Scoping Study

Kimball Avenue / Marshall Avenue
Muddy Brook Culvert Replacement
VTrans Project STP MM18(3)
South Burlington / Williston, Vermont

Prepared for:
City of South Burlington, Vermont
Town of Williston, Vermont

Prepared by:

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EXECUTIVE SUMMARY

The City of South Burlington retained Hoyle, Tanner & Associates, Inc. (Hoyle, Tanner) to prepare this Scoping Study to investigate potential replacement alternatives for the culvert carrying Kimball/Marshall Avenue over the Muddy Brook. The culvert is jointly owned by the City of South Burlington and Town of Williston; as such, this project study was administered through both municipalities, with Tom DiPietro, South Burlington Deputy Director of Public Works, performing Municipal Project Manager duties. The Study is funded by a Municipal Highway and Stormwater Grant through the VTrans Municipal Assistance Bureau (MAB).

The existing 15' diameter corrugated metal pipe culvert was originally constructed in 1986. Due to substantial corrosion the pipe failed in the spring of 2017 causing the closure of Kimball/Marshall Avenue at this crossing until a temporary bridge was installed in August 2017. Personnel from Hoyle, Tanner visited the site to observe and document the condition of the existing culvert as part of this Study. The culvert is severely corroded, has buckled in several locations and the brook partially flows below the pipe bottom. It has been determined that the existing structure is not salvageable, and a complete replacement is necessary for proposed alternatives.

The main purpose of this project is to replace the crossing structure in a cost-effective manner, while minimizing environmental impacts and delays to the traveling public and other users. Additionally, in compliance with Vermont Complete Streets Law, replacement alternatives consider the needs of all users by extending bicycle and pedestrian facilities across Muddy Brook which has presented a barrier for connectivity between South Burlington and Williston.

Through several meetings with Town officials and local residents, it was concluded that complete closure of the road at this crossing during construction is preferred for this project. Roadway closure duration will be limited as much as possible through the use of Accelerated Bridge Construction (ABC) techniques.

Five structure alternatives were investigated in this Study and are referred to as Alternative 1 ("No Build"), Alternative 2 (Precast Concrete Arch), Alternative 3 (Cast-In-Place Concrete Rigid Frame), Alternative 4 (Corrugated Metal Arch), and Alternative 5 (Bridge Structure). The preferred alternative was determined by the Project Team, Williston Selectboard, and South Burlington City Council to be Alternative 2 (Precast Concrete Arch) due to its cost effectiveness, high durability, and reduced road closure duration.

Three alternatives were evaluated and presented for the Roadway and Bicycle/Pedestrian Facility configuration and are referred to as Alternative A (On-Road Facility), Alternative B (10' Shared Use Path with 4' Greenspace), and Alternative C (10' Shared Use Path with 10' Greenspace). The preferred alternative was determined by the Project Team, Williston Selectboard, and South

Burlington City Council to be Alternative 3 (10' Shared Use Path with 10' Greenspace) as it provides the best user comfort, has relatively minor cost difference, and the wider greenspace allows for stormwater treatment, snow storage, and does not require catch basin structures in the roadway shoulder.

Hoyle, Tanner recommends the design and construction of **Structure Alternative 2 (Precast Concrete Arch) with Roadway Alternative C (10' Shared Use Path with 10' Greenspace)**. This alternative meets the project purpose and need and provides a low maintenance, cost effective structure, increases the hydraulic capacity at the crossing, provides safe bicycle and pedestrian facilities at the crossing, and provides increased construction scheduling flexibility while marginally increasing environmental impacts and construction costs. The total estimated cost of construction (including contingency) is $1,810,000. Design Engineering and Resident Engineering fees during construction can be estimated at $190,000 for a budgetary total project cost estimate of $2,000,000 (presented in 2018 Dollars).

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Figure 1 – Location Map
Muddy Brook Culvert Replacement

Northing 712572.6603 Easting 1473646.2950
City of South Burlington / Town of Williston
Chittenden County

Project Area Data

FEMA Flood Zone: Yes - Zone A
Significant Wetlands: Yes – Upstream and Downstream
Threatened/Endangered Species: Yes – Northern long-eared bat
Historic District: No
National Register of Historic Places: No
Annual Average Daily Traffic: 7,385 vehicles/day (2017)

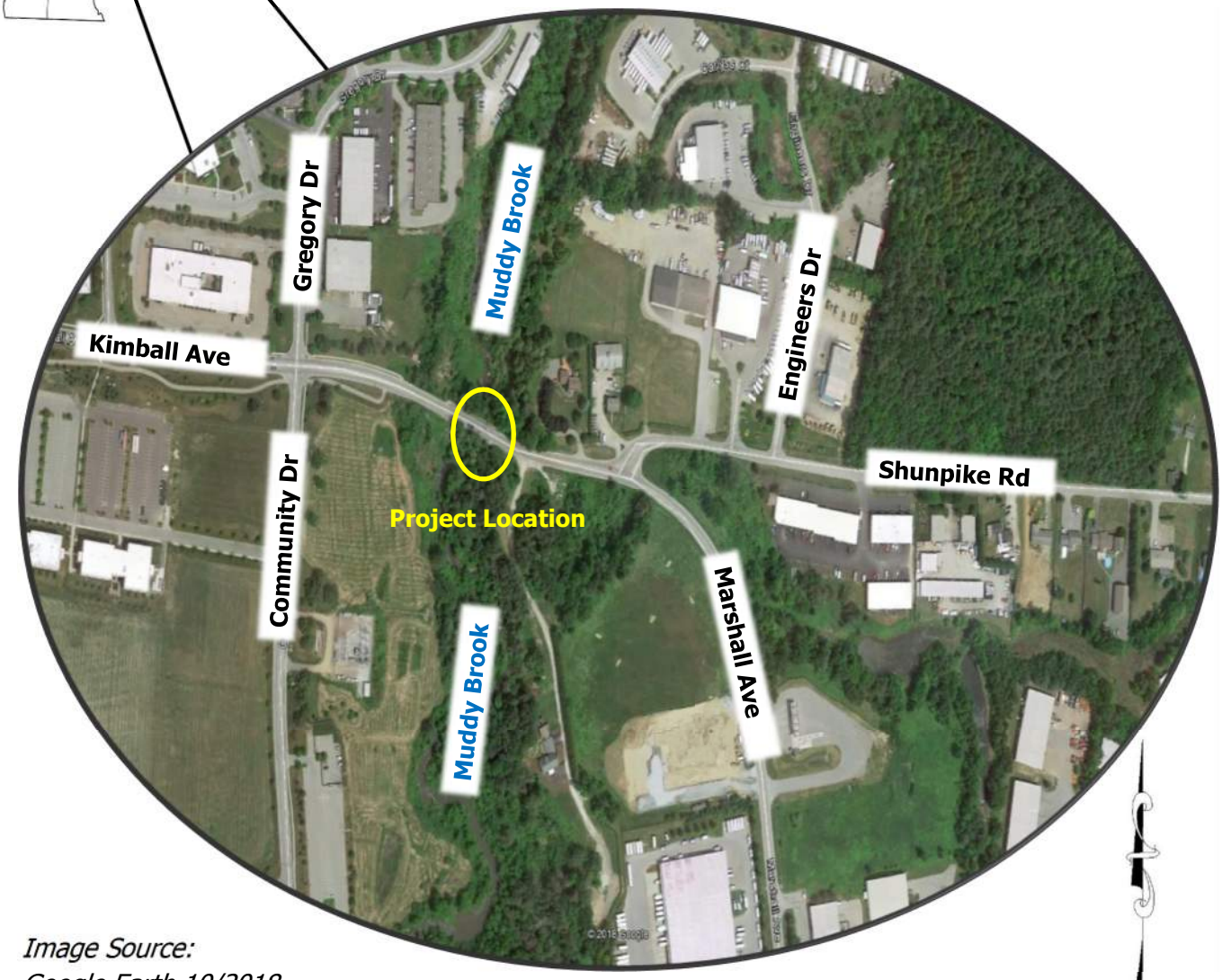

Image Source:
Google Earth 10/2018

Introduction

This Scoping Study for the Muddy Brook Culvert Replacement has been completed in accordance with the VTrans Municipal Assistance Bureau (MAB) 2014 Local Projects Guidebook and Appendices. The purpose of this study was to collect existing information for the project site, solicit public feedback, develop concept alternatives that best meet the purpose and need of the project, and assist the municipalities in the selection of the preferred alternative to advance into design and eventual construction.

I. PUBLIC INVOLVEMENT

Public involvement for this project included a Local Concerns Meeting and a Public Information Meeting held at the Williston Town Hall with a second Public Information Meeting held at South Burlington City Council. A copy of the meeting minutes for each meeting and presentations are included in Appendices I and J, respectively. The meetings were attended by town officials, residents, Public Works staff, and Hoyle, Tanner personnel.

A. Local Concerns Meeting

This meeting provided a general overview of the project and with the purpose of gathering input and concerns from all the stakeholders. Topics of discussion or concern included the following:

- Project Study definition and schedule
- Existing Conditions and past studies
- Bicycle / Pedestrian Facilities and future connectivity
- Need for on-road facility for commuter and long-distance cyclists
- Bike and pedestrian crossing at Shunpike Road
- Deep construction challenges for the structure replacement
- Potential ROW and Environmental Impacts

B. Public Information Meetings

This meeting (held in both Williston and South Burlington) included a presentation of the alternatives studied with the purpose of gathering comments and consensus on the preferred alternative. Discussion topics included the following:

- 50-year flood event elevations and required freeboard
- Environmental impacts associated with alternatives studied
- Roadway width and Bicycle/pedestrian facility alternatives
- Structure type alternatives including roadway closure period, durability and costs
- Wildlife accommodations that could affect structure size and opening
- Path and Street Lighting

II. PURPOSE AND NEED

Purpose

The purpose of the Muddy Brook Culvert Replacement project at Kimball & Marshall Avenue is to replace the failing culvert and temporary bridge with a permanent crossing structure; provide solutions / treatments that will improve the water quality of Muddy Brook; provide safe facilities for all users, including vehicles, pedestrians, and cyclists to cross Muddy Brook; and improve bicycle and pedestrian connectivity between Williston and South Burlington.

Need

The existing culvert is at risk of collapse and in need of replacement. The temporary bridge is not intended as a permanent structure, it constricts the roadway width at this location, and presents maintenance challenges requiring frequent pavement patching.

- **Provide a new crossing structure for Kimball/Marshall Ave roadway.** The new crossing structure shall be a cost efficient, low maintenance, durable solution that safely crosses the Muddy Brook and aides in improving water quality, while meeting Local, State, and Federal permitting requirements.
- **Minimize resource impacts.** Past studies and early resource assessments indicate this area to be resource sensitive. Proposed solutions shall consider least impactful alternatives.
- **Provide safe facilities for bicyclists and pedestrians across Muddy Brook from Community Drive to Shunpike Rd (extent of the Study Limits).** A need has been expressed for a cyclist connection at Shunpike Road – consider widened shoulders on Kimball/Marshall Ave, improve bike/ped crossing to access facilities located on the South side of the road. Safety for all modes of transportation should be considered in this project including identification of potential roadway alignment modifications where feasible and appropriate. Consider different user types with future growth and connectivity of bike/ped facilities: commuter cyclists (on-road & off-road), recreational cyclists (including children and riders less comfortable near vehicular traffic), pedestrians from neighborhoods and workplaces, distance trainers (endurance racers).
- **Improve connectivity between existing and proposed bicycle and pedestrian facilities.** The lack of a safe bicycle and pedestrian crossing at Muddy Brook has presented a barrier between Williston and South Burlington, restricting connectivity for cyclists and pedestrians and thus usage for both recreational and commuter travel. With growing infrastructure in the area, an increase in all modes of transportation is expected, and this crossing is likely to become a critical point of connectivity which will require sufficient facilities for all travel types.

III. PROJECT AREA AND EXISTING CONDITIONS

A. Existing Culvert

Downstream Culvert Elevation

The original construction of the existing 15-foot diameter corrugated metal pipe culvert was completed in 1986. The culvert is failing due to a severe corrosion at the invert (bottom portion of the pipe) resulting in localized buckling at several locations, and fractured plate connections along the walls of the pipe. Currently, a 150'-span temporary bridge (installed in 2017) conveys traffic over the failing culvert. The roadway embankment slopes are retained concrete "cradle walls" at the culvert inlet and outlet with top of wall elevations approximately at half the pipe diameter. Above the walls, the embankment slopes around the culvert to the cradle walls allowing the upper section of the culvert pipe to project from the embankment slope. The roadway embankments approaching the crossing are armored with stone fill and are vegetated.

B. Environmental and Subsurface Information

Hoyle, Tanner completed the documentation for this site with the assistance from the following subconsultants:

i. Hartgen Archeological Associates, Inc.
ii. North Woods Ecological Consulting, LLC (* DBE certified)
iii. Terracon Consultants, Inc.

Environmental documentation included identification of wetland, historical/cultural, and archaeological resources.

Appendix B of this report includes subsurface information from two soil borings (B-1 and B-2) completed on April 30 and May 1, 2018 as part of this study. Boring B-1 is in the eastbound travel lane to the east of the crossing and boring B-2 is in the westbound travel lane to the west of the crossing. The two borings exhibited similar soil characteristics. Generally, the borings identified that it is unlikely that bedrock will be encountered at the culvert foundation depths (between 35' and 40' from the road surface), and new foundations will likely be founded on a layer of sandy silt with clay and gravel.

C. Kimball/Marshall Avenue

Kimball Avenue is a 1-mile long, major collector road within the City of South Burlington that turns into Marshall Avenue, a 1.7-mile long, major collector road within the Town of Williston. Both roads are defined as Class II Town Highways. Traffic on Kimball and Marshall Avenues

Marshall Avenue (Looking West)

Kimball Avenue (Looking East)

operate under free flow conditions within the project area, except for a stop condition on Kimball Avenue just west of the crossing. The conversion of Kimball Avenue to Marshall Avenue occurs at the town line and at the crossing of Muddy Brook beneath the roadway. Kimball/Marshall Avenue is generally oriented west to east. The project area is located at the town line and between Community Drive in South Burlington and Shunpike Road in Williston. The posted speed on Kimball Avenue west of the project is 40-mph. The posted speed on Marshall Avenue east of the project is 30-mph.

The latest VTrans traffic counts conducted in 2017 on Kimball/Marshall Avenue, at the town line, report an Annual Average Daily Traffic (AADT) volume of 7,385 vehicles per day.

C-1. Roadway Geometry

The Marshall/Kimball Avenue horizontal alignment within the project limits (west to east) begins with a short tangent followed by a 1000’ radius right hand curve, a tangent across the existing bridge, an 800’ radius left hand curve, and a tangent to the project limits. The horizontal alignment within the project limits meets current AASHTO design criteria for a 40-mph speed.

The bridge is located within a vertical sag curve with the low point east of the Muddy Brook crossing. Preliminary evaluations indicate this curve meets current AASHTO design criteria for a 35-mph speed.

C-2. Roadway Typical Section

The existing roadway along Kimball/Marshall Avenue consists of two paved travel lanes averaging 12 feet in width with designated 10-foot-wide left turn lanes at the western and eastern project limits, for Community Drive and Shunpike Road respectively. Paved shoulders vary in width from two to four feet. Concrete curb is present on Kimball Avenue in South Burlington and along Marshall Avenue, where it terminates before Shunpike Road. A separated 10-foot-wide shared use path is located on the south side of Kimball Avenue and a 5-foot separated concrete sidewalk is located along the north side. Both the path and sidewalk terminate west of the Muddy Brook crossing into the roadway with no marked roadway crossing. A detectable warning device is located at the shared use path termination.

Pavement Condition East of Bridge

The curves west and east of the Muddy Brook crossing are super-elevated at approximately 7% for the west curve and approximately 6% for the east curve. The cross slope at the bridge is relatively flat.

The pavement condition west of the crossing is in poor condition with surface delamination between the top two pavement courses. East of the bridge the pavement is also in poor condition with longitudinal and transverse cracking and minor wheel rutting.

C-3. Roadway Side Slope and Guardrail

Typical Guardrail and Side Slope

Roadway side slopes along the eastbound lane transition from flat foreslopes west of the crossing to steep 2H:1V slopes through the crossing before returning to relatively flat slopes at the drive east of the crossing. Roadway side slopes along the westbound lane transition from flat foreslopes west of the crossing to 2H:1V slopes through the crossing before transitioning to approximately 2H:1V backslopes with a roadside ditch line east of the crossing.

Steel w-beam guardrail with wood posts is provided

on both sides of Kimball/Marshall Avenue through the Muddy Brook crossing where side slopes are steep. There is approximately 365 feet and 375 feet of guardrail, north and south of the roadway respectively. All ends of the guardrail flare away from the edge of pavement with VTrans standard approach end terminals.

C-4. Roadway Drainage

Curbing is present from Community Drive near the western project limits and runs easterly along both sides of the roadway until approximately 40 feet west of the temporary bridge. Stormwater generally sheet flows off Kimball/Marshall Avenue to the curb line. West of the crossing, near the terminus of the shared use path, a catch basin intercepts the stormwater and discharges it to the side slopes and toward the Muddy Brook. Between the curb and the west side of the temporary bridge, the stormwater sheet flows off the roadway and over the side slopes toward the brook. East of the bridge the stormwater flows along the curb lines toward the low point where there is a curb cut which discharges the stormwater over the side slopes and toward the brook.

C-5. Roadway Sight Distance

From visual inspection, there are potential sight line conflicts along the horizontal curve east of the crossing and with the adjacent tree lines along the north edge of pavement.

IV. DESIGN CRITERIA

Reference **Appendix K** of this report for a summary of Design Criteria for this Project.

V. PROPOSED IMPROVEMENTS

Three typical section alternatives were considered and evaluated. Alternative A includes widened shoulders for on-road bike accommodations with no continuation of the existing shared use path. Alternatives B and C include both on-road bike accommodations and a continuation of the existing shared use path over the crossing separated by a 4-foot green space and a green space of 10 feet, respectively. VTrans Pedestrian and Bicycle Facility Planning and Design Manual section 4.3.1 identifies the minimum shoulder width for on-road bicycle facility as 4-feet for curbed streets without on-street parking.

General improvements associated with all typical section alternatives include:

- Reduced 11-foot travel lanes and increased shoulder widths (4' minimum) to provide more clearance along the shoulders for bicyclists and encourage slower vehicular travel speeds in the narrower lanes.
- The sidewalk along the northern edge of roadway will be removed to encourage use of the shared use path and crossing at the 4-way stop intersection at Community Drive.
- New catch basins at the low point in the roadway.

A. Alternative A – 5' Shoulders and No Path

This alternative consists of two 11-foot travel lanes with 5-foot paved shoulders and curbing. The shared use path that runs parallel on the south side of Kimball Avenue is removed to the Community Drive intersection to promote crossing at the 4-way stop intersection at Community Drive instead of the current mid-block crossing.

B. Alternative B – 4' Shoulders and 10' Path (4' Separation)

This alternative consists of two 11-foot travel lanes with 4-foot paved shoulders and curbing. The curbing is included to provide a vertical separation for the share-use path and vehicular travel-way for added safety and user comfort. The existing shared use path along the south side of the roadway is extended east with a curbed 4-foot green space separating a 10' path from the roadway at the crossing and terminating at the abutting driveway just east of the crossing.

C. Alternative C – 4' Shoulders and 10' Path (10' Separation)

This alternative consists of two 11-foot travel lanes with 4-foot paved shoulders and no curbing. The existing shared use path along the south side of the roadway will be extended east with a 10-foot green space separating the path from the roadway at the crossing terminating at the abutting driveway just east of the crossing. Stormwater will sheet flow from the roadway into the 10-foot green space and the roadway low point where it will be captured in catch basins within the green space and conveyed toward the brook.

- The extended shared use path with 10-foot green space separation is intended to provide additional safety and comfort for pedestrians and bicyclists who prefer separation from vehicular traffic. Additionally, this wider green space provides stormwater treatment, adequate space for roadway signage and utility poles, and room for snow storage between the roadway and the path.

For both Alternatives B and C, the extension of the shared use path allows for future connectivity with Williston bicycle and pedestrian facilities east of the project. The limits of this project terminate the path at the abutting driveway to allow users to transition from the path to the roadway shoulder in the interim and continue on Marshall Avenue towards Williston.

D. Roadway Side Slopes and Guardrail

2H:1V maximum embankment slopes extend from the northern edge of the roadway down toward the culvert outlet and associate wingwalls. Slopes vary on the southern edge of the road based on the Alternative selected. Slopes steeper than 2H:1V will require stone armoring as depicted on the Plans in Appendix A.

VI. STRUCTURE REPLACEMENT ALTERNATIVES

Several structure alternatives have been evaluated to address the purpose and need for the project. Due to the severe buckling and invert failure of the existing pipe, pipe lining is not a feasible repair alternative and was not evaluated in this study.

A minimum clear span length of 33' is recommended for the following reasons:

- Hydraulic considerations
- Spanning 1' beyond the bank-full width of 32' allows for some flexibility during future design phases and construction
- Improved environmental conditions, while meeting to the greatest extent possible, the Guidelines for the Design of Stream/Road Crossings for Passage of Aquatic Organisms in Vermont
- An open-bottom structure allows for the natural stream bottom to continue through the crossing

A minimum rise of 8' was selected for the following reasons:

- Adequate clearance to allow for debris passage during large storm events
- Adequate clearance to allow bridge inspection access
- Allows for natural light to extend further into the culvert

Conceptual features that apply to all the structure replacement alternatives (other than "No Build") include:

- Pedestal walls with a height of about 6ft
- Spread footings with a burial depth of about 6ft below the streambed. Additional hydraulic analysis is needed to determine final footing depths
- Concrete wingwalls with lengths of approximately 15 to 20ft.
- Concrete headwall height of 2 to 5ft depending on the roadway typical section alternative
- The Muddy Brook crossing will be completely closed to traffic during construction and vehicular traffic will be maintained with a temporary detour route

A. Alternative 1 – "No Build"

The "No Build" Alternative does not meet the project purpose and need or the City/Town's goals. The existing culvert has failed and is in need of replacement to avoid further damage, channel obstruction, and improve water quality. Therefore, this alternative is not practical for this project and not recommended.

B. Alternative 2 – Precast Concrete Arch Structure (**Recommended**)

This structure type meets the project purpose and need and is a cost-effective solution for this crossing. Additionally, the precast components allow for better quality control and faster installation. The following cost only includes the cost of the structure and does not include the roadway alternatives described in Section VI. The estimated structure cost of Alternative 2 is

approximately $1,230,000 (see Appendix C). Cost is in 2018 dollars.

The following is a summary of design parameters that apply to this alternative:

- 8-ft rise by 33-foot span Precast Arch type culvert with a total length of 120-ft
- The anticipated roadway closure duration is approximately 7-weeks, with an additional 3 weeks before and after the closure for a total construction duration of 13-weeks.

C. Alternative 3 – Cast-in-Place Reinforced Concrete Rigid Frame

This structure type meets the project purpose and need and other goals. This alternative requires additional construction time (compared to Alternative 2) to form and cast the concrete frame. The following cost only includes the cost of the structure and does not include the roadway alternatives described in Section VI. The estimated structure cost of Alternative 3 is approximately $1,250,000 (see Appendix C). Cost is in 2018 dollars.

The following is a summary of design parameters that apply to this alternative:

- 7.5-ft rise by 33-foot span CIP Reinforced Rigid Frame with a total length of 120-ft
- The anticipated roadway closure duration is approximately 12-weeks, with an additional 3 weeks before and after the closure for a total construction duration of 18-weeks.

D. Alternative 4 – Multi-Plate Aluminum Arch

This structure type meets the project purpose and need and other goals. This alternative can be installed quickly (compared to Alternative 3) with lighter metal plate components that can be erected with smaller cranes. The estimated cost of Alternative 4 (roadway not included) is approximately $1,130,000. Cost is in 2018 dollars. This structure is considered less durable when compared to concrete alternatives due to potential of metal plate damage from debris traveling down Muddy Brook and damage to the metal plates during installation and backfill operations. Both municipalities expressed durability/longevity concerns with a metal plate structure for this span and burial depth and preferred the concrete structure alternatives.

The following is a summary of design parameters that apply to this alternative:

- 12.5-ft rise by 33.08-foot span Aluminum Low Profile Arch Super Span with a total length of 120-ft
- The anticipated roadway closure duration is approximately 7-weeks, with an additional 3 weeks before and after the closure for a total construction duration of 13-weeks.

E. Alternative 5 – Bridge Structure

Due to the depth of the streambed about 30’ below the roadway surface bridge alternatives would either require tall abutment and wing walls or increased span length, driving up project costs significantly and increasing the construction duration / roadway closure. As such, this alternative was not evaluated as it is not practical when compared to the other buried frame/arch structure alternatives which have lower construction costs, require less maintenance, and are more durable (not in direct contact with deicing salts on roadway). In

addition, the buried structure alternatives provide better options for utilities and bicycle/pedestrian facilities.

VII. TEMPORARY TRAFFIC CONTROL CONSIDERATIONS

Three traffic control options were considered as part of this Report:

A. Closure at Brook Crossing with Full Detour (**Recommended**)

Complete closure of the roadway is feasible for this project. However, it will have some impacts on emergency response time, nearby abutters, and commuter traffic with a detour length of approximately 1.4 miles. The detour route would consist of Kimball Avenue from the project site west to Gregory Drive, north to Williston Road, east to South Brownell, and south to Shunpike Road and Marshall Avenue. Based on the Work Zone Safety & Mobility Guidance Document (2007), this project would likely classify as a moderate or significant project requiring a Transportation Management Plan (TMP). The plan shall be consistent with the Work Zone Safety Mobility Guidance, MUTCD provisions, and the AASHTO Roadside Design Guide. Additional coordination will be necessary with both municipalities and VTrans DTA to account for other potential projects on the detour route (e.g. Industrial Drive Intersection Improvements).

A complete closure of the roadway at the Muddy Brook Crossing is the preferred traffic control option based on discussions with Town officials and local residents, site geometry and resource constrictions, constructability concerns, and cost. Accelerated Bridge Construction (ABC) techniques can be used to limit the road closure; with ABC techniques incorporated in the replacement design a 50-day limit is reasonable to require for this project.

B. Phased Construction

This option allows for the culvert to be replaced in two or more phases while maintaining a single lane of alternating two-way traffic. Consequently, this increases construction cost, duration, and site impacts. Additionally, significant travel delays would still be experienced due to the single lane flow. As such, phased construction is not recommended.

C. Temporary Bridge

The use of an off-alignment temporary bridge structure with either a single lane of alternating two-way traffic, or a wider structure carrying two lanes of traffic, was also considered. Compared to a detour, a temporary structure would significantly increase both the construction duration and cost of the project. It also requires a much larger footprint to construct another temporary roadway that would impact more wetlands and private property. Therefore, this temporary traffic control option is not recommended.

VIII. RIGHT-OF-WAY

The majority of proposed work is within the existing right-of-way (ROW) that was obtained from Tax Maps and the 1986 Shunpike Road (CL.3) Record Plans. All alternatives will require temporary construction easements, with potential permanent easement for stone fill limits. Potential impacted properties include those at MAPID 07069.047 and 07016.040.

IX. UTILITY IMPACTS

Overhead and underground utilities are present at the site. These utilities include Vermont Gas, telecom, and electric.

Overhead utilities cross over the roadway in two locations west of the crossing with additional lines connecting and running parallel to the southern edge of pavement.

During a sight visit by Hoyle, Tanner, underground utilities – gas and telecom – were observed near the surface at the temporary bridge crossing running parallel to the southern edge of pavement. From discussions with the City and Town there is no water main or sewer crossing between the City/Town at this location. A South Burlington stormwater line discharges on the south side of Kimball Avenue near the existing catch basin inlet approximately 300-ft west of the crossing.

Underground Utilities at Crossing

Based on our conceptual design we have identified at least two utility poles that may need to be relocated to install the new structure and typical section. These are large poles with many utility lines on them, further coordination will be required during preliminary design to evaluation options for the path design and structure excavation once topographic survey is completed. All alternatives in this study have similar impacts and associated costs to buried and overhead utilities.

X. HYDROLOGIC AND HYDRAULIC ANAYSIS

Preliminary hydrologic and hydraulic analyses were performed for the Kimball Ave/Marshall Ave crossing at the Muddy Brook Culvert in accordance with the VTrans Hydraulic Manual. The contributing drainage area is approximately 20.2 square miles. The existing and replacement structure alternatives were analyzed with a two-dimensional hydraulics software program to establish flooding elevations and stream velocities for the 50-, and 100-year flood events.

A. Hydrology

The VTrans Hydraulic Manual recommends that a 50-year design flood flow (Q_{50}) and corresponding water surface elevation be determined for Collector Roads and Streets (Table

4-2). The Q_{50} design flood event has a 2% chance of being met in a given year. The minimum freeboard required is 1.0' above the Q_{50} elevation.

