Worster Dam – DAM I.D. # 030401
Dam Breach Analysis
and
Flood Inundation Mapping

TETRA TECH PROJECT NO. 114-910349

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1.0 PROJECT OVERVIEW

This report outlines the approach used for performing dam breach analysis and flood inundation mapping for Worster Dam in northwestern Larimer County, Colorado. This analysis was performed in accordance with the Colorado State Engineer's Office (SEO) requirements for inundation mapping as defined in Rule 16 of the Rules and Regulations for Dam Safety and Construction, January 2007.

Worster Dam (DAM I.D. # 030401) is owned and operated by Divide Canal and Reservoir Company. The specific site of the dam is in Section 5, Township 11 North, Range 74 West (Latitude = 40.944391, Longitude = -105.714877). The dam is located on Sheep Creek, which is a tributary of the Cache La Poudre River. A vicinity map of the dam and the reservoir it create, Eaton Reservoir is provided in Figure 1. Eaton Reservoir is fed through flows contributed from the upper reaches of Sheep Creek.

The State Engineer's Office (SEO) conducted routine inspections of the dam in 2013 and 2015. While the conditions observed during the inspection resulted in a recommended safe storage level of full storage, a request was made by the SEO to update the Emergency Action Plan (EAP). The current EAP for the Worster dam is over 20 years old as stated in a letter from Kallie Bauer (SEO, July 17, 2013). In response to the State Engineer's office request, Divide Canal and Reservoir Company (Divide) received grant money from the SEO to perform dam breach analysis and corresponding flood inundation mapping to update the EAP. The dam breach analysis and subsequent flood inundation mapping determines the extent of damages that may occur in the event of a dam breach, thus determining the hazard classification of the dam.

The dam is currently classified as a significant hazard dam under the State of Colorado's Dam Safety Regulations (Rules and Regulations for Dam Safety and Dam Construction, 2007). Per the State of Colorado Dam Safety Office, dam owners are required to determine the flood inundation area resulting from a dam failure as part of the Emergency Action Plan (EAP) for all significant hazard dams throughout the State. In January 2016, Divide contracted with Tetra Tech to preform dam breach analysis and map the flood inundation area to accompany the updated EAP. The development of the dam breach parameters, the modeling associated with the breach of the dam, routing of the dam breach flood wave, and mapping of the flood inundation area are described in the following sections.

2.0 DESCRIPTION OF WORSTER DAM

Based on information from the SEO, Worster Dam is comprised of a compacted earth fill embankment. The dam is classified as a large, significant hazard dam with a maximum embankment height of 72 feet and a crest length of 705 feet. The upstream and downstream slope of the dam face appear to be constructed to 1.5 feet and 2 feet horizontal, respectively, to 1-foot vertical (1.5H:1V & 2H:1V) side slopes. There is riprap on both the upstream and downstream faces of the dam. There is a shelf on the downstream face where piezometers are installed. The upper third of the downstream face appears steeper than the lower 2/3, but is stable. The dam crest is 12 feet wide and is at an elevation of 8,541 feet AMSL.

The dam was designed and constructed with a spillway and low flow outlet structure. The spillway is a fuse plug located along the western portion of the dam embankment, and conveys flow into Sheep Creek, which is tributary to the North Fork of the Cache La Poudre River. The spillway is 95 feet wide with 6 feet of freeboard and has a maximum capacity of 192 cubic feet per second (cfs).

Worster Dam was originally designed in the 1900's and completed in 1911. Improvements to the outlet structure were conducted in the early 1990's and the outlet pipe was slip-lined with solid wall HDPE pipe in 1996. The original design plans for the dam, as well as the plans for the outlet structure improvements are provided in Appendix A. Geometric parameters for Worster Dam are provided in Table 1.

Table 1: Worster Dam Parameters

Parameter	Value
Maximum Dam Height	72 feet
Crest Length	705 feet
Crest Width	12 feet
Crest Elevation	8,541 ft AMSL
Spillway Crest Elevation	8,535 ft AMSL
Freeboard	6 feet
Normal Storage Capacity	3,750 acre-feet
Maximum Storage Capacity	4,018 acre-feet
SEO Size Classification	Large
SEO Hazard Classification	Significant

3.0 DAM BREACH ANALYSIS

For this analysis, Rule 5.9.1, in the State *Rules and Regulations* (SEO, 2007) was followed which requires an evaluation of the dam piping failure flood. To make reliable estimates of the piping failure flood, dam breach parameters need to be estimated from empirical methods. The State provides *Guidelines for Dam Breach Analysis* (SEO, 2010a) to help compute the respective dam breach parameters. Once dam breach parameters are calculated, they can be input into numerical models to develop the outflow dam failure hydrographs. The primary tools used for this analysis is the HEC-HMS and HEC-RAS models for determining the dam failure flood hydrograph (USACE, 2010a).

The SEO requires analysis of the sunny-day or piping failure flood for the hazard classification analysis. A sunny-day, fair-weather, or piping failure is a failure that occurs in the absence of a flood event when a reservoir is at maximum pool level. Typical piping failure modes include cracking due to settlement or seismic activity, or internal seepage erosion that creates an earthen “pipe” through the embankment. Flow through the initial opening increases the size of opening both horizontally and vertically until the section of the embankment over the top of it collapses, yielding a fully-formed breach. The outflow hydrographs from piping failures are usually not as large as outflow hydrographs from storm-related overtopping failures, but piping failures can occur with little or no warning and thus have a higher potential for loss of life.

3.1 Dam Breach Methods and Parameters

The first step in evaluating the outflow hydrograph is the prediction of reasonably accurate breach parameters necessary to make reliable estimates of the breach outflow and resulting downstream inundation. Selection of dam breach parameters was performed using the procedures set forth in Chapter 7 of the State Guidelines (SEO, 2010a). The State Guidelines recommend three empirical methods for predicting dam breach parameters: MacDonald & Langridge-Monopolis (MLM, 1984), Washington State (WA) (2007), and Froehlich (2008) methods. However, only the MLM-WA and Froehlich methods were used for this analysis based on the piping failure empirical method guidance chart adapted from Colorado Rules and Regulations for Dam Safety and Dam Construction, 2007, which is included in Appendix B. The State also provides spreadsheets for computing these parameters on their website. Excerpts from these spreadsheets are provided in Appendix B and each method is described below in more detail.

The overtopping breach was not evaluated as a failure mode for this analysis just the sunny-day breach or piping failure was evaluated for the hazard classification. The sunny-day breach parameters were based on a piping failure scenario in the embankment, and the initial water surface elevation is assumed to be at the spillway crest elevation of 8,535 feet AMSL.

3.2 MacDonald and Langridge-Monopolis and Washington State Methods

MacDonald and Langridge-Monopolis (MLM, 1984) method computes a volume of embankment eroded during the breach formation, based on the product of the reservoir volume (V_w) and the maximum water depth (H_w). This product, termed the Breach Formation Factor (BFF), loosely represents the erosive potential of the water stored in the reservoir. The Washington State method (WA) (2007) took the MLM method and adjusted it based on whether the dam is made of cohesionless or cohesive material. The

State Guidelines indicate the Washington State method is more suited for large dams like Worster Dam, so it was used to calculate the volume of eroded material for this analysis.

The predictive equations for each method are presented below for the volume of earth removed during a breach (V_{er}), the time of breach formation (T_f), and average breach width (B_{avg}). The equations are shown in Table 2 below.

Table 2: MLM and WA Equations

Breach Parameter	MLM (1984)	WA (2007)
Volume Eroded (V_{er})	$V_{er} = 3.264(BFF)^{0.77}$ (best fits all data)	$V_{er} = 3.75(BFF)^{0.77}$ (cohesionless)
	$V_{er} = 0.714(BFF)^{0.852}$ (rockfill)	$V_{er} = 2.5(BFF)^{0.77}$ (cohesive)
Breach Formation Factor (BFF)	$BFF = V_w \times H_w$	$BFF = V_w \times H_w$
Average Breach Width (B_{avg})	$B_{avg} = V_{er}/(H_b \times W_{avg})$	-
Breach Development Time (T_f)	$T_f = 0.016\ (V_{er})^{0.364}$	$T_f = 0.02\ (V_{er})^{0.36}$ (cohesionless)
		$T_f = 0.036\ (V_{er})^{0.36}$ (cohesive)

V_{er} is the volume of cohesionless soil material eroded (cubic yards); V_w is the volume of water released through the breach or the effective storage volume (acre-feet); H_w is the depth water behind dam (feet); H_b is the height of the breach (feet); T_f is the breach formation time (hours); B is the bottom width of the breach (feet); C is the crest width of the dam (feet); Z_b is the slope of the breach formation; and $Z_{u,d}$ is the upstream and downstream slopes, respectively (no units), expressed as X Horizontal : 1 Vertical (XH:1V). The upstream slope of the dam is 1.5H:1V, and the downstream slope is 2H:1V. The side slope of the breach (Z_b) for this earthen (non-cohesive) embankment is assumed to be 2H:1V based on Table 3 of the State Guidelines (SEO, 2010a). The input parameters for this method are listed in Table 3. C_p is the piping coefficient used to calculate peak discharge through the piping hole.

Table 3: Input and Breach Parameters for MLM-WA Methods

Parameter	Unit	Value	Note
V_w	acre-ft	3862	At Spillway Crest
H_b	feet	72	Dam Height
H_w	feet	66	Above Base Level
S_a	acres	137.5	Reservoir Surface Area at H_w
Z_b	XH:1V	2	Breach Side Slope
Z_u	XH:1V	1.5	Slope of Upstream Dam Face
Z_d	XH:1V	2	Slope of Downstream Dam Face
C	feet	12	Dam Crest Width
C_p	dimensionless	0.68	Piping Coefficient
B_b	feet	4.3	Bottom Width of Breach
B_{avg}	feet	148.3	Average Breach Width
T_f	hours	1.01	Breach Formation Time
B_{avg}/H_b	--	2.06	
ER/H_w	--	2.2	ER = Erosion Rate

3.3 Froehlich Method

The SEO recommends Froehlich's method for dams with reservoir volumes greater than 100 acre-ft. The Froehlich (2008) method is dependent only on the volume of the reservoir, height of the breach, and the assumed breach side slope. The empirical equations for breach width and time of failure (i.e., breach formation time), as presented in Table 2 of the State Guidelines (SEO, 2010a), are listed below.

$$B_{avg} = 9.5\ k_o(V_r\ H_d)^{0.25}$$

$$T_f = 0.59\ (V_r^{\ 0.47}\ /\ H_d^{0.9})$$

In these equations, B_{avg} is average breach width (feet); T_f is the breach time (hours); k_o is a coefficient that is equal to 1.0 for piping breach and 1.3 for overtopping breach; V_r is the effective reservoir storage volume (acre-feet); and H_d is the height (feet) of water above the breach bottom. The average breach width is the average width between the bottom width and the width at the dam crest. The input parameters and breach parameters calculated using Froehlich's equations are shown in Table 4.

Table 4: Input and Breach Parameters for Froehlich's Method

Parameter	Units	Piping Failure	Note
k_o	--	1.0	Unitless Coefficient
H_w	feet	66	Above Base Level
V_r	acre-feet	3862	Effective Storage Volume
A_a	acres	137.5	Reservoir Surface Area at H_w
H_b	feet	72	Top of Dam Elevation = 8,541 Feet, Breach Invert = 8,469 Feet
Z_b	XH:1V	0.7	Breach Side Slope
B_b	feet	87	Bottom Width of Breach
B_{avg}	feet	137.4	$B_{avg} = 9.5\ k_o\ (V_r\ H_d)^{0.25}$
T_f	hours	0.56	$T_f = 0.59\ (V_r^{\ 0.47}\ /\ H_d^{0.9})$
B_{avg}/H_b	--	1.91	
ER/H_w	--	3.7	ER = Erosion Rate

The average breach width and time of formation were taken from Froehlich instead of parameters calculated using the MLM-WA methods as recommended by the SEO and because Froehlich method produces shorter breach formation time, which is more conservative.

As an additional check to the validity of the peak discharge dam breach estimates, the SEO recommends two checks. The first check is to determine if the average breach width divided by the height of the breach is less than 0.6. If (B_{avg}/H_b) is greater than 0.6, then full breach development is anticipated. For this analysis, the average breach width divided by the breach height is greater than 0.6 for both dam failure methods. The other check is to evaluate whether the erosion rate divided by the height of the water is in between 1.6 and 21 ($1.6 < [ER/H_w] < 21$). This is the case for both dam failure methods so the erosion rate is assumed reasonable, and the prediction of the peak discharges is also reasonable.

4.0 DAM BREACH MODELING

For this analysis, the breach of Worster Dam from Eaton Reservoir was simulated using the storage area method in HEC-RAS (USACE, 2010). HEC-RAS uses hydraulic equations to generate breach hydrographs, and the breach hydrograph is based on the reservoir stage-storage information and breach formation parameters as described in the following sections.

4.1 STAGE-STORAGE INFORMATION

A partial list of the stage-storage data for the reservoir is provided in Table 5 with a more detailed table located in Appendix C. This information was provided by the SEO. Per recommendations from the SEO, the starting piping elevation was set at the mid-height of the dam.

Table 5: Eaton Reservoir Stage-Storage Data

Stage (ft)	Storage Volume (ac-ft)
8,469	0
8,474	0
8,475	2
8,480	18
8,490	208
8,500	622
8,510	1,237
8,520	2,090
8,530	3,218
8,535	3,862
8,536	3,984
8,537	4,104
8,538	4,220
8,539	4,334
8,540	4,444
8,541	4,551

4.2 DAM BREACH PARAMETERS

Input parameters for the breach data in HEC-RAS are provided in Table 6. Selection of orifice coefficient (Cp), weir coefficient (Cw), and breach progression method were based on the SEO Guidelines for modeling a piping failure in HEC-RAS.

Table 6: Dam Breach Input Parameters for HEC-RAS

Parameter	Value
Center Station of Breach (ft)	478.18
Final Bottom Width (ft)	87
Left Side Slope (ft/ft)	0.7
Right Side Slope (ft/ft)	0.7
Breach Weir Coefficient	3.08
Breach Formation Time (hr)	0.6
Failure Mode	Piping
Piping Coefficient	0.7
Initial Piping Elevation (ft)	8,469 ft AMSL
Starting WSEL (ft)	8,535 ft AMSL

5.0 HYDRAULIC ANALYSIS

The HEC-RAS model (USACE, 2010a) was used for developing flood inundation mapping downstream of the dam. HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and channels. HEC-RAS is a one-dimensional step backwater model so it does not directly model the hydraulic effect of cross section shape changes, bends, and other two- and three-dimensional aspects of flow. However, HEC-RAS (version 4.1) can model steady, gradually varying or unsteady flow, and both were performed for this study.

The outflow hydrograph for the piping failure was determined from the HEC-RAS analysis described above in Section 4 and used as input for the HEC-RAS unsteady flow model. Unsteady flow analysis was performed for the channel downstream of the dam. There are two cross sections upstream of the dam crest and downstream cross sections were cut starting approximately 163 feet downstream of the dam crest, ending at the inlet of Halligan Reservoir. These cross sections were cut using the USGS topography, which is a 10-meter Digital Elevation Map (DEM) with contours generated at 0.5-meter intervals using ArcGIS.

A total of four hundred and ninety-two (492) cross sections were obtained at an interval of approximately 300 feet. These cross sections were numbered beginning at the downstream end of the reach where the North Fork of the Cache La Poudre River enters Halligan Reservoir. The river stations are in meters and generated using the HEC-GeoRAS extension in ArcGIS. The cross sections stop approximately 160 feet upstream of the dam crest.

Cross-sections were subdivided into a main-channel reach, a left overbank, and a right overbank. The flow paths in the main channel and the overbanks differ because of bends in the valley and localized geomorphic features. Manning's n-value of 0.05 was observed for the main channel representing a sand bottom creek bed, and a value of 0.08 was noted for the overbank throughout the creek representing native vegetation that exists along the channel. These n-values were determined from the field reconnaissance. However, due to model instabilities the n-values were increased to 0.07 for the channel and 0.1 for the overbanks, which more closely represent flow conditions during a dam failure flood. Tetra Tech performed field reconnaissance of the flood inundation area downstream of the Worster Dam on April 23, 2016 and took photos of some of the structures, which are included in Appendix E. Due to presence of snow on the roads above certain elevation, only certain structures near the downstream areas were accessible.

The stream is conveyed beneath road crossings through culverts/bridges downstream of the dam. These culverts/bridges do not have the capacity to convey the breach flood, so the culverts and bridges were not modeled. It is assumed that the culverts or bridges will be washed out during the dam failure flood and will not attenuate flood water.

The unsteady flow analysis was performed as a mixed flow regime with an upstream boundary condition of constant lateral inflow of 192 cfs, which is equal to the maximum Worster Dam spillway capacity, and a downstream boundary condition was set at Halligan Reservoir existing spillway crest elevation of 6357.6 feet. The results from the HEC-RAS model are included in Appendix D.

6.0 FLOOD INUNDATION MAPPING

The flood hydrograph from the piping failure flood was routed downstream and the subsequent flood inundation limits were mapped using ArcGIS. The peak flow from this event is approximately 65,709 cfs. HEC-RAS model results were used to create the inundation maps of Sheep Creek and the North Fork of the Cache La Poudre River. The inundation maps are provided as Figure 2 through Figure 10. Flood hydrographs at critical locations/sections are provided at the end of Appendix D. The inundation maps were created by exporting the HEC-RAS model flood inundation limits into ArcGIS. The flood inundation limits for each flood were mapped over the USGS DEM base map and current aerial photography to provide a background image for reference. Also shown on these figures is the location of fifty-four (54) structures and critical sections (i.e., bridges, culverts, or narrow areas) that were determined based on aerial photography.

Worster Dam is currently classified as a "Significant Hazard Dam" by the SEO. Rule 4.2.14 states the "Hazard Classification of a Dam" is the placement of a dam into one of four categories based on the hazard potential derived from an evaluation of the probable incremental adverse consequences due to failure or improper operation of the dam. The hazard potential classification does not reflect the current condition of the dam with regard to safety, structural integrity, or flood routing capacity. The purpose of a hazard classification is to evaluate the potential consequences of the subject dam failure on persons and property below the dam and to determine the adverse impacts of a dam failure flood at critical downstream locations where hazards may exist (SEO, 2010b). Hazard classification does not consider the potential impacts of future downstream or upstream development or changes in land use. It is based on current downstream conditions.

The criteria for determining expected loss of human life as outlined in the Guidelines (SEO, 2010b) are as follows:

1. No loss of life is expected to occur if the depth of flow is two feet or less and the product of the flow depth and the flow velocity at the critical location is less than seven.
2. If the flow velocity cannot be calculated with confidence at the critical location, then the average cross-section flow velocity may be used in calculating the product of depth and velocity.
3. Judgment and sound reason must be used in determining the potential for loss of life at locations where the flow depth is less than two feet and the product of depth and velocity is greater than seven, or where the depth of flow is greater than two feet and the product of depth and velocity is less than seven. An example location may be the basement of a habitable structure.

As seen in Table 7 below, there is a potential for significant damage to 38 of the 54 structures because either the depth of flow (d) is more than two (2) feet or the product of the flow velocity and the flow depth (Vxd) is more than seven (7) at those structures due to the dam failure flood. However, at least 3 of the 38 structures are potentially inhabited all year around and most structures are access roads, storage buildings, barns, or buildings inhabited seasonally (i.e. they may be used as cabins during spring/summer seasons) based on field observation.

Table 7: Summary Data at Critical Sections/Structures

Structure ID[1]	Critical Section ID	Approx. Distance From Dam (mi)	Approx. Structure Base Floor Elev (ft)[2]	Peak WSEL (ft)	Peak Flow (cfs)	Depth of Water above Base Elev, d (ft)	Ave Velocity, V (fps)	Velocity and Depth product (V x d)	Potentially Significant Damage?[3]	Potentially Inhabited Structure?[4]	Initial Flood Wave Arrival Time (hh:mm)	Peak Flood Wave Arrival Time (hh:mm)
1	45242.44	0.04	8486.8	8495.66	65708.9	8.9	18.7	165.9	YES	NO	00:01	00:23
2	45204.38	0.06	8488.8	8494.3	65652.2	5.5	15.7	86.3	YES	NO	00:01	00:23
3	45169.73	0.09	8480.5	8491.05	65599.9	10.5	18.4	193.8	YES	NO	00:01	00:23
4	45169.73	0.09	8520.4	8491.05	65599.9	--	18.4	--	NO	NO	00:01	00:23
5	43803.54	0.93	8449.8	8446.91	63111.3	--	10.1	--	NO	NO	00:14	00:33
6	39669.85	3.50	8337.6	8359.91	52997.7	22.3	10.0	222.4	YES	NO	00:42	00:53
7	36070.57	5.74	8166.0	8180.94	51158.7	14.9	17.6	262.2	YES	NO	00:58	01:06
8	35980.86	5.79	8180.9	8177.99	50781.6	--	9.9	--	NO	NO	00:59	01:06
9	35980.86	5.79	8195.5	8177.99	50781.6	--	9.9	--	NO	NO	00:59	01:06
10	35901.62	5.84	8186.6	8175.01	50309.6	--	11.7	--	NO	NO	00:59	01:07
11	34924.11	6.45	8151.5	8126.73	49877.1	--	12.1	--	NO	NO	01:03	01:11
12	34924.11	6.45	8103.7	8126.73	49877.1	23.1	12.1	279.9	YES	NO	01:03	01:11
13	33815.75	7.14	8053.5	8047.36	49175.1	--	13.7	--	NO	NO	01:07	01:14
14	30011.71	9.50	7700.2	7708.04	46084.0	7.8	20.1	157.2	YES	NO	01:21	01:25
15	28705.96	10.32	7596.9	7608.33	45571.6	11.4	10.5	119.4	YES	NO	01:25	01:29
16	21080.7	15.05	7128.5	7130.52	34584.2	2.0	7.1	14.4	YES	YES	01:57	02:02
17	21004.7	15.10	7123.9	7129.42	34487.0	5.5	5.9	32.8	YES	NO	01:57	02:03
18	21004.7	15.10	7150.3	7129.42	34487.0	--	5.9	--	NO	NO	01:57	02:03
19	20955.1	15.13	7127.1	7128.27	34428.4	1.2	7.1	8.3	YES	NO	01:57	02:03
20	20955.1	15.13	7129.8	7128.27	34428.4	--	7.1	--	NO	NO	01:57	02:03
21	20955.1	15.13	7144.3	7128.27	34428.4	--	7.1	--	NO	NO	01:57	02:03
22	20955.1	15.13	7149.1	7128.27	34428.4	--	7.1	--	NO	NO	01:57	02:03
23	20600.91	15.35	7094.8	7112.72	34099.8	17.9	9.4	167.9	YES	NO	02:00	02:05
24	19772.65	15.87	7076.2	7083.98	29978.5	7.8	5.4	41.9	YES	NO	02:04	02:14
25	18882.93	16.42	7038.1	7044.34	29856.7	6.2	9.0	56.0	YES	NO	02:09	02:17
26	18882.93	16.42	7038.9	7044.34	29856.7	5.4	9.0	48.8	YES	NO	02:09	02:17
27	18882.93	16.42	7040.6	7044.34	29856.7	3.7	9.0	33.5	YES	NO	02:09	02:17
28	18882.93	16.42	7043.1	7044.34	29856.7	1.2	9.0	11.1	YES	NO	02:09	02:17
29	18882.93	16.42	7044.0	7044.34	29856.7	0.3	9.0	3.0	NO	NO	02:09	02:17
30	18882.93	16.42	7046.8	7044.34	29856.7	--	9.0	--	NO	NO	02:09	02:17
31	18843.7	16.44	7033.8	7042.8	29819.1	9.0	7.9	70.9	YES	NO	02:09	02:17
32	18776.4	16.49	7032.6	7040.42	29719.3	7.8	7.7	60.1	YES	YES	02:10	02:18
33	18776.4	16.49	7033.1	7040.42	29719.3	7.3	7.7	56.3	YES	NO	02:10	02:18
34	18776.4	16.49	7035.5	7040.42	29719.3	4.9	7.7	37.8	YES	NO	02:10	02:18
35	18776.4	16.49	7037.6	7040.42	29719.3	2.8	7.7	21.7	YES	NO	02:10	02:18
36	18776.4	16.49	7037.6	7040.42	29719.3	2.8	7.7	21.7	YES	NO	02:10	02:18
37	18776.4	16.49	7037.7	7040.42	29719.3	2.7	7.7	20.9	YES	NO	02:10	02:18
38	18776.4	16.49	7040.5	7040.42	29719.3	--	7.7	--	NO	NO	02:10	02:18
39	18701.43	16.53	7026.3	7038.28	29603.4	12.0	7.5	90.1	YES	NO	02:10	02:18
40	18701.43	16.53	7026.7	7038.28	29603.4	11.6	7.5	87.1	YES	NO	02:10	02:18

Structure ID[1]	Critical Section ID	Approx. Distance From Dam (mi)	Approx. Structure Base Floor Elev (ft)[2]	Peak WSEL (ft)	Peak Flow (cfs)	Depth of Water above Base Elev, d (ft)	Ave Velocity, V (fps)	Velocity and Depth product (V x d)	Potentially Significant Damage?[3]	Potentially Inhabited Structure?[4]	Initial Flood Wave Arrival Time (hh:mm)	Peak Flood Wave Arrival Time (hh:mm)
41	18701.43	16.53	7027.5	7038.28	29603.4	10.8	7.5	81.1	YES	NO	02:10	02:18
42	18701.43	16.53	7028.2	7038.28	29603.4	10.1	7.5	75.8	YES	NO	02:10	02:18
43	18701.43	16.53	7028.9	7038.28	29603.4	9.4	7.5	70.5	YES	NO	02:10	02:18
44	18625.6	16.58	7025.1	7036.62	29547.7	11.5	6.9	79.1	YES	NO	02:11	02:19
45	17627.52	17.20	6993.3	6999.3	29155.6	6.0	7.1	42.6	YES	NO	02:16	02:24
46	17627.52	17.20	6993.4	6999.3	29155.6	5.9	7.1	41.9	YES	NO	02:16	02:24
47	17627.52	17.20	6993.9	6999.3	29155.6	5.4	7.1	38.3	YES	YES	02:16	02:24
48	17071.63	17.54	6971.8	6988.67	26620.6	16.9	5.1	86.1	YES	NO	02:21	02:33
49	16937.91	17.63	6994.8	6987.16	26588.7	-7.6	6.4	N/A	NO	NO	02:21	02:33
50	16697.82	17.78	6961.0	6975.48	26557.6	14.5	8.8	127.4	YES	NO	02:22	02:34
51	16642.46	17.81	6957.3	6974.18	26553.0	16.9	9.7	163.1	YES	NO	02:23	02:34
52	16564.27	17.86	6966.2	6970.81	26548.9	4.6	12.3	56.9	YES	NO	02:23	02:34
53	15176.83	18.72	6959.4	6918.4	26037.9	-41.0	7.0	N/A	NO	NO	02:30	02:41
54	14994.68	18.83	6893.4	6911.12	25835.7	17.7	10.8	191.7	YES	NO	02:32	02:42

[1] Yellow shaded structure IDs correspond to road crossings
[2] Elevations are based on USGS DEM with 10 meter (~33 feet) accuracy
[3] Structures at gray shaded cells have potential for significant damage per SEO criteria
[4] Structures at gray shaded cells are potentially inhabited based on field observation.

7.0 CONCLUSIONS

The Worster Dam is currently classified as a significant hazard dam by the SEO. Results from the dam breach analysis and inundation mapping show that there is a potential for significant damage to 38 structures as a result of possible piping breach of the Worster Dam. Based on a site visit on April 23, 2016, it is believed that there are at least three (3) human-occupied structures located within the Worster Dam flood inundation area. There are potentially more human-occupied structures upstream; however, Tetra Tech personnel were not able to evaluate anything upstream of section 21080.7 because of snow on the road that made the area inaccessible.

It is important to note that the flood inundation mapping in this report is based on using a 10-meter Digital Elevation Map (DEM); thus, there could be up to 30 feet discrepancy between the DEM elevations and the actual field survey elevations. It is recommended that this study be updated when a more accurate topography such as LiDAR or field survey tied to well-established benchmarks (i.e. USGS or Larimer County control points) is available to better represent actual field conditions. Also, finished floor elevations of all structures in the inundation area will need to be tied to this survey.

8.0 REFERENCES

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MacDonald TC, Langridge-Monopolis J. [MLM] 1984. Breaching Characteristics of Dam Failures. Journal of Hydraulic Engineering, 110(5), 567-586.

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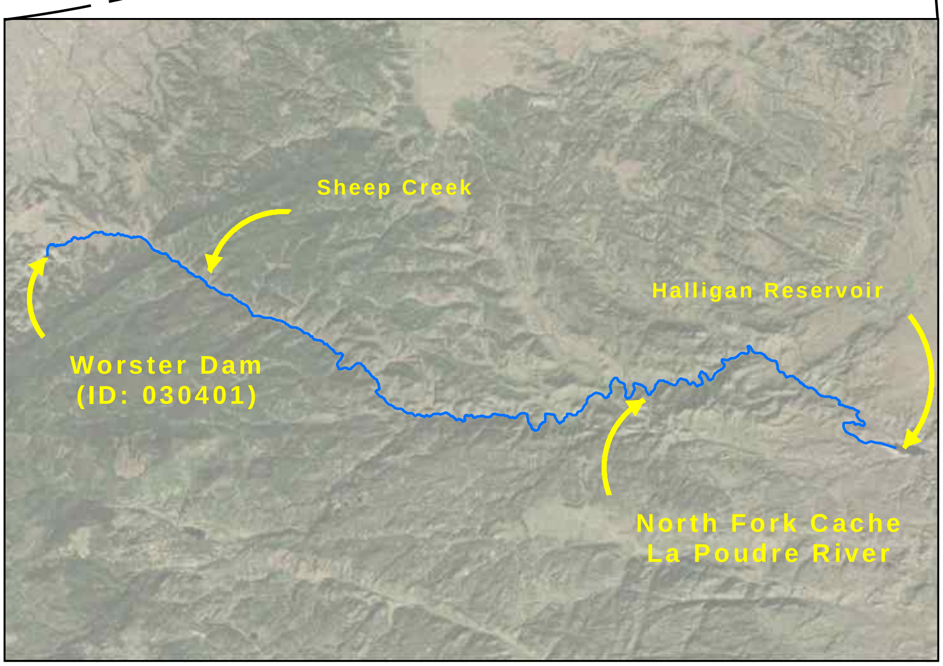
SEO, 2013. Letter from Kallie Bauer to Dale Leach, Subject: 2013 Engineer's Inspection Report – Worster Dam (Eaton Dam), DAMID 030401, Water Division 1, Water District 3. Dated July 17, 2013.

United States Army Corps of Engineers [USACE] Hydraulic Engineering Center. 2010. Hydraulic Engineering Center – River Analysis System (HEC-RAS) [Software]. Version 4.1.

FIGURES

STATE MAP
NOT TO SCALE

REGIONAL LOCATION MAP
NOT TO SCALE

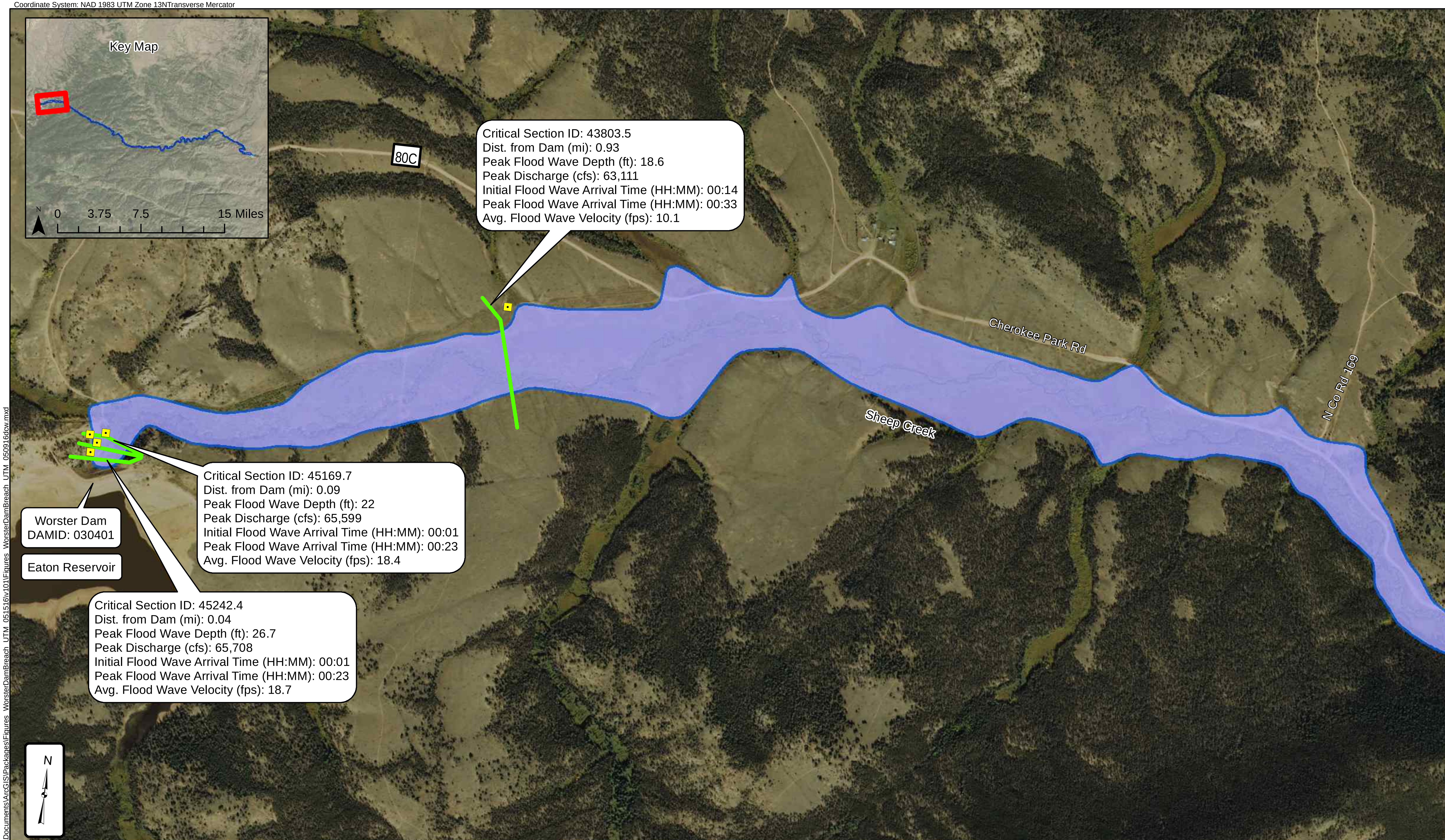


LOCATION MAP
NOT TO SCALE

N

Creek/River Centerline	Prepared for: Divide Canal and Reservoir Co.	WORSTER DAM SITE LOCATION MAP		
	Prepared By: TETRA TECH 3801 Automation Way Suite 100 Fort Collins, Colorado 80525 (970) 223-9600 (970) 223-7171 fax	Project: WORSTER DAM/EATON RES	Project no.: 114-910349	Figure 1
		Location: LARIMER COUNTY, CO	Date: MAY 2016	

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



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Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potenitally Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

TETRA TECH
3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
(970) 223-9600 (970) 223-7171 fax

Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project:	Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 2
Location:	Larimer County, Colorado	May, 2016	

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator

Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potenitally Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

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Fort Collins, Colorado 80525
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Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project: Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 3
Location: Larimer County, Colorado	May, 2016	

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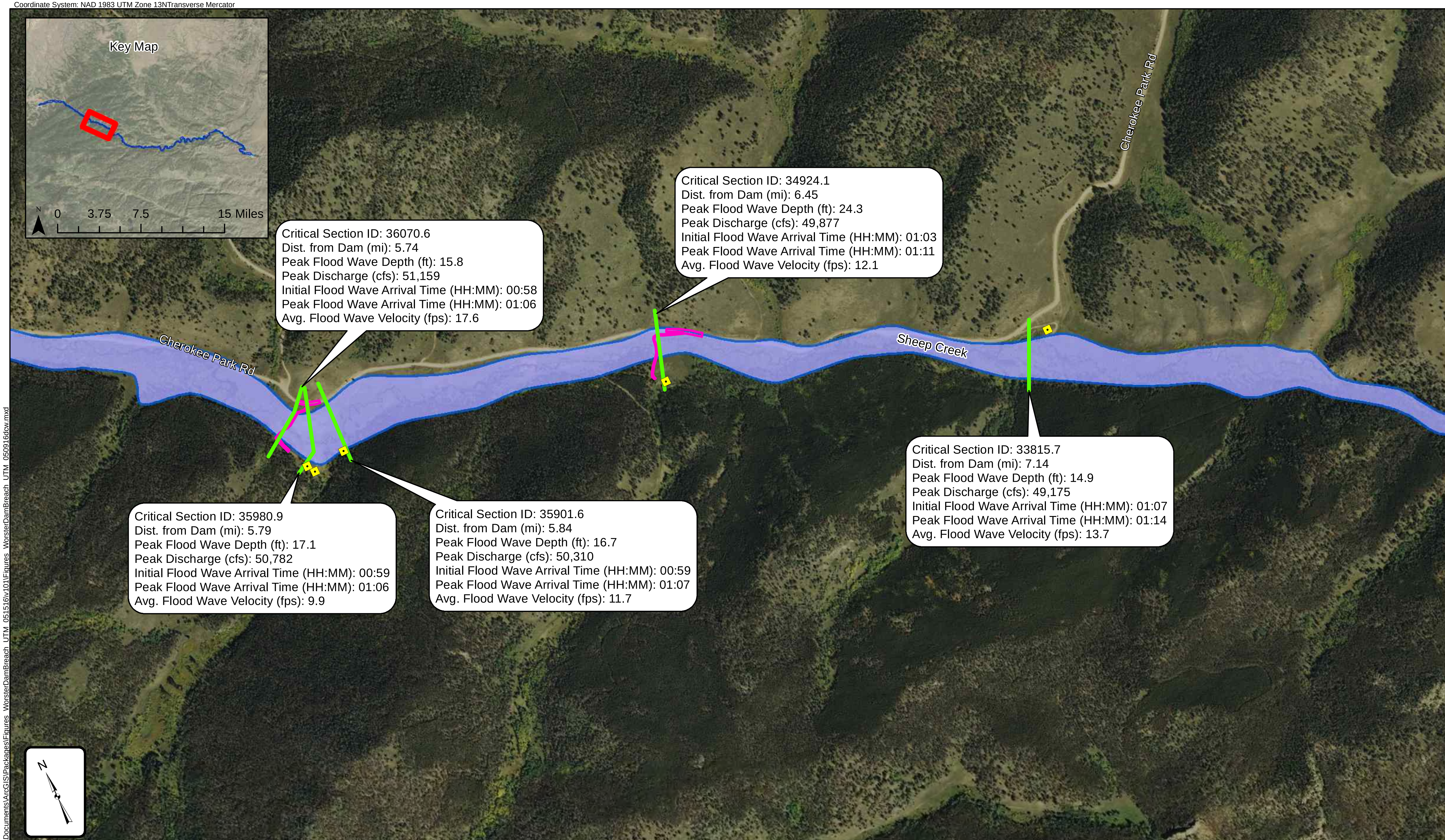
Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potentially Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

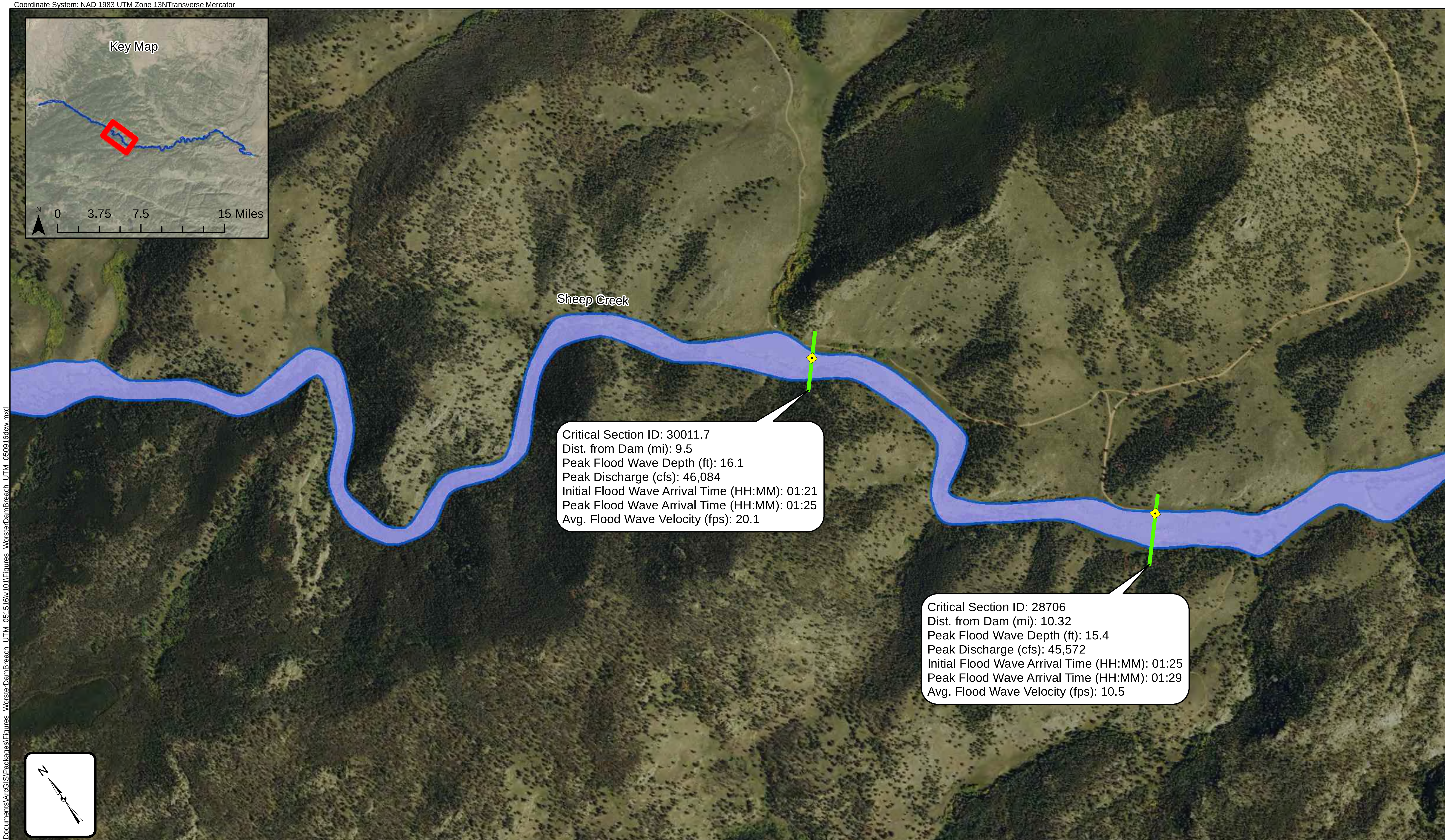
TETRA TECH
3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
(970) 223-9600 (970) 223-7171 fax

Worster Dam Breach
Flood Inundation Map
DAMID: 030401

Revision 1

Project: Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 4
Location: Larimer County, Colorado	May, 2016	

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



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Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potentially Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

