MEMORANDUM

To: Matt Fredrick, West Windsor Selectboard Chair
From: Jordan Duffy, PE; Evan P. Fitzgerald, CPESC, CFM
Re: West Windsor Fire Station Flood Mitigation Study – Alternatives Analysis Memo
Date: February 14, 2025

Background

Fitzgerald Environmental Associates (FEA) was retained by the Town of West Windsor (Town) to conduct a hydraulic alternatives analysis of potential flood mitigation work along the Mill Brook in Brownsville, in relation to flooding of the West Windsor Fire Station. FEA conducted a topographic survey of the brook and surrounding floodplain on April 25, 2024, and developed an existing conditions hydraulic model to assess flooding conditions. Using available data and input from the Town, FEA developed a preliminary list of alternatives and created supporting hydraulic models to assess the effectiveness of the selected alternatives on flood risk mitigation.

Hydrology

FEA analyzed the contributing hydrology of Mill Brook near the Fire Station by breaking out the drainages into two separate areas, one for the Mill Brook main stem, and one for the Beaver Brook tributary, which enters the Mill Brook directly upstream of the study area. The drainage areas were developed using the USGS StreamStats program which uses a coarse digital terrain model. The drainage areas were subsequently reviewed by FEA based on the 2013 0.7-meter LiDAR digital elevation model (DEM) from the Vermont Center for Geographic Information (VCGI). Mill brook, entering from the west, has a drainage area of 28.4 square miles, and the Beaver Brook tributary, entering from the north, has a drainage area of 6. 4 square miles. See Figure 1 below.

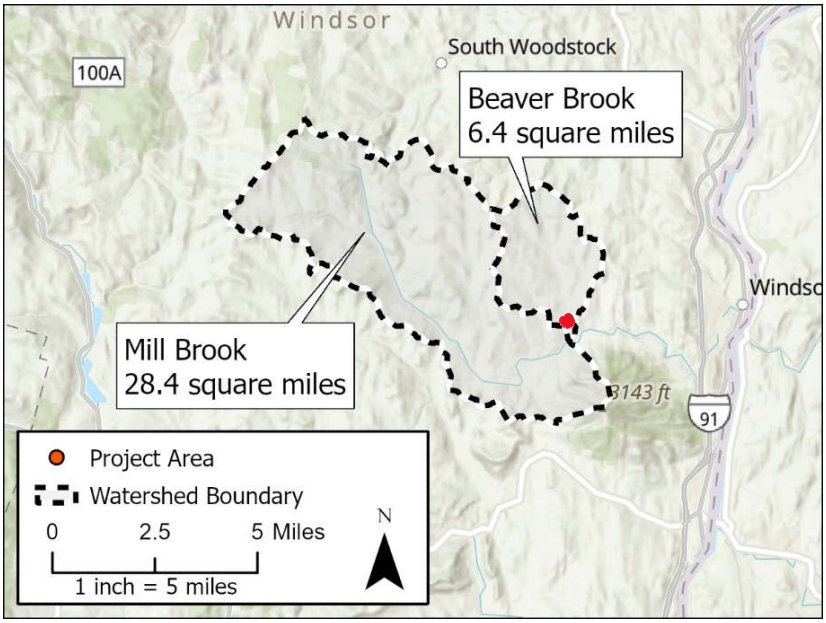

Figure 1: Subwatersheds of the Mill Brook and Beaver Brook.

FEA evaluated the watershed hydrology for estimated discharge flows using regional regression equations for Vermont (USGS) (Olson, 2014), and steep watersheds in New England from the New England Transportation Consortium (NETC) (Jacobs, 2010). Stream flow estimates vary depending on the method used. The NETC results were most applicable, yielded area normalized flood discharges similar to those expected for a headwater stream of this size in the northeast based on FEA's experience, and also produced the most conservative flood estimates. In addition, FEMA flows, sourced from the Windsor County Flood Insurance Study (FIS), were used where data was available (FEMA, 2007). See the table below for summary of hydrology used in the hydraulic analysis.

Table 1: Full list of modeled discharge estimates in cubic feet per second (cfs). All flows calculated using the NETC method, except where noted. Where noted (*) FEMA flows were extracted from FIS report.

Recurrence Interval	2-year	5-year	10-year	25-year	100-year	500-year
Beaver Brook	266	426	570	768	1088	1622
Mill Brook	1013	1623	2180	2945	4550*	6318

Hydraulics

HEC-RAS software version 6.6 (USACE, 2024) was used to create a two-dimensional, unsteady flow river and floodplain hydraulics model of the project area. Topographic survey data collected by FEA on April 25, 2024 was processed in AutoCAD Civil 3D 2025 to develop a surface that was modified to a DEM for use in HEC-RAS. The survey data was supplemented with VCGI LiDAR data (2013). The model was created to assess the existing conditions of the hydraulics in the project area to inform flood mitigation alternatives that would reduce flooding at the Windsor Fire Station. In addition, the existing pedestrian bridge across Mill Brook was considered, as it currently constricts the river, further contributing to the flooding potential of the Mill Brook. The bridge is also in poor condition. The alternatives listed below involve flood mitigation and bridge replacement.

Preliminary Alternatives

FEA developed a list of five alternatives to be further analyzed. The alternatives are generally focused around the confluence of Beaver Brook and Mill Brook. The alternatives consist of varying levels of intervention including channel manipulation, floodplain lowering, and relocating the existing pedestrian bridge. The five proposed alternatives are summarized below and also depicted in the Alternatives Analysis Plan in Attachment 1.

Alternative 1: Removal of southern bridge abutment

- Removal of the existing southern bridge abutment and corresponding channel constriction.
- Installation of new 70' span pedestrian bridge on an elevated southern abutment with a boardwalk and piers down to existing grade.

Alternative 2: Removal of southern bridge abutment; floodplain lowering in south field

- Removal of the existing southern bridge abutment and corresponding channel constriction.
- Lowering of floodplain field south of Mill Brook (maximum cut of ~2 feet)
- Installation of new 70' span pedestrian bridge on an elevated southern abutment with a boardwalk and piers down to proposed floodplain grade.

Alternative 3: Removal of southern bridge abutment; floodplain lowering in south field and forest

- Removal of the existing southern bridge abutment and corresponding channel constriction.
- Lowering of floodplain field south of Mill Brook (maximum cut of ~3 feet)
- Lowering of forested floodplain downstream of field (maximum cut of 2 feet)
- Installation of new 70' span pedestrian bridge on an elevated southern abutment with a boardwalk and piers down to proposed floodplain grade.

Alternative 4: Removal of southern and northern bridge abutment; floodplain lowering in south field and north west bank

- Removal of the existing southern bridge abutment and corresponding channel constriction.
- Lowering of floodplain field south of Mill Brook (maximum cut of ~2 feet)
- Lowering of northern abutment and adjacent northern bank
- Installation of new 70' span pedestrian bridge on elevated southern and northern abutments with a boardwalk and piers down to proposed floodplain grade.

Alternative 5: Removal of southern and northern bridge abutment; floodplain lowering in north west bank

- Removal of the existing southern bridge abutment and corresponding channel constriction.
- Lowering of northern abutment and adjacent northern bank
- Installation of new 70' span pedestrian bridge on elevated southern and northern abutments with a boardwalk and piers down to proposed grade.

Additional alternatives were initially analyzed, including the removal of the upstream stormwater pond, and potential buyouts. These alternatives were deemed unfeasible or not effective, and results were not included in this report.

Alternatives Results

FEA ran a hydraulic model for all the alternatives described above. The focus of the hydraulic modeling results was to decrease the flooding potential at the Fire Station, while still providing pedestrian access over Mill Brook. Under existing conditions, the flood waters at the confluence of Beaver Brook and Mill Brook contribute to flooding at the Fire Station. As floodwaters from Beaver Brook move south to the confluence of Mill Brook, high velocities and water elevations in Mill Brook prevent the flow from entering the main channel of Mill Brook and push waters to move east over the floodplain on the neighboring property (Smith Property), ultimately directing waters towards the Fire Station in an easterly direction.

