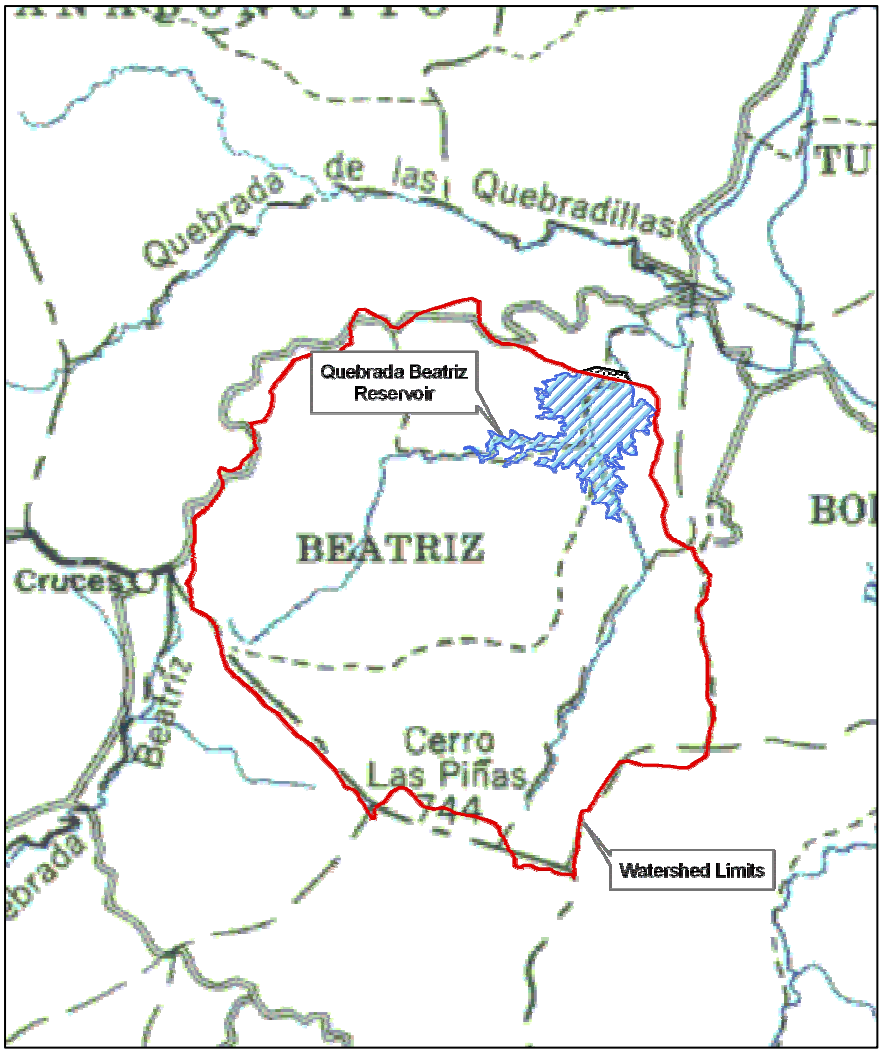
Nota al Lector:

Posterior a la emisión del presente estudio (**Estudio Hidrológico-Hidráulico, Quebrada Beatriz**) se modificó el Plano Conceptual del Proyecto Embalse Beatriz (el Proyecto). El Proyecto según redefinido propone la construcción de una nueva planta de filtración en vez de la ampliación de la planta de filtración Caguas Sur y define las áreas de disposición de sedimentos y área de amortiguamiento de la cortina de la represa. Estas áreas en conjunto ocupan aproximadamente 70 cuerdas adicionales al área de estudio original, las cuales fueron estudiadas separadamente. Además incluye dos alternativas de acceso a la nueva planta de filtración, actualmente en evaluación. Sin embargo, estas modificaciones no alteran los resultados del presente estudio.

Hydrologic and Hydraulic Design
For Beatriz Dam Spillway
Caguas, Puerto Rico



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Abbreviations

AFI	Puerto Rico Infrastructure Finance Administration
CoE	Corps of Engineers
ha	hectarea (10,000 m^2)
in	inch
km	kilometer (1,000 meters, 3,281 feet, 0.62 miles)
mm	millimeter (0.001 meters)
m	meter (3.28 feet)
m2	square meter (10.76 ft2)
m3	cubic meter (35.3 ft3)
mi	mile
NRCS	Natural Resources Conservation Service
PMF	Probable Maximum Precipitation
PMP	Probable Maximum Flood
PRASA	Puerto Rico Aqueduct & Sewer Authority
TP-42	U.S. Weather Bureau Technical Paper #42
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey

Hydrology and Hydraulic Design for Beatriz Dam Spillway

1. INTRODUCTION

1.1. Project Description and Location

The Quebrada Beatriz Off-stream Reservoir will be located in the municipality of Caguas on a site which lies to the East (upstream) of PR-52 (see figure **Figure 1**). The spillway will be located on the abutment to the dam, and will discharge into Qbda. Beatriz below the dam.

1.2. Scope and Purpose of Report

The procedures for developing the hydraulic design parameters for the spillway at the Quebrada Beatriz off-stream reservoir are described in this report.

This information may be used as the basis for sizing the spillway crest and establishing the flood pool elevation. The design of the chute below the weir crest should be subjected to more detailed analysis including physical modeling.

1.3. Limitations

The spillway envisions use of a labyrinth weir and super-critical chute terminating in a USBR Type-II stilling basin. Physical modeling is recommended to finalize and optimize the hydraulic geometry of this structure, since a stepped or non-conventional baffled chute is expected to be more cost-effective.

1.4. Authorization

This report was authorized by the Puerto Rico Infrastructure Finance Authority (AFI) by contract with Gregory L. Morris Engineering.

2. STUDY AREA DESCRIPTION

2.1. Topography and Water Bodies

The Beatriz reservoir has a tributary watershed of 1,141 ha with elevations ranging from 120 to 740 m. The normal pool elevation of the reservoir is anticipated at 152 to 153 m. Qbda. Beatriz has a single well-defined channel with floodplain areas used for cattle grazing plus several abandoned agricultural buildings below the dam. In some areas the stream channel is lined with bamboo. The bed is composed of sands, gravels and cobbles. Point bars typically consist of sand and gravels, while riffles contain gravel and cobbles. There are bedrock outcrops in some locations where the stream runs along the edge of its alluvial valley. In the area of the dam the valley floor has a slope of approximately 0.004 m/m. In the vicinity of the dam the stream is classified C3 by the Rosgen system. Qbda. Beatriz discharges to Río Turabo approximately 2.2 km downstream of the proposed dam site. There are no other water bodies in the area.

2.2. Prior Studies and Floodplain Mapping

Figure 2 shows the flood zone within the project site and surrounding areas on a digitized version of the FEMA Flood Insurance Rate Map (FIRM), panels 72000C1215H, 72000C1220H, 72000C1205H and 72000C1210H with an effective date of April 19, 2005. As shown in this figure the project site is classified as Zone X. This zone indicates areas determined to be outside 500-year floodplain of studied streams. There are no prior studies of hydrology in the area above the damsite, other than the planning-level study undertaken prior to this analysis. There is no atlas of historical flooding along Qbda. Beatriz.

2.3. Field Data

Topographic data for the reservoir stage-area relationship was based on photogrammetric mapping with a 1 m contour interval, prepared for this project.

3. STUDY APPROACH & METHODOLOGY

3.1. System Configuration

The system to be analyzed consists of a watershed and reservoir tributary to a spillway structure. This study analyzes the trade-off between spillway size and flood freeboard in the reservoir. The greater the flood freeboard the greater the flood storage volume and the smaller the spillway. However, volume dedicated to flood freeboard is not available for water supply storage.

The use of both conventional gates and fuse gates was not considered at this site because it was desired to eliminate the operational and maintenance complications which conventional gates represent, and the rapidly-rising below-dam hydrographs which can result from fuse gate operation. Also at this site it was found that adequate water storage volume could be provided without the use of gates.

A generalized plan view of the spillway layout is presented in **Figure 3**. The spillway has been located on the left side of the dam (looking downstream) to allow a straight spillway chute to be used and to intercept the stream roughly parallel to its existing flow direction.

Based on an anticipated spillway discharge in the vicinity of 600 m^3/s (21,200 cfs) for the PMF event, several types of spillway arrangements were considered. In considering the alternative arrangements it was decided to construct the entire spillway structure over native abutment material and not on the fill embankment itself, an arrangement preferred from the standpoint of dam safety. An initial geometric assessment of the site and spillway options indicated this would be feasible.

- A <u>baffled chute spillway</u> of the USBR design type was considered because it would eliminate the need for a downstream stilling basin, since it dissipates energy along the entire spillway length and delivers water to the base of the dam at a relatively low velocity. However, this type of structure has a specific discharge capacity limited to 5.6 m^3/s per meter of chute width (60 cfs/ft). This would result a spillway over 100 m wide which would be costly to build and difficult to accommodate on the site.

An alternative baffled chute configuration was model tested for the Libby Reregulating reservoir, and reportedly can handle specific discharges an order-of-magnitude greater than the USBR design (U.S. Army, 1990). Physical model testing would be required to use this design and therefore it was not included in this analysis. It may be considered as an option at the design stage.

- A stepped spillway was considered but the slope along the proposed spillway alignment is unusually low for a stepped spillway and energy dissipation cannot be accurately predicted from existing design equations. This non-standard configuration would require physical model testing, and may be considered as an option at the design stage.

- A super-critical spillway chute was selected for analysis at this site, which would be followed by a downstream stilling basin, both sized per USBR standards. This configuration was selected because design tables are available. A less costly alternative may be developed through physical modeling.

Several alternatives were considered for the spillway crest which represents the point of hydraulic control for discharge from the reservoir. In considering crest alternatives it was desired to limit the flood surcharge during the PMF event to around 3 m to maximize water supply storage volume below the spillway crest.

A linear spillway crest would produce a crest length on the order of 100 m, which would be both high cost and would also be difficult to accommodate on the site except as a structure on the embankment itself, which was not desirable. It was discarded for this reason.

The optimal spillway at this site was considered to be a labyrinth weir crest design. This configuration produces a high specific discharge and allows better matching of spillway crest width to the downstream chute width.

3.2. Hydrology

Hydrologic modeling was used to simulate 24-hour storm hydrographs from the watershed tributary to the dam for the 2-year, 100-year and full PMP rainfall events. The Probable Maximum Precipitation (PMP) with antecedent moisture condition II (AMC-II) has been used to simulate the Probable Maximum Flood (PMF). The resulting peak rainfalls and discharges were compared to data from Weather Bureau and USGS

gage stations throughout Puerto Rico to insure that the largest probable events had been simulated.

3.3. Hydraulics

To select the desired spillway crest configuration the ICPR unsteady-flow model was used to simulate the behavior of alternative weir crest configurations for different 24-hour storms starting from a reservoir-full condition. The configuration of the chute below the labyrinth spillway was determined by HEC-RAS modeling. The stilling basin configuration was selected based on Bureau of Reclamation guidelines (USBR, 1984).

Peak discharges for the stream without the reservoir and for the proposed condition were compared to document the flood detention effect of the reservoir. Significant flood detention benefit occurs at all discharges as a consequence of temporary storage within the reservoir pool, even though the reservoir is not designed to produce flood mitigation benefits.

The project has been designed with a single spillway. Because large flows along Q. Beatriz are episodic and inflow from Río Turabo is controlled at the river weir, it is anticipated that the spillway will normally not experience overflow.

4. HYDROLOGY

4.1. Watershed

The limits for the 1,141 ha (2,820 acre) watershed tributary to the dam were delimited from the USGS topographic quadrangle for Caguas (**Figure 1**). Land use in the watershed is mostly forested with steep slopes and very limited road access. Although the watershed is crossed by the PR-52 expressway, there are no exits from this highway that provides access, and PR-1 highway only passes through the corner of the watershed near the dam. These factors limit the urban development potential within the watershed.

4.2. Rainfall

4.2.1 Rainfall Depths

Rainfall depths used in the simulation are summarized in **Table 1**, as obtained from Weather Bureau Technical Paper #42 (U.S. Dept. of Commerce, 1961) for the PMP event and from the US Department of Commerce (2006) in NOAA Atlas 14 for the 100-yr and 2-yr events. The PMP rainfall is reported in TP-42 for only three durations, and was not updated in the NOAA Atlas 14 publication. The PMP and 100-year events were used for sizing the spillway and the 2-year event was used to check the degree of flood attenuation by the reservoir for smaller but more frequent runoff events.

Table 1: Rainfall Depths at Beatriz Reservoir.

Rainfall Event	Duration (hrs)	Depth (mm)	Depth (in)
PMP a/	1	267	10.5
PMP a/	6	762	30
PMP a/	24	1,080	42.50
100-year b/	24	429	16.88
2-year b/	24	134	5.29

a/ TP-42
b/ NOAA Atlas 14

Data on maximum rainfalls recorded in Puerto Rico were also obtained as part of the procedure for development of the PMP storm. These data are presented in **Table 2**.

Table 2: Historical Maximum Point Rainfalls in Puerto Rico Through 2005.

Station	Date	Duration (hours)	Precipitation	
			(inches)	(mm)
Yabucoa	10/11/1973	0.25	2	51
Cayey	1/5/1992	0.5	3.3	84
El Yunque	1/5/1992	1	5.9	150
Cayey	1/5/1992	2	8.4	213
Cayey	1/5/1992	3	11.2	284
Cayey	1/5/1992	6	18.4	467
Cerro Maravilla	10/7/1985	24	24.6	625

Source: U.S. Weather Bureau, San Juan.

4.2.2 Rainfall Timewise Distribution

In addition to selecting the total rainfall depth it was also necessary to determine the manner in which this rainfall is distributed over time, since the timewise distribution of precipitation varies from one storm type to another. The following methodology was used to determine the 24-hour hyetograph (rainfall depth over time).

- 100-yr event. A local timewise distribution was constructed from NOAA Atlas 14 depth-duration curves for the area of the dam.

- 2-yr event. Used the same dimensionless distribution as the 100-year event.

- PMP event. Table 3-5 of TP-42 (U.S. Dept of Commerce, 1961) provides guidelines for the ordering of hourly rainfall increments to develop a hyetograph for a hurricane PMP rainfall event. To use this table it is necessary to determine the anticipated rainfall intensities for different durations, from which the hourly increments can be computed for subsequent ordering by Table 3-5 (TP-42).

  Because PMP rainfall depths are given for only three durations (1, 6 and 24 hours) it is necessary to determine the depths for all other durations. The PMP rainfalls (Table 1) and maximum observed rainfalls in Puerto Rico (Table 2) are plotted in **Figure 4**. From this plot it is apparent that a two-stage curve should be used with a break point at 6 hours. An Intensity-Duration (I-D) equation was fitted to the PMP rainfall having the following form:

for duration $\leq$ 6 hrs

$$Depth(mm) = 255D^{0.61}$$

for duration > 6 hrs

$$Depth(mm) = 255D^{0.2925}$$

where depth is total rainfall depth in mm, and D is rainfall duration in hours. There correspond to the two segments of the line plotted in **Figure 4**.

This equation was used to determine the depth of rainfall for durations of 15-, 30- and 45- minutes and for 1 through 24 hours at hourly increments. These hourly rainfall increments were ordered per TP-42 (Table 3-5) recommendations for a 45" PMP event. The peak hour was ordered in 15-minute intervals by intensity with the following sequence: 3, 1, 2, 4. These computations are summarized in **Table 3**. Given the small size of the Beatriz watershed, with a time of concentration less than one hour, there is no difference between the use of the 40" or 45" PMP distribution at this site.

Table 3: Timewise Rainfall Distribution for PMP Modeling

Time in hours	Order Sequence byTP-42, Table 3-5, 45" PMP	By Depth-D Equation		Cumulative Precip. a/
		Precip. Increment a/	Intensity per hour	
Col (1)	Col (2)	Col (3)	Col (4)	Col (5)
1.00	23	0.013	0.013	0.013
2.00	18	0.015	0.015	0.028
3.00	14	0.018	0.018	0.046
4.00	10	0.023	0.023	0.070
5.00	7	0.031	0.031	0.101
6.00	5	0.076	0.076	0.176
7.00	2	0.117	0.117	0.294
7.25	0.75	0.041	0.164	0.335
7.50	0.25	0.096	0.383	0.431
7.75	0.50	0.050	0.202	0.481
8.00	1.00	0.036	0.144	0.517
9.00	3	0.096	0.096	0.613
10.00	4	0.084	0.084	0.696
11.00	6	0.070	0.070	0.766
12.00	8	0.028	0.028	0.794
13.00	9	0.025	0.025	0.820
14.00	11	0.022	0.022	0.841
15.00	12	0.021	0.021	0.862
16.00	13	0.019	0.019	0.881
17.00	15	0.017	0.017	0.899
18.00	16	0.017	0.017	0.915
19.00	17	0.016	0.016	0.931
20.00	19	0.015	0.015	0.946
21.00	20	0.014	0.014	0.960
22.00	21	0.014	0.014	0.974
23.00	22	0.013	0.013	0.987
24.00	24	0.012	0.012	1.000

a/ Decimal of total 24 hour precipitation

The columns in **Table 3** are described below:

Col (1) Time in hours

Col (2) Sequence given in Table 3-5 of TP-42 for 45" PMP rainfall. In this case, the rainfall from the 23rd most intense hour is used at hour one of the day, the 18th for the second hour, etc.

Col (3) Precipitation increment corresponding to the time period in column 2, expressed as decimal part of the 24-hour rainfall. These are computed by the Intensity-duration equation. For example, the rainfall for the 4th most intense hour of rainfall is computed as the

rain with 5 hours duration less the rain with 4 hours duration, and the order provided in column 2 indicates that it is to be placed chronologically during hour 10 in column 1.

Col (4) Intensity of rainfall (decimal/hour) corresponding the rainfall depths in column 3.

Col (5) Cumulative precipitation over the 24 hour period, expressed in decimal format.

4.3. Soils and Curve Number

The curve number represents the runoff potential of the site. This parameter is estimated based on soil type and land use, and is modified by the antecedent moisture condition of the terrain.

The soil types within the watershed above the reservoir pool level were obtained from the Soil Survey Geographic data base, the most detailed level of soil mapping prepared by the Natural Resources Conservation Service (NRCS) and available in GIS format. A soil survey map of the study area is shown in **Figure 5**. Most soils within the watershed have of moderately high runoff potential.

The NRCS runoff Curve Number (CN) for AMC-II was determined for each soil type-land use combination within the watershed following the procedures in TR-55 (NRCS, 1986). **Table 4** summarizes curve number computations for the watershed. The reservoir pool area (below elevation 152) is accounted for in the modeling as "Directly Connected Impervious Area" and therefore does not appear in curve number computations.

Table 4: Curve Number (CN) Determination for Existing Land Use, AMC-III.

Soil Type	Soil Hydrologic Group	Cover Description	Curve Number	Area (acres)
AaC	B	Bushes and Grassland	56	1.99
AaC	B	Rural Low Density	65	1.40
CaE	D	Bushes and Grassland	77	6.89
CaE	D	Rural Low Density	83	1.53
CaE	D	Rural Medium Density	68	1.71
CuF	B	Bushes and Grassland	56	662.5
CuF	B	Dense Woodland Medium Height and Small Canopy	55	50.4
CuF	B	Pastureland	69	51.6
CuF	B	Primary Road (3 + Lanes)	98	23.8
CuF	B	Rural Low Density	65	72.2
CuF	B	Rural Medium Density	68	0.02
CuF	B	Woodland Low Density	66	0.12
Es	B	Pastureland	69	0.04
Hte	C	Bushes and Grassland	70	154.8
Hte	C	Horticulture	85	5.87
Hte	C	Pastureland	79	61.1
Hte	C	Primary Road (3 + Lanes)	98	7.62
Hte	C	Rural High Density	80	10.09
Hte	C	Rural Low Density	77	40.44
Hte	C	Rural Medium Density	79	19.33
Hte	C	Woodland Low Density	77	1.32
HtF	C	Bushes and Grassland	70	174.8
HtF	C	Dense Woodland Medium Height and Small Canopy	70	1.55
HtF	C	Horticulture	85	2.54
HtF	C	Rural Low Density	77	5.35

Soil Type	Soil Hydrologic Group	Cover Description	Curve Number	Area (acres)
HtF	C	Rural Medium Density	79	10.65
HuF	D	Bushes and Grassland	77	64.30
HuF	D	Pastureland	84	0.05
HuF	D	Primary Road (3 + Lanes)	98	5.36
LsE	C	Bushes and Grassland	70	57.07
LsE	C	Dense Woodland Medium Height and Small Canopy	70	3.97
LsE	C	Horticulture	85	1.15
LsE	C	Rural Low Density	77	4.66
LsE	C	Rural Medium Density	79	14.61
LsF	C	Bushes and Grassland	70	45.10
LsF	C	Dense Woodland Medium Height and Small Canopy	70	2.28
LsF	C	Horticulture	85	0.70
LsF	C	Rural Low Density	77	1.01
MxE	D	Bushes and Grassland	77	1.00
MxE	D	Rural Low Density	83	3.09
MxE	D	Rural Medium Density	84	1.00
MxF	D	Bushes and Grassland	77	79.57
MxF	D	Pastureland	84	1.48
MxF	D	Primary Road (3 + Lanes)	98	10.65
MxF	D	Rural Low Density	83	3.76
MxF	D	Rural Medium Density	84	0.02
MxF	D	Urban Under Construction	94	1.60
NaF2	C	Bushes and Grassland	70	530.4
NaF2	C	Pastureland	79	330.3
NaF2	C	Primary Road (3 + Lanes)	98	20.13
NaF2	C	Rural High Density	80	1.42

Soil Type	Soil Hydrologic Group	Cover Description	Curve Number	Area (acres)
NaF2	C	Rural Low Density	77	15.29
NaF2	C	Rural Medium Density	79	21.39
NaF2	C	Urban Under Construction	91	0.04
NaF2	C	Woodland Low Density	77	7.68
RoC2	D	Bushes and Grassland	77	1.02
To	B	Pastureland	69	1.39
Uv	D	Rural Low Density	83	1.18
		Weighted CN:	**70**	

4.4. Time of Concentration

Time of concentration is the time required for rainfall at the hydraulically most-distant point in the watershed to influence discharge at the point of analysis. It was determined based on the following equations and the computations are summarized in **Table 5**.

Sheet flow for the first 91 m (300 feet) was determined by the Manning kinematic flow equation, per TR-55 (NRCS, 1986):

$$T_C = \frac{0.007(n * L)^{0.8}}{P_2^{\,0.5} S^{0.4}}$$

where Tc = time of concentration in hours; n = Manning's roughness using a value of 0.15 per TR-55; P_2 = 2-year precipitation depth in inches; and S = dimensionless slope.

The subsequent reach was computed by the shallow concentrated flow equation, also per TR-55:

$$V = \left(\frac{S}{0.0039}\right)^{0.5}$$

Where V = velocity, ft/s; and S = dimensionless slope.

Thereafter flow velocities were determined by the Manning equation:

$$V = \frac{1}{nR^{(2/3)}S^{(1/2)}}$$

Where V = velocity, m/s; n = Manning's roughness; R = hydraulic radius, which is approximated by the mean flow depth; and S = dimensionless slope.

Hydraulic roughness values were adjusted to limit flow to the sub-critical regime, since the irregularities in natural channels are not conducive to the development of super-critical flow. Flow depths were estimated. Froude numbers were maintained generally in the range of 0.8 to 0.9.

Table 5: Summary Time of Concentration Computations.

	Segment	Length (m)	U/S Elev (m)	D/S Elev (m)	Slope	2-yr Precip (in)	n-value	Avg. Flow Depth (m)	Vel (m/s)	Froude No	Tc (min)	Tc (hrs)
1	Sheet Flow (L<300 ft)	91	670	630	0.440	5	0.400	---	0.13	---	11.97	0.20
2	Shallow Conc. Flow	138	630	570	0.435	---	---	---	3.2	---	0.71	
3	Channel Flow (Manning)	1731	570	220	0.202	---	0.160	1.2	3.2	0.93	9.09	0.15
4	Channel Flow (Manning)	1584	220	150	0.044	---	0.090	2.0	3.7	0.84	7.12	0.12
5	Channel Flow (Manning)	1785	150	120	0.017	---	0.055	2.5	4.3	0.88	6.85	0.11
	Total Distance	5,329								**Total Time of Conc.**	**35.75**	**0.58**

4.5. Results of Hydrologic Analysis

Input and summary output files for the hydrologic simulation are presented in **Appendix A**. Simulation results in **Table 6** show the discharge for the watershed tributary to the dam site.

Table 6: Peak Discharges Entering Reservoir for the Studied Events.

Storm Event	Existing Condition Discharge		Specific Discharge	
	(m^3/s)	(ft^3/s)	($m^3/s/km^2$)	($ft^3/s/mi^2$)
2 - year	105	3,700	9.2	840
100 - year	373	13,170	32.7	2,990
PMP rainfall, PMF flood	848	29,960	74.0	6,801

4.6. Model Verification

Peak discharges registered at 146 USGS stream gage stations throughout Puerto Rico are plotted as a function of watershed area in **Figure 6**. These data have been compiled from USGS gage station records, for stations having records from 1 to 57 years in duration. The flood events computed by the hydrologic analysis are also plotted in **Figure 6**.

There is one outlier streamflow event recorded by the USGS that may be classified as a PMF event, the event of September 21, 1998 (hurricane Georges) Río Grande de Loíza at Quebrada Arenas which generated a peak discharge of 1,275 m^3/s from a 15.5 km^2 watershed (45,000 cfs from a 6.0 mi^2 watershed, equivalent to 7,500 cfs/mi^2). The PMF computed for the watershed tributary to Beatriz reservoir (and without attenuation by the lake) produces a peak specific discharge of 74 $m^3/s/km^2$ (6,800 cfs/mi^2). This falls into the same specific discharge range as the Qbda. Arenas event.

Several regional PMF equations have been used in Puerto Rico in the past, as summarized in Table 4-1 of Black & Veatch (1999) and reproduced below:

Black & Veatch/ Corps of Engineers, Islandwide Study	$12{,}000\ A^{0.5}$
Buck Seifert & Jost	$15{,}000\ A^{0.5}$
Black & Veatch (1999)	$18{,}000\ A^{0.5}$

We evaluated all of these equations against the historical USGS dataset given in **Figure 6**, and they all tended to produce extremely high PMF discharges for small watershed areas, but discharges no greater than historical events for the larger watersheds. This is a questionable result. Therefore, as an alternative we present in **Figure 6** the following PMF equation, which is more consistent with island data that the previous equations:

$$Q = 12{,}000\ A^{0.7}$$

Based on this comparison the peak discharges computed by the hydrologic analysis are considered consistent with extreme discharges characteristic of Puerto Rico.

5. HYDRAULIC ANALYSIS

5.1. Models Prepared

An ICPR hydraulic model was prepared to simulate the inflow of runoff into the reservoir, routing of the inflow to the dam, and discharge over a labyrinth spillway. The spillway hydraulics were based on Falvey (2003) and the design equations presented by Tullis et. al. (1995). This model was used to simulate reservoir water levels and spillway discharges for all events. The reservoir is assumed full at the beginning of each simulation. Performance of the spillway downstream of the labyrinth weir was analyzed by HEC-RAS modeling.

5.2. Layout of the Hydraulic System

The hydraulic system is based on proposed design conditions, and the configuration of the spillway crest and chute are based on a preliminary civil layout of the project. Field survey data for river cross-sections were not available at this design stage.

This report does not provide definitive analysis of the spillway chute downstream of the weir, and a more detailed analysis of chute configuration, energy dissipation, and tie into the Quebrada beatriz channel are required, based on detailed field data.

An n-value of 0.013 was used for concrete structures.

5.3. Results of Spillway Crest Simulations

The spillway configuration definition sketch is presented in **Figure 7**. Hydraulic design parameters for alternative labyrinth spillway configurations are presented in **Appendix B**, from which a stage-discharge rating curve was developed for use in the ICPR model. Alternative spillway configurations may be used, and a final configuration should be selected based on physical modeling. Simulation results are summarized in **Table 7** and copies of input and output files are contained in **Appendix C**.

The peak inflow data in **Table 7** are higher than the existing condition (**Table 6**) because the area below 157 m elevation (64.3 ha) will be lake surface and is simulated as a directly connected impervious area in the ICPR model.

Table 7: Summary of Spillway Crest Simulation Results.

Simulation	Peak Inflow (m^3/s)a/	Peak Spillway Discharge (m^3/s)	Max. Water depth over spillway (m)
36 m 3-cycle labyrinth spillway			
2-year	116	42.8	0.43
100-year	393	230	1.33
PMF	882	574	3.02
44 m 4-cycle labyrinth spillway			
2-year	116	53.7	0.34
100-year	393	260	1.03
PMF	882	615	2.38
54 m 5-cycle labyrinth spillway			
2-year	116	64.3	0.30
100-year	393	282	0.87
PMF	882	655	2.01

a/ Includes rainfall on lake surface.