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3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
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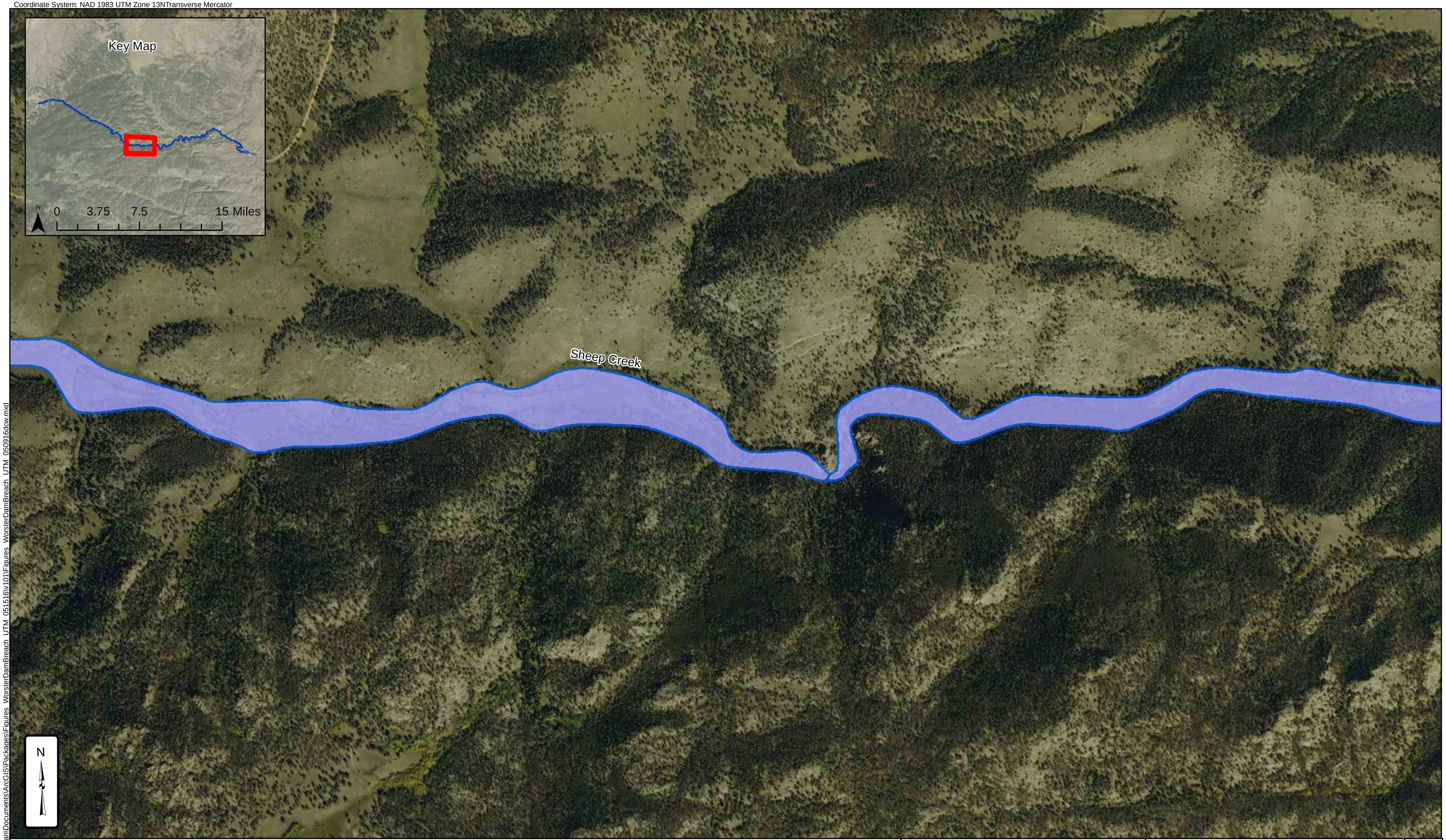
Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project: Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 5
Location: Larimer County, Colorado	May, 2016	

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



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Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potentially Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

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Fort Collins, Colorado 80525
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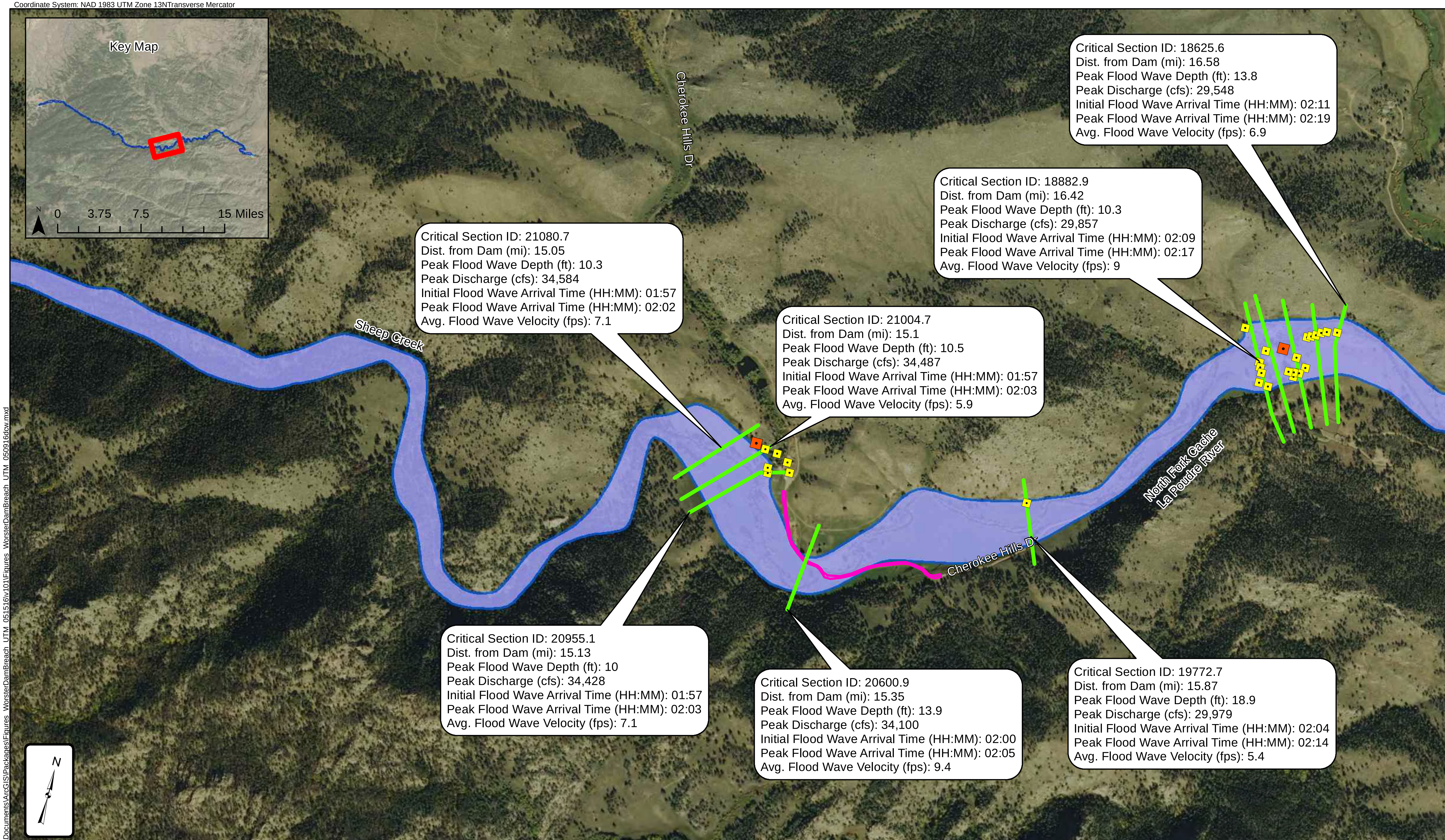
Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project: Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 6
Location: Larimer County, Colorado	May, 2016	

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



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Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potenitally Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

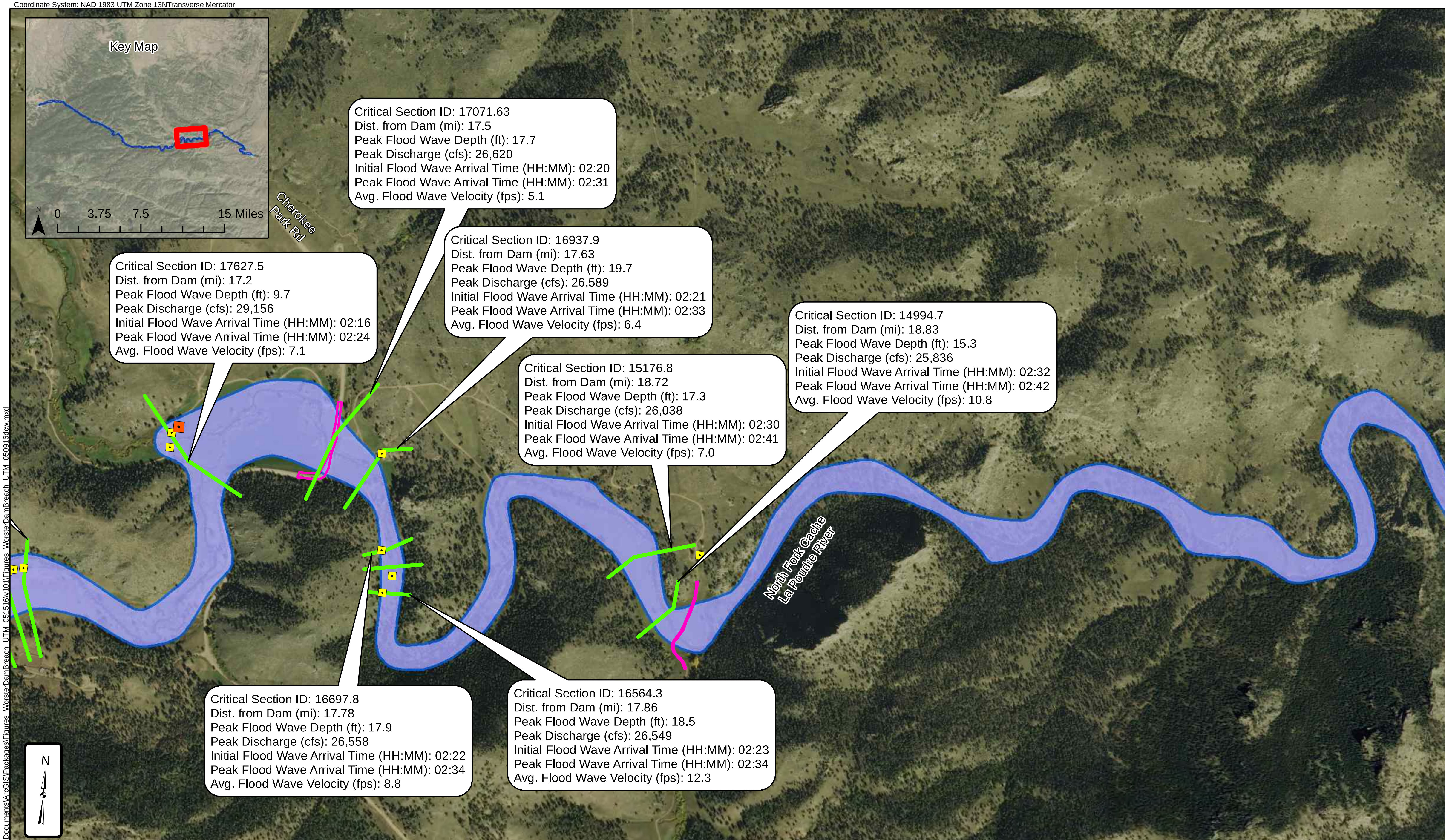
TETRA TECH
3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
(970) 223-9600 (970) 223-7171 fax

Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project: Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 7
Location: Larimer County, Colorado	May, 2016	

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



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Legend:

Flood Inundation Area
Critical Cross Section
Road Crossing
Structure
Potenitally Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

TETRA TECH
3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
(970) 223-9600 (970) 223-7171 fax

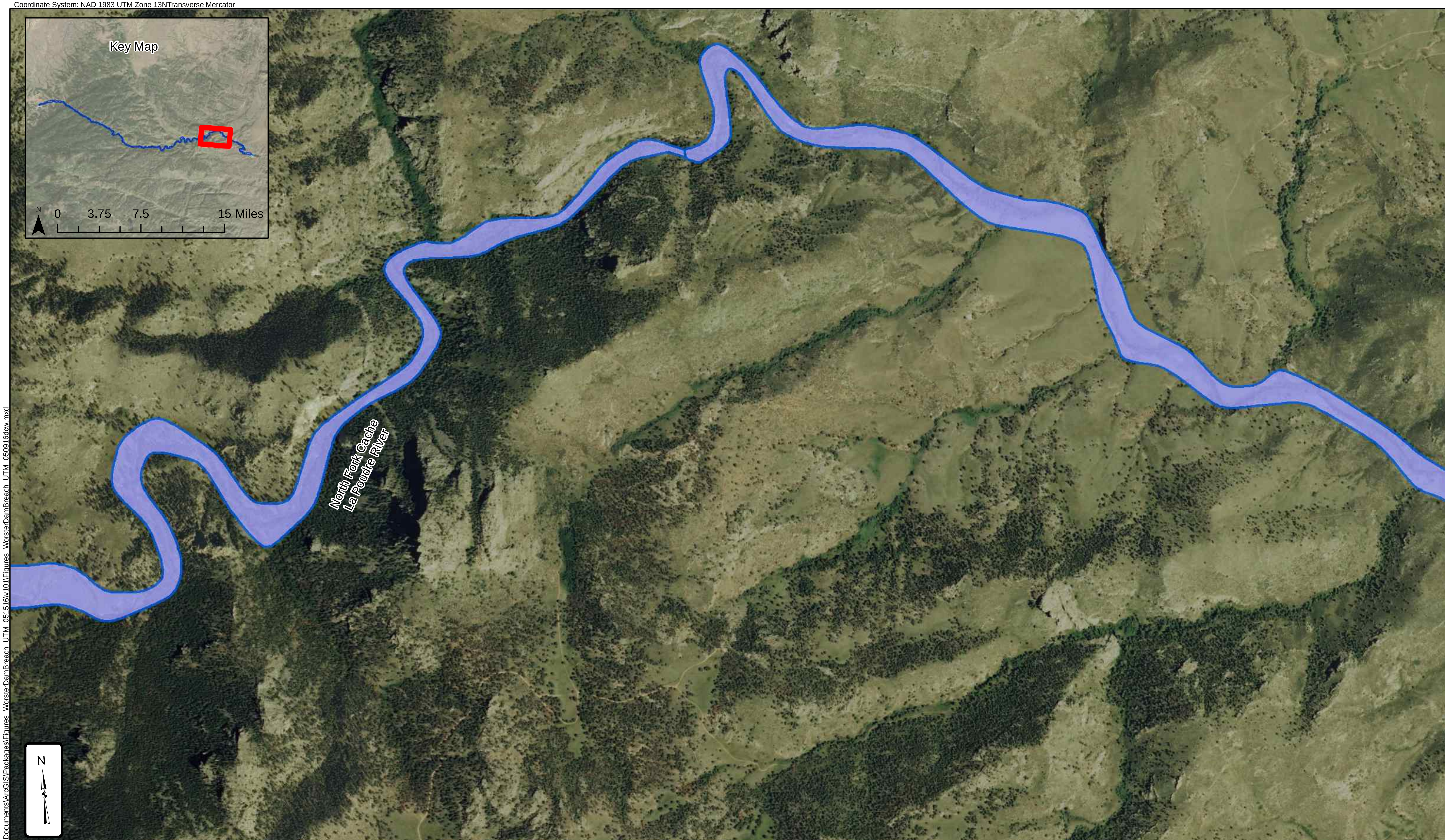
Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project: Worster Dam/Eaton Reservoir
Project no.: 114-910349
Location: Larimer County, Colorado
May, 2016

Figure 8

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



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Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potenitally Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

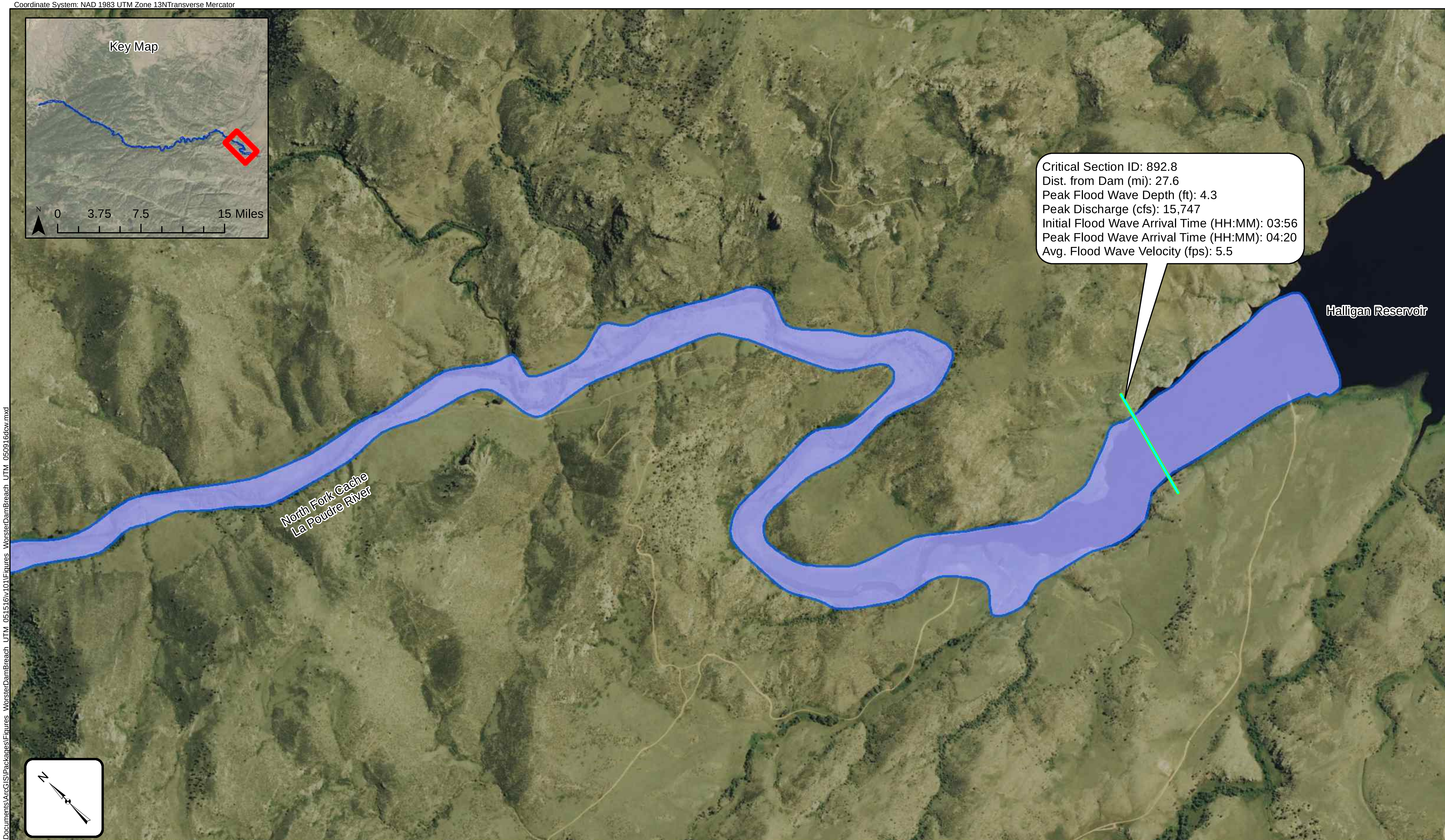
TETRA TECH
3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
(970) 223-9600 (970) 223-7171 fax

Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project: Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 9	
Location: Larimer County, Colorado	May, 2016		

Coordinate System: NAD 1983 UTM Zone 13NTransverse Mercator



Legend:

- Flood Inundation Area
- Critical Cross Section
- Road Crossing
- Structure
- Potenitally Inhabited Structure

0 500 1,000 2,000 Feet

Issued by:

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Fort Collins, Colorado 80525
(970) 223-9600 (970) 223-7171 fax

Worster Dam Breach
Flood Inundation Map
DAMID: 030401

1 Revision

Project:	Worster Dam/Eaton Reservoir	Project no.: 114-910349	Figure 10
Location:	Larimer County, Colorado	May, 2016	

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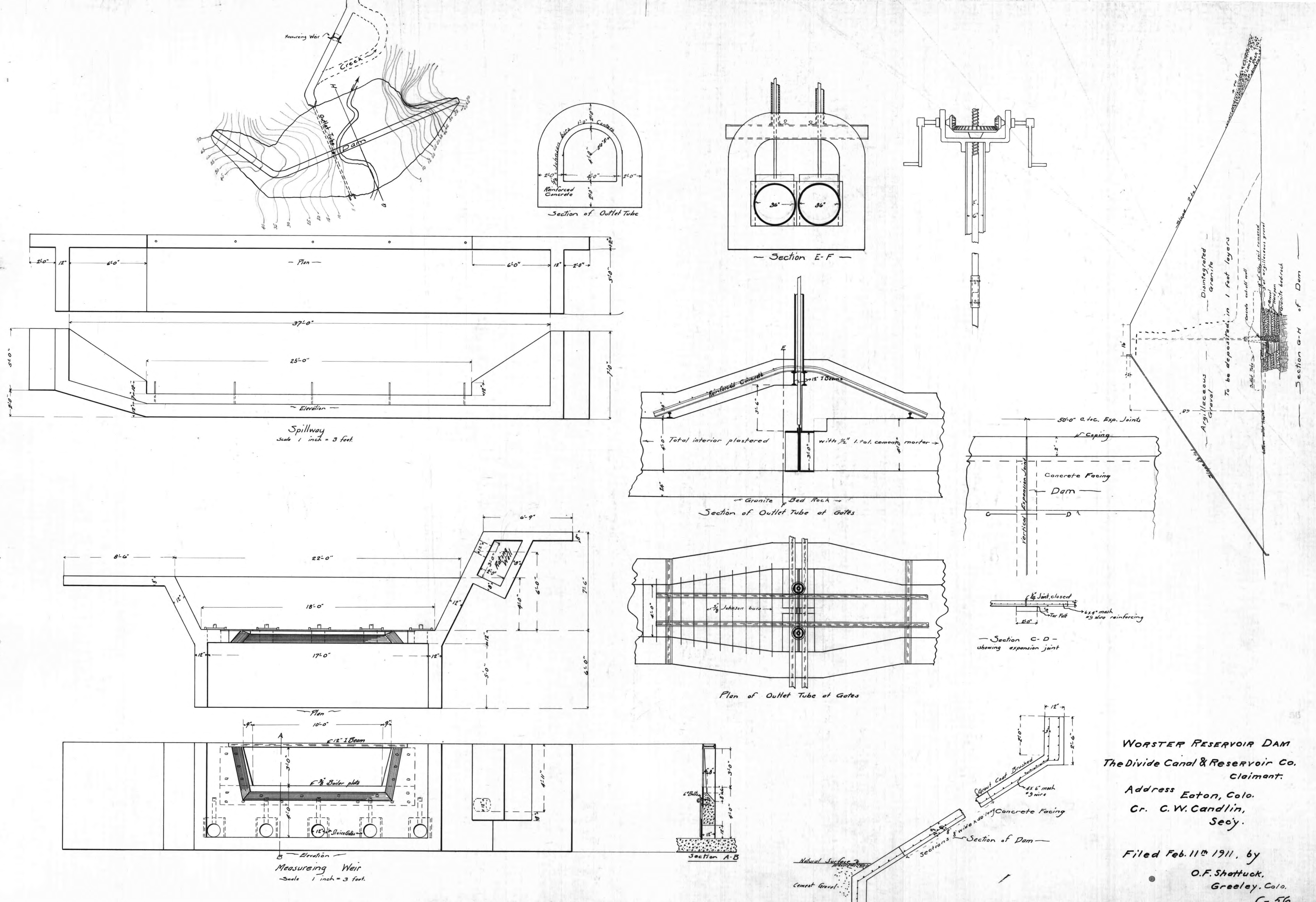
APPENDIX A

GEOMETRIC DAM INFORMATION - CONSTRUCTION PLAN SET



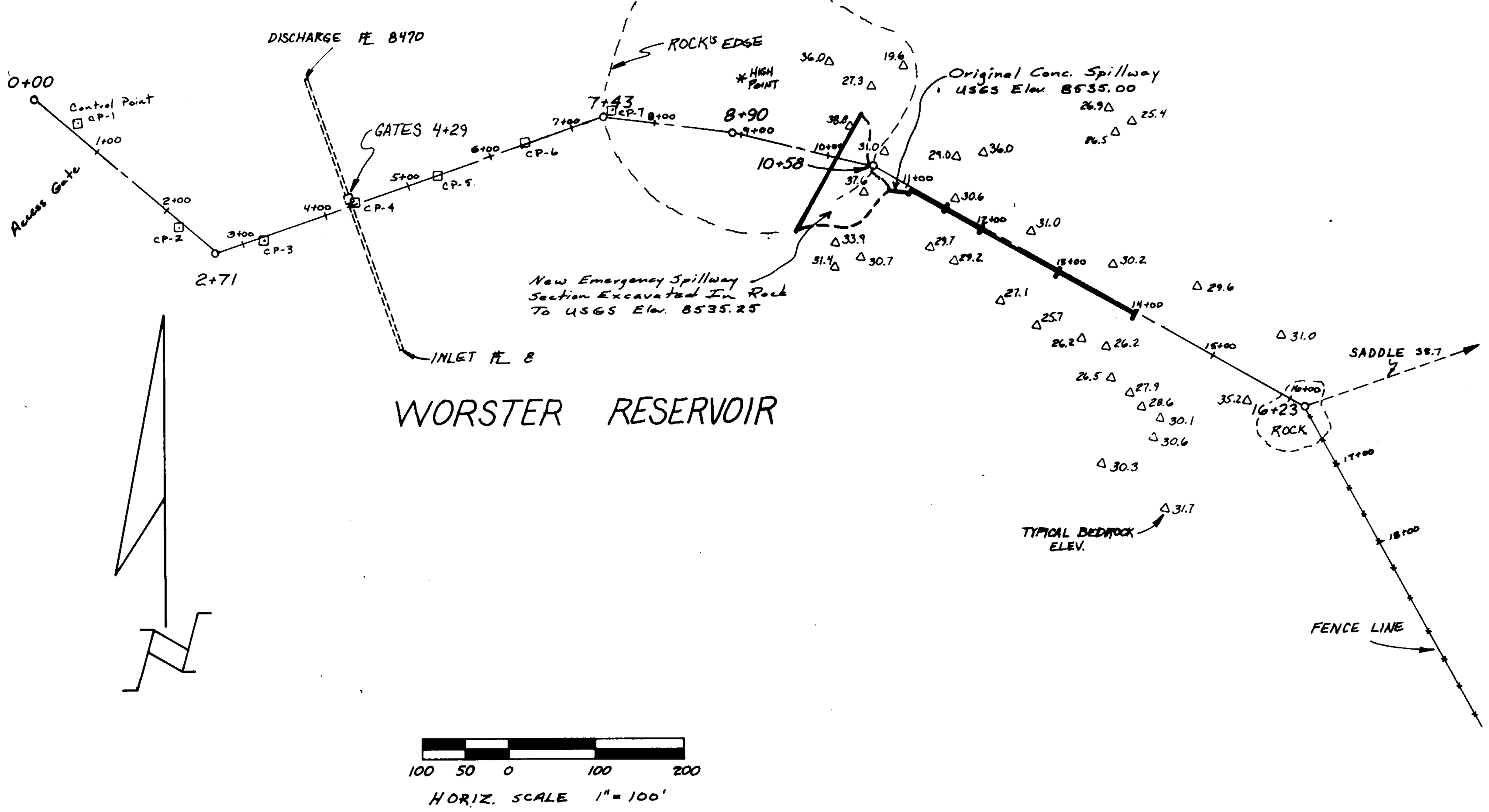
WORSTER RESERVOIR DAM

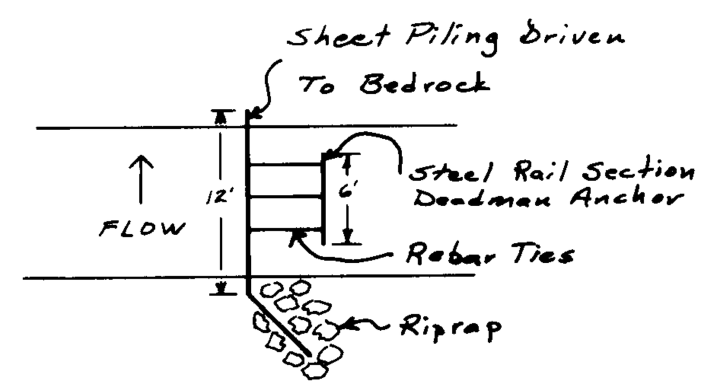
The Divide Canal & Reservoir Co.
Claimant.

Address Eaton, Colo.
Cr. C. W. Candlin,
Sec'y.

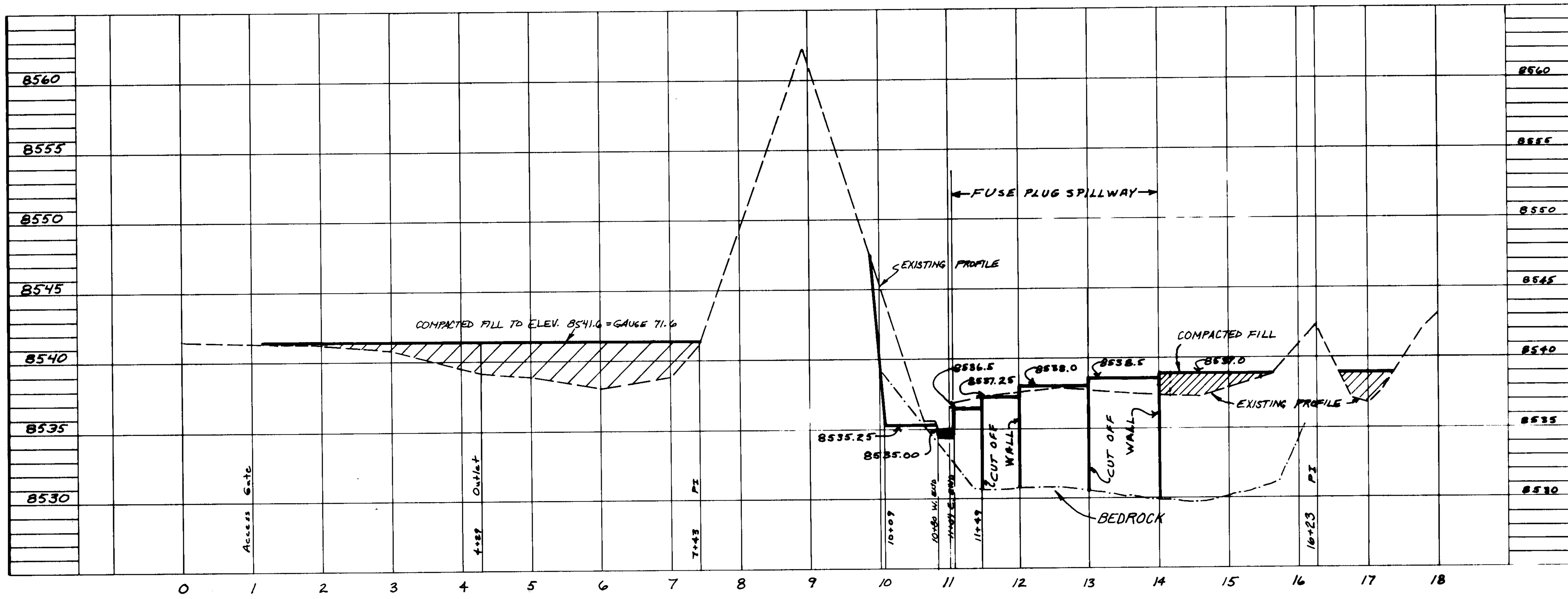
Filed Feb. 11th 1911, by
O. F. Shattuck.
Greeley, Colo.

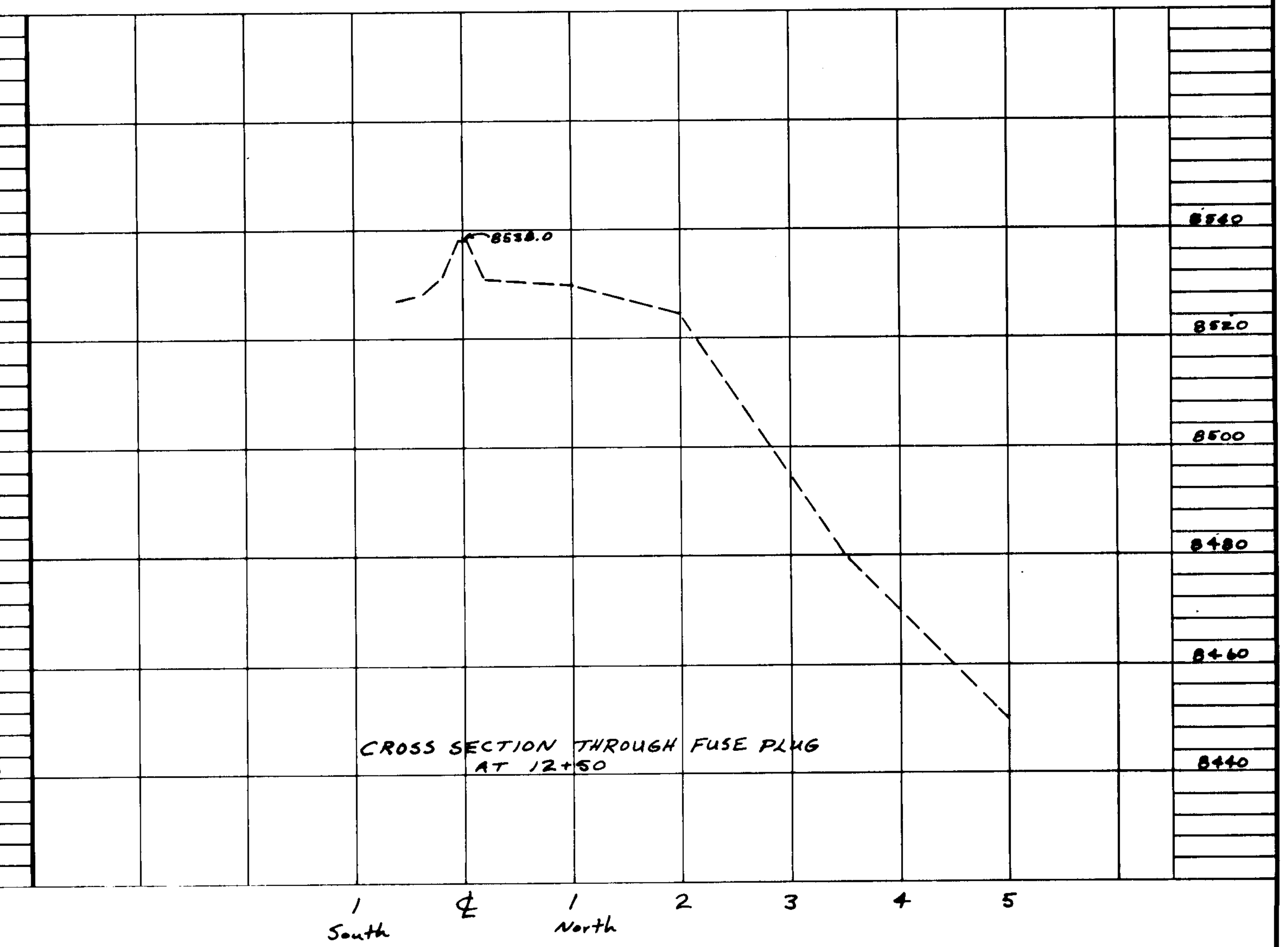
C-56





CUT OFF WALL DETAIL
SCALE 1" = 10'





NOTE: From approx. sta. 0+50 to sta. 3+50 the upstream face of the dam was reconstructed at a slope of 3:1.
From sta. 0+50 to 7+50 and from sta. 14+00 to 16+00 a 12" gravel blanket and an 18" layer of rock riprap was placed from the dam crest down to USGS Elev. 8528.
Control Points are steel pipe set in concrete with chisel marks on the caps.

I hereby certify that these plans represent the As-Constructed Conditions of Worster Reservoir Dam as of the 20th day of September, 1988.

Richard L. Leffler, P.E.

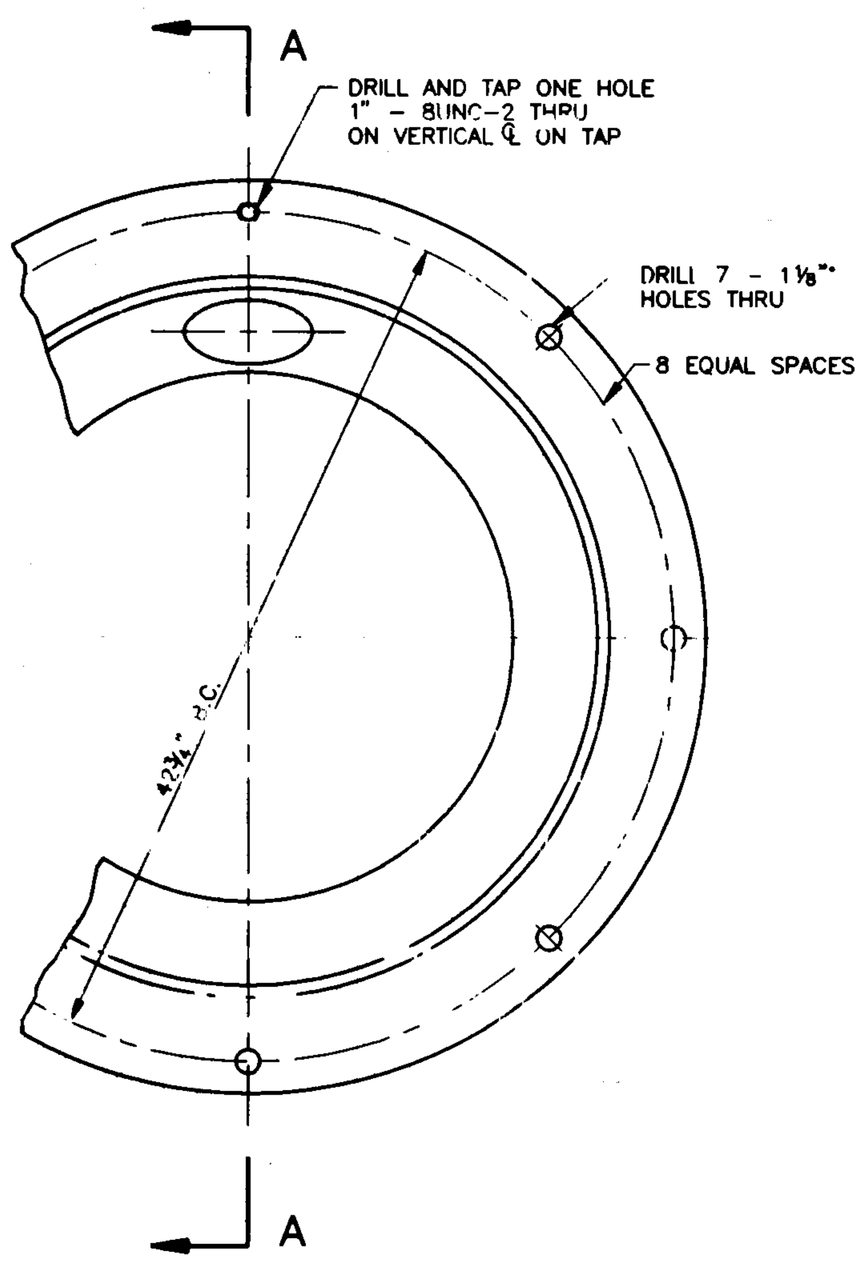
RICHARD L. LEFFLER REGISTERED PROFESSIONAL ENGINEER 13642 STATE OF COLORADO

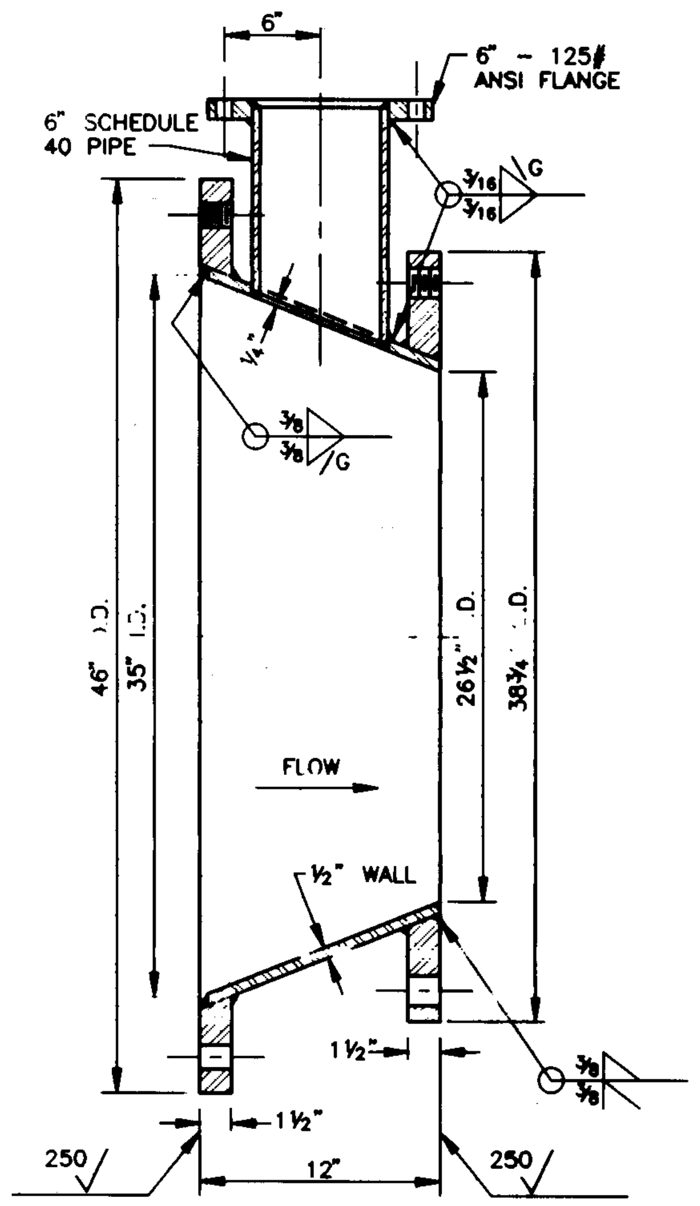
WORSTER RESERVOIR
WATER DIVISION 1, DISTRICT 3
DAM I.D. # 030401
DIVIDE CANAL AND RESERVOIR CO.

