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8. Notes/Comments
This calculation provides additional analyses to supplement the results presented in ANL-EBS-MD-000060 Rev 00.

A review of this document is not required because it is the initial issue and no other organizations or disciplines are affected.

Issuance of this document will resolve TBV-5492.

Alternate calculations used to check the PMF calculations are included in Attachment 26.

See Page 2 for additional notes.

Attachments	Total Number of Pages
List of attachments provided in Section 10 of this calculation	

9. No.	10. Reason for Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. QER (Print/Sign/Date)	16. Approved/Accepted (Print/Sign)	17. Date
00A	Initial issue	356 + 1 CD	26-4	Jeanne Hudson Jeanne Hudson 4/20/04 Matthew Knopp 4/22/04 Vivian Lee 4/20/04 Phillip Mineart 4/20/04 See note on page 2, Block 8	Jeanne Hudson Jeanne Hudson 4/20/04 Vivian Lee 4/20/04 Phillip Mineart 4/20/04 Douglas Wright Douglas Wright 04-21-2004 See note on page 2, Block 8	Dan Tunney Daniel Tunney 4/22/2004	RICHARD PERNISI 4/22/04	

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OCRWM	**Design Calculation or Analysis Cover Sheet**	1.QA: QA 2.Page: 2

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8. Notes/Comments
Several authors prepared this calculation. The originators and checkers of the various sections are shown below. For attachments containing computer program output, the originator and checker (other than the originator) of the attachment also performed and checked the computer runs and files. The originator and checker of files in Attachment 1 are listed in Table 10-1. Attachments 3 and 1.22 contain preliminary sketches that support this preliminary calculation.

Section(s)	**Originator**	**Checker**
Table of Contents; Acronyms; Abbreviations; Sections 1 through 5	Vivian Lee	Jeanne Hudson
Sections 6.1 and 6.2	Jeanne Hudson	Vivian Lee
Sections 6.3 through 6.5	Vivian Lee	Jeanne Hudson
Section 6.6	Phillip Mineart	Jeanne Hudson
Sections 6.7 and 6.8	Vivian Lee	Jeanne Hudson
Section 6.9	Jeanne Hudson	Vivian Lee
Section 6.10	Vivian Lee	Jeanne Hudson
Sections 6.11 and 6.12	Vivian Lee	Phillip Mineart
Section 7.1 and 7.2	Jeanne Hudson	Vivian Lee
Sections 7.3 through 7.7	Vivian Lee	Jeanne Hudson
Section 7.8	Phillip Mineart	Jeanne Hudson
Sections 7.9 and 7.10	Vivian Lee	Jeanne Hudson
Section 7.11	Jeanne Hudson	Vivian Lee
Sections 7.12 through 7.14	Vivian Lee	Phillip Mineart
Sections 8 through 10	Vivian Lee	Jeanne Hudson
Attachment 1 (see note in Block 8)	Hudson, Knopp, Lee, and Mineart	Hudson, Lee, Mineart, and Wright
Attachment 2	Vivian Lee	N/A
Attachment 3	Jeanne Hudson	N/A
Attachment 4	Phillip Mineart	Jeanne Hudson
Attachment 5	Vivian Lee	Jeanne Hudson
Attachment 6	Jeanne Hudson	Vivian Lee
Attachments 7 through 9	Vivian Lee	Jeanne Hudson
Attachment 10	Phillip Mineart	Jeanne Hudson
Attachments 11 and 12	Vivian Lee	Jeanne Hudson
Attachment 13	Jeanne Hudson	Vivian Lee
Attachment 14	Vivian Lee	Jeanne Hudson
Attachment 15	Vivian Lee	Phillip Mineart
Attachments 16 through 20	Vivian Lee	Jeanne Hudson
Attachment 21	Phillip Mineart	Jeanne Hudson
Attachments 22 and 23	Vivian Lee	Jeanne Hudson
Attachment 24	Jeanne Hudson	Vivian Lee
Attachment 25	Vivian Lee	Phillip Mineart
Attachment 26 (Checker's Alternate Calculations for PMF Analyses discussed in Sections 4 and 5)	Jeanne Hudson	N/A

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ACRONYMS

COE	U.S. Army Corps of Engineers
CRWMS	Civilian Radioactive Waste Management System
CSCI	Computer Software Configuration Item
DOE	U.S. Department of Energy
DTN	Data Tracking Number
ESF	Exploratory Studies Facility
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineering Center, River Analysis System
HMR	Hydrometeorological Report
M&O	Management and Operating Contractor
NOAA	National Oceanic and Atmospheric Administration
NPP	North Portal Pad
NRCS	Natural Resources Conservation Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
QARD	Quality Assurance Requirements and Description
SCS	Soil Conservation Service
STN	Software Tracking Number
TDMS	Technical Data Management System
URS	URS Corporation
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
YMP	Yucca Mountain Site Characterization Project

ABBREVIATIONS

cfs	cubic feet per second
ft	feet
ft^2	square feet
ft/s	feet per second
FY	Fiscal Year
mi	miles

1 PURPOSE

PMF Inundation Studies at North Portal Pad and Vicinity were performed to provide preliminary design information for the proposed surface facilities for the Yucca Mountain Nuclear Repository. Knowledge of the potential for inundation due to large flood events is necessary in designing the surface facilities because of the risk of flood damage to the facilities, as well as the flood transport of radioactive materials away from the facilities. A previous study of PMF inundation (Ref. 6) was conducted for the project. However significant design changes have occurred since that study was completed necessitating the need to update the PMF study. For the current study, the study area was enlarged to encompass the South Portal Pad. Two alternative facility layouts were considered.

The purpose of this calculation is to:

1. Determine the magnitude and duration of runoff that would occur in Midway Valley Wash during a PMF event; and

2. Determine flow characteristics during the PMF, including the maximum lateral extent of inundation, flow depths, and velocities that may impact the surface facilities.

3. Provide mitigation measures to prevent flood waters from inundating critical facilities.

2 QUALITY ASSURANCE

This document was developed in accordance with procedure AP-3.12Q, *Design Calculations and Analysis* (Ref. 1). The North Portal Pad and Vicinity include structures (e.g., the Dry Transfer Facility) identified as safety category on the Q List (Ref. 7, p. A-2). Therefore, this document is subject to the Quality Assurance Requirements and Description (QARD) (Ref. 11). As stated in Section 1, this calculation was prepared to support preliminary design activities. As such, preliminary sketches of the surface facilities around the North Portal Pad (included in Attachment 3) as well as the preliminary design data for intake and exhaust shafts were used for the analyses presented herein since the final design of such facilities has not been developed. Where appropriate, comments were included in the calculation to denote the range of validity of these preliminary calculations should the final design differ from that used for the analysis.

3 USE OF COMPUTER SOFTWARE

Software listed in Table 3-1 is qualified and was obtained from Software Configuration Management. The software was appropriate for the applications described in this report, and the software was used within its range of validation. The computers used to run HEC-1 and HEC-RAS software are located in the URS office in Oakland, California. The serial number of the computer used to run HEC-1 is US832900YK. This computer was one of two computers used to run HEC-RAS. The serial number of the second computer is US00303734. The computer used to run ArcINFO V.7.2.1 is located in the Yucca Mountain Las Vegas Office, Nevada. The BSC property tag number of this computer is 700810.

Table 3-1. Software Usage

Reference	Name	STN/CSCI Identifier	CPU Operating Platform	CPU Operating System
Ref. 4, Ref. 21	HEC-1 Version 4.0	30078-V4.0	PC	DOS Emulation
Ref. 5, Ref. 22	HEC-RAS Version 2.1	30079-V2.1	PC	DOS Emulation
Ref. 10, Ref. 23	ArcINFO V.7.2.1	STN 10033-7.2.1-00	SGI	IRIX 6.5

3.1 PROBABLE MAXIMUM FLOOD CALCULATION

The U.S. Army Corps of Engineers' Hydrologic Engineering Center (HEC) HEC-1 computer software, Version 4.0 (Ref. 18) was used to perform the rainfall-runoff simulations using the Probable Maximum Precipitation (PMP) amounts. This is the same software used in the previous study (Ref. 6). HEC-1 was designed to simulate the surface runoff response of a watershed to precipitation. The program represents the watershed as an interconnected network of hydraulic and hydrologic components. A component may be a sub-area of the watershed, river channel, reservoir, or diversion. Each component is described by its physical characteristics and mathematical relations that describe the pertinent hydrologic and hydraulic processes. In the HEC-1 software, the study area was divided into drainage sub-areas so that PMF hydrographs were calculated at key locations in the study area. The HEC-1 input and output files are included in Attachments 1.02 and 1.03.

3.2 FLOOD INUNDATION CALCULATION

The U.S. Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System software (HEC-RAS), Version 2.1 (Ref. 3), was used for the flood inundation analysis. This program is designed for flood inundation studies and flood risk analysis. This software performs standard backwater computations to predict water surface elevations under steady gradually varied flow conditions. HEC-RAS is one of the FEMA nationally accepted computer software that can be used to estimate flood elevations (Ref. 13). This is the same software used in the previous study (Ref. 6). The HEC-RAS input and output files are included in Attachments 1.04 through 1.21, Attachments 6 through 14, and Attachments 16 through 24.

The computational procedure used in HEC-RAS is based on solution of the one-dimensional energy equation. Energy losses consist of surface roughness and expansion/contraction losses. Energy loss by surface roughness is evaluated using Manning's equation and requires the user to define a roughness coefficient. The momentum equation is used in situations where flow is rapidly varied, such as hydraulic jumps and flow through bridges. A rigid channel boundary is used in the computations (i.e., channel cross section shapes do not change as a result of sediment deposition or scour).

3.3 TOPOGRAPHIC SURFACE GENERATION

The ArcINFO Version 7.2.1 software (Ref. 10) developed by Environmental Systems Research Institute (ESRI) was used for the creation of a topographic surface in the form of a Triangulated Irregular Network (TIN) which was needed for the hydrologic analyses. The output TIN is included in Attachment 1.01. The input files are discussed in Section 4.2.3.

3.4 OTHER SOFTWARE

Microsoft Excel 2000 was used to perform routine calculations presented in all the tables in Sections 4 to 7, as well as in attachments including excavation volume calculations, weir flow calculations, and alternate PMF calculations using the Rational Method. Arcview V.3.2 was used to extract elevation data from a TIN by querying information along user-defined lines. ArcGIS V.8.3 was used to calculate areas of watersheds defined as polygons, lengths of streams defined as lines, and present output from HEC-RAS graphically to show inundation boundaries. The solutions are documented in sufficient detail to allow an independent check to reproduce or verify the results without recourse to the originator. The use of these software as described is exempt according to Sections 2.1.2 and 2.1.6 of LP-SI.11Q-BSC (Ref. 2) (see Attachment 2).

4 PROBABLE MAXIMUM FLOOD ANALYSIS FOR ALTERNATIVE 1

4.1 METHOD FOR ALTERNATIVE 1

A rainfall-runoff simulation was performed using the HEC-1 computer software to determine the surface runoff at pertinent locations in the vicinity of the North Portal and South Portal during a Probable Maximum Flood (PMF) event for Alternative 1. The layout sketches for Alternative 1 are provided in Attachment 3. The study area encompasses Midway Valley Wash, Drillhole Wash, and Split Wash, and is bounded by Yucca Mountain to the west, and Fran Ridge and Alice Hill to the east. The area was divided into 14 sub-basins as presented in Figure 4-1 to provide information on flows near the surface facilities. The sub-basins boundaries were modified from the previous report (Ref. 6) around the North Portal Pad to reflect the changes in layout, while additional sub-basins were delineated to include the South Portal in the hydrologic analysis. Figure 4-2 is a schematic diagram of the watershed network illustrating the routing of flow through the sub-basins. The Probable Maximum Precipitation (PMP) was determined using procedures presented in the National Oceanic and Atmospheric Administration's Hydrometeorological Report No. 49 (HMR 49) (Ref. 14).

4.2 INPUTS FOR ALTERNATIVE 1

4.2.1 Layout Design

The preliminary layout sketches of the surface facilities for Alternative 1 (Attachment 3) including the proposed North Portal Pad, Muck Storage Areas, Aging Facilities, and Railroad Alignment were used to define the extent of the drainage area.

4.2.2 Precipitation

The local storm PMP value at the North Portal Pad was calculated in the previous report (Ref. 6, p. 33) to be 13.2 inches with a duration of 6 hours (herein referred to as PMP-North Portal). This hyetograph was adopted in the present calculation. Since a local thunderstorm system affecting the South Portal can be independent of one that occurs at the North Portal Pad, a separate PMP value was developed for the tributary area of Drillhole Wash and Split Wash following HMR 49 procedures (herein referred to as PMP-South Portal). This will lead to a more conservative estimate of the maximum flows at the North Portal and South Portal because the rainfall intensity is inversely related to the drainage area. With an area of 6.5 square miles, the local 6-hour PMP-South Portal was computed to be 12.9 inches. Figure 4-3 shows the 3-minute interval hyetograph generated for the South Portal sub-basins. The calculations supporting the PMP-South Portal are provided in Attachment 4.

4.2.3 Topographic Data

A composite TIN (Triangulated Irregular Network) comprising two datasets (DTN #s MO0002SPATOP00.001 (Ref. 15) and MO9906COV98462.000 (Ref. 16)) was generated using ArcINFO V.7.2.1 to produce a topographic representation of the project area. The output TIN is included in Attachment 1.01. The dataset MO9906COV98462.000 (Ref. 16) contains 2-foot contour data encompassing the North Portal Pad and vicinity, whereas the dataset MO0002SPATOP00.001 (Ref. 15) consists of an output gridded (100-foot spacing) surface that covers the entire watershed. The 2 datasets have overlapping information and the goal was to use the best available data for the region analyzed. The 2-foot contours from DTN MO9906COV98462.000 (Ref. 16) were the preferred data as they have the best vertical resolution available. The 2-foot contours were clipped to the extent of the study area. The gridded elevation points from DTN MO0002SPATOP00.001 (Ref. 15) were then clipped to the same extent, and points overlapping the area where 2-foot contours existed were eliminated.

4.2.4 Sub-Basin Properties

The unit hydrograph method was used to develop the runoff hydrograph for each sub-basin. Two parameters are needed to prescribe the unit hydrograph for each natural sub-basin using the Natural Resources Conservation Service (NRCS) Dimensionless Unit Hydrograph (Ref. 18, pp. 23-24): area and lag time. The areas of the sub-basins were obtained from the topographic data (refer to Section 4.2.3) using ArcGIS V.8.3 and are summarized in Table 4-1. The lag time was calculated using the U.S. Bureau of Reclamation (USBR) empirical formula (Ref. 12, pp. 29-38) according to the previous report (Ref. 6, pp. 18-19, 35-37), with the results tabulated in Table 4-1:

$$lag = C\left(\frac{L \cdot L_{ca}}{\sqrt{S}}\right)^{0.33} \quad \text{(hours)}$$

where C = 1.1 (Ref. 6, p. 19, 35-37)

L = total channel length (mi)

L_{ca} = length along the flow path from the basin outlet to the point opposite the centroid of the basin area (mi)

S = slope of the channel (ft/mi)

Sub-basins that include constructed surfaces such as FAC1, FAC2, FAC3 and FAC4 (see Figure 4-1 for sub-basins layout) were simulated as overland flow elements and did not require lag time calculation.

Table 4-1. Properties of Sub-Basins Used in HEC-1 Model, Alternative 1

Basin Name	Area (mi^2)	Total channel length (mi)	Length from centroid to outlet (mi)	Slope (ft/mi)	Lag time (hr)
ND1	1.156	3.391	1.306	437.66	0.659
ND2	0.394	1.828	0.861	528.52	0.454
D3	1.149	3.429	1.674	526.68	0.696
ND4	0.816	2.931	1.478	349.65	0.679
D5	0.201	0.582	0.242	173.64	0.246
D6	1.380	3.240	1.205	151.53	0.753
S1	0.361	1.311	0.504	639.09	0.330
E1	4.495	6.029	2.613	369.36	1.030
E2	1.808	3.222	1.742	379.60	0.730
E3	0.840	1.832	0.981	150.68	0.583
FAC1	0.368	N/A	N/A	N/A	N/A

Basin Name	Area (mi^2)	Total channel length (mi)	Length from centroid to outlet (mi)	Slope (ft/mi)	Lag time (hr)
FAC2	0.164	N/A	N/A	N/A	N/A
FAC3	0.433	N/A	N/A	N/A	N/A
FAC4	0.244	N/A	N/A	N/A	N/A

4.2.5 Channel Properties

The Muskingum-Cunge method (Ref. 18, pp. 40-41) was used to perform hydrograph routing along the natural channels through the watershed network. Inputs for the HEC-1 model are presented in Table 4-2 and include the length, slope, and dimensions of the channels which were obtained from the topographic data (refer to Section 4.2.3). The roughness coefficient, Manning's n was selected to be 0.09 for the natural channels for the high sediment flow case based on the previous study (Ref. 6, pp. 28-29).

Table 4-2. Properties of Natural Channels Used in HEC-1 Model, Alternative 1

Channel Name	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)
cp5cp6	5120	0.023438	30	10
cp2cp6	13700	0.027007	30	10
fac1cp6	8750	0.027429	25	10
fac3cp6	4250	0.018824	40	32
cp7cp8	5400	0.018519	100	25

4.2.6 Initial Abstraction and Infiltration Rate

An initial abstraction of 1 inch and infiltration rate of 1.5 inches per hour used in the previous report (Ref. 6, pp. 27-28, 35-37) were adopted in this calculation.

4.3 ASSUMPTIONS FOR ALTERNATIVE 1

The following assumptions were used in the HEC-1 model for Alternative 1.

4.3.1 Homogeneity of Watershed Properties

The PMP-North Portal and PMP-South Portal are assumed to be spatially uniform within the respective tributary areas during the entire duration of the storm. The soils are assumed to be fairly homogeneous throughout the site. Because the size of the watershed is relatively small, the assumption of spatial homogeneity is deemed appropriate and is used throughout the analysis.

4.3.2 Overland Flow Elements

Assumptions were made on the site drainage at the Muck Storage Areas (designated as FAC1 and FAC4), Aging Facilities (FAC2) and North Portal Pad (FAC3) to calculate the surface runoff. These facilities were modeled as overland flow elements because they will result in distributed outflows in the absence of surface drainages. Overland flow elements are described by an overland flow length, slope, roughness factor, and percent of sub-basin area represented by the element. The parameters for the North Portal Pad and Aging Facility were computed from the preliminary layout sketches (Attachment 3). A 2 percent slope was assumed for the Aging Facility since the gradient as determined from the preliminary layout sketches was considered too small to allow for proper drainage. The Optional Aging Facility and Muck Storage Areas were assumed to be built up to the same gradient as the existing topographic data (refer to Section 4.2.3) since a detailed grading plan for these facilities has not been developed. The Optional Aging Facility was also assumed to be constructed above the PMF water surface elevations to ensure that waste could not be transported by flood flows. Muck Storage A was assumed to be above the PMF to ensure that the flood flows coming from sub-basins S1 and ND4 would be contained within the manmade channel described in Section 4.3.3 so that these flows would not reach the North Portal Pad. Muck Storage B was assumed to be above the PMF so that flows from sub-basins E1 and FAC4 would be confined to the northern side of the muck pile, resulting in higher water surface elevations near the railroad bridge, and a more conservative design of the bridge opening. The parameters for the areas modeled as overland flow elements are summarized in Table 4-3. A resistance factor of 0.10 was selected for asphalt/concrete surfaces and soil/muck piles (Ref. 18, p. 35).

Table 4-3. Properties of Overland Flow Elements, Alternative 1

Sub-Basin Name	Overland Flow Length (ft)	Slope (ft/ft)	Percent of Sub-Basin Area
FAC1	3500	0.01	100
FAC2 (northern)	2700	0.0426	83.5
FAC2 (southern)	840	0.02	16.5
FAC3 (eastern)	2600	0.035	75
FAC3 (western)	3300	0.0485	25
FAC4 (eastern)	2700	0.0296	50
FAC4 (western)	2400	0.104	50

4.3.3 Manmade Channels

Since one of the objectives of the hydrologic analysis is to reduce the flood elevations at the North Portal Pad, manmade channels were assumed for Alternative 1 to divert the flow away from the pad. Specifically, the following manmade channels were introduced in the analysis:

- Channel s1cp2 to divert the flow from sub-basins S1 and ND4;
- Channel d3cp5 to divert the flow from sub-basin D3 away from North Portal Pad;
- Channel nd2cp3 to divert the flow from sub-basin ND2 around the Aging Facilities;
- Channels cp4cp1 and cp1cp5 to divert the flow from ND1, ND2, FAC2 and D5 away from North Portal Pad;
- Channel e2cp7 to divert the flow from sub-basin E2.

The kinematic wave method was used for routing hydrographs along manmade channels and it requires the inputs of channel length, slope, dimensions and roughness coefficient. Nominal dimensions were assumed for the manmade channels with the slope estimated from the topographic data (refer to Section 4.2.3) as presented in Table 4-4. A Manning's n value of 0.09 was used for the manmade channels.

Table 4-4. Properties of Manmade Channels Used in HEC-1 Model, Alternative 1

Channel Name	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)
s1cp2	3500	0.005714	10	11
d3cp5	7970	0.030113	25	2
nd2cp3	2450	0.02449	25	2
cp4cp1	2580	0.025194	25	2
cp1cp5	1280	0.025	25	2
e2cp7	2700	0.018519	25	2

4.4 RESULTS FOR ALTERNATIVE 1

Table 4-5 summarizes the peak discharges predicted by the HEC-1 computer software for Alternative 1 using the inputs and assumptions discussed in the preceding sub-sections. The complete HEC-1 inputs and results and supplementary calculations are included in Attachments 1.02 and 5. In addition to the discharge for individual sub-basins, HEC-1 also estimated the PMF discharges at flow concentration points where hydrographs from two or more sub-basins are combined before being routed downstream.

The inclusion of manmade channels to divert the floodwaters away from the North Portal Pad reduced the peak discharge along the northern edge of the North Portal Pad to about 9,000 cfs (at Flow Concentration Point CP1), which is substantially less than the peak flow of 20,940 cfs determined from the previous study (Ref. 6, pp. 34, 37). With the proposed railroad alignment, the peak flow through the bridge section is about 21,300 cfs (at Flow Concentration Point CP7).

Table 4-5. Results of PMF Analysis, Alternative 1

Sub-Basin	Peak Flow (cfs)		Flow Concentration Point	Peak Flow (cfs)
ND4	3,853		CP2	6,521
S1	2,801		CP3	7,851
D3	5,322		CP4	8,358
ND2	2,487		CP1	9,009
ND1	5,576		CP5	13,777
FAC2	1,954		CP6	27,989
D5	1,854		CP7	21,287
FAC1	1,953		CP8	23,571
FAC3	4,164		CP9	50,894
D6	6,013			
E1	14,220			
E2	7,498			
E3	4,118			
FAC4	2,260			

5 PROBABLE MAXIMUM FLOOD ANALYSIS FOR ALTERNATIVE 2

5.1 METHOD FOR ALTERNATIVE 2

The same method as described under Section 4.1 was used to determine the surface runoff at pertinent locations in the vicinity of the North Portal and South Portal during a Probable Maximum Flood (PMF) event for Alternative 2. The sub-basins boundaries were modified from those of Alternative 1 to reflect the differences in layout arrangement predominantly near the Aging Facilities and North Portal Pad, giving a total of 15 sub-basins as presented in Figure 5-1. Since the Muck Storage Areas may not be fully constructed at the commencement of repository operation, the PMF analysis was conducted for the worst-case scenario to give the maximum inundation so that the mitigation measures can be adequately designed. As such, Muck Storage A was considered to be not yet constructed which means a larger man-made channel will be needed up-gradient of the muck pile to prevent the flow from upstream sub-basins from impinging on the North Portal Pad. On the other hand, the presence of Muck Storage B will block the free passage of water through the railroad bridge leading to higher water surface elevations around the bridge. Therefore, Muck Storage B was included in the analysis. Figure 5-2 is a schematic diagram of the watershed network illustrating the routing of flow through the sub-basins.

5.2 INPUTS FOR ALTERNATIVE 2

5.2.1 Layout Design

The preliminary layout sketch of the surface facilities for Alternative 2 (Attachment 3) including the proposed North Portal Pad, Muck Storage Areas, Aging Facilities, and Railroad Alignment was used to define the extent of the drainage area.

5.2.2 Precipitation

The PMP values for Alternative 2 were the same as Alternative 1.

5.2.3 Topographic Data

The topographic data used for the analysis were described in Section 4.2.3.

5.2.4 Sub-Basin Properties

The areas and lag times of the Alternative 2 sub-basins are summarized in Table 5-1. Sub-basins that have primarily constructed surfaces such as FAC2, FAC3 and FAC4 (see Figure 5-1 for sub-basins layout) were simulated as overland flow elements and did not require lag time calculation. Aging Pads 2 and 3 were included in their respective sub-basin as impervious area.

Table 5-1. Properties of Sub-Basins Used in HEC-1 Model, Alternative 2

Basin Name	Area (mi^2)	Total channel length (mi)	Length from centroid to outlet (mi)	Slope (ft/mi)	Lag time (hr)
D3	1.135	3.414	1.658	523.78	0.694

Basin Name	Area (mi^2)	Total channel length (mi)	Length from centroid to outlet (mi)	Slope (ft/mi)	Lag time (hr)
D5	0.277	0.971	0.518	171.42	0.375
D6	1.511	3.214	1.254	151.02	0.761
D7	0.091	0.771	0.476	216.03	0.326
D8	0.124	0.775	0.374	199.87	0.305
E1	4.325	6.053	2.745	366.55	1.050
E2	1.808	3.279	1.772	385.56	0.736
E3	0.847	1.925	1.042	127.78	0.622
FAC2	0.085	N/A	N/A	N/A	N/A
FAC3	0.498	N/A	N/A	N/A	N/A
FAC4	0.244	N/A	N/A	N/A	N/A
ND1	1.142	3.676	1.479	421.88	0.709
ND2	0.614	1.935	0.684	507.78	0.432
ND4	0.800	2.833	1.413	341.25	0.664
S1	0.307	1.223	0.475	670.73	0.314

5.2.5 Channel Properties

Table 5-2 presents the length, slope, and dimensions of the Alternative 2 natural channels obtained from the topographic data (refer to Section 4.2.3). These parameters were used in the Muskingum-Cunge routing method (Ref. 18, pp. 40-41). The roughness coefficient, Manning's n was selected to be 0.09 for the natural channels for the high sediment flow case based on the previous study (Ref. 6, pp. 28-29).

Table 5-2. Properties of Natural Channels Used in HEC-1 Model, Alternative 2

Channel Name	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)
cp2cp6	13,700	0.0270	30	10
d3cp1	2,900	0.0414	400	43
cp1cp3	1,660	0.0175	230	10
d8cp5	1,800	0.0306	35	5
cp5cp6	7,000	0.0247	30	10
d7cp6	7,900	0.0265	25	10
fac3cp6	3,960	0.0205	40	32
cp7cp8	5,400	0.0185	100	25

5.2.6 Initial Abstraction and Infiltration Rate

The values of initial abstraction and infiltration rate were the same as Alternative 1 (see Section 4.2.6).

5.3 ASSUMPTIONS FOR ALTERNATIVE 2

The following assumptions were used in the HEC-1 model to determine surface runoff under Alternative 2.

5.3.1 Homogeneity of Watershed Properties

The homogeneity assumption discussed in Section 4.3.1 also applied to Alternative 2.

5.3.2 Overland Flow Elements

Assumptions were made on the site drainage at Muck Storage B (designated as FAC4), Aging Facility (FAC2) and North Portal Pad (FAC3) to calculate the surface runoff. These facilities were modeled as overland flow elements because they will result in distributed outflows in the absence of surface drainages. Overland flow elements are described by an overland flow length, slope, roughness factor, and percent of sub-basin area represented by the element. The parameters for the North Portal Pad and Aging Facility were computed from the preliminary layout sketches (Attachment 3). The North Portal Pad was assumed to be enlarged to encompass the future dry transfer facility. A 2 percent slope was assumed for the Aging Facility to ensure that the water impounding on the pad will drain offsite such that no ponding will occur. The same assumptions stated in Section 4.3.2 were applied to Muck Storage B since it is unchanged from Alternative 1. These parameters are summarized in Table 5-3. A resistance factor of 0.10 was selected for asphalt/concrete surfaces and soil/muck piles (Ref. 18, p. 35).

Table 5-3. Properties of Overland Flow Elements, Alternative 2

Sub-Basin Name	Overland Flow Length (ft)	Slope (ft/ft)	Percent of Sub-Basin Area
FAC2	1600	0.02	100
FAC3 (eastern)	2700	0.023	62
FAC3 (western)	3200	0.0725	38
FAC4 (eastern)	2700	0.0296	50
FAC4 (western)	2400	0.104	50

5.3.3 Manmade Channels

As in Alternative 1, manmade channels were assumed to divert the flow away from the North Portal Pad to reduce the flood elevations. Specifically, the following manmade channels were included in the HEC-1 analysis as they would influence the hydrograph routing:

- Channel s1cp2 to divert the flow from sub-basins S1 and ND4;
- Channel cp3cp4 to divert the flow from ND1, ND2, D3, FAC2 and D5 away from the North Portal Pad;
- Channel e2cp7 to divert the flow from sub-basin E2.

The kinematic wave method was used for routing hydrographs along manmade channels and it requires the inputs of channel length, slope, dimensions and roughness coefficient. Nominal dimensions were assumed for the manmade channels with the slope estimated from the topographic data (refer to Section 4.2.3) as presented in Table 5-4. A Manning's n value of 0.09 was used for the manmade channels as in Alternative 1.

Table 5-4. Properties of Manmade Channels Used in HEC-1 Model, Alternative 2

Channel Name	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)
s1cp2	3,740	0.0075	25	2
cp3cp4	2,300	0.0226	25	2
e2cp7	2,700	0.0185	25	2

5.4 RESULTS FOR ALTERNATIVE 2

Table 5-5 summarizes the peak discharges predicted by the HEC-1 computer software for Alternative 2 using the inputs and assumptions discussed in the preceding sub-sections. The complete HEC-1 inputs and results as well as supplementary calculations are included in Attachments 1.03 and 5. In addition to the discharge for individual sub-basins, HEC-1 also estimated the PMF discharges at flow concentration points where hydrographs from two or more sub-basins are combined before being routed downstream.

The peak discharge along the northern edge of the North Portal Pad is about 14,400 cfs (at Flow Concentration Point CP4), which is significantly higher than that of Alternative 1 because there is no manmade channel to reroute the runoff from sub-basin D3 and part of sub-basin ND2 before it gets to the North Portal Pad. Although the area of impervious surface is smaller than that of Alternative 1, the peak discharge at Flow Concentration Point CP6 is higher due to the different routing arrangement that alters the superposition of hydrographs. On the other hand, the peak flow through the bridge section is slightly reduced to about 20,400 cfs (at Flow Concentration Point CP7) as a result of the southward extension of the North Portal Pad which cuts off a portion of the area draining to the railroad bridge.

Table 5-5. Results of PMF Analysis, Alternative 2

Sub-Basin	Peak Flow (cfs)		Flow Concentration Point	Peak Flow (cfs)
ND4	3,839		CP2	5,731
S1	2,453		CP1	7,859
D3	5,269		CP3	13,284
ND2	3,996		CP4	14,369
ND1	5,213		CP5	14,863
FAC2	1,079		CP6	29,438
D5	2,026		CP7	20,425
D8	1,004		CP8	22,864
D7	712		CP9	50,819
FAC3	4,704			
D6	6,577			
E1	13,474			
E2	7,448			
FAC4	2,260			
E3	3,961			

6 FLOOD INUNDATION ANALYSIS FOR ALTERNATIVE 1

6.1 METHOD, ALTERNATIVE 1

Flood inundation calculations were performed for each facility identified on the three preliminary layout sketches contained in Attachment 3. Alternative 1 includes analyses using the layout shown in the sketch titled "Geological Repository Operations Area North Portal – Plot Plan" and in the sketch labeled "Preliminary for Predecisional Study 8/7/03." For the North Portal Pad, separate inundation calculations were conducted for conditions with no major drainage facilities constructed and with proposed drainage facilities. The proposed drainage facilities are not intended to be detailed designs but were selected to demonstrate the feasibility of protecting critical facilities from the PMF. The inundation calculations are provided in the order from a general north to south direction following the "no mitigation" scenario calculation for the North Portal Pad. The calculations for Alternative 1 are included in Sections 6.2 through 6.12.

6.2 NO MITIGATION SCENARIO FOR THE NORTH PORTAL PAD, ALTERNATIVE 1

6.2.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

One river reach was used for routing flow across the North Portal Pad, assuming that no flood control measures, such as diversion channels or flood walls, were implemented. Flow was routed from FAC2 downstream to the gap between Alice Hill and Fran Ridge as shown in Figure 6-1. Cross sections were developed from the topographic data (refer to Section 4.2.3) using Arcview V.3.2 and modified for the surface facilities based on the preliminary layout sketches (Attachment 3). Cross-sections are included in Attachment 6 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Even though the conditions modeled in the PMF analysis are slightly different than this "no mitigation" scenario, they can be used to estimate the runoff. Peak discharges presented in Table 4-5 were used with a bulking factor as inputs to the HEC-RAS software. As stated in Section 6.2.2, for the no mitigation scenario, it was assumed that the Optional Aging Facility and Muck Storage A would not yet be constructed. Without any flood control measures, runoff from ND4 would reach the upstream edge of the North Portal Pad. Therefore, flow at Station 10815 (see Figure 6-1) would consist of runoff from sub-basins ND2, D3, FAC2, S1, and ND4. Using the bulking factor of 10% based on the previous report, (Ref. 6, pp. 29-30) this results in a flow of 18,058 cfs at the upstream boundary. At Section 9898, flow was increased to 24,192 to account for flow contributed by ND1. At Station 7785, flow was increased to 28,379 cfs to account for the addition of flow from FAC1 and D5. By adding the peak flows from the individual sub-basins, this results in a conservative estimate of the peak flow that could potentially reach the upstream end of the North Portal Pad. Runoff from the existing area proposed for the Optional Aging Facility would also be slightly less than calculated in the PMF analysis.

Some flow would run off the eastern edge of the pad due to the fact that the final grade of the eastern edge will be higher than the natural ground surface as shown on the preliminary layout sketch (Attachment 3).

A conservative approach was used to estimate the quantity of water flowing down the pad. The assumptions of weir flow described in Section 6.2.2 were used to calculate the flow between Stations 7500 and 6940. These calculations are included Attachment 6. At Station 7242, the flow was decreased to 21,544 cfs to account for spill flow over the edge of the pad. From Station 6940 to 5059, flow was estimated to be 10,576 cfs. At Station 4606, flow was increased back to 28,379 to account for the rejoining of spill flows.

6.2.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows under no mitigation scenario for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of Optional Aging Facility and Muck Storage A

It was assumed that the Optional Aging Facility and Muck Storage A would not yet be constructed in order to approximate "existing" conditions. This means runoff from ND4 would reach the Aging Facility and the North Portal Pad.

Spill Flow from North Portal Pad

It was assumed that flow over the edge of the pad could be estimated by using an iterative approach to calculate the weir flow between Stations 7500 and 6940. These calculations are included Attachment 6. The assumption was needed because HEC-RAS is limited to modeling one-dimensional, steady state flow. It was determined that at least 6,835 cfs would run off the pad between Stations 7500 and 7242, and 10,968 cfs would run off between Stations 7242 and 6940. Even though more flow would continue to spill over the edge downstream, it was assumed that the flow from Station 6940 to 5059 would remain at 10,576 cfs to be conservative. At Station 4606, it was assumed that the flow over the pad would rejoin with the spilled flow, so the flow was increased back to 28,379 cfs.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.089 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.04 and 0.03, respectively.

6.2.3 Results

Table 6-1 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, without the construction of major drainage facilities. The extent of the inundation is shown in Figure 6-1. Results indicate that water depths on the Aging Facility would range between 2 and 5 feet. Water depths across the North Portal Pad would range between approximately 2 and 11 feet. The entrance to the North Portal would remain approximately 9 feet above the inundation surface. The complete HEC-RAS output results are included in Attachments 1.04 and 6.

Table 6-1. Flood Inundation Results for No Mitigation Scenario, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
10815	18,058	3778	8.8	0.83
10438	18,058	3765	5.5	0.52
9898	24,192	3757	3.7	0.35
9621	24,192	3750	12.1	1
9236	24,192	3733	7.0	0.57
8940	24,192	3726	7.6	0.61
8553	24,192	3716	6.7	0.6
8327	24,192	3709	7.4	0.69
8038	24,192	3691	18.4	0.99
7785	28,379	3684	5.4	0.43
7500	28,379	3682	3.0	0.28
7242	21,544	3680	3.9	0.4
6940	10,576	3677	2.3	0.23
6704	10,576	3675	4.3	0.5
6416	10,576	3672	0.8	0.05
6130	10,576	3672	0.9	0.06
5837	10,576	3672	0.9	0.06
5511	10,576	3672	0.9	0.06
5059	10,576	3671	6.4	1.01

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
4606	28,379	3615	6.7	0.66
3953	28,379	3594	7.7	0.63
3289	28,379	3577	7.6	0.6
2827	28,379	3565	7.5	0.59
2301	28,379	3554	6.6	0.55
1826	28,379	3542	7.8	0.64
1188	28,379	3529	5.8	0.46
568	28,379	3515	9.2	0.68

6.3 DIVERSION AROUND MUCK STORAGE A, ALTERNATIVE 1

6.3.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing consists of a main river branch extending from the northern boundary of Muck Storage A to the gap between Alice Hill and Fran Ridge as shown in Figure 6-2. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 7 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used with a bulking factor as inputs to the HEC-RAS software. Along the northern boundary of Muck Storage A, i.e., from Station 17644 to Station 12712 (as shown on Figure 6-2), the peak flow at CP2 was used as it represents the combined flows from sub-basins S1 and ND4. With a bulking factor of 10% based on the previous report (Ref. 6, pp. 29-30), the flow for this reach is 7,173 cfs. Downstream of CP2, the flow will increase due to additional runoff from part of sub-basin D6. The area that will drain to the main channel was calculated to be 0.665 mi^2 using ArcGIS V.8.3, and the additional runoff was calculated by proportioning the area to the total drainage area of sub-basin D6, resulting in a total bulked flow of 10,363 cfs. This is a conservative approach because the peak flow from CP2 may not be concurrent with that from sub-basin D6.

6.3.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows around Muck Storage A for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near the North Portal Pad.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the northern boundary of Muck Storage A between Station 16740 and 13226 to divert the flow from sub-basins S1 and ND4 eastward to flow concentration point CP2 to reduce the flow impacting the North Portal Pad. The channel is assumed to have a bottom width of 10 feet, a 2:1 side slope on the downhill side and the natural slope on the uphill side, and a gradient of 0.0026, resulting in an excavation volume of about 68,000 cubic yards (volume calculation included in Attachment 7). The average channel depth is about 14 feet. However, since the channel has to pass through a few ridges along its alignment, the maximum depth of excavation will be approximately 20 feet at the deepest section.

Configuration of Muck Storage A

Muck Storage A is assumed to be approximately 20 feet high along the northern boundary such that it is above the PMF water surface elevations. Since the muck storage has not been designed, this assumption will ensure that the flood flows coming from sub-basins S1 and ND4 will be contained within the manmade channel. Otherwise, if the final configuration of the muck storage is different such that it will be overtopped during the PMF event, more water will reach the North Portal Pad resulting in higher water surface elevations.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.0619 and 0.0244, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

6.3.3 Results

Table 6-2 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-2. Results indicate that the PMF flow is contained within the manmade channel along the northern boundary of Muck Storage A given the assumptions stated above. The PMF flow is also contained within the natural channel downstream of CP2, thus assuring that the flow will not affect the North Portal Pad under the high sediment transport conditions. The complete HEC-RAS output results are included in Attachments 1.05 and 7.

Table 6-2. Flood Inundation Results Around Muck Storage A, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
17644	7173	3933	9.67	0.89
17245	7173	3913	10.46	0.8
16740	7173	3899	2.03	0.09
16126	7173	3899	1.14	0.05
15507	7173	3899	2.36	0.09
14755	7173	3898	5.35	0.26
13676	7173	3890	9.12	0.51
13227	7173	3882	7.02	0.53
12712	7173	3860	7.63	0.54
11769	10363	3827	12.85	0.93
10590	10363	3785	11.2	0.67
8898	10363	3733	16.01	0.84
8023	10363	3706	12.34	0.7
6683	10363	3674	12.26	0.64
4642	10363	3624	11.32	0.7
2917	10363	3584	5.94	0.53
1730	10363	3560	6.33	0.54
286	10363	3527	7.13	0.59

6.4 DOWNSTREAM OF MUCK STORAGE A, ALTERNATIVE 1

6.4.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing consists of a single branch extending from the southern boundary of Muck Storage A to the gap between Alice Hill and Fran Ridge as shown in Figure 6-3. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 8 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). The flow from FAC1 will enter the channel at the upstream boundary with the amount calculated to be 2,150 cfs including bulking. Along the watercourse, the flow will continuously increase due to additional runoff from part of sub-basin D6. The area that will drain to this channel was calculated to be 0.234 mi^2 using ArcGIS V.8.3 (as delineated on Figure 6-3) by proportioning the area to the total drainage area of sub-basin D6, resulting in a total bulked flow of 3,268 cfs that was applied to the entire reach. This is a conservative approach because the peak flow from FAC1 may not be concurrent with that from sub-basin D6, and in reality the incremental runoff will only reach its peak at the downstream end of the channel.

6.4.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows downstream of Muck Storage A for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of Muck Storage A

There is no grading plan developed for Muck Storage A. It is assumed to be configured in such a way to direct the surface runoff to the natural channel identified in this routing so that the North Portal Pad will be protected from flooding resulting from uncontrolled sheetflow.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.0266 and 0.0217, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

6.4.3 Results

Table 6-3 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-3. Results indicate that the capacity of the natural channel is sufficient to carry the PMF flow such that no overtopping is expected to occur. Therefore, the North Portal Pad will not be inundated by the flow propagating down this primary channel. The complete HEC-RAS output results are included in Attachments 1.06 and 8.

Table 6-3. Flood Inundation Results Downstream of Muck Storage A, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
8522	3,268	3758	11.21	0.99
8091	3,268	3744	8.7	0.59
7652	3,268	3731	9.14	0.72
6694	3,268	3701	8.85	0.66
5946	3,268	3679	8.55	0.67
5119	3,268	3653	9.32	0.7
4220	3,268	3627	7.53	0.61
3417	3,268	3606	6.89	0.62
2408	3,268	3577	3.92	0.55
1620	3,268	3560	4.48	0.45
740	3,268	3542	6.28	0.61
59	3,268	3525	4.43	0.5

6.5 DIVERSION EAST OF OPTIONAL AGING FACILITY AND AROUND NORTH CONSTRUCTION PORTAL, ALTERNATIVE 1

6.5.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing as shown on Figure 6-4 consists of a single branch that begins at the base of sub-basin D3, continues along the northern and then the eastern boundary of the Optional Aging Facility, and subsequently goes through a manmade reach before discharging into the natural channel east of sub-basin D5. The routing was set up with the objective to reduce the PMF water surface elevation at the North Portal Pad by diverting the flow from sub-basin D3, which would otherwise impinge on the northern boundary of the pad. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 9 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). Therefore, the bulked peak flow from sub-basin D3 of 5,854 cfs was applied to the entire reach.

6.5.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows east of the optional aging facility for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near the North Portal Pad.

Configuration of Optional Aging Facility, North Construction Portal and Muck Storage A

The Optional Aging Facility and North Construction Portal are assumed to be above the PMF water surface elevation to ensure that waste could not be transported by flood flows. Muck Storage A is also assumed to be above the PMF water surface elevation (see rationale in Section 6.3.2) and 50 feet apart from the Optional Aging Facility, thereby leaving a flow passage of approximately 50 feet wide for the floodwater to get through.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the northern boundary of the Optional Aging Facility (between Station 5460 and 5105 on Figure 6-4) to divert the flow from sub-basin D3 to the natural drainage east of the facility. This will provide proper drainage to contain and route stormwater for protection of the surface facilities. The pad of the North Construction Portal is assumed to be shifted to the north to be above the channel. The channel is assumed to have a bottom width of 25 feet, with 2:1 side slopes and a gradient of 0.0197, requiring about 9,000 cubic yards of excavation. The average channel is about 13 feet. Where the channel passes through the ridge, the channel depth will be about 13 to 15 feet. Secondly, in order to safely convey the flow away from the North Portal Pad, a 2,000-foot long manmade channel is assumed to be constructed between Station 2480 and Station 224 to divert the floodwater to the natural channel. This channel will have a bottom width of 25 feet, with 2:1 side slopes and a gradient of 0.022 to contain the flow within the channel without overtopping. This requires an excavation of approximately 80,000 cubic yards with an average channel depth of 18 feet. The volume calculations are included in Attachment 9.

Blockage of Natural Drainages

In order to direct the floodwater down the manmade channel, the natural drainages between Stations 1371 and 529 are assumed to be blocked with fill material immediately downstream of their intersection with the manmade channel to prevent the water from flowing down to the North Portal Pad. The fill material should be placed at least up to the predicted maximum water surface elevations, or 1 to 2 feet higher for provision of freeboard.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.043 and 0.0385, respectively.

6.5.3 Results

Table 6-4 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-4. The flow coming down from sub-basin D3 will be intercepted by the manmade channel along the northern boundary of Optional Aging Facility and diverted eastward to the natural drainage. Thereafter the flow will be confined in the passage between the Optional Aging Facility and Muck Storage A which serve as barriers to prevent the flow from spreading laterally. Further downstream the water will be conveyed by the manmade channel that is sized to contain the flow until the water is ultimately discharged into the natural channel. The North Portal Pad will not be affected by this flow because of the modifications made to the drainage pattern as discussed above. The complete HEC-RAS output results are included in Attachments 1.07 and 9.

Table 6-4. Flood Inundation Results East of Optional Aging Facility and Around North Construction Portal, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
6504	5,854	3915	6.22	0.6
6220	5,854	3904	9.21	0.87
5862	5,854	3885	3.4	0.34
5668	5,854	3880	11.32	0.82
5460	5,854	3875	8.9	0.54
5252	5,854	3869	11.93	0.78
5105	5,854	3864	9.92	0.7
4958	5,854	3859	9.43	0.7
4705	5,854	3848	9.95	0.86
4239	5,854	3833	8.44	0.58
3831	5,854	3822	11.53	0.62
3425	5,854	3811	11.88	0.63
3077	5,854	3803	12.53	0.7
2808	5,854	3790	16.29	1.1
2480	5,854	3778	9.32	0.57
2191	5,854	3772	9.33	0.57
1831	5,854	3764	9.34	0.57
1371	5,854	3755	9.32	0.57
949	5,854	3746	9.37	0.57
529	5,854	3738	9.22	0.56
224	5,854	3728	13.05	0.85
57	5,854	3722	11.94	0.79

6.6 AGING FACILITY AND NORTH PORTAL PAD, ALTERNATIVE 1

6.6.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing consists of a main river branch extending from the north-west corner of the Optional Aging Facility (area FAC2 in the hydrology model) around the lower Aging Facility and towards the south-east just north of the North Portal Pad (NPP) as shown in Figure 6-5. Cross sections were developed from topographic data described in Section 4.2.3 using Arcview V.3.2 and modified for the surface facilities based on the preliminary layout sketch (Attachment 3). Cross-Sections are included in Attachment 10 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used with a bulking factor as inputs to the HEC-RAS software. Along the aging facilities, i.e., from Station 8215 to Station 3864 (as shown on Figure 6-5), the peak flow at CP3 was used as it represents the combined flows from sub-basins ND1 and ND2. With a bulking factor of 10% based on the previous report (Ref. 6, pp. 29-30), the flow for this reach is 8,636 cfs. Downstream of CP3, the flow will increase due to additional runoff from FAC2 and D5 resulting in a total bulked flow of 9,910 cfs.

6.6.2 Assumptions

The followings assumptions were used in the HEC-RAS software for routing flows around the Aging Facility and North Portal Pad for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near the North Portal Pad.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the western boundary of the Aging Facility to retain runoff from sub-basins ND2 and ND1 and divert it southeastward to flow concentration point CP3 to prevent runon to the Aging Facility. The channel is assumed to have a bottom width of 35 feet, a 2:1 side slope, and a gradient of 0.034, resulting in an excavation volume of about 85,000 cubic yards. The depth of the excavation varies from about 10 feet to 25 feet along its alignment.

From the Aging Facility east past the North Portal Pad it was assumed that the flow would be transported in either a manmade channel or constrained by floodwalls or levees from flowing onto the North Portal Pad. For the channel construction scenario, the channel was assumed to have 2:1 side slopes and a bottom width of 35 feet between Stations 3684 and 1536 decreasing to about 30 feet wide downstream of this station. The average channel depth is about 20 feet, and varies from about 10 feet to 30 feet deep at the deepest location. The average gradient is about 0.027. This requires an excavation of 200,000 cubic yards. The volume calculations are included in Attachment 10. Even with a large channel bottom width the channel is not quite large enough to contain the flow. Small berms on the order of 5 to 6 feet tall would be needed between stations 3440 and 2806 where the gradient is the shallowest. A 2-foot berm would be needed near Station 1283 to prevent flow onto the North Portal Pad. Also, the constructed channel will cross several natural drainages. To prevent stormwater runoff from flowing down those drainages, the drainages should be blocked on the downstream side of the manmade channel at each crossing.

If no drainage channels are constructed north of the North Portal Pad floodwalls or levees will be needed. Assuming the wall is constructed along the same alignment as the channel as shown in Figure 6-6, the wall or levee would need to start at Station 3684 and be tied into Exile Hill. The wall would need to be approximately 10 to 12 feet tall from Station 3225 to Station 2275, and between 4 and 12 feet tall from Station 2275 to Station 469 downstream of the pad. The total length of the wall is about 3,200 feet.

Configuration of Aging Facility FAC2

The Optional Aging Facility was assumed to be above the PMF water surface elevations, which means that the Facility should be approximately 10 feet above the natural ground elevation along the northwestern boundary. The actual height could be more or less depending upon the exact location of the facility.

The Aging Facility, as shown on Figure 6-5 is assumed to be protected by a channel running along its western and southern edge. A small berm or levee may be needed at the northwestern corner of the facility to reduce the size of the channel required at this location. With these drainage structures the facility can be located at any elevation.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.089 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were specified at both boundaries in the HEC-RAS software (i.e., the water surface slope is assumed to follow the channel ground surface slope). The channel ground surface slopes at the downstream and upstream boundaries were estimated from the topographic data described in Section 4.2.3 to be 0.006 and 0.031, respectively.

6.6.3 Results

Table 6-5 presents the best estimate of PMF water surface elevations and flow velocities at each cross section for the scenario with channel construction, with the extent of the inundation shown in Figure 6-5. Results indicate that the PMF flow is contained within the manmade channel along the northern boundary of the North Portal Pad and to the south and west of the Aging Facility. Table 6-6 presents the best estimate of PMF water surface elevations and flow velocities at each cross section for the scenario with floodwalls/levees, with the extent of the inundation shown in Figure 6-6. The complete HEC-RAS output results are included in Attachments 1.08 and 10.

Table 6-5. Flood Inundation Results Around Aging Facility and North Portal Pad, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
8215	8,636	3892	3.22	0.23
8049	8,636	3889	3.07	0.61
7771	8,636	3873	11.76	0.88
7444	8,636	3856	13.94	0.74
7029	8,636	3832	9.67	0.79
6211	8,636	3797	9.47	0.69
5838	8,636	3787	5.15	0.28
5637	8,636	3784	10.07	0.61
5124	8,636	3771	10.71	0.62
4823	8,636	3766	8.5	0.46
4685	8,636	3763	10.98	0.59
4456	8,636	3756	13.9	0.87
4109	8,636	3739	13.89	0.87
3865	8,636	3728	13.24	0.82
3685	9,910	3725	8.51	0.45
3440	9,910	3721	9.18	0.49
3225	9,910	3720	6.35	0.3
3020	9,910	3717	9.61	0.5
2807	9,910	3712	12.88	0.76
2576	9,910	3704	12.88	0.76
2275	9,910	3693	12.83	0.75
1901	9,910	3684	8.35	0.43
1536	9,910	3683	3.67	0.15
1283	9,910	3680	11.81	0.63
942	9,910	3671	11.81	0.67

Table 6-6. Flood Inundation Results Around North Portal Pad with Floodwall/Levee, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
8215	8,636	3892	3.29	0.23
8049	8,636	3888	0.8	0.52
7771	8,636	3873	10.6	0.76
7444	8,636	3856	13.88	0.74
7029	8,636	3833	9.31	0.74
6211	8,636	3797	11.58	0.89
5838	8,636	3788	4.51	0.24
5637	8,636	3783	15.87	1
5124	8,636	3778	9.89	0.56
4823	8,636	3774	8.64	0.47
4685	8,636	3767	15.77	1
4456	8,636	3764	3.69	0.26
4109	8,636	3756	16.15	1
3865	8,636	3743	8.81	0.72
3685	9,910	3734	8.81	0.94
3440	9,910	3727	5.65	0.43
3225	9,910	3727	2.87	0.14
3020	9,910	3726	6.45	0.33
2807	9,910	3723	9.32	0.56
2576	9,910	3719	7.01	0.39
2275	9,910	3714	8.2	0.48
1901	9,910	3702	13.17	0.96
1536	9,910	3691	8.24	0.57
1283	9,910	3688	8.06	0.42
942	9,910	3684	6.78	0.45
469	9,910	3669	11.15	0.98
66	9,910	3644	11.59	0.73

6.7 EAST OF NORTH PORTAL PAD, ALTERNATIVE 1

6.7.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

A single branch representing the primary channel east of the North Portal Pad was set up that extends from the downstream end of the manmade channel draining the Optional Aging Facility to the gap between Alice Hill and Fran Ridge as shown in Figure 6-7. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 11 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). The channel collects floodwater from the two manmade channels that divert water from sub-basin D3 and from flow concentration point CP1, as well as distributed runoff from part of sub-basin D6 along its watercourse. The area that will drain to this channel was calculated to be 0.157 mi^2 using ArcGIS V.8.3 (as delineated on Figure 6-7), and the additional bulked flow was calculated to be 753 cfs by proportioning the area to the total drainage area of sub-basin D6. This amount was added to the bulked flows at d3cp5 and CP5 to give total flows of 6,600 cfs and 15,908 cfs that were used for the reach upstream and downstream of Station 5224, respectively.

6.7.2 Assumptions

The followings assumptions were used in the HEC-RAS software for routing flows east of the North Portal Pad for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.044 and 0.028, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

6.7.3 Results

Table 6-7 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-7. Results indicate that the capacity of the natural channel is sufficient to carry the PMF flow such that no overtopping is expected to occur. Therefore, the North Portal Pad will not be inundated by the flow propagating down this primary channel. The complete HEC-RAS output results are included in Attachments 1.09 and 11.

Table 6-7. Flood Inundation Results for Primary Channel East of North Portal Pad, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
7437	6,600	3719	12.91	0.76
7022	6,600	3701	13.71	0.92
6501	6,600	3683	11.98	0.71
6115	6,600	3668	14.71	0.9
5705	6,600	3658	8.72	0.47
5224	15,908	3645	15.39	0.82
4776	15,908	3633	13.03	0.68
4247	15,908	3618	14.32	0.77
3745	15,908	3604	12.75	0.71
3207	15,908	3591	11.23	0.68
2536	15,908	3572	9.15	0.68
1447	15,908	3549	4.68	0.45
181	15,908	3523	7.56	0.63

6.8 DOWNSTREAM OF NORTH PORTAL PAD, ALTERNATIVE 1

6.8.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing consists of a single branch extending from the eastern boundary of North Portal Pad to the gap between Alice Hill and Fran Ridge as shown in Figure 6-8. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 12 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). The overland flow from sub-basin FAC3 will enter the channel at the upstream boundary with the amount calculated to be 4,580 cfs including bulking. Along the watercourse, the flow will continuously increase due to additional runoff from part of sub-basin D6. The area that will drain to this channel was calculated to be 0.324 mi^2 using ArcGIS V.8.3 (as delineated on Figure 6-8) by proportioning the area to the total drainage area of sub-basin D6, resulting in a total bulked flow of 6,135 cfs that was applied to the entire reach. This is a conservative approach because the peak flow from FAC3 may not be concurrent with that from sub-basin D6, and in reality the incremental runoff will only reach its peak at the downstream end of the channel.

6.8.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows downstream of the North Portal Pad for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of North Portal Pad

The North Portal Pad will be constructed above the PMF water surface elevation according to the preliminary layout sketches (Attachment 3). No site drainage was included in the layout. It is assumed that the runoff from Exile Hill will be routed around the North Portal Pad and discharged into the natural channel downstream of the pad along with the runoff from the pad itself.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.028 and 0.024, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

6.8.3 Results

Table 6-8 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-8. Results indicate that the capacity of the natural channel is sufficient to carry the PMF flow such that no overtopping is expected to occur. Therefore, the North Portal Pad will be outside the inundation limits. The complete HEC-RAS output results are included in Attachments 1.10 and 12.

Table 6-8. Flood Inundation Results Downstream of North Portal Pad, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
3786	6,135	3603	12.69	0.98
3421	6,135	3593	6.92	0.5
3072	6,135	3584	9.95	0.73
2608	6,135	3573	5.91	0.5
2106	6,135	3567	6.23	0.57
1552	6,135	3549	5.34	0.55
1026	6,135	3537	4.82	0.52
557	6,135	3528	5.13	0.48
56	6,135	3517	5.48	0.55

6.9 RAILROAD BRIDGE CROSSING, ALTERNATIVE 1

6.9.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing of flow concentrating at CP7 under the proposed railroad was performed using one river reach. Flow was routed along the northern edge of Muck Storage B down to the gap between Alice Hill and Fran Ridge as shown in Figure 6-9. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and the preliminary layout sketch (Attachment 3). Cross-sections are included in Attachment 13 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used with a bulking factor as inputs to the HEC-RAS software. A conservative approach was taken to size the two bridges north of Muck Storage B. With the proposed railroad graded to elevation 3667.1 feet, the alignment along the southern end of the eastern edge of Muck Storage B would be in cut. Some flow from sub-basin E2 would escape into sub-basin E3 as flow continued north along the railroad until the grade is above the natural ground surface along the eastern edge of the muck storage pile. The assumption described in Section 4.3.3 that all the runoff from E2 would be diverted to CP7 was used to obtain the maximum flow upstream of the railroad and to be consistent with the PMF analysis.

From Station 7120 to Station 6445 (as shown on Figure 6-9), flow was estimated to be 2,486 cfs for the peak flow from FAC4 with a bulking factor of 10% based on the previous report (Ref. 6, pp. 29-30). At Station 6003, flow was increased to 23,416 cfs, which accounts for the bulked flow at CP7. The flow was increased to 25,928 cfs (the bulked peak flow at CP8) at Station 3939 to account for additional flow from sub-basin E3.

6.9.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows under the railroad for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of Muck Storage B

Muck Storage B is assumed to be approximately 20 feet high along the northern boundary and configured so that it does not block the bottom of the channel along its northern edge. This assumption was made because the design of Muck Storage B is not finalized, and this configuration confines the runoff from sub-basins E1 and FAC4 to the northern side of Muck Storage B but still allows flow through the natural channel. The presence of Muck Storage B results in a conservatively high estimate of water surface elevations near the railroad so that the bridge opening can be properly sized to prevent flow from impinging on the North Portal Pad.

Configuration of Structure Shown in Floodplain

It was assumed that the Visitors Center shown on the preliminary layout sketch (Attachment 3) to be located at the base of Fran Ridge would not be protected from the PMF because it is not important to safety, as defined on the Q List (Ref. 7, p. A-2). Therefore, it could be within the flood inundation surface shown in Figure 6-9.

Bridge Openings

Nominal bridge dimensions were assumed because the bridge design had not been developed at the time this analysis was conducted.

The bridge over the realignment of "H" Road was assumed to be 60 feet long and 190 feet wide in the direction of flow. These dimensions were assumed to allow traffic to pass under the bridge, and to allow for grading of the railroad alignment. It was assumed to be a clear span without any piers. The bridge deck was assumed to be 6 feet thick, as assumed in the previous study (Ref. 6, p. 26).

The bridge across the natural channel at CP7, just north of Muck Storage B, was assumed to be 110 feet long, in order to adequately convey the PMF, and 190 feet wide, to allow for grading of the railroad alignment. It was assumed that there would be one row of 4-foot diameter piers down the center of the channel. The bridge deck was assumed to be 6 feet thick. These dimensions are consistent with a typical concrete freeway bridge, as assumed in the previous study (Ref. 6, p. 26).

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.05 and 0.028, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

6.9.3 Results

Table 6-9 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-9. Results indicate that the PMF flow will not overtop the portion of "H" Road leading to the southeastern edge of the North Portal Pad, assuming that the two bridge openings are at least as large as stated above. Therefore, the North Portal Pad will remain outside of the floodplain boundary. If both bridges are constructed as clear spans, the water surface elevation as far upstream as Station 6445 would be approximately 2 feet lower. The complete HEC-RAS output results are included in Attachment 1.11 and Attachment 13.

Table 6-9. Flood Inundation Results Near Railroad Bridge Crossing, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
7120	2,486	3,659	5.6	0.74
6890	2,486	3,651	3.8	0.45
6445	2,486	3,647	0.4	0.02
6003	23,416	3,647	2.1	0.08
5855	23,416	3,647	1.2	0.04
5736	23,416	3,647	0.7	0.02
5600	Bridge			
5478	23416	3,618	21.3	2.1
5180	23,416	3,615	9.5	0.69
4822	23,416	3,607	7.1	0.54
3939	25,928	3,590	7.3	0.53
3331	25,928	3,583	5.7	0.33
2847	25,928	3,575	10.0	0.62
2360	25,928	3,566	8.5	0.52
1909	25,928	3,558	9.9	0.57
1376	25,928	3,549	10.4	0.57
823	25,928	3,538	10.1	0.59
170	25,928	3,522	10.5	0.69

6.10 SOUTH PORTAL, ALTERNATIVE 1

6.10.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The South Portal is located within sub-basin E2. Three routings were performed to determine the limits of inundation in the vicinity of the South Portal during a PMF event. The first routing designated as sportal1 on Figure 6-10 consists of a single river branch along the main stream of sub-basin E2 extending from midway up the sub-basin to south of the Muck Pile Hill. The remaining two routings include the tributaries draining the northern and southern portions of Boundary Ridge, which are sub-catchments within sub-basin E2. These are designated as sportal2 and sportal3 on Figure 6-10. Also shown on Figure 6-10 is the delineation of the two sub-catchments. Cross sections for all the branches were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 14 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 1. Peak discharges presented in Table 4-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). Since the main stream will intercept the runoff from the northern and southern Boundary Ridge sub-catchments downstream of Station 2618 of sportal1, the bulked peak flow of 8,248 cfs at the outlet of sub-basin E2 was only applied to sportal1 downstream of this station. A smaller flow of 6,765 cfs was used for the upstream reach by proportioning the tributary drainage area to the total drainage area of E2, with the tributary drainage area obtained by deducting the areas of the northern and southern Boundary Ridge sub-catchments, which were calculated with ArcGIS V.8.3 to be 0.106 and 0.219 mi^2, respectively. Using these sub-catchment areas, the bulked peak flows for sportal3 and sportal2 were calculated to be 484 and 1,000 cfs, respectively.

6.10.2 Assumptions

The following assumptions were used in the HEC-RAS software for routings around the South Portal for Alternative 1.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of Muck Storage B

Muck Storage B is assumed to be above the PMF water surface elevations because it will be constructed above the existing ground elevation with muck pile. It is also assumed to be shifted westward to accommodate the railroad alignment such that it is tied to the ridge along the southern boundary of sub-basin FAC4, thus blocking the floodwater from flowing over the muck pile. Since Muck Storage B has not been designed, assumptions are needed to route the flood flows around the facility. This assumption has no effect on the inundation around the South Portal Pad because Muck Storage B is located downstream far away from the critical facilities.

Configuration of South Portal Pad

The South Portal Pad is assumed to be above the PMF water surface elevations to ensure that waste could not be transported by flood flows. This is a reasonable assumption given the critical nature of the South Portal.

Spill Over Flow

Although the output from HEC-RAS indicates that the flow at Station 5195 of sportal1 will not be contained in the main channel and will probably undergo sheetflow down the ridge east of the channel (to the adjacent sub-basin), it is assumed that the same amount of water will continue downstream to provide a conservative estimate of the PMF water surface elevations at the downstream locations along sportal1.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries for each branch to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries for sportal1 (i.e., the water surface slope follows the channel ground surface slope). Similarly, normal flow conditions were assumed at the upstream boundaries for sportal2 and sportal3. Since the downstream boundaries of sportal2 and sportal3 are connected to sportal1, the predicted water surface elevations from HEC-RAS at Stations 2618 and 2189 of sportal1 were used. Table 6-10 summarizes the boundary conditions for the 3 south portal branches.

Table 6-10. Boundary Conditions for South Portal Routings, Alternative 1

Routing	Upstream boundary	Downstream boundary
Sportal1	S=0.0458	S=0.0313
Sportal2	S=0.0393	WSEL @ Station 2189 of sportal1
Sportal3	S=0.075	WSEL @ Station 2618 of sportal1

6.10.3 Results

Table 6-11 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 6-10. For sportal1 routing, results indicate that the PMF flow will not be contained within the natural channel at Station 5195 resulting in sheetflow down the ridge east of the main channel. If that happens, the flow will be intercepted by the topsoil storage area and diverted down the valley. Considering the unconsolidated nature of sediments in the watershed, new flow paths may open up during a PMF event and therefore the potential reduction in flow downstream of Station 5195 was ignored in order to obtain the maximum water surface elevation along sportal1. Downstream of Station 1573, the water surface elevation will build up against Muck Storage B, which serves as a barrier to the flow.

For sportal2 routing, the PMF flow is contained within the natural channel and the South Portal is outside the inundation limits. On the other hand, due to the small size of the natural channel the flow will not be contained within sportal3 and the depth of water along the northern edge of the elevated South Portal Pad is estimated to be less than 1 foot.

The complete HEC-RAS output results are included in Attachments 1.12 and 14.

Table 6-11. Flood Inundation Results Around South Portal, Alternative 1

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
Sportal1-main				
5948	6,765	3904	11.04	0.87
5640	6,765	3889	10.16	0.82
5195	6,765	3867	8.14	0.84
4739	6,765	3848	9.38	0.69
4210	6,765	3822	9.73	1.03
3574	6,765	3791	5.6	0.57
3053	6,765	3766	8.73	1.07
2618	8,248	3750	4.3	0.44
2189	8,248	3738	12.82	0.86
1573	8,248	3721	3.7	0.3
1187	8,248	3714	13.24	0.85
770	8,248	3698	9.66	0.74
376	8,248	3683	7.02	0.72

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
22	8,248	3670	4.42	0.58
Sportal2				
2359	1,000	3809	6.36	0.62
2045	1,000	3798	7.18	0.74
1811	1,000	3790	4.71	0.52
1648	1,000	3784	7.65	0.93
1462	1,000	3778	4.21	0.46
1261	1,000	3770	7.13	0.99
1085	1,000	3765	3.21	0.4
895	1,000	3759	7.76	0.88
628	1,000	3751	3.62	0.42
337	1,000	3742	7.62	0.88
12	1,000	3738	1.66	0.11
Sportal3				
1598	484	3842	6.12	0.86
1455	484	3831	6.69	0.93
1335	484	3823	4.89	0.63
1170	484	3814	4.02	0.89
956	484	3801	2.62	0.52
690	484	3785	2.69	0.87
495	484	3772	2.56	0.5
242	484	3758	4.19	0.99
64	484	3749	1.36	0.15

6.11 INTAKE AND EXHAUST SHAFTS, ALTERNATIVE 1

There are 9 intake and exhaust shafts in the study area. Figure 6-11 presents their locations in the watershed. Since they are all located on ridges above the natural channels, no accumulation of runoff is expected to occur around the shafts during a PMF event. Sheetflow over the pads of the shafts is likely to take place during the intense precipitation. Since the depth of flow will be very thin in comparison with the width of flow, the Manning's formula for a wide open channel can be used (Ref. 8, pp. 148-150):

$$q = \frac{1.49}{n}\sqrt{S}\,y_m^{5/3} \qquad (6\text{-}1)$$

where: q = discharge per unit width (cfs/ft)
n = Manning's n
S = slope of surface (ft/ft)
y_m = average depth of flow (ft)

The yield (i.e. flow per unit area) was calculated for each natural sub-basin (i.e. sub-basins modified by surface facilities were excluded) using the flows and areas from the PMF analysis presented in Section 4, and the discharge over the shaft was estimated by multiplying the maximum yield from all the sub-basins by the drainage area of the shaft. Table 6-12 summarizes the yield of the sub-basins with the maximum yield being 9,270 cfs/mi^2.

Table 6-12. Yield of Sub-Basins, Alternative 1

Sub-Basin	Peak Flow (cfs)	Sub-Basin Area (mi^2)	Yield (cfs/mi^2)
ND4	3853	0.82	4,699
S1	2801	0.36	7,781
D3	5322	1.15	4,628
ND2	2487	0.39	6,377
ND1	5576	1.16	4,807
D5	1854	0.2	9,270
D6	6013	1.38	4,357
E1	14220	4.49	3,167
E2	7498	1.81	4,143
E3	4118	0.84	4,902

6.11.1 Assumptions

Flow Width

The width of flow impacting the shaft was assumed to be equal to the diameter of the shaft, which is assumed to be 26 feet (refer to Attachment 1.22).

Drainage Area

Sheetflow usually occurs over a maximum distance of 300 feet before the flow becomes shallow concentrated flow (Ref. 19, p.3-3). Based on this threshold value, the area draining to a shaft pad was taken to be 300 feet multiplied by the width of the flow. This gives a drainage area of 7,800 ft^2.

Slope of Pad

The shaft pad is assumed to have a nominal slope of 2 percent to allow for proper drainage.

Manning's Roughness Coefficient

The Manning's roughness coefficient of 0.09 used in the previous report (Ref. 6, pp. 28-29) was adopted in this calculation.

6.11.2 Results

For a yield of 9,270 cfs/mi^2 and an area of 7,800 ft^2, the maximum discharge is 2.6 cfs. Using a flow width of 26 feet, the discharge per unit width is 0.1 cfs/ft.

Substituting the parameters into the Manning's formula, Equation 6-1, the average depth over the shaft pad is about 0.2 feet.

6.12 SCOUR ANALYSIS, ALTERNATIVE 1

The scour analysis conducted in the previous report (Ref. 6, pp. 42-44) was revised to reflect the changes in railroad alignment. The proposed new bridge is located east of Muck Pile Hill at the outlet of sub-basin FAC4 (see Figure 4-1). The depth of scour at the railroad bridge was estimated using procedures described in the Federal Highway Administration's Hydraulic Engineering Circular No. 18 (HEC-18) (Ref. 17, pp. 6.1 to 6.6).

In the previous report (Ref. 6, pp. 30, 42-44), the total scour at a bridge was calculated as the sum of contraction scour and local scour. The critical velocity for initiation of contraction scour was determined to be 2.9 to 4.3 ft/s (Ref. 6, p. 43). Since the mean velocity immediately upstream of the bridge at Station 5736 (see Table 6-9) is 0.7 ft/s, no contraction scour is predicted to occur.

The local scour at the piers was calculated using the CSU equation (Ref. 17, Eq. 6.3, p. 6.4) as in the previous report (Ref. 6, p. 43). The scour calculations for Alternative 1 are included in Attachment 15. Based on a maximum water depth of 29 feet with Froude number of 0.02 at Station 5736 (see Attachment 13), the local scour depth at the bridge located immediately north of Muck Storage B is estimated to be 3.6 feet. Similarly, with a water depth of 8 feet the local scour depth at the H-road bridge is about 2.3 feet.

7 FLOOD INUNDATION ANALYSIS FOR ALTERNATIVE 2

7.1 METHOD, ALTERNATIVE 2

The HEC-RAS software was used to perform river routing simulations for determination of flood inundation extents. As mentioned in Section 6.1, Alternative 2 includes analyses using the layout shown in the sketch titled "Midway Valley Wash" (Sketch No. 100-C0K-CD04-00101-000-00A) included in Attachment 3. For the North Portal Pad, the potential for inundation without major drainage facilities constructed is described in Section 7.2. Inundation calculations conducted for the proposed drainage facilities are described in Sections 7.3 to 7.14. The proposed drainage facilities are not intended to be detailed designs but were selected to demonstrate the feasibility of protecting critical facilities from the PMF. The inundation calculations are provided in the order from a general north to south direction following the no mitigation scenario for the North Portal Pad.

7.2 NO MITIGATION SCENARIO FOR THE NORTH PORTAL PAD, ALTERNATIVE 2

As discussed in Section 6.2, without any flood control measures, the Aging Facility and North Portal Pad would be inundated under the PMF. Calculations to determine the extent of inundation were not performed for Alternative 2 because flooding would be similar to that occurring for Alternative 1. Flow from upstream watersheds, including sub-basins ND1, ND2, FAC2, D3, D5, D7, D8, S1, and ND4 (shown in Figure 5-1) would be directed toward the Aging Facility, Aging Pads 2 and 3, and the North Portal Pad. Therefore, some form of flood protection will be required in order to protect the critical facilities within the study area.

7.3 DIVERSION AROUND MUCK STORAGE A, ALTERNATIVE 2

7.3.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

As explained in Section 5.1, Muck Storage A is considered to be not yet constructed to determine the maximum inundation for sizing the manmade channel around its northern boundary to divert the flows from sub-basins S1 and ND4. The routing consists of a main river branch extending from the base of sub-basin S1 to the gap between Alice Hill and Fran Ridge as shown in Figure 7-1. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 16 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2 presented in Section 5. Peak discharges presented in Table 5-5 were used with a bulking factor as inputs to the HEC-RAS software. From the base of sub-basin S1 to the eastern end of sub-basin ND4, i.e., Station 17331 to Station 12712 (as shown on Figure 7-1), the peak flow at CP2 was used as it represents the combined flows from sub-basins S1 and ND4. With a bulking factor of 10% based on the previous report (Ref. 6, pp. 29-30), the flow for this reach is 6,300 cfs. Downstream of CP2, the flow will increase due to additional runoff from part of sub-basin D6. The area that will drain to the main channel was calculated to be 0.735 mi^2 using ArcGIS V.8.3, and the additional runoff was calculated by proportioning the area to the total drainage area of sub-basin D6, resulting in a total bulked flow of 9,820 cfs. This is a conservative approach because the peak flow from CP2 may not be concurrent with that from sub-basin D6.

7.3.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows around Muck Storage A for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new flow paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near the North Portal Pad.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed to the north of Muck Storage A between Station 16814 and 13175 to divert the flow from sub-basins S1 and ND4 eastward to flow concentration point CP2 to reduce the flow impacting the North Portal Pad. The channel is assumed to have a bottom width of 25 feet with 2:1 side slopes, and a gradient of 0.0065, resulting in an excavation volume of about 195,000 cubic yards (volume calculation included in Attachment 16). The average channel depth is about 20 feet. However, since the channel has to pass through a few ridges along its alignment, the maximum depth of excavation will be approximately 28 feet at the deepest section. In addition, to avoid excessive channel excavation, a 2 to 10-foot high berm will be needed downhill of the manmade channel between Stations 16814 and 16390.

Blockage of Natural Drainages

In order to direct the floodwater down the manmade channel, the natural drainages along the northern boundary of Muck Storage A (as shown on Figure 7-1) are assumed to be blocked with fill material immediately downhill of their intersection with the manmade channel to prevent the water from flowing down to the North Portal Pad. The fill material should be placed at least up to the predicted maximum water surface elevations, or 1 to 2 feet higher for provision of freeboard.

Configuration of Muck Storage A

Since the location of Muck Storage A has not been fixed, it is assumed to be constructed within the limits indicated on Figure 7-1 such that it will be between the manmade channel and the future Aging Pads 2 and 3 in the north-south direction, and will not block the natural channels in sub-basins D6 and ND2. The analysis conducted for Alternative 2 will be valid as long as Muck Storage A lies within those limits.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.0619 and 0.0244, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

7.3.3 Results

Table 7-1 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-1. Results indicate that the PMF flow is contained within the proposed manmade channel. The PMF flow is also contained within the natural channel downstream of CP2, thus assuring that the flow will not affect the North Portal Pad under the high sediment transport conditions. The complete HEC-RAS output results are included in Attachments 1.13 and 16.

Table 7-1. Flood Inundation Results Around Muck Storage A, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
17,331	6,300	3,933	8.5	0.78
17,044	6,300	3,919	10.4	0.86
16,814	6,300	3,905	7.0	0.37
16,390	6,300	3,902	6.2	0.29
15,650	6,300	3,898	6.2	0.33
15,011	6,300	3,894	6.3	0.34
14,371	6,300	3,889	6.3	0.34
13,789	6,300	3,885	6.6	0.36
13,273	6,300	3,881	7.3	0.4
13,175	6,300	3,875	13.4	0.89
12,712	6,300	3,859	8.1	0.61
11,769	9,820	3,827	11.4	0.81
10,590	9,820	3,784	11.9	0.74
8,898	9,820	3,733	14.4	0.74
8,023	9,820	3,706	13.3	0.79
6,683	9,820	3,676	9.1	0.45
4,642	9,820	3,623	12.5	0.82
2,917	9,820	3,587	3.0	0.2
1,730	9,820	3,559	6.2	0.54
286	9,820	3,527	7.0	0.59

7.4 DIVERSION AROUND AGING PAD 3, ALTERNATIVE 2

7.4.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing as shown on Figure 7-2 consists of a single branch that begins with a manmade reach along the northern and eastern boundaries of Aging Pad 3, subsequently discharges into the natural channel downstream of sub-basin D7, and ends at the gap between Alice Hill and Fran Ridge. The objectives of the routing are to determine the diversion required to prevent flooding at Aging Pad 3, and to confirm that the runoff from sub-basin D7 will be contained in the natural channel downstream of the pad. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 17 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). Therefore, the bulked peak flow from sub-basin D7 of 780 cfs was applied to the upper reach between Stations 9975 and 7842. Downstream of the pad, the flow will increase due to additional runoff from part of sub-basin D6. The area that will drain to the main channel was calculated to be 0.194 mi^2 using ArcGIS V.8.3, and the additional runoff was calculated by proportioning the area to the total drainage area of sub-basin D6, resulting in a total bulked flow of 1,710 cfs. This is a conservative approach because the peak flow from sub-basin D7 may not be concurrent with that from sub-basin D6.

7.4.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows around Aging Pad 3 for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new flow paths cannot be predicted.

Configuration of Aging Pad 3 and Muck Storage A

Since the grading plan is not available for Aging Pad 3 on the preliminary sketch included as Attachment 3, from a construction standpoint it is logical to assume that the pad will be partly in cut (likely the northern portion) and partly on fill (likely the southern portion) to optimize the quantities of excavation and borrow materials. This means that the runoff from sub-basin D7 will impinge directly on Aging Pad 3 if there is no diversion to route the flow around the facility. Secondly, Muck Storage A is assumed to be not yet constructed or once constructed to have a similar slope as the existing topography. This will ensure that the runoff from D7 will not be greater than that adopted in the analysis.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the northern and eastern boundaries of Aging Pad 3 (between Station 9975 and 7652 on Figure 7-2) to intercept and divert the flow from sub-basin D7 around the pad to the natural channel southeast of the facility. The channel is assumed to have a bottom width of 10 feet, with 2:1 side slopes and variable gradient to fit the local terrain. The average gradient is about 0.039, yielding a total volume of excavation of 25,000 cubic yards. The average depth of channel is about 10 feet because part of the channel has to pass through ridges. The volume calculations are included in Attachment 17.

Blockage of Natural Drainages

In order to direct the floodwater to the manmade channel, the natural drainage between Stations 9975 and 9801 is assumed to be blocked with fill material immediately downhill of its intersection with the manmade channel to prevent the water from flowing down to Aging Pad 3. The fill material should be placed at least up to the predicted maximum water surface elevations, or 1 to 2 feet higher for provision of freeboard.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.037 and 0.0217, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

7.4.3 Results

Table 7-2 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-2. The flow coming down from sub-basin D7 will be intercepted by the manmade channel that is sized to contain the water within its banks along the entire reach. Once the water is discharged into the natural channel, results indicate that the capacity of the natural channel is sufficient to carry the PMF flow such that no overtopping is expected to occur. Therefore, the North Portal Pad will not be inundated by the flow propagating down this primary channel. The complete HEC-RAS output results are included in Attachments 1.14 and 17.

Table 7-2. Flood Inundation Results Around Aging Pad 3, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
9975	780	3,815	7.6	0.93
9801	780	3,807	5.6	0.5
9677	780	3,805	5.6	0.49
9556	780	3,802	5.2	0.45
9414	780	3,801	3.9	0.31
9295	780	3,795	8.8	0.88
9139	780	3,787	7.7	0.74
8969	780	3,780	6.3	0.58
8735	780	3,770	8.2	0.81
8465	780	3,759	5.7	0.57
8166	780	3,748	7.7	0.74
7842	780	3,735	6.6	0.61
7652	1,710	3,729	8.6	0.68
6694	1,710	3,699	7.0	0.62
5946	1,710	3,677	6.7	0.63
5119	1,710	3,651	7.4	0.66
4220	1,710	3,626	6.7	0.58
3417	1,710	3,605	5.5	0.59
2408	1,710	3,576	2.7	0.48
1620	1,710	3,559	3.6	0.42
740	1,710	3,541	4.6	0.55
59	1,710	3,524	3.6	0.48

7.5 DIVERSION AROUND AGING PAD 2, ALTERNATIVE 2

7.5.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing as shown on Figure 7-3 consists of a single branch that begins with a manmade channel along the northern boundary of Aging Pad 2, continues in the natural channel to the east of the pad, and ends where it meets another manmade channel built to route floodwater around the North Portal Pad (refer to Section 7.8). Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 18 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). Therefore, the bulked peak flow of 1,100 cfs for sub-basin D8 was used. The incremental flow from the portion of sub-basin D5 that drains to this routing reach was neglected because it is insignificant compared to the runoff from D8.

7.5.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows around Aging Pad 2 for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new flow paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near Aging Pad 2.

Configuration of Aging Pad 2 and Muck Storage A

Since the grading plan is not available for Aging Pad 2 on the preliminary sketches included as Attachment 3, from a construction standpoint it is logical to assume that the pad will be partly in cut (likely the northern portion) and partly on fill (likely the southern portion) to optimize the quantities of excavation and borrow materials. This means that the runoff from sub-basin D8 will impinge directly on Aging Pad 2 in the absence of any diversions. Secondly, Muck Storage A is assumed to be not yet constructed or once constructed to have a similar slope as the existing topography. This will ensure that the runoff from D8 will not be greater than that adopted in the analysis.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the northern boundary of Aging Pad 2 (between Stations 4432 and 3408 on Figure 7-3) to intercept and divert the flow from sub-basin D8 to the second natural channel east of the pad. The second natural channel was chosen because it has a larger capacity and it is farther away from Aging Pad 2. A longer manmade channel will be required if the flow is discharged into the natural channel along the eastern boundary of Aging Pad 2 because the northern portion of the pad is likely to be in cut. The channel is assumed to have a bottom width of 10 feet, 2:1 side slopes, and an average gradient of 0.007. The average depth is 12 feet while the total volume of excavation is about 15,000 cubic yards. The volume calculations are included in Attachment 18.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow was assumed at the upstream boundary in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope) using the manmade channel ground slope of 0.005 along the northern boundary. In reality, the runoff from sub-basin D8 will enter the channel laterally and hence the value used for the upstream boundary is irrelevant. Because this routing ends at the other manmade channel CP3CP4, the water surface elevation predicted at Station 1828 of CP3CP4 was used for the downstream boundary.

7.5.3 Results

Table 7-3 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-3. The flow coming down from sub-basin D8 will be intercepted by the manmade channel that is sized to contain the water within its banks. Once the water is discharged into the natural channel, results indicate that the capacity of the natural channel is sufficient to carry the PMF flow such that no overtopping is expected to occur. Therefore, the North Portal Pad will not be inundated by uncontrolled flow propagating down this primary channel. The complete HEC-RAS output results are included in Attachments 1.15 and 18.

Table 7-3. Flood Inundation Results Around Aging Pad 2, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
4432	1,100	3,823	3.8	0.27
4158	1,100	3,821	3.8	0.28
3935	1,100	3,820	4.0	0.29
3745	1,100	3,819	4.3	0.32
3574	1,100	3,814	8.2	0.72
3408	1,100	3,808	5.1	0.62
3259	1,100	3,802	5.3	0.65
3057	1,100	3,794	6.4	0.72
2801	1,100	3,782	6.3	0.71
2441	1,100	3,770	5.6	0.56
2046	1,100	3,757	7.0	0.7
1394	1,100	3,735	5.8	0.58
924	1,100	3,719	7.0	0.72
543	1,100	3,709	4.1	0.39
76	1,100	3,692	7.8	0.84

7.6 NORTH CONSTRUCTION PORTAL, ALTERNATIVE 2

7.6.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing as shown on Figure 7-4 consists of a single branch that begins at the base of sub-basin D3, continues along the natural channel west of the North Construction Portal, and ends at flow concentration point 1. There are a few indistinct natural drainages at the base of sub-basin D3. Since the objective of this routing is to determine the inundation extent in the vicinity of the North Construction Portal, the preferred flow path was set up along the natural channel closest to the North Construction Portal. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 19 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). Therefore, the bulked peak flow from sub-basin D3 of 5,800 cfs was applied from the upstream end of the channel to Station 2746, beyond that the bulked flow of 8650 cfs at CP1 was used.

7.6.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows around the North Construction Portal for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of North Construction Portal and Aging Facility

Since the design elevation has not been determined, the North Construction Portal is assumed to be above the PMF water surface elevation to ensure that floodwater will not get into the underground facilities through the portal. Given the critical nature of the facilities, it is reasonable to assume that an adequate level of protection will be incorporated into the final design to prevent the intrusion of floodwater either by elevating the portal or by some kind of flood barriers (e.g. walls or berms). Similarly, it is assumed that preventive measures will be implemented around the Aging Facility to protect it against floodwater. Refer to Section 7.7 for detailed flood inundation analysis at the Aging Facility.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.044 and 0.031, respectively.

7.6.3 Results

Table 7-4 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-4. The flow coming down from sub-basin D3 will be combined with runoff from sub-basin ND2 and spread over the small natural drainages. Since the North Construction Portal and Aging Facility are assumed to be protected against the PMF, they are outside the inundation limits. The complete HEC-RAS output results are included in Attachments 1.16 and 19.

Table 7-4. Flood Inundation Results Near North Construction Portal, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
3737	5,800	3,932	3.6	0.42
3205	5,800	3,908	8.6	0.94
2746	5,800	3,885	4.9	0.56
2380	8,650	3,869	4.5	0.64
1975	8,650	3,848	6.1	0.8
1551	8,650	3,830	4.5	0.54
1094	8,650	3,814	9.0	0.76
644	8,650	3,796	8.7	0.74
84	8,650	3,777	6.4	0.63

7.7 DIVERSION NORTH OF AGING FACILITY, ALTERNATIVE 2

7.7.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing as shown on Figure 7-5 consists of a single branch that begins at the foothill of the ridge northwest of the Aging Facility, continues in a manmade reach that runs along the northern boundary of Aging Facility, then discharges into the natural channel and ends where it meets another manmade channel built to route floodwater around the North Portal Pad (refer to Section 7.8). Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 20 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). Therefore, the bulked peak flow of 8,650 cfs at flow concentration point CP1 was applied to the entire reach. The incremental flow from the portion of sub-basin D5 that drains to this routing reach was neglected because it is insignificant compared to the flow at CP1.

7.7.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows north of the aging facility for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new flow paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near the North Portal Pad.

Configuration of Aging Facility

The grading of the Aging Facility is not available on the preliminary sketch for Alternative 2 and it is assumed that it will be partly in cut and partly on fill as in Alternative 1 in order to balance the quantities of excavation and import volumes. Based on the existing topography, it is likely that the northern and western portion of the pad will be in cut. This means that the runoff from sub-basins D3 and ND2 will inundate the Aging Facility in the absence of any diversions.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the northern boundary of the Aging Facility (between Station 4055 and 1743 on Figure 7-5) to capture and divert the flow from sub-basins D3 and ND2 to the natural channel east of the pad. This assumption is necessary to ensure that the waste handling facility will not be flooded during the PMF event. The channel is assumed to have a bottom width of 25 feet with 2:1 side slopes. The gradient is steepest at the foothill at 0.091 and flattens to 0.027 along the northern boundary of the Aging Facility, resulting in an average slope of 0.038. The total volume of excavation is about 80,000 cubic yards and the average channel depth is about 16 feet. The volume calculations are included in Attachment 20.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow was assumed at the upstream boundary in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope) with the channel ground surface slope estimated to be 0.099 from the topographic data (refer to Section 4.2.3). Because this routing ends at the other manmade channel CP3CP4, the average of the water surface elevations predicted at Stations 3612 and 3053 of CP3CP4 was used for the downstream boundary.

7.7.3 Results

Table 7-5 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-5. The flow coming down from sub-basins D3 and ND2 will be intercepted by the manmade channel along the northern boundary of the Aging Facility and diverted eastward to the natural drainage. The manmade channel is sized to completely contain the flow such that the Aging Facility will not be inundated regardless of its final design elevation. The flow will be ultimately discharged into the natural channel, which is large enough to convey the water without overtopping according to the model outputs. This means the Aging Facility will stay out of the inundation extent. The complete HEC-RAS output results are included in Attachments 1.17 and 20.

Table 7-5. Flood Inundation Results North of Aging Facility, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
4055	8,650	3,857	18.5	1.23
3929	8,650	3,846	17.4	1.13
3732	8,650	3,827	18.4	1.21
3521	8,650	3,817	15.6	0.98
3407	8,650	3,813	11.5	0.67
3177	8,650	3,806	11.5	0.67
2836	8,650	3,797	11.5	0.67
2576	8,650	3,790	11.5	0.67
2322	8,650	3,783	11.4	0.66
2220	8,650	3,781	11.2	0.64
2044	8,650	3,775	12.7	0.75
1743	8,650	3,768	8.0	0.59
1280	8,650	3,756	9.4	0.67
955	8,650	3,746	10.3	0.73
643	8,650	3,737	9.0	0.62
351	8,650	3,728	10.1	0.76
49	8,650	3,721	6.0	0.39

7.8 AGING FACILITY AND NORTH PORTAL PAD, ALTERNATIVE 2

7.8.2 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing consists of a main river branch extending from the north-west corner of the western aging facility (area FAC2 in the hydrology model) following the western then southern edge of the aging facility then south-east just north of the North Portal Pad (NPP) as shown in Figure 7-6. Cross sections were developed from topographic data described in Section 4.2.3 using Arcview V.3.2 and modified for the surface facilities based on the preliminary layout sketch (Attachment 3). Cross-sections are included in Attachment 21 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used with a bulking factor of 10% as inputs to the HEC-RAS software. Along the aging facilities, i.e., from Station 7795 to Station 4476 (as shown on Figure 7-6), the peak flow at ND1 was used. With a bulking factor of 10% based on the previous report (Ref. 6, pp. 29-30), the flow for this reach is 5,734 cfs. Downstream of the aging facility the flow at CP4 was used which includes additional runoff from FAC2, D5, D3 and ND2 and resulting in a total bulked flow of 15806 cfs (see Figure 5-1 for location of sub-basins).

7.8.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows around the Aging Facility and North Portal Pad for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted. For the proposed mitigation designs the flows are directed into existing channels to increase the probability that new channels will not form near the North Portal Pad.

Properties of Manmade Channel

It is assumed that a manmade channel will be constructed along the western and southern boundaries of the Aging Facility to capture runoff from sub-basins ND2 and ND1 and divert it eastward to flow concentration point CP3 to prevent runon to the Aging Facility. The channel has an average depth of approximately 25 feet and a bottom width of from 5 feet to 28 feet around the aging facility with 2:1 side slopes. The excavation volume is about 121,500 cubic yards. The volume calculations are included in Attachment 21.

From the Aging Facility east past the North Portal Pad it was assumed that the flow would be transported in a manmade channel to prevent it from flowing onto the North Portal Pad. The channel was assumed to have 2:1 side slopes and a bottom width of 15 feet between Stations 4249 and 40. The average channel depth is about 20 feet, and varies from about 10 feet to 30 feet deep at the deepest location. This channel requires an excavation of approximately 175,000 cubic yards. The volume calculations are included in Attachment 21. The channel is not quite large enough to contain the flow immediately downstream of Exile Hill. Small berms or levees on the order of 3 to 4 feet tall would be needed starting upstream of station 3612 continuing to downstream of Station 3053. Also, the constructed channel will cross several natural drainages. To prevent stormwater runoff from flowing down those drainages, the drainages should be blocked on the downstream side of the manmade channel at each crossing.

Configuration of Aging Facility FAC2

The Aging Facility, as shown on Figure 7-6 is assumed to be protected by a channel running along its western and southern edge. The Aging Facility was assumed to be built at an elevation of 3790. This results in the Aging Facility being in cut west of between Stations 5009 and 5468 and on fill east of this point. The constructed channel was assumed to fade out between Stations 5009 and 4477 where the fill would prevent runon of storm water runoff. If the Aging Facility is built at an elevation different than 3790 the flood elevations presented in this report will not be affected as long as the fill east of Station 5009 is greater than about 3 feet.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were specified at both boundaries in the HEC-RAS software (i.e., the water surface slope is assumed to follow the channel ground surface slope). The channel ground surface slopes at the downstream and upstream boundaries were estimated from the topographic data described in Section 4.2.3 to be 0.025 and 0.001, respectively.

7.8.2 Results

Table 7-6 presents the best estimate of PMF water surface elevations and flow velocities at each cross with the extent of the inundation shown in Figure 7-6. The man-made channel is sized to transport the PMF around the North Portal Pad. The exact layout and elevation of the pad will not affect the results as long as the layout remains south and west of the man-made channel and the natural drainage the flood waters discharge into. The complete HEC-RAS output results are included in Attachments 1.18 and 21.

Table 7-6. Flood Inundation Results Around Aging Facility and North Portal Pad, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
7796	5,734	3846	11.0	0.69
7318	5,734	3836	8.8	0.52
6710	5,734	3825	9.3	0.56
6265	5,734	3816	9.4	0.56
5925	5,734	3808	11.0	0.68
5468	5,734	3796	9.2	0.57
5009	5,734	3784	8.7	0.59
4477	5,734	3760	1.3	0.18
4249	15,806	3752	11.2	0.76
3612	15,806	3729	7.9	0.48
3053	15,806	3713	12.4	0.59
2431	15,806	3701	12.0	0.59
2029	15,806	3693	11.8	0.58
1828	16,349	3689	12.1	0.6
1383	16,349	3680	12.2	0.6
968	16,349	3671	13.1	0.66
519	16,349	3659	11.3	0.64
40	16,349	3645	10.5	0.65

7.9 EAST OF NORTH PORTAL PAD, ALTERNATIVE 2

7.9.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

A single branch representing the primary channel east of the North Portal Pad was set up that extends from the downstream end of the manmade channel diverting flow around the North Portal Pad to the gap between Alice Hill and Fran Ridge as shown in Figure 7-7. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 22 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). The channel collects stormwater from the manmade channel that diverts water around the North Portal Pad, as well as distributed runoff from part of sub-basin D6 along its watercourse. Note that the delineation of sub-catchments in sub-basin D6 is not exact because there is no distinct drainage divide in the wash towards the bottom of D6. The area that will drain to this channel was calculated to be 0.204 mi^2 using ArcGIS V.8.3 (as delineated on Figure 7-7), and the additional bulked flow was calculated by proportioning the area to the total drainage area of sub-basin D6. This amount was added to the bulked flows at flow concentration point CP5 to give a total flow of 17,330 cfs that was used for the entire reach. This is a conservative approach because the peak discharge from sub-basin D6 is unlikely to be concurrent with the peak flow at CP5.

7.9.2 Assumptions

The followings assumptions were used in the HEC-RAS software for routing flows east of the North Portal Pad for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.025 and 0.028, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

7.9.3 Results

Table 7-7 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-7. Results indicate that the capacity of the natural channel is sufficient to carry the PMF flow upstream of Station 3745, beyond which the flow will spread over the wash and ultimately converge at the gap between Alice Hill and Fran Ridge. Nonetheless, the North Portal Pad will not be inundated by the flow propagating down this primary channel because the overtopping occurs downstream of the pad. The complete HEC-RAS output results are included in Attachments 1.19 and 22.

Table 7-7. Flood Inundation Results for Primary Channel East of North Portal Pad, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
5224	17,330	3,645	15.8	0.82
4776	17,330	3,634	12.8	0.64
4247	17,330	3,618	15.2	0.81
3745	17,330	3,605	12.2	0.65
3207	17,330	3,590	12.7	0.77
2536	17,330	3,572	2.7	0.2
1447	17,330	3,550	4.5	0.42
181	17,330	3,523	7.8	0.64

7.10 DOWNSTREAM OF NORTH PORTAL PAD, ALTERNATIVE 2

7.10.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing consists of a single branch representing the main channel extending from the eastern boundary of North Portal Pad to the gap between Alice Hill and Fran Ridge as shown in Figure 7-8. The objective is to determine the degree of flooding immediately downstream of the North Portal Pad. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and are included in Attachment 23 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used as inputs to the HEC-RAS software, and were increased by a bulking factor that was determined to be 10% in a previous report (Ref. 6, pp. 29-30). The overland flow from sub-basin FAC3 will enter the channel at the upstream boundary with the amount calculated to be 5,170 cfs including bulking. Along the watercourse, the flow will continuously increase due to additional runoff from part of sub-basin D6. The area that will drain to this channel was calculated to be 0.377 mi^2 using ArcGIS V.8.3 (as delineated on Figure 7-8) by proportioning the area to the total drainage area of sub-basin D6, resulting in a total bulked flow of 6,980 cfs that was applied to the entire reach. This is a conservative approach because the peak flow from FAC3 may not be concurrent with that from sub-basin D6, and in reality the incremental runoff will only reach its peak at the downstream end of the channel.

7.10.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows downstream of the North Portal Pad for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of North Portal Pad

The nominal elevations of the main platform of the North Portal Pad and the balance of plant are 3,666 and 3,635 feet, respectively according to the preliminary sketch for Alternative 2 (Refer to Attachment 3). Both pads are assumed to have a 2 percent slope eastward so that the runoff from Exile Hill along with the runoff from the pads themselves will be discharged into the natural channel located east of the balance of the plant. This means that the elevation of the balance of plant will vary from 3,647 to 3,623 feet along its edge adjacent to the natural channel. Since no facilities important to safety are located on the balance of plant as identified on the Q list (Ref. 7, p. A-2), it is assumed that no flood protection measures will be provided for this lower pad.

Configuration of Evaporation Pond

The evaporation pond located to the east of the North Portal Pad is assumed to be constructed at grade because no design elevation is given in the layout sketch for Alternative 2. Since it is not a critical facility, it is assumed that no flood protection measures will be provided.

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.030 and 0.024, respectively. The upstream ground slope will actually be modified by the construction of the main platform and will become fairly steep. To be conservative, the natural ground slope was used instead of the slope of the graded fill since the fill gradient is not shown on the preliminary sketch. On the other hand, the actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

7.10.3 Results

Table 7-8 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-8. Results indicate that the floodwater will be piled up against the North Portal Pad along the northeastern edge of the balance of plant based on the assumed pad slope and elevation. However, the balance of plant will be inundated if its northern corner is below 3,539 feet elevation and the inundation limits will be different than that shown in Figure 7-8. Secondly, the evaporation pond is predicted to be inundated with floodwater under the assumption given above. The complete HEC-RAS output results are included in Attachments 1.20 and 23.

Table 7-8. Flood Inundation Results Downstream of North Portal Pad, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
5102	6,980	3,639	7.1	0.65
5018	6,980	3,637	5.3	0.56
4874	6,980	3,632	6.5	0.64
4582	6,980	3,624	5.6	0.54
4340	6,980	3,620	6.2	0.4
4085	6,980	3,612	8.4	0.77
3906	6,980	3,605	9.6	0.71
3687	6,980	3,599	7.6	0.62
3422	6,980	3,593	6.9	0.48
3072	6,980	3,585	9.7	0.71
2608	6,980	3,574	5.7	0.49
2106	6,980	3,563	5.4	0.56
1552	6,980	3,549	5.5	0.55
1026	6,980	3,537	5.1	0.53
557	6,980	3,528	4.5	0.46
56	6,980	3,517	5.5	0.55

7.11 RAILROAD BRIDGE CROSSING, ALTERNATIVE 2

7.11.1 Inputs

Inputs for the HEC-RAS computer software consist of river geometry and inflows.

River Network and Cross Sections

The routing of flow concentrating at CP7 under the proposed railroad was performed using one river reach. Flow was routed along the northern edge of Muck Storage B down to the gap between Alice Hill and Fran Ridge as shown in Figure 7-9. Cross sections were developed from topographic data (refer to Section 4.2.3) using Arcview V.3.2 and the preliminary layout sketch for Alternative 2 (Attachment 3). Cross-sections are included in Attachment 24 to this calculation.

Flows

Inflows needed for the flood inundation analysis were obtained from the PMF analysis for Alternative 2. Peak discharges presented in Table 5-5 were used with a bulking factor as inputs to the HEC-RAS software. With the proposed railroad graded to elevation 3666 feet, the alignment along the southern end of the eastern edge of Muck Storage B would be in cut. Some flow from sub-basin E2 would escape into sub-basin E3 as flow continued north along the railroad until the grade is above the natural ground surface along the eastern edge of the muck storage pile. To be consistent with the PMF analysis described in Section 5, and to be conservative in sizing the two bridges along the railroad alignment north of Muck Storage B, all the runoff from E2 was diverted to CP7 to obtain the maximum flow upstream of the railroad.

From Station 7119 to Station 6220 (as shown on Figure 7-9), flow was estimated to be 2,490 cfs for the peak flow from FAC4 with a bulking factor of 10% based on the previous report (Ref. 6, pp. 29-30). At Station 6028, flow was increased to 22,470 cfs, which accounts for the bulked flow at CP7. The flow was increased to 25,150 cfs (the bulked peak flow at CP8) at Station 3938 to account for additional flow from sub-basin E3.

7.11.2 Assumptions

The following assumptions were used in the HEC-RAS software for routing flows under the railroad for Alternative 2.

Fixed flow path

New flow paths often form during large floods in a wash such as Midway Valley Wash as evident by the numerous channels in Midway Valley Wash that appear to have been formed by historic floods. For the purpose of calculating the PMF water surface elevations, it is assumed that the floodwater will follow the channels used in the HEC-RAS simulations because the formation of new paths cannot be predicted.

Configuration of Muck Storage B

Muck Storage B is assumed to be approximately 20 feet high along the northern boundary and configured so that it does not block the bottom of the channel along its northern edge. This assumption was made because the design of Muck Storage B is not finalized, and this configuration confines the runoff from sub-basins E1 and FAC4 to the northern side of Muck Storage B but still allows flow through the natural channel. The presence of Muck Storage B results in a conservatively high estimate of water surface elevations near the railroad so that the bridge opening can be properly sized to prevent flow from impinging on the North Portal Pad.

Configuration of Structure Shown in Floodplain

It was assumed that the Visitors Center shown on the preliminary layout sketch (Attachment 3) to be located at the base of Fran Ridge would not be protected from the PMF because it is not important to safety, as defined on the Q List (Ref. 7, p. A-2). Therefore, it could be within the flood inundation surface shown in Figure 7-9.

Bridge Openings

Nominal bridge dimensions were assumed because the bridge design had not been developed at the time this analysis was conducted.

The bridge over the realignment of "H" Road was assumed to be 60 feet long and 190 feet wide in the direction of flow. These dimensions were assumed to allow traffic to pass under the bridge, and to allow for grading of the railroad alignment. It was assumed to be a clear span without any piers. The bridge deck was assumed to be 6 feet thick, as assumed in the previous study (Ref. 6, p. 26).

The bridge across the natural channel at CP7, just north of Muck Storage B, was assumed to be 90 feet long, in order to adequately convey the PMF, and 190 feet wide, to allow for grading of the railroad alignment. It was assumed that there would be one row of 4-foot diameter piers down the center of the channel. The bridge deck was assumed to be 6 feet thick. These dimensions are consistent with a typical concrete freeway bridge, as assumed in the previous study (Ref. 6, p. 26).

Manning's Roughness Coefficient

Manning's roughness coefficient of 0.09 was used in the previous report (Ref. 6, pp. 28-29) for both the main channel and the floodplains in the HEC-RAS software to evaluate energy loss due to friction under the high sediment transport conditions. This best estimate value was adopted in this calculation because it provides a conservatively high, yet realistic, estimate of water surface elevations that may occur during a PMF event.

Boundary Conditions

Boundary conditions are required at the upstream and downstream boundaries to allow for both supercritical and subcritical flow conditions within the river reach. Normal flow conditions were assumed at both boundaries in the HEC-RAS software (i.e., the water surface slope follows the channel ground surface slope). The channel ground surface slopes at the upstream and downstream boundaries were estimated from the topographic data (refer to Section 4.2.3) to be 0.05 and 0.028, respectively. The actual downstream boundary is probably different than the normal flow conditions because the water surface elevation is also governed by the other streams merging at the gap. However, the impact of the downstream condition will not extend very far upstream (on the order of a few hundred feet) in consideration of the gradient of the channel, which means the inundation results will be essentially unaffected by this assumption.

7.11.3 Results

Table 7-9 presents the best estimate of PMF water surface elevations and flow velocities at each cross section, with the extent of the inundation shown in Figure 7-9. Results indicate that the PMF flow will not impinge on the North Portal Pad, assuming that the two bridge openings are approximately as large as stated above. Therefore, the North Portal Pad will remain outside of the floodplain boundary. If both bridges are constructed as clear spans, the water surface elevations from the bridges to as far upstream as Station 6570 would be nearly 3 feet lower. The complete HEC-RAS output results and the output table for this clear span scenario are included in Attachment 1.21 and Attachment 24 to this calculation.

Table 7-9. Flood Inundation Results Near Railroad Bridge Crossing, Alternative 2

Station	Peak PMF Flow (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Froude No.
7119	2,486	3,659	5.6	0.75
6858	2,486	3,650	3.8	0.45
6570	2,486	3,647	0.6	0.03
6220	2,486	3,647	0.3	0.01
6028	22,470	3,647	2.2	0.08
5846	22,470	3,647	1.4	0.05
5681	22,470	3,647	1.0	0.03
5580	Bridge			
5477	22,470	3,617	25.4	2.6
5139	22,470	3,614	8.4	0.58
4765	22,470	3,606	8.2	0.62
4344	22,470	3,597	6.6	0.49
3938	25,150	3,590	7.2	0.53
3332	25,150	3,583	5.6	0.33
2846	25,150	3,575	10.0	0.62
2361	25,150	3,566	8.2	0.51
1910	25,150	3,558	10.2	0.61
1377	25,150	3,551	7.3	0.36
826	25,150	3,537	12.4	0.8
479	25,150	3,529	7.1	0.41
171	25,150	3,522	10.4	0.68

7.12 SOUTH PORTAL, ALTERNATIVE 2

The layout at the South Portal is the same between Alternatives 1 and 2 as shown on the sketches included as Attachment 3 to this calculation. Therefore, the PMF water surface elevations and the resulting inundation surface presented in Section 6.10 are also valid for Alternative 2. In essence, the South Portal is outside the inundation limits based on the results of the HEC-RAS software.

7.13 INTAKE AND EXHAUST SHAFTS, ALTERNATIVE 2

The major changes between Alternatives 1 and 2 are the configuration of the North Portal Pad and Aging Facilities. As such, the analysis conducted for the intake and exhaust shafts as presented in Section 6.11 for Alternative 1 is also valid for Alternative 2. That is, the average depth over the shaft pad is about 0.2 feet.

7.14 SCOUR ANALYSIS, ALTERNATIVE 2

Although the railroad alignment has not changed from Alternative 1, scour analysis was conducted for Alternative 2 because the flow dynamics are slightly altered with different discharges and bridge opening configuration. The scour calculations for Alternative 2 are included in Attachment 25. Similar to Alternative 1, no contraction scour is predicted to occur as the mean velocity immediately upstream of the bridge of 1.0 ft/s is substantially lower than the critical velocity for initiation scour of 2.9 to 4.3 ft/s (Ref. 6, p.43). On the other hand, the local scour depths at piers, estimated using the CSU equation (Ref. 17, Eq. 6.3, p. 6.4), are slightly larger at 4.4 and 2.9 feet for the bridges located immediately north of Muck Storage B and at H-road, respectively.

8 CONCLUSIONS AND LIMITATIONS

8.1 CONCLUSIONS FOR FLOOD INUNDATION ANALYSES

Hydrologic and hydraulic analyses were conducted for storm water runoff from a Probable Maximum Precipitation (PMP) event at the Yucca Mountain site for two alternative configurations of the surface facilities. Sections 4 and 5 of the report describe the rainfall and runoff generated for Alternatives 1 and 2, respectively. The flows generated from the PMP (i.e., the Probable Maximum Flood (PMF)) were routed around critical facilities to determine water surface elevations at critical locations. Outputs from the computer software are considered reasonable based on the input data.

Figure 6-1 shows the inundation at the North Portal Pad for Alternative 1 during a PMF event without implementing any mitigation measures. Because of the critical nature of the facilities near the North Portal Pad and vicinity, mitigation measures were designed that eliminated flooding at the facility. Sections 6-3 through 6-10 describe the hydraulic analyses and mitigations when required for Alternative 1. The mitigation measures consist mainly of large drainage channels that direct flows away from critical facilities, and their properties are summarized in Table 8-1. It should be emphasized that the channel dimensions are intended for use in the hydraulic analysis presented in this report, and not meant to replace detailed design that will be required at the project's final design stage. In the case of drainage just north of the North Portal Pad, in addition to the option of a drainage channel, the option of a floodwall or levee was also studied. The total volume of excavation required for all the manmade channels to prevent flooding at the North Portal Pad is about 442,000 cubic yards. For the diversion just north of the North Portal Pad about 200,000 yards of excavation could be eliminated by constructing a 3,200-foot long levee ranging from 2 to 12 feet high, excluding freeboard. The combined inundation surfaces for the critical facilities near the North Portal Pad and vicinity under Alternative 1 are shown on Figure 8-1.

Similar inundation results at the North Portal Pad are anticipated for Alternative 2 in the absence of any mitigation measures because the pad is in the same general location and the elevation of the final grade is lower. Therefore, mitigation measures were included in the hydraulic analyses when required, as presented in Sections 7-3 through 7-12 for Alternative 2. Table 8-2 summarizes the properties of the manmade channels designed to divert flows away from the critical facilities. Additional manmade channels are needed to route flows around Aging Pads 2 and 3. Note that the larger channel for diverting flows around Muck Storage A is not due to the differences between Alternatives 1 and 2, but the premise that the muck pile is not yet constructed and thus there is no barrier on the downhill side. It should also be emphasized that the channel dimensions are intended for use in the hydraulic analysis presented in this report, and not meant to replace detailed design that will be required at the project's final design stage. The total volume of excavation required for all the manmade channels to prevent flooding at the North Portal Pad is about 442,000 cubic yards. The combined inundation surfaces for the critical facilities near the North Portal Pad and vicinity under Alternative 2 are shown on Figure 8-2.

Results of these analyses are appropriate for the intended use of the study as stated under Section 1 of this report.

Table 8-1. Summary of Manmade Channels for Diversion of Flows Away From Critical Facilities, Alternative 1

Manmade Channel	Starting Station	Ending Station	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)	Volume of Excavation (CY)
Diversion around Muck Storage A	16740	13227	3514	0.0026	10	2	68,000
East of Optional Aging Facility – Reach 1	5460	5105	355	0.0197	25	2	9,000
East of Optional Aging Facility – Reach 2	2480	224	2256	0.022	25	2	80,000
Aging Facility	5838	3864	1974	0.034	35	2	85,000
North Portal Pad	3684	66	3618	0.027 (average)	30-35	2	200,000
Total Volume							442,000

Table 8-2. Summary of Manmade Channels for Diversion of Flows Away From Critical Facilities, Alternative 2

Manmade Channel	Starting Station	Ending Station	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Side Slope (h:1)	Volume of Excavation (CY)
Diversion around Muck Storage A	16814	13175	3639	0.0065	25	2	195,000
Diversion around Aging Pad 3	9975	7652	2323	0.039	10	2	25,000
Diversion around Aging Pad 2	4432	3408	1024	0.007	10	2	15,000
Northern boundary of Aging Facility	4055	1743	2312	0.038	25	2	80,000
Western and southern boundaries of Aging Facility	7796	4477	3319	0.024	15	2	121,500
North Portal Pad	4249	40	4209	0.027	15	2	175,000
Total Volume							611,500

8.2 LIMITATIONS

As pointed out in the assumption for the flood routing analyses, new flow paths may be opened up during a PMF event because of the unconsolidated nature of sediments in

Midway Valley Wash. However, since a rigid channel bed is implicitly assumed in the HEC-RAS software and the formation of new paths cannot be predicted with the current state-of-the-technology, there is uncertainty in the estimate of flow propagation and hence the flood inundation extents.

The scour analysis presented in Sections 6-12 and 7-14 assumed uniform soil property with depth but in reality, the erosion may stop if a harder stratum is encountered depending on the erodibility of the bed material. This means that the scour depth could have been overestimated.

The effect of wind waves has not been included in this analysis. The transitory nature of the flooding, short fetch distance, and relatively shallow water depth make additional height of water from wind action very minimal.

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10 ATTACHMENTS

There are a total of 27 attachments to this calculation listed as follows. Refer to Table 10-1 for the detailed listing of contents in Attachment 1. Note that the cover sheet is included in each attachment.

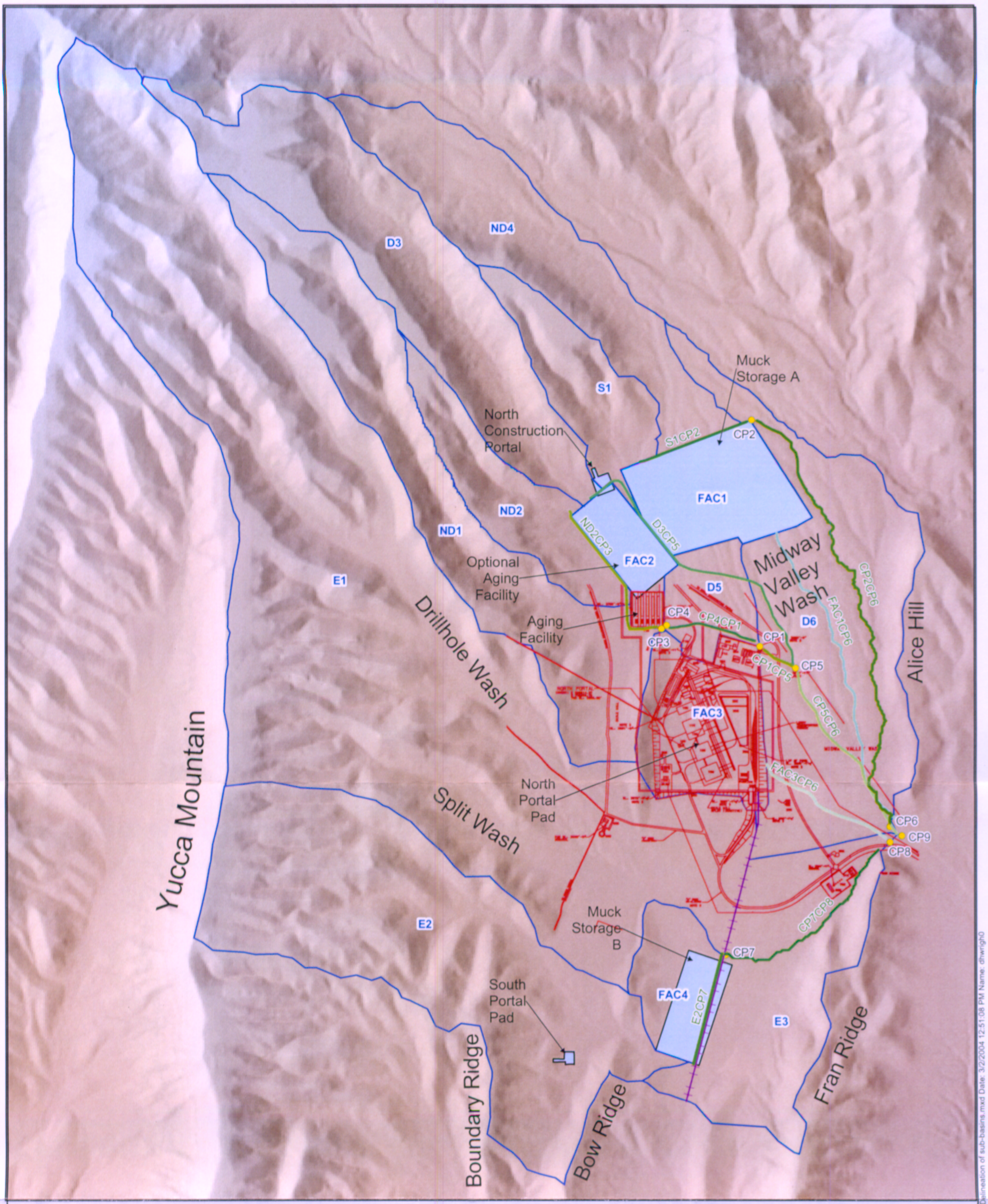
No.	No. of Pages	Content
1	1	CD containing electronic files
2	5	Correspondence with SCM
3	4	Layout Sketches of Alternatives 1 and 2
4	4	PMP Calculations for South Portal
5	3	Hydrology Calculations for Alternatives 1 and 2
6	18	Hydraulic Calculations for No Mitigation Scenario, Alternative 1
7	14	Hydraulic Calculations for Routing Around Muck Storage A, Alternative 1
8	6	Hydraulic Calculations for Routing Downstream of Muck Storage A, Alternative 1
9	16	Hydraulic Calculations for Routing Around Optional Aging Facility and North Construction Portal, Alternative 1
10	20	Hydraulic Calculations for Routing Around Aging Facility and North Portal Pad, Alternative 1
11	7	Hydraulic Calculations for Routing East of North Portal Pad, Alternative 1
12	6	Hydraulic Calculations for Routing Downstream of North Portal Pad, Alternative 1
13	10	Hydraulic Calculations for Routing Near Railroad Bridge Crossing, Alternative 1
14	17	Hydraulic Calculations for South Portal Routings, Alternative 1
15	2	Scour Analysis, Alternative 1
16	14	Hydraulic Calculations for Routing Around Muck Storage A, Alternative 2
17	16	Hydraulic Calculations for Routing Around Aging Pad 3, Alternative 2
18	12	Hydraulic Calculations for Routing Around Aging Pad 2, Alternative 2
19	7	Hydraulic Calculations for Routing Around North Construction Portal, Alternative 2
20	14	Hydraulic Calculations for Routing North of Aging Facility, Alternative 2
21	14	Hydraulic Calculations for Routing Around Aging Facility and North Portal Pad, Alternative 2
22	6	Hydraulic Calculations for Routing East of North Portal Pad, Alternative 2

No.	No. of Pages	Content
23	8	Hydraulic Calculations for Routing Downstream of North Portal Pad, Alternative 2
24	13	Hydraulic Calculations for Routing Near Railroad Bridge Crossing, Alternative 2
25	2	Scour Analysis, Alternative 2
26	5	Checker's Alternate Calculations for PMF

Table 10-1. List of Electronic Files Included in Attachment 1

Directory	File name	Size (kilobyte)	Time	Date	Originator	Checker
1.01	urssurf.e00	108,524	9:51 am	11/10/2003	Matthew Knopp	Douglas Wright
1.02	FINAL.out	117	4:37 pm	3/1/2004	Vivian Lee	Jeanne Hudson
1.03	ALT2.out	121	4:00 pm	2/18/2004	Vivian Lee	Jeanne Hudson
1.04	Exist2.rep	87	4:31 pm	3/1/2004	Jeanne Hudson	Vivian Lee
1.05	cp2cp6.rep	29	9:21 am	12/8/2003	Vivian Lee	Jeanne Hudson
1.06	fac1.rep	29	1:59 pm	11/24/2003	Vivian Lee	Jeanne Hudson
1.07	fac2.rep	31	2:08 pm	11/24/2003	Vivian Lee	Jeanne Hudson
1.08	nppq.rep	82	10:25 am	12/12/2003	Phillip Mineart	Jeanne Hudson
1.08	nppq-levee.rep	41	9:41 am	12/12/2003	Phillip Mineart	Jeanne Hudson
1.09	cp5.rep	28	3:00 pm	11/24/2003	Vivian Lee	Jeanne Hudson
1.10	fac3.rep	20	3:55 pm	11/24/2003	Vivian Lee	Jeanne Hudson
1.11	underrr.rep	63	4:26 pm	3/1/2004	Jeanne Hudson	Vivian Lee
1.12	sportal1.rep	29	6:08 pm	11/26/2003	Vivian Lee	Jeanne Hudson
1.12	sportal2.rep	19	6:04 pm	11/26/2003	Vivian Lee	Jeanne Hudson
1.12	sportal3.rep	18	9:23 am	12/8/2003	Vivian Lee	Jeanne Hudson
1.13	a2_cp2cp6.rep	35	5:48 pm	2/19/2004	Vivian Lee	Jeanne Hudson
1.14	a2_d7cp6.rep	40	11:35 am	2/24/2004	Vivian Lee	Jeanne Hudson
1.15	a2_d8cp5.rep	31	5:49 pm	2/26/2004	Vivian Lee	Jeanne Hudson
1.16	a2_d3.rep	21	2:13 pm	2/13/2004	Vivian Lee	Jeanne Hudson
1.17	a2_nd2cp3.rep	32	3:34 pm	2/25/2004	Vivian Lee	Jeanne Hudson
1.18	a2_npp.rep	1,009	3:07 pm	2/27/2004	Phillip Mineart	Jeanne Hudson
1.19	a2_cp5.rep	20	10:10 am	2/26/2004	Vivian Lee	Jeanne Hudson
1.20	a2_fac3.rep	34	2:17 pm	2/26/2004	Vivian Lee	Jeanne Hudson
1.21	rr_alt2.rep	65	12:25 pm	3/1/2004	Jeanne Hudson	Vivian Lee
1.22	800-P00-TUN0-00701-000-00A.jpg	4,280	2:02 pm	9/16/2003	Vivian Lee See note in Block 8 on page 2 of the cover sheet.	N/A

Note: The file sizes and times may vary with operating system.
The name of the directory is the same as the attachment number.



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

Railroad Alignment

● Flow Concentration Points

Watershed Boundaries

High : 6660.330078

Low : 2438.387939

Feet
0 2,000 4,000 6,000 8,000

N

URS	Yucca Mountain Project # 18839594	Delineation of Sub-basins for HEC-1 Model, Alternative 1	Figure 4-1

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Delineation of sub-basins.mxd Date: 3/2/2004 12:51:08 PM Name: dhwrigh0

Figure 4-2. Schematic Diagram of Watershed Network, Alternative 1

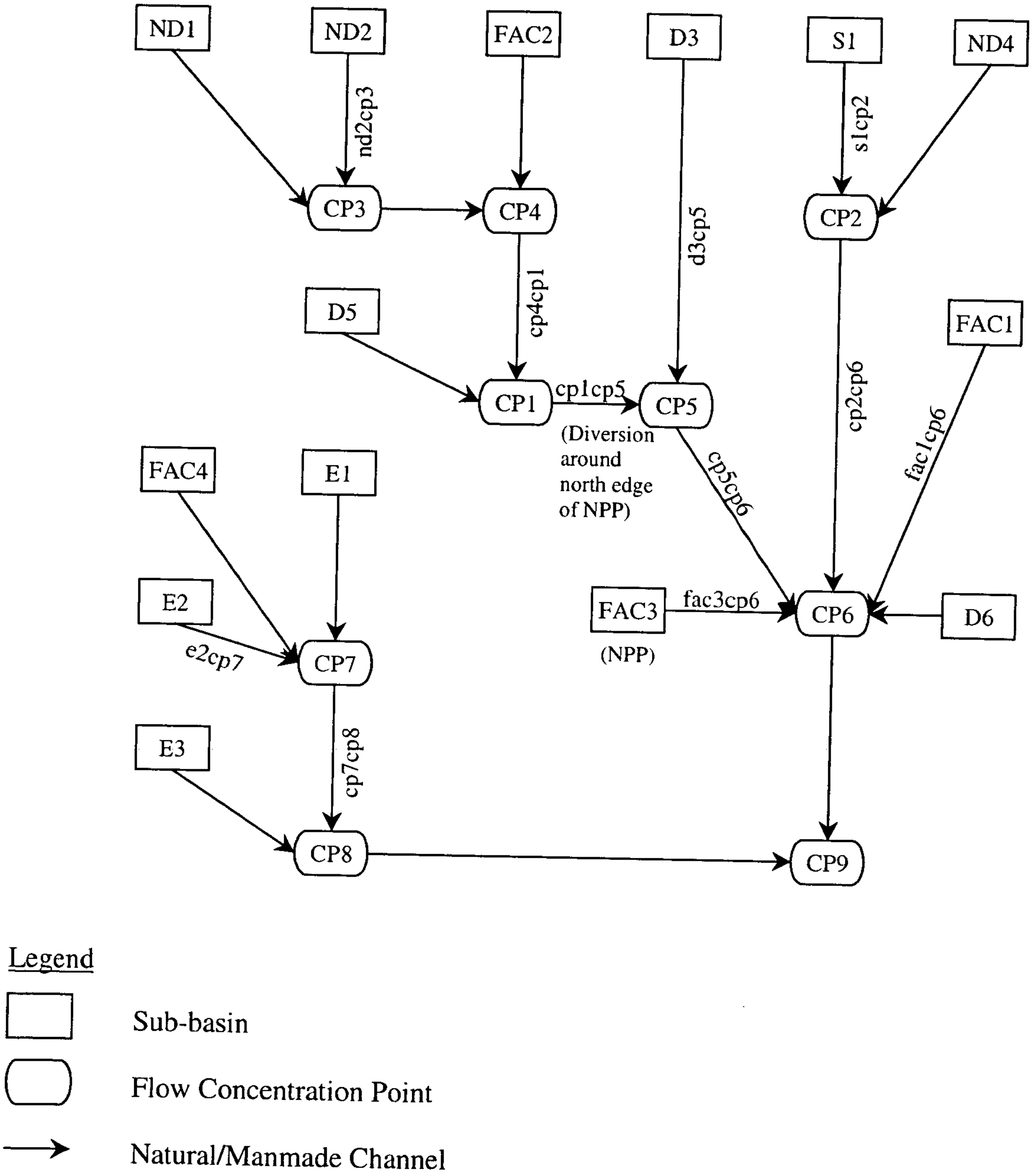
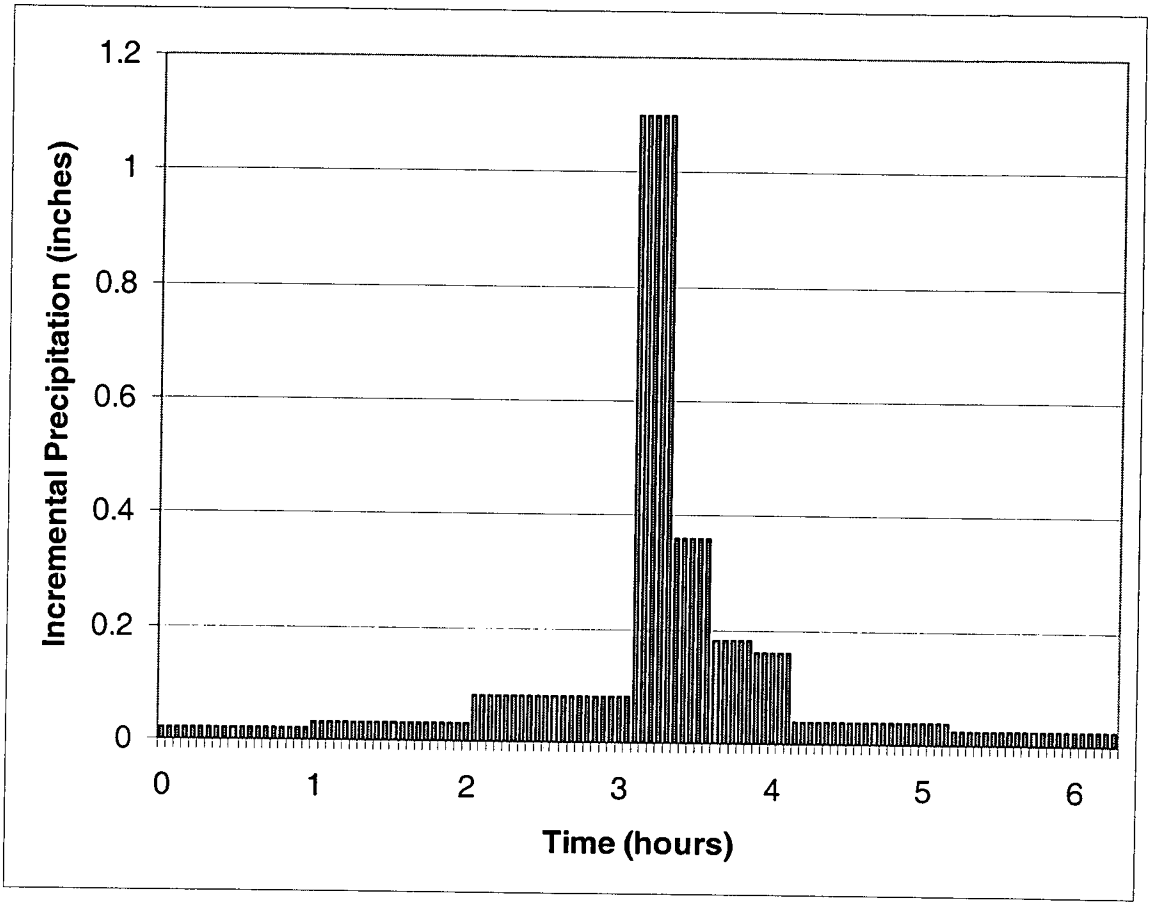
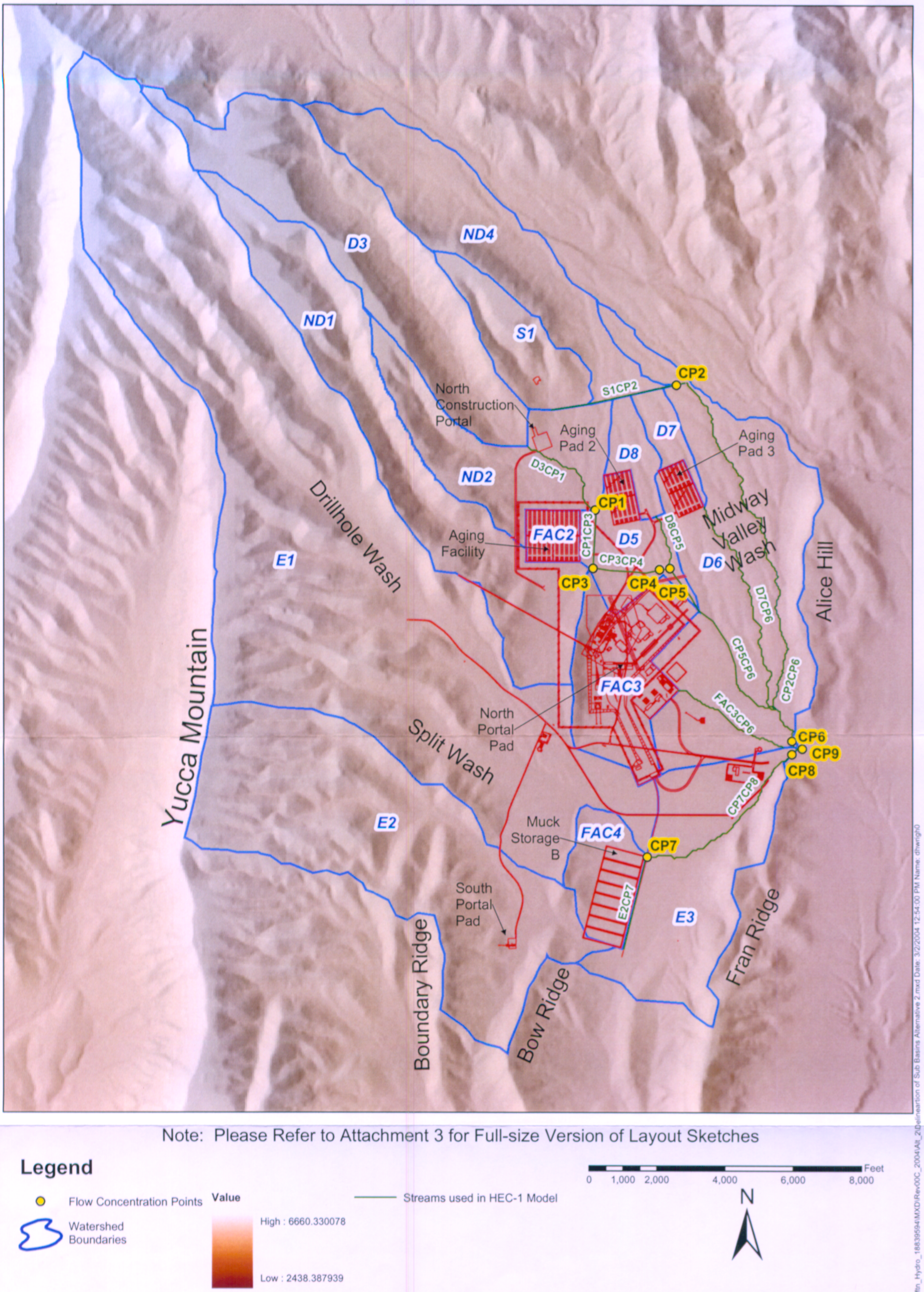


**Figure 4-3. PMP Hyetograph for the South Portal
(3-minute interval)**



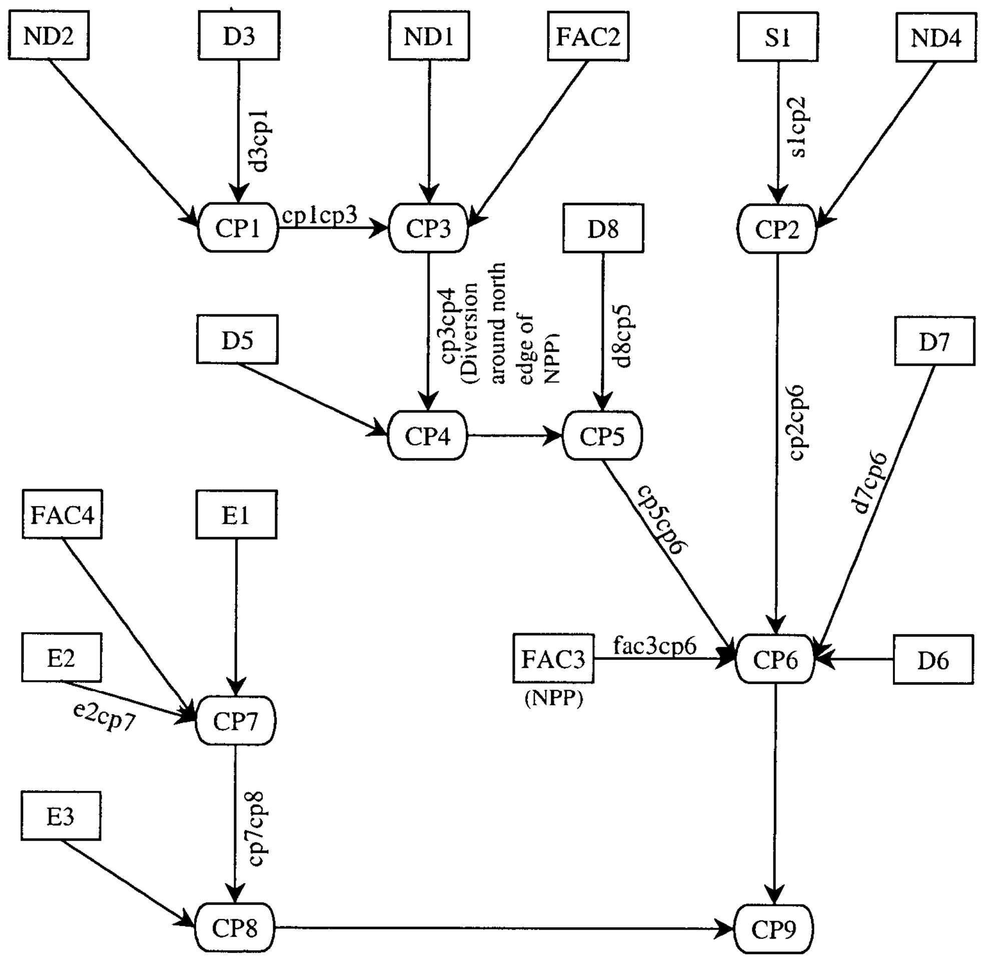


Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_2\Delineartion of Sub Basins Alternative 2.mxd Date: 3/2/2004 12:54:00 PM Name: dhwrigh0

URS	Yucca Mountain Project # 18839594	Delineation of Sub-basins for HEC-1 Model, Alternative 2	Figure 5-1

Figure 5-2. Schematic Diagram of Watershed Network, Alternative 2

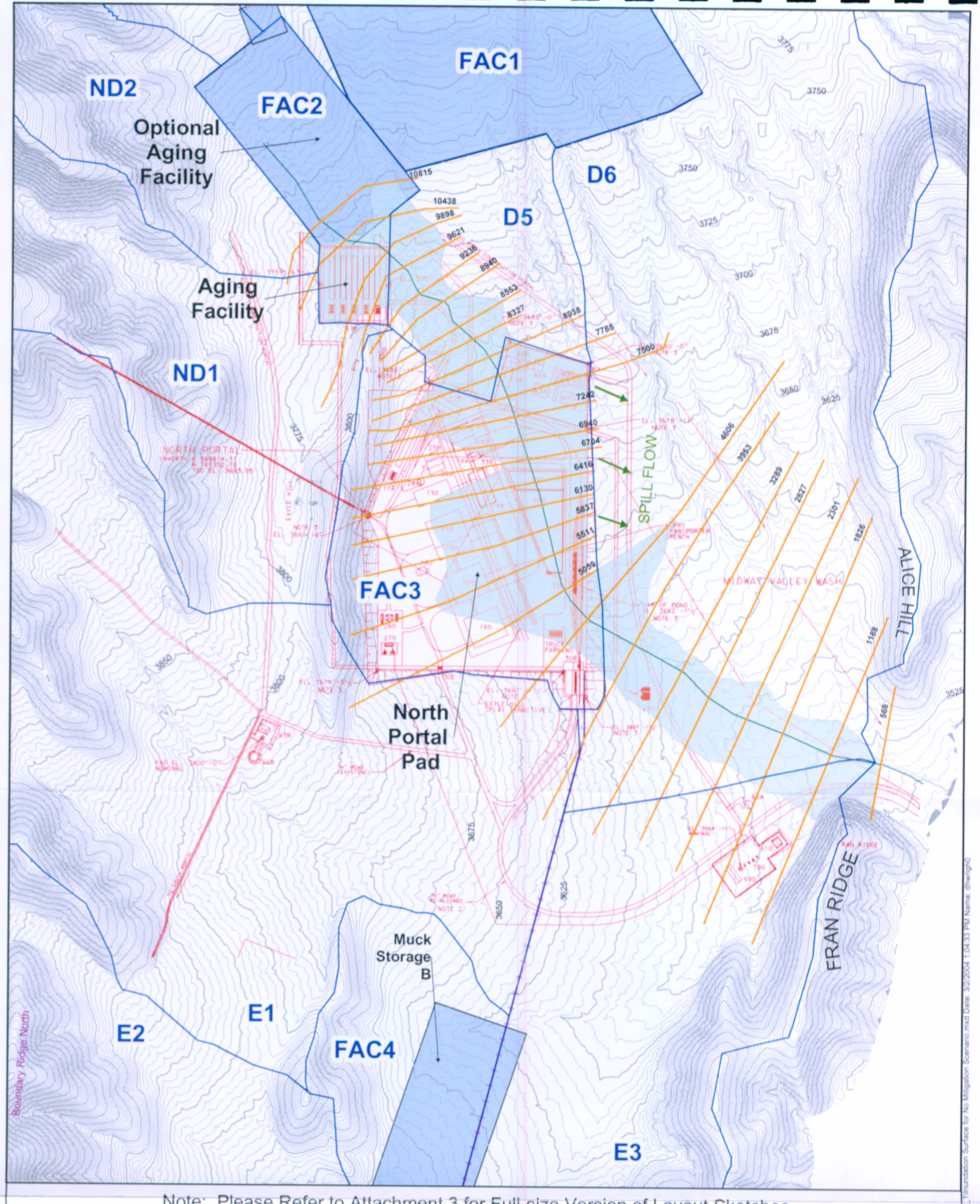


Legend

☐ Sub-basin

▢ Flow Concentration Point

→ Natural/Manmade Channel



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

- Watershed Boundaries
- Inundation Surface

Elevation Contours
(for Presentation Purposes Only)

- 25 ft. Interval
- 5 ft. Interval

0 1,000 2,000 3,000 Feet

N

URS

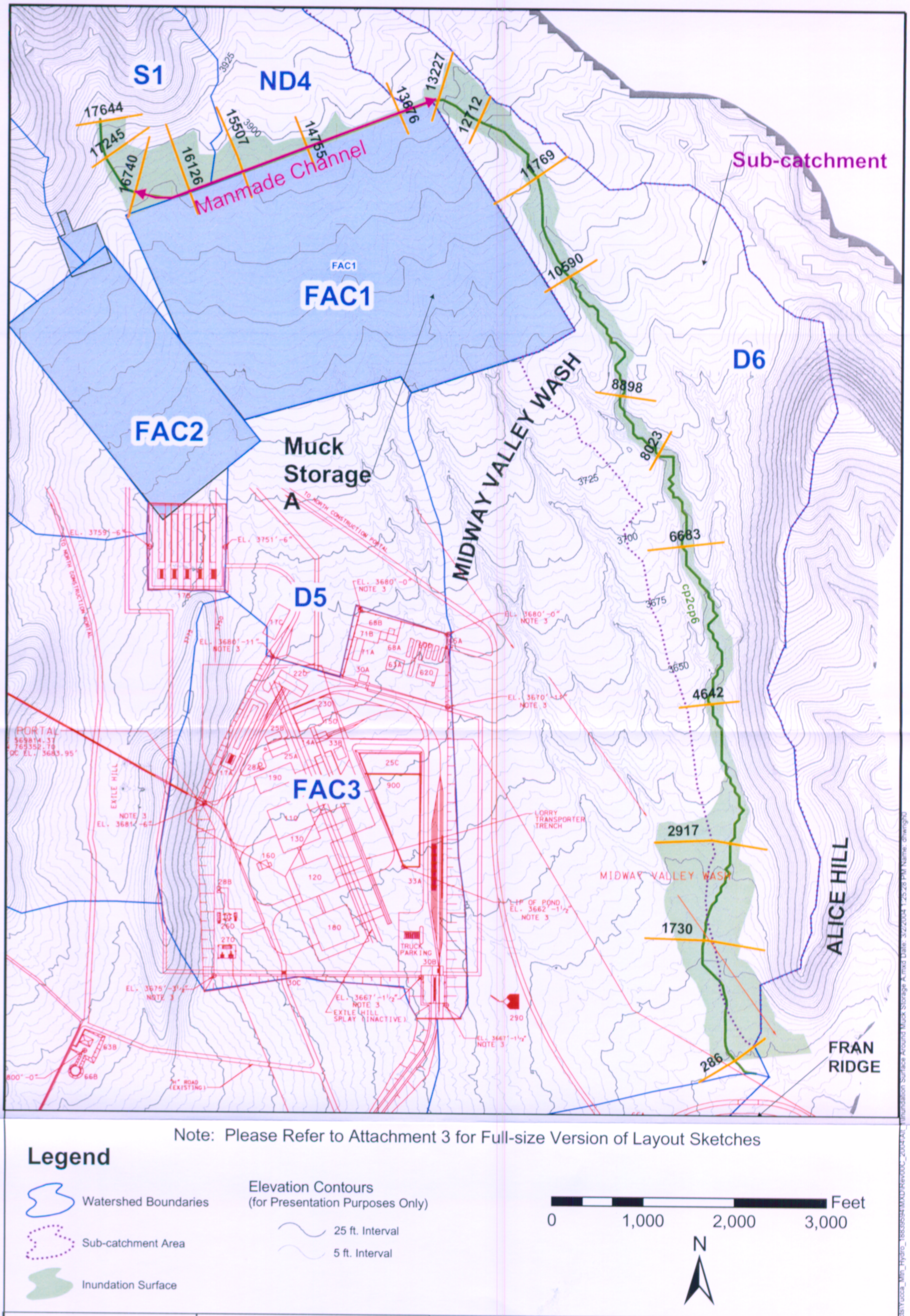
Yucca Mountain

Project # 18839594

Inundation Surface
for No Mitigation Scenario,
Alternative 1

Figure
6-1

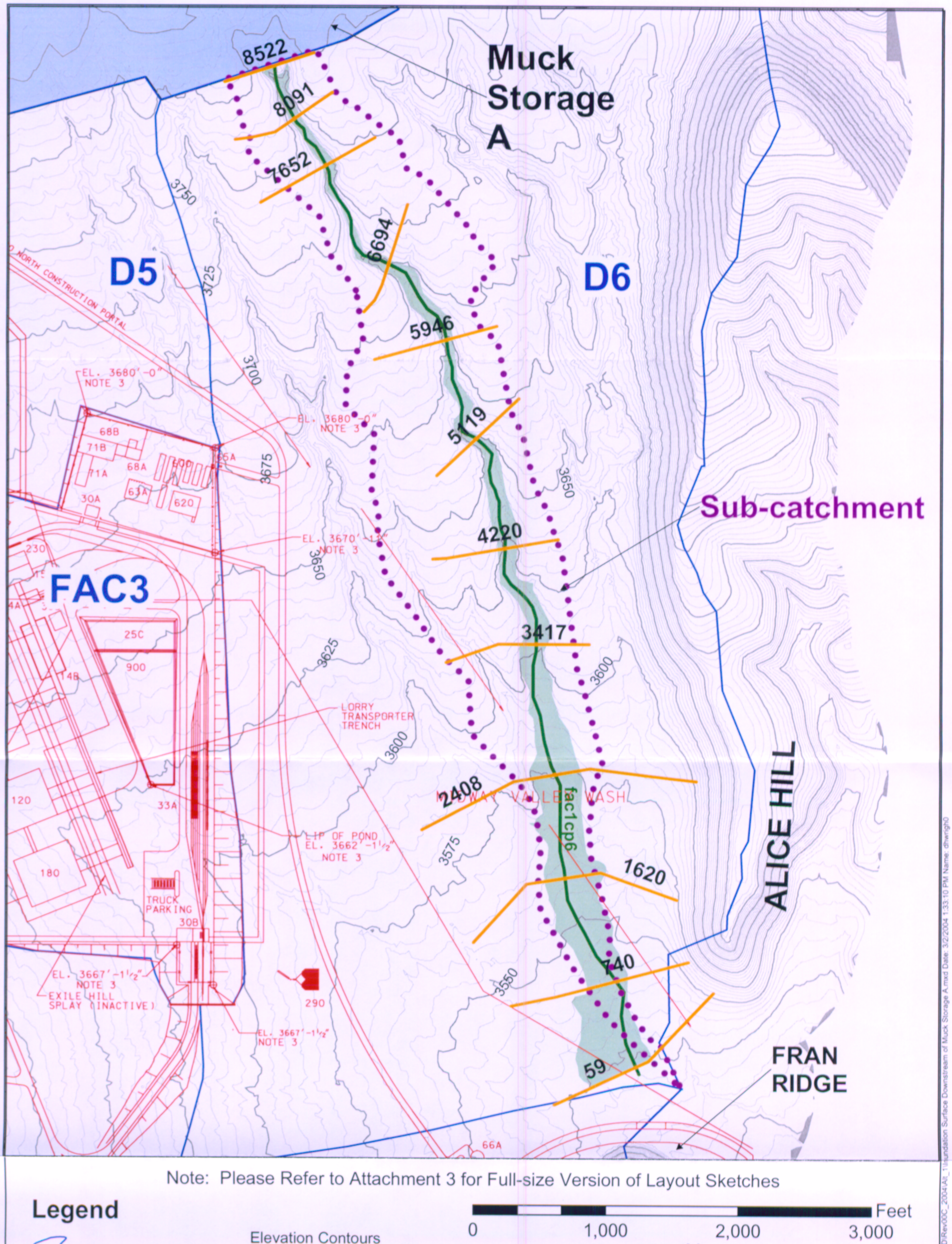
URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Inundation Surface for No Mitigation Scenario.mxd Date: 3/2/2004 1:04:33 PM Name: dhwright0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS	Yucca Mountain Project # 18839594	Inundation Surface Around Muck Storage A, Alternative 1	Figure 6-2

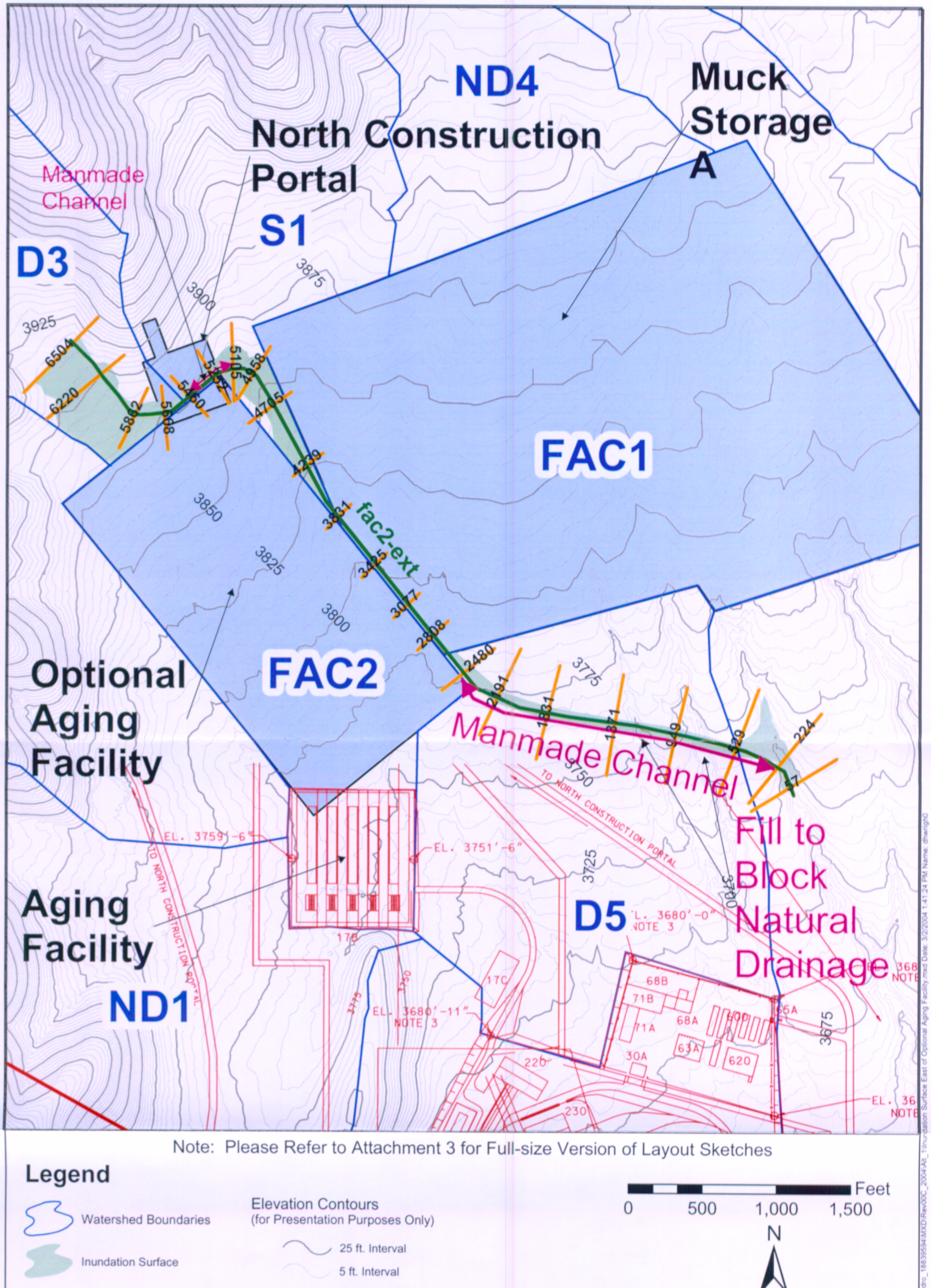
URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt1\Inundation Surface Around Muck Storage A.mxd Date: 3/2/2004 1:25:28 PM Name: dhwnghu



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Inundation Surface Downstream of Muck Storage A.mxd Date: 3/2/2004 1:33:10 PM Name: dwright0

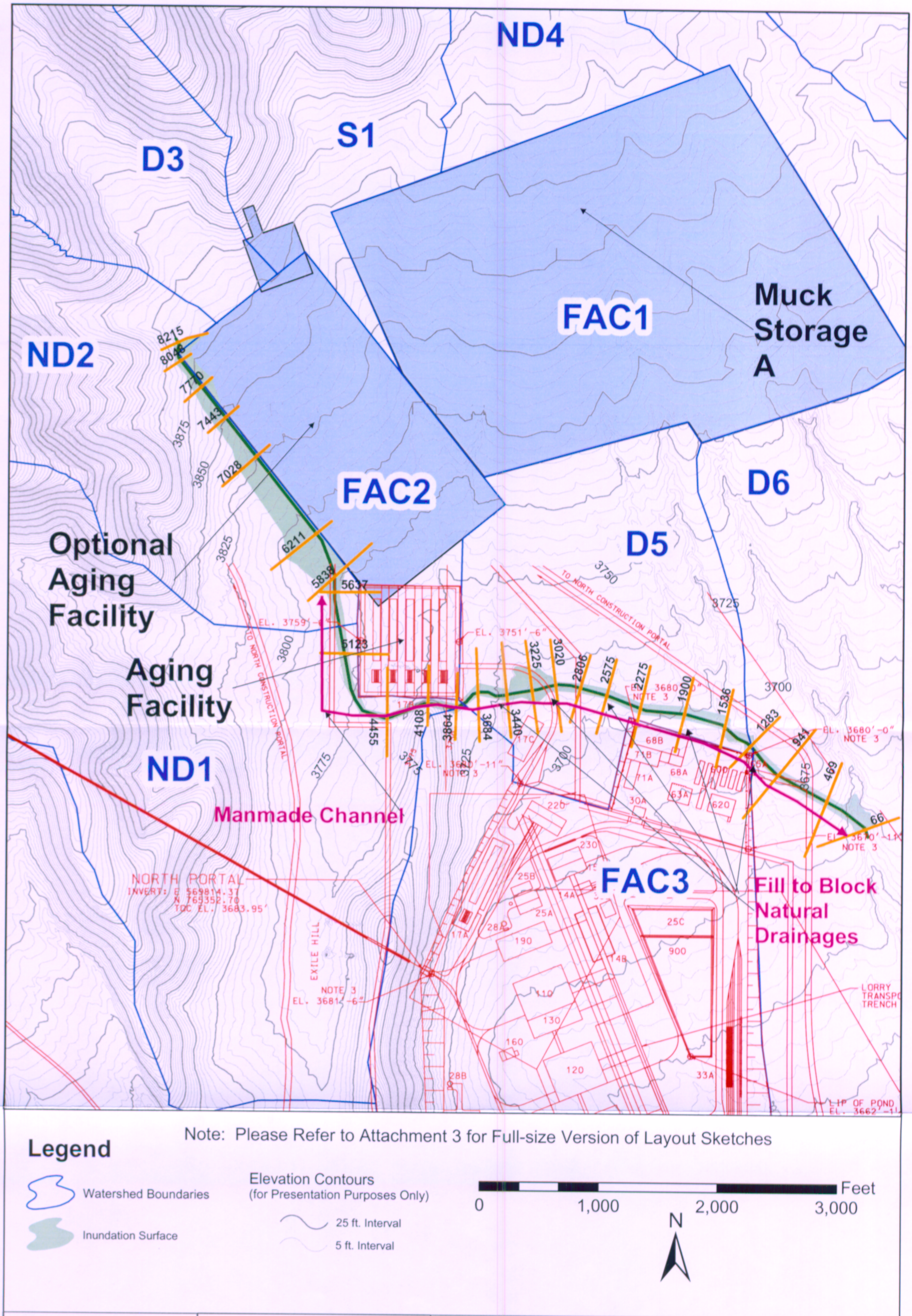
URS	Yucca Mountain Project # 18839594	Inundation Surface Downstream of Muck Storage A, Alternative 1	Figure 6-3



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS	Yucca Mountain Project # 18839594	Inundation Surface East of Optional Aging Facility and Around North Construction Portal, Alternative 1	Figure 6-4

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Inundation Surface East of Optional Aging Facility.mxd Date: 3/2/2004 1:41:24 PM Name: dhwrigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

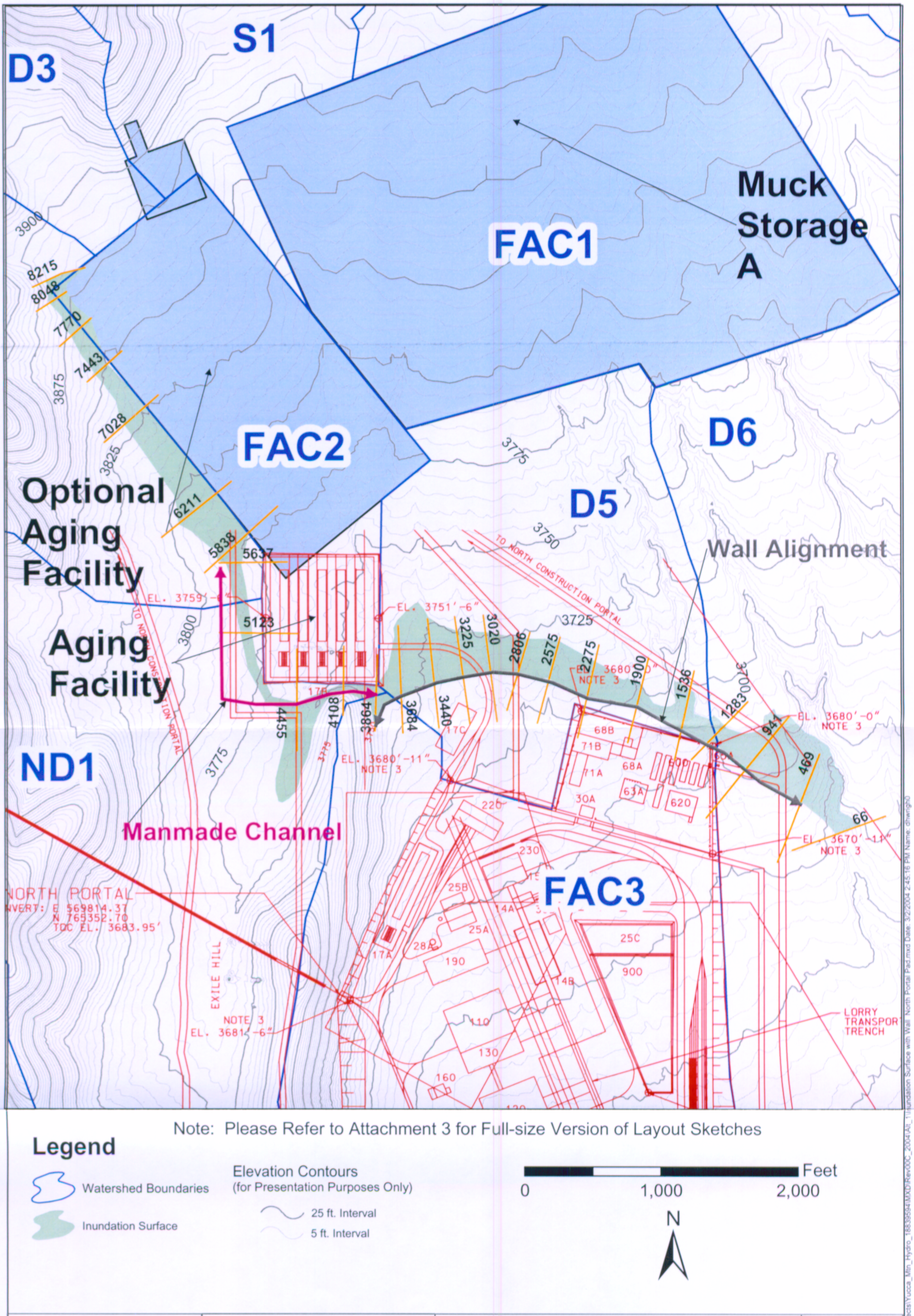
URS

Yucca Mountain

Project # 18839594

Inundation Surface Near Aging Facility and North Portal Pad (Channel Alternative), Alternative 1

