VTrans Fall 2023 Transportation Alternatives (TAP)
and
Municipal Highway and Stormwater Mitigation Program Grant (MHSMP)

Combined Application

Thoroughly read the TAP and MHSMP application guidebooks before you begin your application. It includes important program information and step-by-step instructions. Pay particular attention to the application process requirements. **Applications are due by e-mail by December 8, 2023.** Please e-mail the completed application to: Ross.gouin@vermont.gov and Scott.robertson@vermont.gov.

Middle Rd. Culvert Replacement
(Project Name/Title)

Dusty Huestis
(Municipality contact person responsible for the management of this project)

Bridport
(Town)

05734
(Zip Code)

P.O. Box 27, Bridport, VT 05734
(Mailing Address)

802-349-7051
(Phone)

bridportdpw@gmavt.net
(e-mail address)

$ 776,880
Amount of **Federal Funds requested** (no more than 80% of the project cost estimate).

$194,220
Amount of Local Match. Example:
Federal Award = $600,000 (*80% of total*)
Local Match = $150,000 (*20% of total*)
Total Project Cost = $750,000 (*100% of the total*)

County: Addison

Town/Village/City: Bridport

Specific location, street, or road: ~3305 Middle Road

Regional Planning Commission: Addison County Regional Planning Commission

If a linear project, what is the length in feet? NA

Is the project on or intersecting to a State maintained highway? Yes ☐ No x

- *Note: If yes, be sure to include documentation that you have notified the VTrans District Transportation Administrator of the intent to apply for TA funding and have provided them with a brief (one paragraph) description of the proposed project.*

Project type being applied for: ☐ **Scoping** x **Design/Construction**

The municipality understands that a typical construction project utilizing TAP or MHSMP Program funds will take roughly three years (min.) in the Design and ROW phases prior to going to construction (as pointed out in the TAP and MHSMP Application Guides)? Yes X No ☐

Does this project have a previously completed scoping or feasibility study? Yes X No ☐

Note:
Attach a map(s) of the project area and clearly show the limits of the project as well as surrounding benefits from the proposed improvement. If the project is within or adjacent to a designated downtown, village or growth center, clearly indicate the relationship of the proposed project to the boundary of the designated area. Color photos of the area are also recommended.

Fiscal Information:

Accounting System Automated x Manual ☐ Combination☐

SAM Unique Identifier # 02-5223421

Fiscal Year End Month June.

Property Ownership:

If the proposed project is on private property that will need to be acquired by the Municipality through purchase, easement, or eminent domain (includes temporary construction rights) in accordance with the "Uniform Act", then the municipality is committed to exercising its right of ***eminent domain*** to acquire the rights to construct the project if necessary. Yes x No ☐

Funding:
Does this project already have existing funding? If so, please describe. Yes ☐ No x
NA

Please note that existing projects will not be considered for additional funding without a current NEPA clearance and ROW clearance. Please provide date of clearances below:
NA

Will you accept an award less than you applied for? Yes ☐ No x

- If yes, please indicate whether local funds will be used to make up the shortfall, or if the project scope will be reduced. If the project scope is to be reduced, describe what part of the project (please be specific) you would accept partial funding for.

  NA

A support letter from the governing body of the applicant municipality or organization and an acknowledgement and source of the local match and commitment to future maintenance responsibility for construction projects is required (must be dated within 1 year of the application). Is a letter of support attached?

Yes x No ☐

Regional Planning Commission Letter of Support:

In order to apply, the project must have a letter of support from the regional planning commission. Is a letter of support attached?

Yes x No ☐

PLEASE NOTE*:* If this application is for salt or sand shed funding, the applicant must read and understand the ***Municipal Assistance Section Salt Shed Application Guide***. All of the following scoring questions below must thoroughly convey an understanding of the salt and sand guidance provided.

Application Scoring Criteria:

1. **Please give a brief description of the project (be sure to indicate the primary facility type being applied for and be concise). (10 points max.)**

   We propose to replace the twin 72" culverts that carry the east branch of Dead Creek under Middle Road in Bridport. Approximately 270 cars per day traverse Middle Road. Replacement would follow the recommendations set forth in the attached scoping study completed by Fuss & O'Neill using FY21 Stormwater Mitigation Funds.

2. **What is the feasibility of this project? Feasibility (or Scoping) study applications will not be scored on this criterion. Also, please describe the extent of project development to date. (10 points max.)**

   A scoping study for this project was completed in May of 2022, and no significant impediments to feasibility were found. There are no underground utilities. Overhead utilities are beyond the toes of the roadway embankment slope and relocation may not be necessary. Temporary right of way construction easements are likely needed, but permanent work will occur within the town right of way. The project will require wetland permits. There are no occurrences of rare, threatened, or endangered species with the project vicinity. No historic impediments were identified, and archeological potential is low.

3. **Does this project address a need identified in a local or regional planning document? If so, please describe.**

   (5 points max.)
   Bridport's Town Plan establishes a policy to "provide and maintain a transportation system that is safe, efficient and affordable." It does not identify any specific projects. Middle Road is not mentioned in the Regional Plan..

4. **Does this project:**
   A. **Benefit a State Designated Center per the link below (i.e., downtowns, villages, or neighborhood growth centers recognized by the Vermont Department of Economic, Housing and Community Development?**

      Not applicable for Environmental Mitigation Categories **(5 points max.)**
      http://maps.vermont.gov/ACCD/PlanningAtlas/index.html?viewer=PlanningAtlas
      NA - this is an Environmental Mitigation Proposal

   B. **Benefit mobility for disadvantaged populations to include elderly, disabled, minorities, and low-income residents. Please describe this impact (if applicable) in detail. Supporting documentation, including recent data must be included.**

      Not applicable for Environmental Mitigation Categories **(10 points max.)**
      NA - this is an Environmental Mitigation Proposal

5. **Provide a project cost estimate below (project costs below include both federal dollars and local dollars). Projects will be scored based on whether the cost appears realistic for the size and scope of the project. For scoping studies, use PE and Local Project Management lines only.**
   Note: If you are applying for additional funds for an existing project, show the amount being requested for this grant in the PE, ROW, Construction, Construction Engineering, and Municipal Project Management rows below. Also, be clear regarding total project cost and other funding amounts and sources in the additional funding comments box below.
   (10 points max.)

Right-of-way / Acquisition (ROW) *(appraisals, land acquisition and legal fees)*	$ 6,000

Construction

(construction costs with reasonable contingency) $ 708,100

Construction Engineering
(cost to provide inspection during construction) $ 79,000

Municipal Project Management Costs
(minimum of 10% of total PE, ROW and Construction Phases). $ 20,000

Total Project Cost **$** 971,100

Addition Funding Comments: (ex. Total and additional funding for existing projects)

NA.

6. Select the eligibility category below (A, B, C or D) that best fits your project and answer the corresponding questions for that category (choose only one category). 10 bonus points will be awarded to projects that are primarily Bicycle or Pedestrian facilities.

☐ **A. Bicycle and Pedestrian Facilities (includes Safe Routes for Non-Drivers and Conversion of abandoned railroad corridors.**

(i) Will the project contribute to a system of pedestrian and/or bicycle facilities?

(10 points max.)
Click here to enter text.

(ii) Will the project provide access to likely generators of pedestrian and/or bicyclist activity? **(10 points max.)**

Click here to enter text.

(iii) Will the project address a known, documented safety concern? **(10 points max.)**

Click here to enter text.

☐ **B. Community Improvement Activities:**

i. Explain how the project improves the economic wellbeing of the community and/or provide a benefit to state tourism? **(10 points max.)**

Click here to enter text.

ii. Describe the anticipated impact to the public; degree of visibility, public exposure and/or public use. **(10 points max.)**

Click here to enter text.

iii. Answer only one of the following based on the type of project:

a) Construction of turnouts, overlooks, and viewing areas as related to scenic or historic sites. *To what extent will the project provide a view of a highly unique and scenic area?*

b) **(10 points max.)**

Click here to enter text.

c) Preservation or rehabilitation of historic transportation facilities. *Describe the historic significance of the historic transportation facility and the importance of the facility to the state.* **(10 points max.)**

Click here to enter text.

d) Archeological planning and research related to impacts from a transportation project. *Describe the associated transportation project and benefit of the proposed activities.* **(10 points max.)**

Click here to enter text.

e) Vegetation management in transportation rights of way to improve roadway safety, prevent invasive species, and provide erosion control. *Describe the extent of the current problem and the impact on the site and surrounding area.* **(10 points max.)**

Click here to enter text.

X C. Environmental Mitigation Activity Related to Stormwater and Highways (Including Salt and Sand Sheds)

i. Please describe how this application provides environmental mitigation relating to stormwater and highways. **(10 points max.)**

The culverts are failing. The road has been overtopped by flood waters repeatedly, most recently during the 2019 Halloween Storm. Failure of the culverts would lead to increased sediment and debris in Dead Creek, potentially harm adjacent wetlands, and disrupt travel. The Otter Creek Tactical Basin Plan identifies Dead Creek as a high priority area for implementation of a wide-range of clean water projects. The east branch of Dead Creek is already identified as a stressed waterway due to high turbidity, TSS, nutrients, and temperature.

ii. What information or data is provided to substantiate the current stormwater problem and associated environmental impacts? **(10 points max.)**

Please see Project Scoping Report.

iii. What substantiating data or information is provided to show that the proposed application is an effective and maintainable solution to the problem? **(10 points max.)**

Please see Project Scoping Report.

☐ D. Environmental Mitigation Activity Related to Wildlife

i. Please describe how this application will reduce vehicle-caused wildlife mortality or will restore and maintain connectivity among terrestrial or aquatic habitats. **(10 points max.)**
Click here to enter text.

ii. What information or data is provided to substantiate the current problem and associated environmental impacts? **(10 points max.)**

Click here to enter text.

iii. What substantiating data or information is provided to show that the proposed application is an effective and manageable solution to the problem? **(10 points max.)**

Click here to enter text.

TOWN OF BRIDPORT
PO Box 27, 82 Crown Point Road
Bridport, Vermont 05734
802-758-2483 | 802-758-2483 fax
bridporttown@gmavt.net

October 27, 2023

Ross Gouin

VTrans-Municipal Assistance Section

Ross.gouin@vermont.gov

Dear Ross,

The Town of Bridport is excited to submit this application for funding through the 2024 Environmental Mitigation Grant Programming, Bridport seeks funding to replace twin culverts on Middle Rd. The town has identified this project as a high priority for protecting our transportation infrastructure.

Bridport is committed to meeting its Grant Match obligation ($194,220) and seeing the project through to completion

Sincerely,

Select board Chair

Addison County Regional Planning Commission
14 Seminary Street Middlebury, VT 05753 • www.acrpc.org • Phone: 802.388.3141

October 27, 2023

Ross Gouin
VTrans - Municipal Assistance Section
ross.gouin@vermont.gov

Dear Ross,

I am writing to express Addison County Regional Planning Commission's support for the Town of Bridport's application to the SFY 2024 Environmental Mitigation Grant Program. Bridport has demonstrated a commitment to upgrading its transportation infrastructure and I have no doubt that this project will aid in building a safer, more resilient transportation system.

Bridport seeks to replace twin culverts on Middle Rd. that carry the East Branch of Dead Creek. Bridport has already completed a scoping report for this project and ACRPC served as the Municipal Project Manager for that report. Middle Road sees 270 vehicles on an average day.

The current structures are failing and have been overtopped in the past, resulting in temporary road closures and potential damage to the road and culverts. Replacement of the twin culverts with a larger structure is necessary to replace the corroded culverts prior to collapse and to eliminate or reduce the frequency of overtopping events to maintain vehicular and pedestrian traffic through the project location.

The Town of Bridport clearly understands the importance of infrastructure asset management and it has the full support of ACRPC in these efforts. Please do not hesitate to contact me if you have any questions regarding this letter or if I may offer you any further assistance. I can be reached at mwinslow@acrpc.org.

Sincerely,

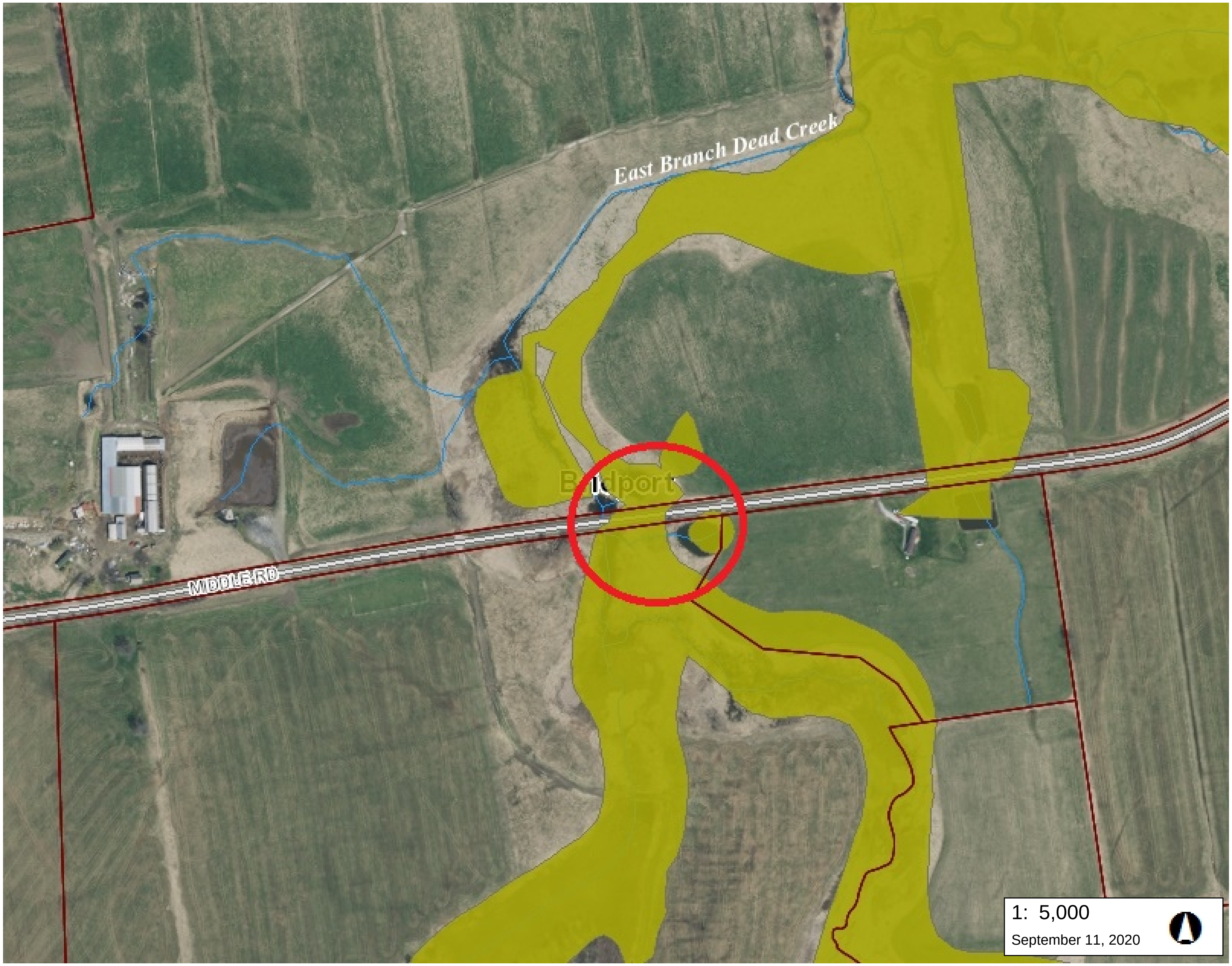
Mike Winslow
Transportation Planner

VERMONT

Natural Resources Atlas

Vermont Agency of Natural Resources

vermont.gov



1: 5,000

September 11, 2020

LEGEND

Wetland - VSWI
- 🟧 Class 1 Wetland
- 🟨 Class 2 Wetland
- ⬜ Buffer

☐ Parcels (standardized)

☐ Parcels (non-standardized)

Roads
- ▬ Interstate
- ▬ Principal Arterial
- ▬ Minor Arterial
- ▬ Major Collector
- ▬ Minor Collector
- ▬ Local
- ▬ Not part of function Classification S

— Stream/River

☐ Town Boundary

254.0 0 127.00 254.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 417 Ft. 1cm = 50 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

NOTES

Map created using ANR's Natural Resources Atlas

	Est. 2022 F&O	Adj. 2028		Assumptions	
Construction Costs	$612,000.00	$694,000.00		Average inflation rate 2022-2028	3.27%
Contingency	NA	$104,100.00		Cumulative Inflation rate 2022-2028	13.40%
MPM costs	$18,000.00	$20,000.00			
Preliminary Engineering	$60,000.00	$68,000.00			
ROW costs	$5,000.00	$6,000.00			
Construction Engineering	$70,000.00	$79,000.00			
Total	**$765,000.00**	**$971,100.00**			
Federal Request	$776,880.00				
Match	$194,220.00				

Scoping Report
Bridport STP MM21(4)
Middle Road Over East Branch Dead Creek
Middle Road Culvert Replacement
Bridport, VT

Town of Bridport
Bridport, Vermont

May 6, 2022

FUSS & O'NEILL

205 Billings Farm Road, Suite 6B
White River Junction, VT 05001

Project No. 20210607.A10

Table of Contents

Scoping Report – Draft
Middle Road Culvert Replacement
Bridport, VT

1 Project Description

1.1 Site Information

The project site is on town maintained Middle Road approximately 1.3 miles west of the intersection of Middle Road and Vermont State Route 22A in the Town of Bridport, Addison County, Vermont. Middle Road runs east to west and ends at a junction with Lake Street near the western Vermont border with New York. The existing twin 72-inch corrugated metal pipes (CMPs) run almost perpendicular to the road with minimal fill over the tops of the pipes and corroded inverts. See Figure 1 below for a Project Location Map.

Figure 1 – Project Location

The existing conditions were gathered from a combination of a site visit, a 2014 State Assessment of the culvert, and field measurements. See Appendices for more detailed information

Roadway Classification:	Class III Local Road
Culvert Type:	Twin Corrugated Metal Pipes (CMPs)
Culvert Diameter:	6 feet
Culvert Length:	30 feet
Ownership:	Town of Bridport

1.2 Purpose and Need

The Middle Road Over East Branch Dead Creek twin 72-inch diameter corrugated metal pipes (CMPs) are in poor condition with corroded inverts. In addition, the road at the crossing is subject to overtopping due to the creek's large drainage area. This overtopping results in temporary road closures and potential damage to the road and culverts. Replacement of the twin CMPs with a larger structure is necessary to replace the corroded culverts prior to collapse and to eliminate or reduce the frequency of overtopping events to maintain vehicular and pedestrian traffic through the project location.

1.3 Traffic and Safety

Traffic data is not available for the project location. A bridge inspection for another bridge on Middle Road indicates an ADT of 220 with 2% trucks. There are no recorded crashes between 2010 and the present in the vicinity of the culverts.

1.4 Design Criteria

The design standards for this bridge project are the Vermont State Standards (VSS) dated October 22, 1997, AASHTO Low Volume Manual (AASHTO), and ANR Correspondence. Minimum standards are based on an ADT of 220 and a design speed of 50 mph for a Local Road.

Design Criteria	Source	Existing Condition	Minimum Standard	Comment
Approach Lane and Shoulder Widths	VSS and AASHTO	9'/2' (22')	7'/1' (16')	
Bridge Lane and Shoulder Widths	VSS and AASHTO	9'/2' (22')	7'/1' (16')	
Clear Zone Distance	AASHTO	No Issues Noted	12'	
Banking	AASHTO	Normal Crown	e_{Max} = 8%	
Speed		50 mph		
Horizontal Alignment	AASHTO	R=infinity	R_{min}=587'	
Vertical Grade	AASHTO	Flat > 0.5%	Max = 7%	
K Values for Vertical Curves	AASHTO	N/A	79	
Stopping Sight Distance	AASHTO	> 500'	360'	
Bicycle/Pedestrian Criteria	N/A	N/A	N/A	
Bridge Railing	Structures Manual Section 13.2	N/A	TL-3	
Hydraulics	Hydraulic Manual & ANR	$HW/D_{(4\% AEP)}=1.2$ Clear Span: 12'	$HW/D_{(4\% AEP)=}1$ Freeboard=1' BFW: 16'	Substandard
Structural Capacity	Structures DesignManual, Ch. 3.4.1	Unknown	Design Live Load: HL-93	

1.5 Hydraulics

The area surrounding the crossing is primarily comprised of agricultural fields with a few residential homes. The project is in Zone A of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the Town of Bridport, dated August 15, 1979, which indicates the project location is not in a detailed study area. The upstream drainage area of the project was estimated by United States Geological Survey (USGS) StreamStats application reports to be 3.3 total square miles. Downstream of the culverts, flow from the project site combines with other watersheds before eventually flow converging with Otter Creek approximately 15 miles north.

Hydraulic capacity is a major concern for this project as the road has a history of overtopping in the vicinity of the crossing, most recently during the October 31, 2019, Halloween Storm during which the road overtopped with a depth of 6 inches per the Town.

Two factors were evaluated in the development of a proposed structure size: hydraulic capacity and stream crossing requirements. The VTrans Hydraulic Manual specifies a design 4% (25-Year) Annual Exceedance Probability (AEP) storm event for a Class III Local Road with a minimum Headwater-to-Depth Ratio (HW/D) of 1.2 for a closed-bottom structure with a rise of 3 feet to 5 feet or 1 foot of freeboard for an open-bottom structure. Fuss and O'Neill contacted the Vermont Department of Environmental Conservation (VTDEC) Agency of Natural Resources (ANR) to ensure the replacement structure meets ANR requirements in anticipation of future permitting. VTDEC confirmed the design flow rate but specified a more conservative HW/D ratio of 1.0. ANR also specified a minimum required span of 1 times bank full width (BFW), which corresponds with the design guidance criteria in the River Management Principles and Practices Manual. The State Assessment completed in 2014 indicates a BFW of 16 feet.

StreamStats was utilized to obtain AEP storm event flow rates. The AEP peak flow rates for the project site are shown below.

AEP (%) (Storm Event)	Flow Rate (cfs)
50% (2-Year)	90.9
40% (5-Year)	143.0
10% (10-Year)	182.0
4% (25-Year)	241.0
2% (50-Year)	291.0
1% (100-Year)	344.0

Table 1 – AEP Flow Rates

A hydraulic model for the existing twin culverts was created by Fuss & O'Neill utilizing FHWA's HY-8 culvert modeling software with input data from publicly available Lidar and supplemented with field data. The existing twin CMPs result in a HW/D of 1.2, which exceeds the minimum HW/D ratio of 1.0. The existing model also shows overtopping of the roadway at the low point of the road just past the crossing during the 50-Year Peak Flow Rate.

Several alternatives for a replacement structure were evaluated: these alternatives are discussed in Section 2 of this report. Per VTDEC's recommendations, all alternatives will need an embedment below the equilibrium of the required stream profile, which is 30% of the opening height of the structure. In addition, a tailwater condition may be required depending on the depth of the stream. For closed-bottom structures, infill may not be required inside the replacement structure if the stream profile slope is less than 0.5%. The conceptual hydraulic results assume a level streambed profile with tailwater conditions for all alternatives. Therefore, infill inside the structure is not required. See Appendix 6.3 for additional information.

A detailed hydraulic model utilizing a steady flow river analysis program is recommended in the next design stage of this project to verify the above results. If infill is required by final hydraulics or for permitting, E-Stone, Type II shall be utilized inside the box with sediment retention sills. Sediment retention sills shall have a maximum 8-foot spacing with one at each invert. A box culvert requires v-notch shaped retention sills with a height of 12 inches at the outsides of the sill and 6 inches at the center to preserve the material inside the box during a storm event.

1.6 Utilities

Utilities were noted in the field as overhead wires on the north side of the road. However, these lines are located beyond the toes of the roadway embankment slope. Therefore, relocations may not be necessary for most of the proposed alternatives. These utilities are shown on the Base Map in Appendix 6.8.

The Town indicated there may be a buried phone line through the project area that may be impacted. The presence of this line and verification of its exact location will need to be determined at the next design stage of this project to determine potential relocation options.

1.7 Right-of-Way

Approximate existing right-of-way (ROW) is shown on the Base Map in Appendix 6.8. It is anticipated that temporary construction easements may be necessary, but permanent easements will not be required except for Alternative 4 for which the structure extends past the existing ROW.

1.8 Environmental and Cultural Resources

The environmental resources present at this project are as follows:

1.8.1 Wetlands/Floodplains

The project is located within a wide floodplain in agricultural farmland. GIS wetland lines indicate that wetlands extend up to the toe of slope on both sides of the roadway embankment to the edge of open water. It is anticipated that all the alternatives will result in wetland and floodplain impacts. The anticipated required permit requirements are noted below:

- <u>Floodplain Permit</u>: For a Town-owned (municipally regulated) structure, a variance is required through the Town of Bridport's Zoning Regulations (ZR) for a culvert replacement within a Federal Emergency Management (FEMA) Special Flood Hazard Zone. The Vermont Floodplain Manager can facilitate coordination with the Town's Zoning Administrator.

- Wetland Permit/Permission: The wetland buffer extends 50 feet in all directions. Wetland impacts greater than 250 square feet require a permit/permission, though it should be noted that impacts below the Ordinary High Water (OHW) elevation or any aspect of the project that overlaps the existing road prism or the existing footprint of the existing culvert, do not count as impacts. The area of impacts determines the tier of permit/permission required. The four potential permits/permissions include Allowed Use, Non-Reporting General Permit (NRGP), General Permit (GP), or Individual Permit. This project will likely qualify for a Non-Reporting General Permit part IV(c), which has no fee and requires only submission of a registration form. Wetland staff should review the replacement alternative concept to provide more specific feedback. The project number created during conceptual coordination is #2021-0991.

- Stream Alterations General Permit: Hydraulic requirements should be submitted to the River Engineer for review as part of the coordination necessary to obtain this permit.

- Army Corps of Engineers (ACOE) Permit: Self-verification (SV), which does not require application or notification to the ACOE provided the activity will meet the terms and conditions of applicable GPs, is acceptable unless permanent and temporary impacts exceed 5,000 square feet per GP 18 of the ACOE Errata Sheet for the Vermont General Permits dated August 9, 2018, (https://www.nae.usace.army.mil/Portals/74/docs/regulatory/StateGeneralPermits/Vermont/VTGP-w-erratasheet.pdf), which is not anticipated. In-stream time-of-year (TOY) restrictions under the SV Permit would be from July 1 to October 1.

1.8.2 Rare, Threatened, and Endangered Species

There are no occurrences of rare, threatened, or endangered species within the project vicinity.

According to the ANR Atlas (https://anrmaps.vermont.gov/websites/ANRA5/default.html) and BioFinder (https://anrmaps.vermont.gov/websites/BioFinder/), and the US Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) mapping, the project area is within the summer range of the Indiana Bat, and the Northern Long Eared Bat (NLEB) has also been seen within the project area. The Indiana Bat is a federally listed endangered species, and the NLEB is a federally listed threatened species. Suitable bat habitats per guidance from USFWS include trees greater than 3 inches in diameter that have holes, crevices, cracks, or peeling bark. As there are no trees matching this description at the crossing, no impacts to either bat species are anticipated.

1.8.3 Wildlife Habitat

VT Fish and Wildlife identifies the study area as a Highest Priority Class 2 Wetland and a Highest Priority surface water and riparian area in the VT Conservation Design Community and Species Scale Components. The landscape adjacent to the river is grassland managed agricultural lands and generally consists of low vegetation such as forbs and shrubs and is categorized as an Upland Shrub Forb area within the Champlain Valley. The project location also has the Highest Priority Physical Landscape Diversity of low elevation with fine sediments and wet flats, and a representative category within the Vermont Conservation Design Landscape Scale. A planting plan should be included in the design plans to revegetate the disturbed areas within the project limits. The plants should match the landscape types noted above.

The existing CMP inverts are submerged under normal flow conditions due to the shallow channel slope and storage area in the vicinity of the crossing. Therefore, aquatic organism passage (AOP) may currently be provided, though the length and narrow opening of the CMPs may discourage AOP due to limited sunlight. A replacement structure will provide greater opportunities for AOP due to a larger hydraulic opening and corresponding decrease in velocity, as well as a shorter structure length allowing sunlight to penetrate further underneath. Construction operations may negatively affect AOP. Therefore, all construction activities are required to be performed during periods of low flow, a sediment and erosion control plan will be required in the final plans, and post construction revegetation in the form of a planting plan as noted above will be required to mitigate these impacts.

1.8.4 Agricultural Soils

Soils within the project area were identified as hydric soil Livingston Clay, flooded, from the NRCS County Soil Survey. The general soil profile from some environmental borings taken from a project about two miles from the project location confirms that settlement will likely be a concern for the stability of the replacement structure foundations. Bedrock was not identified in the borings, so depth to bedrock is unknown.

1.9 Hazardous Materials

According to the Vermont Agency of Natural Resources (VANR) Vermont Hazardous Sites List, there are no hazardous waste sites located in the project area.

1.10 Historic

The existing CMPs are not National Register eligible, and the structures in the vicinity of the crossing include two mobile homes that are also not National Register eligible. A dairy farm complex up the hill to the west of the crossing about a quarter of a mile away is listed on the State Register with the barn listed as circa 1885, the milk house circa 1910, a second barn circa 1945, and the house circa 1850. However, this complex is located too far away to be affected by this project. See Appendix 6.6 for Hartgen Archaeological Associates, Inc. report for additional information.

1.11 Archaeological

The direct Area of Potential Effect (APE) is entirely within the marshy saturated area surrounding the culverts. It is very wet, and a soil core encountered quite uniform soil, indicating a lack of development of an A horizon (topsoil) that might have hosted precontact occupation along the brook. Therefore, the archeological potential at the culverts is low. See Appendix 6.5 for Hartgen Archaeological Associates, Inc. report for additional information.

1.12 Stormwater

The area of disturbance for this project is anticipated to be less than one (1) acre, so a Construction Stormwater (CSW) Permit will not be required. In addition, there are no stormwater or drainage concerns for this project. Stone swales will be provided at the low ends of any proposed curb lines to prevent erosion at those locations.

2 Alternatives Discussion

Fuss & O'Neill established three replacement alternatives to be considered for this project, along with a no action alternative. As the existing CMPs are undersized, a rehabilitation alternative was not evaluated as it would not address the hydraulic inadequacies of the crossing.

Each alternative contains advantages and disadvantages, and this scoping report was developed to provide the information the Town needs to decide on a replacement alternative. Alternatives include an at-grade precast concrete three-sided rigid frame, a buried steel plate arch, and an at-grade precast concrete box culvert.

Roadway Width

Given the low AADT and rural location, the AASHTO Low Volume Manual indicates that the existing 22-foot paved roadway width without guardrail is sufficient for the project location. However, since guardrail is proposed for the replacement structure, a 24-foot paved roadway width (face of rail-to-face of rail) is preferred to facilitate maintenance operations and large equipment passage.

2.1 Alternative 1 – No Action

The no action alternative would involve leaving both existing CMPs in place and continuing with routine maintenance by the Town.

Advantages: This alternative has no immediate cost.

Disadvantages: This alternative does not address the deficiencies of the existing structures. The existing structures will remain hydraulically insufficient and overtopping of the roadway resulting in temporary roadway closings and traffic disruptions will continue. Potential roadway damage may occur during overtopping events. Additionally, if the corrosion of the CMP inverts is not addressed, the CMPs will eventually become structurally deficient leading to lower load postings and eventually closure.

2.2 Alternative 2 – At-Grade Precast Concrete 3-Sided Rigid Frame

An at-grade precast concrete rigid frame is a three-sided structure that is constructed of multiple segments fabricated at a shop and delivered to the project location. Each segment is placed on the chosen foundation type and attached together before being backfilled. No backfill will be placed over the top of the structure. A minimum 5-inch-thick reinforced concrete overlay will be provided over the frame to form the normal crown configuration of the road, and 3 inches of pavement will be provided over the top of the frame.

To maximize the available structure rise and resulting hydraulic opening, 2-Bar Box Beam Bridge Rail will be mounted to the top of the precast concrete headwalls, with approach railing required along each roadway approach. Steel beam guardrail will extend off the approach rail and terminate at the project limits. The total guardrail length, including bridge and approach rail, will be 150 feet. Wingwalls will be flared at 45 degrees to convey stream flow through the structure. As the existing structure is a CMP, E-Stone, Type II will be required to define the new channel upstream, downstream, and through the proposed frame to create a natural stone channel bottom.

2.2.1 Structure Size, Length, and Skew

The conceptual hydraulics indicate that a 16-foot span that meets 1 times BFW does not provide 1 foot of freeboard. Therefore, larger spans were evaluated including a 20-foot span, and 25-foot span, and a 30-foot span. Although the hydraulic opening increases significantly with each 5-foot increase in span, the resulting headwater elevation only changes approximately 0.1 feet. This is a result of the wide floodplain. The increased span eliminates the constriction at the crossing, and the headwater elevation is at the same elevation as the rest of the floodplain, as evidenced by the results of the hydraulic models showing similar upstream and downstream water surface elevations. Therefore, the freeboard requirement cannot be met for this alternative. As the 16-foot span comes close to submerging the low chord of the frame, a 20-foot span is recommended for this alternative to minimize the potential for pressure flow to develop, which can increase the scour potential at the crossing. It should be noted that the roadway for this alternative is not anticipated to be overtopped up to and including the 100-year peak flow rate.

The frame will be aligned perpendicular to the road with no skew. The resulting structure length is 27 feet to accommodate a 24-foot roadway width and mounted bridge rail.

2.2.2 Foundation

Geotechnical investigations have not been performed; however, it is clear from the environmental borings and NRCS soil type classification that the soils at the project location consist of silt and clay, which increases settlement concerns for shallow foundation options like spread footings. Shallow foundations are typically the most cost-effective option, however, if the size of the footings increase to minimize settlement, the cost and impacts of the spread footing become prohibitive and deep foundations become more economically feasible. The most likely deep foundation for the project would be a pile foundation with piles extending to bedrock.

The estimate in the evaluation matrix assumes 8-foot wide by 2-foot-thick precast concrete footings for the rigid frame, which is a conservative estimate for footing size. The bottom of footing is placed 6 feet below streambed for frost and scour protection. However, deep foundations will significantly increase project costs if required. Therefore, a conservative estimate for a pile foundation was developed and included as a separate line item in the Evaluation Matrix to provide the Town with an estimate for any potential foundation cost increases during final design.

2.2.3 Conclusions

Advantages: An open-bottom structure is the preferred configuration for permitting and aquatic organism passage. The open bottom will also accommodate the use of one of the existing CMPs for temporary water diversion during construction or the use of a temporary pipe.

Disadvantages: This alternative does not meet freeboard requirements, and as it is an open-bottom structure, this may lead to an increased chance of scour. The construction of spread footings will require excavation 6 feet below streambed, which may require cofferdams and water control to ensure the footings are placed in the dry. This will also increase construction time and costs. In addition, if geotechnical evaluations indicate deep foundations are required, pile driving may be required.

2.3 Alternative 3 – Buried Steel Plate Arch

A buried steel plate pipe arch is a prefabricated arch that is delivered to the project site in segments and assembled in the field. The arch segments are placed on the chosen foundation type and backfilled after placement is complete. A minimum of 2 feet of backfill material (includes pavement and roadway subbase) would be placed over the top of the arch. The structure would be fabricated with beveled ends to match into the roadway embankment slope eliminating the need for wingwalls, and guardrail would be double nested to span the structure and avoid driving posts over the top of the arch. The total guardrail length, including double-nested rail, will be 150 feet. As the existing structure is a CMP, E-Stone, Type II will be required to define the new channel upstream, downstream, and through the proposed arch to create a natural stone channel bottom.

2.3.1 Structure Size, Length, and Skew

Like the rigid frame option, a 16-foot span that meets 1 times BFW will not provide 1 foot of freeboard. Therefore, two spans were evaluated: a 20-foot span and a 25-foot span. Although the hydraulic opening increases significantly with each 5-foot increase in span, the resulting headwater elevation only changes approximately 0.1 feet. This is a result of the wide floodplain. The increased span eliminates the constriction at the crossing, and the headwater elevation is at the same elevation as the rest of the floodplain, as evidenced by the results of the hydraulic models showing similar upstream and downstream water surface elevations. Therefore, the freeboard requirement cannot be met for this alternative. Although both spans evaluated result in a submerged low chord, the 25-foot span is recommended for this alternative as it is the only span that eliminates overtopping up to and including the 100-year peak flow rate.

The arch will be aligned perpendicular to the road with no skew. The resulting structure length is 71.25 feet and extends past the existing right-of-way.

2.3.2 Foundation

Like the rigid frame alternative, 8-foot wide by 2-foot-thick spread footings placed 6 feet below grade are assumed for the development of the estimate for this alternative, and deep foundations may be required depending on geotechnical evaluations. However, the advantage to this alternative over the rigid frame is its lighter weight. The steel plate arch is significantly lighter than the rigid frame, despite the additional 2 feet of fill over the top of the arch. Therefore, the risk of settlement is decreased, potentially decreasing the potential for deep foundation requirements.

