based hypothetical storm used by the runoff model for the basin hydrologic response analysis were generated using the data shown in Table 1.

The total storm is automatically distributed according to the specified depth/duration data for each analyzed exceedance probability (100-year). A triangular precipitation distribution (balanced storm) for 24 hours duration was constructed such that the depth specified for any duration occurs during the central part of the storm.

Table 1. Rainfall depths used in the HEC-1 model.

Duration, hr	0.083	0.25	1	2	3	6	12	24
100-yr, in	0.96	1.68	3.99	5.84	6.98	9.68	12.67	16.05

Time of Concentration

The time of concentration (*Tc*) is defined as the time it takes to the most hydraulically remote drop of water to travel to the basin outlet. Time of Concentration within each sub-basin was estimated using the Kirpich equation,

$$T_c = 0.00013*(L^{0.77}/S^{0.385}) \quad (1)$$

where, T_c is the time of concentration in hours, L is the length of the overland flow in feet, and S is the average overland slope in ft/ft. Appendix A includes the computations for the time of concentration for the studied basin for both conditions.

Soils

The soils classification was taken from the Web Soil Survey for Humacao Area, Puerto Rico Eastern Part, and San Juan Area, Puerto Rico, published by the Natural Resources Conservation

Service [NRCS, 2008]. The soils within the studied area are composed of hydrologic soil group B, and D. The weighted curve numbers for each sub-basin are included in the Appendix A.

Peak Discharges

The HEC-1 modeling was performed using: 1) the rainfall depths; 2) the basin's area; 3) the curve number (CN) and; 4) the basin's lag time ($0.6T_c$). Peak flow discharge for the 100-year event was computed at the sub-basin outlet. The hydrologic analysis results are shown in Table 2 for the 100-year rainfall event. The estimated CN value and peak flow discharge for the studied sub-basin are shown in this table (for AMC II).

Table 2. Hydrologic analysis results for the 100-year rainfall event.

CONDITION	BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
EXISTING	RM	3,394.08 (5.3033)	82	44	13,272 (375.82)

Flow Discharges for Frequent and Non-Frequent Events

The USGS station no. 50093000 was used to simulate frequent and non frequent events for Río Marín. The mean monthly and peak flows reported at this station were used to simulate these scenarios. In addition water surface elevation on Lago Patillas reported in the USGS station no. 50093045 was used to establish the boundary condition downstream.

Appendix A includes the USGS data. Tables 3 and 4 show the mean monthly flows, and peak flows, respectively, for the USGS station no. 50093000. A total of 8 extreme events were included in the peak flows analysis.

Table 3. Mean monthly flows for the USGS station no. 50093000 Río Marín Near Patillas, PR, and water surface elevation for Lago Patillas (USGS station no. 50093045).

Month	Mean Monthly Flow (cfs)	Mean Monthly Flow (m^3/s)	Mean Monthly Lake Surface Elevation (m)
January	10	0.28	67.44
February	8.4	0.24	67.31
March	6.6	0.19	67.16
April	10	0.28	66.83
May	14	0.40	66.74
June	16	0.45	66.85
July	18	0.51	66.80
August	21	0.59	67.08
September	21	0.59	67.32
October	30	0.85	67.41
November	30	0.85	67.49
December	18	0.51	67.49

Table 4. Peak flows for the USGS station no. 50093000 Río Marín Near Patillas, PR, and water surface elevation for Lago Patillas (USGS station no. 50093045).

Event Number	Date	Peak Flow (cfs)	Peak Flow (m^3/s)	Lake Surface Elevation (m)
1	Sep. 11, 2000	2,140	60.60	67.47
2	Sep. 01, 2001	4,970	140.73	67.25
3	Aug. 18, 2002	2,160	61.16	67.33
4	Apr. 17, 2003	2,700	76.46	67.60
5	Sep. 15, 2004	4,010	113.55	67.56
6	Nov. 14, 2004	2,530	71.64	67.46
7	Oct. 23, 2005	1,330	37.66	67.60
8	Oct. 13, 2006	926	26.22	67.43

III. HYDRAULIC DATA

Field survey data submitted by Mr. José A. Lebrón Quiñones, PLS was used to construct the hydraulic geometry model. Seventeen (17) cross sections were surveyed, for Río Marín. Some cross sections were extended using the USGS topographic maps of Patillas and Humacao. A copy of the field surveyed data is included in Appendix G. The cross sections location plan is shown in Figure 4.

IV. SEDIMENT DATA

A mechanical particle size analysis performed for Rio Marín on May 2000 by Mr. Víctor Mario Rivera, P.E. was used to simulate the bed gradation distribution in the sediment transport model. Table 5 shows the gradation distribution for the analyzed sample. The particle size data is included in Appendix E.

Table 5. Particle size distribution for the bed gradation.

Sieve Designation	Nominal Sieve Opening (mm)	% Finer
1	25.4	57
4	4.76	38
10	2.00	31
40	0.42	7
200	0.074	1

V. SEDIMENTATION ANALYSIS

Methodology

Hydraulic Analysis

A hydraulic analysis was performed to determine the existing 100-yr water surface elevation for the existing and proposed conditions. The River Analysis System (HEC-RAS 4.1.0) model, developed by the U.S. Army Corps of Engineers [USACE, 2010], was applied for this purpose.

The model was conceptualized for a reach named ***MARIN***. As mentioned earlier, field survey data submitted by Mr. José A. Lebrón Quiñones, PLS, was used to construct the hydraulic geometry model.

The 100-yr peak flow discharge calculated in the hydrologic analysis was used in this analysis for steady state condition (375.82 m^3/s). Known water surface elevation was used as boundary condition downstream. It was determined using the 100-yr flood mark presented in the FEMA's flood insurance rate map No. 1770H. The mark corresponds to an elevation of 70.00 m (msl).

The Manning's roughness coefficients were determined by visual inspection of the site. The values used for the existing condition model were 0.04 in the main channel and 0.06 in the floodplain; contraction and expansion coefficients of 0.1 and 0.3, respectively, were used for gradual transitions and, 0.3 and 0.5 for abrupt transitions.

Sediment Transport Analysis

A sediment transport analysis was performed to determine the bed elevation change and the material transport capacity for the concerned reach. This analysis was performed using the sediment transport option included in the River Analysis System (HEC-RAS 4.1.0) model, developed by the U.S. Army Corps of Engineers [USACE, 2010].

For the sediment transport analysis a quasi-unsteady flow data and the stage data for Lago Patillas were used as boundary conditions upstream and downstream respectively. Two scenarios were evaluated for the sediment transport analysis: 1) mean monthly flows and; 2) peak flows. The data used for these scenarios was the reported in the USGS stations nos. 50093000 and 50093045 (see Tables 3 and 4).

In addition, the model requires a water temperature series. Based on water quality samples taken at the USGS station no. 50093000; an average water temperature of 26°C was used for the sediment transport simulation.

For the simulation of the sediments transport process the Toffaleti's transport function was applied. This method is a Modified-Einstein total load function that breaks the suspended load distribution into vertical zones, for simulating two-dimensional sediment movement. Four zones are used to define the sediment distribution. They are the upper zone, the middle zone, the lower zone and, the bed zone. The sediment transport is calculated independently for each zone and then added to determine the total sediment transport.

The transport function was chosen based in the particle distribution and the channel morphology. The range of input values for sediment transport functions are specified in the reference manual for HEC-RAS 4.1.0 [USACE, 2010].

The sorting method used in this analysis was Active Layer based in a two layer algorithm. The fall velocity method used corresponds to the Toffaleti's sediment transport function. The right and the left bank for the sediment transport analysis were determined using the field data included in Appendix G.

A maximum erodible depth of 3.0 meters was assumed for the sediment analysis. The equilibrium load upstream from cross section 17 was used as boundary condition. This section is located out of the proposed extraction reach. The model assumes no aggradation or erosion at this section for the equilibrium load.

Existing Condition

Hydraulic Results

Computed water levels at each cross section, along the analyzed reach, for the 100-year flood event are presented in Table 6. Figure 5 shows the water surface profile for the 100-year flood. Detailed results for this frequency flood event are included in Appendix F (Plan: ***EXISTING***).

Table 6. Hydraulic modeling results for the existing condition model: 100-year flood event.

River sta	Reach	Profile	Q total	Min Ch El	W.S. Elev	Vel Chnl
			(m^3/s)	(m)	(m)	(m/s)
1	MARIN	100-yr	375.82	66.31	70.00	0.76
2				66.18	70.02	0.57
3				66.79	70.00	1.17
4				66.90	70.06	0.88
5				67.06	70.07	1.12
6				67.59	70.09	1.48
7				67.34	70.19	1.44
8				67.88	70.18	2.65
9				67.91	70.49	2.48
10				67.99	70.64	3.24
11				68.29	71.31	4.72
12				69.44	72.33	4.51
12.3				Existing (5) 1.53 x 1.50 (span x rise) Box Culvert		
12.5				69.44	73.53	2.76
13				70.01	73.92	4.62
14				72.11	75.80	4.69
15				73.94	77.46	5.28
16				74.83	78.80	4.90
17				77.78	81.33	4.85

The hydraulic analysis for the existing condition shows that the existing culvert over Rio Marín is flooded during the 100-yr rainfall event. The flood depth calculated was 2.39 meter from the top elevation.

Sediment Transport Results

Computed change in the channel invert elevations for the mean monthly flow analysis at each cross section, are presented in Table 7. Detailed results for this scenario are included in Appendix F (Plan: ***MEAN_EXIS***).

Table 7. Sediment transport results for the existing condition model: mean monthly flow.

River sta	MONTH											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Invert Channel Change (m)											
1	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3	0.00	0.00	0.00	0.00	-0.07	-0.10	-0.13	-0.14	-0.14	-0.14	-0.14	-0.14
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	-0.01	-0.02	-0.02	0.00	-0.01
6	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	-0.01	0.00
7	0.00	0.00	0.00	0.00	0.02	-0.01	-0.01	0.01	0.01	0.01	0.01	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
12	0.00	0.01	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.05
12.5	0.00	0.01	0.01	0.01	-0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
13	0.00	0.00	0.00	-0.02	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
14	0.00	-0.01	-0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
15	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
16	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	0.01	0.02
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The results for ***mean monthly flow*** indicate that aggradation predominates at cross section 1, 2, 7, 10, 12 and 12.5 For cross sections 3, 5, 6, 11, 13, 14, 15 and 16, erosion is the predominant process. Sections 4, 8, 9 and 17 present not change. The aggradation ranged from 0.01 to 0.05 meter and the erosion ranged from 0.01 to 0.14 meter. Figure 6 shows the channel invert comparison for the final and initial condition for this scenario.

The mass transport capacity for the analyzed reach under mean monthly flow varied from 1 to 205 tons per day. The maximum values were calculated for cross section 17 for the month of December.

Computed change in the channel invert elevations for the peak flow analysis at each cross section, are presented in Table 8. Detailed results for these flood events are included in Appendix F (Plan: ***PEAK_EXIS***).

The results for ***peak flow analysis*** shows that erosion processes predominates at cross sections 2, 3, 4, 12, 14 and 15. For cross sections 1, 5, 6, 7, 8, 9, 10, 11, 12.5, 13, 16 and 17, aggradation is the predominant process. The erosion depth varied from 0.01 to 0.08 meter, with the maximum value occurring at cross section 11. In addition, the aggradation depth varied from 0.01 to 1.20 meters with the maximum value occurring at cross section 12.5, located upstream from the existing culvert. Figure 7 shows the channel invert comparison for the final and initial condition for this scenario.

Table 8. Sediment transport results for the existing condition model: peak flows.

River sta	Number of Event						
	1	2	3	4	5	6	7
Invert Channel Change (m)							
1	0.00	0.00	0.02	0.08	0.07	0.10	0.17
2	0.00	-0.02	-0.02	-0.01	-0.01	-0.01	0.00
3	0.00	-0.05	-0.06	-0.04	-0.04	-0.03	0.00
4	0.00	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02
5	0.00	0.00	0.00	0.02	0.02	0.03	0.03
6	0.00	0.00	0.00	0.01	0.02	0.03	0.04
7	0.00	0.01	0.01	0.04	0.04	0.04	0.06
8	0.00	0.00	0.01	0.04	0.04	0.05	0.07
9	0.00	0.00	0.03	0.04	0.04	0.07	0.10
10	0.00	0.05	0.06	0.01	0.03	0.09	0.08
11	0.00	0.03	-0.08	-0.01	0.03	0.02	0.06
12	0.00	-0.08	-0.02	-0.01	0.03	0.02	0.01
12.5	0.00	0.73	1.06	1.20	1.20	1.20	1.20
13	0.00	0.06	0.01	0.12	0.10	0.11	0.17
14	0.00	-0.02	-0.02	-0.01	0.00	0.02	0.07
15	0.00	-0.03	-0.04	-0.02	0.00	0.00	0.06
16	0.00	-0.03	0.00	0.04	0.08	0.10	0.25
17	0.00	0.01	0.01	0.02	0.03	0.03	0.04

The mass transport capacity for the analyzed reach under peak flow analysis varied from 180 to 12,305 tons per day. The maximum values were calculated at cross section 12.5 for event no. 4 (76.46 ft^3/s).

Proposed Condition

Hydraulic Results

For the proposed condition, the existing geometry model was modified, lowering the channel invert elevations from cross sections 1 to 11 and from 13 to 14. This last segment was proposed to clean the sediment accumulation from the existing culvert until approximately 150 meters upstream. For this reason a cross section located between cross section 14 and 15 was interpolated to determine that limit. The cross section was named 14.3533.

The invert elevations between cross sections 1 and 11 and between 13 and 14 were modified to provide a uniform slope. Figure 11 shows the channel invert comparison for the existing and proposed invert elevations.

Levels at each cross section, along the analyzed reach, for the 100-year flood were computed for the proposed channel invert elevations. Results are presented in Table 9. Figure 8 shows the water surface profile for the 100-year flood. In addition, Figures 13, 14 and 15 shows the proposed cross sections. Detailed results for this frequency flood event are included in Appendix F (Plan: ***PROPOSED***).

Not raise was calculated for the water surface elevation in any cross section for the proposed condition compared with the existing condition model. Therefore, it complies with the requirements of the Planning Regulation No. 13 of the PR Planning Board for rural areas (0.30 meter of maximum increase).

Table 9. Hydraulic modeling results for the proposed condition model: 100-year flood event.

River sta	Reach	Profile	Q total (m^3/s)	Min Ch El (m)	W.S. Elev (m)	Vel Chnl (m/s)
1	MARIN	100-yr	375.82	65.30	70.00	0.45
2				65.45	70.00	0.45
3				65.65	70.00	0.51
4				65.85	70.01	0.56
5				66.02	70.01	0.64
6				66.20	70.01	0.76
7				66.38	70.01	1.03
8				66.60	69.97	1.87
9				66.80	70.02	2.15
10				67.00	69.96	3.25
11				67.70	71.18	4.66
12				69.44	72.33	4.51
12.3				Existing (5) 1.53 x 1.50 (span x rise) Box Culvert		
12.5				69.44	73.53	2.76
13				69.80	73.79	4.67
14				72.11	75.80	4.69
14.3533				72.76	76.42	4.91
15				73.94	77.46	5.28
16				74.83	78.80	4.90
17				77.78	81.33	4.85

Sediment Transport Results

A sediment transport analysis was performed for the proposed channel bed profile described in the proposed hydraulic modeling. Computed change in the channel invert elevations for the mean monthly flow analysis at each cross section, are presented Table 10. Detailed results for this scenario are included in Appendix F (Plan: ***MEAN_PROP***).

Table 10. Sediment transport results for the proposed condition model: mean monthly flow.

River sta	MONTH											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Invert Channel Change (m)												
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01
11	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
12	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
12.5	0.00	0.01	0.01	0.00	0.03	0.01	0.00	0.02	0.00	0.01	0.01	0.01
13	0.00	0.00	0.00	0.00	0.00	-0.02	-0.01	-0.01	0.00	-0.01	-0.01	-0.01
14	0.00	-0.01	-0.02	-0.01	-0.02	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
14.3533	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
16	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	0.00	0.02
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The results for ***mean monthly flow*** shows that erosion processes predominate at cross sections 13, 14, 15 and 16. At cross sections 9, 10, 12, and 12.5, the results indicate aggradation. Sections 1, 2, 3, 4, 5, 6, 7, 8, 14.3533 and 17 present no change. The aggradation varied from 0.01 to 0.03 meter and the erosion varied from 0.01 to 0.02 meter. The mass transport capacity for the analyzed reach under monthly flow conditions varied from 1 to 598 tons per day. The

maximum value was calculated at cross section 14.3533. Figure 9 shows the channel invert comparison for the final and initial condition for this scenario.

Computed change in the channel invert elevations for the peak flow analysis at each cross section, are presented in Table 11. Detailed results for these flood events are included in Appendix F (Plan: ***PEAK_PROP***).

Table 11. Sediment transport results for the proposed condition model: peak flows.

River sta	Number of Event						
	1	2	3	4	5	6	7
	Invert Channel Change (m)						
1	0.00	0.00	0.01	0.04	0.05	0.07	0.08
2	0.00	0.01	0.02	0.05	0.06	0.09	0.10
3	0.00	0.02	0.03	0.07	0.07	0.10	0.12
4	0.00	0.02	0.04	0.08	0.07	0.10	0.13
5	0.00	0.01	0.02	0.03	0.04	0.05	0.09
6	0.00	0.03	0.04	0.07	0.08	0.10	0.15
7	0.00	-0.02	-0.01	0.02	0.03	0.05	0.08
8	0.00	-0.02	-0.01	0.04	0.03	0.05	0.10
9	0.00	-0.01	0.01	0.01	0.02	0.05	0.09
10	0.00	0.01	0.01	0.02	0.02	0.06	0.07
11	0.00	0.02	-0.03	0.01	0.03	0.06	0.05
12	0.00	-0.09	-0.08	-0.03	0.02	-0.02	-0.01
12.5	0.00	0.65	0.82	1.20	1.20	1.20	1.20
13	0.00	0.04	0.09	0.16	0.13	0.18	0.17
14	0.00	-0.03	-0.03	0.01	0.04	0.04	0.09
14.3533	0.00	0.05	0.07	0.07	0.01	0.05	0.06
15	0.00	-0.03	-0.03	-0.01	0.00	0.05	0.07
16	0.00	-0.03	0.01	0.04	0.09	0.09	0.16
17	0.00	0.01	0.01	0.02	0.02	0.03	0.04

The results for ***peak flow analysis*** shows that erosion processes predominate at cross sections 12, and 15. Aggradation process predominates at cross sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.5 13, 14, 14.3533 15, 16 and 17. The erosion depth varied from 0.01 to 0.09 meter with the maximum value occurring at section 12. In addition, the aggradations depth varied from 0.01 to 1.20 meters with the maximum value occurring at section 12.5. Figure 10 shows the channel invert comparison for the final and initial condition for this scenario.

The mass transport capacity for the analyzed reach under peak flow analysis varied from 1 to 26,606 tons per day. The maximum value was calculated at cross section 14.3533 for event no. 6 (71.64 m^3/s).

VI. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Not raise was calculated for the water surface elevation in any cross section for the proposed condition compared with the existing condition model. Therefore, it complies with the requirements of the Planning Regulation No. 13 of the PR Planning Board for rural areas (0.30 meter of maximum increase).

2. The hydraulic analysis for the existing condition shows that the existing culvert over Rio Marín is flooded during the 100-yr rainfall event. The flood depth calculated was 2.39 meter from the top elevation.

3. For the existing condition, The results for ***mean monthly flow*** indicate that aggradation predominates at cross section 1, 2, 7, 10, 12 and 12.5 For cross sections 3, 5, 6, 11, 13, 14, 15 and 16, erosion is the predominant process. Sections 4, 8, 9 and 17 present not change. The aggradation ranged from 0.01 to 0.05 meter and the erosion ranged from 0.01 to 0.14 meter.

4. For the existing condition, the results for ***mean monthly flow*** indicate that the mass transport capacity for the analyzed reach under mean monthly flow varied from 1 to 205 tons per day. The maximum values were calculated for cross section 17 for the month of December.

5. For the existing condition, the results for peak flow analysis shows that erosion processes predominates at cross sections 2, 3, 4, 12, 14 and 15. For cross sections 1, 5, 6, 7, 8, 9, 10, 11, 12.5, 13, 16 and 17, aggradation is the predominant process. The erosion depth varied from 0.01 to 0.08 meter with the maximum value occurring at cross section 11. In addition, the aggradation depth varied from 0.01 to 1.20 meters with the maximum value occurring at cross section 12.5, located upstream from the existing culvert.

6. For the existing condition, the results for peak flow analysis shows that the mass transport capacity for the analyzed reach under peak flow analysis varied from 180 to 12,305 tons per day. The maximum values were calculated at cross section 12.5 for event no. 4 (76.46 ft3/s).

7. For the proposed condition, the results for mean monthly flow shows that erosion processes predominate at cross sections 13, 14, 15 and 16. At cross sections 9, 10, 12, and 12.5 indicate aggradation. Sections 1, 2, 3, 4, 5, 6, 7, 8, 14.3533 and 17 present no change. The aggradation varied from 0.01 to 0.03 meter and the erosion varied from 0.01 to 0.02 meter. The maximum values were calculated at cross section 14.3533.

8. The results for mean monthly flow for the proposed condition shows that the mass transport capacity for the analyzed reach under monthly flow conditions varied from 1 to 598 tons per day. It is higher than calculated for the existing condition, which will be allowing the material replenishment.

9. For the proposed condition, the results for peak flow analysis shows that erosion processes predominate at cross sections 12, and 15. Aggradation process predominates at cross sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.5 13, 14, 14.3533 15, 16 and 17. The erosion depth varied from 0.01 to 0.09 meter with the maximum value occurring at section 12. In addition, the aggradations depth varied from 0.01 to 1.20 meters with the maximum value occurring at section 12.5.

10. The mass transport capacity for the analyzed reach under peak flow analysis for the proposed condition varied from 1 to 26,606 tons per day. The maximum value was calculated at cross section 14.3533 for event no. 6 (71.64 m3/s). It is higher than calculated for the existing condition, which will be allowing the material replenishment.

Recommendations

1. The proposed extraction activity should be developed between cross sections 1 to 11. That is, 501 meters (as indicated in the Field Study). And between cross sections 13 to 14 with 98 meters. Figure 12 show the location plan for the proposed extraction activity.

2. The amount of material that can be extracted is approximately **94,655 m^3**. That volume results from the multiplication of the average area between sections and the approximated length of the extraction reach (599 meters).

3. The section for extraction should be trapezoidal in shape with lateral sides with minimum slops 3:1 (H:V).

4. Figures 13, 14 and 15 shows the proposed cross section.

Study Limitations

All recommendations specified herein must be implemented to assure performance in accordance with the results of this study. Excavation activities deeper than the recommended in this study or beyond the limits of the river reach evaluated might result in a greater impact on the equilibrium sediment transport than the computed in this study.

This analysis is based on the field data as submitted by Mr. José A. Lebrón Quiñones, PLS. Inaccuracies in this data may total or partially invalidate the results and recommendations contained in this study.

VII. CERTIFICATION

I certify that the hydrologic-hydraulic study presented herein was performed by me and the information is true, correct, and complete as per my knowledge. I know and accept the consequences of include and submit incomplete, unfinished or false information in this document. To state this, I sign the present certification in *Carolina, Puerto Rico*, on June 8, 2010.

Respectfully submitted,

Miguel Menar Figueroa, MSCE, PE
PE License #13051

VIII. REFERENCES

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FIGURES

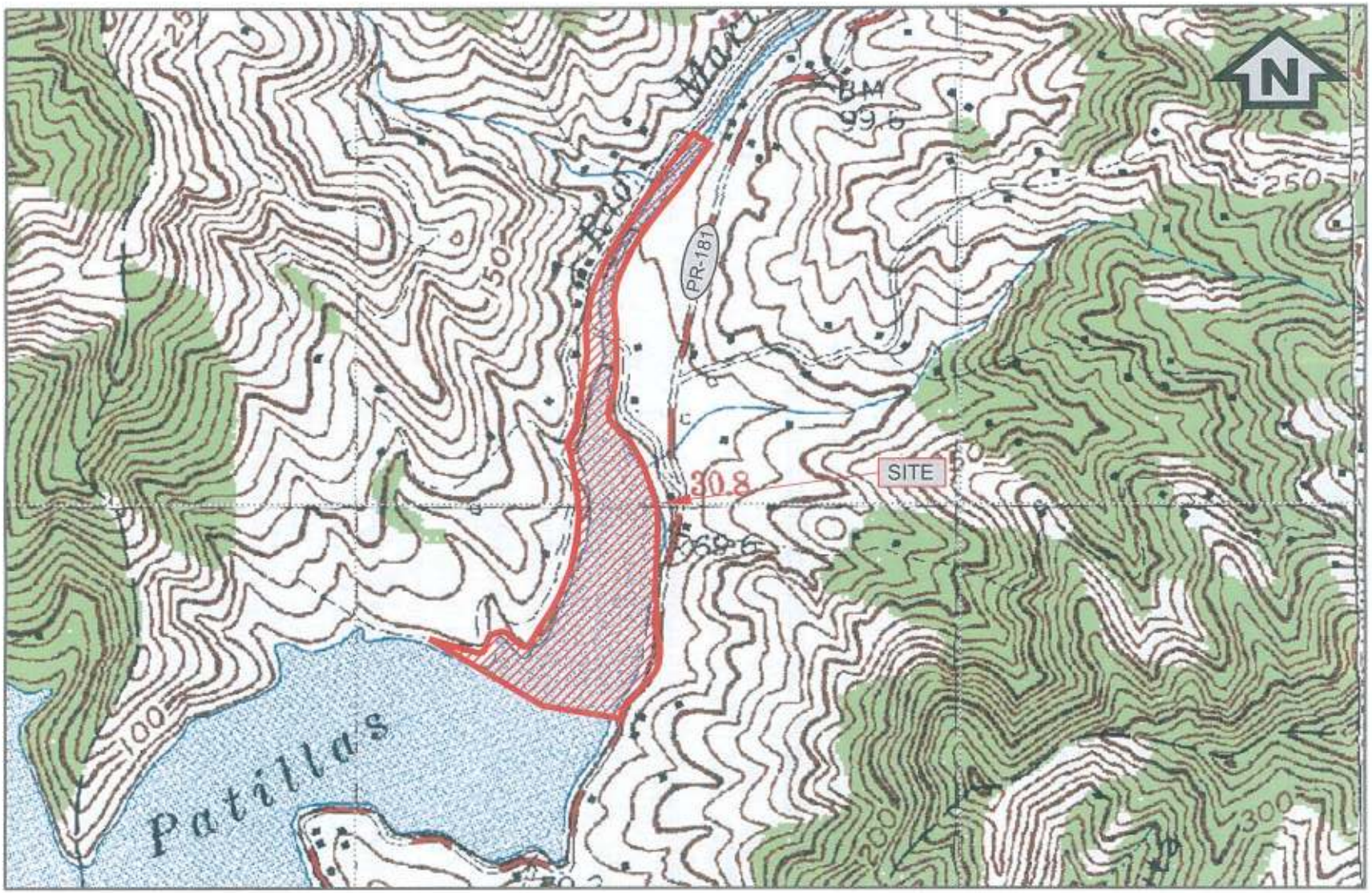

Figure 1. Studied reach location on the USGS topographic map of Patillas (scale 1:10,000).

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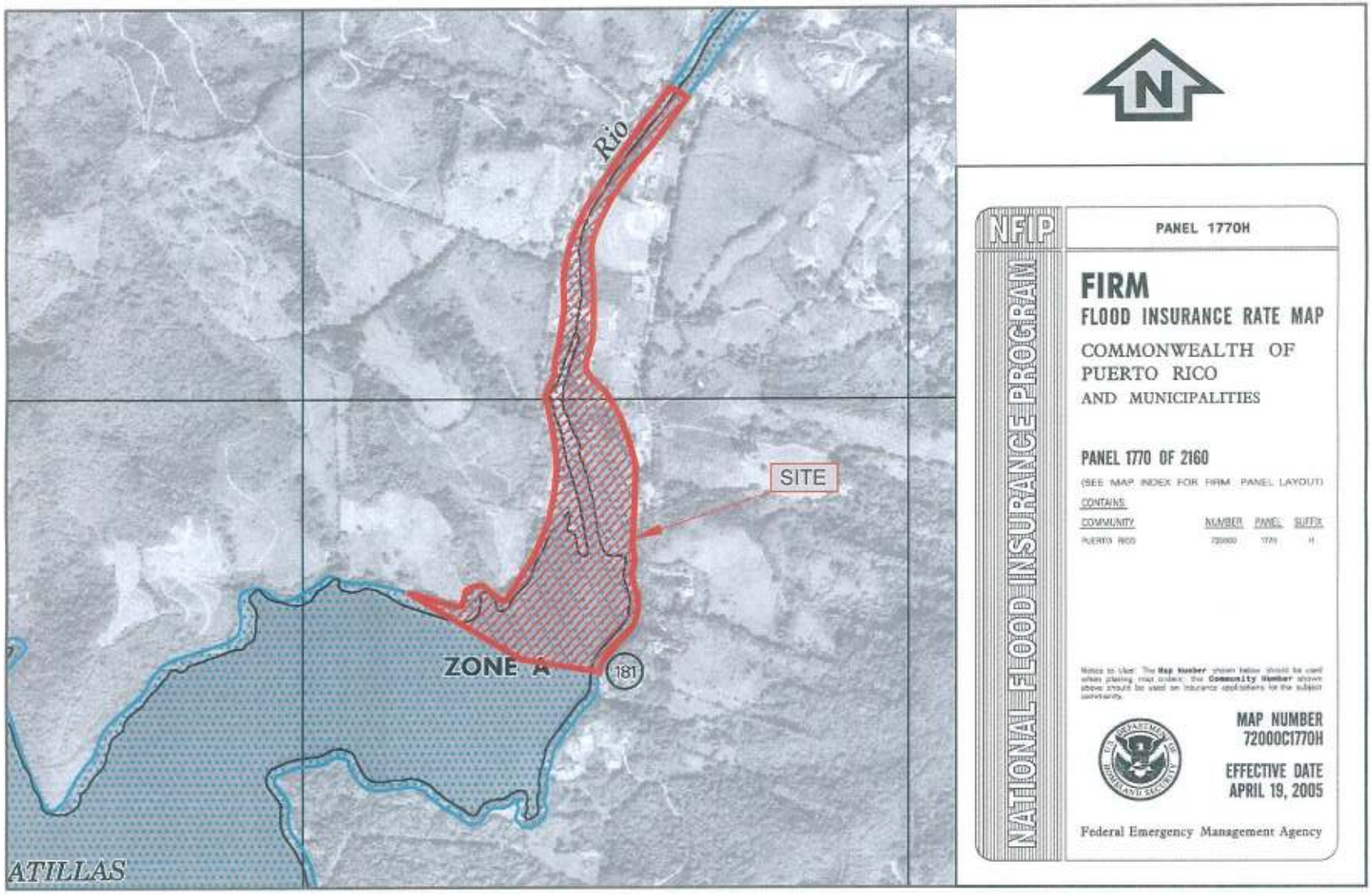

Figure 2. Studied reach location on partial copy of FEMA's Flood Insurance Rate Map No. 1170H (scale 1:10,000).

