NVEnergy

REPORT

Periodic (5 Year) Hazard Potential Classification Assessment, Ponds M5 and M7, Reid Gardner Station

PREPARED FOR:	File
PREPARED BY:	NV Energy, Jacobs
DATE:	October 11, 2021

1.0 INTRODUCTION

This report documents the first five year (quinquennial) periodic review and update of the Hazard Classification Assessment for surface impoundments M5 and M7 at the Reid Gardner Station (Station) as required by the U.S. Environmental Protection Agency's Coal Combustion Residuals (CCR) Rule. This periodic assessment concluded that the initial 2016 assessment hazard potential classification of the Ponds M5 and M7 as "high hazard potential CCR surface impoundments" continues to meet the CCR Rule requirements.

1.1 Purpose and Scope

In accordance with §257.73(f)(3), Hazard Classification Assessment reviews and updates must be competed when conditions change or at 5-year intervals. This quinquennial review and update of the existing CCR surface impoundments M5 and M7 Hazard Classification Assessment included checking for changes in site conditions since the initial Hazard Class Assessment in 2016, conducting new calculations and modeling for a breach and inundation analysis, and development of an updated dam breach inundation map.

1.2 Site Description, Background and Pond Closure Initiation

The Station is located 50 miles northeast of Las Vegas, within the Moapa Valley and was formerly a coal-fired electric power generation facility that produced approximately 557 megawatts of power from four generating units. Units 1 through 3 were retired in 2014 and Unit 4 was retired in 2017. Station demolition was completed in 2020.

Ponds M5 and M7 are defined under §257.53 of the CCR Rule as existing CCR surface impoundments because the ponds received CCR both before and after October 19, 2015.

Ponds M5 and M7 are also permitted as dams by the Nevada Division of Water Resources (State Engineer). The National Inventory of Dam Number for Pond M5 is NV10779 and the Nevada State Identification Number is J-652. The National Inventory of Dam Number for Pond M7 is NV10780 and the Nevada State Identification Number is also J-652. Closure of Ponds M5 and M7 was initiated on April 7, 2021, when the influent piping was air-gapped and the influent pumping station decommissioned. Notification of Intent to Initiate Closure, as required under §257.101(a) and §257.102(g), was placed in the operating record on April 6, 2021, in accordance with

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§257.105(i)(7). Accordingly, Ponds M5 and M7 no longer receive any influent, are largely empty, and the residual pools of standing water are diminishing by evaporation.

2.0 REGULATORY OVERVIEW

The CCR Rule was published in the Federal Register on April 17, 2015, and became effective on October 19, 2015. The CCR Rule regulates the disposal of CCR as solid waste in landfills, surface impoundments, and lateral expansions under Subtitle D of the Resource Conservation and Recovery Act. The CCR Rule sets forth minimum criteria for the structural integrity of CCR surface impoundments in §257.73.

Ponds M5 and M7 are subject to the structural integrity criteria in the CCR Rule because the ponds are considered existing unlined CCR surface impoundments. A CCR surface impoundment is a "man-made excavation, or diked area, which is designed to hold an accumulation of CCR and liquids, and the unit, treats, stores, and disposes of CCR" (§257.53). Furthermore, they are classified as existing CCR surface impoundments under the CCR Rule because they received CCR both before and after October 19, 2015. As a result, both ponds must comply with the CCR Rule and more specifically the structural integrity criteria as required by §257.73.

Per §257.73(a) and §257.73(a)(2) of the CCR Rule, a hazard potential classification assessment must be conducted for all existing CCR surface impoundments, except for incised impoundments. Ponds M5 and M7 do not qualify as an incised CCR surface impoundment, as defined in §257.53, because they were not "constructed by excavating entirely below the natural ground surface."

The CCR Rule defines a hazard potential classification as "the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the diked CCR surface impoundment or mis-operation of the diked CCR surface impoundment or its appurtenances" (§257.53). The different hazard potential classifications listed in Section 257.73(a)(2)(i) are defined in §257.53 and listed in the following paragraphs:

- "Low hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment owner's property."
- "Significant hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns."
- "High hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation will probably cause loss of human life."

The initial hazard potential classification assessment was completed and placed in the Station's operating record on October 12, 2016, in accordance with §257.73(f)(1) and §257.105(f)(5). Within 30 days of placement, the State Director was notified as required by §257.106(d) and §257.106(f)(4), and the assessment was placed on a publicly accessible internet site per §257.107(d) and §257.107(f)(4).

Periodic hazard potential classification assessments are required to be completed and placed in the operating record every 5 years from the date that the initial assessment was placed into the operating record (§257.73(f)(3) and §257.105(f)(5)). Accordingly, this updated Hazard Classification Assessment must be placed in the operating record by October 12, 2021, and within

30 days of placing in the operating record, the required notifications to the State Director (§257.106(d) and §257.106(f)(4)) and placement of the update plan on the publicly accessible internet site must also be completed (§257.107(d) and §257.107(f)(4)). The initial and periodic hazard potential classification assessments must be certified by a qualified professional engineer (§257.73(a)(2)(ii)). ”

3.0 INITIAL HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

The initial 2016 Hazard Assessment (CH2M, 2016) classified Ponds M5 and M7 as “High” hazard potential dams, primarily due to the existence of residences and structures in the downstream floodplain that would be created by a potential dam failure. The CH2M initial 2016 Hazard Assessment Ponds M5 and M7 breach inundation maps and HEC-RAS analysis are included in Attachment 1.

Although Ponds M5 and M7 are designated as “High” hazard under the CCR Rule (§257.53), they are registered as “Significant” hazard dams by the Nevada Division of Water Resources (State Engineer). As part of the permitting process, the State Engineer assigned a hazard classification rating of “Significant” to ponds M5 and M7, in accordance with Nevada Administrative Code (NAC) 535.140, as determined by a review attached to the initial Emergency Action Plan (EAP) and developed by Stanley Consultants (Stanley 2010). Per NAC 535.140, a dam will be classified as a “significant hazard if failure of the dam carries a: (1) Reasonable probability of causing a loss of human life; or (2) High probability of causing extensive economic loss or disruption in a lifeline.

The inundation map and technical memo from the 2010 Stanley EAP has been included in Attachment 2. The EAP itself was subsequently revised as required by §257.73(a)(3) (Jacobs, 2021c).

4.0 REVIEW OF HAZARD POTENTIAL CLASSIFICATION

A review of current topography confirms the available storage volume in each of the ponds has not changed from the amounts described in the 2016 Hazard Assessment. Pond M5 can hold 260.17 acre-feet at the embankment crest. Pond M7 can hold 264.34 acre-feet.

Similar to the assessment done in 2016, Pond M5 was chosen for analysis in this 2021 assessment because it has a more direct path to the Muddy River based on downstream topography. Additionally, it is expected that modeling the failure of Pond M7 would produce an inundation area that is nearly identical to the one produced by failure of Pond M5. As a result, it is expected that the impact of failure on downstream areas would be the same for Ponds M5 and M7.

For this assessment, it was conservatively assumed that the water surface elevation in Pond M5 reached the top of the embankment before flowing over the crest or breaching the embankment. Modeling the breach flood as an overtopping of the embankment crest is conservative compared to applying the maximum storage pool or maximum surcharge loading conditions used in the Safety Factor Assessment (Jacobs 2021d), as those conditions have some freeboard inside the embankment. Because closure of these impoundments was initiated in April 2021 (Jacobs 2021a, 2021b) the current liquid level inside both impoundments is considerably lower than maximum storage pool, with approximately 18 feet of freeboard. The assumption used for the breach flood corresponds to a water surface elevation of approximately 1,720 feet and a water volume of approximately 260.17 acre-feet as shown on the Record Drawings (CH2M HILL, 2011). The size of the breach created by water flowing over the crest was estimated using the Froehlich 2008 Method. The detailed calculation for the breach size is provided in Attachment 3.

The analysis limits in this study extend from the upstream limits, defined as the subject Pond M5 embankment, to the downstream limits defined as the Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (SFHA) boundary for the Muddy River. It is common practice that an emergency dam breach analysis terminates at the next viable FEMA SFHA in the downstream watercourse because the property owners are aware and required to carry flood insurance in case of a major flood event. Additionally, based on the previous dam breach analysis in the EAP (Stanley, 2010) and the Initial Hazard Assessment (CH2M, 2016), the unsteady flood wave dissipates to a 100-year flow rate significantly less than the FIS base flood elevations within the SFHA. Therefore, the use of the SFHA boundary downstream of the breach analysis is considered acceptable.

Using the US Army Corps of Engineers HEC-RAS Version 5.0.7 software, a conservative hydraulic analysis was prepared for this assessment by analyzing a steady state flow condition with the maximum flow from the breach computed as 7,506 cubic feet per second conveyed through the watercourse to the SFHA. The boundary conditions were set as critical depth at the upstream boundary due to breaching water at the discharge point, and normal depth at the downstream boundary in the Muddy River. The manning's roughness for the watercourse of cavernous washes has been selected as 0.08 to represent the sluggish, weedy, deep pools, similar to the 2016 analysis.

Ponds M5 and M7 are located on top of a plateau, approximately 150 vertical feet above the Muddy River floodplain. The downstream inundation resulting from a breach of the embankment or overtopping of the embankment of Ponds M5 and M7 migrates through well incised cavernous washes in a northerly direction and then turns east into a Zone 'AE' with Floodway SFHA that encumbers the Muddy River floodplain, per Flood Insurance Rate Map (FIRM) Panels 32003C0670E and 32003C0690E dated September 27, 2002. Figure 1 included in Attachment 4 displays the SFHA from the FEMA FIRM panels along with the breach inundation boundary that extends from the Ponds to the Muddy River floodplain. The inundation boundary is shown by extent of the flood water surface elevation lines

The land downstream of Ponds M5 and M7 was examined to understand the potential effects of the downstream inundation in case of a potential embankment failure. The Clark County Assessor's site, aerial photography and a site visit were utilized to understand the conditions of the downstream property and if any habitable structures are present in the watercourse. Based on this review, it was determined that the dam breach travels a watercourse that includes washes on an undeveloped private property and into the Muddy River floodplain that is encumbered by a FEMA designated SFHA that is generally used for agriculture. There are a few structures (of which one is assumed to be habitable) located near the discharge point from the washes located downstream of the two ponds, as well as a rural roadway that acts as primary access to the area from Interstate 15. As the dam breach material and excess flow travels downstream in the Muddy River and SFHA, it is expected the impacts will lessen due to flood wave dissipation and the conditions of the Muddy River such as lateral inflows, abstractions, etc. approaching State Route 168 and Interstate 15. The M5 and M7 Pond Breach Inundation Map (Attachment 4) is used as reference for the potential impacts of an emergency scenario.

5.0 CONCLUSION AND RECOMMENDATION

Similar to 2016, the evaluation of the appropriate hazard potential classification includes a stepwise consideration of each hazard classification. The stepwise consideration is repeated in the following paragraphs along with a discussion of their relevance to Ponds M5 and M7.

- A low hazard potential classification is appropriate for CCR surface impoundments where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses (§257.53). Due to the potential agricultural impacts that salt and sediment laden flow resulting from a breach and drainage of the impoundments would produce along the Muddy River, a risk for environmental impacts is considered. Therefore, a low hazard potential classification is not appropriate for Ponds M5 and M7.
- A significant hazard potential classification is appropriate for CCR surface impoundments where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns (§257.53). As a result of the downstream road and residence structures observed in the Muddy River floodplain there may be a risk for human life. As a result, a significant hazard potential classification is not appropriate for Ponds M5 and M7.
- A high hazard potential classification is appropriate for CCR surface impoundments where failure or mis-operation will probably cause loss of human life (§257.53). The impacts that dam breach flooding would have on structures and a primary access road for the area from Interstate 15 in close proximity to the breach, results in an appropriate classification at this time of "high hazard" for Ponds M5 and M7.

Therefore, this 2021 quinquennial review of the Hazard Assessment results in the "high hazard" classification remaining for Ponds M5 and M7. Because the ponds are classified as a high hazard potential CCR surface impoundments, a written EAP is maintained in the operating records as required by §257.73(a)(3)(i) and §257.105(F)(6)). The most recent EAP revision was April 2021 (Jacobs, 2021c).

6.0 CERTIFICATION

This section of the assessment contains the certification by a qualified professional engineer as required by Section 257.73(a)(2)(ii) of the CCR Rule.

Stephen M. Jones, P.E.

Digitally signed by Stephen M. Jones, P.E.
DN: C=US, E=steve.jones1@jacobs.com, O=Jacobs, CN="Stephen M. Jones, P.E."
Date: 2021.10.12 08:55:36-07'00'

The originally certified document inadvertently included Adobe comment call-outs on one map attachment. After the certification above, the call-outs were removed. No other changes were made, as certified below.

Stephen M. Jones, P.E.

Digitally signed by Stephen M. Jones, P.E.
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Date: 2021.10.28 10:25:37-07'00'

7.0 REFERENCES

CH2M HILL, Inc. 2011. *Reid Gardner Station Drawings for Construction of Mesa Evaporation Ponds – M5 and M7. Record Drawings.* Schedule A. July.

CH2M HILL, Inc. 2016. *Initial Hazard Potential Classification Assessment for CCR Surface Impoundments Ponds M5 and M7, Reid Gardner Generating Station.* October 12.

Jacobs Engineering Group Inc. (Jacobs). 2021a. *Notification of Intent to Initiate Closure, Pond M5, Reid Gardner Generating Station.* April 5.

Jacobs Engineering Group Inc. (Jacobs). 2021b. *Notification of Intent to Initiate Closure, Pond M7, Reid Gardner Generating Station.* April 5.

Jacobs Engineering Group (Jacobs). 2021c. *Emergency Action Plan, Ponds M5 and M7, Reid Gardner Generating Station.* Revision 3. April.

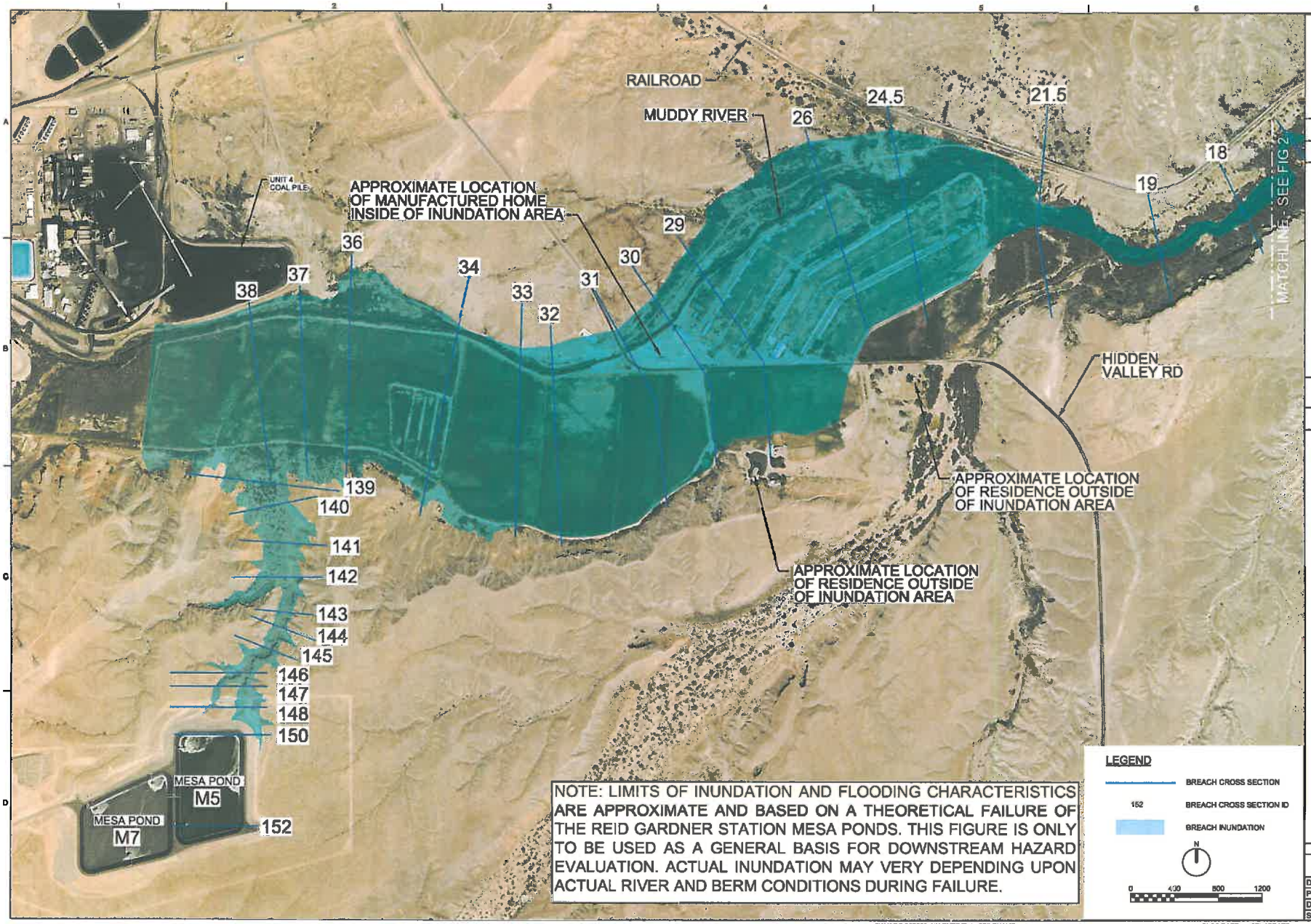
Jacobs Engineering Group Inc. (Jacobs). 2021d. *Quinquennial Safety Factor Assessment, Ponds M5 and M7, Reid Gardner Generating Station.* August 10.