Deep foundations will significantly increase project costs if required. Therefore, a conservative estimate for a pile foundation was developed and included as a separate line item in the Evaluation Matrix to provide the Town with an estimate for any potential foundation cost increases during final design.

2.3.3 Conclusions

Advantages: An open-bottom structure is the preferred configuration for permitting and aquatic organism passage. The open bottom will also accommodate the use of one of the existing CMPs for temporary water diversion during construction or the use of a temporary pipe. The lighter weight of this alternative also decreases potential bearing pressure, reducing the likelihood of settlement.

Disadvantages: This alternative does not meet freeboard requirements. In addition, the low chord is submerged during the design 25-year peak flow, significantly increasing scour potential. The construction of spread footings will require excavation 6 feet below streambed, which may require cofferdams and water control to ensure the footings are placed in the dry. This will also increase construction time and costs. In addition, if geotechnical evaluations indicate deep foundations are required, pile driving may be required. The length of this alternative will also result in permanent ROW impacts and increased wetland impacts as compared to the other alternatives.

2.4 Alternative 4 – Precast Concrete Box Culvert

An at-grade precast concrete box culvert is a four-sided structure that is constructed of multiple segments fabricated at a shop and delivered to the project location. Each segment is placed on a prepared subgrade and attached together before being backfilled. No backfill will be placed over the top of the structure. A minimum 5-inch-thick reinforced concrete overlay will be provided over the box to form the normal crown configuration of the road, and 3 inches of pavement will be provided over the top of the box.

To maximize the available structure rise and resulting hydraulic opening, 2-Bar Box Beam Bridge Rail will be mounted to the top of the precast concrete headwalls, with approach railing required along each roadway approach. Steel beam guardrail will extend off the approach rail and terminate at the project limits. The total guardrail length, including bridge and approach rail, will be 150 feet. Wingwalls will be flared at 45 degrees to facilitate stream flow through the structure. As the box culvert is a closed-bottom structure, E-Stone, Type II will be required inside the box to meet embedment requirements and create a natural stream bottom. Sediment retention sills will also be required to retain the stone. E-Stone, Type II will also be required in the upstream and downstream channels to define the stream where the existing CMPs used to be.

2.4.1 Structure Size, Length, and Skew

The conceptual hydraulics indicate that a 16-foot span has a HW/D ratio of just greater than 1, which meets hydraulic requirements. The roadway for this alternative is not anticipated to be overtopped up to and including the 100-year peak flow rate.

The frame will be aligned perpendicular to the road with no skew. The resulting structure length is 27 feet to accommodate a 24-foot roadway width and mounted bridge rail.

2.4.2 Foundation

Unlike the rigid frame and arch alternatives, the box culvert does not have spread footings. The closed bottom of the box culvert provides a greater area to spread its weight out over the subgrade, reducing settlement potential. Box culverts are generally a better option for project locations with poor soils such as this one. However, if the soil will still not meet bearing pressure requirements for the weight of the box, subgrade improvements may be recommended. There are two methods of subgrade improvement: injections into the soil to improve its bearing capacity or removal of the poor material and replacement with a standard backfill material.

The estimate in the evaluation matrix assumes 2 feet of excavation below the box to place a crushed stone subbase. However, subgrade improvements could potentially significantly increase project costs if required. Therefore, a conservative estimate for an assumed 8-foot depth of excavation under the box was developed and included as a separate line item in the Evaluation Matrix to provide the Town with an estimate for any potential foundation cost increases during final design.

2.4.3 Conclusions

Advantages: Structure hydraulics support one foot of freeboard required by the VTrans Hydraulics Manual. Less chance of scouring compared to the other two build options. Faster construction time compared to the other two build options.

Disadvantages: Construction will likely require continuous pumping during construction, or a stream relocation pipe would need to be constructed outside the limits of culvert construction.

2.5 Future Maintenance

Maintenance for prefabricated structures is minimal. The Town will need to ensure the hydraulic opening is maintained and ensure aggradation and/or debris within the channel at the crossing is removed to ensure the structure can accommodate any potential flood flow. Similarly, the channel will need to be inspected regularly and after larger storm events for any evidence of scour along the footings of the open-bottom alternatives and replace any riprap that is displaced or washed away.

With respect to the roadway, the shoulders and the faces of curb will need to be cleared after winter storms to accommodate stormwater runoff and prevent ice buildup that could result in dangerous driving conditions.

2.6 Maintenance of Traffic

Three options for traffic control were analyzed: phased construction, a temporary bridge, and an off-site detour. Phased construction assuming two phases and one-way alternating traffic with temporary signals would require over-widening the replacement structure, significantly increasing costs, construction time, and wetland and right-of-way impacts, as well as potential utility relocations. As the road is straight and the wetland comes right up to the edge of the roadway embankments, a temporary bridge would result in extensive wetland impacts, along with ROW and utility impacts. After discussion with the Town, the preferred traffic control option would be a bridge closure with off-site detour. The detour route, as advised by the town, is 6 miles point to point, or approximately 10 minutes. See Figure 2 below for the proposed detour route. A closure is safer, provides the Contractor with sufficient room for storage and space to work, and decreases construction time for all the alternatives.

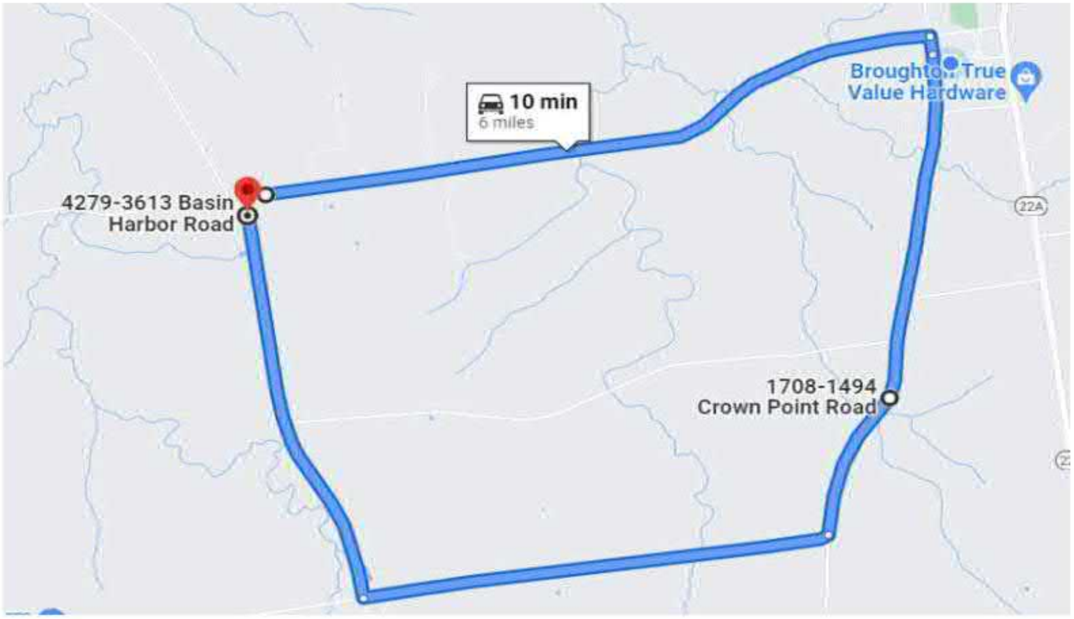


Figure 2 – Detour Route

This route should be evaluated at final design to ensure it can accommodate the large farm equipment and truck traffic that currently utilizes Middle Road. It is anticipated that construction will occur during the summer months when school is closed, however, if school is in session, school bus stop accommodations will be required. Locations of bus stops should be coordinated with the school transportation coordinator. The detour will be signed in compliance with the MUTCD, and traffic control measures at the construction site will also be required. A Traffic Management Plan (TMP) Checklist is required for all contracts for informational purposes.

All estimates assume a bridge closure with off-site detour.

3 Alternatives Summary

Based on the existing site conditions, culvert condition, and recommendations as noted above, the following alternatives are proposed:

- Alternative 1 – No Action
- Alternative 2 – Precast Concrete 3-Sided Rigid Frame on Spread Footings with Traffic Maintained on an Offsite Detour.
- Alternative 3 – Buried Steel Plate Arch on Spread Footings with Traffic Maintained on an Offsite Detour
- Alternative 4 – Precast Concrete Box Culvert with Traffic Maintained on an Offsite Detour

A cost evaluation for each alternative is shown below.

4 Evaluations Matrix

Category		Alternative 1	Alternative 2	Alternative 3	Alternative 4
		Do Nothing	At-Grade Precast Concrete 3-Sided Rigid Frame on Spread Footings	Buried Steel Plate Arch on Spread Footings	At-Grade Precast Concrete Box Culvert
Cost	Roadway		$153,000	$172,000	$143,000
	Structure		$437,000	$520,000	$338,000
	Detour		$8,000	$8,000	$8,000
	Traffic & Safety		$13,000	$13,000	$13,000
	Total		$611,000	$713,000	$502,000
	Deep Foundations / Foundation Improvements		$170,000	$280,000	$110,000
	Total		$781,000	$993,000	$612,000
Engineering	Typical Section	1.5-9-9-1.5	2-10-10-2	2-10-10-2	2-10-10-2
	Align. Change	None	None	None	None
	Bicycle Access	Travel Lane	Travel Lane	Travel Lane	Travel Lane
	Hydraulic Performance	Sufficient	Improved by Minimal Freeboard	Improved by Submerged Low Chord	Meets HW/D > 1
	Utilities	No Impact	Aerial	Aerial	Aerial
Impacts	Ag. Lands	None	None	None	None
	Archaeological	None	None	None	None
	Historic	None	No Adverse	No Adverse	No Adverse
	Hazardous Materials	None	None	None	None
	Floodplains	None	490 SF	3,980 SF	830 SF
	Fish & Wildlife	None	Minimal	Minimal	Moderate
	Rare, Threatened & Endangered Species	None	None	None	None
	Public Lands – Sect. 4(f)	None	None	None	None
	LWCP – Sect. 6(f)	None	None	None	None
	Noise	None	No Change	No Change	No Change
	Wetlands	None	250 SF	1,800 SF	250 SF
Local & Regional Issues	Concerns	Overtopping	Scour	Scour	No Concerns
	Aesthetics	Unchanged	Improved	Improved	Improved
	Community Character	Unchanged	Relatively Unchanged	Relatively Unchanged	Relatively Unchanged
	Economic Impacts	None	None	None	None
	Conformance to Reg. Transportation Plan	No	No	No	Yes
	Satisfies Purpose & Need	No	Yes	Yes	Yes
Permits	ACT 250	No	No	No	No
	401 Water Quality	No	No	No	No
	404 COE Permit	No	Yes	Yes	Yes
	Stream Alteration	No	Yes	Yes	Yes
	State Wetland Permit	No	Yes	Yes	Yes
	Storm Water Discharge	No	No	No	No
	Lakes & Ponds	No	No	No	No
	T & E Species	No	No	No	No
	SHPO	No	No	No	No
Other	AOP	Limited	Provided	Provided	Provided

5 Conclusions and Recommendations

Only one of the four alternatives evaluated satisfy all the requirements for this culvert replacement project and is therefore the recommended alternative: the at-grade precast concrete box culvert. The 16-foot span box culvert is the only alternative that meets hydraulic requirements and is the least likely to require additional foundation improvements. It is also the least expensive alternative per the evaluation matrix.

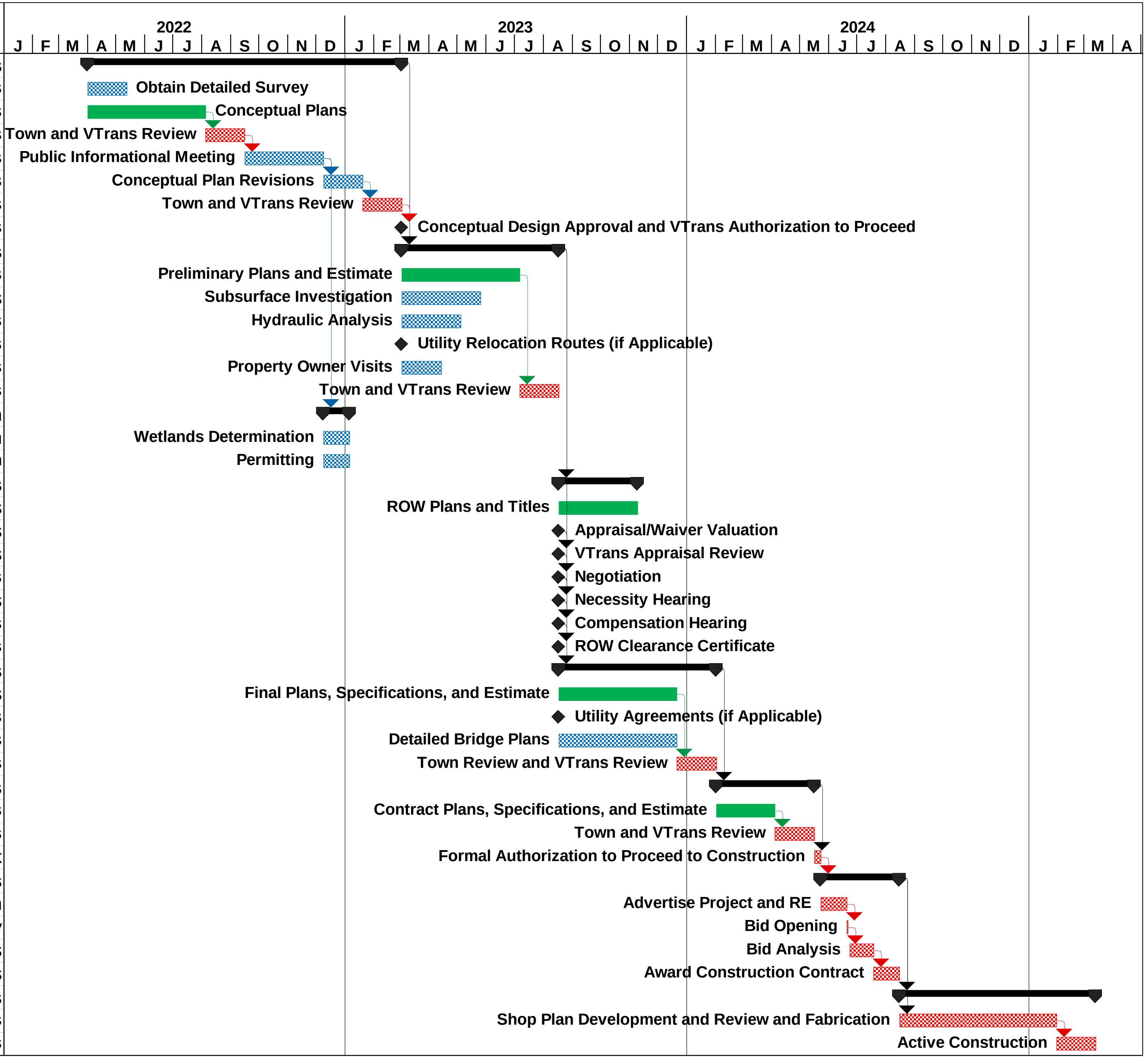
An off-site detour is recommended with a detour length of 6 miles (10 minutes).

5.1 Project Timeline

A preliminary planning schedule has been provided. The schedule assumes funding is granted for the next phase of the project on Town Meeting Day in March 2022. However, the schedule can easily be adjusted if funding approval is not immediately approved.

Middle Road Culvert Replacement
Town of Bridport
Planning Schedule

ID	Task Name	start	Finish	Duration
1	**25% Conceptual Design**	**Fri 4/1/22**	**Thu 3/2/23**	**12 mons**
2	Obtain Detailed Survey	Fri 4/1/22	Thu 5/12/22	6 wks
3	Conceptual Plans	Fri 4/1/22	Thu 8/4/22	90 days
4	Town and VTrans Review	Fri 8/5/22	Thu 9/15/22	30 days
5	Public Informational Meeting	Fri 9/16/22	Thu 12/8/22	60 days
6	Conceptual Plan Revisions	Fri 12/9/22	Thu 1/19/23	30 days
7	Town and VTrans Review	Fri 1/20/23	Thu 3/2/23	30 days
8	Conceptual Design Approval and VTrans Authorization to Proceed	Thu 3/2/23	Thu 3/2/23	0 days
9	**60% Plan Development**	**Thu 3/2/23**	**Thu 8/17/23**	**6 mons**
10	Preliminary Plans and Estimate	Fri 3/3/23	Thu 7/6/23	90 days
11	Subsurface Investigation	Fri 3/3/23	Thu 5/25/23	60 days
12	Hydraulic Analysis	Fri 3/3/23	Thu 5/4/23	45 days
13	Utility Relocation Routes (if Applicable)	Thu 3/2/23	Thu 3/2/23	0 days
14	Property Owner Visits	Fri 3/3/23	Thu 4/13/23	30 days
15	Town and VTrans Review	Fri 7/7/23	Thu 8/17/23	30 days
16	**Permitting**	**Fri 12/9/22**	**Thu 1/5/23**	**1 mon**
17	Wetlands Determination	Fri 12/9/22	Thu 1/5/23	1 mon
18	Permitting	Fri 12/9/22	Thu 1/5/23	1 mon
19	**Right-of-Way**	**Thu 8/17/23**	**Thu 11/9/23**	**3 mons**
20	ROW Plans and Titles	Fri 8/18/23	Thu 11/9/23	60 days
21	Appraisal/Waiver Valuation	Thu 8/17/23	Thu 8/17/23	0 days
22	VTrans Appraisal Review	Thu 8/17/23	Thu 8/17/23	0 days
23	Negotiation	Thu 8/17/23	Thu 8/17/23	0 days
24	Necessity Hearing	Thu 8/17/23	Thu 8/17/23	0 days
25	Compensation Hearing	Thu 8/17/23	Thu 8/17/23	0 days
26	ROW Clearance Certificate	Thu 8/17/23	Thu 8/17/23	0 days
27	**85% Plan Development**	**Thu 8/17/23**	**Thu 2/1/24**	**6 mons**
28	Final Plans, Specifications, and Estimate	Fri 8/18/23	Thu 12/21/23	90 days
29	Utility Agreements (if Applicable)	Thu 8/17/23	Thu 8/17/23	0 days
30	Detailed Bridge Plans	Fri 8/18/23	Thu 12/21/23	90 days
31	Town Review and VTrans Review	Fri 12/22/23	Thu 2/1/24	30 days
32	**100% Contract Plans**	**Fri 2/2/24**	**Thu 5/16/24**	**3.75 mons**
33	Contract Plans, Specifications, and Estimate	Fri 2/2/24	Thu 4/4/24	45 days
34	Town and VTrans Review	Fri 4/5/24	Thu 5/16/24	30 days
35	Formal Authorization to Proceed to Construction	Fri 5/17/24	Thu 5/23/24	1 wk
36	**Procurement of Construction Services**	**Fri 5/24/24**	**Thu 8/15/24**	**3 mons**
37	Advertise Project and RE	Fri 5/24/24	Thu 6/20/24	1 mon
38	Bid Opening	Fri 6/21/24	Fri 6/21/24	1 day
39	Bid Analysis	Mon 6/24/24	Thu 7/18/24	19 days
40	Award Construction Contract	Fri 7/19/24	Thu 8/15/24	4 wks
41	**Construction**	**Fri 8/16/24**	**Thu 3/13/25**	**7.5 mons**
42	Shop Plan Development and Review and Fabrication	Fri 8/16/24	Thu 1/30/25	6 mons
43	Active Construction	Fri 1/31/25	Thu 3/13/25	6 wks



Project: Middle Road over East Branch D
Date: Tue 1/18/22

Task	▨	Rolled Up Split	┈	External Milestone	◆	Manual Task	▬	Finish-only	]
Split	┈	Rolled Up Milestone	◇	Inactive Task	▪	Duration-only	▬	Progress	▬
Milestone	◆	Rolled Up Progress	▬	Inactive Task	▭	Manual Summary Rollup	▬	Deadline	⇩
Summary	▬	External Tasks	▨	Inactive Milestone	◇	Manual Summary	▬		
Rolled Up Task	▨	Project Summary	▬	Inactive Summary	▭	Start-only	[		

6 Appendices

6.1 Site Pictures

Photo 1: Roadway Looking Westbound Dated: 07/14/2021

Photo 2: Roadway Looking Eastbound Dated: 06/29/2021

Photo 3: Culvert Upstream Inlets Dated: 07/14/2021

Photo 4: Culvert Downstream Outlets Dated: 07/14/2021

Photo 5: Culvert Outlet Corrosion Dated: 06/29/2021

Photo 6: Culvert Interior Dated: 06/29/2021

Photo 7: Culvert Downstream Invert Out Dated: 06/29/2021

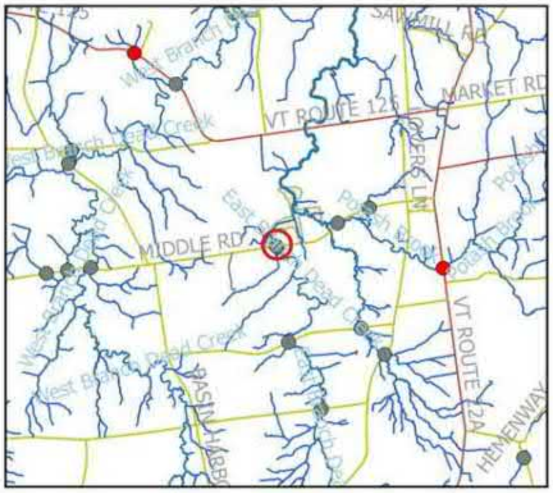
Photo 8: Debris at Culvert Downstream Invert Out Dated: 06/29/2021

Photo 7: Upstream Reach Dated: 09/07/2021

Photo 8: Downstream Reach Dated: 07/14/2021

6.2 State Assessment

SGAID:	400027000101021	**Assessment:**	9/21/2014	**Town:**	Bridport
Stream:	East Branch Dead Creek	**Latitude:**	43.97962	**Longitude:**	-73.33694
Location:		**Road:**	MIDDLE RD,	**Surface:**	Paved



Structure		**Stream**	
Structure (overflow):	Culvert (No)	Structure skewed:	No
Material:	Steel Corrugated	Floodplain filled:	Entirely
Width:	6 ft	Avulsion (distance):	Cross Road ()
Height:	6 ft	U/S bed (bedrock):	Unknown (No)
Length:	30 ft	Struct. bed (bedrock):	Unknown (No)
Footers:		D/S bed (bedrock):	Unknown (No)

Aquatic Organism Passage

Coarse screen	Gray	Pool present:	Yes
Outlet (drop):	Entirely Backwatered (0 ft)	Pool depth (at outlet):	2 ft
Backwater length:	30 ft	Pool depth (max):	5 ft
Depth at outlet:	2 ft	Substrate throughout:	No
Number of culverts:	2	Inlet obstructions:	None
Retrofit potential:	MLL	High Flow Stage:	No

Geomorphic Compatibility

Coarse Screen (25 max)	17	Structure slope:	Same
BFW:	16 ft (Measured)	Break in slope:	No
% BFW:	37.5%	U/S erosion:	Low
U/S deposits (>50% BFH):	None (No)	D/S erosion:	Low
D/S scour:	Culvert	U/S armoring:	None
D/S bank > U/S Bank:	No	D/S armoring:	None
Approach angle:	Naturally straight	Steep riffle:	No

Stream Network

U/S Total:	19.9 mi	U/S Mainstem:	1.5 mi
U/S Net	3.4 mi	Net:	3.4 mi
U/S, D/S Barriers:	4, 0		

Comment:

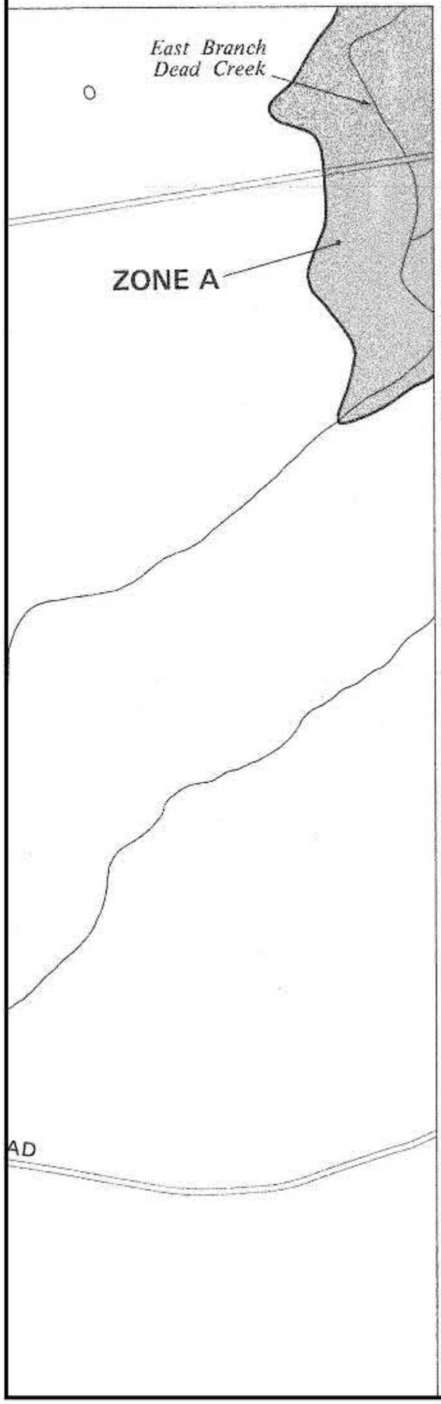
Upstream

Inlet

Downstream

Outlet

6.3 Hydraulic Coordination and Analyses



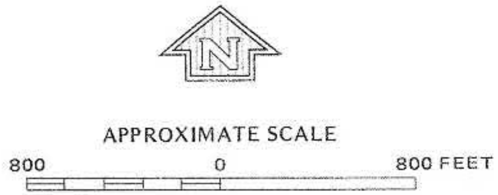
KEY TO MAP

500-Year Flood Boundary	ZONE B
100-Year Flood Boundary	
Zone Designations* With Date of Identification e.g., 12/2/74	ZONE A1 DATE / ZONE A5 DATE
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
River Mile	• M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

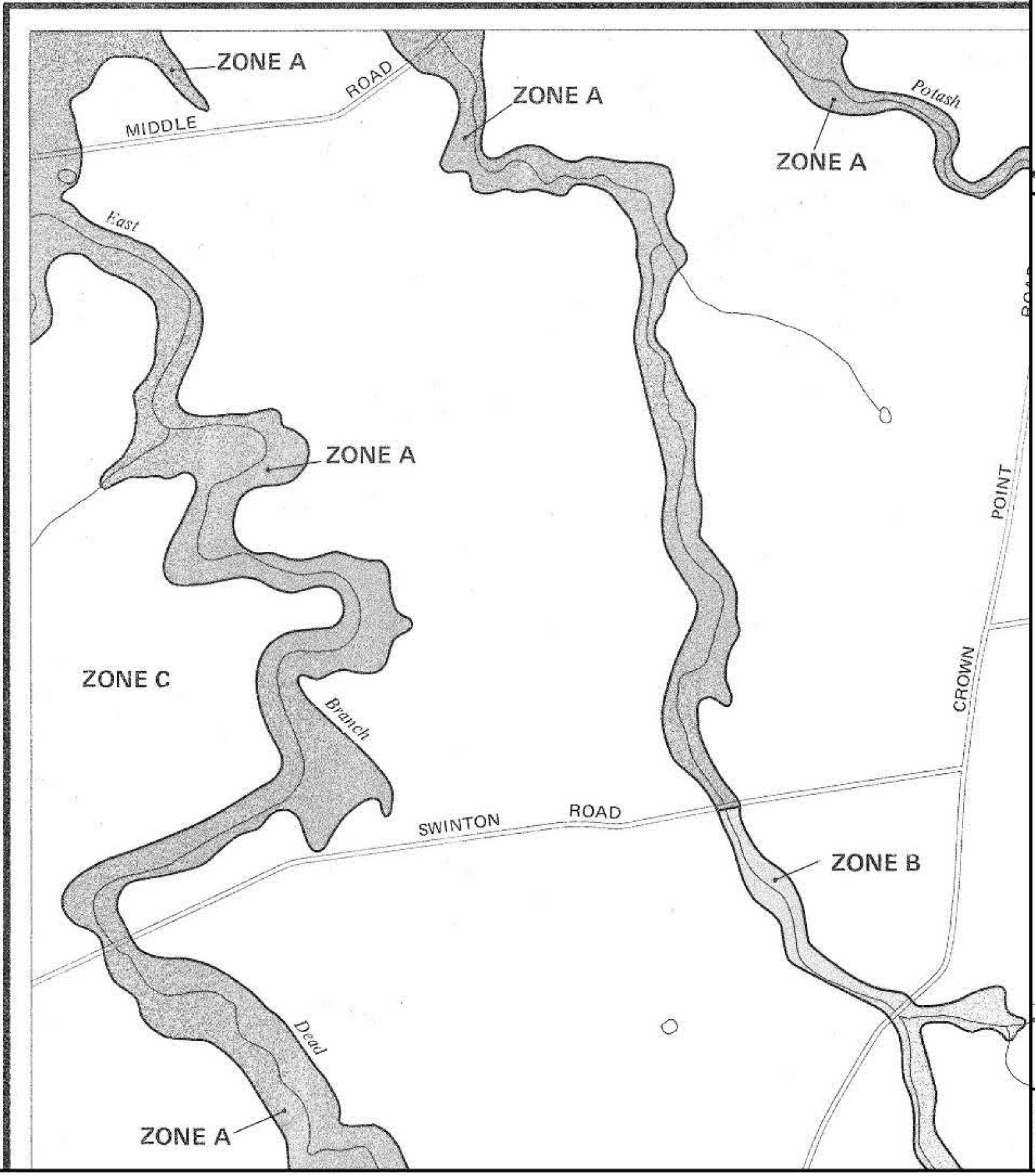
TOWN OF
BRIDPORT,
VERMONT
ADDISON COUNTY

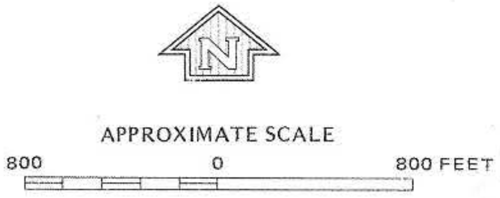
PANEL 15 OF 20

COMMUNITY-PANEL NUMBER
500164 0015 A

EFFECTIVE DATE:
AUGUST 15, 1979

U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION





NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
BRIDPORT,
VERMONT
ADDISON COUNTY

PANEL 20 OF 20

COMMUNITY-PANEL NUMBER
500164 0020 A

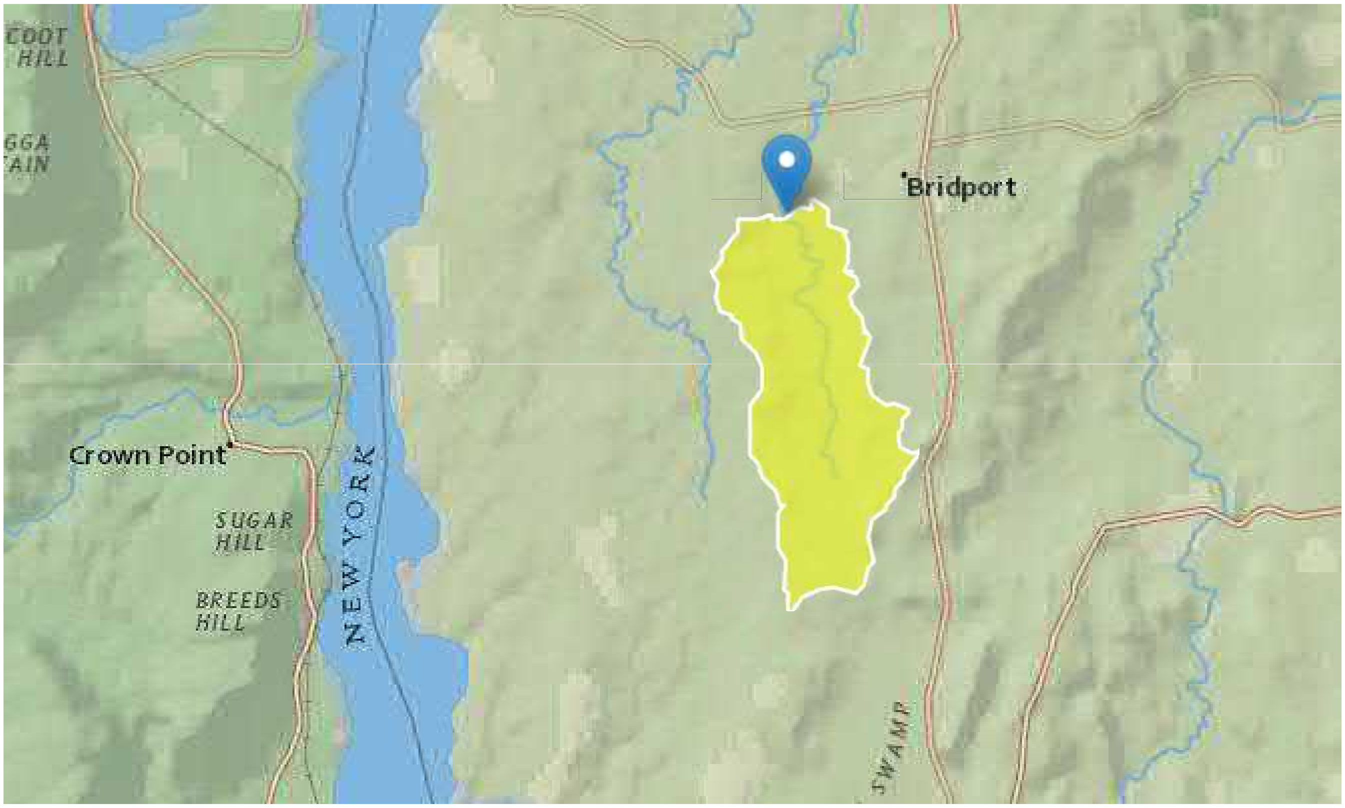
EFFECTIVE DATE:
AUGUST 15, 1979

U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION

This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at https://msc.fema.gov.