Figure 6-5

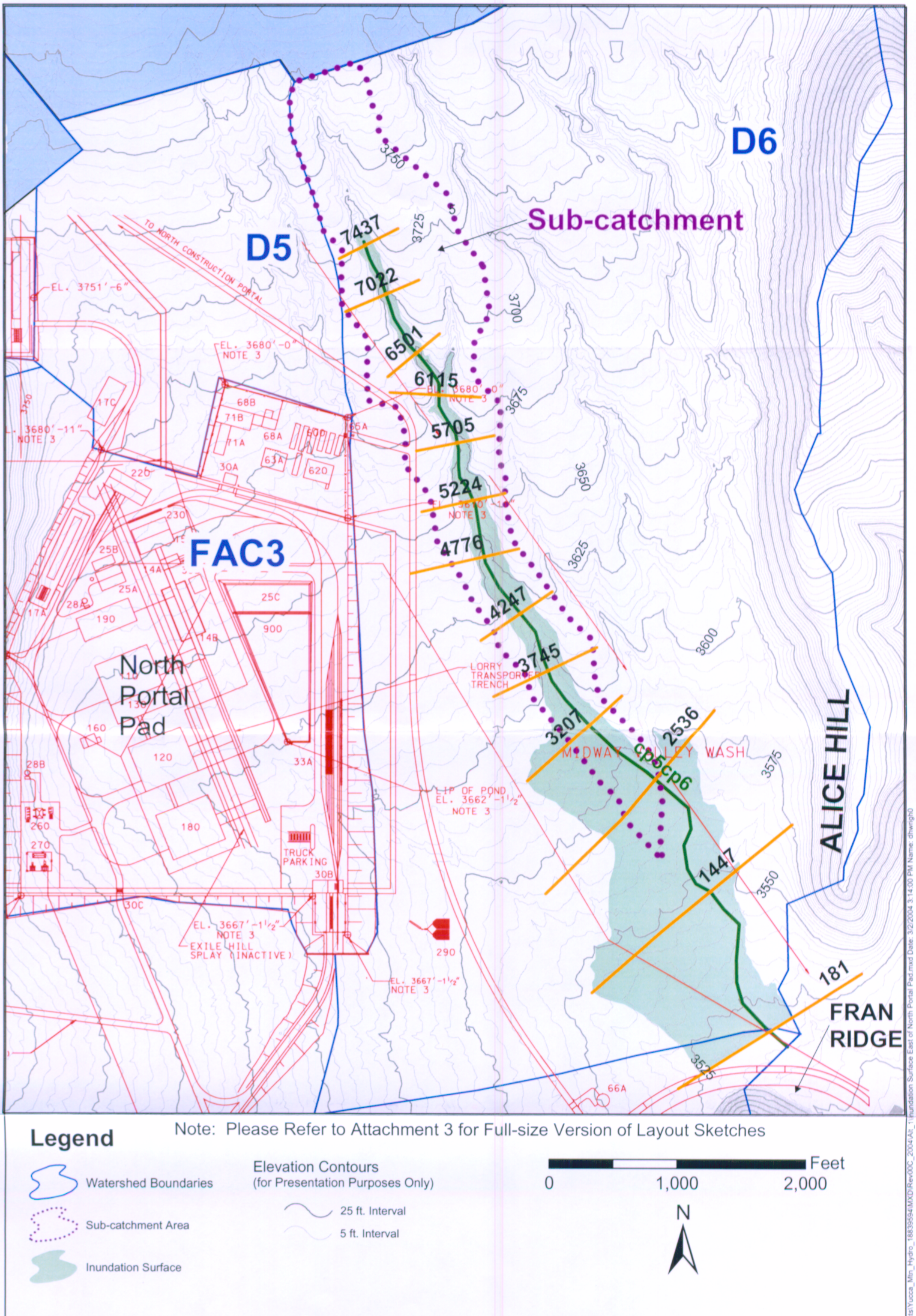


Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Att_1\Inundation Surface with Wall_North Portal Pad.mxd Date: 3/2/2004 2:45:16 PM Name: dhwrigh0

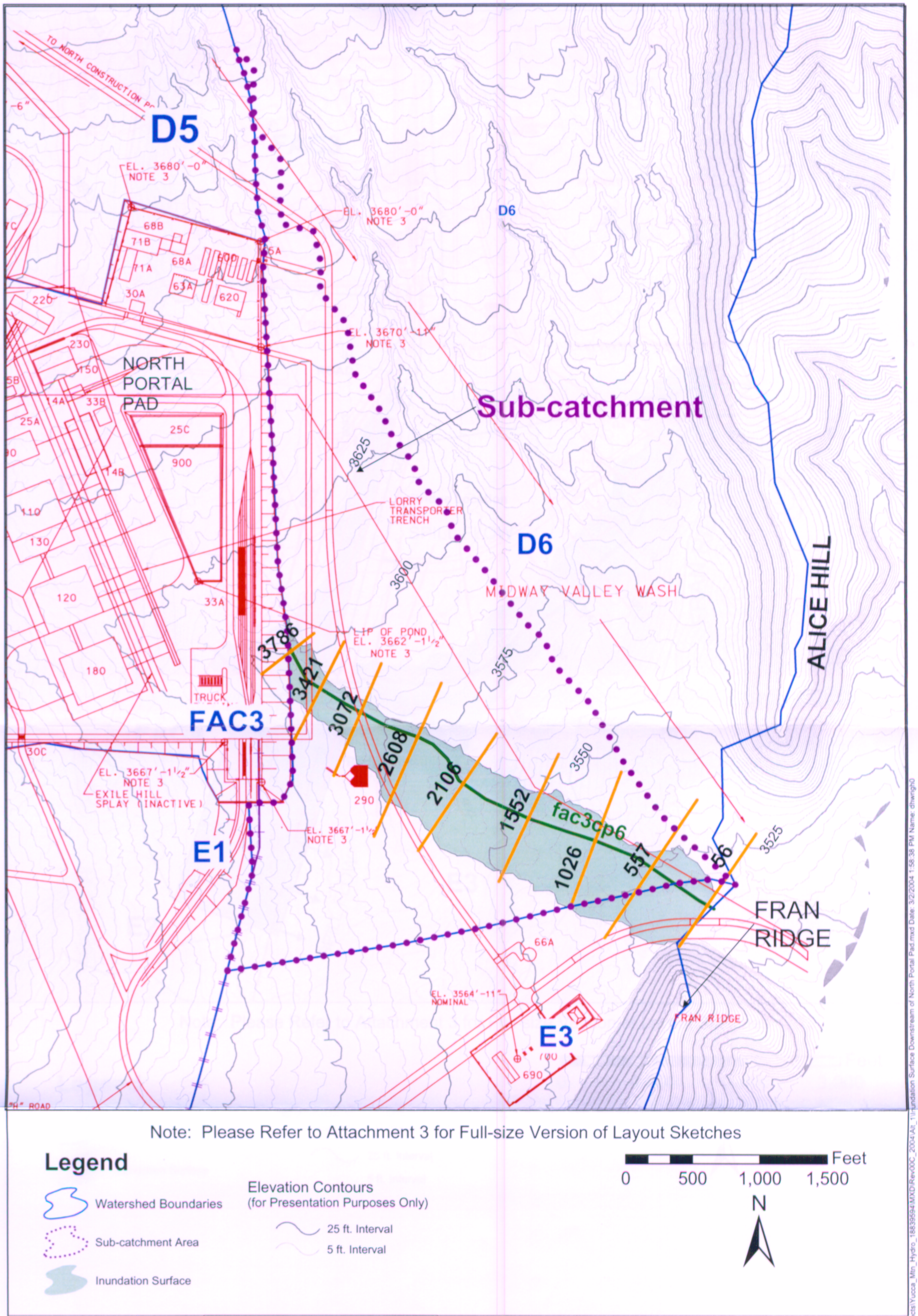
URS	Yucca Mountain Project # 18839594	Inundation Surface Near Aging Facility and North Portal Pad (Wall Alternative), Alternative 1	Figure 6-6

Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches



URS	Yucca Mountain Project # 18839594	Inundation Surface East of North Portal Pad, Alternative 1	Figure 6-7

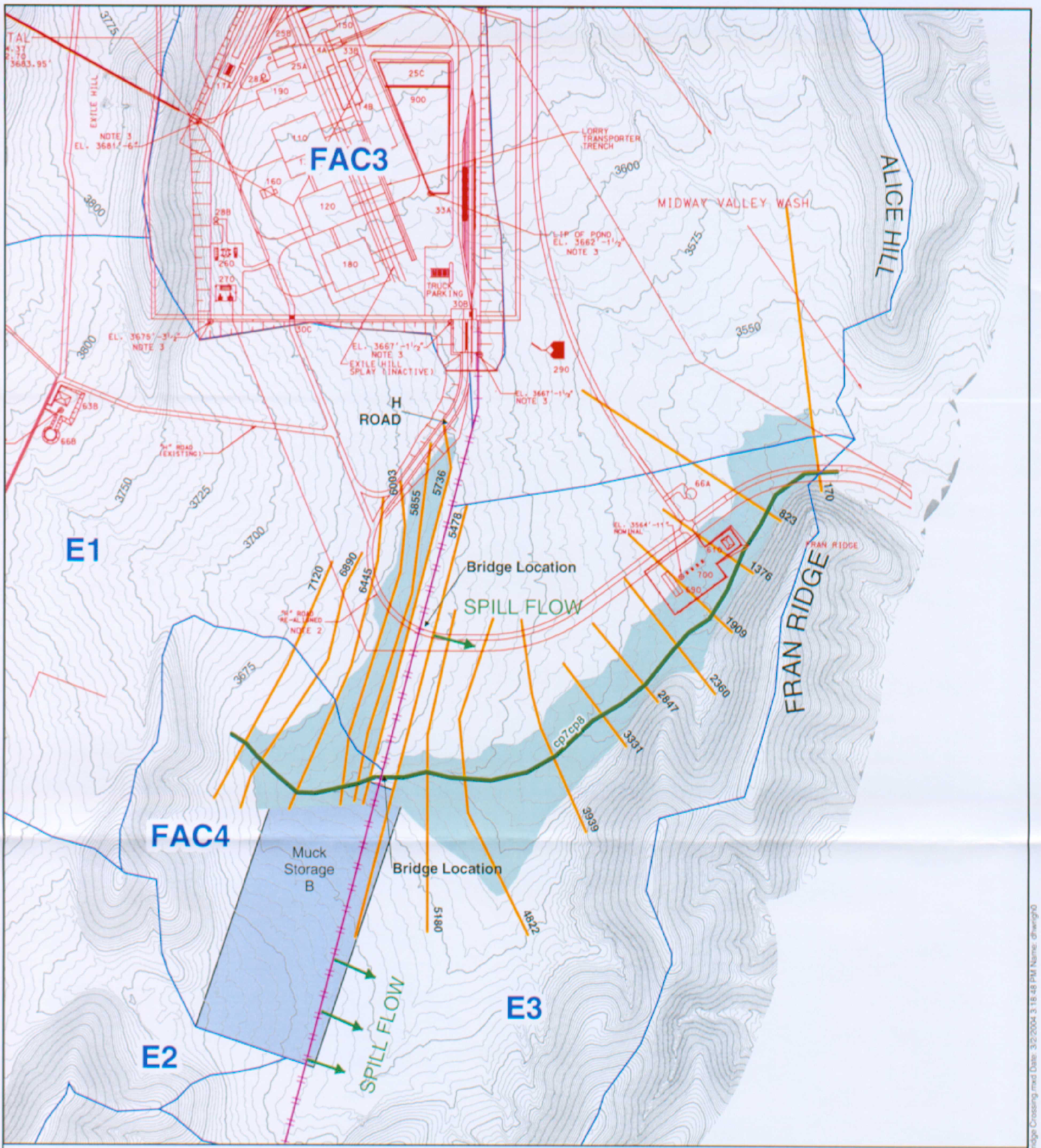
URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Att_1\Inundation Surface East of North Portal Pad.mxd Date: 3/2/2004 3:14:00 PM Name: dwright0



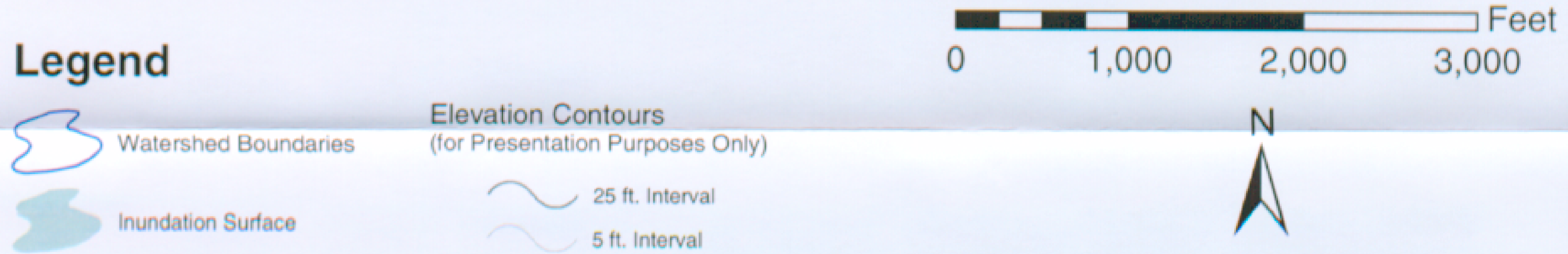
Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS	Yucca Mountain Project # 18839594	Inundation Surface Downstream of North Portal Pad, Alternative 1	Figure 6-8

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Att_1\Inundation Surface Downstream of North Portal Pad.mxd Date: 3/2/2004 1:58:38 PM Name: dhwngh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches



Legend

Watershed Boundaries

Inundation Surface

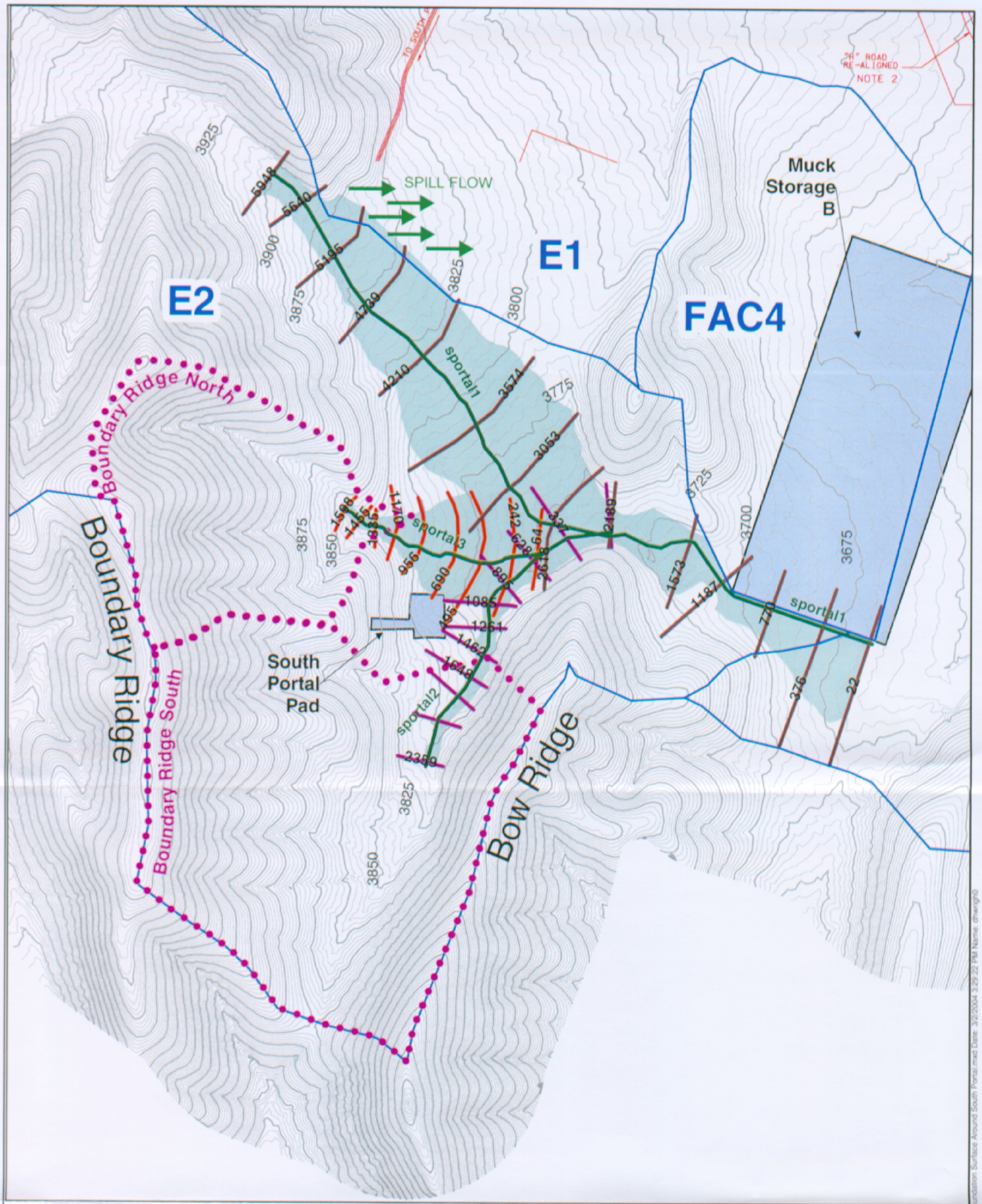
Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

5 ft. Interval

URS	Yucca Mountain Project # 18839594	Inundation Surface Near Railroad Bridge Crossing, Alternative 1	Figure 6-9

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Inundation Surface Near Railroad Bridge Crossing.mxd Date: 3/2/2004 3:18:48 PM Name: dhwigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

Watershed Boundaries

Sub-catchment Area

Inundation Surface

Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

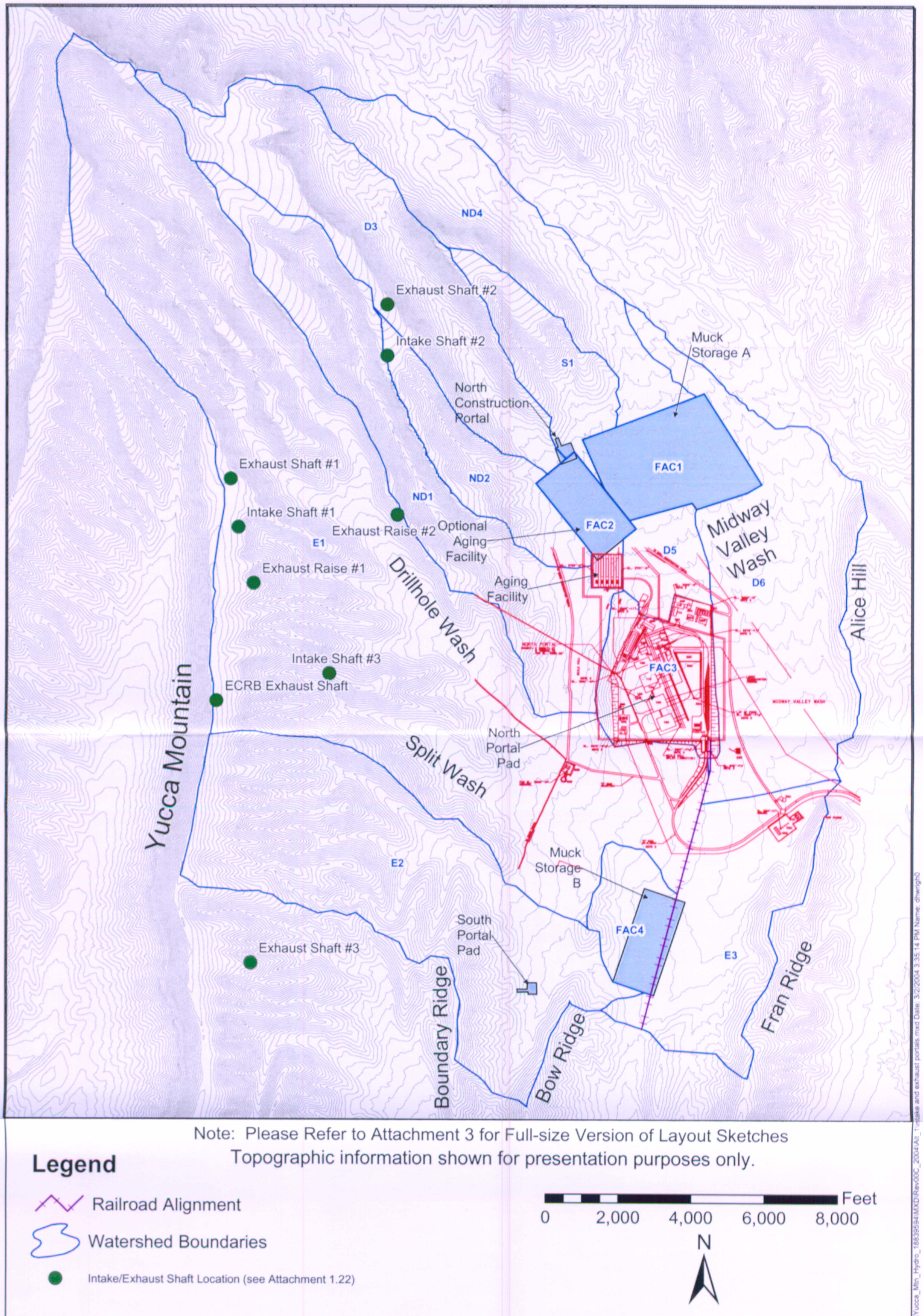
5 ft. Interval

0 500 1,000 1,500 2,000 Feet

N

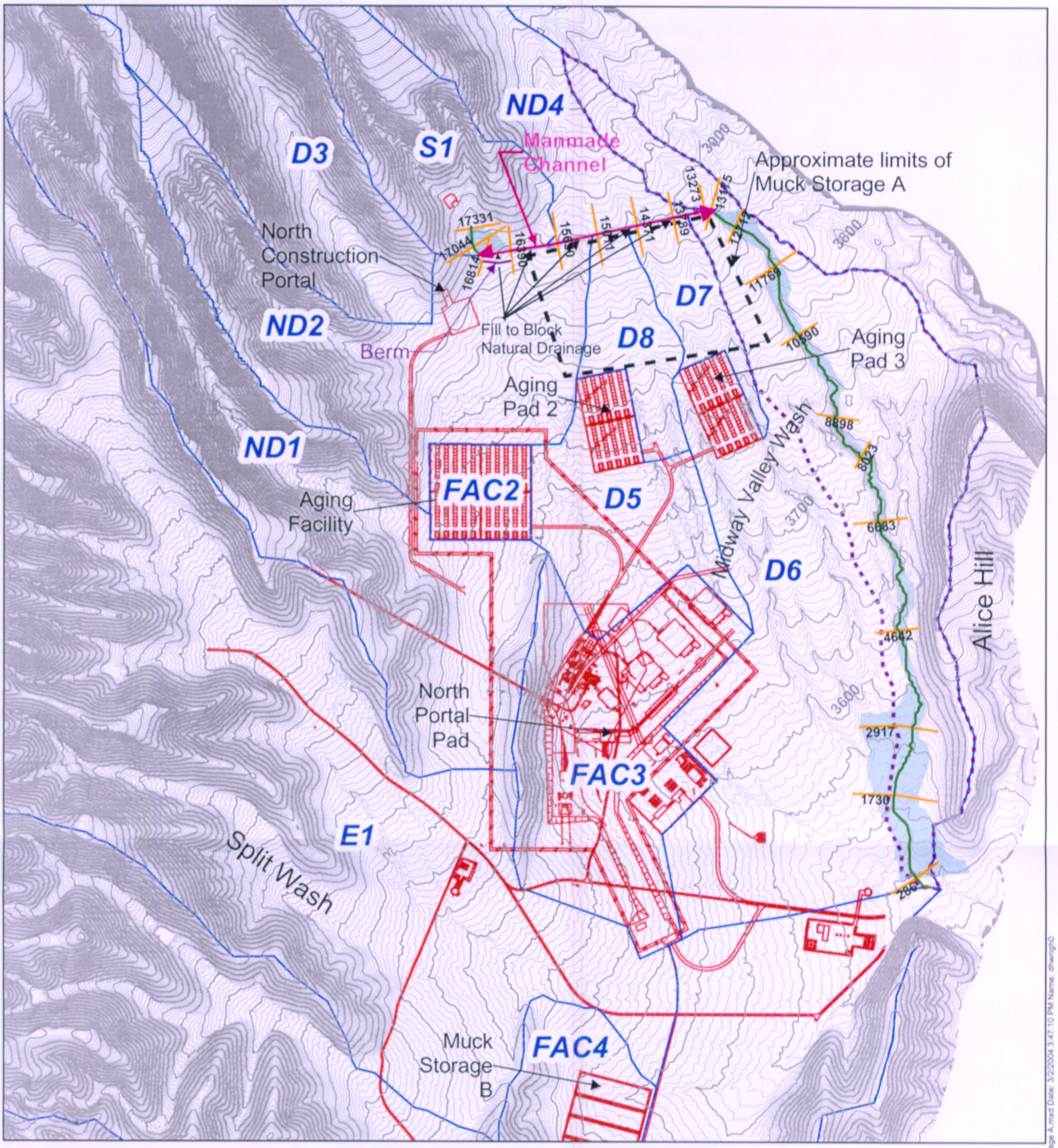
URS	Yucca Mountain Project # 18839594	Inundation Surface Around South Portal, Alternative 1	Figure 6-10

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Inundation Surface Around South Portal.mxd Date: 3/2/2004 3:29:22 PM Name: dhanigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches
Topographic information shown for presentation purposes only.

URS	Yucca Mountain Project # 18839594	Intake and Exhaust Portals, Alternative 1	Figure 6-11



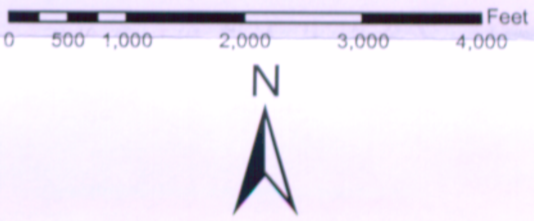
Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

- Watershed Boundaries
- Sub-catchment Area
- Inundation Surface

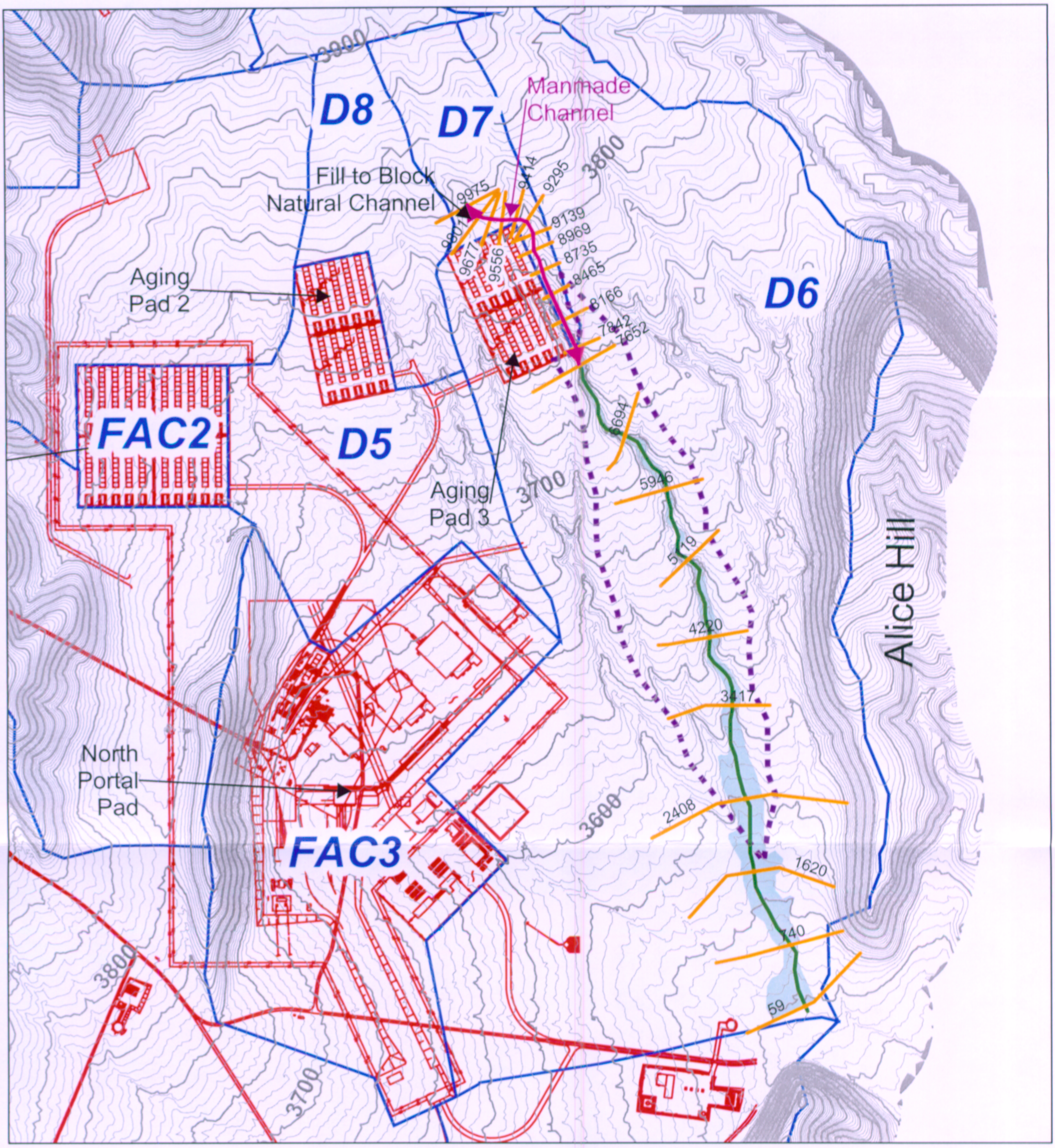
Elevation Contours
(for Presentation Purposes Only)

- 25 ft. Interval
- 5 ft. Interval



URS	Yucca Mountain	Inundation Surface Around Muck Storage A , Alternative 2	Figure 7-1
	Project # 18839594		

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_2\Inundation Surface Around Muck Storage A.mxd Date: 3/2/2004 3:47:10 PM Name: dhwigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

Watershed Boundaries

Sub-catchment Area

Inundation Surface

Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

5 ft. Interval

0 500 1,000 2,000 3,000 4,000 Feet

N

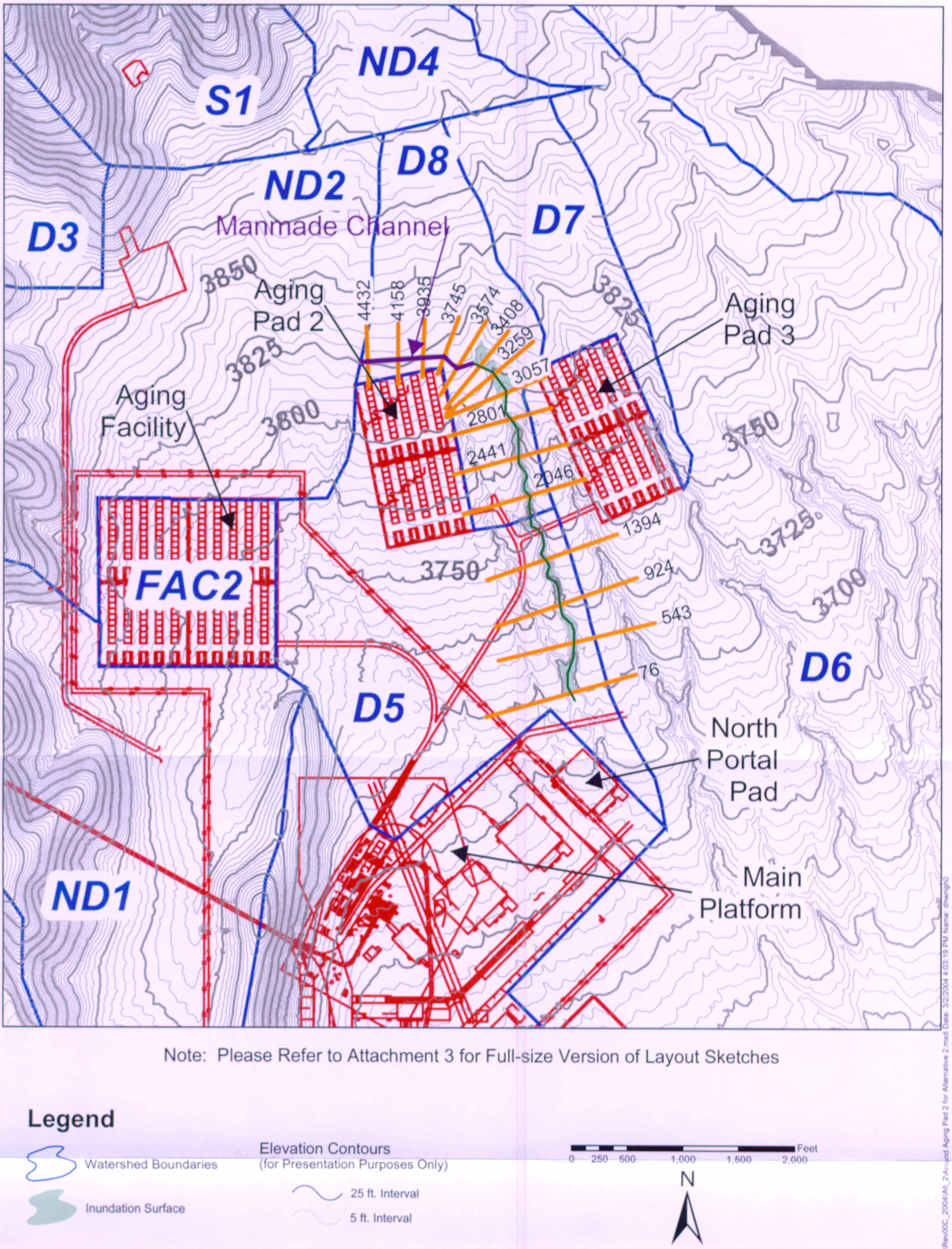
URS

Yucca Mountain

Project # 18839594

Inundation Surface Around
Aging Pad 3, Alternative 2

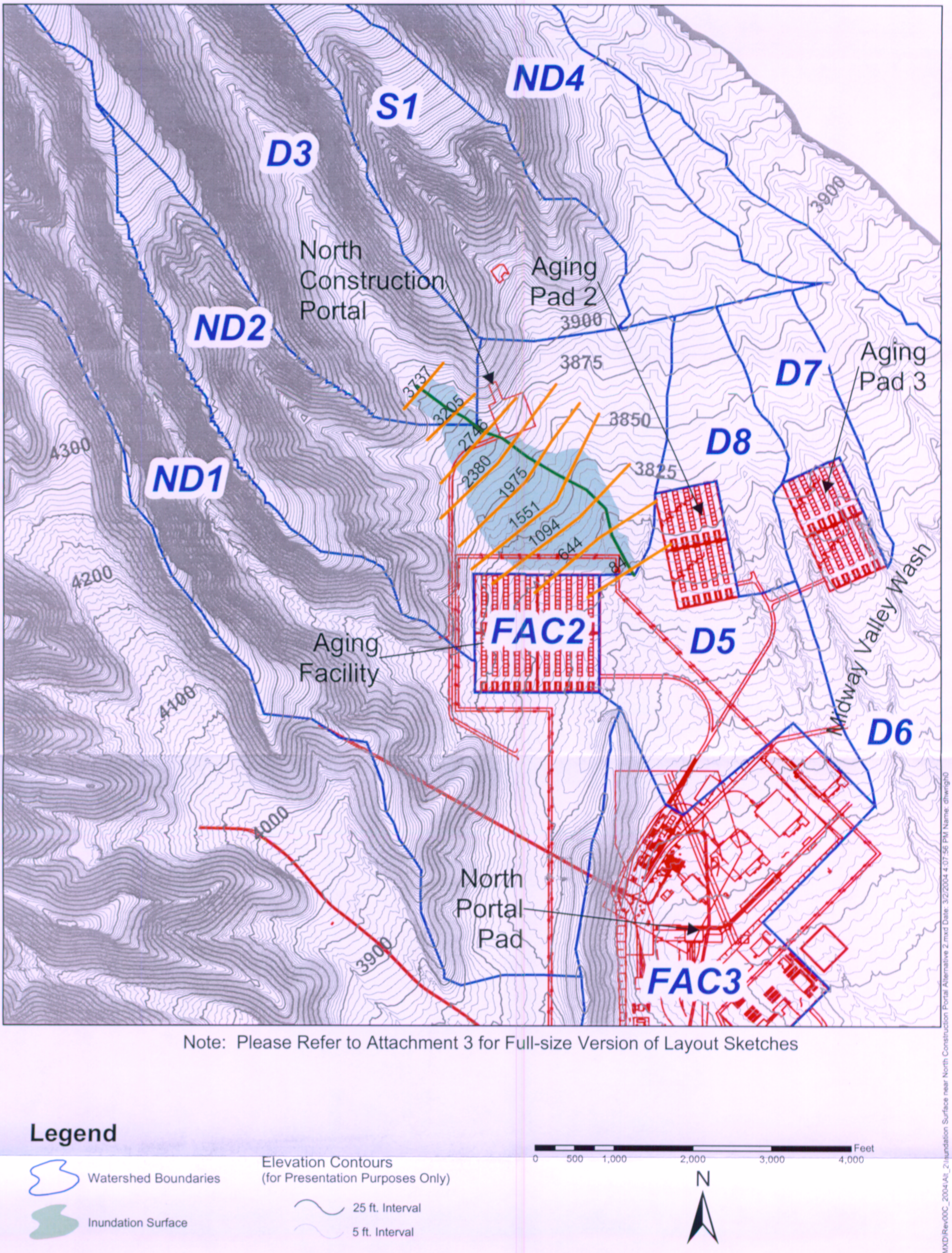
Figure
7-2



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS	Yucca Mountain Project # 18839594	Inundation Surface Around Aging Pad 2, Alternative 2	Figure 7-3

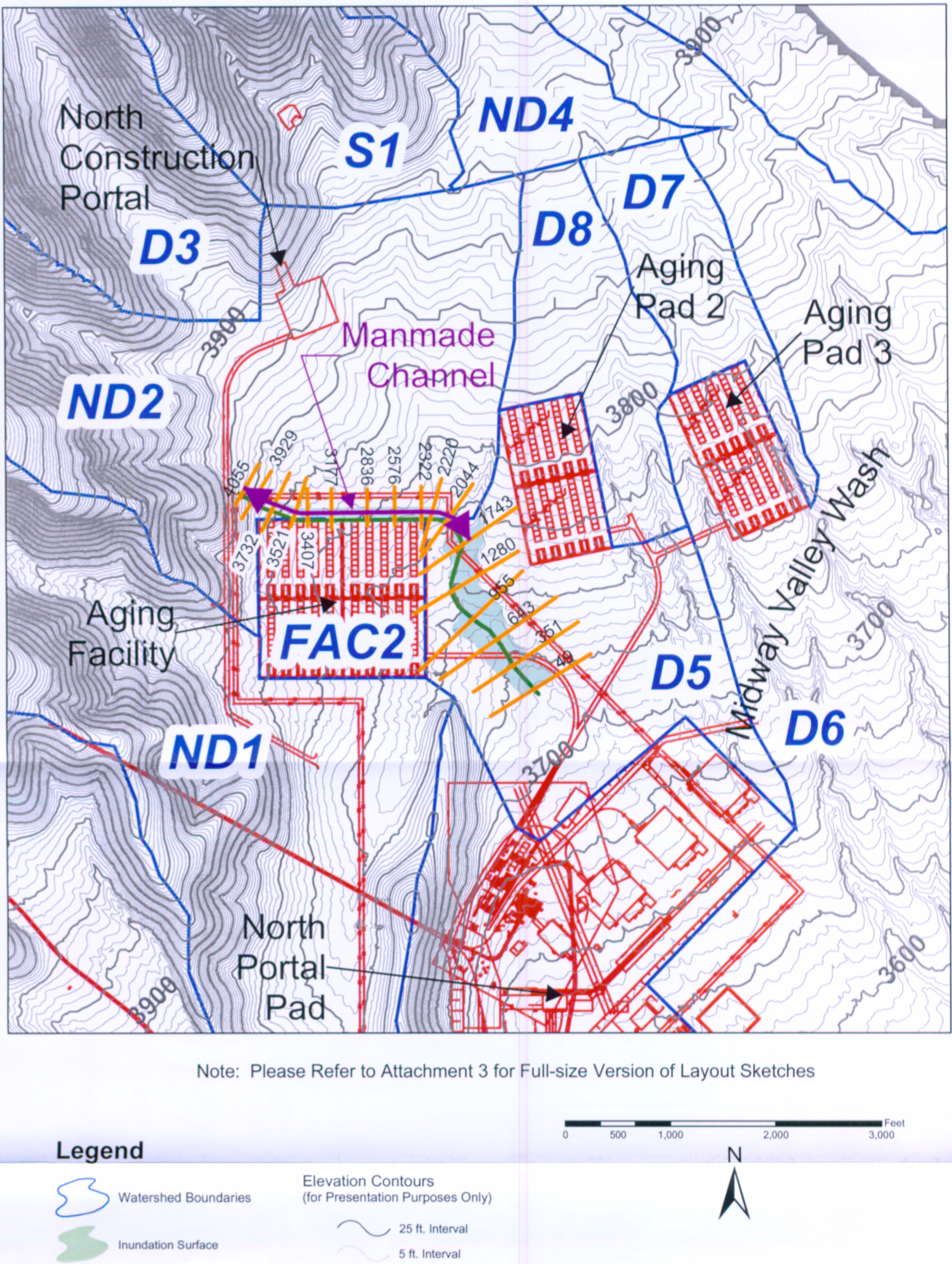
URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_2\Around Aging Pad 2 for Alternative 2.mxd Date: 3/2/2004 4:03:19 PM Name: dhwrigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_2\Inundation Surface near North Construction Portal Alternative 2.mxd Date: 3/2/2004 4:07:56 PM Name: dhwrigh0

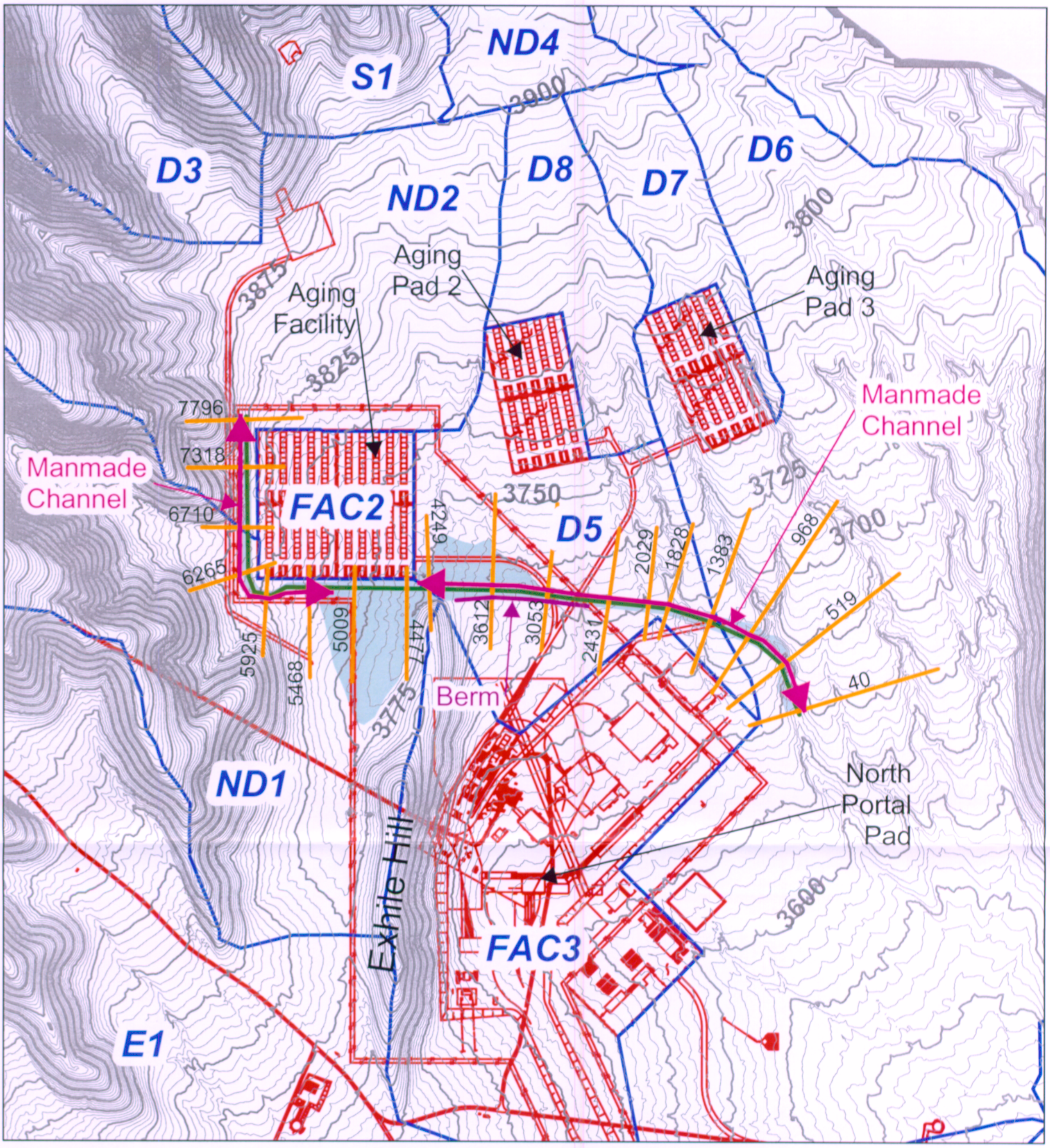
URS	Yucca Mountain Project # 18839594	Inundation Surface near North Construction Portal, Alternative 2	Figure 7-4



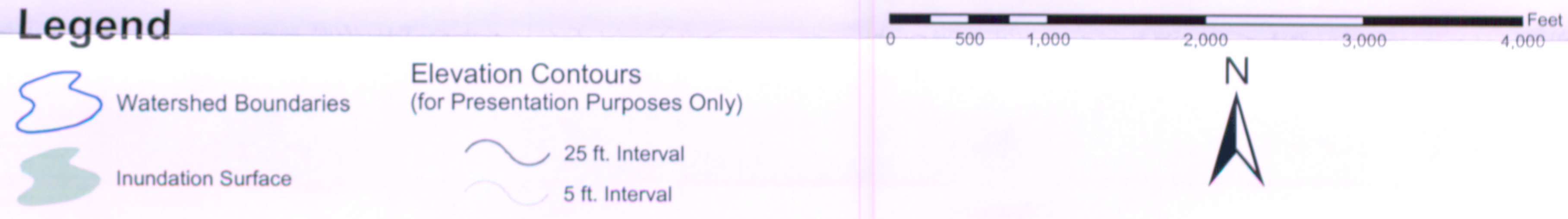
Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS	Yucca Mountain Project # 18839594	Inundation Surface North of Aging Facility, Alternative 2	Figure 7-5

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Att_3\Inundation Surface North of Aging Facility Alternative 2.mxd Date: 3/2/2004 4:23:05 PM Name: dwrigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches



URS

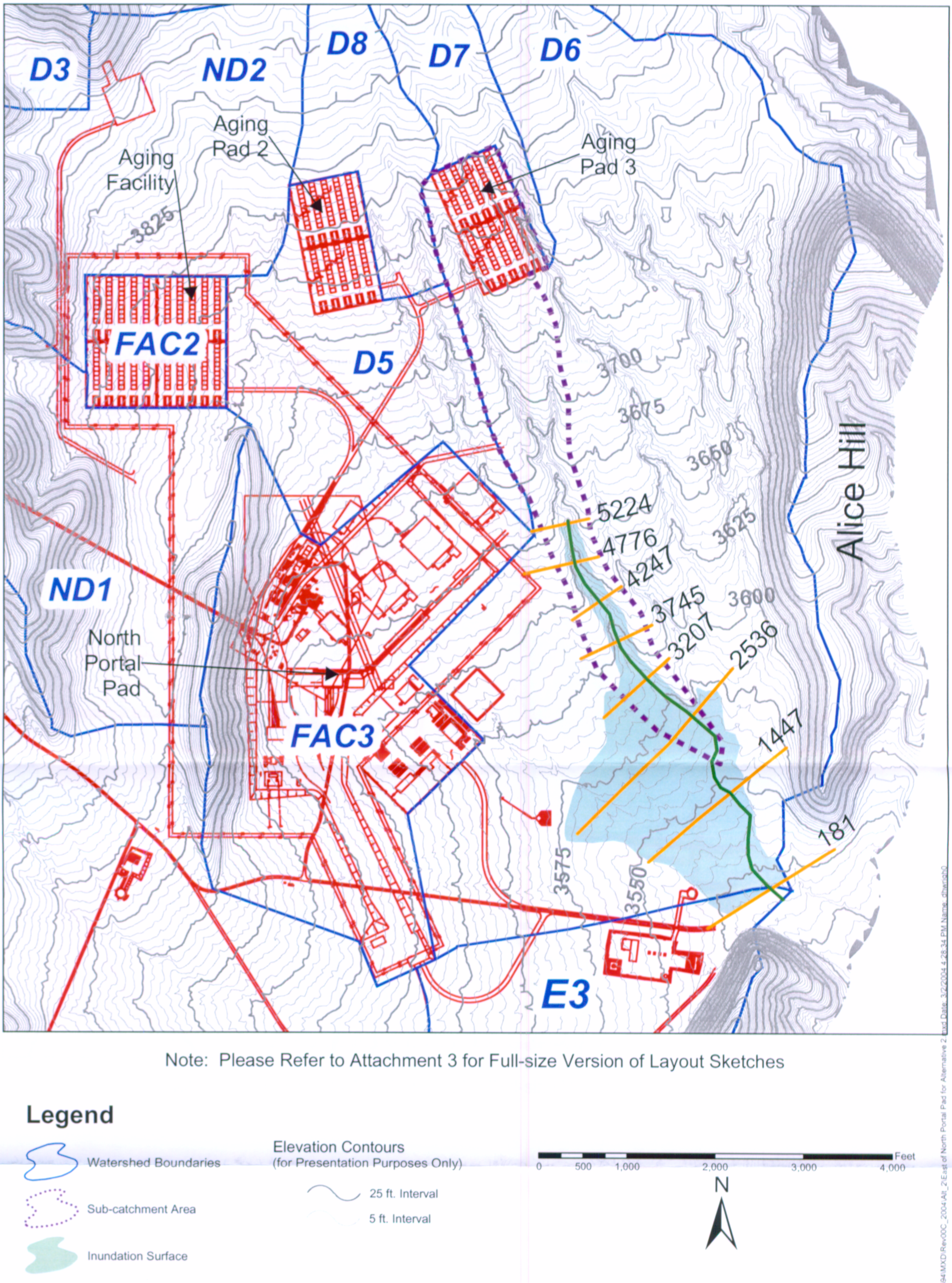
Yucca Mountain

Project # 18839594

Inundation Surface Around
Aging Facility and North Portal Pad,
Alternative 2

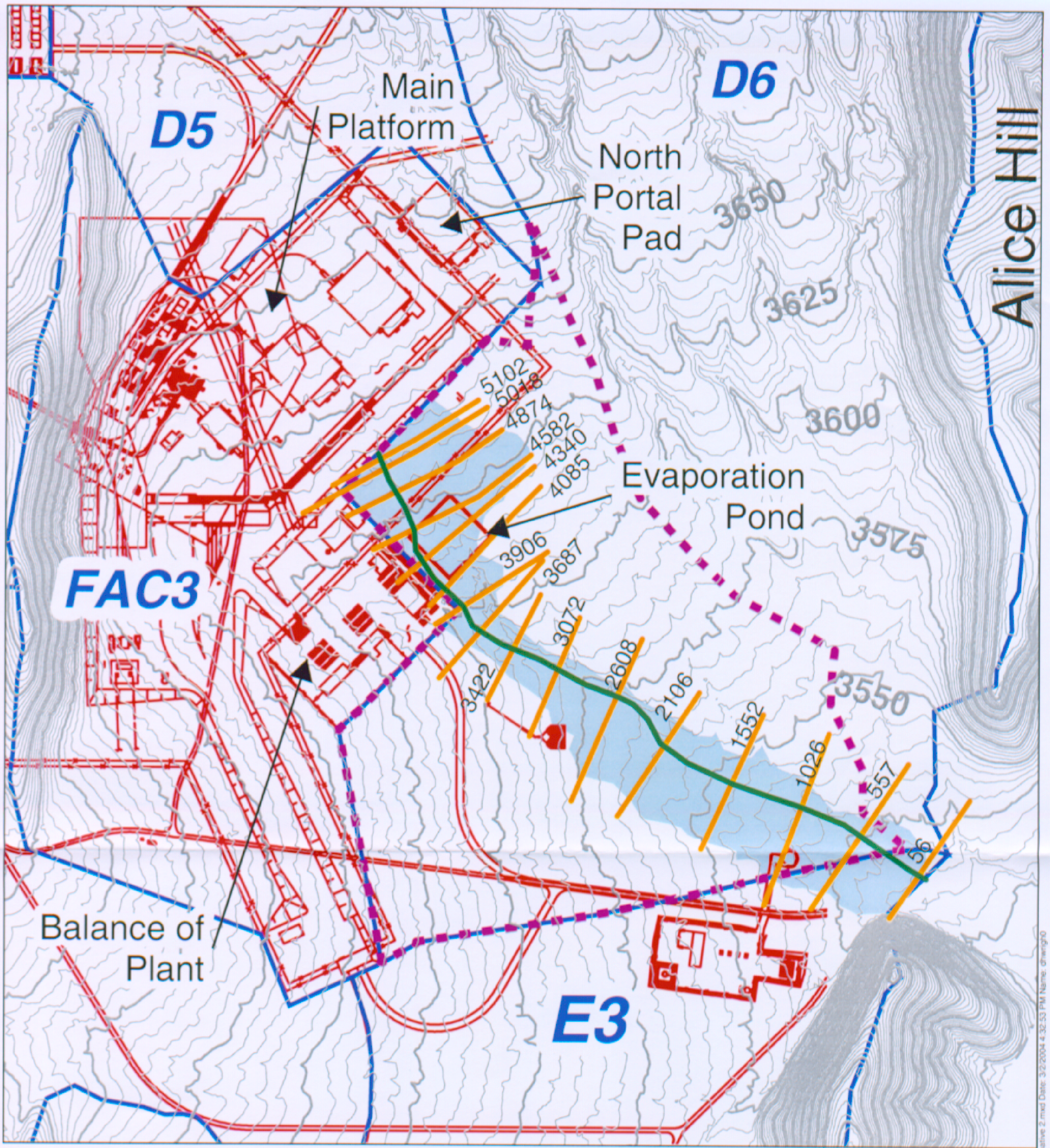
Figure
7-6

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_2\Inundation Surface Aroung Aging Facility for Alternative 2.mxd Date: 3/2/2004 11:26:45 AM Name: dhwright0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

URS	Yucca Mountain Project # 18839594	Inundation Surface East of North Portal Pad, Alternative 2	Figure 7-7



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

Watershed Boundaries

Sub-catchment Area

Inundation Surface

Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

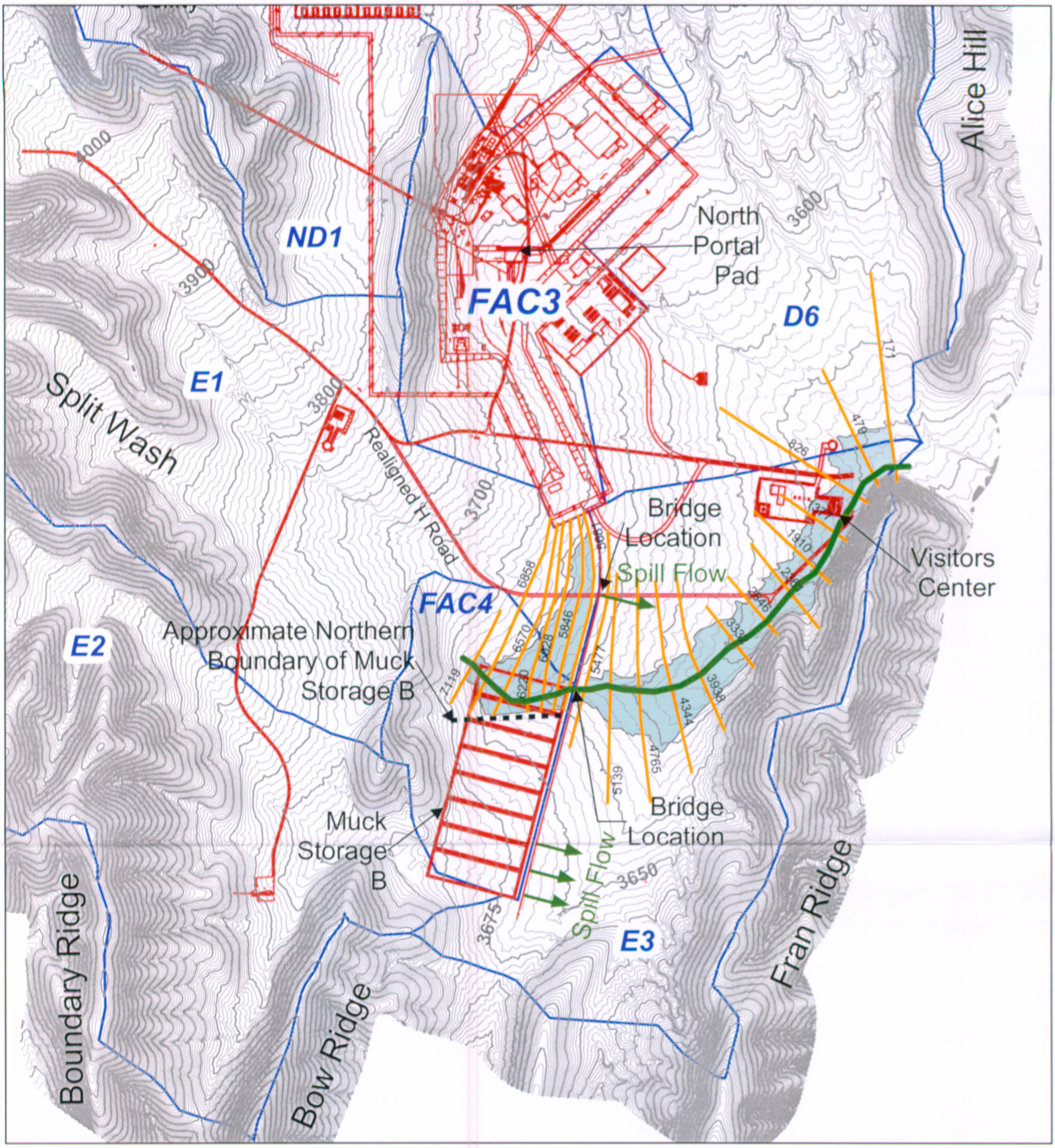
5 ft. Interval

0 250 500 1,000 1,500 2,000 Feet

N

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594 MXD\Rev00C_2004\Alt_2\Downstream of North Portal Pad for Alternative 2.mxd Date: 3/2/2004 4:32:53 PM Name: dhangho

URS	Yucca Mountain Project # 18839594	Inundation Surface Downstream of North Portal Pad, Alternative 2	Figure 7-8



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

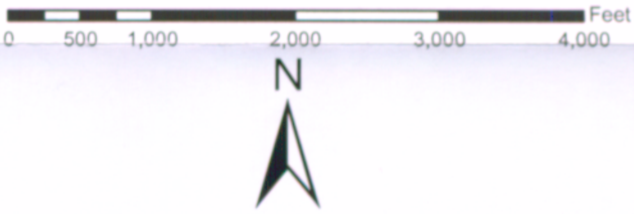
Watershed Boundaries

Inundation Surface

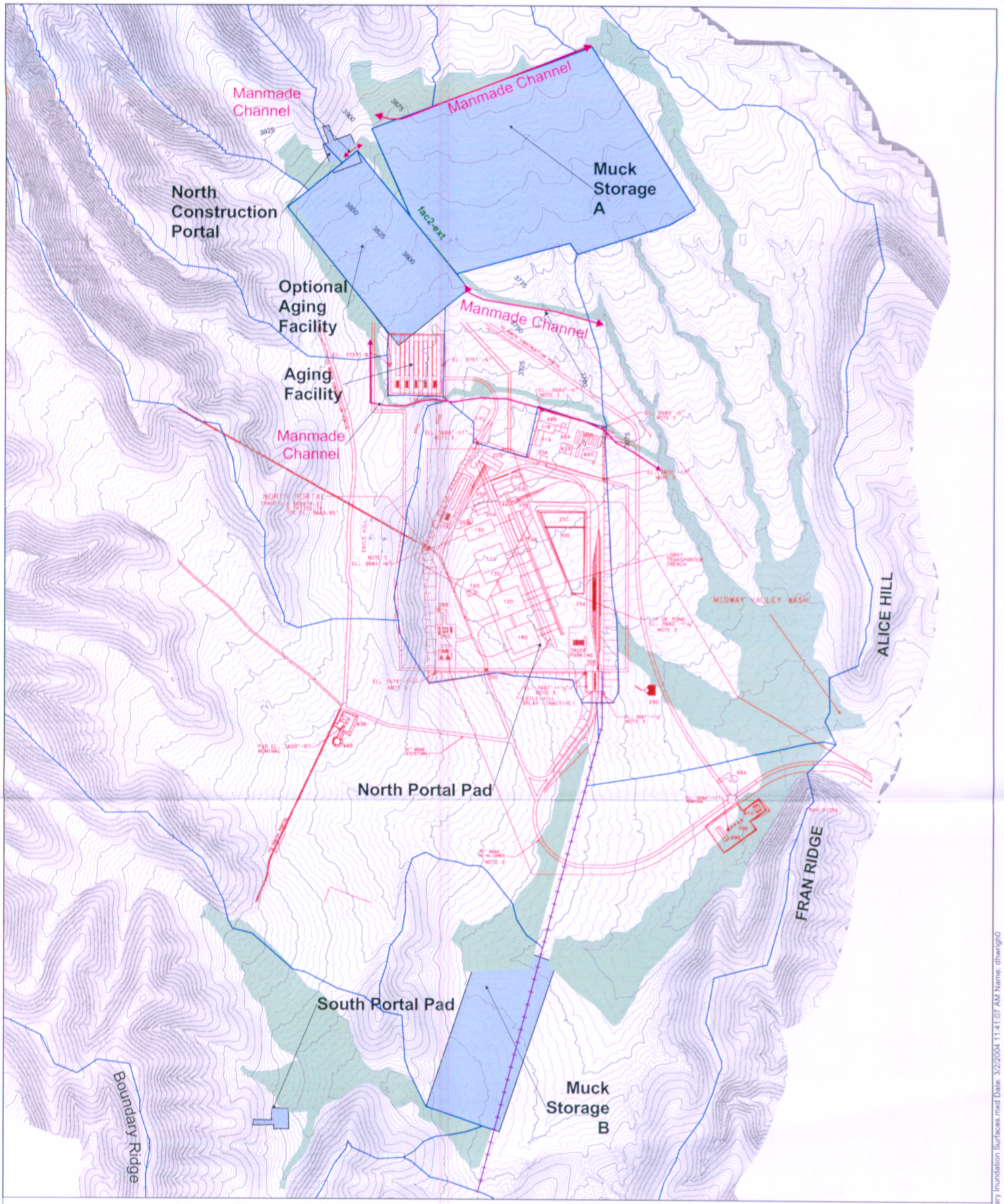
Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

5 ft. Interval



URS	Yucca Mountain Project # 18839594	Inundation Surface for Railroad Bridge Crossing, Alternative 2	Figure 7-9



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches

Legend

Watershed Boundaries

Inundation Surface

Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

5 ft. Interval

Feet
0 2,000 4,000

N

URS

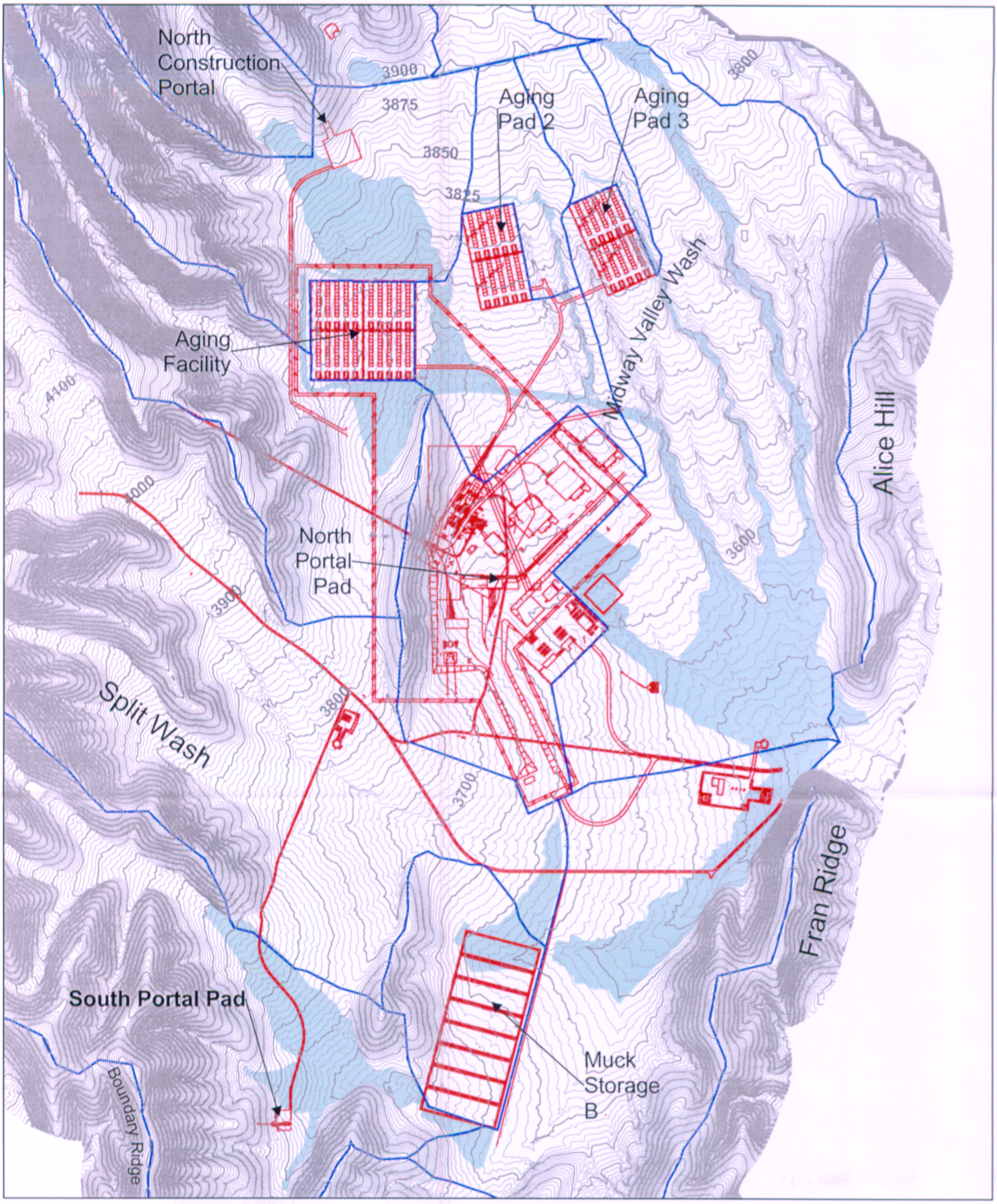
Yucca Mountain

Project # 18839594

Combined Inundation Surfaces
Near North Portal Pad and Vicinity,
Alternative 1

Figure 8-1

URS Corporation L:\Projects\Yucca_Mtn_Hydro_18839594\MXD\Rev00C_2004\Alt_1\Summary Inundation Surfaces.mxd Date: 3/2/2004 11:41:07 AM Name: dhwrigh0



Note: Please Refer to Attachment 3 for Full-size Version of Layout Sketches
The inundation surface near the South Portal Pad is unchanged
from Alternative 1 and is shown on Figure 8-1.

Legend

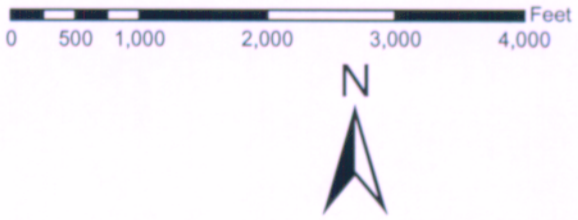
Watershed Boundaries

Inundation Surface

Elevation Contours
(for Presentation Purposes Only)

25 ft. Interval

5 ft. Interval



URS

Yucca Mountain

Project # 18839594

Combined Inundation Surfaces
Near North Portal Pad and Vicinity,
Alternative 2

Figure
8-2

Attachment 1: CD ontaining electronic files
(Document ID: 000-00C-CD04-00100-000-00A)

Attachment 2: Correspondence with SCM
(Document ID: 000-00C-CD04-00100-000-00A)

"Jeffery Mason/YM/RWDOE" <Jeffery_Mason@Notes.YMP.GOV>
10/09/2003 07:59 AM

To: Susan_Olig@urscorp.com
cc: Vivian_Lee@urscorp.com, "Lyle Southworth/YM/RWDOE" <Lyle_Southworth@ymp.gov>
Subject: Re: Use of ARCVIEW v. 3.2 and ArcInfo v. 8 for hydrologic analysis

Susan,

After discussing this with SCM management it was determined that using these codes under the 2.1.6 exemption is acceptable, as long as the last sentence, "The solution must be documented in sufficient detail in a technical product to allow an independent reviewer to reproduce or verify the results by visual inspection or hand calculation without recourse to the originator." SCM would only recommend that you seek a third party, not associated with this technical product, to review and see if the work done with these programs meets the definition of the exemption.

Please let me know if you need anything else.

Jeff

Susan_Olig@URSCorp.com on 10/08/2003 04:18:15 PM

To: Jeffery_Mason@notes.ymp.gov
cc: Vivian_Lee@URSCorp.com
Subject: Use of ARCVIEW v. 3.2 and ArcInfo v. 8 for hydrologic analysis
User Filed as: Not Categorized in ERMS

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-----------------------------------------------------------------------------
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      |
|
      |  If this external e-mail is a record and you are the first OCRWM
recipient, click  |
      |          the 'File to ERMS' button in the toolbar to categorize this
e-mail        |
-----------------------------------------------------------------------------
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Jeff,
I tried calling you about this but must have an old number! (702-295-5547). Hopefully Vivian has provided you with enough info below. She should be in on the call and her number is 510-874-1733.
I will be out of the office on Th and F but can still participate in a call from home on Th between 8 and 10 or between 11:45 and 2:30 (home phone is 925-229-2909). Alternatively, you can just do the call with Vivian or I'll

be back in on Monday.
By the way, Vivian can do a conference call from our office and patch both you and I in, as well as a few others if you don't want to go to the hassle of setting up a bridge number. However, we need the phone numbers.
thanks,
susan

Susan S. Olig, R.G.
Sr. Project Geologist
Seismic Hazards Group
URS Corporation
500 12th Street, Suite 200
Oakland, CA 94607-4014

ph: 510-874-1729
fax: 510-874-3268
email: susan_olig@urscorp.com

----- Forwarded by Susan Olig/Oakland/URSCorp on 10/08/2003 03:58 PM -----

Vivian Lee
10/07/2003 04:19 PM

To: Susan_Olig@urscorp.com
cc: "Jeffery Mason/YM/RWDOE" <Jeffery_Mason@Notes.YMP.GOV>
Subject: Use of ARCVIEW v. 3.2 and ArcInfo v. 8 for hydrologic analysis
(Document link: Susan Olig)

Hi Susan,

We use ARCVIEW v. 3.2 and ARCInfo v. 8 for pre- and post-processing of data that are used in or generated by a qualified software (HEC-RAS) to calculate water surface elevations.

Specifically, ARCVIEW v.3.2 has been used to extract elevation data from a digital elevation model (DEM) by querying information along user-defined lines.

Several functions have been utilized in ARCInfo v.8:
(1) Calculate area of watersheds which are defined as polygons;
(2) Calculate length of streams which are defined as lines;
(3) Present output from HEC-RAS graphically to show inundation boundaries.

I hope this helps in clarifying how the software are used in our analysis.

Vivian

"Jeffery Mason/YM/RWDOE"
<Jeffery_Mason@Not

To: Susan_Olig@urscorp.com
cc:

Vivian_Lee@urscorp.com
es.YMP.GOV>
3.2 COTS?

Subject: Re: Is ARCVIEW v. 3.2 COTS?

10/07/2003 02:32
PM

Susan,

Good to hear from you again! The questions you have posed have been argued back and forth quite extensively and the final decision came down to how the software was being used. If you could provide me a more detailed explanation as to what the software is being used to support. I will have SCM management review it and I'll put together a conference call to provide you an informed direction.

Jeff

Susan_Olig@URSCorp.com on 10/07/2003 09:44:50 AM

To: Jeffery_Mason@notes.ymp.gov
cc: Vivian_Lee@URSCorp.com
Subject: Is ARCVIEW v. 3.2 COTS?

User Filed as: Not Categorized in ERMS

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|
|
| If this external e-mail is a record and you are the first OCRWM recipient, click |
| the 'File to ERMS' button in the toolbar to categorize this e-mail |

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Hi Jeff,
Would ARCVIEW v. 3.2 be considered COTS (Commercial off the shelf software)? How about ARCINFO v. 8? I was guessing it would be, but on

checking the SBR for week ending 7-25-03, I noticed that ARCINFO v. 7.2.1 is baselined, which made me wonder, because if its COTS, why was that version qualified?

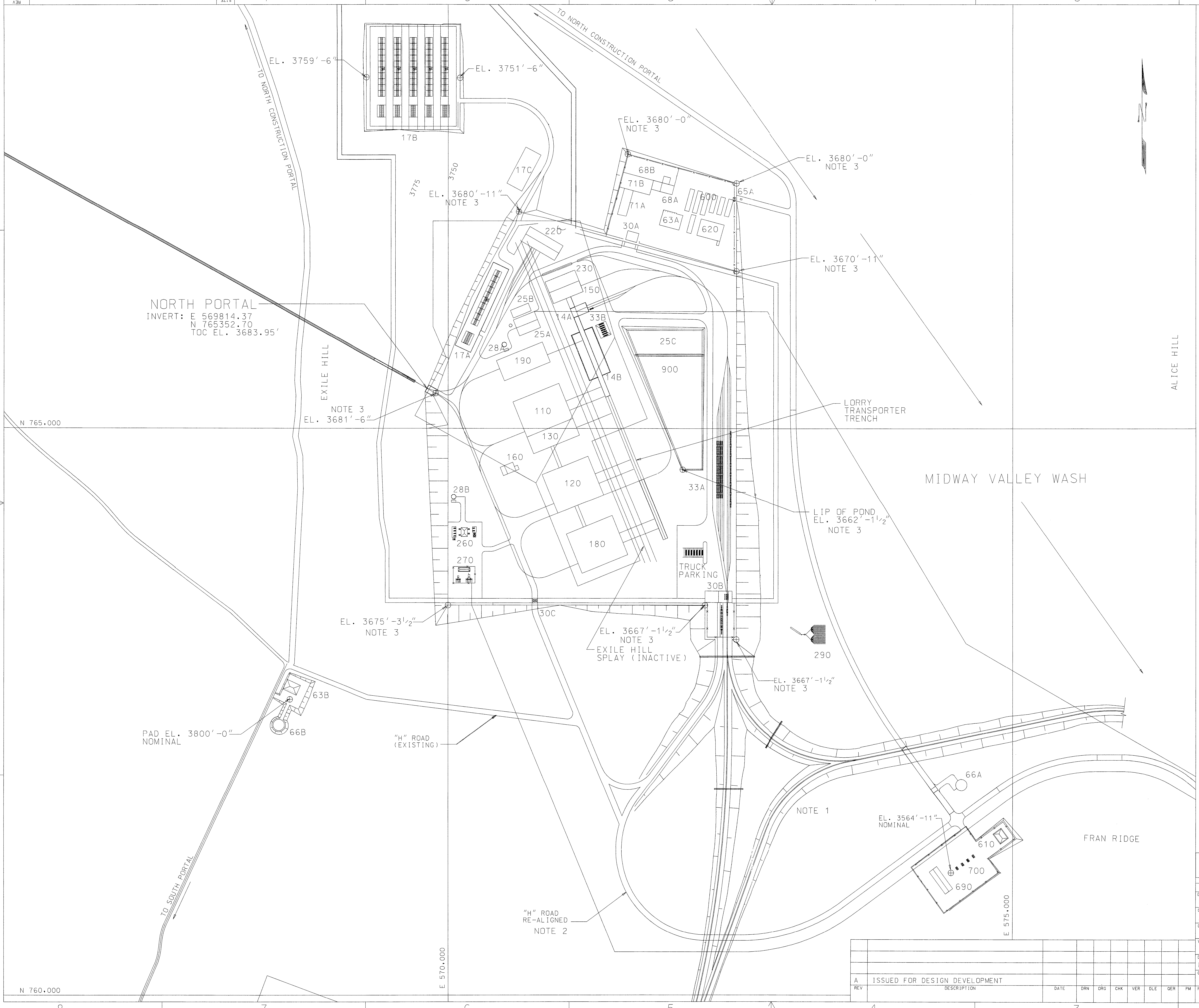
We have some hydrologists using it for some Q calculations (generating cross sections and calculating areas for input into an anlysis) and they were thinking its COTS that does not need to be qualified as per section 2.1.6 of the Software Management procedure. Is that correct?
thanks,
susan

Susan S. Olig, R.G.
Sr. Project Geologist
Seismic Hazards Group
URS Corporation
500 12th Street, Suite 200
Oakland, CA 94607-4014

ph: 510-874-1729
fax: 510-874-3268
email: susan_olig@urscorp.com

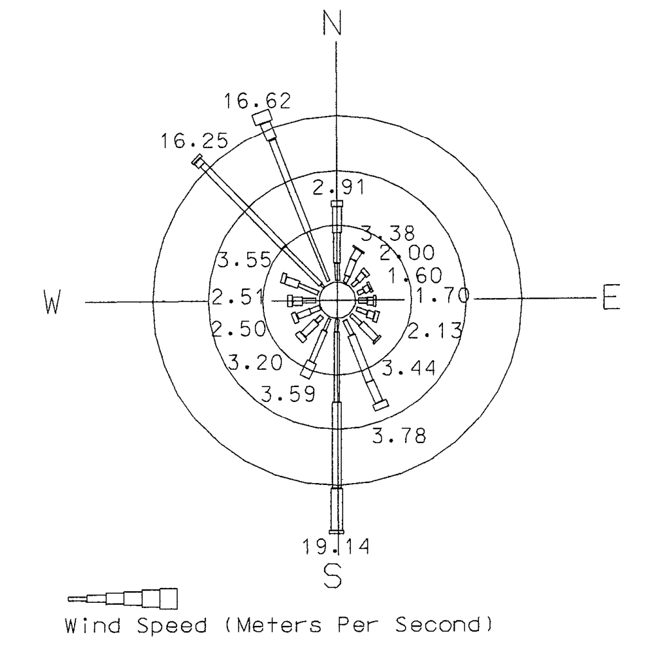
Attachment 3: Layout Sketches of Alternatives 1 and 2
(Document ID: 000-00C-CD04-00100-000-00A)

Document ID: 000-00C-CD04-00100-000-00A



REV	DESCRIPTION	DATE	DRN	ORG	CHK	VER	DLE	QER	PM
A	ISSUED FOR DESIGN DEVELOPMENT								

Joint Frequency Distribution
For Raw Data File C:JohnFreqWork1998.dat



Wind Speed (Meters Per Second)

LEGEND

AREA No.	DESCRIPTION
17A	AGING (1000 MTHM)
17B	AGING (5,000 MTHM) FUTURE
17C	SHIELDED CANISTER FACILITY (SCF) FUTURE
110	DRY TRANSFER FACILITY #1 (DTF-1)
120	DRY TRANSFER FACILITY #2 (DTF-2)
130	REMEDIATION BLDG (RB)
14A	TRANSPORTATION CASK RECEIPT BUILDING (TCRB)
14B	TRANSPORTATION CASK BUFFER STORAGE AREA(30 DAYS)
150	WASTE PACKAGE RECEIPT BUILDING (WPRB)
160	LOW LEVEL WASTE HANDLING (LLWH)
180	DRY TRANSFER FACILITY #3 (DTF-3) FUTURE
190	CANISTER HANDLING FACILITY (CHF)
220	HEAVY EQUIPMENT MAINTENANCE BUILDING (HEMB)
230	EQUIPMENT MAINTENANCE/WAREHOUSE BUILDING (EMWB)
25A	UTILITY BUILDING
25B	COOLING TOWER
25C	EVAPORATION POND
260	ELECTRICAL GENERATORS AND SWITCH HOUSE
270	MAIN SWITCHYARD
28A	FIRE WATER FACILITY
28B	FIRE WATER FACILITY
290	SEPTIC TANK & LEACH FIELD (EXISTING)
30A	CENTRAL SECURITY STATION
30B	CASK RECEIPT SECURITY STATION
30C	SOUTH PERIMETER SECURITY STATION
33A	RAILROAD CAR STAGING AREA
33B	TRUCK STAGING
600	NORTH CENTRAL PARKING
610	VISITOR CENTER
620	ADMINISTRATION BUILDING
63A	FIRE, RESCUE AND MEDICAL BUILDING
63B	FIRE, RESCUE AND MEDICAL BUILDING (CONSTRUCTION/REMOTE)
65A	ADMINISTRATION SECURITY STATION
66A	HELICOPTER PAD
66B	HELICOPTER PAD (CONSTRUCTION/REMOTE)
68A	WAREHOUSE/CENTRAL RECEIVING
68B	MATERIALS/YARD STORAGE
690	SMALL VEHICLE REPAIR SHOP
700	FUEL DEPOT
71A	CRAFT SHOPS
71B	EQUIPMENT YARD STORAGE
900	STORM WATER / RETENTION POND

—×—	FENCE
——	FUTURE
3625	25' CONTOURS
——	5' CONTOURS
——	CHARACTERIZED AREA (NEW)
——	CHARACTERIZED AREA (EXISTING)
——	WATER
——	POWER
——	RAILROAD
——	ROAD
——	SECURITY FENCE (GROA)

NOTES:

1 RAIL ALIGNMENT SHOWN IS CONCEPTUAL. FINAL ALIGNMENT TO BE DETERMINED BY TRANSPORTATION STUDY.

2 ROAD ALIGNMENT SHOWN IS CONCEPTUAL. FINAL ALIGNMENT TO BE DETERMINED IN DETAIL DESIGN PHASE

3 ALL PAD ELEVATIONS SHOWN ARE PRELIMINARY AND THEREFORE ARE SUBJECT TO CHANGE AS THE FACILITY DESIGN DEVELOPES

400 200 0 400 800 FT
1" = 400'-0"

THIS DRAWING IS PRELIMINARY AND NOT

OR FABRICATION.

APPROVALS	INITIAL/DATE
DRAWN BY RF PAVELKA	
ORIGINATOR A. EDMONSTONE	
CHECKED	
VERIFICATION	
DESIGN LEAD ENGINEER F. BASAMANOWICZ	
QUALITY ENGINEERING REP	
PROJECT MANAGER	

BECHTEL SAIC COMPANY, LLC Management and Operation of the Office of Civilian Radioactive Waste Management Program

GEOLOGICAL REPOSITORY
OPERATIONS AREA
NORTH PORTAL - PLOT PLAN

SIZE	SCALE	DOCUMENT IDENTIFIER	REV
D	1"-400'-0	100-POK-MGR0-10701-000-	00A

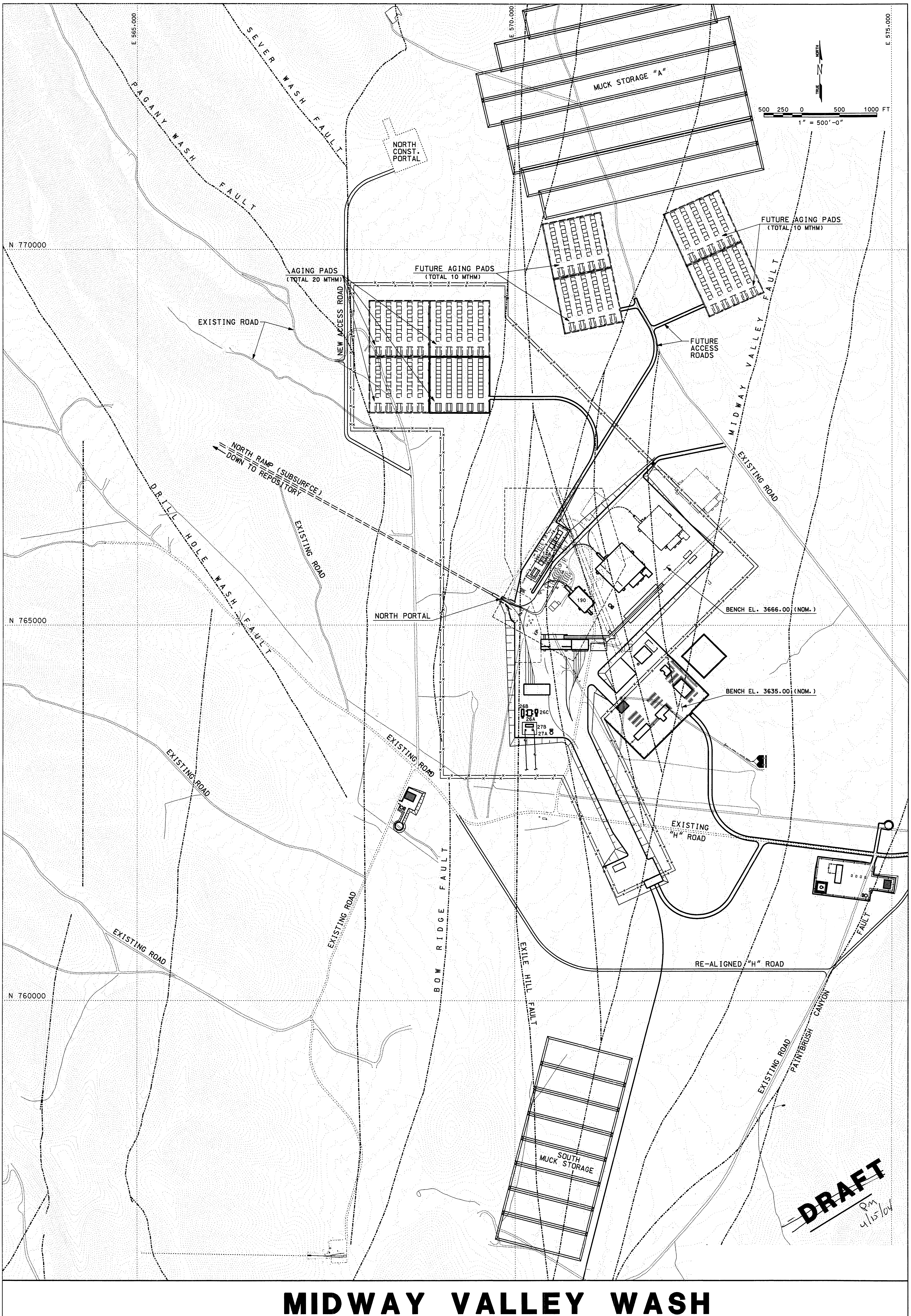
QA CLASSIFICATION	CAD FILENAME	SHEET
NA RM 4/15/04	100POKMGR010701.SKT	1of1

CAGE CODE:

ARCH D - 24"x36"   RECORD DESIGNATOR QA: NA RM 4/15/04

$$$$SYTIME$$$$$$$$

HYDROLOGIC ENGINEERING STUDIES FOR ① 04/29/04
THE NORTH PORTAL PAD AND VICINITY 3-1
Document ID1 000-00C-C004-00100-00

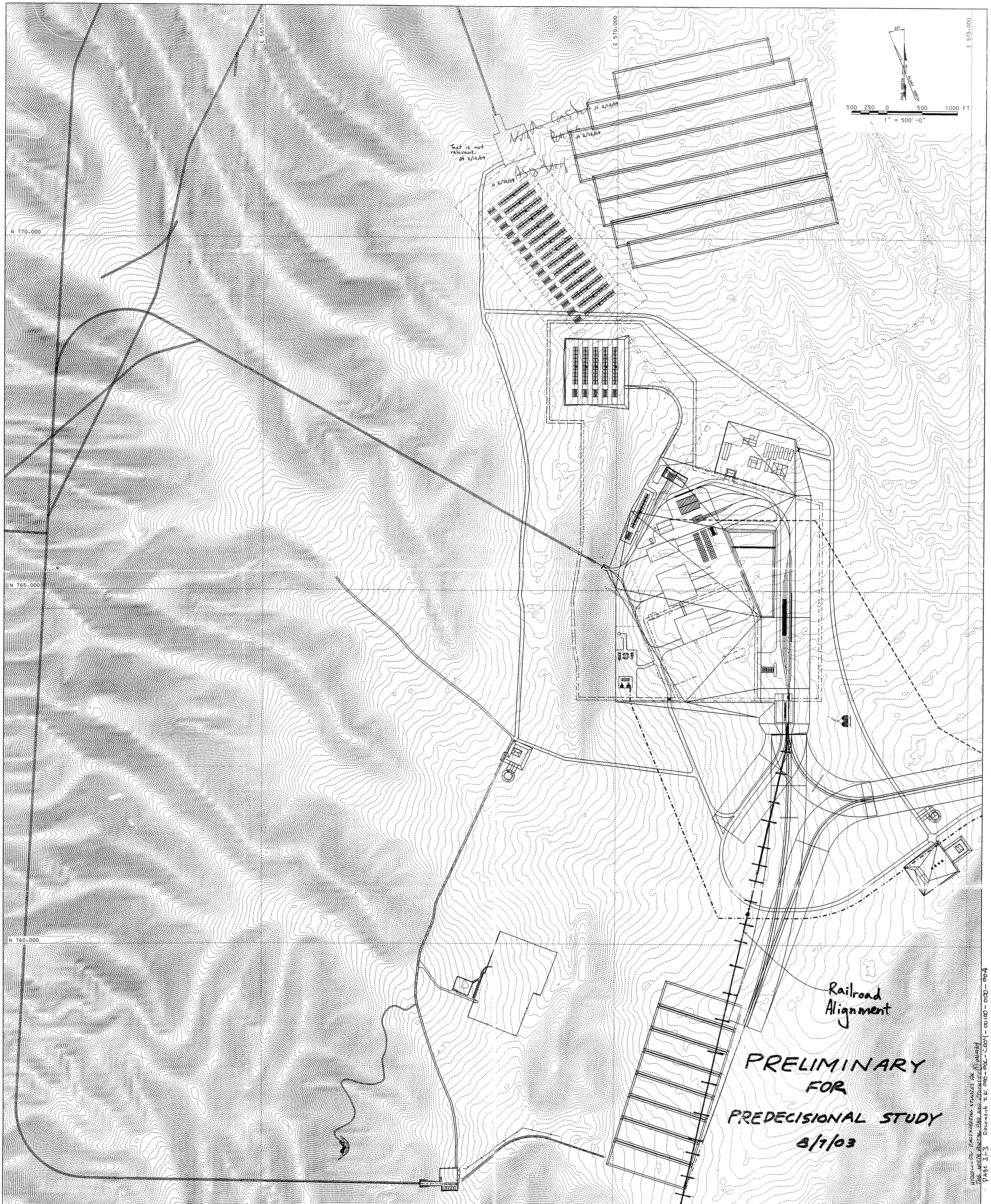


~~DRAFT~~
Pm 4/15/04

MIDWAY VALLEY WASH
SKETCH NO. 100-C0K-CD04-00101-000-00A

HYDROLOGIC ENGINEERING STUDIES FOR THE NORTH PORTAL PAD AND VICINITY (1) 04/29/04
Document ID: 000-00C-CD04-00100-000-00A

3-2



Text is not relevant.
JH 2/12/04

JH 2/12/04
JH 2/12/04
JH 2/12/04

PRELIMINARY
FOR
PREDECISIONAL STUDY
8/7/03

HYDROLOGIC ENGINEERING STUDIES FOR
THE NORTH PORTAL PAD AND VICINITY (1) 04/29/04
PAGE 3-3 Document ID: 000-00C-CD04-00100-000-00A

Attachment 4: PMP Calculations for South Portal
(Document ID: 000-00C-CD04-00100-000-00A)

Attachment 4: PMP Calculations for South Portal Pad

The procedures presented in HMR 49 (Ref. 14) were used to calculate the PMP – South Portal. The calculations on the following pages show that the 6-hour duration local storm PMP of 12.9 inches is more severe than the largest 6-hour general storm of 5.8 inches, which was calculated to occur during the month of September.

Table 6.1.--General-storm PMP computations for the Colorado River and Great Salt Pm 3/3/04 basin

Drainage Midway Valley - South Portal Area Area 6.5 ~~mi~~^{2} ~~(km^2)~~ Pm 3/3/04

note: above correction should read mi^2 ~~(km^2)~~ BM 4/15/04

Latitude 36° 51', Longitude 116° 27' of basin center

Month September

Step		Duration (hrs) 6	12	18	24	48	72	
A. Convergence PMP								
1. Drainage average value from one of figures 2.5 to 2.16	10.8 in. ~~(mm)~~ Pm 3/3/04							
2. Reduction for barrier-elevation [fig. 2.18]	65 %							
3. Barrier-elevation reduced PMP [step 1 X step 2]	7.0 in. ~~(mm)~~ Pm 3/3/04							
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].		68	NA	NA	NA	NA	NA	%
5. Convergence PMP for indicated durations [steps 3 X 4]		4.8	NA	NA	NA	NA	NA	in. ~~(mm)~~ Pm 3/3/04
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]		4.8	NA	NA	NA	NA	NA	in. ~~(mm)~~ Pm 3/3/04
7. Areal reduction [select from figs. 2.28 and 2.29]		100	NA	NA	NA	NA	NA	%
8. Areally reduced PMP [step 6 X step 7]		4.8	NA	NA	NA	NA	NA	in. ~~(mm)~~ Pm 3/3/04
9. Drainage average PMP [accumulated values of step 8]		4.8	NA	NA	NA	NA	NA	in. ~~(mm)~~ Pm 3/3/04
B. Orographic PMP								
1. Drainage average orographic index from figure 3.11a to d.	3.0 in. ~~(mm)~~ Pm 3/3/04							
2. Areal reduction [figure 3.20]	100 %							
3. Adjustment for month [one of figs. 3.12 to 3.17]	100 %							
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3]	3.0 in. ~~(mm)~~ Pm 3/3/04							
5. Durational variation [table 3.6]		32	NA	NA	NA	NA	NA	%
6. Orographic PMP for given durations [steps 4 X 5]		1.0	NA	NA	NA	NA	NA	in. ~~(mm)~~ Pm 3/3/04
C. Total PMP								
1. Add steps A9 and B6		5.8	NA	NA	NA	NA	NA	in. ~~(mm)~~ Pm 3/3/04

2. PMP for other durations from smooth curve fitted to plot of computed data.

3. Comparison with local-storm PMP (see sec. 6.3).

Table 6.3A.--Local-storm PMP computation, Colorado River, Great Basin and California drainages. For drainage average depth PMP. Go to table 6.3B if areal variation is required.

Drainage Midway Valley - South Portal Area Area 6.5 mi^2 ~~(km^2)~~ 3/3/04
Latitude 36° 51' Longitude 116° 27' Minimum Elevation 3520 ft ~~(m)~~

Steps correspond to those in sec. 6.3A.

1. Average 1-hr 1-mi^2 (2.6-km^2) PMP for drainage [fig. 4.5]. 10.3 in. ~~(mm)~~ 3/3/04

2. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m): 5% decrease per 1,000 feet (305 m) above 5,000 feet (1,524 m)]. 100 %

   b. Multiply step 1 by step 2a. 10.3 in. ~~(mm)~~

3. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.36 3/3/04

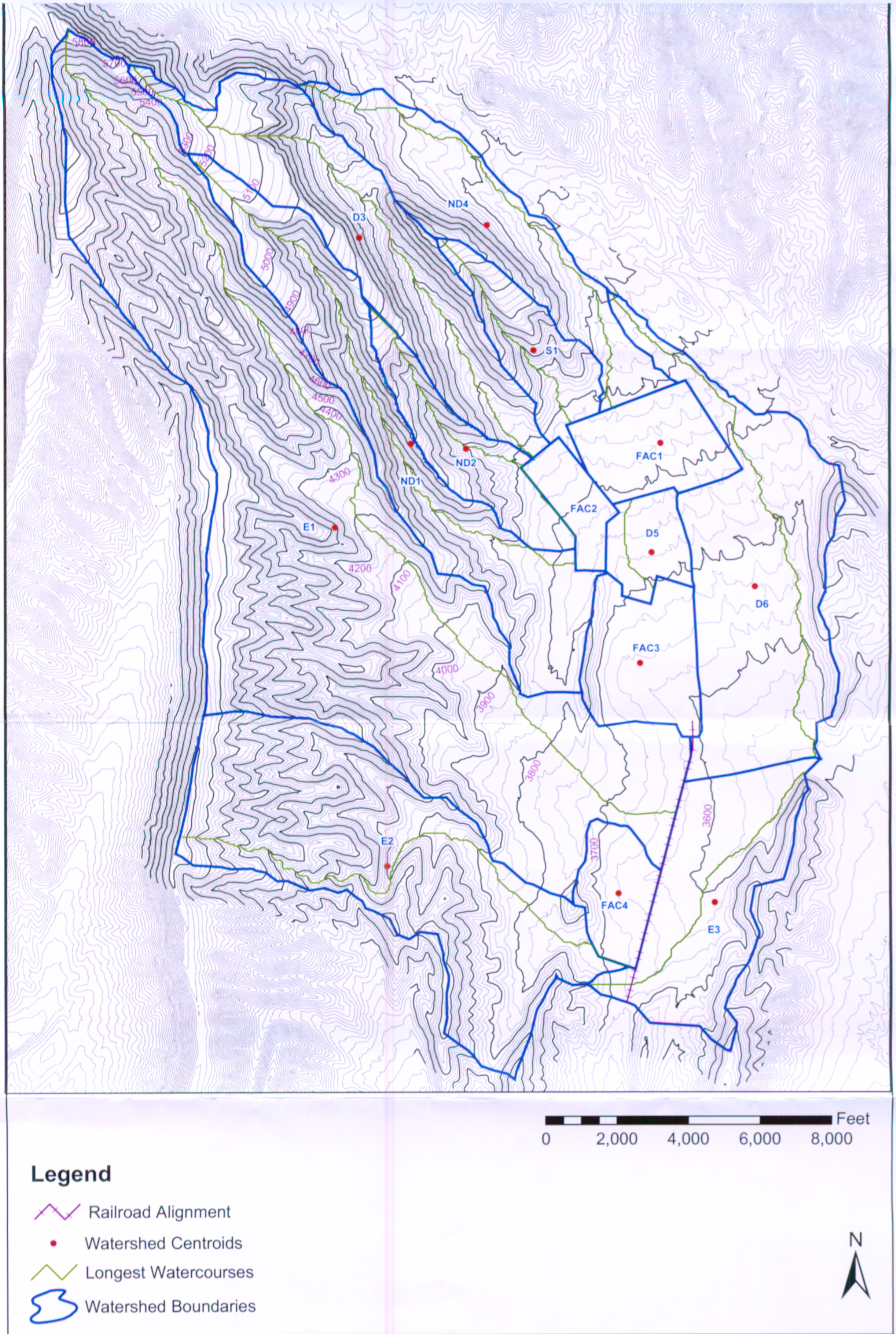
	Duration (hr)									
	1/4	1/2	3/4	1	2	3	4	5	6	
4. Durational variation for 6/1-hr ratio of step 3 [table 4.4].	67	85	94	100	116	124	129	133	136	%
5. 1-mi^2 (2.6-km^2) PMP for indicated durations [step 2b X step 4].	6.9	8.8	9.7	10.3	11.9	12.8	13.3	13.7	14.0	in. ~~(mm)~~ 3/3/04
6. Areal reduction [fig. 4.9].	80	83	85	87	88	89	90	91	92	%
7. Areal reduced PMP [steps 5 X 6].	5.5	7.3	8.2	9.0	10.5	11.4	12.0	12.5	12.9	in. ~~(mm)~~ 3/3/04
8. Incremental PMP [successive subtraction in step 7].				9.0	1.5	0.9	0.6	0.5	0.4	in. ~~(mm)~~ 3/3/04
	5.5	1.8	0.9	0.8	} 15-min. increments					

9. Time sequence of incremental PMP according to:

Used EM 1110-2-1411 COE
Method as in previous report
(Ref. 6, p. 16)

Hourly increments [table 4.7].	0.4	0.6	1.5	9.0	0.9	0.5	in. ~~(mm)~~ 3/3/04
Four largest 15-min. increments [table 4.8].	5.5	1.8	0.9	0.8			in. ~~(mm)~~ 3/3/04

Attachment 5: Hydrology Calculations for Alternatives 1 and 2
(Document ID: 000-00C-CD04-00100-000-00A)



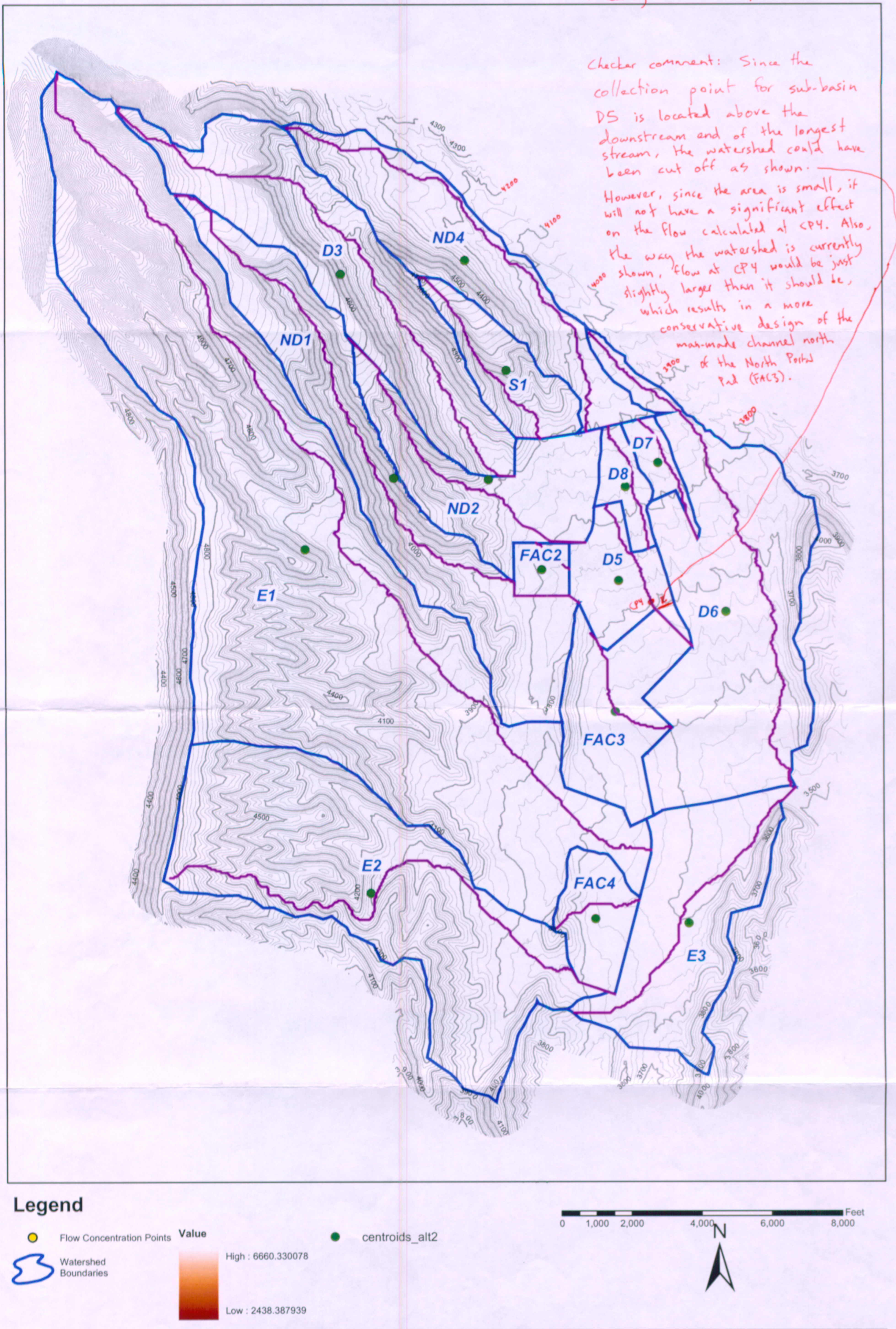
Yucca Mountain

Project # 18839594

Calculation of Sub-basin Properties for Inputs to HEC-1 Model, Alternative 1

Figure

Checked by J Hudson 2/19/04



Checker comment: Since the collection point for sub-basin D5 is located above the downstream end of the longest stream, the watershed could have been cut off as shown. However, since the area is small, it will not have a significant effect on the flow calculated at CP4. Also, the way the watershed is currently shown, flow at CP4 would be just slightly larger than it should be, which results in a more conservative design of the man-made channel north of the North Portal Pad (FAC3).

URS

Yucca Mountain

Project # 18839594

Delineation of Sub-basins for HEC-1 Model for Alternative 2

Figure x

Attachment 6: Hydraulic Calculations for No Mitigation Scenario, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)

These numbers refer to the page number of the attached HEC-RAS results →

			1	2	3	4	5	6	1		2		3		4		5	
River Station	Length Between Sections (ft)	Elev. At Left Edge of Pad (ft)	WSE w/o any spills (ft)	WSE after 1st Iteration (ft)	WSE after 2nd Iteration (ft)	WSE after 3rd Iteration (ft)	WSE after 4th Iteration (ft)	WSE after 5th Iteration (ft)	Depth w/o any spills (ft)		Depth after 1st Iteration (ft)		Depth after 2nd Iteration (ft)		Depth after 3rd Iteration (ft)		Depth after 4th Iteration (ft)	
7500		3678.2	3682.1	3681.7	3682	3681.8	3681.9	3681.8	3.9		3.5		3.8		3.6		3.7	
	258									5.8		4.15		5.2		4.55		4.9
7242		3673.7	3681.4	3678.5	3680.3	3679.2	3679.8	3679.5	7.7		4.8		6.6		5.5		6.1	
	302									8.2		3.55		7.0		5.3		6.3
6940		3671	3679.7	3673.3	3678.3	3676.1	3677.5	3676.8	8.7		2.3		7.3		5.1		6.5	

Values taken directly from HEC-RAS

Example Depth Calculations: (after 3rd Iteration)

$5.5 = \underset{\uparrow \text{ WSE after 3rd Iteration}}{3679.2} - \underset{\uparrow \text{ Elev at Left Edge of Pad}}{3673.7}$

5.3 = Average depth between Stations 7242 and 6940

$5.3 = \frac{5.5 + 5.1}{2}$

HEC-RAS results show that water starts to spill over the left edge (facing downstream) of the pad at River Station 7500.

To be conservative, flow spilling over the edge will only be calculated between stations 7500 and 7242 and Stations 7242 and 6940. Flows in HEC-RAS will be decreased at the downstream sections (Stations 7242 and 6940).

✓

Computed by J. Hudson 12/3/2003

6		2	3	4	5	6	7	1	2	3	4	5	6	7
Depth after 5th Iteration (ft)		Spill over Edge of Pad for 1st Iteration[1] (cfs)	Spill over Edge of Pad for 2nd Iteration[1] (cfs)	Spill over Edge of Pad for 3rd Iteration[1] (cfs)	Spill over Edge of Pad for 4th Iteration[1] (cfs)	Spill over Edge of Pad for 5th Iteration[1] (cfs)	Spill over Edge of Pad for 6th Iteration[1] (cfs)	Total Q down Pad w/o any spills (cfs)	Total Q down Pad for 1st Iteration (cfs)	Total Q down Pad for 2nd Iteration (cfs)	Total Q down Pad for 3rd Iteration (cfs)	Total Q down Pad for 4th Iteration (cfs)	Total Q down Pad for 5th Iteration (cfs)	Total Q down Pad for 6th Iteration (cfs)
3.6								28379	28379	28379	28379	28379	28379	28379
	4.7	9370	5671	7954	6510	7276	6835							
5.8								28379	19009	22708	20425	21869	21103	21544
	5.8	18437	5252	14387	9581	12416	10968							
5.8								28379	572	17456	6038	12288	8687	10576

[1] Calculate spill using weir equation, $Q = CLH^{3/2}$, assuming C =2.6 (HEC-RAS manual states that C ranges from 2.5 to 3.1) (Ref. ~~2~~ 3, p. ~~101~~ 5-23)
JH 3/2/04 JH 2/12/0

Example spill Calculation - (for 4th Iteration)

$$9581 = 2.6\,(302)\,(5.3)^{3/2}$$

↑ Length between Stations 7242 and 6940

↑ Average Depth between Stations 7242 and 6940

Example Calculation of Total Flow Down Pad (for 4th Iteration)

$$12{,}288 = 21{,}869 - 9581$$

↑ Total flow at section upstream

↑ Spill flow Calculated for this iteration.

✓

Results after Initial Run Without Spills over Edge of North Portal Pad

HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052897	0.6184	8.76	1976.55	545.6	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020345	0.5864	5.45	3314.41	955.88	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009195	0.5569	3.66	6604.95	2011.41	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070457	0.5632	12.04	2010.27	455.58	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022125	0.5092	6.99	3462.18	732.74	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025645	0.4884	7.57	3195.02	669.64	0.61
reach1	8552.508	24192	3706	10.19	3716.19		3716.89	0.026828	0.4606	6.72	3601.48	934.31	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036493	0.434	7.34	3296.63	943.47	0.69
reach1	8037.583	24192	3680	10.73	3690.73	3690.73	3696.07	0.063988	0.3648	18.55	1304.35	123.1	1
reach1	7785.279	28379	3678.2	5.97	3684.17	3682.26	3684.66	0.01489	0.3577	5.65	5023.77	1172.19	0.46
reach1	7499.846	28379	3670.25	25.35	3682.07	3679.74	3682.13	0.001492	0.3298	1.58	15176.4	3245.35	0.14
reach1	7241.71	28379	3673.7	7.66	3681.36		3681.51	0.005864	0.3432	3.15	9005.38	2319.7	0.28
reach1	6939.672	28379	3671	8.67	3679.67		3679.83	0.005242	0.3342	3.21	8852.61	2041.11	0.27
reach1	6704.251	28379	3670.7	6.71	3677.41		3677.85	0.020248	0.333	5.31	5345.61	1593.57	0.51
reach1	6416.374	28379	3662.13	12.58	3674.7		3674.74	0.000506	0.3032	1.57	18073.73	2108.91	0.09
reach1	6129.828	28379	3662.13	12.41	3674.53		3674.58	0.000629	0.3032	1.7	16712.41	2041.4	0.1
reach1	5837.239	28379	3662.13	12.21	3674.33		3674.38	0.00073	0.3032	1.75	16236.68	2123.45	0.11
reach1	5510.757	28379	3662.13	11.96	3674.09		3674.13	0.000779	0.3032	1.71	16580.19	2349.28	0.11
reach1	5058.868	28379	3668.7	3.72	3672.42	3672.42	3673.35	0.094322	0.3177	7.74	3665.62	1972.08	1
reach1	4605.871	28379	3600.08	12.29	3612.37	3613.67	3615.66	0.158819	0.1662	14.56	1948.62	695.45	1.42
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

Results after 1st Iteration

HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052914	0.6184	8.76	1976.28	545.55	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020341	0.5864	5.45	3314.64	955.91	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009197	0.5569	3.66	6604.49	2011.38	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070533	0.5632	12.05	2009.61	455.55	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022113	0.5092	6.99	3462.89	732.82	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025681	0.4884	7.58	3193.06	669.33	0.61
reach1	8552.508	24192	3706	10.2	3716.2		3716.9	0.02676	0.4606	6.71	3605.14	934.91	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036695	0.434	7.35	3290.64	943.1	0.69
reach1	8037.583	24192	3680	10.8	3690.8	3690.8	3696.07	0.062753	0.3648	18.43	1312.5	123.11	0.99
reach1	7785.279	28379	3678.2	6.15	3684.35	3682.26	3684.81	0.013097	0.3577	5.43	5223.74	1177.88	0.44
reach1	7499.846	28379	3670.25	25	3681.72	3679.74	3681.88	0.006732	0.3298	3.15	8921.15	3091.64	0.3
reach1	7241.71	19009	3673.7	4.76	3678.46	3677.64	3678.92	0.03375	0.3432	5.46	3483.28	1462.96	0.62
reach1	6939.672	572	3671	2.32	3673.32		3673.33	0.002404	0.3342	0.9	634.36	546.38	0.15
reach1	6704.251	572	3670.7	1.58	3672.28		3672.34	0.018443	0.333	1.93	296.14	375.08	0.38
reach1	6416.374	572	3662.13	7.57	3669.7		3669.7	0.000002	0.3032	0.07	8672.02	1629.95	0.01
reach1	6129.828	572	3662.13	7.57	3669.7		3669.7	0.000002	0.3032	0.07	7973.27	1565.58	0.01
reach1	5837.239	572	3662.13	7.57	3669.7		3669.7	0.000002	0.3032	0.07	7627.82	1590.67	0.01
reach1	5510.757	572	3662.13	7.57	3669.7		3669.7	0.000003	0.3032	0.07	7672.94	1706.99	0.01
reach1	5058.868	572	3668.7	0.78	3669.48	3669.48	3669.68	0.158819	0.3177	3.55	161.28	413.66	1
reach1	4605.871	28379	3600.08	14.52	3614.6	3613.67	3615.29	0.034897	0.1662	6.69	4242.21	1504.98	0.66
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

Results after 2nd Iteration

HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052914	0.6184	8.76	1976.28	545.55	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020341	0.5864	5.45	3314.64	955.91	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009197	0.5569	3.66	6604.49	2011.38	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070533	0.5632	12.05	2009.61	455.55	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022113	0.5092	6.99	3462.89	732.82	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025681	0.4884	7.58	3193.06	669.33	0.61
reach1	8552.508	24192	3706	10.2	3716.2		3716.9	0.02676	0.4606	6.71	3605.14	934.91	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036695	0.434	7.35	3290.64	943.1	0.69
reach1	8037.583	24192	3680	10.8	3690.8	3690.8	3696.07	0.062753	0.3648	18.43	1312.5	123.11	0.99
reach1	7785.279	28379	3678.2	6.18	3684.38	3682.26	3684.84	0.01283	0.3577	5.4	5256.56	1178.75	0.43
reach1	7499.846	28379	3670.25	25.31	3682.03	3679.74	3682.16	0.005144	0.3298	2.91	9705.87	3196.26	0.26
reach1	7241.71	22708	3673.7	6.6	3680.3		3680.48	0.008436	0.3432	3.39	6694.37	2028.12	0.33
reach1	6939.672	17456	3671	7.34	3678.34		3678.46	0.004822	0.3342	2.75	6344.23	1727.9	0.25
reach1	6704.251	17456	3670.7	5.54	3676.24		3676.59	0.021333	0.333	4.79	3640.92	1315.16	0.51
reach1	6416.374	17456	3662.13	11.23	3673.36		3673.38	0.000306	0.3032	1.14	15322.33	1986.21	0.07
reach1	6129.828	17456	3662.13	11.13	3673.26		3673.28	0.000378	0.3032	1.23	14185.68	1917.86	0.08
reach1	5837.239	17456	3662.13	11.01	3673.14		3673.16	0.000436	0.3032	1.27	13779.63	1986.02	0.08
reach1	5510.757	17456	3662.13	10.87	3672.99		3673.02	0.000461	0.3032	1.24	14091.19	2188.86	0.09
reach1	5058.868	17456	3668.7	3.06	3671.76	3671.76	3672.53	0.100593	0.3177	7.02	2485.28	1623.82	1
reach1	4605.871	28379	3600.08	14.52	3614.6	3613.67	3615.29	0.034897	0.1662	6.69	4242.21	1504.98	0.66
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

Results after 3rd Iteration

HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052914	0.6184	8.76	1976.28	545.55	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020341	0.5864	5.45	3314.64	955.91	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009197	0.5569	3.66	6604.49	2011.38	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070533	0.5632	12.05	2009.61	455.55	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022113	0.5092	6.99	3462.89	732.82	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025681	0.4884	7.58	3193.06	669.33	0.61
reach1	8552.508	24192	3706	10.2	3716.2		3716.9	0.02676	0.4606	6.71	3605.14	934.91	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036695	0.434	7.35	3290.64	943.1	0.69
reach1	8037.583	24192	3680	10.8	3690.8	3690.8	3696.07	0.062753	0.3648	18.43	1312.5	123.11	0.99
reach1	7785.279	28379	3678.2	6.16	3684.36	3682.26	3684.81	0.013062	0.3577	5.43	5227.98	1177.99	0.44
reach1	7499.846	28379	3670.25	25.08	3681.8	3679.74	3681.95	0.00626	0.3298	3.08	9126.78	3134.58	0.29
reach1	7241.71	20425	3673.7	5.52	3679.22		3679.52	0.017727	0.3432	4.36	4680.14	1695.77	0.46
reach1	6939.672	6038	3671	5.13	3676.13		3676.19	0.0039	0.3342	1.95	3098.46	1207.55	0.21
reach1	6704.251	6038	3670.7	3.71	3674.41		3674.62	0.021483	0.333	3.69	1637.87	882.09	0.48
reach1	6416.374	6038	3662.13	9.32	3671.45		3671.45	0.00008	0.3032	0.52	11697.16	1811.89	0.04
reach1	6129.828	6038	3662.13	9.3	3671.42		3671.43	0.000098	0.3032	0.56	10830.7	1740.33	0.04
reach1	5837.239	6038	3662.13	9.27	3671.39		3671.4	0.000112	0.3032	0.58	10488.79	1785.46	0.04
reach1	5510.757	6038	3662.13	9.23	3671.36		3671.36	0.000118	0.3032	0.56	10704.54	1949.49	0.04
reach1	5058.868	6038	3668.7	1.99	3670.69	3670.69	3671.2	0.119722	0.3177	5.75	1050.11	1055.52	1.02
reach1	4605.871	28379	3600.08	14.52	3614.6	3613.67	3615.29	0.034897	0.1662	6.69	4242.21	1504.98	0.66
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

Results after 4th Iteration

HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052914	0.6184	8.76	1976.28	545.55	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020341	0.5864	5.45	3314.64	955.91	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009197	0.5569	3.66	6604.49	2011.38	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070533	0.5632	12.05	2009.61	455.55	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022113	0.5092	6.99	3462.89	732.82	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025681	0.4884	7.58	3193.06	669.33	0.61
reach1	8552.508	24192	3706	10.2	3716.2		3716.9	0.02676	0.4606	6.71	3605.14	934.91	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036695	0.434	7.35	3290.64	943.1	0.69
reach1	8037.583	24192	3680	10.8	3690.8	3690.8	3696.07	0.062753	0.3648	18.43	1312.5	123.11	0.99
reach1	7785.279	28379	3678.2	6.17	3684.37	3682.26	3684.82	0.012969	0.3577	5.42	5239.36	1178.3	0.43
reach1	7499.846	28379	3670.25	25.19	3681.91	3679.74	3682.05	0.005667	0.3298	2.99	9415.61	3176.58	0.27
reach1	7241.71	21869	3673.7	6.14	3679.84		3680.06	0.01149	0.3432	3.77	5795.86	1887.11	0.38
reach1	6939.672	12288	3671	6.52	3677.52		3677.61	0.004501	0.3342	2.46	5003.35	1534.48	0.24
reach1	6704.251	12288	3670.7	4.83	3675.53		3675.84	0.021817	0.333	4.43	2774.64	1148.09	0.5
reach1	6416.374	12288	3662.13	10.47	3672.59		3672.6	0.000204	0.3032	0.89	13827.93	1916.27	0.06
reach1	6129.828	12288	3662.13	10.4	3672.53		3672.54	0.00025	0.3032	0.96	12808.31	1847.04	0.06
reach1	5837.239	12288	3662.13	10.32	3672.45		3672.46	0.000288	0.3032	0.99	12434.88	1906.61	0.07
reach1	5510.757	12288	3662.13	10.23	3672.35		3672.37	0.000303	0.3032	0.97	12717.94	2095.1	0.07
reach1	5058.868	12288	3668.7	2.65	3671.35	3671.35	3672.03	0.108585	0.3177	6.62	1856	1403.26	1.01
reach1	4605.871	28379	3600.08	14.52	3614.6	3613.67	3615.29	0.034897	0.1662	6.69	4242.21	1504.98	0.66
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

Results after 5th Iteration

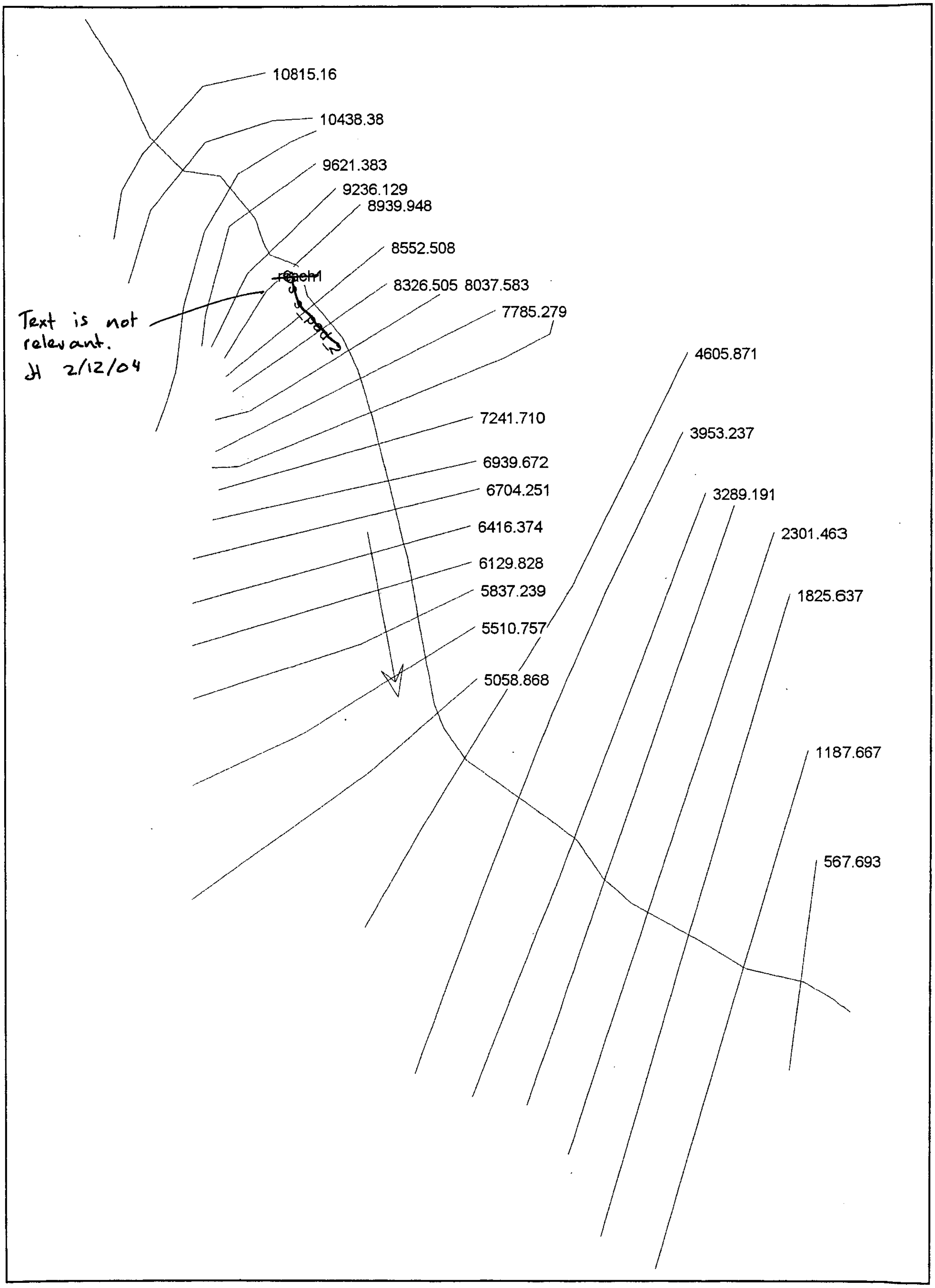
HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052914	0.6184	8.76	1976.28	545.55	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020341	0.5864	5.45	3314.64	955.91	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009197	0.5569	3.66	6604.49	2011.38	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070533	0.5632	12.05	2009.61	455.55	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022113	0.5092	6.99	3462.89	732.82	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025681	0.4884	7.58	3193.06	669.33	0.61
reach1	8552.508	24192	3706	10.2	3716.2		3716.9	0.02676	0.4606	6.71	3605.14	934.91	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036695	0.434	7.35	3290.64	943.1	0.69
reach1	8037.583	24192	3680	10.8	3690.8	3690.8	3696.07	0.062753	0.3648	18.43	1312.5	123.11	0.99
reach1	7785.279	28379	3678.2	6.16	3684.36	3682.26	3684.82	0.013034	0.3577	5.42	5231.42	1178.09	0.44
reach1	7499.846	28379	3670.25	25.12	3681.84	3679.74	3681.99	0.006029	0.3298	3.05	9234.69	3157.05	0.28
reach1	7241.71	21103	3673.7	5.8	3679.5		3679.76	0.014527	0.3432	4.08	5167.93	1781.95	0.42
reach1	6939.672	8687	3671	5.8	3676.8		3676.87	0.004203	0.3342	2.19	3957.89	1364.78	0.23
reach1	6704.251	8687	3670.7	4.25	3674.95		3675.2	0.021775	0.333	4.06	2140.73	1008.45	0.49
reach1	6416.374	8687	3662.13	9.85	3671.97		3671.98	0.000131	0.3032	0.69	12660.81	1859.82	0.05
reach1	6129.828	8687	3662.13	9.81	3671.93		3671.94	0.000161	0.3032	0.74	11727.38	1789.5	0.05
reach1	5837.239	8687	3662.13	9.76	3671.88		3671.89	0.000185	0.3032	0.76	11374.29	1841.57	0.05
reach1	5510.757	8687	3662.13	9.69	3671.82		3671.83	0.000194	0.3032	0.75	11625.07	2017.37	0.05
reach1	5058.868	8687	3668.7	2.3	3671	3671	3671.59	0.11344	0.3177	6.17	1407.65	1222.07	1.01
reach1	4605.871	28379	3600.08	14.52	3614.6	3613.67	3615.29	0.034897	0.1662	6.69	4242.21	1504.98	0.66
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

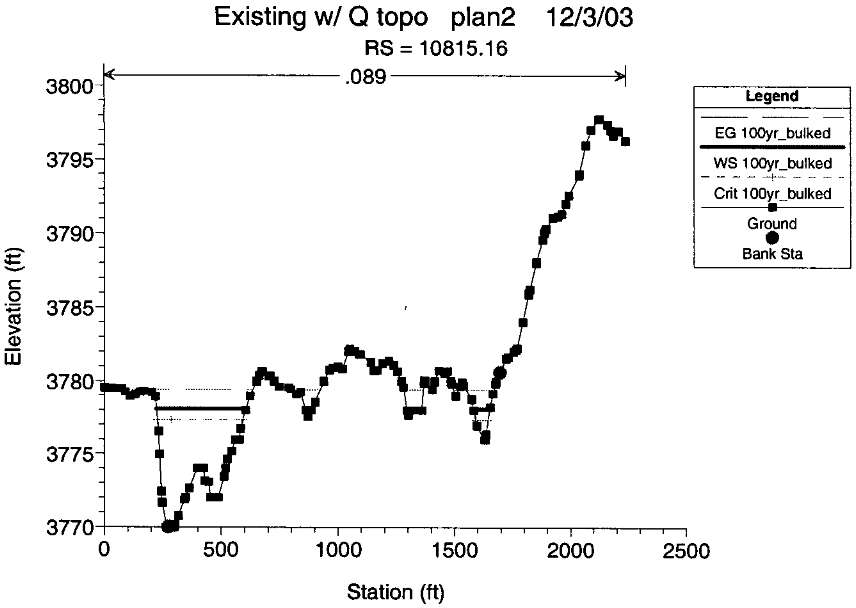
Final Results

HEC-RAS Plan: plan2 River: cross_pad_2 Reach: reach1

Reach	River Sta	Q Total	Min Ch El	Max Chl Dpth	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Invert Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(sq ft)	(ft)	
reach1	10815.16	18058	3770	8.07	3778.07	3777.32	3779.41	0.052914	0.6184	8.76	1976.28	545.55	0.83
reach1	10438.38	18058	3757.94	6.81	3764.75	3762.56	3765.21	0.020341	0.5864	5.45	3314.64	955.91	0.52
reach1	9898.005	24192	3742	14.95	3756.95	3753.01	3757.16	0.009197	0.5569	3.66	6604.49	2011.38	0.35
reach1	9621.383	24192	3743.75	6.45	3750.2	3750.2	3752.45	0.070533	0.5632	12.05	2009.61	455.55	1
reach1	9236.129	24192	3722.94	10.47	3733.41		3734.17	0.022113	0.5092	6.99	3462.89	732.82	0.57
reach1	8939.948	24192	3716.78	9.44	3726.22		3727.11	0.025681	0.4884	7.58	3193.06	669.33	0.61
reach1	8552.508	24192	3706	10.2	3716.2		3716.9	0.02676	0.4606	6.71	3605.14	934.91	0.6
reach1	8326.505	24192	3700	9.05	3709.05		3709.89	0.036695	0.434	7.35	3290.64	943.1	0.69
reach1	8037.583	24192	3680	10.8	3690.8	3690.8	3696.07	0.062753	0.3648	18.43	1312.5	123.11	0.99
reach1	7785.279	28379	3678.2	6.16	3684.36	3682.26	3684.82	0.013001	0.3577	5.42	5235.39	1178.19	0.43
reach1	7499.846	28379	3670.25	25.16	3681.88	3679.74	3682.02	0.005833	0.3298	3.02	9330.98	3170.72	0.28
reach1	7241.71	21544	3673.7	5.98	3679.68		3679.92	0.012814	0.3432	3.92	5501.61	1838.58	0.4
reach1	6939.672	10576	3671	6.2	3677.2		3677.28	0.004367	0.3342	2.34	4521.77	1458.76	0.23
reach1	6704.251	10576	3670.7	4.57	3675.27		3675.55	0.021754	0.333	4.26	2482.03	1085.86	0.5
reach1	6416.374	10576	3662.13	10.18	3672.31		3672.32	0.000169	0.3032	0.8	13287.98	1890.36	0.05
reach1	6129.828	10576	3662.13	10.13	3672.25		3672.27	0.000208	0.3032	0.86	12308.65	1820.67	0.06
reach1	5837.239	10576	3662.13	10.06	3672.19		3672.2	0.000239	0.3032	0.89	11945.32	1876.87	0.06
reach1	5510.757	10576	3662.13	9.98	3672.11		3672.12	0.000251	0.3032	0.87	12214.32	2059.64	0.06
reach1	5058.868	10576	3668.7	2.5	3671.2	3671.2	3671.83	0.109279	0.3177	6.39	1654.51	1324.91	1.01
reach1	4605.871	28379	3600.08	14.52	3614.6	3613.67	3615.29	0.034897	0.1662	6.69	4242.21	1504.98	0.66
reach1	3953.237	28379	3581.01	12.94	3593.95	3592.19	3594.88	0.02765	0.137	7.71	3683.01	795.15	0.63
reach1	3289.191	28379	3568	8.56	3576.56		3577.45	0.024896	0.1174	7.59	3766.7	813.19	0.6
reach1	2826.662	28379	3558.01	7.27	3565.28		3566.14	0.024051	0.0958	7.48	3881.66	856.5	0.59
reach1	2301.463	28379	3546	7.54	3553.54		3554.22	0.021106	0.073	6.6	4300.65	959.69	0.55
reach1	1825.637	28379	3534	7.82	3541.82		3542.73	0.028048	0.0478	7.78	3810.09	956.28	0.64
reach1	1187.667	28379	3520	8.57	3528.57		3529.07	0.014489	0.0258	5.84	5076.89	1119.2	0.46
reach1	567.693	28379	3504	11.31	3515.31	3513.83	3516.69	0.030058		9.18	3024.2	517.92	0.68

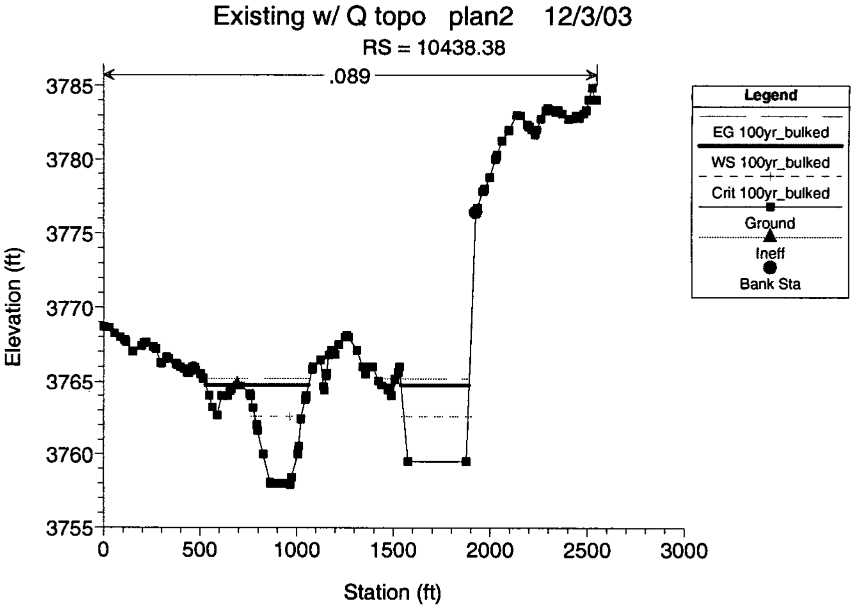


Text is not relevant.
JH 2/12/04



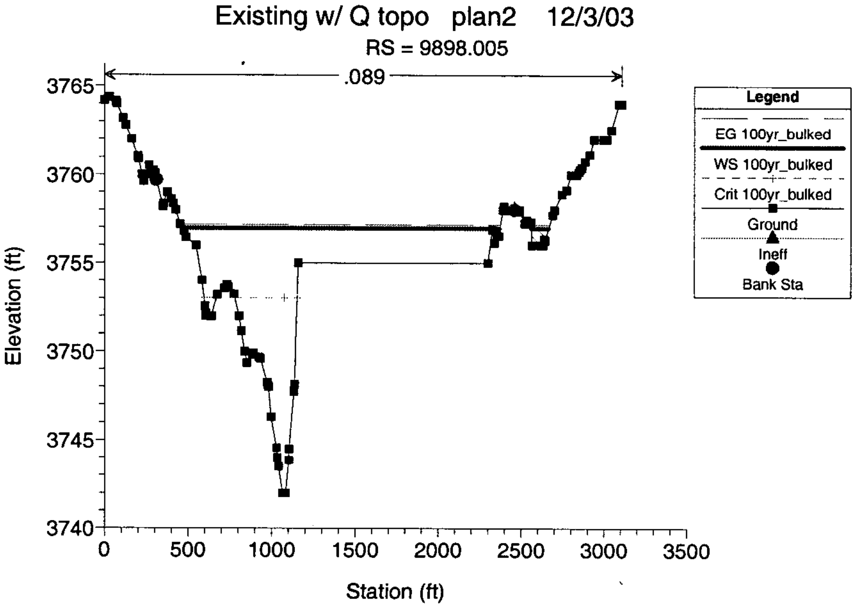
Existing w/ Q topo plan2 12/3/03

RS = 10815.16



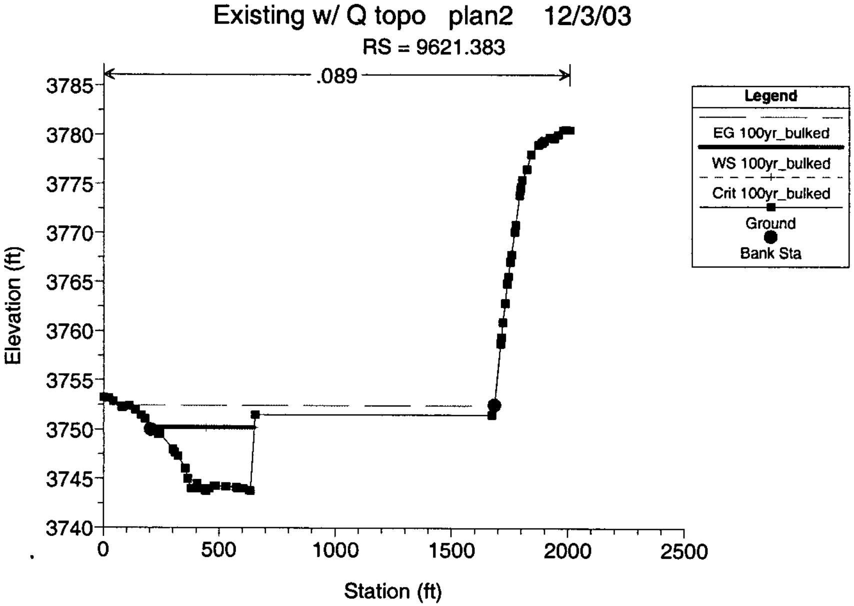
Existing w/ Q topo plan2 12/3/03

RS = 10438.38



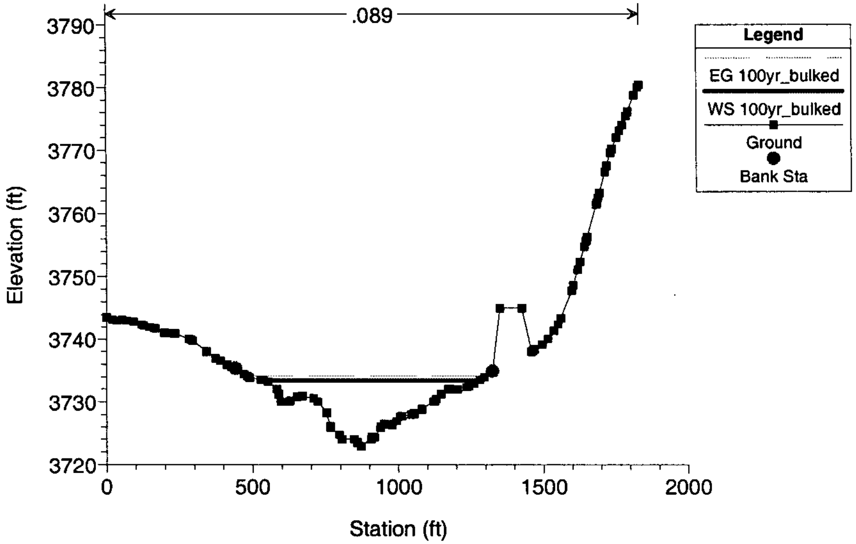
Existing w/ Q topo plan2 12/3/03

RS = 9898.005



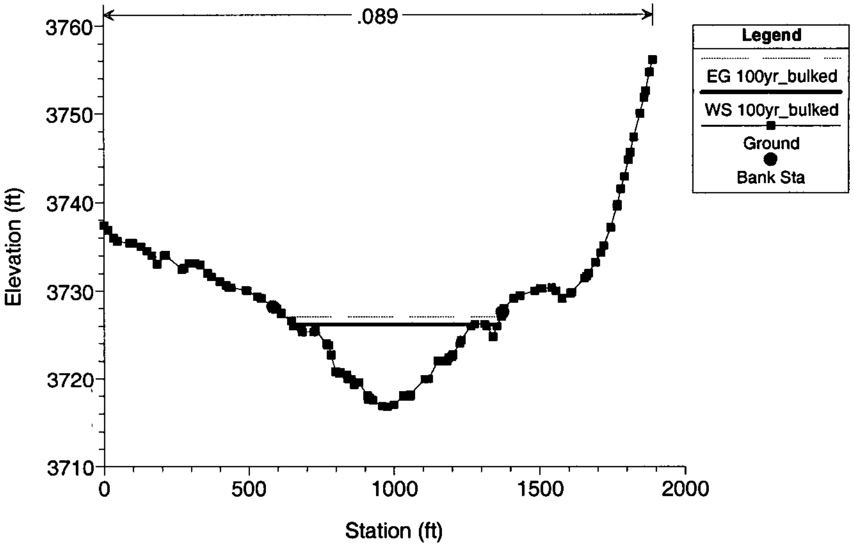
Existing w/ Q topo plan2 12/3/03

RS = 9621.383



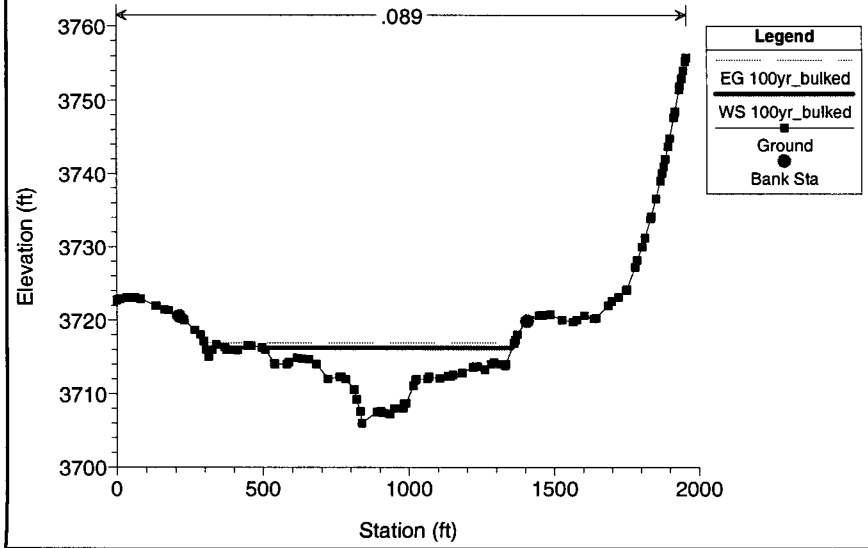
Existing w/ Q topo plan2 12/3/03

RS = 9236.129



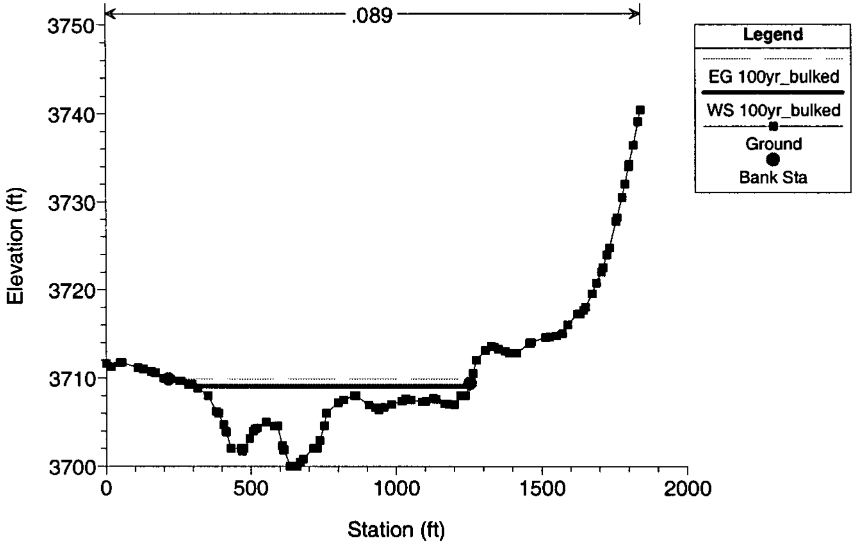
Existing w/ Q topo plan2 12/3/03

RS = 8939.948



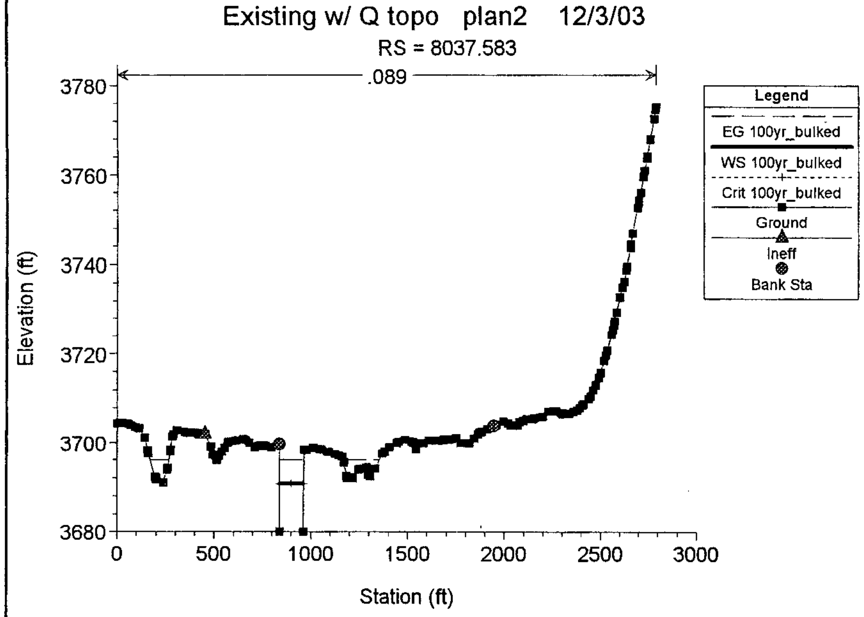
Existing w/ Q topo plan2 12/3/03

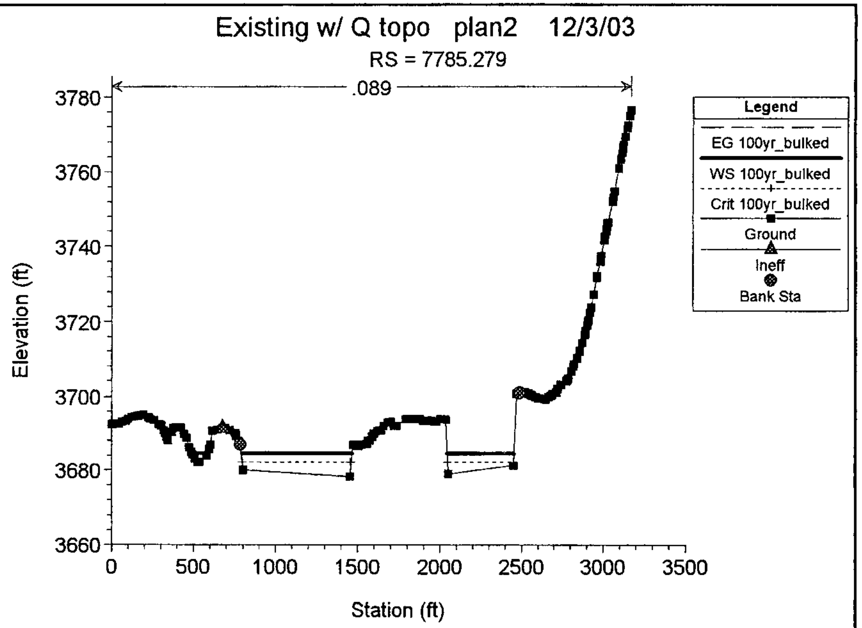
RS = 8552.508

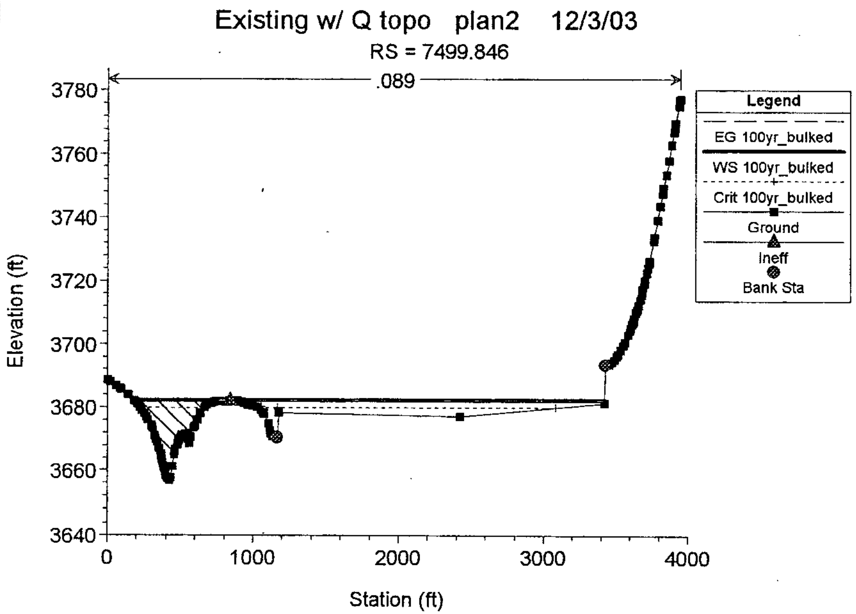


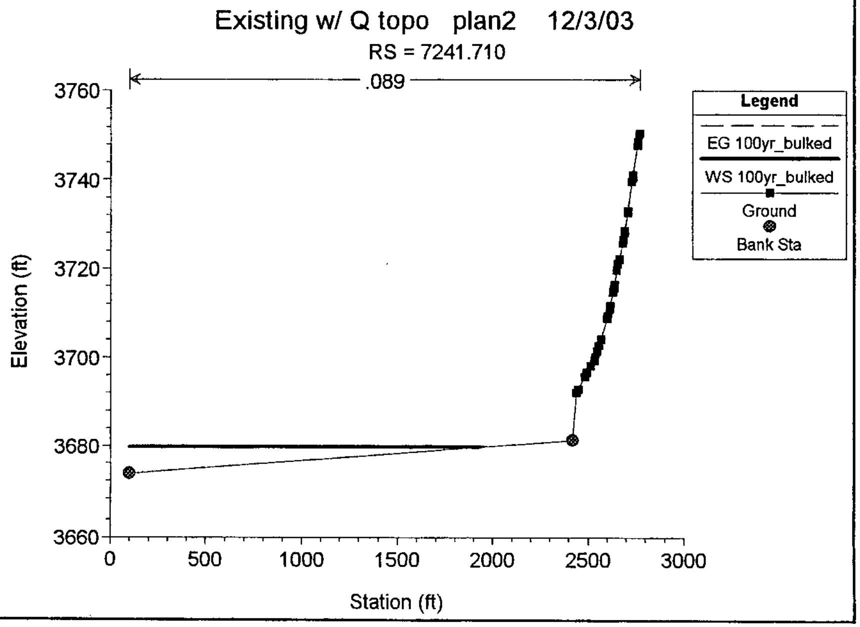
Existing w/ Q topo plan2 12/3/03

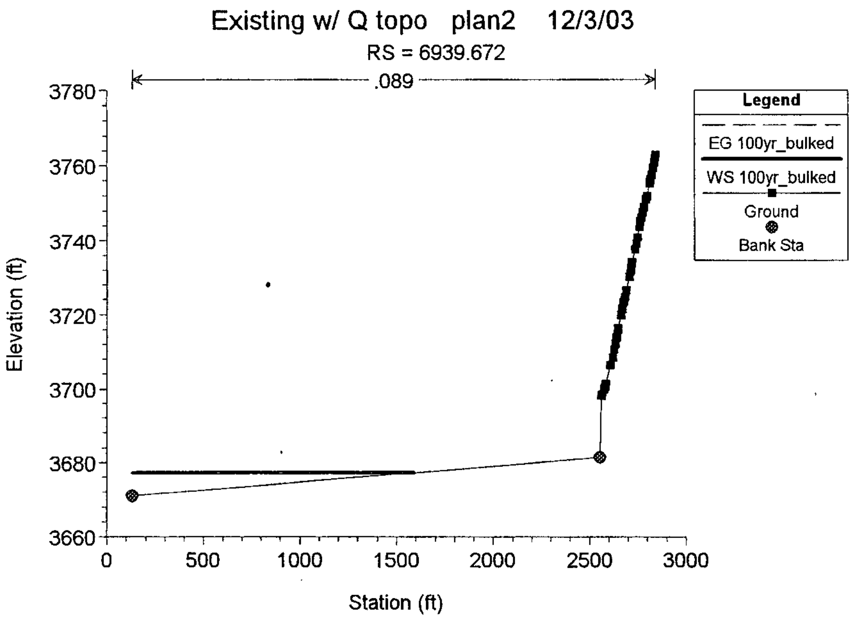
RS = 8326.505

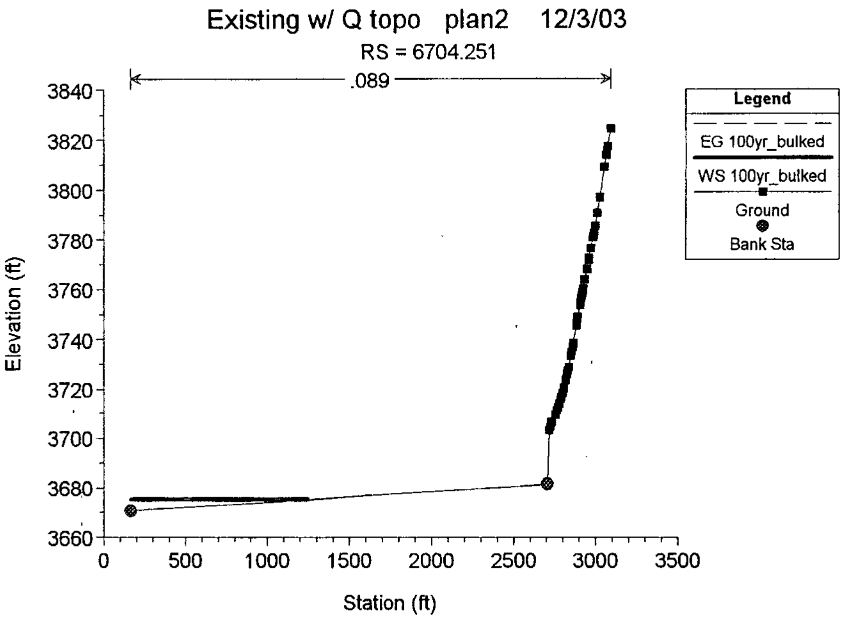

Existing w/ Q topo plan2 12/3/03
RS = 8037.583
.089
Elevation (ft)
3780
3760
3740
3720
3700
3680
0
500
1000
1500
2000
2500
3000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Crit 100yr_bulked
Ground
Ineff
Bank Sta

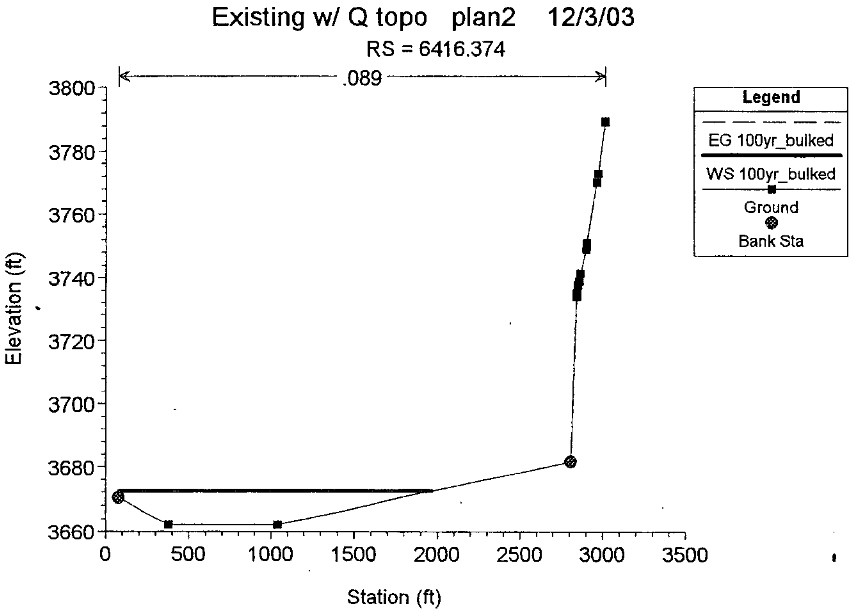

Existing w/ Q topo plan2 12/3/03
RS = 7785.279
.089
Elevation (ft)
3780
3760
3740
3720
3700
3680
3660
0
500
1000
1500
2000
2500
3000
3500
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Crit 100yr_bulked
Ground
Ineff
Bank Sta

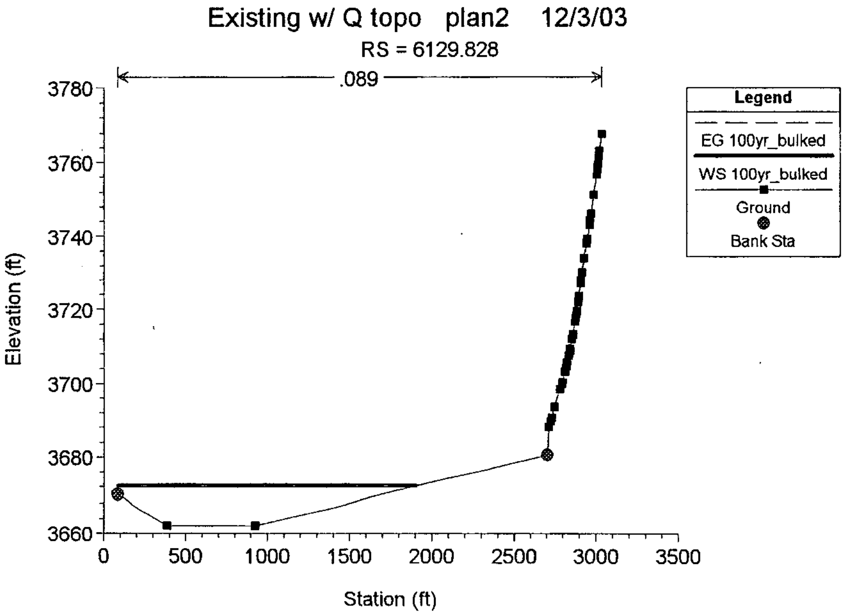

Existing w/ Q topo plan2 12/3/03
RS = 7499.846
.089
Elevation (ft)
3780
3760
3740
3720
3700
3680
3660
3640
0
1000
2000
3000
4000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Crit 100yr_bulked
Ground
Ineff
Bank Sta


