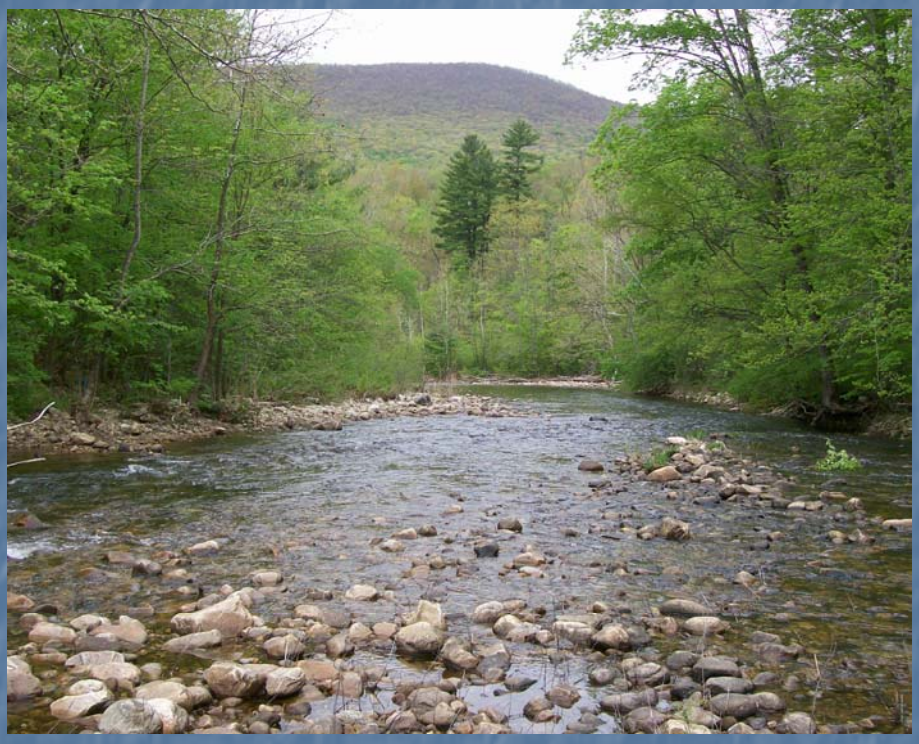
Batten Kill Restoration Study

A hydraulic and geomorphic analysis of berm removal along the Roaring Branch

Arlington, VT



FINAL REPORT
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Prepared for:

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BATTEN KILL WATERSHED ALLIANCE

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Executive Summary

The purpose of this study was to conduct a hydraulic and geomorphic analysis at the confluence of the Batten Kill and Roaring Branch Rivers in Arlington, Vermont for the Batten Kill Watershed Alliance (BKWA) under a grant from the Vermont Department of Environmental Conservation (VT DEC). More specifically, the study evaluated the changes in flood inundation area, water depth, and energy dissipation at the Roaring Branch/Batten Kill confluence resulting from the removal of berms along the lower reach of the Roaring Branch.

The Batten Kill within the state of Vermont flows through a broad valley between the Taconic Mountains to the west and the Green Mountains to the east. The Roaring Branch is one of the Batten Kill's high-gradient tributaries originating from the western slopes of the Green Mountains. Historically, the Roaring Branch dissipated sediment and excess energy in a broad alluvial fan at its confluence with the Batten Kill. However, in response to severe flooding in the 1930s and again in 1973, portions of the Roaring Branch were dredged and bermed, which has confined floodwaters and increased stream power in the channel under larger flows, leading to further degradation and the inability to re-establish a new floodplain.

After the Roaring Branch became constrained by berms, its historic floodplain became more developed, specifically by a campground known as Camping on the Batten Kill in the river-left corridor and several year-round and seasonal residences, as well as a restaurant, in the river-right corridor. Although portions of the berms may be providing critical flood protection for these structures, other area of the berms are experiencing deterioration, and have even been breached in spots by flood chutes. It appears that the berms are being pressured by increased in-channel energy and are at risk of failing and potentially damaging property. Therefore, the BKWA and the VT DEC, as well as several landowners in the project area, wanted to evaluate alternatives to alleviate some of the pressure on the structures and campground in the floodplain by removing a portion or a combination of the berms, thus helping to restore the sediment regime and dissipate excess energy.

A HEC-RAS hydraulic model was developed to model the 2-, 10-, 50-, 100-, and 500-year floods in the region of the Roaring Branch and Batten Kill confluence. Cross-sections for the model were "cut" in GIS across a digital elevation model (DEM) created from LiDAR and topographic survey for the study area. Four scenarios were modeled—existing conditions, lower left berm removed, lower right berm removed, and both lower berms removed.

Results were presented in various formats—inundation maps, water depth maps, water surface profiles, velocity distributions, and energy grade profiles. All results point to one conclusion: that the removal of both lower berms (or even just the left berm) along the Roaring Branch appears to have little to no negative effect on existing infrastructure in the floodplain, and that it likely will lessen the severity of flood inundation areas, water depths, and flow velocities. These changes would result in increased dissipation of excess energy and sediment, thus helping to restore the confluence back to its historic alluvial fan state. Consequently, in-channel energy and stream power of the Roaring Branch would decrease, reducing further incision of the reach and allowing the stream to re-establish its floodplain through aggradation and planform adjustments. Furthermore, effects would extend to the Batten Kill, helping to alleviate further erosion of the mass failure opposite of the confluence and reducing the amount of sediment deposited upstream of bridge openings farther downstream.

Physical removal of the berms appears to be relatively straightforward. Probably the most complicating factor is the presence of heavy vegetation and full-grown trees on the berms, which would have to be removed and dealt with appropriately. Once the berms have been cleared, they could be "removed" by grading them backwards with an excavator into the natural topography.

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1.0 Introduction

The purpose of this study was to conduct a hydraulic and geomorphic analysis at the confluence of the Batten Kill and Roaring Branch Rivers in Arlington, Vermont for the Batten Kill Watershed Alliance (BKWA) under a grant from the Vermont Department of Environmental Conservation (VT DEC). More specifically, the study evaluated the changes in flood inundation area, water depth, and energy dissipation at the Roaring Branch/Batten Kill confluence resulting from the removal of berms along the lower reach of the Roaring Branch.

The Batten Kill within the state of Vermont has a drainage area of approximately 200 square miles. It flows through a broad valley, fed by the bedrock-controlled streams of the Taconic Mountains to the west and the more sediment-laden streams of the Green Mountains to the east. Eventually, it empties into the Hudson River in the state of New York.

The Roaring Branch is one of the Batten Kill's high-gradient tributaries originating from the western slopes of the Green Mountains. Like the rest of the Green Mountain tributaries, the Roaring Branch has a high rate of sediment production and historically dissipated this sediment and excess energy in a broad alluvial fan at its confluence with the Batten Kill. However, in response to severe flooding in the 1930s and again in 1973, portions of the Roaring Branch were dredged and bermed, including the majority of the most downstream reach where it enters the Batten Kill. These berms have confined floodwaters and increased stream power in the channel under larger flows, leading to further degradation and the inability to re-establish a new floodplain within the over-widened channel. In addition to incision and other impacts on the Roaring Branch, the increased stream power has also contributed to a very large mass failure on the far bank of the Batten Kill at the confluence (pictured above).

After the Roaring Branch became constrained by berms, its historic floodplain became more developed. Specifically, a campground known as Camping on the Batten Kill was developed in the river-left corridor near the confluence. Also, several year-round and seasonal residences, as well as a restaurant, are located in the river-right corridor. Although portions of the berms may be providing critical flood protection for these structures, other areas of the berms are experiencing deterioration, and have even been breached in spots by flood chutes. It appears that the berms are being pressured by increased in-channel energy and are at risk of failing and potentially damaging property.

The BKWA and the VT DEC, as well as several landowners in the project area, wanted to evaluate alternatives to alleviate some of the pressure on the structures and campground in the floodplain by removing a portion or a combination of the berms, thus helping to restore the sediment regime and dissipate excess energy. This study compares alternatives through the use of a hydrologic analysis, hydraulic model, and inundation mapping.

2.0 Geomorphology

2.1 Description of Study Area

The area of interest for this study includes the lower portion of the Roaring Branch from the Route 7A Bridge downstream to the confluence with the Batten Kill. The Batten Kill itself, from just upstream of the Roaring Branch to the Route 313 Bridge, was also included in the study area for the hydraulic model.

Downstream of the Route 7A bridge, the Roaring Branch is confined by four major berms—two on the river left bank and two on the river right bank. These are roughly broken into an upstream and downstream berm on each side. Although this study originally proposed to investigate the effects of removing all four berms, field observations made it apparent that removal of one or both of the upstream berms would significantly increase the flooding experienced by structures in the floodplain. Therefore, the study was revised to investigate only the effects of removing the two downstream berms.

Sparse development is present in the floodplain on both sides of the Roaring Branch. The campground property occupies most of the river-left corridor, although the only year-round structures are the campground office/residence and barn located at the very upstream end of the study area, just downstream of the Route 7A Bridge. The rest of the campground is comprised of seasonal sites and small outbuildings. In the river-right corridor, a restaurant and mobile home are located just downstream of the bridge, a seasonal camp is located in close proximity to the stream bank a little farther downstream, and a 2-story home downstream from there is set further back in the floodplain.

The floodplain is lightly wooded with both deciduous and coniferous trees. Most of the berms are vegetated with saplings and even full-grown trees (as seen in the photo at left looking down the lower right berm). A large sidebar occupies most of the river-left half of the channel beginning under the bridge and extending about 200 feet downstream. Just beyond there, a significant mid-channel bar has been enlarging recently, according to local observations. At the downstream end of the reach, the majority of the flow bends to the left to enter the Batten Kill, while a smaller side channel heads sharply off to the right and joins the Batten Kill about 200 feet upstream. The downstream right berm follows this side channel for about half of its length. Behind this berm is a low depression area, which has been partially filled with stumps and other debris. Just across from the confluence, the Batten Kill's right bank is undergoing severe erosion at a large mass failure site.

2.2 Current Geomorphic Condition

Both Phase 1 and Phase 2 stream geomorphic assessments have been completed for the Batten Kill mainstem and its major tributaries, including the Roaring Branch. A corridor plan has also been developed. All three studies recommended exploring the options of removing berms and restoring access to floodplains where feasible along the Green Mountain tributaries. VT DEC protocols for stream geomorphic assessments categorize streams geomorphically as being in either reference, good, fair, or poor condition, based on a range of scores from zero to 1.0. According to the Phase 2 results, the current geomorphic condition of the most downstream reach of the Roaring Branch (T2.01) is poor (0.275 out of 1.0). This reach has degraded from a historic C-type channel to an entrenched F-type channel. The reach is currently undergoing Stage IV of the F-stage channel evolution process as it attempts to narrow and

establish a new floodplain through aggradation and the development of bar features. However, the increased stream power in the channel due to the berms has prevented successful re-vegetation of these bar features and the completion of the channel evolution process.

2.3 Topographic Survey

Base topography for the hydraulic model was developed from LiDAR (Light Detection And Ranging) data, which is comprised of thousands of points each representing an elevation of the land surface. For further detail in the study area of interest, the LiDAR data was supplemented by a topographic survey covering the channel and bank areas (particularly the berms) of the Roaring Branch. The approximate footprint of each berm was also delineated using a backpack GPS unit.

To create the digital elevation model (DEM) necessary for the hydraulic model, the LiDAR elevation points in the Roaring Branch's channel and bank areas were replaced with those from the topographic survey. The elevation points were then converted to a TIN (Triangulated Irregular Network) representing existing conditions. To represent the removal of a berm, the elevation points defining the berm were overwritten with lower elevation points matching those in the floodplain behind them. A new TIN was then created with these modified points and the original LiDAR and survey points for the rest of the model area. In total, four TINs were created to represent each of the four scenarios (existing, lower left berm removed, lower right berm removed, and both lower berms removed).

The TIN created for existing conditions is shown in Figure 2.1 on the following page. The topographic survey area and berm locations are also delineated in this figure.

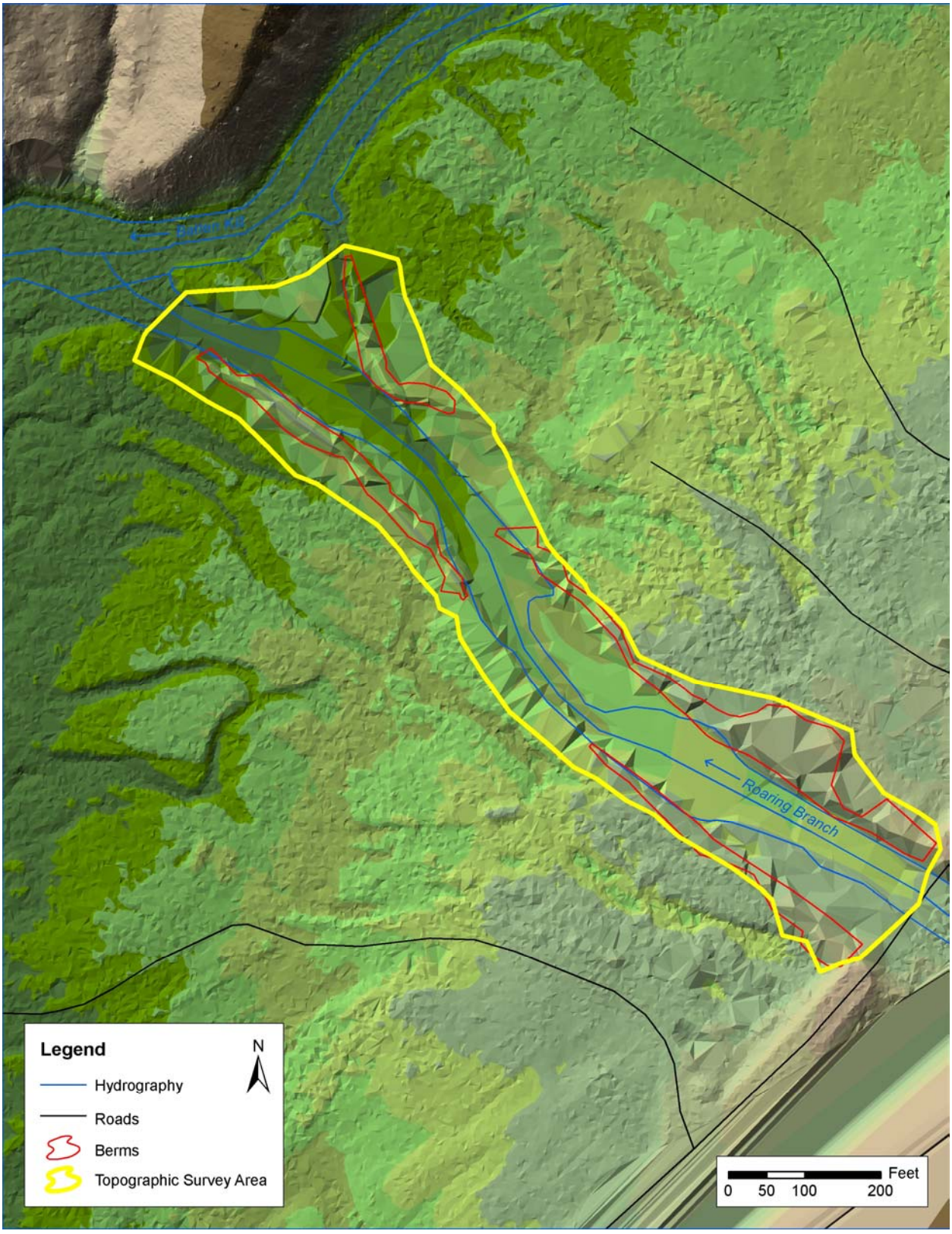


Figure 2-1: Existing Conditions Elevation Model with Survey Area and Berm Footprints Delineated

3.0 Hydrology

A hydrologic analysis was conducted to compute the flood flows necessary for the hydraulic model. The 2-, 10-, 50-, 100-, and 500-year flood flows were modeled, although only the 2- and 100-year floods were chosen for result presentation and analysis. USGS Gage No. 01329000 on the Batten Kill near Arlington, located just downstream of the Roaring Branch confluence (drainage area = 152 mi^2), was active from 1928 to 1984. The Flood Insurance Study (FIS) published by the Federal Emergency Management Agency (FEMA) for the town of Arlington in 1986 includes flood flows for the Batten Kill and Roaring Branch. Flood estimates in the FIS were derived from the Arlington USGS gage using a Log-Pearson Type III flood frequency analysis. The Log-Pearson Type III analysis can use a weighted skew, generalized skew, or station skew. FEMA did not report the type of skew or the period of record used in their analysis. For this study, the flood frequency analysis was re-computed for the Arlington gage using the weighted skew option and the full period of record.

The results of the re-computed flood frequency analysis were adjusted to reflect flood flows on the Batten Kill at the downstream corporate limits (drainage area = 202.2 mi^2) for comparison with the results published in the FIS. (The adjustment factor was based on the ratio of drainage areas raised to the 0.7 power, as reported in the FIS.) The conservatively higher results of the re-computed flood frequency analysis were chosen for use in the hydraulic model.

The results of the flood frequency analysis were then adjusted to reflect flood flows at the upstream extent of the hydraulic model on both the Batten Kill and the Roaring Branch. These locations and their respective drainage areas, along with the estimated flows for the range of floods, are given in Table 3.1 below.

Table 3-1: Estimated Flood Flows for Use in the Hydraulic Model

Recurrence Interval (yrs)	**Annual Exceedance Probability**	**Estimated Flow (cfs)** *(at location with drainage area given in square miles)*		
		Batten Kill at USGS gage	Batten Kill at upstream extent of model	Roaring Branch at upstream extent of model
		152	95.3	54.6
2	0.5	3225	2326	1575
10	0.1	5493	3962	2683
50	0.02	7980	5755	3897
100	0.01	9195	6632	4491
500	0.002	12450	8979	6080

4.0 Hydraulic Analysis

4.1 Model Set-Up

A steady-state hydraulic model was developed using HEC-RAS and the HEC-GeoRAS tools in GIS. On the Roaring Branch, the model began just upstream of the Route 7A Bridge. On the Batten Kill, the model extended from just upstream of the Roaring Branch confluence to just downstream of the Route 313 Bridge.

Roughness coefficients, or Manning's 'n' values, defining the roughness of the channel and overbank areas were interpolated from those published in the FIS and revised as necessary based on observations during the site visit and the results of the pebble count performed during the Phase 2 assessment.

Cross-sections were "cut" in GIS using HEC-GeoRAS tools. The layout of cross-sections is shown in Figure 4.1 on the following page. The cross-section cut lines for the Roaring Branch were curved backward through the floodplain to model the fan-like path of the floodwaters in what was historically an alluvial fan (cross-section cut lines should be perpendicular to the direction of flow in the overbank areas).

4.2 Modeling Scenarios

Originally, it was proposed to model the removal of all four berms along the lower reach of the Roaring Branch. However, upon field inspection, it became apparent that removal of one or both of the upstream berms would significantly increase the flooding experienced by several houses and other buildings in the floodplain behind those berms. Therefore, the study was revised to investigate only the effects of removing the two downstream berms, both individually and simultaneously. The following four scenarios were modeled:

1. Existing Conditions
2. Downstream Left Berm Removed
3. Downstream Right Berm Removed
4. Both Downstream Berms Removed

For the purposes of this report, the 'left berm' represents the downstream river left berm and the 'right berm' represents the downstream river right berm.

Results of the existing conditions scenario were also compared to those published in the FIS as a quality assurance measure.

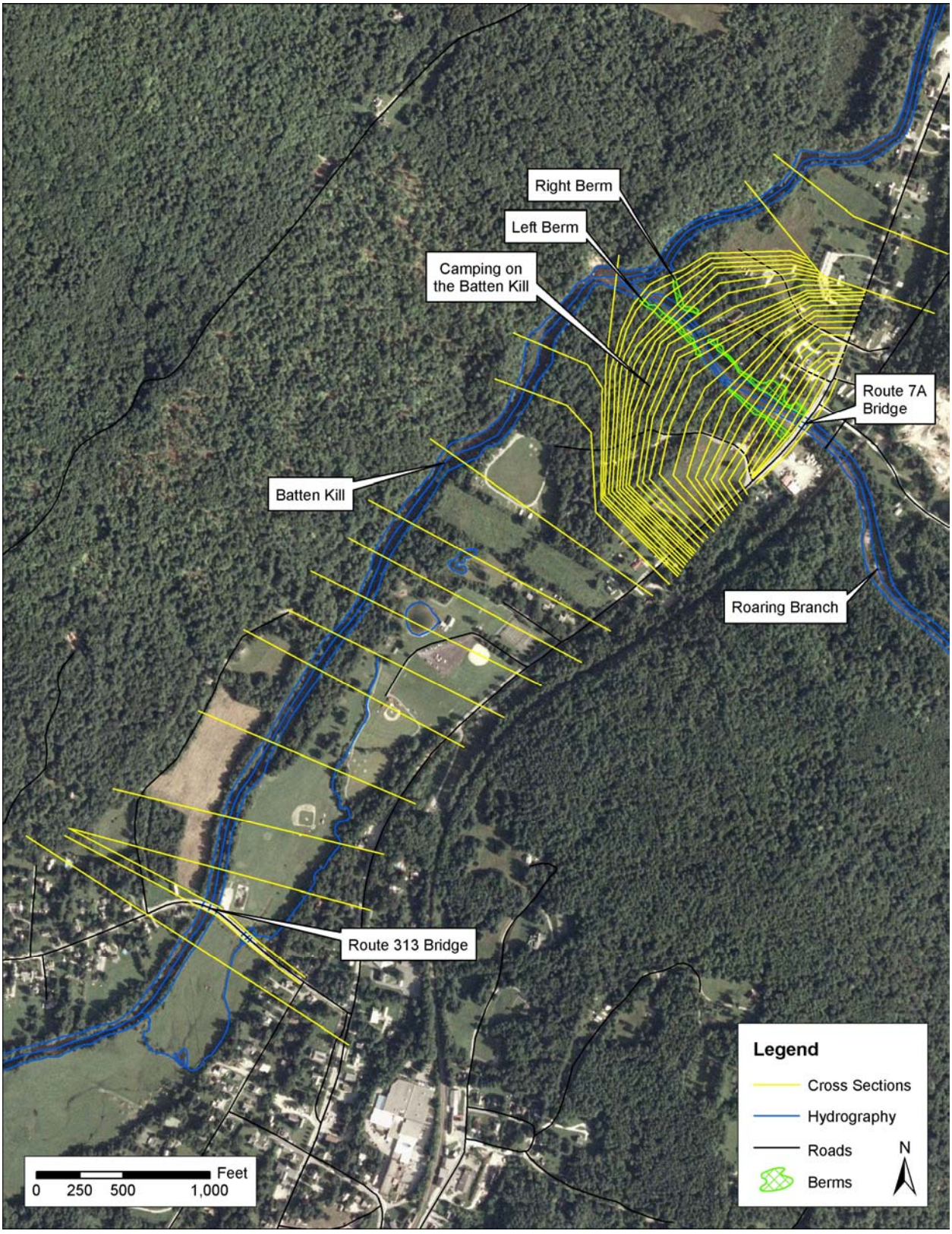


Figure 4-1: Cross-Section Locations for Hydraulic Model

5.0 Results

Before proceeding with the modeling of the three proposed alternatives, the results of the baseline scenario were compared to those of the published FIS. Water surface elevations computed along both the Roaring Branch and the Batten Kill were similar to those of the earlier study. Additionally, the 100-year water surface elevation computed at the Route 313 Bridge (608.6 feet) was within 0.2 feet of 100-year flood elevation for which the Route 313 Bridge was designed (608.8 feet).

Basic results (i.e., inundation areas & water surface profiles) are presented for all four scenarios. However, given the similarity of the results among the three berm-removal scenarios, comparisons and discussions between berm removal and existing conditions were focused on the removal of both berms (Scenario 4). Since the results for removal of the left berm only (Scenario 2) closely matched the results of removal of both berms, and because it may be more logistically feasible to remove just the left berm, comparison figures were provided for the left berm removal scenario as well. When discussion focuses on removal of both berms, it can be assumed that removal of the left berm only would lead to similar results.

Additionally, presentation of results was limited to the 2-year and 100-year flood profiles. The 2-year flood is important because it usually approximates the channel-forming, bankfull flow, while the 100-year flood is important because it is the large-scale flood for which infrastructure (i.e. bridges) is usually designed for.

Appendix A – Inundation Maps

The water surface information computed by the HEC-RAS hydraulic analysis can be uploaded back into GIS and "inundated" on the original land surface layer (i.e., the TIN) to create an inundation area map. Inundation maps produced using HEC-GeoRAS tools are provided in Appendix A. Each map compares two different flood inundation areas, with the bottom (typically larger) inundation area shown in red and the top (typically smaller) inundation area shown in yellow. Regions where the two inundation areas overlap appear orange. The first four maps (as listed below) compare the 2-year flood to the 100-year flood for each scenario for the entire modeled area (i.e., the Roaring Branch and the Batten Kill):

- **Figure A-1:** Model Area Inundation – Existing Conditions
- **Figure A-2:** Model Area Inundation – Left Berm Removed
- **Figure A-3:** Model Area Inundation – Right Berm Removed
- **Figure A-4:** Model Area Inundation – Both Berms Removed

The next four maps compare the same two floods for each scenario, but are zoomed in to the area of interest on the Roaring Branch:

- **Figure A-5:** Study Area Inundation – Existing Conditions
- **Figure A-6:** Study Area Inundation – Left Berm Removed
- **Figure A-7:** Study Area Inundation – Right Berm Removed
- **Figure A-8:** Study Area Inundation – Both Berms Removed

The final four maps compare existing conditions versus two different berm removal scenarios. Figures A-9 and A-10 compare removal of the left berm only (Scenario 2) to existing conditions for both the 2-year flood and the 100-year flood, respectively, while Figures A-11 and A-12 compare removal of both berms (Scenario 4) to existing conditions for both the 2-year flood and the 100-year flood, respectively:

- **Figure A-9:** Study Area Inundation – Existing Conditions vs. Left Berm Removed (2-yr)
- **Figure A-10:** Study Area Inundation – Existing Conditions vs. Left Berm Removed (100-yr)
- **Figure A-11:** Study Area Inundation – Existing Conditions vs. Both Berms Removed (2-yr)
- **Figure A-12:** Study Area Inundation – Existing Conditions vs. Both Berms Removed (100-yr)

Inundation area along the Batten Kill remained essentially constant among the four scenarios. For the most part, the Batten Kill is unconstrained and utilizes the majority of its floodplain, which primarily extends out several hundred feet to 1,000 feet in the river-left corridor. Exceptions include short incised sections just upstream and downstream of the confluence, where flood flows are somewhat confined to about twice the channel width.

The Roaring Branch also appears to utilize most of its floodplain, particularly in the river-left corridor. Much of the area, however, is inundated not directly outward from the channel, where flows are confined by berms, but instead by low velocity overland flow from upstream areas where berms are nonexistent, low, or have been breached. The most significant difference among scenarios is the 100-year flood inundation area in the river-right corridor to the far right of the downstream berm. Under existing conditions, this flood appears to extend approximately 500 feet beyond the extent of the 2-year flood area, while in the remaining three scenarios, the 100-year flood inundation area is essentially no larger than that of the 2-year flood. Scenario 3 (right berm removed) appears to have a slightly broader 100-year flood in this region, but not nearly as broad as that experienced under existing conditions.

Under existing conditions, the only structure that appears to be significantly affected by flood waters is the campground office/residence in the river-left corridor. This structure experiences slight encroachment from the 2-year flood, and is almost entirely inundated by the 100-year flood. The inundation area in the region of this structure, or any of the structures of interest for that matter, does not appear to change between any of the scenarios.

Comparison of existing conditions to the berm removal berm removal scenarios (Figures A-9 through A-12) shows that the 2-year flood area is virtually identical, with the exception of the narrow strips behind the removed berms that become inundated under the latter scenario. Under the 100-year flood profile, this same difference is noted, while it also becomes apparent that the inundation area may significantly shrink upon removal of the left or both berms, specifically in the downstream right floodplain as described previously.

Looking back at the full-scale inundation maps (Figures A-1 and A-4, in this case), it should also be noted that removal of both berms (or just the left berm) appears to relieve some flooding in the residential area further south of the campground entrance along Route 7A (pictured at right in a blow-up of Figure A-10 depicting the 100-year flood). However, this region is beyond the extents of the study area for the Roaring Branch and may not reflect the most accurate results. Although overland flows from the Roaring Branch would likely continue past its most downstream cross-section, the model was limited by the number of cross-sections that could be physically placed along the channel without intersecting at any point.

Appendix B – Water Depth Maps

Although the area inundated by floodwaters in two scenarios may appear similar, the depth of those floodwaters could be significantly different. To investigate this, water depth maps were developed depicting Roaring Branch study area for the scenarios of interest (existing conditions and both berms removed). These maps are provided in Appendix B.

The first two maps show water depths under existing conditions (Scenario 1) for the 2-year and 100-year floods, respectively:

- **Figure B-1:** Study Area Water Depth – Existing Conditions, 2-yr Flood
- **Figure B-2:** Study Area Water Depth – Existing Conditions, 100-yr Flood

The second two maps show water depths with the left berm removed (Scenario 2) for the 2-year and 100-year floods, respectively:

- **Figure B-3:** Study Area Water Depth – Left Berm Removed, 2-yr Flood
- **Figure B-4:** Study Area Water Depth – Left Berm Removed, 100-yr Flood

The last two maps show water depths with both berms removed (Scenario 4) for the 2-year and 100-year floods, respectively:

- **Figure B-5:** Study Area Water Depth – Both Berms Removed, 2-yr Flood
- **Figure B-6:** Study Area Water Depth – Both Berms Removed, 100-yr Flood

Looking at these maps, it can be seen that even where the flood inundation areas are similar between the existing conditions and berm removal (left or both), the depth of the flood is indeed lower in the berm removal scenarios, as indicated by the overall lighter appearance of the depth coverage. This is particularly evident in the 100-year flood.

Appendix C – Water Surface Profiles

The decreased water surface noted with the water depth maps is further supported by the water surface profiles. These graphs are longitudinal profiles depicting the river bottom (labeled as "ground" on the plots) at each station along the reach, topped by the corresponding 2-year and 100-year flood elevations, or water surface (labeled as "WS" on the plots).

A profile for both the Roaring Branch and the Batten Kill are shown for each scenario in Figures C-1 through C-8 of Appendix C:

- **Figure C-1:** Roaring Branch Water Surface Profile – Existing Conditions
- **Figure C-2:** Batten Kill Water Surface Profile – Existing Conditions
- **Figure C-3:** Roaring Branch Water Surface Profile – Left Berm Removed
- **Figure C-4:** Batten Kill Water Surface Profile – Left Berm Removed
- **Figure C-5:** Roaring Branch Water Surface Profile – Right Berm Removed
- **Figure C-6:** Batten Kill Water Surface Profile – Right Berm Removed
- **Figure C-7:** Roaring Branch Water Surface Profile – Both Berms Removed
- **Figure C-8:** Batten Kill Water Surface Profile – Both Berms Removed

Note that the "jump" appearing near the upstream extent of the Batten Kill occurs at the transition between reach M05 upstream of the Roaring Branch and M04 downstream.

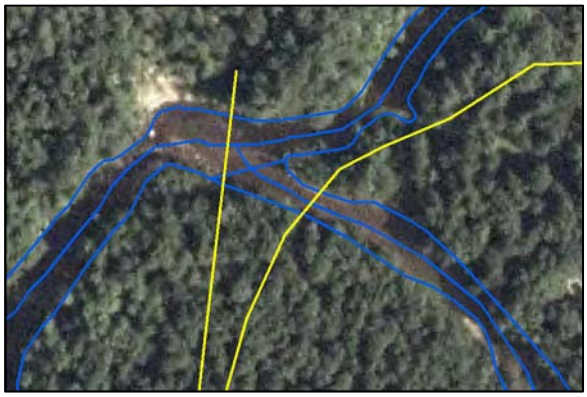
The last four figures compare water surface profiles on the Roaring Branch between existing conditions and the two berm removal scenarios (left only and both). Figures C-9 and C-10 compare removal of the left berm only (Scenario 2) to existing conditions for both the 2-year flood and the 100-year flood, respectively, while figures C-11 and C-12 compare removal of both berms (Scenario 4) to existing conditions for both the 2-year flood and the 100-year flood, respectively:

- **Figure C-9:** Roaring Branch Water Surface Profile – Existing Conditions vs. Left Berm Removed (2-yr Flood)
- **Figure C-10:** Roaring Branch Water Surface Profile – Existing Conditions vs. Left Berm Removed (100-yr Flood)
- **Figure C-11:** Roaring Branch Water Surface Profile – Existing Conditions vs. Both Berms Removed (2-yr Flood)
- **Figure C-12:** Roaring Branch Water Surface Profile – Existing Conditions vs. Both Berms Removed (100-yr Flood)

Looking at the last four figures, it can be seen that the water surface profiles closely match for the upper half of the reach, then begin to separate toward the middle (as they near the downstream berms of interest) for all comparisons. Under both floods, the water surface elevations are lower upon removal of the left or both berms—significantly so in the case of the 100-year flood.

Appendix D – Velocity Distributions

In addition to the extent and depth of the floodwaters, the velocity of the water moving through various regions of the cross-sections can be an important comparison tool. Velocity distributions for the confluence region are presented in Appendix D. This region was chosen to investigate whether removal of the berms might have an effect on the velocity with which flows from the Roaring Branch impact the bank opposite from the confluence on the Batten Kill, and consequently reduce the growth of the mass failure erosion site. Specifically, the cross-section just above the confluence on the Roaring Branch and the cross-section just below the confluence on the Batten Kill were plotted (see cross-section and mass failure locations in detail map at right).



The first four figures (D-1 through D-4) represent existing conditions, the next four figures (D-5 through D-8 represent removal of the left berm only (Scenario 2), and the last four (D-9 through D-12) represent removal of both berms (Scenario 4). Within each set, the first two figures show the velocity distribution for the Roaring Branch under both the 2-year and 100-year flood, while the second two figures show the same for the Batten Kill.