8.0 LIST OF ATTACHMENTS

1. Previous Dam Breach Inundation Results – 2016 Analysis
2. Previous Dam Breach Inundation Results – 2010 Analysis
3. Dam Breach HEC-RAS Calculations – 2021 Analysis
4. Revised Dam Breach Inundation Map – 2021 Analysis

Attachment 1
Dam Breach Inundation Results – 2016 Analysis

Inundation Map – 2016



NO.	DATE	REVISION	BY	APVD
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ch2m:

RGS

REID GARDNER STATION
Moapa, Nevada

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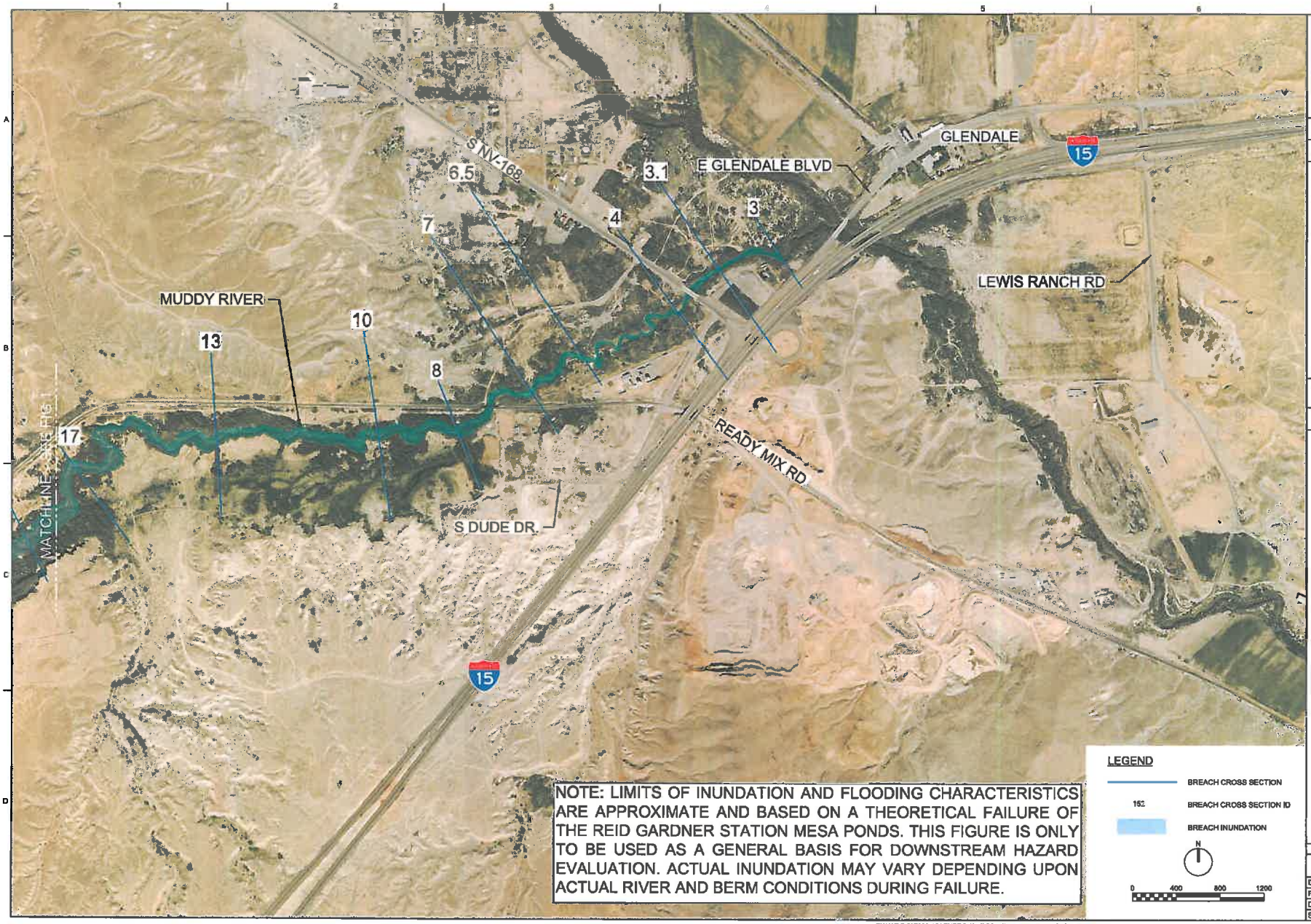
M5M7 BREACH INUNDATION MAP

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	OCT 2016
PROJ	671058
DWG	FIG 4
SHEET	1 OF 2

PW-WBG:387230_NV ENERGY\ $FILENAME
PLOT DATE: $PLOTDATE
PLOT TIME: $PLOTTIME



NOTE: LIMITS OF INUNDATION AND FLOODING CHARACTERISTICS ARE APPROXIMATE AND BASED ON A THEORETICAL FAILURE OF THE REID GARDNER STATION MESA PONDS. THIS FIGURE IS ONLY TO BE USED AS A GENERAL BASIS FOR DOWNSTREAM HAZARD EVALUATION. ACTUAL INUNDATION MAY VARY DEPENDING UPON ACTUAL RIVER AND BERM CONDITIONS DURING FAILURE.

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M5M7 BREACH INUNDATION MAP

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

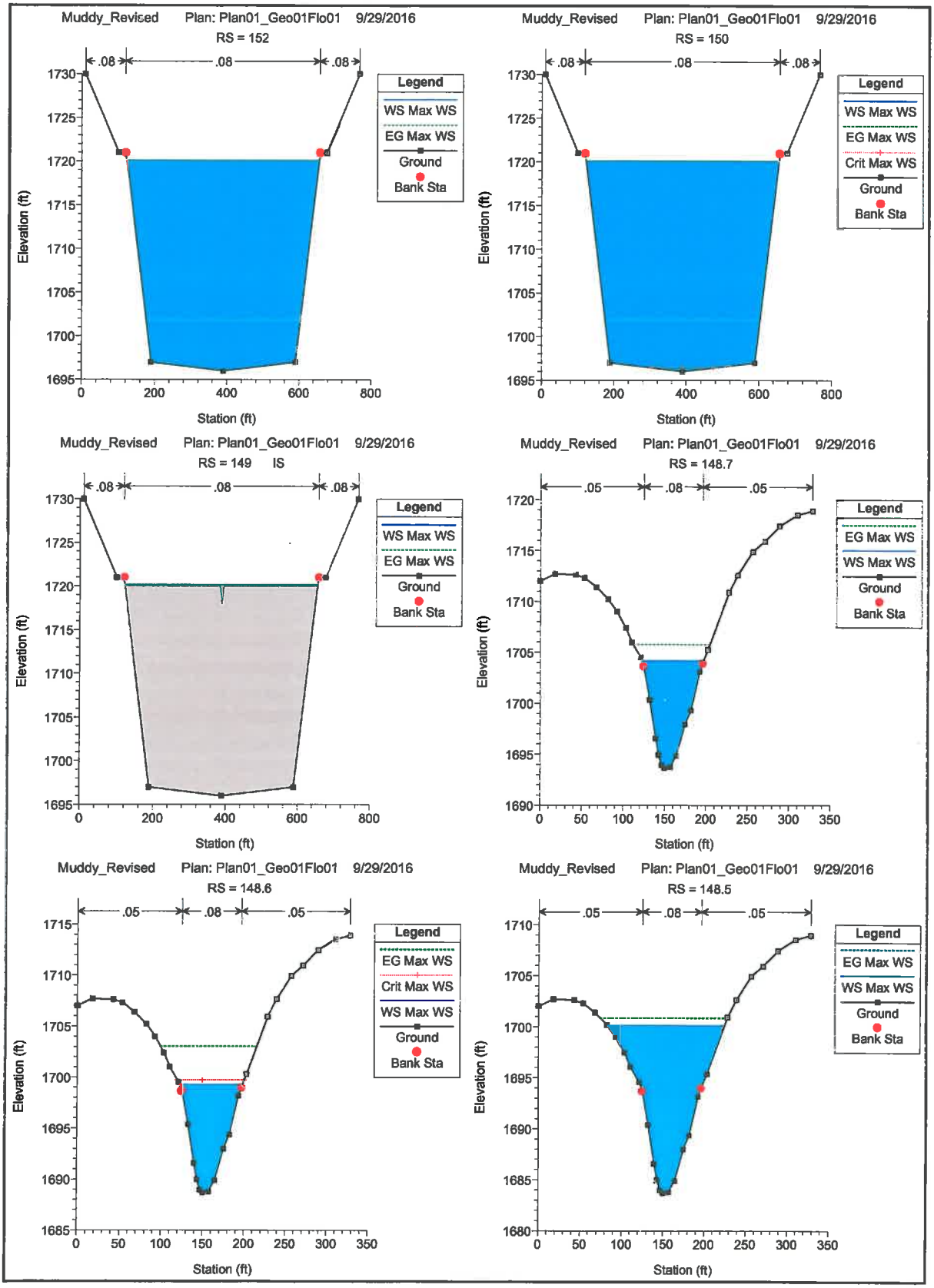
DATE	OCT 2016
PROJ	671059
DWG	FIG 2
SHEET	2 OF 2

PW-WBG:387230_NV ENERGY \ RGS_M5M7_Breach_Analysis2_670439.dgn PLOT DATE: 2016\10\07 PLOT TIME: 10:27:11 AM