United States Geological Service (USGS) Regression (2014) equations in conjunction with *StreamStats* was used to determine the 2-, 5-, 10, 25-, 50-, 100- and 500-year flows. The summary of flows can be found in Appendix D.

B. Muddy Brook Characteristics

The Muddy Brook has a longitudinal slope of approximately 0.5% to 1.2% within the vicinity of the project limits. Based on field observations, the brook bed material consists of silty-clayey material and cobbles. The overbanks (or floodplains) typically consist of dense forest areas with trees and bushes. For the hydraulics analysis, a Manning's n (surface roughness) of 0.03 and 0.08 was used for the main channel and overbank areas, respectively.

The extents of the hydraulic model developed for this project are approximately 1800-ft upstream and 3400-ft downstream of the crossing. The model also considered the US Route 2 Crossing, about 2,000-ft downstream of the Kimball/Marshall Avenue crossing, to evaluate potential backwater that this crossing develops during a storm event.

C. Flood History and Model Verification

Based on discussions between Town officials and Hoyle, Tanner personnel, the Muddy Brook Culvert has not experienced an overtopping event. Historical water surface elevations are not available, but the municipalities have indicated that they have never seen the culvert flow full.

D. Existing Hydraulic Conditions

Table XI.1 indicates that the existing culvert meets the freeboard requirements of 1-foot during the 50-year storm event.

Table XI.1 - Existing Bridge Hydraulic Data: 50- & 100-year Flood Event

	50-Year	100-year
Drainage Area (square miles)	20.2	20.2
Peak Flow (cubic feet per seconds - cfs)	1150	1340
Roadway Surface Elevation (low point at east approach, ft)	322.9	322.9
Culvert Crown Elevation (ft.)	307.5	307.5
Water Surface Elevation (ft.)	303.6	304.8
Freeboard with respect to Culvert Crown (ft.)	3.9	2.7
Max Velocity at Bridge (feet per seconds - fps)	16.2	16.9
Bridge Opening (square ft)	176.6	176.6

E. Bankfull Width

The bankfull discharge events typically have a return period of 1.2 to 2 years and is a metric that applies typically to a river. The bankfull width for Muddy Brook is approximately 32' and was joint
ly measured by Hoyle, Tanner and the Vermont Agency of Natural Resources' district River Management Engineer. As requested by the River Management Engineer, the minimum clear span of the proposed structure should be 32' (or Bankfull Width) – reference Appendix E for supporting documentation.

F. Proposed Hydraulic Conditions

Hydraulic analyses assume a crown/low chord elevation of 300.4. Table XI.2 indicates that the 50-year storm event water surface is more than 6' lower with the bridge replacement and it passes the event with 3.2 feet of freeboard. The 100-year storm event is also more than 6' lower with the bridge replacement and passes the event with 2.4 feet of freeboard.

Table XI.2 – 8'-rise x 33'-span Precast Arch Bridge Alternative Hydraulic Data: 50- & 100-year Flood Event

	50-Year	100-Year
Drainage Area (square miles)	20.2	20.2
Peak Flow (cubic feet per seconds - cfs)	1150	1340
Roadway Surface Elevation (low point at east approach) (ft.)	322.9	322.9
Bridge Low Chord Elevation (ft.)	300.4	300.4
Water Surface Elevation (ft.)	297.2	298.0
Freeboard with respect to Bridge Crown (ft.)	3.2	2.4
Max Velocity at Bridge (feet per seconds - fps)	12.4	12.8
Bridge Opening (square ft)	234	234

G. Other Structure Type Considerations

For this Report, a 7.5-ft rise by 33-foot span frame was also modeled. The results are similar to the precast arch bridge alternative. For this reason, the precast arch bridge alternative is presented in Appendix D.

H. River Training Structures Consideration

River Training refers to structural measures taken to improve a river (or brook) and its banks. For this Report, spurs were considered to mitigate toe erosion at the southwestern embankment just upstream of the crossing. Based on the analysis, these river training structures did not provide a benefit to the project. The hydraulic analysis indicates that the spurs actually have an undesirable impact of increasing the stream velocities within the vicinity of the proposed inlet and said embankment.

I. Floodplain Development Ordinances and Regulations

This crossing is located within a FEMA Special Flood Hazard Area (SFHA), Zone A and does not have an established base flood elevation – reference Appendix D. The federal floodplain management regulations, specifically 44 CFR §60.3(b)(7), states: "*Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained*." The preliminary hydraulic analysis for the proposed conditions indicates that flood carrying capacity within the project area will increase.

XI. NATURAL AND CULTURAL RESOURCES

The following is a summary from the Hartgen Archaeological Associated Report, reference Appendix F for full report.

A. Cultural Resources

A-1. Historical Investigation

Hartgen Archaeological Associates, Inc. (Hartgen) examined the files at Vermont Department of Historic Preservation (VDHP) and identified no properties on the National Register of Historic Places (NR), no properties eligible for the NR, and no properties previously determined to be ineligible for the NR within the proposed project area.

A-2. Archaeological Investigation

Hartgen performed an Archaeological Resource Assessment (ARA) for the project to assess the potential archaeological sensitivity and historic sensitivity of the proposed project area. Four areas of particular archeological potential were identified (Appendix F). Because project disturbance from either of the proposed alternatives would disturb these areas, a Phase IB archeological reconnaissance survey will be required during the early design phase of the project. This survey will determine the presence, absence or nature of buried archaeological resources.

B. Environmental Considerations

B-1. Stream Alteration Considerations

The Vermont Agency of Natural Resources (VT-ANR) Department of Environmental Conservation (DEC) administers the state's Stream Alteration Rule (Chapter 27: Effective March 10, 2017) regulating activities that take place in or along streams. A permit is required for:
1) movement, excavation, or fill of 10 or more cubic yards annually in any perennial stream; or, 2) any bridge or culvert repair or replacement. Per Chapter 27, an Individual Stream Alteration Permit will be required for this project because the proposed alternative will include channel and roadway realignment.

In addition, the proposed alternatives will be reviewed applying the following performance standards listed in the Stream Alteration Permit:

Equilibrium Standard. The proposed design shall not change the physical integrity of the stream in a manner that causes it to depart from, further depart from, or impede its attainment of the channel width, depth, meander pattern, and slope associated with the stream processes and the equilibrium conditions of a given reach of stream (V.S.A. §27-402(b)).

Connectivity Standard. (A) An activity shall not change physical stream forms or alter local channel hydraulics, natural streambank stability, or floodplain connectivity in a manner such that changes in the erosion or deposition of instream materials results in localized, abrupt changes to Vermont Stream Alteration Rule Page 10 or disconnects within the horizontal alignment of streambanks or the vertical profile of the stream bed. (B) A person shall not, unless authorized by the Secretary, change the course, current, or cross-section of a watercourse so as to create a physical obstruction or velocity barrier to the movement of aquatic organisms or change the vertical stream bed profile in a manner that impedes the movement of aquatic organisms (V.S.A. §27-402(b)).

The watershed area of the Muddy River at Kimball Avenue is >10 square miles with a bankfull width of 32'. An appropriate replacement structure in this location (per the VT-ANR District River Management Engineer) should have a width of 1.0x bankfull width to meet the Equilibrium Standard.

Coordination with the Vermont Fish and Wildlife Department (through the VT-ANR River Management Engineer) will be required to ensure the proposed alternative will meet the Connectivity Standard and allow for adequate aquatic organism passage (AOP).

B-2. Wetlands

Vermont Permitting

A wetland delineation and evaluation was performed by April Mouleart, Professional Wetland Scientist (PWS), on 5/31/2018. The northwest and southeast quadrants of the project area include a wetland dominated by dense, persistent non-woody vegetation that is adjacent to Muddy Brook. The wetland meets a presumption of significance under Section 4.6 of the Vermont Wetland Rules and is classified as a Class II Significant Wetland, pending determination by the State District Wetland Ecologist.

Because the project will affect a Class II wetland, a permit will be required per the Vermont Wetland Rules. The perennial flow regime of Muddy Brook and the project's applicability to the VT Stream Alteration Rules make it ineligible for coverage under the Wetlands General Permit, thus, any action alternative will require an Individual Permit from the Vermont Wetlands Program. A GIS shapefile will be included with the wetland permit application for inclusion in the Vermont Significant Wetland Inventory (VSWI).

There are no recorded occurrences for state-listed species or exemplary natural communities within the project impact area, as determined via a database search of the VT-ANR Natural Resources Atlas and BioFinder Tools (Appendix E).

Federal Permitting

Any proposed alternative for the Muddy Brook culvert replacement will fall under the jurisdiction of the US Army Corps of Engineers (USACE) for the discharge of dredged or fill material into "waters of the United States" under Section 404 of the Clean Water Act. The project will likely qualify for coverage under the USACE Vermont General Permit requiring a Pre-Construction Notification (PCN). Coordination with USACE New England District Office should commence early in the preliminary design process.

The US Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPAC) online tool was used to review the project area for federally-listed threatened or endangered species or their habitat within the project area. The report indicated the potential habitat for the threatened Northern long-eared bat (*Myotis septentrionalis*). Proposed project alternatives will likely involve tree removal within potential suitable summer habitat for this species. Per the USFWS guidelines for non-federal projects adhering to the 4(d) rule of the Endangered Species Act, the project may result in incidental take, but it will not require formal consultation with the USFWS because the project does not involve any of the following: 1) removing a northern long-eared bat known occupied maternity roost tree or any trees within 150 feet of a known occupied maternity roost tree from June 1 through July 31; or 2) removing any trees within 0.25 miles of a northern long-eared bat hibernaculum at any time of year. Submittal of the 4(d) Streamlined Consultation Form to USACE will be required, this should be completed as soon as project limits are defined in advance of the full USACE PCN submission.

Stormwater Permitting

Under the National Pollutant Discharge Elimination System (NPDES), construction projects involving one acre or more of land disturbance require a permit for the discharge of stormwater. The state of Vermont has assumed the NPDES program from the federal government and issues permits through the VT-ANR DEC Watershed Management Division. The Construction General Permit 3-9020 authorizes permittees to discharge stormwater runoff from construction activities provided the project is in compliance with the requirements of the general permit and will be applicable to this project.

XII. MAINTENANCE

A. Alternative A – 5’ Shoulders and No Path

Regular winter maintenance procedures will be improved with the reconstructed roadway and additional roadway width. Snow plows can stay within the nearest lane and shoulder without encroaching in the opposing travel lane, improving traffic safety for vehicles and bicyclists. The 5’ shoulders also allow additional room for temporary snow storage during large snowfall events to keep the vehicular travel way clear until the snow in the shoulders can be removed. The improvements in the wearing surface condition and drainage will allow the roadway to be cleared of snow and ice more completely than the existing roadway, potentially reducing the frequency or concentration of deicing treatments on the roadway.

B. Alternative B – 4' Shoulders and 10' Path (4' Separation)

The roadway maintenance for this alternative is similar to Alternative A except that there is less shoulder area for temporary snow storage. The 4-foot greenspace that separates the roadway from the path in this alternative provides some additional room for snow storage on one side of the roadway during winter maintenance. Additional snow removal measures will be required to keep the new shared use path clear during snow events and to remove thrown snow on the path from adjacent roadway plows. The improvements in the wearing surface condition and drainage will allow the roadway to be cleared of snow and ice more completely than the existing roadway. This is anticipated to reduce the frequency or concentration of deicing treatments on the roadway. Since the roadway for this alternative is less wide (2') than Alternative A, the potential quantity of deicing measures may also be reduced. During the growing season, the greenspace will require mowing and nutrient management.

C. Alternative C – 4' Shoulders and 10' Path (10' Separation)

The roadway maintenance for this alternative is similar to Alternative B. The 10-foot greenspace that separates the roadway from the path in this alternative provides significant room for additional snow storage on one side of the roadway during winter maintenance. Additional snow removal measures will be required to keep the new shared use path clear during snow events. During the growing season, the greenspace will require additional mowing and nutrient management compared to Alternative B.

XIII. COMPATIBILITY WITH PLANNING EFFORTS

The existing culvert is undersized causing high outlet velocities and downstream erosion which contributes to reduced water quality. In its current condition, the culvert will eventually have a complete failure causing mass water quality contamination and negative brook and embankment impacts. Replacing the structure to meet current standards and bank-full width opening will aid in meeting the water quality improvement goals for Muddy Brook, the Winooski River, and Lake Champlain. There are no current planning efforts for Muddy Brook water quality or joint municipal stormwater improvements, however water quality is being monitored by the Rethink Runoff Stream Team, reference 2017 Water Quality Monitoring Report: https://dec.vermont.gov/sites/dec/files/RRSTWaterQualityReport2017_FINAL.pdf

The improvements to Kimball/Marshall Avenue and the extended 10' wide shared use path on the south side of the road are consistent with the Bicycle and Pedestrian Current and Future Facility Mapping presented in the current Comprehensive Plans for the Town of Williston and City of South Burlington (reference Appendix H). Extending the path across Muddy Brook will remove a long-term barrier that has restricted connectivity for this path to other locations in Williston.

XIV. ALTERNATIVE COMPARISONS AND COST ESTIMATES

The following matrices summarize the project alternatives and estimated costs. A detailed breakdown of costs is provided in Appendix C. All of the alternatives developed assume a full bridge closure during construction, and all of the alternatives will have temporary buried utility impacts.

Structures Type Comparison

All the potential structure options evaluated below are open-bottom crossing structures with similar Resource, ROW, and Utility Impacts. In addition, all structure options assume a full bridge closure during construction with a temporary detour on US Route 2, Williston Road.

Category	**Alt 1:** *No Build*	**Alt 2:** *Precast Arch/Frame*	**Alt 3:** *CIP Rigid Frame*	**Alt 4:** *Multi-Plate Arch*	**Alt 5:** *Bridge*
Meets Purpose & Need	No (Does not provide a new permanent crossing)	Yes	Yes	Yes	Not Evaluated Reference Section VII of this Report.
Road Closure Duration	None	7 Weeks	12 Weeks	7 Weeks	
Durability	-	High	High	Medium	
Structure Cost	$0	$1,230,000	$1,250,000	$1,130,000	

Project Alternatives Comparison

Category		**Alternative A:** *5′ Shoulders and No Path*	**Alternative B:** *4′ Shoulders and 10′ Path (4′ Separation)*	**Alternative C:** *4′ Shoulders and 10′ Path (10′ Separation)*
Cost	*Roadway*	$470,000	$592,000	$580,000
	Precast Arch Structure (Alt 2)	$1,190,000	$1,208,000	$1,230,000
	Total Construction Cost	**$1,660,000**	**$1,800,000**	**$1,810,000**
Bike/Ped Facilities	*Shoulders*	5′	4′	
	Shared Use Path	None	10′ with 4′ separation	10′ with 10′ separation
Impacts	*ROW (* See Note below table)*	Temp = 6,000sf	Temp = 11,200sf Perm = 980sf	Temp = 14,300sf Perm = 1,100sf
	Overhead Utility	None	Possible Pole Relocations	
	Resource	Temporary		
	Ag. Lands	None		
	Archaeological	Potential		

	Historic	None		
	Hazardous Materials	None Identified		
	Floodplains	Zone A		
	Fish & Wildlife	Improvement to AOP		
	Rare, Threatened & Endangered Species	Northern Long-Eared Bat – Tree Clearing Impacts		
	Public Lands – Sect. 4(f)	None		
	LWCP – Sect. 6(f)	None		
	Noise	Temporary from Construction		
	Wetlands	Impacts to Class II Significant Wetland		
Permits	*ACT 250*	No		
	401 Water Quality	Yes		
	404 USACE	Pre-Construction Notification for Vermont General Permit		
	Stream Alteration	Yes		
	State Individual Wetland Permit	Yes		
	Storm Water Discharge	Construction General Permit 3-9020		
	Lakes & Ponds	None		
	T & E Species	Coordination with USFWS – Likely no tree clearing from 4/15-10/31		
	Historic/Archaeological Resources	Phase 1B Archeological Survey		
Meets Purpose & Need		Partial (On-Road Facility)	Yes	
Other Considerations		- Does not provide separation of Bike/Ped from Vehicles		- Best Bike/Ped Safety and User Comfort - Greenspace Provides snow storage, signage and utility location, and stormwater treatment

** ROW Note: Areas shown are approximate based on conceptual plan measurements for comparison purposes only. Temporary impacts are based on 20′ offset from slope limits. Permanent Easement Areas represent a small section of path on the west of the project limits and guardrail on the east limits (both on the south side of road).*

XV. PROJECT TIME LINE

The project schedule is dependent on the funding available and associated project development procedures with potential grant programs. The design phase duration is also affected by the permitting and ROW process. The following schedule has been prepared based on past project experience and typical schedules for standard VTrans funded projects. Best case scenarios are presented for a project that is funded in an expedited manner, has few programmatic requirements, does not have Federal funding, and receives strong abutter and

regulatory support.

Project funding opportunities for this project are limited, the following are a sample of potential funding sources, and how they impact the project timeline shown below:

Funding Source	Federal Funding	Max Funding Amount	Project Timeline
Municipally Bonded	No	-	A (Best Case)
VTrans MAB – Muni Hwy & SW Grant	Yes	80% (20% Municipal Match)	B (Typical)
VTrans MAB – TA Grant	Yes	80%, $300k Max (20% Municipal Match)	B (Typical)
VTrans TH Structures	No	$350,000 ($175k/Municipality)	A (Best Case)

Project Funding Acquisition:
- A - Best Case – January 2019 - December 2019
- B - Typical – 3 years for Procurement _ December 2021

Design Phase (accounts for steps completed in this Scoping Study):
- A - Best Case - January 2020 - January 2021
- B - Typical – 2-year Design & Permitting Phase _ December 2023

Construction:
- A - Best Case - July 2021 – October 2021
- B - Typical – 1-year Construction Complete by _ October 2024

XVI. CONCLUSIONS AND RECOMMENDATIONS

The City of South Burlington City Council and Town of Williston Selectboard voted unanimously for the preferred alternative to advance into design as:

- **Roadway Alternative C – 10' Shared-use Path with a 10' Greenspace and Structure Alternative #2 – Precast Concrete Arch Culvert.**

The Project Team also recommends this combined alternative for advancement into final design as it best meets the purpose and need statement for the project considering roadway, bicycle & pedestrian facilities, stormwater treatment, snow storage, long-term maintenance, structure durability, resource impacts, water quality, cost, and road closure duration for construction.

The following is a summary of recommendations and requirements to complete the project that have been collected during public meetings, site investigations, and the alternatives development that should be considered in the design phase of this project:

- Design should provide signage stating "Path Ends Ahead" until future connectivity is

made in Williston.

- Town of Williston should consider bicycle and pedestrian crossing needs at the Shunpike and Marshall Ave intersection. Potential intersection and Marshall Avenue geometry improvements could be incorporated as well as temporary lane markings and roadway signage. This investigation/study should be completed independently of this culvert replacement project.
- If possible, complete four (4) additional borings located at the proximity of the proposed footing corner locations. This will likely require a track rig that can access both sides of the temporary bridge and will require coordination with buried utilities. Rock cores should be competed if refusal is met above the proposed bottom of footing elevations (coordinate with hydraulic analysis).
- Topographical survey limits should extend a minimum of 200' west of the Community Drive Intersection, and 900' east / south of the Shunpike Road Intersection so that preliminary roadway design can consider horizontal and vertical geometry improvements.
- The Construction start will need to be coordinated with the Williston STP M 5500(7)S Industrial Ave intersection reconstruction and resurfacing of US 2 in Williston beginning at the South Burlington-Williston Townline and extending easterly 1.05 miles, currently scheduled for July 2020 - February 2022.
- Early coordination with VTrans should be completed during the preliminary design phase to determine the classification of the detour for this project (moderate or significant) and the level of Transportation Management Plan (TMP) that will be required.
- Design phase should consider potential sight line improvements on Marshall Avenue within the culvert replacement project limits.
- Future design should consider shared use path and street lighting, particularly at intersections and roadway crossings.
- Conventional spread footings have been assumed in this study.
- Temporary Construction and Permanent Easements will be required for the culvert, armored slopes, and shared use path.
- During preliminary design, coordination between the municipalities, Hoyle, Tanner, and the utility owners is required to avoid any construction delays. Utilities should be permanently and/or temporarily relocated in advance of the construction start.
- CLOMR/LOMR is not anticipated to be required (Further analysis will be conducted during final design to confirm the effects within the floodplain).
- Finalize Hydraulic analysis and proposed improvements including embankment armoring and upstream impacts during high flows.
- Phase IB Archaeological Reconnaissance Survey is required. This should be completed in advance of further design.
- Coordinate with UVM Spatial Analysis Laboratory regarding the Wildlife Travel Corridor identified in the Williston Comprehensive Plan (Appendix H). Consider crossing accommodations (e.g. structure height, stream bank section) within the structure for

the species identified in this corridor.

- The following Permits will be required:
  - Vermont River Management Program – Individual Stream Alteration Permit
  - Vermont Wetland Program – Individual Permit
  - Army Corps of Engineers – PCN Vermont General Permit

This Study has been completed utilizing information available as of December 2018. Design criteria, permitting requirements, field data obtained by Hoyle, Tanner and reports or survey information prepared by others, are subject to change. The condition of an existing structure can change rapidly, or it can be damaged through manmade or natural events that could alter the conclusions reached herein. Therefore, the conceptual design, estimate of construction cost, and conclusions reached in this Study should not be relied upon for an extended period.

APPENDIX A

Plans of Proposed Improvements

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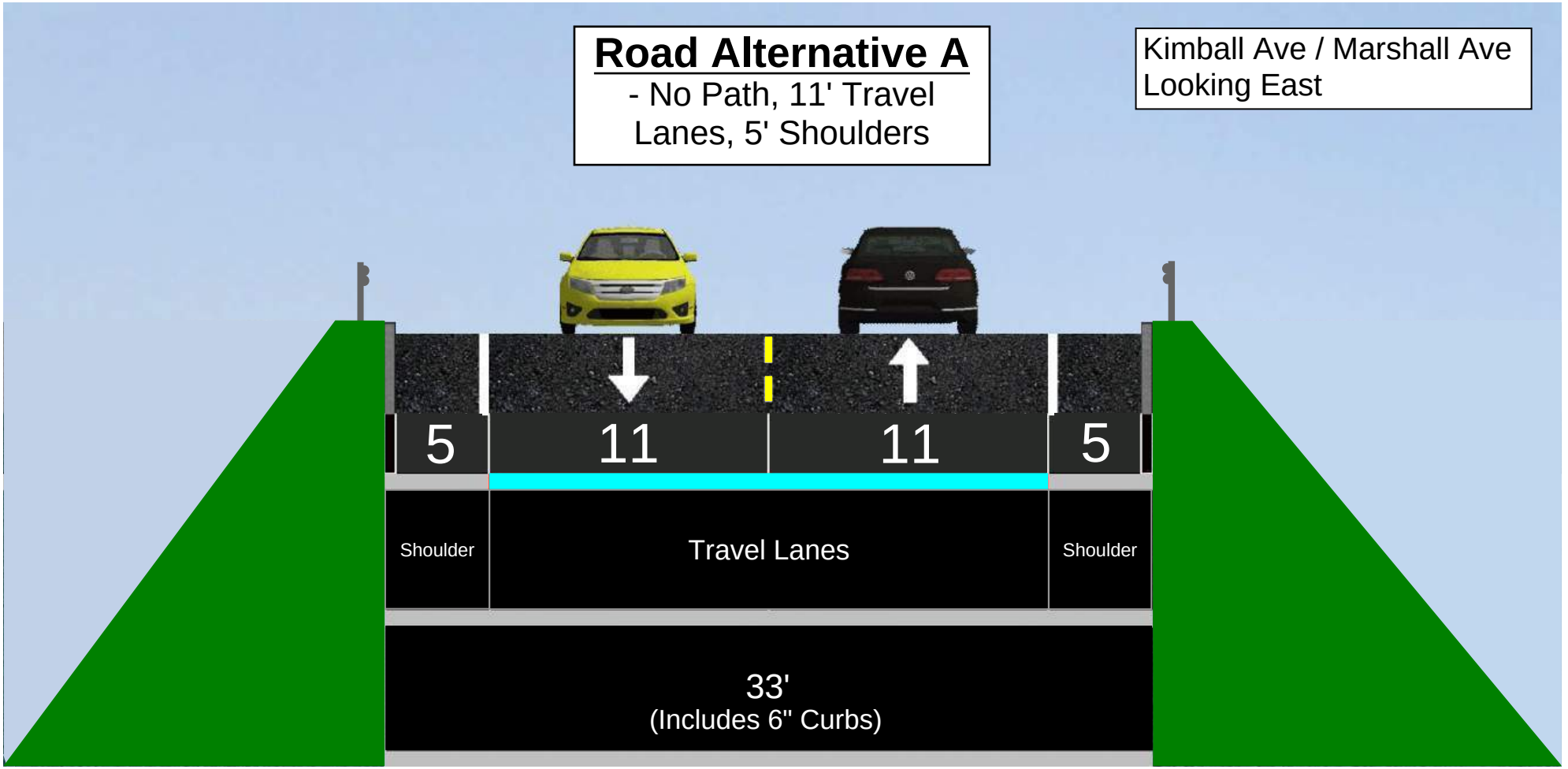

FIGURE 1
FIGURE 1 OF 6

PROJECT NO. 910909

KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT
MUDDY BROOK CULVERT REPLACEMENT
ROAD ALTERNATIVE A

Hoyle, Tanner & Associates, Inc.
125 College Street, 4th Floor, Burlington, VT 05401
Tel (802) 860-1331
www.hoyletanner.com

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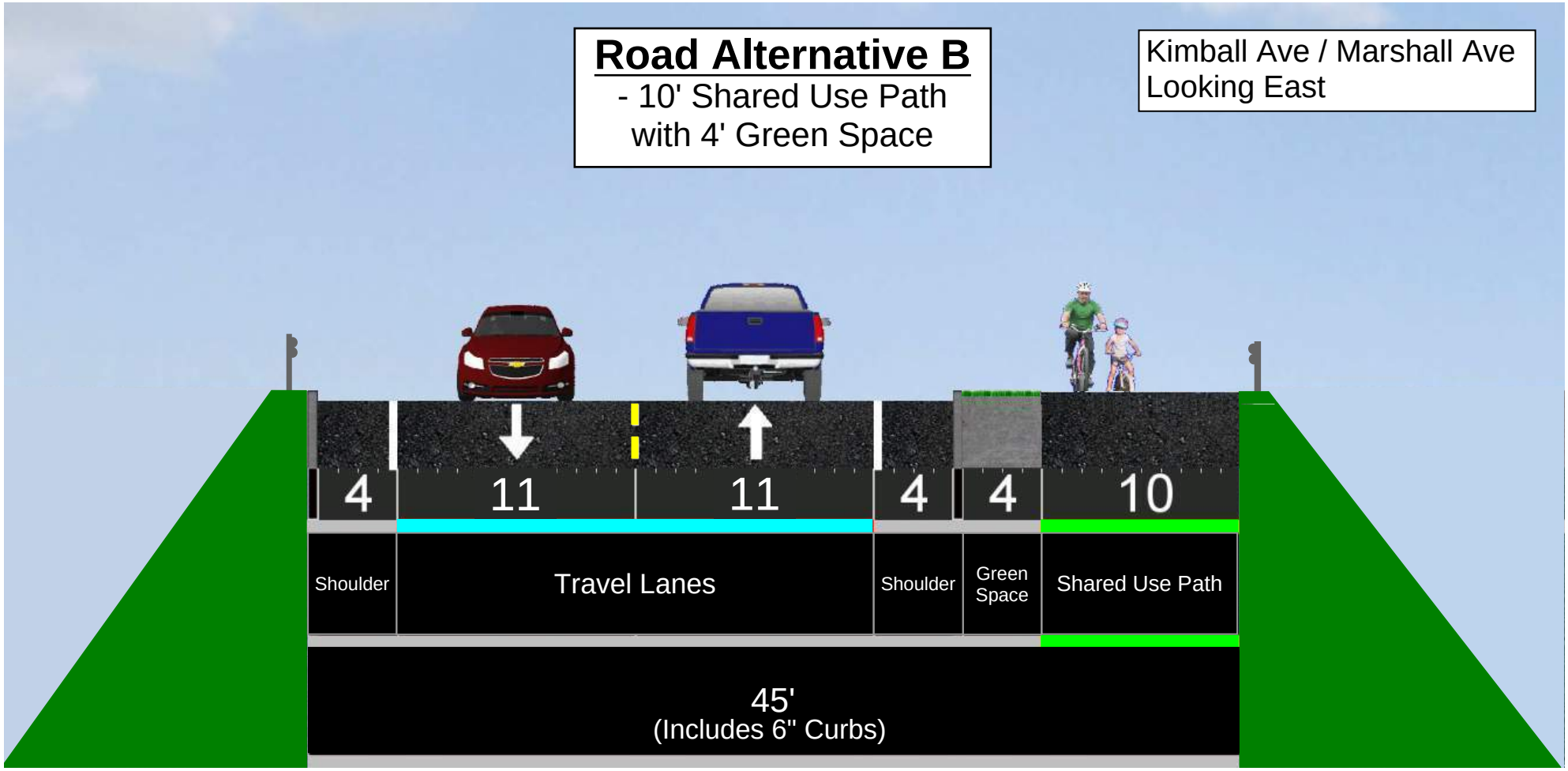