- **Figure D-1:** Velocity Distribution for Roaring Branch just Upstream of Confluence – Existing Conditions, 2-yr Flood
- **Figure D-2:** Velocity Distribution for Roaring Branch just Upstream of Confluence – Existing Conditions, 100-yr Flood
- **Figure D-3:** Velocity Distribution for Batten Kill just Downstream of Confluence – Existing Conditions, 2-yr Flood
- **Figure D-4:** Velocity Distribution for Batten Kill just Downstream of Confluence – Existing Conditions, 100-yr Flood

- **Figure D-5:** Velocity Distribution for Roaring Branch just Upstream of Confluence – Left Berm Removed, 2-yr Flood
- **Figure D-6:** Velocity Distribution for Roaring Branch Upstream of Confluence – Left Berm Removed, 100-yr Flood
- **Figure D-7:** Velocity Distribution for Batten Kill just Downstream of Confluence – Left Berm Removed, 2-yr Flood
- **Figure D-8:** Velocity Distribution for Batten Kill just Downstream of Confluence – Left Berm Removed, 100-yr Flood
- **Figure D-9:** Velocity Distribution for Roaring Branch just Upstream of Confluence – Both Berms Removed, 2-yr Flood
- **Figure D-10:** Velocity Distribution for Roaring Branch Upstream of Confluence – Both Berms Removed, 100-yr Flood
- **Figure D-11:** Velocity Distribution for Batten Kill just Downstream of Confluence – Both Berms Removed, 2-yr Flood
- **Figure D-12:** Velocity Distribution for Batten Kill just Downstream of Confluence – Both Berms Removed, 100-yr Flood

It should be noted that the same set of colors is used in each plot to represent a different range of velocities (i.e., dark blue does not necessarily represent the same velocity in all plots). Refer to the legend of each plot for velocity values.

Looking at the Roaring Branch, it can be seen that the velocity of flows in the channel and overbank areas reduced upon berm removal (left only or both) for both the 2-year and 100-year floods. Upon removal of both berms, velocities within the channel reduced from 1.4 to 1.2 feet/second for the 2-year flood and from 4.0 to 3.5 feet/second for the 100-year flood. Left and right overbank flow velocities were reduced by similar magnitudes as well.

For the Batten Kill, the reduction in velocity is not as apparent, but there is evidence that the in-channel energy is reduced by removal of the left or both berms. Looking at the removal of both berms, this evidence is present under both flows, but is most visible for the 100-year flood (Figures D-4 and D-12). Although the majority of the channel still flows at 5 feet/second in both scenarios, the "buffer zone" of lower-velocity flows along each side of the channel becomes wider—particularly on the right (where the flow is approximately 2 feet/second). It should also be noted that flow velocities are significantly higher for the 2-year flood (20 feet/second) than for the 100-year flood (5 feet/second). Although this may seem counterintuitive, it can easily be explained by the fact that the 2-year flood flows are completely contained within the channel, constrained on the right by a steep valley wall and on the left by a high area (probably a former floodplain recently abandoned due to incision caused by the increased stream power of the Roaring Branch), while the 100-year flood overtops that high area and gains over 1,000 feet of floodplain over which to dissipate the velocity of its flows.

Appendix E – Energy Grade Profiles

Energy grade is the sum of the pressure head, elevation head, and velocity head of a flow. When plotted in a profile view, it is referred to as the energy grade line, or EGL. This parameter can be useful in grasping changes in the energy of flood flows under the different scenarios due to a combination of factors.

Appendix E contains figures comparing energy grade profiles on both the Roaring Branch and the Batten Kill between existing and berm removal scenarios (left only or both berms) for both the 2-year and 100-year floods. The first four figures compare existing conditions versus left berm removal. Within that set, the first two figures show the Roaring Branch under both the 2-yr and 100-yr floods (Figures E-1 and E-2,

respectively), while the last two show the Batten Kill under the same two floods (Figures E-3 and E-4, respectively).

- **Figure E-1:** Roaring Branch Energy Grade Profile – Existing Conditions vs. Left Berm Removed (2-yr Flood)
- **Figure E-2:** Roaring Branch Energy Grade Profile – Existing Conditions vs. Left Berm Removed (100-yr Flood)
- **Figure E-3:** Batten Kill Energy Grade Profile – Existing Conditions vs. Left Berm Removed (2-yr Flood)
- **Figure E-4:** Batten Kill Energy Grade Profile – Existing Conditions vs. Left Berm Removed (100-yr Flood)

The last four figures compare existing conditions versus removal of both berms. Within that set, the first two figures show the Roaring Branch under both the 2-yr and 100-yr floods (Figures E-5 and E-6, respectively), while the last two show the Batten Kill under the same two floods (Figures E-7 and E-8, respectively).

- **Figure E-5:** Roaring Branch Energy Grade Profile – Existing Conditions vs. Both Berms Removed (2-yr Flood)
- **Figure E-6:** Roaring Branch Energy Grade Profile – Existing Conditions vs. Both Berms Removed (100-yr Flood)
- **Figure E-7:** Batten Kill Energy Grade Profile – Existing Conditions vs. Both Berms Removed (2-yr Flood)
- **Figure E-8:** Batten Kill Energy Grade Profile – Existing Conditions vs. Both Berms Removed (100-yr Flood)

The trends in these figures are almost identical to those of the water surface profiles (Appendix C). On the Roaring Branch, the energy grade profiles closely match for the upper half of the reach, then begin to separate toward the middle (as they near the lower berms). Under both floods, the energy grade line is lower upon removal of the berms—significantly so in the case of the 100-year flood.

Appendix F – Field Photographs

Select field photographs taken during the January 2008 site visit and the May 2008 topographic survey are included in Appendix F.

6.0 Other Considerations

6.1 Qualitative Description of Sediment Transport

The velocity distribution plots discussed in the previous section are a good indicator that removal of both berms or just the left berm may help restore a more natural sediment transport regime as typically found in an alluvial fan setting. Throughout the Roaring Branch channel and overbank areas, flow velocities are reduced by removing either the left or both berms. The lower velocities of flows in this scenario would not be able to suspend and transport the same quantity or size of sediment particles as observed under existing conditions. Less and smaller sediment being carried by lower-velocity flows will translate to reduced stream power and a decreased ability to erode the channel bed and banks. This will help alleviate further degradation and incision of the reach, and allow the stream to effectively re-establish new floodplain at a lower elevation through aggradation and planform changes. Furthermore, it will lessen the impacts of erosion and sediment accumulation farther downstream on the Batten Kill (i.e., the mass failure at the confluence and aggradation upstream of bridges).

6.2 List of Permits Required

Various individuals were contacted relative to the permits that would be required to remove the lower berms (left only or both). The following is a summary of those discussions.

For estimation purposes, it was assumed that both lower berms would be removed. The total footprint area of the lower berms was grossly estimated to be 18,218 square feet, which is far less than one acre (1 acre = 43,560 square feet). The total volume of berm material was estimated, also very roughly, to be 1,400 cubic yards. (For consideration of removal of the left berm only, it could be assumed that the footprint of the left berm is approximately 11,600 ft^2 and that the volume of the left berm is approximately 1,000 yd^3.)

US Army Corps of Engineers, 404 Permit – Based on discussions with the Essex, VT office of the Corps of Engineers, a 404 permit would only be required if any of the areas to be disturbed (access locations, spoil locations, etc.) are located in a wetland. Assuming that all work could take place from the upland area, no wet areas would be disturbed and thus no 404 permit would be required.

Vermont Agency of Natural Resources, Wetlands, Conditional Use Determination Permit – Based on discussions with Mic Metz (District Wetlands Ecologist, Rutland, VT), removal of the lower berms is considered a restoration project. Therefore, according to Mic Metz, a Conditional Use Determination Permit would not be required.

Vermont Agency of Natural Resources, 401 Water Quality Certificate – Based on discussions with Brian Fitzgerald with VANR, a 401 water quality certificate would only be necessary if a Corps of Engineers 404 permit was required. Since it appears that a 404 permit would not be required, a 401 water quality certificate would also not be required.

Vermont Agency of Natural Resources, Stormwater Permit – Because the area of disturbance is less than one acre, a stormwater permit would not be required. This has been confirmed by Matt Probasco with VANR (802-241-4581).

Vermont Agency of Natural Resources, Stream Alteration Permit – Based on discussions with Patrick Ross (Stream Alteration Permit Engineer), a stream alternation permit would be required because the excavation volume is greater than 10 cubic yards.

Town Floodplain Permit – Based on discussions with Al Godreau of the Town of Arlington zoning department and it appears that a permit would be required under their Flood Hazard Areas Regulations, Section 7.12.6, which are being sent to us. Upon receipt of these regulations, they will be included in Appendix G.

6.3 Budgetary Estimate of Cost

The following threshold questions regarding landowners must be addressed prior to conducting any work related to removal of the lower berms:

- Do the landowners understand and accept the study findings that removal of the lower berms will not increase flooding of their lands, houses, and associated buildings?

- If the landowners agree that removal of the berms is reasonable, will they:
  - Allow access to their lands to facilitate removal of the berms?
  - Allow tree cutting on their lands, if necessary, to provide for excavator access to the berms?
  - Allow tree cutting on and near the berms to facilitate physical removal of the berms?
  - Allow excavated material (berm material, stumps, etc) to be spoiled on-site (or will they require the material to be hauled off-site)?

An order-of-magnitude cost estimate was developed assuming the landowners would grant permission to remove the lower berms. The estimate, provided in Table 5.1 on the following page, includes the following tasks and assumptions. Again, it was assumed that both lower berms would be removed. The estimate would have to be adjusted for removal of the left berm only.

Development of Design Plans – It is assumed that the design would be relatively straightforward; however, general plans showing work limits, disposal locations, erosion control measures, etc. would need to be developed.

Permitting – Required permits are noted in Section 5.2 above.

Mobilization/Demobilization – This includes the cost to haul equipment to and from the work site.

Erosion Control Measures – Before any work is initiated, erosion control measures, including silt fencing, would be necessary to contain sediment in the work area.

Access to Berms – It is assumed that the berms would be removed from the upland side, so no in-water work would be required. To move the equipment to the work areas, some removal of trees may be necessary. Again, because the lands on both sides of the river are privately owned, prior discussions with landowners regarding access are imperative.

Tree Removal – As noted above, the berms have been in place for many years and trees of varying size (see photo inset) have established on top of and around the berms. Prior to excavating the lower berms, the trees should be removed. Again, because the lands are privately owned, discussions with the landowners regarding tree removal are necessary. Also, assuming the landowners agree to tree removal, it would also be important to discuss whether the timber should be sold (if feasible) or retained by the landowners for their own use. For the purposes of this cost estimate, it was assumed that the timber would be cut and stacked on site for homeowner use. It was also assumed that branches and smaller material could be buried on-site.

Berm Excavation – It is assumed an excavator (such as the one pictured) would be the preferred equipment to with which to remove the berms. It is also assumed that berm material would be sloped gently backward to match the existing upland grade. Any larger material, such as stumps or large rocks, may need to be disposed of on-site in an agreed-upon location with the landowners. If this assumption is incorrect, then the cost estimate would increase to account for the trucking/hauling and proper disposal of material. It should also be noted that any material spoiled on-site would be located outside any wetlands jurisdiction.

Replanting – The existing trees and vegetation on the berms provide some riparian habitat along lower Roaring Branch. Removal of the berms will leave the area disturbed and it is recommended that some vegetation (i.e., trees) be replanted at the disturbed locations.

Letter of Map Revision – Based on discussions with Rob Evans (VT Floodplain Management Coordinator), a Letter of Map Revision (LOMR) would not be required for this project. However, FEMA would require submission of the HEC-RAS model and the report for their records.

Table 6-1: Order-of-Magnitude Estimate to Remove Lower Berms on the Roaring Branch

Item	Description	Estimated Cost
1	Development of Design Plans	$5,000
2	Permitting	$5,000
3	Mobilization/Demobilization	$2,000
4	Erosion Control Measures	$1,000
5	Tree Removal Along Berms, Clearing, and Grubbing	$6,000
6	Excavator - Stockpile Trees, Remove Berms, and Redistribute Material On-Site (assumes $200/hr for equipment & operator x 110 hrs)	$22,000
7	Purchase and Replanting of Trees	$5,000
	Sum of Tasks	$46,000
	20% Contingency	$9,200
	TOTAL ESTIMATE TO REMOVE BERMS (including contingency)	**$55,200**

ASSUMPTIONS:
1. Assumes trees are stockpiled on site for landowner use. Estimate does not include costs for hauling trees off-site or selling the timber.
2. Assumes all berm material, including stumps, are spoiled on-site outside any wetlands area. Estimate does not include costs for hauling the material off-site.
3. Assumes work is conducted by a local contractor, thus reducing mobilization and demobilization costs.

7.0 Conclusion

The results of the hydraulic and geomorphic analysis of the Roaring Branch and the Batten Kill, presented in many different formats, all point to one conclusion: that the removal both downstream berms (or even just the left berm) along the Roaring Branch appears to have little or no negative effect on existing infrastructure in the floodplain, and that it likely will lessen the severity of flood inundation areas, water depths, and flow velocities. These changes would result in increased dissipation of excess energy and sediment, thus helping to restore the confluence back to its historic alluvial fan state. Consequently, in-channel energy and stream power of the Roaring Branch would decrease, reducing further incision of the reach and allowing the stream to re-establish its floodplain through aggradation and planform adjustments. Furthermore, effects would extend to the Batten Kill, helping to alleviate further erosion of the mass failure opposite of the confluence and reducing the amount of sediment deposited upstream of bridge openings farther downstream.

Physical removal of the berms appears to be relatively straightforward. Probably the most complicating factor is the presence of heavy vegetation and full-grown trees on the berms, which would have to be removed and dealt with appropriately as discussed above. Once the berms have been cleared, they could be "removed" by grading them backwards with an excavator into the natural topography. If too much material is present to grade it evenly onto the floodplain without filling in low or potentially wet areas, some or all of the material might need to be transported away from the site, which would increase costs.

References

Federal Emergency Management Agency. (1986). *Flood Insurance Study: Town of Arlington, Vermont*.

Jaquith, S. (VT DEC), Kline, M. (VT DEC), Field, J. (Field Geology Services), & Henderson, J (Batten Kill Watershed Alliance). (2004). *Phase 1 Geomorphic Assessment of the Batten Kill Main-Stem and Major Tributaries.* VT DEC River Management Program.

Field, J. (Field Geology Services). (2005). *Phase 2 Geomorphic Assessment of the Batten Kill, Vermont.* VT DEC River Management Program.

Field, J. (Field Geology Services). (2007). *River Corridor Planning on the Batten Kill, Vermont*. VT DEC River Management Program.

APPENDIX G

Flood Hazard Area Regulations

3. Existing Sand and Gravel Operations:

Existing sand and gravel or other extractive operations must conform to this Bylaw from its effective date if extraction has not occurred on the site within the previous 20 years, or if the extractive operations are enlarged to exceed the limits of existing property lines.

7.12 FLOOD HAZARD AREAS

Purpose

In addition to the purpose of the zoning district(s) underlying the Flood Hazard Areas, the purpose of this regulation is to protect the public health, safety, persons, and property against the hazards of flood water inundation, and for the protection of the community against the costs which may be incurred when unsuitable development occurs in swamps, marshes, along water courses, or in areas subject to flooding.

1. Flood Hazard Area Maps:

These regulations shall apply in all areas in the Town of Arlington identified as areas of special flood hazard on the National Flood Insurance Program maps, FIRM and the Floodway Map, which are hereby adopted by reference and declared to be part of these regulations.

2. Base Flood Elevations and Floodway Limits:

Where available (i.e., Zone A1 – A30, AE, and AH), the base flood elevations and floodway limits provided by the National Flood Insurance Program in the Flood Insurance Study and accompanying maps shall be used to administer and enforce these regulations.

In areas where base flood elevations and floodway limits have not been provided by the National Flood Insurance Program (i.e., Zone A) base flood elevations and floodway information available from State or Federal agencies or other sources, shall be obtained and reasonably utilized to administer and enforce these regulations.

3. Review Procedure and Development Standards:

Review Procedure: Except as provided for in Section 7.12.5, all land development, including the division of a parcel into two or more parcels, the construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any building or other structure (including prefabricated units or manufactured homes), or of any mining, excavation, or land fill, and any change in the use of land in the Flood Hazard Area may be permitted only by the Zoning Board of Adjustment as a conditional use, in accordance with the procedures of Section 7.1 of this Bylaw.

Upon receipt of an application and plans, the Zoning Board of Adjustment shall transmit one copy to the Vermont ANR / DEC (Floodplain Management), and shall consider all comments received from the Department. A permit may be issued only following receipt of comments from the Department or the expiration of 30 days from the date the application was mailed to the Department, whichever is sooner.

Adjacent communities and the Vermont ANR / DEC (Floodplain Management) shall be notified at least 15 days prior to issuing any permit for the alteration or relocation of a watercourse, and copies of such notification shall be submitted to the Administrator of the Federal Insurance Administration.

Proposed development shall be reviewed to assure that all necessary permits have been received from those governmental agencies from which approval is required by Federal and State law.

Development Standards: In addition to the district requirements, the Board of Adjustment shall determine that the land development is:

a. designed and anchored to prevent flotation, collapse, or lateral movement of the structure.

b. constructed of materials and utility equipment that are resistant to flood damage.

c. constructed using methods and practices that will minimize flood damage.

d. consistent with the need to minimize flood damage.

e. designed so that public utilities and facilities, such as sewer, gas, electrical, and water systems, are located, elevated, and constructed to minimize or eliminate flood damage. Construction shall insure that electrical, heating, ventilation, plumbing, and air conditioning equipment, and other service facilities are designed and/or located so as to prevent water from entering or accumulating within components during conditions of flooding.

f. designed so that adequate drainage is provided so as to reduce exposure to flood hazards.

g. new or replacement water supply systems, and/or sanitary sewage systems, are designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters, and that on-site disposal systems are located so as to avoid impairment of them or contamination from them during flooding.

h. base flood elevation and floodway data identified in Section 7.12.2 shall be used to ensure that the lowest floor (including basement) of residential buildings is elevated to be at or above the base flood elevation and the floodway be kept free of obstructions.

i. the lowest floor (including basement) of non-residential buildings and other structures, shall be elevated or floodproofed to at least one foot above the 100 year flood level, or be designed to be watertight below the base flood elevation with the walls substantially impermeable and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. A permit

for a building proposed to be floodproofed shall not be issued until a registered professional engineer or architect has reviewed the structural design, specifications, and plans, and has certified that the design and proposed methods of construction are in accordance with accepted standards of practice for meeting the provisions of this subsection.

j. All new construction, and substantial improvements, with fully enclosed areas below the lowest floor that are subject to flooding, shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect, or meet or exceed the following criteria: a minimum of two openings, having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding, shall be provided. The bottom of all such openings shall be no higher than one foot above grade. Openings may be equipped with screens, louvers, valves, or other coverings or devices, provided that they permit the automatic entry and exit of floodwaters.

k. Storage of materials or equipment may be permitted if not subject to damage by floodwater, and are firmly anchored or secured to prevent flotation.

l. Fill may be permitted in the flood hazard area only when it can be demonstrated that flood flows will not be obstructed or diverted. No fill shall be permitted in the floodway unless a registered professional engineer certifies that the proposed fill will not result in any increase in flood levels during the occurrence of the base flood.

m. New and replacement manufactured homes shall be elevated on properly compacted fill, such that the top of the fill (the pad) under the entire manufactured home is above the base flood elevation.

n. The flood carrying capacity within any altered or relocated portion of a watercourse shall be maintained.

o. Recreational Vehicles placed on sites within Zones A1 – A30, AH and AE shall either (i) be on the site for fewer than 180 consecutive days, (ii) be fully licensed and ready for highway use, or (iii) meet all standards of Section 60.3(b)(1) of the National Flood Insurance Program Regulations and the elevation and anchoring requirements for "manufactured homes" of Section 60.3(c)(6).

4. Burden of Proof:

In reviewing the proposed land development, the burden of proof shall be on the applicant.

5. Prohibited Uses:

Junkyards as defined in 24 V.S.A. 2068, solid waste disposal sites, and storage facilities for floatable materials, chemicals, explosives, flammable liquids, or other hazardous or toxic materials, are prohibited within the floodway. If prescribed by the zoning ordinance district regulations, these facilities may be permitted outside of the floodway, provided the area is

filled to at least one foot above the base flood elevation, and the development meets all applicable requirements of the zoning ordinance.

All structures, other than those existing on the effective date of this bylaw and those specifically identified in Sections 7.12.6 (a-i) and 7.12.7 (b-e), are prohibited in floodway areas.

6. Permitted Uses in Flood Hazard Areas:

The following uses are permitted in flood hazard areas, provided that they do not reduce the flood carrying capacity of the stream. A permit may be issued for these uses by the Land Use Administrator without conditional use approval by the Board of Adjustment. Any state and federal permits applicable to the subject activity must be submitted as part of the zoning permit application.

a. Streambank restoration and stabilization;
b. Necessary improvements by the municipality in case of an emergency;
c. Landscaping that does not involve the erection of any structure;
d. Culverts;
e. Swales;
f. Drainage ditches;
g. Fish and wildlife habitat improvement not requiring structures;
h. Agricultural uses;
i. A wall or fence, provided it does not impede the flow of flood waters.

7. Conditional Uses in Flood Hazard Areas:

The following uses are conditionally permitted in flood hazard areas, subject to the requirements of this section and all other applicable sections of the zoning bylaw. Any state and federal permits applicable to the subject activity must be submitted as part of the zoning permit application.

a. Uses permitted or conditionally permitted in the land use district in which the subject property is located, that are not specifically identified in Section 7.12.5;
b. Bridges;
c. Fish and wildlife habitat improvement requiring structures;
d. Ponds, provided that all excavated material is removed from the floodway;
e. Access ramps for canoes, boats, tubes, swimmers, and fishermen.

8. Expansion of Existing Buildings in the Floodway:

No existing building in the floodway may be enlarged to create a greater encroachment on the floodway.

9. Application Requirements:

Applications shall include, in addition to any other requirements of this bylaw, plans in triplicate, drawn to scale, showing the nature, location, dimensions, and elevations of the lot,

plat, or parcel, existing and proposed structures, fill and storage of materials, floodproofing measures, and the relationship of the above to the location of the channel, flood hazard area, and, based on the best information available, the elevation of the 100 year flood. A valley cross-section showing the stream channel, and elevation of land adjoining each side of the channel, and areas occupied by the proposed development may be required.

10. Precedent of Law:

Where this regulation imposes a greater restriction upon the land development, the provisions of this regulation shall control.

11. Administration and Enforcement:

The provisions of this regulation shall be administered and enforced as provided for in Section 8 of the permanent zoning bylaw of the Town. The Administrative Officer shall maintain a record of:

a. all permits issued for development in areas of special flood hazard.
b. the elevation, in relation to mean sea level, of the lowest floor, including the basement, of all new or substantially improved buildings.
c. the elevation, in relation to mean sea level, to which buildings have been floodproofed.
d. all floodproofing certifications required under this regulation.
e. all variance actions, including justification for their issuance.

Variances shall be granted by the Board of Adjustment only:

a. in accordance with the provisions of 24 V.S.A. Section 4469;
b. upon determination that the variance will not result in increased flood heights that pose threats to public safety, extraordinary public expense, create nuisances or victimization of the public, or conflict with existing local laws or ordinances.

12. Disclaimer:

These regulations shall not be construed to imply that areas outside of the Flood Hazard Areas, or land uses permitted hereunder, within such Flood Hazard Areas, will be free from flooding or flood damage. No permit issued hereunder, or development permitted in accordance herewith, shall create any liability on the part of the Town of Arlington, or any officer, agent, or employee thereof.

13. Definitions:

The National Flood Insurance Program definitions contained in 44 CFR Section 59.1 are hereby adopted by reference and shall be used to interpret and enforce these regulations.

APPENDIX F

Field Photographs

Figure F-1: Looking downstream from Route 7A Bridge. Large sidebar on left with upper left berm in background.

Figure F-2: Looking upstream from Route 7A Bridge towards railroad bridge.

Figure F-3: Under Route 7A Bridge looking toward channel center from left sidebar.

Figure F-4: Under Route 7A Bridge from left sidebar looking toward upper left berm.

Figure F-5: From left bank looking across upper left berm toward campground office/residence.

Figure F-6: From left bank looking across channel to seasonal camp on opposite bank behind upper right berm.

Figure F-7: Looking down upper left berm. Island in background.

Figure F-8: Looking upstream from upper left berm toward Route 7A Bridge.

Figure F-9: Campground sites behind upper left berm.

Figure F-10: Looking downstream in the river-left floodplain behind the upper left berm. Note campsites in background.

Figure F-11: Typical berm texture (upper left berm looking downstream).

Figure F-12: Saplings and trees on upper left berm (looking downstream).

Figure F-13: Confluence with the Batten Kill with mass failure site on opposite bank.

Figure F-14: Close-up of mass failure site.

Figure F-15: Looking up the Batten Kill (left) and Roaring Branch (right) from the confluence.

Figure F-16: Looking up the Roaring Branch and left overbank area from the river-left bank at the confluence.

Figure F-17: Two-story home in the river right corridor viewed from the left bank.

Figure F-18: Restaurant (foreground) and mobile home (background) behind the upper right berm (looking downstream).

Figure F-19: Lower left berm viewed from right bank.

Figure F-20: Lower right berm viewed from right floodplain behind it looking upstream (note debris piled in low area).

Figure F-21: Looking upstream along river-right bank from lower end of island. Note Route 7A Bridge in background.

Figure F-22: Looking downstream from lower end of island.

Figure F-23: Downstream end of lower left berm. Note erosion.

Figure F-24: Close-up of downstream end of lower left berm and erosion site.

Figure F-25: Looking downstream toward confluence and mass-failure site on opposite bank.

Figure F-26: Close-up of mass-failure site.

Figure F-27: Point where side channel enters the Batten Kill upstream of the main confluence. Looking down the side channel toward the Batten Kill.

Figure F-28: Looking down the Batten Kill from the side channel exit point toward the main confluence (at sediment deposit).

APPENDIX E

Energy Grade Profiles

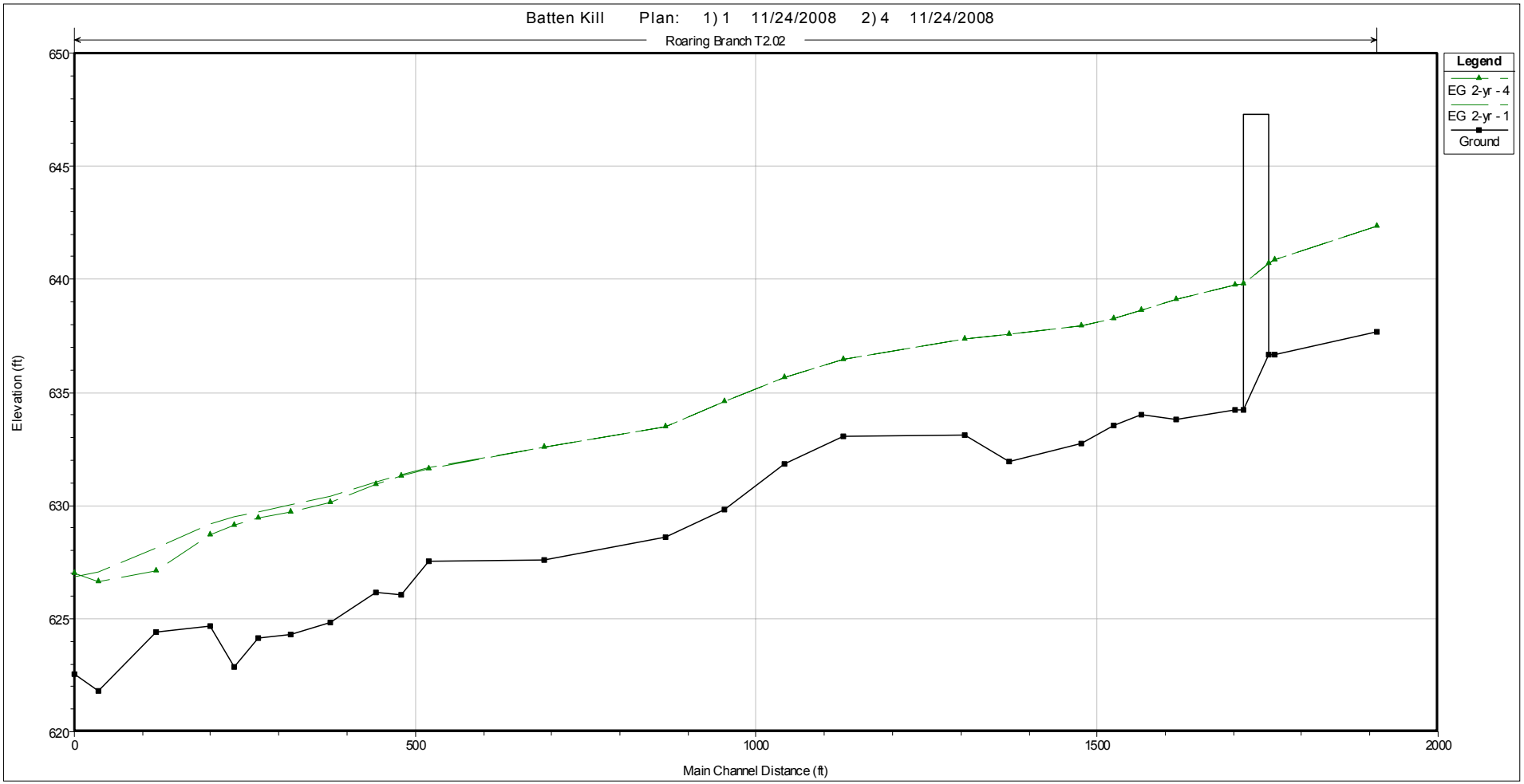


Figure E-1: Roaring Branch Energy Grade Profile – Existing Conditions vs. Both Berms Removed (2-yr Flood)

Note: Dashed line represents existing conditions (Scenario 1); dashed line with triangles represents both berms removed (Scenario 4).

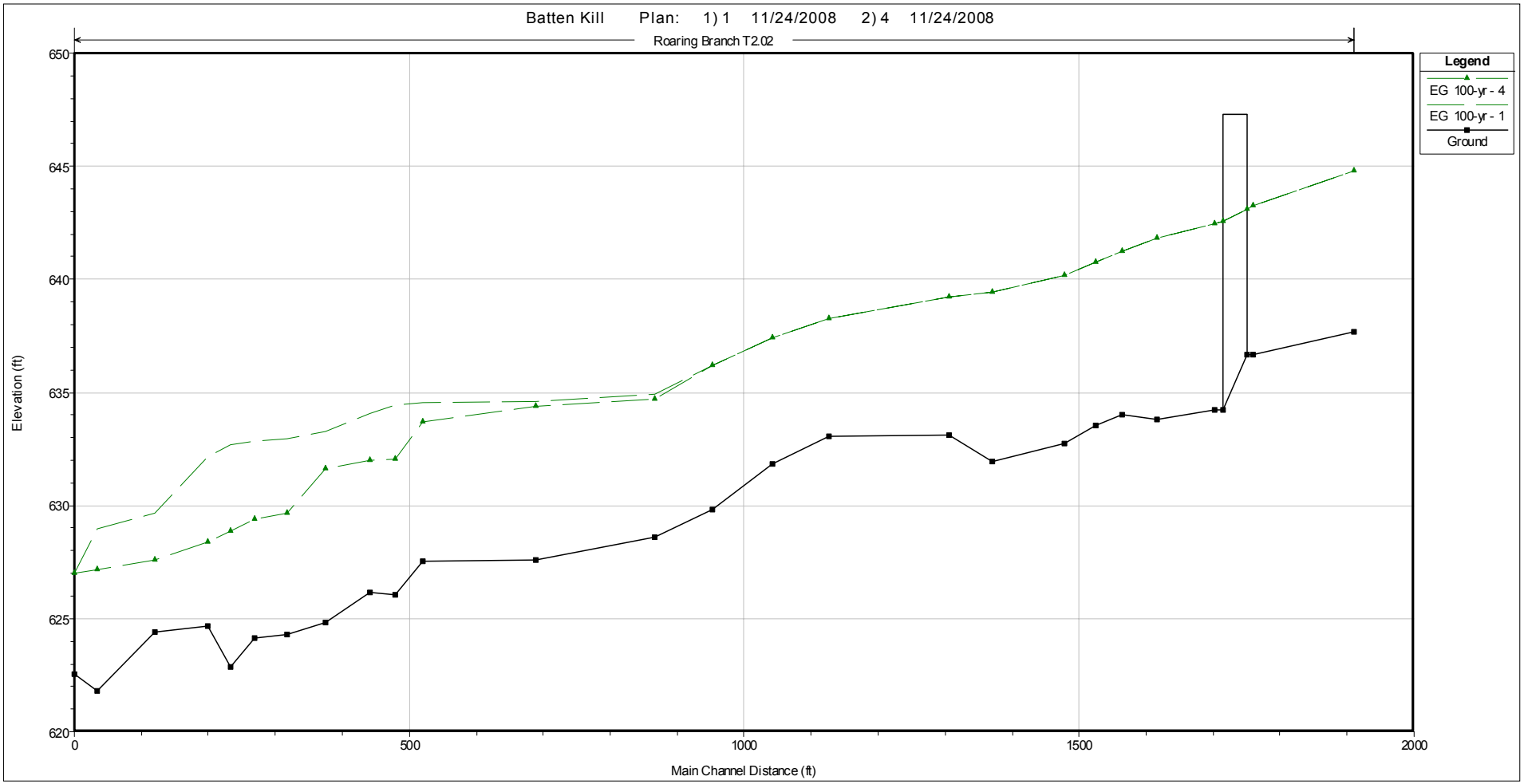


Figure E-2: Roaring Branch Energy Grade Profile – Existing Conditions vs. Both Berms Removed (100-yr Flood)

Note: Dashed line represents existing conditions (Scenario 1); dashed line with triangles represents both berms removed (Scenario 4).