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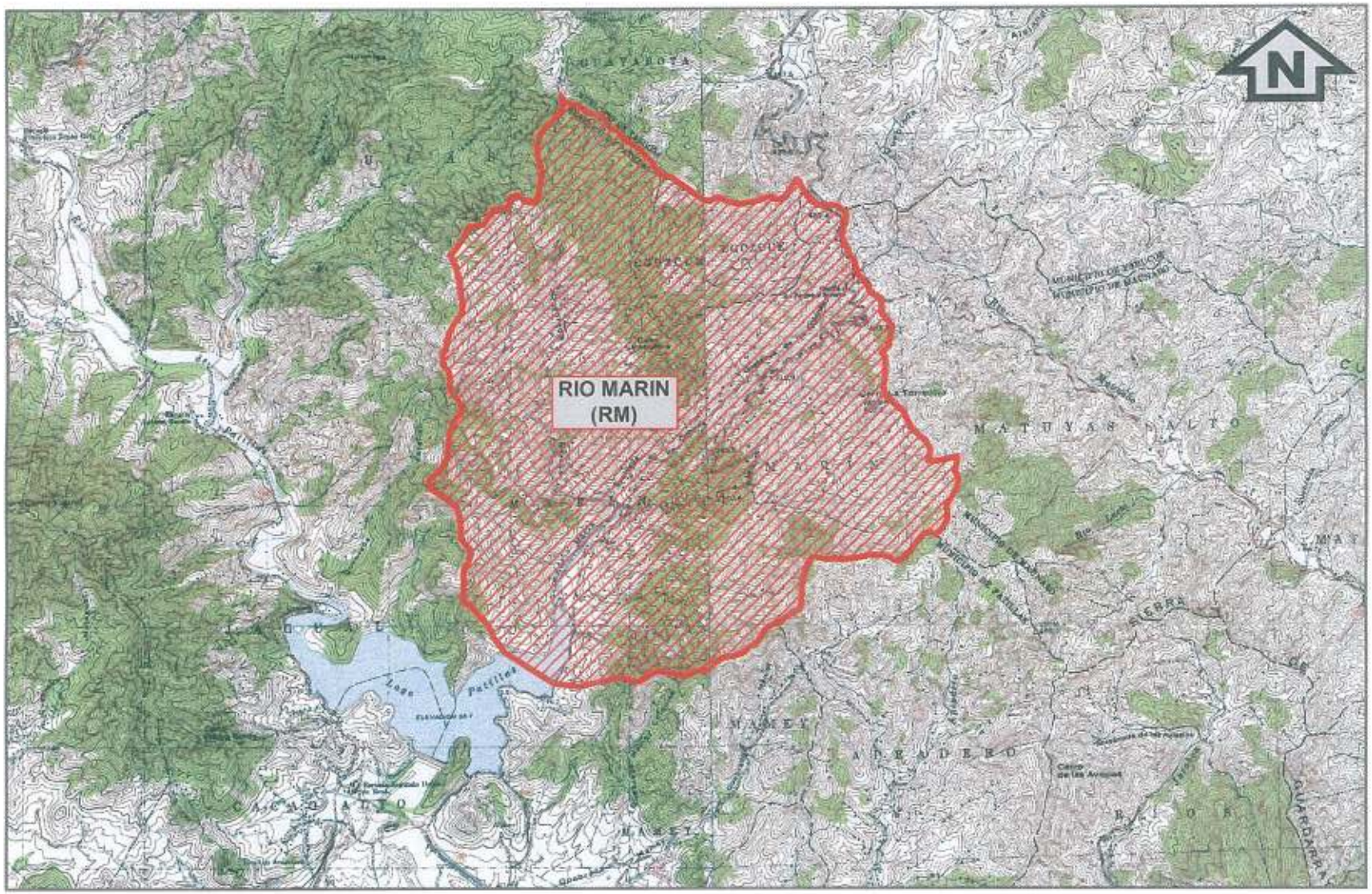

Figure 3. Drainage watershed limits for the Rio Marin (scale 1:50,000).

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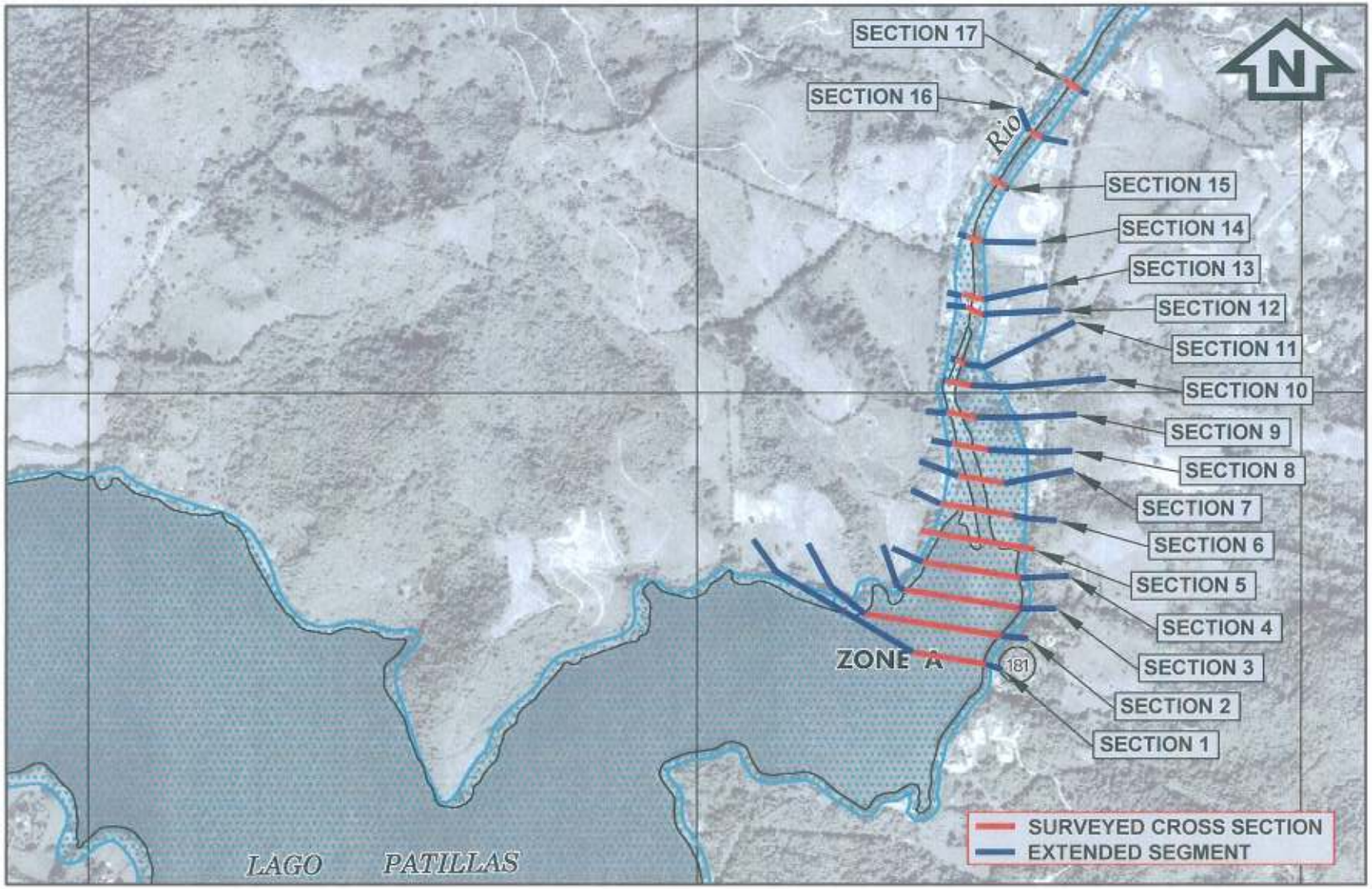

Figure 4. Cross sections location plan on the FEMA's Flood Insurance Rate Map No. 1770H (scale 1:10,000).

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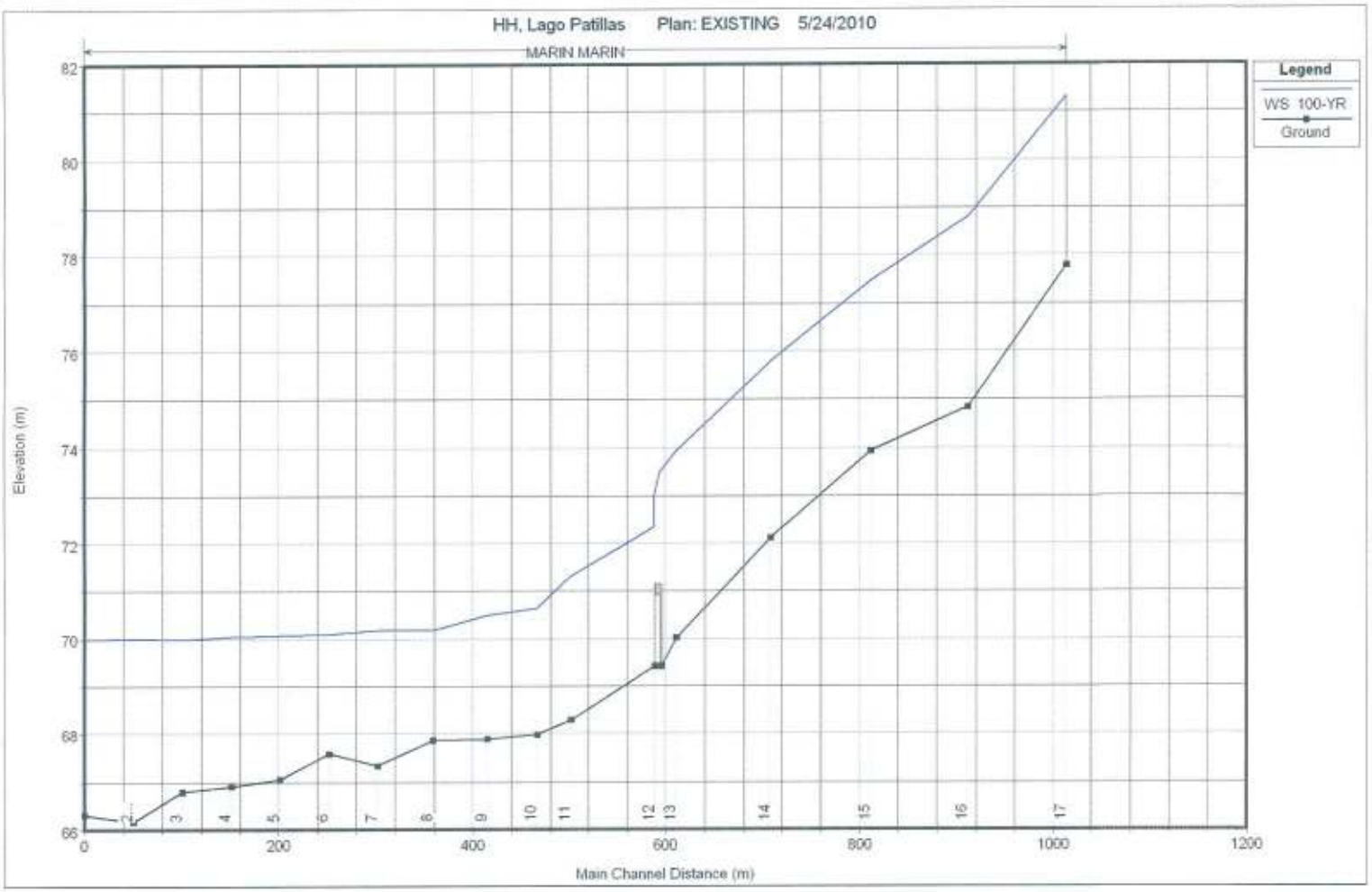

Figure 5. Water surface profile for the existing condition: 100-year flood (scale as shown).

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Figure 6. Channel invert profile comparison for the existing condition: Mean monthly flows: Marin (scale as shown).

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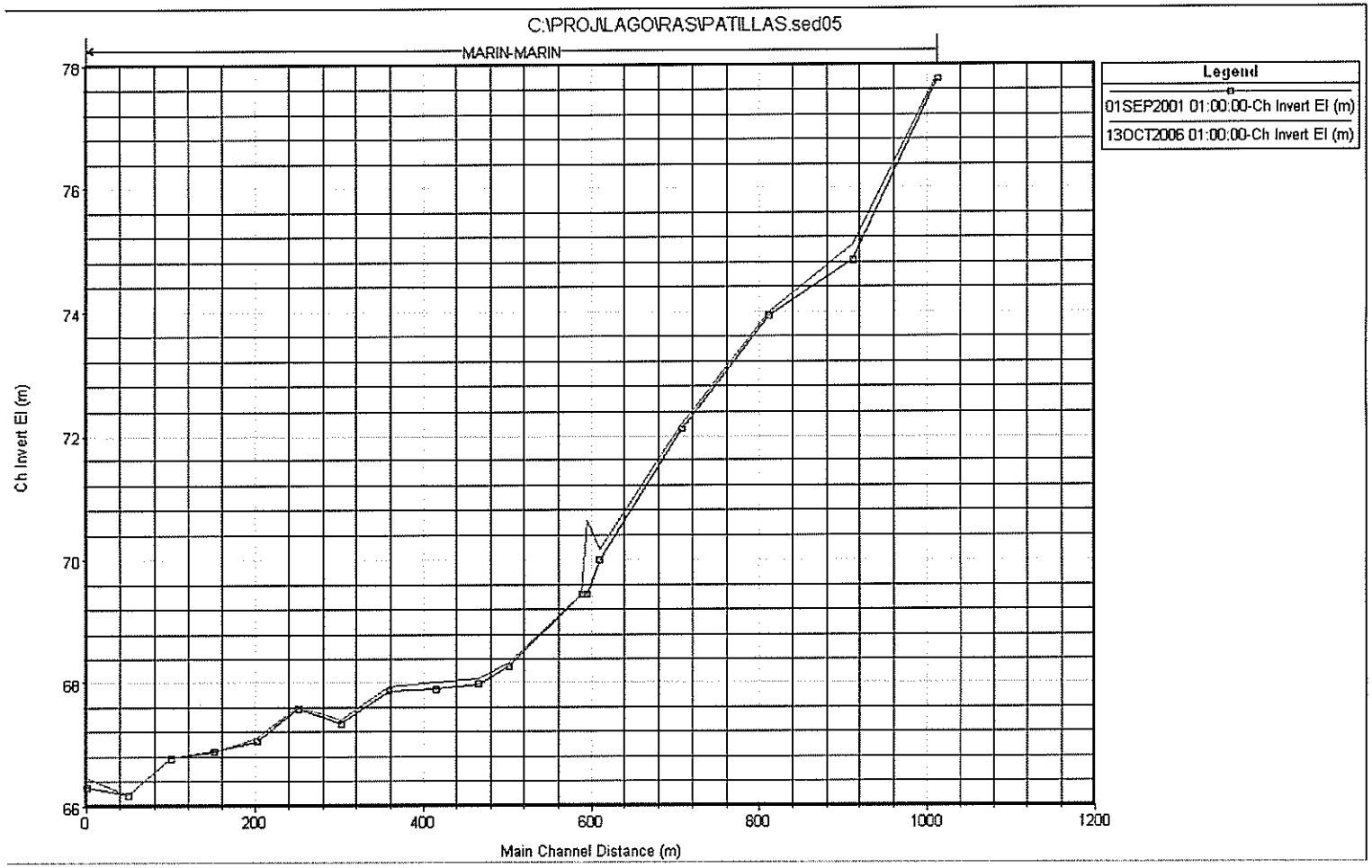

Figure 7. Channel invert profile comparison for the existing condition: Peak flows: Marin (scale as shown).

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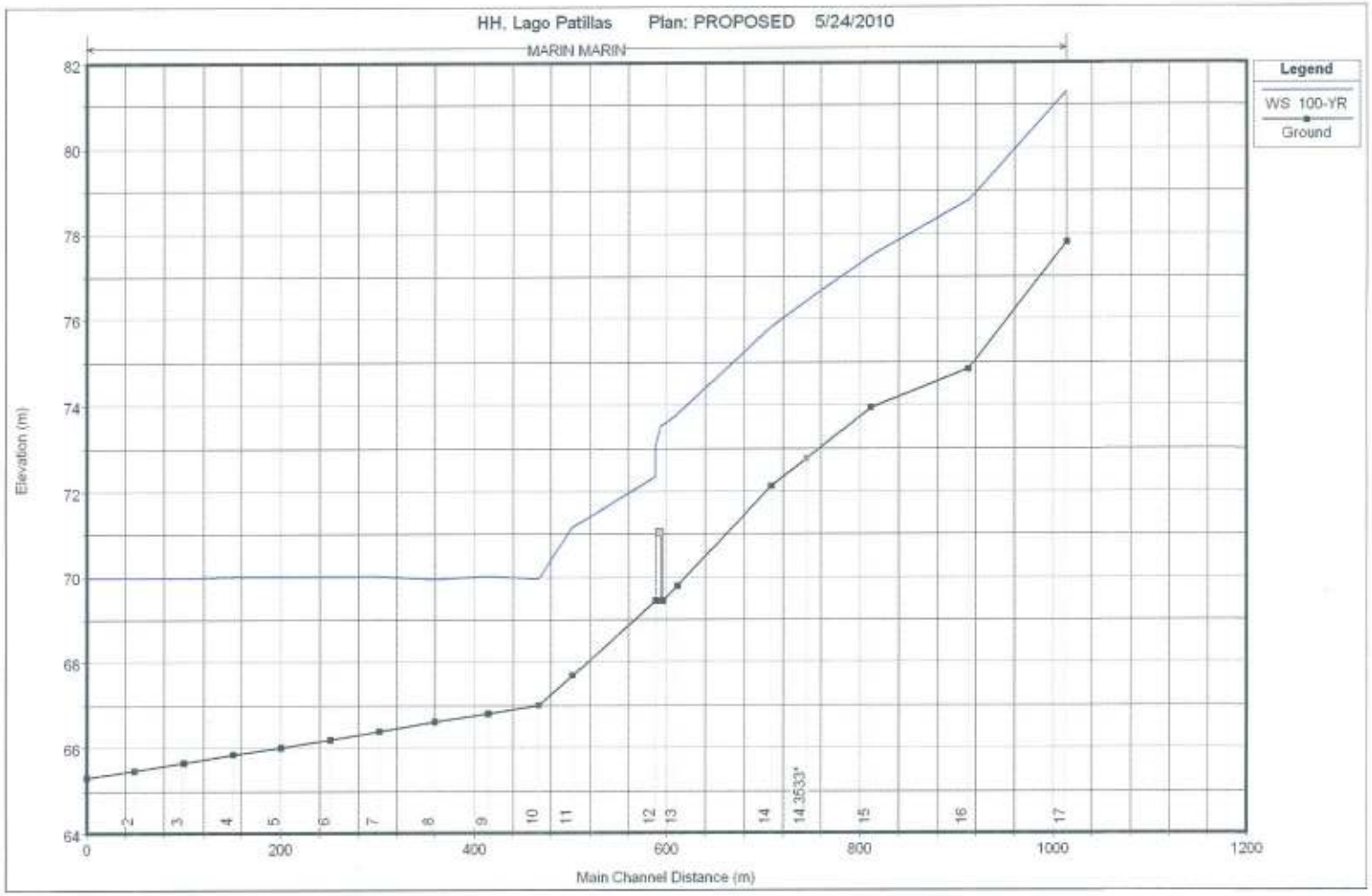

Figure 8. Water surface profile for the proposed condition: 100-year flood (scale as shown).

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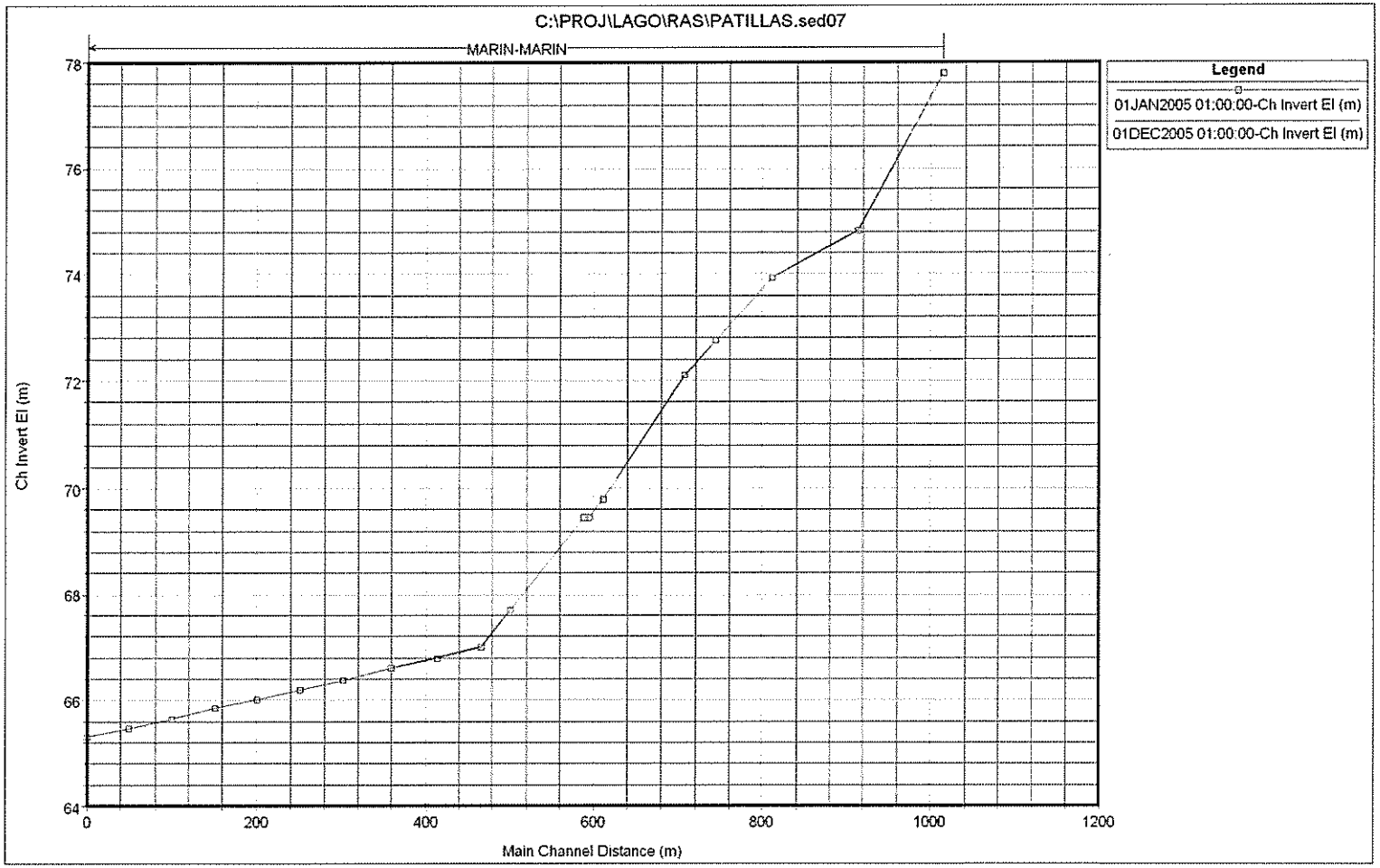

Figure 9. Channel invert profile comparison for the proposed condition: Mean monthly flows: Marin (scale as shown).

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Figure 10. Channel invert profile comparison for the proposed condition: Peak flows: Marin (scale as shown).

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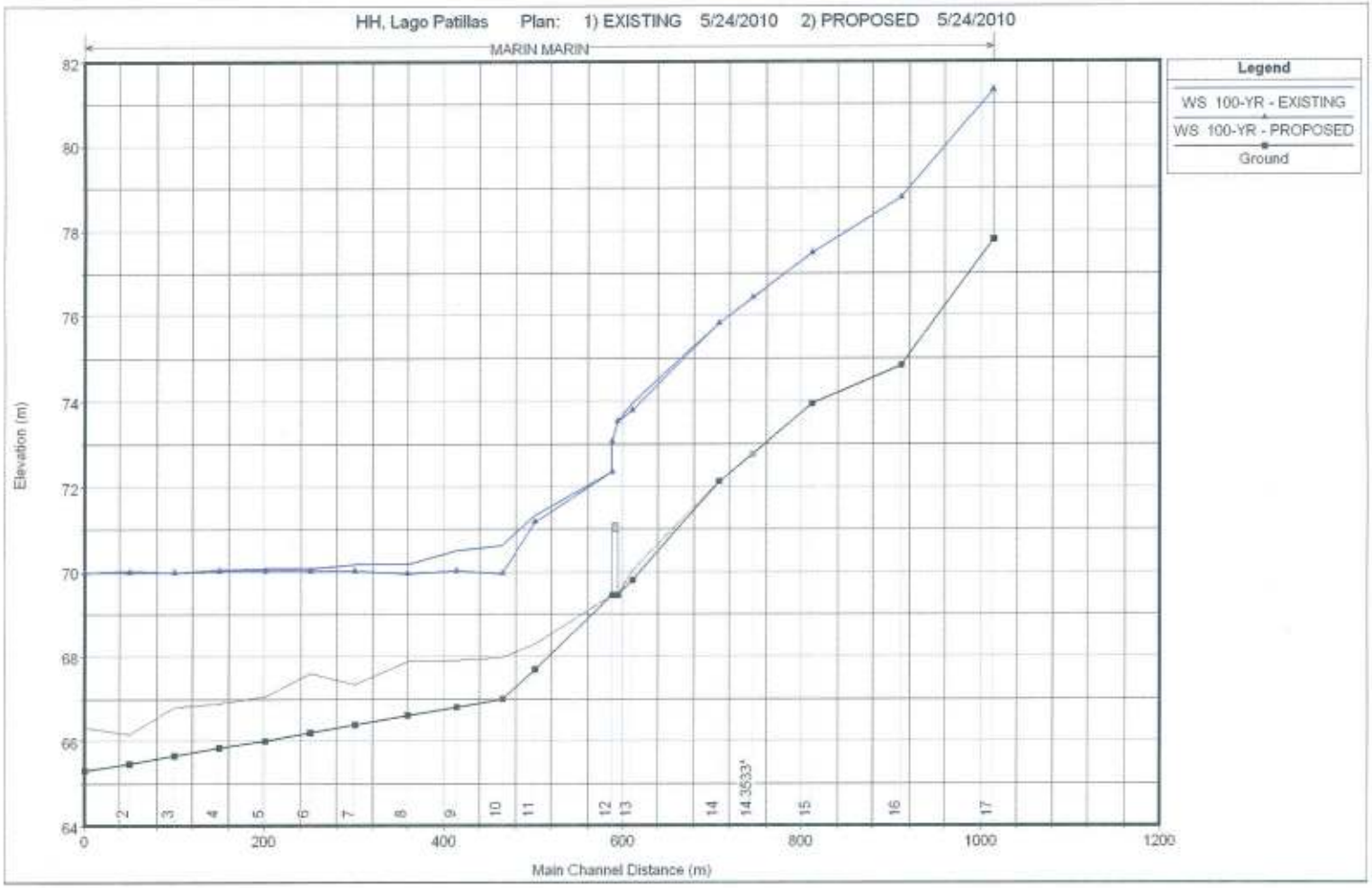

Figure 11. Channel inverts profile comparison for the existing and proposed conditions (scale as shown).