HEC-RAS Analysis Table and Sections - 2016

HEC-RAS Plan: Plan01 River: RIVER-1 Reach: Reach-1 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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	152	Max WS	100.00	1696.00	1720.13		1720.13	0.000000	0.01	10989.60	532.99	0.00
Reach-1	150	Max WS	99.97	1696.00	1720.13	1696.43	1720.13	0.000000	0.01	10989.60	532.99	0.00
Reach-1	149		Inl Struct									
Reach-1	148.7	Max WS	4619.34	1693.60	1704.16		1705.71	0.025691	10.01	462.24	74.84	0.69
Reach-1	148.6	Max WS	7267.19	1688.60	1699.22	1699.63	1702.99	0.061454	15.58	467.20	75.44	1.07
Reach-1	148.5	Max WS	7281.66	1683.60	1700.06		1700.79	0.005531	7.15	1094.11	141.23	0.36
Reach-1	148.3	Max WS	7253.21	1678.60	1686.19	1689.62	1697.42	0.281209	26.90	269.67	57.14	2.18
Reach-1	148	Max WS	7264.54	1673.60	1683.73	1684.63	1688.14	0.078514	16.84	431.39	71.08	1.20
Reach-1	147	Max WS	7055.68	1667.10	1678.46		1679.28	0.009812	7.24	974.46	120.69	0.45
Reach-1	146	Max WS	7279.86	1657.40	1669.26	1670.38	1673.29	0.089961	16.13	451.42	86.91	1.25
Reach-1	145	Max WS	7265.51	1626.50	1636.62	1639.24	1645.17	0.153370	23.47	309.62	47.11	1.61
Reach-1	144	Max WS	7253.56	1611.70	1621.87		1624.81	0.047114	13.77	526.64	77.63	0.93
Reach-1	143	Max WS	7215.02	1604.20	1615.97		1617.34	0.017628	9.41	766.90	97.41	0.59
Reach-1	142	Max WS	7198.49	1593.70	1601.24	1601.22	1603.83	0.055818	12.90	557.81	107.82	1.00
Reach-1	141	Max WS	7172.30	1583.10	1587.60		1588.59	0.033342	7.96	900.56	249.02	0.74
Reach-1	140	Max WS	7149.76	1575.20	1579.02		1579.52	0.019731	5.85	1266.47	397.22	0.56
Reach-1	139	Max WS	6401.65	1569.70	1575.15		1575.21	0.001494	2.04	3297.15	971.85	0.16
Reach-1	38	Max WS	6486.53	1561.36	1572.47		1572.57	0.002553	3.46	2840.01	1555.55	0.23
Reach-1	37	Max WS	6331.11	1559.89	1570.31		1570.58	0.006179	5.38	1838.92	1201.56	0.35
Reach-1	36.5	Max WS	5401.49	1559.35	1569.50		1569.56	0.002155	2.76	2754.55	1620.31	0.20
Reach-1	36	Max WS	4658.66	1558.80	1569.21		1569.24	0.000694	2.01	3478.99	1625.92	0.12
Reach-1	35	Max WS	4383.93	1557.60	1568.75		1568.82	0.001098	2.43	2181.28	793.65	0.15
Reach-1	34.5	Max WS	4326.19	1557.17	1568.29		1568.34	0.000910	2.18	2363.47	753.76	0.14
Reach-1	34	Max WS	4304.32	1556.58	1566.83		1567.18	0.009020	5.92	969.79	479.50	0.41
Reach-1	33	Max WS	4261.23	1554.70	1563.63		1563.83	0.005133	4.86	1519.21	1245.46	0.32
Reach-1	32.5	Max WS	4242.15	1553.20	1562.20		1562.45	0.007946	5.26	1348.39	1250.12	0.38
Reach-1	32	Max WS	4136.85	1551.92	1561.00		1561.12	0.003716	3.71	1848.89	1509.84	0.26
Reach-1	31	Max WS	3997.44	1550.90	1559.27		1559.38	0.003618	3.51	1635.76	1097.85	0.28
Reach-1	30	Max WS	3960.42	1549.89	1557.85		1557.94	0.002363	3.19	1862.60	1111.41	0.25
Reach-1	29	Max WS	3904.52	1548.90	1556.19		1556.33	0.004336	3.50	1473.36	1005.26	0.35
Reach-1	28	Max WS	3889.44	1547.89	1554.55		1554.63	0.002614	2.86	1843.37	1108.51	0.22
Reach-1	27	Max WS	3352.05	1546.89	1553.34		1553.38	0.001758	1.93	2060.29	1261.22	0.17
Reach-1	26	Max WS	3141.53	1545.80	1552.79		1552.81	0.000607	1.26	2787.03	1335.26	0.10
Reach-1	25.5	Max WS	3124.90	1545.25	1552.49		1552.53	0.001616	1.46	1954.04	1314.98	0.16
Reach-1	25	Max WS	3120.37	1544.80	1552.09		1552.15	0.002219	1.84	1641.10	998.02	0.18
Reach-1	24.5	Max WS	3104.58	1544.30	1551.10		1551.22	0.005623	2.89	1123.05	777.69	0.29
Reach-1	24	Max WS	3068.83	1543.33	1550.18		1550.27	0.003234	3.16	1396.59	975.68	0.24
Reach-1	23	Max WS	3022.79	1539.12	1548.55		1548.74	0.003123	3.91	930.40	419.45	0.25
Reach-1	22	Max WS	3017.99	1536.17	1546.23		1546.56	0.006242	4.51	654.33	115.52	0.34
Reach-1	21.5	Max WS	2956.89	1532.90	1542.80		1543.16	0.009368	4.79	616.84	139.75	0.40
Reach-1	21	Max WS	2805.13	1531.49	1541.40		1541.52	0.002123	2.76	1017.02	173.90	0.20
Reach-1	20	Max WS	2627.09	1527.60	1540.06		1540.15	0.001159	2.31	1139.73	162.95	0.15
Reach-1	19	Max WS	2528.53	1525.85	1538.84		1539.04	0.002498	3.52	717.60	92.20	0.22
Reach-1	18	Max WS	2493.78	1524.10	1538.09		1538.14	0.000517	1.77	1407.43	159.13	0.10
Reach-1	17	Max WS	2490.09	1522.80	1537.41		1537.51	0.000983	2.52	1005.38	133.48	0.15
Reach-1	16	Max WS	2484.37	1521.89	1536.81		1536.90	0.000894	2.37	1059.58	144.77	0.14
Reach-1	15	Max WS	2445.46	1520.46	1531.83		1532.29	0.007233	5.47	447.22	64.98	0.37
Reach-1	14	Max WS	2333.84	1517.78	1529.27		1529.36	0.001021	2.39	976.32	115.52	0.14
Reach-1	13	Max WS	2307.73	1514.10	1528.53		1528.65	0.001388	2.85	814.45	111.69	0.17
Reach-1	12	Max WS	2298.80	1511.61	1528.07		1528.14	0.000671	2.01	1141.28	125.55	0.12
Reach-1	11	Max WS	2283.30	1510.70	1526.10		1526.42	0.005333	4.55	501.59	71.81	0.30
Reach-1	10	Max WS	2267.16	1509.83	1524.38		1524.49	0.001278	2.69	842.62	96.21	0.16
Reach-1	9	Max WS	2256.11	1508.89	1523.01		1523.23	0.002774	3.75	601.79	74.49	0.23
Reach-1	8	Max WS	2210.61	1508.38	1521.41		1521.78	0.005756	4.90	469.35	97.44	0.33
Reach-1	7.2	Max WS	2184.17	1507.81	1520.55	1513.23	1520.65	0.001438	2.52	866.94	124.73	0.17
Reach-1	7.15		Bridge									
Reach-1	7.1	Max WS	2182.10	1507.69	1520.43		1520.53	0.001580	2.58	846.89	127.05	0.18
Reach-1	7	Max WS	2152.70	1506.15	1519.44		1519.61	0.002123	3.35	641.86	74.69	0.20
Reach-1	6.5	Max WS	2097.01	1505.32	1518.16		1518.57	0.005952	5.11	410.15	52.63	0.32
Reach-1	6	Max WS	2059.00	1504.27	1517.36		1517.39	0.000337	1.34	1541.76	195.63	0.08
Reach-1	5	Max WS	2047.79	1503.14	1516.80		1516.88	0.001055	2.34	873.67	110.29	0.15
Reach-1	4	Max WS	2037.26	1502.33	1515.22		1515.43	0.003270	3.67	554.98	82.37	0.25
Reach-1	3.2	Max WS	2035.65	1502.10	1514.83	1508.15	1514.97	0.001744	2.98	683.23	86.15	0.19
Reach-1	3.15		Bridge									
Reach-1	3.1	Max WS	2034.25	1501.30	1514.23		1514.39	0.002243	3.23	629.78	84.72	0.21
Reach-1	3	Max WS	2030.16	1501.67	1513.48		1513.67	0.002812	3.49	581.23	83.11	0.23
Reach-1	2	Max WS	2026.07	1500.90	1512.36		1512.46	0.001574	2.55	795.31	121.43	0.18
Reach-1	1	Max WS	2024.97	1500.25	1508.22		1508.72	0.011721	5.72	354.20	71.41	0.45
Reach-1	0.5	Max WS	2024.72	1499.87	1506.90	1503.84	1507.18	0.002422	4.29	471.51	91.79	0.33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Ground
Bank Sta
Elevation (ft)
Station (ft)
