EXHIBIT B

Report of Robert S. Young, PhD, PG ("Young Report")

A Scientific Analysis of the Environmental Assessment: Nimmo Parkway Phase VII-B

A Scientific Analysis of the Environmental Assessment: Nimmo Parkway Phase VII-B

Robert S. Young, PhD, PG

Brief Bio

The author is a coastal geologist, hazards specialist, and sea level rise/storm surge expert. He is director of the Program for the Study of Developed Shorelines, a Western Carolina University/Duke University joint project. Dr. Young grew up in the Tidewater, Virginia area and recently served the Commonwealth as a member of the Technical Advisory Committee for the Virginia Coastal Resilience Master Plan.

Introduction

On behalf of the Southern Environmental Law Center ("SELC"), I have reviewed the Draft Environmental Assessment ("Draft EA") for the proposed Nimmo Parkway Phase VII-B project ("Proposed Project") that was prepared by the Virginia Department of Transportation and the Department of Public Works of the City of Virginia Beach and is dated May 2022. I have also reviewed the Natural Resources Technical Report ("NR Report") and the Indirect and Cumulative Effects Technical Report ("ICE Report") that are included within Appendix C of the Draft EA and dated are February 2021 and February 2020, respectively. This report summarizes my observations and findings with respect to the analyses of the Proposed Project's impacts on flooding and hydrology included in those documents. In short, the documents are lacking in necessary detail and even basic analysis in the most critical areas of potential impacts, and the Proposed Project's impacts on flooding and hydrology are likely to be significant.

The Draft EA[1] Ignores How the Proposed Project Would Significantly Increase Flood Risk from Storm Surge and Wind-Driven Flooding

Any effort to properly assess the potential of the Proposed Project to increase flood water elevations and exacerbate flood risk in the surrounding area must include careful consideration of how the Proposed Project could influence flooding that is caused by coastal storm surges and winds. The Draft EA concludes that the proposed project would not pose a substantial flooding risk,[2] but I have been unable to find any indication that storm surge and wind-tides have been considered in the Draft EA's flooding analysis. As I discuss further below, based on my analysis and knowledge of the hydrological conditions in this area—both current conditions and future conditions that account for the ongoing effects of climate change—I anticipate that the Proposed Project would alter storm surge from tropical storms tracking south to north along the coast, as well as wind-driven flooding from seasonal wind events, especially in combination with Nimmo Parkway Phase VII-A.[3] Further, those alterations would place homes and other private property

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[1] Unless otherwise noted, my use of the term "Draft EA" in this report refers to the Draft Environmental Assessment, the Natural Resources Technical Report, and the Indirect and Cumulative Effects Technical Report.
[2] Draft EA at 25, 46, 77; NR Technical Report at 19-20; ICE Technical Report at 35.
[3] I understand that the City is proposing to connect the proposed Nimmo Parkway Phase VII-B project with the Nimmo Parkway Phase VII-A project. I also understand that the Nimmo VII-A project will be constructed on top of fill to an elevation that will at least equal the Base Flood Elevation plus an additional three feet, and that all existing culvert crossings of Sandbridge Road in the VII-A corridor will be maintained by the VII-A project.

at significantly greater risk from flooding and storm damage during those events than they are under current conditions, and there is no analysis in the Draft EA that supports a conclusion of no significant impact.

It appears to me that the Draft EA assumes that all water in the vicinity of the Proposed Project would be conveyed through Asheville Bridge Creek and other smaller conveyances such as ditches. This is a reasonably accurate assumption during typical precipitation events, but it is not accurate when water levels are elevated in the area as a result of wind-driven tides or coastal storms generating storm surge. During these events, water also moves across this wetland floodplain as broad surface flow, and typically from south to north. Asheville Bridge Creek and other smaller conveyances are not adequate to convey all of the flow during these events.

The proposed project would place what will effectively be a large dam across this significant floodway. When the area is impacted by storm surge, strong wind tides, and other events that can generate surface flow across this wetland floodplain, the Proposed Project would interrupt the movement of the water, raising the elevation of the surge or floodwater to the south of the project.

Further, the project would not need to raise the surge or wind-driven flooding by a significant amount before nearby properties would be impacted by the resulting increase in flood levels. To illustrate this point, I used a Light Detection and Radar ("LiDAR")-derived Digital Elevation Model (NGS, 2019) to create the graphic labeled "Potential Surge Impact of Proposed Project" that I have attached to my report as Exhibit 1. This is a simple elevation-based assessment demonstrating that the Proposed Project need only have a small impact on flood water elevation to generate flooding in adjacent neighborhoods, primarily in those colored areas that are directly connected to the existing FEMA AE Zone.

The areas in Exhibit 1 that are <u>not</u> shown in the red, orange, or yellow shading are all, at most, 1 foot above the projected Base Flood Elevation ("BFE") (of 3 feet), and they are therefore already vulnerable to flooding from an estimated 100-year storm. These are mostly natural, undeveloped areas that are part of the Back Bay National Wildlife Refuge.

The areas shown in red on Exhibit 1 are between 1 to 3 feet above the projected Base Flood Elevation, and the areas shown in orange are between 3 to 5 feet above the projected Base Flood Elevation. These red and orange areas largely consist of homes, neighborhoods, and other development, and they are currently not predicted to flood during a 100-year storm.

However, if the Proposed Project raised the surge from the 100-year storm by 1 to 3 feet above that current BFE, most of the areas shown in red on Exhibit 1 would now flood. If the Proposed Project raised the flood levels from 3 to 5 feet above the current BFE, most of the areas shown in orange on Exhibit 1 would now flood.

Based on the project description provided in the Draft EA, it is reasonable to anticipate that the Proposed Project would increase the surge from a moderate-sized storm by several feet, particularly in combination with the Nimmo Parkway Phase VII-A project. In summary, the Proposed Project would increase storm surge and flooding for properties to the east (in

Sandbridge), the west (Lago Mar neighborhood), and in areas to the south of the project. These are significant impacts that should be studied in detail as part of any responsible review of this proposal.

The draft EA concludes, to the contrary, that "[t]he Build Alternative would not pose a substantial flooding risk[;] nor is it anticipated that the Build Alternative would substantially increase flood elevations, the probability of flooding, or the potential for property loss or hazard to life."[4] But there is almost no analysis in the Draft EA to support this conclusion. The only purported analysis offered in any of those documents to support the conclusion is a reference to a "[p]reliminary hydrologic and hydraulic analysis" that reportedly "showed no significant impact to hydrology (0.01' increase for the 10, 25, 50, and 100- year storms and 0.02' increase for the 500- year storm) in the vicinity associated with the Build Alternative."[5]

SELC requested a copy of this "preliminary hydrologic and hydraulic analysis" from the City of Virginia Beach and the Federal Highway Administration, and I understand that they were provided with the document that I have attached to my report as Exhibit 2. After reviewing this printout, it appears to me to be output from the Hydrologic Engineering System's River Analysis System—a model that is used to assess potential changes to river levels resulting from various scenarios, such as building a bridge across the river. Based on my review, the City's "preliminary hydrologic and hydraulic analysis" simply indicates that the proposed bridge over Ashville Bridge Creek that is being considered as part of the Proposed Project would not significantly impact the hydrology of Ashville Bridge Creek. The model, and its resulting output, do not allow for an assessment of the large-scale changes to the hydrology of the larger wetland system in the vicinity of the Proposed Project that would occur as a result of placing a major barrier to surface flow across the vast majority of the floodway. As such, these data have no relevance to the impact that the non-bridged portion of the Proposed Project would have on storm surge or wind-driven flooding—either as an individual project or in combination with the Nimmo Parkway Phase VII-A project. They certainly do not support a conclusion that the project would not substantially increase flood elevations or flood risk during coastal storms and wind-driven flooding in the surrounding area. To the contrary, I anticipate that the Proposed Project would substantially increase the risk of flooding during coastal storms and wind-driven flooding affecting this area.

The same paragraph of the Draft EA that mentions the "preliminary hydrologic and hydraulic analysis" also states that "three circular culverts are proposed, starting at approximately 1,200 feet east of the Atwoodtown Road and Nimmo Parkway intersection, to maintain an opening for the existing man-made ditches that are crossed by the roadway section."[6] To the extent that the Draft EA is flagging the possible inclusion of these culverts as somehow addressing potential hydrological or flooding impacts of the Proposed Project, it is important to note that the simple addition of three culverts lined up with existing ditches would not address any of the hydrological or flood concerns discussed in this report.

[4] Draft EA at 46.
[5] Draft EA at 44.
[6] Draft EA at 44.

Further, the Draft EA fails to assess the potential for damage to adjacent property, or to the Proposed Project itself, from waves resulting from storm surge, and how the Proposed Project could exacerbate that risk. The section of the Draft EA describing the existing conditions of the floodplains in the area of the project states:

> The study area is located within the FEMA Flood Zone AE with a flood elevation of +3.0 NAVD88, on the western portion of the corridor, and +4.0 NAVD88 on the eastern portion of the corridor, per the Flood Insurance Rate Map (FIRM) revised January 16, 2015. Ashville Bridge Creek is not affected by wave velocity coming from North Bay, as indicated on the FIRM.[7]

Based on this description, it appears to me that the Draft EA is assuming that since the Proposed Project would not be located within the FEMA Flood Zone VE, it would not experience wave impact from storm surge. However, this is not true. Areas within a FEMA Flood Zone AE (which is the FEMA Flood Zone in which the Proposed Project is located) may have storm waves up to 3 feet on top of any flood-elevated water.[8] Elevated storm surge from the Proposed Project would allow waves to reach areas that were not previously exposed, and it would also allow larger waves to impact areas within the current flood zones. Yet the Draft EA includes no wave study examining how waves, combined with elevated storm surge resulting from the Proposed Project, could impact nearby property—including the foundations of homes. There is also no analysis for how those waves may impact the Proposed Project itself. The first big storm that pushes surge from the south may significantly erode the earthen structure supporting the road. This would result in a need to armor the roadway at significant expense.

In short, the analysis provided in the Draft EA is irrelevant to the concerns I raise in this report, and it is clearly inadequate to support its conclusion that the Proposed Project would not pose a substantial flooding risk, substantially increase the probability of flooding, or substantially increase the potential for property loss or hazard to life during coastal storms and related flooding. As discussed, I anticipate that the Proposed Project in fact would likely place homes and other private property at substantially greater risk from flooding and storm damage than they are under current conditions.

<u>The Draft EA Fails to Properly Evaluate the Changes to Wetland Hydrology from the Proposed Project</u>

Table 15 in the Draft EA summarizes the estimated permanent wetland impacts from the proposed project at 9.7 acres, and this estimate is based on the planning-level limits of disturbance assessed for the project (as shown in Figures 9a, 9b, and 9c of the Draft EA).[9] According to the Draft EA, the [i]mpacts to waters and wetlands resulting from roadway construction for the Build Alternative would likely include discharges of fill material for

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[7] Draft EA at 45.

[8] FEMA's website warns of the "higher risk of damage from waves to homes and other structures in the Coastal A Zone." FEMA therefore "encourages the practice of building to V Zone standards within this area," and notes that "[m]any local building codes require that buildings in the Coastal A Zone be built to V Zone standards." https://www.fema.gov/flood-maps/coastal/insurance-rate-maps

[9] See note at the bottom of each Figure explaining that "[e]nvironmental impacts described in the EA are based on this planning level limits of disturbance."

roadway cut/fill slopes; bridge approaches and abutments; and shading impacts for the Ashville Bridge Creek crossing."[10] This appears to indicate that the 9.7 acres of wetland impacts included in Table 15 and discussed in other sections of the Draft EA include only direct impacts to wetlands that would result from construction of the road. However, the Proposed Project would also indirectly impact additional wetlands by altering hydrology within the larger wetland system surrounding the proposed road corridor. These impacts are not accounted for in the Draft EA.

The potential for indirect impacts to wetlands are mentioned in section 3.17.1.2.2 of the Draft EA and in the ICE Technical Report. However, only the latter mentions that the Proposed Project could change wetland vegetation composition and hydrology,[11] and even then it only discusses the threat to wetland hydrology in the context of potential impacts from stormwater runoff from the proposed roadway.[12] As with the discussion of direct impacts to wetlands, there is no consideration of the large-scale changes to the hydrology within the larger wetland system that the Proposed Project would cause, or how those changes could, in turn, impact other natural resources.

The Back Bay National Wildlife Refuge (BBNWR) protects a wide variety of wetland ecosystems, all in equilibrium with current hydrological conditions. The hydrology is complex. Water enters the system largely from the north and south. These coastal wetlands are also supported by a near-surface water table which is rising over time as sea level continues to rise. Wind tides bring water in from the south, primarily seasonally (summer). Large precipitation events can bring water down from the north through manmade and natural conveyances. Flood events of all kinds can generate surface flow in either direction.

As discussed above, the proposed project would literally block this north-south exchange of water across BBNWR outside of Ashville Bridge Creek and a few small conveyances. This would change the local hydrology—the hydrology to which all current wetland ecosystems are adapted. In conjunction with the Nimmo Parkway Phase VII-A project, the larger basin between North Bay and Lake Tecumseh would be divided into two smaller basins, with each now responding to different hydrological conditions altered by the Proposed Project. When the Proposed Project changes the hydrology, either permanently or seasonally (especially with high water during the growing season), the nature of this mosaic of ecosystems will change, along with the wildlife habitat within.

In short, the impacts to protected wetland ecosystems could be significant (even disastrous), both from the Proposed Project alone and in combination with the Nimmo Parkway Phase VII-A project. In light of this, and in order to properly evaluate impacts to this important national wildlife refuge, there must be a detailed hydrological study of the area to elucidate the potential impacts of such a major hydrologic block within BBNWR. Changing the way the water moves around, the depth of flooding, the duration of flooding and even the direction of flow would change the nature and viability of all natural resources within the larger project area. Without this analysis, all conclusions regarding potential impacts to natural resources are incomplete and likely inaccurate.

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[10] Draft EA at 43.
[11] ICE Technical Report at 32.
[12] ICE Technical Report at 34-35.

The Draft EA Fails to Assess the Proposed Project's Vulnerability to Hurricanes

NOAA's SLOSH modeling indicates that a Category 3 hurricane occurring today would inundate the new, elevated roadway. With rising sea level, the proposed road would be inundated with smaller storms. This is not discussed or even acknowledged in the EA, and I believe it is an important fact that should not be ignored.