FIGURE 2 OF 6

FIGURE 2

PROJECT NO. 910909

KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT

MUDDY BROOK CULVERT REPLACEMENT

ROAD ALTERNATIVE B

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www.hoyletanner.com

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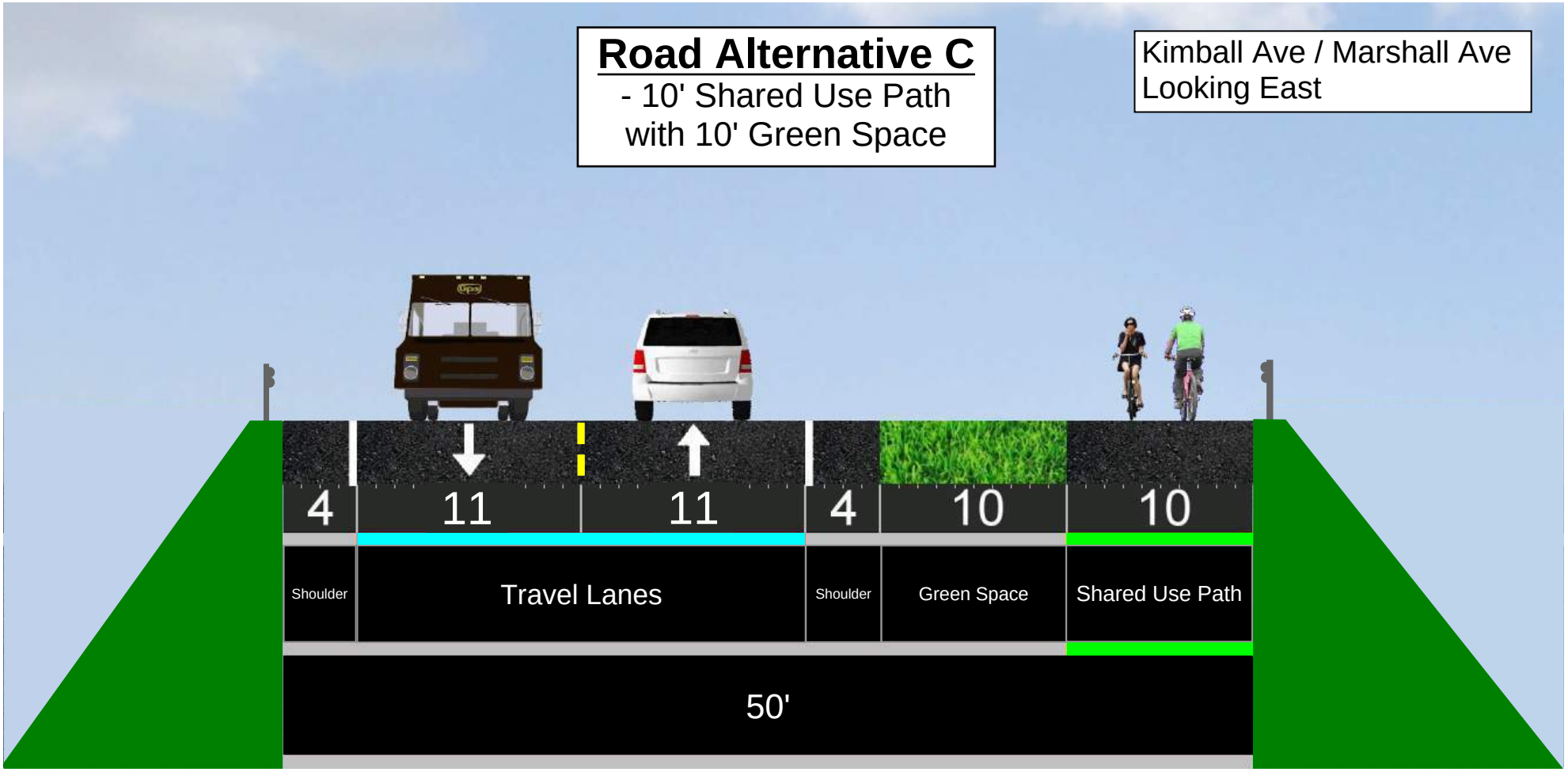

FIGURE 3 OF 6

FIGURE 3

PROJECT NO. 910909

KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT

MUDDY BROOK CULVERT REPLACEMENT

ROAD ALTERNATIVE C

Hoyle, Tanner & Associates, Inc.
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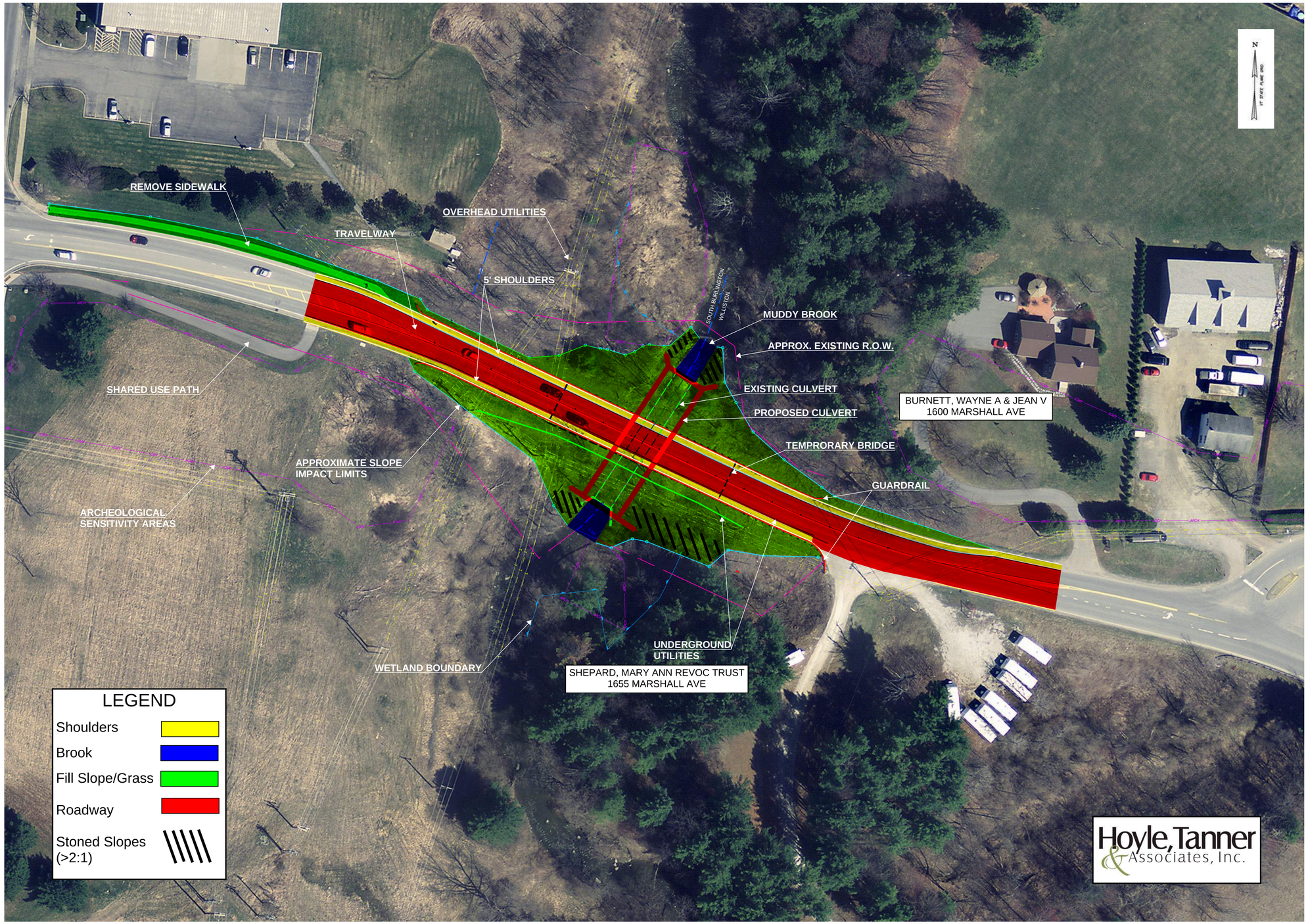

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DATE	SEPTEMBER 12, 2018

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KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT
MUDDY BROOK CULVERT REPLACEMENT
ALTERNATIVE A

PROJECT NO. 910909

FIGURE
4

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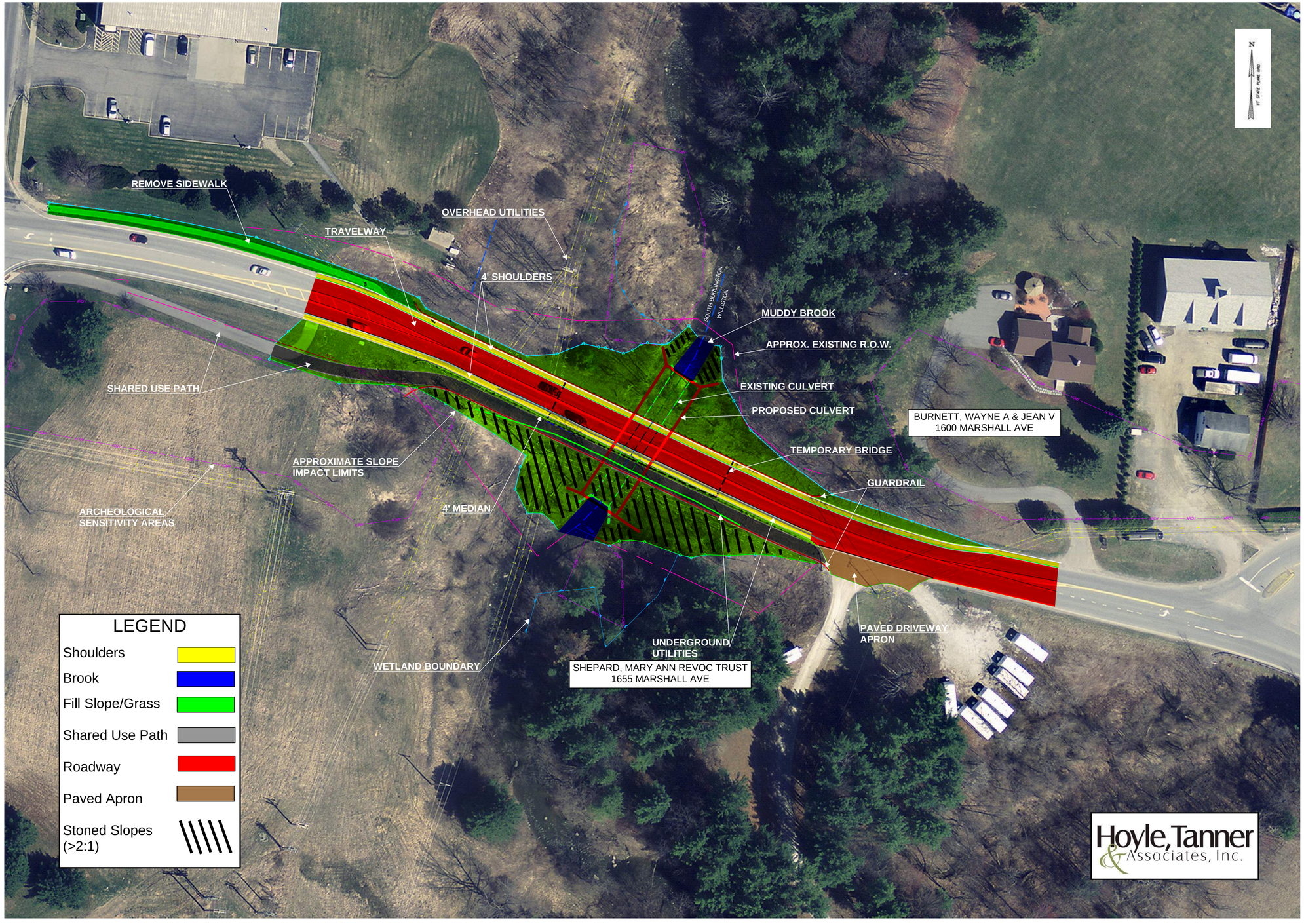

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KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT
MUDDY BROOK CULVERT REPLACEMENT
ALTERNATIVE B

PROJECT NO. 910909

FIGURE
5

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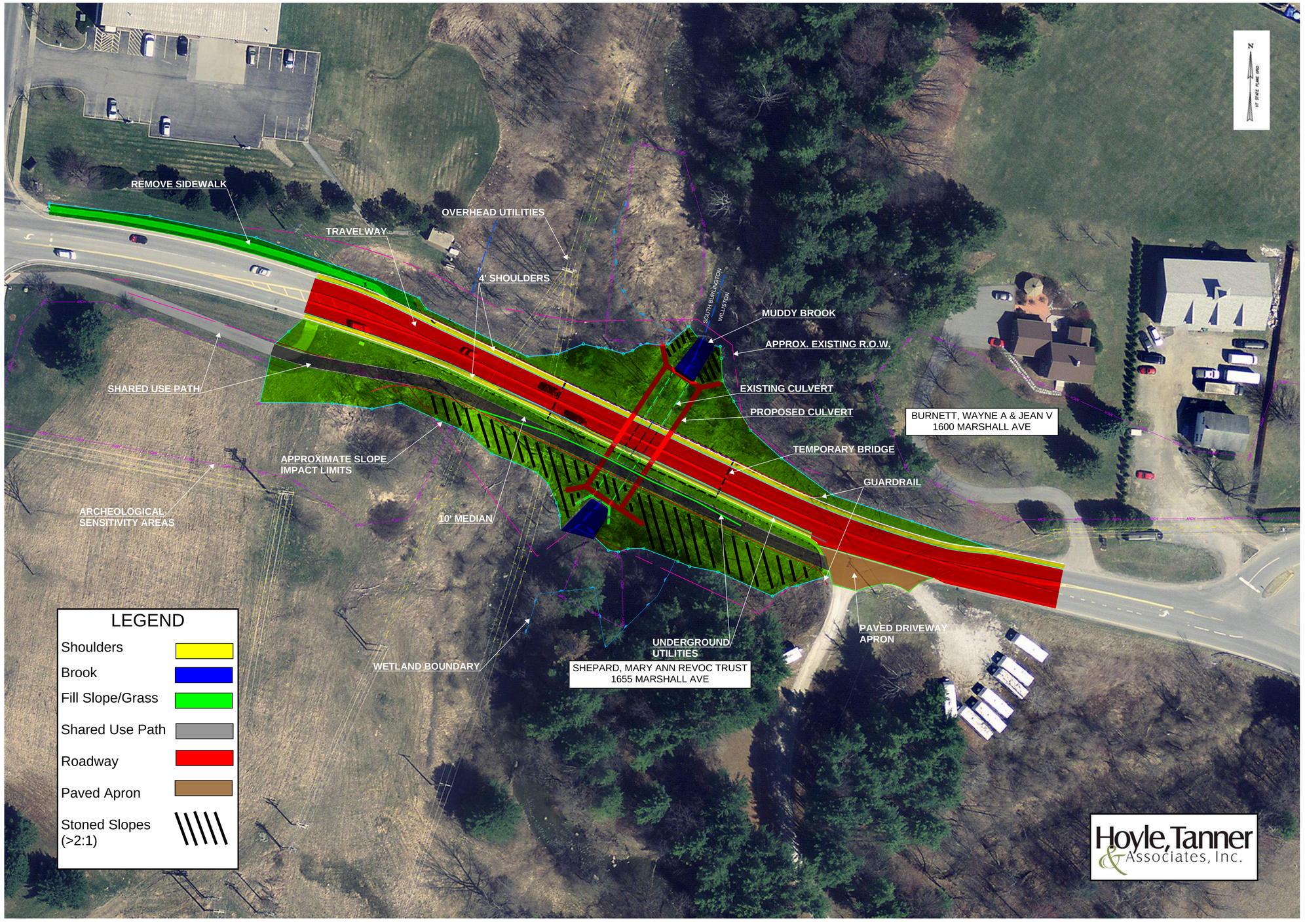

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KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT
MUDDY BROOK CULVERT REPLACEMENT
ALTERNATIVE C

PROJECT NO. 910909

FIGURE
6

FIGURE 6 OF 6

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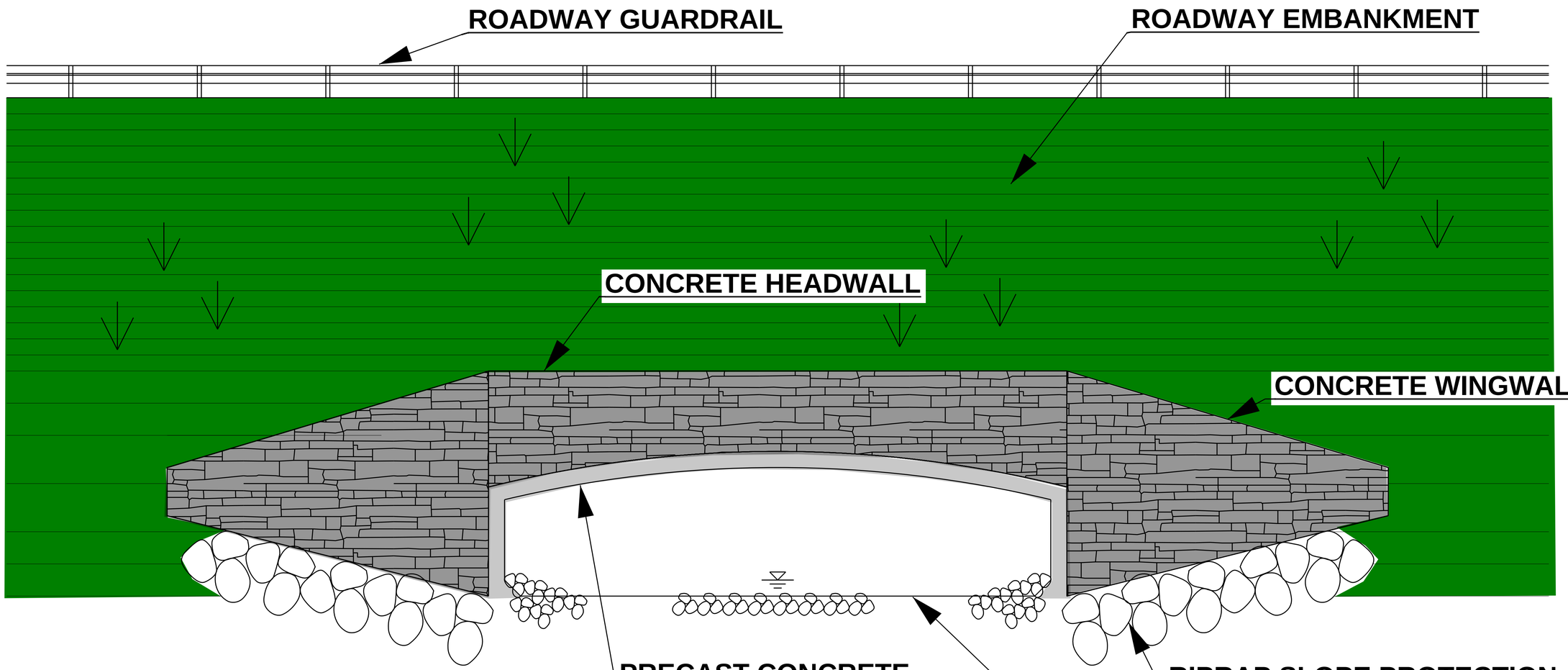

STRUCTURE ELEVATION

NOTE: STRUCTURE ALT 2 SHOWN

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FILENAME 910909genplans
MODEL NAME XSU01
SCALE AS SHOWN
DATE SEPTEMBER 12, 2018

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KIMBALL AVE / MARSHALL AVE
CITY OF SOUTH BURLINGTON / TOWN OF WILLISTON, VT
MUDDY BROOK CULVERT REPLACEMENT
STRUCTURE ELEVATION

PROJECT NO. 910909

FIGURE
7

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APPENDIX B

Boring Location Plan, Logs, and Site Characterization Report

Site Characterization Report

Muddy Brook Culvert at Kimball Ave and Marshall Ave
South Burlington, Vermont

August 1, 2018
Terracon Project No. J1185022

Prepared for:
Hoyle Tanner & Associates, Inc.
Burlington, VT

Prepared by:
Terracon Consultants, Inc.
Manchester, New Hampshire

August 1, 2018

Hoyle Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, VT 05401

Attn: Mr. Jon Olin, Vice President – Vermont Transportation Group Manager
P: (802) 860 1331 x 314
E: jolin@hoyletanner.com

Re: Site Characterization Report
Muddy Brook Culvert at Kimball Ave and Marshall Ave
South Burlington, Vermont
Terracon Project No. J1185022

Dear Mr. Olin:

We have completed the Site Characterization services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PJ1185022 dated February 21, 2018. This report presents the findings of the subsurface exploration for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Anant Panwalkar
Senior Project Engineer

Lawrence J. Dwyer, P.E.
Principal

REPORT TOPICS

INTRODUCTION 1
SITE CONDITIONS 1
PROJECT DESCRIPTION 2
GEOTECHNICAL CHARACTERIZATION 2
GENERAL COMMENTS 3

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon GeoReport logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS (Boring Logs)
SUPPORTING INFORMATION (General Notes and Unified Soil Classification System)

Site Characterization Report

Muddy Brook Culvert at Kimball Ave and Marshall Ave
South Burlington, Vermont

Terracon Project No. J1185022
August 1, 2018

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed culvert to be located at Muddy Brook Culvert under Kimball Avenue and Marshall Avenue in South Burlington, Vermont. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions

The geotechnical engineering scope of services for this project included the advancement of two test borings to depth of approximately 50 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The boring logs are included in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at Muddy Brook Culvert under Kimball Avenue and Marshall Avenue in South Burlington, Vermont.

Item	Description
Existing Improvements	The existing Muddy Brook culvert is a 16' diameter multi-plate metal pipe structure. A substantial amount of corrosion has occurred along the spring line of the pipe causing it to fail in several locations along its length resulting in potholing in the roadway above and loss of structural integrity. In spring of 2017, Kimball avenue was closed and a temporary bridge placed above the culvert. The existing structure is hydraulically undersized and has led to erosion issues both upstream and downstream of the stream crossing. Increased stream velocities may be contributing to a large embankment failure is located downstream of the culvert as well as a deep plunge pool at the pipe outlet with a drop from the pipe invert.
Current Ground Cover	Asphalt paved roadway
Existing Topography	Ground surface is relatively flat.
Site Access	We expect the site, and all exploration locations, are accessible with our truck-mounted drilling equipment.
Expected Subsurface Conditions	Our experience near the vicinity of the culvert indicates granular alluvial or organic deposits, with depth to rock below our anticipated boring depth.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and our final understanding of the project conditions is as follows:

Item	Description
Structures	The project will include replacement of existing culvert under Kimball Ave/Marshall Ave.
Finished Grade Elevation	Match existing roadway grade. Wing walls at the culvert outlet to hold back the grade at the flow diversion structure.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density
Surface	1-inch	Asphalt Pavement	N/A
1	18.0 to 21.0	Fill – Poorly graded Sand with silt and gravel, to sandy silt with wood fragments, gray-brown, some iron staining	Loose to very dense
2	28.0	Silty SAND with Gravel (SM), gray	Dense
3	42.4 to > 52.0	Sandy SILT (ML) to laminated SILT and SAND with gravel, gray	Dense to very dense

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

Water was introduced in the bore holes during drilling as such ground water table was not measured during drilling.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Exploration Number	Boring Depth (feet)	Location
B-1	42	Culvert
B-2	52	Culvert

Exploration Layout and Elevations: Unless otherwise noted, Terracon personnel provide the exploration layout. Coordinates are obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations are obtained by interpolation from the google earth. If elevations and a more precise exploration layout are desired, we recommend explorations be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advance the borings with a track-mounted rotary drill rig using continuous flight augers (solid stem and/or hollow stem as necessary depending on soil conditions). Four samples are obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter.

In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. For safety purposes, borings are backfilled with auger cuttings after their completion. Pavements are patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information are recorded on the field boring logs. The samples are placed in appropriate containers and taken to our soil laboratory for testing and classification by a geotechnical engineer. Our exploration team prepares field boring logs as part of the drilling operations. These field logs include visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs are prepared from the field logs. The final boring logs represent the geotechnical engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION

Muddy Brook Culvert ■ South Burlington, VT
May 4, 2018 ■ Terracon Project No. J1185022

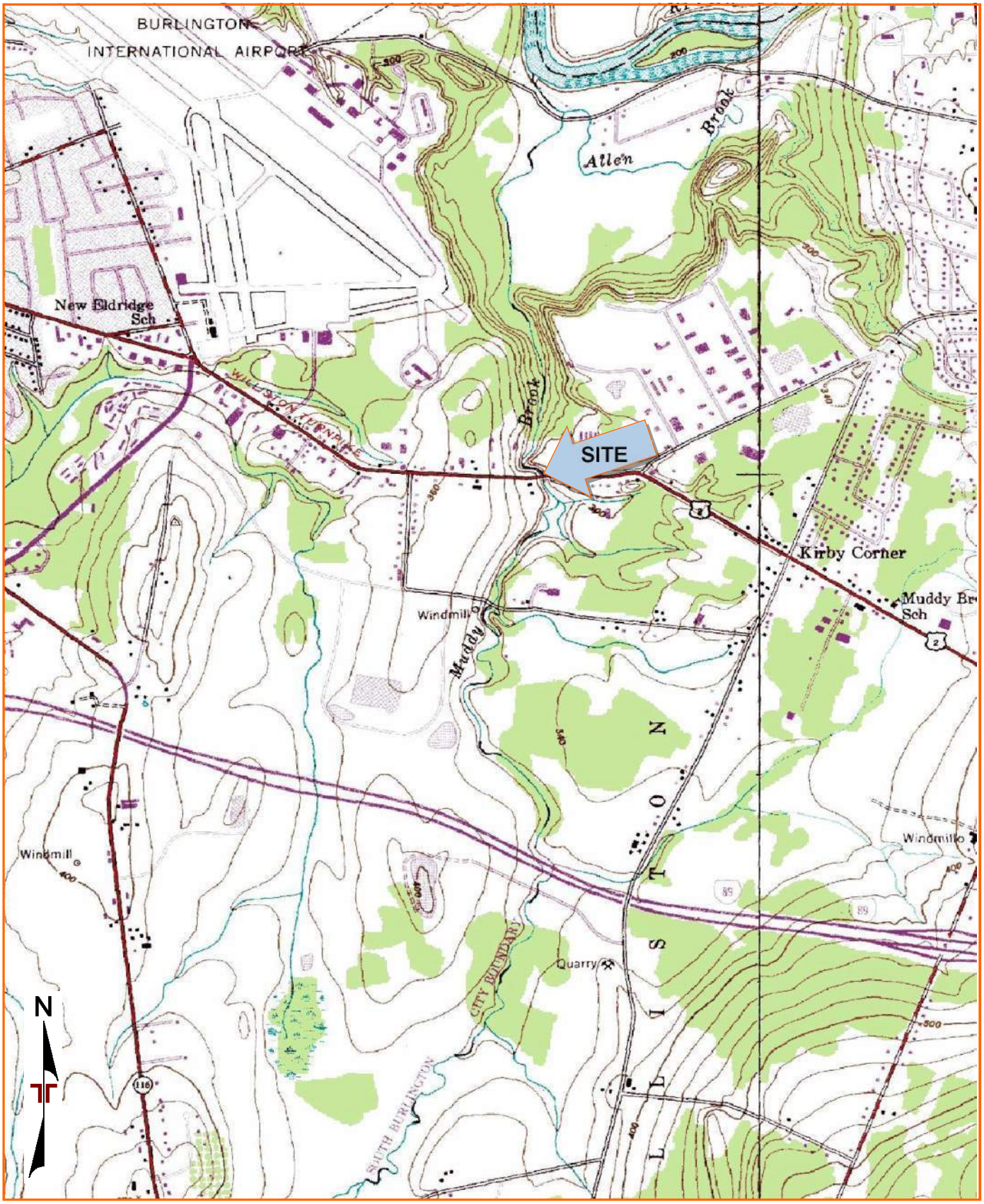


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: BURLINGTON, VT (1/1/1987) and ESSEX JUNCTION, VT (1/1/1987).