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RS = 150
.08 .08 .08
Legend
WS Max WS
EG Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
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RS = 149 IS
.08 .08 .08
Legend
WS Max WS
EG Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 148.7
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 148.6
.05 .08 .05
Legend
EG Max WS
Crit Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 148.5
.05 .08 .05
Legend
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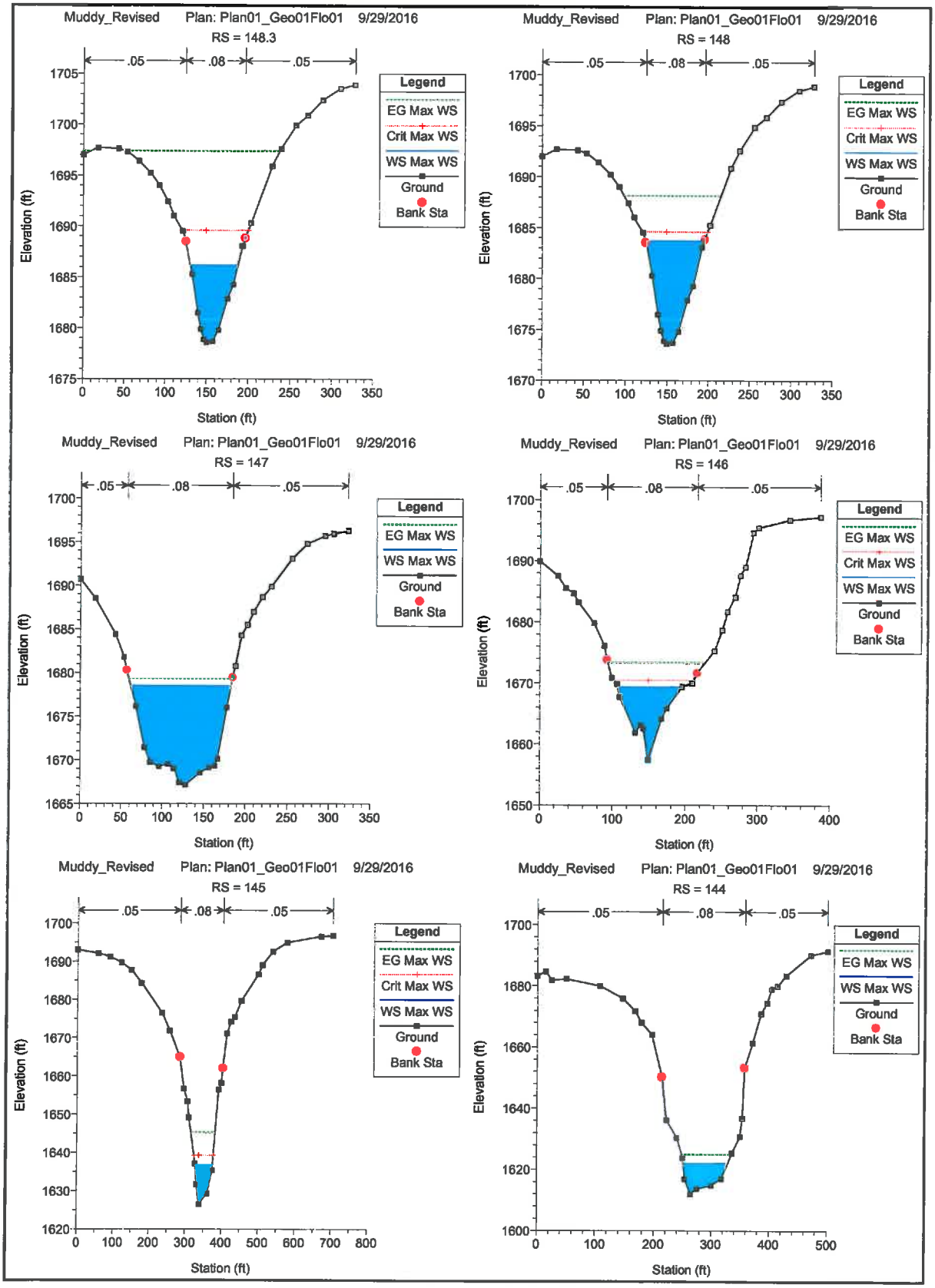
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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.05 .08 .05
Legend
EG Max WS
Crit Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
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RS = 148
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 147
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
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RS = 145
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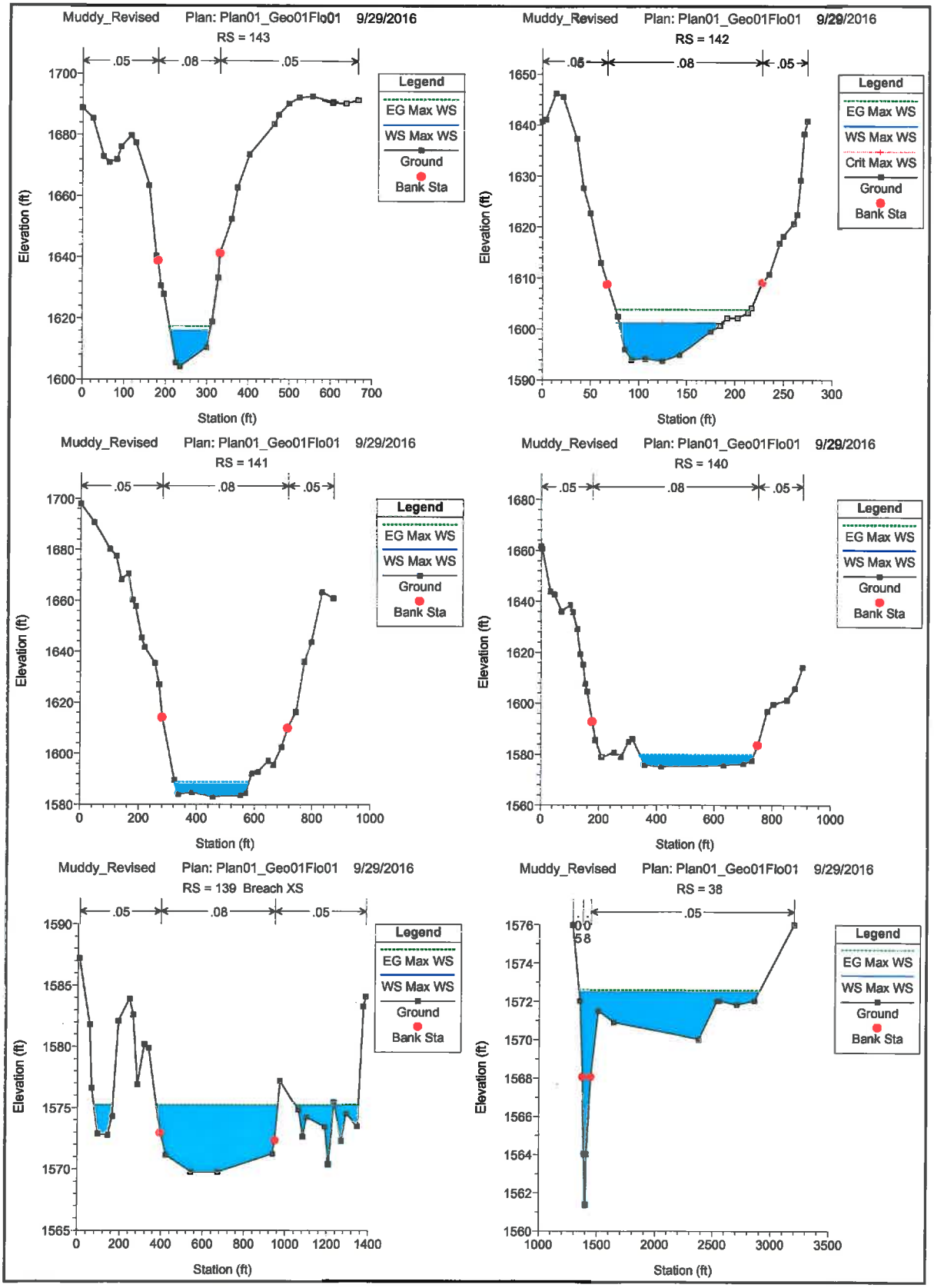
RS = 144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.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
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RS = 142
.05 .08 .05
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 141
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 140
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 139 Breach XS
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 38
.05
Legend
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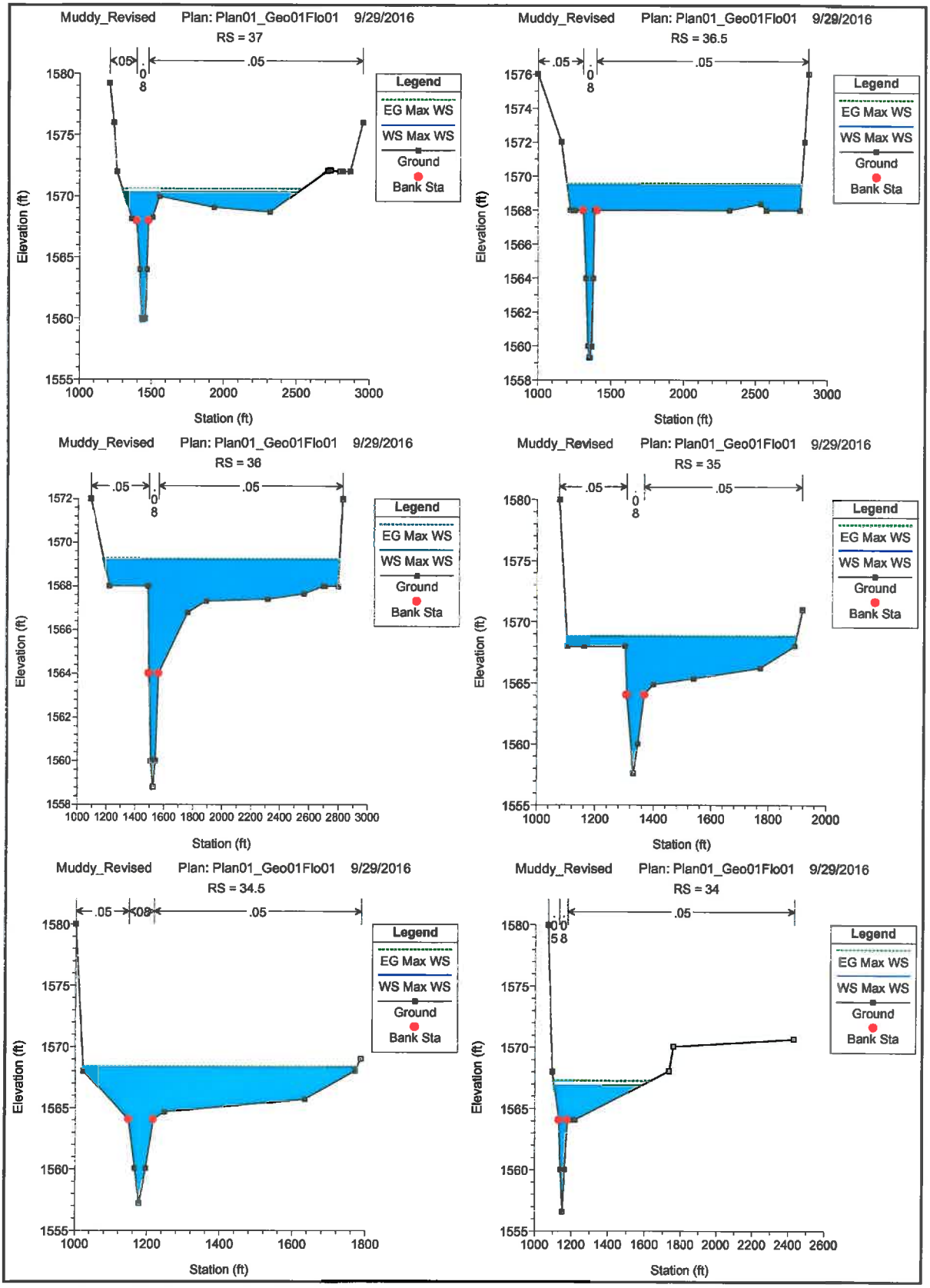
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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.05
.08
.05
Legend
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WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 36.5
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 36
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 35
.05
.08
.05
Legend
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WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 34.5
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
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.05
.05
.08
Legend
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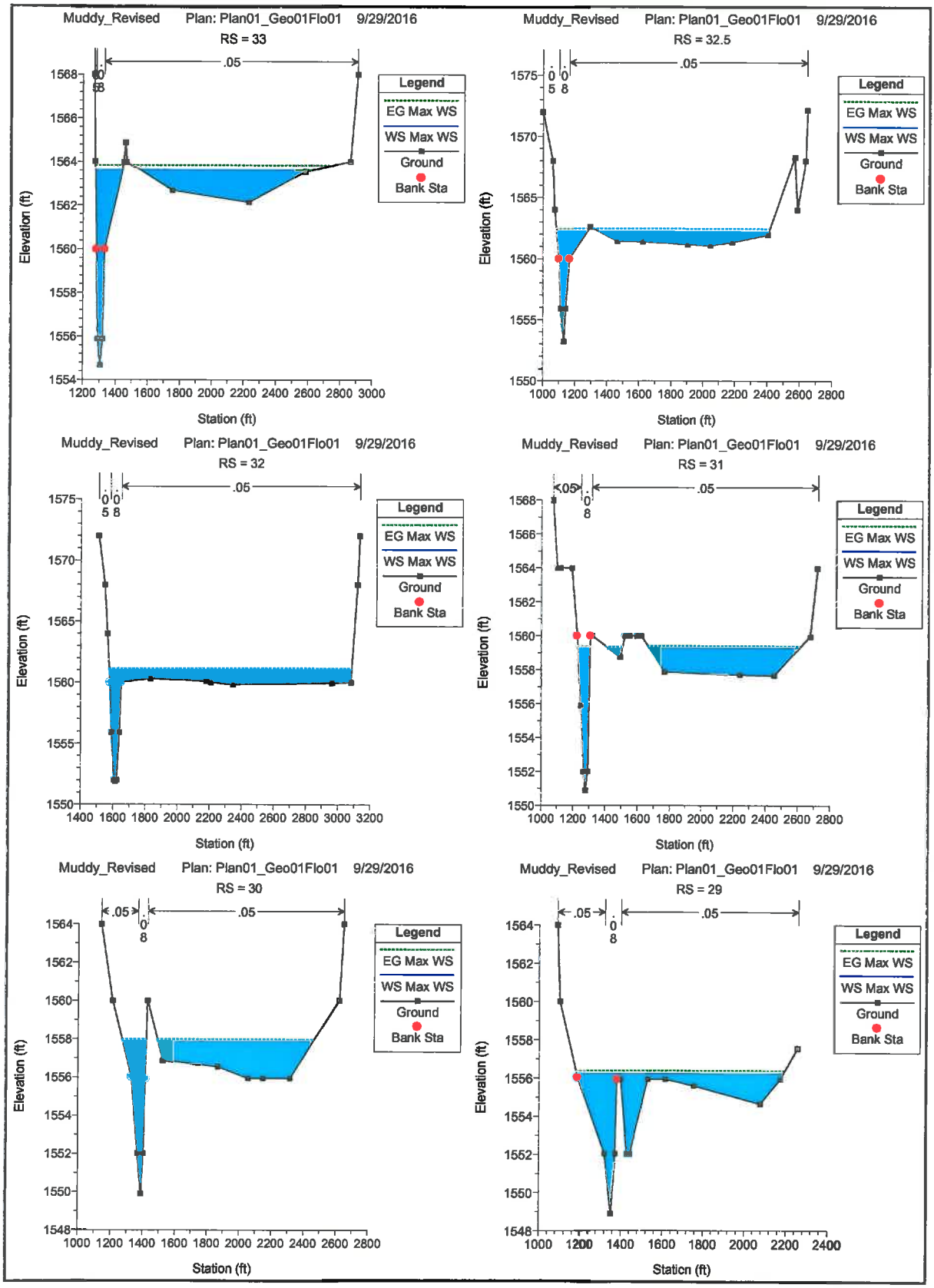
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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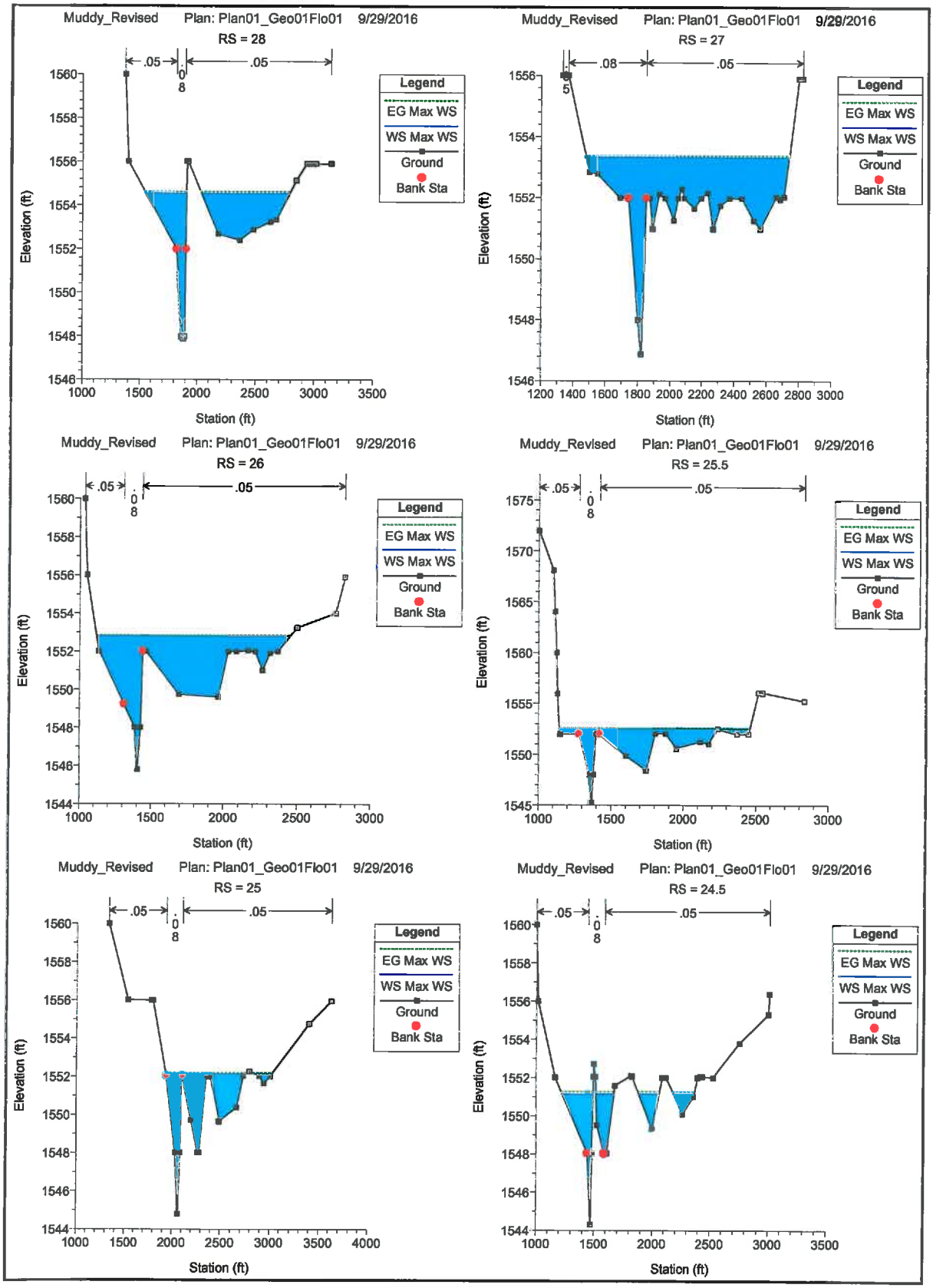
RS = 33
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 32.5
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 32
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 31
.05
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 30
.05
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 29
.05
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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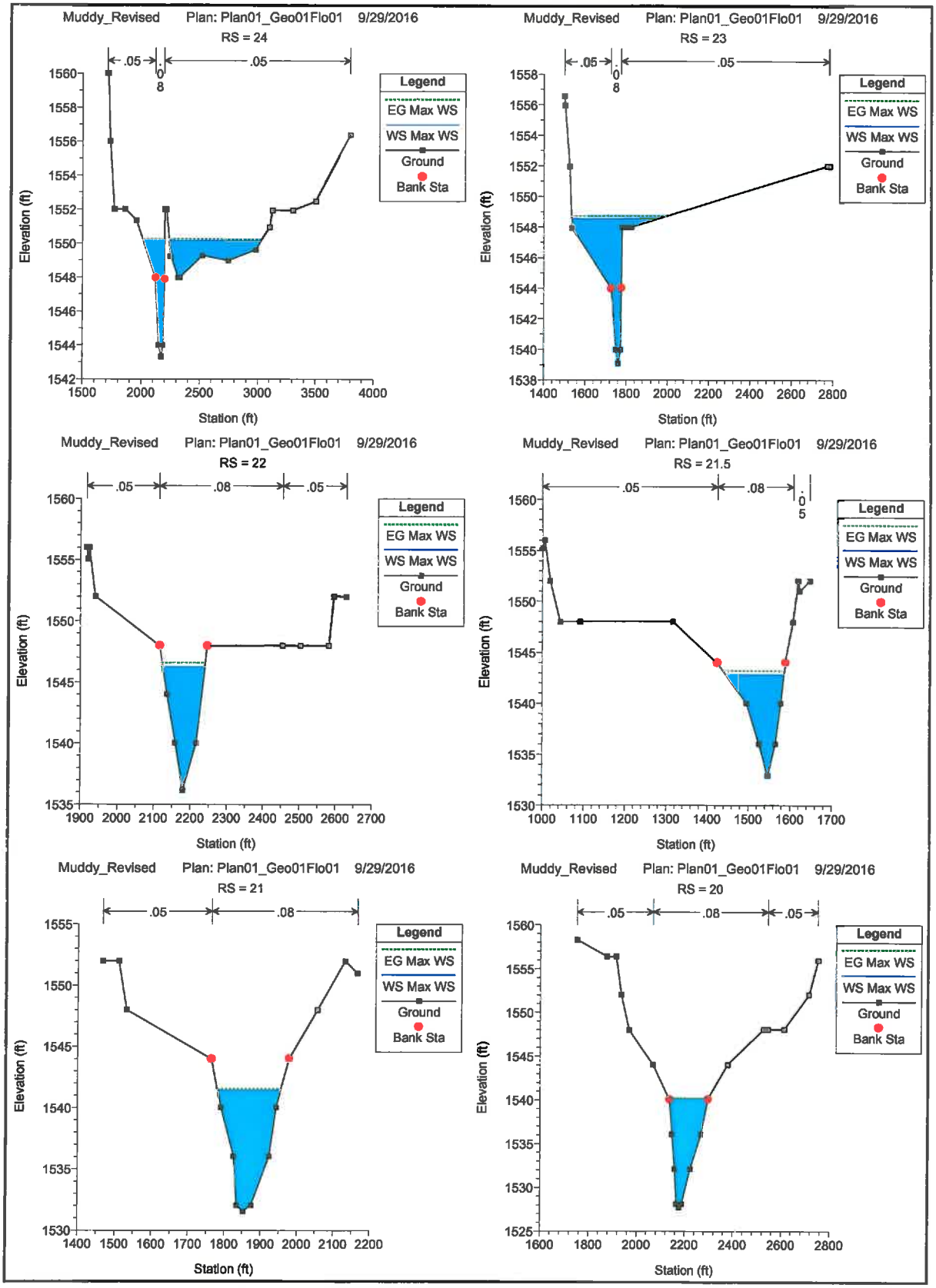
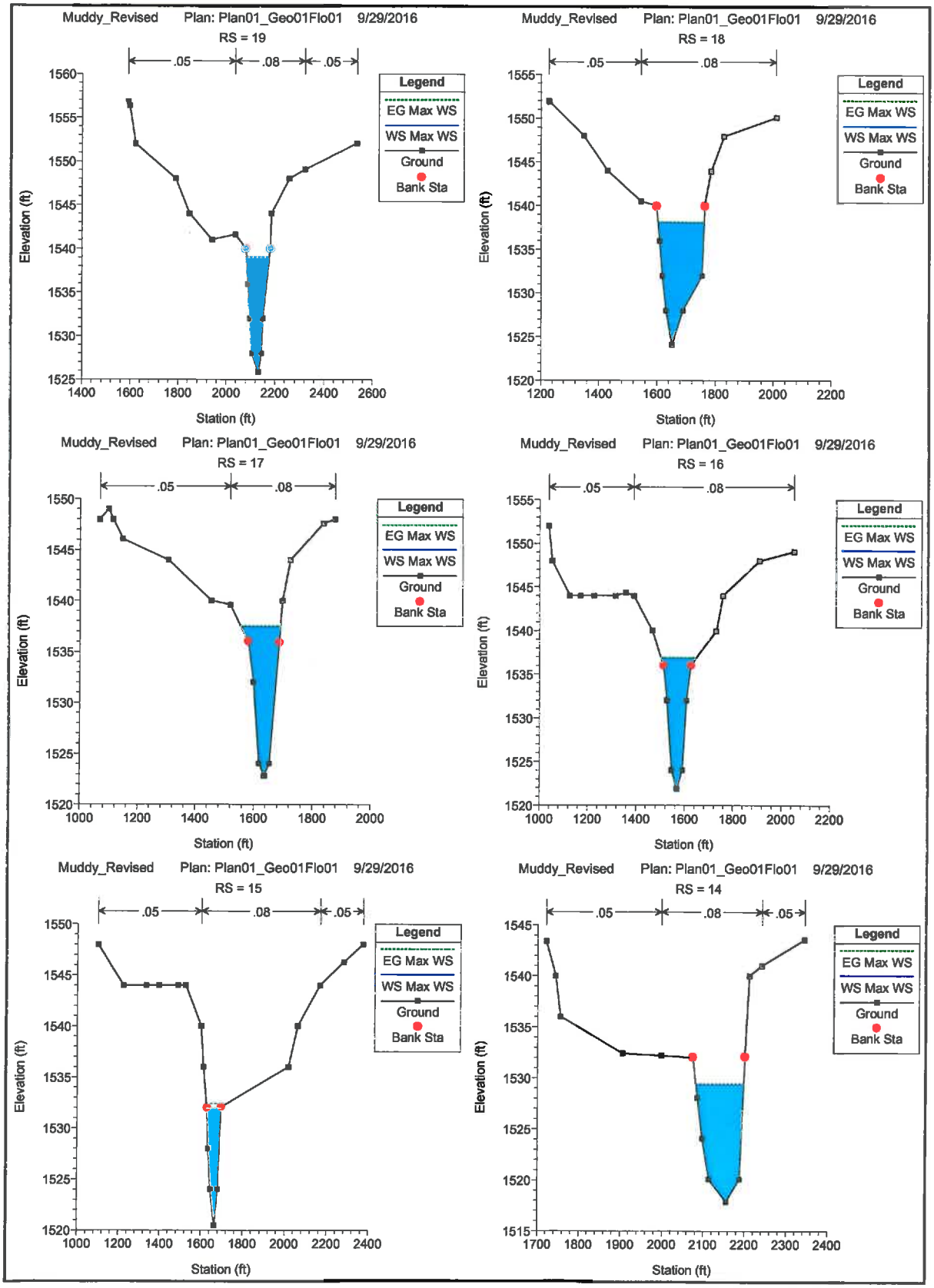
RS = 28
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 27
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 26
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 25.5
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 25
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 24.5
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 24
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 23
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 22
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 21.5
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 21
.05
.08
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 20
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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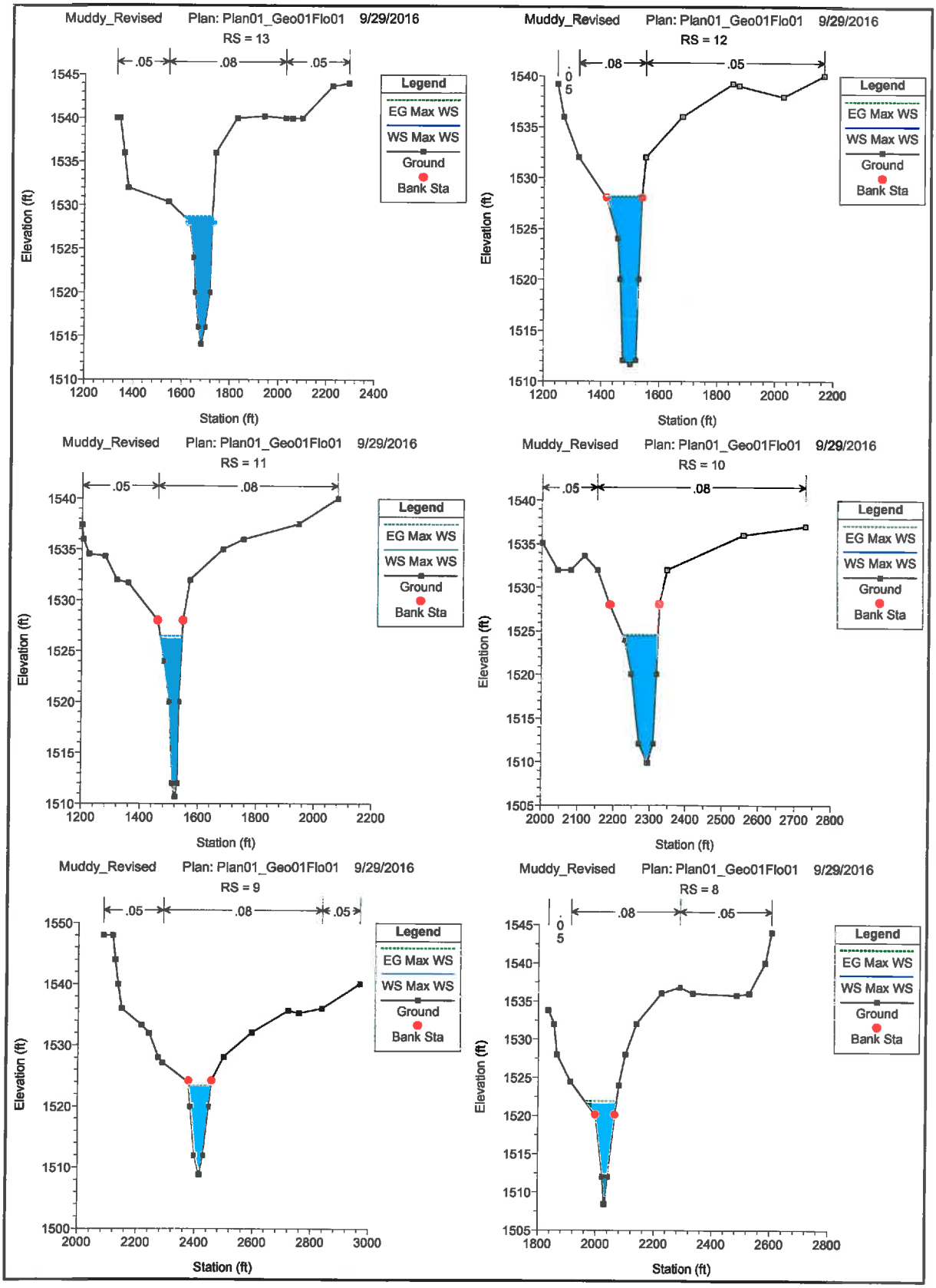
RS = 19
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 18
.05 .08
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 17
.05 .08
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 16
.05 .08
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 15
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 14
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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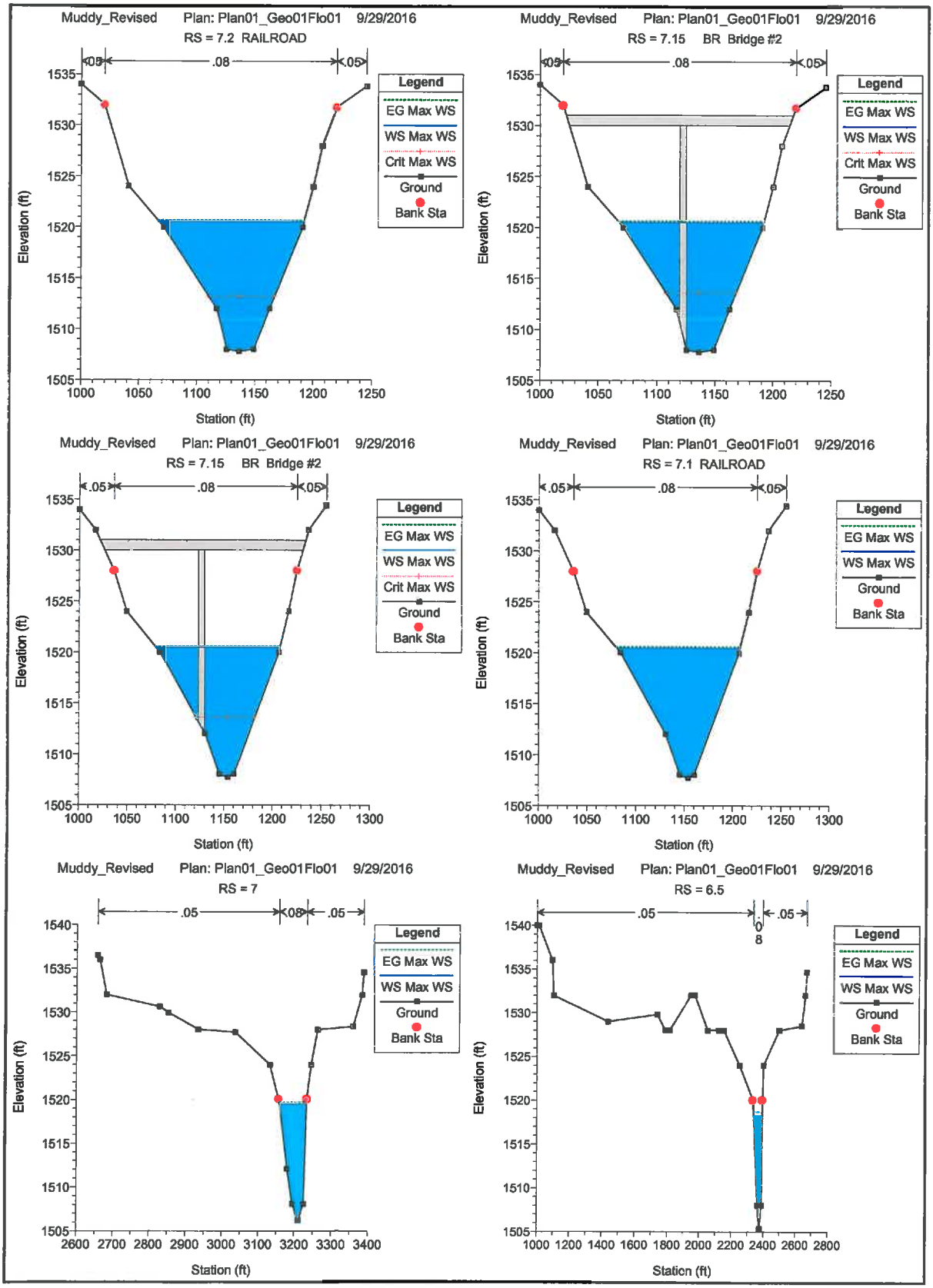
RS = 13
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 12
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 11
.05
.08
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 10
.05
.08
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 9
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 8
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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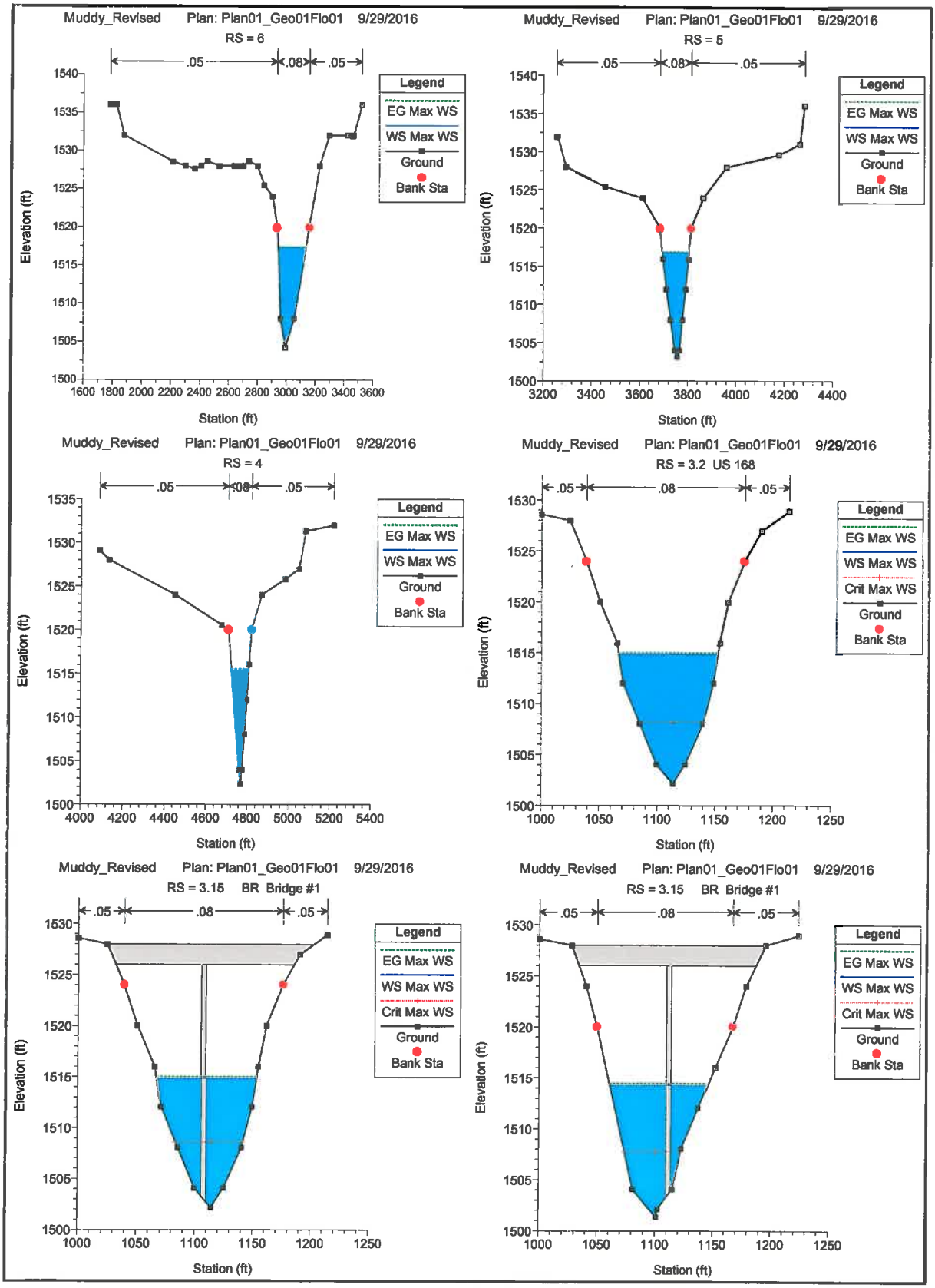
RS = 7.2 RAILROAD
.05
.08
.05
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 7.15 BR Bridge #2
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 7.15 BR Bridge #2
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 7.1 RAILROAD
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 7
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 6.5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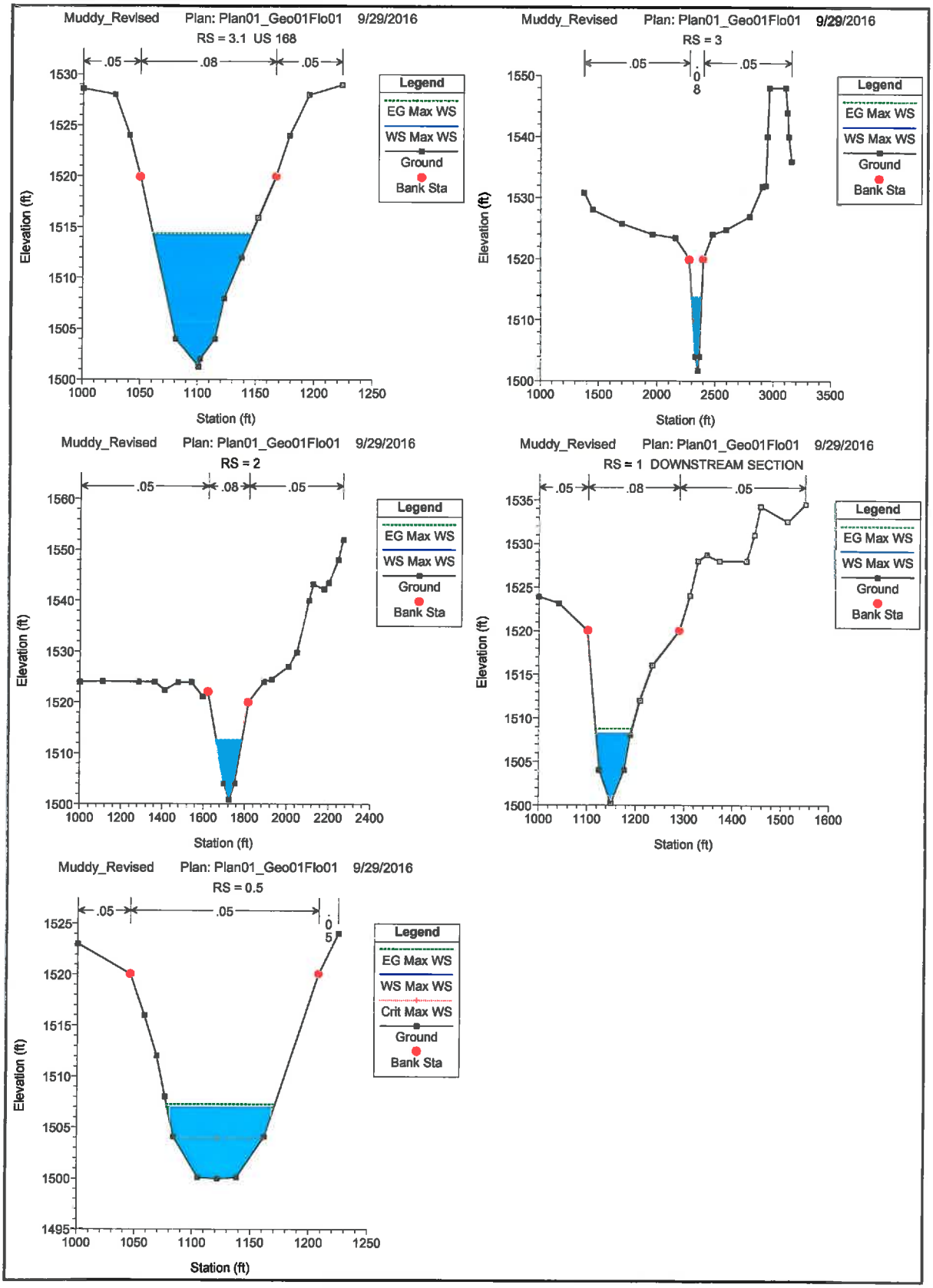
RS = 6
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 5
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 4
.05 .08 .05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 3.2 US 168
.05 .08 .05
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 3.15 BR Bridge #1
.05 .08 .05
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 3.15 BR Bridge #1
.05 .08 .05
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)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RS = 3.1 US 168
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 3
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 2
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 1 DOWNSTREAM SECTION
.05
.08
.05
Legend
EG Max WS
WS Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)
Muddy_Revised Plan: Plan01_Geo01Flo01 9/29/2016
RS = 0.5
.05
.05
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
Bank Sta
Elevation (ft)
Station (ft)