Existing w/ Q topo plan2 12/3/03
RS = 7241.710
.089
Elevation (ft)
3760
3740
3720
3700
3680
3660
0
500
1000
1500
2000
2500
3000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta

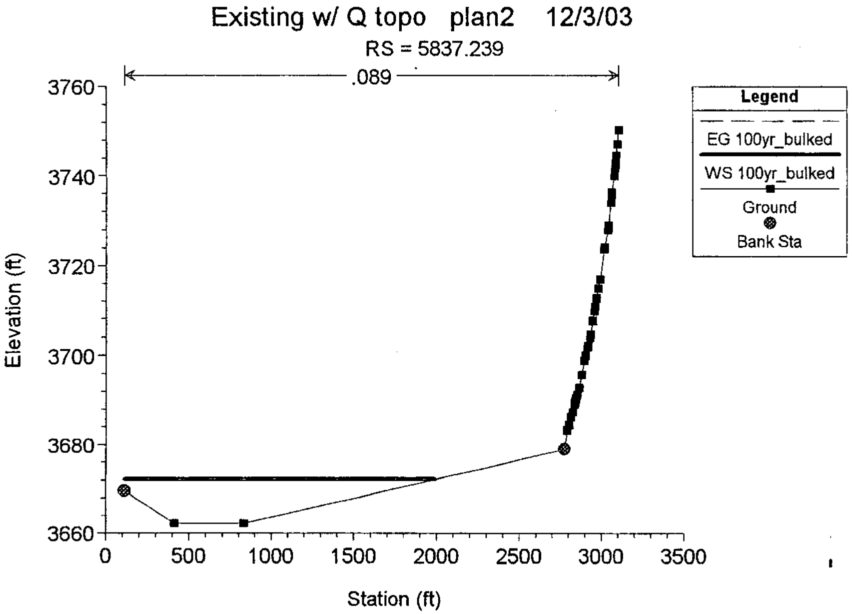

Existing w/ Q topo plan2 12/3/03
RS = 6939.672
.089
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta
Elevation (ft)
3660
3680
3700
3720
3740
3760
3780
Station (ft)
0
500
1000
1500
2000
2500
3000


Existing w/ Q topo plan2 12/3/03
RS = 6704.251
.089
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta
Elevation (ft)
3660
3680
3700
3720
3740
3760
3780
3800
3820
3840
Station (ft)
0
500
1000
1500
2000
2500
3000
3500

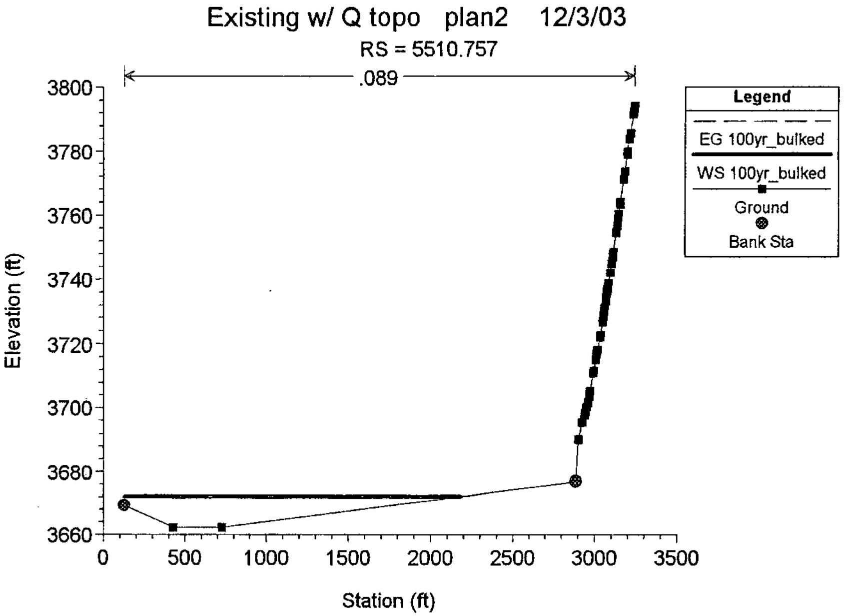

Existing w/ Q topo plan2 12/3/03
RS = 6416.374
.089
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta
Elevation (ft)
3660
3680
3700
3720
3740
3760
3780
3800
Station (ft)
0
500
1000
1500
2000
2500
3000
3500


Existing w/ Q topo plan2 12/3/03
RS = 6129.828
.089
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta
Elevation (ft)
3660
3680
3700
3720
3740
3760
3780
Station (ft)
0
500
1000
1500
2000
2500
3000
3500

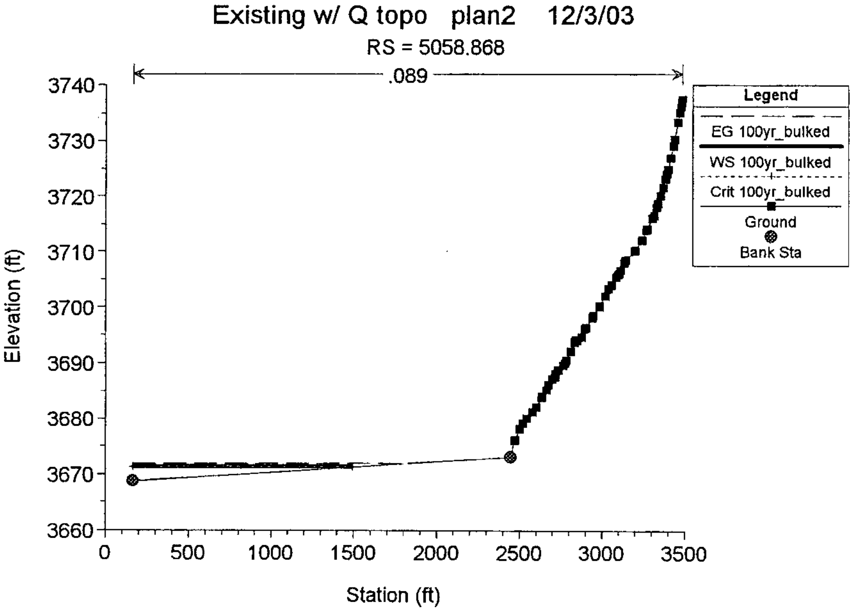
6-14


Existing w/ Q topo plan2 12/3/03

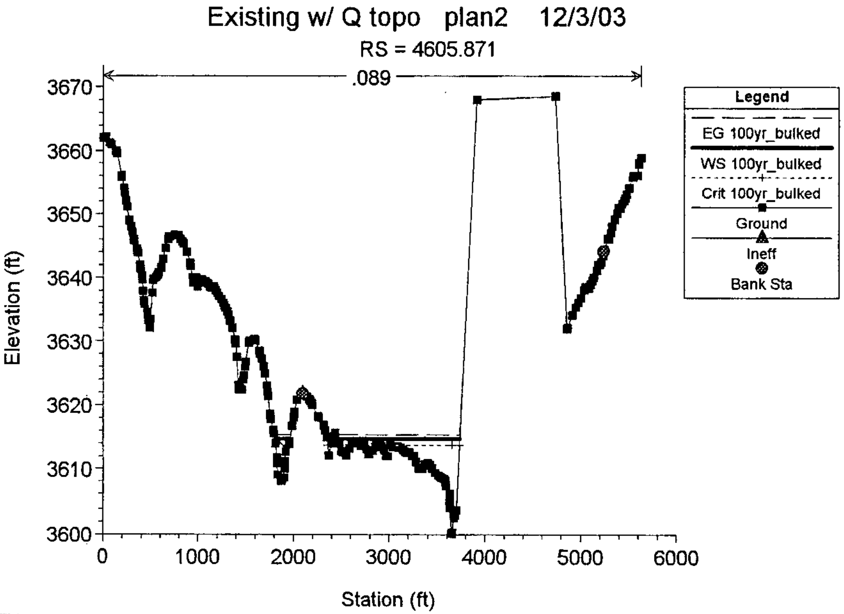
RS = 5837.239


Existing w/ Q topo plan2 12/3/03

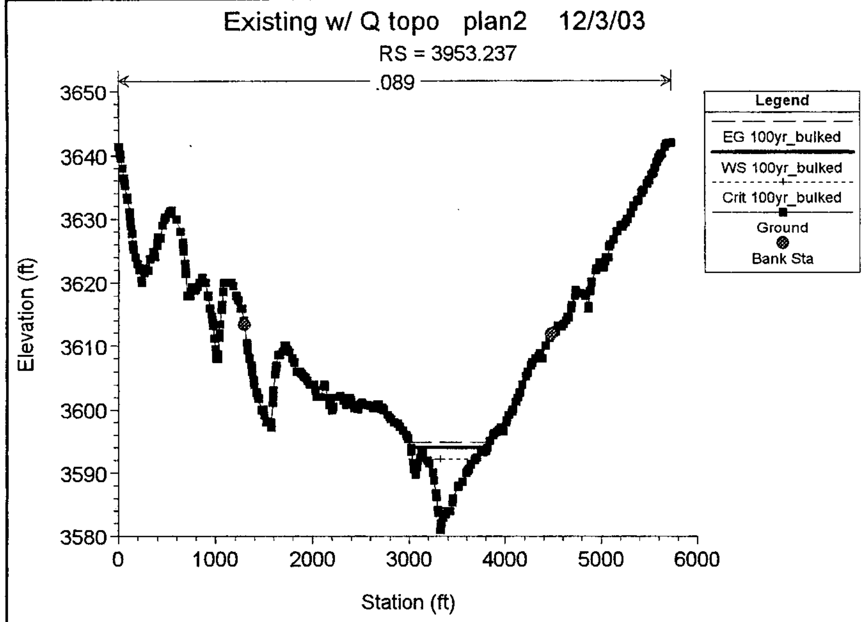
RS = 5510.757

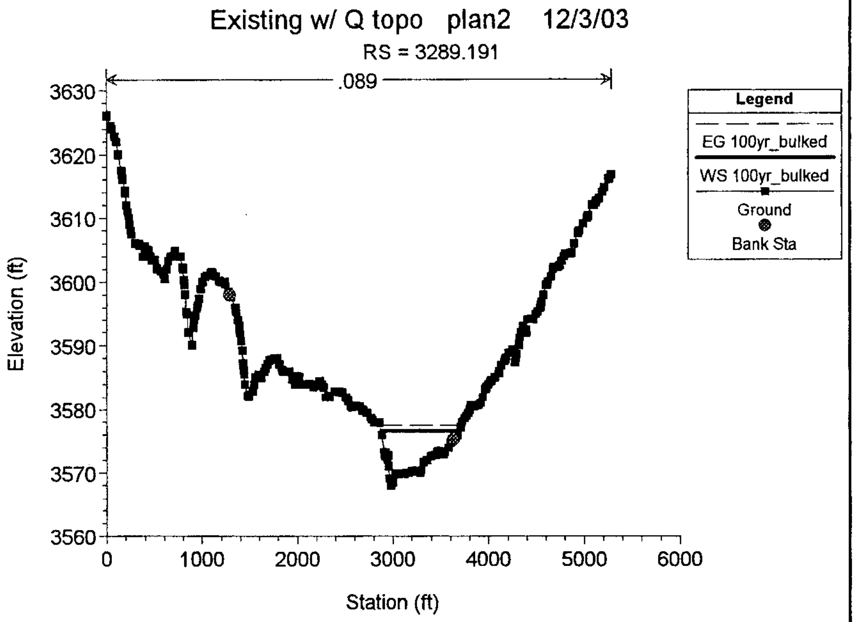

Existing w/ Q topo plan2 12/3/03

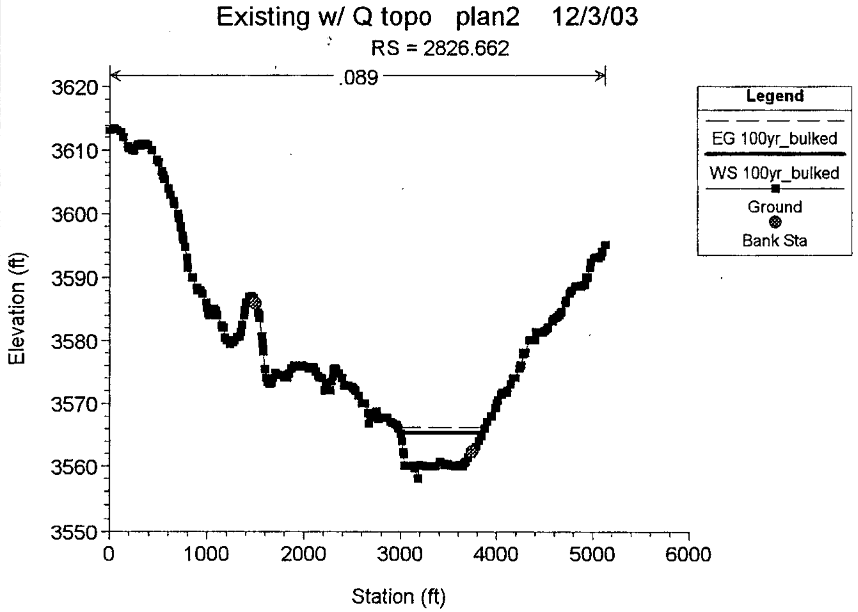
RS = 5058.868

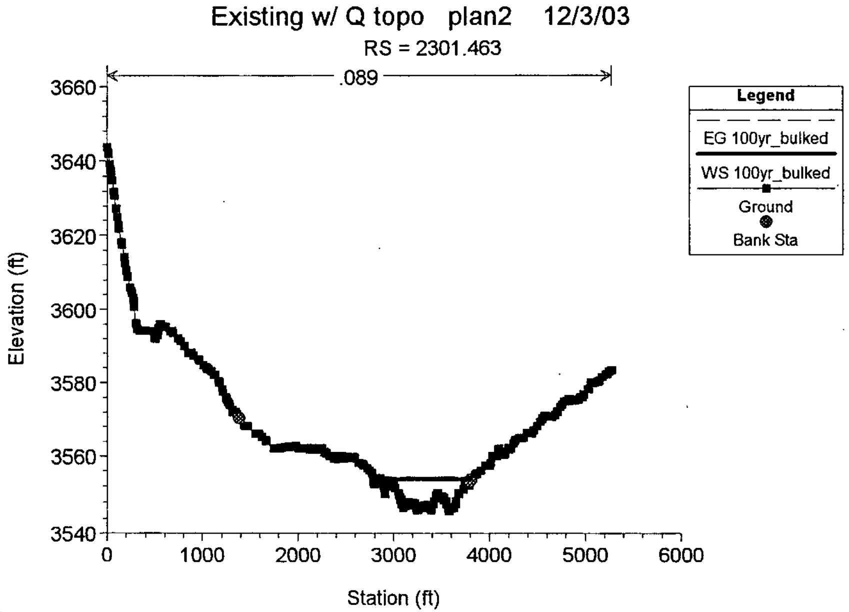

Existing w/ Q topo plan2 12/3/03

RS = 4605.871


Existing w/ Q topo plan2 12/3/03
RS = 3953.237
.089
Elevation (ft)
3650
3640
3630
3620
3610
3600
3590
3580
0
1000
2000
3000
4000
5000
6000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Crit 100yr_bulked
Ground
Bank Sta

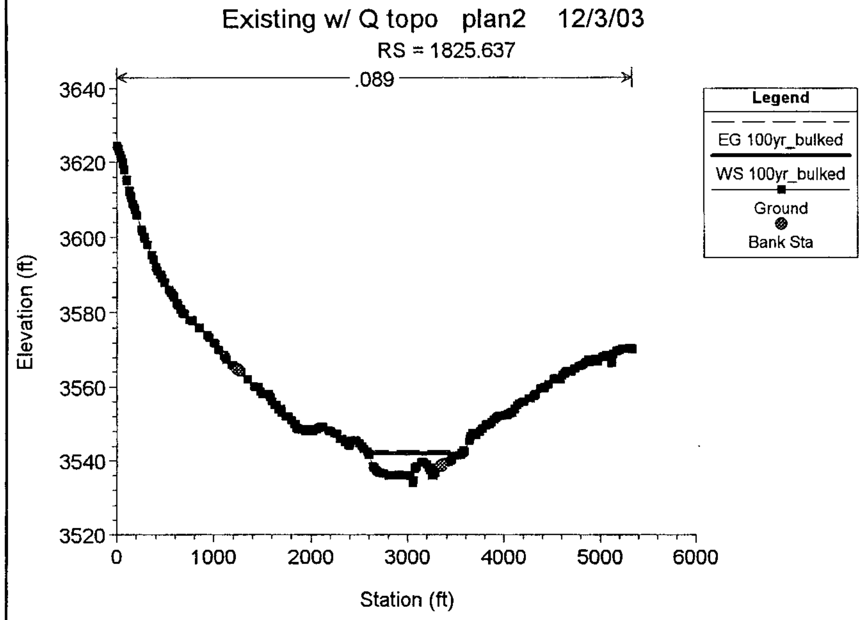

Existing w/ Q topo plan2 12/3/03
RS = 3289.191
.089
Elevation (ft)
3630
3620
3610
3600
3590
3580
3570
3560
0
1000
2000
3000
4000
5000
6000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta


Existing w/ Q topo plan2 12/3/03
RS = 2826.662
.089
Elevation (ft)
3620
3610
3600
3590
3580
3570
3560
3550
0
1000
2000
3000
4000
5000
6000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta


Existing w/ Q topo plan2 12/3/03
RS = 2301.463
.089
Elevation (ft)
3660
3640
3620
3600
3580
3560
3540
0
1000
2000
3000
4000
5000
6000
Station (ft)
Legend
EG 100yr_bulked
WS 100yr_bulked
Ground
Bank Sta

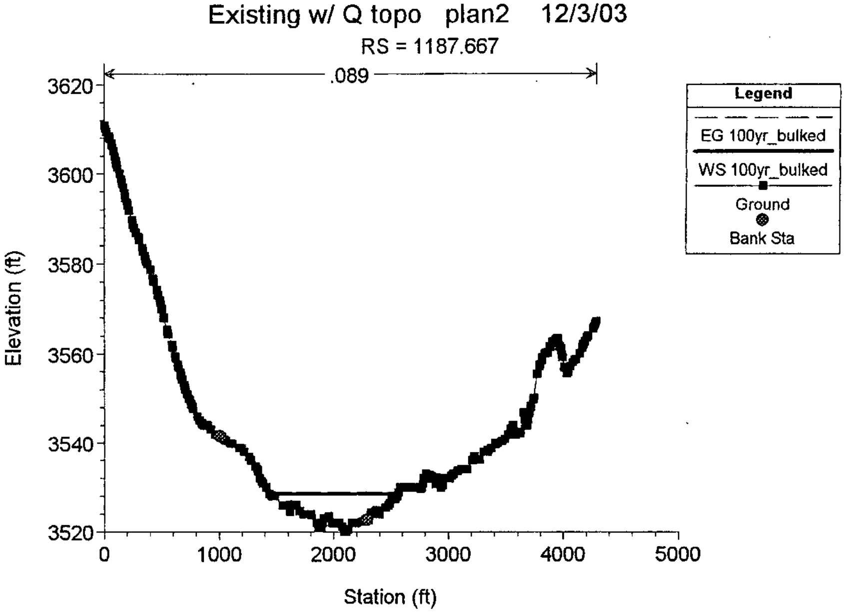
Existing w/ Q topo plan2 12/3/03

RS = 1825.637



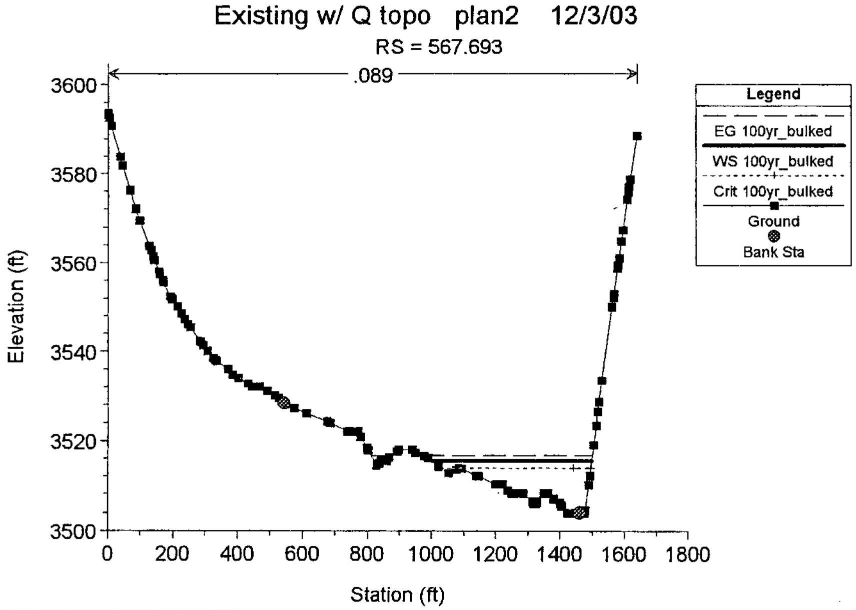
Existing w/ Q topo plan2 12/3/03

RS = 1187.667



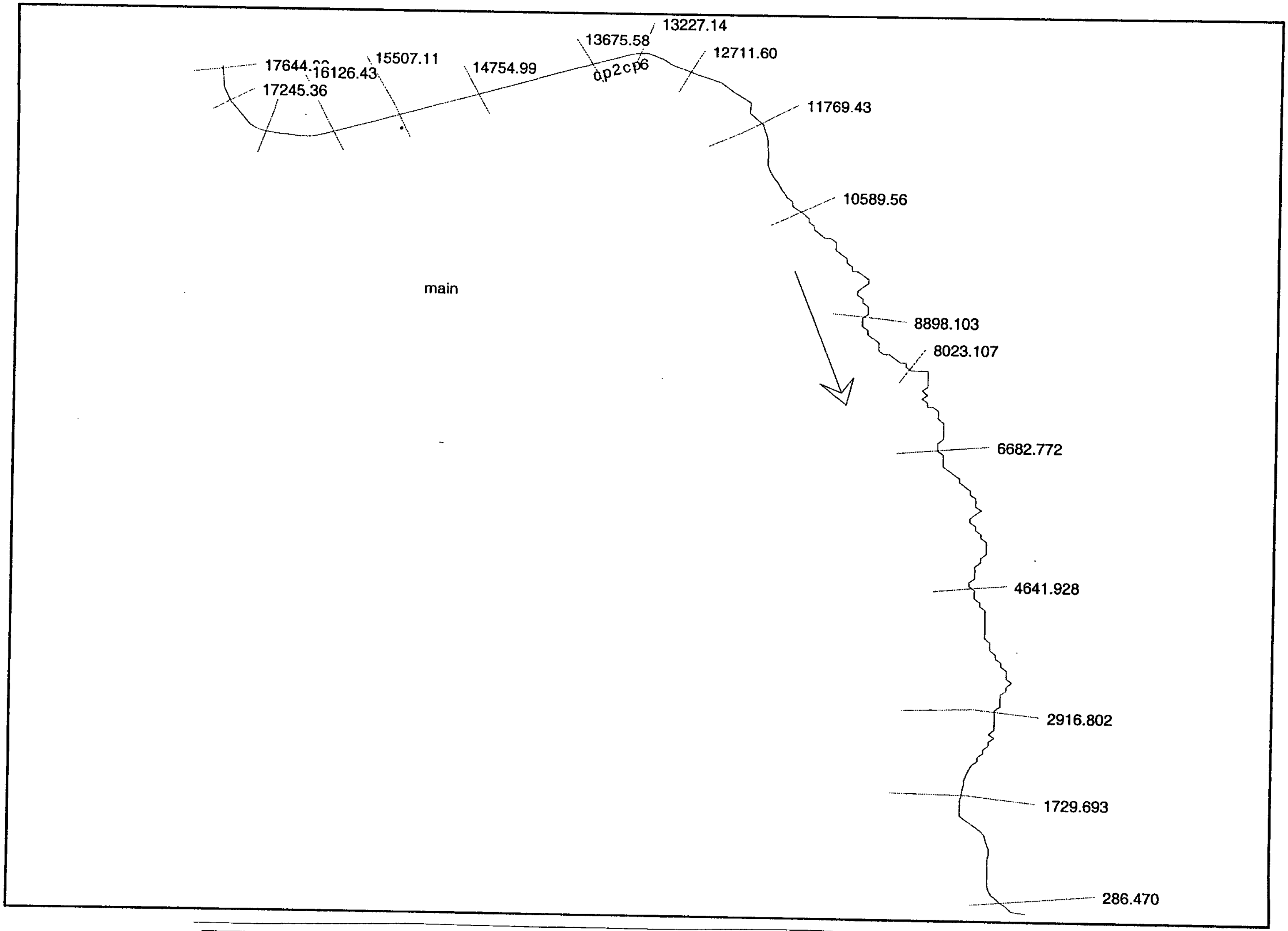
Existing w/ Q topo plan2 12/3/03

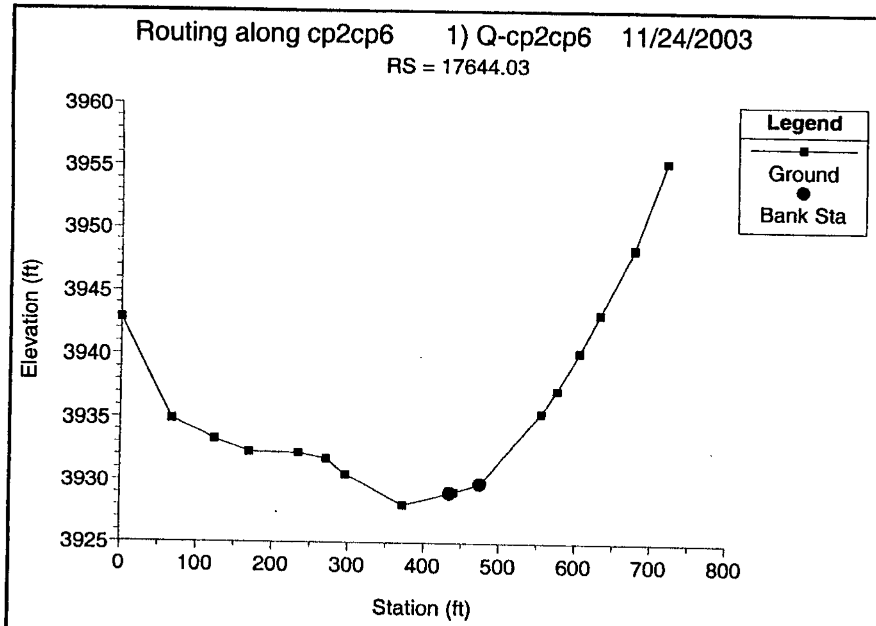
RS = 567.693

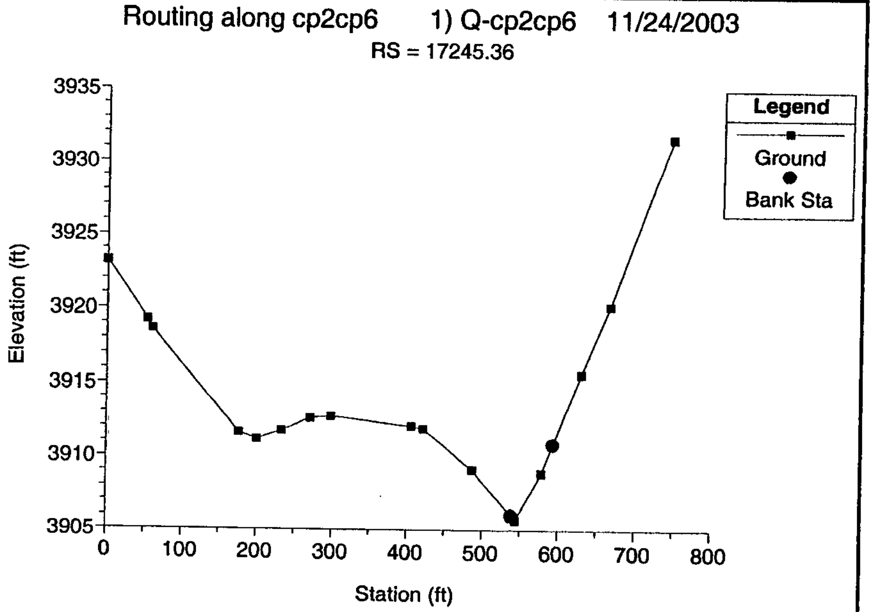


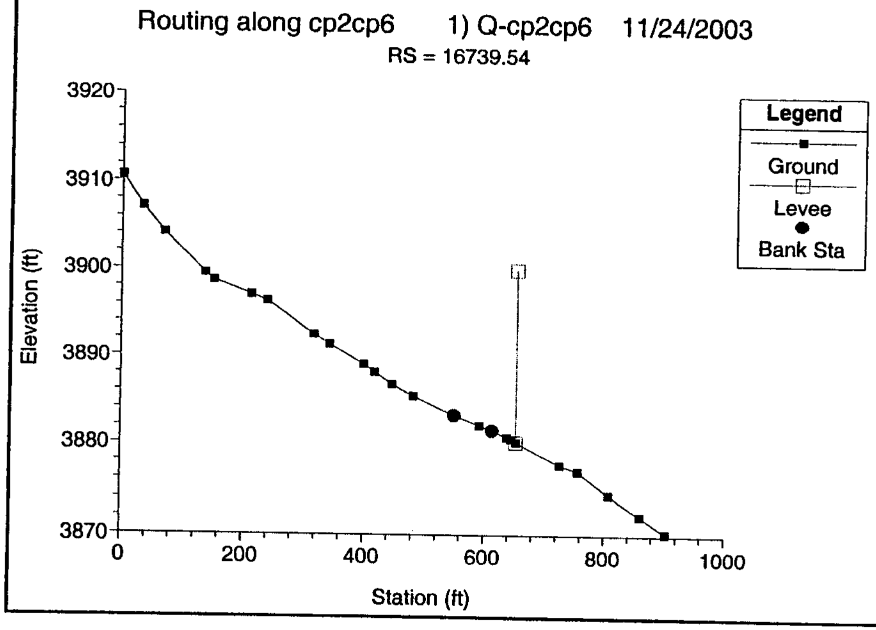
7

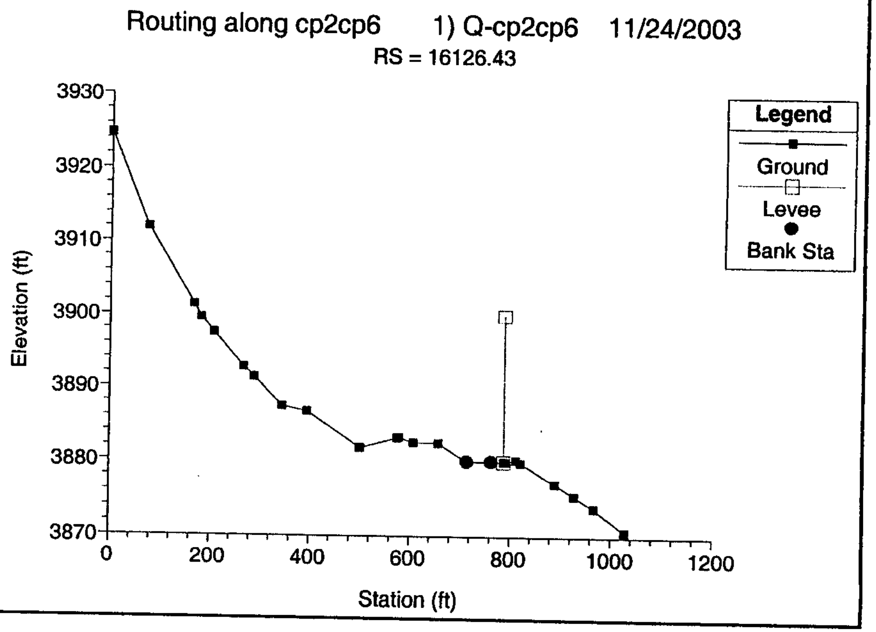
Attachment 7: Hydraulic Calculations for Routing Around Muck Storage A, Alternative 1 (Document ID: 000-00C-CD04-00100-000-00A)


13227.14
13675.58
12711.60
17644.
16126.43
15507.11
14754.99
cp2cp6
17245.36
11769.43
10589.56
main
8898.103
8023.107
6682.772
4641.928
2916.802
1729.693
286.470


Routing along cp2cp6 1) Q-cp2cp6 11/24/2003
RS = 17644.03

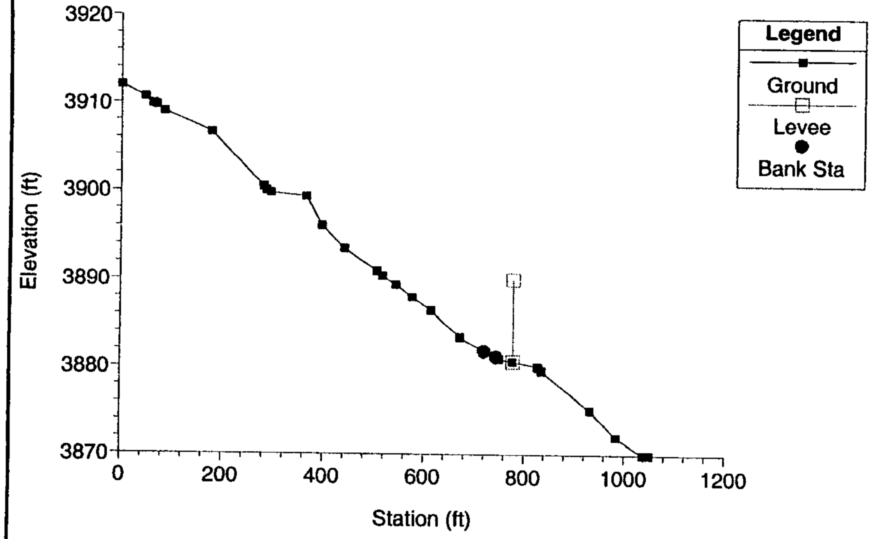

Routing along cp2cp6 1) Q-cp2cp6 11/24/2003
RS = 17245.36


Routing along cp2cp6 1) Q-cp2cp6 11/24/2003
RS = 16739.54


Routing along cp2cp6 1) Q-cp2cp6 11/24/2003
RS = 16126.43

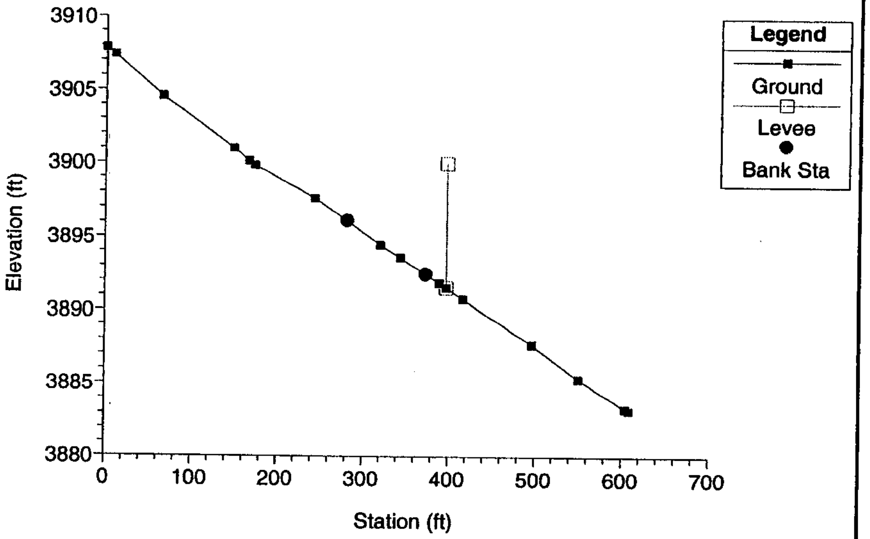
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 15507.11



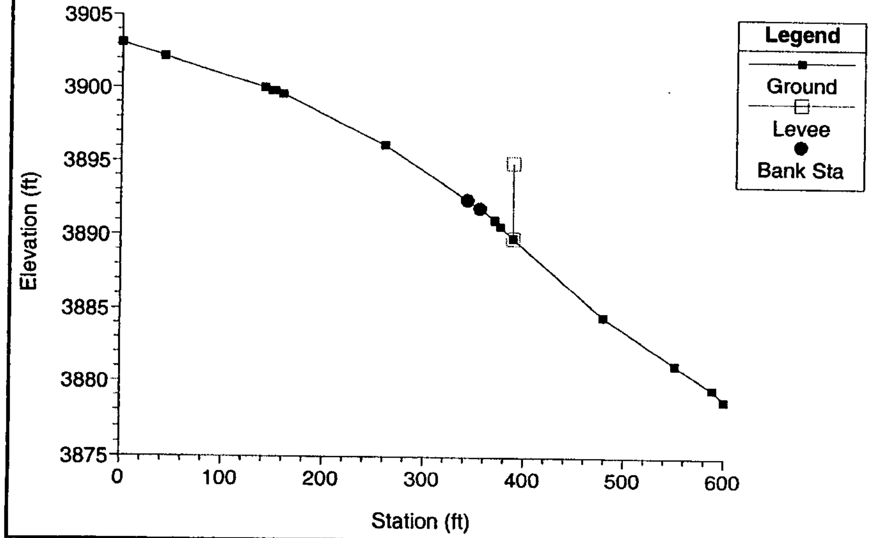
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 14754.99



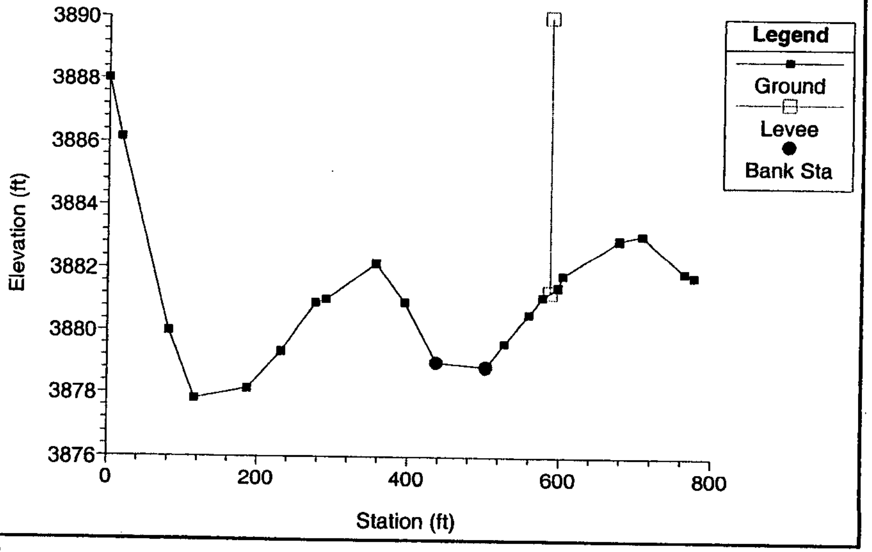
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 13675.58



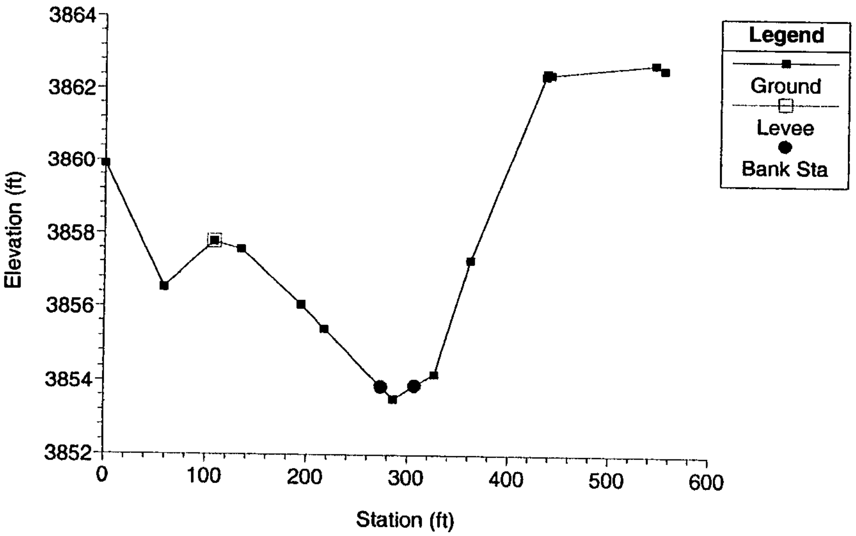
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 13227.14



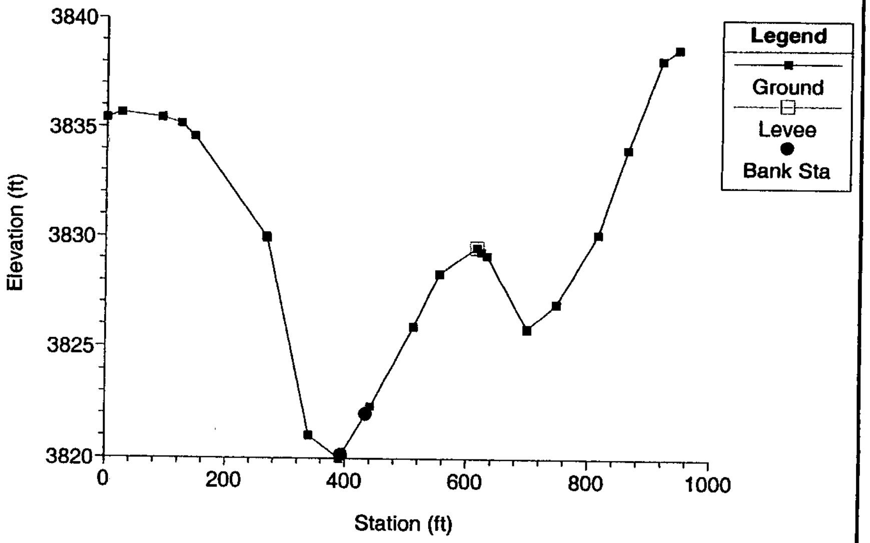
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 12711.60



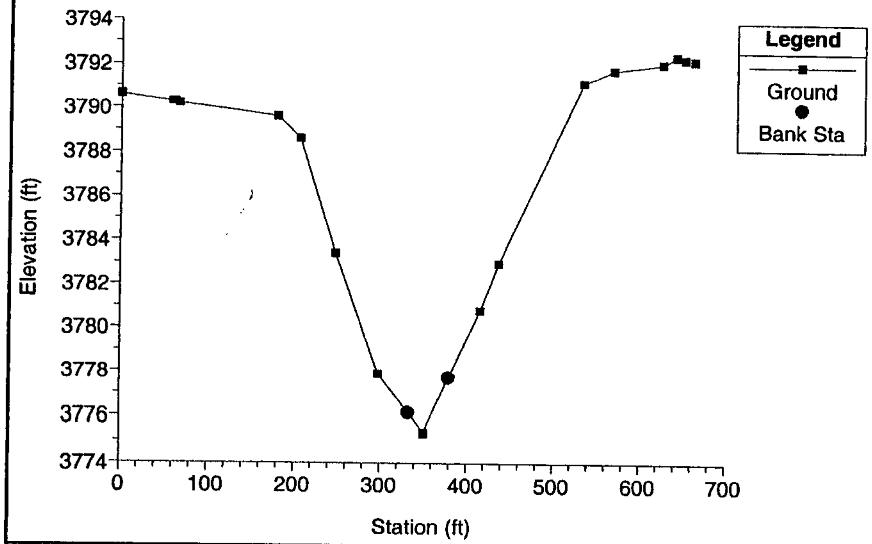
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 11769.43



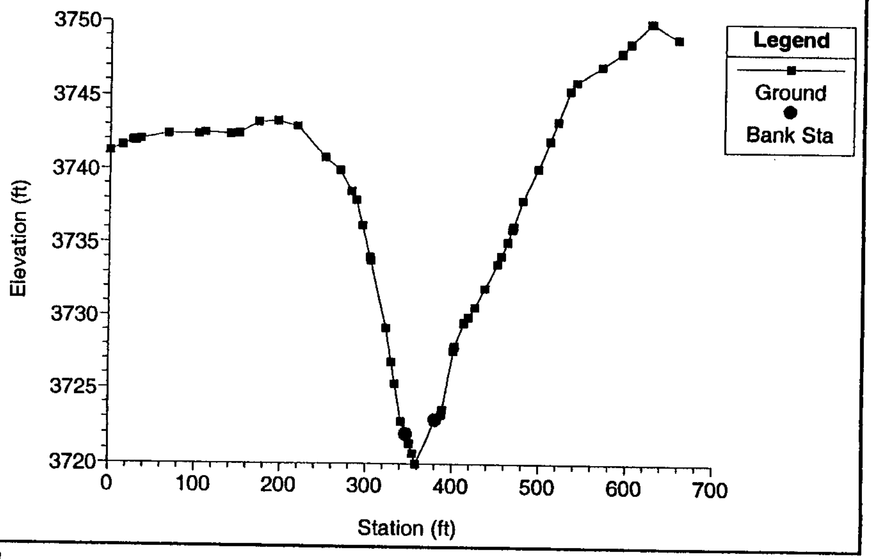
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

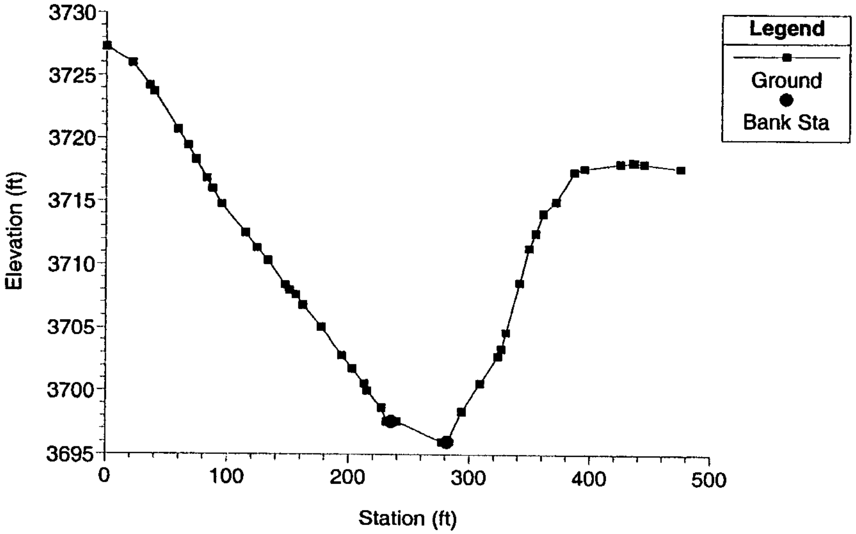
RS = 10589.56



Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

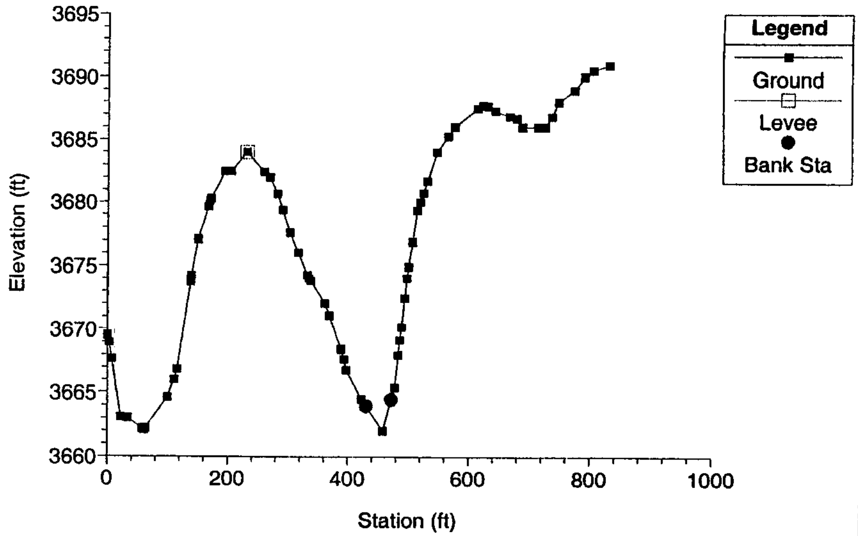
RS = 8898.103





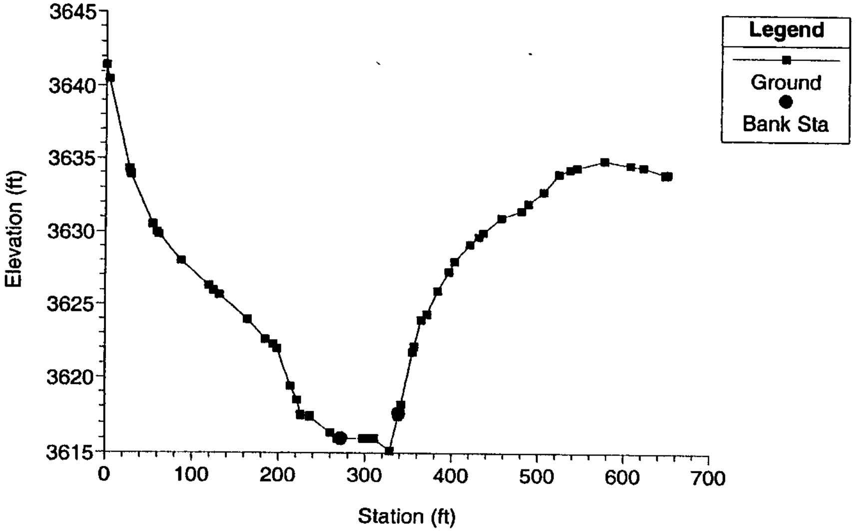
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 8023.107



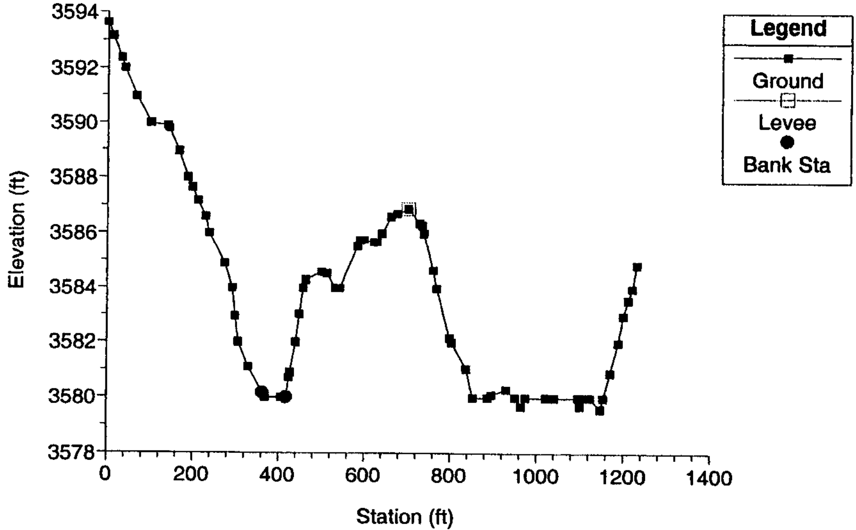
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 6682.772



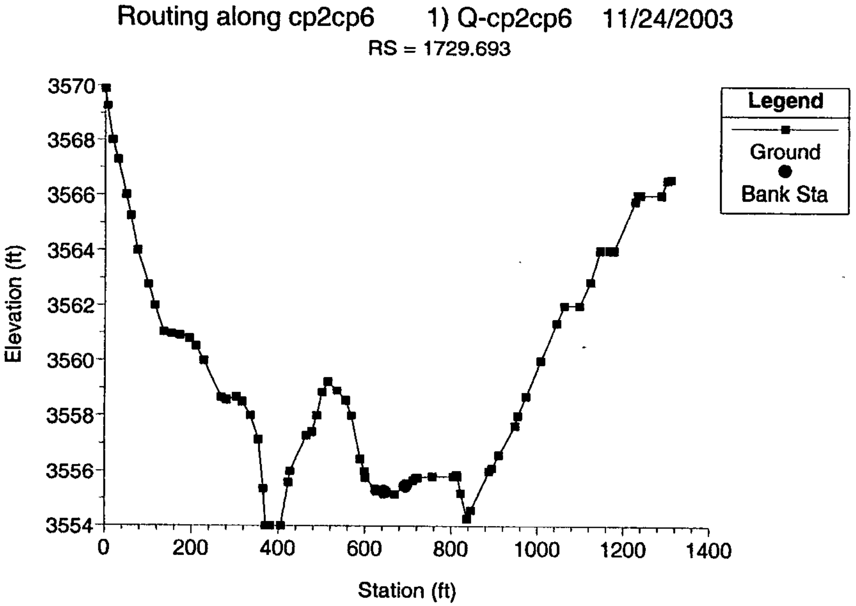
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 4641.928



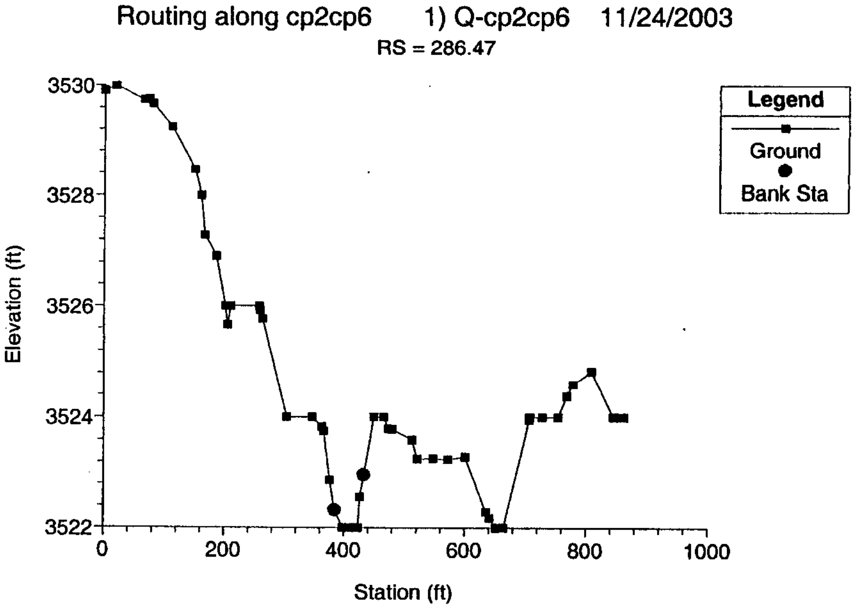
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

RS = 2916.802



Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

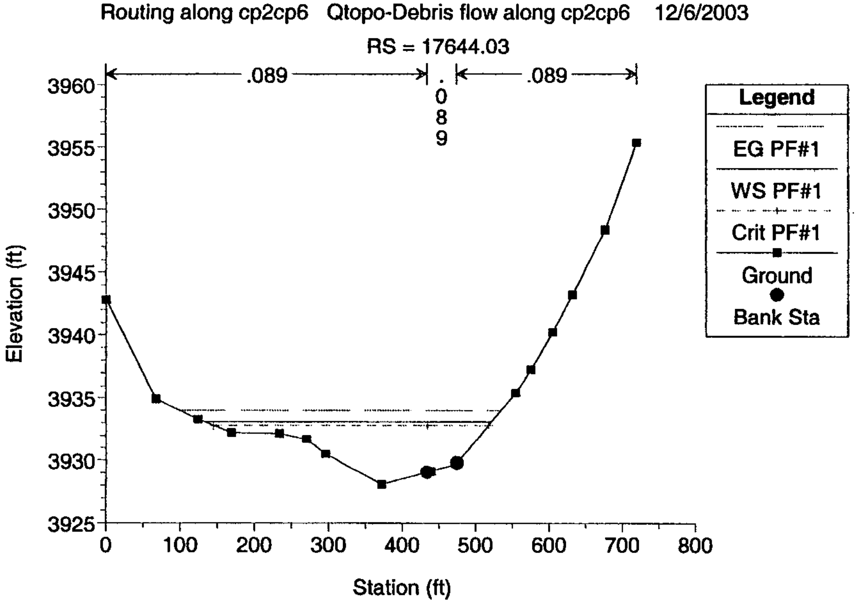
RS = 1729.693

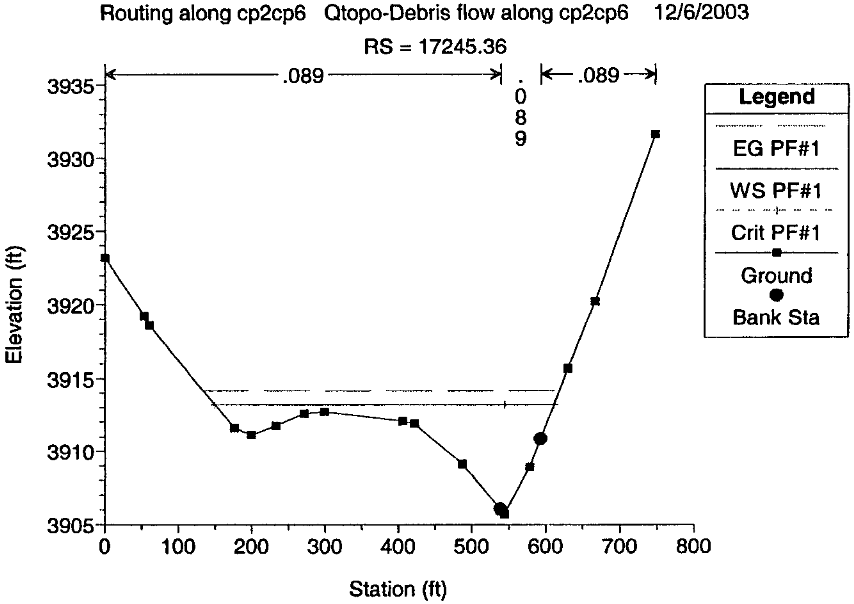


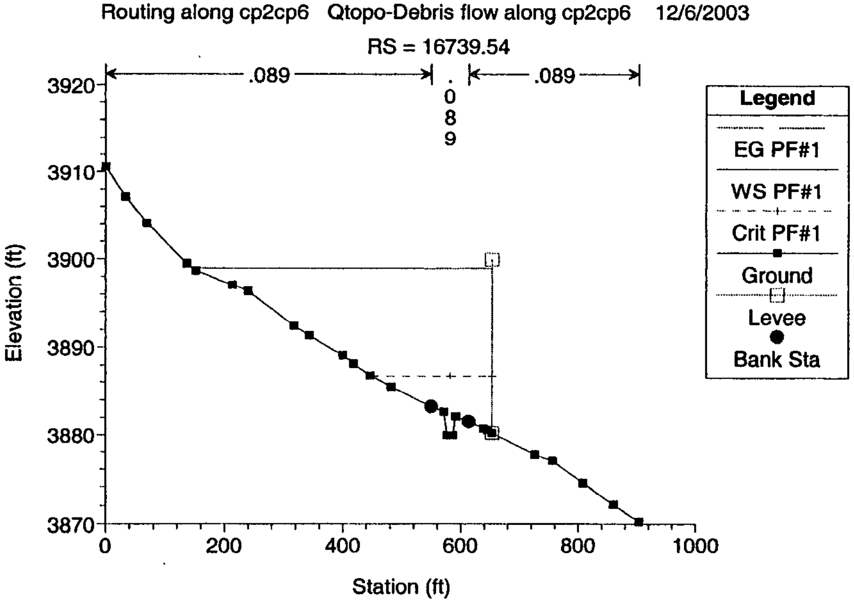
Routing along cp2cp6 1) Q-cp2cp6 11/24/2003

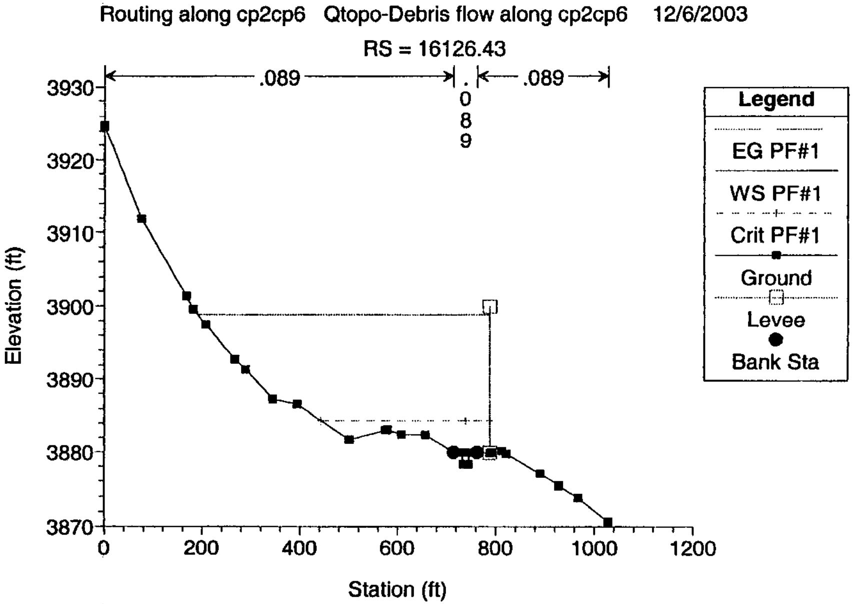
RS = 286.47

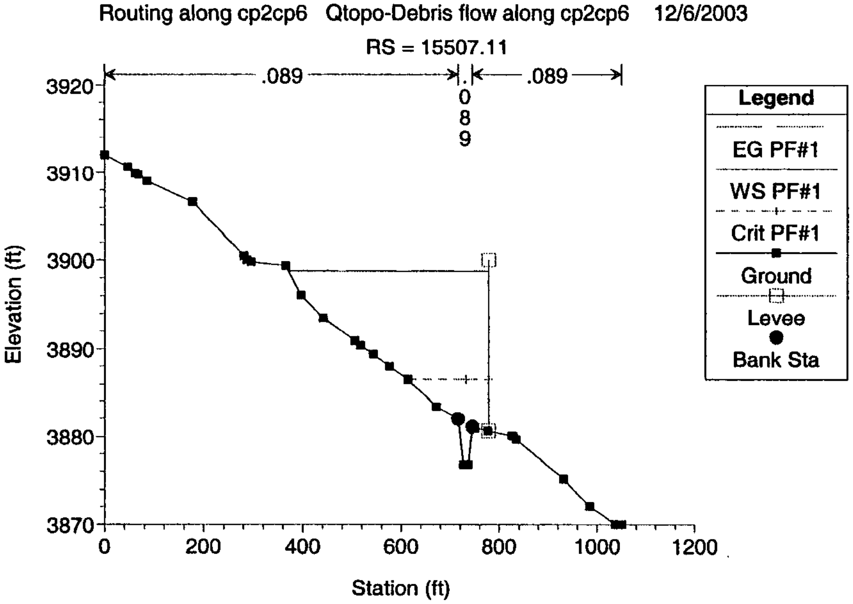
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-cp2cp6  River: cp2cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 18
# Plans             = 1
# Profiles          = 1

 Reach            River Sta          Q Total   Min Ch El   W.S. Elev  Crit W.S.   E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                       (cfs)        (ft)        (ft)       (ft)        (ft)   (ft/ft)      (ft/s)    (sq ft)       (ft)

 main             17644.03           7173.00     3929.04     3933.07    3932.80     3934.00  0.059018        9.67     952.37     388.31          0.89
 main             17245.36           7173.00     3905.72     3913.22    3913.22     3914.19  0.042263       10.46    1069.69     461.61          0.80
 main             16739.54           7173.00     3880.00     3898.96    3886.70     3898.99  0.000344        2.03    4924.89     506.36          0.09
 main             16126.43           7173.00     3878.41     3898.88    3884.44     3898.89  0.000092        1.14    8033.91     597.24          0.05
 main             15507.11           7173.00     3876.80     3898.74    3886.51     3898.78  0.000397        2.36    4415.71     406.99          0.09
 main             14754.99           7173.00     3874.84     3897.64    3887.71     3898.07  0.003604        5.35    1430.15     155.15          0.26
 main             13675.58           7173.00     3872.03     3889.51    3884.91     3890.81  0.016160        9.12     786.11      79.93          0.51
 main             13227.14           7173.00     3870.87     3882.18    3882.18     3882.67  0.019262        7.02    1463.04     562.68          0.53
 main             12711.60           7173.00     3853.52     3859.80    3858.65     3860.29  0.018706        7.63    1348.92     396.68          0.54
 main             11769.43          10363.00     3820.16     3826.95    3826.86     3828.89  0.055918       12.85     972.42     238.21          0.93
 main             10589.56          10363.00     3775.33     3785.00    3783.59     3786.33  0.025036       11.20    1205.04     224.59          0.67
 main             8898.103          10363.00     3720.00     3732.74                3735.60  0.036330       16.01     860.06     134.87          0.84
 main             8023.107          10363.00     3696.00     3706.40                3708.12  0.026802       12.34    1057.27     169.51          0.70
 main             6682.772          10363.00     3662.00     3674.27    3672.07     3675.91  0.021662       12.26    1110.63     166.54          0.64
 main             4641.928          10363.00     3615.16     3624.08    3622.30     3625.61  0.028251       11.32    1117.47     203.60          0.70
 main             2916.802          10363.00     3580.00     3583.98    3582.69     3584.41  0.020158        5.94    1984.76     616.40          0.53
 main             1729.693          10363.00     3555.15     3559.45                3559.86  0.021243        6.33    2096.67     748.55          0.54
 main             286.470           10363.00     3522.00     3526.69    3525.78     3527.18  0.024412        7.13    1913.94     672.31          0.59
```

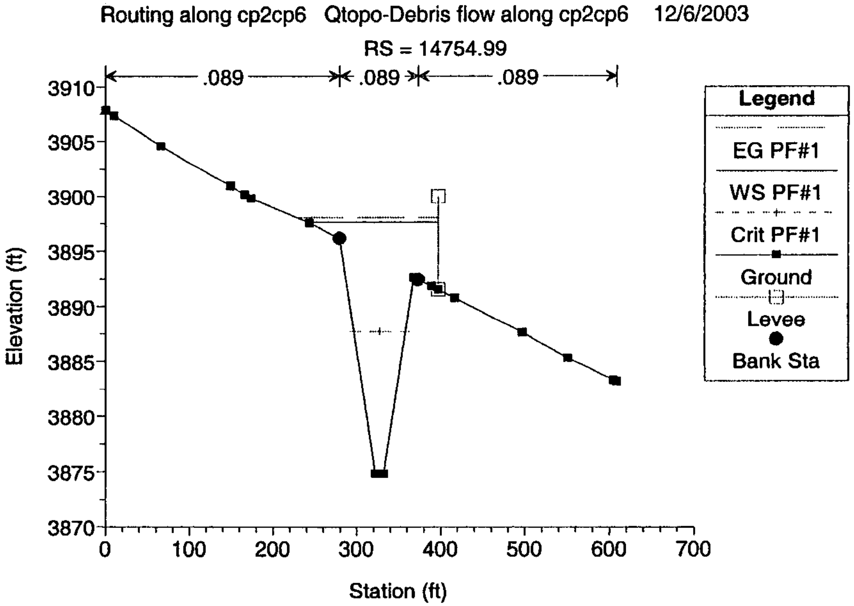

Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 17644.03
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3960
3955
3950
3945
3940
3935
3930
3925
Station (ft)
0
100
200
300
400
500
600
700
800

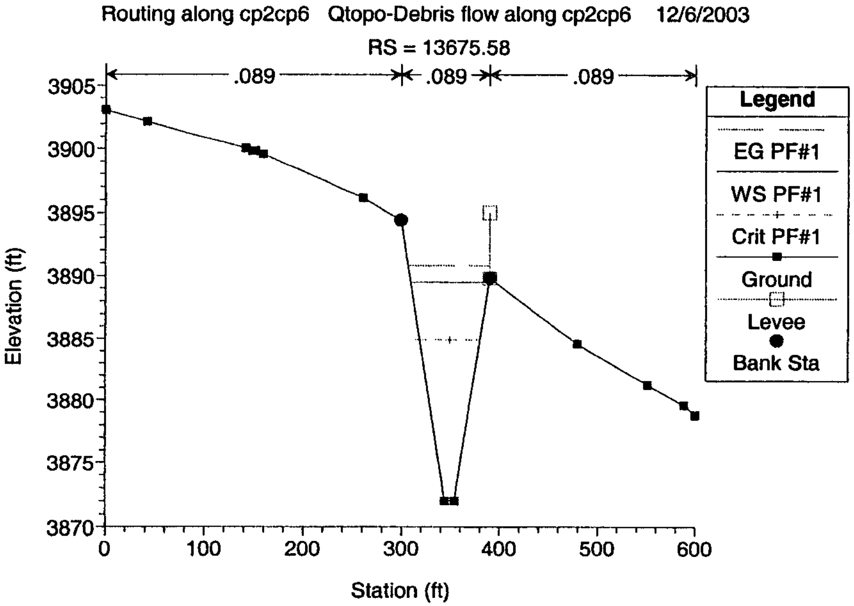

Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 17245.36
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3935
3930
3925
3920
3915
3910
3905
Station (ft)
0
100
200
300
400
500
600
700
800

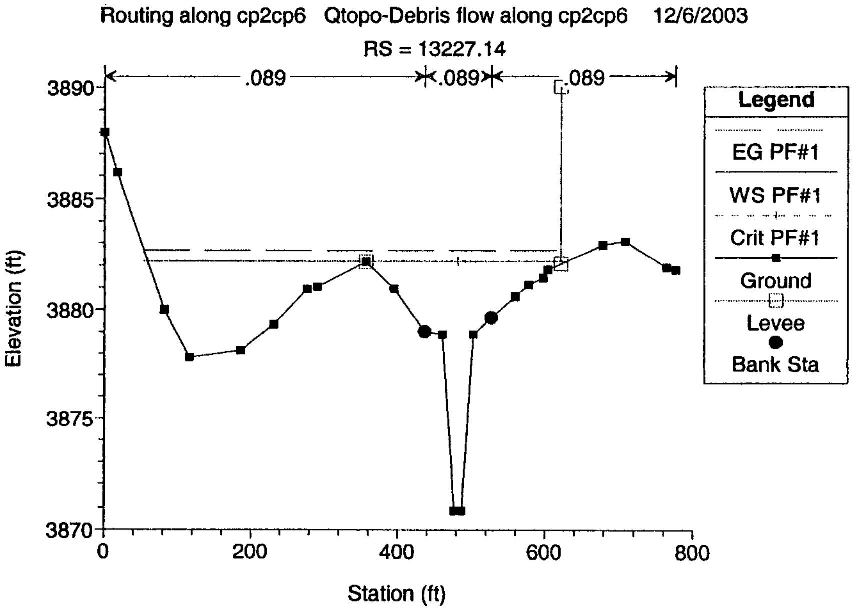

Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 16739.54
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3920
3910
3900
3890
3880
3870
Station (ft)
0
200
400
600
800
1000

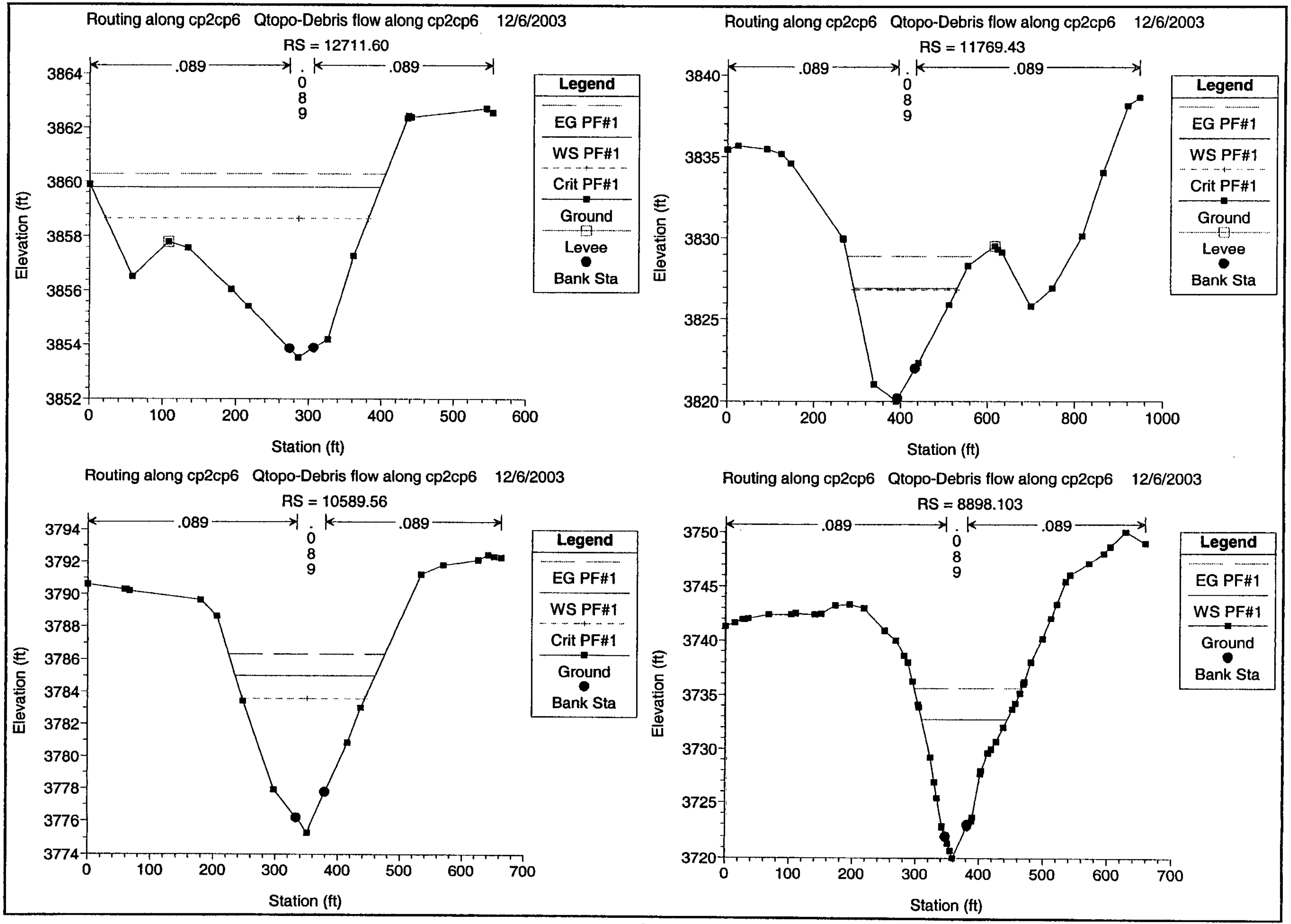

Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 16126.43
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3930
3920
3910
3900
3890
3880
3870
Station (ft)
0
200
400
600
800
1000
1200


Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 15507.11
.089
.089
.089
Elevation (ft)
3870
3880
3890
3900
3910
3920
Station (ft)
0
200
400
600
800
1000
1200
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 14754.99
.089
.089
.089
Elevation (ft)
3870
3875
3880
3885
3890
3895
3900
3905
3910
Station (ft)
0
100
200
300
400
500
600
700
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

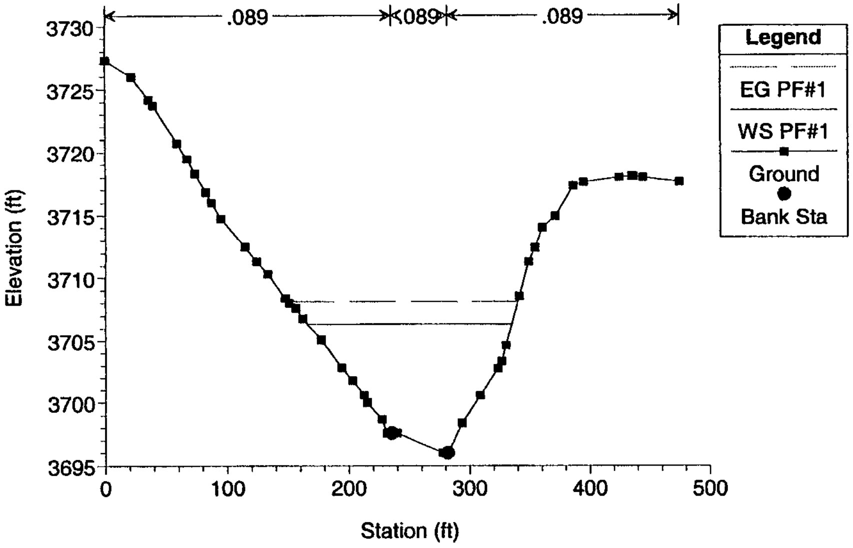

Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 13675.58
.089
.089
.089
Elevation (ft)
3870
3875
3880
3885
3890
3895
3900
3905
Station (ft)
0
100
200
300
400
500
600
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 13227.14
.089
.089
.089
Elevation (ft)
3870
3875
3880
3885
3890
Station (ft)
0
200
400
600
800
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 12711.60
.089
.089
.089
Elevation (ft)
Station (ft)
3864
3862
3860
3858
3856
3854
3852
0
100
200
300
400
500
600
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 11769.43
.089
.089
.089
Elevation (ft)
Station (ft)
3840
3835
3830
3825
3820
0
200
400
600
800
1000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 10589.56
.089
.089
.089
Elevation (ft)
Station (ft)
3794
3792
3790
3788
3786
3784
3782
3780
3778
3776
3774
0
100
200
300
400
500
600
700
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003
RS = 8898.103
.089
.089
.089
Elevation (ft)
Station (ft)
3750
3745
3740
3735
3730
3725
3720
0
100
200
300
400
500
600
700
Legend
EG PF#1
WS PF#1
Ground
Bank Sta

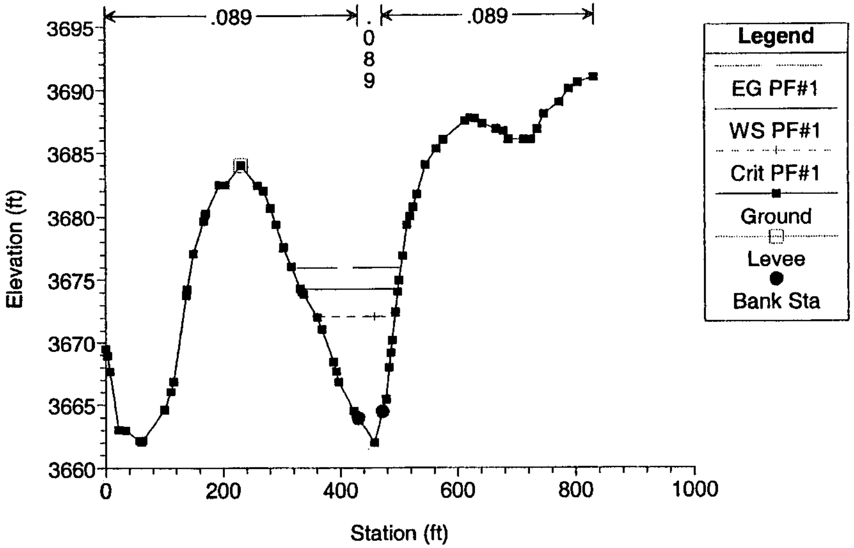
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003

RS = 8023.107



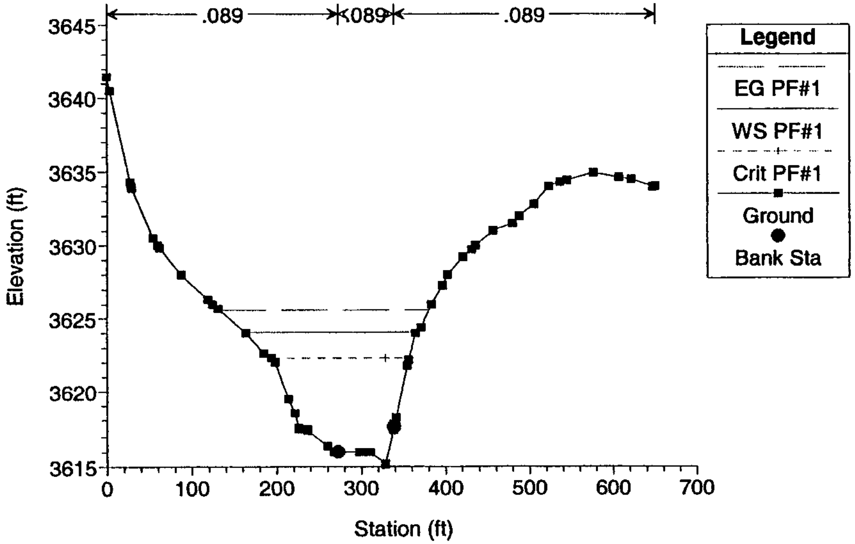
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003

RS = 6682.772



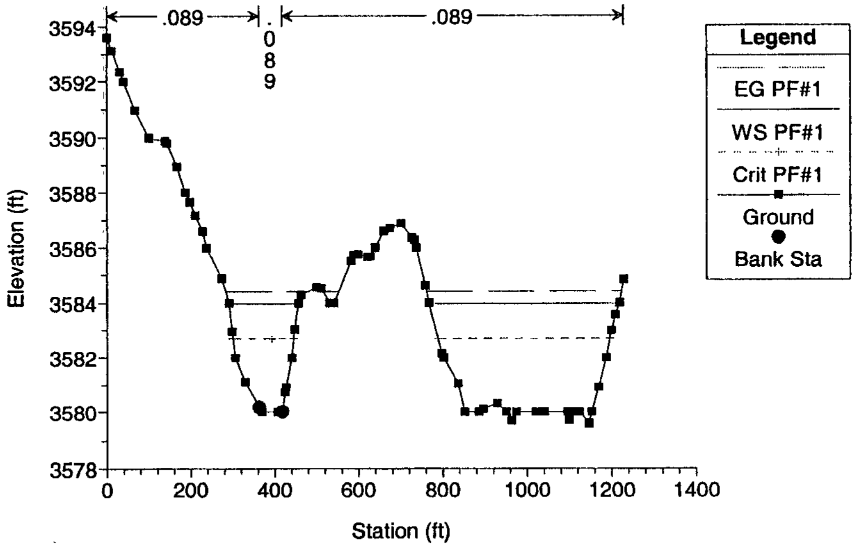
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003

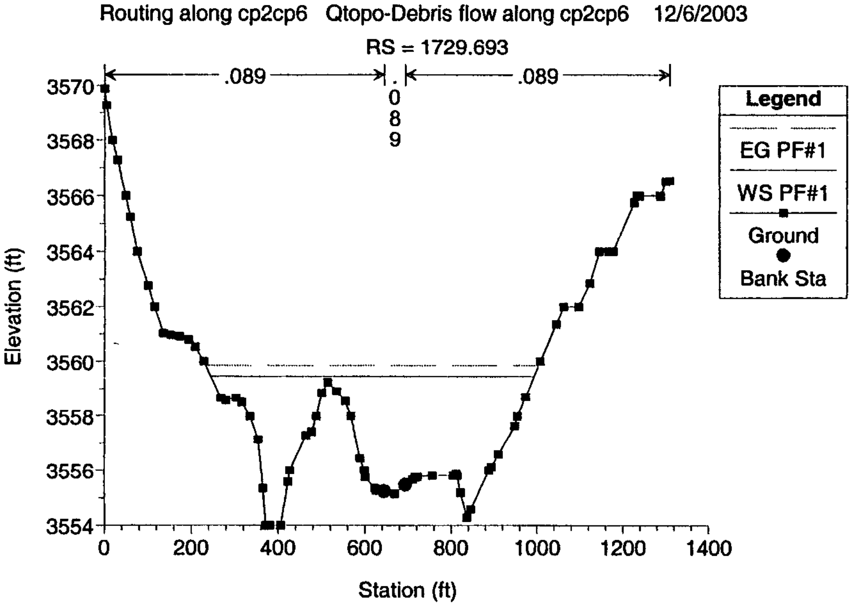
RS = 4641.928



Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003

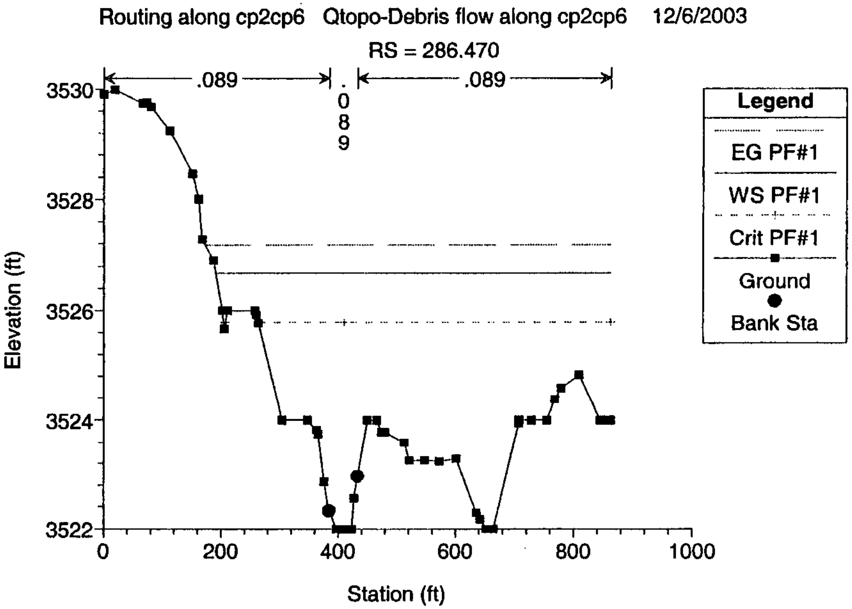
RS = 2916.802





Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003

RS = 1729.693



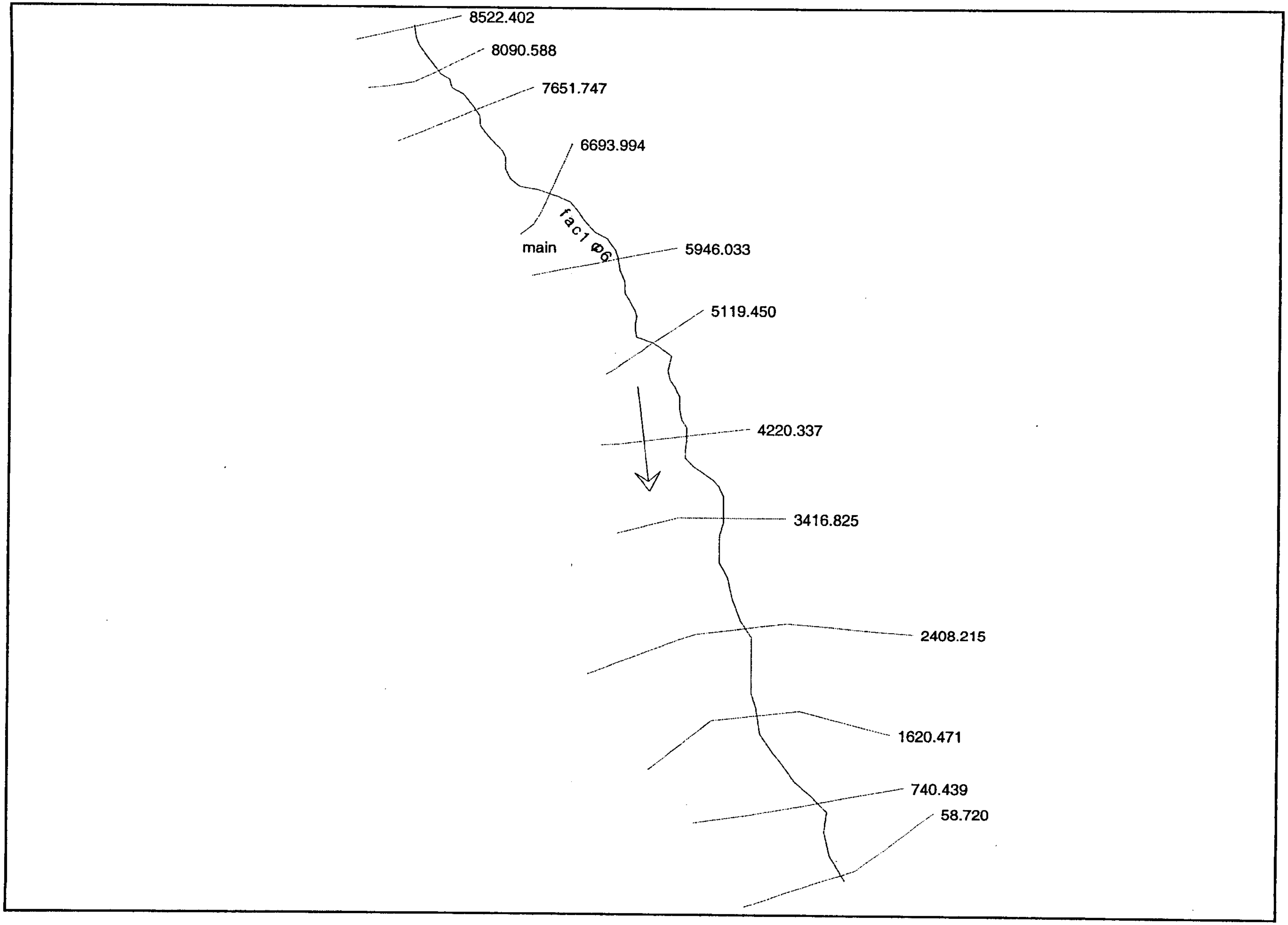
Routing along cp2cp6 Qtopo-Debris flow along cp2cp6 12/6/2003

RS = 286.470

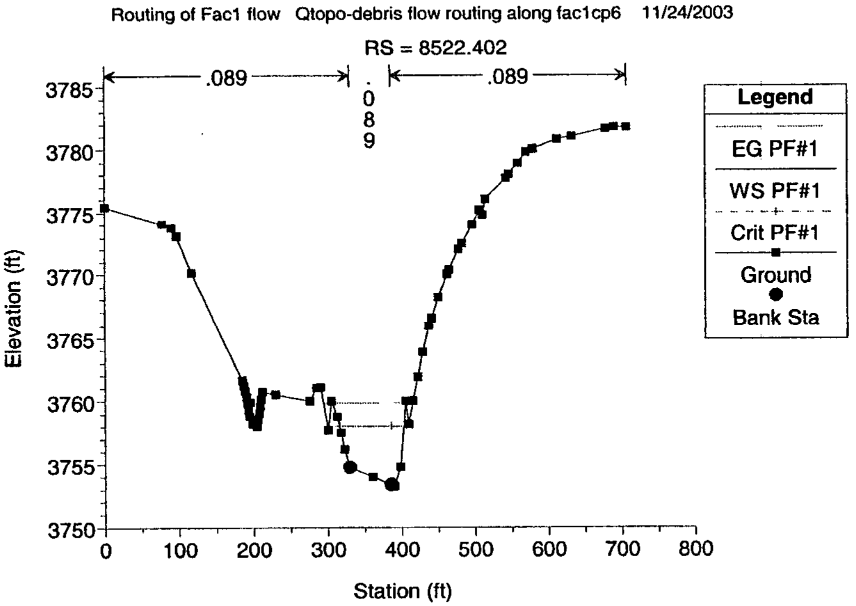
Channel Modification - Cut and Fill Data

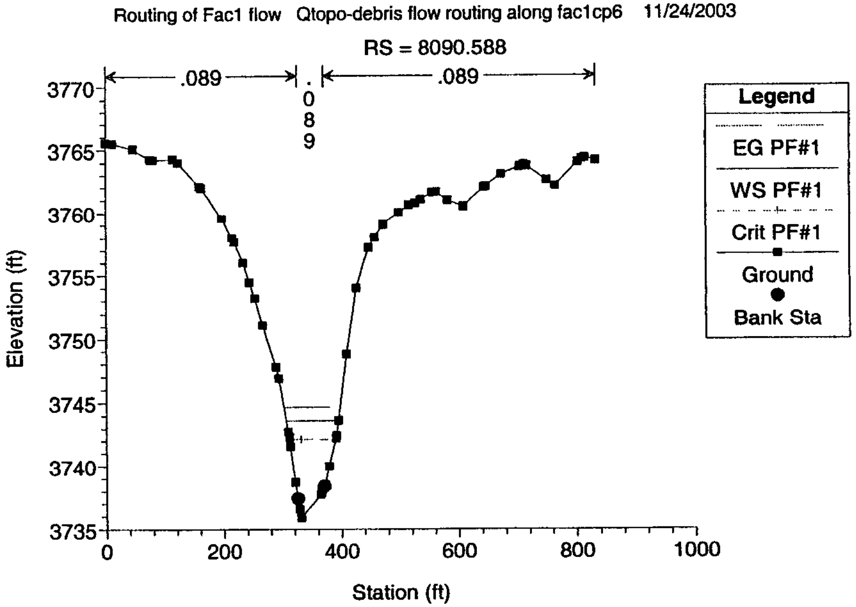
River:	cp2cp6	Reach:	main						
RS		Area L	Area Ch	Area R	Area T	Volume L	Volume Ch	Volume R	Volume T
		(sq ft)	(sq ft)	(sq ft)	(sq ft)	(cu yd)	(cu yd)	(cu yd)	(cu yd)
16739.54	Cut	0	36	0	36	0	647	0	647
	Fill	0	0	0	0	0	0	0	0
	Net	0	36	0	36	0	647	0	647
16126.43	Cut	0	21	0	21	29	1243	7	1280
	Fill	0	0	0	0	0	0	0	0
	Net	0	21	0	21	29	1243	7	1280
15507.11	Cut	3	88	1	91	46	14450	9	14505
	Fill	0	0	0	0	0	0	0	0
	Net	3	88	1	91	46	14450	9	14505
14754.99	Cut	1	950	0	951	8631	24005	6629	39265
	Fill	0	0	0	0	0	0	0	0
	Net	1	950	0	951	8631	24005	6629	39265
13675.58	Cut	431	251	332	1014	3586	3792	2759	10137
	Fill	0	0	0	0	0	0	0	0
	Net	431	251	332	1014	3586	3792	2759	10137
13226.35	Cut	0	205	0	205	0	1953	0	1953
	Fill	0	0	0	0	0	0	0	0
	Net	0	205	0	205	0	1953	0	1953
Total	Cut					12292	46091	9403	67786
	Fill					0	0	0	0
	Net					12292	46091	9403	67786

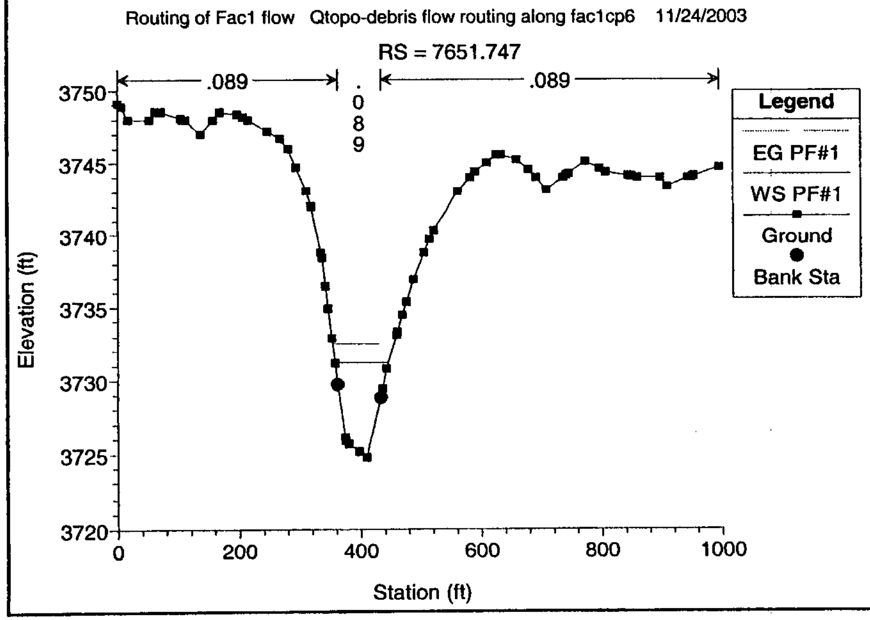
Attachment 8: Hydraulic Calculations for Routing Downstream of Muck Storage A, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)

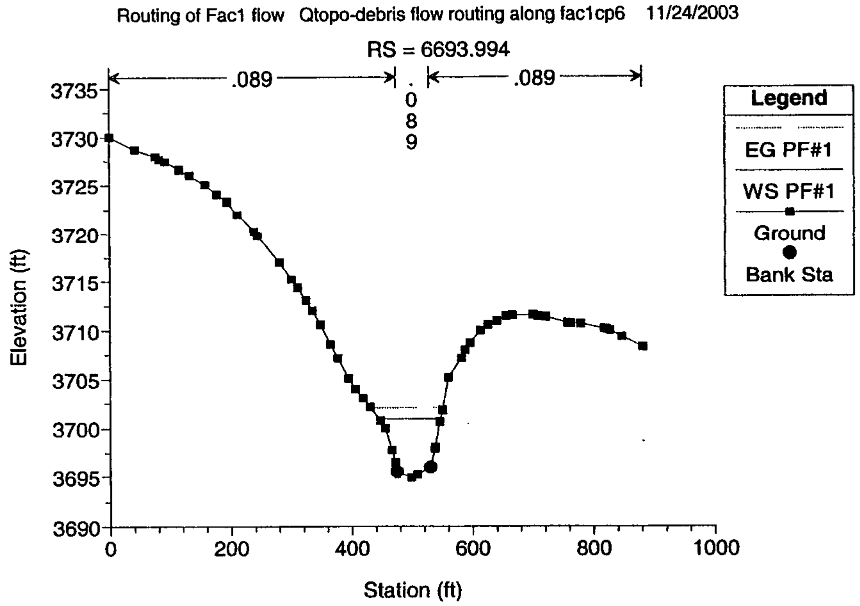

8522.402
8090.588
7651.747
6693.994
main
fac106
5946.033
5119.450
4220.337
3416.825
2408.215
1620.471
740.439
58.720

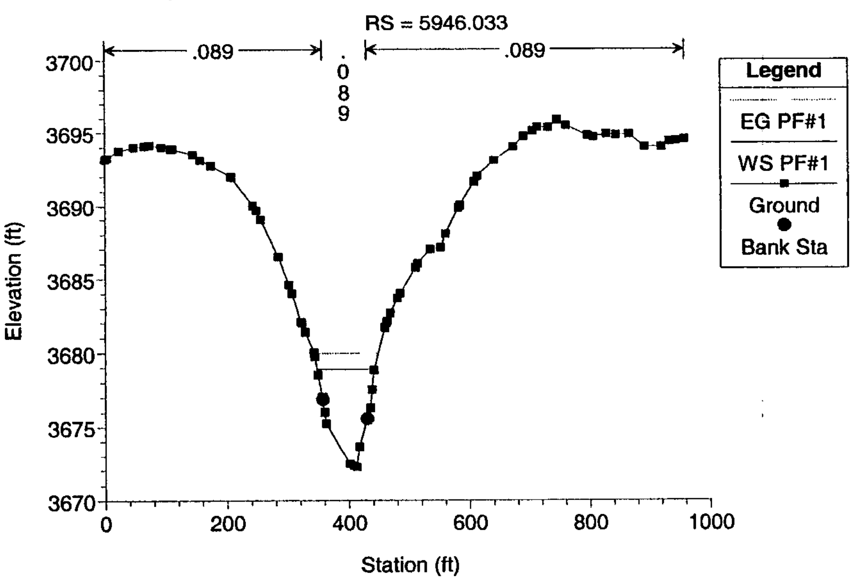
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-fac1  River: fac1cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 12
# Plans             = 1
# Profiles          = 1

 Reach            River Sta            Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope  Vel Chnl  Flow Area  Top Width Froude # Chl
                                         (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

 main             8522.402             3268.00    3753.36    3758.05    3758.05    3759.85   0.071011      11.21     309.78      89.71          0.99
 main             8090.588             3268.00    3735.90    3743.63    3742.10    3744.65   0.021732       8.70     431.96      89.31          0.59
 main             7651.747             3268.00    3724.81    3731.26               3732.54   0.036110       9.14     368.78      87.99          0.72
 main             6693.994             3268.00    3694.90    3700.97               3702.05   0.028167       8.85     417.08     101.43          0.66
 main             5946.033             3268.00    3672.24    3678.88               3679.98   0.030962       8.55     399.42      93.96          0.67
 main             5119.450             3268.00    3646.00    3652.70               3653.90   0.032203       9.32     400.87     104.68          0.70
 main             4220.337             3268.00    3621.48    3627.27               3628.07   0.025554       7.53     485.59     138.95          0.61
 main             3416.825             3268.00    3601.45    3605.75    3604.85    3606.36   0.028456       6.89     554.40     202.36          0.62
 main             2408.215             3268.00    3574.58    3576.70    3576.18    3577.04   0.029494       3.92     723.83     386.09          0.55
 main             1620.471             3268.00    3556.00    3560.20    3559.10    3560.45   0.015675       4.48     899.22     467.37          0.45
 main             740.439              3268.00    3537.20    3541.57    3540.68    3542.09   0.029095       6.28     616.59     310.04          0.61
 main             58.720               3268.00    3522.00    3524.75    3524.13    3524.97   0.021705       4.43     896.18     528.25          0.50
```

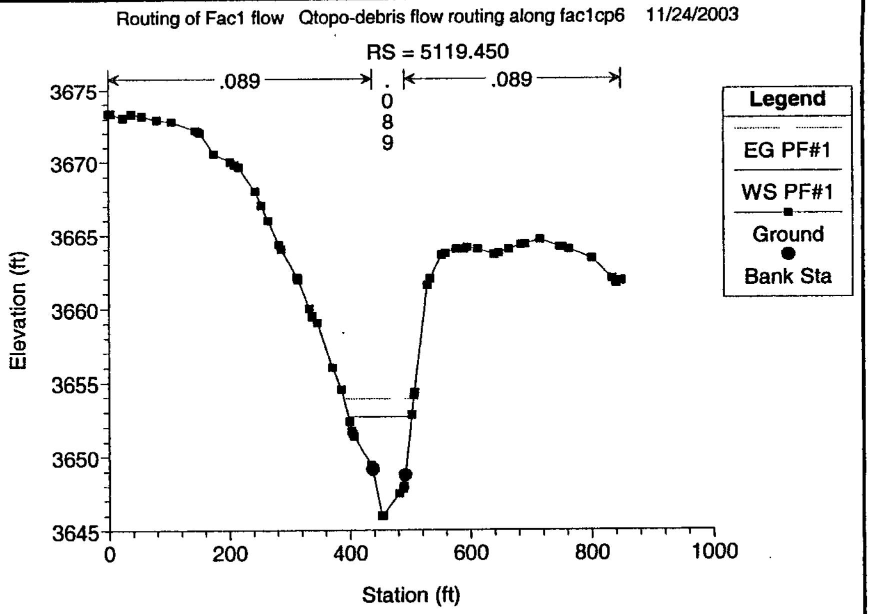

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 8522.402
.089
.089
.089
Elevation (ft)
3785
3780
3775
3770
3765
3760
3755
3750
0
100
200
300
400
500
600
700
800
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta

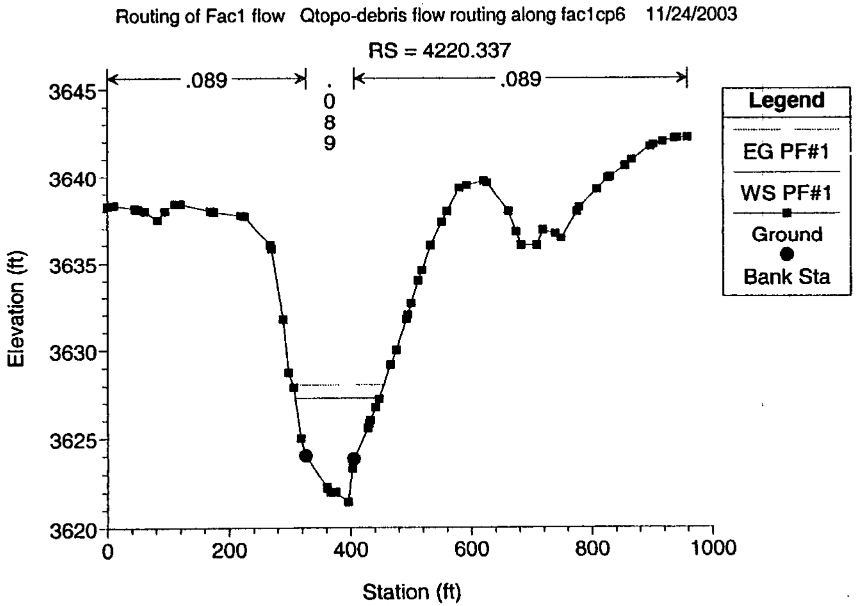

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 8090.588
.089
.089
.089
Elevation (ft)
3770
3765
3760
3755
3750
3745
3740
3735
0
200
400
600
800
1000
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta

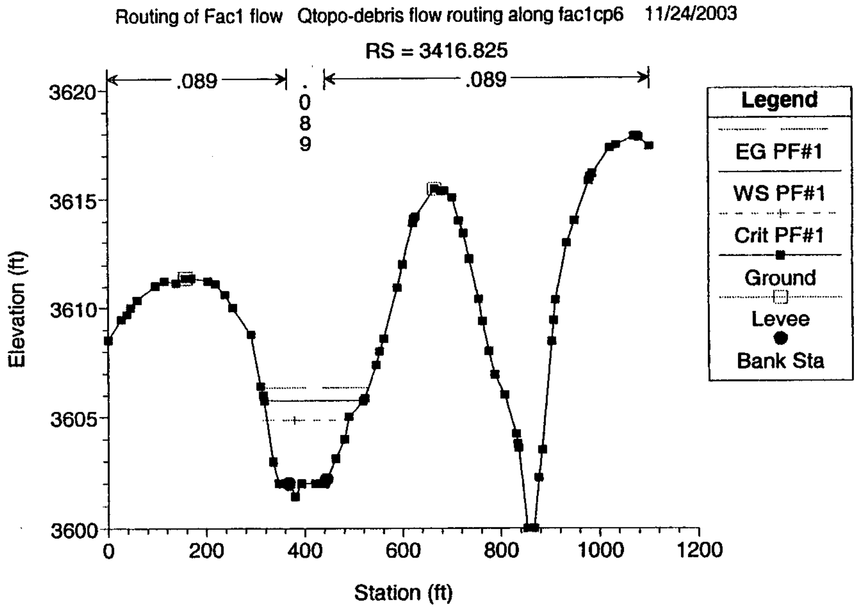

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 7651.747
.089
.089
.089
Elevation (ft)
3750
3745
3740
3735
3730
3725
3720
0
200
400
600
800
1000
Station (ft)
Legend
EG PF#1
WS PF#1
Ground
Bank Sta

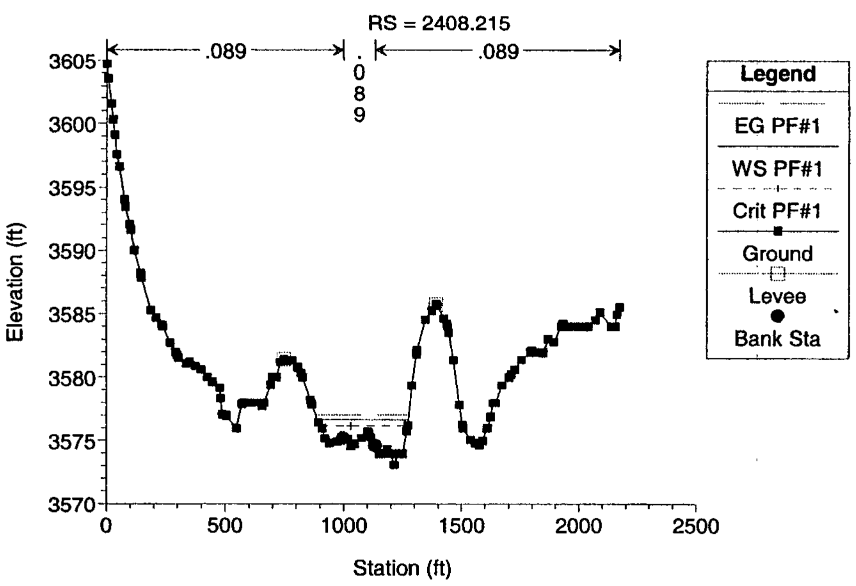

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 6693.994
.089
.089
.089
Elevation (ft)
3735
3730
3725
3720
3715
3710
3705
3700
3695
3690
0
200
400
600
800
1000
Station (ft)
Legend
EG PF#1
WS PF#1
Ground
Bank Sta


Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 5946.033
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3700
3695
3690
3685
3680
3675
3670
Station (ft)
0
200
400
600
800
1000

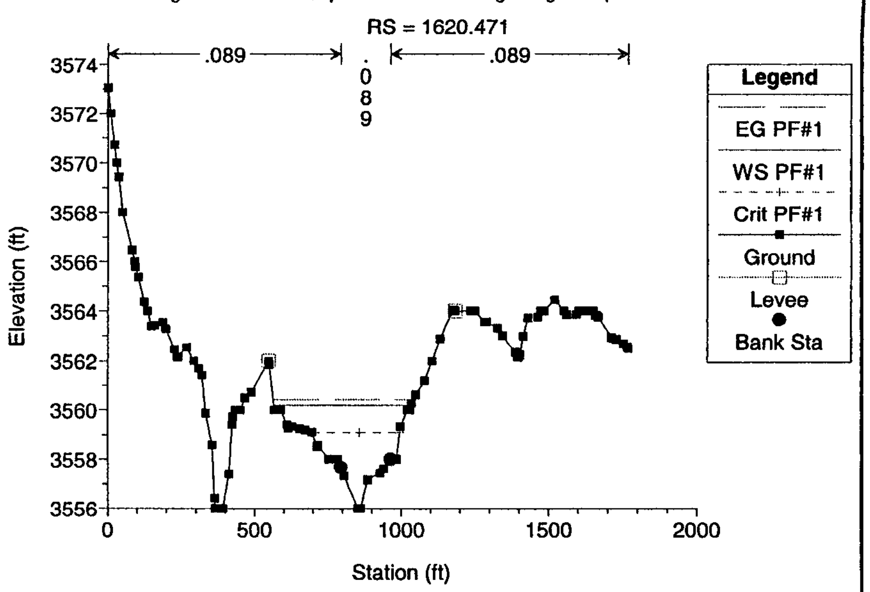

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 5119.450
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3675
3670
3665
3660
3655
3650
3645
Station (ft)
0
200
400
600
800
1000


Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 4220.337
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3645
3640
3635
3630
3625
3620
Station (ft)
0
200
400
600
800
1000

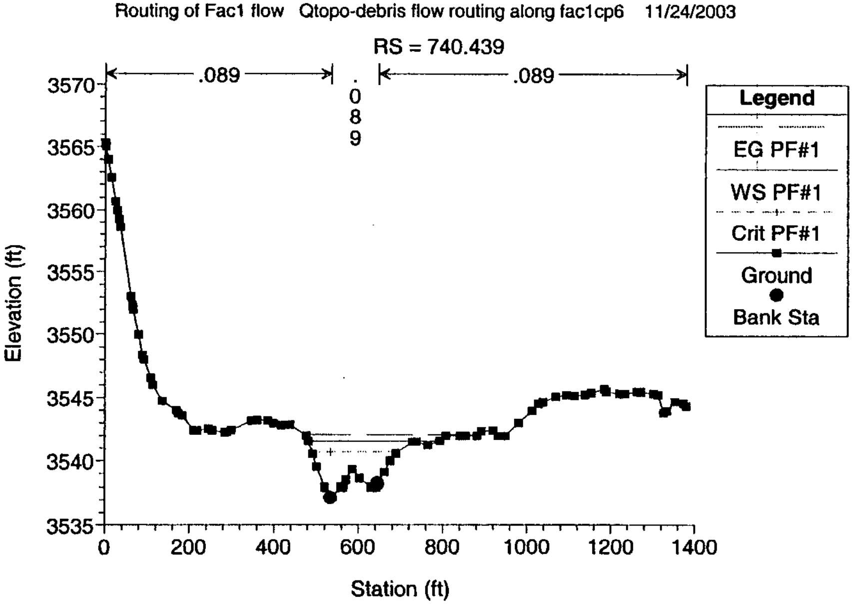

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003
RS = 3416.825
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3620
3615
3610
3605
3600
Station (ft)
0
200
400
600
800
1000
1200


Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003

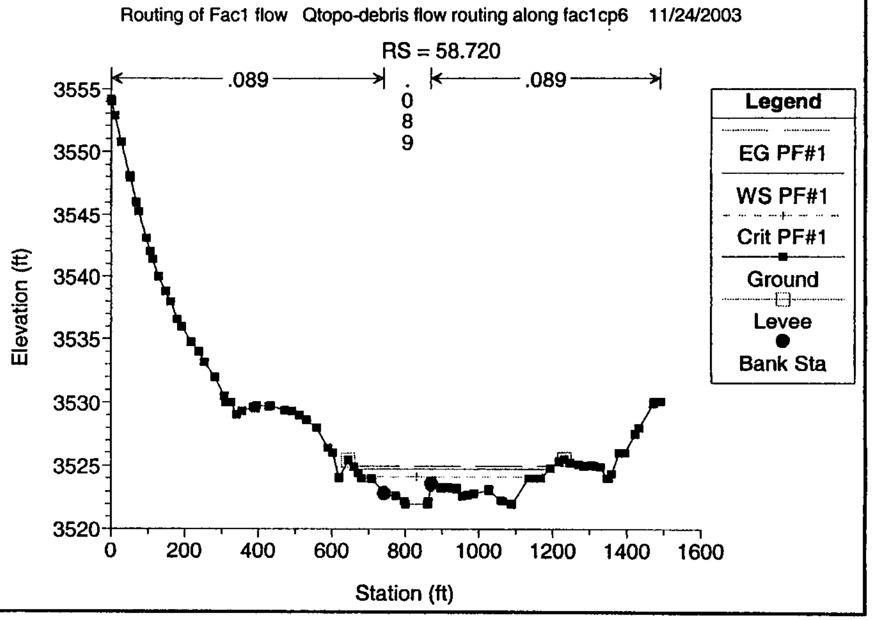
RS = 2408.215


Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003

RS = 1620.471

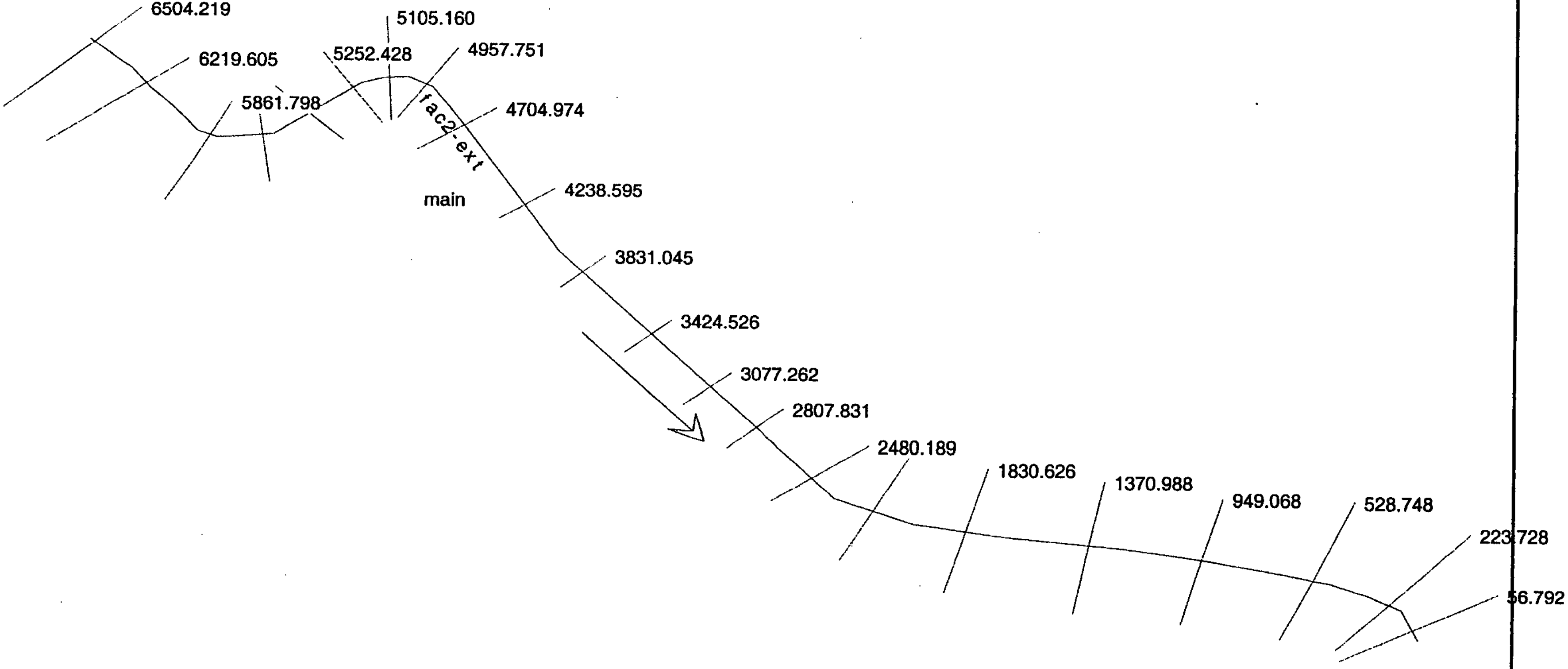

Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003

RS = 740.439


Routing of Fac1 flow Qtopo-debris flow routing along fac1cp6 11/24/2003

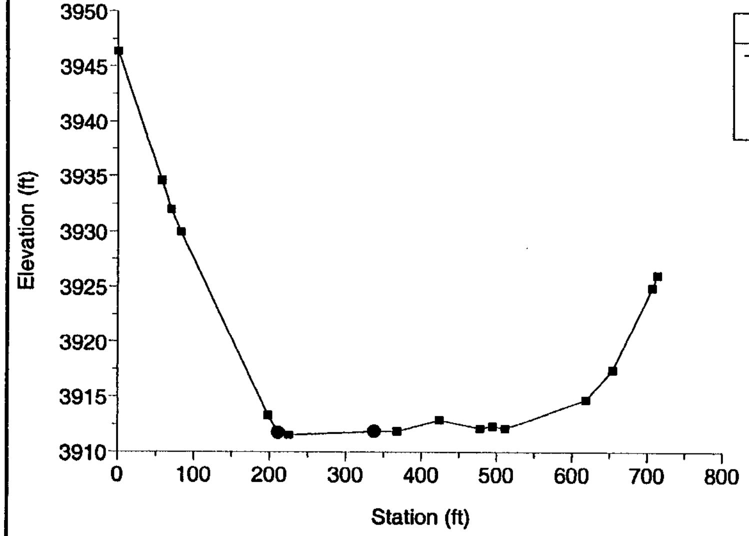
RS = 58.720

Attachment 9: Hydraulic Calculations for Routing Around Optional Aging Facility and
North Construction Portal, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)


6504.219
6219.605
5861.798
5252.428
5105.160
4957.751
4704.974
fac2-ext
main
4238.595
3831.045
3424.526
3077.262
2807.831
2480.189
1830.626
1370.988
949.068
528.748
223.728
56.792

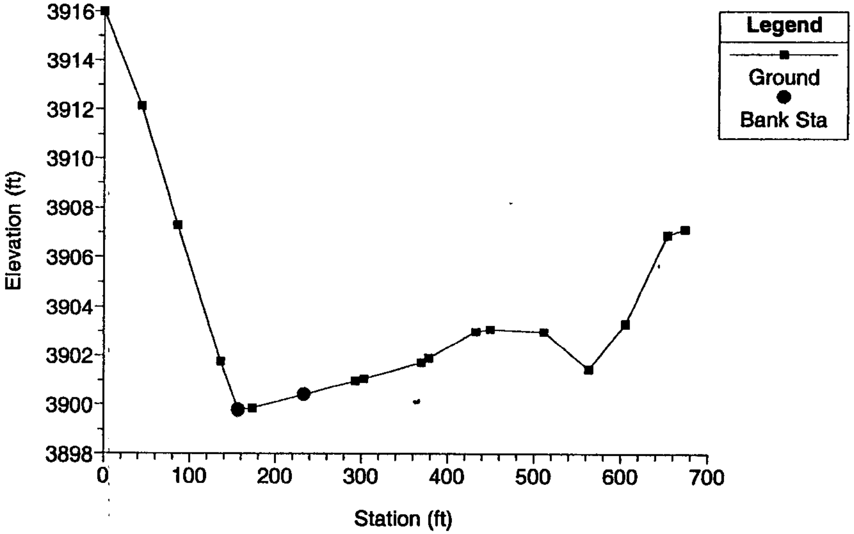
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

RS = 6504.219



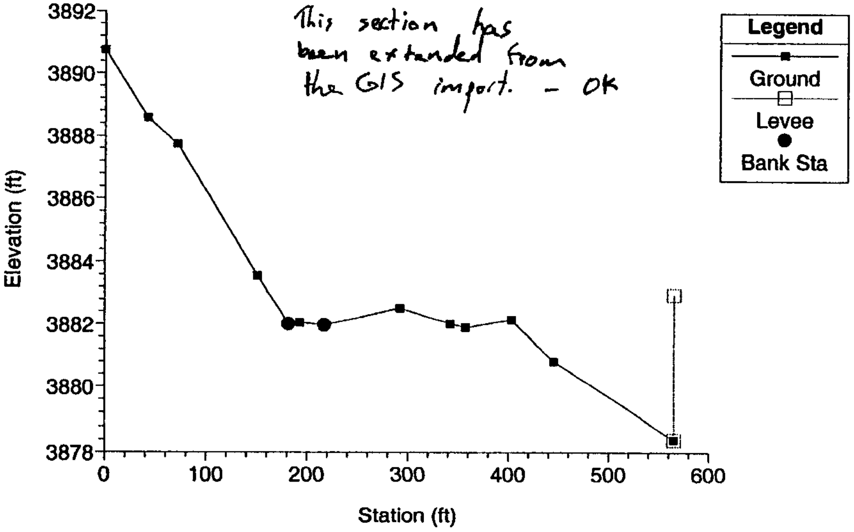
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

RS = 6219.605



Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

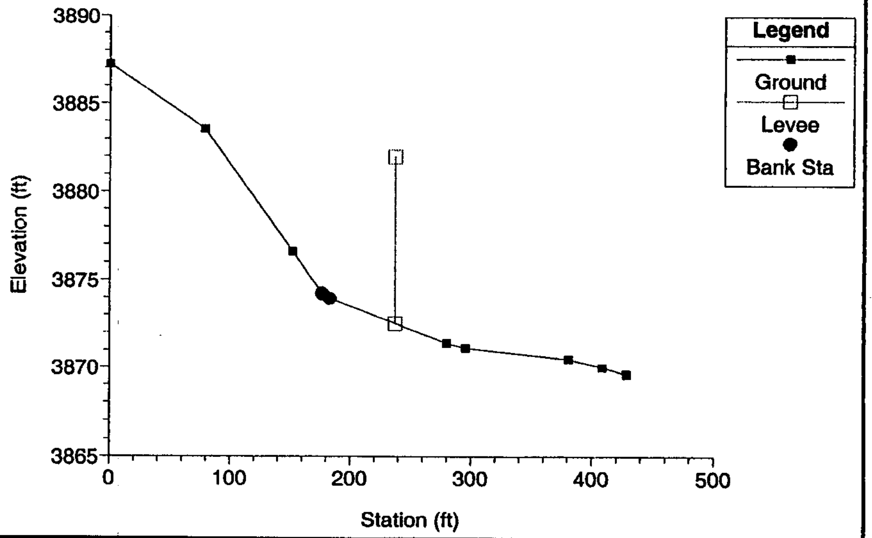
RS = 5861.798

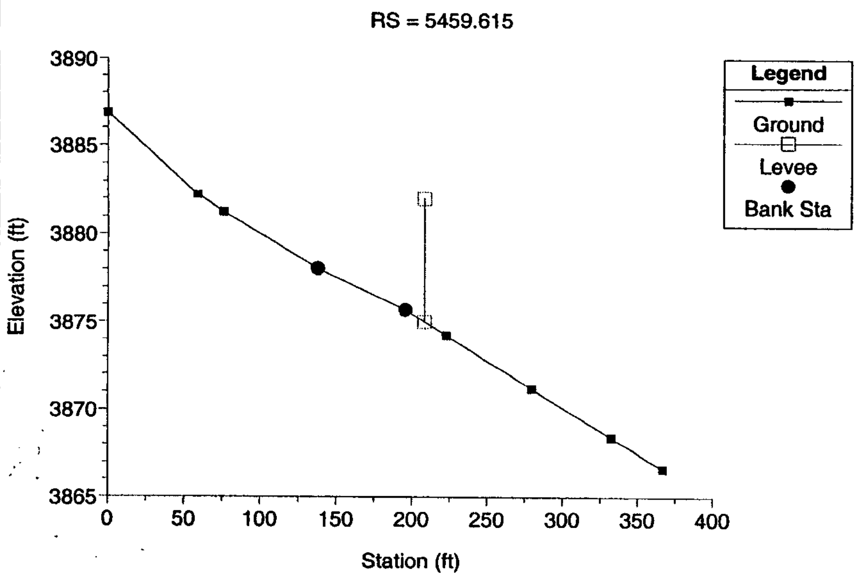


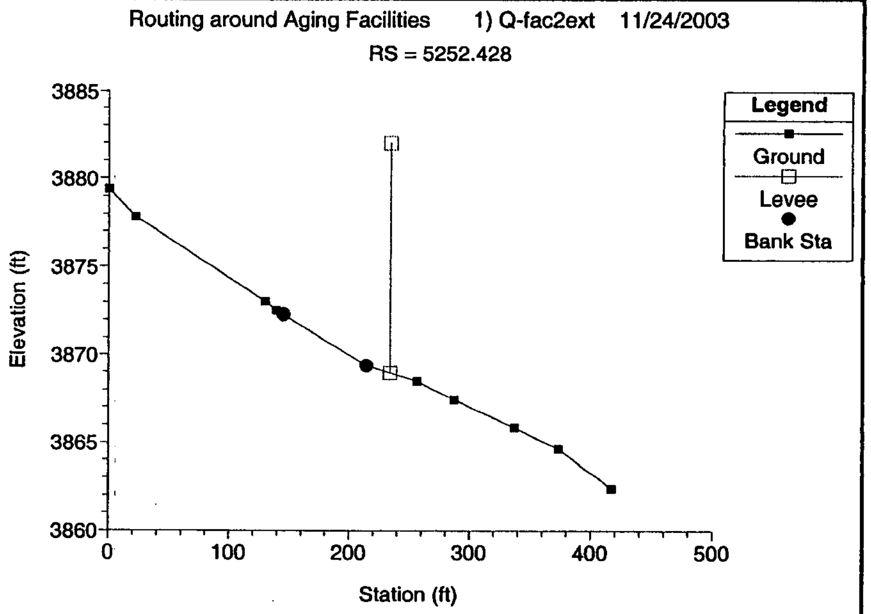
This section has been extended from the GIS import. - OK

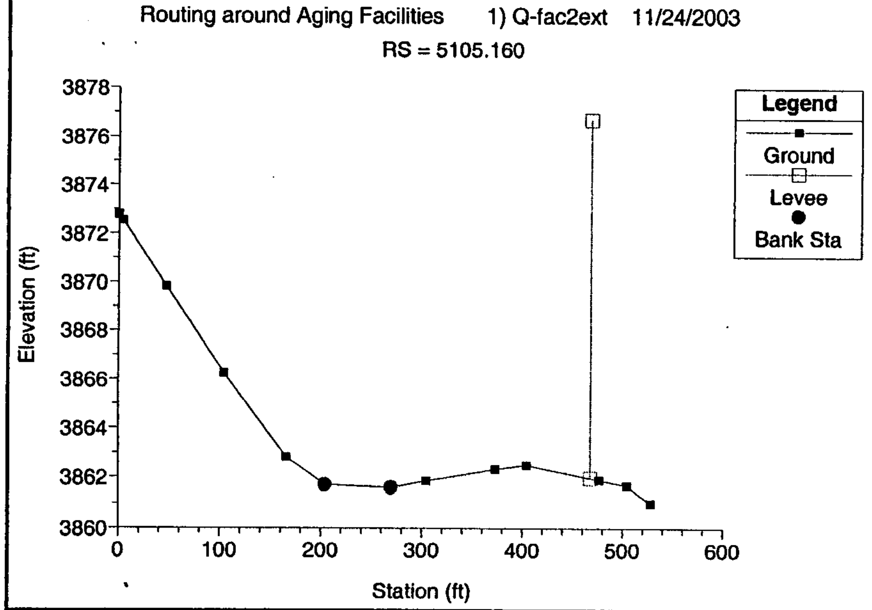
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

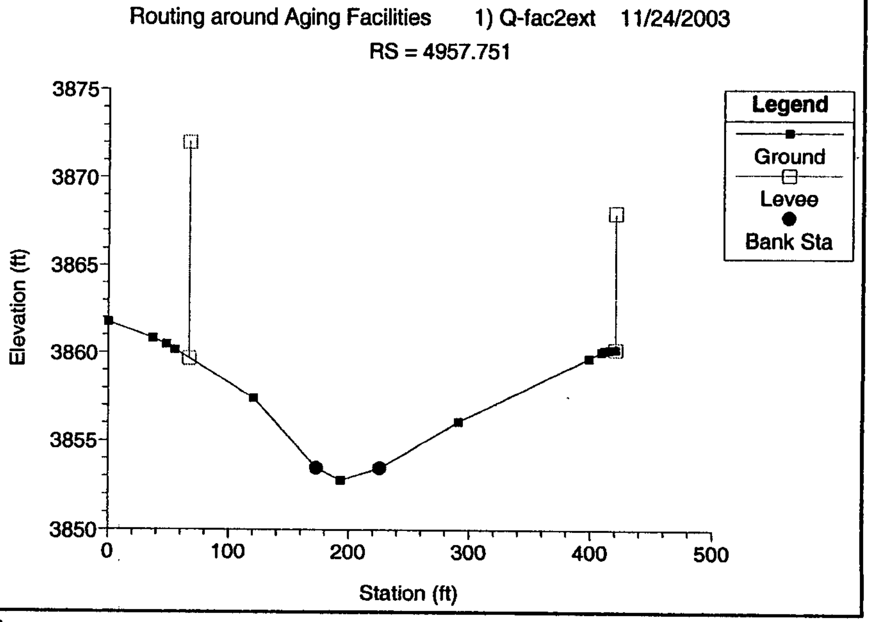
RS = 5668.085

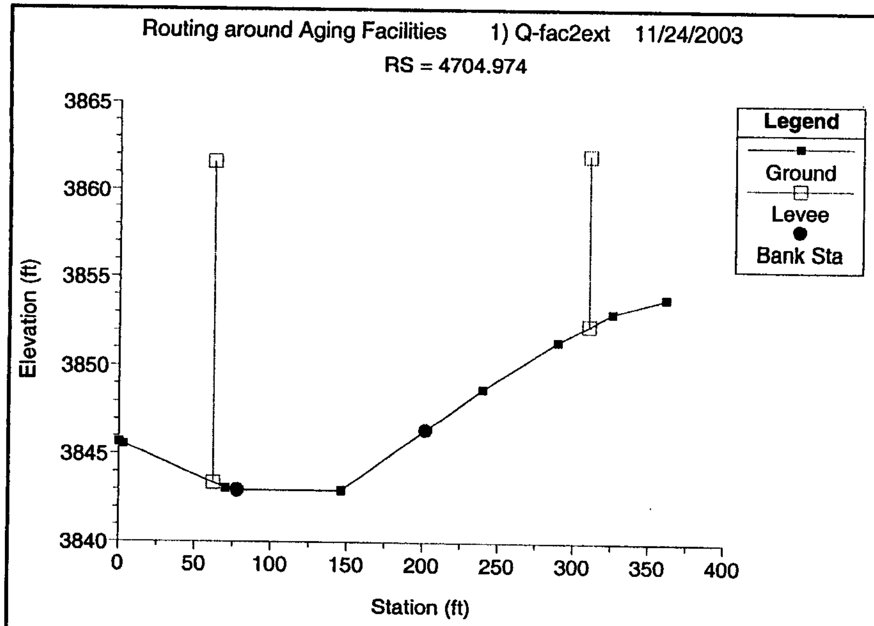



Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 5459.615
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3890
3885
3880
3875
3870
3865
Station (ft)
0
50
100
150
200
250
300
350
400


Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 5252.428
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3885
3880
3875
3870
3865
3860
Station (ft)
0
100
200
300
400
500

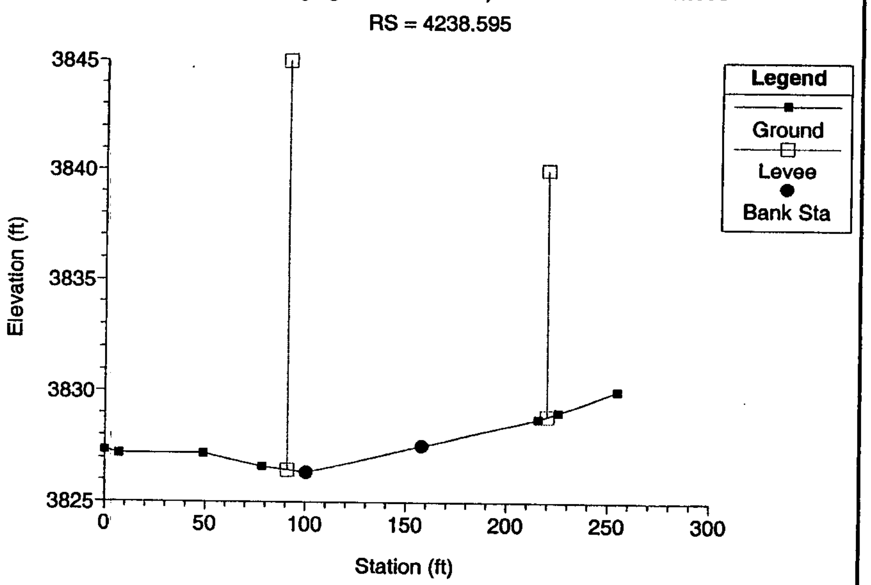

Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 5105.160
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3878
3876
3874
3872
3870
3868
3866
3864
3862
3860
Station (ft)
0
100
200
300
400
500
600


Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 4957.751
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3875
3870
3865
3860
3855
3850
Station (ft)
0
100
200
300
400
500



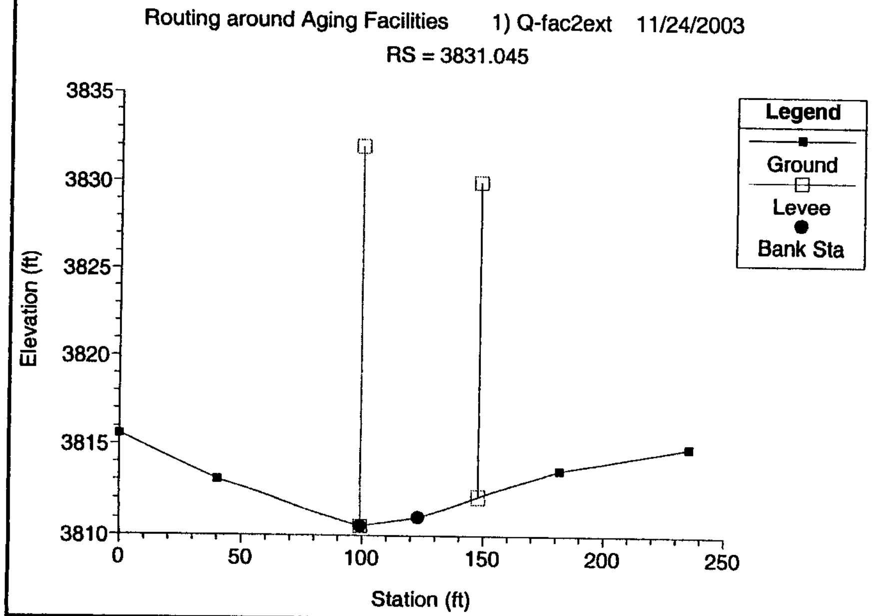
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

RS = 4704.974



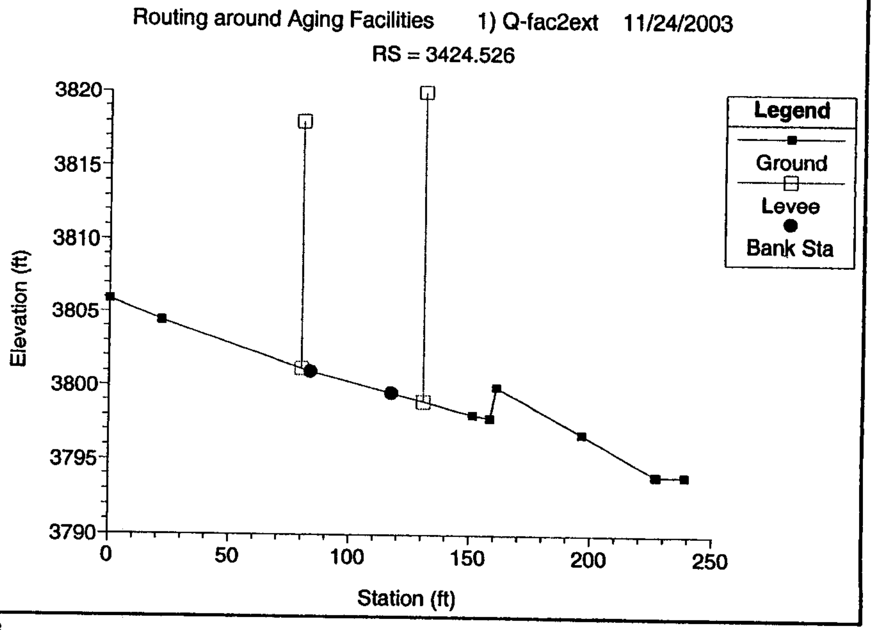
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

RS = 4238.595



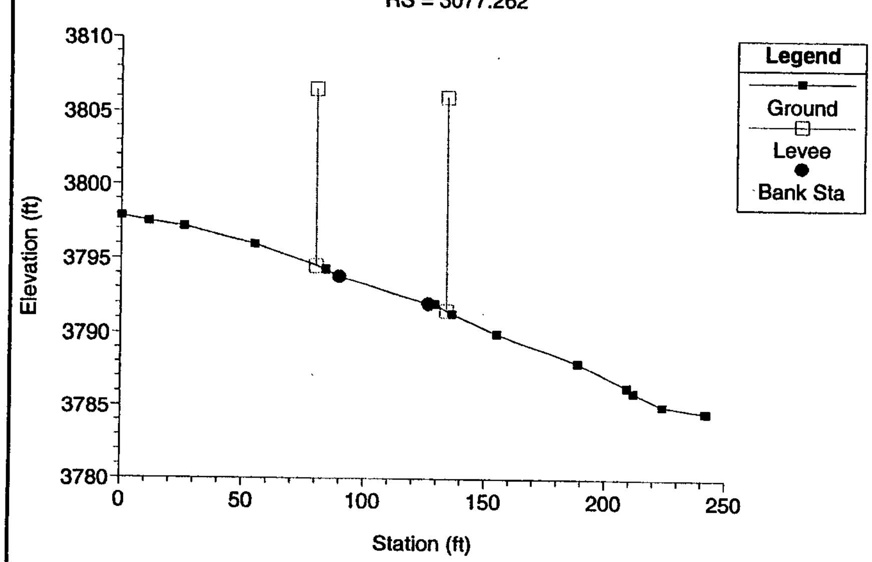
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

RS = 3831.045

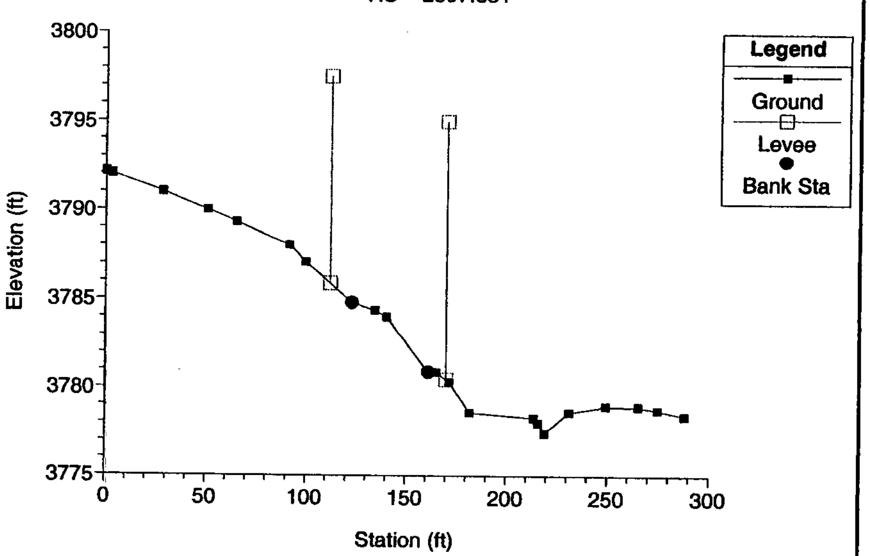


Routing around Aging Facilities 1) Q-fac2ext 11/24/2003

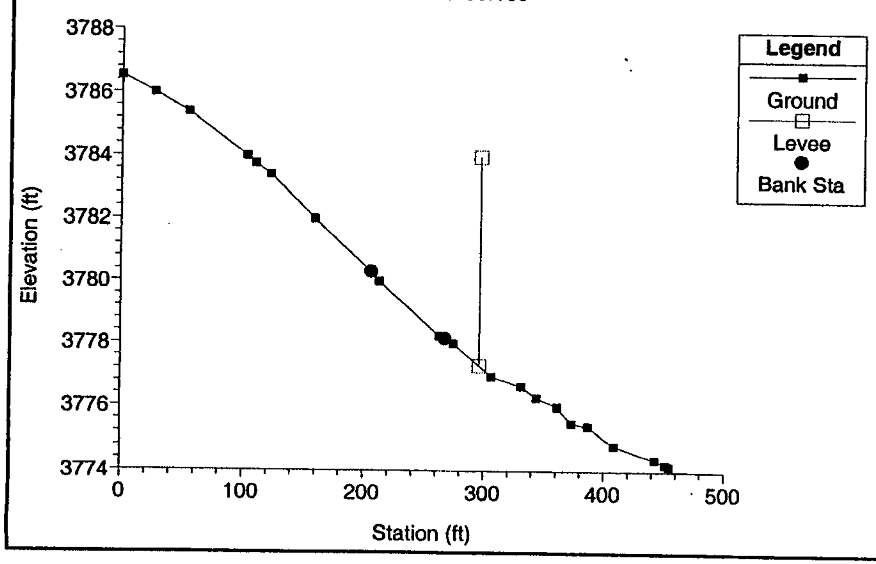
RS = 3424.526



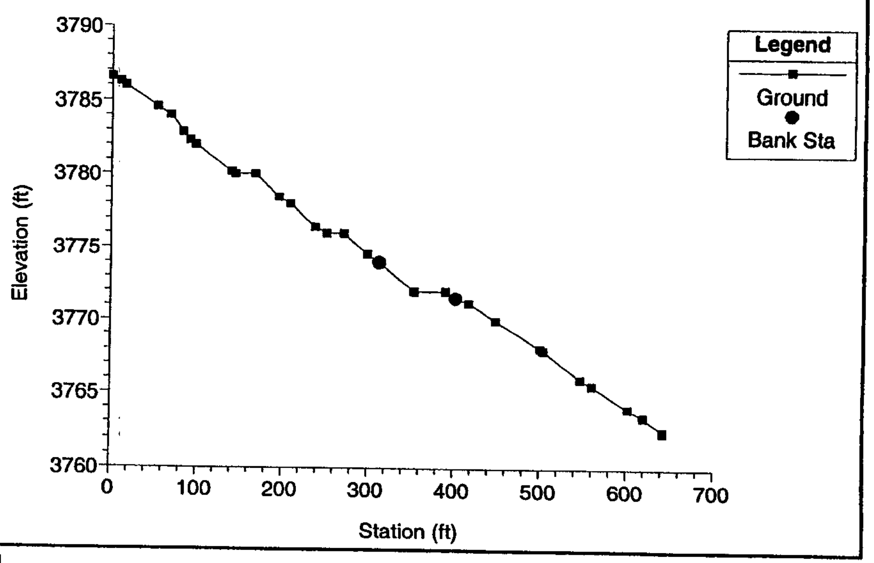
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 3077.262



Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 2807.831

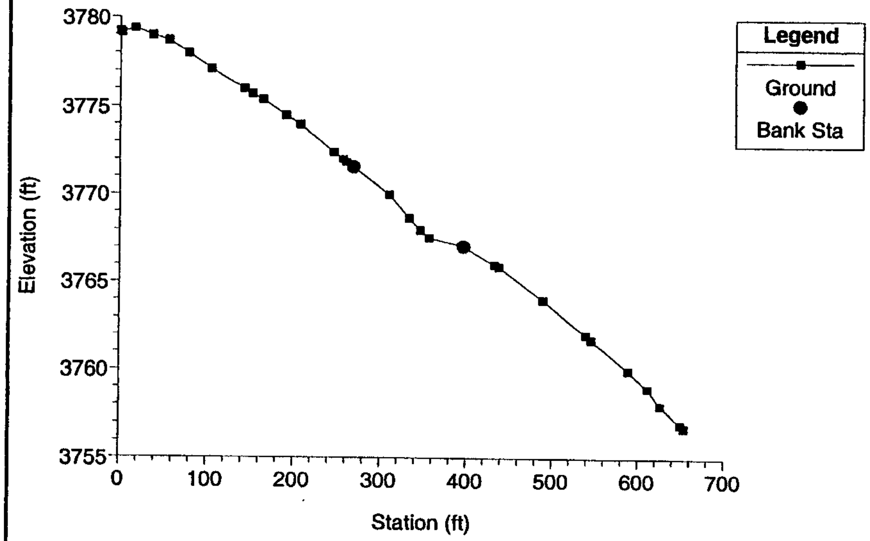


Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 2480.189



Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 2190.768

Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 1830.626



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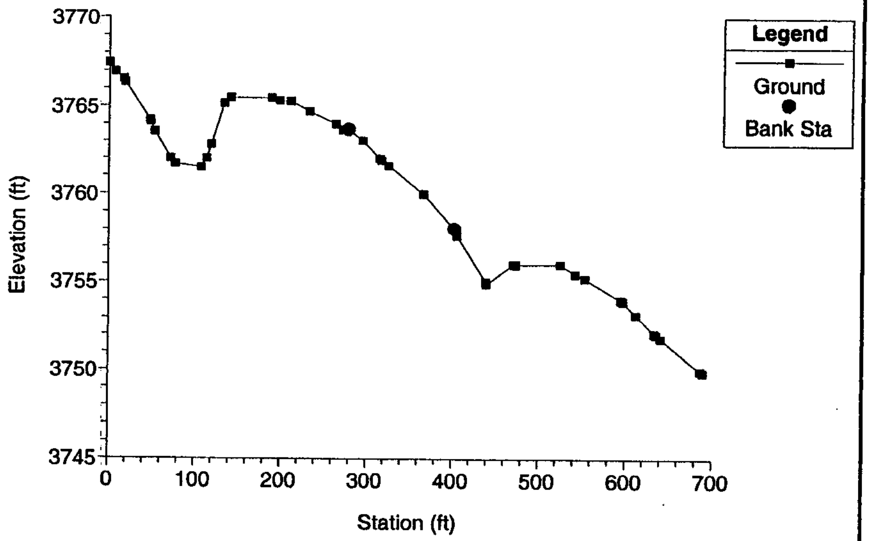
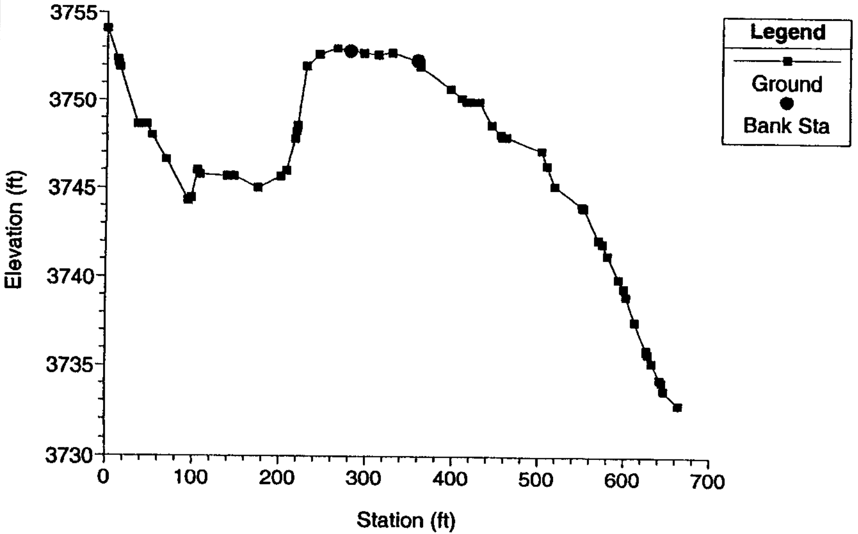
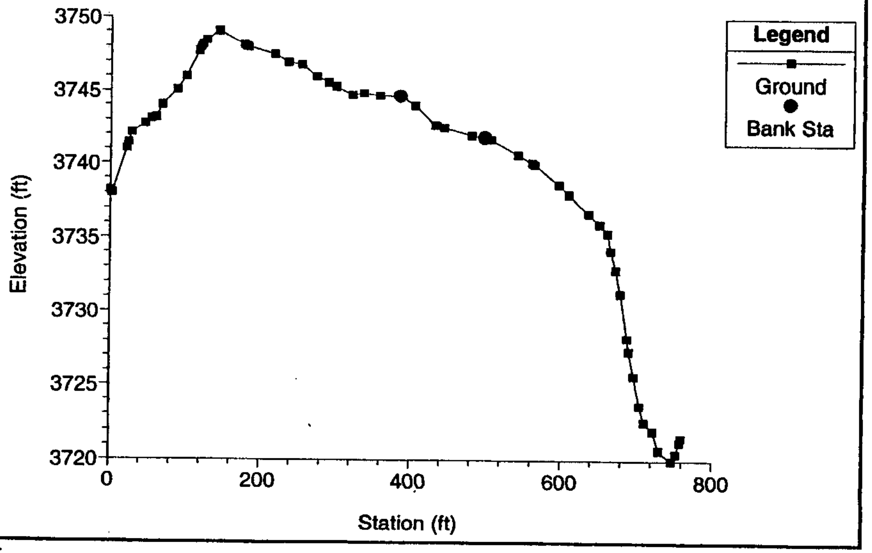
RS = 1370.988

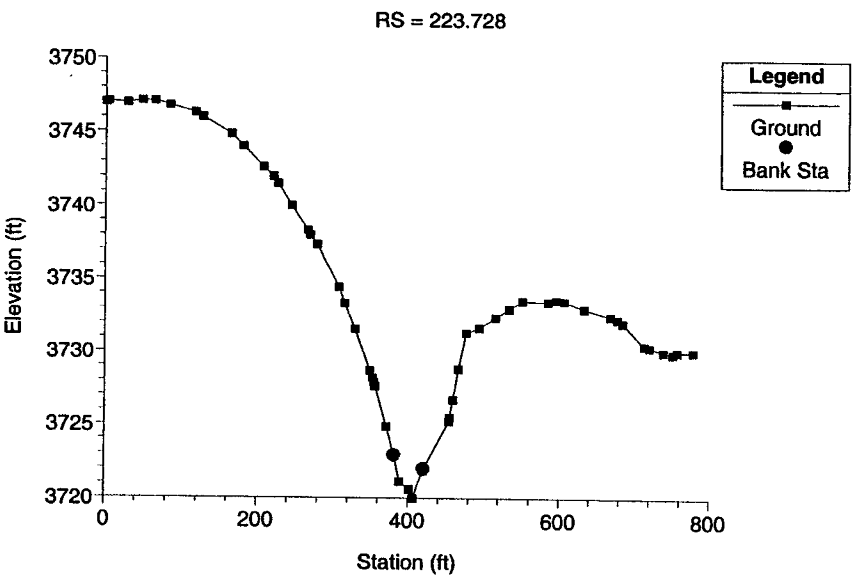


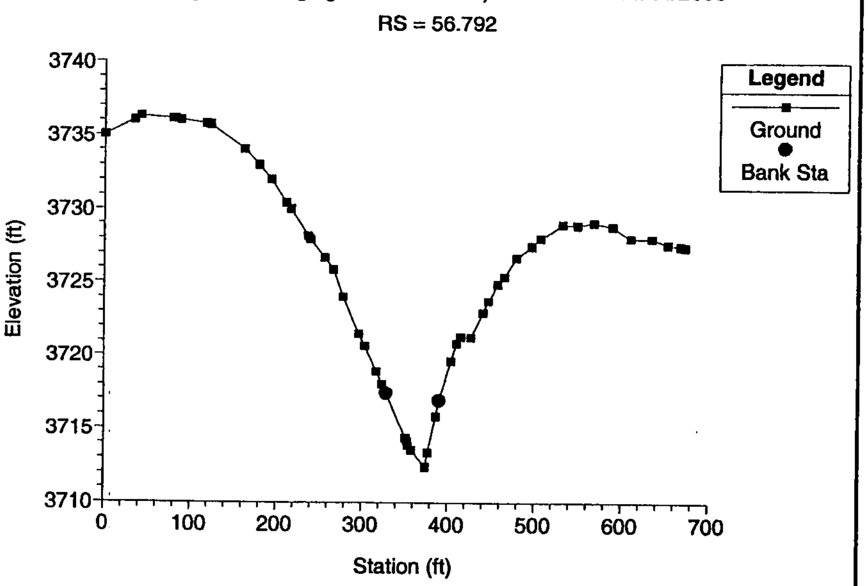
Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 949.068



Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 528.748



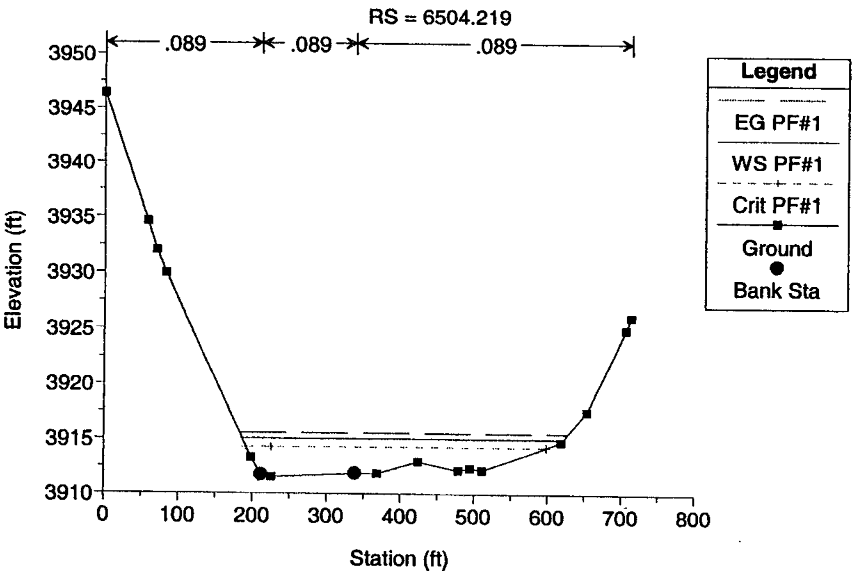

Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 223.728
Legend
Ground
Bank Sta
Elevation (ft)
3750
3745
3740
3735
3730
3725
3720
Station (ft)
0
200
400
600
800


Routing around Aging Facilities 1) Q-fac2ext 11/24/2003
RS = 56.792
Legend
Ground
Bank Sta
Elevation (ft)
3740
3735
3730
3725
3720
3715
3710
Station (ft)
0
100
200
300
400
500
600
700

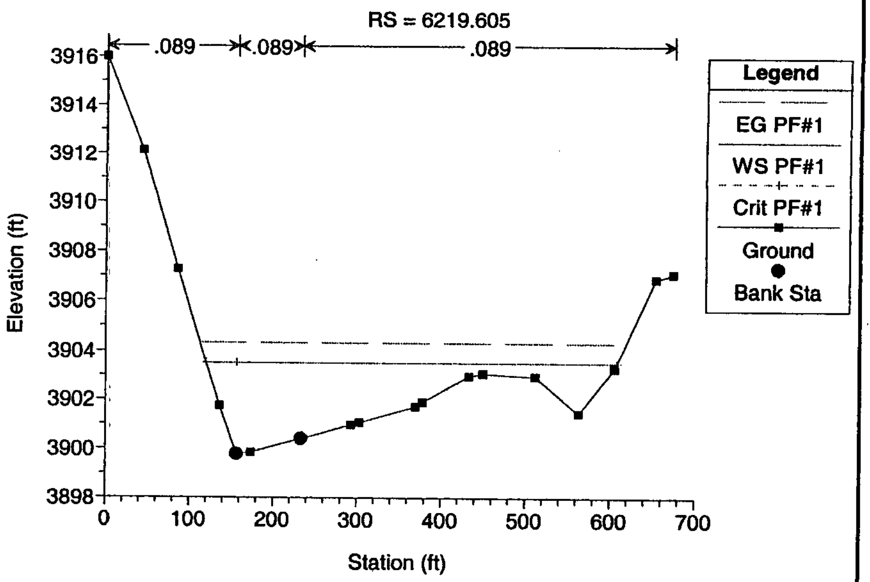
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-fac2ext  River: fac2-ext  Reach: main

# Rivers             = 1
# Hydraulic Reaches  = 1
# River Stations     = 22
# Plans              = 1
# Profiles           = 1