The depth of water immediately upstream of the fire station during the 100 and 500-year storm events was used as a means of estimating the flooding risk and the flood mitigation potential of each alternative. The decrease in water depth for each alternative compared to existing conditions is summarized in the

Project Alternatives Matrix, found in Attachment 2. In addition, relative costs for each alternative are summarized in the Alternatives Matrix. This cost accounts for the approximate volume of materials to be removed (floodplain lowering) and restored, as well as the cost of the proposed bridge and associated boardwalk approaches (which will be included in all of the alternatives). Graphical results of the hydraulic model simulations are shown in Attachment 3, comparing each alternative to the existing conditions model results.

For each alternative analyzed, the proposed 70' pedestrian bridge was positioned in the location of the current bridge. An additional location for the pedestrian bridge was identified just downstream of the current location (directly downstream of the second in-stream grade control weir). The change in the proposed bridge location has a minimal effect on flooding potential. As a flood mitigation alternative is chosen, FEA will work with the Town, as well as DeWolfe Engineering Associates (Structural Engineer) to choose the proposed bridge location based on ideal access, property impacts, floodwaters / velocity, and proposed grading. Included on sheet 4 of Attachment 1 is a typical 70-foot pedestrian bridge plan, provided by Bedford reinforced plastics. This is the preliminarily scoped pedestrian bridge, made of reinforced plastic material, placed on cast in place concrete abutments. This is a cost-effective option for this size and scale of pedestrian bridge alternatives.

Recommendations and Next Steps

Based on the hydraulic analysis and summary table results above, FEA recommends that Alternative 4 move forward to preliminary design. This alternative decreases the water surface elevation upstream of the fire station by 0.43 feet during the 500-year flood event, providing the maximum flood resiliency analyzed. This alternative would need agreement from the Town, the landowner directly to the west (Smith property), and the hotel property owner (Orange Lakes).

Next steps include a meeting with all effected property owners to review the alternatives assessed, and discuss the feasibility and priority of each alternative. In addition, the location of the bridge will be discussed with the effected property owners prior to moving into preliminary design. Once an alternative is chosen, FEA will move the selected alternative into a preliminary design phase, and provide a preliminary cost estimate for the construction of the project.

Attachments

- Attachment 1 – Alternatives Analysis Plan
- Attachment 2 – Alternatives Matrix
- Attachment 3 – Hydraulic Model Simulations

References

FEMA (Federal Emergency Management Agency), 2007. Flood Insurance Study 50027CV001A, Windsor County, Vermont. Available at: https://msc.fema.gov/portal/home

Olson, S. A., 2014, Estimation of Flood Discharges at Selected Annual Exceedance Probabilities for Unregulated, Rural Streams in Vermont, United States Geologic Survey, USGS Scientific Investigations Report 2014-5078.

Jacobs, J., 2010. Estimating the Magnitude of Peak Flows for Steep Gradient Streams in New England. New England Transportation Consortium Report NETC81, Project No. NETC 04-3. New England Transportation Consortium in cooperation with the Federal Highway Administration, Burlington, VT.

USACE (US Army Corps of Engineers), 2024. HEC-RAS River Analysis System, Version 6.6. Available at: https://www.hec.usace.army.mil/software/hec-ras/download.aspx

Attachment 1

Alternatives Analysis Plan

Fitzgerald
Environmental

LEGEND

EXISTING

- BUILDINGS/STRUCTURES
- PAVED SURFACE
- GRAVEL SURFACE
- TREELINE
- TOP OF BANK
- EDGE OF WATER
- STREAM CENTERLINE
- STORMWATER PIPE
- PARCEL BOUNDARY
- 5-FOOT CONTOURS
- 1-FOOT CONTOURS

HYDROLOGY SUMMARY:

- DRAINAGE AREA = 34.8 SQUARE MILES
- APPROXIMATE BANKFULL WIDTH (BASED ON REGRESSION) = 62.5'
- APPROXIMATE BANKFULL DEPTH (BASED ON REGRESSION) = 2.8'

NOTES:

- CONTOURS BASED ON 0.7M LIDAR DEM.
- LIDAR TOPOGRAPHY WAS VERIFIED AND SUPPLEMENTED BY FEA FIELD SURVEY WITH TOTAL STATION AND TRIMBLE CM GPS ON 4/25/2024.
- GEOGRAPHIC DATA AND PLANS ARE REFERENCED TO THE VERMONT STATE PLANE IN US SURVEY FEET (NAD83). ELEVATIONS ARE BASED ON NAVD88.
- THIS PLAN IS NOT A BOUNDARY SURVEY AND SHALL NOT BE USED OR CONSTRUED FOR SUCH PURPOSES.

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SIGNATURE

REVISIONS

#	DESCRIPTION	DATE

20 0 10 20

1" = 20'

N

CONCEPTUAL PLANS

SITE PLAN - EXISTING CONDITIONS

WEST WINDSOR FIRE DEPARTMENT
FLOOD RESILIENCY STUDY

889 VT-44
WEST WINDSOR, VT

NOT FOR CONSTRUCTION

DRAWN	CHECKED
AEM	JMD

SCALE	1" = 20'
DATE	2025-02-14
PROJECT NO.	24009
SHEET NO.	1 OF 3
SHEET NAME	EX-1

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ALTERNATIVES SUMMARY		
ALTERNATIVE 1		REMOVAL OF SOUTH BRIDGE ABUTMENT
ALTERNATIVE 2		REMOVAL OF SOUTHERN BRIDGE ABUTMENT; FLOODPLAIN LOWERING IN SOUTH FIELD
ALTERNATIVE 3		REMOVAL OF SOUTHERN ABUTMENT; FLOODPLAIN LOWERING IN SOUTH FIELD AND FOREST
ALTERNATIVE 4		REMOVAL OF SOUTHERN AND NORTHERN BRIDGE ABUTMENT; FLOODPLAIN LOWERING IN SOUTH FIELD AND NORTH WEST BANK
ALTERNATIVE 5		REMOVAL OF SOUTHERN AND NORTHERN BRIDGE ABUTMENT; FLOODPLAIN LOWERING ON NORTH WEST BANK

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SIGNATURE

REVISIONS

#	DESCRIPTION	DATE

20 0 10 20
1" = 20'
N

SITE PLAN - PROPOSED ALTERNATIVES
WEST WINDSOR FIRE DEPARTMENT
FLOOD RESILIENCY STUDY
889 VT-44
WEST WINDSOR, VT
NOT FOR CONSTRUCTION
CONCEPTUAL PLANS