Attachment 2
Dam Breach Inundation Results – 2010 Analysis

MEMO

Minneapolis, MN

TO: Becky Svatos, P.E. – Project Manager **DATE:** September 20, 2010

FROM: Andrew Judd, P.E. – Hydraulic Engineer

SUBJECT: Nevada Energy – Reid Gardner Station
Proposed Mesa Ponds M5 & M7
Dam Breach Analysis and Results

The purpose of this analysis is to evaluate the downstream hydraulic impacts (inundation) due to a "sunny day" breach of one of the proposed Mesa Evaporation Ponds to be constructed at Nevada Energy's Reid Gardner Station. The facility is located on the Muddy River, 3 miles west of Glendale, Nevada. Breach flows from the ponds would be conveyed by the Muddy River. The Dam Breach Analysis model was developed utilizing the cross-sections from the 1996 Flood Insurance Study (FIS) for Muddy River. The vertical datum of the cross-sectional data is NAVD 1988.

Analysis

The analysis consisted of the following steps:

- Obtain Muddy River HEC-2 model of the Moapa Reach (extends upstream of Reid Gardner Station and downstream to Glendale) from the 1996 FIS analysis.
- Import HEC-2 model into HEC-RAS.
- Adjust Muddy River HEC-RAS model to replicate the FIS results (peak water surface elevation) of the HEC-2 model.
- Obtain digital elevation model (DEM) of the Reid Gardner Site (1-meter resolution).
- Obtain FEMA Digital Flood Insurance Rate Map (DFIRM) which is a GIS representation of the Flood Insurance Study (FIS) elements, including floodplain extents and FIS cross-section locations.
- Develop Mesa Pond breach channel cross-sections down existing gulley that is the most likely pathway for breach flows using DEM connecting Mesa Ponds to Muddy River.
- Create HEC-RAS Dam Breach Model (Dam Breach Model) using new Mesa Pond breach channel cross-sections and FIS Muddy River geometry.
- Run Dam Breach Model and establish peak water surface elevations in downstream channel cross-sections.
- Create Dam Breach Inundation Maps for Mesa Ponds and downstream section of Muddy River.

The following is a list of Analysis assumptions/comments:

- The Dam Breach Model ends at the City of Glendale (downstream end at cross-section BH).
- A constant base flow of 100 cfs was included in the Dam Breach Model (helps prevent unsteady HEC-RAS model from crashing).
- Breach channel cross-sections used Manning's roughness coefficients similar to the FIS cross-sections.
- Bridges from the HEC-2 model were included in the HEC-RAS model.
- The dam/breach enters the Muddy River Channel at cross-section BZ in the FIS
- The breach occurs with water level at the top of the embankment at hour 4.0
- The breach does not coincide with a flooding event on Muddy River (Sunny Day Failure).

Pond breach parameters were developed using the Federal Energy Regulatory Commission guidelines. The M5 and M7 Mesa Ponds are of similar size, height and volume. Pond M5 has a more direct connection to the Muddy River (i.e. flood wave would have less opportunity to dissipate) so was used for the breach simulation. Pond Geometry and Breach Parameters are summarized by the following:

- Reservoir top of embankment elevation – 1720.0 ft
- Water surface area at 1720.0 ft – 13.8 Acres
- Reservoir volume at 1720.0 – 260 ac-ft
- Reservoir bottom elevation – 1697.0 ft
- Water surface area at 1697.0 ft – 9.2 Acres
- Water elevation at time of breach – 1720.0 ft
- Bottom of breach elevation – 1697.0 ft
- Side slope of breach – 0.75H:1V
- Breach bottom width – 40 ft
- Time to breach = 0.6 hr

Results

- The Dam Breach Model results are compared in Table 1 to the FIS water surface elevations which are representative of the 100-year flood.
- Table 2 compares the Dam Breach Model sunny day failure peak elevations with the Dam Breach Model no failure elevations.
- Maps 1 and 2 display the analysis cross-sections, inundation and floodplain extents, and aerial imagery.
- The flows for the 10 and 50 year events were not available for the upper reach of Muddy River and floodplain extents were not available for the full reach of Muddy River.

Conclusions

- The flood wave peak flow from the Dam Breach Model is 90% of the peak 100-year flow from the FIS model at the point where the breach flow enters the Muddy River Channel (FIS cross-section BZ, near the Reid Gardner Site).
- The flood wave peak flow from the Dam Breach Model is 12% of the peak 100-year flow from the FIS model at the downstream end near where the Muddy River flows through the City of Glendale (FIS cross-section BH).
- The Dam Breach Model estimated a travel time for the leading edge of the flood wave (beginning of significant rise in flow) of approximately 2 hours and a travel time for the peak of the flood wave of approximately 2.8 hours from the Mesa Ponds to the City of Glendale (FIS cross-section BH).
- Flood depths from the Dam Breach Model in the City of Glendale are in the range of 10 feet from the deepest point in the channel.
- The Dam Breach Model demonstrated the flood wave peak elevations through the City of Glendale are contained within the channel banks and will continue to attenuate (dissipate) downstream.

Table 1: Dam Breach Model – Sunny Day Failure

Cross Section Number	River Mile (mi)	FIS – 10 yr	FIS – 50 yr	FIS – 100 yr		Dam Breach Model – Sunny Day Failure			
								Arrival Time (hr)	
		Flow (cfs)	Flow (cfs)	Flow (cfs)	Elev (ft)	Peak Flow (cfs)	Peak Elev (ft)	Peak	Leading Edge
BZ	11.022	na	na	6500	1572.3	5447	1572.2	0.63	0.33
BY	11.119	na	na	6500	1570.4	5461	1570.1	0.65	0.38
BX	11.213	na	na	6500	1569.8	4052	1568.9	0.82	0.38
BW	11.456	na	na	6500	1567.3	3747	1566.6	0.88	0.45
BV	11.646	na	na	6500	1561.6	3625	1560.9	0.98	0.53
BU	11.933	na	na	6500	1556.8	3386	1556.0	1.17	0.63
BT	12.225	na	na	6500	1553.7	2897	1552.6	1.43	0.77
BS	12.371	na	na	6500	1552.2	2862	1551.0	1.50	0.82
BR	12.700	na	na	6500	1550	2747	1542.5	1.72	0.98
BQ	13.032	3620	10900	16000	1547.8	2306	1538.4	1.98	1.12
BP	13.430	3620	10900	16000	1543.5	2266	1536.4	2.00	1.37
BO	13.876	3620	10900	16000	1538.9	2104	1528.0	2.32	1.47
BN	14.193	3620	10900	16000	1535.6	2060	1523.9	2.40	1.58
BM	14.376	3620	10900	16000	1533.2	2013	1520.9	2.50	1.63
BL	14.536	3620	10900	16000	1530.6	1958	1518.9	2.58	1.75
BK	14.649	3620	10900	16000	1529.8	1901	1517.7	2.65	1.80
BJ	14.919	3620	10900	16000	1528.8	1845	1514.8	2.73	1.90
BI	15.018	3620	10900	16000	1526.6	1842	1513.8	2.75	1.95
BH	15.123	3620	10900	16000	1525.9	1839	1513.1	2.77	1.97

Notes:

na – Not Available

Vertical Datum is NAVD 1988

Table 2: Elevation Difference

Cross Section Number	River Mile (mi)	Sunny Day Failure		No Failure		Elevation Difference (ft)
		Peak Flow (cfs)	Peak Elev (ft)	Flow (cfs)	Elev (ft)	
BZ	11.022	5447	1572.2	100	1564.5	7.7
BY	11.119	5461	1570.1	100	1562.9	7.2
BX	11.213	4052	1568.9	100	1562.4	6.5
BW	11.456	3747	1566.6	100	1560.1	6.5
BV	11.646	3625	1560.9	100	1555.0	5.9
BU	11.933	3386	1556.0	100	1551.5	4.5
BT	12.225	2897	1552.6	100	1549.3	3.3
BS	12.371	2862	1551.0	100	1547.1	3.9
BR	12.700	2747	1542.5	100	1535.5	7.0
BQ	13.032	2306	1538.4	100	1528.8	9.6
BP	13.430	2266	1536.4	100	1525.4	11.0
BO	13.876	2104	1528.0	100	1515.8	12.2
BN	14.193	2060	1523.9	100	1513.8	10.1
BM	14.376	2013	1520.9	100	1511.7	9.3
BL	14.536	1958	1518.9	100	1509.4	9.5
BK	14.649	1901	1517.7	100	1508.2	9.5
BJ	14.919	1845	1514.8	100	1506.7	8.1
BI	15.018	1842	1513.8	100	1505.6	8.2
BH	15.123	1839	1513.1	100	1505.3	7.81

Notes:

Vertical Datum is NAVD 1988

NV Energy
Reid Gardner
Station

BZ
BY
BX
BW
BV
BU
BT
BS
BR
BQ

139
140
141
142
143
144
145
146
147
148

Mesa
Pond M5

Mesa
Pond M7

78
Hidden Valley Rd
Muddy

MATCH LINE
MAP 2

River Mile: 11.022 MI
No Breach W.S.E.: 1564.46
Breach W.S.E.: 1572.16
FIS W.S.E.: 1572.30
Leading Edge Arrival: 0.33 HR
Peak Arrival: 0.63 HR

River Mile: 11.933 MI
No Breach W.S.E.: 1551.48
Breach W.S.E.: 1555.96
FIS W.S.E.: 1556.80
Leading Edge Arrival: 0.63 HR
Peak Arrival: 1.17 HR

River Mile: 13.032 MI
No Breach W.S.E.: 1528.84
Breach W.S.E.: 1538.39
FIS W.S.E.: 1547.80
Leading Edge Arrival: 1.12 HR
Peak Arrival: 1.98 HR

Legend

- BREACH CROSS-SECTION
- FIS CROSS-SECTION
- BREACH INUNDATION

NOTE: LIMITS OF INUNDATION AND FLOODING CHARACTERISTICS SHOWN ARE APPROXIMATE AND BASED ON A THEORETICAL FAILURE OF REID GARDNER STATION PONDS. THIS FIGURE IS ONLY TO BE USED AS A GENERAL BASIS FOR DOWNSTREAM HAZARD EVALUATION. ACTUAL INUNDATION MAY VARY DEPENDING UPON ACTUAL RIVER AND BERM CONDITIONS DURING FAILURE.

\\mnp-fs1\Mnp-Projects-1\22835\Active\14-GIS\InundationMaps.mxd

Stanley Consultants INC.

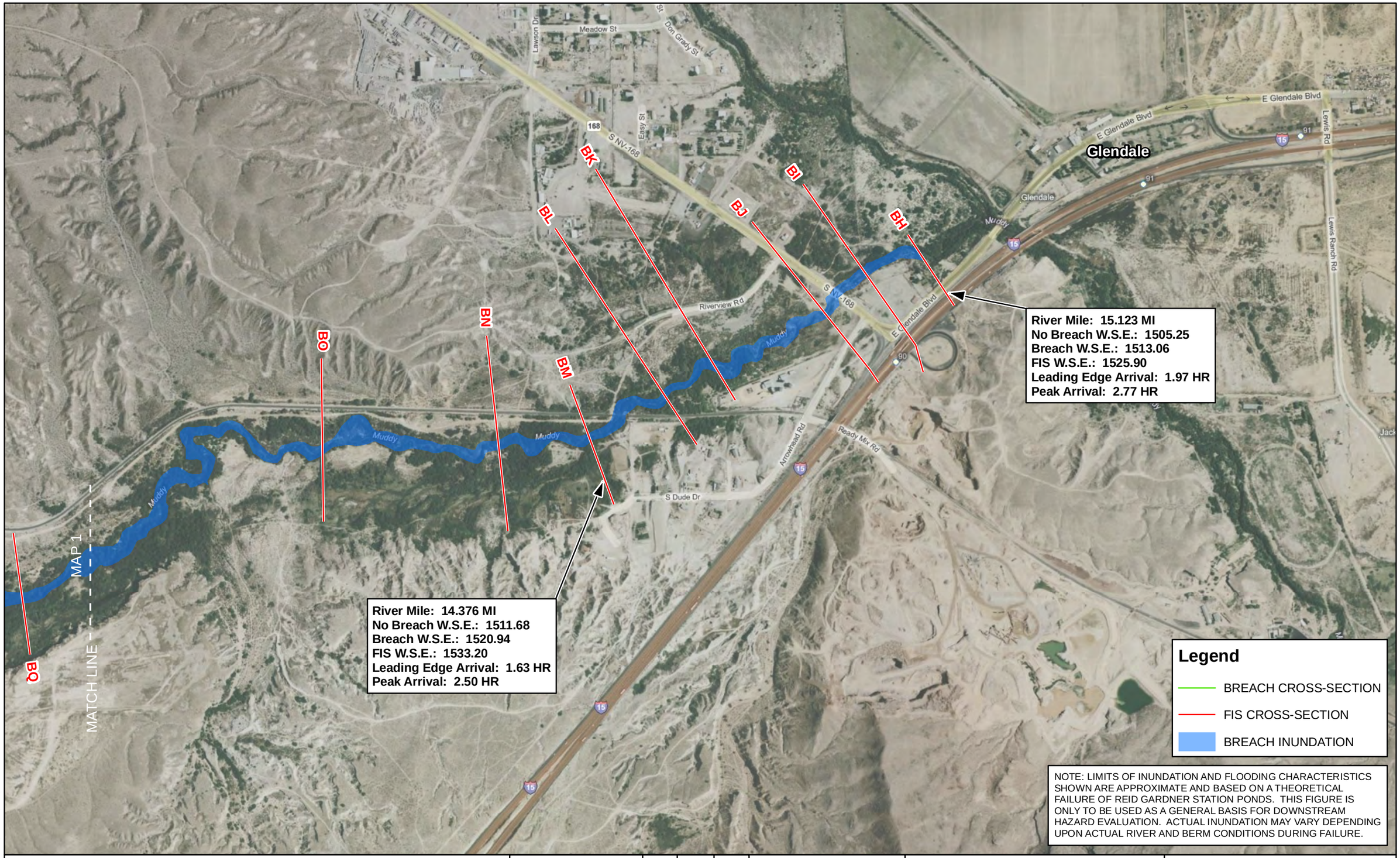
0 500 1,000 Feet

REVISIONS	DWN	CKD	APPD

DRAWN BY: D. ROTSCHAFER
CHECKED BY: A. JUDD
APPROVED BY: B. SVATOS
DATE: 9-JUNE-2010

NEVADA ENERGY
REID GARDNER STATION
CLARK COUNTY, NEVADA

MESA POND BREACH ANALYSIS MAP 1 OF 2



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Stanley Consultants INC.