Middle Road over East Branch Dead Creek StreamStats Report

Region ID: VT
Workspace ID: VT20210701121822056000
Clicked Point (Latitude, Longitude): 43.97961, -73.33683
Time: 2021-07-01 08:18:38 -0400



MP210607.A10

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	3.3	square miles
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	1.55	percent

Parameter Code	Parameter Description	Value	Unit
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	36	inches

Peak-Flow Statistics Parameters [Statewide Peak Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.3	square miles	0.18	689
LC06STOR	Percent Storage from NLCD2006	1.55	percent	0	18.5
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	36	inches	33.5	70.4

Peak-Flow Statistics Flow Report [Statewide Peak Flow]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
50-percent AEP flood	90.9	ft^3/s	51.3	161	34.8
20-percent AEP flood	143	ft^3/s	79.3	258	36.1
10-percent AEP flood	182	ft^3/s	96.8	342	38.6
4-percent AEP flood	241	ft^3/s	121	480	42.5
2-percent AEP flood	291	ft^3/s	141	602	44.9
1-percent AEP flood	344	ft^3/s	161	737	47.3
0.5-percent AEP flood	404	ft^3/s	179	910	50.8
0.2-percent AEP flood	493	ft^3/s	206	1180	55.2

Peak-Flow Statistics Citations

Olson, S.A.,2014, Estimation of flood discharges at selected annual exceedance probabilities for unregulated, rural streams in Vermont, with a section on Vermont regional skew regression, by Veilleux, A.G.: U.S. Geological Survey Scientific Investigations Report 2014–5078, 27 p. plus appendixes. (http://pubs.usgs.gov/sir/2014/5078/)

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Application Version: 4.5.3
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

Maximum Flow: 344 cfs

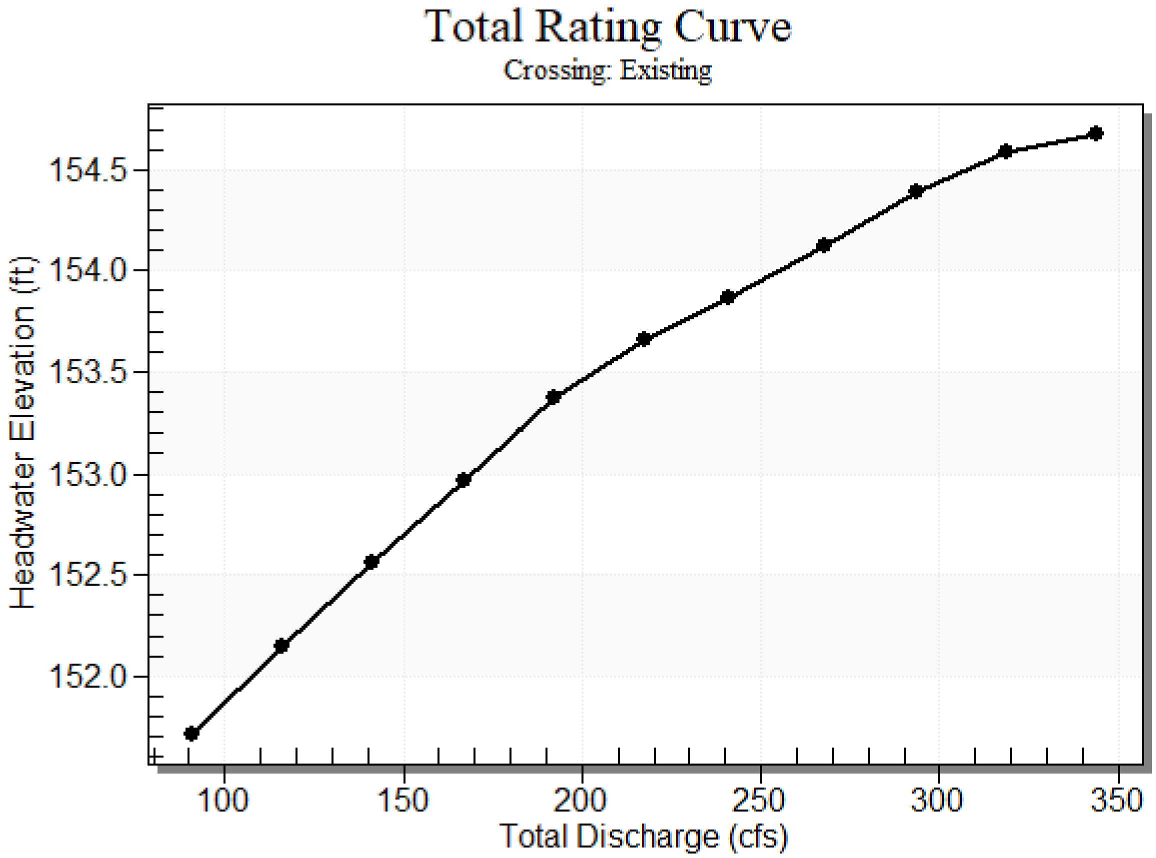
EXISTING CMPs

Table 1 - Summary of Culvert Flows at Crossing: Existing

Headwater Elevation (ft)	Total Discharge (cfs)	East CMP Discharge (cfs)	West CMP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
151.72	90.90	42.80	48.10	0.00	4
152.15	116.21	55.27	60.91	0.00	3
152.56	141.52	67.83	73.68	0.00	3
152.96	166.83	80.43	86.38	0.00	3
153.37	192.14	93.08	99.02	0.00	7
153.66	217.45	105.69	111.73	0.00	4
153.86	241.00	117.75	123.15	0.00	3
154.13	268.07	131.51	136.40	0.00	9
154.39	293.38	144.25	148.69	0.00	21
154.58	318.69	152.53	156.75	8.77	13
154.68	344.00	156.68	160.77	26.05	9
154.40	293.48	144.52	148.96	0.00	Overtopping

EXISTING CMPs

Rating Curve Plot for Crossing: Existing



EXISTING CMPs

Table 2 - Culvert Summary Table: East CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	42.80	151.72	2.821	3.916	7-A2c	-1.000	1.824	1.824	2.099	6.604	1.646
116.21	55.27	152.15	3.253	4.350	7-A2c	-1.000	2.082	2.082	2.405	7.144	1.776
141.52	67.83	152.56	3.667	4.763	7-A2c	-1.000	2.324	2.324	2.678	7.591	1.885
166.83	80.43	152.96	4.070	5.164	7-A2c	-1.000	2.539	2.539	2.928	8.034	1.980
192.14	93.08	153.37	4.473	5.567	7-A2c	-1.000	2.738	2.738	3.158	8.456	2.064
217.45	105.69	153.66	4.883	5.856	7-A2c	-1.000	2.927	2.927	3.374	8.850	2.140
241.00	117.75	153.86	5.287	6.062	7-A2c	-1.000	3.095	3.095	3.563	9.226	2.204
268.07	131.51	154.13	5.774	6.325	7-A2c	-1.000	3.280	3.280	3.768	9.634	2.273
293.38	144.25	154.39	6.254	6.594	7-A2c	-1.000	3.438	3.438	3.950	10.020	2.332
318.69	152.53	154.58	6.586	6.782	7-A2c	-1.000	3.537	3.537	4.124	10.273	2.387
344.00	156.68	154.68	6.757	6.880	7-A2c	-1.000	3.585	3.585	4.290	10.400	2.439

EXISTING CMPs

****

Straight Culvert

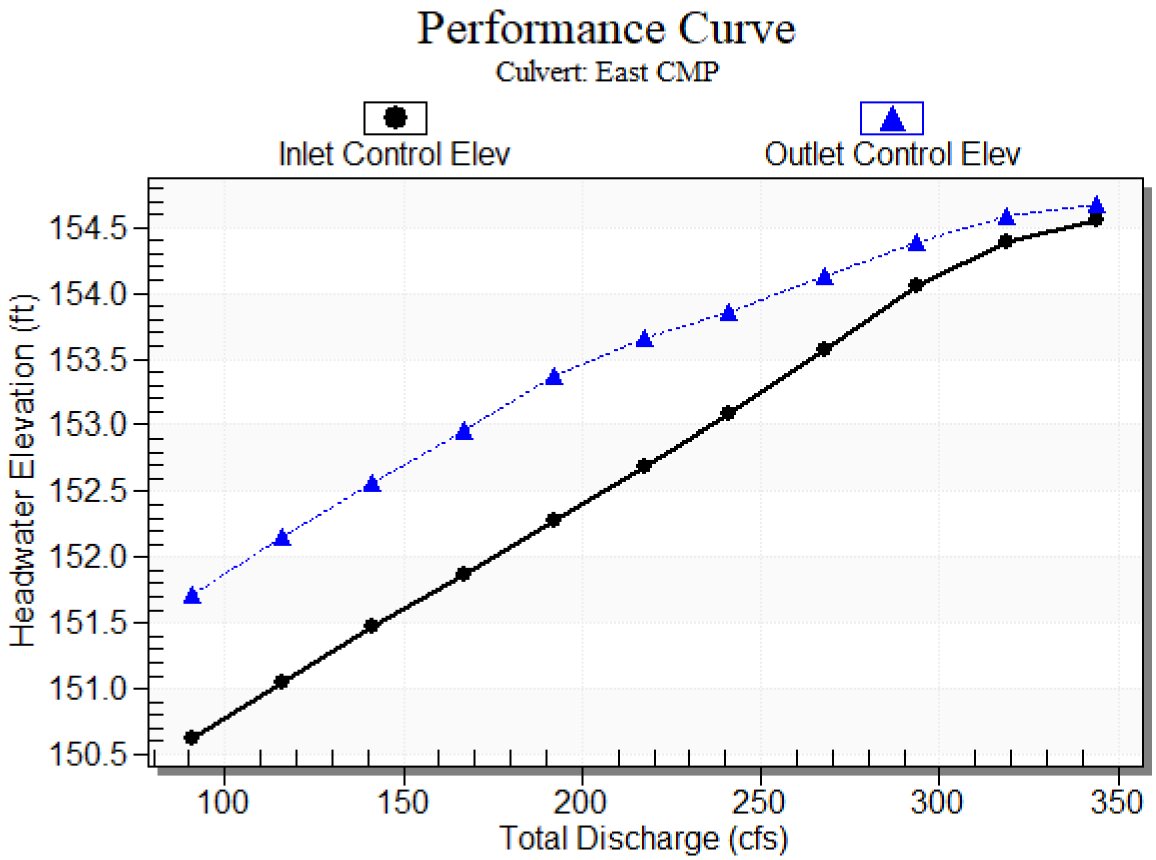
Inlet Elevation (invert): 147.80 ft,   Outlet Elevation (invert): 149.00 ft

Culvert Length: 40.02 ft,   Culvert Slope: -0.0300

****

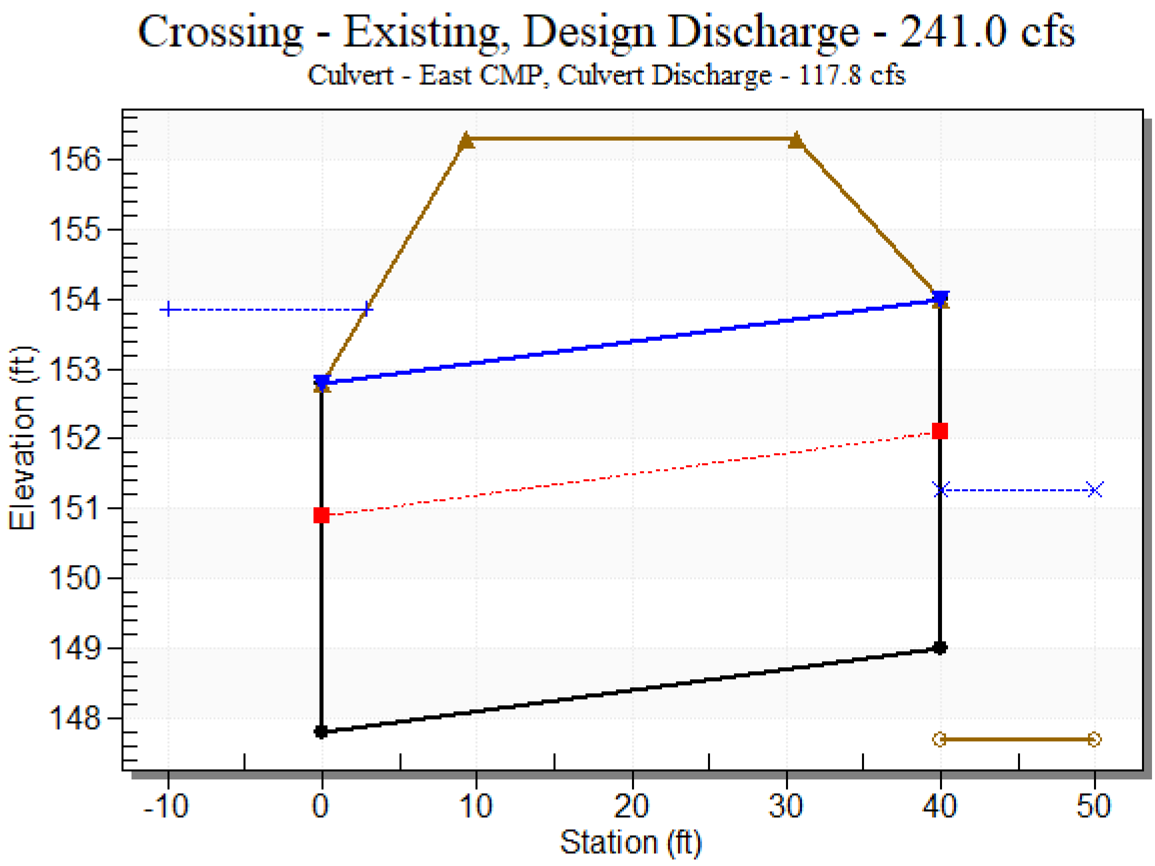
EXISTING CMPs

Culvert Performance Curve Plot: East CMP



EXISTING CMPs

Water Surface Profile Plot for Culvert: East CMP



Site Data - East CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 147.80 ft

Outlet Station: 40.00 ft

Outlet Elevation: 149.00 ft

Number of Barrels: 1

Culvert Data Summary - East CMP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

EXISTING CMPs

Table 3 - Culvert Summary Table: West CMP

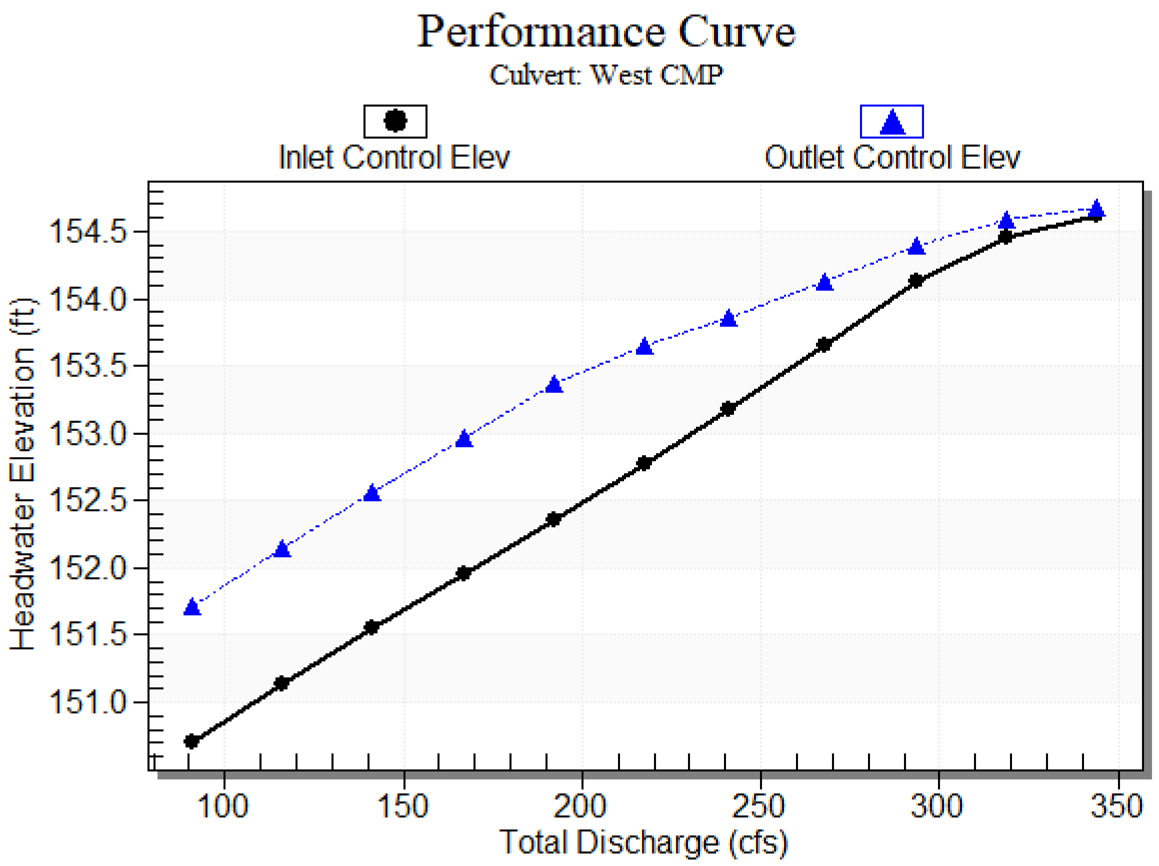
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	48.10	151.72	3.001	4.016	7-A2c	-1.000	1.937	1.937	2.099	6.846	1.646
116.21	60.91	152.15	3.435	4.450	7-A2c	-1.000	2.194	2.194	2.405	7.345	1.776
141.52	73.68	152.56	3.849	4.863	7-A2c	-1.000	2.426	2.426	2.678	7.798	1.885
166.83	86.38	152.96	4.253	5.264	7-A2c	-1.000	2.633	2.633	2.928	8.242	1.980
192.14	99.02	153.37	4.659	5.667	7-A2c	-1.000	2.827	2.827	3.158	8.651	2.064
217.45	111.73	153.66	5.077	5.956	7-A2c	-1.000	3.012	3.012	3.374	9.039	2.140
241.00	123.15	153.86	5.468	6.162	7-A2c	-1.000	3.167	3.167	3.563	9.392	2.204
268.07	136.40	154.13	5.948	6.425	7-A2c	-1.000	3.342	3.342	3.768	9.782	2.273
293.38	148.69	154.39	6.424	6.693	7-A2c	-1.000	3.491	3.491	3.950	10.155	2.332
318.69	156.75	154.58	6.754	6.882	7-A2c	-1.000	3.585	3.585	4.124	10.402	2.387
344.00	160.77	154.68	6.925	6.980	7-A2c	-1.000	3.631	3.631	4.290	10.526	2.439

EXISTING CMPs

```
********************************************************************************
                          Straight Culvert
Inlet Elevation (invert): 147.70 ft,    Outlet Elevation (invert): 148.80 ft
           Culvert Length: 40.02 ft,    Culvert Slope: -0.0275
********************************************************************************
```

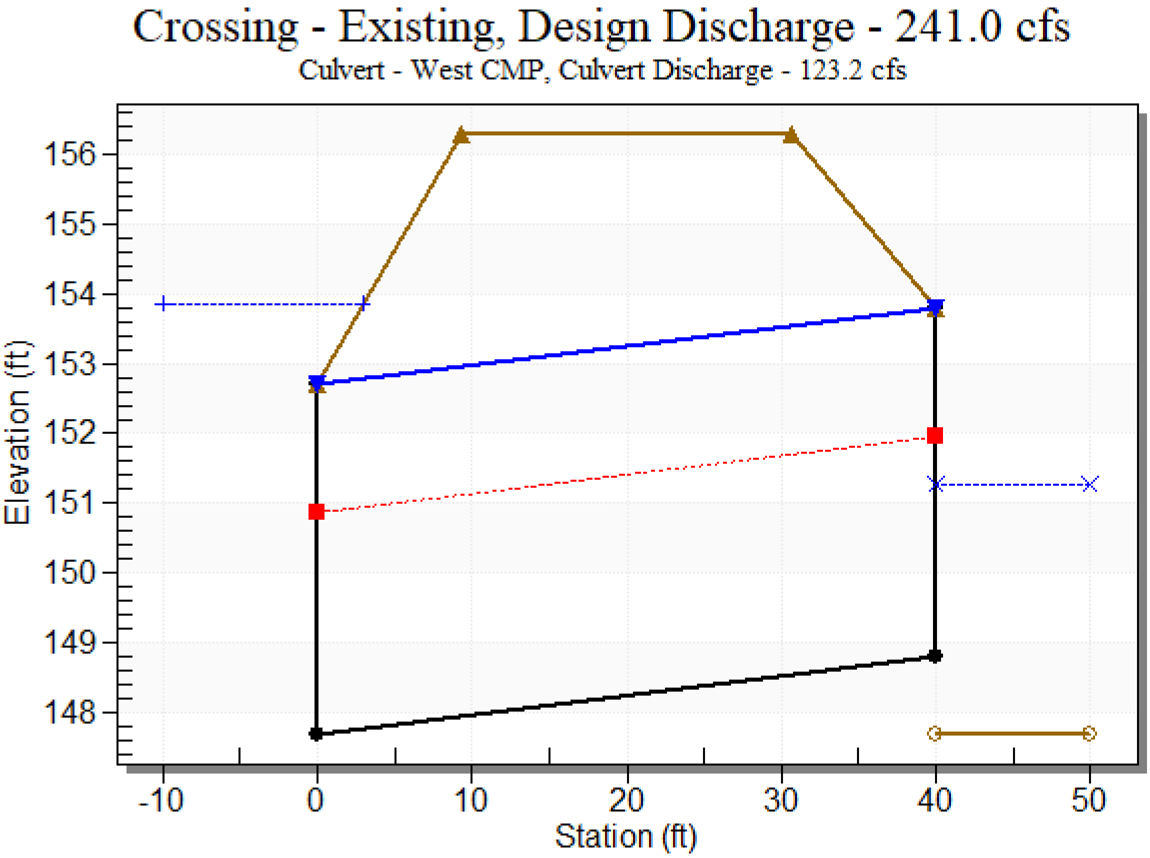
EXISTING CMPs

Culvert Performance Curve Plot: West CMP



EXISTING CMPs

Water Surface Profile Plot for Culvert: West CMP



Site Data - West CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 147.70 ft

Outlet Station: 40.00 ft

Outlet Elevation: 148.80 ft

Number of Barrels: 1

Culvert Data Summary - West CMP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 4 - Downstream Channel Rating Curve (Crossing: Existing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	149.80	2.10	1.65	0.13	0.22
116.21	150.10	2.40	1.78	0.15	0.23
141.52	150.38	2.68	1.88	0.17	0.23
166.83	150.63	2.93	1.98	0.18	0.23
192.14	150.86	3.16	2.06	0.20	0.24
217.45	151.07	3.37	2.14	0.21	0.24
241.00	151.26	3.56	2.20	0.22	0.24
268.07	151.47	3.77	2.27	0.24	0.24
293.38	151.65	3.95	2.33	0.25	0.24
318.69	151.82	4.12	2.39	0.26	0.24
344.00	151.99	4.29	2.44	0.27	0.24

EXISTING CMPs

Tailwater Channel Data - Existing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 20.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Existing

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

Maximum Flow: 344 cfs

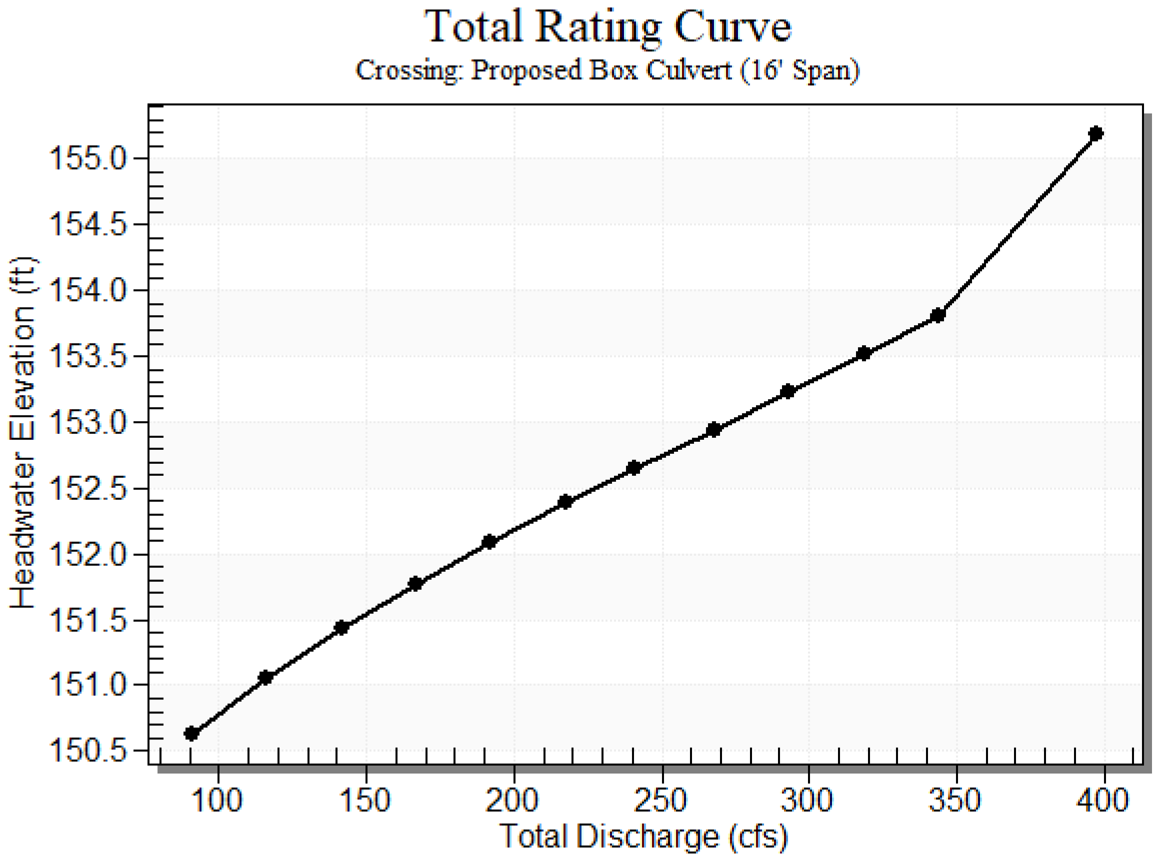
5' Rise x16' Span Box Culvert

Table 5 - Summary of Culvert Flows at Crossing: Proposed Box Culvert (16' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Box Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.63	90.90	90.90	0.00	1
151.05	116.21	116.21	0.00	1
151.43	141.52	141.52	0.00	1
151.77	166.83	166.83	0.00	1
152.09	192.14	192.14	0.00	1
152.39	217.45	217.45	0.00	1
152.65	241.00	241.00	0.00	1
152.94	268.07	268.07	0.00	1
153.22	293.38	293.38	0.00	1
153.51	318.69	318.69	0.00	1
153.80	344.00	344.00	0.00	1
154.40	397.55	397.55	0.00	Overtopping

5' Rise x16' Span Box Culvert

Rating Curve Plot for Crossing: Proposed Box Culvert (16' Span)



5' Rise x16' Span Box Culvert

Table 6 - Culvert Summary Table: Box Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.63	1.549	2.935	7-H2t	-1.000	1.165	2.779	2.779	2.247	1.863
116.21	116.21	151.05	1.811	3.353	7-H2t	-1.000	1.374	3.169	3.169	2.488	1.999
141.52	141.52	151.43	2.049	3.728	7-H2t	-1.000	1.562	3.517	3.517	2.707	2.114
166.83	166.83	151.77	2.270	4.071	7-H2t	-1.000	1.736	3.832	3.832	2.911	2.214
192.14	192.14	152.09	2.476	4.390	7-H2t	-1.000	1.898	4.123	4.123	3.101	2.302
217.45	217.45	152.39	2.677	4.688	7-H2t	-1.000	2.046	4.393	4.393	3.280	2.381
241.00	241.00	152.65	2.864	4.950	7-H2t	-1.000	2.173	4.629	4.629	3.439	2.449
268.07	268.07	152.94	3.080	5.236	7-H2t	-1.000	2.313	4.885	4.885	3.614	2.520
293.38	293.38	153.22	3.281	5.524	4-FFf	-1.000	2.440	5.000	5.112	3.860	2.582
318.69	318.69	153.51	3.482	5.814	4-FFf	-1.000	2.555	5.000	5.328	4.193	2.640
344.00	344.00	153.80	3.678	6.100	4-FFf	-1.000	2.673	5.000	5.534	4.526	2.695

5' Rise x16' Span Box Culvert

****

Straight Culvert

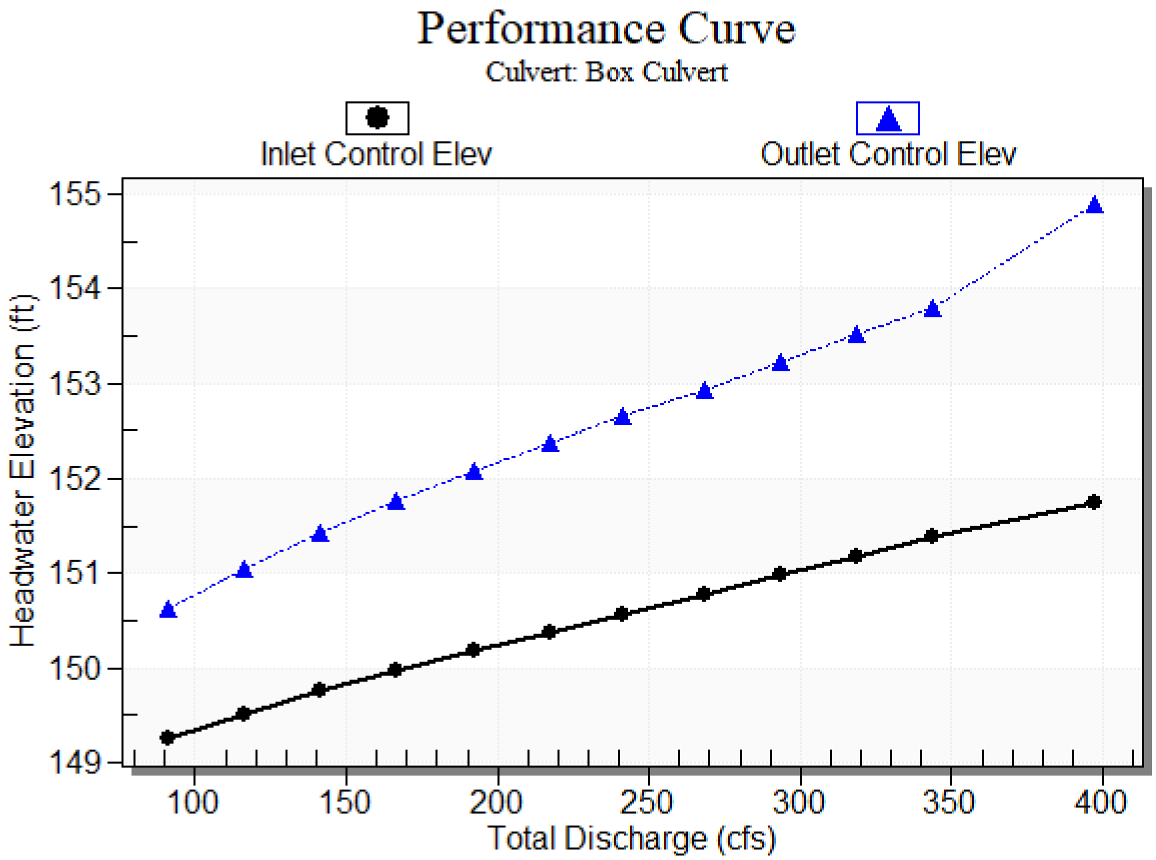
Inlet Elevation (invert): 147.70 ft,   Outlet Elevation (invert): 147.70 ft

Culvert Length: 33.00 ft,   Culvert Slope: 0.0000

****

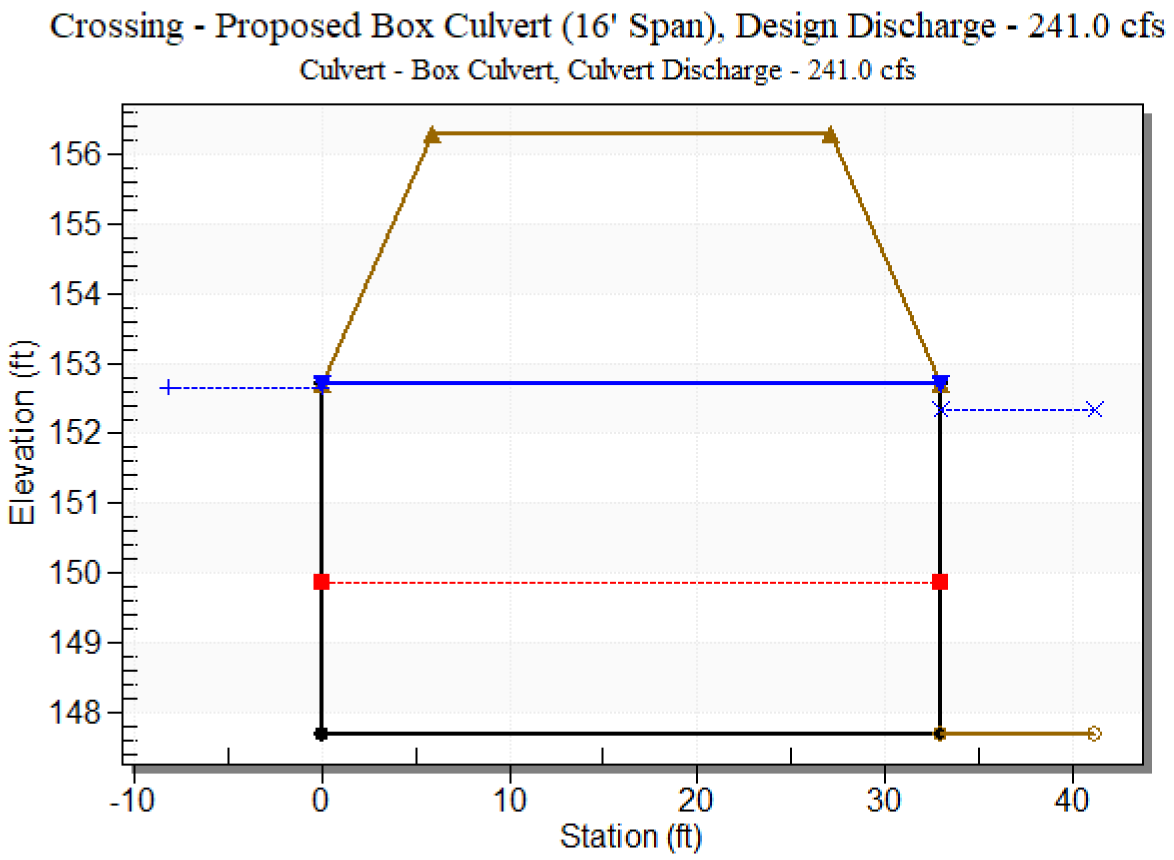
5' Rise x16' Span Box Culvert

Culvert Performance Curve Plot: Box Culvert



5' Rise x16' Span Box Culvert

Water Surface Profile Plot for Culvert: Box Culvert



Site Data - Box Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 147.70 ft

Outlet Station: 33.00 ft

Outlet Elevation: 147.70 ft

Number of Barrels: 1

Culvert Data Summary - Box Culvert

Barrel Shape: User Defined

Barrel Span: 16.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

5' Rise x16' Span Box Culvert

Table 7 - Downstream Channel Rating Curve (Crossing: Proposed Box Culvert (16'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

5' Rise x16' Span Box Culvert

Tailwater Channel Data - Proposed Box Culvert (16' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Box Culvert (16' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

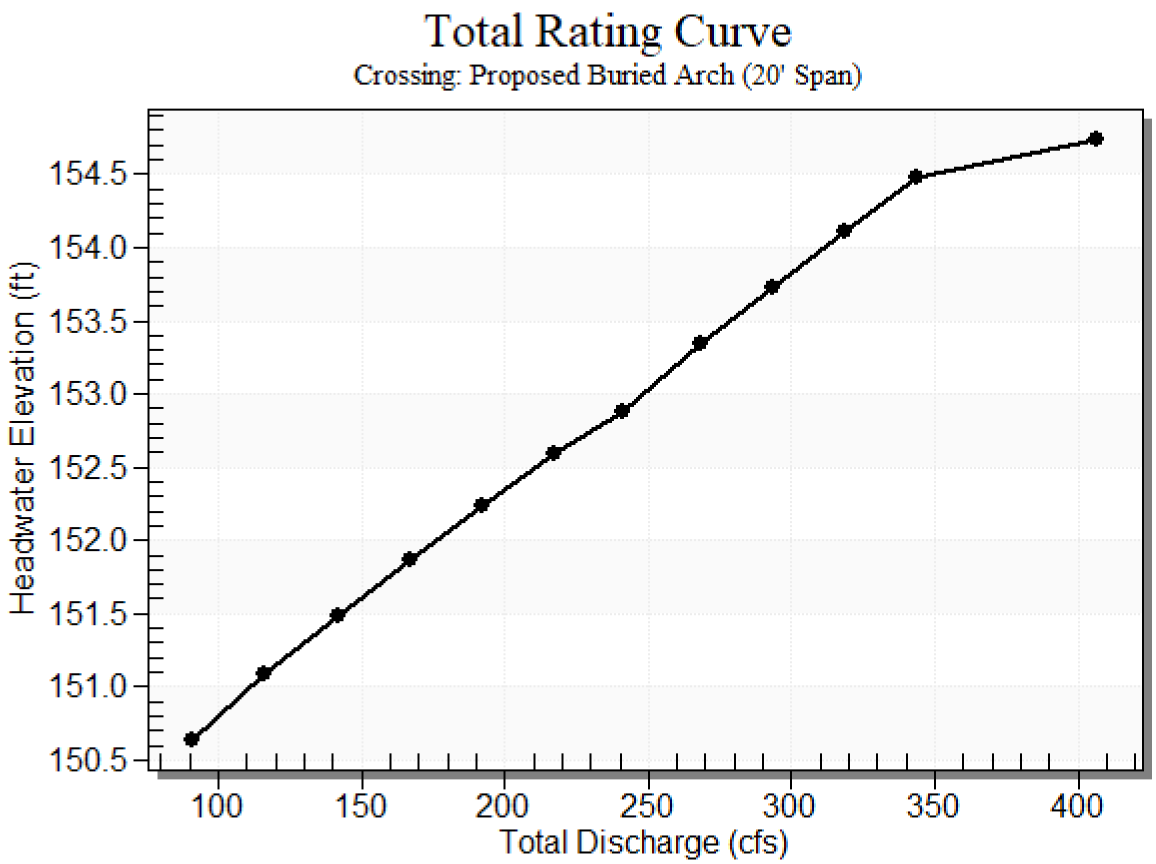
Maximum Flow: 344 cfs

Table 8 - Summary of Culvert Flows at Crossing: Proposed Buried Arch (20' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Arch_OpenBottom Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.64	90.90	90.90	0.00	1
151.08	116.21	116.21	0.00	1
151.49	141.52	141.52	0.00	1
151.87	166.83	166.83	0.00	1
152.23	192.14	192.14	0.00	1
152.59	217.45	217.45	0.00	1
152.88	241.00	241.00	0.00	1
153.35	268.07	268.07	0.00	1
153.73	293.38	293.38	0.00	1
154.11	318.69	318.69	0.00	1
154.47	344.00	342.63	0.85	25
154.40	337.90	337.90	0.00	Overtopping

20' Span Steel Plate Arch

Rating Curve Plot for Crossing: Proposed Buried Arch (20' Span)