DRAWN: AEM	CHECKED: JMD
SCALE: 1" = 20'	
DATE: 2025-02-14	
PROJECT NO.: 24009	
SHEET NO.: 2 OF 3	
SHEET NAME: **ALT-1**	

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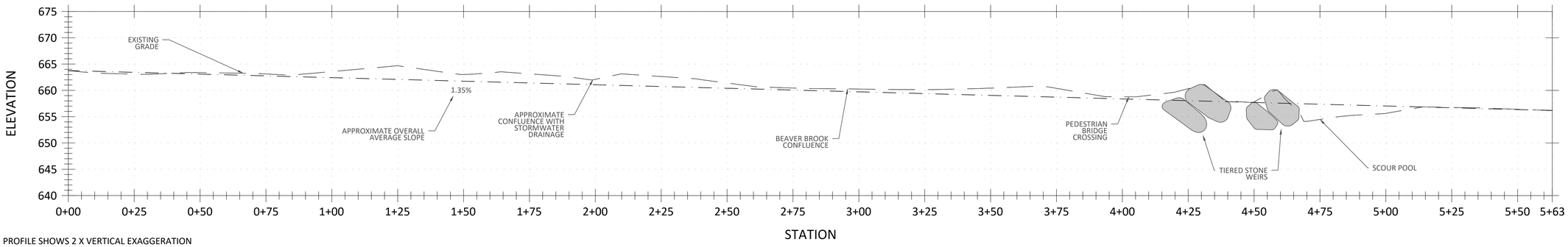
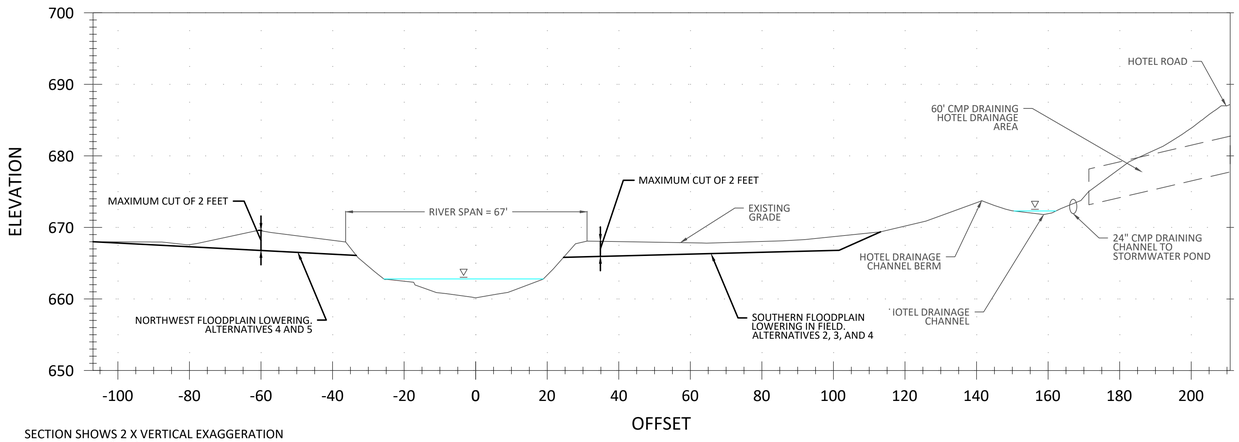
MILL BROOK PROFILE



PROFILE SHOWS 2 X VERTICAL EXAGGERATION
HORIZONTAL: 1"=20'
VERTICAL: 1"=10'

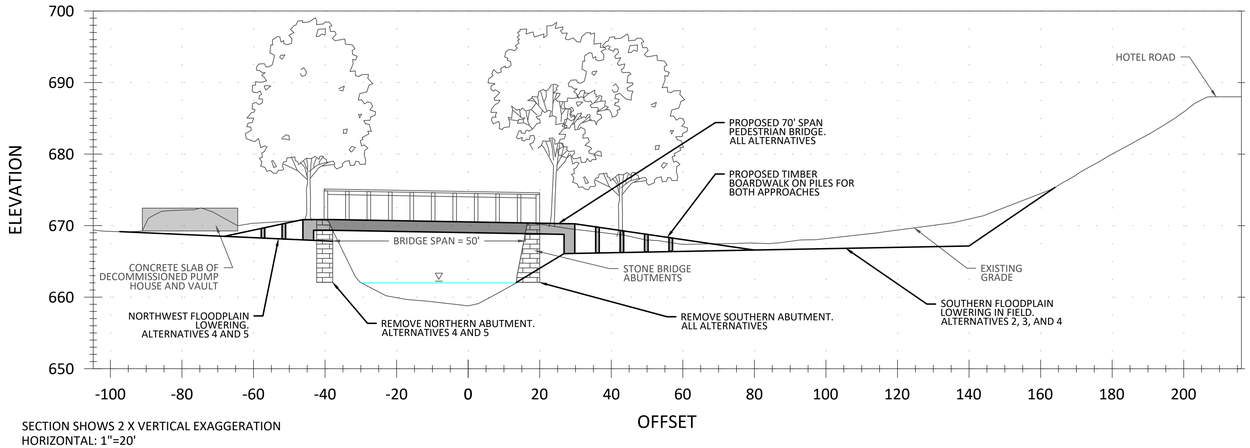
CROSS SECTIONS

MILL BROOK CROSS SECTION STA 3+30



SECTION SHOWS 2 X VERTICAL EXAGGERATION
HORIZONTAL: 1"=20'
VERTICAL: 1"=10'

MILL BROOK CROSS SECTION STA 4+00



SECTION SHOWS 2 X VERTICAL EXAGGERATION
HORIZONTAL: 1"=20'
VERTICAL: 1"=10'

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SIGNATURE

REVISIONS

#	DESCRIPTION	DATE

20 0 10 20
1" = 20'
N

SITE PLAN - PROFILE AND CROSS SECTIONS
WEST WINDSOR FIRE DEPARTMENT
FLOOD RESILIENCY STUDY
889 VT-44
WEST WINDSOR, VT
NOT FOR CONSTRUCTION
CONCEPTUAL PLANS

DRAWN: AEM	CHECKED: JMD
SCALE: 1" = 20'	
DATE: 2025-02-14	
PROJECT NO.: 24009	
SHEET NO.: 3 OF 3	

PRO-1
SHEET NAME

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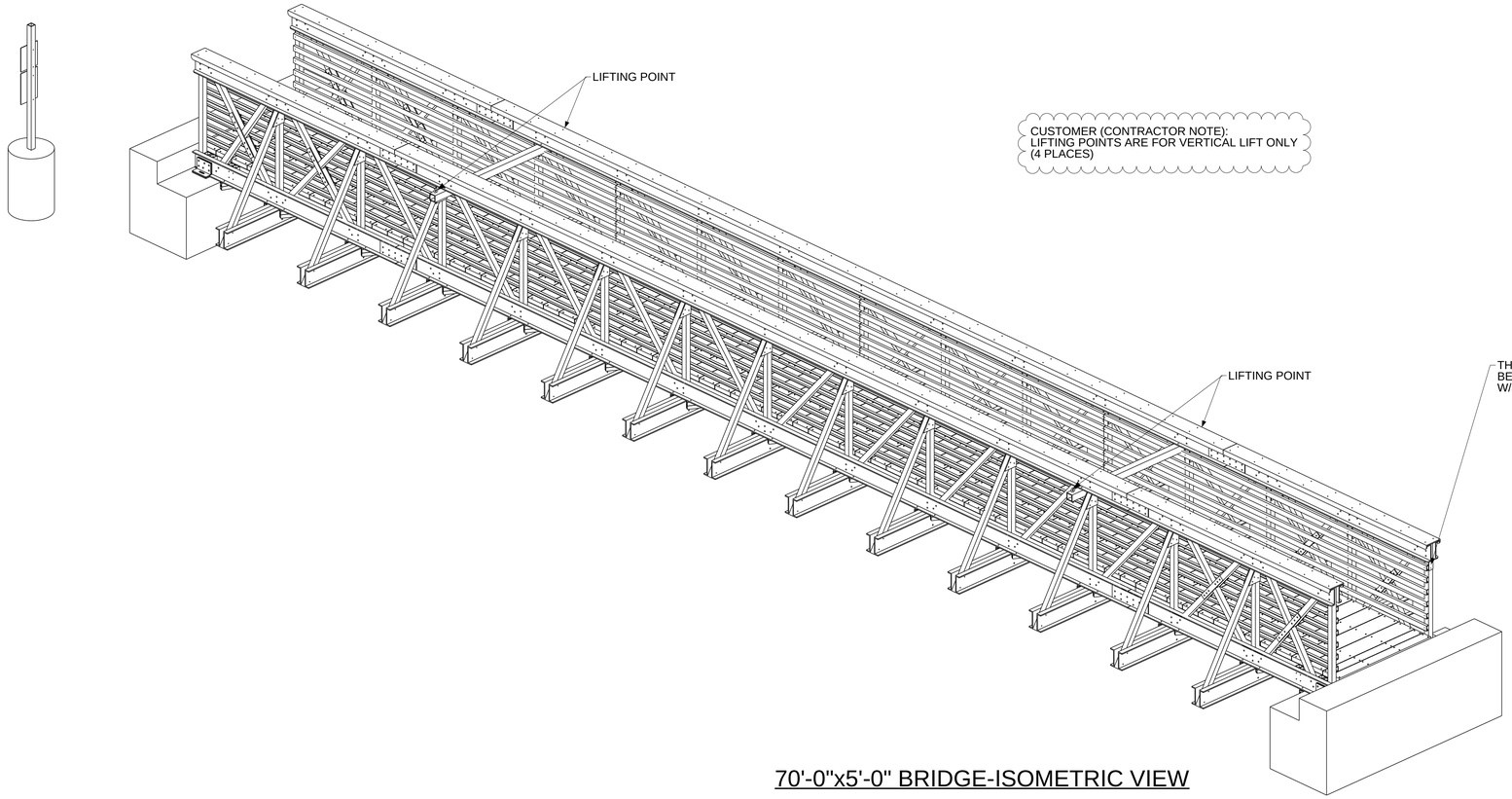

CUSTOMER (CONTRACTOR NOTE):
LIFTING POINTS ARE FOR VERTICAL LIFT ONLY
(4 PLACES)

70'-0"x5'-0" BRIDGE-ISOMETRIC VIEW

TOTAL DEAD WEIGHT OF 70'-0"x5'-0" BRIDGE IS EQUAL TO: 13,537 LBS
THIS DEAD WEIGHT INCLUDES THE DECKING WEIGHT OF 3,275 LBS.