0 500 1,000 Feet

REVISIONS	DWN	CKD	APPD

DRAWN BY: D. ROTSCHAFER
CHECKED BY: A. JUDD
APPROVED BY: B. SVATOS
DATE: 9-JUNE-2010

NEVADA ENERGY
REID GARDNER STATION
CLARK COUNTY, NEVADA

MESA POND BREACH ANALYSIS MAP 2 OF 2

Attachment 3
Dam Breach HEC-RAS Calculations – 2021 Analysis

Froelich Breach Calculations – 2021

ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROEHLICH 2008 METHOD

PROJECT: M5 MESA POND

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu:	OVERTOPPING	
Height of water over base elevation of breach (H_w) =	23.0	Feet
Volume of water in the reservoir at the time of failure (V_w) =	260.0	Acre-Feet
Reservoir Surface Area at Hw (A_s) =	13.8	Acres
Height of breach (H_b) =	23.0	Feet
Failure Mode Factor (K_o) =	1.3	
Breach Side-Slope Ratio (Z_b) =	1	Z(H):1(V)
Dam Size Class:	Small	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	72.0	Feet
Bottom Width of Breach (B_b) =	49.0	Feet
Breach Formation Time (T_f) =	0.45	Hours
Storage Intensity (SI) =	11.3	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	7506	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	3.13	If (B_{avg}/H_b) > 0.6, Full Breach Devlopment is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	159.0	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	6.9	If 1.6 < (ER/H_w) < 21, Erosion Rate is Assumed Reasonable

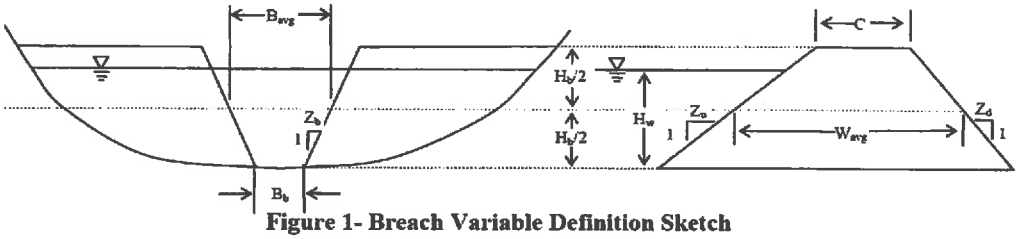


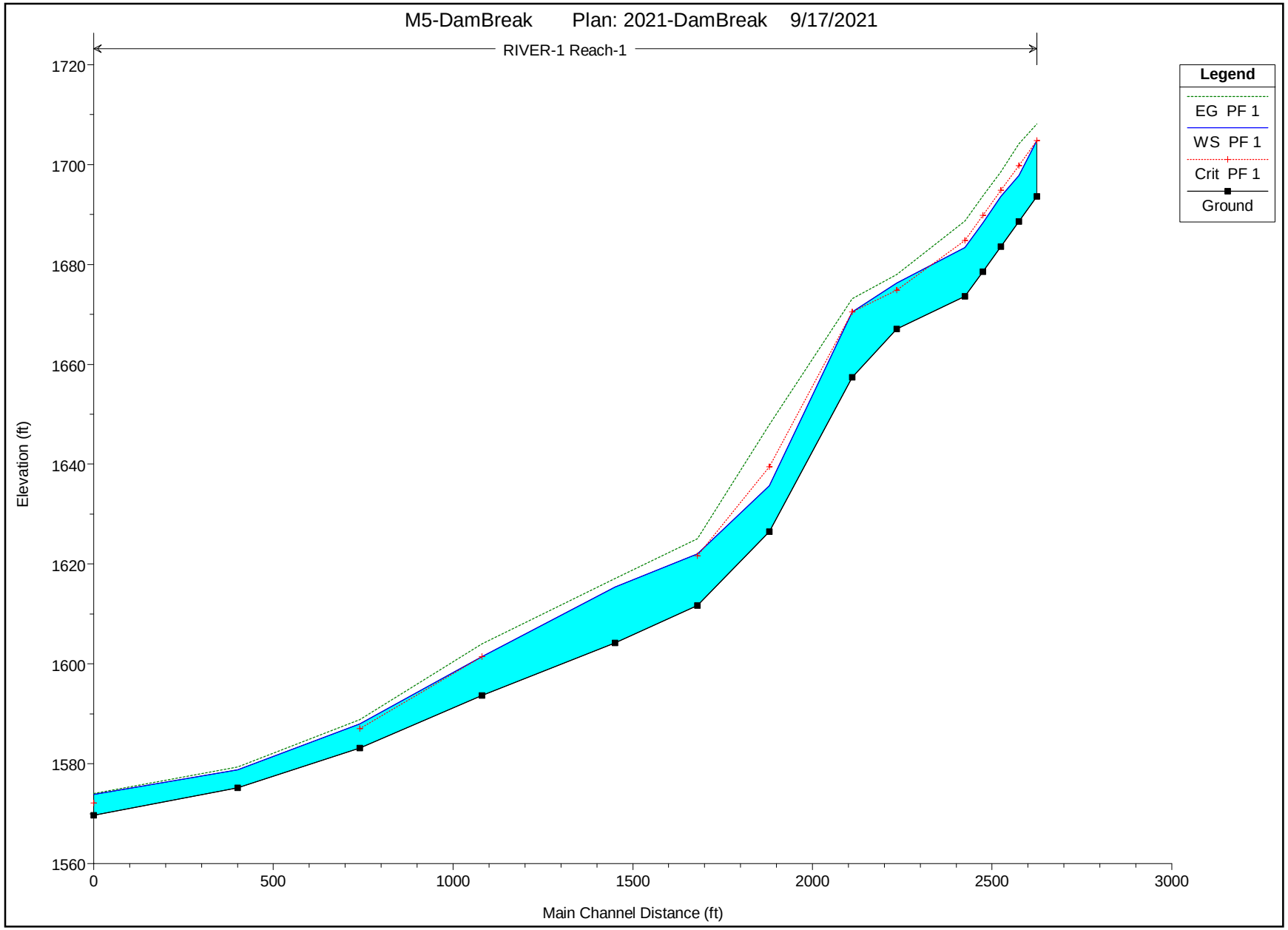
Figure 1- Breach Variable Definition Sketch

RAS Summary Table – 2021

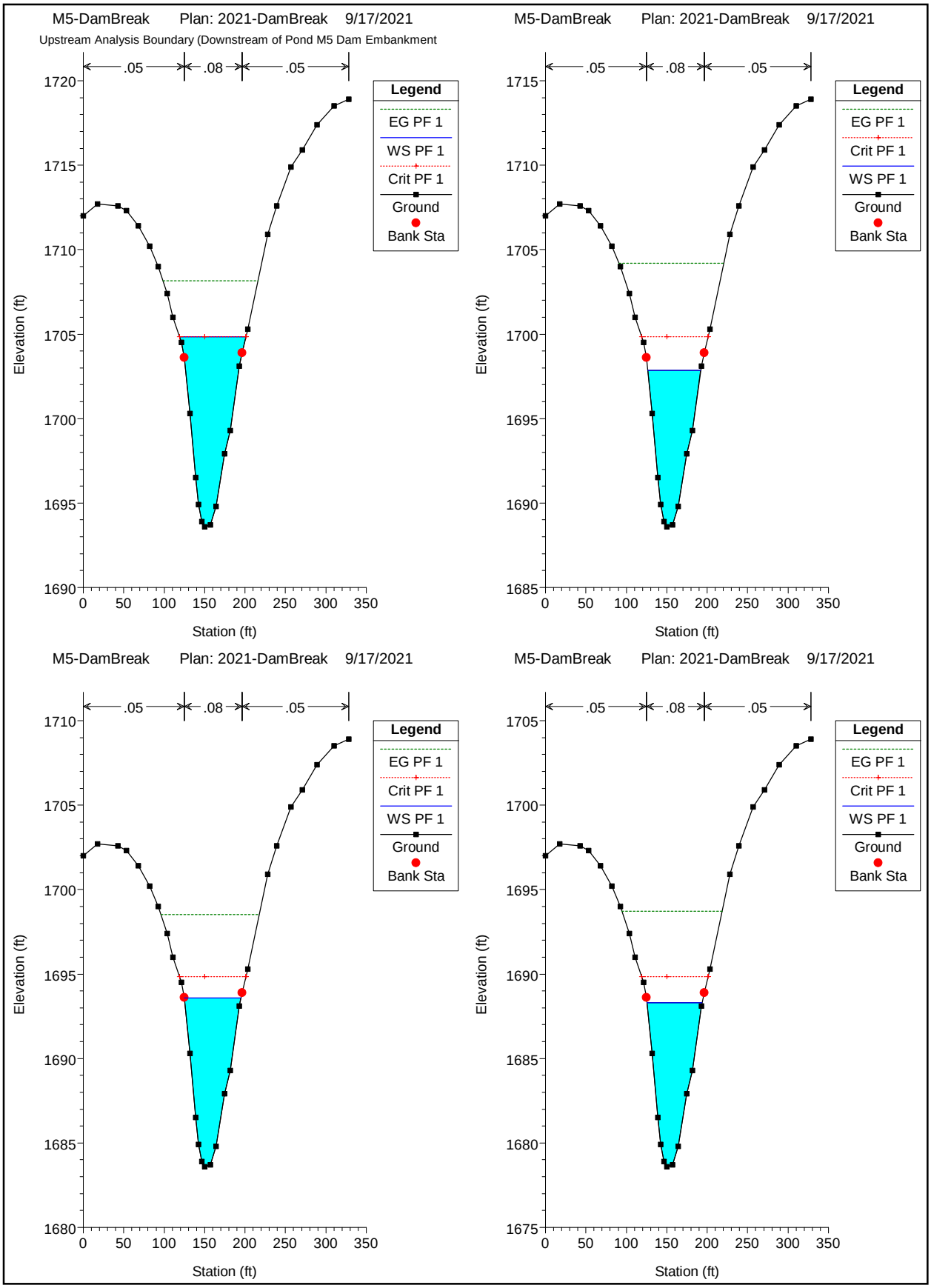
HEC-RAS Plan: 2021-DamBreak River: RIVER-1 Reach: Reach-1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	148.7	PF 1	7506.00	1693.60	1704.84	11.24	1704.84	1708.17	0.048248	14.66	515.70	82.15	0.97
Reach-1	148.6	PF 1	7506.00	1688.60	1697.85	9.24	1699.84	1704.21	0.125034	20.23	371.03	65.36	1.50
Reach-1	148.5	PF 1	7506.00	1683.60	1693.59	9.99	1694.84	1698.52	0.089554	17.82	421.32	69.88	1.28
Reach-1	148.3	PF 1	7506.00	1678.60	1688.32	9.72	1689.84	1693.72	0.100766	18.65	402.39	68.06	1.35
Reach-1	148	PF 1	7506.00	1673.60	1683.35	9.74	1684.84	1688.70	0.099505	18.56	404.37	68.25	1.34
Reach-1	147	PF 1	7506.00	1667.10	1676.27	9.17	1674.86	1677.96	0.026877	10.41	720.76	110.77	0.72
Reach-1	146	PF 1	7506.00	1657.40	1670.50	13.10	1670.50	1673.15	0.057845	13.05	574.96	110.06	1.01
Reach-1	145	PF 1	7506.00	1626.50	1635.72	9.22	1639.45	1647.93	0.250702	28.03	267.77	45.74	2.04
Reach-1	144	PF 1	7506.00	1611.70	1622.02	10.32	1621.68	1625.04	0.047311	13.95	538.20	78.01	0.94
Reach-1	143	PF 1	7506.00	1604.20	1615.37	11.17		1617.11	0.024091	10.59	709.08	95.64	0.69
Reach-1	142	PF 1	7506.00	1593.70	1601.40	7.70	1601.40	1604.05	0.055595	13.06	574.71	108.73	1.00
Reach-1	141	PF 1	7506.00	1583.10	1587.97	4.86	1587.00	1588.86	0.026773	7.57	991.75	250.99	0.67
Reach-1	140	PF 1	7506.00	1575.20	1578.74	3.54		1579.39	0.028462	6.49	1155.73	386.79	0.66
Reach-1	139	PF 1	7506.00	1569.70	1573.82	4.12	1572.12	1574.03	0.007501	3.68	2092.52	795.71	0.35

RAS Profile – 2021


M5-DamBreak Plan: 2021-DamBreak 9/17/2021
RIVER-1 Reach-1
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
1720
1700
1680
1660
1640
1620
1600
1580
1560
0
500
1000
1500
2000
2500
3000
Main Channel Distance (ft)