20' Span Steel Plate Arch

Table 9 - Culvert Summary Table: Arch_OpenBottom

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.64	1.738	2.939	7-H2t	-1.000	0.992	2.775	2.779	2.214	1.863
116.21	116.21	151.08	2.061	3.379	7-H2t	-1.000	1.164	3.166	3.169	2.552	1.999
141.52	141.52	151.49	2.362	3.783	7-H2t	-1.000	1.329	3.514	3.517	2.883	2.114
166.83	166.83	151.87	2.625	4.162	7-H2t	-1.000	1.479	3.829	3.832	3.211	2.214
192.14	192.14	152.23	2.886	4.527	7-H2t	-1.000	1.626	4.120	4.123	3.546	2.302
217.45	217.45	152.59	3.147	4.888	7-H2t	-1.000	1.767	4.390	4.393	3.893	2.381
241.00	241.00	152.88	3.390	5.172	7-H2t	-1.000	1.897	4.626	4.629	4.239	2.449
268.07	268.07	153.35	3.640	5.647	4-FFf	-1.000	2.033	4.757	4.885	4.697	2.520
293.38	293.38	153.73	3.863	6.024	4-FFf	-1.000	2.155	4.757	5.112	5.140	2.582
318.69	318.69	154.11	4.085	6.405	4-FFf	-1.000	2.277	4.757	5.328	5.583	2.640
344.00	342.63	154.47	4.295	6.779	4-FFf	-1.000	2.382	4.757	5.534	6.003	2.695

20' Span Steel Plate Arch

****

Straight Culvert

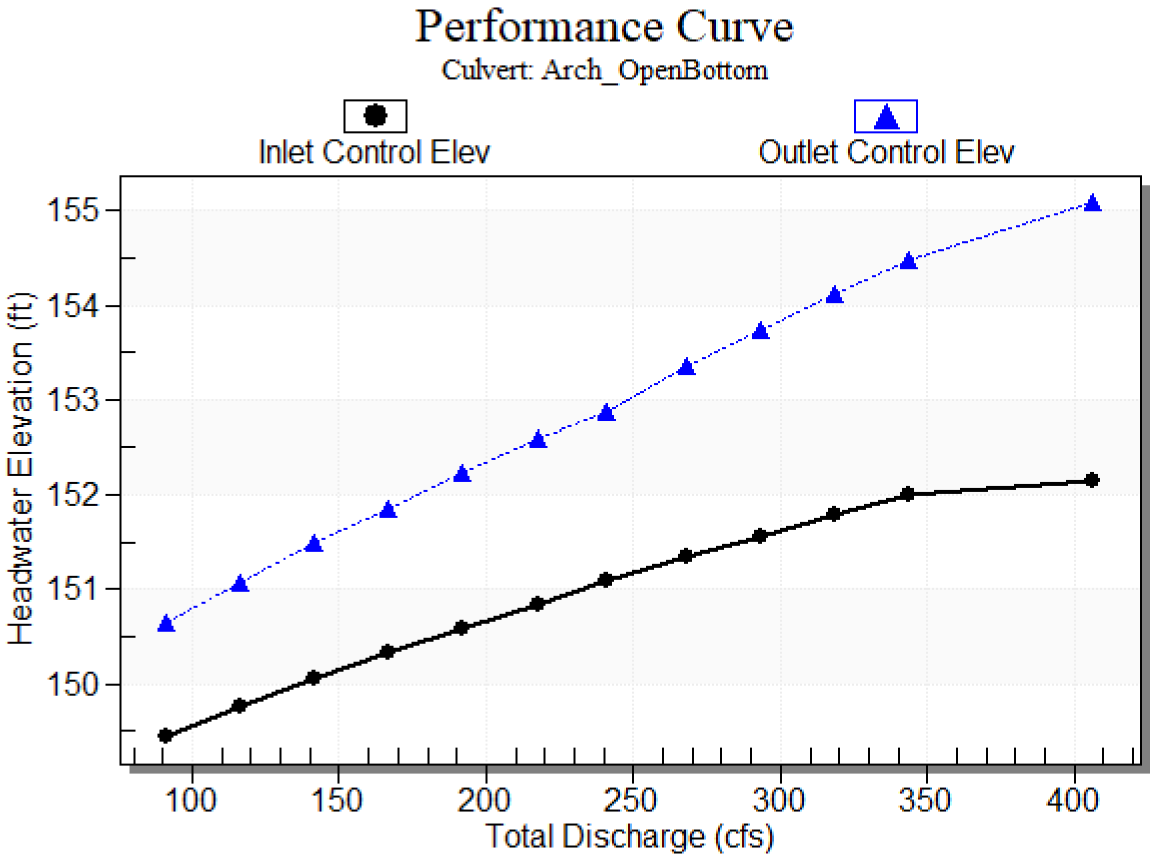
Inlet Elevation (invert): 147.70 ft,   Outlet Elevation (invert): 147.70 ft

Culvert Length: 33.00 ft,   Culvert Slope: 0.0000

****

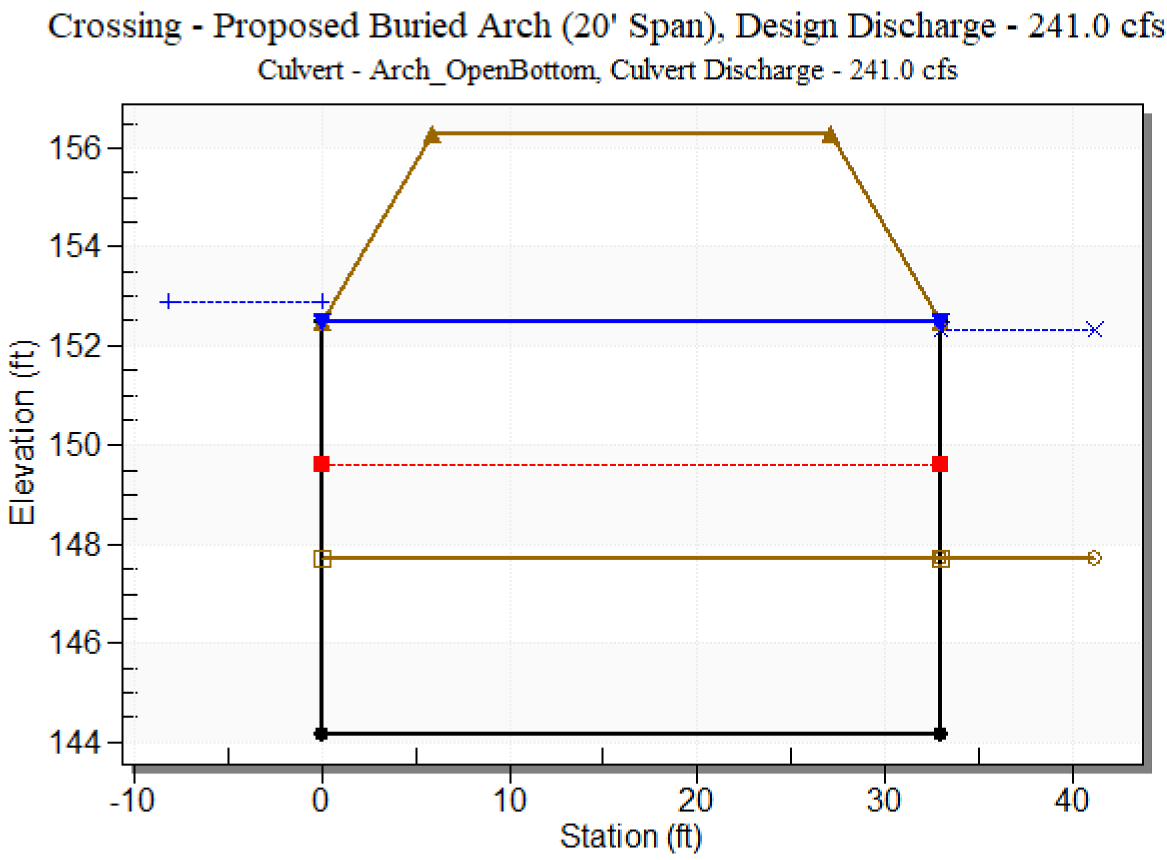
20' Span Steel Plate Arch

Culvert Performance Curve Plot: Arch_OpenBottom



20' Span Steel Plate Arch

Water Surface Profile Plot for Culvert: Arch_OpenBottom



Site Data - Arch_OpenBottom

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 144.17 ft

Outlet Station: 33.00 ft

Outlet Elevation: 144.17 ft

Number of Barrels: 1

Culvert Data Summary - Arch_OpenBottom

Barrel Shape: Arch, Open Bottom

Barrel Span: 16.26 ft

Barrel Rise: 8.29 ft

Barrel Material: Corrugated Steel

Embedment: 42.40 in

Barrel Manning's n: 0.0350 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

20' Span Steel Plate Arch

Table 10 - Downstream Channel Rating Curve (Crossing: Proposed Buried Arch (20'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

20' Span Steel Plate Arch

Tailwater Channel Data - Proposed Buried Arch (20' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Buried Arch (20' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

Maximum Flow: 344 cfs

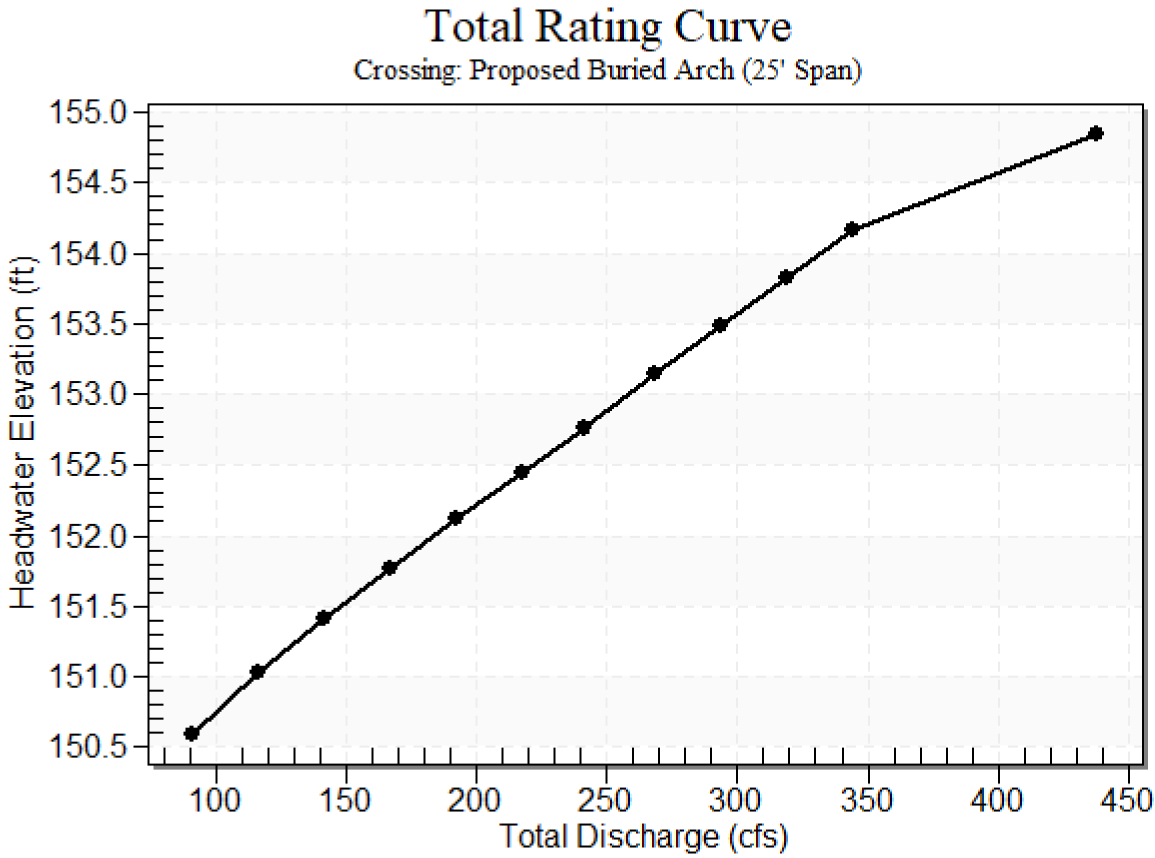
25' Span Steel Plate Arch

Table 1 - Summary of Culvert Flows at Crossing: Proposed Buried Arch (25' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Arch_LowProfile Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.60	90.90	90.90	0.00	1
151.02	116.21	116.21	0.00	1
151.41	141.52	141.52	0.00	1
151.77	166.83	166.83	0.00	1
152.12	192.14	192.14	0.00	1
152.45	217.45	217.45	0.00	1
152.76	241.00	241.00	0.00	1
153.15	268.07	268.07	0.00	1
153.48	293.38	293.38	0.00	1
153.82	318.69	318.69	0.00	1
154.16	344.00	344.00	0.00	1
154.40	362.11	362.07	0.00	Overtopping

25' Span Steel Plate Arch

Rating Curve Plot for Crossing: Proposed Buried Arch (25' Span)



25' Span Steel Plate Arch

Table 2 - Culvert Summary Table: Arch_LowProfile

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.60	1.558	2.894	7-H2t	-1.000	0.878	2.777	2.779	1.875	1.863
116.21	116.21	151.02	1.844	3.321	7-H2t	-1.000	1.033	3.168	3.169	2.164	1.999
141.52	141.52	151.41	2.113	3.708	7-H2t	-1.000	1.177	3.515	3.517	2.445	2.114
166.83	166.83	151.77	2.369	4.070	7-H2t	-1.000	1.314	3.831	3.832	2.724	2.214
192.14	192.14	152.12	2.594	4.413	7-H2t	-1.000	1.444	4.121	4.123	3.008	2.302
217.45	217.45	152.45	2.816	4.747	7-H2t	-1.000	1.569	4.392	4.393	3.300	2.381
241.00	241.00	152.76	3.022	5.058	7-H2t	-1.000	1.682	4.628	4.629	3.590	2.449
268.07	268.07	153.15	3.259	5.445	4-FFf	-1.000	1.807	4.798	4.885	3.969	2.520
293.38	293.38	153.48	3.481	5.782	4-FFf	-1.000	1.920	4.798	5.112	4.344	2.582
318.69	318.69	153.82	3.673	6.119	4-FFf	-1.000	2.028	4.798	5.328	4.719	2.640
344.00	344.00	154.16	3.862	6.456	4-FFf	-1.000	2.134	4.798	5.534	5.094	2.695

25' Span Steel Plate Arch

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Straight Culvert

Inlet Elevation (invert): 147.70 ft,   Outlet Elevation (invert): 147.70 ft

Culvert Length: 33.00 ft,   Culvert Slope: 0.0000

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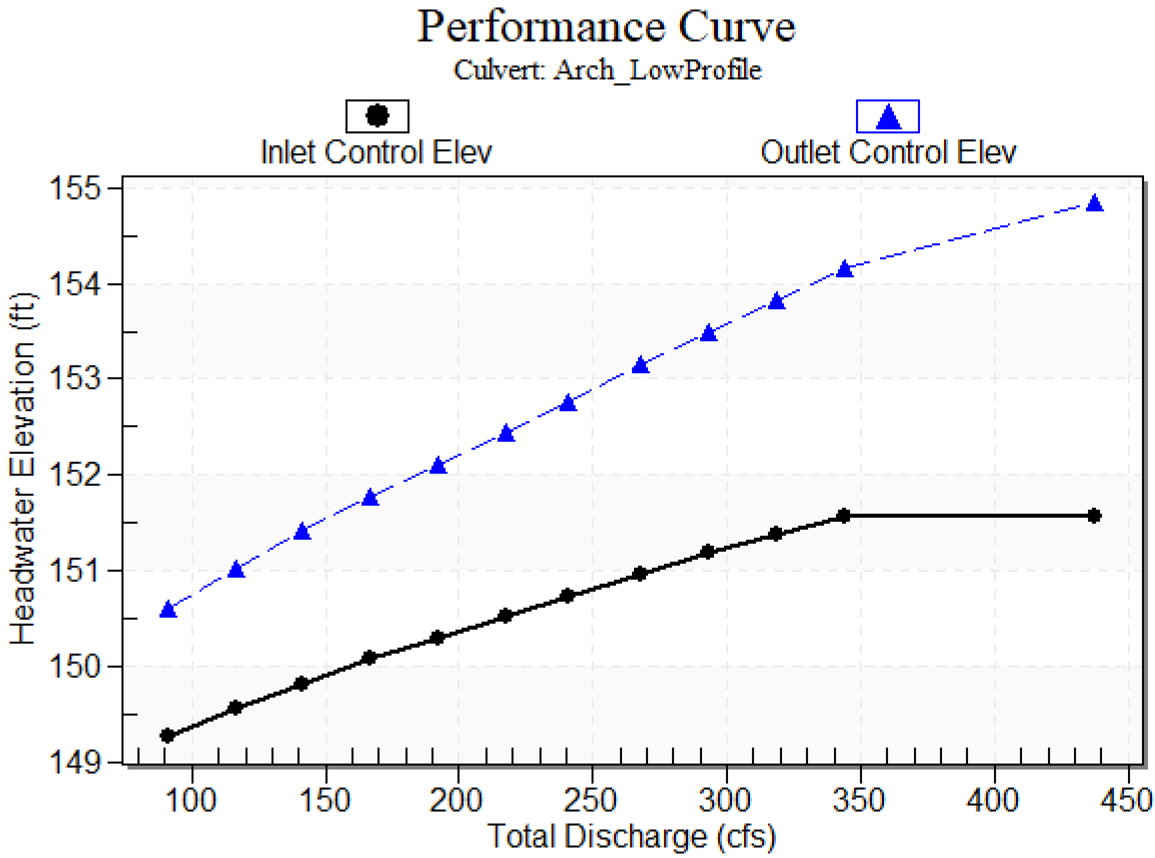
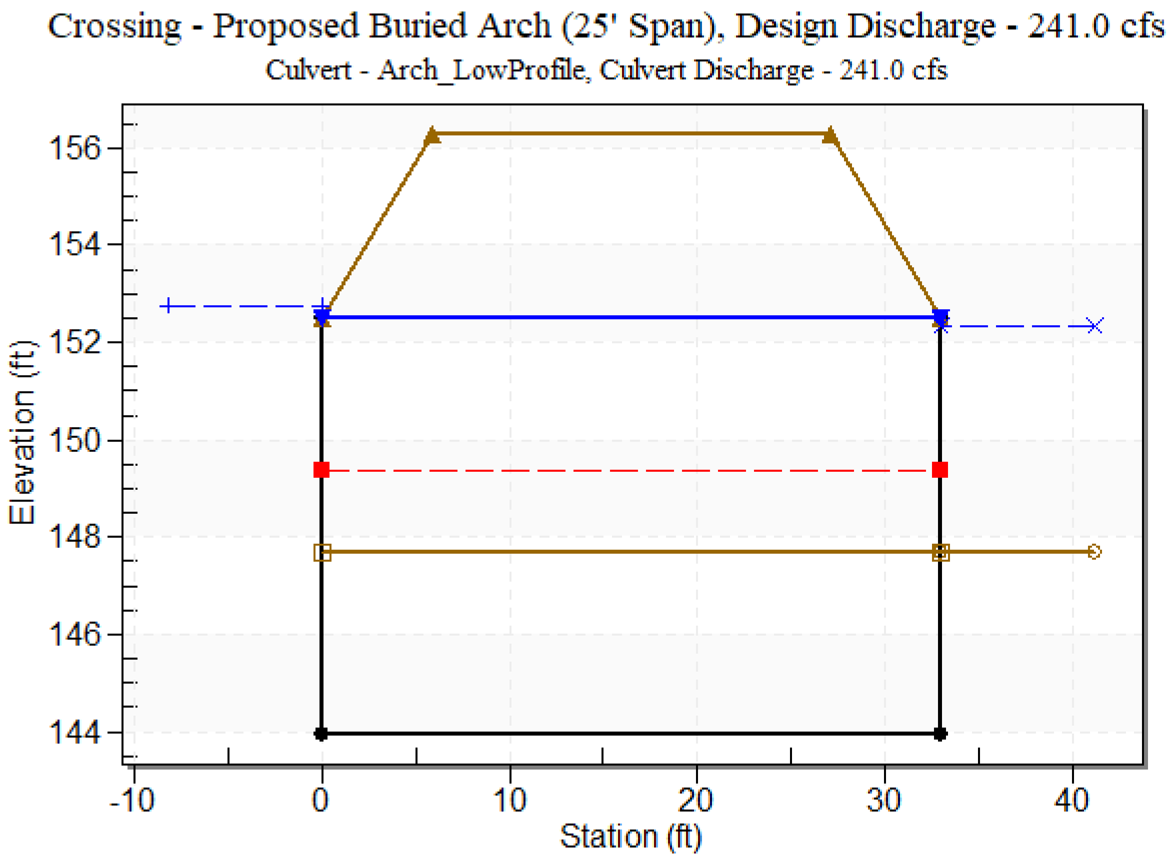
25' Span Steel Plate Arch

Culvert Performance Curve Plot: Arch_LowProfile



25' Span Steel Plate Arch

Water Surface Profile Plot for Culvert: Arch_LowProfile



Site Data - Arch_LowProfile

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 143.96 ft

Outlet Station: 33.00 ft

Outlet Elevation: 143.96 ft

Number of Barrels: 1

Culvert Data Summary - Arch_LowProfile

Barrel Shape: Arch, Open Bottom

Barrel Span: 19.32 ft

Barrel Rise: 8.54 ft

Barrel Material: Corrugated Steel

Embedment: 44.90 in

Barrel Manning's n: 0.0350 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

25' Span Steel Plate Arch

Table 3 - Downstream Channel Rating Curve (Crossing: Proposed Buried Arch (25'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

25' Span Steel Plate Arch

Tailwater Channel Data - Proposed Buried Arch (25' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Buried Arch (25' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

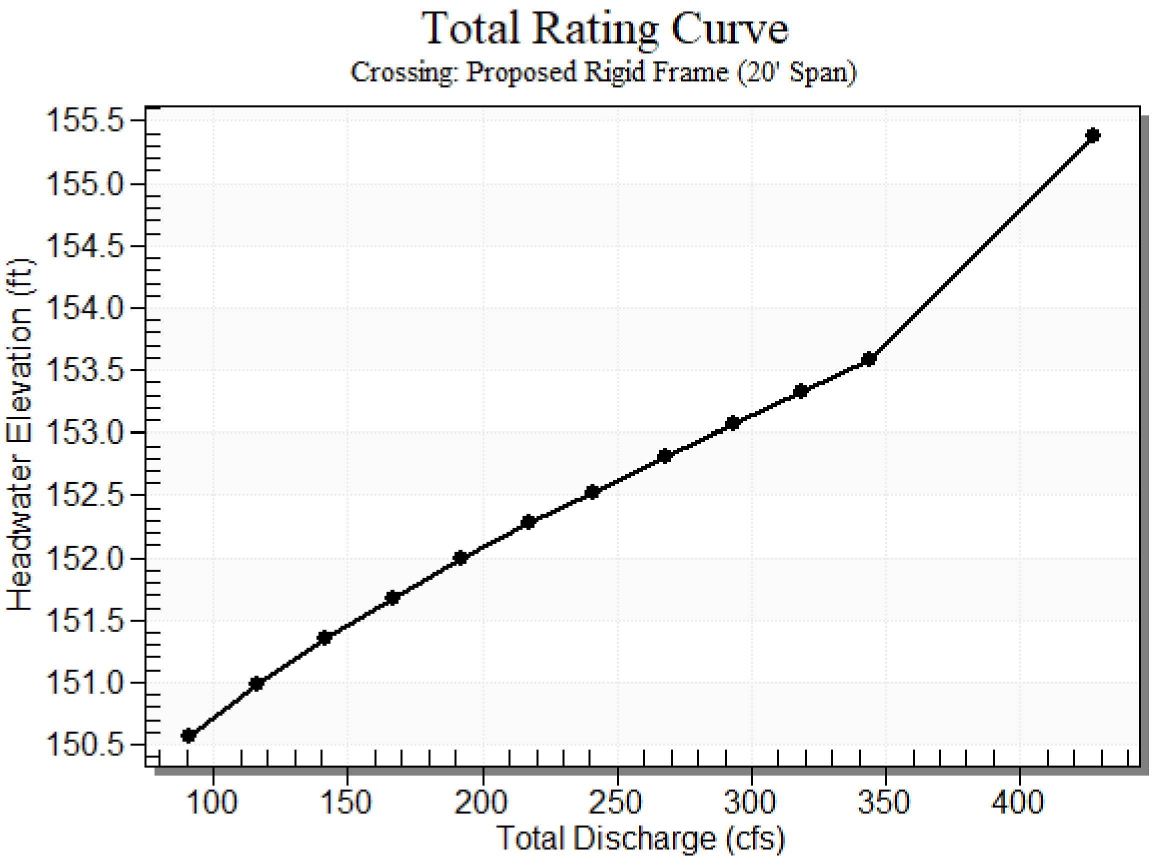
Maximum Flow: 344 cfs

20' Span Rigid Frame

Table 11 - Summary of Culvert Flows at Crossing: Proposed Rigid Frame (20' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Rigid Frame Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.57	90.90	90.90	0.00	1
150.98	116.21	116.21	0.00	1
151.35	141.52	141.52	0.00	1
151.68	166.83	166.83	0.00	1
151.99	192.14	192.14	0.00	1
152.28	217.45	217.45	0.00	1
152.53	241.00	241.00	0.00	1
152.80	268.07	268.07	0.00	1
153.07	293.38	293.38	0.00	1
153.33	318.69	318.69	0.00	1
153.59	344.00	344.00	0.00	1
154.40	427.22	427.22	0.00	Overtopping

Rating Curve Plot for Crossing: Proposed Rigid Frame (20' Span)



20' Span Rigid Frame

Table 12 - Culvert Summary Table: Rigid Frame

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.57	1.324	2.874	7-H2t	-1.000	0.974	2.779	2.779	1.763	1.863
116.21	116.21	150.98	1.550	3.282	7-H2t	-1.000	1.143	3.169	3.169	1.957	1.999
141.52	141.52	151.35	1.762	3.647	7-H2t	-1.000	1.312	3.517	3.517	2.133	2.114
166.83	166.83	151.68	1.956	3.981	7-H2t	-1.000	1.460	3.832	3.832	2.296	2.214
192.14	192.14	151.99	2.138	4.289	7-H2t	-1.000	1.597	4.123	4.123	2.449	2.302
217.45	217.45	152.28	2.311	4.577	7-H2t	-1.000	1.730	4.393	4.393	2.593	2.381
241.00	241.00	152.53	2.465	4.829	7-H2t	-1.000	1.847	4.629	4.629	2.720	2.449
268.07	268.07	152.80	2.636	5.104	7-H2t	-1.000	1.977	4.885	4.885	2.861	2.520
293.38	293.38	153.07	2.795	5.368	4-FFf	-1.000	2.087	5.000	5.112	3.056	2.582
318.69	318.69	153.33	2.954	5.630	4-FFf	-1.000	2.198	5.000	5.328	3.320	2.640
344.00	344.00	153.59	3.113	5.886	4-FFf	-1.000	2.301	5.000	5.534	3.583	2.695

20' Span Rigid Frame

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Straight Culvert

Inlet Elevation (invert): 147.70 ft,   Outlet Elevation (invert): 147.70 ft

Culvert Length: 33.00 ft,   Culvert Slope: 0.0000

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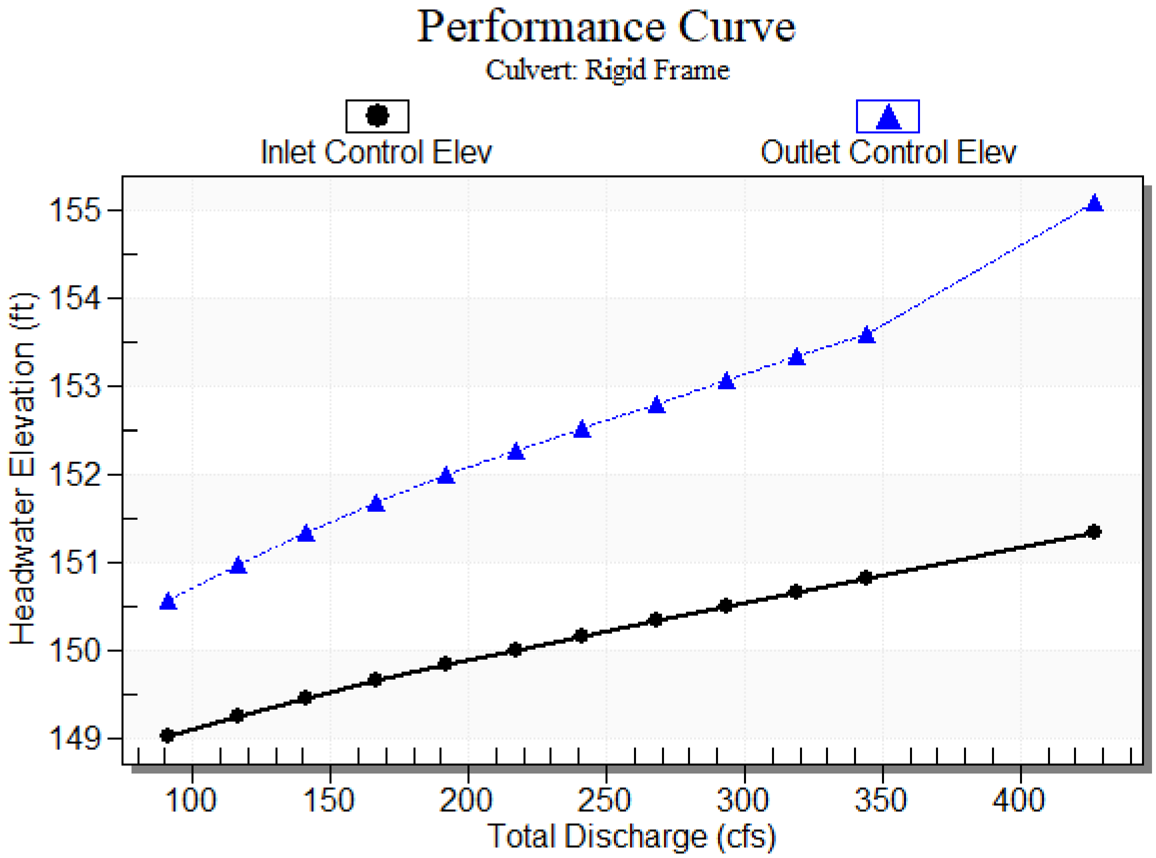
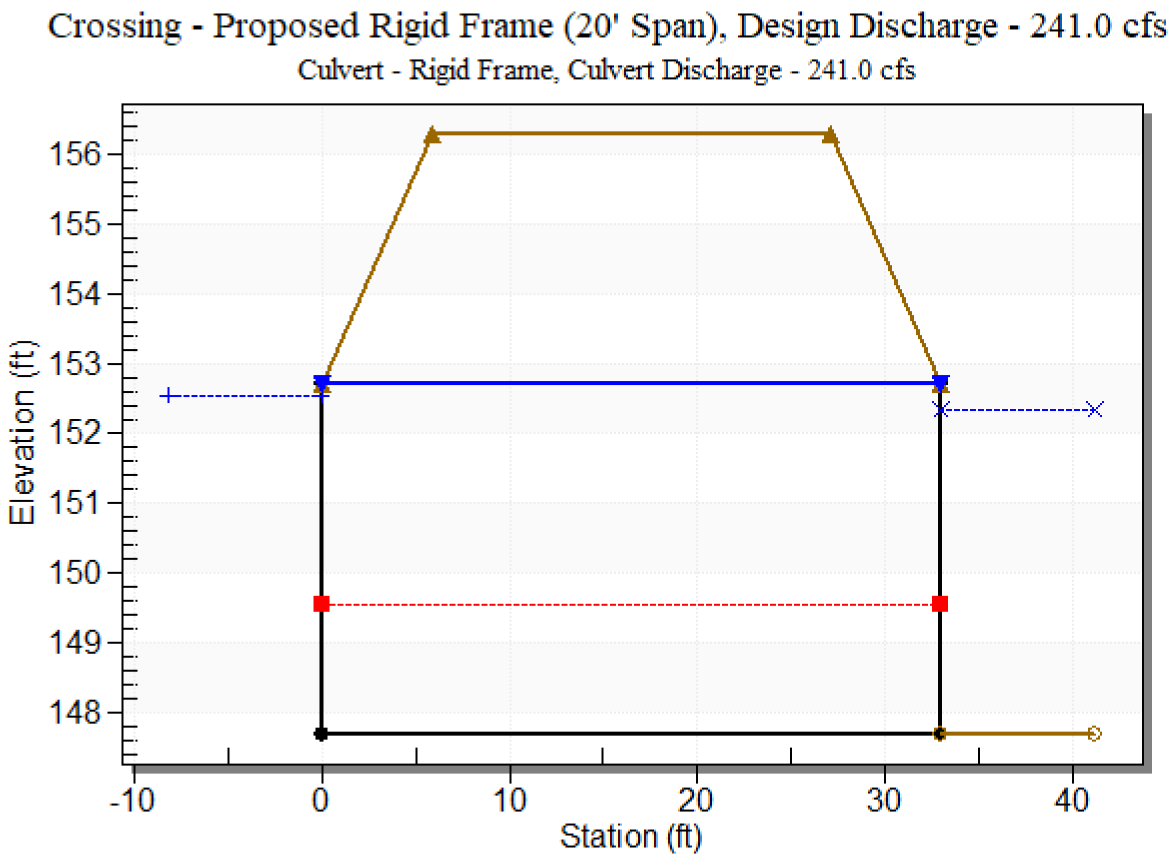
20' Span Rigid Frame

Culvert Performance Curve Plot: Rigid Frame



20' Span Rigid Frame

Water Surface Profile Plot for Culvert: Rigid Frame



Site Data - Rigid Frame

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 147.70 ft

Outlet Station: 33.00 ft

Outlet Elevation: 147.70 ft

Number of Barrels: 1

Culvert Data Summary - Rigid Frame

Barrel Shape: User Defined

Barrel Span: 20.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

20' Span Rigid Frame

Table 13 - Downstream Channel Rating Curve (Crossing: Proposed Rigid Frame (20'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

20' Span Rigid Frame

Tailwater Channel Data - Proposed Rigid Frame (20' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Rigid Frame (20' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

Maximum Flow: 344 cfs

Table 1 - Summary of Culvert Flows at Crossing: Proposed Buried Arch (25' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Arch_LowProfile Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.60	90.90	90.90	0.00	1
151.02	116.21	116.21	0.00	1
151.41	141.52	141.52	0.00	1
151.77	166.83	166.83	0.00	1
152.12	192.14	192.14	0.00	1
152.45	217.45	217.45	0.00	1
152.76	241.00	241.00	0.00	1
153.15	268.07	268.07	0.00	1
153.48	293.38	293.38	0.00	1
153.82	318.69	318.69	0.00	1
154.16	344.00	344.00	0.00	1
154.40	362.11	362.07	0.00	Overtopping

Rating Curve Plot for Crossing: Proposed Buried Arch (25' Span)