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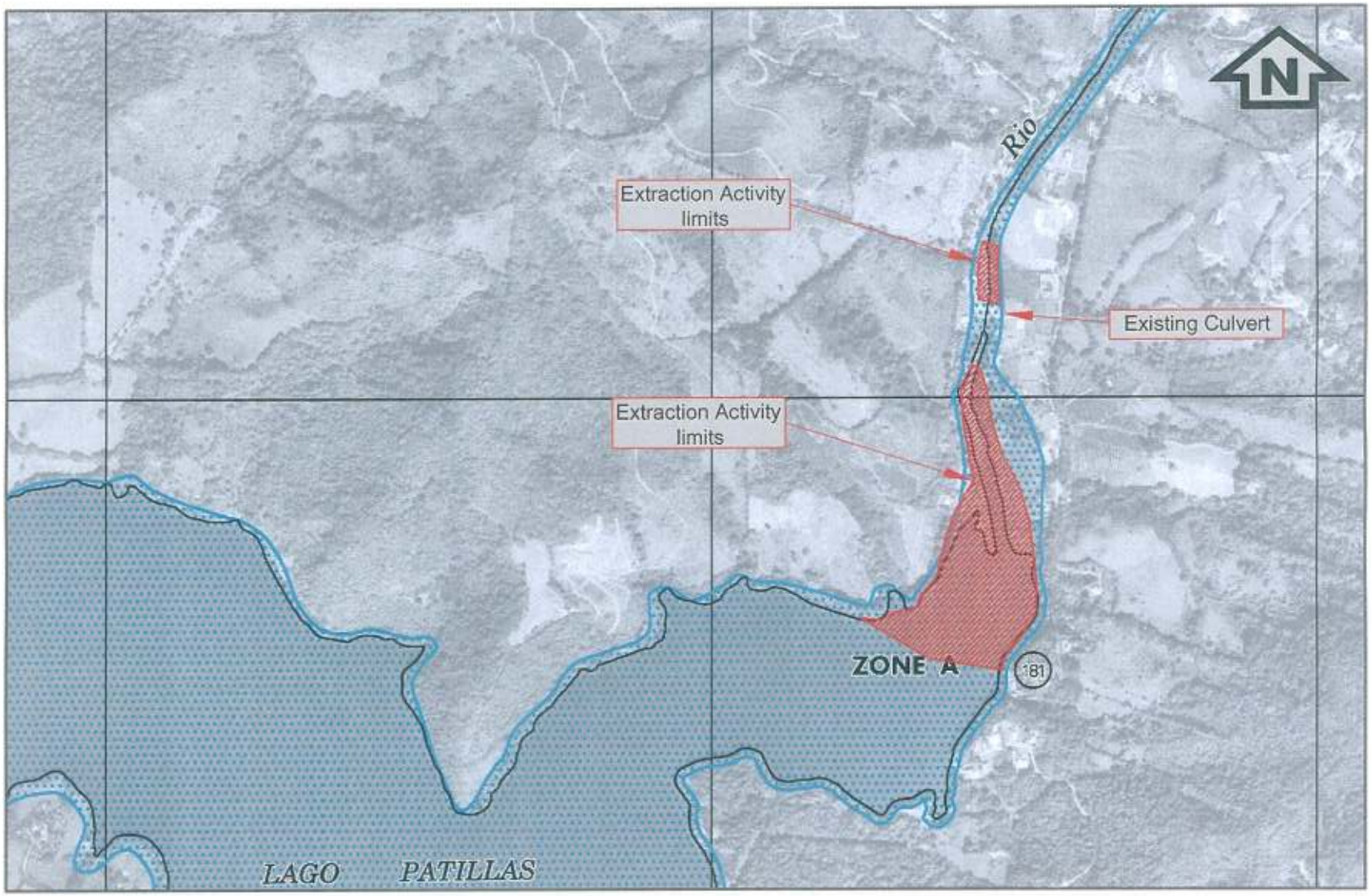

Figure 12. Plan view for the proposed extraction activity limits (scale 1:10,000).

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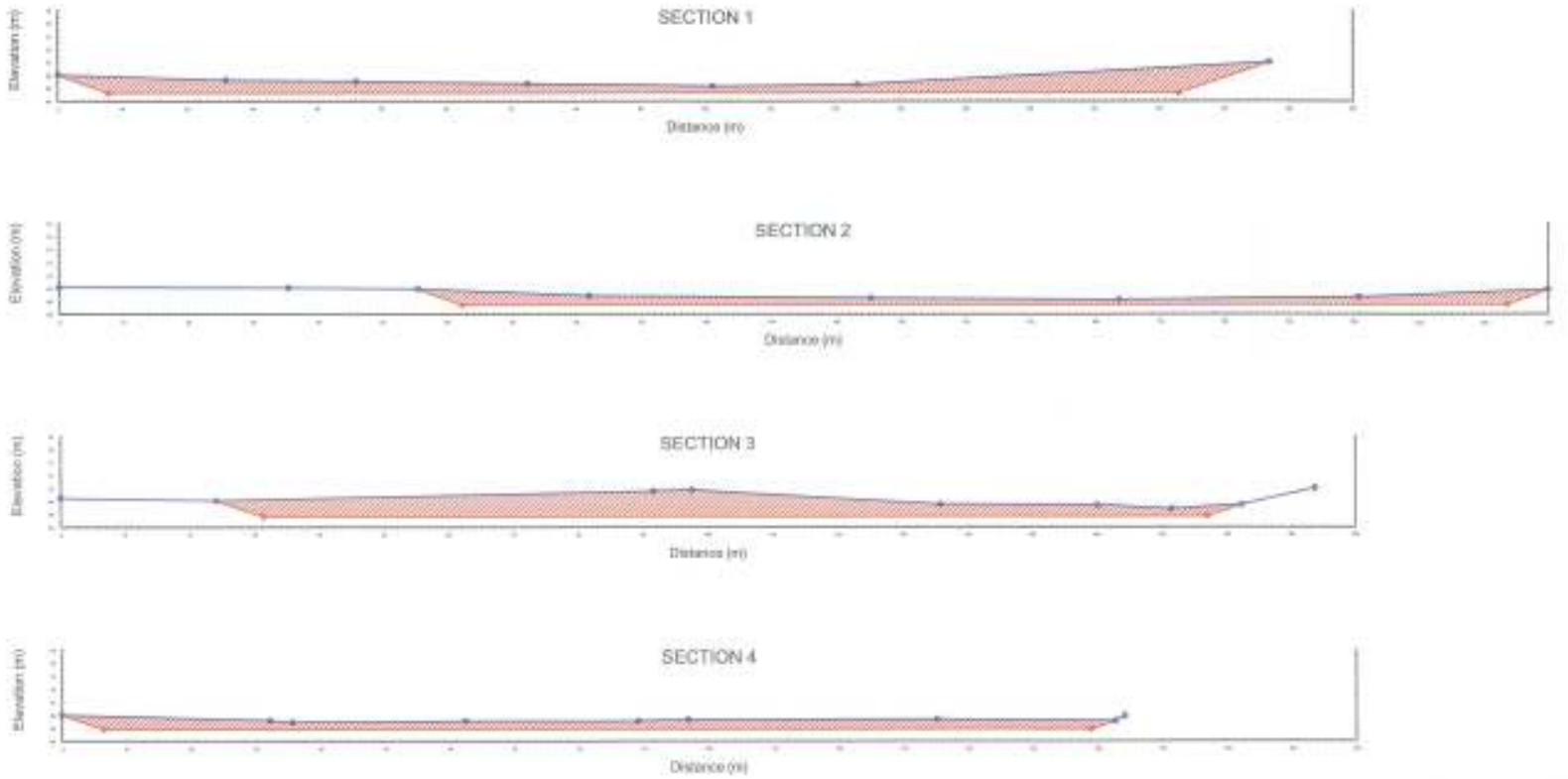

Figure 13. Existing and proposed cross section 1 to 4 (scale 1:750).

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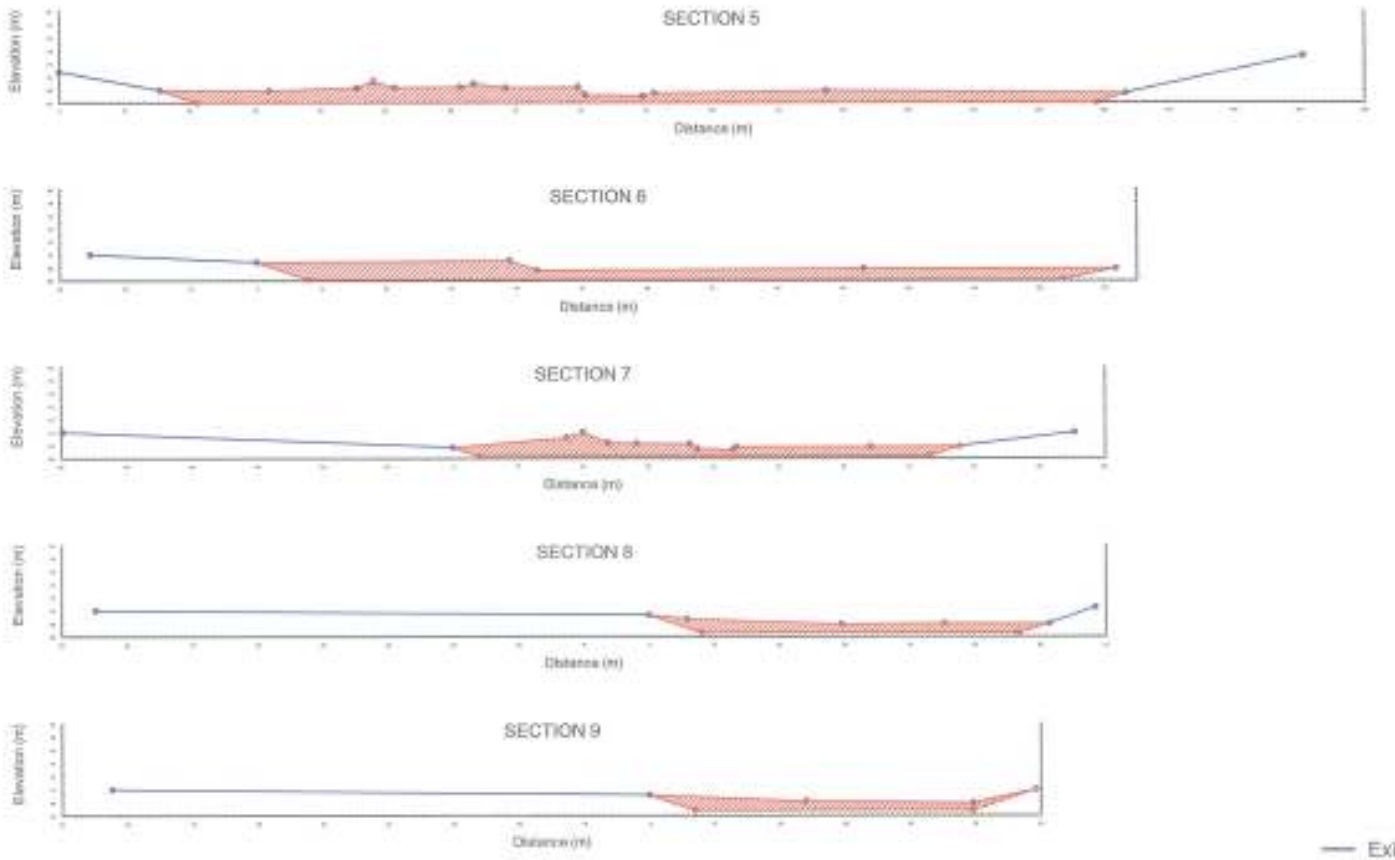

Figure 14. Existing and proposed cross section 5 to 9 (scale 1:750).

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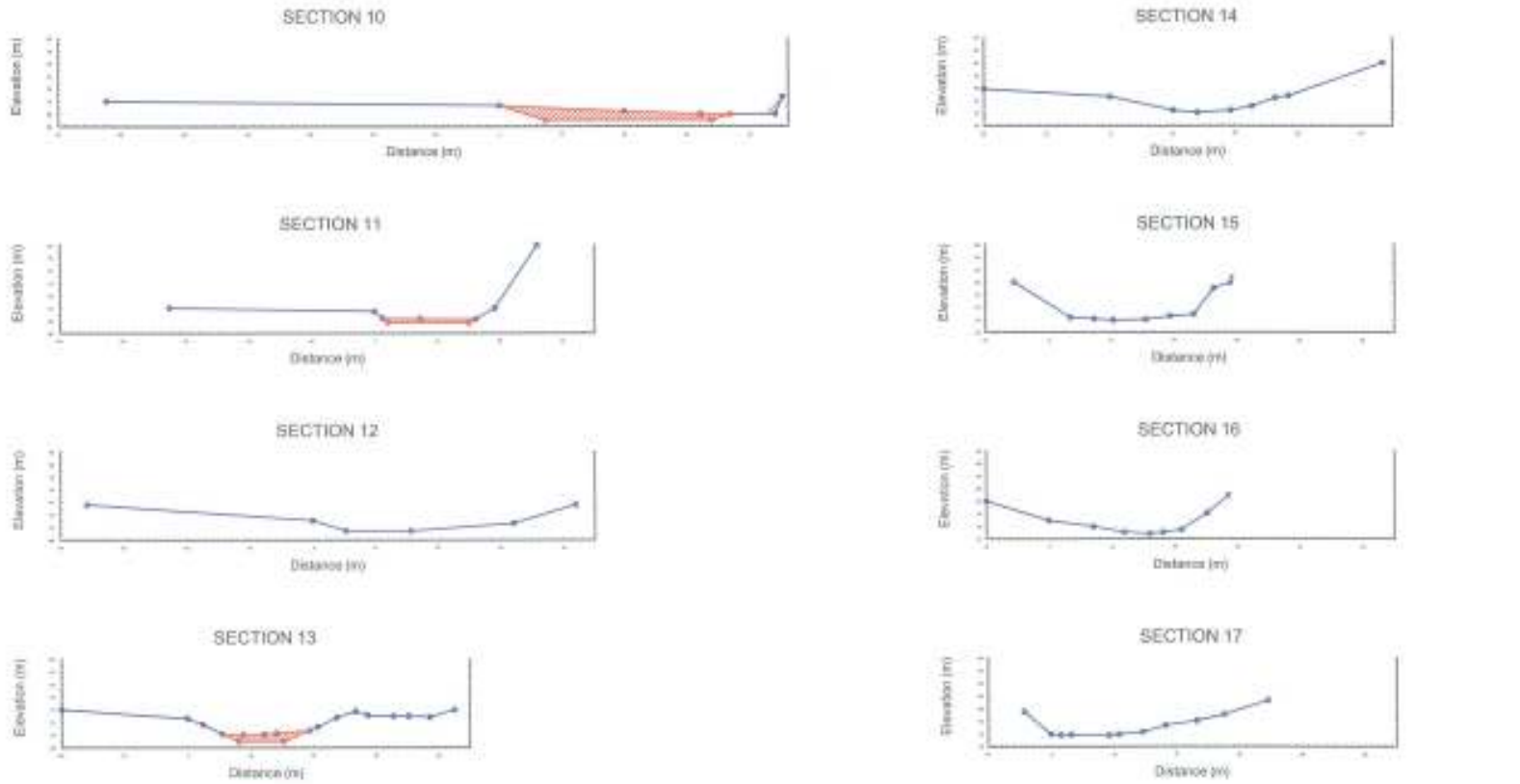

Figure 15. Existing and proposed cross sections 10 to 17 (scale 1:750).

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APPENDIX A

HYDROLOGIC DATA

WORKSHEET: CURVE NUMBER

Project: LAGO PATILLAS By: GAS Date: SEP. 30 2009

Location: PATILLAS Checked: MMF Date: OCT. 01 2009

BASIN NAME: RIO MARIN (RM) **CONDITION: EXIS. & PROP.**

BASIN AREA (Ac) = 3394.08

BASIN AREA (mi^2) = 5.3033

SOILS NAME (SYMBOL), HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
Pandura Loam (PaF2), Pandura Loam (PaF2), D	Grass	84	2924.5	245658
Patillas clay loam (PmE2), Patillas clay loam (PmD2), B	Grass	69	469.58	32401.02
				0
				0
				0
		Totals	3394.08	278059.02

CN	82

* Antecedent moisture condition II

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITION: **EXIS & PROP** **BASIN NAME:** **RM**

L = 6,160 meters x 3.28 = 20,209.97 feet

S = 525 (top) – 70 (bottom) = 455.00 ÷ 6,160 = 0.0739

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(20{,}209.97)^{0.77}}{(0.0739)^{0.385}}$$

Total = 0.732 x 60 = 43.92 minutes*

Tc = 44 minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 18.033043N **Longitude: 66.011644W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall ,in 2 YR	0.46	0.81	1.93	2.51	2.80	3.51	4.31	5.07
Rainfall ,in 100 YR	0.96	1.68	3.99	5.84	6.98	9.68	12.67	16.05

HYDROLOGIC ANALYSIS

USGS STATION NO. 50093000 DATA

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USGS Water Resources

Data Category: Surface Water | Geographic Area: Puerto Rico | GO

News New Mapper and Experimental Real-Time Web Service - updated August 2009

USGS Surface-Water Daily Statistics for Puerto Rico

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.

USGS 50093000 RIO MARIN NR PATILLAS, PR

Available data for this site | Time-series: Daily statistics | GO

Patillas Municipio, Puerto Rico
Hydrologic Unit Code 21010004
Latitude 18°02'16", Longitude 66°00'31" NAD27
Drainage area 4.45 square miles
Gage datum 295.3 feet above sea level NGVD29

Output formats
HTML table of all data
Tab-separated data
Reselect output format

00060, Discharge, cubic feet per second,												
Day of month	Mean of daily mean values for each day for 7 - 8 years of record in, cfs (Calculation Period 1999-10-01 -> 2007-09-3(											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13	8.5	6.5	6.7	6.9	8.1	12	14	42	11	16	1
2	12	7.8	6.3	6.0	6.4	13	13	32	16	26	25	1
3	9.9	9.2	6.5	5.7	7.3	9.0	21	22	12	49	24	1
4	9.4	8.1	6.2	7.0	10	23	16	18	20	16	15	1
5	11	7.7	6.2	5.7	10	24	12	16	13	23	15	1
6	16	7.5	6.2	5.1	8.0	26	25	17	10	26	18	5
7	10	9.2	5.9	14	21	19	23	25	20	20	28	2
8	9.1	9.7	6.0	6.3	8.7	11	19	30	20	26	49	1
9	9.3	12	5.9	5.7	7.0	15	14	24	13	30	24	1
10	12	8.3	6.6	5.1	6.4	28	29	18	12	93	17	1
11	10	7.8	6.1	13	10	17	15	17	27	73	63	2
12	9.2	8.4	5.9	7.2	7.8	14	14	12	11	33	100	1
13	9.2	7.0	5.8	6.2	10	11	27	15	9.6	32	62	1
14	9.6	6.9	8.2	11	11	9.4	18	14	14	21	77	1
15	25	7.2	6.6	6.5	17	14	32	13	72	32	47	1
16	10	7.5	6.1	14	12	11	15	16	49	27	37	2
17	8.7	13	6.1	33	37	10	14	17	44	19	26	2
18	8.8	7.9	11	29	16	23	12	45	39	27	36	2
19	8.8	11	6.6	15	16	18	17	19	19	25	25	2
20	8.5	8.3	7.1	13	15	18	25	13	15	18	18	2
21	7.7	11	7.8	22	34	29	18	11	15	23	17	2
22	8.9	7.8	8.8	8.6	25	26	15	48	13	44	20	1
23	8.6	7.2	6.5	7.4	21	11	14	50	11	50	20	1
24	8.1	8.8	6.3	8.4	19	11	11	17	12	29	23	1
25	9.8	7.7	6.2	7.0	12	10	14	15	13	24	20	1
26	7.8	7.0	6.9	7.2	9.0	11	16	33	12	21	17	1
27	7.3	6.7	5.8	6.9	8.5	11	14	13	21	20	18	1
28	14	6.6	6.5	6.4	9.7	11	15	22	24	27	14	1
29	8.6	15	7.3	6.5	14	19	21	17	12	30	14	1
30	7.7		6.9	6.2	35	13	23	15	12	19	15	1
31	7.9		5.5		11		11	22		16		1

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National Water Information System: Web Interface

USGS Water Resources

Data Category: Surface Water | Geographic Area: Puerto Rico | GO

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USGS Surface-Water Monthly Statistics for Puerto Rico

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.

USGS 50093000 RIO MARIN NR PATILLAS, PR

Available data for this site | Time-series: Monthly statistics | GO

Patillas Municipio, Puerto Rico Hydrologic Unit Code 21010004 Latitude 18°02'16", Longitude 66°00'31" NAD27 Drainage area 4.45 square miles Gage datum 295.3 feet above sea level NGVD29	**Output formats** HTML table of all data Tab-separated data Reselect output format

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 2000-03-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000			4.80	5.87	16.6	9.11	7.16	15.3	27.4	17.6	13.4	14.1
2001	6.19	7.10	6.48	7.06	10.6	4.77	7.67	25.5	17.4	20.5	14.4	26.4
2002	11.4	8.83	5.92	16.4	14.4	30.4	11.9	17.2	14.7	10.1	11.4	10.4
2003	9.21	11.5	6.61	29.7	12.8	16.9	23.0	33.5	15.9	23.9	83.9	35.6
2004	13.6	12.8	15.2	8.04	38.4	20.8	20.9	17.5	61.9	20.1	31.1	9.83
2005	6.68	4.25	2.80	2.61	9.11	16.2	28.1	18.7	8.38	95.0	38.8	12.5
2006	13.5	7.06	4.73	4.17	5.68	21.7	34.6	19.8	8.91	22.9	16.9	16.6
2007	10.8	7.24	6.65	6.94	7.16	6.54	8.10	22.8	12.3			
Mean of monthly Discharge	10	8.4	6.6	10	14	16	18	21	21	30	30	18

** No Incomplete data have been used for statistical calculation

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U.S. Department of the Interior | U.S. Geological Survey
Title: Surface Water data for Puerto Rico: USGS Surface-Water Monthly

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National Water Information System: Web Interface

USGS Water Resources

Data Category: Surface Water
Geographic Area: Puerto Rico
GO

News New Mapper and Experimental Real-Time Web Service - updated August 2009

Peak Streamflow for Puerto Rico
USGS 50093000 RIO MARIN NR PATILLAS, PR

Available data for this site Surface-water: Peak streamflow GO

Patillas Municipio, Puerto Rico
Hydrologic Unit Code 21010004
Latitude 18°02'16", Longitude 66° 00'31" NAD27
Drainage area 4.45 square miles
Gage datum 295.3 feet above sea level NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
2000	Sep. 11, 2000	10.02	2,140	2004	Sep. 15, 2004	12.33	4,010
2001	Sep. 01, 2001	13.28	4,970	2005	Nov. 14, 2004	10.57	2,530
2002	Aug. 18, 2002	10.05	2,160	2006	Oct. 23, 2005	8.78	1,330
2003	Apr. 17, 2003	10.80	2,700	2007	Oct. 13, 2006	7.99	926

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U.S. Department of the Interior | U.S. Geological Survey
Title: Surface Water for Puerto Rico: Peak Streamflow
URL: http://waterdata.usgs.gov/pr/nwis/peak?

USA.gov
TAKE PRIDE IN AMERICA

Page Contact Information: Puerto Rico NWISWeb Maintainer
Page Last Modified: 2009-09-29 14:48:52 EDT
1.39 1.39 nadww01

APPENDIX B

RAINFALL DATA (NOAA ATLAS 14, VOL 3, VERSION 4.0)

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Puerto Rico 18.033043 N 66.011644 W 328 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 3, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Wed Sep 30 2009

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Docs | Return to State Map

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.34	0.46	0.59	0.94	1.39	1.74	2.15	2.67	3.26	3.83	5.11	5.90	7.00	7.88	10.61	13.24	16.68	20.18
2	0.46	0.63	0.81	1.30	1.93	2.51	2.80	3.51	4.31	5.07	6.78	7.83	9.23	10.30	13.65	16.90	21.14	25.47
5	0.58	0.79	1.02	1.63	2.41	3.28	3.73	4.83	6.00	7.20	9.66	11.10	12.88	14.01	17.70	21.35	26.18	31.00
10	0.67	0.91	1.17	1.87	2.78	3.85	4.44	5.85	7.38	8.98	12.08	13.84	15.93	17.05	21.00	24.94	30.22	35.37
25	0.78	1.07	1.37	2.19	3.25	4.63	5.41	7.29	9.34	11.57	15.60	17.85	20.36	21.40	25.63	29.90	35.73	41.21
50	0.87	1.19	1.52	2.44	3.62	5.23	6.18	8.46	10.96	13.73	18.55	21.22	24.08	24.97	29.37	33.85	40.06	45.75
100	0.96	1.31	1.68	2.69	3.99	5.84	6.98	9.68	12.67	16.05	21.70	24.83	28.06	28.79	33.25	37.90	44.46	50.28
200	1.05	1.43	1.84	2.94	4.37	6.49	7.82	10.99	14.51	18.56	25.12	28.76	32.37	32.89	37.40	42.15	49.04	54.95
500	1.17	1.60	2.05	3.29	4.88	7.37	9.00	12.83	17.11	22.15	30.02	34.40	38.55	39.01	43.23	48.06	55.30	61.25
1000	1.27	1.73	2.22	3.56	5.28	8.06	9.93	14.32	19.22	25.09	34.03	39.03	43.62	44.02	47.89	52.79	60.24	66.12

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

*** Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)**

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.40	0.54	0.69	1.11	1.65	2.14	2.40	3.02	3.73	4.28	5.86	6.79	8.01	8.91	11.81	14.63	18.29	21.98
2	0.51	0.69	0.89	1.42	2.11	2.77	3.13	3.98	4.93	5.68	7.81	9.02	10.57	11.66	15.18	18.64	23.16	27.74
5	0.63	0.86	1.10	1.77	2.62	3.61	4.15	5.44	6.84	8.01	11.04	12.72	14.70	15.77	19.62	23.49	28.64	33.68
10	0.72	0.99	1.27	2.03	3.02	4.24	4.93	6.58	8.38	9.96	13.76	15.82	18.14	19.17	23.27	27.43	33.04	38.43
25	0.85	1.16	1.49	2.38	3.54	5.10	6.03	8.22	10.64	12.82	17.80	20.40	23.20	24.06	28.41	32.90	39.07	44.84
50	0.95	1.29	1.66	2.66	3.94	5.79	6.92	9.58	12.52	15.20	21.18	24.27	27.45	28.14	32.60	37.28	43.85	49.88
100	1.05	1.43	1.84	2.94	4.36	6.50	7.85	11.04	14.50	17.77	24.86	28.46	32.08	32.58	37.08	41.85	48.78	54.93
200	1.15	1.58	2.02	3.24	4.80	7.25	8.87	12.61	16.75	20.61	28.91	33.11	37.14	37.35	41.84	46.71	54.01	60.29
500	1.30	1.77	2.28	3.64	5.41	8.30	10.27	14.85	19.84	24.67	34.72	39.78	44.43	44.55	48.56	53.55	61.21	67.53
1000	1.41	1.93	2.48	3.96	5.88	9.15	11.44	16.70	22.40	28.02	39.58	45.30	50.52	50.52	54.10	59.05	66.99	73.22

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.

Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

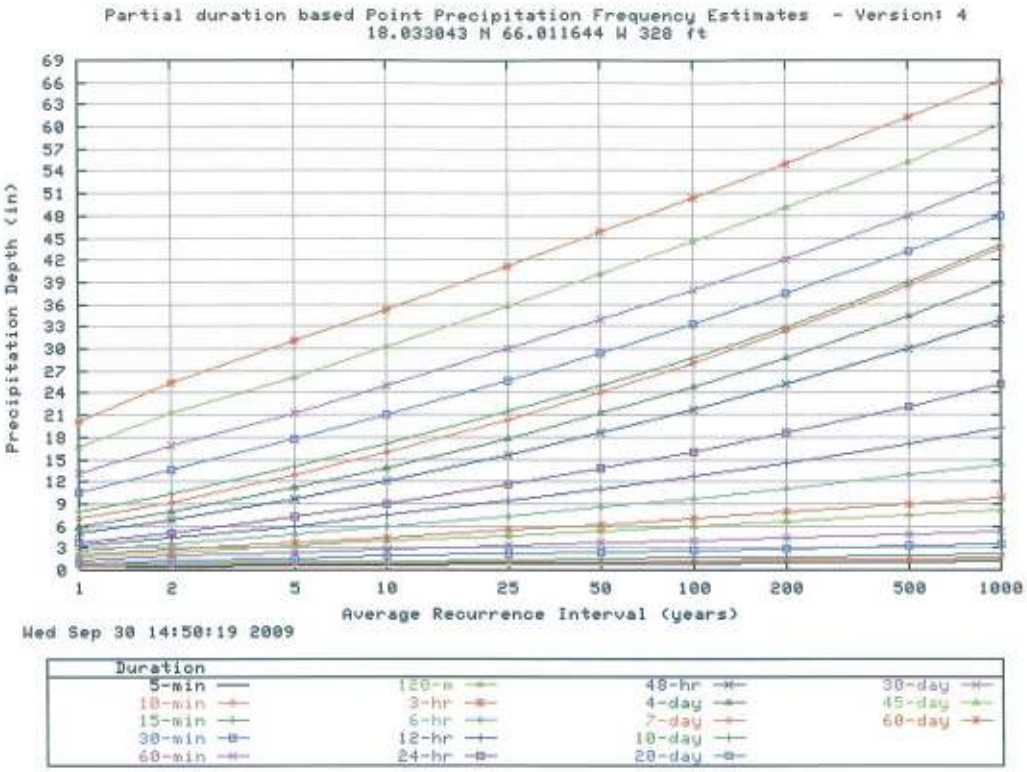
*** Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)**

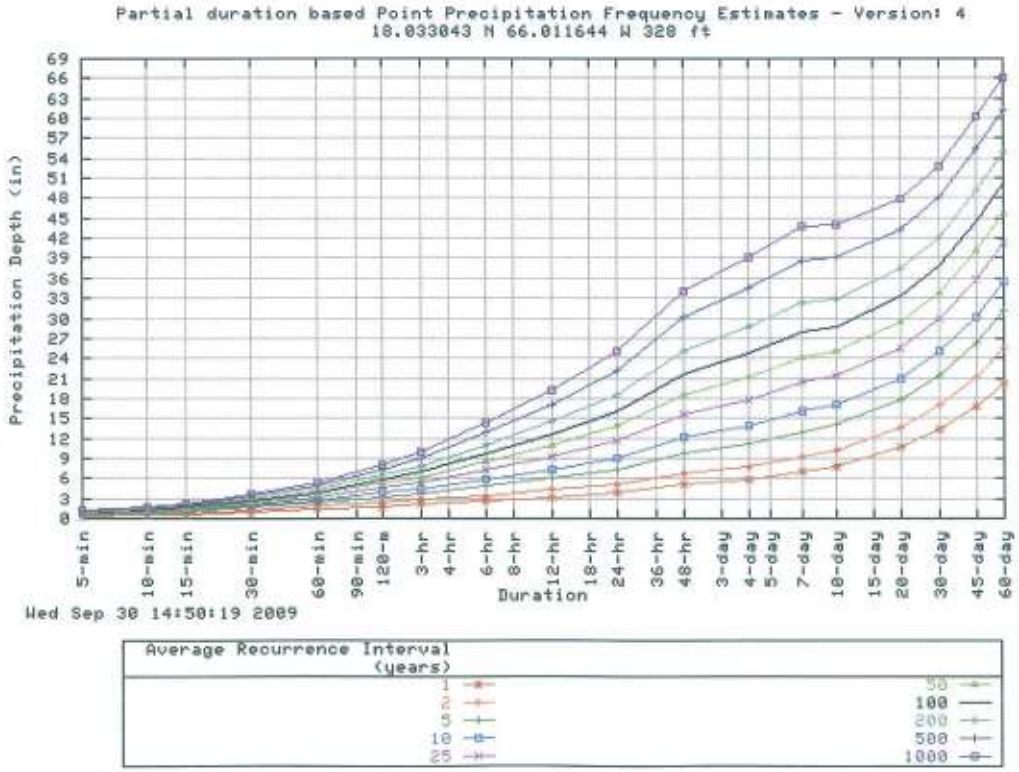
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.33	0.45	0.58	0.93	1.39	1.72	1.93	2.36	2.85	3.44	4.47	5.15	6.13	6.98	9.55	12.03	15.25	18.53
2	0.42	0.58	0.74	1.19	1.77	2.26	2.51	3.10	3.77	4.56	5.94	6.83	8.09	9.13	12.29	15.36	19.34	23.39
5	0.53	0.72	0.93	1.49	2.21	2.95	3.35	4.27	5.25	6.47	8.45	9.67	11.27	12.39	15.90	19.37	23.91	28.42
10	0.61	0.83	1.06	1.70	2.53	3.46	3.96	5.15	6.41	8.04	10.49	11.99	13.86	14.99	18.79	22.56	27.51	32.34
25	0.71	0.97	1.24	1.99	2.95	4.12	4.77	6.34	8.01	10.29	13.40	15.30	17.55	18.68	22.80	26.90	32.35	37.50
50	0.78	1.07	1.37	2.20	3.26	4.62	5.41	7.29	9.29	12.14	15.82	18.06	20.58	21.67	25.98	30.29	36.11	41.45
100	0.86	1.17	1.50	2.40	3.57	5.13	6.05	8.25	10.61	14.10	18.34	20.91	23.75	24.77	29.21	33.69	39.85	45.33
200	0.93	1.27	1.63	2.62	3.88	5.65	6.73	9.26	12.02	16.22	21.08	23.98	27.13	28.04	32.61	37.22	43.69	49.27
500	1.03	1.41	1.81	2.89	4.29	6.34	7.63	10.67	13.95	19.16	24.87	28.29	31.88	32.88	37.27	42.03	48.84	54.49
1000	1.10	1.51	1.94	3.10	4.60	6.88	8.33	11.78	15.49	21.54	27.93	31.81	35.72	36.76	40.95	45.78	52.80	58.51

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than.
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.