5.4. Hydraulic Analysis of Spillway Chute

The spillway chute configuration is defined only at a schematic level and is based on the 36 m wide labyrinth spillway. As a conventional design a super-critical chute could be designed with a USBR Type II stilling basin, with a 36 m width. This configuration has been selected as the baseline design. Other less-costly alternatives should exist using either a steeped spillway or chute blocks designed for high specific discharge. The objective is to dissipate as much energy as possible, eliminating high velocities and a stilling basin at the downstream end. Physical modeling is recommended to analyze these non-conventional alternatives.

The overall configuration of the spillway chute for the base line condition was selected with guidance from Khatsuria (2005), Peterka (1978) and U.S. Army (1995).

The selected spillway chute configuration is a super-critical channel which was analyzed by HEC-RAS. The HEC-RAS model starts at the downstream limit of the labyrinth weir, runs downstream along the spillway chute, and ends at the downstream limit of the stilling basin. This hydraulic model is presented in **Appendix D**.

There is a 29.5 ha (73 acre) watershed which drains across the axis of the spillway chute. Preliminary computations indicate a PMP discharge on the order of 31 m^3/s. A 96″ dia. culvert should be adequate to discharge the PMP flow from the drainage beneath the spillway chute, indicating that it should not represent a significant infrastructure conflict. Sizing of this culvert is not within the scope of this analysis and should be considered in the design stage.

5.5. Stilling Basin Configuration

A USBR Type-II stilling basin was configured based on USBR guidelines (Peterka, 1978). This stilling basin is included in the HEC-RAS model, but its geometry was based on USBR guidelines (which are based on physical model studies) and not on the results of numerical modeling. According to the USBR guidelines the length of the stilling basin should be 32 m.

5.6. Flood Detention Impacts of the Project

Peak flows at the damsite for the existing condition are compared to the peak post-project discharge below the dam (spillway discharge) in **Table 8.** These data show that the project has a significant flood-reduction impact along Quebrada Beatriz.

Table 8: Reservoir and Spillway Impacts on Peak Discharges.

Return Interval	Existing Inflow to Dam, m^3/s	Proposed Discharge at Dam, m^3/s	Reduction of Peak, %
2-yrs	105	42.8	59
100-yrs	373	230	38
PMF	848	574	32

6. REFERENCES

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FIGURES

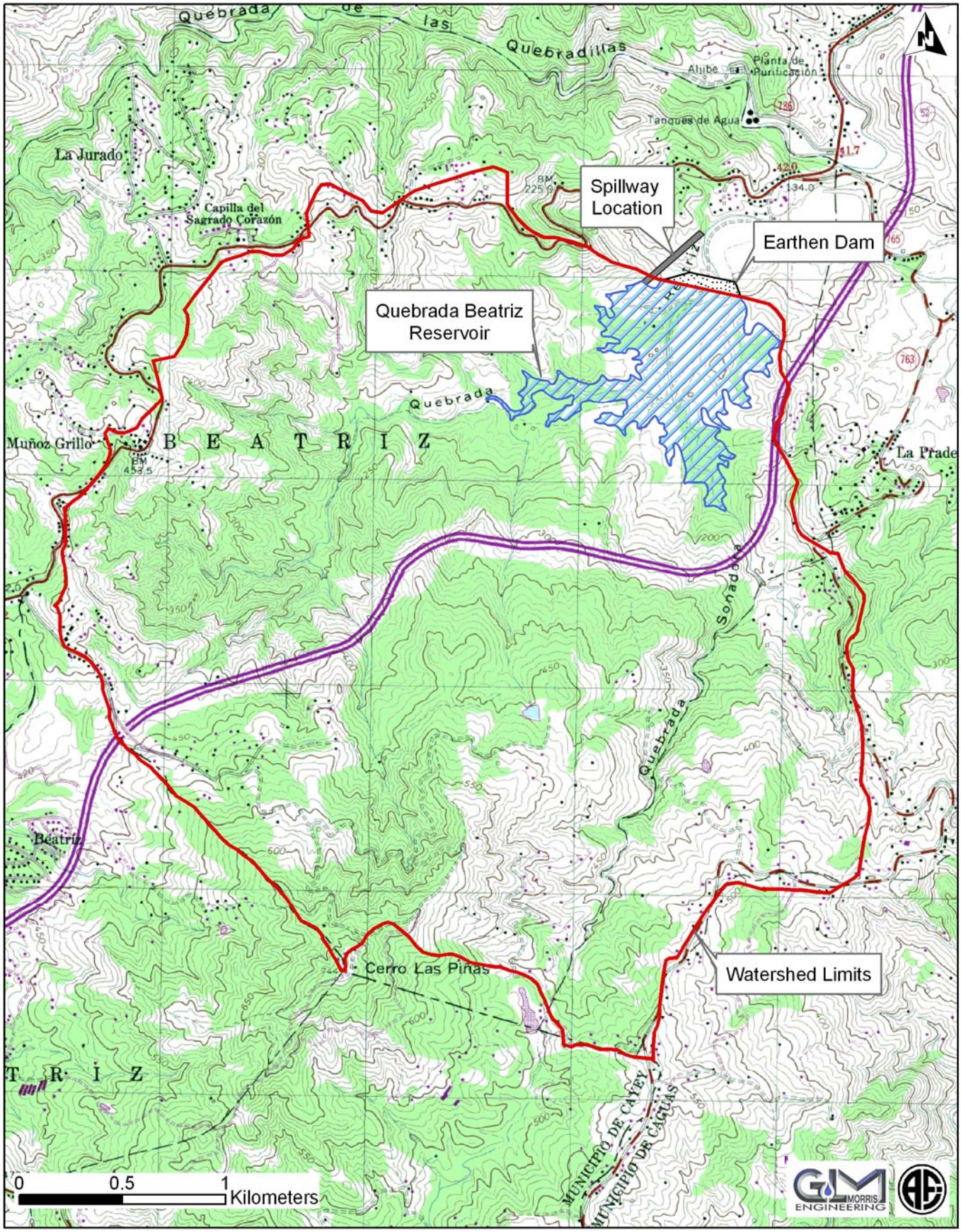


Figure 1: Site location and watershed limits map in USGS Topographic Quadrangle for Caguas.

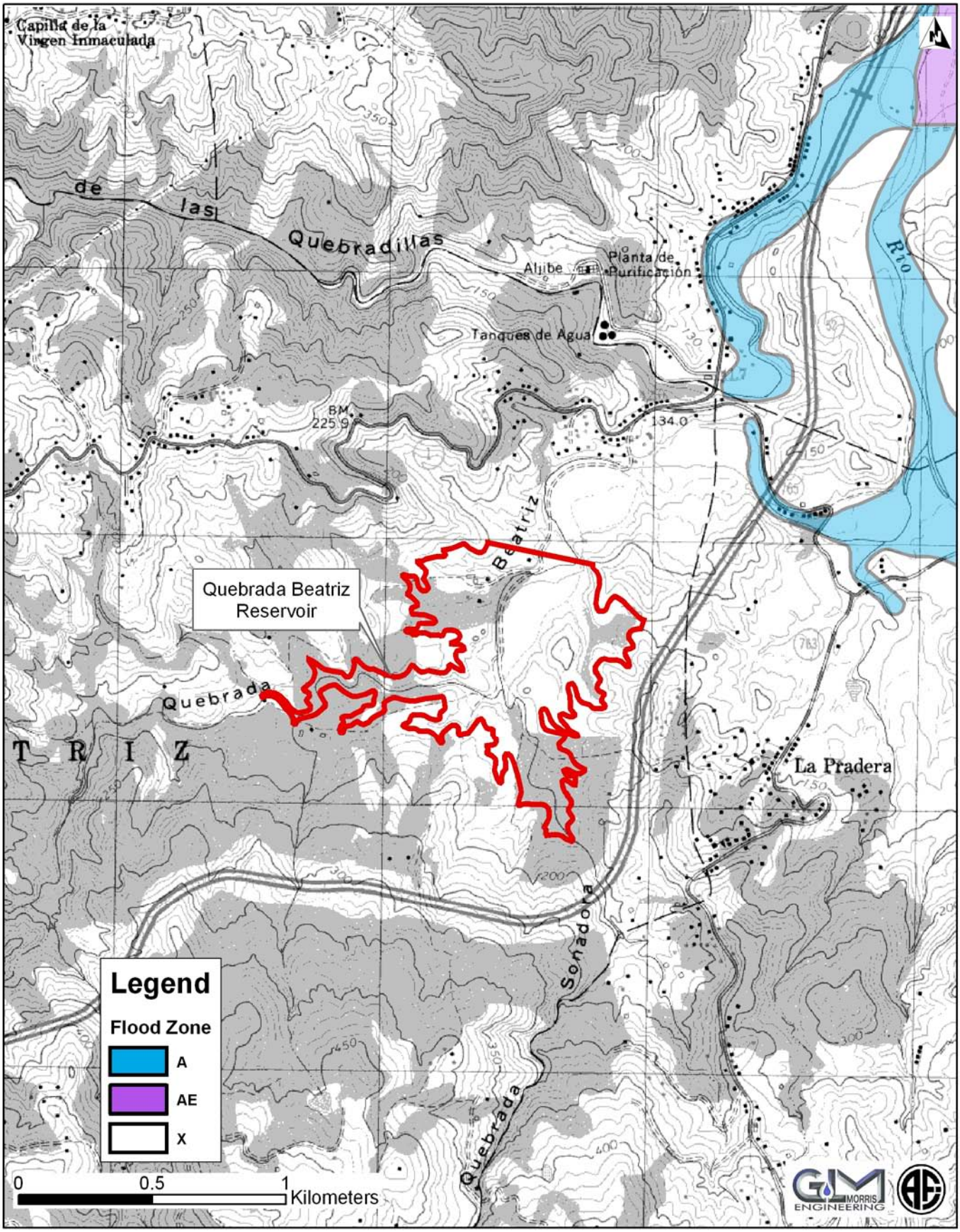


Figure 2: FEMA FIRM Map, panel 1215H, 1220H, 1205H, and 1210H, dated April 19, 2005.

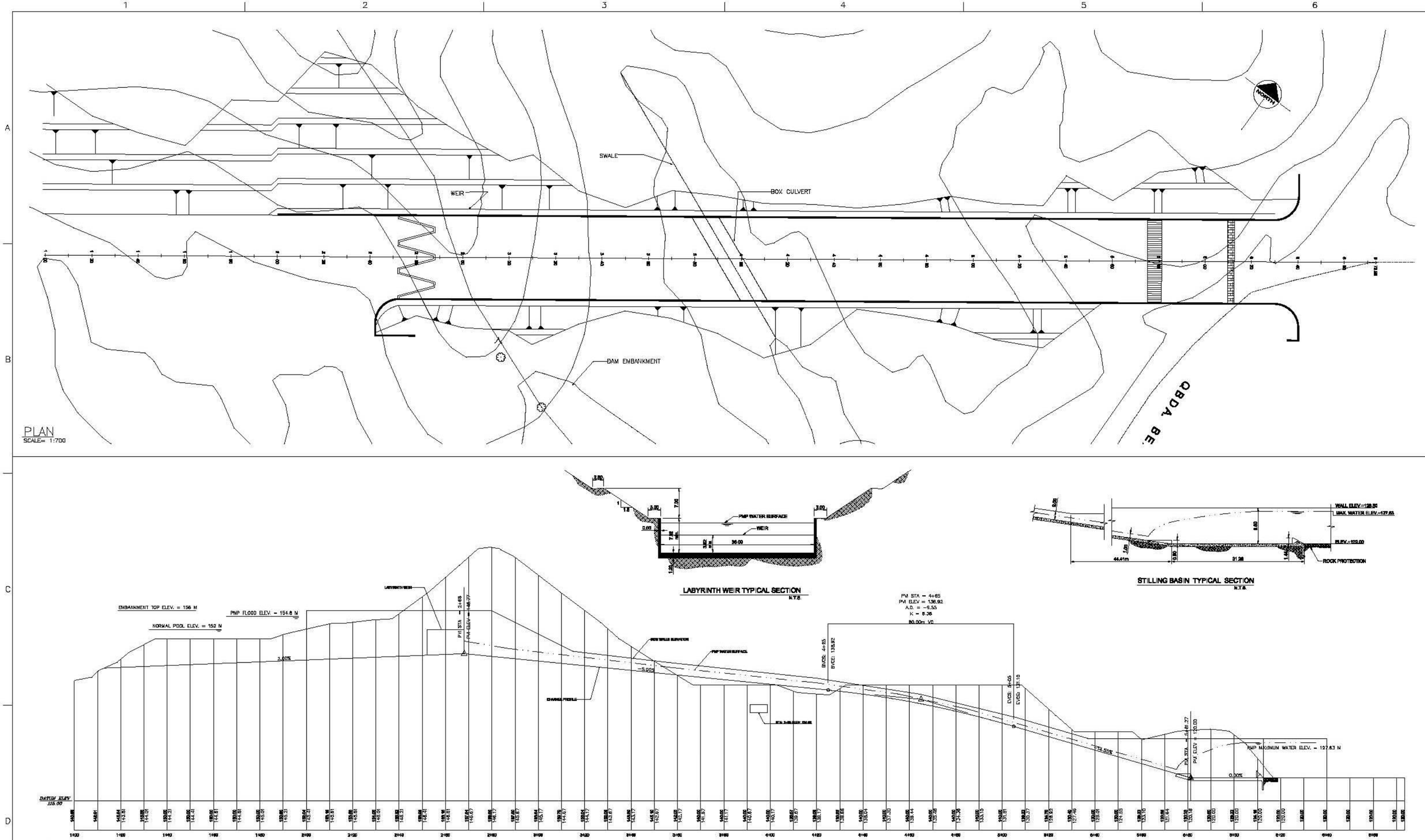


Figure 3: Conceptual plan view and profile of Beatriz spillway layout.

FILE:				
DR: R. ROSA				
CHK: R. ROSA				
APVD:	NO.	DATE	REVISION	BY	APVD

SCALE VERIFICATION
BAR IS TWO CM ON ORIGINAL DRAWING.
0 2CM
IF NOT TWO CM ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

GM MORRIS ENGINEERING

- HYDROLOGY
- HYDRAULICS
- ENVIRONMENTAL ENGINEERING
- CIVIL ENGINEERING

BEATRIZ DAM - SPILLWAY AND CHUTE PLAN AND PROFILE

FEASIBILITY LEVEL DESIGN
BEATRIZ RESERVOIR, CAGUAS P.R.

PLAN SCALE= AS SHOWN
UNITS: METERS UNLESS OTHERWISE NOTED

DWG: RS-1 22/28
JOB: BEATRIZ
DATE: JULY-2005
TASK ORDER:

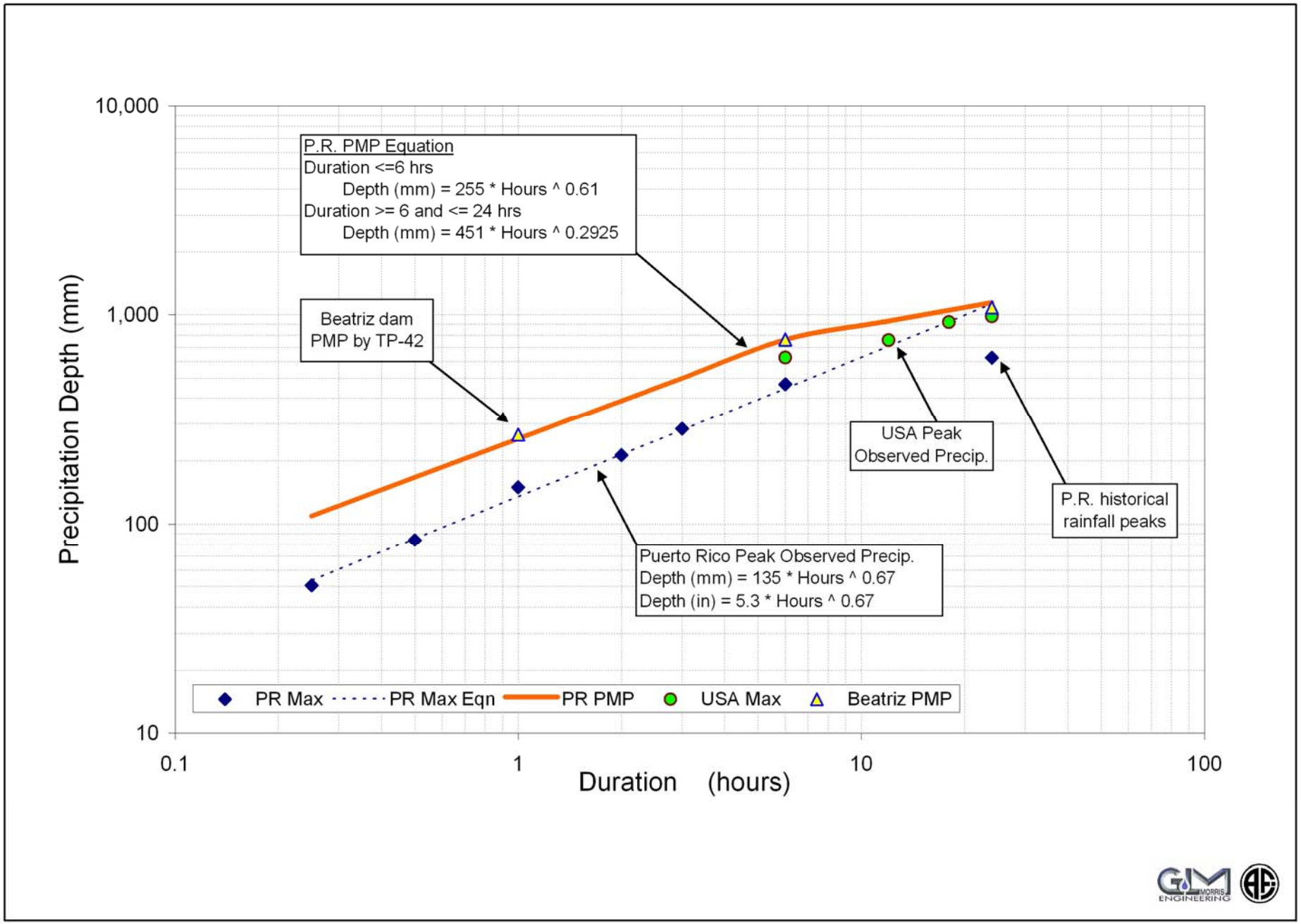


Figure 4: Depth-Duration data and computed relationships for Puerto Rico.

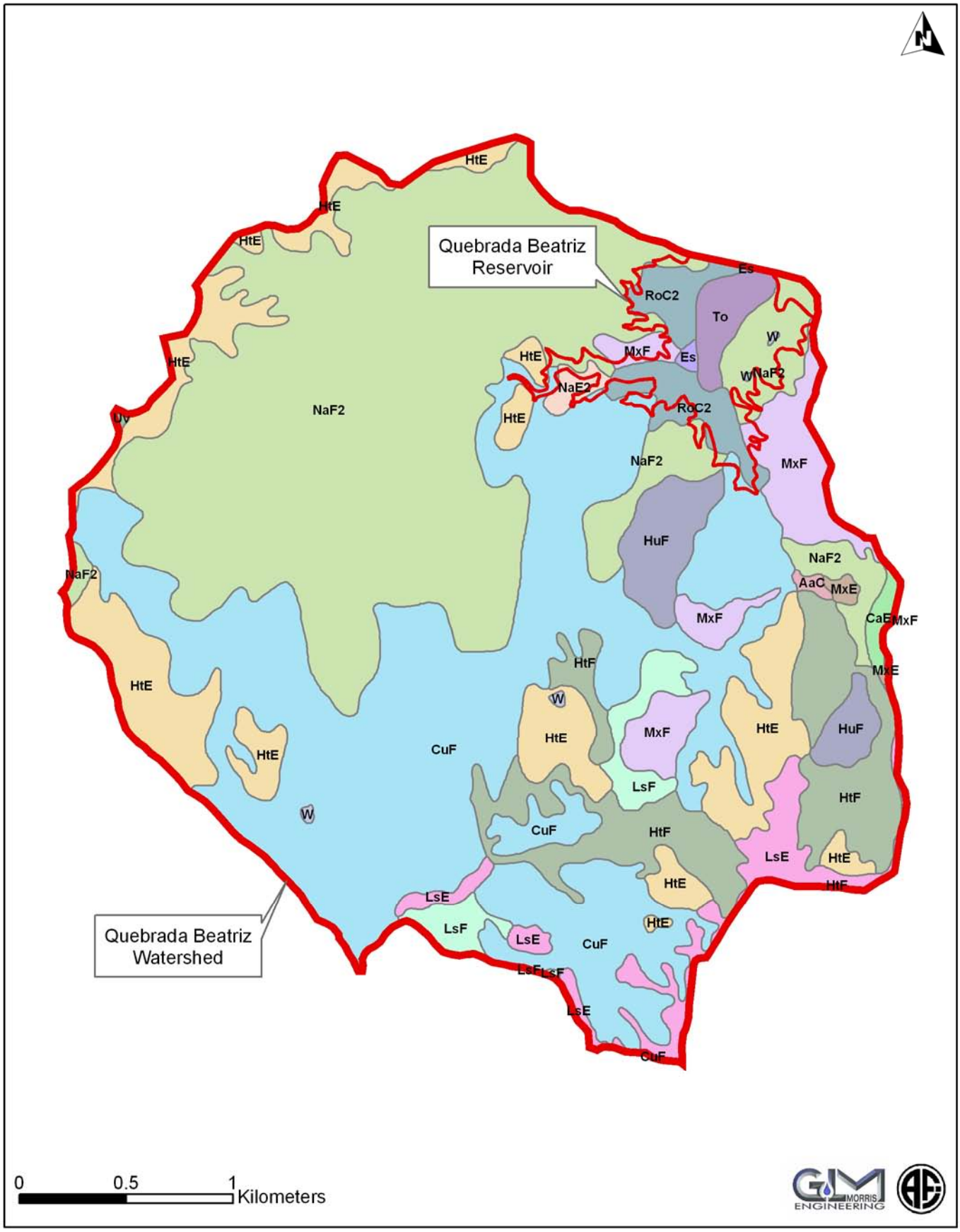


Figure 5: Soils in the watershed tributary to the dam, from Soil Survey Geographic (NRCS-SSURGO) data base of San Juan Area.

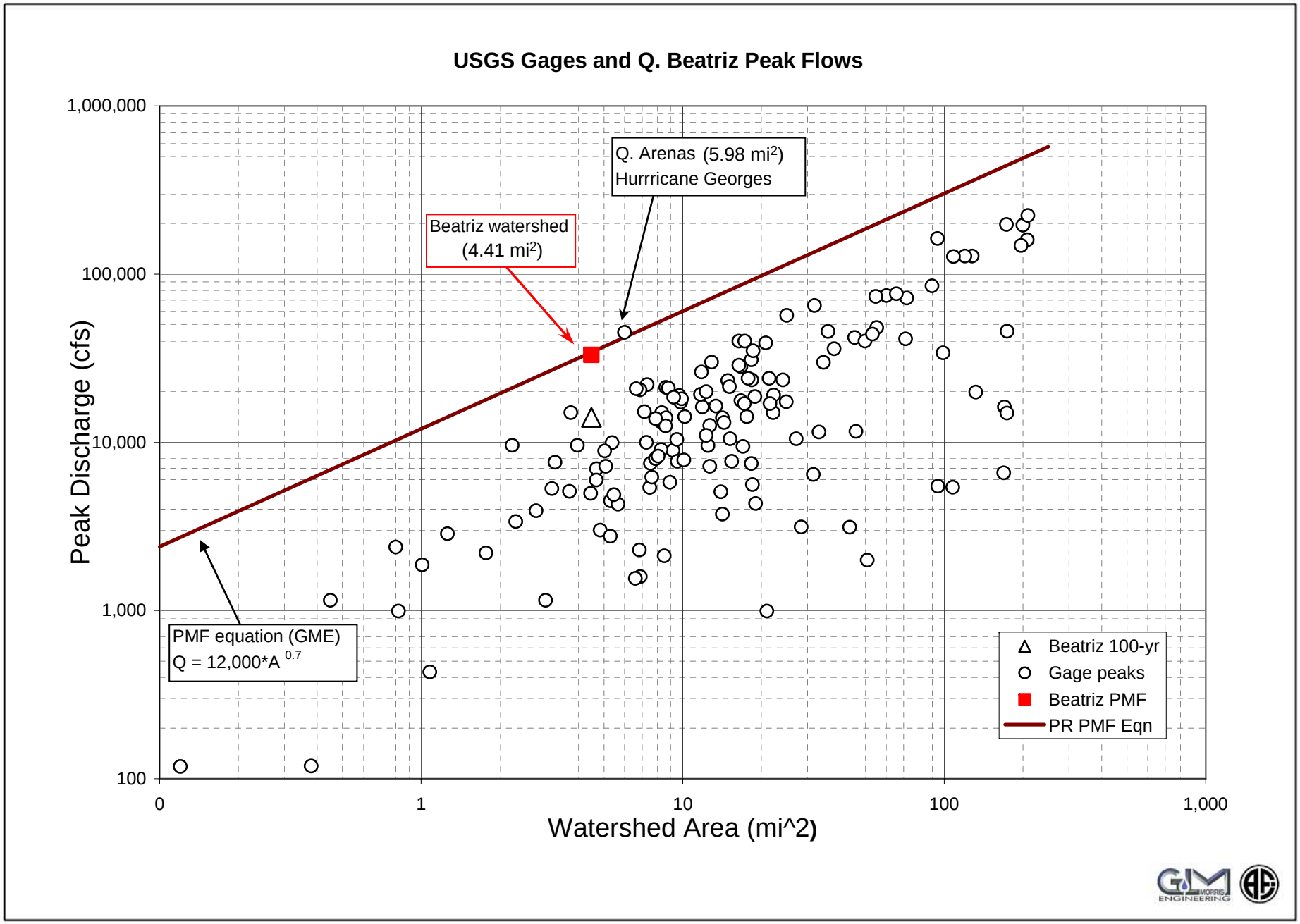


Figure 6: Comparison of predicted discharges at Q. Beatriz dam with USGS historical peak discharges in Puerto Rico.

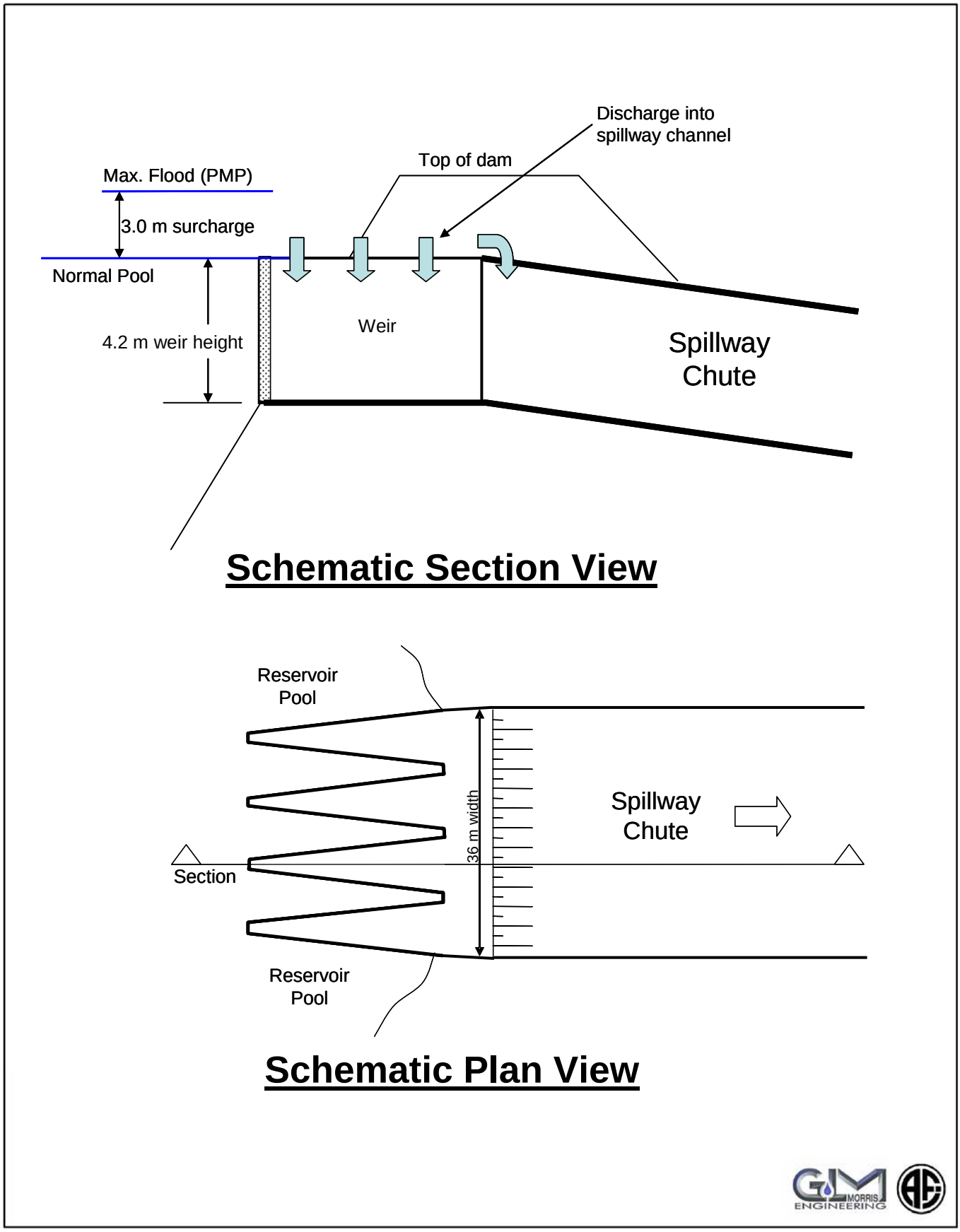


Figure 7: Schematic layout for labyrinth spillway, Beatriz dam. .