C-56A

Revisions: AS-BUILT 10-31-88	Scale:			
Drawn By: TMG	Checked By: RLL	Project No. 259.8302	Date: SEPT. 6, 1986	Sheet 1 of 1

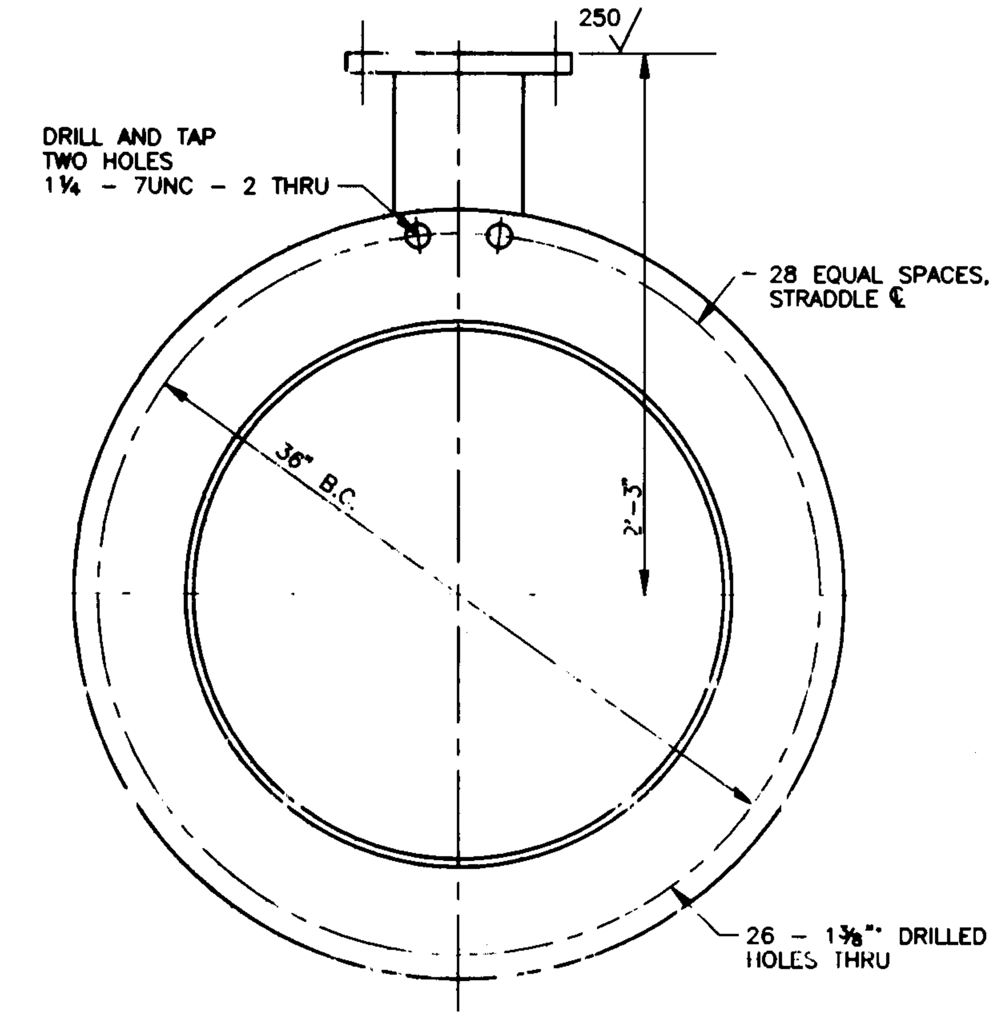
GREELEY, COLORADO





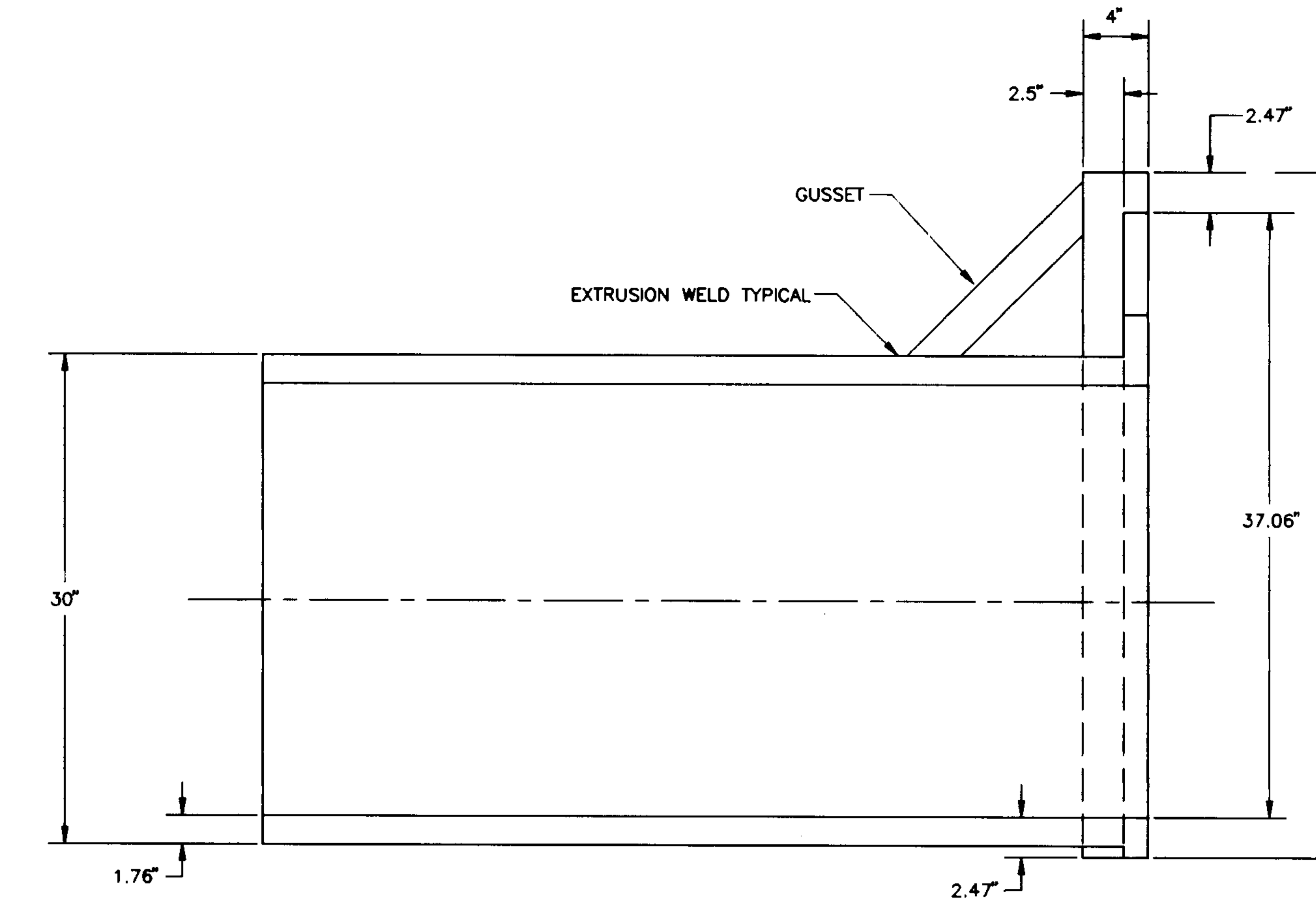
STEEL REDUCING THIMBLE SECTION AND DETAIL

SCALE: 1½" = 1'-0"



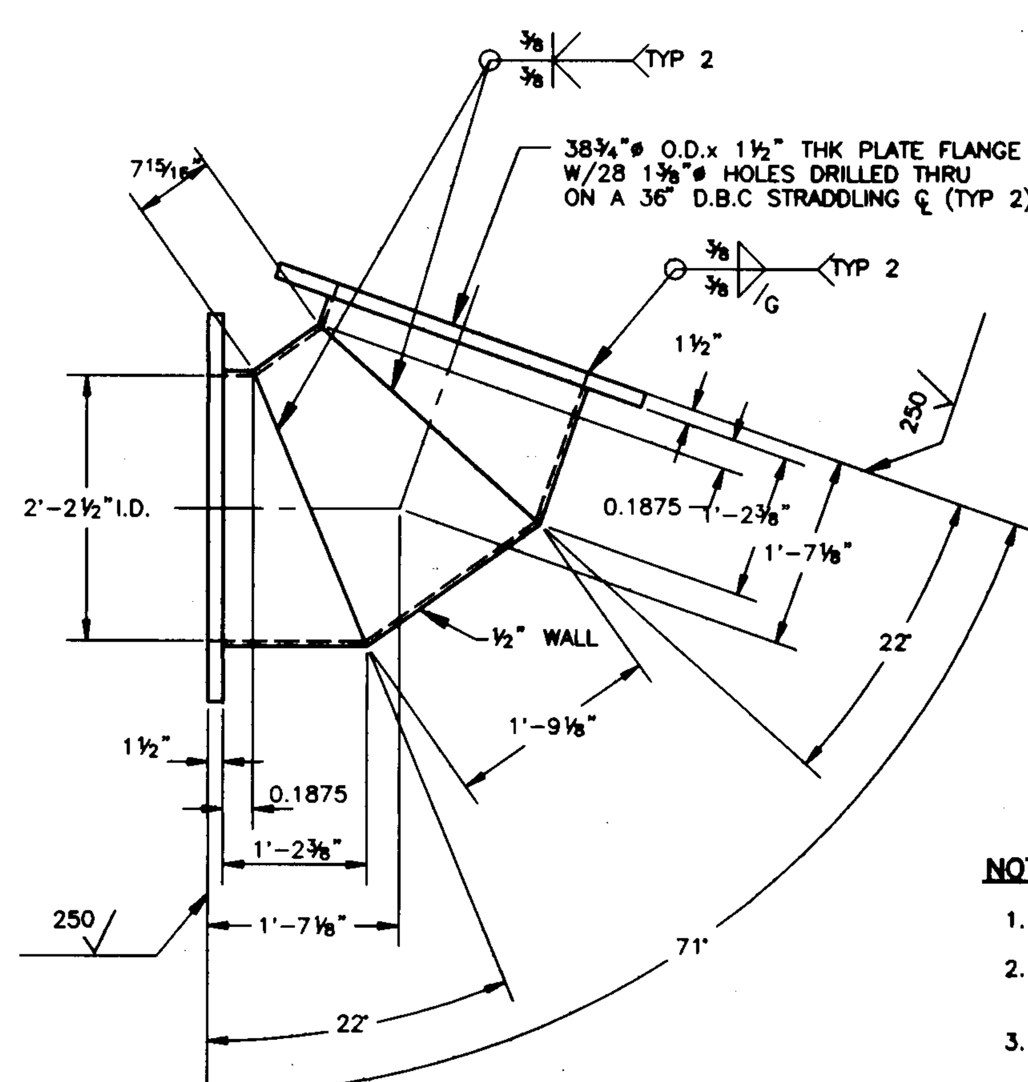
NOTES:

1. STEEL SHALL BE ASTM A36 OR EQUAL
2. BLAST CLEAN INTERIOR FLUIDWAY PER SSPC-SPIO
3. PAINT INTERIOR FLUIDWAY ONLY WITH TNEMEC 46H-413 COAL TAR EPOXY TDFT: 16 MILS COLOR: BALCK
OR
AMERON-AMERLOCK 400 HIGH SOLIDS EPOXY TDFT: 16 MILS COLOR: WHITE



HDPE ECCENTRIC REDUCER SECTION

SCALE: 1½" = 1'-0"



STEEL ELBOW DETAIL

SCALE: ¾" = 1'-0"

NOTES:

1. STEEL SHALL BE ASTM A36 OR EQUAL
2. BLAST CLEAN INTERIOR FLUIDWAY PER SSPC-SPIO
3. PAINT INTERIOR FLUIDWAY ONLY WITH TNEMEC 46H-413 COAL TAR EPOXY TDFT: 16 MILS COLOR: BALCK
OR
AMERON-AMERLOCK 400 HIGH SOLIDS EPOXY TDFT: 16 MILS COLOR: WHITE

RECORD DRAWING

DRAWN BY: G.O.J.	DATE 7/1/93	CHECKED BY: C.N.H.	DATE 5/1/95
AS CONSTRUCTED - CORRECTIONS COMPLETE BY C.N.H. DATE 12/28/95			

REVISIONS

NO.	DESCRIPTION	DATE	BY

INLET ELBOW, REDUCING THIMBLE AND HDPE REDUCER SECTIONS AND DETAIL

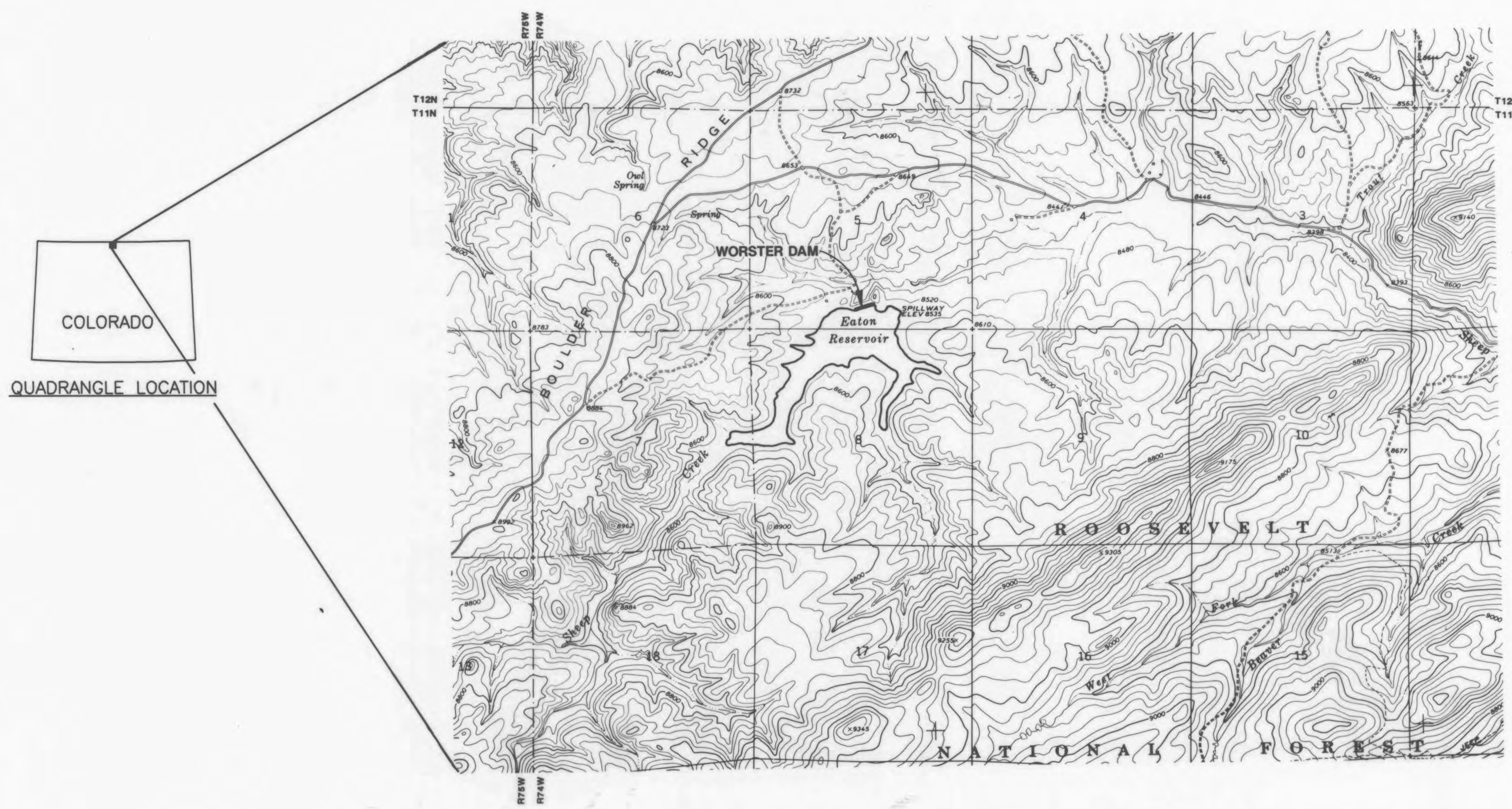
Woodward-Clyde Consultants
Consulting Engineers — Denver, Colorado

WORSTER DAM AND OUTLET REHABILITATION PROJECT NO. 23172-23112	DRAWING NO.	OF
	5	5

3172-10

CONSTRUCTION PLANS
FOR
WORSTER DAM AND OUTLET REHABILITATION

SECTION 5, TOWNSHIP 11 NORTH, RANGE 74 WEST
LARIMER COUNTY, COLORADO
WATER DIVISION 1, WATER DISTRICT 3, DAM ID. 030401



MAP REFERENCE: U.S.G.S. EATON RESERVOIR QUADRANGLE, COLORADO-WYOMING, 7.5 MINUTE SERIES

SITE LOCATION MAP

0 1000 2000 4000
SCALE IN FEET

N

INDEX OF DRAWINGS

DRAWING NO.	TITLE
1 OF 5	COVER SHEET AND LOCATION MAP
2 OF 5	FLEXIBLE MEMBRANE LINER AND BORROW AREA PLAN VIEW AND LINER ANCHOR DETAILS
3 OF 5	OUTLET AND VALVE CHAMBER PROFILE, SECTIONS AND DETAILS
4 OF 5	INLET TRASH RACK, WEIR BOX AND STAFF GAUGE, PLAN, SECTIONS, AND DETAILS
5 OF 5	INLET ELBOW, REDUCING THIMBLE AND HDPE REDUCER SECTIONS AND DETAIL △

PREPARED FOR
CANAL DIVIDE AND RESERVOIR COMPANY

PREPARED BY
WOODWARD-CLYDE CONSULTANTS
DENVER, COLORADO

DANIEL L. JOHNSON CO. PE # 13365

APPROVED ON THE 24th DAY OF May 19 95

HAL D. SIMPSON
STATE ENGINEER

DEPUTY

STATE ENGINEER OF COLORADO

THESE PLANS REPRESENT THE AS-CONSTRUCTED CONDITIONS OF WORSTER DAM OUTLET REHABILITATION TO THE BEST KNOWLEDGE AND JUDGMENT, BASED IN PART ON INFORMATION FURNISHED BY OTHERS AS OF THE 21 DAY OF Jan, 19 96.

Daniel L. Johnson — ENGINEER'S PRINTED NAME
13365 — CO. PE #

SIGNATURE

RECORD DRAWING

C-0056B

DRAWN BY: G.O.J.	DATE 7/1/93	CHECKED BY: C.N.H.	DATE 5/1/95
AS CONSTRUCTED – CORRECTIONS COMPLETE			
BY C.N.H.	DATE 12/28/95		

REVISIONS

NO.	DESCRIPTION	DATE	BY
△	ADD SHEET 5 WITH DETAIL	12/28/95	C.N.H.

COVER SHEET AND LOCATION MAP

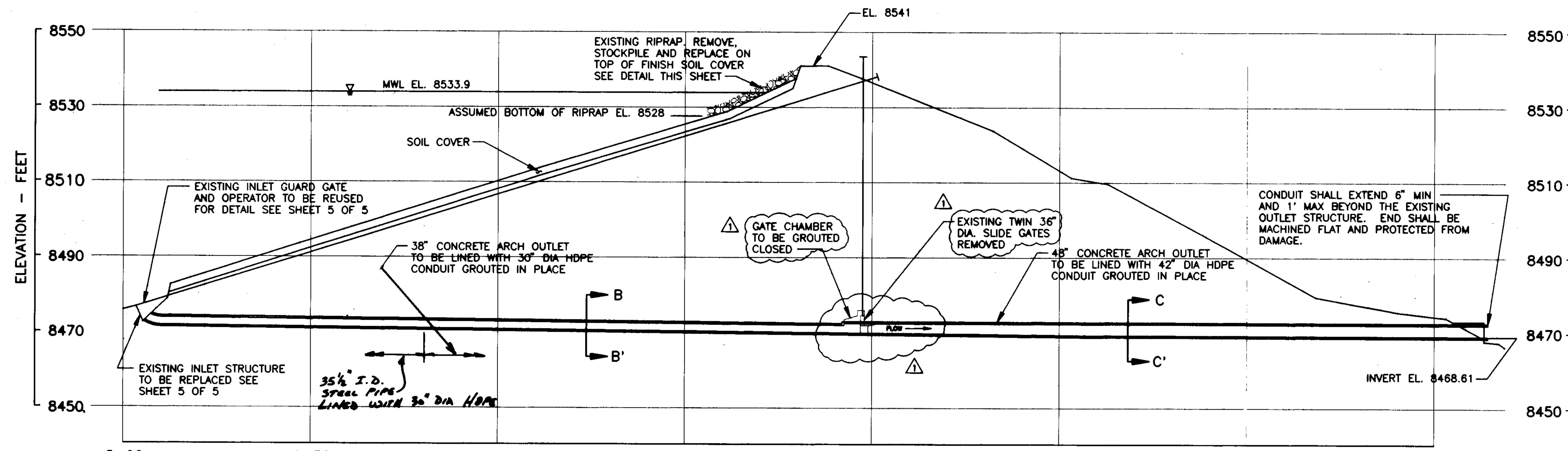
Woodward-Clyde Consultants
Consulting Engineers — Denver, Colorado

WORSTER DAM AND OUTLET REHABILITATION
PROJECT NO. 23172-23112

DRAWING NO. 1 OF 5

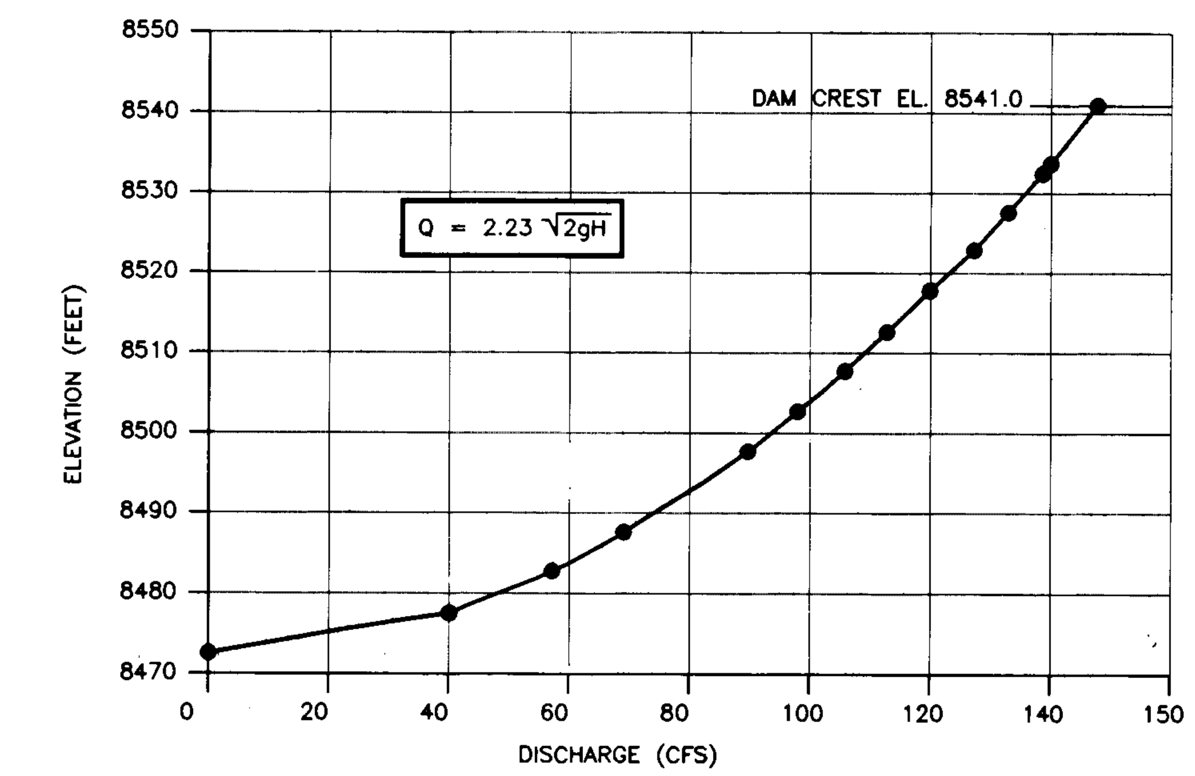
3172-1

103224

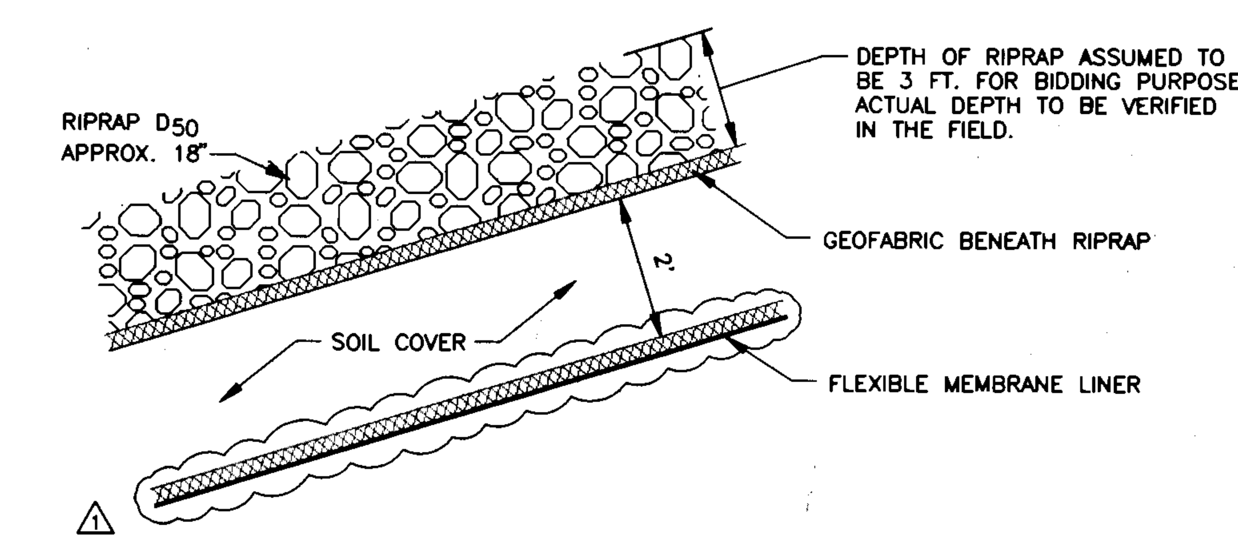


OUTLET CONDUIT PROFILE A-A'

SCALE: 1"=20'

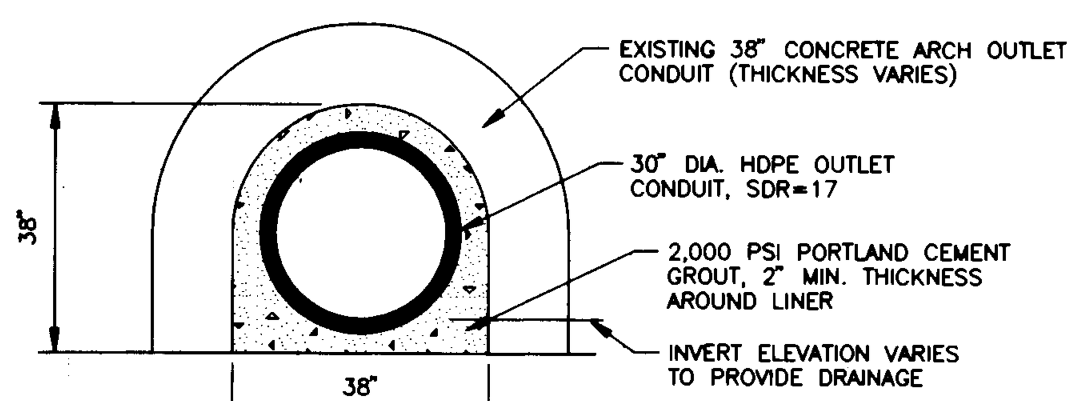


OUTLET WORKS RATING CURVE



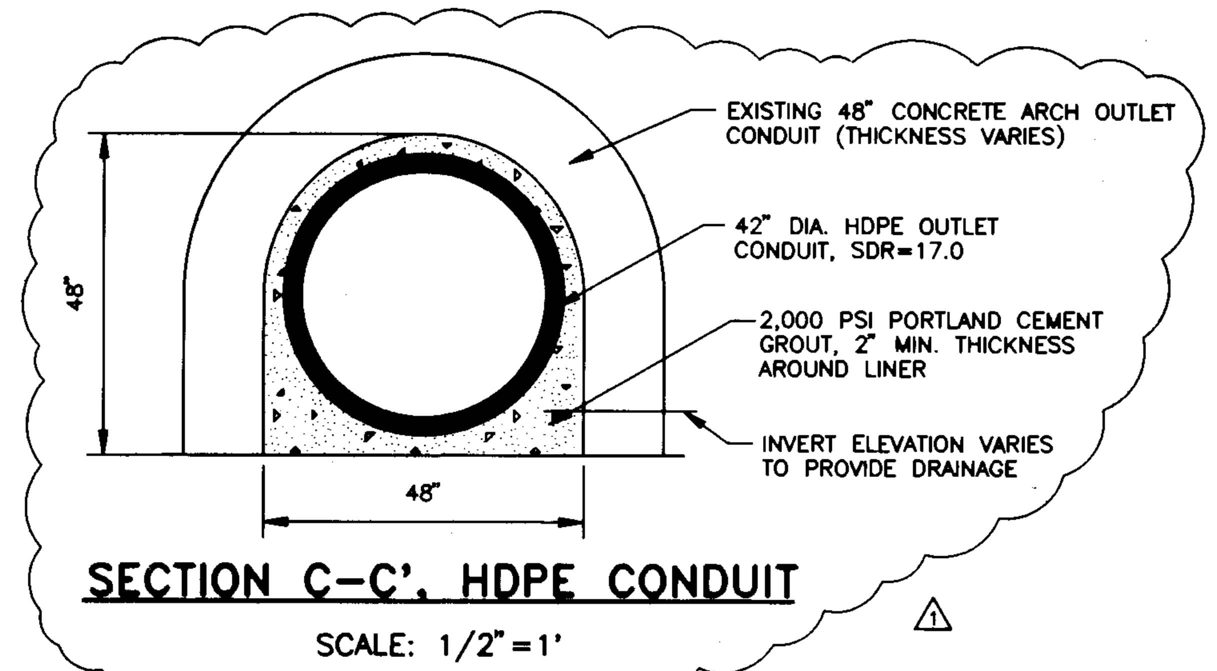
TYPICAL RIPRAP DETAIL

NOT TO SCALE



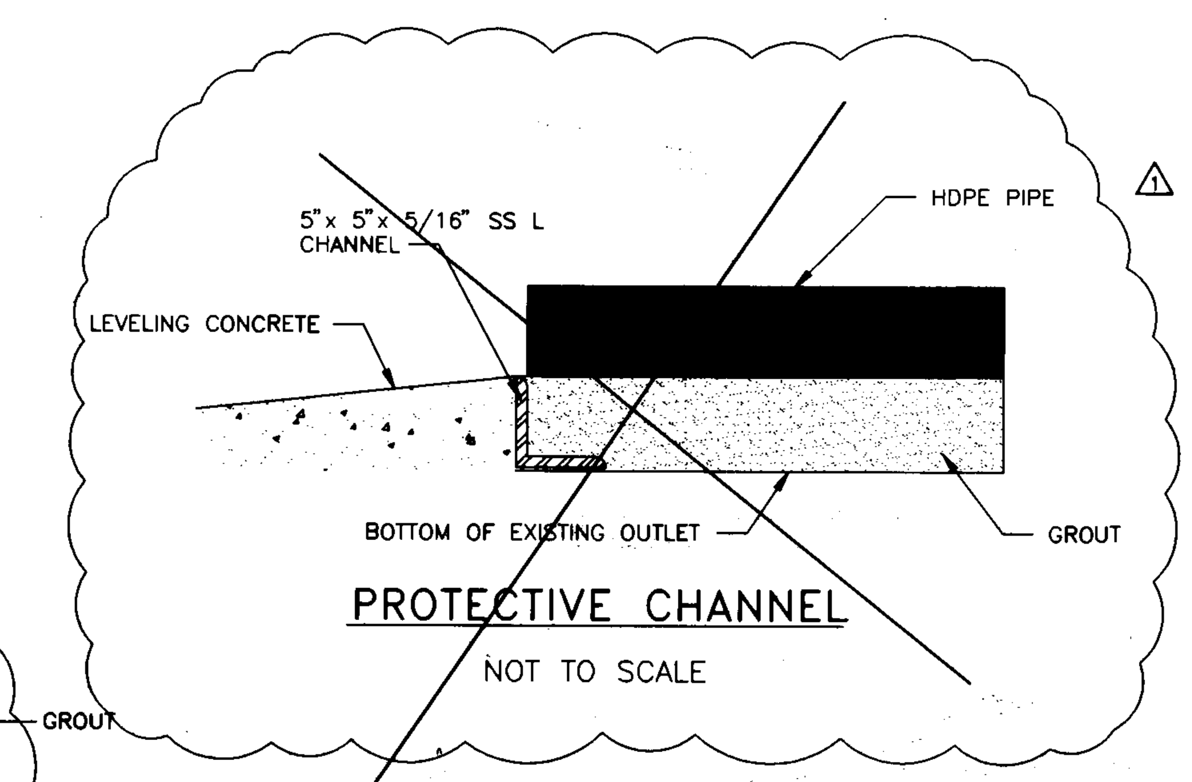
SECTION B-B', HDPE CONDUIT

SCALE: 1/2"=1'



SECTION C-C', HDPE CONDUIT

SCALE: 1/2"=1'



PROTECTIVE CHANNEL

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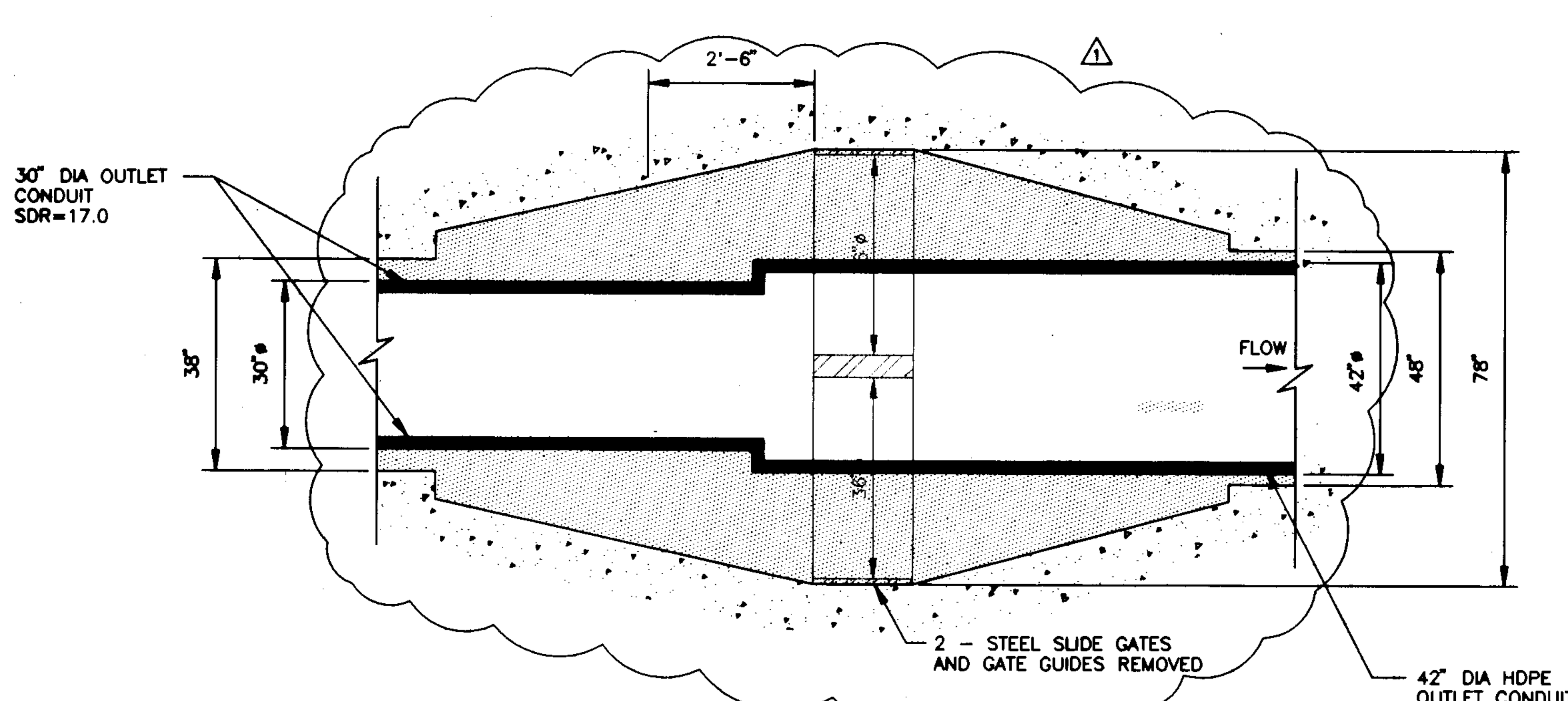
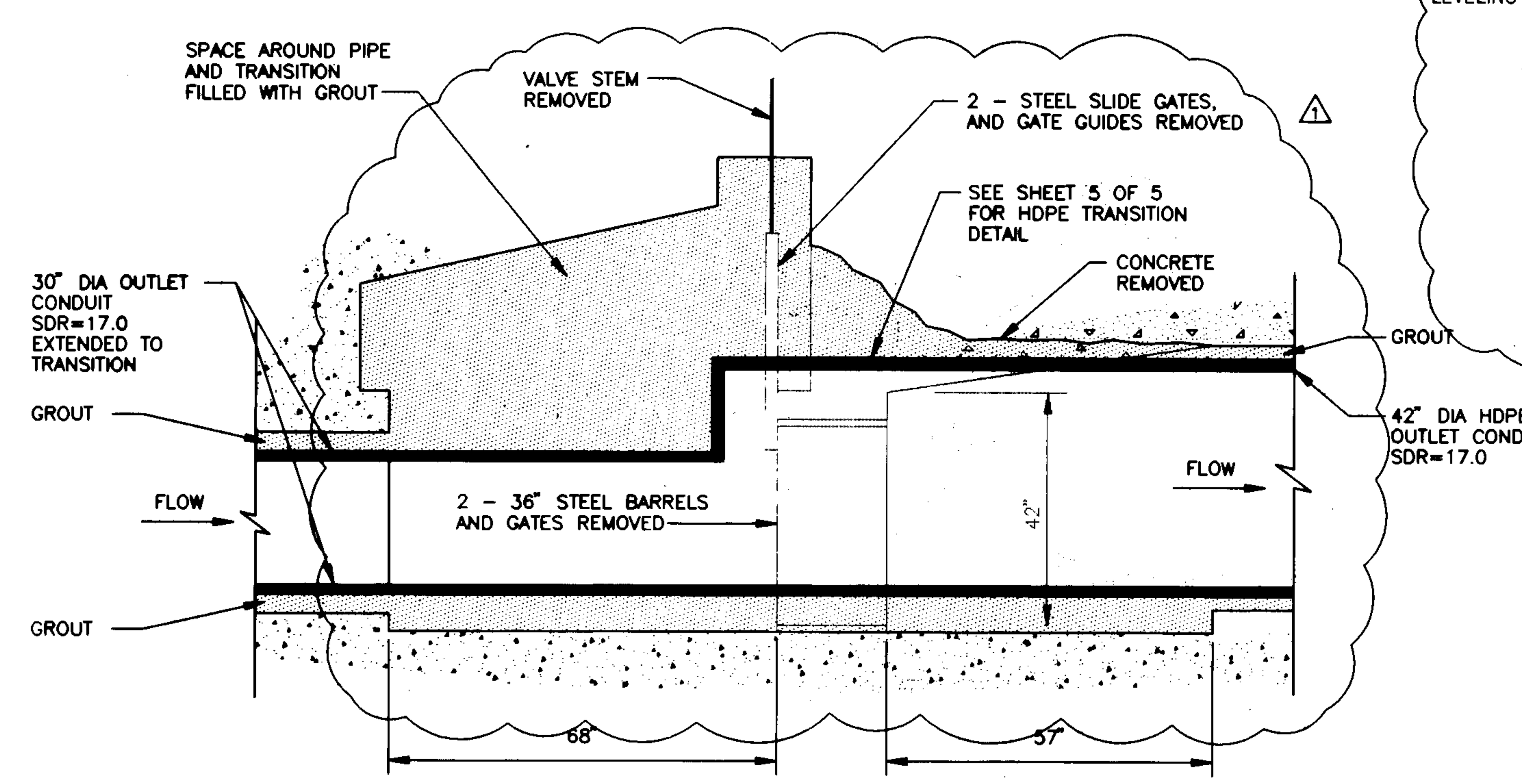


VALVE CHAMBER PLAN VIEW

NOT TO SCALE



VALVE CHAMBER PROFILE

NOT TO SCALE

NOTES:

1. CONTRACTOR SHALL SUBMIT PLANS THAT SHOW HOW THE CONDUIT WILL BE CENTERED, DISCUSS HOW THE CONDUIT WILL BE PROTECTED FROM COLLAPSE, BULK HEAD DETAILS, GROUT PORT AND SNORKEL DETAILS, GROUT RETURN TUBES, HOW THE GROUT PRESSURE WILL BE MEASURED, AND AN ESTIMATE OF THE TOTAL GROUT TAKE.
2. ALL DIMENSIONS SHOWN ARE APPROXIMATE AND SHOULD BE VERIFIED BY THE CONTRACTOR IN THE FIELD.

RECORD DRAWING

DRAWN BY: GOJ/CNH/JAF DATE 2/15/94 — CHECKED BY: C.N.H. DATE 5/1/95

AS CONSTRUCTED - CORRECTIONS COMPLETE BY C.N.H. DATE 12/28/95

REVISIONS

NO.	DESCRIPTION	DATE	BY
1	REVISE SECTION AND DETAILS TO SHOW CONTINUOUS OUTLET AND REMOVAL OF GATES	12/28/95	C.N.H.

OUTLET AND VALVE CHAMBER PROFILE, SECTIONS, AND DETAILS

Woodward-Clyde Consultants
Consulting Engineers — Denver, Colorado

WORSTER DAM AND OUTLET REHABILITATION
PROJECT NO. 23172-23112

DRAWING NO. 3 OF 5

3172-3

RECORD DRAWING

DRAWN BY: CNH	DATE 2/17/94	CHECKED BY:	DATE
AS CONSTRUCTED – CORRECTIONS COMPLETE BY C.N.H.	DATE 12/28/95		

REVISIONS

NO.	DESCRIPTION	DATE	BY
1	REVISE INLET STRUCTURE	12/28/95	C.N.H.

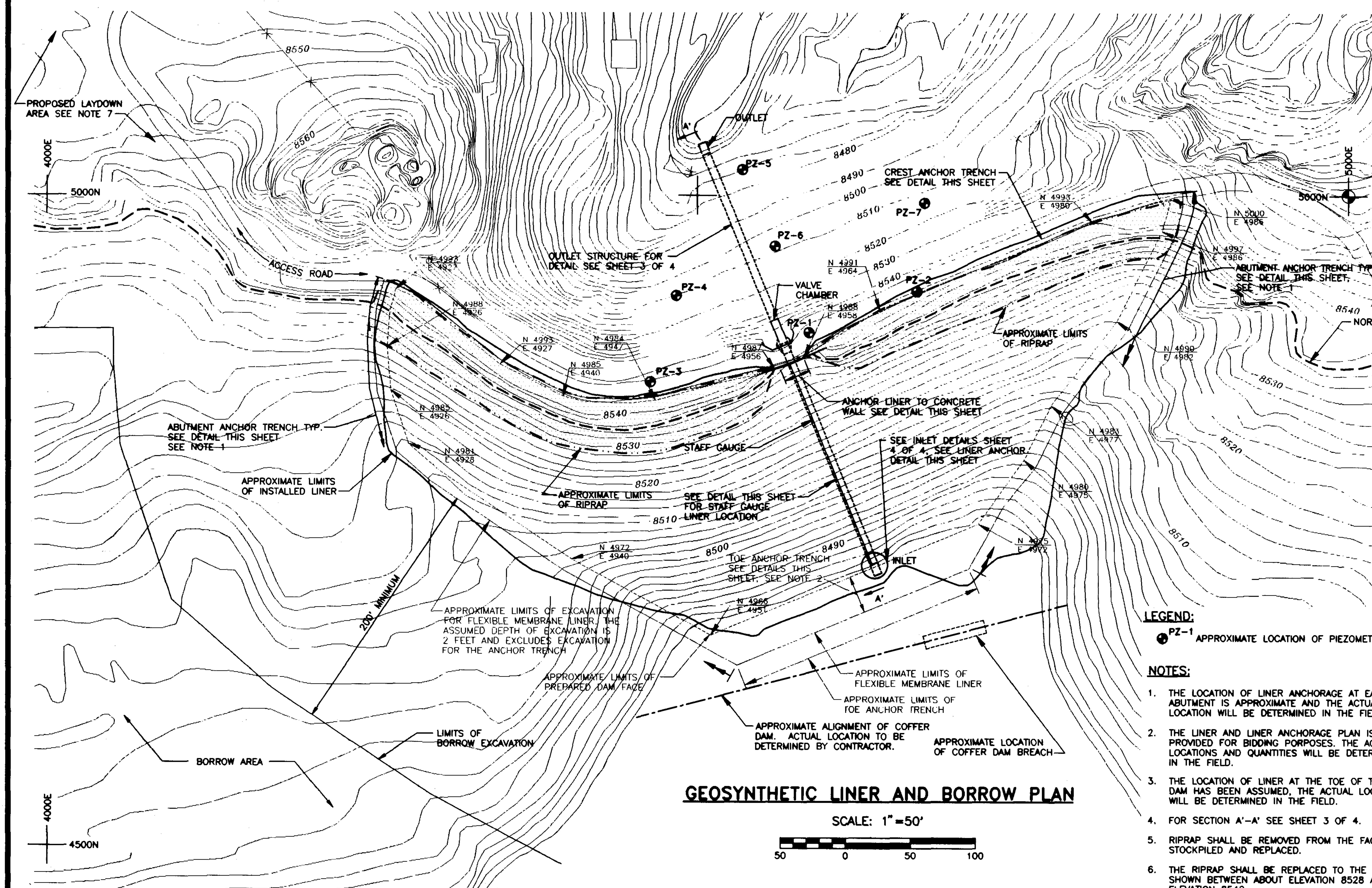
INLET, TRASH RACK, WEIR BOX, AND STAFF GAUGE, PLAN, SECTIONS AND DETAIL

Woodward-Clyde Consultants
Consulting Engineers — Denver, Colorado

WORSTER DAM AND OUTLET REHABILITATION
PROJECT NO. 23172-23112

DRAWING NO. 4 OF 5

3172-4



GEOSYNTHETIC LINER AND BORROW PLAN

SCALE: 1"=50'

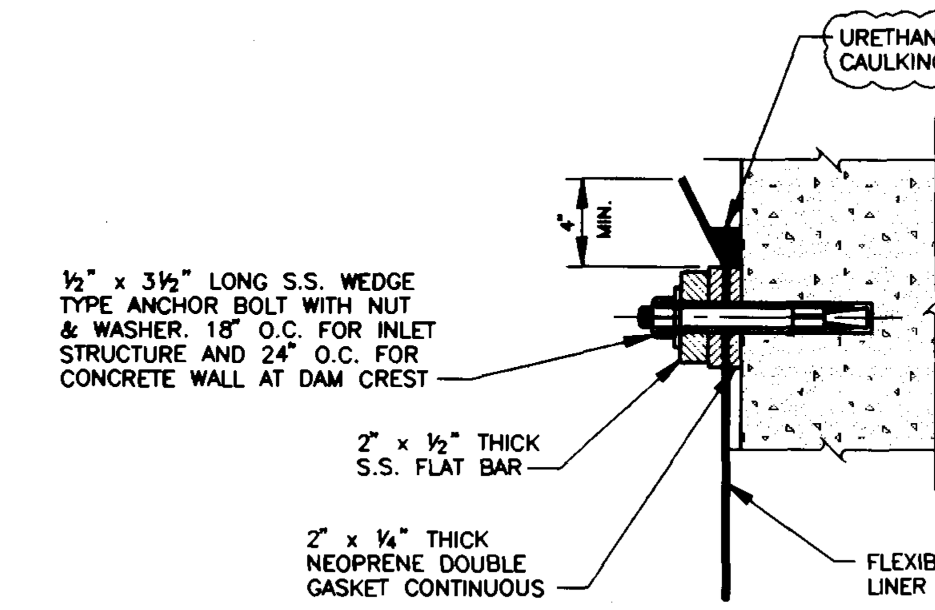
50 0 50 100

LEGEND:

PZ-1 APPROXIMATE LOCATION OF PIEZOMETER

NOTES:

1. THE LOCATION OF LINER ANCHORAGE AT EACH ABUTMENT IS APPROXIMATE AND THE ACTUAL LOCATION WILL BE DETERMINED IN THE FIELD.
2. THE LINER AND LINER ANCHORAGE PLAN IS PROVIDED FOR BIDDING PURPOSES. THE ACTUAL LOCATIONS AND QUANTITIES WILL BE DETERMINED IN THE FIELD.
3. THE LOCATION OF LINER AT THE TOE OF THE DAM HAS BEEN ASSUMED. THE ACTUAL LOCATION WILL BE DETERMINED IN THE FIELD.
4. FOR SECTION A'-A' SEE SHEET 3 OF 4.
5. RIPRAP SHALL BE REMOVED FROM THE FACE, STOCKPILED AND REPLACED.
6. THE RIPRAP SHALL BE REPLACED TO THE LIMITS SHOWN BETWEEN ABOUT ELEVATION 8528 AND ELEVATION 8542.
7. LAY DOWN AREA TO BE APPROVED BY OWNER.