APPENDIX D

Velocity Distributions

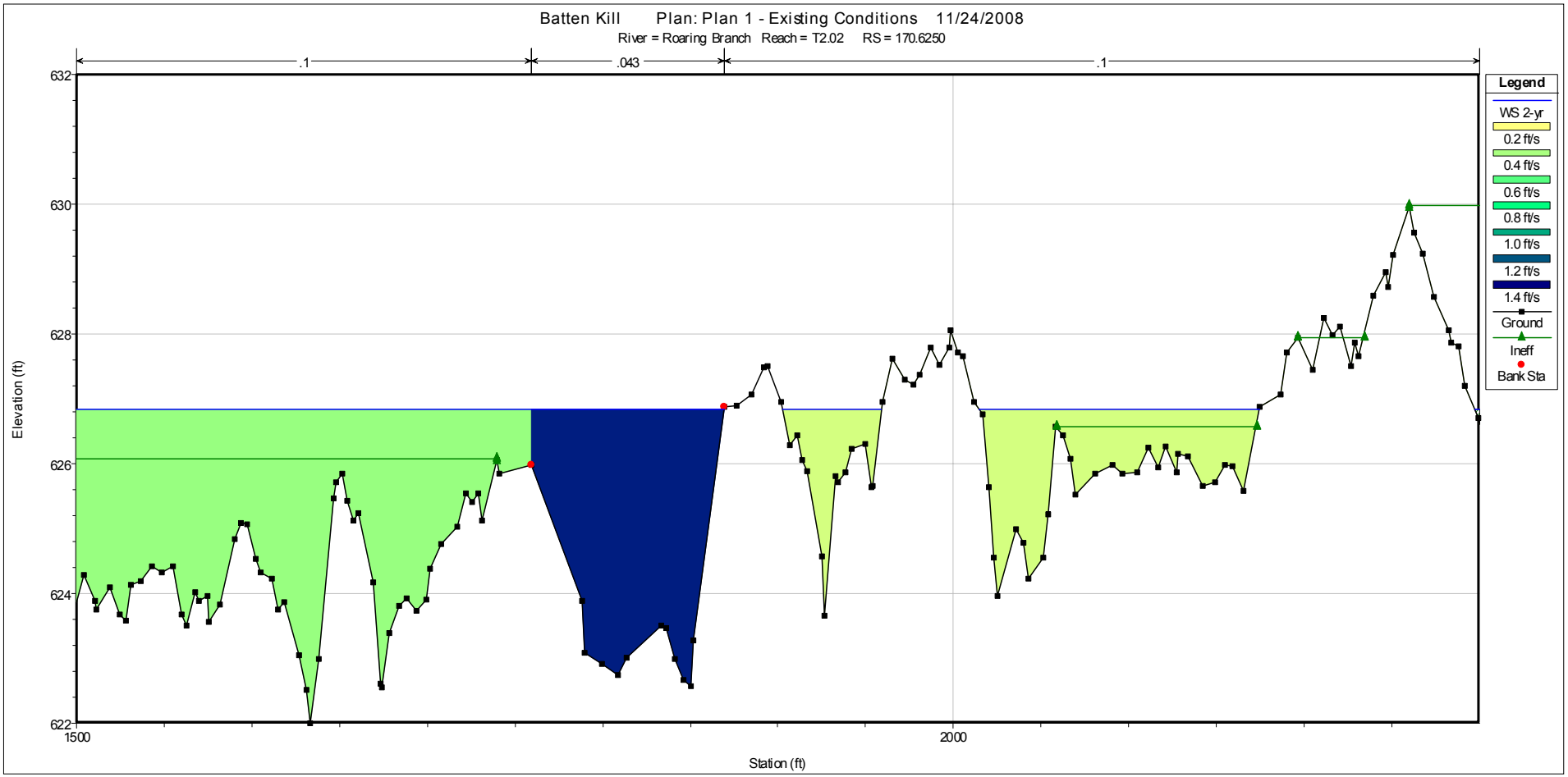


Figure D-1: Velocity Distribution for Roaring Branch just upstream of Confluence – Existing Conditions, 2-yr Flood

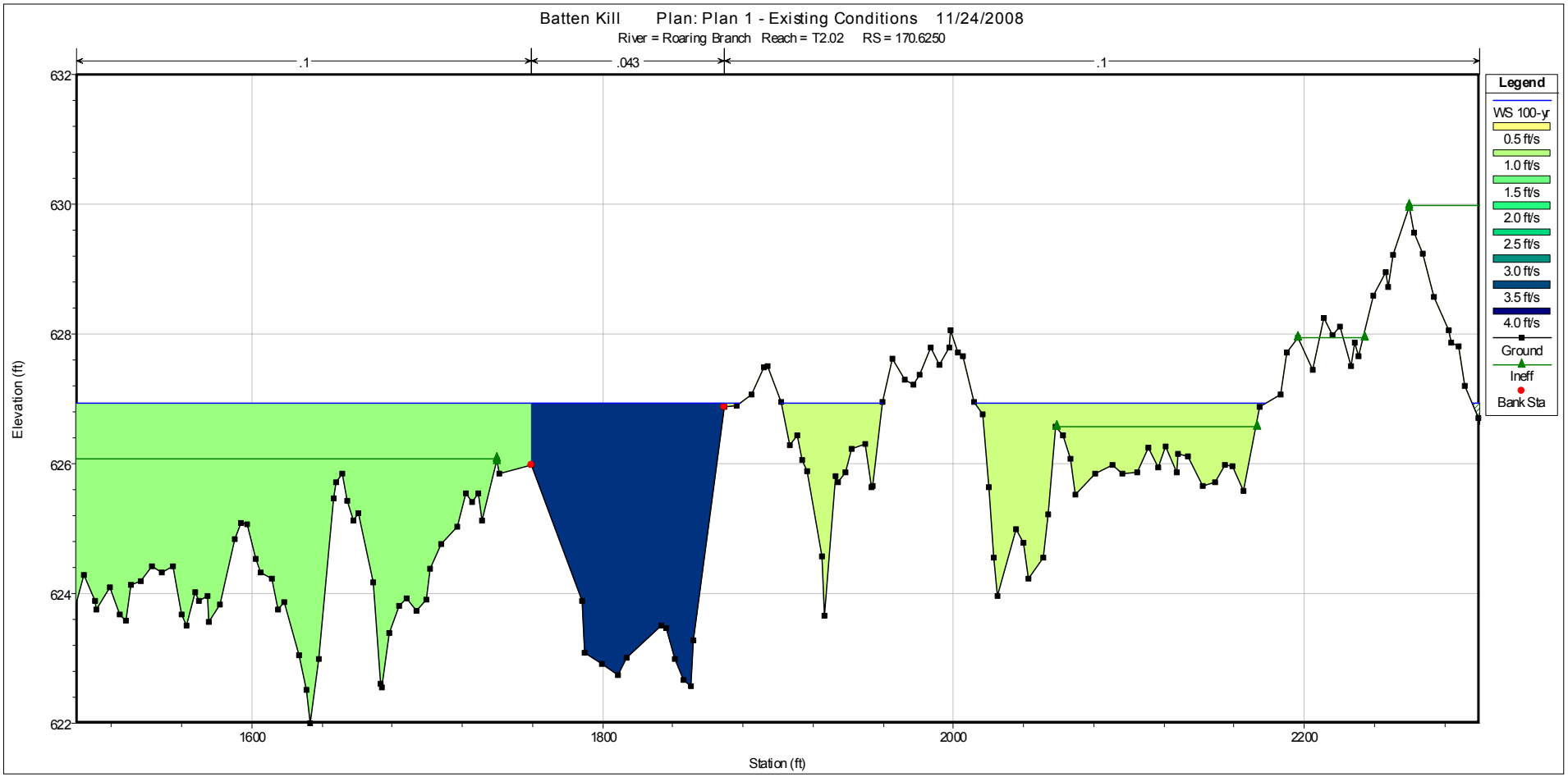


Figure D-2: Velocity Distribution for Roaring Branch just upstream of Confluence – Existing Conditions, 100-yr Flood

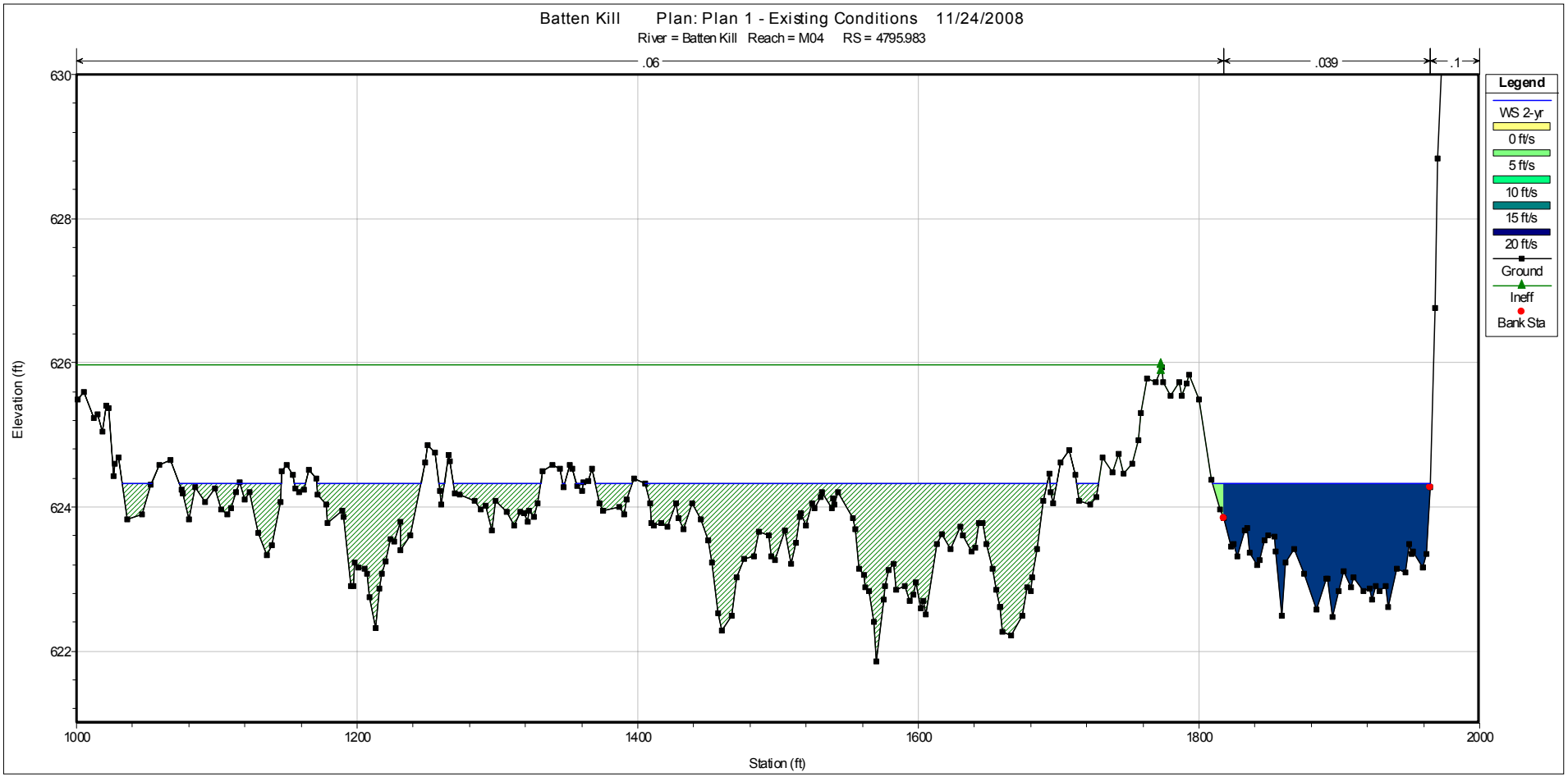


Figure D-3: Velocity Distribution for Batten Kill just downstream of Confluence – Existing Conditions, 2-yr Flood

Note: The dark green color in the left overbank is actually a hatching representing an ineffective flow area (i.e., very low velocity).

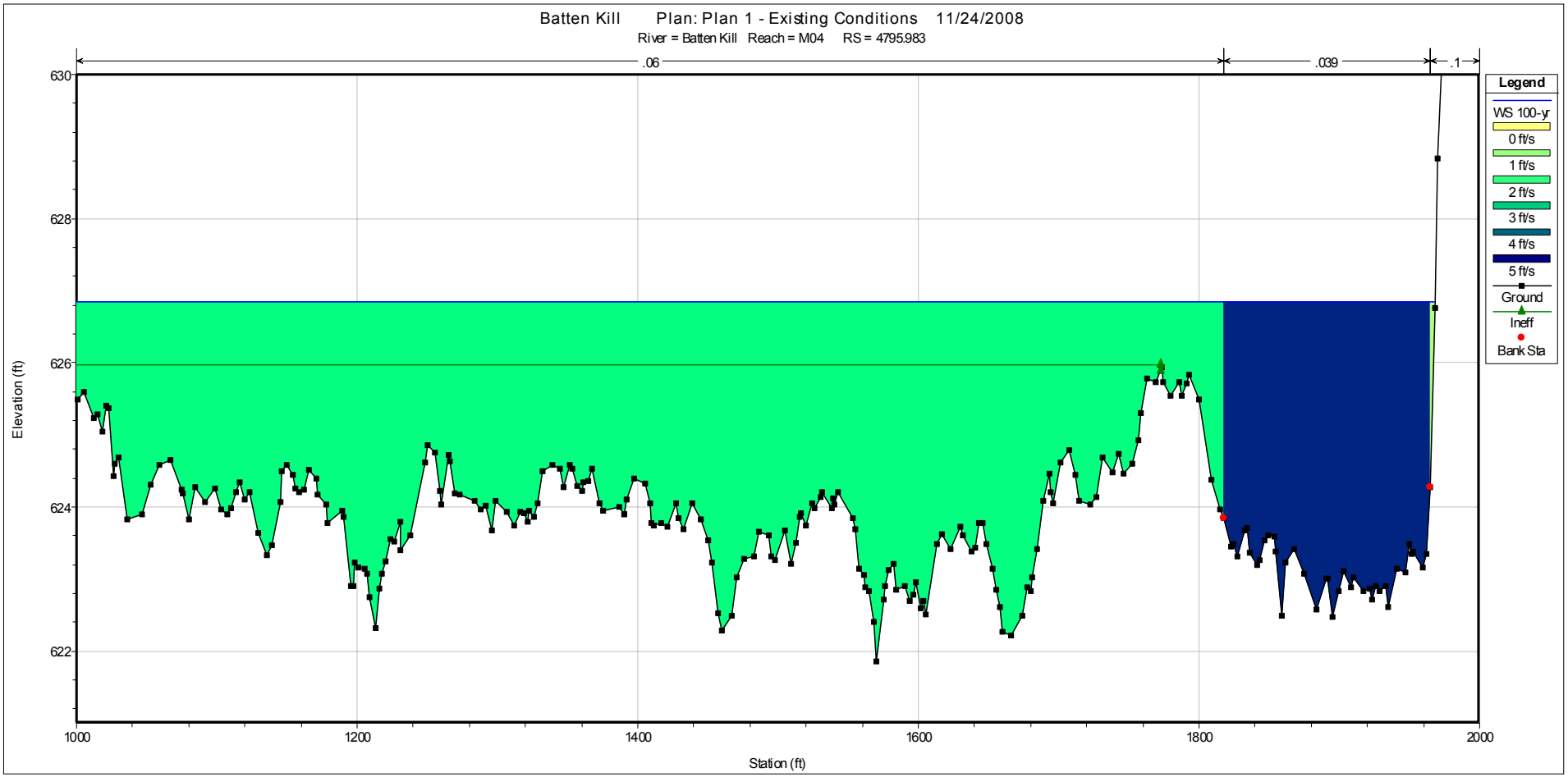


Figure D-4: Velocity Distribution for Batten Kill just downstream of Confluence – Existing Conditions, 100-yr Flood

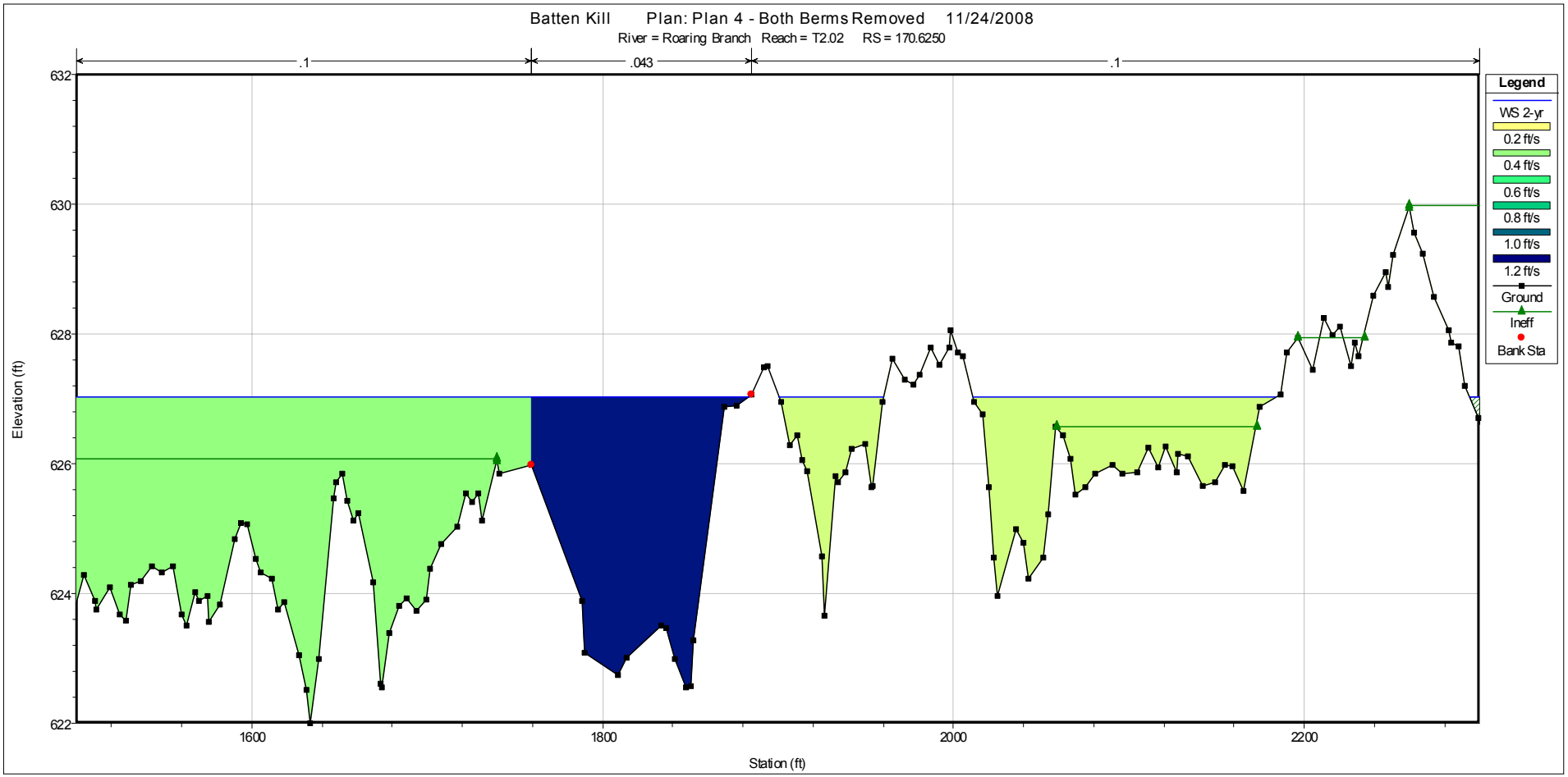


Figure D-5: Velocity Distribution for Roaring Branch just upstream of Confluence – Both Berms Removed, 2-yr Flood

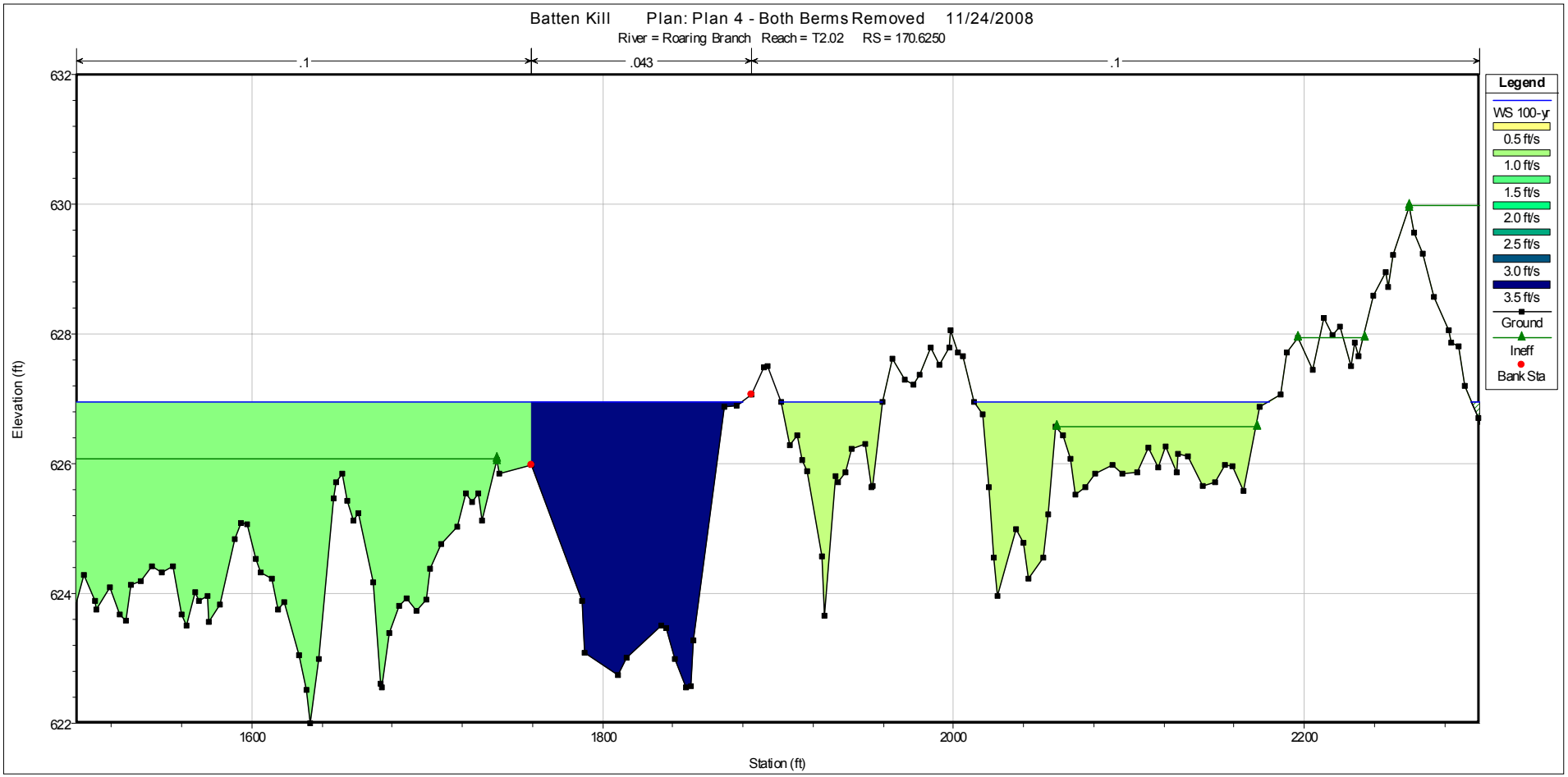


Figure D-6: Velocity Distribution for Roaring Branch just upstream of Confluence – Both Berms Removed, 100-yr Flood

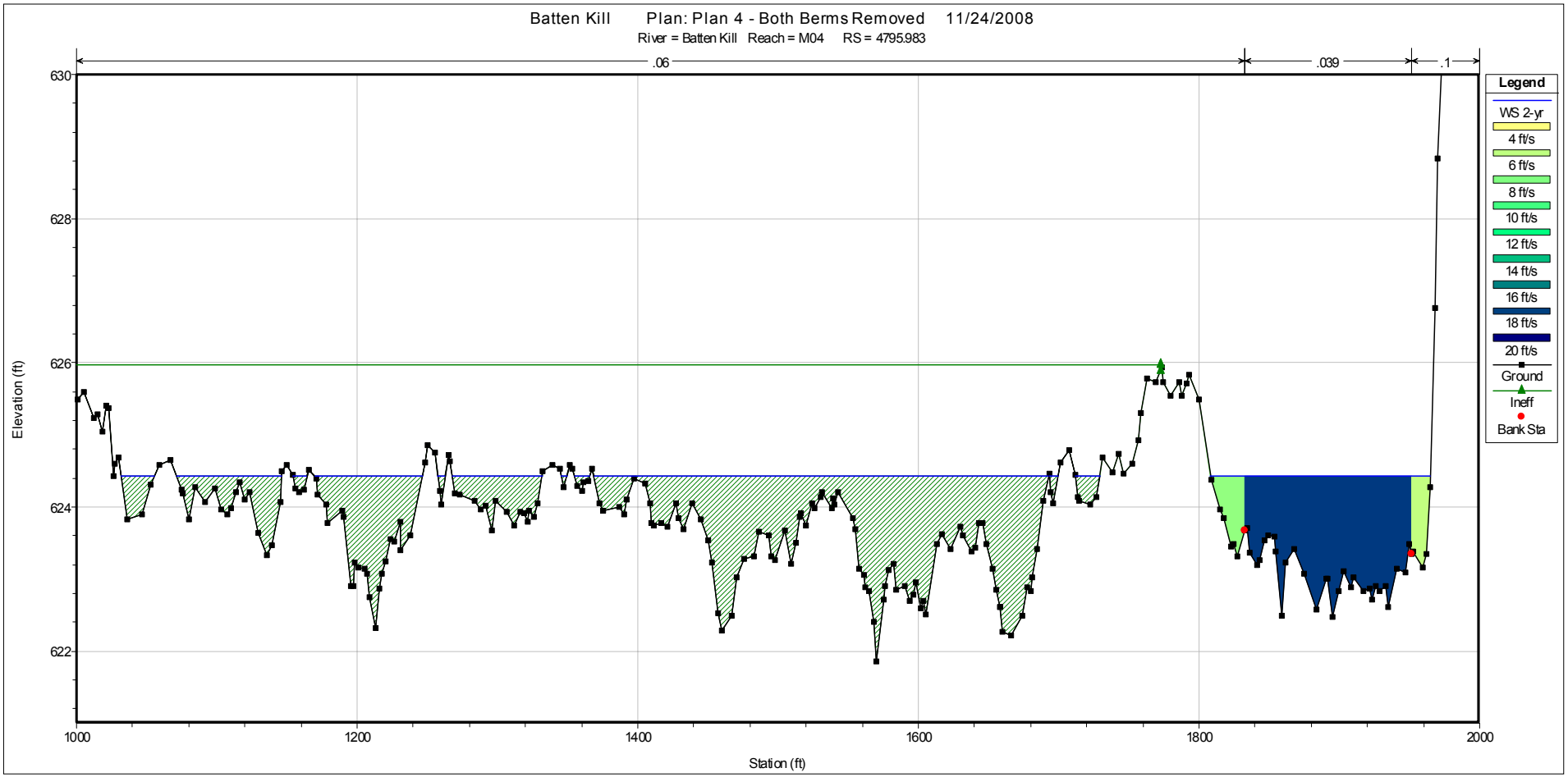


Figure D-7: Velocity Distribution for Batten Kill just downstream of Confluence – Both Berms Removed, 2-yr Flood

Note: The dark green color in the left overbank is actually a hatching representing an ineffective flow area (i.e., very low velocity).

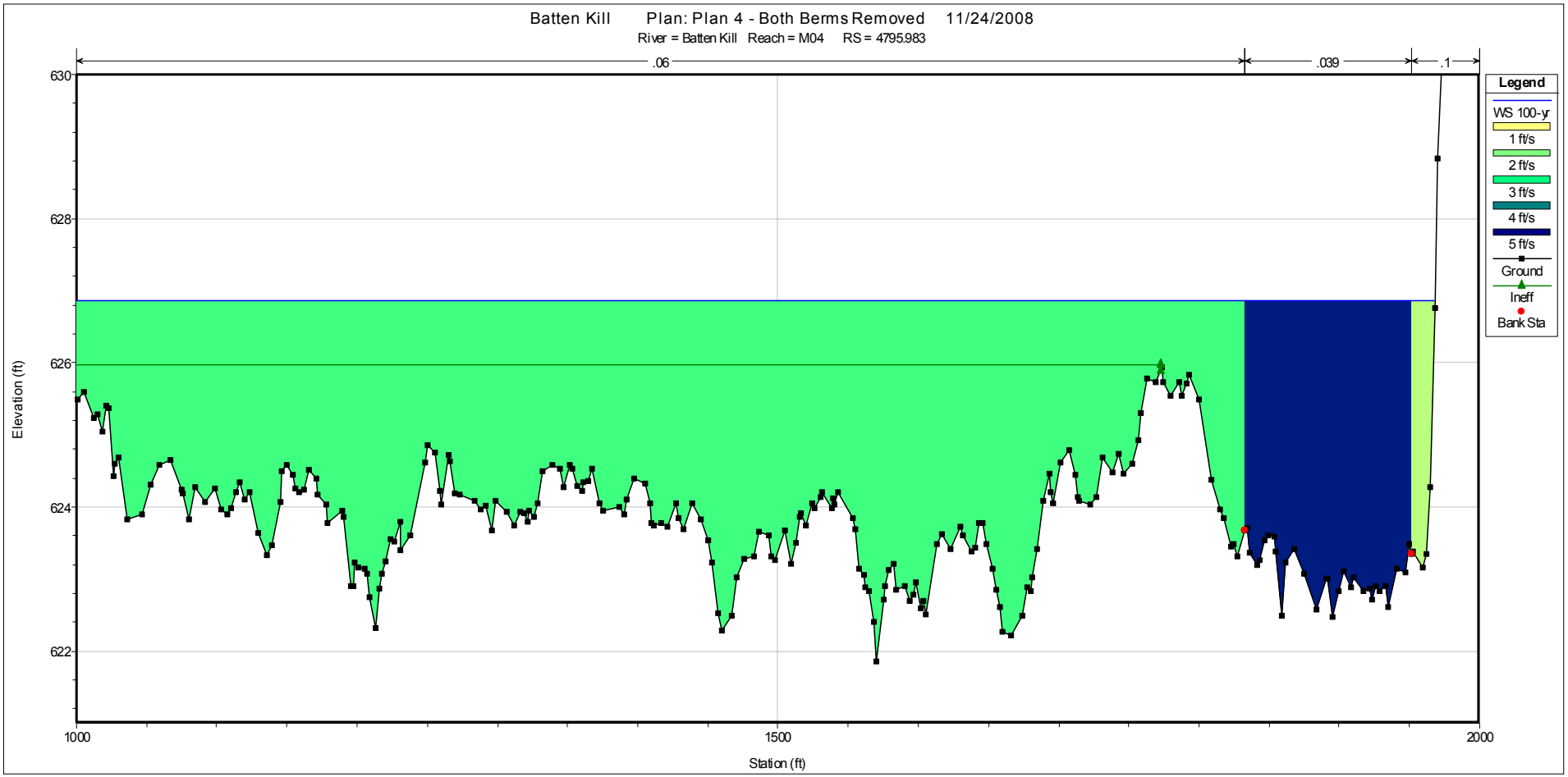


Figure D-8: Velocity Distribution for Batten Kill just downstream of Confluence – Both Berms Removed, 100-yr Flood