APPENDIX A: Hydrologic Modeling Results

APPENDIX A1: Hydrologic Modeling Results: Existing Condition

```
==========================================================================================
==== Basins ==============================================================================
==========================================================================================

         Name: Beatriz                  Node: BoundaryII             Status: Onsite
        Group: AMCII                    Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh484                   Peaking Factor: 484.0
          Rainfall File: 100-yr NOAA 1       Storm Duration(hrs): 24.00
    Rainfall Amount(cm): 42.880                Time of Conc(min): 36.00
               Area(ha): 1141.000                Time Shift(hrs): 0.00
           Curve Number: 70.00             Max Allowable Q(cms): 28316.822
                DCIA(%): 0.00


==========================================================================================
==== Nodes ===============================================================================
==========================================================================================

      Name: BoundaryII          Base Flow(cms): 0.000           Init Stage(m): 120.000
     Group: AMCII                                               Warn Stage(m): 120.000
      Type: Time/Stage




      Time(hrs)        Stage(m)
--------------- ---------------
           0.00         120.000
          24.00         120.000

==========================================================================================
==== Hydrology Simulations ===============================================================
==========================================================================================

         Name: 100 yr
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: No

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           10.00
13.000          1.00
24.000          10.00

-------------------------------------------------------------------------------------------------
         Name: 2 yr
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: 2yr NOAA 1
    Rainfall Amount(cm): 13.44

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           10.00
13.000          1.00
24.000          10.00

-------------------------------------------------------------------------------------------------
         Name: Half-pmp
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: TP 42 Gold
    Rainfall Amount(cm): 57.15

Time(hrs)       Print Inc(min)
--------------- ---------------
```

```
6.000           10.00
13.000          1.00
24.000          10.00

-----------------------------------------------------------------------------------------------
         Name: PMP
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: TP 42 Gold
    Rainfall Amount(cm): 107.95

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           10.00
13.000          1.00
24.000          10.00

==========================================================================================
==== Boundary Conditions ================================================================
==========================================================================================
```

Quebrada Beatriz Existing Condition

Simulation	Basin	Group	Time Max hrs	Flow Max cms	Volume cm	Volume m3
100 yr	Beatriz	AMCII	12.24	372.860	32.071	3659303
2 yr	Beatriz	AMCII	12.32	104.794	5.720	652610
Half-pmp	Beatriz	AMCII	7.76	409.933	45.819	5228004
PMP	Beatriz	AMCII	7.76	848.316	95.764	10926671

APPENDIX A2: Hydrologic Modeling Results: Proposed Condition

Quebrada Beatriz Proposed Condition

Simulation	Basin	Group	Time Max hrs	Flow Max cms	Volume cm	Volume m3
100 yr	Beatriz	AMCII	12.21	393.487	32.579	3717264
2 yr	Beatriz	AMCII	12.28	116.545	6.089	694750
Half-pmp	Beatriz	AMCII	7.73	429.163	46.359	5289530
PMP	Beatriz	AMCII	7.73	883.081	96.333	10991555

APPENDIX B: Hydraulic Design Parameters

Beatriz Reservoir

Labyrinth Weir Design Parameters

Spillway Alternative - Option 1

Parameter	Symbol	Value	Units	Source, equation or notes
		Input Data		
Maximum flow	Q_{max}	581	m^3/s	
Maximum reservoir elevation	res		m	
Approach channel elevation	/		m	
Crest elevation	el		m	
Total Head	H_t	2.8	m	H_t = res-crest-loss
Estimated inlet loss at Q_{max}	Loss	0.13	m	Estimated
Number of cycles	N	3	/	Select to keep w/P ~ 3 to 4
Weir Crest height	P	3.92	m	Computed as P = 1.4H_t
Crest Coefficient	C_d	0.455	/	From weir coefficient calculation sheet
Inside width at apex ratio		2	/	Select between t and 2t (put 1 for t or 2 for 2t)
Angle of side legs	α	15	deg.	Normally 8° to 16°
		Calculated data		
Thickness of wall	t	0.65	m	t = P/6
Inside width at apex	A	1.31	m	
Outside width of apex	D	2.31	m	D = A + 2t * tan (45 - α/2)
Total Head/crest height	Ht/P	0.71	/	
Effective crest length	L	**92.31**	m	$1.5Q_{max}/((C_d*H_t^{1.5})*(2g)^{0.5})$
Length of apron (parallel to flow)	B	16.00	m	B = [L/(2N) + t*tan(45-α/2)]cos(α)+t
Actual length of side leg	L_1	15.89	m	L_1 = (B-t)/cos(α)
Effective length of side leg	L_2	15.38	m	L_2 = L_1 - t*tan (45-α/2)
Total Length of walls	L_3	106.17	m	L_2 = N($2L_1$+D+A)
Distance between cycles	w	11.84	m	w = $2L_1$*sin(α)+A+D
Width of labyrinth (normal to flow)	W	**35.52**	m	W = N * w
Distance between cycles/crest height	w/P	3.02	/	w/P ratio should be ~3 to 4

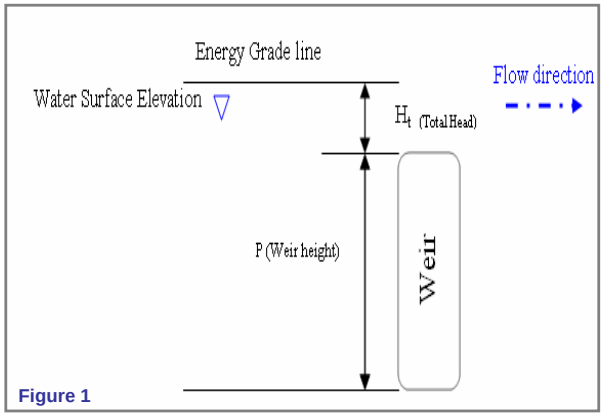


Figure 1

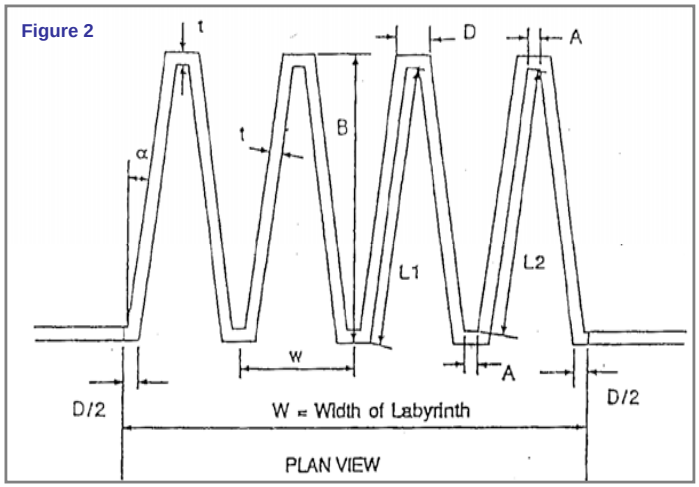


Figure 2

Beatriz Reservoir

Labyrinth Weir Design Parameters

Spillway Alternative - Option 2

Parameter	Symbol	Value	Units	Source, equation or notes
		Input Data		
Maximum flow	Q_{max}	655	m^3/s	
Maximum reservoir elevation	res		m	
Approach channel elevation	/		m	
Crest elevation	el		m	
Total Head	H_t	2.0	m	H_t = res-crest-loss
Estimated inlet loss at Q_{max}	Loss	0.13	m	Estimated
Number of cycles	N	5	/	Select to keep w/P ~ 3 to 4
Weir Crest height	P	2.8	m	Computed as P = 1.4H_t
Crest Coefficient	C_d	0.309	/	From weir coefficient calculation sheet
Inside width at apex ratio		2	/	Select between t and 2t (put 1 for t or 2 for 2t)
Angle of side legs	α	10	deg.	Normally 8° to 16°
		Calculated data		
Thickness of wall	t	0.47	m	t = P/6
Inside width at apex	A	0.93	m	
Outside width of apex	D	1.72	m	D = A + 2t * tan (45 - α/2)
Total Head/crest height	Ht/P	0.71	/	
Effective crest length	L	**253.60**	m	$1.5Q_{max}/((C_d*H_t^{1.5})*(2g)^{0.5})$
Length of apron (parallel to flow)	B	25.83	m	B = [L/(2N) + t*tan(45-α/2)]cos(α)+t
Actual length of side leg	L_1	25.75	m	L_1 = (B-t)/cos(α)
Effective length of side leg	L_2	25.36	m	L_2 = L_1 - t*tan (45-α/2)
Total Length of walls	L_3	270.76	m	L_2 = N($2L_1$+D+A)
Distance between cycles	w	11.59	m	w = $2L_1$*sin(α)+A+D
Width of labyrinth (normal to flow)	W	**57.97**	m	W = N * w
Distance between cycles/crest height	w/P	**4.14**	/	**w/P ratio should be ~3 to 4**

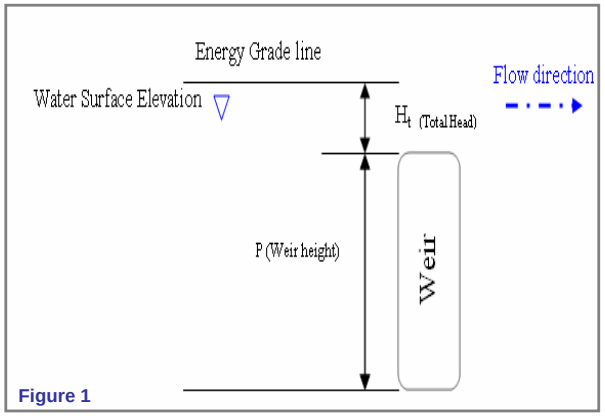


Figure 1

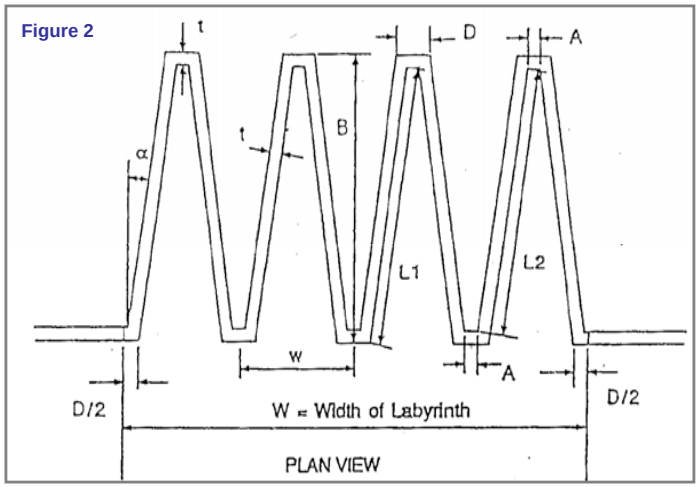


Figure 2

Beatriz Reservoir

Labyrinth Weir Design Parameters

Spillway Alternative - Option 3

Parameter	Symbol	Value	Units	Source, equation or notes
		Input Data		
Maximum flow	Q_{max}	625	m^3/s	
Maximum reservoir elevation	res		m	
Approach channel elevation	/		m	
Crest elevation	el		m	
Total Head	H_t	2.5	m	H_t = res-crest-loss
Estimated inlet loss at Q_{max}	Loss	0.13	m	Estimated
Number of cycles	N	4	/	Select to keep w/P ~ 3 to 4
Weir Crest height	P	3.5	m	Computed as $P = 1.4H_t$
Crest Coefficient	C_d	0.336	/	From weir coefficient calculation sheet
Inside width at apex ratio		2	/	Select between t and 2t (put 1 for t or 2 for 2t)
Angle of side legs	α	11	deg.	Normally 8° to 16°
		Calculated data		
Thickness of wall	t	0.58	m	t = P/6
Inside width at apex	A	1.17	m	
Outside width of apex	D	2.13	m	D = A + 2t * tan (45 - α/2)
Total Head/crest height	Ht/P	0.71	/	
Effective crest length	L	**159.30**	m	$1.5Q_{max}/((C_d*H_t^{1.5})*(2g)^{0.5})$
Length of apron (parallel to flow)	B	20.60	m	B = [L/(2N) + t*tan(45-α/2)]cos(α)+t
Actual length of side leg	L_1	20.39	m	L_1 = (B-t)/cos(α)
Effective length of side leg	L_2	19.91	m	$L_2 = L_1$ - t*tan (45-α/2)
Total Length of walls	L_3	176.33	m	$L_2 = N(2L_1+D+A)$
Distance between cycles	w	11.08	m	$w = 2L_1*\sin(\alpha)+A+D$
Width of labyrinth (normal to flow)	W	**44.31**	m	W = N * w
Distance between cycles/crest height	w/P	3.17	/	w/P ratio should be ~3 to 4

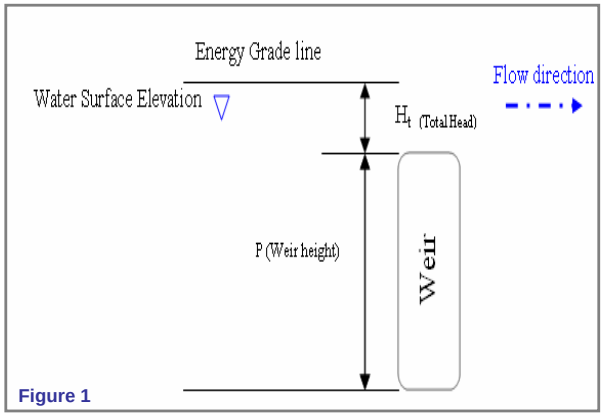


Figure 1

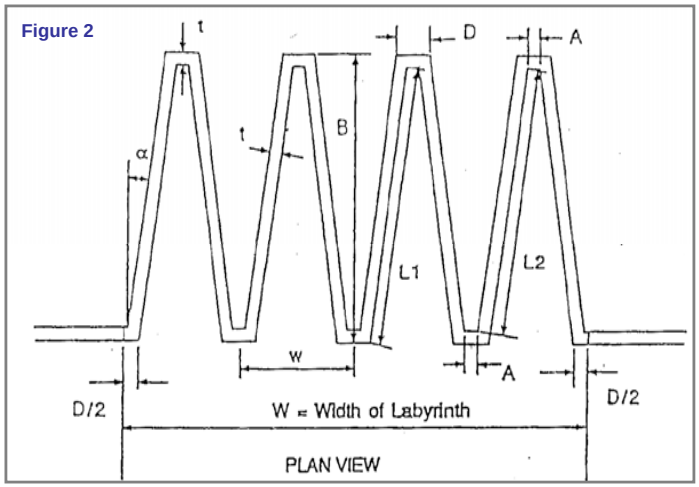


Figure 2

APPENDIX C: Spillway Crest Hydraulic Modeling Results

```
==========================================================================================
==== Basins ==============================================================================
==========================================================================================

         Name: Beatriz                  Node: RepresaII              Status: Onsite
        Group: AMCII                    Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh484                   Peaking Factor: 484.0
          Rainfall File: 100-yr NOAA 1       Storm Duration(hrs): 24.00
    Rainfall Amount(cm): 42.880                Time of Conc(min): 32.50
              Area(ha): 1141.000                Time Shift(hrs): 0.00
           Curve Number: 70.00             Max Allowable Q(cms): 28316.822
                DCIA(%): 5.00


==========================================================================================
==== Nodes ===============================================================================
==========================================================================================

      Name: BoundaryII          Base Flow(cms): 0.000           Init Stage(m): 120.000
     Group: AMCII                                               Warn Stage(m): 120.000
      Type: Time/Stage




      Time(hrs)        Stage(m)
--------------- ---------------
           0.00         120.000
          24.00         120.000

------------------------------------------------------------------------------------------
      Name: RepresaII           Base Flow(cms): 0.000           Init Stage(m): 152.000
     Group: AMCII                                               Warn Stage(m): 155.000
      Type: Stage/Area



       Stage(m)        Area(ha)
--------------- ---------------
        120.000          0.7600
        125.000          6.4000
        130.000         11.6600
        135.000         18.2600
        140.000         24.7300
        145.000         33.8700
        150.000         47.2000
        155.000         62.6000
        160.000         75.4300

==========================================================================================
==== Operating Tables ====================================================================
==========================================================================================

      Name: RatingCurveWeir      Group: AMCII
      Type: Rating Curve
  Function: US Stage vs. Discharge



    US Stage(m)  Discharge(cms)
--------------- ---------------
        152.000            0.00
        152.100            4.42
        152.200           12.96
        152.400           38.53
        152.600           72.43
        152.800          112.10
        153.000          155.30
        153.200          200.20
        153.400          245.06
        153.600          289.48
```

```
        153.800          332.26
        154.000          373.74
        154.200          413.40
        154.400          452.80
        154.600          491.15
        154.800          531.02
        155.000          570.52
        155.100          591.85
        155.200          612.92
        155.300          633.70
        155.400          654.19

==========================================================================================
==== Weirs ===============================================================================
==========================================================================================

         Name: Weir emergency      From Node: RepresaII
        Group: AMCII                 To Node: BoundaryII
         Flow: None                    Count: 1
         Type: Vertical: Mavis      Geometry: Rectangular

                   Span(cm): 6000.00
                   Rise(cm): 900.00
                  Invert(m): 155.000
        Control Elevation(m): 155.000
                                          TABLE
             Bottom Clip(cm): 0.000
                Top Clip(cm): 0.000
         Weir Discharge Coef: 2.600
      Orifice Discharge Coef: 0.600



==========================================================================================
==== Rating Curves =======================================================================
==========================================================================================

         Name: Spill II            From Node: RepresaII               Count: 1
        Group: AMCII                 To Node: BoundaryII               Flow: Both

               TABLE           ELEV ON(m)      ELEV OFF(m)
           #1: RatingCurveWeir 152.000         152.000
           #2:                 0.000           0.000
           #3:                 0.000           0.000
           #4:                 0.000           0.000


==========================================================================================
==== Hydrology Simulations ===============================================================
==========================================================================================

         Name: 100 yr
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: No

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.00
13.000          1.00
24.000          1.00

-----------------------------------------------------------------------------------------------------
         Name: 2 yr
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: 2yr NOAA 1
    Rainfall Amount(cm): 13.44

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.00
```

```
13.000          1.00
24.000          1.00

-----------------------------------------------------------------------------------------------
         Name: Half-pmp
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: TP 42 Gold
    Rainfall Amount(cm): 57.15

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.00
13.000          1.00
24.000          1.00

-----------------------------------------------------------------------------------------------
         Name: PMP
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: TP 42 Gold
    Rainfall Amount(cm): 107.95

Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.00
13.000          1.00
24.000          1.00

===============================================================================================
==== Routing Simulations ======================================================================
===============================================================================================

         Name: 100 yr              Hydrology Sim: 100 yr
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Execute: Yes         Restart: No            Patch: No
  Alternative: No

         Max Delta Z(m): 0.50                     Delta Z Factor: 0.00500
    Time Step Optimizer: 0.000
        Start Time(hrs): 0.000                     End Time(hrs): 24.00
     Min Calc Time(sec): 1.0000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:


Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.000
13.000          1.000
24.000          1.000

Group           Run
--------------- -----
AMCII           Yes


-----------------------------------------------------------------------------------------------
         Name: 2 yr                Hydrology Sim: 2 yr
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Execute: Yes         Restart: No            Patch: No
  Alternative: No

         Max Delta Z(m): 0.50                     Delta Z Factor: 0.00500
    Time Step Optimizer: 0.000
        Start Time(hrs): 0.000                     End Time(hrs): 24.00
     Min Calc Time(sec): 1.0000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:
```

```
Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.000
13.000          1.000
24.000          1.000

Group           Run
--------------- -----
AMCII           Yes


-----------------------------------------------------------------------------------------------
         Name: Half pmp            Hydrology Sim: Half-pmp
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Execute: No          Restart: No            Patch: No
  Alternative: No

         Max Delta Z(m): 0.50                     Delta Z Factor: 0.00500
    Time Step Optimizer: 0.000
        Start Time(hrs): 0.000                     End Time(hrs): 24.00
     Min Calc Time(sec): 1.0000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:



Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.000
13.000          1.000
24.000          1.000

Group           Run
--------------- -----
AMCII           Yes


-----------------------------------------------------------------------------------------------
         Name: PMP                 Hydrology Sim: PMP
     Filename: Q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Beatriz CSA corrections Jan07\Rainfall v

      Execute: Yes         Restart: No            Patch: No
  Alternative: No

         Max Delta Z(m): 0.50                     Delta Z Factor: 0.00500
    Time Step Optimizer: 0.000
        Start Time(hrs): 0.000                     End Time(hrs): 24.00
     Min Calc Time(sec): 1.0000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:



Time(hrs)       Print Inc(min)
--------------- ---------------
6.000           1.000
13.000          1.000
24.000          1.000

Group           Run
--------------- -----
AMCII           Yes


===============================================================================================
==== Boundary Conditions ======================================================================
===============================================================================================
```

Quebrada Beatriz Proposed Condition

Name	Group	Simulation	Max Time Stage hrs	Max Stage m	Warning Stage m	Max Delta Stage m	Max Surf Area m2	Max Time Inflow hrs	Max Inflow cms	Max Time Outflow hrs	Max Outflow cms
BoundaryII	AMCII	100 yr	0.00	120.000	120.000	0.0000	0	12.63	230.217	0.00	0.000
RepresaII	AMCII	100 yr	3.85	153.334	155.000	0.0025	574682	12.22	393.370	12.63	230.217
BoundaryII	AMCII	2 yr	0.00	120.000	120.000	0.0000	0	12.82	42.767	0.00	0.000
RepresaII	AMCII	2 yr	3.91	152.425	155.000	0.0025	546690	12.27	116.295	12.82	42.767
BoundaryII	AMCII	Half pmp	0.00	120.000	120.000	0.0000	0	8.19	287.136	0.00	0.000
RepresaII	AMCII	Half pmp	2.50	153.589	155.000	0.0025	582555	7.73	428.860	8.19	287.136
BoundaryII	AMCII	PMP	0.00	120.000	120.000	0.0000	0	8.19	574.342	0.00	0.000
RepresaII	AMCII	PMP	2.50	155.018	155.000	-0.0025	626460	7.73	882.267	8.19	574.342

APPENDIX D: Spillway Chute Hydraulic Modeling Results

HEC-RAS Version 3.1.2 April 2004
U.S. Army Corp 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: Channel Model A3
Project File : QBeatriA3.prj
Run Date and Time: 4/17/2006 6:02:20 PM

Project in SI units

PLAN DATA

Plan Title: Plan 27
Plan File : q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Spillway\Hec-Ras\QBeatriz new configuration 2\QBeatriA3.p27

Geometry Title: Geom A-3 (new)
Geometry File : q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Spillway\Hec-Ras\QBeatriz new configuration 2\QBeatriA3.g13

Flow Title : Flow Test A-3
Flow File : q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Spillway\Hec-Ras\QBeatriz new configuration 2\QBeatriA3.f05

Plan Summary Information:

Number of:	Cross Sections	= 41	Multiple Openings	=	0
	Culverts	= 0	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: Mixed Flow

FLOW DATA

Flow Title: Flow Test A-3
Flow File : q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Spillway\Hec-Ras\QBeatriz new configuration 2\QBeatriA3.f05

Flow Data (m3/s)

River	Reach	RS	PMP	100-yr	2-yr
Q. Beatriz	Channel	14	604.27	236	39.1

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Q. Beatriz	Channel	PMP	Known WS = 149.52	Normal S = 0.001

GEOMETRY DATA

Geometry Title: Geom A-3 (new)
Geometry File : q:\Feasibility\Beatriz\Hydrologic and Hydraulic Analysis\Spillway\Hec-Ras\QBeatriz new configuration 2\QBeatriA3.g13

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 14

INPUT
Description: Sta 2+68
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	151.77	0	146.77	36	146.77	36	151.77

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	151.42	Element	Left OB	Channel	Right OB
Vel Head (m)	1.90	Wt. n-Val.		0.013	
W.S. Elev (m)	149.52	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	149.83	Flow Area (m2)		99.00	
E.G. Slope (m/m)	0.001976	Area (m2)		99.00	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	6.10	Avg. Vel. (m/s)		6.10	
Max Chl Dpth (m)	2.75	Hydr. Depth (m)		2.75	
Conv. Total (m3/s)	13595.4	Conv. (m3/s)		13595.4	
Length Wtd. (m)	9.81	Wetted Per. (m)		41.50	
Min Ch El (m)	146.77	Shear (N/m2)		46.21	
Alpha	1.00	Stream Power (N/m s)		282.08	
Frctn Loss (m)		Cum Volume (1000 m3)		17.61	
C & E Loss (m)		Cum SA (1000 m2)		13.75	

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.9375*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	151.279	0	146.279	36	146.279	36	151.279

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	151.31	Element	Left OB	Channel	Right OB
Vel Head (m)	2.74	Wt. n-Val.		0.013	
W.S. Elev (m)	148.57	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	149.34	Flow Area (m2)		82.38	
E.G. Slope (m/m)	0.003537	Area (m2)		82.38	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	7.34	Avg. Vel. (m/s)		7.34	
Max Chl Dpth (m)	2.29	Hydr. Depth (m)		2.29	
Conv. Total (m3/s)	10160.0	Conv. (m3/s)		10160.0	
Length Wtd. (m)	9.81	Wetted Per. (m)		40.58	
Min Ch El (m)	146.28	Shear (N/m2)		70.43	

```
  Alpha                      1.00    Stream Power (N/m s)               516.59
  Frctn Loss (m)             0.03    Cum Volume (1000 m3)                16.72
  C & E Loss (m)             0.08    Cum SA (1000 m2)                    13.40


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 13.875*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 150.789       0 145.789      36 145.789      36 150.789

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           151.21    Element                 Left OB    Channel
Right OB
  Vel Head (m)              3.35    Wt. n-Val.                          0.013
  W.S. Elev (m)           147.86    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           148.85    Flow Area (m2)                      74.55
  E.G. Slope (m/m)      0.004864    Area (m2)                           74.55
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)           8.11    Avg. Vel. (m/s)                      8.11
  Max Chl Dpth (m)          2.07    Hydr. Depth (m)                      2.07
  Conv. Total (m3/s)      8664.1    Conv. (m3/s)                       8664.1
  Length Wtd. (m)           9.81    Wetted Per. (m)                     40.14
  Min Ch El (m)           145.79    Shear (N/m2)                        88.59
  Alpha                     1.00    Stream Power (N/m s)               718.06
  Frctn Loss (m)            0.04    Cum Volume (1000 m3)                15.96
  C & E Loss (m)            0.06    Cum SA (1000 m2)                    13.04


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION
```

```
RIVER: Q. Beatriz
REACH: Channel            RS: 13.8125*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 150.298       0 145.298      36 145.298      36 150.298

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           151.10    Element                 Left OB    Channel
Right OB
  Vel Head (m)              3.88    Wt. n-Val.                          0.013
  W.S. Elev (m)           147.22    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           148.36    Flow Area (m2)                      69.27
  E.G. Slope (m/m)      0.006153    Area (m2)                           69.27
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)           8.72    Avg. Vel. (m/s)                      8.72
  Max Chl Dpth (m)          1.92    Hydr. Depth (m)                      1.92
  Conv. Total (m3/s)      7703.4    Conv. (m3/s)                       7703.4
  Length Wtd. (m)           9.81    Wetted Per. (m)                     39.85
  Min Ch El (m)           145.30    Shear (N/m2)                       104.89
  Alpha                     1.00    Stream Power (N/m s)               915.02
  Frctn Loss (m)            0.05    Cum Volume (1000 m3)                15.25
  C & E Loss (m)            0.05    Cum SA (1000 m2)                    12.69


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 13.75*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 149.807       0 144.807      36 144.807      36 149.807

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           150.98    Element                 Left OB    Channel
Right OB
  Vel Head (m)              4.36    Wt. n-Val.                          0.013
  W.S. Elev (m)           146.62    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           147.87    Flow Area (m2)                      65.29
  E.G. Slope (m/m)      0.007437    Area (m2)                           65.29
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)           9.25    Avg. Vel. (m/s)                      9.25
  Max Chl Dpth (m)          1.81    Hydr. Depth (m)                      1.81
  Conv. Total (m3/s)      7006.8    Conv. (m3/s)                       7006.8
  Length Wtd. (m)           9.81    Wetted Per. (m)                     39.63
  Min Ch El (m)           144.81    Shear (N/m2)                       120.18
  Alpha                     1.00    Stream Power (N/m s)              1112.16
  Frctn Loss (m)            0.07    Cum Volume (1000 m3)                14.59
  C & E Loss (m)            0.05    Cum SA (1000 m2)                    12.34


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 13.6875*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 149.317       0 144.317      36 144.317      36 149.317

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           150.86    Element                 Left OB    Channel
Right OB
  Vel Head (m)              4.82    Wt. n-Val.                          0.013
  W.S. Elev (m)           146.04    Reach Len. (m)            9.81       9.81
9.81
```