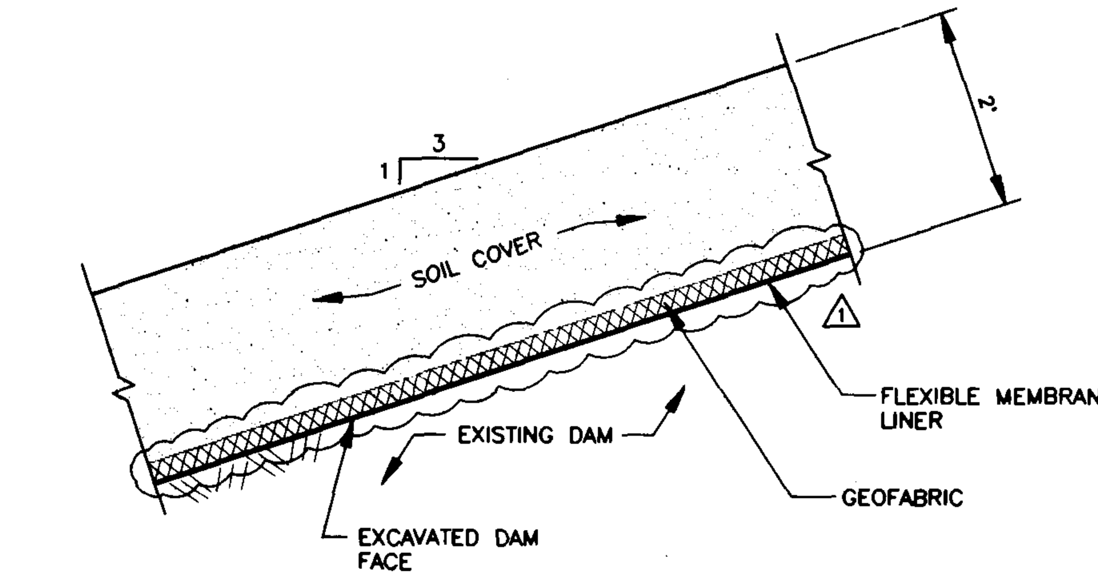


NOTE:

1. THE CONTRACTOR SHALL PLACE URETHANE CAULKING OVER CONCRETE SURFACE AND AROUND ANCHOR BOLTS PRIOR TO PLACING NEOPRENE GASKET.
2. THE CONTRACTOR SHALL INSTALL AND SET ANCHOR BOLT PER WRITTEN INSTRUCTIONS BY ANCHOR BOLT MANUFACTURER.
3. THE CONTRACTOR SHALL PRELOAD BOLT TO AT LEAST 50 PERCENT OF LOAD CAPACITY.
4. CONTRACTOR SHALL WRINKLE LINER BELOW ANCHORAGE SUCH THAT 12 LINER INCHES OF MATERIAL IS SHORTENED TO 11 INCHES.
5. THE MECHANICAL ANCHOR DETAIL FOR CONCRETE IS USED TO ANCHOR LINER TO THE INLET STRUCTURE AND THE CONCRETE WALL NEAR THE CREST.

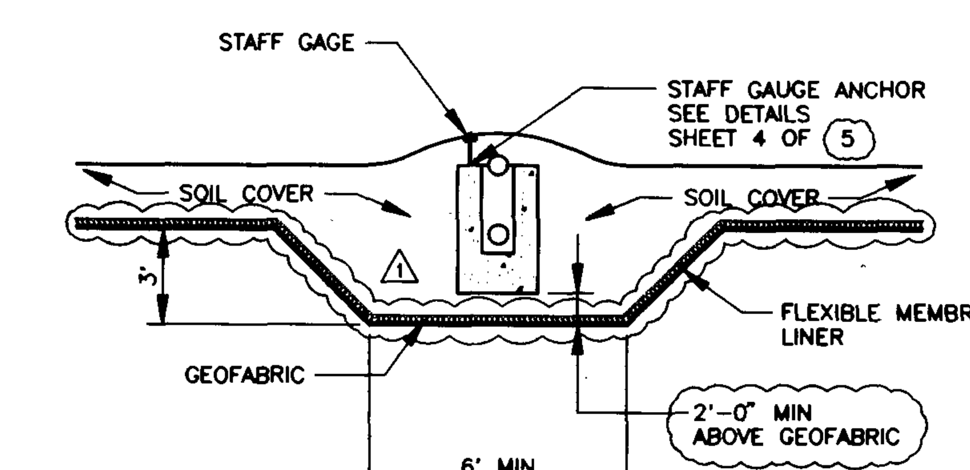
MECHANICAL ANCHOR DETAIL FOR CONCRETE

NOT TO SCALE



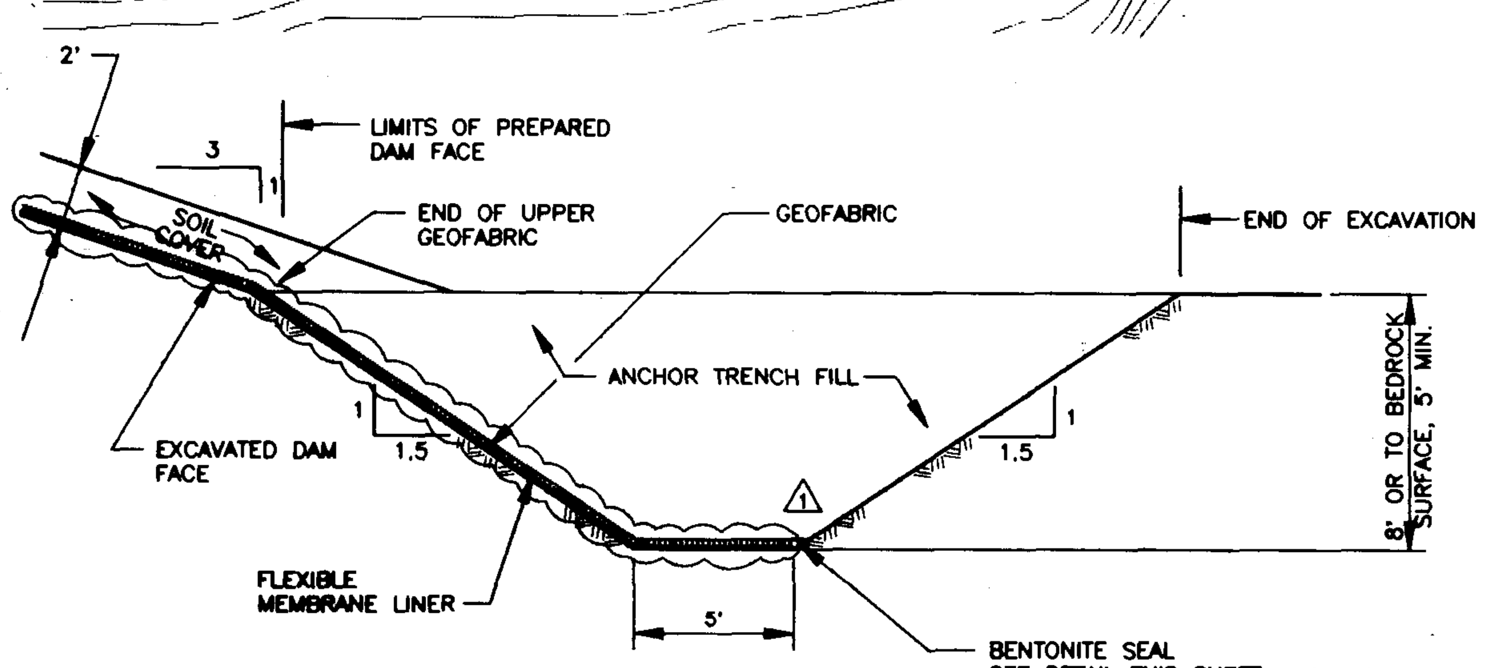
TYPICAL SLOPE DETAIL

NOT TO SCALE



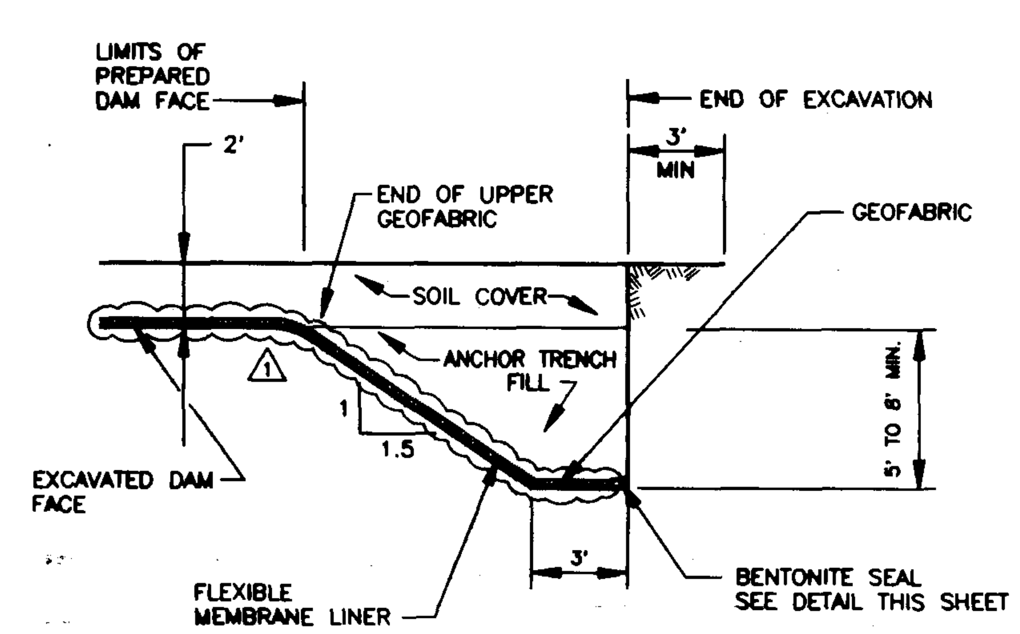
STAFF GAUGE / LINER LOCATION DETAIL

NOT TO SCALE



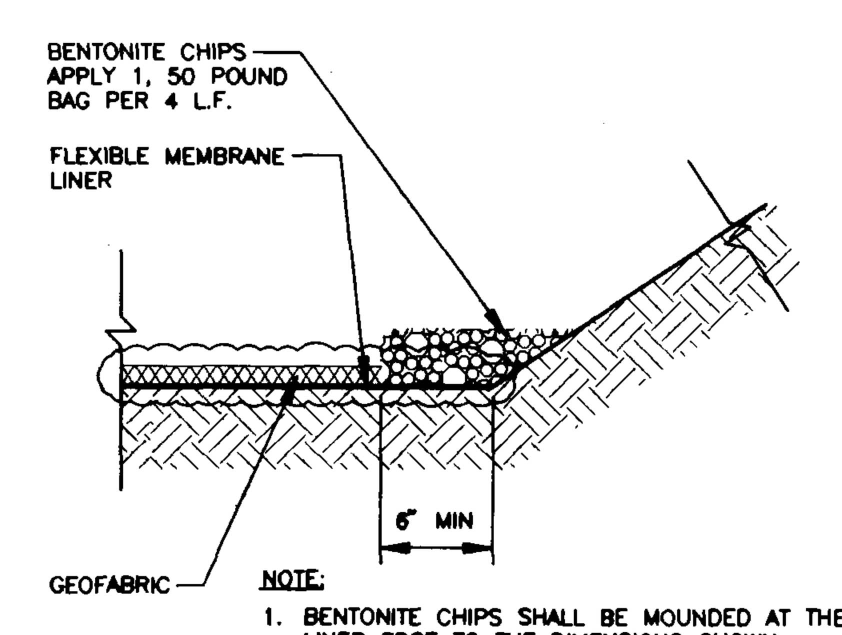
TOE ANCHOR TRENCH DETAIL

NOT TO SCALE



ABUTMENT ANCHOR TRENCH DETAIL

NOT TO SCALE

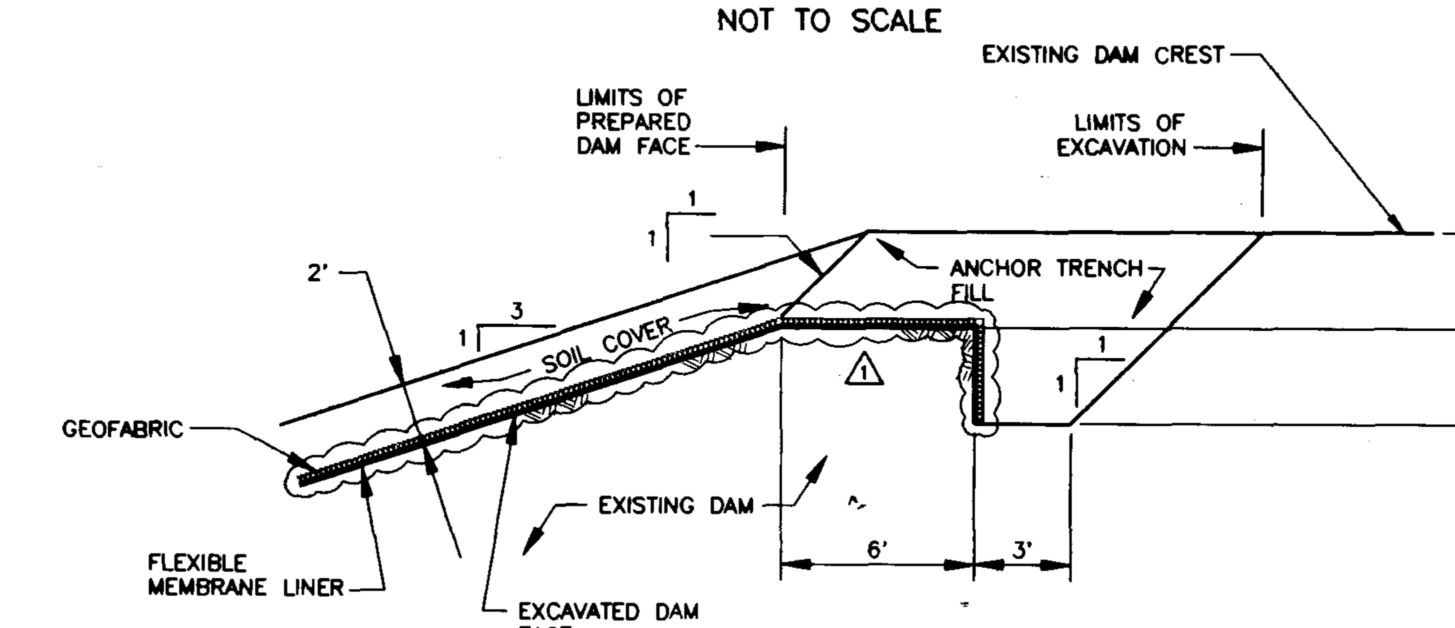


NOTE:

1. BENTONITE CHIPS SHALL BE MOUNDED AT THE LINER EDGE TO THE DIMENSIONS SHOWN.

BENTONITE SEAL DETAIL

NOT TO SCALE



CREST ANCHOR TRENCH DETAIL

NOT TO SCALE

GENERAL NOTE:

1. AT THE CONTRACTOR'S OPTION, (2) FEET OF MATERIAL SHALL BE REMOVED FROM THE DAM FACE OR THE FACE MAY BE PREPARED AND (2) FEET OF FILL FROM THE BORROW AREA MAY BE PLACED OVER THE LINER. SEE THE SPECIFICATION FOR SPECIFIC REQUIREMENTS FOR PREPARATION OF DAM FACE AND FILL OVER THE LINER. CONTRACTOR REMOVED 2 FEET OF MATERIAL FROM THE DAM FACE AND PLACED OVER THE LINER.

RECORD DRAWING

DRAWN BY: CNH/JAF	DATE 2/15/94	CHECKED BY: C.N.H.	DATE 5/1/95
AS CONSTRUCTED – CORRECTIONS COMPLETE			
BY C.N.H.	DATE 12/28/95		

REVISIONS

NO.	DESCRIPTION	DATE	BY
1	REVISE LINER AND GEOFABRIC INTERFACE AND LOCATION OF LINER. REVISE CAULKING	12/28/95	C.N.H.

FLEXIBLE MEMBRANE LINER AND BORROW AREA PLAN VIEW AND LINER ANCHOR DETAILS

Woodward-Clyde Consultants
Consulting Engineers — Denver, Colorado

WORSTER DAM AND OUTLET REHABILITATION
PROJECT NO. 23172-23112

DRAWING NO.	OF
2	5

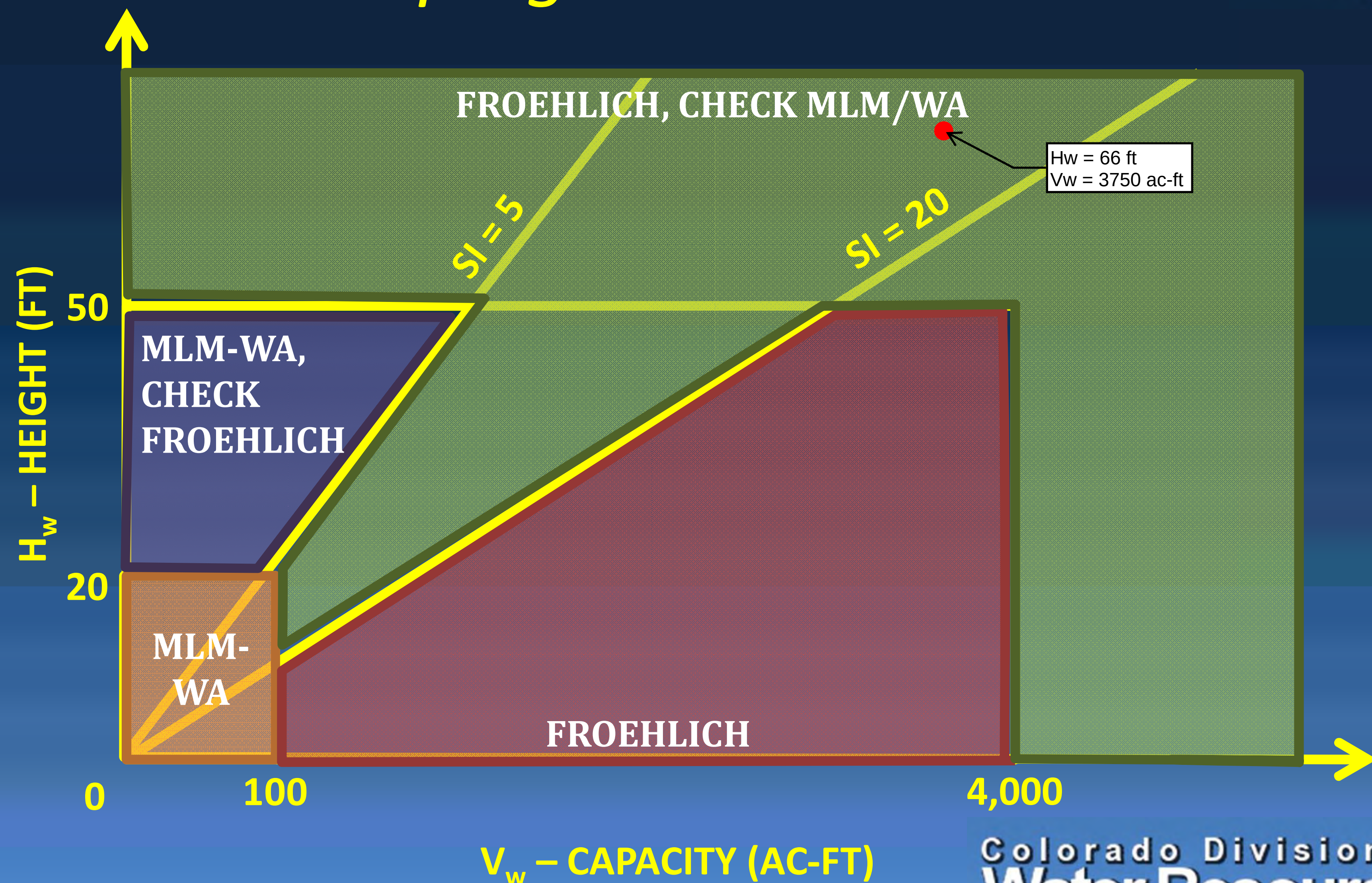
3172-2

APPENDIX B

DAM BREACH ANALYSIS SPREADSHEETS

Empirical Method Guidance
Piping Failure Mode

$$SI = \frac{V_w}{H_w}$$



Colorado Division of Water Resources

Adapted from Colorado Rules and Regulations for Dam Safety and Dam Construction, 2007

ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROEHLICH 2008 METHOD

PROJECT: **Worster Dam (Eaton Reservoir), DamID 030401**

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu:	PIPING	
Height of water over base elevation of breach (H_w) =	66.0	Feet
Volume of water in the reservoir at the time of failure (V_w) =	3,862.0	Acre-Feet
Reservoir Surface Area at Hw (A_s) =	137.5	Acres
Height of breach (H_b) =	72.0	Feet
Failure Mode Factor (K_o) =	1	
Breach Side-Slope Ratio (Z_b) =	0.7	Z(H):1(V)
Dam Size Class:	Large	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	137.4	Feet
Bottom Width of Breach (B_b) =	87.0	Feet
Breach Formation Time (T_f) =	0.56	Hours
Storage Intensity (SI) =	58.5	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	134381	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	1.91	If (B_{avg}/H_b) > 0.6, Full Breach Devlopment is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	246.5	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	3.7	If 1.6 < (ER/H_w) < 21, Erosion Rate is Assumed Reasonable

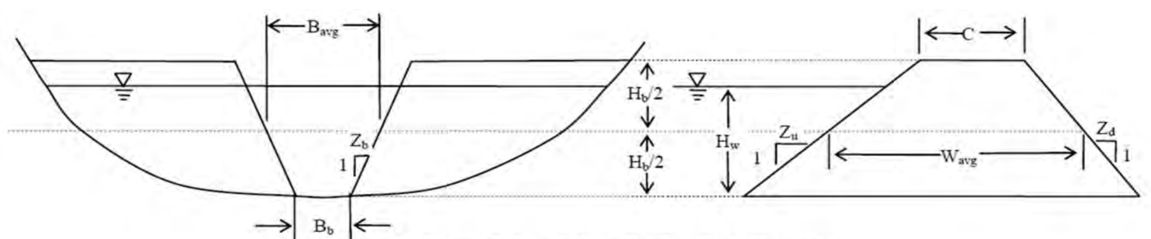


Figure 1- Breach Variable Definition Sketch

ESTIMATION OF DAM BREACH PARAMETERS
USING THE MACDONALD & LANGRIDGE-MONOPOLIS OR WASHINGTON STATE METHODS
WITH ALL FAILURE TIMES ESTIMATED BY WASHINGTON STATE METHOD

PROJECT: Worster Dam (Eaton Reservoir), DamID 030401

BREACH INPUT PARAMETERS:

Select Embankment Type From Drop-Down Menu: EARTHEN (NON-COHESIVE)

Height of water over base elevation of breach (H_w) =	66.0	Feet
Volume of water stored in reservoir at time of failure (V_w) =	3862.0	Acre-Feet
Reservoir Surface Area at H_w (S_a) =	137.5	Acres
Crest width of dam (C) =	12.0	Feet
Height of breach from dam crest to base elevation of breach (H_b) =	72.0	Feet
Slope of upstream dam face (Z_u) =	1.5	Z(H):1(V)
Slope of downstream dam face (Z_d) =	2.0	Z(H):1(V)
Breach side-slope ratio (Z_b) =	2.0	Z(H):1(V)
Piping Orifice Coefficient (C_p) =	0.68	Used To Calculate Peak Discharge Through Piping Hole
Dam Size Class:	Large	Assumes Full Reservoir At Time of Breach

CALCULATED BREACH CHARACTERISTICS:

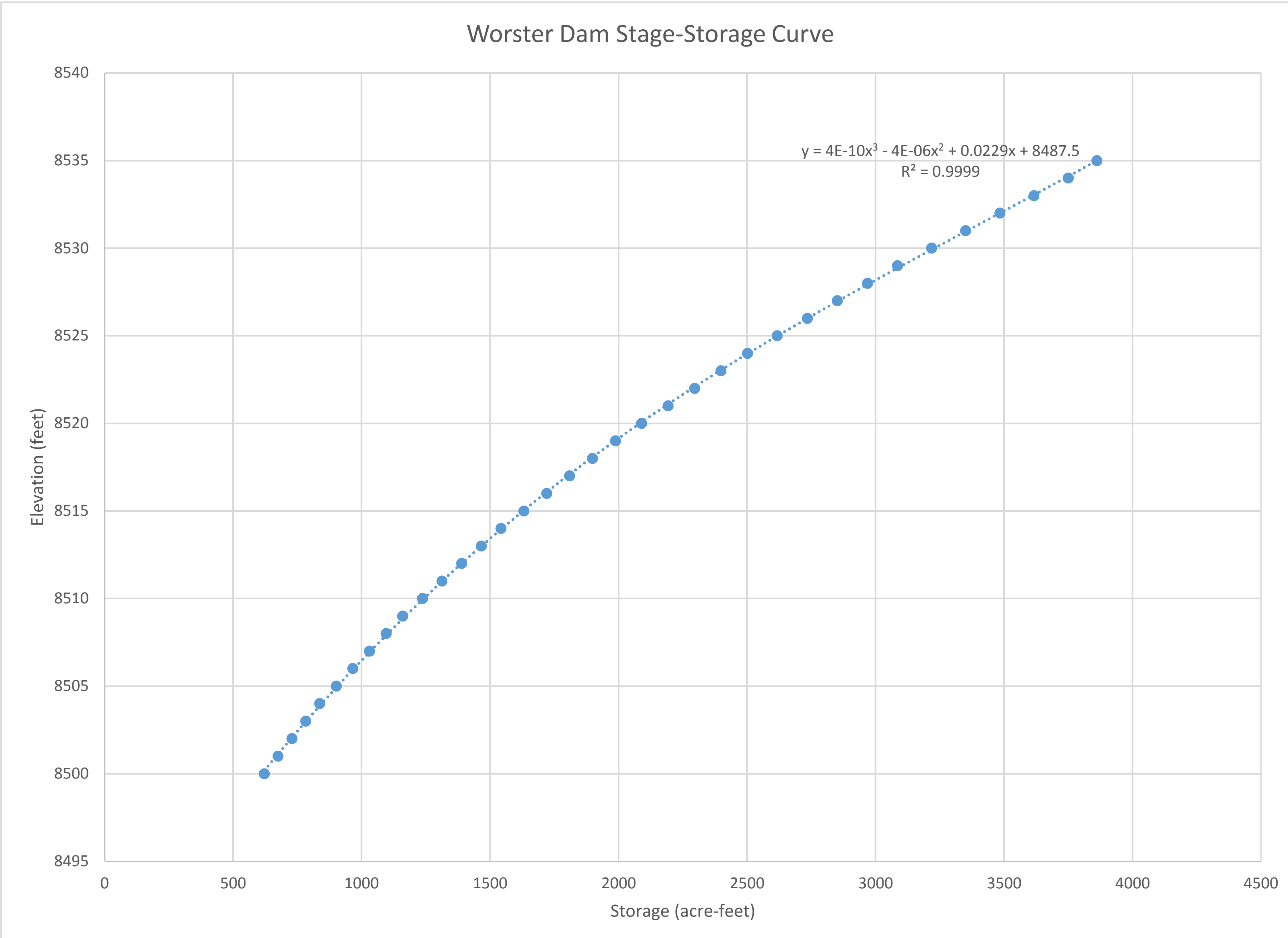
Breach Formation Factor (BFF) =	254892	
Embankment Volume Eroded (V_{er}) =	54566.4	Cubic Yards
Average Dam Width (W_{avg}) =	138.0	Feet (In Direction of Flow)
Average Breach Width (B_{avg}) =	148.3	Feet
Bottom Width of Breach (B_b) =	4.3	Feet
Breach Formation Time (T_f) =	1.01	Hours
Storage Intensity (SI) =	58.5	Acre Feet/Foot
Peak Breach Discharge (Q_p) =	93805	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (Bavg/Hb) =	2.06	If (Bavg/Hb) > 0.6, Full Breach Development is Anticipated
Erosion Rate (ER), Calculated as (Bavg/Tf) =	146.1	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/Hw) =	2.2	If 1.6 < (ER/Hw) < 21, Erosion Rate is Assumed Reasonable

APPENDIX C

STAGE-STORAGE INFORMATION FOR EATON RESERVOIR


Worster Dam Stage-Storage Curve
y = 4E-10x³ - 4E-06x² + 0.0229x + 8487.5
R² = 0.9999
Elevation (feet)
Storage (acre-feet)
8540
8535
8530
8525
8520
8515
8510
8505
8500
8495
0
500
1000
1500
2000
2500
3000
3500
4000
4500

Eaton Resevoir Stage Storage

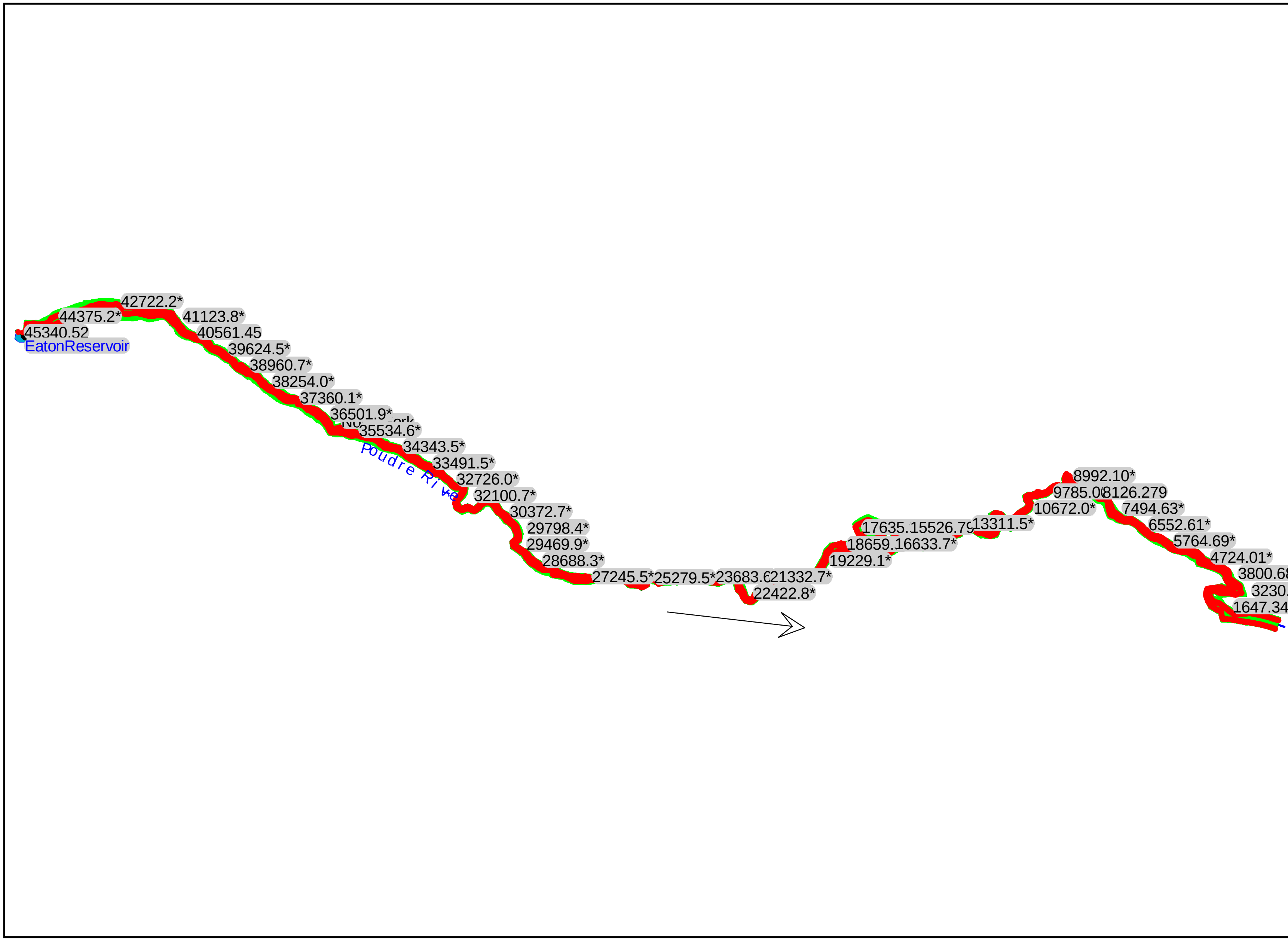
Gage Height	Elevation	Storage	Surface Area
0	8469	0	0.0
5	8474	0	0.0
6	8475	2	4.0
7	8476	4	4.8
8	8477	6	5.6
9	8478	8	6.3
10	8479	12	7.1
11	8480	18	7.9
12	8481	25	8.7
13	8482	35	9.5
14	8483	47	10.2
15	8484	63	11.0
16	8485	81	11.8
17	8486	101	15.7
18	8487	124	19.5
19	8488	149	23.4
20	8489	175	27.2
21	8490	208	31.1
22	8491	242	35.0
23	8492	277	38.8
24	8493	313	42.7
25	8494	350	46.5
26	8495	392	50.4
27	8496	436	50.5
28	8497	480	50.6
29	8498	524	50.8
30	8499	569	50.9
31	8500	622	51.0
32	8501	675	51.1
33	8502	729	51.2
34	8503	783	51.4
35	8504	837	51.5
36	8505	902	51.6
37	8506	966	55.9
38	8507	1031	60.2
39	8508	1096	64.4
40	8509	1160	68.7
41	8510	1237	73.0
42	8511	1313	77.3
43	8512	1390	81.6
44	8513	1466	85.8
45	8514	1543	90.1
46	8515	1632	94.4
47	8516	1721	95.2

Eaton Resevoir Stage Storage

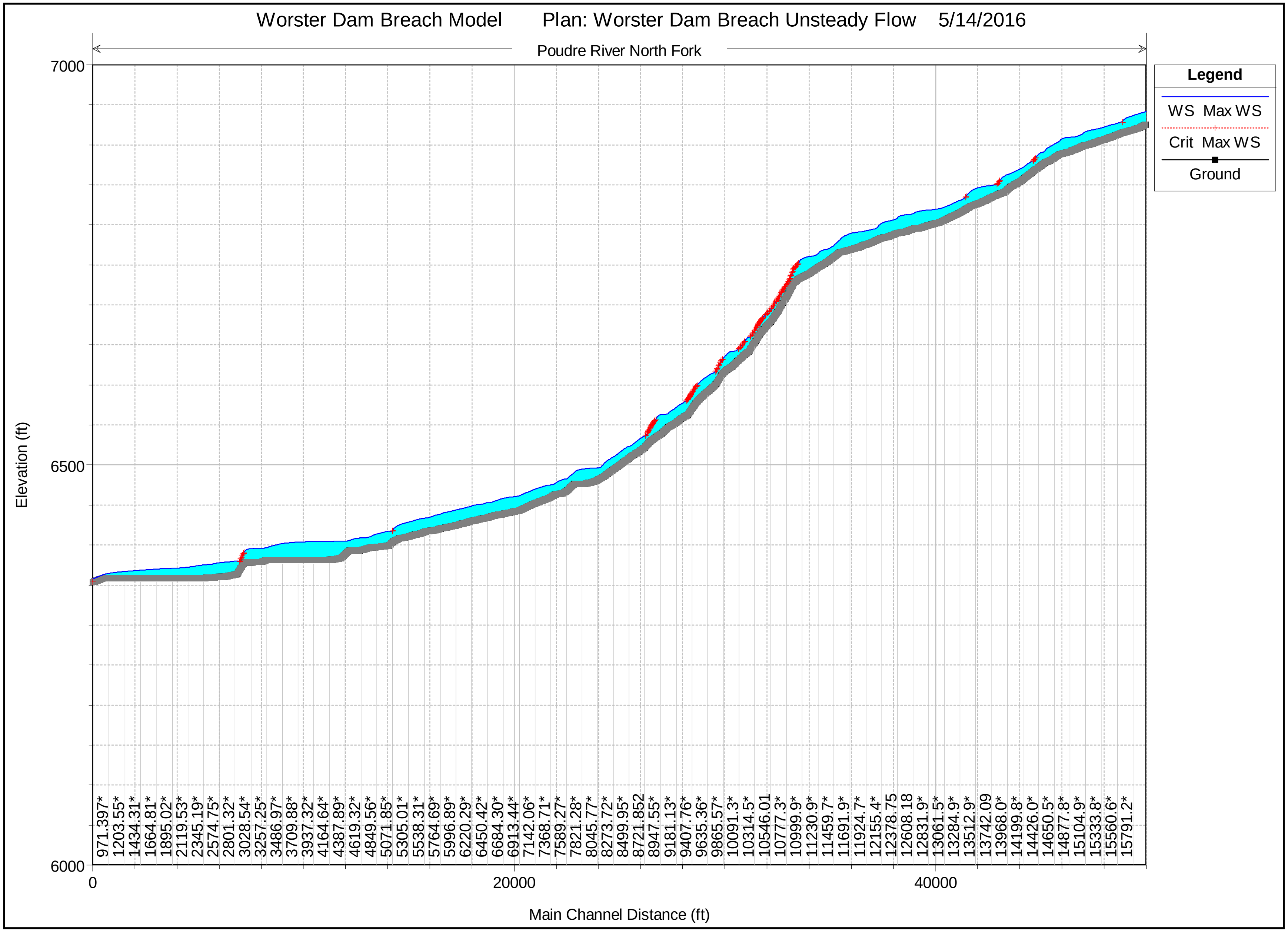
Gage Height	Elevation	Storage	Surface Area
48	8517	1810	96.1
49	8518	1899	96.9
50	8519	1988	97.8
51	8520	2090	98.6
52	8521	2193	99.4
53	8522	2296	100.3
54	8523	2399	101.1
55	8524	2502	102.0
56	8525	2618	102.8
57	8526	2735	106.3
58	8527	2852	109.7
59	8528	2969	113.2
60	8529	3086	116.7
61	8530	3218	120.1
62	8531	3351	123.6
63	8532	3484	127.1
64	8533	3617	130.5
65	8534	3750	134.0
66	8535	3862	137.5
67	8536	3984	140.9
68	8537	4104	144.4
69	8538	4220	147.9
70	8539	4334	151.3
71	8540	4444	154.8
72	8541	4551	158.3