RAS Sections – 2021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Upstream Analysis Boundary (Downstream of Pond M5 Dam Embankment
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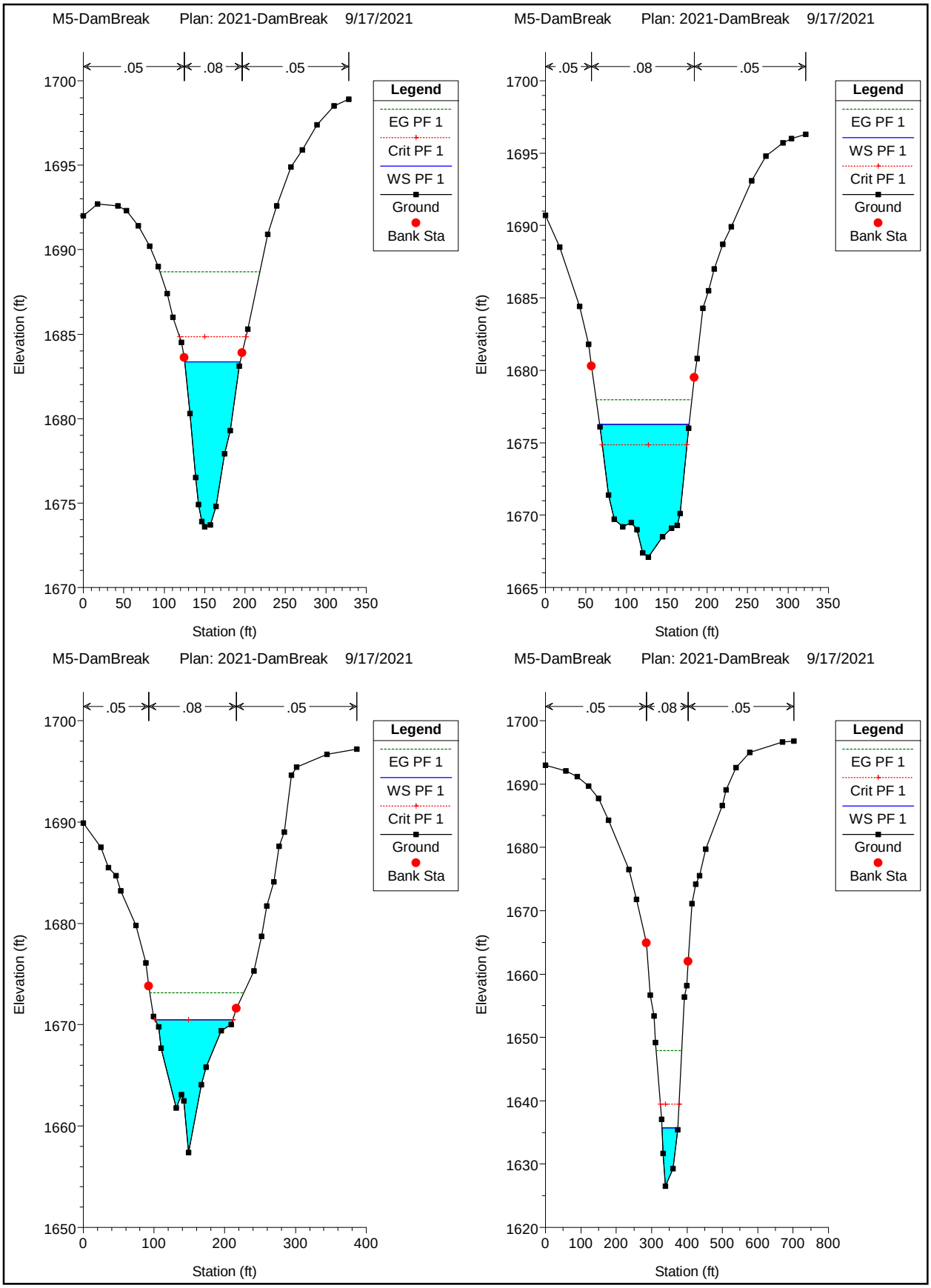
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
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.05
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
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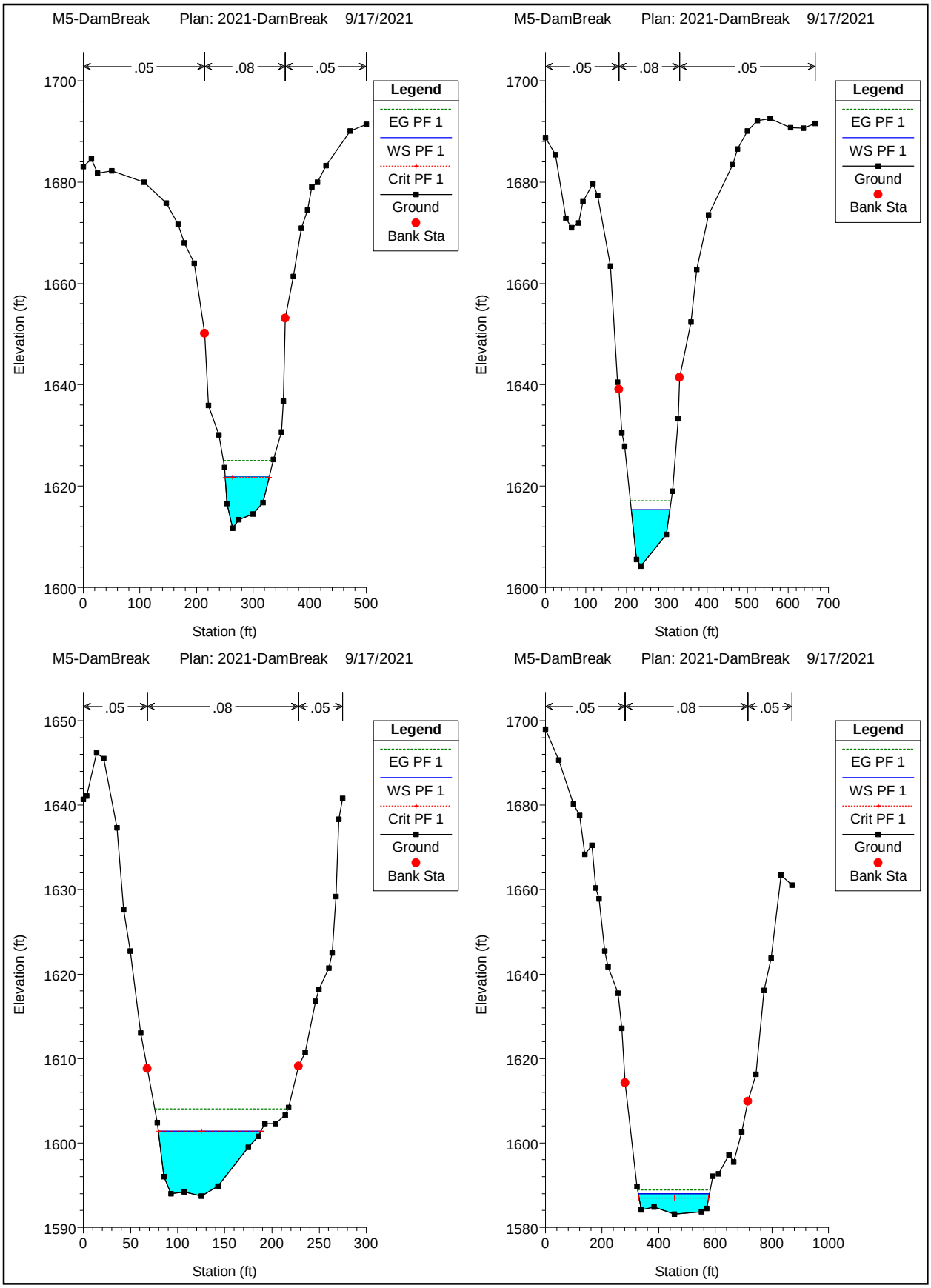
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
M5-DamBreak Plan: 2021-DamBreak 9/17/2021
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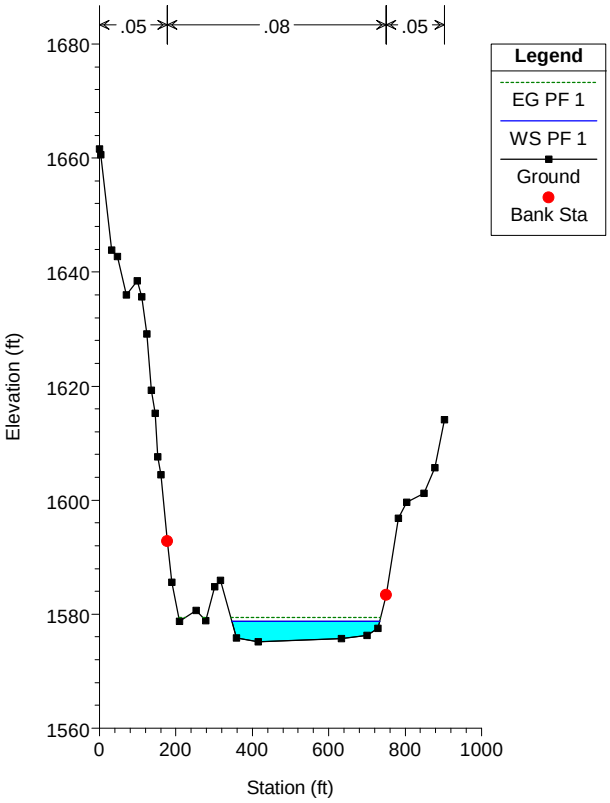
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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.05
.08
.05
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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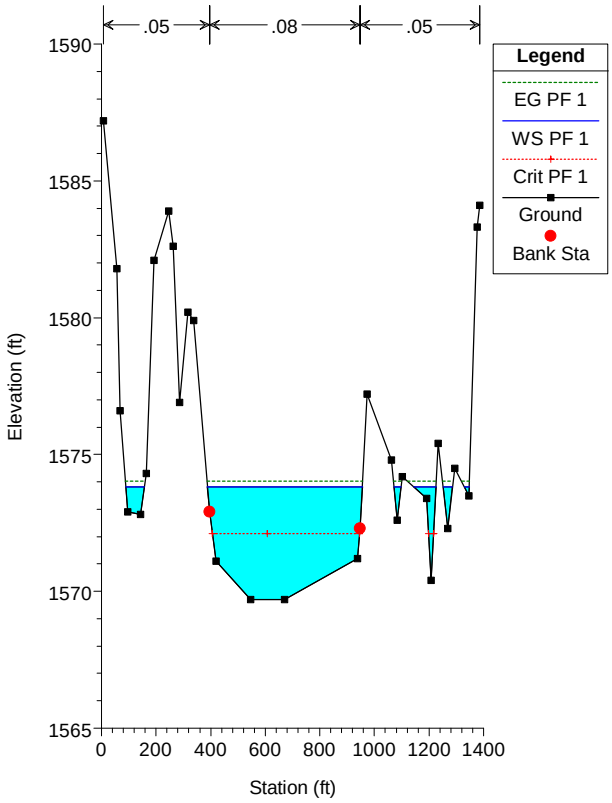
1660
1640
1620
1600
1580
1560
0
200
400
600
800
1000


M5-DamBreak Plan: 2021-DamBreak 9/17/2021
Downstream Analysis Boundary (SFHA Boundary Muddy River)
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
1590
1585
1580
1575
1570
1565
0
200
400
600
800
1000
1200
1400

RAS Report - 2021

HEC-RAS HEC-RAS 5.0.7 March 2019
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X        X
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X     X  XXXXXX    XXXX       X    X   X    X   XXXXX
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PROJECT DATA
Project Title: M5-DamBreak
Project File : M5-DamBreak.prj
Run Date and Time: 9/17/2021 2:45:32 PM

Project in English units

Project Description:
2021 NVE Pond M5
Dam Breach Emergency Inundation
Steady State Analysis
M5
Embankment to Muddy River SFHA

PLAN DATA

Plan Title: 2021-DamBreak
Plan File : p:\NVEnergy\NVE01918_CCR_2021_Mesa_LF_M5M7\900_Working_Documents\M5_M7_Hazard_Classification\2021_Calcs\HEC-RAS\M5-DamBreak.p09

Geometry Title: 2021 Shortened Geometry - SFHA Limits
Geometry File :
p:\NVEnergy\NVE01918_CCR_2021_Mesa_LF_M5M7\900_Working_Documents\M5_M7_Hazard_Classification\2021_Calcs\HEC-RAS\M5-DamBreak.g02

Flow Title : 2021-DamBreak
Flow File :
p:\NVEnergy\NVE01918_CCR_2021_Mesa_LF_M5M7\900_Working_Documents\M5_M7_Hazard_Classification\2021_Calcs\HEC-RAS\M5-DamBreak.f04

Plan Summary Information:
Number of: Cross Sections = 14 Multiple Openings = 0
Culverts = 0 Inline Structures = 0
Bridges = 0 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: Between every coordinate point (HEC2 Style)
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: 2021-DamBreak
Flow File : p:\NVEnergy\NVE01918_CCR_2021_Mesa_LF_M5M7\900_Working_Documents\M5_M7_Hazard_Classification\2021_Calcs\HEC-RAS\M5-DamBreak.f04

Flow Data (cfs)

River	Reach	RS	PF 1
RIVER-1	Reach-1	148.7	7506

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
RIVER-1	Reach-1	PF 1	Critical	Normal S = 0.0075

GEOMETRY DATA

Geometry Title: 2021 Shortened Geometry - SFHA Limits
Geometry File : p:\NVEnergy\NVE01918_CCR_2021_Mesa_LF_M5M7\900_Working_Documents\M5_M7_Hazard_Classification\2021_Calcs\HEC-RAS\M5-DamBreak.g02

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 148.7

INPUT
Description: Upstream Analysis Boundary (Downstream of Pond M5 Dam Embankment)
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1712	17.8	1712.7	42.8	1712.6	53.5	1712.3	67.8	1711.4
82.1	1710.2	92.8	1709	103.5	1707.4	110.6	1706	121.3	1704.5
124.9	1703.6	132	1700.3	139.1	1696.5	142.7	1694.9	146.3	1693.9
149.8	1693.6	157	1693.7	164.1	1694.8	174.8	1697.9	181.9	1699.3
192.6	1703.1	196.2	1703.9	203.4	1705.3	228.3	1710.9	239	1712.6
256.9	1714.9	271.1	1715.9	289	1717.4	310.4	1718.5	328.2	1718.9

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	124.9	.08	196.2	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
124.9	196.2	50	50	50	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1708.17	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.33	Wt. n-Val.	0.050	0.080	0.050
W.S. Elev (ft)	1704.84	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	1704.84	Flow Area (sq ft)	3.25	510.18	2.27
E.G. Slope (ft/ft)	0.048248	Area (sq ft)	3.25	510.18	2.27
Q Total (cfs)	7506.00	Flow (cfs)	16.34	7480.82	8.84
Top Width (ft)	82.15	Top Width (ft)	6.02	71.30	4.83
Vel Total (ft/s)	14.56	Avg. Vel. (ft/s)	5.02	14.66	3.90
Max Chl Dpth (ft)	11.24	Hydr. Depth (ft)	0.54	7.16	0.47
Conv. Total (cfs)	34171.9	Conv. (cfs)	74.4	34057.3	40.2
Length Wtd. (ft)	50.00	Wetted Per. (ft)	6.16	74.88	4.92
Min Ch El (ft)	1693.60	Shear (lb/sq ft)	1.59	20.52	1.39
Alpha	1.01	Stream Power (lb/ft s)	8.00	300.94	5.41
Frctn Loss (ft)	3.67	Cum Volume (acre-ft)	0.33	47.58	0.47
C & E Loss (ft)	0.30	Cum SA (acres)	0.42	11.25	0.64

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 148.6

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1707	17.8	1707.7	42.8	1707.6	53.5	1707.3	67.8	1706.4
82.1	1705.2	92.8	1704	103.5	1702.4	110.6	1701	121.3	1699.5
124.9	1698.6	132	1695.3	139.1	1691.5	142.7	1689.9	146.3	1688.9
149.8	1688.6	157	1688.7	164.1	1689.8	174.8	1692.9	181.9	1694.3
192.6	1698.1	196.2	1698.9	203.4	1700.3	228.3	1705.9	239	1707.6
256.9	1709.9	271.1	1710.9	289	1712.4	310.4	1713.5	328.2	1713.9

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	124.9	.08	196.2	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
124.9	196.2	50	50	50	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1704.21	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.36	Wt. n-Val.		0.080	
W.S. Elev (ft)	1697.85	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	1699.84	Flow Area (sq ft)		371.03	
E.G. Slope (ft/ft)	0.125034	Area (sq ft)		371.03	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	65.36	Top Width (ft)		65.36	
Vel Total (ft/s)	20.23	Avg. Vel. (ft/s)		20.23	
Max Chl Dpth (ft)	9.24	Hydr. Depth (ft)		5.68	
Conv. Total (cfs)	21227.3	Conv. (cfs)		21227.3	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		68.63	
Min Ch El (ft)	1688.60	Shear (lb/sq ft)		42.20	
Alpha	1.00	Stream Power (lb/ft s)		853.67	

Frctn Loss (ft)	5.25	Cum Volume (acre-ft)	0.33	47.08	0.47
C & E Loss (ft)	0.43	Cum SA (acres)	0.42	11.17	0.64

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 148.5

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1702	17.8	1702.7	42.8	1702.6	53.5	1702.3	67.8	1701.4
82.1	1700.2	92.8	1699	103.5	1697.4	110.6	1696	121.3	1694.5
124.9	1693.6	132	1690.3	139.1	1686.5	142.7	1684.9	146.3	1683.9
149.8	1683.6	157	1683.7	164.1	1684.8	174.8	1687.9	181.9	1689.3
192.6	1693.1	196.2	1693.9	203.4	1695.3	228.3	1700.9	239	1702.6
256.9	1704.9	271.1	1705.9	289	1707.4	310.4	1708.5	328.2	1708.9

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	124.9	.08	196.2	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
124.9	196.2	50	50	50	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	1698.52	Element			
Vel Head (ft)	4.93	Wt. n-Val.		0.080	
W.S. Elev (ft)	1693.59	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	1694.84	Flow Area (sq ft)		421.32	
E.G. Slope (ft/ft)	0.089554	Area (sq ft)		421.32	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	69.88	Top Width (ft)		69.88	
Vel Total (ft/s)	17.82	Avg. Vel. (ft/s)		17.82	
Max Chl Dpth (ft)	9.99	Hydr. Depth (ft)		6.03	
Conv. Total (cfs)	25082.2	Conv. (cfs)		25082.2	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		73.42	
Min Ch El (ft)	1683.60	Shear (lb/sq ft)		32.08	
Alpha	1.00	Stream Power (lb/ft s)		571.55	
Frctn Loss (ft)	4.75	Cum Volume (acre-ft)	0.33	46.62	0.47
C & E Loss (ft)	0.05	Cum SA (acres)	0.42	11.09	0.64

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 148.3

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1697	17.8	1697.7	42.8	1697.6	53.5	1697.3	67.8	1696.4
82.1	1695.2	92.8	1694	103.5	1692.4	110.6	1691	121.3	1689.5
124.9	1688.6	132	1685.3	139.1	1681.5	142.7	1679.9	146.3	1678.9
149.8	1678.6	157	1678.7	164.1	1679.8	174.8	1682.9	181.9	1684.3
192.6	1688.1	196.2	1688.9	203.4	1690.3	228.3	1695.9	239	1697.6
256.9	1699.9	271.1	1700.9	289	1702.4	310.4	1703.5	328.2	1703.9

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	124.9	.08	196.2	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
124.9	196.2	50	50	50	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	1693.72	Element			
Vel Head (ft)	5.41	Wt. n-Val.		0.080	
W.S. Elev (ft)	1688.32	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	1689.84	Flow Area (sq ft)		402.39	
E.G. Slope (ft/ft)	0.100766	Area (sq ft)		402.39	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	68.06	Top Width (ft)		68.06	
Vel Total (ft/s)	18.65	Avg. Vel. (ft/s)		18.65	

Max Chl Dpth (ft)	9.72	Hydr. Depth (ft)	5.91			
Conv. Total (cfs)	23645.7	Conv. (cfs)	23645.7			
Length Wtd. (ft)	50.00	Wetted Per. (ft)	71.51			
Min Ch El (ft)	1678.60	Shear (lb/sq ft)	35.40			
Alpha	1.00	Stream Power (lb/ft s)	660.33			
Frctn Loss (ft)	5.01	Cum Volume (acre-ft)	0.33	46.15	0.47	
C & E Loss (ft)	0.02	Cum SA (acres)	0.42	11.01	0.64	

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 148

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1692	17.8	1692.7	42.8	1692.6	53.5	1692.3	67.8	1691.4
82.1	1690.2	92.8	1689	103.5	1687.4	110.6	1686	121.3	1684.5
124.9	1683.6	132	1680.3	139.1	1676.5	142.7	1674.9	146.3	1673.9
149.8	1673.6	157	1673.7	164.1	1674.8	174.8	1677.9	181.9	1679.3
192.6	1683.1	196.2	1683.9	203.4	1685.3	228.3	1690.9	239	1692.6
256.9	1694.9	271.1	1695.9	289	1697.4	310.4	1698.5	328.2	1698.9

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	124.9	.08	196.2	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
124.9	196.2	190	190	190	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1688.70	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.35	Wt. n-Val.		0.080	
W.S. Elev (ft)	1683.35	Reach Len. (ft)	190.00	190.00	190.00
Crit W.S. (ft)	1684.84	Flow Area (sq ft)		404.37	
E.G. Slope (ft/ft)	0.099505	Area (sq ft)		404.37	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	68.25	Top Width (ft)		68.25	
Vel Total (ft/s)	18.56	Avg. Vel. (ft/s)		18.56	
Max Chl Dpth (ft)	9.74	Hydr. Depth (ft)		5.92	
Conv. Total (cfs)	23795.0	Conv. (cfs)		23795.0	
Length Wtd. (ft)	190.00	Wetted Per. (ft)		71.71	
Min Ch El (ft)	1673.60	Shear (lb/sq ft)		35.03	
Alpha	1.00	Stream Power (lb/ft s)		650.23	
Frctn Loss (ft)	6.70	Cum Volume (acre-ft)	0.33	45.69	0.47
C & E Loss (ft)	0.49	Cum SA (acres)	0.42	10.93	0.64

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 147

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1690.7	17.7	1688.5	42.5	1684.4	53.1	1681.8	56.6	1680.3
67.2	1676.1	77.9	1671.4	84.9	1669.7	95.6	1669.2	106.2	1669.5
113.2	1669	120.3	1667.4	127.4	1667.1	145.1	1668.5	155.7	1669.1
162.8	1669.3	166.3	1670.1	177	1676	184	1679.5	187.6	1680.8
194.6	1684.3	201.7	1685.5	208.8	1687	219.4	1688.7	230	1689.9
254.8	1693.1	272.5	1694.8	293.7	1695.7	304.4	1696	322.1	1696.3

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	56.6	.08	184	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
56.6	184	124	124	124	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1677.96	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.69	Wt. n-Val.		0.080	
W.S. Elev (ft)	1676.27	Reach Len. (ft)	124.00	124.00	124.00
Crit W.S. (ft)	1674.86	Flow Area (sq ft)		720.76	
E.G. Slope (ft/ft)	0.026877	Area (sq ft)		720.76	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	110.77	Top Width (ft)		110.77	
Vel Total (ft/s)	10.41	Avg. Vel. (ft/s)		10.41	
Max Chl Dpth (ft)	9.17	Hydr. Depth (ft)		6.51	