Crit W.S. (m)	147.38	Flow Area (m2)	62.14
E.G. Slope (m/m)	0.008718	Area (m2)	62.14
Q Total (m3/s)	604.27	Flow (m3/s)	604.27
Top Width (m)	36.00	Top Width (m)	36.00
Vel Total (m/s)	9.72	Avg. Vel. (m/s)	9.72
Max Chl Dpth (m)	1.73	Hydr. Depth (m)	1.73
Conv. Total (m3/s)	6471.6	Conv. (m3/s)	6471.6
Length Wtd. (m)	9.81	Wetted Per. (m)	39.45
Min Ch El (m)	144.32	Shear (N/m2)	134.67
Alpha	1.00	Stream Power (N/m s)	1309.51
Frctn Loss (m)	0.08	Cum Volume (1000 m3)	13.96
C & E Loss (m)	0.05	Cum SA (1000 m2)	11.99

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.625*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	148.826	0	143.826	36	143.826	36	148.826

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	150.73	Element	Left OB	Channel	Right OB
Vel Head (m)	5.25	Wt. n-Val.		0.013	
W.S. Elev (m)	145.48	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	146.88	Flow Area (m2)		59.55	
E.G. Slope (m/m)	0.010002	Area (m2)		59.55	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	10.15	Avg. Vel. (m/s)		10.15	
Max Chl Dpth (m)	1.65	Hydr. Depth (m)		1.65	
Conv. Total (m3/s)	6042.2	Conv. (m3/s)		6042.2	
Length Wtd. (m)	9.81	Wetted Per. (m)		39.31	
Min Ch El (m)	143.83	Shear (N/m2)		148.59	
Alpha	1.00	Stream Power (N/m s)		1507.79	
Frctn Loss (m)	0.09	Cum Volume (1000 m3)		13.37	
C & E Loss (m)	0.04	Cum SA (1000 m2)		11.63	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.5625*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	148.336	0	143.336	36	143.336	36	148.336

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	150.58	Element	Left OB	Channel	Right OB
Vel Head (m)	5.65	Wt. n-Val.		0.013	
W.S. Elev (m)	144.93	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	146.39	Flow Area (m2)		57.36	
E.G. Slope (m/m)	0.011283	Area (m2)		57.36	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	10.53	Avg. Vel. (m/s)		10.53	
Max Chl Dpth (m)	1.59	Hydr. Depth (m)		1.59	
Conv. Total (m3/s)	5688.9	Conv. (m3/s)		5688.9	
Length Wtd. (m)	9.81	Wetted Per. (m)		39.19	
Min Ch El (m)	143.34	Shear (N/m2)		161.97	
Alpha	1.00	Stream Power (N/m s)		1706.15	
Frctn Loss (m)	0.10	Cum Volume (1000 m3)		12.79	
C & E Loss (m)	0.04	Cum SA (1000 m2)		11.28	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.5*

```
INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 147.845       0 142.845      36 142.845      36 147.845

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           150.43    Element                 Left OB    Channel
Right OB
  Vel Head (m)              6.04    Wt. n-Val.                          0.013
  W.S. Elev (m)           144.39    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           145.90    Flow Area (m2)                      55.49
  E.G. Slope (m/m)      0.012557    Area (m2)                           55.49
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          10.89    Avg. Vel. (m/s)                     10.89
  Max Chl Dpth (m)          1.54    Hydr. Depth (m)                      1.54
  Conv. Total (m3/s)      5392.4    Conv. (m3/s)                       5392.4
  Length Wtd. (m)           9.81    Wetted Per. (m)                     39.08
  Min Ch El (m)           142.85    Shear (N/m2)                       174.84
  Alpha                     1.00    Stream Power (N/m s)              1903.93
  Frctn Loss (m)            0.12    Cum Volume (1000 m3)                12.24
  C & E Loss (m)            0.04    Cum SA (1000 m2)                    10.93


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 13.4375*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 147.354       0 142.354      36 142.354      36 147.354

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

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

```
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           150.26    Element                 Left OB    Channel
Right OB
  Vel Head (m)              6.41    Wt. n-Val.                          0.013
  W.S. Elev (m)           143.85    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           145.41    Flow Area (m2)                      53.88
  E.G. Slope (m/m)      0.013813    Area (m2)                           53.88
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          11.22    Avg. Vel. (m/s)                     11.22
  Max Chl Dpth (m)          1.50    Hydr. Depth (m)                      1.50
  Conv. Total (m3/s)      5141.4    Conv. (m3/s)                       5141.4
  Length Wtd. (m)           9.81    Wetted Per. (m)                     38.99
  Min Ch El (m)           142.35    Shear (N/m2)                       187.17
  Alpha                     1.00    Stream Power (N/m s)              2099.18
  Frctn Loss (m)            0.13    Cum Volume (1000 m3)                11.70
  C & E Loss (m)            0.04    Cum SA (1000 m2)                    10.57


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 13.375*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 146.864       0 141.864      36 141.864      36 146.864

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           150.08    Element                 Left OB    Channel
Right OB
  Vel Head (m)              6.76    Wt. n-Val.                          0.013
  W.S. Elev (m)           143.32    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           144.92    Flow Area (m2)                      52.46
  E.G. Slope (m/m)      0.015054    Area (m2)                           52.46
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
```

Top Width (m)	36.00	Top Width (m)	36.00
Vel Total (m/s)	11.52	Avg. Vel. (m/s)	11.52
Max Chl Dpth (m)	1.46	Hydr. Depth (m)	1.46
Conv. Total (m3/s)	4924.9	Conv. (m3/s)	4924.9
Length Wtd. (m)	9.81	Wetted Per. (m)	38.91
Min Ch El (m)	141.86	Shear (N/m2)	199.03
Alpha	1.00	Stream Power (N/m s)	2292.44
Frctn Loss (m)	0.14	Cum Volume (1000 m3)	11.18
C & E Loss (m)	0.04	Cum SA (1000 m2)	10.22

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.3125*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	146.373	0	141.373	36	141.373	36	146.373

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	149.89	Element	Left OB	Channel	Right OB
Vel Head (m)	7.10	Wt. n-Val.		0.013	
W.S. Elev (m)	142.80	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	144.43	Flow Area (m2)		51.20	
E.G. Slope (m/m)	0.016287	Area (m2)		51.20	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	11.80	Avg. Vel. (m/s)		11.80	
Max Chl Dpth (m)	1.42	Hydr. Depth (m)		1.42	
Conv. Total (m3/s)	4734.9	Conv. (m3/s)		4734.9	
Length Wtd. (m)	9.81	Wetted Per. (m)		38.84	
Min Ch El (m)	141.37	Shear (N/m2)		210.53	
Alpha	1.00	Stream Power (N/m s)		2484.57	
Frctn Loss (m)	0.15	Cum Volume (1000 m3)		10.67	
C & E Loss (m)	0.03	Cum SA (1000 m2)		9.87	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.25*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	145.883	0	140.883	36	140.883	36	145.883

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	149.69	Element	Left OB	Channel	Right OB
Vel Head (m)	7.42	Wt. n-Val.		0.013	
W.S. Elev (m)	142.27	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	143.94	Flow Area (m2)		50.08	
E.G. Slope (m/m)	0.017501	Area (m2)		50.08	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	12.07	Avg. Vel. (m/s)		12.07	
Max Chl Dpth (m)	1.39	Hydr. Depth (m)		1.39	
Conv. Total (m3/s)	4567.8	Conv. (m3/s)		4567.8	
Length Wtd. (m)	9.81	Wetted Per. (m)		38.78	
Min Ch El (m)	140.88	Shear (N/m2)		221.60	
Alpha	1.00	Stream Power (N/m s)		2674.02	
Frctn Loss (m)	0.17	Cum Volume (1000 m3)		10.18	
C & E Loss (m)	0.03	Cum SA (1000 m2)		9.51	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.1875*

INPUT
Description:

```
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 145.392       0 140.392      36 140.392      36 145.392

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           149.49    Element                 Left OB    Channel
Right OB
  Vel Head (m)              7.73    Wt. n-Val.                          0.013
  W.S. Elev (m)           141.75    Reach Len. (m)            9.81       9.81
9.81
  Crit W.S. (m)           143.45    Flow Area (m2)                      49.05
  E.G. Slope (m/m)      0.018712    Area (m2)                           49.05
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          12.32    Avg. Vel. (m/s)                     12.32
  Max Chl Dpth (m)          1.36    Hydr. Depth (m)                      1.36
  Conv. Total (m3/s)      4417.5    Conv. (m3/s)                       4417.5
  Length Wtd. (m)           9.81    Wetted Per. (m)                     38.73
  Min Ch El (m)           140.39    Shear (N/m2)                       232.43
  Alpha                     1.00    Stream Power (N/m s)              2863.26
  Frctn Loss (m)            0.18    Cum Volume (1000 m3)                 9.69
  C & E Loss (m)            0.03    Cum SA (1000 m2)                     9.16


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 13.125*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 144.901       0 139.901      36 139.901      36 144.901

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.81    9.81    9.81             .1       .3
```

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	149.27	Element	Left OB	Channel	Right OB
Vel Head (m)	8.03	Wt. n-Val.		0.013	
W.S. Elev (m)	141.24	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	142.96	Flow Area (m2)		48.13	
E.G. Slope (m/m)	0.019897	Area (m2)		48.13	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	12.55	Avg. Vel. (m/s)		12.55	
Max Chl Dpth (m)	1.34	Hydr. Depth (m)		1.34	
Conv. Total (m3/s)	4283.9	Conv. (m3/s)		4283.9	
Length Wtd. (m)	9.81	Wetted Per. (m)		38.67	
Min Ch El (m)	139.90	Shear (N/m2)		242.84	
Alpha	1.00	Stream Power (N/m s)		3048.70	
Frctn Loss (m)	0.19	Cum Volume (1000 m3)		9.21	
C & E Loss (m)	0.03	Cum SA (1000 m2)		8.81	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13.0625*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	144.411	0	139.411	36	139.411	36	144.411

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.81	9.81	9.81	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	149.04	Element	Left OB	Channel	Right OB
Vel Head (m)	8.31	Wt. n-Val.		0.013	
W.S. Elev (m)	140.72	Reach Len. (m)	9.81	9.81	9.81
Crit W.S. (m)	142.47	Flow Area (m2)		47.30	
E.G. Slope (m/m)	0.021052	Area (m2)		47.30	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	12.77	Avg. Vel. (m/s)		12.77	

Max Chl Dpth (m)	1.31	Hydr. Depth (m)	1.31
Conv. Total (m3/s)	4164.7	Conv. (m3/s)	4164.7
Length Wtd. (m)	9.81	Wetted Per. (m)	38.63
Min Ch El (m)	139.41	Shear (N/m2)	252.81
Alpha	1.00	Stream Power (N/m s)	3229.59
Frctn Loss (m)	0.20	Cum Volume (1000 m3)	8.75
C & E Loss (m)	0.03	Cum SA (1000 m2)	8.45

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 13

INPUT
Description: Sta 4+25
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	143.92	0	138.92	36	138.92	36	143.92

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	5	5	5	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	148.80	Element	Left OB	Channel	Right OB
Vel Head (m)	8.59	Wt. n-Val.		0.013	
W.S. Elev (m)	140.21	Reach Len. (m)	5.00	5.00	5.00
Crit W.S. (m)	141.98	Flow Area (m2)		46.54	
E.G. Slope (m/m)	0.022185	Area (m2)		46.54	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	12.98	Avg. Vel. (m/s)		12.98	
Max Chl Dpth (m)	1.29	Hydr. Depth (m)		1.29	
Conv. Total (m3/s)	4057.0	Conv. (m3/s)		4057.0	
Length Wtd. (m)	5.00	Wetted Per. (m)		38.59	
Min Ch El (m)	138.92	Shear (N/m2)		262.43	
Alpha	1.00	Stream Power (N/m s)		3407.06	
Frctn Loss (m)	0.21	Cum Volume (1000 m3)		8.29	
C & E Loss (m)	0.03	Cum SA (1000 m2)		8.10	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 12

INPUT
Description: Sta 4+30
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	143.66	0	138.66	36	138.66	36	143.66

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	10	10	10	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	148.67	Element	Left OB	Channel	Right OB
Vel Head (m)	8.73	Wt. n-Val.		0.013	
W.S. Elev (m)	139.94	Reach Len. (m)	10.00	10.00	10.00
Crit W.S. (m)	141.72	Flow Area (m2)		46.16	
E.G. Slope (m/m)	0.022790	Area (m2)		46.16	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	13.09	Avg. Vel. (m/s)		13.09	
Max Chl Dpth (m)	1.28	Hydr. Depth (m)		1.28	
Conv. Total (m3/s)	4002.7	Conv. (m3/s)		4002.7	
Length Wtd. (m)	10.00	Wetted Per. (m)		38.56	
Min Ch El (m)	138.66	Shear (N/m2)		267.50	
Alpha	1.00	Stream Power (N/m s)		3501.92	
Frctn Loss (m)	0.11	Cum Volume (1000 m3)		8.05	
C & E Loss (m)	0.01	Cum SA (1000 m2)		7.92	

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 11

INPUT
Description: Sta 4+40
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	143.04	0	138.04	36	138.04	36	143.04

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36               10      10      10             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           148.40    Element                 Left OB    Channel
Right OB
  Vel Head (m)              9.10    Wt. n-Val.                          0.013
  W.S. Elev (m)           139.30    Reach Len. (m)           10.00      10.00
10.00
  Crit W.S. (m)           141.10    Flow Area (m2)                      45.21
  E.G. Slope (m/m)      0.024388    Area (m2)                           45.21
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          13.37    Avg. Vel. (m/s)                     13.37
  Max Chl Dpth (m)          1.26    Hydr. Depth (m)                      1.26
  Conv. Total (m3/s)      3869.4    Conv. (m3/s)                       3869.4
  Length Wtd. (m)          10.00    Wetted Per. (m)                     38.51
  Min Ch El (m)           138.04    Shear (N/m2)                       280.73
  Alpha                     1.00    Stream Power (N/m s)              3752.58
  Frctn Loss (m)            0.24    Cum Volume (1000 m3)                 7.60
  C & E Loss (m)            0.04    Cum SA (1000 m2)                     7.56


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 10

INPUT
Description: Sta 4+50
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   142.3       0   137.3      36   137.3      36   142.3

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36               10      10      10             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           148.10    Element                 Left OB    Channel
Right OB
  Vel Head (m)              9.57    Wt. n-Val.                          0.013
  W.S. Elev (m)           138.52    Reach Len. (m)           10.00      10.00
10.00
```

Crit W.S. (m)	140.36	Flow Area (m2)	44.08
E.G. Slope (m/m)	0.026467	Area (m2)	44.08
Q Total (m3/s)	604.27	Flow (m3/s)	604.27
Top Width (m)	36.00	Top Width (m)	36.00
Vel Total (m/s)	13.71	Avg. Vel. (m/s)	13.71
Max Chl Dpth (m)	1.22	Hydr. Depth (m)	1.22
Conv. Total (m3/s)	3714.3	Conv. (m3/s)	3714.3
Length Wtd. (m)	10.00	Wetted Per. (m)	38.45
Min Ch El (m)	137.30	Shear (N/m2)	297.57
Alpha	1.00	Stream Power (N/m s)	4079.17
Frctn Loss (m)	0.25	Cum Volume (1000 m3)	7.15
C & E Loss (m)	0.05	Cum SA (1000 m2)	7.20

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 9

INPUT
Description: Sta 4+60
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	141.44	0	136.44	36	136.44	36	141.44

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	10	10	10	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	147.76	Element	Left OB	Channel	Right OB
Vel Head (m)	10.13	Wt. n-Val.		0.013	
W.S. Elev (m)	137.63	Reach Len. (m)	10.00	10.00	10.00
Crit W.S. (m)	139.50	Flow Area (m2)		42.84	
E.G. Slope (m/m)	0.029034	Area (m2)		42.84	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	14.10	Avg. Vel. (m/s)		14.10	
Max Chl Dpth (m)	1.19	Hydr. Depth (m)		1.19	
Conv. Total (m3/s)	3546.3	Conv. (m3/s)		3546.3	
Length Wtd. (m)	10.00	Wetted Per. (m)		38.38	
Min Ch El (m)	136.44	Shear (N/m2)		317.83	
Alpha	1.00	Stream Power (N/m s)		4482.82	
Frctn Loss (m)	0.28	Cum Volume (1000 m3)		6.72	
C & E Loss (m)	0.06	Cum SA (1000 m2)		6.84	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 8

INPUT
Description: Sta 4+70
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	140.46	0	135.46	36	135.46	36	140.46

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	10	10	10	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	147.40	Element	Left OB	Channel	Right OB
Vel Head (m)	10.78	Wt. n-Val.		0.013	
W.S. Elev (m)	136.61	Reach Len. (m)	10.00	10.00	10.00
Crit W.S. (m)	138.52	Flow Area (m2)		41.54	
E.G. Slope (m/m)	0.032105	Area (m2)		41.54	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	14.55	Avg. Vel. (m/s)		14.55	
Max Chl Dpth (m)	1.15	Hydr. Depth (m)		1.15	
Conv. Total (m3/s)	3372.4	Conv. (m3/s)		3372.4	
Length Wtd. (m)	10.00	Wetted Per. (m)		38.31	
Min Ch El (m)	135.46	Shear (N/m2)		341.39	
Alpha	1.00	Stream Power (N/m s)		4966.32	
Frctn Loss (m)	0.31	Cum Volume (1000 m3)		6.29	
C & E Loss (m)	0.06	Cum SA (1000 m2)		6.48	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 7

INPUT
Description: Sta 4+80
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	139.36	0	134.36	36	134.36	36	139.36

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	10	10	10	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	146.98	Element	Left OB	Channel	Right OB
Vel Head (m)	11.50	Wt. n-Val.		0.013	
W.S. Elev (m)	135.48	Reach Len. (m)	10.00	10.00	10.00
Crit W.S. (m)	137.42	Flow Area (m2)		40.21	
E.G. Slope (m/m)	0.035685	Area (m2)		40.21	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	15.03	Avg. Vel. (m/s)		15.03	
Max Chl Dpth (m)	1.12	Hydr. Depth (m)		1.12	
Conv. Total (m3/s)	3198.8	Conv. (m3/s)		3198.8	
Length Wtd. (m)	10.00	Wetted Per. (m)		38.23	
Min Ch El (m)	134.36	Shear (N/m2)		368.04	
Alpha	1.00	Stream Power (N/m s)		5530.75	
Frctn Loss (m)	0.34	Cum Volume (1000 m3)		5.89	
C & E Loss (m)	0.07	Cum SA (1000 m2)		6.12	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 6

INPUT
Description: Sta 4+90
Station Elevation Data num= 4

```
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  138.15       0  133.15      36  133.15      36  138.15

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36               10      10      10             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           146.53    Element                 Left OB    Channel
Right OB
  Vel Head (m)             12.30    Wt. n-Val.                          0.013
  W.S. Elev (m)           134.23    Reach Len. (m)           10.00      10.00
10.00
  Crit W.S. (m)           136.21    Flow Area (m2)                      38.90
  E.G. Slope (m/m)      0.039763    Area (m2)                           38.90
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          15.54    Avg. Vel. (m/s)                     15.54
  Max Chl Dpth (m)          1.08    Hydr. Depth (m)                      1.08
  Conv. Total (m3/s)      3030.3    Conv. (m3/s)                       3030.3
  Length Wtd. (m)          10.00    Wetted Per. (m)                     38.16
  Min Ch El (m)           133.15    Shear (N/m2)                       397.45
  Alpha                     1.00    Stream Power (N/m s)              6174.53
  Frctn Loss (m)            0.38    Cum Volume (1000 m3)                 5.49
  C & E Loss (m)            0.08    Cum SA (1000 m2)                     5.76


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 5

INPUT
Description: Sta 5+00
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  136.81       0  131.81      36  131.81      36  136.81

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

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

```
             0      36                5       5       5             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           146.02    Element                 Left OB    Channel
Right OB
  Vel Head (m)             13.16    Wt. n-Val.                          0.013
  W.S. Elev (m)           132.85    Reach Len. (m)            5.00       5.00
5.00
  Crit W.S. (m)           134.87    Flow Area (m2)                      37.59
  E.G. Slope (m/m)      0.044434    Area (m2)                           37.59
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          16.07    Avg. Vel. (m/s)                     16.07
  Max Chl Dpth (m)          1.04    Hydr. Depth (m)                      1.04
  Conv. Total (m3/s)      2866.6    Conv. (m3/s)                       2866.6
  Length Wtd. (m)           5.00    Wetted Per. (m)                     38.09
  Min Ch El (m)           131.81    Shear (N/m2)                       430.07
  Alpha                     1.00    Stream Power (N/m s)              6913.00
  Frctn Loss (m)            0.42    Cum Volume (1000 m3)                 5.11
  C & E Loss (m)            0.09    Cum SA (1000 m2)                     5.40


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 4

INPUT
Description: Sta 5+05
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   136.1       0   131.1      36   131.1      36   136.1

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36            9.534   9.534   9.534             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           145.74    Element                 Left OB    Channel
Right OB
  Vel Head (m)             13.62    Wt. n-Val.                          0.013
  W.S. Elev (m)           132.13    Reach Len. (m)            9.53       9.53
9.53
```

Crit W.S. (m)	134.16	Flow Area (m2)	36.96
E.G. Slope (m/m)	0.046959	Area (m2)	36.96
Q Total (m3/s)	604.27	Flow (m3/s)	604.27
Top Width (m)	36.00	Top Width (m)	36.00
Vel Total (m/s)	16.35	Avg. Vel. (m/s)	16.35
Max Chl Dpth (m)	1.03	Hydr. Depth (m)	1.03
Conv. Total (m3/s)	2788.5	Conv. (m3/s)	2788.5
Length Wtd. (m)	9.53	Wetted Per. (m)	38.05
Min Ch El (m)	131.10	Shear (N/m2)	447.29
Alpha	1.00	Stream Power (N/m s)	7312.61
Frctn Loss (m)	0.23	Cum Volume (1000 m3)	4.92
C & E Loss (m)	0.05	Cum SA (1000 m2)	5.22

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 3.875*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	134.713	0	129.713	36	129.713	36	134.713

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.534	9.534	9.534	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	145.19	Element	Left OB	Channel	Right OB
Vel Head (m)	14.48	Wt. n-Val.		0.013	
W.S. Elev (m)	130.71	Reach Len. (m)	9.53	9.53	9.53
Crit W.S. (m)	132.77	Flow Area (m2)		35.85	
E.G. Slope (m/m)	0.051900	Area (m2)		35.85	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	16.86	Avg. Vel. (m/s)		16.86	
Max Chl Dpth (m)	1.00	Hydr. Depth (m)		1.00	
Conv. Total (m3/s)	2652.5	Conv. (m3/s)		2652.5	
Length Wtd. (m)	9.53	Wetted Per. (m)		37.99	
Min Ch El (m)	129.71	Shear (N/m2)		480.20	
Alpha	1.00	Stream Power (N/m s)		8095.13	
Frctn Loss (m)	0.47	Cum Volume (1000 m3)		4.57	
C & E Loss (m)	0.09	Cum SA (1000 m2)		4.88	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 3.75*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	133.325	0	128.325	36	128.325	36	133.325

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.534	9.534	9.534	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	144.59	Element	Left OB	Channel	Right OB
Vel Head (m)	15.29	Wt. n-Val.		0.013	0.013
W.S. Elev (m)	129.29	Reach Len. (m)	9.53	9.53	9.53
Crit W.S. (m)	131.38	Flow Area (m2)		34.88	
E.G. Slope (m/m)	0.056761	Area (m2)		34.88	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	17.33	Avg. Vel. (m/s)		17.33	
Max Chl Dpth (m)	0.97	Hydr. Depth (m)		0.97	
Conv. Total (m3/s)	2536.3	Conv. (m3/s)		2536.3	
Length Wtd. (m)	9.53	Wetted Per. (m)		37.94	
Min Ch El (m)	128.33	Shear (N/m2)		511.69	
Alpha	1.00	Stream Power (N/m s)		8865.91	
Frctn Loss (m)	0.52	Cum Volume (1000 m3)		4.24	
C & E Loss (m)	0.08	Cum SA (1000 m2)		4.53	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 3.625*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	131.938	0	126.938	36	126.938	36	131.938

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.534	9.534	9.534	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	143.95	Element	Left OB	Channel	Right OB
Vel Head (m)	16.06	Wt. n-Val.		0.013	
W.S. Elev (m)	127.88	Reach Len. (m)	9.53	9.53	9.53
Crit W.S. (m)	130.00	Flow Area (m2)		34.03	
E.G. Slope (m/m)	0.061504	Area (m2)		34.03	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	17.76	Avg. Vel. (m/s)		17.76	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.95	
Conv. Total (m3/s)	2436.6	Conv. (m3/s)		2436.6	
Length Wtd. (m)	9.53	Wetted Per. (m)		37.89	
Min Ch El (m)	126.94	Shear (N/m2)		541.67	
Alpha	1.00	Stream Power (N/m s)		9618.70	
Frctn Loss (m)	0.56	Cum Volume (1000 m3)		3.91	
C & E Loss (m)	0.08	Cum SA (1000 m2)		4.19	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 3.5*

INPUT
Description:
Station Elevation Data num= 4

```
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  130.55       0  125.55      36  125.55      36  130.55

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36            9.534   9.534   9.534             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           143.27    Element                 Left OB    Channel
Right OB
  Vel Head (m)             16.79    Wt. n-Val.                          0.013
  W.S. Elev (m)           126.47    Reach Len. (m)            9.53       9.53
9.53
  Crit W.S. (m)           128.61    Flow Area (m2)                      33.28
  E.G. Slope (m/m)      0.066122    Area (m2)                           33.28
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          18.16    Avg. Vel. (m/s)                     18.16
  Max Chl Dpth (m)          0.92    Hydr. Depth (m)                      0.92
  Conv. Total (m3/s)      2349.9    Conv. (m3/s)                       2349.9
  Length Wtd. (m)           9.53    Wetted Per. (m)                     37.85
  Min Ch El (m)           125.55    Shear (N/m2)                       570.20
  Alpha                     1.00    Stream Power (N/m s)             10352.27
  Frctn Loss (m)            0.61    Cum Volume (1000 m3)                 3.59
  C & E Loss (m)            0.07    Cum SA (1000 m2)                     3.85


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 3.375*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 129.163       0 124.163      36 124.163      36 129.163