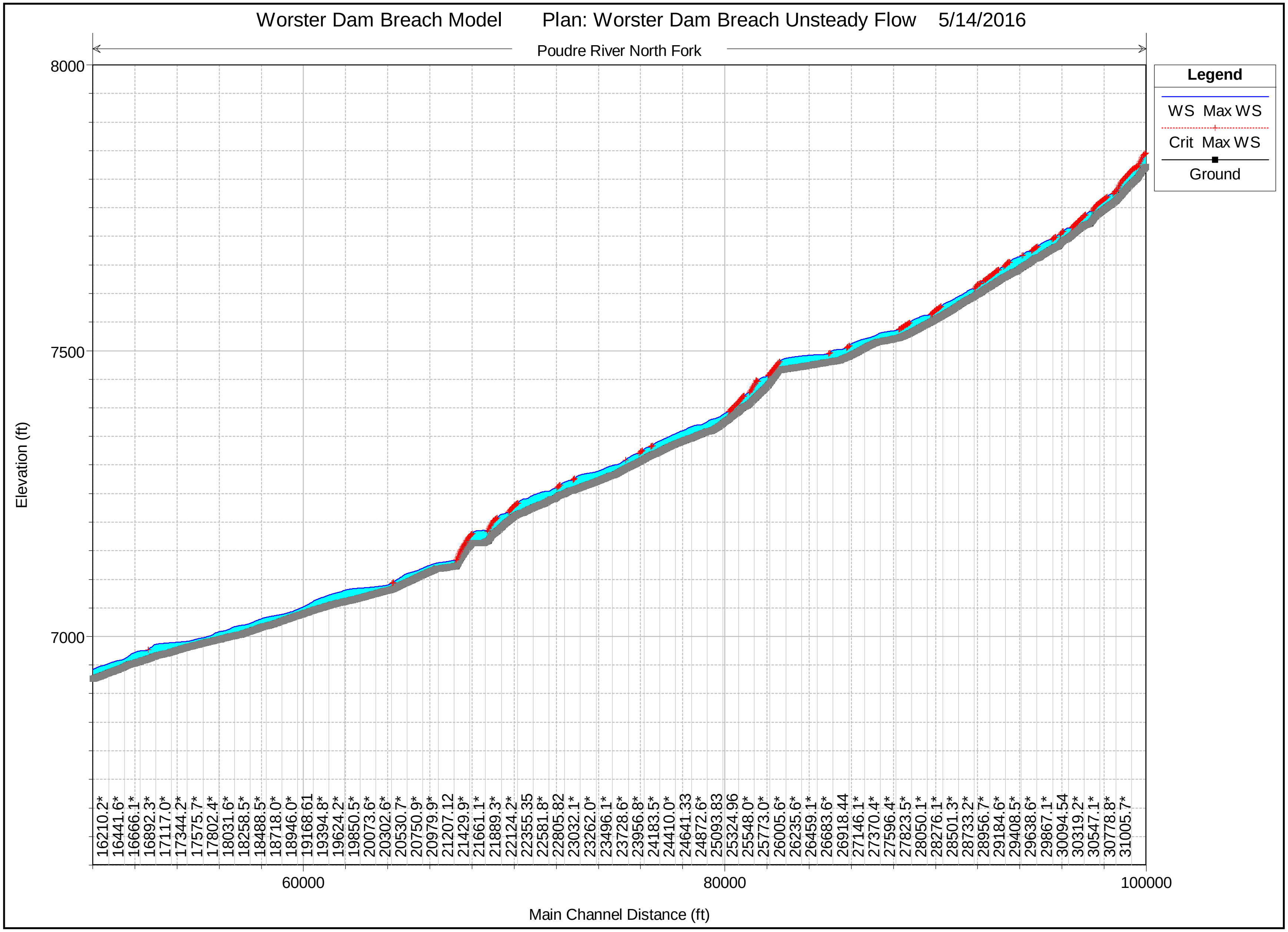
APPENDIX D

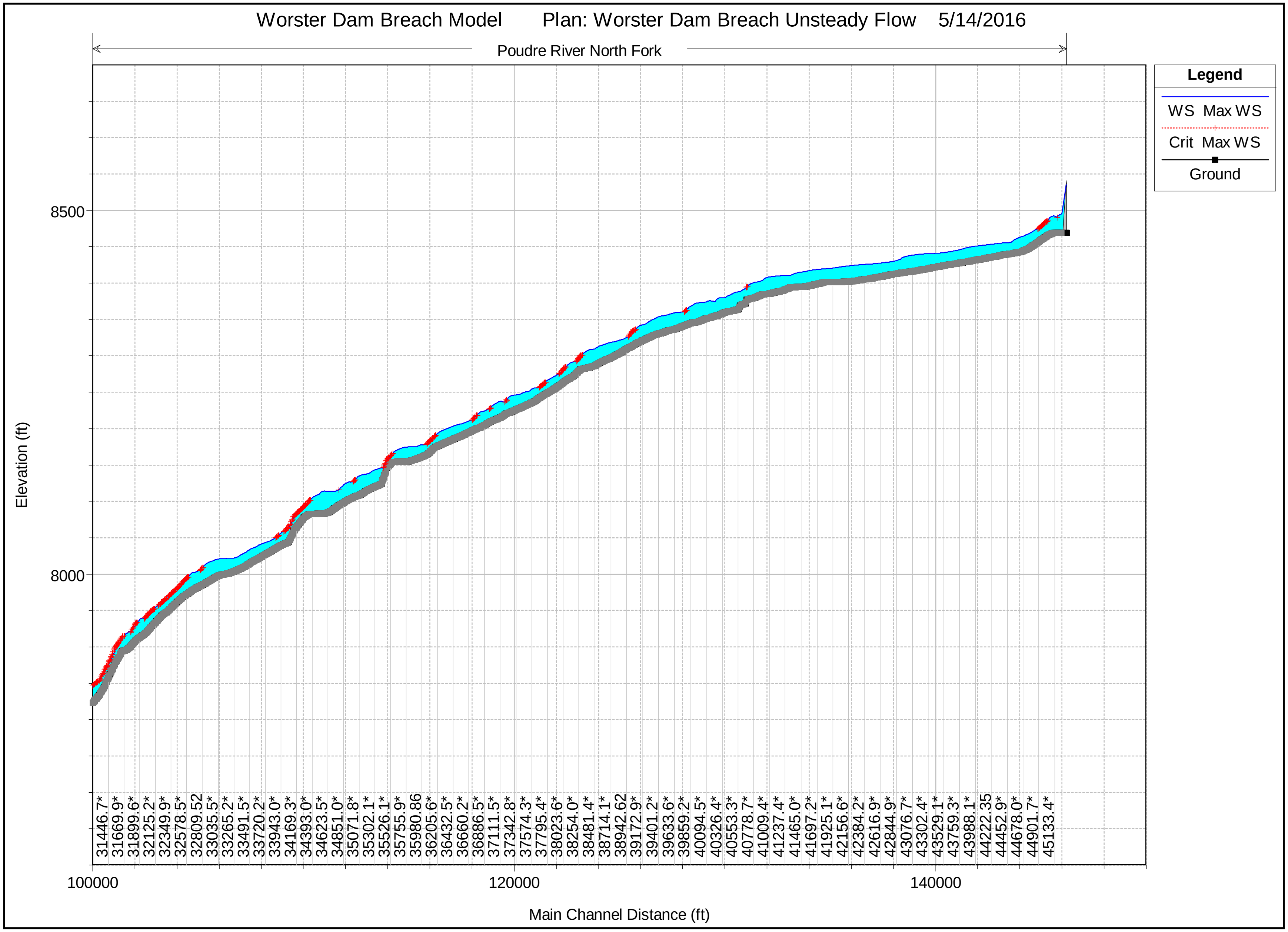
HEC-RAS MODELING RESULTS



42722.2*
44375.2*
45340.52
EatonReservoir
41123.8*
40561.45
39624.5*
38960.7*
38254.0*
37360.1*
36501.9*
35534.6*
34343.5*
33491.5*
32726.0*
32100.7*
30372.7*
29798.4*
29469.9*
28688.3*
27245.5*
25279.5*
21332.7*
22422.8*
19229.1*
16633.7*
13311.5*
8992.10*
8126.279
10672.0*
7494.63*
6552.61*
5764.69*
4724.01*
3800.68*
3230.58*
1647.34*


Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow 5/14/2016
Poudre River North Fork
Legend
WS Max WS
Crit Max WS
Ground
Elevation (ft)
7000
6500
6000
0
20000
40000
Main Channel Distance (ft)
971.397*
1203.55*
1434.31*
1664.81*
1895.02*
2119.53*
2345.19*
2574.75*
2801.32*
3028.54*
3257.25*
3486.97*
3709.88*
3937.32*
4164.64*
4387.89*
4619.32*
4849.56*
5071.85*
5305.01*
5538.31*
5764.69*
5996.89*
6220.29*
6450.42*
6684.30*
6913.44*
7142.06*
7368.71*
7589.27*
7821.28*
8045.77*
8273.72*
8499.95*
8721.852
8947.55*
9181.13*
9407.76*
9635.36*
9865.57*
10091.3*
10314.5*
10546.01
10777.3*
10999.9*
11230.9*
11459.7*
11691.9*
11924.7*
12155.4*
12378.75
12608.18
12831.9*
13061.5*
13284.9*
13512.9*
13742.09
13968.0*
14199.8*
14426.0*
14650.5*
14877.8*
15104.9*
15333.8*
15560.6*
15791.2*


Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
Poudre River North Fork
Legend
WS Max WS
Crit Max WS
Ground
Elevation (ft)
8000
7500
7000
Main Channel Distance (ft)
60000
80000
100000
16210.2*
16441.6*
16666.1*
16892.3*
17117.0*
17344.2*
17575.7*
17802.4*
18031.6*
18258.5*
18488.5*
18718.0*
18946.0*
19168.61
19394.8*
19624.2*
19850.5*
20073.6*
20302.6*
20530.7*
20750.9*
20979.9*
21207.12
21429.9*
21661.1*
21889.3*
22124.2*
22355.35
22581.8*
22805.82
23032.1*
23262.0*
23496.1*
23728.6*
23956.8*
24183.5*
24410.0*
24641.33
24872.6*
25093.83
25324.96
25548.0*
25773.0*
26005.6*
26235.6*
26459.1*
26683.6*
26918.44
27146.1*
27370.4*
27596.4*
27823.5*
28050.1*
28276.1*
28501.3*
28733.2*
28956.7*
29184.6*
29408.5*
29638.6*
29867.1*
30094.54
30319.2*
30547.1*
30778.8*
31005.7*


Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
Poudre River North Fork
Legend
WS Max WS
Crit Max WS
Ground
Elevation (ft)
8500
8000
Main Channel Distance (ft)
100000
120000
140000
31446.7*
31669.9*
31899.6*
32125.2*
32349.9*
32578.5*
32809.52
33035.5*
33265.2*
33491.5*
33720.2*
33943.0*
34169.3*
34393.0*
34623.5*
34851.0*
35071.8*
35302.1*
35526.1*
35755.9*
35980.86
36205.6*
36432.5*
36660.2*
36886.5*
37111.5*
37342.8*
37574.3*
37795.4*
38023.6*
38254.0*
38481.4*
38714.1*
38942.62
39172.9*
39401.2*
39633.6*
39859.2*
40094.5*
40326.4*
40553.3*
40778.7*
41009.4*
41237.4*
41465.0*
41697.2*
41925.1*
42156.6*
42384.2*
42616.9*
42844.9*
43076.7*
43302.4*
43529.1*
43759.3*
43988.1*
44222.35
44452.9*
44678.0*
44901.7*
45133.4*

HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	45340.52	Max WS	192.00	8469.00	8535.00		8535.00	0.000000	0.00	49973.11	958.37	0.00	0.00
North Fork	45306.54	Max WS	192.00	8469.00	8535.00		8535.00	0.000000	0.01	27461.98	622.54	0.00	0.01
North Fork	45292.07		Inl Struct										
North Fork	45242.44	Max WS	65708.92	8469.00	8495.66		8501.32	0.023965	19.17	3508.96	264.94	0.88	18.73
North Fork	45204.38	Max WS	65652.16	8469.00	8494.30		8498.32	0.016004	16.19	4185.29	303.61	0.73	15.69
North Fork	45169.73	Max WS	65599.91	8469.00	8491.05	8490.35	8496.49	0.026164	18.78	3570.76	297.30	0.91	18.37
North Fork	45115.25	Max WS	65401.66	8469.00	8492.47		8493.61	0.003566	8.60	7785.61	492.01	0.36	8.40
North Fork	45047.09	Max WS	65264.02	8466.40	8487.61		8492.73	0.018322	18.28	3752.95	305.92	0.80	17.39
North Fork	44994.39	Max WS	65288.01	8462.99	8483.16	8483.71	8490.51	0.030478	21.95	3136.75	266.79	1.01	20.81
North Fork	44952.74	Max WS	65244.37	8460.43	8479.50	8478.88	8485.00	0.022570	19.26	3760.11	340.58	0.88	17.35
North Fork	44859.25	Max WS	65142.72	8453.97	8473.69		8477.86	0.016063	16.53	4143.35	329.12	0.74	15.72
North Fork	44765.35	Max WS	65028.63	8448.00	8468.31		8472.50	0.015222	16.58	4128.75	311.65	0.73	15.75
North Fork	44651.91	Max WS	64853.75	8443.18	8463.66		8467.06	0.012439	15.02	4676.55	376.34	0.66	13.87
North Fork	44513.91	Max WS	64402.16	8440.65	8456.91		8460.89	0.022856	16.11	4185.32	464.19	0.84	15.39
North Fork	44409.45	Max WS	64129.65	8439.24	8455.63		8456.54	0.003707	7.69	8524.11	630.46	0.36	7.52
North Fork	44298.24	Max WS	63919.07	8437.04	8454.36		8455.23	0.003467	7.50	8801.31	682.86	0.34	7.26
North Fork	44222.35	Max WS	63806.83	8435.63	8453.43		8454.35	0.003625	7.76	8658.03	659.39	0.35	7.37
North Fork	44105.01	Max WS	63619.72	8433.60	8452.13		8452.98	0.003485	7.51	8963.73	709.00	0.35	7.10
North Fork	43943.21	Max WS	63427.22	8430.81	8450.21		8451.12	0.003554	7.85	8898.88	732.75	0.35	7.13
North Fork	43803.54	Max WS	63111.26	8428.35	8446.91		8448.78	0.008127	11.23	6235.56	581.21	0.52	10.12
North Fork	43671.08	Max WS	62369.52	8426.31	8444.24		8445.55	0.006296	9.49	7498.93	745.89	0.46	8.32
North Fork	43493.63	Max WS	60969.45	8423.46	8441.59		8442.46	0.003869	7.69	8858.51	833.61	0.36	6.88
North Fork	43256.97	Max WS	60502.95	8419.09	8440.23		8440.59	0.001233	4.88	13023.03	930.49	0.21	4.65
North Fork	43103.38	Max WS	60469.41	8416.60	8438.79		8439.68	0.003014	7.63	8338.84	602.88	0.33	7.25
North Fork	42996.96	Max WS	60413.60	8414.99	8437.08		8438.37	0.004812	9.13	6780.36	507.15	0.41	8.91
North Fork	42906.38	Max WS	60362.82	8414.04	8432.98		8436.21	0.014566	14.50	4325.80	378.54	0.69	13.95
North Fork	42765.98	Max WS	59396.13	8411.75	8429.31		8430.96	0.007642	10.33	5894.51	505.93	0.50	10.08
North Fork	42634.92	Max WS	58196.55	8409.15	8427.85		8428.59	0.004175	6.89	8547.98	817.93	0.36	6.81
North Fork	42517.79	Max WS	57417.91	8407.15	8426.57		8427.31	0.002927	7.18	9149.56	763.29	0.32	6.28
North Fork	42375.29	Max WS	56827.61	8404.99	8425.69		8426.21	0.001801	5.94	10558.30	775.91	0.25	5.38
North Fork	42210.37	Max WS	56357.45	8402.63	8424.23		8424.99	0.002982	7.07	8412.55	673.58	0.32	6.70
North Fork	42058.08	Max WS	55906.78	8401.58	8422.61		8423.57	0.003021	8.04	7556.76	524.12	0.33	7.40
North Fork	41943.21	Max WS	55304.41	8401.58	8420.77		8422.14	0.004901	9.57	6310.75	494.18	0.42	8.76
North Fork	41816.7	Max WS	55164.43	8401.58	8419.84		8420.56	0.002864	6.93	8670.04	721.47	0.31	6.36
North Fork	41706.07	Max WS	54981.39	8398.98	8418.86		8419.58	0.002429	6.84	8271.56	564.06	0.29	6.65
North Fork	41537.8	Max WS	54792.61	8395.34	8416.14		8417.71	0.005459	10.10	5648.57	407.55	0.44	9.70
North Fork	41437.81	Max WS	54681.65	8394.69	8414.77		8416.13	0.004251	9.47	6039.59	385.43	0.39	9.05
North Fork	41317.38	Max WS	53971.48	8394.23	8410.49		8413.37	0.013524	13.77	4121.05	369.39	0.67	13.10
North Fork	41184.21	Max WS	53954.17	8389.04	8410.24		8410.81	0.001915	6.08	9266.80	629.09	0.26	5.82
North Fork	41080.8	Max WS	53897.13	8387.30	8409.39		8410.15	0.002185	7.11	8074.38	496.49	0.29	6.68
North Fork	41000.54	Max WS	53892.90	8385.27	8408.41		8409.46	0.003137	8.26	6720.36	409.54	0.34	8.02
North Fork	40911.36	Max WS	53874.89	8384.55	8403.68		8407.90	0.016639	16.79	3489.55	290.15	0.76	15.44
North Fork	40796.62	Max WS	53819.85	8379.99	8401.20		8403.15	0.007379	11.61	5229.60	412.14	0.51	10.29
North Fork	40680.62	Max WS	53792.39	8377.17	8394.20	8394.89	8399.77	0.033214	19.71	3169.04	381.03	1.02	16.97
North Fork	40668.4	Max WS	53792.04	8372.15	8393.48		8397.49	0.017975	16.64	3763.97	396.62	0.78	14.29
North Fork	40586.43	Max WS	53724.22	8369.62	8388.14		8392.42	0.020873	16.87	3447.83	343.46	0.82	15.58
North Fork	40561.45	Max WS	53731.11	8364.08	8388.35		8391.07	0.007682	13.63	4481.07	311.34	0.54	11.99
North Fork	40521.13	Max WS	53698.49	8363.03	8387.39		8390.00	0.007747	13.15	4378.57	292.52	0.53	12.26
North Fork	40452.61	Max WS	53696.74	8361.45	8384.23		8387.91	0.012366	15.52	3624.61	255.56	0.66	14.81
North Fork	40368.76	Max WS	53570.57	8360.20	8380.15		8384.17	0.017500	16.13	3372.15	264.71	0.76	15.89
North Fork	40301.13	Max WS	53544.31	8356.79	8380.14		8381.94	0.004774	10.89	5209.83	299.29	0.43	10.28
North Fork	40224.49	Max WS	53431.31	8354.89	8374.84		8380.29	0.020991	18.88	2975.12	236.78	0.85	17.96
North Fork	40140.19	Max WS	53344.21	8352.07	8375.73		8377.07	0.003826	9.36	5949.16	357.42	0.38	8.97
North Fork	40085.43	Max WS	53277.47	8351.15	8373.83		8376.16	0.007454	12.32	4495.45	297.75	0.52	11.85
North Fork	39966.5	Max WS	53256.59	8346.56	8372.82		8374.10	0.003660	9.23	6160.49	376.21	0.37	8.64
North Fork	39894.65	Max WS	53234.66	8345.70	8369.48		8372.90	0.010523	15.05	3792.35	261.04	0.62	14.04
North Fork	39806.25	Max WS	53221.98	8342.45	8363.18	8362.75	8369.56	0.024392	20.60	2781.25	223.17	0.91	19.14
North Fork	39669.85	Max WS	52997.72	8337.53	8359.91		8361.67	0.005496	10.82	5317.31	374.85	0.45	9.97
North Fork	39543.02	Max WS	52866.43	8334.55	8356.62		8359.07	0.007991	13.00	4625.56	345.53	0.54	11.43
North Fork	39435.61	Max WS	52838.27	8331.10	8354.64		8356.53	0.006129	11.28	5098.67	354.03	0.47	10.36
North Fork	39349.57	Max WS	52800.88	8328.94	8351.11		8354.45	0.011232	15.09	3949.45	307.21	0.64	13.37
North Fork	39232.59	Max WS	52775.54	8323.52	8344.52		8349.69	0.018199	18.80	3173.22	252.11	0.80	16.63
North Fork	39147.36	Max WS	52743.62	8319.95	8342.28		8345.30	0.009647	14.52	4248.88	323.95	0.59	12.41
North Fork	39075.61	Max WS	52734.20	8316.60	8337.17	8336.27	8342.65	0.020828	19.33	3089.58	266.51	0.85	17.07
North Fork	39006.21	Max WS	52729.49	8312.47	8330.79	8332.66	8339.21	0.044020	23.56	2385.80	246.78	1.18	22.10
North Fork	38942.62	Max WS	52694.64	8309.58	8325.29		8327.86	0.018719	12.88	4115.14	459.16	0.74	12.81
North Fork	38875.38	Max WS	52512.08	8305.41	8322.61		8324.62	0.010036	11.53	4846.56	469.08	0.57	10.83
North Fork	38810.45	Max WS	52437.65	8302.17	8320.60		8322.63	0.008886	11.61	4883.24	440.91	0.55	10.74
North Fork	38705.42	Max WS	52337.82	8296.88	8318.41		8320.06	0.005822	10.43	5349.44	403.50	0.45	9.78
North Fork	38633.61	Max WS	52285.89	8294.26	8316.21		8318.53	0.007992	12.46	4600.51	355.38	0.53	11.37
North Fork	38556.76	Max WS	52254.54	8290.52	8313.81		8316.51	0.008617	13.94	4499.75	335.61	0.56	11.61
North Fork	38490.27	Max WS	52217.77	8286.91	8309.76		8314.26	0.015426	17.38	3321.85	259.86	0.74	15.72
North Fork	38410.43	Max WS	52209.20	8284.02	8308.69		8311.14	0.007195	12.97	4629.92	337.33	0.52	11.28
North Fork	38345.05	Max WS	52161.52	8283.07	8305.32		8309.17	0.013363	15.90	3482.83	262.01	0.69	14.98
North Fork	38271.87	Max WS	52204.27	8281.20	8298.77	8300.09	8306.55	0.040760	22.57	2418.33	233.55	1.14	21.59
North Fork	38182.82	Max WS	52194.84	8272.67	8292.42		8294.72	0.009007	12.33	4483.48	342.76	0.56	11.64
North Fork	38050.54	Max WS	52176.23	8265.26	8283.65	8284.55	8290.90	0.032098	22.25	2650.66	251.42	1.04	19.68
North Fork	37969.97	Max WS	52166.43	8259.28	8276.28	8275.47	8280.73	0.023397	17.07	3220.14	326.21	0.86	16.20
North Fork	37895.8	Max WS	52154.16	8254.53	8271.79		8275.30	0.017478	15.21	3644.50	353.31	0.75	14.31
North Fork	37822.26	Max WS	52131.62	8250.33	8267.98		8271.25	0.014863	14.70	3811.77	358.31	0.70	13.68
North Fork	37759.68	Max WS	52115.76	8247.05	8263.37	8262.99	8268.05	0.023090	18.26	3409.68	361.66	0.88	15.28

HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	37687.43	Max WS	52103.92	8242.62	8257.80	8257.34	8262.34	0.024498	17.56	3304.38	352.54	0.89	15.77
North Fork	37615.79	Max WS	52048.55	8237.70	8256.04		8257.94	0.007545	11.16	4950.54	427.20	0.51	10.51
North Fork	37532.82	Max WS	51981.62	8233.99	8251.30		8255.13	0.021318	16.02	3548.70	388.45	0.82	14.65
North Fork	37482.2	Max WS	51910.07	8231.89	8250.49		8252.37	0.008975	11.03	4844.09	428.38	0.54	10.72
North Fork	37409.32	Max WS	51782.41	8228.48	8247.45		8249.94	0.012407	12.73	4246.33	415.45	0.63	12.19
North Fork	37351.94	Max WS	51734.02	8226.44	8246.60		8248.13	0.005971	10.05	5452.60	431.85	0.45	9.49
North Fork	37288.53	Max WS	51731.27	8223.56	8245.54		8247.01	0.004993	9.98	5817.15	460.58	0.42	8.89
North Fork	37201.87	Max WS	51720.08	8220.47	8238.94	8239.34	8245.79	0.032552	21.06	2510.66	217.86	1.03	20.60
North Fork	37120	Max WS	51640.66	8215.22	8237.61		8238.72	0.004265	8.53	6251.49	463.63	0.38	8.26
North Fork	37052.56	Max WS	51608.93	8212.93	8234.63		8237.43	0.010581	13.47	3914.08	288.80	0.60	13.19
North Fork	36980.75	Max WS	51598.75	8209.88	8229.34	8228.43	8234.58	0.021375	18.75	3025.61	267.85	0.85	17.05
North Fork	36920.45	Max WS	51585.79	8206.56	8225.92		8230.17	0.017051	16.71	3270.65	272.42	0.76	15.77
North Fork	36835.62	Max WS	51562.84	8202.10	8223.15		8226.03	0.009969	13.80	4005.77	301.48	0.59	12.87
North Fork	36767.5	Max WS	51555.07	8199.67	8217.56	8218.22	8224.03	0.030840	20.85	2738.06	278.33	1.01	18.83
North Fork	36684.5	Max WS	51530.22	8195.87	8211.62		8214.52	0.014857	13.69	3823.64	347.23	0.69	13.48
North Fork	36619.75	Max WS	51468.78	8192.98	8208.78		8211.47	0.013795	13.30	4072.65	390.94	0.67	12.64
North Fork	36519.39	Max WS	51307.93	8188.48	8206.02		8207.63	0.008359	10.50	5541.27	603.37	0.52	9.26
North Fork	36458.5	Max WS	51282.19	8186.25	8204.19		8206.02	0.008201	11.30	5218.21	485.79	0.53	9.83
North Fork	36311.66	Max WS	51216.41	8180.41	8198.78		8201.25	0.011594	12.72	4221.44	389.07	0.62	12.13
North Fork	36229.29	Max WS	51204.14	8176.61	8194.66		8197.90	0.015951	14.68	3758.94	370.00	0.72	13.62
North Fork	36174.13	Max WS	51188.83	8174.90	8190.44	8190.20	8194.79	0.028719	16.94	3191.83	378.79	0.93	16.04
North Fork	36070.57	Max WS	51158.66	8165.19	8180.94	8180.69	8186.27	0.026605	18.80	2913.76	283.34	0.93	17.56
North Fork	35980.86	Max WS	50781.59	8160.89	8177.99		8179.81	0.007804	11.23	5132.76	453.82	0.52	9.89
North Fork	35901.62	Max WS	50309.61	8158.27	8175.01		8177.35	0.011217	12.42	4295.59	410.49	0.61	11.71
North Fork	35783.2	Max WS	50321.22	8154.69	8174.83		8175.40	0.001762	6.16	8658.22	557.27	0.25	5.81
North Fork	35655.93	Max WS	50286.92	8154.86	8171.87		8173.90	0.008782	11.54	4589.61	392.58	0.54	10.96
North Fork	35559.9	Max WS	50272.66	8154.20	8166.10	8165.89	8170.36	0.029919	16.68	3125.97	372.74	0.94	16.08
North Fork	35475.62	Max WS	50267.19	8146.29	8156.23	8157.86	8162.52	0.067314	20.16	2518.58	393.32	1.34	19.96
North Fork	35396.43	Max WS	50167.88	8123.66	8146.33		8148.85	0.009054	12.92	4206.43	338.29	0.56	11.93
North Fork	35311.25	Max WS	50127.45	8120.51	8143.52		8146.38	0.009486	14.13	4158.99	332.56	0.59	12.05
North Fork	35238.26	Max WS	50056.57	8117.26	8139.37		8143.54	0.020004	16.47	3166.03	302.36	0.80	15.81
North Fork	35167.22	Max WS	49946.42	8113.71	8137.41		8140.26	0.008470	13.89	4042.58	292.46	0.56	12.36
North Fork	35097	Max WS	49950.86	8109.32	8135.97		8138.33	0.007711	12.43	4229.15	313.11	0.52	11.81
North Fork	35013.23	Max WS	49929.32	8106.59	8129.80	8129.40	8136.16	0.026514	20.31	2532.81	213.28	0.93	19.71
North Fork	34924.11	Max WS	49877.11	8102.43	8126.73		8129.12	0.008369	12.45	4107.33	289.95	0.54	12.14
North Fork	34841.91	Max WS	49844.73	8097.70	8121.70		8125.96	0.018252	16.57	3008.99	210.14	0.77	16.57
North Fork	34782.39	Max WS	49784.16	8094.65	8116.46	8115.51	8122.42	0.024099	19.64	2587.35	197.65	0.90	19.24
North Fork	34714.65	Max WS	49219.29	8090.06	8113.64		8117.18	0.014723	15.11	3294.68	253.58	0.70	14.94
North Fork	34649.5	Max WS	49216.38	8085.60	8113.57		8115.35	0.004600	10.85	4903.27	307.97	0.42	10.04
North Fork	34571.55	Max WS	49297.00	8082.91	8114.16		8114.69	0.001159	5.91	8762.16	461.00	0.21	5.63
North Fork	34500.92	Max WS	49280.11	8083.10	8110.17		8113.99	0.012338	15.72	3192.19	197.88	0.65	15.44
North Fork	34425.92	Max WS	49266.04	8082.55	8106.96		8110.72	0.014432	15.56	3188.26	224.22	0.70	15.45
North Fork	34352.04	Max WS	49261.86	8082.58	8100.70	8101.12	8107.41	0.031658	20.97	2460.13	222.40	1.02	20.02
North Fork	34275.73	Max WS	49251.34	8077.92	8093.22	8093.16	8098.85	0.027726	19.36	2743.44	261.84	0.95	17.95
North Fork	34204.66	Max WS	49243.15	8068.90	8086.76	8086.41	8091.88	0.028854	18.18	2738.33	262.23	0.95	17.98
North Fork	34125.3	Max WS	49234.72	8058.79	8076.73	8079.34	8086.18	0.062966	24.67	1995.79	196.57	1.36	24.67
North Fork	34054.7	Max WS	49223.57	8043.83	8064.64	8065.09	8071.87	0.027916	22.16	2491.98	213.24	0.98	19.75
North Fork	33976.87	Max WS	49218.43	8041.11	8058.67		8063.46	0.020825	17.74	2911.70	244.75	0.83	16.90
North Fork	33900.73	Max WS	49223.51	8037.34	8052.99	8052.76	8058.22	0.027623	18.53	2789.73	273.07	0.94	17.64
North Fork	33815.75	Max WS	49175.09	8032.45	8047.36		8050.38	0.018924	14.03	3601.23	366.95	0.76	13.66
North Fork	33737.29	Max WS	49044.24	8028.08	8044.12		8046.27	0.010802	12.07	4521.22	466.70	0.59	10.85
North Fork	33669.04	Max WS	49000.44	8024.51	8041.81		8043.88	0.010085	11.66	4422.63	419.06	0.57	11.08
North Fork	33605.38	Max WS	48966.36	8020.77	8038.85		8041.61	0.013181	13.51	3867.98	362.75	0.66	12.66
North Fork	33517.54	Max WS	48915.09	8016.34	8035.02		8037.78	0.012798	13.46	3828.43	345.85	0.65	12.78
North Fork	33431.05	Max WS	48894.52	8010.93	8030.00		8033.73	0.017783	15.54	3216.65	281.45	0.76	15.20
North Fork	33325.89	Max WS	48530.16	8006.00	8024.00		8027.70	0.020438	15.51	3237.04	328.57	0.80	14.99
North Fork	33196.04	Max WS	46523.91	8001.18	8021.71		8022.63	0.003975	7.70	6064.97	449.86	0.36	7.67
North Fork	33112.43	Max WS	46508.85	7999.64	8021.47		8021.95	0.001547	5.59	8423.89	517.27	0.24	5.52
North Fork	33061.92	Max WS	46502.38	7998.62	8021.08		8021.65	0.002054	6.08	7807.64	550.36	0.27	5.96
North Fork	32974.03	Max WS	46457.42	7994.69	8018.79		8020.69	0.006863	11.07	4273.33	298.95	0.49	10.87
North Fork	32895.22	Max WS	46440.32	7989.93	8016.00		8018.66	0.009486	13.10	3564.39	226.48	0.57	13.03
North Fork	32809.52	Max WS	46429.57	7985.27	8009.06	8008.76	8016.20	0.026204	21.62	2251.55	164.60	0.94	20.62
North Fork	32734.75	Max WS	46413.56	7981.66	8003.91		8009.09	0.020527	18.28	2566.10	184.02	0.83	18.09
North Fork	32665.26	Max WS	46393.82	7977.99	8002.25		8005.53	0.008881	14.87	3430.17	209.12	0.58	13.53
North Fork	32595.14	Max WS	46387.17	7973.23	7995.84	7995.94	8003.80	0.027987	22.91	2142.27	151.50	0.98	21.65
North Fork	32528.91	Max WS	46382.27	7968.90	7989.52	7990.12	7997.15	0.031943	22.38	2179.05	177.96	1.03	21.29
North Fork	32439.18	Max WS	46372.90	7961.48	7980.70	7980.18	7986.53	0.026097	19.45	2443.15	203.60	0.92	18.98
North Fork	32366.58	Max WS	46366.48	7954.73	7974.13	7974.29	7980.26	0.030387	19.91	2385.38	237.78	0.98	19.44
North Fork	32300.13	Max WS	46354.75	7948.49	7968.46		7973.30	0.020941	18.07	2816.18	247.86	0.84	16.46
North Fork	32218.33	Max WS	46341.52	7942.78	7961.54	7961.33	7967.34	0.027373	19.47	2484.64	227.68	0.94	18.65
North Fork	32141.59	Max WS	46325.64	7934.94	7955.60		7960.79	0.020710	18.32	2577.22	196.26	0.83	17.98
North Fork	32076.2	Max WS	46320.22	7928.45	7950.03	7950.27	7957.03	0.029182	21.40	2275.58	192.72	0.98	20.36
North Fork	31999.86	Max WS	46314.47	7920.15	7942.32	7942.89	7950.48	0.033510	22.97	2054.22	150.00	1.03	22.55
North Fork	31935.78	Max WS	46306.88	7915.29	7939.80		7943.08	0.009899	14.56	3239.40	192.23	0.59	14.29
North Fork	31845.38	Max WS	46300.12	7909.25	7931.20	7933.18	7940.88	0.049990	24.96	1855.33	145.70	1.23	24.96
North Fork	31761.19	Max WS	46290.71	7899.84	7921.52		7925.70	0.014142	16.90	3071.70	227.46	0.71	15.07
North Fork	31695.3	Max WS	46277.46	7895.14	7917.50		7922.08	0.020168	17.25	2755.32	220.03	0.81	16.80
North Fork	31644.66	Max WS	46274.27	7894.16	7911.72	7913.55	7920.78	0.045526	24.27	1954.53	166.95	1.20	23.68
North Fork	31535.62	Max WS	46270.85	7875.92	7893.56	7898.20	7908.64	0.072894	31.42	1546.35	141.38	1.52	29.92
North Fork	31472.74	Max WS	46268.79	7862.50	7879.51	7882.63	7890.48	0.054347	27.21	1888.15	192.98	1.33	24.50
North Fork	31386	Max WS	46266.00	7844.62	7864.21	7866.85	7875.27	0.053273	26.77	1759.64	141.24	1.29	26.29

HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	31315.1	Max WS	46222.47	7833.83	7854.42	7853.87	7861.00	0.024142	20.87	2362.92	174.56	0.91	19.56
North Fork	31249.57	Max WS	46254.71	7826.38	7848.39	7849.32	7857.31	0.033203	24.14	2004.92	146.04	1.05	23.07
North Fork	31170.88	Max WS	46252.57	7815.75	7837.22	7841.60	7852.12	0.073514	31.00	1500.75	116.93	1.49	30.82
North Fork	31093.19	Max WS	46247.32	7802.00	7823.08	7822.21	7829.53	0.023865	20.46	2322.68	167.44	0.90	19.91
North Fork	31014.47	Max WS	46242.57	7792.98	7814.99	7816.68	7824.75	0.043962	25.08	1853.11	139.33	1.18	24.95
North Fork	30944.9	Max WS	46235.55	7784.65	7805.11	7807.14	7815.30	0.041058	25.85	1882.33	149.16	1.17	24.56
North Fork	30860.36	Max WS	46232.04	7772.44	7792.42	7796.06	7805.22	0.060720	28.86	1659.68	147.17	1.39	27.86
North Fork	30787.54	Max WS	46229.79	7762.83	7779.84	7780.28	7786.24	0.032407	20.77	2414.69	225.65	1.02	19.15
North Fork	30709.21	Max WS	46213.19	7755.58	7774.28		7777.90	0.013251	15.37	3120.13	218.65	0.68	14.81
North Fork	30646.55	Max WS	46204.64	7750.03	7768.73	7768.67	7775.20	0.028047	20.52	2333.11	192.82	0.96	19.80
North Fork	30565.12	Max WS	46197.76	7743.08	7760.85	7761.04	7767.15	0.029894	20.35	2394.41	217.45	0.99	19.29
North Fork	30493.27	Max WS	46191.52	7736.12	7752.81	7753.98	7759.72	0.046343	21.10	2194.17	224.26	1.17	21.05
North Fork	30408.55	Max WS	46178.59	7722.74	7743.93		7747.35	0.013900	14.85	3132.66	228.31	0.68	14.74
North Fork	30327.94	Max WS	46171.68	7719.33	7736.46	7736.90	7743.38	0.034802	21.14	2204.74	182.20	1.05	20.94
North Fork	30258.11	Max WS	46164.73	7713.52	7728.32	7728.67	7734.25	0.035063	19.57	2391.27	235.58	1.04	19.31
North Fork	30192.09	Max WS	46159.07	7707.09	7721.01	7721.26	7725.99	0.031524	18.25	2748.91	324.38	0.98	16.79
North Fork	30094.54	Max WS	46110.20	7696.79	7714.83		7716.44	0.008854	10.18	4563.97	422.23	0.53	10.10
North Fork	30011.71	Max WS	46083.97	7691.93	7708.04	7708.80	7714.35	0.040905	20.17	2298.09	235.84	1.11	20.05
North Fork	29955.02	Max WS	46076.80	7683.17	7703.07		7707.40	0.016705	16.91	2891.28	226.23	0.76	15.94
North Fork	29893.19	Max WS	46073.85	7680.15	7698.07	7698.31	7704.27	0.029589	20.20	2420.18	230.40	0.98	19.04
North Fork	29823.76	Max WS	46008.35	7675.43	7694.36		7697.28	0.011796	13.82	3458.25	264.17	0.63	13.30
North Fork	29739.45	Max WS	45970.01	7669.29	7689.93		7693.63	0.016562	15.49	3041.59	251.77	0.74	15.11
North Fork	29672.38	Max WS	45952.04	7663.25	7684.95		7690.06	0.021131	18.25	2626.79	224.51	0.84	17.49
North Fork	29613.27	Max WS	45940.10	7661.25	7680.07	7680.06	7685.81	0.031119	19.26	2419.64	227.35	0.99	18.99
North Fork	29505.56	Max WS	45824.96	7651.64	7673.60		7676.11	0.009218	12.82	3730.43	275.24	0.57	12.28
North Fork	29434.26	Max WS	45801.18	7646.88	7667.87	7667.20	7673.55	0.026576	19.14	2406.27	194.34	0.92	19.03
North Fork	29357.06	Max WS	45756.55	7639.73	7663.60		7667.77	0.013655	16.43	2858.28	184.86	0.69	16.01
North Fork	29284.71	Max WS	45737.29	7636.42	7659.95		7664.00	0.015698	16.17	2862.73	199.94	0.72	15.98
North Fork	29211.54	Max WS	45725.99	7631.00	7652.62	7653.85	7661.47	0.036119	24.03	1982.15	155.66	1.09	23.07
North Fork	29139.69	Max WS	45715.58	7626.84	7646.55		7651.24	0.016643	17.52	2729.39	191.13	0.76	16.75
North Fork	29064.61	Max WS	45698.23	7620.60	7640.34	7640.29	7647.06	0.028367	20.92	2267.07	182.74	0.97	20.16
North Fork	28983.41	Max WS	45688.49	7614.08	7632.88	7632.74	7638.92	0.027648	19.90	2409.61	213.18	0.95	18.96
North Fork	28894.59	Max WS	45674.05	7607.84	7624.84	7624.37	7629.58	0.026128	17.58	2710.17	287.46	0.91	16.85
North Fork	28839.28	Max WS	45655.65	7602.69	7620.50		7624.56	0.023607	16.22	2865.53	282.32	0.86	15.93
North Fork	28769.52	Max WS	45646.22	7597.93	7613.14	7614.93	7621.06	0.047271	22.71	2092.75	233.46	1.21	21.81
North Fork	28705.96	Max WS	45571.55	7592.98	7608.33		7610.05	0.009403	10.55	4359.99	395.18	0.55	10.45
North Fork	28618.06	Max WS	45555.16	7587.66	7602.77		7606.51	0.024533	15.52	2939.13	296.89	0.86	15.50
North Fork	28536.83	Max WS	45496.73	7581.63	7596.93		7600.19	0.019231	14.55	3232.88	346.77	0.77	14.07
North Fork	28439.27	Max WS	45426.37	7573.36	7590.34		7594.30	0.020935	16.12	2961.56	292.80	0.82	15.34
North Fork	28345.18	Max WS	45354.27	7566.70	7584.98		7588.05	0.015789	14.05	3237.33	274.99	0.71	14.01
North Fork	28241.67	Max WS	45316.00	7559.35	7577.17	7576.98	7582.58	0.029089	18.73	2477.09	238.24	0.96	18.29
North Fork	28163.8	Max WS	45306.93	7554.27	7569.80	7570.11	7575.23	0.031470	18.92	2557.59	286.01	0.99	17.71
North Fork	28092.73	Max WS	45091.53	7549.21	7563.48		7566.77	0.023096	14.72	3240.40	398.07	0.83	13.92
North Fork	28016.08	Max WS	44645.19	7544.65	7561.73		7562.86	0.005951	8.52	5249.73	453.30	0.44	8.50
North Fork	27935.91	Max WS	44545.33	7539.24	7558.07		7560.95	0.013368	13.72	3405.41	313.88	0.66	13.08
North Fork	27797.58	Max WS	44470.03	7530.15	7549.49	7548.82	7554.99	0.024210	19.03	2472.42	215.80	0.90	17.99
North Fork	27656.8	Max WS	44429.46	7522.93	7538.68	7538.15	7543.28	0.023872	17.55	2774.58	292.83	0.88	16.01
North Fork	27527.46	Max WS	43720.87	7519.29	7534.26		7535.63	0.007101	9.42	4674.11	404.55	0.48	9.35
North Fork	27422.72	Max WS	43636.85	7517.00	7532.32		7533.42	0.005786	8.46	5232.66	456.39	0.43	8.34
North Fork	27326.94	Max WS	43579.29	7514.90	7528.02		7530.67	0.018069	13.14	3413.40	387.47	0.74	12.77
North Fork	27191.29	Max WS	43037.48	7507.55	7522.10		7523.70	0.009318	10.14	4242.98	382.80	0.54	10.14
North Fork	27037.88	Max WS	42849.32	7497.11	7516.55		7519.28	0.011158	13.70	3562.43	316.56	0.62	12.03
North Fork	26918.44	Max WS	42798.96	7489.83	7508.53	7508.05	7514.09	0.026197	19.04	2328.78	205.99	0.92	18.38
North Fork	26778.72	Max WS	42516.83	7482.91	7502.03		7504.13	0.007983	11.73	3835.01	301.05	0.52	11.09
North Fork	26707.8	Max WS	42521.74	7481.69	7501.36		7502.63	0.005049	9.12	4825.62	370.50	0.41	8.81
North Fork	26643.47	Max WS	42499.46	7480.32	7496.62	7496.27	7501.49	0.027710	17.79	2466.10	255.01	0.93	17.23
North Fork	26548.45	Max WS	38392.52	7478.51	7493.29		7494.41	0.006524	8.50	4622.48	468.61	0.45	8.31
North Fork	26492.28	Max WS	38322.05	7477.26	7493.06		7493.62	0.002604	6.03	6413.10	509.18	0.29	5.98
North Fork	26409.34	Max WS	38310.63	7475.69	7492.56		7493.01	0.002022	5.40	7178.61	557.43	0.26	5.34
North Fork	26339.29	Max WS	38170.39	7474.12	7491.93		7492.47	0.002523	5.91	6466.36	496.29	0.29	5.90
North Fork	26253.4	Max WS	38096.97	7472.38	7491.05		7491.70	0.002950	6.48	5943.15	457.85	0.31	6.41
North Fork	26155.8	Max WS	38022.95	7470.60	7489.53		7490.53	0.004715	8.02	4764.79	381.68	0.39	7.98
North Fork	26032.03	Max WS	37975.77	7468.34	7487.24		7488.36	0.005914	8.51	4461.32	372.12	0.43	8.51
North Fork	25908.79	Max WS	37964.61	7466.17	7479.67	7480.51	7484.99	0.047224	18.52	2050.37	253.30	1.15	18.52
North Fork	25754.96	Max WS	37944.81	7439.73	7457.50	7456.91	7462.84	0.027544	18.55	2060.14	177.17	0.93	18.42
North Fork	25680	Max WS	37930.54	7430.97	7453.77		7456.58	0.012002	13.44	2821.94	194.17	0.62	13.44
North Fork	25574.25	Max WS	37921.50	7418.60	7443.29	7447.91	7458.96	0.067688	32.19	1264.28	101.22	1.42	29.99
North Fork	25460.54	Max WS	37915.55	7404.86	7426.43		7430.14	0.018231	15.46	2453.10	189.61	0.76	15.46
North Fork	25381.26	Max WS	37911.20	7400.26	7418.03	7419.66	7426.81	0.048694	23.78	1595.57	135.60	1.21	23.76
North Fork	25324.96	Max WS	37909.16	7393.60	7409.87	7410.70	7416.82	0.035986	21.31	1850.60	176.97	1.07	20.48
North Fork	25234.06	Max WS	37903.08	7385.70	7399.54	7399.90	7404.44	0.032812	17.93	2245.49	290.13	0.99	16.88
North Fork	25170.1	Max WS	37896.18	7379.43	7393.55		7396.91	0.022292	14.79	2644.83	309.79	0.82	14.33
North Fork	25093.83	Max WS	37887.03	7372.90	7387.98		7391.61	0.023758	15.30	2478.38	244.58	0.84	15.29
North Fork	25035.33	Max WS	37856.13	7367.19	7383.61		7387.02	0.019992	14.81	2561.30	237.41	0.78	14.78
North Fork	24941	Max WS	37838.41	7360.24	7380.28		7382.52	0.008401	12.06	3188.49	212.45	0.54	11.87
North Fork	24864.13	Max WS	37846.08	7358.14	7375.15		7379.53	0.022495	16.83	2280.95	198.93	0.84	16.59
North Fork	24790.95	Max WS	37771.53	7354.50	7370.70		7374.27	0.019517	15.23	2532.23	228.45	0.78	14.92
North Fork	24719.47	Max WS	37739.40	7351.15	7369.89		7371.36	0.006769	9.77	3887.89	302.77	0.47	9.71
North Fork	24641.33	Max WS	37711.86	7347.08	7366.96		7369.34	0.011154	12.41	3072.07	244.18	0.60	12.28
North Fork	24559.24	Max WS	37695.12	7343.96	7362.20		7365.85	0.018813	15.36	2481.17	217.75	0.77	15.19
North Fork	24486.87	Max WS	37656.53	7340.65	7359.03		7361.73	0.014561	13.19	2887.33	261.80	0.68	13.04

HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	24401.49	Max WS	37638.26	7336.29	7354.27		7357.48	0.015929	14.49	2713.69	251.79	0.71	13.87
North Fork	24274.38	Max WS	37599.92	7329.36	7347.21		7350.48	0.017478	14.57	2645.65	254.88	0.74	14.21
North Fork	24138.18	Max WS	37572.21	7320.57	7339.73		7342.95	0.016246	14.40	2620.24	221.76	0.72	14.34
North Fork	24069.48	Max WS	37557.97	7317.65	7333.76	7333.46	7338.96	0.027754	18.49	2133.07	209.01	0.94	17.61
North Fork	24002.22	Max WS	37536.46	7313.42	7330.86		7333.25	0.011568	12.47	3095.89	272.36	0.61	12.12
North Fork	23920.56	Max WS	37527.61	7307.58	7324.64	7324.69	7329.75	0.033066	18.17	2088.35	225.37	1.00	17.97
North Fork	23849.25	Max WS	37496.10	7303.15	7319.93		7322.01	0.012124	11.58	3284.86	328.51	0.61	11.41
North Fork	23764.63	Max WS	37469.36	7298.03	7315.01		7318.42	0.018797	14.87	2586.66	257.08	0.77	14.49
North Fork	23692.59	Max WS	37465.34	7294.00	7309.53	7308.91	7313.76	0.026618	16.54	2311.28	250.25	0.90	16.21
North Fork	23611.81	Max WS	37433.79	7288.62	7303.17		7306.50	0.026036	14.64	2557.08	290.71	0.87	14.64
North Fork	23541.76	Max WS	37272.24	7283.46	7300.33		7302.23	0.009240	11.21	3529.99	328.41	0.55	10.56
North Fork	23450.44	Max WS	37223.38	7280.09	7297.17		7299.36	0.011183	11.97	3256.29	314.94	0.60	11.43
North Fork	23374.97	Max WS	37185.75	7276.28	7293.33		7296.31	0.016922	13.94	2794.45	309.48	0.73	13.31
North Fork	23227.28	Max WS	36582.06	7268.83	7287.04		7289.08	0.010733	11.45	3217.11	286.18	0.58	11.37
North Fork	23146.45	Max WS	36513.13	7265.62	7285.49		7286.87	0.006457	9.46	3918.57	330.99	0.46	9.32
North Fork	23068.25	Max WS	36463.58	7262.24	7283.74		7285.30	0.006226	10.21	3855.34	320.68	0.46	9.46
North Fork	22951	Max WS	36448.43	7256.60	7276.46	7276.12	7282.24	0.028555	19.33	1917.10	168.37	0.95	19.01
North Fork	22877.2	Max WS	36414.85	7254.59	7273.24		7275.92	0.010734	13.23	2847.82	217.75	0.60	12.79
North Fork	22805.82	Max WS	36397.54	7249.64	7269.98		7273.14	0.013801	14.31	2592.32	205.03	0.67	14.04
North Fork	22732.35	Max WS	36390.25	7247.08	7264.16	7264.57	7269.96	0.035143	19.42	1927.42	200.19	1.04	18.88
North Fork	22669.21	Max WS	36361.31	7241.24	7259.67		7262.95	0.014368	14.60	2568.32	212.73	0.69	14.16
North Fork	22606.85	Max WS	36268.41	7239.37	7255.34		7259.48	0.024900	16.32	2229.92	211.21	0.87	16.26
North Fork	22523.39	Max WS	36107.00	7233.37	7253.91		7255.30	0.005841	9.54	3944.69	321.77	0.44	9.15
North Fork	22439.77	Max WS	36050.87	7229.63	7250.88		7253.20	0.010841	12.25	2976.69	239.57	0.59	12.11
North Fork	22355.35	Max WS	36022.63	7225.39	7247.29		7250.04	0.012792	13.30	2712.66	206.86	0.64	13.28
North Fork	22284.91	Max WS	36008.65	7221.69	7242.22		7246.78	0.020690	17.16	2129.91	168.67	0.82	16.91
North Fork	22211.37	Max WS	35991.88	7216.96	7240.35		7242.87	0.009615	12.75	2861.90	204.54	0.57	12.58
North Fork	22133.31	Max WS	35975.84	7214.08	7234.18	7233.59	7239.63	0.029700	18.75	1919.02	157.04	0.95	18.75
North Fork	22060.58	Max WS	35969.58	7208.56	7226.14	7226.84	7232.99	0.037685	21.03	1729.80	160.95	1.08	20.79
North Fork	21972.82	Max WS	35921.64	7200.13	7216.71		7220.62	0.021565	15.87	2263.49	192.13	0.81	15.87
North Fork	21897.95	Max WS	35915.84	7191.90	7213.83		7216.38	0.011624	12.82	2800.78	203.60	0.61	12.82
North Fork	21829.26	Max WS	35903.62	7183.96	7207.16	7207.24	7214.31	0.033861	21.46	1673.19	119.76	1.01	21.46
North Fork	21767.76	Max WS	35897.66	7178.84	7198.58	7201.84	7210.88	0.063117	28.24	1296.38	108.40	1.38	27.69
North Fork	21705.88	Max WS	35775.77	7167.75	7186.40	7188.46	7195.23	0.053673	23.86	1511.78	143.96	1.26	23.66
North Fork	21634.35	Max WS	35499.43	7163.45	7185.65		7186.29	0.002146	6.43	5524.84	326.72	0.27	6.43
North Fork	21547.12	Max WS	35443.95	7163.45	7185.02		7185.67	0.002227	6.46	5492.36	333.26	0.28	6.45
North Fork	21471.33	Max WS	35418.71	7163.45	7180.01	7180.45	7185.27	0.041360	18.41	1923.95	215.56	1.08	18.41
North Fork	21405.06	Max WS	35413.20	7154.79	7170.07	7171.93	7177.62	0.060734	22.05	1606.34	182.91	1.31	22.05
North Fork	21305.56	Max WS	35404.98	7137.30	7149.41	7151.98	7158.47	0.076348	24.15	1469.67	181.55	1.46	24.09
North Fork	21242.22	Max WS	35394.73	7122.84	7134.74	7135.17	7139.66	0.037307	17.84	2027.69	256.38	1.04	17.46
North Fork	21207.12	Max WS	34975.33	7122.70	7133.43		7134.60	0.009017	8.67	4061.44	472.22	0.51	8.61
North Fork	21080.7	Max WS	34584.16	7120.18	7130.52		7131.31	0.006302	7.11	4863.29	559.20	0.42	7.11
North Fork	21004.7	Max WS	34486.98	7118.93	7129.42		7129.97	0.004553	5.94	5809.39	688.84	0.36	5.94
North Fork	20955.1	Max WS	34428.38	7118.31	7128.27		7129.04	0.007252	7.06	4876.86	630.84	0.45	7.06
North Fork	20887.39	Max WS	34384.63	7114.80	7125.90		7127.10	0.011613	8.81	3949.23	561.13	0.56	8.71
North Fork	20759.79	Max WS	34278.90	7108.01	7119.88		7121.46	0.016642	10.08	3399.28	480.31	0.67	10.08
North Fork	20600.91	Max WS	34099.82	7098.82	7112.72		7114.09	0.009192	9.38	3634.35	366.85	0.52	9.38
North Fork	20469.37	Max WS	34050.25	7091.70	7106.03		7109.10	0.022831	14.08	2435.62	282.83	0.82	13.98
North Fork	20320.09	Max WS	34020.71	7082.68	7094.47	7094.07	7097.95	0.028051	15.11	2373.91	331.46	0.90	14.33
North Fork	20171.79	Max WS	31396.97	7078.22	7088.38		7088.90	0.005010	5.84	5376.87	700.46	0.37	5.84
North Fork	20020.1	Max WS	30266.31	7073.16	7086.24		7086.74	0.003768	5.69	5326.84	590.84	0.33	5.68
North Fork	19876.51	Max WS	30006.17	7068.24	7084.79		7085.22	0.002537	5.25	5710.44	522.61	0.28	5.25
North Fork	19772.65	Max WS	29978.48	7065.03	7083.98		7084.43	0.002130	5.39	5564.33	428.84	0.26	5.39
North Fork	19694.43	Max WS	29953.82	7062.73	7082.64		7083.65	0.004436	8.18	3866.70	336.39	0.38	7.75
North Fork	19580.35	Max WS	29936.04	7059.84	7078.63		7081.25	0.011653	13.05	2358.27	197.53	0.62	12.69
North Fork	19438.75	Max WS	29914.81	7055.58	7074.04		7076.07	0.012026	11.41	2620.95	239.44	0.61	11.41
North Fork	19315.68	Max WS	29902.80	7051.02	7068.73		7071.12	0.014134	12.39	2414.44	223.00	0.66	12.38
North Fork	19168.61	Max WS	29888.16	7045.64	7061.12		7064.32	0.023537	14.37	2089.80	231.97	0.83	14.30
North Fork	19009.25	Max WS	29878.51	7038.85	7050.74		7053.03	0.018038	12.17	2506.92	323.72	0.72	11.92
North Fork	18882.93	Max WS	29856.70	7034.06	7044.34		7045.84	0.017116	10.04	3326.86	698.57	0.67	8.97
North Fork	18843.7	Max WS	29819.06	7032.28	7042.80		7043.77	0.011122	7.88	3782.80	571.95	0.54	7.88
North Fork	18776.4	Max WS	29719.26	7029.63	7040.42		7041.35	0.009842	7.75	3865.45	589.05	0.51	7.69
North Fork	18701.43	Max WS	29603.35	7026.31	7038.28		7039.19	0.007779	7.68	3934.23	530.66	0.47	7.52
North Fork	18625.6	Max WS	29547.69	7022.84	7036.62		7037.36	0.006514	6.87	4298.17	532.65	0.43	6.87
North Fork	18551.14	Max WS	29495.97	7020.05	7034.92		7035.77	0.006586	7.37	4009.38	467.62	0.44	7.36
North Fork	18408.17	Max WS	29467.56	7015.68	7030.27		7032.07	0.012952	10.77	2745.53	304.59	0.62	10.73
North Fork	18293.57	Max WS	29442.28	7010.40	7024.81		7026.89	0.015780	11.62	2569.05	305.04	0.68	11.46
North Fork	18126.97	Max WS	29293.26	7003.71	7019.44		7020.41	0.005247	8.07	3900.77	382.77	0.41	7.51
North Fork	17970.93	Max WS	29276.49	6999.61	7013.60		7016.39	0.018626	13.41	2199.07	238.49	0.75	13.31
North Fork	17829.77	Max WS	29249.70	6995.41	7008.74		7009.93	0.007144	8.76	3367.57	321.62	0.47	8.69
North Fork	17720.49	Max WS	29239.09	6992.29	7003.16		7006.18	0.031840	13.94	2105.70	305.82	0.92	13.89
North Fork	17627.52	Max WS	29155.63	6989.63	6999.30		7000.08	0.012455	7.10	4105.53	790.02	0.55	7.10
North Fork	17567.09	Max WS	29074.53	6987.96	6997.56		6998.11	0.005922	5.94	4893.50	704.92	0.40	5.94
North Fork	17453.25	Max WS	28912.27	6984.32	6994.36		6995.18	0.010470	7.28	3972.14	647.11	0.52	7.28
North Fork	17317.02	Max WS	27009.12	6980.05	6991.17		6991.56	0.003785	5.03	5366.52	708.60	0.32	5.03
North Fork	17071.63	Max WS	26620.59	6971.00	6988.67		6989.07	0.002608	5.10	5219.73	510.17	0.28	5.10
North Fork	16937.91	Max WS	26588.69	6967.45	6987.16		6987.80	0.003361	6.42	4145.39	353.61	0.33	6.41
North Fork	16846.74	Max WS	26585.37	6963.91	6982.52		6986.11	0.019652	15.21	1756.70	154.05	0.77	15.13
North Fork	16784.72	Max WS	26582.87	6960.76	6977.11	6976.57	6981.96	0.028242	17.71	1527.03	143.64	0.93	17.41
North Fork	16697.82	Max WS	26557.63	6957.61	6975.48		6976.72	0.005063	8.95	3018.81	226.61	0.41	8.80
North Fork	16642.46	Max WS	26552.96	6955.35	6974.18		6975.63	0.007287	9.66	2749.13	216.87	0.48	9.66

HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS (Continued)

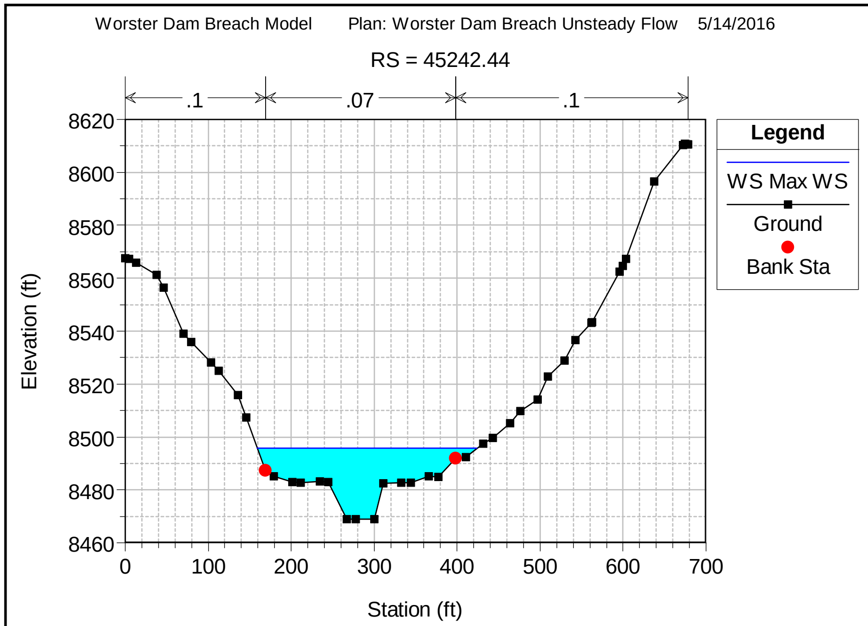
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	16564.27	Max WS	26548.93	6952.33	6970.81		6973.18	0.012789	12.34	2151.76	176.79	0.62	12.34
North Fork	16504.39	Max WS	26546.79	6950.82	6965.98		6969.81	0.026286	15.70	1690.42	168.78	0.87	15.70
North Fork	16423.7	Max WS	26541.74	6946.10	6959.98		6962.99	0.020227	13.93	1923.60	206.16	0.78	13.80
North Fork	16351.26	Max WS	26529.83	6942.32	6957.86		6959.34	0.009159	9.83	2762.17	287.71	0.53	9.60
North Fork	16201.42	Max WS	26514.46	6936.02	6951.98		6954.18	0.015021	11.92	2224.71	225.29	0.67	11.92
North Fork	16119.98	Max WS	26498.55	6931.63	6948.95		6950.77	0.009999	10.82	2484.45	238.41	0.56	10.67
North Fork	16061.96	Max WS	26491.88	6929.30	6946.55		6948.52	0.014362	11.27	2351.10	248.86	0.65	11.27
North Fork	15973.5	Max WS	26466.34	6925.46	6941.74		6944.03	0.016899	12.13	2181.82	233.40	0.70	12.13
North Fork	15881.43	Max WS	26441.15	6921.46	6939.36		6940.74	0.007957	9.41	2818.55	254.76	0.49	9.38
North Fork	15773.21	Max WS	26432.67	6918.54	6936.13		6937.71	0.008638	10.09	2622.31	222.48	0.51	10.08
North Fork	15693.7	Max WS	26424.71	6916.54	6933.71		6935.33	0.010423	10.20	2595.66	257.02	0.56	10.18
North Fork	15636.89	Max WS	26416.46	6915.22	6929.31	6928.41	6933.40	0.022772	16.42	1721.93	186.55	0.85	15.34
North Fork	15526.79	Max WS	26331.88	6911.65	6926.05		6927.57	0.011286	9.92	2681.74	310.53	0.57	9.82
North Fork	15473.48	Max WS	26267.69	6909.84	6925.11		6926.02	0.006854	7.66	3465.44	408.73	0.45	7.58
North Fork	15386.33	Max WS	26185.71	6907.19	6922.71		6923.82	0.008976	8.43	3105.11	362.13	0.51	8.43
North Fork	15316.41	Max WS	26098.45	6905.45	6920.95		6921.90	0.007008	7.80	3345.63	362.05	0.45	7.80
North Fork	15176.83	Max WS	26037.90	6901.05	6918.40		6919.15	0.004870	6.96	3739.36	364.32	0.38	6.96
North Fork	15059.97	Max WS	25998.94	6898.56	6913.77		6916.15	0.016756	12.37	2101.11	216.53	0.70	12.37
North Fork	14994.68	Max WS	25835.65	6895.87	6911.12		6912.93	0.013279	10.80	2392.28	255.60	0.62	10.80
North Fork	14850.86	Max WS	25778.82	6890.88	6909.50		6909.90	0.001955	5.09	5069.27	398.57	0.25	5.09
North Fork	14730.79	Max WS	25761.26	6888.48	6905.14		6907.76	0.016957	12.97	1985.60	190.69	0.71	12.97
North Fork	14588.11	Max WS	25752.24	6880.35	6897.97		6900.68	0.013088	13.21	1949.91	146.82	0.64	13.21
North Fork	14516.2	Max WS	25749.72	6877.99	6892.95		6896.97	0.027999	16.09	1600.58	164.25	0.90	16.09
North Fork	14452.96	Max WS	25744.40	6873.46	6890.12		6892.19	0.013270	11.56	2227.38	212.72	0.63	11.56
North Fork	14390.16	Max WS	25741.33	6869.85	6884.95		6889.13	0.028161	16.43	1574.74	165.73	0.91	16.35
North Fork	14321.03	Max WS	25739.29	6865.42	6879.61		6882.50	0.018765	13.76	1977.99	235.46	0.75	13.01
North Fork	14216.91	Max WS	25733.80	6858.33	6873.19		6876.03	0.021694	13.53	1908.75	220.32	0.79	13.48
North Fork	14148.68	Max WS	25721.62	6853.74	6869.84		6871.78	0.013105	11.20	2327.59	258.26	0.62	11.05
North Fork	14011.63	Max WS	25686.69	6847.44	6864.09		6865.81	0.012431	10.53	2440.02	257.18	0.60	10.53
North Fork	13933.24	Max WS	25679.81	6841.01	6861.20		6863.50	0.009706	12.22	2139.73	153.98	0.56	12.00
North Fork	13863.35	Max WS	25678.47	6839.08	6855.45	6855.10	6860.50	0.031640	18.03	1423.97	130.38	0.96	18.03
North Fork	13795.25	Max WS	25545.59	6836.58	6849.99		6852.98	0.016877	13.93	1875.57	177.74	0.73	13.62
North Fork	13742.09	Max WS	25490.41	6834.51	6849.32		6850.75	0.009159	9.60	2654.59	255.60	0.53	9.60
North Fork	13658.15	Max WS	25453.85	6830.58	6848.53		6849.12	0.003473	6.16	4132.18	380.32	0.33	6.16
North Fork	13558.48	Max WS	25421.65	6827.10	6846.63		6847.70	0.006173	8.30	3061.45	272.08	0.44	8.30
North Fork	13440.17	Max WS	25412.44	6823.29	6841.91		6844.43	0.015927	12.74	1994.88	184.34	0.68	12.74
North Fork	13373.56	Max WS	25410.24	6819.82	6835.90	6835.73	6840.76	0.032742	17.70	1443.61	147.74	0.98	17.60
North Fork	13267.17	Max WS	25388.38	6814.44	6830.21		6831.86	0.012446	10.29	2466.58	269.30	0.60	10.29
North Fork	13121.8	Max WS	25199.23	6808.60	6824.39		6825.98	0.011595	10.15	2483.90	262.10	0.58	10.15
North Fork	13009.82	Max WS	24779.44	6803.71	6820.77		6822.18	0.008399	9.54	2596.99	235.84	0.51	9.54
North Fork	12875.4	Max WS	24525.46	6800.62	6818.89		6819.57	0.004018	6.62	3740.87	384.27	0.35	6.56
North Fork	12770.99	Max WS	24506.52	6797.87	6818.22		6818.65	0.002120	5.21	4762.17	428.31	0.26	5.15
North Fork	12701.47	Max WS	24466.41	6795.83	6817.19		6817.91	0.004676	6.81	3593.70	349.78	0.37	6.81
North Fork	12608.18	Max WS	24402.18	6795.18	6814.07		6815.75	0.012527	10.41	2344.01	252.16	0.60	10.41
North Fork	12516.88	Max WS	24374.64	6791.93	6812.98		6813.67	0.003411	6.65	3664.43	289.65	0.33	6.65
North Fork	12378.75	Max WS	24361.37	6789.60	6808.30		6811.36	0.016377	14.09	1758.03	153.02	0.71	13.86
North Fork	12238.76	Max WS	24344.76	6784.94	6804.66		6806.27	0.006276	10.21	2461.79	190.49	0.46	9.89
North Fork	12171.81	Max WS	24337.37	6784.12	6802.89		6804.61	0.009662	10.53	2317.28	205.84	0.55	10.50
North Fork	12098.33	Max WS	24333.83	6781.76	6797.64		6801.54	0.028982	15.85	1537.30	167.95	0.91	15.83
North Fork	12028.01	Max WS	24207.23	6778.61	6794.67		6796.38	0.011190	10.48	2311.69	227.14	0.58	10.47
North Fork	11949.53	Max WS	24129.54	6776.18	6793.25		6794.25	0.006065	8.00	3017.19	280.49	0.43	8.00
North Fork	11900.01	Max WS	24087.23	6775.07	6792.12		6793.21	0.006551	8.39	2886.11	282.01	0.45	8.35
North Fork	11823.58	Max WS	24073.32	6772.08	6791.16		6791.85	0.003543	6.68	3602.97	292.88	0.34	6.68
North Fork	11735.01	Max WS	24060.31	6769.95	6790.07		6790.80	0.003726	6.87	3499.73	282.67	0.34	6.87
North Fork	11666.03	Max WS	24051.96	6768.14	6787.96		6789.55	0.008576	10.10	2381.06	200.00	0.52	10.10
North Fork	11548.09	Max WS	24045.85	6765.78	6781.37		6784.90	0.026203	15.07	1605.65	182.60	0.87	14.98
North Fork	11433.25	Max WS	24037.82	6757.87	6772.71		6775.22	0.020815	12.72	1889.23	220.70	0.77	12.72
North Fork	11327.52	Max WS	23987.70	6751.64	6769.16		6770.07	0.006916	7.65	3136.25	345.62	0.45	7.65
North Fork	11239.94	Max WS	23976.03	6747.28	6764.55		6767.43	0.019932	13.61	1761.10	178.13	0.76	13.61
North Fork	11096.57	Max WS	23921.92	6738.78	6760.49		6761.54	0.004771	8.22	2911.68	213.43	0.39	8.22
North Fork	11034.32	Max WS	23916.80	6736.19	6759.02		6760.40	0.006376	9.47	2550.95	203.00	0.45	9.38
North Fork	10948.44	Max WS	23913.20	6732.58	6752.45	6752.15	6757.93	0.032912	18.78	1273.57	110.05	0.97	18.78
North Fork	10879.08	Max WS	23912.17	6727.07	6743.25	6745.44	6751.84	0.061517	23.51	1016.91	101.66	1.31	23.51
North Fork	10804.61	Max WS	23911.29	6714.27	6729.13	6729.28	6734.32	0.037129	18.28	1307.80	133.33	1.03	18.28
North Fork	10722.87	Max WS	23909.21	6702.36	6718.20	6719.09	6724.28	0.045822	19.78	1208.88	128.11	1.13	19.78
North Fork	10646.63	Max WS	23907.73	6691.14	6707.33	6707.72	6712.62	0.039417	18.45	1297.59	141.35	1.06	18.42
North Fork	10546.01	Max WS	23906.10	6678.97	6695.09		6699.50	0.027642	16.88	1425.09	139.67	0.91	16.78
North Fork	10447.52	Max WS	23903.38	6669.82	6685.42		6689.99	0.028743	17.15	1393.54	127.38	0.91	17.15
North Fork	10389.11	Max WS	23902.37	6663.29	6678.48	6679.17	6684.56	0.042893	19.79	1207.96	121.06	1.10	19.79
North Fork	10331.68	Max WS	23901.37	6655.18	6670.30	6670.79	6675.90	0.039537	19.00	1266.95	139.24	1.07	18.87
North Fork	10228.94	Max WS	23899.00	6641.63	6659.89		6663.03	0.016354	14.23	1681.19	136.00	0.71	14.22
North Fork	10171.14	Max WS	23897.85	6637.93	6654.70	6654.70	6659.78	0.035474	18.10	1320.54	131.22	1.01	18.10
North Fork	10064.76	Max WS	23888.78	6629.46	6643.57		6646.87	0.027691	14.59	1637.39	191.57	0.88	14.59
North Fork	9991.054	Max WS	23857.11	6623.10	6642.15		6643.05	0.005554	7.62	3130.77	291.16	0.41	7.62
North Fork	9909.546	Max WS	23849.49	6618.77	6637.95		6640.94	0.016426	13.87	1719.90	142.77	0.70	13.87
North Fork	9830.398	Max WS	23847.34	6611.78	6629.05	6630.69	6636.79	0.053007	22.32	1068.24	102.80	1.22	22.32
North Fork	9757.763	Max WS	23844.63	6600.92	6618.03	6617.38	6623.44	0.027175	18.72	1301.92	109.48	0.92	18.32
North Fork	9680.721	Max WS	23841.26	6594.95	6613.72		6616.89	0.015699	14.28	1670.70	129.89	0.69	14.27
North Fork	9608.147	Max WS	23838.01	6589.57	6609.43		6613.29	0.016368	15.79	1541.37	115.82	0.72	15.47
North Fork	9533.745	Max WS	23834.84	6583.99	6604.42		6608.92	0.023160	17.04	1411.21	128.14	0.83	16.89
North Fork	9459.335	Max WS	23833.54	6576.67	6596.97	6597.66	6603.47	0.043461	20.45	1169.45	113.64	1.10	20.38

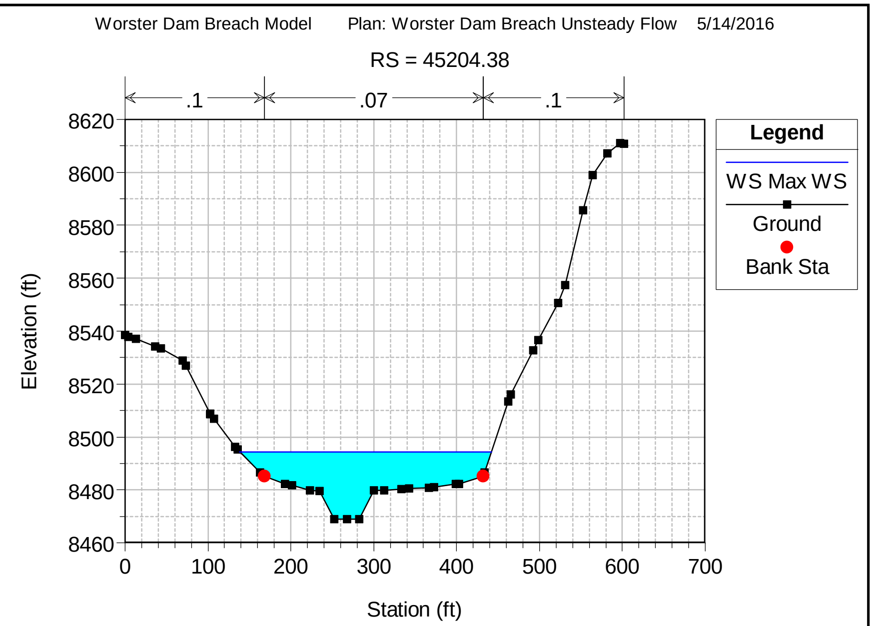
HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS (Continued)

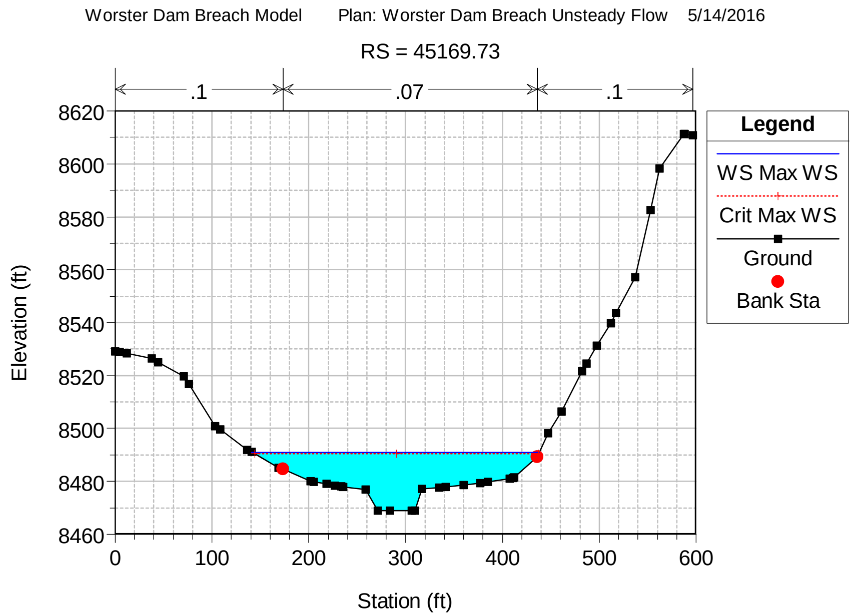
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	9347.589	Max WS	23831.28	6562.60	6582.65	6582.10	6588.55	0.028830	19.62	1257.04	102.13	0.93	18.96
North Fork	9250.326	Max WS	23826.64	6557.97	6576.32		6579.41	0.017139	14.09	1697.67	151.96	0.72	14.03
North Fork	9155.181	Max WS	23820.76	6551.48	6570.16		6573.84	0.020395	15.39	1548.55	130.21	0.78	15.38
North Fork	9063.983	Max WS	23787.60	6547.05	6564.35		6567.80	0.024633	14.91	1595.44	164.53	0.84	14.91
North Fork	8974.13	Max WS	23775.50	6539.57	6563.39		6564.31	0.003612	7.73	3076.45	198.78	0.35	7.73
North Fork	8885.528	Max WS	23770.38	6534.84	6557.01	6557.18	6563.11	0.037254	19.82	1199.55	102.90	1.02	19.82
North Fork	8796.289	Max WS	23768.85	6528.84	6544.68	6545.97	6551.69	0.050663	21.27	1123.81	120.51	1.20	21.15
North Fork	8721.852	Max WS	23765.38	6521.49	6536.24		6538.99	0.013447	13.52	1883.64	175.72	0.66	12.62
North Fork	8639.503	Max WS	23762.73	6516.50	6531.77		6534.79	0.018666	13.94	1712.82	167.32	0.75	13.87
North Fork	8568.702	Max WS	23760.28	6512.96	6526.75		6530.06	0.023544	14.62	1635.78	177.16	0.83	14.53
North Fork	8491.359	Max WS	23749.10	6508.01	6523.27		6525.13	0.011403	10.96	2219.31	233.10	0.59	10.70
North Fork	8414.232	Max WS	23743.79	6503.51	6519.08		6521.58	0.018209	12.68	1872.88	198.07	0.73	12.68
North Fork	8332.566	Max WS	23738.76	6497.90	6513.56		6516.58	0.021137	13.95	1702.27	175.54	0.79	13.95
North Fork	8256.919	Max WS	23730.72	6493.41	6509.42		6511.73	0.016183	12.19	1949.20	204.61	0.69	12.17
North Fork	8187.507	Max WS	23725.19	6488.88	6505.76		6508.02	0.015432	12.06	1966.52	198.10	0.67	12.06
North Fork	8126.279	Max WS	23720.19	6485.11	6500.69		6504.46	0.029954	15.60	1520.80	170.69	0.92	15.60
North Fork	8036.835	Max WS	23175.52	6480.94	6496.45		6497.58	0.006386	8.55	2749.70	258.19	0.45	8.43
North Fork	7953.829	Max WS	23142.58	6478.18	6496.08		6496.54	0.002086	5.44	4272.59	334.22	0.26	5.42
North Fork	7839.429	Max WS	23139.00	6476.38	6495.08		6495.71	0.002485	6.45	3837.89	317.27	0.29	6.03
North Fork	7703.31	Max WS	23123.88	6476.38	6490.26		6493.32	0.019709	14.12	1707.14	204.29	0.77	13.55
North Fork	7605.526	Max WS	23114.08	6468.11	6483.07		6486.89	0.024692	15.70	1493.45	162.30	0.86	15.48
North Fork	7548.64	Max WS	23093.27	6464.86	6482.20		6483.63	0.009349	9.63	2431.88	254.70	0.53	9.50
North Fork	7422.638	Max WS	22993.68	6462.89	6476.41		6478.67	0.019284	12.04	1909.59	228.49	0.73	12.04
North Fork	7332.77	Max WS	22879.62	6458.17	6474.82		6475.47	0.004549	6.45	3550.27	378.82	0.37	6.44
North Fork	7231.582	Max WS	22823.18	6455.28	6472.38		6473.68	0.007290	9.16	2491.93	216.46	0.47	9.16
North Fork	7088.354	Max WS	22740.92	6450.26	6468.01		6469.66	0.011058	10.30	2208.07	219.58	0.57	10.30
North Fork	6922.396	Max WS	22556.32	6443.41	6461.88		6464.15	0.011617	12.09	1865.00	145.79	0.60	12.09
North Fork	6779.19	Max WS	22492.54	6440.68	6459.98		6460.81	0.003577	7.29	3083.45	217.36	0.34	7.29
North Fork	6649.797	Max WS	22430.94	6438.32	6457.71		6458.90	0.005190	8.77	2558.37	179.27	0.41	8.77
North Fork	6579.229	Max WS	22373.44	6437.53	6455.47		6457.33	0.008465	10.98	2086.38	167.78	0.52	10.72
North Fork	6508.262	Max WS	22249.47	6435.66	6453.31		6455.10	0.010756	10.75	2069.50	187.54	0.57	10.75
North Fork	6442.157	Max WS	22235.63	6434.06	6452.84		6453.61	0.003989	7.08	3141.34	254.99	0.36	7.08
North Fork	6387.313	Max WS	22161.60	6433.14	6451.29		6452.62	0.007194	9.25	2395.97	201.04	0.47	9.25
North Fork	6296.562	Max WS	22123.10	6431.37	6450.43		6451.05	0.002861	6.37	3565.37	294.09	0.31	6.20
North Fork	6211.819	Max WS	22042.10	6429.82	6448.40		6449.73	0.008091	9.28	2384.82	227.55	0.50	9.24
North Fork	6136.926	Max WS	21975.29	6427.76	6446.76		6447.91	0.006674	8.60	2566.24	240.04	0.45	8.56
North Fork	6078.103	Max WS	21937.60	6426.51	6445.46		6446.61	0.006730	8.58	2564.28	239.65	0.45	8.56
North Fork	5924.708	Max WS	21840.44	6423.10	6442.18		6443.31	0.006435	8.53	2561.44	226.49	0.44	8.53
North Fork	5845.11	Max WS	21807.59	6421.79	6440.79		6441.73	0.005620	7.76	2810.52	256.45	0.41	7.76
North Fork	5773.113	Max WS	21755.79	6420.54	6438.59		6440.09	0.009141	9.83	2212.38	203.21	0.53	9.83
North Fork	5705.748	Max WS	21722.71	6418.57	6437.48		6438.46	0.005671	7.94	2735.41	243.33	0.42	7.94
North Fork	5635.153	Max WS	21632.99	6417.91	6435.03		6436.69	0.011047	10.33	2094.33	206.98	0.57	10.33
North Fork	5555.945	Max WS	21592.08	6416.77	6433.84		6434.64	0.004748	7.18	3024.53	296.11	0.38	7.14
North Fork	5476.622	Max WS	21558.14	6414.17	6432.63		6433.38	0.004731	6.92	3116.96	298.93	0.38	6.92
North Fork	5400.43	Max WS	21527.84	6412.89	6430.89		6431.96	0.006953	8.31	2591.17	250.97	0.46	8.31
North Fork	5322.054	Max WS	21515.79	6410.76	6428.91		6430.11	0.007642	8.76	2457.03	235.61	0.48	8.76
North Fork	5245.362	Max WS	21505.62	6409.22	6427.28		6428.34	0.006430	8.25	2610.63	248.05	0.44	8.24
North Fork	5177.678	Max WS	21497.26	6408.24	6425.20		6426.66	0.009187	9.69	2217.94	209.83	0.53	9.69
North Fork	5080.471	Max WS	21505.91	6404.23	6418.75	6418.67	6423.19	0.033800	16.93	1281.14	150.28	0.98	16.79
North Fork	5028.746	Max WS	21427.37	6399.02	6417.21		6418.46	0.006994	8.96	2400.86	217.38	0.46	8.92
North Fork	4939.782	Max WS	21399.07	6398.33	6415.78		6416.65	0.006570	7.49	2856.53	309.73	0.43	7.49
North Fork	4867.696	Max WS	21365.91	6397.61	6414.19		6415.10	0.006408	7.67	2786.24	286.73	0.43	7.67
North Fork	4758.908	Max WS	21217.46	6396.82	6410.39		6412.00	0.014079	10.20	2079.46	252.66	0.63	10.20
North Fork	4601.875	Max WS	21146.79	6393.27	6408.76		6409.09	0.001758	4.65	4552.09	378.54	0.24	4.65
North Fork	4450.735	Max WS	17800.54	6393.21	6405.49		6406.56	0.009044	8.31	2141.23	254.47	0.51	8.31
North Fork	4334.034	Max WS	17497.37	6383.79	6404.76		6405.03	0.001336	4.15	4211.74	334.09	0.21	4.15
North Fork	4254.052	Max WS	17421.46	6382.38	6404.60		6404.78	0.000626	3.41	5181.98	350.29	0.15	3.36
North Fork	4155.702	Max WS	17419.66	6381.40	6404.51		6404.63	0.000365	2.86	6405.78	402.17	0.12	2.72
North Fork	4057.636	Max WS	17384.73	6381.40	6404.40		6404.52	0.000334	2.74	6480.05	379.77	0.11	2.68
North Fork	3982.988	Max WS	17337.00	6381.40	6404.01		6404.35	0.001500	4.64	3751.10	292.14	0.22	4.62
North Fork	3864.25	Max WS	17356.61	6381.40	6404.03		6404.11	0.000228	2.29	7745.21	455.04	0.09	2.24
North Fork	3646.323	Max WS	17314.59	6381.40	6403.27		6403.65	0.001811	4.98	3474.51	261.37	0.24	4.98
North Fork	3569.228	Max WS	17296.51	6381.40	6402.72		6403.15	0.002229	5.27	3280.62	262.26	0.26	5.27
North Fork	3432.143	Max WS	17264.84	6381.40	6400.86		6401.55	0.006617	6.64	2605.71	349.54	0.42	6.63
North Fork	3266.139	Max WS	17119.18	6381.40	6396.73		6397.72	0.011540	7.95	2154.04	329.43	0.55	7.95
North Fork	3177.252	Max WS	17092.93	6378.97	6396.09		6396.25	0.001307	3.26	5238.18	595.82	0.19	3.26
North Fork	3074.034	Max WS	17087.26	6378.54	6395.75		6395.92	0.000871	3.26	5242.86	435.94	0.17	3.26
North Fork	2928.466	Max WS	17080.97	6377.95	6390.39	6391.27	6394.92	0.055304	17.07	1000.42	156.18	1.19	17.07
North Fork	2828.146	Max WS	16940.83	6363.39	6380.22		6380.91	0.003815	6.67	2538.11	217.04	0.34	6.67
North Fork	2649.368	Max WS	16825.51	6360.56	6378.55		6378.90	0.002393	4.73	3560.87	361.89	0.27	4.73
North Fork	2566.46	Max WS	16798.69	6360.27	6377.79		6378.21	0.002522	5.21	3226.22	296.04	0.28	5.21
North Fork	2475.234	Max WS	16716.31	6359.09	6376.16		6377.22	0.005746	8.26	2041.07	178.43	0.42	8.19
North Fork	2319.181	Max WS	16620.65	6358.83	6374.85		6375.33	0.003042	5.58	2979.30	282.43	0.30	5.58
North Fork	2190.516	Max WS	16450.88	6358.63	6373.15		6373.80	0.004367	6.48	2537.74	252.16	0.36	6.48
North Fork	2048.555	Max WS	16201.56	6358.63	6371.67		6372.13	0.002871	5.50	2947.29	271.10	0.29	5.50
North Fork	1921.849	Max WS	16084.66	6358.63	6370.98		6371.23	0.001641	4.02	4002.65	393.88	0.22	4.02
North Fork	1760.911	Max WS	15985.85	6358.63	6370.40		6370.56	0.000975	3.14	5098.89	491.63	0.17	3.14
North Fork	1629.868	Max WS	15905.87	6358.63	6369.66		6369.93	0.002041	4.20	3789.77	412.23	0.24	4.20
North Fork	1513.25	Max WS	15847.83	6358.63	6369.03		6369.19	0.002192	3.24	4885.86	828.91	0.24	3.24
North Fork	1302.759	Max WS	15783.81	6358.63	6367.65		6367.90	0.002114	4.04	3918.86	473.41	0.25	4.03
North Fork	1041.231	Max WS	15752.60	6358.63	6365.48		6365.74	0.003418	4.13	3817.55	628.64	0.30	4.13

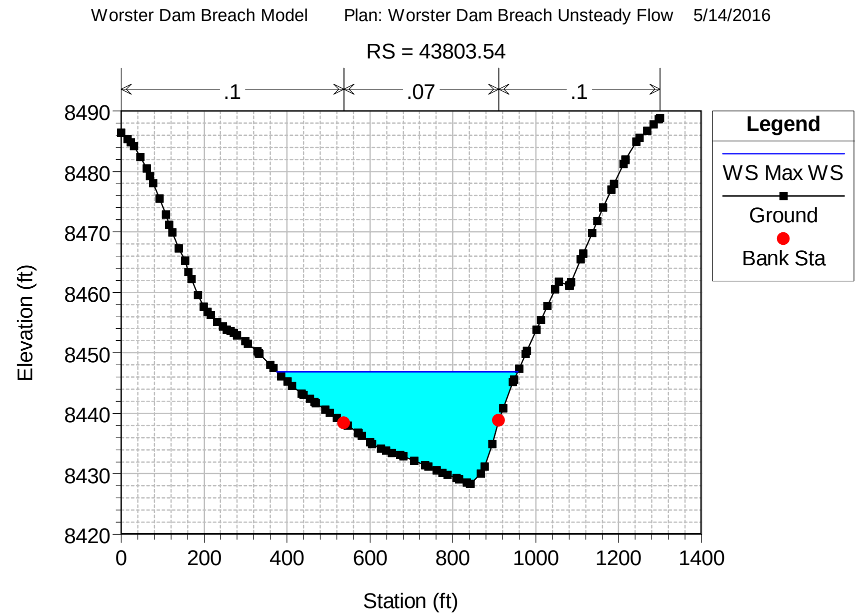
HEC-RAS Plan: WorsterUnstdy River: Poudre River Reach: North Fork Profile: Max WS (Continued)

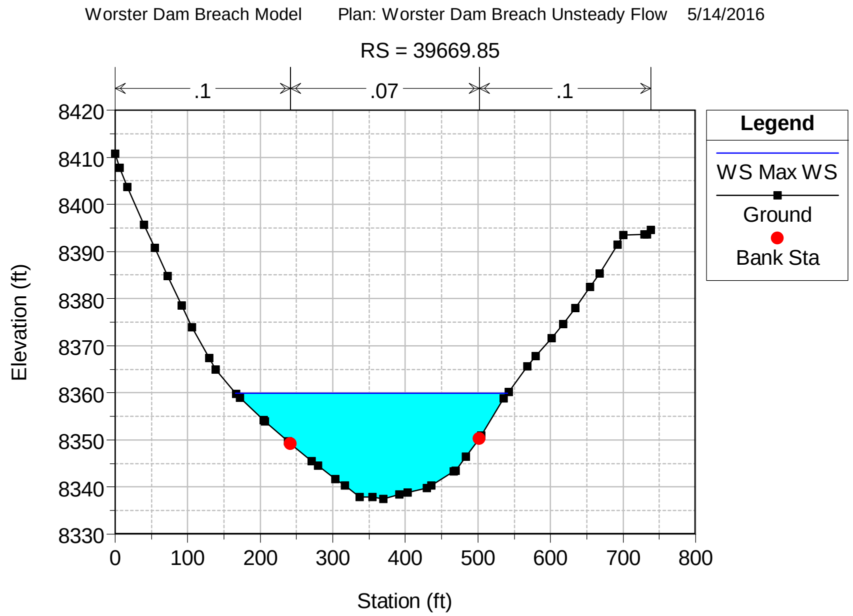
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft/s)
North Fork	892.8347	Max WS	15747.52	6358.63	6362.88		6363.35	0.010104	5.47	2877.53	699.42	0.48	5.47
North Fork	792	Max WS	15746.80	6357.63	6361.88		6362.34	0.010165	5.48	2872.18	699.38	0.48	5.48
North Fork	692	Max WS	15746.23	6356.63	6360.86		6361.33	0.010280	5.50	2862.28	699.28	0.48	5.50
North Fork	592	Max WS	15745.21	6355.63	6359.82		6360.30	0.010632	5.56	2832.92	698.99	0.49	5.56
North Fork	492	Max WS	15744.95	6354.63	6358.69		6359.20	0.011867	5.75	2739.46	698.07	0.51	5.75
North Fork	392	Max WS	293.45	6353.63	6357.60	6353.82	6357.60	0.000004	0.11	2678.82	697.46	0.01	0.11