BRIDGE TO BE PRE-CAMBERED TO 1 3/4".

FRP STRUCTURAL SHAPES :

FRP STRUCTURAL SHAPES BY BEDFORD REINFORCED PLASTICS, STANDARD GRADE POLYESTER 1-400 RESIN, COLOR TO BE OLIVE GREEN. STANDARD STRUCTURAL SHAPES ARE MANUFACTURED USING A SURFACE VEIL AS U.V. INHIBITOR TO PROTECT AGAINST U.V. DEGRADATION.

FASTENERS :

ALL HARDWARE IS A307 HD GRADE A GALVANIZED U.N.O.
AT TRUSS WEB/CHORD CONNECTIONS ONLY, TIGHTEN DOWN BOLT ASSEMBLIES WITH A TORQUE WRENCH SET AT A MINIMUM AMOUNT OF 45 FT-LBS.
FOR ALL OTHER CONNECTIONS OF THE BRIDGE, TIGHTEN DOWN BOLT ASSEMBLIES TO COMPRESS OR FLATTEN THE SPRING WASHERS. OVERTIGHTENED BOLTS CAN CAUSE DAMAGE TO HOLLOW PARTS.

ANCHOR BOLTS :

ALL ANCHOR BOLTS ARE PROVIDED BY OTHERS.
ANCHOR BOLTS AT SLOTTED CONNECTION MUST BE DOUBLE NUTTED AND SHOULD NOT BE TIGHTENED DOWN SO AS TO ALLOW FOR LONGITUDINAL BRIDGE MOVEMENT ALONG THE SLOT.

DECKING :

3x12 PT SYP WOODEN DECKING IS TO BE PROVIDED BY BEDFORD.

NOTES:

1. ALL A572 GR.50 STEEL TO BE GALVANIZED.
2. ALL A500 GRADE C, STEEL, EXCEPT LIFTING BEAMS, TO BE GALVANIZED.
3. POLE-MOUNTED SIGNS TO BE INSTALLED AT EACH END OF BRIDGE THAT READ "PEDESTRIAN, EQUESTRIAN, RTV, ATV, AND GOLF CART TRAFFIC ONLY".
4. AN ADDITIONAL SIGN BELOW THE TOP SIGN WILL READ "SPEED LIMIT 5".
5. THE VERTICAL TRUSSES ARE NOT RATED TO WITHSTAND LATERAL VEHICULAR IMPACT.

PEDESTRIAN, EQUESTRIAN, RTV, ATV, AND GOLF CART TRAFFIC ONLY

SPEED LIMIT 5

SIGN EXAMPLE

P.N: READYSPAN_SIGN_12X14_PERAG &
READYSPAN_SIGN_12X18_5MPH

BRIDGE PARTS BILL-OF-MATERIAL (BOM)

P/N	QTY.	DESCRIPTION	LENGTH
AN17	24	L4X4X1/2 FRP ANGLE	0'-6"
B868	4	C10X2 3/4X1/2 FRP TOP CHORD BEAM	45'-0"
B870	4	C10X2 3/4X1/2 FRP CAP BEAM	12'-6"
B880	2	C10X2 3/4X1/2 FRP CAP BEAM	45'-0"
B881	4	C10X2 3/4X1/2 FRP TOP CHORD BEAM	12'-6"
B882	4	C10X2 3/4X1/2 FRP TOP CHORD BEAM	12'-6"
B883	2	C10X2 3/4X1/2 FRP BOTTOM CHORD BEAM	12'-6"
B884	2	C10X2 3/4X1/2 FRP FLOOR BEAM	12'-6"
B885	2	C10X2 3/4X1/2 FRP FLOOR BEAM	12'-6"
B886	2	C10X2 3/4X1/2 FRP BOTTOM CHORD BEAM	12'-6"
B887	2	C10X2 3/4X1/2 FRP BOTTOM CHORD BEAM	12'-6"
B888	2	C10X2 3/4X1/2 FRP BOTTOM CHORD BEAM	12'-6"
B889	2	C10X2 3/4X1/2 FRP BOTTOM CHORD BEAM	45'-0"
B890	2	C10X2 3/4X1/2 FRP BOTTOM CHORD BEAM	45'-0"
B891	2	C10X2 3/4X1/2 FRP FLOOR BEAM	45'-0"
BR3	26	SQTB3X3X1/4 FRP OUTRIGGER BRACING	6'-5 7/8"
BR24	28	SQTB2X2X1/4 FRP HOR. BRACE SPACER	0'-5"
BR197	4	SQTB3X3X1/2 FRP DIAGONAL WEB TUBE	3'-5 5/8"
BR202	4	SQTB3X3X1/2 FRP DIAGONAL WEB TUBE	2'-11 5/16"
BR203	4	SQTB2X2X1/4 FRP HOR. BRACE SPACER	0'-10 1/2"
BR204	2	SQTB2X2X1/4 FRP HORIZONTAL BRACE	7'-1 7/8"
BR205	2	SQTB2X2X1/4 FRP HORIZONTAL BRACE	7'-1 7/8"
BR206	24	SQTB2X2X1/4 FRP HOR. BRACE SPACER	0'-11"
BR207	12	SQTB2X2X1/4 FRP HORIZONTAL BRACE	7'-9 9/16"
BR208	12	SQTB2X2X1/4 FRP HORIZONTAL BRACE	7'-9 9/16"
BR260	12	SQTB3X3X1/2 FRP DIAGONAL WEB TUBE	6'-11"
BR261	8	SQTB3X3X1/4 FRP DIAGONAL WEB TUBE	6'-11"
BR265	8	SQTB3X3X1/2 FRP DIAGONAL WEB TUBE	3'-3 1/2"
ETFB_29	2	C10X2 3/4X1/2 FRP BEAM	2'-0"
ETFB_30	4	C10X2 3/4X1/2 FRP BEAM	1'-7 3/4"
GUST_3	52	PL1/2"X8 3/16" FRP GUSSET PLATE	0'-8 1/2"
LTB_26	26	C10X2 3/4X1/2 FRP TRANSVERSE BEAM	12'-10"
MR145	12	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
MR153	24	C3X1 1/2X1/4 FRP MIDRAIL	14'-11 7/8"
MR163	2	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
MR164	2	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
MR165	2	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
MR166	2	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
MR167	2	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
MR168	2	C3X1 1/2X1/4 FRP MIDRAIL	19'-9 15/16"
P8	2	SQTB3X3X1/4 FRP SIGN POST	8'-0"
P77	1	SQTB3X3X1/2 FRP VERTICAL WEB TUBE	5'-6 1/2"
P78	2	SQTB3X3X1/2 FRP VERTICAL WEB TUBE	5'-6 1/2"
P82	1	SQTB3X3X1/2 FRP VERTICAL WEB TUBE	5'-6 1/2"
P102	20	SQTB3X3X1/2 FRP VERTICAL WEB TUBE	6'-4 1/2"
P103	6	SQTB3X3X1/2 FRP VERTICAL WEB TUBE	6'-4 1/2"
PL20	2	PL1/2"X10" FRP BASE PLATE	1'-1"
PL21	2	PL1/2"X10" FRP BASE PLATE	1'-1"
PL22	8	PL1/2"X6 1/4" FRP SPACER PLATE	0'-10"
PL31	4	PL1/2"X5 7/16" FRP SPACER PLATE	0'-6"
PL41	4	PL1/2"X10" FRP BASE PLATE	0'-9"
P_BRPLATE_3	8	PL1/2"X3" FRP PLATE	2'-1 1/2"
P_BRPLATE_8	8	PL1/2"X3" FRP PLATE	1'-9 5/16"
SP38	8	SQTB3X3X1/4 FRP SPACER TUBE	0'-10"
SP44	4	SQTB3X3X1/4 FRP SPACER TUBE	0'-10"
SP52	26	SQTB3X3X1/4 FRP SPACER TUBE	1'-8"
SP54	4	SQTB3X3X1/4 FRP SPACER TUBE	0'-10"
SPLICE_1	8	PL1/2"X8" FRP SPLICE PLATE	1'-4"
DECK71	72	3X12 PT SYP WOOD DECKBOARD	5'-6 1/2"
DECK75	2	3X12 PT SYP WOOD DECKBOARD	5'-6 1/2"
BR264	4	HSS3X3X1/4 A500-GR.C GALV. STEEL TUBE	6'-4 13/16"
BR266	4	HSS3X3X1/4 A500-GR.C GALV. STEEL TUBE	6'-11"
LB15	2	HSS4X4X5/16 A500-GR.C LIFT BEAM	7'-10"
P_BRKT_7	4	L6X4X1/2 A572 GR.50 GALV. ANGLE	0'-6"
P_BRKT_8	4	L6X4X1/2 A572 GR.50 GALV. ANGLE	0'-6"
P_SPLICE_2	16	PL3/8"X8 1/2" A572 GR.50 GALV. SPLICE PLATE	2'-2 1/2"
READYSPAN_SIGN_12X14_ PERAG	2	PL1/4"X12" SIGN PLATE	1'-2"
READYSPAN_SIGN_12X18_ 5MPH	2	PL1/4"X12" SIGN PLATE	1'-6"
V_BRKT_13	2	L7X4X1/2 A572 GR.50 GALV. ANGLE	0'-10"
V_BRKT_14	2	L7X4X1/2 A572 GR.50 GALV. ANGLE	0'-10"
V_BRKT_15	2	L7X4X1/2 A572 GR.50 GALV. ANGLE	0'-10"
V_BRKT_16	2	L7X4X1/2 A572 GR.50 GALV. ANGLE	0'-10"