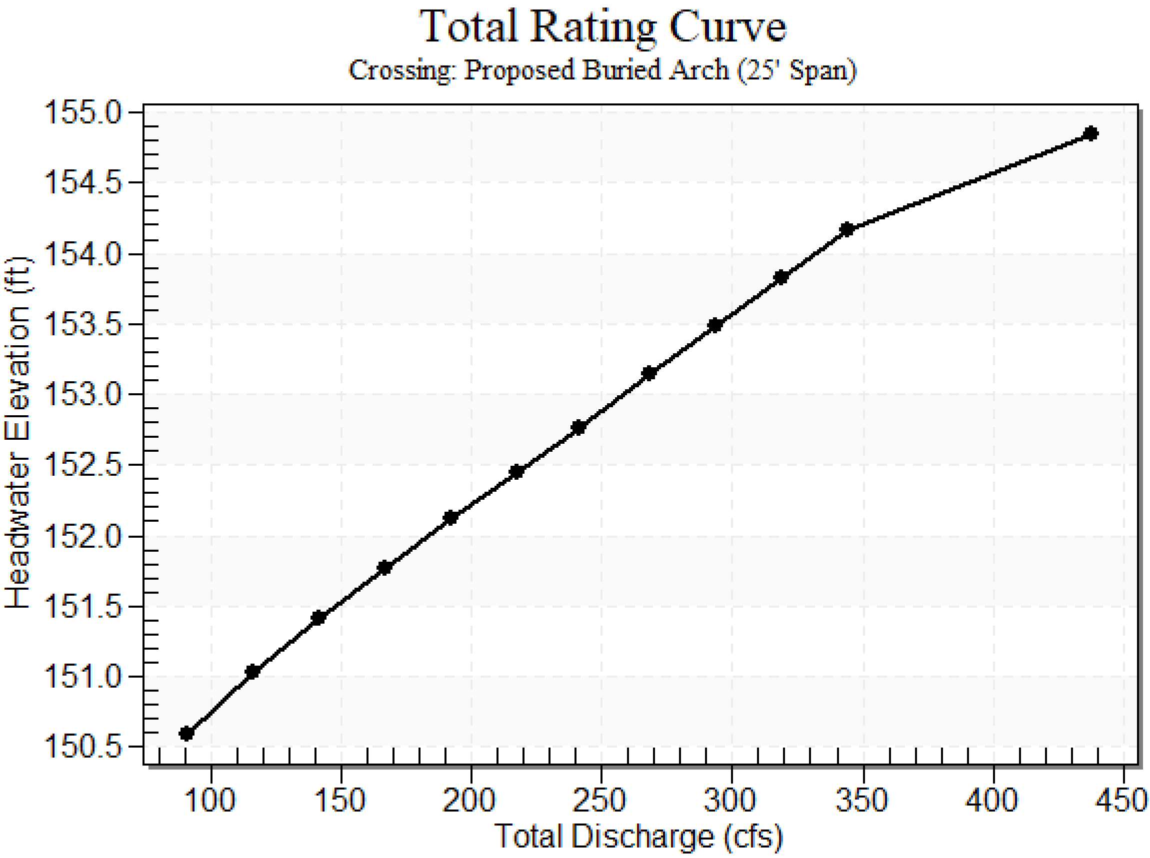


Table 2 - Culvert Summary Table: Arch_LowProfile

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.60	1.558	2.894	7-H2t	-1.000	0.878	2.777	2.779	1.875	1.863
116.21	116.21	151.02	1.844	3.321	7-H2t	-1.000	1.033	3.168	3.169	2.164	1.999
141.52	141.52	151.41	2.113	3.708	7-H2t	-1.000	1.177	3.515	3.517	2.445	2.114
166.83	166.83	151.77	2.369	4.070	7-H2t	-1.000	1.314	3.831	3.832	2.724	2.214
192.14	192.14	152.12	2.594	4.413	7-H2t	-1.000	1.444	4.121	4.123	3.008	2.302
217.45	217.45	152.45	2.816	4.747	7-H2t	-1.000	1.569	4.392	4.393	3.300	2.381
241.00	241.00	152.76	3.022	5.058	7-H2t	-1.000	1.682	4.628	4.629	3.590	2.449
268.07	268.07	153.15	3.259	5.445	4-FFf	-1.000	1.807	4.798	4.885	3.969	2.520
293.38	293.38	153.48	3.481	5.782	4-FFf	-1.000	1.920	4.798	5.112	4.344	2.582
318.69	318.69	153.82	3.673	6.119	4-FFf	-1.000	2.028	4.798	5.328	4.719	2.640
344.00	344.00	154.16	3.862	6.456	4-FFf	-1.000	2.134	4.798	5.534	5.094	2.695

****

Straight Culvert

Inlet Elevation (invert): 147.70 ft,   Outlet Elevation (invert): 147.70 ft

Culvert Length: 33.00 ft,   Culvert Slope: 0.0000

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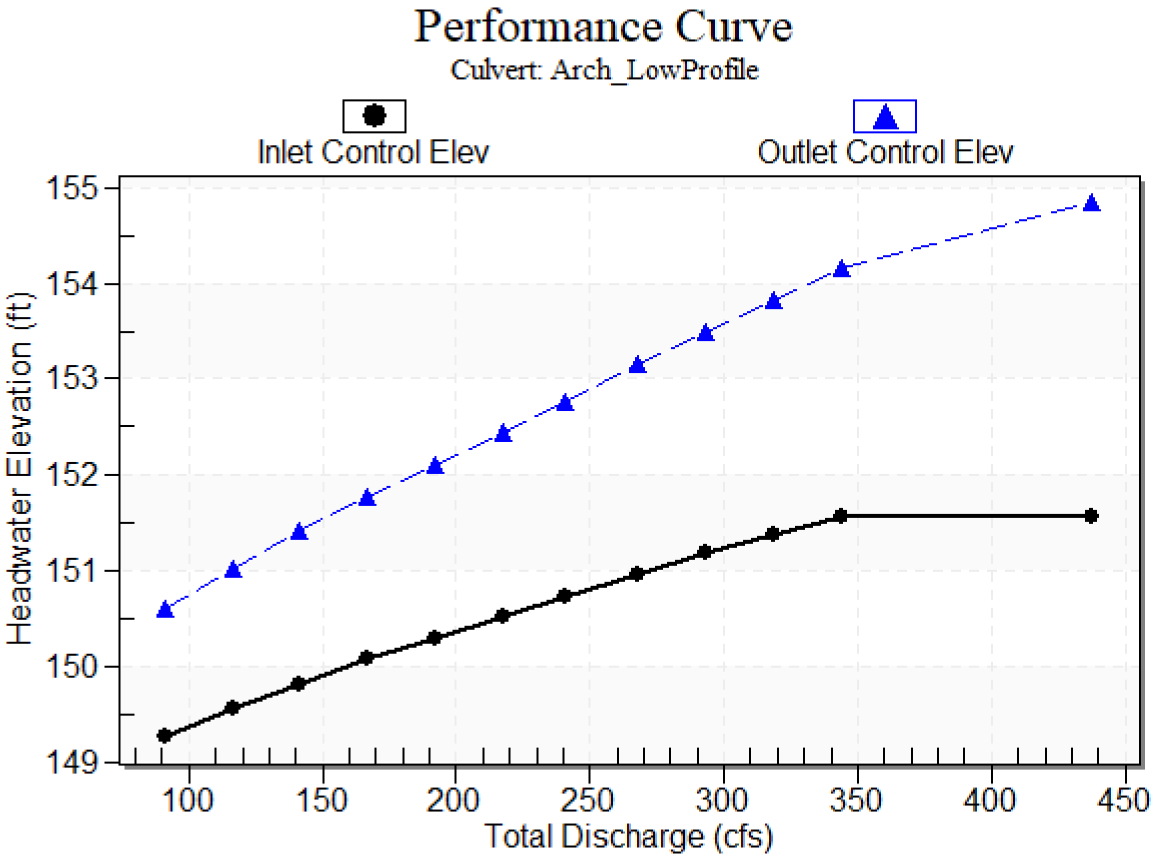
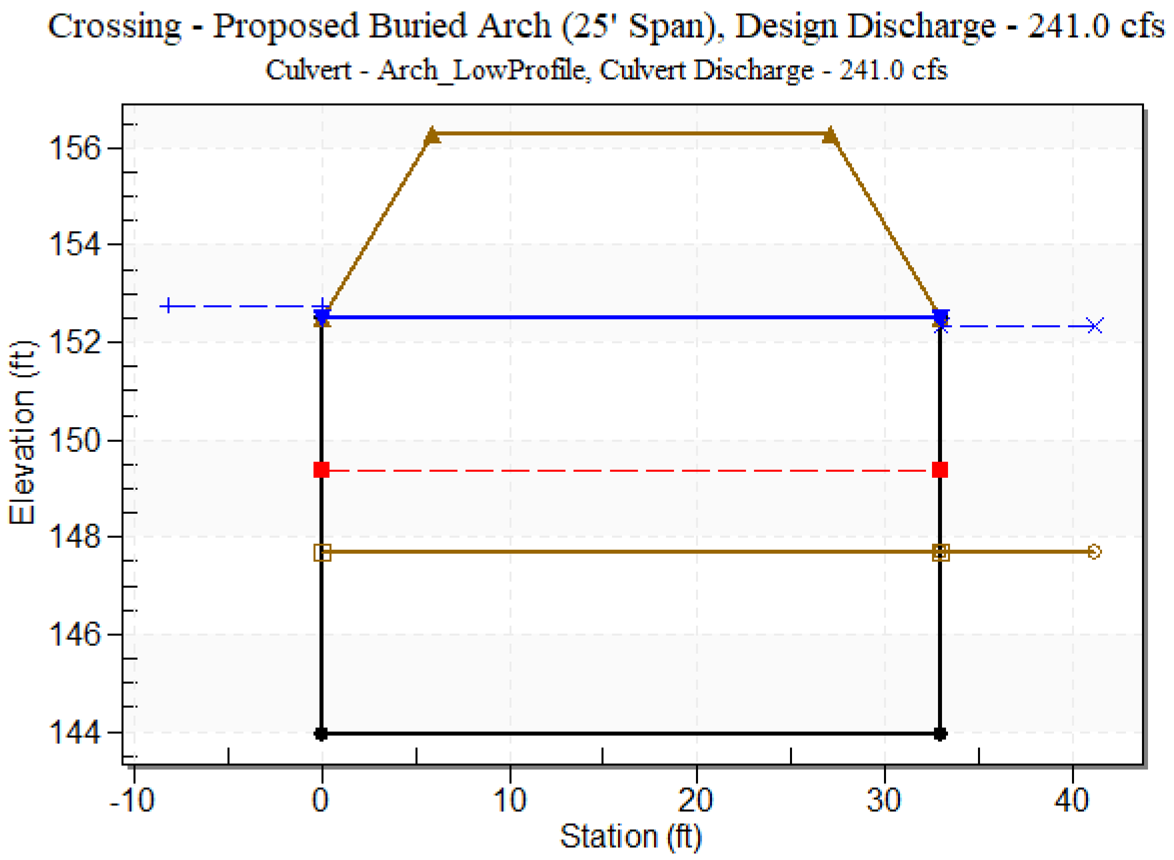
Culvert Performance Curve Plot: Arch_LowProfile



Water Surface Profile Plot for Culvert: Arch_LowProfile



Site Data - Arch_LowProfile

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 143.96 ft

Outlet Station: 33.00 ft

Outlet Elevation: 143.96 ft

Number of Barrels: 1

Culvert Data Summary - Arch_LowProfile

Barrel Shape: Arch, Open Bottom

Barrel Span: 19.32 ft

Barrel Rise: 8.54 ft

Barrel Material: Corrugated Steel

Embedment: 44.90 in

Barrel Manning's n: 0.0350 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Proposed Buried Arch (25'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

Tailwater Channel Data - Proposed Buried Arch (25' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Buried Arch (25' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

Maximum Flow: 344 cfs

Table 4 - Summary of Culvert Flows at Crossing: Proposed Rigid Frame (25' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Rigid Frame Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.53	90.90	90.90	0.00	1
150.93	116.21	116.21	0.00	1
151.29	141.52	141.52	0.00	1
151.62	166.83	166.83	0.00	1
151.92	192.14	192.14	0.00	1
152.20	217.45	217.45	0.00	1
152.44	241.00	241.00	0.00	1
152.71	268.07	268.07	0.00	1
152.98	293.38	293.38	0.00	1
153.23	318.69	318.69	0.00	1
153.47	344.00	344.00	0.00	1
154.40	447.67	447.45	0.00	Overtopping

Rating Curve Plot for Crossing: Proposed Rigid Frame (25' Span)

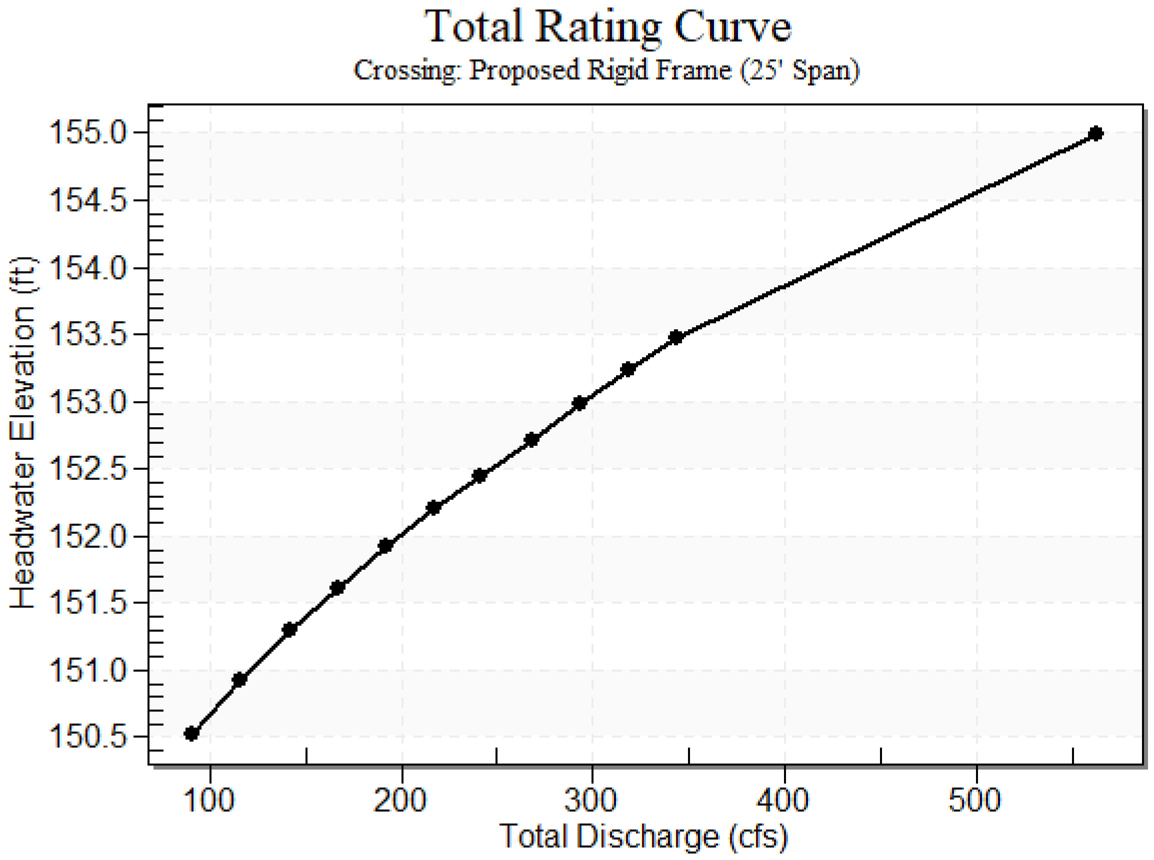
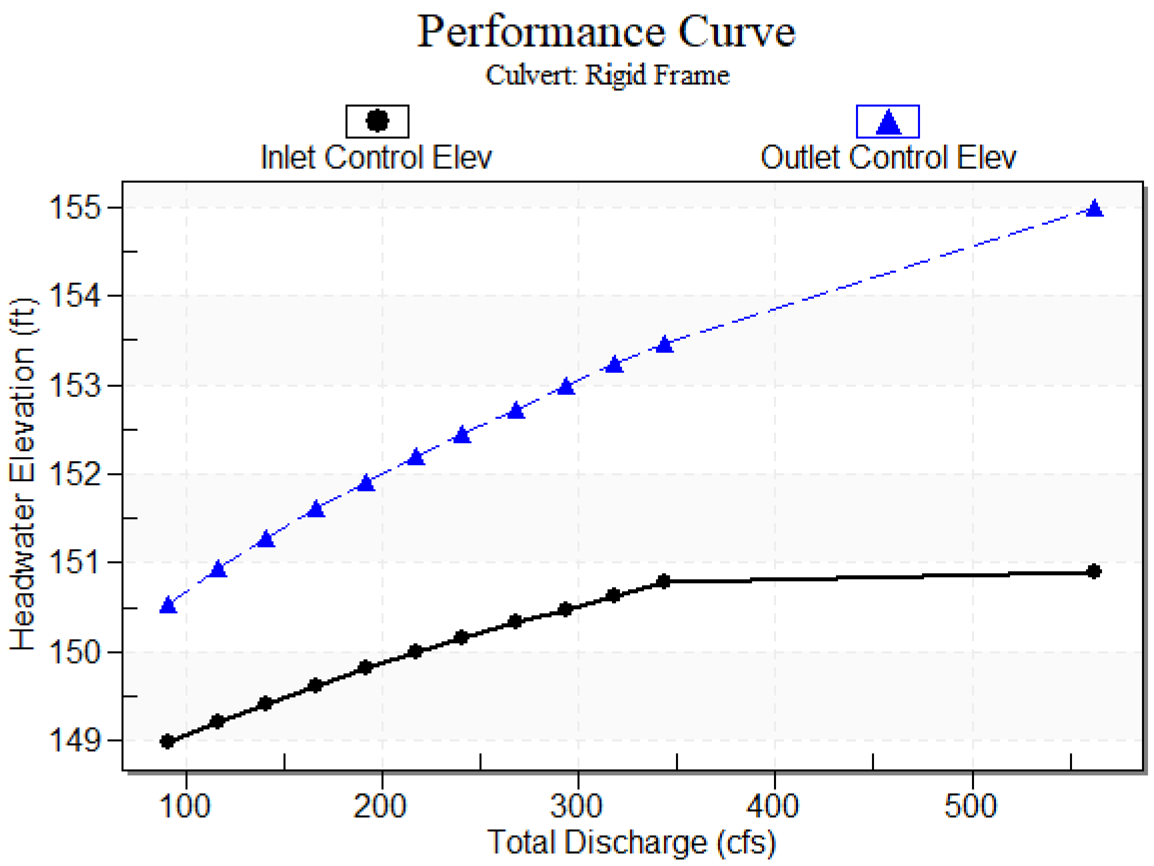


Table 5 - Culvert Summary Table: Rigid Frame

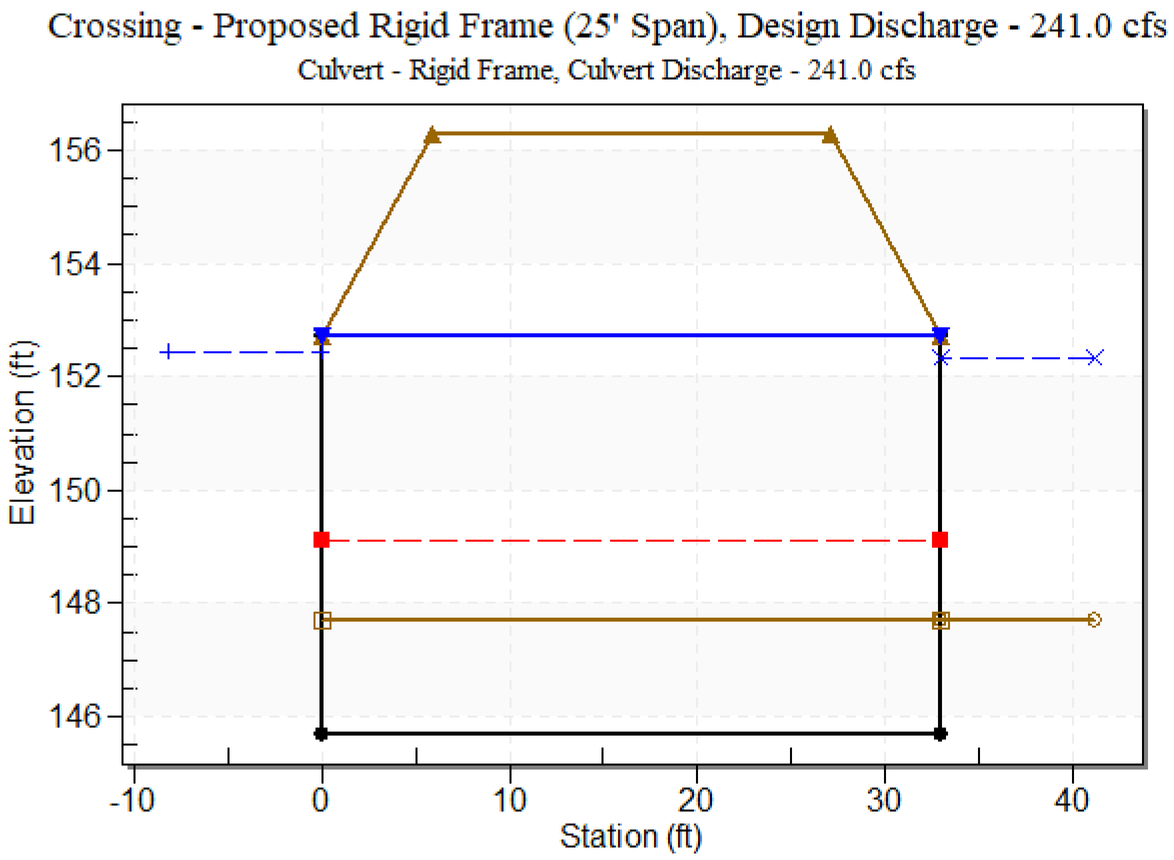
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.53	1.277	2.829	7-H2t	-1.000	0.743	2.779	2.779	1.309	1.863
116.21	116.21	150.93	1.504	3.231	7-H2t	-1.000	0.875	3.169	3.169	1.467	1.999
141.52	141.52	151.29	1.715	3.589	7-H2t	-1.000	0.998	3.517	3.517	1.610	2.114
166.83	166.83	151.62	1.914	3.916	7-H2t	-1.000	1.114	3.832	3.832	1.741	2.214
192.14	192.14	151.92	2.103	4.217	7-H2t	-1.000	1.224	4.123	4.123	1.864	2.302
217.45	217.45	152.20	2.283	4.498	7-H2t	-1.000	1.329	4.393	4.393	1.980	2.381
241.00	241.00	152.44	2.445	4.745	7-H2t	-1.000	1.424	4.629	4.629	2.082	2.449
268.07	268.07	152.71	2.621	5.013	7-H2t	-1.000	1.529	4.885	4.885	2.195	2.520
293.38	293.38	152.98	2.777	5.284	4-FFf	-1.000	1.623	5.000	5.112	2.347	2.582
318.69	318.69	153.23	2.929	5.531	4-FFf	-1.000	1.715	5.000	5.328	2.550	2.640
344.00	344.00	153.47	3.077	5.771	4-FFf	-1.000	1.805	5.000	5.534	2.752	2.695

```
******************************************************************************
Straight Culvert
Inlet Elevation (invert): 147.70 ft,    Outlet Elevation (invert): 147.70 ft
Culvert Length: 33.00 ft,    Culvert Slope: 0.0000
******************************************************************************
```

Culvert Performance Curve Plot: Rigid Frame



Water Surface Profile Plot for Culvert: Rigid Frame



Site Data - Rigid Frame

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 145.70 ft

Outlet Station: 33.00 ft

Outlet Elevation: 145.70 ft

Number of Barrels: 1

Culvert Data Summary - Rigid Frame

Barrel Shape: Concrete Box

Barrel Span: 25.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 24.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Proposed Rigid Frame (25'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

Tailwater Channel Data - Proposed Rigid Frame (25' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Rigid Frame (25' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 90.9 cfs

Design Flow: 241 cfs

Maximum Flow: 344 cfs

Table 7 - Summary of Culvert Flows at Crossing: Proposed Rigid Frame (30' Span)

Headwater Elevation (ft)	Total Discharge (cfs)	Rigid Frame Discharge (cfs)	Roadway Discharge (cfs)	Iterations
150.51	90.90	90.90	0.00	1
150.91	116.21	116.21	0.00	1
151.27	141.52	141.52	0.00	1
151.59	166.83	166.83	0.00	1
151.89	192.14	192.14	0.00	1
152.17	217.45	217.45	0.00	1
152.41	241.00	241.00	0.00	1
152.67	268.07	268.07	0.00	1
152.93	293.38	293.38	0.00	1
153.17	318.69	318.69	0.00	1
153.40	344.00	344.00	0.00	1
154.40	463.03	462.94	0.00	Overtopping

Rating Curve Plot for Crossing: Proposed Rigid Frame (30' Span)

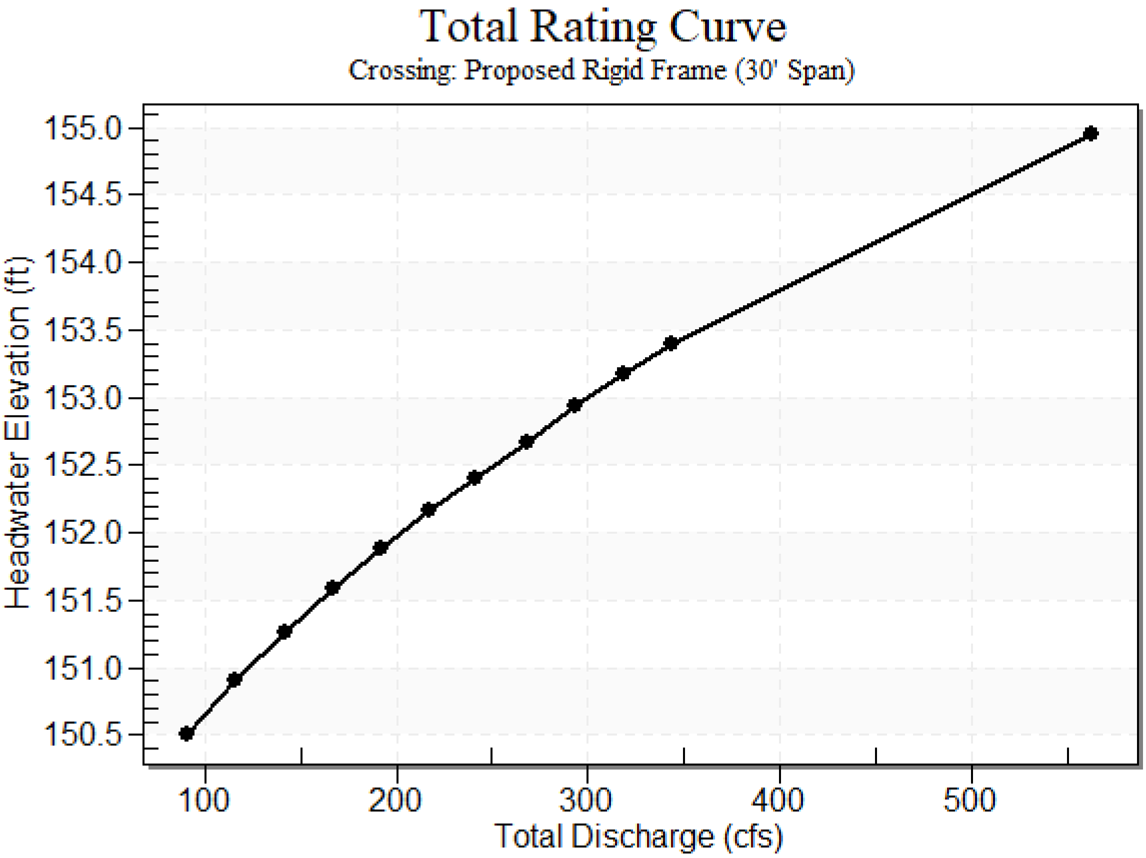
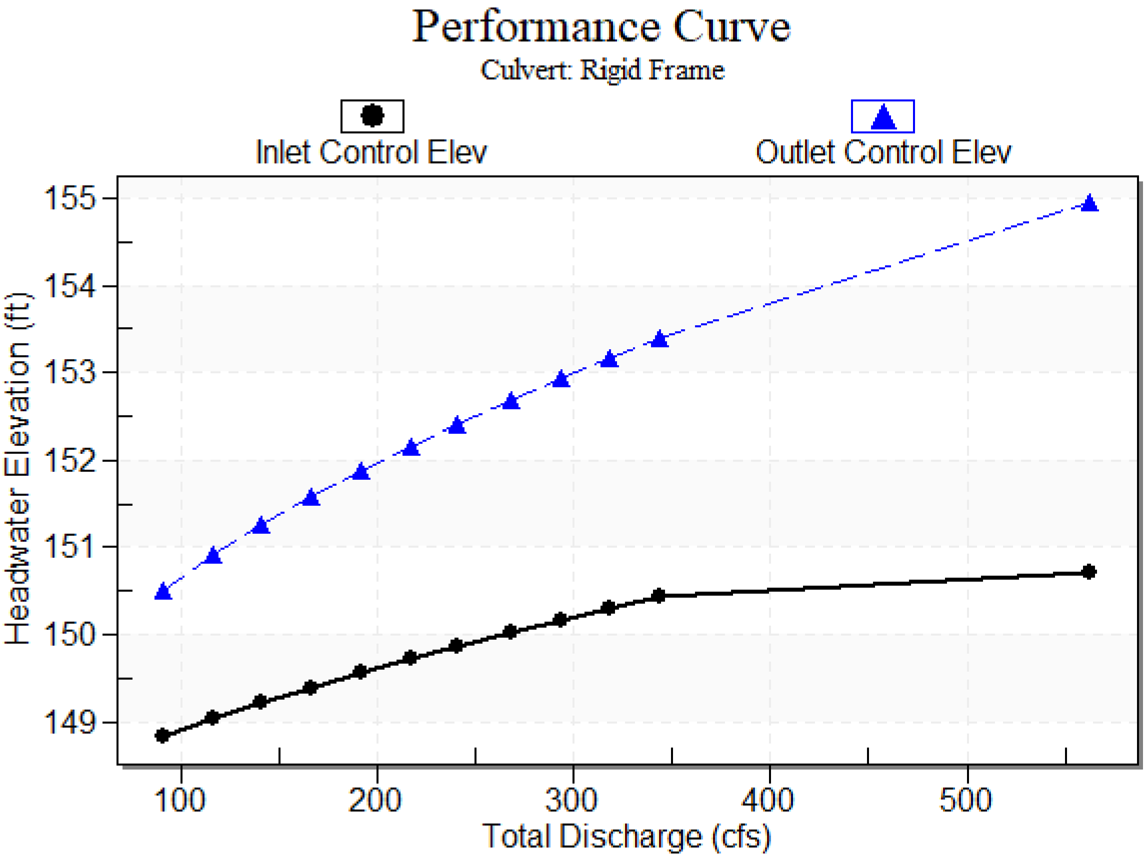


Table 8 - Culvert Summary Table: Rigid Frame

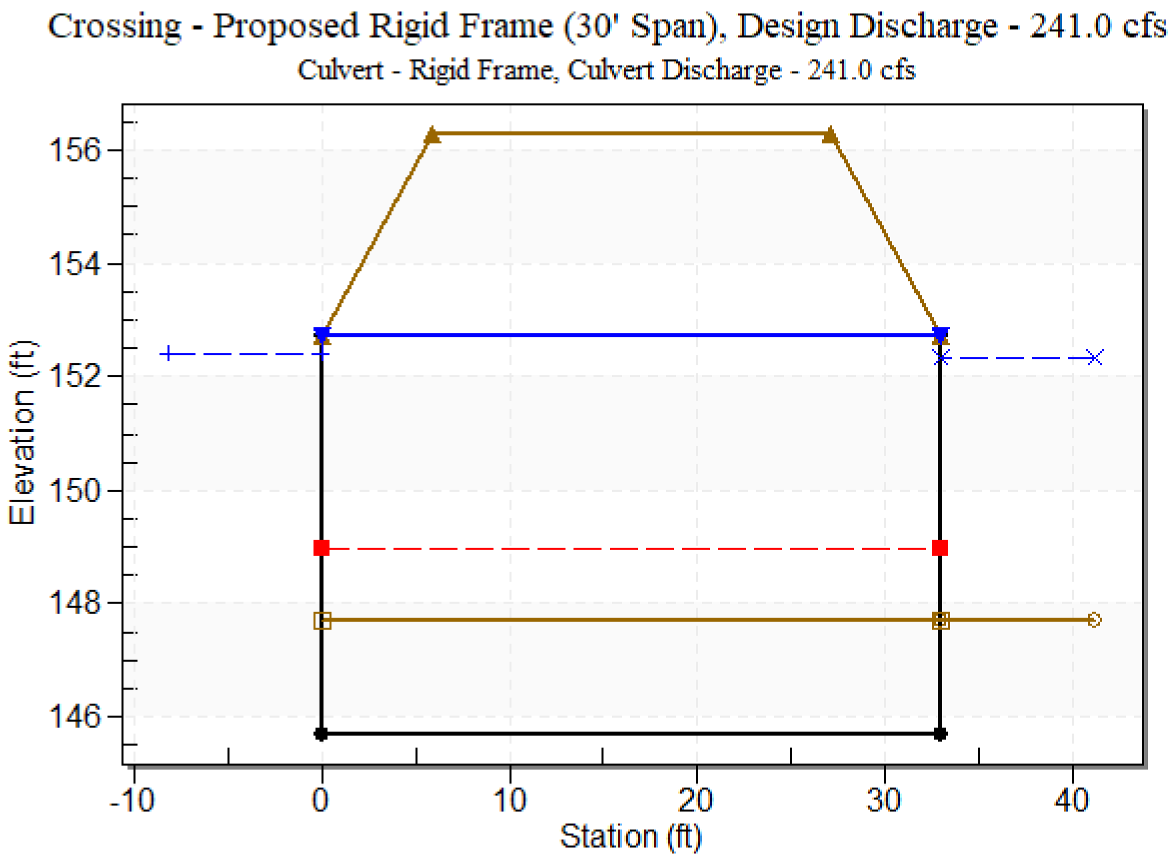
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
90.90	90.90	150.51	1.131	2.814	7-H2t	-1.000	0.658	2.779	2.779	1.090	1.863
116.21	116.21	150.91	1.332	3.212	7-H2t	-1.000	0.775	3.169	3.169	1.222	1.999
141.52	141.52	151.27	1.519	3.567	7-H2t	-1.000	0.884	3.517	3.517	1.341	2.114
166.83	166.83	151.59	1.695	3.890	7-H2t	-1.000	0.987	3.832	3.832	1.451	2.214
192.14	192.14	151.89	1.862	4.189	7-H2t	-1.000	1.084	4.123	4.123	1.553	2.302
217.45	217.45	152.17	2.022	4.466	7-H2t	-1.000	1.177	4.393	4.393	1.650	2.381
241.00	241.00	152.41	2.166	4.709	7-H2t	-1.000	1.261	4.629	4.629	1.735	2.449
268.07	268.07	152.67	2.325	4.974	7-H2t	-1.000	1.354	4.885	4.885	1.829	2.520
293.38	293.38	152.93	2.469	5.231	4-FFf	-1.000	1.438	5.000	5.112	1.956	2.582
318.69	318.69	153.17	2.605	5.468	4-FFf	-1.000	1.519	5.000	5.328	2.125	2.640
344.00	344.00	153.40	2.736	5.698	4-FFf	-1.000	1.598	5.000	5.534	2.293	2.695

```
*******************************************************************************
Straight Culvert
Inlet Elevation (invert): 147.70 ft,    Outlet Elevation (invert): 147.70 ft
Culvert Length: 33.00 ft,    Culvert Slope: 0.0000
*******************************************************************************
```

Culvert Performance Curve Plot: Rigid Frame



Water Surface Profile Plot for Culvert: Rigid Frame



Site Data - Rigid Frame

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 145.70 ft

Outlet Station: 33.00 ft

Outlet Elevation: 145.70 ft

Number of Barrels: 1

Culvert Data Summary - Rigid Frame

Barrel Shape: Concrete Box

Barrel Span: 30.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 24.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: Proposed Rigid Frame (30'

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
90.90	150.48	2.78	1.86	0.17	0.23
116.21	150.87	3.17	2.00	0.20	0.23
141.52	151.22	3.52	2.11	0.22	0.23
166.83	151.53	3.83	2.21	0.24	0.23
192.14	151.82	4.12	2.30	0.26	0.24
217.45	152.09	4.39	2.38	0.27	0.24
241.00	152.33	4.63	2.45	0.29	0.24
268.07	152.59	4.89	2.52	0.30	0.24
293.38	152.81	5.11	2.58	0.32	0.24
318.69	153.03	5.33	2.64	0.33	0.24
344.00	153.23	5.53	2.69	0.35	0.25

Tailwater Channel Data - Proposed Rigid Frame (30' Span)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0010

Channel Manning's n: 0.0400

Channel Invert Elevation: 147.70 ft

Roadway Data for Crossing: Proposed Rigid Frame (30' Span)

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 21.25 ft

6.4 Environmental Boring Logs

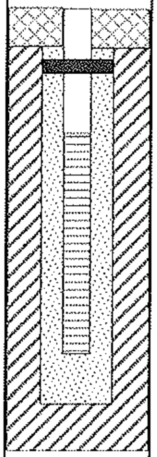
The Verterre Group
414 Roosevelt Highway Colchester, Vermont 05446
(802) 654-8663 FAX: (802) 654-8667

MONITORING WELL/SOIL BORING LOG

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-1/MW-1**

INSTALL DATE:	August 19, 2008	WELL DEPTH: 9 ft	BORING DEPTH: 9 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: 8 ft
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: 1-inch SCREEN TYPE/SIZE: 0.010"-slot schedule 40 PVC	DEPTH: 3-9 ft bgs
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE: Schedule 40 PVC solid riser	
SAMPLING METHOD:	Macrocore	RISER DIA.: 1-inch	DEPTH: 0-3 ft bgs
REFERENCE POINT (RP):	Top of casing	GUARD TYPE: Aluminum Roadbox	
ELEVATION OF RP:	100.10	RISER CAP: locking expansion plug	
REMARKS:	Boring was completed as a monitoring well with an aluminum Roadbox.		



DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*
0		0-4	<0.1	28" recovery	0-6": Asphalt. 6-15": Sandy gravel. 15-28": Dense brown silt, with crushed shale, dry.
1					
2					
3					
4		4-7	14.1	48" recovery	0-46": Dense, grayish brown silty clay, blocky structure.
5			1059		46-48": Gray silty clay, moist. Petro odor present.
6					
7		7-9	2403	30" recovery	0-7": Brown silty clay.
8 ▼					7-8": Fine, brown sandy gravel. 8-19": Dense, Gray sandy silt, with small cobble, moist. Petro odor present. 19-30": Dense, Light brown sandy till, some large cobble.
9			34.8 6.0(tip)		
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

LEGEND

▨	CEMENT GROUT
▧	NATIVE BACKFILL
■	BENTONITE SEAL
░	SAND PACK
☰	WELL SCREEN
☐	RISER PIPE
HS	HEAD SPACE
▼	WATER LEVEL (APPROXIMATE)

GRANULAR SOILS

BLOWS/FT	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	M.DENSE
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS

BLOWS/FT	DENSITY
<2	V.SOFT
2-4	SOFT
4-8	M.STIFF
8-15	STIFF
15-30	V.STIFF
>30	HARD

PROPORTIONS USED

TRACE	0-10%
LITTLE	10-20%
SOME	20-35%
AND	35-50%

NOTES:

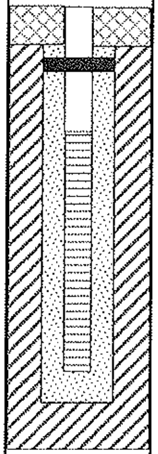
1. See **Figure 2**, SITE Plan, for boring locations

The Verterre Group
414 Roosevelt Highway Colchester, Vermont 05446
(802) 654-8663 FAX: (802) 654-8667

MONITORING WELL/SOIL BORING LOG

Project Name:	**Pratt UST**	WELL/ BORING ID:
Location:	**Bridport, Vermont**	
Verterre Project #:	**08016**	**SB-2/MW-2**

INSTALL DATE:	August 19, 2008	WELL DEPTH:	10 ft	BORING DEPTH:	10 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)		Approximately:	4 ft
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA:	1-inch	DEPTH:	3-10 ft bgs
		SCREEN TYPE/SIZE:	0.010"-slot schedule 40 PVC		
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE:	Schedule 40 PVC solid riser		
SAMPLING METHOD:	Macrocore	RISER DIA.:	1-inch	DEPTH:	0-3 ft bgs
REFERENCE POINT (RP):	Top of casing	GUARD TYPE:	Aluminum Roadbox		
ELEVATION OF RP:	99.87	RISER CAP:	locking expansion plug		
REMARKS:	Boring was completed as a monitoring well with an aluminum Roadbox.				

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0 1 2 3		0-4	<0.1	40" recovery	0-6": Asphalt. 6-18": Dense brown gravel, and old asphalt. 18-33": Dense brown silt, with crushed shale, dry. 33-40": Dense brown silt, with some sand.	▨ CEMENT GROUT ▨ NATIVE BACKFILL ■ BENTONITE SEAL ▒ SAND PACK ☰ WELL SCREEN ☐ RISER PIPE HS HEAD SPACE ▼ WATER LEVEL (APPROXIMATE)
4 ▼ 5 6 7		4-8	<0.1	42" recovery	0-8": Moderately dense, brown silty clay with sand, wet. 8-42": Dense, brown silty clay, blocky structure.	
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25		8-10	<0.1	32" recovery	0-15": Brown silty clay, with some sand, and fractured shale. 15-32": Dense, brown sandy till, moist to dry.	

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%
4-10	LOOSE	2-4	SOFT	SOME	20-35%
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%
30-50	DENSE	8-15	STIFF		
>50	V.DENSE	15-30	V.STIFF		
		>30	HARD		

NOTES: 1. See **Figure 2**, SITE Plan, for boring locations

The Verterre Group
414 Roosevelt Highway Colchester, Vermont 05446
(802) 654-8663 FAX: (802) 654-8667

MONITORING WELL/SOIL BORING LOG

Project Name:	**Pratt UST**	WELL/ BORING ID:
Location:	**Bridport, Vermont**	
Verterre Project #:	**08016**	**SB-3**

INSTALL DATE:	August 19, 2008	WELL DEPTH:	NA	BORING DEPTH:	<2 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)		Approximately:	NA
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA:	NA	DEPTH:	NA
		SCREEN TYPE/SIZE:	NA		
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE:	NA		
SAMPLING METHOD:	Macrocore	RISER DIA.:	NA	DEPTH:	NA
REFERENCE POINT (RP):	NA	GUARD TYPE:	NA		
ELEVATION OF RP:	NA	RISER CAP:	NA		
REMARKS:	Boring was backfilled with native soil and fill.				

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4			Refusal at <2 feet	▨ CEMENT GROUT
1	O					
2						▨ NATIVE BACKFILL
3	W					
4	E					■ BENTONITE SEAL
5	L					
6	L					░ SAND PACK
7						
8	I					☰ WELL SCREEN
9	N					
10	S					☐ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY		
0-4	V.LOOSE	<2	V.SOFT	TRACE	0-10%
4-10	LOOSE	2-4	SOFT	LITTLE	10-20%
10-30	M.DENSE	4-8	M.STIFF	SOME	20-35%
30-50	DENSE	8-15	STIFF	AND	35-50%
>50	V.DENSE	15-30	V.STIFF		
		>30	HARD		

NOTES:

1. See **Figure 2**, SITE Plan, for boring locations

The Verterre Group
414 Roosevelt Highway Colchester, Vermont 05446
(802) 654-8663 FAX: (802) 654-8667

MONITORING WELL/SOIL BORING LOG

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-4**

INSTALL DATE:	August 19, 2008	WELL DEPTH: NA	BORING DEPTH: <2 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: NA
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: NA SCREEN TYPE/SIZE: NA	DEPTH: NA
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE: NA	
SAMPLING METHOD:	Macrocore	RISER DIA.: NA	DEPTH: NA
REFERENCE POINT (RP):	NA	GUARD TYPE: NA	
ELEVATION OF RP:	NA	RISER CAP: NA	
REMARKS:	Boring was backfilled with native soil and fill.		

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4			Refusal at <2 feet	▨ CEMENT GROUT
1	O					
2						▨ NATIVE BACKFILL
3	W					
4	E					■ BENTONITE SEAL
5	L					░ SAND PACK
6	L					
7						
8	I					☰ WELL SCREEN
9	N					
10	S					☐ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY		
0-4	V.LOOSE	<2	V.SOFT	TRACE	0-10%
4-10	LOOSE	2-4	SOFT	LITTLE	10-20%
10-30	M.DENSE	4-8	M.STIFF	SOME	20-35%
30-50	DENSE	8-15	STIFF	AND	35-50%
>50	V.DENSE	15-30	V.STIFF		
		>30	HARD		

NOTES:
1. See **Figure 2**, SITE Plan, for boring locations

MONITORING WELL/SOIL BORING LOG

The Verterre Group
414 Roosevelt Highway Colchester, Vermont 05446
(802) 654-8663 FAX: (802) 654-8667

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-5**

INSTALL DATE:	August 19, 2008	WELL DEPTH:	NA	BORING DEPTH:	<2 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)		Approximately:	NA
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA:	NA	DEPTH:	NA
		SCREEN TYPE/SIZE:	NA		
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE:	NA		
SAMPLING METHOD:	Macrocore	RISER DIA.:	NA	DEPTH:	NA
REFERENCE POINT (RP):	NA	GUARD TYPE:	NA		
ELEVATION OF RP:	NA	RISER CAP:	NA		
REMARKS:	Boring was backfilled with native soil and fill.				

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4			Refusal at <2 feet	▩ CEMENT GROUT
1	O					
2						▧ NATIVE BACKFILL
3	W					
4	E					■ BENTONITE SEAL
5	L					
6	L					░ SAND PACK
7						
8	I					☰ WELL SCREEN
9	N					
10	S					□ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%	1. See **Figure 2**, SITE Plan, for boring locations
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%	
4-10	LOOSE	2-4	SOFT	SOME	20-35%	
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%	
30-50	DENSE	8-15	STIFF			
>50	V.DENSE	15-30	V.STIFF			
		>30	HARD			

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The Verterre Group
414 Roosevelt Highway Colchester, Vermont 05446
(802) 654-8663 FAX: (802) 654-8667

MONITORING WELL/SOIL BORING LOG

Project Name:	**Pratt UST**	WELL/ BORING ID:
Location:	**Bridport, Vermont**	
Verterre Project #:	**08016**	**SB-6**

INSTALL DATE:	August 19, 2008	WELL DEPTH: NA	BORING DEPTH: <2 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: NA
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: NA SCREEN TYPE/SIZE: NA	DEPTH: NA
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE: NA	
SAMPLING METHOD:	Macrocore	RISER DIA.: NA	DEPTH: NA
REFERENCE POINT (RP):	NA	GUARD TYPE: NA	
ELEVATION OF RP:	NA	RISER CAP: NA	
REMARKS:	Boring was backfilled with native soil and fill.		

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4			Refusal at <2 feet	▦ CEMENT GROUT
1	O					
2						▨ NATIVE BACKFILL
3	W					
4	E					■ BENTONITE SEAL
5	L					
6	L					░ SAND PACK
7						
8	I					☰ WELL SCREEN
9	N					
10	S					☐ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%	1. See **Figure 2**, SITE Plan, for boring locations
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%	
4-10	LOOSE	2-4	SOFT	SOME	20-35%	
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%	
30-50	DENSE	8-15	STIFF			
>50	V.DENSE	15-30	V.STIFF			
		>30	HARD			

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MONITORING WELL/SOIL BORING LOG

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/
BORING ID:
SB-7

INSTALL DATE:	August 19, 2008	WELL DEPTH:	NA	BORING DEPTH:	8.5 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)		Approximately:	NA
DRILLING CO:	Verterre	SCREEN DIA:	NA	DEPTH:	NA
	Colchester, VT	SCREEN TYPE/SIZE:	NA		
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE:	NA		
SAMPLING METHOD:	Macrocore	RISER DIA.:	NA	DEPTH:	NA
REFERENCE POINT (RP):	NA	GUARD TYPE:	NA		
ELEVATION OF RP:	NA	RISER CAP:	NA		
REMARKS:	Boring was backfilled with native soil and fill.				

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4	<0.1	31" recovery	0-15" - Asphalt and pulverized shale 15-25" - Dense brown silt and pulverized shale 25-25.5" - Fine brown sand 25.5-27" - Dense brown silt, dry. 27-29" - Fine sandy gravel 29-31" - Dense brown silt, dry	▦ CEMENT GROUT
1	O					
2						▨ NATIVE BACKFILL
3	W					
4	E	4-7	285.2	19" recovery	0-2" - Fine brown sandy silt, medium dense. 2-19" - Brown to gray silt, dense, dry.	■ BENTONITE SEAL
5	L					
6	L					░ SAND PACK
7		7-8.5	446.8 1033 (tip)	31" recovery	0-19" - Brown silt and pulverized shale, dense. 19-31" - Pulverized brown shale, petro odor, dry. Refusal at 8.5'	
8	I					☰ WELL SCREEN
9	N				No well set -- dry.	
10	S					□ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS

BLOWS/FT	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	M.DENSE
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS

BLOWS/FT	DENSITY
<2	V.SOFT
2-4	SOFT
4-8	M.STIFF
8-15	STIFF
15-30	V.STIFF
>30	HARD

PROPORTIONS USED

TRACE	0-10%
LITTLE	10-20%
SOME	20-35%
AND	35-50%

NOTES:

1. See **Figure 2**, SITE Plan, for boring locations

MONITORING WELL/SOIL BORING LOG

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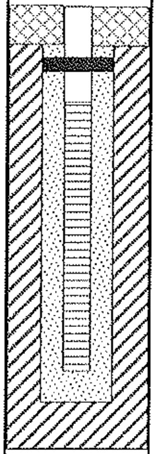
Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-8/MW-3**

INSTALL DATE:	August 19, 2008	WELL DEPTH: 10 ft	BORING DEPTH: 10 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: 4 ft
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: 1-inch	DEPTH: 2.5-10 ft bgs
		SCREEN TYPE/SIZE: 0.010"-slot schedule 40 PVC	
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE: Schedule 40 PVC solid riser	
SAMPLING METHOD:	Macrocore	RISER DIA.: 1-inch	DEPTH: 0-2.5 ft bgs
REFERENCE POINT (RP):	Top of casing	GUARD TYPE: Aluminum Roadbox	
ELEVATION OF RP:	98.08	RISER CAP: locking expansion plug	
REMARKS:	Boring was completed as a monitoring well with an aluminum Roadbox.		

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0		0-4	1.4	18" recovery	0-4": Asphalt. 4-18": Black surepac.	▨ CEMENT GROUT
1						
2						▧ NATIVE BACKFILL
3						
4 ▼		4-8	3.8	5" recovery	0-5": Black sandy gravel, saturated.	■ BENTONITE SEAL
5						░ SAND PACK
6						
7						
8		8-10 (refusal)	10.2	9" recovery	0-4": Black gravel fill. 4-9": Brown gravel fill. Tip: Dense pulverized shale	☰ WELL SCREEN
9			10.0			
10						☐ RISER PIPE
11						
12						HS HEAD SPACE
13						
14						▼ WATER LEVEL (APPROXIMATE)
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%	1. See **Figure 2**, SITE Plan, for boring locations
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%	
4-10	LOOSE	2-4	SOFT	SOME	20-35%	
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%	
30-50	DENSE	8-15	STIFF			
>50	V.DENSE	15-30	V.STIFF			
		>30	HARD			

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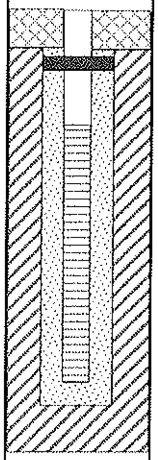
MONITORING WELL/SOIL BORING LOG

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-9/MW-4**

INSTALL DATE:	August 19, 2008	WELL DEPTH: 10.5 ft	BORING DEPTH: 10.5 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: ft
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: 1-inch	DEPTH: 3-10.5 ft bgs
		SCREEN TYPE/SIZE:	0.010"-slot schedule 40 PVC
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE:	Schedule 40 PVC solid riser
SAMPLING METHOD:	Macrocore	RISER DIA.: 1-inch	DEPTH: 0-3 ft bgs
REFERENCE POINT (RP):	Top of casing	GUARD TYPE:	Aluminum Roadbox
ELEVATION OF RP:	97.90	RISER CAP:	locking expansion plug
REMARKS:	Boring was completed as a monitoring well with an aluminum Roadbox.		



DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0		0-4	<0.1	34" recovery	0-7": Asphalt. 7-20": Gray silty gravel.. 20-34": Dense brown silty clay.	▩ CEMENT GROUT
1						
2						▨ NATIVE BACKFILL
3						
4		4-8	<0.1	48" recovery	0-48": Moderately dense brown silty clay, blocky structure.	■ BENTONITE SEAL
5						
6						░ SAND PACK
7						
8		8-10	<0.1	37" recovery	0-37": Moderately dense brown silty.	☰ WELL SCREEN
9						
10		10-10.5 (refusal)	<0.1	15" recovery	0-15": Brown silt and pulverized shale.	☐ RISER PIPE
11						
12						HS HEAD SPACE
13						
14						▼ WATER LEVEL (APPROXIMATE)
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%
4-10	LOOSE	2-4	SOFT	SOME	20-35%
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%
30-50	DENSE	8-15	STIFF		
>50	V.DENSE	15-30	V.STIFF		
		>30	HARD		

NOTES:

1. See **Figure 2**, SITE Plan, for boring locations

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MONITORING WELL/SOIL BORING LOG

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-10**

INSTALL DATE:	August 19, 2008	WELL DEPTH: NA	BORING DEPTH: 3 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: NA
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: NA SCREEN TYPE/SIZE: NA	DEPTH: NA
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE: NA	
SAMPLING METHOD:	Macrocore	RISER DIA.: NA	DEPTH: NA
REFERENCE POINT (RP):	NA	GUARD TYPE: NA	
ELEVATION OF RP:	NA	RISER CAP: NA	
REMARKS:	Boring was backfilled with native soil and fill.		

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4			Refusal at 3 feet	▨ CEMENT GROUT
1	O					
2						▧ NATIVE BACKFILL
3	W					
4	E					■ BENTONITE SEAL
5	L					
6	L					░ SAND PACK
7						
8	I					☰ WELL SCREEN
9	N					
10	S					☐ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%	1. See **Figure 2**, SITE Plan, for boring locations
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%	
4-10	LOOSE	2-4	SOFT	SOME	20-35%	
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%	
30-50	DENSE	8-15	STIFF			
>50	V.DENSE	15-30	V.STIFF			
		>30	HARD			

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MONITORING WELL/SOIL BORING LOG

Project Name: **Pratt UST**
Location: **Bridport, Vermont**
Verterre Project #: **08016**

WELL/ BORING ID: **SB-11**

INSTALL DATE:	August 19, 2008	WELL DEPTH: NA	BORING DEPTH: 1.5 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: NA
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: NA SCREEN TYPE/SIZE: NA	DEPTH: NA
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE: NA	
SAMPLING METHOD:	Macrocore	RISER DIA.: NA	DEPTH: NA
REFERENCE POINT (RP):	NA	GUARD TYPE: NA	
ELEVATION OF RP:	NA	RISER CAP: NA	
REMARKS:	Boring was backfilled with native soil and fill.		

DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*	LEGEND
0	N	0-4			Refusal at 1.5 feet	▨ CEMENT GROUT
1	O					
2						▨ NATIVE BACKFILL
3	W					
4	E					■ BENTONITE SEAL
5	L					
6	L					▒ SAND PACK
7						
8	I					☰ WELL SCREEN
9	N					
10	S					☐ RISER PIPE
11	T					
12	A					HS HEAD SPACE
13	L					
14	L					▼ WATER LEVEL (APPROXIMATE)
15	E					
16	D					
17						
18						
19						
20						
21						
22						
23						
24						
25						

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%	1. See **Figure 2**, SITE Plan, for boring locations
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%	
4-10	LOOSE	2-4	SOFT	SOME	20-35%	
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%	
30-50	DENSE	8-15	STIFF			
>50	V.DENSE	15-30	V.STIFF			
		>30	HARD			

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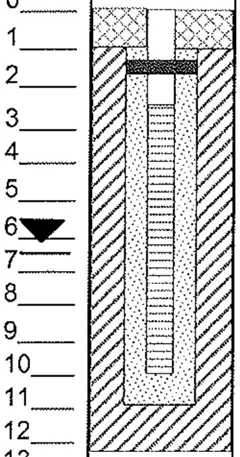
MONITORING WELL/SOIL BORING LOG

Project Name:	**Pratt UST**	WELL/ BORING ID:
Location:	**Bridport, Vermont**	
Verterre Project #:	**08016**	**SB-12/MW-5**

INSTALL DATE:	August 19, 2008	WELL DEPTH:	10.5 ft BORING DEPTH: 10.5 ft
VERTERRE REP:	Rod Lindsay II	DEPTH TO WATER: (during drilling)	Approximately: 6.5 ft
DRILLING CO:	Verterre Colchester, VT	SCREEN DIA: SCREEN TYPE/SIZE:	1-inch DEPTH: 2.5-10 ft bgs 0.010"-slot schedule 40 PVC
DRILLING METHOD:	Geoprobe® Tools	RISER TYPE:	Schedule 40 PVC solid riser
SAMPLING METHOD:	Macrocore	RISER DIA.:	1-inch DEPTH: 0-2.5 ft bgs
REFERENCE POINT (RP):	Top of casing	GUARD TYPE:	Aluminum Roadbox
ELEVATION OF RP:	96.91	RISER CAP:	locking expansion plug
REMARKS:	Boring was completed as a monitoring well with an aluminum Roadbox.		



DEPTH IN FEET	WELL PROFILE	SAMPLE DEPTH (FT)	PID (PPMV)	BLOWS/6" AND RECOVERY	SOIL DESCRIPTION AND NOTES*
0		0-4	<0.1	32" recovery	0-13": Asphalt and surcpac. 13-28": Crushed stone. 28-32": Dense Brown silt.
4		4-8	<0.1	23" recovery	0-9": Dense brown silty clay. 9-23": Dense brown silty clay, moist.
8		8-10.5 (refusal)	<0.1	32" recovery	0-32": Moderately to very dense brown silty clay, moist.

DEPTH IN FEET: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25

LEGEND

- ▨ CEMENT GROUT
- ▧ NATIVE BACKFILL
- ■ BENTONITE SEAL
- ░ SAND PACK
- ☰ WELL SCREEN
- □ RISER PIPE
- HS HEAD SPACE
- ▼ WATER LEVEL (APPROXIMATE)

GRANULAR SOILS		COHESIVE SOILS		PROPORTIONS USED	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	TRACE	0-10%
0-4	V.LOOSE	<2	V.SOFT	LITTLE	10-20%
4-10	LOOSE	2-4	SOFT	SOME	20-35%
10-30	M.DENSE	4-8	M.STIFF	AND	35-50%
30-50	DENSE	8-15	STIFF		
>50	V.DENSE	15-30	V.STIFF		
		>30	HARD		

NOTES: 1. See **Figure 2**, SITE Plan, for boring locations

6.5 Archaeological Memo

HARTGEN
archeological associates inc

ARCHEOLOGICAL RESOURCE ASSESSMENT

Middle Road Culvert Replacement Project
STP MM21(4)

Middle Road
Town of Bridport
Addison County, Vermont

HAA # 5744-11

Submitted to:
Fuss & O'Neill, Inc.
205 Billings Farm Road, Suite 6B
White River Junction, VT 05001

Prepared by:
Hartgen Archeological Associates, Inc.

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An ACRA Member Firm
www.acra-crm.org

January 2022

MANAGEMENT SUMMARY

VTrans Project Number: *STP MM21(4)*
Involved State and Federal Agencies: *Vermont Agency of Transportation (VTrans)*
Phase of Survey: *Archeological Resource Assessment (ARA)*

LOCATION INFORMATION

Municipality: *Town of Bridport*
County: *Addison County, Vermont*

SURVEY AREA

Length: *300 feet (91 m)*
Width: *150 feet (46 m)*
Area: *1.03 acres (0.4 ha)*

RESULTS OF RESEARCH

Archeological sites within one mile: *1 precontact*
Surveys in or adjacent: *1*
NR/NRE sites in or adjacent: *1*
Precontact Sensitivity: *low*
Historic Sensitivity: *low*

RECOMMENDATIONS

The archeological potential of the APE is low and no further archeological review is recommended for the project. If project plans change to affect areas outside of the current APE, further review may be warranted. This report should be submitted to the VTrans archeology officer for review and concurrence.

Report Authors: *Thomas R. Jamison, PhD, RPA #16566*
Date of Report: *January 2022*

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Map List

Photograph List

Table List

ARCHEOLOGICAL RESOURCE ASSESSMENT

1 Introduction

Hartgen Archeological Associates, Inc. (Hartgen) conducted an Archeological Resource Assessment for the proposed Middle Road Culvert Replacement (STP MM21(4)) (Project) located in the Town of Bridport, Addison County, Vermont (Map 1). The Project requires approvals by Vermont Agency of Transportation (VTrans). This investigation was conducted to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, and will be reviewed by the VTrans archeology officers. This investigation adheres to the Vermont State Historic Preservation Office's (SHPO) *Guidelines for Conducting Archeology in Vermont* (VDHP 2017).

2 Project Information

A site visit was conducted by Rachel Freeman on December 2, 2021 to observe and photograph existing conditions within the Project Area. The information gathered during the site visit is included in the relevant sections of the report.

2.1 Project Location

The project is located on Middle Road near the center of the Town of Bridport.

2.2 Description of the Project

The project will replace the two corrugated metal culverts that pass the East Branch of Dead Creek under Middle Road.

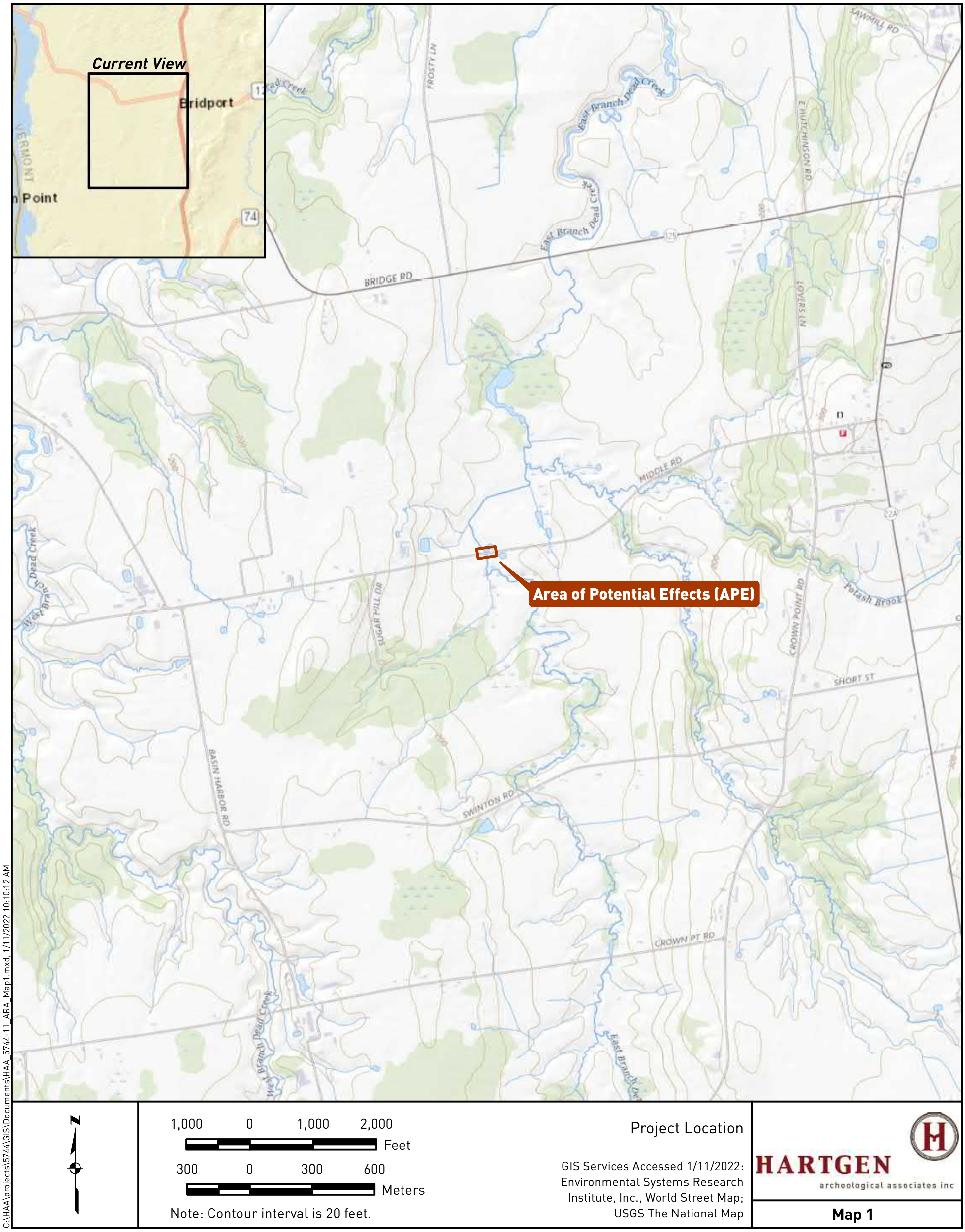
2.3 Description of the Area of Potential Effects (APE)

The area of potential effects (APE) includes all portions of the property that will be directly or indirectly altered by the proposed undertaking. The APE extends approximately 300 feet (91 m) along Middle Road and 150 feet (46 m) in width centered on the road and culverts, for a total area of approximately 0.3 acres (0.4 ha).

3 Environmental Background

The environment of an area is significant for determining the sensitivity of the Project Area for archeological resources. Precontact and historic groups often favored level, well-drained areas near wetlands and waterways. Therefore, topography, proximity to wetlands, and soils are examined to determine if there are landforms in the Project Area that are more likely to contain archeological resources. In addition, bedrock formations may contain chert or other resources that may have been quarried by precontact groups. Soil conditions can provide a clue to past climatic conditions, as well as changes in local hydrology.

Middle Road Culvert Replacement, STP MM21(4), Town of Bridport, Addison County, Vermont
Archeological Resource Assessment



Note: Contour interval is 20 feet.

Project Location

GIS Services Accessed 1/11/2022:
Environmental Systems Research
Institute, Inc., World Street Map;
USGS The National Map

HARTGEN
archeological associates inc

Map 1

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Project Map

Vermont Center for Geographic Information, Orthoimagery, 2016-2020

Map 2

C:\HAA\projects\5744\GIS\Documents\HAA_5744-11_ARA_Map2.mxd, 1/11/2022 10:10:55 AM

3.1 Present Land Use and Current Conditions

The project APE is currently used only for Middle Road and the culverts to allow the East Branch of Dead Creek to pass under the road (Photos 1 and 2). The APE is an area of marsh not suited to any agricultural use.

Photo 1. Project APE. Note twin culverts on the right middle view with marshy areas on either side of Middle Road. View to the west.

Photo 2. Project APE. North side of APE. Note marshy conditions. View to the north.

3.2 Soils

Soil surveys provide a general characterization of the types and depths of soils that are found in an area. This information is an important factor in determining the appropriate methodology if and when a field study is recommended. The soil type also informs the degree of artifact visibility and likely recovery rates. For example, artifacts are more visible and more easily recovered in sand than in stiff glacial clay, which will not pass through a screen easily.

The soils of the APE are entirely within the Livingston clay that was deposited by various glacial lakes and the Champlain Sea at the end of the Pleistocene era (USDA 2022). This soil is hydric, usually saturated by the waters of the East Branch of Dead Creek.

Table 1. Soils in Project Area

Symbol	Name	Textures	Slope	Drainage	Landform
Lk	Livingston	Clay	0-3%	Very poorly drained	Glacial lake plain

3.3 Bedrock Geology

The bedrock in the Project Area is the Stony Point Formation, a "dark-gray calcareous shale and beds of bluish-gray limestone." (Ratcliffe 2011). This formation was not typically used by Native American groups for stone tool manufacture. However, it could have been utilized on an expedient basis.

3.4 Physiography and Hydrology

The Project Area is nearly level, aside from the embankment of Middle Road, being in a marshy area. It is centered on the East Branch of Dead Creek that flows through the two culverts as it passes under Middle Road.

4 Documentary Research

Hartgen conducted research at the Vermont Division for Historic Preservation (VDHP) to identify previously reported archeological sites, State and National Register (NR) properties, properties determined eligible for the NR (NRE), and previous cultural resource surveys.

4.1 Archeological Sites

The archeological site files at VDHP contained one site within one mile (1.6 km) of the Project Area (Table 2). Previously reported archeological sites provide an overview of both the types of sites that may be present in the APE and the relationship of sites throughout the surrounding region. The presence of few reported sites, however, may result from a lack of previous systematic survey and does not necessarily indicate a decreased archeological sensitivity within the APE.

Although there is only one site reported in the vicinity of the project, the wider area hosts many more precontact and some historic sites. Many of the precontact sites are located along drainages such as Potash Brook to the east where the Hartline site and other sites are located. Also, the Lemon Fair River and the dendritic drainage of Dead Creek have many sites along their banks. The frequently marshy nature of the Dead Creek drainages in the project vicinity may have pushed precontact sites away from the course of the creek, resulting in fewer sites identified.

Table 2. Vermont Archeological Inventory (VAI) sites within one mile (1.6 km) of the Project Area

VAI Site No.	Site Identifier	Description	Proximity to Project Area
VT-AD-0839	Hartline	Early Woodland, chert Meadowood projectile point, chert scrapers, quartz point base, chert flakes	0.9 mi/1.4 km to E

4.2 Historic Properties

An examination of the files at VDHP identified one State Register (SR) property, within the vicinity of the APE (Table 3). This property is a dairy farm complex on the same parcel and up the hill to the west of the APE about a quarter mile (0.4 km). The complex is listed on the State Register with a c. 1885 barn, c. 1910 milk house, c. 1945 barn and a c. 1850 classic cottage (Johnson, et al. 1992:40).

Table 3. Inventoried properties within or adjacent to the APE

Johnson et al 1992	Property Name/Address	Description of Building
#20	1450 Middle Road	Dairy farm with c. 1885 barn, c. 1910 milk house, c. 1945 barn and a c. 1850 classic cottage

4.3 Previous Surveys

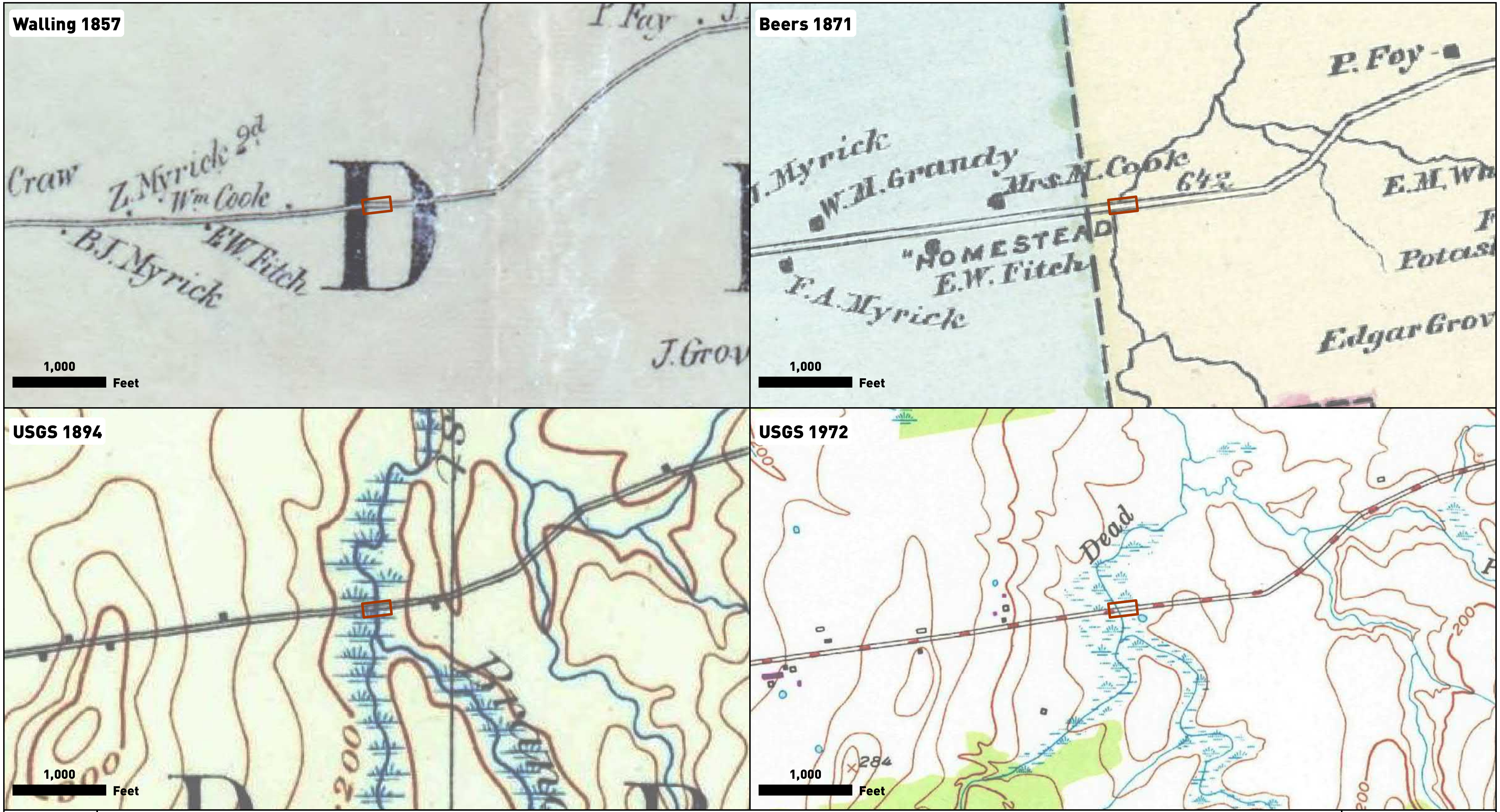
On file at VDHP is one previous survey within the immediate vicinity of the Project (Table 4). That survey was an USDA-NRCS investigation into proposed water runoff management efforts at the historic dairy farm at 1450 Middle Road, west of the APE. The work entailed placing geotextile fabric and wood chips in cattle lane, installing pipe to divert water from cattle holding area (Skinas 1996). Area determined to have low archeological sensitivity and no further review was recommended.

Table 4. Relevant previous surveys within or adjacent to the Project

Year	Investigator	Methodology	Results	Notes
1996	David Skinas, USDA-NRCS	Desktop review	Low archeological sensitivity, no further review	(Skinas 1996)

5 Historical Map Review

Neither the 1857 Walling map (Walling 1857) nor the 1871 Beers map (Beers 1871) of the area depict any structures within the APE (Map 3). They show widely spaced farmsteads characteristic of the Addison County area. The nearest structure shown on those maps is the Cook farmstead, the location of the State Register property discussed above. Similarly, the USGS quadrangles show no development within the APE (USGS 1894, 1972). Of note, however, the USGS quadrangles show wide marshy margins on both sides of the East Branch of Dead Creek within the APE and to the north and south.