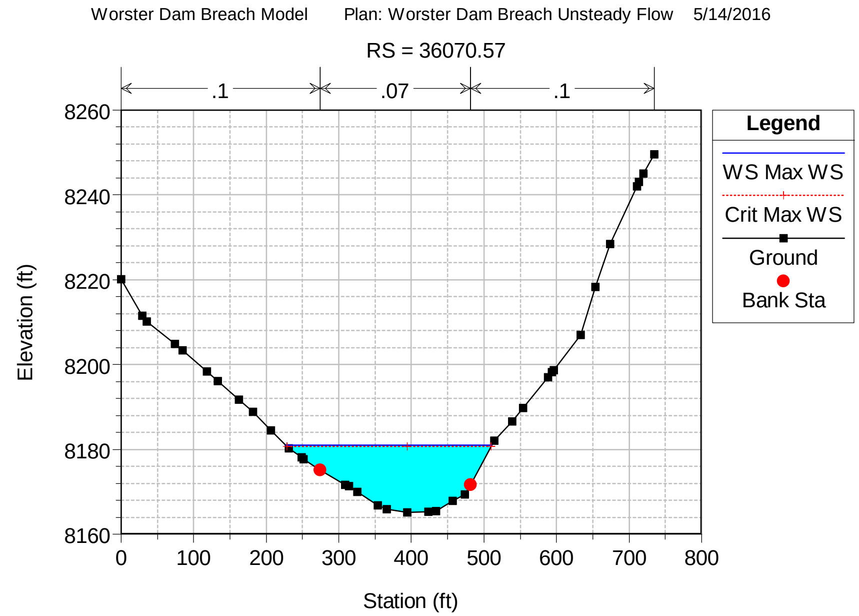

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 45242.44
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8460
8480
8500
8520
8540
8560
8580
8600
8620
0
100
200
300
400
500
600
700

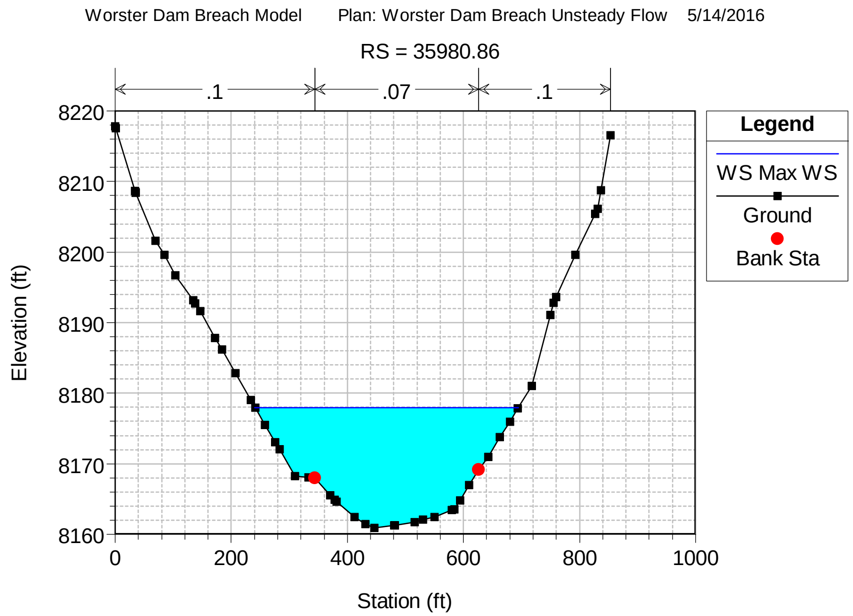

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 45204.38
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8460
8480
8500
8520
8540
8560
8580
8600
8620
0
100
200
300
400
500
600
700

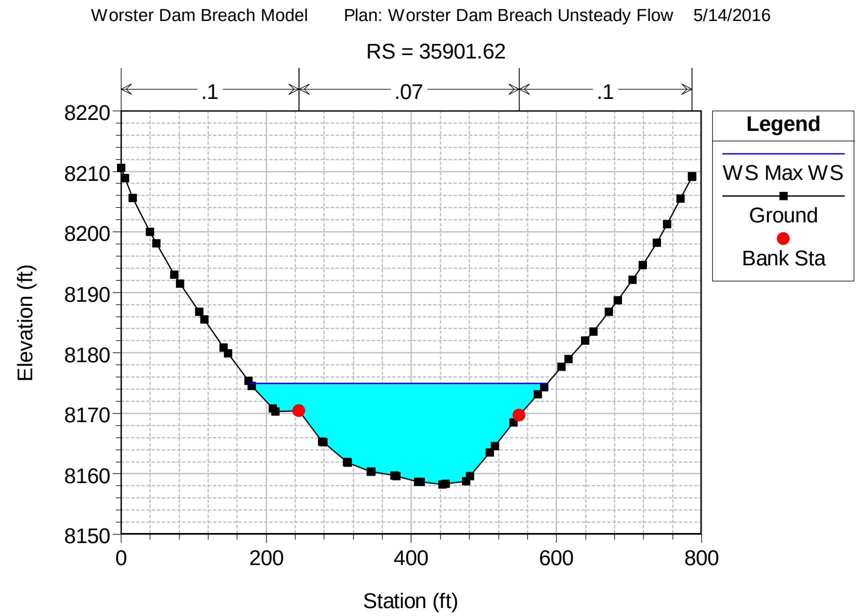

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 45169.73
.1
.07
.1
Legend
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8460
8480
8500
8520
8540
8560
8580
8600
8620
0
100
200
300
400
500
600

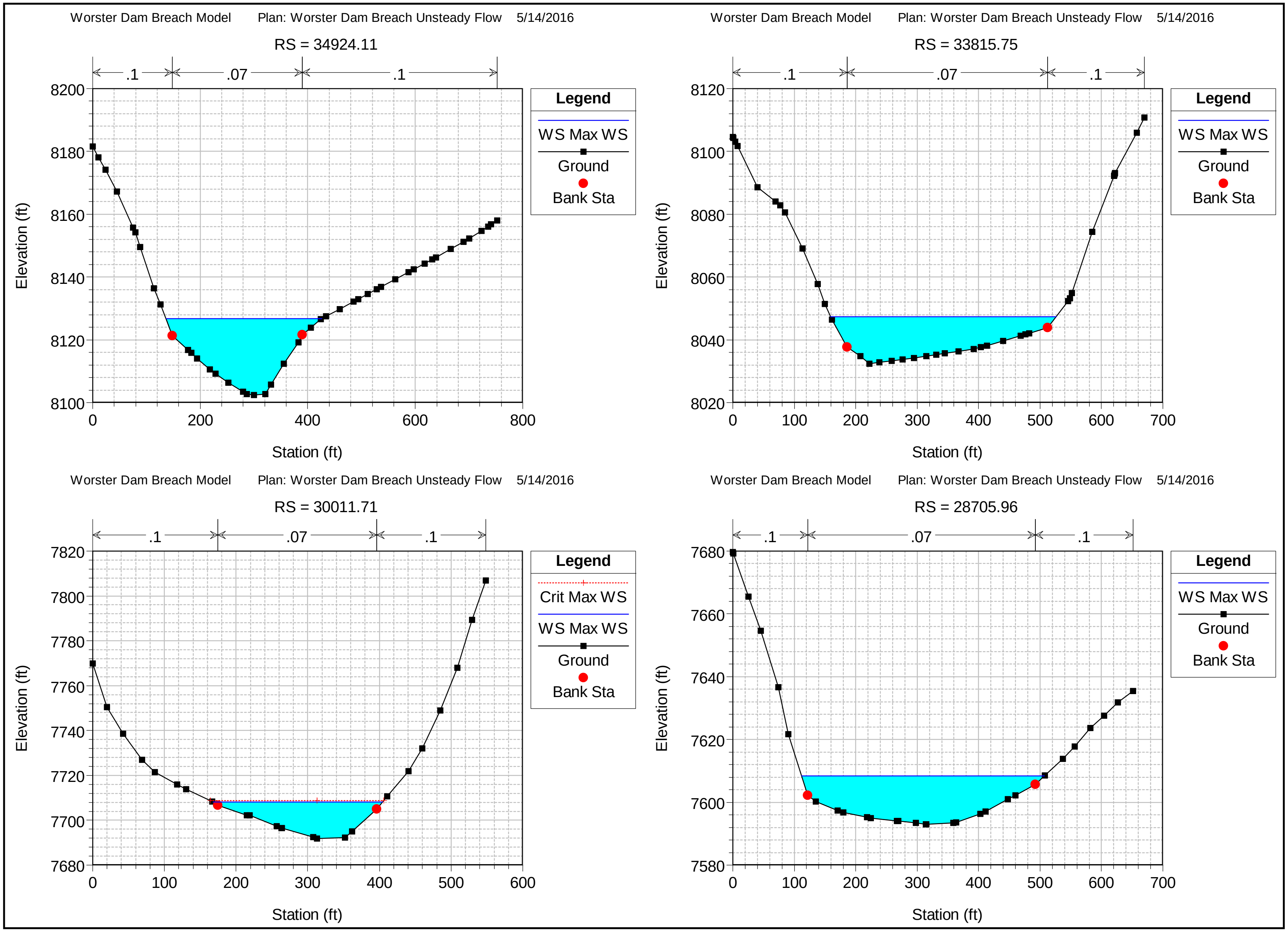

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 43803.54
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8420
8430
8440
8450
8460
8470
8480
8490
0
200
400
600
800
1000
1200
1400

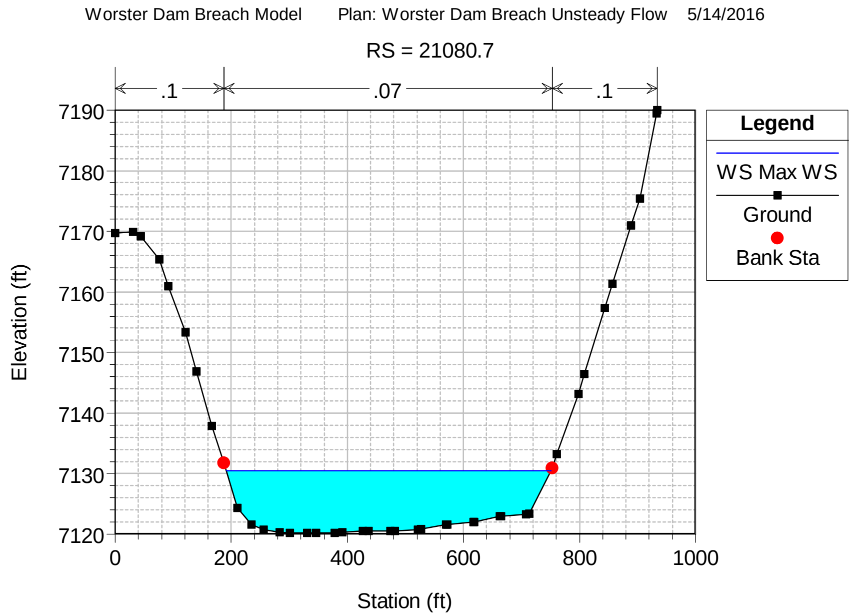

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 39669.85
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8330
8340
8350
8360
8370
8380
8390
8400
8410
8420
0
100
200
300
400
500
600
700
800

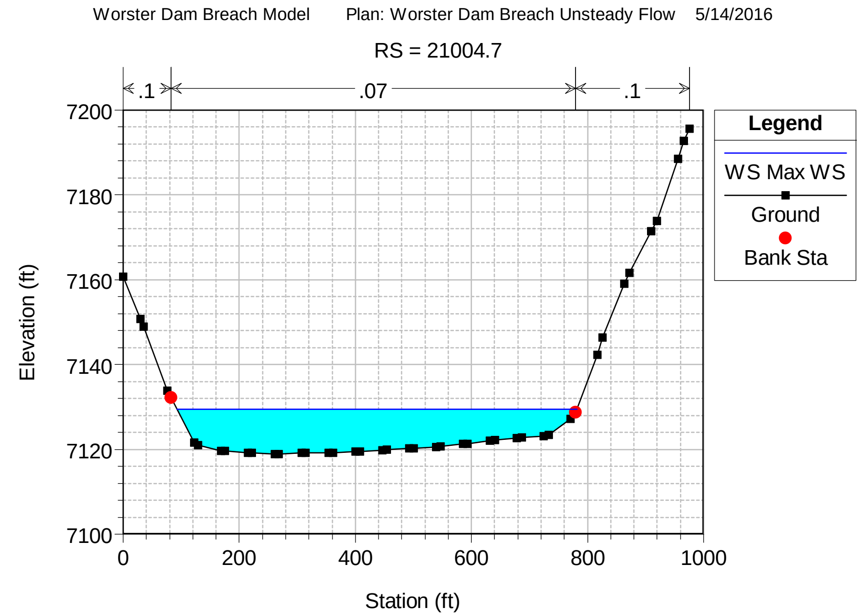

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 36070.57
.1
.07
.1
Legend
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8160
8180
8200
8220
8240
8260
0
100
200
300
400
500
600
700
800

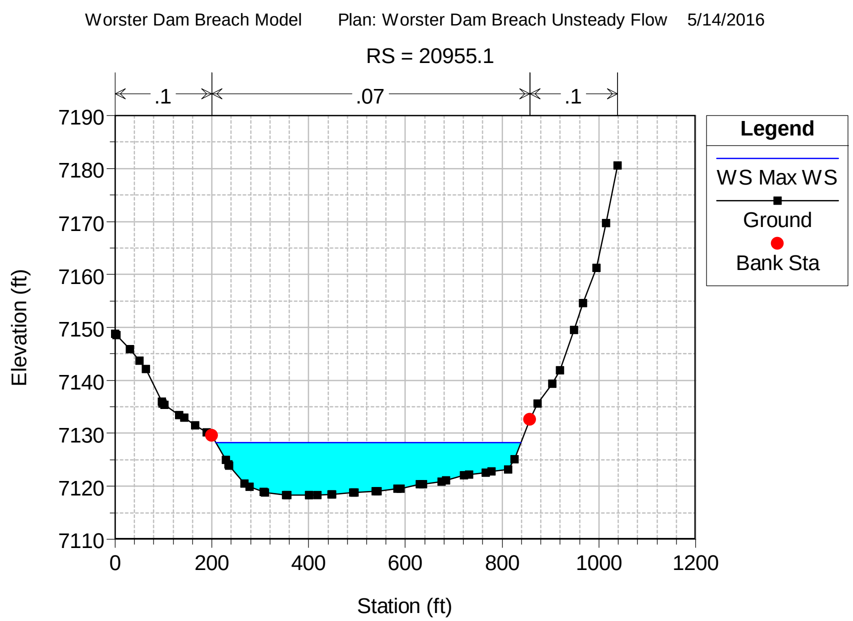

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 35980.86
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8160
8170
8180
8190
8200
8210
8220
0
200
400
600
800
1000

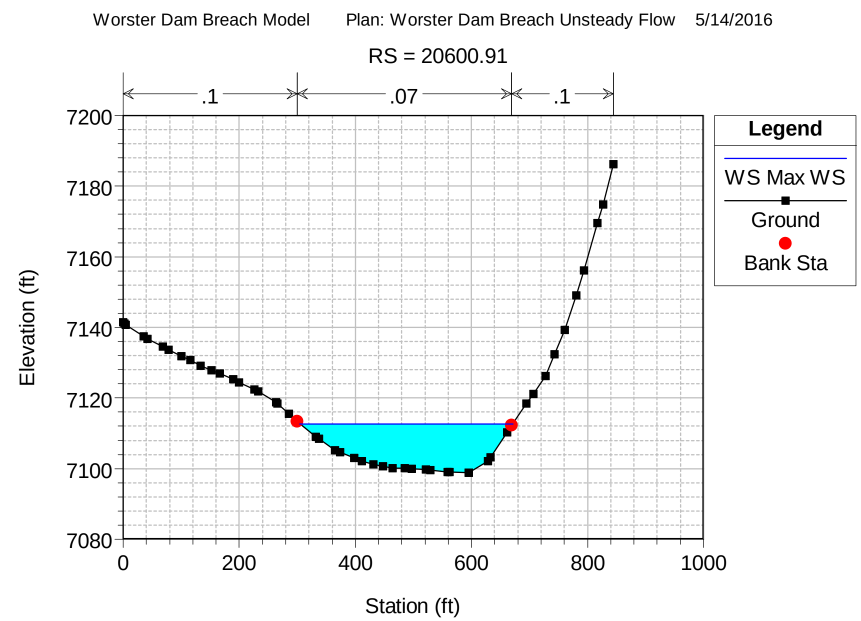

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 35901.62
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
8150
8160
8170
8180
8190
8200
8210
8220
0
200
400
600
800

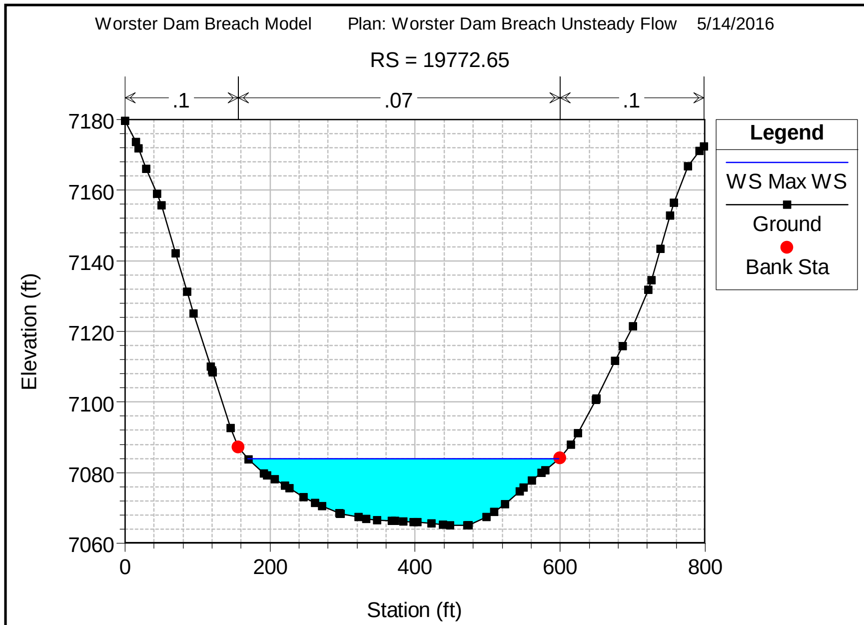

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 34924.11
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS Max WS
Ground
Bank Sta
Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 33815.75
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS Max WS
Ground
Bank Sta
Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 30011.71
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
Crit Max WS
WS Max WS
Ground
Bank Sta
Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 28705.96
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS Max WS
Ground
Bank Sta

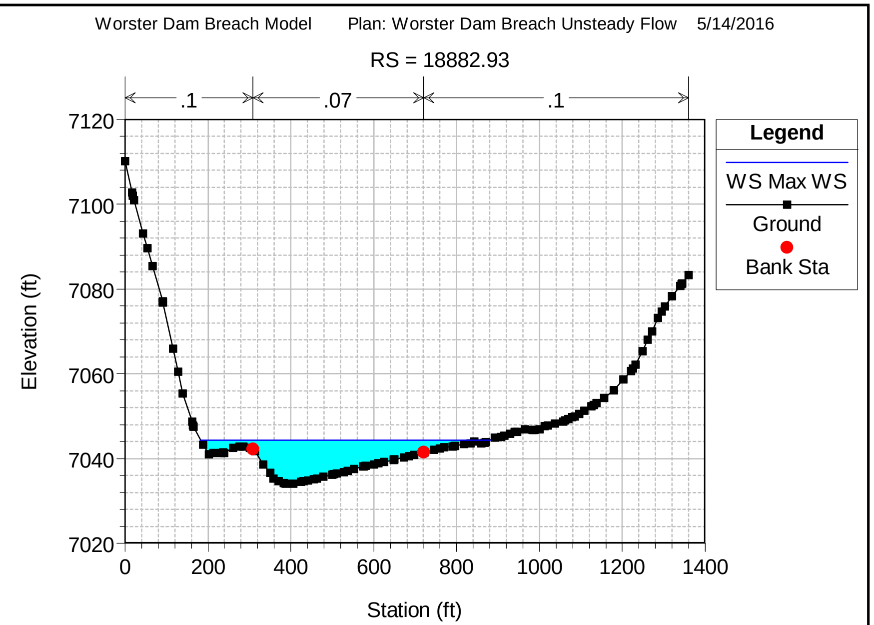

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 21080.7
.1
.07
.1
Elevation (ft)
7190
7180
7170
7160
7150
7140
7130
7120
0
200
400
600
800
1000
Station (ft)
Legend
WS Max WS
Ground
Bank Sta

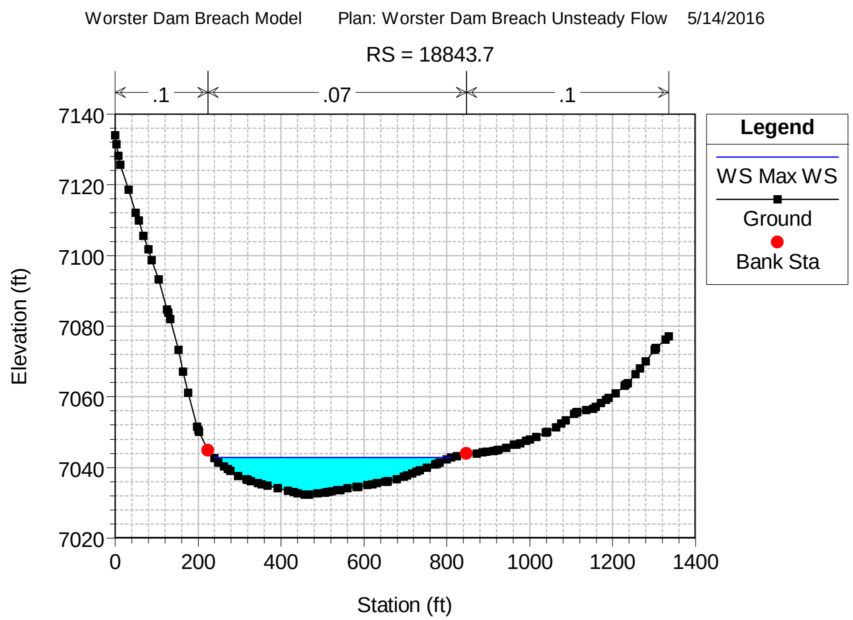

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 21004.7
.1
.07
.1
Elevation (ft)
7200
7180
7160
7140
7120
7100
0
200
400
600
800
1000
Station (ft)
Legend
WS Max WS
Ground
Bank Sta

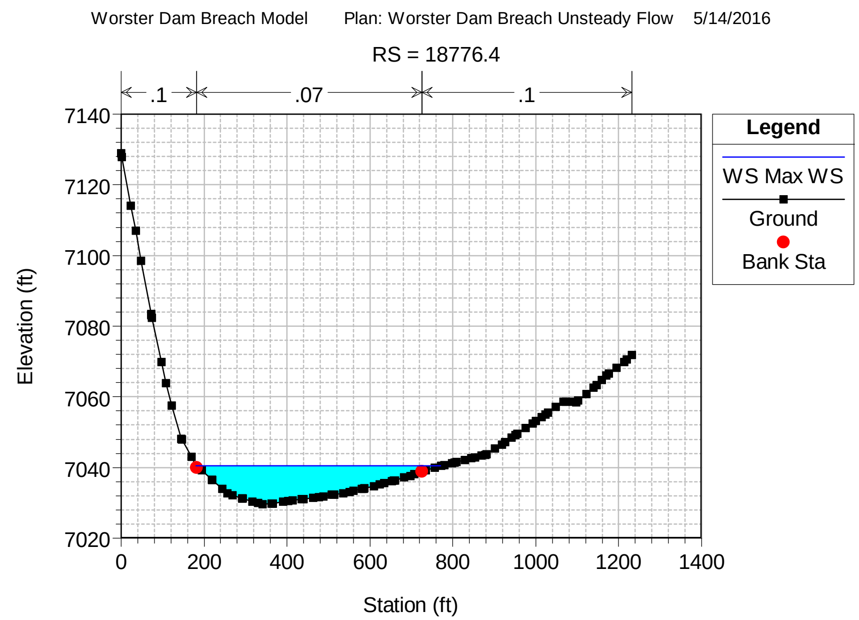

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 20955.1
.1
.07
.1
Elevation (ft)
7190
7180
7170
7160
7150
7140
7130
7120
7110
0
200
400
600
800
1000
1200
Station (ft)
Legend
WS Max WS
Ground
Bank Sta

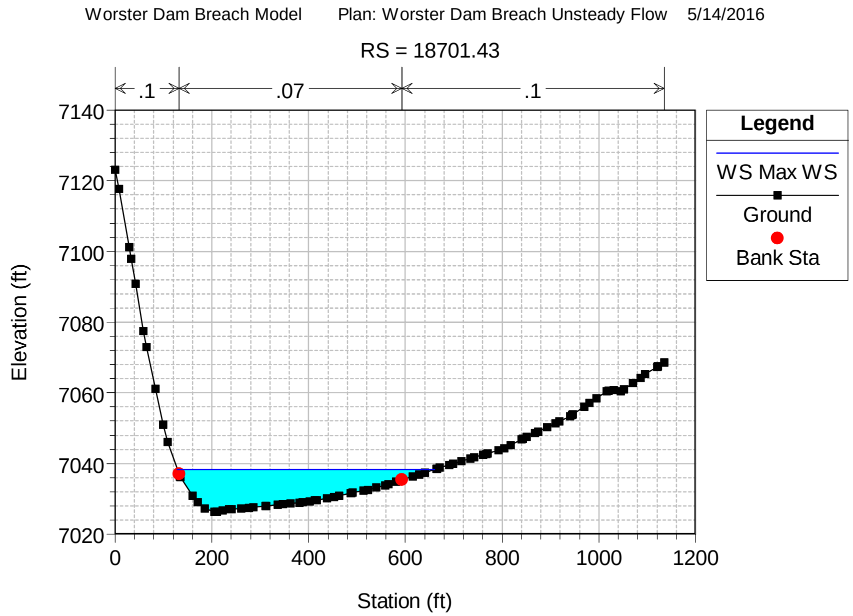

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 20600.91
.1
.07
.1
Elevation (ft)
7200
7180
7160
7140
7120
7100
7080
0
200
400
600
800
1000
Station (ft)
Legend
WS Max WS
Ground
Bank Sta

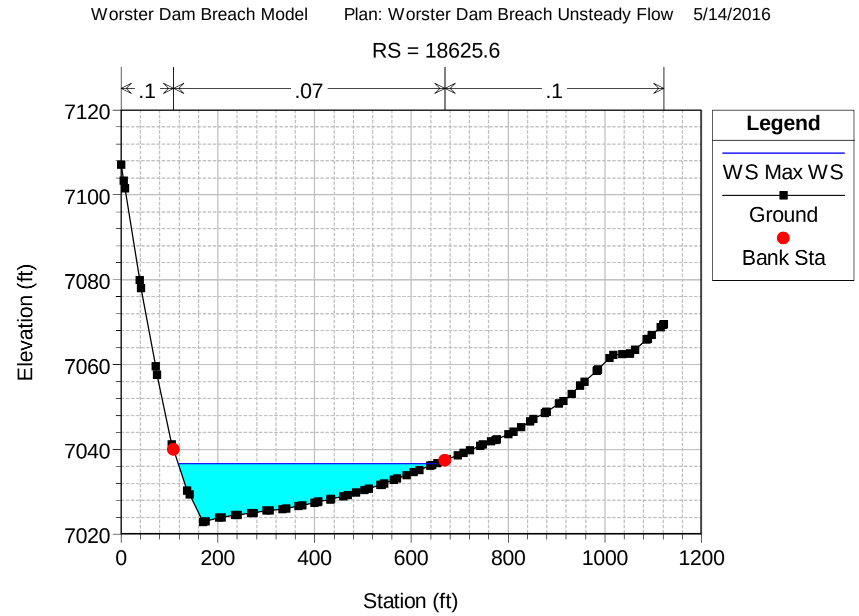

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 19772.65
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
7180
7160
7140
7120
7100
7080
7060
0
200
400
600
800

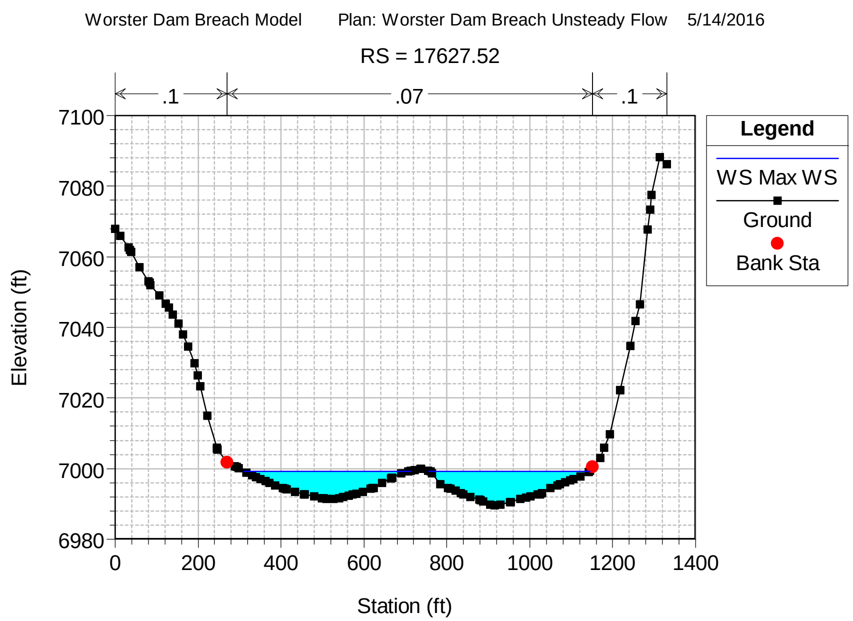

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 18882.93
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
7120
7100
7080
7060
7040
7020
0
200
400
600
800
1000
1200
1400

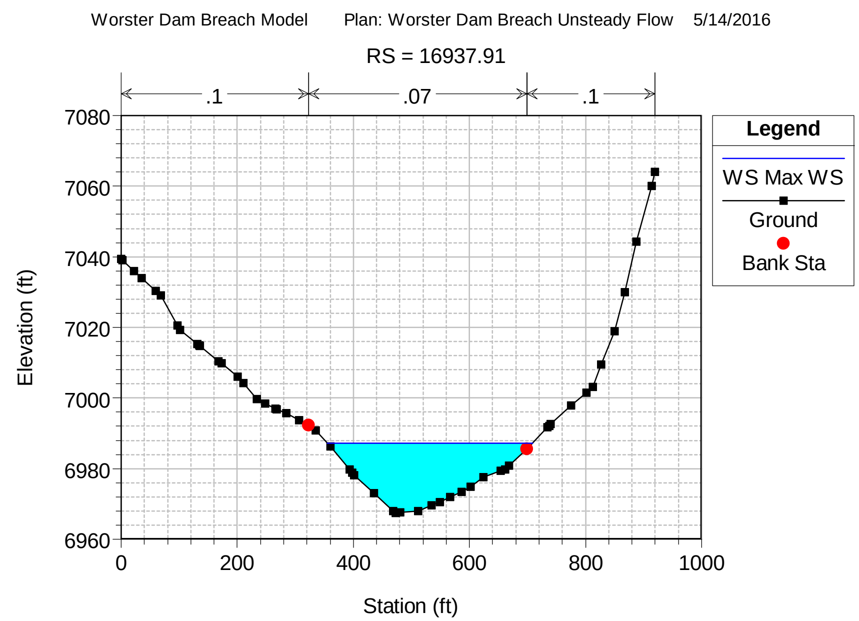

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 18843.7
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
7140
7120
7100
7080
7060
7040
7020
0
200
400
600
800
1000
1200
1400

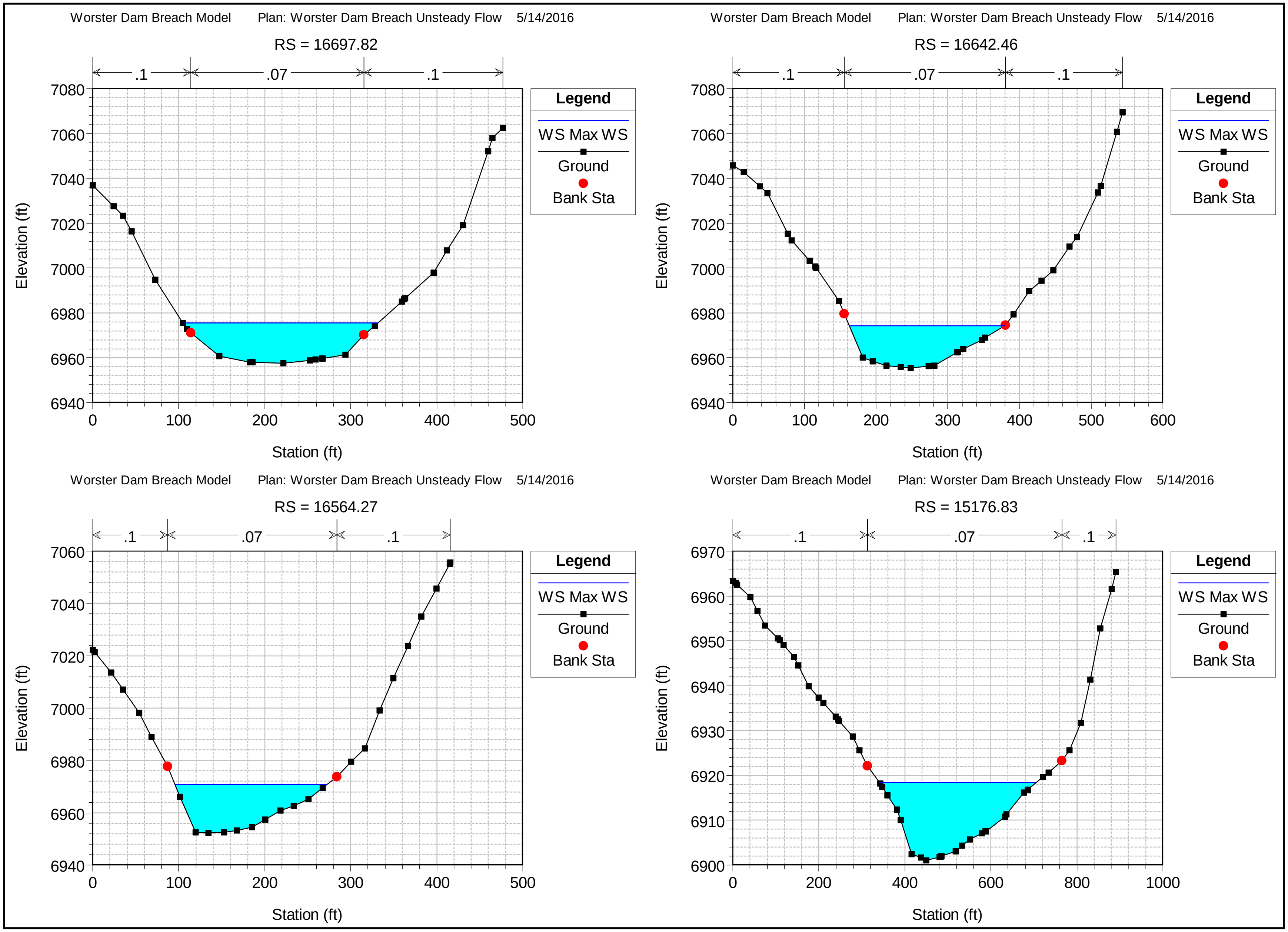

Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 18776.4
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
7140
7120
7100
7080
7060
7040
7020
0
200
400
600
800
1000
1200
1400

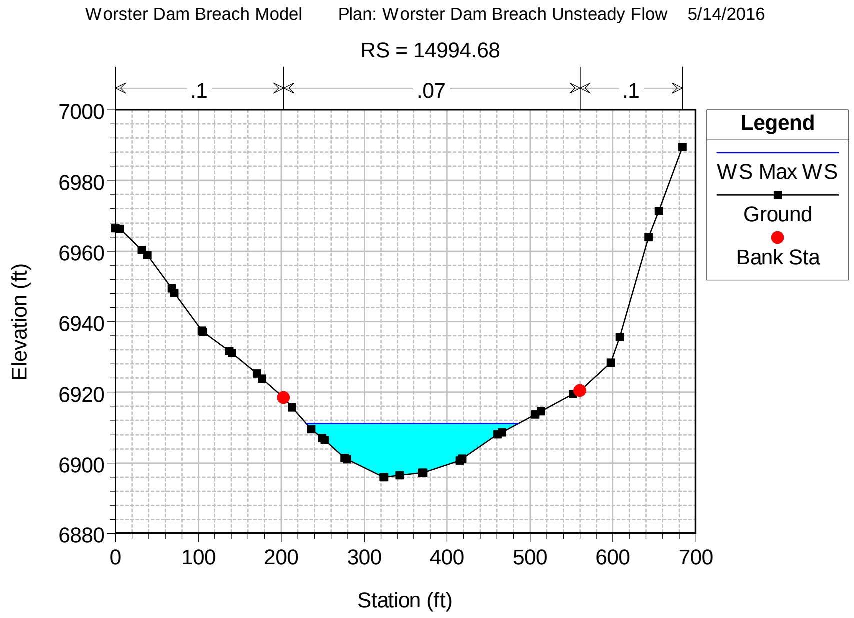

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 18701.43
.1
.07
.1
Elevation (ft)
Station (ft)
7140
7120
7100
7080
7060
7040
7020
0
200
400
600
800
1000
1200
Legend
WS Max WS
Ground
Bank Sta


Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 18625.6
.1
.07
.1
Elevation (ft)
Station (ft)
7120
7100
7080
7060
7040
7020
0
200
400
600
800
1000
1200
Legend
WS Max WS
Ground
Bank Sta

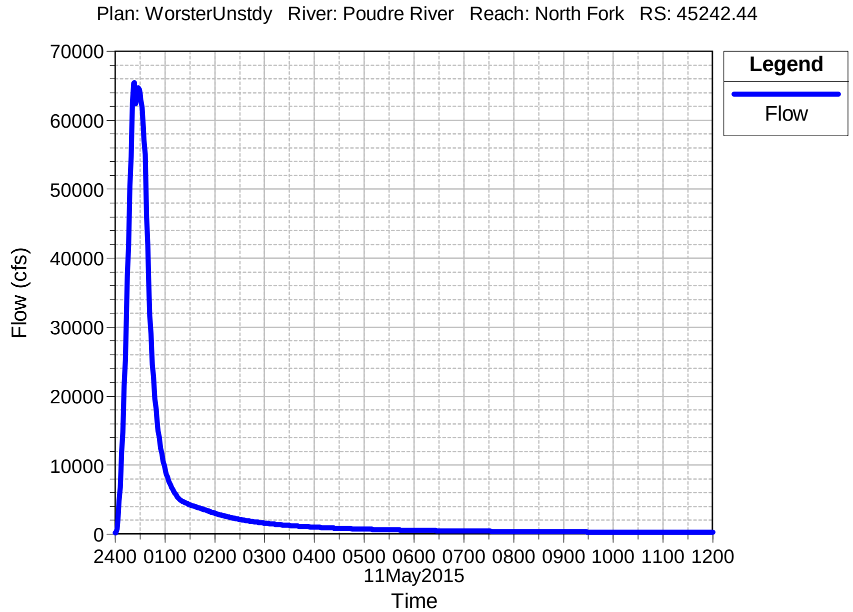

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 17627.52
.1
.07
.1
Elevation (ft)
Station (ft)
7100
7080
7060
7040
7020
7000
6980
0
200
400
600
800
1000
1200
1400
Legend
WS Max WS
Ground
Bank Sta

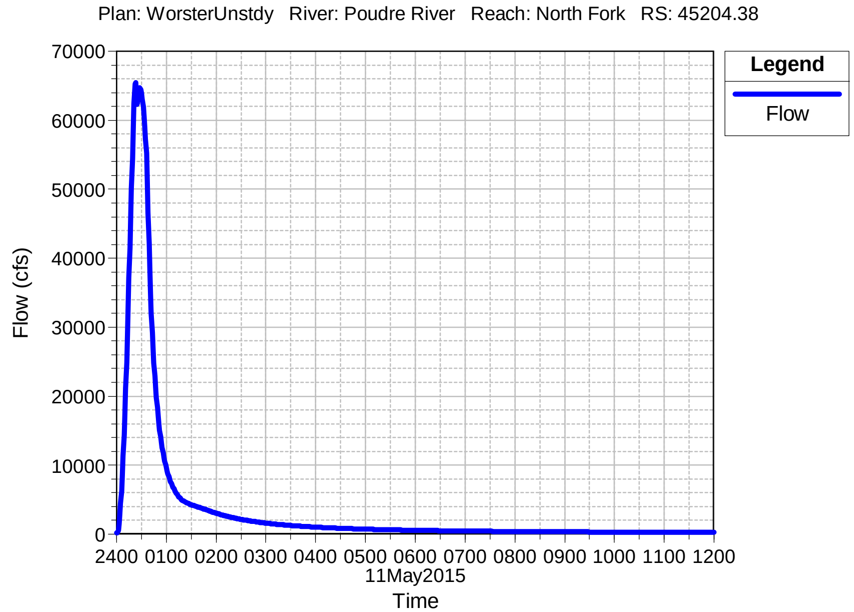

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 16937.91
.1
.07
.1
Elevation (ft)
Station (ft)
7080
7060
7040
7020
7000
6980
6960
0
200
400
600
800
1000
Legend
WS Max WS
Ground
Bank Sta

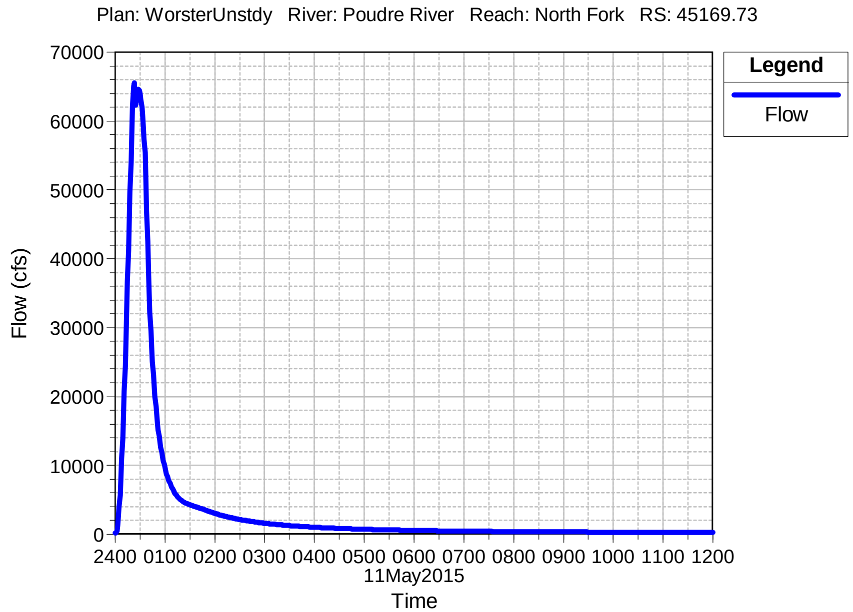

Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 16697.82
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 16642.46
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 16564.27
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Worster Dam Breach Model
Plan: Worster Dam Breach Unsteady Flow
5/14/2016
RS = 15176.83
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)