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

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

```
             0      36            9.534   9.534   9.534             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           142.55    Element                 Left OB    Channel
Right OB
  Vel Head (m)             17.48    Wt. n-Val.                          0.013
  W.S. Elev (m)           125.07    Reach Len. (m)            9.53       9.53
9.53
  Crit W.S. (m)           127.22    Flow Area (m2)                      32.62
  E.G. Slope (m/m)      0.070589    Area (m2)                           32.62
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          18.52    Avg. Vel. (m/s)                     18.52
  Max Chl Dpth (m)          0.91    Hydr. Depth (m)                      0.91
  Conv. Total (m3/s)      2274.4    Conv. (m3/s)                       2274.4
  Length Wtd. (m)           9.53    Wetted Per. (m)                     37.81
  Min Ch El (m)           124.16    Shear (N/m2)                       597.25
  Alpha                     1.00    Stream Power (N/m s)             11062.34
  Frctn Loss (m)            0.65    Cum Volume (1000 m3)                 3.27
  C & E Loss (m)            0.07    Cum SA (1000 m2)                     3.50


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 3.25*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 127.775       0 122.775      36 122.775      36 127.775

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36            9.534   9.534   9.534             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           141.79    Element                 Left OB    Channel
Right OB
  Vel Head (m)             18.12    Wt. n-Val.                          0.013
  W.S. Elev (m)           123.66    Reach Len. (m)            9.53       9.53
9.53
```

Crit W.S. (m)	125.83	Flow Area (m2)	32.04
E.G. Slope (m/m)	0.074907	Area (m2)	32.04
Q Total (m3/s)	604.27	Flow (m3/s)	604.27
Top Width (m)	36.00	Top Width (m)	36.00
Vel Total (m/s)	18.86	Avg. Vel. (m/s)	18.86
Max Chl Dpth (m)	0.89	Hydr. Depth (m)	0.89
Conv. Total (m3/s)	2207.9	Conv. (m3/s)	2207.9
Length Wtd. (m)	9.53	Wetted Per. (m)	37.78
Min Ch El (m)	122.78	Shear (N/m2)	622.91
Alpha	1.00	Stream Power (N/m s)	11749.17
Frctn Loss (m)	0.69	Cum Volume (1000 m3)	2.97
C & E Loss (m)	0.06	Cum SA (1000 m2)	3.16

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 3.125*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	126.388	0	121.388	36	121.388	36	126.388

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.534	9.534	9.534	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	140.99	Element	Left OB	Channel	Right OB
Vel Head (m)	18.73	Wt. n-Val.		0.013	
W.S. Elev (m)	122.26	Reach Len. (m)	9.53	9.53	9.53
Crit W.S. (m)	124.45	Flow Area (m2)		31.52	
E.G. Slope (m/m)	0.079040	Area (m2)		31.52	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	19.17	Avg. Vel. (m/s)		19.17	
Max Chl Dpth (m)	0.88	Hydr. Depth (m)		0.88	
Conv. Total (m3/s)	2149.4	Conv. (m3/s)		2149.4	
Length Wtd. (m)	9.53	Wetted Per. (m)		37.75	
Min Ch El (m)	121.39	Shear (N/m2)		647.08	

```
  Alpha                      1.00    Stream Power (N/m s)             12406.94
  Frctn Loss (m)             0.73    Cum Volume (1000 m3)                 2.66
  C & E Loss (m)             0.06    Cum SA (1000 m2)                     2.82


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 3

INPUT
Description: Sta 5+81.27
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     125       0     120      36     120      36     125

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.82    9.82    9.82             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           140.16    Element                 Left OB    Channel
Right OB
  Vel Head (m)             19.30    Wt. n-Val.                          0.013
  W.S. Elev (m)           120.86    Reach Len. (m)            9.82       9.82
9.82
  Crit W.S. (m)           123.06    Flow Area (m2)                      31.05
  E.G. Slope (m/m)      0.083021    Area (m2)                           31.05
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          19.46    Avg. Vel. (m/s)                     19.46
  Max Chl Dpth (m)          0.86    Hydr. Depth (m)                      0.86
  Conv. Total (m3/s)      2097.2    Conv. (m3/s)                       2097.2
  Length Wtd. (m)           9.82    Wetted Per. (m)                     37.72
  Min Ch El (m)           120.00    Shear (N/m2)                       670.00
  Alpha                     1.00    Stream Power (N/m s)             13040.91
  Frctn Loss (m)            0.77    Cum Volume (1000 m3)                 2.36
  C & E Loss (m)            0.06    Cum SA (1000 m2)                     2.47


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
```

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 2.85714*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	125	0	120	36	120	36	125

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.82	9.82	9.82	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	139.04	Element	Left OB	Channel	Right OB
Vel Head (m)	18.15	Wt. n-Val.		0.013	
W.S. Elev (m)	120.89	Reach Len. (m)	9.82	9.82	9.82
Crit W.S. (m)	123.06	Flow Area (m2)		32.01	
E.G. Slope (m/m)	0.075115	Area (m2)		32.01	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	18.88	Avg. Vel. (m/s)		18.88	
Max Chl Dpth (m)	0.89	Hydr. Depth (m)		0.89	
Conv. Total (m3/s)	2204.8	Conv. (m3/s)		2204.8	
Length Wtd. (m)	9.82	Wetted Per. (m)		37.78	
Min Ch El (m)	120.00	Shear (N/m2)		624.14	
Alpha	1.00	Stream Power (N/m s)		11782.23	
Frctn Loss (m)	0.77	Cum Volume (1000 m3)		2.05	
C & E Loss (m)	0.34	Cum SA (1000 m2)		2.12	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 2.71428*

```
INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     125       0     120      36     120      36     125

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.82    9.82    9.82             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           138.03    Element                 Left OB    Channel
Right OB
  Vel Head (m)             17.11    Wt. n-Val.                          0.013
  W.S. Elev (m)           120.92    Reach Len. (m)            9.82       9.82
9.82
  Crit W.S. (m)           123.06    Flow Area (m2)                      32.97
  E.G. Slope (m/m)      0.068197    Area (m2)                           32.97
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          18.33    Avg. Vel. (m/s)                     18.33
  Max Chl Dpth (m)          0.92    Hydr. Depth (m)                      0.92
  Conv. Total (m3/s)      2313.9    Conv. (m3/s)                       2313.9
  Length Wtd. (m)           9.82    Wetted Per. (m)                     37.83
  Min Ch El (m)           120.00    Shear (N/m2)                       582.83
  Alpha                     1.00    Stream Power (N/m s)             10681.98
  Frctn Loss (m)            0.70    Cum Volume (1000 m3)                 1.74
  C & E Loss (m)            0.31    Cum SA (1000 m2)                     1.77


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 2.57142*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     125       0     120      36     120      36     125

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
```

```
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.82    9.82    9.82             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           137.10    Element                 Left OB    Channel
Right OB
  Vel Head (m)             16.16    Wt. n-Val.                          0.013
  W.S. Elev (m)           120.94    Reach Len. (m)            9.82       9.82
9.82
  Crit W.S. (m)           123.06    Flow Area (m2)                      33.93
  E.G. Slope (m/m)      0.062117    Area (m2)                           33.93
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          17.81    Avg. Vel. (m/s)                     17.81
  Max Chl Dpth (m)          0.94    Hydr. Depth (m)                      0.94
  Conv. Total (m3/s)      2424.5    Conv. (m3/s)                       2424.5
  Length Wtd. (m)           9.82    Wetted Per. (m)                     37.88
  Min Ch El (m)           120.00    Shear (N/m2)                       545.49
  Alpha                     1.00    Stream Power (N/m s)              9716.03
  Frctn Loss (m)            0.64    Cum Volume (1000 m3)                 1.41
  C & E Loss (m)            0.29    Cum SA (1000 m2)                     1.41


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 2.42857*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     125       0     120      36     120      36     125

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.82    9.82    9.82             .1       .3

CROSS SECTION OUTPUT  Profile #PMP
```

```
  E.G. Elev (m)           136.26    Element                 Left OB    Channel
Right OB
  Vel Head (m)             15.29    Wt. n-Val.                          0.013
  W.S. Elev (m)           120.97    Reach Len. (m)            9.82       9.82
9.82
  Crit W.S. (m)           123.06    Flow Area (m2)                      34.88
  E.G. Slope (m/m)      0.056748    Area (m2)                           34.88
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
  Vel Total (m/s)          17.33    Avg. Vel. (m/s)                     17.33
  Max Chl Dpth (m)          0.97    Hydr. Depth (m)                      0.97
  Conv. Total (m3/s)      2536.6    Conv. (m3/s)                       2536.6
  Length Wtd. (m)           9.82    Wetted Per. (m)                     37.94
  Min Ch El (m)           120.00    Shear (N/m2)                       511.61
  Alpha                     1.00    Stream Power (N/m s)              8863.93
  Frctn Loss (m)            0.58    Cum Volume (1000 m3)                 1.07
  C & E Loss (m)            0.26    Cum SA (1000 m2)                     1.06


Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may
indicate the need for
         additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.
         This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Q. Beatriz
REACH: Channel            RS: 2.28571*

INPUT
Description:
Station Elevation Data    num=       4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     125       0     120      36     120      36     125

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013      36    .013

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.
Expan.
             0      36             9.82    9.82    9.82             .1       .3

CROSS SECTION OUTPUT  Profile #PMP

  E.G. Elev (m)           135.49    Element                 Left OB    Channel
Right OB
  Vel Head (m)             14.49    Wt. n-Val.                          0.013
  W.S. Elev (m)           121.00    Reach Len. (m)            9.82       9.82
9.82
  Crit W.S. (m)           123.06    Flow Area (m2)                      35.83
  E.G. Slope (m/m)      0.051987    Area (m2)                           35.83
  Q Total (m3/s)          604.27    Flow (m3/s)                        604.27
  Top Width (m)            36.00    Top Width (m)                       36.00
```

Vel Total (m/s)	16.87	Avg. Vel. (m/s)	16.87
Max Chl Dpth (m)	1.00	Hydr. Depth (m)	1.00
Conv. Total (m3/s)	2650.2	Conv. (m3/s)	2650.2
Length Wtd. (m)	9.82	Wetted Per. (m)	37.99
Min Ch El (m)	120.00	Shear (N/m2)	480.77
Alpha	1.00	Stream Power (N/m s)	8108.94
Frctn Loss (m)	0.53	Cum Volume (1000 m3)	0.72
C & E Loss (m)	0.24	Cum SA (1000 m2)	0.71

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 2.14285*

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	125	0	120	36	120	36	125

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	9.82	9.82	9.82	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	134.78	Element	Left OB	Channel	Right OB
Vel Head (m)	13.76	Wt. n-Val.		0.013	
W.S. Elev (m)	121.02	Reach Len. (m)	9.82	9.82	9.82
Crit W.S. (m)	123.06	Flow Area (m2)		36.77	
E.G. Slope (m/m)	0.047755	Area (m2)		36.77	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	16.43	Avg. Vel. (m/s)		16.43	
Max Chl Dpth (m)	1.02	Hydr. Depth (m)		1.02	
Conv. Total (m3/s)	2765.2	Conv. (m3/s)		2765.2	
Length Wtd. (m)	9.82	Wetted Per. (m)		38.04	
Min Ch El (m)	120.00	Shear (N/m2)		452.65	
Alpha	1.00	Stream Power (N/m s)		7438.55	
Frctn Loss (m)	0.49	Cum Volume (1000 m3)		0.37	
C & E Loss (m)	0.22	Cum SA (1000 m2)		0.35	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Q. Beatriz
REACH: Channel RS: 2

INPUT
Description: Sta 6+50
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	125	0	120	36	120	36	125

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	36	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	36	0	0	0	.1	.3

CROSS SECTION OUTPUT Profile #PMP

E.G. Elev (m)	134.13	Element	Left OB	Channel	Right OB
Vel Head (m)	13.08	Wt. n-Val.		0.013	
W.S. Elev (m)	121.05	Reach Len. (m)			
Crit W.S. (m)	123.06	Flow Area (m2)		37.71	
E.G. Slope (m/m)	0.043974	Area (m2)		37.71	
Q Total (m3/s)	604.27	Flow (m3/s)		604.27	
Top Width (m)	36.00	Top Width (m)		36.00	
Vel Total (m/s)	16.02	Avg. Vel. (m/s)		16.02	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)		1.05	
Conv. Total (m3/s)	2881.6	Conv. (m3/s)		2881.6	
Length Wtd. (m)		Wetted Per. (m)		38.10	
Min Ch El (m)	120.00	Shear (N/m2)		426.91	
Alpha	1.00	Stream Power (N/m s)		6840.21	
Frctn Loss (m)	0.45	Cum Volume (1000 m3)			
C & E Loss (m)	0.20	Cum SA (1000 m2)			

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.

SUMMARY OF MANNING'S N VALUES

River:Q. Beatriz

Reach	River Sta.	n1	n2	n3
Channel	14	.013	.013	.013
Channel	13.9375*	.013	.013	.013
Channel	13.875*	.013	.013	.013
Channel	13.8125*	.013	.013	.013
Channel	13.75*	.013	.013	.013
Channel	13.6875*	.013	.013	.013
Channel	13.625*	.013	.013	.013
Channel	13.5625*	.013	.013	.013
Channel	13.5*	.013	.013	.013
Channel	13.4375*	.013	.013	.013
Channel	13.375*	.013	.013	.013
Channel	13.3125*	.013	.013	.013
Channel	13.25*	.013	.013	.013
Channel	13.1875*	.013	.013	.013
Channel	13.125*	.013	.013	.013
Channel	13.0625*	.013	.013	.013
Channel	13	.013	.013	.013
Channel	12	.013	.013	.013
Channel	11	.013	.013	.013
Channel	10	.013	.013	.013
Channel	9	.013	.013	.013
Channel	8	.013	.013	.013
Channel	7	.013	.013	.013
Channel	6	.013	.013	.013
Channel	5	.013	.013	.013
Channel	4	.013	.013	.013
Channel	3.875*	.013	.013	.013
Channel	3.75*	.013	.013	.013
Channel	3.625*	.013	.013	.013
Channel	3.5*	.013	.013	.013
Channel	3.375*	.013	.013	.013
Channel	3.25*	.013	.013	.013
Channel	3.125*	.013	.013	.013
Channel	3	.013	.013	.013
Channel	2.85714*	.013	.013	.013
Channel	2.71428*	.013	.013	.013
Channel	2.57142*	.013	.013	.013
Channel	2.42857*	.013	.013	.013
Channel	2.28571*	.013	.013	.013
Channel	2.14285*	.013	.013	.013
Channel	2	.013	.013	.013

SUMMARY OF REACH LENGTHS

River: Q. Beatriz

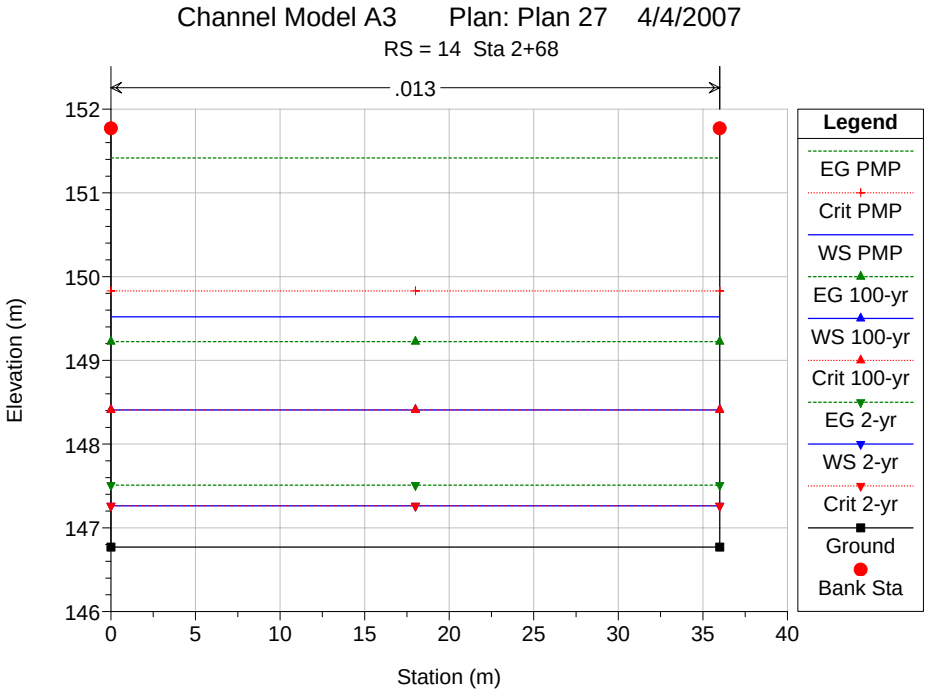
Reach	River Sta.	Left	Channel	Right

Channel	14	9.81	9.81	9.81
Channel	13.9375*	9.81	9.81	9.81
Channel	13.875*	9.81	9.81	9.81
Channel	13.8125*	9.81	9.81	9.81
Channel	13.75*	9.81	9.81	9.81
Channel	13.6875*	9.81	9.81	9.81
Channel	13.625*	9.81	9.81	9.81
Channel	13.5625*	9.81	9.81	9.81
Channel	13.5*	9.81	9.81	9.81
Channel	13.4375*	9.81	9.81	9.81
Channel	13.375*	9.81	9.81	9.81
Channel	13.3125*	9.81	9.81	9.81
Channel	13.25*	9.81	9.81	9.81
Channel	13.1875*	9.81	9.81	9.81
Channel	13.125*	9.81	9.81	9.81
Channel	13.0625*	9.81	9.81	9.81
Channel	13	5	5	5
Channel	12	10	10	10
Channel	11	10	10	10
Channel	10	10	10	10
Channel	9	10	10	10
Channel	8	10	10	10
Channel	7	10	10	10
Channel	6	10	10	10
Channel	5	5	5	5
Channel	4	9.534	9.534	9.534
Channel	3.875*	9.534	9.534	9.534
Channel	3.75*	9.534	9.534	9.534
Channel	3.625*	9.534	9.534	9.534
Channel	3.5*	9.534	9.534	9.534
Channel	3.375*	9.534	9.534	9.534
Channel	3.25*	9.534	9.534	9.534
Channel	3.125*	9.534	9.534	9.534
Channel	3	9.82	9.82	9.82
Channel	2.85714*	9.82	9.82	9.82
Channel	2.71428*	9.82	9.82	9.82
Channel	2.57142*	9.82	9.82	9.82
Channel	2.42857*	9.82	9.82	9.82
Channel	2.28571*	9.82	9.82	9.82
Channel	2.14285*	9.82	9.82	9.82
Channel	2	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Q. Beatriz

Reach	River Sta.	Contr.	Expan.
Channel	14	.1	.3
Channel	13.9375*	.1	.3
Channel	13.875*	.1	.3
Channel	13.8125*	.1	.3
Channel	13.75*	.1	.3
Channel	13.6875*	.1	.3

Channel	13.625*	.1	.3
Channel	13.5625*	.1	.3
Channel	13.5*	.1	.3
Channel	13.4375*	.1	.3
Channel	13.375*	.1	.3
Channel	13.3125*	.1	.3
Channel	13.25*	.1	.3
Channel	13.1875*	.1	.3
Channel	13.125*	.1	.3
Channel	13.0625*	.1	.3
Channel	13	.1	.3
Channel	12	.1	.3
Channel	11	.1	.3
Channel	10	.1	.3
Channel	9	.1	.3
Channel	8	.1	.3
Channel	7	.1	.3
Channel	6	.1	.3
Channel	5	.1	.3
Channel	4	.1	.3
Channel	3.875*	.1	.3
Channel	3.75*	.1	.3
Channel	3.625*	.1	.3
Channel	3.5*	.1	.3
Channel	3.375*	.1	.3
Channel	3.25*	.1	.3
Channel	3.125*	.1	.3
Channel	3	.1	.3
Channel	2.85714*	.1	.3
Channel	2.71428*	.1	.3
Channel	2.57142*	.1	.3
Channel	2.42857*	.1	.3
Channel	2.28571*	.1	.3
Channel	2.14285*	.1	.3
Channel	2	.1	.3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.013
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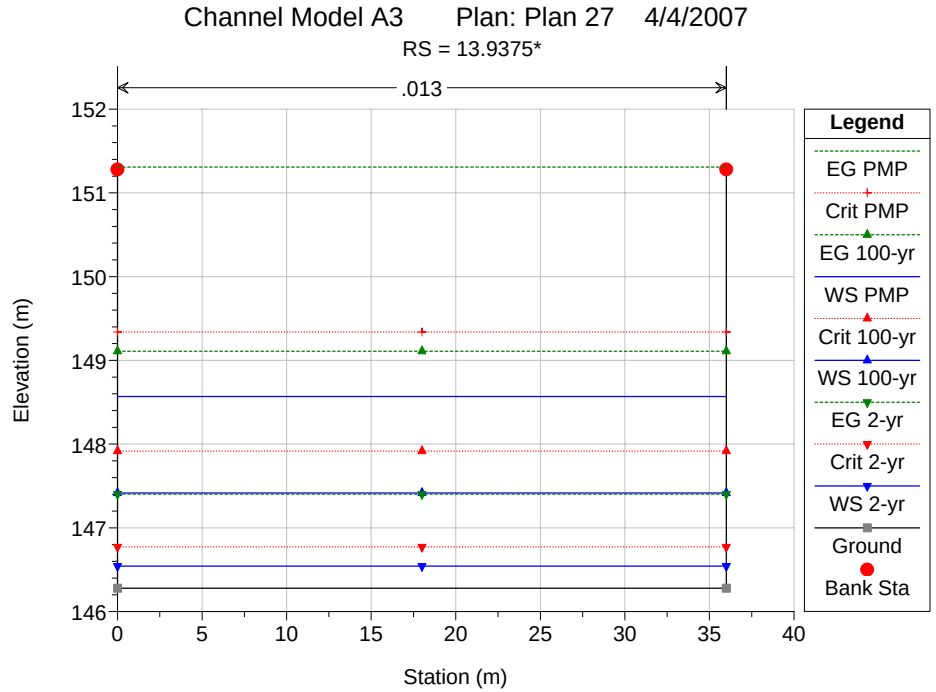
Station (m)
Legend
EG PMP
Crit PMP
WS PMP
EG 100-yr
WS 100-yr
Crit 100-yr
EG 2-yr
WS 2-yr
Crit 2-yr
Ground
Bank Sta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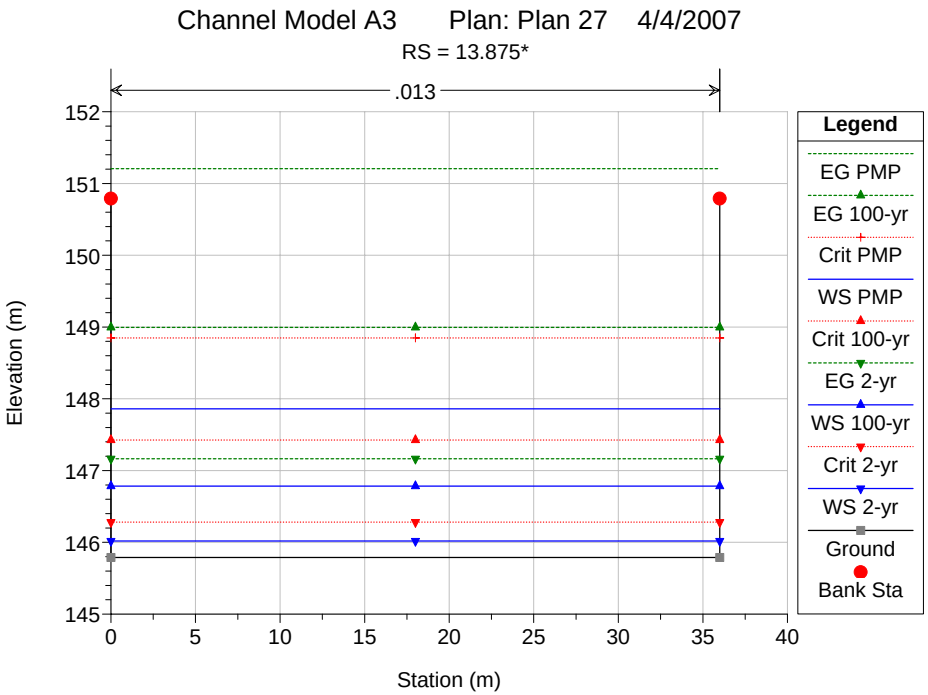
RS = 13.9375*
.013
Elevation (m)
Station (m)
Legend
EG PMP
Crit PMP
EG 100-yr
WS PMP
Crit 100-yr
WS 100-yr
EG 2-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta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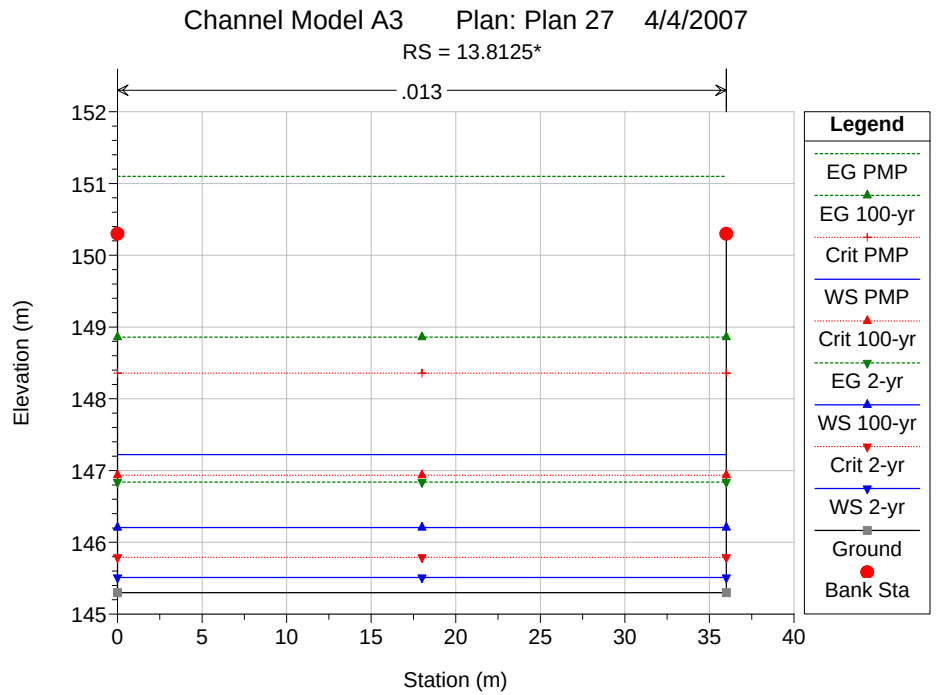
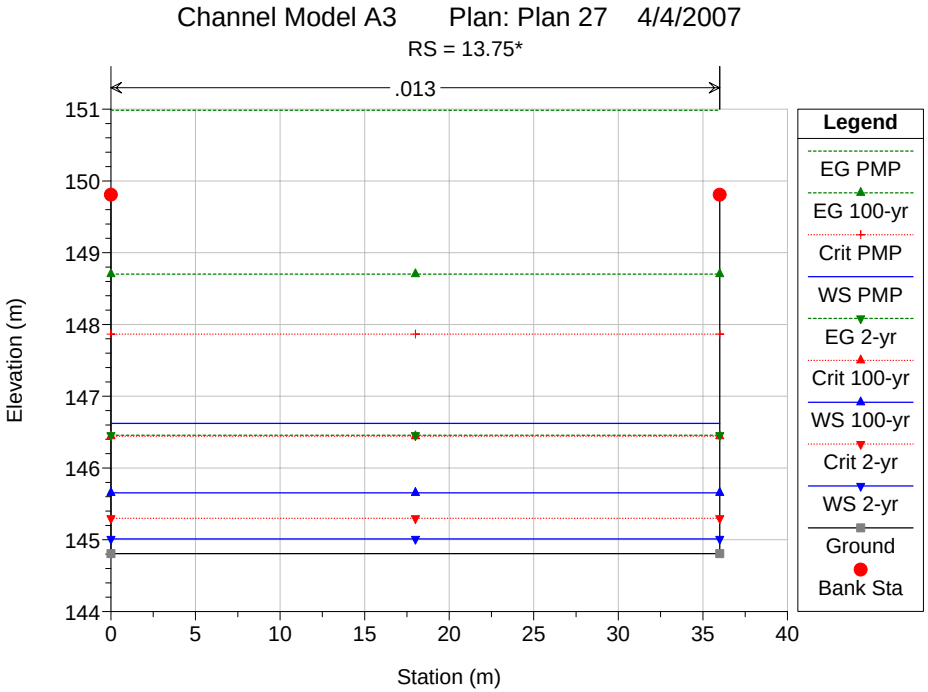
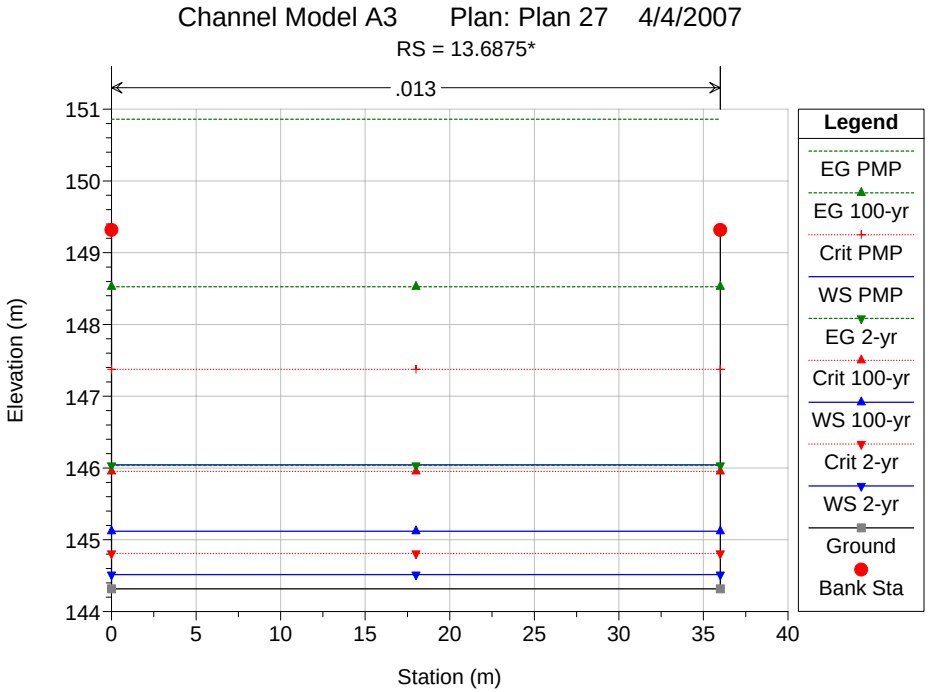
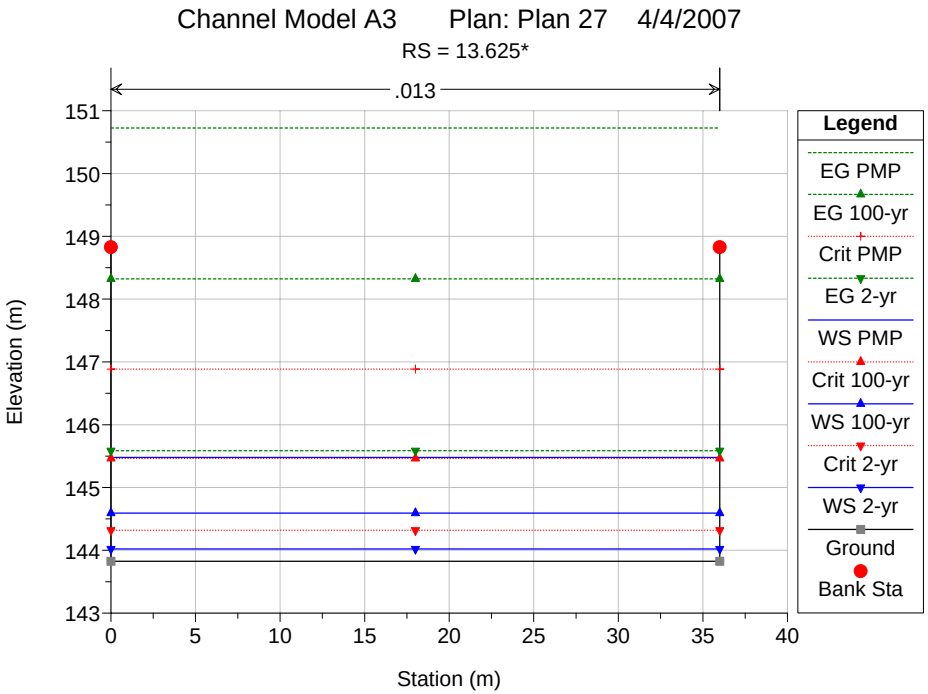
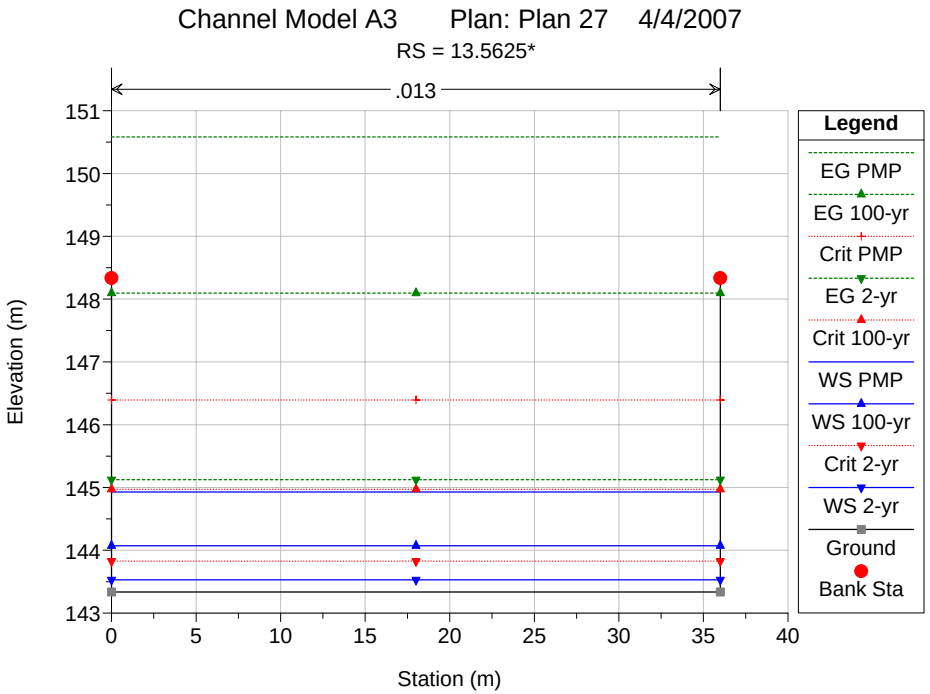
RS = 13.875*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
WS PMP
Crit 100-yr
EG 2-yr
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta


Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.8125*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
WS PMP
Crit 100-yr
EG 2-yr
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

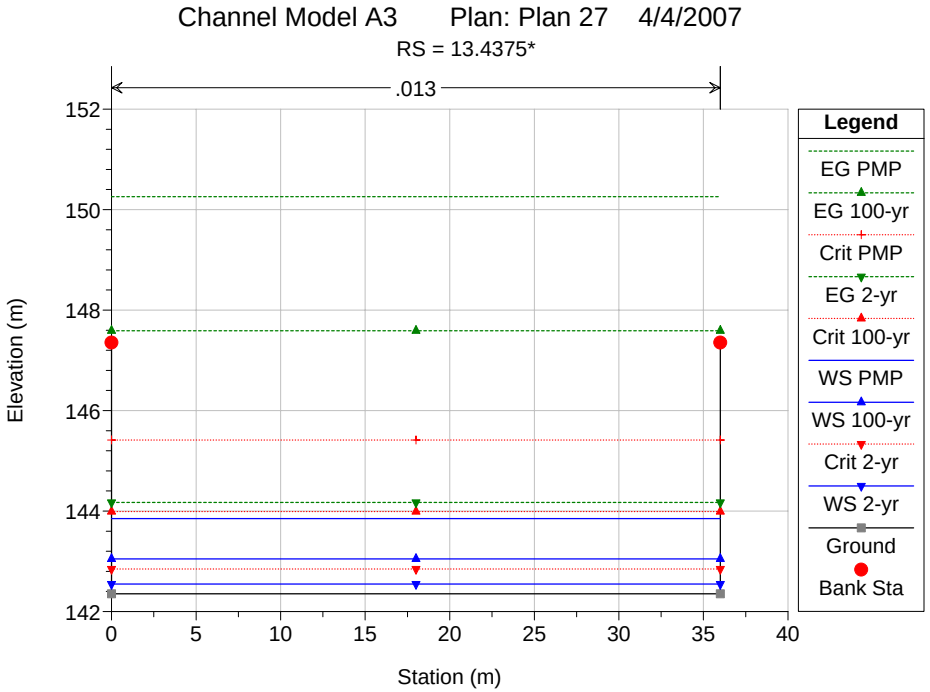

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.75*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
WS PMP
EG 2-yr
Crit 100-yr
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

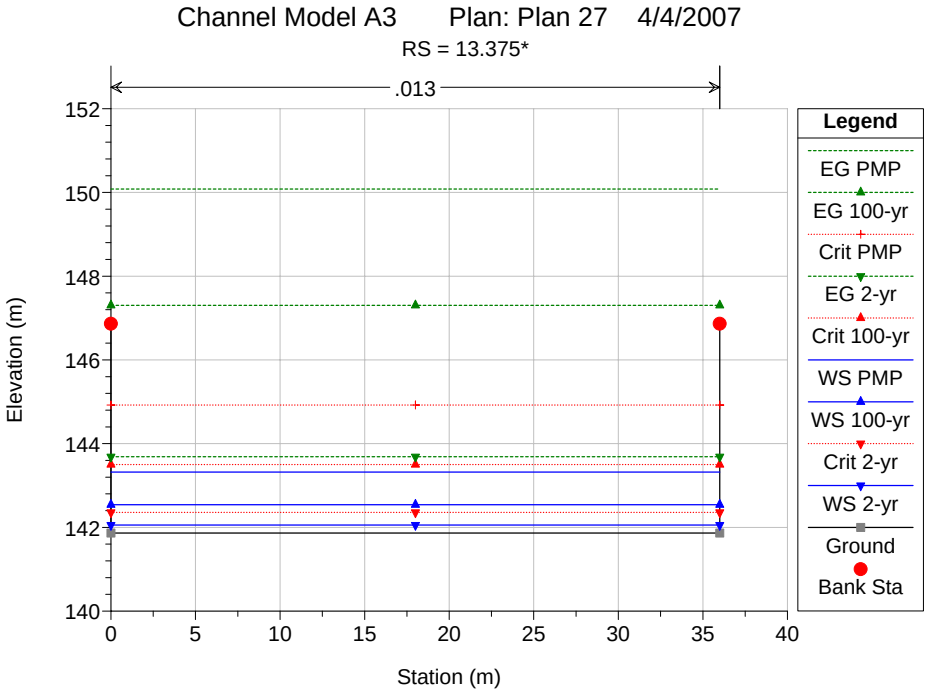

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.6875*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
WS PMP
EG 2-yr
Crit 100-yr
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

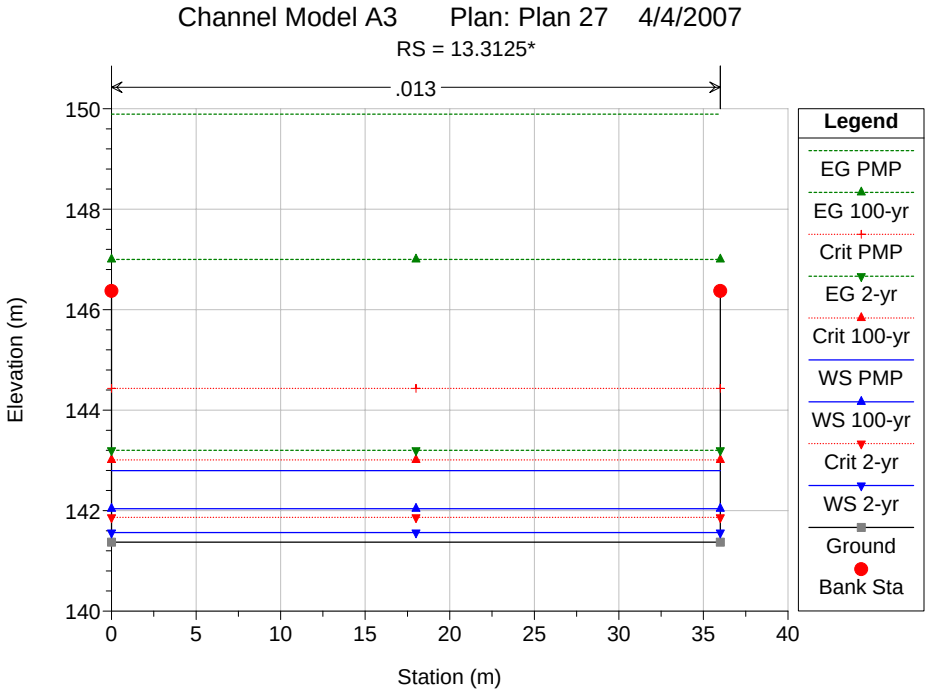

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.625*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
WS PMP
Crit 100-yr
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

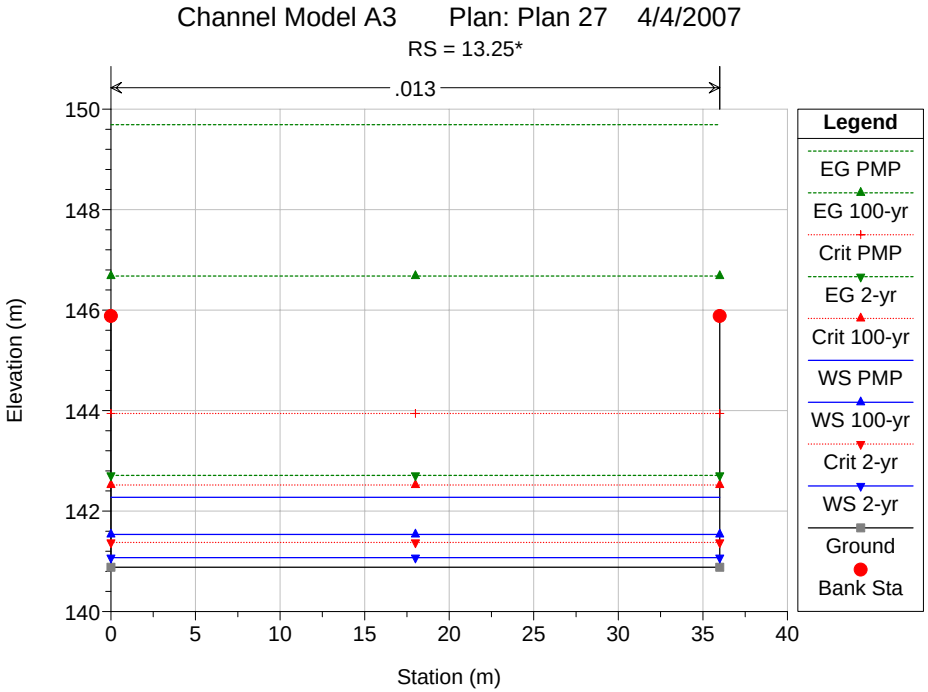

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.5625*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

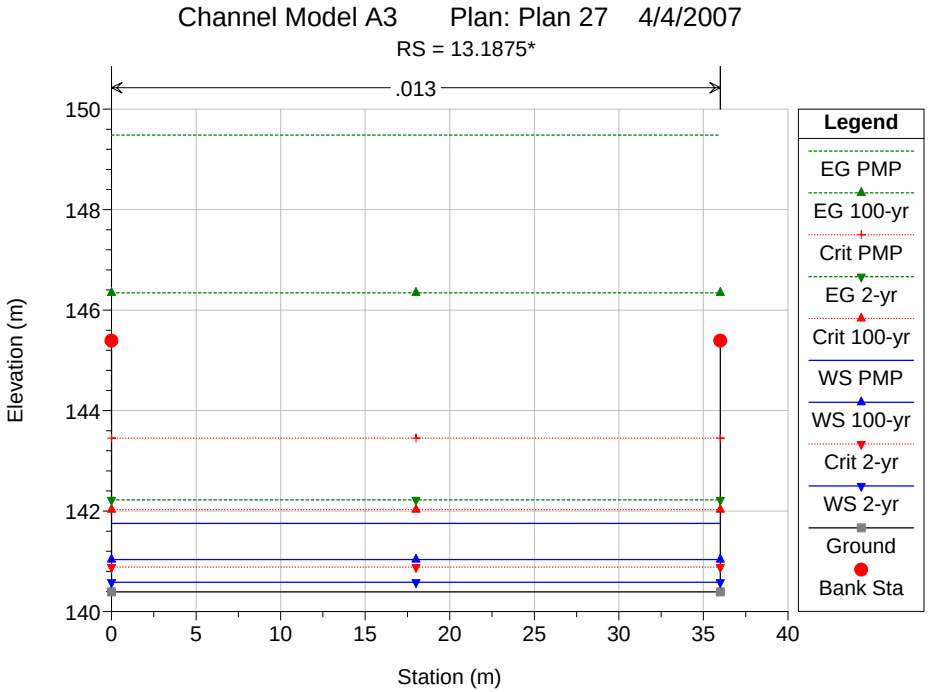
No Data for Plot

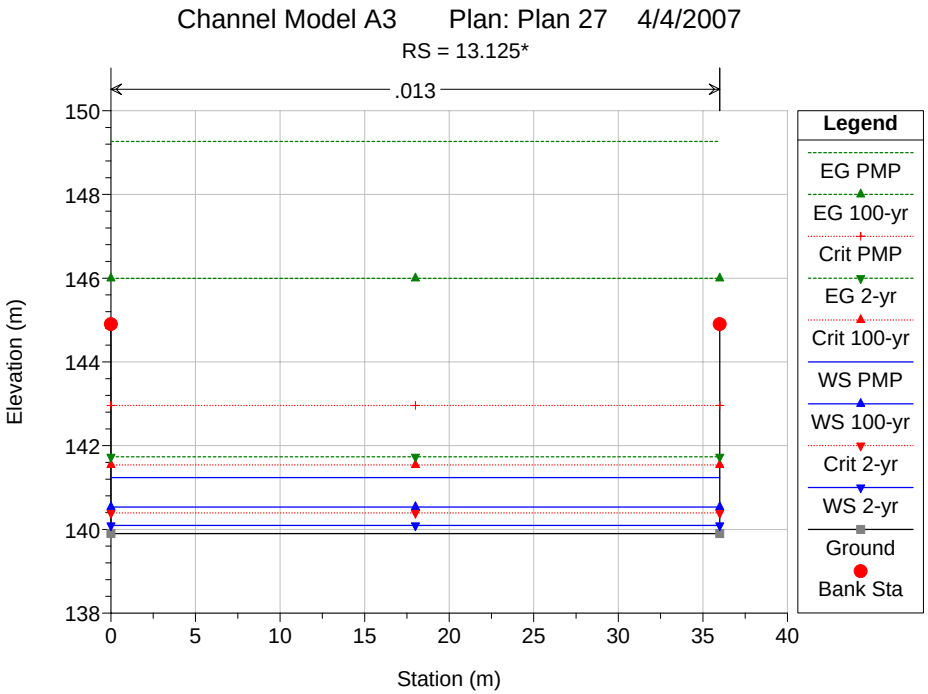


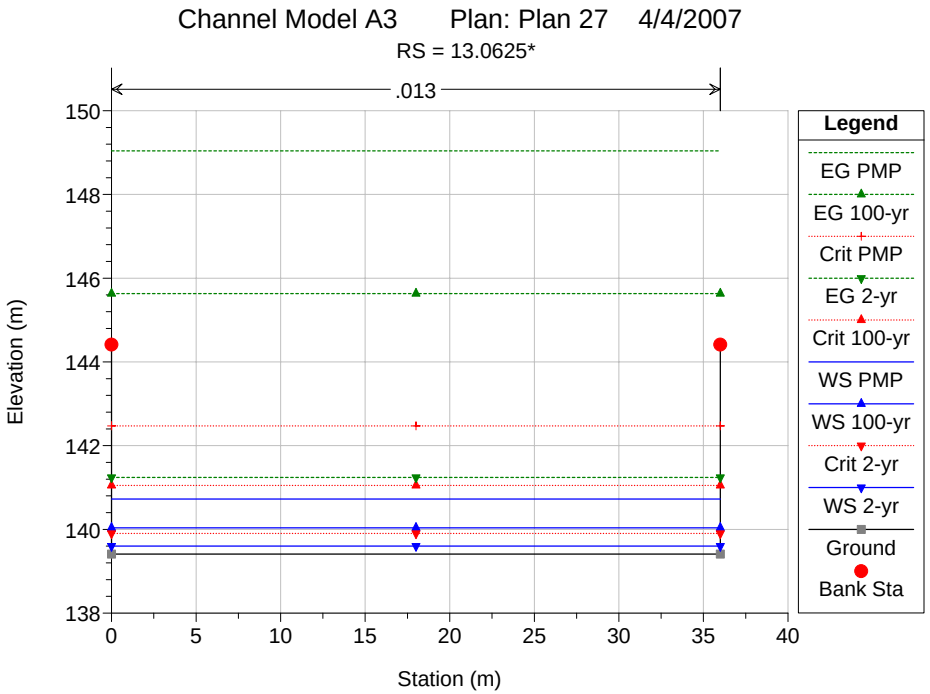


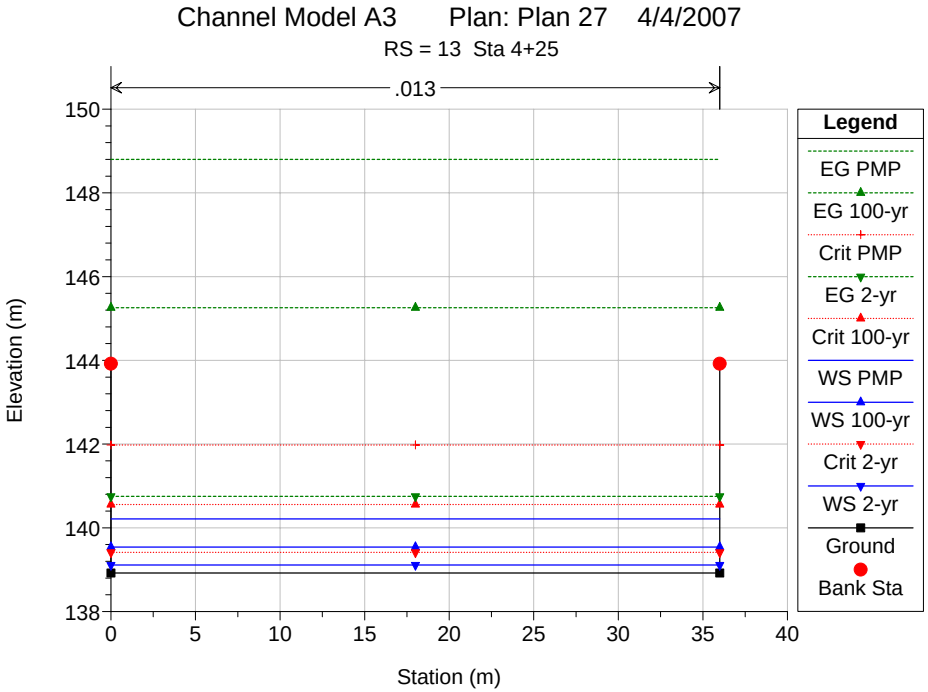


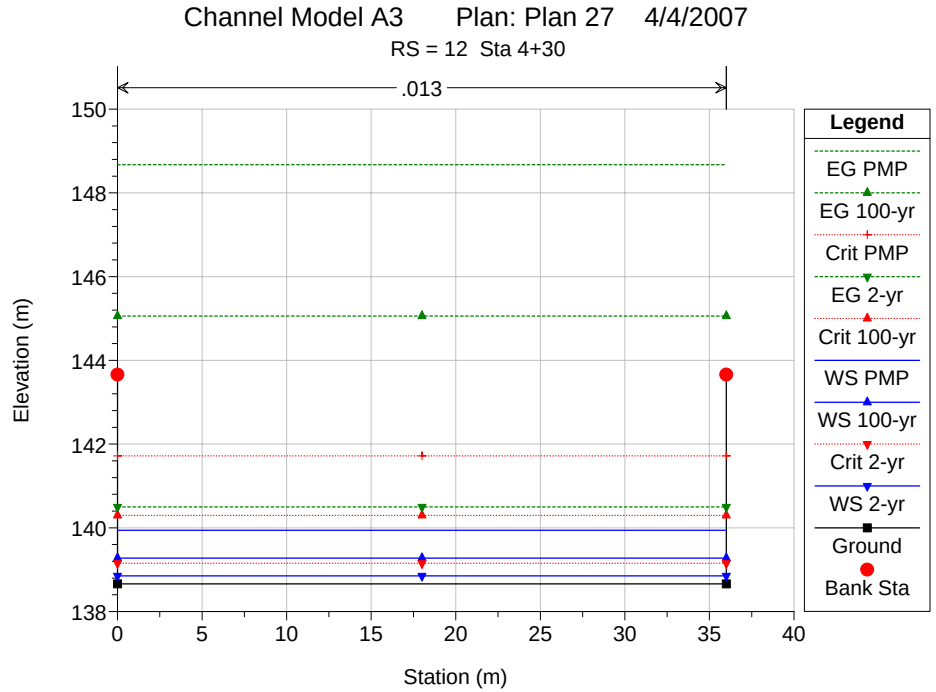

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.25*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

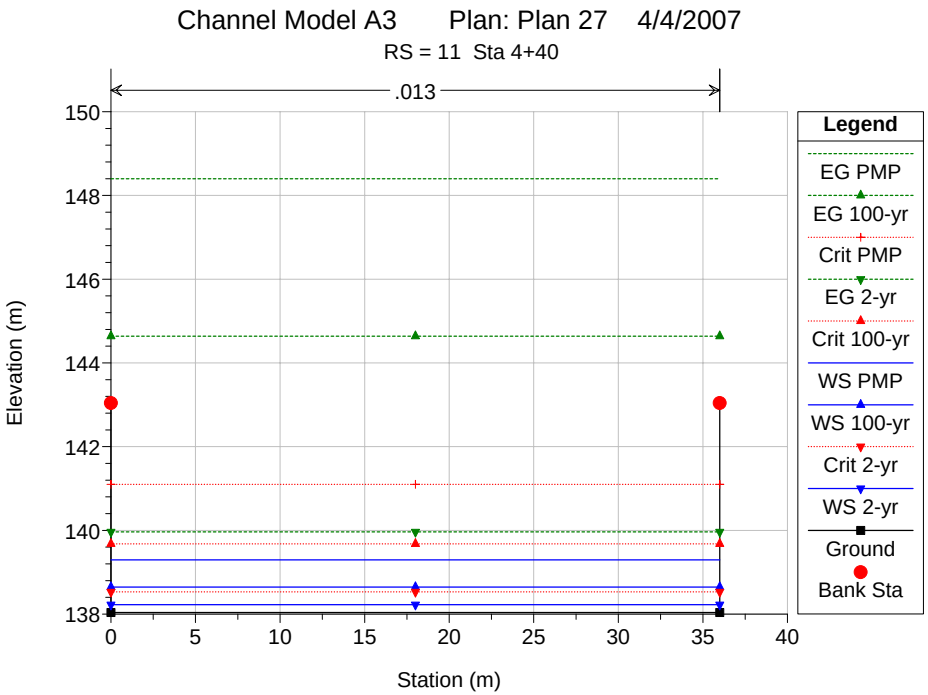

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.1875*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

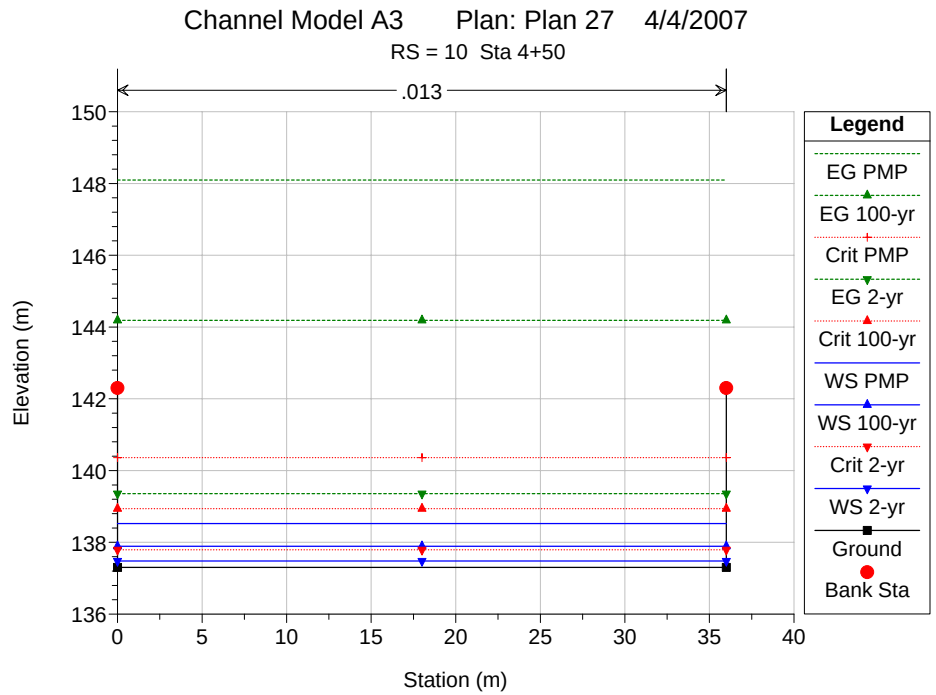

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.125*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