EXPLORATION PLAN

Muddy Brook Culvert ■ South Burlington, VT
May 4, 2018 ■ Terracon Project No. J1185022

Terracon GeoReport

N

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. B-1

PROJECT: Muddy Brook Culvert Replacement

CLIENT: Hoyle, Tanner & Associates, Inc.
Burlington, VT

SITE: Kimball Ave and Marshall Ave Intersection
South Burlington, VT

LOCATION See Exploration Plan

Latitude: 44.453° Longitude: -73.1381°

Approximate Surface Elev: 322 (Ft.) +/-

DEPTH	ELEVATION (Ft.)		DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
0.2	322+/-	1-inch of asphalt				
		FILL - POORLY GRADED SAND WITH SILT AND GRAVEL, brown, medium dense			11	11-12-14-18 N=26
		FILL - POORLY GRADED SAND WITH GRAVEL, brown, medium dense, some iron staining			14	19-13-12-10 N=25
		FILL - SANDY SILT, with clay, gray	5		10	11-5-9-13 N=14
		Similar, with gravel			10	12-9-16-19 N=25
		Pockets of lean clay, with thin sand seams, gray-brown	10		9	10-7-9-19 N=16
		FILL - POORLY GRADED SAND WITH SILT, gray-brown, medium dense to dense	15		10	10-16-15-17 N=31
21.0	301+/-	Similar, with gravel, some wood fragments, loose	20		10	2-2-1-1 N=3
		SILTY SAND WITH GRAVEL (SM), gray, dense	25		11	15-15-15-24 N=30
28.0	294+/-	**LAMINATED SILT AND SAND**, with gravel, gray, dense to very dense	30		14	17-22-22-75 N=44
			35		17	39-71-72-51 N=143
			40		13	40-42-54-50/2"
42.4	279.5+/-	Rock chips in bottom of sampler				50/4"
		Refusal at 42.4 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Drive and wash, 4-inch casing

Abandonment Method:
Boring backfilled with auger cuttings and asphalt patch upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 04-30-2018 | Boring Completed: 04-30-2018

Drill Rig: CME-55 | Driller: Terracon/Sam S.

Project No.: J1185022

BORING LOG NO. B-2

PROJECT: Muddy Brook Culvert Replacement

CLIENT: Hoyle, Tanner & Associates, Inc.
Burlington, VT

SITE: Kimball Ave and Marshall Ave Intersection
South Burlington, VT

LOCATION See Exploration Plan

Latitude: 44.4533° Longitude: -73.1388°

Approximate Surface Elev: 322 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
0.2	322+/-	1-inch of asphalt			
		FILL - POORLY GRADED SAND WITH SILT AND GRAVEL, brown, medium dense		13	12-14-15-11 N=29
				12	18-14-12-10 N=26
				6	6-10-11-11 N=21
				11	20-27-38-35 N=65
		FILL - SILTY SAND WITH GRAVEL, brown, dense		17	20-19-16-16 N=35
18.0	304+/-			11	17-23-30-24 N=53
		SILTY SAND WITH GRAVEL (SM), olive-brown, very dense		14	39-46-45-53 N=91
28.0	294+/-			5	40-50/2"
		SANDY SILT (ML), with clay and gravel, gray, very dense		13	27-31-39-33 N=70
				16	42-48-45-53 N=93
				9	44-50/5"
				2	50/4"
50.0	272+/-				
		SILTY CLAY (CL-ML), with sand layers, gray, very dense		19	28-38-38-57 N=76
52.0	270+/-				
		Boring Terminated at 52 Feet			

DEPTH (Ft.): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

WATER LEVEL OBSERVATIONS

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Drive and wash, 4-inch casing

Abandonment Method:
Boring backfilled with auger cuttings and asphalt patch upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 05-01-2018 | Boring Completed: 05-01-2018

Drill Rig: CME-55 | Driller: Terracon/Sam S.

Project No.: J1185022

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

Muddy Brook Culvert at Kimball Ave and Marshall Ave ■ South Burlington, Vermont

August 1, 2018 ■ Terracon Project No. J1185022

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ³ 4 and 1 £ Cc £ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ³ 6 and 1 £ Cc £ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above “A”		CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay [K, L, M, N] / Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above “A” line		CH	Fat clay [K, L, M]
			PI plots below “A” line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay [K, L, M, P] / Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ³ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ³ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ³ 30% plus No. 200 predominantly sand, add “sandy” to group name.

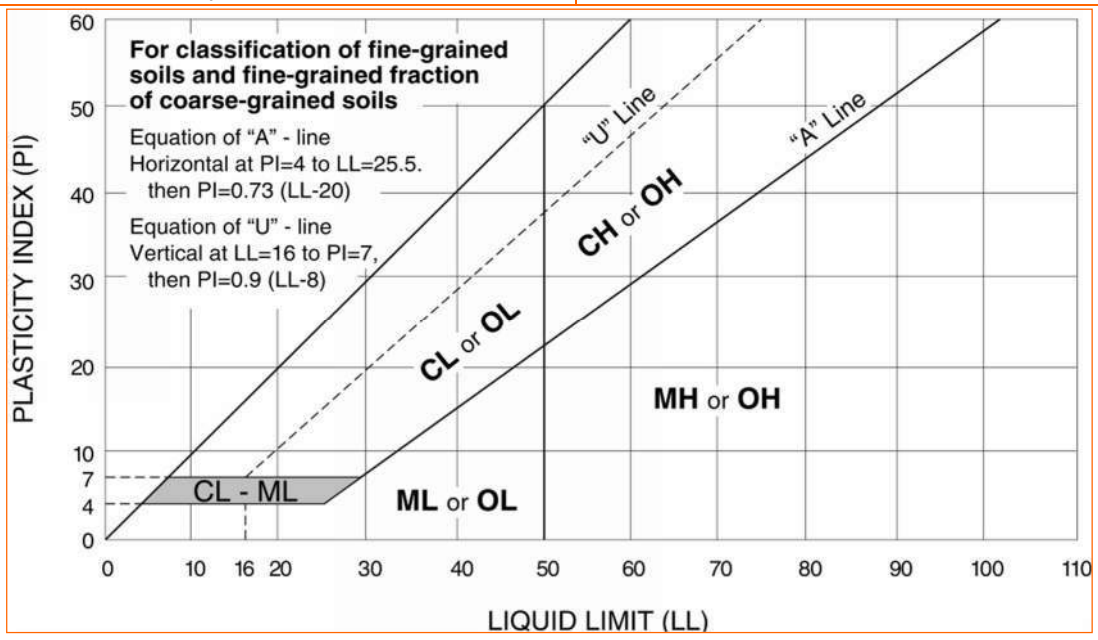
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ³ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.



APPENDIX C

Engineer's Estimate of Probable Project Costs

Hoyle, Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, Vermont 05401
802-860-1331
802-860-6499 fax
www.hoyletanner.com

Project: Muddy Brook Culvert Replacement
HTA Project #: 910909
Location: Kimball/Marshall Ave. South Burlington, VT
Task: Conceptual Estimate
Calculated By: NLR Date: 10/10/2018
Checked By: AGB Date: 10/11/2018

ROAD ALTERNATIVE A - 5' SHOULDERS / NO PATH

MUDDY BROOK CULVERT REPLACEMENT

SECTION A - MAJOR ITEMS

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRE	0.55	$ 33,000.00	$ 18,150.00
203.15	COMMON EXCAVATION	CY	2400	$ 10.00	$ 24,000.00
203.30	EARTH BORROW	CY	2160	$ 11.00	$ 23,760.00
301.25	SUBBASE OF CRUSHED GRAVEL, COURSE GRADED	CY	940	$ 36.00	$ 33,840.00
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	890	$ 40.00	$ 35,600.00
490.30	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	860	$ 80.00	$ 68,800.00
613.11	STONE FILL, TYPE II	CY	320	$ 43.00	$ 13,760.00
616.26	PRECAST REINFORCED CONCRETE CURB, TYPE B	LF	1300	$ 37.00	$ 48,100.00
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	750	$ 16.00	$ 12,000.00
	MISCELLANEOUS ROADWAY		10% OF ABOVE TOTAL		$ 27,801.00
			SUBTOTAL A		**$ 305,811.00**

SECTION B - MISCELLANEOUS ITEMS

SIGNS, MARKINGS, LOAM/HUMUS, ETC.	5%	$	15,290.55
	SUBTOTAL B	**$**	**321,101.55**

SECTION C - DRAINAGE ITEMS

PIPES, UNDERDRAIN, CB's, MH's, ETC.	7%	$	22,477.11
	SUBTOTAL C	**$**	**343,578.66**

SECTION D - TRAFFIC CONTROL

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
621.90	TEMPORARY TRAFFIC BARRIER	LF	100	$ 13.00	$ 1,300.00
630.10	UNIFORMED TRAFFIC OFFICERS	HR	40	$ 52.00	$ 2,080.00
630.15	FLAGGERS	HR	170	$ 25.00	$ 4,250.00
	MISCELLANEOUS TRAFFIC CONTROL		10% OF ABOVE TOTAL		$ 763.00
			SUBTOTAL D		**$ 351,971.66**

SECTION E - EROSION AND SEDIMENT CONTROL

EROSION, SEDIMENT, AND POLLUTION CONTROL (HAY BALES, SILT FENCE, SWPPP, TEMP. WATER POLL. CONTROL, ETC.)	5% OF DRAINAGE	$	17,178.93
	SUBTOTAL E	**$**	**369,150.59**

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HTA Project #:	910909		
Location:	Kimball/Marshall Ave. South Burlington, VT		
Task:	Conceptual Estimate		
Calculated By:	NLR	Date:	10/10/2018
Checked By:	AGB	Date:	10/11/2018

ROAD ALTERNATIVE A - 5' SHOULDERS / NO PATH

MUDDY BROOK CULVERT REPLACEMENT

SECTION F - MOBILIZATION AND CONTINGENCIES

ROADWAY MOBILIZATION	10%	$	36,915.06
ROADWAY CONTINGENCIES	15%	$	55,372.59
	SUBTOTAL F	$	461,438.24

SECTION G - ADDITIONAL ITEMS

	SUBTOTAL G	$	461,438.24
	ROUNDED ROADWAY TOTAL:	$	462,000.00

SEE ADDITIONAL SHEET FOR ASSUMPTIONS MADE WHILE COMPILING THIS ESTIMATE.

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Task:	Conceptual Estimate		
Calculated By:	NLR	Date:	10/10/2018
Checked By:	AGB	Date:	9/7/2018

ROAD ALTERNATIVE A - 5' SHOULDERS / NO PATH - ASSUMPTIONS

This Conceptual Engineer's Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as Hoyle, Tanner's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be ntoed that changes in material or labor costs in the construction industry could impact the project cost in either direction. Assumptions used for this estimate are listed below.

1. Assume 6" pavement thickness due to large AADT
2. Assume Full Depth Reconstruction (12" crushed, 12" gravel)
3. Assume 1 month construction duration
4.
5.
6.
7.
8.
9.
10.

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ROAD ALTERNATIVE B - 4' GREEN SPACE

MUDDY BROOK CULVERT REPLACEMENT

SECTION A - MAJOR ITEMS

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRE	0.7	$ 33,000.00	$ 23,100.00
203.15	COMMON EXCAVATION	CY	2410	$ 10.00	$ 24,100.00
203.30	EARTH BORROW	CY	3100	$ 11.00	$ 34,100.00
301.25	SUBBASE OF CRUSHED GRAVEL, COURSE GRADED	CY	1030	$ 36.00	$ 37,080.00
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	890	$ 40.00	$ 35,600.00
490.30	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	890	$ 80.00	$ 71,200.00
613.11	STONE FILL, TYPE II	CY	1285	$ 43.00	$ 55,255.00
616.26	PRECAST REINFORCED CONCRETE CURB, TYPE B	LF	1300	$ 37.00	$ 48,100.00
618.15	BITUMINOUS CONCRETE SIDEWALK	TON	100	$ 136.00	$ 13,600.00
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	750	$ 16.00	$ 12,000.00
	MISCELLANEOUS ROADWAY		10% OF ABOVE TOTAL		$ 35,413.50
			SUBTOTAL A		**$ 389,548.50**

SECTION B - MISCELLANEOUS ITEMS

SIGNS, MARKINGS, LOAM/HUMUS, ETC.	5%	$ 19,477.43
	SUBTOTAL B	**$ 409,025.93**

SECTION C - DRAINAGE ITEMS

PIPES, UNDERDRAIN, CB's, MH's, ETC.	7%	$ 28,631.81
	SUBTOTAL C	**$ 437,657.74**

SECTION D - TRAFFIC CONTROL

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST	COST
621.90	TEMPORARY TRAFFIC BARRIER	LF	100	$ 13.00	$ 1,300.00
630.10	UNIFORMED TRAFFIC OFFICERS	HR	40	$ 52.00	$ 2,080.00
630.15	FLAGGERS	HR	350	$ 25.00	$ 8,750.00
	MISCELLANEOUS TRAFFIC CONTROL		10% OF ABOVE TOTAL		$ 1,213.00
			SUBTOTAL D		**$ 451,000.74**

SECTION E - EROSION AND SEDIMENT CONTROL

EROSION, SEDIMENT, AND POLLUTION CONTROL (HAY BALES, SILT FENCE, SWPPP, TEMP. WATER POLL. CONTROL, ETC.)	5% OF DRAINAGE	$ 21,882.89
	SUBTOTAL E	**$ 472,883.63**

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Task:	Conceptual Estimate		
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Checked By:	AGB	Date:	10/11/2018

ROAD ALTERNATIVE B - 4' GREEN SPACE

MUDDY BROOK CULVERT REPLACEMENT

SECTION F - MOBILIZATION AND CONTINGENCIES

ROADWAY MOBILIZATION	10%	$	47,288.36
ROADWAY CONTINGENCIES	15%	$	70,932.54
	SUBTOTAL F	$	591,104.53

SECTION G - ADDITIONAL ITEMS

	SUBTOTAL G	$	591,104.53
	ROUNDED ROADWAY TOTAL:	$	592,000.00

SEE ADDITIONAL SHEET FOR ASSUMPTIONS MADE WHILE COMPILING THIS ESTIMATE.

Hoyle, Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, Vermont 05401
802-860-1331
802-860-6499 fax
www.hoyletanner.com

Project:	Muddy Brook Culvert Replacement		
HTA Project #:	910909		
Location:	Kimball/Marshall Ave. South Burlington, VT		
Task:	Conceptual Estimate		
Calculated By:	NLR	Date:	10/10/2018
Checked By:	AGB	Date:	9/7/2018

ROAD ALTERNATIVE B - 4' GREEN SPACE - ASSUMPTIONS

This Conceptual Engineer's Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as Hoyle, Tanner's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be ntoed that changes in material or labor costs in the construction industry could impact the project cost in either direction. Assumptions used for this estimate are listed below.

1. Assume 6" pavement thickness due to large AADT
2. Assume Full Depth Reconstruction (12" crushed, 12" gravel)
3. Assume 2 month construction duration
4.
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10.

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802-860-6499 fax
www.hoyletanner.com

Project: Muddy Brook Culvert Replacement
HTA Project #: 910909
Location: Kimball/Marshall Ave. South Burlington, VT
Task: Conceptual Estimate
Calculated By: NLR Date: 10/10/2018
Checked By: AGB Date: 10/11/2018

ROAD ALTERNATIVE C - 10' GREEN SPACE

MUDDY BROOK CULVERT REPLACEMENT

SECTION A - MAJOR ITEMS

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRE	0.7	$ 33,000.00	$ 23,100.00
203.15	COMMON EXCAVATION	CY	2400	$ 10.00	$ 24,000.00
203.30	EARTH BORROW	CY	3600	$ 11.00	$ 39,600.00
301.25	SUBBASE OF CRUSHED GRAVEL, COURSE GRADED	CY	1030	$ 36.00	$ 37,080.00
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	890	$ 40.00	$ 35,600.00
490.30	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	890	$ 80.00	$ 71,200.00
613.11	STONE FILL, TYPE II	CY	1285	$ 43.00	$ 55,255.00
616.26	PRECAST CONCRETE CURB, TYPE B	LF	540	$ 37.00	$ 19,980.00
618.15	BITUMINOUS CONCRETE SIDEWALK	TON	100	$ 136.00	$ 13,600.00
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	750	$ 16.00	$ 12,000.00
900.675	ADDITIONAL WINGWALL AND HEADWALL AREA	SF	201	$ 75.00	$ 15,075.00
	MISCELLANEOUS ROADWAY		10% OF ABOVE TOTAL		$ 34,649.00
			SUBTOTAL A		**$ 381,139.00**

SECTION B - MISCELLANEOUS ITEMS

SIGNS, MARKINGS, LOAM/HUMUS, ETC.	5%	$ 19,056.95
	SUBTOTAL B	**$ 400,195.95**

SECTION C - DRAINAGE ITEMS

PIPES, UNDERDRAIN, CB's, MH's, ETC.	7%	$ 28,013.72
	SUBTOTAL C	**$ 428,209.67**

SECTION D - TRAFFIC CONTROL

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
621.90	TEMPORARY TRAFFIC BARRIER	LF	100	$ 13.00	$ 1,300.00
630.10	UNIFORMED TRAFFIC OFFICERS	HR	40	$ 52.00	$ 2,080.00
630.15	FLAGGERS	HR	350	$ 25.00	$ 8,750.00
	MISCELLANEOUS TRAFFIC CONTROL		10% OF ABOVE TOTAL		$ 1,213.00
			SUBTOTAL D		**$ 441,552.67**

SECTION E - EROSION AND SEDIMENT CONTROL

EROSION, SEDIMENT, AND POLLUTION CONTROL (HAY BALES, SILT FENCE, SWPPP, TEMP. WATER POLL. CONTROL, ETC.)	5% OF DRAINAGE	$ 21,410.48
	SUBTOTAL E	**$ 462,963.15**

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Project:	Muddy Brook Culvert Replacement		
HTA Project #:	910909		
Location:	Kimball/Marshall Ave. South Burlington, VT		
Task:	Conceptual Estimate		
Calculated By:	NLR	Date:	10/10/2018
Checked By:	AGB	Date:	10/11/2018

ROAD ALTERNATIVE C - 10' GREEN SPACE

MUDDY BROOK CULVERT REPLACEMENT

SECTION F - MOBILIZATION AND CONTINGENCIES

ROADWAY MOBILIZATION	10%	$	46,296.31
ROADWAY CONTINGENCIES	15%	$	69,444.47
	SUBTOTAL F	$	578,703.94

SECTION G - ADDITIONAL ITEMS

	SUBTOTAL G	$	578,703.94
	ROUNDED ROADWAY TOTAL:	$	579,000.00

SEE ADDITIONAL SHEET FOR ASSUMPTIONS MADE WHILE COMPILING THIS ESTIMATE.

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Project:	Muddy Brook Culvert Replacement		
HTA Project #:	910909		
Location:	Kimball/Marshall Ave. South Burlington, VT		
Task:	Conceptual Estimate		
Calculated By:	NLR	Date:	10/10/2018
Checked By:		Date:	

ROAD ALTERNATIVE C - 10' GREEN SPACE - ASSUMPTIONS

This Conceptual Engineer's Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as Hoyle, Tanner's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be ntoed that changes in material or labor costs in the construction industry could impact the project cost in either direction. Assumptions used for this estimate are listed below.

1. Assume 6" pavement thickness due to large AADT
2. Assume Full Depth Reconstruction (12" crushed, 12" gravel)
3. Assume 2 month construction duration
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Project: Muddy Brook Culvert Replacement
HTA Project #: 910909
Location: Kimball/Marshall Ave. South Burlington, VT
Task: Conceptual Estimate
Calculated By: JAD Date: 9/7/2018
Checked By: JAO Date: 9/7/2018

STRUCTURAL ALTERNATIVE 2 - PRECAST CULVERT

MUDDY BROOK CULVERT REPLACEMENT

SECTION A - MAJOR ITEMS

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
203.27	UNCLASSIFIED CHANNEL EXCATION	CY	167	$ 15.00	$ 2,505.00
204.25	STRUCTURAL EXCAVATION	CY	5103	$ 23.00	$ 117,369.00
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	5123	$ 30.00	$ 153,690.00
540.1	PRECAST CONCRETE STRUCTURE (INCLUDING WING WALLS, FOOTINGS)	LS	1	$611,100.00	$ 611,100.00
900.608	INSTREAM RIPRAP	CY	378.0	$ 50.00	$ 18,900.00
900.64	TEMPORARY WATER DIVERSION	LS	1	$ 30,000.00	$ 30,000.00
900.64	REMOVAL OF TEMPORARY BRIDGE	LS	1	$ 60,000.00	$ 60,000.00
	STRUCTURES MOBILIZATION	LS		10%	$ 93,356.40
	STRUCTURES CONTINGENCY	LS		15%	$ 140,034.60

ROUNDED STRUCTURAL TOTAL: $ 1,227,000

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802-860-6499 fax
www.hoyletanner.com

Project: Muddy Brook Culvert Replacement
HTA Project #: 910909
Location: Kimball/Marshall Ave. South Burlington, VT
Task: Conceptual Estimate
Calculated By: JAD Date: 9/7/2018
Checked By: JAO Date: 9/7/2018

STRUCTURAL ALTERNATIVE 3 - CIP CULVERT

MUDDY BROOK CULVERT REPLACEMENT

SECTION A - MAJOR ITEMS

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
203.27	UNCLASSIFIED CHANNEL EXCATION	CY	167	$ 15.00	$ 2,505.00
204.25	STRUCTURAL EXCAVATION	CY	5103	$ 23.00	$ 117,369.00
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	5123	$ 30.00	$ 153,690.00
540.11	CIP CONCRETE STRUCTURE (INCLUDING FOOTINGS)	LS	1	$537,700.00	$ 537,700.00
900.608	INSTREAM RIPRAP	CY	378.0	$ 50.00	$ 18,900.00
900.64	TEMPORARY WATER DIVERSION	LS	1	$ 30,000.00	$ 30,000.00
900.675	CONCRETE FACED WINGWALLS	SF	1150	$ 75.00	$ 86,250.00
900.64	REMOVAL OF TEMPORARY BRIDGE	LS	1	$ 60,000.00	$ 60,000.00
	STRUCTURES MOBILIZATION	LS		10%	$ 94,641.40
	STRUCTURES CONTINGENCY	LS		15%	$ 141,962.10

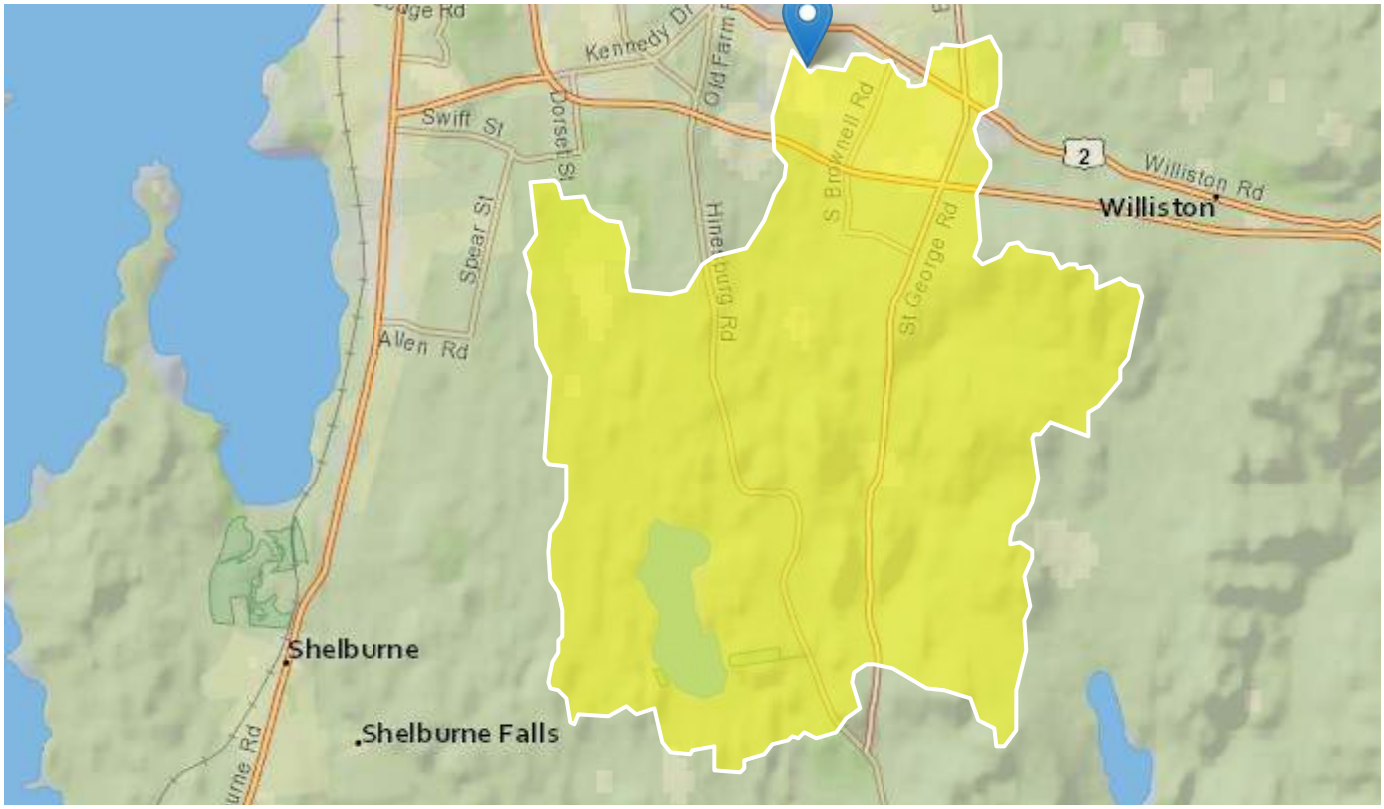
ROUNDED STRUCTURAL TOTAL: $ 1,244,000

APPENDIX D

Hydrology & Hydraulic Analysis Results

Muddy Brook

Region ID: VT
Workspace ID: VT20180412200857361000
Clicked Point (Latitude, Longitude): 44.45334, -73.13835
Time: 2018-04-12 16:09:11 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	20.2	square miles
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	7.47	percent
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	39.5	inches

Peak-Flow Statistics Parameters [Statewide Peak Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	20.2	square miles	0.18	689
LC06STOR	Percent Storage from NLCD2006	7.47	percent	0	18.5
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	39.5	inches	33.5	70.4

Peak-Flow Statistics Flow Report [Statewide Peak Flow]

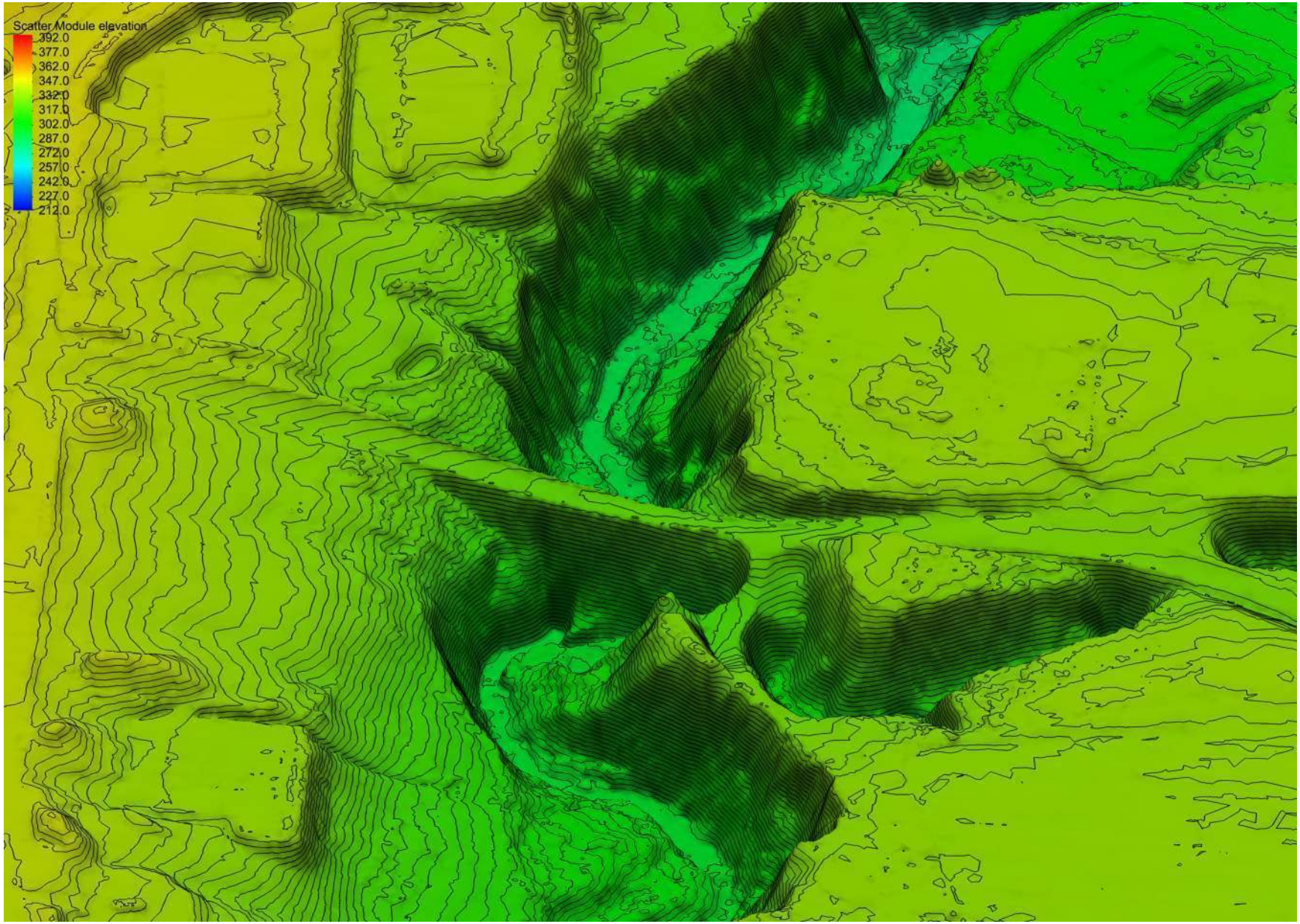
PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	386	ft^3/s	220	678	34.8
5 Year Peak Flood	591	ft^3/s	331	1050	36.1
10 Year Peak Flood	744	ft^3/s	401	1380	38.6
25 Year Peak Flood	963	ft^3/s	492	1890	42.5
50 Year Peak Flood	1150	ft^3/s	565	2330	44.9
100 Year Peak Flood	1340	ft^3/s	638	2810	47.3
200 Year Peak Flood	1550	ft^3/s	705	3430	50.8
500 Year Peak Flood	1870	ft^3/s	797	4370	55.2