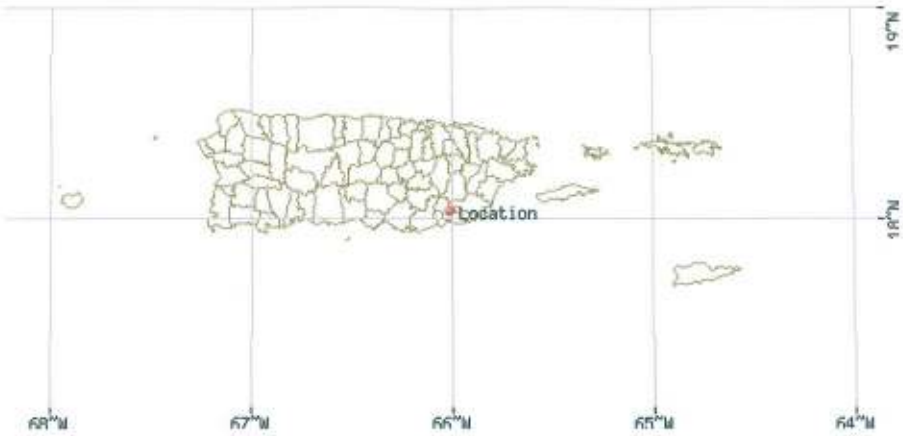
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Text version of tables





Maps -



These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.

LEGEND

State
County
Indian Resv
Lake/Pond/Ocean
Street
Expressway
Highway
Connector
Stream
Military Area
National Park
Other Park
City
County

Scale 1:228583
*average--true scale depends on monitor resolution

Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to NOAA Atlas 14 Document.

Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (18.033043/-66.011644). Digital ASCII data can be obtained directly from **NCDC**.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910

(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

Disclaimer

APPENDIX C

CUSTOM SOIL RESOURCE REPORT (WEB SOIL SURVEY)

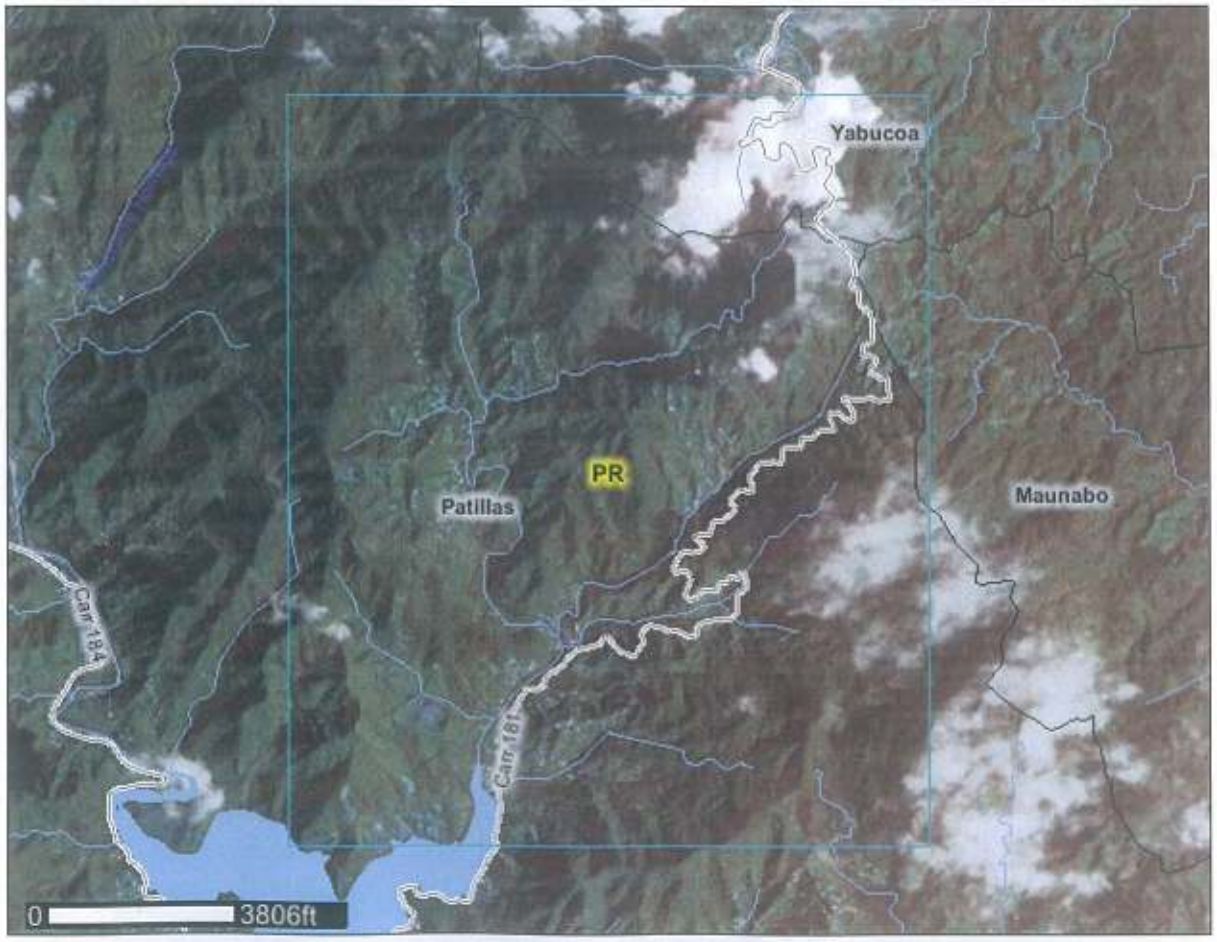
United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Humacao Area, Puerto Rico Eastern Part

Patillas Lake



September 30, 2009

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

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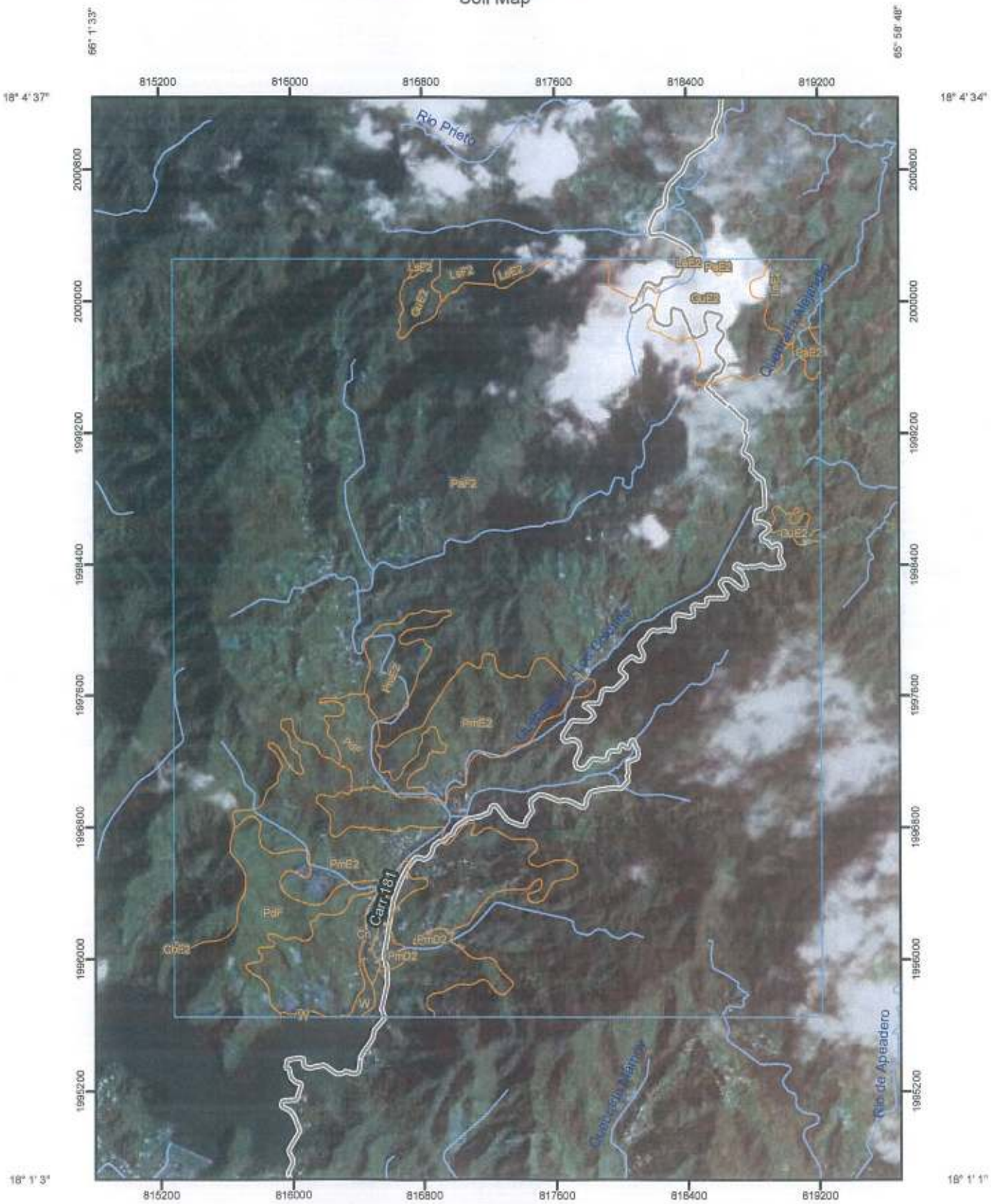
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:31,400 if printed on A size (8.5" x 11") sheet.

N

Meters: 0 300 600 1,200 1,800

Feet: 0 1,000 2,000 4,000 6,000

66° 1' 37"

65° 58' 51"

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:31,400 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Humacao Area, Puerto Rico Eastern Part
Survey Area Data: Version 3, Aug 19, 2008

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

APPENDIX D

HEC-1 INPUT AND OUTPUT DATA

EXISTING CONDITION (100-YR FREQUENCY): RM100.DAT

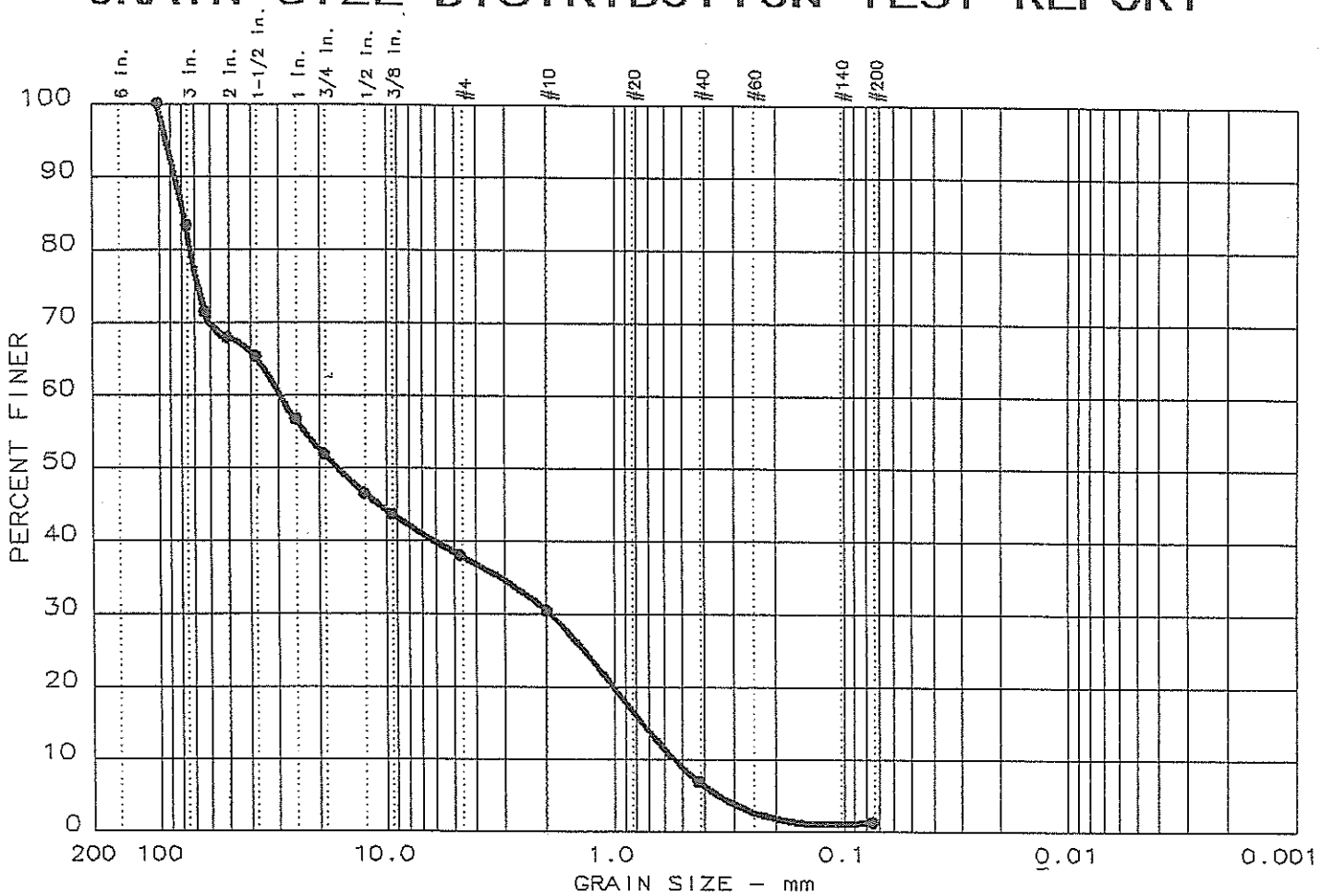
```
1****************************************                                    ****************************************
 *                                      *                                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998              *                                    *   HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.1                *                                    *         609 SECOND STREET            *
 *                                      *                                    *      DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   24MAY10  TIME  09:27:24  *                                    *          (916) 756-1104              *
 *                                      *                                    *                                      *
 ****************************************                                    ****************************************

                                        X     X  XXXXXXX   XXXXX          X
                                        X     X  X        X     X        XX
                                        X     X  X        X               X
                                        XXXXXXX  XXXX     X        XXXXX  X
                                        X     X  X        X               X
                                        X     X  X        X     X         X
                                        X     X  XXXXXXX   XXXXX        XXX

          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                HEC-1 INPUT                                                PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1           ID        MENAR HYDROSYSTEMS ENGINEERING
            2           ID
            3           ID        HYDROLOGIC ANALISIS FOR RIO MARIN, PATILLAS, PUERTO RICO
            4           ID
            5           ID        EXISTING CONDITION
            6           ID        ANTECEDENT MOISTURE CONDITION II
            7           ID        LAG TIME ESTIMATED FROM KIRPICH EQUATION
            8           ID        POINT PRECIPITATION FREQUECY ESTIMATES FROM NOAA ATLAS 14
            9           ID        LATITUDE: 18.033043 N LONGITUDE: 66.011644 W
           10           ID        24-HOURS BALANCED STORM DISTRIBUTION
           11           ID        100-YEAR FREQUENCY STORM
           12           ID        FILENAME: RM100.DAT
           13           ID        OCTOBER 2009
           14           ID
           15           IT      13 01OCT09       0     300 01OCT09    2400
           16           IO       3
                        *
                        *
                        *DIAGRAM
                        *
                        *
                        *  RIO MARIN
                        *
                        *

           17           KK      RM
           18           BA  5.3033
           19           LS       0      82
           20           UD    0.44
           21           PH       0       0    0.96    1.68    3.99    5.84    6.98    9.68   12.67   16.05
                        *
                        *
                        *
           22           ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    17          RM

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                    ****************************************
 *                                      *                                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998              *                                    *   HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.1                *                                    *         609 SECOND STREET            *
 *                                      *                                    *      DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   24MAY10  TIME  09:27:24  *                                    *          (916) 756-1104              *
 *                                      *                                    *                                      *
 ****************************************                                    ****************************************

                                MENAR HYDROSYSTEMS ENGINEERING

                                HYDROLOGIC ANALISIS FOR RIO MARIN, PATILLAS, PUERTO RICO

                                EXISTING CONDITION
                                ANTECEDENT MOISTURE CONDITION II
                                LAG TIME ESTIMATED FROM KIRPICH EQUATION
                                POINT PRECIPITATION FREQUECY ESTIMATES FROM NOAA ATLAS 14
                                LATITUDE: 18.033043 N LONGITUDE: 66.011644 W
                                24-HOURS BALANCED STORM DISTRIBUTION
                                100-YEAR FREQUENCY STORM
                                FILENAME: RM100.DAT
                                OCTOBER 2009
```

```
  16 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          13  MINUTES IN COMPUTATION INTERVAL
                       IDATE      10CT 9  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         112  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      20CT 9  ENDING DATE
                      NDTIME        0003  ENDING TIME
                       ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL     .22 HOURS
                       TOTAL TIME BASE   24.05 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
            **************
            *            *
  17 KK     *        RM  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

  18 BA          SUBBASIN CHARACTERISTICS
                       TAREA        5.30  SUBBASIN AREA

                 PRECIPITATION DATA

  21 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .96    1.68    3.99    5.84    6.98    9.68   12.67   16.05     .00     .00     .00     .00

                                                   STORM AREA =    5.30

  19 LS          SCS LOSS RATE
                       STRTL         .44  INITIAL ABSTRACTION
                      CRVNBR       82.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

  20 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG         .44  LAG

                                                                  ***

VALUE EXCEEDS TABLE IN LOGLOG        24.05000         .01667       24.00000

                                                      UNIT HYDROGRAPH
                                                 12 END-OF-PERIOD ORDINATES
             1429.     4318.     4410.     2740.     1372.      732.      386.      202.      107.       56.
               32.       12.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION       RM

    TOTAL RAINFALL =   15.94, TOTAL LOSS =    2.36, TOTAL EXCESS =   13.58

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.05-HR
+   (CFS)       (HR)
                          (CFS)
+   13272.     12.57                  5131.       1931.       1914.       1914.
                        (INCHES)     8.771      13.450      13.450      13.450
                         (AC-FT)     2481.       3804.       3804.       3804.

                        CUMULATIVE AREA =    5.30 SQ MI

1
                                                      RUNOFF SUMMARY
                                                 FLOW IN CUBIC FEET PER SECOND
                                               TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
          OPERATION       STATION    FLOW    PEAK                                          AREA      STAGE     MAX STAGE
+                                                        6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                            RM     13272.   12.57        5131.       1931.       1914.       5.30


 *** NORMAL END OF HEC-1 ***
```

APPENDIX E

SEDIMENT DATA

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	16.7	45.2	36.8	1.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			78.1	29.3	16.5	1.92	0.746	0.534	0.23	55.0

MATERIAL DESCRIPTION	USCS	AASHTO
●	GP	A-1-a

Project No.: 5300
Project: TERRA TECH
● Location:

Date: 5/3/00

Remarks:

ING. VICTOR MARIO RIVERA

GRAIN SIZE DISTRIBUTION TEST REPORT
Metropolitan Soils and Engineering Materials Laboratory, Inc.

Figure No. _____

APPENDIX F

HEC-RAS INPUT AND OUTPUT DATA

HYDRAULIC ANALYSIS

STEADY FLOW PLAN: EXISTING

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X        X
X     X  X        X    X      X   X    X    X        X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX


PROJECT DATA
Project Title: HH, Lago Patillas
Project File : PATILLAS.prj
Run Date and Time: 5/24/2010 9:36:53 AM

Project in SI units


PLAN DATA

Plan Title: EXISTING
Plan File : C:\PROJ\LAGO\RAS\PATILLAS.p01

          Geometry Title: EXISTING
          Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g01

          Flow Title    : EXISTING
          Flow File     : C:\PROJ\LAGO\RAS\PATILLAS.f01

Plan Summary Information:
Number of:  Cross Sections =   18    Multiple Openings  =    0
            Culverts       =    1    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed at all cross sections
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow


FLOW DATA

Flow Title: EXISTING
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f01

Flow Data (m3/s)

  River          Reach          RS                100-YR
  MARIN          MARIN          17                375.82


Boundary Conditions

  River          Reach          Profile                     Upstream                Downstream

  MARIN          MARIN          100-YR                   Normal S = 0.03            Known WS = 70


GEOMETRY DATA

Geometry Title: EXISTING
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g01

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 17

INPUT
Description:
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -14.2      90   -4.24   81.52       0   77.92    1.59   77.79     3.2   77.87
    9.23   77.78   10.78   77.93   14.53   78.28   18.17   79.33   23.18   80.06
```

```
   27.56   81.06   34.56   83.27

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.2     .06   -4.24     .04   34.56     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -4.24   34.56             87.52  101.87    84.4             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 16

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.66      90       0   76.94    7.01   75.96    11.9   75.07   15.98   74.83
   18.11   75.04   21.02   75.45   25.08   78.09   39.62      90

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.66     .06       0     .04   25.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0   25.08            122.87  100.85  127.39             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 15

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -5.43      80       0   77.22    3.49   74.36    7.23   74.16    10.3   73.94
   15.44   74.06    19.3   74.57   23.04   74.85   26.26   78.99   28.96   79.88

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -5.43     .06       0     .04   26.26     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0   26.26             99.29  103.25  104.82             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -87.11      80       0   74.62    5.84   73.12   10.08   72.44   13.93   72.11
   19.24   72.41   22.63   73.09   26.35   74.44   28.47   74.77   43.41      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -87.11     .06       0     .04   28.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0   28.47              73.6   97.46   98.38             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 13

INPUT
Description:
Station Elevation Data      num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -107.15      80       0    72.6    2.42   71.65    5.48   70.15    8.85   70.01
   12.08   70.13   14.04   70.33   19.35   70.69   20.66   71.26    23.7   72.72
   26.71   73.74   28.67    73.1   32.78   72.97   35.22   72.85   38.63   72.82
   63.01      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -107.15     .06       0     .04    23.7     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0    23.7             40.29   16.05   14.77             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 12.5
```

```
INPUT
Description:
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -127.46      80        0    71.07     5.27    69.44    15.67    69.44    32.02    70.64
   63.63      80

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
 -127.46     .06        0      .04    32.02      .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02              6.5     6.5     6.5              .3       .5

CULVERT


RIVER: MARIN
REACH: MARIN               RS: 12.3

INPUT
Description:
Distance from Upstream XS =      .01
Deck/Roadway Width        =     6.35
Weir Coefficient          =      1.4
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    -100   71.14              100   71.14

Upstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -127.46      80        0    71.07     5.27    69.44    15.67    69.44    32.02    70.64
   63.63      80

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
 -127.46     .06        0      .04    32.02      .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02              .3       .5

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    -100   71.14              100   71.14

Downstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -127.46      80        0    71.07     5.27    69.44    15.67    69.44    32.02    70.64
   63.63      80

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
 -127.46     .06        0      .04    32.02      .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02              .3       .5

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise     Span
Culvert #1          Box       1.5     1.53
FHWA Chart # 58- Rectangular concrete
FHWA Scale # 1 - Side tapered; Less favorable edges
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 .1    6.37     .015      .015          0                  .5                 1
Number of Barrels =  5
Upstream   Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3
Downstream Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 12

INPUT
Description:
Station Elevation Data     num=       6
```

```
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -127.46       80        0    71.07     5.27    69.44    15.67    69.44    32.02    70.64
   63.63       80

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 -127.46      .06        0      .04    32.02      .06

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
              0    32.02              29.03    86.62    87.37              .3        .5

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 11

INPUT
Description:
Station Elevation Data      num=        8
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -197.07       80   -32.58       70        0    69.47     1.32    68.38      7.3    68.34
   16.13    68.29    19.13       70    25.9       80

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 -197.07      .06        0      .04    19.13      .06

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
              0    19.13             107.31    35.28     36.7              .1        .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 10

INPUT
Description:
Station Elevation Data      num=        8
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -222.02       80   -62.41       70        0    69.45    19.88    68.59    32.04      68
   43.94    67.99    45.09    70.76    48.92       80

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 -222.02      .06        0      .04    45.09      .06

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
              0    45.09              76.35    51.55     59.5              .1        .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 9

INPUT
Description:
Station Elevation Data      num=        7
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -164.69       80   -82.36       70        0    69.14    23.96    68.16    49.64    67.91
   59.24       70    84.26       80

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 -164.69      .06        0      .04    59.24      .06

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
              0    59.24              59.84    55.19    48.62              .1        .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 8

INPUT
Description:
Station Elevation Data      num=        9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -137.97       80   -84.81       70        0     69.3     5.84     68.7    29.47    67.88
   45.31    67.98    61.31    68.01    68.39    70.49    95.46       80

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 -137.97      .06        0      .04    68.39      .06

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
              0    68.39              31.95    57.86    39.08              .1        .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 7
```

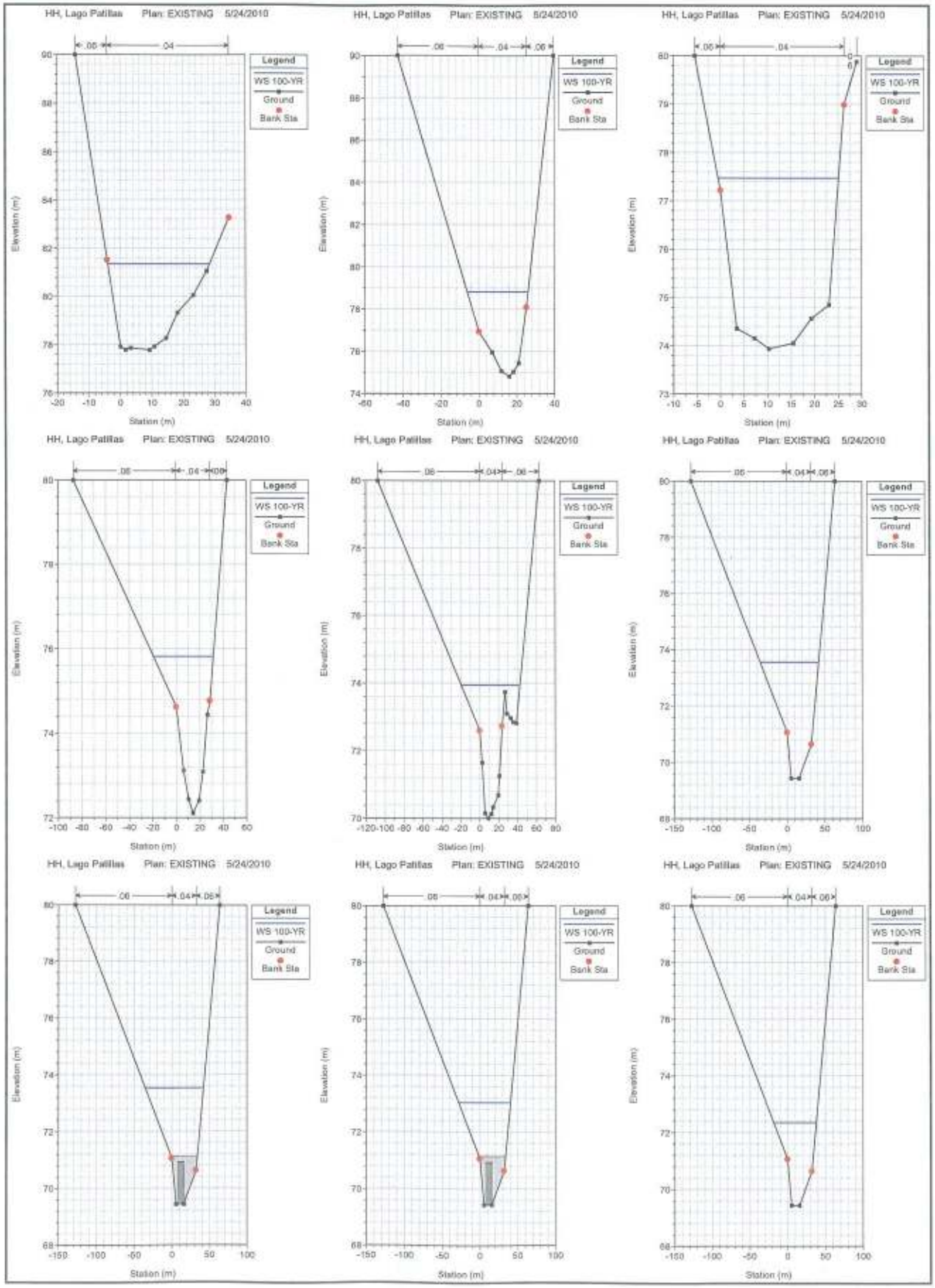
```
INPUT
Description:
Station Elevation Data     num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -115.07      80  -59.76      70       0   67.71   17.45   69.15   19.96   70.01
   23.78   68.36    28.2   68.32   36.36   68.24   37.53   67.52   43.04   67.34
   43.49   67.79   63.96    67.8   77.69   67.87   95.29      70  146.29      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -115.07     .06  -59.76     .04   95.29     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -59.76   95.29             86.88   50.09   49.69              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 6