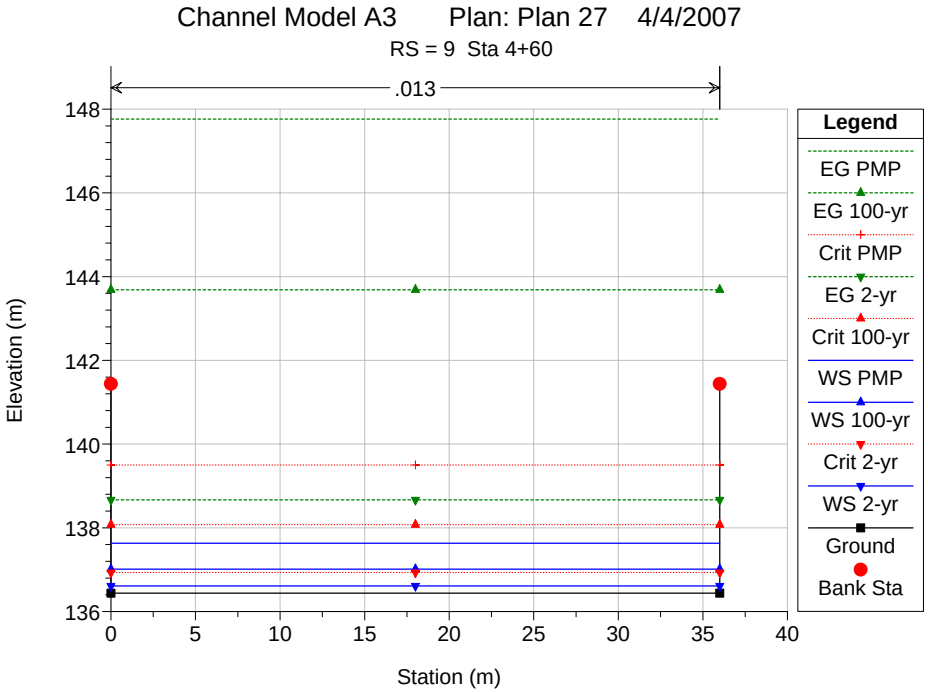

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13.0625*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

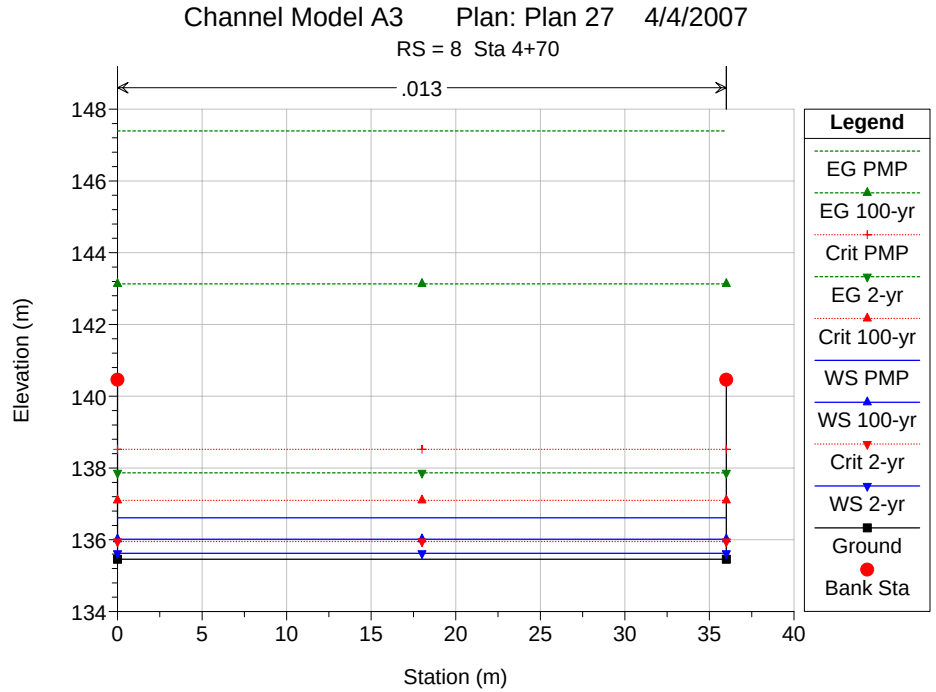

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 13 Sta 4+25
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

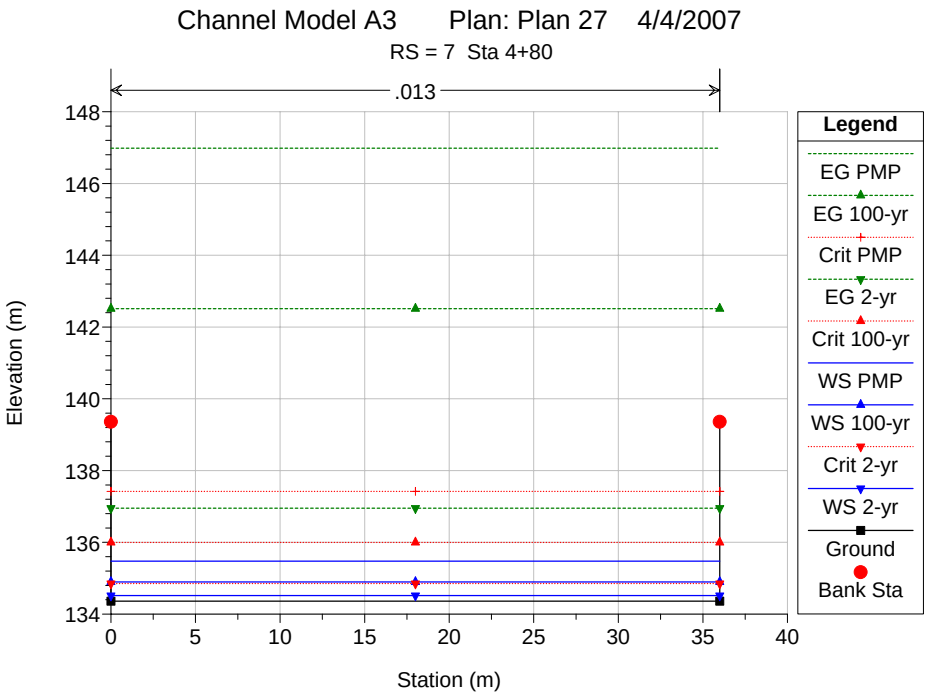

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 12 Sta 4+30
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

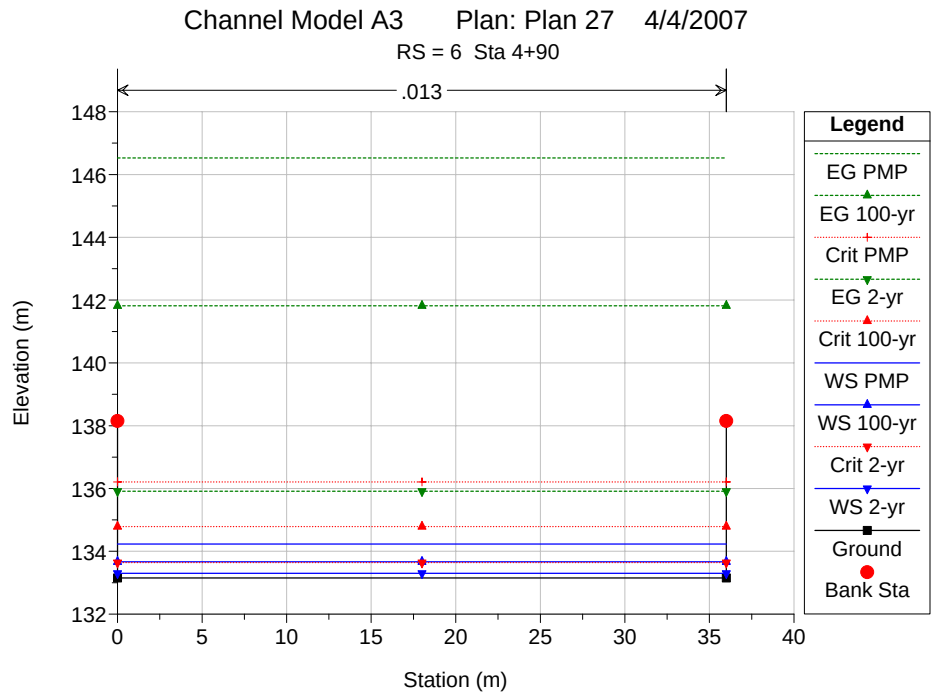

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 11 Sta 4+40
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

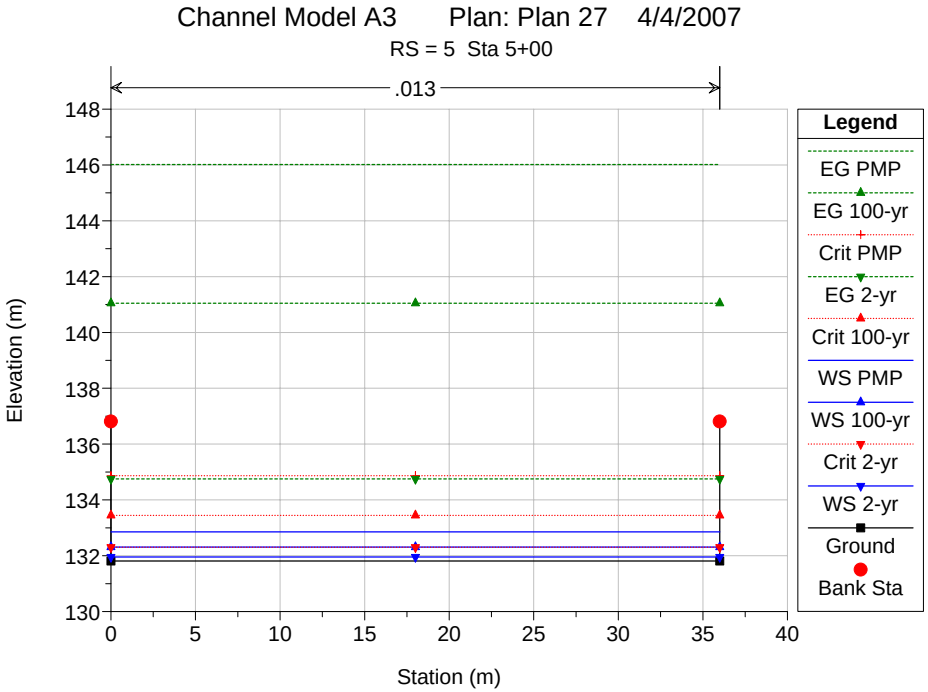

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 10 Sta 4+50
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

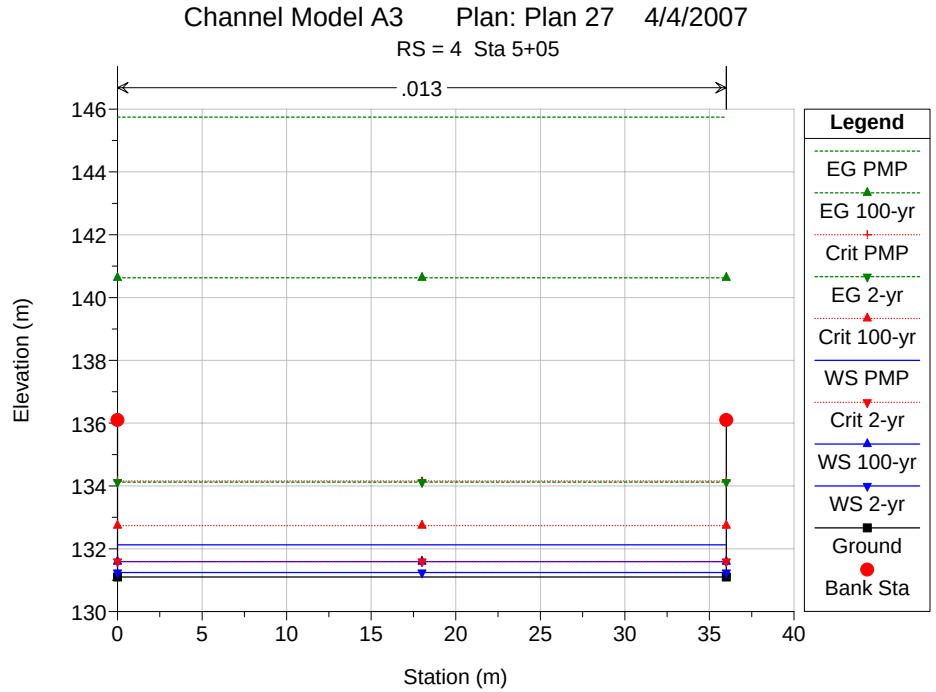

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 9 Sta 4+60
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

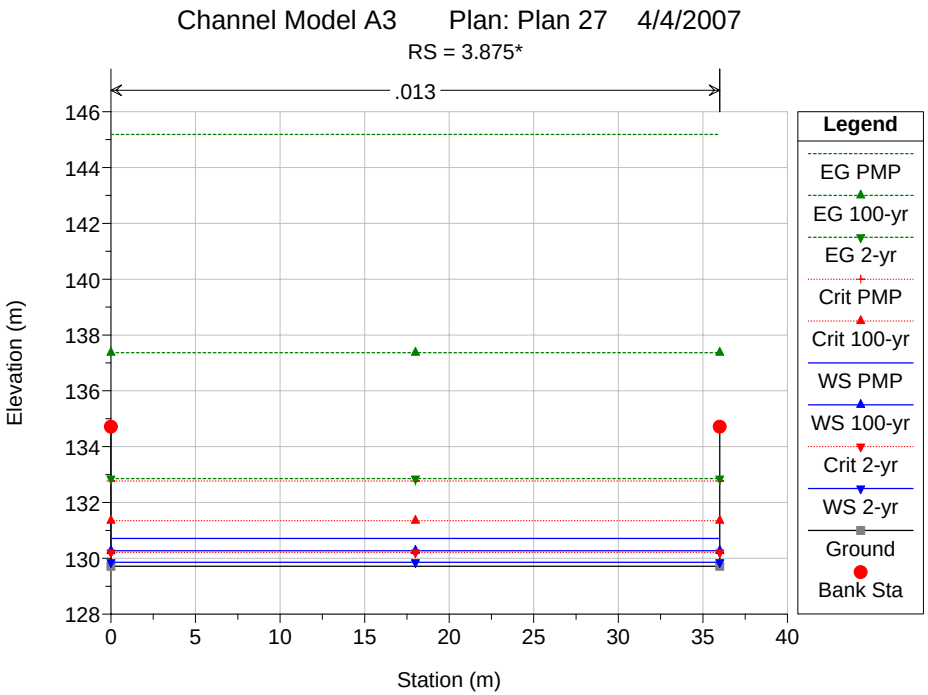

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 8 Sta 4+70
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

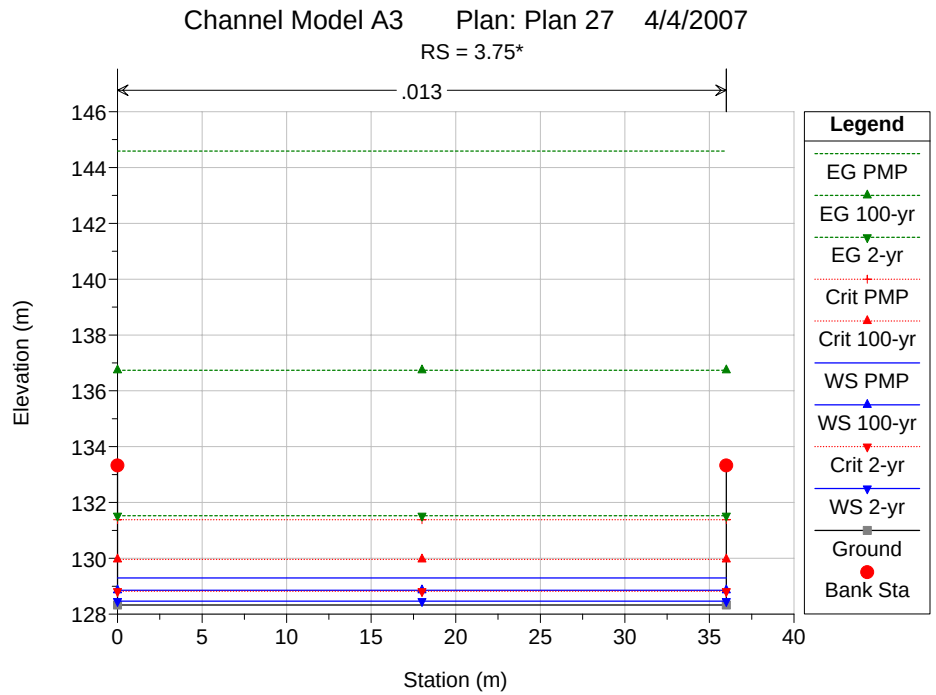

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 7 Sta 4+80
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

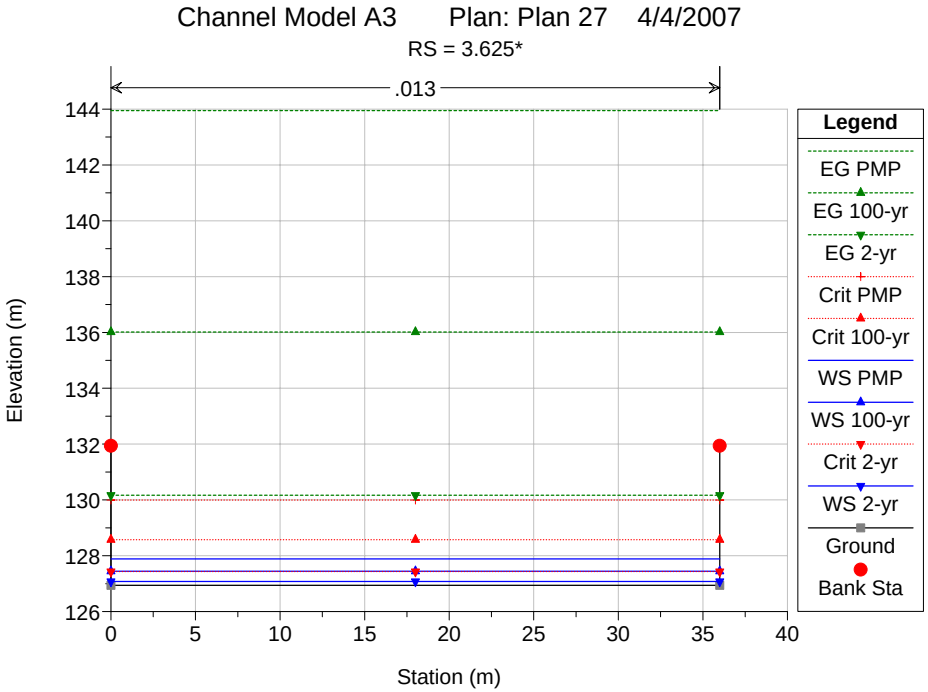

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 6 Sta 4+90
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

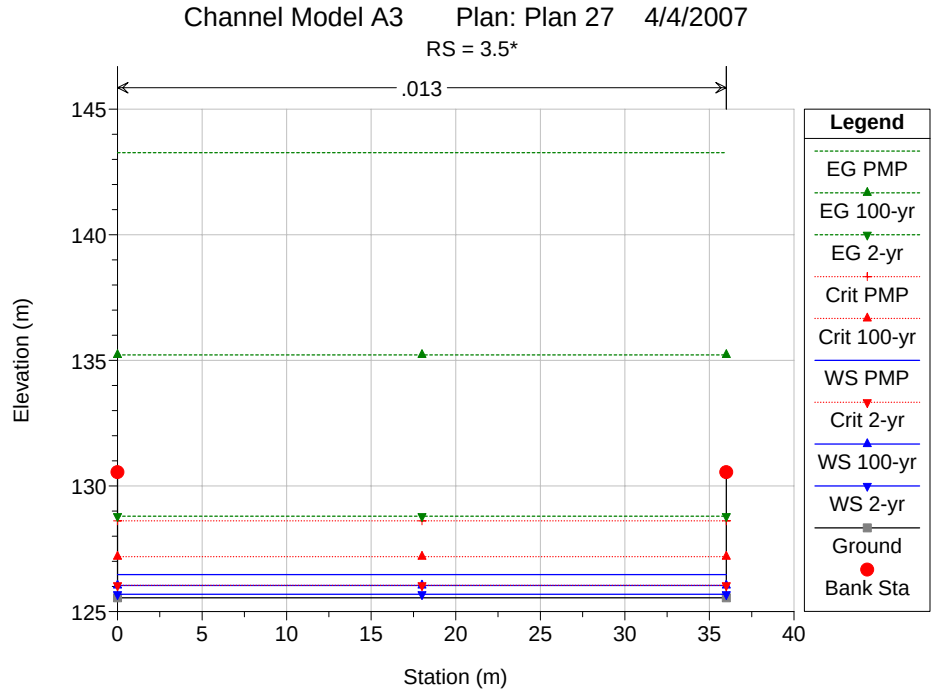

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 5 Sta 5+00
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

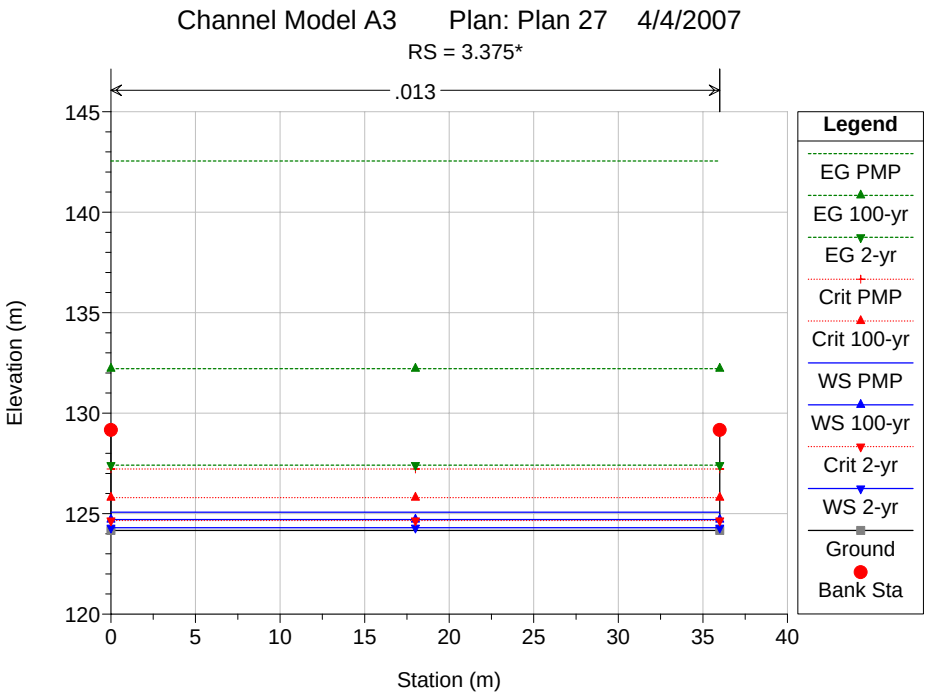

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 4 Sta 5+05
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
Crit 2-yr
WS 100-yr
WS 2-yr
Ground
Bank Sta

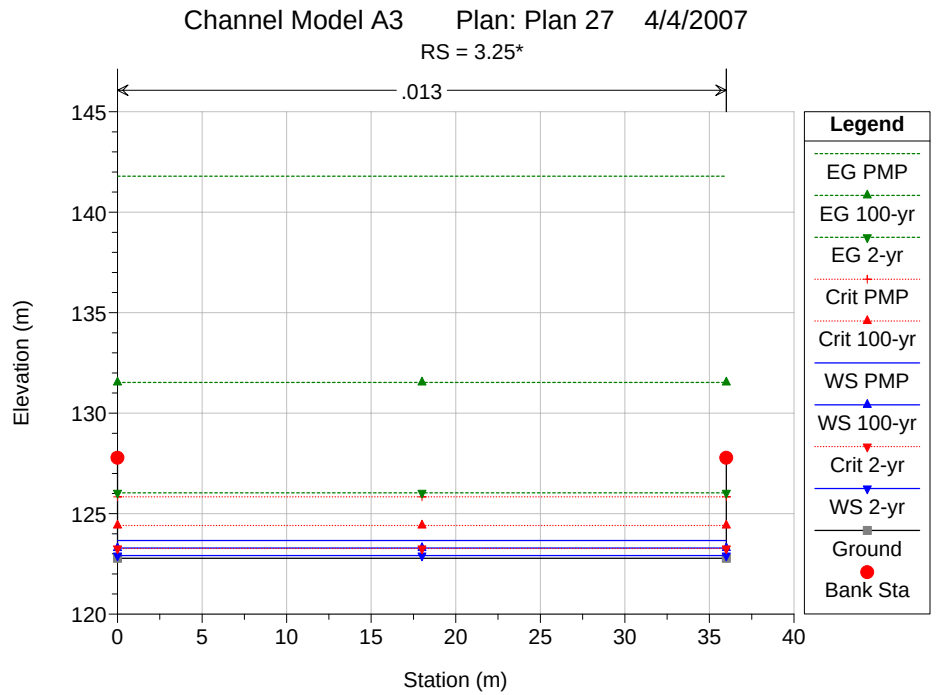

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.875*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

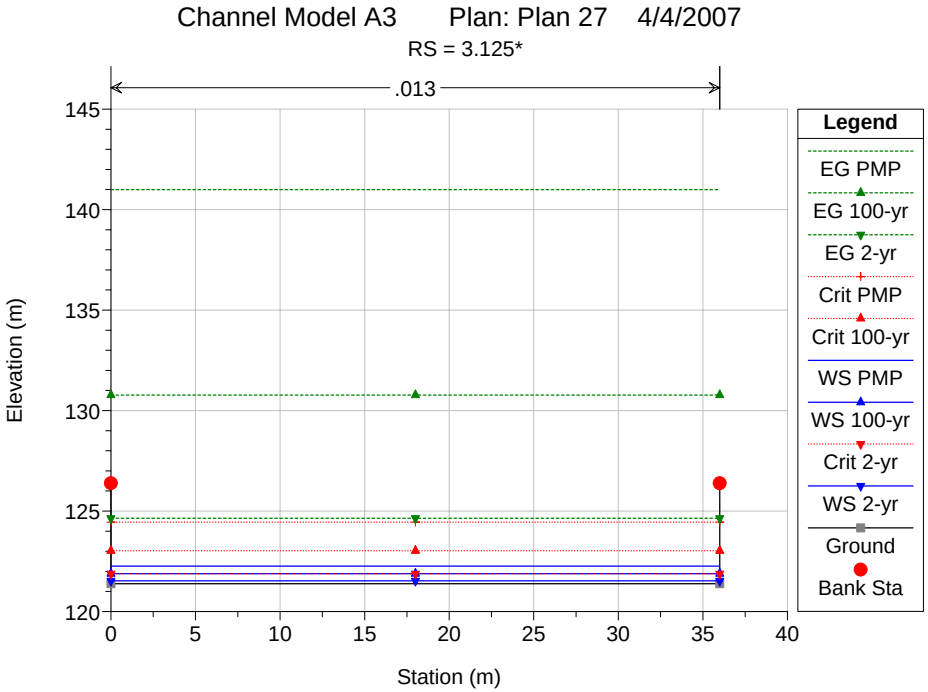

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.75*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

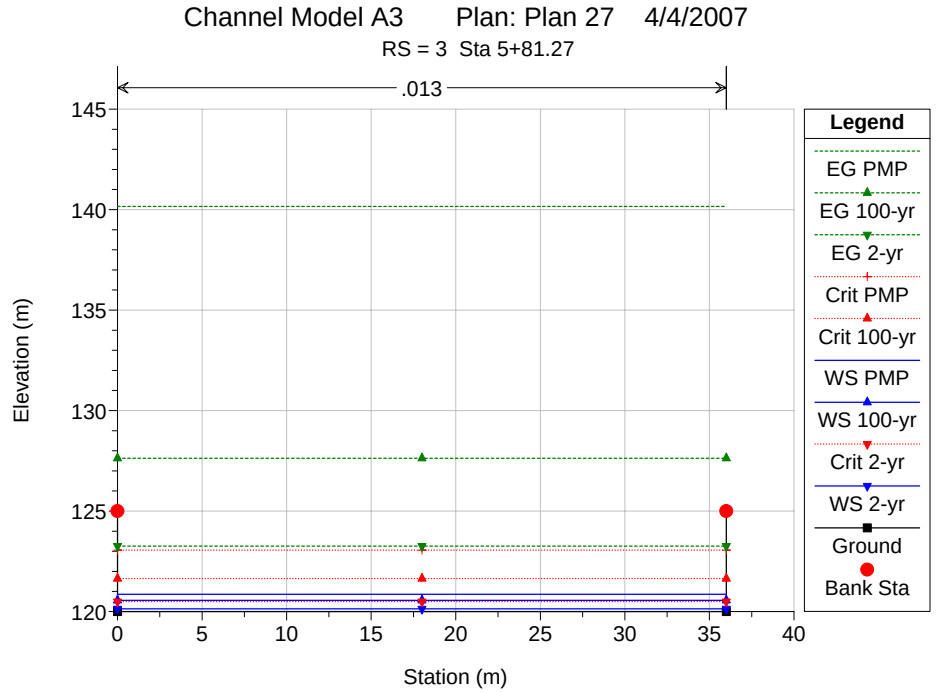

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.625*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