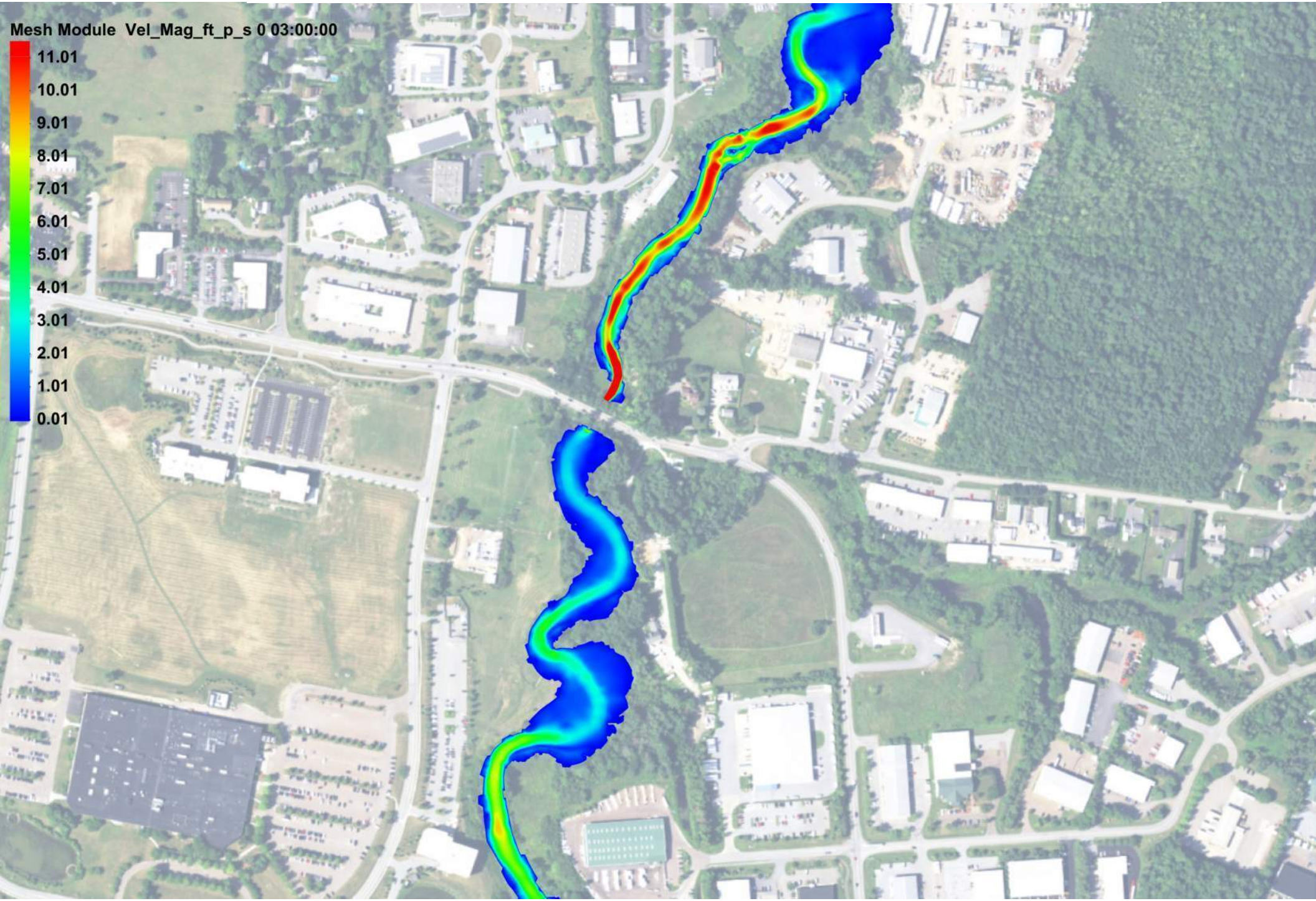
Peak-Flow Statistics Citations

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/)

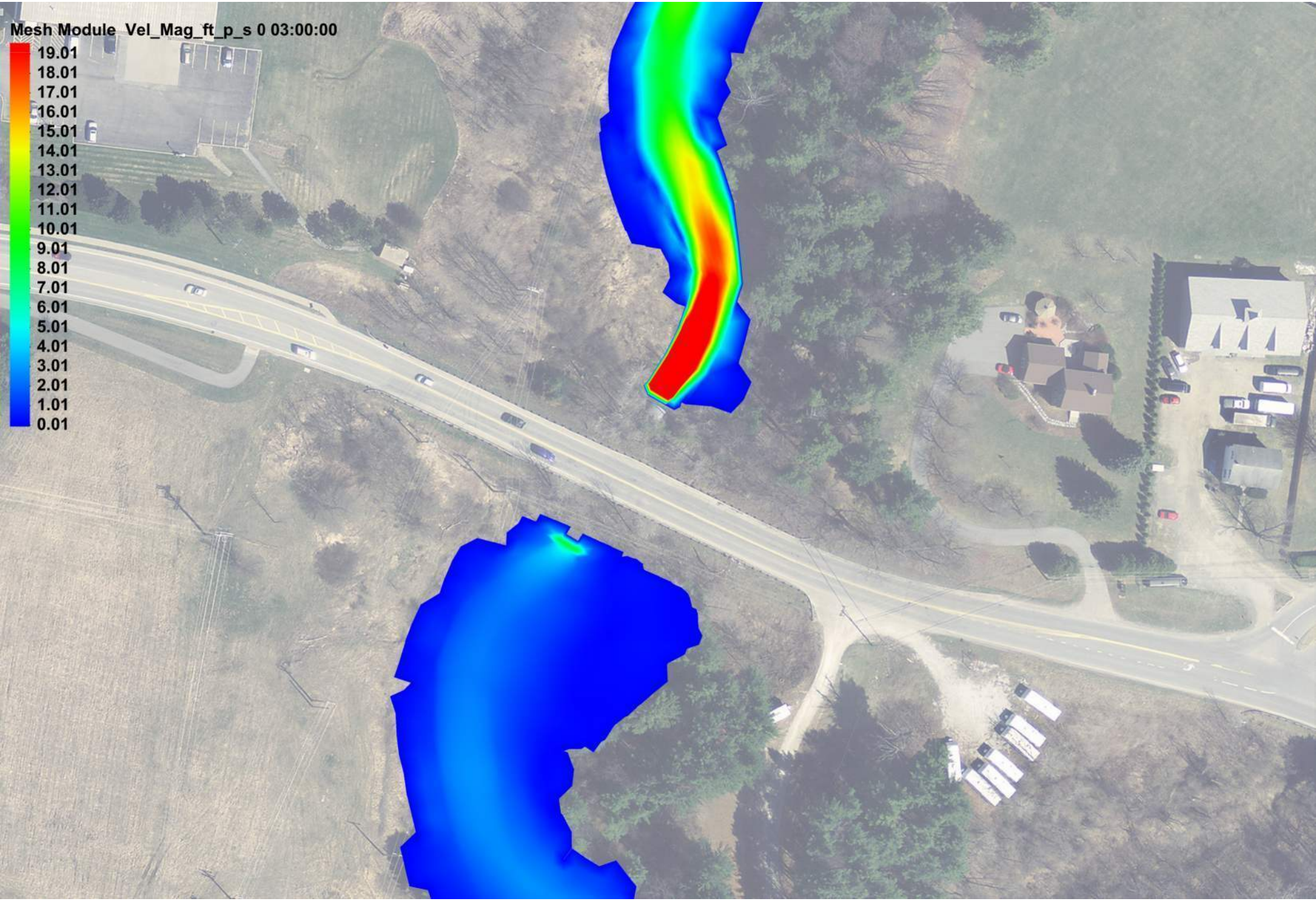
Existing LiDAR



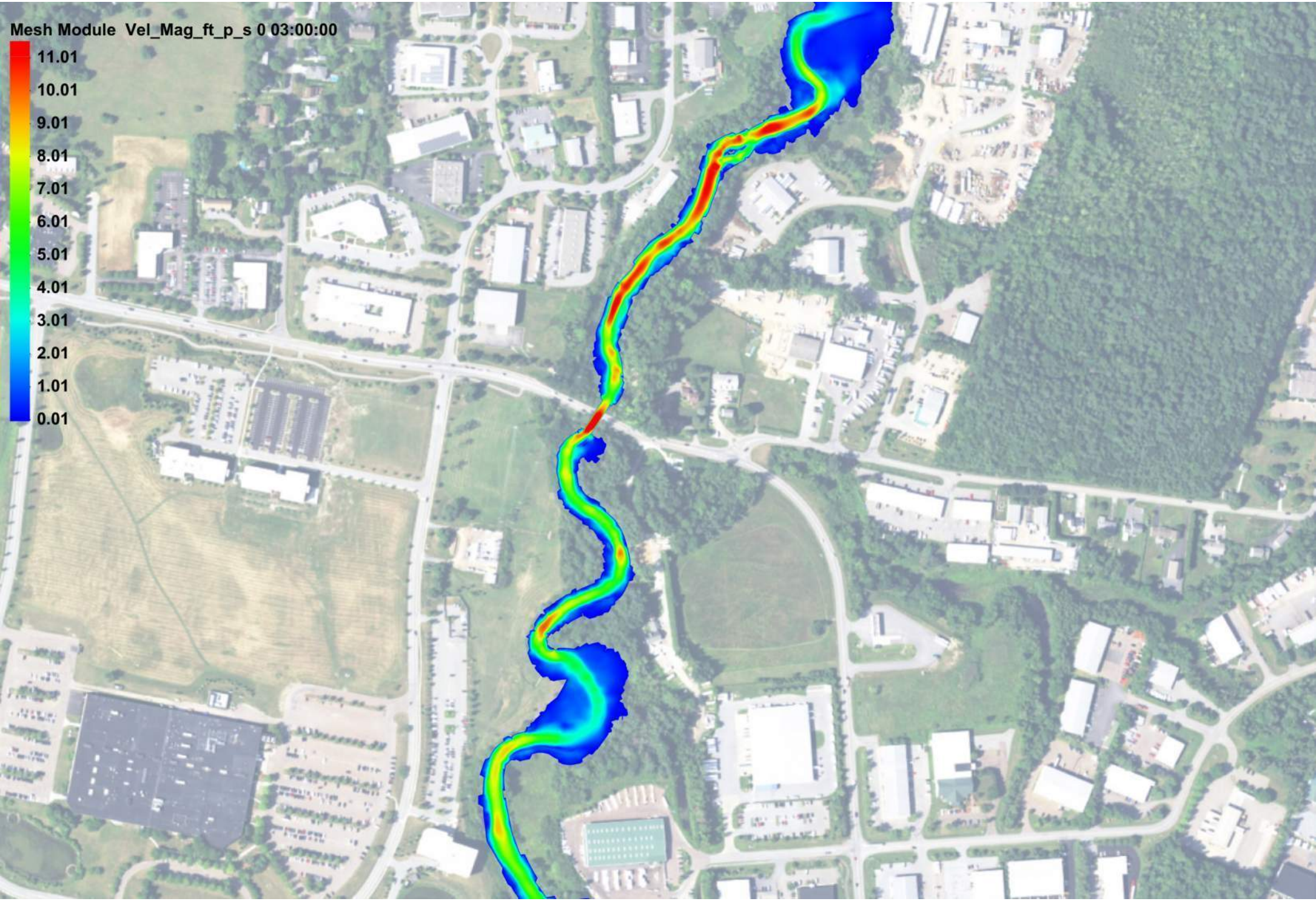
Existing Q50 Velocity Profile @ Within Model Domain



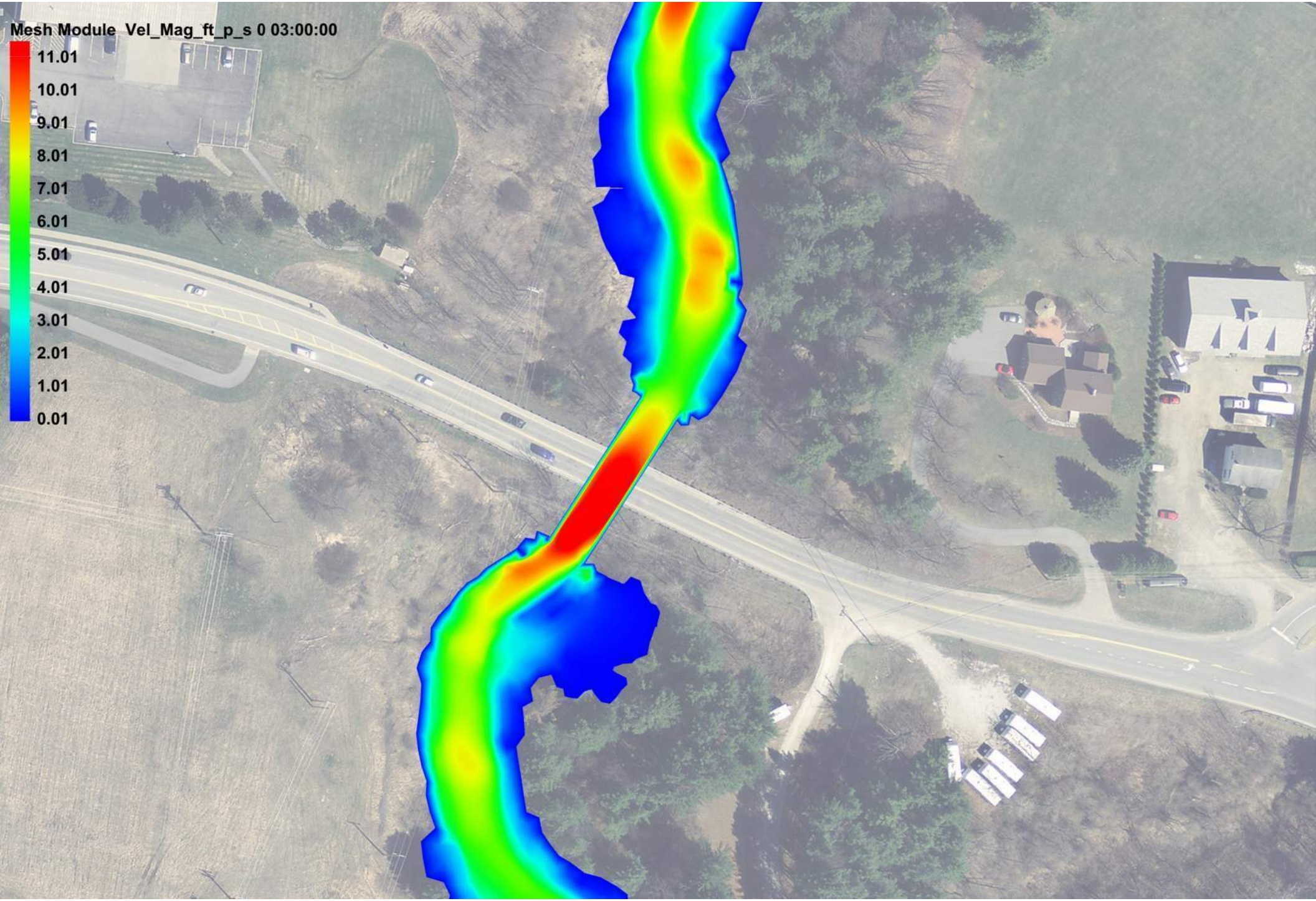
Existing Q50 Velocity Profile @ Kimball Ave/Marshal Ave



Proposed Q50 Velocity Profile @ Within Model Domain

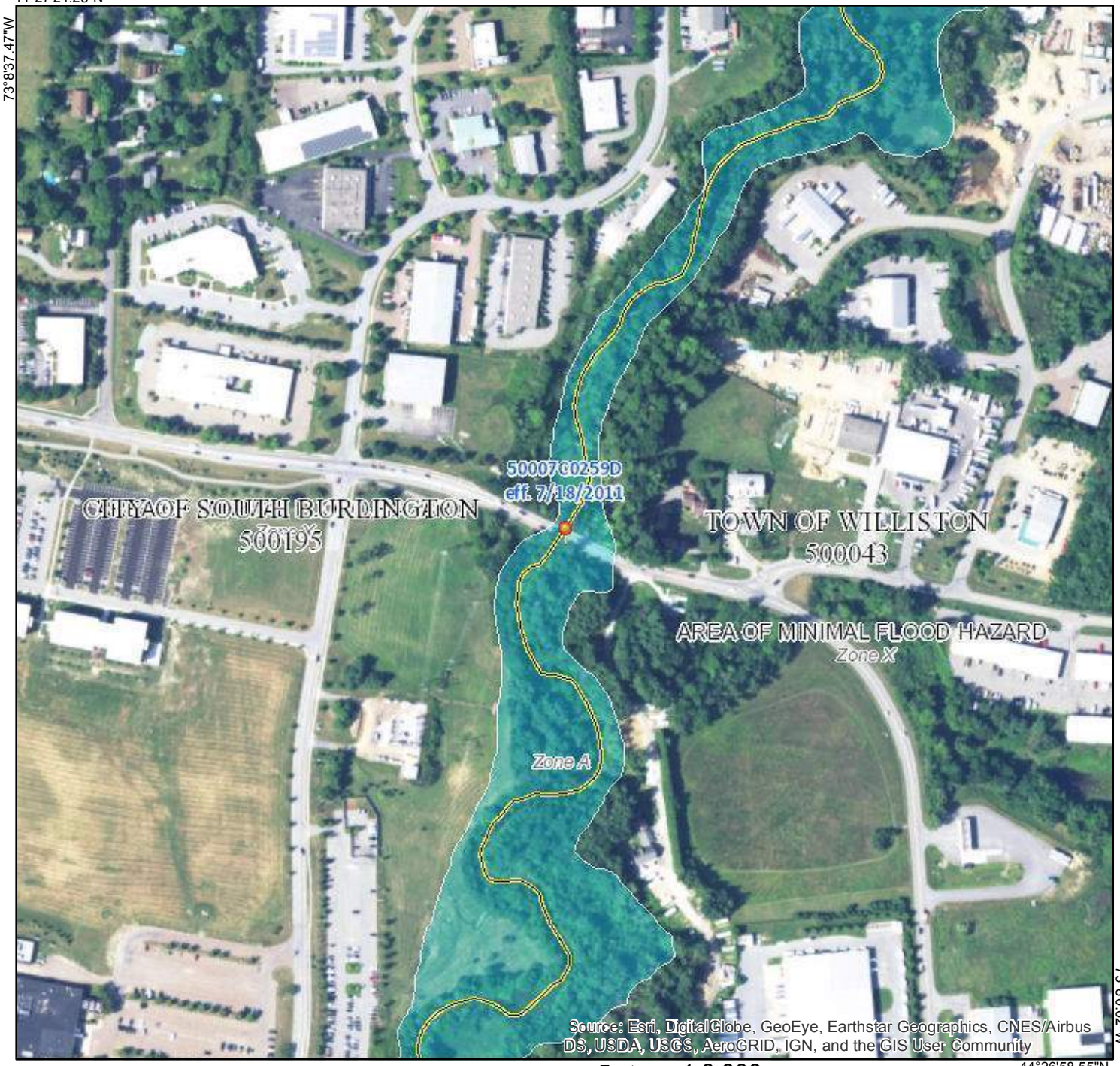


Proposed Q50 Velocity Profile @ Kimball Ave/Marshal Ave



National Flood Hazard Layer FIRMette

FEMA



Feet

0 250 500 1,000 1,500 2,000

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth
- Regulatory Floodway *Zone AE, AO, AH, VE, AR*

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

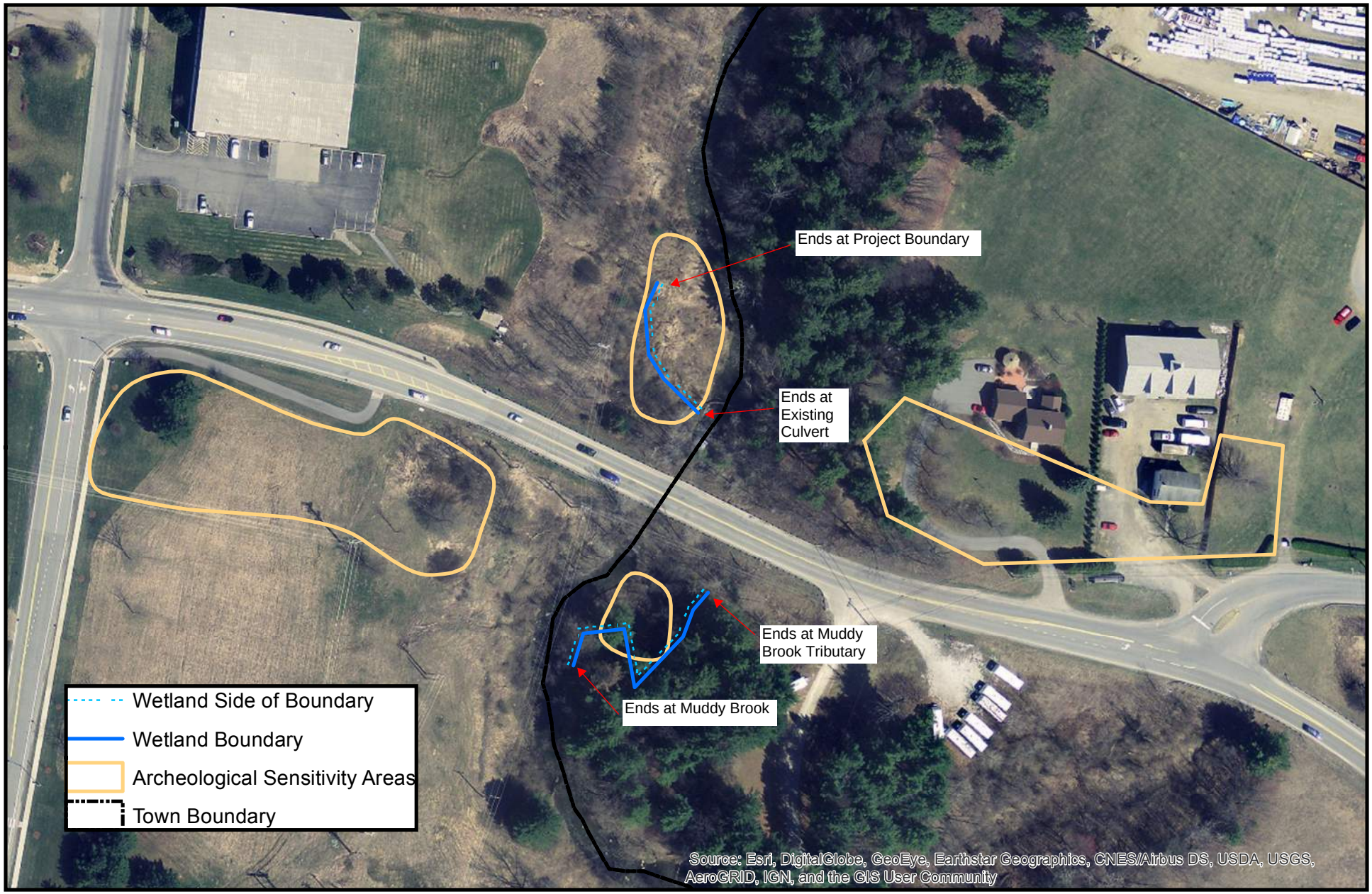
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/21/2018 at 10:22:43 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX E

Environmental and Cultural Resource Maps & Bankfull Determination



V:\HSG\91090913-GIS\Permitting\Env-Cultural Map.mxd

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Manchester, NH 03101-1227
Tel 603-669-5555
Fax 603-669-4168
Web Page www.hoyletanner.com

SCALE
1 inch = 125 feet

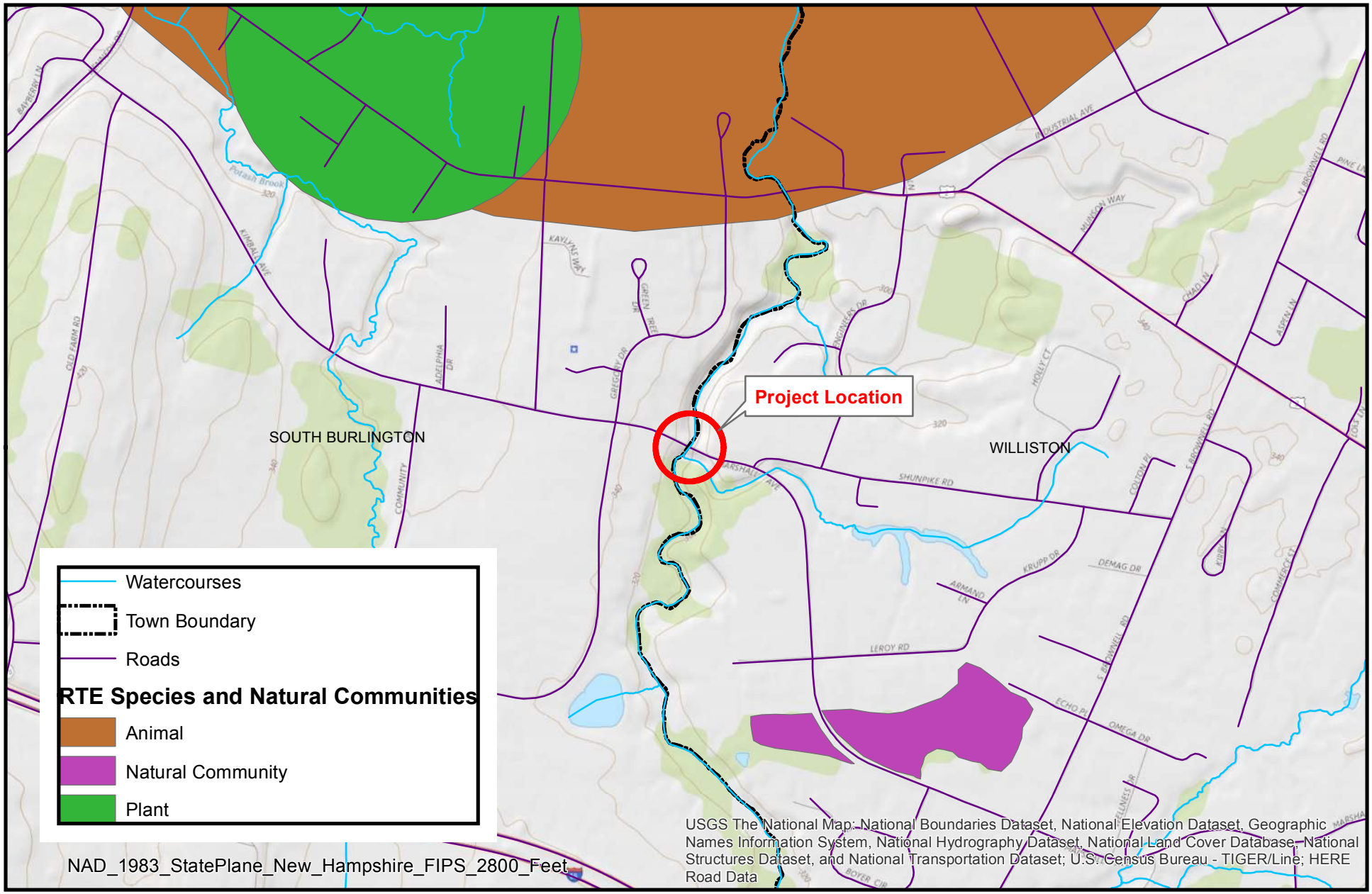
DATE
9/6/2018

DR. BY
jtheriault

SOUTH BURLINGTON MM18(3) SCOPING STUDY
KIMBALL ROAD OVER MUDDY BROOK
SOUTH BURLINGTON, VT

ENVIRONMENTAL AND CULTURAL RESOURCE BOUNDARY MAP

V:\HSG\9109094-Design\Permitting\VTANR\Muddy Brook RTE Location Map.mxd



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Manchester, NH 03101-1227
Tel 603-669-5555
Fax 603-669-4168
Web Page www.hoyletanner.com

SCALE
1 inch = 1,000 feet

DATE
6/14/2018

DR. BY
jtheriault

SOUTH BURLINGTON MM18(3) SCOPING STUDY
KIMBALL ROAD OVER MUDDY BROOK
SOUTH BURLINGTON, VT

ELEMENT OCCURRENCE LOCATION MAP

FIGURE
1

Olin, Jon A.