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -71.56      80  -25.41      70       0   68.85   38.85    69.1   43.08   67.59
   93.08   67.86  131.75   68.87  185.12      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -71.56     .06  -25.41     .04  131.75     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -25.41  131.75             60.74   50.42   69.56              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 5

INPUT
Description:
Station Elevation Data     num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   70.79   15.33   67.94   32.05   67.84   45.43   68.32   48.05   69.33
   51.75   68.35   61.34   68.45   63.44   68.94   68.29   68.34   79.48    68.4
   80.53   67.23   89.28   67.06   91.16   67.48  117.38   67.87  163.34   67.49
  190.63   73.24

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   15.33     .04  163.34     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          15.33  163.34             71.08   50.59   59.91              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 4

INPUT
Description:
Station Elevation Data     num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -78.14      80       0   68.02   32.02   68.19   35.57    66.9    62.4   68.08
      89   67.07   96.74   67.29  135.19    67.3  162.75    67.1  164.19   67.88
  219.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -78.14     .06       0     .04  164.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0  164.19             57.38   50.03   16.47              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 3

INPUT
Description:
Station Elevation Data     num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -59.56      80       0   68.44   23.97   68.08    91.5   69.53   97.49   69.71
  135.86   67.53  160.11   67.41  171.55   66.79  182.36   67.41  193.77      70
  268.04      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -59.56     .06       0     .04  193.77     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
```

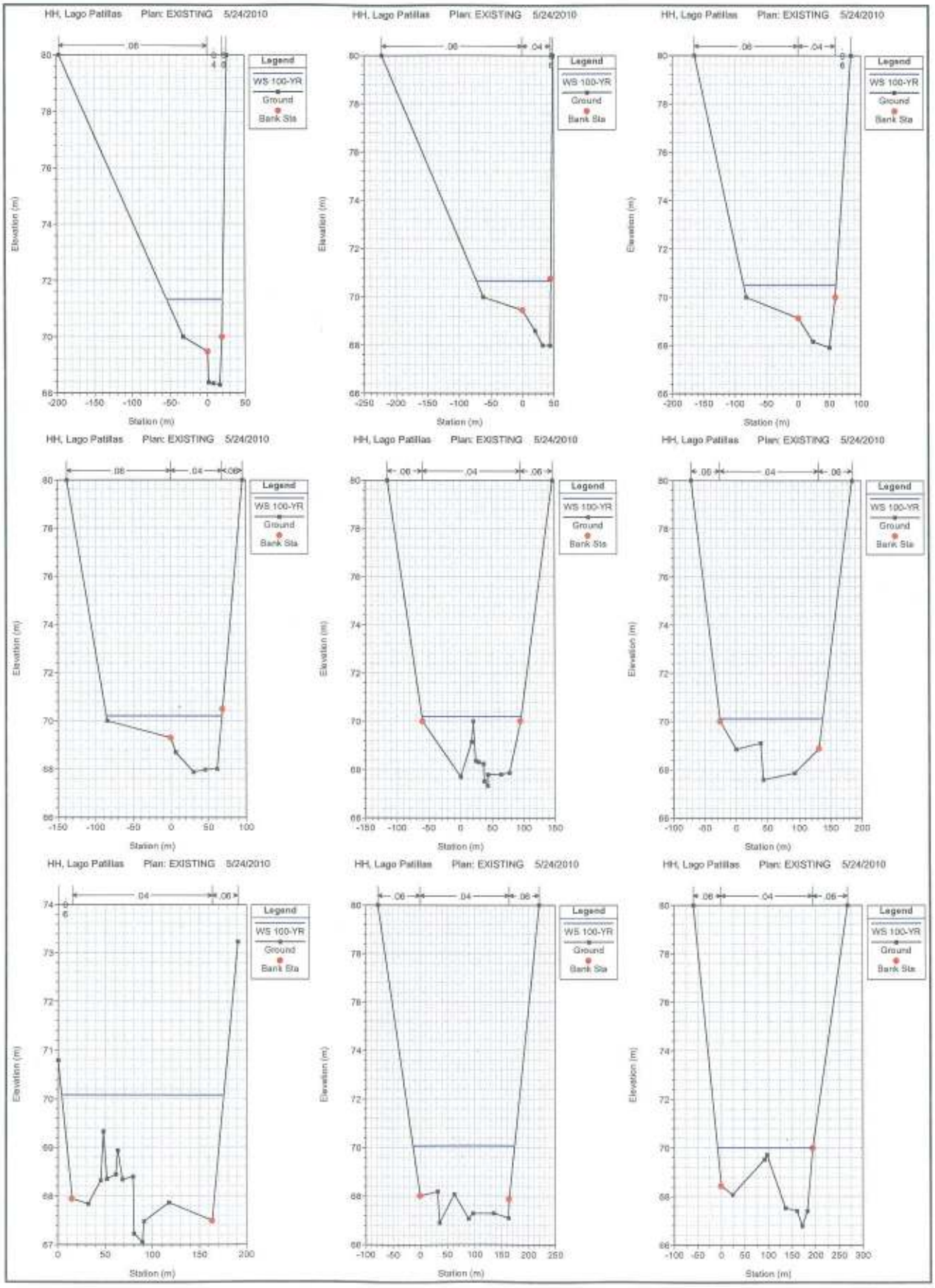
```
            0  193.77            67.86   50.32  123.88             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 2

INPUT
Description:
Station Elevation Data    num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.77      80       0   68.15   35.32   68.05    55.4   67.92   81.75   66.83
  125.41   66.45 163.272   66.18 200.718   66.61   229.9   67.76  302.97      70
  383.13      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.77     .06    55.4     .04   229.9     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          55.4   229.9            66.79      50   91.38              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 1

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -28.16      80       0   67.91    25.9   67.29  45.915   67.07  72.368    66.7
  101.08   66.31  123.37   66.54  187.11      70  251.95      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -28.16     .06       0     .04  187.11     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  187.11                 0       0       0              .1       .3


SUMMARY OF MANNING'S N VALUES

River:MARIN

      Reach          River Sta.       n1        n2        n3

 MARIN                17                .06       .04       .06
 MARIN                16                .06       .04       .06
 MARIN                15                .06       .04       .06
 MARIN                14                .06       .04       .06
 MARIN                13                .06       .04       .06
 MARIN                12.5              .06       .04       .06
 MARIN                12.3         Culvert
 MARIN                12                .06       .04       .06
 MARIN                11                .06       .04       .06
 MARIN                10                .06       .04       .06
 MARIN                9                 .06       .04       .06
 MARIN                8                 .06       .04       .06
 MARIN                7                 .06       .04       .06
 MARIN                6                 .06       .04       .06
 MARIN                5                 .06       .04       .06
 MARIN                4                 .06       .04       .06
 MARIN                3                 .06       .04       .06
 MARIN                2                 .06       .04       .06
 MARIN                1                 .06       .04       .06


SUMMARY OF REACH LENGTHS

River: MARIN

      Reach          River Sta.      Left     Channel    Right

 MARIN                17              87.52    101.87     84.4
 MARIN                16             122.87    100.85   127.39
 MARIN                15              99.29    103.25   104.82
 MARIN                14               73.6     97.46    98.38
 MARIN                13              40.29     16.05    14.77
 MARIN                12.5              6.5       6.5      6.5
 MARIN                12.3         Culvert
 MARIN                12              29.03     86.62    87.37
 MARIN                11             107.31     35.28     36.7
 MARIN                10              76.35     51.55     59.5
 MARIN                9               59.84     55.19    48.62
 MARIN                8               31.95     57.86    39.08
 MARIN                7               86.88     50.09    49.69
 MARIN                6               60.74     50.42    69.56
 MARIN                5               71.08     50.59    59.91
 MARIN                4               57.38     50.03    16.47
 MARIN                3               67.86     50.32   123.88
```

MARIN	2	66.79	50	91.38
MARIN	1	0	0	0

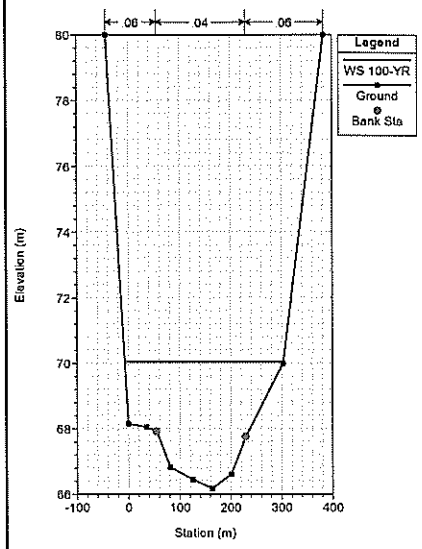
SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: MARIN

Reach	River Sta.	Contr.	Expan.
MARIN	17	.1	.3
MARIN	16	.1	.3
MARIN	15	.1	.3
MARIN	14	.1	.3
MARIN	13	.1	.3
MARIN	12.5	.3	.5
MARIN	12.3	Culvert	
MARIN	12	.3	.5
MARIN	11	.1	.3
MARIN	10	.1	.3
MARIN	9	.1	.3
MARIN	8	.1	.3
MARIN	7	.1	.3
MARIN	6	.1	.3
MARIN	5	.1	.3
MARIN	4	.1	.3
MARIN	3	.1	.3
MARIN	2	.1	.3
MARIN	1	.1	.3

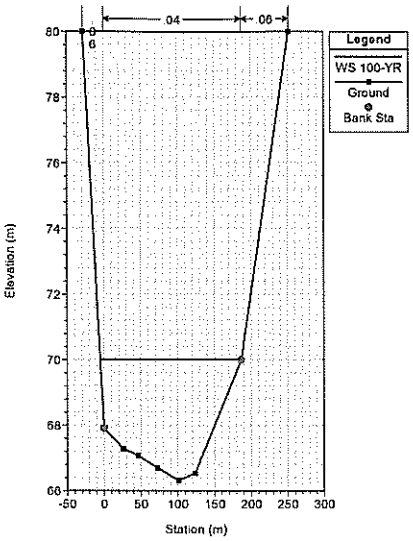

HH, Lago Patillas Plan: EXISTING 5/24/2010
Legend
WS 100-YR
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Patillas Plan: EXISTING 5/24/2010
Legend
WS 100-YR
Ground
Bank Sta
Elevation (m)
Station (m)

HH, Lago Patillas Plan: EXISTING 5/24/2010



HH, Lago Patillas Plan: EXISTING 5/24/2010



HEC-RAS Plan: EXISTING River: MARIN Reach: MARIN Profile: 100-YR

Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl
			(m3/s)	(m)	(m/s)
MARIN	1	100-YR	375.82	70.00	0.76
MARIN	2	100-YR	375.82	70.02	0.57
MARIN	3	100-YR	375.82	70.00	1.17
MARIN	4	100-YR	375.82	70.06	0.88
MARIN	5	100-YR	375.82	70.07	1.12
MARIN	6	100-YR	375.82	70.09	1.48
MARIN	7	100-YR	375.82	70.19	1.44
MARIN	8	100-YR	375.82	70.18	2.65
MARIN	9	100-YR	375.82	70.49	2.48
MARIN	10	100-YR	375.82	70.64	3.24
MARIN	11	100-YR	375.82	71.31	4.72
MARIN	12	100-YR	375.82	72.33	4.51
MARIN	12.3		Culvert		
MARIN	12.5	100-YR	375.82	73.53	2.76
MARIN	13	100-YR	375.82	73.92	4.62
MARIN	14	100-YR	375.82	75.80	4.69
MARIN	15	100-YR	375.82	77.46	5.28
MARIN	16	100-YR	375.82	78.80	4.90
MARIN	17	100-YR	375.82	81.33	4.85

STEADY FLOW PLAN: PROPOSED

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: HH, Lago Patillas
Project File : PATILLAS.prj
Run Date and Time: 5/24/2010 9:49:05 AM

Project in SI units

PLAN DATA

Plan Title: PROPOSED
Plan File : C:\PROJ\LAGO\RAS\PATILLAS.p06

Geometry Title: PROPOSED
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g02

Flow Title : PROPOSED
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f02

Plan Summary Information:

Number of:	Cross Sections =	19	Multiple Openings =	0
	Culverts =	1	Inline Structures =	0
	Bridges =	0	Lateral Structures =	0

Computational Information
Water surface calculation tolerance = 0.003
Critical depth calculation tolerance = 0.003
Maximum number of iterations = 20
Maximum difference tolerance = 0.1
Flow tolerance factor = 0.001

Computation Options
Critical depth computed at all cross sections
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: PROPOSED
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f02

Flow Data (m3/s)

River	Reach	RS	100-YR
MARIN	MARIN	17	375.82

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
MARIN	MARIN	100-YR	Normal S = 0.03	Known WS = 70

GEOMETRY DATA

Geometry Title: PROPOSED
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g02

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 17

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-14.2	90	-4.24	81.52	0	77.92	1.59	77.79	3.2	77.87
9.23	77.78	10.78	77.93	14.53	78.28	18.17	79.33	23.18	80.06

```
   27.56   81.06   34.56   83.27

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.2     .06   -4.24     .04   34.56     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -4.24   34.56             87.52  101.87    84.4             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 16

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.66      90       0   76.94    7.01   75.96    11.9   75.07   15.98   74.83
   18.11   75.04   21.02   75.45   25.08   78.09   39.62      90

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.66     .06       0     .04   25.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   25.08            122.87  100.85  127.39             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 15

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -5.43      80       0   77.22    3.49   74.36    7.23   74.16    10.3   73.94
   15.44   74.06    19.3   74.57   23.04   74.85   26.26   78.99   28.96   79.88

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -5.43     .06       0     .04   26.26     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   26.26            64.209   66.77  67.785             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14.3533*

INPUT
Description:
Station Elevation Data      num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -58.251      80       0  75.539   4.285  73.744   5.302  73.542   8.878  73.079
   9.152  73.042  12.647  72.757  17.492   72.97  18.141  73.025   21.13  73.548
  21.648  73.627  24.654  74.394  25.496  74.991  27.689  76.261  38.305  79.958

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -58.251     .06       0     .04  27.689     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0  27.689            35.081   36.48  37.035             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -87.11      80       0   74.62    5.84   73.12   10.08   72.44   13.93   72.11
   19.24   72.41   22.63   73.09   26.35   74.44   28.47   74.77   43.41      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -87.11     .06       0     .04   28.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   28.47              73.6   97.46   98.38             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 13

INPUT
```

```
Description:
Station Elevation Data     num=      15
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 -107.15       80       0     72.6    2.42    71.65    5.48    70.15     8.05     69.8
   15.27     69.8   19.35    70.69   20.66    71.26    23.7    72.72    26.71    73.74
   28.67     73.1   32.78    72.97   35.22    72.85   38.63    72.82    63.01       80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -107.15     .06       0     .04    23.7     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0    23.7             40.29   16.05   14.77              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 12.5

INPUT
Description:
Station Elevation Data     num=       6
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 -127.46       80       0    71.07    5.27    69.44   15.67    69.44    32.02    70.64
   63.63       80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02               6.5     6.5     6.5              .3       .5

CULVERT


RIVER: MARIN
REACH: MARIN               RS: 12.3

INPUT
Description:
Distance from Upstream XS =      .01
Deck/Roadway Width        =     6.35
Weir Coefficient          =      1.4
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    -100   71.14              100   71.14

Upstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 -127.46       80       0    71.07    5.27    69.44   15.67    69.44    32.02    70.64
   63.63       80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02              .3       .5

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    -100   71.14              100   71.14

Downstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 -127.46       80       0    71.07    5.27    69.44   15.67    69.44    32.02    70.64
   63.63       80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02              .3       .5

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1          Box       1.5    1.53
FHWA Chart # 58- Rectangular concrete
FHWA Scale # 1 - Side tapered; Less favorable edges
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
```

```
                .1    6.37     .015     .015        0                    .5                 1
Number of Barrels =  5
Upstream   Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3
Downstream Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 12

INPUT
Description:
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02            29.03   86.62   87.37              .3       .5

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 11

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -197.07      80  -32.58      70       0   69.47    1.32   68.38    2.17    67.7
   15.08    67.7   16.13   68.29   19.13      70    25.9      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -197.07     .06       0     .04   19.13     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   19.13           107.31   35.28    36.7              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 10

INPUT
Description:
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -222.02      80  -62.41      70       0   69.45    7.35      67   33.81      67
    36.8      68   43.94   67.99   45.09   70.76   48.92      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -222.02     .06       0     .04   45.09     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   45.09            76.35   51.55    59.5              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 9

INPUT
Description:
Station Elevation Data    num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -164.69      80  -82.36      70       0   69.14    7.02    66.8   49.64    66.8
   59.24      70   84.26      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -164.69     .06       0     .04   59.24     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   59.24            59.84   55.19   48.62              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 8
```

```
INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -137.97      80  -84.81      70       0    69.3     8.1    66.6   56.72    66.6
   68.39   70.49   95.46      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -137.97     .06       0     .04   68.39     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   68.39             31.95   57.86   39.08              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 7

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -115.07      80  -59.76      70       0   67.71    3.99   66.38   73.21   66.38
   77.69   67.87   95.29      70  146.29      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -115.07     .06  -59.76     .04   95.29     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -59.76   95.29             86.88   50.09   49.69              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 6

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -71.56      80  -25.41      70       0   68.85    7.95    66.2  123.74    66.2
  131.75   68.87  185.12      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -71.56     .06  -25.41     .04  131.75     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -25.41  131.75             60.74   50.42   69.56              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 5

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   70.79   15.33   67.94   21.09   66.02  158.93   66.02  163.34   67.49
  190.63   73.24

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   15.33     .04  163.34     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         15.33  163.34             71.08   50.59   59.91              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 4

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -78.14      80       0   68.02    6.51   65.85     159   65.85  162.75    67.1
  164.19   67.88  219.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -78.14     .06       0     .04  164.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  164.19             57.38   50.03   16.47              .1       .3