APPENDIX C

Water Surface Profiles

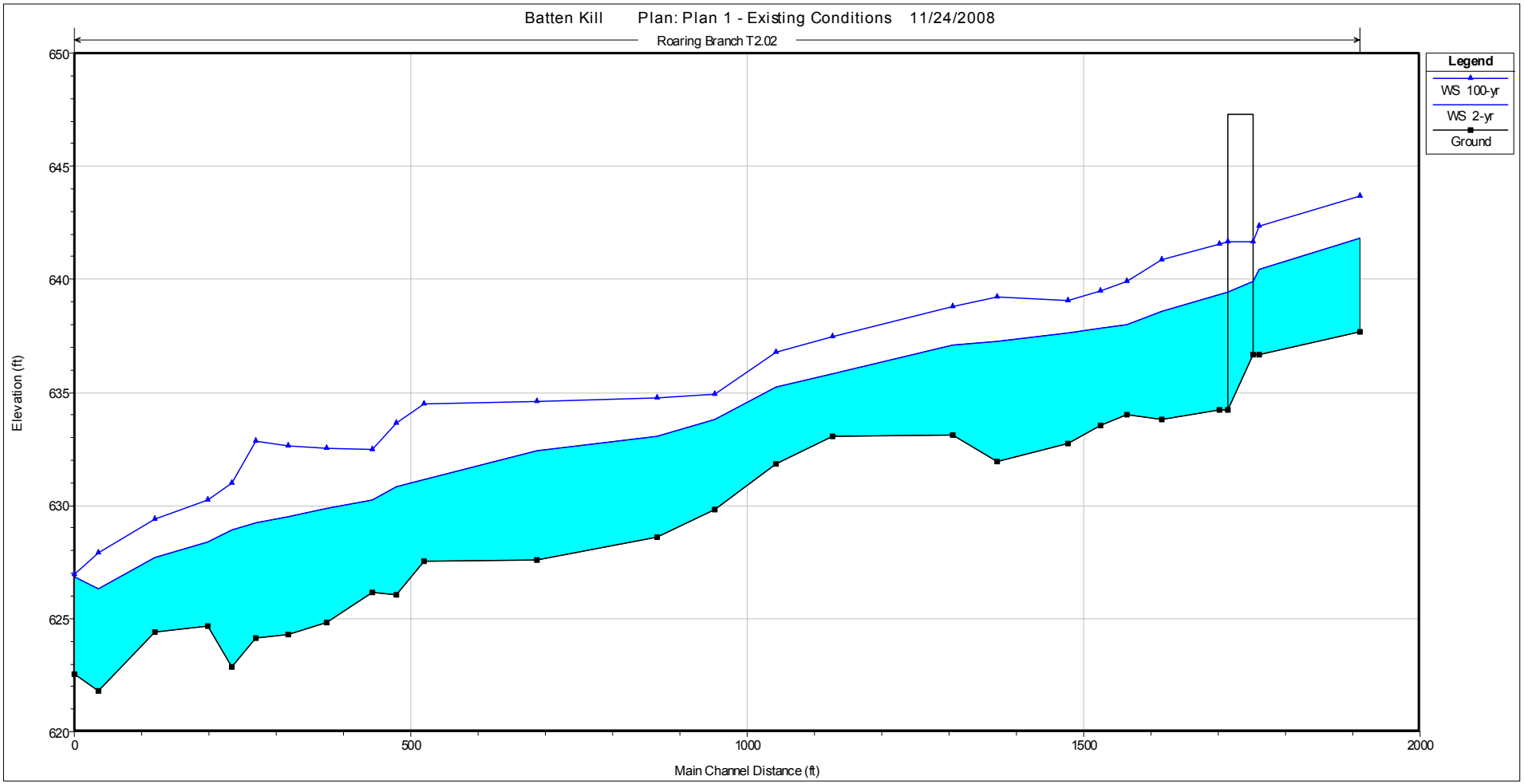


Figure C-1: Roaring Branch Water Surface Profile – Existing Conditions

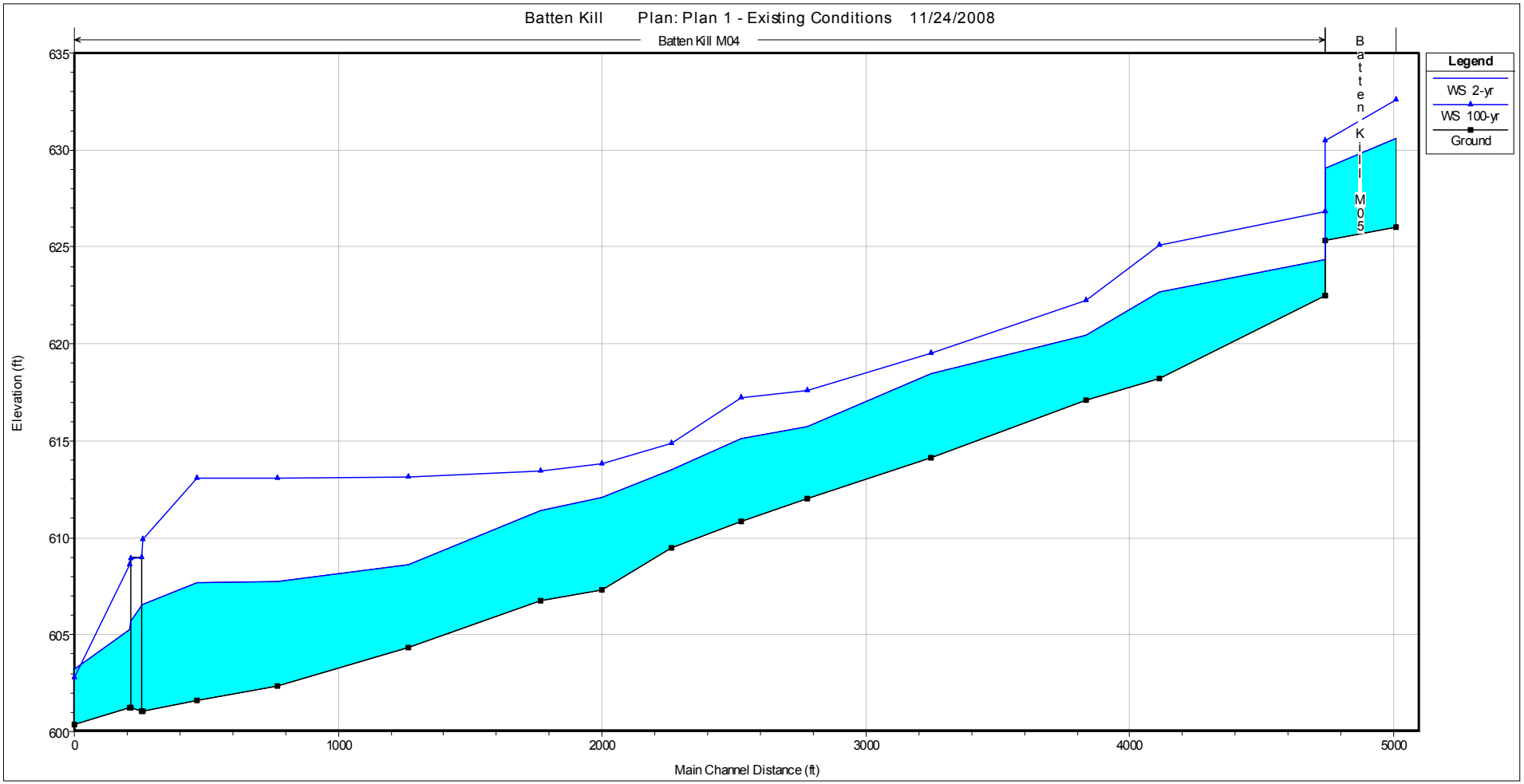


Figure C-2: Batten Kill Water Surface Profile – Existing Conditions

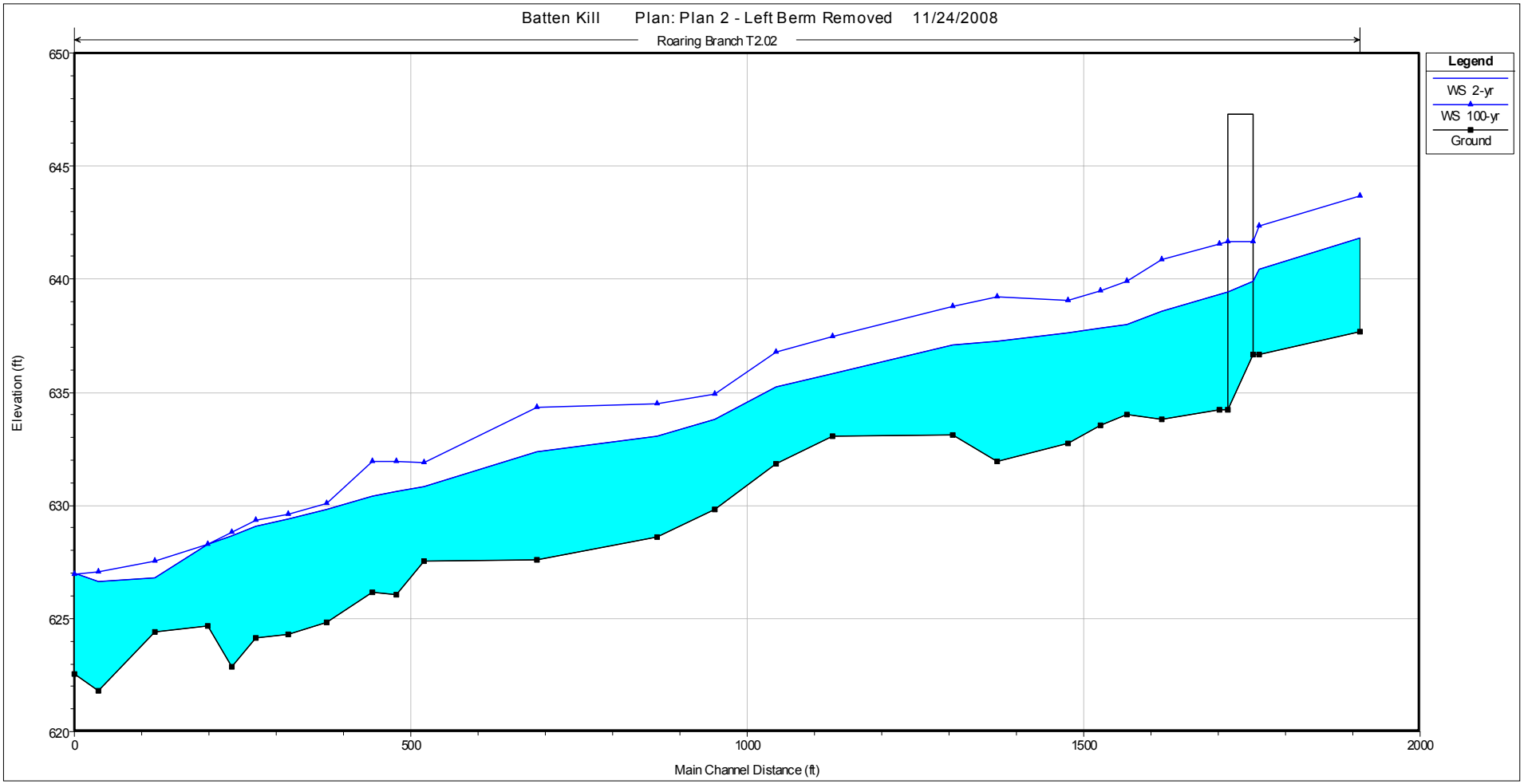


Figure C-3: Roaring Branch Water Surface Profile – Left Berm Removed

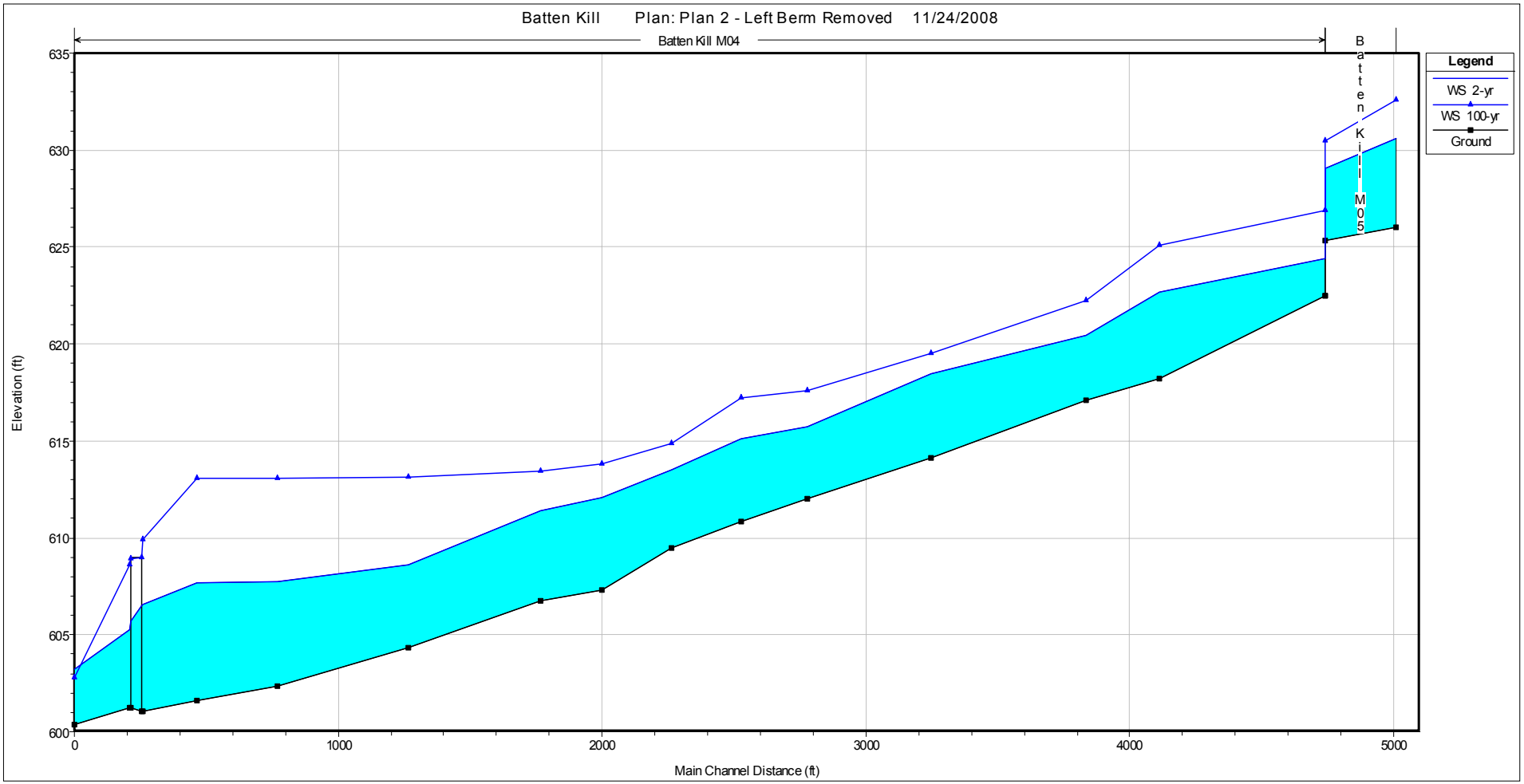


Figure C-4: Batten Kill Water Surface Profile – Left Berm Removed

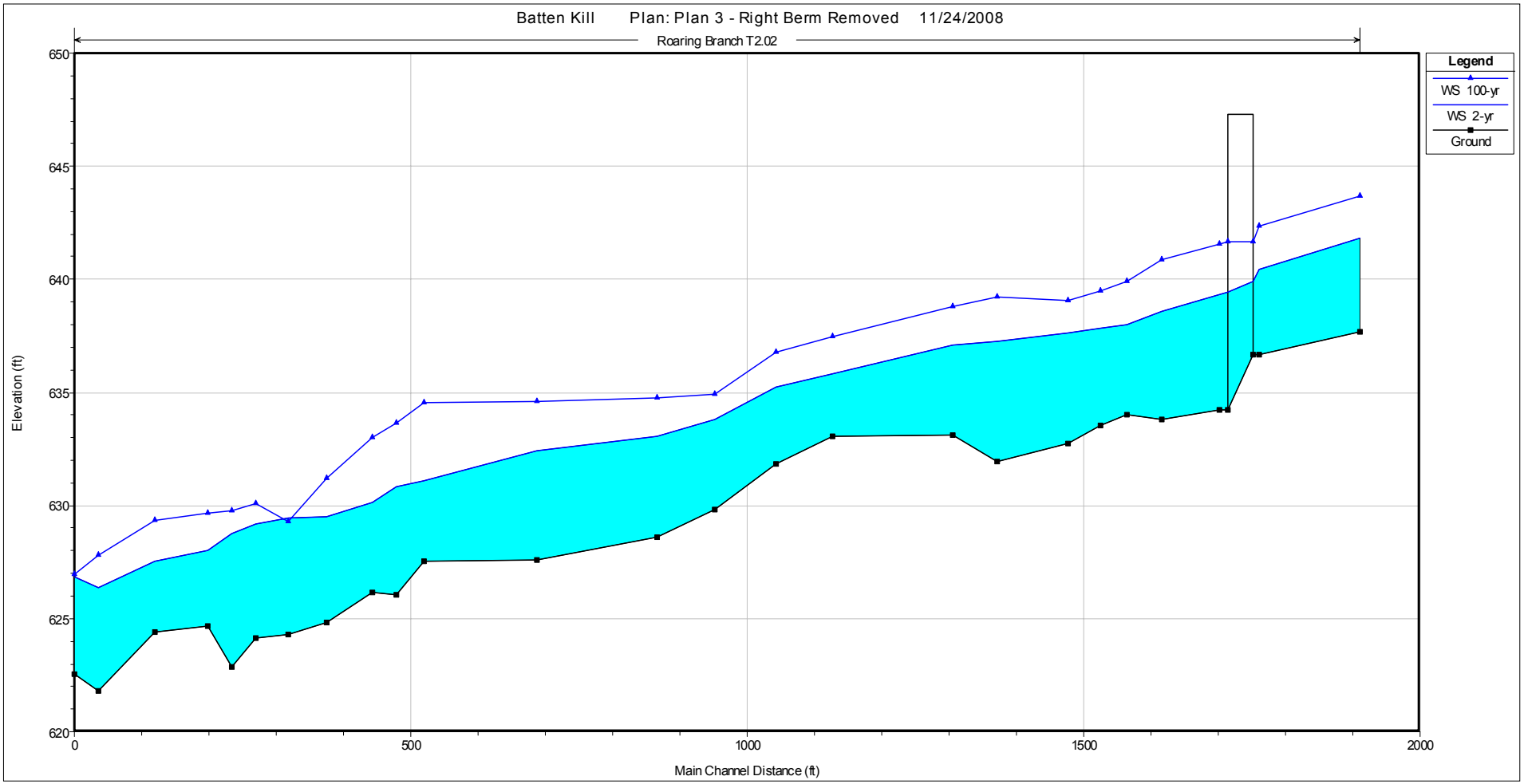


Figure C-5: Roaring Branch Water Surface Profile – Right Berm Removed

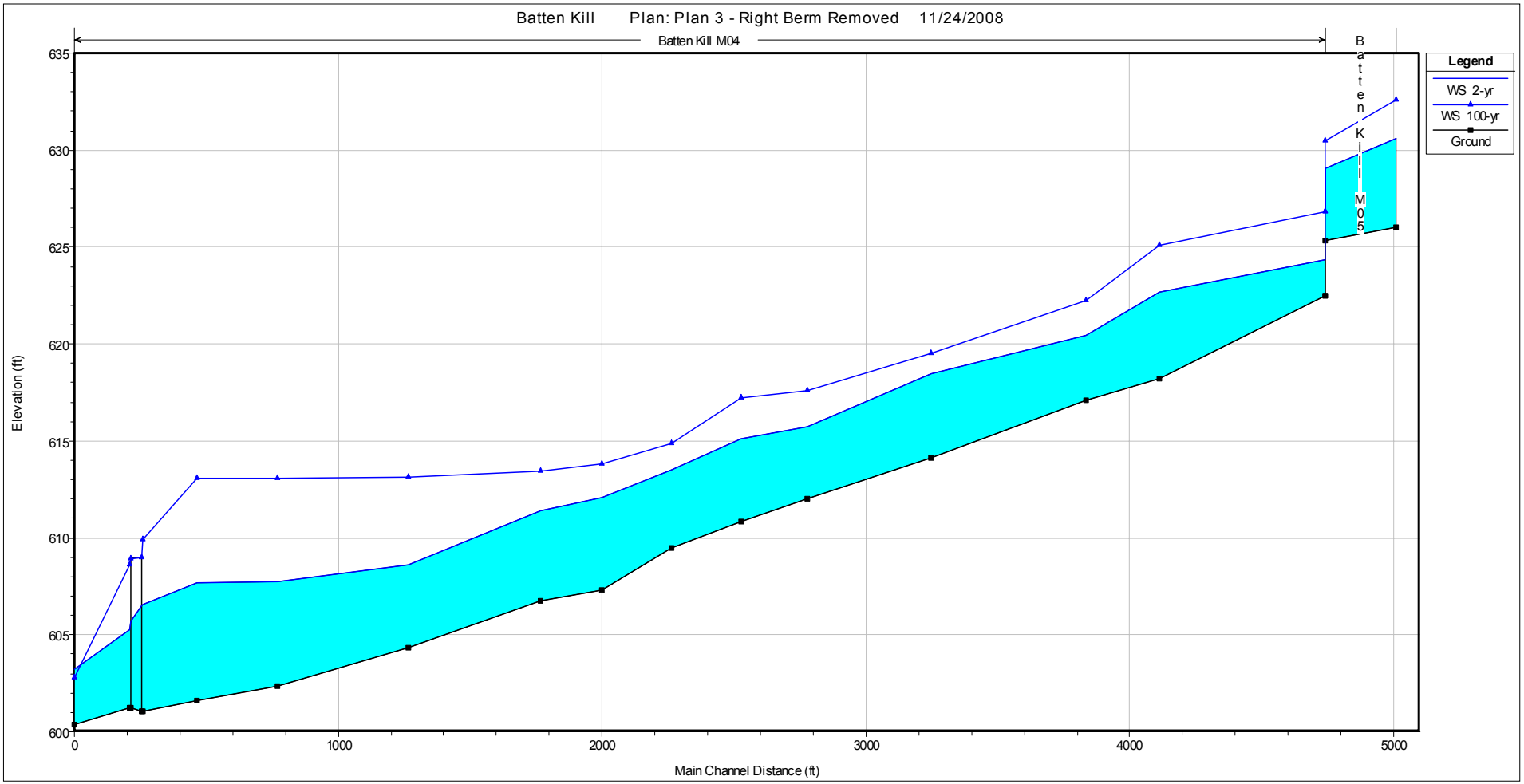


Figure C-6: Batten Kill Water Surface Profile – Right Berm Removed

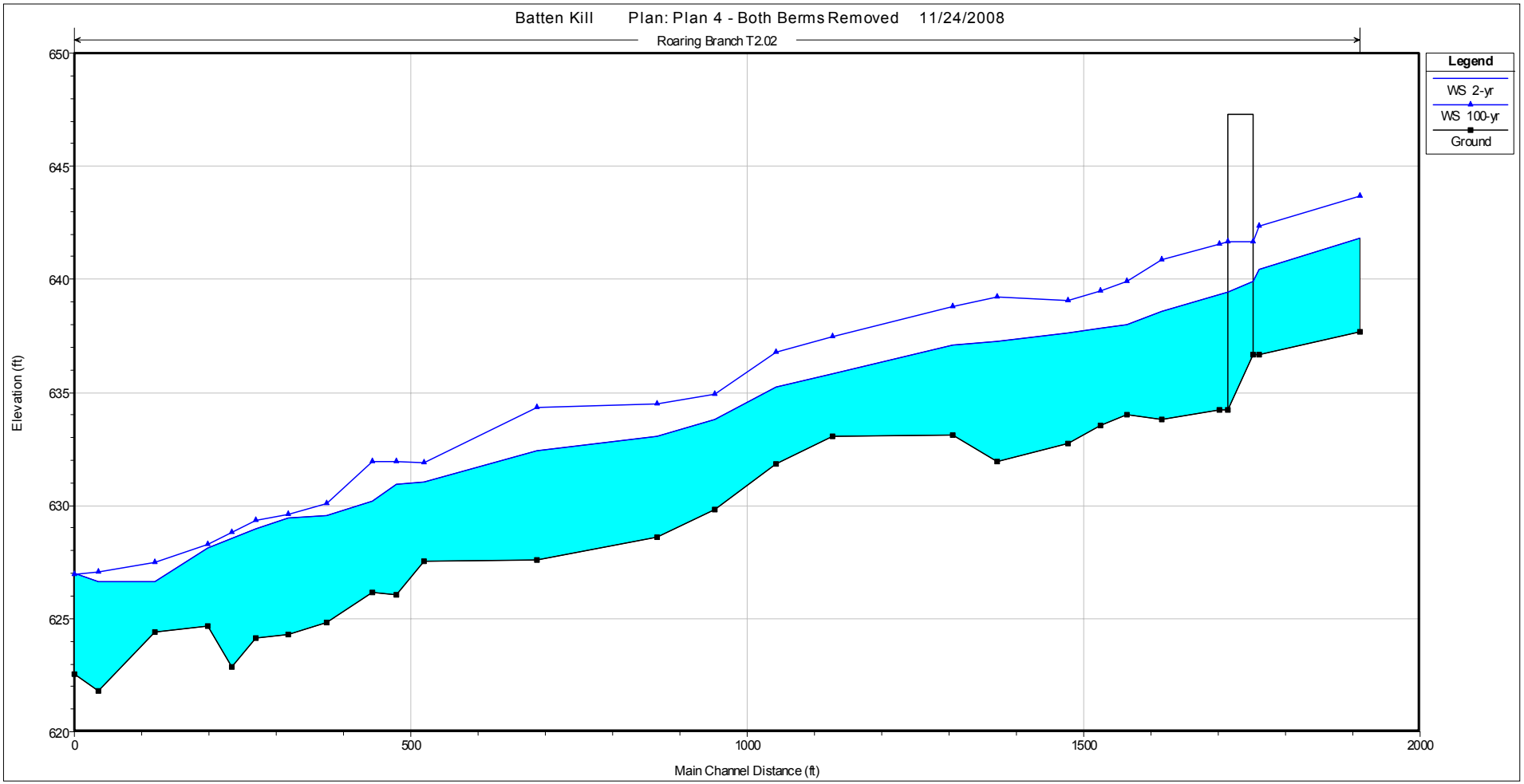


Figure C-7: Roaring Branch Water Surface Profile – Both Berms Removed

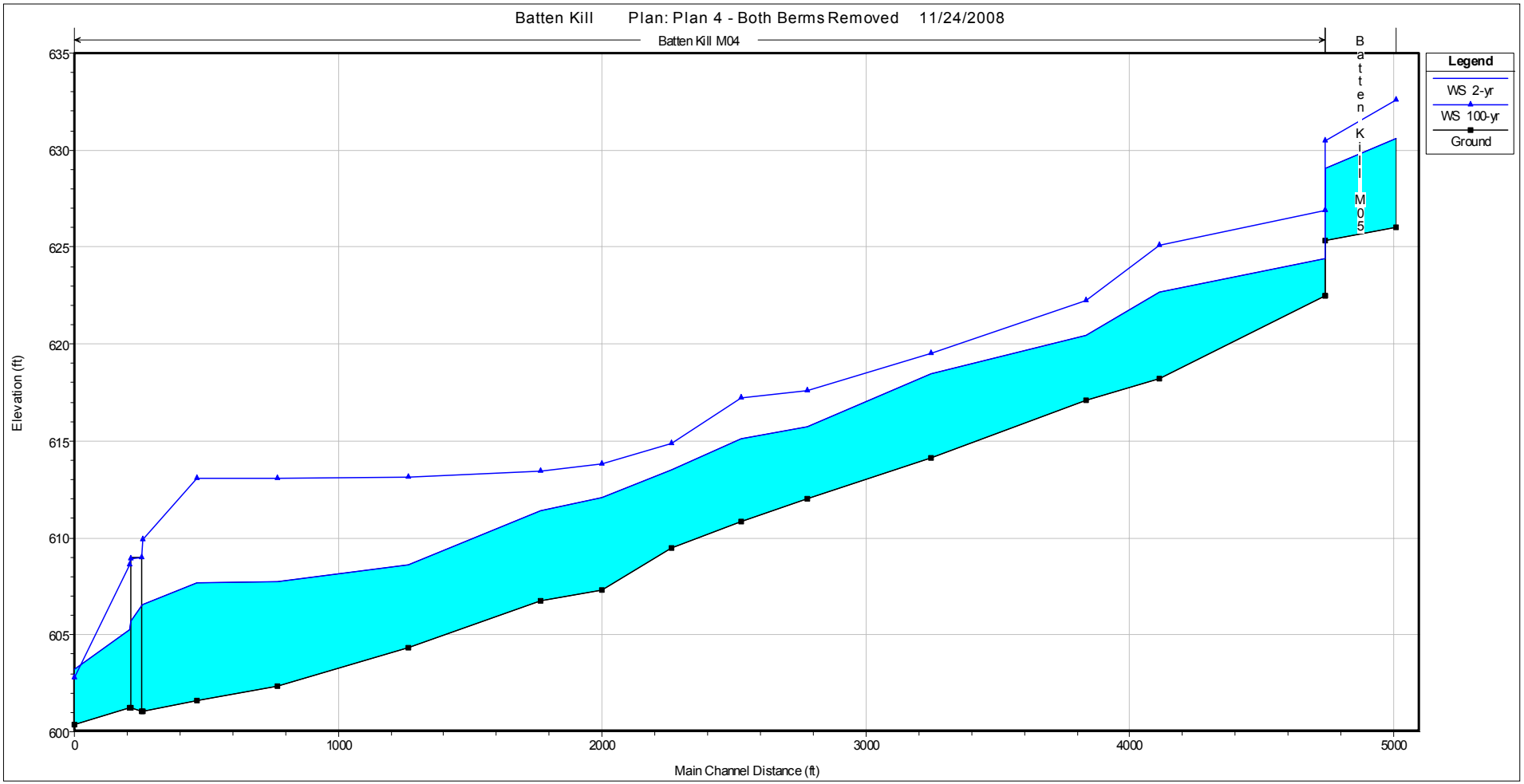


Figure C-8: Batten Kill Water Surface Profile – Both Berms Removed

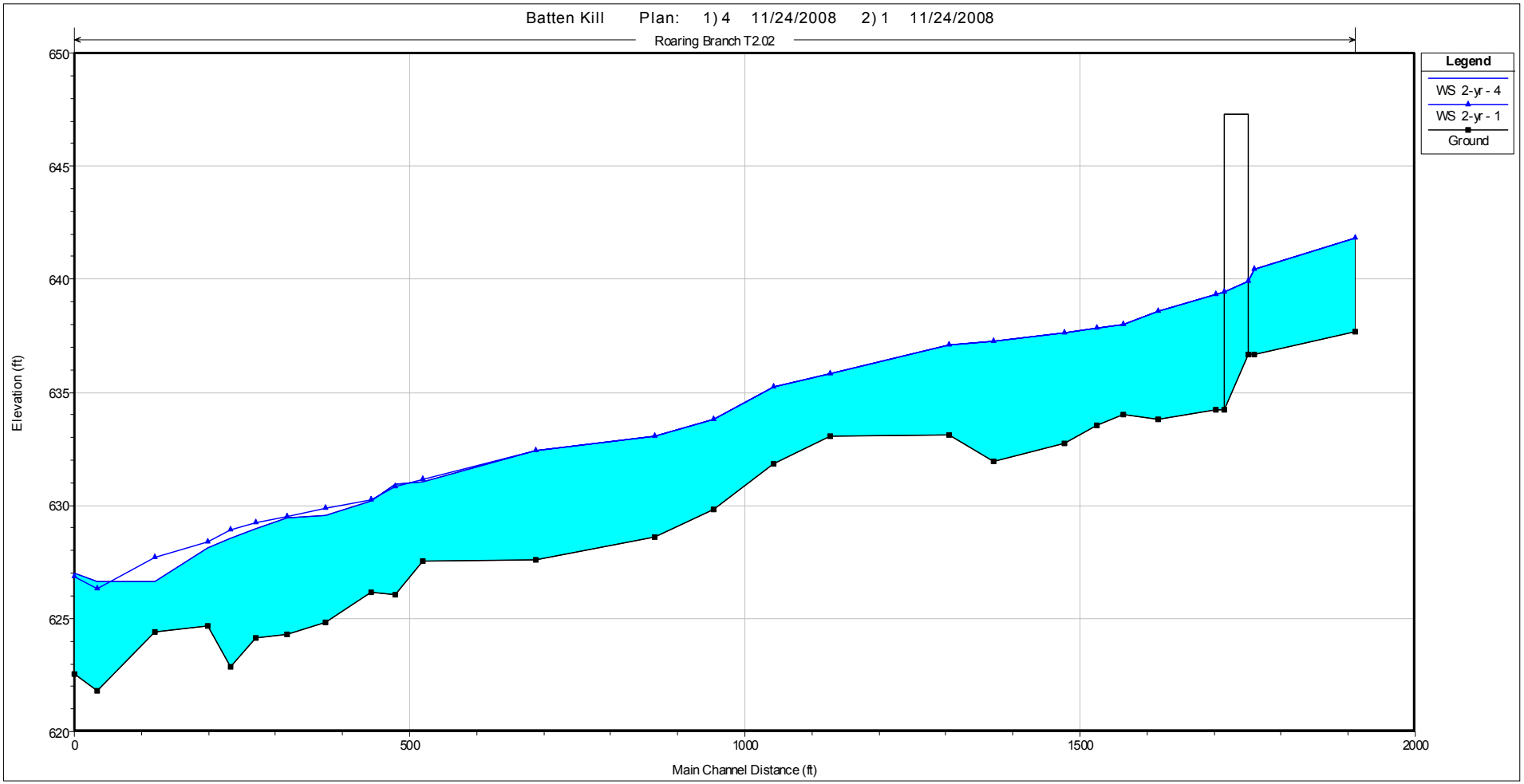


Figure C-9: Roaring Branch Water Surface Profile – Existing Conditions vs. Both Berms Removed (2-yr Flood)

Note: Filled area represents both berms removed (Scenario 4); top line with triangles represents existing conditions (Scenario 1).

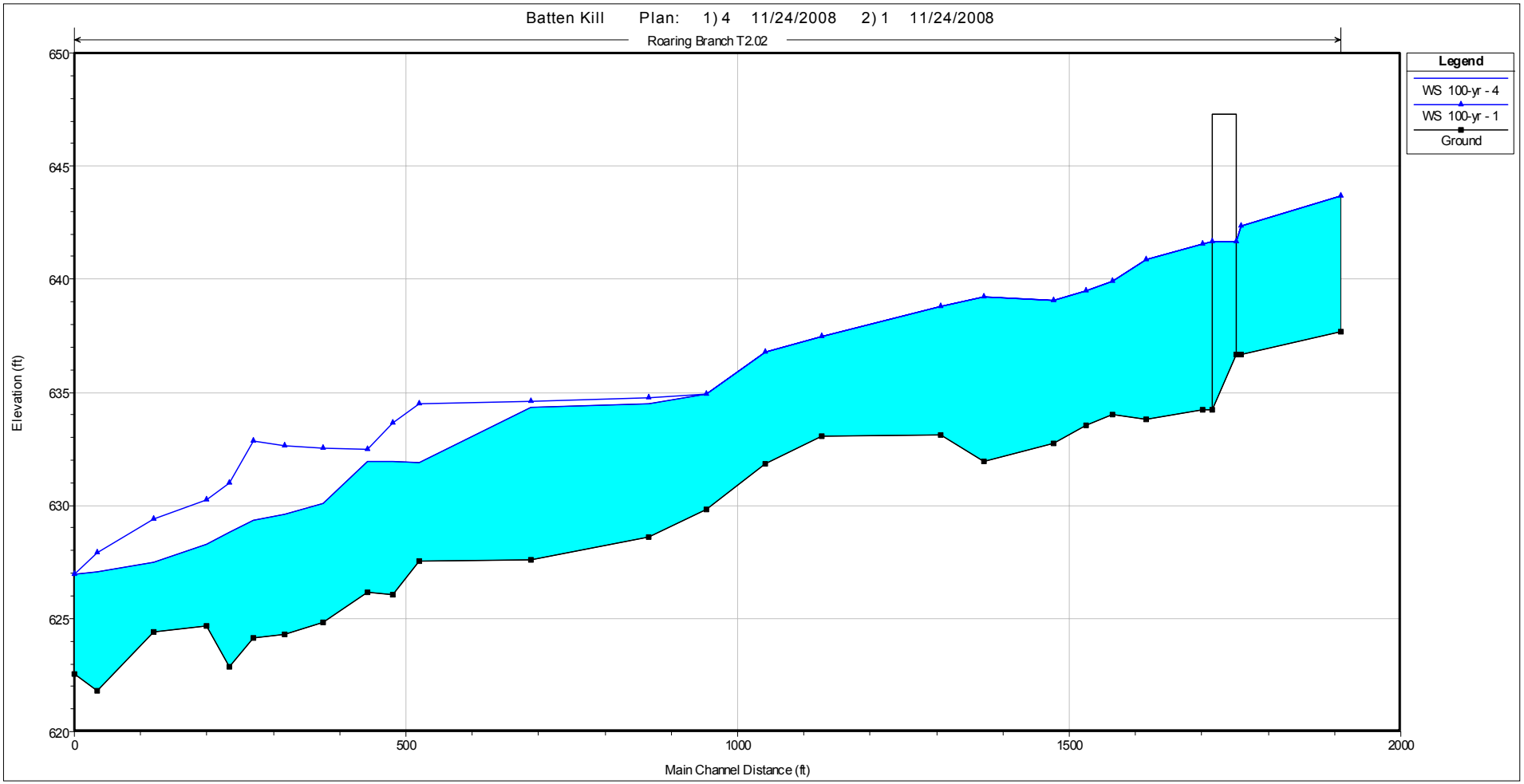


Figure C-10: Roaring Branch Water Surface Profile – Existing Conditions vs. Both Berms Removed (100-yr Flood)

Note: Filled area represents both berms removed (Scenario 4); top line with triangles represents existing conditions (Scenario 1).