HARDWARE BOM

QTY.	DIA.	DESCRIPTION	LENGTH
84	1/2"	BOLT A307 GRADE A-GALV.	0'-3 1/2"
92	1/2"	BOLT A307 GRADE A-GALV.	0'-5 1/2"
24	3/4"	BOLT A307 GRADE A-GALV.	0'-7 1/2"
40	3/8"	BOLT A307 GRADE A-GALV.	0'-2 1/2"
120	3/8"	BOLT A307 GRADE A-GALV.	0'-5 1/2"
52	3/8"	BOLT A307 GRADE A-GALV.	0'-5"
288	5/8"	BOLT A307 GRADE A-GALV.	0'-2 1/2"
16	5/8"	BOLT A307 GRADE A-GALV.	0'-3 1/2"
32	5/8"	BOLT A307 GRADE A-GALV.	0'-3"
588	5/8"	BOLT A307 GRADE A-GALV.	0'-5 1/2"
78	5/8"	BOLT A307 GRADE A-GALV.	0'-5"
192	3/8"	BOLT CRGE. A307 GRADE A-GALV.	0'-2"
216	#14	18-8SS SELF DRILLING HEX HEAD SCREW	0'-2 1/2"
592	#14	18-8SS SELF DRILLING FLAT HEAD SCREW	0'-4"
8	5/16	18-8SS PHILLIPS TRUSS MACHINE SCREW	0'-4"
4	7/8"	MCMASTER-CARR#3018T41 EYE BOLT	-
176	1/2"	NUT HEX	-
24	3/4"	NUT HEX	-
404	3/8"	NUT HEX	-
1002	5/8"	NUT HEX	-
8	7/8"	NUT HEX	-
8	5/16	LOCK NUT	-
4	7/8"	WASHER 3" OD FENDER	-
352	1/2"	WASHER PLAIN	-
48	3/4"	WASHER PLAIN	-
616	3/8"	WASHER PLAIN	-
2004	5/8"	WASHER PLAIN	-
8	5/16	WASHER PLAIN	-
176	1/2"	WASHER SPRING	-
24	3/4"	WASHER SPRING	-
212	3/8"	WASHER SPRING	-
1002	5/8"	WASHER SPRING	-

☐ REVISE AND RESUBMIT

☐ APPROVED AS NOTED

☐ APPROVED

SIGNATURE DATE

REV.	BY	DATE	DESCRIPTION	REV.	BY	DATE	DESCRIPTION	REV.	BY	DATE	DESCRIPTION	REV.	BY	DATE	DESCRIPTION	REV.	BY	DATE	DESCRIPTION	REV.	BY	DATE	DESCRIPTION
8	SVK	05/09/2024	FOR NINTH RELEASE	7	SVK	05/06/2024	FOR EIGHTH RELEASE	6	SVK	01/19/2024	FOR SEVENTH RELEASE	5	SKE	11/23/2023	FOR SIXTH RELEASE	4	SKE	10/26/2023	FOR FIFTH RELEASE				
3	SKE	10/25/2023	FOR FOURTH RELEASE	2	SKE	10/19/2023	FOR THIRD RELEASE	1	SKE	10/18/2023	FOR SECOND RELEASE	0	SKE	08/23/2023	FOR FIRST RELEASE								

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TOLERANCES	DRAWN BY: SVK	TITLE
X/Y: ± 1/16	CHECKED BY: PVR	
.XX: ± .030	DESIGNED BY: TCC	JOB P70.5.54.GS.WD.GN.LB
.XXX: ± .010	DATE: 05/06/2024	DRAWING NO. S1 D-SIZE
ANG: ± 0.5°	REF.	SCALE - REV. 8 SHEET S1 OF S8

Tedds Structures

Attachment 2

Alternatives Matrix

Town of West Windsor - Fire Department

Flood Mitigation Alternatives Matrix

February 14, 2025

Legend

● Effective ◒ Limited ○ Ineffective

		BENEFITS & COST		Fire Station Flood Reduction		
Alternative	**Priority**	**Reduces Flood Risk[1]**	**Relative Cost Comparison**	**Q100 Water Surface Elevation (WSE) Decrease (ft)[2]**	**Q500 Water Surface Elevation (WSE) Decrease (ft)**	**Comments**
#1) Removal of southern bridge abutment	Low	○	$	0.08	0.09	Minimal Change to flooding; 1 Landowner Affected
#2) Removal of southern bridge abutment; floodplain lowering in south field	Medium	◒	$$	0.33	0.24	Reduced flooding by opening up floodplain access to the south; 1 Landowner Affected;
#3) Removal of southern bridge abutment; floodplain lowering in south field and forest	Low	◒	$$$	0.36	0.31	Flood reduction, although large impact to forested setting and tree clearing for only a minimal reduction compared to Alternative 2; 3 Landowners Affected
#4) Removal of southern and northern bridge abutment; floodplain lowering in south field and north west bank	High	●	$$	0.36	0.43	Largest flooding redution assessed. Permission from 911 Rt 44 land owner (Smith Proeperty) will be required; 2 Landowners Affected
#5) Removal of southern and northern bridge abutment; floodplain lowering in north west bank	Medium	◒	$	0.36	0.27	Reduced flooding by allowing water to pass through confluence to Mill Brook more effectively. Permission from 911 Rt 44 land owner (Smith Proeperty) will be required; 2 Landowners affected.

[1] Reduces Flood Risk - The proposed project/strategy lowers the flood level directly upstream and around the Fire Station Building.

[2] Existing conditions water depth is 0.36 feet. Alternatives 3, 4, and 5 fully remove the modeled flooding at the Fire Station for the Q100 flood event.

Attachment 3

Hydraulic Model Simulations

Hydraulic Model Simulations

Alternatives Analysis

Plan View Results

The results below compare the flood extents of the existing conditions of the confluence of the Mill Brook and Beaver Brook near the Fire Station location to several proposed alternative conditions. The velocities of the proposed conditions results are shown in a color gradient (with associated flow vector arrows), and the existing conditions flood extents are shown in gray underneath.