From: Brunelle, Chris <Chris.Brunelle@vermont.gov>
Sent: Wednesday, May 30, 2018 12:06 PM
To: Olin, Jon A.
Subject: Muddy Brook. Williston/South Burlington

Based on our field measurements and my review of the geomorphic assessment raw data the bank full width = 32’ and the appropriate structure width is 1.0x bank full

Christopher Brunelle
River Management Engineer
VT Agency of Natural Resources

APPENDIX F

Archeological Resource Assessment Report

HARTGEN
archeological associates inc

ARCHEOLOGICAL RESOURCE ASSESSMENT

STP MM18(3)

City of South Burlington and Town of Williston
Chittenden County, Vermont

HAA # 5249-11

Submitted to:
Hoyle Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, Vermont 05401

Prepared by:
Hartgen Archeological Associates, Inc.

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An ACRA Member Firm
www.acra-crm.org

May 2018

MANAGEMENT SUMMARY

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

LOCATION INFORMATION

Municipality: *City of South Burlington and Town of Williston*
County: *Chittenden County, Vermont*

SURVEY AREA

Length: *800 feet (244 m)*
Width: *80 feet (24 m)*
Area: *1.47acres (0.6 ha)*

RESULTS OF RESEARCH

Archeological sites within one mile: *13*
Surveys in or adjacent: *2*
NR/NRE sites in or adjacent: *0*
Precontact Sensitivity: *high*
Historic Sensitivity: *high*

RECOMMENDATIONS

Four areas of archeological potential were identified along the project alignment. If the project effects extend into these areas, Phase IB archeological reconnaissance survey is recommended. If the project effects can be limited to previously disturbed areas, no further review is recommended.

Report Authors: *Thomas R. Jamison, PhD, RPA #16566*
Date of Report: *May 2018*

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Photograph List

Photo 1. Northwest quadrant of the APE. Note sidewalk along Kimball Avenue on the right, pump station in the center of the view and undulating landscaped lawn associated with Muddy Brook in the background within the tree line. View to the east/southeast. 4
Photo 2. Southwest quadrant of the APE. Note sidewalk with field and temporary bridge over the culvert and incision of Muddy Brook in the background. ASA 1 extends to the right from the sidewalk. View to the east/northeast. 5
Photo 3. Northeast quadrant of the APE. Note driveway of 1600 Marshall Avenue on the right with road cut into raised landform (ASA 2) to the right. View to the west/southwest. 5
Photo 4. Southeast quadrant of the APE. Note manhole, hydrant and buried telephone line marker. A gas line is also present on this alignment. The area to the left has been filled with gravel for a former parking area. View to the west/northwest. 6
Photo 5. Raised landform of 1600 Marshall Avenue, ASA 2. View to the west/northwest. 15

Photo 6. Low terrace adjacent to Muddy Brook, ASA 3. View to the north/northeast. 16
Photo 7. Low terrace adjacent to the east side of Muddy Brook and the tributary, ASA 4. View to the east/southeast. 16

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ARCHEOLOGICAL RESOURCE ASSESSMENT

1 Introduction

Hartgen Archeological Associates, Inc. (Hartgen) conducted an Archeological Resource Assessment for the proposed Muddy Brook Culvert Replacement Project (STP MM 18(3)) (Project) located in the City of South Burlington and Town of Williston, Chittenden 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 VTrans. 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 Thomas R. Jamison on April 9, 2018 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 at the border between the City of South Burlington and the Town of Williston, where Muddy Brook crosses Kimball Avenue (South Burlington) and Marshall Avenue (Williston).

2.2 Description of the Project

The project design has yet to be completed and will be responsive to public input (Map 2). The project may include the following components:

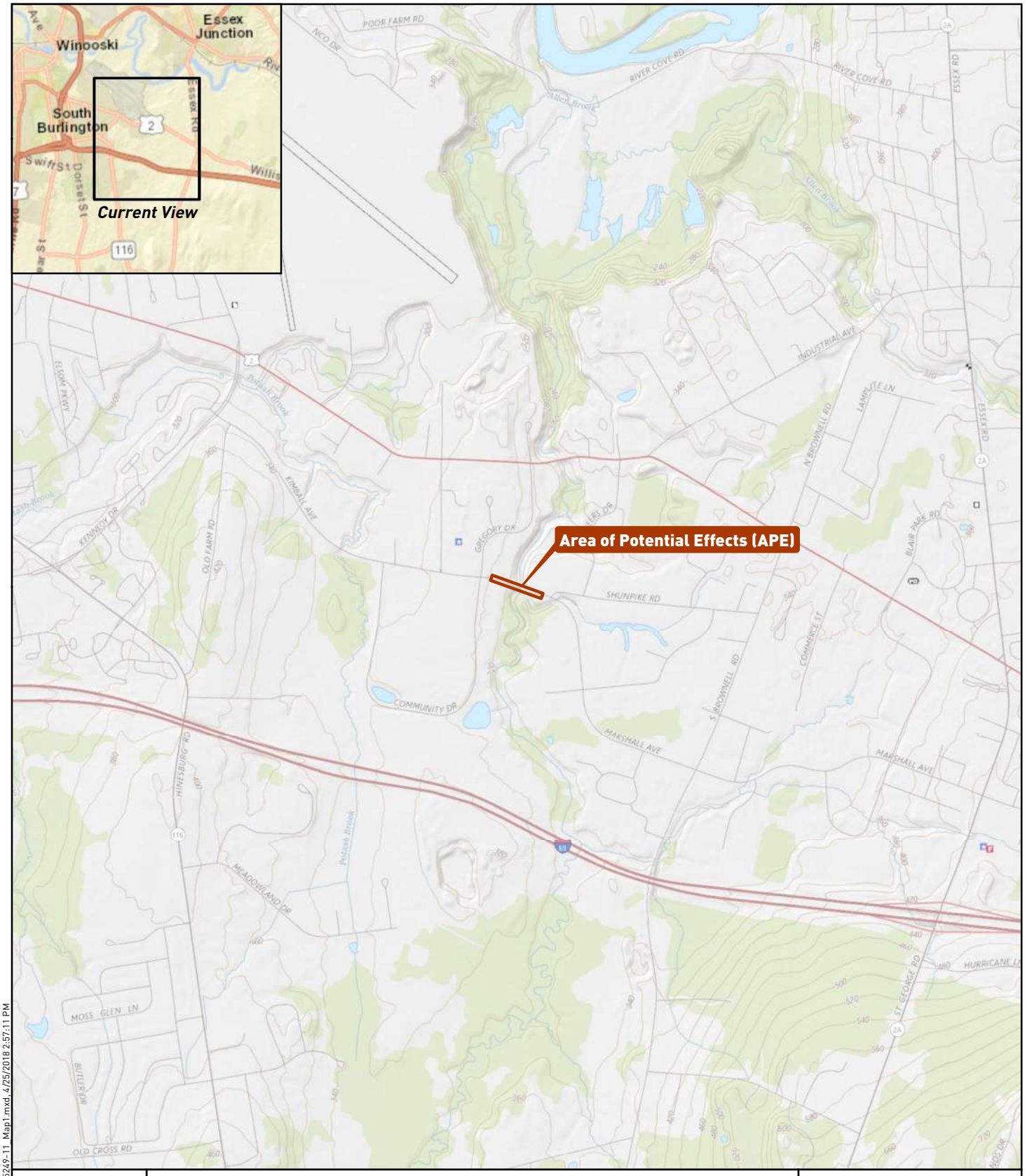
- Replace 16 foot (4.9 m) diameter culvert.
- Possible water quality improvements.
- Possible shared-use path.
- Possible road safety improvements.

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. Based on the proposed effects listed above, the APE is anticipated to extend 400 feet (122 m) on either side of the culvert, for a total length of 800 feet (244 m). The width of the APE is anticipated to extend 40 feet (12 m) on either side of the roadway centerline, for a total width of 80 feet (24 m). Therefore, the APE is estimated at 1.47acres (0.6 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.



1,000 0 1,000 2,000 Feet

300 0 300 600 Meters

Note: Contour interval is 10 feet.

Project Location
(ESRI 2018; USGS 2015)

HARTGEN archeological associates inc

Map 1

G:\5249\GIS\Documents\HAA_5249-11_Map1.mxd, 4/25/2018 2:57:11 PM

70 0 70 140 Feet
21 0 21 42 Meters

Legend

- Photo Angle
- Structure (Standing)
- Map-Documented Structure (MDS)
- Municipal Boundary
- Archaeologically Sensitive Area
- APE

Project Map
(Hartgen 2018; ESRI 2018)

HARTGEN archeological associates inc

Map 2

G:\GIS2\GIS\Documents\HAA_GIS\9-11_Map2.mxd, 4/26/2018 9:43:43 AM

3.1 Present Land Use and Current Conditions

The project area has been increasingly developed over the past 40 years as industrial development encroached on former agricultural fields. However, development in the immediate project location has been limited to road work and landscaping of adjacent previously agricultural fields. Along the northwest and southwest quadrants of the APE, sidewalks have been added and landscaping has somewhat modified the topography (Photos 1 and 2). The northeast quadrant of the APE includes a cut bank along the road with a raised landform that appears relatively undisturbed away from the cut bank as the yard areas of 1600 Marshall Avenue and 599 Shunpike Road (Photo 3). The southeast quadrant exhibits some disturbance due to use utility alignments and cutting and filling related to a drive installation and parking area (Photo 4).

Photo 1. Northwest quadrant of the APE. Note sidewalk along Kimball Avenue on the right, pump station in the center of the view and undulating landscaped lawn associated with Muddy Brook in the background within the tree line. View to the east/southeast.

Photo 2. Southwest quadrant of the APE. Note sidewalk with field and temporary bridge over the culvert and incision of Muddy Brook in the background. ASA 1 extends to the right from the sidewalk. View to the east/northeast.

Photo 3. Northeast quadrant of the APE. Note driveway of 1600 Marshall Avenue on the right with road cut into raised landform (ASA 2) to the right. View to the west/southwest.

Photo 4. Southeast quadrant of the APE. Note manhole, hydrant and buried telephone line marker. A gas line is also present on this alignment. The area to the left has been filled with gravel for a former parking area. View to the west/northwest.

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 project APE include from east to west Hinesburg fine sandy loam, Limerick silt loam and Vergennes clay (USDA 2018). Most of these soils do not have the potential for deeply stratified archeological deposits. However, the Limerick soils developed in recent alluvium and do have potential for deeply stratified deposits.

Table 1. Soils in Project Area

Symbol	Name	Textures	Slope	Drainage	Landform
HnA	Hinesburg	Fine sandy loam	0-3%	Well drained	Lake plain or delta
HnE	Hinesburg	Fine sandy loam	25-60%	Well drained	Lake plain or delta
Lf	Limerick	Silt loam, very wet	0-3%	Poorly drained	Alluvium
VeB	Vergennes	Clay	2-6%	Moderately well drained	Glacial lake plain
VeC	Vergennes	Clay	6-12%	Moderately well drained	Glacial lake plain
VeE	Vergennes	Clay	25-60%	Moderately well drained	Glacial lake plain

3.3 Bedrock Geology

The bedrock in the Project Area is the Bascom Formation that consists of dolostone and dolomitic limestone or calcite marble and calcareous sandstone (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 located on a Pleistocene lake plain and delta, creating generally level topography. Slopes in the project area are located along drainages such as Muddy Brook where the brook has incised the sediments and formed steep sided drainages. The brook is incised about 35 feet (11 m) below the surrounding topography. Muddy Brook flows north through the project, emptying into the Winooski River about 2.7 miles (4.3 km) to the north. A small tributary stream enters Muddy Brook from the east along the south side of the APE.

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 13 sites within ½ mile (0.8 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.

The reported sites in the project vicinity include twelve precontact sites ranging from Early Archaic to Late Woodland. They are predominantly short-term campsites probably related to resource exploitation including hunting and gathering of materials along Muddy Brook and adjacent tributaries. The one historic site is defined as field scatter associated with farming of the level lake plain. This list demonstrates the high sensitivity of the project area for precontact sites. In particular, VT-CH-0079 (Willis Site #3) and VT-CH-0873, southeast and southwest of the culvert respectively, are located on the same landforms as the project and may extend into the APE.

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-CH-0018	Muddy Brook Site	Early and Middle or Late Woodland, Meadowood projectile point, debitage, ceramics	0.18 mi/0.29 km to NW
VT-CH-0076	Willis Site #1	Middle or Late Woodland, triangular projectile point, debitage	0.46 mi/0.75 km to W
VT-CH-0079	Willis Site #3	Early and Late Archaic and Middle or Late Woodland, Swanton Corner Notched and Otter Creek projectile point, ceramics, debitage	0.04 mi/0.06 km to S/SE
VT-CH-0265		Unknown precontact, projectile point, debitage, FCR	0.49 mi/0.78 km to S
VT-CH-0335	Pidgeon	Unknown precontact, debitage	0.3 mi/0.48 km to NE
VT-CH-0823		Unknown precontact, debitage and possible ceramic fragment	0.5 mi/0.8 km to NE
VT-CH-0873		Unknown precontact, biface, debitage	0.05 mi/0.07 km to SW
VT-CH-0874		Late Archaic, Otter Creek and Vosburg-like projectile points, debitage, FCR	0.11 mi/0.18 km to SW
VT-CH-0875		Middle or Late Woodland, Levanna projectile	0.18 mi/0.29 km to S

		point, debitage, utilized flake	
VT-CH-0876		Late Archaic, two loci, Vosburg-like projectile point, debitage, FCR	0.33 mi/0.52 km to S
VT-CH-1206	Robear Site 2	Unknown precontact, debitage and historic field scatter	0.42 mi/0.68 km to E/NE
VT-CH-1207	Robear Site 3	Unknown precontact, lithics	0.43 mi/0.69 km to E
VT-CH-1208	Robear Site 4	Unknown precontact, lithics	0.27 mi/0.43 km to E

4.2 Historic Properties

An examination of the files at VDHP identified no NR properties, no NRE properties and no properties previously determined to be ineligible within the APE. Recent development in the surrounding area has removed historic structures that had previously been inventoried, but not listed on the State or National Registers.

4.3 Previous Surveys

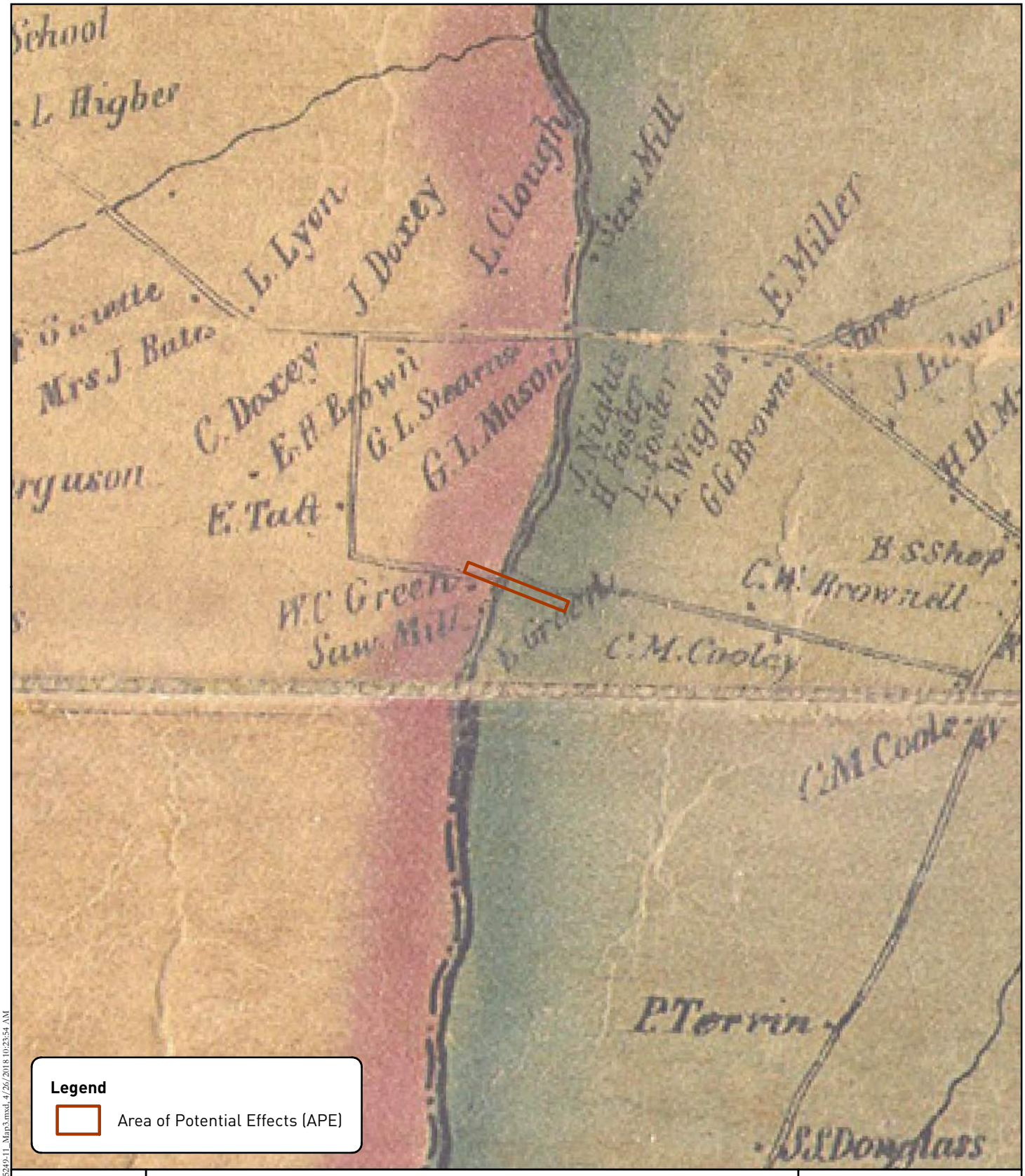
On file at VDHP are two previous surveys within the immediate vicinity of the Project (Table 3). The adjacent to the southeast quadrant of the APE, Werner Archaeological Consulting conducted surface collection and shovel testing to define precontact site VT-CH-0079, Willis Site #3 (Werner Archaeological Consulting 1997). Adjacent to the southwest quadrant of the APE, the University of Vermont Consulting Archaeology Program conducted surface collection and shovel testing of precontact site VT-CH-0873, located in the field adjacent to the APE (Mandel, et al. 2002). In both instances light distributions of precontact lithic materials were encountered in the plowzone with no evidence of intact deposits below the plowzone and no further work was recommended. However, testing for both projects was not conducted directly adjacent to the current APE, leaving the possibility of intact archeological deposits along the southern edge of the APE.

Table 3. Relevant previous surveys within or adjacent to the Project

Year	Investigator	Methodology	Results	Notes
1997	Werner Archaeological Consulting	Surface collection and shovel testing	Site VT-CH-0079, in plowzone	No further work recommended
2002	Mandel et al.	Surface collection and shovel testing	Site VT-CH-0873 in plowzone	No further work recommended

5 Historical Map Review

The 1857 Walling map of the project area depicts a residence labeled W. C. Green and an adjacent saw mill adjacent to the southwest quadrant of the APE. A residence labeled E. Green may be adjacent to the northeast quadrant, although that location is unclear (Map 3). On the 1869 Beers map of the area, the W. C. Green residence is now labeled S. S. Brown and the sawmill is absent. Along the northeast quadrant are two structures, an unlabeled one to the west and an adjacent structure labeled J. Skane to the east (Map 4). It is unclear which of these may have been the house labeled E. Green on the 1857 map. The 1906 USGS quadrangle shows two structures in these approximate locations (Map 5). The 1948 USGS quadrangle also shows two structures in these general locations with a windmill depicted adjacent to the structure along the southwest quadrant (Map 6). Between 1972 and 1987 the building at the southwest quadrant was removed. In the same time period, several structures were added along the northeast quadrant and the structure south of the southeast quadrant was added (Map 7).



Legend

Area of Potential Effects (APE)

N

500 0 500 1,000 Feet

150 0 150 300 Meters

Historical Map
(Walling 1857)

HARTGEN archeological associates inc

Map 3

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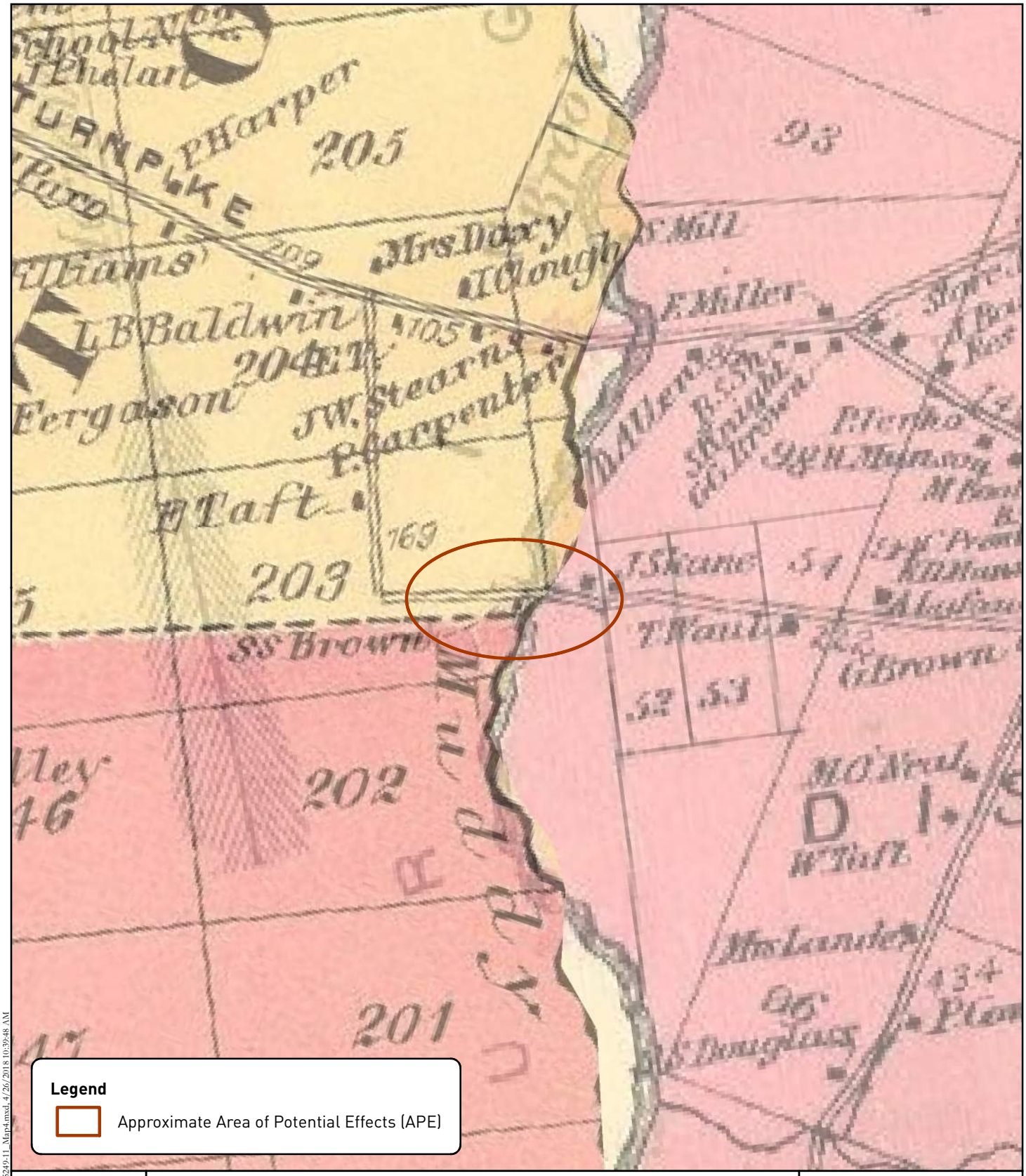

500 0 500 1,000 Feet

150 0 150 300 Meters

Historical Map
(Beers 1869)

HARTGEN archeological associates inc

Map 4

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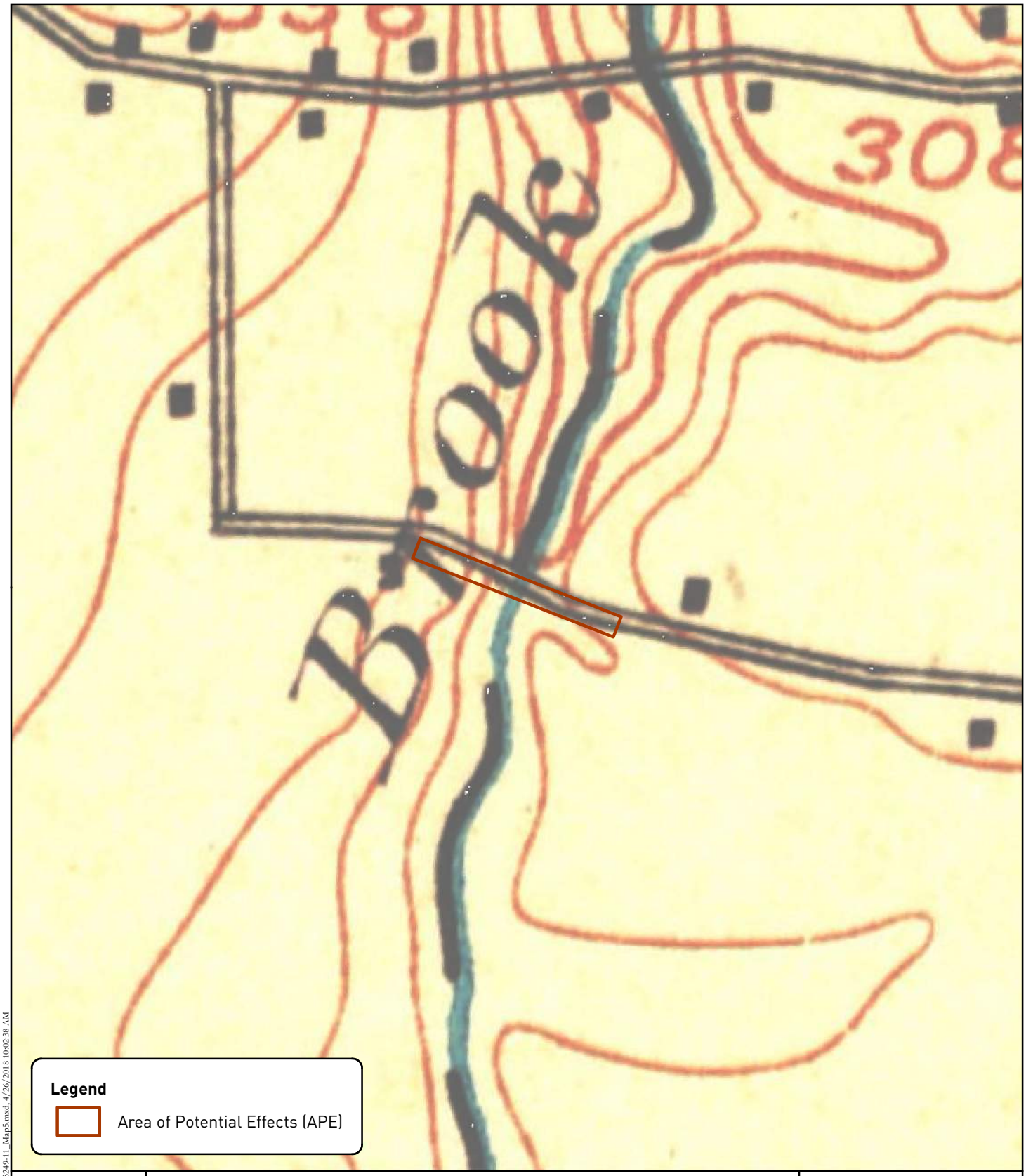