 Reach            River Sta          Q Total  Min Ch El   W.S. Elev   Crit W.S.   E.G. Elev E.G. Slope    Vel Chnl   Flow Area   Top Width Froude # Chl
                                       (cfs)       (ft)        (ft)        (ft)        (ft)    (ft/ft)      (ft/s)     (sq ft)        (ft)

 main             6504.219           5854.00    3911.56     3915.06     3914.29     3915.52   0.027901        6.22     1104.38      436.18         0.60
 main             6219.605           5854.00    3899.78     3903.52     3903.52     3904.33   0.058436        9.21      898.10      488.45         0.87
 main             5861.798           5854.00    3881.99     3885.09     3883.27     3885.32   0.009378        3.40     1545.79      443.35         0.34
 main             5668.085           5854.00    3873.96     3880.07     3879.44     3881.81   0.042476       11.32      584.35      121.45         0.82
 main             5459.615           5854.00    3862.00     3874.93     3871.27     3876.16   0.017921        8.90      657.97       76.74         0.54
 main             5252.428           5854.00    3857.92     3868.53     3867.20     3870.74   0.039863       11.93      490.70       67.46         0.78
 main             5105.160           5854.00    3855.02     3863.94     3863.94     3865.08   0.033164        9.92      834.06      322.35         0.70
 main             4957.751           5854.00    3852.78     3858.78     3858.13     3859.68   0.031697        9.43      861.12      282.60         0.70
 main             4704.974           5854.00    3842.98     3847.89     3847.51     3849.39   0.053566        9.95      605.81      164.00         0.86
 main             4238.595           5854.00    3826.35     3833.48     3831.61     3834.41   0.020965        8.44      768.52      129.00         0.58
 main             3831.045           5854.00    3810.54     3821.66     3818.86     3823.70   0.033011       11.53      510.54       48.80         0.62
 main             3424.526           5854.00    3799.57     3811.24     3807.61     3813.12   0.020874       11.88      565.20       50.70         0.63
 main             3077.262           5854.00    3792.00     3802.90     3800.21     3805.01   0.026180       12.53      535.73       54.00         0.70
 main             2807.831           5854.00    3780.89     3790.21     3790.21     3793.78   0.073665       16.29      399.07       58.00         1.10
 main             2480.189           5854.00    3765.00     3777.54     3774.29     3778.89   0.020358        9.32      628.67       82.57         0.57
 main             2190.768           5854.00    3759.10     3771.63     3768.35     3772.98   0.020409        9.33      627.21       75.11         0.57
 main             1830.626           5854.00    3751.75     3764.28     3761.02     3765.63   0.020439        9.34      626.88       75.10         0.57
 main             1370.988           5854.00    3742.37     3754.92     3751.65     3756.26   0.020309        9.32      628.37       75.18         0.57
 main             949.068            5854.00    3733.77     3746.27     3743.05     3747.63   0.020607        9.37      625.00       75.00         0.57
 main             528.748            5854.00    3725.19     3737.82     3734.46     3739.14   0.019755        9.22      634.83       75.53         0.56
 main             223.728            5854.00    3720.00     3728.40     3728.09     3730.47   0.043376       13.05      548.18      114.05         0.85
 main             56.792             5854.00    3712.38     3721.63     3721.03     3723.64   0.038526       11.94      568.95      134.82         0.79
```

9-8

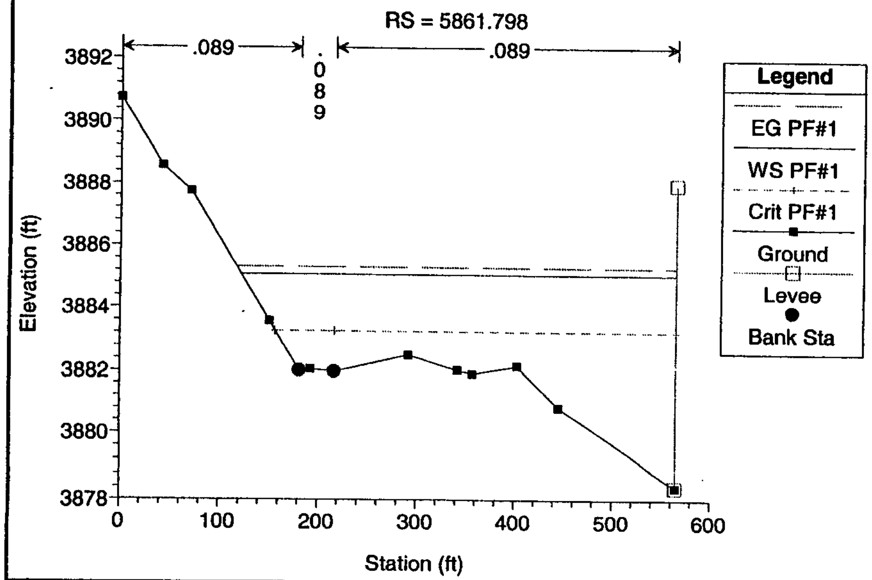
Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003



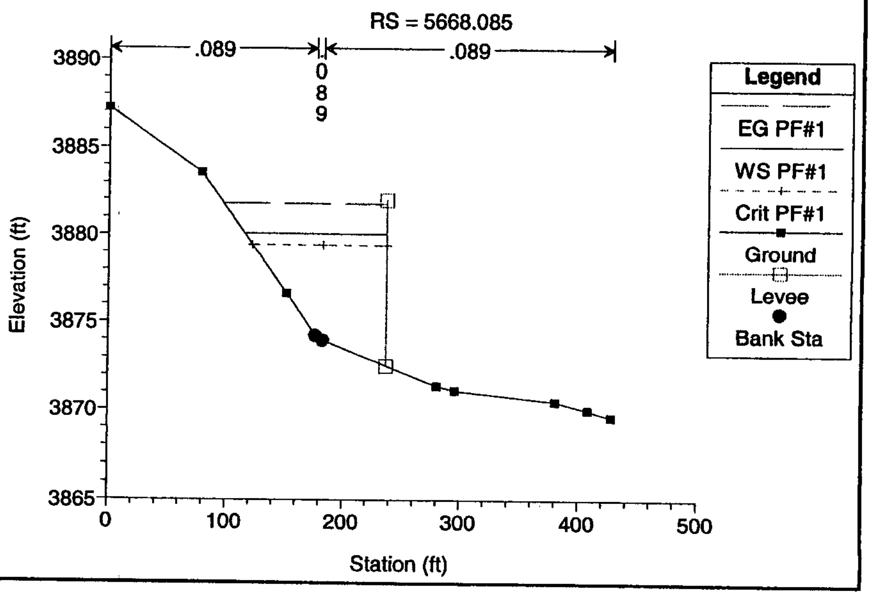
Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

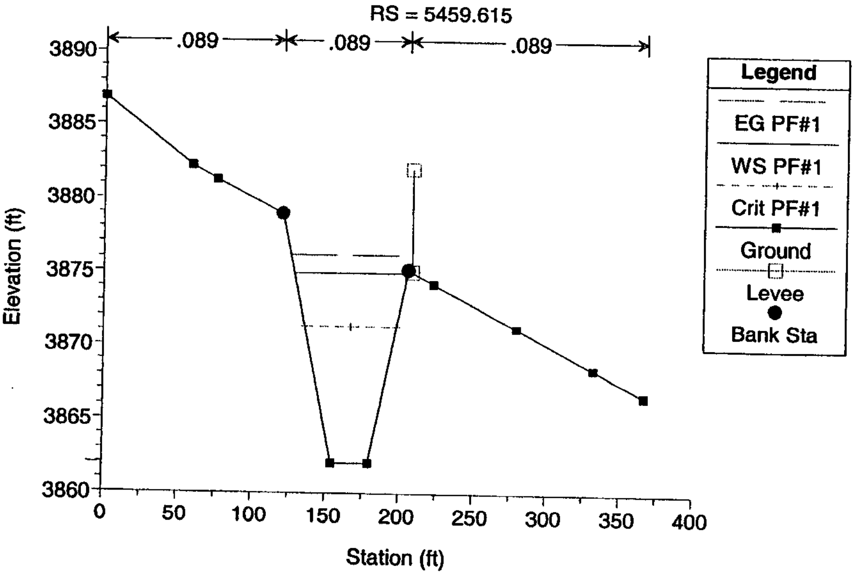


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

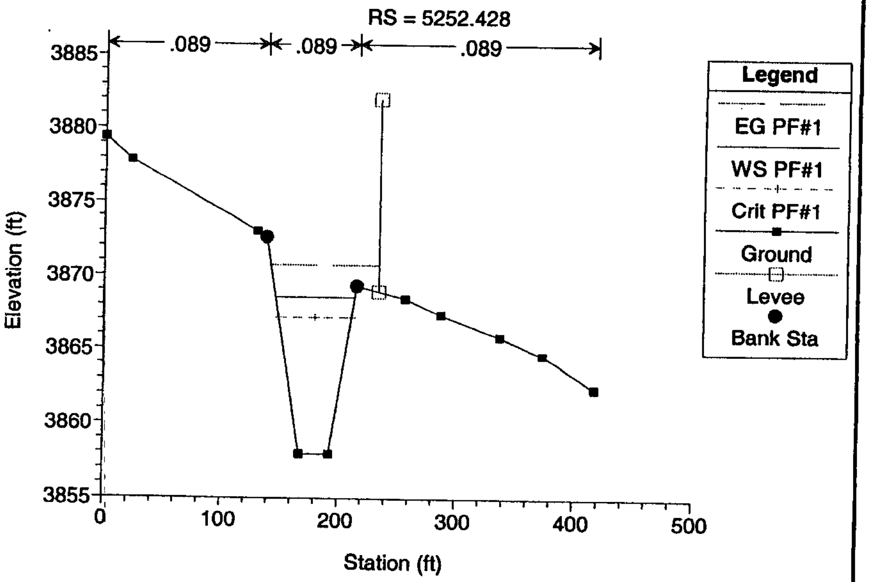


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

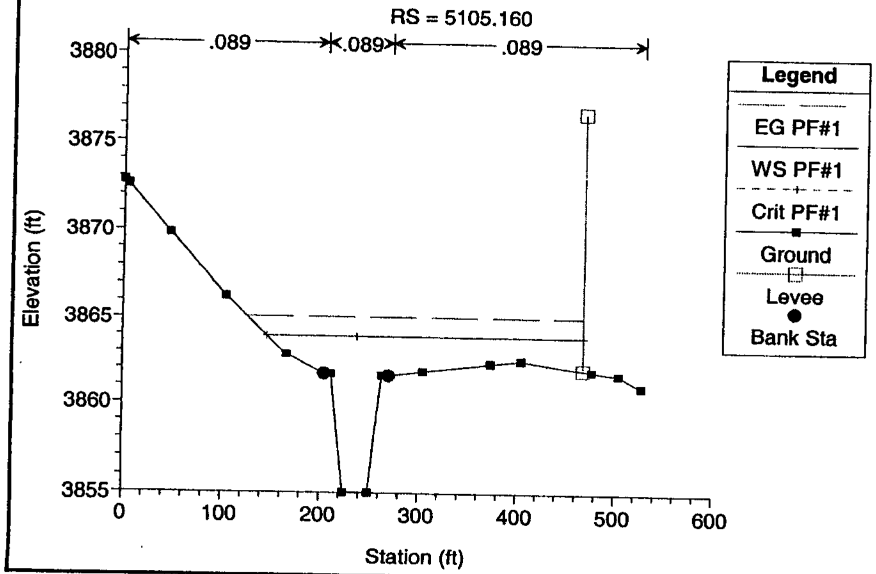




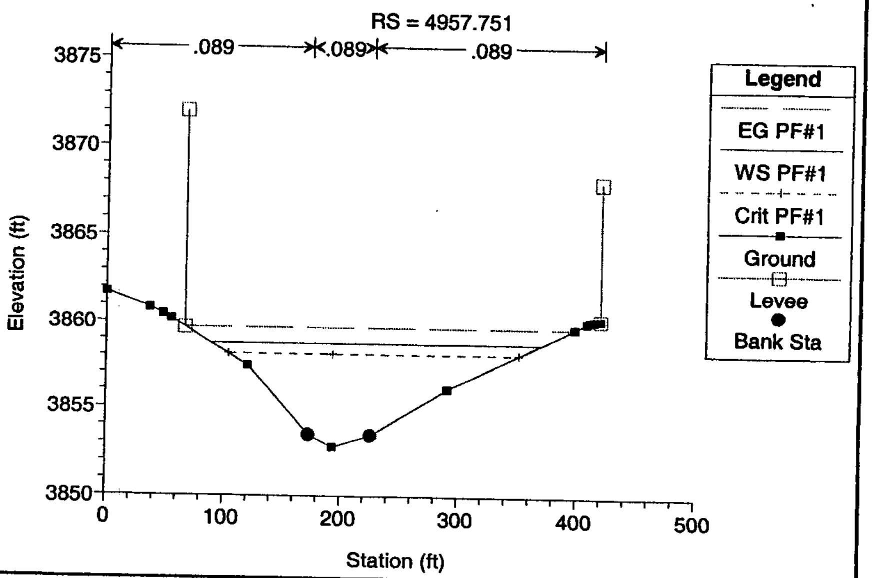
Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003



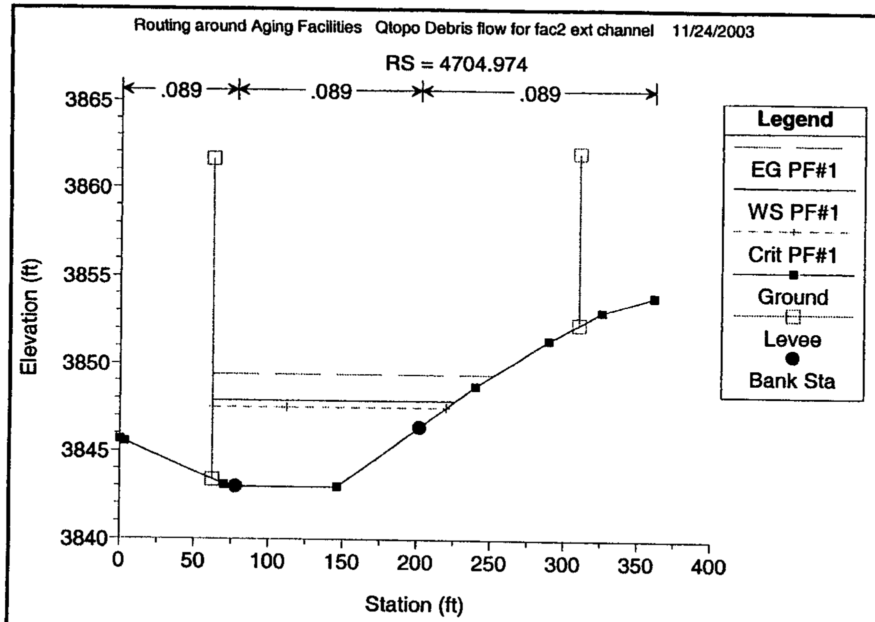
Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003



Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003



Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003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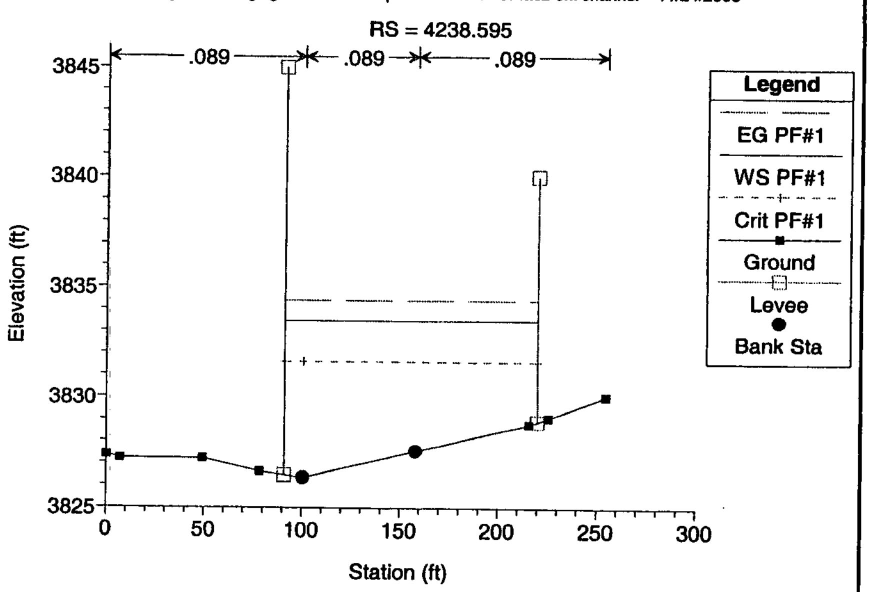
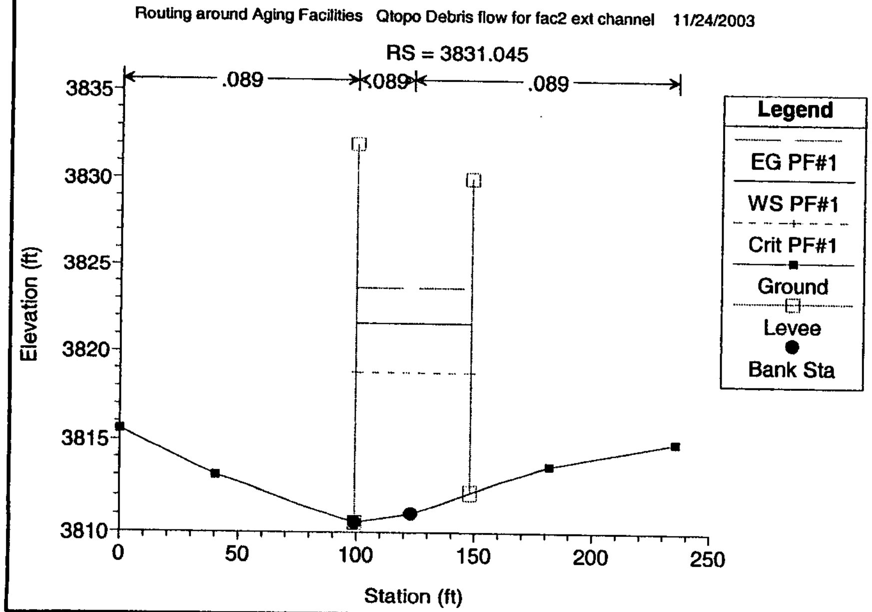
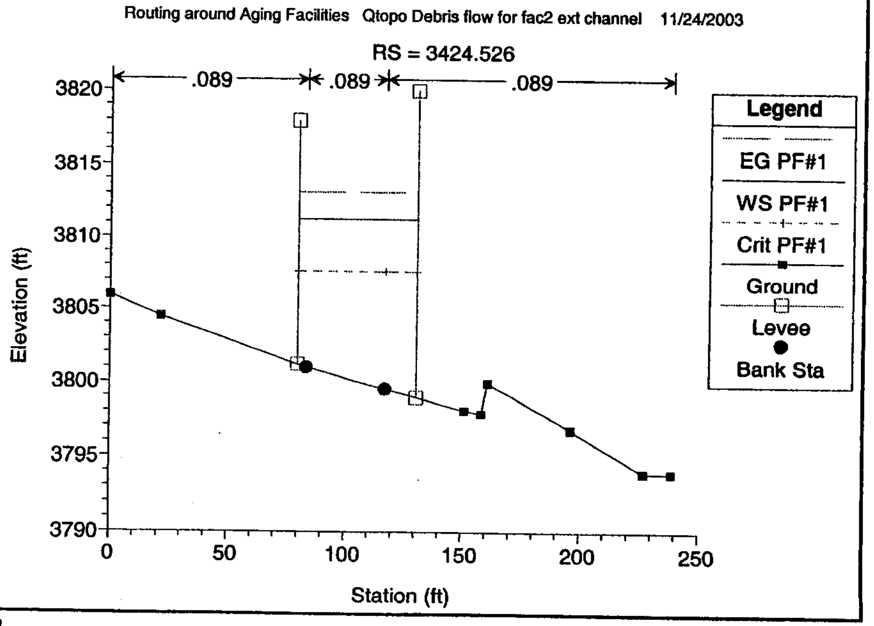
RS = 4704.974


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

RS = 4238.595


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

RS = 3831.045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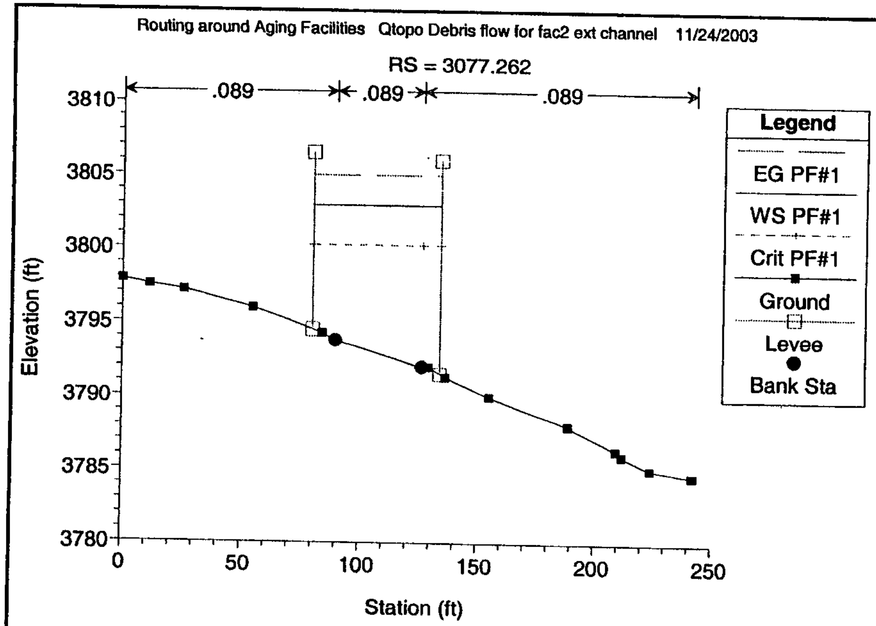
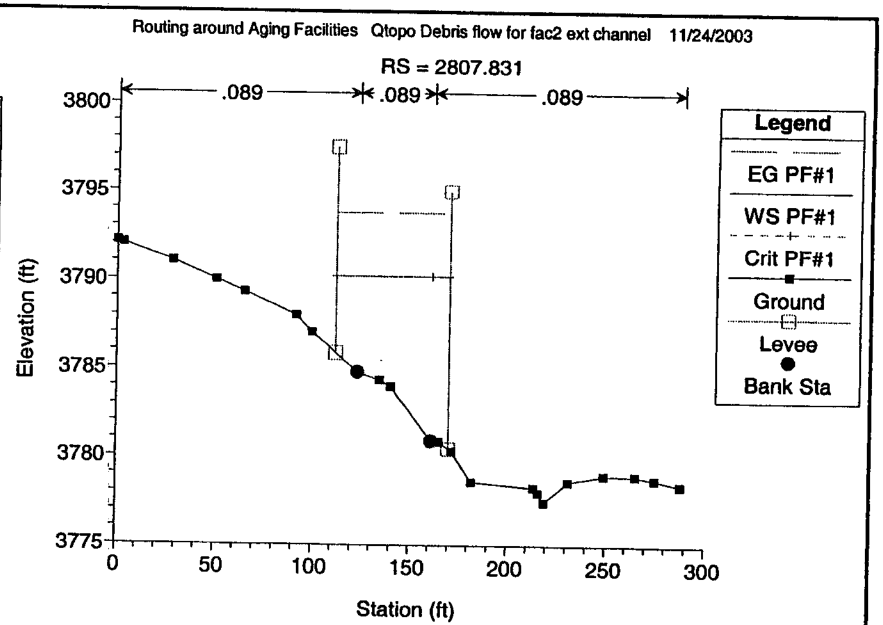
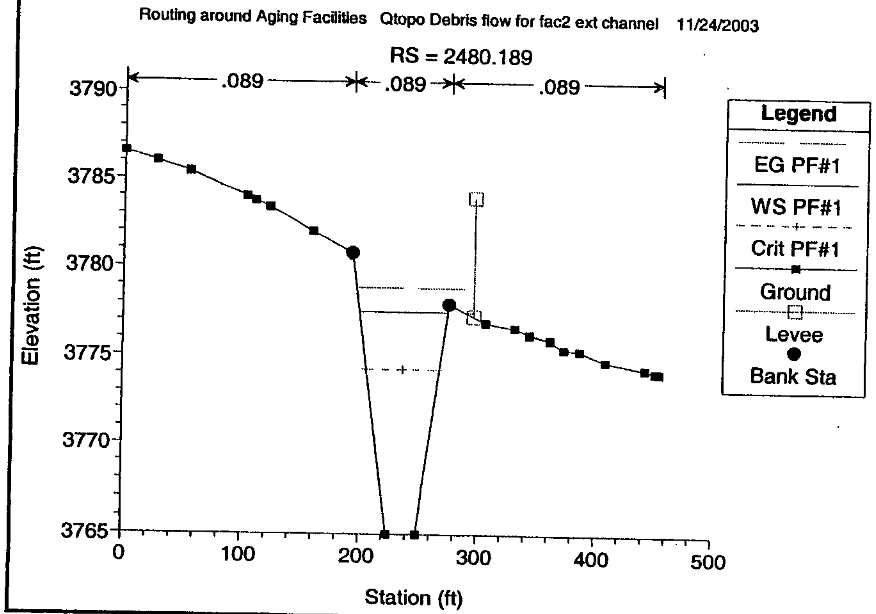
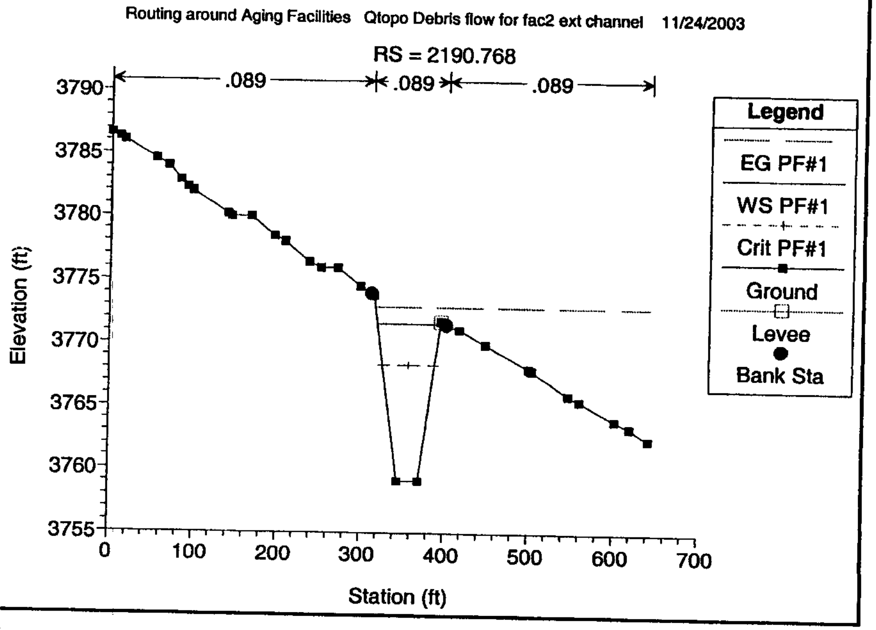
RS = 3424.526

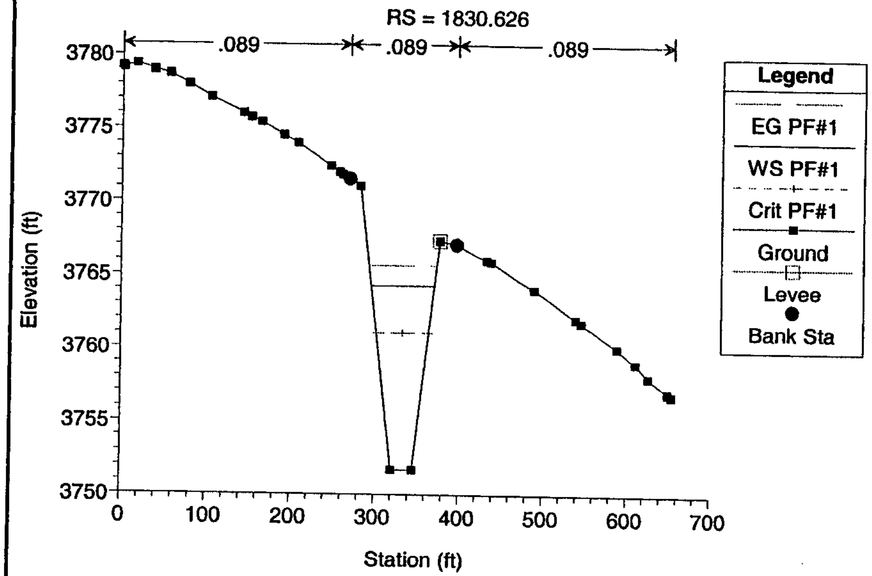

Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003
RS = 3077.262
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3810
3805
3800
3795
3790
3785
3780
0
50
100
150
200
250
Station (ft)


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003
RS = 2807.831
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3800
3795
3790
3785
3780
3775
0
50
100
150
200
250
300
Station (ft)

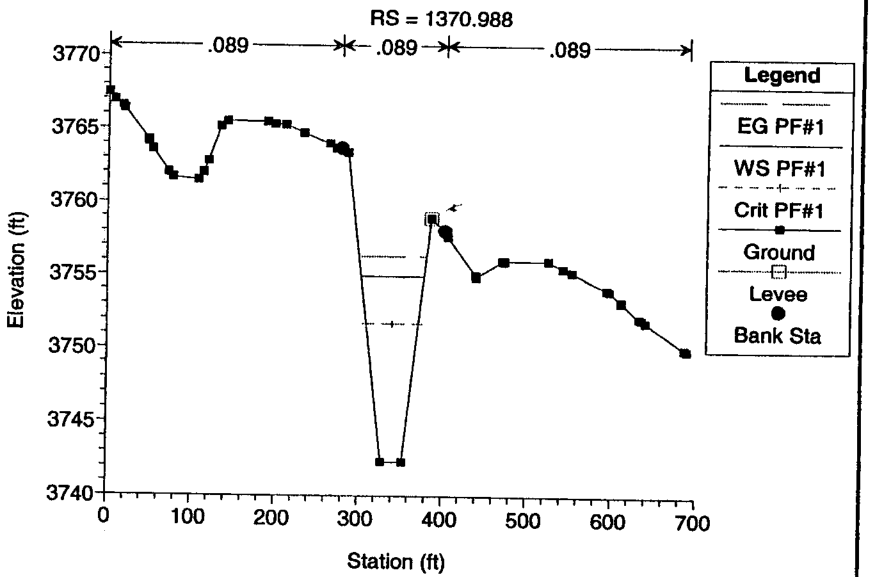

Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003
RS = 2480.189
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3790
3785
3780
3775
3770
3765
0
100
200
300
400
500
Station (ft)


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003
RS = 2190.768
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3790
3785
3780
3775
3770
3765
3760
3755
0
100
200
300
400
500
600
700
Station (ft)

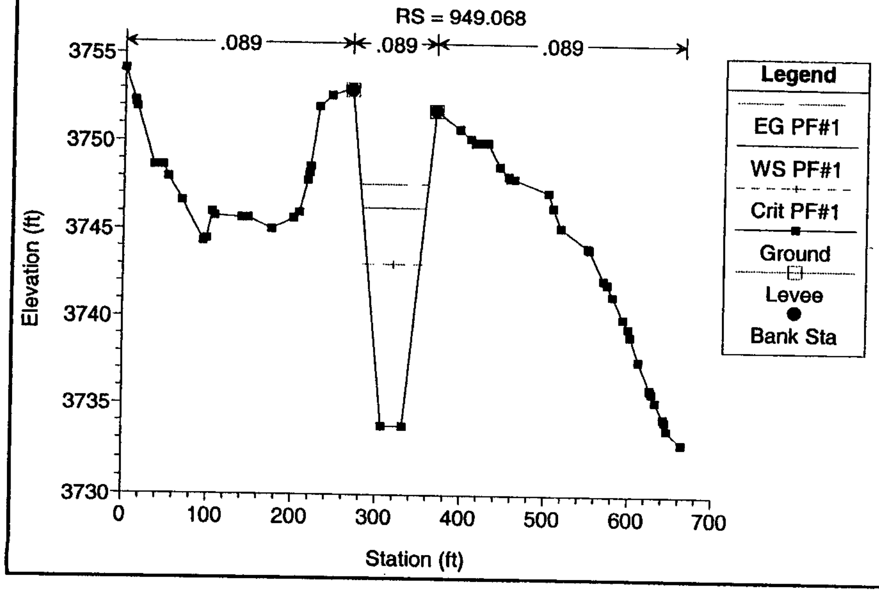
Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003



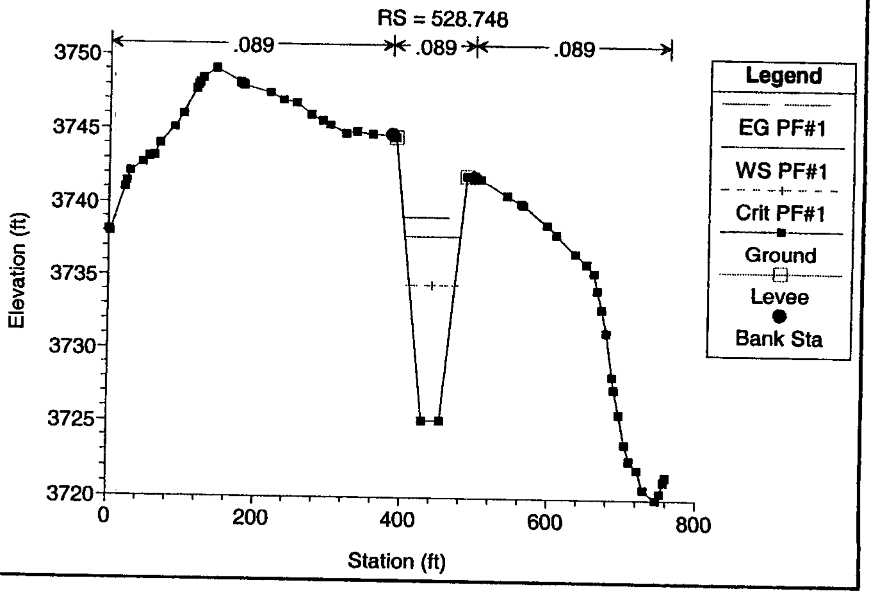
Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

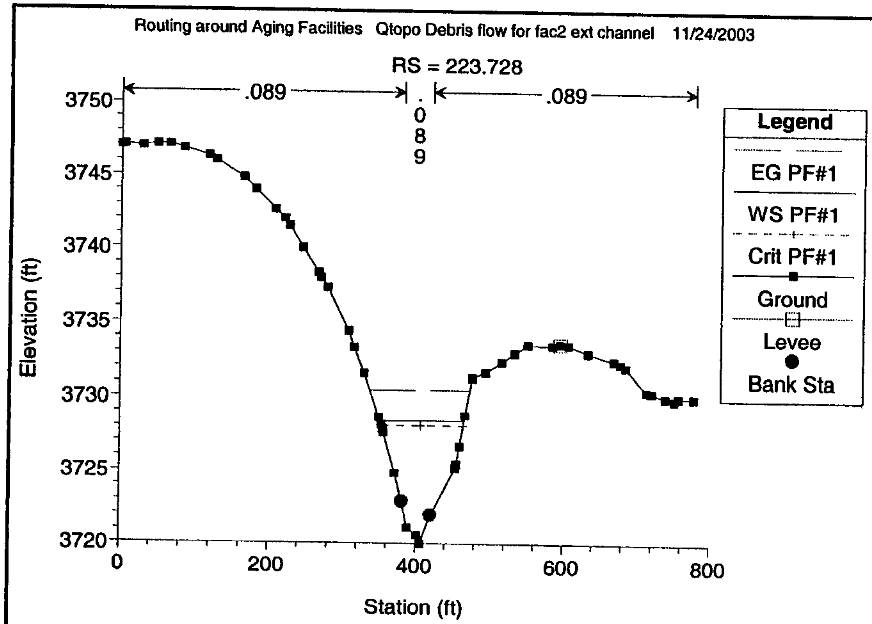


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

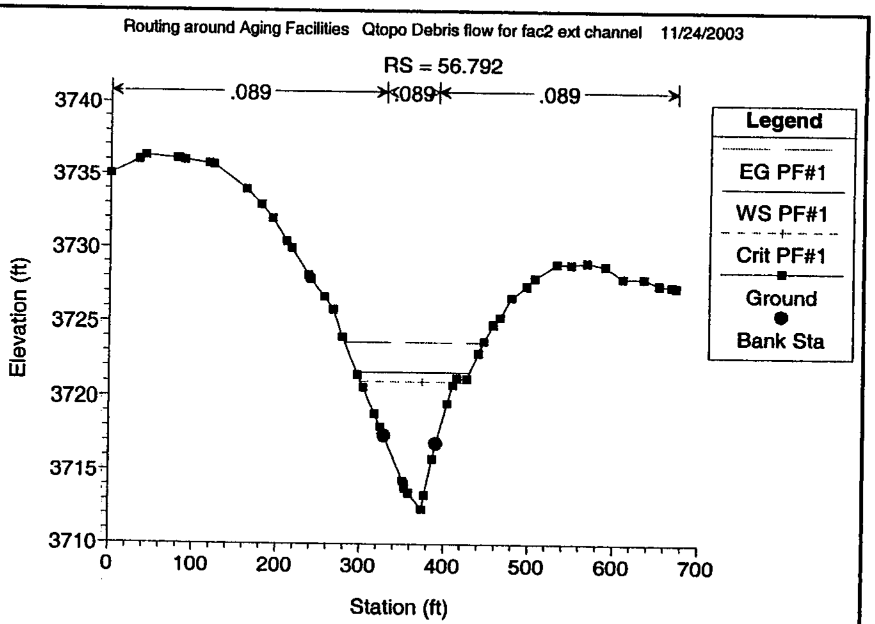


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003




Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

RS = 223.728


Routing around Aging Facilities Qtopo Debris flow for fac2 ext channel 11/24/2003

RS = 56.792

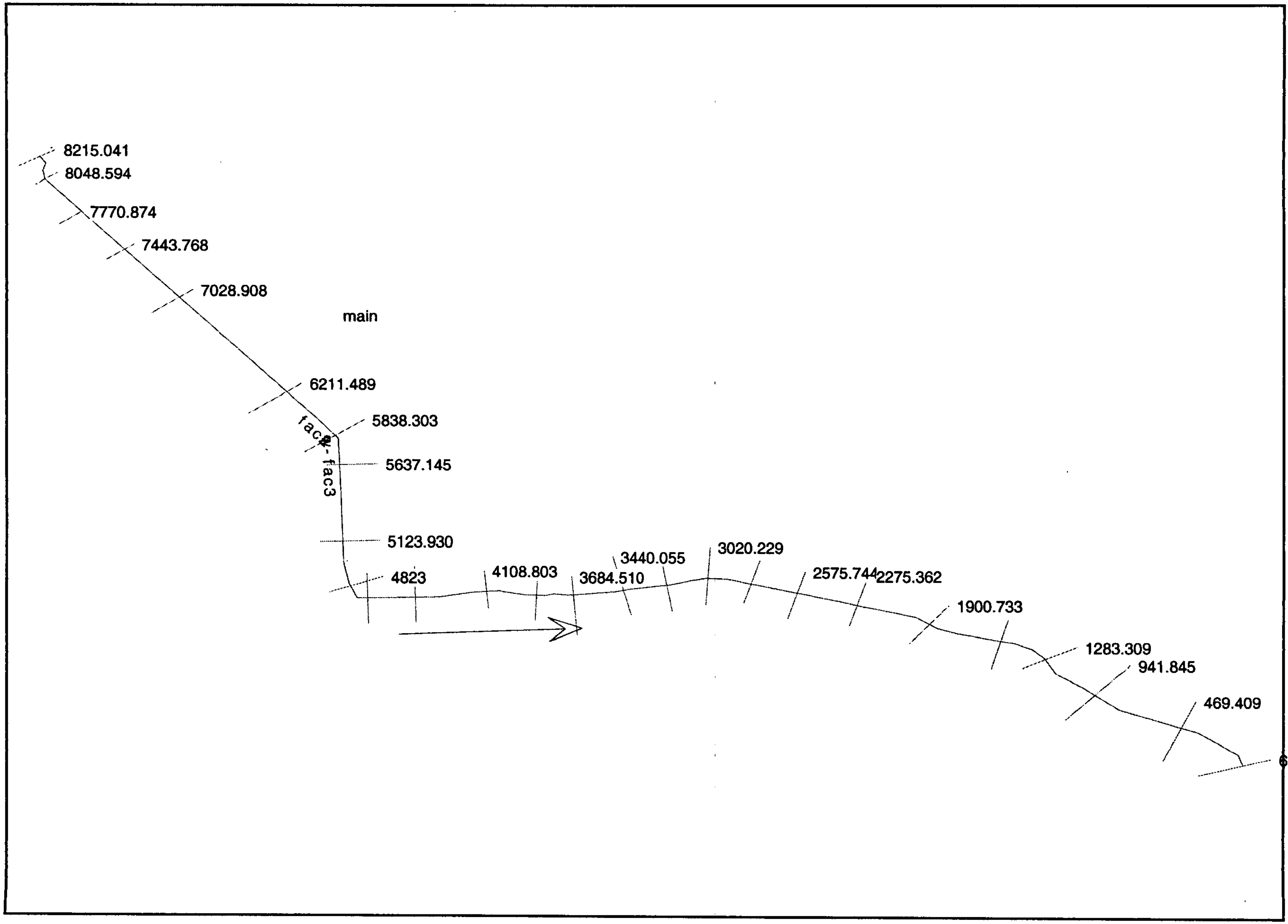
Channel Modification - Cut and Fill Data

River: fac2-ext Reach: main

RS		Area L	Area Ch	Area R	Area T	Volume L	Volume Ch	Volume R	Volume T
		(sq ft)	(sq ft)	(sq ft)	(sq ft)	(cu yd)	(cu yd)	(cu yd)	(cu yd)
5459.615	Cut	69	724	27	820	310	5265	105	5680
	Fill	0	0	0	0	0	0	0	0
	Net	69	724	27	820	310	5265	105	5680
5252.428	Cut	12	648	0	660	33	2461	1	2495
	Fill	0	0	0	0	0	0	0	0
	Net	12	648	0	660	33	2461	1	2495
5105.16	Cut	0	254	0	254	0	695	0	695
	Fill	0	0	0	0	0	0	0	0
	Net	0	254	0	254	0	695	0	695
Total	**Cut**					**343**	**8420**	**106**	**8869**
	Fill					**0**	**0**	**0**	**0**
	Net					**343**	**8420**	**106**	**8869**
2480.189	Cut	41	704	16	761	222	7458	84	7763
	Fill	0	0	0	0	0	0	0	0
	Net	41	704	16	761	222	7458	84	7763
2190.768	Cut	0	687	0	687	0	11374	0	11374
	Fill	0	0	0	0	0	0	0	0
	Net	0	687	0	687	0	11374	0	11374
1830.626	Cut	0	1018	0	1018	0	18626	0	18626
	Fill	0	0	0	0	0	0	0	0
	Net	0	1018	0	1018	0	18626	0	18626
1370.988	Cut	0	1170	0	1170	269	17916	188	18373
	Fill	0	0	0	0	0	0	0	0
	Net	0	1170	0	1170	269	17916	188	18373
949.068	Cut	34	1123	24	1182	268	17035	188	17490
	Fill	0	0	0	0	0	0	0	0
	Net	34	1123	24	1182	268	17035	188	17490
528.748	Cut	0	1065	0	1065	0	6018	0	6018
	Fill	0	0	0	0	0	0	0	0
	Net	0	1065	0	1065	0	6018	0	6018
Total	**Cut**					**758**	**78428**	**460**	**79645**
	Fill					**0**	**0**	**0**	**0**
	Net					**758**	**78428**	**460**	**79645**

Attachment 10: Hydraulic Calculations for Routing Around Aging Facility and North Portal Pad, Alternative 1

(Document ID: 000-00C-CD04-00100-000-00A)

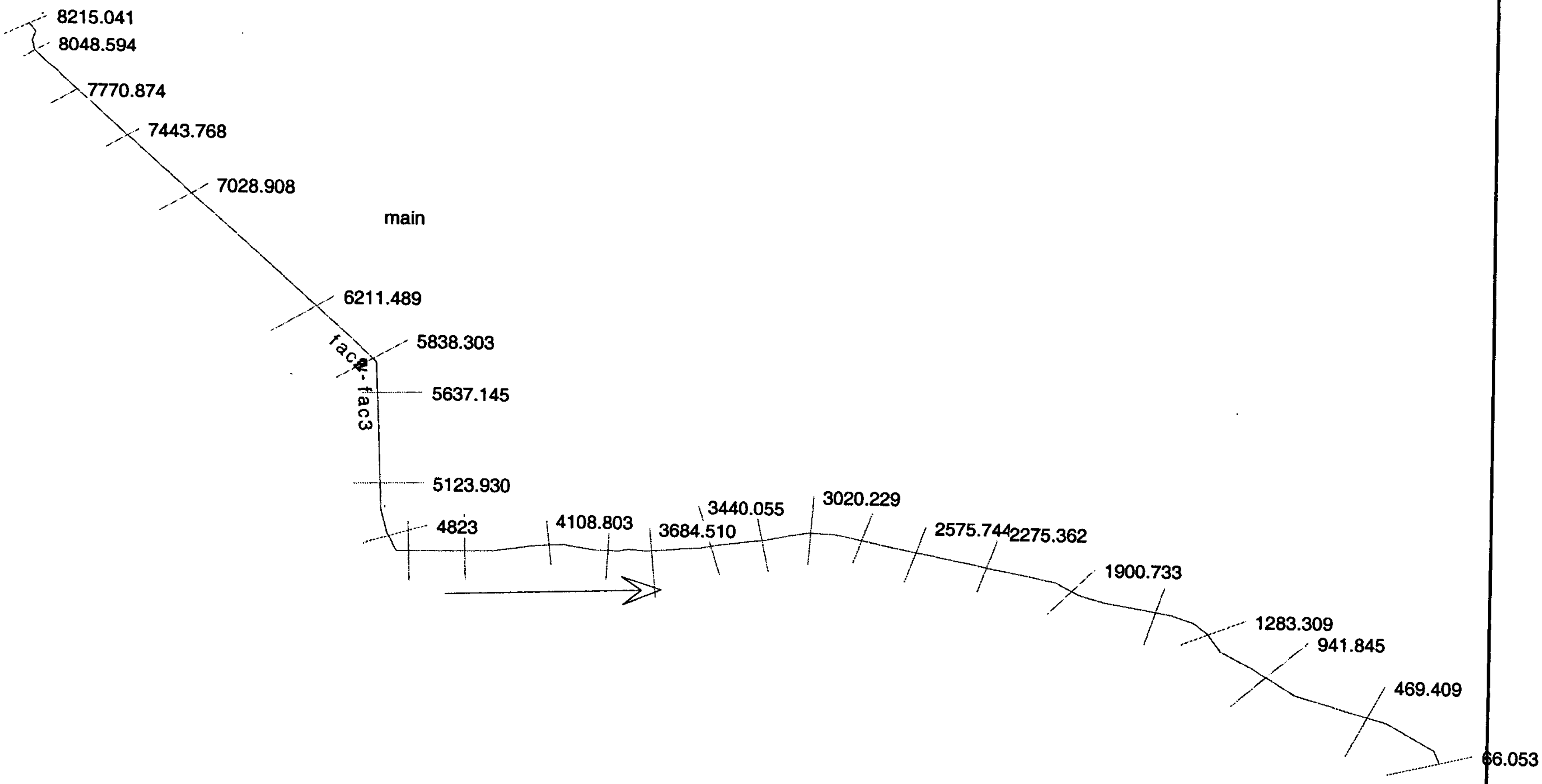

8215.041
8048.594
7770.874
7443.768
7028.908
main
6211.489
5838.303
fac4
fac3
5637.145
5123.930
4823
4108.803
3684.510
3440.055
3020.229
2575.744
2275.362
1900.733
1283.309
941.845
469.409
66.053

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Plan 12  River: fac2w-fac3  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 27
# Plans             = 1
# Profiles          = 1

 Reach            River Sta         Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope  Vel Chnl  Flow Area  Top Width Froude # Chl
                                      (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)    (ft/s)    (sq ft)       (ft)

 main             8215.041          8636.00    3885.44    3891.96    3886.43    3892.21   0.003189      3.22    2286.52     299.66          0.23
 main             8048.594          8636.00    3887.62    3888.54    3887.74    3890.36   0.045852      3.07     802.71     150.43          0.61
 main             7770.874          8636.00    3865.13    3872.71    3872.57    3874.74   0.055504     11.76     795.11     192.47          0.88
 main             7443.768          8636.00    3844.00    3856.12    3856.12    3858.18   0.066204     13.94     768.39     172.71          0.74
 main             7028.908          8636.00    3825.63    3832.44    3832.14    3833.73   0.042874      9.67    1019.55     336.38          0.79
 main             6211.489          8636.00    3790.00    3797.18    3796.60    3798.00   0.030728      9.47    1274.72     383.59          0.69
 main             5838.303          8636.00    3775.40    3787.44    3782.85    3787.77   0.004766      5.15    2002.21     294.67          0.28
 main             5637.145          8636.00    3770.39    3783.64    3780.65    3785.21   0.023227     10.07     857.91     100.63          0.61
 main             5123.930          8636.00    3757.61    3770.76    3767.70    3772.54   0.023385     10.71     806.22      87.61          0.62
 main             4823              8636.00    3750.12    3765.55    3760.21    3766.67   0.012417      8.50    1015.79      96.70          0.46
 main             4685              8636.00    3748.00    3762.63    3758.73    3764.50   0.021426     10.98     786.57      72.55          0.59
 main             4455.997          8636.00    3744.81    3755.74    3754.93    3758.74   0.048006     13.90     621.26      78.71          0.87
 main             4108.803          8636.00    3728.14    3739.07               3742.07   0.047928     13.89     621.63      78.73          0.87
 main             3864.722          8636.00    3716.43    3727.74               3730.47   0.041982     13.24     652.08      80.26          0.82
 main             3684.510          9910.00    3707.78    3724.70    3718.68    3725.82   0.011268      8.51    1164.44     102.67          0.45
 main             3440.055          9910.00    3705.25    3721.32    3716.15    3722.63   0.013846      9.18    1079.36     104.69          0.49
 main             3225.065          9910.00    3703.10    3719.58    3715.09    3720.06   0.004883      6.35    2090.92     329.32          0.30
 main             3020.229          9910.00    3701.05    3716.80    3711.97    3718.23   0.014714      9.61    1032.34      94.43          0.50
 main             2806.897          9910.00    3698.92    3711.65    3709.84    3714.22   0.034991     12.88     769.61      85.92          0.76
 main             2575.744          9910.00    3690.83    3703.56    3701.73    3706.13   0.035013     12.88     769.42      85.90          0.76
 main             2275.362          9910.00    3680.31    3693.07    3691.21    3695.63   0.034632     12.83     772.52      86.06          0.75
 main             1900.733          9910.00    3667.20    3684.33    3678.10    3685.41   0.010711      8.35    1186.33     103.52          0.43
 main             1536.204          9910.00    3654.44    3683.44    3665.34    3683.65   0.001164      3.67    2697.79     151.03          0.15
 main             1283.309          9910.00    3666.24    3680.14    3678.14    3682.17   0.022687     11.81     944.81     145.35          0.63
 main             941.845           9910.00    3657.02    3671.33    3668.55    3673.50   0.027021     11.81     839.16      87.25          0.67
 main             469.409           9910.00    3644.26    3658.05    3655.80    3660.47   0.031439     12.48     793.81      85.15          0.72
 main             66.053            9910.00    3633.37    3643.49    3642.75    3645.39   0.031036     11.66     970.17     181.32          0.72
```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7770.874
7443.768
7028.908
main
6211.489
5838.303
fac2 - fac3
5637.145
5123.930
4823
4108.803
3684.510
3440.055
3020.229
2575.744
2275.362
1900.733
1283.309
941.845
469.409
66.053

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Plan 12  River: fac2w-fac3  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 27
# Plans             = 1
# Profiles          = 1

 Reach           River Sta           Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope  Vel Chnl  Flow Area  Top Width Froude # Chl
                                       (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)    (ft/s)    (sq ft)       (ft)

 main            8215.041            8636.00    3885.44    3891.96    3886.43    3892.21   0.003189      3.22    2286.52     299.66         0.23
 main            8048.594            8636.00    3887.62    3888.54    3887.74    3890.36   0.045852      3.07     802.71     150.43         0.61
 main            7770.874            8636.00    3865.13    3872.71    3872.57    3874.74   0.055504     11.76     795.11     192.47         0.88
 main            7443.768            8636.00    3844.00    3856.12    3856.12    3858.18   0.066204     13.94     768.39     172.71         0.74
 main            7028.908            8636.00    3825.63    3832.44    3832.14    3833.73   0.042874      9.67    1019.55     336.38         0.79
 main            6211.489            8636.00    3790.00    3797.18    3796.60    3798.00   0.030728      9.47    1274.72     383.59         0.69
 main            5838.303            8636.00    3775.40    3787.44    3782.85    3787.77   0.004766      5.15    2002.21     294.67         0.28
 main            5637.145            8636.00    3770.39    3783.64    3780.65    3785.21   0.023227     10.07     857.91     100.63         0.61
 main            5123.930            8636.00    3757.61    3770.76    3767.70    3772.54   0.023385     10.71     806.22      87.61         0.62
 main            4823                8636.00    3750.12    3765.55    3760.21    3766.67   0.012417      8.50    1015.79      96.70         0.46
 main            4685                8636.00    3748.00    3762.63    3758.73    3764.50   0.021426     10.98     786.57      72.55         0.59
 main            4455.997            8636.00    3744.81    3755.74    3754.93    3758.74   0.048006     13.90     621.26      78.71         0.87
 main            4108.803            8636.00    3728.14    3739.07               3742.07   0.047928     13.89     621.63      78.73         0.87
 main            3864.722            8636.00    3716.43    3727.74               3730.47   0.041982     13.24     652.08      80.26         0.82
 main            3684.510            9910.00    3707.78    3724.70    3718.68    3725.82   0.011268      8.51    1164.44     102.67         0.45
 main            3440.055            9910.00    3705.25    3721.32    3716.15    3722.63   0.013846      9.18    1079.36     104.69         0.49
 main            3225.065            9910.00    3703.10    3719.58    3715.09    3720.06   0.004883      6.35    2090.92     329.32         0.30
 main            3020.229            9910.00    3701.05    3716.80    3711.97    3718.23   0.014714      9.61    1032.34      94.43         0.50
 main            2806.897            9910.00    3698.92    3711.65    3709.84    3714.22   0.034991     12.88     769.61      85.92         0.76
 main            2575.744            9910.00    3690.83    3703.56    3701.73    3706.13   0.035013     12.88     769.42      85.90         0.76
 main            2275.362            9910.00    3680.31    3693.07    3691.21    3695.63   0.034632     12.83     772.52      86.06         0.75
 main            1900.733            9910.00    3667.20    3684.33    3678.10    3685.41   0.010711      8.35    1186.33     103.52         0.43
 main            1536.204            9910.00    3654.44    3683.44    3665.34    3683.65   0.001164      3.67    2697.79     151.03         0.15
 main            1283.309            9910.00    3666.24    3680.14    3678.14    3682.17   0.022687     11.81     944.81     145.35         0.63
 main            941.845             9910.00    3657.02    3671.33    3668.55    3673.50   0.027021     11.81     839.16      87.25         0.67
 main            469.409             9910.00    3644.26    3658.05    3655.80    3660.47   0.031439     12.48     793.81      85.15         0.72
 main            66.053              9910.00    3633.37    3643.49    3642.75    3645.39   0.031036     11.66     970.17     181.32         0.72
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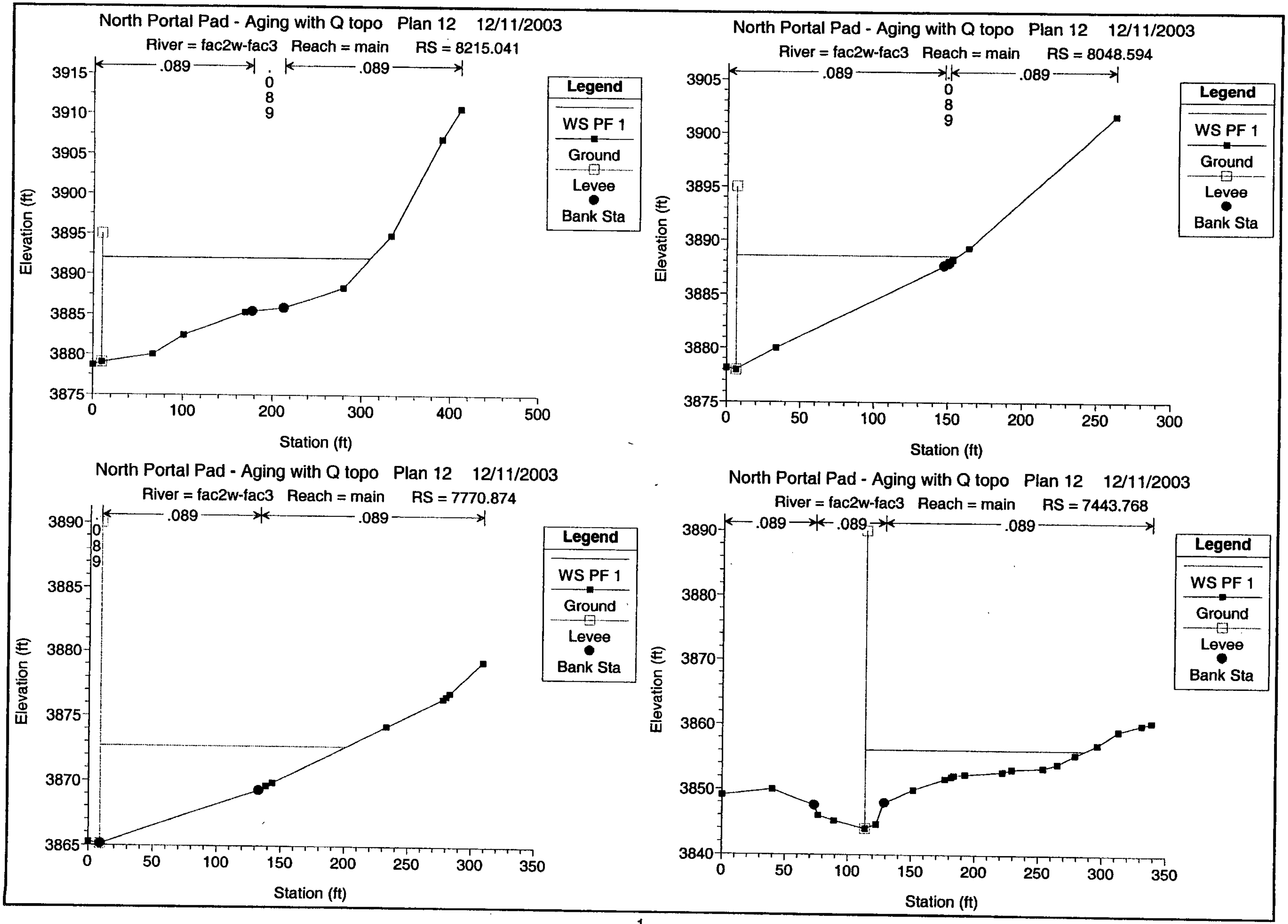
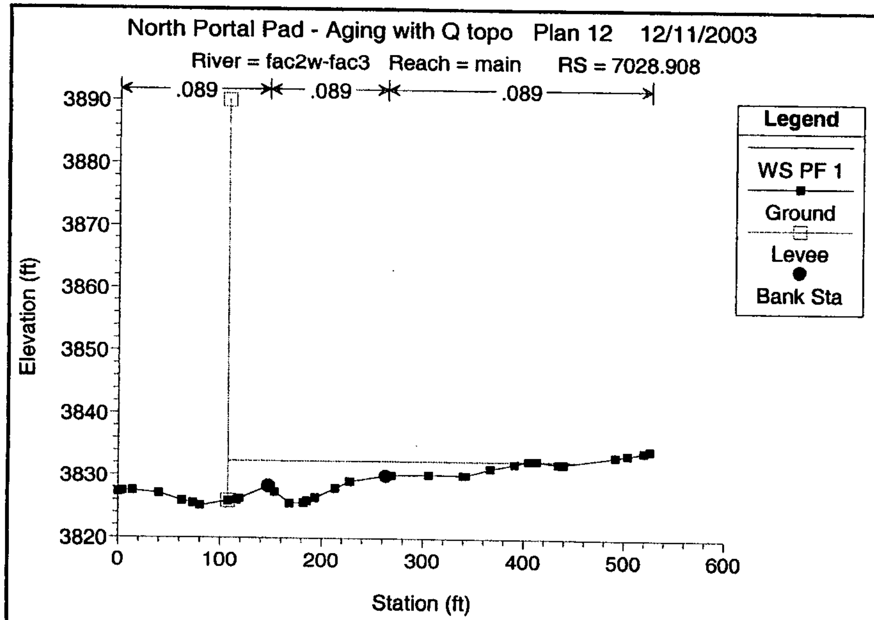
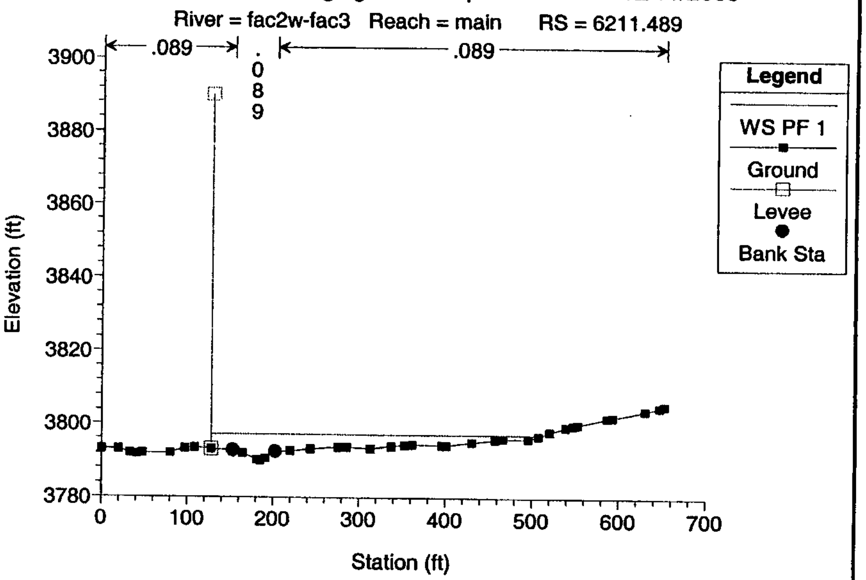
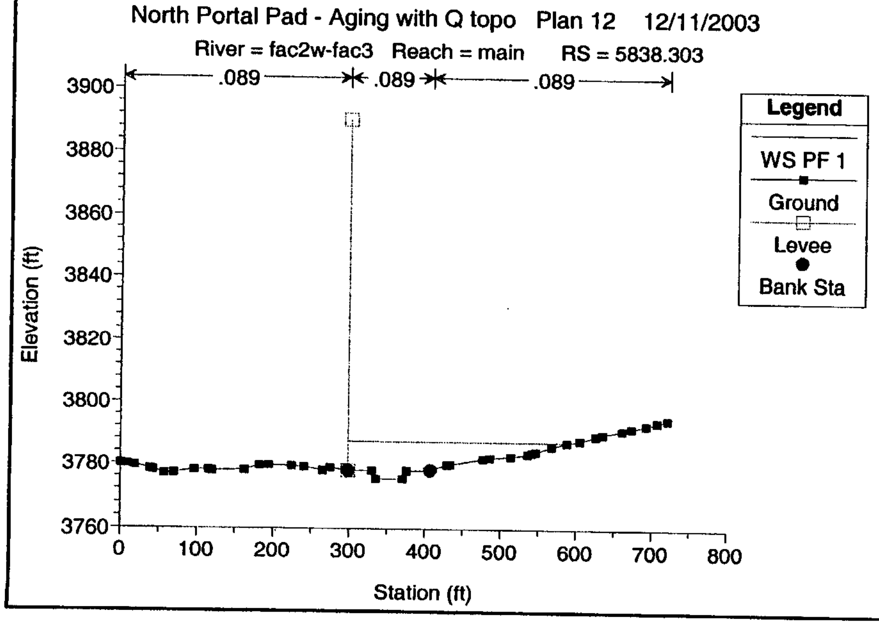

North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 8215.041
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3875
3880
3885
3890
3895
3900
3905
3910
3915
Station (ft)
0
100
200
300
400
500
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 8048.594
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3875
3880
3885
3890
3895
3900
3905
Station (ft)
0
50
100
150
200
250
300
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 7770.874
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3865
3870
3875
3880
3885
3890
Station (ft)
0
50
100
150
200
250
300
350
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 7443.768
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3840
3850
3860
3870
3880
3890
Station (ft)
0
50
100
150
200
250
300
350


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 7028.908
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3890
3880
3870
3860
3850
3840
3830
3820
Station (ft)
0
100
200
300
400
500
600


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 6211.489
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3900
3880
3860
3840
3820
3800
3780
Station (ft)
0
100
200
300
400
500
600
700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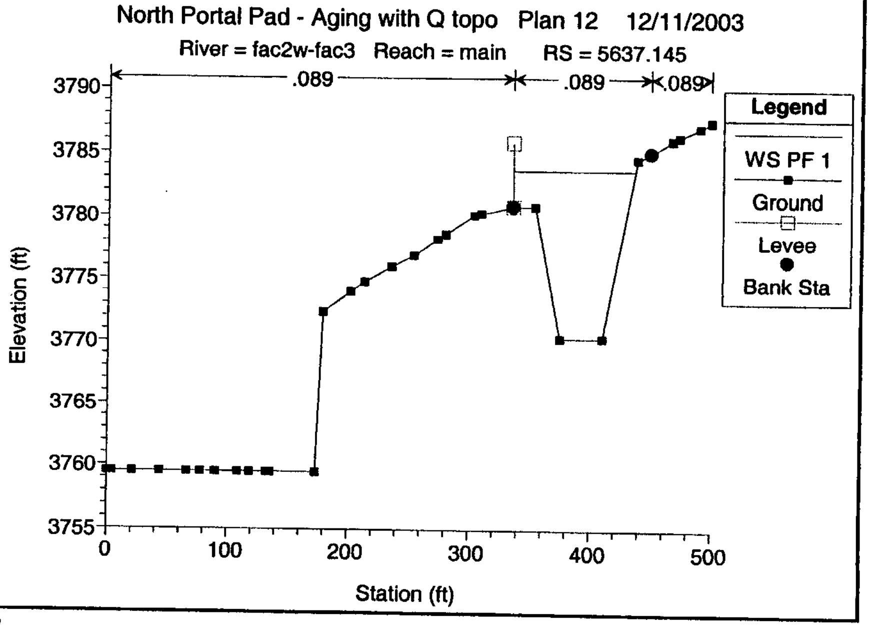
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3900
3880
3860
3840
3820
3800
3780
3760
Station (ft)
0
100
200
300
400
500
600
700
800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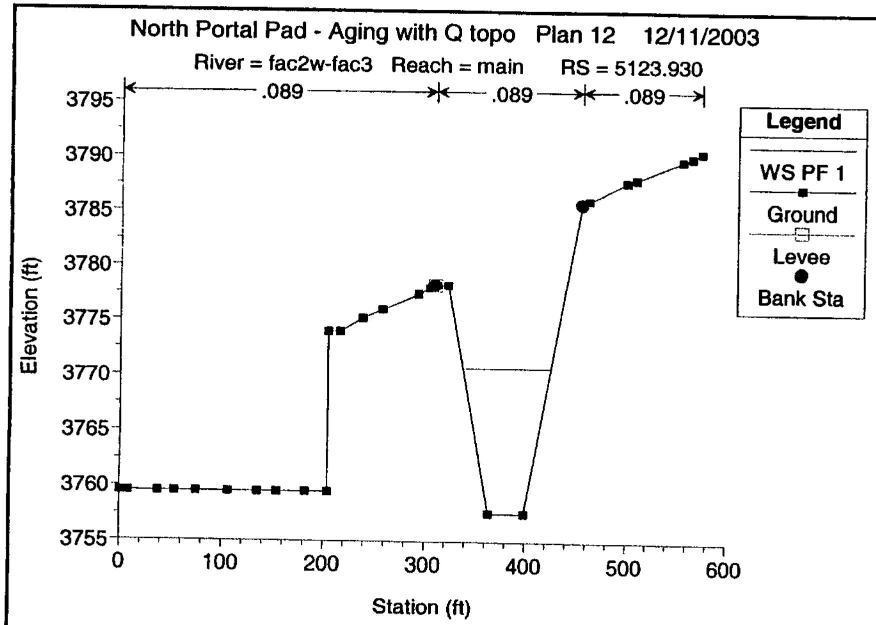
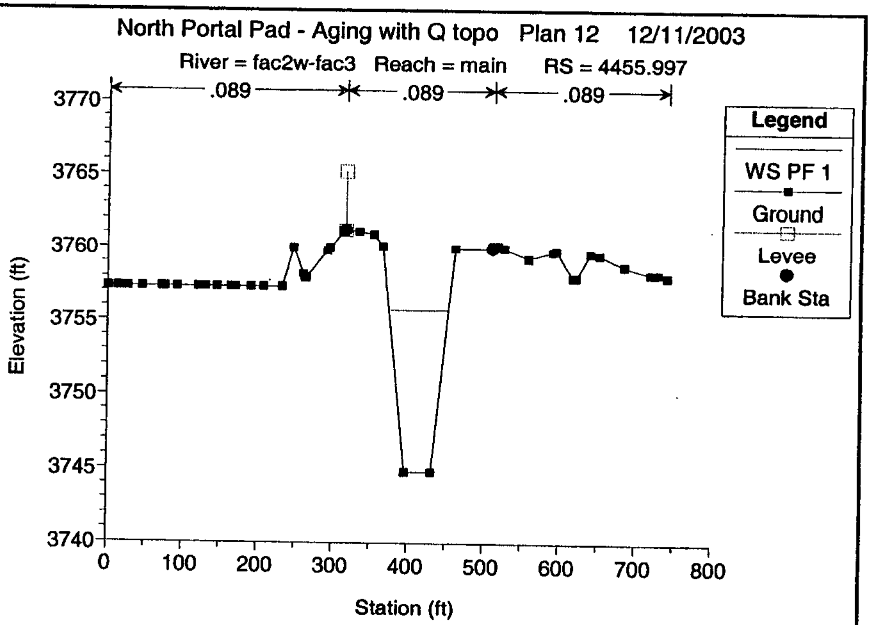
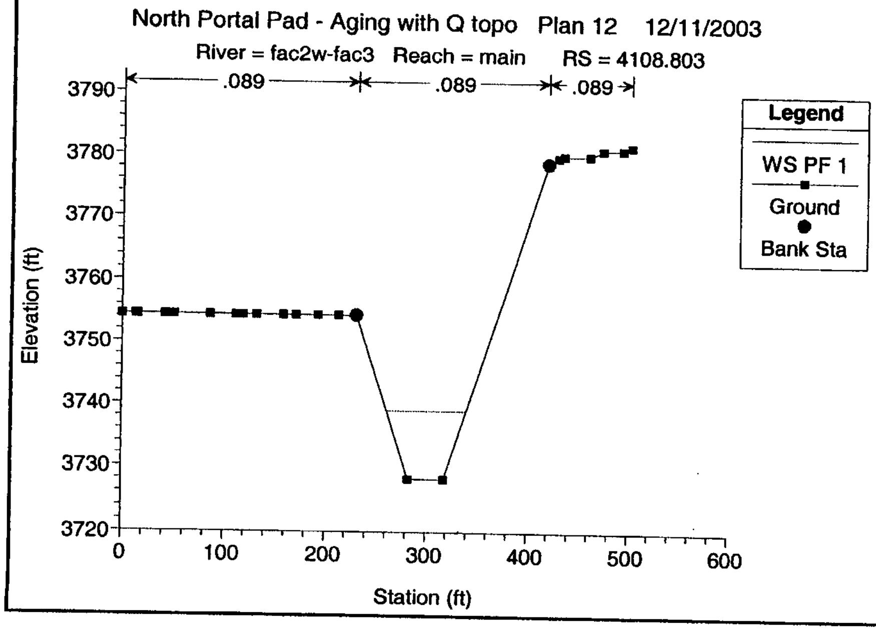
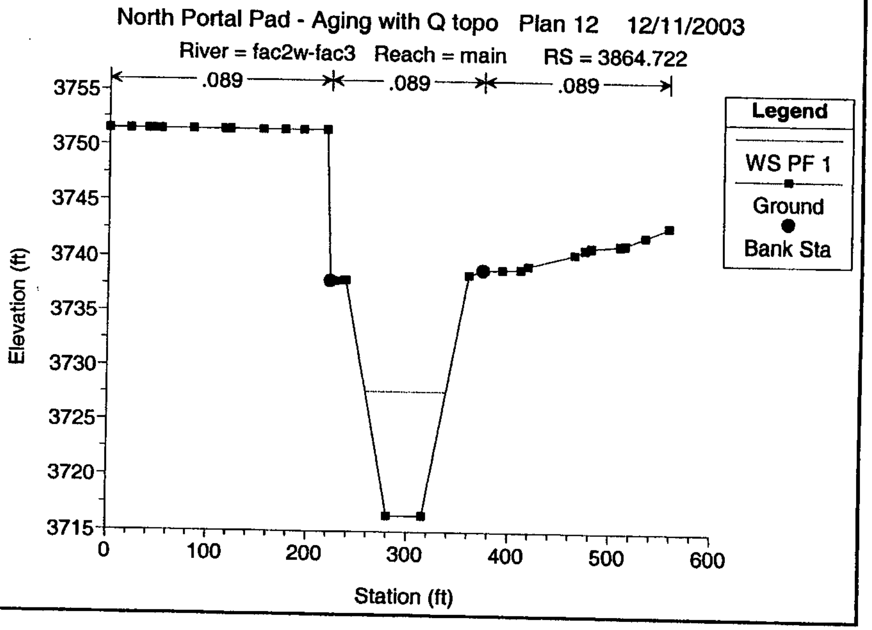
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3790
3785
3780
3775
3770
3765
3760
3755
Station (ft)
0
100
200
300
400
500


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 5123.930
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3795
3790
3785
3780
3775
3770
3765
3760
3755
Station (ft)
0
100
200
300
400
500
600

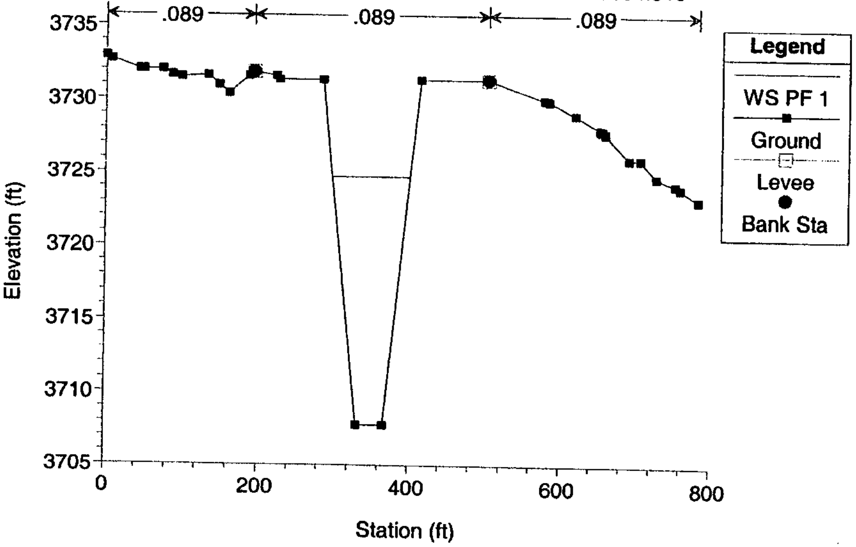

North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 4455.997
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3770
3765
3760
3755
3750
3745
3740
Station (ft)
0
100
200
300
400
500
600
700
800


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 4108.803
.089
.089
.089
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
3790
3780
3770
3760
3750
3740
3730
3720
Station (ft)
0
100
200
300
400
500
600

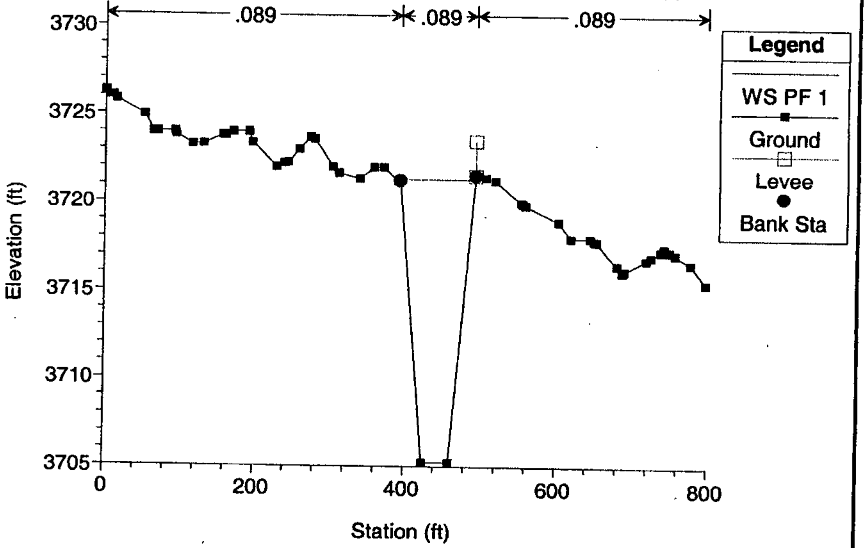

North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 3864.722
.089
.089
.089
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
3755
3750
3745
3740
3735
3730
3725
3720
3715
Station (ft)
0
100
200
300
400
500
600

10-5

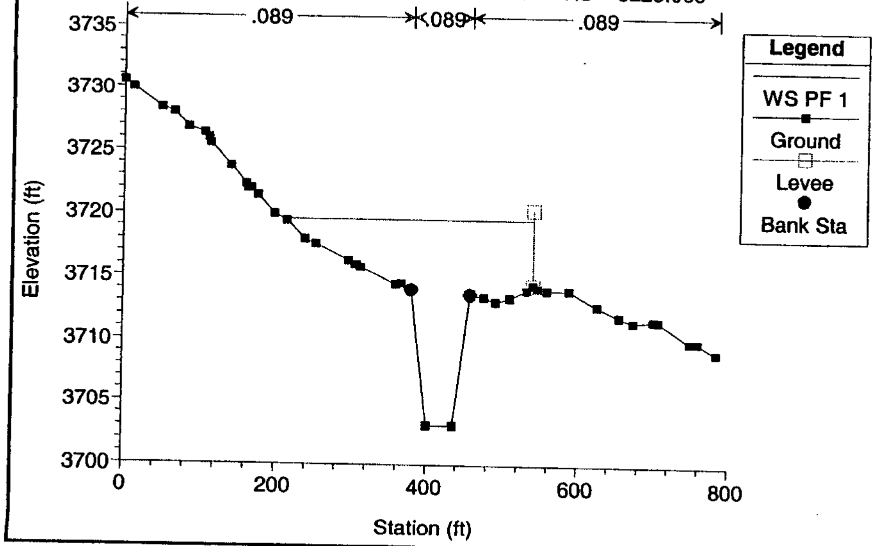
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 3684.510



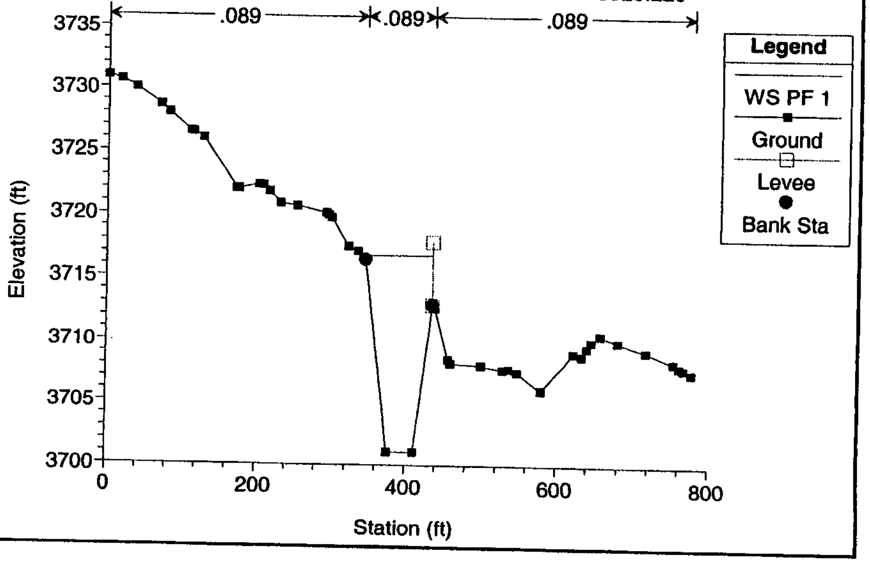
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 3440.055

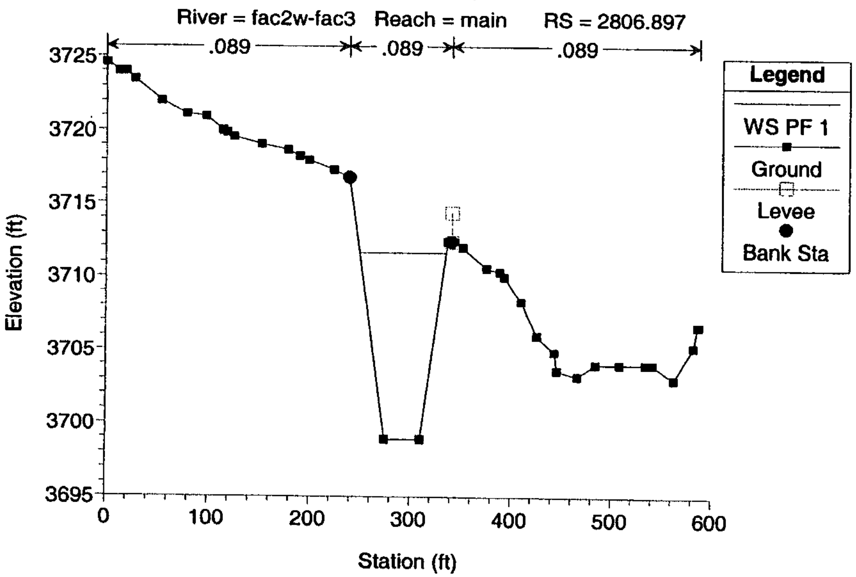


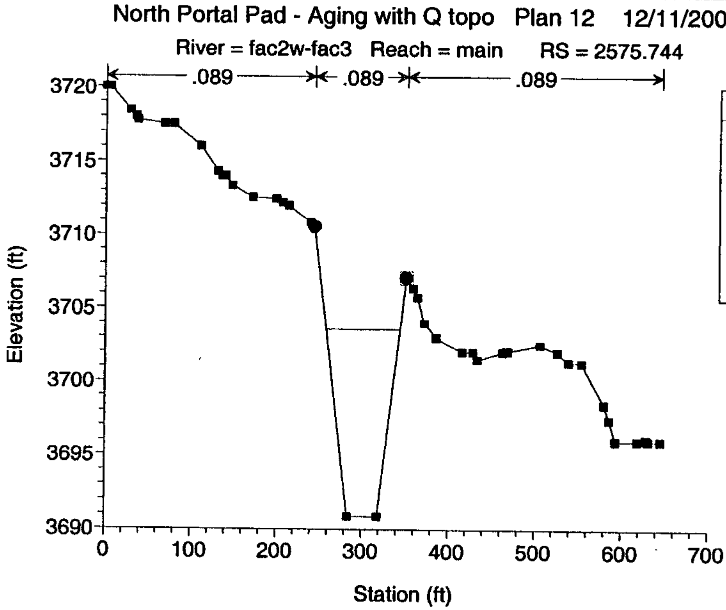
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 3225.065

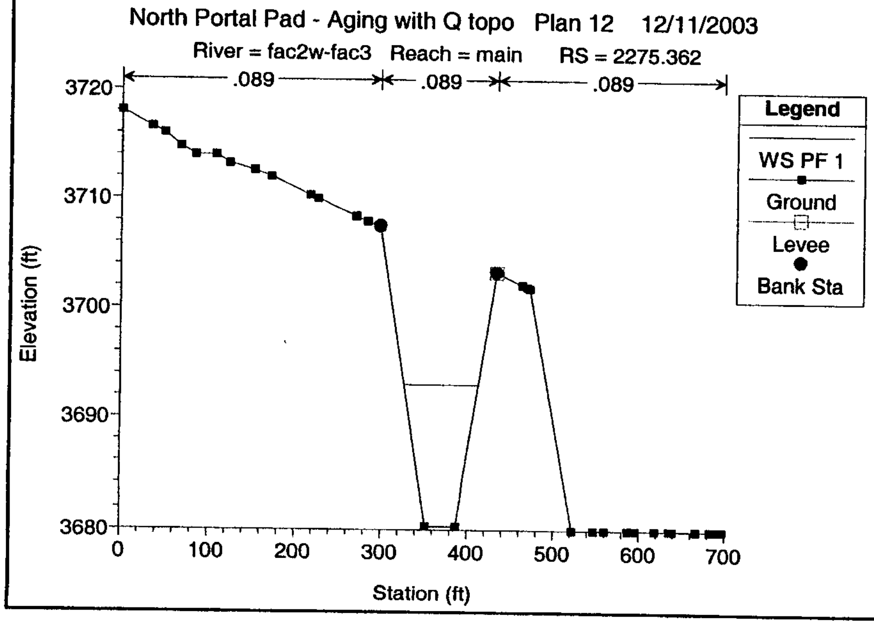


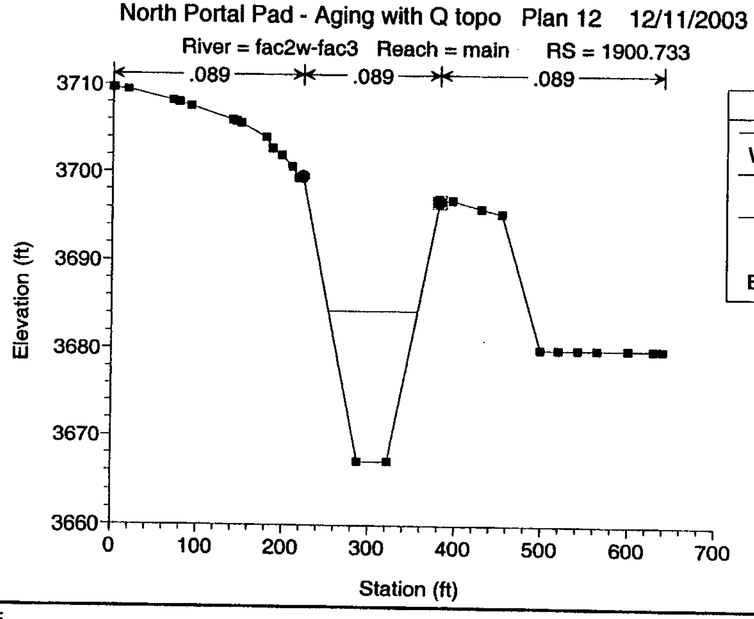
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 3020.229



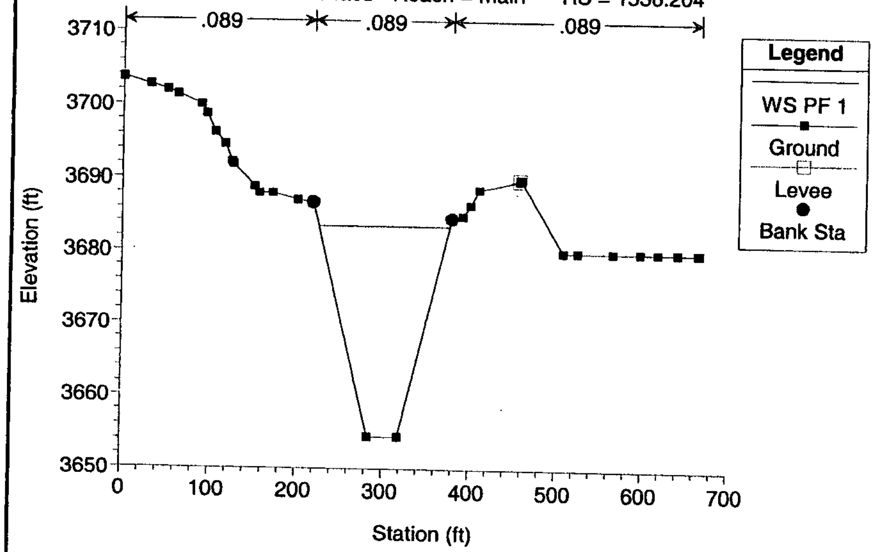

North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 2806.897
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3725
3720
3715
3710
3705
3700
3695
Station (ft)
0
100
200
300
400
500
600


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 2575.744
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3720
3715
3710
3705
3700
3695
3690
Station (ft)
0
100
200
300
400
500
600
700

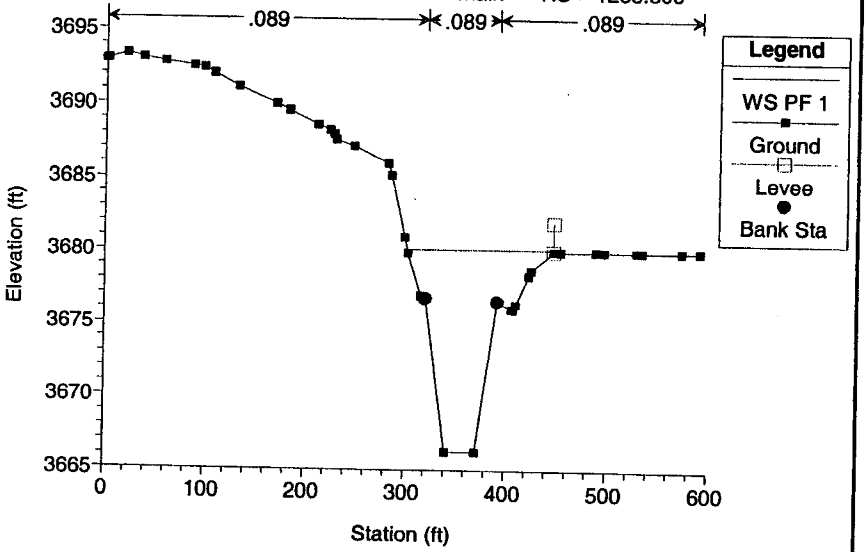

North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 2275.362
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3720
3710
3700
3690
3680
Station (ft)
0
100
200
300
400
500
600
700


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 1900.733
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3710
3700
3690
3680
3670
3660
Station (ft)
0
100
200
300
400
500
600
700

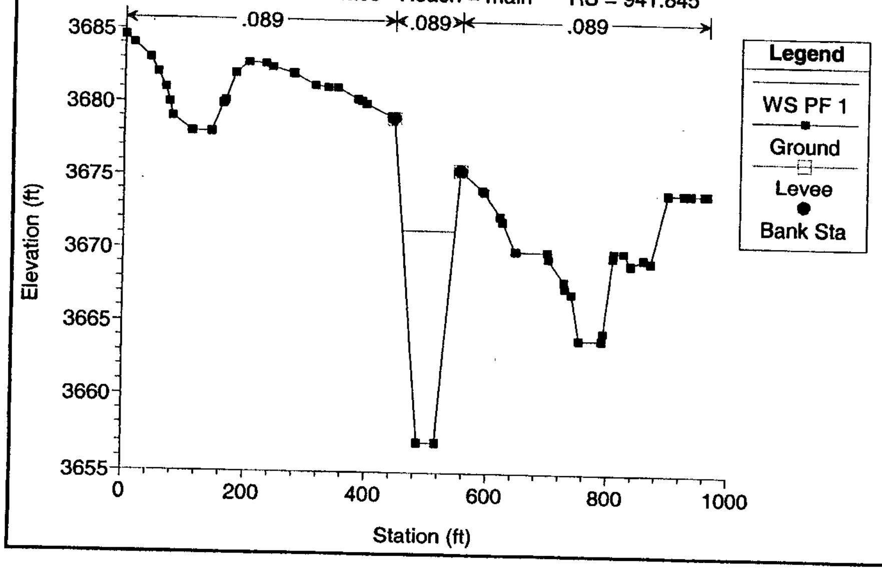
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 1536.204



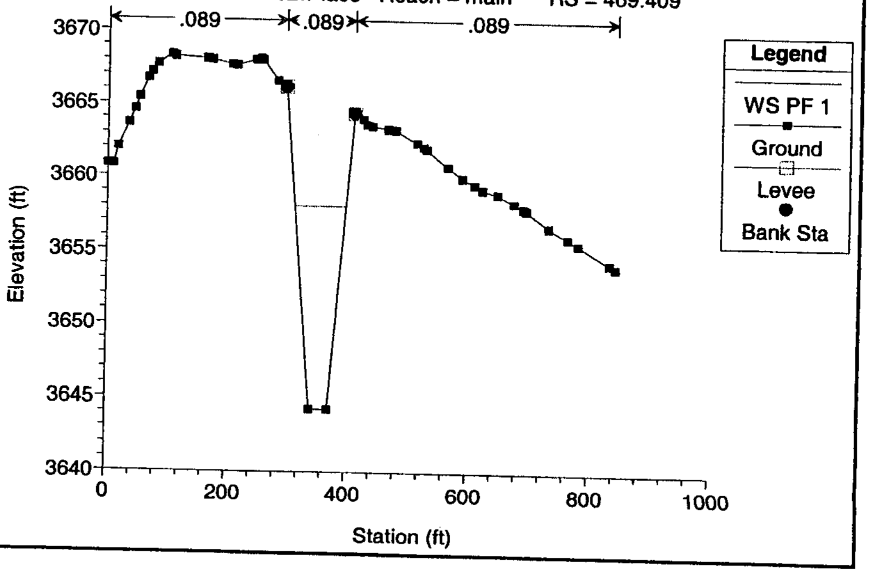
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 1283.309



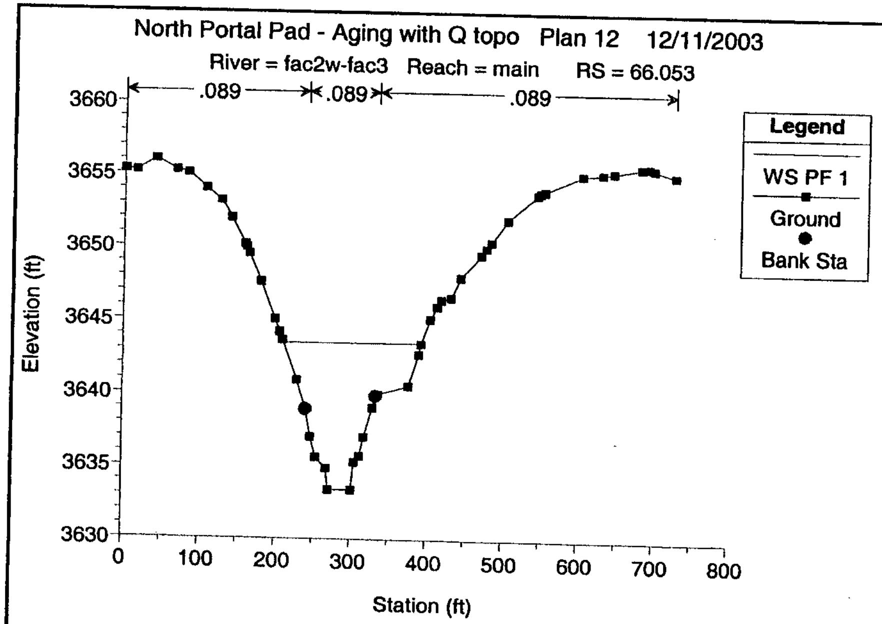
North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 941.845



North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 469.409



10-8


North Portal Pad - Aging with Q topo Plan 12 12/11/2003
River = fac2w-fac3 Reach = main RS = 66.053
.089
.089
.089
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
3660
3655
3650
3645
3640
3635
3630
0
100
200
300
400
500
600
700
800
Station (ft)

10-9

Calculations of Volume to be Excavated for North Portal Pad Channel

Delta Column			0			3			6			9			12			15			18		
Delta Row	0		18			15			12			6			7			4			5		
River Station	3684.51		3440.0552			3225.0647			3020.2293			2806.897			2575.7443			2275.362			1900.7328		
Bottom width	35		35	E40	E39	35	H37	H36	35	K34	K33	35	N28	N27	35	Q29	Q28	35	T26	T25	35	W27	W26
Top Width	129.24		99.57	E41	E38	77.88	H38	H35	89.51	K35	K32	97.72	N29	N26	106.91	Q30	Q27	135.61	T27	T24	158.69	W28	W25
Depth (L)	23.56		16.01	F39	F38	10.9	I36	I35	15.41	L33	L32	17.89	O27	O26	19.73	R28	R27	27.27	U25	U24	32.3	X26	X25
Depth (R)	23.56		16.27	F41	F40	10.54	I38	I37	11.85	L35	L34	13.47	O29	O28	16.23	R30	R29	23.03	U27	U26	29.54	X28	X27
Area	1934.747		1085.9799			605.0368			848.53565			1040.5248			1275.7709			2145.42075			2994.4474		
Volume (yds)			13,675			6,732			5,514			7,463			9,915			19,031			35,658		
	0	3732.88	0	3726.27		0	3730.56		0	3730.93		0	3724.59		0	3720		0	3718.01		0	3709.64	
Cross - Section																							
Data	6.88	3732.68	6.96	3726		0.16	3730.55		17.21	3730.62		0.25	3724.59		4.63	3720		0.37	3718		1.54	3709.61	
	44.05	3732	9.82	3726		11.25	3730		37.28	3730		12.08	3724		28.06	3718.4		34.41	3716.59		17.25	3709.42	
	48.78	3732	14.21	3725.8		48.83	3728.37		70.35	3728.62		18.79	3724		35.02	3718		48.86	3716		70.18	3708.19	
	73.52	3732	51.53	3724.93		64.65	3728		81.67	3728		27.72	3723.47		36.69	3717.76		67.52	3714.78		76.29	3708.05	
	86.36	3731.65	63.84	3724		83.89	3726.86		110.67	3726.55		53.73	3722		68	3717.49		84.47	3714		77.49	3708	
	98.25	3731.51	69.46	3724		104.93	3726.41		114.02	3726.48		78.65	3721.12		78.89	3717.5		108.24	3714		91.27	3707.57	
	132.91	3731.62	92.64	3724		110.49	3726		127.51	3726		97.41	3720.94		110.43	3716		123.78	3713.21		139.64	3706	
	147.47	3730.94	93.76	3723.85		113.02	3725.57		172.43	3722.02		114.35	3720		130.73	3714.31		152.38	3712.61		144	3705.83	
	160.47	3730.38	116.33	3723.28		139.59	3723.77		172.61	3722.01		118.36	3719.84		135.78	3714		171.84	3712		149.59	3705.64	
	186.97	3731.6	130.93	3723.31		160.04	3722.33		172.73	3722		124.98	3719.57		139.18	3714		216.7	3710.28		178.94	3704	
	193.86	3731.86	156.49	3723.83		162	3722		175.08	3722		152.19	3719.07		147.45	3713.34		225.56	3710		186.46	3702.76	
	222.62	3731.6	159.99	3723.8		165.83	3722		201.8	3722.32		178.16	3718.69		171.66	3712.55		269.76	3708.43		197.3	3702	
	226.37	3731.34	170.69	3724		175.21	3721.44		207.79	3722.27		189.96	3718.25		198.79	3712.45		282.96	3708		209.58	3700.67	
	283.68	3731.34	191.26	3724		197.31	3720		216.1	3721.79		199.03	3718		206.28	3712.2		297.4	3707.58		217.07	3699.34	
	283.84	3731.34	195.82	3723.39		213.93	3719.47		231.27	3720.88		223.58	3717.32		213.17	3712		351.95	3680.31		222.4	3699.5	
	330.96	3707.78	228.35	3722		237.49	3718		253.12	3720.66		238.93	3716.81		238.85	3710.86		386.95	3680.31		287.01	3667.2	
	365.96	3707.78	238.58	3722.23		251.84	3717.62		291.96	3720.14		274.71	3698.92		243.79	3710.56		433.01	3703.34		322.01	3667.2	
	413.08	3731.34	243.91	3722.26		295.44	3716.31		295.28	3720		309.71	3698.92		283.24	3690.83		462.66	3702.22		381.09	3696.74	
	413.24	3731.34	258.52	3723.02		303.7	3716		299.2	3719.77		336.65	3712.39		318.24	3690.83		468.58	3702		395.78	3696.92	
	503.06	3731.34	273.58	3723.74		305.66	3716		322.22	3717.5		340.91	3712.39		350.7	3707.06		471.37	3701.9		429.33	3696	
	576.79	3730	278.73	3723.62		311.04	3715.8		334.65	3717.16		351.88	3712		358.73	3706.36		522.4	3680		452.8	3695.42	
	580.22	3729.96	303.28	3722		357.49	3714.42		344.92	3716.46		375.32	3710.6		363.6	3705.73		547.37	3680		498.64	3680	
	581.07	3729.95	311.49	3721.67		365.21	3714.51		375.74	3701.05		388.61	3710.34		371.41	3704		559.92	3680		519.15	3680	
	583.08	3729.89	338.93	3721.35		377.71	3714		410.74	3701.05		393.15	3710		385.58	3702.99		587.11	3680		541.61	3680	
	618.22	3729	358.19	3722		378.52	3714		434.43	3712.9		409.79	3708.31		416.02	3702		596.04	3680		564.11	3680	
	651.23	3728	370.64	3722		400.32	3703.1		437.05	3712.69		425.48	3705.99		428.19	3702		618.41	3680		599.66	3680	
	653.77	3727.94	390.18	3721.21		435.32	3703.1		455.48	3708.49		443.27	3704.88		433.43	3701.48		635.53	3680		628.77	3680	
	658.29	3727.74	392.99	3721.26		456.4	3713.64		458.44	3708.2		445.7	3703.59		462.44	3702		638.83	3680		639.69	3680	
	689.87	3726	425.02	3705.25		474.78	3713.45		498.7	3708.04		465.98	3703.21		467.15	3702.09		666.5	3680				
	705.18	3726	460.02	3705.25		490.29	3713.09		499.15	3708		484.09	3704		468.37	3702.07		683.22	3680				
	726.23	3724.75	492.56	3721.52		508.94	3713.39		499.36	3707.99		508.19	3704		505.85	3702.52		686.15	3680				
	752.04	3724.22	505.85	3721.41		531.63	3714		527.63	3707.66		534.06	3704		525.92	3702		688.74	3680				
	758.56	3724	518.6	3721.25		539.8	3714.4		535.36	3707.75		541.18	3704		538.94	3701.31		697.09	3680				
	782.5	3723.22	553.43	3720		545.54	3714.15		547.05	3707.49		562.39	3703.02		554.15	3701.27							
			555.07	3719.95		557.76	3714		578.44	3706		582.21	3705.24		580	3698.44							
			558.41	3719.86		587.34	3714		621.54	3709.02		586.07	3706.67		586.46	3697.42							
			602.32	3718.95		624.77	3712.8		632.27	3708.83		587.35	3706.66		593.24	3696							
			618.9	3718		654.53	3712		639.19	3709.45					618.51	3696							
			644.44	3718		673.52	3711.56		644.55	3710					628.7	3696.09							
			649.32	3717.85		700.15	3711.72		656.46	3710.57					629.9	3696.06							
			652.53	3717.81		706.53	3711.66		679.81	3710					631.43	3696							
			679.6	3716.45		748.84	3710		717.24	3709.21					645.15	3696							
			687.04	3716.09		751.08	3710		753.36	3708.31													
			688.07	3716.11		759.4	3710		761.18	3708													
			689.62	3716.16		784.06	3709.1		766.06	3707.81													
			718.22	3716.8					777.13	3707.49													
			724.46	3716.97																			
			737.53	3717.29																			
			742.13	3717.47																			
			748.87	3717.28																			
			756.54	3717.12																			
			776.69	3716.57																			
			797.1	3715.47																			

Calculations of Volume to be Excavated for North Portal Pad Channel

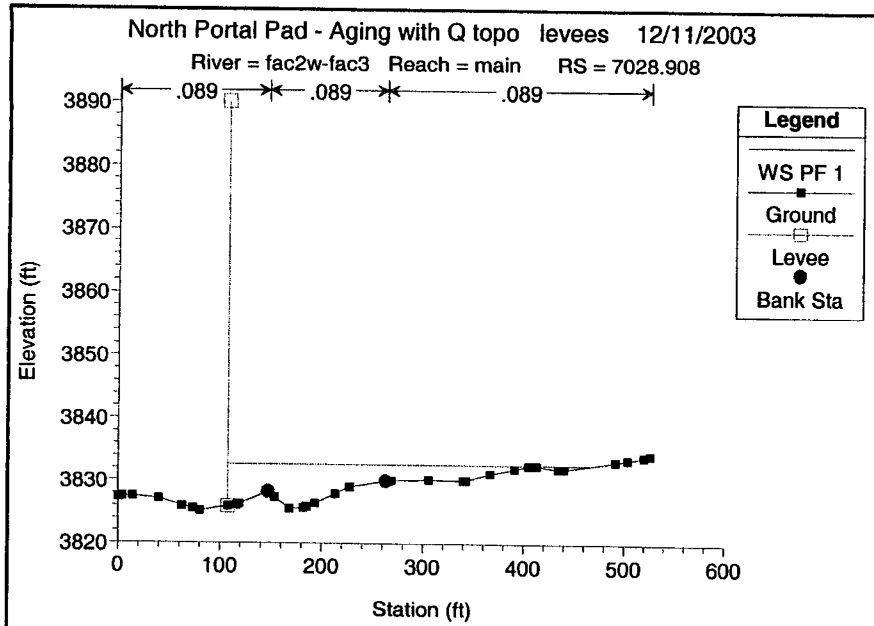
Delta Column	21			24			27			30			33						
Delta Row	4			11			18			12			11						
River Station	1536.2041			1283.3092			941.845			469.4095			66.05						
Bottom width	35	Z26	Z25	30	AC33	AC32	30	AF40	AF39	30	AI34	AI33	30	AL33	AL32				
Top Width	159.71	Z27	Z24	71.59	AC34	AC31	110.9	AF41	AF38	114.09	AI35	AI32	36.85	AL34	AL31	Total Volume	Max Value	MinValue	Average
Depth (L)	32.27	AA25	AA24	10.5	AD32	AD31	21.99	AG39	AG38	21.9	AJ33	AJ32	1.5	AM32	AM31		32.3	10.5	20.8
Depth (R)	30.08	AA27	AA26	10.29	AD34	AD33	18.46	AG41	AG40	20.14	AJ35	AJ34	1.92	AM34	AM33		30.08	10.29	18.6
Area	3035.042125			528.014025			1424.85125			1514.386			57.15675						
Volume (yds)	40,702			16,687			12,349			25,715			11,739			205,179			
	0	3703.6		0	3692.92		0	3684.56		0	3660.84		0	3655.27					
Cross - Section																			
Data	30.8	3702.66		1.93	3692.95		14.41	3684		0.12	3660.85		1.31	3655.26					
	49.84	3702		20.68	3693.31		41.24	3683.01		5.74	3660.84		15.27	3655.19					
	62.01	3701.38		36.98	3693.06		53.83	3682		9.39	3660.79		40.4	3656					
	89.03	3700		58.79	3692.77		66.41	3680.99		17.17	3662		41.09	3656					
	95.71	3698.74		87.32	3692.49		73.27	3680		35.15	3663.63		67.56	3655.24					
	105.05	3696.24		97.88	3692.4		78.88	3679.02		44.77	3664.59		83.16	3655.07					
	116.55	3694.63		108.05	3692		110.23	3678		52.36	3665.4		106.62	3654					
	124.75	3692.24		132.5	3691.14		110.37	3678.01		66.55	3666.7		126.75	3653.18					
	126.16	3691.88		170.26	3690		110.93	3678		72.52	3667.16		139.98	3652					
	150.9	3688.86		183.06	3689.59		142.08	3678		82.31	3667.69		157.87	3650.18					
	156.39	3688		211.83	3688.6		160.74	3679.93		105.87	3668.32		159.87	3650					
	171.72	3688		223.82	3688.25		162.24	3680		111.24	3668.2		163.7	3649.54					
	200.35	3687.05		228.08	3688		164.78	3680.16		163.9	3668.05		179.3	3647.6					
	218.64	3686.71		230.16	3687.63		181.2	3682		165.5	3668.06		198.72	3645.06					
	283.19	3654.44		247.81	3687.18		202.02	3682.76		172.65	3668		204.8	3644.2					
	318.19	3654.44		282.16	3686		230.4	3682.68		206.33	3667.67		208.58	3643.66					
	378.35	3684.52		285.63	3685.23		241.36	3682.43		213.53	3667.64		228.01	3640.93					
	391.15	3684.85		299.51	3680.97		274.95	3682.03		246.14	3668		239.79	3638.93					
	400.01	3686.47		302.69	3679.88		275.8	3682.03		254.18	3668.09		246.72	3637.03					
	410.06	3688.61		315.46	3676.93		276.64	3682		256.93	3668		253.8	3635.61					
	456.62	3689.93		320.19	3676.74		311.48	3681.22		282.46	3666.57		268.01	3634.87					
	457.71	3690		341.2	3666.24		332.38	3681.09		296.57	3666.16		271.02	3633.37					
	458.08	3689.99		371.2	3666.24		348.4	3681.08		340.37	3644.26		301.02	3633.37					
	458.99	3689.96		391.78	3676.53		381.8	3680.31		370.37	3644.26		304.86	3635.29					
	507.79	3680		406.01	3676		388.24	3680.2		410.66	3664.4		311.37	3635.71					
	524.53	3680		406.96	3675.99		395.53	3680		424.75	3664		316.84	3637.03					
	565.62	3680		407.4	3676		436.96	3679.16		431.33	3663.61		328.13	3639.05					
	597.54	3680		409.8	3676.34		442.07	3679.01		439.55	3663.54		332.24	3639.85					
	618.15	3680		422.83	3678.31		486.05	3657.02		466.23	3663.35		332.7	3639.95					
	640.99	3680		425.35	3678.69		516.05	3657.02		478.41	3663.3		335.09	3640					
	664.7	3680		447.3	3680		552.97	3675.48		514.36	3662.44		374.91	3640.59					
	666.65	3680		448.68	3680		589.6	3674.13		524.8	3662.15		388.16	3642.73					
				454.29	3680		592.49	3674		530.1	3662		390.96	3643.47					
				489.29	3680		618.92	3672.34		565.66	3660.79		403.15	3645.13					
				497.2	3680		623.52	3672		589.84	3660		411.77	3646					
				529.41	3680		644.49	3670.04		610.11	3659.57		417.28	3646.47					
				531.92	3680		644.99	3670.02		623.42	3659.25		429.9	3646.64					
				534.47	3680		646.33	3670		648.88	3658.96		442.39	3648					
				573.97	3680		698.24	3670		675.78	3658.34		469.08	3649.56					
				591.99	3680		699.97	3669.55		690.86	3658		476.12	3650					
							726.65	3668		693.25	3657.95		482.07	3650.44					
							728.19	3667.54		696.26	3657.87		503.77	3652					
							739.3	3667.15		733.44	3656.74		542.87	3653.74					
							753.11	3664		764.85	3656		547.02	3653.9					
							790.53	3664		782.56	3655.57		552.17	3654					
							792.45	3664.53		835.02	3654.29		602.15	3655.1					
							807.31	3669.68		844.62	3654.03		628.99	3655.23					
							808.22	3670					643.87	3655.34					
							824.9	3670					680.79	3655.68					
							837.04	3669.18					690.48	3655.72					
							858.35	3669.6					697.49	3655.6					
							870	3669.36					725.98	3655.13					
							897.2	3674											
							923.66	3674											
							927.98	3674											
							935.5	3674											
							958.97	3674											
							962.7	3674											

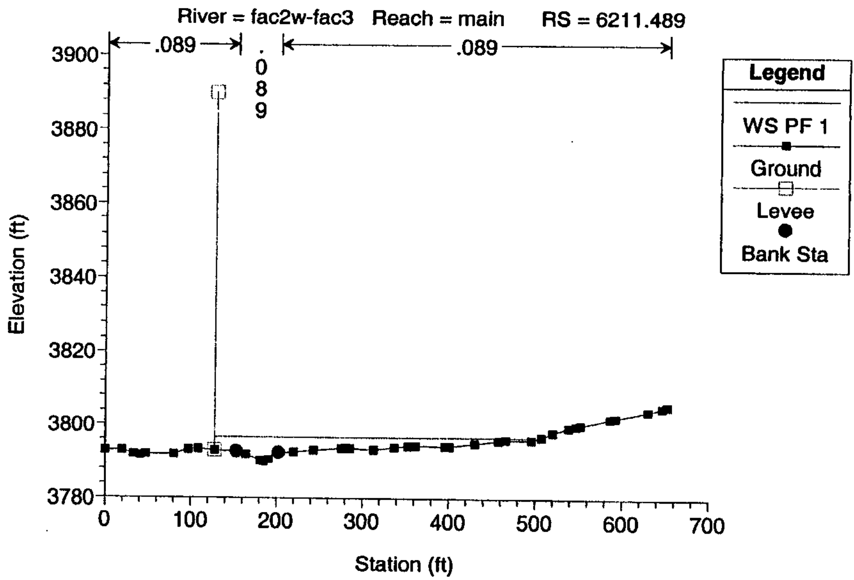
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: lev  River: fac2w-fac3  Reach: main

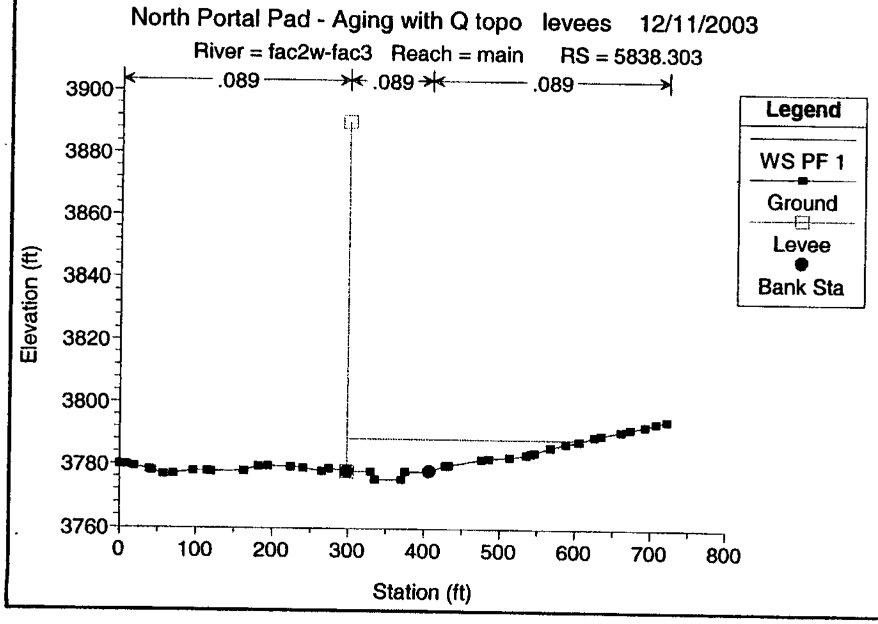
# Rivers           = 1
# Hydraulic Reaches = 1
# River Stations    = 27
# Plans            = 1
# Profiles         = 1

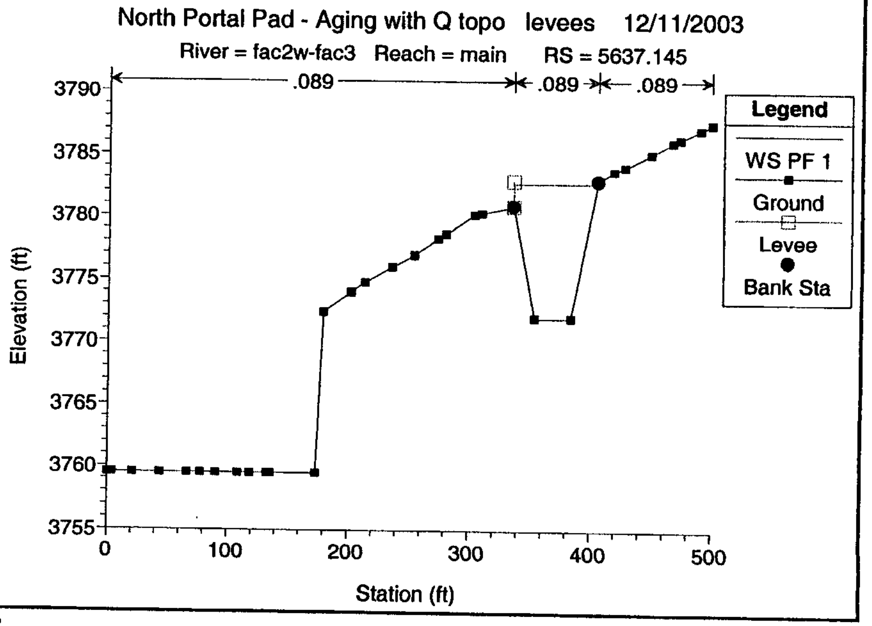
 Reach            River Sta           Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                        (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

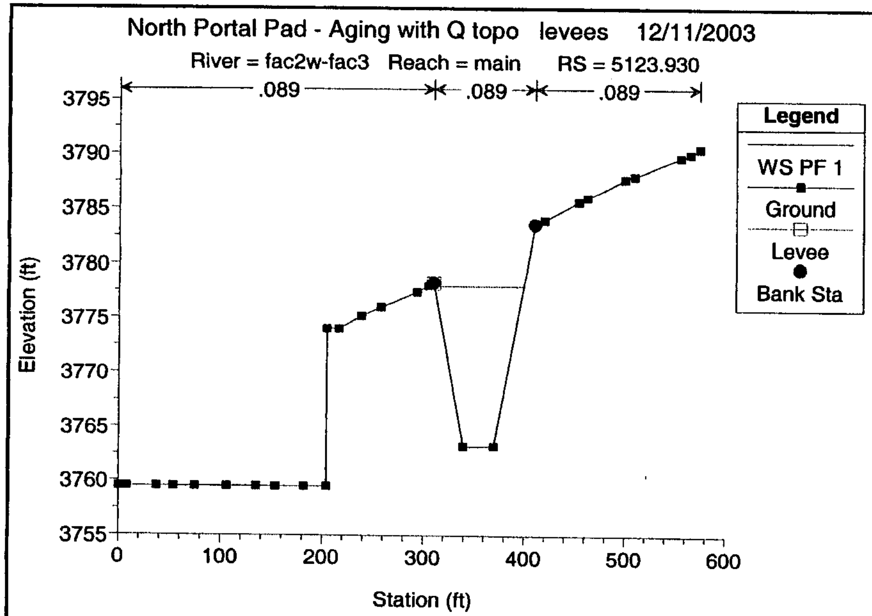
 main             8215.041            8636.00    3885.44    3891.74    3886.43    3892.00   0.003481       3.29    2219.06     297.80          0.23
 main             8048.594            8636.00    3887.62    3887.77    3887.77    3890.21   0.074641       0.80     688.78     143.01          0.52
 main             7770.874            8636.00    3865.13    3873.20    3872.62    3874.83   0.040449      10.60     891.78     202.47          0.76
 main             7443.768            8636.00    3844.00    3856.14    3856.14    3858.18   0.065561      13.88     771.04     172.88          0.74
 main             7028.908            8636.00    3825.63    3832.65    3832.14    3833.84   0.037487       9.31    1094.00     359.98          0.74
 main             6211.489            8636.00    3790.00    3796.64    3796.64    3797.86   0.052309      11.58    1068.69     377.00          0.89
 main             5838.303            8636.00    3775.40    3788.43    3782.77    3788.68   0.003269       4.51    2302.78     312.78          0.24
 main             5637.145            8636.00    3771.98    3782.64    3782.64    3786.56   0.064877      15.87     544.07      69.03          1.00
 main             5123.930            8636.00    3763.26    3777.96    3774.02    3779.48   0.018437       9.89     872.81      88.78          0.56
 main             4823                8636.00    3758.14    3773.61    3768.41    3774.77   0.012899       8.64    1000.03      95.59          0.47
 main             4685                8636.00    3755.80    3767.24    3767.24    3771.10   0.064256      15.77     547.71      70.76          1.00
 main             4455.997            8636.00    3751.90    3764.44    3761.18    3764.63   0.004262       3.69    2481.61     425.34          0.26
 main             4108.803            8636.00    3746.00    3756.42    3756.42    3760.47   0.066421      16.15     534.63      65.50          1.00
 main             3864.722            8636.00    3737.87    3742.83    3742.24    3743.84   0.035385       8.81    1141.07     334.48          0.72
 main             3684.510            9910.00    3730.02    3733.57    3733.53    3734.66   0.074547       8.81    1202.36     503.06          0.94
 main             3440.055            9910.00    3721.78    3727.18    3725.39    3727.60   0.014582       5.65    1918.27     461.91          0.43
 main             3225.065            9910.00    3713.81    3726.88    3718.20    3726.97   0.000972       2.87    4235.01     448.13          0.14
 main             3020.229            9910.00    3714.00    3726.06    3722.19    3726.51   0.007600       6.45    1935.10     294.72          0.33
 main             2806.897            9910.00    3712.88    3722.95    3721.60    3723.88   0.022123       9.32    1372.74     289.87          0.56
 main             2575.744            9910.00    3708.76    3718.95    3715.98    3719.57   0.015308       7.01    1581.93     290.21          0.39
 main             2275.362            9910.00    3704.24    3714.20    3711.86    3714.94   0.015431       8.20    1581.54     328.55          0.48
 main             1900.733            9910.00    3695.65    3701.94    3701.94    3704.44   0.062605      13.17     804.57     163.04          0.96
 main             1536.204            9910.00    3684.24    3691.14    3689.54    3691.84   0.019907       8.24    1503.77     324.40          0.57
 main             1283.309            9910.00    3676.00    3687.82    3682.62    3688.60   0.008857       8.06    1513.21     196.26          0.42
 main             941.845             9910.00    3676.42    3684.19    3682.55    3684.62   0.015100       6.78    1959.36     515.62          0.45
 main             469.409             9910.00    3665.22    3669.35    3669.35    3670.72   0.078687      11.15    1069.45     375.79          0.98
 main             66.053              9910.00    3634.00    3643.76    3643.05    3645.62   0.031040      11.59     982.56     185.25          0.73
```


North Portal Pad - Aging with Q topo levees 12/11/2003
River = fac2w-fac3 Reach = main RS = 7028.908
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3890
3880
3870
3860
3850
3840
3830
3820
Station (ft)
0
100
200
300
400
500
600

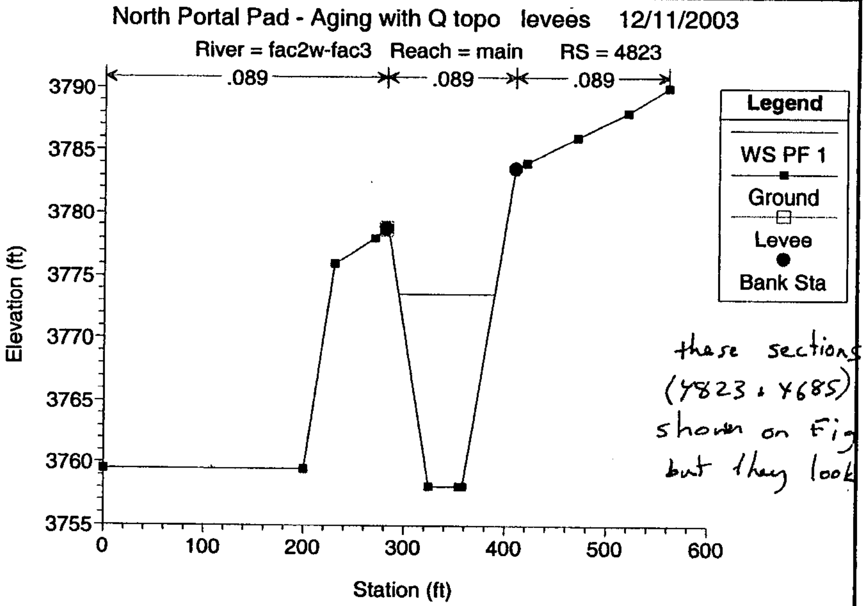

North Portal Pad - Aging with Q topo levees 12/11/2003
River = fac2w-fac3 Reach = main RS = 6211.489
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3900
3880
3860
3840
3820
3800
3780
Station (ft)
0
100
200
300
400
500
600
700


North Portal Pad - Aging with Q topo levees 12/11/2003
River = fac2w-fac3 Reach = main RS = 5838.303
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3900
3880
3860
3840
3820
3800
3780
3760
Station (ft)
0
100
200
300
400
500
600
700
800


North Portal Pad - Aging with Q topo levees 12/11/2003
River = fac2w-fac3 Reach = main RS = 5637.145
.089
.089
.089
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3790
3785
3780
3775
3770
3765
3760
3755
Station (ft)
0
100
200
300
400
500

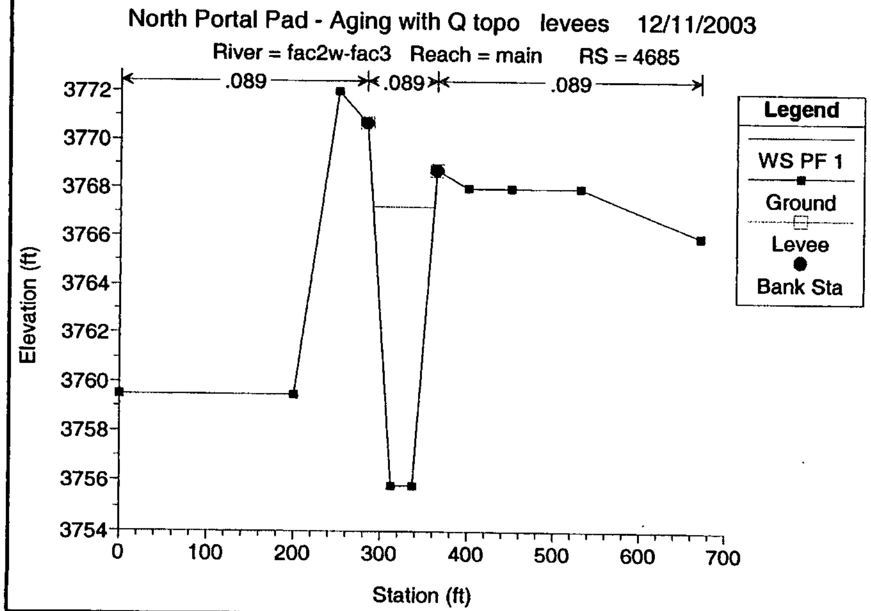

North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 5123.930

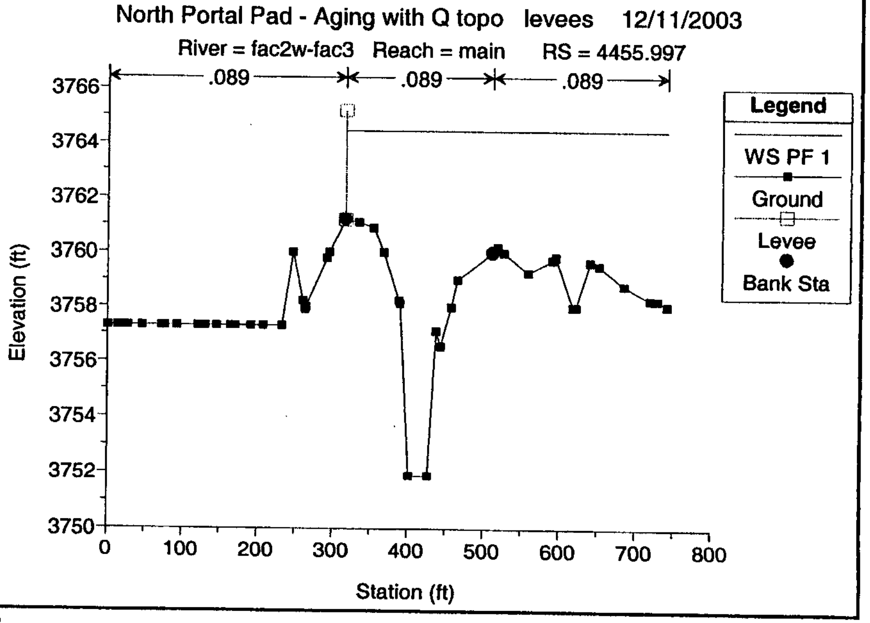

North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 4823

these sections (4823 + 4685) aren't shown on Fig 5-6, but they look OK.


North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 4685

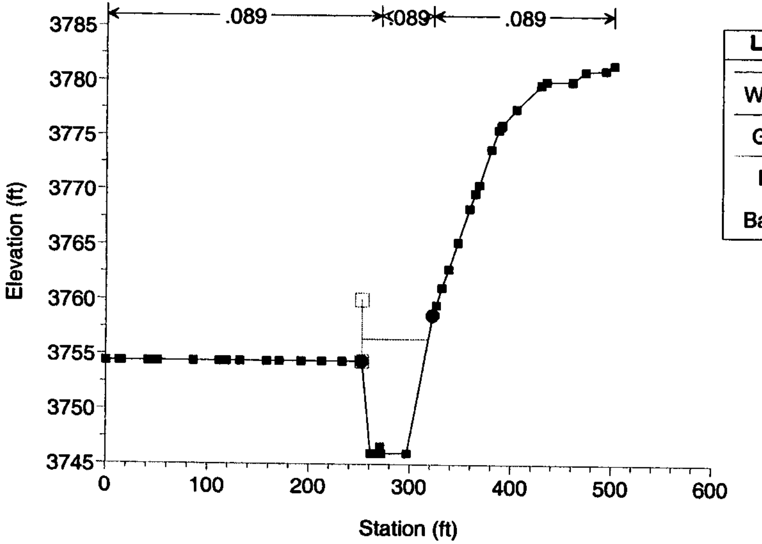

North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 4455.997

10-15

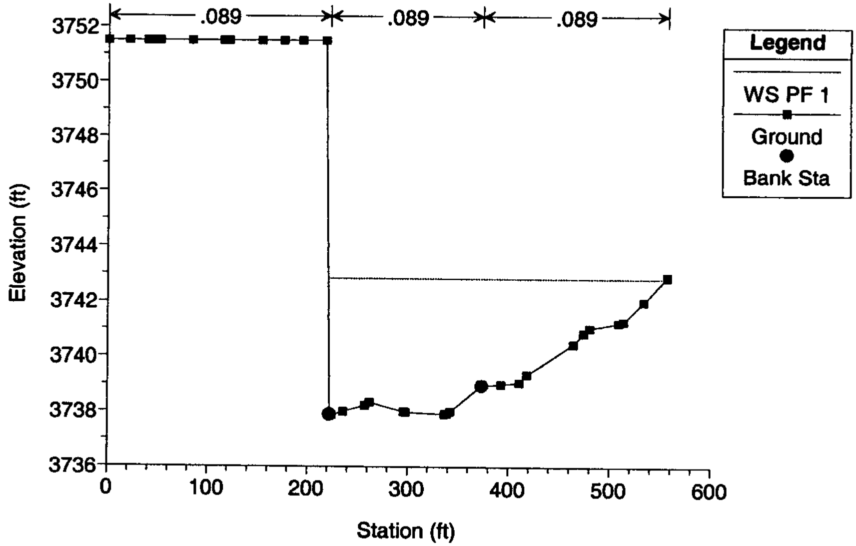
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 4108.803



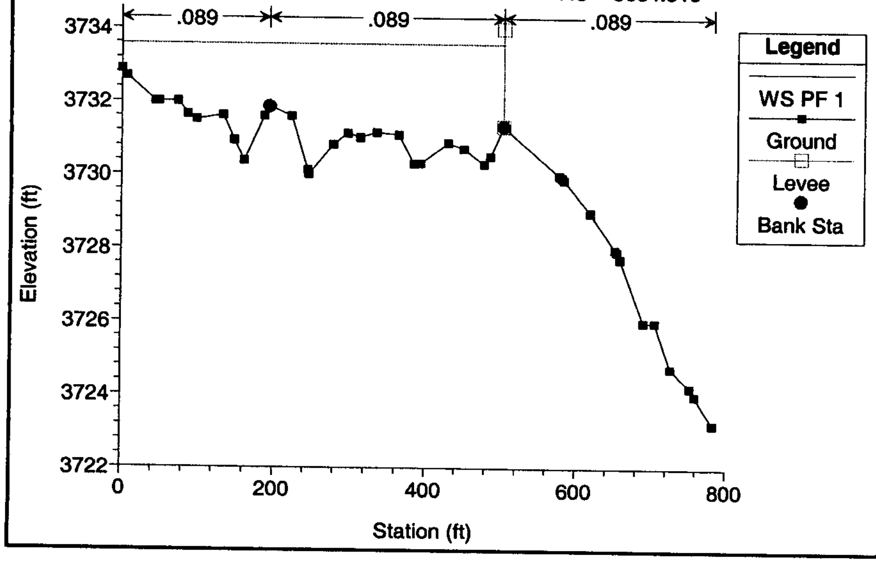
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 3864.722



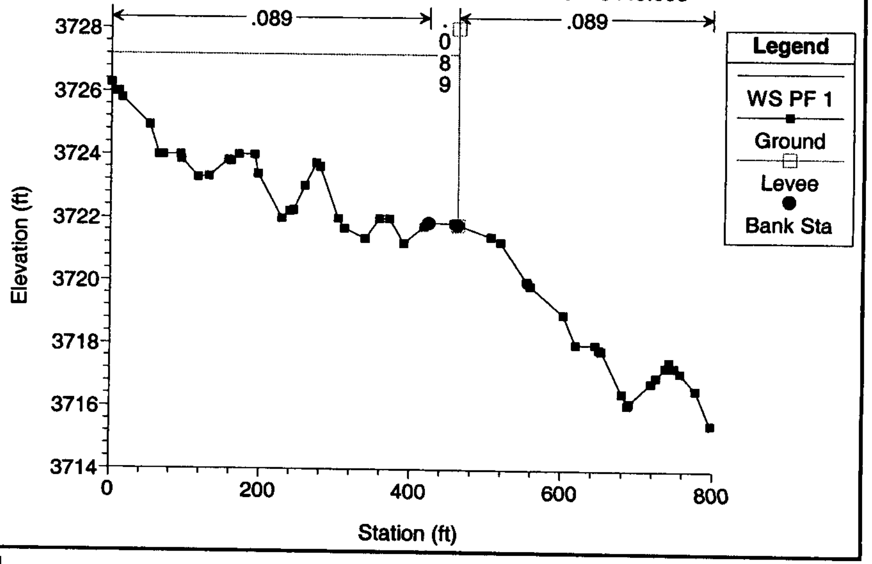
North Portal Pad - Aging with Q topo levees 12/11/2003

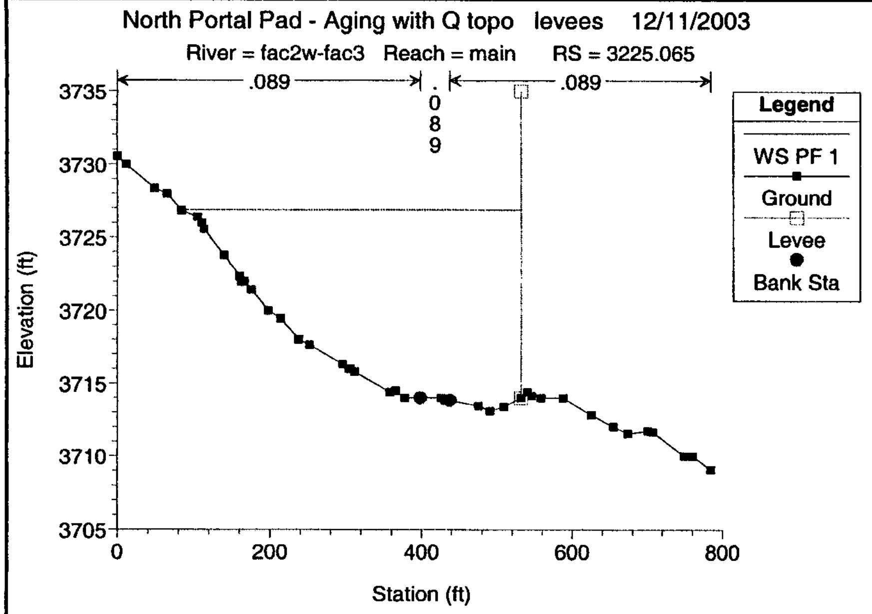
River = fac2w-fac3 Reach = main RS = 3684.510



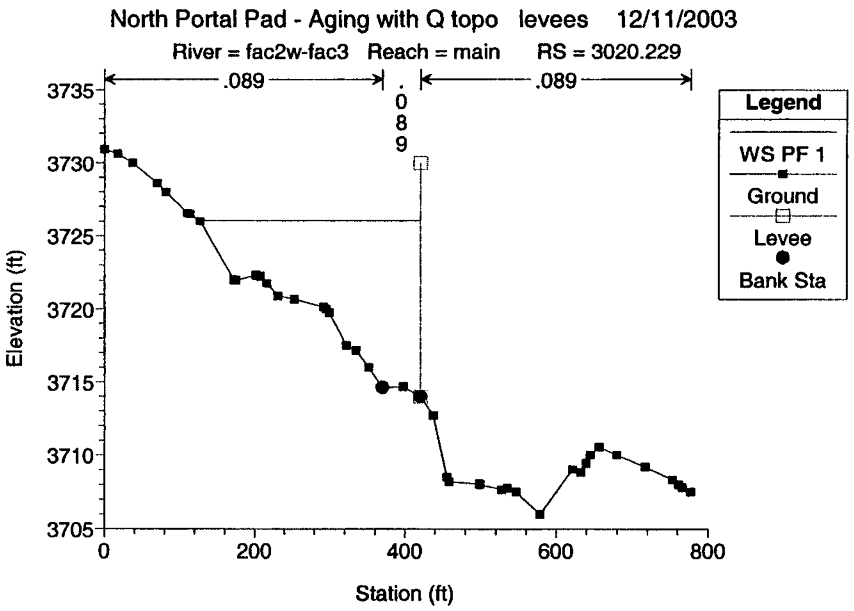
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 3440.055

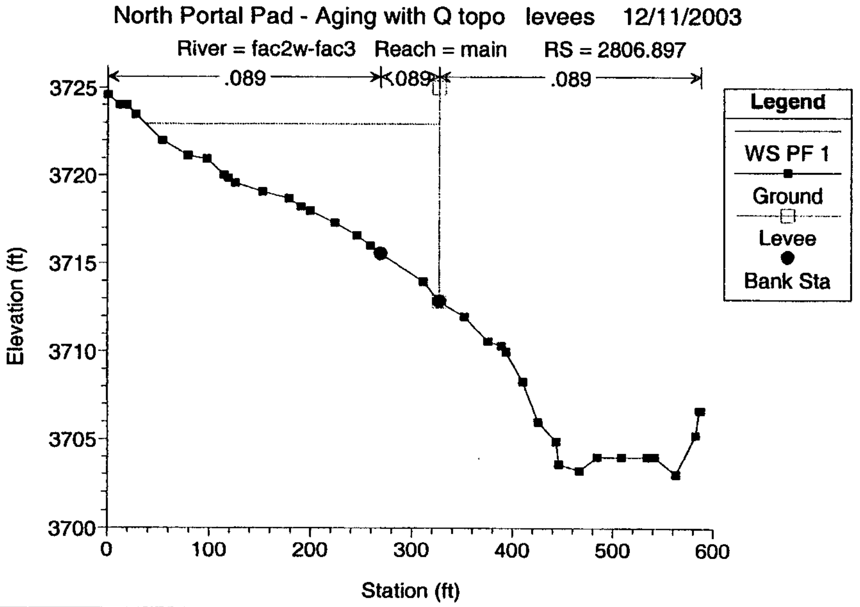



North Portal Pad - Aging with Q topo levees 12/11/2003

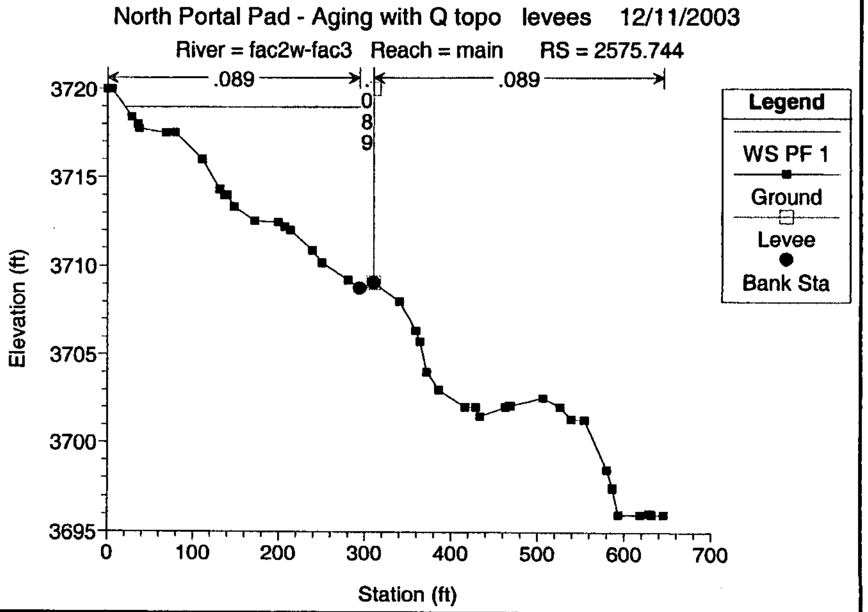
River = fac2w-fac3 Reach = main RS = 3225.065


North Portal Pad - Aging with Q topo levees 12/11/2003

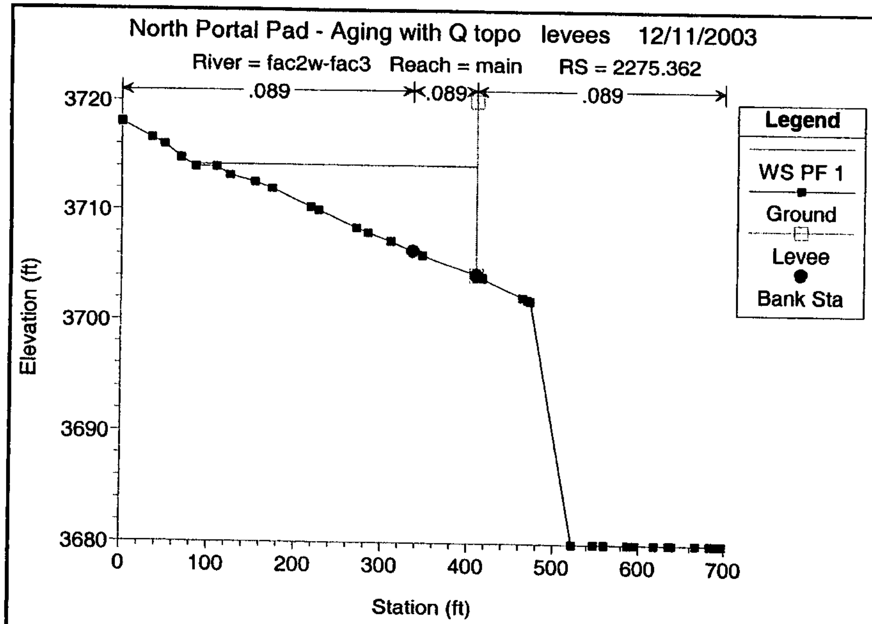
River = fac2w-fac3 Reach = main RS = 3020.229


North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 2806.897

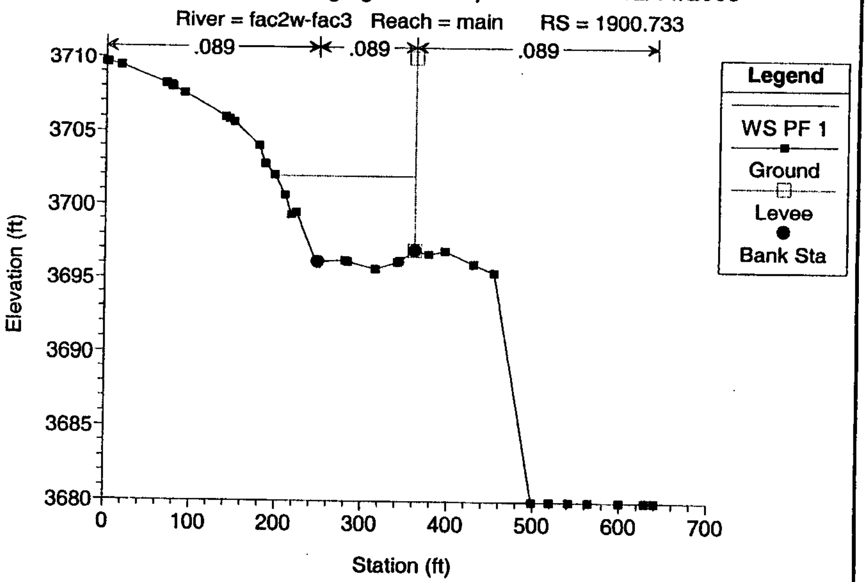

North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 2575.744



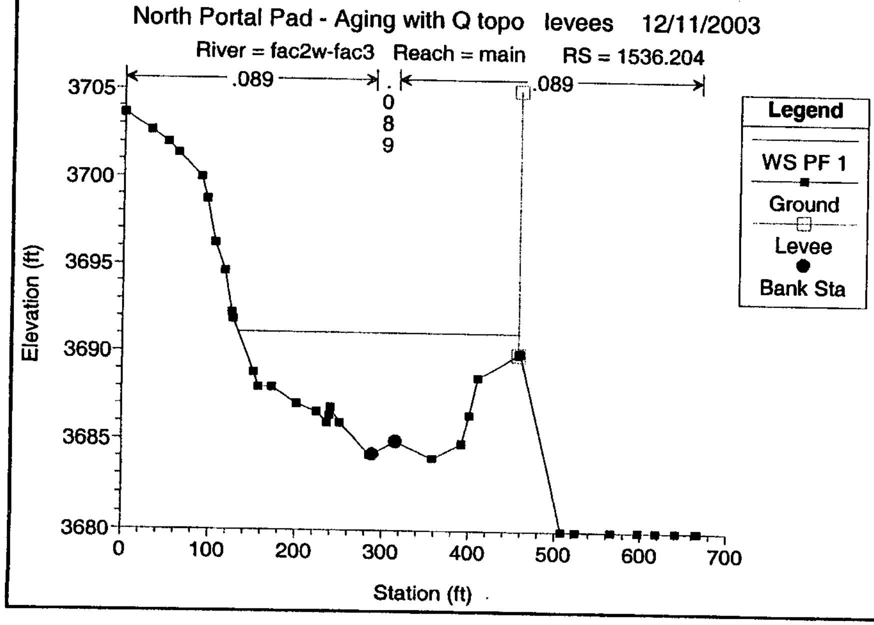
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 2275.362



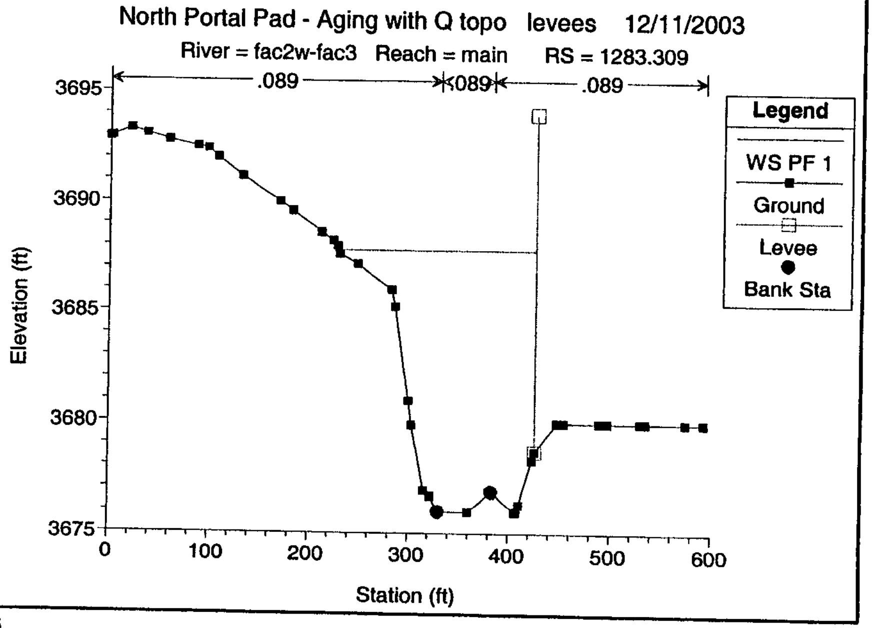
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 1900.733



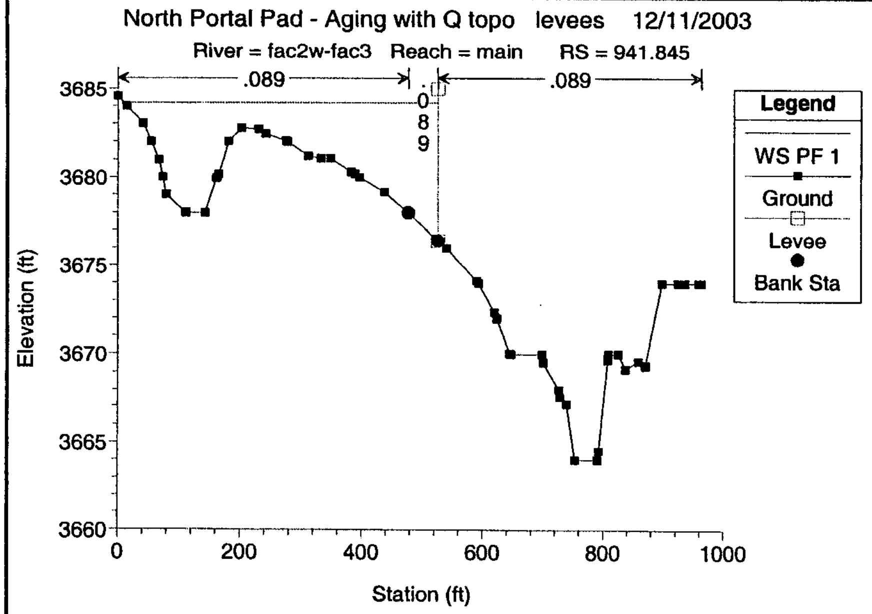
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 1536.204



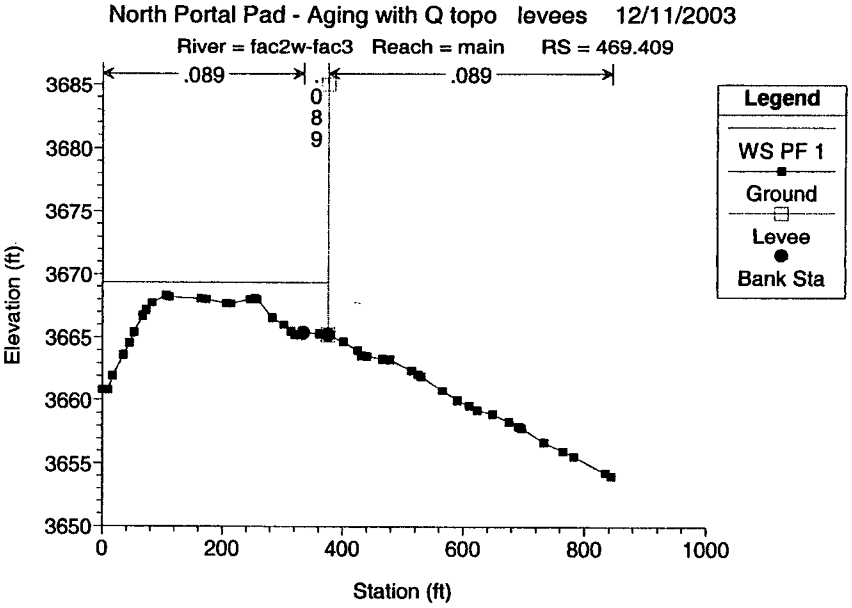
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 1283.309



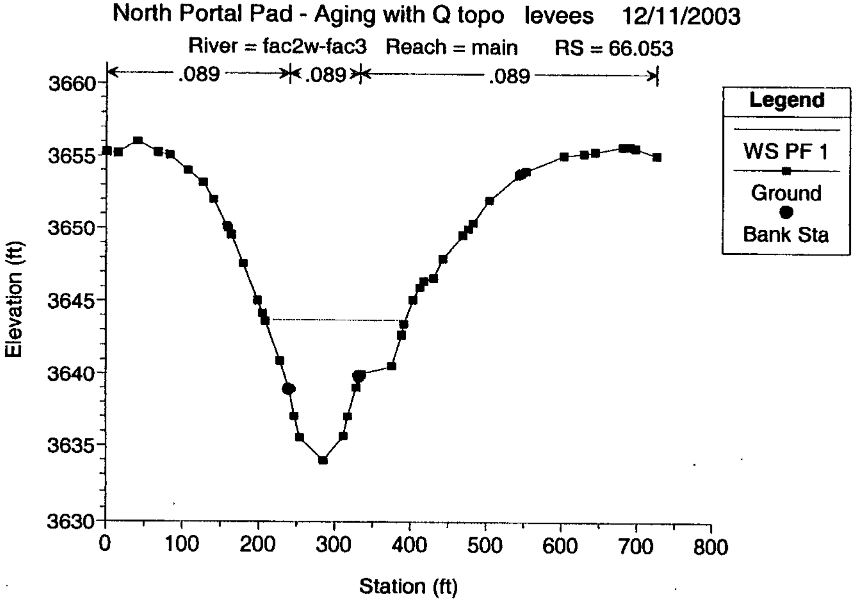
North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 941.845



North Portal Pad - Aging with Q topo levees 12/11/2003

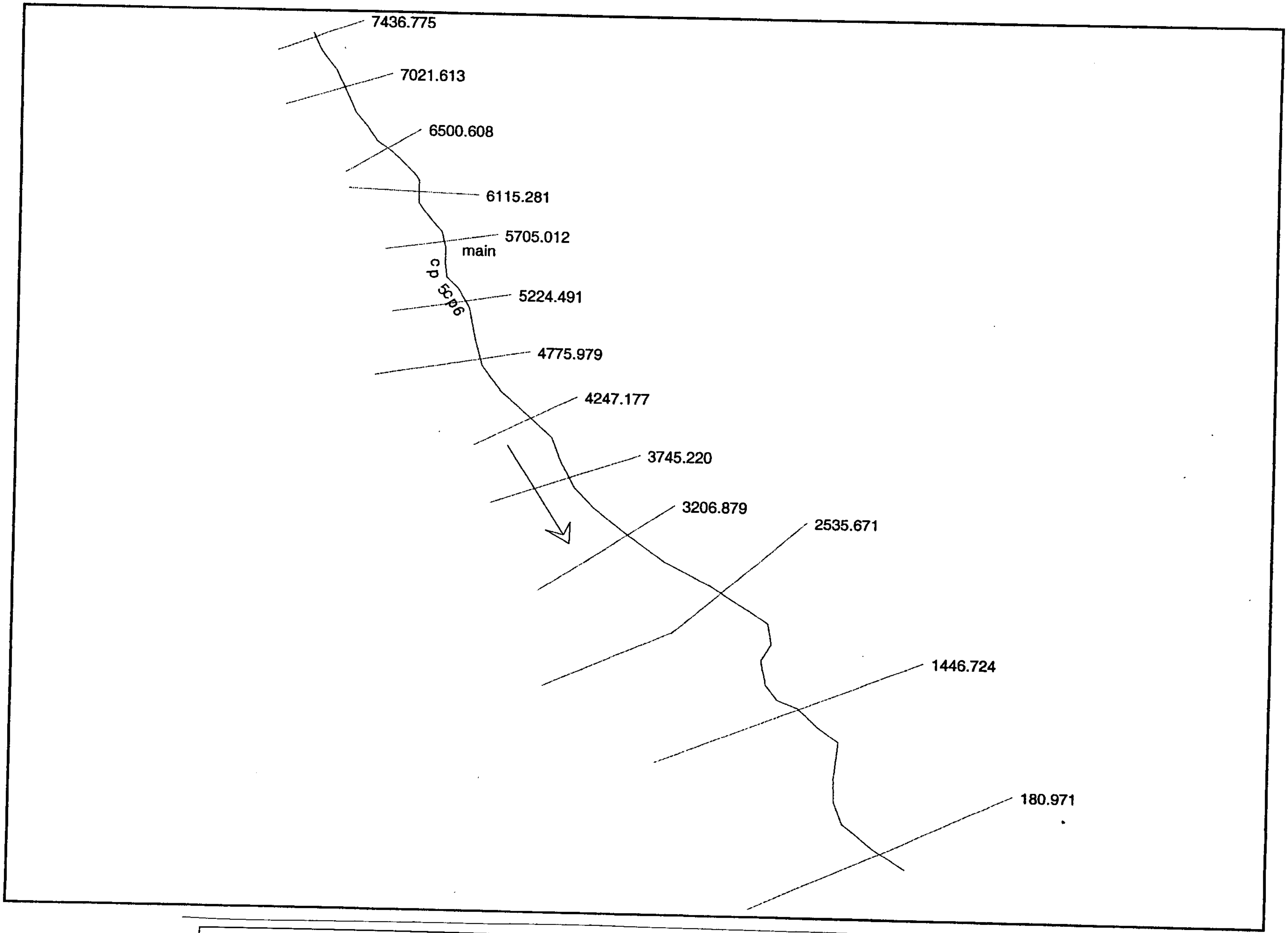
River = fac2w-fac3 Reach = main RS = 469.409



North Portal Pad - Aging with Q topo levees 12/11/2003

River = fac2w-fac3 Reach = main RS = 66.053

Attachment 11: Hydraulic Calculations for Routing East of North Portal Pad, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)



Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A

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Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-cp5cp6  River: cp5cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 13
# Plans             = 1
# Profiles          = 1

 Reach            River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                       (cfs)       (ft)       (ft)       (ft)       (ft)   (ft/ft)     (ft/s)    (sq ft)      (ft)

 main             7436.775           6600.00    3709.79    3719.37    3718.74    3721.30  0.032914      12.91     664.09     130.04           0.76
 main             7021.613           6600.00    3692.64    3701.44    3701.42    3704.22  0.052392      13.71     519.91     100.92           0.92
 main             6500.608           6600.00    3673.63    3682.86               3684.47  0.027864      11.98     680.37     108.51           0.71
 main             6115.281           6600.00    3658.08    3667.61    3667.61    3670.56  0.047553      14.71     518.79      93.26           0.90
 main             5705.012           6600.00    3646.93    3658.26    3654.87    3659.12  0.011765       8.72     939.60     129.96           0.47
 main             5224.491          15908.00    3634.00    3644.94               3647.51  0.035105      15.39    1371.07     215.95           0.82
 main             4775.979          15908.00    3620.03    3632.71               3634.55  0.023438      13.03    1576.09     217.78           0.68
 main             4247.177          15908.00    3607.26    3618.28               3620.38  0.030858      14.32    1483.03     231.20           0.77
 main             3745.220          15908.00    3593.93    3604.11               3605.90  0.026697      12.75    1580.81     242.08           0.71
 main             3206.879          15908.00    3582.00    3590.58    3589.20    3591.54  0.025769      11.23    2477.53     800.61           0.68
 main             2535.671          15908.00    3566.00    3572.29    3571.66    3572.90  0.029679       9.15    2772.39    1050.63           0.68
 main             1446.724          15908.00    3546.00    3549.28               3549.53  0.016088       4.68    3978.98    1556.38           0.45
 main             180.971           15908.00    3518.07    3522.69    3521.63    3523.32  0.028034       7.56    2539.46     776.58           0.63
```
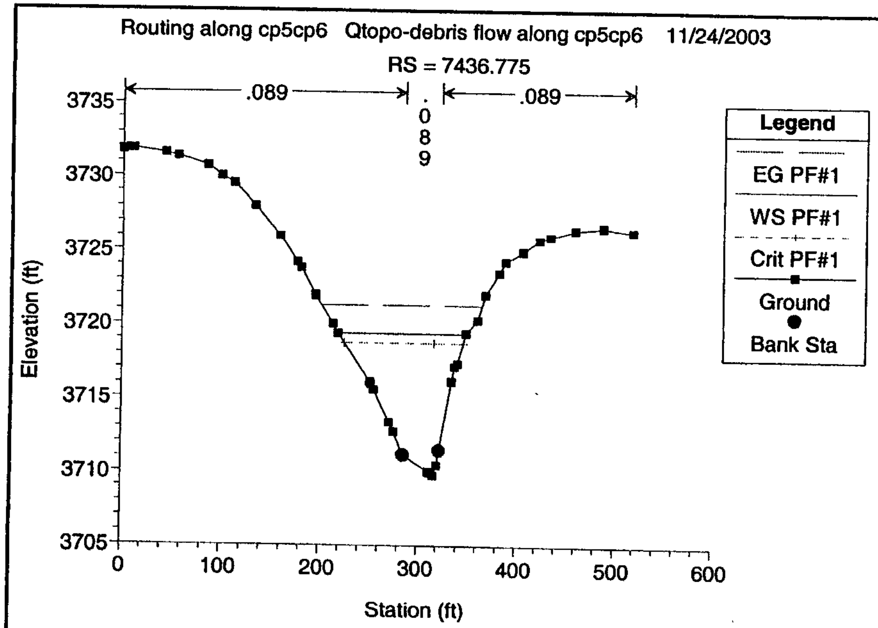
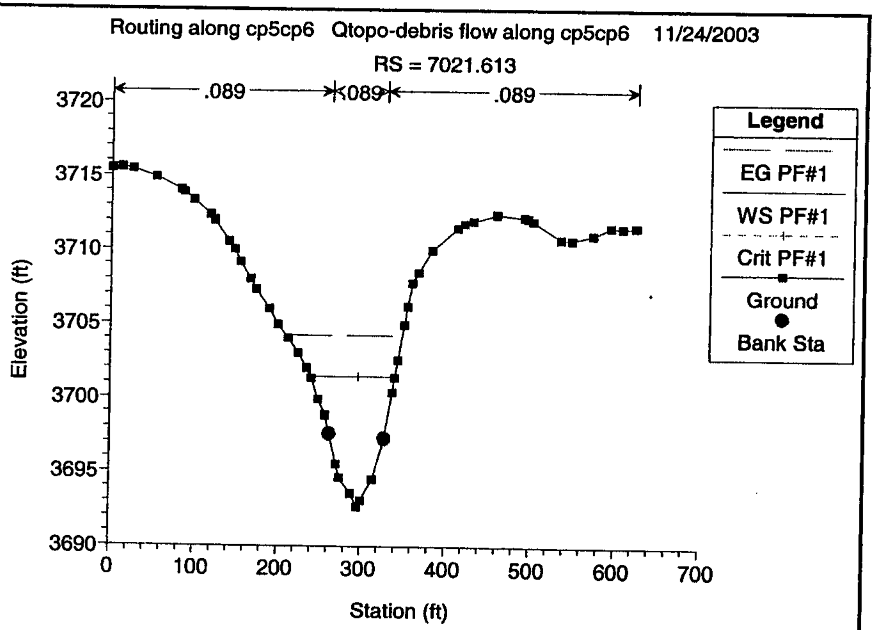
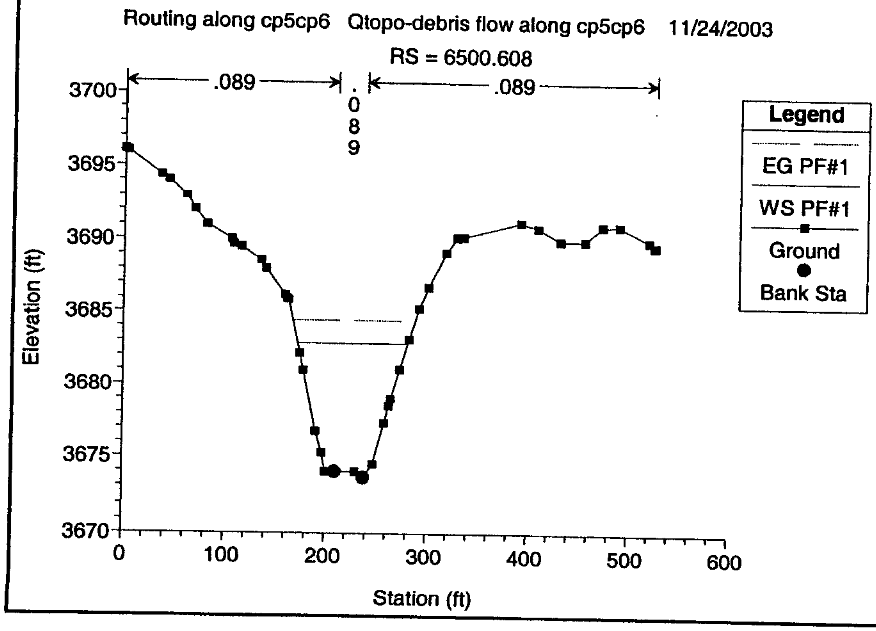