Legend

▭ Area of Potential Effects (APE)

N

Historical Maps

1857-1972

HARTGEN
archeological associates inc

Map 3

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6 Archeological Discussion

6.1 Precontact Archeological Sensitivity Assessment

Completion of the VDHP Environmental Predictive Model provides a measure of the precontact archeological sensitivity of the project area (Appendix 1). The Project Area is sensitive for proximity to the East Branch of Dead Creek, along with the confluence of that creek and a tributary creek. Points were also added for the Project Area being within a wetland area and on the travel corridor of the creek. The Project Area has a score of 48. A score of 32 and above is considered to indicate precontact sensitivity.

6.2 Historic Archeological Sensitivity Assessment

The historic sensitivity of an area is based primarily on proximity to previously documented historic archeological sites, map-documented structures, or other documented historical activities (e.g. battlefields).

The historic maps and the nature of the APE indicate a low sensitivity for historic archeological deposits due to the low marshy nature of the APE.

6.3 Archeological Potential

Archeological potential is the likelihood of locating intact archeological remains within an area. The consideration of archeological potential takes into account subsequent uses of an area and the impact those uses would likely have on archeological remains.

Although the APE has a moderate sensitivity for precontact archeological deposits, the site visit failed to identify areas within the APE that might contain such deposits. At the time of the site visit, and at most times, the APE was saturated with water from the creek. Soil cores were taken in a few spots without standing water and the soil was found to be quite uniform with no evidence of soil horizon development that might indicate a stable landform that could be inhabited. That said, the marshy and creek could have been a locus for gathering of important flora and fauna for subsistence in terms of food, medicine or raw materials for clothing, woven containers, etc. Such collecting activities are unlikely to have left visible traces in the marshy area of the APE. Adjacent landforms such as terraces overlooking the marsh may retain precontact archeological sites, but they are outside of the APE. As stated above, the potential for historic deposits is low.

6.4 Archeological Recommendations

The archeological potential of the APE is low and no further archeological review is recommended for the project. If project plans change to affect areas outside of the current APE, further review may be warranted, although the APE itself is considered to have low sensitivity, the higher landforms next to this area (farm fields) are considered to be highly sensitive and must be avoided during construction. This report should be submitted to the VTrans archeology officer for review and concurrence.

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2017 *Guidelines for Conducting Archaeology in Vermont*. Vermont Division for Historic Preservation, Montpelier, VT.

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Appendix 1: VDHP Environmental Predictive Model

VERMONT DIVISION FOR HISTORIC PRESERVATION

Environmental Predictive Model for Locating Pre-contact Archaeological Sites

Project Name STP MM21(4) Middle Road **County** Addison **Town** Bridport
DHP No. **Map No.** **Staff Init.** T. Jamison **Date** 1/11/2022

Additional Information

Environmental Variable	Proximity	Value	Assigned Score
A. RIVERS and STREAMS (EXISTING or RELICT):			
1) Distance to River or Permanent Stream (measured from top of bank)	0- 90 m 90- 180 m	12 6	12
2) Distance to Intermittent Stream	0- 90 m 90-180 m	8 4	
3) Confluence of River/River or River/Stream	0-90 m 90 –180 m	12 6	12
4) Confluence of Intermittent Streams	0 – 90 m 90 – 180 m	8 4	
5) Falls or Rapids	0 – 90 m 90 – 180 m	8 4	
6) Head of Draw	0 – 90 m 90 – 180 m	8 4	
7) Major Floodplain/Alluvial Terrace		32	
8) Knoll or swamp island		32	
9) Stable Riverine Island		32	
B. LAKES and PONDS (EXISTING or RELICT):			
10) Distance to Pond or Lake	0- 90 m 90 -180 m	12 6	
11) Confluence of River or Stream	0-90 m 90 –180 m	12 6	
12) Lake Cove/Peninsula/Head of Bay		12	
C. WETLANDS:			
13) Distance to Wetland (wetland > one acre in size)	0- 90 m 90 -180 m	12 6	12
14) Knoll or swamp island		32	
D. VALLEY EDGE and GLACIAL LAND FORMS:			
15) High elevated landform such as Knoll Top/Ridge Crest/ Promontory		12	
16) Valley edge features such as Kame/Outwash Terrace**		12	

17) Marine/Lake Delta Complex**		12	
18) Champlain Sea or Glacial Lake Shore Line**		32	
E. OTHER ENVIRONMENTAL FACTORS:			
19) Caves /Rockshelters		32	
20) ☑ Natural Travel Corridor ☐ Sole or important access to another drainage ☐ Drainage divide		12	12
21) Existing or Relict Spring	0 – 90 m 90 – 180 m	8 4	
22) Potential or Apparent Prehistoric Quarry for stone procurement	0 – 180 m	32	
23)) Special Environmental or Natural Area, such as Milton acquifer, mountain top, etc. (these may be historic or prehistoric sacred or traditional site locations and prehistoric site types as well)		32	
F. OTHER HIGH SENSITIVITY FACTORS:			
24) High Likelihood of Burials		32	
25) High Recorded Site Density		32	
26) High likelihood of containing significant site based on recorded or archival data or oral tradition		32	
G. NEGATIVE FACTORS:			
27) Excessive Slope (>15%) or Steep Erosional Slope (>20)		- 32	
28) Previously disturbed land as evaluated by a qualified archeological professional or engineer based on coring, earlier as-built plans, or obvious surface evidence (such as a gravel pit)		- 32	

**** refer to 1970 Surficial Geological Map of Vermont**

Total Score: 48

Other Comments :

0- 31 = Archeologically Non- Sensitive
32+ = Archeologically Sensitive

6.6 Historic Memo

HARTGEN
archeological associates inc

HISTORIC RESOURCES IDENTIFICATION

Middle Road Culvert Replacement

Middle Road
Town of Bridport
Addison County, Vermont

HAA # 5744-11

Submitted to:
Fuss & O'Neill, Inc.
The Gateway Bldg., 50 Commercial Street, Unit 2S
Manchester, NH 03101

Prepared by:
Hartgen Archeological Associates, Inc.

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An ACRA Member Firm
www.acra-crm.org

February 2022

MANAGEMENT SUMMARY

There are no National Register eligible or listed resources within the project APE. There are no anticipated impacts on any historic resources by this project.

Report Authors:	*Walter R. Wheeler, Jennifer Geraghty, and Rachel Freeman*
Date of Report:	*15 February 2022*

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Figure List

Photo List

Table List

1 Introduction

Hartgen Archeological Associates, Inc. (Hartgen) conducted an Historic Resources Identification Assessment for the proposed Middle Road Culvert Replacement (Project) located in the Town of Bridport, Addison County, Vermont (Map 1). The Project requires approvals by the Vermont Agency of Transportation (VTrans). This investigation was conducted to comply with Section 106 of the National Historic Preservation Act of 1966, as amended, and will be reviewed by VTrans.

Background research was conducted at the Vermont Division for Historic Preservation (VDHP) ORC (Online Resource Center) site where archeological site files, National Register (NR), State Register (SR) and town information were reviewed. A site visit was conducted by Rachel Freeman on December 2, 2021, to observe and photograph existing conditions within the Project Area.

2 Project Location and Description

The project is located on Middle Road where there are two adjacent culverts on the East Branch of Dead Creek.

2.1 Description of the Area of Potential Effects (APE)

The area of potential effects (APE) includes all portions of the property that will be directly or indirectly altered by the proposed undertaking. The APE encompasses approximately less than an acre in area.

3 Historical Background

The history of Bridport was described in the 1992 publication *The Historic Architecture of Addison County, Vermont State Register of Historic Places: Bridport*

> The first white settlers came to the town of Bridport, which lies between Lake Champlain and the southern foothills of Snake Mountain in Addison County, beginning in the 1770s. Bridport village developed after 1790 at the intersection of the Whitehall to Vergennes stage road (now V T Route 22A), a road to the lake, and a road to Middlebury (now V T Route 125). Farmers soon shipped potash, grain, and livestock from several ferries along the lake, and the hamlet of West Bridport evolved around one ferry to Crown Point, New York. By 1830 many farmers raised sheep for wool, but by mid-century most found stockbreeding more profitable. Around 1900 many farmers shifted to dairying, which continues to be the focus of the town economy today. Several camps along the lakeshore comprise the extent of more recent development, and Bridport retains the aura of a nineteenth century agricultural community (Vermont Division for Historic Preservation 1992).

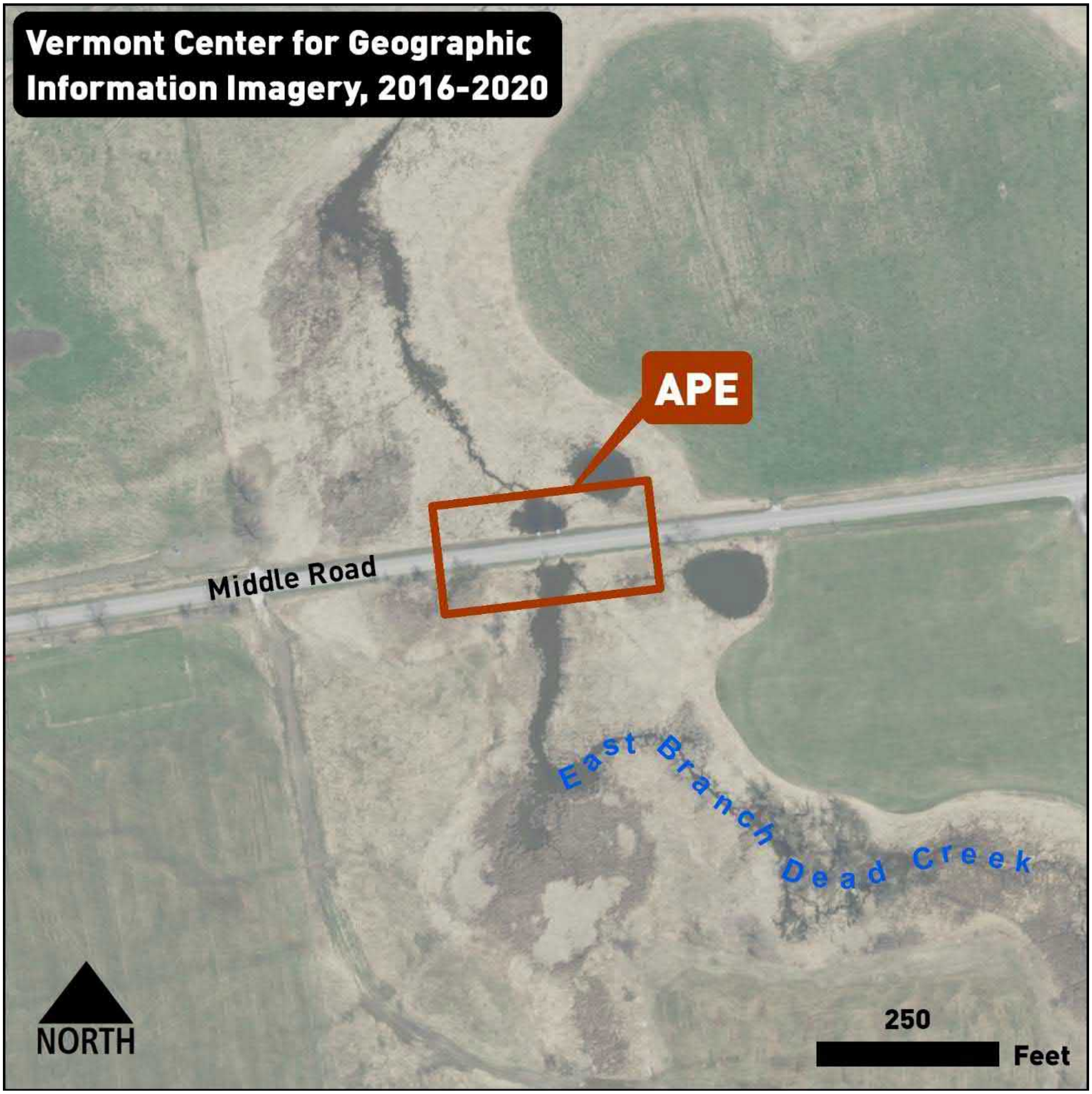

Figure 1. The APE outlined on aerial imagery.

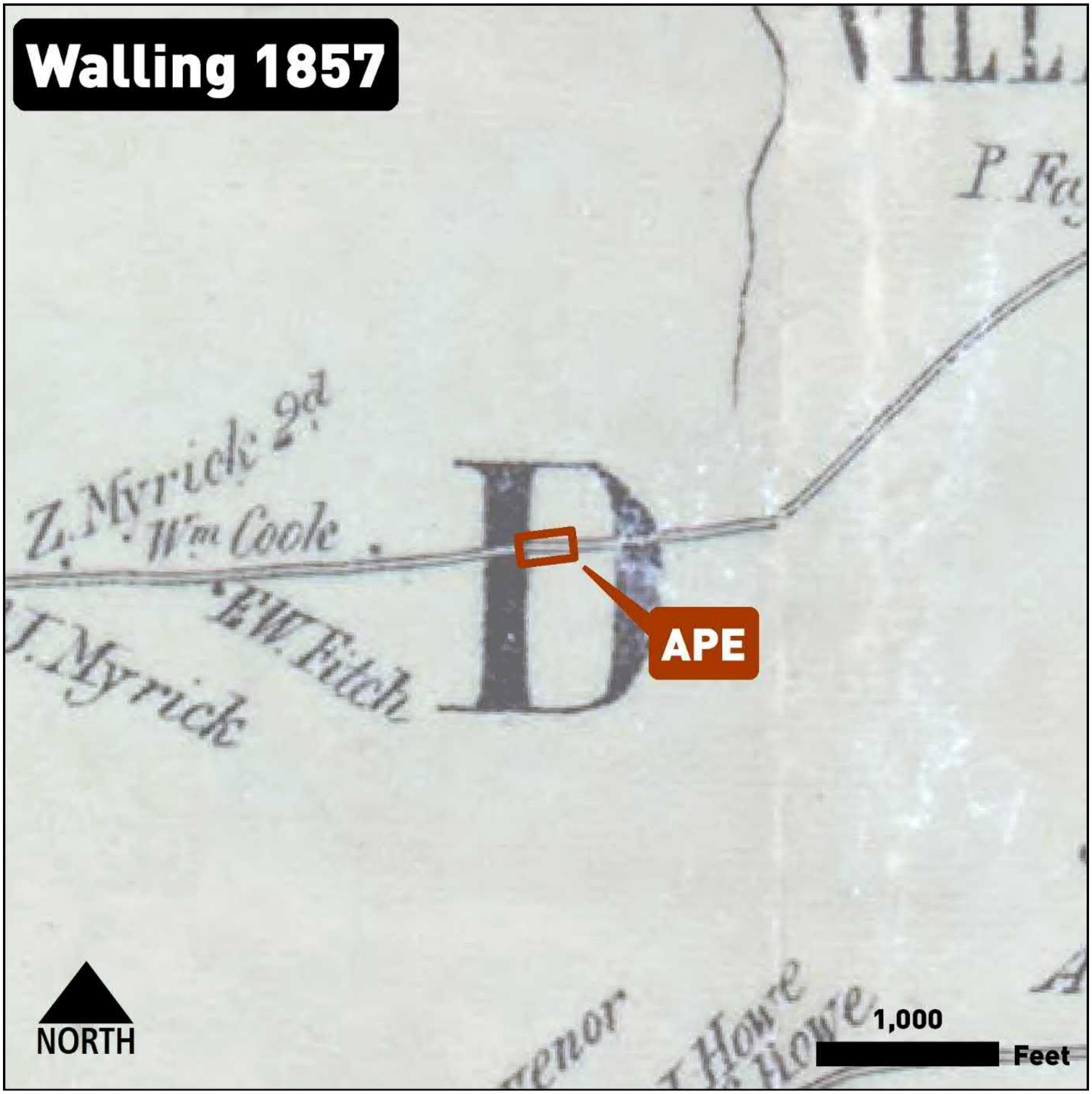

Figure 2. The APE outlined on the 1857 Walling *Map of Addison County* (Walling 1857).

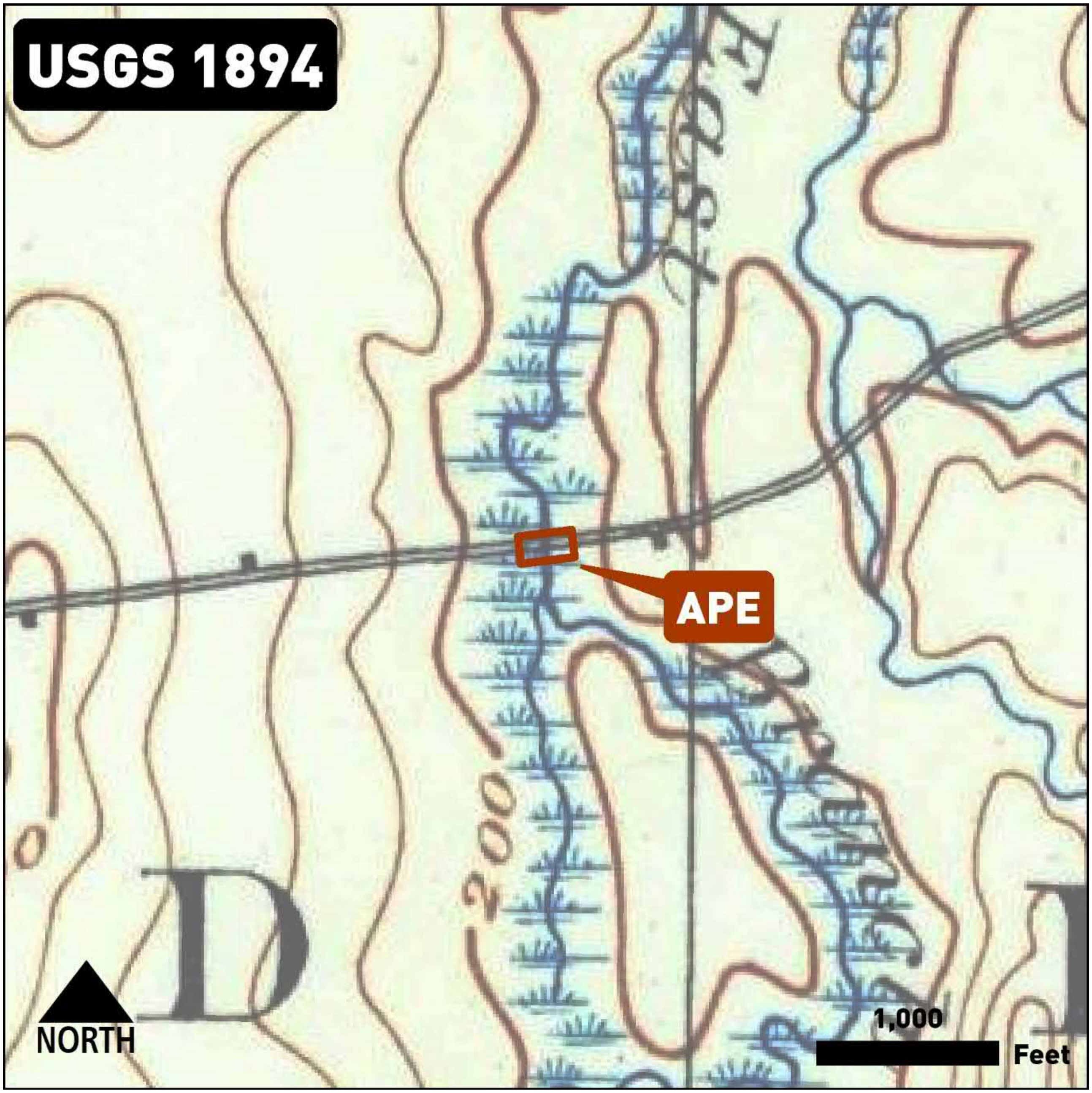

Figure 3. The APE outlined on the 1894 topographic map (United States Geological Survey (USGS) 1894).

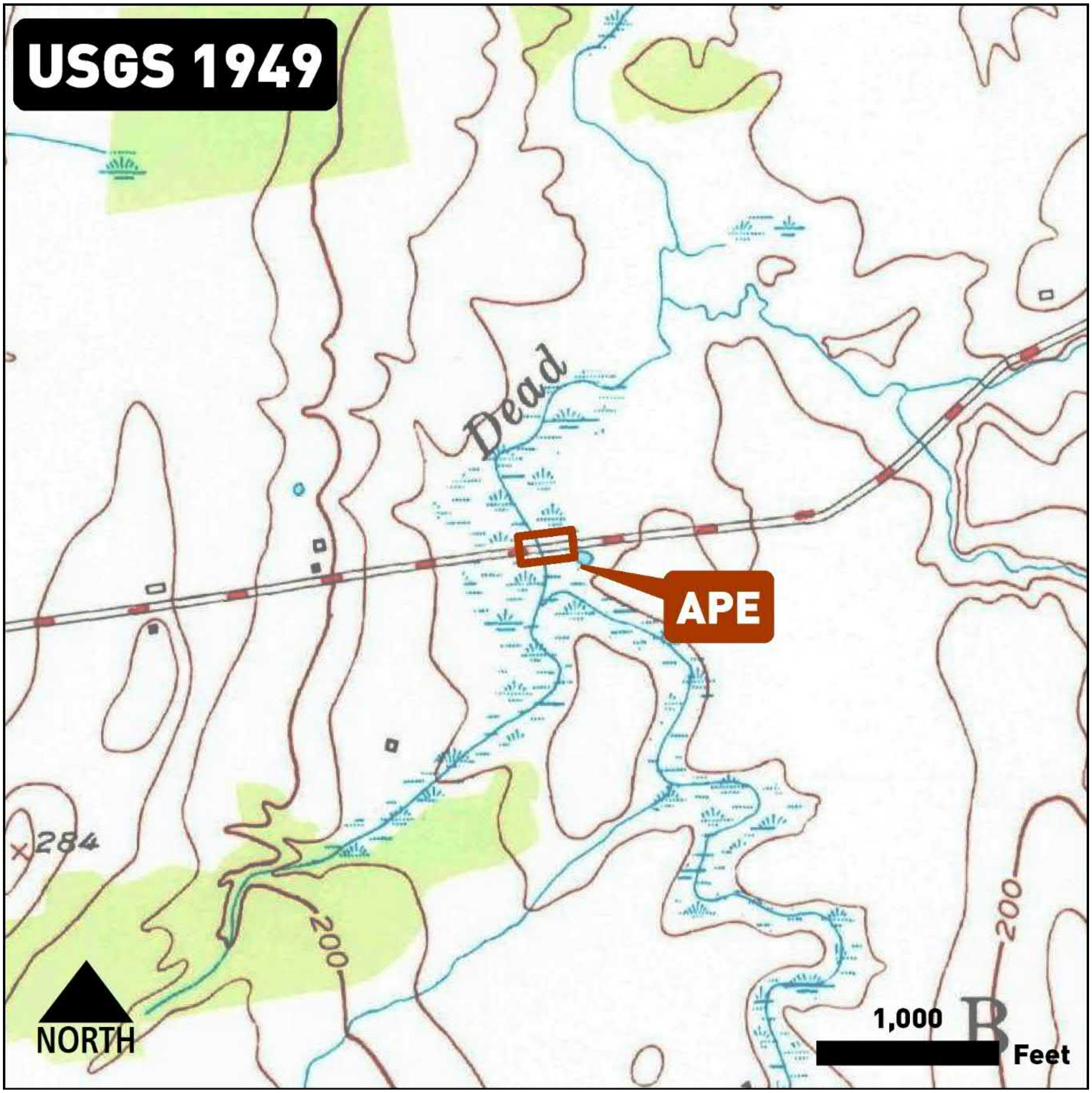

Figure 4. The APE outlined on the 1949 topographic map (United States Geological Survey (USGS) 1949).

Figure 5. The APE outlined on a 1974 aerial photograph (U.S. Geological Survey 1974).

3.1 Historical Map Review

Only one resource involved in this study was constructed prior to 1857 (Figure 2). The Farmhouse at 1450 Middle Road (Structure 2) was identified on the 1857 Walling *Map of Addison County* as the home of William Cooke. William Cooke, a native of Massachusetts, was listed in the population census of 1850 as a farmer. He was recorded as living on this property with his wife, Mary, and their six children (United States Census Bureau 1850; Walling 1857).

One resource included in this survey was built between 1857 and 1894. Although not depicted on the 1894 topographical map, one of the barns associated with Structure 2 was constructed c. 1885 (Figure 3) (United States Geological Survey (USGS) 1894; Vermont Division for Historic Preservation 1992).

Although not shown on the 1949 topographical map, two of the buildings within this survey were built between 1894 and 1949 (Figure 4). The milk-house associated with Structure 2 was constructed c. 1910 while the ground stable barn, also associated with Structure 2, was built c. 1945 (United States Geological Survey (USGS) 1949; Vermont Division for Historic Preservation 1992).

Examination of aerial photography document that the building at 1480 Middle Road (Structure 2) was built between 1974 and 1985 (Figure 5) (Netronline 2022; U.S. Geological Survey 1974).

According to Google Earth imagery, Structure 3 was constructed between 2003 and 2006 (USDA Farm Service Agency 2003, 2006).

3.2 Previously Surveyed Properties

An examination of the files at VDHP identified no NR listed (NRL) properties, one SR Listed (SRL) property, no NR eligible (NRE) properties, no properties previously determined to be ineligible, and no properties of undetermined status within the APE. These properties are indicated in Table 1 on Page 17.

4 Streetscape Views

Photo 1. View of Middle Road, facing west-southwest. Structure 1 seen in foreground and Structure 2 seen in background at right.

Photo 2. View of Middle Road, facing east-northeast. Structures 1 and 3 in sight in the distance.

Photo 3. View of Middle Road, facing east-northeast. Structure 2 in view.

Photo 4. View of Middle Road, facing west. Structure 3 is in view to the left.

5 Architectural Descriptions

5.1 Structure 1. Middle Road—Middle Road Culvert

Structure 1 (Photos 5 to 7) is comprised of two adjacent culverts on the East Branch of Dead Creek. The culverts are of corrugated galvanized steel construction and are nearly round in section. Each culvert has a height of 73 inches, a width of 72 inches and a length of 39 feet. Header material is stone masonry (Vermont Agency of Transportation 2022).

These culverts were installed less than 50 years ago, and are not eligible for listing on the National Register.

Photo 5. View of Structure 1, looking east-northeast.

Photo 6. View of Structure 1, looking west. The north side of Structure 1 is in view.

Photo 7. View of Structure 1, looking west. The south side of Structure 1 is in view.

5.2 Structure 2. 1450-1480 Middle Road

Structure 2 (Photos 8 to 14) includes multiple buildings on the same parcel; three with their own distinct addresses. Four of the buildings were previously recorded as a farm complex and were listed on the Vermont State Register and published in 1992 in *The Historic Architecture of Addison County, Vermont State Register of Historic Places*. In that document the farmhouse at 1450 Middle Road was described as a Classic Cottage constructed c. 1850 (Photos 8 and 9). The outbuildings include a c. 1885 barn, featuring a hay door, a c. 1910 milk-house, and a c. 1945 ground stable barn with a gambrel roof, featuring a hoist, hay door, and weathervane (Vermont Division for Historic Preservation 1992).

Examination of aerial photography, suggests that the building at 1480 Middle Road (Photo 14) was built between 1974 and 1985 (Netronline 2022; U.S. Geological Survey 1974).

Subsequent to its listing on the Vermont State Register in 1992, the domestic component of this complex was significantly altered, with changes made to the location and form of its windows and exterior sheathing which is now vinyl. Although possibly remaining eligible for the Vermont State Register on the strength of its associated outbuildings, the complex is not eligible for listing on the National Register due to this loss of integrity.

Photo 8. View of farmhouse at 1450 Middle Road, looking north-northeast.

Photo 9. View of farmhouse at 1450 Middle Road, looking northwest.

Photo 10. View of barn-complex associated with Structure 2, facing northeast.

Photo 11. View of barn-complex associated with Structure 2, facing northwest.

Photo 12. View of Barn at 1452 Middle Road associated with Structure 2, facing northwest.

Photo 13. View of barn associated with Structure 2, facing north-northeast.

Photo 14. View of building at 1480 Middle Road associated with Structure 2, facing northwest.

5.3 Structure 3. 1175 Middle Road

Structure 3 (Photos 15 and 16) is a modular home. According to Google Earth imagery, Structure 3 was constructed between 2003 and 2006 (USDA Farm Service Agency 2003, 2006).

Structure 3 is ineligible for listing on the National Register due to insufficient age.

Photo 15. View of Structure 3, facing southeast.

Photo 16. View of Structure 3, facing southwest.

6 National Register Eligibility Summary

Three structures or groups of structures were included in this survey. None of these structures are eligible for listing on the National Register. Structures 1 and 3 are ineligible due to insufficient age; Structure 2 is ineligible based upon loss of integrity. There are no anticipated impacts on any historic resources by this project.

Table 1. Summary of Resources Surveyed for the Middle Road Culvert Replacement Study Area

Building No. (see Map 2)	**Resource Address**	**Construction Date**	**Historic Use or Name**	**Previous Survey and/or NR status**	**Recommended National Register Status**
1	Middle Road	c. 1980	Middle Road Culvert	None	Not NRE
2	1450-1480 Middle Road	c.1850/ c. 1885/ c. 1910/ c. 1945/ 1947-1985		1992 individually SRL complex (#20)	Not NRE
3	1175 Middle Road	Between 2003-2006		None	Not NRE

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U.S. Geological Survey

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United States Census Bureau

1850 Population Schedule of the Seventh Census of the United States for the Town of Bridport, Rutland County, Vermont. Electronic document, http://www.ancestry.com, accessed on February 8, 2022.

United States Geological Survey (USGS)

1894 *Ticonderoga, 15-Minute Topographic Quadrangle.* U.S. Government Printing Office, Washington D.C.

1949 *Bridport, New York Topographic Quadrangle Map, 1:24,000 scale.* USGS Historical Topographic Map Explorer, Reston, Virginia, http://historicalmaps.arcgis.com/usgs.

USDA Farm Service Agency

2003 *Aerial Photography for Bridport, Vermont.* U.S. Geological Survey, Sioux Falls, South Dakota.

2006 *Aerial Photography for Bridport, Vermont.* U.S. Geological Survey, Sioux Falls, South Dakota.

Vermont Agency of Transportation

2022 Bridge and Culvert Inventories collected by the Regional Planning Commissions (RPCs), towns and their contractors. Electronic document, accessed on January 5, 2022, https://vtculverts.org/viewstructure/75a4d9cb-9794-43e2-b51a-f4609eeaa1e9.

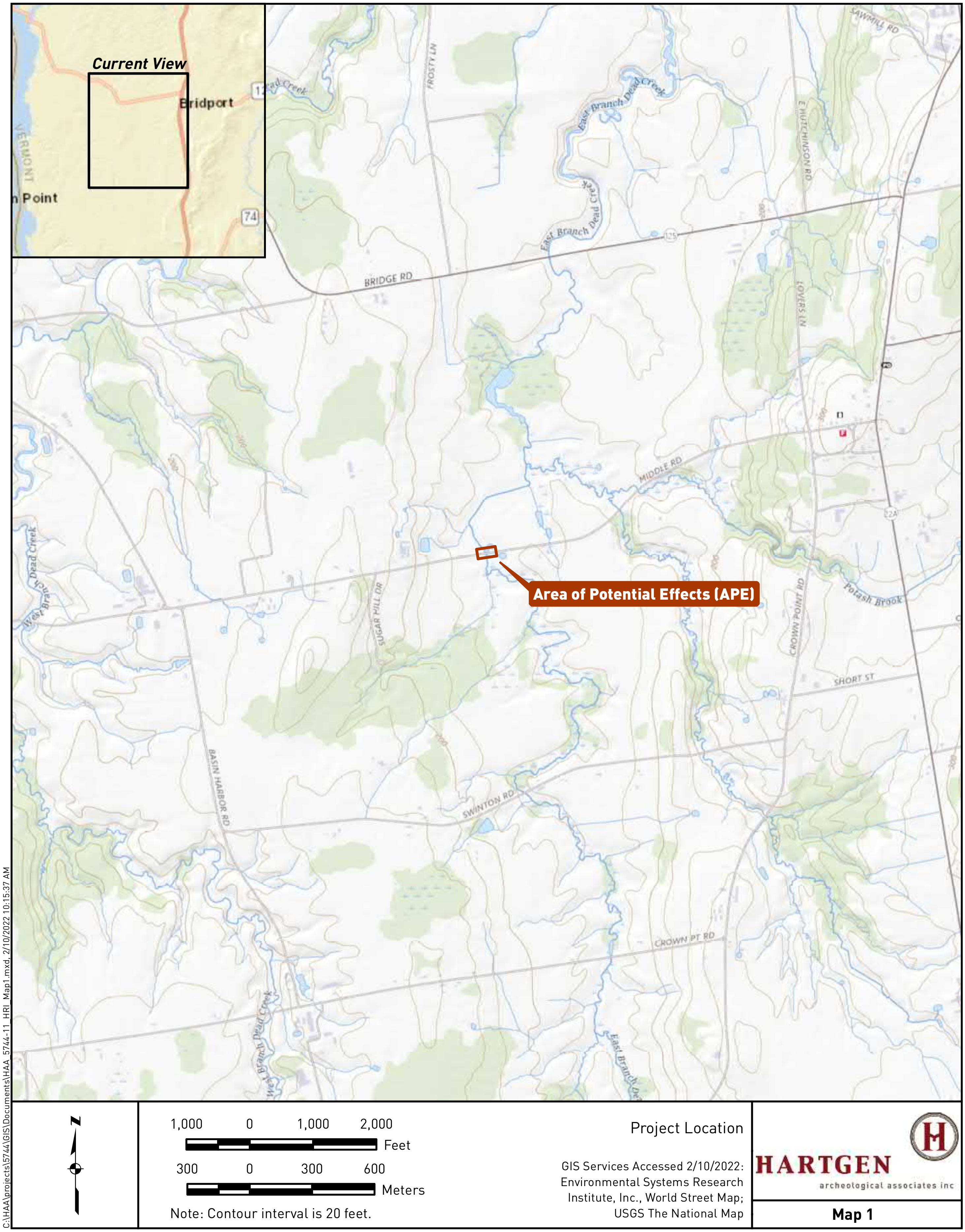
Vermont Division for Historic Preservation

1992 *The Historic Architecture of Addison County, Vermont State Register of Historic Places: Bridport.* On file at Vermont Division for Historic Preservation, Online Resource Center, https://orc.vermont.gov.

Walling, H.F.

1857 *Map of Addison County, Vermont.* Baker, Tilden & Co, Boston.

Maps



Note: Contour interval is 20 feet.

Project Location

GIS Services Accessed 2/10/2022:
Environmental Systems Research Institute, Inc., World Street Map;
USGS The National Map

HARTGEN archeological associates inc

Map 1

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Project Map

Vermont Center for Geographi
Information, Orthoimagery, 2016-2020

Map 2

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Qualifications

WALTER R. WHEELER

Senior Architectural Historian

EDUCATION: Rensselaer Polytechnic Institute
Bachelor of Architecture May 1987
Bachelor of Science, Building Science, May 1986

QUALIFICATIONS: 36 CFR Part 61 Qualified Architectural Historian

PROFESSIONAL EXPERIENCE:

June 1999 – Present Senior Architectural Historian
Hartgen Archeological Associates, Inc.
Oversee and prepare reconnaissance and intensive architectural resource surveys; literature reviews and historical documentation; field reconnaissance; report and proposal preparation for projects in New York, New England and the mid-Atlantic. Responsible for preparing documents to be reviewed by NYSOPRHP, NHDHR, MHC, VAOT, VDHP, and USACOE, for SEQR, Section 106 and NEPA. Preparation of reports generated under ACT 250 and the FCCs Nationwide Programmatic Agreement, including preparation of forms 620 and 621. Conducted resource surveys in NY, VT, MA, NJ, NH, and PA.

November 1992 – June 1999 Architectural History Consultant
Identified, analyzed, and assessed historic structures; researched and wrote for exhibitions and publications including Historic Structures Reports; executed drawings in connection with restoration projects; and conducted reconnaissance and intensive resource surveys. Clients included Rensselaer County Historical Society; Robert Pierpont, both in Troy, NY; towns of Durham and Oak Hill, NY; Albany Institute of History and Art; Metropolitan Museum of Art; the New York Public Library, and John G. Waite Associates, Albany, NY.

May 1984—November 1992 Junior Architect
Worked for the Office of the New York State Architect, Wagoner & Reynolds, and in the office of Robert N. Pierpont as a Junior Architect. Responsible for restoration projects including the Governor's Mansion, the New York State Capitol, and Wilborn Temple (all in Albany, NY), and the Knickerbocker Mansion, in Schaghticoke, NY.

PRINCIPAL PUBLICATIONS:

In preparation *Building Albany: Studies in the Vernacular Architecture of the Upper Hudson and Lower Mohawk Valleys.* Albany, NY: SUNY Press.

2017 "Magical Dwelling: Apotropaic Practices in the New World Dutch Cultural Hearth," in *Ruralia XI: Religious Places, Cults, and Rituals in the Medieval Rural Environment.* Turnhout, Belgium: Brepols Publishers NV.