Robert S. Young

June 23, 2022

Exhibit 1

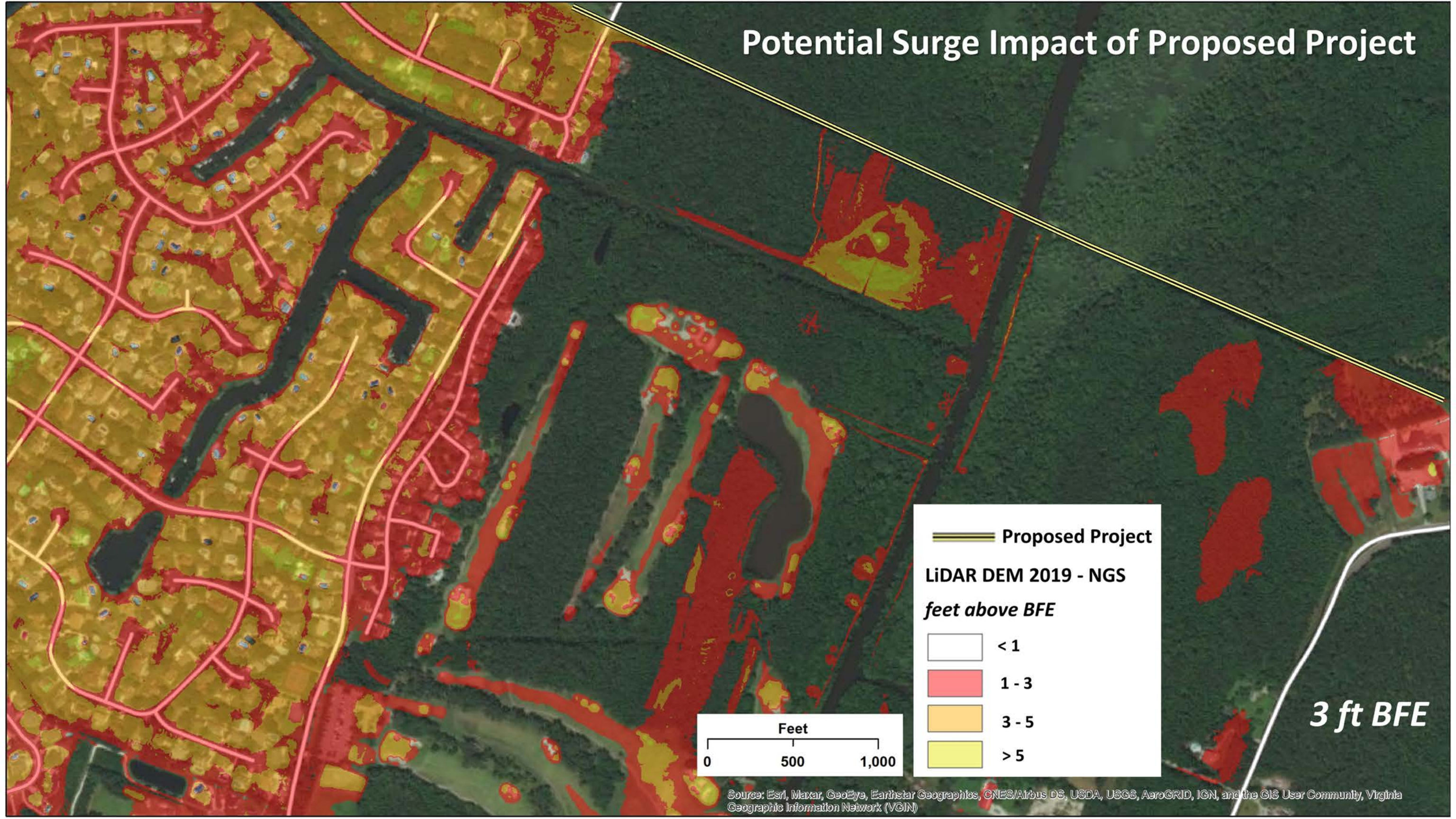
Potential Surge Impact of Proposed Project
Proposed Project
LiDAR DEM 2019 - NGS
feet above BFE
< 1
1 - 3
3 - 5
> 5
Feet
0
500
1,000
3 ft BFE
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Virginia Geographic Information Network (VGIN)

Exhibit 2

Existing Water Surface Cross Section Summary (WSE 0.0)

HEC-RAS Plan: Nimmo_existi River: h06 Reach: ASH

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)	
ASH	2084	10-year	741.00	-5.00	1.86		1.88	0.000084	1.10	1206.79	1555.01	0.09
ASH	2084	25-year	924.00	-5.00	2.28		2.30	0.000079	1.12	1995.85	2287.10	0.09
ASH	2084	50-year	1118.00	-5.00	2.40		2.42	0.000100	1.27	2284.63	2497.72	0.10
ASH	2084	100-year	1244.00	-5.00	2.65		2.67	0.000089	1.23	2948.18	2760.86	0.10
ASH	2084	500-year	1801.00	-5.00	3.48		3.49	0.000066	1.13	5555.95	3499.65	0.08
ASH	1383	10-year	741.00	-4.60	1.80		1.82	0.000078	1.08	1182.51	1132.80	0.09
ASH	1383	25-year	924.00	-4.60	2.22		2.24	0.000080	1.13	1728.37	1480.42	0.09
ASH	1383	50-year	1118.00	-4.60	2.33		2.35	0.000105	1.31	1886.28	1600.15	0.10
ASH	1383	100-year	1244.00	-4.60	2.58		2.60	0.000120	1.27	2335.62	1963.30	0.11
ASH	1383	500-year	1801.00	-4.60	3.42		3.43	0.000104	1.17	4448.37	2923.49	0.10
ASH	1260	10-year	741.00	-4.80	1.78		1.81	0.000156	1.37	918.60	748.54	0.12
ASH	1260	25-year	924.00	-4.80	2.20		2.23	0.000153	1.43	1355.54	1409.30	0.12
ASH	1260	50-year	1118.00	-4.80	2.29		2.33	0.000199	1.65	1492.62	1474.90	0.14
ASH	1260	100-year	1244.00	-4.80	2.55		2.58	0.000181	1.63	1881.96	1602.14	0.14
ASH	1260	500-year	1801.00	-4.80	3.39		3.41	0.000139	1.57	3910.06	3267.85	0.12
ASH	1210	10-year	741.00	-4.85	1.78		1.80	0.000122	1.28	841.49	651.23	0.11
ASH	1210	25-year	924.00	-4.85	2.19		2.22	0.000128	1.39	1215.78	1202.01	0.11
ASH	1210	50-year	1118.00	-4.85	2.28		2.32	0.000170	1.62	1330.67	1299.34	0.13
ASH	1210	100-year	1244.00	-4.85	2.54		2.57	0.000161	1.62	1697.03	1623.02	0.13
ASH	1210	500-year	1801.00	-4.85	3.38		3.41	0.000128	1.57	3870.43	3304.90	0.12
ASH	960	10-year	741.00	-4.90	1.72		1.76	0.000197	1.54	581.47	456.93	0.14
ASH	960	25-year	924.00	-4.90	2.14		2.18	0.000209	1.68	815.26	694.71	0.14
ASH	960	50-year	1118.00	-4.90	2.21		2.26	0.000289	1.99	866.09	743.39	0.17
ASH	960	100-year	1244.00	-4.90	2.46		2.52	0.000280	2.02	1064.66	832.56	0.17
ASH	960	500-year	1801.00	-4.90	3.31		3.36	0.000249	2.09	2387.22	2501.25	0.16
ASH	337	10-year	741.00	-5.30	1.66		1.68	0.000077	1.17	804.07	435.35	0.09
ASH	337	25-year	924.00	-5.30	2.07		2.09	0.000090	1.32	1017.30	676.43	0.10
ASH	337	50-year	1118.00	-5.30	2.11		2.14	0.000128	1.58	1045.67	713.98	0.12
ASH	337	100-year	1244.00	-5.30	2.36		2.39	0.000131	1.64	1259.75	993.61	0.12
ASH	337	500-year	1801.00	-5.30	3.20		3.25	0.000137	1.81	2907.81	2905.66	0.12
ASH	0	10-year	741.00	-5.50	1.64	-3.12	1.66	0.000070	1.09	958.06	519.94	0.09
ASH	0	25-year	924.00	-5.50	2.04	-2.82	2.06	0.000080	1.22	1220.56	874.46	0.09
ASH	0	50-year	1118.00	-5.50	2.07	-2.56	2.10	0.000115	1.46	1247.58	931.08	0.11
ASH	0	100-year	1244.00	-5.50	2.32	-2.40	2.35	0.000116	1.51	1518.73	1202.00	0.11
ASH	0	500-year	1801.00	-5.50	3.17	-1.83	3.20	0.000115	1.62	3172.44	2465.47	0.11

Existing Water Surface Cross Section Summary (WSE 3.0)