Legend

Area of Potential Effects (APE)

N

250 0 250 500 Feet

75 0 75 150 Meters

Historical Map
(USGS 1906)

HARTGEN archeological associates inc

Map 5

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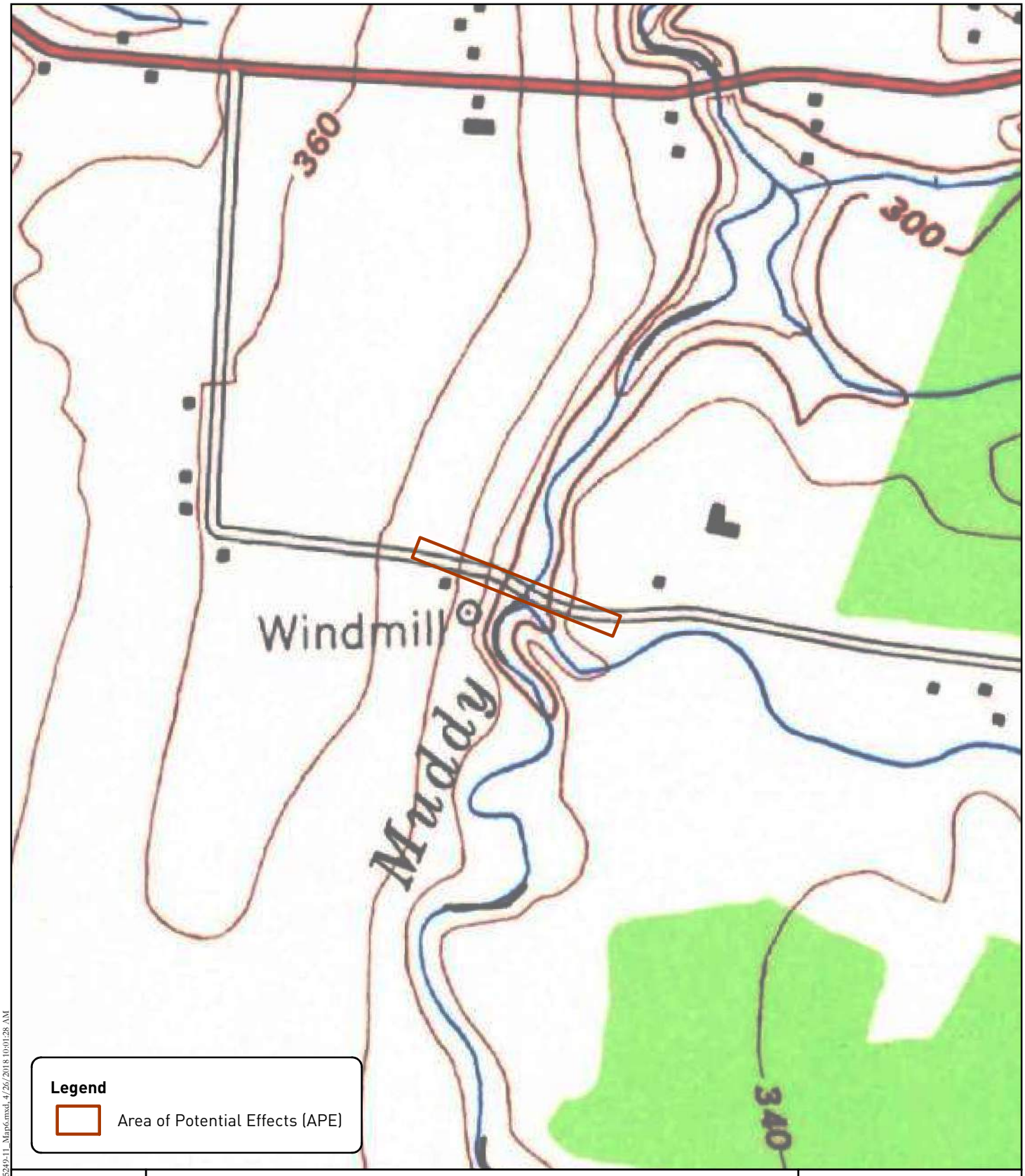

250 0 250 500 Feet

75 0 75 150 Meters

Historical Map
(USGS 1948)

HARTGEN archeological associates inc

Map 6

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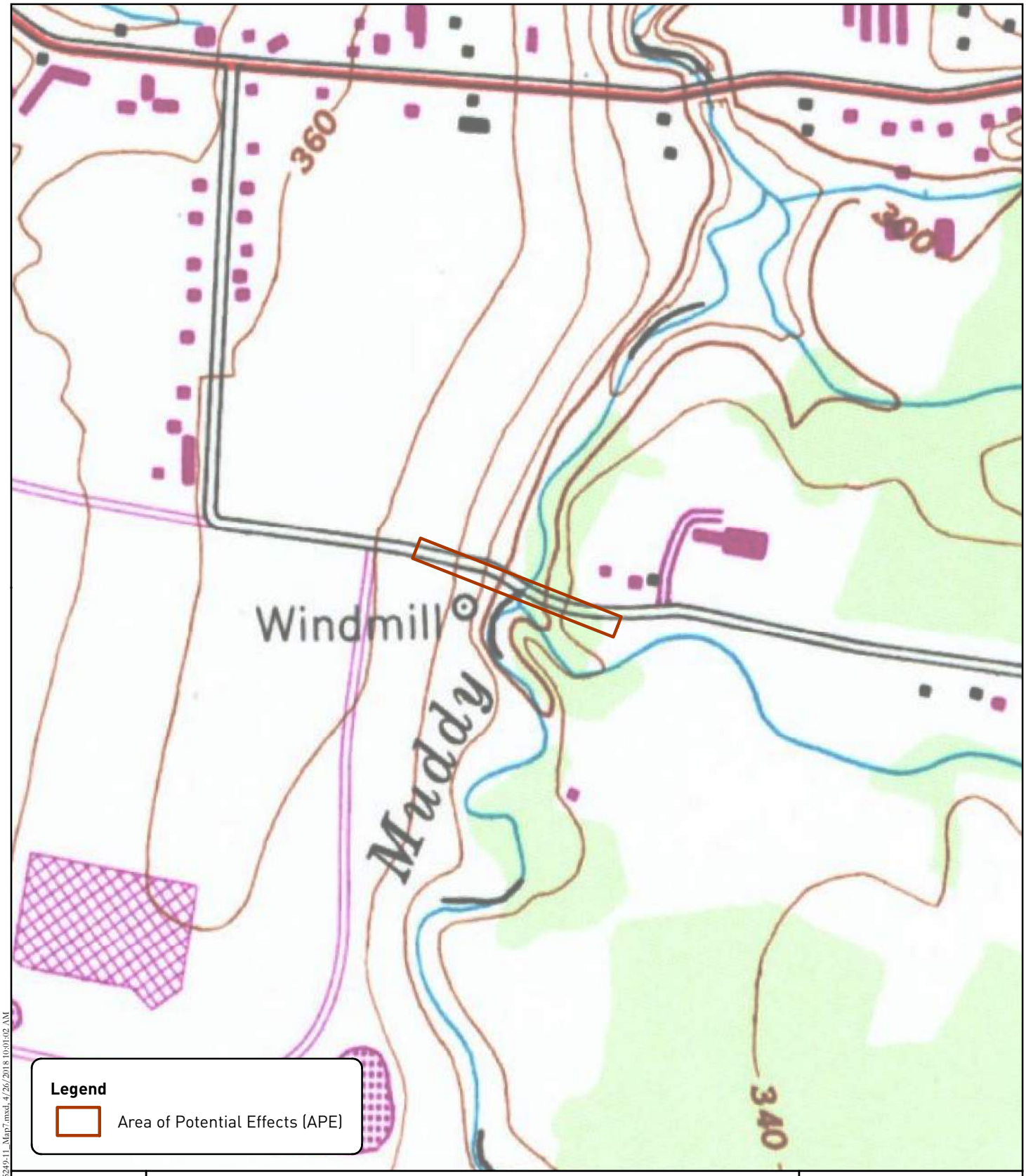

250 0 250 500 Feet

75 0 75 150 Meters

Historical Map
(USGS 1987)

HARTGEN archeological associates inc

Map 7

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5.1 Map-Documented and Existing Structures

Each past or current structure within the Project Area is assigned a unique structure number. Map-documented structures—those structures that are depicted on one or more maps—are distinguished using the abbreviation "MDS" after the structure number (e.g. Structure 3 (MDS)).

Table 4. Summary of map-documented and existing structures within the Project Area/APE

Structure #	Map 4. Project area in 1869	Map 5. Project area in 1906	Map 6. Project area in 1948	Map 7. Project area in 1987	Error! Reference source	Extant (2018)
1						X
2					X	X
3					X	X
4						X
5					X	X
6						X
7						X
8					?	X
9						X
10	X	X	X	X		
11	X					
12	X	X	X	X	X	
13				X	X	

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 Muddy Brook, a small tributary brook and the confluence of the two. Points were also added for the Project Area being at the head of draw adjacent to the brook, on lake/marine delta deposits, on a travel corridor and in an area of high site density. The score was reduced due to disturbance noted along the project corridor, mostly related to utility and culvert installation. The Project Area has a score of 52. 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 sensitivity of the APE is related to several 19th-century and early 20th-century structures that were once adjacent to the project alignment (Map documented structures 8-10). These structures variously appear on Maps 3 to 7, although the identification of Structure 10 at the northeast quadrant of the APE is unclear on the later maps.

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.

Disturbance within the project APE includes several utility alignments along the south side of the road. In addition, installation of the current culvert and the existing temporary bridge has created disturbance. Road work has cut into slopes on either side of the APE east of the brook and filled along the northwest quadrant.

Sidewalks along the northwest and southwest quadrants have also disturbed some of the APE. In addition, some landscaping on the northwest and southwest quadrants may have disturbed some of the APE.

Previous archeological investigations adjacent to the southeast and southwest quadrants were restricted to areas set to the south of the APE. In both cases, precontact archeological sites were identified in the plowzone soils with no evidence of intact archeological deposits below the plowzone. However, no archeological investigation is known to have taken place directly adjacent to or within the APE.

Four Archeology Sensitivity Areas (ASA) have been defined adjacent to the APE (Map 2). ASA 1 is located along the southwest quadrant outside of known utility and sidewalk disturbance (Photo 2). In this location there is potential for intact precontact related to site VT-CH-0873 previously identified south of the APE and historic archeological deposits related to the Green/Brown residence on the mid-19th-century maps. ASA 2 is located along the northeast quadrant of the APE and has the potential for precontact and historic archeological deposits (Photo 3 and 5). ASA 3 is located on a low terrace directly adjacent to the west side of Muddy Brook on the north side of the APE (Photo 6) and ASA 4 is located adjacent to the east side of Muddy Brook on the south side of the APE (Photo 7). ASA 3 and 4 have a lower potential for archeological deposits due to the potential for flood scouring, but currently appear to be quite stable landforms that could retain intact archeological deposits.

Photo 5. Raised landform of 1600 Marshall Avenue, ASA 2. View to the west/northwest.

Photo 6. Low terrace adjacent to Muddy Brook, ASA 3. View to the north/northeast.

Photo 7. Low terrace adjacent to the east side of Muddy Brook and the tributary, ASA 4. View to the east/southeast.

6.4 Archeological Recommendations

Due to the high archeological site density in the area and several map documented structures, four areas of archeological potential have been defined overlapping or adjacent to the APE. It is recommended that the project APE be restricted to areas of previous disturbance. If project disturbance will extend into the areas of archeological potential as defined on Map 2, Phase IB archeological reconnaissance survey is recommended for those locations.

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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 MM18(3) **County** Chittenden **Town** S Burl/Williston
DHP No. **Map No.** **Staff Init.** **Date** April 19, 2018

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	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	
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	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	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	-32
**** refer to 1970 Surficial Geological Map of Vermont**			
		Total Score:	52
Other Comments :			
0- 31 = Archeologically Non- Sensitive **32+ = Archeologically Sensitive**			

APPENDIX G

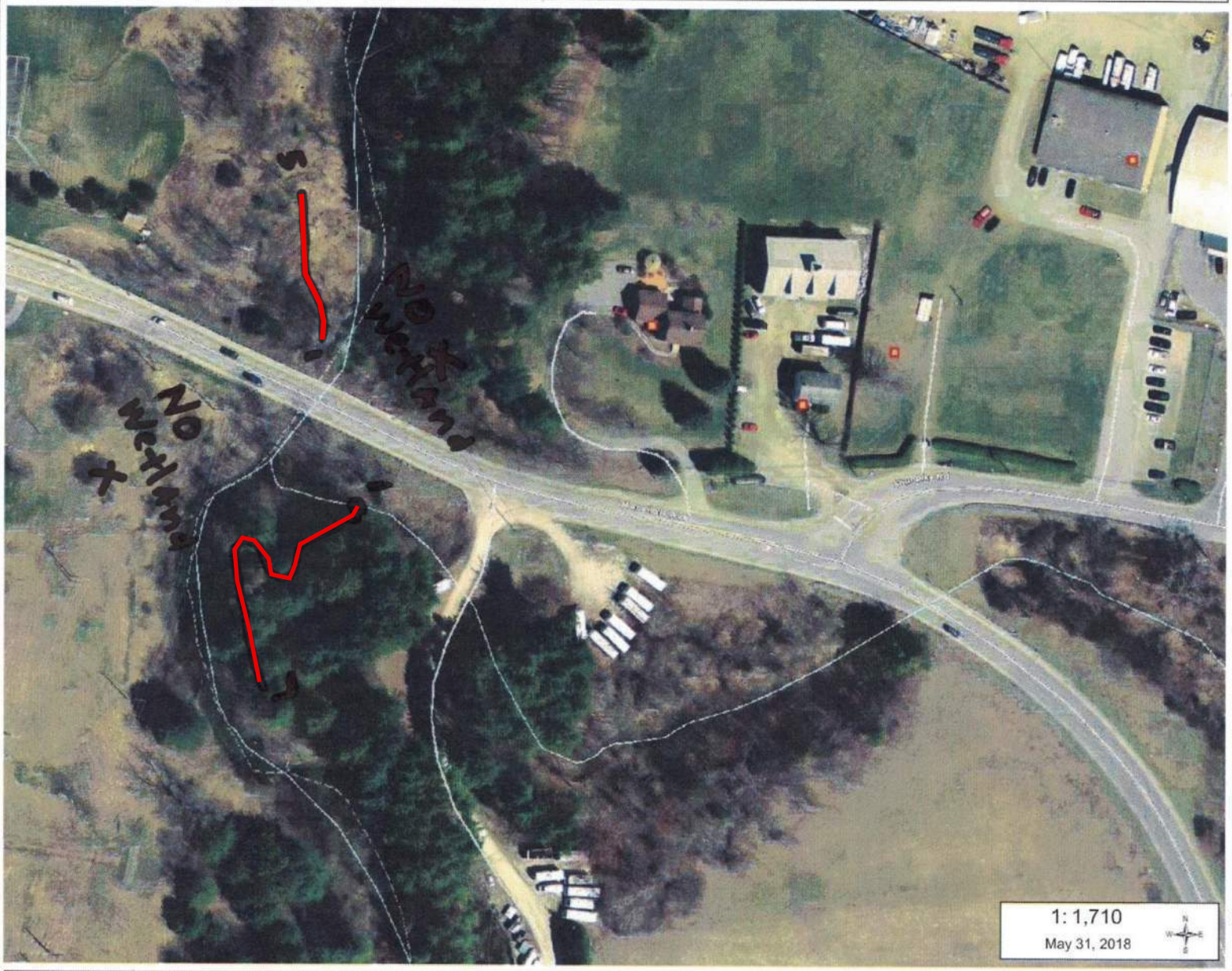
Wetlands Survey and Forms

VERMONT

VT Interactive Map Viewer

Vermont Center for Geographic Information

vermont.gov



LEGEND

- Airports
- Rail Lines
- Town Boundaries
- County Boundaries
- Buildings
- Village Boundaries
- Buildings
- VT Significant Wetlands Invent
- National Wetlands Inventory
- Whitewater Rivers
- Image
  - Red: Band_1
  - Green: Band_2
  - Blue: Band_3
- VT State Boundary

VCGI

NOTES

This map was created with the VT Interactive Map Viewer.

0.05 0 0.03 0.05 Miles

WGS_1984_Web_Mercator_Auxiliary_Sphere

THIS MAP IS NOT TO BE USED FOR NAVIGATION

VERMONT WETLAND EVALUATION FORM

Project Name: Muddy Brook Culvert Wetland Project #: _____

Date: 5/31/18 Investigator: April Moulaert, PQS

SUMMARY OF FUNCTIONAL EVALUATION:
Each function gets a score of 0= not present; L = Low; P = Present; or H = High.

1. Water Storage for Flood Water and Storm Runoff	H	**6. Rare, Threatened, and Endangered Species Habitat**	H
2. Surface & Ground Water Protection	H	**7. Education and Research in Natural Sciences**	H
3. Fish Habitat	H	**8. Recreational Value and Economic Benefits**	H
4. Wildlife Habitat	H	**9. Open Space and Aesthetics**	H
5. Exemplary Wetland Natural Community	H	**10. Erosion Control through Binding and Stabilizing the Soil**	H

Note:

- ***When to use this form:*** This is a field form to help you compile data needed to evaluate the 10 possible functions and values of a wetland as described in the Vermont Wetland Rules. All information in this form is replicated in the applications for both wetland determinations and wetland permits.
- ***Both a desktop review and field examination*** should be employed to accurately determine surrounding land use, hydrology, hydroperiod, vegetation, position in the landscape, and physical attributes.
- ***The entire wetland or wetland complex*** in question must be evaluated to determine the level of function in all ten (10) categories for accurate classification. A wetland complex can be defined as a series of interconnected wetland types.
- ***The surrounding upland and outflow area*** of the wetland should be examined to determine land use, development, nearby natural resources, and hydrology. The surrounding land use, previous development, and cumulative impacts may play a role in the current function of the wetland. For best results please read all descriptions prior to scoring activity.
- ***Evaluation***: The first portion in each section determines whether the wetland does or does not provide the function. If none of the conditions listed in the first section are met, proceed

to the next section. If any of these conditions are met, determine if the wetland provides this function at a higher or lower level based on the information listed in the subsequent sections.

- ***Presumptions:*** Please note that many wetlands are already presumed to be significant under the Vermont Wetland Rules. A wetland is presumed to be significant if:
    - The wetland is mapped on the VSWI map
    - The wetland is contiguous to a VSWI mapped wetland
    - The wetland meets the presumptions of significance under Section 4.6
    - The wetland has a preliminary determination that it is Class II

1. Water Storage for Flood Water and Storm Runoff

[X] Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- [ ] Constricted outlet or no outlet and an unconstricted inlet.
- [X] Physical space for floodwater expansion and dense, persistent, emergent vegetation or dense woody vegetation that slows down flood waters or stormwater runoff during peak flows and facilitates water removal by evaporation and transpiration.
- [X] If a stream is present, its course is sinuous and there is sufficient woody vegetation to intercept surface flows in the portion of the wetland that floods.
- [x] Physical evidence of seasonal flooding or ponding such as water stained leaves, water marks on trees, drift rows, debris deposits, or standing water.
- [ ] Hydrologic or hydraulic study indicates wetland attenuates flooding.

If any of the above boxes are checked, the wetland provides this function. Complete the following to determine if the wetland provides this function above or below a moderate level:

[ ] Check box if any of the following conditions apply that may indicate the wetland provides this function at a *lower* level.

- [ ] Significant flood storage capacity upstream of the wetland, and the wetland in question provides this function at a negligible level in comparison to upstream storage (unless the upstream storage is temporary such as a beaver impoundment).
- [ ] Wetland is contiguous to a major lake or pond that provides storage benefits independently of the wetland.
- [ ] Wetland's storage capacity is created primarily by recent beaver dams or other temporary structures.
- [ ] Wetland is very small in size, not contiguous to a stream, and not part of a collection of small wetlands in the landscape that provide this function cumulatively.

[X] Check box if any of the following conditions apply that may indicate the wetland provides this function at a *higher* level.

- [ ] History of downstream flood damage to public or private property.
- [x] Any of the following conditions present downstream of the wetland, but upstream of a major lake or pond, could be impacted by a loss or reduction of the water storage function.
  - [X] 1. Developed public or private property.
  - [X] 2. Stream banks susceptible to scouring and erosion.
  - [X] 3. Important habitat for aquatic life.
- [X] The wetland is large in size and naturally vegetated.

[X] Any of the following conditions present upstream of the wetland may indicate a large volume of runoff may reach the wetland.

- [X] 1. A large amount of impervious surface in urbanized areas.
- [ ] 2. Relatively impervious soils.
- [X] 3. Steep slopes in the adjacent areas.

2. Surface and Ground Water Protection

[X] Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- [ ] Constricted or no outlets.
- [X] Low water velocity through dense, persistent vegetation.
- [X] Hydroperiod permanently flooded or saturated.
- [X] Wetlands in depositional environments with persistent vegetation wider than 20 feet.
- [ ] Wetlands with persistent vegetation comprising a defined delta, island, bar or peninsula.
- [ ] Presence of seeps or springs.
- [ ] Wetland contains a high amount of microtopography that helps slow and filter surface water.
- [ ] Position in the landscape indicates the wetland is a headwaters area.
- [X] Wetland is adjacent to surface waters.
- [ ] Wetland recharges a drinking water source.
- [ ] Water sampling indicates removal of pollutants or nutrients.
- [ ] Water sampling indicates retention of sediments or organic matter.
- [ ] Fine mineral soils and alkalinity not low.
- [X] The wetland provides an obvious filter between surface water or ground water and land uses that may contribute point or nonpoint sources of sediments, toxic substances or nutrients to the wetland, such as: steep erodible slopes; row crops; dumps; areas of pesticide, herbicide or fertilizer application; feed lots; parking lots or heavily traveled road; and septic systems.

If any of the above boxes are checked, the wetland provides this function. Complete the following to determine if the wetland provides this function above or below a moderate level.

[ ] Check box if any of the following conditions apply that may indicate the wetland provides this function at a *lower* level.

- [ ] Presence of dead forest or shrub areas in sufficient amounts to result in diminished

nutrient uptake.

- ☐ Presence of ditches or channels that confine water and restrict contact of water with vegetation.
- ☐ Wetland is very small in size, not contiguous to a stream, and not part of a collection of small wetlands in the landscape that provide this function cumulatively.
- ☐ Current use in the wetland results in disturbance that compromises this function.

☒ Check box if any of the following conditions apply that may indicate the wetland provides this function at a *higher* level.

- ☐ The wetland is adjacent to a well head or source protection area, and provides ground water recharge.
- ☐ The wetland provides flows to Class A surface waters.
- ☒ The wetland contributes to the protection or improvement of water quality of any impaired waters.
- ☒ The wetland is large in size and naturally vegetated.

3. Fish Habitat

☒ Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- ☒ Contains woody vegetation that overhangs the banks of a stream or river and provides any of the following: shading that controls summer water temperature; cover including refuges created by overhanging branches or undercut banks; source of terrestrial insects as fish food; or streambank stability.
- ☒ Provides spawning, nursery, feeding or cover habitat for fish (documented or professionally judged). Common habitat includes deep marsh and shallow marsh associates with lakes and streams, and seasonally flooded wetlands associated with streams and rivers.
- ☐ Documented or professionally judged spawning habitat for northern pike.
- ☐ Provides cold spring discharge that lowers the temperature of receiving waters and creates summer habitat for salmonoid species.
- ☐ The wetland is located along a tributary that does not support fish, but contributes to a larger body of water that does support fish. The tributary supports downstream fish by providing cooler water, and food sources.

4. Wildlife Habitat

[X] Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- [X] Provides resting, feeding staging or roosting habitat to support waterfowl migration, and feeding habitat for wading birds. Good habitats for these species include open water wetlands.
- [X] Habitat to support one or more breeding pairs or broods of waterfowl including all species of ducks, geese, and swans. Good habitats for these species include open water habitats adjacent shallow marsh, deep marsh, shrub wetland, forested wetland, or naturally vegetated buffer zone.
- [X] Provides a nest site, a buffer for a nest site or feeding habitat for wading birds including but not limited to: great blue heron, black-crowned night heron, green-backed heron, cattle egret, or snowy egret. Good habitats for these species include open water or deep marsh adjacent to forested wetlands, or standing dead trees.
- [X] Supports or has the habitat to support one or more breeding pairs of any migratory bird that requires wetland habitat for breeding, nesting, rearing of young, feeding, staging roosting, or migration, including: Virginia rail, common snipe, marsh wren, American bittern, northern water thrush, northern harrier, spruce grouse, Cerulean warbler, and common loon.
- [ ] Supports winter habitat for white-tailed deer. Good habitats for these species include softwood swamps. Evidence of use includes deer browsing, bark stripping, worn trails, or pellet piles.
- [ ] Provides important feeding habitat for black bear, bobcat, or moose based on an assessment of use. Good habitat for these types of species includes wetlands located in a forested mosaic.
- [X] Has the habitat to support muskrat, otter or mink. Good habitats for these species include deep marshes, wetlands adjacent to bodies of water including lakes, ponds, rivers and streams.
- [ ] Supports an active beaver dam, one or more lodges, or evidence of use in two or more consecutive years by an adult beaver population.
- [X] Provides the following habitats that support the reproduction of Uncommon Vermont amphibian species including:
  - [X] 1. Wood Frog, Jefferson Salamander, Blue-spotted Salamander, or Spotted Salamander. Breeding habitat for these species includes vernal pools and small ponds.
  - [ ] 2. Northern Dusky Salamander and the Spring Salamander. Habitat for these species includes headwater seeps, springs, and streams.
  - [ ] 3. The Four-toed salamander; Fowler's Toad; Western or Boreal Chorus frog, or other amphibians found in Vermont of similar significance.

[X] Supports or has the habitat to support significant populations of Vermont amphibian species including, but not limited to Pickerel Frog, Northern Leopard Frog, Mink Frog, and others found in Vermont of similar significance. Good habitat for these types of species includes large marsh systems with open water components.

[X] Supports or has the habitat to support populations of uncommon Vermont reptile species including: Wood Turtle, Northern Map Turtle, Eastern Musk Turtle, Spotted Turtle, Spiny Softshell, Eastern Ribbonsnake, Northern Watersnake, and others found in Vermont of similar significance.

[X] Supports or has the habitat to support significant populations of Vermont reptile species, including Smooth Greensnake, DeKay's Brownsnake, or other more common wetland-associated species.

[X] Meets four or more of the following conditions indicative of wildlife habitat diversity:

- [X] 1. Three or more wetland vegetation classes (greater than 1/2 acre) present including but not limited to: open water contiguous to, but not necessarily part of, the wetland, deep marsh, shallow marsh, shrub swamp, forested swamp, fen, or bog;
- [x] 2. The dominant vegetation class is one of the following types: deep marsh, shallow marsh, shrub swamp or, forested swamp;
- [X] 3. Located adjacent to a lake, pond, river or stream;
- [x] 4. Fifty percent or more of surrounding habitat type is one or more of the following: forest, agricultural land, old field or open land;
- [ ] 5. Emergent or woody vegetation occupies 26 to 75 percent of wetland, the rest is open water;
- [x] 6. One of the following:
  - [X] i. hydrologically connected to other wetlands of different dominant classes or open water within 1 mile;
  - [X] ii. hydrologically connected to other wetlands of same dominant class within 1/2 mile;
  - [ ] iii. within 1/4 mile of other wetlands of different dominant classes or open water, but not hydrologically connected;

[X] Wetland or wetland complex is owned in whole or in part by state or federal government and managed for wildlife and habitat conservation; and

[X] Contains evidence that it is used by wetland dependent wildlife species.

If any of the above boxes are checked, the wetland provides this function. Complete the following to determine if the wetland provides this function above or below a moderate level.

[ ] Check box if any of the following conditions apply that may indicate the wetland provides this function at a *lower* level.

- [ ] The wetland is small in size for its type and does not represent fugitive habitat in

developed areas (vernal pools and seeps are generally small in size, so this does not apply).

- ☐ The surrounding land use is densely developed enough to limit use by wildlife species (with the exception of wetlands with open water habitat). Can be negated by evidence of use.
- ☐ The current use in the wetland results in frequent cutting, mowing or other disturbance.
- ☐ The wetland hydrology and character is at a drier end of the scale and does not support wetland dependent species.