Conv. Total (cfs)	45784.6	Conv. (cfs)	45784.6		
Length Wtd. (ft)	124.00	Wetted Per. (ft)	113.96		
Min Ch El (ft)	1667.10	Shear (lb/sq ft)	10.61		
Alpha	1.00	Stream Power (lb/ft s)	110.51		
Frctn Loss (ft)	4.71	Cum Volume (acre-ft)	0.33	43.23	0.47
C & E Loss (ft)	0.10	Cum SA (acres)	0.42	10.54	0.64

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Note: Hydraulic jump has occurred between this cross section and the previous upstream section.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 146

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1689.9	24.8	1687.5	35.5	1685.5	46.1	1684.7	53.2	1683.2
74.5	1679.8	88.7	1676.1	92.2	1673.8	99.3	1670.8	106.4	1669.8
110	1667.7	131.3	1661.8	138.4	1663.1	141.9	1662.5	149	1657.4
166.7	1664.1	173.8	1665.8	195.1	1669.4	209.3	1670	216.4	1671.6
241.2	1675.3	251.9	1678.7	259	1681.7	269.6	1684.1	276.7	1687.6
283.8	1689	294.4	1694.6	301.5	1695.4	344.1	1696.7	386.7	1697.2

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	92.2	.08	216.4	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
92.2	216.4	410.01	230.01	110.01	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1673.15	Element	Left OB	Channel	Right OB	
Vel Head (ft)	2.65	Wt. n-Val.		0.080		
W.S. Elev (ft)	1670.50	Reach Len. (ft)	410.01	230.01	110.01	
Crit W.S. (ft)	1670.50	Flow Area (sq ft)		574.96		
E.G. Slope (ft/ft)	0.057845	Area (sq ft)		574.96		
Q Total (cfs)	7506.00	Flow (cfs)		7506.00		
Top Width (ft)	110.06	Top Width (ft)		110.06		
Vel Total (ft/s)	13.05	Avg. Vel. (ft/s)		13.05		
Max Chl Dpth (ft)	13.10	Hydr. Depth (ft)		5.22		
Conv. Total (cfs)	31208.6	Conv. (cfs)		31208.6		
Length Wtd. (ft)	230.01	Wetted Per. (ft)		115.09		
Min Ch El (ft)	1657.40	Shear (lb/sq ft)		18.04		
Alpha	1.00	Stream Power (lb/ft s)		235.52		
Frctn Loss (ft)	24.27	Cum Volume (acre-ft)	0.33	41.39	0.47	
C & E Loss (ft)	0.96	Cum SA (acres)	0.42	10.23	0.64	

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 145

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1693	57.1	1692.1	89.2	1691.2	121.3	1689.7	149.8	1687.7
178.3	1684.3	235.4	1676.5	256.8	1671.8	285.3	1664.9	296	1656.7
306.7	1653.4	310.3	1649.2	328.1	1637.1	331.7	1631.7	338.8	1626.5
360.2	1629.3	374.5	1635.4	392.3	1656.4	399.4	1658.2	403	1662
413.7	1671.1	424.4	1674.2	435.1	1675.5	452.9	1679.7	499.3	1686.6
510	1689.1	538.5	1692.6	577.7	1695	670.4	1696.6	702.5	1696.8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	285.3	.08	403	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
285.3	403	150	200	270	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1647.93	Element	Left OB	Channel	Right OB	
Vel Head (ft)	12.21	Wt. n-Val.		0.080		
W.S. Elev (ft)	1635.72	Reach Len. (ft)	150.00	200.00	270.00	
Crit W.S. (ft)	1639.45	Flow Area (sq ft)		267.77		
E.G. Slope (ft/ft)	0.250702	Area (sq ft)		267.77		
Q Total (cfs)	7506.00	Flow (cfs)		7506.00		
Top Width (ft)	45.74	Top Width (ft)		45.74		
Vel Total (ft/s)	28.03	Avg. Vel. (ft/s)		28.03		
Max Chl Dpth (ft)	9.22	Hydr. Depth (ft)		5.85		
Conv. Total (cfs)	14991.0	Conv. (cfs)		14991.0		
Length Wtd. (ft)	200.00	Wetted Per. (ft)		51.17		
Min Ch El (ft)	1626.50	Shear (lb/sq ft)		81.90		
Alpha	1.00	Stream Power (lb/ft s)		2295.88		
Frctn Loss (ft)	10.31	Cum Volume (acre-ft)	0.33	39.16	0.47	
C & E Loss (ft)	0.38	Cum SA (acres)	0.42	9.82	0.64	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Note: Program found supercritical flow starting at this cross section.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 144

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1683.1	14.3	1684.6	25	1681.8	50	1682.2	107.1	1680
146.4	1675.9	167.8	1671.7	178.5	1668	196.3	1664	214.2	1650.1
221.3	1635.9	239.2	1630.1	249.9	1623.7	253.5	1616.6	264.2	1611.7
274.9	1613.4	299.9	1614.5	317.7	1616.7	335.6	1625.3	349.8	1630.7
353.4	1636.8	357	1653.1	371.3	1661.4	385.5	1670.9	396.3	1674.5
403.4	1679	414.1	1680	428.4	1683.3	471.2	1690.1	499.8	1691.4

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	214.2	.08	357	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
214.2	357	159.99 230.01	300	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1625.04	Element	Left OB	Channel	Right OB	
Vel Head (ft)	3.02	Wt. n-Val.		0.080		
W.S. Elev (ft)	1622.02	Reach Len. (ft)	159.99	230.01	300.00	
Crit W.S. (ft)	1621.68	Flow Area (sq ft)		538.20		
E.G. Slope (ft/ft)	0.047311	Area (sq ft)		538.20		
Q Total (cfs)	7506.00	Flow (cfs)		7506.00		
Top Width (ft)	78.01	Top Width (ft)		78.01		
Vel Total (ft/s)	13.95	Avg. Vel. (ft/s)		13.95		
Max Chl Dpth (ft)	10.32	Hydr. Depth (ft)		6.90		
Conv. Total (cfs)	34508.8	Conv. (cfs)		34508.8		
Length Wtd. (ft)	230.01	Wetted Per. (ft)		83.91		
Min Ch El (ft)	1611.70	Shear (lb/sq ft)		18.94		
Alpha	1.00	Stream Power (lb/ft s)		264.20		
Frctn Loss (ft)	7.55	Cum Volume (acre-ft)	0.33	37.31	0.47	
C & E Loss (ft)	0.38	Cum SA (acres)	0.42	9.53	0.64	

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 143

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1688.8	25	1685.4	49.9	1672.9	64.2	1671	82	1671.9
92.7	1676.1	117.7	1679.7	128.4	1677.4	160.5	1663.4	178.3	1640.5
181.9	1639.1	189	1630.6	196.1	1627.9	224.6	1605.5	235.3	1604.2
299.5	1610.5	313.8	1619	328.1	1633.3	331.6	1641.4	360.2	1652.4
374.4	1662.8	402.9	1673.5	463.6	1683.4	474.3	1686.5	499.2	1690.1
524.2	1692.1	556.3	1692.5	606.2	1690.7	638.3	1690.6	666.8	1691.6

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	181.9	.08	331.6	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
181.9	331.6	360	370	410	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1617.11	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.74	Wt. n-Val.		0.080	
W.S. Elev (ft)	1615.37	Reach Len. (ft)	360.00	370.00	410.00
Crit W.S. (ft)		Flow Area (sq ft)		709.08	
E.G. Slope (ft/ft)	0.024091	Area (sq ft)		709.08	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	95.64	Top Width (ft)		95.64	
Vel Total (ft/s)	10.59	Avg. Vel. (ft/s)		10.59	
Max Chl Dpth (ft)	11.17	Hydr. Depth (ft)		7.41	
Conv. Total (cfs)	48359.6	Conv. (cfs)		48359.6	
Length Wtd. (ft)	370.00	Wetted Per. (ft)		100.78	
Min Ch El (ft)	1604.20	Shear (lb/sq ft)		10.58	
Alpha	1.00	Stream Power (lb/ft s)		112.02	
Frctn Loss (ft)	12.97	Cum Volume (acre-ft)	0.33	34.02	0.47
C & E Loss (ft)	0.09	Cum SA (acres)	0.42	9.07	0.64

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 142

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1640.7	3.6	1641.1	14.3	1646.2	21.4	1645.5	35.7	1637.3
42.8	1627.6	49.9	1622.7	60.6	1613	67.8	1608.8	78.5	1602.4
85.6	1596	92.8	1594	107	1594.2	124.9	1593.7	142.7	1594.9
174.8	1599.5	185.5	1600.8	192.6	1602.3	203.3	1602.3	214	1603.3
217.6	1604.2	228.3	1609.1	235.4	1610.7	246.1	1616.8	249.7	1618.2
260.4	1620.7	264	1622.5	267.6	1629.2	271.1	1638.3	274.7	1640.8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	67.8	.08	228.3	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
67.8	228.3	370	340	310	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1604.05	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.65	Wt. n-Val.		0.080	
W.S. Elev (ft)	1601.40	Reach Len. (ft)	370.00	340.00	310.00
Crit W.S. (ft)	1601.40	Flow Area (sq ft)		574.71	
E.G. Slope (ft/ft)	0.055595	Area (sq ft)		574.71	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	108.73	Top Width (ft)		108.73	
Vel Total (ft/s)	13.06	Avg. Vel. (ft/s)		13.06	
Max Chl Dpth (ft)	7.70	Hydr. Depth (ft)		5.29	
Conv. Total (cfs)	31833.9	Conv. (cfs)		31833.9	
Length Wtd. (ft)	340.00	Wetted Per. (ft)		111.60	
Min Ch El (ft)	1593.70	Shear (lb/sq ft)		17.87	
Alpha	1.00	Stream Power (lb/ft s)		233.45	
Frctn Loss (ft)	12.69	Cum Volume (acre-ft)	0.33	28.57	0.47
C & E Loss (ft)	0.53	Cum SA (acres)	0.42	8.21	0.64

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 141

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1698	46.3	1690.7	99.6	1680.2	121	1677.5	138.8	1668.4
163.7	1670.5	177.9	1660.4	188.6	1657.8	209.9	1645.4	220.6	1641.7
256.2	1635.5	270.4	1627.1	281.1	1614.2	323.8	1589.6	338	1584.1
384.3	1584.8	455.4	1583.1	551.5	1583.7	569.3	1584.5	590.6	1592.1
612	1592.7	647.5	1597.2	665.3	1595.5	693.8	1602.6	715.1	1609.9
743.6	1616.3	772.1	1636.1	797	1643.8	832.6	1663.4	871.7	1661

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	281.1	.08	715.1	.05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
281.1 715.1 250 340 405 .1 .3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1588.86	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.89	Wt. n-Val.		0.080	
W.S. Elev (ft)	1587.97	Reach Len. (ft)	250.00	340.00	405.00
Crit W.S. (ft)	1587.00	Flow Area (sq ft)		991.75	
E.G. Slope (ft/ft)	0.026773	Area (sq ft)		991.75	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	250.99	Top Width (ft)		250.99	
Vel Total (ft/s)	7.57	Avg. Vel. (ft/s)		7.57	
Max Chl Dpth (ft)	4.86	Hydr. Depth (ft)		3.95	
Conv. Total (cfs)	45873.7	Conv. (cfs)		45873.7	
Length Wtd. (ft)	340.00	Wetted Per. (ft)		252.36	
Min Ch El (ft)	1583.10	Shear (lb/sq ft)		6.57	
Alpha	1.00	Stream Power (lb/ft s)		49.71	
Frctn Loss (ft)	9.38	Cum Volume (acre-ft)	0.33	22.45	0.47
C & E Loss (ft)	0.07	Cum SA (acres)	0.42	6.80	0.64

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 140

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1661.6	3.6	1660.6	32	1643.9	46.2	1642.7	71.1	1636
99.6	1638.5	110.2	1635.7	124.5	1629.2	135.1	1619.3	145.8	1615.2
152.9	1607.6	160	1604.5	177.8	1592.8	188.5	1585.6	209.8	1578.8
252.5	1580.6	277.4	1578.9	302.3	1584.8	316.5	1585.9	359.2	1575.8
416.1	1575.2	633	1575.7	700.6	1576.3	729.1	1577.5	750.4	1583.4
782.4	1596.8	803.7	1599.6	850	1601.2	878.4	1605.7	903.3	1614.1

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	177.8	.08	750.4	.05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
177.8 750.4 480 400 330 .1 .3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1579.39	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.66	Wt. n-Val.		0.080	
W.S. Elev (ft)	1578.74	Reach Len. (ft)	480.00	400.00	330.00
Crit W.S. (ft)		Flow Area (sq ft)		1155.73	
E.G. Slope (ft/ft)	0.028462	Area (sq ft)		1155.73	
Q Total (cfs)	7506.00	Flow (cfs)		7506.00	
Top Width (ft)	386.79	Top Width (ft)		386.79	
Vel Total (ft/s)	6.49	Avg. Vel. (ft/s)		6.49	
Max Chl Dpth (ft)	3.54	Hydr. Depth (ft)		2.99	
Conv. Total (cfs)	44491.7	Conv. (cfs)		44491.7	
Length Wtd. (ft)	399.09	Wetted Per. (ft)		387.33	
Min Ch El (ft)	1575.20	Shear (lb/sq ft)		5.30	
Alpha	1.00	Stream Power (lb/ft s)		34.43	
Frctn Loss (ft)	5.23	Cum Volume (acre-ft)	0.33	14.07	0.47
C & E Loss (ft)	0.14	Cum SA (acres)	0.42	4.31	0.64

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: RIVER-1

REACH: Reach-1 RS: 139

INPUT
Description: Downstream Analysis Boundary (SFHA Boundary Muddy River)
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
7.1	1587.2	57	1581.8	67.7	1576.6	96.2	1572.9	142.6	1572.8
163.9	1574.3	192.5	1582.1	245.9	1583.9	263.7	1582.6	285.1	1576.9
317.2	1580.2	338.6	1579.9	395.6	1572.9	420.6	1571.1	545.3	1569.7
670	1569.7	937.3	1571.2	948	1572.3	973	1577.2	1062.1	1574.8
1083.5	1572.6	1101.3	1574.2	1190.4	1573.4	1208.2	1570.4	1233.2	1575.4
1268.8	1572.3	1293.7	1574.5	1347.2	1573.5	1375.7	1583.3	1386.4	1584.1

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
7.1	.05	395.6	.08	948	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
395.6	948	0	0	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	1574.03	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.20	Wt. n-Val.	0.050	0.080	0.050
W.S. Elev (ft)	1573.82	Reach Len. (ft)			
Crit W.S. (ft)	1572.12	Flow Area (sq ft)	59.18	1909.29	124.05
E.G. Slope (ft/ft)	0.007501	Area (sq ft)	59.18	1909.29	124.05
Q Total (cfs)	7506.00	Flow (cfs)	136.12	7020.01	349.87
Top Width (ft)	795.71	Top Width (ft)	75.49	552.40	167.81
Vel Total (ft/s)	3.59	Avg. Vel. (ft/s)	2.30	3.68	2.82
Max Chl Dpth (ft)	4.12	Hydr. Depth (ft)	0.78	3.46	0.74
Conv. Total (cfs)	86667.5	Conv. (cfs)	1571.7	81056.1	4039.7
Length Wtd. (ft)		Wetted Per. (ft)	75.64	552.53	168.86
Min Ch El (ft)	1569.70	Shear (lb/sq ft)	0.37	1.62	0.34
Alpha	1.02	Stream Power (lb/ft s)	0.84	5.95	0.97
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

Warning: Divided flow computed for this cross-section.

SUMMARY OF MANNING'S N VALUES

River:RIVER-1

Reach	River Sta.	n1	n2	n3
Reach-1	148.7	.05	.08	.05
Reach-1	148.6	.05	.08	.05
Reach-1	148.5	.05	.08	.05
Reach-1	148.3	.05	.08	.05
Reach-1	148	.05	.08	.05
Reach-1	147	.05	.08	.05
Reach-1	146	.05	.08	.05
Reach-1	145	.05	.08	.05
Reach-1	144	.05	.08	.05
Reach-1	143	.05	.08	.05
Reach-1	142	.05	.08	.05
Reach-1	141	.05	.08	.05
Reach-1	140	.05	.08	.05
Reach-1	139	.05	.08	.05

SUMMARY OF REACH LENGTHS

River: RIVER-1

Reach	River Sta.	Left	Channel	Right
Reach-1	148.7	50	50	50
Reach-1	148.6	50	50	50
Reach-1	148.5	50	50	50
Reach-1	148.3	50	50	50
Reach-1	148	190	190	190
Reach-1	147	124	124	124
Reach-1	146	410.01	230.01	110.01
Reach-1	145	150	200	270
Reach-1	144	159.99	230.01	300
Reach-1	143	360	370	410
Reach-1	142	370	340	310
Reach-1	141	250	340	405
Reach-1	140	480	400	330
Reach-1	139	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: RIVER-1

Reach	River Sta.	Contr.	Expan.
Reach-1	148.7	.1	.3
Reach-1	148.6	.1	.3
Reach-1	148.5	.1	.3
Reach-1	148.3	.1	.3
Reach-1	148	.1	.3
Reach-1	147	.1	.3
Reach-1	146	.1	.3
Reach-1	145	.1	.3
Reach-1	144	.1	.3
Reach-1	143	.1	.3
Reach-1	142	.1	.3
Reach-1	141	.1	.3
Reach-1	140	.1	.3
Reach-1	139	.1	.3

Attachment 4
Revised Dam Breach Inundation Map – 2021 Analysis

PANEL
32003C0690E
eff. 9/27/2002

PANEL
32003C0690E
eff. 9/27/2002

PANEL
32003C0670E
eff. 9/27/2002

REID
GARDNER
STATION

PANEL
32003C0670E
eff. 9/27/2002

PANEL
32003C0690E
eff. 9/27/2002

PANEL
32003C0690E
eff. 9/27/2002

POND
M5

POND
M7

UPRR

Hidden Valley Road

Legend
- Dam Breach Inundation
- Parcel Boundary with Parcel Number
- Existing Structure
- RAS Cross Sections (ID Number on Top)
- NFHL Data Available
- FIRM Panels
- Topographic Low Confidence Areas
- River Mile Markers
- Base Flood Elevations
- Water Lines
- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee
- Area with Risk Due to Levee

N

0 0.075 0.15 0.3 0.45 0.6 Miles

FIGURE 1 - REID GARDNER STATION MAP

Hazard Assessment - M5 & M7 Pond Breach Inundation
Reid Gardner Station

NVEnergy
Jacobs