HEC-RAS Plan: Nimmo_existi River: h06 Reach: ASH

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)	
ASH	2084	10-year	741.00	-5.00	3.23		3.23	0.000015	0.54	4712.00	3304.48	0.04
ASH	2084	25-year	924.00	-5.00	3.33		3.34	0.000020	0.63	5057.76	3372.28	0.05
ASH	2084	50-year	1118.00	-5.00	3.46		3.46	0.000026	0.71	5481.75	3490.33	0.05
ASH	2084	100-year	1244.00	-5.00	3.54		3.54	0.000029	0.75	5773.84	3527.96	0.06
ASH	2084	500-year	1801.00	-5.00	3.90		3.90	0.000039	0.92	7054.92	3608.62	0.07
ASH	1383	10-year	741.00	-4.60	3.22		3.22	0.000021	0.55	3875.31	2746.56	0.05
ASH	1383	25-year	924.00	-4.60	3.31		3.32	0.000030	0.64	4150.20	2829.63	0.06
ASH	1383	50-year	1118.00	-4.60	3.43		3.44	0.000039	0.72	4492.73	2932.17	0.06
ASH	1383	100-year	1244.00	-4.60	3.51		3.52	0.000044	0.76	4731.38	2980.49	0.07
ASH	1383	500-year	1801.00	-4.60	3.86		3.87	0.000061	0.92	5825.24	3354.63	0.08
ASH	1260	10-year	741.00	-4.80	3.21		3.22	0.000031	0.72	3326.83	3181.79	0.06
ASH	1260	25-year	924.00	-4.80	3.31		3.31	0.000041	0.85	3635.89	3226.56	0.07
ASH	1260	50-year	1118.00	-4.80	3.42		3.43	0.000051	0.95	4015.85	3282.62	0.07
ASH	1260	100-year	1244.00	-4.80	3.50		3.51	0.000057	1.01	4279.31	3317.30	0.08
ASH	1260	500-year	1801.00	-4.80	3.85		3.86	0.000074	1.20	5450.21	3454.47	0.09
ASH	1210	10-year	741.00	-4.85	3.21		3.21	0.000027	0.71	3305.14	3190.07	0.05
ASH	1210	25-year	924.00	-4.85	3.30		3.31	0.000037	0.84	3613.93	3258.48	0.06
ASH	1210	50-year	1118.00	-4.85	3.42		3.43	0.000047	0.95	3995.83	3317.26	0.07
ASH	1210	100-year	1244.00	-4.85	3.50		3.51	0.000052	1.01	4260.56	3343.22	0.08
ASH	1210	500-year	1801.00	-4.85	3.84		3.86	0.000068	1.20	5432.76	3447.43	0.09
ASH	960	10-year	741.00	-4.90	3.19		3.20	0.000049	0.91	2105.16	2425.25	0.07
ASH	960	25-year	924.00	-4.90	3.28		3.30	0.000068	1.09	2326.58	2485.47	0.09
ASH	960	50-year	1118.00	-4.90	3.39		3.41	0.000086	1.24	2605.70	2559.09	0.10
ASH	960	100-year	1244.00	-4.90	3.47		3.49	0.000096	1.32	2803.50	2612.79	0.10
ASH	960	500-year	1801.00	-4.90	3.81		3.83	0.000131	1.59	3728.92	2892.73	0.12
ASH	337	10-year	741.00	-5.30	3.18		3.18	0.000024	0.75	2824.22	2849.52	0.05
ASH	337	25-year	924.00	-5.30	3.26		3.27	0.000034	0.90	3065.52	2988.86	0.06
ASH	337	50-year	1118.00	-5.30	3.36		3.37	0.000044	1.04	3380.31	3122.83	0.07
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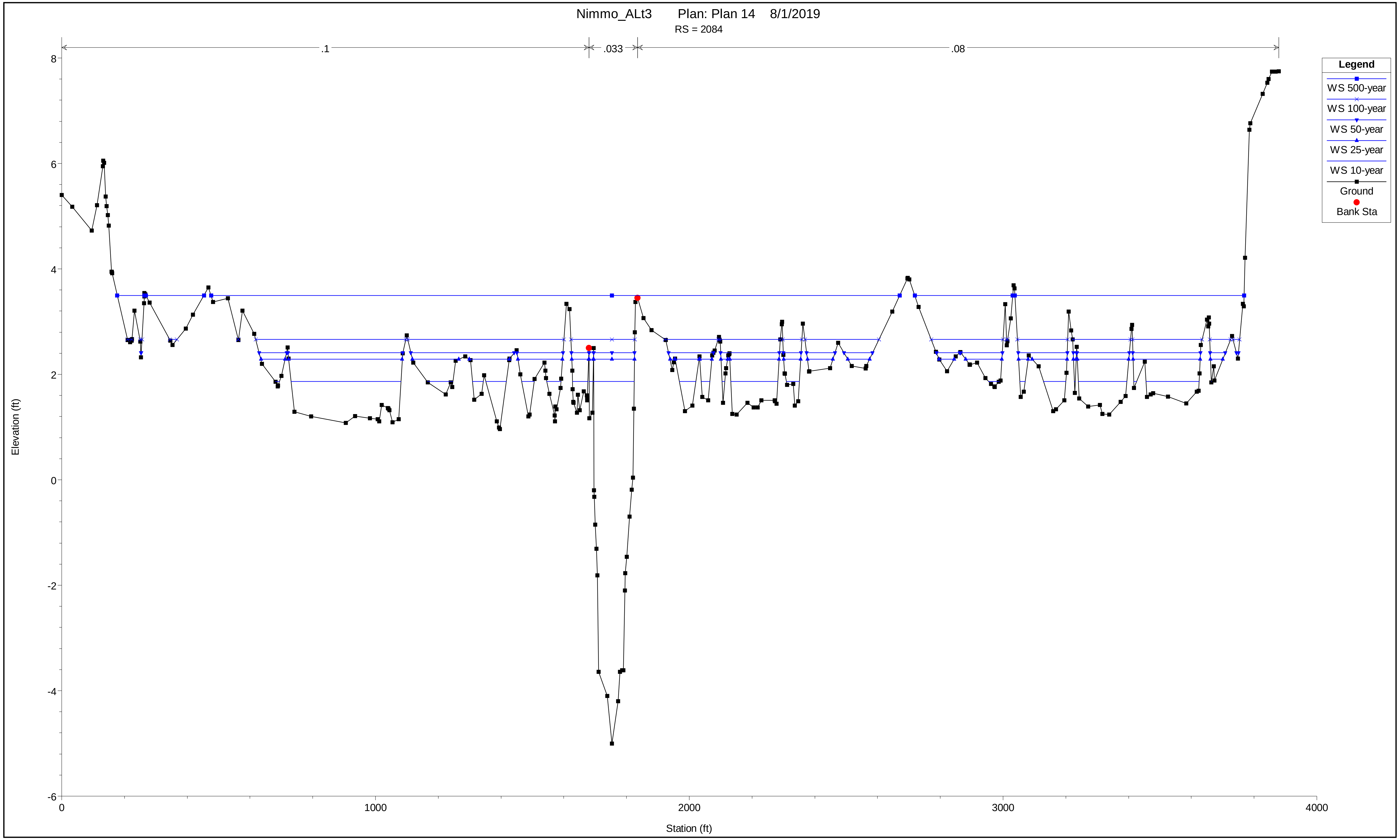
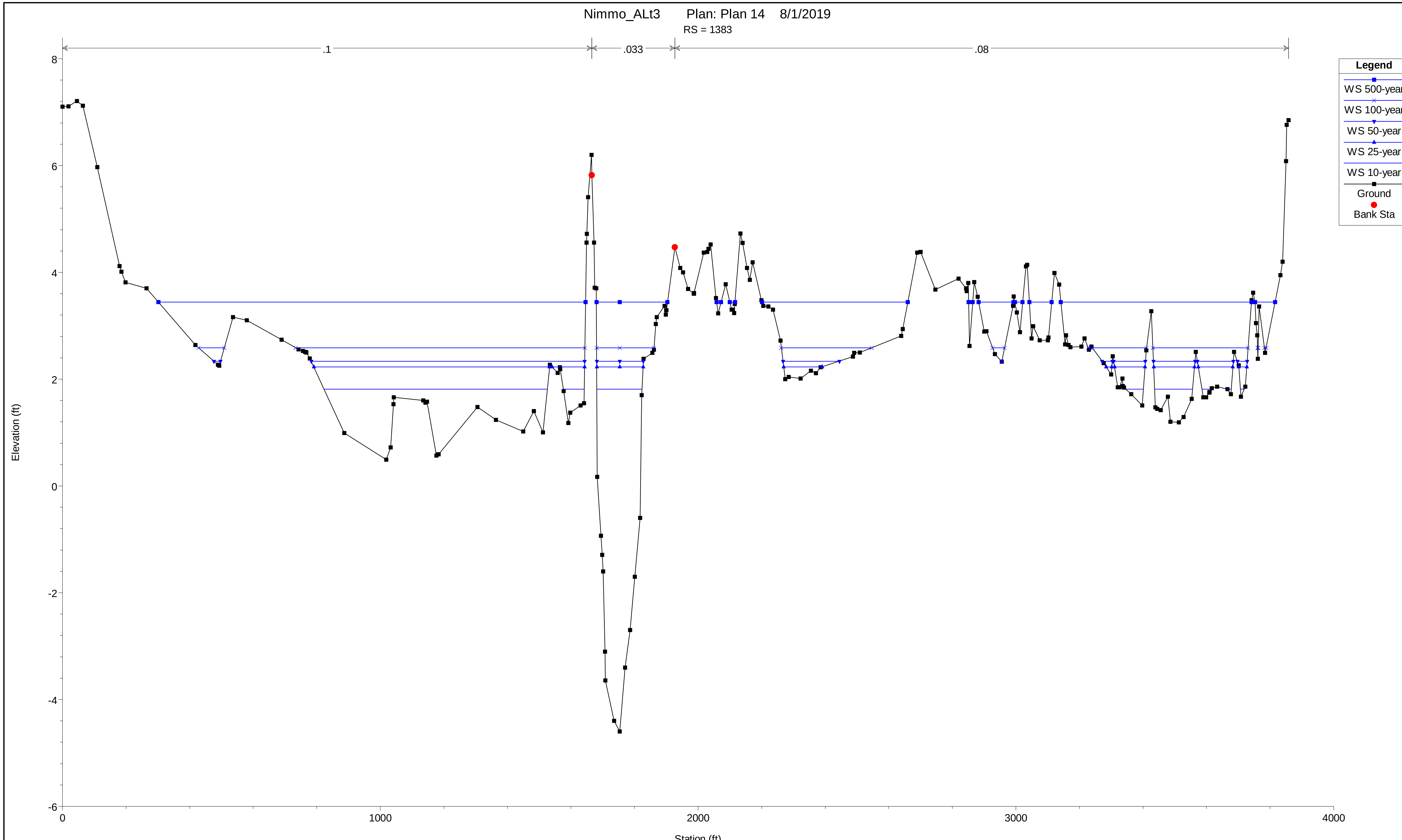
ASH	337	500-year	1801.00	-5.30	3.75		3.77	0.000075	1.38	4649.28	3368.77	0.09
ASH	0	10-year	741.00	-5.50	3.17	-3.12	3.18	0.000019	0.67	3172.44	2465.47	0.05
ASH	0	25-year	924.00	-5.50	3.25	-2.82	3.26	0.000028	0.80	3371.23	2504.11	0.06
ASH	0	50-year	1118.00	-5.50	3.35	-2.56	3.36	0.000036	0.93	3624.07	2553.29	0.06
ASH	0	100-year	1244.00	-5.50	3.42	-2.40	3.43	0.000042	1.00	3804.14	2592.65	0.07
ASH	0	500-year	1801.00	-5.50	3.73	-1.83	3.75	0.000064	1.27	4656.32	2949.91	0.09

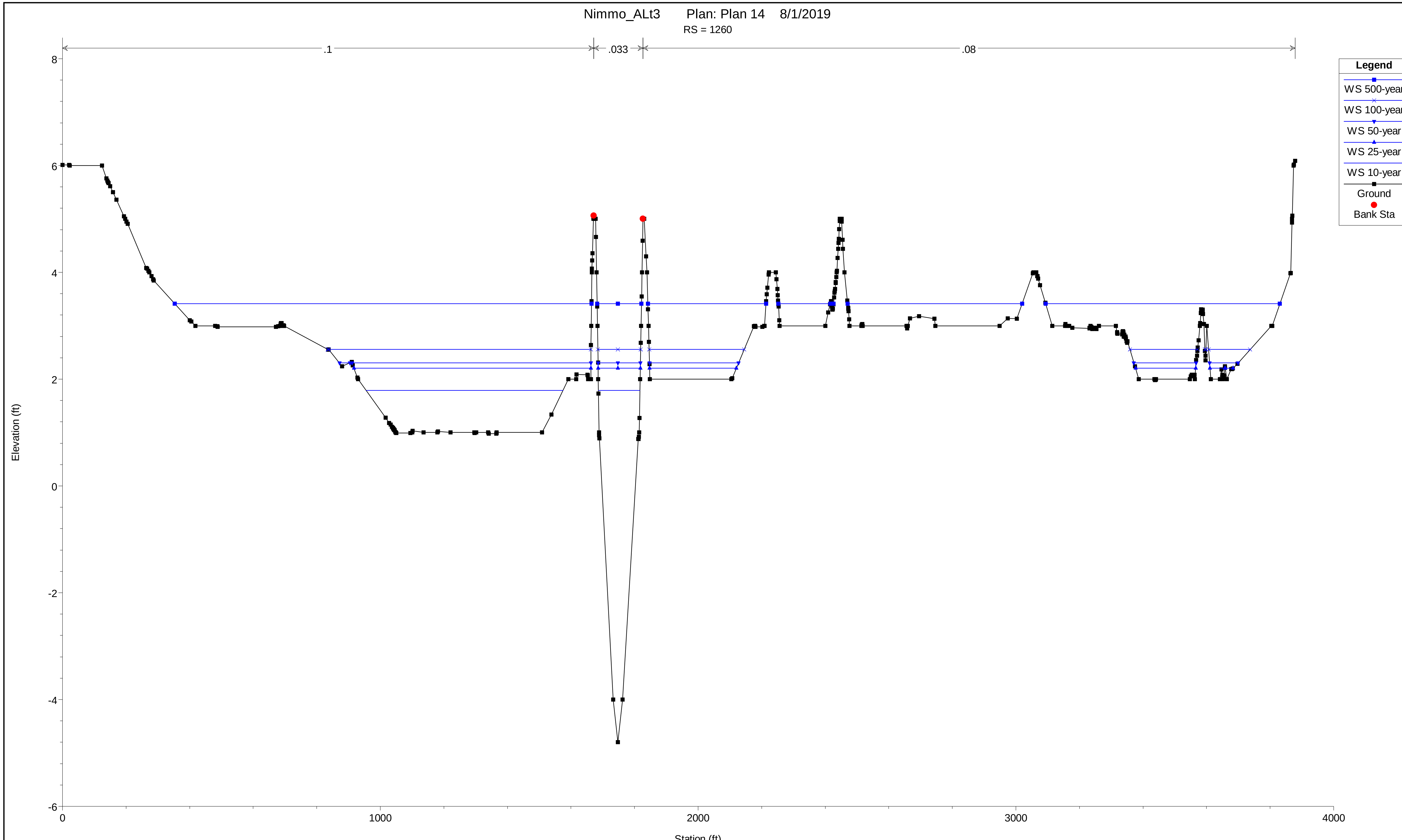
Proposed Water Surface Cross Section (WSE 0.0)



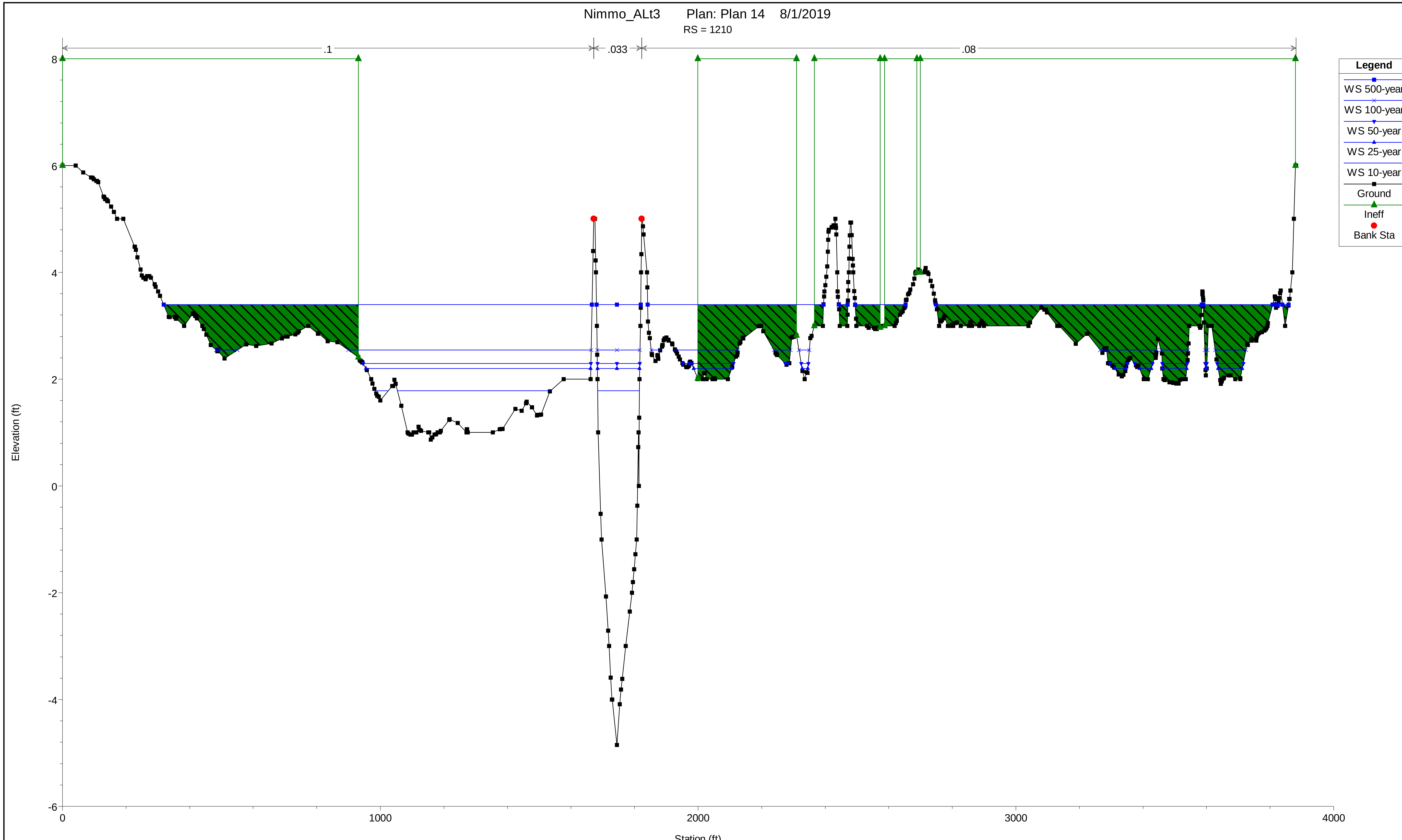
Proposed Water Surface Cross Section (WSE 0.0)