CROSS SECTION
```

RIVER: MARIN
REACH: MARIN RS: 3

INPUT
Description:
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-59.56	80	0	68.44	23.97	68.08	31.26	65.65	177.08	65.65
182.36	67.41	193.77	70	268.04	80				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-59.56	.06	0	.04	193.77	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	193.77	67.86	50.32	123.88	.1	.3

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 2

INPUT
Description:
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-42.77	80	0	68.15	35.32	68.05	55.4	67.92	62.21	65.45
223.57	65.45	229.9	67.76	302.97	70	383.13	80		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-42.77	.06	55.4	.04	229.9	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
55.4	229.9	66.79	50	91.38	.1	.3

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 1

INPUT
Description:
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.16	80	0	67.91	7.83	65.3	173.01	65.3	187.11	70
251.95	80								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-28.16	.06	0	.04	187.11	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	187.11	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:MARIN

Reach	River Sta.	n1	n2	n3
MARIN	17	.06	.04	.06
MARIN	16	.06	.04	.06
MARIN	15	.06	.04	.06
MARIN	14.3533*	.06	.04	.06
MARIN	14	.06	.04	.06
MARIN	13	.06	.04	.06
MARIN	12.5	.06	.04	.06
MARIN	12.3	Culvert		
MARIN	12	.06	.04	.06
MARIN	11	.06	.04	.06
MARIN	10	.06	.04	.06
MARIN	9	.06	.04	.06
MARIN	8	.06	.04	.06
MARIN	7	.06	.04	.06
MARIN	6	.06	.04	.06
MARIN	5	.06	.04	.06
MARIN	4	.06	.04	.06
MARIN	3	.06	.04	.06
MARIN	2	.06	.04	.06
MARIN	1	.06	.04	.06

SUMMARY OF REACH LENGTHS

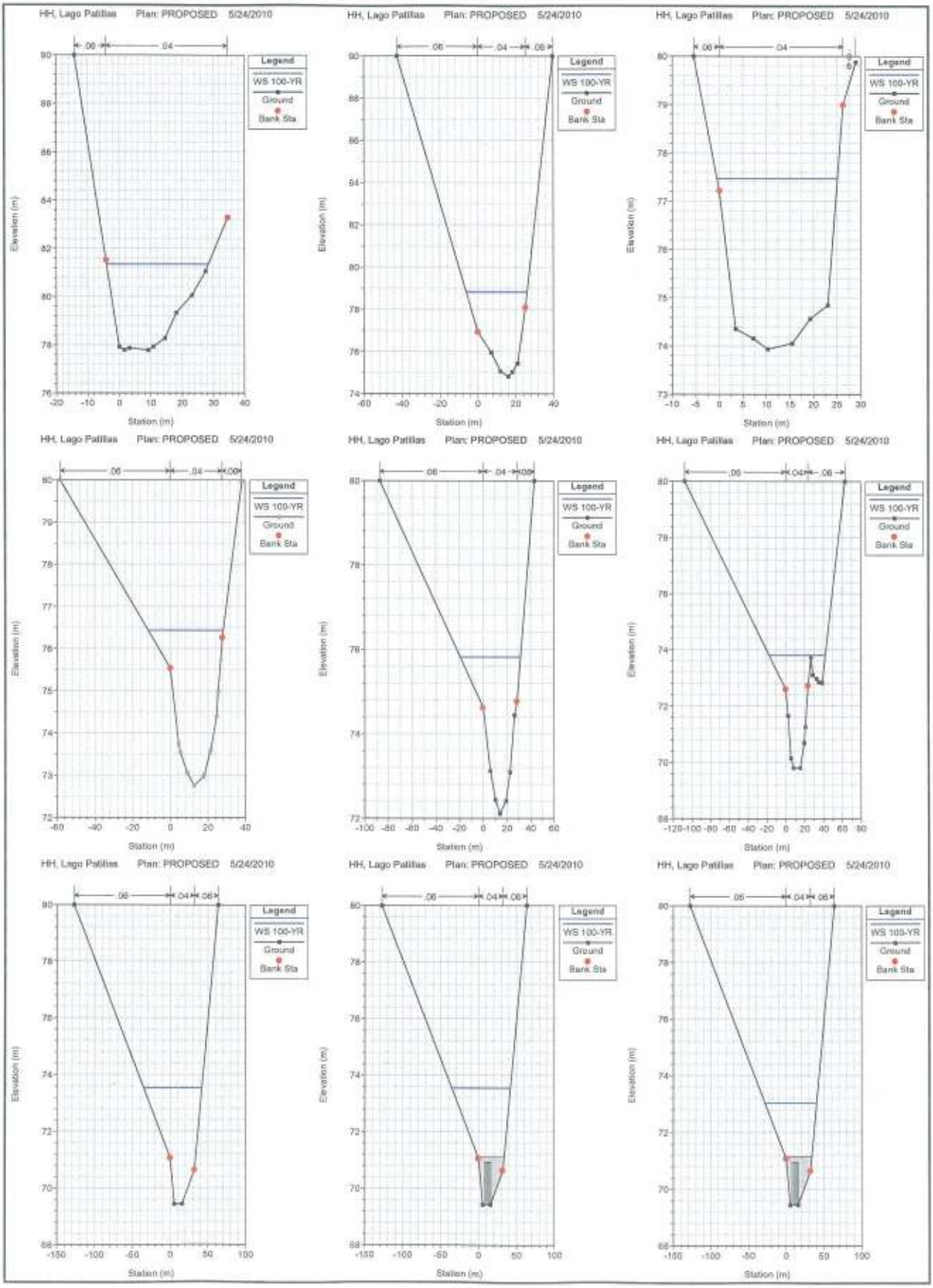
River: MARIN

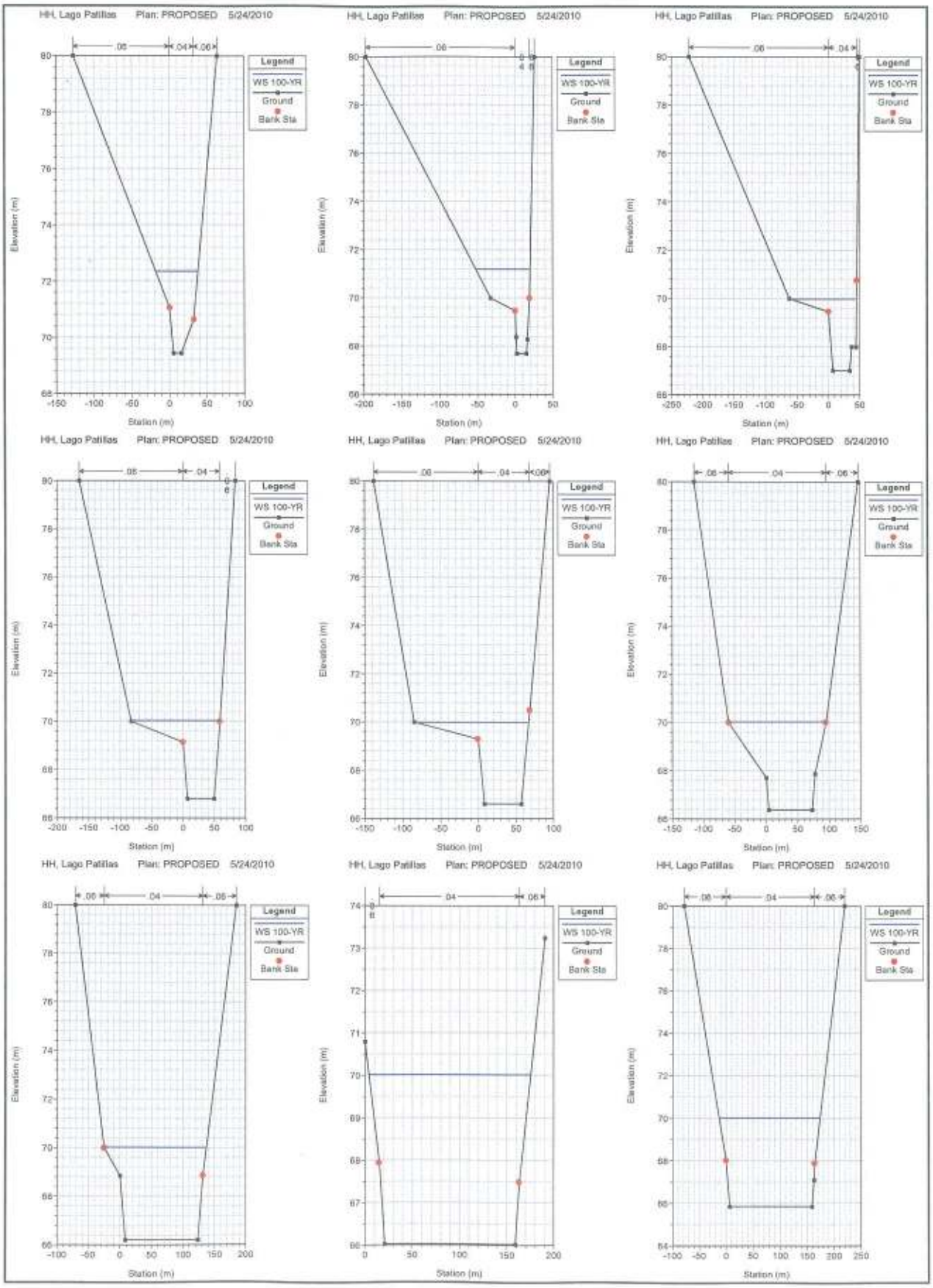
Reach	River Sta.	Left	Channel	Right
MARIN	17	87.52	101.87	84.4
MARIN	16	122.87	100.85	127.39

MARIN	15	64.209	66.77	67.785
MARIN	14.3533*	35.081	36.48	37.035
MARIN	14	73.6	97.46	98.38
MARIN	13	40.29	16.05	14.77
MARIN	12.5	6.5	6.5	6.5
MARIN	12.3	Culvert		
MARIN	12	29.03	86.62	87.37
MARIN	11	107.31	35.28	36.7
MARIN	10	76.35	51.55	59.5
MARIN	9	59.84	55.19	48.62
MARIN	8	31.95	57.86	39.08
MARIN	7	86.88	50.09	49.69
MARIN	6	60.74	50.42	69.56
MARIN	5	71.08	50.59	59.91
MARIN	4	57.38	50.03	16.47
MARIN	3	67.86	50.32	123.88
MARIN	2	66.79	50	91.38
MARIN	1	0	0	0

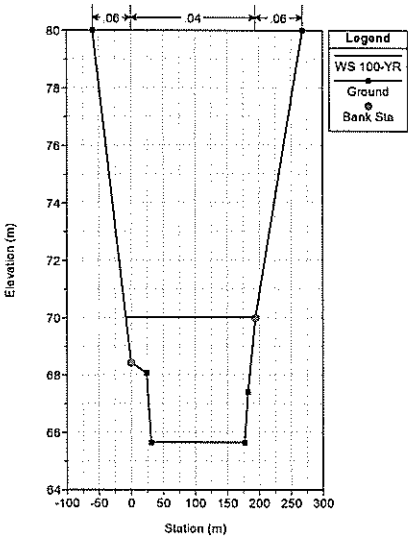
SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: MARIN

Reach	River Sta.	Contr.	Expan.
MARIN	17	.1	.3
MARIN	16	.1	.3
MARIN	15	.1	.3
MARIN	14.3533*	.1	.3
MARIN	14	.1	.3
MARIN	13	.1	.3
MARIN	12.5	.3	.5
MARIN	12.3	Culvert	
MARIN	12	.3	.5
MARIN	11	.1	.3
MARIN	10	.1	.3
MARIN	9	.1	.3
MARIN	8	.1	.3
MARIN	7	.1	.3
MARIN	6	.1	.3
MARIN	5	.1	.3
MARIN	4	.1	.3
MARIN	3	.1	.3
MARIN	2	.1	.3
MARIN	1	.1	.3

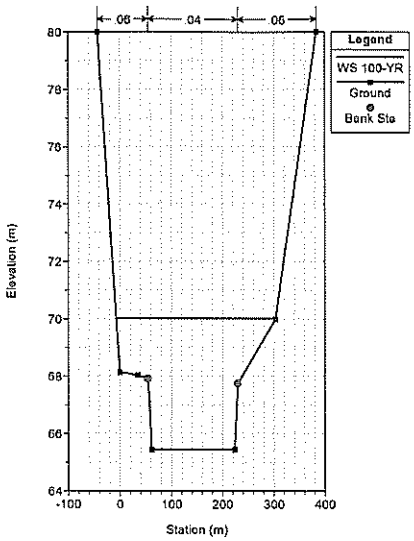

HH, Lago Patillas Plan: PROPOSED 5/24/2010
Legend
WS 100-YR
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Patillas Plan: PROPOSED 5/24/2010
Legend
WS 100-YR
Ground
Bank Sta
Elevation (m)
Station (m)

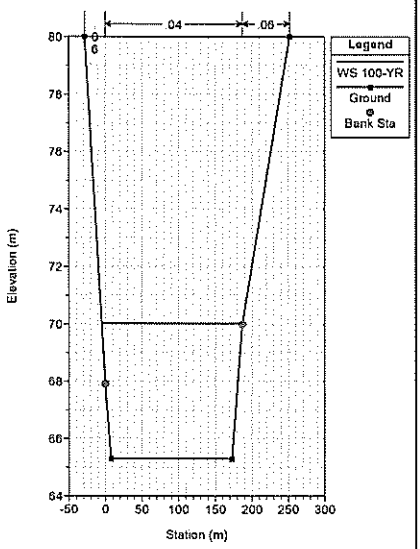
HH, Lago Patillas Plan: PROPOSED 5/24/2010



HH, Lago Patillas Plan: PROPOSED 5/24/2010



HH, Lago Patillas Plan: PROPOSED 5/24/2010



HEC-RAS Plan: PROPOSED River: MARIN Reach: MARIN Profile: 100-YR

Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl
			(m3/s)	(m)	(m/s)
MARIN	1	100-YR	375.82	70.00	0.45
MARIN	2	100-YR	375.82	70.00	0.45
MARIN	3	100-YR	375.82	70.00	0.51
MARIN	4	100-YR	375.82	70.01	0.56
MARIN	5	100-YR	375.82	70.01	0.64
MARIN	6	100-YR	375.82	70.01	0.76
MARIN	7	100-YR	375.82	70.01	1.03
MARIN	8	100-YR	375.82	69.97	1.87
MARIN	9	100-YR	375.82	70.02	2.15
MARIN	10	100-YR	375.82	69.96	3.25
MARIN	11	100-YR	375.82	71.18	4.66
MARIN	12	100-YR	375.82	72.33	4.51
MARIN	12.3		Culvert		
MARIN	12.5	100-YR	375.82	73.53	2.76
MARIN	13	100-YR	375.82	73.79	4.67
MARIN	14	100-YR	375.82	75.80	4.69
MARIN	14.3533*	100-YR	375.82	76.42	4.91
MARIN	15	100-YR	375.82	77.46	5.28
MARIN	16	100-YR	375.82	78.80	4.90
MARIN	17	100-YR	375.82	81.33	4.85

SEDIMENT TRANSPORT ANALYSIS

SEDIMENT TRANSPORT PLAN: MEAN_EXIS

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X       X    X       X   X     X  X    X
X     X  X       X            X   X    X    X   X
XXXXXXX  XXXX    X       XXX  XXXX    XXXXXX    XXXX
X     X  X       X            X  X    X    X       X
X     X  X       X    X       X   X    X    X       X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX


PROJECT DATA
Project Title: HH, Lago Patillas
Project File : PATILLAS.prj
Run Date and Time: 5/24/2010 10:35:14 AM

Project in SI units


PLAN DATA

Plan Title: MEAN_EXIS
Plan File : C:\PROJ\LAGO\RAS\PATILLAS.p04

           Geometry Title: EXISTING
           Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g01

           Flow Title    : EXISTING
           Flow File     : C:\PROJ\LAGO\RAS\PATILLAS.f01

Plan Summary Information:
Number of:  Cross Sections =   18    Multiple Openings  =    0
            Culverts       =    1    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: EXISTING
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f01

Flow Data (m3/s)

  River          Reach          RS                  PF 1


Boundary Conditions

  River          Reach          Profile                      Upstream                 Downstream



GEOMETRY DATA

Geometry Title: EXISTING
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g01

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 17

INPUT
Description:
Station Elevation Data     num=      12
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
   -14.2       90   -4.24    81.52       0    77.92    1.59    77.79     3.2    77.87
    9.23    77.78   10.78    77.93   14.53    78.28   18.17    79.33   23.18    80.06
   27.56    81.06   34.56    83.27
```

```
Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.2     .06   -4.24     .04   34.56     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -4.24   34.56             87.52  101.87    84.4              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 16

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.66      90       0   76.94    7.01   75.96    11.9   75.07   15.98   74.83
   18.11   75.04   21.02   75.45   25.08   78.09   39.62      90

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.66     .06       0     .04   25.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   25.08            122.87  100.85  127.39              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 15

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -5.43      80       0   77.22    3.49   74.36    7.23   74.16    10.3   73.94
   15.44   74.06    19.3   74.57   23.04   74.85   26.26   78.99   28.96   79.88

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -5.43     .06       0     .04   26.26     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   26.26             99.29  103.25  104.82              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -87.11      80       0   74.62    5.84   73.12   10.08   72.44   13.93   72.11
   19.24   72.41   22.63   73.09   26.35   74.44   28.47   74.77   43.41      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -87.11     .06       0     .04   28.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   28.47              73.6   97.46   98.38              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 13

INPUT
Description:
Station Elevation Data      num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -107.15      80       0    72.6    2.42   71.65    5.48   70.15    8.85   70.01
   12.08   70.13   14.04   70.33   19.35   70.69   20.66   71.26    23.7   72.72
   26.71   73.74   28.67    73.1   32.78   72.97   35.22   72.85   38.63   72.82
   63.01      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -107.15     .06       0     .04    23.7     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0    23.7             40.29   16.05   14.77              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 12.5

INPUT
Description:
```

```
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02              6.5     6.5     6.5              .3       .5

CULVERT


RIVER: MARIN
REACH: MARIN               RS: 12.3

INPUT
Description:
Distance from Upstream XS =      .01
Deck/Roadway Width        =     6.35
Weir Coefficient          =      1.4
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    -100   71.14              100   71.14

Upstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02              .3       .5

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    -100   71.14              100   71.14

Downstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02              .3       .5

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1          Box       1.5    1.53
FHWA Chart # 58- Rectangular concrete
FHWA Scale # 1 - Side tapered; Less favorable edges
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                  .1    6.37     .015     .015          0                  .5                 1
Number of Barrels =  5
Upstream   Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3
Downstream Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 12

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
```

```
   63.63      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -127.46     .06        0     .04    32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02             29.03   86.62   87.37              .3       .5

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 11

INPUT
Description:
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -197.07      80  -32.58      70       0   69.47    1.32   68.38     7.3   68.34
   16.13   68.29   19.13      70    25.9      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -197.07     .06        0     .04    19.13     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   19.13            107.31   35.28    36.7              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 10

INPUT
Description:
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -222.02      80  -62.41      70       0   69.45   19.88   68.59   32.04      68
   43.94   67.99   45.09   70.76   48.92      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -222.02     .06        0     .04    45.09     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   45.09             76.35   51.55    59.5              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 9

INPUT
Description:
Station Elevation Data      num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -164.69      80  -82.36      70       0   69.14   23.96   68.16   49.64   67.91
   59.24      70   84.26      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -164.69     .06        0     .04    59.24     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   59.24             59.84   55.19   48.62              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 8

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -137.97      80  -84.81      70       0    69.3    5.84    68.7   29.47   67.88
   45.31   67.98   61.31   68.01   68.39   70.49   95.46      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -137.97     .06        0     .04    68.39     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   68.39             31.95   57.86   39.08              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 7

INPUT
Description:
```

```
Station Elevation Data     num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -115.07      80  -59.76      70       0   67.71   17.45   69.15   19.96   70.01
   23.78   68.36    28.2   68.32   36.36   68.24   37.53   67.52   43.04   67.34
   43.49   67.79   63.96    67.8   77.69   67.87   95.29      70  146.29      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -115.07     .06  -59.76     .04   95.29     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -59.76   95.29             86.88   50.09   49.69             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 6

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -71.56      80  -25.41      70       0   68.85   38.85    69.1   43.08   67.59
   93.08   67.86  131.75   68.87  185.12      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -71.56     .06  -25.41     .04  131.75     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -25.41  131.75             60.74   50.42   69.56             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 5

INPUT
Description:
Station Elevation Data     num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   70.79   15.33   67.94   32.05   67.84   45.43   68.32   48.05   69.33
   51.75   68.35   61.34   68.45   63.44   68.94   68.29   68.34   79.48    68.4
   80.53   67.23   89.28   67.06   91.16   67.48  117.38   67.87  163.34   67.49
  190.63   73.24

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   15.33     .04  163.34     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         15.33  163.34             71.08   50.59   59.91             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 4

INPUT
Description:
Station Elevation Data     num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -78.14      80       0   68.02   32.02   68.19   35.57    66.9    62.4   68.08
      89   67.07   96.74   67.29  135.19    67.3  162.75    67.1  164.19   67.88
  219.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -78.14     .06       0     .04  164.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0  164.19             57.38   50.03   16.47             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 3

INPUT
Description:
Station Elevation Data     num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -59.56      80       0   68.44   23.97   68.08    91.5   69.53   97.49   69.71
  135.86   67.53  160.11   67.41  171.55   66.79  182.36   67.41  193.77      70
  268.04      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -59.56     .06       0     .04  193.77     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0  193.77             67.86   50.32  123.88             .1       .3
```

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 2

INPUT
Description:
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-42.77	80	0	68.15	35.32	68.05	55.4	67.92	81.75	66.83
125.41	66.45	163.272	66.18	200.718	66.61	229.9	67.76	302.97	70
383.13	80								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-42.77	.06	55.4	.04	229.9	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
55.4	229.9	66.79	50	91.38	.1	.3

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 1

INPUT
Description:
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.16	80	0	67.91	25.9	67.29	45.915	67.07	72.368	66.7
101.08	66.31	123.37	66.54	187.11	70	251.95	80		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-28.16	.06	0	.04	187.11	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	187.11	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:MARIN

Reach	River Sta.	n1	n2	n3
MARIN	17	.06	.04	.06
MARIN	16	.06	.04	.06
MARIN	15	.06	.04	.06
MARIN	14	.06	.04	.06
MARIN	13	.06	.04	.06
MARIN	12.5	.06	.04	.06
MARIN	12.3	Culvert		
MARIN	12	.06	.04	.06
MARIN	11	.06	.04	.06
MARIN	10	.06	.04	.06
MARIN	9	.06	.04	.06
MARIN	8	.06	.04	.06
MARIN	7	.06	.04	.06
MARIN	6	.06	.04	.06
MARIN	5	.06	.04	.06
MARIN	4	.06	.04	.06
MARIN	3	.06	.04	.06
MARIN	2	.06	.04	.06
MARIN	1	.06	.04	.06

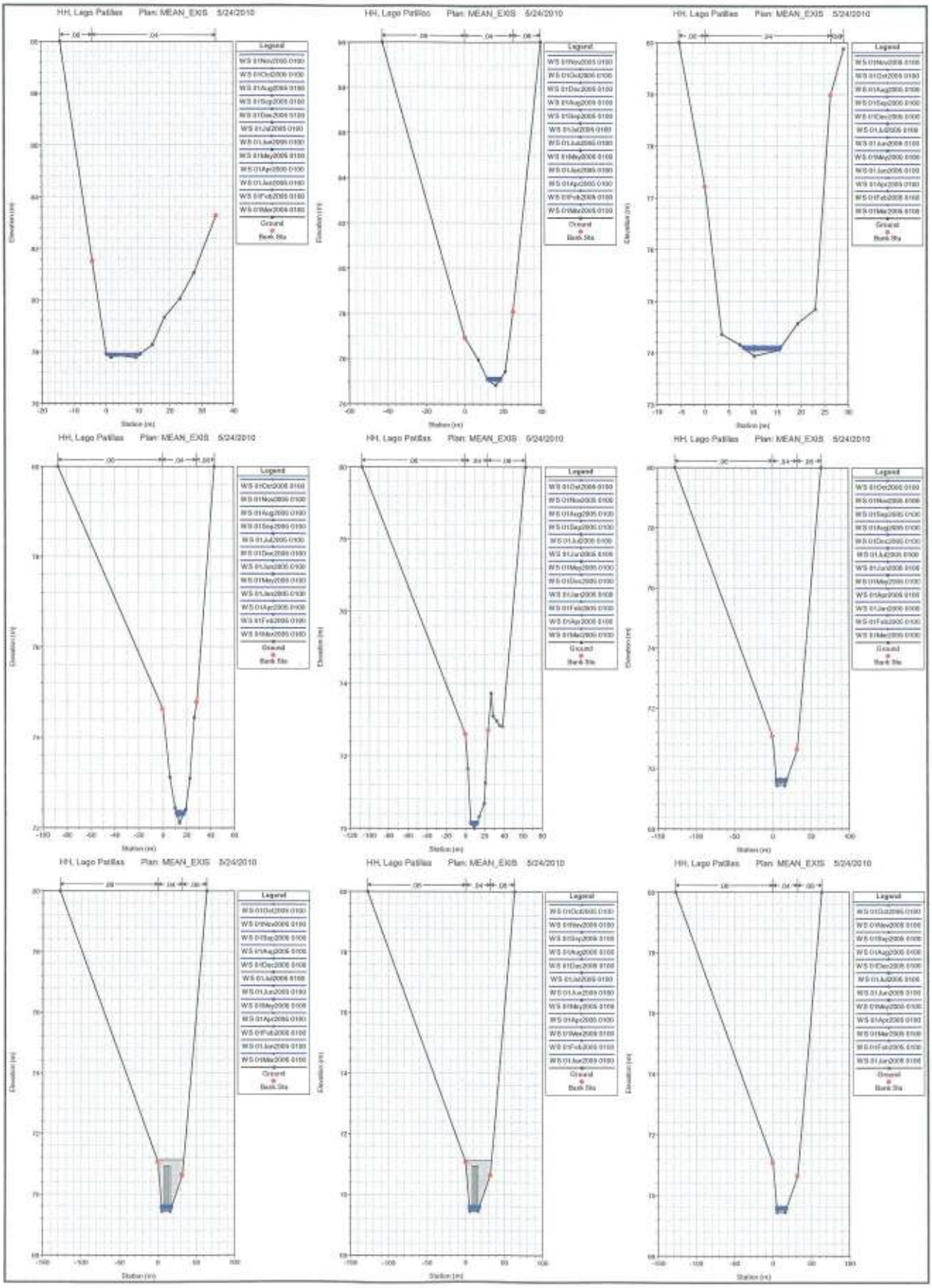
SUMMARY OF REACH LENGTHS

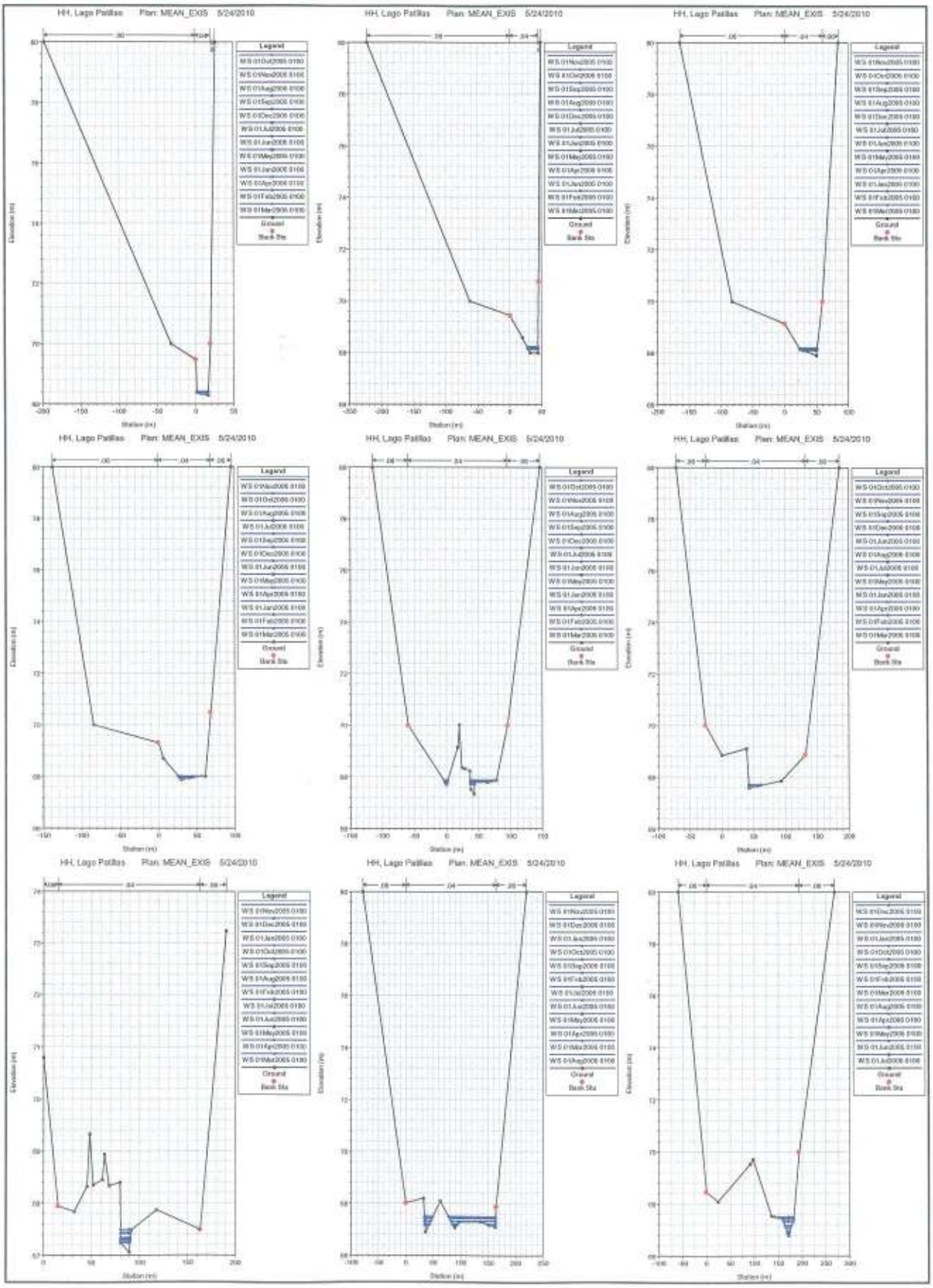
River: MARIN

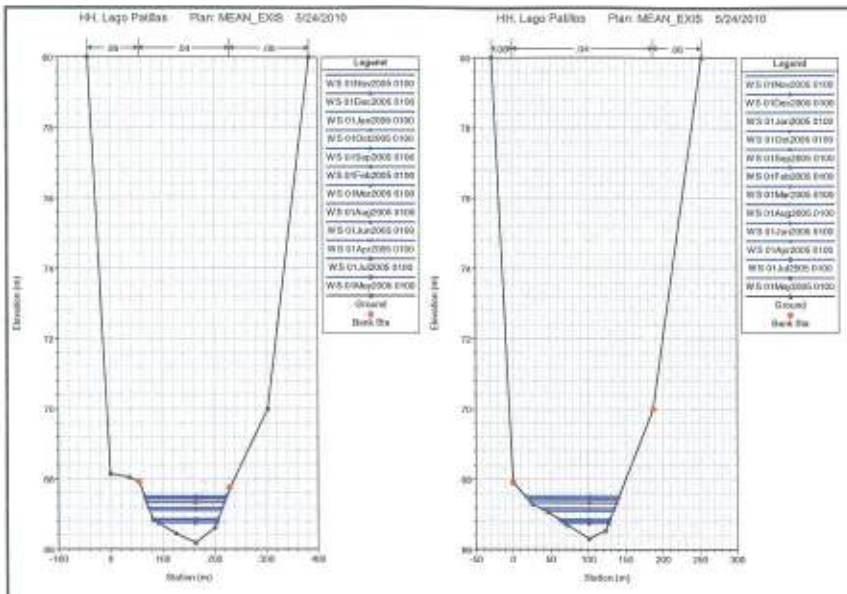
Reach	River Sta.	Left	Channel	Right
MARIN	17	87.52	101.87	84.4
MARIN	16	122.87	100.85	127.39
MARIN	15	99.29	103.25	104.82
MARIN	14	73.6	97.46	98.38
MARIN	13	40.29	16.05	14.77
MARIN	12.5	6.5	6.5	6.5
MARIN	12.3	Culvert		
MARIN	12	29.03	86.62	87.37
MARIN	11	107.31	35.28	36.7
MARIN	10	76.35	51.55	59.5
MARIN	9	59.84	55.19	48.62
MARIN	8	31.95	57.86	39.08
MARIN	7	86.88	50.09	49.69
MARIN	6	60.74	50.42	69.56
MARIN	5	71.08	50.59	59.91
MARIN	4	57.38	50.03	16.47
MARIN	3	67.86	50.32	123.88
MARIN	2	66.79	50	91.38
MARIN	1	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: MARIN

Reach	River Sta.	Contr.	Expan.
MARIN	17	.1	.3
MARIN	16	.1	.3
MARIN	15	.1	.3
MARIN	14	.1	.3
MARIN	13	.1	.3
MARIN	12.5	.3	.5
MARIN	12.3	Culvert	
MARIN	12	.3	.5
MARIN	11	.1	.3
MARIN	10	.1	.3
MARIN	9	.1	.3
MARIN	8	.1	.3
MARIN	7	.1	.3
MARIN	6	.1	.3
MARIN	5	.1	.3
MARIN	4	.1	.3
MARIN	3	.1	.3
MARIN	2	.1	.3
MARIN	1	.1	.3


HH, Lago Patillas Plan: MEAN_EXIS 5/24/2010
Legend
Ground
Bank Sta
Station (m)
Elevation (m)


HH, Lago Patillas Plan: MEAN_EXIS 5/24/2010
Legend
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Pallas Plan: MEAN_EXIS 5/24/2010
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
HH, Lago Pallas Plan: MEAN_EXIS 5/24/2010
Legend
Ground
Bank Sta
Elevation (m)
Station (m)

SEDIMENT TRANSPORT PLAN: PEAK_EXIS

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X       X    X       X   X     X  X    X
X     X  X       X            X   X    X    X   X
XXXXXXX  XXXX    X       XXX  XXXX     XXXXXX    XXXX
X     X  X       X            X  X     X    X       X
X     X  X       X    X       X   X    X    X       X
X     X  XXXXXX    XXXX        X    X  X    X   XXXXX


PROJECT DATA
Project Title: HH, Lago Patillas
Project File : PATILLAS.prj
Run Date and Time: 5/24/2010 10:52:50 AM

Project in SI units


PLAN DATA

Plan Title: PEAK_EXIS
Plan File : C:\PROJ\LAGO\RAS\PATILLAS.p05

           Geometry Title: EXISTING
           Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g01

           Flow Title    : EXISTING
           Flow File     : C:\PROJ\LAGO\RAS\PATILLAS.f01

Plan Summary Information:
Number of:  Cross Sections =   18    Multiple Openings  =    0
            Culverts       =    1    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed at all cross sections
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: EXISTING
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f01

Flow Data (m3/s)

  River          Reach          RS                  PF 1


Boundary Conditions

  River          Reach          Profile                      Upstream                Downstream




GEOMETRY DATA

Geometry Title: EXISTING
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g01

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 17

INPUT
Description:
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -14.2      90   -4.24   81.52       0   77.92    1.59   77.79     3.2   77.87
    9.23   77.78   10.78   77.93   14.53   78.28   18.17   79.33   23.18   80.06
   27.56   81.06   34.56   83.27
```

```
Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.2     .06   -4.24     .04   34.56     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         -4.24   34.56             87.52  101.87    84.4              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 16

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.66      90       0   76.94    7.01   75.96    11.9   75.07   15.98   74.83
   18.11   75.04   21.02   75.45   25.08   78.09   39.62      90

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.66     .06       0     .04   25.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   25.08            122.87  100.85  127.39              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 15

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -5.43      80       0   77.22    3.49   74.36    7.23   74.16    10.3   73.94
   15.44   74.06    19.3   74.57   23.04   74.85   26.26   78.99   28.96   79.88

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -5.43     .06       0     .04   26.26     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   26.26             99.29  103.25  104.82              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -87.11      80       0   74.62    5.84   73.12   10.08   72.44   13.93   72.11
   19.24   72.41   22.63   73.09   26.35   74.44   28.47   74.77   43.41      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -87.11     .06       0     .04   28.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   28.47              73.6   97.46   98.38              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 13

INPUT
Description:
Station Elevation Data      num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -107.15      80       0    72.6    2.42   71.65    5.48   70.15    8.85   70.01
   12.08   70.13   14.04   70.33   19.35   70.69   20.66   71.26    23.7   72.72
   26.71   73.74   28.67    73.1   32.78   72.97   35.22   72.85   38.63   72.82
   63.01      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -107.15     .06       0     .04    23.7     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0    23.7             40.29   16.05   14.77              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 12.5

INPUT
Description:
```

```
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02              6.5     6.5     6.5              .3       .5

CULVERT


RIVER: MARIN
REACH: MARIN               RS: 12.3

INPUT
Description:
Distance from Upstream XS =      .01
Deck/Roadway Width        =     6.35
Weir Coefficient          =      1.4
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -100   71.14             100   71.14

Upstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02             .3       .5

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -100   71.14             100   71.14

Downstream Bridge Cross Section Data
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02             .3       .5

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name     Shape      Rise    Span
Culvert #1         Box       1.5    1.53
FHWA Chart # 58- Rectangular concrete
FHWA Scale # 1 - Side tapered; Less favorable edges
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 .1    6.37     .015     .015        0                  .5                  1
Number of Barrels =  5
Upstream   Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3
Downstream Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 12

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
```

```
   63.63      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -127.46     .06        0     .04    32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02             29.03   86.62   87.37             .3       .5

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 11

INPUT
Description:
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -197.07      80  -32.58      70       0   69.47    1.32   68.38     7.3   68.34
   16.13   68.29   19.13      70    25.9      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -197.07     .06        0     .04    19.13     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   19.13            107.31   35.28    36.7             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 10

INPUT
Description:
Station Elevation Data      num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -222.02      80  -62.41      70       0   69.45   19.88   68.59   32.04      68
   43.94   67.99   45.09   70.76   48.92      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -222.02     .06        0     .04    45.09     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   45.09             76.35   51.55    59.5             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 9

INPUT
Description:
Station Elevation Data      num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -164.69      80  -82.36      70       0   69.14   23.96   68.16   49.64   67.91
   59.24      70   84.26      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -164.69     .06        0     .04    59.24     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   59.24             59.84   55.19   48.62             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 8

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -137.97      80  -84.81      70       0    69.3    5.84    68.7   29.47   67.88
   45.31   67.98   61.31   68.01   68.39   70.49   95.46      80

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -137.97     .06        0     .04    68.39     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   68.39             31.95   57.86   39.08             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 7

INPUT
Description:
```

```
Station Elevation Data     num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -115.07      80  -59.76      70       0   67.71   17.45   69.15   19.96   70.01
   23.78   68.36    28.2   68.32   36.36   68.24   37.53   67.52   43.04   67.34
   43.49   67.79   63.96    67.8   77.69   67.87   95.29      70  146.29      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -115.07     .06  -59.76     .04   95.29     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -59.76   95.29             86.88   50.09   49.69              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 6

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -71.56      80  -25.41      70       0   68.85   38.85    69.1   43.08   67.59
   93.08   67.86  131.75   68.87  185.12      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -71.56     .06  -25.41     .04  131.75     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -25.41  131.75             60.74   50.42   69.56              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 5

INPUT
Description:
Station Elevation Data     num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   70.79   15.33   67.94   32.05   67.84   45.43   68.32   48.05   69.33
   51.75   68.35   61.34   68.45   63.44   68.94   68.29   68.34   79.48    68.4
   80.53   67.23   89.28   67.06   91.16   67.48  117.38   67.87  163.34   67.49
  190.63   73.24

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   15.33     .04  163.34     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          15.33  163.34             71.08   50.59   59.91              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 4