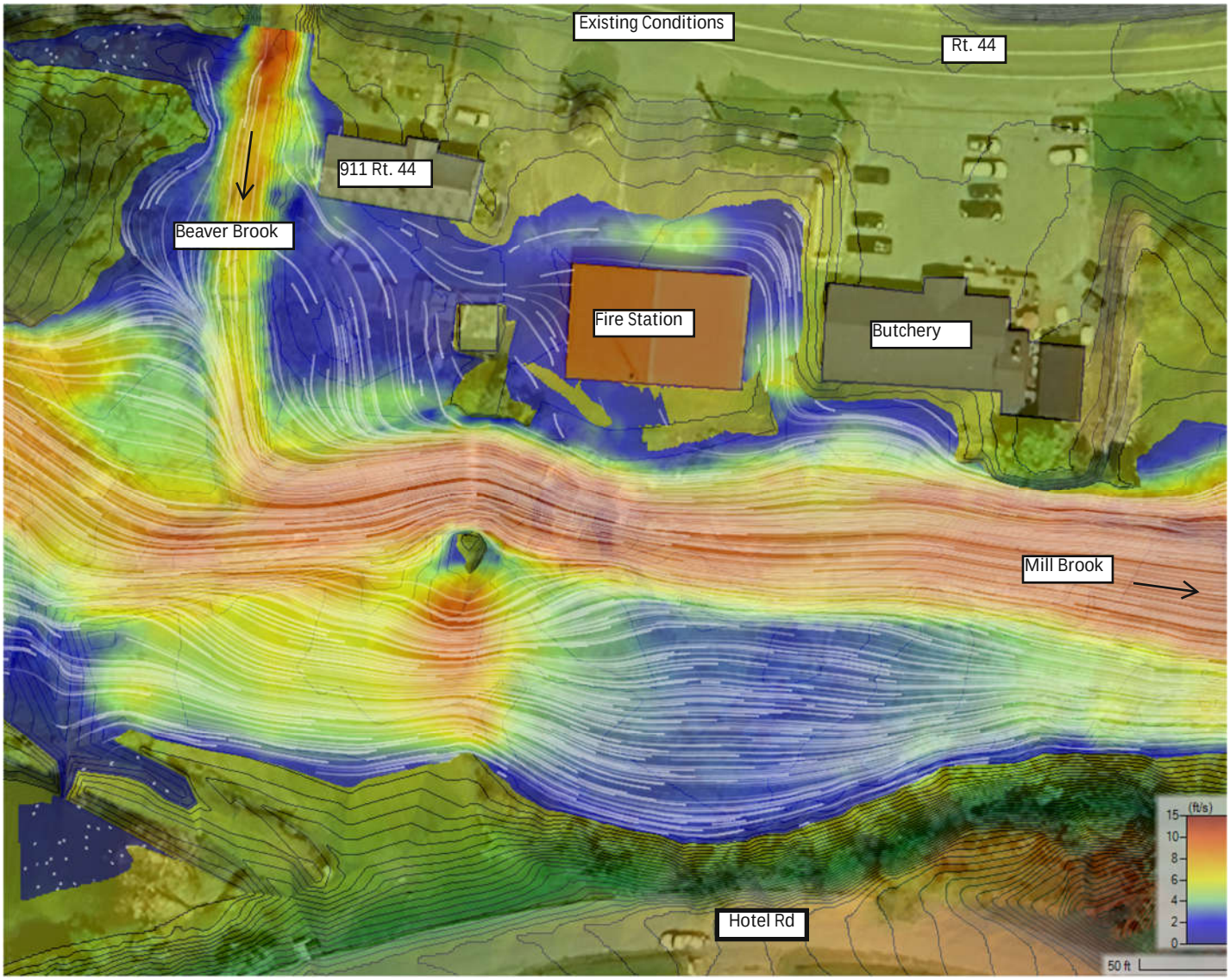

Photo 1: Existing conditions HEC-RAS model results for showing the velocity of floodwaters during a 100-year (1%) flood.

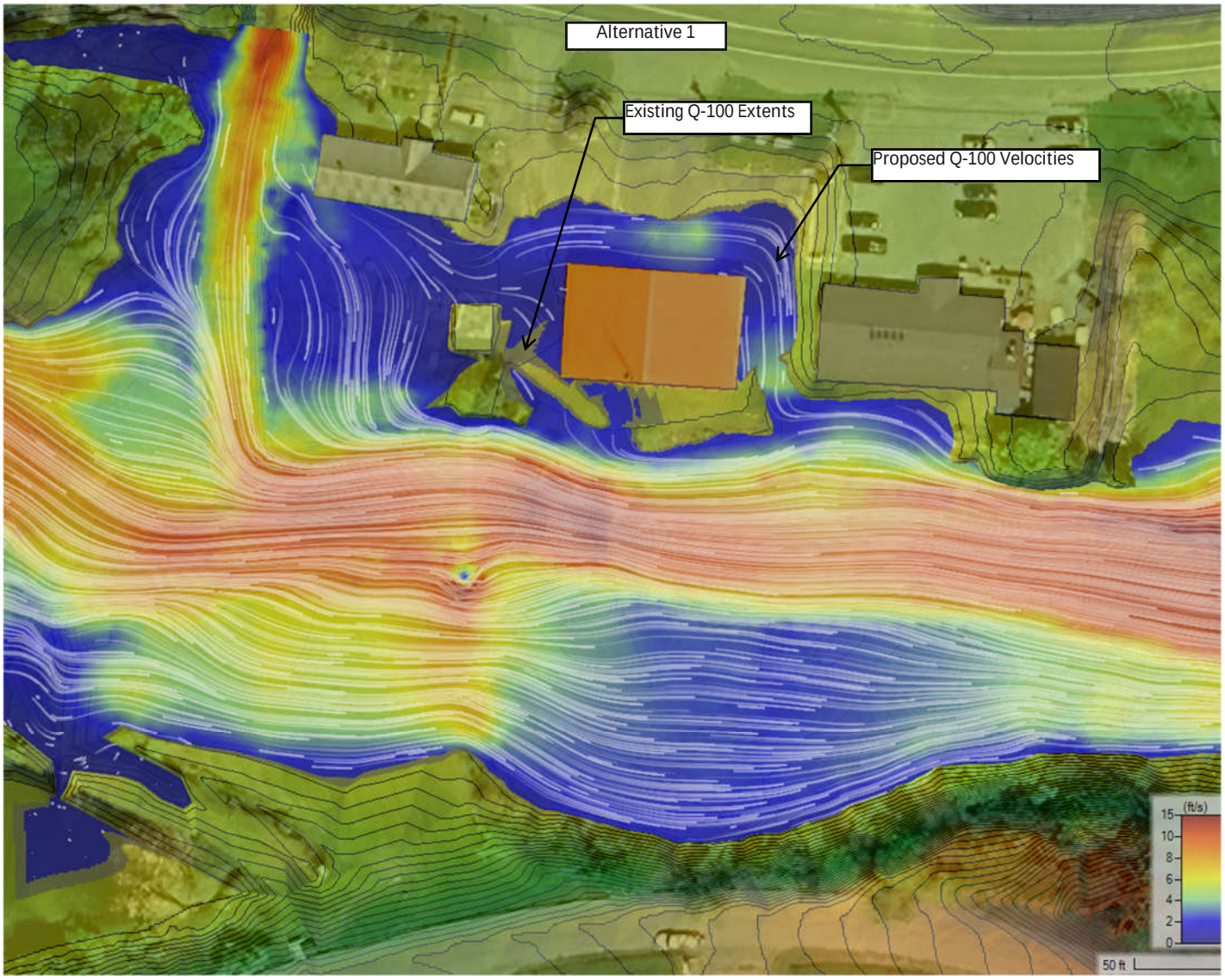

Photo 2: Proposed conditions HEC-RAS model results for **Alternative 1** (Removal of southern bridge abutment). There is a minimal visible reduction in the flood extents near the Fire Station.