APPENDIX B
Water Depth Maps

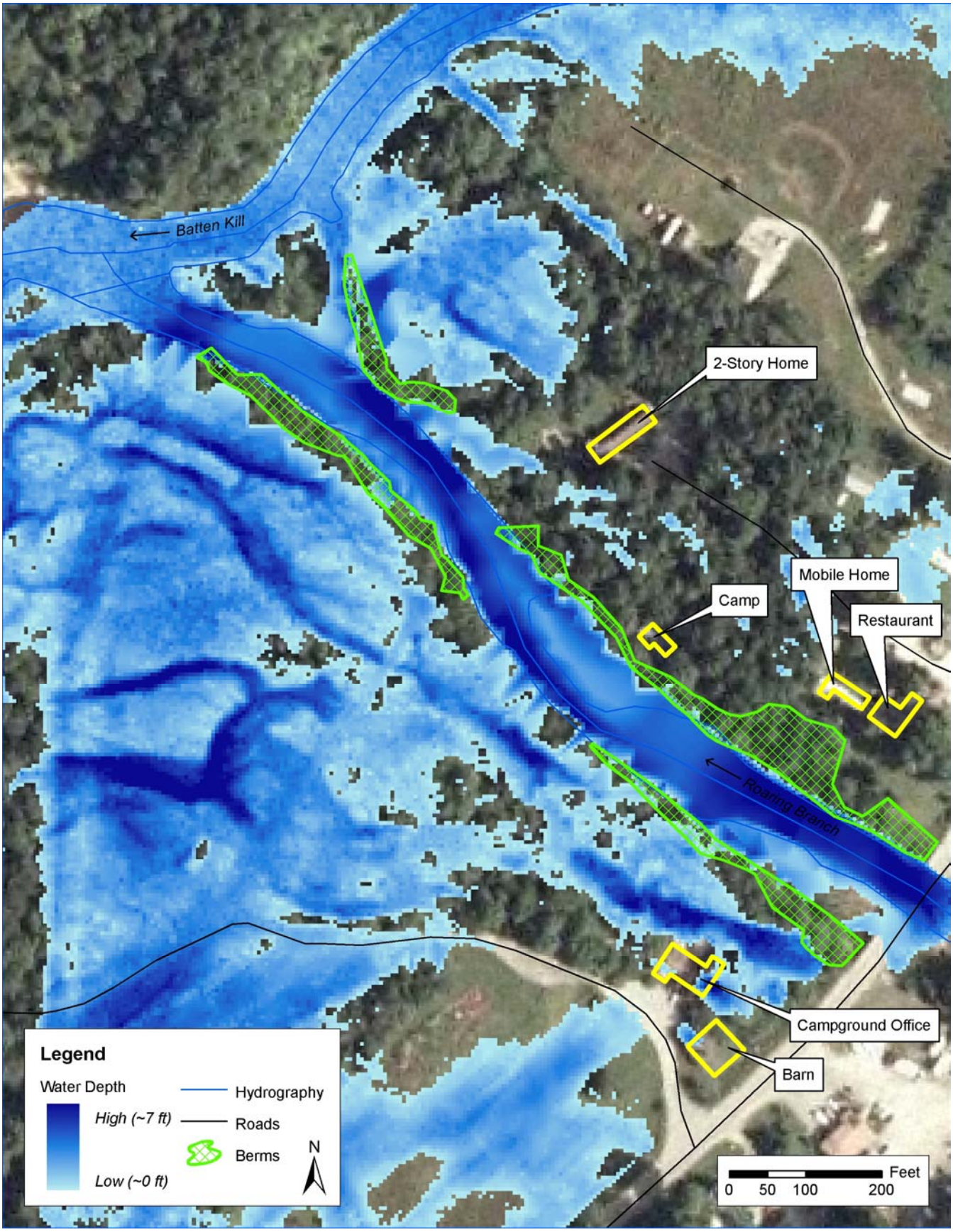


Figure B-1: Study Area Water Depth – Existing Conditions, 2-yr Flood

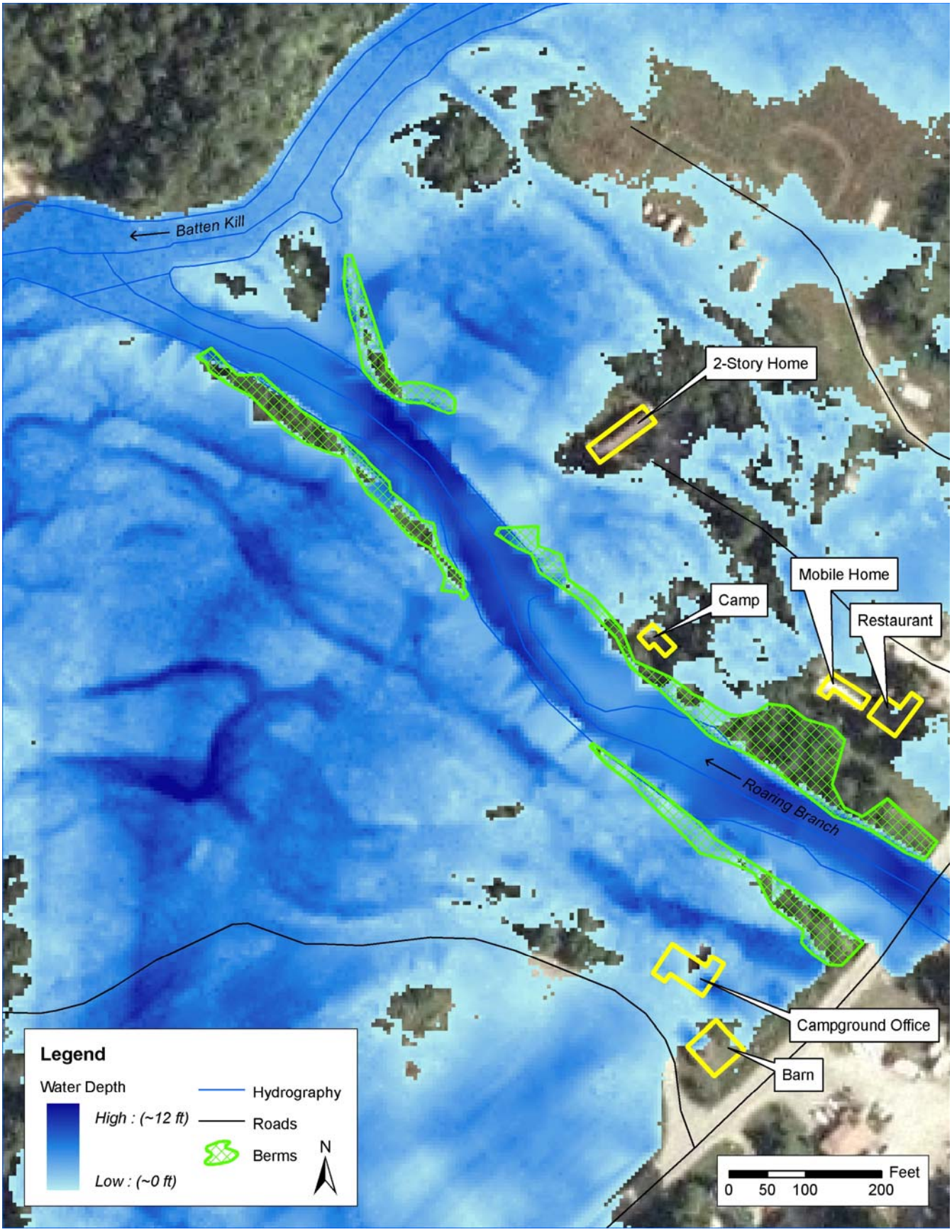


Figure B-2: Study Area Water Depth – Existing Conditions, 100-yr Flood

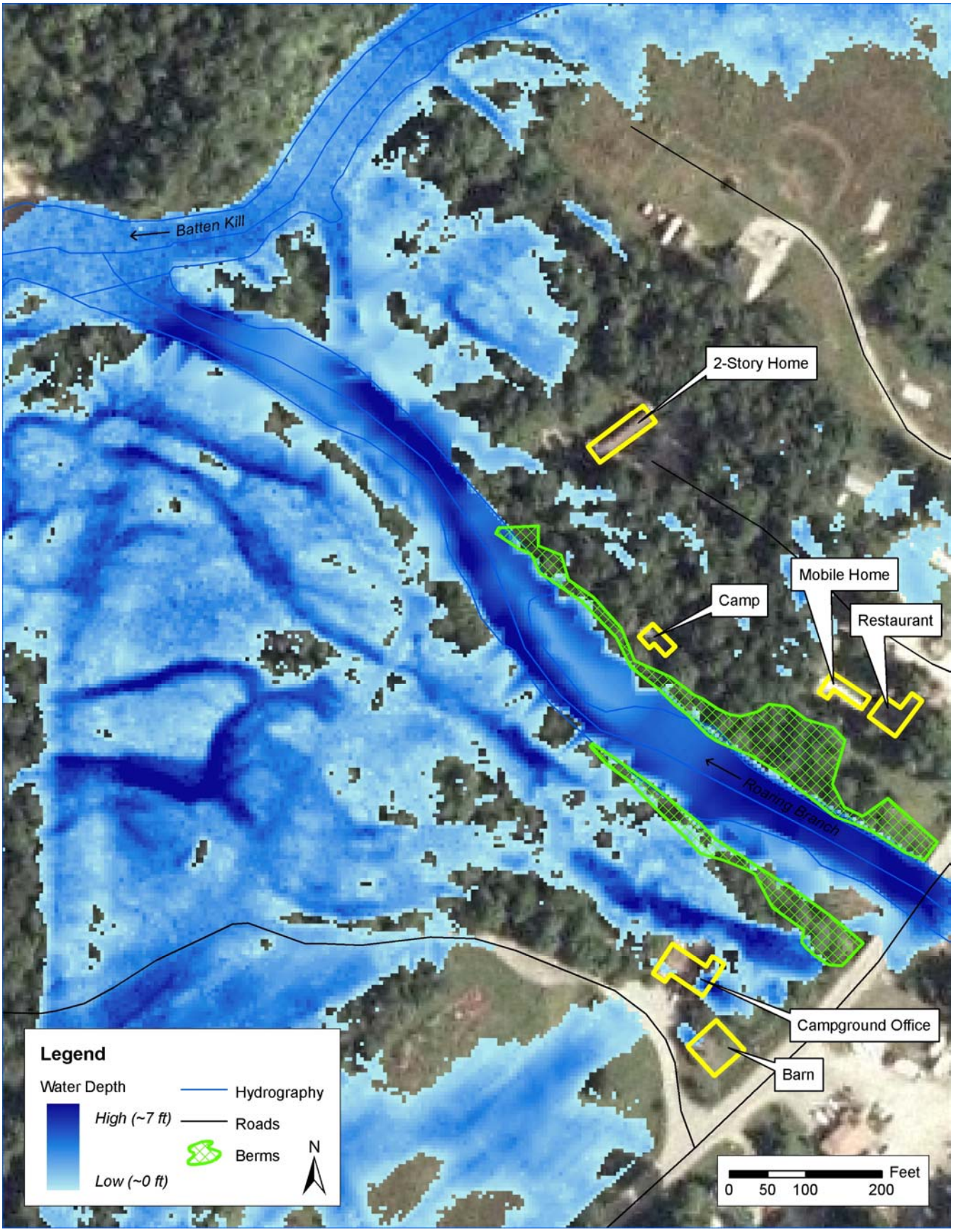


Figure B-3: Study Area Water Depth – Both Berms Removed, 2-yr Flood

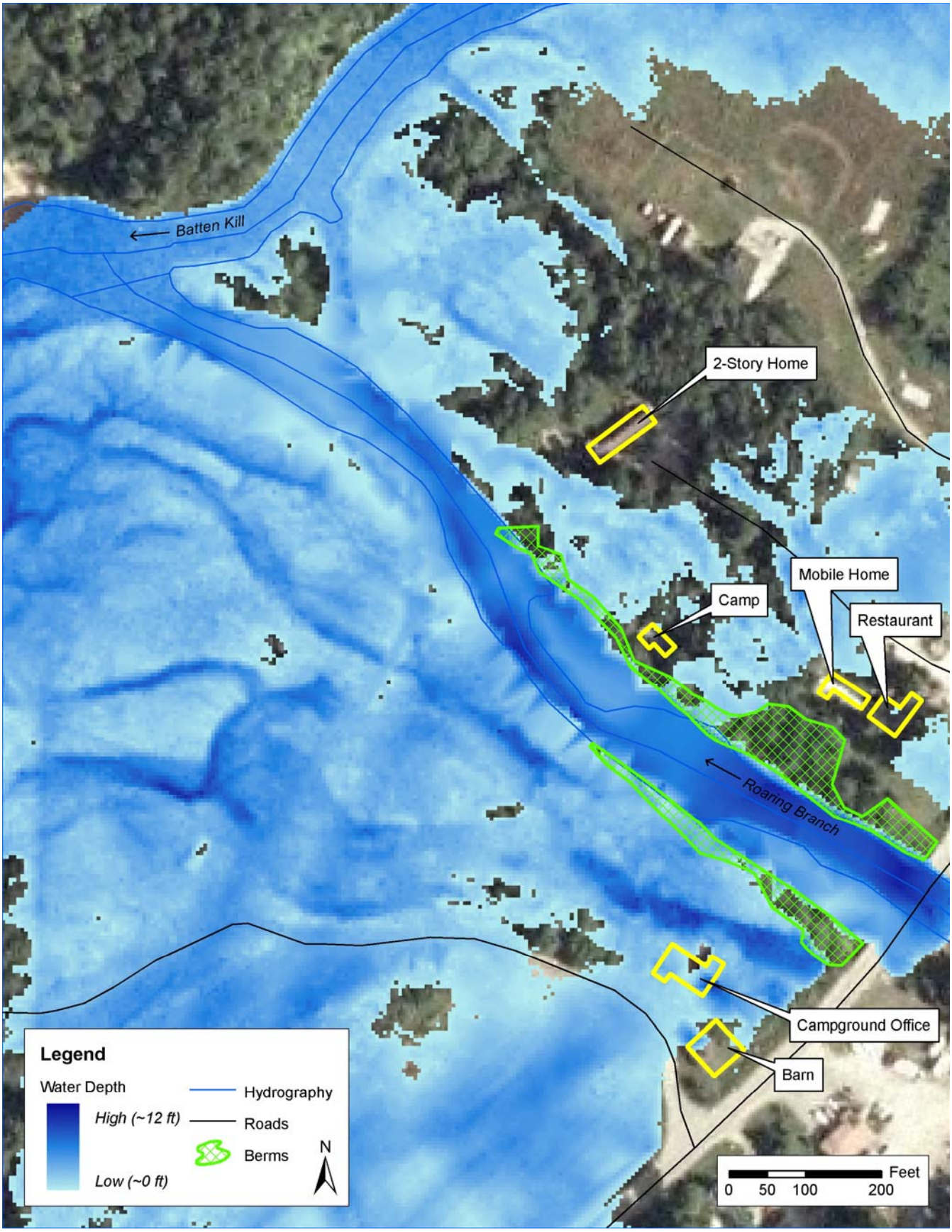


Figure B-4: Study Area Water Depth – Both Berms Removed, 100-yr Flood

APPENDIX A

Inundation Maps

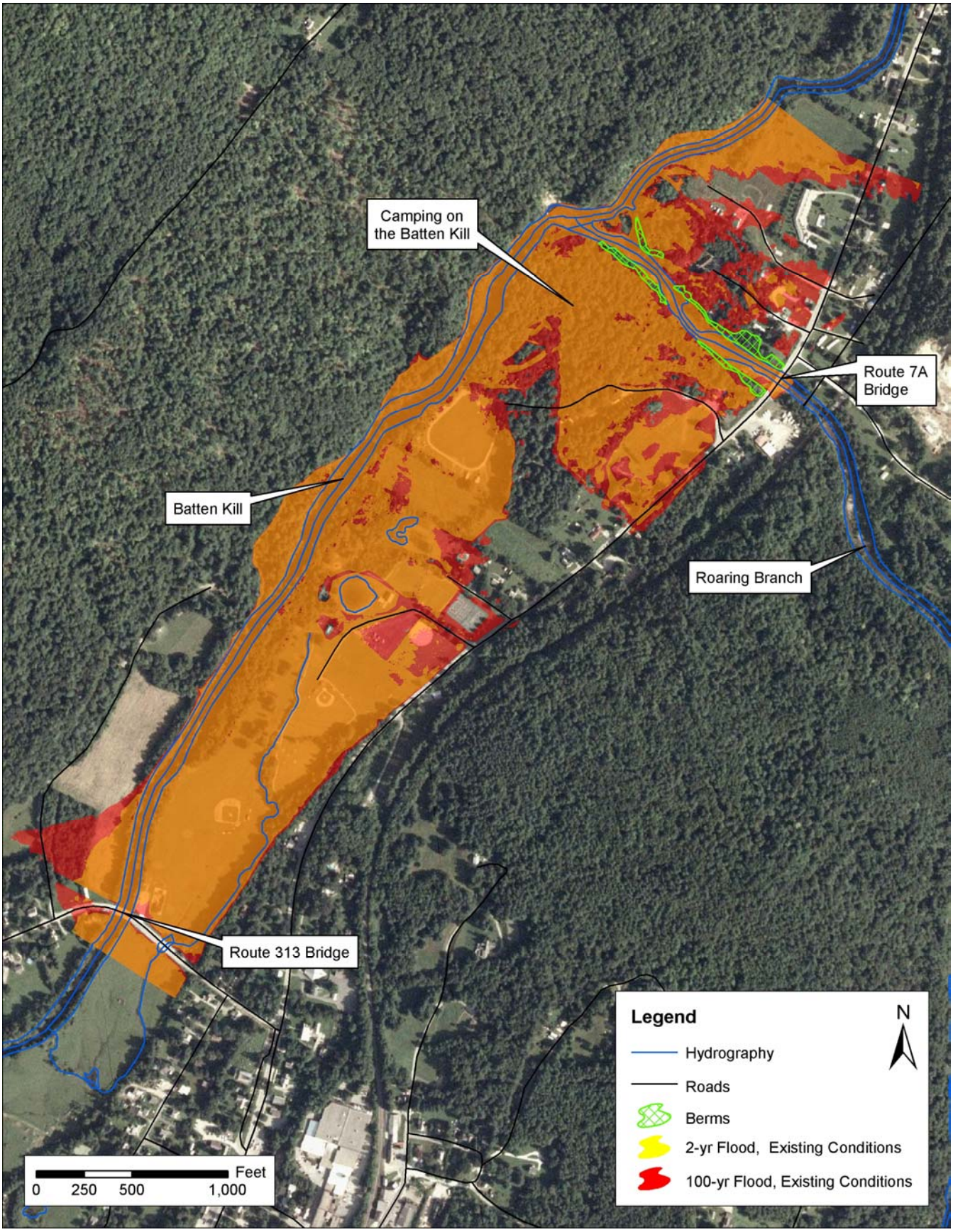


Figure A-1: Model Area Inundation – Existing Conditions

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

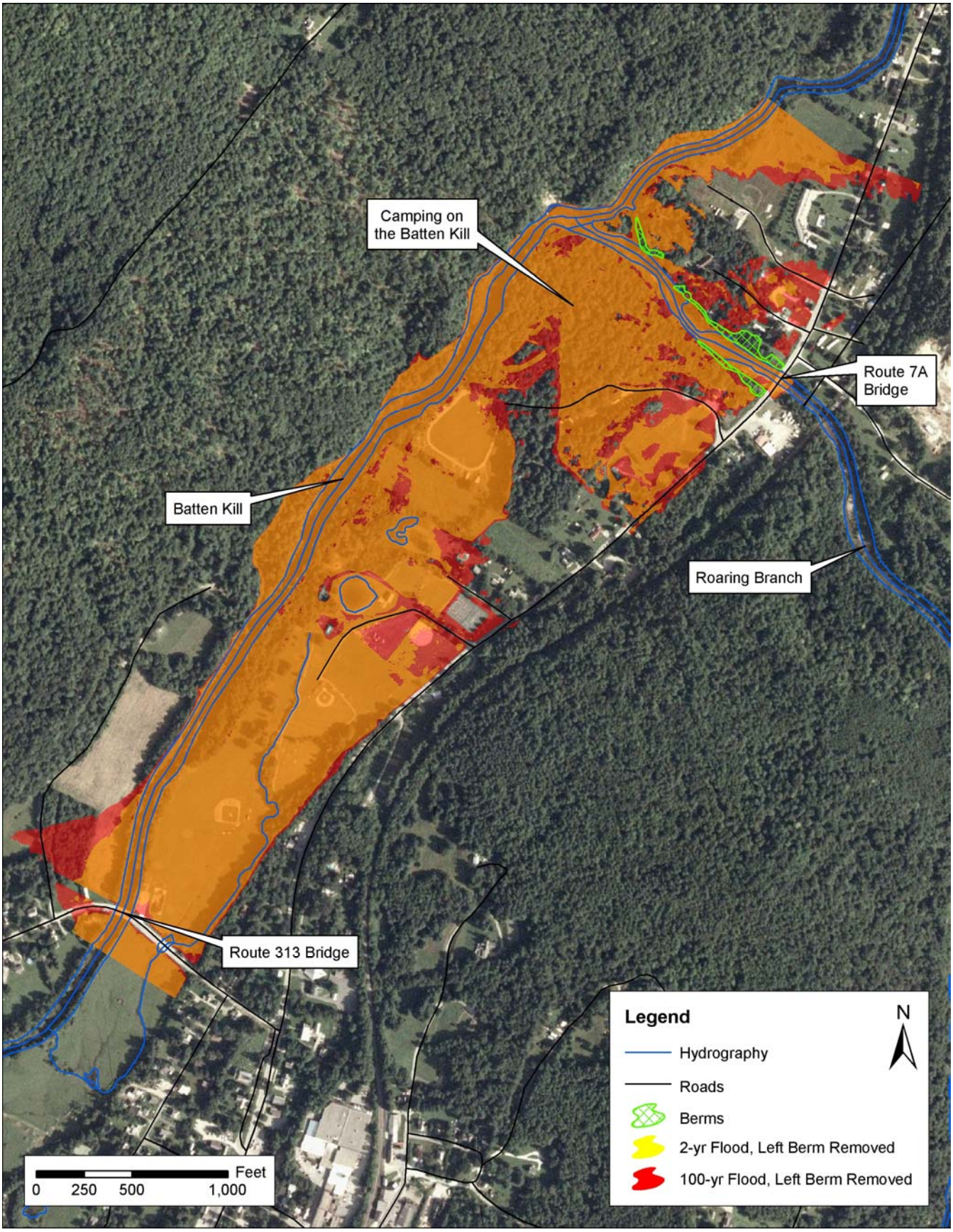


Figure A-2: Model Area Inundation – Left Berm Removed

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

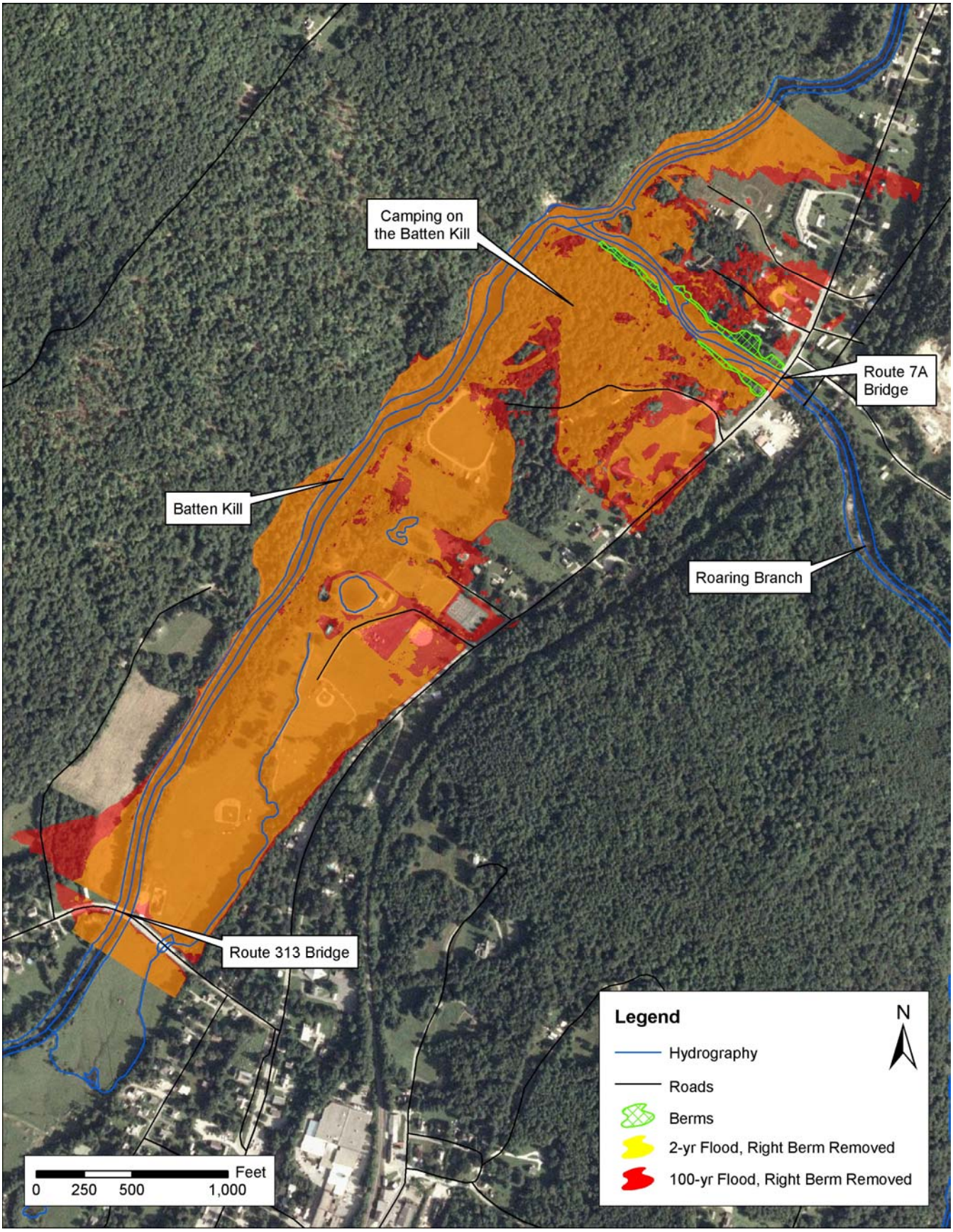


Figure A-3: Model Area Inundation – Right Berm Removed

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

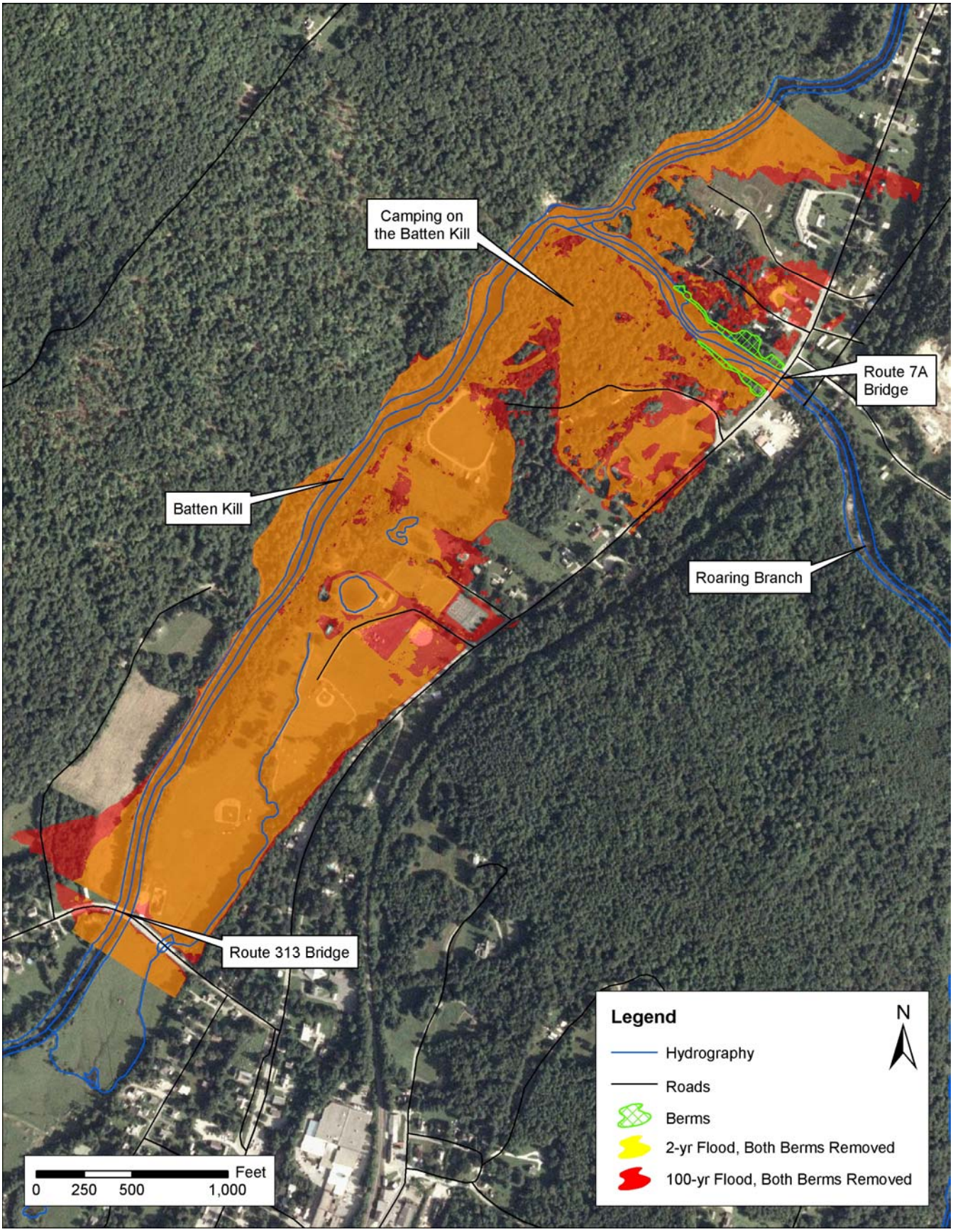


Figure A-4: Model Area Inundation – Both Berms Removed

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

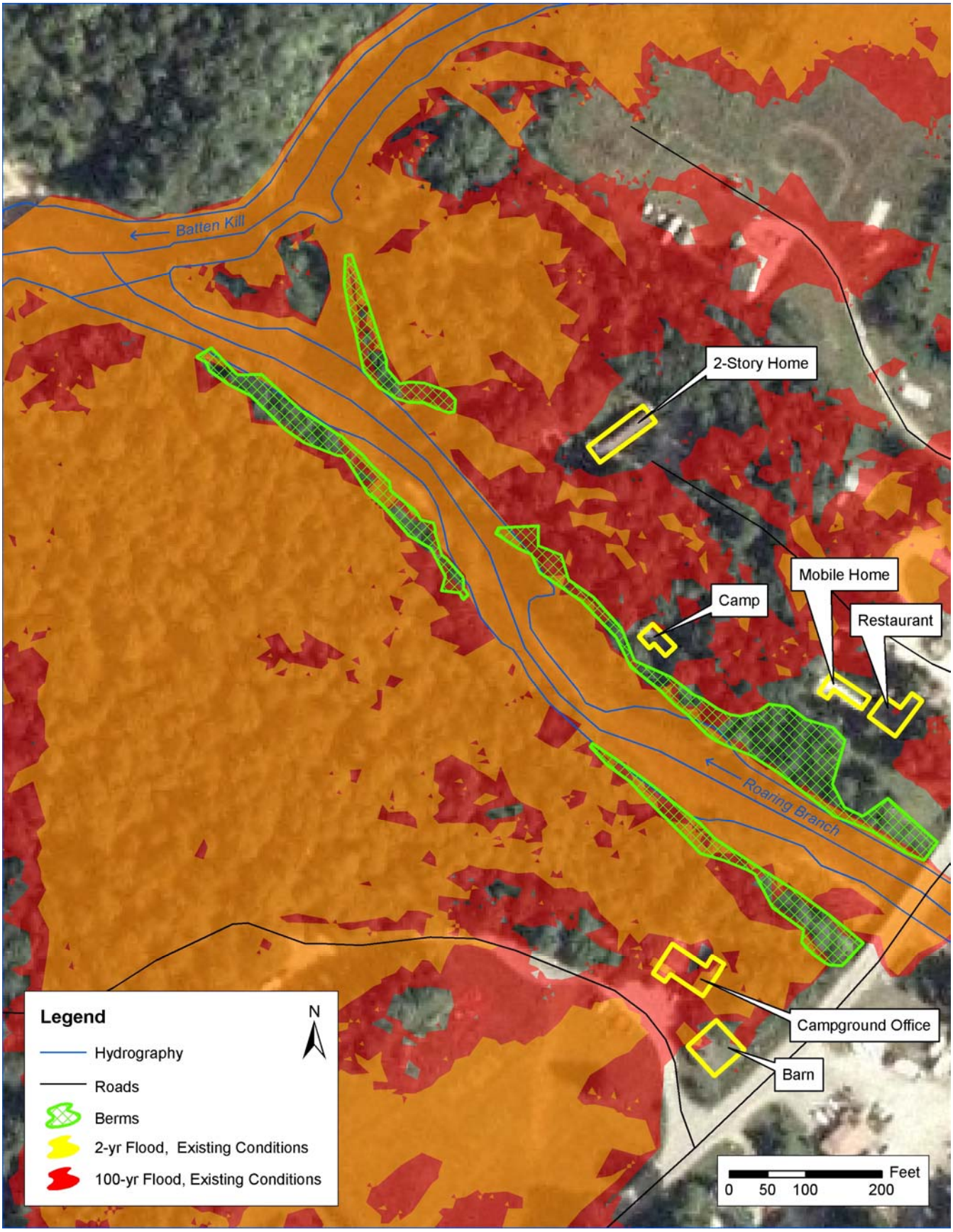


Figure A-5: Study Area Inundation – Existing Conditions

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

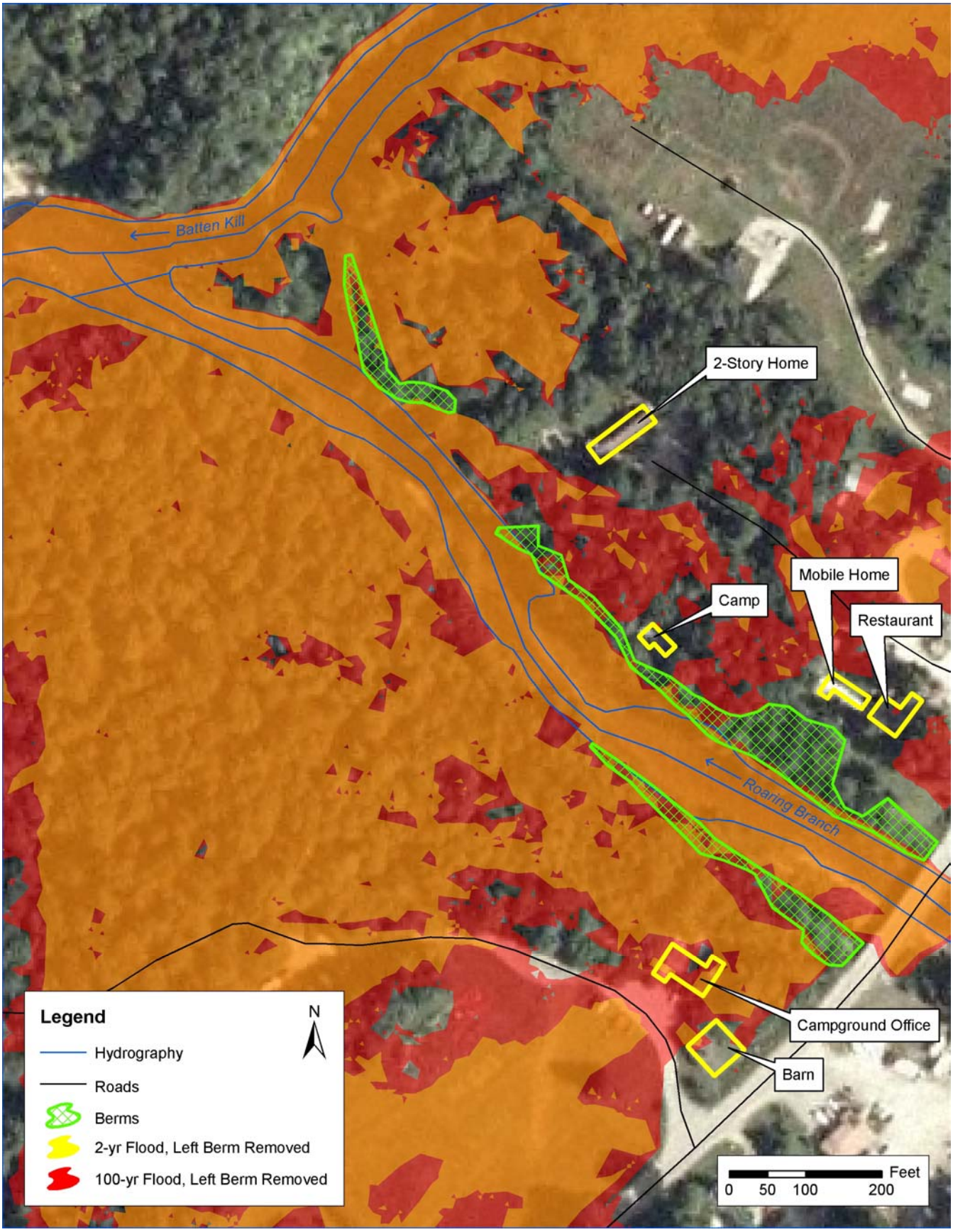


Figure A-6: Study Area Inundation – Left Berm Removed

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

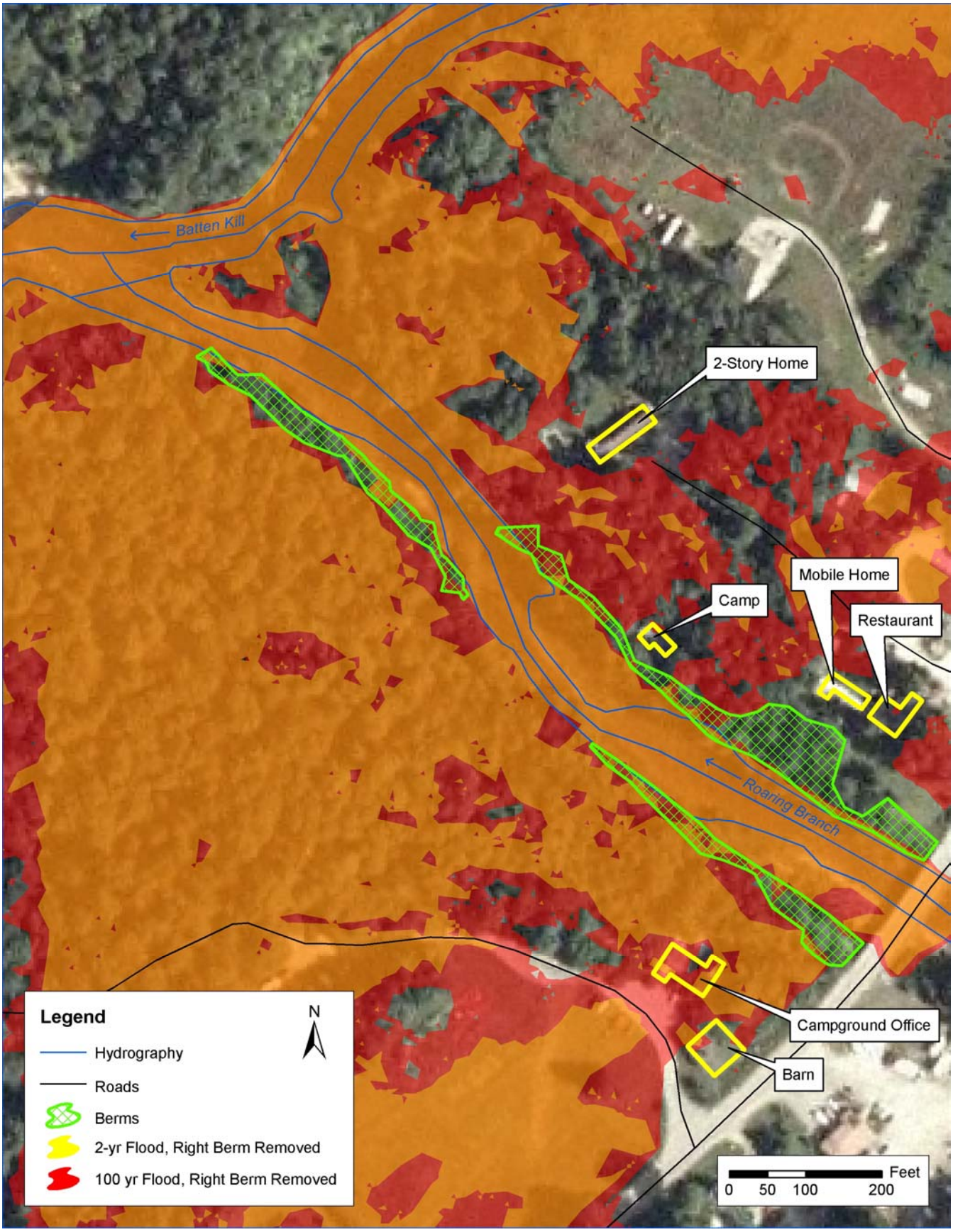


Figure A-7: Study Area Inundation – Right Berm Removed

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

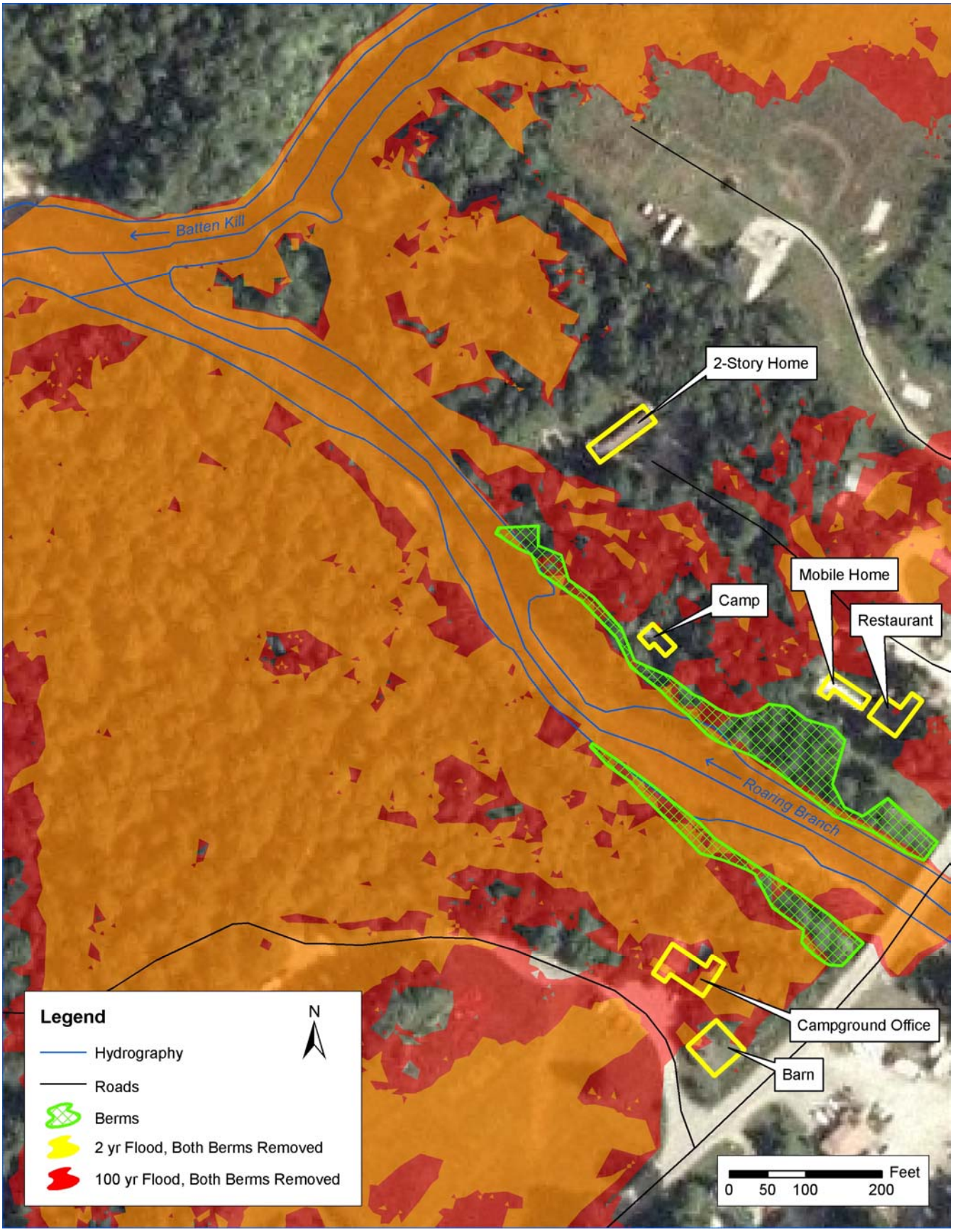


Figure A-8: Study Area Inundation – Both Berms Removed

Note: The 2-yr flood appears orange where it overlaps the 100-yr flood.

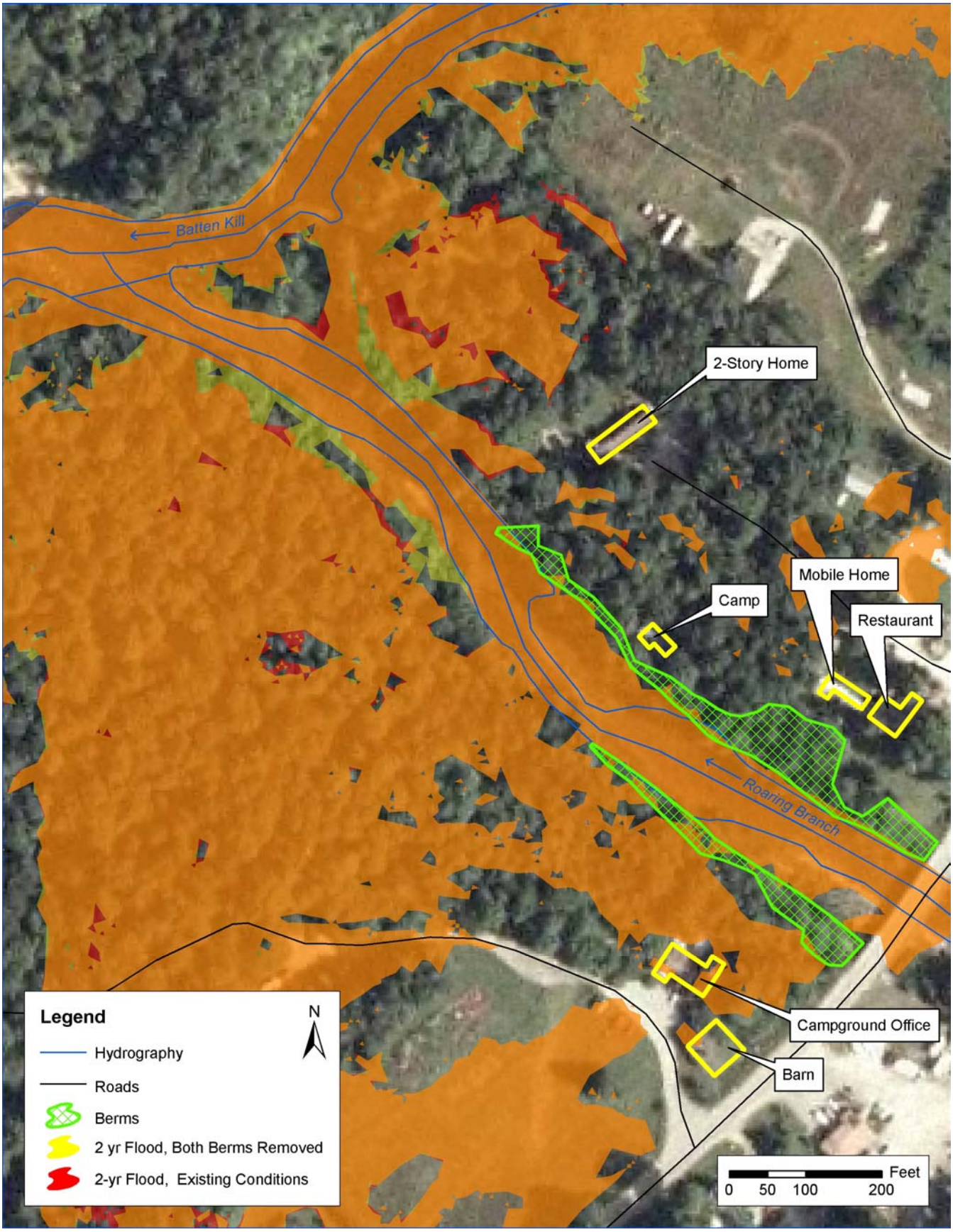


Figure A-9: Study Area Inundation – Existing Conditions vs. Both Berms Removed (2-yr Flood)

Note: The berms-removed flood appears orange where it overlaps the existing conditions flood.

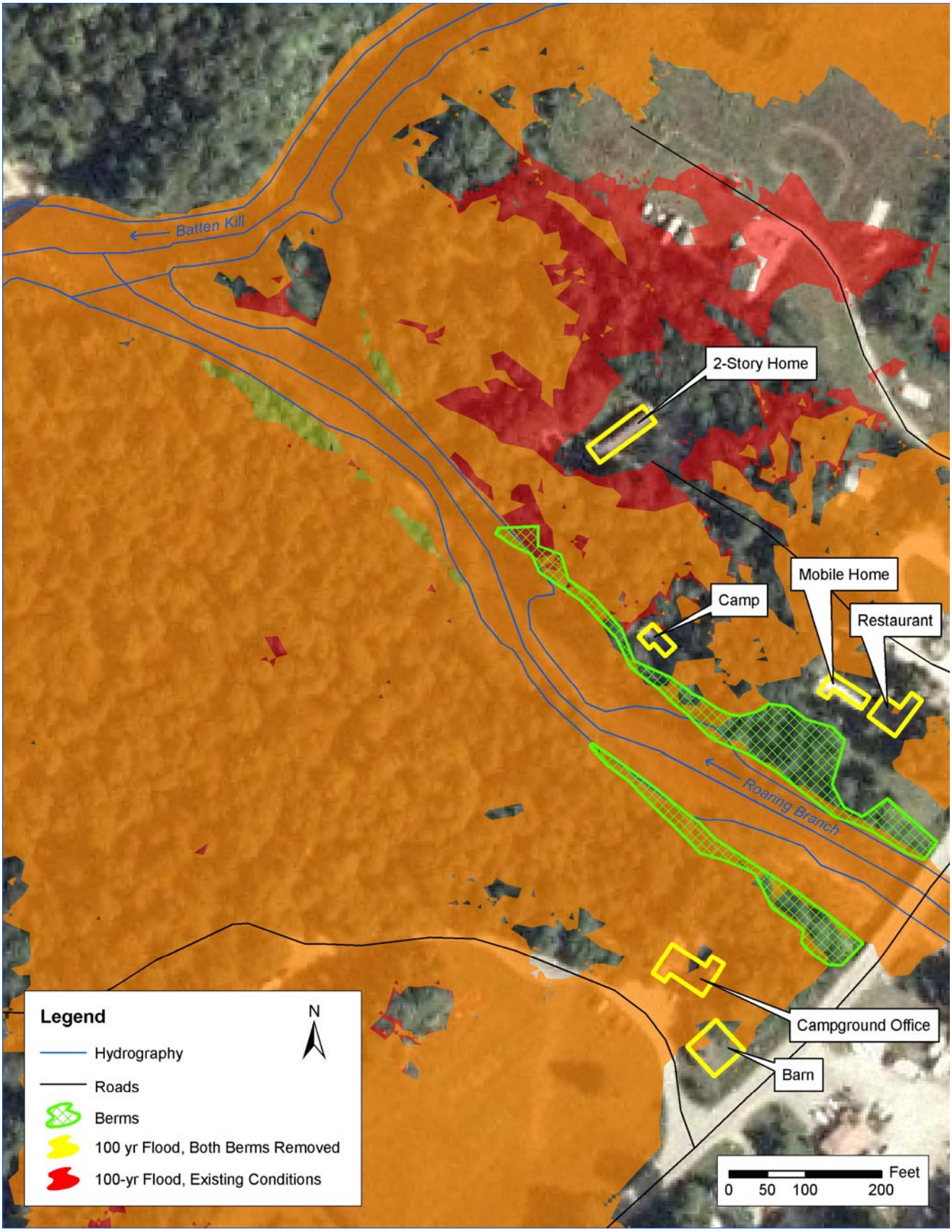


Figure A-10: Study Area Inundation – Existing Conditions vs. Both Berms Removed (100-yr Flood)

Note: The berms-removed flood appears orange where it overlaps the existing conditions flood.

APPENDIX H

FEMA Application Forms & Instructions for Letter of Map Revision

MT-2

Revisions to National Flood Insurance Program Maps

Application Forms and Instructions for Conditional Letters of Map Revision and Letters of Map Revision

FEMA Form 81-89 Series
February 2006

FEMA

INSTRUCTIONS FOR COMPLETING THE APPLICATION FORMS FOR CONDITIONAL LETTERS OF MAP REVISION AND LETTERS OF MAP REVISION

GENERAL

In 1968, the U.S. Congress passed the National Flood Insurance Act, which created the National Flood Insurance Program (NFIP). The NFIP was designed to reduce future flood losses through local floodplain management and to provide protection for property owners against potential losses through flood insurance.

As part of the agreement for making flood insurance available in a community, the NFIP requires the participating community to adopt floodplain management ordinances containing certain minimum requirements intended to reduce future flood losses. The NFIP regulations for floodplain management are the minimum criteria a community must adopt for participation in the NFIP. The community is responsible for approving all proposed floodplain development and for ensuring that permits required by Federal or State law have been received. State and community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If the State or Community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

The community is also responsible for submitting data to the Federal Emergency Management Agency (FEMA) reflecting revised flood hazard information so that NFIP maps can be revised as appropriate. This will allow risk premium rates and floodplain management requirements to be based on current data.

Submissions to FEMA for revisions to effective Flood Insurance Studies (FISs), Flood Insurance Rate Maps (FIRMs), or Flood Boundary Floodway Maps (FBFMs) by individual and community requesters will require the signing of application forms. These forms will provide FEMA with assurance that all pertinent data relating to the revision are included in the submittal. They will also ensure that: (a) the data and methodology are based on current conditions; (b) qualified professionals have assembled data and performed all necessary computations; and (c) all individuals and organizations affected by proposed changes are aware of the changes and will have an opportunity to comment on them.

If the submission involves revisions to multiple flooding sources, then separate forms should be completed for each flooding source.

NFIP regulations can be accessed at http://www.access.gpo.gov/nara/cfr/waisidx_02/44cfrv1_02.html or can be obtained by calling FEMA's Map Assistance Center at 1-877-FEMA MAP (1-877-336-2627). FEMA's Internet site at http://www.fema.gov/fhm/frm_form.shtm provides access to the forms and latest fees and revision procedures. FEMA is preparing online tutorials to assist users of the NFIP maps. The tutorials for revisions to the NFIP maps are currently being prepared and will be available soon. Other online tutorials are available at http://www.fema.gov/fhm/ot_main.shtm.

WHEN TO USE THESE FORMS

This package is applicable for requests of the following:

Conditional Letter of Map Revision (CLOMR)	A letter from FEMA commenting on whether a proposed project, if built as proposed, would meet minimum NFIP standards or proposed hydrology changes [see 44 Code of Federal Regulations (CFR) Ch. 1, Parts 60, 65, and 72].
Letter of Map Revision (LOMR)	A letter from FEMA officially revising the current NFIP map to show changes to floodplains, floodways, or flood elevations (see 44 CFR Ch. 1, Parts 60, 65, and 72).

WHEN NOT TO USE THESE FORMS

This package is not applicable for requests of the following:

Letter of Map Amendment (LOMA)	A letter from FEMA stating that an **existing** structure or parcel of land that has not been elevated by fill (**natural ground**) would not be inundated by the base flood.
Conditional Letter of Map Amendment (CLOMA)	A letter from FEMA stating that a **proposed** structure that is not to be elevated by fill (**natural ground**) would not be inundated by the base flood if built as proposed.
Letter of Map Revision Based on Fill (LOMR-F)	A letter from FEMA stating that an **existing** structure or parcel of land that has been **elevated by fill** would not be inundated by the base flood.
Conditional Letter of Map Revision Based on Fill (CLOMR-F)	A letter from FEMA stating that a parcel of land or **proposed** structure that will be **elevated by fill** would not be inundated by the base flood if fill is placed on the parcel as proposed or the structure is built as proposed.

For these requests, either the MT-EZ form package titled *Amendments to National Flood Insurance Program Maps, Application Form for Single Residential Lot or Structures,* or the MT-1 form package titled *Amendments and Revisions to National Flood Insurance Program Maps, Application Forms and Instructions for Letters of Map Amendment, Conditional Letters of Map Amendment, Letters of Map Revision Based on Fill, and Conditional Letters of Map Revision Based on Fill* are appropriate. The MT-EZ forms are used for single structure or lot requests that do not involve the placement of fill. The MT-1 forms are used for requests involving multiple structures or lots. The MT-EZ form package may be downloaded from FEMA's Internet site at http://www.fema.gov/fhm/dl_mt-ez.shtm, and the MT-1 form package may be downloaded from FEMA's Internet site at http://www.fema.gov/fhm/dl_mt-1.shtm. Either form package may also be obtained by calling FEMA's Map Assistance Center at 1-877-FEMA MAP (1-877-336-2627).

SUMMARY OF FORMS

Application forms for requesting a revision from FEMA are included in the back of this package. There are six forms plus a payment form in this package, which cover various situations for revisions. When submitting a request only the forms applicable to the request need to be submitted. The following is a list of the forms and a brief summary of when each is applicable.

Form 1 - Overview & Concurrence Form provides the basic information regarding the revision request and requires the signatures of the requester, community official, and engineer. This form is required for all revision requests.

Form 2 - Riverine Hydrology & Hydraulics Form provides the basic information on the scope and methodology of hydrologic and/or hydraulic analyses that are prepared in support of the revision request. This form should be used for revision requests that involve new or revised hydrologic and/or hydraulic analyses of rivers, streams, ponds, or small lakes.

Form 3 - Riverine Structures Form provides the basic information regarding hydraulic structures constructed in the stream channel or floodplain. This form should be used for revision requests that involve new or proposed channelization, bridges/culverts, dams, and/or levees/floodwalls.

Form 4 - Coastal Analysis Form provides the basic information on the scope and methodology of coastal analyses that are prepared in support of the revision request. This form should be used for any revision requests that involve new or revised coastal analyses.

Form 5 - Coastal Structures Form provides the basic information regarding hydraulic structures constructed along the coast. This form should be used for revision requests that involve new or proposed levees/dikes, breakwaters, bulkheads, seawalls, and/or revetments located along the coast.

Form 6 - Alluvial Fan Flooding Form provides the basic information for analyses of alluvial fans. This form should be used for revision requests involving alluvial fans.

Payment Information Form - Provides the basic information regarding any fees paid for a CLOMR, LOMR, or External Data Request.

FEES

FEMA has implemented a procedure to recover costs associated with reviewing and processing requests for modifications to published flood information and maps. The current fees for review and processing of CLOMR and LOMR requests may be obtained from FEMA's Internet site at http://www.fema.gov/fhm/frm_fees.shtm or by calling FEMA's Map Assistance Center at 1-877-FEMA MAP (1-877-336-2627).

Some requests for revisions may be exempt from the fees. NFIP Regulation, 44 CFR Ch. 1, Section 72.5, describes the circumstances for requests to be exempt from paying the fees. The exemptions are also described on FEMA's Internet site at http://www.fema.gov/fhm/frm_fees.shtm.