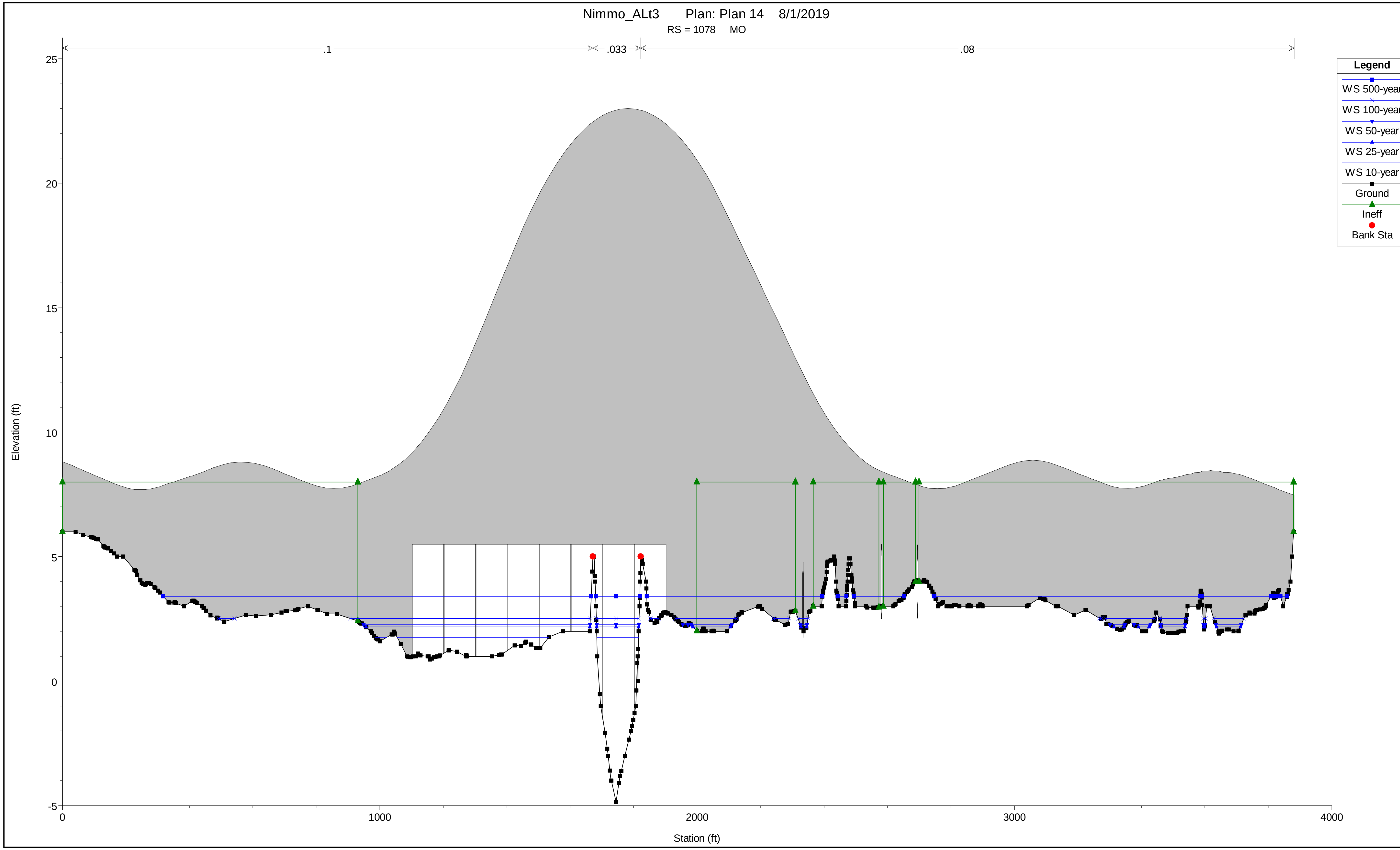
Proposed Water Surface Cross Section (WSE 0.0)



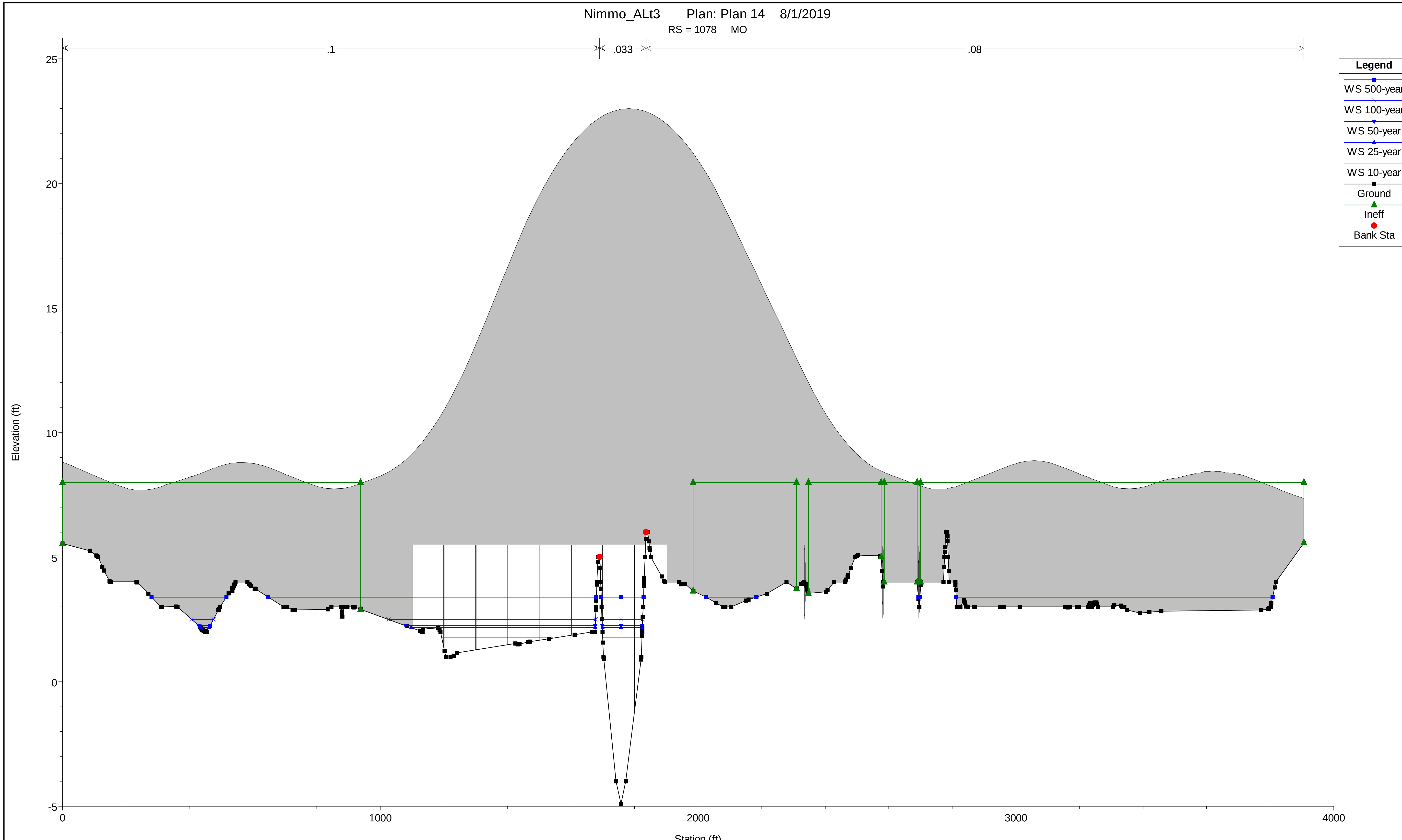
Proposed Water Surface Cross Section (WSE 0.0)



Proposed Water Surface Cross Section (WSE 0.0)



Proposed Water Surface Cross Section (WSE 0.0)



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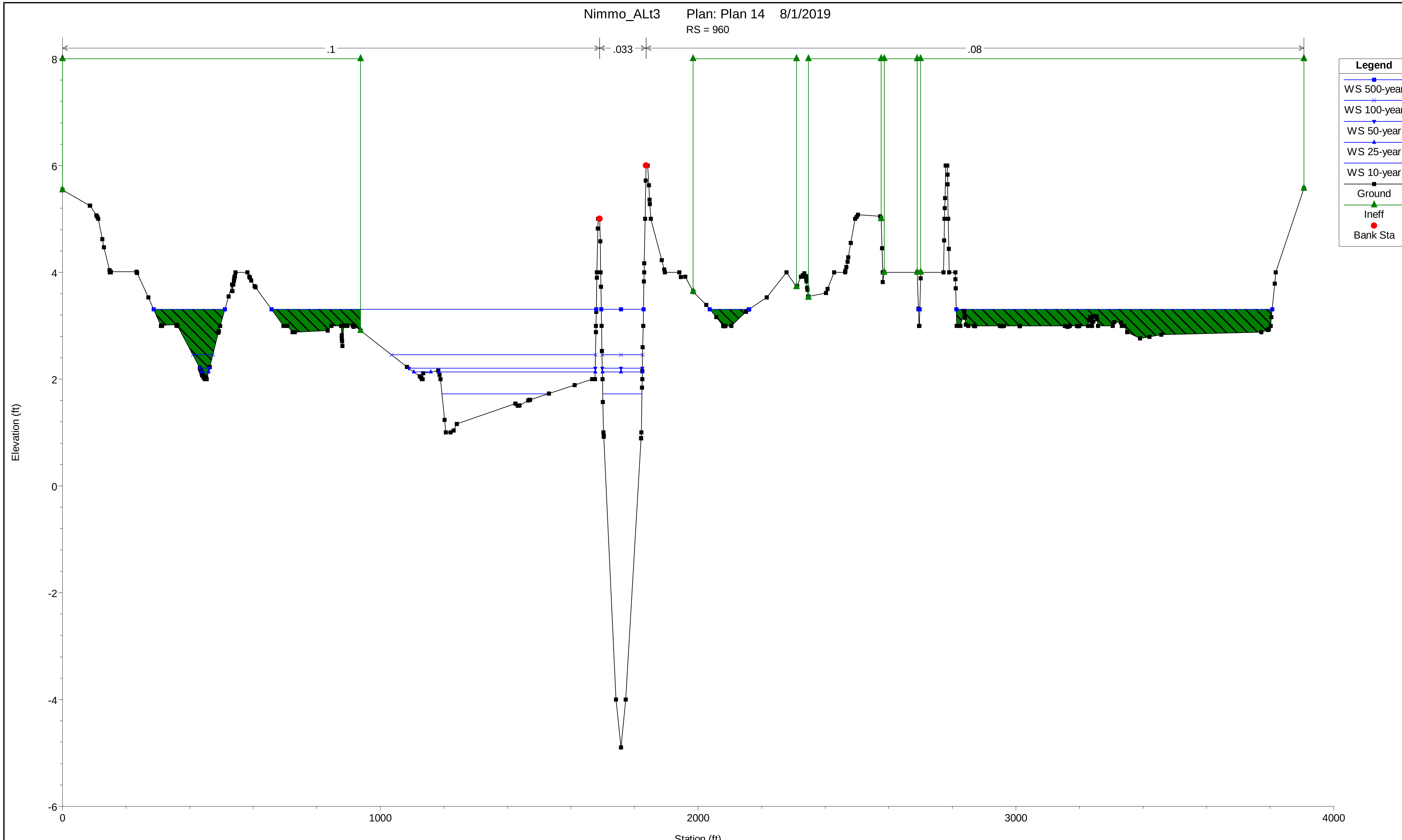
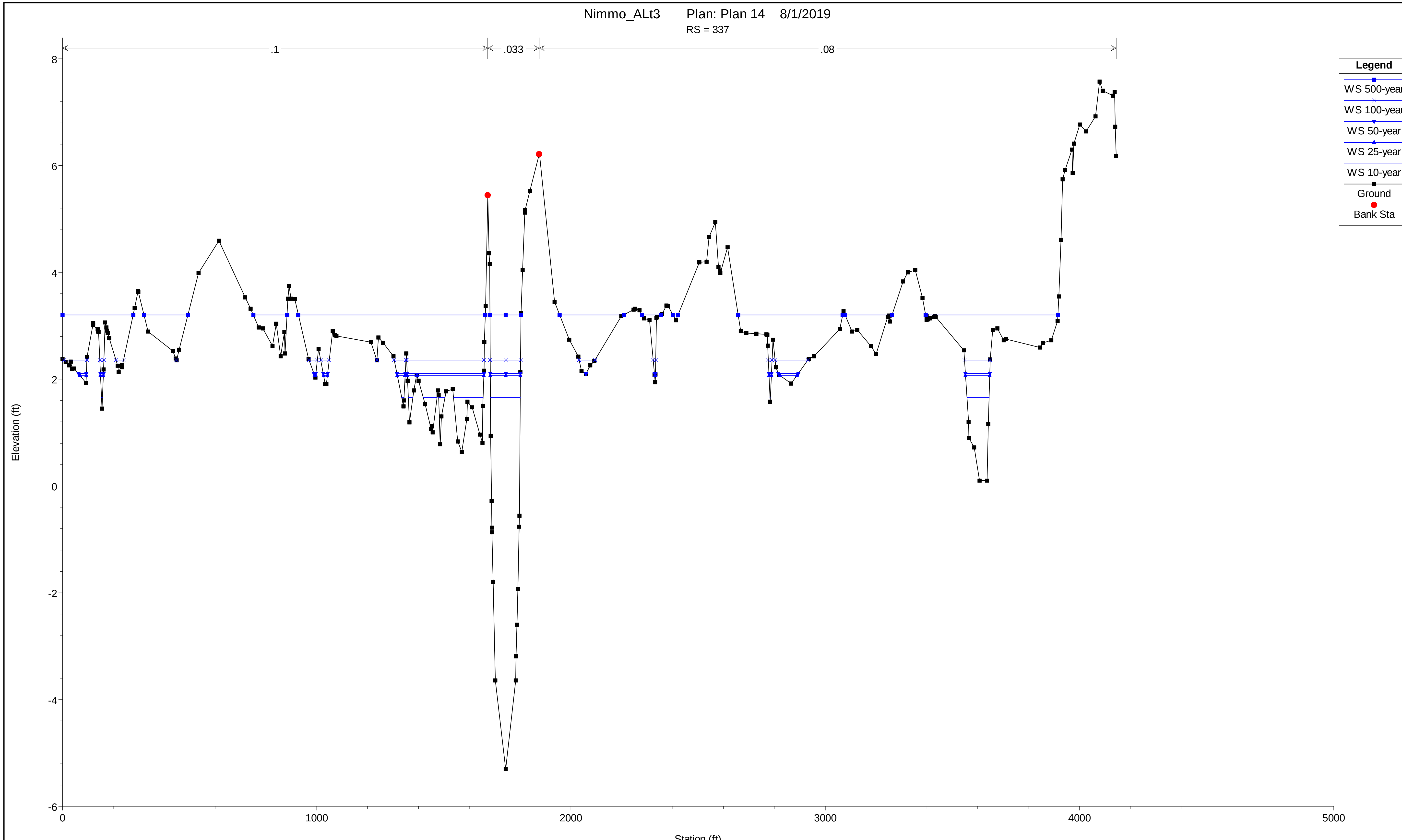