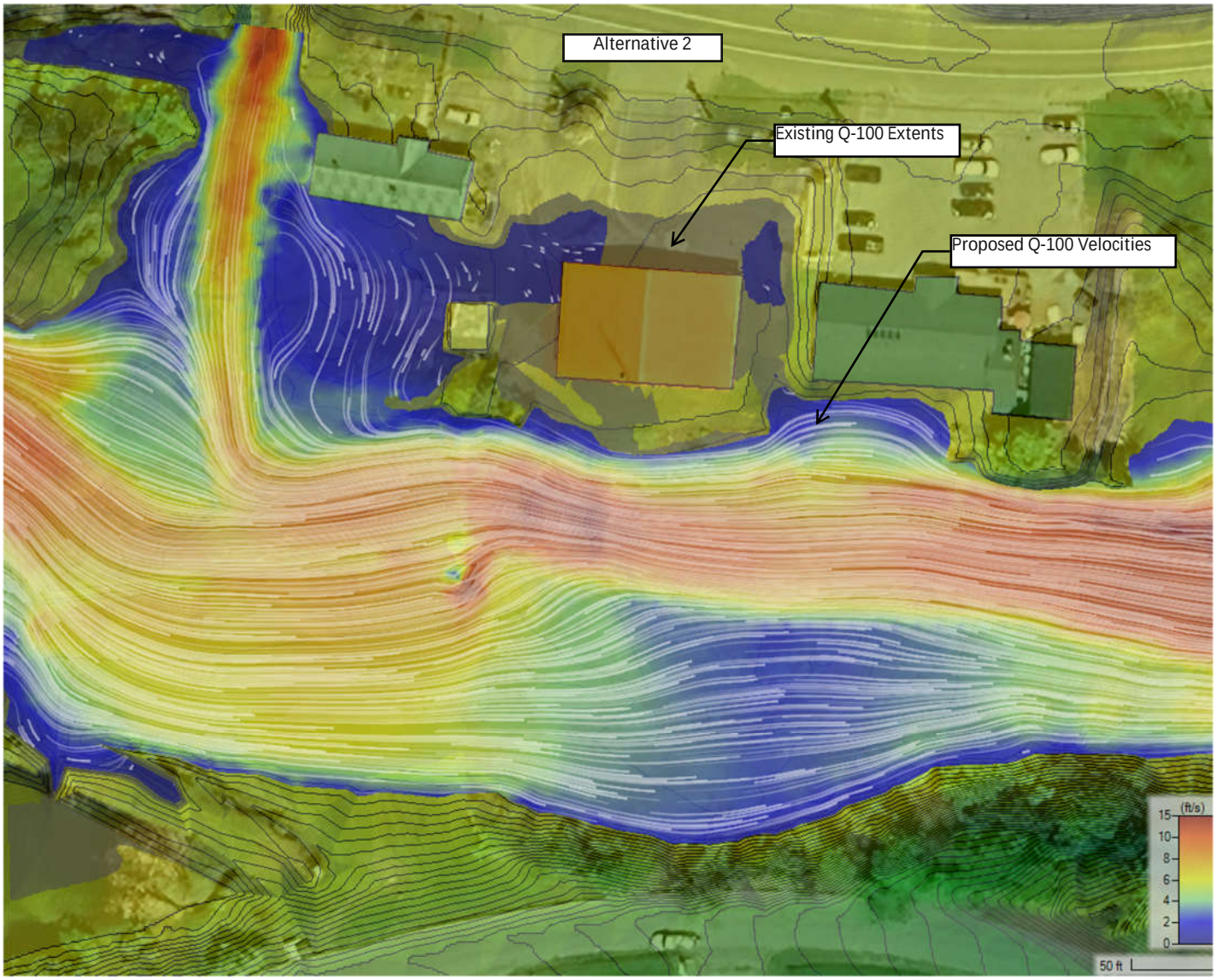

Photo 3: Proposed conditions HEC-RAS model results for **Alternative 2** (Removal of southern bridge abutment; floodplain lowering in field). There is a visible reduction in the flood extents near the Fire Station, with a minimal amount of water hitting the northwest side of the building.

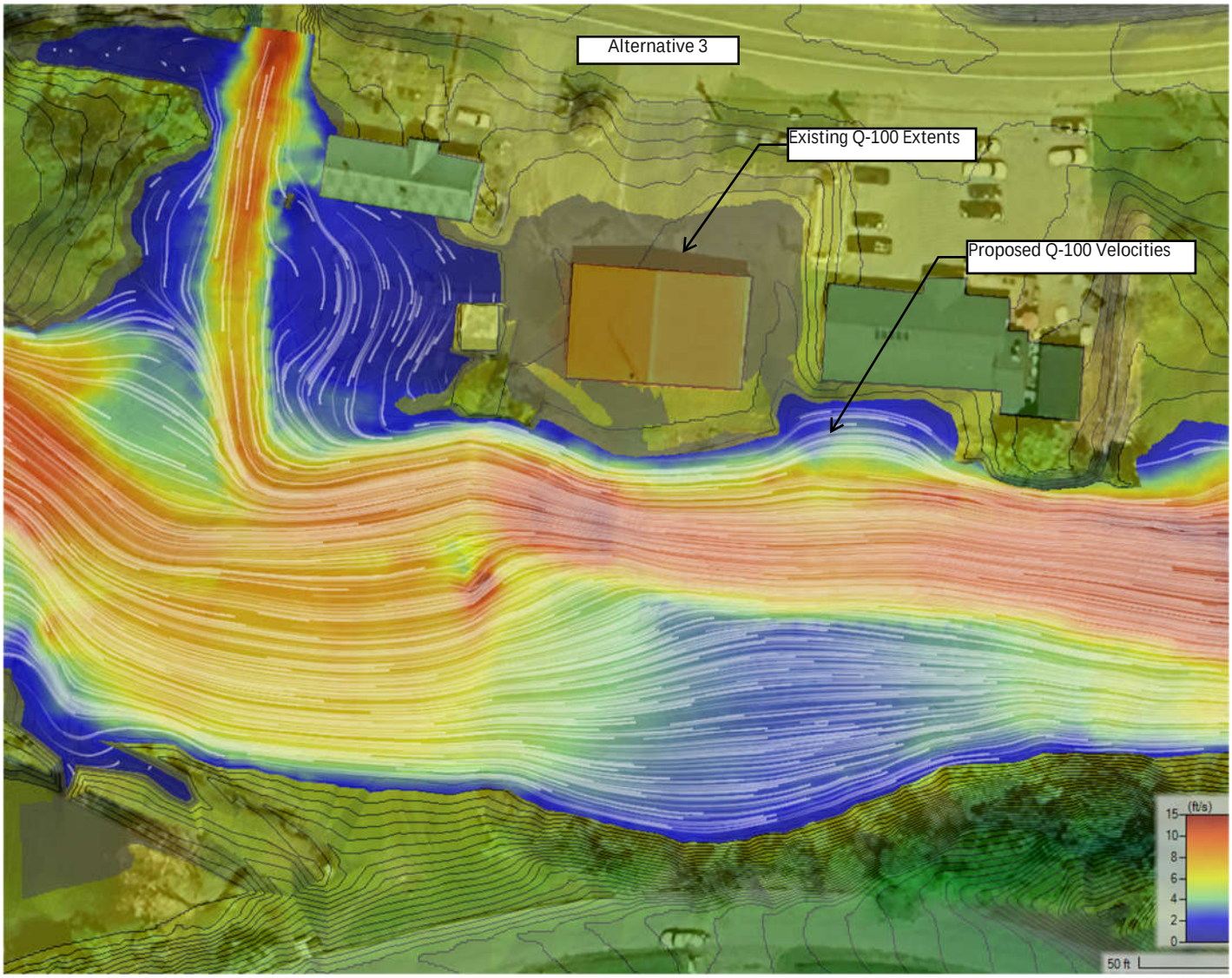

Photo 4: Proposed conditions HEC-RAS model results for **Alternative 3** (Removal of southern bridge abutment; floodplain lowering in field and forest). There is a visible reduction in the flood extents near the Fire Station, with no water flowing at or around the building.