2010 "Once adorned with quaint Dutch tiles...: A Preliminary Analysis of Delft Tiles Found in Archaeological Contexts and Historical Collections in the Upper Hudson Valley," in Penelope Ballard Drooker and John P. Hart, eds*., Soldiers, Cities and Landscapes: Papers in Honor of Charles L. Fisher.* New York State Museum Bulletin 513, 107-150. Albany, NY: New York State Museum.

2009 *Architects in Albany*. Diana S. Waite, editor. Albany, NY: Mt Ida Press/ Historic Albany Foundation. Contributed two biographical essays.

2005 *The Encyclopedia of New York State*, Peter Eisenstadt, editor. Syracuse, NY: Syracuse University Press, 2005. Author of entries "Philip Hooker," "Archimedes Russell," "Upright and Wing Houses," "Cobblestone Architecture," "Empire State Plaza," and "Architects and Architecture of Syracuse and Central New York."

2000 *The Marble House in Second Street: Biography of a Town House and its Occupants, 1825-2000.* Troy, NY: Rensselaer County Historical Society.

1993 *In a Neat Plain Modern Stile: The Architecture of Philip Hooker and His Contemporaries, 1796-1836.* Amherst, MA: University of Massachusetts Press.

6.7 Coordination Emails and Public Meeting Minutes

FUSS & O'NEILL

Town of Bridport, VT Meeting Notes

September 3, 2021

F&O PROJECT NUMBER: 20210607.A10

PROJECT NAME: Middle Road Culverts Scoping Study

ATTENDEES:

Name	Company
Dusty Huestis	Road Foreman, Bridport DPW
Bill (Dusty's assistant)	Bridport DPW
Mike Winslow	Addison County Regional Planning Comm.
Josh Robinson	Fuss & O'Neill
Phil Forzley	Fuss & O'Neill

RE: Project Kickoff Meeting

SUBMITTED BY: Phil Forzley, Josh Robinson

Phil and Josh arrived at the site early to gather additional topographic data and site information that would be useful during the scoping study. Dusty, Bill and Mike joined us at 11am for the kickoff meeting and we reviewed the scope of work for this project. The scope items and points we discussed follow.

The DPW identified the main issues the town has had with the culverts. Middle Road overtopped during what the town describes as the Halloween storm in 2019, when the road overtopped by 6 inches. During the winter ice forms and sometimes blocks the culvert. Recently, beaver activity blocked the culverts on the downstream side and debris was removed with a backhoe or excavator.

The DPW and ACRPCC indicated they anticipate getting federal funds to replace the culverts and that the project needs to comply with those requirements.

Base mapping to document existing conditions

Base mapping will be developed using available GIS data and F&O's field observations. We will obtain traffic and bicycle/pedestrian count data from the Addison County Regional Planning Commission (ACRPC) to include in our report. Mike offered that ACRPC would get this information for us.. Information the town provides may be added when we distribute the base map for review.

Development of concept design alternatives

a. Roadway considerations – we discussed road and shoulder width and guard rails. The town prefers not to have guard rails because they cause snow drifting. Instead, the town prefers wider shoulders. We pointed out the limited space available at the existing culverts, and that we would include consideration of wider shoulders into concept design. The group acknowledged the increased impact to wetlands that would result from lengthening the culverts.

b. Maintenance of traffic – the group agreed that a detour was the best option for accommodating traffic. The most practical detour is only about 3.3 miles or 6 minutes.
c. Geotechnical conditions – the culverts are in a floodplain and the soil boring we included in our submittal to the ACRPC and the town, while it is from a site not in proximity, is believed to be representative of subsurface conditions in this project area. Dusty agreed that is the case based on work the DPW has done in the area. We expect subsurface soils to consist of silt and silty clay up to depths greater than 100 feet below surface grade. There is likely silt and organic sediment within the first 5 feet below surface grade.
d. Hydraulic / hydraulics – we discussed the minimal stream gradients, potential difficulty to practically contain flood flows within culvert(s) and designing to accommodate road overtopping. The group agreed that if necessary the road could be allowed to overtop as long as the design includes protection of the road embankment from erosion. Our field work on the meeting date indicated there may be a low point not in the immediate vicinity of the culverts. The DPW indicated that adjacent landowner would probably not object to protecting the road embankment from overtopping with riprap or another solution.
e. Identify right of way issues – F&O will obtain available mapping of the right of way. The DPW believes there are two landowners, and they do not anticipate strong objections to the project from them.
f. Utility conflicts – overhead power is the only utility in the project area. F&O's base mapping will depict the location of the utility poles.
g. Natural and cultural resources – F&O has subcontracted with Hartgen Archaeological Associations Inc for a survey of cultural resources in the project vicinity. F&O's mapping will depict the approximate location of wetlands. The project will impact wetlands on both sides of the road. Measurement of bank full width is not included in this scoping study, but a September 21, 2014 state assessment includes some information including bank full width that may be included in this scoping study.

F&O will work with the town and the ACRPC to develop a schedule that will allow the project to be completed no later than January 31, 2022.

STPMM21.4 - Bridport Middle Rd. Culverts Scoping Study
Local Concerns Meeting October 7, 2021
Bridport DPW conference room

Attending: From Bridport - Tim Howlett, Bob Sunderland, Joan Huestis, Steve Huestis, Dusty Huestis. From Fuss & O’Neill - Shannon Beaumont and Josh Robinson. From ACRPC - Mike Winslow

Minutes:

- F&O noted that the point of the meeting is to get the town’s input on replacement options, traffic control, and any other issues that should be discussed.
- F&O described the project area, the outcomes of the kickoff meeting, and the existing conditions.
- Residents noted that a pond northwest of the project area identified on the base maps is actually a manure pit and should not show a hydrologic connection to Dead Creek.
- F&O identified two traffic control options. 1. Use phased construction and maintain one lane of alternating traffic through the project duration. This option would require temporary signals to be installed, would increase construction time, and would require a longer culvert leading to increased costs, but maintaining traffic flow. 2. Close the road for the duration of the project and reroute traffic. This would require a maximum 5.3 mile, 10-minute detour. Town officials and F&O agreed that option 2 was preferred. Town officials recommended rerouting traffic to Crown Point Road rather than Swinton Rd. Crown Point Rd. is a little bit farther, but is in better condition.
- F&O identified three construction options and noted they are not considering rehabilitation of the existing structures. 1. At-grade rigid frame culverts. 2. At-grade box culvert. 3. Buried steel-plate pipe(s). The buried pipes would allow over-topping during high flows, but their advisability is dependent upon the results of a yet to be completed hydraulic study. Dusty asked which options ANR would approve, to which Shannon noted that is part of the next step in analysis.
- The alternatives meeting is scheduled for December 9. At that meeting F&O will present probable costs, pros and cons of each alternative, and a construction schedule. Feedback from the alternatives meeting will be used to finalize the scoping project report.
- Dusty noted that the bridge and road standards will drive what is allowed at the location, and that F&O should consult with Jaron Borg, the district river management engineer. Shannon said the preliminary bankfull width assessment suggests it is less than 20’. If that holds, all options discussed would still be feasible.
- Additional information
    - Middle Road is a school bus route
    - The detour was not expected to be a significant impediment to farm equipment
    - Summer would be the best time for the project to avoid issues with the school bus, farm harvesting, and potentially to take advantage of drier conditions
- Tim asked how construction would take place in the wetlands. Shannon described how pumps and a sedimentation basin would be used to manage water.

- Bob asked about the relative advantage of a culvert vs. a bridge. Shannon said they would try to avoid a bridge due to costs and believed they would be able to do so based on their assessment of bankfull widths. A bridge would only be necessary if required by permitting.
- Dusty described how Middle Rd., Swinton Rd., and Crown Point Rd. all had similar features of a similar age. He is hopeful that the design for Middle Rd. can be used as a model for replacing those culverts as well.
- Tim asked how often over-topping occurs now at the site. Dusty mentioned a 1996 ice jam and a 2019 rain storm that caused overtopping. In both cases, the duration of overtopping and the extent of flow were minimal. The low point for overtopping is not at the culverts, thus they are protected during overtopping.
- Tim asked what the remaining life expectancy of the culverts was. Shannon said there are no visible holes and no deformation, so they need not be replaced immediately. Dusty suggested they have about 6-8 years of useful life yet, which is about the time it would take to get to construction using a federal grant.
- The question of guardrail was raised. Shannon noted they will be required by codes and standards. Dusty requested they be as short as possible to avoid catching drifting snow.

Meeting adjourned 7:02 PM
Minutes by Mike Winslow

STPMM21.4 - Bridport Middle Rd. Culverts Scoping Study
Alternatives Review Meeting December 9, 2021
Bridport DPW conference room

Attending: From Bridport - 5 individuals including Selectboard Chair Tim Howlett and Road Foreman Dusty Huestis. From Fuss & O'Neill - Shannon Beaumont and Josh Robinson. From ACRPC - Mike Winslow

Minutes:

- Josh reviewed the existing site conditions
- Shannon discussed the three alternatives that were developed: an at-grade precast concrete box culvert, an at-grade precast concrete rigid frame, and a buried steel plate arch.
- In designing the three options, F&O considered the following:
    - Hydraulic limitations - the final structure will need to be 1x bankfull width or a minimum of 16' wide. Design was for the Q25 storm. A closed bottom structure would need a headwater to depth ratio >= 1 while an open bottom structure would need 1' of freeboard. The box culvert is the only option that meets the hydrological requirements. The others could potentially be permitted, but there would be added expense.
        - *Dusty asked if the newest iteration of the road and bridge standards required designing to a Q25 storm or a Q50 storm. Mike agreed to track down an answer.*
    - Geotechnical - Overall the soils in the project area are not good for construction, and bedrock depth is unknown. There is a potential that soil remediation would be necessary. The box culvert is the best option for allowing weight displacement on the existing soils rather than requiring driving piles or other support structures.
    - RIght of way impacts - temporary easements may be necessary for all structures, but no permanent easements are anticipated
    - Utilities - There are overhead utility lines in the project area. F&O anticipate that relocation may not be necessary.
        - *Dusty noted that he believes there is also a buried phone line in the area that may be impacted*.
    - Permitting constraints - the project will require:
        - Floodplain permit issued by the town for the special flood hazard area
        - Wetlands permit is likely
        - A stream alteration permit
        - Army Corps permits for which self-verification should be sufficient
    - Archeological impacts - work is on-going but the potential for impacts is low
    - Cost - Initial cost estimates are for construction only, assumes no piles need to be driven, and include a 30% contingency
        - Box culvert - $445,000
        - Rigid frame - $645,000
        - Buried arch - $1,000,000

    - Traffic control impacts - A six mile detour during construction is anticipated
- F&O recommended the box culvert as the preferred option and town officials all agreed.
- F&O predicted a two month construction period for the project.
- Next steps. F&O will
    - Complete an evaluation matrix for the three alternatives
    - Finalize their estimates
        - *In finalizing the estimates attendees requested that F&O include contingency estimates for driving piles, and for a longer culvert. These would not be included in the evaluation matrix.*
        - *Town officials agreed a 24’ road width rail to rail was preferred for the project area*
    - Incorporate the archeological findings
    - Produce a final report

Meeting adjourned 7:25 PM
Minutes by Mike Winslow

From: Josh Robinson
Sent: Tuesday, October 12, 2021 4:47 PM
To: Shannon Beaumont
Cc: Phil Forzley; Jacob Fowler
Subject: RE: [External] Minutes from Bridport culvert local concerns meeting

Hey Shannon,

Just spoke to Jaron Borg at VTDEC.

Had a great talk with Jaron at VTDEC. He gave a bunch of helpful information regarding hydraulics and geomorphology. The information he provides is not
something I'm used to so if there is some information that you need clarified please let me know:

- Jaron noted that we need to provide 1X the measured bankfull width provided by the State (16' is the minimum).
- Our design must be for a Q25 storm or the requirements of the roadway, whichever is greater. He thought that Middle Road is Class III.
- Closed bottom structure: Will require a headwater to depth ratio of 1
- Open bottom structure: 1' freeboard at design storm level to minimize scour
- Embedment below equilibrium of stream profile required. 30% of opening height of structure. For example, opening height at 4' (1.3 or 1.4 feet of embedment below that)
- Depending on depth of stream. May need a tailwater controlling condition. May not require infill, if slope is less than 0.5%. Jaron noted that the slope is flat, and this may apply
- If infill is required – Type 1 stream bed infill. Sediment retention sills shall be 8' maximum apart with one at inlet and one at outlet.
- V notched shape required for box culvert, 12 inches outside, 6 inches on inside. Required to preserve material within culvert during storm event as a precaution

Please let me know if you have any questions.

Thanks,
Josh

Joshua Robinson (he / him)
Senior Environmental Scientist
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Shannon Beaumont

From: David Rosengarten
Sent: Wednesday, October 20, 2021 10:44 AM
To: Shannon Beaumont
Cc: Josh Robinson; Phil Forzley; Daniel Monette; Jacob Fowler
Subject: RE: Bridport VT help

Follow Up Flag: Follow up
Flag Status: Flagged

Hi All, Jaron pointed out in hi email below that the Fish and Wildlife guidelines are not stream alteration permitting requirements, for design guidance criteria the River Management Principles and Practices manual is more appropriate. Page 150 (155 PDF) confirms for a Stream Alteration General Permit it is only required to be sized at 1X bankfull (no banks in the culvert).

"Where more capacity is needed based on flow, material deposition, or scour, structure width shall be 1.2 x bankfull width or larger (e.g., floodprone width)." Do we have a reason to think this 1.2X bankfull or greater would be required? It doesn't seem to be from Jarod's summary "areas of heavy sediment deposition and braiding streams".

This should clear up your initial question, I'll reach back out to confirm the GP eligibility and requirements and contact the folks mentioned below about wetlands and floodplain permitting.

-David

From: Borg, Jaron Jaron.Borg@vermont.gov
Sent: Wednesday, October 20, 2021 10:06 AM
To: David Rosengarten DRosengarten@fando.com
Subject: [External] RE: Middle Rd Bridport Questions

David,

The document you are referencing is guidance specific for Fish and Wildlife with the intent of maximizing passage. Statewide the minimum structure sizing for Stream Alteration is 1.0XBankfull Width, requiring more in areas of heavy sediment deposition and braiding streams. The River Management Principles and Practices is a more appropriate design guidance. Glad to follow up with a phone call as there is some valuable background I can provide for both documents.

Sincerely,

Jaron

Jaron Borg, River Management Engineer
Watershed Management Division, Rivers Program
Vermont Department of Environmental Conservation
1 National Life Drive, Main 2
Montpelier, VT 05620-3522
802-371-8342 / Jaron.Borg@vermont.gov
On the Web @ https://dec.vermont.gov/watershed/rivers

From: David Rosengarten <DRosengarten@fando.com>
Sent: Wednesday, October 20, 2021 9:46 AM
To: Borg, Jaron <Jaron.Borg@vermont.gov>
Subject: Middle Rd Bridport Questions

EXTERNAL SENDER: Do not open attachments or click on links unless you recognize and trust the sender.
Hi Jaron, it was nice to meet you at the Rivers and Roads training last week! One of my colleagues Josh Robinson contacted you recently about a project in Bridport that I have a few more questions about. I've included some info on the location below.

I understand we generally need to provide 1X the bankfull width (no banks inside the structure) and, for a closed bottom structure, embedded 30% of the height for a round culvert or the equivalent precent opening size for other culvert shapes, is that correct?
I see for low slope design, 1.25X bankfull is required. In section 6.3.6 Culvert Width of the Guidelines it is specified for banks to "add two to four times the diameter of the largest mobile material in the bed to the bankfull width as an initial estimate". What other situations besides low slope would require constructing banks inside a culvert?

I may have other permitting questions as we get further into this project, look forward to hearing from you. If you'd prefer to set up a call, let me know what your upcoming availability is and I'd be glad to chat.

Best regards,

-David

43.9796240481691, -73.33690265472715

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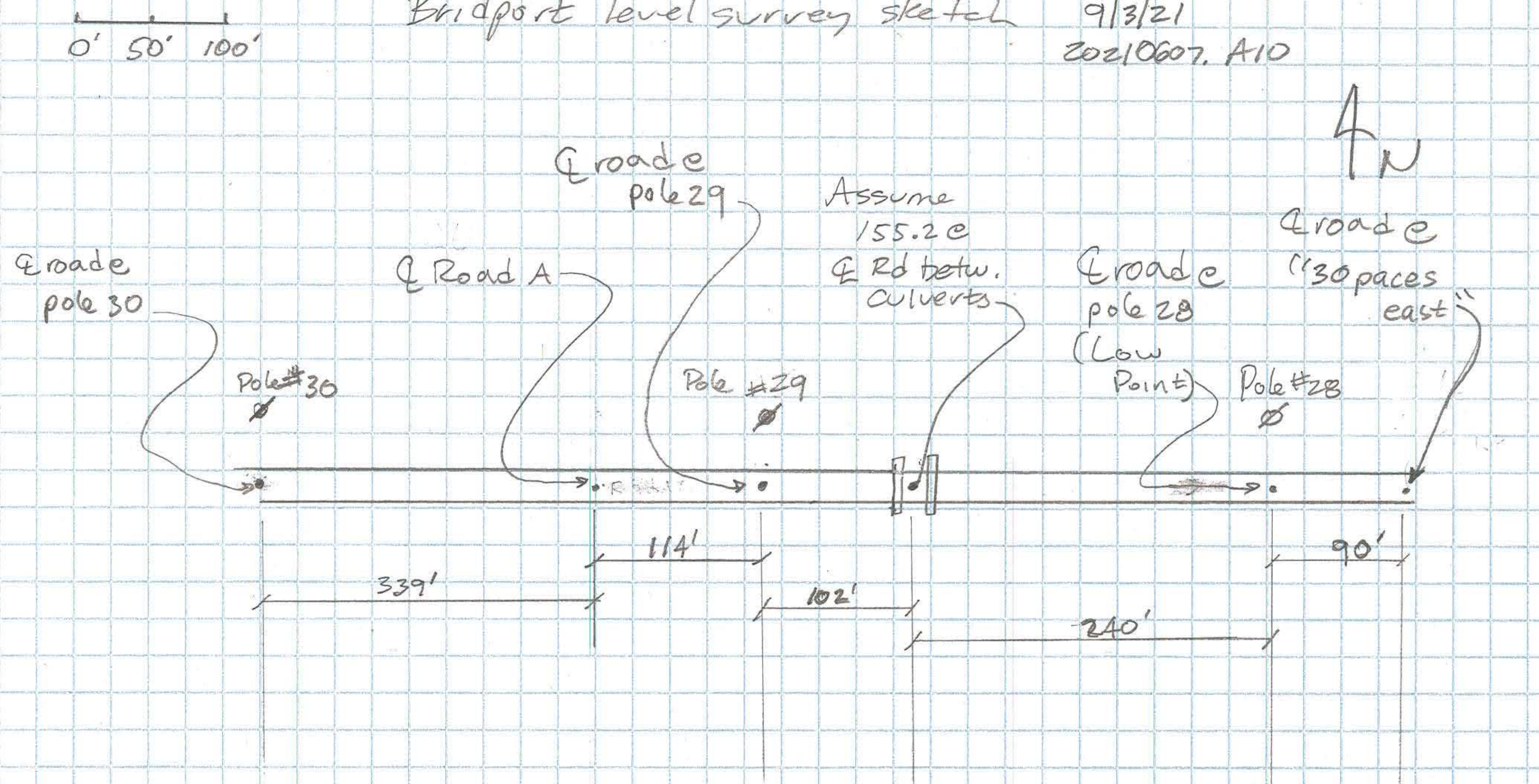
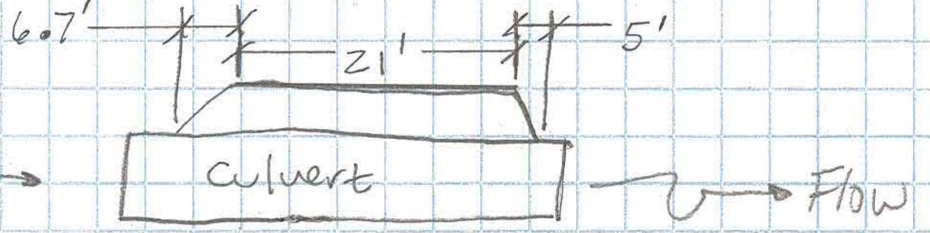
Bridport level survey sketch 9/3/21
20210607. A10



Typical shoulders @ culverts:



Bridport level survey

20210607.A10

assume reference elev (from GIS base map)	155.2	centerline of road between 2 culverts
BS (Ht of instrument)	4.4	
Elev of instrument	159.6	

Shot	FS	Elevation	
CL road at pole #30	3.3	156.3	
CL road A	4.9	154.7	This is lower than CL of road at culverts
CL road at pole #29	4.6	155	
CL road at pole #28	5.2	154.4	This is the low point in Middle Road
CL road "30 paces east"	4.9	154.7	

Pipe diameters 60" or 5 ft

Shot	FS	Elevation	Invert
Top of east culvert in	6.8	152.8	147.8
Top of east culvert out	5.6	154	149
Top of west culvert in	6.9	152.7	147.7
Top of west culvert out	5.8	153.8	148.8

\\private\DFS\Projectdata\P2021\0607\A10\Notes\reduce level survey notes.xlsx

20210607.A10 1/3

9/3/21 Bridport kickoff w/ town

- Halloween storm 2019 OT (6"). Winter/ice block.
- Federal funds
- detour ok
- ok to design for overtopping
- Dusty - no guardrail - snow drifting. Shoulders wider

<u>Mike Winslow</u>

RFPs

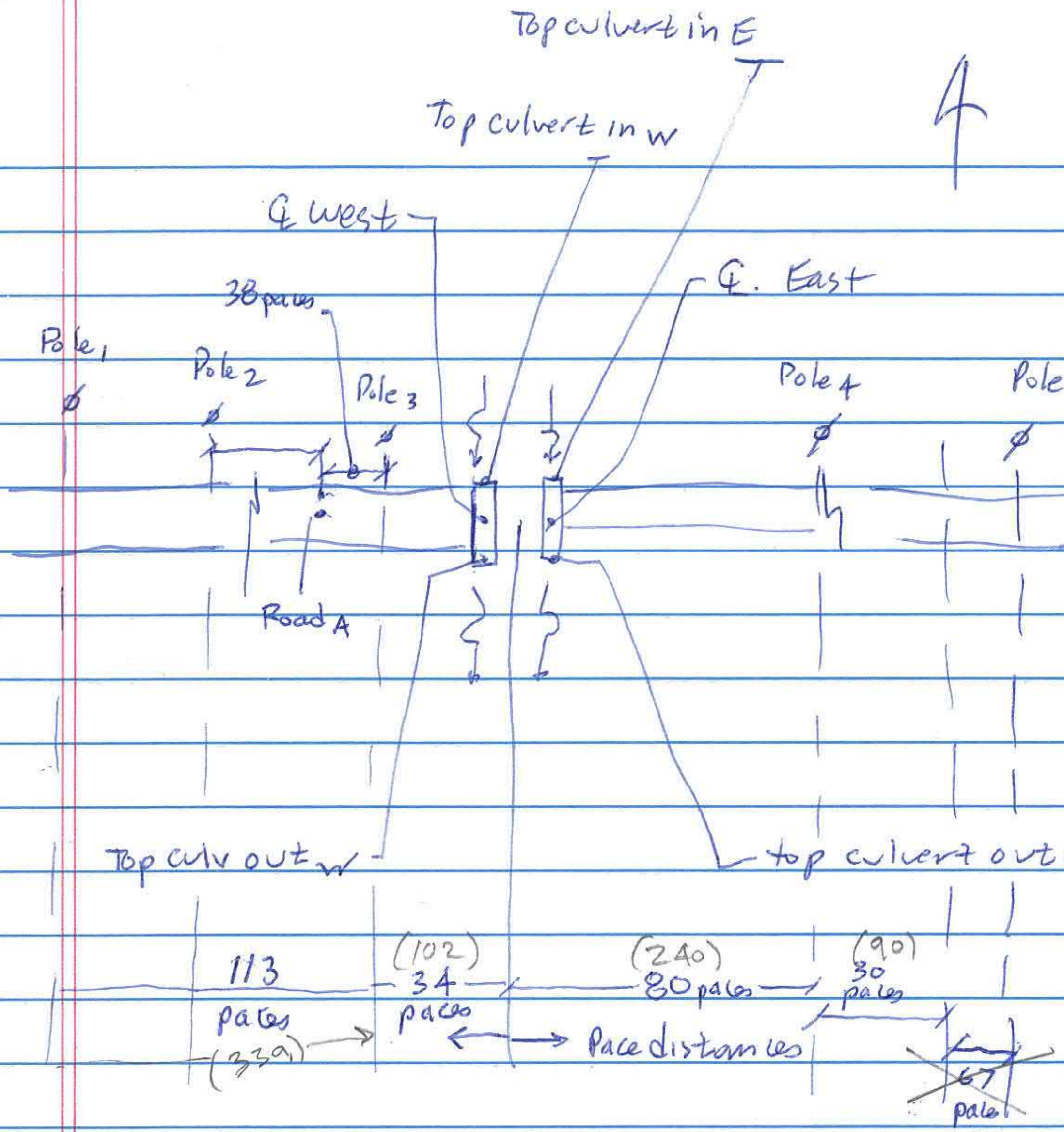
- Intersection in (Middlebury?)
- sidewalk scoping study Bristol

170 mi

2/3

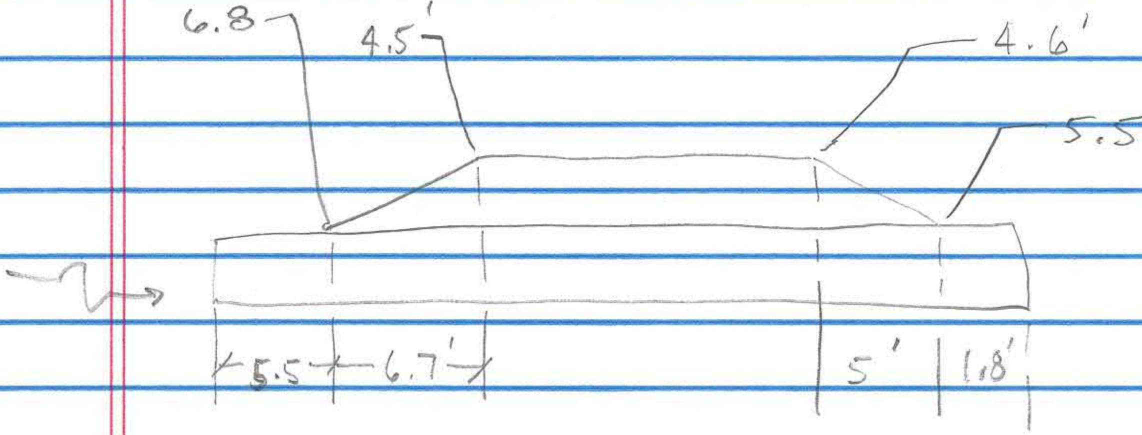
4

Dusty Town
Mike W.
Bill(?) Town
Josh
Phil

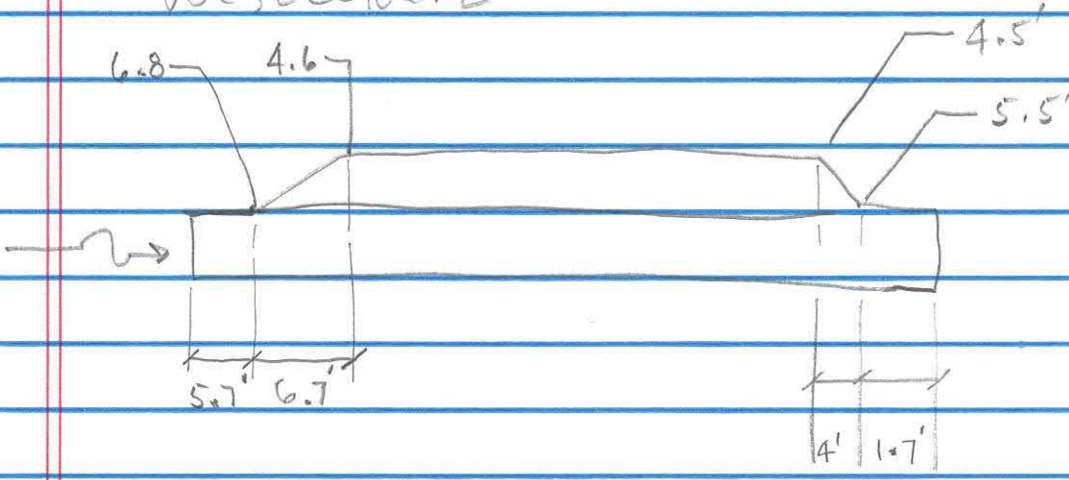


Instrument:	4.4'	
CL Rd CL west ~~culverts~~	4.12	
Top culvert ~~CL~~ East in	6.82	
Top culv ~~CL~~ west in	6.9	
Top culv East out	5.6	
" " West out	5.8	
Rd e Pole 3	4.6	(#29)
" Pole 2	3.3	(#30)
" Pole 1		
Road A	4.9	
Pole 4	5.2	(#28)
30 paces (East)	4.9	

East culvert



West culvert



Shannon Beaumont

From:	Josh Robinson
Sent:	Wednesday, June 30, 2021 1:32 PM
To:	Shannon Beaumont
Cc:	Phil Forzley; Jaime French; Patricia Shedd
Subject:	Bridport, VT - Middle Road Culvert Info

Shannon,

I was able to get all of the information you requested for the Bridport culverts.

The photos you requested are here:

\\private\DFS\Projectdata\P2021\0607\A10\Photos\20210629_Bridport Culverts

A few observations made that I think are important to note:

- ➢ The area is a large drainage area from adjacent farms with a few hundred acres that are hydraulically connected to the area.
- ➢ The East Branch of the Dead River is a very low energy river that during the summer months can become stagnant between rain events.
- ➢ Water levels within the creek fluctuate significantly throughout the year.
- ➢ There are adjacent farms, however Middle Road has very little through traffic

Measurements:

1. Existing roadway widths (at approaches and at crossing)

    - East Side Approach: 21.25” Center of Culverts: 21.25” West Side Approach: 21”

2. Current water depths

    - East Side Upstream: No water present. Culvert opening impacted by wood debris and sediment.
    - West Side Upstream: 8”
    - East Side Downstream: 2’
    - West Side Downstream: 2’

3. Channel bed to existing top of roadway (upstream and downstream)

    - East Side Upstream: 8’
    - West Side Upstream: 8’
    - East Side Downstream: 9’
    - West Side Downstream: 9’

4. Existing Culvert Lengths

    - East Side: 40’
    - West Side: 40’

5. Distance between centerlines of culverts

    - 27’

6. If the pipes are perched, distance from riverbed to pipe inverts.

   - Not perched. Flush with the bottom of the pool areas. No sediment observed within the culverts.

7. Confirm pipe diameter

   - Confirmed as 6’ diameter

8. If possible, a couple of bank widths in the upstream and downstream reaches (to possibly give us an idea of bank full width).

   - Approximately 9-10 feet adjacent to upstream culvert openings.
   - Downstream (north) the bank widths are not possible as it is a large flat area with ponding (see photos).

Please let me know if you need any more information.

Thanks,

Joshua Robinson (he / him)
Environmental Scientist
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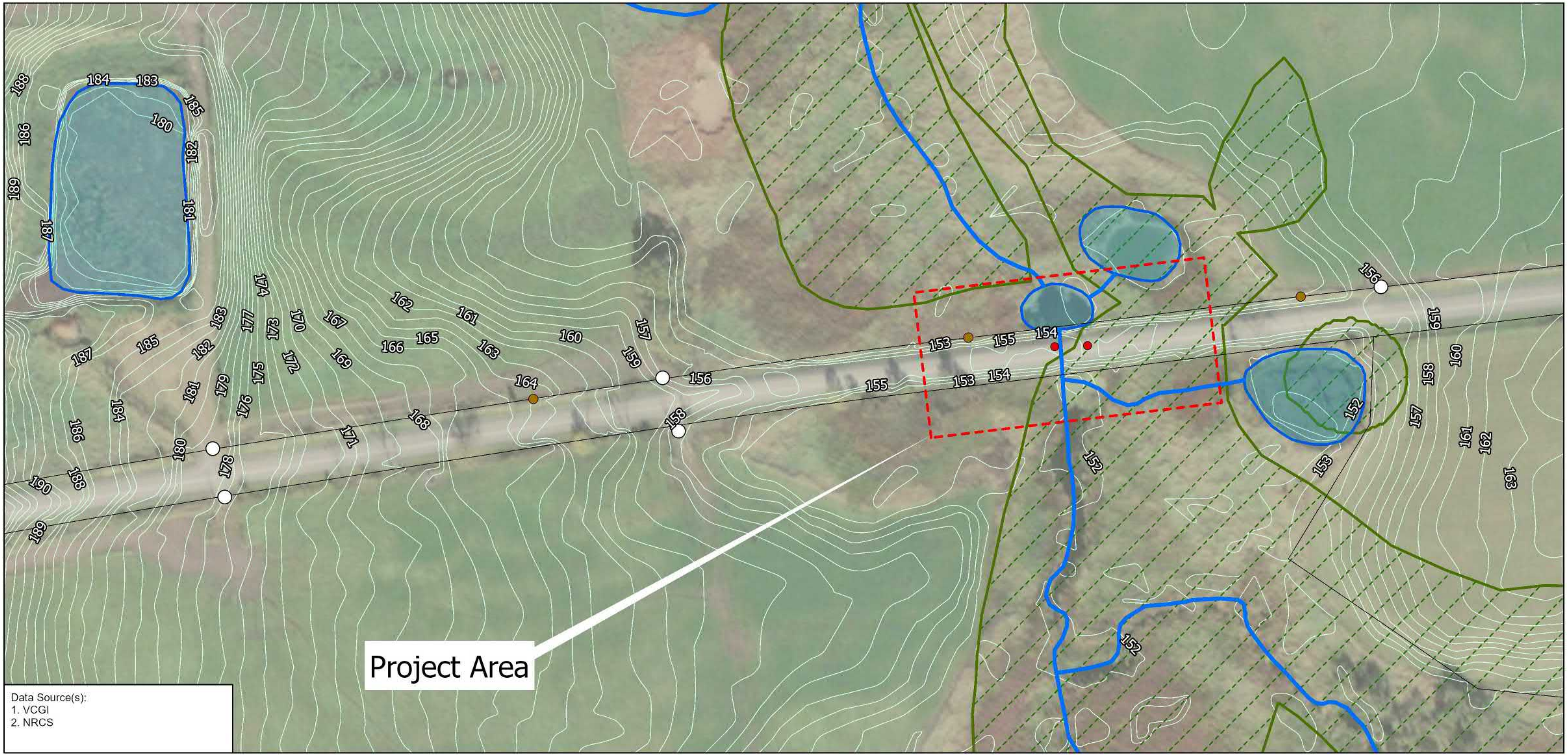
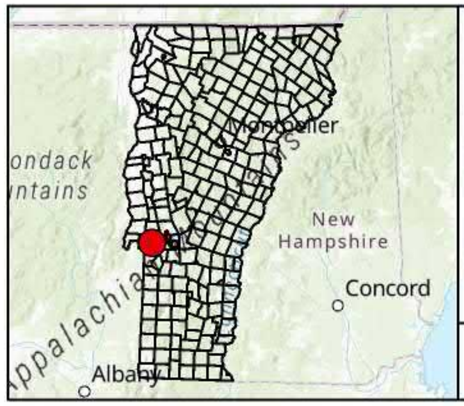
6.8 Base Map



Data Source(s):
1. VCGI
2. NRCS



Legend

●	Utility Poles	▬	Stream/River
○	Access Points	▭	Lake/Pond
●	Transportation Structure	▭	Wetlands (VSWI)
▭	VT Statewide Standardized Parcel Data	▭	ProjectArea

Middle Road Culvert Replacement
Municipal Scoping Study
Base Map

Bridport VT

FUSS & O'NEILL

Figure
#1

Project No. 20210607.A10

Folder: K:\P2021\0607\A10\MXD\ Project: BasePlan Layout: Std_11x17 Landscape_Bottom Map: Main Data Frame Map Frame
Date Exported: User: DRosengarten Date Saved: 12/8/2021 11:25 AM

Path: K:\P2021\0607\A10\MXD\BasePlan.aprx Layout: CAD.v1_FnO_24x36_Landscape Bottom , Map Name: Map
User: DRosengarten Date Exported: 3/4/2021 8:11 AM

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.	12/8/2021		XX/XX	XX

Scale
HORZ.: 1 inch = 150 feet
VERT.:
Datum:
HORZ.:NAD 1983 StatePlane Vermont FIPS
VERT.:
150 75 0 150
GRAPHIC SCALE

FUSS & O'NEILL

Middle Road Culvert Replacement
Municipal Scoping Study
Base Map

Bridport VT

Project No: 20210607.A10
Date: October 2021

Fig. 1