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 7436.775
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3735
3730
3725
3720
3715
3710
3705
0
100
200
300
400
500
600
Station (ft)


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 7021.613
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3720
3715
3710
3705
3700
3695
3690
0
100
200
300
400
500
600
700
Station (ft)


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
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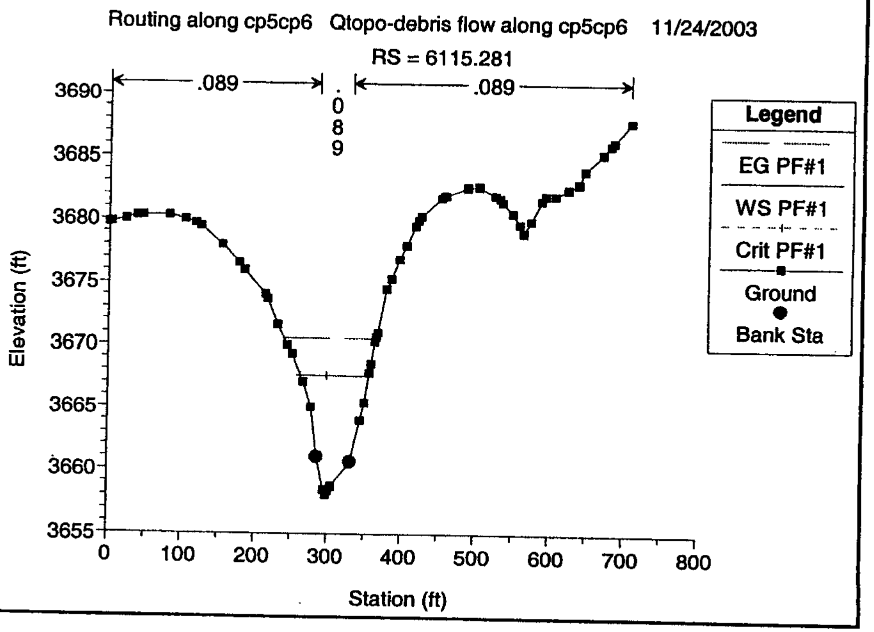
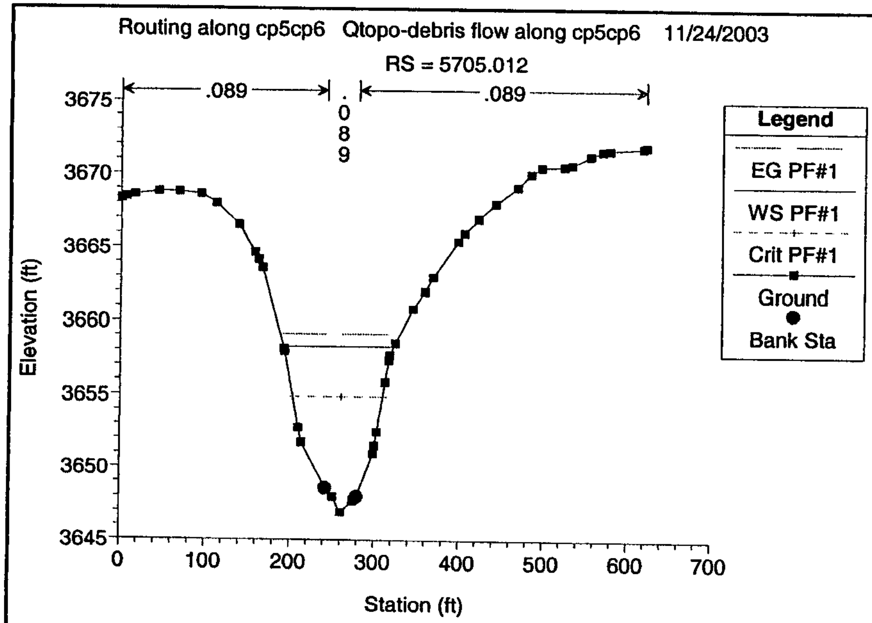
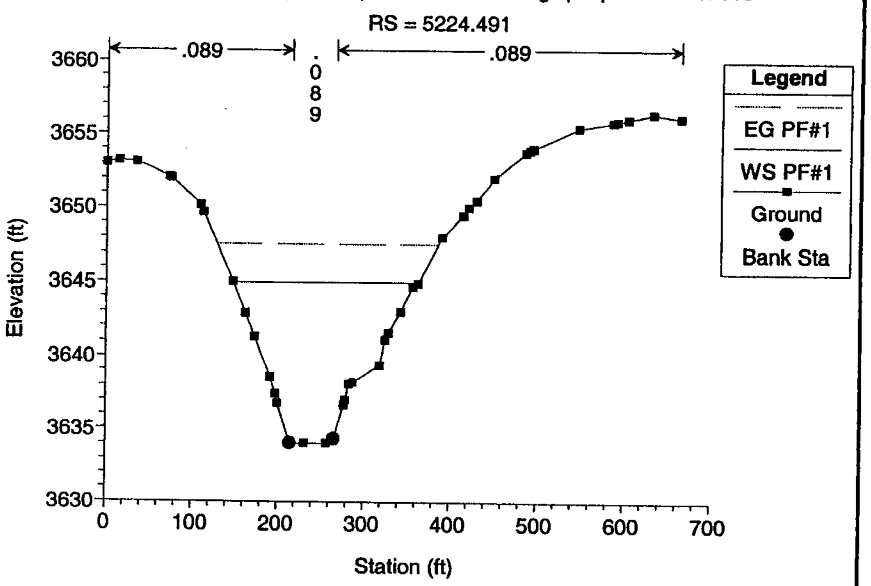
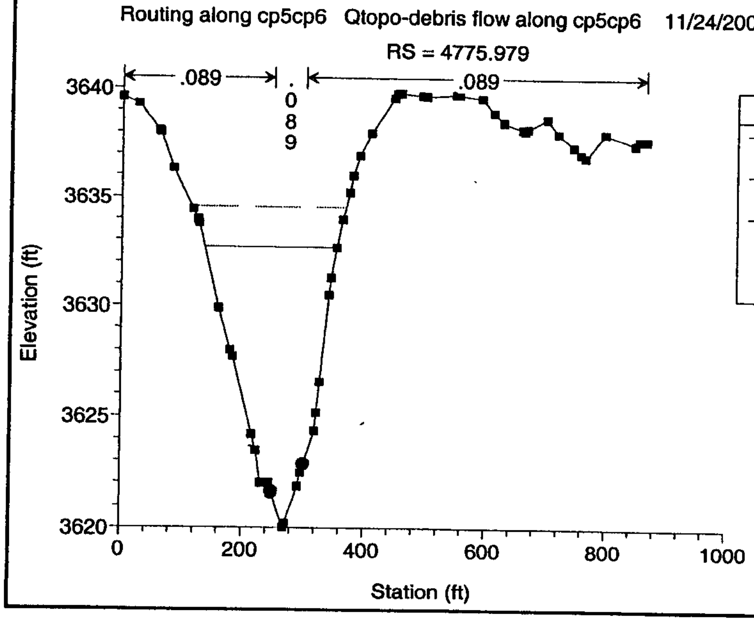
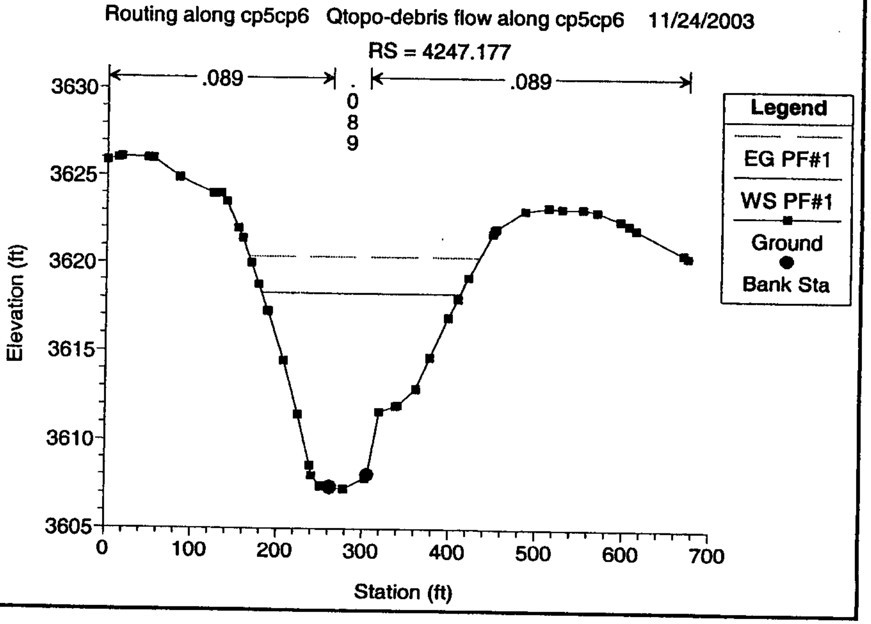
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3700
3695
3690
3685
3680
3675
3670
0
100
200
300
400
500
600
Station (ft)

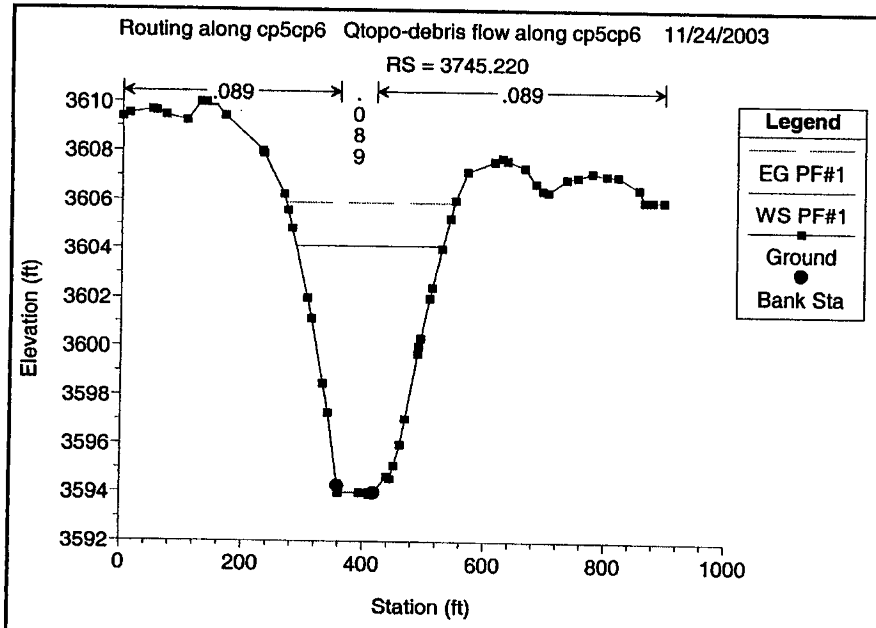

Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 6115.281
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3690
3685
3680
3675
3670
3665
3660
3655
0
100
200
300
400
500
600
700
800
Station (ft)


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 5705.012
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3675
3670
3665
3660
3655
3650
3645
Station (ft)
0
100
200
300
400
500
600
700


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 5224.491
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3660
3655
3650
3645
3640
3635
3630
Station (ft)
0
100
200
300
400
500
600
700

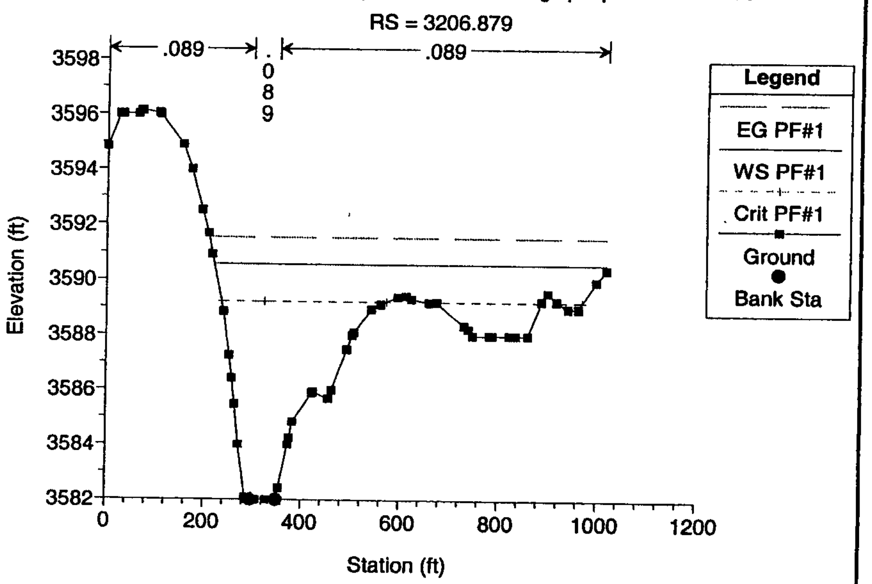

Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 4775.979
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3640
3635
3630
3625
3620
Station (ft)
0
200
400
600
800
1000


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 4247.177
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3630
3625
3620
3615
3610
3605
Station (ft)
0
100
200
300
400
500
600
700



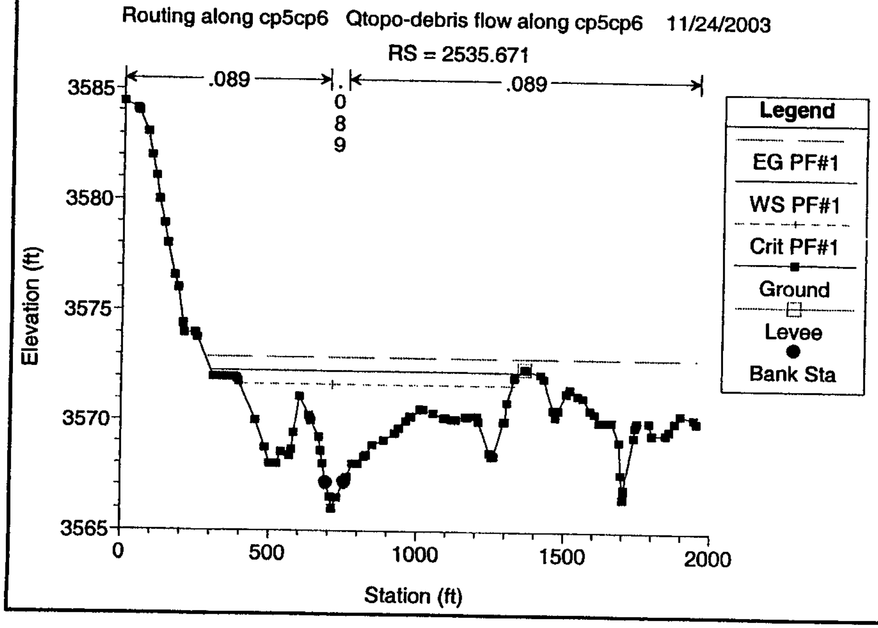
Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003

RS = 3745.220



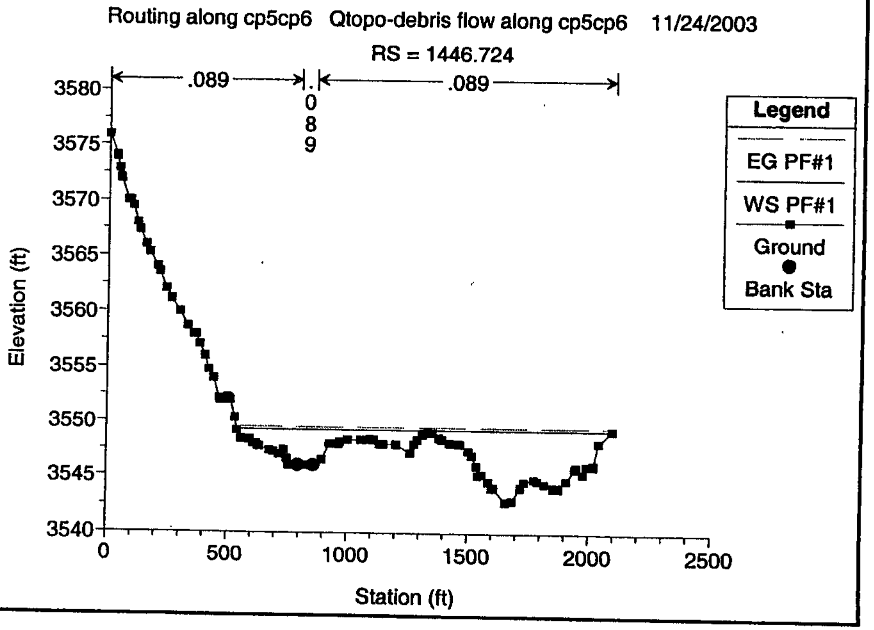
Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003

RS = 3206.879



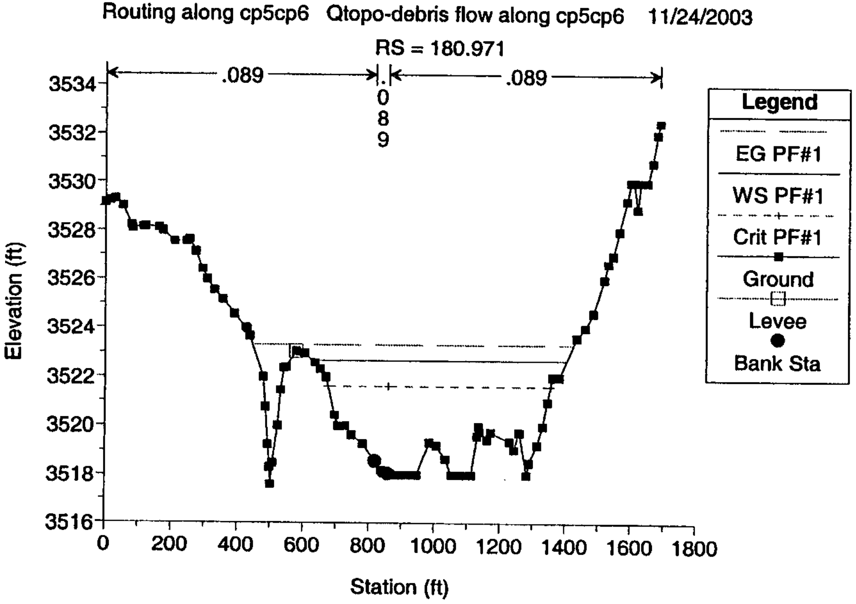
Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003

RS = 2535.671

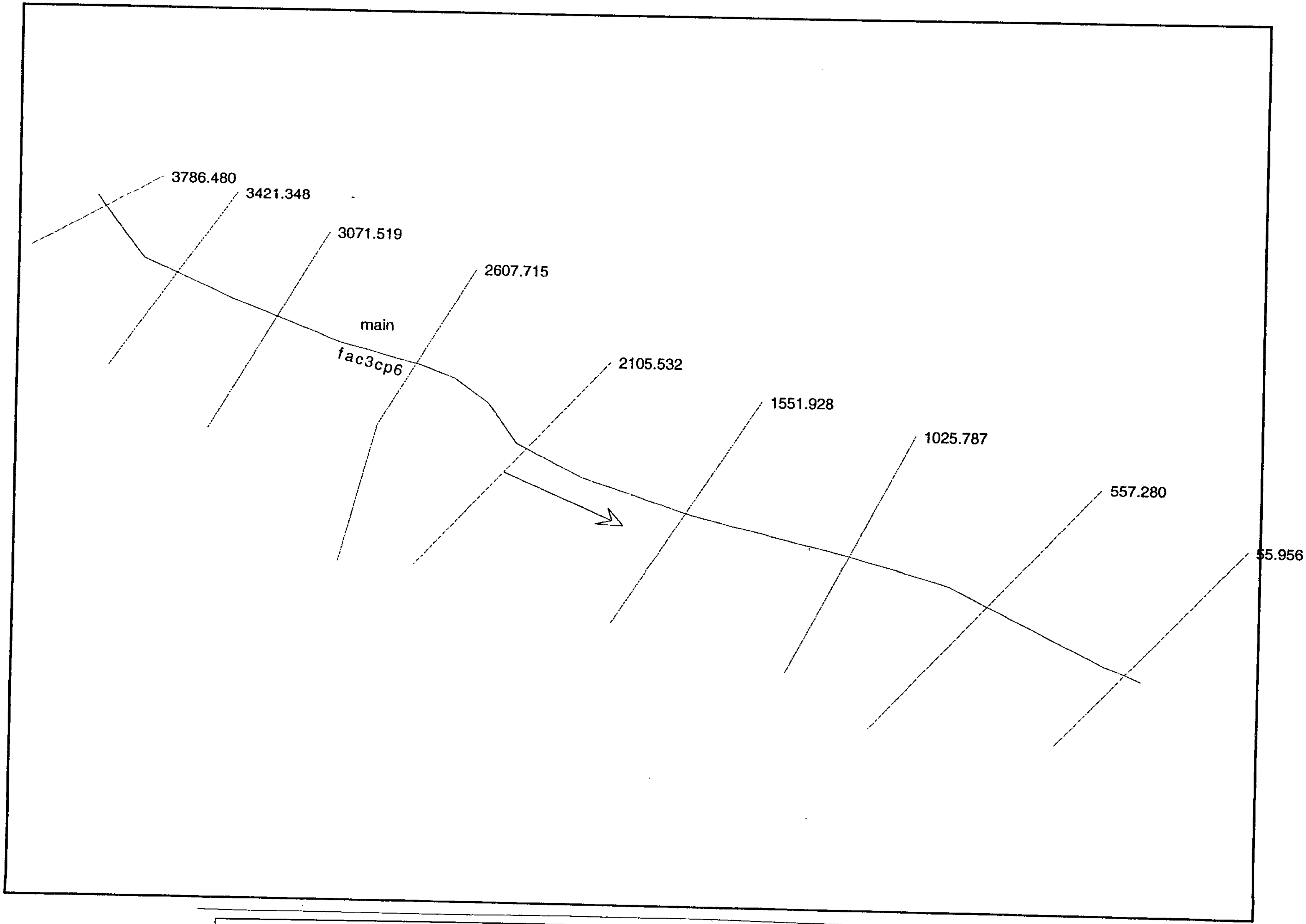


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003

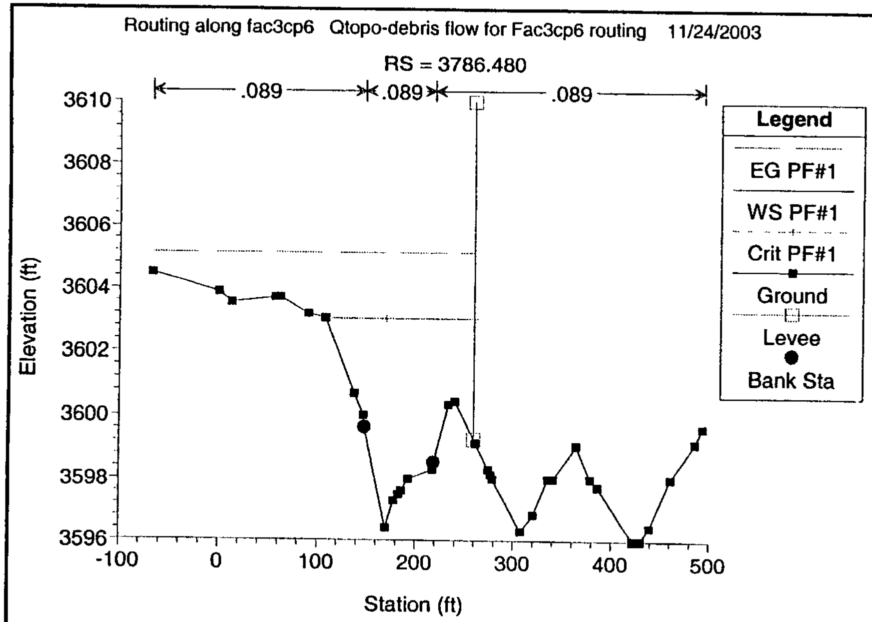
RS = 1446.724


Routing along cp5cp6 Qtopo-debris flow along cp5cp6 11/24/2003
RS = 180.971
.089
.089
.089
Elevation (ft)
3534
3532
3530
3528
3526
3524
3522
3520
3518
3516
Station (ft)
0
200
400
600
800
1000
1200
1400
1600
1800
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

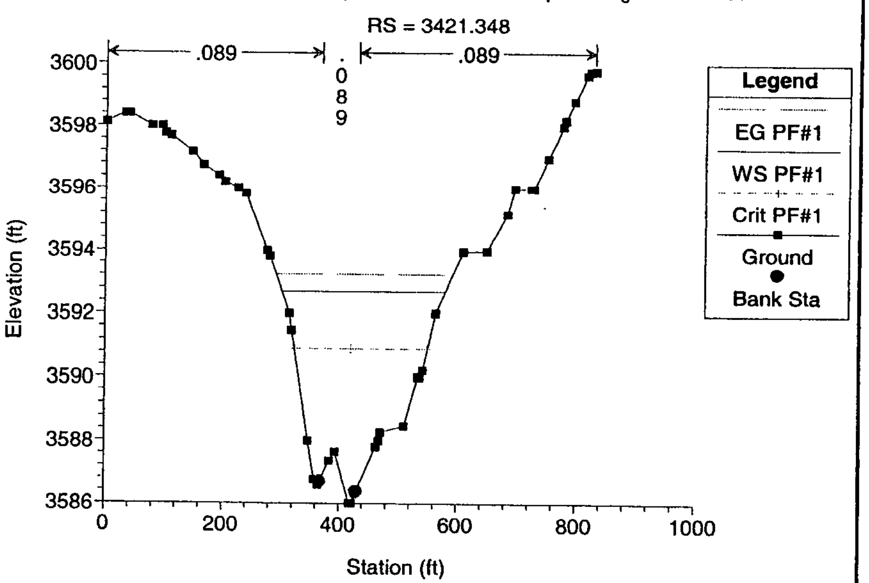
Attachment 12: Hydraulic Calculations for Routing Downstream of North Portal Pad, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)


3786.480
3421.348
3071.519
2607.715
main
fac3cp6
2105.532
1551.928
1025.787
557.280
55.956

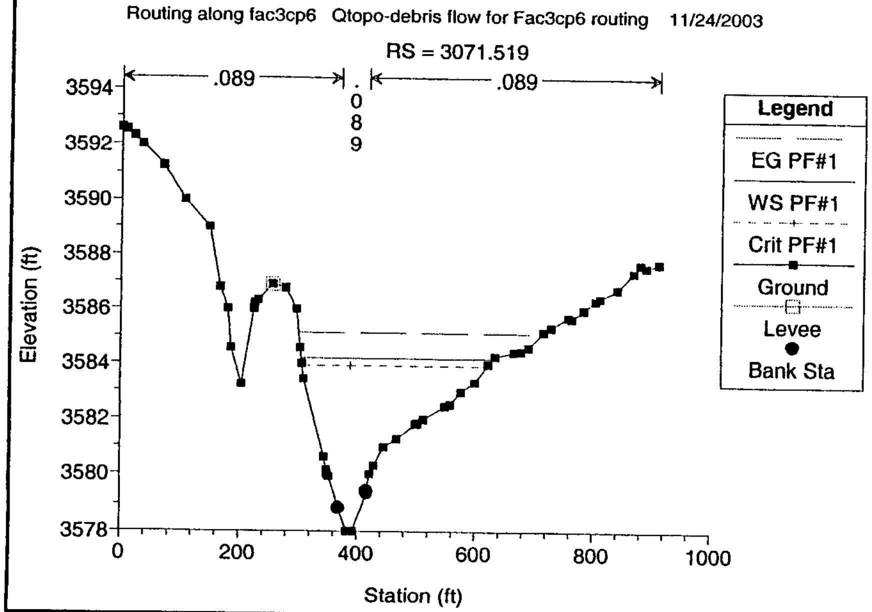
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-fac3cp6  River: fac3cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 9
# Plans             = 1
# Profiles          = 1

 Reach            River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                      (cfs)      (ft)       (ft)       (ft)       (ft)    (ft/ft)      (ft/s)    (sq ft)      (ft)

 main             3786.480           6135.00    3596.41    3603.02    3603.02    3605.15   0.065069      12.69     558.57     151.10          0.98
 main             3421.348           6135.00    3586.00    3592.69    3590.90    3593.22   0.016318       6.92    1107.96     278.51          0.50
 main             3071.519           6135.00    3578.00    3584.19    3583.93    3585.14   0.034721       9.95     900.89     324.18          0.73
 main             2607.715           6135.00    3568.00    3573.32               3573.63   0.018078       5.91    1479.82     628.25          0.50
 main             2105.532           6135.00    3558.00    3562.67    3562.01    3563.04   0.024826       6.23    1336.95     627.99          0.57
 main             1551.928           6135.00    3546.00    3549.20    3548.22    3549.50   0.024055       5.34    1410.40     655.44          0.55
 main             1025.787           6135.00    3533.78    3536.87               3537.16   0.022853       4.82    1411.47     665.47          0.52
 main             557.280            6135.00    3524.00    3527.52    3526.39    3527.80   0.017614       5.13    1500.34     631.04          0.48
 main             55.956             6135.00    3514.00    3517.09    3516.17    3517.54   0.024009       5.48    1167.38     434.55          0.55
```


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

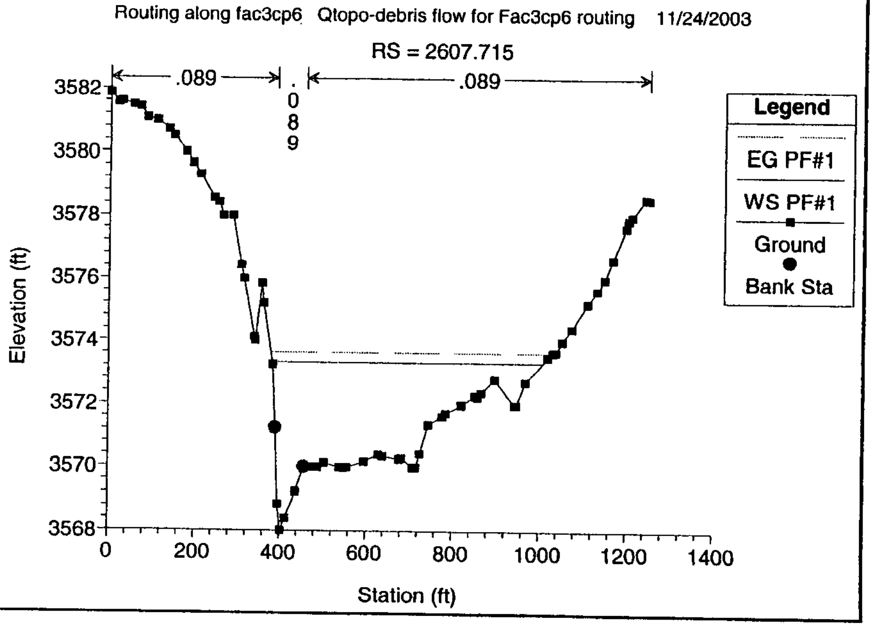
RS = 3786.480


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

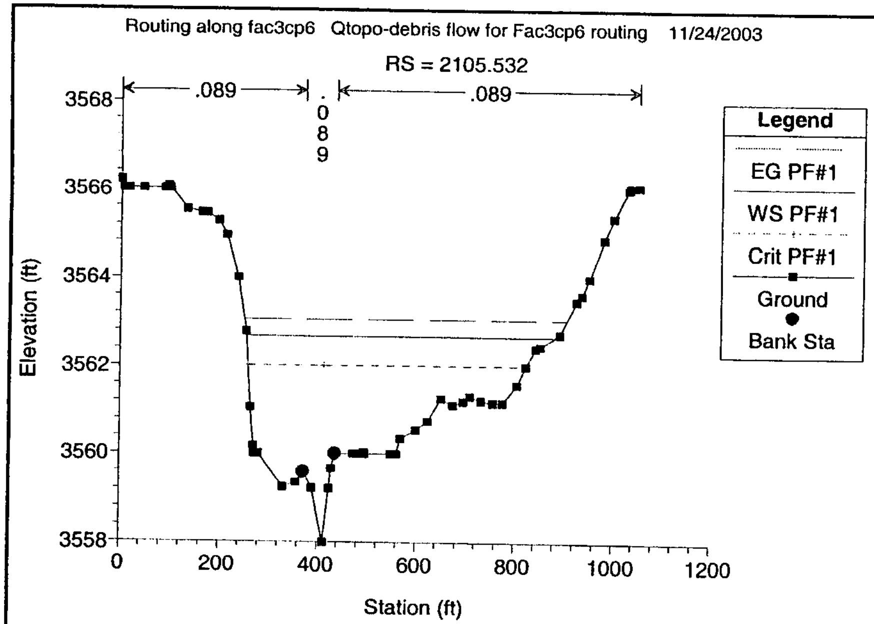
RS = 3421.348


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

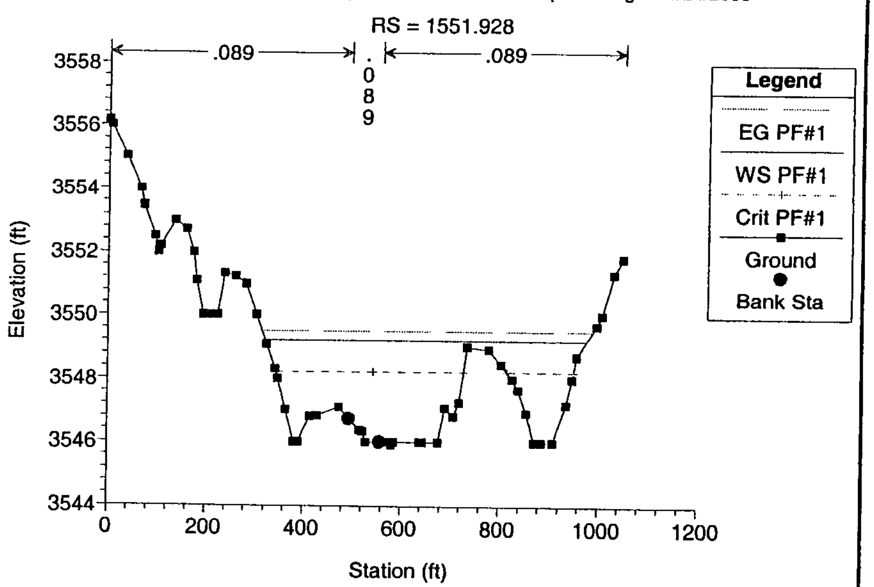
RS = 3071.519


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

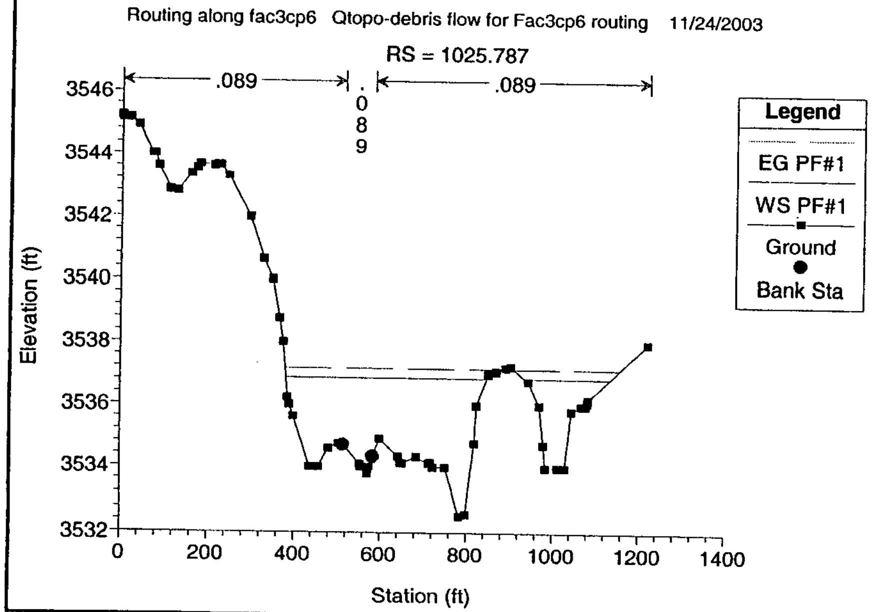
RS = 2607.715


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

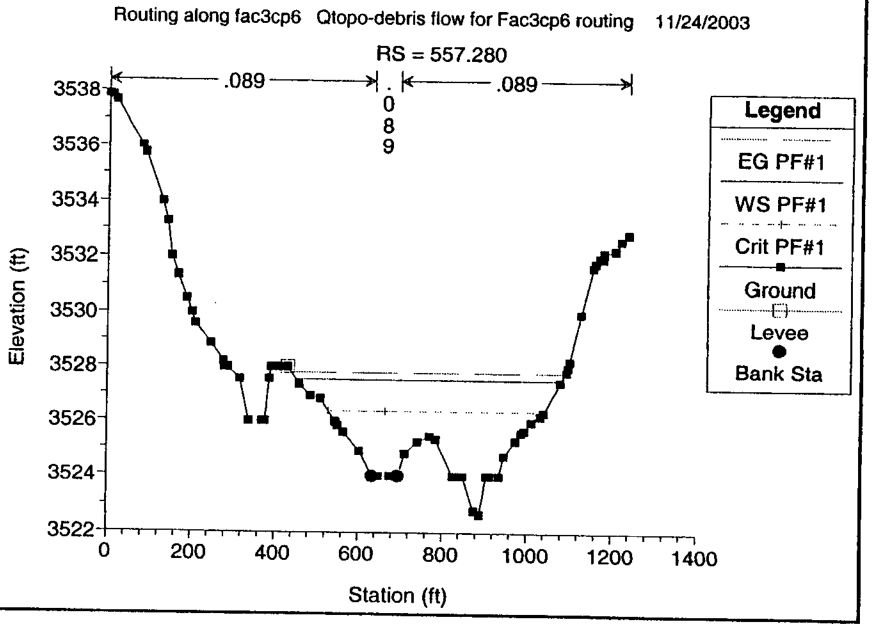
RS = 2105.532


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

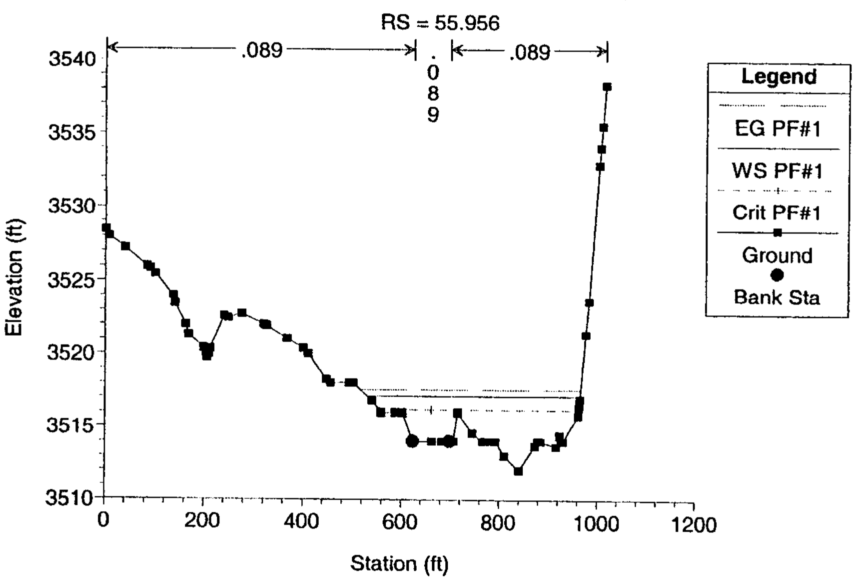
RS = 1551.928


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

RS = 1025.787

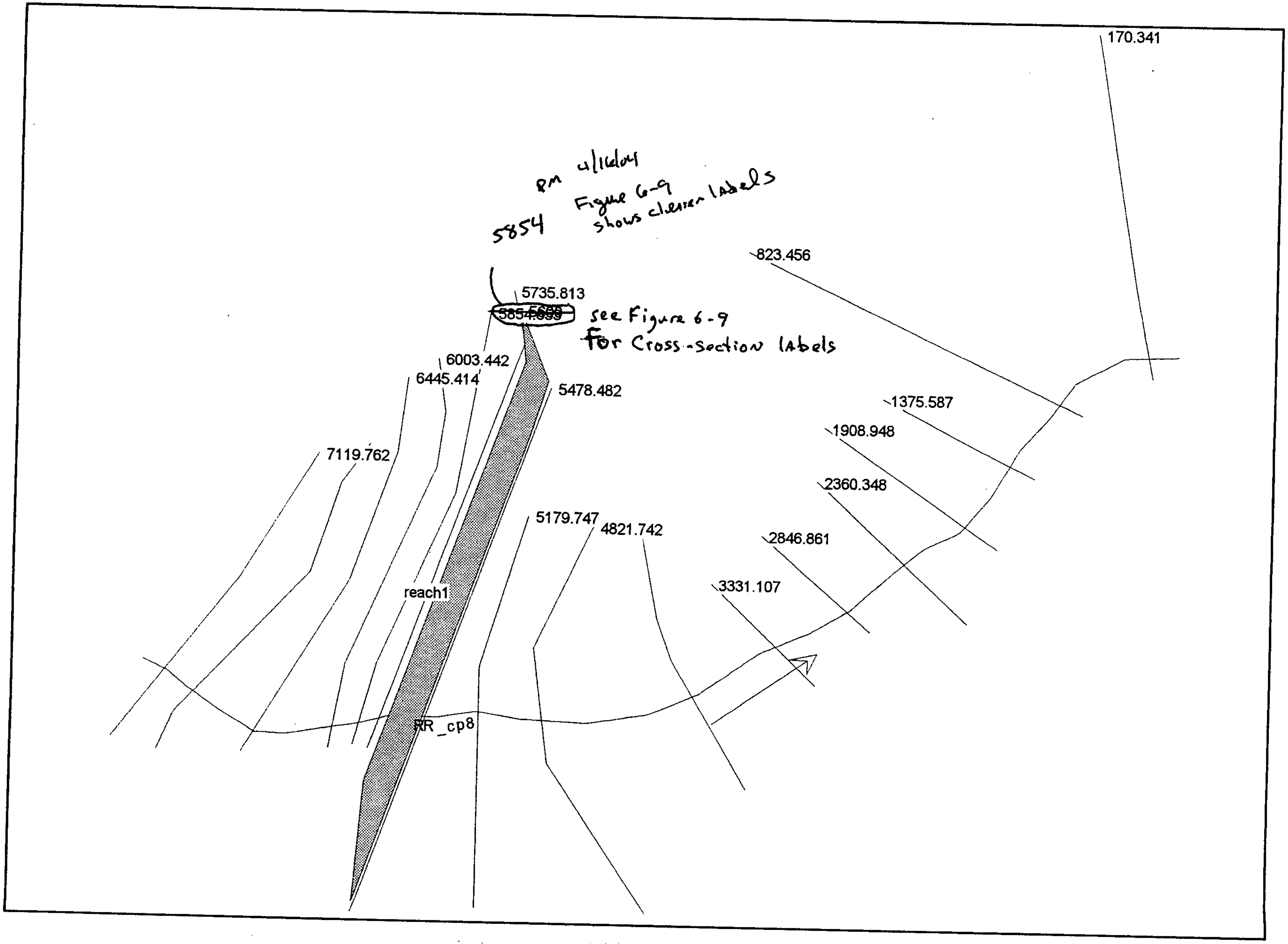

Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003

RS = 557.280


Routing along fac3cp6 Qtopo-debris flow for Fac3cp6 routing 11/24/2003
RS = 55.956
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3540
3535
3530
3525
3520
3515
3510
0
200
400
600
800
1000
1200
Station (ft)

12-5

Attachment 13: Hydraulic Calculations for Routing Near Railroad Bridge Crossing, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)



PM 4/16/04

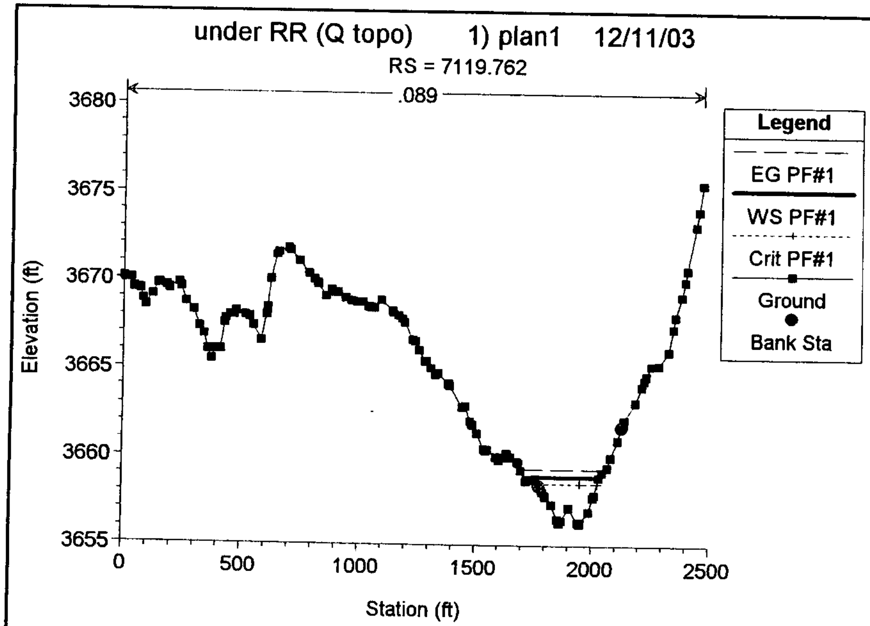
5854 Figure 6-9 shows clearer labels

see Figure 6-9 for Cross-section labels

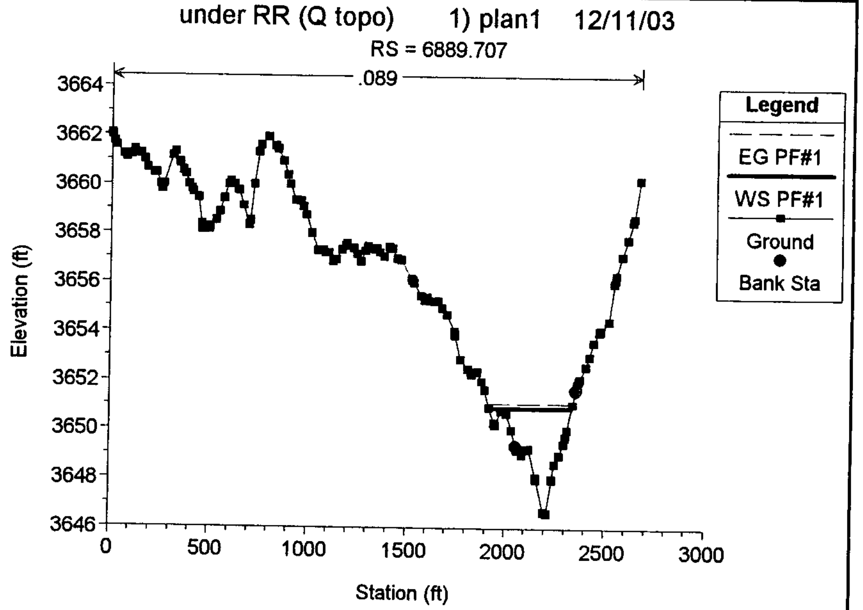
HEC-RAS Output for Routing Under Railroad Bridge, Alternative 1

HEC-RAS Plan: plan1 River: RR_cp8 Reach: reach1

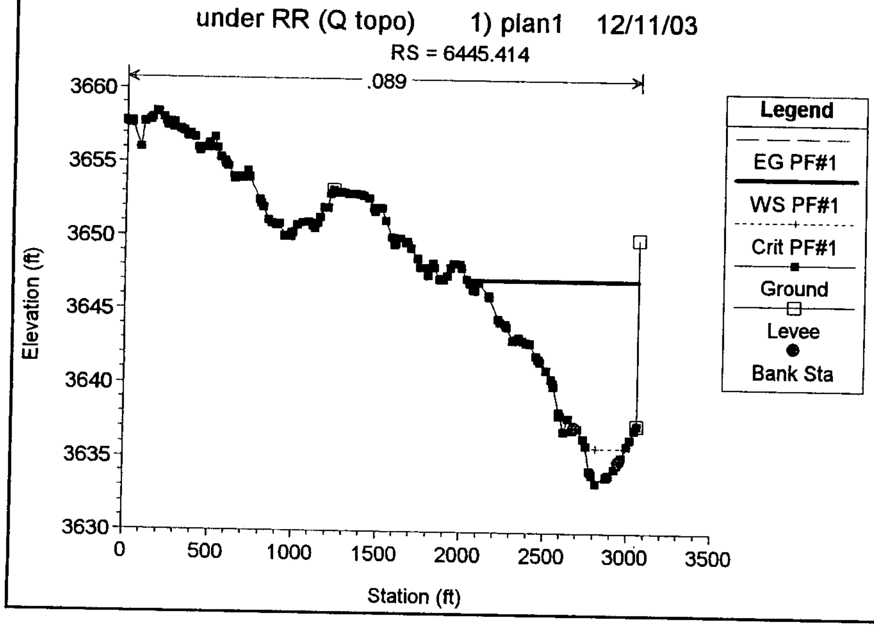
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Max Chl Dpth	Invert Slope
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	
reach1	7119.762	2486	3656.23	3658.83	3658.5	3659.31	0.053031	5.57	455.31	320.23	0.74	2.6	0.3575
reach1	6889.707	2486	3646.61	3650.86		3651.07	0.017481	3.8	696.35	415.52	0.45	4.25	0.3157
reach1	6445.414	2486	3633.43	3647.15	3635.82	3647.15	0.000023	0.43	7351.54	1026.74	0.02	13.72	0.2861
reach1	6003.442	23416	3624	3647.04	3632.38	3647.08	0.00028	2.1	17241.76	2423.55	0.08	23.04	0.2647
reach1	5854.853	23416	3620	3647.03	3628.87	3647.04	0.000073	1.18	32209.01	3240.41	0.04	27.03	0.2378
reach1	5735.813	23416	3618	3647.03	3627.01	3647.03	0.000023	0.69	49084.55	3496.47	0.02	29.03	0.221
reach1	5600	Bridge											
reach1	5478.482	23416	3612.2	3618.16	3620.24	3625.04	0.348387	21.26	1129.56	388.1	2.1	5.96	0.1905
reach1	5179.747	23416	3605.27	3614.95	3613.97	3616.22	0.03011	9.54	2832.41	732.19	0.69	9.68	0.1673
reach1	4821.742	23416	3598	3606.58		3607.16	0.018957	7.07	4198.95	1248.33	0.54	8.58	0.147
reach1	3938.849	25928	3581.82	3589.82		3590.63	0.017788	7.28	3626.1	721.75	0.53	8	0.1287
reach1	3331.107	25928	3570	3582.81		3583.29	0.006124	5.73	4845.21	660.74	0.33	12.81	0.1092
reach1	2846.861	25928	3562	3574.95		3576.42	0.021805	10	2791.26	457.3	0.62	12.95	0.0927
reach1	2360.348	25928	3552	3566.11		3567.09	0.015862	8.48	3594.06	719.01	0.52	14.11	0.0721
reach1	1908.948	25928	3544	3558.08		3559.41	0.01797	9.88	3088.44	548.84	0.57	14.08	0.0544
reach1	1375.587	25928	3534.76	3548.63		3550.07	0.017219	10.41	3027.2	524.03	0.57	13.87	0.0371
reach1	823.456	25928	3526.79	3538.47		3539.84	0.019766	10.08	2968.3	477.5	0.59	12.47	0.0226
reach1	170.341	25928	3512	3522.38	3521.19	3523.96	0.028024	10.5	2769.85	559.06	0.69	10.38	


under RR (Q topo) 1) plan1 12/11/03

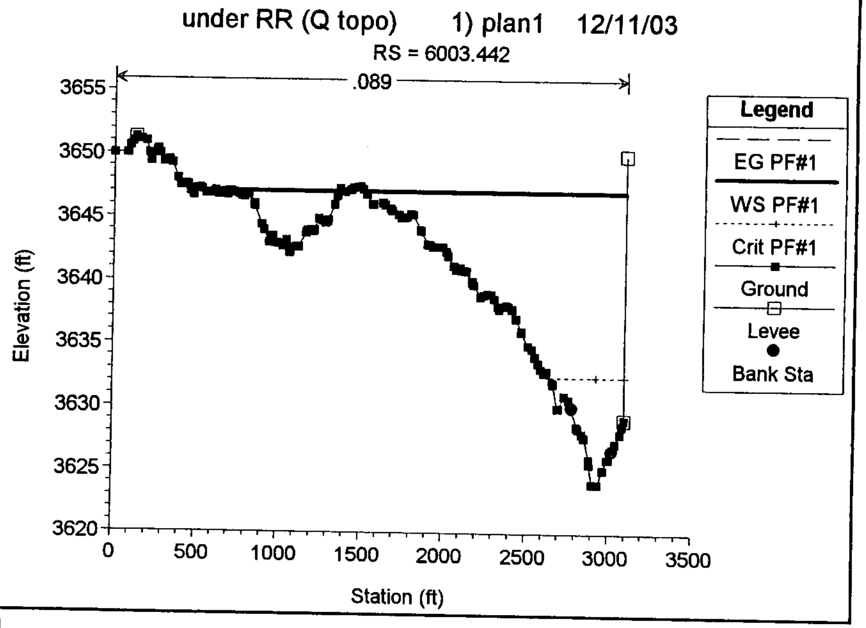
RS = 7119.762


under RR (Q topo) 1) plan1 12/11/03

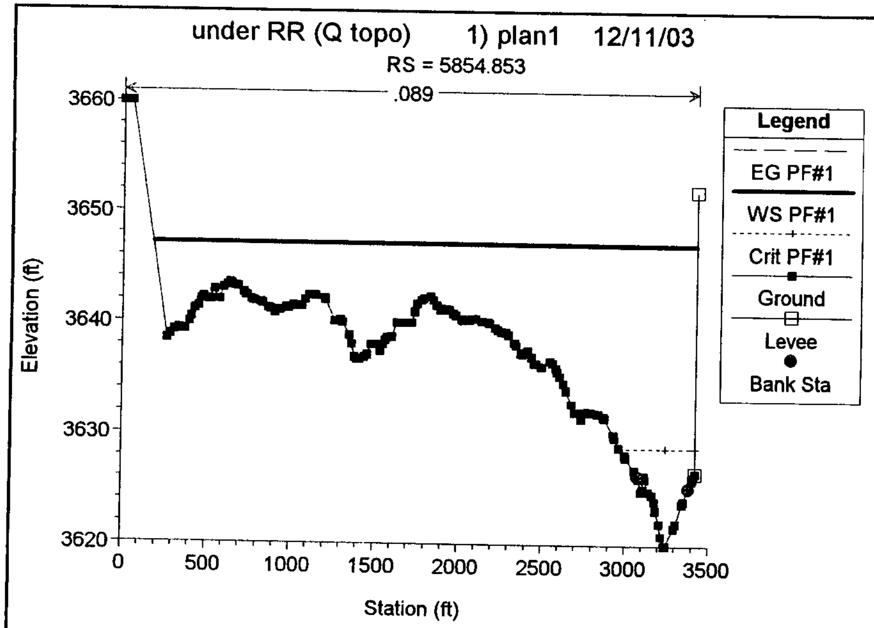
RS = 6889.707

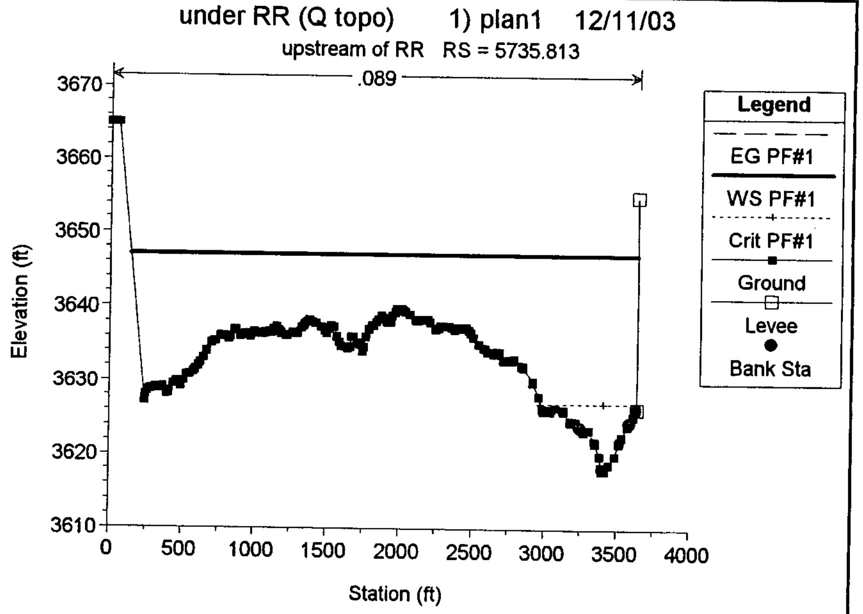

under RR (Q topo) 1) plan1 12/11/03

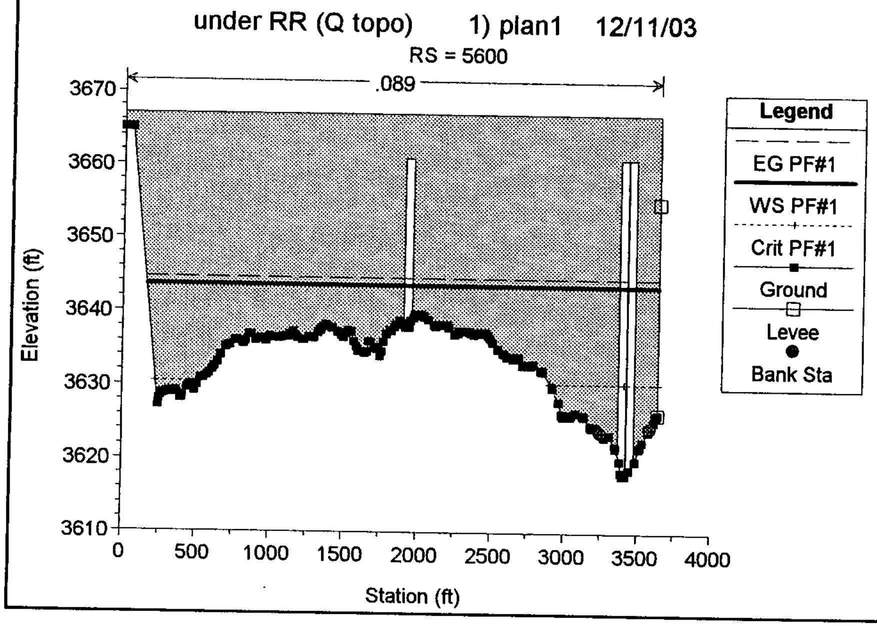
RS = 6445.414

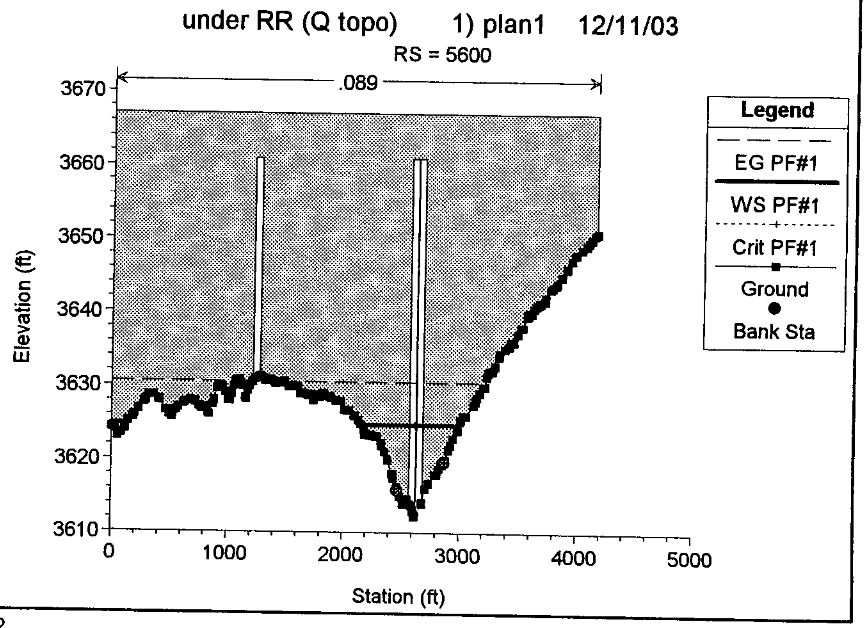

under RR (Q topo) 1) plan1 12/11/03

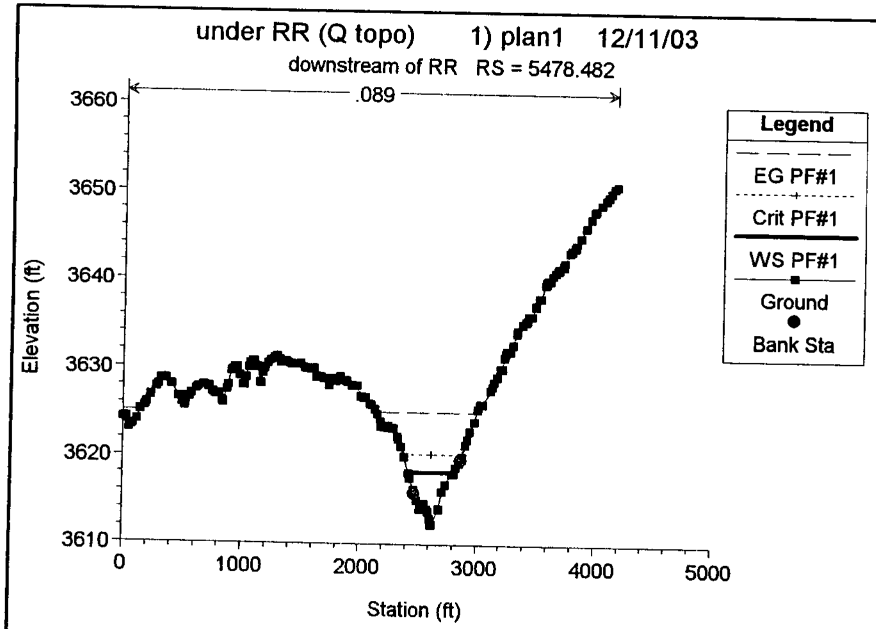
RS = 6003.442


under RR (Q topo) 1) plan1 12/11/03
RS = 5854.853
.089
Elevation (ft)
3660
3650
3640
3630
3620
Station (ft)
0
500
1000
1500
2000
2500
3000
3500
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


under RR (Q topo) 1) plan1 12/11/03
upstream of RR RS = 5735.813
.089
Elevation (ft)
3670
3660
3650
3640
3630
3620
3610
Station (ft)
0
500
1000
1500
2000
2500
3000
3500
4000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

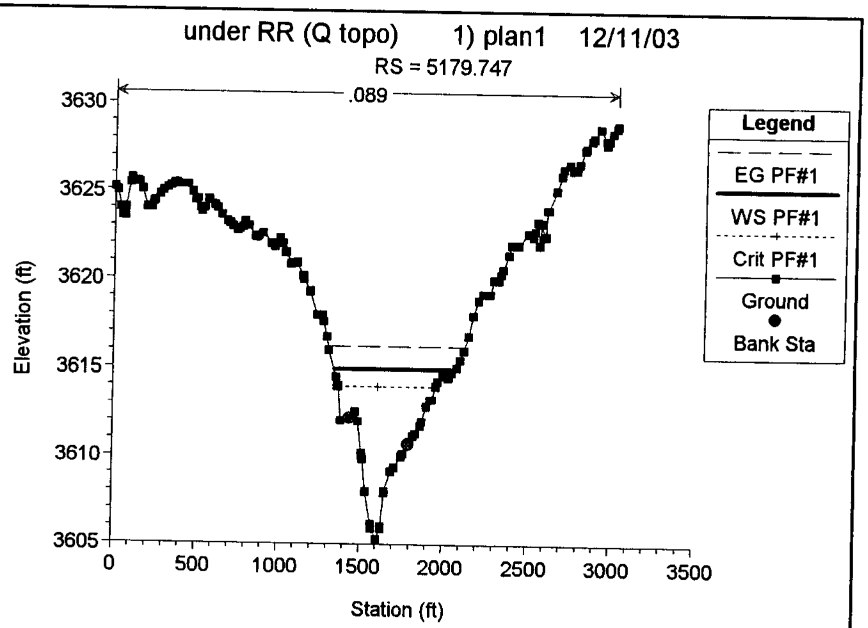

under RR (Q topo) 1) plan1 12/11/03
RS = 5600
.089
Elevation (ft)
3670
3660
3650
3640
3630
3620
3610
Station (ft)
0
500
1000
1500
2000
2500
3000
3500
4000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


under RR (Q topo) 1) plan1 12/11/03
RS = 5600
.089
Elevation (ft)
3670
3660
3650
3640
3630
3620
3610
Station (ft)
0
1000
2000
3000
4000
5000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta



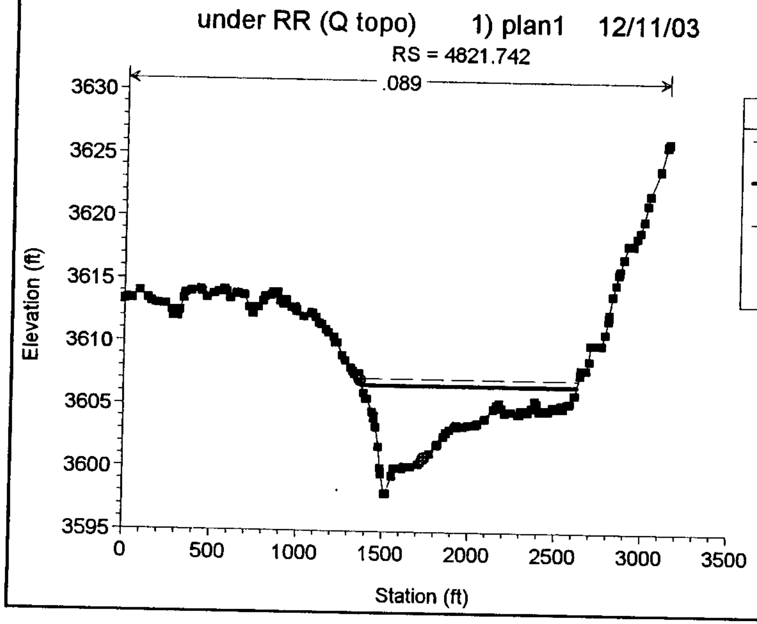
under RR (Q topo) 1) plan1 12/11/03

downstream of RR RS = 5478.482



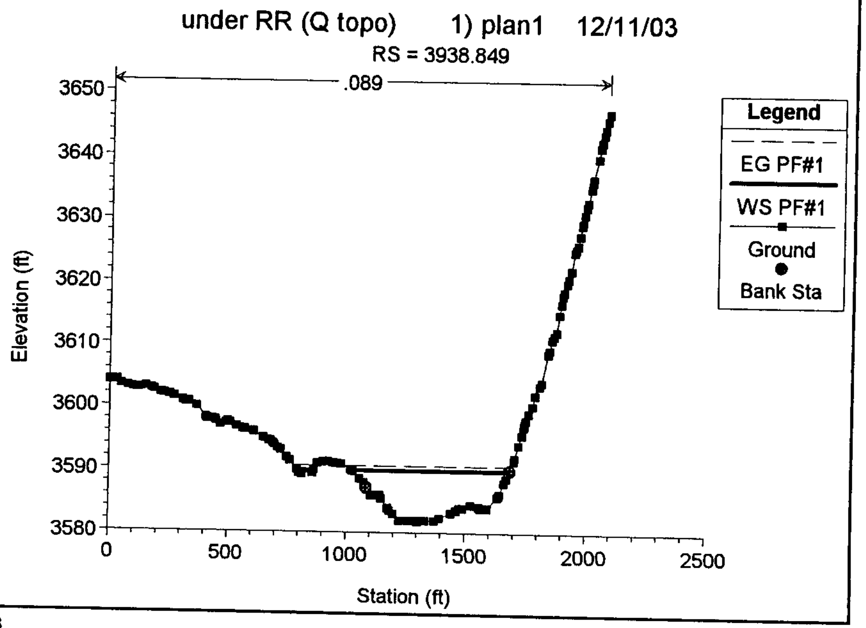
under RR (Q topo) 1) plan1 12/11/03

RS = 5179.747



under RR (Q topo) 1) plan1 12/11/03

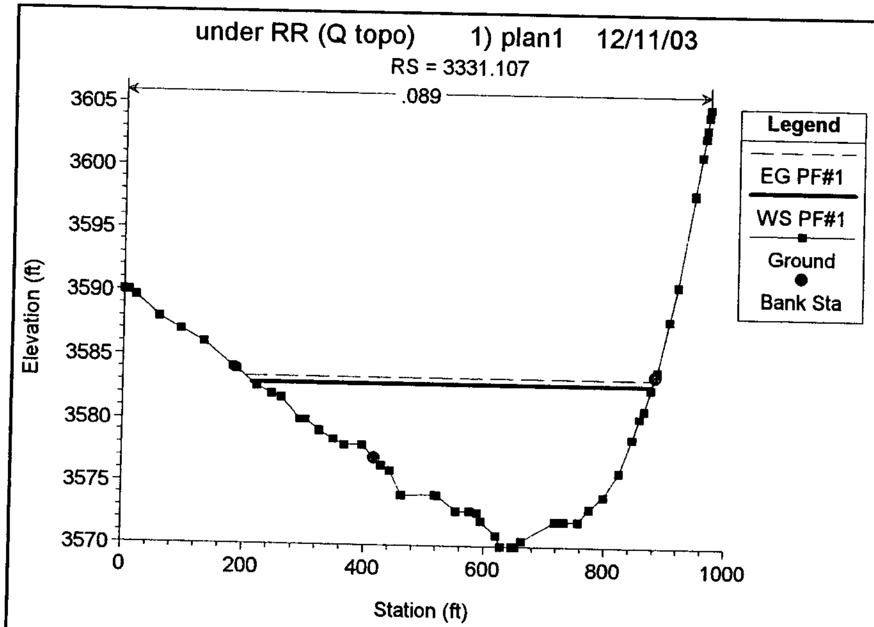
RS = 4821.742



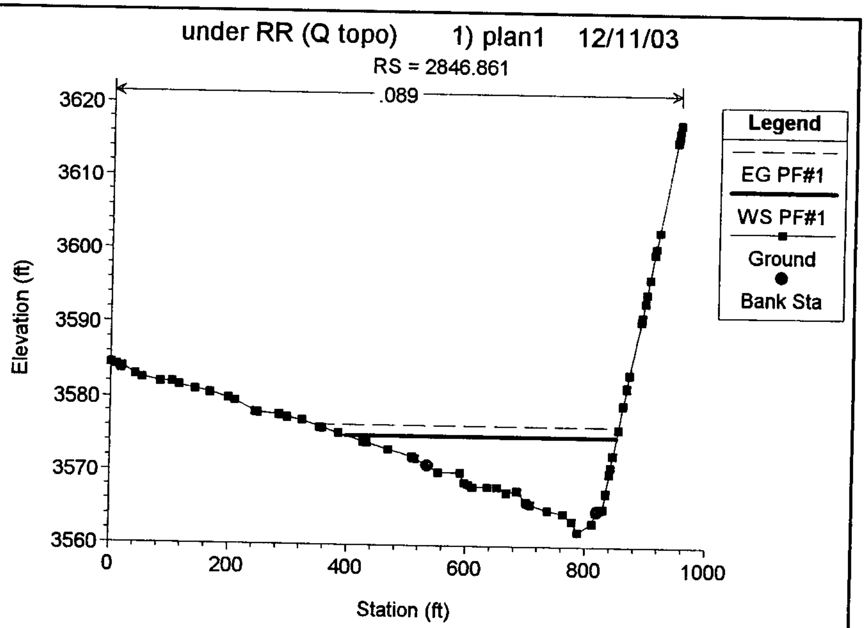
under RR (Q topo) 1) plan1 12/11/03

RS = 3938.849

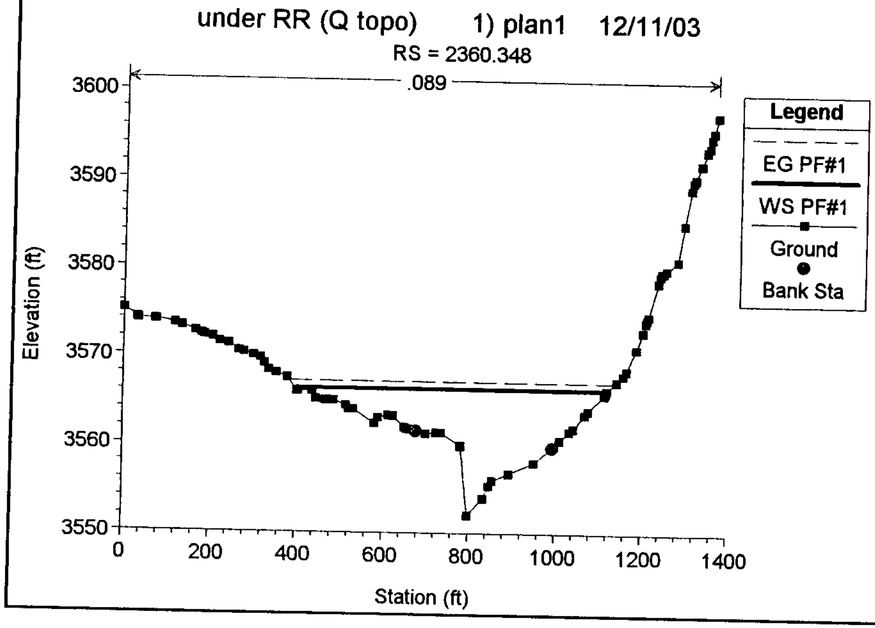
13-5


under RR (Q topo) 1) plan1 12/11/03

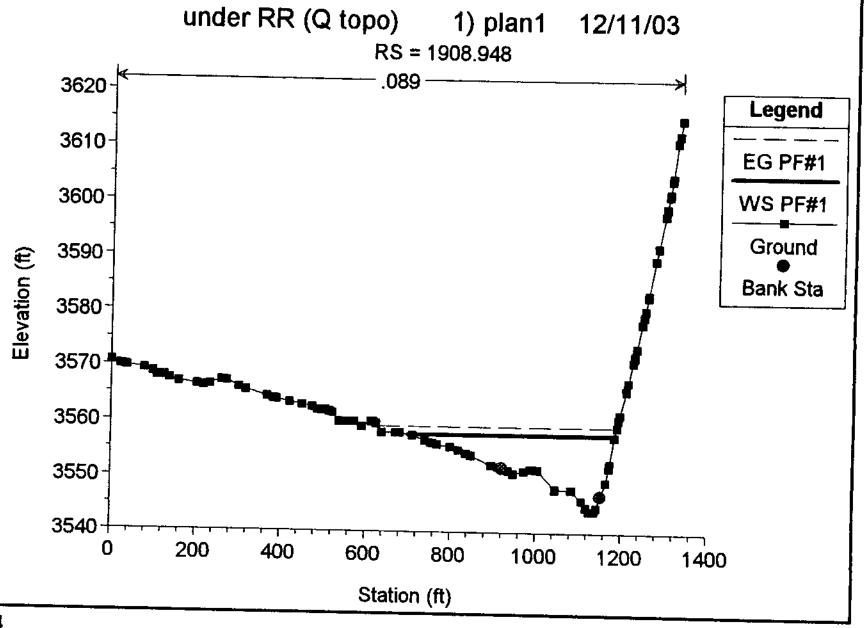
RS = 3331.107


under RR (Q topo) 1) plan1 12/11/03

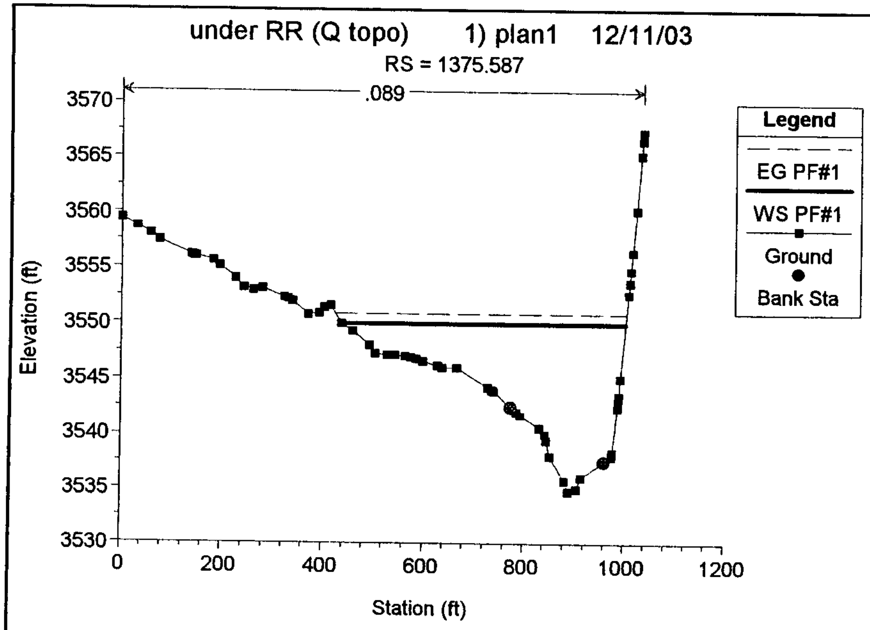
RS = 2846.861


under RR (Q topo) 1) plan1 12/11/03

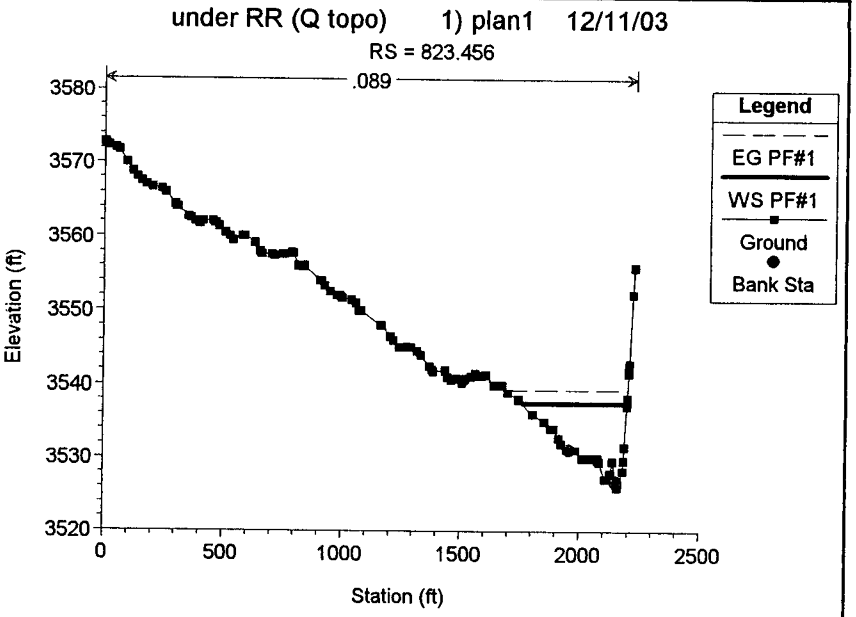
RS = 2360.348


under RR (Q topo) 1) plan1 12/11/03

RS = 1908.948



under RR (Q topo) 1) plan1 12/11/03
RS = 1375.587
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3570
3565
3560
3555
3550
3545
3540
3535
3530
0
200
400
600
800
1000
1200
Station (ft)



under RR (Q topo) 1) plan1 12/11/03
RS = 823.456
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3580
3570
3560
3550
3540
3530
3520
0
500
1000
1500
2000
2500
Station (ft)

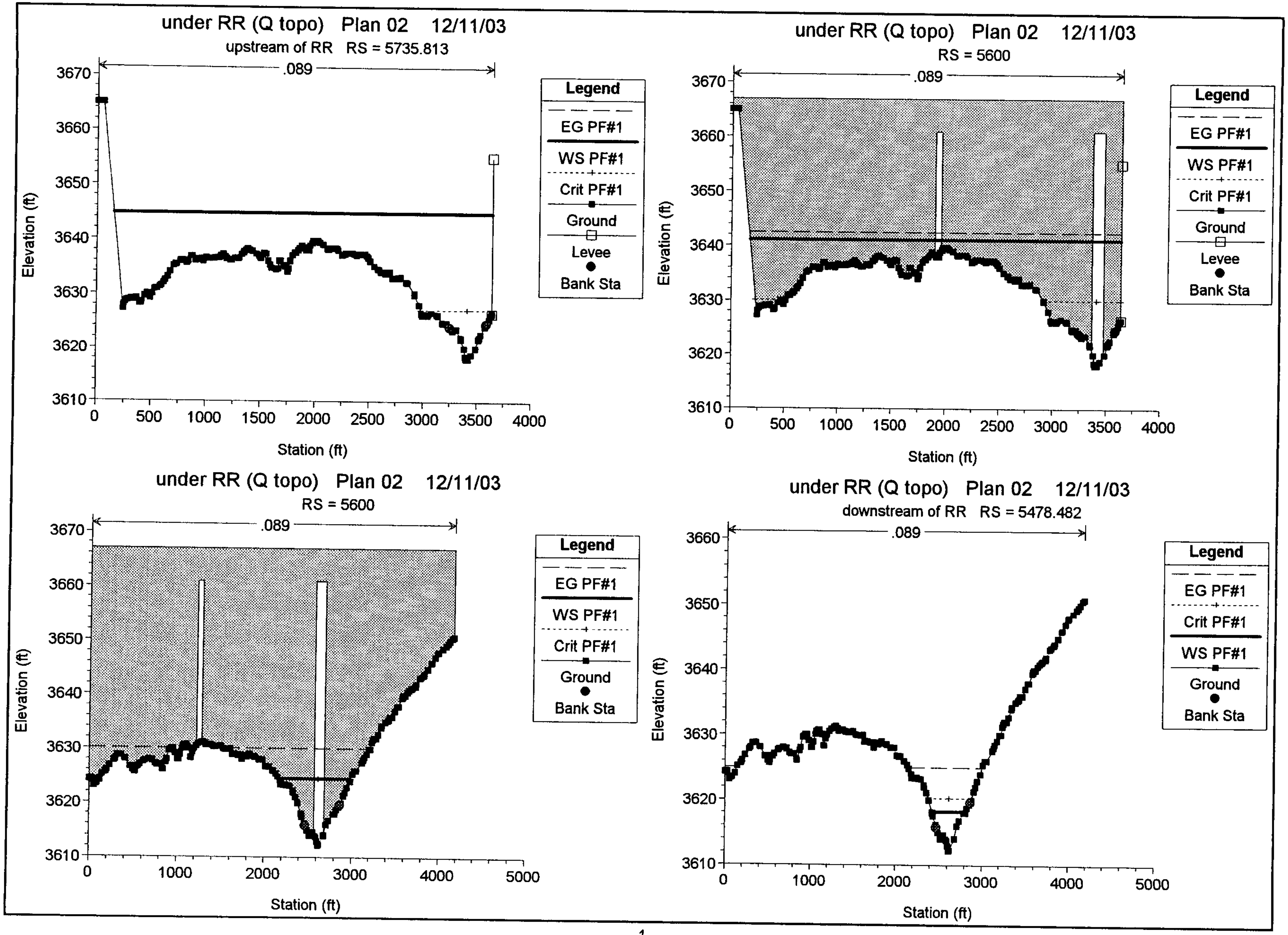
HEC-RAS Output for Clear Span Scenario for Alternative 1

HEC-RAS Plan: nopiers River: RR_cp8 Reach: reach1

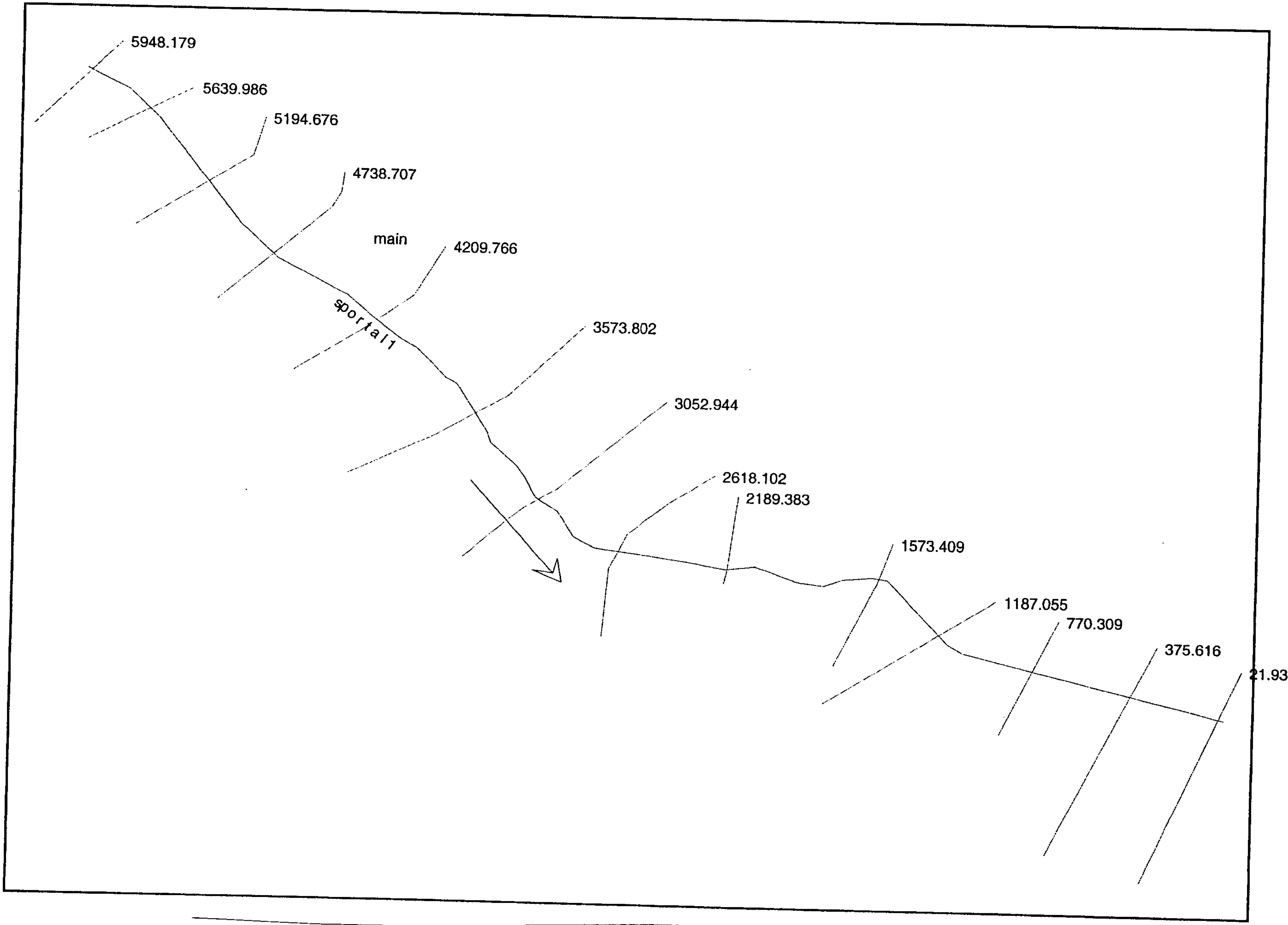
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Max Chl Dpth	Invert Slope
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	
reach1	7119.762	2486	3656.23	3658.5	3658.5	3659.23	0.103598	6.88	361.52	255.36	1.01	2.27	0.3575
reach1	6889.707	2486	3646.61	3650.58	3649.87	3650.87	0.026398	4.36	590.86	355.04	0.54	3.97	0.3157
reach1	6445.414	2486	3633.43	3644.91	3635.82	3644.92	0.000054	0.57	5308.68	853.11	0.03	11.48	0.2861
reach1	6003.442	23416	3624	3644.72	3632.38	3644.79	0.000505	2.61	12728.37	1645.46	0.11	20.72	0.2647
reach1	5854.853	23416	3620	3644.7	3628.87	3644.72	0.000155	1.6	24689.21	3216.85	0.06	24.7	0.2378
reach1	5735.813	23416	3618	3644.7	3627.01	3644.71	0.00004	0.86	40957.2	3484.69	0.03	26.7	0.221
reach1	5600	Bridge											
reach1	5478.482	23416	3612.2	3618.17	3620.24	3624.99	0.34365	21.17	1134.97	388.75	2.09	5.97	0.1905
reach1	5179.747	23416	3605.27	3614.95	3613.97	3616.22	0.03011	9.54	2832.41	732.19	0.69	9.68	0.1673
reach1	4821.742	23416	3598	3606.58		3607.16	0.018957	7.07	4198.95	1248.33	0.54	8.58	0.147
reach1	3938.849	25928	3581.82	3589.82		3590.63	0.017788	7.28	3626.1	721.75	0.53	8	0.1287
reach1	3331.107	25928	3570	3582.81		3583.29	0.006124	5.73	4845.21	660.74	0.33	12.81	0.1092
reach1	2846.861	25928	3562	3574.95		3576.42	0.021805	10	2791.26	457.3	0.62	12.95	0.0927
reach1	2360.348	25928	3552	3566.11		3567.09	0.015862	8.48	3594.06	719.01	0.52	14.11	0.0721
reach1	1908.948	25928	3544	3558.08		3559.41	0.01797	9.88	3088.44	548.84	0.57	14.08	0.0544
reach1	1375.587	25928	3534.76	3548.63		3550.07	0.017219	10.41	3027.2	524.03	0.57	13.87	0.0371
reach1	823.456	25928	3526.79	3538.47		3539.84	0.019766	10.08	2968.3	477.5	0.59	12.47	0.0226
reach1	170.341	25928	3512	3522.38	3521.19	3523.96	0.028024	10.5	2769.85	559.06	0.69	10.38	

These results show how water surface elevations upstream of the railroad bridge would be approximately 2 ft. lower if both bridges were constructed as clear spans.

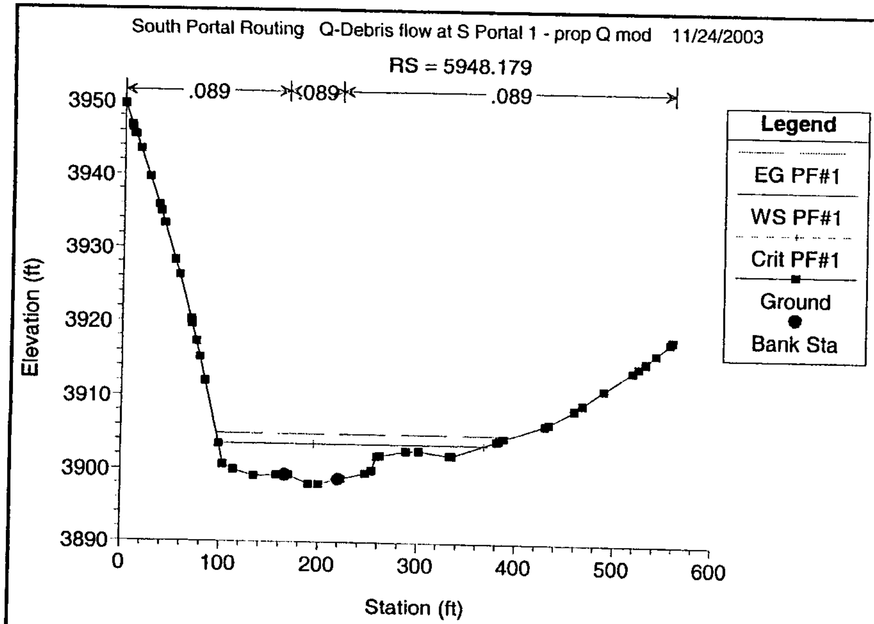
Clear Span Scenario

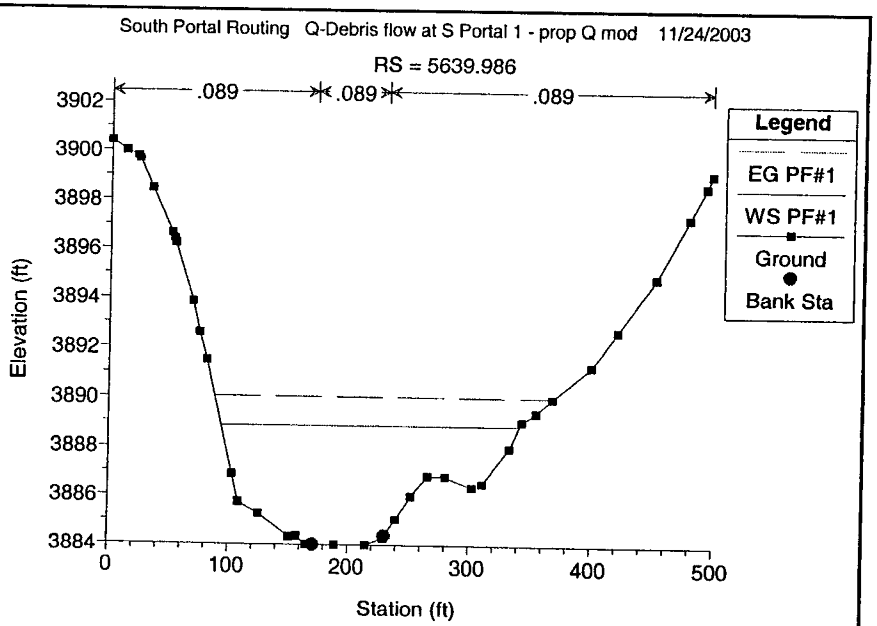


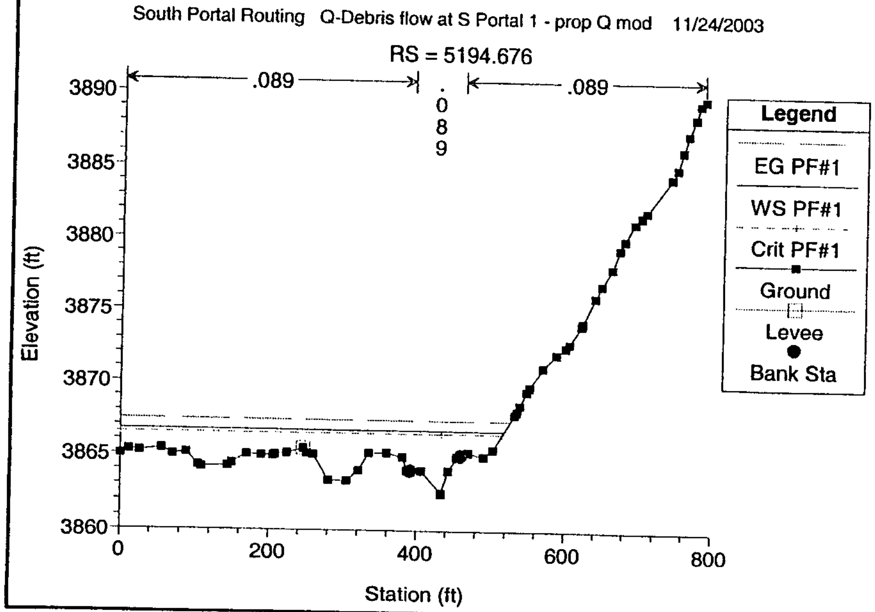
Attachment 14: Hydraulic Calculations for South Portal Routings, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)

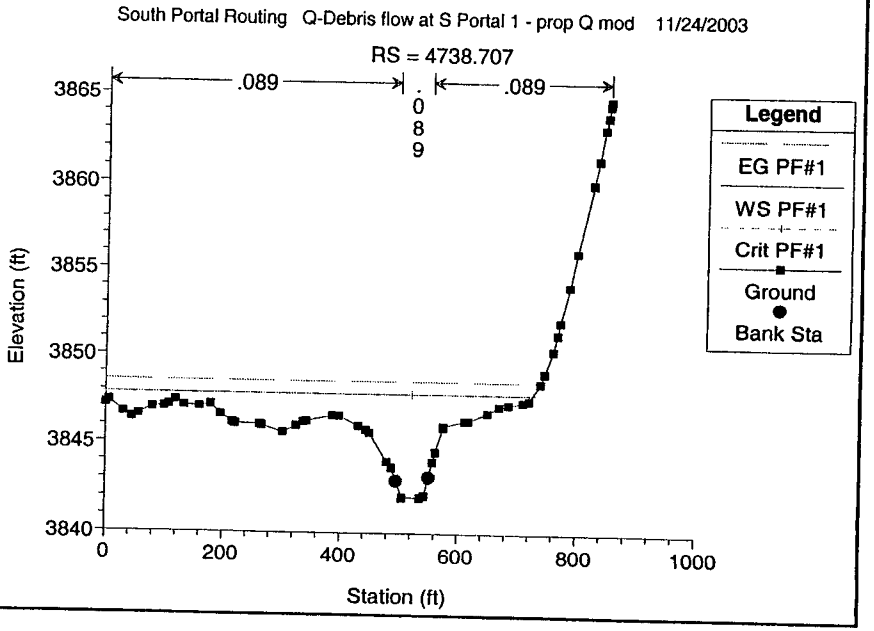

5948.179
5639.986
5194.676
4738.707
main
4209.766
sportal1
3573.802
3052.944
2618.102
2189.383
1573.409
1187.055
770.309
375.616
21.937

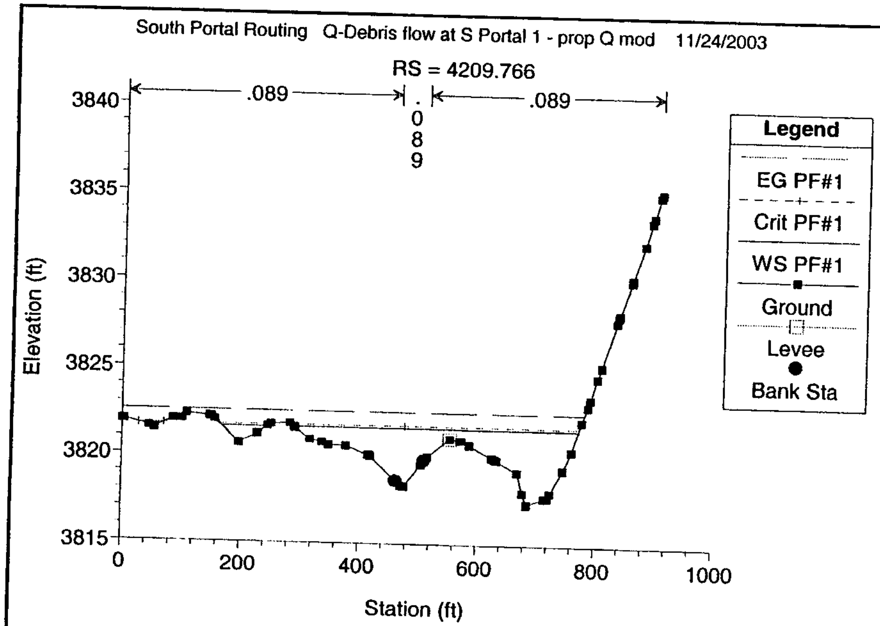
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Qspl-mod  River: sportall  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 14
# Plans             = 1
# Profiles          = 1

 Reach            River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                       (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

 main             5948.179           6765.00    3898.00    3903.50    3903.46    3904.88   0.050825      11.04     790.50     270.29          0.87
 main             5639.986           6765.00    3884.00    3888.86               3890.05   0.045509      10.16     815.74     247.94          0.82
 main             5194.676           6765.00    3862.50    3866.70    3866.48    3867.38   0.056452       8.14    1046.61     518.39          0.84
 main             4738.707           6765.00    3842.00    3847.83    3847.83    3848.56   0.031369       9.38    1309.00     726.66          0.69
 main             4209.766           6765.00    3818.29    3821.60    3821.72    3822.54   0.087759       9.73     914.13     581.06          1.03
 main             3573.802           6765.00    3787.35    3791.09    3790.36    3791.34   0.026304       5.60    1736.35    1029.80          0.57
 main             3052.944           6765.00    3764.00    3766.08    3766.08    3766.88   0.103582       8.73     955.90     657.58          1.07
 main             2618.102           8248.00    3746.97    3750.18    3748.97    3750.50   0.015978       4.30    1964.28     801.29          0.44
 main             2189.383           8248.00    3730.59    3737.99    3737.99    3739.61   0.045036      12.82     912.70     255.30          0.86
 main             1573.409           8248.00    3715.33    3720.63    3717.91    3720.84   0.006012       3.70    2252.07     477.20          0.30
 main             1187.055           8248.00    3705.73    3713.67    3713.07    3715.76   0.042005      13.24     744.83     127.27          0.85
 main             770.309            8248.00    3692.50    3698.07    3697.23    3699.14   0.036600       9.66    1013.01     254.20          0.74
 main             375.616            8248.00    3679.79    3682.98    3682.34    3683.60   0.041746       7.02    1310.81     523.23          0.72
 main             21.937             8248.00    3668.22    3670.36    3669.63    3670.83   0.031300       4.42    1502.13     595.81          0.58
```

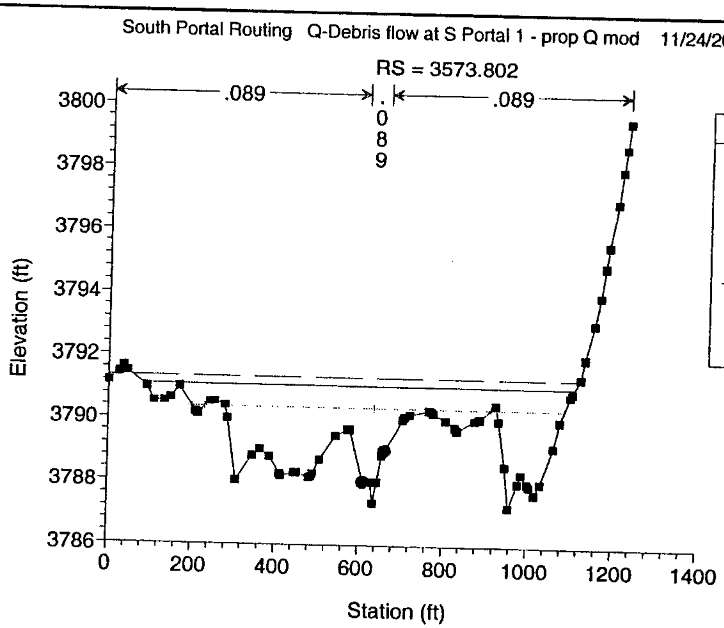

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 5948.179
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3950
3940
3930
3920
3910
3900
3890
0
100
200
300
400
500
600
Station (ft)

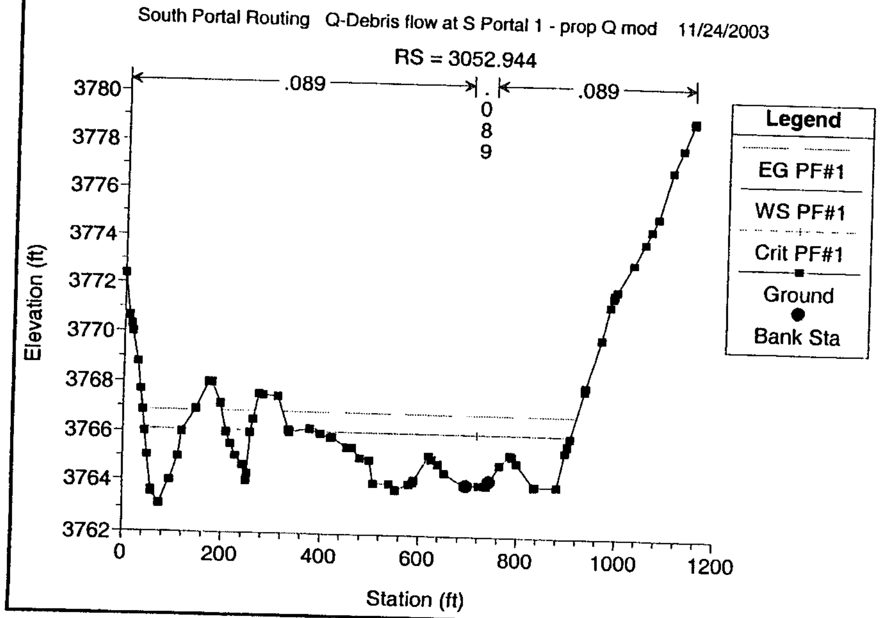

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 5639.986
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3902
3900
3898
3896
3894
3892
3890
3888
3886
3884
0
100
200
300
400
500
Station (ft)

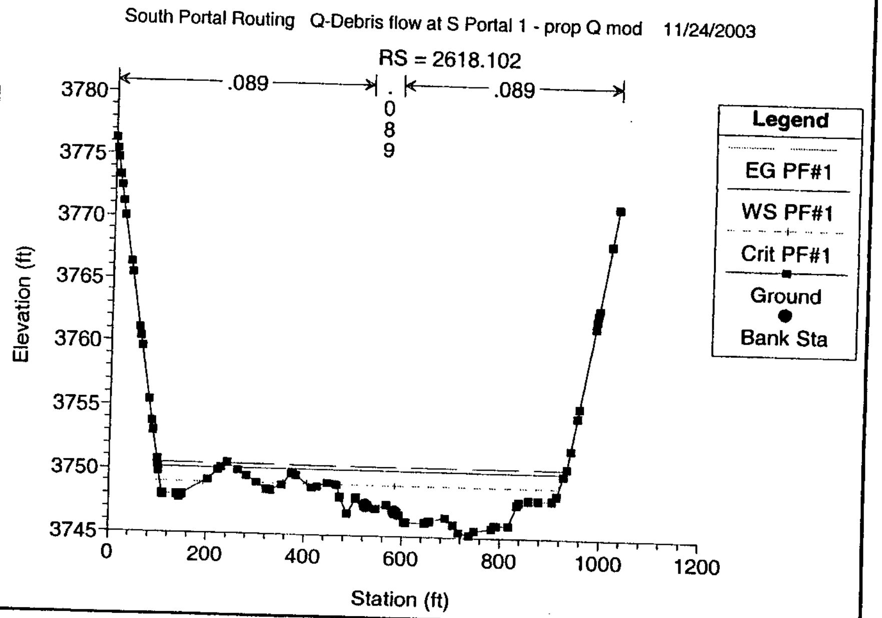

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 5194.676
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3890
3885
3880
3875
3870
3865
3860
0
200
400
600
800
Station (ft)

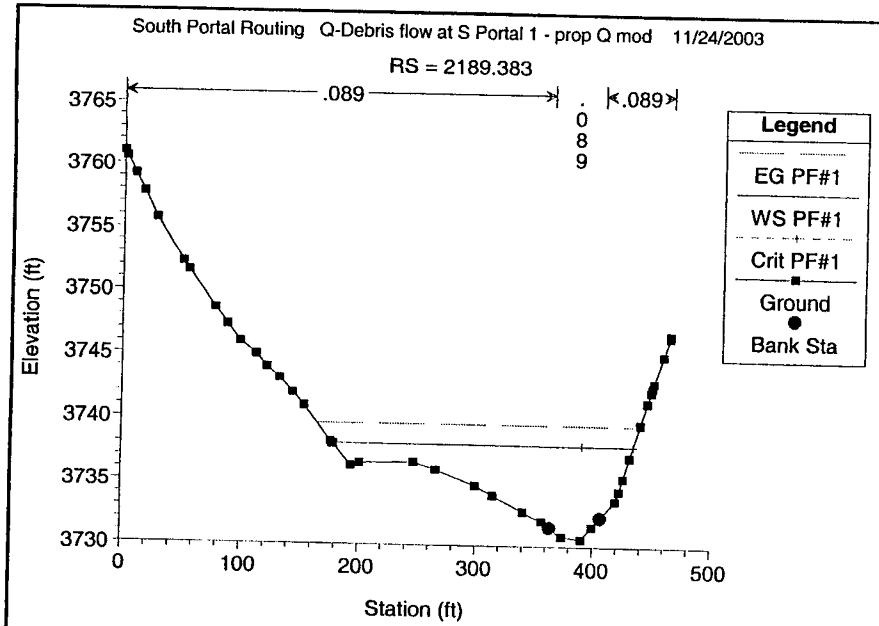

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 4738.707
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3865
3860
3855
3850
3845
3840
0
200
400
600
800
1000
Station (ft)

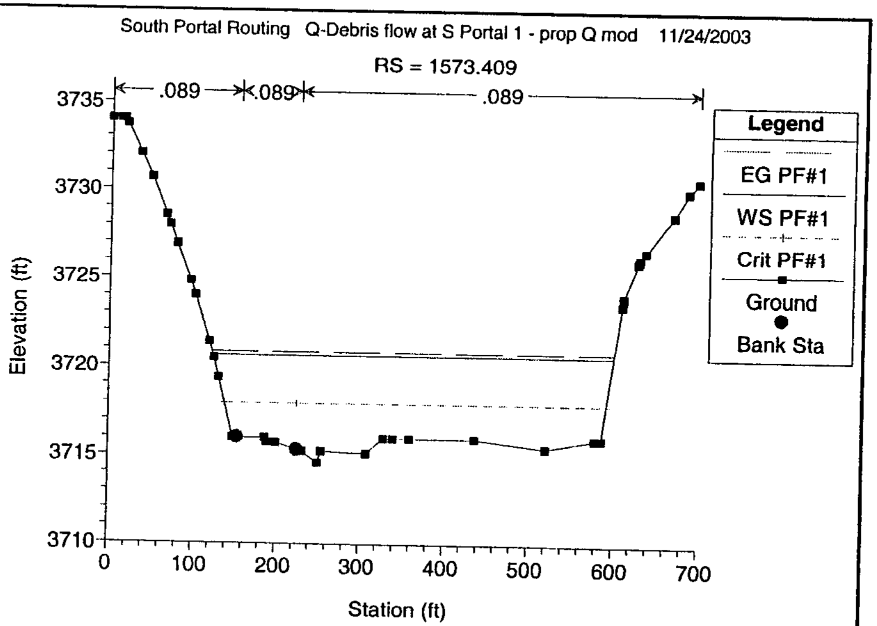

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 4209.766
.089
.089
.089
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3840
3835
3830
3825
3820
3815
0
200
400
600
800
1000
Station (ft)

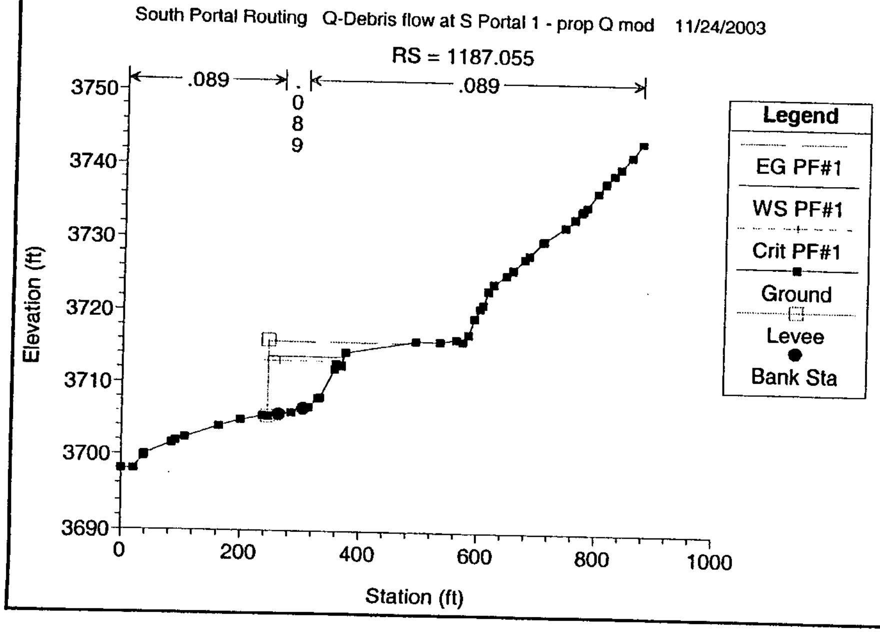

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 3573.802
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3800
3798
3796
3794
3792
3790
3788
3786
0
200
400
600
800
1000
1200
1400
Station (ft)

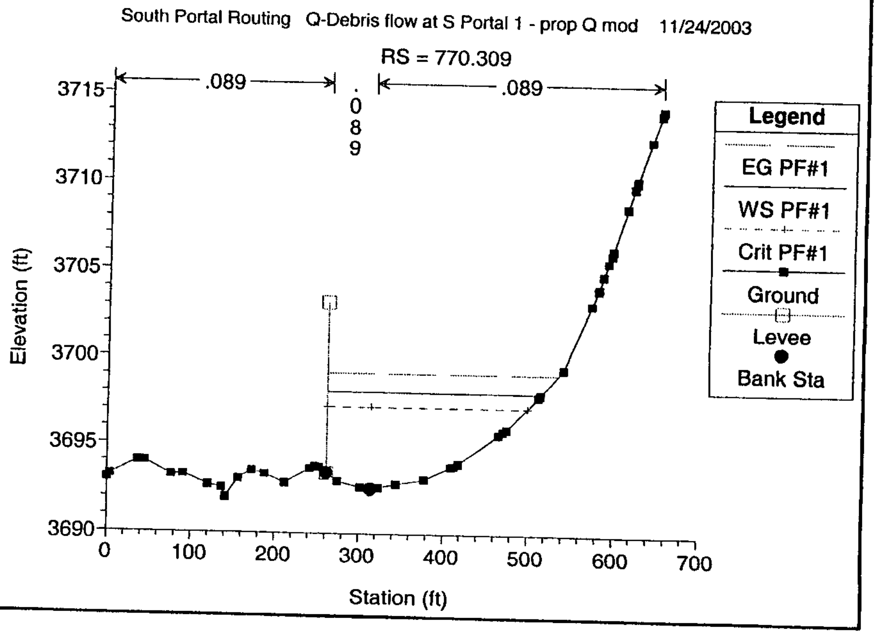

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 3052.944
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3780
3778
3776
3774
3772
3770
3768
3766
3764
3762
0
200
400
600
800
1000
1200
Station (ft)

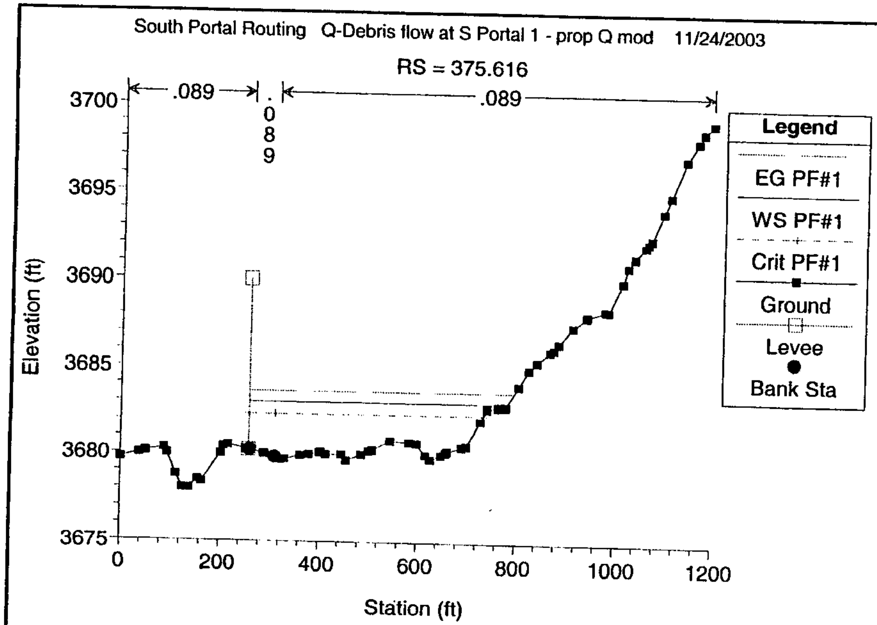

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 2618.102
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3780
3775
3770
3765
3760
3755
3750
3745
0
200
400
600
800
1000
1200
Station (ft)


South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 2189.383
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3765
3760
3755
3750
3745
3740
3735
3730
0
100
200
300
400
500
Station (ft)


South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 1573.409
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3735
3730
3725
3720
3715
3710
0
100
200
300
400
500
600
700
Station (ft)

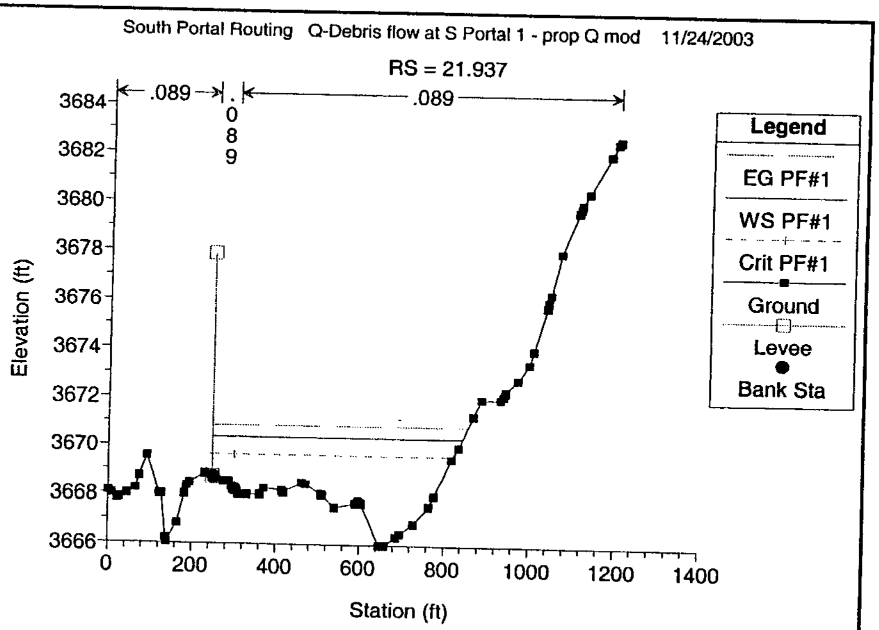

South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 1187.055
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3750
3740
3730
3720
3710
3700
3690
0
200
400
600
800
1000
Station (ft)


South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003
RS = 770.309
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3715
3710
3705
3700
3695
3690
0
100
200
300
400
500
600
700
Station (ft)



South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003

RS = 375.616



South Portal Routing Q-Debris flow at S Portal 1 - prop Q mod 11/24/2003

RS = 21.937

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-sportal2  River: sportal2  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 11
# Plans             = 1
# Profiles          = 1

 Reach            River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope  Vel Chnl  Flow Area  Top Width Froude # Chl
                                      (cfs)      (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)      (ft)

 main             2359.352           1000.00    3805.70    3809.18    3808.43    3809.72   0.029921      6.36     182.24      77.50         0.62
 main             2045.065           1000.00    3794.00    3797.60               3798.27   0.045202      7.18     167.22      91.72         0.74
 main             1811.135           1000.00    3787.56    3790.47               3790.78   0.023241      4.71     231.46     111.42         0.52
 main             1648.293           1000.00    3781.36    3783.72    3783.72    3784.42   0.078375      7.65     159.88     113.66         0.93
 main             1461.889           1000.00    3774.92    3777.68    3776.85    3777.89   0.017931      4.21     287.96     165.93         0.46
 main             1260.977           1000.00    3768.44    3770.17    3770.17    3770.83   0.095761      7.13     157.98     121.74         0.99
 main             1085.369           1000.00    3762.00    3764.62    3763.69    3764.77   0.014725      3.21     324.35     182.10         0.40
 main             894.514            1000.00    3756.00    3758.71    3758.71    3759.51   0.066417      7.76     152.43      98.54         0.88
 main             628.252            1000.00    3748.41    3750.81    3749.95    3750.97   0.015826      3.62     322.01     187.08         0.42
 main             336.737            1000.00    3738.00    3741.76    3741.76    3742.46   0.069236      7.62     164.31     117.30         0.88
 main             11.824             1000.00    3730.41    3737.99    3733.55    3738.02   0.000762      1.66     815.11     233.27         0.11
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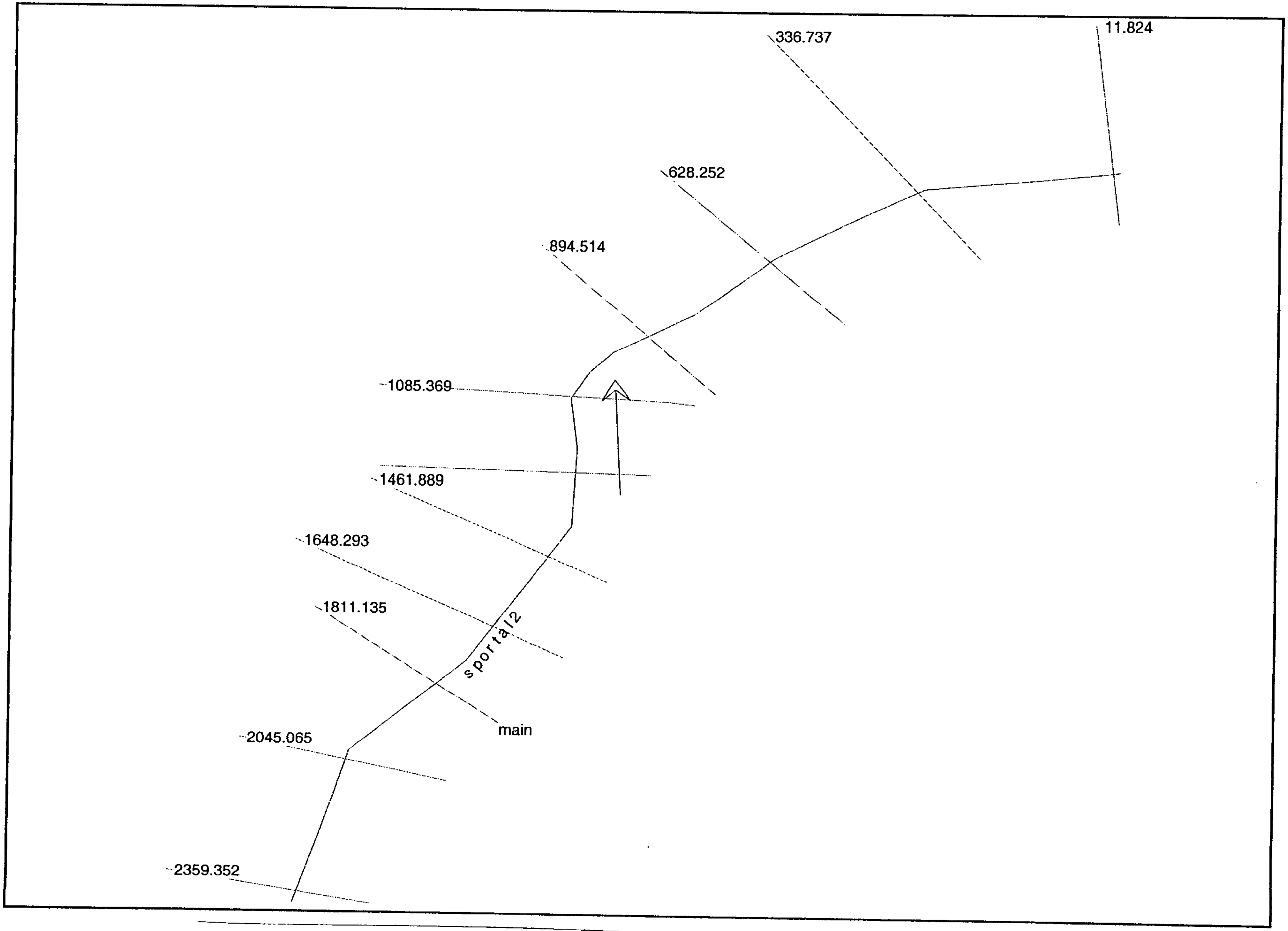
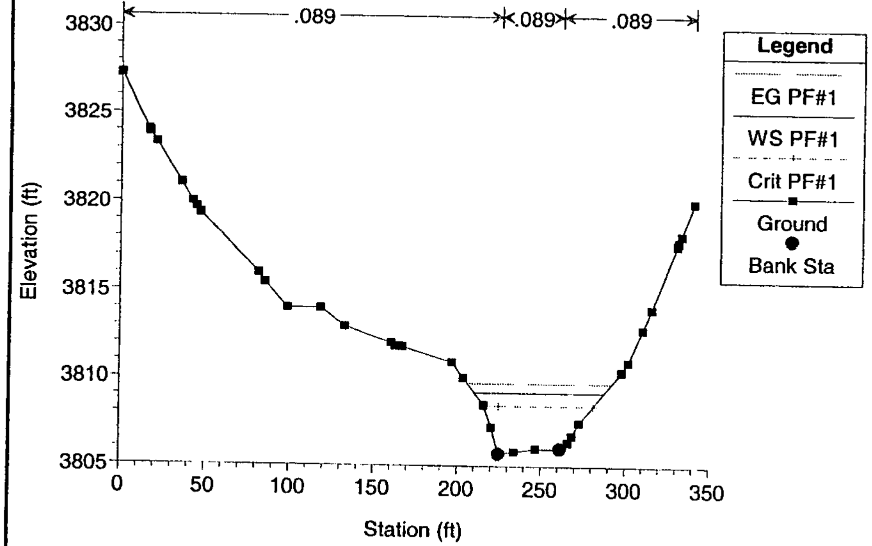


Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A

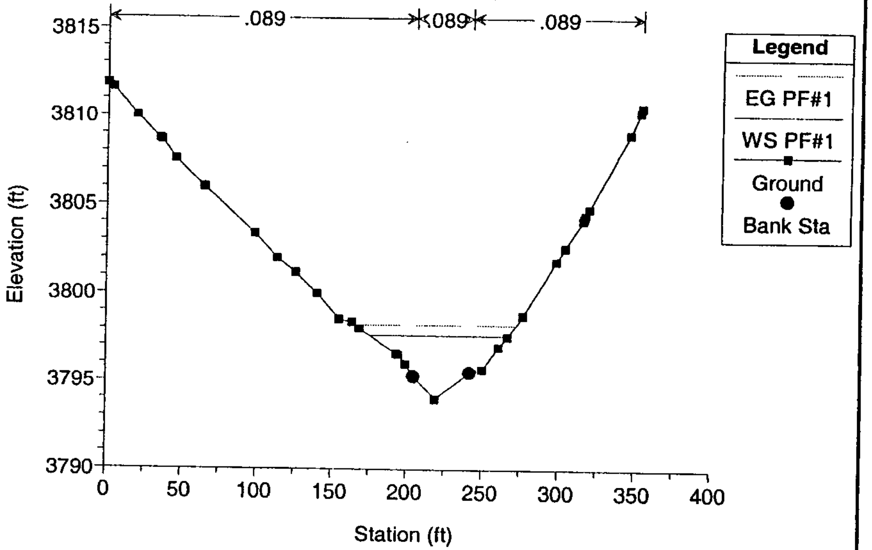
South Portal Routing Q-Debris flow at S Portal 2 11/24/2003

RS = 2359.352



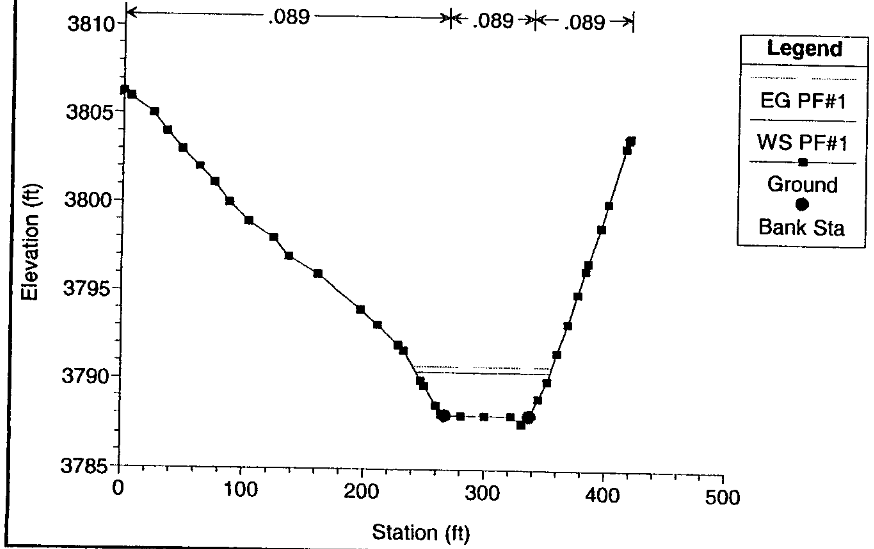
South Portal Routing Q-Debris flow at S Portal 2 11/24/2003

RS = 2045.065



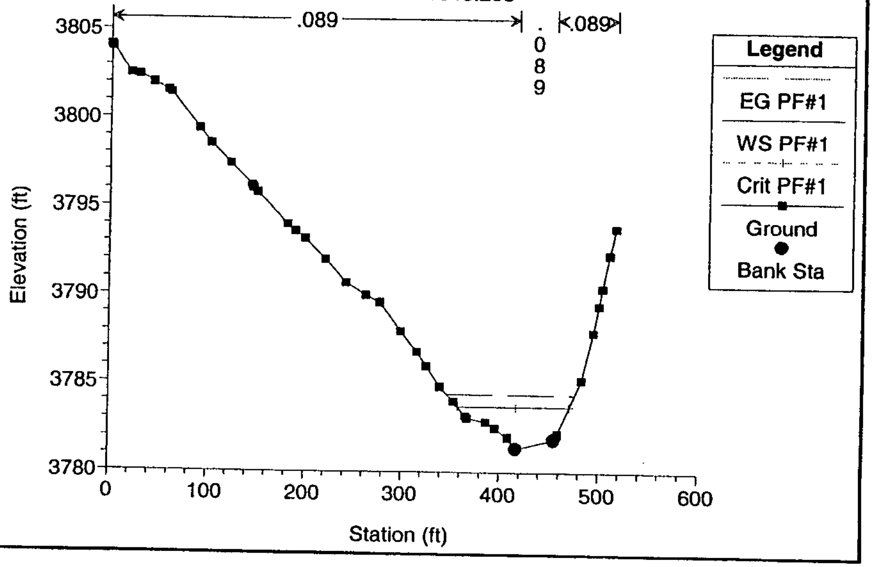
South Portal Routing Q-Debris flow at S Portal 2 11/24/2003

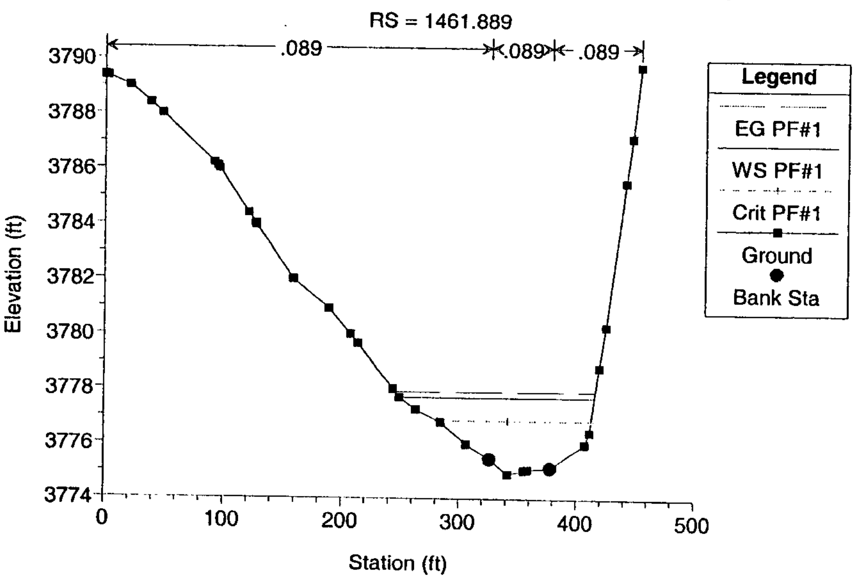
RS = 1811.135

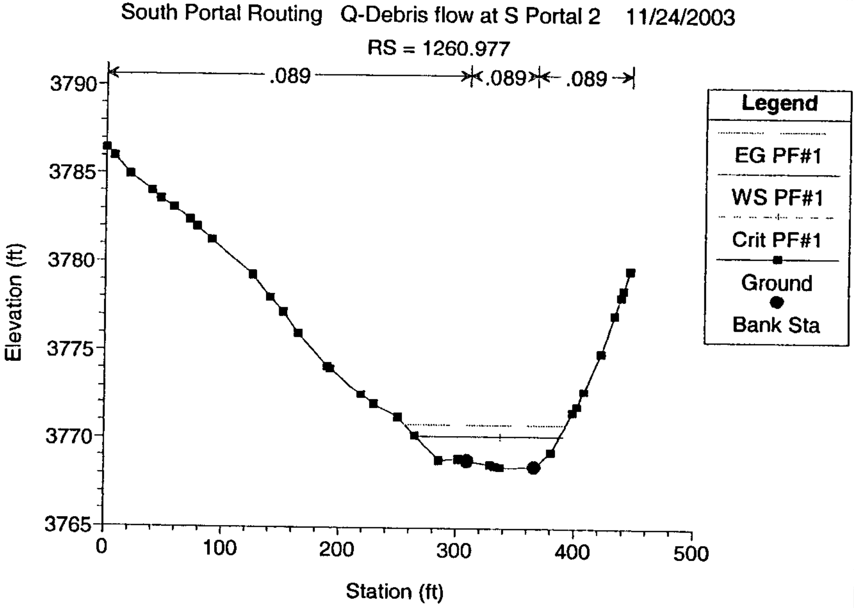


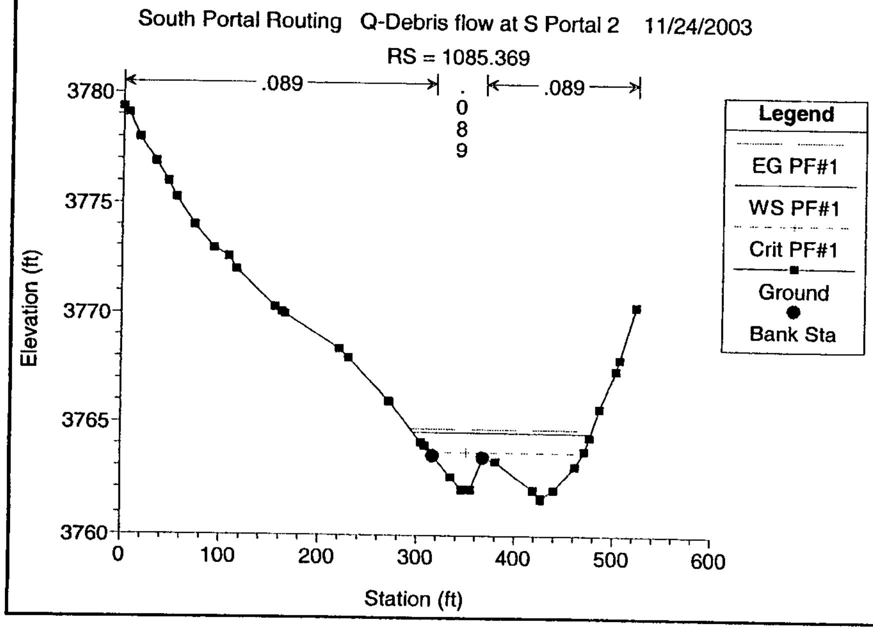
South Portal Routing Q-Debris flow at S Portal 2 11/24/2003

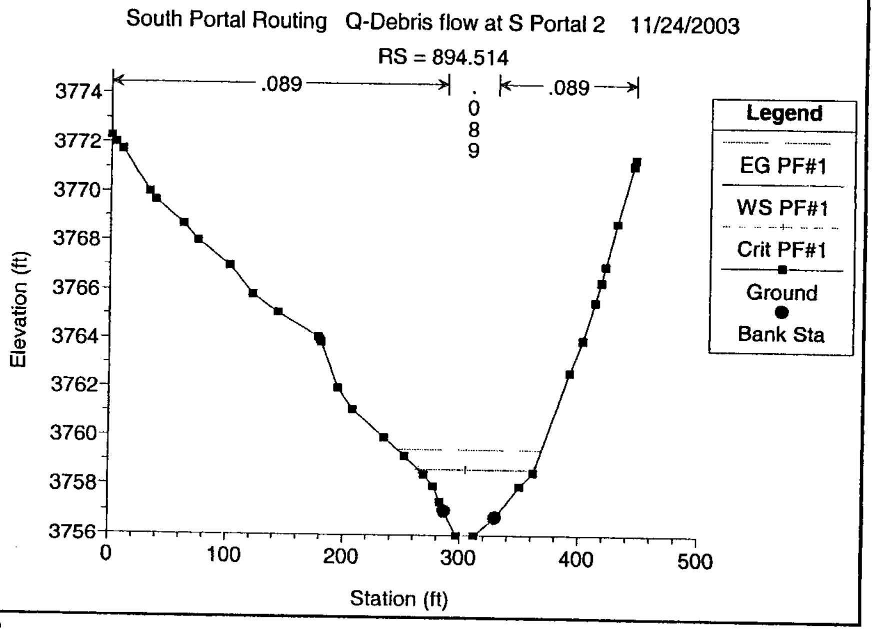
RS = 1648.293

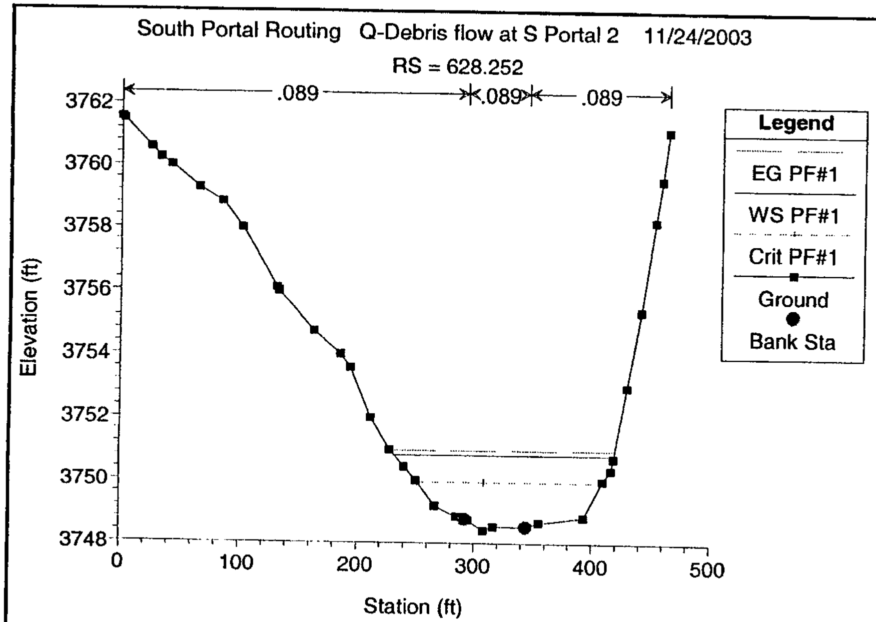


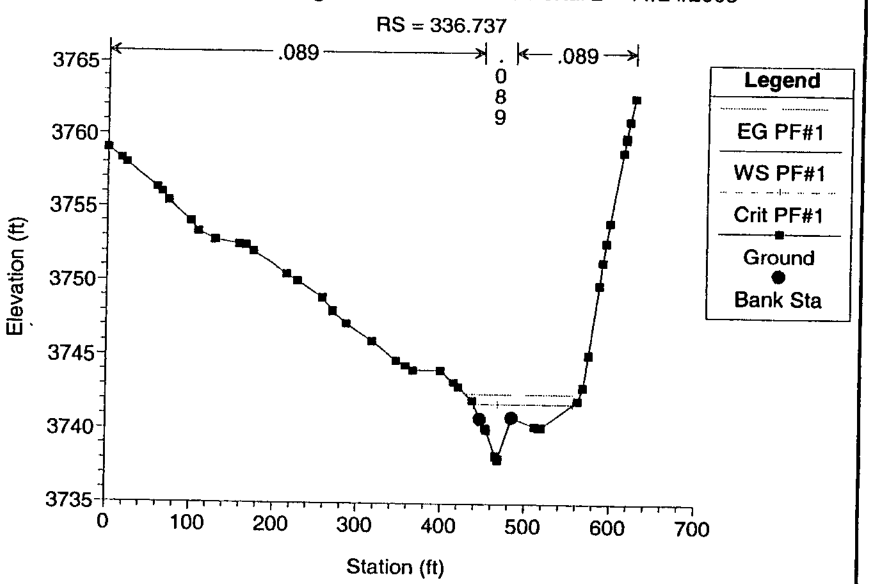

South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 1461.889
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3790
3788
3786
3784
3782
3780
3778
3776
3774
Station (ft)
0
100
200
300
400
500

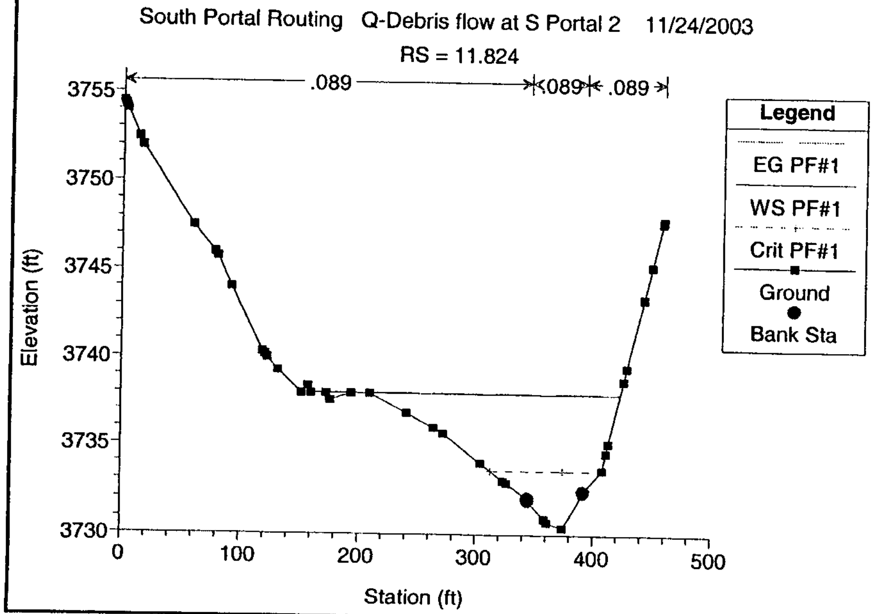

South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 1260.977
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3790
3785
3780
3775
3770
3765
Station (ft)
0
100
200
300
400
500


South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 1085.369
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3780
3775
3770
3765
3760
Station (ft)
0
100
200
300
400
500
600


South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 894.514
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3774
3772
3770
3768
3766
3764
3762
3760
3758
3756
Station (ft)
0
100
200
300
400
500


South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 628.252


South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 336.737

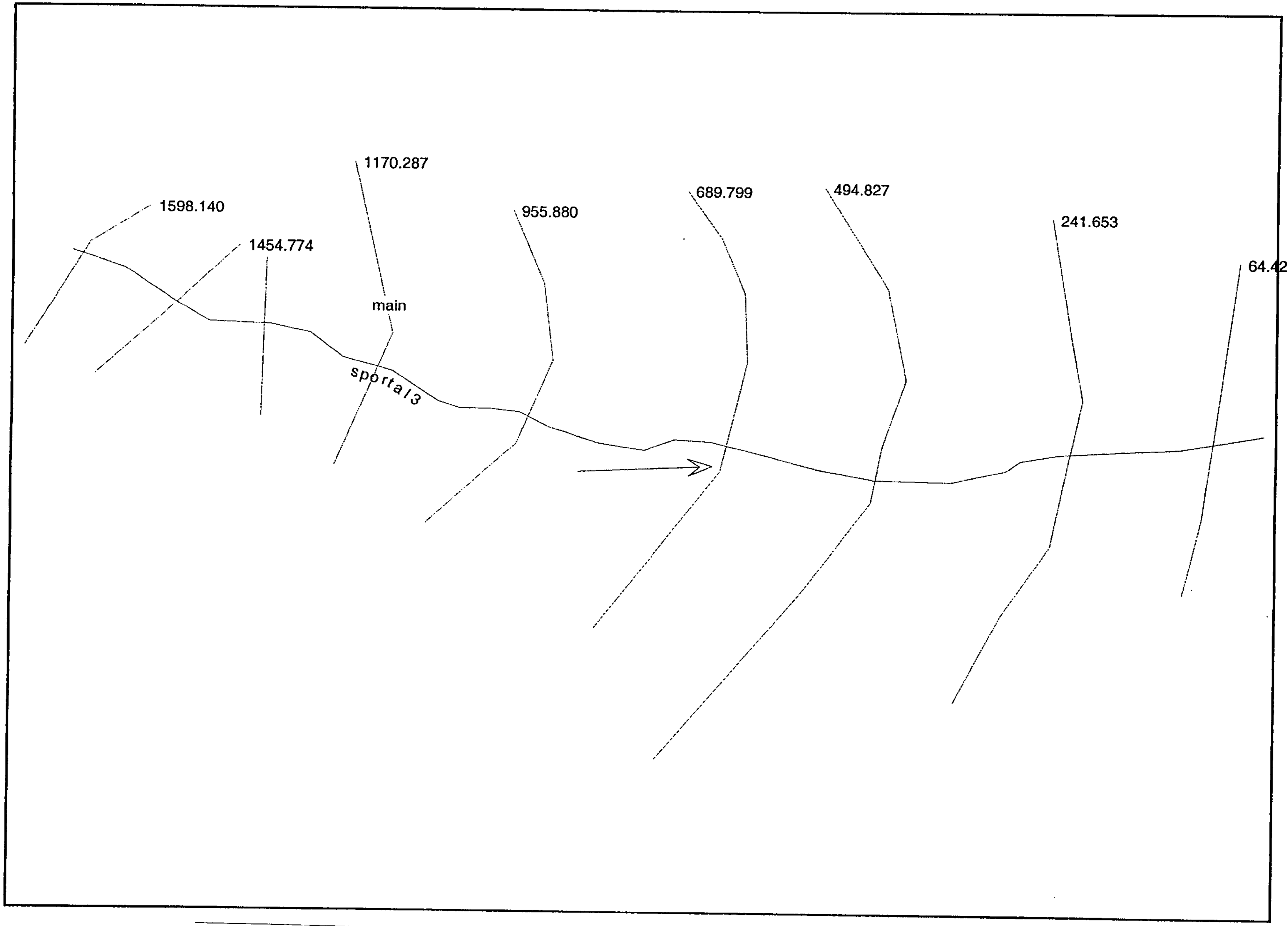

South Portal Routing Q-Debris flow at S Portal 2 11/24/2003
RS = 11.824

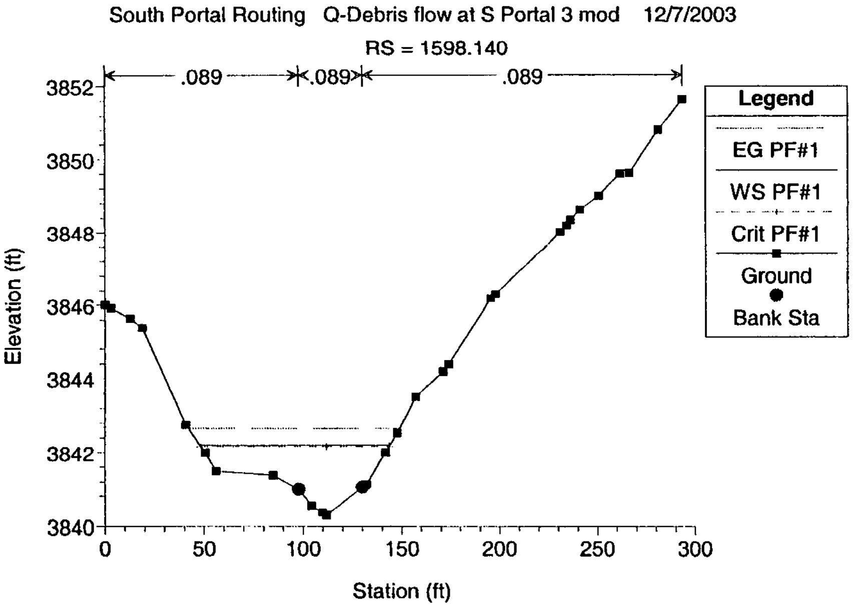
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: Q-sportal3  River: sportal3  Reach: main

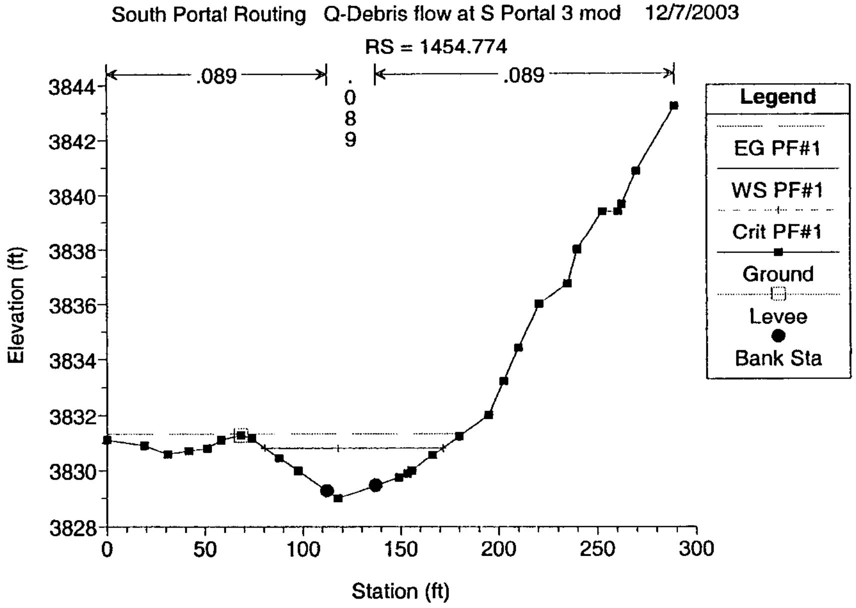
# Rivers             = 1
# Hydraulic Reaches  = 1
# River Stations     = 9
# Plans              = 1
# Profiles           = 1

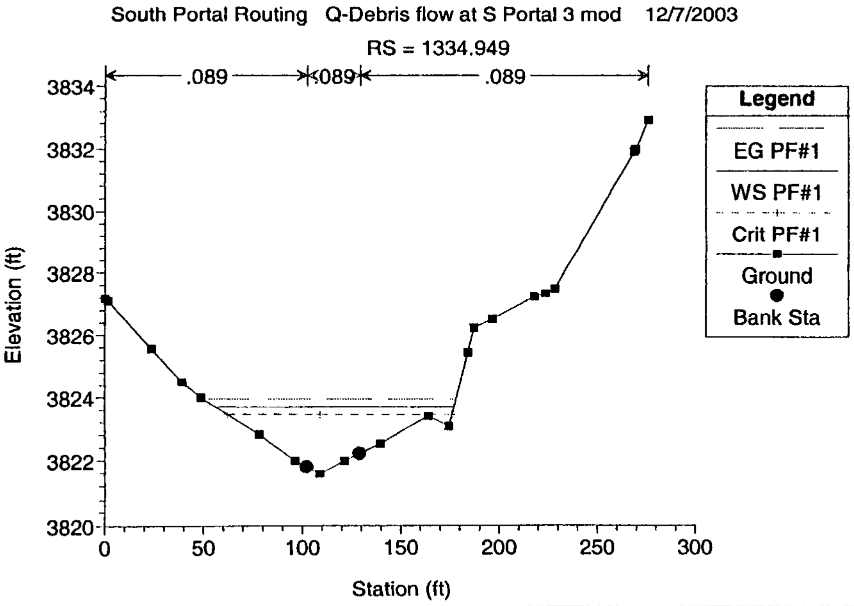
 Reach          River Sta         Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                   (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)   (sq ft)      (ft)