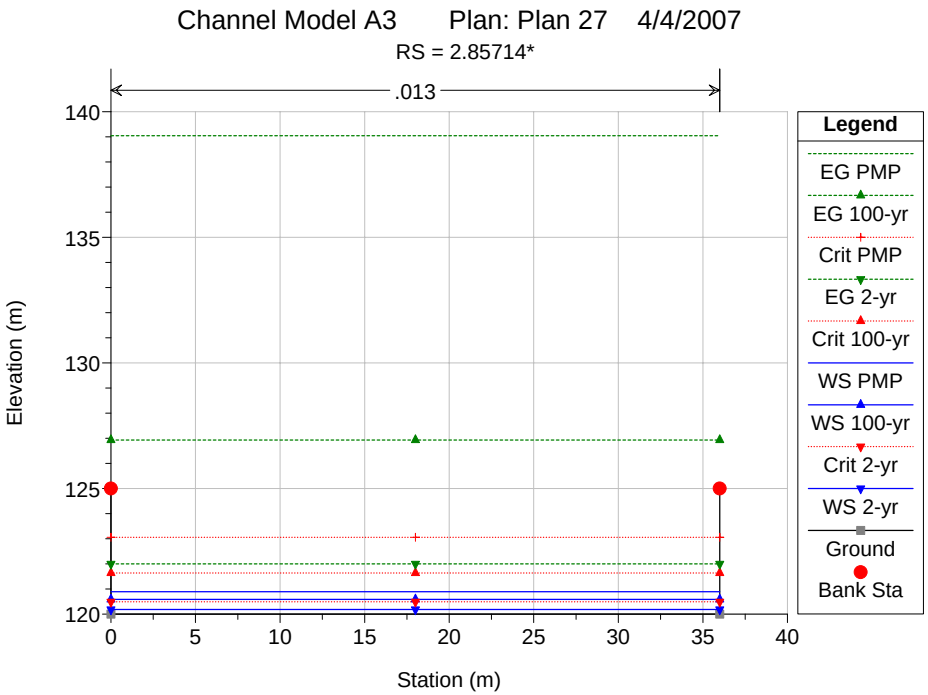

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.5*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
Crit 2-yr
WS 100-yr
WS 2-yr
Ground
Bank Sta

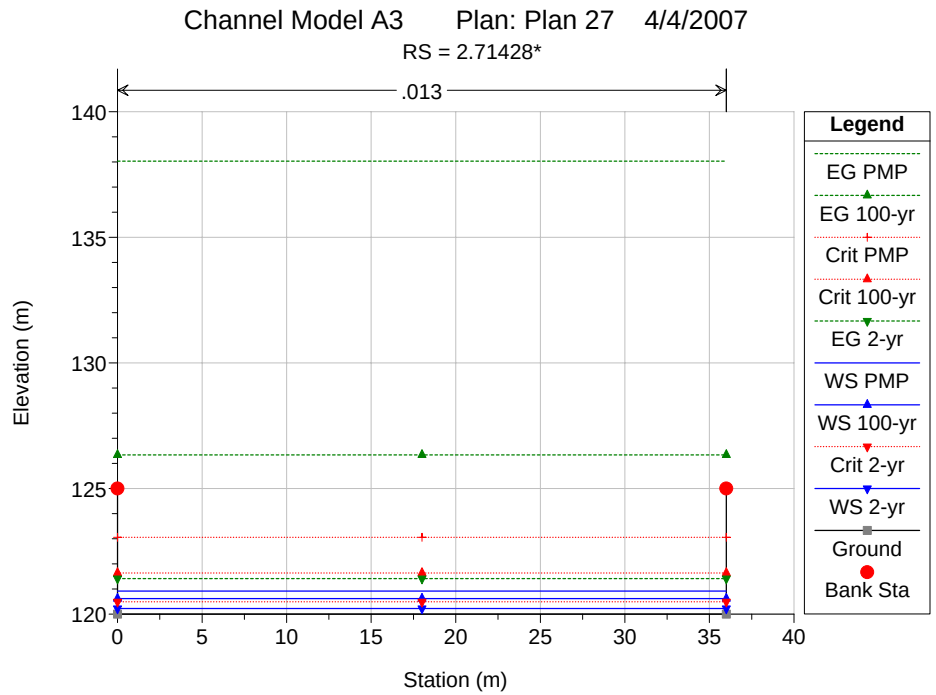

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.375*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

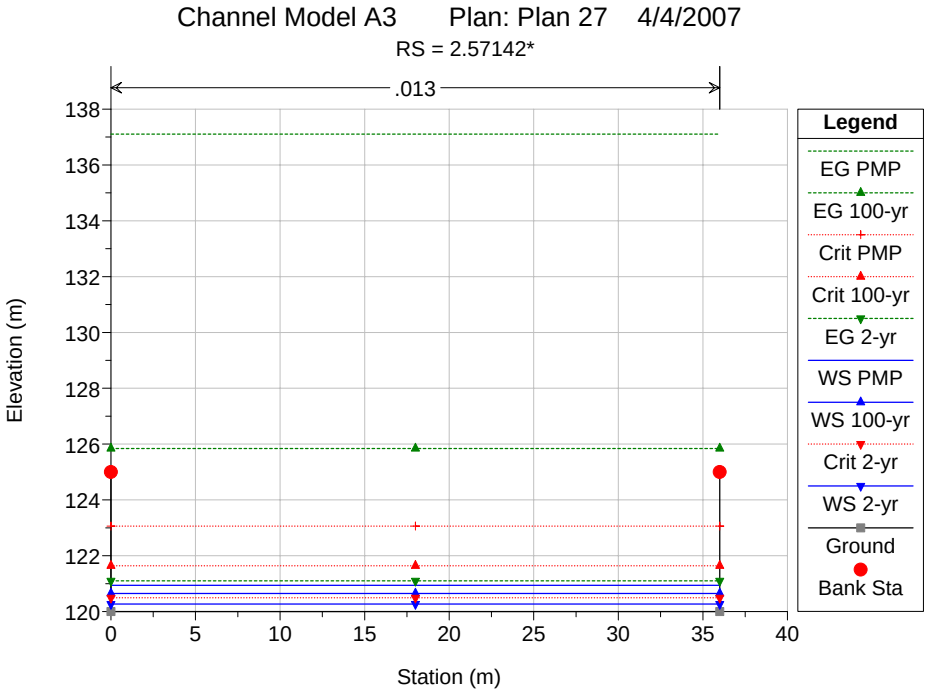

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.25*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

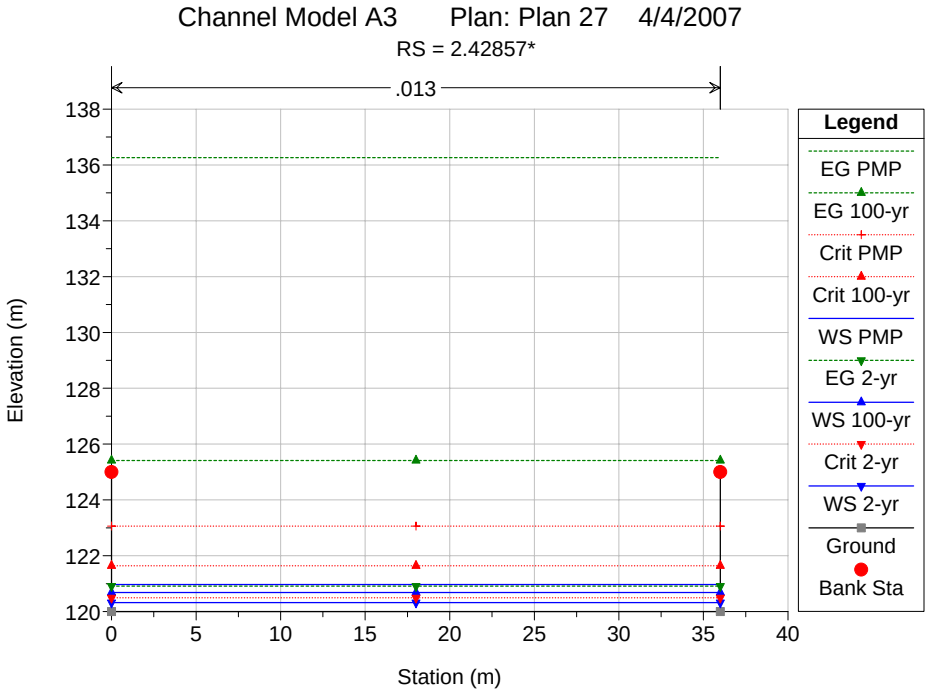

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3.125*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

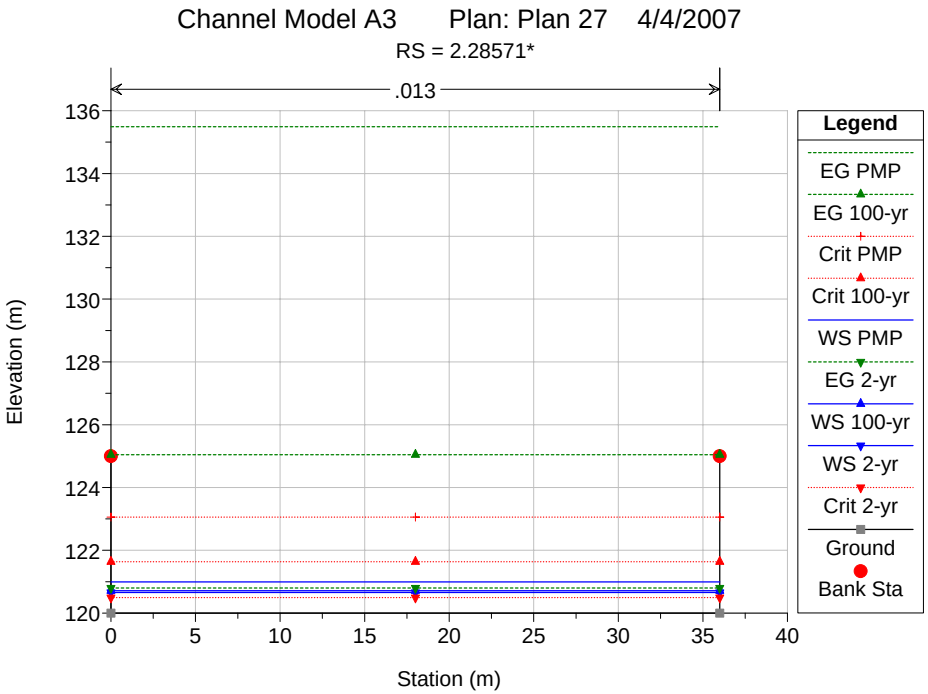

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 3 Sta 5+81.27
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
EG 2-yr
Crit PMP
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

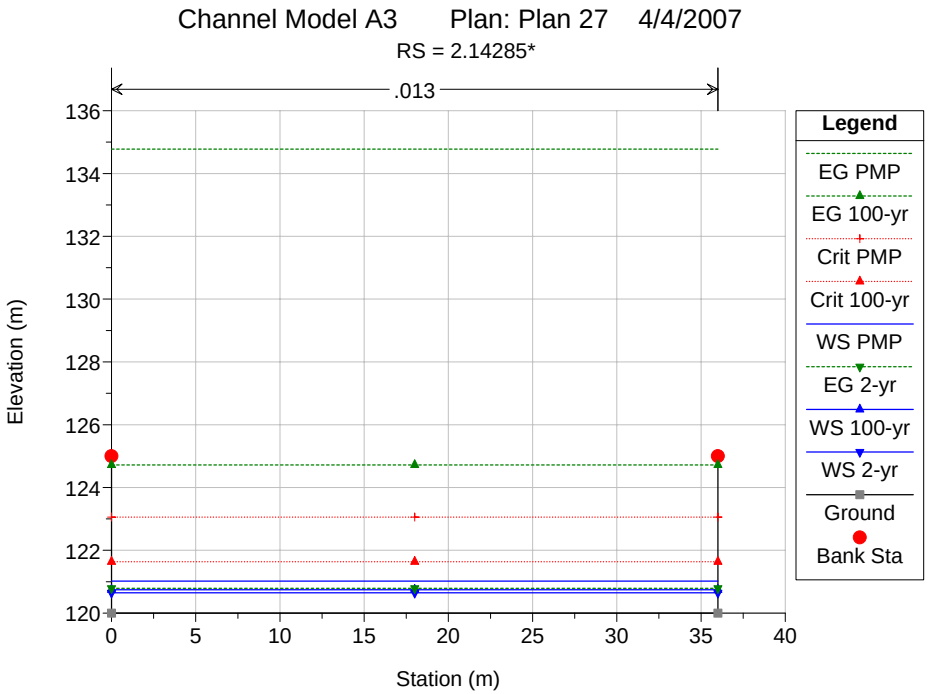

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 2.85714*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
EG 2-yr
Crit 100-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta


Channel Model A3 Plan: Plan 27 4/4/2007
RS = 2.71428*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
Crit 100-yr
EG 2-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta


Channel Model A3 Plan: Plan 27 4/4/2007
RS = 2.57142*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
Crit 100-yr
EG 2-yr
WS PMP
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

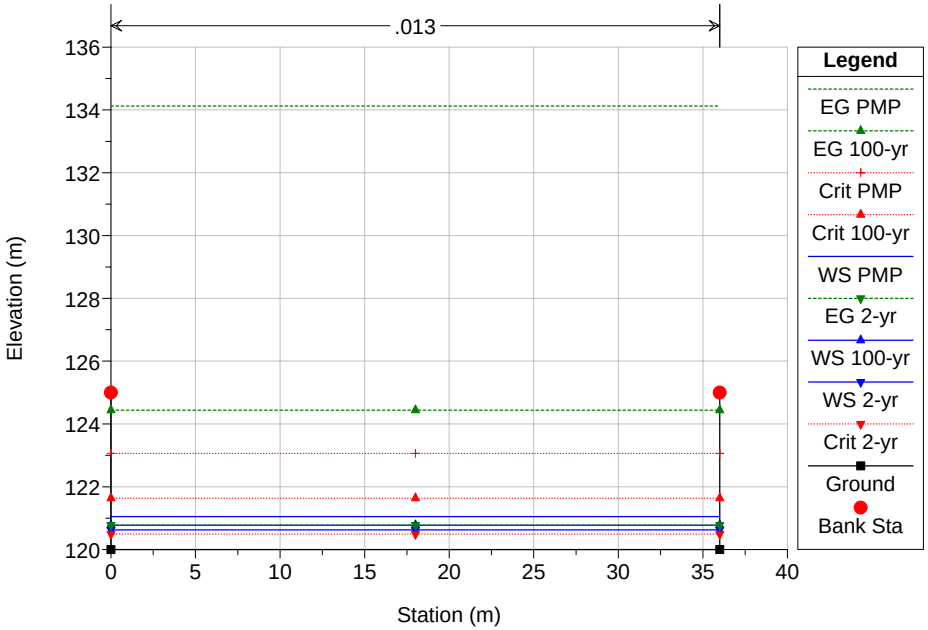

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 2.42857*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
Crit 100-yr
WS PMP
EG 2-yr
WS 100-yr
Crit 2-yr
WS 2-yr
Ground
Bank Sta

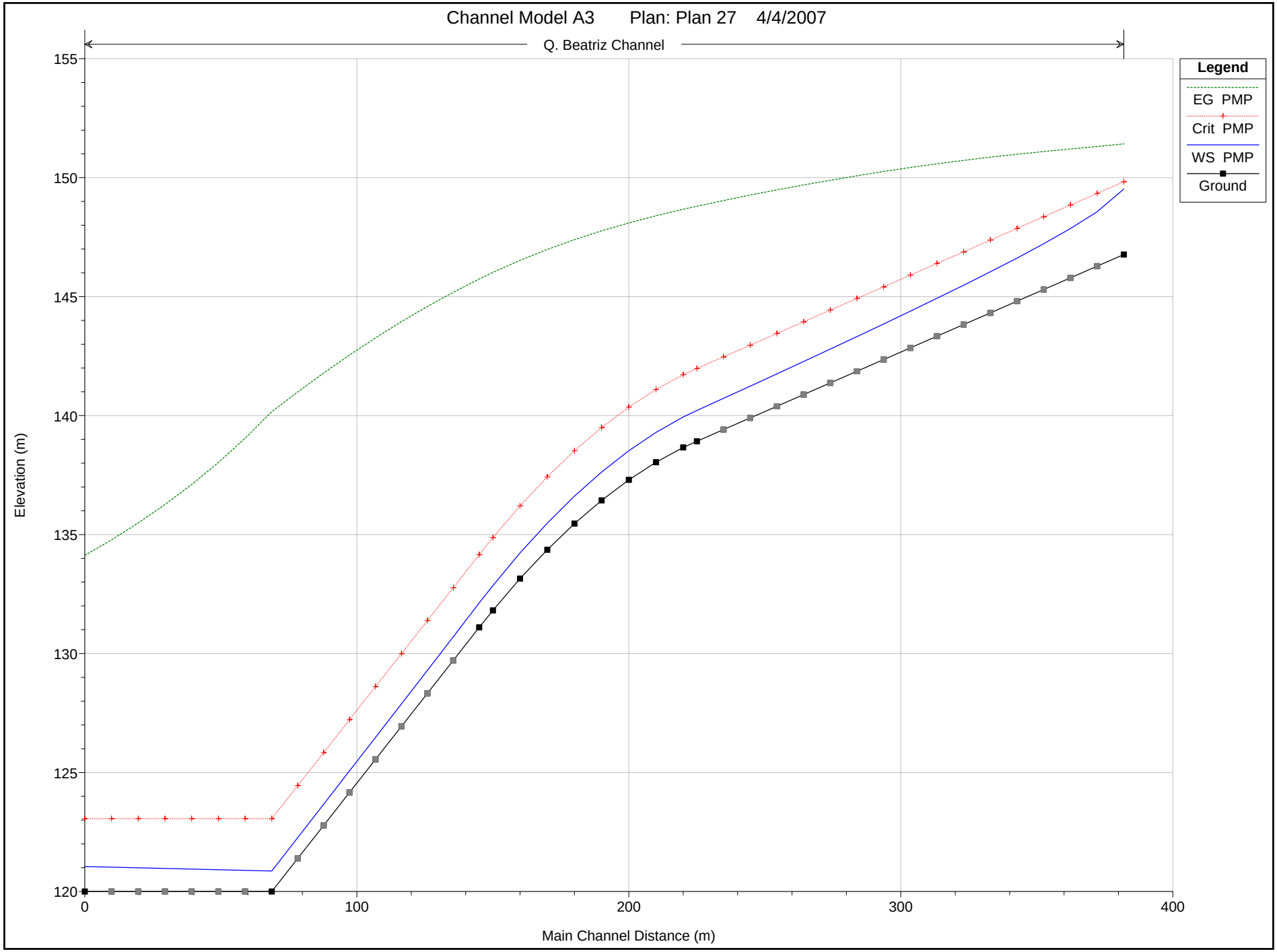

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 2.28571*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
Crit 100-yr
WS PMP
EG 2-yr
WS 100-yr
WS 2-yr
Crit 2-yr
Ground
Bank Sta

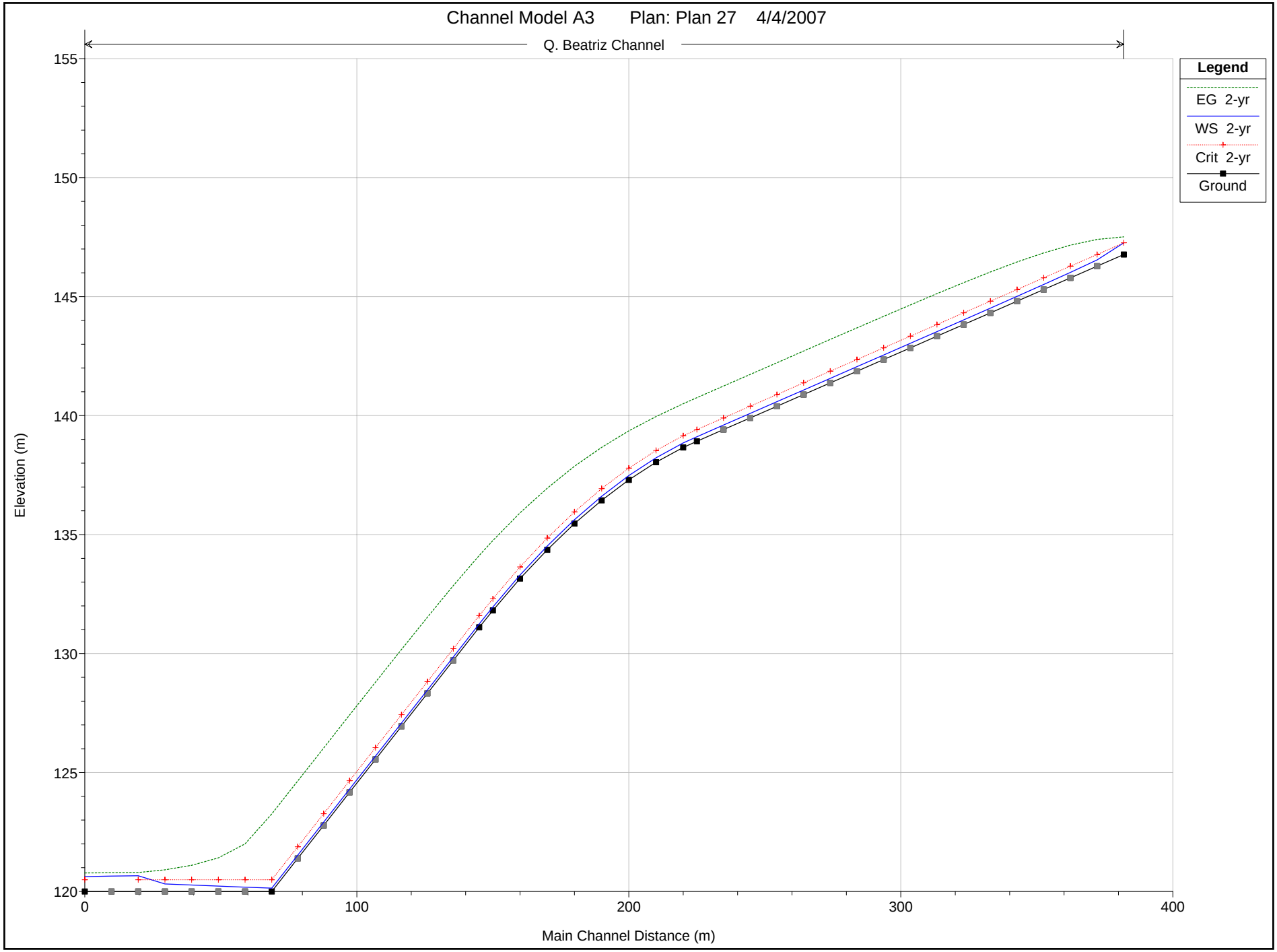

Channel Model A3 Plan: Plan 27 4/4/2007
RS = 2.14285*
.013
Elevation (m)
Station (m)
Legend
EG PMP
EG 100-yr
Crit PMP
Crit 100-yr
WS PMP
EG 2-yr
WS 100-yr
WS 2-yr
Ground
Bank Sta

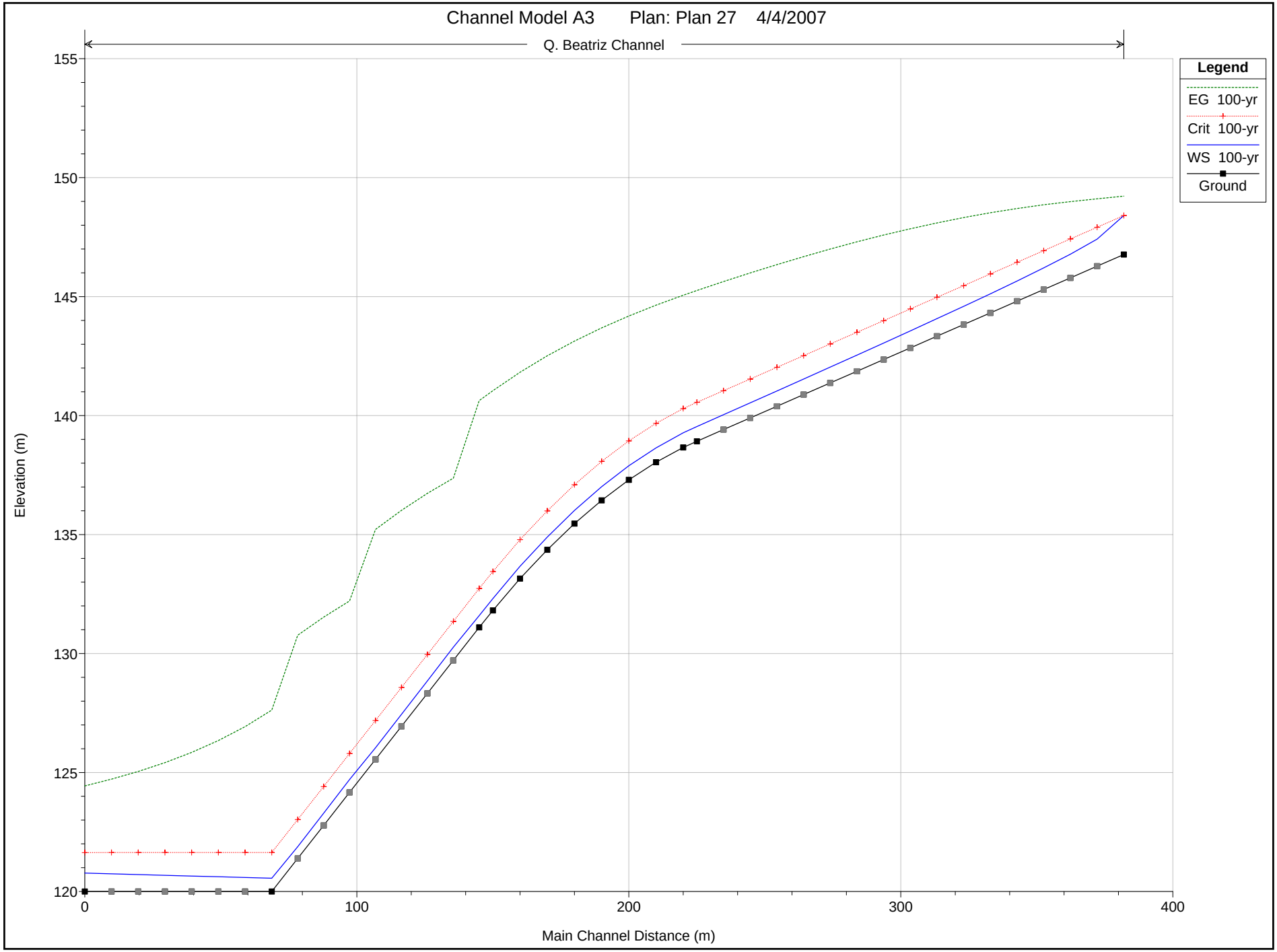
Channel Model A3 Plan: Plan 27 4/4/2007

RS = 2 Sta 6+50




Channel Model A3 Plan: Plan 27 4/4/2007
Q. Beatriz Channel
Legend
EG PMP
Crit PMP
WS PMP
Ground
Elevation (m)
155
150
145
140
135
130
125
120
0
100
200
300
400
Main Channel Distance (m)


Channel Model A3 Plan: Plan 27 4/4/2007
Q. Beatriz Channel
Legend
EG 2-yr
WS 2-yr
Crit 2-yr
Ground
Elevation (m)
155
150
145
140
135
130
125
120
0
100
200
300
400
Main Channel Distance (m)


Channel Model A3 Plan: Plan 27 4/4/2007
Q. Beatriz Channel
Legend
EG 100-yr
Crit 100-yr
WS 100-yr
Ground
Elevation (m)
155
150
145
140
135
130
125
120
0
100
200
300
400
Main Channel Distance (m)