Proposed Water Surface Cross Section (WSE 0.0)



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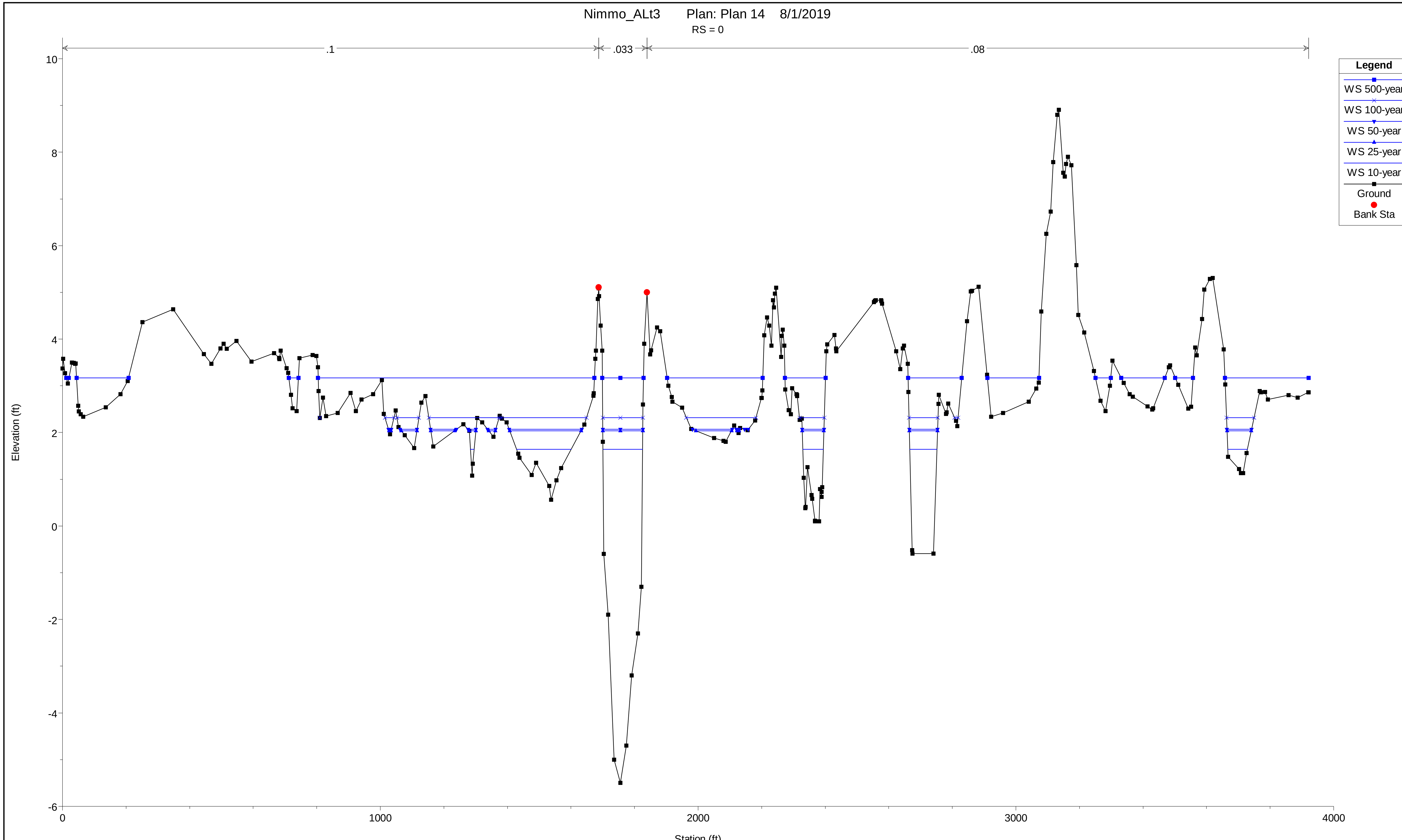

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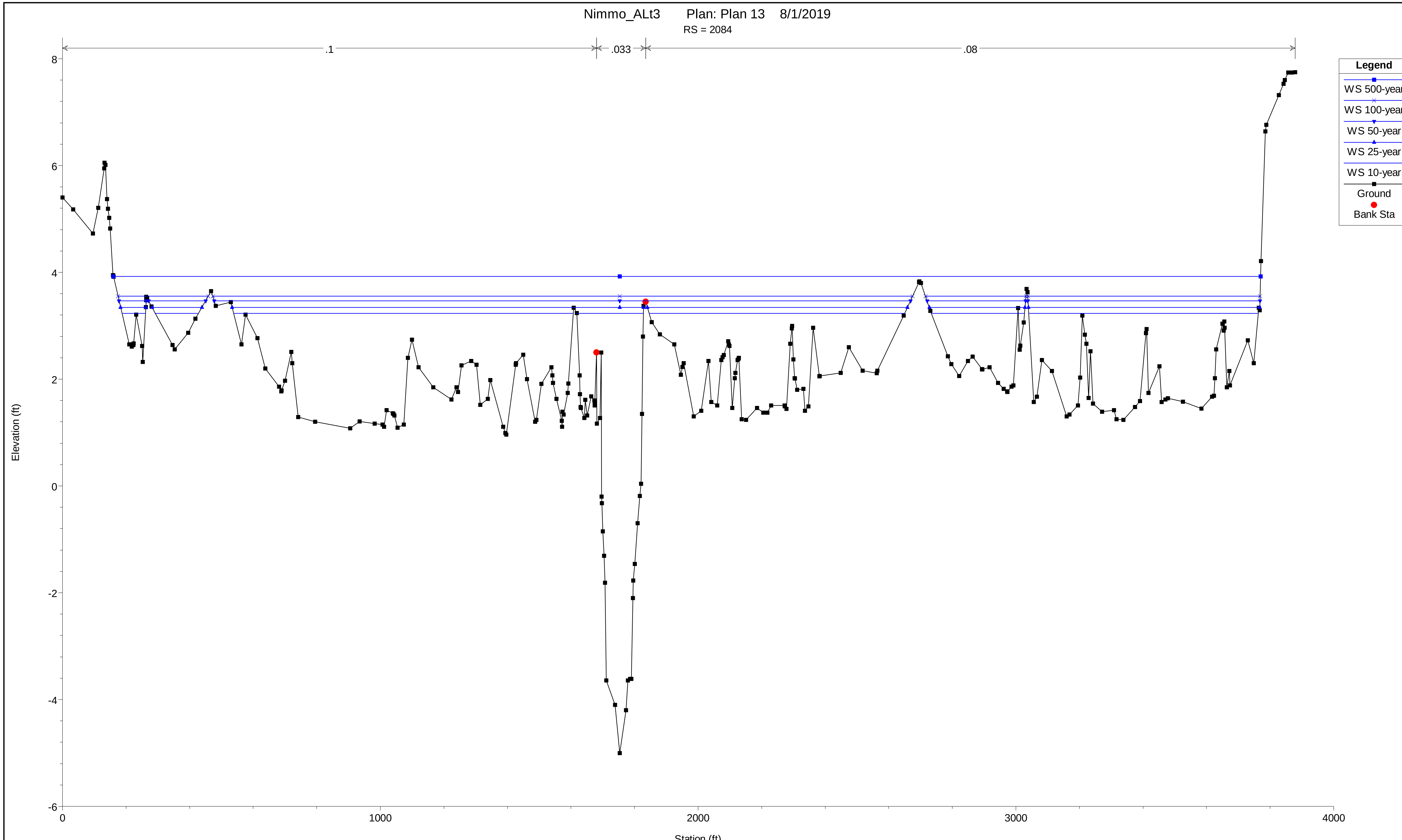

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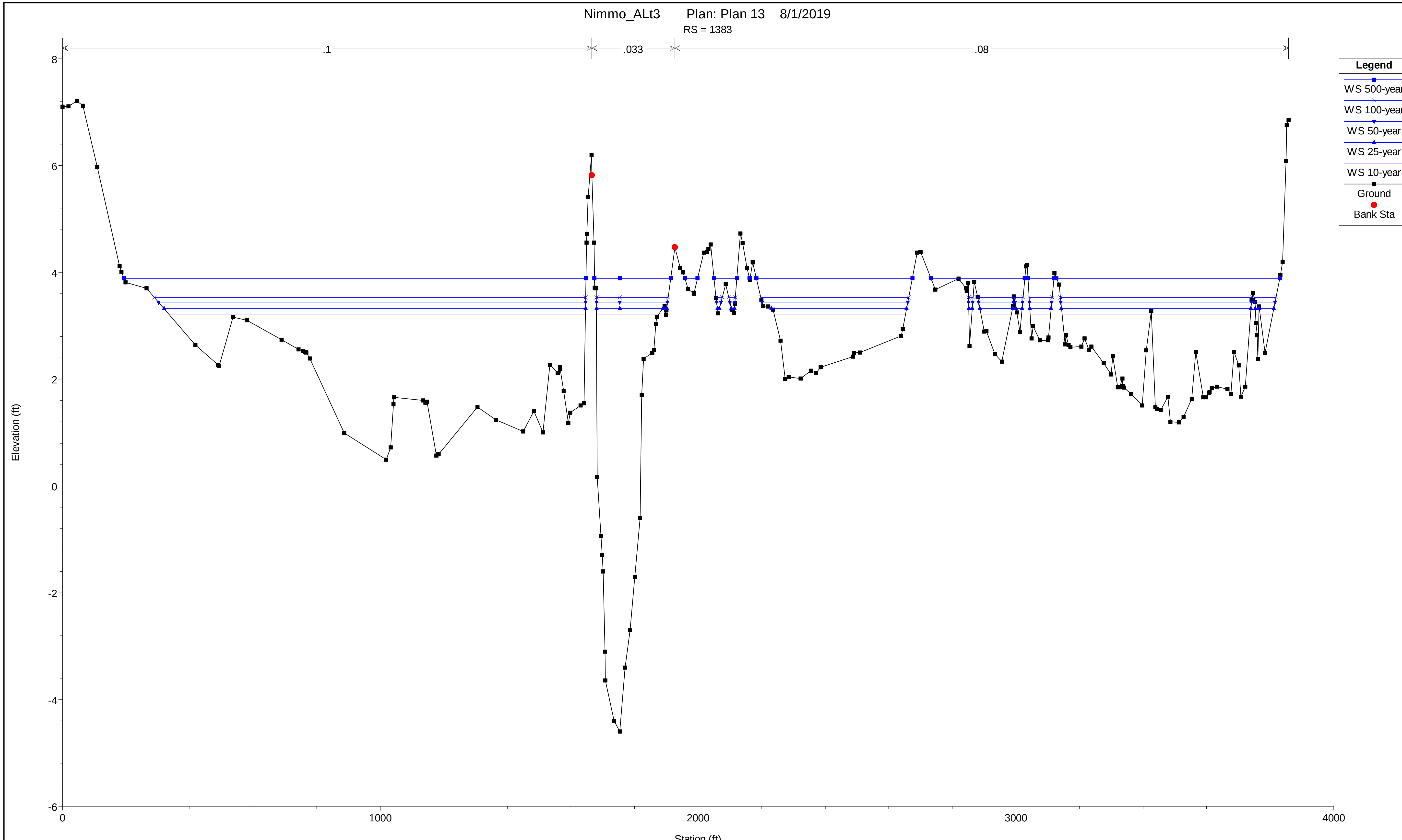

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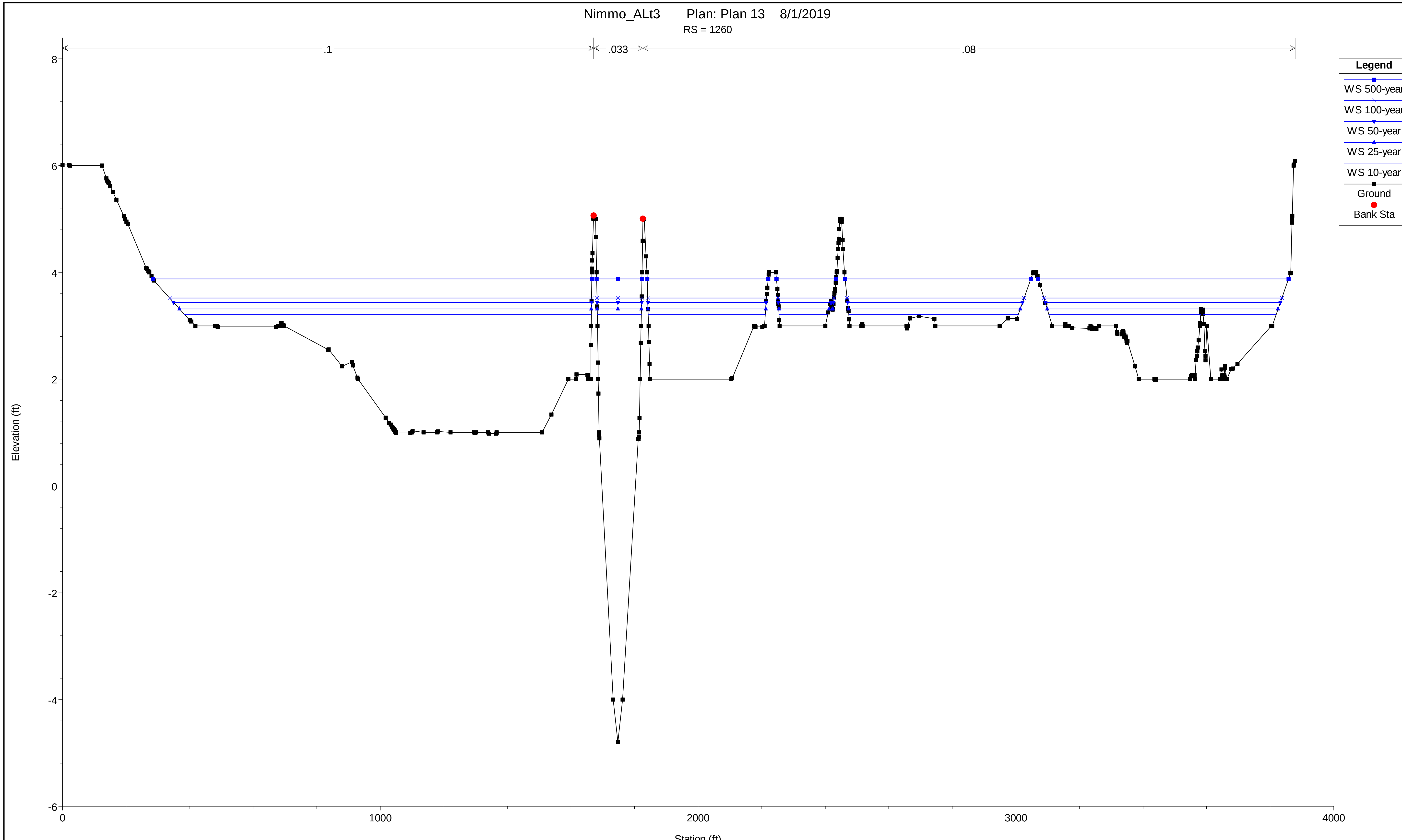