INPUT
Description:
Station Elevation Data     num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -78.14      80       0   68.02   32.02   68.19   35.57    66.9    62.4   68.08
      89   67.07   96.74   67.29  135.19    67.3  162.75    67.1  164.19   67.88
  219.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -78.14     .06       0     .04  164.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0  164.19             57.38   50.03   16.47              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 3

INPUT
Description:
Station Elevation Data     num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -59.56      80       0   68.44   23.97   68.08    91.5   69.53   97.49   69.71
  135.86   67.53  160.11   67.41  171.55   66.79  182.36   67.41  193.77      70
  268.04      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -59.56     .06       0     .04  193.77     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0  193.77             67.86   50.32  123.88              .1       .3
```

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 2

INPUT
Description:
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-42.77	80	0	68.15	35.32	68.05	55.4	67.92	81.75	66.83
125.41	66.45	163.272	66.18	200.718	66.61	229.9	67.76	302.97	70
383.13	80								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-42.77	.06	55.4	.04	229.9	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
55.4	229.9	66.79	50	91.38	.1	.3

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 1

INPUT
Description:
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.16	80	0	67.91	25.9	67.29	45.915	67.07	72.368	66.7
101.08	66.31	123.37	66.54	187.11	70	251.95	80		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-28.16	.06	0	.04	187.11	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	187.11	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:MARIN

Reach	River Sta.	n1	n2	n3
MARIN	17	.06	.04	.06
MARIN	16	.06	.04	.06
MARIN	15	.06	.04	.06
MARIN	14	.06	.04	.06
MARIN	13	.06	.04	.06
MARIN	12.5	.06	.04	.06
MARIN	12.3	Culvert		
MARIN	12	.06	.04	.06
MARIN	11	.06	.04	.06
MARIN	10	.06	.04	.06
MARIN	9	.06	.04	.06
MARIN	8	.06	.04	.06
MARIN	7	.06	.04	.06
MARIN	6	.06	.04	.06
MARIN	5	.06	.04	.06
MARIN	4	.06	.04	.06
MARIN	3	.06	.04	.06
MARIN	2	.06	.04	.06
MARIN	1	.06	.04	.06

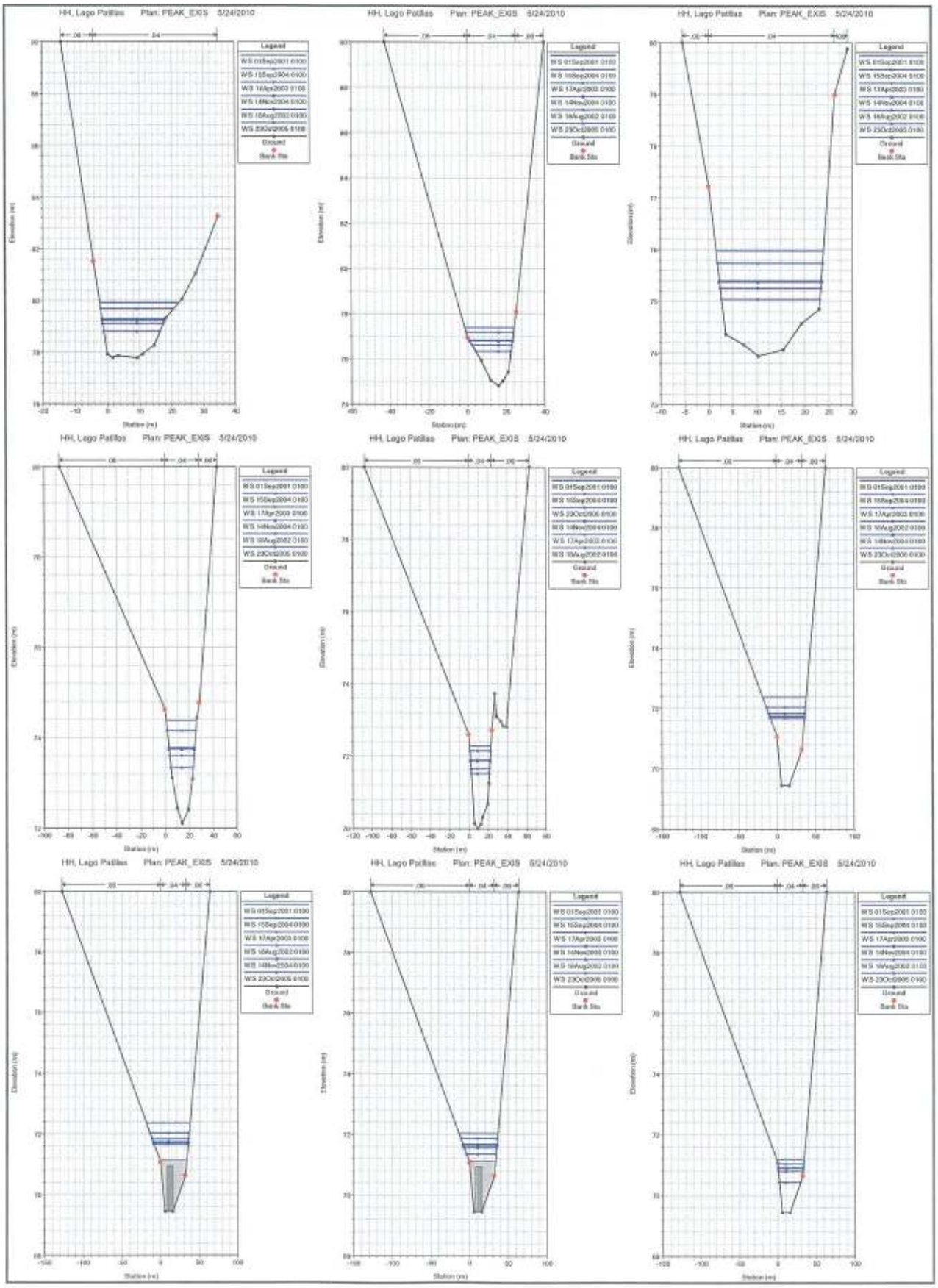
SUMMARY OF REACH LENGTHS

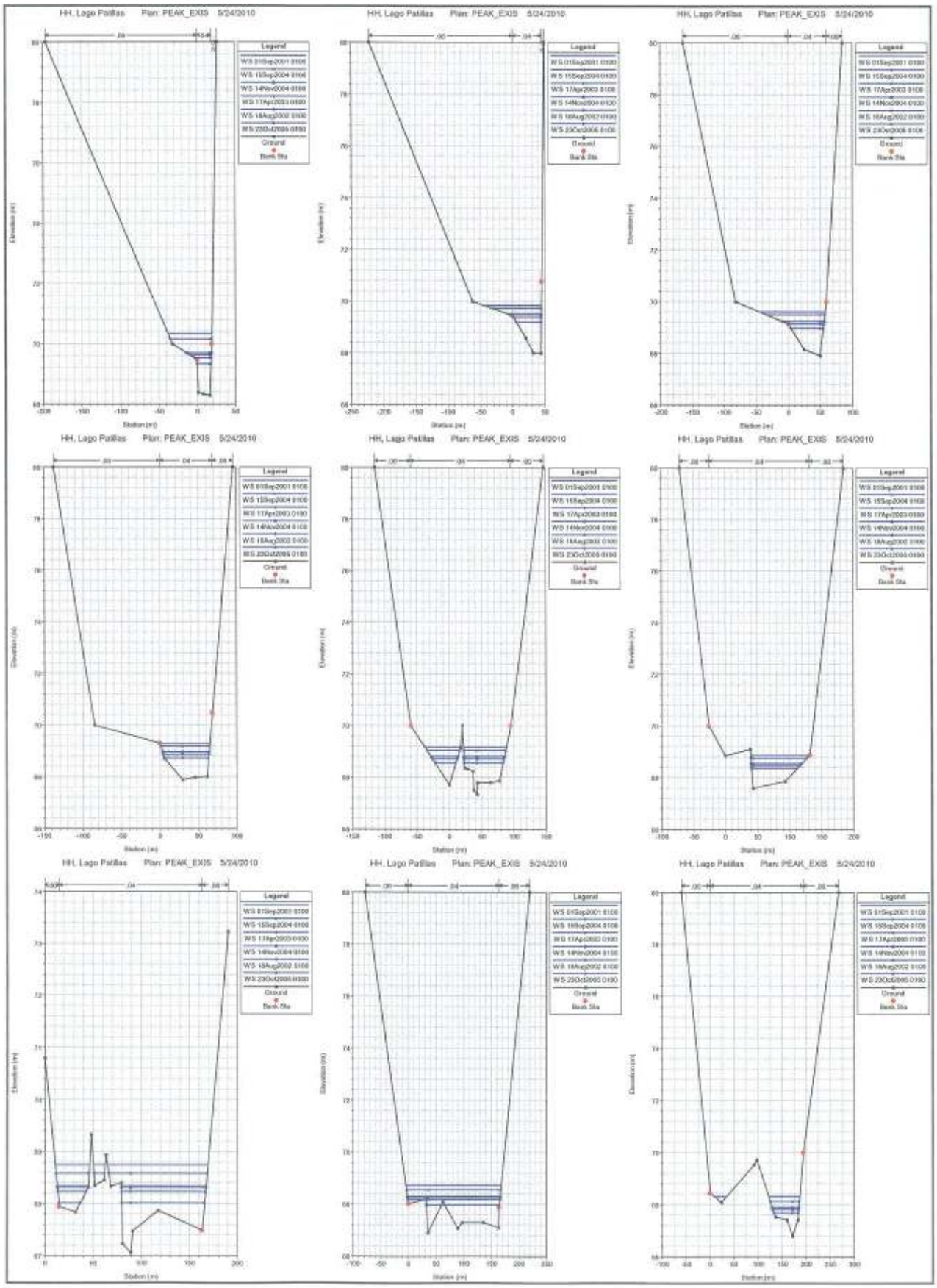
River: MARIN

Reach	River Sta.	Left	Channel	Right
MARIN	17	87.52	101.87	84.4
MARIN	16	122.87	100.85	127.39
MARIN	15	99.29	103.25	104.82
MARIN	14	73.6	97.46	98.38
MARIN	13	40.29	16.05	14.77
MARIN	12.5	6.5	6.5	6.5
MARIN	12.3	Culvert		
MARIN	12	29.03	86.62	87.37
MARIN	11	107.31	35.28	36.7
MARIN	10	76.35	51.55	59.5
MARIN	9	59.84	55.19	48.62
MARIN	8	31.95	57.86	39.08
MARIN	7	86.88	50.09	49.69
MARIN	6	60.74	50.42	69.56
MARIN	5	71.08	50.59	59.91
MARIN	4	57.38	50.03	16.47
MARIN	3	67.86	50.32	123.88
MARIN	2	66.79	50	91.38
MARIN	1	0	0	0

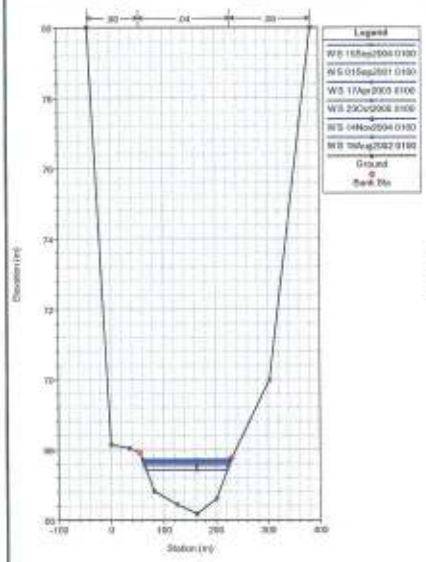
SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: MARIN

Reach	River Sta.	Contr.	Expan.
MARIN	17	.1	.3
MARIN	16	.1	.3
MARIN	15	.1	.3
MARIN	14	.1	.3
MARIN	13	.1	.3
MARIN	12.5	.3	.5
MARIN	12.3	Culvert	
MARIN	12	.3	.5
MARIN	11	.1	.3
MARIN	10	.1	.3
MARIN	9	.1	.3
MARIN	8	.1	.3
MARIN	7	.1	.3
MARIN	6	.1	.3
MARIN	5	.1	.3
MARIN	4	.1	.3
MARIN	3	.1	.3
MARIN	2	.1	.3
MARIN	1	.1	.3

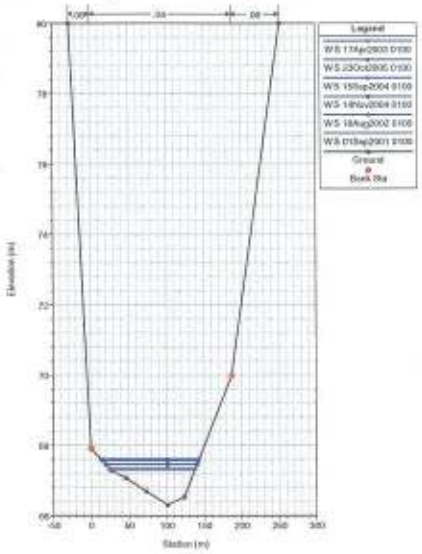

HH, Lago Patillas Plan: PEAK_EXIS 5/24/2010
Legend
Ground
Bank Sta
Station (m)
Elevation (m)


HH, Lago Patillas Plan: PEAK_EXIS 5/24/2010
Legend
WS 01Sep2001 0100
WS 15Sep2004 0100
WS 14Nov2004 0100
WS 11Apr2003 0100
WS 18Aug2002 0100
WS 23Oct2005 0100
Ground
Bank Sta
Elevation (m)
Station (m)

HH, Lago Paillas Plan: PEAK_EXIS 5/24/2010



HH, Lago Paillas Plan: PEAK_EXIS 5/24/2010



SEDIMENT TRANSPORT PLAN: MEAN_PROP

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X       X
X     X  X        X    X      X   X    X    X       X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX


PROJECT DATA
Project Title: HH, Lago Patillas
Project File : PATILLAS.prj
Run Date and Time: 5/24/2010 11:53:09 AM

Project in SI units


PLAN DATA

Plan Title: MEAN_PROP
Plan File : C:\PROJ\LAGO\RAS\PATILLAS.p07

           Geometry Title: PROPOSED
           Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g02

           Flow Title    : PROPOSED
           Flow File     : C:\PROJ\LAGO\RAS\PATILLAS.f02

Plan Summary Information:
Number of:  Cross Sections =   19    Multiple Openings  =    0
            Culverts       =    1    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow


FLOW DATA

Flow Title: PROPOSED
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f02

Flow Data (m3/s)

  River          Reach          RS                  PF 1


Boundary Conditions

  River          Reach          Profile                      Upstream                 Downstream


GEOMETRY DATA

Geometry Title: PROPOSED
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g02

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 17

INPUT
Description:
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -14.2      90   -4.24   81.52       0   77.92    1.59   77.79     3.2   77.87
    9.23   77.78   10.78   77.93   14.53   78.28   18.17   79.33   23.18   80.06
   27.56   81.06   34.56   83.27
```

```
Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.2     .06   -4.24     .04   34.56     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -4.24   34.56             87.52  101.87    84.4             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 16

INPUT
Description:
Station Elevation Data      num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.66      90       0   76.94    7.01   75.96    11.9   75.07   15.98   74.83
   18.11   75.04   21.02   75.45   25.08   78.09   39.62      90

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.66     .06       0     .04   25.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0   25.08            122.87  100.85  127.39             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 15

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -5.43      80       0   77.22    3.49   74.36    7.23   74.16    10.3   73.94
   15.44   74.06    19.3   74.57   23.04   74.85   26.26   78.99   28.96   79.88

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -5.43     .06       0     .04   26.26     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0   26.26            64.209   66.77  67.785             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14.3533*

INPUT
Description:
Station Elevation Data      num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -58.251      80       0  75.539   4.285  73.744   5.302  73.542   8.878  73.079
    9.152  73.042  12.647  72.757  17.492   72.97  18.141  73.025   21.13  73.548
   21.648  73.627  24.654  74.394  25.496  74.991  27.689  76.261  38.305  79.958

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -58.251     .06       0     .04  27.689     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0  27.689            35.081   36.48  37.035             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 14

INPUT
Description:
Station Elevation Data      num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -87.11      80       0   74.62    5.84   73.12   10.08   72.44   13.93   72.11
   19.24   72.41   22.63   73.09   26.35   74.44   28.47   74.77   43.41      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -87.11     .06       0     .04   28.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
               0   28.47              73.6   97.46   98.38             .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 13

INPUT
Description:
Station Elevation Data      num=      15
```

```
    Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -107.15     80       0    72.6    2.42   71.65    5.48   70.15    8.05    69.8
   15.27    69.8   19.35   70.69   20.66   71.26    23.7   72.72   26.71   73.74
   28.67    73.1   32.78   72.97   35.22   72.85   38.63   72.82   63.01      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -107.15     .06       0     .04    23.7     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0    23.7             40.29   16.05   14.77              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 12.5

INPUT
Description:
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46     80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63     80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02              6.5     6.5     6.5              .3       .5

CULVERT


RIVER: MARIN
REACH: MARIN              RS: 12.3

INPUT
Description:
Distance from Upstream XS =     .01
Deck/Roadway Width        =    6.35
Weir Coefficient          =     1.4
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -100   71.14             100   71.14

Upstream Bridge Cross Section Data
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46     80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63     80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02             .3       .5

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -100   71.14             100   71.14

Downstream Bridge Cross Section Data
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46     80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63     80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02             .3       .5

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1          Box       1.5    1.53
FHWA Chart # 58- Rectangular concrete
FHWA Scale # 1 - Side tapered; Less favorable edges
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 .1    6.37     .015      .015          0                 .5                 1
Number of Barrels =  5
```

```
Upstream   Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3
Downstream Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 12

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02             29.03   86.62   87.37              .3       .5

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 11

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -197.07      80  -32.58      70       0   69.47    1.32   68.38    2.17    67.7
   15.08    67.7   16.13   68.29   19.13      70    25.9      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -197.07     .06       0     .04   19.13     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   19.13            107.31   35.28    36.7              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 10

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -222.02      80  -62.41      70       0   69.45    7.35      67   33.81      67
    36.8      68   43.94   67.99   45.09   70.76   48.92      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -222.02     .06       0     .04   45.09     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   45.09             76.35   51.55    59.5              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 9

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -164.69      80  -82.36      70       0   69.14    7.02    66.8   49.64    66.8
   59.24      70   84.26      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -164.69     .06       0     .04   59.24     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   59.24             59.84   55.19   48.62              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 8

INPUT
Description:
```

```
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -137.97      80  -84.81      70       0    69.3     8.1    66.6   56.72    66.6
   68.39   70.49   95.46      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -137.97     .06       0     .04   68.39     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   68.39             31.95   57.86   39.08              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 7

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -115.07      80  -59.76      70       0   67.71    3.99   66.38   73.21   66.38
   77.69   67.87   95.29      70  146.29      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -115.07     .06  -59.76     .04   95.29     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -59.76   95.29             86.88   50.09   49.69              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 6

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -71.56      80  -25.41      70       0   68.85    7.95    66.2  123.74    66.2
  131.75   68.87  185.12      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -71.56     .06  -25.41     .04  131.75     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        -25.41  131.75             60.74   50.42   69.56              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 5

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   70.79   15.33   67.94   21.09   66.02  158.93   66.02  163.34   67.49
  190.63   73.24

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   15.33     .04  163.34     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         15.33  163.34             71.08   50.59   59.91              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 4

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -78.14      80       0   68.02    6.51   65.85     159   65.85  162.75    67.1
  164.19   67.88  219.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -78.14     .06       0     .04  164.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  164.19             57.38   50.03   16.47              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 3
```

INPUT
Description:
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-59.56	80	0	68.44	23.97	68.08	31.26	65.65	177.08	65.65
182.36	67.41	193.77	70	268.04	80				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-59.56	.06	0	.04	193.77	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	193.77	67.86	50.32	123.88	.1	.3

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 2

INPUT
Description:
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-42.77	80	0	68.15	35.32	68.05	55.4	67.92	62.21	65.45
223.57	65.45	229.9	67.76	302.97	70	383.13	80		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-42.77	.06	55.4	.04	229.9	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
55.4	229.9	66.79	50	91.38	.1	.3

CROSS SECTION

RIVER: MARIN
REACH: MARIN RS: 1

INPUT
Description:
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.16	80	0	67.91	7.83	65.3	173.01	65.3	187.11	70
251.95	80								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-28.16	.06	0	.04	187.11	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	187.11	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:MARIN

Reach	River Sta.	n1	n2	n3
MARIN	17	.06	.04	.06
MARIN	16	.06	.04	.06
MARIN	15	.06	.04	.06
MARIN	14.3533*	.06	.04	.06
MARIN	14	.06	.04	.06
MARIN	13	.06	.04	.06
MARIN	12.5	.06	.04	.06
MARIN	12.3	Culvert		
MARIN	12	.06	.04	.06
MARIN	11	.06	.04	.06
MARIN	10	.06	.04	.06
MARIN	9	.06	.04	.06
MARIN	8	.06	.04	.06
MARIN	7	.06	.04	.06
MARIN	6	.06	.04	.06
MARIN	5	.06	.04	.06
MARIN	4	.06	.04	.06
MARIN	3	.06	.04	.06
MARIN	2	.06	.04	.06
MARIN	1	.06	.04	.06

SUMMARY OF REACH LENGTHS

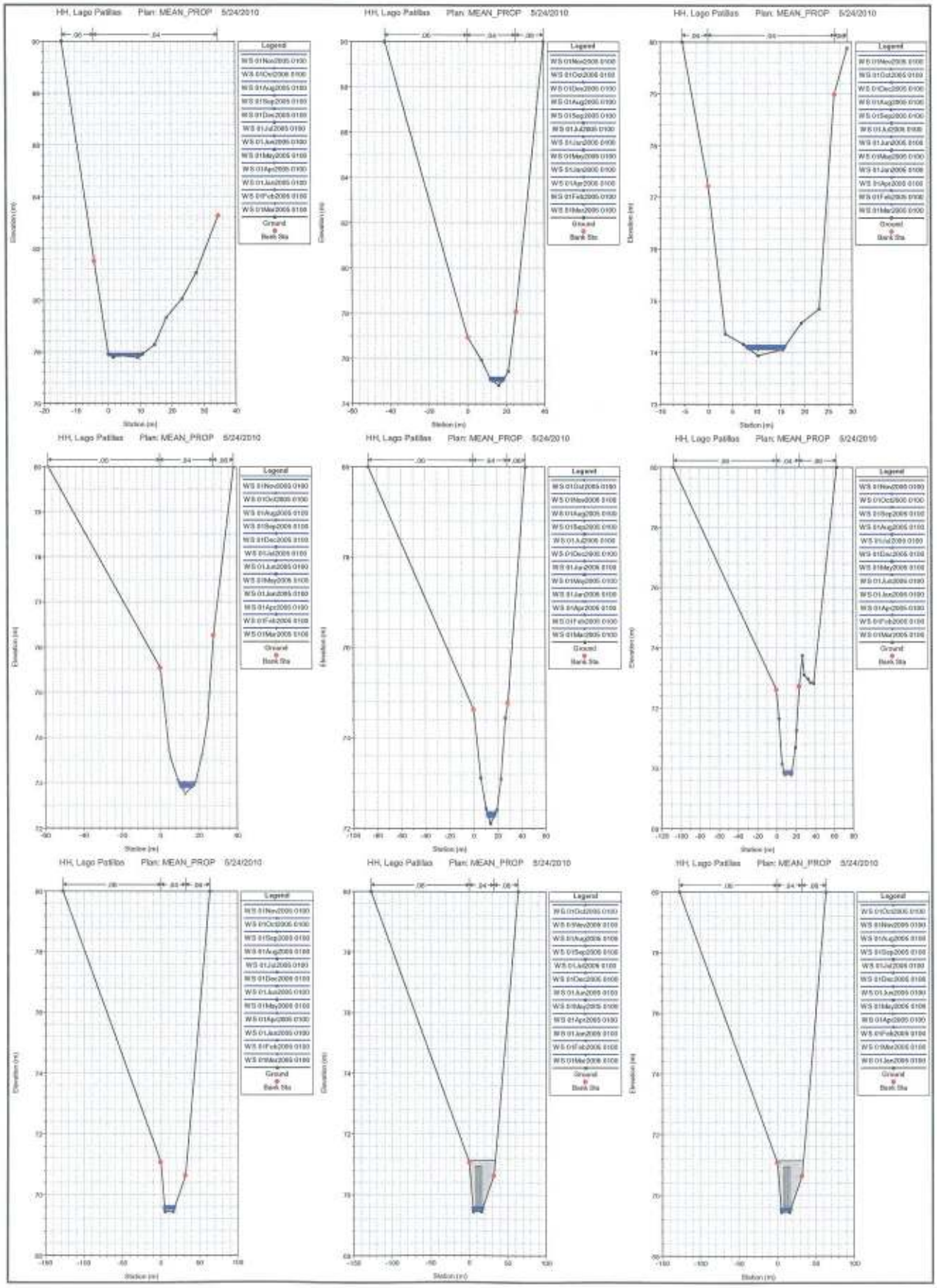
River: MARIN

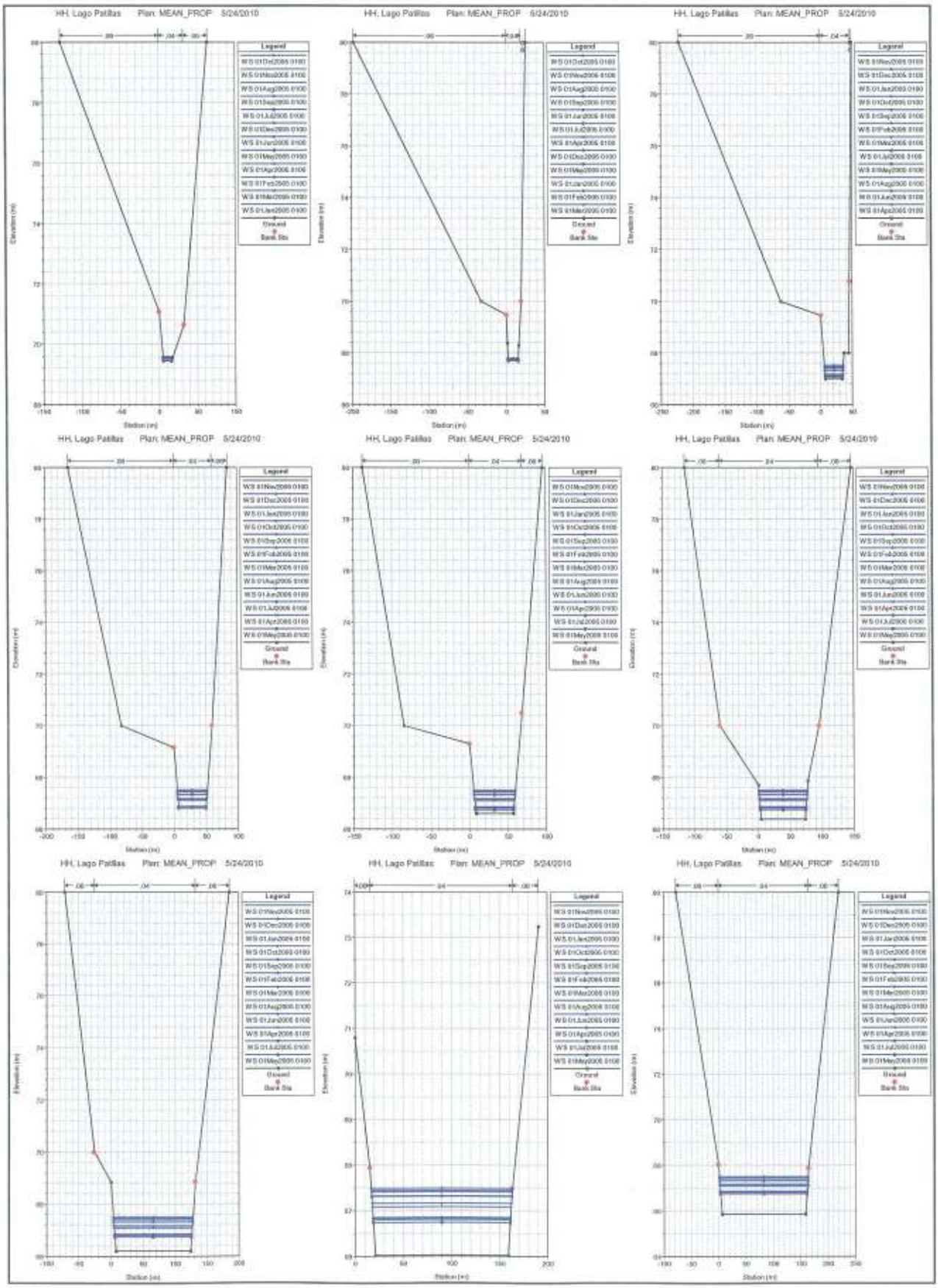
Reach	River Sta.	Left	Channel	Right
MARIN	17	87.52	101.87	84.4
MARIN	16	122.87	100.85	127.39
MARIN	15	64.209	66.77	67.785
MARIN	14.3533*	35.081	36.48	37.035