Payment must be made by credit card, check or money order. Checks and money orders should be made payable in U.S. funds to the National Flood Insurance Program. Please forward payment along with a completed Payment Information Form to the following address:

Using U.S. Postal Service:
Federal Emergency Management Agency
Revisions Fee-Collection System Administrator
P.O. Box 22787
Alexandria, VA 22304

Using Overnight Service:
Revisions Fee-Collection System Administrator
c/o Michael Baker Jr., Inc.
3601 Eisenhower Ave
Alexandria, VA 22304

Please note, that the fee is to be sent to a different address than the request package. See page 4 for where to submit the request package.

WHAT TO SUBMIT

A CLOMR or LOMR request should include the application forms along with the appropriate supporting information. A notebook-style format is preferred. The submittal should include the following:

1. Completed application forms.
2. Narrative on project and submittal (optional but very helpful). Knowing the project and purpose of the request better ensures the needs of the requester are met.
3. Hydrologic Computations (if applicable) along with digital files of computer models used.
4. Hydraulic Computations (if applicable) along with digital files of computer models used.
5. Certified topographic map with floodplain and floodway (if applicable) delineations.
6. Annotated FEMA FIRM and/or FBFM to reflect changes due to project (FIRMs and /or FBFMs can be ordered on-line at http://store.msc.fema.gov/).
7. Items required to satisfy any FEMA NFIP regulatory requirements.

Before FEMA will replace the effective FIS information with the revised, the requester must: (a) provide all of the data used in determining the revised floodplain boundaries, flood profiles, floodway boundaries, etc.; (b) provide all data necessary to demonstrate that the physical modifications to the floodplain meet NFIP regulations, have been adequately designed to withstand the impacts of the 1% annual chance flood event, and will be adequately maintained; and (c) demonstrate that the revised information (e.g., hydrologic and hydraulic analyses and the resulting floodplain and floodway boundaries) is consistent with the effective FIS information.

Where to Submit

The completed package should be submitted to the appropriate address indicated below. Fees are submitted to a separate address (see "Fees," page 3).

Mail your request to…

FEMA Map Coordination Contractor
3601 Eisenhower Avenue, Suite 600
Alexandria, VA 22304-6425

INSTRUCTIONS FOR COMPLETING THE OVERVIEW & CONCURRENCE FORM (FORM 1)

This form provides the basic information regarding revision requests and must be submitted with each request. It contains much of the material needed for the Federal Emergency Management Agency (FEMA) to assess the nature and complexity of the proposed revision. It will identify: (a) the type of response expected from FEMA; (b) those elements that will require supporting data and analyses; and (c) items needing concurrence of others. This form will also ensure that the community is aware of the impacts of the request and has notified affected property owners, if required. All items must be completed accurately. If the revision request is being submitted by an individual, firm, or other non-community official, contact should be made with appropriate community officials. National Flood Insurance Program (NFIP) regulation Title 44 CFR Ch. 1, Section 65.4, requires that revisions based on new technical data be submitted through the Chief Executive Officer (CEO) of the community or a designated official. Should the CEO refuse to submit such a request on behalf of another party, FEMA will agree to review it only if written evidence is provided indicating that the CEO or designee has been requested to do so.

Section A: Requested Response from FEMA

Indicate the type of response being requested. Brief descriptions of possible responses are provided in the introduction; more detail regarding these responses and the data required to obtain each response are provided in the NFIP regulations, Title 44 CFR Ch. 1.

Section B: Overview

1. The Community Number, Community Name, State, Map Number, Panel Number, and Effective Date can be obtained from the Flood Insurance Rate Map (FIRM) title block. The sample FIRM panels (Figures 1 and 2) provide a convenient example of information to complete item 1.

2. Flooding source refers to a specific lake, stream, ocean, etc. This should match the flooding source name shown on the FIRM, if it has been labeled. (Examples: Lake Michigan, Duck Pond, or Big Hollow Creek).

3. Project Name/Identifier can be the name of a flood control project or other pertinent structure having an impact on the effective FIS, the name of a subdivision or area, or some other identifying phrase.

4. The zone designations affected can be obtained from the FIRM.

5. a. Indicate the basis for the revision request.
    - Physical Changes include watershed development, flood control structures, etc. Note that fees will be assessed for FEMA's review of proposed and "as-built" projects, as outlined in NFIP regulations 44 CFR Ch. 1, Part 72.
    - Improved Methodology/Data may be a different technique (model) or adjustments to models used in the effective FIS.
    - Regulatory Floodway Revisions involve any shift in the FEMA-designated floodway boundaries, regardless of whether the shift is mappable.
    - Other involves any basis for the request not including the above items.

    b. Indicate the types of flooding and structure(s) associated with the revision request.

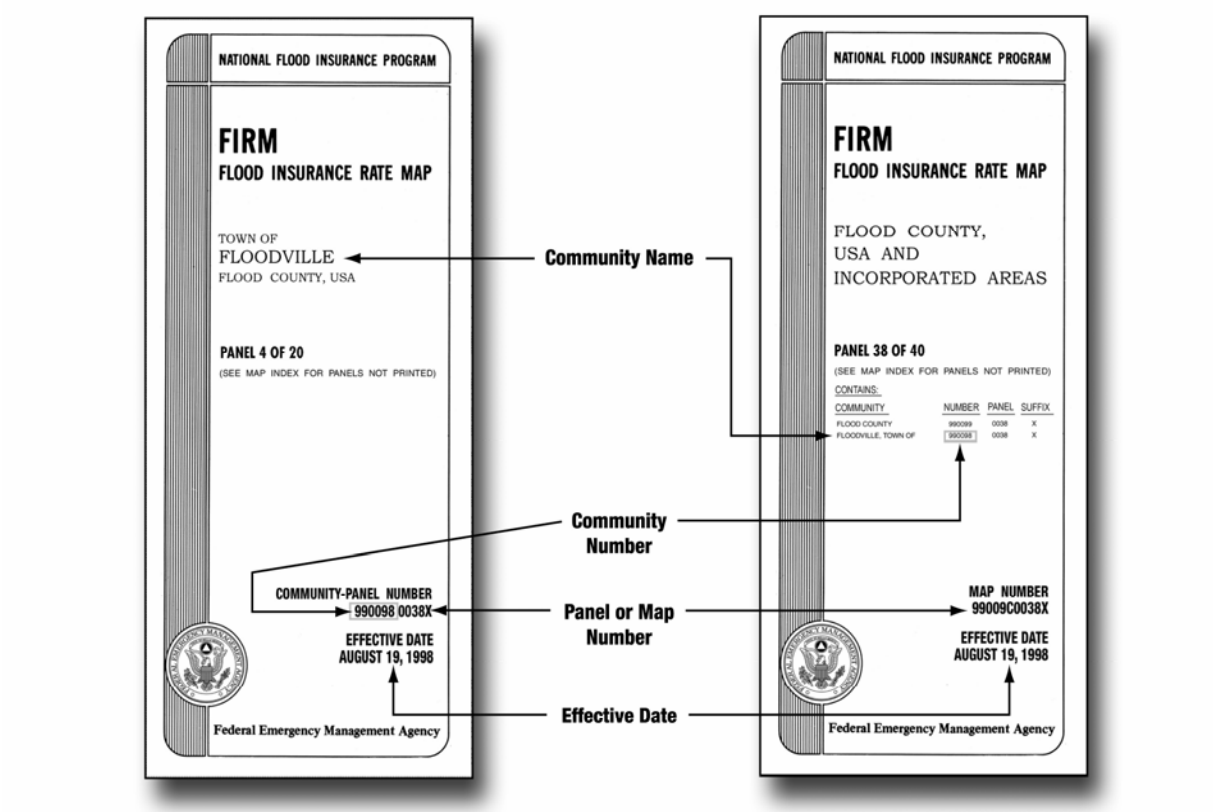


Figure 1. Sample FIRM Panel (Single Community)

Figure 2. Sample FIRM Panel (Countywide)

Section C: Review Fee

Enter the fee amount associated with the request, or attach an explanation as to why the revision meets the requirements for a fee exemption. The current fees for review and processing of Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) requests may be obtained from FEMA's Internet site at http://www.fema.gov/fhm/frm_fees.shtm.

Section D: Signature

Signature and Title of Revision Requester

The person signing this certification should own the property involved in the request or have legal authority to represent a group/firm/organization or other entity in legal actions pertaining to the NFIP.

The requester is responsible for obtaining all necessary Federal, State, and local permits as a condition of obtaining a LOMR or CLOMR. The community is required to make sure that all necessary permits have been obtained prior to issuing a floodplain development permit. The most commonly required Federal permits are wetlands permits under Section 404 of the Clean Water Act of 1972 and incidental take permits under Section 10 of the Endangered Species Act of 1972. Necessary State permits vary depending on the State. If the requester needs a wetlands permit or is not sure if one is required, he should contact the U.S. Army Corps of Engineers District Office. If the requester's proposed development impacts threatened or endangered species or if he is unsure if it does, he should consult with the nearest U.S. Fish and Wildlife Service field office.

Signature and Title of Community Official

The person signing this certification should be the CEO for the community involved in this revision request or an official legally designated by the CEO. If more than one community is affected by the change, the community official from the community that is most affected should sign the form, and letters from the other affected communities should be enclosed. If the community or communities disagree with the proposed revision, a signed statement should be attached to the request explaining the reasons or basis for disagreement.

Under 44 CFR 60.3(a)(2), the community is required to ensure, prior to issuing a floodplain development permit that an applicant has obtained all necessary Federal and State permits related to development. The most commonly required Federal permits are wetlands permits under Section 404 of the Clean Water Act of 1972 and incidental take permits under Section 10 of the Endangered Species Act of 1972. Necessary State permits vary depending on the State. If the community is not sure if a wetlands permit is required, refer the applicant to the U.S. Army Corps of Engineers District Office. If the proposed development impacts on threatened or endangered species or the community is unsure if it does, have the applicant consult with the nearest U.S. Fish and Wildlife Service field office.

Certification by Registered Professional Engineer and/or Land Surveyor

The person certifying this submittal must provide a valid license number and expiration date for their license. If this information is provided, affixing a seal is optional. If a seal is available, however, it may be affixed in the seal box provided on this form. The licensed professional engineer and/or land surveyor should have a current license in the State where the affected communities are located. While the individual signing this form is not required to have obtained the supporting data or performed the analyses, he or she must have supervised and reviewed the work.

A certification by a registered professional engineer or other party does not constitute a warranty or guarantee of performance, expressed or implied. Certification of data is a statement that the data is accurate to the best of the certifier's knowledge. Certification of analyses is a statement that the analyses have been performed correctly and in accordance with sound engineering practices. Certification of structural works is a statement that the works are designed in accordance with sound engineering practices to provide protection from the 1% annual chance flood. Certification of "as-built" conditions is a statement that the structure(s) has been built according to the plans being certified, is in place, and is fully functioning.

If the requester is a Federal agency who is responsible for the design and construction of flood control facilities, a letter stating that, "the analyses submitted have been performed correctly and in accordance with sound engineering practices" may be submitted in lieu of certification by a registered professional engineer. Regarding the certification of completion of flood control facilities, a letter from the Federal agency certifying its completion and the flood frequency event to which the project protects may be submitted in lieu of this form.