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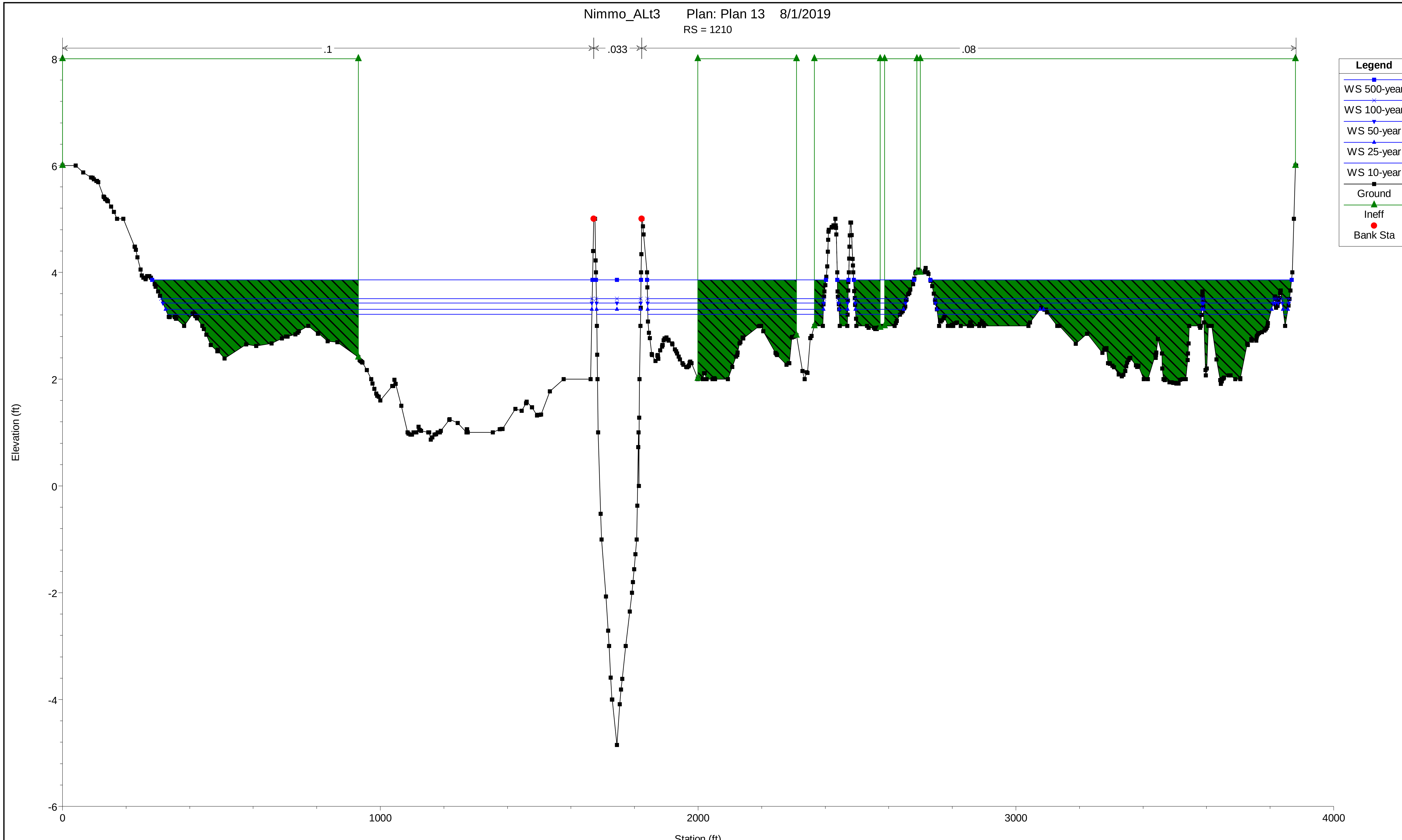

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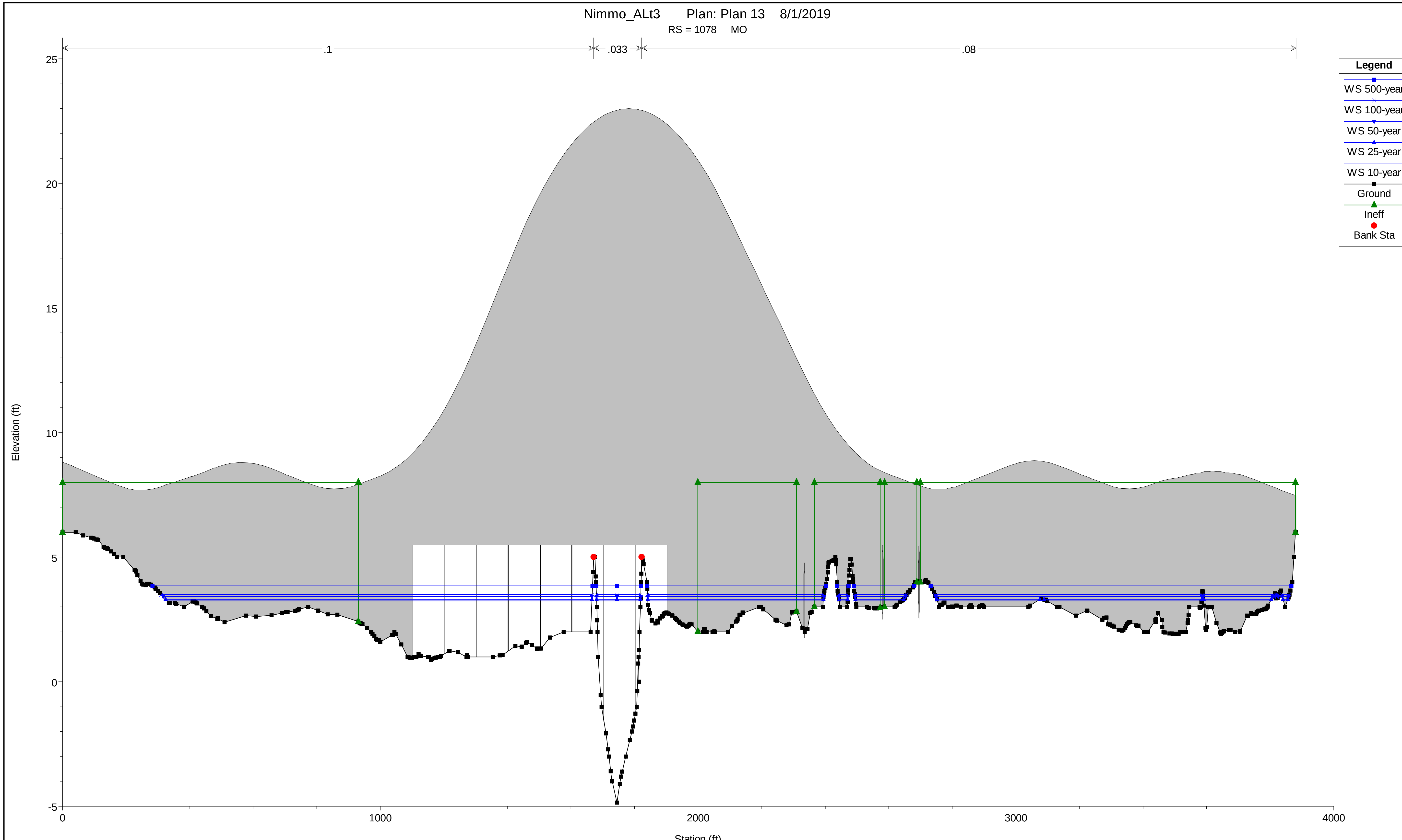

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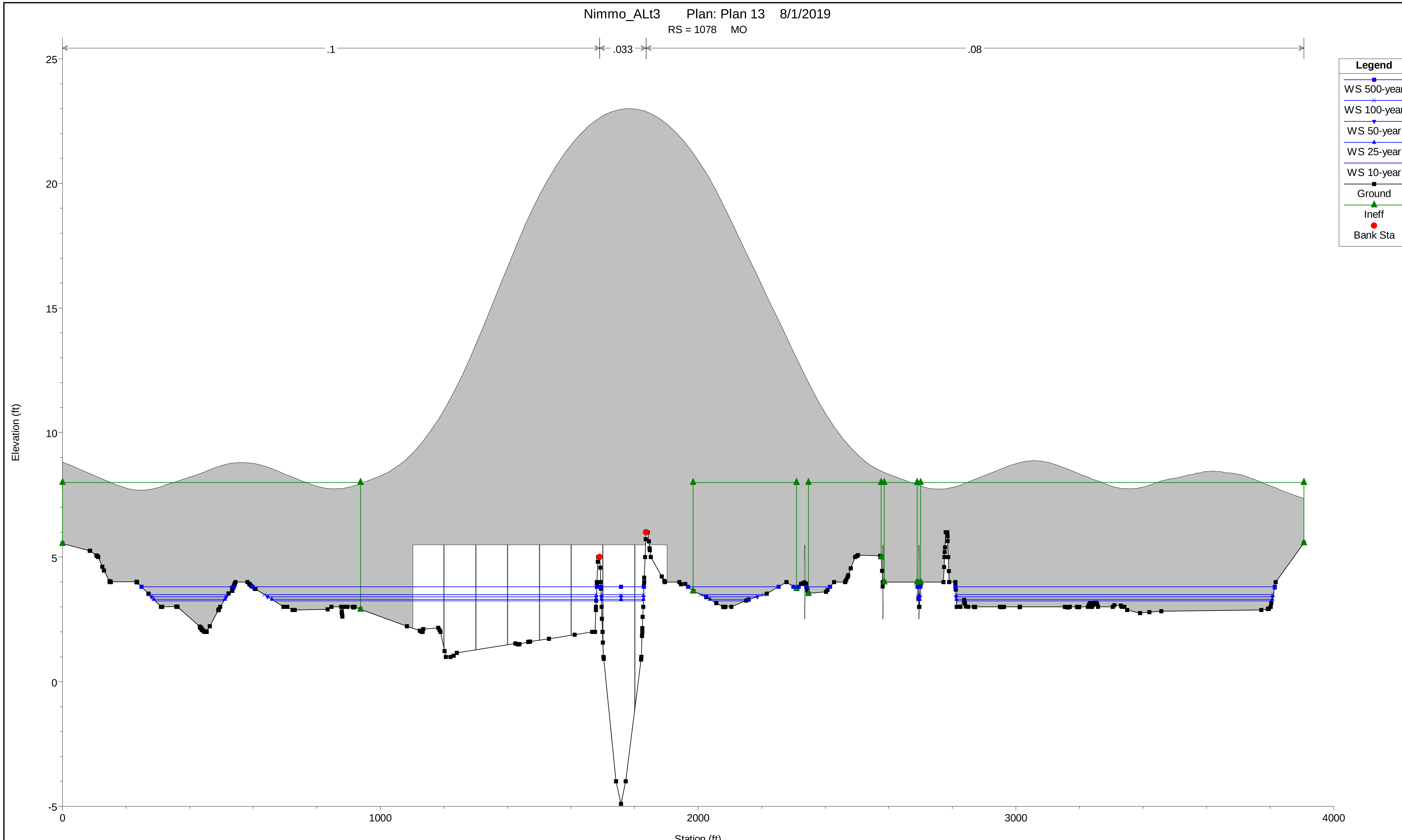

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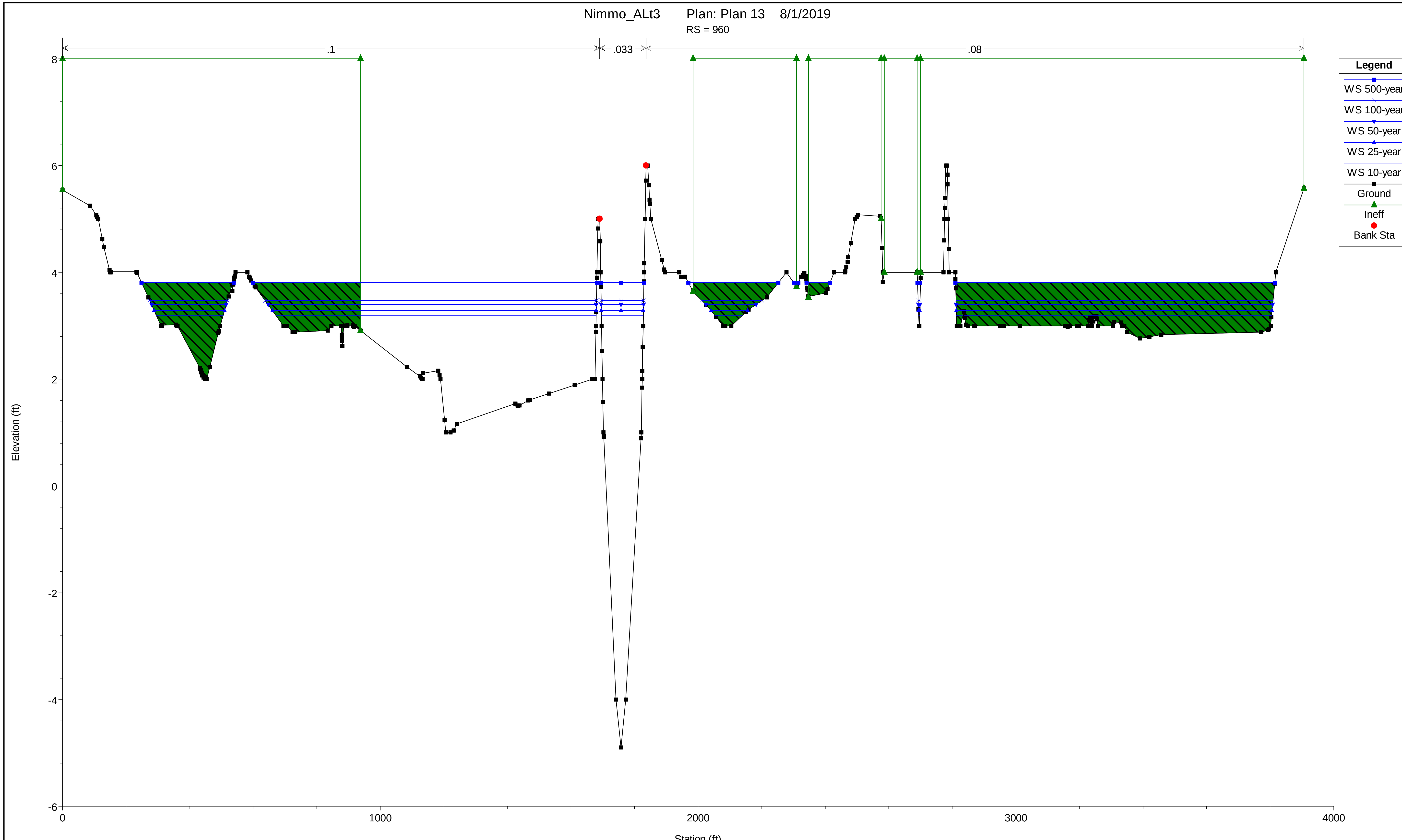