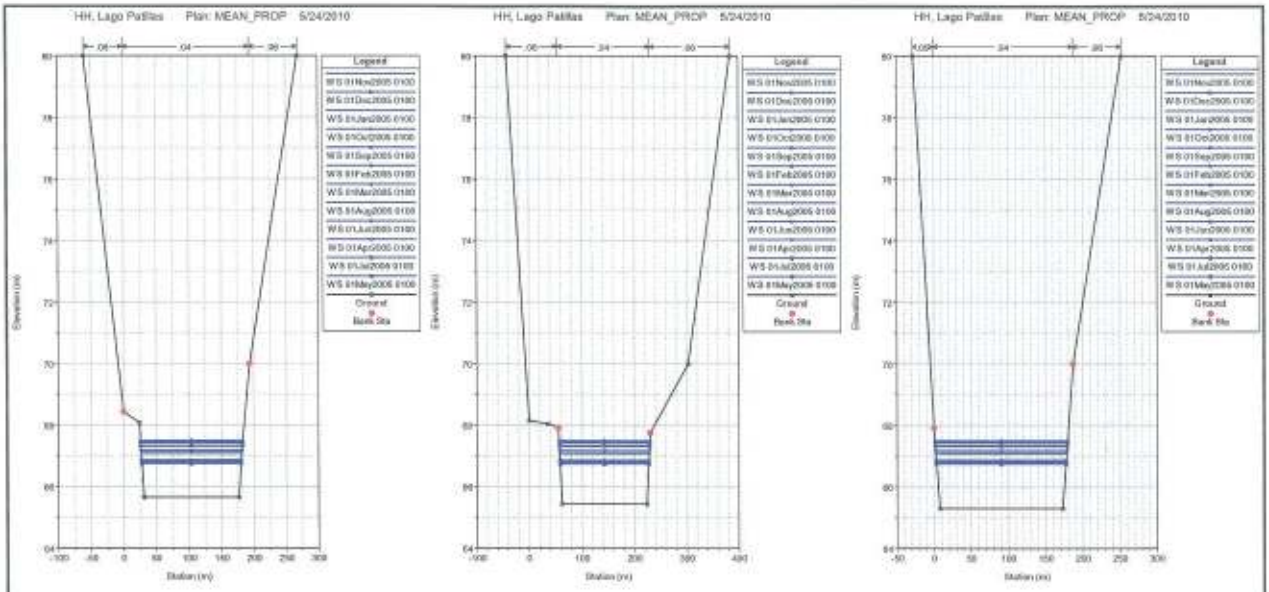
MARIN	14	73.6	97.46	98.38
MARIN	13	40.29	16.05	14.77
MARIN	12.5	6.5	6.5	6.5
MARIN	12.3	Culvert		
MARIN	12	29.03	86.62	87.37
MARIN	11	107.31	35.28	36.7
MARIN	10	76.35	51.55	59.5
MARIN	9	59.84	55.19	48.62
MARIN	8	31.95	57.86	39.08
MARIN	7	86.88	50.09	49.69
MARIN	6	60.74	50.42	69.56
MARIN	5	71.08	50.59	59.91
MARIN	4	57.38	50.03	16.47
MARIN	3	67.86	50.32	123.88
MARIN	2	66.79	50	91.38
MARIN	1	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: MARIN

Reach	River Sta.	Contr.	Expan.
MARIN	17	.1	.3
MARIN	16	.1	.3
MARIN	15	.1	.3
MARIN	14.3533*	.1	.3
MARIN	14	.1	.3
MARIN	13	.1	.3
MARIN	12.5	.3	.5
MARIN	12.3	Culvert	
MARIN	12	.3	.5
MARIN	11	.1	.3
MARIN	10	.1	.3
MARIN	9	.1	.3
MARIN	8	.1	.3
MARIN	7	.1	.3
MARIN	6	.1	.3
MARIN	5	.1	.3
MARIN	4	.1	.3
MARIN	3	.1	.3
MARIN	2	.1	.3
MARIN	1	.1	.3


HH, Lago Patillas Plan: MEAN_PROP 5/24/2010
Legend
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Patillas Plan: MEAN_PROP 5/24/2010
Legend
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Patillas Plan: MEAN_PROP 5/24/2010
Legend
WS 01Nov2005 0100
WS 01Dec2005 0100
WS 01Jan2006 0100
WS 01Oct2006 0100
WS 01Sep2005 0100
WS 01Feb2005 0100
WS 01Mar2005 0100
WS 01Aug2005 0100
WS 01Jun2005 0100
WS 01Apr2005 0100
WS 01Jul2005 0100
WS 01May2005 0100
Ground
Bank Sta
Elevation (m)
Station (m)

SEDIMENT TRANSPORT PLAN: PEAK_PROP

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X       X
X     X  X        X    X      X   X    X    X       X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX


PROJECT DATA
Project Title: HH, Lago Patillas
Project File : PATILLAS.prj
Run Date and Time: 5/24/2010 1:34:18 PM

Project in SI units


PLAN DATA

Plan Title: PEAK_PROP
Plan File : C:\PROJ\LAGO\RAS\PATILLAS.p08

          Geometry Title: PROPOSED
          Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g02

          Flow Title    : PROPOSED
          Flow File     : C:\PROJ\LAGO\RAS\PATILLAS.f02

Plan Summary Information:
Number of:  Cross Sections =   19    Multiple Openings  =    0
            Culverts       =    1    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed at all cross sections
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow


FLOW DATA

Flow Title: PROPOSED
Flow File : C:\PROJ\LAGO\RAS\PATILLAS.f02

Flow Data (m3/s)

  River          Reach          RS                  PF 1


Boundary Conditions

  River          Reach          Profile                      Upstream                Downstream


GEOMETRY DATA

Geometry Title: PROPOSED
Geometry File : C:\PROJ\LAGO\RAS\PATILLAS.g02

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 17

INPUT
Description:
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -14.2      90   -4.24   81.52       0   77.92    1.59   77.79     3.2   77.87
    9.23   77.78   10.78   77.93   14.53   78.28   18.17   79.33   23.18   80.06
   27.56   81.06   34.56   83.27
```

```
Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.2     .06   -4.24     .04   34.56     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -4.24   34.56            87.52  101.87    84.4              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 16

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.66      90       0   76.94    7.01   75.96    11.9   75.07   15.98   74.83
   18.11   75.04   21.02   75.45   25.08   78.09   39.62      90

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.66     .06       0     .04   25.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   25.08           122.87  100.85  127.39              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 15

INPUT
Description:
Station Elevation Data     num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -5.43      80       0   77.22    3.49   74.36    7.23   74.16    10.3   73.94
   15.44   74.06    19.3   74.57   23.04   74.85   26.26   78.99   28.96   79.88

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -5.43     .06       0     .04   26.26     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   26.26            64.209   66.77  67.785              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 14.3533*

INPUT
Description:
Station Elevation Data     num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -58.251      80       0  75.539   4.285  73.744   5.302  73.542   8.878  73.079
   9.152  73.042  12.647  72.757  17.492   72.97  18.141  73.025   21.13  73.548
  21.648  73.627  24.654  74.394  25.496  74.991  27.689  76.261  38.305  79.958

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -58.251     .06       0     .04  27.689     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0  27.689           35.081   36.48  37.035              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 14

INPUT
Description:
Station Elevation Data     num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -87.11      80       0   74.62    5.84   73.12   10.08   72.44   13.93   72.11
   19.24   72.41   22.63   73.09   26.35   74.44   28.47   74.77   43.41      80

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -87.11     .06       0     .04   28.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
              0   28.47             73.6   97.46   98.38              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 13

INPUT
Description:
Station Elevation Data     num=      15
```

```
    Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -107.15      80       0    72.6    2.42   71.65    5.48   70.15    8.05    69.8
   15.27    69.8   19.35   70.69   20.66   71.26    23.7   72.72   26.71   73.74
   28.67    73.1   32.78   72.97   35.22   72.85   38.63   72.82   63.01      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -107.15     .06       0     .04    23.7     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0    23.7            40.29   16.05   14.77              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN              RS: 12.5

INPUT
Description:
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02              6.5     6.5     6.5              .3       .5

CULVERT


RIVER: MARIN
REACH: MARIN              RS: 12.3

INPUT
Description:
Distance from Upstream XS =     .01
Deck/Roadway Width        =    6.35
Weir Coefficient          =     1.4
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -100   71.14             100   71.14

Upstream Bridge Cross Section Data
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02             .3       .5

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -100   71.14             100   71.14

Downstream Bridge Cross Section Data
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
             0   32.02             .3       .5

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1          Box       1.5    1.53
FHWA Chart # 58- Rectangular concrete
FHWA Scale # 1 - Side tapered; Less favorable edges
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 .1    6.37     .015     .015        0                  .5                 1
Number of Barrels =  5
```

```
Upstream   Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3
Downstream Elevation =  69.44
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
    8.46   10.17   11.88   13.59    15.3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 12

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -127.46      80       0   71.07    5.27   69.44   15.67   69.44   32.02   70.64
   63.63      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -127.46     .06       0     .04   32.02     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   32.02             29.03   86.62   87.37              .3       .5

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 11

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -197.07      80  -32.58      70       0   69.47    1.32   68.38    2.17    67.7
   15.08    67.7   16.13   68.29   19.13      70    25.9      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -197.07     .06       0     .04   19.13     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   19.13            107.31   35.28    36.7              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 10

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -222.02      80  -62.41      70       0   69.45    7.35      67   33.81      67
    36.8      68   43.94   67.99   45.09   70.76   48.92      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -222.02     .06       0     .04   45.09     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   45.09             76.35   51.55    59.5              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 9

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -164.69      80  -82.36      70       0   69.14    7.02    66.8   49.64    66.8
   59.24      70   84.26      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -164.69     .06       0     .04   59.24     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   59.24             59.84   55.19   48.62              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN                RS: 8

INPUT
Description:
```

```
Station Elevation Data     num=       7
     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -137.97      80  -84.81       70       0    69.3     8.1    66.6   56.72    66.6
   68.39   70.49   95.46       80

Manning's n Values         num=       3
     Sta   n Val     Sta    n Val     Sta   n Val
 -137.97     .06       0      .04   68.39     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   68.39             31.95   57.86   39.08              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 7

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -115.07      80  -59.76       70       0   67.71    3.99   66.38   73.21   66.38
   77.69   67.87   95.29       70  146.29      80

Manning's n Values         num=       3
     Sta   n Val     Sta    n Val     Sta   n Val
 -115.07     .06  -59.76      .04   95.29     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         -59.76   95.29             86.88   50.09   49.69              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 6

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -71.56      80  -25.41       70       0   68.85    7.95    66.2  123.74    66.2
  131.75   68.87  185.12       80

Manning's n Values         num=       3
     Sta   n Val     Sta    n Val     Sta   n Val
  -71.56     .06  -25.41      .04  131.75     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         -25.41  131.75             60.74   50.42   69.56              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 5

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   70.79   15.33    67.94   21.09   66.02  158.93   66.02  163.34   67.49
  190.63   73.24

Manning's n Values         num=       3
     Sta   n Val     Sta    n Val     Sta   n Val
       0     .06   15.33      .04  163.34     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          15.33  163.34             71.08   50.59   59.91              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 4

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta     Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -78.14      80       0    68.02    6.51   65.85     159   65.85  162.75    67.1
  164.19   67.88  219.63       80

Manning's n Values         num=       3
     Sta   n Val     Sta    n Val     Sta   n Val
  -78.14     .06       0      .04  164.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  164.19             57.38   50.03   16.47              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 3
```

```
INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -59.56      80       0   68.44   23.97   68.08   31.26   65.65  177.08   65.65
  182.36   67.41  193.77      70  268.04      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -59.56     .06       0     .04  193.77     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  193.77             67.86   50.32  123.88              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 2

INPUT
Description:
Station Elevation Data     num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -42.77      80       0   68.15   35.32   68.05    55.4   67.92   62.21   65.45
  223.57   65.45   229.9   67.76  302.97      70  383.13      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -42.77     .06    55.4     .04   229.9     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          55.4   229.9             66.79      50   91.38              .1       .3

CROSS SECTION


RIVER: MARIN
REACH: MARIN               RS: 1

INPUT
Description:
Station Elevation Data     num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -28.16      80       0   67.91    7.83    65.3  173.01    65.3  187.11      70
  251.95      80

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  -28.16     .06       0     .04  187.11     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  187.11                 0       0       0              .1       .3


SUMMARY OF MANNING'S N VALUES

River:MARIN
```

Reach	River Sta.	n1	n2	n3
MARIN	17	.06	.04	.06
MARIN	16	.06	.04	.06
MARIN	15	.06	.04	.06
MARIN	14.3533*	.06	.04	.06
MARIN	14	.06	.04	.06
MARIN	13	.06	.04	.06
MARIN	12.5	.06	.04	.06
MARIN	12.3	Culvert		
MARIN	12	.06	.04	.06
MARIN	11	.06	.04	.06
MARIN	10	.06	.04	.06
MARIN	9	.06	.04	.06
MARIN	8	.06	.04	.06
MARIN	7	.06	.04	.06
MARIN	6	.06	.04	.06
MARIN	5	.06	.04	.06
MARIN	4	.06	.04	.06
MARIN	3	.06	.04	.06
MARIN	2	.06	.04	.06
MARIN	1	.06	.04	.06

SUMMARY OF REACH LENGTHS

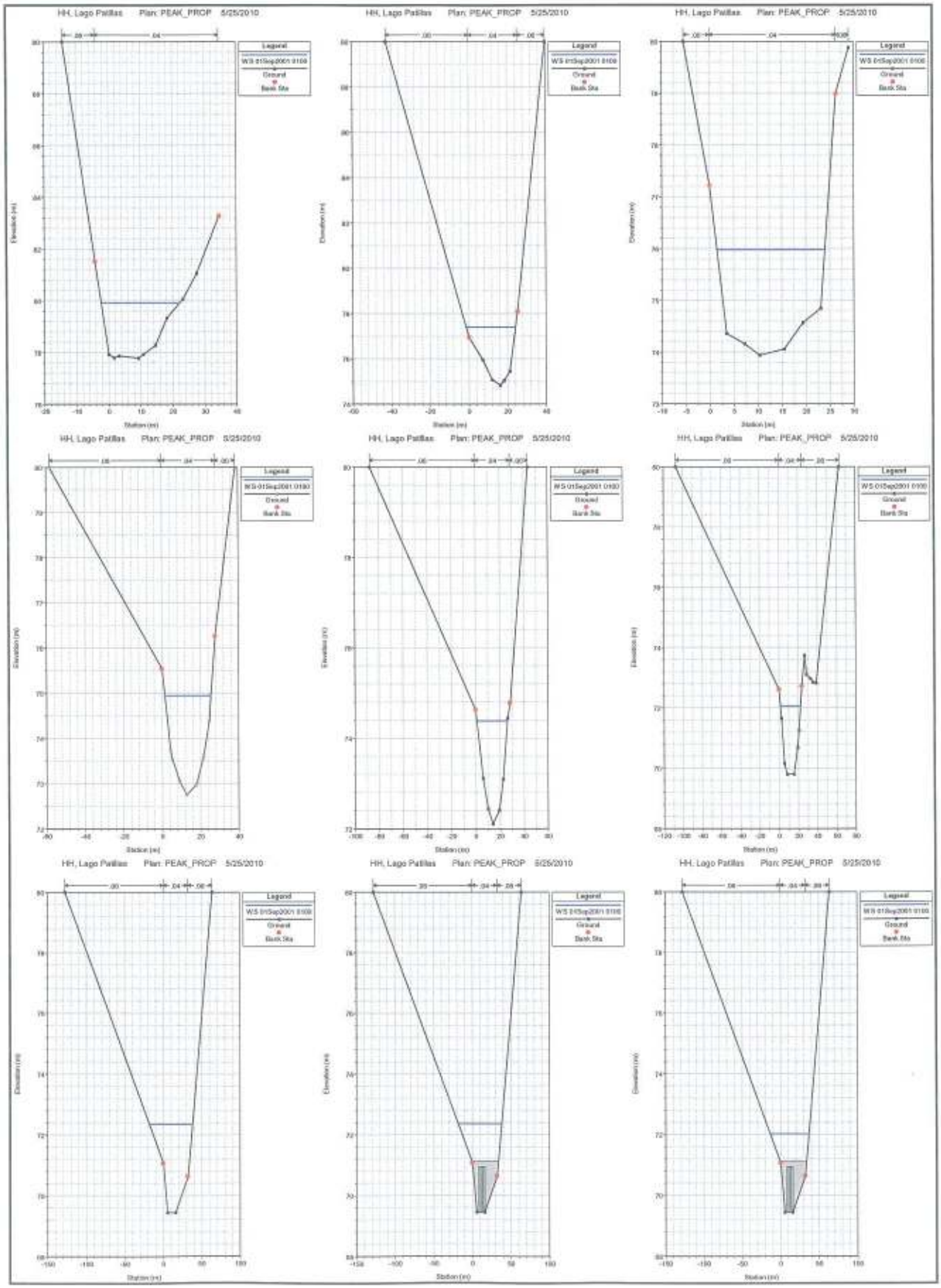
River: MARIN

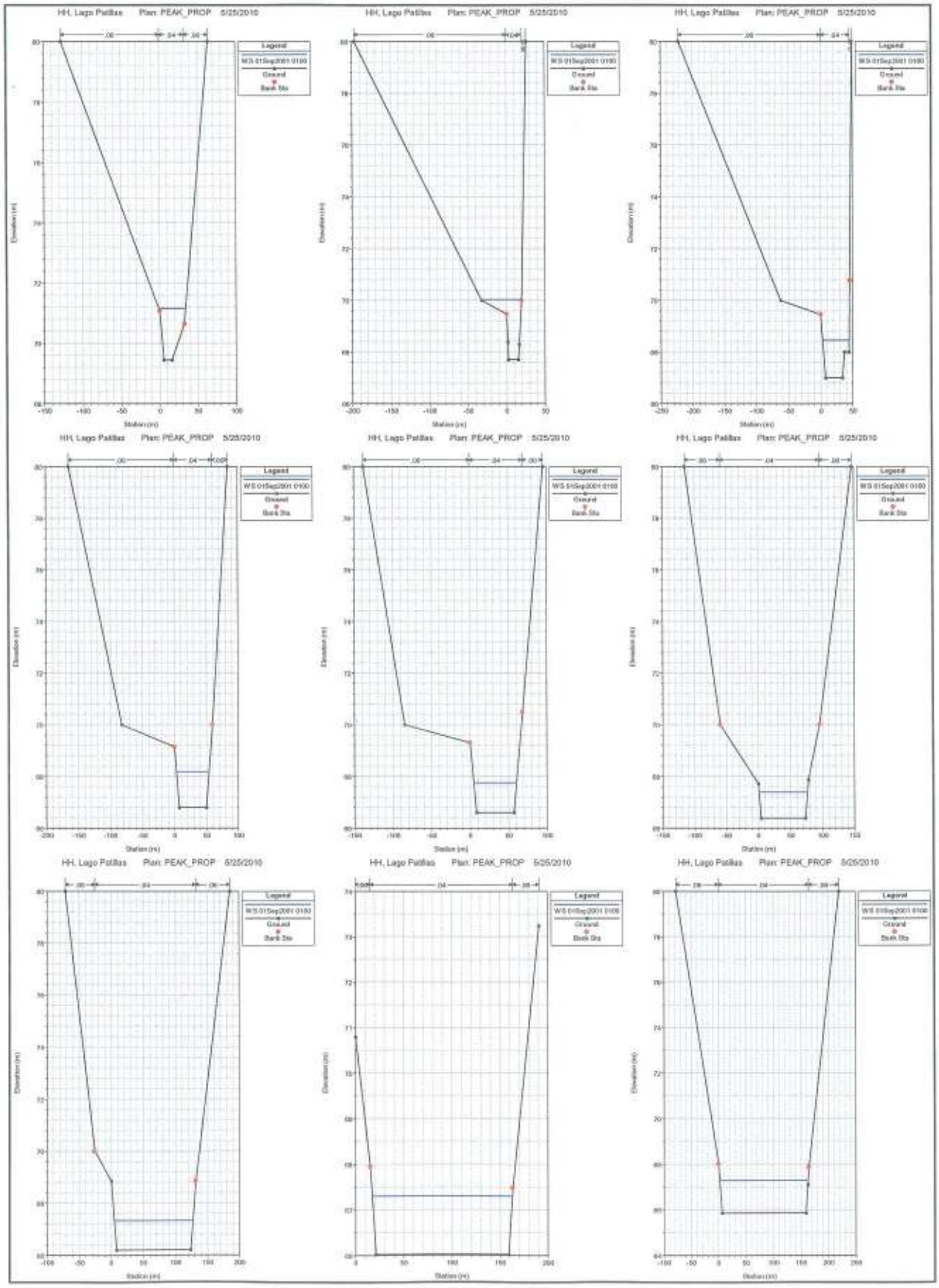
Reach	River Sta.	Left	Channel	Right
MARIN	17	87.52	101.87	84.4
MARIN	16	122.87	100.85	127.39
MARIN	15	64.209	66.77	67.785
MARIN	14.3533*	35.081	36.48	37.035

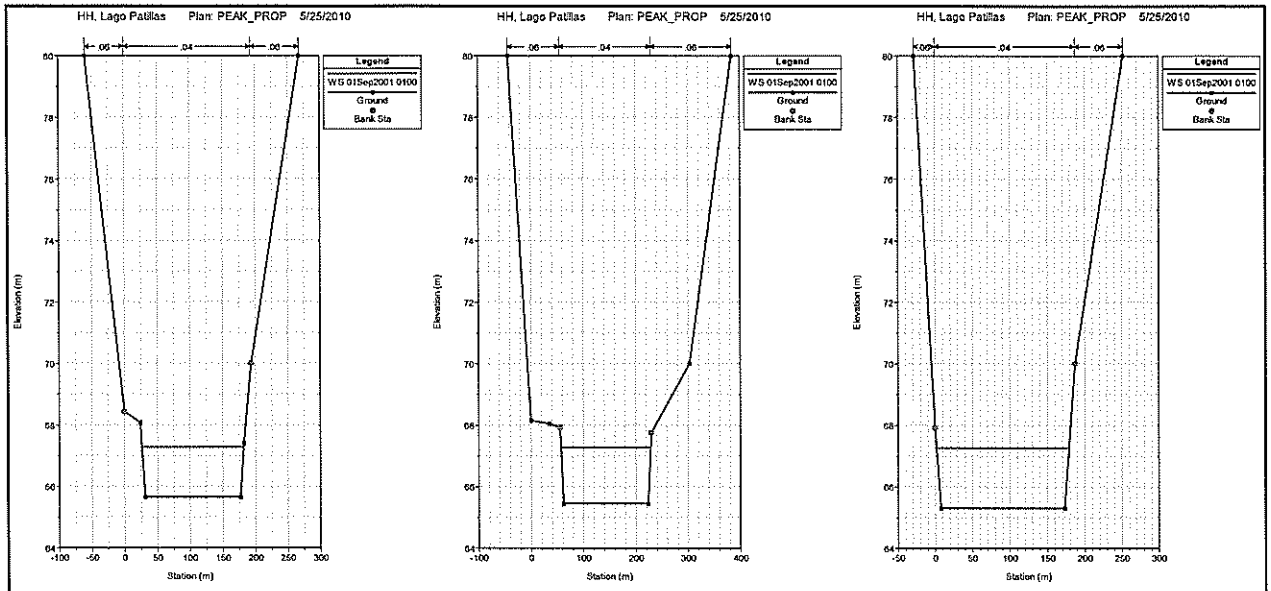
MARIN	14	73.6	97.46	98.38
MARIN	13	40.29	16.05	14.77
MARIN	12.5	6.5	6.5	6.5
MARIN	12.3	Culvert		
MARIN	12	29.03	86.62	87.37
MARIN	11	107.31	35.28	36.7
MARIN	10	76.35	51.55	59.5
MARIN	9	59.84	55.19	48.62
MARIN	8	31.95	57.86	39.08
MARIN	7	86.88	50.09	49.69
MARIN	6	60.74	50.42	69.56
MARIN	5	71.08	50.59	59.91
MARIN	4	57.38	50.03	16.47
MARIN	3	67.86	50.32	123.88
MARIN	2	66.79	50	91.38
MARIN	1	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: MARIN

Reach	River Sta.	Contr.	Expan.
MARIN	17	.1	.3
MARIN	16	.1	.3
MARIN	15	.1	.3
MARIN	14.3533*	.1	.3
MARIN	14	.1	.3
MARIN	13	.1	.3
MARIN	12.5	.3	.5
MARIN	12.3	Culvert	
MARIN	12	.3	.5
MARIN	11	.1	.3
MARIN	10	.1	.3
MARIN	9	.1	.3
MARIN	8	.1	.3
MARIN	7	.1	.3
MARIN	6	.1	.3
MARIN	5	.1	.3
MARIN	4	.1	.3
MARIN	3	.1	.3
MARIN	2	.1	.3
MARIN	1	.1	.3

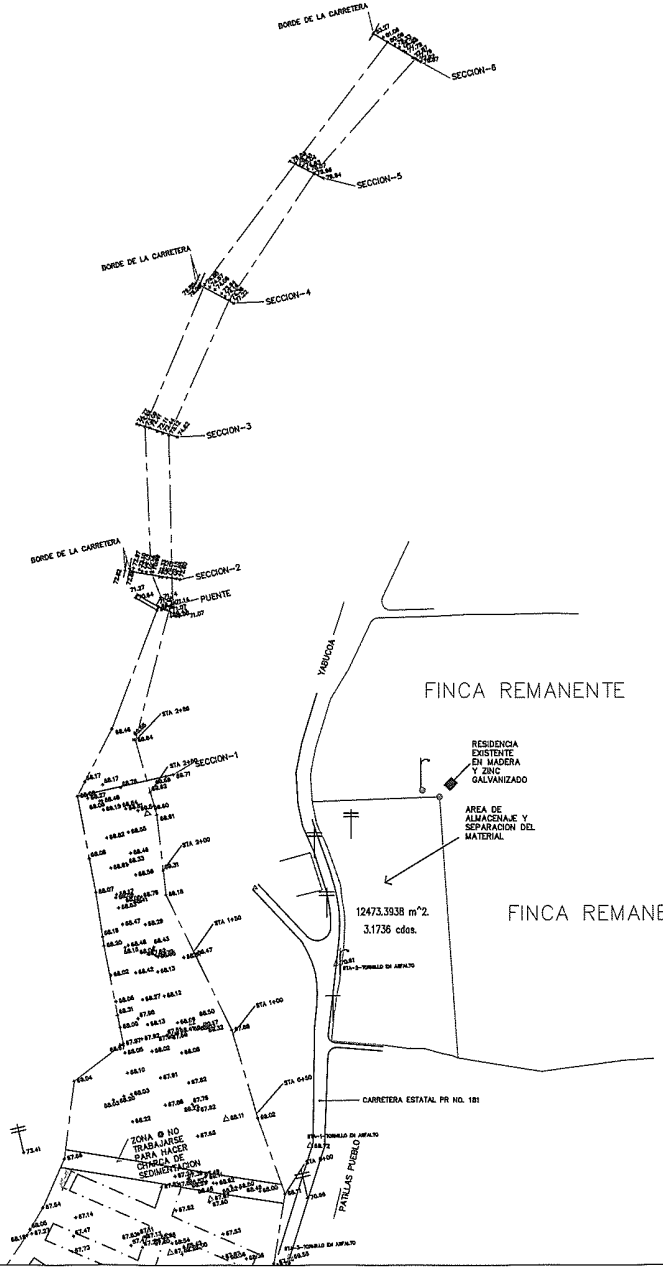

HH, Lago Patillas Plan: PEAK_PROP 5/25/2010
Legend
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Patillas Plan: PEAK_PROP 5/25/2010
Legend
WS 01Sep2001 0100
Ground
Bank Sta
Elevation (m)
Station (m)


HH, Lago Patillas Plan: PEAK_PROP 5/25/2010
.06
.04
.06
Legend
WS 01Sep2001 0100
Ground
Bank Sta
Elevation (m)
Station (m)
HH, Lago Patillas Plan: PEAK_PROP 5/25/2010
.06
.04
.06
Legend
WS 01Sep2001 0100
Ground
Bank Sta
Elevation (m)
Station (m)
HH, Lago Patillas Plan: PEAK_PROP 5/25/2010
.04
.06
Legend
WS 01Sep2001 0100
Ground
Bank Sta
Elevation (m)
Station (m)

APPENDIX G

FIELD DATA



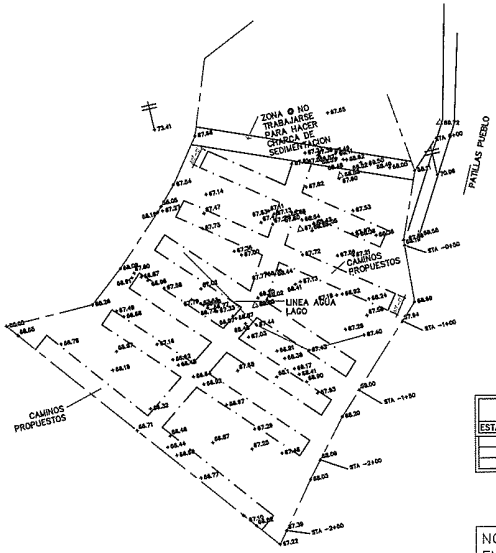
NOVIEMBRE/2009

LOCALIZACIÓN

COORDENADAS
ESTE: 197,123.5000
NORTE: 22,355.0000

NORTE
ESCALA: 1:20,000

C:\Documents and Settings\Hector\Desktop\R180564_MARIN.bmp



ESTACIONES DE CONTROL				
ESTACION	(Y) NORTE	(X) ESTE	ELEVACION	DESCRIPCION
1	21754.0355	197154.5815	69.72	STA. 1 TORNILLO
2	21875.1774	197172.2524	70.61	STA. 2 TORNILLO
3	21679.6374	197140.6893	69.55	STA. 3 TORNILLO

NOTA: LAS ELEVACIONES ESTAN EXPRESADAS EN METROS(MSL).

NOTA:

LOS CAMINOS PROPUESTOS SE CONSTRUIRAN EN PIEDRA DE GABION DE 1"@6" Y SE REMOVERAN DESPUES DE FINALIZAR EL TRABAJO

DEVELOPER NAME

REVISIONS	SYMBOL	DATE	BY

PLANO: PROYECTO DE LIMPIEZA
RIO MARIN, CARRETERA ESTATAL # 181, KM.4.4
PATILLAS PUERTO RICO

STAMP

CERTIFICO CORRECTO
WILLIAM GONZALEZ MARTINEZ
ING. CIVIL LIC. NUM. 8124

Project:
Drawing by: H. LARA
Revised by:

1 of 1

PLAN
ESCALA: 1:1,000
MARZO/2010