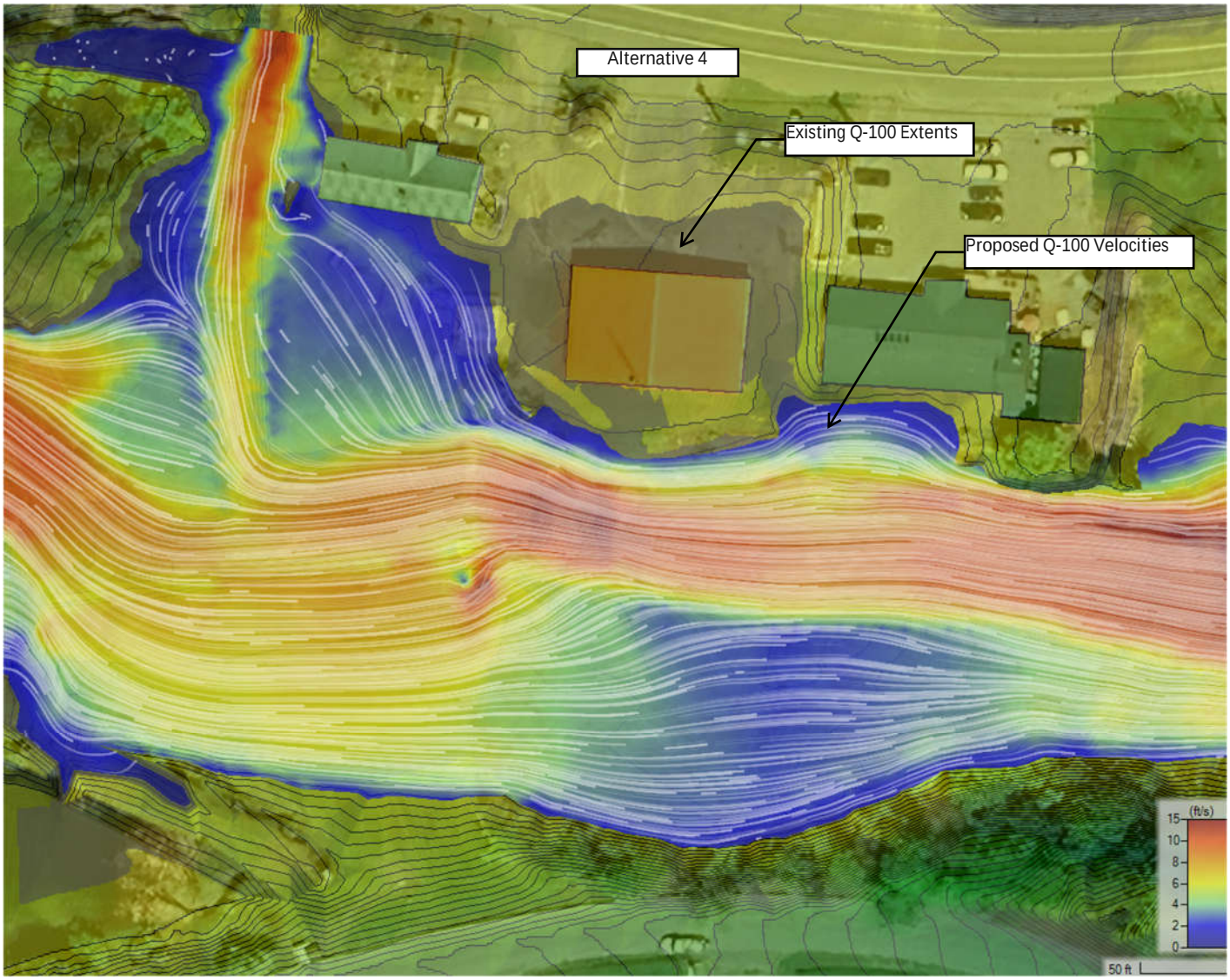

Photo 5: Proposed conditions HEC-RAS model results for **Alternative 4** (Removal of southern and northern bridge abutment; floodplain lowering in field and north west bank). There is a visible reduction in the flood extents near the Fire Station, with no water flowing at or around the building.

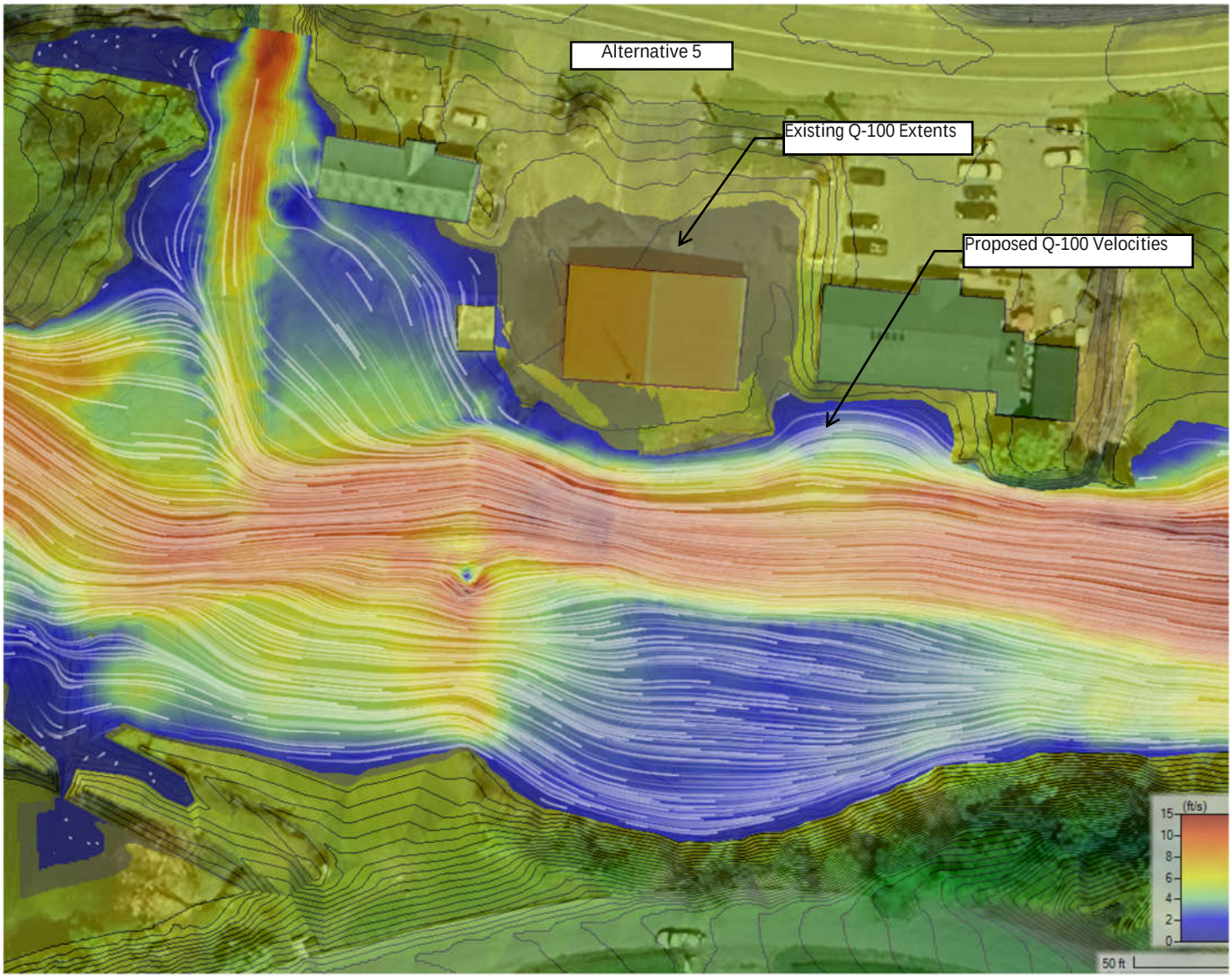

Photo 6: Proposed conditions HEC-RAS model results for **Alternative 5** (Removal of southern and northern bridge abutment; floodplain lowering in north west bank). There is a visible reduction in the flood extents near the Fire Station, with no water flowing at or around the building.