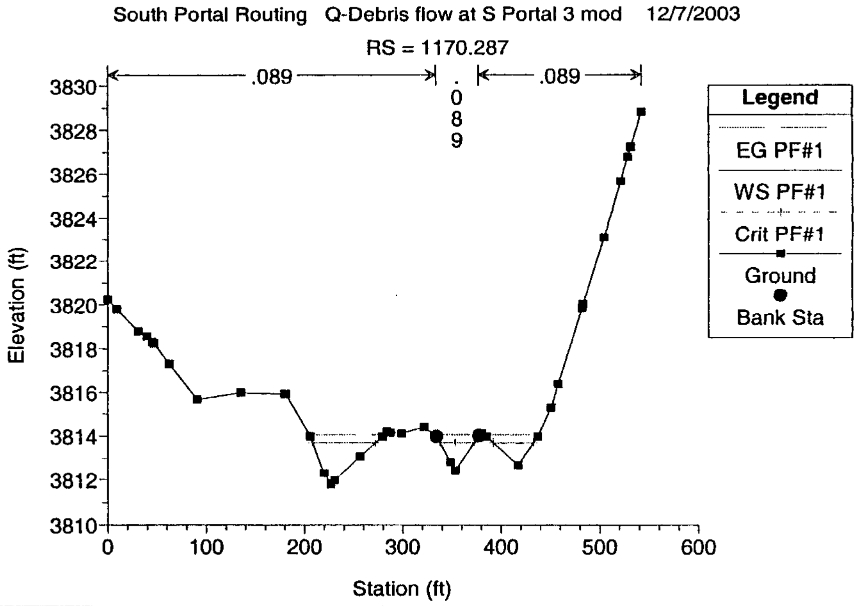
 main           1598.140           484.00    3840.29    3842.20    3842.16    3842.65   0.073753      6.12      97.58      96.20         0.86
 main           1454.774           484.00    3829.00    3830.83    3830.83    3831.33   0.084764      6.69      92.24      91.06         0.93
 main           1334.949           484.00    3821.59    3823.71    3823.47    3823.97   0.037830      4.89     131.11     121.09         0.63
 main           1170.287           484.00    3812.45    3813.72    3813.72    3814.08   0.106348      4.02     103.95     139.46         0.89
 main           955.880            484.00    3800.00    3800.84    3800.66    3800.94   0.033011      2.62     208.66     368.87         0.52
 main           689.799            484.00    3784.23    3784.81    3784.81    3784.99   0.131993      2.69     144.42     433.96         0.87
 main           494.827            484.00    3771.33    3772.46    3772.22    3772.53   0.031766      2.56     237.97     450.38         0.50
 main           241.653            484.00    3756.97    3757.74    3757.74    3757.96   0.136168      4.19     127.84     303.44         0.99
 main           64.428             484.00    3747.10    3750.18    3748.87    3750.20   0.001836      1.36     512.92     370.45         0.15
```


1170.287
1598.140
1454.774
955.880
689.799
494.827
241.653
64.428
main
sportal3


South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003
RS = 1598.140
.089
.089
.089
Elevation (ft)
3852
3850
3848
3846
3844
3842
3840
0
50
100
150
200
250
300
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta


South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003
RS = 1454.774
.089
.089
.089
Elevation (ft)
3844
3842
3840
3838
3836
3834
3832
3830
3828
0
50
100
150
200
250
300
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

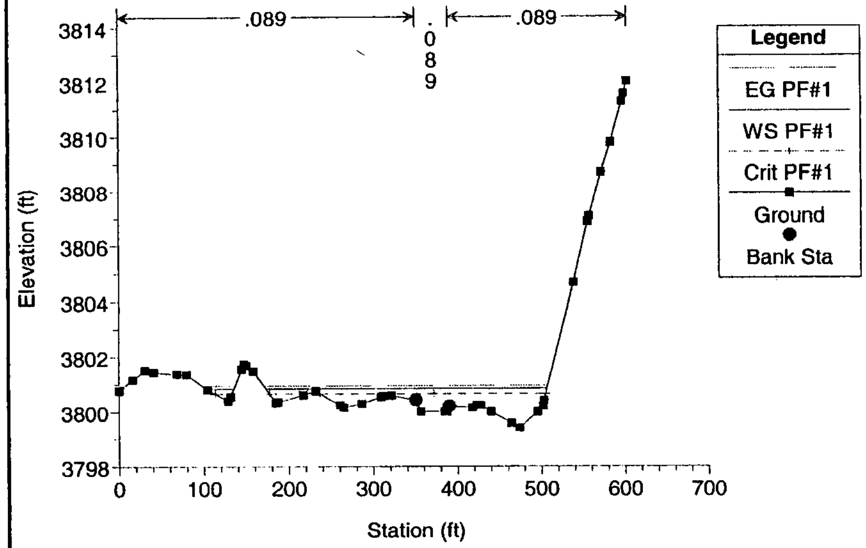

South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003
RS = 1334.949
.089
.089
.089
Elevation (ft)
3834
3832
3830
3828
3826
3824
3822
3820
0
50
100
150
200
250
300
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta


South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003
RS = 1170.287
.089
.089
.089
Elevation (ft)
3830
3828
3826
3824
3822
3820
3818
3816
3814
3812
3810
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta

14-14

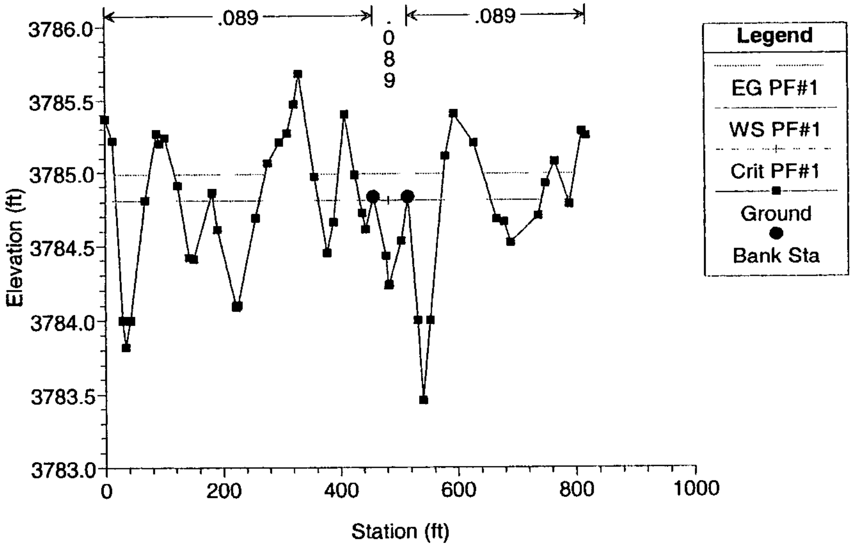
South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003

RS = 955.880



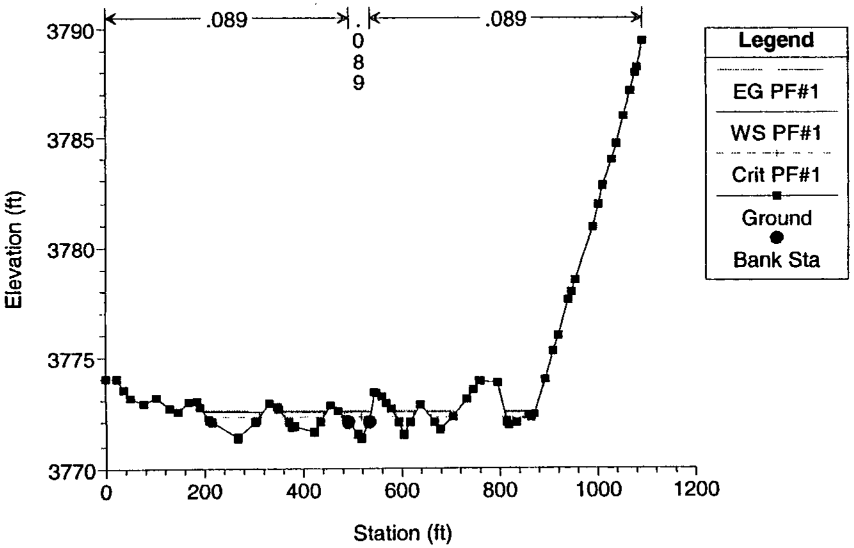
South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003

RS = 689.799



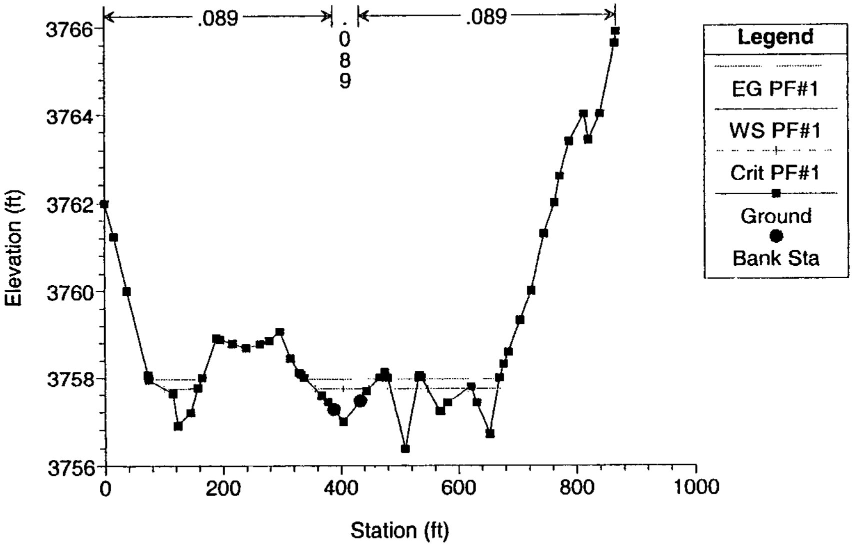
South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003

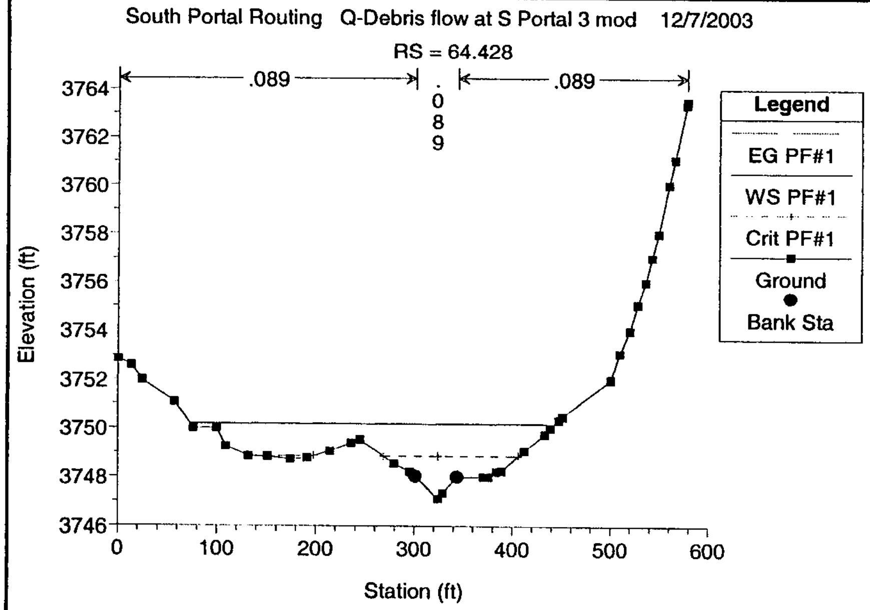
RS = 494.827



South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003

RS = 241.653




South Portal Routing Q-Debris flow at S Portal 3 mod 12/7/2003
RS = 64.428
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
●
Bank Sta
Elevation (ft)
3764
3762
3760
3758
3756
3754
3752
3750
3748
3746
0
100
200
300
400
500
600
Station (ft)

Attachment 15: Scour Analysis, Alternative 1
(Document ID: 000-00C-CD04-00100-000-00A)

URS

Job Yucca Mtn. Revised hydrologic Study
Description Scour Analysis @ bridge – Alternative 1
Project No. N/A
Computed by V.bell
Checked by Pm
Page N of A
Sheet 1 of 1
Date 2/27/04
Date 4/1/04
Reference

CSU Equation for local scour

$$\frac{y_s}{a} = 2.0 K_1 K_2 K_3 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43}$$ (Eq. ~~22~~ 6.3 JK 3/13/04) (Ref. 17)

max. water depth y_1 = ~~29~~ feet @ bridge north of Muck Storage A
~~26.7~~ OK Pm 3/1/04

from previous study (BGC, 2002)
$K_1 = 1.0$ round nose pier
$K_2 = 1.0$ piers aligned w/ flow
$K_3 = 1.2$ medium dunes

(Ref. 6, p. 43) $$\frac{y_s}{a} = 2.0 \times 1 \times 1 \times 1.2 \times \left(\frac{29}{4}\right)^{0.35} (0.02)^{0.43}$$

$$\therefore \frac{y_s}{a} = 0.89$$ ✓

$$y_s = 0.89 \times 4 = \boxed{3.6 \text{ ft}}$$ ✓

Note: That the value of K_4 using the new method is 1.0 so answer is unchanged.

At the bridge @ H-road

y_1 = 8 feet

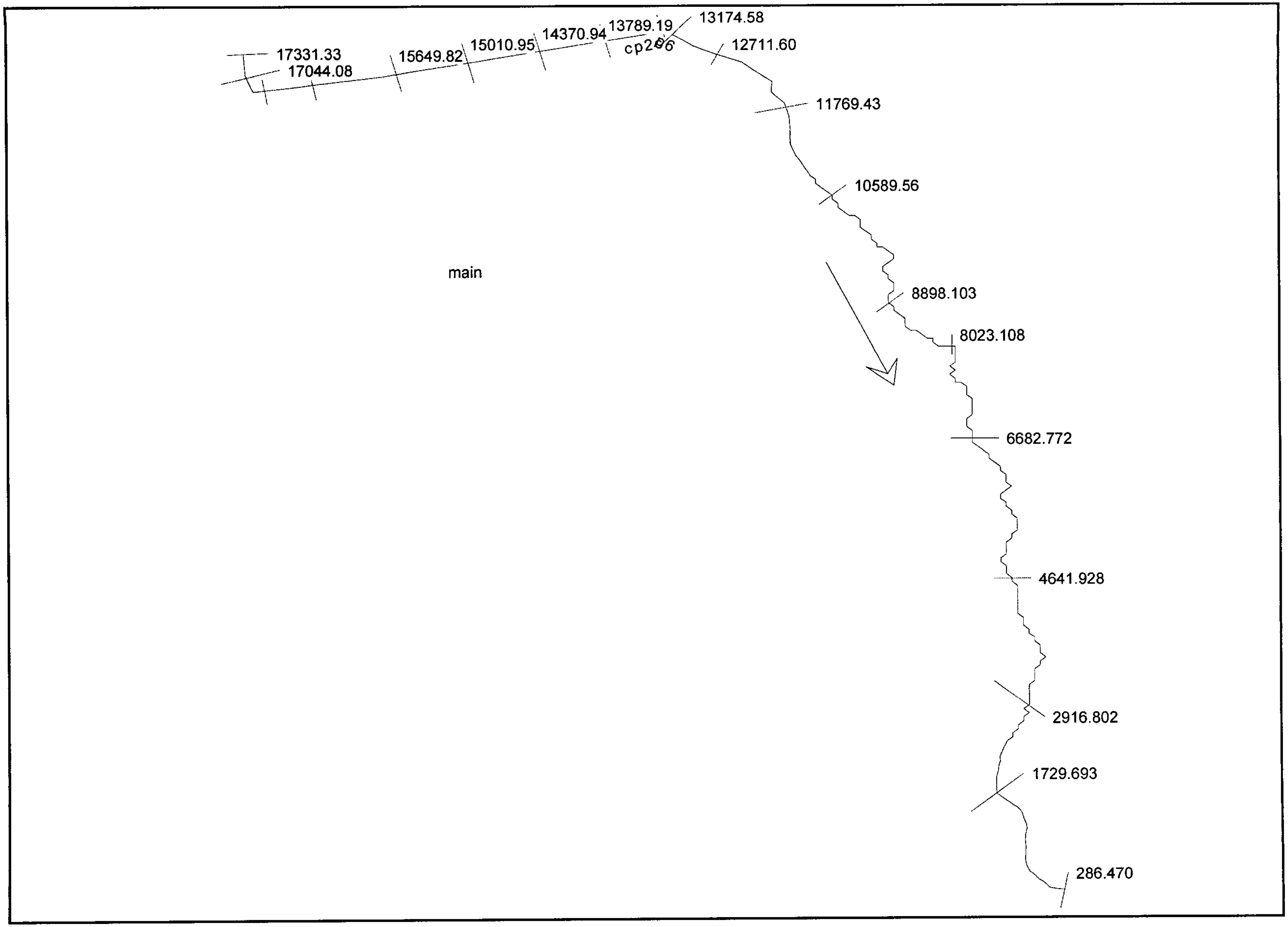
$$\frac{y_s}{a} = 2 \times 1 \times 1 \times 1.2 \times \left(\frac{8}{4}\right)^{0.35} (0.02)^{0.43}$$

$$= 0.57$$

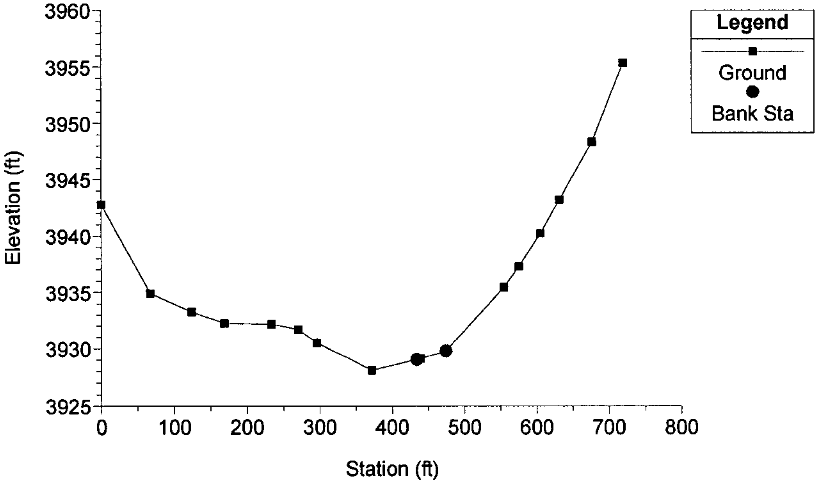
$$y_s = 0.57 \times 4 = \boxed{2.3 \text{ ft}}$$

Attachment 16: Hydraulic Calculations for Routing Around Muck Storage A, Alternative 2

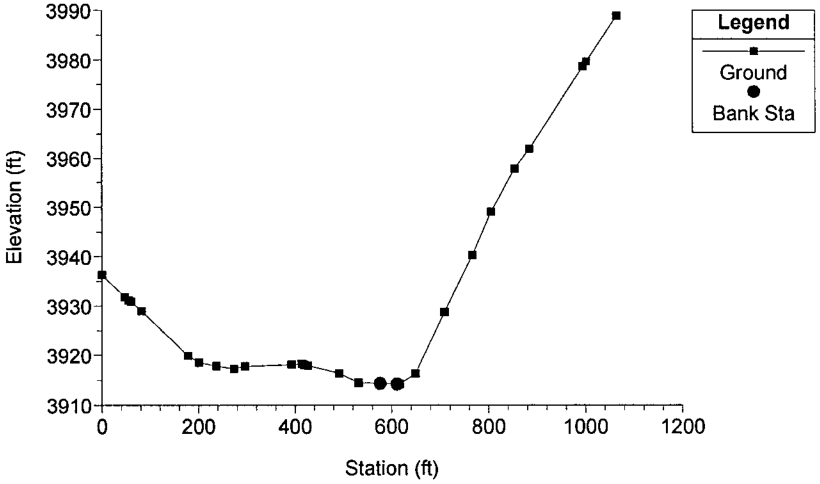
(Document ID: 000-00C-CD04-00100-000-00A)


17331.33
17044.08
15649.82
15010.95
14370.94
13789.19
cp2&6
13174.58
12711.60
11769.43
10589.56
main
8898.103
8023.108
6682.772
4641.928
2916.802
1729.693
286.470

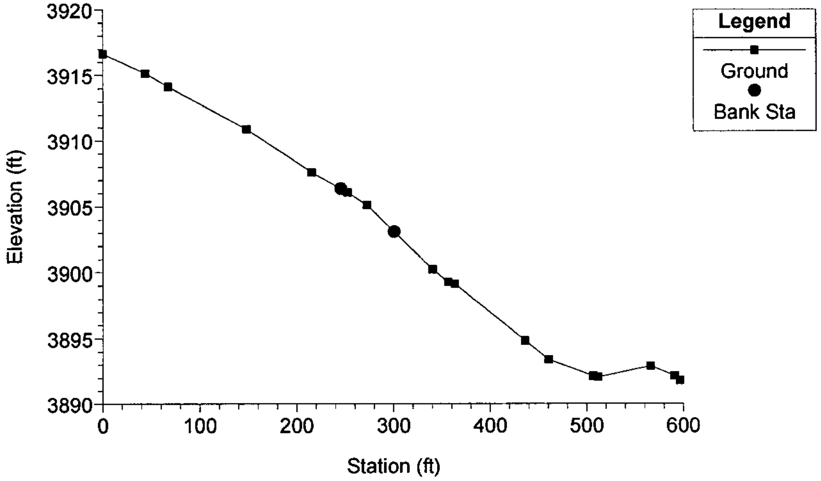
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 17331.33



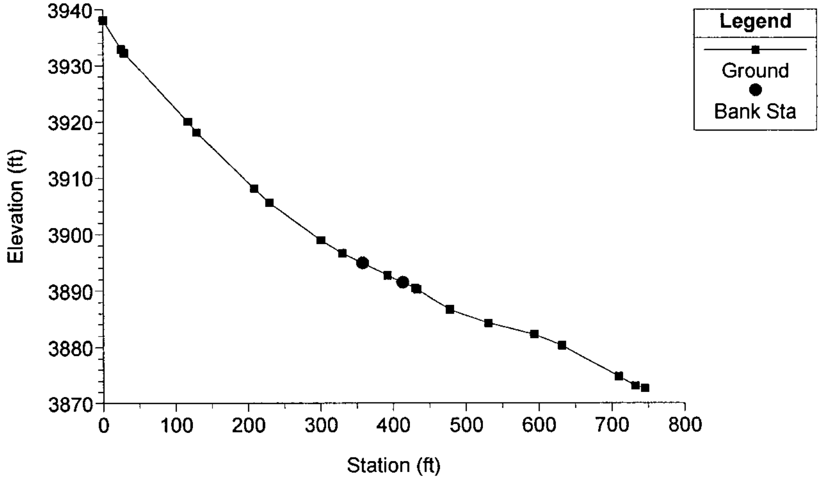
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 17044.08



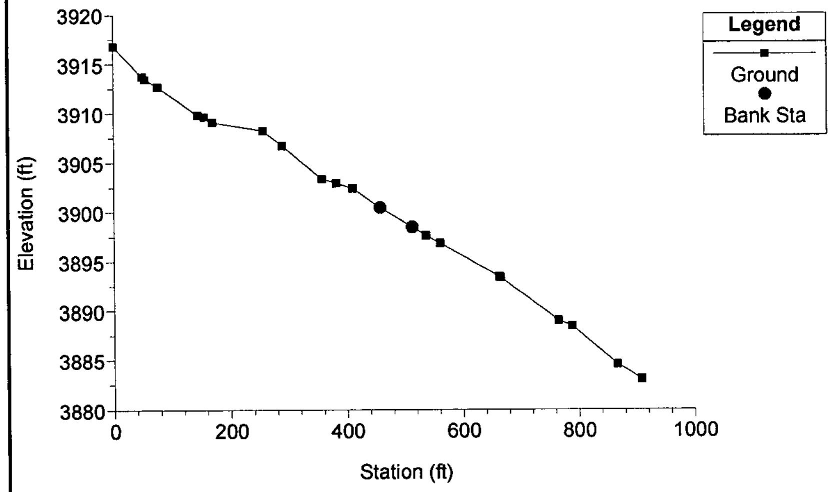
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 16814.03



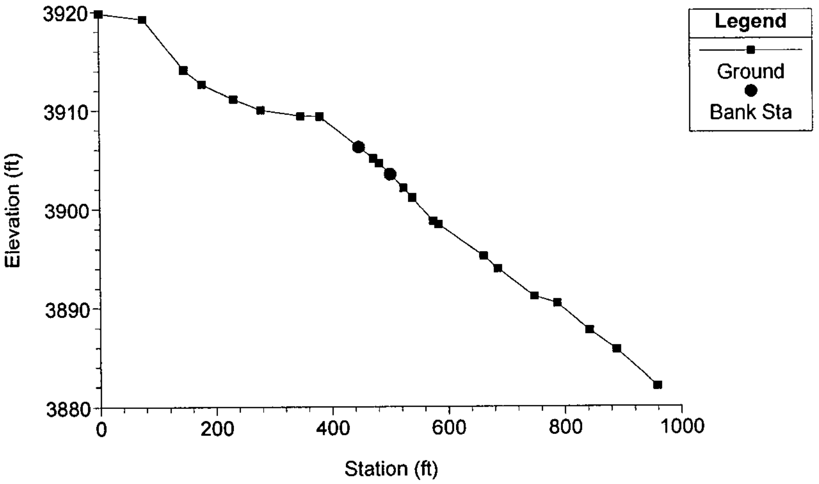
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 16390.46



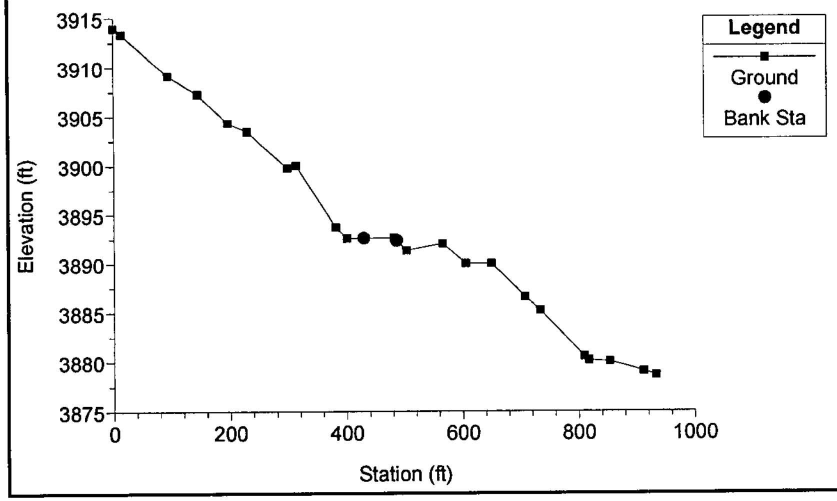
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 15649.82



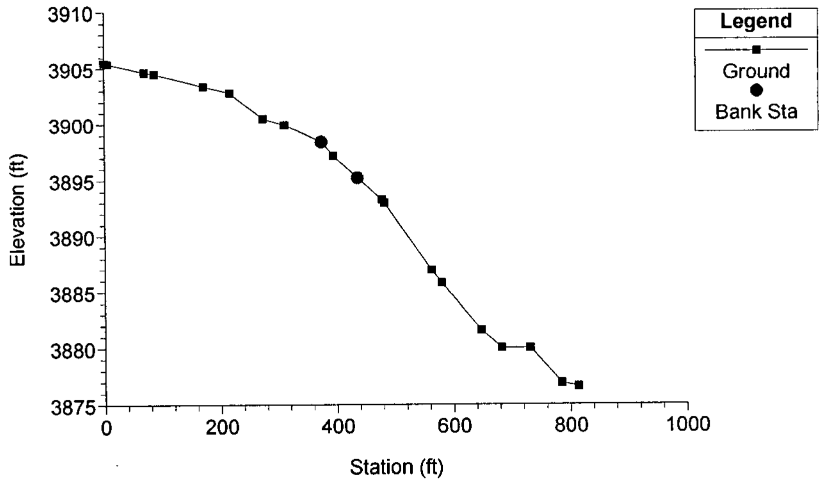
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 15010.95



Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 14370.94



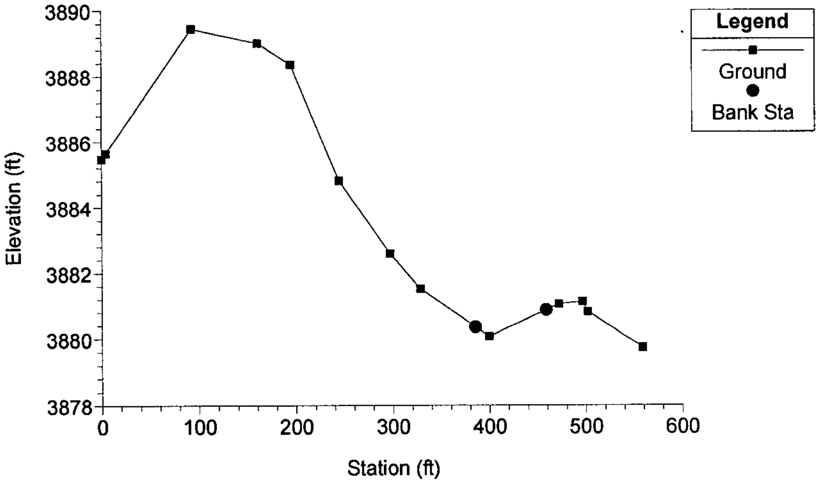
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 13789.19



Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004

Geom: Exist. ground for cp2cp6 routing - Alt2

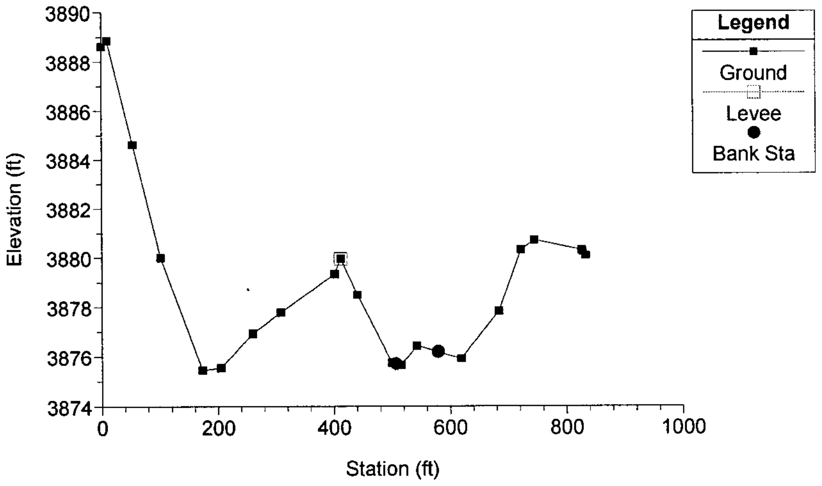
RS = 13272.53



Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004

Geom: Exist. ground for cp2cp6 routing - Alt2

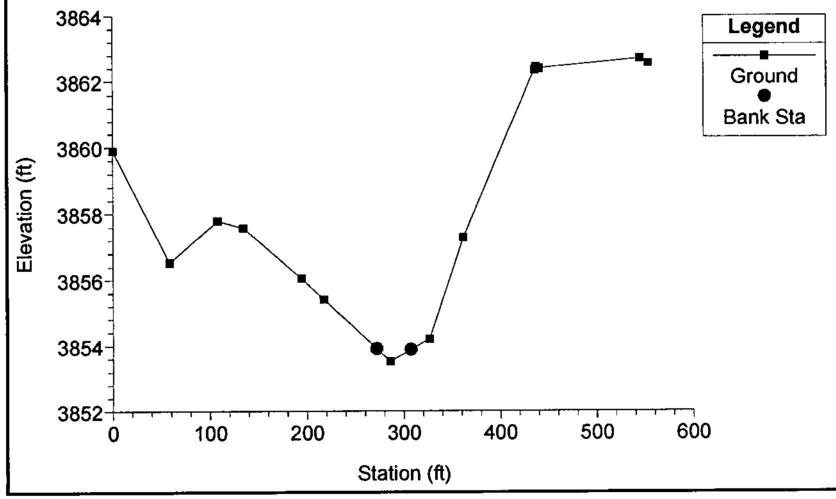
RS = 13174.58



Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004

Geom: Exist. ground for cp2cp6 routing - Alt2

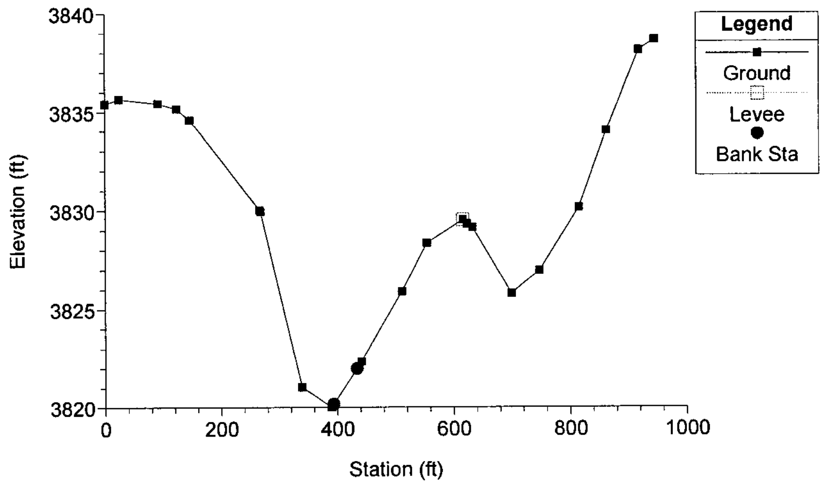
RS = 12711.60



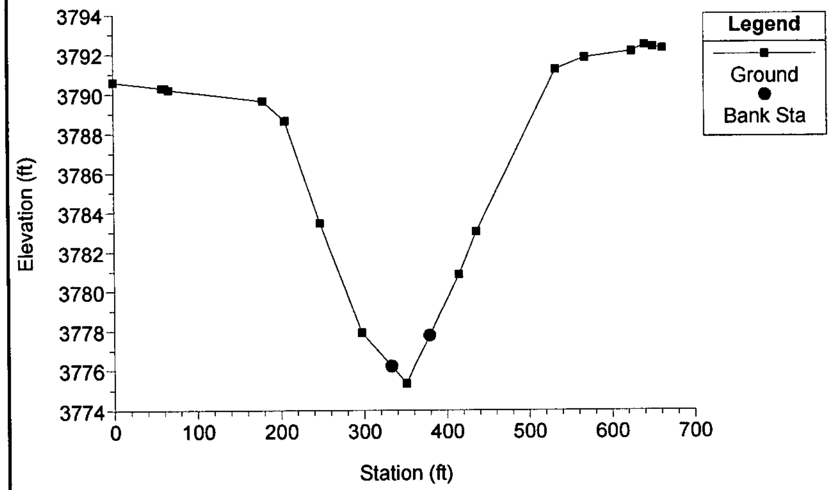
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004

Geom: Exist. ground for cp2cp6 routing - Alt2

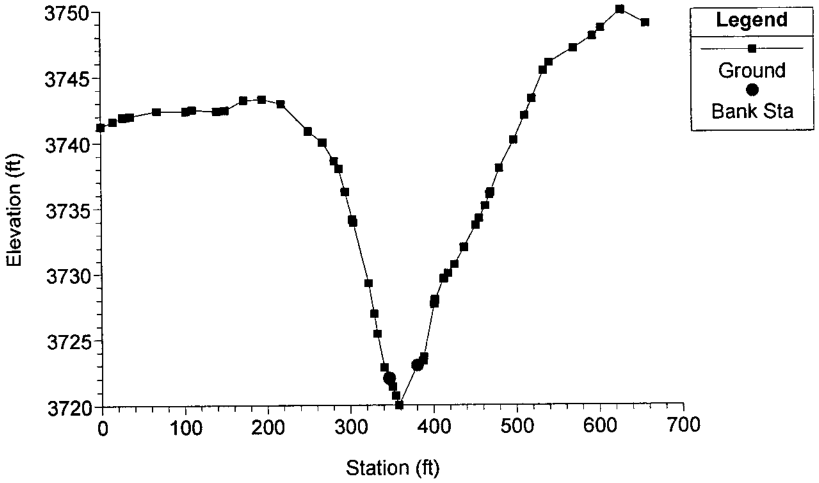
RS = 11769.43



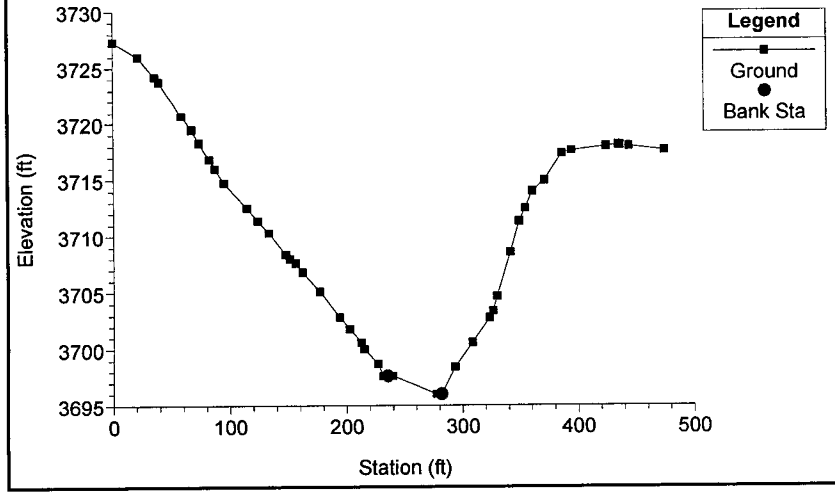
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 10589.56



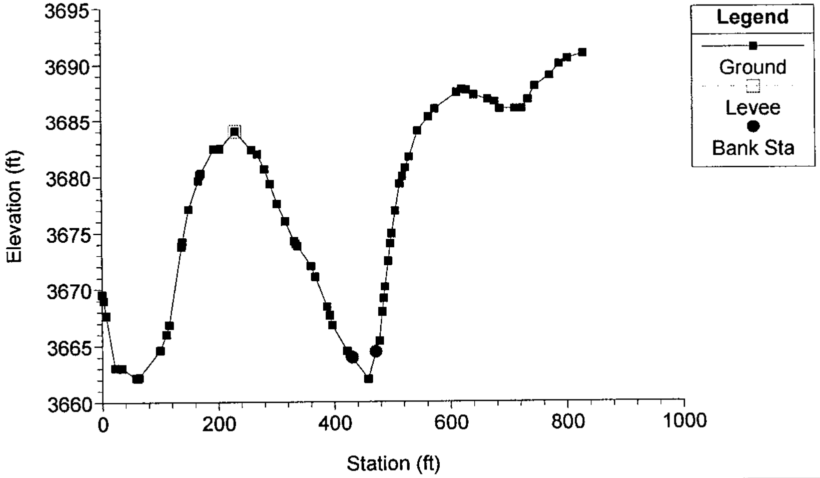
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 8898.103

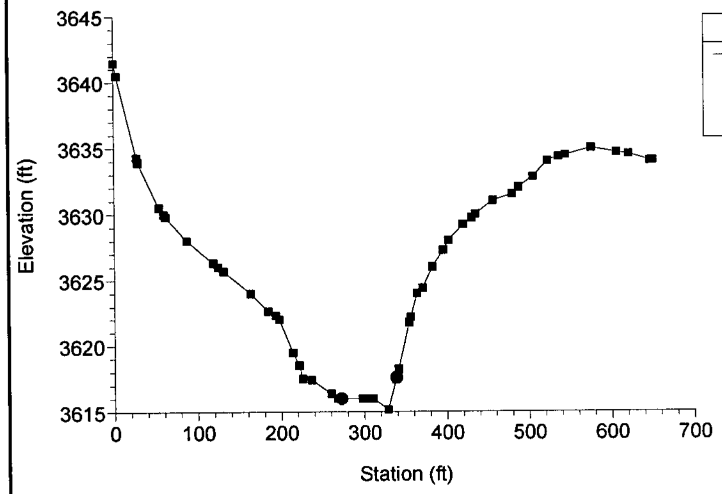


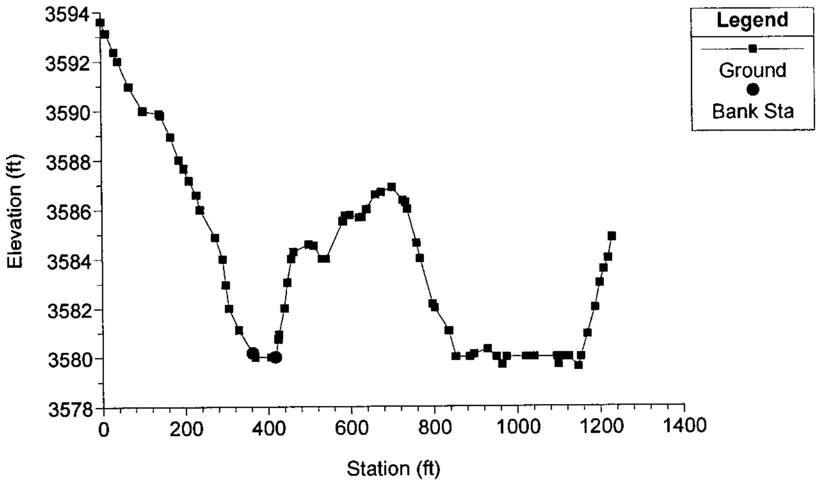
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 8023.108

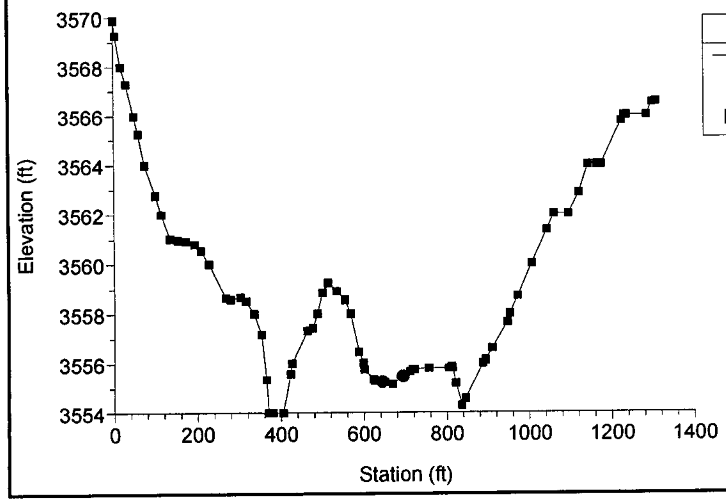


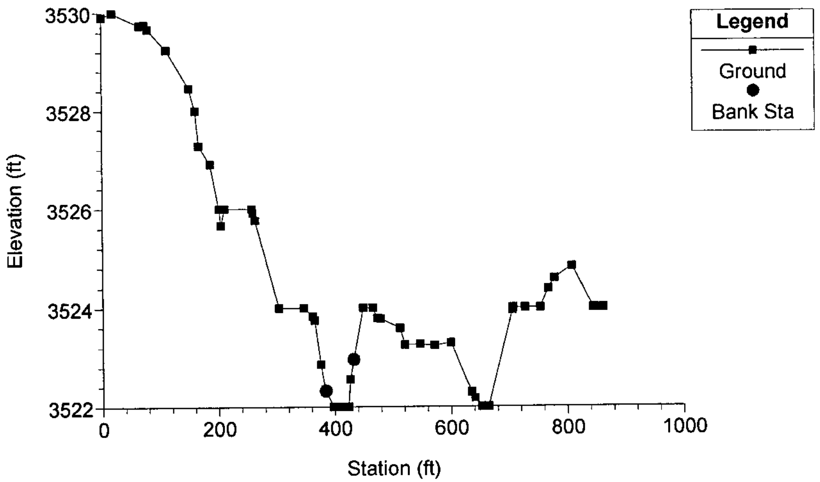
Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 6682.772




Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 4641.928


Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 2916.802


Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 1729.693

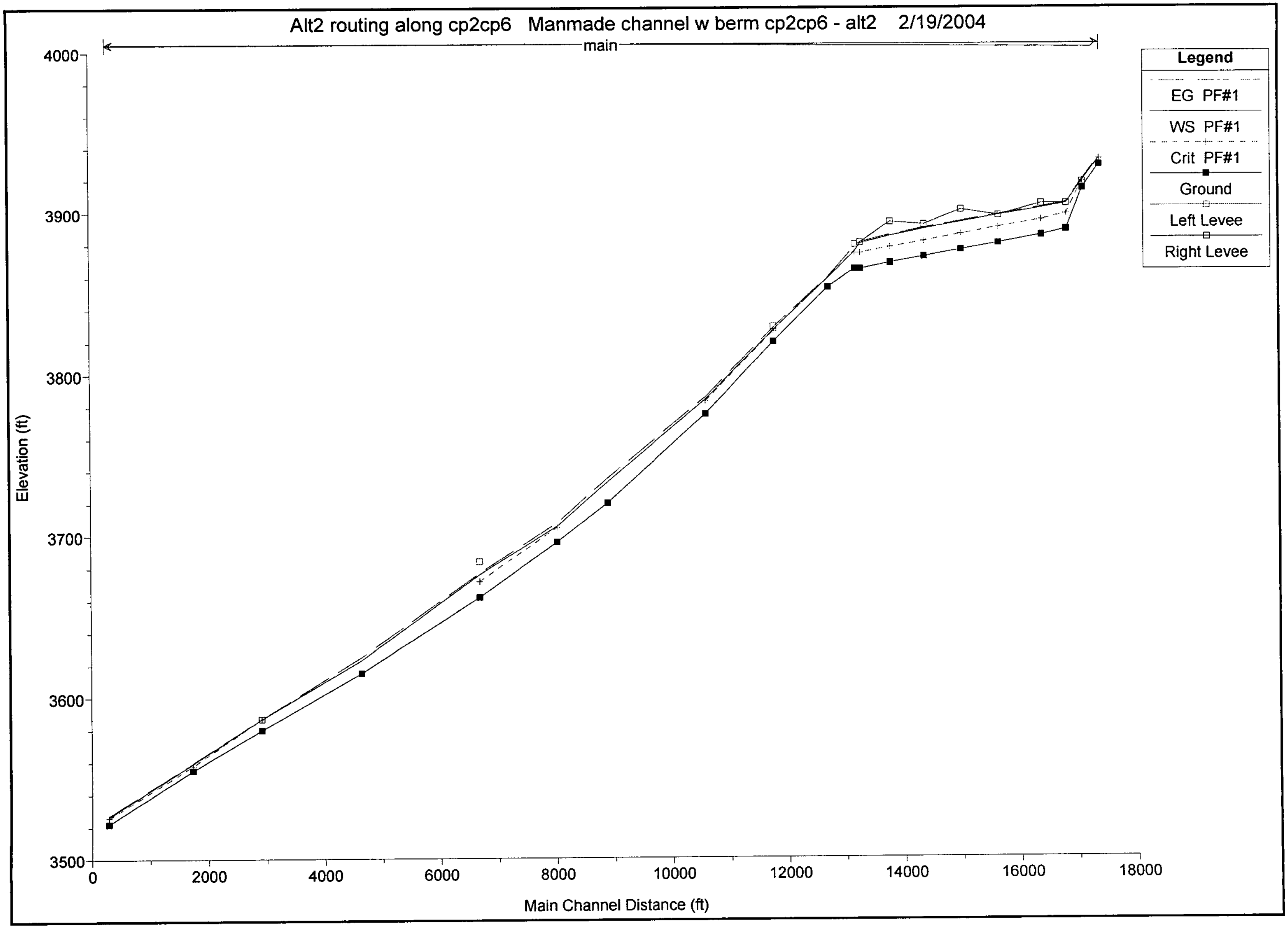

Alt2 routing along cp2cp6 1) a2-cp2cp6-b 2/19/2004
Geom: Exist. ground for cp2cp6 routing - Alt2
RS = 286.470

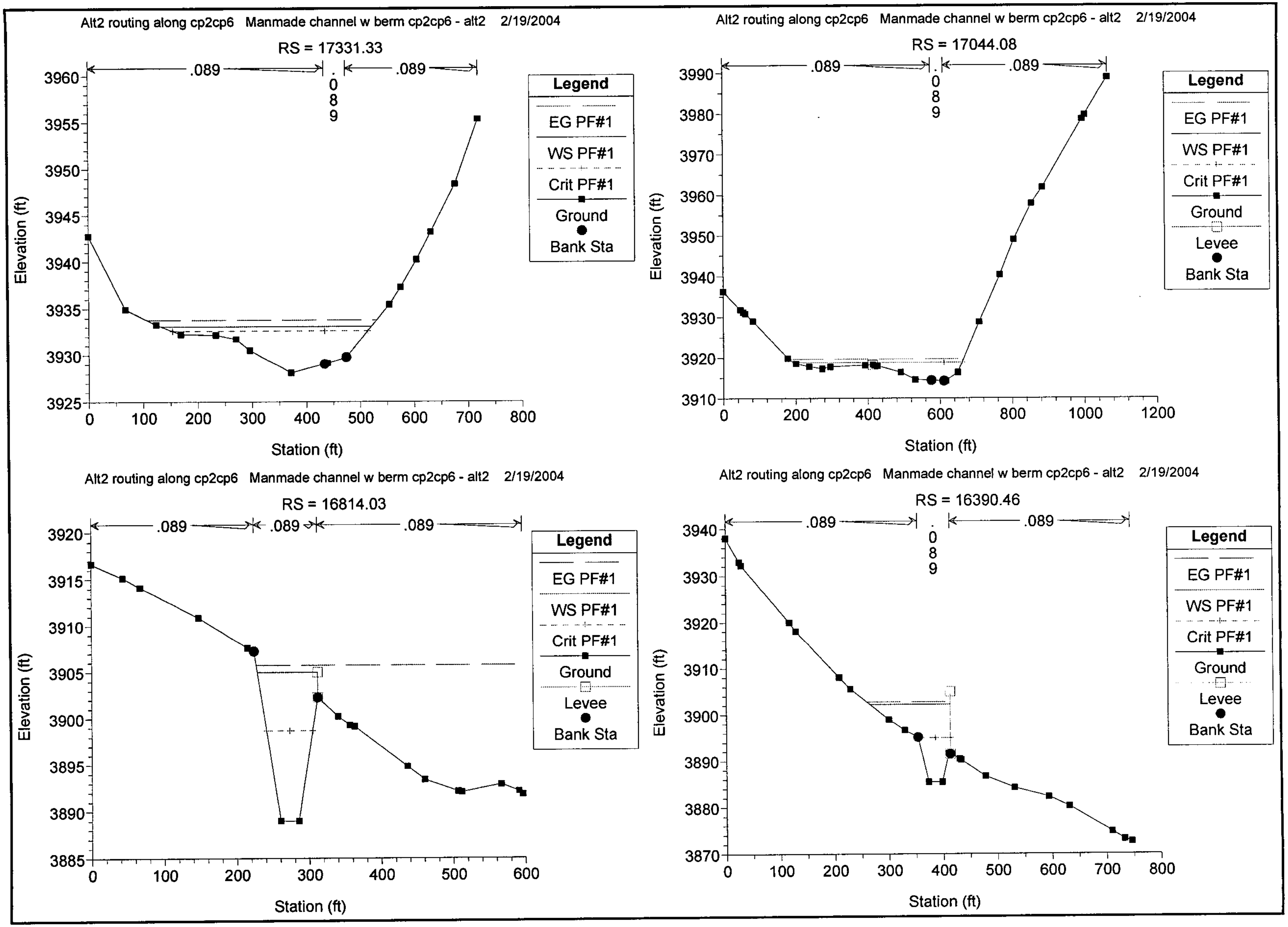
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: a2-cp2cp6-b  River: cp2cp6  Reach: main

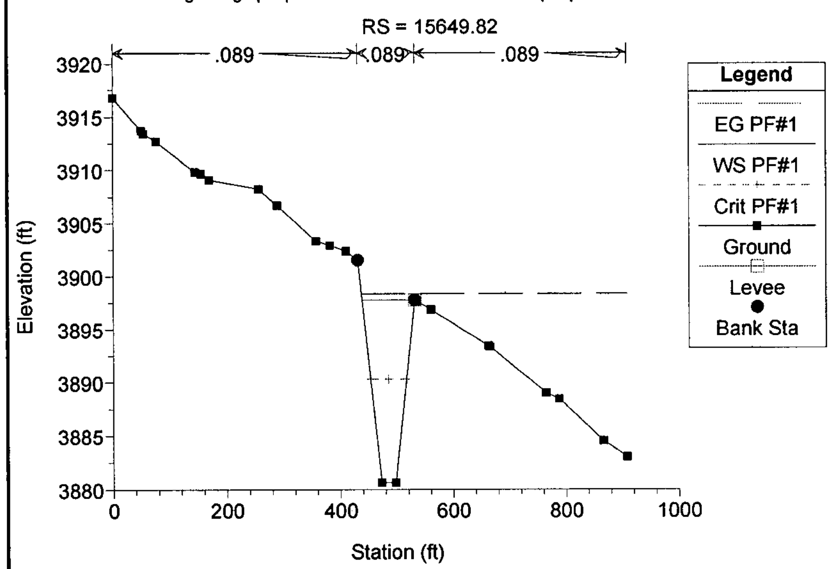
# Rivers             = 1
# Hydraulic Reaches  = 1
# River Stations     = 20
# Plans              = 1
# Profiles           = 1

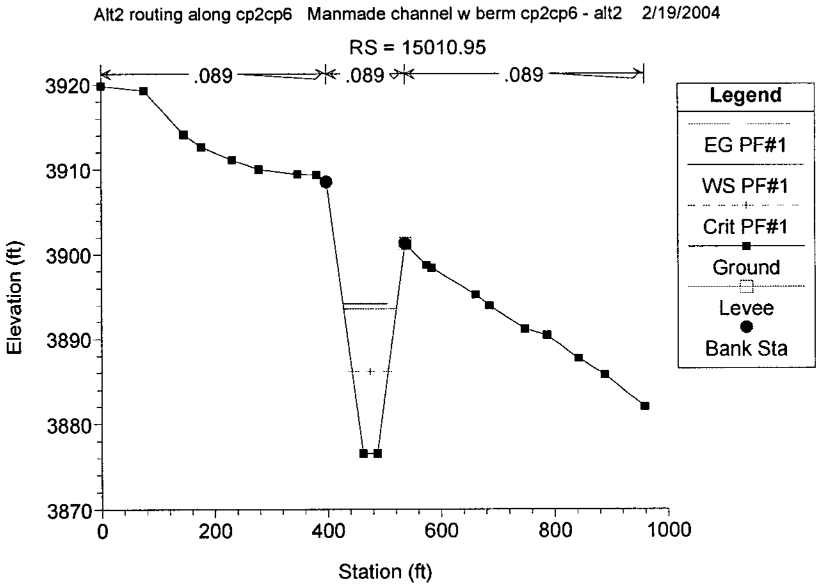
 Reach            River Sta           Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                        (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

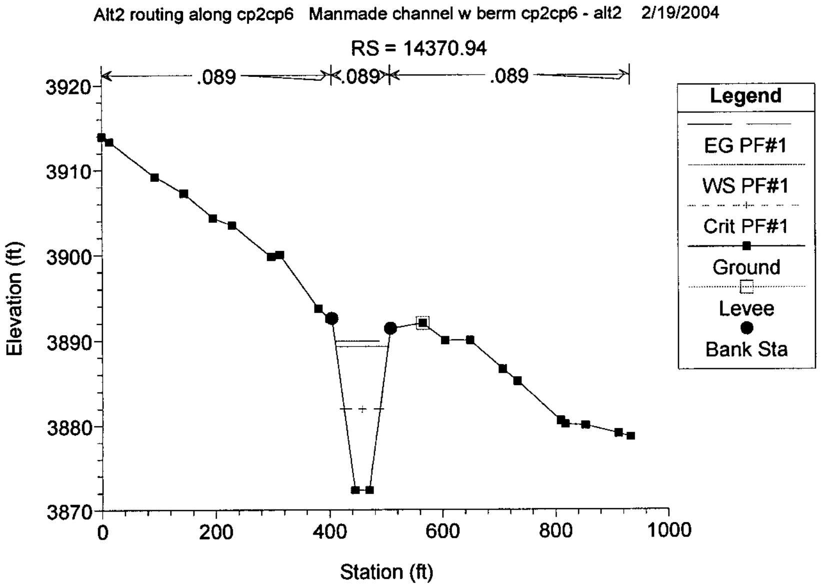
 main             17331.33            6300.00    3929.04    3933.06    3932.60    3933.78   0.045862       8.51     949.91     387.94         0.78
 main             17044.08            6300.00    3914.24    3918.78    3918.78    3919.65   0.052248      10.36     948.96     465.05         0.86
 main             16814.03            6300.00    3889.00    3904.99    3898.69    3905.74   0.008430       6.97     903.55      83.52         0.37
 main             16390.46            6300.00    3885.48    3902.22    3894.98    3902.75   0.005388       6.23    1188.76     148.29         0.29
 main             15649.82            6300.00    3880.66    3897.73    3890.29    3898.34   0.006510       6.24    1009.98      93.30         0.33
 main             15010.95            6300.00    3876.51    3893.56    3886.14    3894.16   0.006558       6.25    1007.21      93.17         0.34
 main             14370.94            6300.00    3872.35    3889.29    3881.98    3889.91   0.006735       6.32     997.38      92.76         0.34
 main             13789.19            6300.00    3868.57    3885.11    3878.20    3885.77   0.007458       6.56     960.35      91.15         0.36
 main             13272.53            6300.00    3864.98    3880.50    3874.61    3881.31   0.009759       7.25     869.32      87.06         0.40
 main             13174.58            6300.00    3865.00    3875.31    3874.64    3878.10   0.051846      13.40     470.30      66.23         0.89
 main             12711.60            6300.00    3853.52    3859.22               3859.78   0.024392       8.14    1123.65     378.12         0.61
 main             11769.43            9820.00    3820.16    3827.25    3826.68    3828.76   0.041261      11.41    1045.59     245.96         0.81
 main             10589.56            9820.00    3775.33    3784.35    3783.37    3785.88   0.031563      11.94    1061.83     211.52         0.74
 main             8898.103            9820.00    3720.00    3733.13               3735.41   0.028049      14.38     913.27     139.67         0.74
 main             8023.108            9820.00    3696.00    3705.56    3704.83    3707.61   0.035381      13.34     919.31     159.79         0.79
 main             6682.772            9820.00    3662.00    3676.11    3671.91    3676.99   0.009811       9.13    1437.62     188.24         0.45
 main             4641.928            9820.00    3615.16    3623.12               3625.05   0.040989      12.54     932.16     183.17         0.82
 main             2916.802            9820.00    3580.00    3586.90    3586.90    3586.98   0.002506       3.03    4373.92    1010.61         0.20
 main             1729.693            9820.00    3555.15    3559.36    3558.03    3559.75   0.021017       6.21    2029.47     743.48         0.54
 main             286.470             9820.00    3522.00    3526.59    3525.70    3527.06   0.024421       7.03    1849.18     670.71         0.59
```

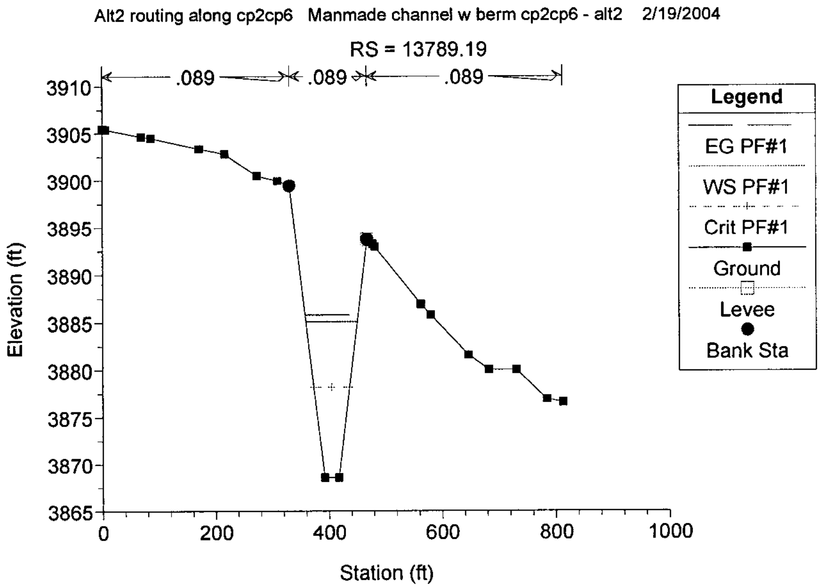
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
main
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Left Levee
Right Levee
Elevation (ft)
4000
3900
3800
3700
3600
3500
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Main Channel Distance (ft)

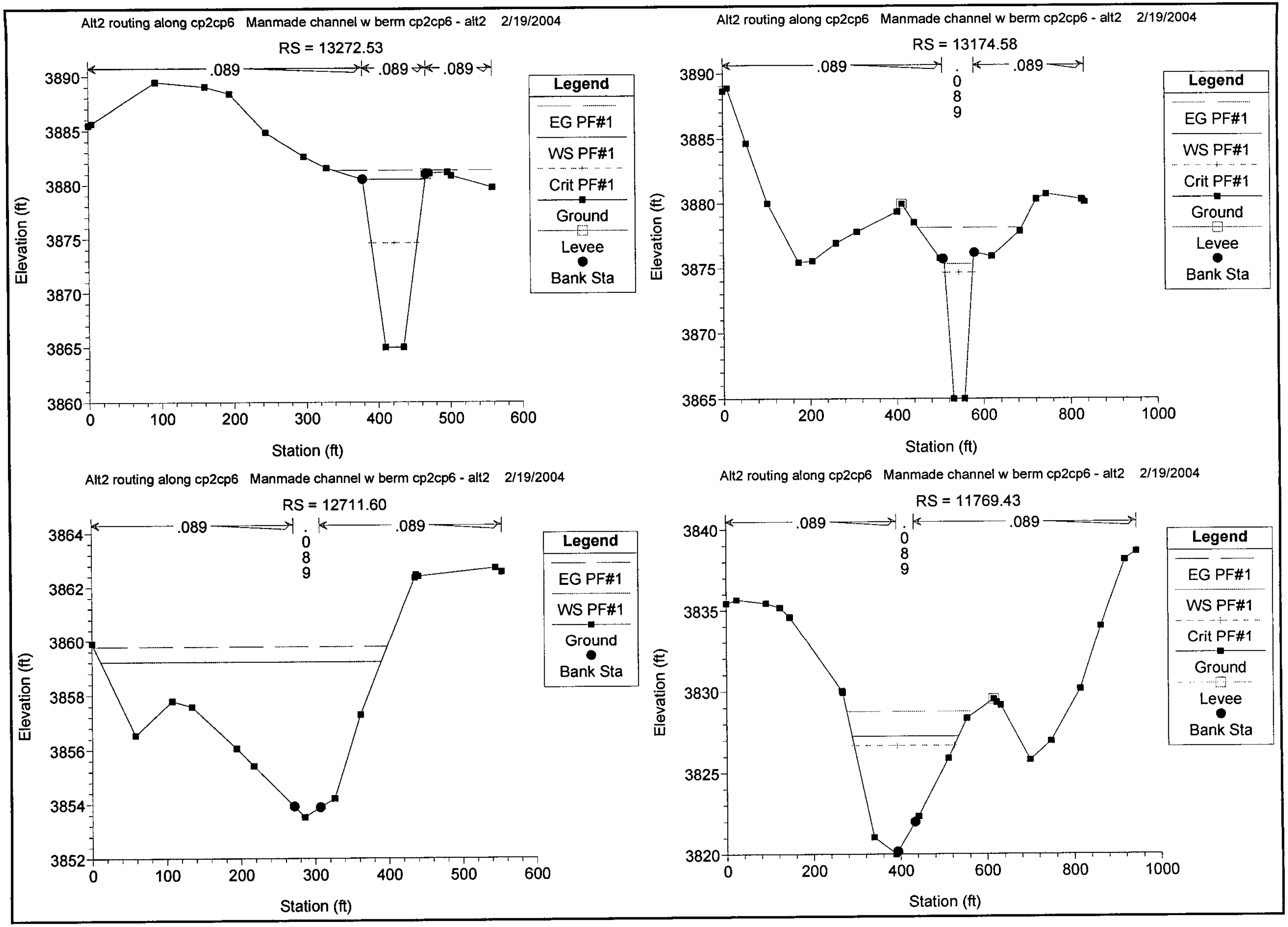

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 17331.33
.089
.089
.089
Elevation (ft)
3925
3930
3935
3940
3945
3950
3955
3960
Station (ft)
0
100
200
300
400
500
600
700
800
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 17044.08
.089
.089
.089
Elevation (ft)
3910
3920
3930
3940
3950
3960
3970
3980
3990
Station (ft)
0
200
400
600
800
1000
1200
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 16814.03
.089
.089
.089
Elevation (ft)
3885
3890
3895
3900
3905
3910
3915
3920
Station (ft)
0
100
200
300
400
500
600
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 16390.46
.089
.089
.089
Elevation (ft)
3870
3880
3890
3900
3910
3920
3930
3940
Station (ft)
0
100
200
300
400
500
600
700
800
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

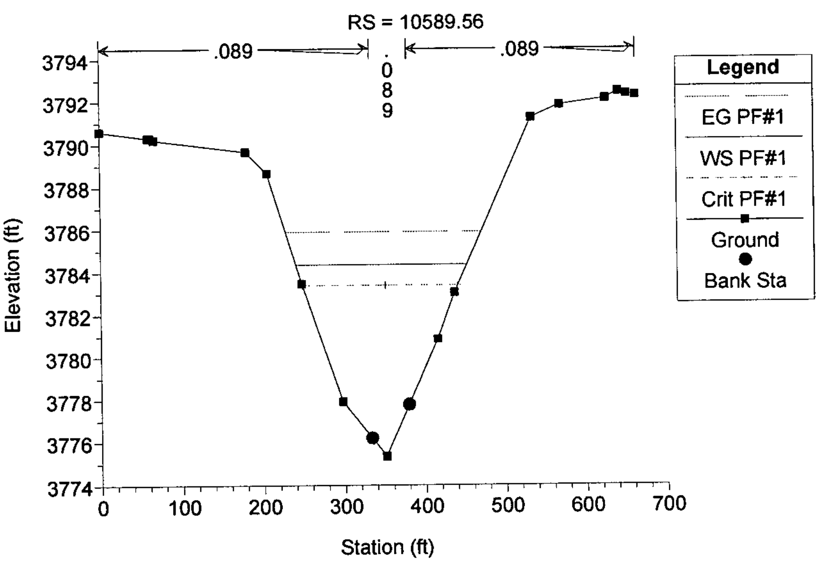

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 15649.82
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3920
3915
3910
3905
3900
3895
3890
3885
3880
Station (ft)
0
200
400
600
800
1000

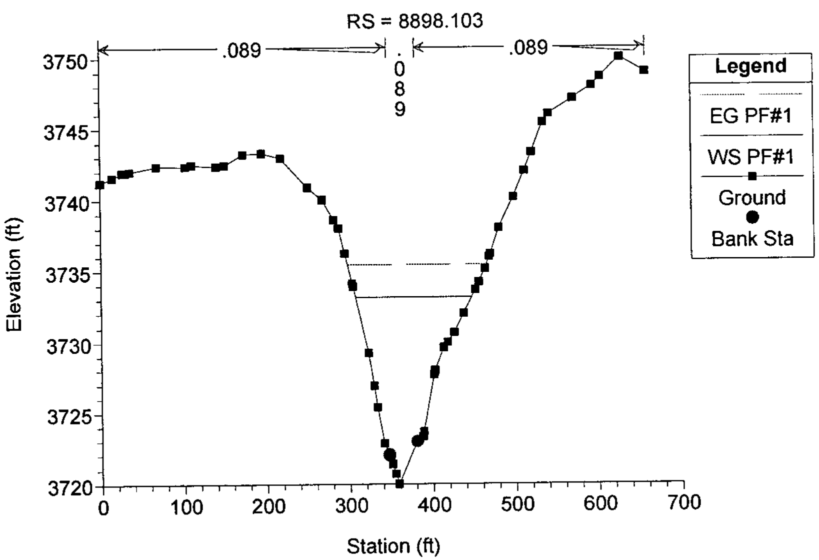

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 15010.95
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3920
3910
3900
3890
3880
3870
Station (ft)
0
200
400
600
800
1000

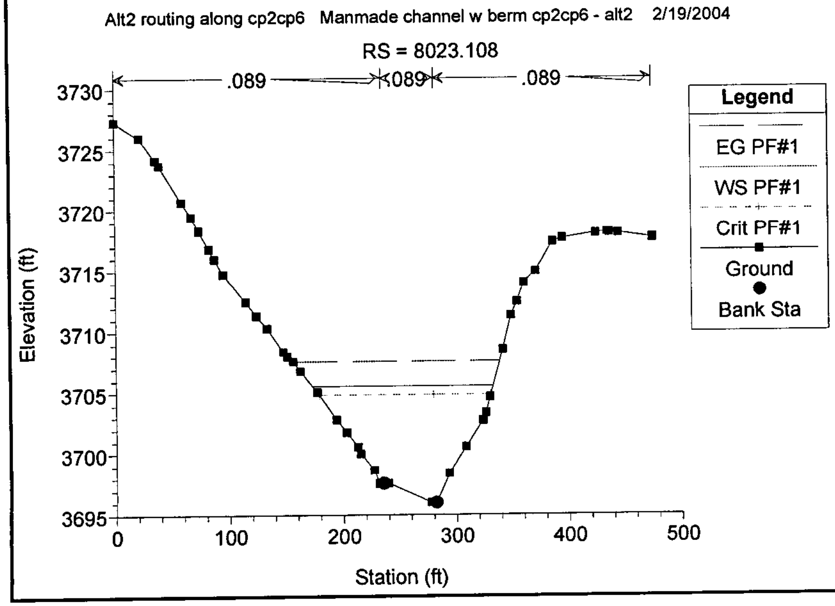

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 14370.94
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3920
3910
3900
3890
3880
3870
Station (ft)
0
200
400
600
800
1000

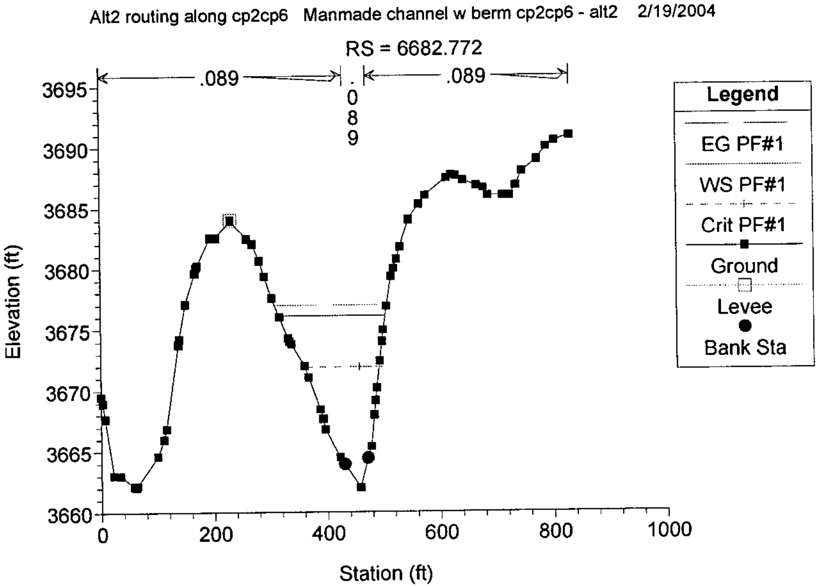

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 13789.19
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3910
3905
3900
3895
3890
3885
3880
3875
3870
3865
Station (ft)
0
200
400
600
800
1000

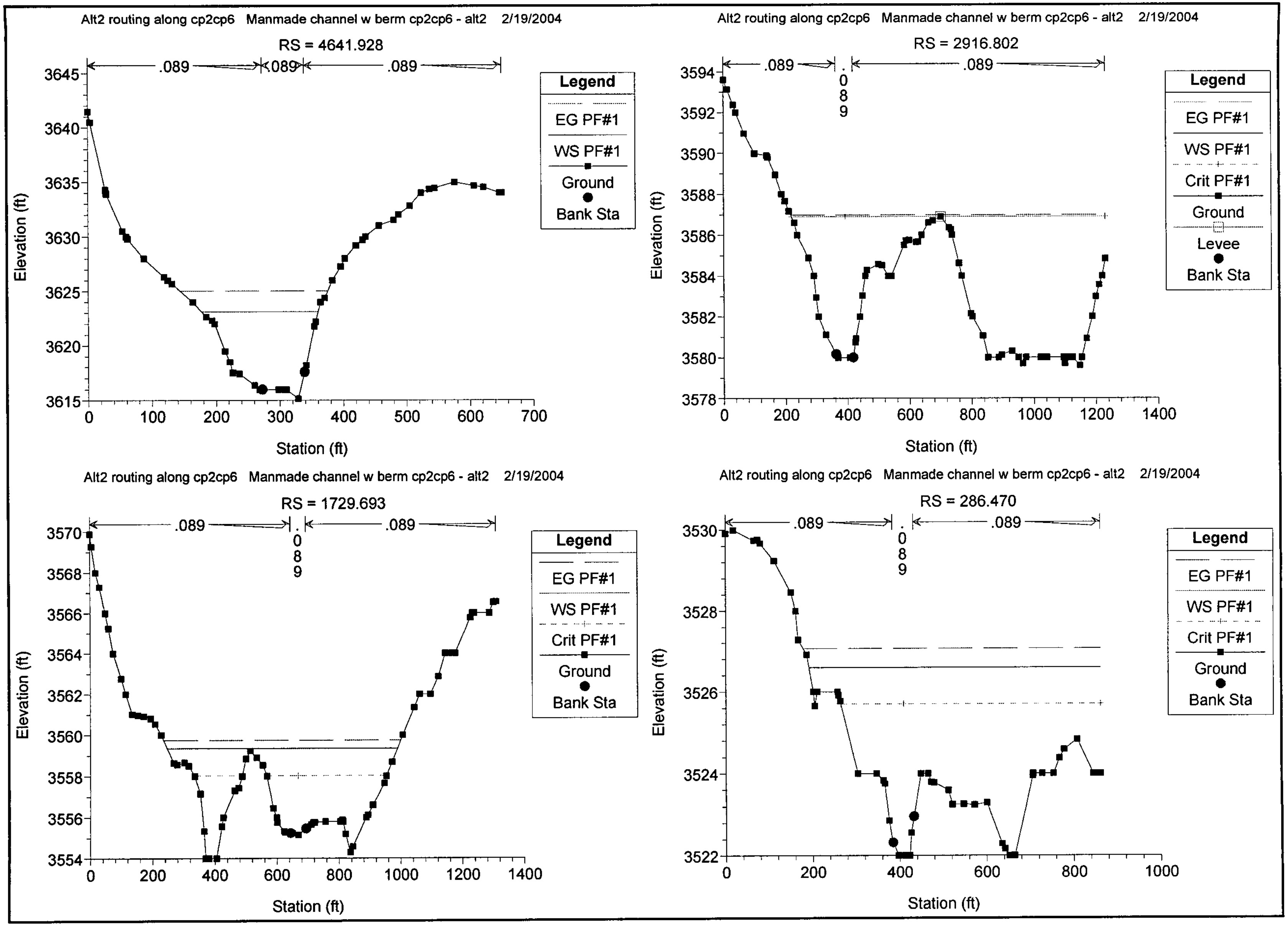

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 13272.53
.089
.089
.089
Elevation (ft)
3860
3865
3870
3875
3880
3885
3890
Station (ft)
0
100
200
300
400
500
600
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 13174.58
.089
.089
.089
Elevation (ft)
3865
3870
3875
3880
3885
3890
Station (ft)
0
200
400
600
800
1000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 12711.60
.089
.089
.089
Elevation (ft)
3852
3854
3856
3858
3860
3862
3864
Station (ft)
0
100
200
300
400
500
600
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 11769.43
.089
.089
.089
Elevation (ft)
3820
3825
3830
3835
3840
Station (ft)
0
200
400
600
800
1000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 10589.56
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3774
3776
3778
3780
3782
3784
3786
3788
3790
3792
3794
Station (ft)
0
100
200
300
400
500
600
700

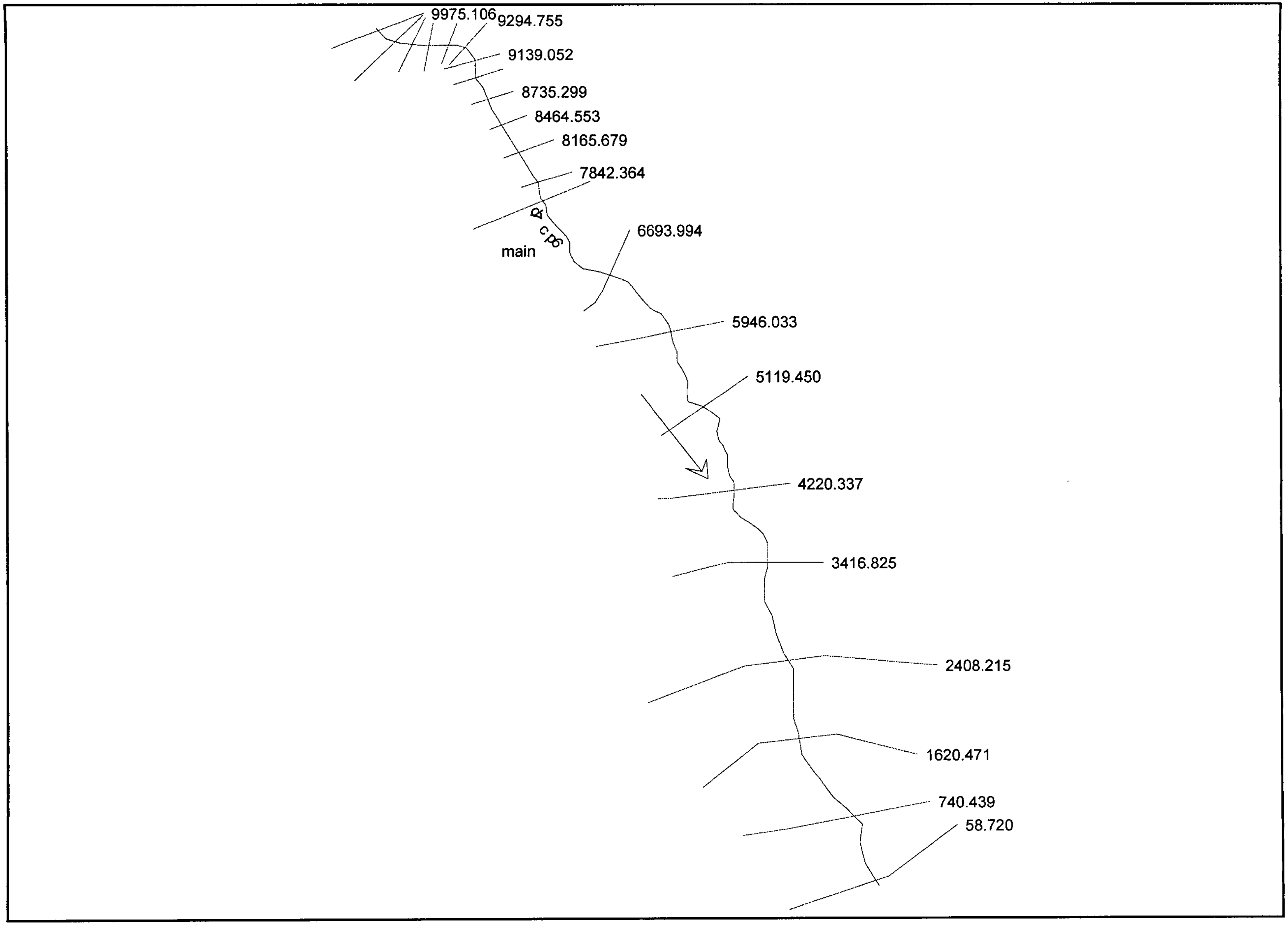

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 8898.103
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3720
3725
3730
3735
3740
3745
3750
Station (ft)
0
100
200
300
400
500
600
700

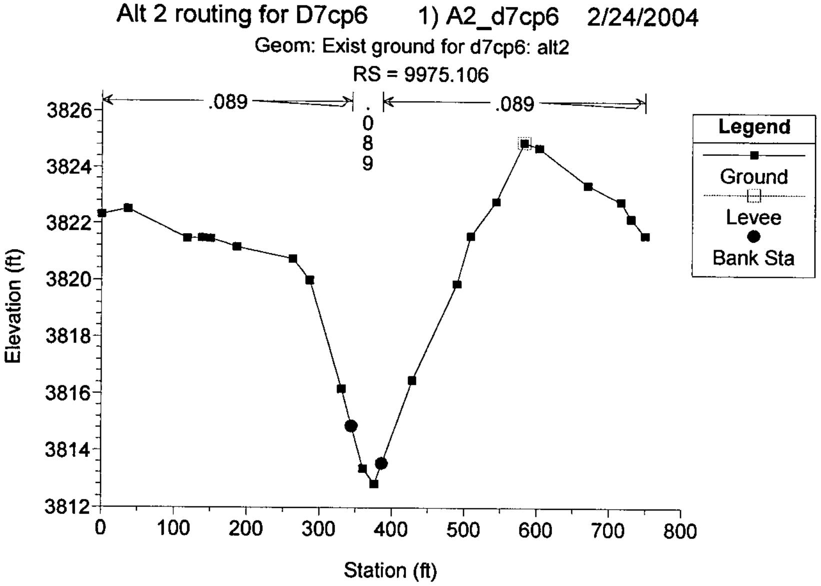

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 8023.108
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3695
3700
3705
3710
3715
3720
3725
3730
Station (ft)
0
100
200
300
400
500

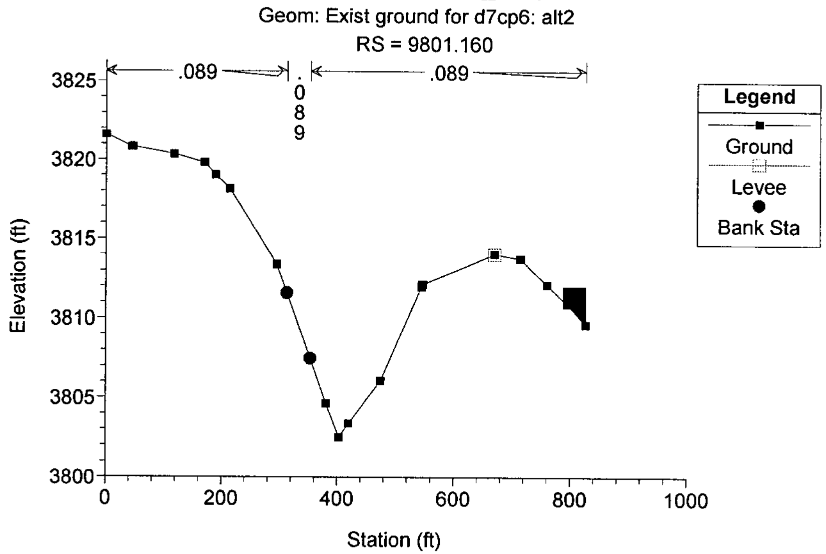

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 6682.772
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3660
3665
3670
3675
3680
3685
3690
3695
Station (ft)
0
200
400
600
800
1000

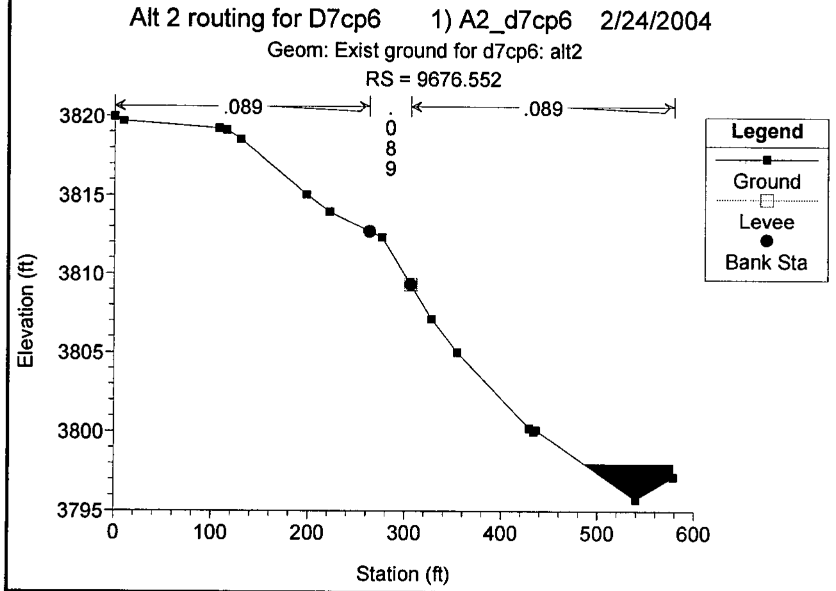

Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 4641.928
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3645
3640
3635
3630
3625
3620
3615
Station (ft)
0
100
200
300
400
500
600
700
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 2916.802
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3594
3592
3590
3588
3586
3584
3582
3580
3578
Station (ft)
0
200
400
600
800
1000
1200
1400
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 1729.693
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3570
3568
3566
3564
3562
3560
3558
3556
3554
Station (ft)
0
200
400
600
800
1000
1200
1400
Alt2 routing along cp2cp6 Manmade channel w berm cp2cp6 - alt2 2/19/2004
RS = 286.470
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3530
3528
3526
3524
3522
Station (ft)
0
200
400
600
800
1000

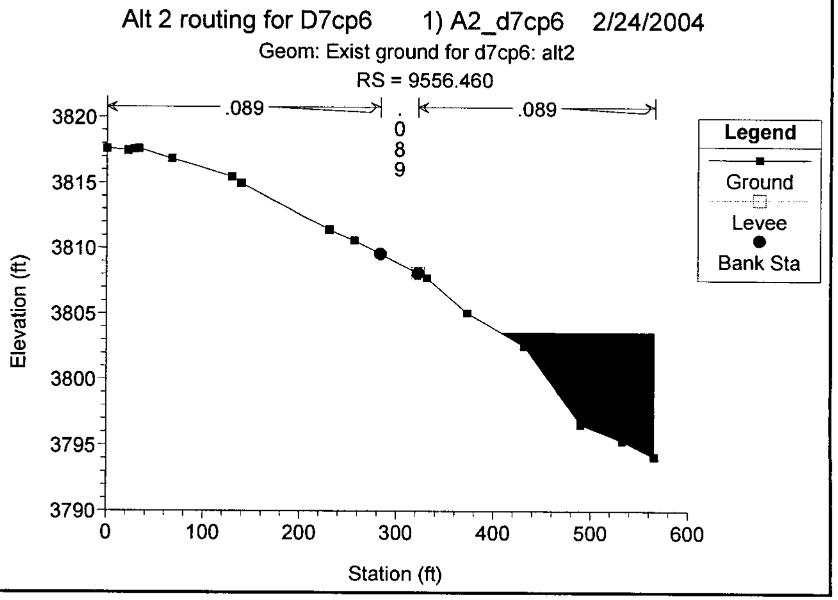
Attachment 17: Hydraulic Calculations for Routing Around Aging Pad 3, Alternative 2
(Document ID: 000-00C-CD04-00100-000-00A)

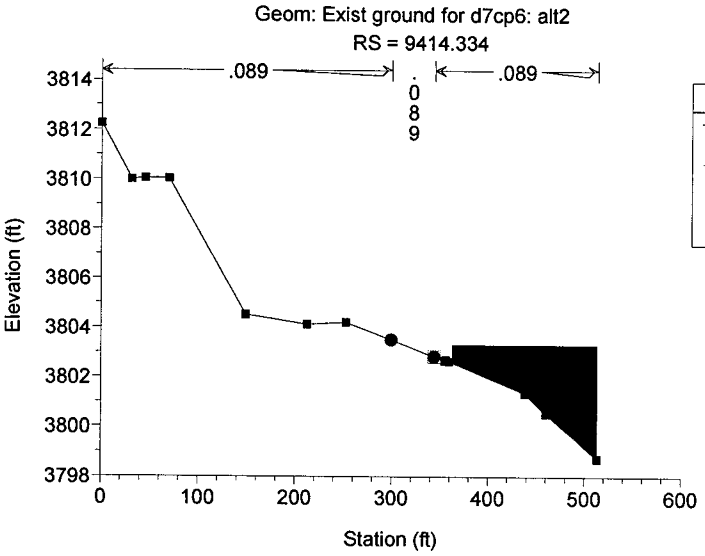

9975.106
9294.755
9139.052
8735.299
8464.553
8165.679
7842.364
dc p6
main
6693.994
5946.033
5119.450
4220.337
3416.825
2408.215
1620.471
740.439
58.720

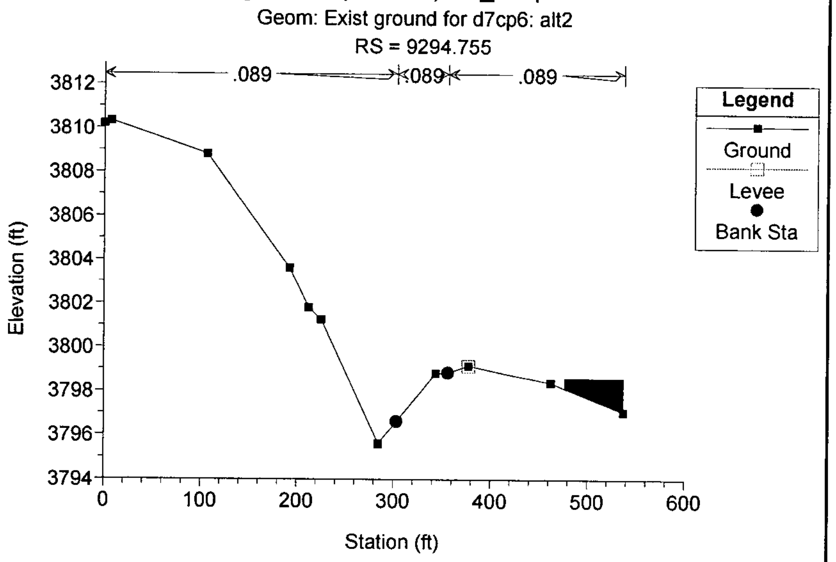

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9975.106
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3812
3814
3816
3818
3820
3822
3824
3826
Station (ft)
0
100
200
300
400
500
600
700
800

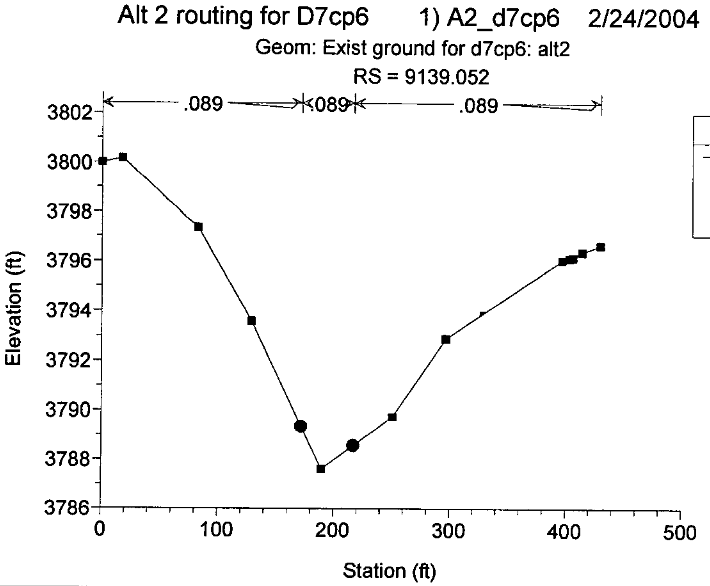

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9801.160
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3800
3805
3810
3815
3820
3825
Station (ft)
0
200
400
600
800
1000

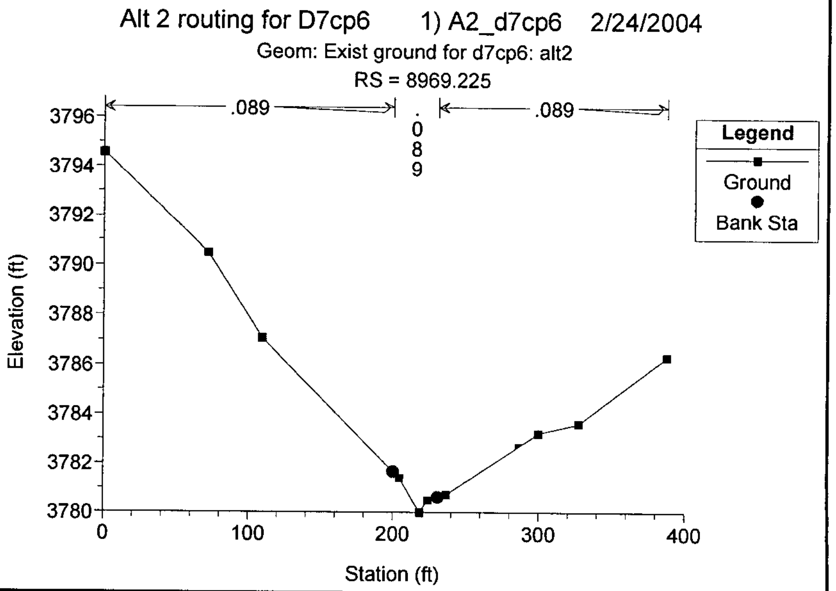

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9676.552
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3795
3800
3805
3810
3815
3820
Station (ft)
0
100
200
300
400
500
600

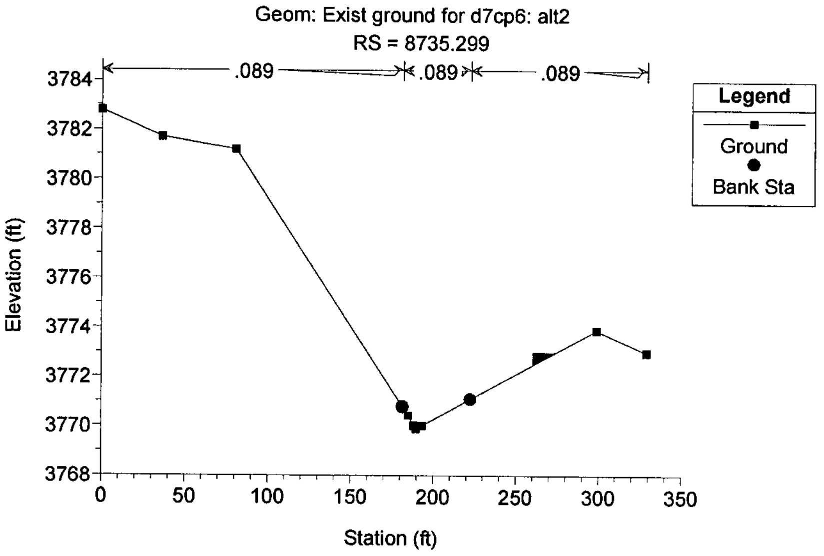

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9556.460
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3790
3795
3800
3805
3810
3815
3820
Station (ft)
0
100
200
300
400
500
600


Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9414.334
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3814
3812
3810
3808
3806
3804
3802
3800
3798
Station (ft)
0
100
200
300
400
500
600

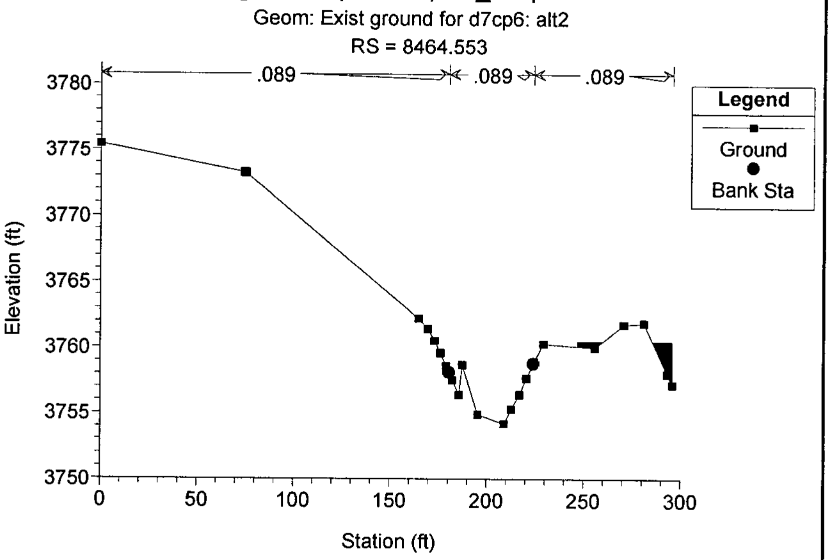

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9294.755
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3812
3810
3808
3806
3804
3802
3800
3798
3796
3794
Station (ft)
0
100
200
300
400
500
600


Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 9139.052
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3802
3800
3798
3796
3794
3792
3790
3788
3786
Station (ft)
0
100
200
300
400
500

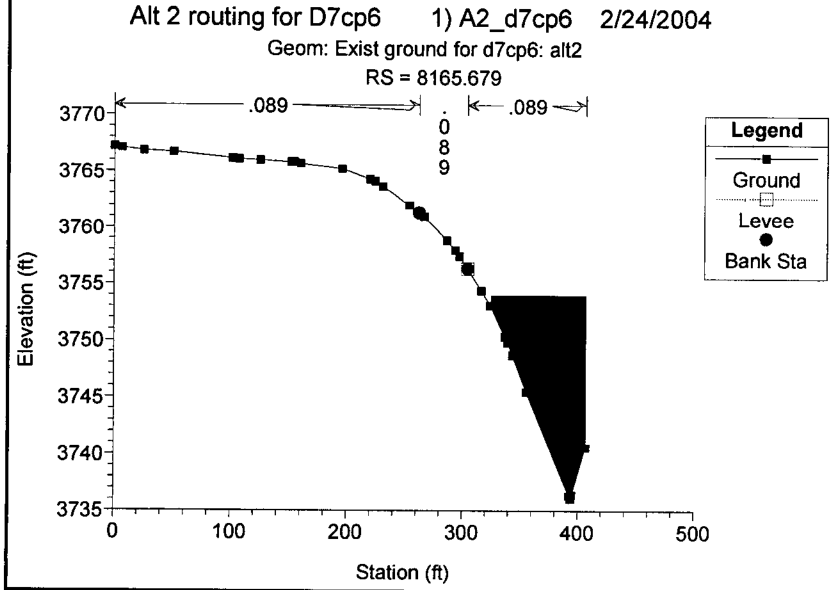

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 8969.225
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3796
3794
3792
3790
3788
3786
3784
3782
3780
Station (ft)
0
100
200
300
400



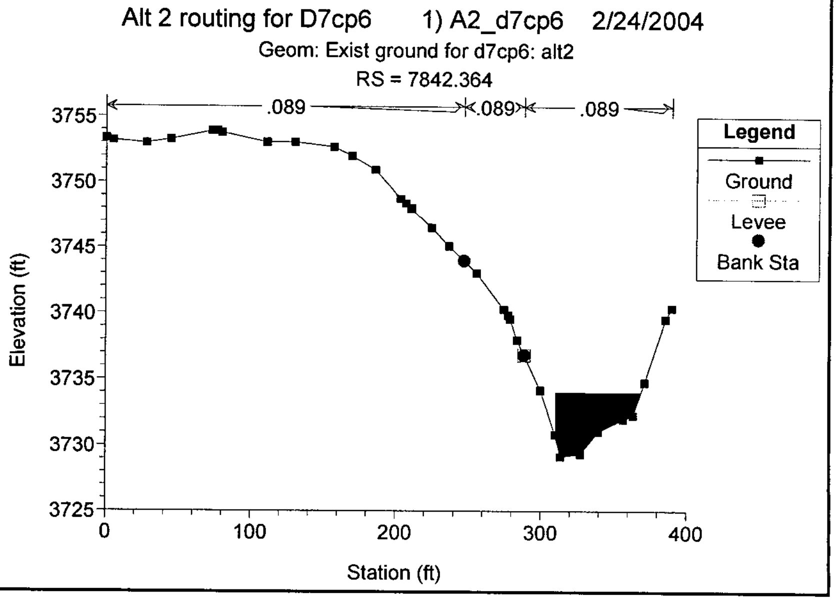
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 8735.299



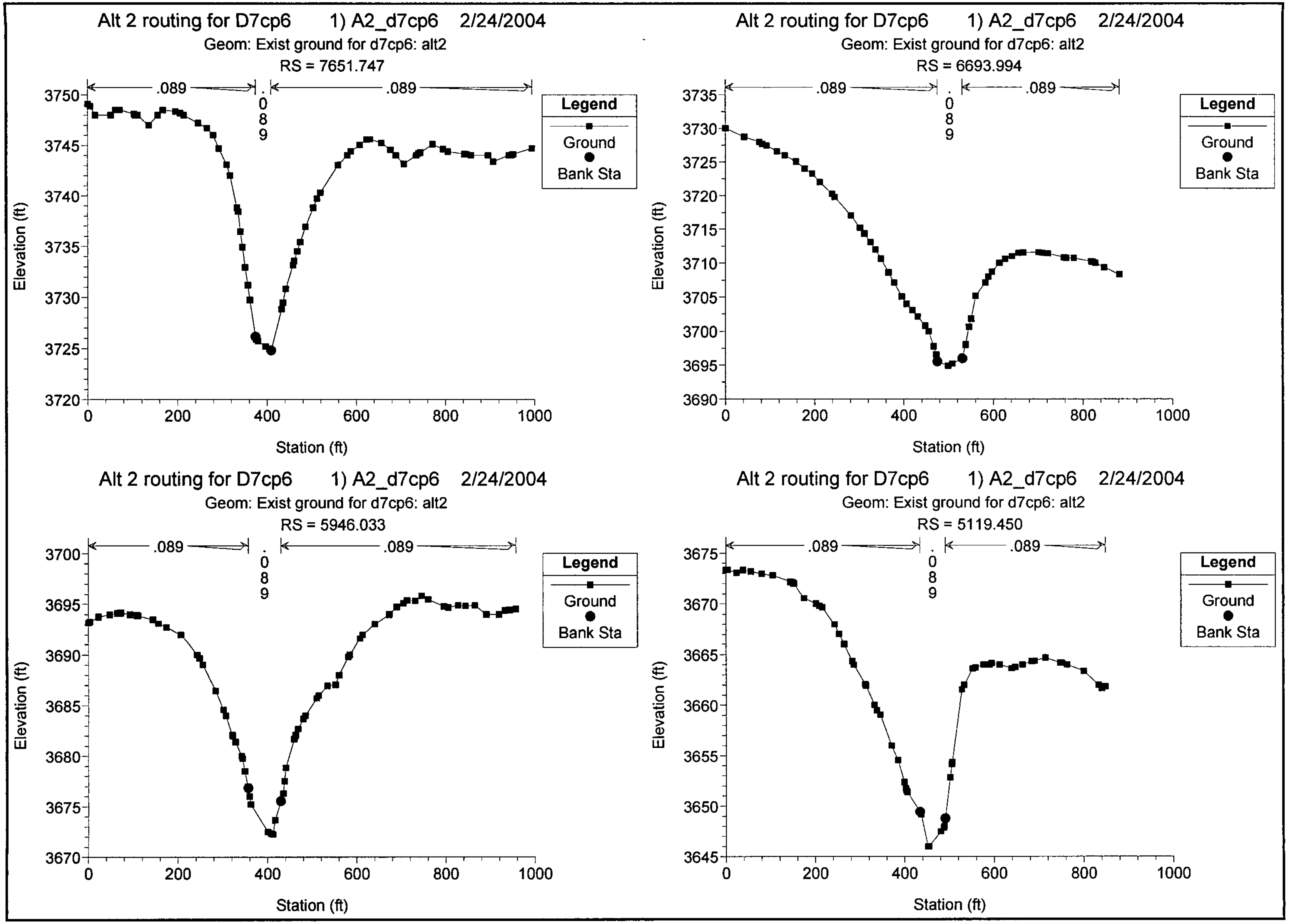
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 8464.553



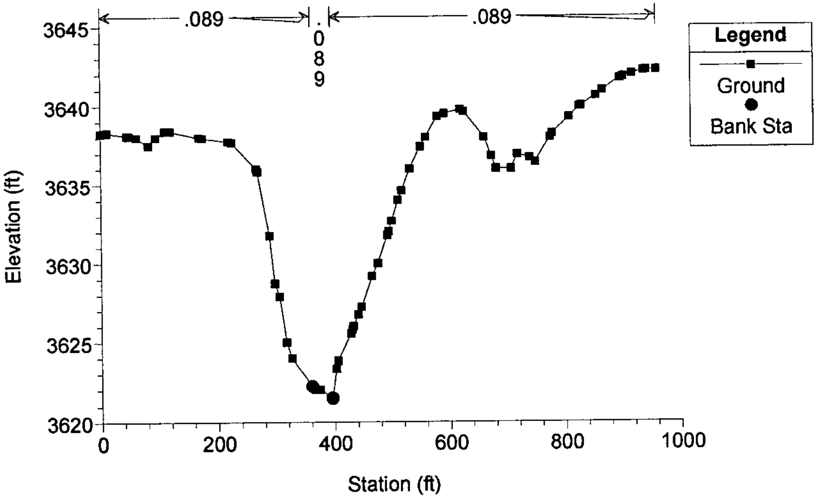
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 8165.679



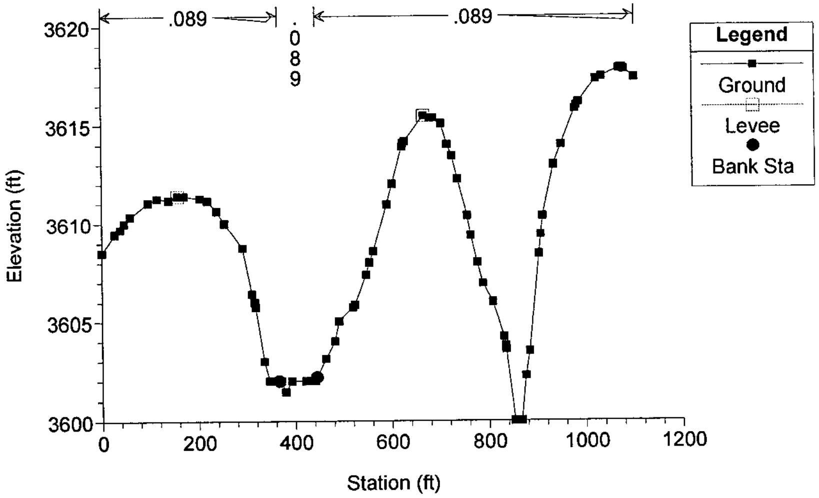
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 7842.364


Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 7651.747
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3720
3725
3730
3735
3740
3745
3750
Station (ft)
0
200
400
600
800
1000
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 6693.994
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3690
3695
3700
3705
3710
3715
3720
3725
3730
3735
Station (ft)
0
200
400
600
800
1000
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 5946.033
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3670
3675
3680
3685
3690
3695
3700
Station (ft)
0
200
400
600
800
1000
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 5119.450
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3645
3650
3655
3660
3665
3670
3675
Station (ft)
0
200
400
600
800
1000

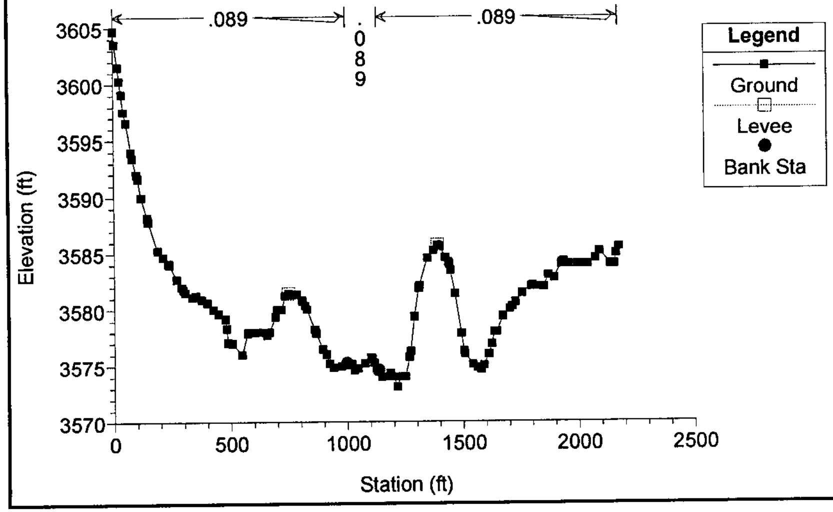
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 4220.337



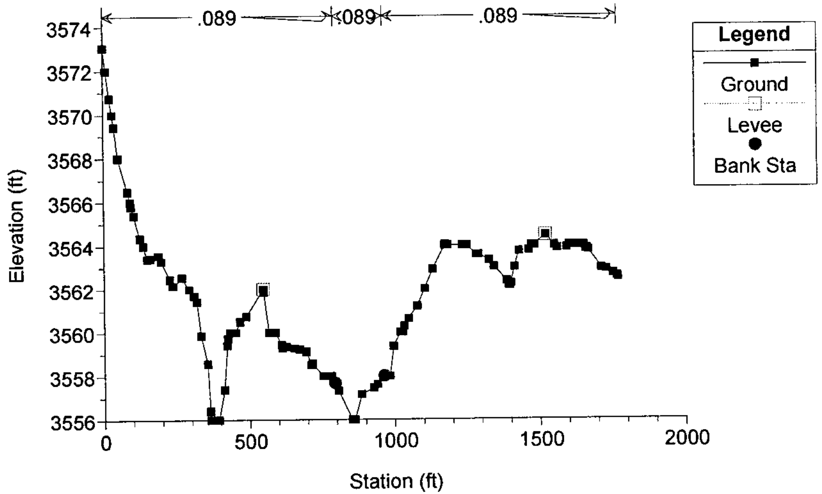
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 3416.825

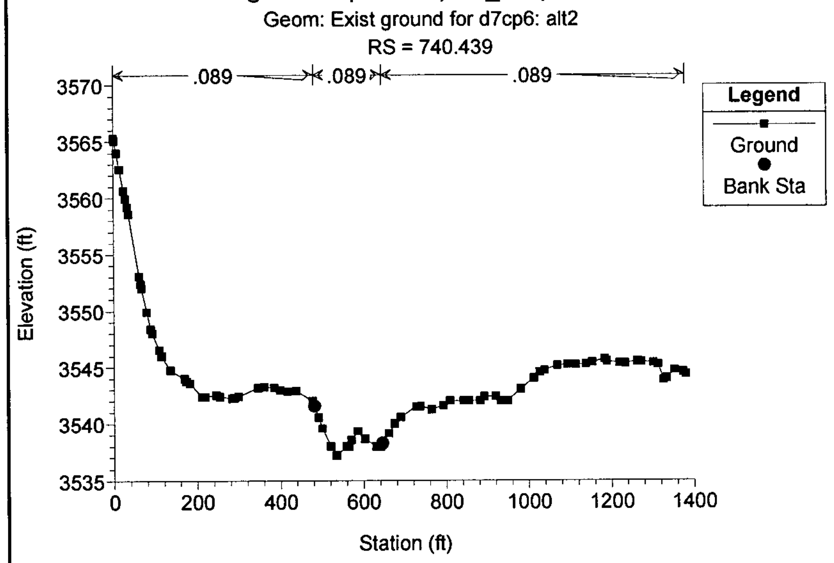


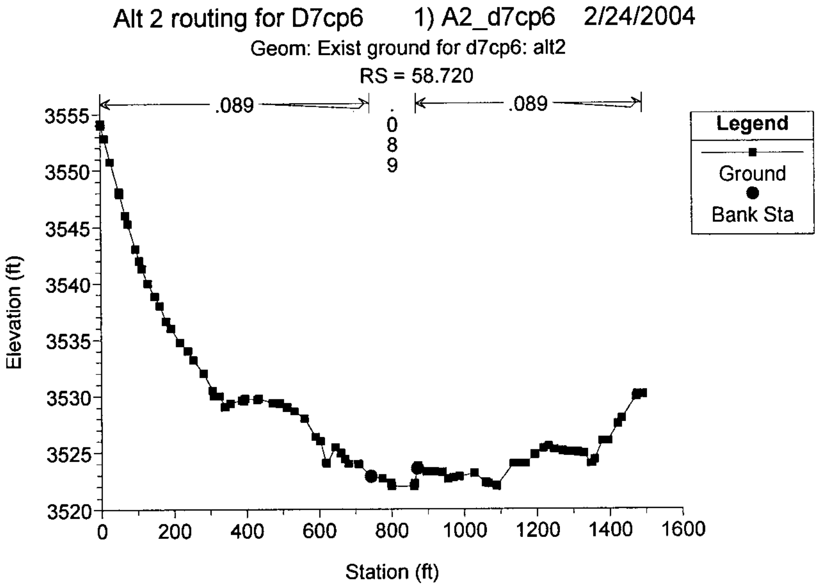
Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 2408.215



Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 1620.471




Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 740.439
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3570
3565
3560
3555
3550
3545
3540
3535
Station (ft)
0
200
400
600
800
1000
1200
1400

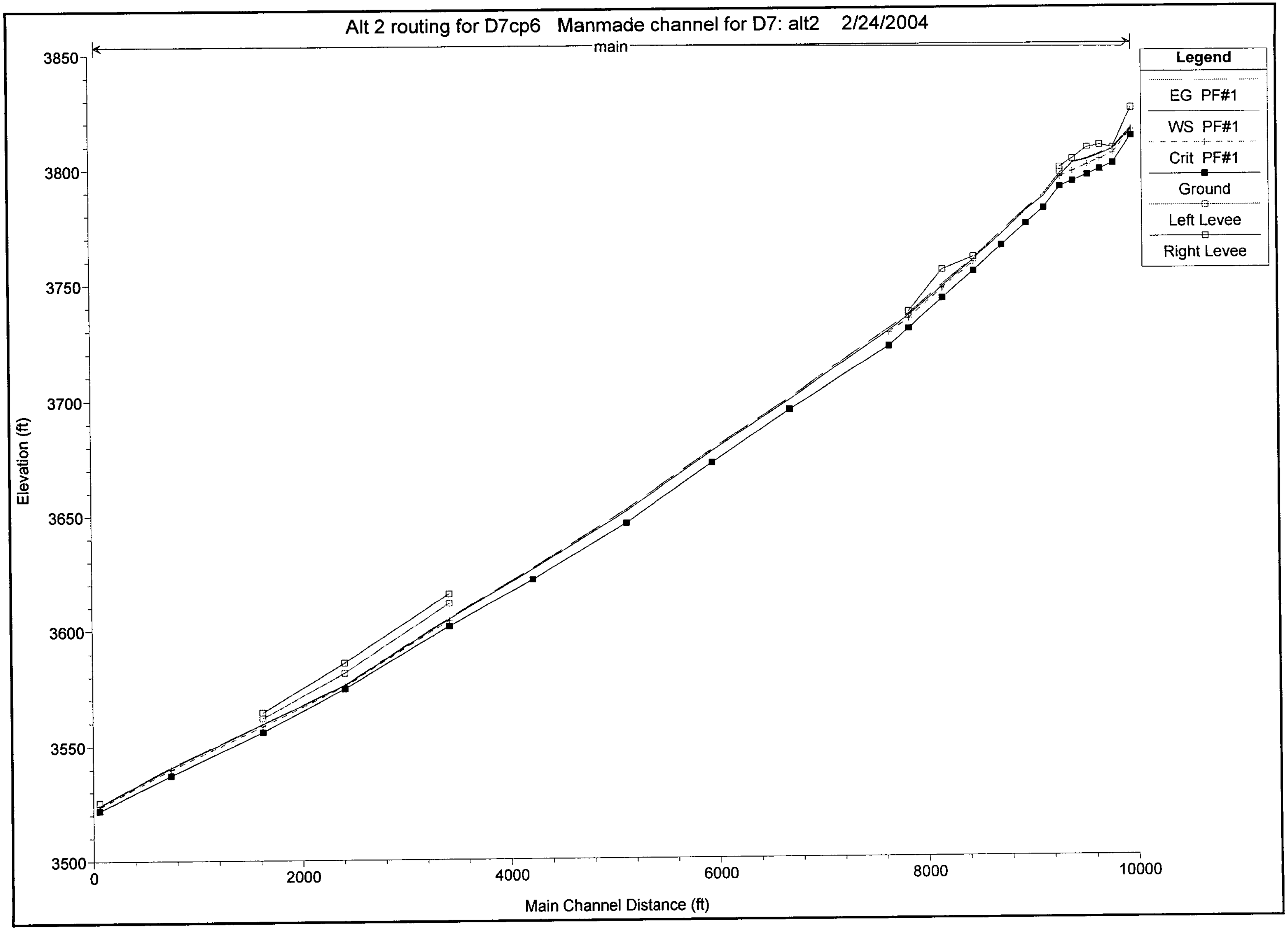

Alt 2 routing for D7cp6 1) A2_d7cp6 2/24/2004
Geom: Exist ground for d7cp6: alt2
RS = 58.720
.089
.089
.089
Legend
Ground
Bank Sta
Elevation (ft)
3555
3550
3545
3540
3535
3530
3525
3520
Station (ft)
0
200
400
600
800
1000
1200
1400
1600

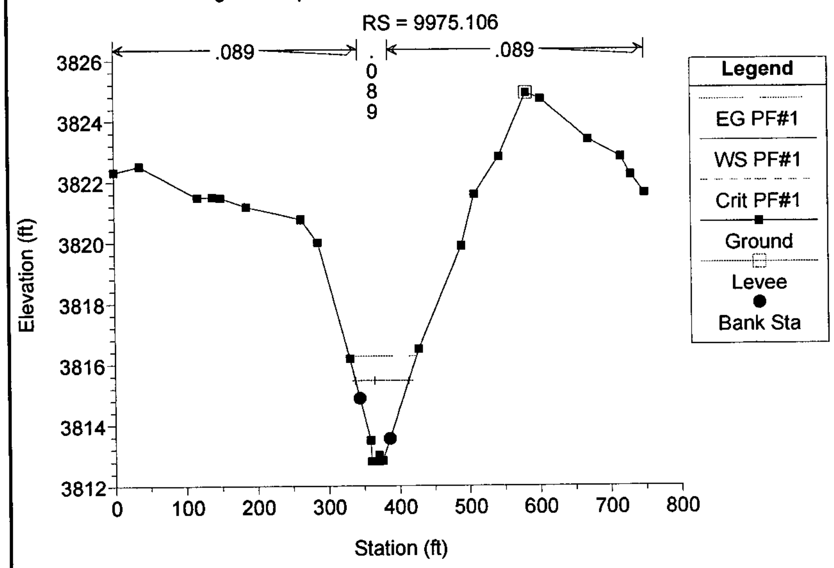
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: A2_d7cp6  River: d7cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 22
# Plans             = 1
# Profiles          = 1

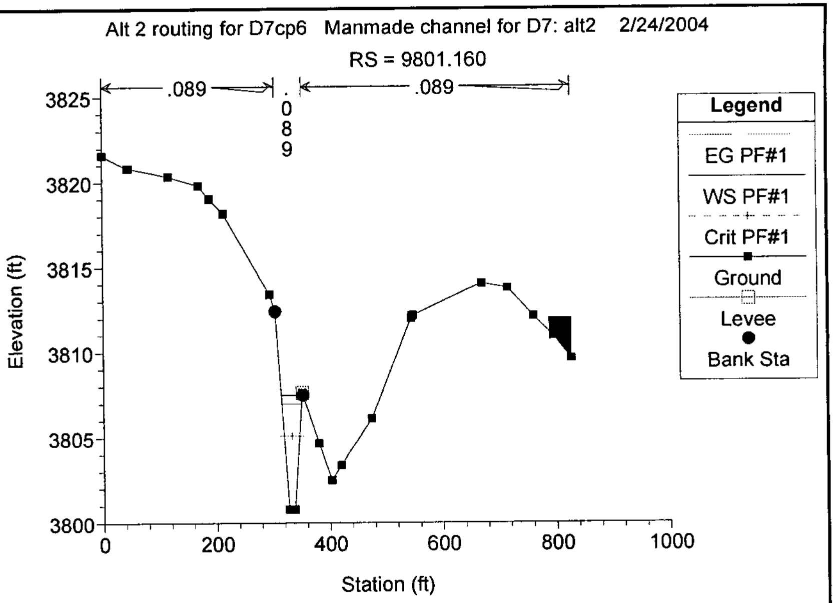
 Reach           River Sta            Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area Top Width Froude # Chl
                                        (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)      (ft)

 main            9975.106             780.00    3812.80    3815.46    3815.45    3816.27   0.079881       7.60     114.29      75.37         0.93
 main            9801.160             780.00    3800.80    3806.99    3805.09    3807.48   0.019990       5.62     138.69      34.79         0.50
 main            9676.552             780.00    3798.31    3804.53    3802.60    3805.01   0.019684       5.59     139.46      34.87         0.49
 main            9556.460             780.00    3795.91    3802.42    3800.20    3802.84   0.016216       5.21     149.84      36.04         0.45
 main            9414.334             780.00    3793.06    3800.87    3797.35    3801.10   0.007460       3.90     199.88      41.22         0.31
 main            9294.755             780.00    3790.67    3795.27    3794.96    3796.48   0.068210       8.84      88.22      28.38         0.88
 main            9139.052             780.00    3781.48    3786.52               3787.44   0.046738       7.69     101.37      30.19         0.74
 main            8969.225             780.00    3774.69    3780.43               3781.05   0.027528       6.33     123.20      32.94         0.58
 main            8735.299             780.00    3765.33    3770.15               3771.21   0.056321       8.23      94.77      29.38         0.81
 main            8464.553             780.00    3754.22    3759.17    3758.07    3759.67   0.027637       5.69     138.44      47.84         0.57
 main            8165.679             780.00    3742.54    3747.58    3746.83    3748.50   0.046967       7.71     101.18      30.16         0.74
 main            7842.364             780.00    3729.61    3735.20    3733.90    3735.87   0.030749       6.59     118.27      32.34         0.61
 main            7651.747            1710.00    3721.99    3728.65    3727.90    3729.68   0.033758       8.60     224.95      65.99         0.68
 main            6693.994            1710.00    3694.90    3699.29               3700.00   0.028090       6.98     265.11      82.62         0.62
 main            5946.033            1710.00    3672.24    3677.33               3678.01   0.030711       6.65     262.15      83.03         0.63
 main            5119.450            1710.00    3646.00    3651.15               3651.96   0.032238       7.37     249.90      88.11         0.66
 main            4220.337            1710.00    3621.48    3625.98               3626.49   0.024142       6.66     318.71     118.41         0.58
 main            3416.825            1710.00    3601.45    3604.59    3603.92    3604.99   0.029213       5.48     347.31     161.72         0.59
 main            2408.215            1710.00    3574.58    3576.05    3575.66    3576.28   0.027433       2.68     480.67     363.32         0.48
 main            1620.471            1710.00    3556.00    3559.39    3558.53    3559.57   0.015234       3.62     557.12     387.03         0.42
 main            740.439             1710.00    3537.20    3540.59    3539.86    3540.91   0.027174       4.64     387.06     199.58         0.55
 main            58.720              1710.00    3522.00    3524.13    3523.58    3524.29   0.021711       3.64     581.65     494.32         0.48
```

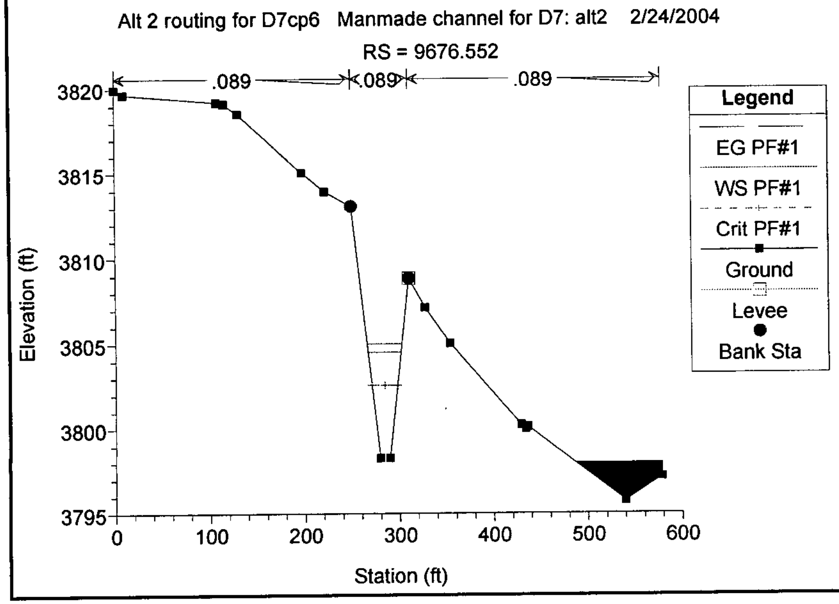

Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
main
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Left Levee
Right Levee
Elevation (ft)
3850
3800
3750
3700
3650
3600
3550
3500
0
2000
4000
6000
8000
10000
Main Channel Distance (ft)


Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004

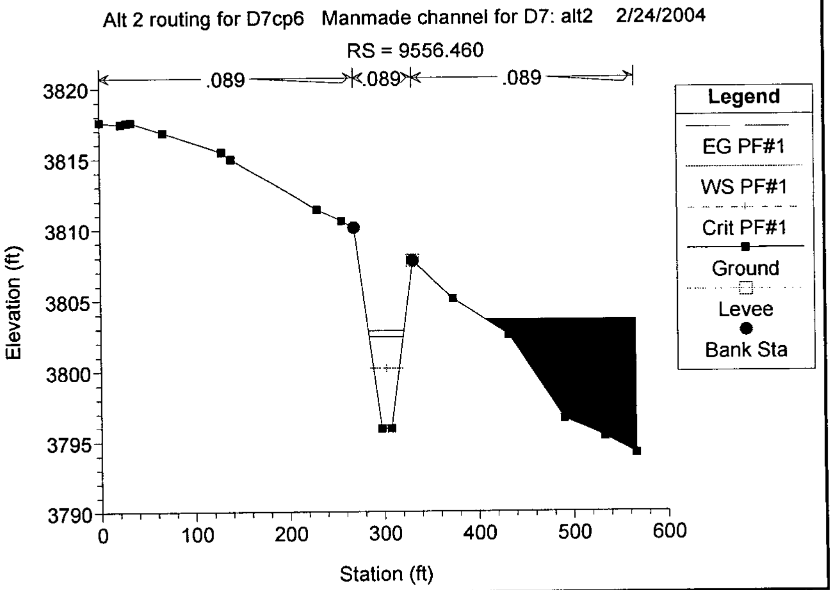
RS = 9975.106


Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004

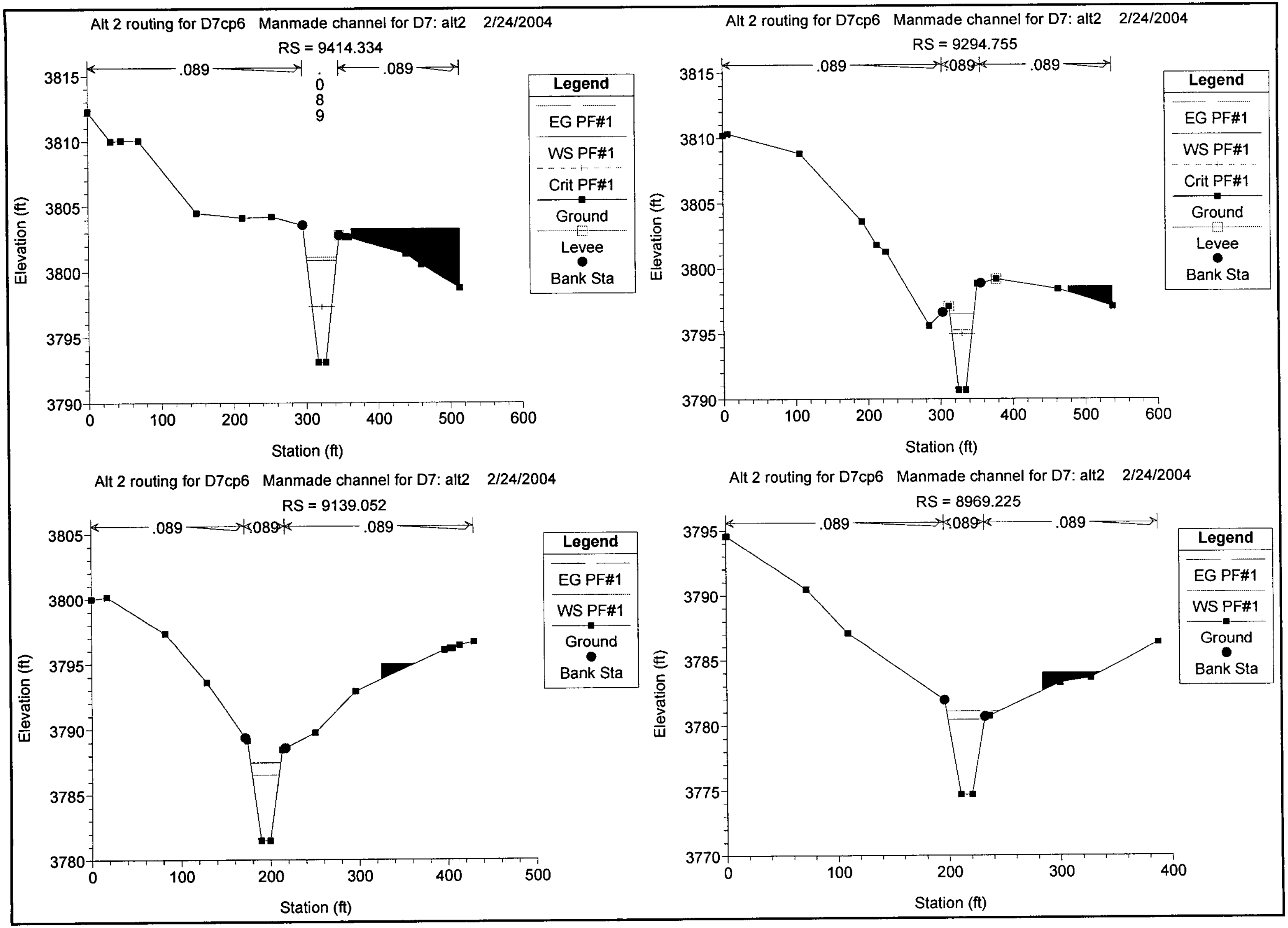
RS = 9801.160

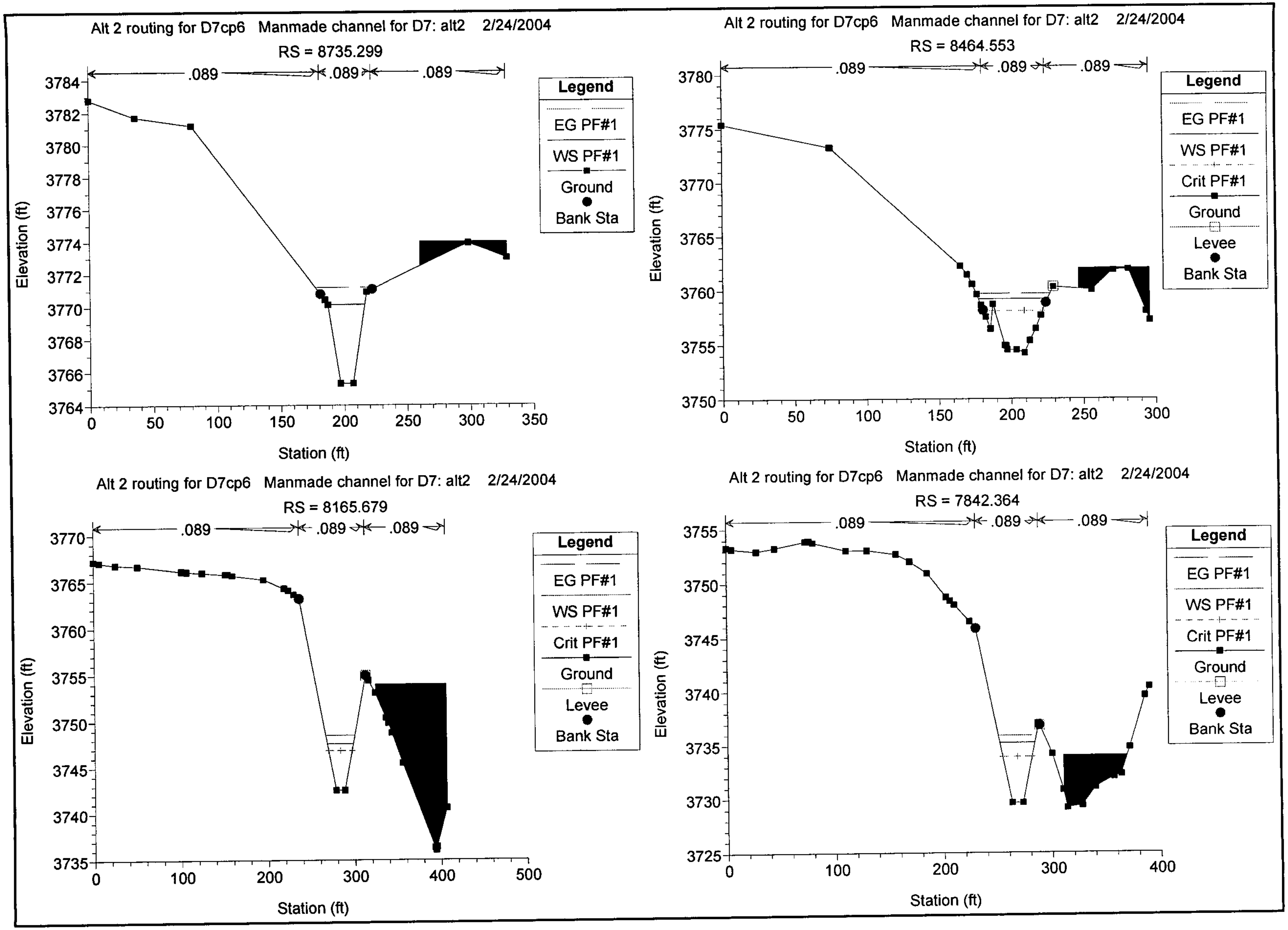

Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004

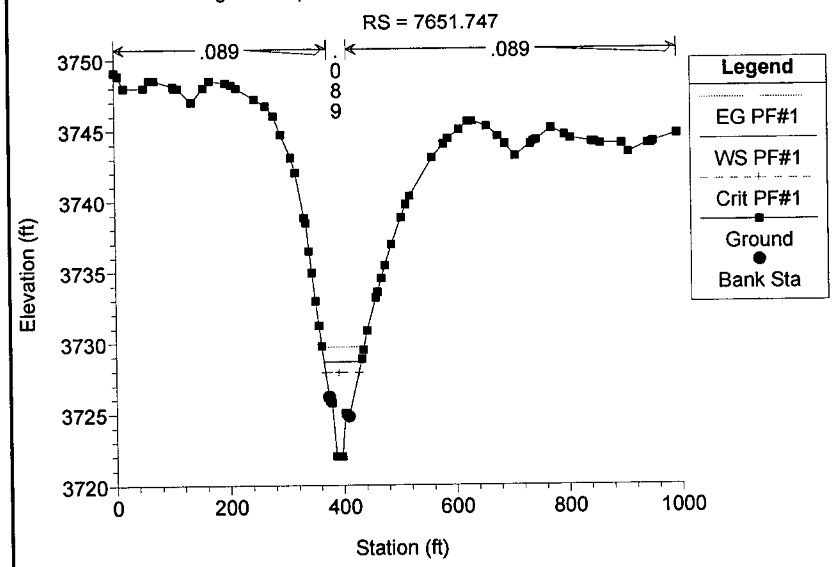
RS = 9676.552

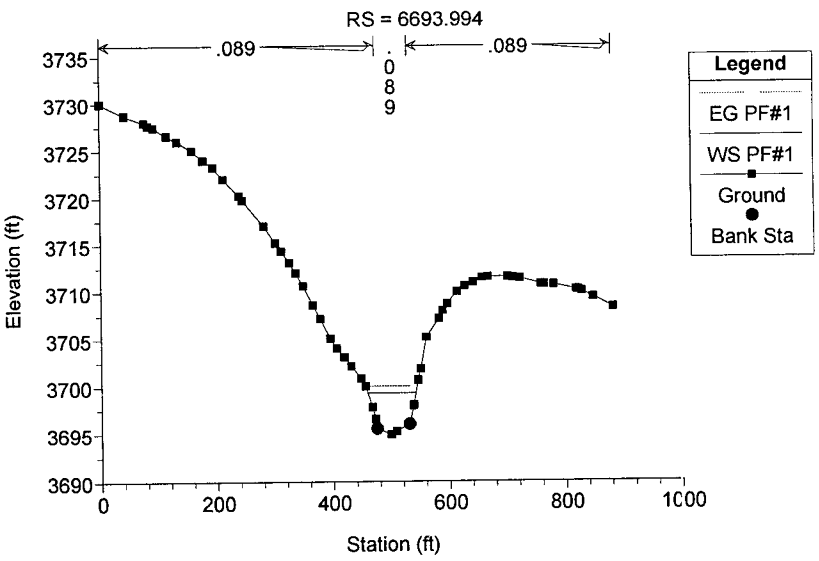

Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004

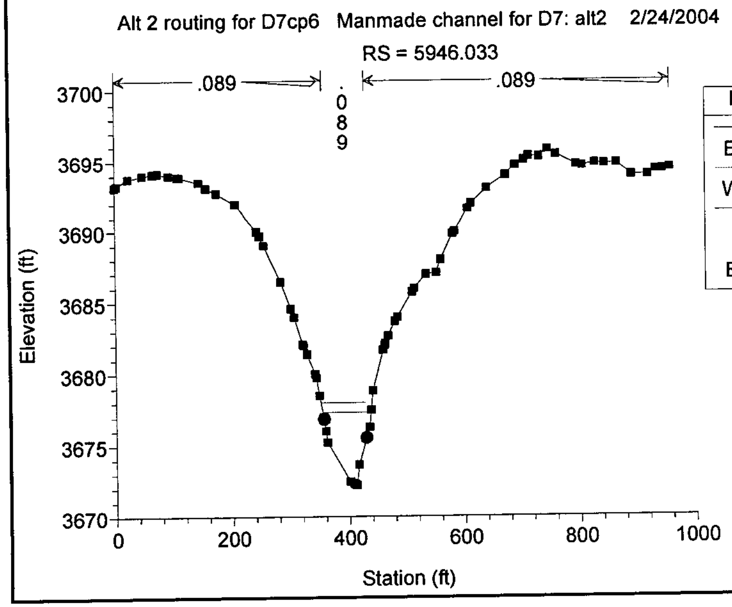
RS = 9556.460

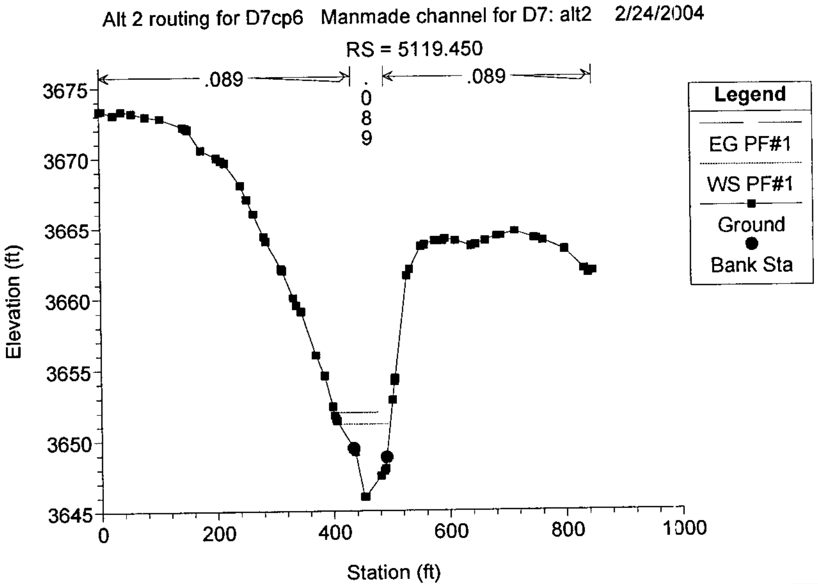

Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 9414.334
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3815
3810
3805
3800
3795
3790
Station (ft)
0
100
200
300
400
500
600
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 9294.755
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3815
3810
3805
3800
3795
3790
Station (ft)
0
100
200
300
400
500
600
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 9139.052
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3805
3800
3795
3790
3785
3780
Station (ft)
0
100
200
300
400
500
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 8969.225
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3795
3790
3785
3780
3775
3770
Station (ft)
0
100
200
300
400

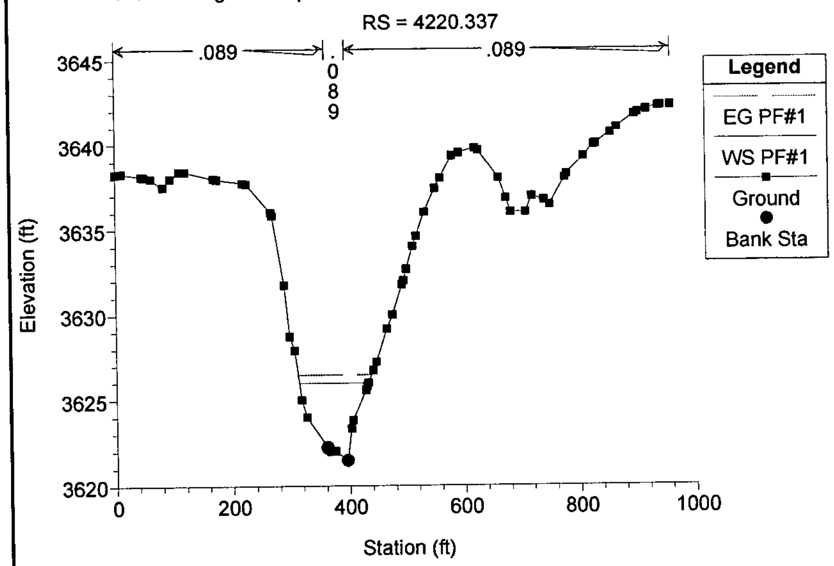

Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 8735.299
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3784
3782
3780
3778
3776
3774
3772
3770
3768
3766
3764
Station (ft)
0
50
100
150
200
250
300
350
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 8464.553
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3780
3775
3770
3765
3760
3755
3750
Station (ft)
0
50
100
150
200
250
300
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 8165.679
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3770
3765
3760
3755
3750
3745
3740
3735
Station (ft)
0
100
200
300
400
500
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 7842.364
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3755
3750
3745
3740
3735
3730
3725
Station (ft)
0
100
200
300
400

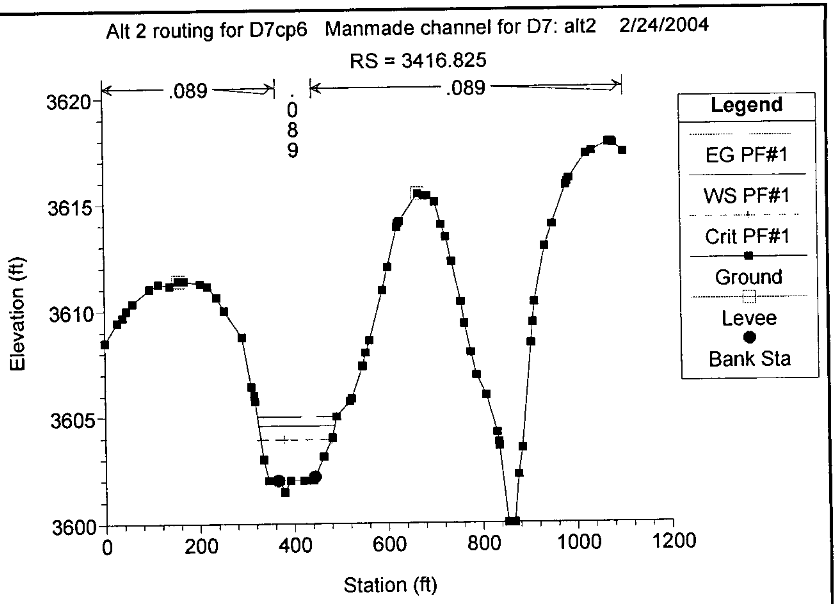

Alt 2 routing for D7cp6   Manmade channel for D7: alt2   2/24/2004
RS = 7651.747
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3750
3745
3740
3735
3730
3725
3720
0
200
400
600
800
1000
Station (ft)

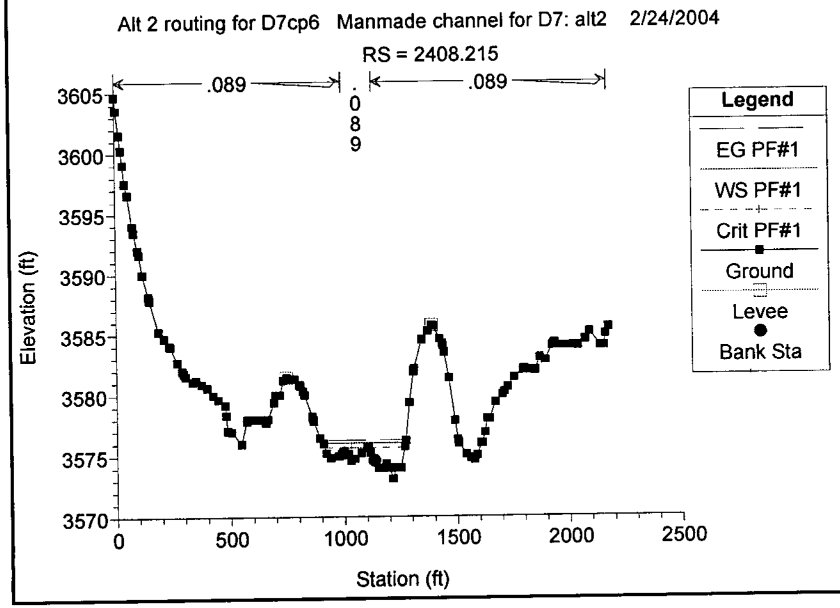

Alt 2 routing for D7cp6   Manmade channel for D7: alt2   2/24/2004
RS = 6693.994
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3735
3730
3725
3720
3715
3710
3705
3700
3695
3690
0
200
400
600
800
1000
Station (ft)

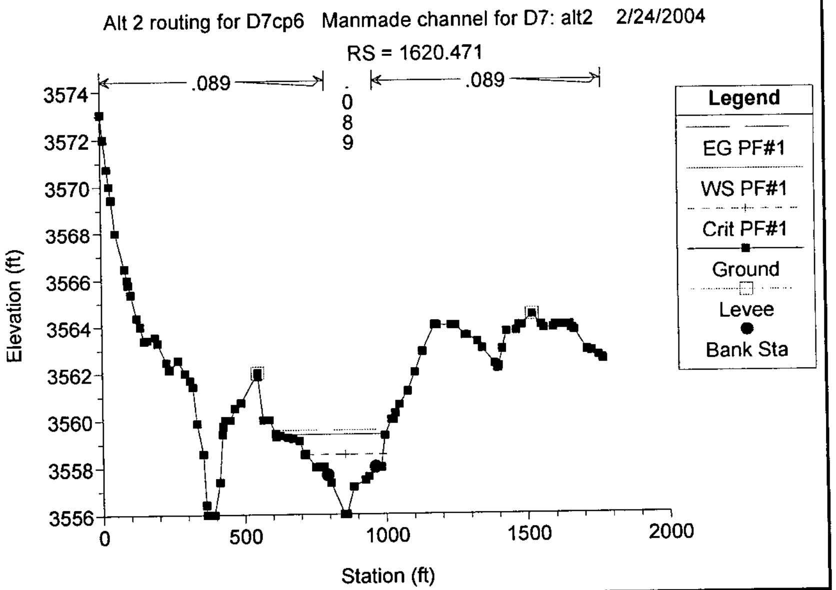

Alt 2 routing for D7cp6   Manmade channel for D7: alt2   2/24/2004
RS = 5946.033
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3700
3695
3690
3685
3680
3675
3670
0
200
400
600
800
1000
Station (ft)

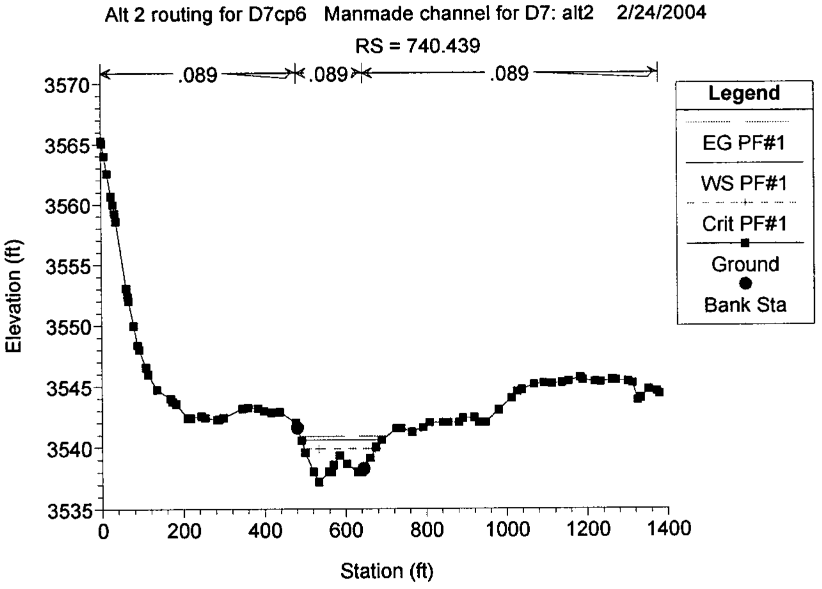

Alt 2 routing for D7cp6   Manmade channel for D7: alt2   2/24/2004
RS = 5119.450
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3675
3670
3665
3660
3655
3650
3645
0
200
400
600
800
1000
Station (ft)


Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 4220.337
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3645
3640
3635
3630
3625
3620
0
200
400
600
800
1000
Station (ft)


Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 3416.825
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3620
3615
3610
3605
3600
0
200
400
600
800
1000
1200
Station (ft)

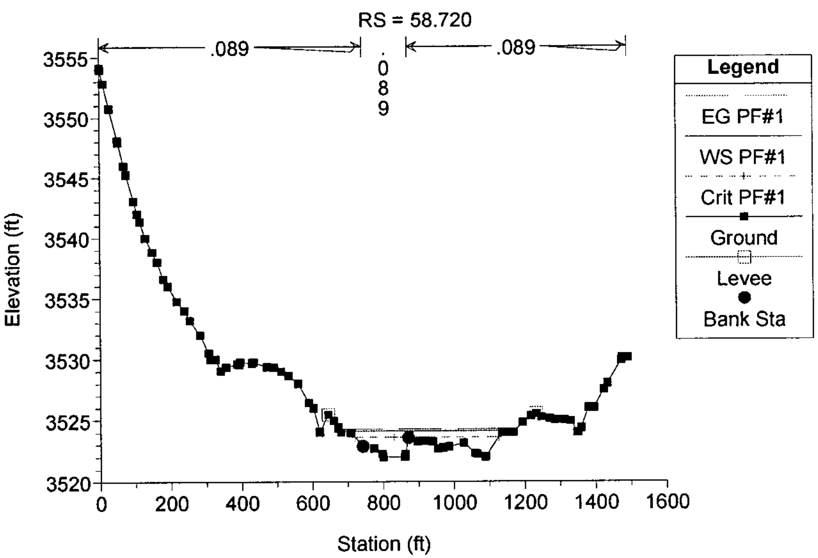

Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 2408.215
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3605
3600
3595
3590
3585
3580
3575
3570
0
500
1000
1500
2000
2500
Station (ft)


Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004
RS = 1620.471
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3574
3572
3570
3568
3566
3564
3562
3560
3558
3556
0
500
1000
1500
2000
Station (ft)



Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004

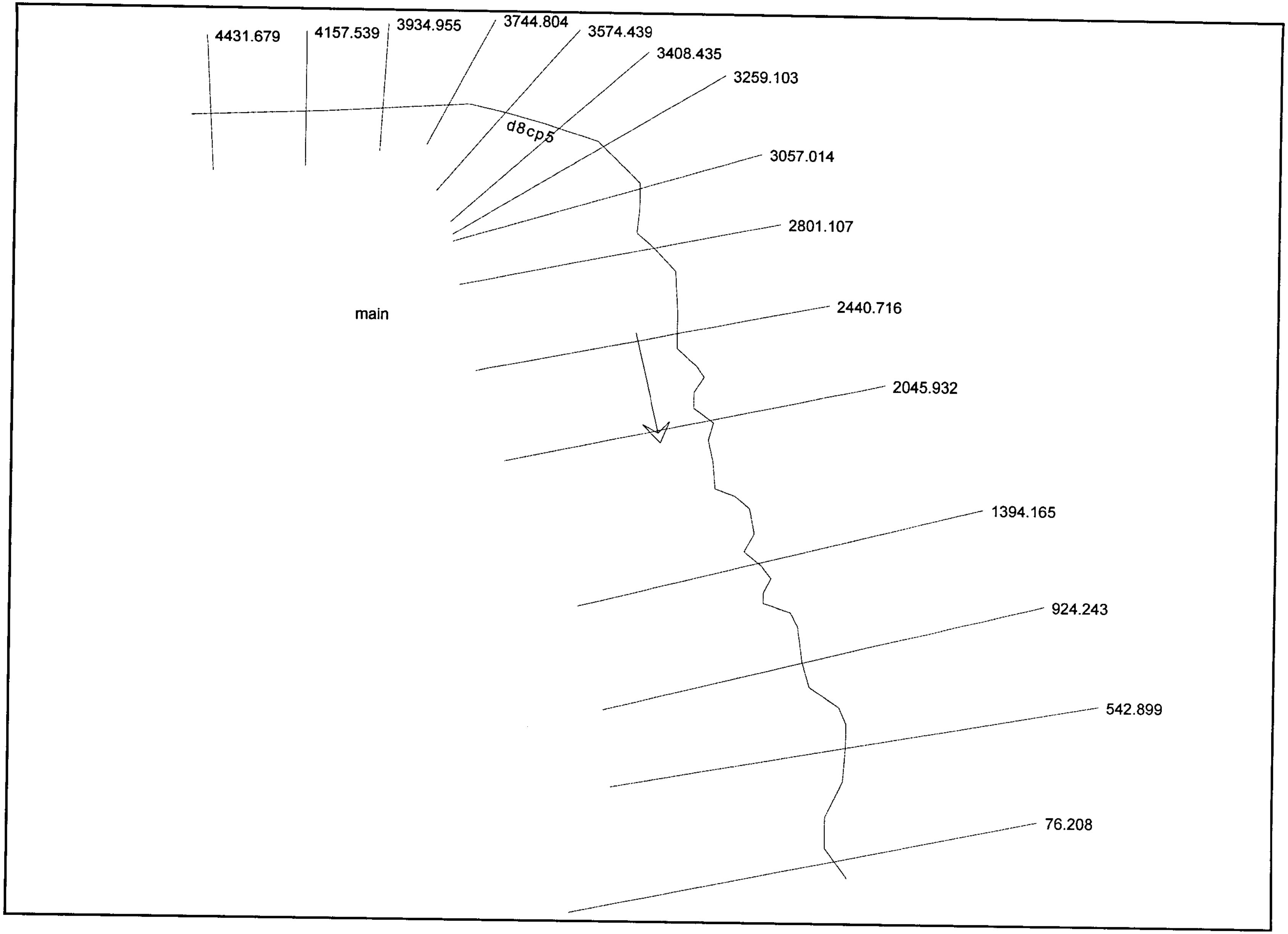
RS = 740.439



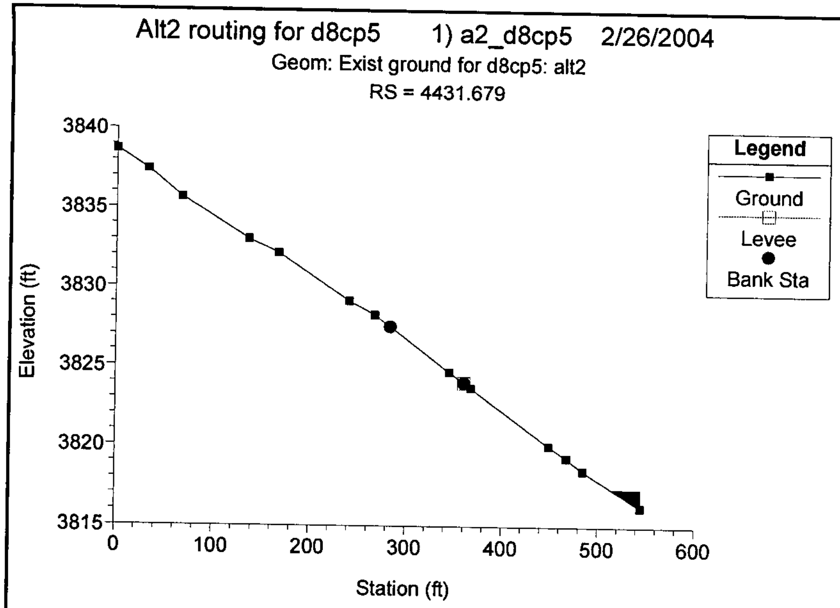
Alt 2 routing for D7cp6 Manmade channel for D7: alt2 2/24/2004

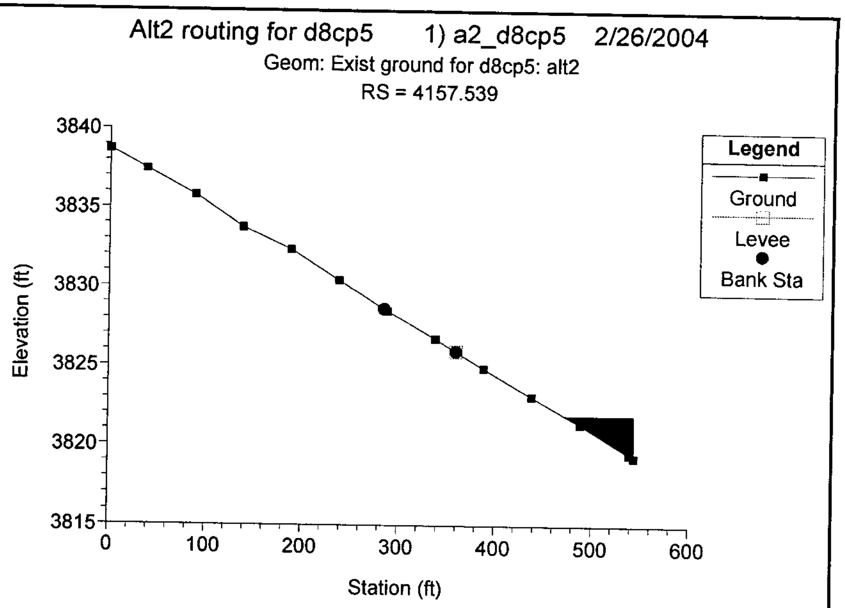
RS = 58.720

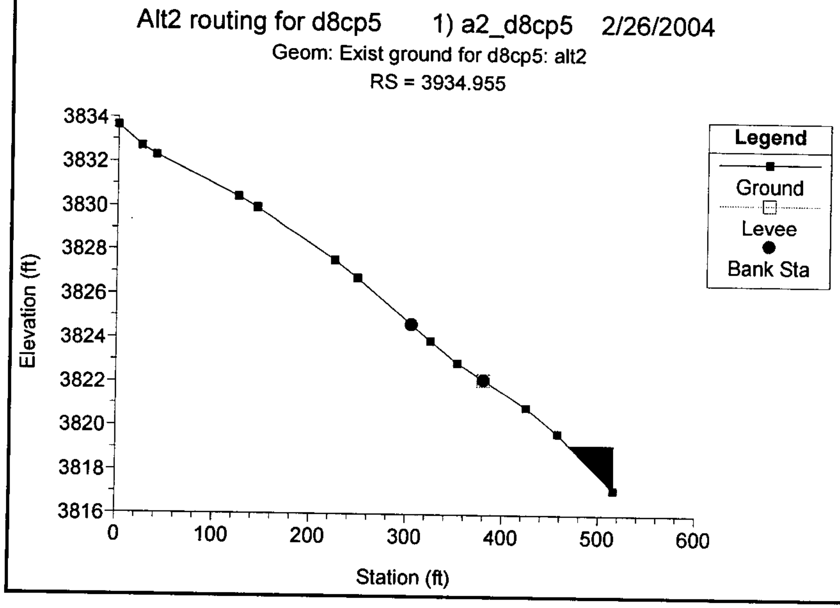
Attachment 18: Hydraulic Calculations for Routing Around Aging Pad 2, Alternative 2
(Document ID: 000-00C-CD04-00100-000-00A)

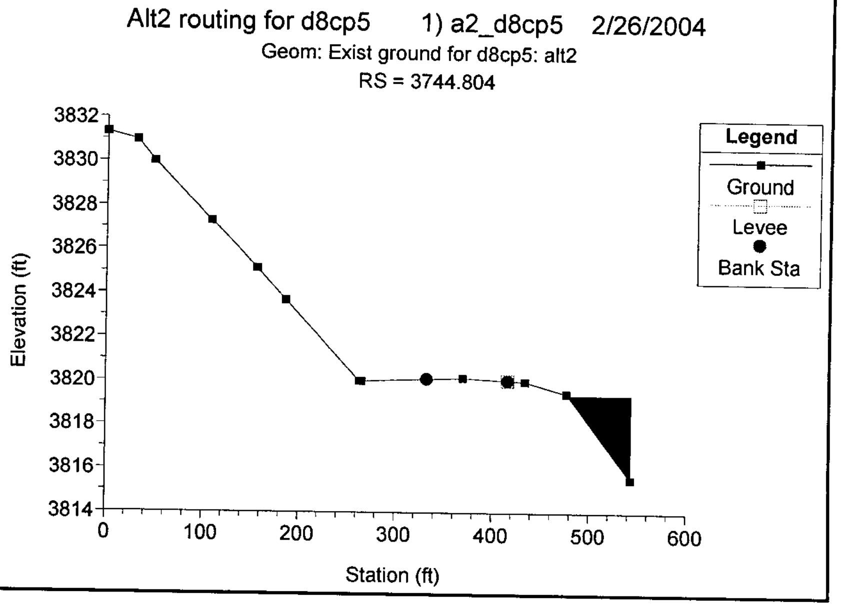


Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A

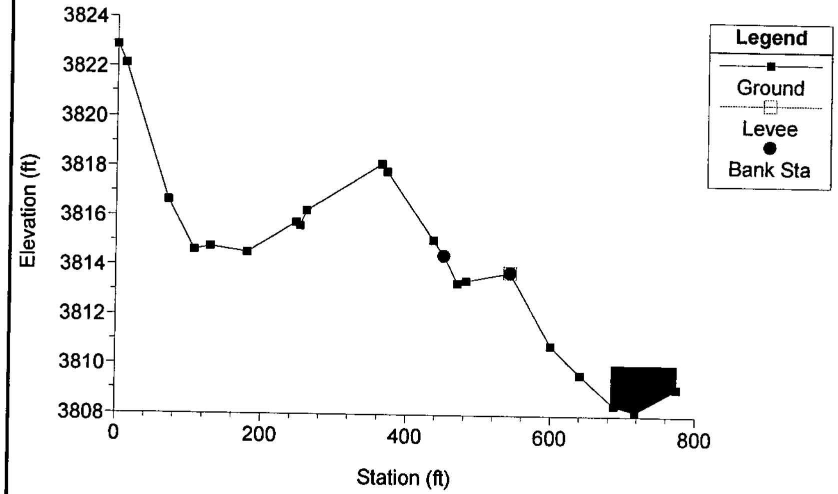

Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 4431.679


Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 4157.539

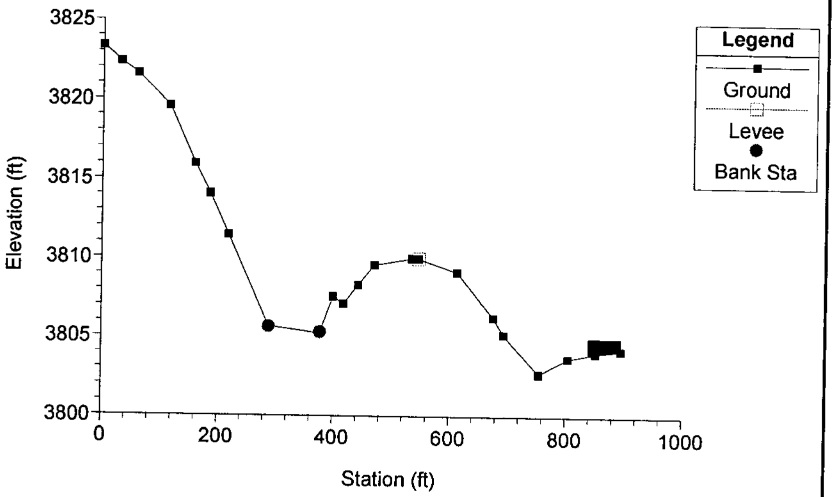

Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 3934.955


Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 3744.804

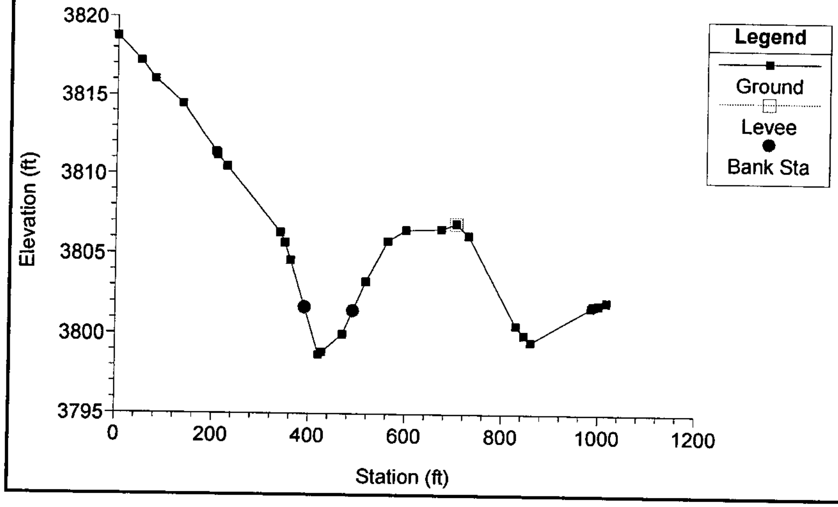
Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 3574.439



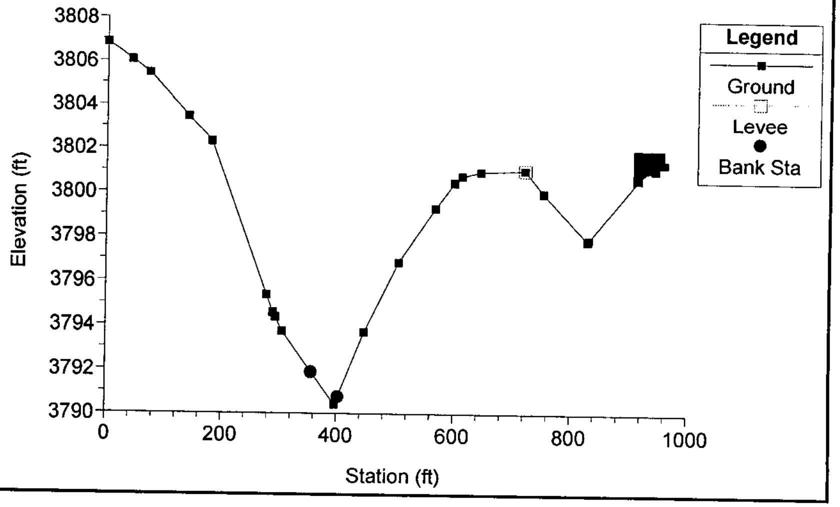
Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 3408.435

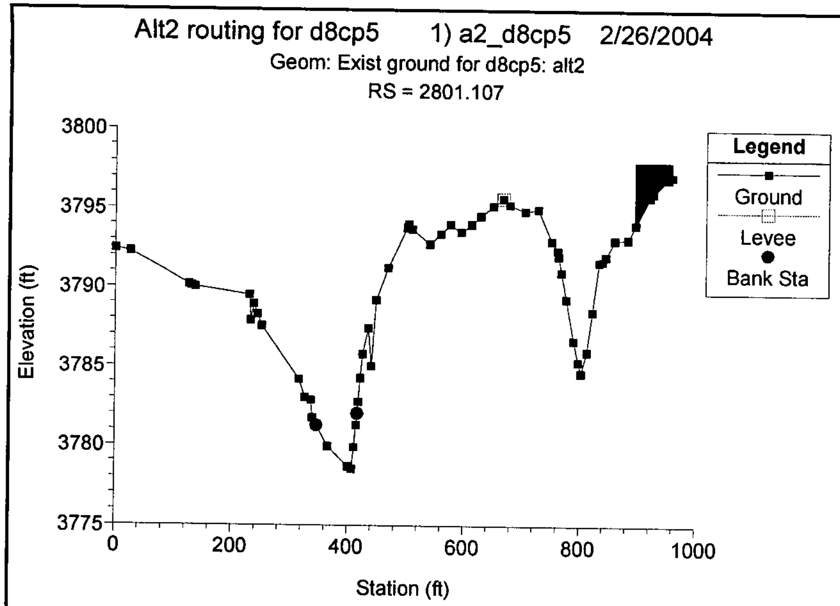


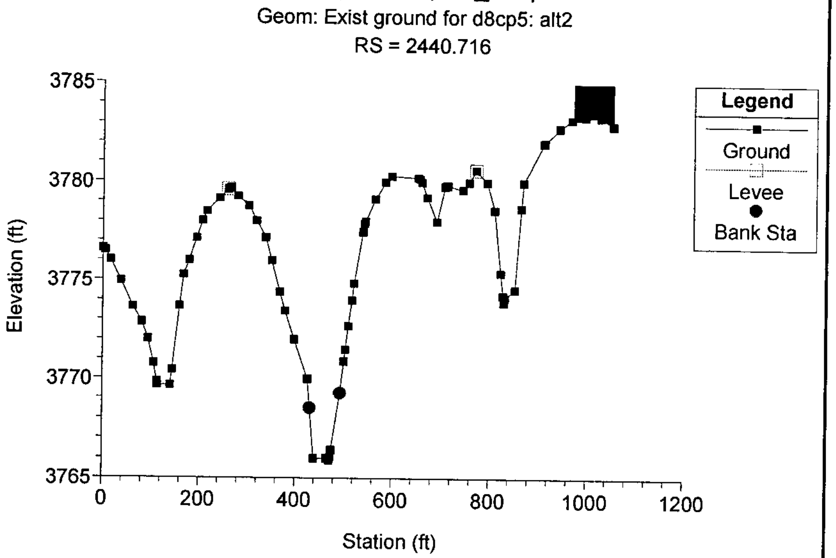
Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 3259.103

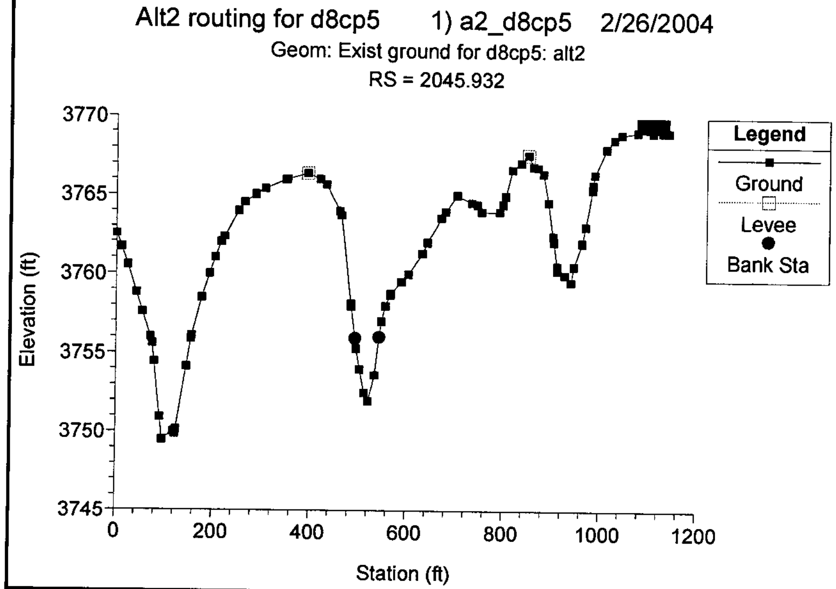


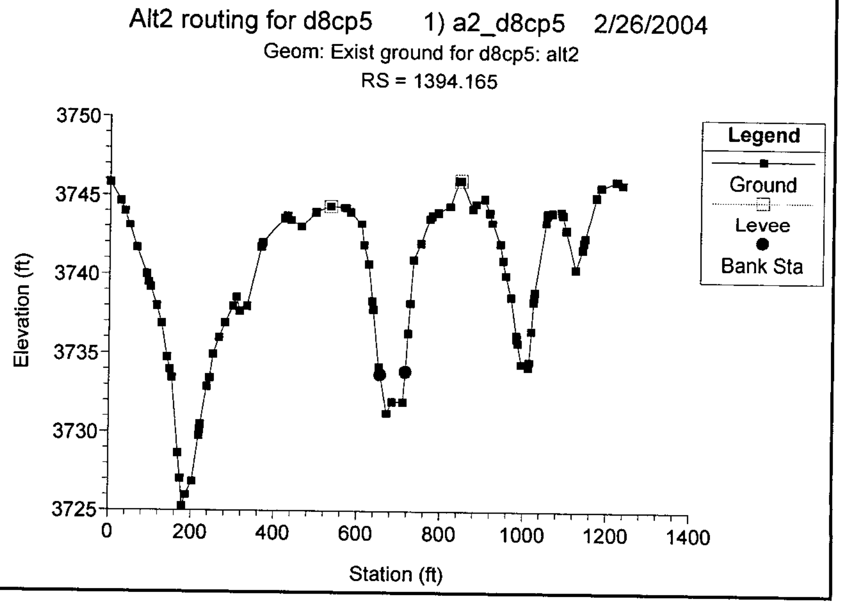
Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 3057.014

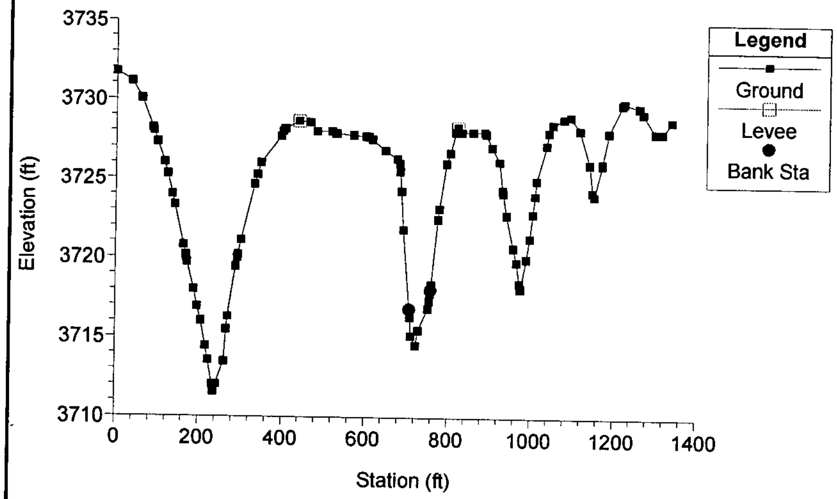



Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 2801.107

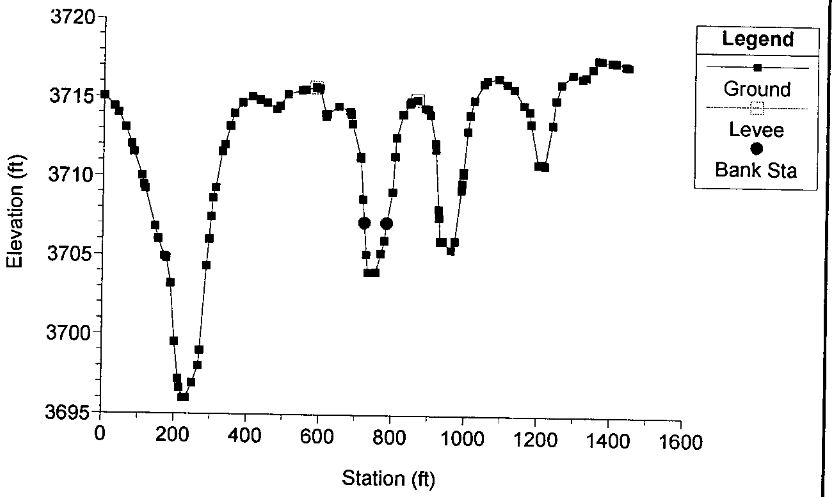

Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 2440.716


Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 2045.932

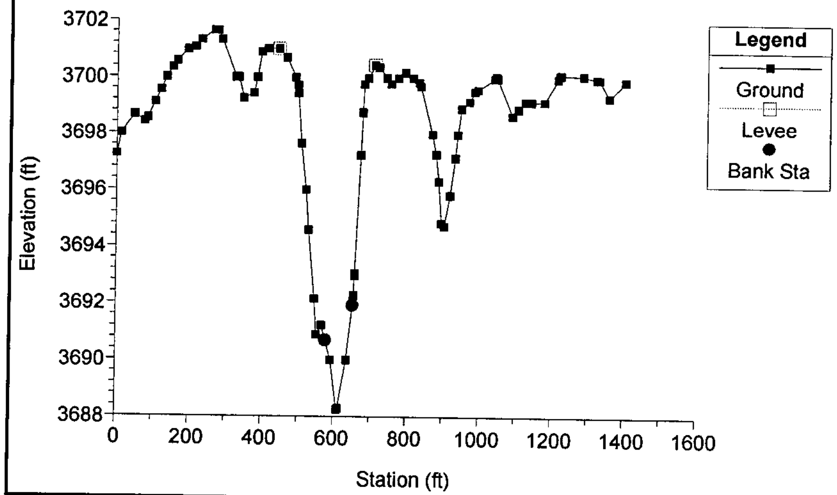

Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 1394.165



Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 924.243



Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 542.899



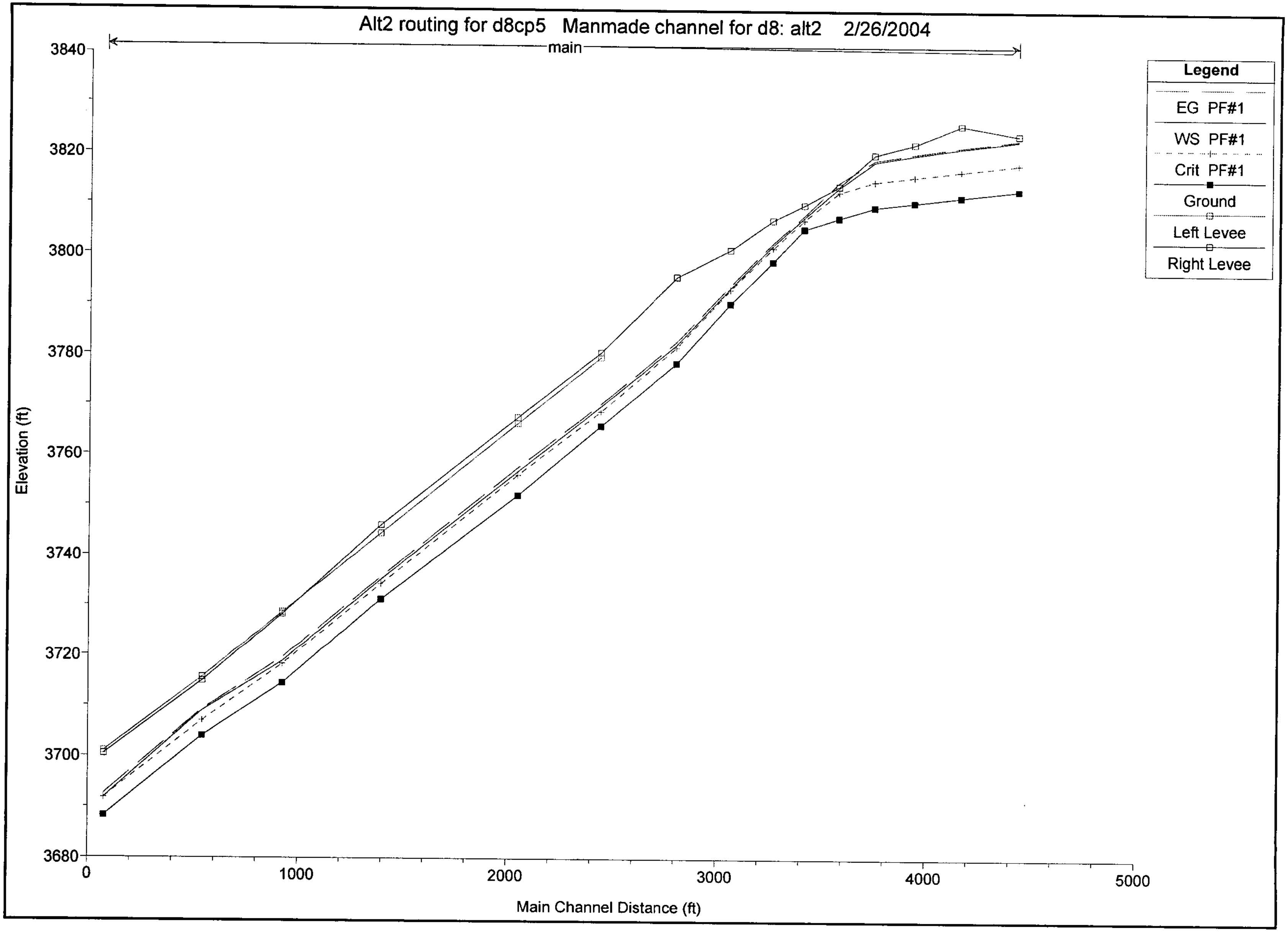
Alt2 routing for d8cp5 1) a2_d8cp5 2/26/2004
Geom: Exist ground for d8cp5: alt2
RS = 76.208

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: a2_d8cp5  River: d8cp5  Reach: main

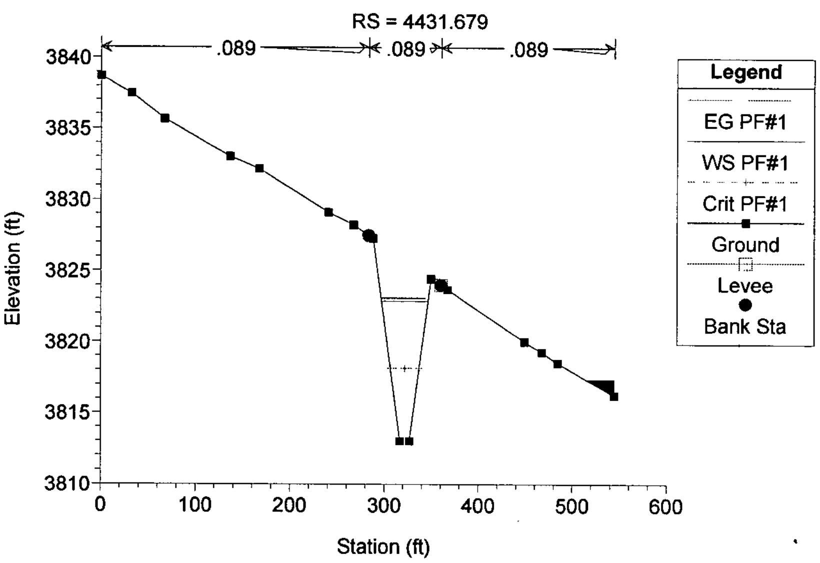
# Rivers           = 1
# Hydraulic Reaches = 1
# River Stations   = 15
# Plans            = 1
# Profiles         = 1

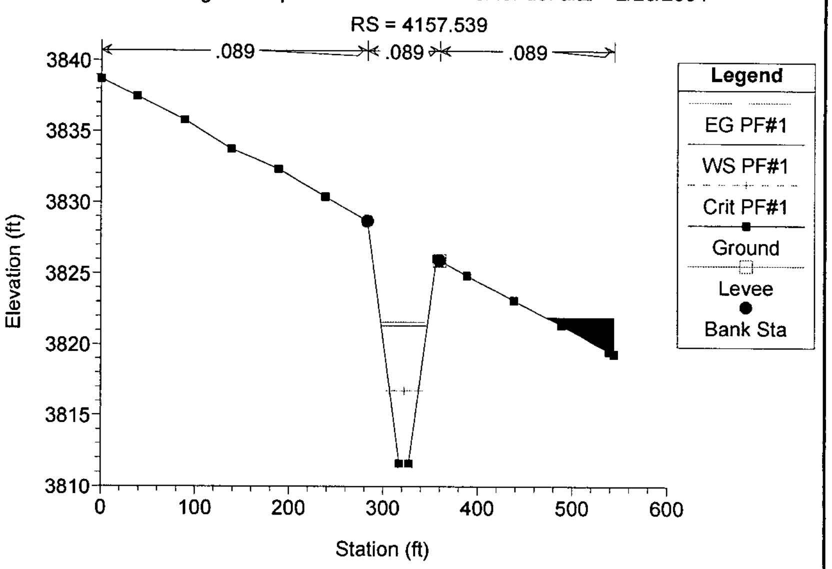
 Reach            River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                       (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

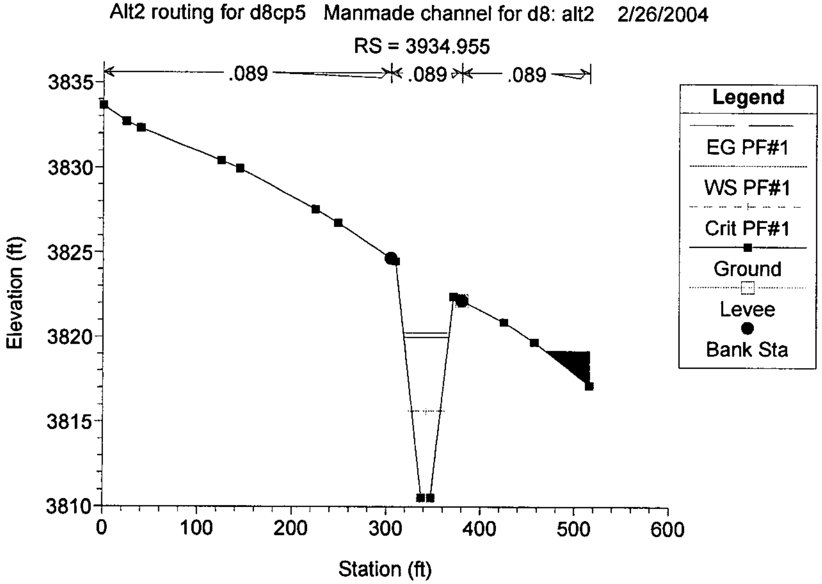
 main             4431.679           1100.00    3813.00    3822.87    3818.14    3823.09   0.005292       3.75     293.48      49.48          0.27
 main             4157.539           1100.00    3811.63    3821.36    3816.77    3821.59   0.005643       3.84     286.53      48.91          0.28
 main             3934.955           1100.00    3810.52    3820.01    3815.66    3820.25   0.006311       4.00     274.83      47.94          0.29
 main             3744.804           1100.00    3809.57    3818.62    3814.71    3818.91   0.007766       4.32     254.36      46.21          0.32
 main             3574.439           1100.00    3807.44    3813.52    3812.58    3814.55   0.042556       8.16     136.40      47.10          0.72
 main             3408.435           1100.00    3805.23    3807.52    3807.02    3807.89   0.035208       5.12     235.82     157.91          0.62
 main             3259.103           1100.00    3798.72    3801.97    3801.43    3802.41   0.038158       5.29     209.69     110.17          0.65
 main             3057.014           1100.00    3790.41    3793.54    3793.24    3794.05   0.044581       6.41     209.48     133.90          0.72
 main             2801.107           1100.00    3778.49    3782.16    3781.67    3782.77   0.043389       6.30     177.68      78.45          0.71
 main             2440.716           1100.00    3765.91    3769.82    3768.79    3770.31   0.025259       5.62     198.18      69.49          0.56
 main             2045.932           1100.00    3752.00    3756.72    3756.07    3757.49   0.039563       7.04     158.00      56.25          0.70
 main             1394.165           1100.00    3731.26    3735.22    3734.32    3735.73   0.027044       5.78     195.54      71.52          0.58
 main             924.243            1100.00    3714.52    3718.85    3718.30    3719.60   0.041610       7.03     160.81      60.58          0.72
 main             542.899            1100.00    3704.00    3708.97    3707.01    3709.23   0.012056       4.09     269.24      80.68          0.39
 main             76.208             1100.00    3688.25    3691.75    3691.75    3692.56   0.059159       7.78     168.82     102.25          0.84
```