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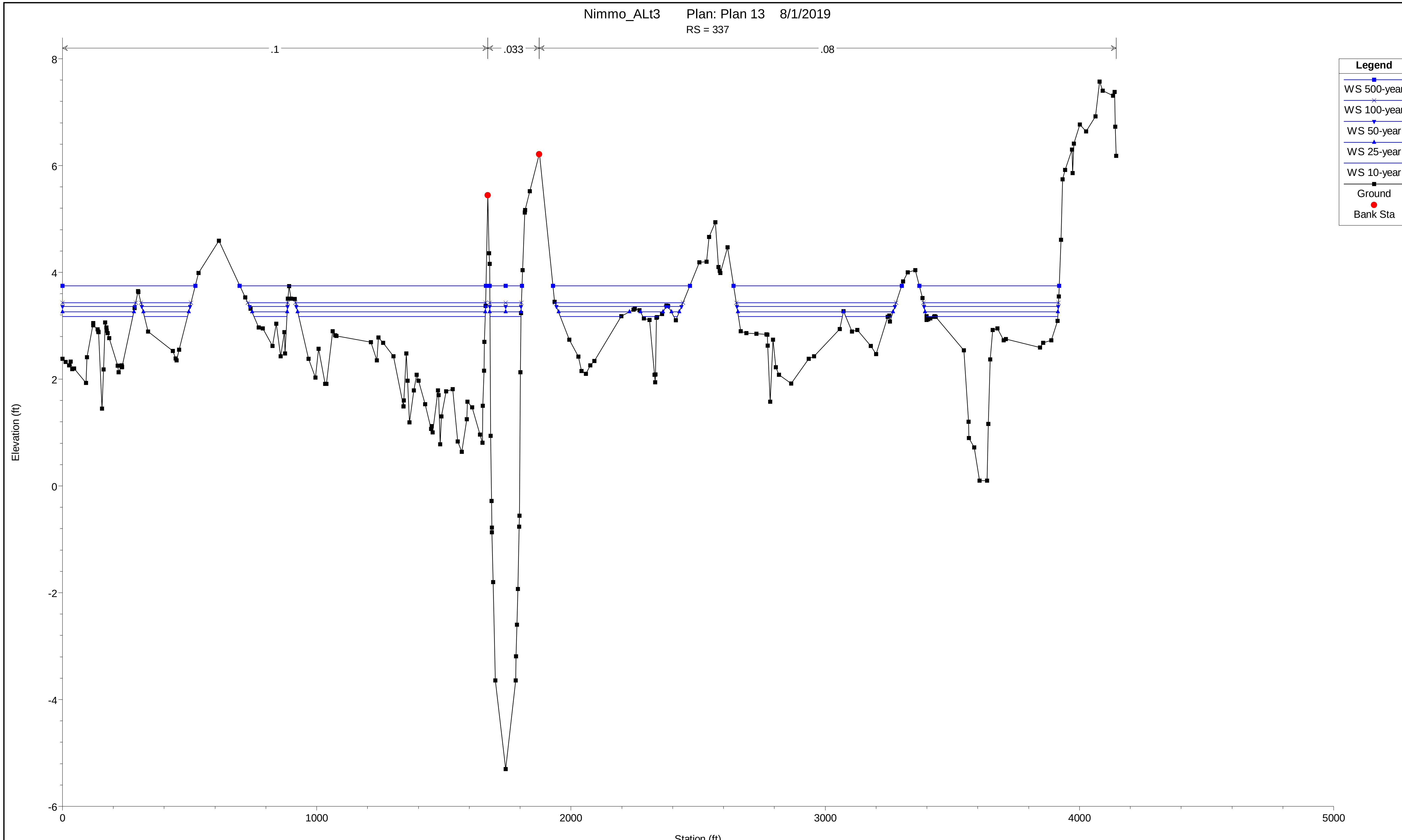
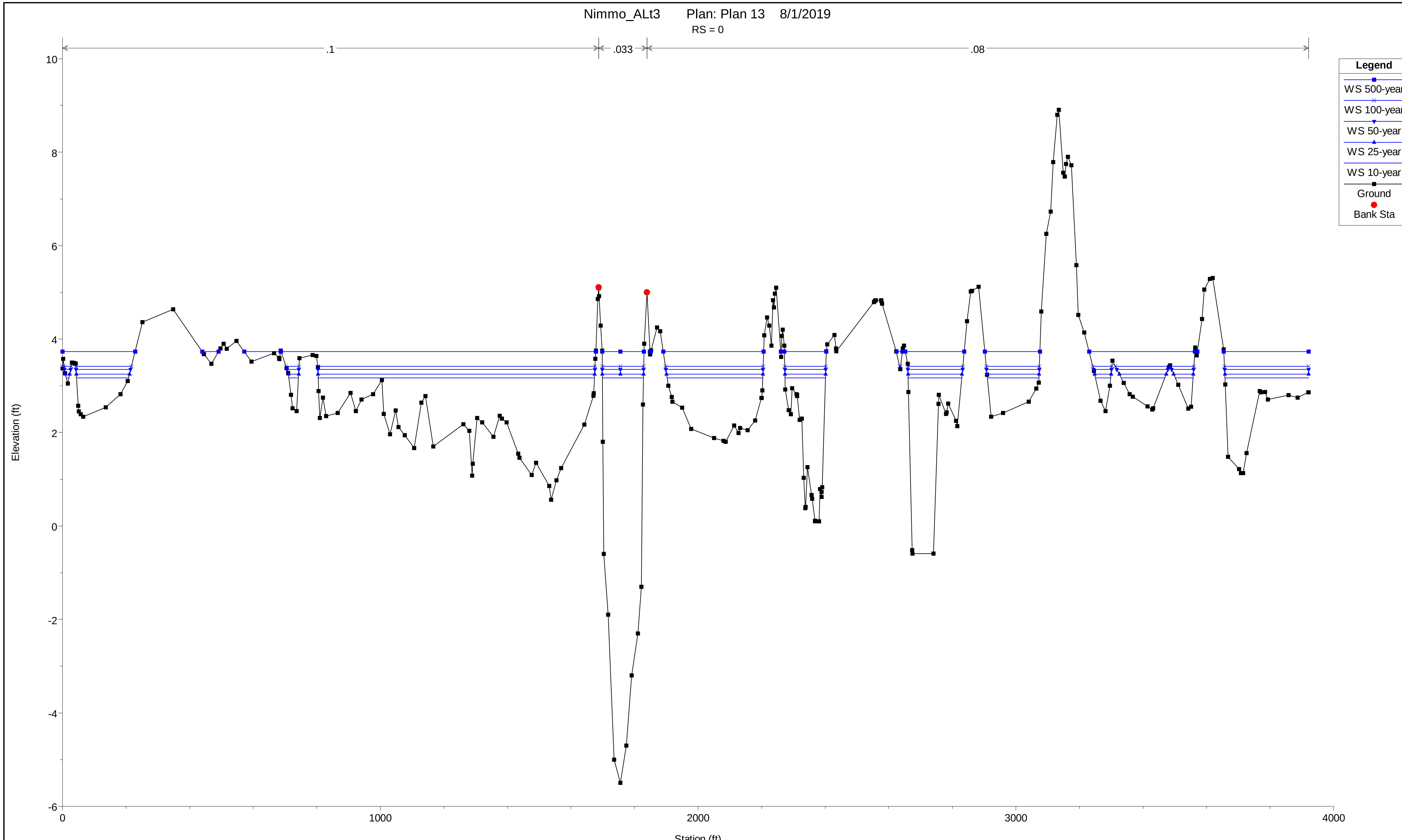


Proposed Water Surface Cross Section (WSE 3.0)



Proposed Water Surface Cross Section Summary (WSE 0.0)

HEC-RAS Plan: Plan 14 River: h06 Reach: ASH

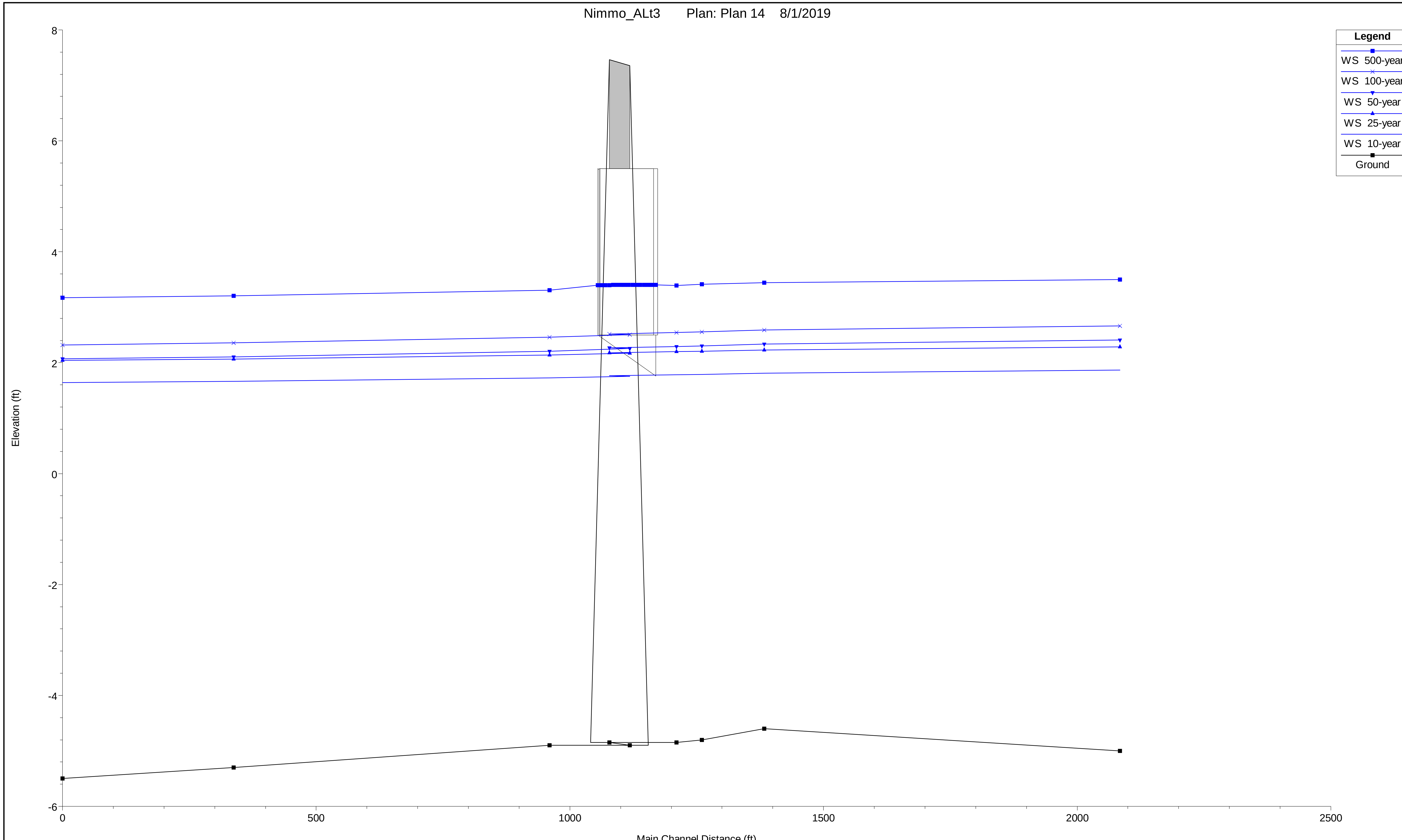
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
ASH	2084	10-year	741.00	-5.00	1.87		1.88	0.000083	1.09	1216.25	1563.92	0.09
ASH	2084	25-year	924.00	-5.00	2.29		2.30	0.000079	1.11	2010.23	2299.47	0.09
ASH	2084	50-year	1118.00	-5.00	2.41		2.43	0.000099	1.26	2306.02	2509.49	0.10
ASH	2084	100-year	1244.00	-5.00	2.66		2.68	0.000088	1.23	2974.03	2773.15	0.10
ASH	2084	500-year	1801.00	-5.00	3.50		3.51	0.000064	1.11	5630.14	3508.97	0.08
ASH	1383	10-year	741.00	-4.60	1.81		1.83	0.000078	1.07	1189.81	1138.06	0.09
ASH	1383	25-year	924.00	-4.60	2.23		2.25	0.000079	1.13	1738.25	1487.44	0.09
ASH	1383	50-year	1118.00	-4.60	2.34		2.36	0.000104	1.31	1901.17	1611.98	0.10
ASH	1383	100-year	1244.00	-4.60	2.59		2.61	0.000119	1.27	2355.78	1978.76	0.11
ASH	1383	500-year	1801.00	-4.60	3.44		3.45	0.000101	1.15	4515.46	2936.62	0.10
ASH	1260	10-year	741.00	-4.80	1.79		1.81	0.000155	1.36	923.53	749.91	0.12
ASH	1260	25-year	924.00	-4.80	2.21		2.23	0.000151	1.43	1365.24	1412.38	0.12
ASH	1260	50-year	1118.00	-4.80	2.30		2.34	0.000196	1.65	1506.92	1483.31	0.14
ASH	1260	100-year	1244.00	-4.80	2.56		2.59	0.000179	1.62	1899.09	1610.06	0.14
ASH	1260	500-year	1801.00	-4.80	3.41		3.44	0.000135	1.55	3988.33	3278.83	0.12
ASH	1210	10-year	741.00	-4.85	1.78	-2.07	1.81	0.000121	1.28	845.80	654.13	0.11
ASH	1210	25-year	924.00	-4.85	2.20	-1.81	2.23	0.000128	1.39	1166.13	1206.28	0.11
ASH	1210	50-year	1118.00	-4.85	2.29	-1.58	2.33	0.000171	1.62	1250.29	1310.45	0.13
ASH	1210	100-year	1244.00	-4.85	2.54	-1.44	2.58	0.000166	1.65	1491.96	1635.60	0.13
ASH	1210	500-year	1801.00	-4.85	3.39	-0.91	3.43	0.000157	1.74	2403.90	3308.83	0.13
ASH	1078		Mult Open									
ASH	960	10-year	741.00	-4.90	1.72	-2.10	1.76	0.000197	1.54	581.47	456.93	0.14
ASH	960	25-year	924.00	-4.90	2.14	-1.80	2.18	0.000209	1.68	813.19	694.71	0.14
ASH	960	50-year	1118.00	-4.90	2.21	-1.52	2.26	0.000289	1.99	862.16	743.39	0.17
ASH	960	100-year	1244.00	-4.90	2.46	-1.36	2.52	0.000281	2.02	1048.85	832.54	0.17
ASH	960	500-year	1801.00	-4.90	3.31	-0.72	3.37	0.000266	2.16	1767.29	2500.75	0.17
ASH	337	10-year	741.00	-5.30	1.66		1.68	0.000077	1.17	804.07	435.35	0.09
ASH	337	25-year	924.00	-5.30	2.07		2.09	0.000090	1.32	1017.30	676.43	0.10
ASH	337	50-year	1118.00	-5.30	2.11		2.14	0.000128	1.58	1045.67	713.98	0.12
ASH	337	100-year	1244.00	-5.30	2.36		2.39	0.000131	1.64	1259.75	993.61	0.12
ASH	337	500-year	1801.00	-5.30	3.20		3.25	0.000137	1.81	2907.81	2905.66	0.12
ASH	0	10-year	741.00	-5.50	1.64	-3.12	1.66	0.000070	1.09	958.06	519.94	0.09
ASH	0	25-year	924.00	-5.50	2.04	-2.83	2.06	0.000080	1.22	1220.56	874.46	0.09
ASH	0	50-year	1118.00	-5.50	2.07	-2.56	2.10	0.000115	1.46	1247.58	931.08	0.11
ASH	0	100-year	1244.00	-5.50	2.32	-2.40	2.35	0.000116	1.51	1518.73	1202.00	0.11
ASH	0	500-year	1801.00	-5.50	3.17	-1.83	3.20	0.000115	1.62	3172.44	2465.47	0.11