Forms Submitted

Indicate which forms are submitted with the revision request.

INSTRUCTIONS FOR COMPLETING THE RIVERINE HYDROLOGY & HYDRAULICS FORM (FORM 2)

This form should be used for revision requests that involve new or revised hydrologic and/or hydraulic analyses of rivers, streams, ponds, or small lakes. A separate form should be used for each flooding source.

Section A: Hydrology

This section is to be completed when discharges other than those used in the effective Flood Insurance Study (FIS) are proposed.

1. Indicate the reason for the new or revised hydrologic analysis. For revisions based on alternative methodologies or improved data, an explanation as to why the alternative methodology or improved data provides better results over the FIS must be presented and supported throughout the form.

2. Compare the effective 1% annual chance (100-year) discharges to the revised 1% annual chance discharges at three representative locations.

   In accordance with National Flood Insurance Program (NFIP) regulations, if only a portion of a detailed study stream is revised, transition to the unrevised portion must be ensured to maintain the continuity of the study. Attach an explanation of how the proposed discharge in the revised portion of the stream transitions to the effective discharge in the unrevised portion of the stream, and vice versa.

3. Specify the method used for the new analysis. Attach any additional backup computations and supporting data such as a drainage area map, soils map, soil group names, time of concentration computations, curve numbers, etc. Disks with the digital models should also be included. Models submitted in support of a revision request must meet the requirements of Subparagraph 65.6(a)(6) of the NFIP regulations. A list of accepted FEMA hydrologic models can be found at http://www.fema.gov/fhm/en_hydro.shtm.

4. If approval of the new hydrologic analysis is required by a local, State, or Federal agency, indicate if the analysis and resulting peak discharge value(s), have been approved by the appropriate local, State, or Federal agency and attach evidence of the approval.

5. In locations where sediment transport affects hydrology, the effects of sediment transport should be considered in the hydrology and Section F of Form 3 should be submitted.

Section B: Hydraulics

This section is to be completed when the request involves a hydraulic analysis for riverine flooding that differs from that used to develop the Flood Insurance Rate Map (FIRM).

1. Indicate the reach of stream to be revised. The area of the revision is defined by an effective tie-in at the upstream and downstream limits. For streams that have a detailed study, an effective tie-in is obtained when the revised base flood and floodway elevations are within 0.5 feet of the effective elevations, and the revised floodway encroachment stations match the effective floodway stations at both the upstream and downstream limits. For streams that do not have a detailed study, an effective tie-in is obtained when the revised base flood elevations are within 0.5 feet of the pre-project conditions model at both the upstream and downstream limits. Please note that the area of revision and the project area are not necessarily the same. If the revised model does not tie-in to the effective study at the project limits, the model must be extended upstream and downstream until it ties-in to the effective study.

2. Indicate the Hydraulic Method used for the revision. A list of Hydraulic models accepted by FEMA can be found at http://www.fema.gov/fhm/en_hydra.shtm. If using a hydraulic model that does not appear on the list of accepted models, please provide documentation showing that the model meets the requirements of NFIP regulation 65.6(a)(6).

3. Indicate if the CHECK-2 or CHECK-RAS programs were used to verify that the hydraulic estimates and assumptions in the model are comparable to the assumptions and limitations of HEC-2 or HEC-RAS. CHECK-2 and CHECK-RAS are review tools that identify areas of potential error or concern. These tools do not replace engineering judgment. CHECK-2 and CHECK-RAS can be downloaded from FEMA's Internet site at http://www.fema.gov/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with the comment messages, please attach an explanation of why the messages are not valid in each case. To reduce processing time, review your hydraulic model and resolve valid modeling discrepancies, before submitting it for review.

4. Indicate the hydraulic models submitted. Provide name of plans used, if HEC-RAS models are submitted. Also, indicate vertical datum used for each of the submitted hydraulic models.

   Submittal requirements for areas that have detailed flooding: Printouts of input and output listings along with files on diskette or CD for each of the models and supporting data (e.g., description of vegetation and land use map) for the source of input parameters used in the models listed below must be provided. The summary must include a description of any changes made from model to model (e.g., Duplicate Effective Model to Corrected Effective Model). At a minimum, the Duplicate Effective Model and the Revised or Post-Project Conditions Model must be submitted. The hydraulic analyses shall be performed for all flood frequencies and the floodway published in the effective FIS.

   Submittal requirements for areas that do not have detailed flooding: Only the 1% annual chance (Base) flood computations are required. A hydraulic model is not required for areas that do not have detailed flooding; however, Base Flood Elevations (BFEs) may not be added to the revised FIRM. If a hydraulic model is developed for the area, the Existing or Pre-project Model and the Revised or Post-Project Conditions Model, if applicable, described below must be submitted.

   Duplicate Effective Model

   The duplicate effective model is a copy of the hydraulic analysis used in the effective FIS, referred to as the effective model. The effective model should be obtained and then reproduced on the requester's equipment to produce the duplicate effective model. This is required to ensure that the effective model's input data has been transferred correctly to the requester's equipment and to ensure that the revised data will be integrated into the effective data to provide a continuous FIS model upstream and downstream of the revised reach.

   For information on how to obtain copies of the effective FIS models, see FEMA's Internet site at http://www.fema.gov/fhm/st_order.shtm. If data from the effective model is available and the same modeling program is being used, the requester must generate models that duplicate the FIS profiles and the elevations shown in the Floodway Data Table in the FIS report to within 0.1 foot. The appropriate FEMA Regional Office should be contacted if this model cannot be produced. See Appendix C for the addresses and telephone numbers of FEMA's Regional Offices. If the effective model is not available, the new model must be calibrated to reproduce the FIS profiles within 0.5 foot. If an alternative hydraulic model is used, it must be shown that the use of the original model is inappropriate and the new model must be calibrated to reproduce the FIS profiles within 0.5 foot.

   Corrected Effective Model

   The Corrected Effective Model is the model that corrects any errors that occur in the Duplicate Effective Model, adds any additional cross sections to the Duplicate Effective Model, or incorporates more detailed topographic information than that used in the current effective model. The Corrected Effective Model must not reflect any man-made physical changes since the date of the effective model. An error could be a technical error in the modeling procedures, or any construction in the floodplain that occurred prior to the date of the effective model but was not incorporated into the effective model.

Existing or Pre-Project Conditions Model

The Duplicate Effective Model or Corrected Effective Model is modified to produce the Existing or Pre-Project Conditions Model to reflect any modifications that have occurred within the floodplain since the date of the Effective model but prior to the construction of the project for which the revision is being requested. If no modification has occurred since the date of the effective model, then this model would be identical to the Corrected Effective Model or Duplicate Effective Model. The existing or pre-project model may be required to support conclusions about the actual impacts of the project associated with the revised or post-project model or to establish more up-to-date models on which to base the revised or post-project conditions model.

Revised or Post-Project Conditions Model

The Existing or Pre-Project Conditions Model (or Duplicate Effective Model or Corrected Effective Model, as appropriate) is modified to reflect revised or post-project conditions. This model must incorporate any physical changes to the floodplain since the effective model was produced as well as the effects of the project. When the request is for a proposed project, this model must reflect proposed conditions.

The information requested on the Riverine Hydrology & Hydraulics Form is intended to document the steps taken by the requester in the process of preparing the revised or post-project conditions hydraulic model and the resulting revised FIS information. The following guidelines should be followed when completing the form:

- All changes to the duplicate and subsequent models must be supported by certified topographic information, bridge plans, construction plans, survey notes, etc.

- Changes to the hydraulic models should be limited to the stream reach for which the revision is being requested. Cross sections upstream and downstream of the revised reach should be identical to those in the effective model. If this is done, water surface elevations and topwidths computed by the revised models should match those in the effective models upstream and downstream of the revised reach as required.

- There must be consistency between the revised hydraulic models, the revised floodplain and floodway delineations, the revised flood profiles, topographic work map, annotated FIRMs and/or Flood Boundary Floodway Maps (FBFMs), construction plans, bridge plans, etc.

Section C: Mapping Requirements

A certified topographic map of suitable scale, contour interval, and planimetric definition must be submitted showing the applicable items indicated on the form. If a digital version of the map is available, it may be submitted so that the FIRM may be more easily revised.

Attach an annotated FIRM panel showing the revised 1% and 0.2% annual chance floodplains and floodway boundaries. The revised boundaries must tie into the effective boundaries. The annotated FIRM ensures that FEMA is aware of how the requester anticipates the FIRM will be revised.

Indicate if annotated FIRM and/or FBFM and digital mapping data (GIS or CADD) submitted.

Section D: Common Regulatory Requirements

1. Indicate "yes" for the following situations:
   - Projects that will have construction within the floodway, which cause the BFEs to increase (more than 0.00 feet), or
   - Projects that will have construction within the floodplain of streams that have a detailed effective study, but for which a floodway has not been established, which cause the BFEs to increase more than 1.0 foot (or any other more stringent requirement set by the community or State).

   If either of the two situations occurs, then the conditions in NFIP Regulation 44 CFR Ch. 1, Section 65.12 must be met. The conditions of NFIP Regulation 44 CFR Ch. 1, Section 65.12 include:

- An evaluation of alternatives, which would not result in a BFE increase above that permitted demonstrating why these alternatives are not feasible;
- Documentation of individual legal notice to all affected property owners within and outside of the community, explaining the impact of the proposed action on their property;
- Concurrence of the Chief Executive Officer (CEO) and any other communities affected by the proposed actions; and
- Certification that no structures are located in areas that would be impacted by the increased base flood elevation.

2. Indicate if the placement of fill is involved with the revision request. Fill is defined as material from any source placed to raise the ground to or above the BFE. If fill has been placed to remove an area or structure from the Special Flood Hazard Area (SFHA), the community must sign the appropriate section of Form 1 certifying that the area to be removed from the special flood hazard area, to include any structures or proposed structures, (will) meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with NFIP Regulation 44 CFR 65.2(c). "Reasonably safe from flooding" means that the base flood waters will not inundate the land or damage the structures to be removed from the SFHA and that any subsurface waters related to the base flood will not damage existing or proposed buildings. Information on ensuring that structures built on fill in or near the SFHA are reasonably safe from flooding may be obtained from FEMA's Technical Bulletin 10-01, "Ensuring That Structures Built on Fill In or Near Special Flood Hazard Areas Are Reasonably Safe from Flooding," which is available on FEMA's Internet site at http://www.fema.gov/pdf/fima/tb1001.pdf.

3. Indicate if the request involves a floodway revision. If the floodway is being revised, the requirements of NFIP Regulation 44 CFR Ch. 1, Section 65.7 must be met. These requirements include submitting a copy of a public notice distributed by the community stating the community's intent to revise the floodway or a statement by the community that it has notified all affected property owners and affected adjacent jurisdictions. Samples of a public notice and of an individual notification for a floodway revision are shown in Figures 3 and 4, respectively.

4. Indicate if the revision request has the potential to impact an endangered species. Section 9 of the Endangered Species Act (ESA) prohibits anyone from "taking" or harm endangered species. If an action might harm an endangered species, provide necessary documentation for the compliance of Section 9 and/or Section 7(a)(2) of ESA.

5. Indicate if property owner notification and acceptance (if available) are required because the revision request involves increases in flood hazards from those shown on the FIRM. FEMA must provide a statutory 90-day appeal period for all map revisions entailing Base (1% annual chance [100-year]) Flood Elevation (BFE) changes. LOMRs with decreasing flood hazards (1% annual chance water-surface elevations, floodplains, or floodways) typically are effective the day of issuance, with any necessary appeal period provided afterwards. LOMRs with increasing flood hazards typically are not effective until after any required appeal period has expired and any necessary ordinance changes have been made by the community (3 to 6 months). However, a LOMR that reflects increasing flood hazards may be effective on the day of issuance if all property owners affected by these increases are notified and approve of the increases, and the community concurs with the revision. Samples of individual notifications for various increases in the SFHAs, BFEs, and floodways are shown on Figures 4 through 8.

The {insert community name} {insert appropriate community department for floodplain management}, in accordance with National Flood Insurance Program regulation 65.7(b)(1), hereby gives notice of the {insert community designation Township's / Village's/ Borough's / County's} intent to revise the floodway, generally located between {insert general location of floodway revision}. Specifically, the floodway shall be revised from a point {describe downstream limit of floodway revision} to a point {describe upstream limit of floodway revision}. As a result of the floodway revision, the floodway shall {widen and/or narrow} with a maximum widening of {insert maximum widening} feet at a point approximately {insert location of widening} and/or a maximum narrowing of {insert maximum narrowing} feet at a point approximately {insert location of narrowing}.

Maps and detailed analysis of the floodway revision can be reviewed at the {insert location} at {insert location address}. Interested persons may call {insert community contact name or position} at {insert contact phone number} for additional information from ... to ... {insert dates during which community contact person can be contacted}.

Figure 3.
SAMPLE NOTIFICATION FOR FLOODWAY REVISION
(to be used by community when placing a notice in a newspaper)

{Date}

{Affected property owner name}
{Affected property owner mailing address}

Re: Notification of Floodway Revision for {flooding source}

Dear Mr./Ms./Mr. & Mrs. {Affected property owner}

The Flood Insurance Rate Map (FIRM) for a community depicts the floodplain, the area which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The floodway is the portion of the floodplain that includes the channel of a river or other watercourse and the adjacent land area that must be reserved in order to discharge the base flood without cumulatively increasing the water-surface elevation by more than a designated height.

The {insert community name} {insert appropriate community department for floodplain management}, in accordance with National Flood Insurance Program regulation 65.7(b)(1), hereby gives notice of the {insert community designation Township's / Village's/ Borough's / County's} intent to revise the 1% annual chance (100-year) floodway, generally located between {insert general location of floodway revision}. Specifically, the floodway shall be revised from a point {describe downstream limit of floodway revision} to a point {describe upstream limit of floodway revision}. As a result of the floodway revision the floodway shall {widen and/or narrow} with a maximum widening of {insert maximum widening} feet at a point approximately {insert location of widening} and a maximum narrowing of {insert maximum narrowing} feet at a point approximately {insert location of narrowing}.

Maps and detailed analysis of the floodway revision can be reviewed at the {insert location} at {insert location address}. If you have any questions or concerns about the proposed project or its affect on your property, you may contact {name of appropriate community official} of {name of community} at {community official contact information} from ... to ... {insert dates during which community contact person can be contacted}.

Sincerely,

{Community official name}
{Community official position}
{Community official contact information}

Figure 4.
SAMPLE LETTER FOR FLOODWAY REVISION NOTIFICATION
(to be used by community if notifying property owners individually by letter)

{Date}

{Affected property owner name}
{Affected property owner mailing address}

Re: Notification of increases in 1% (100-year) annual chance water-surface elevations

Dear Mr./Ms./Mr. & Mrs. {Affected property owner}

The Flood Insurance Rate Map (FIRM) for a community depicts land which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

{Revision Requester} is applying for a Conditional Letter of Map Revision from the Federal Emergency Management Agency (FEMA) on behalf of {Revision requester's client} to revise FIRM {insert FIRM #, panel #, and suffix} for {insert community name, state} along {insert name of flooding source}. {Revision requester's client} is proposing {describe project} as part of {explain project purpose}.

The proposed project will result in increases {and decreases} in the 1% annual chance water-surface elevations for {insert flooding source} with a maximum increase of {enter maximum increase} feet at a point approximately (location of maximum increase} and a maximum decrease in the 1% annual chance water-surface elevation of {enter maximum decrease} feet at a point approximately {location of maximum decrease}.

This letter is to inform you of the proposed increases in the 1% annual chance water-surface elevations on your property at {insert physical address}.

If you have any questions or concerns about the proposed project or its affect on your property, you may contact {name of appropriate community official} of {name of community} at {community official contact information} from … to … {insert dates during which community contact person would like to be contacted}.

Sincerely,

{Revision requester name}

Figure 5.
SAMPLE LETTER FOR CLOMR NOTIFICATION OF INCREASES IN BFEs

{Date}

{Affected property owner name}
{Affected property owner mailing address}

Re: Notification of {widening and/or narrowing} of 1% (100-year) annual chance floodplain

Dear Mr./Ms./Mr. & Mrs. {Affected property owner}

The Flood Insurance Rate Map (FIRM) for a community depicts land which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

{Revision Requester} is applying for a Letter of Map Revision (LOMR) from the Federal Emergency Management Agency (FEMA) on behalf of {Revision requester's client} to revise FIRM {insert FIRM #, panel #, suffix} for {insert community name, state} along {insert name of flooding source}. {Revision requester} is proposing to revise the FIRM to reflect {describe project}.

The revision to the FIRM will result in widening {and narrowing} of the 1% annual chance (Zone A) floodplain for {insert name of flooding source}. The maximum widening of {enter maximum increase} feet occurs at a point approximately {location of maximum widening} while the maximum narrowing of {enter maximum narrowing} feet occurs at a point approximately {location of maximum narrowing}.

{Choose one of the following two paragraphs}

This letter is to inform you of the revision of the 1% annual chance (Zone A) floodplain on your property at {insert physical address}.

{or}

We would like to obtain your acceptance of revision of the 1% annual chance (Zone A) floodplain on your property at {insert physical address}. Please sign and date the provided copy of this letter to signify your acceptance and return it to {Revision Requester's address} by {insert date to return acceptance by}.

If you have any questions or concerns about the proposed changes to the FIRM or its effects on your property, you may contact me at {Revision requester contact phone number}.

Sincerely,

{Revision requester name}

{Insert the following if asking for property owner acceptance}
I, {insert property owner name}, accept the redelineation of the 1% annual chance floodplain as described above.

_____ _____
{insert property owner name} Date

Figure 6.
SAMPLE LETTER FOR LOMR NOTIFICATION & ACCEPTANCE IN ZONE A THAT WILL WIDEN AND NARROW THE FLOODPLAIN BUT NOT ESTABLISH BFEs

{Date}

{Affected property owner name}
{Affected property owner mailing address}

Re: Notification of {widening and/narrowing} of 1% (100-year) annual chance floodplain and establishment of Base Flood Elevations

Dear Mr./Ms./Mr. & Mrs. {Affected property owner}

The Flood Insurance Rate Map (FIRM) for a community depicts land which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

{Revision Requester} is applying for a Letter of Map Revision (LOMR) from the Federal Emergency Management Agency (FEMA) on behalf of {Revision requester's client} to revise FIRM {insert FIRM #, panel #, suffix} for {insert community name, state} along {insert name of flooding source}. {Revision requester} is proposing to revise the FIRM to reflect {describe project}.

The Letter of Map Revision will result in:

1. Establishment of Base (1% annual chance) Flood Elevations (BFEs). Currently, the flooding along {flooding source} is based on an approximate study.

2. Widening {and narrowing} of the 1% annual chance floodplain with the maximum widening of {enter maximum increase} feet at a point approximately {location of maximum widening} and the maximum narrowing of {enter maximum narrowing} feet at a point approximately {location of maximum narrowing}.

{Please choose one of the following two paragraphs}

This letter is to inform you of the establishment of Base Flood Elevations and revision of the 1% annual chance floodplain on your property at {insert physical address}.

{or}

We would like to obtain your acceptance of the establishment of Base Flood Elevations and revision of the 1% annual chance floodplain on your property at {insert physical address}. Please sign and date the provided copy of this letter and return it to {Revision Requester's address} by {insert date to return acceptance by}.

If you have any questions or concerns about the proposed changes to the FIRM or its effect on your property, you may contact me at {Revision requester contact phone number}.

Sincerely,

{Revision requester name}

{Insert the following if asking for property owner acceptance}
I, {insert property owner name}, accept establishment of Base Flood Elevation on {insert flooding source name} and redelineation of the 1% annual chance floodplain as described above.

_____ _____
{insert property owner name} Date

Figure 7.
SAMPLE LETTER FOR LOMR NOTIFICATION & ACCEPTANCE IN ZONE A THAT WILL ESTABLISH BFEs & WIDEN AND NARROW THE FLOODPLAIN

{Date}

{Affected property owner name and address}

Re: Notification of 1% (100-year) annual chance water-surface elevation increases {and widening of the 1% annual chance floodplain}

Dear Mr./Ms./Mr. & Mrs. {Affected property owner}

The Flood Insurance Rate Map (FIRM) for a community depicts land which has been determined to be subject to a 1% (100-year) or greater annual chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

{Revision Requester} is applying for a Letter of Map Revision (LOMR) from the Federal Emergency Management Agency (FEMA) on behalf of {Revision requester's client} to revise FIRM {insert FIRM #, panel #, suffix} for {insert community name, state} along {insert name of flooding source}. {Revision requester's client} is proposing {describe project} as part of {explain project purpose}.

The Letter of Map Revision will result in:

1. Increases {and decreases} in the 1% annual chance water-surface elevations with a maximum increase of {enter maximum increase} feet at a point approximately {location of maximum increase} and a maximum decrease in the 1% annual chance water-surface elevation of {enter maximum decrease} feet at a point approximately {location of maximum decrease}.

2. Widening {and narrowing} of the 1% annual chance floodplain with the maximum widening of {enter maximum increase} feet at a point approximately {location of maximum widening} and the maximum narrowing of {enter maximum narrowing} feet at a point approximately {location of maximum narrowing}.

{Choose one of the following two paragraphs}

This letter is to inform you of revision of the 1% annual chance water-surface elevation and 1% annual chance floodplain on your property at {insert physical address}.

{or}

We would like to obtain your acceptance of revision of the 1% annual chance water-surface elevation and 1% annual chance floodplain on your property at {insert physical address}. Please sign and date the provided copy of this letter to signify your acceptance and return it to {Revision Requester's address} by {insert date to return acceptance by}.

If you have any questions or concerns about the proposed changes to the FIRM or its effect on your property, you may contact me at {Revision requester contact phone number}.

Sincerely,

{Revision requester name}

{Insert the following if asking for property owner acceptance}
I, {insert property owner name}, accept increases in the 1% annual chance water-surface elevations and redelineation of the 1% annual chance floodplain as described above.

_____ _____

{insert property owner name} Date

Figure 8.
SAMPLE LETTER FOR LOMR NOTIFICATION & ACCEPTANCE THAT WILL RESULT IN INCREASES IN ZONE AE OF BFEs & WIDENING OF THE FLOODPLAIN

INSTRUCTIONS FOR COMPLETING THE RIVERINE STRUCTURES FORM (FORM 3)

This form should be used for revision requests that involve new or proposed channelization, bridges/culverts, dams, and/or levees/floodwalls. Only complete the sections of this form that are applicable to the revision request. A separate form should be used for each flooding source that has structures involved in the revision request.

Section A: General

Provide the name of the structure (e.g., Main Street Bridge or Flood Creek channelization), the type of structure, the location of the structure (e.g., 1000 feet upstream of Main Street or River Mile 10.4), and the appropriate cross-section labels for the structures that are part of the revision request. Attach additional pages if the revision request involves more than 3 structures. This form is not required for existing structures that are included in the hydraulic model for the effective Flood Insurance Rate Map (FIRM).

Section B: Channelization

This section is to be completed when any portion of the stream channel is altered or relocated. The purpose of the Channelization section and the information to be submitted, is to ensure that the channel will function properly as designed and pass the 1% annual chance flood as determined by the hydraulic analysis. When the Channelization section is submitted, a Riverine Hydrologic & Hydraulic Form (Form 2) must also be submitted.

1. Indicate all accessory structures included with the channelization. The accessory structures should be shown on the submitted plans.

2. Attach engineering drawings of the channelization certified by a registered professional engineer. The drawings should include a plan view of the channelization that shows pre-construction topography and post-construction grading, channel cross section, channel lining, channel inlet and outlet, and details for any accessory structures included with the channelization.

   Typically, channelization increases the channel velocity above the natural channel velocity. Provide information that supports the conclusion that the channel lining will withstand the velocities associated with the 1% annual chance flood. The type of channel lining should be indicated on the plans.

3. Indicate the channel design criteria (i.e., capacity and type of flow) and if there is a potential for a hydraulic jump.

4. In locations where sediment transport will affect the Base Flood Elevations (BFEs), the effects of sediment transport should be considered in the channelization analysis and Section F of Form 3 should be submitted.

Section C: Bridge/Culvert

This section is to be completed when the request involves a new bridge or culvert or a new or revised analysis of an existing bridge or culvert.

1. Indicate the reason for the new or revised bridge/culvert modeling.

2. Indicate the model used to analyze the hydraulics at the bridge/culvert. If this model is different than the model used to analyze the flooding on the stream, then include an explanation of why a different model was used to analyze the bridge/culvert.

3. Attach plans of the structure certified by a registered professional engineer. The bridge/culvert plans should include the information listed on the form. Indicate the items included on the plans, and attach an explanation of why any information is not included.

4. In locations where sediment transport will affect the BFEs, the effects of sediment transport should be considered in the bridge/culvert analysis and Section F of Form 3 should be submitted.

Section D: Dam

This section is to be filled out when there is an existing, proposed, or modified dam along a stream studied in detail. Provide a complete engineering analysis and engineering drawings of the dam. The drawings should indicate the dam dimensions (height, top width, side slopes), the crest elevation of the top of the dam, the type of spillway, the spillway dimensions, the crest elevation of the spillway, the type of outlet, the outlet dimensions, and the invert elevation of the outlet.

1. Indicate the reason for the revision request involving a dam.

2. Indicate the agency or organization that designed the dam.

3. Indicate name of the agency or organization responsible for permitting the dam along with the appropriate permit or identification number for the dam.

4. Indicate if the hydrologic analysis is revised as a result of the dam. Any storage upstream of the dam, considered in the hydrologic analysis to reduce the peak base flood discharge, should be totally dedicated to flood control. If the outflow of the dam is regulated, submit an explanation of the flow regulation plan. Complete Form 2, Riverine Hydrology & Hydraulics Form, if the hydrology changes.

5. In locations where sediment transport will affect the BFEs, the effects of sediment transport should be considered in the dam analysis and Section F of Form 3 should be submitted.

6. Indicate if the Base Flood Elevations change as a result of the dam. If impacted, list the elevations. Indicate the stillwater elevations behind the dam.

7. Attach a copy of the Operation and Maintenance Plan for the dam with the revision request.

Section E: Levee/Floodwall

This section is to be completed when the revision request involves a new or modified levee and/or floodwall system. A levee is a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding. The purpose of this section is to ensure that the levee or floodwall is designed and/or constructed to provide protection from the 1% annual chance flood, in full compliance with National Flood Insurance Program (NFIP) Regulation 44 CFR Ch. 1, Section 65.10, before reflecting its effects on an NFIP map.

In addition, a vicinity map along with a complete set of flood profile sheets, plan sheets, and layout detail sheets must be submitted. These sheets must be numbered, and an index must be provided that clearly identifies those sheets specifically relating to the levee or floodwall in question.

1. Indicate all the applicable levee/floodwall system elements, including their locations and types, and provide engineering drawings certified by a registered professional engineer. The drawings should show the items indicated.

2. Indicate the amount of freeboard that the levee has above the base flood elevation. Riverine levees must provide a minimum freeboard of three feet above the BFE. An additional one-half foot above the minimum must be provided at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee. An additional one-foot above the minimum freeboard is required on both sides of the river or stream for a distance of 100 feet upstream of structures (such as bridges) riverward of the levee or wherever the flow is constricted. If exceptions to the minimum freeboard requirements are requested, attach documentation addressing NFIP Regulation 44 CFR Ch. 1, Subparagraph 65.10(b)(1)(ii).

   Ice-jams can increase the flood elevations on a stream. Indicate if the stream has a history of ice-jams, and, if so, provide evidence that the minimum freeboard still exists with the ice-jam effects.

3. List the closure devices for all openings through the levee system. All openings must be provided with closure devices that are structural parts of the system during operation and design.

4. Complete the information to show where embankment protection is required, and submit supporting embankment protection analysis. The embankment protection analysis must demonstrate that no appreciable erosion of the levee embankment can be expected during the 1% annual chance flood, as a result of either current or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. Factors to be addressed include, but are not limited to: expected flow velocities, expected wind and wave action, ice loading, impact of debris, slope protection techniques, duration of flooding at various stages and velocities, embankment and foundation materials, levee alignment, bends, transitions, and levee side slopes. The table provide in the form is for riprap protection. If another method of embankment protection is used, then a table with similar information should be prepared and submitted with the forms.

5. Complete the information to summarize the analysis of the levee and foundation. This analysis must evaluate both stability and seepage during the loading conditions associated with the base flood. The seepage analysis shall demonstrate that seepage into or through the levee embankment and foundation will not result in seepage and piping that will jeopardize the embankment and foundation stability. The slope stability analysis shall demonstrate that the levee cross section is stable under all loading and unloading conditions for the base flood. The analysis should include the river or channel slopes. Guidance on seepage and stability analyses is outlined in the U.S. Army Corps of Engineers (USACE) manual "Design and Construction of Levees," EM 1110-2-1913. This manual may be obtained at http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-1913/toc.htm. Additional information on acceptable factors of safety for underseepage is in USACE technical letter "Design Guidance for Levees," ETL 1110-2-555. This technical letter may be obtained from the USACE Internet site at http://www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-2-555/toc.html. The factors that must be addressed in these analyses include: depth of flooding, duration of flooding, foundation conditions at the site, embankment and cut slope geometry and length of seepage path at the critical locations, internal drainage in the levee, seepage and/or stability berms and management of trees and vegetation. All backup material for these analyses should be submitted.

6. See above embankment and foundation stability discussion. In addition, waterstops and joint materials should be incorporated into the floodwall design as outlined in USACE manual "Waterstops and Other Preformed Joint Materials for Civil Works Structures," EM 1110-2-2102 to prevent passage of water through the wall. This manual may be obtained at http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-2102/toc.htm.

7. Complete the information to summarize the results from an analysis of potential settling of the levee. The settlement analysis must assess the potential and magnitude of future losses of freeboard and must demonstrate that the minimum freeboard requirements will be maintained. The analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, a detailed settlement analysis and determination of the appropriate amount of overbuild using procedures such as those described in USACE manuals "Settlement Analysis," EM 1110-2-1904 and "Design and Construction of Levees," EM 1110-2-1913, Chapter 6, must be submitted. Submit all backup information used in the analysis.

8. Complete the information to summarize an analysis of potential flooding from interior drainage. In accordance with NFIP Regulation 44 CFR Ch. 1, Subparagraph 65.10(b)(6), the interior drainage analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities for evacuating interior floodwaters. The analysis must identify the extent of the flooded area, and the water-surface elevation(s) of the 1% annual chance flood if the average depth is greater than one foot. This information is to show on a certified topographic work map. Submit the calculation and back-up information for the analysis of flooding potential from interior drainage.

9. Complete the information and attach any supporting documentation regarding the design criteria indicated.

10. Complete the information to summarize the operational plan and criteria. For a levee system to be recognized by the Federal Emergency Management Agency (FEMA), the operational criteria must be as described in NFIP Regulation 44 CFR Ch. 1, Subparagraph 65.10(c).

11. Indicate if the maintenance plan for the levee is in compliance with NFIP Regulation 44 CFR Ch. 1, Subparagraph 65.10(d).

12. Submit a copy of the Operation and Maintenance Plan with the revision request. This plan should address maintenance standards, intervals and procedures. It should also include requirements for management of vegetation similar to what is outlined in USACE manual "Landscape Planting and Vegetation Management for Floodwalls, Levees and Embankment Dams," EM 1110-2-301. This manual can be obtained from the USACE Internet site at http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-301/toc.htm. This plan should also include the design and construction requirements and inspection procedures for future utility crossings. The Operation and Maintenance Plan may not have to be submitted when requesting a Conditional Letter of Map Revision (CLOMR) for a proposed levee. However, it will be required after the levee is constructed and a revision to the FIRM is requested.

Section F: Sediment Transport

Complete the information to summarize an analysis of sediment transport (including scour and deposition) if there is any indication from historical records that sediment transport can affect the BFE, or if based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport to affect the BFE or a structure. If sediment transport will not affect the BFE or a structure, then indicate that this section is not applicable and include an explanation as to why a sediment analysis was not performed. Please note that bulked flows are used to evaluate the performance of a structure during the base flood, but FEMA does not map BFEs based on bulked flows.

INSTRUCTIONS FOR COMPLETING THE COASTAL ANALYSIS FORM (FORM 4)

The information requested on the Coastal Analysis Form is intended to document the steps taken by the requester in the process of preparing the revised models or analyses and the resulting revised Flood Insurance Study (FIS) information. Refer to the *Consolidated Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix D: Guidance for Coastal Flooding Analyses and Mapping,* which can be obtained from the Federal Emergency Management Agency's (FEMA's) Internet site at http://www.fema.gov/fhm/dl_cgs.shtm, for the wave height analyses and mapping procedures used by FEMA for coastal areas. Wave height, wave run-up, and storm induced erosion may be analyzed using the program, CHAMP 1.1, which was developed for FEMA. CHAMP 1.1 may be obtained from FEMA's Internet site at http://www.fema.gov/fhm/frm_soft.shtm. A list of accepted FEMA coastal models can be found on FEMA's Internet site at http://www.fema.gov/fhm/en_coast.shtm. The following guidelines should be followed when completing the form:

Section A: Coastline to be Revised

Describe the limits of the restudied area. Road names and/or landmarks in the vicinity of the restudied area or transects used in the effective FIS may be used as reference points.

Section B: Effective FIS

The type of analyses (approximate or detailed wave parameter computations) used for the effective FIS for the community being restudied must be provided. This information is available in the hydrologic and hydraulic sections of the FIS report.

Section C: Revised Analysis

All changes to effective models must be supported by certified topographic information, structure plans, survey notes, storm surge data, meteorological data, etc. All equations or models used must be referenced. Descriptions and/or sketches of transect profiles should be attached for revised erosion, wave height, wave runup, and wave overtopping analyses. Wave runup and wave overtopping should be considered when the wave heights approach the crest of the shore protection structure or natural land forms. If FEMA procedures are not used in the revised analyses, provide an explanation.

Section D: Results

Information must be provided to determine the impact of the analysis on the mapping of the coastal high hazard areas, including the location of the coastal high hazard area boundaries, maximum wave height elevation, and the maximum wave runup elevation. Mapping resulting from the re-analysis of the effective study must tie-in with areas not re-studied. The mapped inland limit of the coastal high hazard areas (V Zones) as a result of the re-analysis must be in compliance with National Flood Insurance Program (NFIP) Regulation 44 CFR Ch. 1, Section 65.11 in areas where primary frontal dunes are present.

Section E: Mapping Requirements

With the revision request, submit a certified topographic map showing the information indicated in the Mapping Requirements Section of the Coastal Analysis Form. Also submit a copy of the current FIRM annotated to show the revised 1% annual chance floodplain boundaries.

INSTRUCTIONS FOR COMPLETING THE COASTAL STRUCTURES FORM (FORM 5)

The Coastal Structures Form is to be completed when a revision to coastal flood hazard elevations and/or areas is requested based on coastal structures being credited as providing protection from the base flood. The purpose of the Coastal Structures Form is to ensure that the structure is designed and constructed to provide protection from the base flood without failing or causing an increase in flood hazards to adjacent areas. Refer to the *Consolidated Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix D: Guidance for Coastal Flooding Analyses and Mapping* which can be obtained from the Federal Emergency Management Agency's (FEMA's) Internet site at http://www.fema.gov/fhm/dl_cgs.shtm, for the criteria for evaluating flood protection structures.