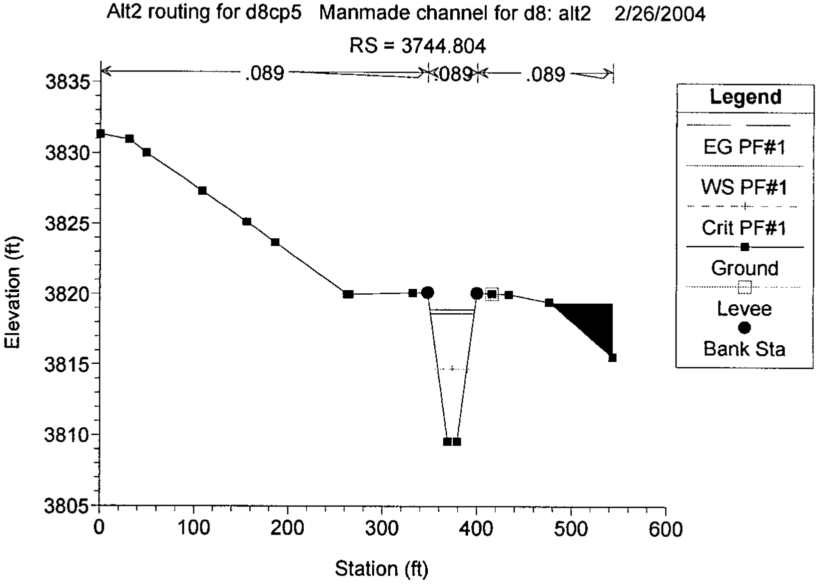


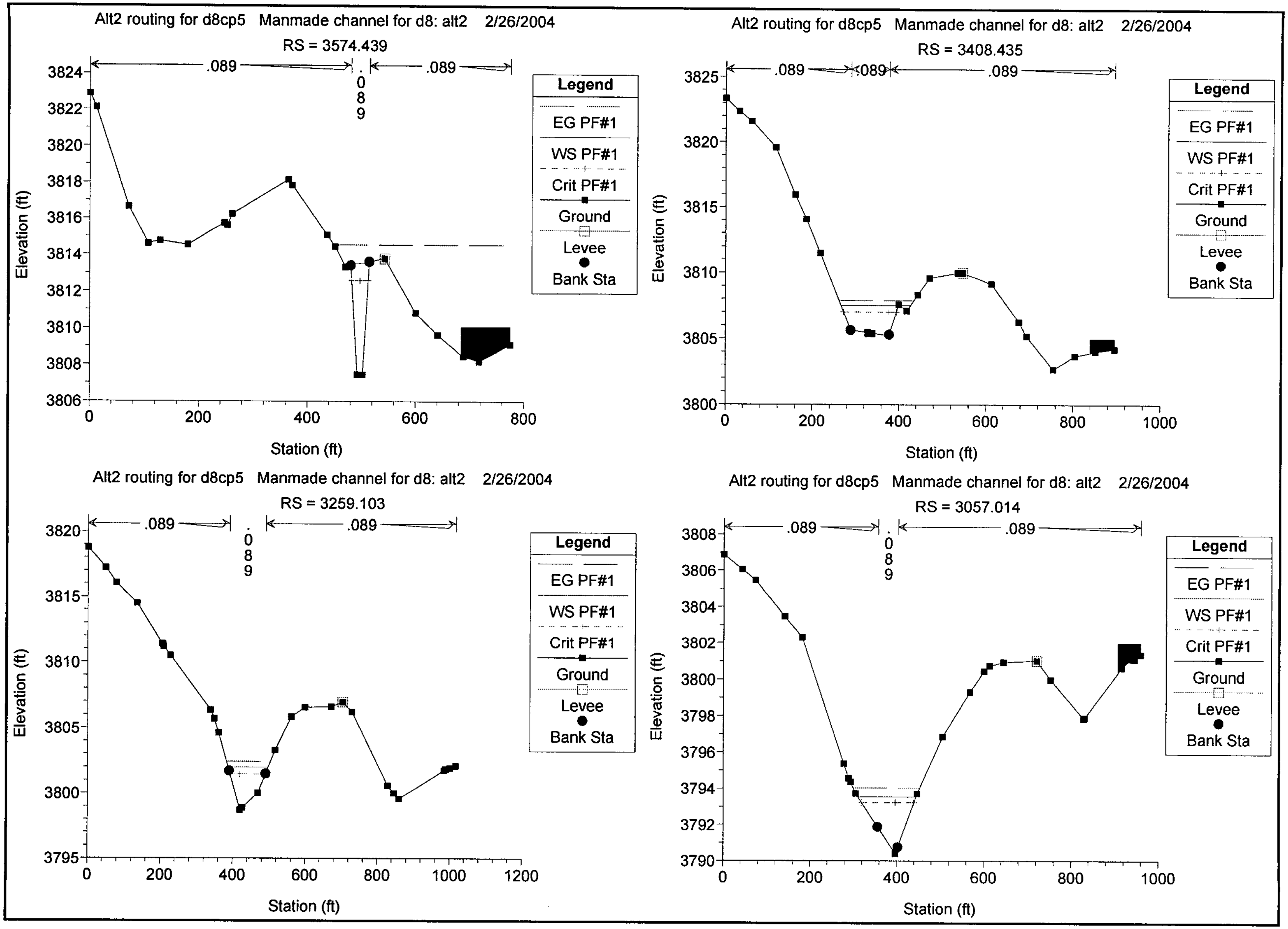
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
main
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Left Levee
Right Levee
Elevation (ft)
3840
3820
3800
3780
3760
3740
3720
3700
3680
0
1000
2000
3000
4000
5000
Main Channel Distance (ft)


Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 4431.679
.089
.089
.089
Elevation (ft)
3840
3835
3830
3825
3820
3815
3810
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 4157.539
.089
.089
.089
Elevation (ft)
3840
3835
3830
3825
3820
3815
3810
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

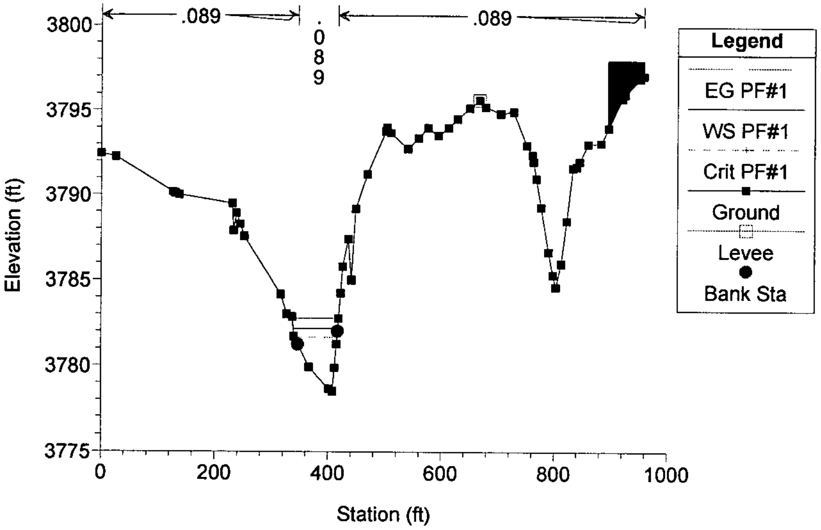

Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 3934.955
.089
.089
.089
Elevation (ft)
3835
3830
3825
3820
3815
3810
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 3744.804
.089
.089
.089
Elevation (ft)
3835
3830
3825
3820
3815
3810
3805
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta


Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 3574.439
.089
.089
.089
3824
3822
3820
3818
3816
3814
3812
3810
3808
3806
Elevation (ft)
0
200
400
600
800
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 3408.435
.089
.089
.089
3825
3820
3815
3810
3805
3800
Elevation (ft)
0
200
400
600
800
1000
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 3259.103
.089
.089
.089
3820
3815
3810
3805
3800
3795
Elevation (ft)
0
200
400
600
800
1000
1200
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 3057.014
.089
.089
.089
3808
3806
3804
3802
3800
3798
3796
3794
3792
3790
Elevation (ft)
0
200
400
600
800
1000
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

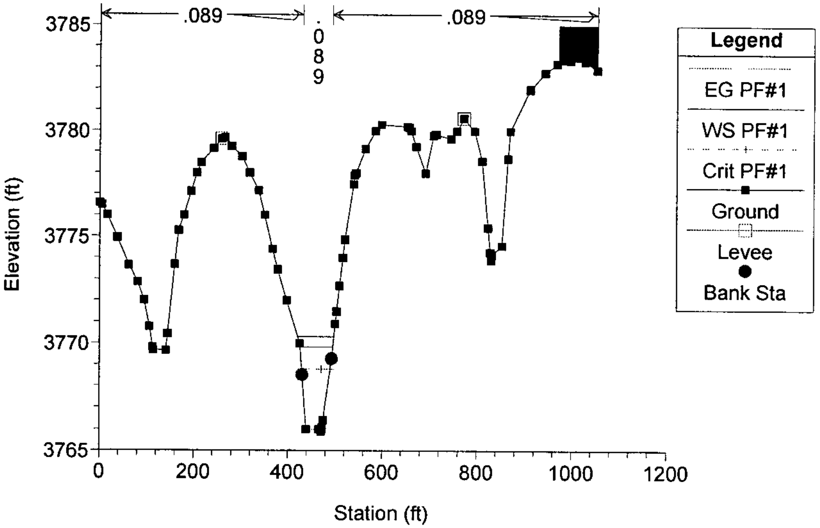
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004

RS = 2801.107



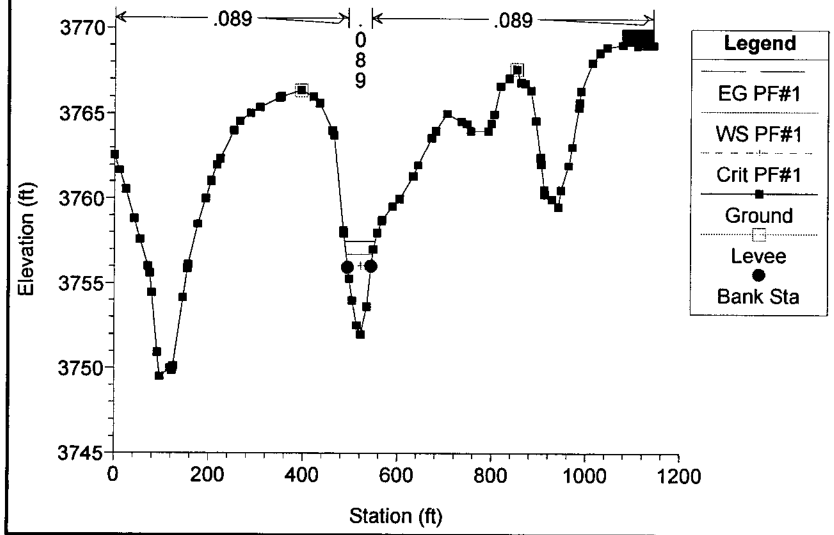
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004

RS = 2440.716



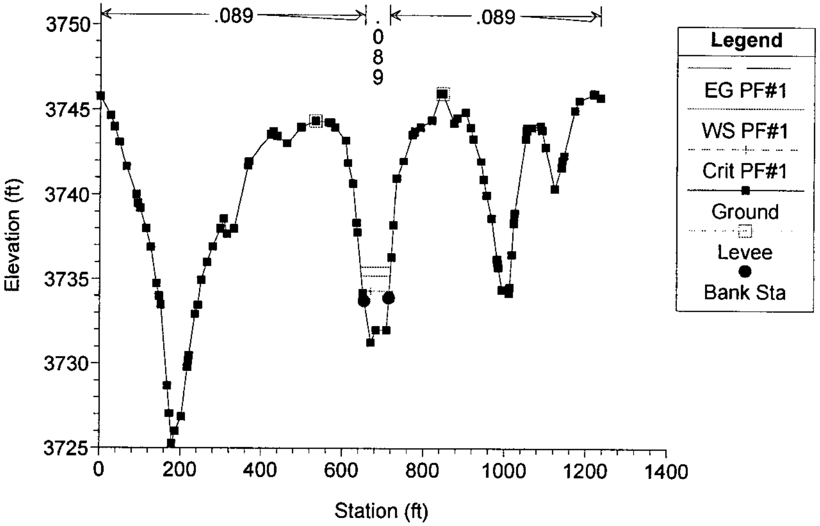
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004

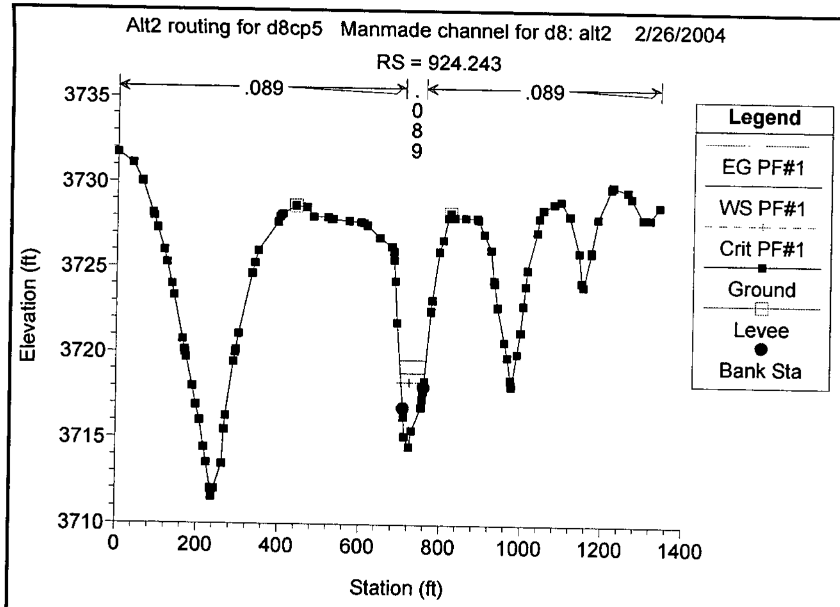
RS = 2045.932

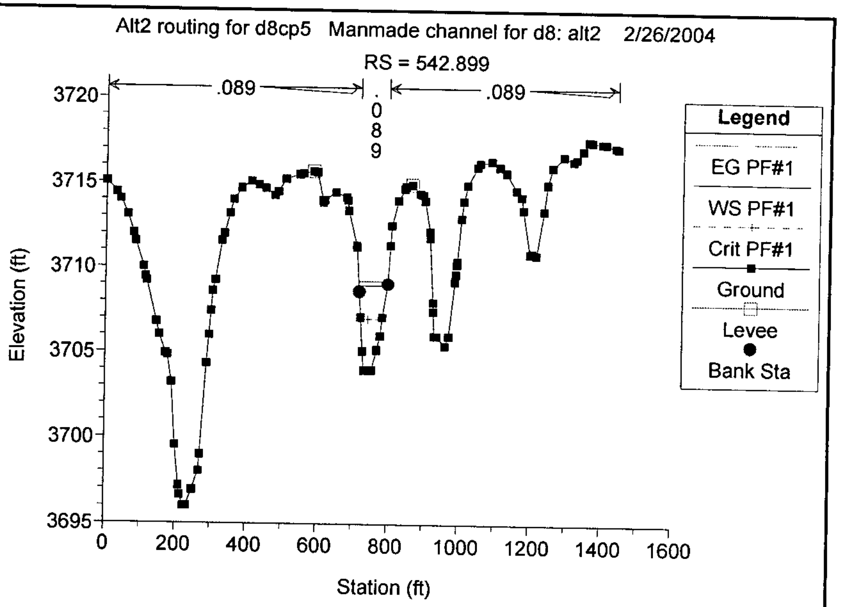


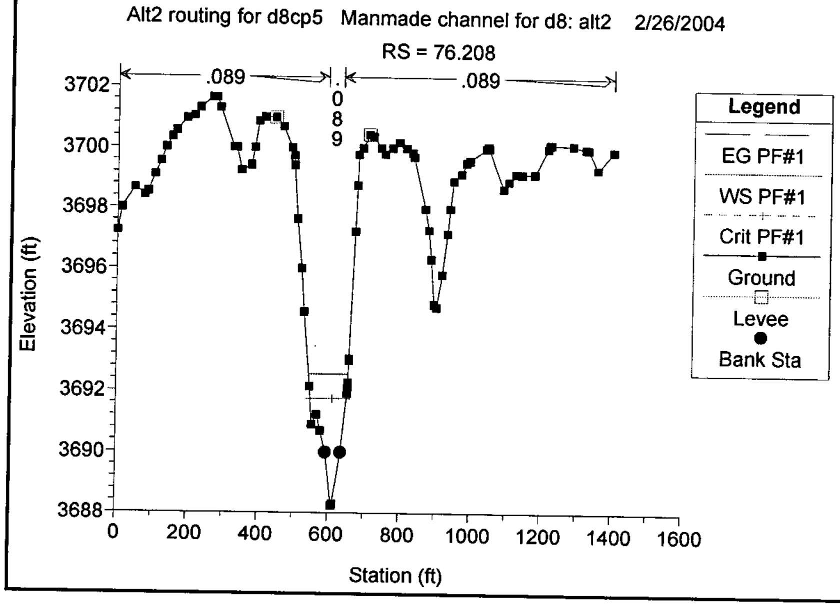
Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004

RS = 1394.165



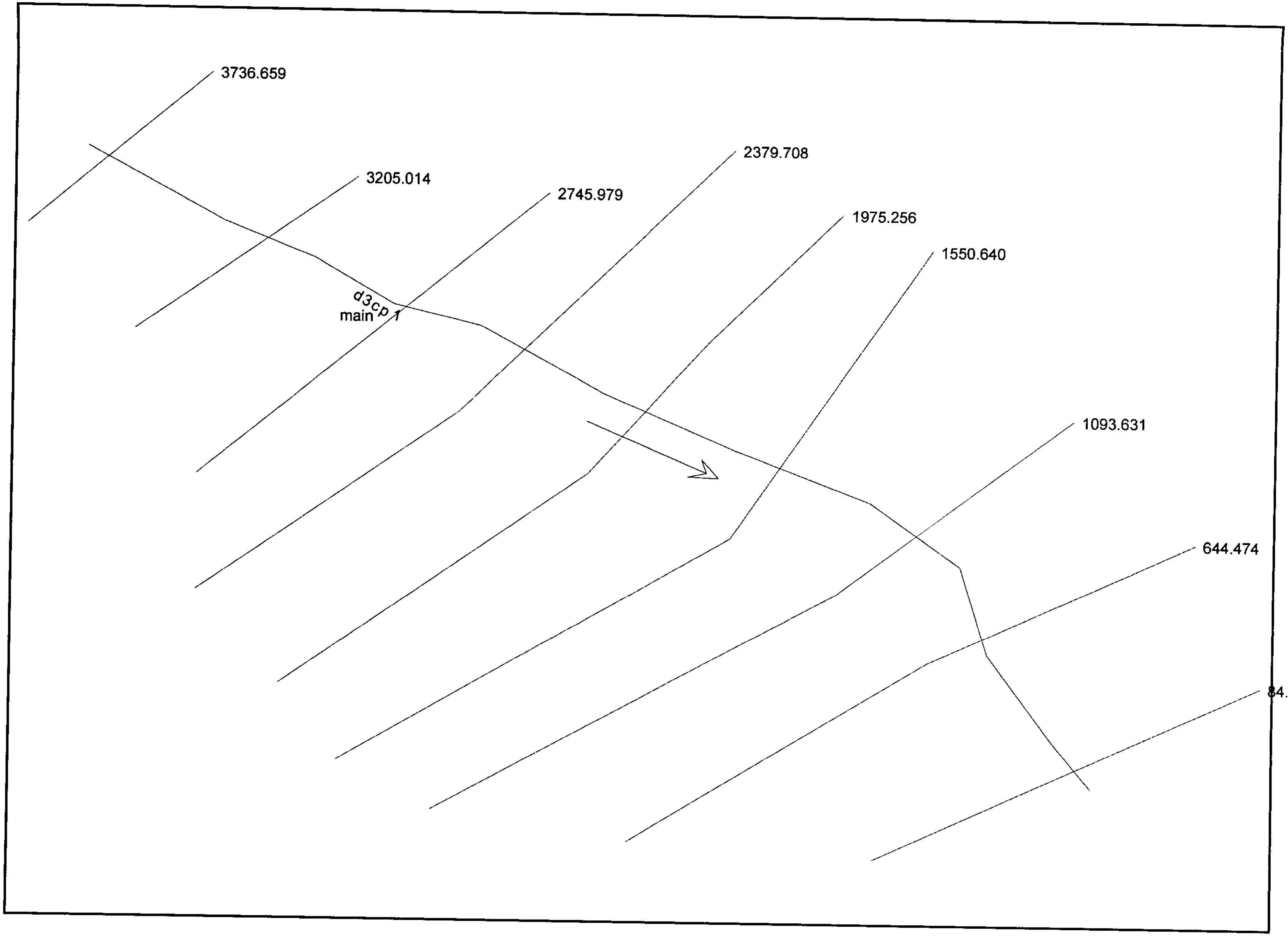

Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 924.243
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3735
3730
3725
3720
3715
3710
Station (ft)
0
200
400
600
800
1000
1200
1400


Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 542.899
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3720
3715
3710
3705
3700
3695
Station (ft)
0
200
400
600
800
1000
1200
1400
1600


Alt2 routing for d8cp5 Manmade channel for d8: alt2 2/26/2004
RS = 76.208
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3702
3700
3698
3696
3694
3692
3690
3688
Station (ft)
0
200
400
600
800
1000
1200
1400
1600

Attachment 19: Hydraulic Calculations for Routing Around North Construction Portal, Alternative 2

(Document ID: 000-00C-CD04-00100-000-00A)

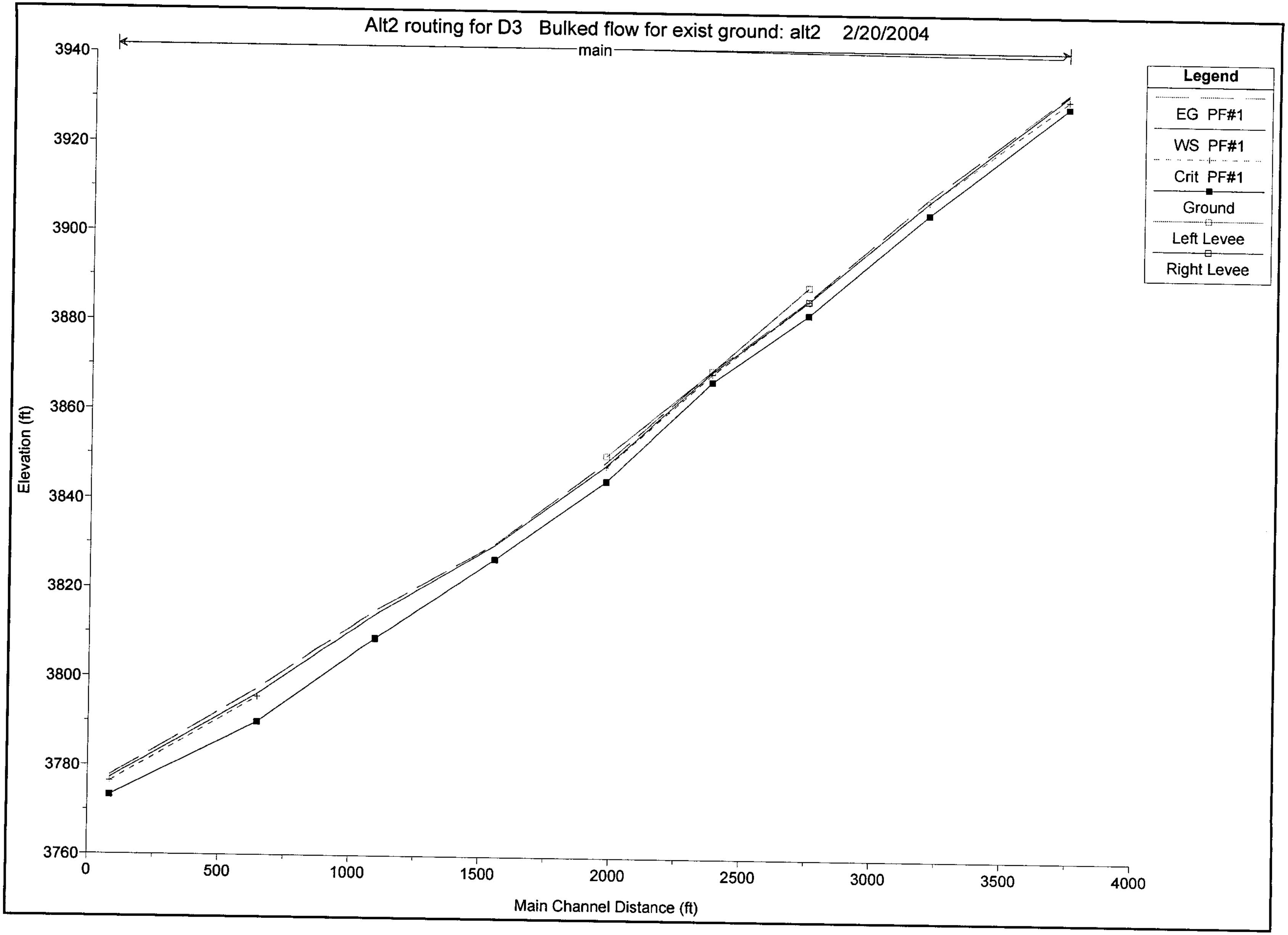

3736.659
3205.014
2745.979
2379.708
1975.256
1550.640
1093.631
644.474
84.385
d3cp 1
main

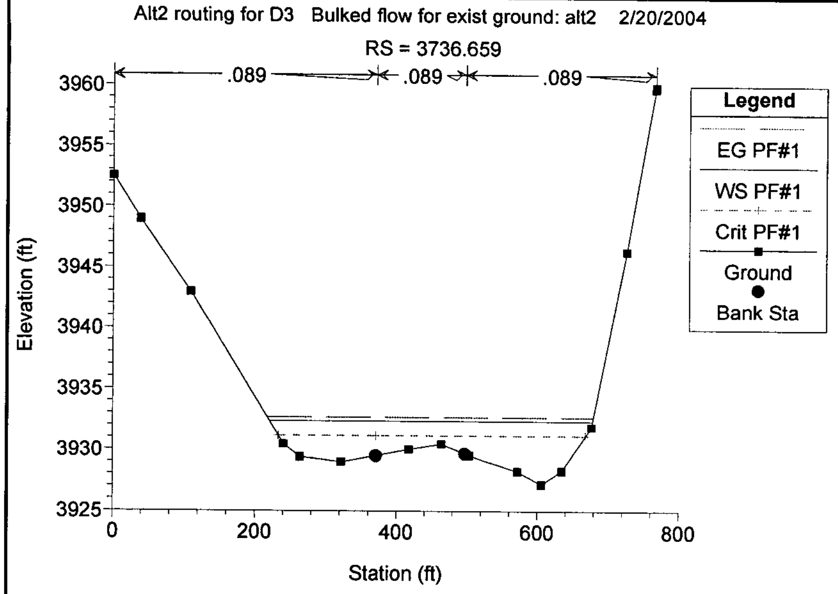
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: A2-D3  River: d3cp1  Reach: main

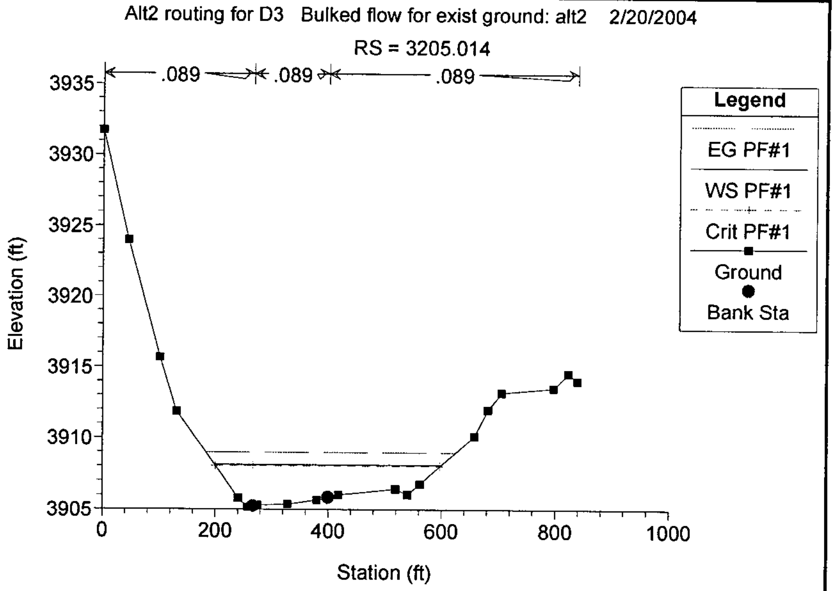
# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 9
# Plans             = 1
# Profiles          = 1

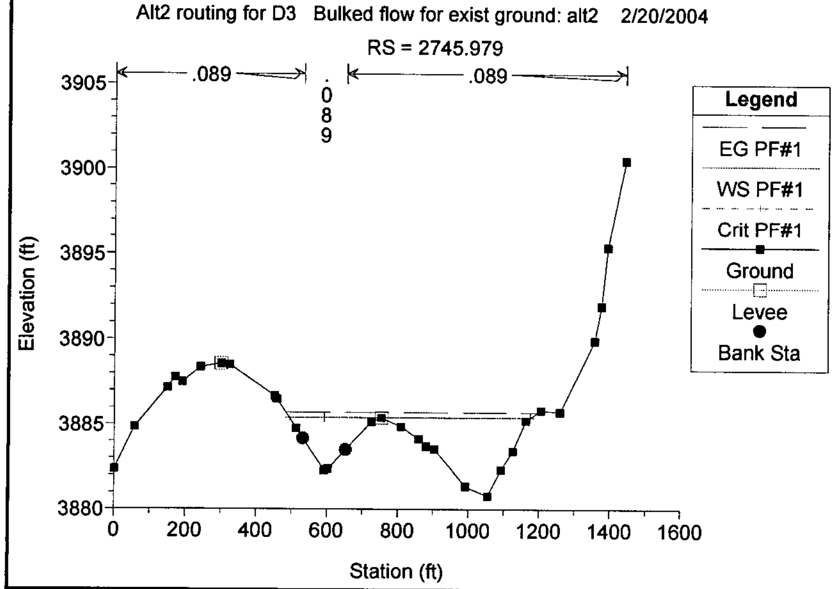
 Reach         River Sta         Q Total  Min Ch El  W.S. Elev  Crit W.S.   E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                  (cfs)      (ft)       (ft)       (ft)        (ft)     (ft/ft)     (ft/s)    (sq ft)      (ft)

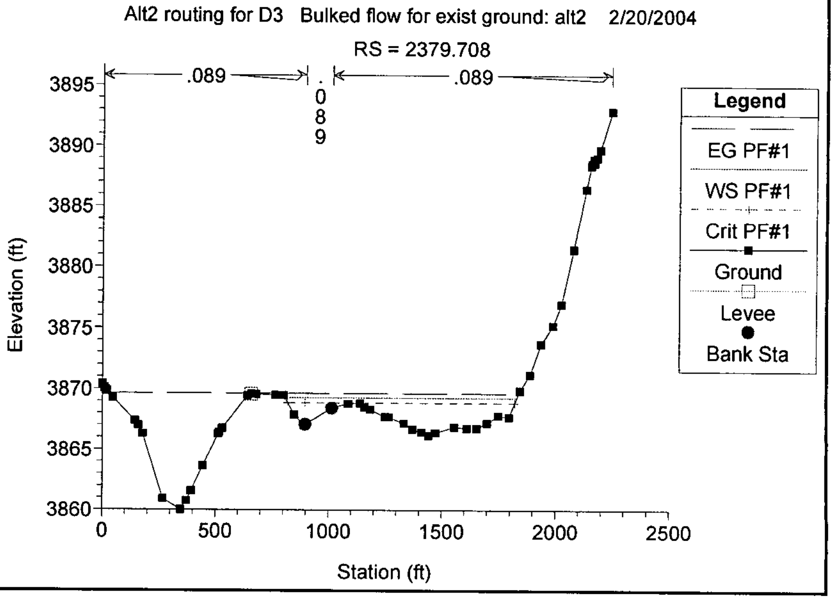
 main          3736.659          5800.00    3929.48    3932.32    3931.13    3932.62   0.015351       3.62    1344.61     457.65          0.42
 main          3205.014          5800.00    3905.25    3908.10    3908.02    3908.99   0.073431       8.59     791.40     400.40          0.94
 main          2745.979          5800.00    3882.28    3885.41    3885.41    3885.71   0.027046       4.88    1328.21     682.88          0.56
 main          2379.708          8650.00    3867.08    3869.28    3868.85    3869.65   0.040791       4.45    1771.86    1023.70          0.64
 main          1975.256          8650.00    3844.68    3848.18    3847.91    3848.95   0.061402       6.07    1262.63     635.92          0.80
 main          1550.640          8650.00    3826.82    3829.94               3830.25   0.025824       4.47    1942.50     922.80          0.54
 main          1093.631          8650.00    3808.81    3814.15               3815.08   0.040280       9.00    1254.51     582.66          0.76
 main          644.474           8650.00    3789.90    3796.18    3795.50    3797.37   0.038413       8.70    1011.72     305.15          0.74
 main          84.385            8650.00    3773.28    3777.18    3776.41    3777.74   0.030999       6.38    1446.63     585.80          0.63
```

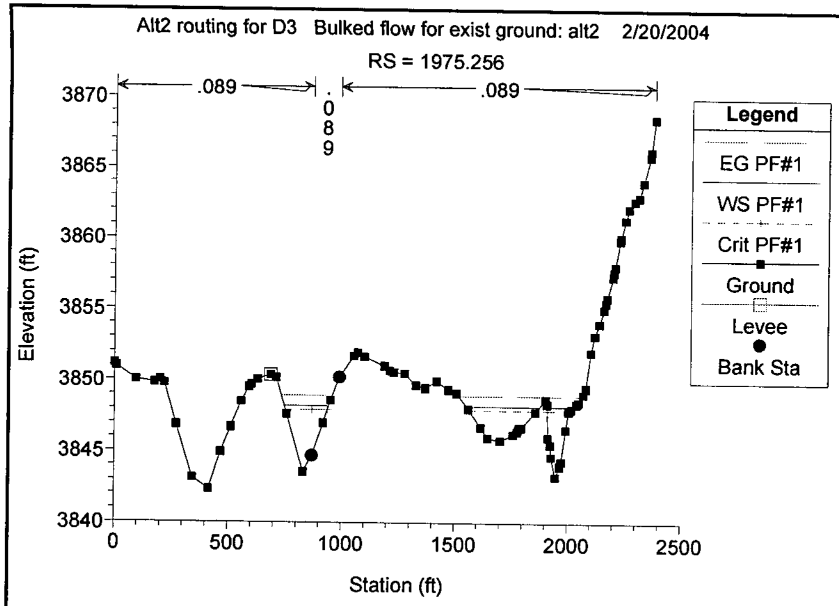

Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004
main
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Left Levee
Right Levee
Elevation (ft)
3940
3920
3900
3880
3860
3840
3820
3800
3780
3760
0
500
1000
1500
2000
2500
3000
3500
4000
Main Channel Distance (ft)


Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004
RS = 3736.659
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3960
3955
3950
3945
3940
3935
3930
3925
0
200
400
600
800
Station (ft)


Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004
RS = 3205.014
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3935
3930
3925
3920
3915
3910
3905
0
200
400
600
800
1000
Station (ft)

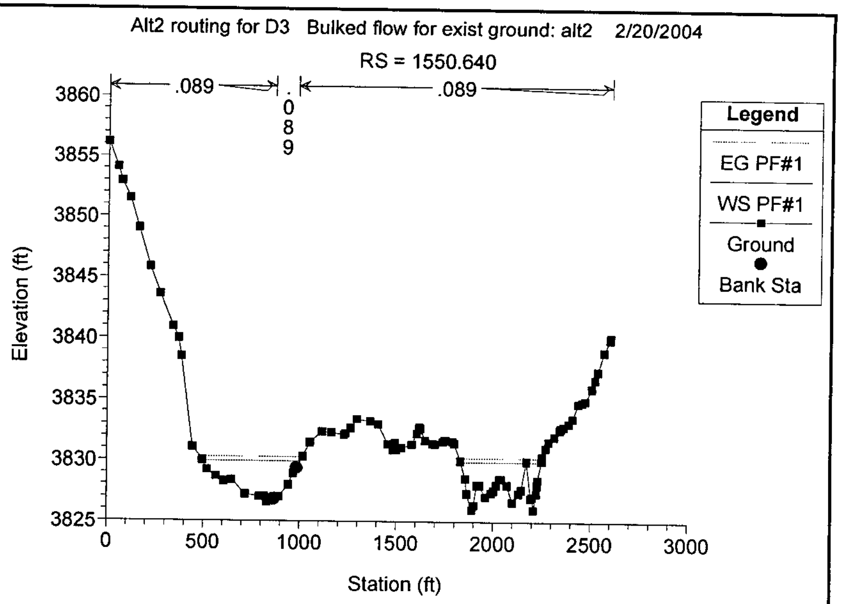

Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004
RS = 2745.979
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3905
3900
3895
3890
3885
3880
0
200
400
600
800
1000
1200
1400
1600
Station (ft)


Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004
RS = 2379.708
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3895
3890
3885
3880
3875
3870
3865
3860
0
500
1000
1500
2000
2500
Station (ft)



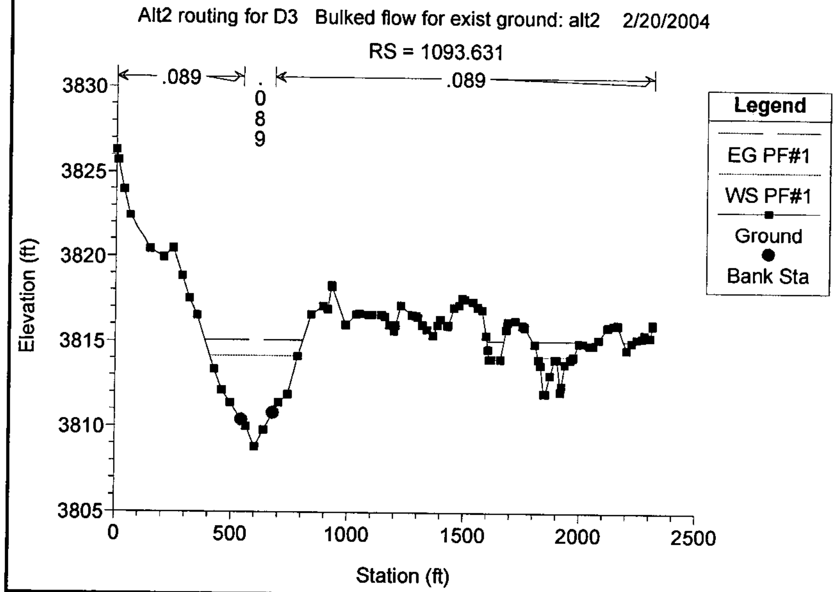
Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004

RS = 1975.256



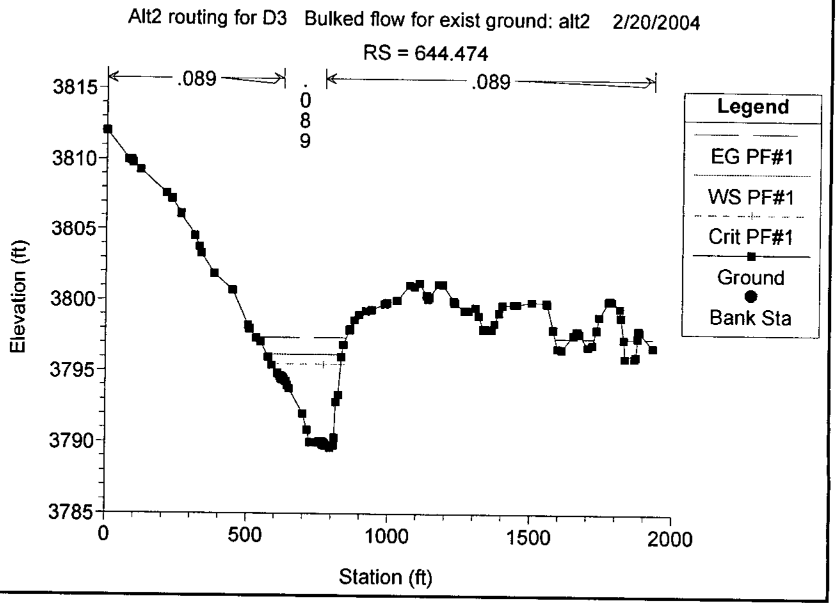
Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004

RS = 1550.640



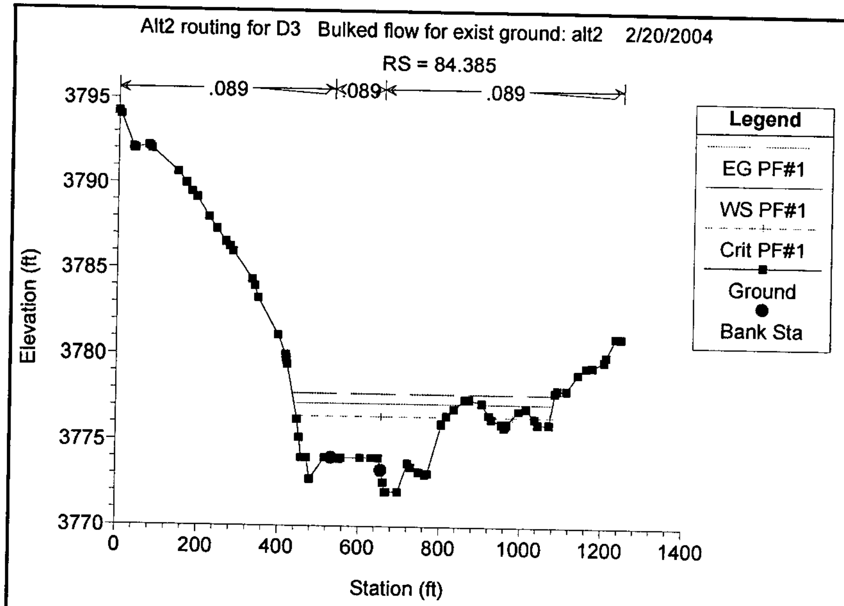
Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004

RS = 1093.631



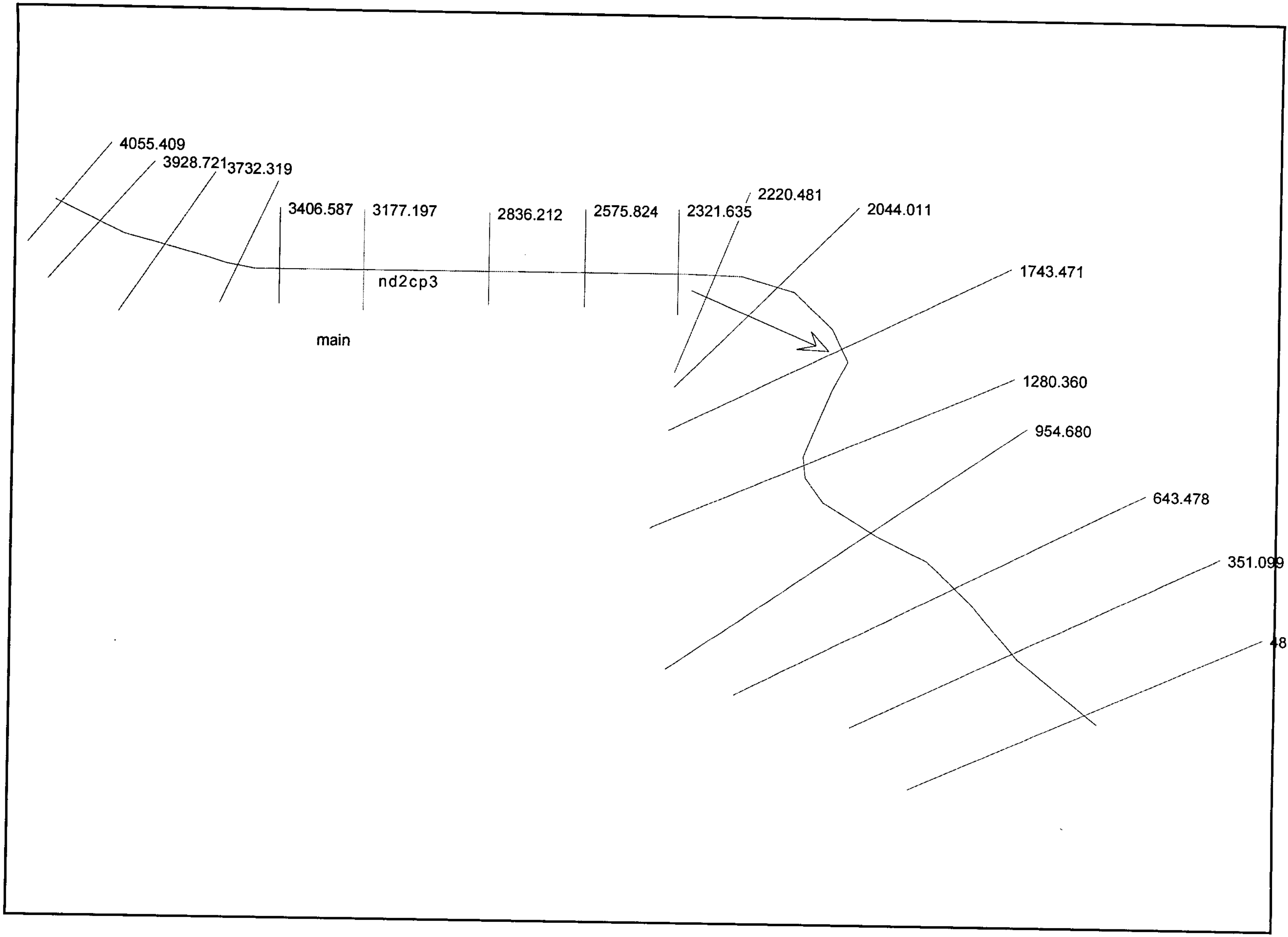
Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004

RS = 644.474


Alt2 routing for D3 Bulked flow for exist ground: alt2 2/20/2004
RS = 84.385
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3795
3790
3785
3780
3775
3770
Station (ft)
0
200
400
600
800
1000
1200
1400

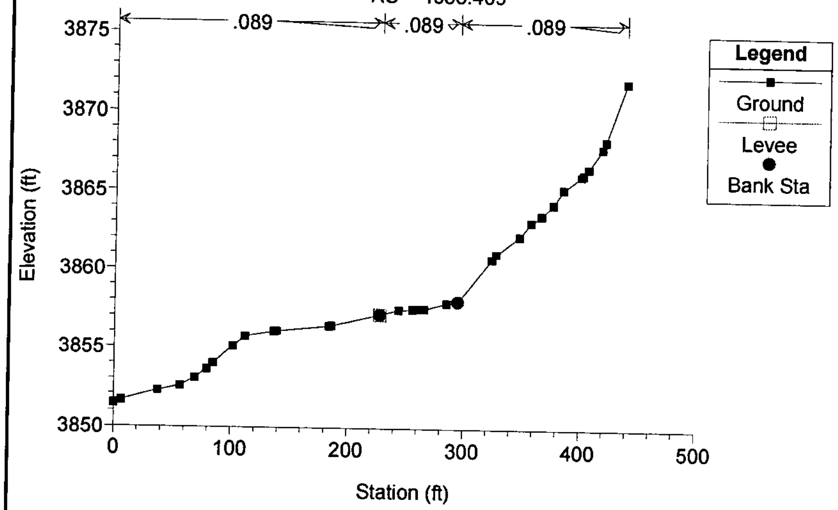
Attachment 20: Hydraulic Calculations for Routing North of Aging Facility, Alternative 2

(Document ID: 000-00C-CD04-00100-000-00A)

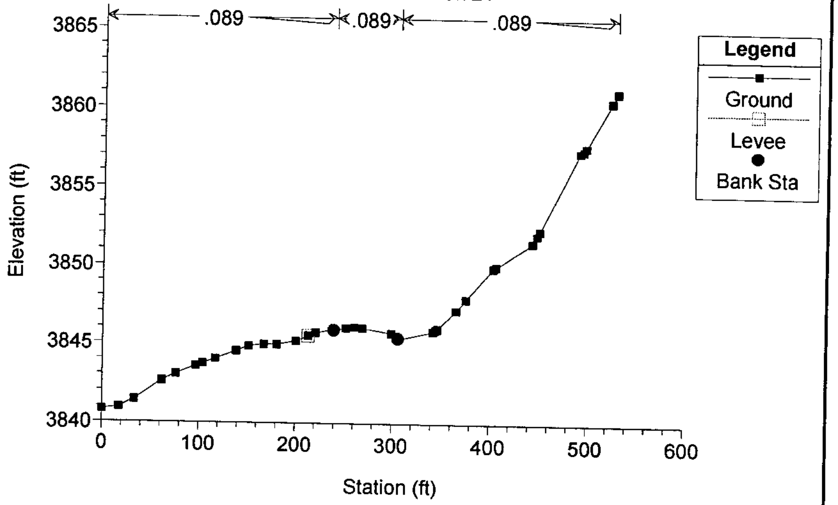


Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A

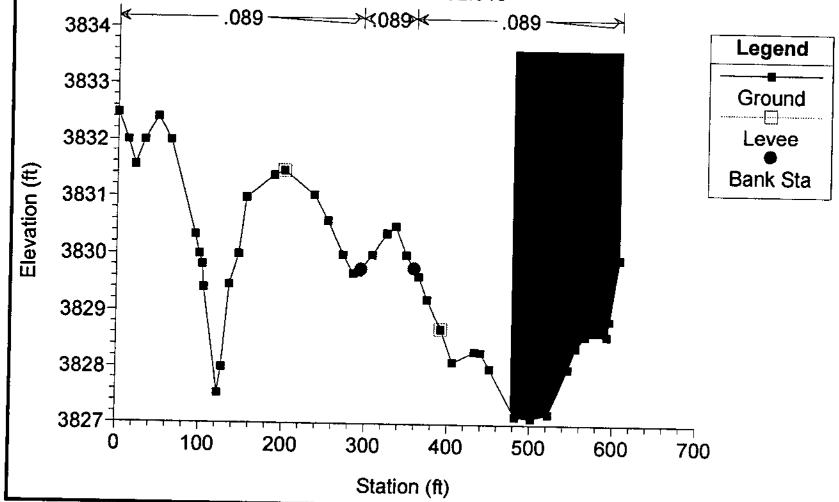
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 4055.409



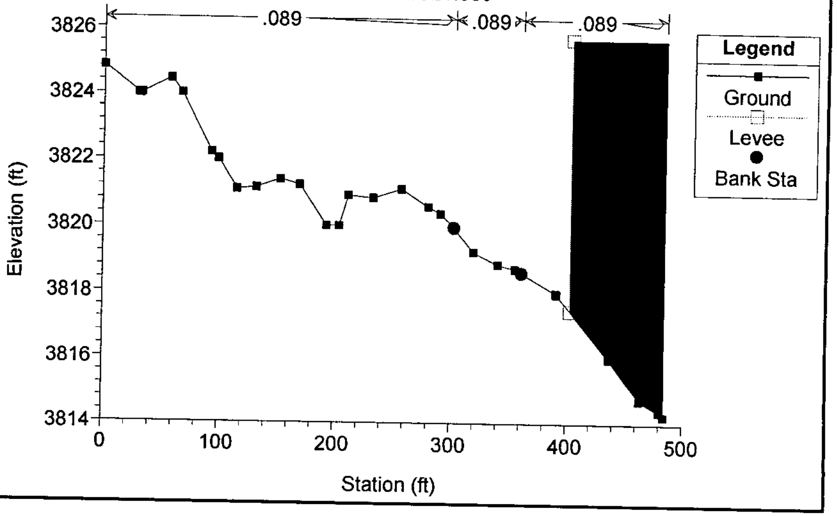
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 3928.721

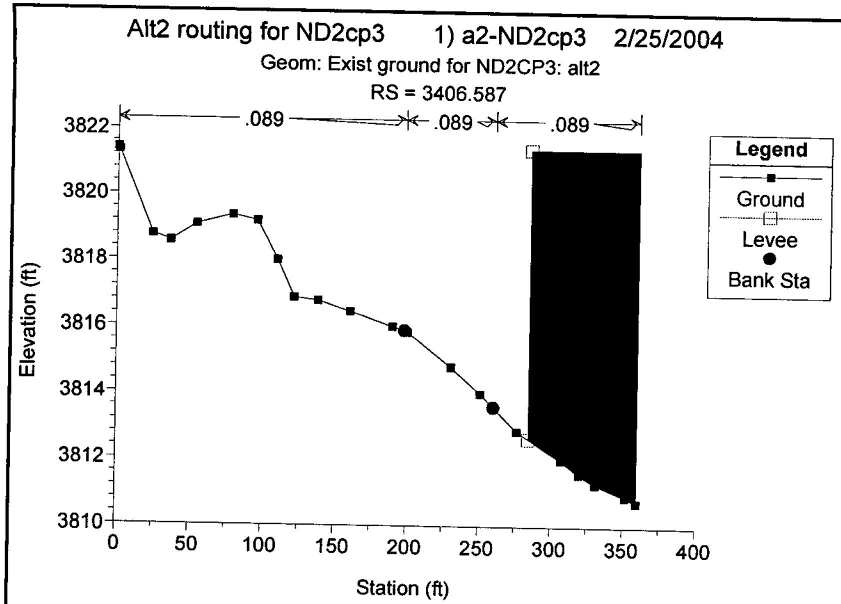


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 3732.319



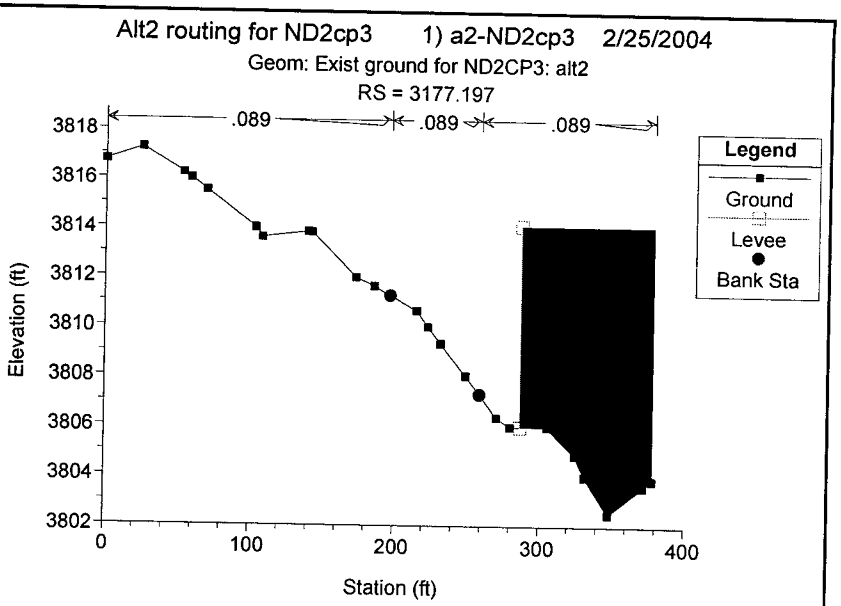
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 3521.369




Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004

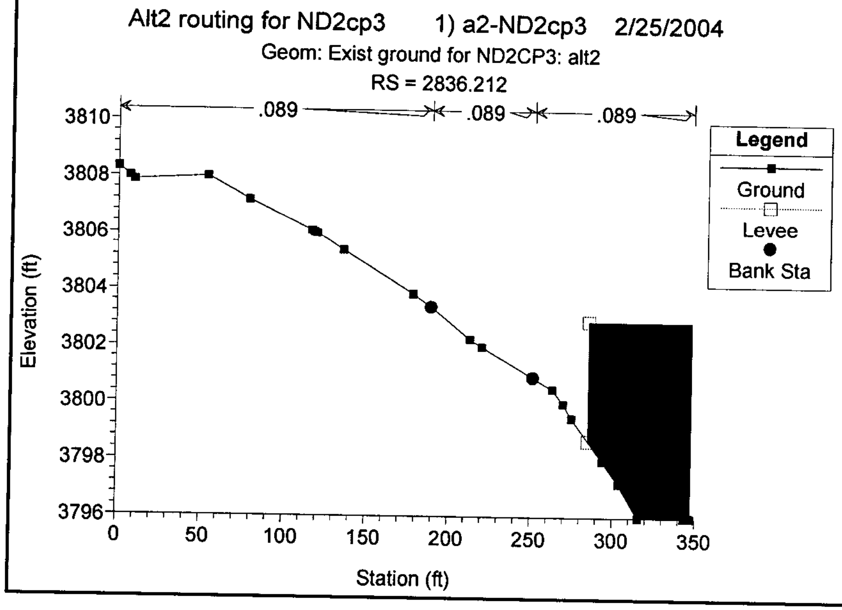
Geom: Exist ground for ND2CP3: alt2

RS = 3406.587


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004

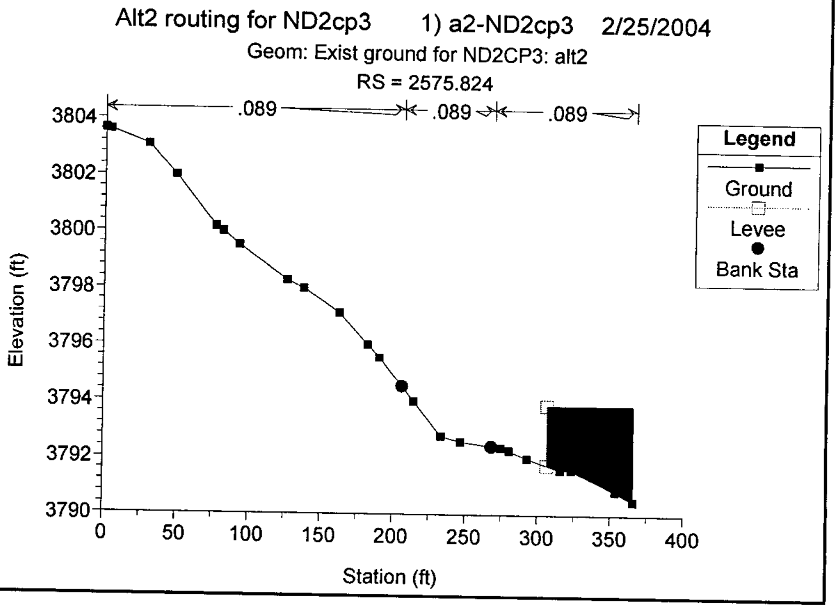
Geom: Exist ground for ND2CP3: alt2

RS = 3177.197


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004

Geom: Exist ground for ND2CP3: alt2

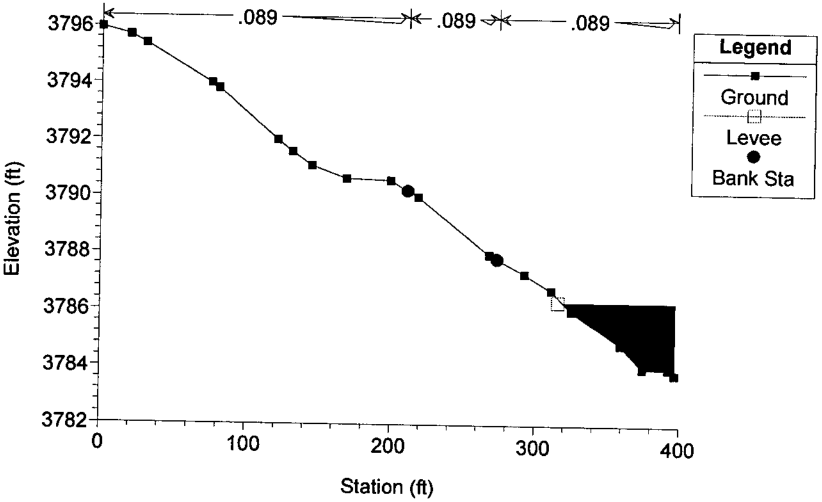
RS = 2836.212


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004

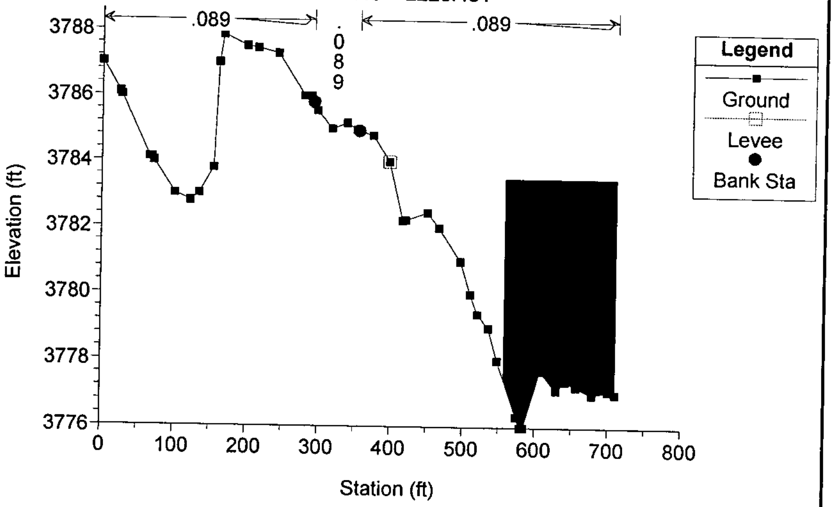
Geom: Exist ground for ND2CP3: alt2

RS = 2575.824

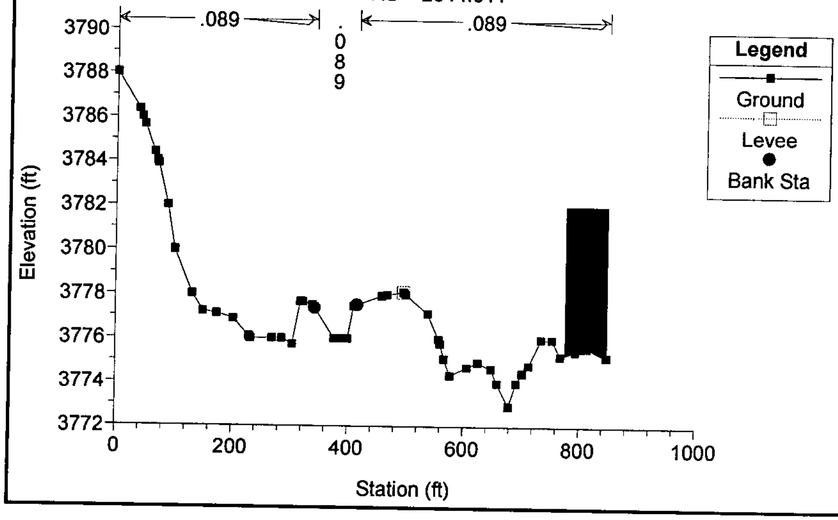
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 2321.635



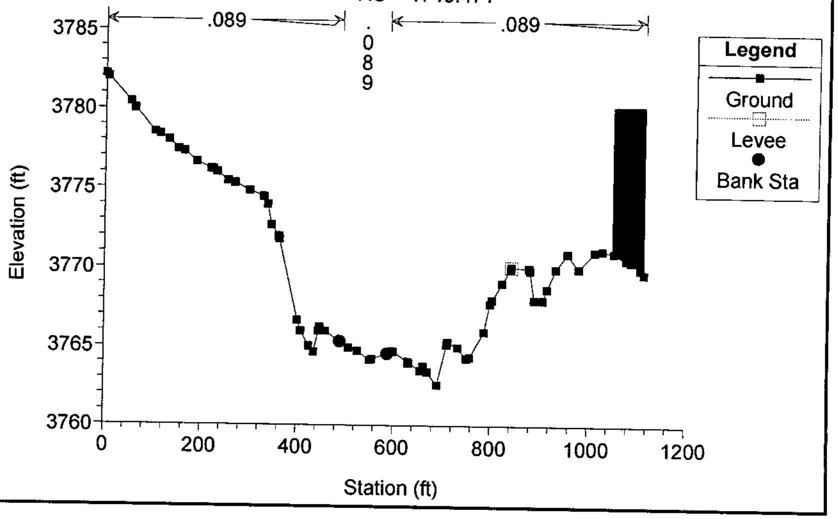
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 2220.481

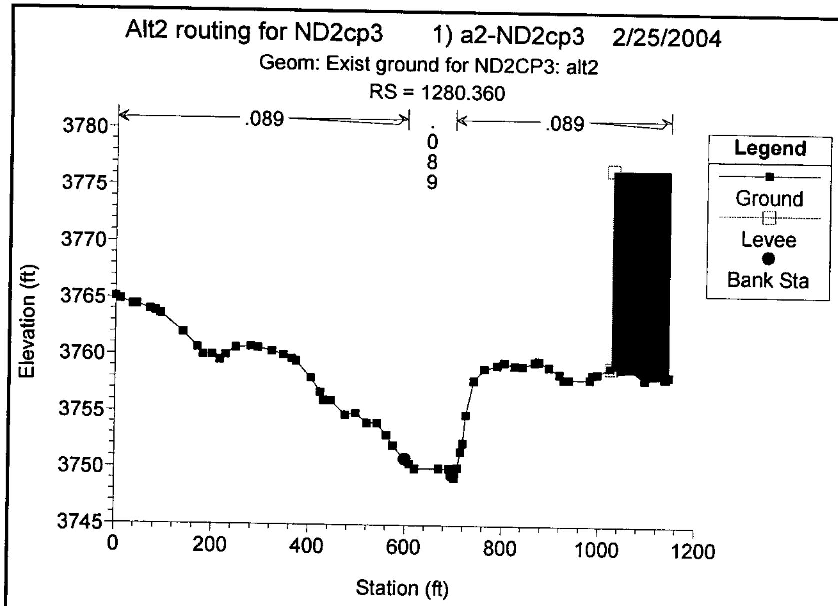


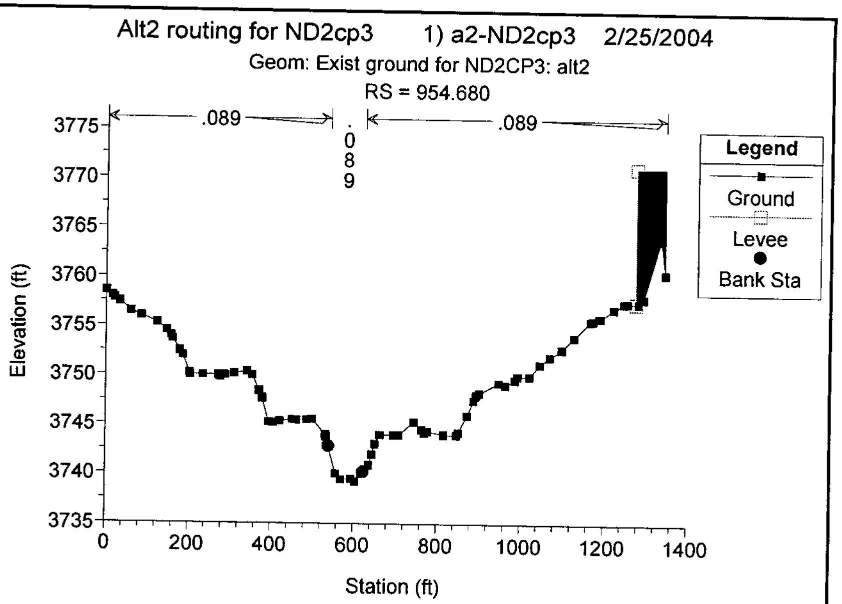
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 2044.011

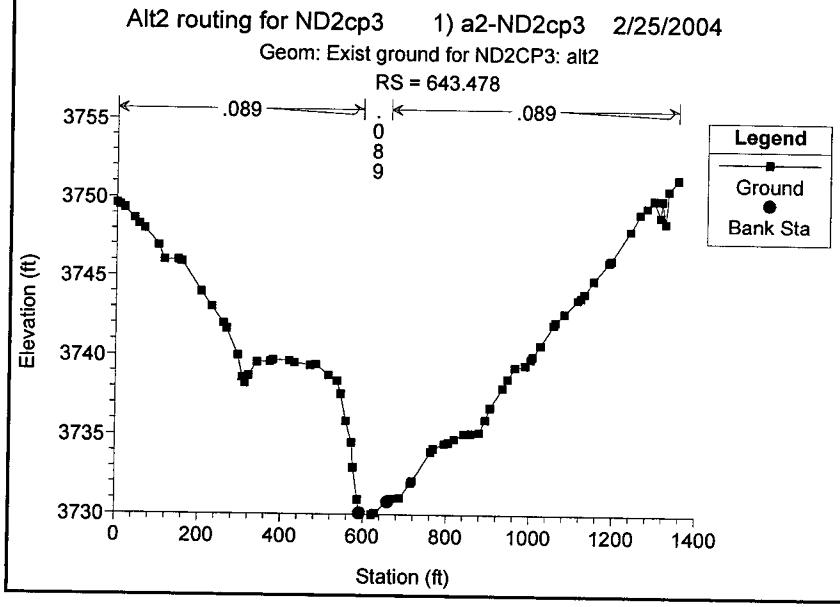


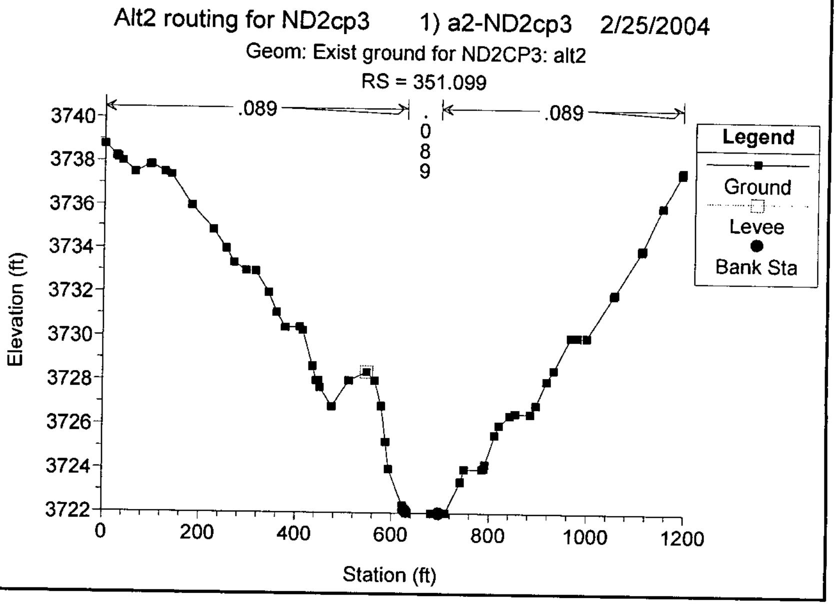
Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 1743.471

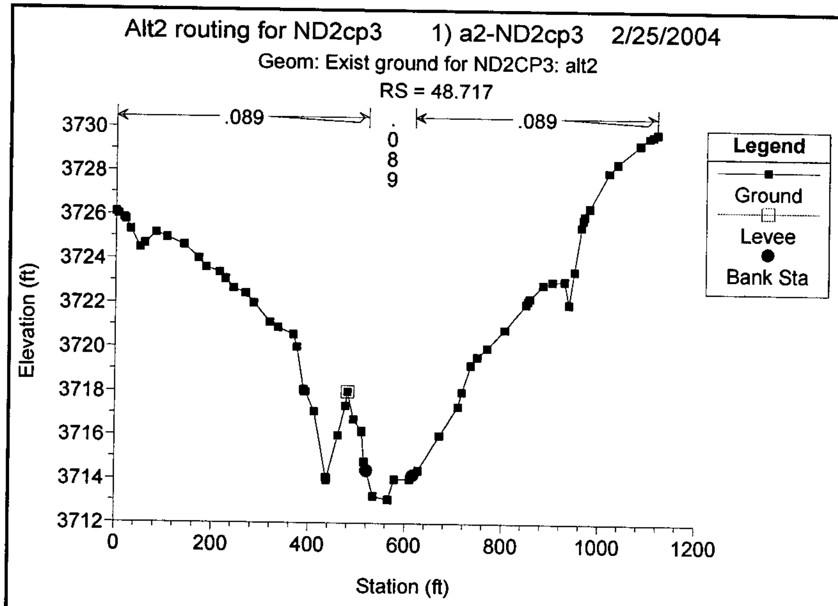



Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 1280.360


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 954.680


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 643.478


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 351.099


Alt2 routing for ND2cp3 1) a2-ND2cp3 2/25/2004
Geom: Exist ground for ND2CP3: alt2
RS = 48.717
.089
.089
.089
Elevation (ft)
3730
3728
3726
3724
3722
3720
3718
3716
3714
3712
0
200
400
600
800
1000
1200
Station (ft)
Legend
Ground
Levee
Bank Sta

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: a2-ND2cp3  River: nd2cp3  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 17
# Plans             = 1
# Profiles          = 1

 Reach             River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                       (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)      (ft)

 main              4055.409           8650.00    3846.50    3856.77    3857.18    3862.08   0.099283      18.50     467.65      66.08        1.23
 main              3928.721           8650.00    3834.93    3845.63    3846.02    3850.34   0.083505      17.43     499.27      89.02        1.13
 main              3732.319           8650.00    3817.00    3827.33    3828.47    3832.55   0.097137      18.35     471.39      66.31        1.21
 main              3521.369           8650.00    3805.02    3816.56    3816.50    3820.33   0.062313      15.60     554.54      71.14        0.98
 main              3406.587           8650.00    3798.50    3812.63    3809.91    3814.68   0.027209      11.50     752.25      81.50        0.67
 main              3177.197           8650.00    3792.26    3806.39    3803.67    3808.44   0.027153      11.49     752.83      81.53        0.67
 main              2836.212           8650.00    3782.99    3797.12    3794.40    3799.17   0.027206      11.50     752.31      81.51        0.67
 main              2575.824           8650.00    3775.90    3790.01    3787.30    3792.07   0.027302      11.51     751.32      81.46        0.67
 main              2321.635           8650.00    3768.99    3783.20    3780.41    3785.21   0.026565      11.40     758.96      81.84        0.66
 main              2220.481           8650.00    3766.24    3780.64    3777.66    3782.58   0.025126      11.17     774.70      82.59        0.64
 main              2044.011           8650.00    3761.44    3774.71    3772.87    3777.19   0.035252      12.65     683.76      78.08        0.75
 main              1743.471           8650.00    3758.00    3767.73    3766.90    3768.41   0.019566       7.96    1434.26     406.11        0.59
 main              1280.360           8650.00    3749.40    3756.27    3755.50    3757.37   0.027968       9.44    1141.80     305.37        0.67
 main              954.680            8650.00    3739.21    3746.18    3746.18    3747.35   0.033468      10.31    1220.39     486.96        0.73
 main              643.478            8650.00    3730.00    3736.78    3735.97    3737.59   0.023636       9.00    1314.49     355.71        0.62
 main              351.099            8650.00    3722.00    3727.51    3726.33    3728.59   0.037894      10.14    1125.98     339.22        0.76
 main              48.717             8650.00    3713.07    3720.90    3718.42    3721.27   0.009155       5.98    1954.03     472.95        0.39
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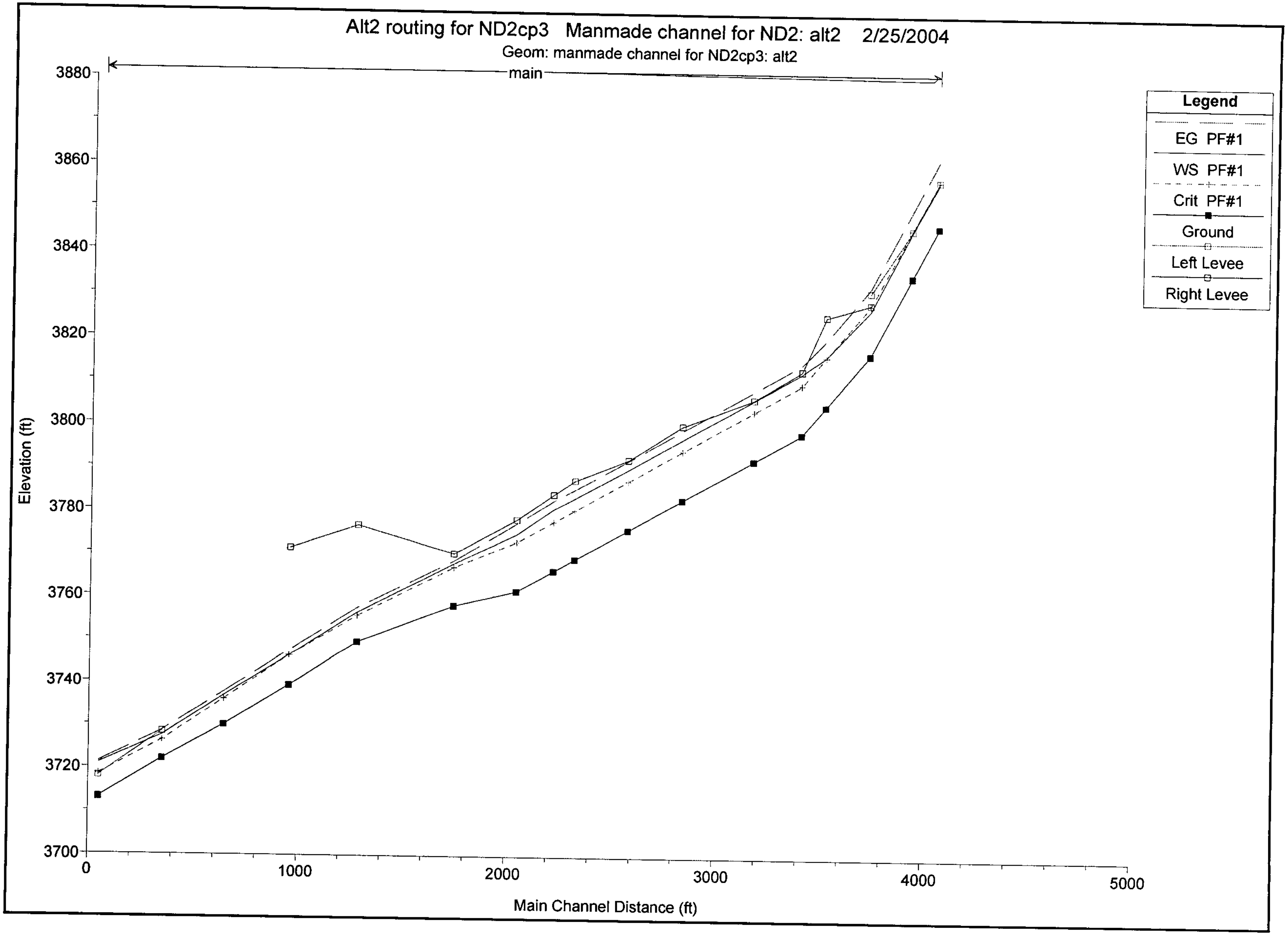
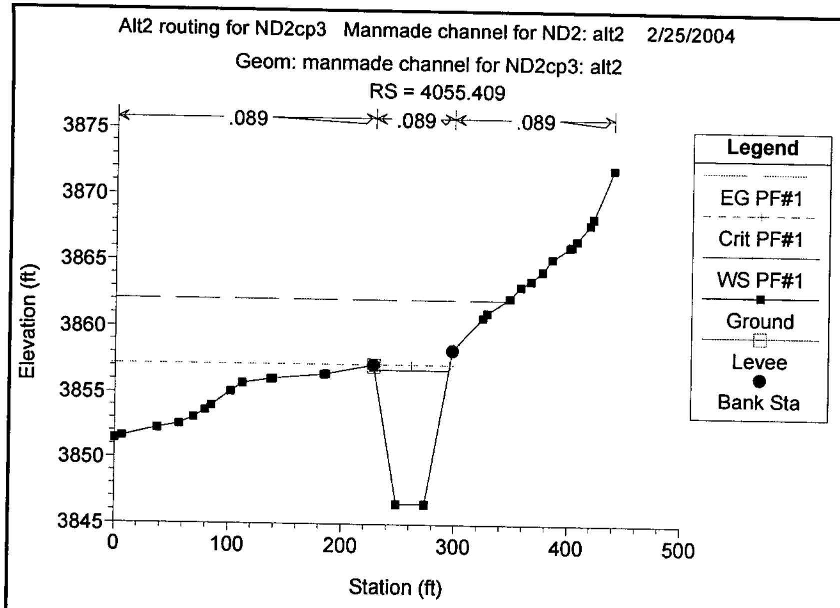
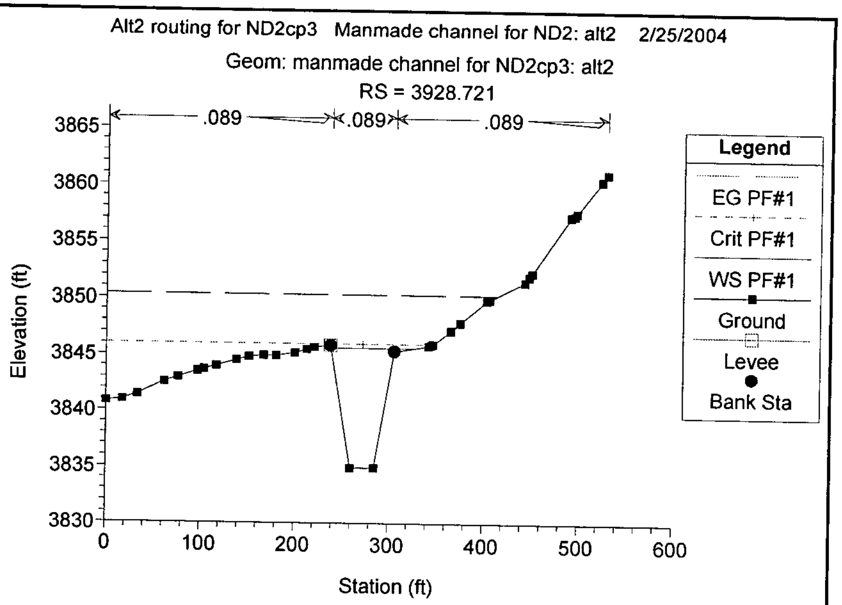
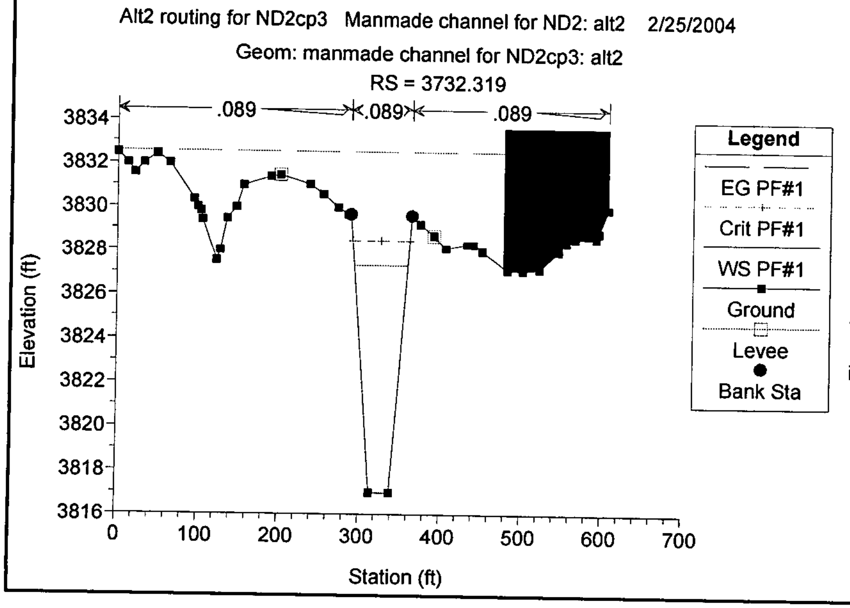
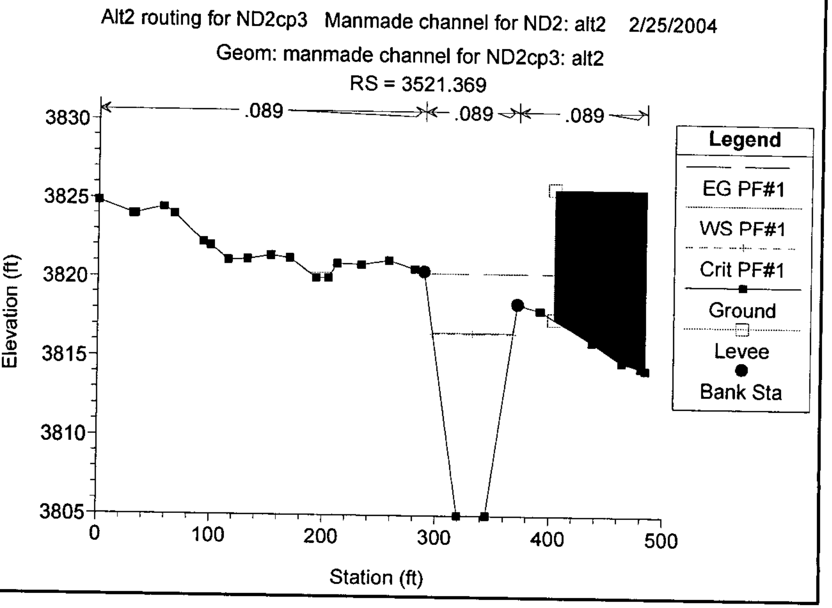


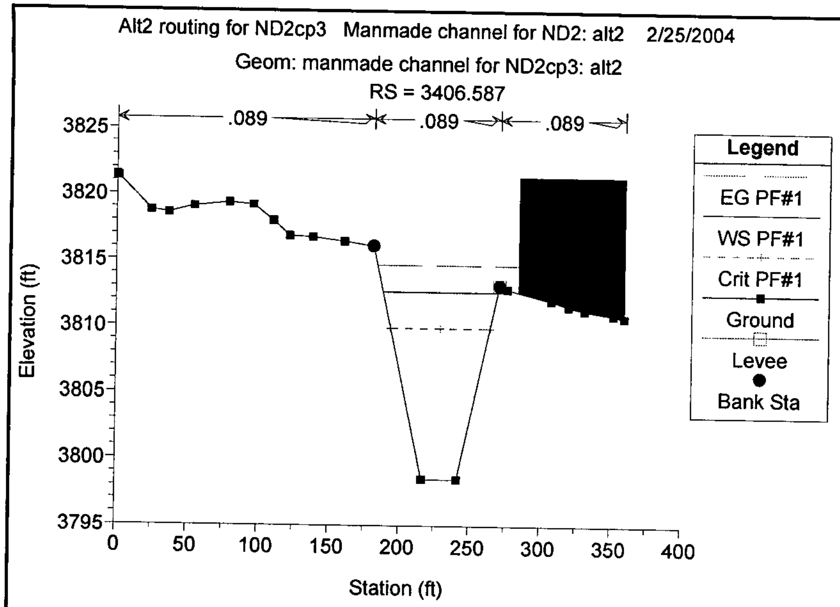
Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A

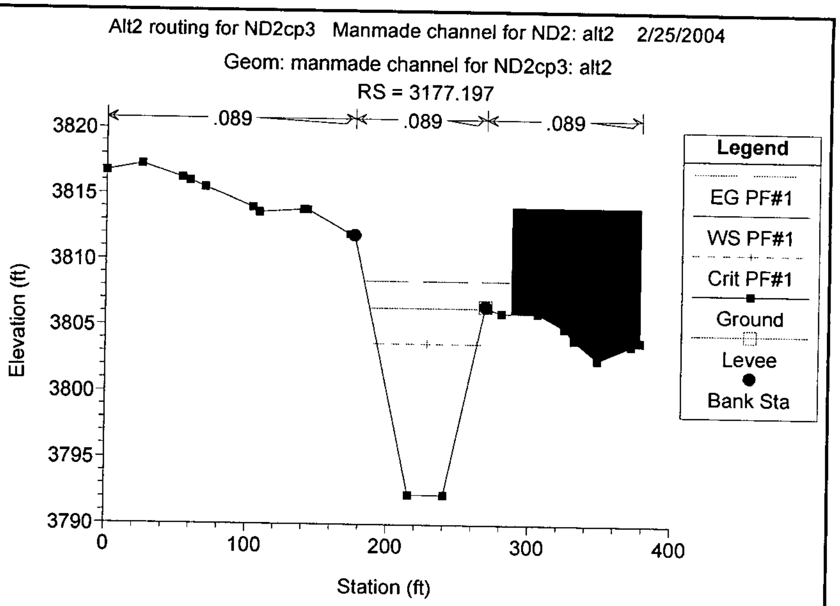

Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 4055.409

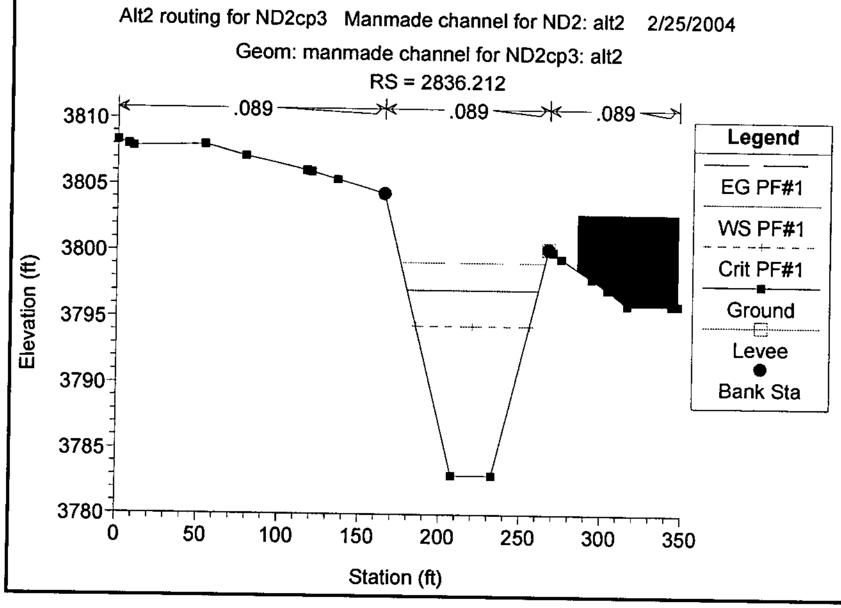

Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 3928.721

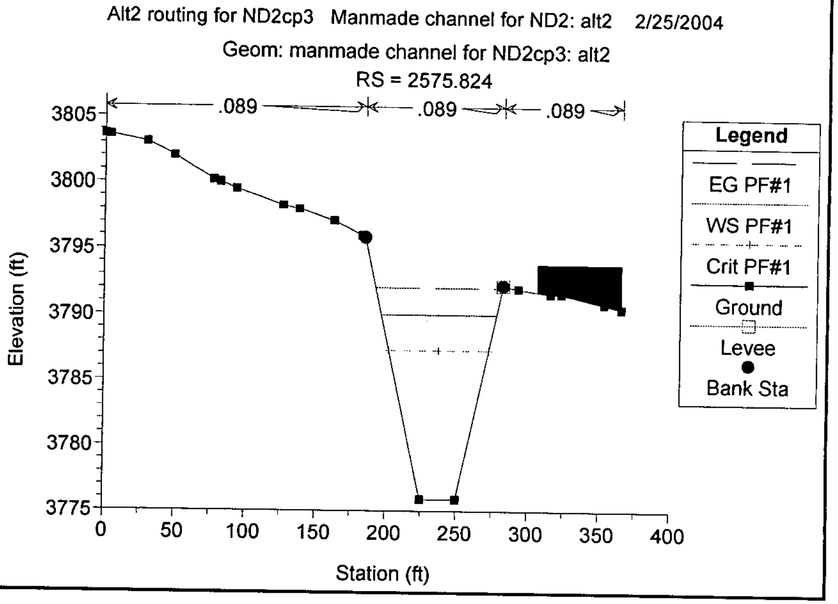

Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 3732.319

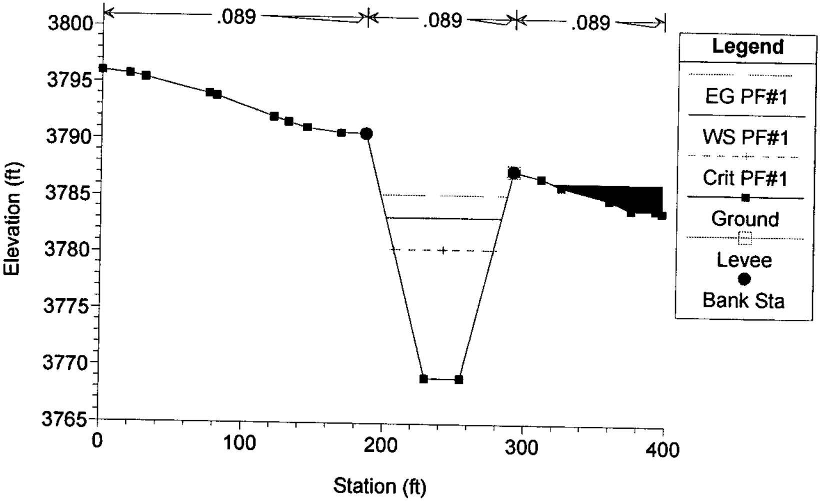

Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 3521.369


Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 3406.587


Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 3177.197


Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 2836.212

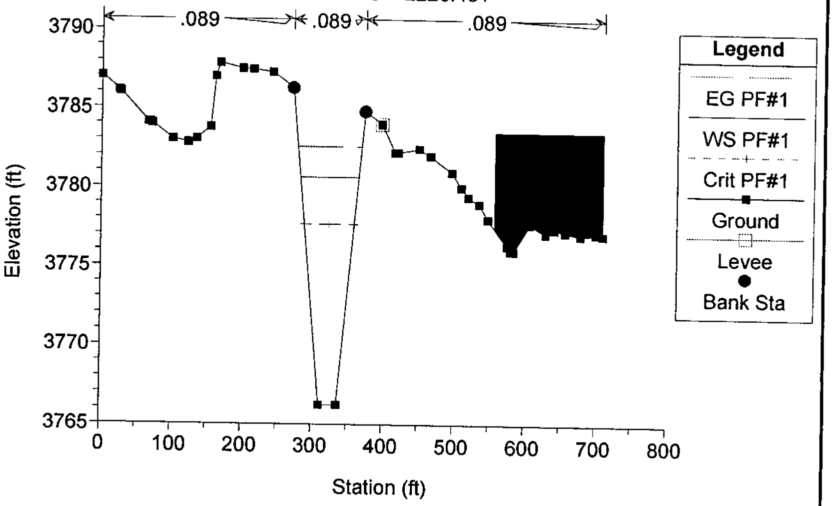

Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 2575.824



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

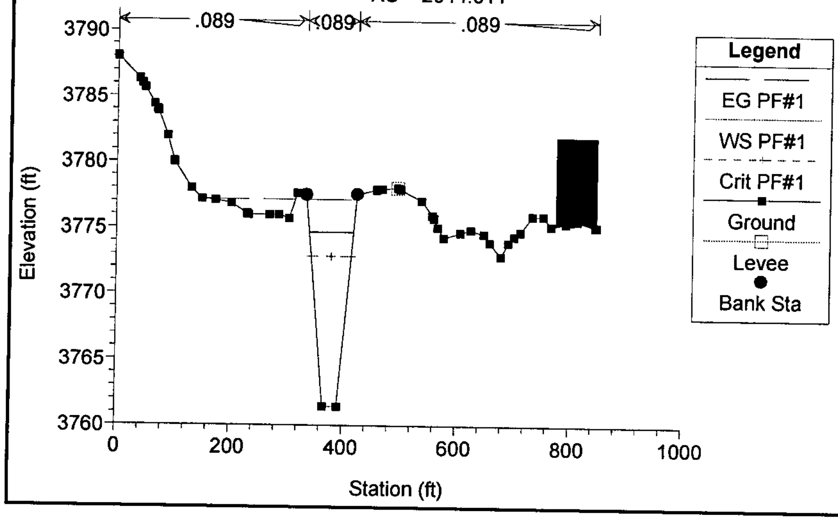
RS = 2321.635



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

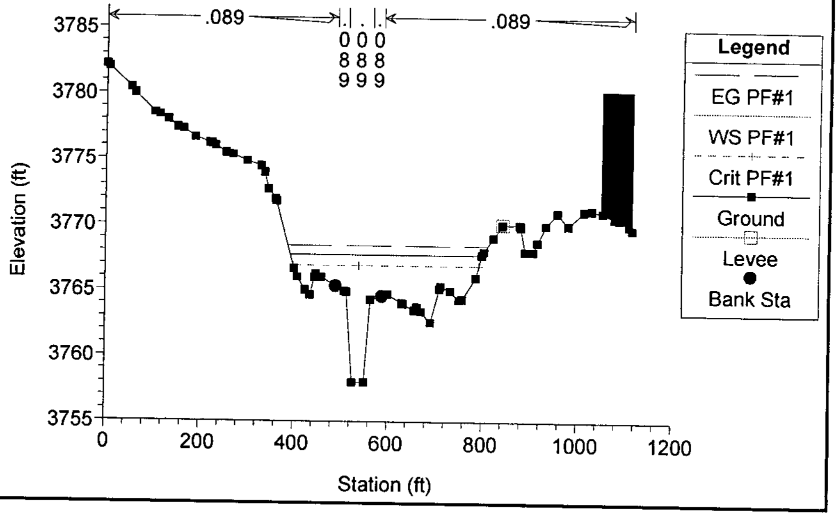
RS = 2220.481



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

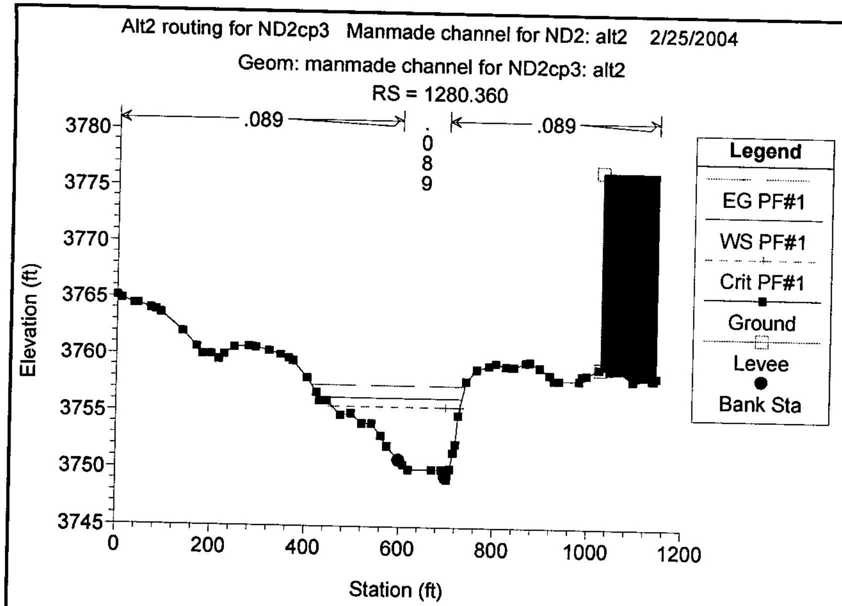
RS = 2044.011



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

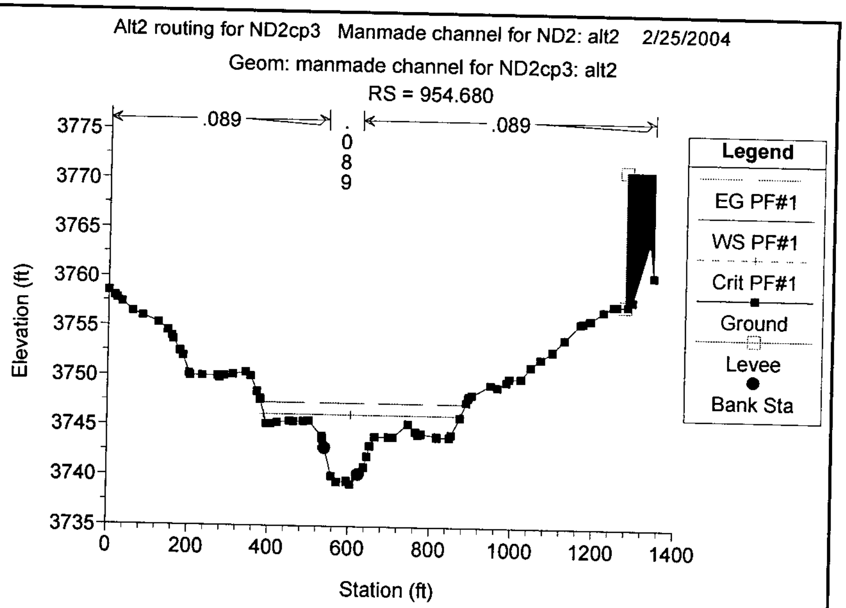
RS = 1743.471



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

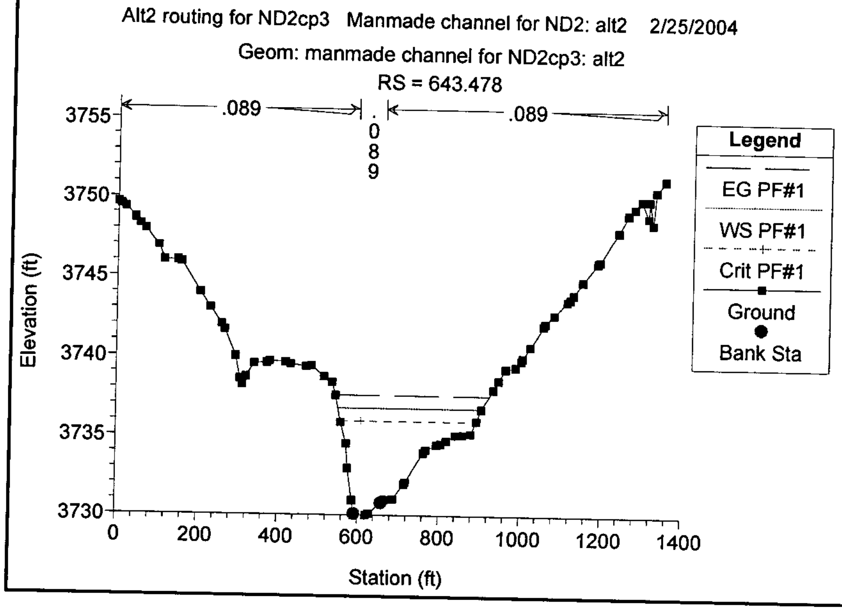
RS = 1280.360



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

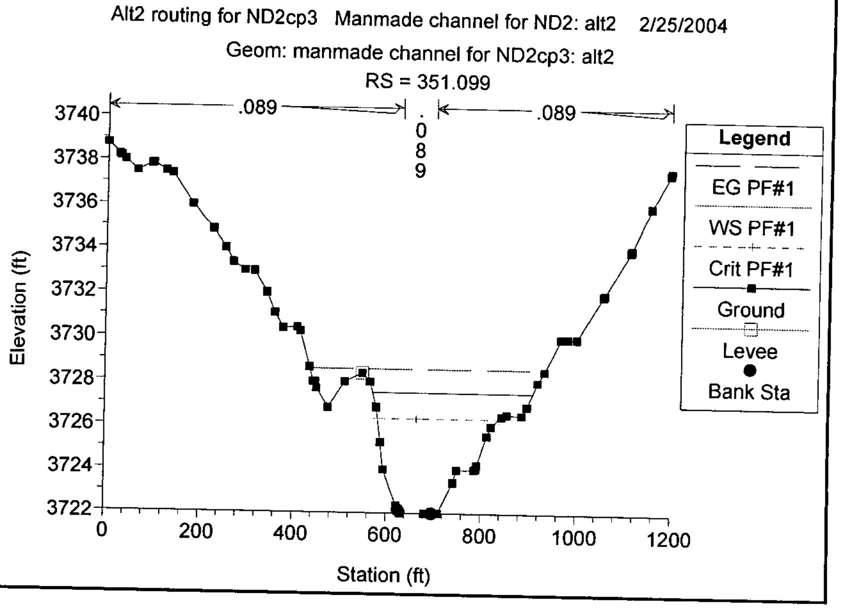
RS = 954.680



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

Geom: manmade channel for ND2cp3: alt2

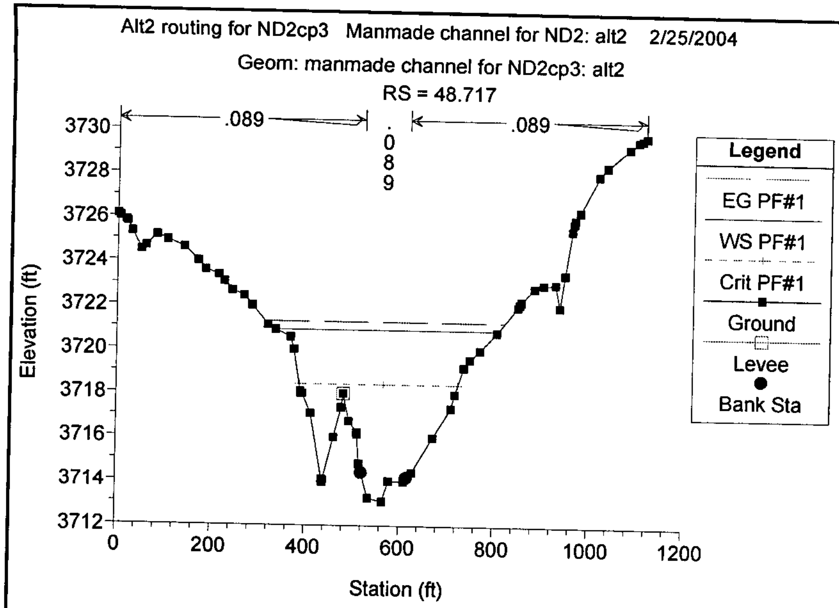
RS = 643.478



Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004

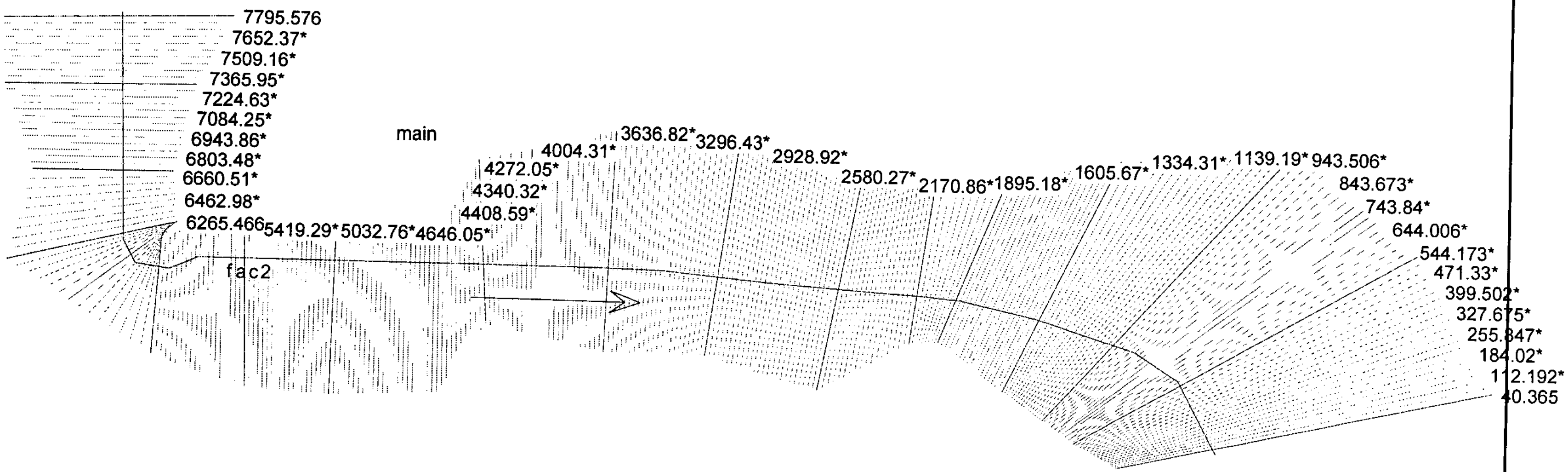
Geom: manmade channel for ND2cp3: alt2

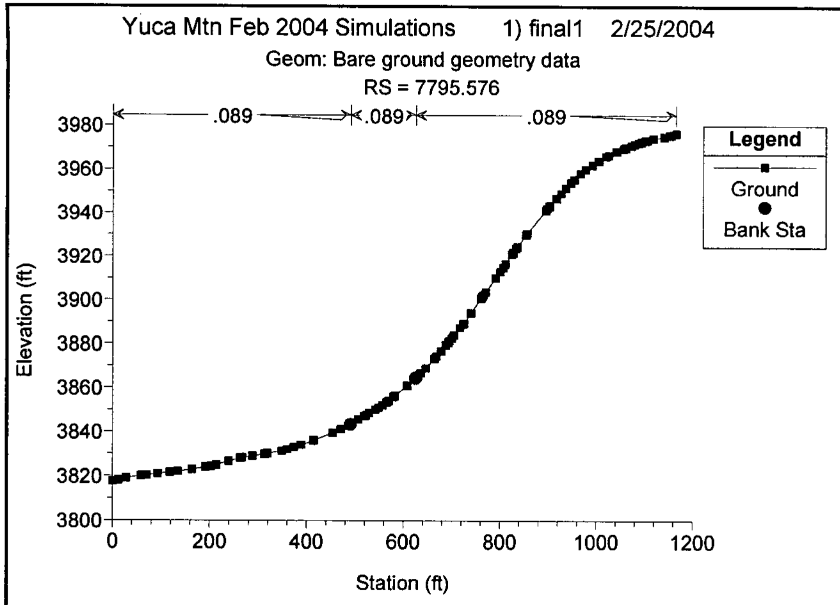
RS = 351.099


Alt2 routing for ND2cp3 Manmade channel for ND2: alt2 2/25/2004
Geom: manmade channel for ND2cp3: alt2
RS = 48.717
.089
.089
.089
3730
3728
3726
3724
3722
3720
3718
3716
3714
3712
Elevation (ft)
0
200
400
600
800
1000
1200
Station (ft)
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta

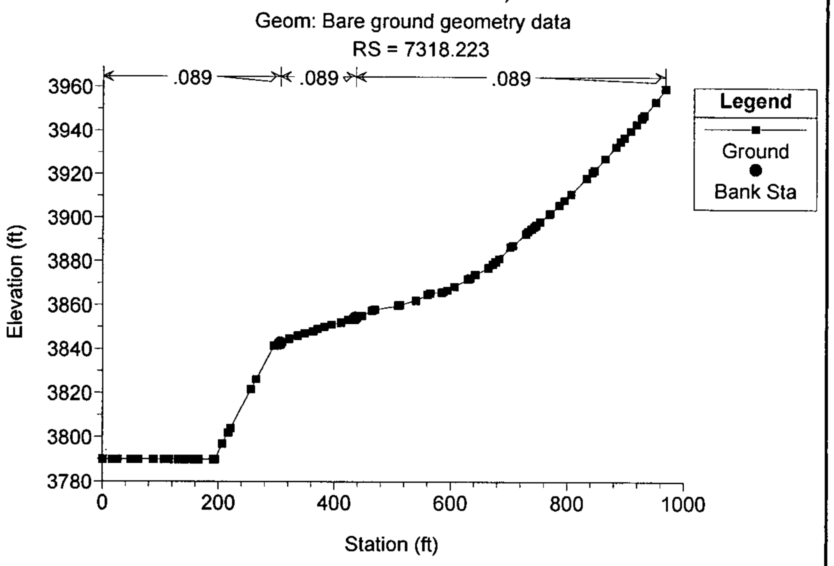
Attachment 21: Hydraulic Calculations for Routing Around Aging Facility and North Portal Pad, Alternative 2

(Document ID: 000-00C-CD04-00100-000-00A)

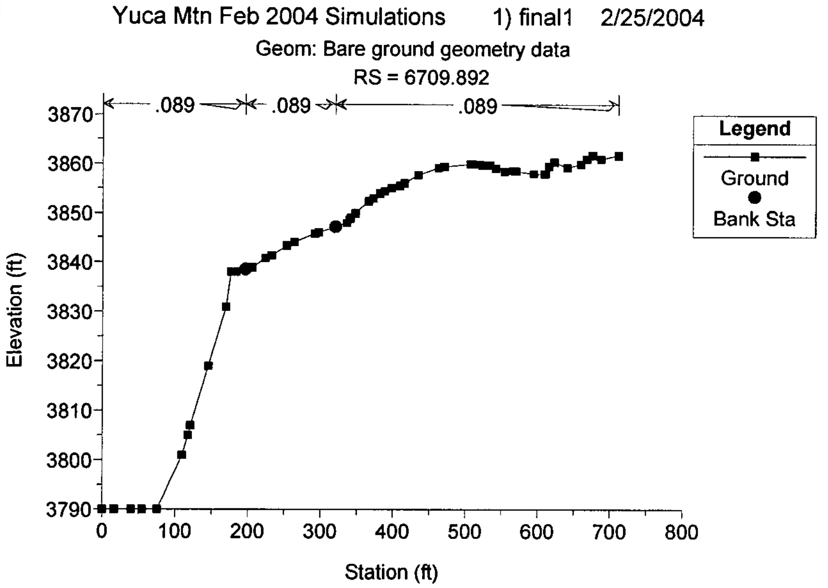

7795.576
7652.37*
7509.16*
7365.95*
7224.63*
7084.25*
6943.86*
6803.48*
6660.51*
6462.98*
6265.466
5419.29*
5032.76*
4646.05*
fac2
main
4408.59*
4340.32*
4272.05*
4004.31*
3636.82*
3296.43*
2928.92*
2580.27*
2170.86*
1895.18*
1605.67*
1334.31*
1139.19*
943.506*
843.673*
743.84*
644.006*
544.173*
471.33*
399.502*
327.675*
255.847*
184.02*
112.192*
40.365



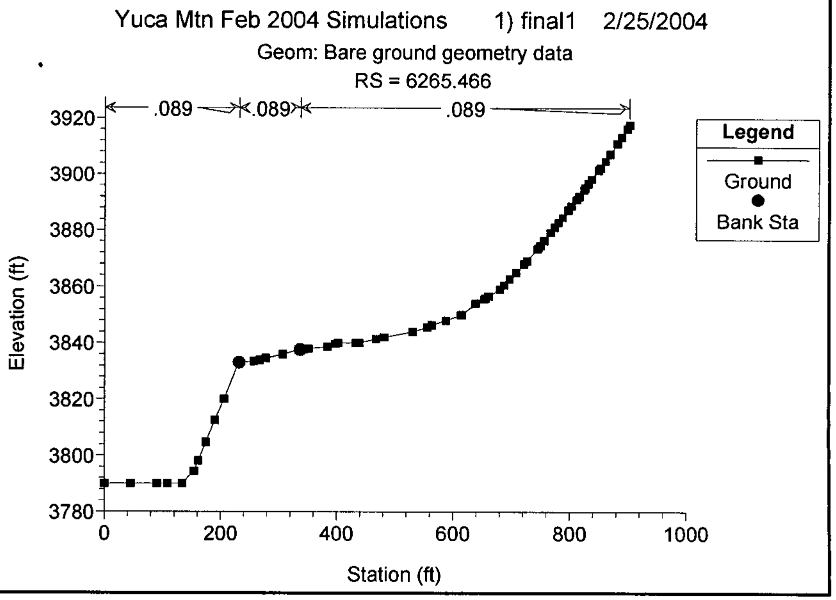
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 7795.576



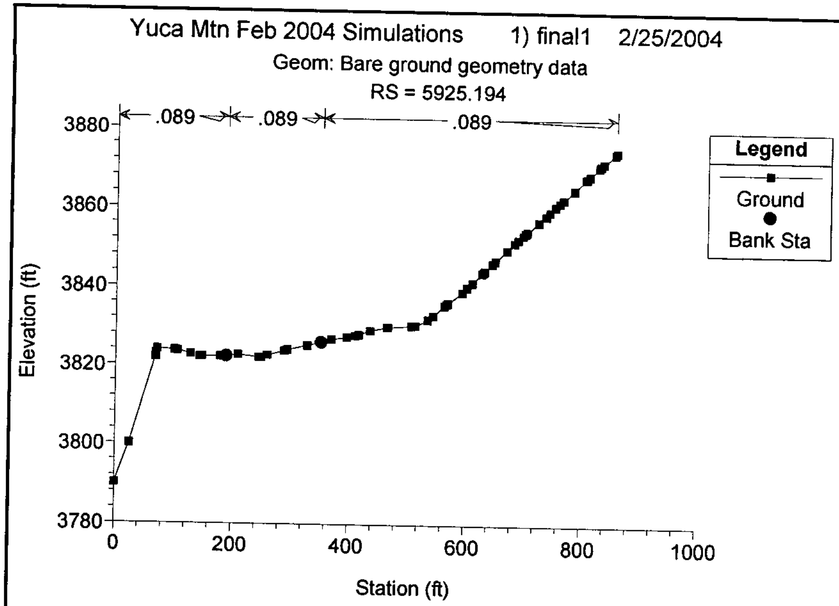
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 7318.223



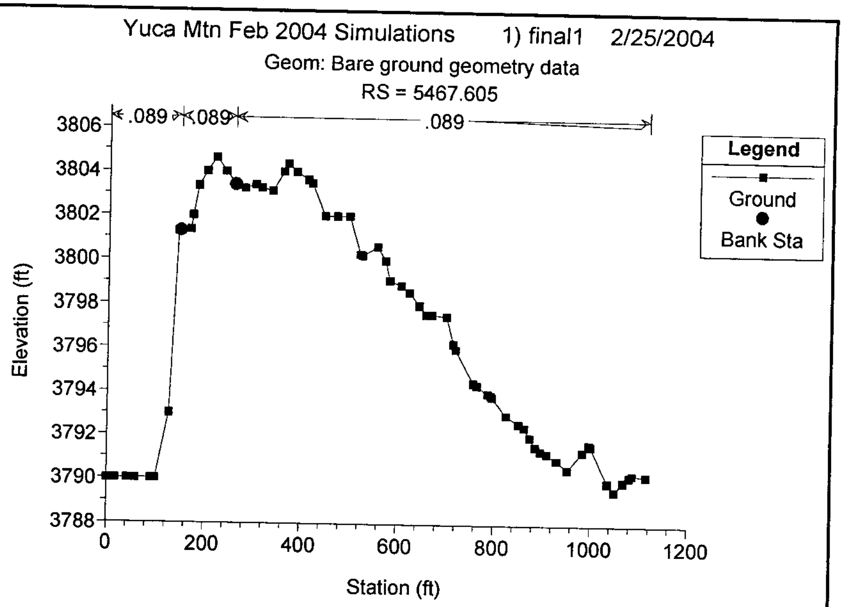
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 6709.892



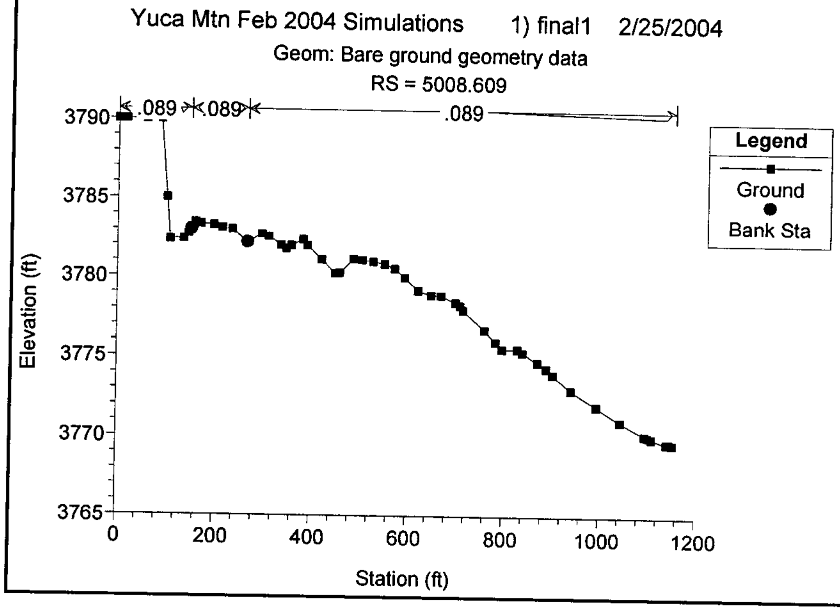
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 6265.466



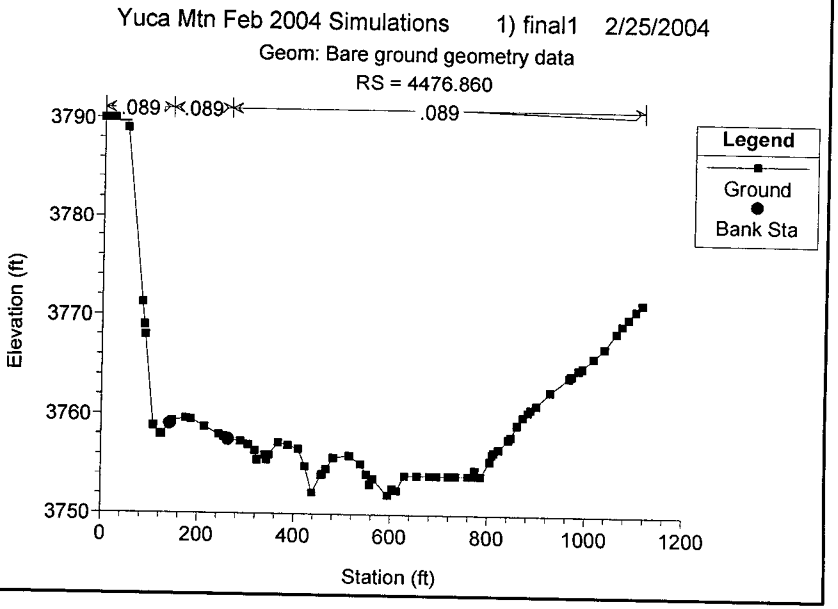
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 5925.194



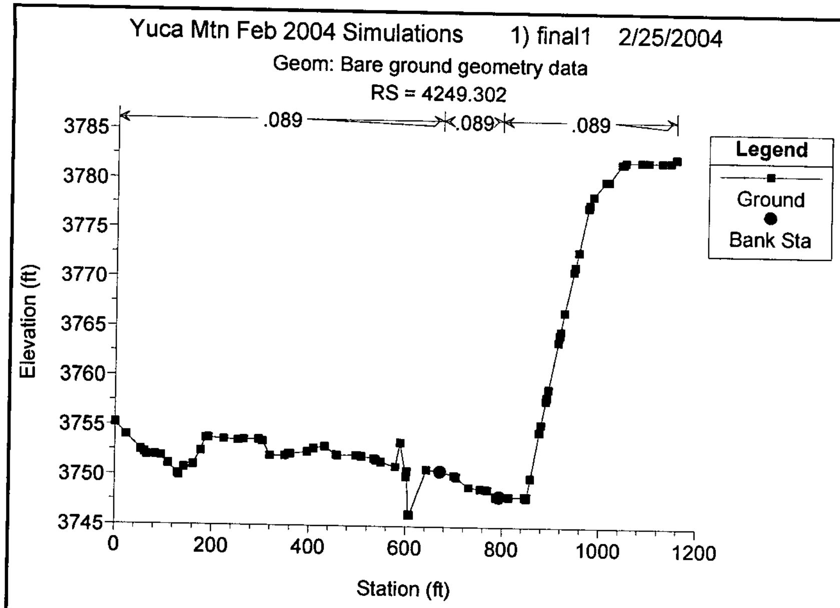
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 5467.605

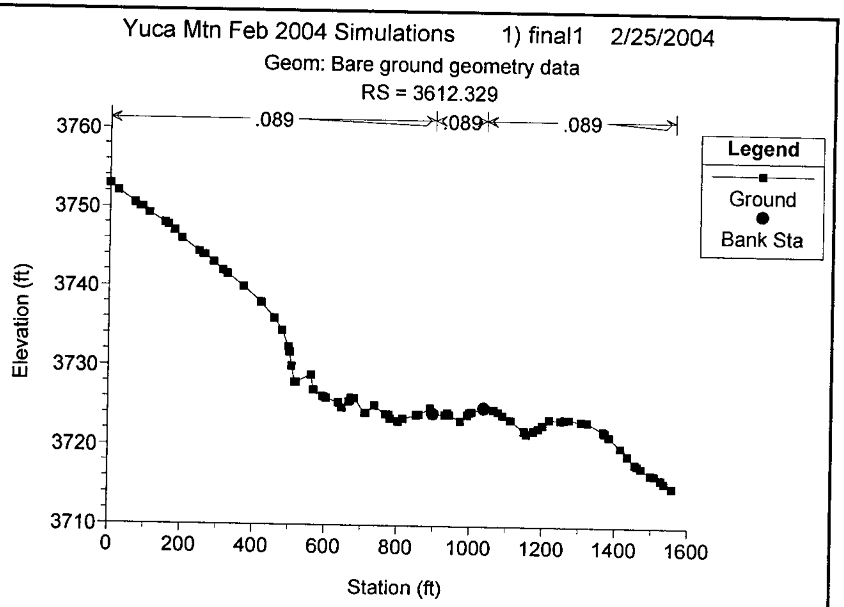


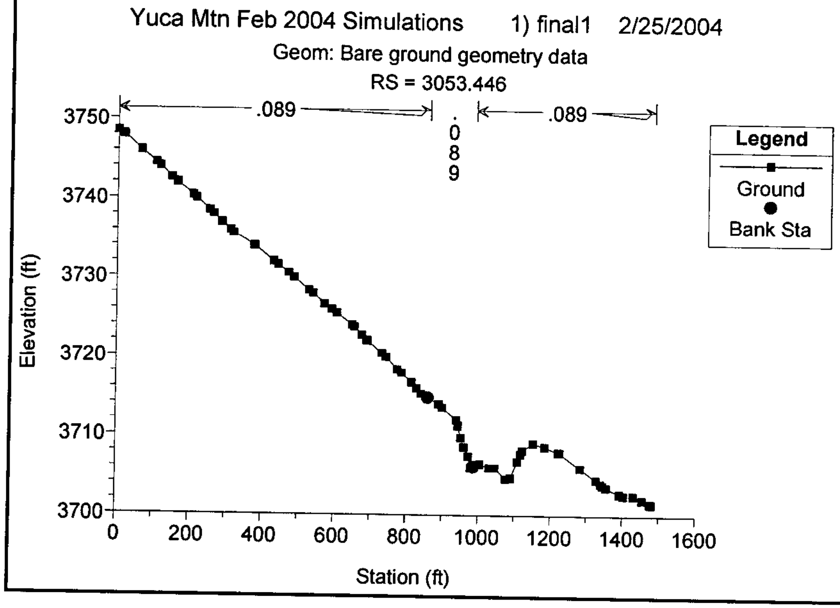
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 5008.609

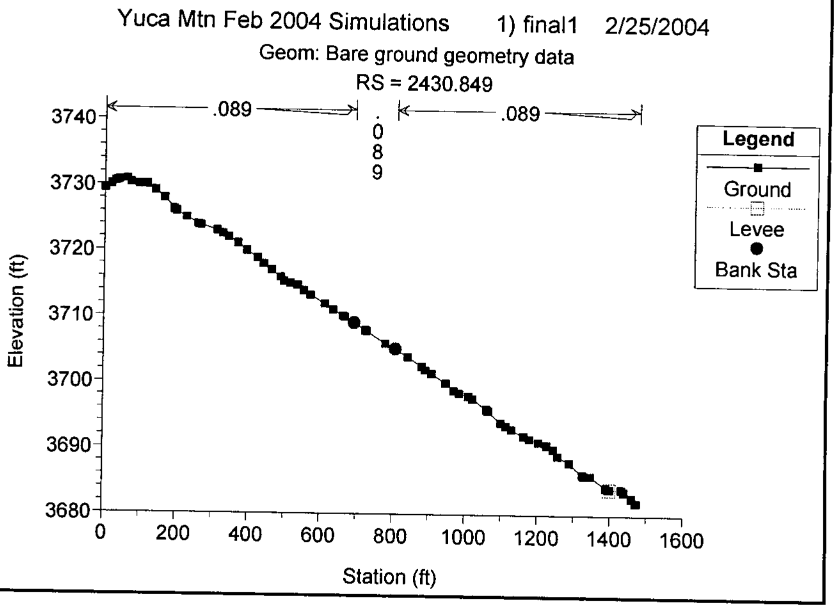


Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 4476.860

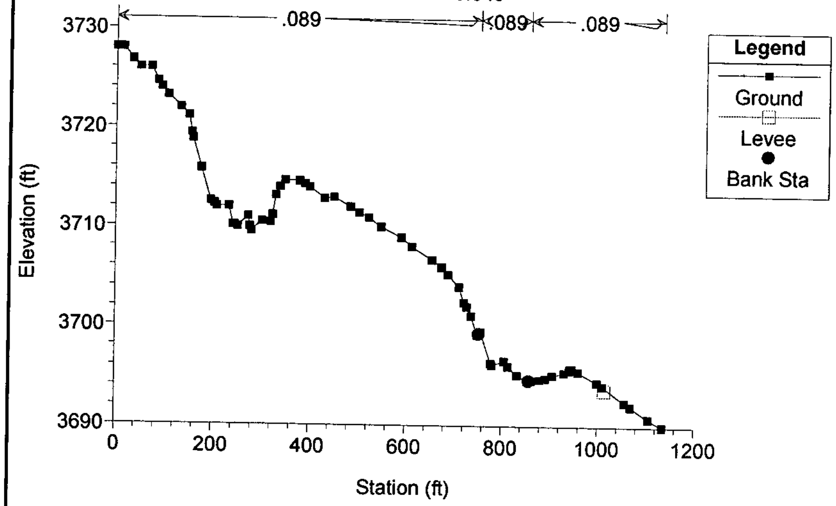

Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 4249.302


Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 3612.329

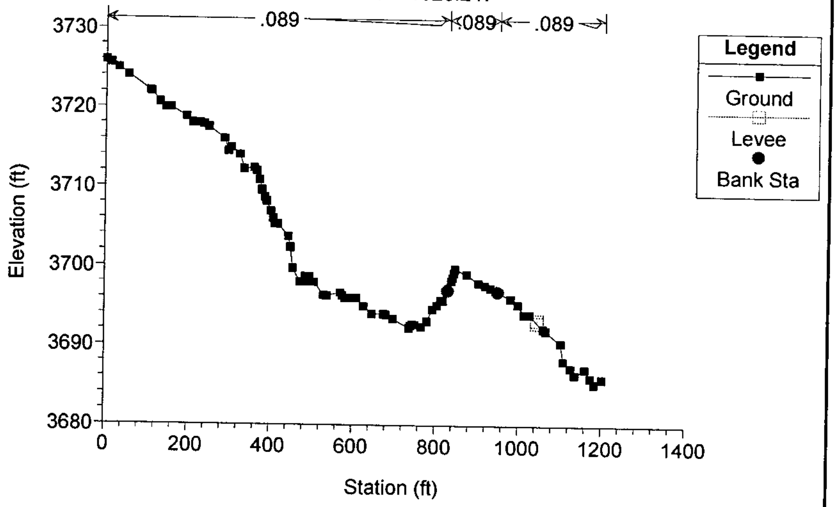

Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 3053.446


Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 2430.849

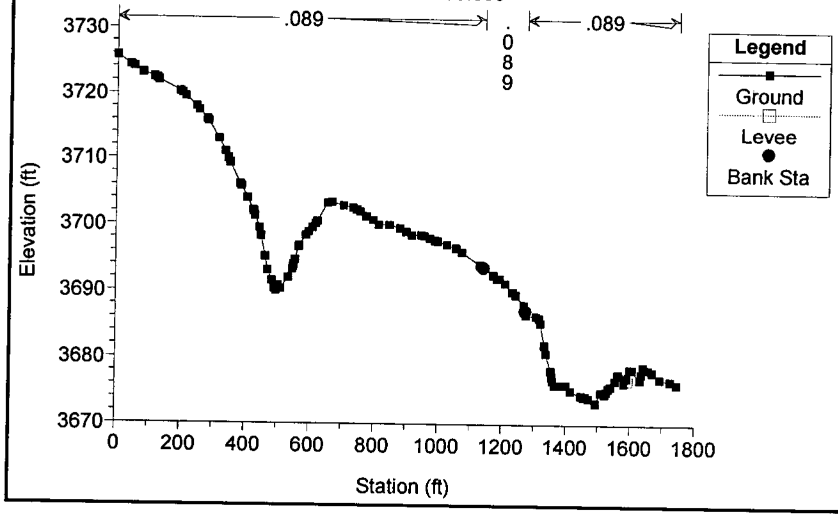
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 2029.049



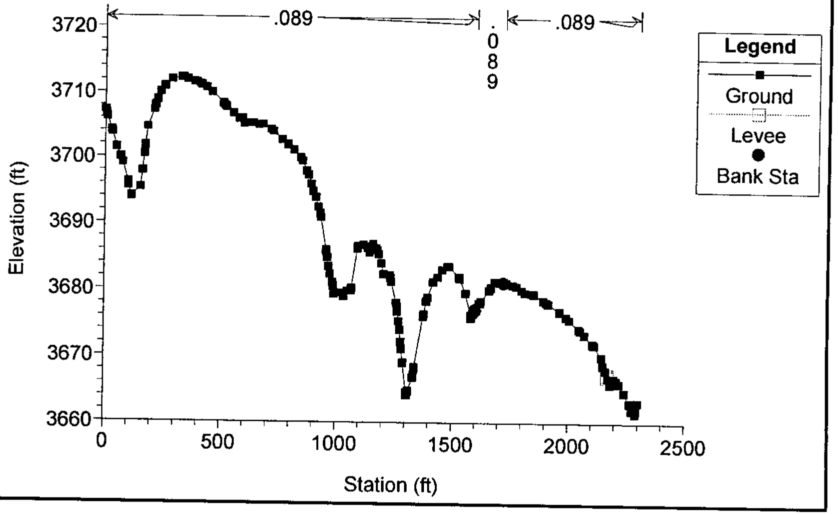
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 1828.247

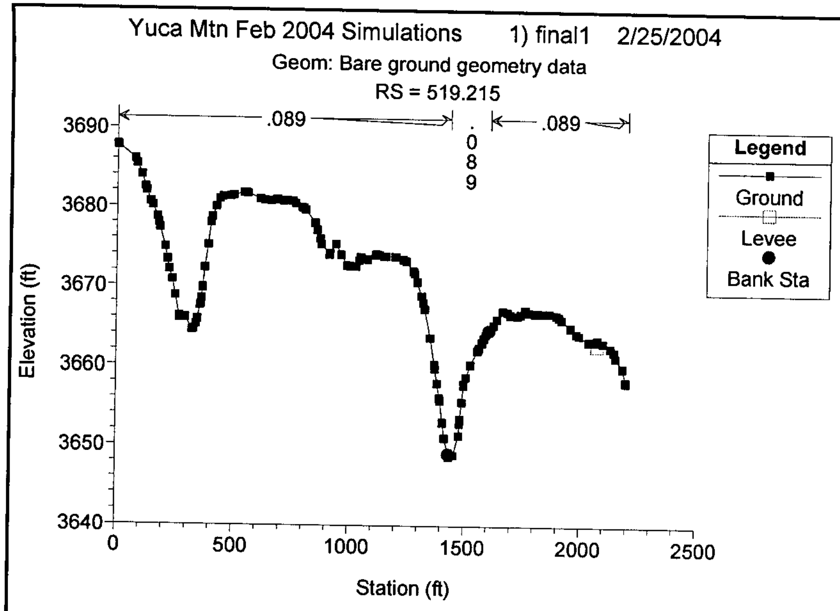


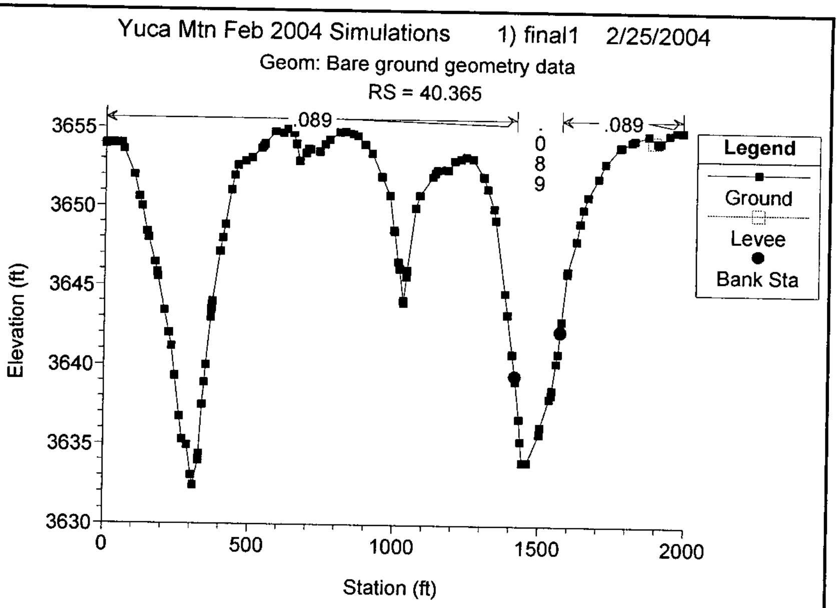
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 1383.099



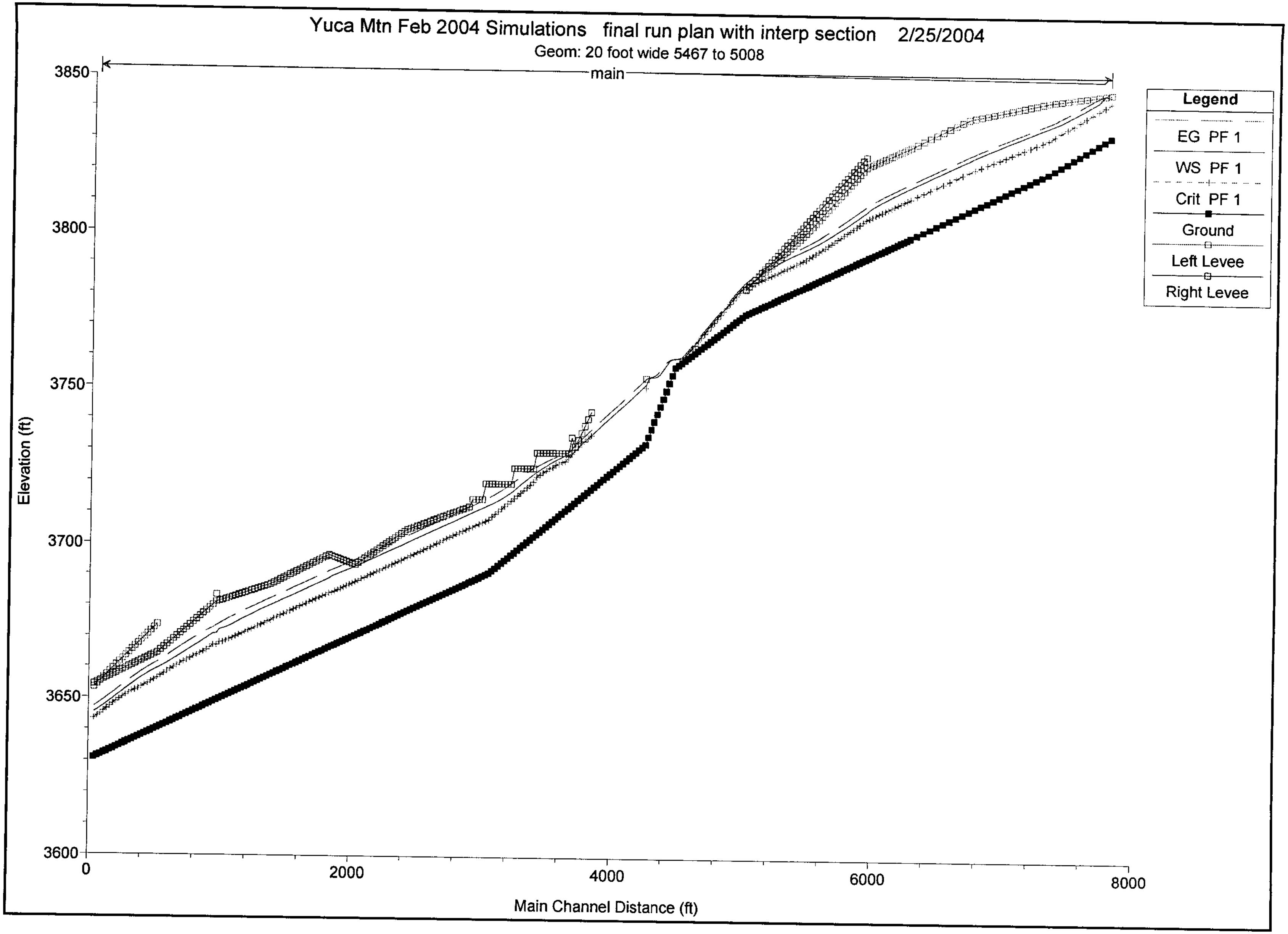
Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 968.465




Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 519.215
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3690
3680
3670
3660
3650
3640
0
500
1000
1500
2000
2500
Station (ft)

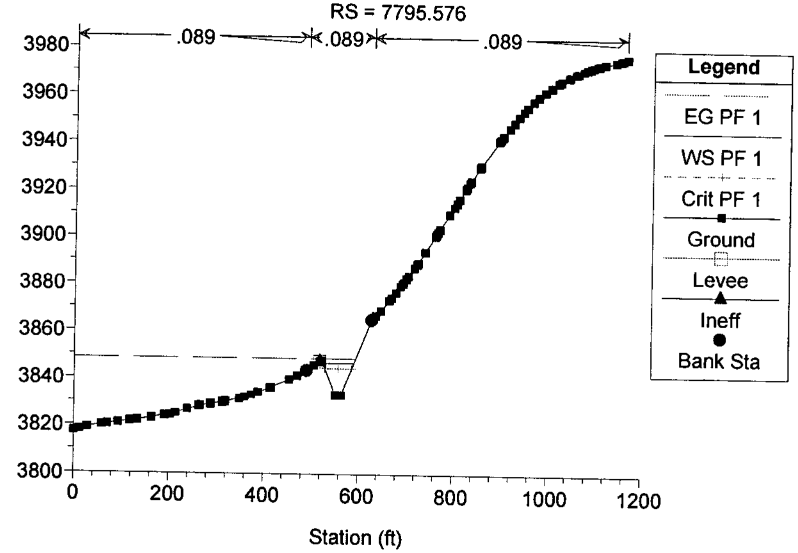

Yuca Mtn Feb 2004 Simulations 1) final1 2/25/2004
Geom: Bare ground geometry data
RS = 40.365
.089
.089
.089
Legend
Ground
Levee
Bank Sta
Elevation (ft)
3655
3650
3645
3640
3635
3630
0
500
1000
1500
2000
Station (ft)

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: finall  River: fac2  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 18
# Plans             = 1
# Profiles          = 1

 Reach            River Sta           Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                        (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

 main             7795.576            5734.00    3833.00    3846.42    3844.22    3848.30   0.031012      11.00     521.23      65.68          0.69
 main             7318.223            5734.00    3821.07    3836.14    3832.13    3837.35   0.017308       8.84     648.49      73.18          0.52
 main             6709.892            5734.00    3808.90    3825.21    3821.55    3826.57   0.019974       9.34     613.95      70.26          0.56
 main             6265.466            5734.00    3800.02    3816.29    3812.67    3817.66   0.020252       9.39     610.76      70.08          0.56
 main             5925.194            5734.00    3793.21    3808.18    3805.86    3810.05   0.030611      10.96     523.06      64.88          0.68
 main             5467.605            5734.00    3784.06    3796.10    3792.89    3797.43   0.020312       9.23     621.41      75.69          0.57
 main             5008.609            5734.00    3774.88    3784.50    3784.09    3785.39   0.023337       8.69     887.57    1050.19          0.59
 main             4476.860            5734.00    3757.54    3760.39    3757.02    3760.51   0.003266       1.27    2150.44     776.71          0.18
 main             4249.302           15806.00    3733.00    3752.03    3751.10    3753.85   0.037296      11.18    1574.57     361.63          0.76
 main             3612.329           15806.00    3710.71    3728.65    3727.10    3729.39   0.014480       7.94    2492.73     512.88          0.48
 main             3053.446           15806.00    3691.15    3713.18    3708.51    3715.56   0.020284      12.38    1276.46      93.24          0.59
 main             2430.849           15806.00    3678.70    3700.87    3696.07    3703.11   0.019877      12.01    1315.94     103.69          0.59
 main             2029.049           15806.00    3670.66    3693.02    3688.03    3695.20   0.019113      11.84    1335.39     104.44          0.58
 main             1828.247           16349.00    3666.65    3689.11    3684.30    3691.40   0.020017      12.15    1346.14     104.86          0.60
 main             1383.099           16349.00    3657.74    3680.19    3675.39    3682.49   0.020062      12.16    1344.99     104.81          0.60
 main             968.465            16349.00    3649.45    3670.94    3667.13    3673.62   0.024585      13.12    1246.38     100.98          0.66
 main             519.215            16349.00    3640.47    3659.44    3656.30    3661.44   0.024022      11.35    1440.58     149.40          0.64
 main             40.365             16349.00    3630.89    3645.39    3643.28    3647.09   0.025003      10.51    1576.28     215.66          0.65
```


Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
Geom: 20 foot wide 5467 to 5008
main
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Left Levee
Right Levee
Elevation (ft)
3850
3800
3750
3700
3650
3600
0
2000
4000
6000
8000
Main Channel Distance (ft)

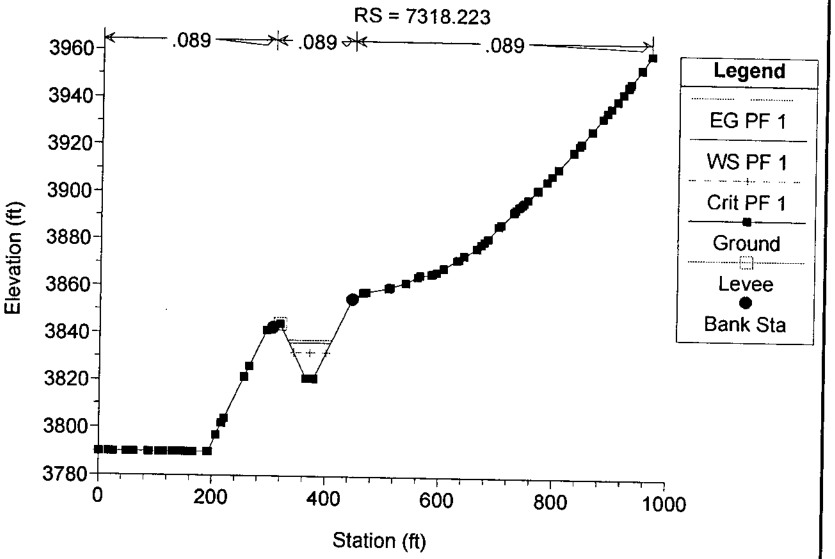
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

RS = 7795.576



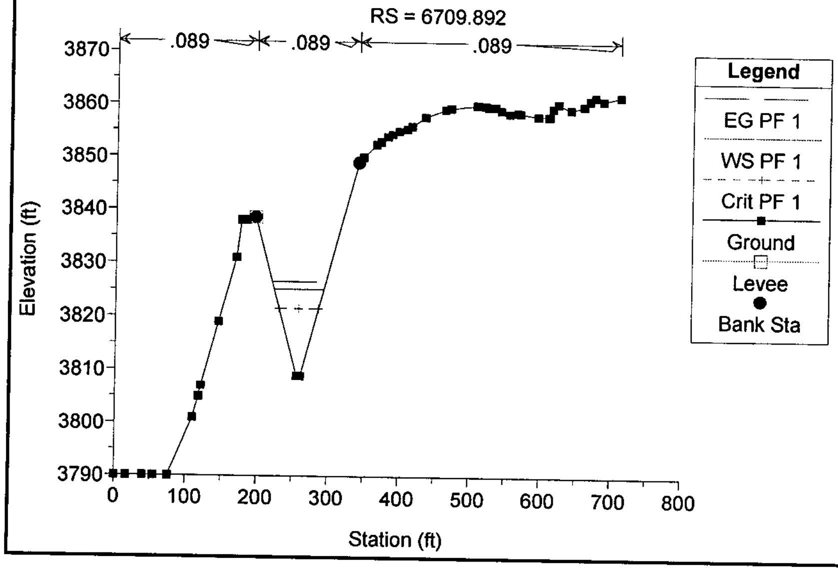
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

RS = 7318.223



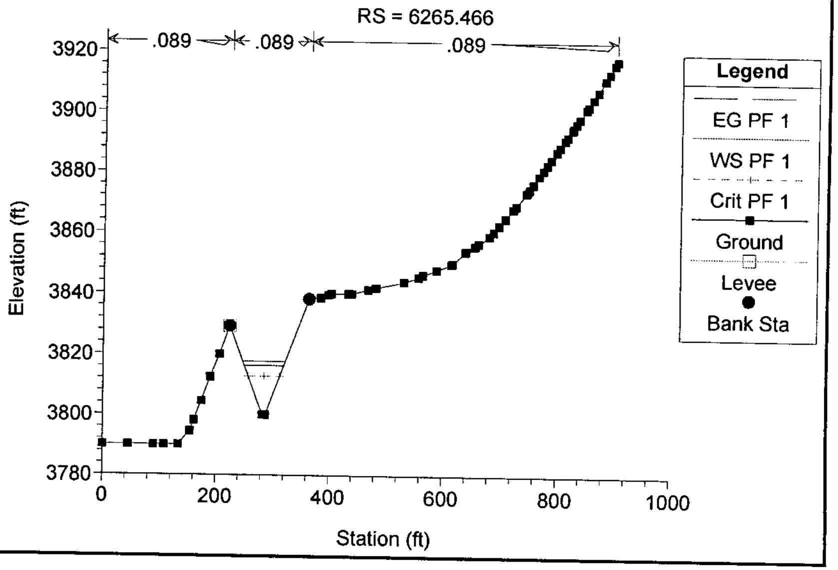
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

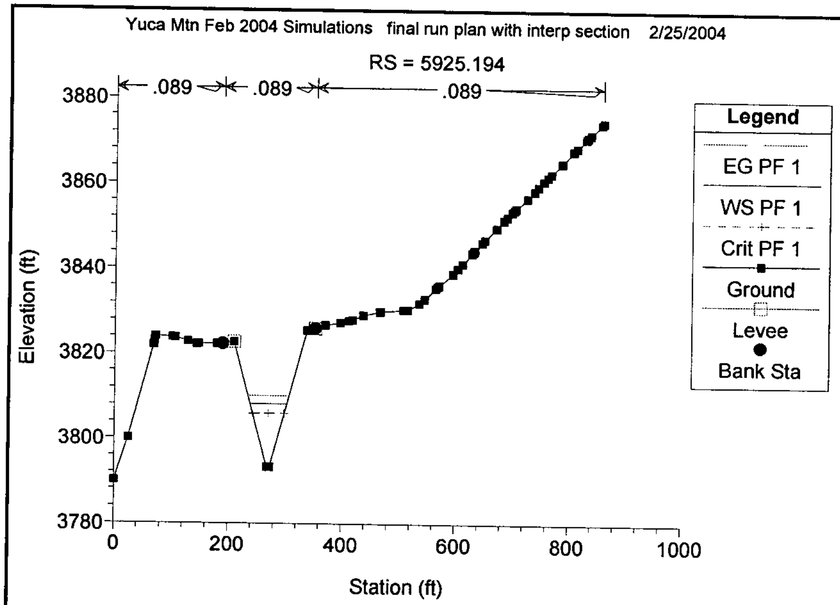
RS = 6709.892

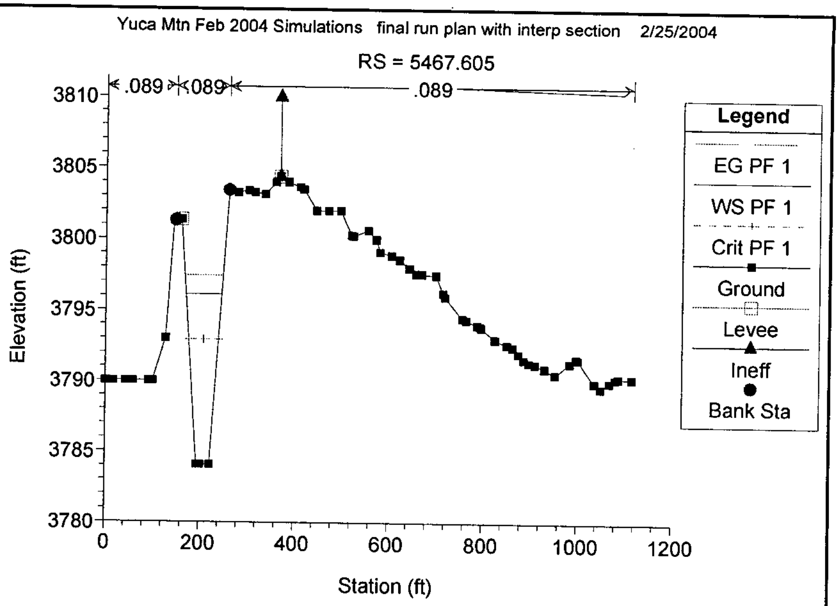


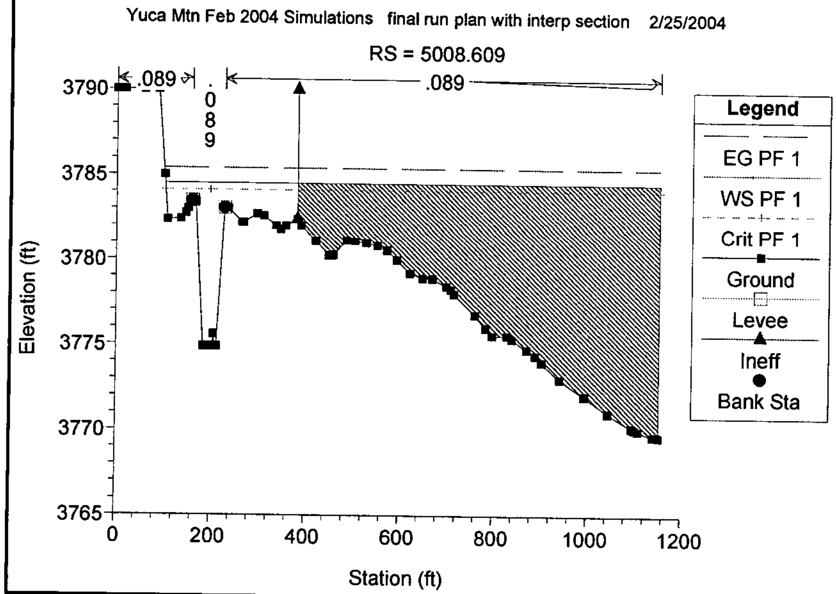
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

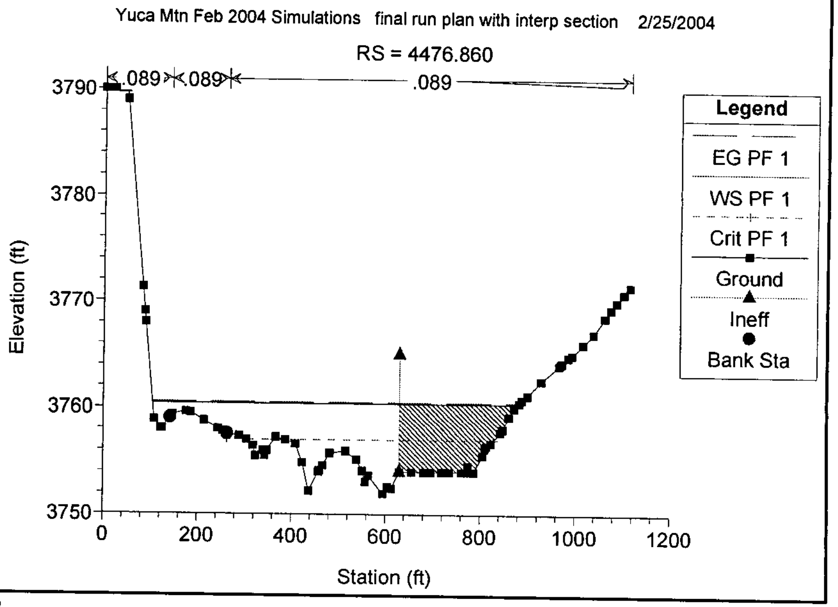
RS = 6265.466

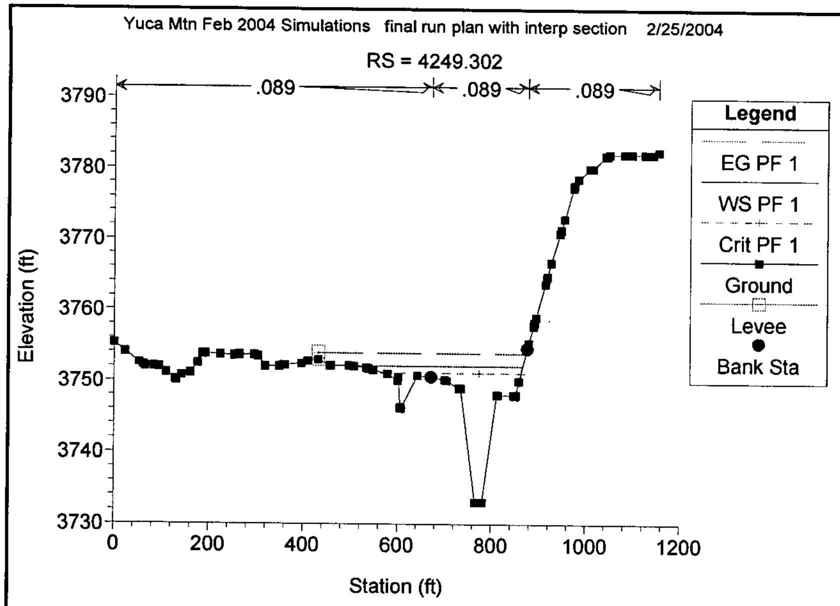


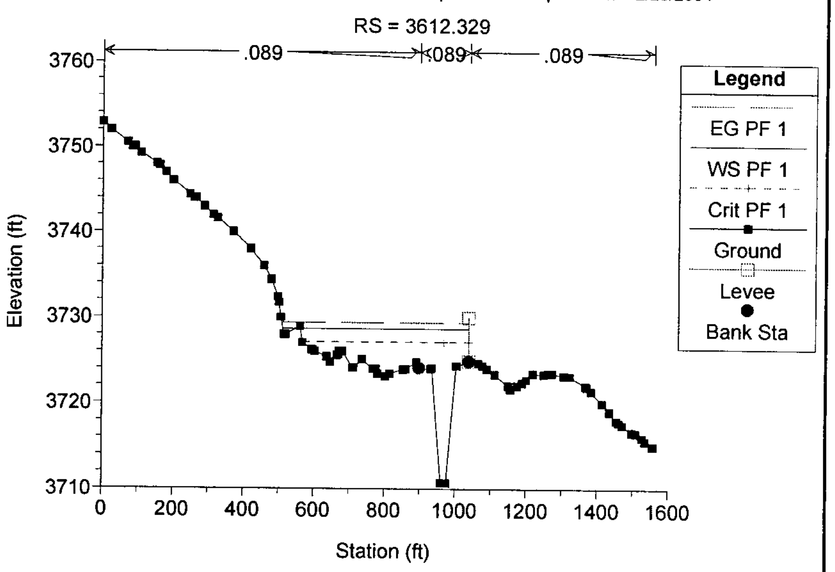

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 5925.194
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3880
3860
3840
3820
3800
3780
0
200
400
600
800
1000
Station (ft)

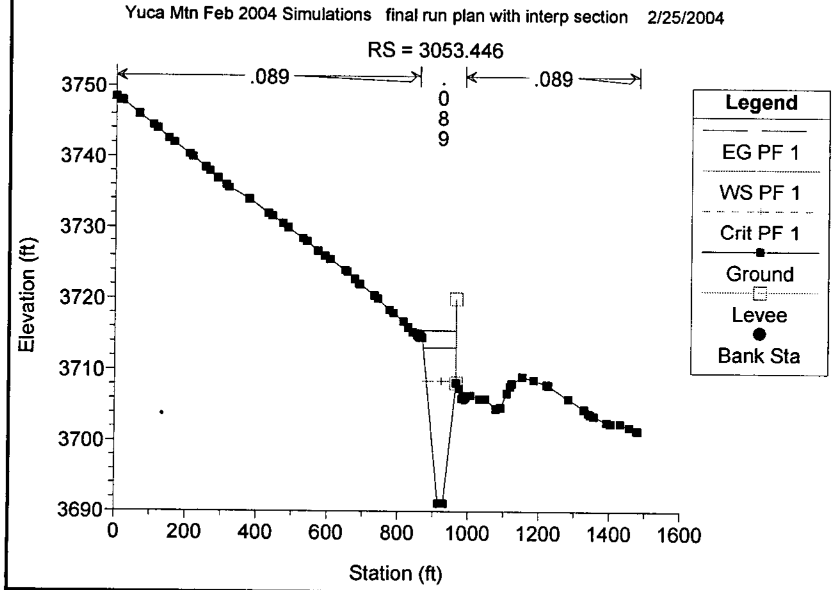

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 5467.605
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
3810
3805
3800
3795
3790
3785
3780
0
200
400
600
800
1000
1200
Station (ft)

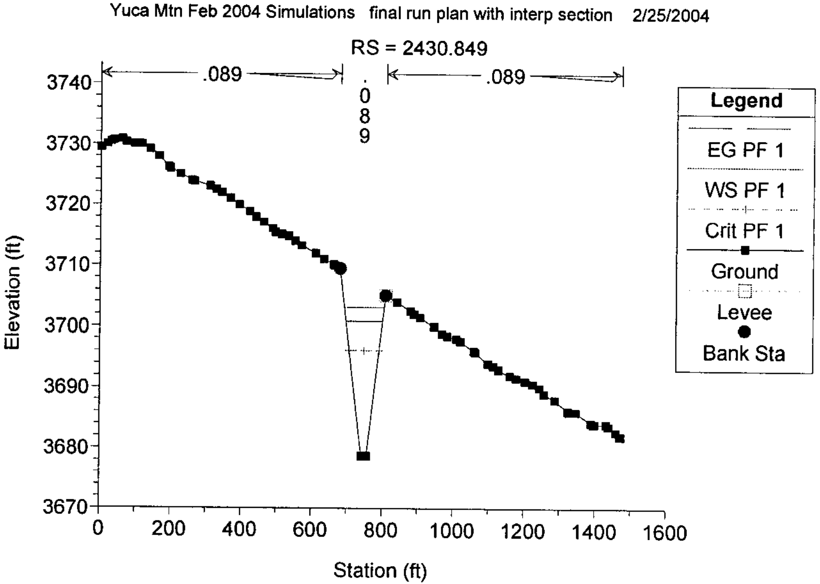

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 5008.609
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
3790
3785
3780
3775
3770
3765
0
200
400
600
800
1000
1200
Station (ft)

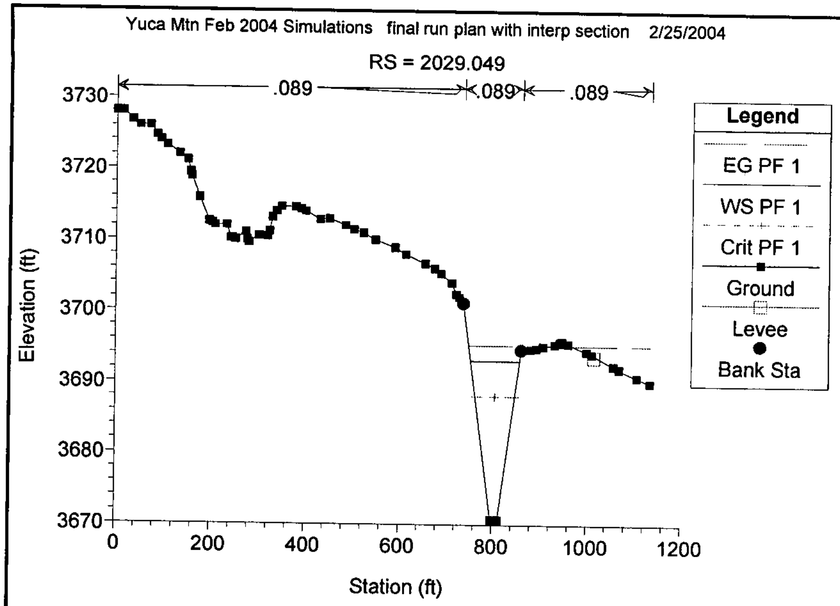

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 4476.860
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
3790
3780
3770
3760
3750
0
200
400
600
800
1000
1200
Station (ft)


Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 4249.302
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3790
3780
3770
3760
3750
3740
3730
0
200
400
600
800
1000
1200
Station (ft)


Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 3612.329
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3760
3750
3740
3730
3720
3710
0
200
400
600
800
1000
1200
1400
1600
Station (ft)

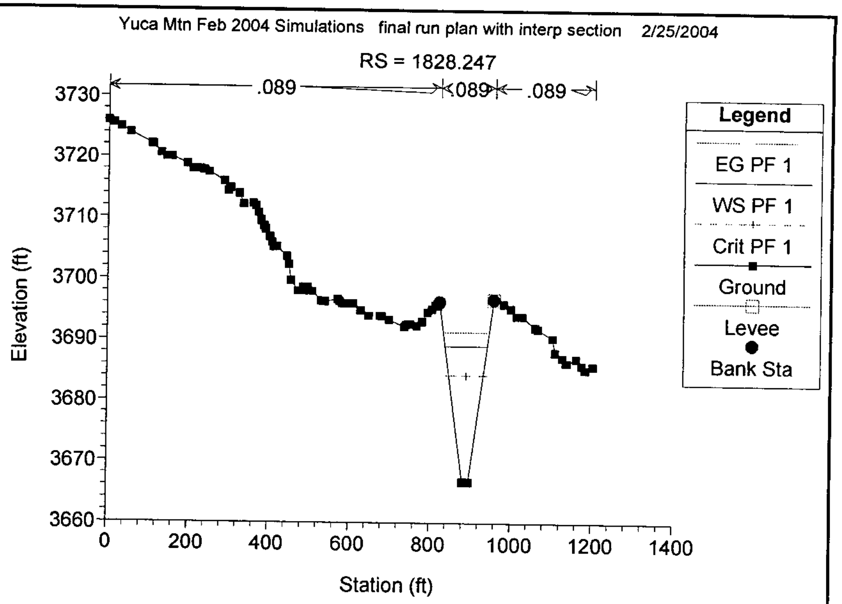

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 3053.446
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3750
3740
3730
3720
3710
3700
3690
0
200
400
600
800
1000
1200
1400
1600
Station (ft)


Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 2430.849
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3740
3730
3720
3710
3700
3690
3680
3670
0
200
400
600
800
1000
1200
1400
1600
Station (ft)



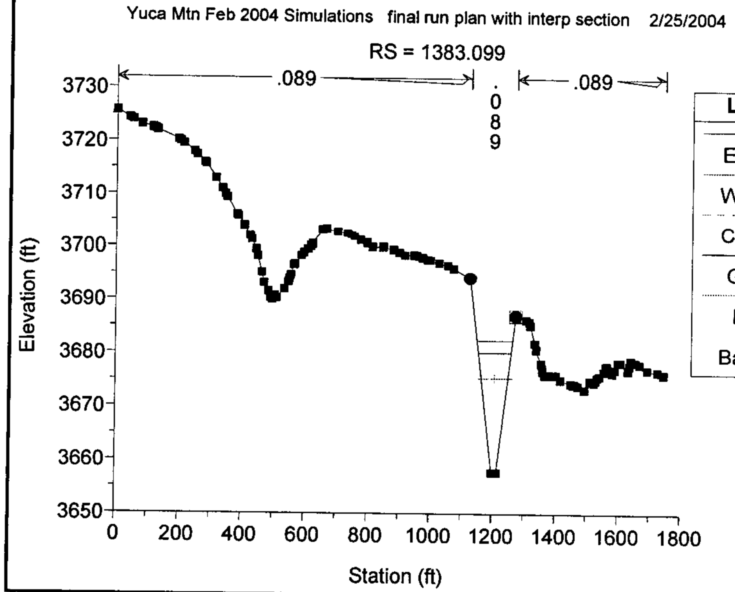
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

RS = 2029.049



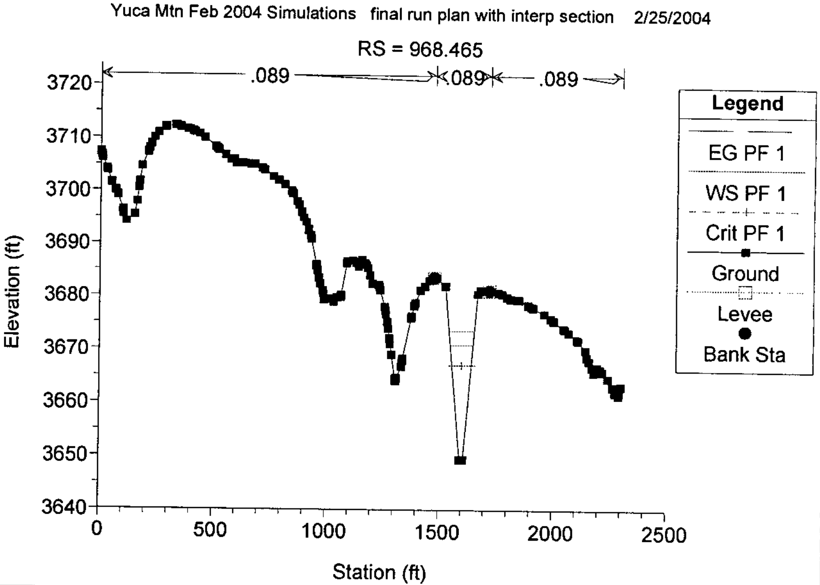
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

RS = 1828.247



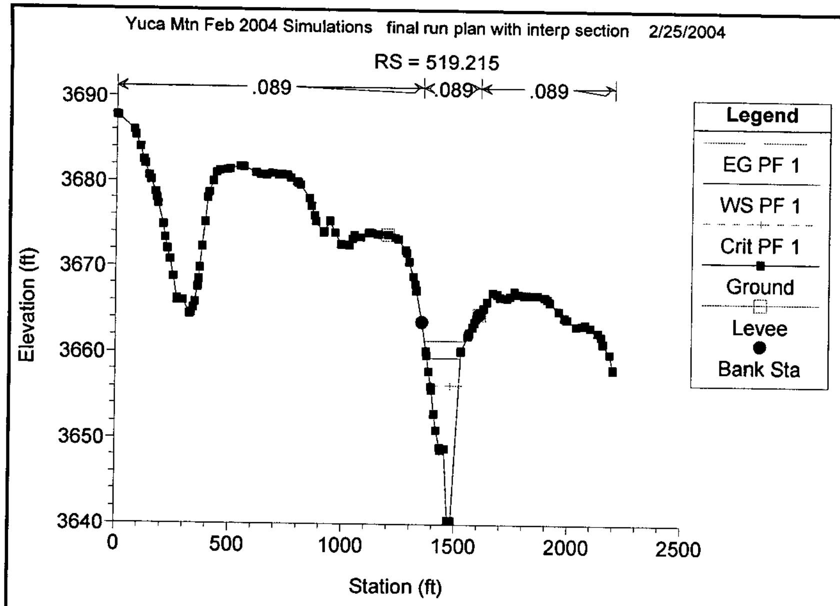
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

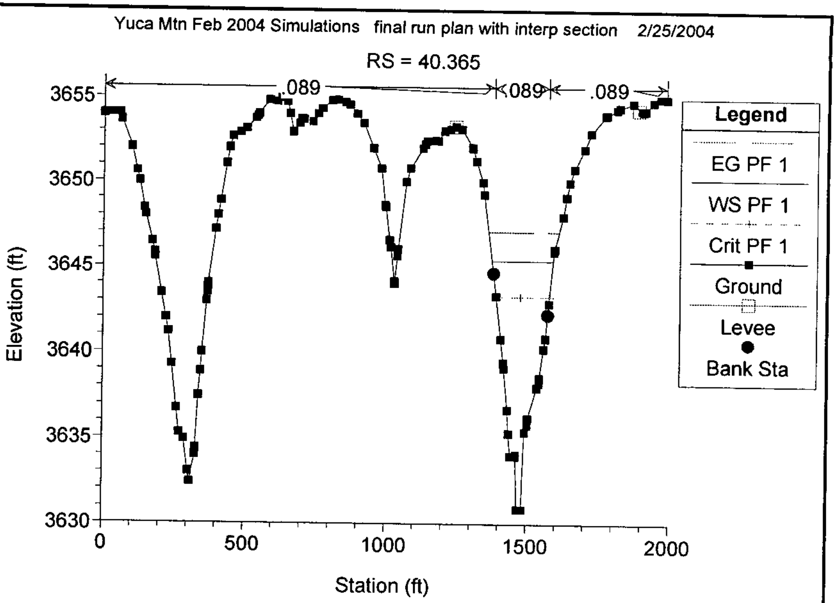
RS = 1383.099



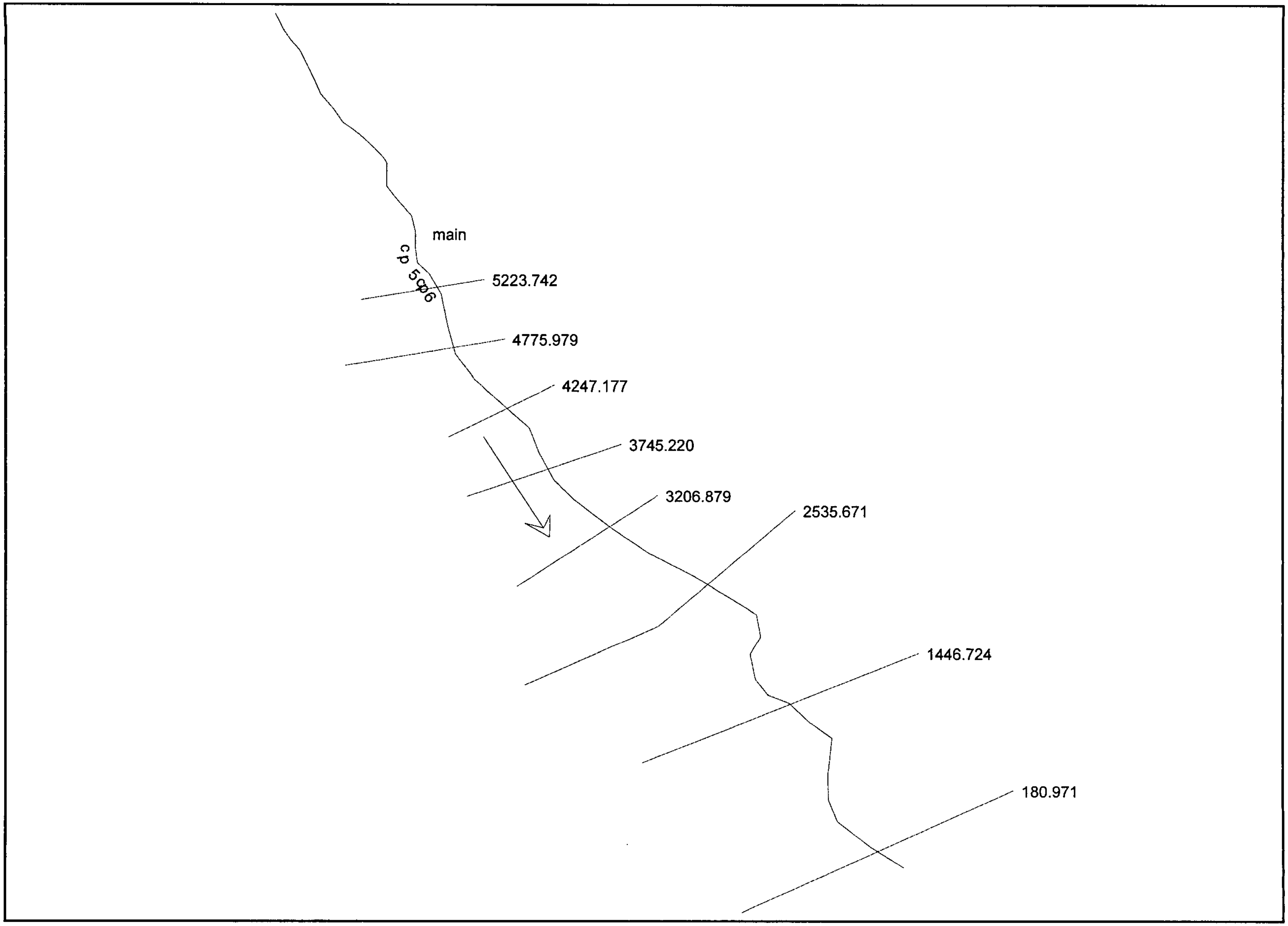
Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004

RS = 968.465

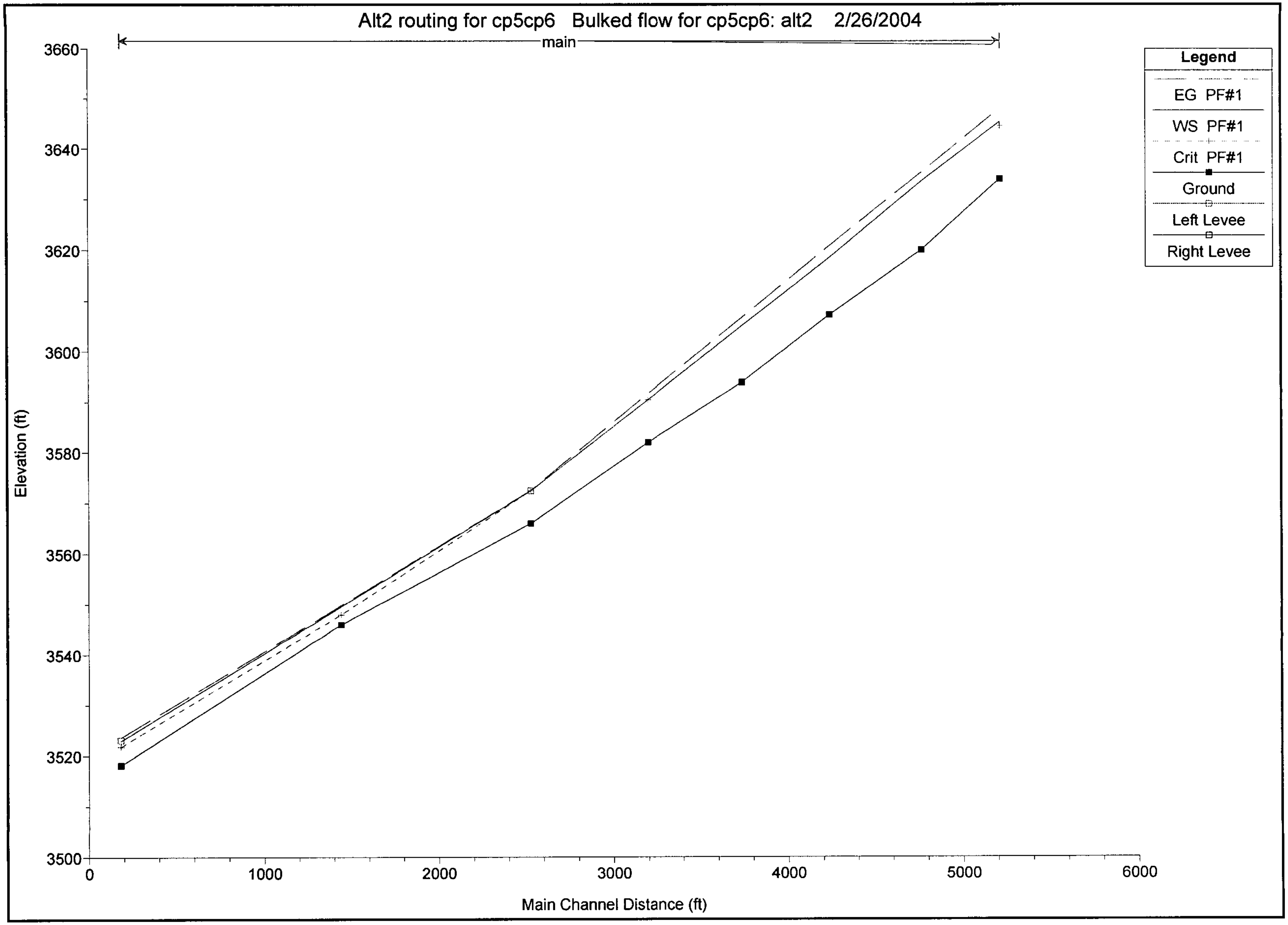

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 519.215
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3690
3680
3670
3660
3650
3640
0
500
1000
1500
2000
2500
Station (ft)

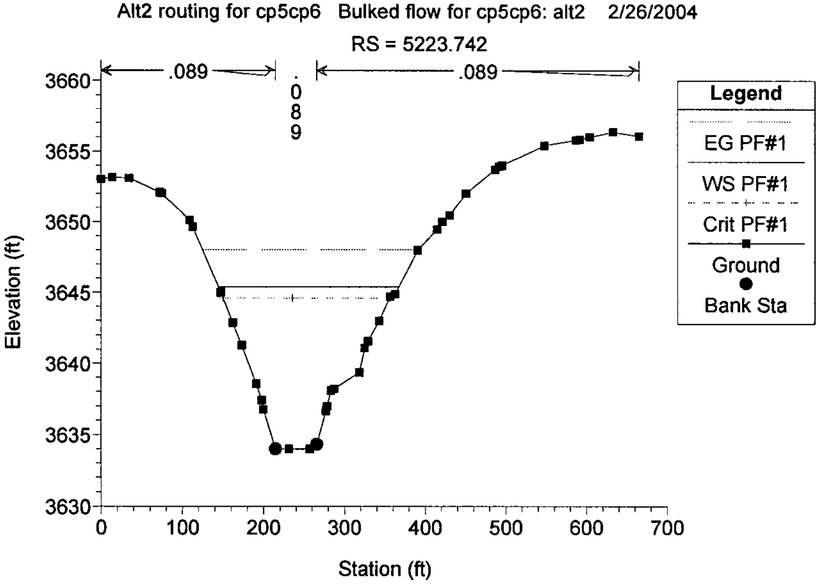

Yuca Mtn Feb 2004 Simulations final run plan with interp section 2/25/2004
RS = 40.365
.089
.089
.089
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
3655
3650
3645
3640
3635
3630
0
500
1000
1500
2000
Station (ft)

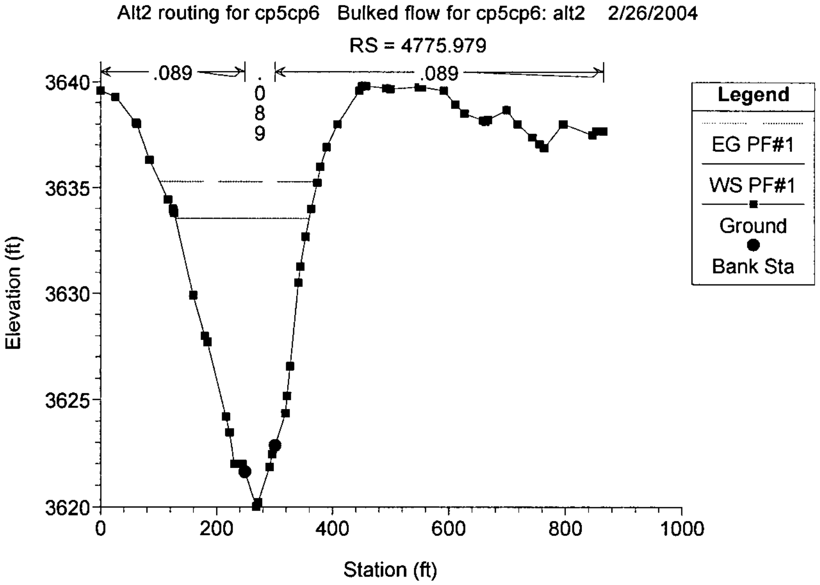
Attachment 22: Hydraulic Calculations for Routing East of North Portal Pad, Alternative 2
(Document ID: 000-00C-CD04-00100-000-00A)

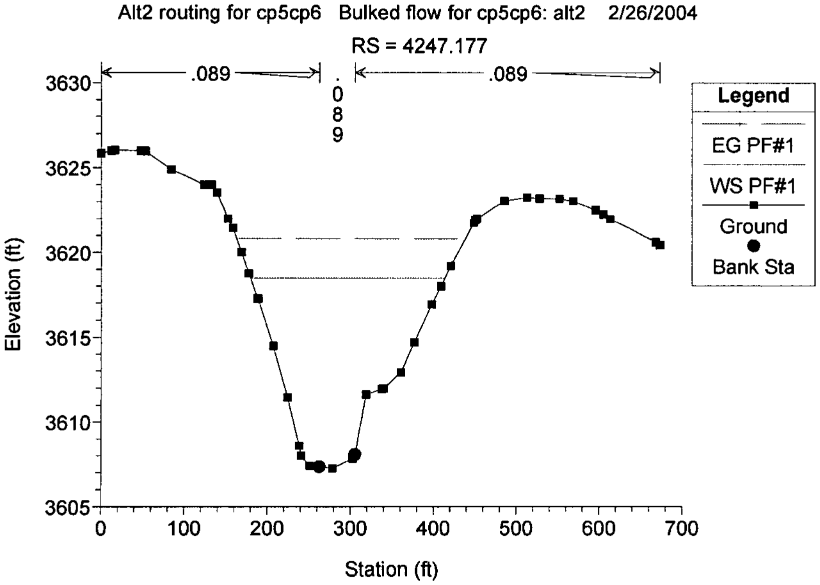

main
cp 5
cp 6
5223.742
4775.979
4247.177
3745.220
3206.879
2535.671
1446.724
180.971

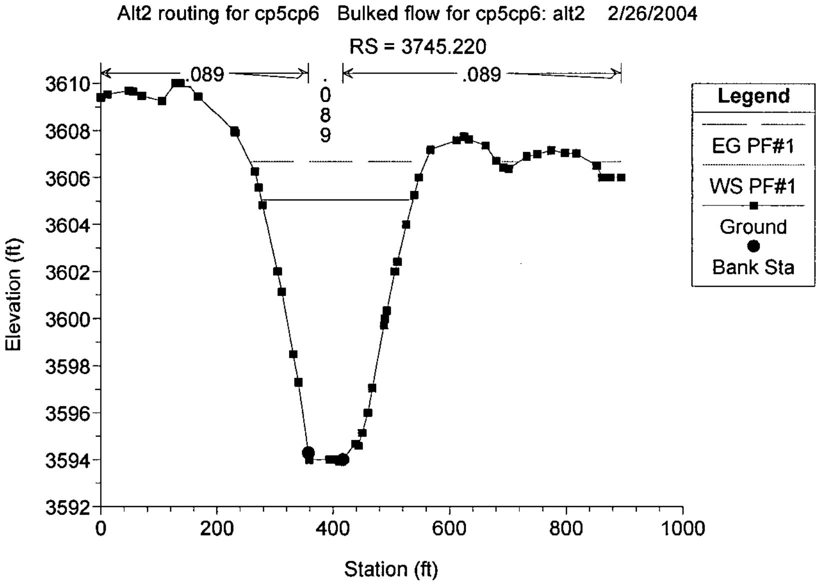
```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: A2_cp5cp6  River: cp5cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 8
# Plans             = 1
# Profiles          = 1

 Reach            River Sta           Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope   Vel Chnl  Flow Area  Top Width Froude # Chl
                                        (cfs)       (ft)       (ft)       (ft)       (ft)    (ft/ft)     (ft/s)    (sq ft)       (ft)

 main             5223.742           17330.00    3634.00    3645.37    3644.60    3648.03   0.034979      15.76    1465.02     222.87         0.82
 main             4775.979           17330.00    3620.03    3633.54               3635.29   0.020735      12.83    1760.65     230.73         0.64
 main             4247.177           17330.00    3607.26    3618.48               3620.82   0.033822      15.17    1528.05     234.43         0.81
 main             3745.220           17330.00    3593.93    3605.07               3606.69   0.021729      12.22    1824.37     261.40         0.65
 main             3206.879           17330.00    3582.00    3590.48    3590.48    3591.72   0.033435      12.70    2399.21     799.46         0.77
 main             2535.671           17330.00    3566.00    3572.43    3572.43    3572.49   0.002486       2.69    8749.40    2445.81         0.20
 main             1446.724           17330.00    3546.00    3549.56    3547.97    3549.80   0.013636       4.54    4409.66    1559.53         0.42
 main             180.971            17330.00    3518.07    3522.90    3521.78    3523.56   0.028031       7.79    2700.65     801.06         0.64
```

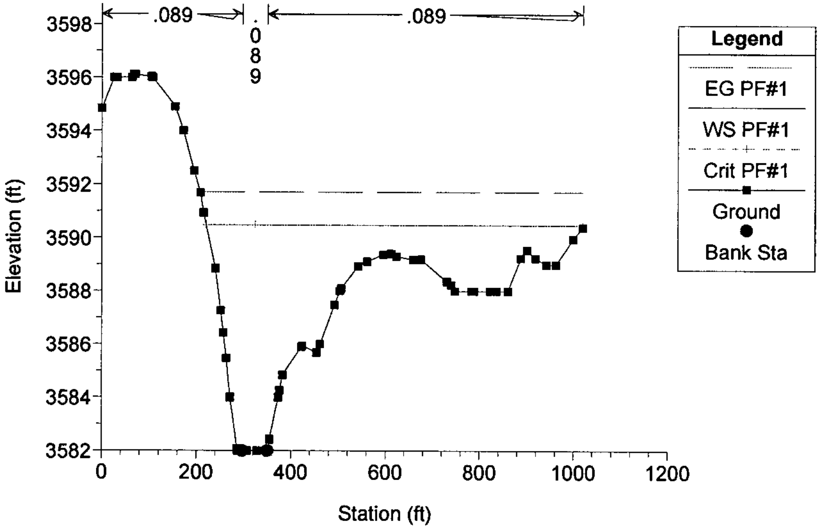

Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004
main
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Left Levee
Right Levee
Elevation (ft)
3660
3640
3620
3600
3580
3560
3540
3520
3500
0
1000
2000
3000
4000
5000
6000
Main Channel Distance (ft)


Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004
RS = 5223.742
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3630
3635
3640
3645
3650
3655
3660
Station (ft)
0
100
200
300
400
500
600
700


Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004
RS = 4775.979
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3620
3625
3630
3635
3640
Station (ft)
0
200
400
600
800
1000

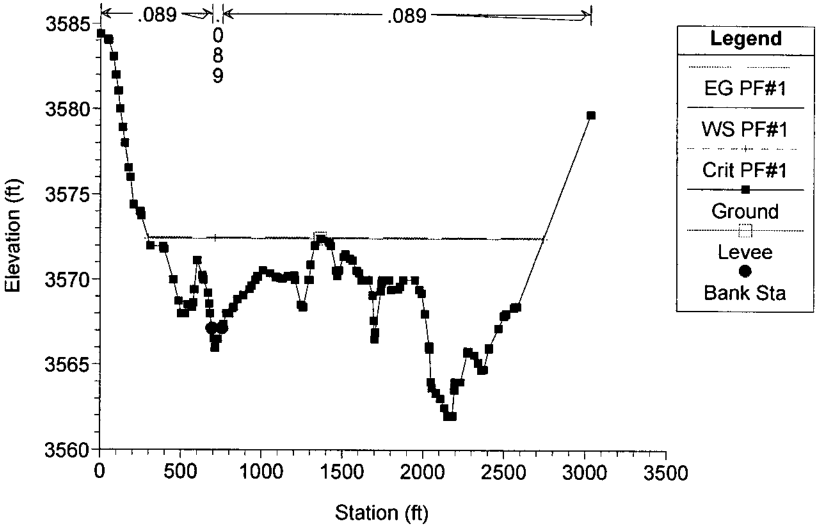

Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004
RS = 4247.177
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3605
3610
3615
3620
3625
3630
Station (ft)
0
100
200
300
400
500
600
700


Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004
RS = 3745.220
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3592
3594
3596
3598
3600
3602
3604
3606
3608
3610
Station (ft)
0
200
400
600
800
1000



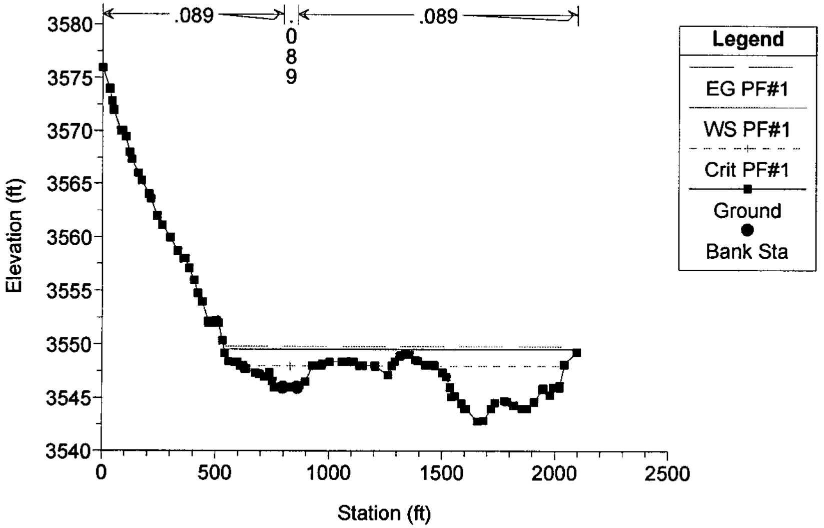
Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004

RS = 3206.879



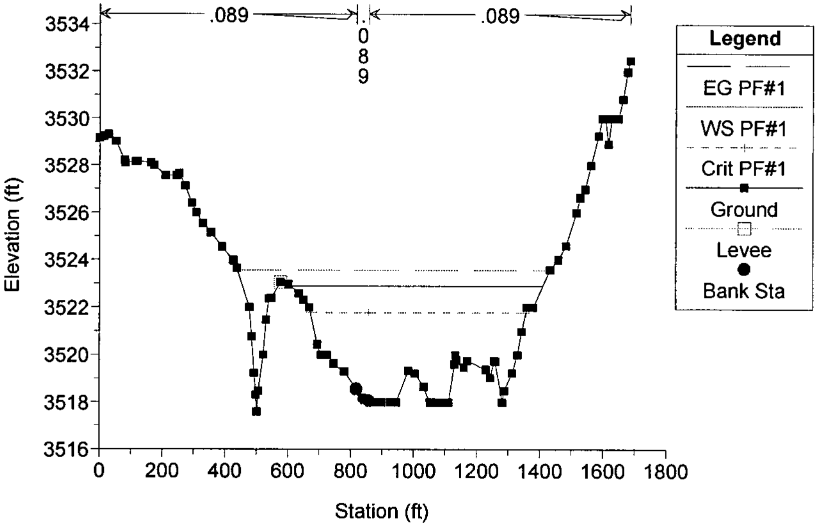
Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004

RS = 2535.671



Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004

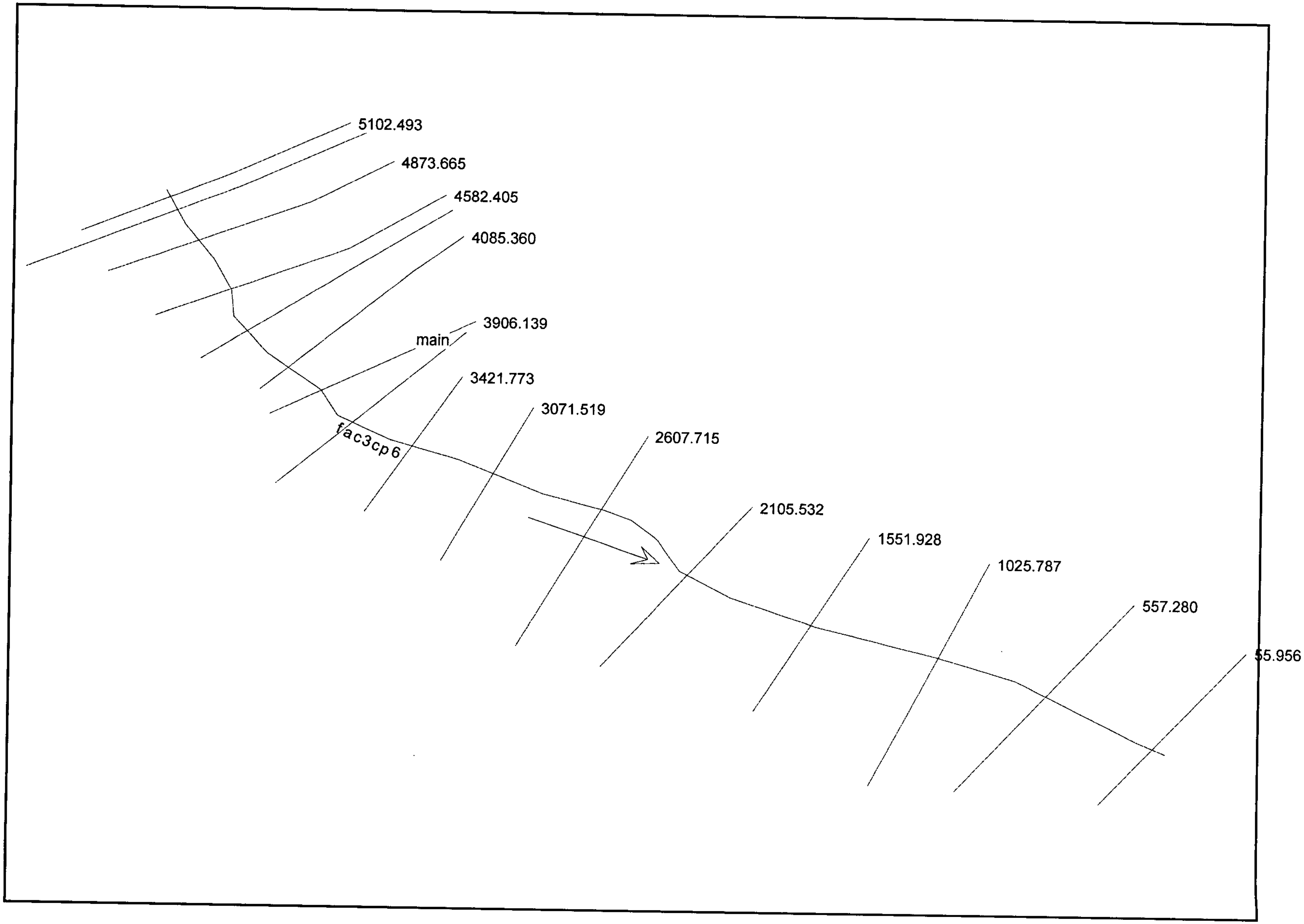
RS = 1446.724



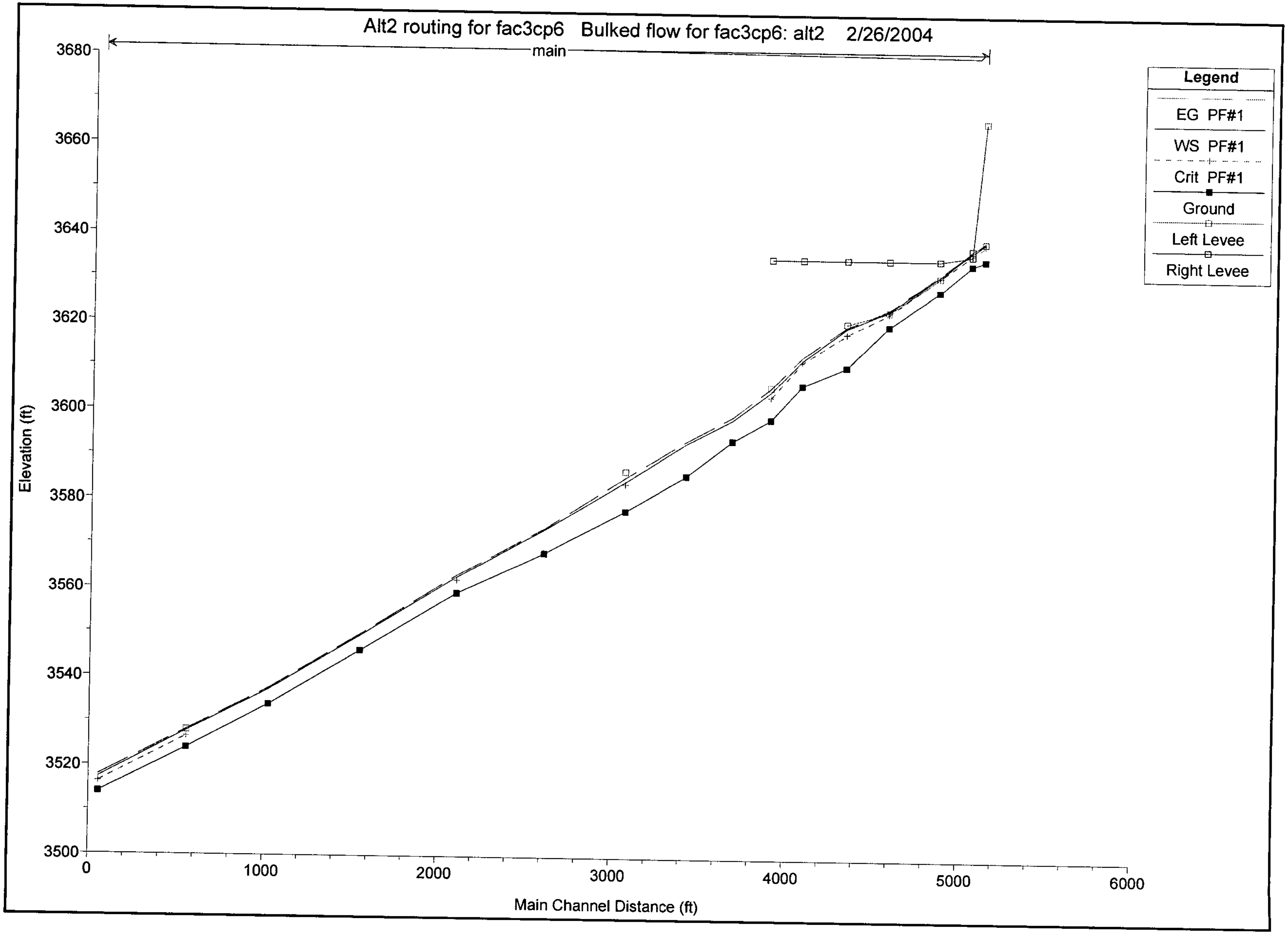
Alt2 routing for cp5cp6 Bulked flow for cp5cp6: alt2 2/26/2004

RS = 180.971

Attachment 23: Hydraulic Calculations for Routing Downstream of North Portal Pad, Alternative 2
(Document ID: 000-00C-CD04-00100-000-00A)

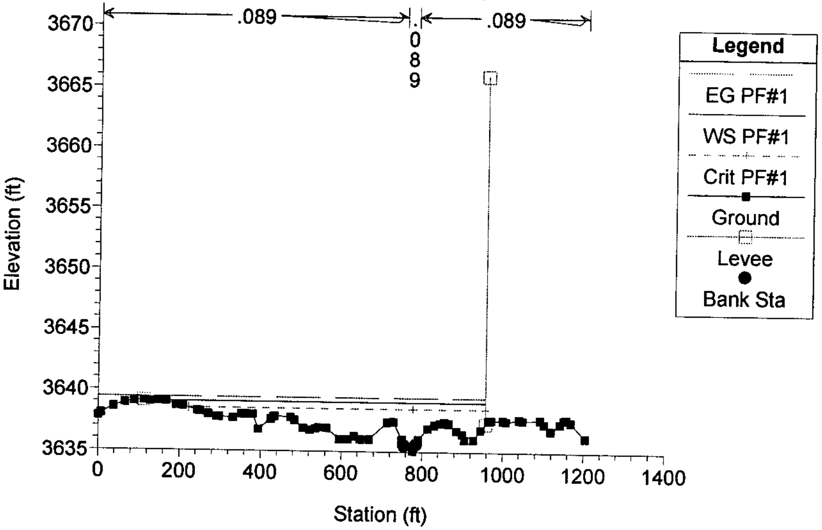

5102.493
4873.665
4582.405
4085.360
3906.139
main
3421.773
3071.519
fac3cp6
2607.715
2105.532
1551.928
1025.787
557.280
55.956

```
Profile Output Table - Standard Table 1
HEC-RAS  Plan: a2_fac3cp6  River: fac3cp6  Reach: main

# Rivers            = 1
# Hydraulic Reaches = 1
# River Stations    = 16
# Plans             = 1
# Profiles          = 1

Reach      River Sta    Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev E.G. Slope  Vel Chnl  Flow Area  Top Width Froude # Chl
                          (cfs)      (ft)       (ft)       (ft)       (ft)    (ft/ft)    (ft/s)    (sq ft)      (ft)

main       5102.493     6980.00    3635.06    3639.03    3638.51    3639.40   0.031133      7.08    1504.37     790.51          0.65
main       5017.680     6980.00    3634.00    3636.98    3636.38    3637.23   0.025676      5.25    1752.93     976.44          0.56
main       4873.665     6980.00    3628.00    3631.59    3631.24    3631.92   0.032024      6.53    1586.77    1033.94          0.64
main       4582.405     6980.00    3620.00    3623.62    3622.94    3623.86   0.023055      5.60    1915.23    1175.73          0.54
main       4340.225     6980.00    3610.72    3619.61    3618.20    3619.92   0.009497      6.19    1796.24     678.53          0.40
main       4085.360     6980.00    3606.53    3612.19    3611.76    3612.95   0.044787      8.37    1028.55     391.30          0.77
main       3906.139     6980.00    3598.79    3605.08    3603.88    3605.93   0.033165      9.59    1077.62     390.66          0.71
main       3687.420     6980.00    3594.00    3598.64               3599.34   0.026950      7.62    1078.67     311.41          0.62
main       3421.773     6980.00    3586.00    3593.26               3593.78   0.014487      6.89    1270.78     302.03          0.48
main       3071.519     6980.00    3578.00    3584.60    3584.06    3585.54   0.032344      9.69    1043.38     384.14          0.71
main       2607.715     6980.00    3568.38    3573.62               3573.91   0.016995      5.67    1667.75     652.27          0.49
main       2105.532     6980.00    3559.21    3562.85    3562.14    3563.25   0.025431      5.44    1449.15     643.42          0.56
main       1551.928     6980.00    3546.00    3549.40               3549.72   0.023655      5.53    1544.21     668.49          0.55
main       1025.787     6980.00    3533.78    3537.10               3537.42   0.023128      5.12    1545.56     677.65          0.53
main       557.280      6980.00    3524.00    3527.76    3526.54    3528.05   0.016738      4.50    1654.32     650.96          0.46
main       55.956       6980.00    3514.00    3517.32    3516.33    3517.81   0.024003      5.50    1268.53     442.31          0.55
```

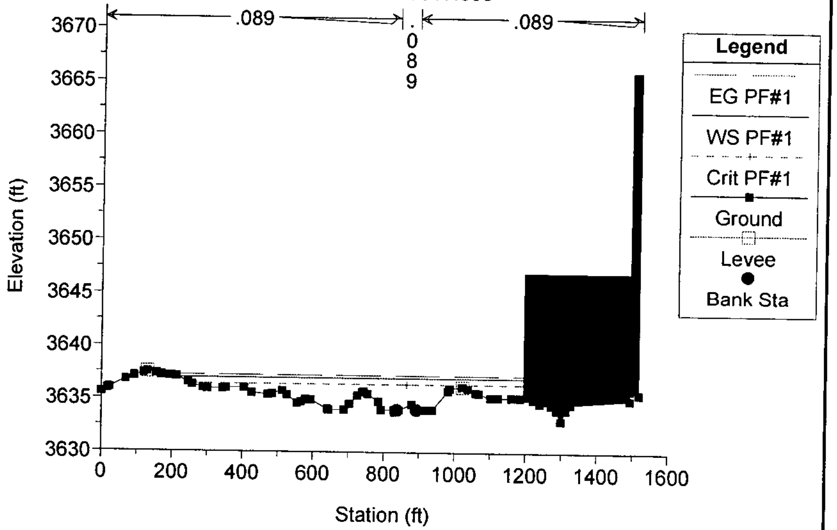


Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A

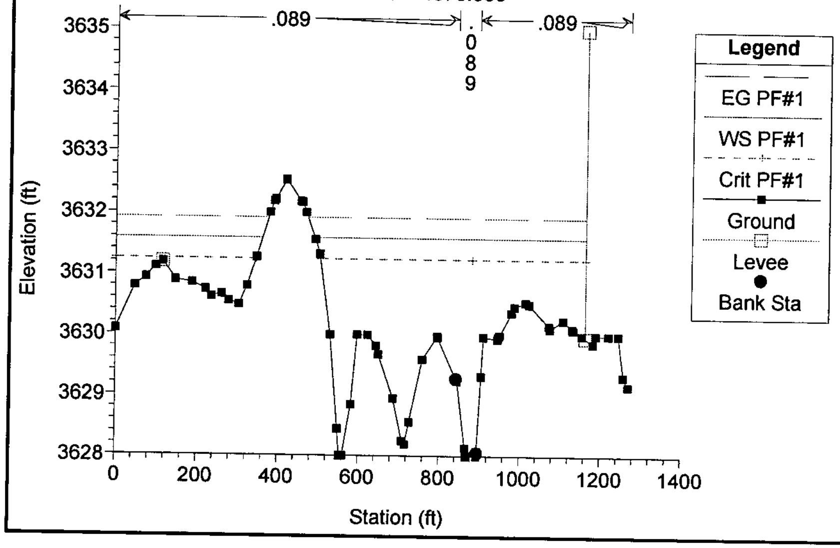
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 5102.493



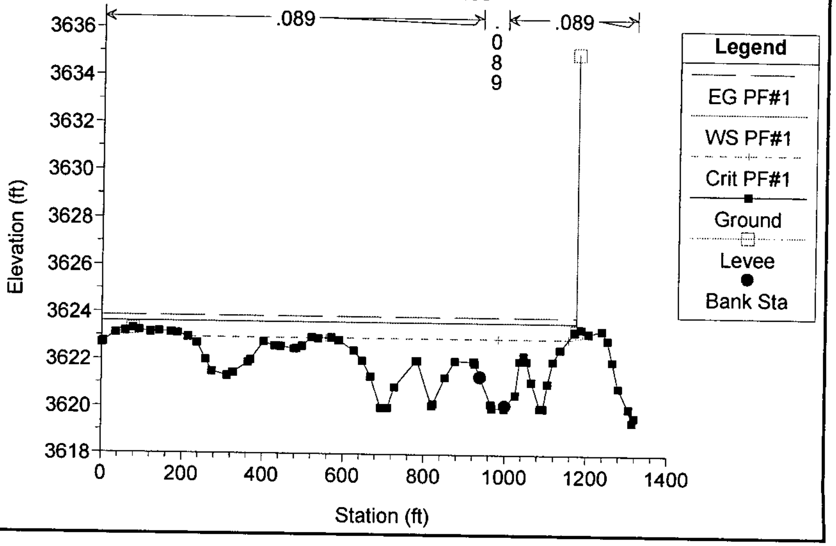
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 5017.680

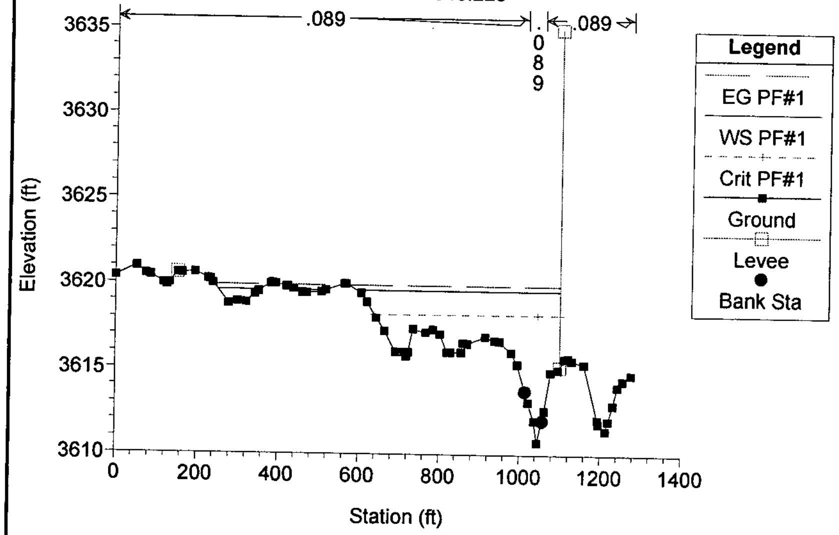


Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 4873.665



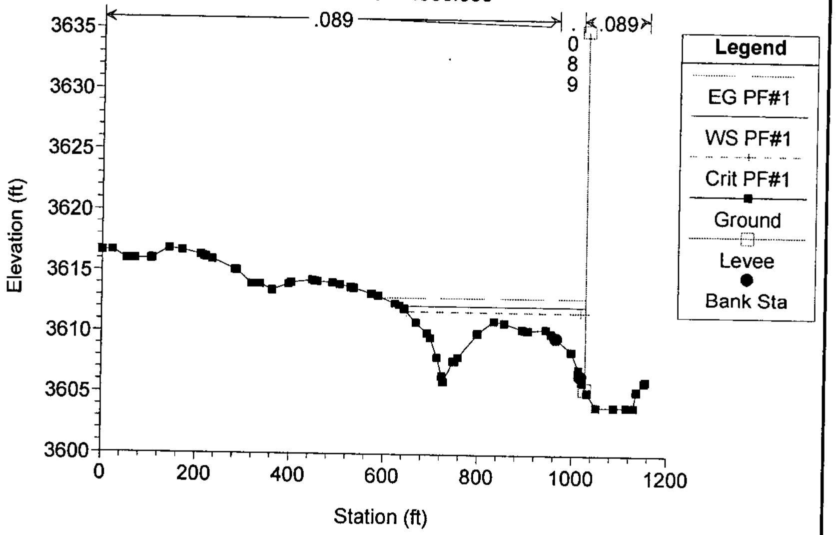
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 4582.405





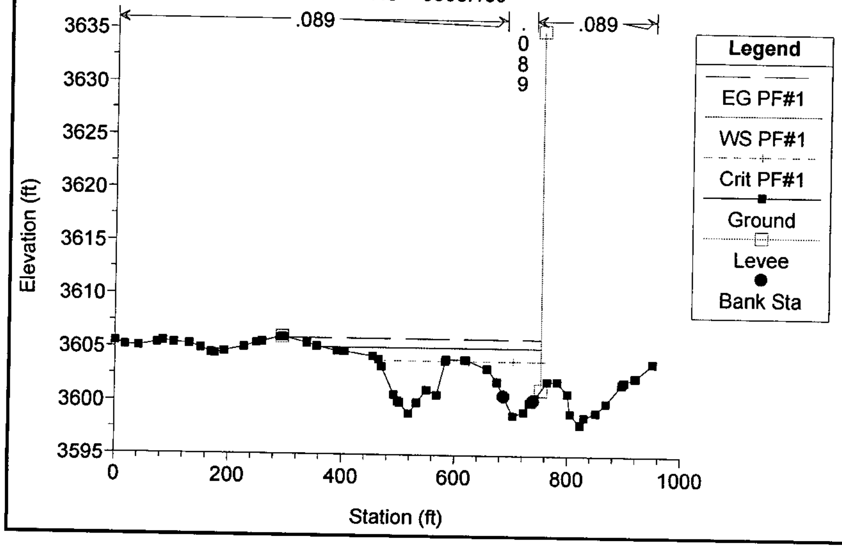
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

RS = 4340.225



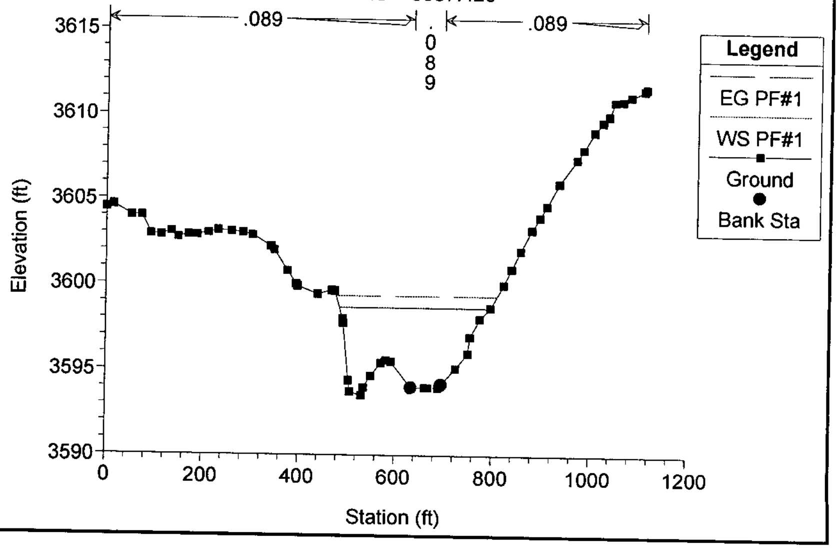
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

RS = 4085.360



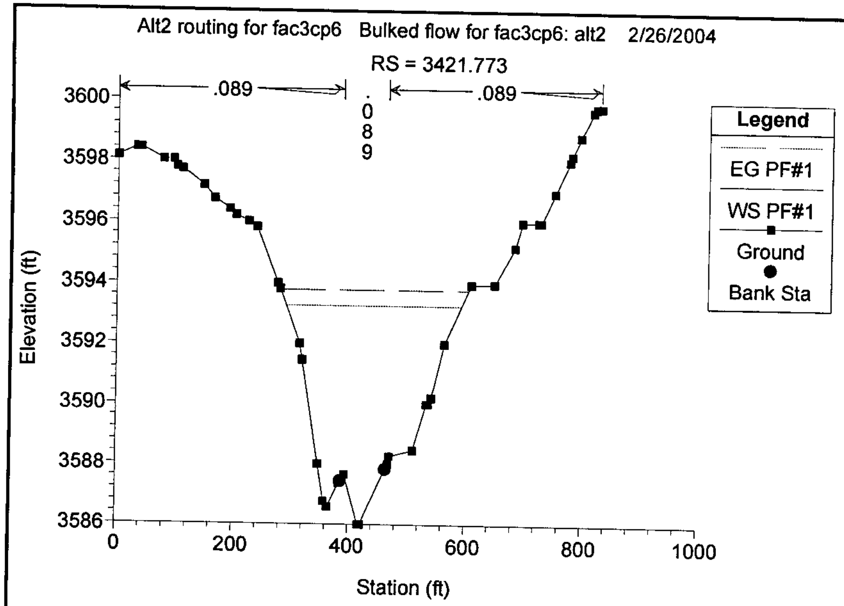
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

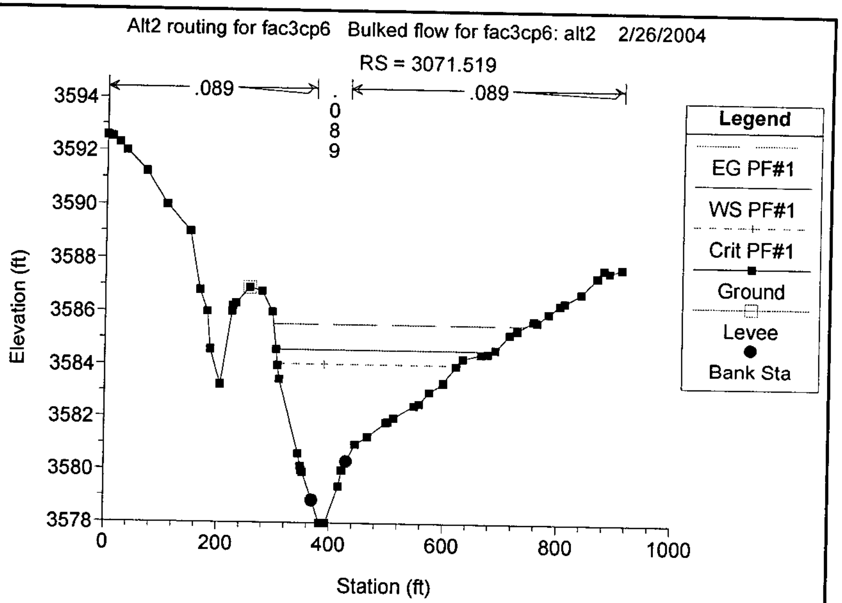
RS = 3906.139

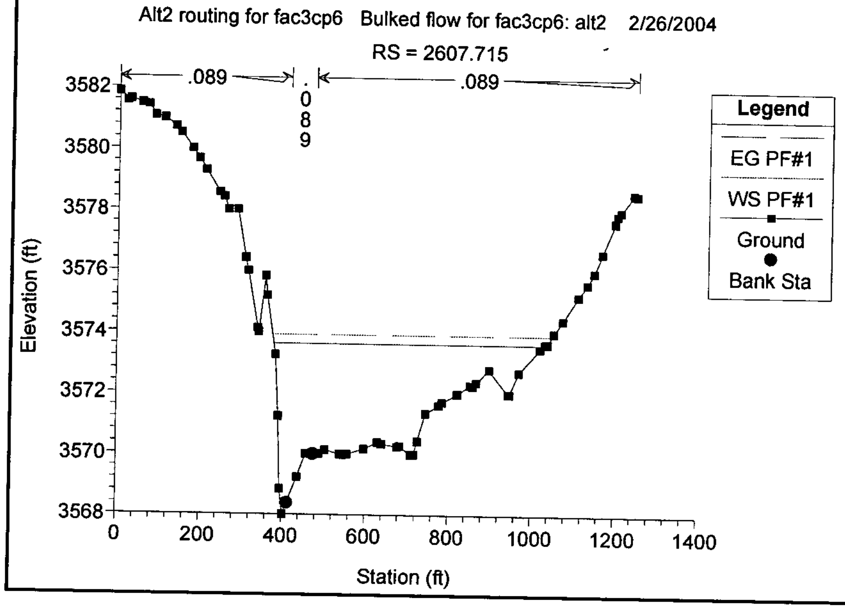


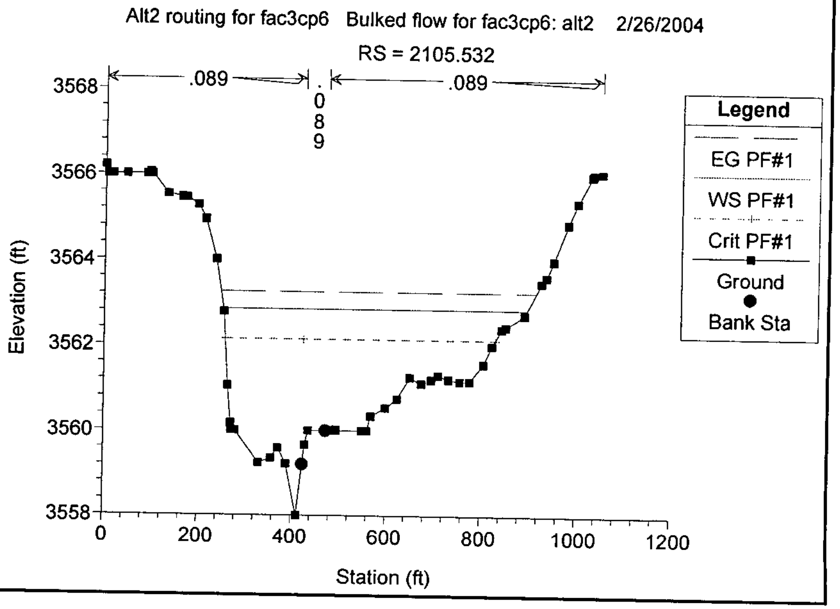
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

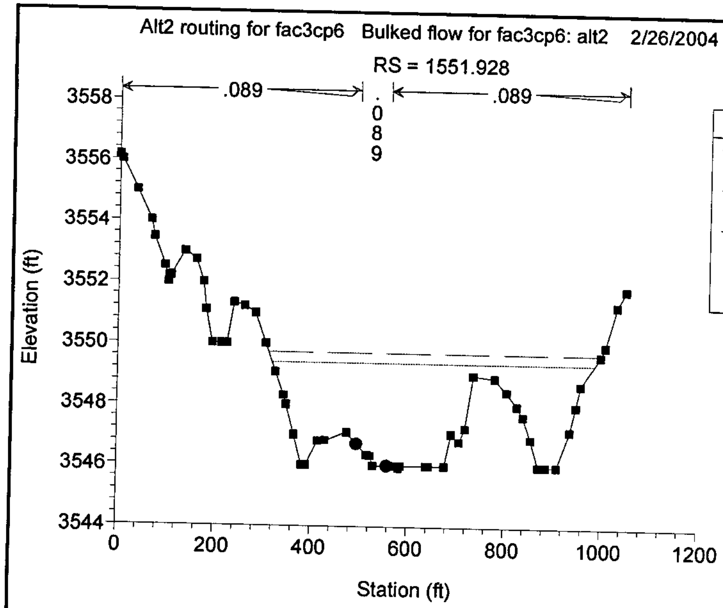
RS = 3687.420


Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 3421.773
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3600
3598
3596
3594
3592
3590
3588
3586
Station (ft)
0
200
400
600
800
1000


Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 3071.519
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3594
3592
3590
3588
3586
3584
3582
3580
3578
Station (ft)
0
200
400
600
800
1000

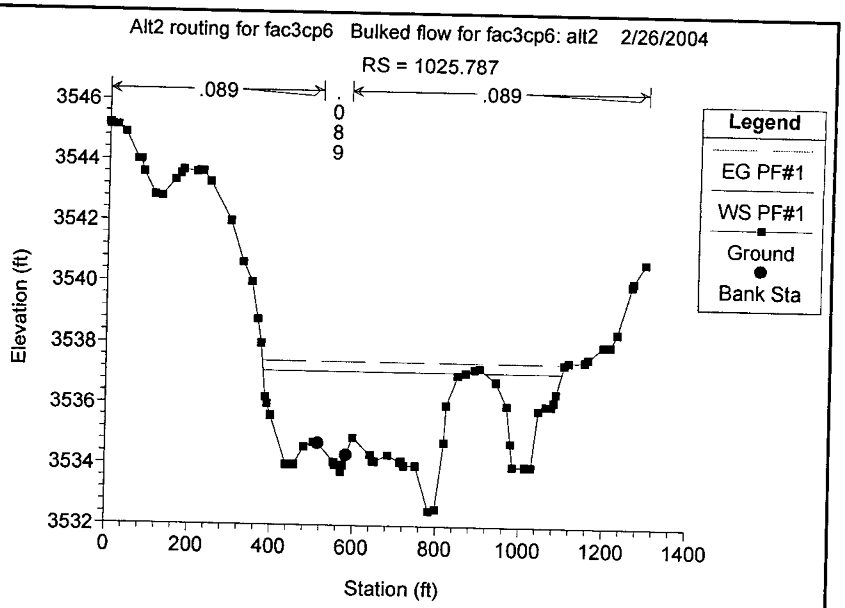

Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 2607.715
.089
.089
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3582
3580
3578
3576
3574
3572
3570
3568
Station (ft)
0
200
400
600
800
1000
1200
1400


Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004
RS = 2105.532
.089
.089
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3568
3566
3564
3562
3560
3558
Station (ft)
0
200
400
600
800
1000
1200



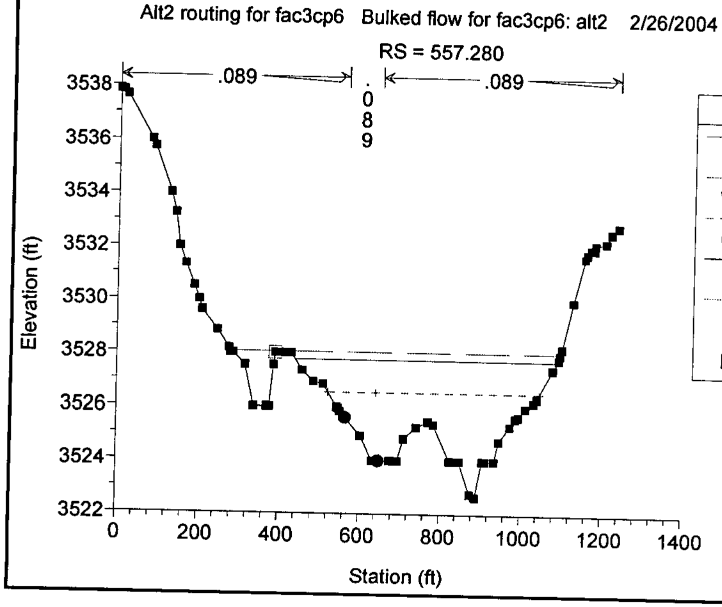
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

RS = 1551.928



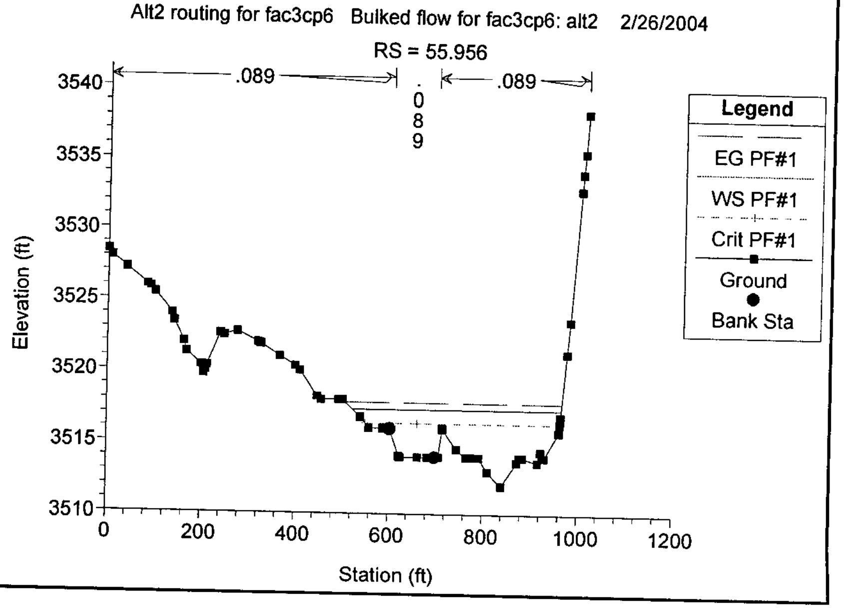
Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

RS = 1025.787



Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

RS = 557.280

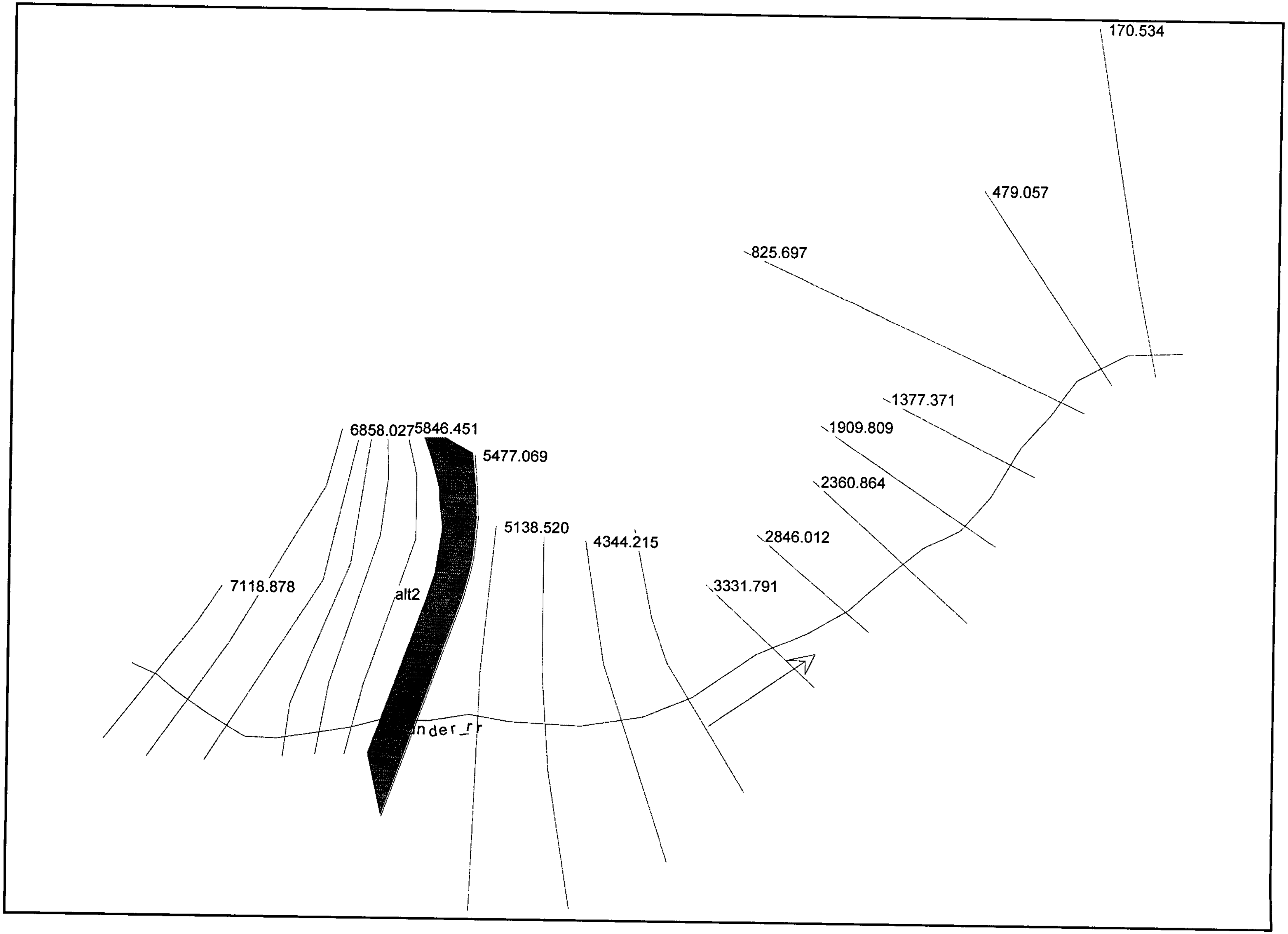


Alt2 routing for fac3cp6 Bulked flow for fac3cp6: alt2 2/26/2004

RS = 55.956

Attachment 24: Hydraulic Calculations for Routing Near Railroad Bridge Crossing, Alternative 2

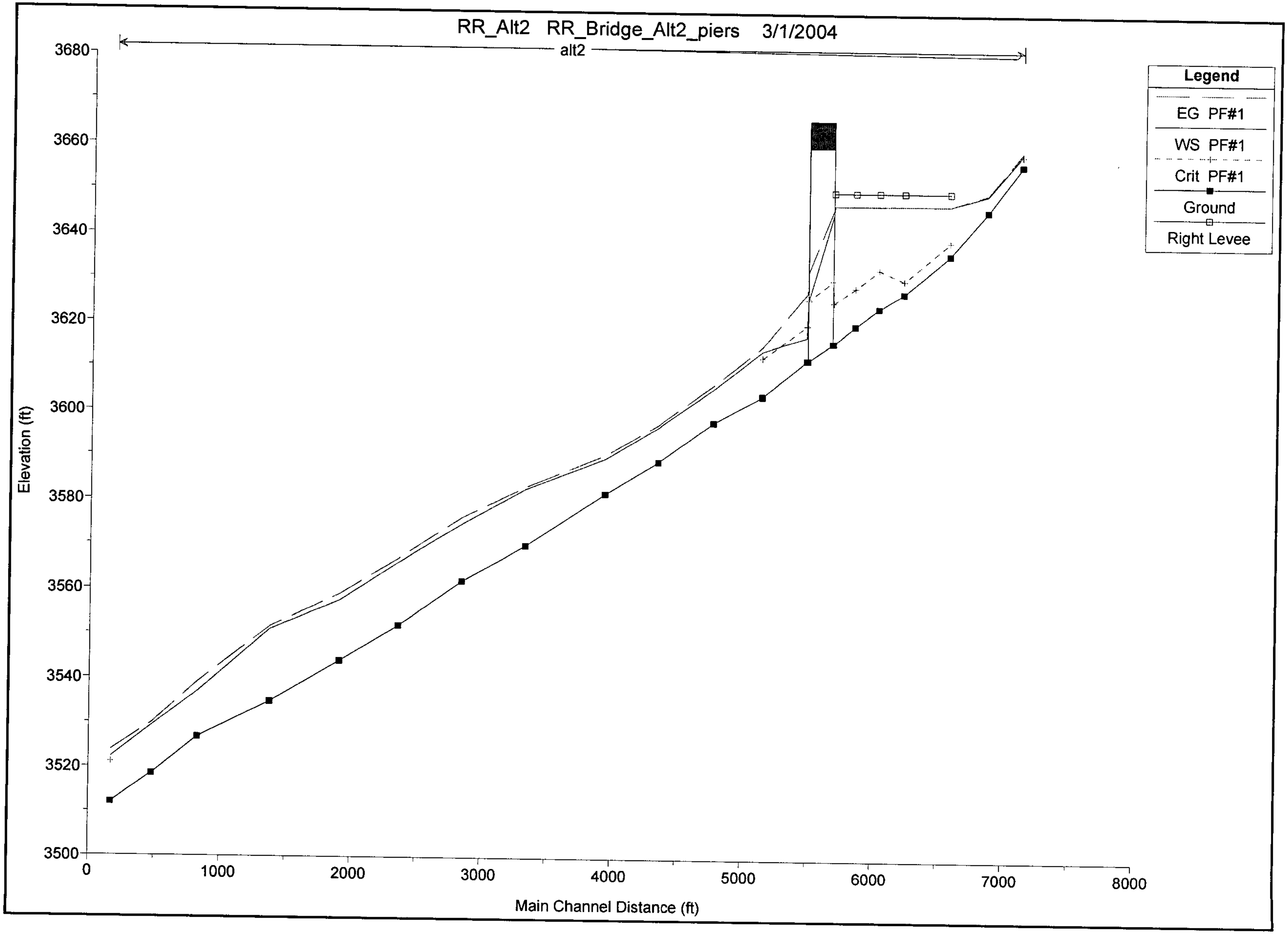
(Document ID: 000-00C-CD04-00100-000-00A)

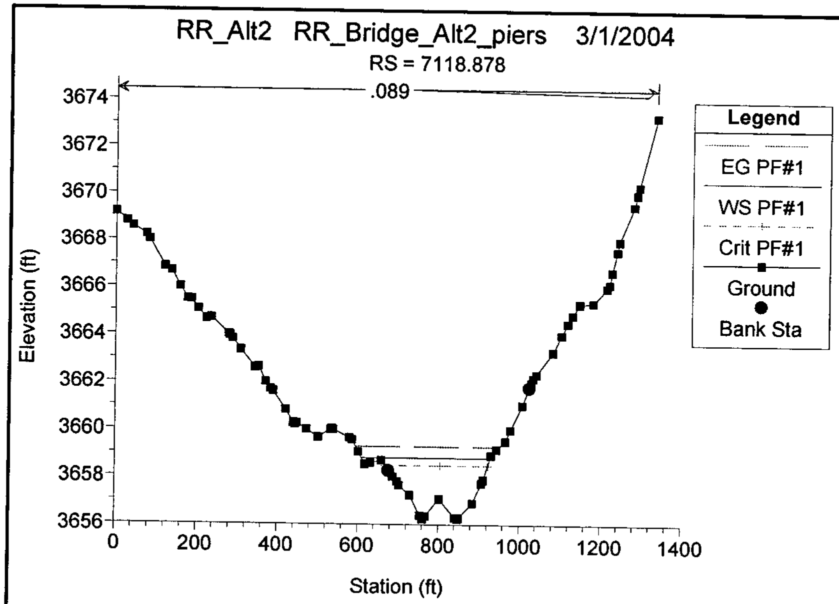

170.534
479.057
825.697
1377.371
1909.809
2360.864
2846.012
3331.791
4344.215
5138.520
5477.069
5846.451
6858.027
7118.878
alt2
under_rr

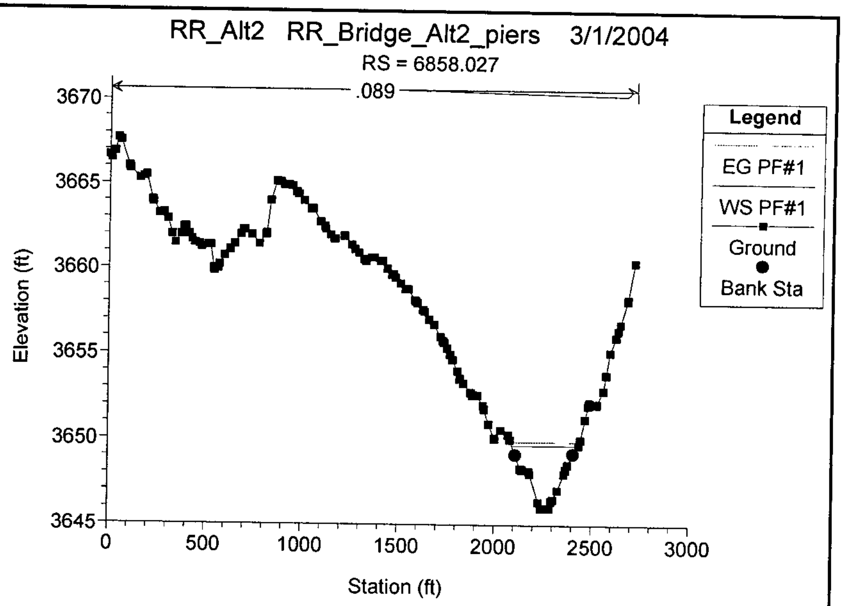
HEC-RAS Output for Routing Under Railroad Bridge, Alternative 2

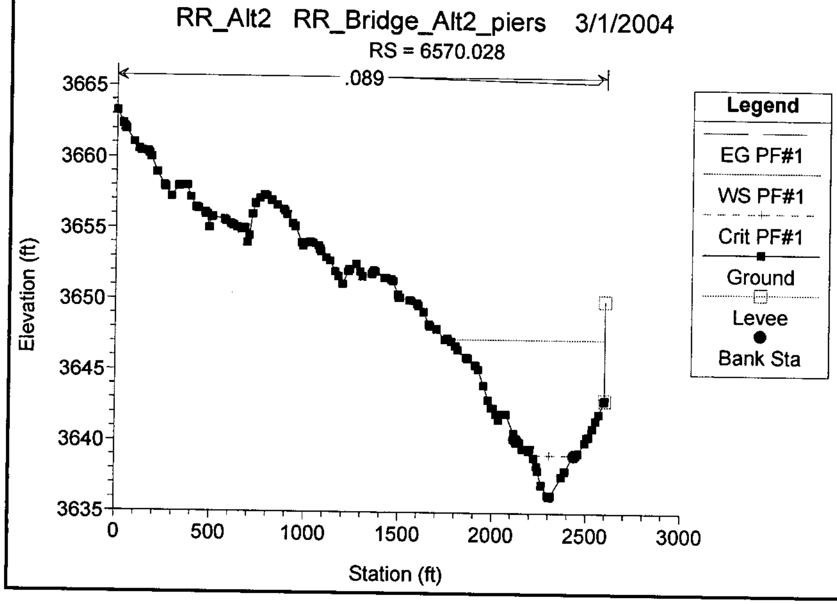
HEC-RAS Plan: plan3 River: under_rr Reach: alt2

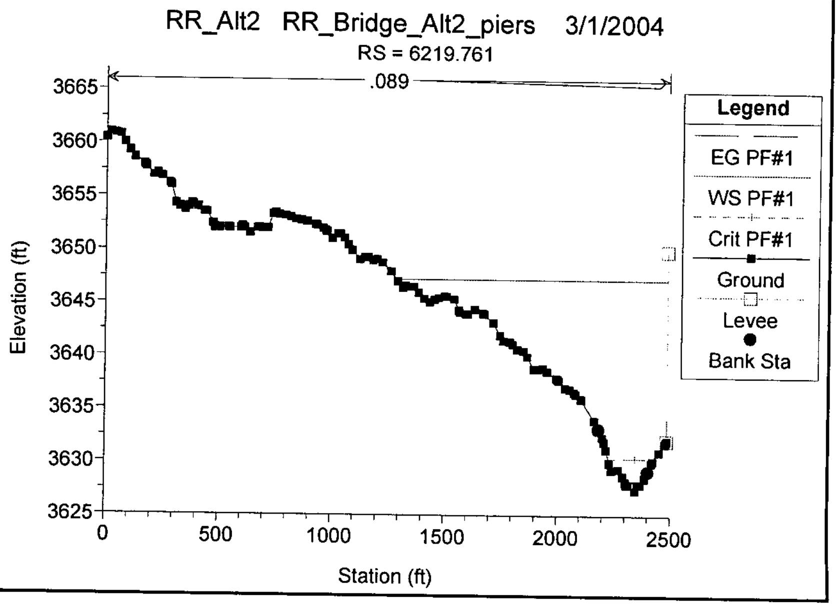
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Max Chl Dpth	Invert Slope
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	
alt2	7118.878	2486	3656.22	3658.79	3658.47	3659.27	0.053886	5.6	454.08	319.65	0.75	2.57	0.4129
alt2	6858.027	2486	3646	3649.66		3649.88	0.017609	3.76	669.79	343.68	0.45	3.66	0.3737
alt2	6570.028	2486	3636.17	3647.26	3639.1	3647.27	0.000065	0.59	5040.69	835.53	0.03	11.09	0.3396
alt2	6219.761	2486	3627.41	3647.25	3630.43	3647.26	0.000009	0.34	10270.6	1197.51	0.01	19.84	0.3146
alt2	6028.322	22470	3624	3647.17	3632.86	3647.22	0.000298	2.15	14663.79	1388.87	0.08	23.17	0.2968
alt2	5846.451	22470	3620	3647.16	3628.66	3647.18	0.000094	1.35	24813.68	2217.36	0.05	27.16	0.2748
alt2	5680.882	22470	3616	3647.15	3625.29	3647.16	0.00004	0.95	33714.25	2358.41	0.03	31.15	0.2506
alt2	5580	Bridge											
alt2	5477.069	22470	3612.15	3617.47	3620.07	3627.36	0.544806	25.39	901.87	330.1	2.6	5.32	0.2304
alt2	5138.52	22470	3604	3614.18	3612.64	3615.18	0.020596	8.43	3052.76	717.27	0.58	10.18	0.2063
alt2	4765.212	22470	3598	3605.56		3606.46	0.0257	8.22	3107.76	768.23	0.62	7.56	0.1902
alt2	4344.215	22470	3589.07	3596.87		3597.45	0.015766	6.6	3798.33	864.28	0.49	7.8	0.169
alt2	3938.028	25150	3581.77	3589.68		3590.48	0.017869	7.21	3545.6	714.12	0.53	7.91	0.151
alt2	3331.791	25150	3570	3582.71		3583.18	0.005978	5.63	4780.4	655.99	0.33	12.71	0.1316
alt2	2846.012	25150	3562	3574.77		3576.23	0.022201	9.95	2711.36	449.85	0.62	12.77	0.1152
alt2	2360.864	25150	3552	3566.13		3567.06	0.014803	8.21	3602.81	719.43	0.51	14.13	0.0945
alt2	1909.809	25150	3544	3557.57		3559	0.020592	10.18	2832.3	477.97	0.61	13.57	0.0768
alt2	1377.371	25150	3534.83	3551		3551.65	0.006358	7.25	4367.44	617.07	0.36	16.17	0.0596
alt2	825.697	25150	3526.81	3536.95		3539.11	0.03854	12.37	2268.69	419.41	0.8	10.89	0.045
alt2	479.057	25150	3518.52	3529.32		3529.92	0.009507	7.09	4305.31	679.53	0.41	10.8	0.0211
alt2	170.534	25150	3512	3522.27	3521.11	3523.82	0.028031	10.4	2707.62	556.26	0.68	10.27	


RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
alt2
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Right Levee
Elevation (ft)
3680
3660
3640
3620
3600
3580
3560
3540
3520
3500
0
1000
2000
3000
4000
5000
6000
7000
8000
Main Channel Distance (ft)


RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 7118.878
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3674
3672
3670
3668
3666
3664
3662
3660
3658
3656
Station (ft)
0
200
400
600
800
1000
1200
1400

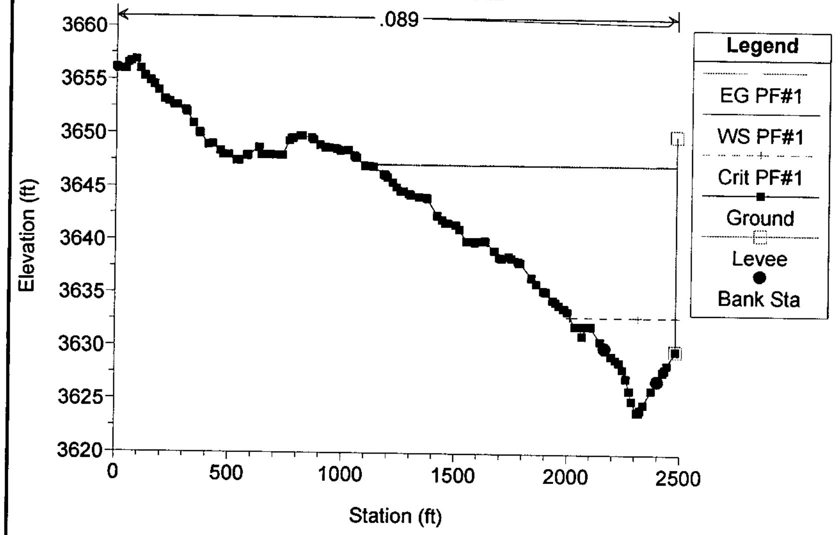

RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 6858.027
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3670
3665
3660
3655
3650
3645
Station (ft)
0
500
1000
1500
2000
2500
3000


RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 6570.028
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3665
3660
3655
3650
3645
3640
3635
Station (ft)
0
500
1000
1500
2000
2500
3000


RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 6219.761
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
Elevation (ft)
3665
3660
3655
3650
3645
3640
3635
3630
3625
Station (ft)
0
500
1000
1500
2000
2500

RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

RS = 6028.322



RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

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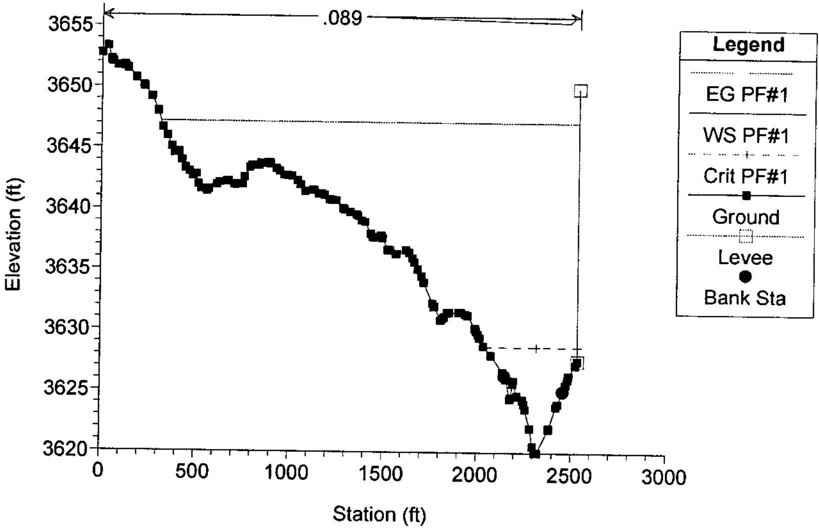
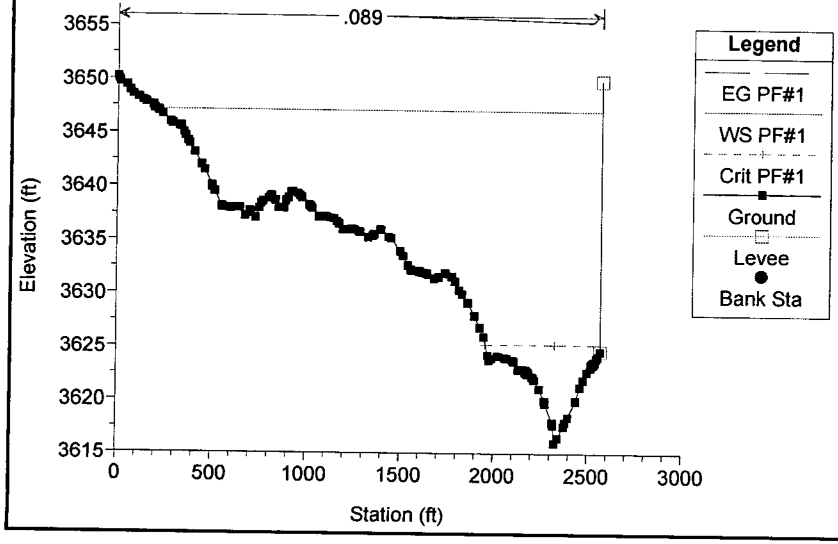


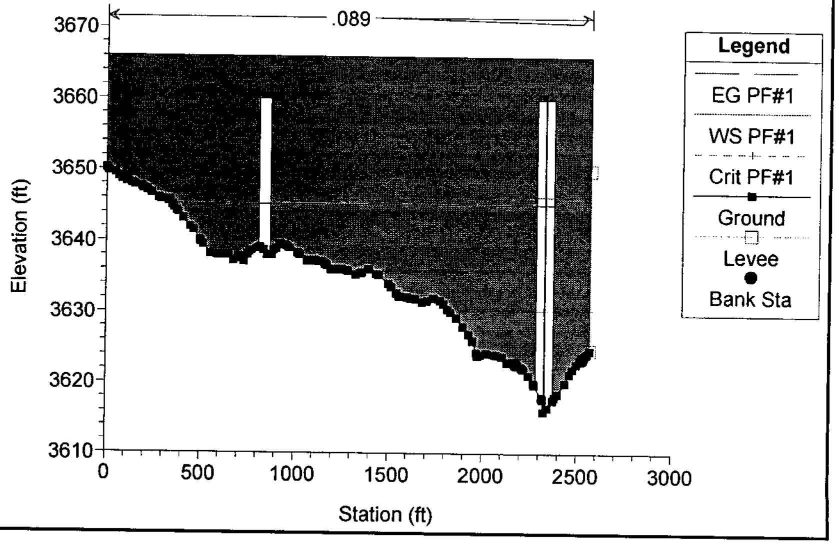
RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

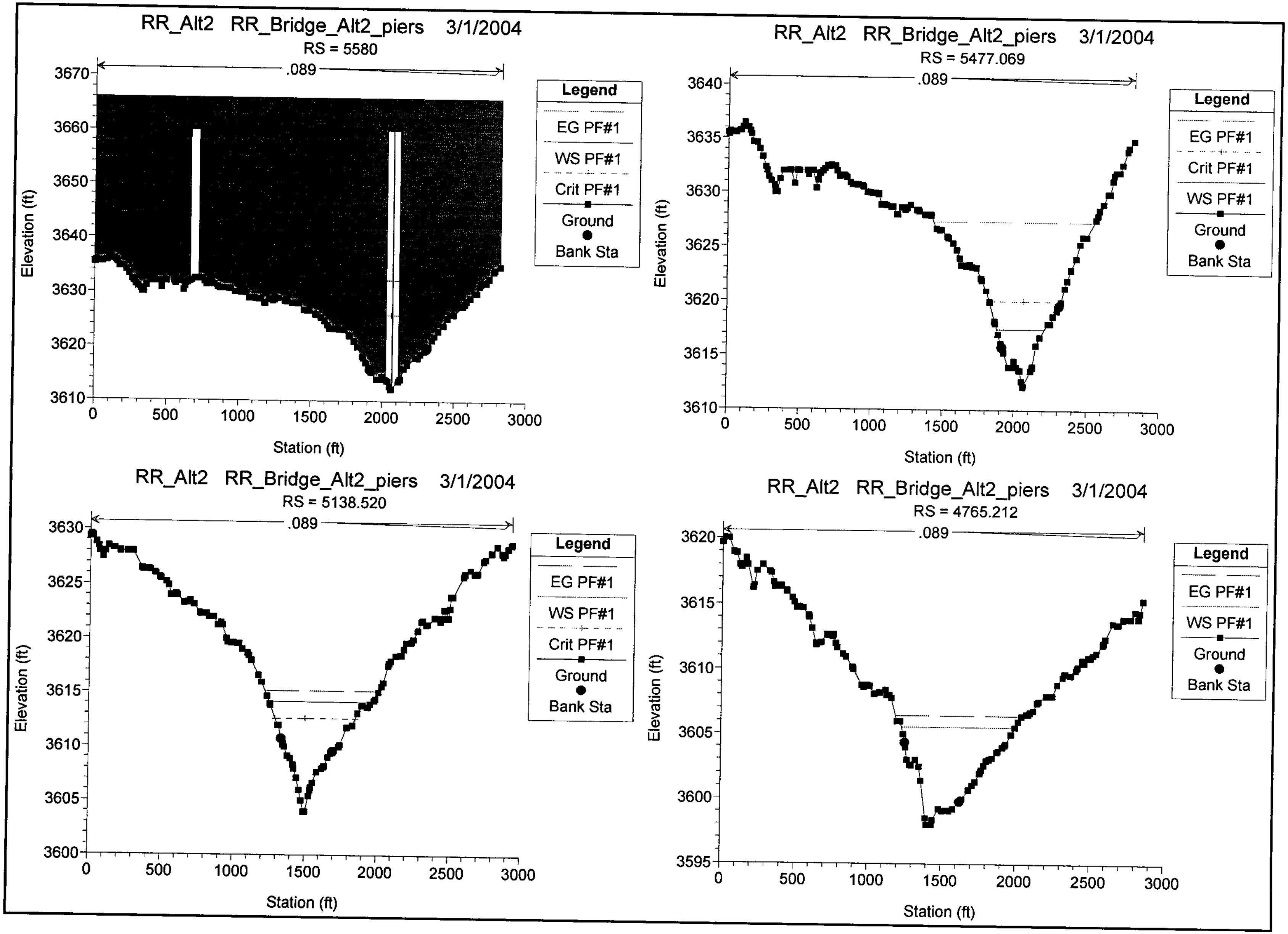
RS = 5680.882

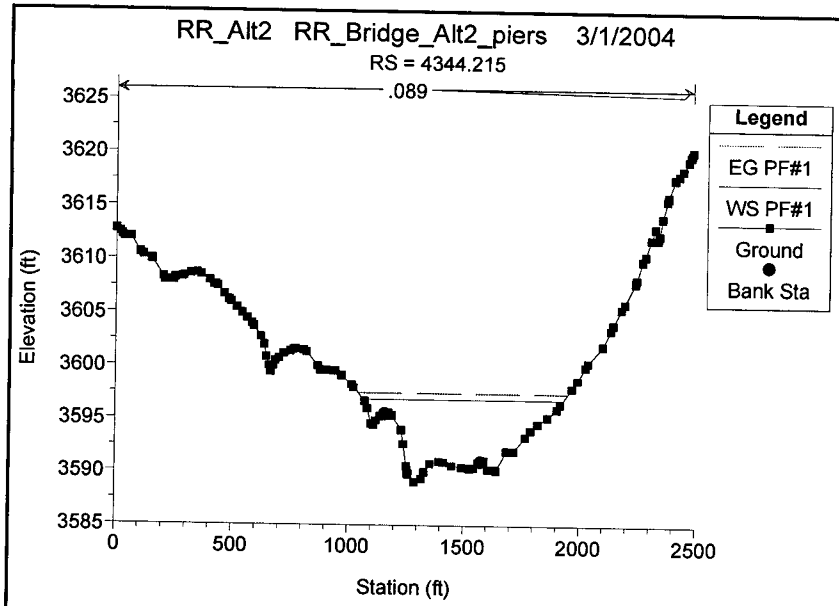


RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

RS = 5580




RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 5580
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3610
3620
3630
3640
3650
3660
3670
Station (ft)
0
500
1000
1500
2000
2500
3000
RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 5477.069
.089
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3610
3615
3620
3625
3630
3635
3640
Station (ft)
0
500
1000
1500
2000
2500
3000
RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 5138.520
.089
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
Elevation (ft)
3600
3605
3610
3615
3620
3625
3630
Station (ft)
0
500
1000
1500
2000
2500
3000
RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 4765.212
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3595
3600
3605
3610
3615
3620
Station (ft)
0
500
1000
1500
2000
2500
3000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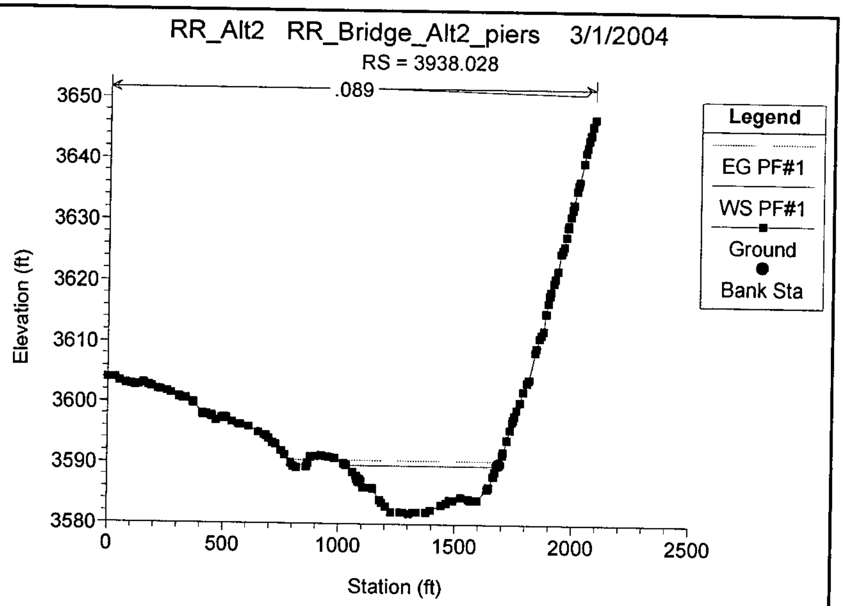
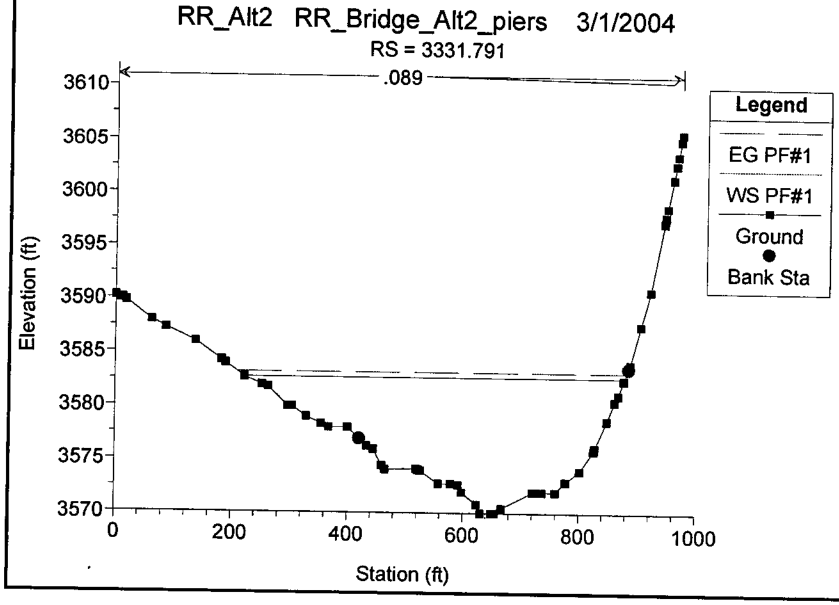

RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

RS = 3938.028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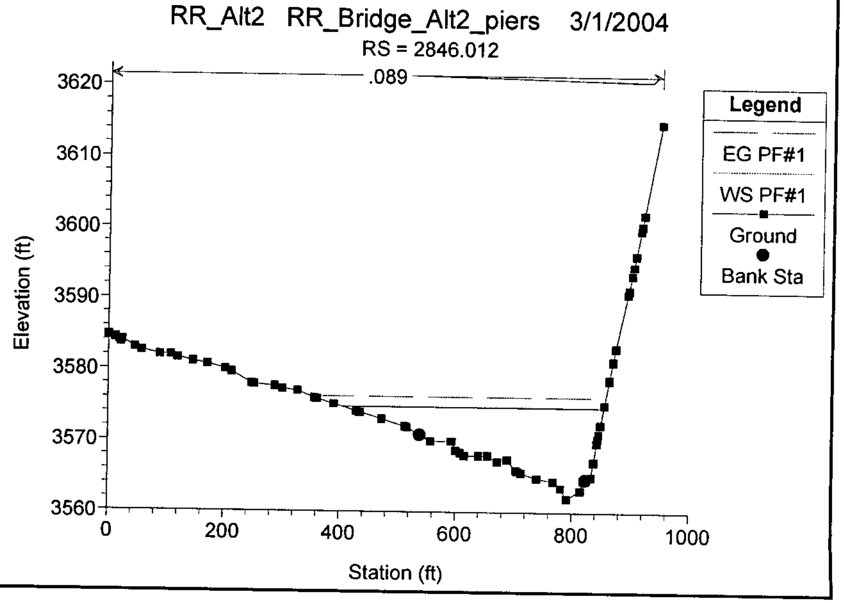
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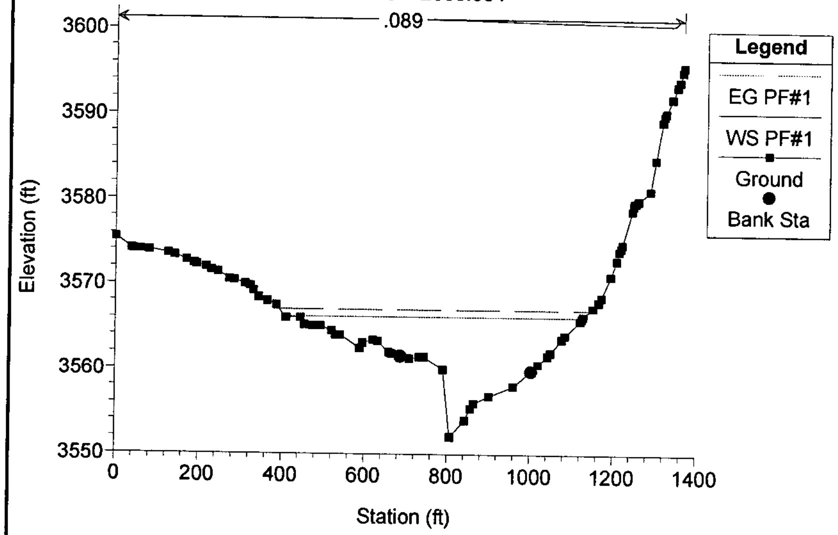
RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

RS = 2360.864



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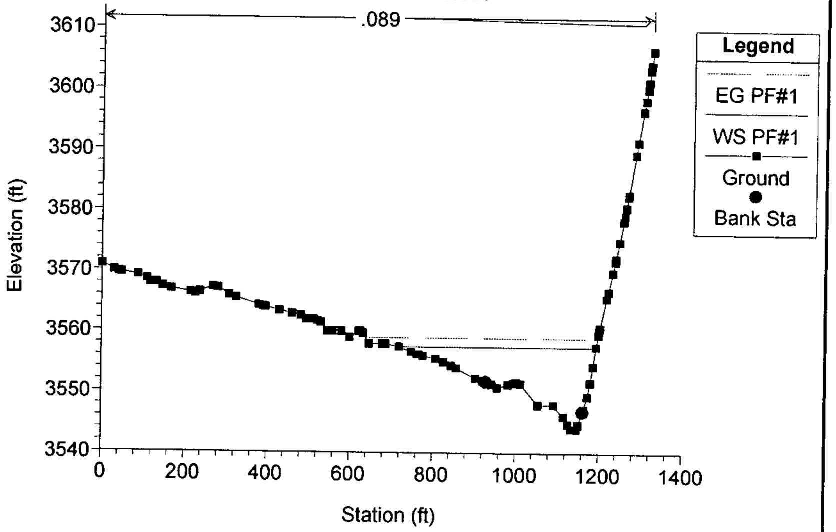

RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

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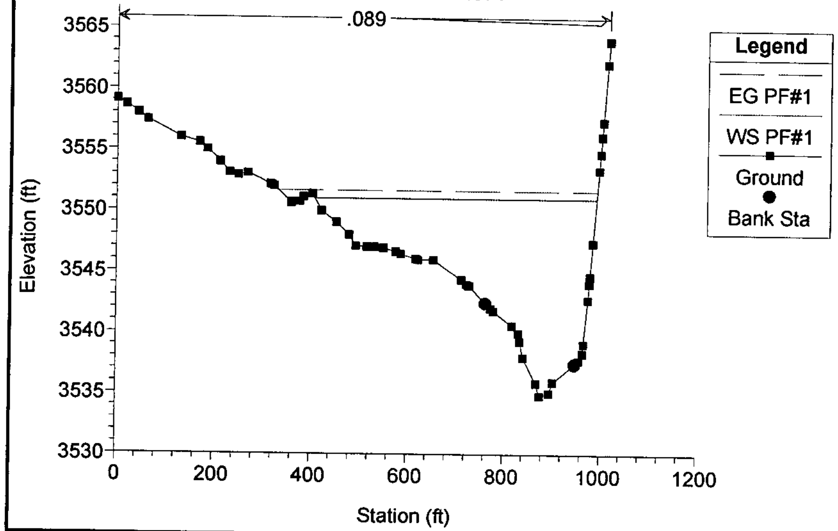

RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004

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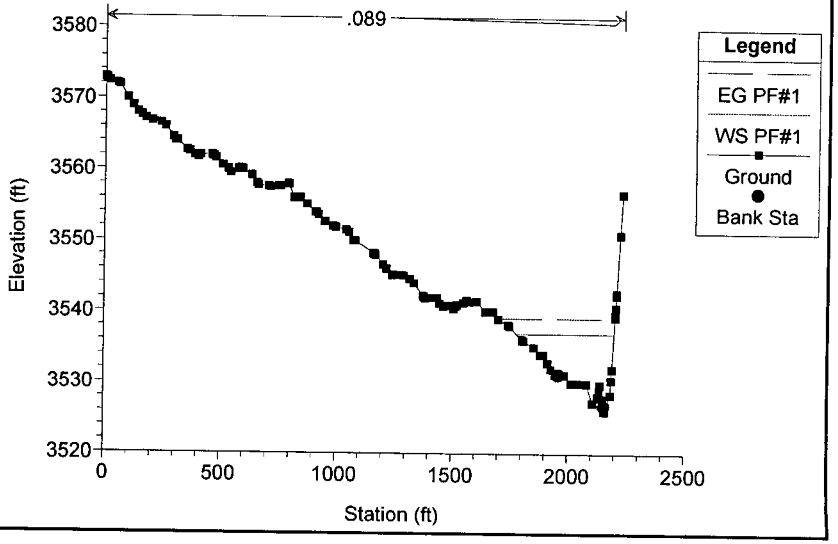
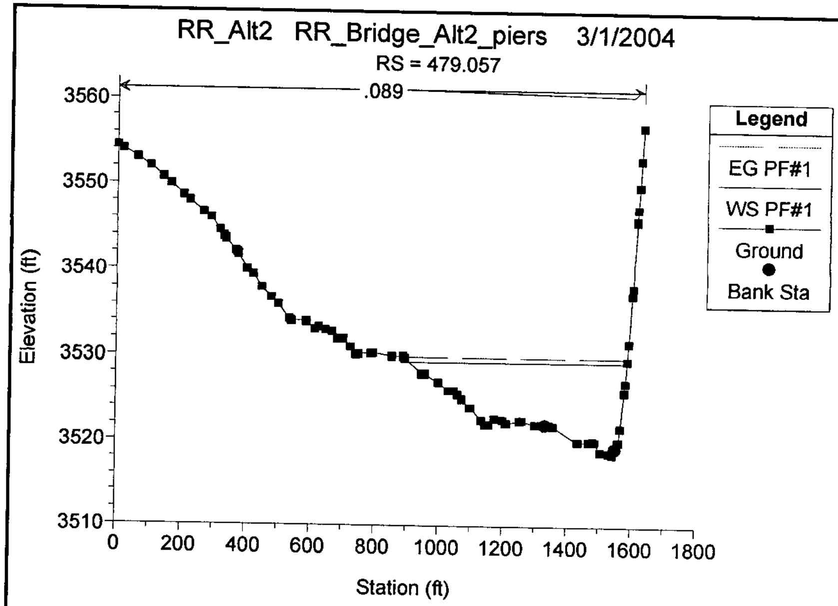


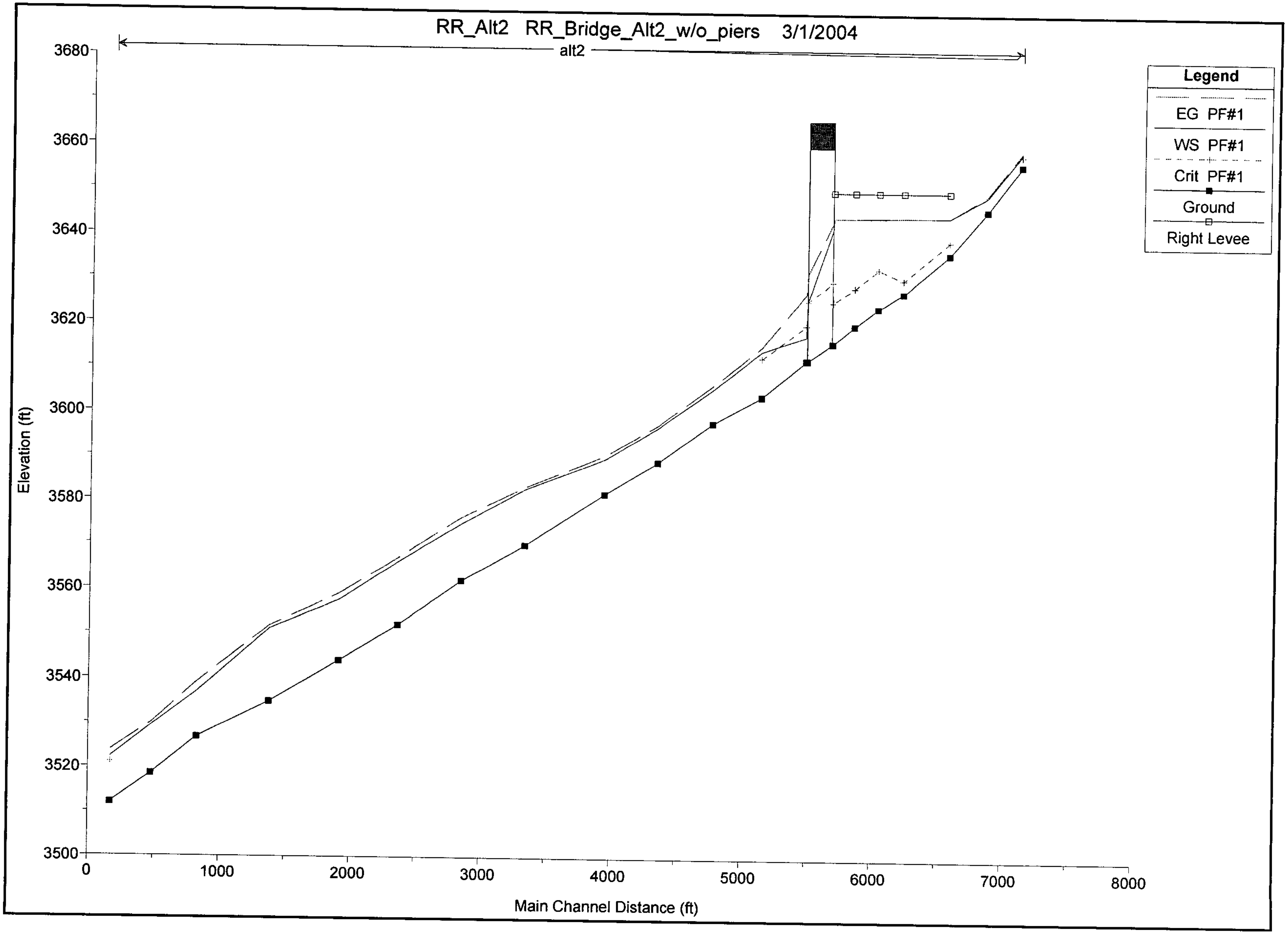

RR_Alt2 RR_Bridge_Alt2_piers 3/1/2004
RS = 479.057
.089
Legend
EG PF#1
WS PF#1
Ground
Bank Sta
Elevation (ft)
3560
3550
3540
3530
3520
3510
0
200
400
600
800
1000
1200
1400
1600
1800
Station (ft)

HEC-RAS Output for Clear Span Scenario for Alternative 2

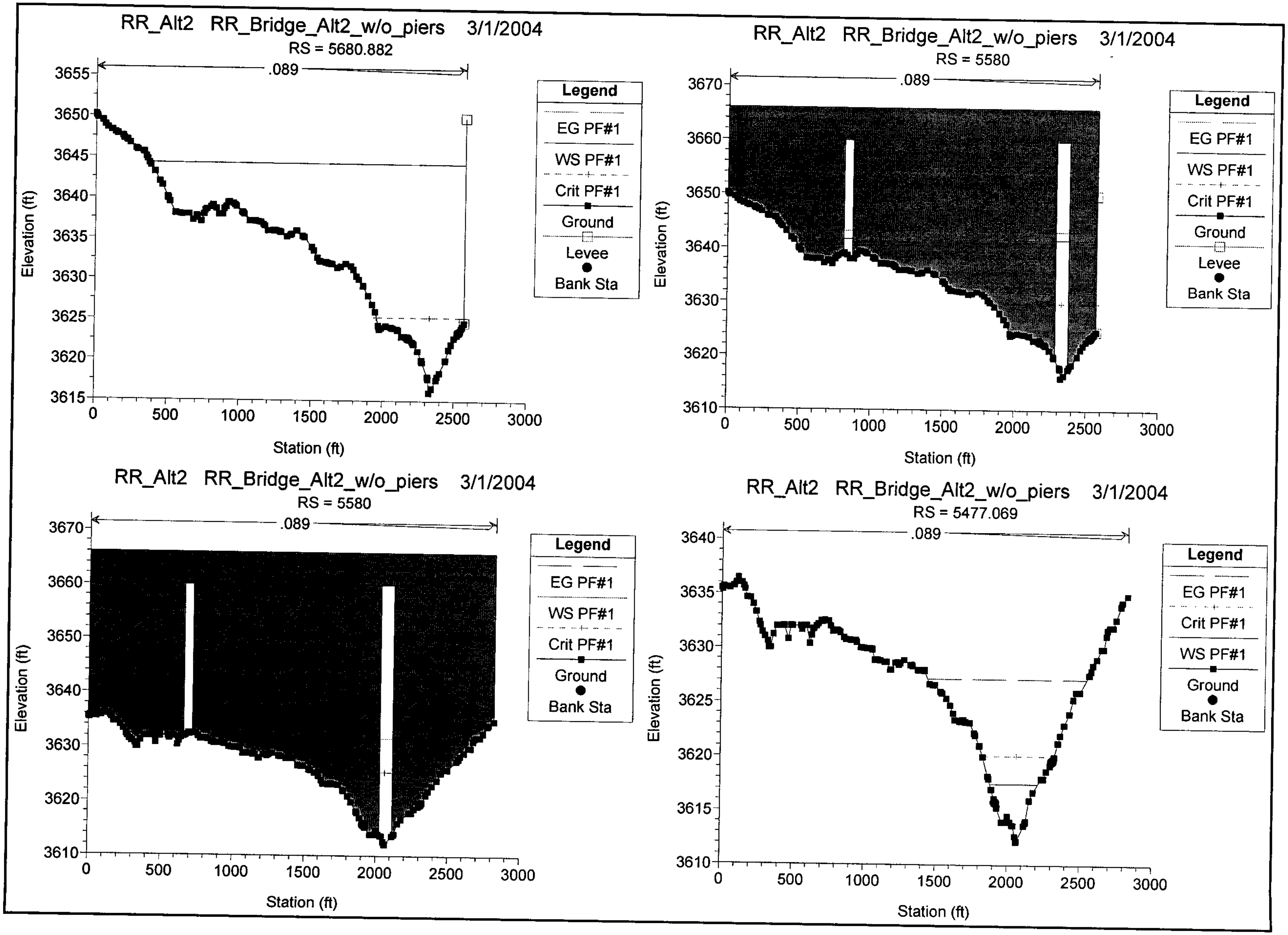
HEC-RAS Plan: w/o piers River: under_rr Reach: alt2

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Max Chl Dpth	Invert Slope
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	
alt2	7118.878	2486	3656.22	3658.95	3658.47	3659.34	0.040398	5.09	505.31	328.9	0.66	2.73	0.4129
alt2	6858.027	2486	3646	3649.27		3649.59	0.034327	4.6	540.53	307.15	0.6	3.27	0.3737
alt2	6570.028	2486	3636.17	3644.51	3639.1	3644.53	0.000272	0.94	3022.76	658.11	0.07	8.34	0.3396
alt2	6219.761	2486	3627.41	3644.47	3630.43	3644.47	0.000019	0.45	7312.3	923.94	0.02	17.06	0.3146
alt2	6028.322	22470	3624	3644.32	3632.86	3644.41	0.000604	2.77	11029.08	1176.09	0.12	20.32	0.2968
alt2	5846.451	22470	3620	3644.28	3628.66	3644.31	0.000205	1.83	18554.51	2112.68	0.07	24.28	0.2748
alt2	5680.882	22470	3616	3644.27	3625.29	3644.29	0.000073	1.19	27185.71	2197.73	0.04	28.27	0.2506
alt2	5580	Bridge											
alt2	5477.069	22470	3612.15	3617.5	3620.07	3627.17	0.528484	25.1	912.46	332.19	2.56	5.35	0.2304
alt2	5138.52	22470	3604	3614.18	3612.64	3615.18	0.020596	8.43	3052.76	717.27	0.58	10.18	0.2063
alt2	4765.212	22470	3598	3605.56		3606.46	0.0257	8.22	3107.76	768.23	0.62	7.56	0.1902
alt2	4344.215	22470	3589.07	3596.87		3597.45	0.015766	6.6	3798.33	864.28	0.49	7.8	0.169
alt2	3938.028	25150	3581.77	3589.68		3590.48	0.017869	7.21	3545.6	714.12	0.53	7.91	0.151
alt2	3331.791	25150	3570	3582.71		3583.18	0.005978	5.63	4780.4	655.99	0.33	12.71	0.1316
alt2	2846.012	25150	3562	3574.77		3576.23	0.022201	9.95	2711.36	449.85	0.62	12.77	0.1152
alt2	2360.864	25150	3552	3566.13		3567.06	0.014803	8.21	3602.81	719.43	0.51	14.13	0.0945
alt2	1909.809	25150	3544	3557.57		3559	0.020592	10.18	2832.3	477.97	0.61	13.57	0.0768
alt2	1377.371	25150	3534.83	3551		3551.65	0.006358	7.25	4367.44	617.07	0.36	16.17	0.0596
alt2	825.697	25150	3526.81	3536.95		3539.11	0.03854	12.37	2268.69	419.41	0.8	10.89	0.045
alt2	479.057	25150	3518.52	3529.32		3529.92	0.009507	7.09	4305.31	679.53	0.41	10.8	0.0211
alt2	170.534	25150	3512	3522.27	3521.11	3523.82	0.028031	10.4	2707.62	556.26	0.68	10.27	

These results show how water surface elevations upstream of the railroad bridge would be nearly 3 ft. lower if both bridges were constructed as clear spans.



Title: Hydrologic Engineering Studies for the North Portal Pad and Vicinity
Document ID: 000-00C-CD04-00100-000-00A


RR_Alt2 RR_Bridge_Alt2_w/o_piers 3/1/2004
RS = 5680.882
.089
Elevation (ft)
3655
3650
3645
3640
3635
3630
3625
3620
3615
Station (ft)
0
500
1000
1500
2000
2500
3000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
RR_Alt2 RR_Bridge_Alt2_w/o_piers 3/1/2004
RS = 5580
.089
Elevation (ft)
3670
3660
3650
3640
3630
3620
3610
Station (ft)
0
500
1000
1500
2000
2500
3000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Levee
Bank Sta
RR_Alt2 RR_Bridge_Alt2_w/o_piers 3/1/2004
RS = 5580
.089
Elevation (ft)
3670
3660
3650
3640
3630
3620
3610
Station (ft)
0
500
1000
1500
2000
2500
3000
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Bank Sta
RR_Alt2 RR_Bridge_Alt2_w/o_piers 3/1/2004
RS = 5477.069
.089
Elevation (ft)
3640
3635
3630
3625
3620
3615
3610
Station (ft)
0
500
1000
1500
2000
2500
3000
Legend
EG PF#1
Crit PF#1
WS PF#1
Ground
Bank Sta

Attachment 25: Scour Analysis, Alternative 2
(Document ID: 000-00C-CD04-00100-000-00A)

URS

Job: Yucca Mtn. Revised hydrologic Study
Project No.: N/A
Page N/of A
Sheet 1 of 1
Description: Scour Analysis @ bridge Alternative 2
Computed by: V. Lee
Date: 2/27/04
Checked by: Pm
Date: 2/28/04

Reference

CSU Equation: for local Scour

$$\frac{y_s}{a} = 2.0 K_1 K_2 K_3 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43}$$

(Eq. ~~22~~ 6.3) (Ref. 17)
JH 3/3/04

✓ max. water depth, $y_1 = 31$ feet @ bridge north of Muck Storage A

Aligned with flow

$K_1 = 1.0$ (Round Nose)
$K_2 = 1.0$ } From previous study (BSC, 2002) (Ref. 6, pp. 42-44)
$K_3 = 1.2$ medium dunes(?)
$a = 4$ ft

$$\frac{y_s}{a} = 2.0 \times 1 \times 1 \times 1.2 \times \left(\frac{31}{4}\right)^{0.35} (0.03)^{0.43}$$

$$\frac{y_s}{a} = 1.1$$

$$y_s = 1.1 \times 4 = \boxed{4.4 \text{ ft}}$$ ✓

At the bridge at realigned H-Road

$y_1 = 10$ feet ✓

$$\therefore \frac{y_s}{a} = 2.0 \times 1 \times 1 \times 1.2 \times \left(\frac{10}{4}\right)^{0.35} (0.03)^{0.43}$$

$= 0.73$ ~~× 0.366~~ Pm 2/28/04 ✓

note: correction should be: ~~× 0.366~~
Pm
4/15/04

$$\therefore y_s = 0.73 \times 4 = \boxed{2.9 \text{ ft}}$$ ✓

Attachment 26: Checker's Alternate Calculations for PMF (Document ID: 000-00C-CD04-00100-000-00A)

URS

Page 1 of 4

Job Yucca Mtn

Project No. 18839594

Sheet NA of NA

Description Alternate Method Check of HEC-1 Peak Flow

Computed by J. Hudson

Date 2/11/04

Checked by NA

Date NA

Originator Initials and Date: JH 3/26/04

Reference

Check of Runoff Calculations for Subbasin ND1 using SCS Curve Number Method (Ref. ~~10~~ 19 JH 3/2/04, pp. ~~11-21~~ 2-1 to 2-11 JH 2/12/04)

① Estimate CN for basin. Soils in vicinity generally belong to Group B and D as stated in previous report (Ref. 6, p. 28).

Assumption: Used CN = average of B and D for Desert Shrub in poor hydrologic condition (Ref. 19 ~~10~~ JH 3/2/04, p. ~~18~~ 2-8) JH 2/12/04

Rationale: Exact Hydrologic Soil Group is not known, and this assumption is only being used to approximate runoff as a check.

$$CN = \frac{77 + 88}{2}$$

$$\boxed{CN = 83}$$

② Calculate Runoff from Rainfall.

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

(Ref.: ~~10~~ 19 JH 3/2/04, p. ~~11~~ 2-1) JH 2/12/04

Q = runoff (in)
P = rainfall (in)
S = potential max. retention after runoff begins (in)
I_a = initial abstraction (in)

$$I_a = 0.2 \cdot S$$

(Ref. ~~10~~ 19 JH 3/2/04, p. ~~11~~ 2-1) JH 2/12/04

$$S = \frac{1000}{CN} - 10$$

(Ref. ~~10~~ 19 JH 3/2/04, p. ~~11~~ 2-1) JH 2/12/04

URS

Page 2 of 4
Job Yucca Mtn
Project No. 18839594
Sheet NA of NA
Description Alternate Method Check of HEC-1 Peak Flow
Computed by J. Hudson
Date 2/11/04
Checked by NA
Date NA
Originator Initials and Date: JH 3/26/04
Reference

$$Q = \frac{\left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2}{P - 0.2\left(\frac{1000}{CN} - 10\right) + \frac{1000}{CN} - 10}$$

$$Q = \frac{\left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2}{P + 0.8\left[\left(\frac{1000}{CN}\right) - 10\right]}$$

for ND1, P = 13.2 in from HEC-1 output

$$Q = \frac{\left[13.2 - 0.2\left(\frac{1000}{83} - 10\right)\right]^2}{13.2 + 0.8\left[\left(\frac{1000}{83}\right) - 10\right]}$$

$$Q = \frac{163.6}{14.8} \qquad \boxed{Q = 11\text{ in}} \quad = \text{rainfall excess over 6 hrs}$$

③ Determine Time of Concentration (T_c) from

~~$T_c = 0.000$~~ JH 2/11/04

$$T_c = 0.0078\left[\frac{L}{S^{0.5}}\right]^{0.77}$$ (Ref. ~~*~~ 20, p. 434) JH 3/2/04

T_c (min)
L (ft) = Length from Table 4-1 = 3.391 mi for ND1 = 17,904 ft
S ($\frac{ft}{ft}$) = slope from Table 4-1 = 437.66 $\frac{ft}{mi}$ = 0.083 ft/ft

$$T_c = 0.0078\left[\frac{17{,}904}{(0.083)^{0.5}}\right]^{0.77}$$

$$T_c = 38.3\text{ min} \qquad \boxed{T_c = 0.6\text{ hr}}$$

URS

Page 3 of 4

Job Yucca Mtn

Project No. 18839594

Sheet NA of NA

Description Alternate Method Check of HEC-1 Peak Flow

Computed by J. Hudson

Date 2/11/04

Checked by NA

Date NA

Originator Initials and Date: JH 3/26/04

Reference

④ Calculate Peak Discharge using Graphical Peak Discharge Method (Ref. ~~10~~ 19 JH 3/2/04, pp. ~~32-38~~ 4-1 to 4-7 JH 2/12/04)

$$q_p = q_u A_m Q F_p$$

q_p = peak discharge (cfs)

q_u = unit peak discharge (csm/in)

A_m = drainage area (mi^2) = 1.156 for ND1 (from Table 4-1)

Q = runoff (in) = 11 in (previously calc'd)

F_p = pond and swamp adjustment factor = 1 (Ref. ~~10~~ 19 JH 3/2/04, p. ~~33~~ 4-2 JH 2/12/04)

for CN = 83, I_a = initial abstraction = 0.410 in (Ref. ~~10~~ 19 JH 3/2/04, p. ~~32~~ 4-1 JH 2/12/04)

$$\frac{I_a}{P} = \frac{0.410}{13.2} = 0.03$$

Rainfall Distribution = Type II (Ref. ~~10~~ 19 JH 3/2/04, p. ~~142~~ B-2 JH 2/12/04)

$q_u \approx 490$ csm/in (Ref. ~~10~~ 19 JH 3/2/04, p. ~~37~~ 4-6 JH 2/12/04)

$$q_p = 490 (1.156)(11)(1)$$

$$\boxed{q_p = 6231 \text{ cfs}}$$

This shows good agreement w/ the HEC-1 output for ND1 of 5576 cfs.

Originator Initials and Date: JH 3/26/04

Check of total Peak flow from all basins using Rational Method

Copied values are from Table 4-1 and HEC-1 output

	(copied)	(calc'd)	(copied)	(calc'd)	(copied)	(calc'd)	(calc'd) Tc = 0.0078([L/(S^0.5)]^0.77) (Ref. 20, p. 434)	(calc'd) Q = CIA (Ref. 20, p. 507)	(calc'd) Q = CIA (Ref. 20, p. 507)	(copied) from HEC-1
Basin Name	**Area (mi2)**	**Area (acres)**	**Total channel length (mi)**	**Total channel length (ft)**	**Slope (ft/mi)**	**Slope (ft/ft)**	**Kirpich Time of Concentration (min)**	**Low Peak Q, C = 0.2 (cfs)**	**High Peak Q, C = 1 (cfs)**	**Peak Q (cfs)**
ND1	1.156	740	3.391	17904	437.66	0.083	38.3	1611	8055	5576
ND2	0.394	252	1.828	9652	528.52	0.100	22.1	549	2746	2487
D3	1.149	735	3.429	18105	526.68	0.100	36.0	1601	8007	5322
ND4	0.816	522	2.931	15476	349.65	0.066	37.3	1137	5686	3853
D5	0.201	129	0.582	3073	173.64	0.033	14.1	280	1401	1854
D6	1.38	883	3.24	17107	151.53	0.029	55.6	1923	9616	6013
S1	0.361	231	1.311	6922	639.09	0.121	15.9	503	2516	2801
E1	4.495	2877	6.029	31833	369.36	0.070	63.7	6265	31323	14220
E2	1.808	1157	3.222	17012	379.6	0.072	38.9	2520	12599	7498
E3	0.84	538	1.832	9673	150.68	0.029	35.9	1171	5853	4118
FAC1	0.368	236	N/A	N/A	N/A	N/A	N/A	513	2564	2099
FAC2	0.164	105	N/A	N/A	N/A	N/A	N/A	229	1143	1978
FAC3	0.433	277	N/A	N/A	N/A	N/A	N/A	603	3017	4695
FAC4	0.244	156	N/A	N/A	N/A	N/A	N/A	340	1700	2475
							36 (avg)	**19,245** (sum)	**96,225** (sum)	**64,989** (sum)

The total flow from HEC-1 falls right within the range calculated using the Rational Method, which shows good agreement.

3-min Precip for North Portal Copied from HEC-1 (in)

0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
0.085	0.085	0.085	**0.085**	**0.085**	**0.085**	**0.085**	**0.085**	**0.085**	**0.085**
1.18	**1.18**	**1.18**	**1.18**	**1.18**	0.38	0.38	0.38	0.38	0.38
0.18	0.18	0.18	0.18	0.18	0.14	0.14	0.14	0.14	0.14
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.04
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025

peak of precip over average Tc of 36 minutes, shown in bold and totals: 6.5 in
rainfall intensity, **I**, to use with Rational method: **10.9** in/hr

C will fall in range between 0.2 for unimproved areas (Ref. 20, p. 508) to 1 for 100% of rainfall converting to runoff.

ENG.20050823.0020

BSC

Engineering Change Notice

Complete only applicable items.

1. QA: QA
2. Page 1 of 1

000-00C-CD04-00100-000-00A-ECN1

3. Document Identifier:	4. Rev.:	5. Title:	6. ECN:
000-00C-CD04-00100-000-00A	00A	Hydrologic Engineering Studies for the North Portal Pad and Vicinity	1

7. Reason for Change:

These calculations will be used in the License Application documents, therefore the status must be identified as committed.

The status designation of Hydrologic Engineering Studies for the North Portal Pad and Vicinity (000-00C-CD04-00100-000-00A) can be changed to "Committed" as the results are not expected to change in such a manner that will affect support of regulatory submittals.

8. Supersedes Change Document: ☐ Yes If, Yes, Change Doc.: ________ ☒ No

9. Change Impact:

Inputs Changed:	☐ Yes	☒ No	Results Impacted:	☐ Yes	☒ No
Assumptions Changed:	☐ Yes	☒ No	Design Impacted:	☐ Yes	☒ No

10. Description of Change: (Address any "Yes" answers)

Replace existing cover sheet with revised calculation cover sheet from LP 3.12 Q marked "committed".

11. Originator: (Print/Sign/Date)
VALERIE D SAUNDERS / Valerie D Saunders / 8/23/05

Checker: (Print/Sign/Date)
Michael S Ruben Michael S. Ruben 8/23/05

Approved: (Print/Sign/Date)
RICHARD PERNISI / Richard E Pernisi 8/23/05

L. D. Abernathy
QERC
8/23/05

LP-3.12Q-BSC

FORM NO. L312-1 (Rev. 05/20/2005)

No comments