Proposed Water Surface Cross Section Summary (WSE 3.0)

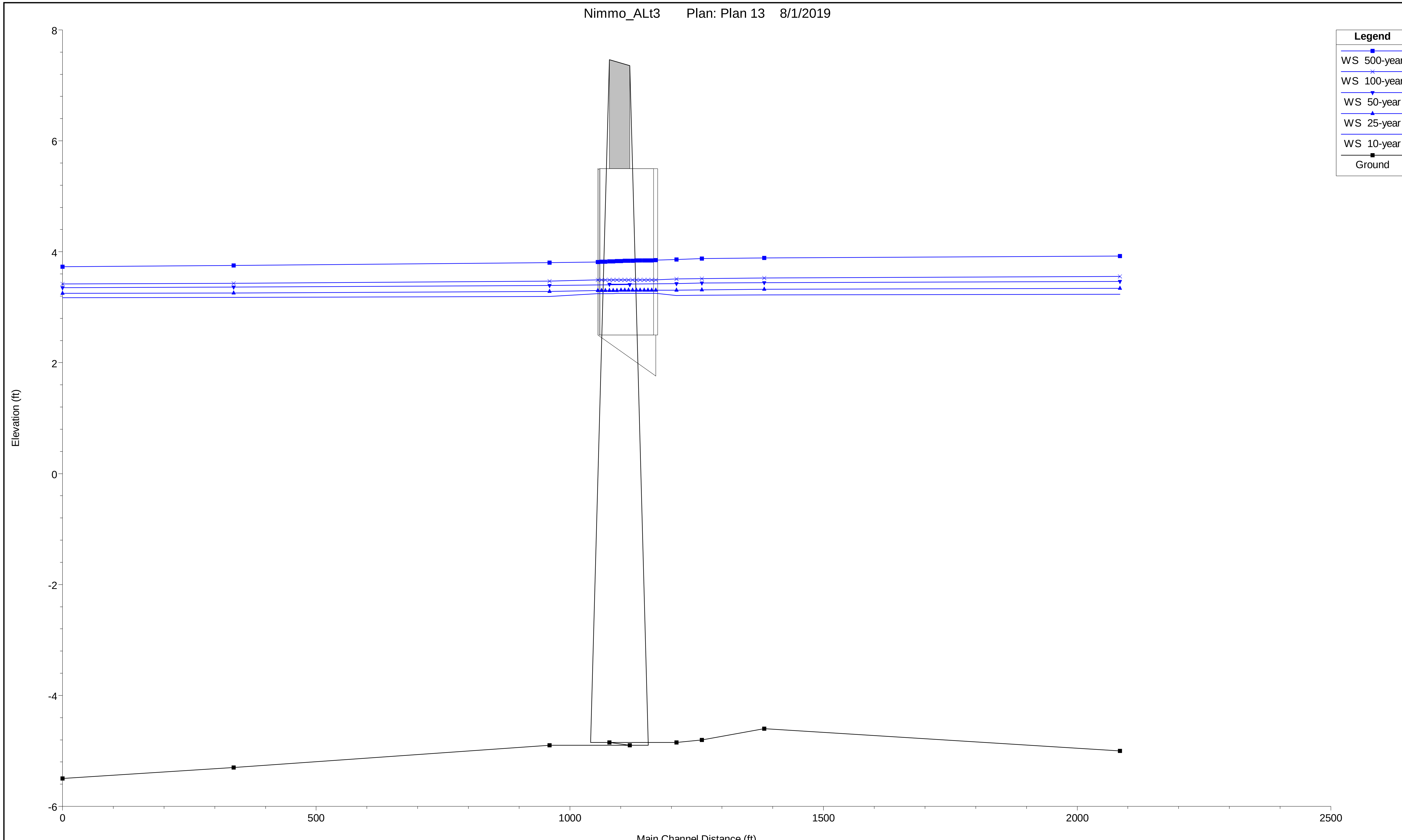
HEC-RAS Plan: Plan 15 River: h06 Reach: ASH

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)	
ASH	2084	10-year	741.00	-5.00	3.23		3.24	0.000015	0.53	4729.48	3307.38	0.04
ASH	2084	25-year	924.00	-5.00	3.34		3.34	0.000020	0.63	5083.13	3377.42	0.05
ASH	2084	50-year	1118.00	-5.00	3.47		3.47	0.000026	0.70	5520.22	3495.17	0.05
ASH	2084	100-year	1244.00	-5.00	3.55		3.56	0.000028	0.75	5823.20	3533.01	0.06
ASH	2084	500-year	1801.00	-5.00	3.92		3.93	0.000038	0.90	7154.29	3609.80	0.06
ASH	1383	10-year	741.00	-4.60	3.22		3.22	0.000021	0.55	3890.06	2750.05	0.05
ASH	1383	25-year	924.00	-4.60	3.32		3.33	0.000030	0.64	4171.94	2837.03	0.05
ASH	1383	50-year	1118.00	-4.60	3.44		3.45	0.000039	0.71	4526.05	2938.77	0.06
ASH	1383	100-year	1244.00	-4.60	3.53		3.53	0.000043	0.76	4774.49	2989.20	0.07
ASH	1383	500-year	1801.00	-4.60	3.89		3.90	0.000059	0.91	5921.77	3379.37	0.08
ASH	1260	10-year	741.00	-4.80	3.22		3.22	0.000030	0.72	3344.03	3184.06	0.06
ASH	1260	25-year	924.00	-4.80	3.31		3.32	0.000041	0.84	3660.90	3232.16	0.07
ASH	1260	50-year	1118.00	-4.80	3.43		3.44	0.000050	0.95	4053.72	3287.82	0.07
ASH	1260	100-year	1244.00	-4.80	3.52		3.53	0.000056	1.00	4328.08	3323.09	0.08
ASH	1260	500-year	1801.00	-4.80	3.88		3.89	0.000071	1.18	5551.34	3463.82	0.09
ASH	1210	10-year	741.00	-4.85	3.21	-2.07	3.22	0.000031	0.76	2203.65	3193.10	0.06
ASH	1210	25-year	924.00	-4.85	3.31	-1.81	3.32	0.000045	0.92	2310.21	3261.79	0.07
ASH	1210	50-year	1118.00	-4.85	3.43	-1.58	3.44	0.000059	1.07	2440.10	3319.43	0.08
ASH	1210	100-year	1244.00	-4.85	3.51	-1.44	3.52	0.000068	1.16	2529.58	3346.94	0.09
ASH	1210	500-year	1801.00	-4.85	3.86	-0.91	3.88	0.000105	1.49	2918.06	3451.54	0.11
ASH	1078		Mult Open									
ASH	960	10-year	741.00	-4.90	3.19	-2.10	3.20	0.000050	0.93	1667.50	2425.20	0.07
ASH	960	25-year	924.00	-4.90	3.28	-1.80	3.30	0.000071	1.12	1746.41	2485.32	0.09
ASH	960	50-year	1118.00	-4.90	3.39	-1.52	3.42	0.000095	1.30	1843.38	2558.74	0.10
ASH	960	100-year	1244.00	-4.90	3.47	-1.36	3.50	0.000110	1.41	1910.50	2612.30	0.11
ASH	960	500-year	1801.00	-4.90	3.80	-0.72	3.84	0.000172	1.82	2207.85	2891.28	0.14
ASH	337	10-year	741.00	-5.30	3.18		3.18	0.000024	0.75	2824.22	2849.52	0.05
ASH	337	25-year	924.00	-5.30	3.26		3.27	0.000034	0.90	3065.52	2988.86	0.06
ASH	337	50-year	1118.00	-5.30	3.36		3.37	0.000044	1.04	3380.31	3122.83	0.07
ASH	337	100-year	1244.00	-5.30	3.43		3.45	0.000051	1.12	3606.70	3178.38	0.08
ASH	337	500-year	1801.00	-5.30	3.75		3.77	0.000075	1.38	4649.28	3368.77	0.09
ASH	0	10-year	741.00	-5.50	3.17	-3.12	3.18	0.000019	0.67	3172.44	2465.47	0.05
ASH	0	25-year	924.00	-5.50	3.25	-2.83	3.26	0.000028	0.80	3371.23	2504.11	0.06
ASH	0	50-year	1118.00	-5.50	3.35	-2.56	3.36	0.000036	0.93	3624.07	2553.29	0.06
ASH	0	100-year	1244.00	-5.50	3.42	-2.40	3.43	0.000042	1.00	3804.14	2592.65	0.07
ASH	0	500-year	1801.00	-5.50	3.73	-1.83	3.75	0.000064	1.27	4656.32	2949.91	0.09

Proposed Water Surface Profile (WSE 0.0)



Proposed Water Surface Profile (WSE 3.0)



Robert S. Young, PhD, PG
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Robert S. Young is the Director of the Program for the Study of Developed Shorelines, a joint Duke University/Western Carolina University venture. He is also a Professor of Geosciences at Western Carolina University and a licensed professional geologist in three states (FL, NC, SC). The Program for the Study of Developed Shorelines (PSDS) is a research and policy outreach center serving the global coastal community. The primary mission of PSDS is to conduct scientific research into coastal processes, storm impacts, hazard vulnerability and sea level rise and to translate that science into management and policy recommendations through a variety of professional and public outreach mechanisms. The Program specializes in evaluating the design and implementation of coastal engineering and restoration projects and helping communities develop coastal adaptation strategies.

Dr. Young received a BS degree in Geology (Phi Beta Kappa) from the College of William & Mary, and MS degree in Quaternary Studies from the University of Maine, and a PhD in Geology from Duke University where he was a James B. Duke Distinguished Doctoral Fellow. Dr. Young serves on Editorial Boards of the *Journal of Coastal Research* and *Environmental Geosciences*. He currently oversees more than $5.5 Million in grant-funded research projects related to coastal science and management. He has been awarded Western Carolina University's highest honor for scholarship (University Scholar Award) and service (Paul A. Reid Distinguished Service Award). He is an elected Fellow of the Geological Society of America. Washington State presented him an award for Excellence in Environmental Education and Diversity in Action for his work with science education in Native American communities. And, he was named a Fulbright Senior Scholar for the 2012-2013 academic year where he worked on the development of coastal management planning along the Black Sea coast of Bulgaria. The North Carolina Coastal Federation presented him with the Pelican Award for Coastal Stewardship.

Dr. Young is a frequent contributor to the popular media. He has written numerous articles for outlets like the New York Times, USA Today, Architectural Record, the Houston Chronicle, and the Raleigh News and Observer, among others. He regularly appears on programs like PBS Now, CNN's Anderson Cooper, National Public Radio, and many others. He is co-author of two books, *The Rising Sea* and co-editor of *Geologic Monitoring*, both released in 2009. Finally, Dr. Young has testified before congress and numerous state legislatures on coastal issues. He currently serves State of South Carolina as a member of the Governor's Flood Commission and the State of Virginia on the Technical Advisory Committee for the state's Coastal Master Plan.

He is leading a major project for the National Park Service to identify the vulnerability of all coastal park assets to coastal storms, erosion and sea level rise for the purpose of adaptation planning.