If the coastal structure is a levee/floodwall, complete the Levee/Floodwall System section of the Riverine Structure Form (Form 3), in addition to this form. When the Coastal Structures Form is submitted, the Coastal Analysis Form (Form 4) should also be submitted.

Section A: Background

Information about the type of structure, the location, the material being used, and the age of the structure must be provided. Certified "as built" plans must also be provided. If these plans are not available, an explanation must be given with sketches of the general structure dimensions as described. If the structure design has been certified by a Federal agency to provide flood protection and withstand forces from the 1% annual chance (base) flood, the dates of the project completion and certification of the structure should be provided, and the remainder of the form does not need to be completed.

Section B: Design Criteria

Documentation must be provided that ensures a coastal structure is designed and constructed to withstand the wind and wave forces associated with the base flood. The minimum freeboard of the structure must be in compliance with National Flood Insurance Program (NFIP) Regulation 44 CFR Ch. 1, Section 65.10. Additional concerns include the impact to areas directly landward of the structure that may be subjected to overtopping and erosion along with possible failure of the structure due to undermining from the backside and the possible increase in erosion to unprotected properties at the ends of the structure. The evaluation of protection provided by sand dunes must follow the criteria outlined in NFIP Regulation 44 CFR Ch. 1, Section 65.11.

Section C: Adverse Impact Evaluation

If the structure is new, proposed, or modified, and will impact flooding and erosion for the areas adjacent to the structure, provide an explanation and documentation to support your conclusions.

Section D: Community and/or State Review

Provide documentation of Community and/or State review of the revision.

Section E: Certification

The licensed professional engineer and/or land surveyor should have a current license in the State where the affected communities are located. While the individual signing this form is not required to have obtained the supporting data or performed the analyses, he or she must have supervised and reviewed the work.

If the requester is a Federal agency who is responsible for the design and construction of flood control facilities, a letter stating that "the analyses submitted have been performed correctly and in accordance with sound engineering practices" may be submitted in lieu of certification by a registered professional engineer. Regarding the certification of completion of flood control facilities, a letter from the Federal agency certifying its completion and the flood frequency event to which the project protects may be submitted in lieu of this form.

INSTRUCTIONS FOR COMPLETING THE ALLUVIAL FAN FLOODING FORM (FORM 6)

This form should be used for revision requests involving alluvial fans. The purpose of this form is to ensure that a structural flood control measure in areas subject to alluvial fan flooding is designed and/or constructed to provide protection from the 1% annual chance flood, in compliance with National Flood Insurance Program (NFIP) Regulation 44 CFR Ch. 1, Section 65.13, before it is recognized on an NFIP map. Elevating a parcel of land or a structure by fill or other means will not serve as a basis for removing areas subject to alluvial fan flooding from an area of special flood hazards. See NFIP Regulation 44 CFR Ch. 1, Section 65.13. Complete engineering analyses must be submitted in support of each section of this form. In addition, it may be necessary to complete other forms relating to specific flood control measures, such as levees/floodwalls, channelization, or dams.

Section A: Three-Stage Analysis

The three-stage analysis of alluvial fans is described in the Federal Emergency Management Agency's (FEMA's) *Consolidated Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping,* which can be obtained from the Federal Emergency Management Agency's (FEMA's) Internet site at http://www.fema.gov/fhm/dl_cgs.shtm.

1. Complete the information regarding the characterization of the alluvial fan landform.

2. Complete the information regarding the definition of active and inactive areas.

3. Complete the information regarding the determination of the 100-year floodplain boundaries.

Section B: Structural Flood Control Measures

Complete the information regarding any flood control structures. Submit Form 3, Riverine Structure Form, and an Operation and Maintenance Plan with the revision request. The Operation and Maintenance Plan may be submitted when requesting a Conditional Letter of Map Revision (CLOMR), but is not required. However, it will be required after construction is complete and a revision to the Flood Insurance rate Map (FIRM) is requested.

Section C: Mapping Requirements

With the revision request, submit a certified topographic map showing the information indicated in the Mapping Requirements section of the Alluvial Fan Flooding Form. Also submit a copy of the current FIRM annotated to show the revised 1% annual chance floodplain boundaries.

INSTRUCTIONS FOR COMPLETING THE PAYMENT INFORMATION FORM

The Payment Information Form must be completed for all requests requiring a fee. The current fee schedule for the reviewing and processing of Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) requests may be obtained from the Federal Emergency Management Agency's (FEMA's) Internet site at http://www.fema.gov/fhm/frm_fees.shtm or by calling FEMA's Map Assistance Center at 1-877-FEMA MAP (1-877-336-2627).

Indicate the name of the community and a project identifier (e.g., Floodville Estates Subdivision or Small Creek Channel Improvements). The fees are sent to a different location from the revision request package. It is important to have the name of the community and a project identifier on the fee form, so that fees can be matched to the revision requests.

Indicate whether the fee is being submitted for an MT-1 application, an MT-2 application, or an External Data Request. This form is used for several types of requests. The type of request should be indicated so that the fees can be matched to the revision requests.

The request or case number should be indicated if it is known. Generally, this number is not known when a revision is initially requested. However, the case number should be indicated in any subsequent correspondence with FEMA.

Indicate the amount and method of payment being used to pay the fee.

APPENDIX A - COMMONLY USED ACRONYMS

BFE	Base (1% annual chance) Flood Elevation. It is the height of the base flood, usually in feet, in relation to the datum used, or the depth of the base flood usually in feet, above the ground surface. The base flood is the flood that has a 1% probability of being equaled or exceeded in any given year (also referred to as the 100-year flood or the 1% annual chance flood).
CFR	Code of Federal Regulations.
CHHA	Coastal High Hazard Area. An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. CHHAs are indicated as V or VE Zones on the Flood Insurance Rate Maps.
CLOMR	Conditional Letter of Map Revision. A letter from FEMA commenting on whether a proposed project, if built as proposed, would meet the minimum standards of the National Flood Insurance Program.
FBFM	The Flood Boundary and Floodway Map. The floodplain management map issued by FEMA that depicts, on the basis of detailed analyses, the boundaries of the 100- and 500-year floodplain and the regulatory floodway.
FEMA	Federal Emergency Management Agency.
FHBM	The Flood Hazard Boundary Map. The initial flood insurance map issued by FEMA that identified on the basis of approximate analyses, the areas of 100-year flood hazard in a community.
FIRM	Flood Insurance Rate Map. An official map of a community, on which the Administrator has delineated both the special hazard areas and the risk premium zones applicable to the community.
FIS	Flood Insurance Study. An engineering study performed under contract to FEMA to identify flood-prone areas and to determine BFEs, flood insurance rate zones, and other flood risk data for a community.
LOMR	Letter of Map Revision. A letter from FEMA officially revising the current NFIP map to show changes to floodplains, floodways, or flood elevations.
NFIP	National Flood Insurance Program.
PMR	Physical Map Revision. A reprinted NFIP map incorporating changes to floodplains, floodways, or flood elevations. Because of the time and cost involved to change, reprint, and redistribute an NFIP map, a PMR is usually processed when a revision reflects large scope changes.
SFHA	Special Flood Hazard Area. Areas inundated by a flood having a 1% probability of being equaled or exceeded in any given year (also referred to as the 100-year flood).
USACE	U.S. Army Corps of Engineers.
WSEL	Water Surface Elevation.

APPENDIX B - USEFUL INTERNET SITES

Public Information:

http://www.fema.gov - FEMA's Internet site.

http://www.fema.gov/fhm/en_main.shtm - FEMA's Internet site for engineers and surveyors.

http://www.fema.gov/fhm/ot_main.shtm - FEMA's Internet site for online tutorials.

http://www.fema.gov/fema/csb.shtm - National Flood Insurance Program Community Status Book.

http://store.msc.fema.gov/ - Internet site for ordering NFIP maps.

http://www.access.gpo.gov/nara/cfr/waisidx_02/44cfrv1_02.html - NFIP regulations.

Amendment/Revision Forms and Information:

http://www.fema.gov/fhm/dl_mt-ez.shtm - MT-EZ form package, *Amendments to National Flood Insurance Program Maps, Application Form for Single Residential Lot or Structure.*

http://www.fema.gov/fhm/dl_mt-1.shtm - MT-1 form package, *Revisions to National Flood Insurance Program Maps, Application Forms for Conditional and Final Letters of Map Amendment and Letters of Map Revision Based on Fill.*

http://www.fema.gov/fhm/dl_mt-2.shtm - MT-2 form package, *Revisions to National Flood Insurance Program Maps, Application Forms and Instructions for Conditional Letters of Map Revision and Letters of Map Revision.*

http://www.fema.gov/fhm/frm_fees.shtm - Fee schedule for review and processing of CLOMR and LOMR requests.

http://www.fema.gov/fhm/st_order.shtm - Internet site for ordering backup information for an existing Flood Insurance Study.

Documents, Guidelines and Manuals:

http://www.fema.gov/pdf/fima/tb1001.pdf - FEMA's Technical Bulletin 10-01, "Ensuring That Structures Built on Fill In or Near Special Flood Hazard Areas Are Reasonably Safe from Flooding."

http://www.fema.gov/fhm/dl_zonea.shtm - FEMA's manual, "Managing Floodplain Development in Approximate Zone A Areas, A Guide for obtaining and developing Base (100-year) Flood Elevations."

http://www.fema.gov/fhm/dl_cgs.shtm - FEMA's *Consolidated Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping.*

http://www.fema.gov/fhm/dl_cgs.shtm - FEMA's *Consolidated Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix D: Guidance for Coastal Flooding Analyses and Mapping.*

http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-1913/toc.htm - USACE manual "Design and Construction of Levees," EM 1110-2-1913.

http://www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-2-555/toc.html - USACE technical letter "Design Guidance for Levees," ETL 1110-2-555.

http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-2102/toc.htm - USACE manual "Waterstops and Other Preformed Joint Materials for Civil Works Structures," EM 1110-2-2102.

http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-301/toc.htm - USACE manual "Landscape Planting and Vegetation Management for Floodwalls, Levees and Embankment Dams," EM 1110-2-301.

Software:

http://www.fema.gov/fhm/en_modl.shtm - List of numerical models accepted by FEMA for the NFIP usage.

http://www.fema.gov/fhm/frm_soft.shtm - Engineering software developed by FEMA. The site also includes additional information, such as tutorials, user's manuals and guidance documentation for certain programs.

Federal Agencies:

http://www.epa.gov/ - Environmental Protection Agency

http://www.nasa.gov/ - National Aeronautics and Space Administration (NASA)

http://www.noaa.gov/ - National Oceanic and Atmospheric Administration (NOAA)

http://www.nws.noaa.gov/ - National Weather Service (NWS)

http://www.nrcs.usda.gov/ - Natural Resources Conservation Service (NRCS)

http://www.usace.army.mil/ - U.S. Army Corps of Engineers (USACE)

http://www.hec.usace.army.mil/ - USACE Hydrologic Engineering Center (HEC)

http://www.usda.gov/ - U.S. Department of Agriculture (USDA)

http://www.fws.gov/index.html - U.S. Fish & Wildlife Service

APPENDIX C - FEMA OFFICES

REGION I

(Connecticut, Maine, Massachusetts,
New Hampshire, Rhode Island, Vermont)

FEMA, Federal Insurance and Mitigation Division
J. W. McCormack Post Office and
Courthouse Building, Room 442
Boston, Massachusetts 02109-4595
(617) 223-9540

REGION II

(New York, Puerto Rico, New Jersey)

FEMA, Federal Insurance and Mitigation Division
26 Federal Plaza, Room 1351
New York, New York 10278-0001
(212) 667-8900

REGION III

(Delaware, D.C., Maryland,
Pennsylvania, Virginia, West Virginia)

FEMA, Federal Insurance and Mitigation Division
One Independence Mall, Sixth Floor
615 Chestnut Street
Philadelphia, Pennsylvania 19106-4404
(215) 931-5506

REGION IV

(Alabama, Florida, Georgia, Kentucky,
Mississippi, N. Carolina, S. Carolina, Tenn.)

FEMA, Federal Insurance and Mitigation Division
Koger Center - Rutgers Building
3003 Chamblee Tucker Road
Atlanta, Georgia 30341-4112
(770) 220-5400

REGION V

(Illinois, Indiana, Michigan
Minnesota, Ohio, Wisconsin)

FEMA, Federal Insurance and Mitigation Division
536 South Clark Street, Sixth Floor
Chicago, Illinois 60605-1509
(312) 408 5548

REGION VI

(Arkansas, Louisiana, New Mexico, Oklahoma, Texas)

FEMA, Federal Insurance and Mitigation Division
Federal Regional Center
800 North Loop 288
Denton, Texas 76209-3606
(940) 898-5165

REGION VII

(Iowa, Kansas, Missouri, Nebraska)

FEMA, Federal Insurance and Mitigation Division
2323 Grand Boulevard, Suite 900
Kansas City, Missouri 64108-2670
(816) 283-7062

REGION VIII

(Colorado, Montana, N. Dakota, S. Dakota, Utah,
Wyoming)

FEMA, Federal Insurance and Mitigation Division
Denver Federal Center
Building 710, Box 25267
Denver, Colorado 80225-0267
(303) 235-4800

REGION IX

(Arizona, California, Hawaii, Nevada)

FEMA, Federal Insurance and Mitigation Division
1111 Broadway, Suite 1200
Oakland, California 94607-4036
(510) 627-7100

REGION X

(Alaska, Idaho, Oregon, Washington)

FEMA, Federal Insurance and Mitigation Division
Federal Regional Center
130 228th Street, S.W.
Bothell, Washington, 98021-9796
(206) 487-4600

HEADQUARTERS

Federal Emergency Management Agency
Federal Insurance and Mitigation Administration
Hazards Studies Branch
500 C Street, SW
Washington, DC 20472
1-877-FEMA MAP (1-877-336-2627)

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☐ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See Parts 60 & 65 of the NFIP Regulations.)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301	City of Katy	TX	480301	0005D	02/08/83
480287	Harris County	TX	48201C	0220G	09/28/90

2. Flooding Source:

3. Project Name/Identifier:

4. FEMA zone designations affected: (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

☐ Physical Change ☐ Improved Methodology/Data

☐ Regulatory Floodway Revision ☐ Other (Attach Description)

Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following types of flooding and structures (check all that apply)

Types of Flooding:	☐ Riverine	☐ Coastal	☐ Shallow Flooding (e.g., Zones AO and AH)
	☐ Alluvial fan	☐ Lakes	☐ Other (Attach Description)
Structures:	☐ Channelization	☐ Levee/Floodwall	☐ Bridge/Culvert
	☐ Dam	☐ Fill	☐ Other, Attach Description

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☐ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name:	Company:	
Mailing Address:	Daytime Telephone No.:	Fax No.:
	E-Mail Address:	
Signature of Requester (required):		Date:

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title:		Telephone No.:
Community Name:	Community Official's Signature (required):	Date:

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name:	License No.:	Expiration Date:
Company Name:	Telephone No.:	Fax No.:
Signature:		Date:

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if …
☐ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☐ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source:
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section 2) ☐ No existing analysis ☐ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model [TR-20, HEC-1, HEC-HMS etc.]
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis. The document, "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by DHS-FEMA. This document can be found at: http://www.fema.gov/fhm/en_modl.shtm.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☐ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Water-Surface Elevations (ft.) Proposed/Revised
Downstream Limit				
Upstream Limit				

2. Hydraulic Method Used

Hydraulic Analysis [HEC-2 , HEC-RAS, Other (Attach description)]

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. These tools do not replace engineering judgment. CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with a message, please attach an explanation of why the message is not valid in this case. Review of your submittal and resolution of valid modeling discrepancies will result in reduced review time.

HEC-2/HEC-RAS models reviewed with CHECK-2/CHECK-RAS? ☐ Yes ☐ No

4. Models Submitted ☐ Diskette Submitted

	Natural Run		Floodway Run		Datum
Duplicate Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	_____
Corrected Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	_____
Existing or Pre-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	_____
Revised or Post-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	_____
Other - (attach description)	File Name:	Plan Name:	File Name:	Plan Name:	_____

*Not required for revisions to approximate 1%-annual-chance floodplains (Zone A) – for details, refer to the corresponding section of the instructions.

The document "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by DHS-FEMA. This document can be found at: http://www.fema.gov/fhm/en_modl.shtm.

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

☐ Annotated FIRM and/or FBFM Included ☐ Digital Mapping (GIS/CADD) Data Submitted (Recommended)

D. COMMON REGULATORY REQUIREMENTS*

1. For CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☐ No

For CLOMR requests, if either of the following is true, please submit evidence of compliance with Section 65.12 of the NFIP regulations:
- The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
- The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☐ No

If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR/CLOMR requests, is the regulatory floodway being revised? ☐ Yes ☐ No

If Yes, attach evidence of regulatory floodway revision notification. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☐ No

If Yes, please submit documentation from the community to show that they have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA.

5. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☐ No

If Yes, please attach proof of property owner notification and acceptance (if available). Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

*** Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.**

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source:
Note: Fill out one form for each flooding source studied

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization ..... complete Section B
Bridge/Culvert ..... complete Section C
Dam..... complete Section D
Levee/Floodwall ..... complete Section E
Sediment Transport..... complete Section F (if required)

Description Of Structure

1. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

2. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

3. Name of Structure:

Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

NOTE: For more structures, attach additional pages as needed.

B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transitions in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
☐ Other locations (specify):

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source:

Name of Structure:

1. This revision reflects (check one):

- ☐ New bridge/culvert not modeled in the FIS
- ☐ Modified bridge/culvert previously modeled in the FIS
- ☐ New analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8):
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

- ☐ Dimensions (height, width, span, radius, length)
- ☐ Shape (culverts only)
- ☐ Material
- ☐ Beveling or Rounding
- ☐ Wing Wall Angle
- ☐ Skew Angle
- ☐ Distances Between Cross Sections
- ☐ Erosion Protection
- ☐ Low Chord Elevations – Upstream and Downstream
- ☐ Top of Road Elevations – Upstream and Downstream
- ☐ Structure Invert Elevations – Upstream and Downstream
- ☐ Stream Invert Elevations – Upstream and Downstream
- ☐ Cross-Section Locations

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

D. DAM

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam

2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency ☐ Private organization

   Name of the agency or organization:

3. The Dam was permitted as (check one) ☐ Federal Dam ☐ State Dam ☐ Local Government Dam ☐ None

   Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

   Permit or ID number _____ Permitting Agency or Organization _____

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.

6. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

Stillwater Elevation Behind the Dam

FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)		
50-year (2%)		
100-year (1%)		
500-year (0.2%)		
Normal Pool Elevation		

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

☐ upgrading of an existing levee/floodwall system
☐ a newly constructed levee/floodwall system
☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc.	Station	to
☐ structural floodwall	Station	to
☐ Other (describe):	Station	to

c. Structural Type (check one):

☐ monolithic cast-in place reinforced concrete
☐ reinforced concrete masonry block
☐ sheet piling
☐ Other (describe):

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency?

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers:
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers:
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers:
4. A layout detail for the embankment protection measures. Sheet Numbers:
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers:

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

E. LEVEE/FLOODWALL (CONTINUED)

2. Freeboard (continued)

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope landside is:

b. The maximum levee slope floodside is:

c. The range of velocities along the levee during the base flood is: (min.) to (max.)

d. Embankment material is protected by (describe what kind):

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

E. LEVEE/FLOODWALL (CONTINUED)

4. Embankment Protection (continued)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength ϕ = degrees, c = psf

slope: SS = (h) to (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

c. Summary of stability analysis results.

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is hours.

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ P_A = psf; P_p = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ P_w = psf

☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = %g

☐ 1%-annual-chance significant wave height: ft.

☐ 1%-annual-chance significant wave period: sec.

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)

(Note: Extend table on an added sheet as needed and reference)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is ft. to ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: acres
Draining to ponding area: acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

f. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No

If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is cfs

h. The length of levee system used to drive this seepage rate in item g: ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants:
For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No

Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No

If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No
If No, please attach supporting documentation.

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

F. SEDIMENT TRANSPORT

Flooding Source:

Name of Structure:

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume acre-feet

Debris load associated with the base flood discharge: Volume acre-feet

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport:

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition:

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

COASTAL ANALYSIS FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK REDUCTION ACT

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Flooding Source:
Note: Fill out one form for each flooding source studied

A. COASTLINE TO BE REVISED

Describe limits of study area:

B. EFFECTIVE FIS

The area being revised in the effective FIS was studied by detailed methods using (check all that apply):

- ☐ Storm surge modeling
- ☐ Wave height computations
- ☐ Wave overtopping computations
- ☐ Primary Frontal Dune Assessment
- ☐ Wave setup computations
- ☐ Wave runup computations
- ☐ Dune erosion computations
- ☐ N/A (area not studied by detailed methods)

C. REVISED ANALYSIS

1. Number of transects in revised analysis:

2. Information used to prepare the revision (check all that apply):

- ☐ Wave setup analyses (complete Items 3, 4, and 5 below)
- ☐ Stillwater elevation determinations (complete Item 3)
- ☐ Erosion considerations (complete Item 4)
- ☐ Wave runup analysis (complete Items 4 and 5)
- ☐ Wave height analysis (complete Items 4 and 5)
- ☐ Wave overtopping assessment (complete Items 4 and 5)
- ☐ More detailed topographic information (complete Section E)
- ☐ Shore protection structures (attach completed Coastal Structures Form - Form 5)
- ☐ Primary frontal dune assessment (complete Item 5)
- ☐ Other, attach basis of revision request with explanation

3. Stillwater Elevation Determination

a. How were stillwater elevations determined?
- ☐ Gage analysis (If revised gage analysis was used, provide copies of gage data and revised analysis.)
- ☐ Storm surge analysis
- ☐ Other (Describe):

b. Specify what datum was used in the calculations:

If not the FIS datum, have the calculations been adjusted to the FIS datum? ☐ Yes ☐ No Conversion factor:

c. If revised storm surge analysis, was FEMA's storm surge model utilized? ☐ Yes ☐ No

d. If FEMA's storm surge model was used, attach a detailed description of the differences between the current and the revised analyses, and why the revised analysis should replace the current analysis.

e. If wave setup was computed, attach a description of methodology used.
Amount of wave setup added to stillwater elevation: feet

C. REVISED ANALYSIS (CONTINUED)

4. Revised Analysis (i.e., erosion, wave height, wave runup, primary frontal dune, and wave overtopping)

If FEMA procedures were utilized to perform the revision, attach a detailed description of differences between the current and the revised analyses, and why the revised analysis should replace the current analysis.

If FEMA procedures were not utilized to perform the revision, provide full documentation on methodology and/or models used; including operational program, detailed differences between methodology and/or models utilized and FEMA's methodology and/or models. Also, attach an explanation of why new methodology and/or models should replace current methodology and/or models.

If revision reflects more detailed topographic information and fill has been/will be placed in a V Zone, and is not protected from erosion by a shore protection structure, provide a detailed description of how the fill has been treated in the revised analysis.

5. Wave Runup, Wave Height, And Wave Overtopping Analysis

Wave height analyses along a transect are greatly affected by starting wave conditions that propagate inland. Wave runup and overtopping analyses are typically considered when wave heights and/or wave runup are close to or greater than the crest of shore protection structures or natural land forms.

a. Was an analysis performed to determine starting wave height and period for input into WHAFIS?
☐ Yes ☐ No

If Yes, attach an explanation of the method utilized. If No, explain why these analyses were not performed.

b. Was wave setup included in wave height analysis and removed for erosion and wave runup analyses?
☐ Yes ☐ No

c. Was an overtopping analysis performed for any coastal shore protection structures or natural land forms that may be overtopped?
☐ Yes ☐ No

If Yes, attach an explanation of the methodology utilized and describe in detail the results of the analysis.

If overtopping was not analyzed, attach an explanation for why these analyses were not performed.

D. RESULTS

1. Stillwater storm surge elevation: feet Datum
2. Wave setup: feet
3. Starting deep-water significant wave condition:
   height: period:
4. Maximum wave height elevation: feet
5. Maximum wave runup elevation: feet
6. Estimated amount of maximum overtopping: cfs/feet
7. The areas designated as coastal high hazard areas (V Zones) have:
   ☐ increased ☐ decreased ☐ both

Attach a description where they have increased and/or decreased.

8. As a result of the revised analyses, the V Zone location has shifted a maximum of feet seaward and feet landward of its existing position.
9. The Base Flood Elevations have:
   ☐ increased ☐ decreased
   a. What was the greatest increase? feet
   b. What was the greatest decrease? feet
10. The special flood hazard area has:
    ☐ increased ☐ decreased ☐ both

Attach a description where it has increased or decreased.

E. MAPPING REQUIREMENTS

A certified topographic map must be submitted showing the following information (where applicable): effective, existing conditions, and proposed conditions 1%-annual-chance floodplain boundaries, revised shoreline due to either erosion or accretion, location and alignment of all transects, correct location and alignment of any structures, current community easements and boundaries, boundary of the requester's property, certification of a professional engineer registered in the subject State, location and description of reference marks, and the referenced vertical datum (NGVD, NAVD, etc.).

Note that the existing or proposed conditions floodplain boundaries to be shown on the revised FIRM must tie-in with the effective floodplain boundaries. Please attach a copy of the current FIRM annotated to show the revised 1%-annual-chance floodplain boundaries that tie-in with effective 1%-annual-chance floodplain boundaries along the entire extent of the area of revision.

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

COASTAL STRUCTURES FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source:
Note: Fill out one form for each flooding source studied

A. BACKGROUND

1. Name of structure (if applicable):

2. Structure location:

3. Type of structure (check one):

☐ Levee/Floodwall* ☐ Anchored Bulkhead ☐ Revetment ☐ Gravity Seawall

☐ Breakwater ☐ Pile supported seawall ☐ Other:

***Note:** If the coastal structure is a levee/floodwall, complete Section E of Form 3 (Riverine Structures Form). The remainder of this form does not need to be completed.

4. Material structure is composed of (check all that apply):

☐ Stone ☐ Earthen fill ☐ Concrete ☐ Steel

☐ Sand ☐ Other

5. The structure is (check one):

☐ New or proposed ☐ Existing ☐ Modification of existing structure

☐ Replacement structure of the same size and design as what was previously at the site

Describe in detail the existing structure and/or modifications being made to the structure and the purpose of the modifications:

If existing, please include date of construction:

6. Copies of certified "as-built" plans ☐ are ☐ are not attached. Attach all design analyses that apply.

If "as-built" plans are not available for submittal, please explain why and attach a sketch with general structure dimensions including: face slope, height, length, depth, and toe elevation referenced to the appropriate datum (e.g. NGVD 1929, NAVD 1988, etc.).

7. Has a Federal agency with responsibility for the design of coastal flood protection structures designed or certified that the structures have been adequately designed and constructed to provide protection against the 1%-annual-chance event?

☐ Yes ☐ No

If Yes, specify the name of the agency and dates of project completion and certification.

If Yes, then no other sections of this form need to be completed.

B. DESIGN CRITERIA

1. Design Parameters

   a. Were physical parameters representing the 1%-annual-chance event or greater used to design the coastal flood protection structure?

   ☐ Yes ☐ No

   b. The number of design water levels that were evaluated (number) range from the mean low water elevation of feet to the 1%-annual-chance stillwater surge elevation of feet. The critical water level is feet. The datum that these elevations are referenced to is (e.g.: NGVD 1929, NAVD 1988, etc.).

   Attach an explanation specifying which water levels and associated wave heights and periods were analyzed.

   c. Were breaking wave forces used to design the structure?

   ☐ Yes ☐ No If No, attach an explanation why they were not used for design.

2. Settlement

   a. What is the expected settlement rate at the site of the structure?

   Please attach a settlement analysis.

3. Freeboard

   a. Does the structure have 1 foot of freeboard above the height of the 1%-annual-chance wave-height elevation or maximum wave runup (whichever is greater)?

   ☐ Yes ☐ No

   b. Does the structure have freeboard of at least 2 feet above the 1% annual chance stillwater surge elevation?

   ☐ Yes ☐ No

4. Toe Protection

   Specify the type of toe protection:

   If no toe protection is provided, provide analysis of scour potential and attach an evaluation of structural stability performed with potential scour at the toe.

5. Backfill Protection

   Will the structure be overtopped during the 1%-annual-chance event? ☐ Yes ☐ No

   If the structure will be overtopped, attach an explanation of what measures are used to prevent the loss of backfill from rundown over the structure, drainage landward, under or laterally around the ends of the structure, or through seams and drainage openings in the structure.

6. Structural Stability - Minimum Water Level

   a. For coastal revetments, was a geotechnical analysis of potential failure in the landward direction by rotational gravity slip performed for maximum loads associated with minimum seaward water level, no wave action, saturated soil conditions behind the structure, and maximum toe scour?

   ☐ Yes ☐ No

   b. For gravity and pile-supported seawalls, were engineering analyses of landward sliding, landward overturning, and of foundation adequacy using maximum pressures developed in the sliding and overturning calculations performed?

   ☐ Yes ☐ No

   c. For anchored bulkheads, were engineering analyses performed for shear failure, moment failure, and adequacy of tiebacks and deadmen to resist loading under low-water conditions?

   ☐ Yes ☐ No

B. DESIGN CRITERIA (CONTINUED)

7. Structural Stability - Critical Water Level (Note: All structures must be designed to resist the maximum loads associated with the critical water level to be credited as providing protection from the 1% annual chance event.)

a. For coastal revetments were geotechnical analyses performed investigating the potential failure in the seaward direction by rotational gravity slip or foundation failure due to inadequate bearing strength?

☐ Yes ☐ No

b. For revetments, were engineering analyses of rock, riprap, or armor blocks' stability under wave action or uplift forces on the rock, riprap, or armor blocks performed?

☐ Yes ☐ No

c. Are the rocks graded?

☐ Yes ☐ No

d. Are soil or geotextile filters being used in the design?

☐ Yes ☐ No

e. For gravity and pile supported seawalls, were engineering analyses of landward sliding, landward overturning, and foundation adequacy performed?

☐ Yes ☐ No

f. For anchored bulkheads, were engineering analyses of shear and moment failure performed using "shock" pressures?

☐ Yes ☐ No

For all analyses marked "No" above for the appropriate type of structure, please attach an explanation why the analyses were not performed.

8. Material Adequacy

The design life of the structure given the existing conditions at the structure site is years.

9. Ice and Impact Alignment

a. Will the structure be subjected to ice forces?

☐ Yes ☐ No

If Yes, attach impact analysis and design details for such forces.

b. Will the structure be subjected to impact forces from boats, ships, or large debris?

☐ Yes ☐ No

If Yes, attach impact analysis.

10. Structure Plan Alignment

The structure is (check one):

☐ Isolated ☐ Part of a continuous structure with redundant return walls at frequent intervals.

Please provide a map showing the location of the structure and any natural land features that shelter the structure from wave actions.

C. ADVERSE IMPACT EVALUATION

If the structure is new, proposed, or modified, will the structure impact flooding and erosion for areas adjacent to the structure?

☐ Yes ☐ No

If Yes, attach an explanation.

D. COMMUNITY AND/OR STATE REVIEW

Has the design, maintenance, and impact of the structure been reviewed and approved by the community, and any Federal, State, or local agencies having jurisdiction over flood control and coastal construction activities in the area the structure impacts?

☐ Yes ☐ No

If Yes, attach a list of agencies who have reviewed and approved the project.

If No, attach an explanation why review and approval by the appropriate community or agency has not been obtained.

E. CERTIFICATION

As a Professional Engineer, I certify that the above structures will withstand all hydraulic and wave forces associated with the 1% annual chance flood without significant structural degradation. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name:

License No.: Exp. Date:

Company Name:

Telephone No.: Fax. No.:

Signature: _____ Date:

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

ALLUVIAL FAN FLOODING FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK REDUCTION ACT

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Flooding Source:
Note: Fill out one form for each flooding source studied

A. THREE-STAGE ANALYSIS (Based on FEMA Guidelines dated February 23, 2000)

1. Stage 1 Analysis

   a. The landform is composed of (check one) ☐ alluvial ☐ debris flow deposits.

   b. Source of data used to determine composition, morphology, and location of the landform:

   c. Is there an NRCS soils survey and soil survey map available? ☐ Yes ☐ No
   If Yes, please include a copy of the map and any pertinent sections of the soil survey

2. Stage 2 Analysis

   a. The alluvial fan exhibits ☐ active ☐ inactive ☐ a combination of active and inactive alluvial fan flooding.

   b. Approximate age of inactive fan surfaces (thousands of years): yrs.

   c. Is there an opportunity for avulsions that could lead channels or sheetfloods across the older fan surfaces?
   ☐ Yes ☐ No

   d. Is there evidence of headcutting that could lead to stream piracy? ☐ Yes ☐ No

   e. Is there geomorphic evidence of past avulsions during the Holocene epoch? ☐ Yes ☐ No

   f. The fan exhibits the following types of flooding (check one):

   ☐ Flooding along stable channels
   ☐ Sheetflow
   ☐ Debris flow
   ☐ Unstable flow path flooding

3. Stage 3 Analysis

   The boundaries of the 1%-annual-chance floodplain have been determined using (check one):

   ☐ Risk-Based Analysis
   ☐ FEMA FAN program (if discharge at the apex is different than that given in the effective FIS, then attach MT-2, Form 2 along with a plot of the flood frequency curve on log-normal probability paper and include the drainage area above the hydrographic apex, and the mean, standard deviation, and skew coefficient of the curve)
   ☐ Sheetflow Methods
   ☐ Hydraulic Analytical Methods
   ☐ Geomorphic Data, Post-Flood Hazard Verification, and Historical Information
   ☐ Composite Methods

B. STRUCTURAL FLOOD CONTROL MEASURES

1. The following structural flood control measures are proposed or built (check one):

   ☐ Channelization ☐ Levee/Floodwall ☐ Dam ☐ Sedimentation Basin

2. Do the constructed or proposed structural measures affect flood hazards (including velocity, scour, and sediment deposition) on other areas of the fan? ☐ Yes ☐ No

3. Attach completed Form 3 (Riverine Structures Form).

4. Sediment Transport Considerations:
   Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Form 3, Section F (Sediment Transport).
   If No, then attach your explanation for why sediment transport was not considered.

5. Please attach a copy of the formal Operations and Maintenance Plan.

C. MAPPING REQUIREMENTS

Attach a certified topographic work map showing the following:

- The boundaries of the alluvial fan including: toe, topographic and hydrologic apexes, and lateral boundaries
- The delineation of the active and inactive portions of the fan as determined by the Stage 2 analysis
- The revised 1%-annual-chance floodplain boundaries, as determined by the Stage 3 Analysis, that tie into the effective floodplain boundaries
- The correct alignment of all structural features
- The map scale