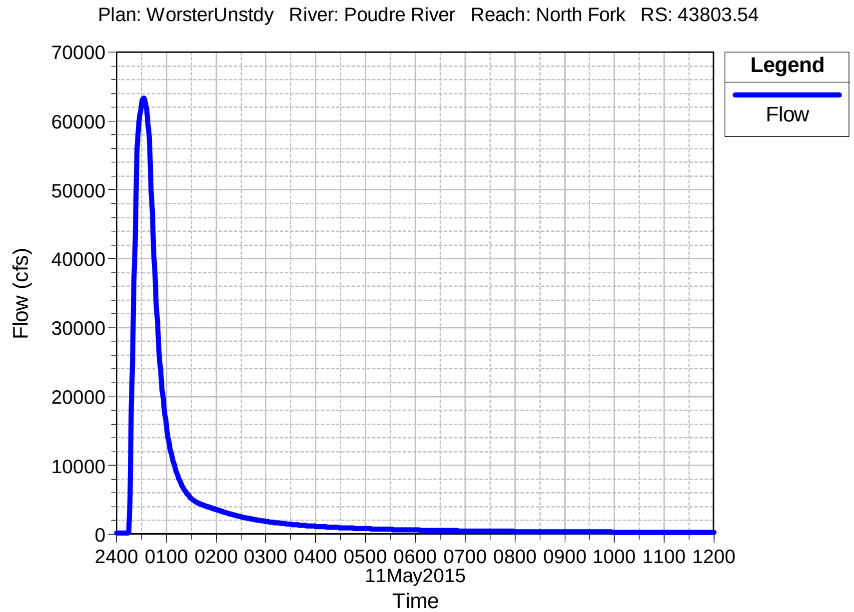


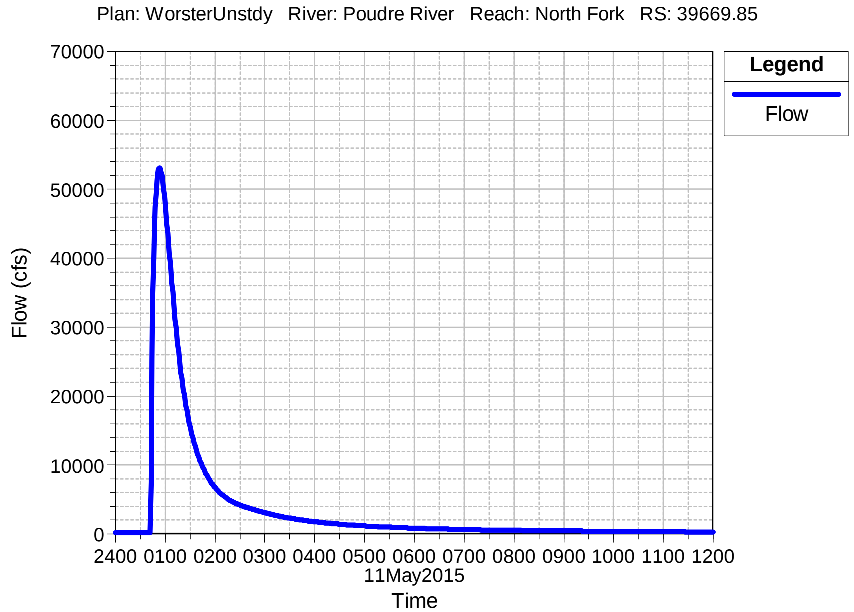
Worster Dam Breach Model Plan: Worster Dam Breach Unsteady Flow 5/14/2016
RS = 14994.68
.1
.07
.1
Legend
WS Max WS
Ground
Bank Sta
Elevation (ft)
7000
6980
6960
6940
6920
6900
6880
0
100
200
300
400
500
600
700
Station (ft)

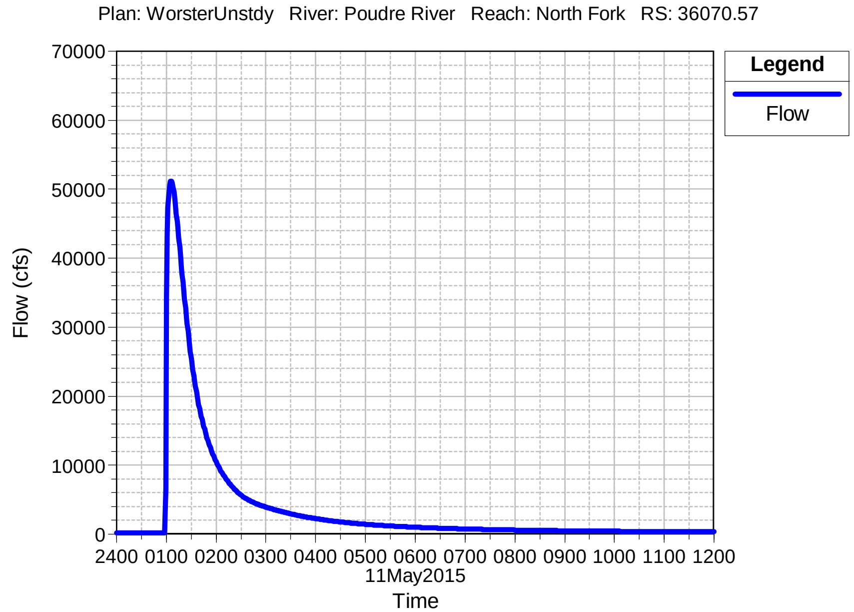

Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 45242.44
Flow (cfs)
0
10000
20000
30000
40000
50000
60000
70000
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow

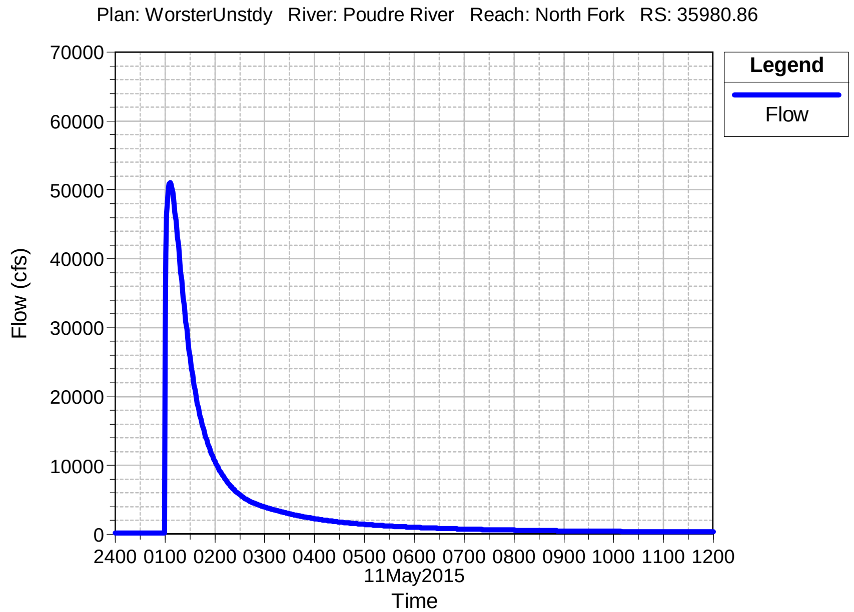

Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 45204.38
Flow (cfs)
0
10000
20000
30000
40000
50000
60000
70000
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 45169.73
Flow (cfs)
0
10000
20000
30000
40000
50000
60000
70000
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 43803.54
Flow (cfs)
0
10000
20000
30000
40000
50000
60000
70000
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 39669.85
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 36070.57
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 35980.86
Legend
Flow
Flow (cfs)
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50000
40000
30000
20000
10000
0
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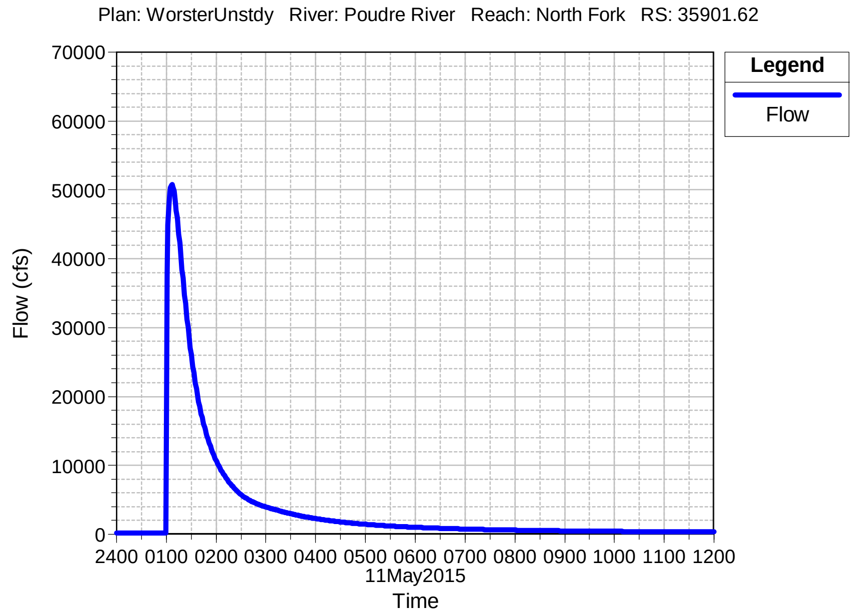
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 35901.62
Legend
Flow
Flow (cfs)
70000
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50000
40000
30000
20000
10000
0
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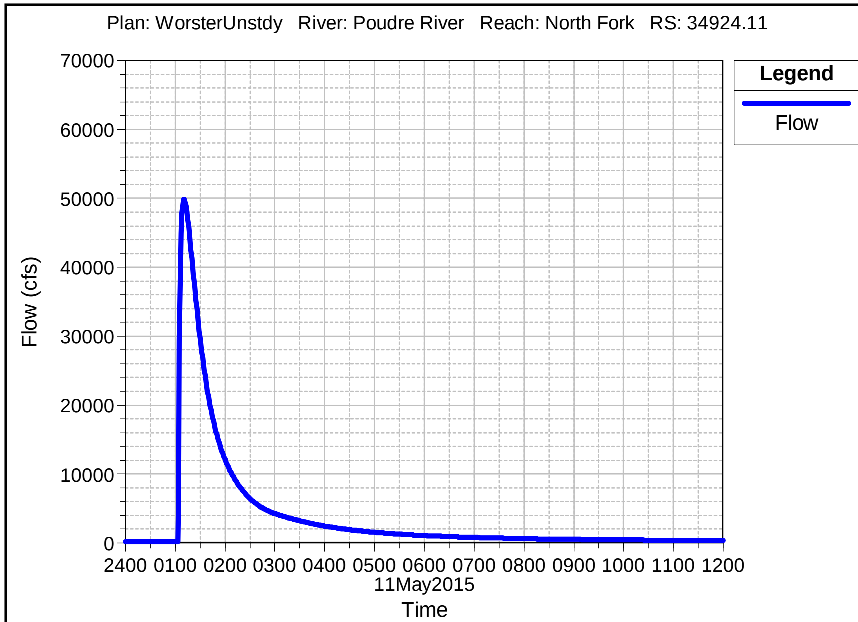
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 34924.11
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
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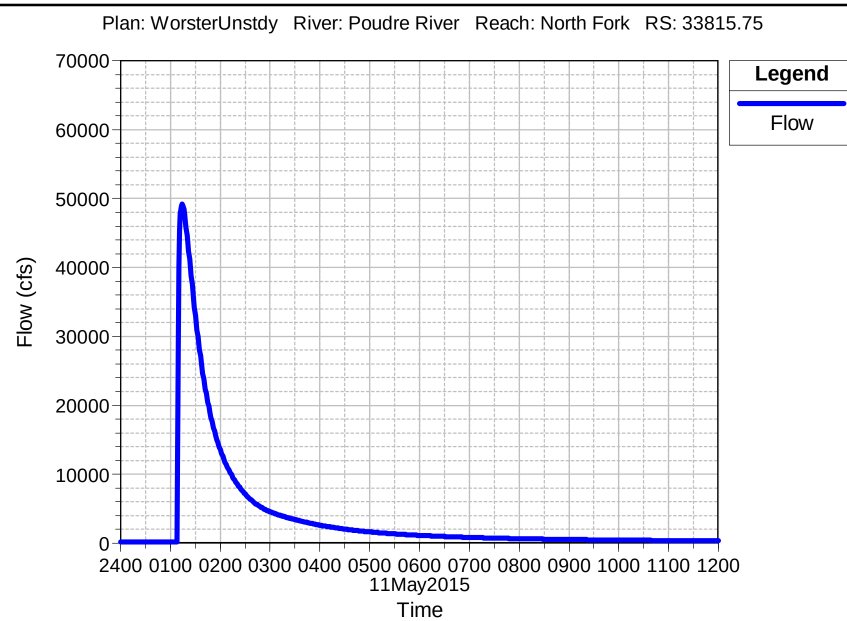
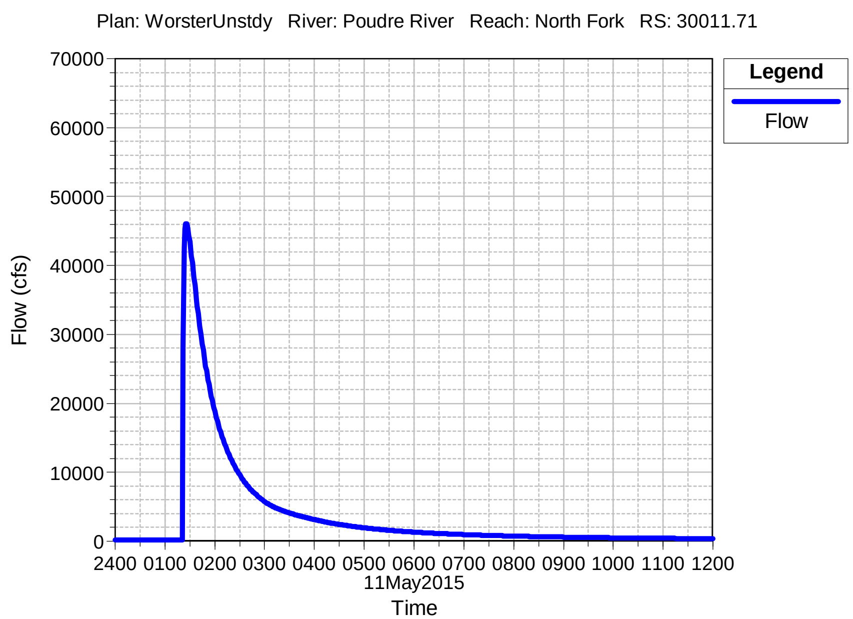
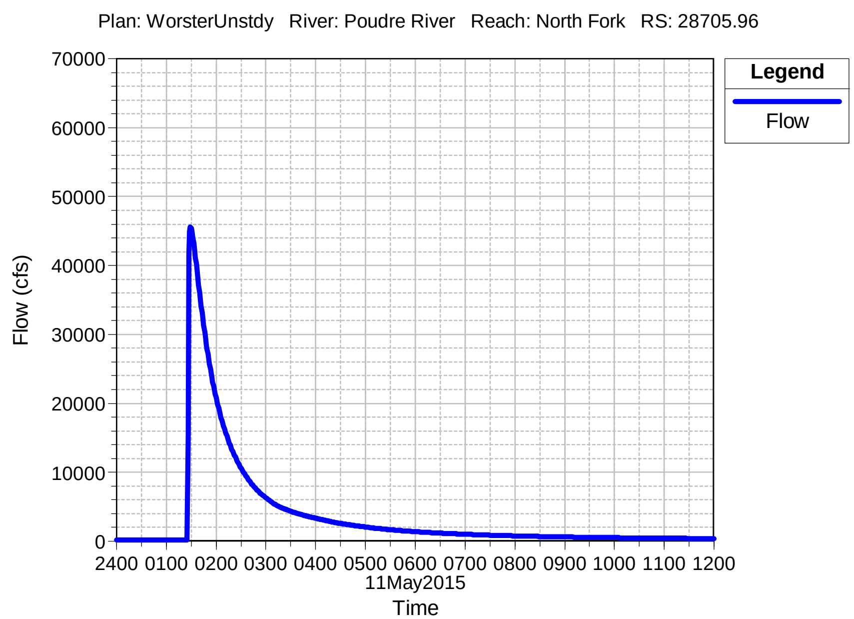
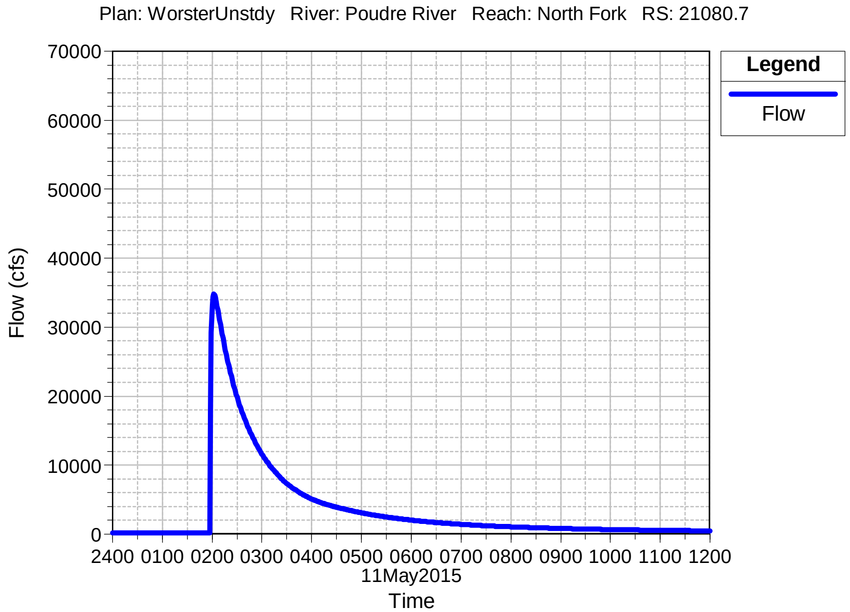
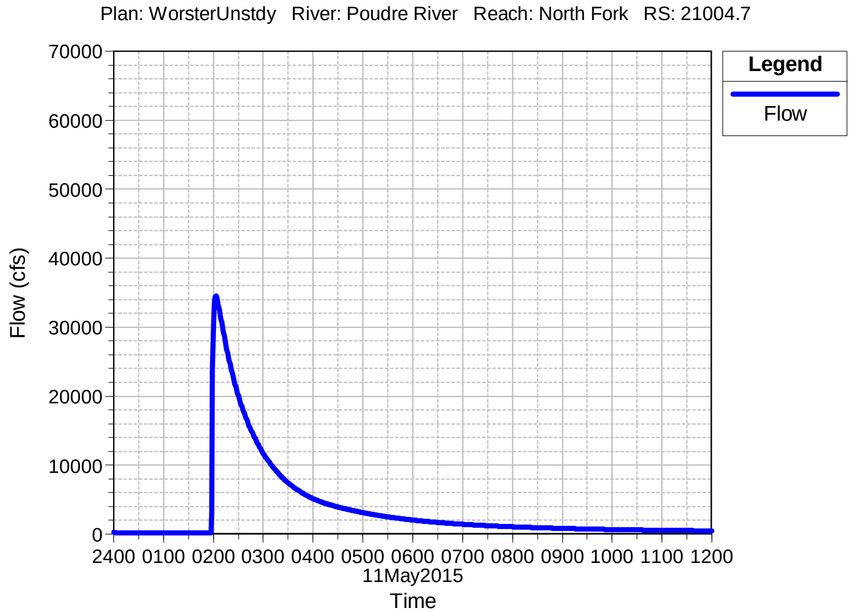
11May2015
Time

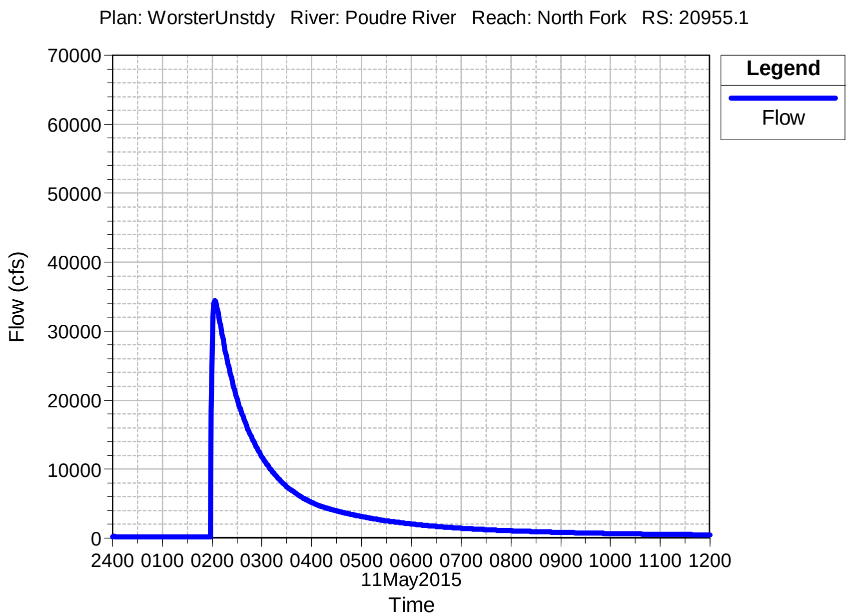

Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 33815.75
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 30011.71
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 28705.96
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 21080.7
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 21004.7
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 20955.1
Flow (cfs)
70000
60000
50000
40000
30000
20000
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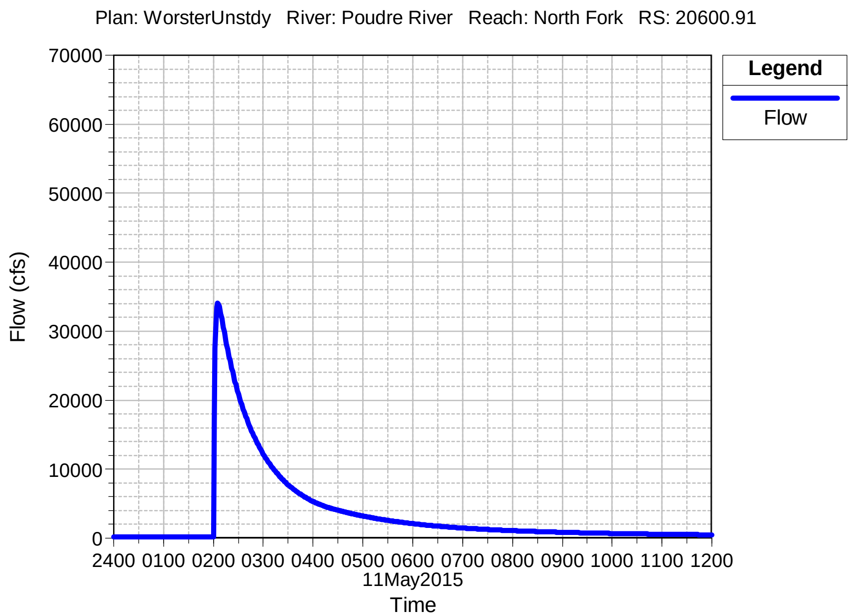
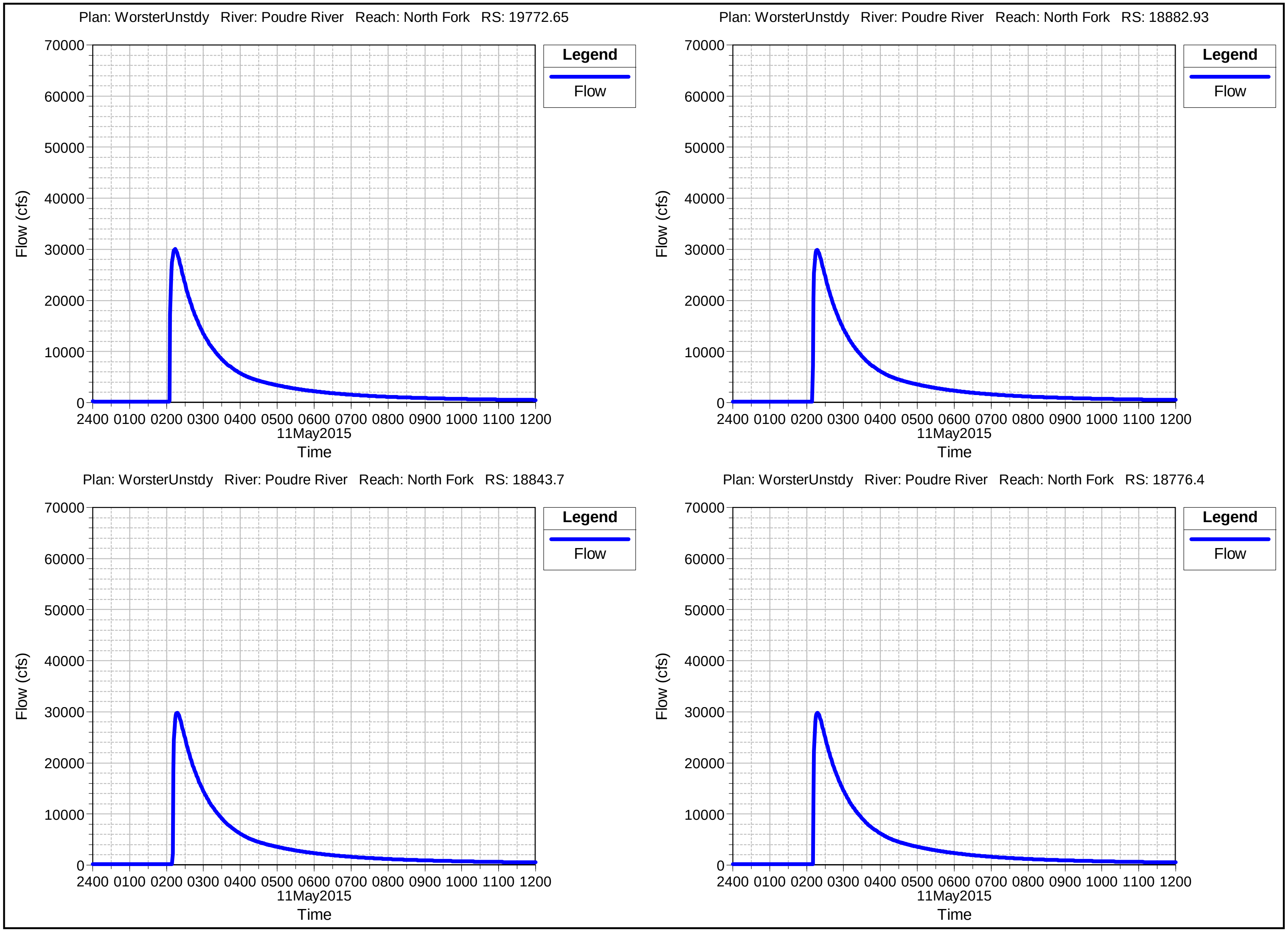
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 20600.91
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time
Legend
Flow


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 19772.65
Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 18882.93
Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 18843.7
Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 18776.4
Legend
Flow
Flow (cfs)
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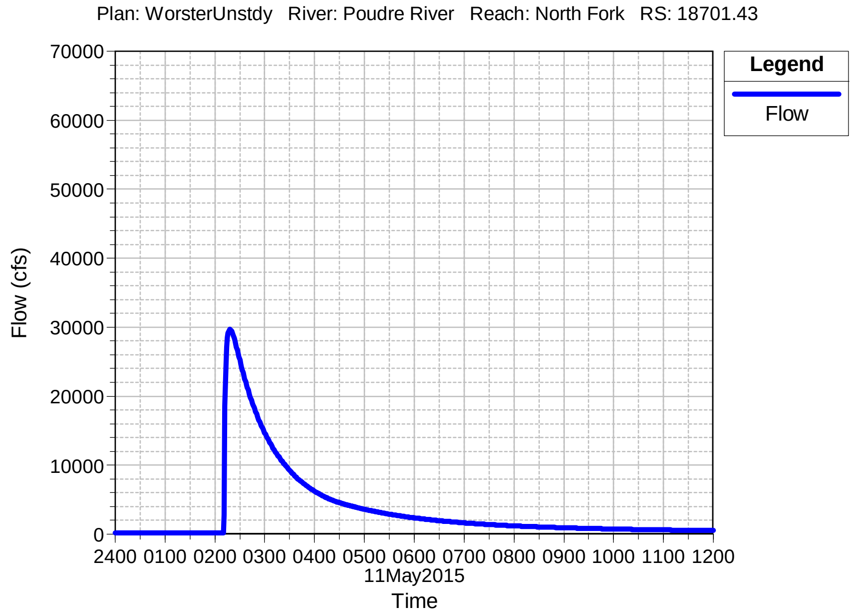
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 18701.43
Legend
Flow
Flow (cfs)
70000
60000
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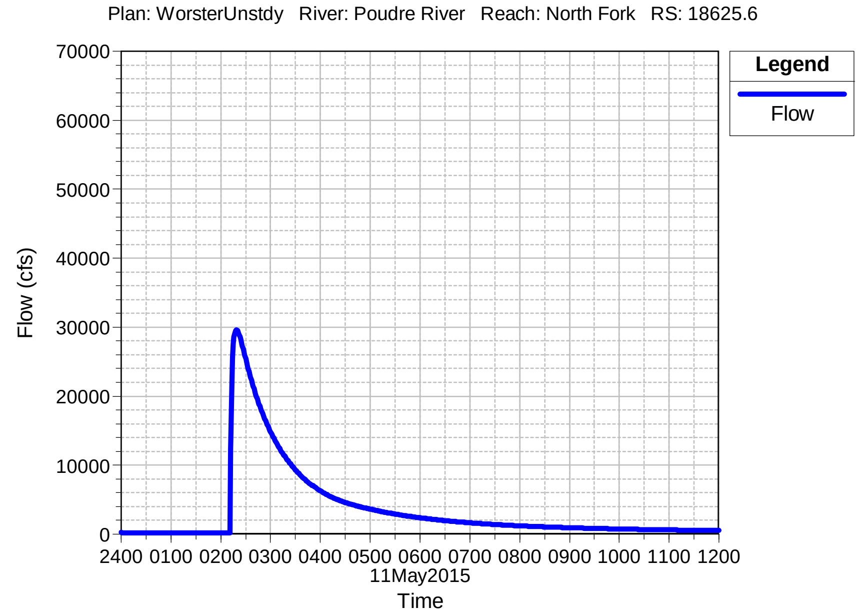
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 18625.6
Legend
Flow
Flow (cfs)
70000
60000
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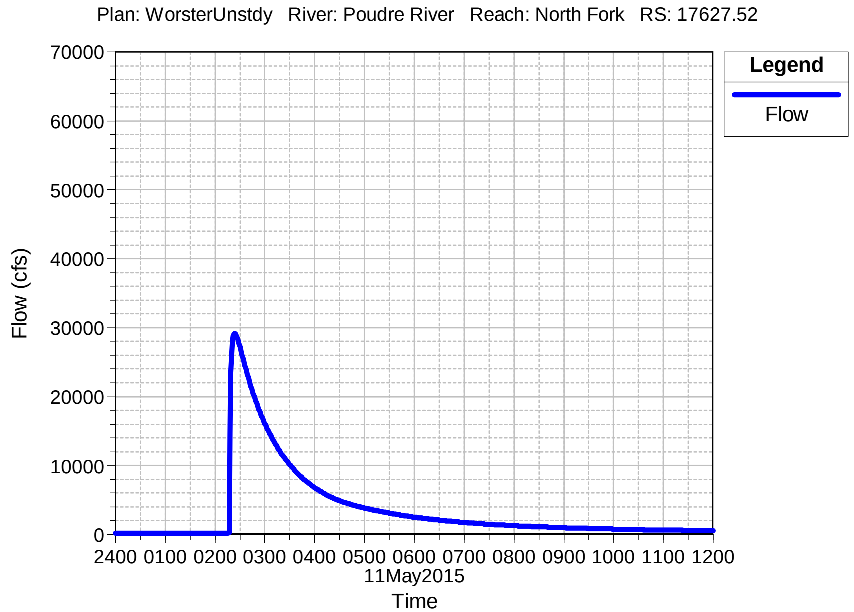
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 17627.52
Legend
Flow
Flow (cfs)
70000
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50000
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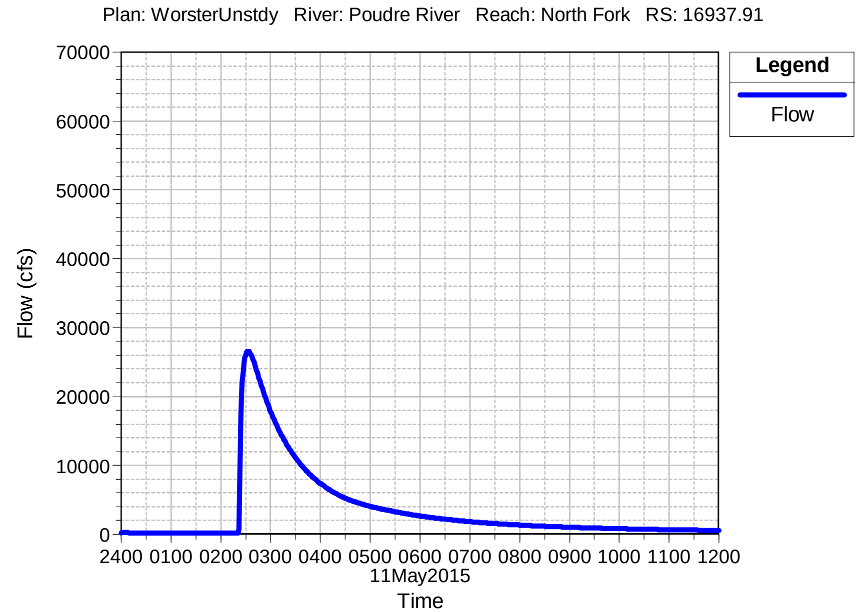
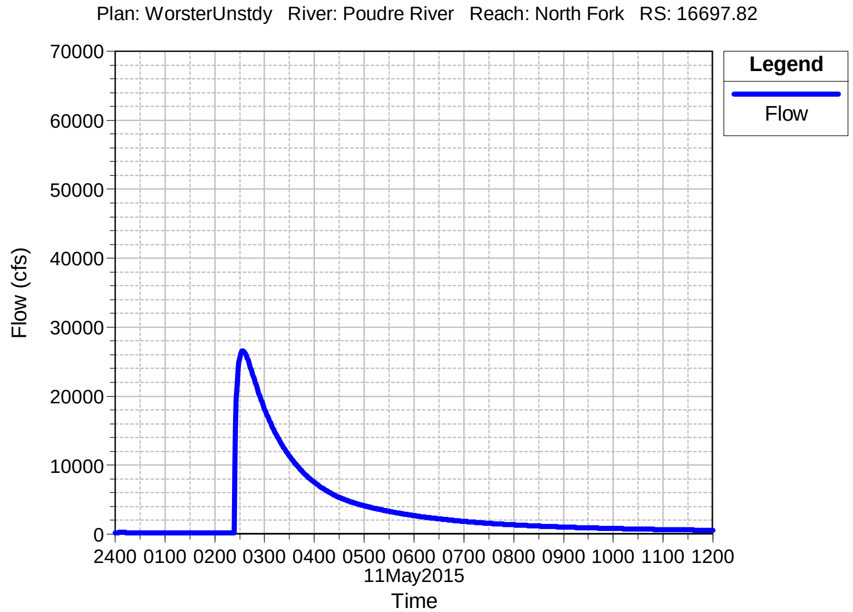
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 16937.91
Legend
Flow
Flow (cfs)
70000
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 16697.82
Legend
Flow
Flow (cfs)
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50000
40000
30000
20000
10000
0
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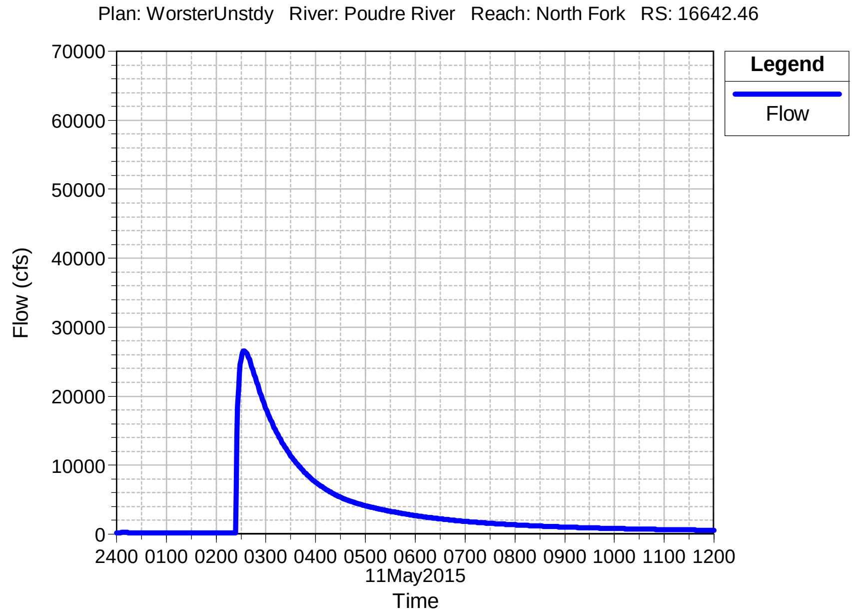
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 16642.46
Legend
Flow
Flow (cfs)
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50000
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30000
20000
10000
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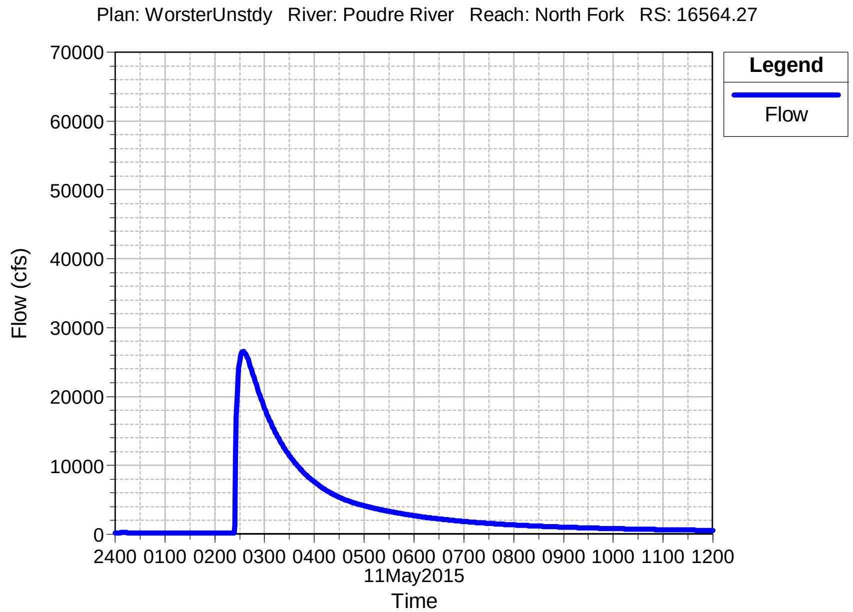
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 16564.27
Legend
Flow
Flow (cfs)
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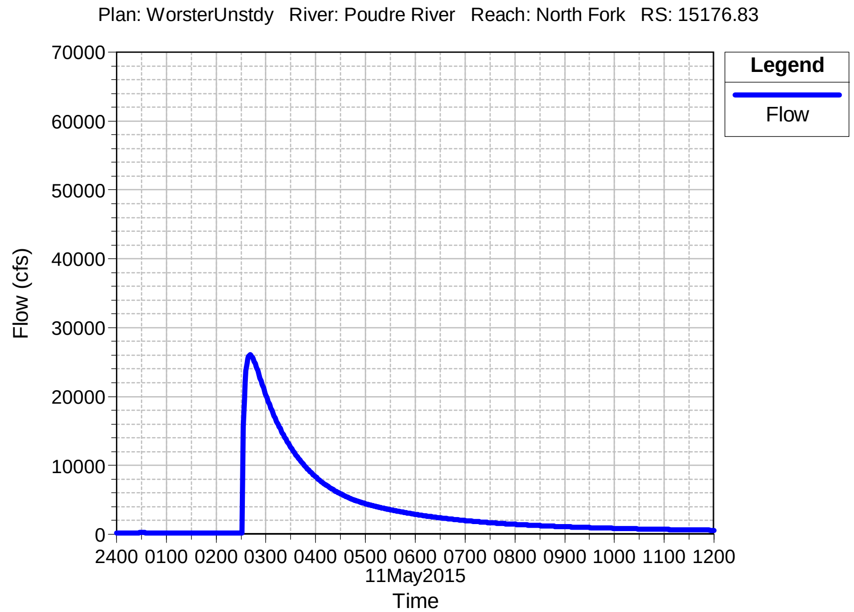
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 15176.83
Legend
Flow
Flow (cfs)
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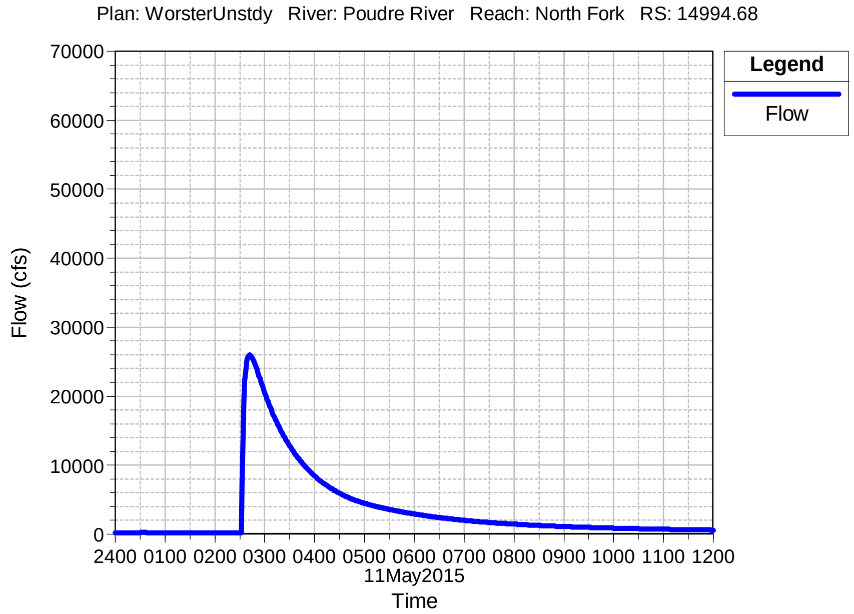
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 14994.68
Legend
Flow
Flow (cfs)
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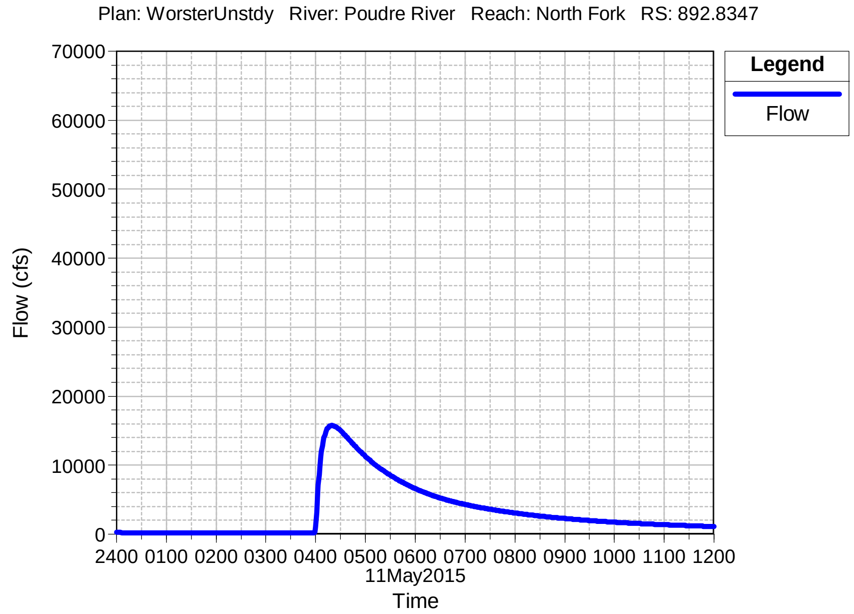
60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time


Plan: WorsterUnstdy River: Poudre River Reach: North Fork RS: 892.8347
Legend
Flow
Flow (cfs)
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60000
50000
40000
30000
20000
10000
0
2400 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200
11May2015
Time

APPENDIX E

SITE PHOTOS

Photo 1 – Structure near Critical Section 16697.8

Photo 2 – Structure at Critical Section 16937.9

Photo 3 – Structures at Critical Section 17627.5

Photo 4 – Structure at Critical Section 17627.5

Photo 5 – North Fork Cache La Poudre River near Critical Section 20600.9

Photo 6 – Structure at Critical Section 20955.1

Photo 7 – Structures at Critical Section 21004.7

Photo 8 – Snow-covered access road to Worster Dam