☒ Check box if any of the following conditions apply that may indicate the wetland provides this function at a *higher* level.

- ☒ The wetland complex is large in size and high in quality.
- ☒ The habitat has the potential to support several species based on the assessment above.
- ☐ Wetland is associated with an important wildlife corridor.
- ☐ The wetland has been identified by ANR-F&W as important habitat.

5. Exemplary Wetland Natural Community

☒ Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- ☐ Wetlands that are identified as high quality examples of Vermont's natural community types recognized by the Natural Heritage Information Project of the Vermont Fish and Wildlife Department, including rare types such as dwarf shrub bogs, rich fens, alpine peatlands, red maple-black gum swamps and the more common types including deep bulrush marshes, cattail marshes, northern white cedar swamps, spruce-fir-tamarack swamps, and red maple-black ash seepage swamps are automatically significant for this function.

The wetland is also likely to be significant if any of the following conditions are met:

- ☒ Is an example of a wetland natural community type that has been identified and mapped by, or meets the ranking and mapping standards of, the Natural Heritage Information Project of the Vermont Fish and Wildlife Department.
- ☐ Contains ecological features that contribute to Vermont's natural heritage, including, but not limited to:
  - ☐ Deep peat accumulation reflecting a long history of wetland formation;
  - ☐ Forested wetlands displaying very old trees and other old growth characteristics;
  - ☐ A wetland natural community that is at the edge of the normal range for that type;

[X] A wetland mosaic containing examples of several to many wetland community types; or

[X] A large wetland complex with examples of several wetland community types.

6. Rare, Threatened, and Endangered Species Habitat

[X] Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

[x] Wetlands that contain one or more species on the federal or state threatened or endangered lists, as well as species that are rare in Vermont, are automatically significant for this function.

The wetland is also likely to be significant if any of the following apply:

[X] There is creditable documentation that the wetland provides important habitat for any species on the federal or state threatened or endangered species lists;

[X] There is creditable documentation that threatened or endangered species have been present in past 10 years;

[X] There is creditable documentation that the wetland provides important habitat for any species listed as rare in Vermont (S1 or S2 ranks), state historic (SH rank), or rare to uncommon globally (G1, G2, or G3 ranks) by the Natural Heritage Information Project of the Vermont Fish and Wildlife Department;

[x] There is creditable documentation that the wetland provides habitat for multiple uncommon species of plants or animals (S3 rank).

List name of species and ranking:

Brown Stickleback, (S3), Long-eared bat (Fed: LT, State: E, G1G2, S1), Hookers Bog Orchid (State: T, S2), Common watersnake (State: S3), False Hop Sedge (S2), Eastern ribbonsnake (S2), Broad beech fern (S2S3), Straight-leaf pondweed (S2S3), Sphagnum subfluvum (S1)

7. Education and Research in Natural Sciences

[X] Function is present and likely to be significant: Any of the following characteristics indicate the wetland provides this function.

[x] Owned by or leased to a public entity dedicated to education or research.

[X] History of use for education or research.

[x] Has one or more characteristics making it valuable for education or research.

8. Recreational Value and Economic Benefits

[X] Function is present and likely to be significant: Any of the following characteristics indicate the wetland provides this function.

- [X] Used for, or contributes to, recreational activities.
- [ ] Provides economic benefits.
- [ ] Provides important habitat for fish or wildlife which can be fished, hunted or trapped under applicable state law.
- [ ] Used for harvesting of wild foods.

Comments:

9. Open Space and Aesthetics

[X] Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- [X] Can be readily observed by the public; and
  - [X] Possesses special or unique aesthetic qualities; or
  - [X] Has prominence as a distinct feature in the surrounding landscape;
- [X] Has been identified as important open space in a municipal, regional or state plan.

10. Erosion Control through Binding and Stabilizing the Soil

[X] Function is present and likely to be significant: Any of the following physical and vegetative characteristics indicate the wetland provides this function.

- [X] Erosive forces such as wave or current energy are present and any of the following are present as well:
  - [X] Dense, persistent vegetation along a shoreline or stream bank that reduces an adjacent erosive force.
  - [X] Good interspersion of persistent emergent vegetation and water along course of water flow.
  - [ ] Studies show that wetlands of similar size, vegetation type, and hydrology are important for erosion control.

What type of erosive forces are present?

- [ ] Lake fetch and waves
- [x] High current velocities
- [ ] Water level influenced by upstream impoundment

If any of the above boxes are checked, the wetland provides this function. Complete the following to determine if the wetland provides this function above or below a moderate level.

[ ] Check box if any of the following conditions apply that may indicate the wetland provides this function at a *lower* level.

- [ ] The stream is artificially channelized and/or lacks vegetation that contributes to controlling the erosive force.

[x] Check box if any of the following conditions apply that may indicate the wetland provides this function at a *higher* level.

- [ ] The stream contains high sinuosity.
- [x] Has been identified through fluvial geomorphic assessment to be important in maintaining the natural condition of the stream or river corridor.

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Muddy Brook Culvert City/County: South Burlington/ Chittenden Sampling Date: 5/31/18

Applicant/Owner: State: VT Sampling Point: Wetland

Investigator(s): April Moulaert, PWS Section, Township, Range:

Landform (hillside, terrace, etc.): Floodplain Local relief (concave, convex, none): None Slope %: 0

Subregion (LRR or MLRA): LRR R Lat: 44° 27' 12.69164" N Long: 73°8' 18.79153" W Datum:

Soil Map Unit Name: Vergennes clay, 6 to 12 percent slopes NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes x No

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area**
Hydric Soil Present?	Yes X	No	**within a Wetland?** **Yes** X **No**
Wetland Hydrology Present?	Yes X	No	If yes, optional Wetland Site ID:

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- x Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- x Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No x	Depth (inches): ____
Water Table Present?	Yes ____	No x	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes x	No ____	Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: Wetland

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Tilia americana*	5	Yes	FACU
2.			
3.			
4.			
5.			
6.			
7.			
	5 =Total Cover		
Herb Stratum (Plot size: 5)			
1. *Lythrum salicaria*	20	Yes	OBL
2. *Solidago gigantea*	50	Yes	FACW
3. *Lonicera sp.*	5	No	
4. *Impatiens capensis*	20	Yes	FACW
5. Unknown grass- not in flower	20	Yes	
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	115 =Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
	=Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	20	x 1 =	20
FACW species	70	x 2 =	140
FAC species	0	x 3 =	0
FACU species	5	x 4 =	20
UPL species	0	x 5 =	0
Column Totals:	95 (A)		180 (B)

Prevalence Index = B/A = 1.89

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)
Wet meadow vegetation in a floodplain setting.

VEGETATION – Use scientific names of plants.

Sampling Point: Wetland

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Tilia americana*	5	Yes	FACU
2.			
3.			
4.			
5.			
6.			
7.			
	5 =Total Cover		
Herb Stratum (Plot size: 5)			
1. *Lythrum salicaria*	20	Yes	OBL
2. *Solidago gigantea*	50	Yes	FACW
3. *Lonicera sp.*	5	No	
4. *Impatiens capensis*	20	Yes	FACW
5. Unknown grass- not in flower	20	Yes	
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	115 =Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
	=Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	20	x 1 =	20
FACW species	70	x 2 =	140
FAC species	0	x 3 =	0
FACU species	5	x 4 =	20
UPL species	0	x 5 =	0
Column Totals:	95 (A)		180 (B)

Prevalence Index = B/A = 1.89

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)
Wet meadow vegetation in a floodplain setting.

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Muddy Brook Culvert City/County: South Burlington/ Chittenden Sampling Date: 5/31/18

Applicant/Owner: State: VT Sampling Point: Upland

Investigator(s): April Moulaert, PWS Section, Township, Range:

Landform (hillside, terrace, etc.): Hillside Local relief (concave, convex, none): Concave Slope %: 20

Subregion (LRR or MLRA): LRR R Lat: 44° 27' 12.31255" N Long: 73°8' 19.08121"W Datum:

Soil Map Unit Name: Vergennes clay, 6 to 12 percent slopes NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes x No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No X	**Is the Sampled Area**
Hydric Soil Present?	Yes ____	No X	**within a Wetland?** **Yes** ____ **No** X
Wetland Hydrology Present?	Yes ____	No X	If yes, optional Wetland Site ID: ____

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ____	Depth (inches): ____
Water Table Present?	Yes ____	No ____	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No ____	Depth (inches): ____

Wetland Hydrology Present? **Yes** ____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
No hydrology indicators were observed.

VEGETATION – Use scientific names of plants.

Sampling Point: Upland

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
		=Total Cover	
Sapling/Shrub Stratum (Plot size: 15)			
1. *Lonicera sp.*	75	Yes	
2. *Rhamnus cathartica*	30	Yes	FAC
3. *Acer negundo*	5	No	FAC
4.			
5.			
6.			
7.			
	110	=Total Cover	
Herb Stratum (Plot size: 5)			
1. *Circaea canadensis*	20	Yes	FACU
2. *Parthenocissus quinquefolia*	10	No	FACU
3. *Ranunculus repens*	10	No	FAC
4. *Carex novae-angliae*	30	Yes	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	70	=Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
		=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 25.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	45	x 3 =	135
FACU species	60	x 4 =	240
UPL species	0	x 5 =	0
Column Totals:	105 (A)		375 (B)

Prevalence Index = B/A = 3.57

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ___ **No** X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: Upland

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	10YR 3/4	100					Loamy/Clayey	
5-14	10YR 4/2	100					Loamy/Clayey	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains.

[2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ High Chroma Sands (S11) (**LRR K, L)**
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

APPENDIX H

South Burlington and Williston Comprehensive Plan Maps

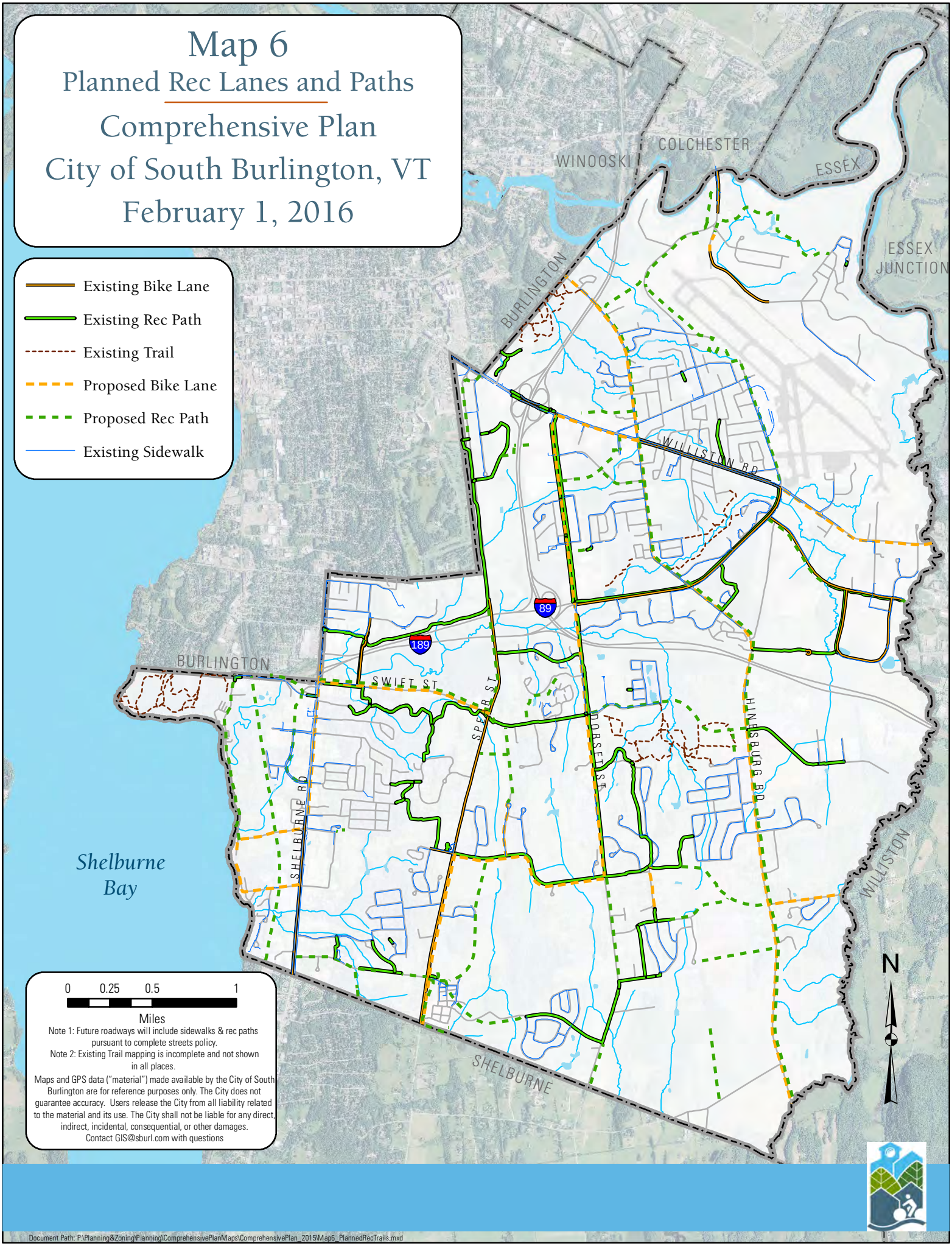
Map 6

Planned Rec Lanes and Paths

Comprehensive Plan

City of South Burlington, VT

February 1, 2016

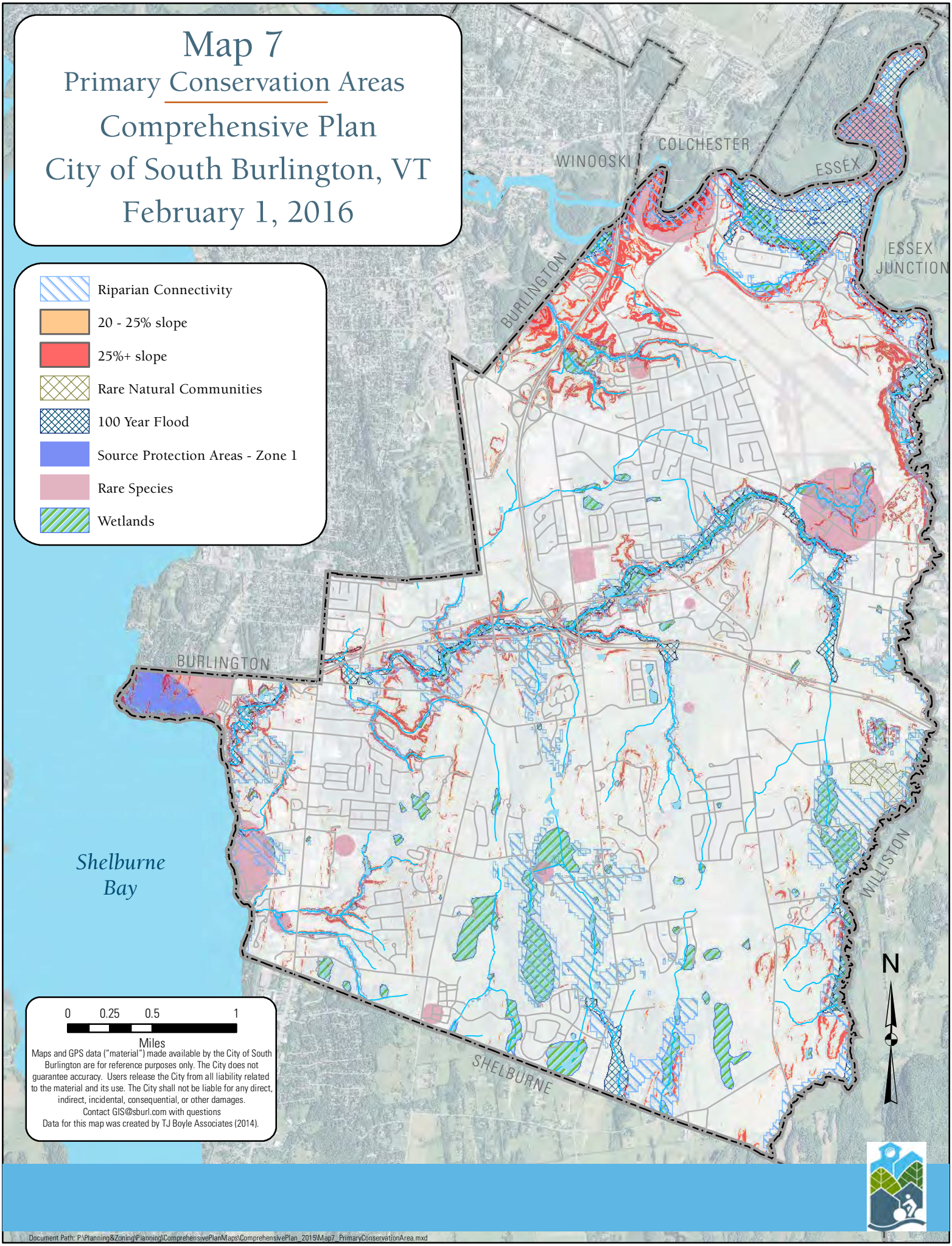


Note 1: Future roadways will include sidewalks & rec paths pursuant to complete streets policy.

Note 2: Existing Trail mapping is incomplete and not shown in all places.

Document Path: P:\Planning&Zoning\Planning\ComprehensivePlanMaps\ComprehensivePlan_2015\Map6_PlannedRecTrails.mxd

Map 7
Primary Conservation Areas
Comprehensive Plan
City of South Burlington, VT
February 1, 2016

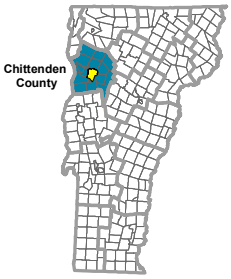


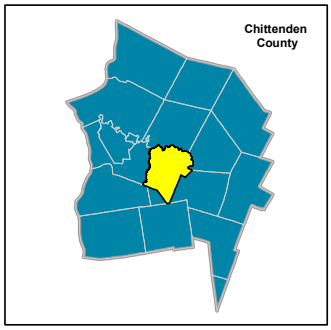
Williston 2016-2024 Comprehensive Plan
Map 18 - Conservation Areas

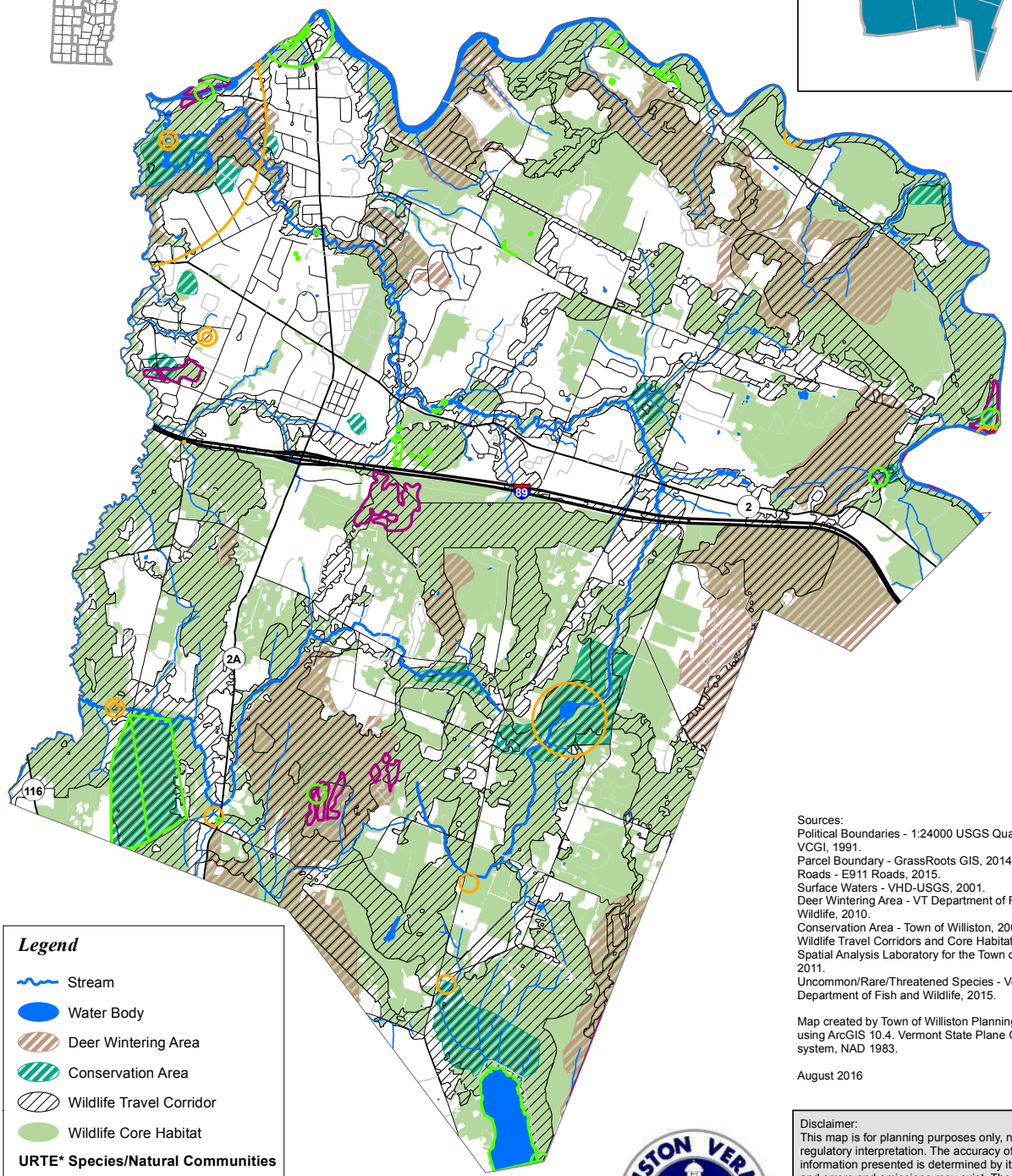
N

1:45,000

0 0.5 1 Miles







Legend

- Stream
- Water Body
- Deer Wintering Area
- Conservation Area
- Wildlife Travel Corridor
- Wildlife Core Habitat

URTE* Species/Natural Communities

- Animal
- Plant
- Natural Community

* Uncommon, Rare, Threatened or Endangered

Sources:
Political Boundaries - 1:24000 USGS Quadrangles, VCGI, 1991.
Parcel Boundary - GrassRoots GIS, 2014.
Roads - E911 Roads, 2015.
Surface Waters - VHD-USGS, 2001.
Deer Wintering Area - VT Department of Fish and Wildlife, 2010.
Conservation Area - Town of Williston, 2006.
Wildlife Travel Corridors and Core Habitat - UVM Spatial Analysis Laboratory for the Town of Williston, 2011.
Uncommon/Rare/Threatened Species - Vermont Department of Fish and Wildlife, 2015.

Map created by Town of Williston Planning Office using ArcGIS 10.4. Vermont State Plane Coordinate system, NAD 1983.

August 2016

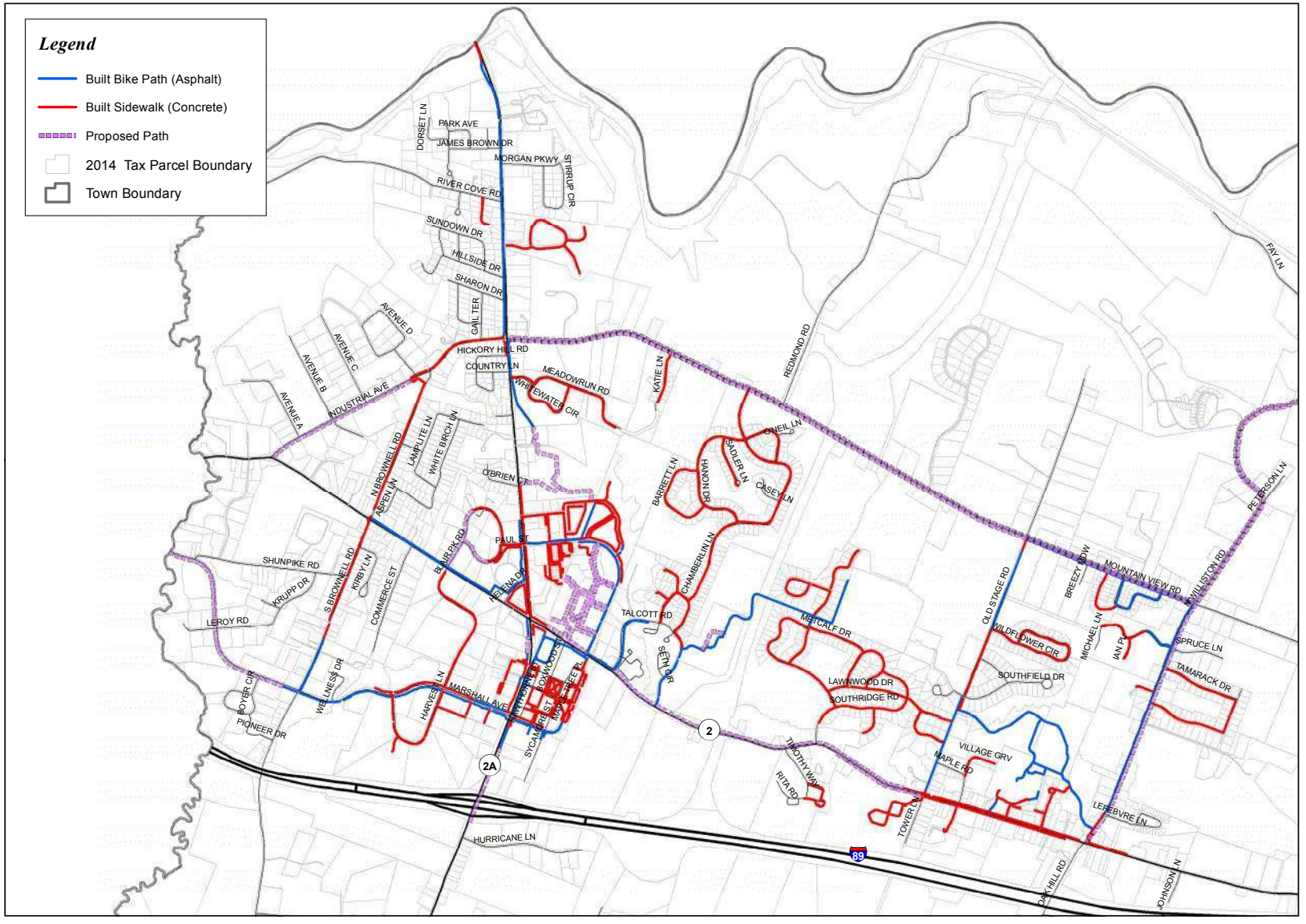
WILLISTON VERMONT PLANNING

Williston 2016-2024 Comprehensive Plan
Map 11 - Sidewalks and Paths

N

1:24,000

0 0.5 1 Miles



Sources:
Sidewalks and Paths: Town of Williston, 2016.
Political Boundaries - 1:24000 USGS Quadrangles, VCGI, 1991.
Parcel Boundary - GrassRoots GIS, 2014
Roads - E911 Roads, 2015
Surface Waters - VHD-USGS, 2001.

Map created by Town of Williston Planning Office using ArcGIS 10.4. Vermont State Plane Coordinate system, NAD 1983.

August 2016

APPENDIX I

Local Concerns Meeting Minutes and Presentation

Hoyle, Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, Vermont 05401
802-860-1331
www.hoyletanner.com

MEETING NOTES

PROJECT: Muddy Brook Culvert Replacement
STP MM18(3)

MEETING DATE: June 19, 2018

LOCATION: Williston Town Hall

ATTENDEES:
J. Fehrs, *Williston Selectboard*
T. Zittritsch, *Williston Selectboard*
T. Kenny, *Williston Selectboard*
J. Limoge, *Williston Selectboard*
T. Macaig, *Williston Selectboard*
R. McGuire, *Williston Town Manager*
E. Wells, *Assistant to the Williston Town Manager*
B. Hoar, *Williston Public Works Director*
T. DiPietro, *South Burlington Deputy Director of Public Works, Municipal Project Manager*
C. LaRose, *South Burlington City Planner, South Burlington Bike/Ped Committee, Williston Resident*
L. Bresee, *Lake Champlain Bikeways, South Burlington Bike/Ped Committee*
C. Forde, *CCRPC Senior Transportation Planner*
J. Olin, *Hoyle, Tanner Vice President, Vermont Transportation Group Manager*
N. Raub, *Hoyle, Tanner Transportation Engineer*
B. Rose, *Williston Village Resident, Cross Vermont Trail Assoc.*
W. Burnett, *Homeowner, 1600 Marshall Ave.*
B. Pasco, *Williston Resident*
G. Sweeney, *Williston Resident*
C. Davis, *Williston Resident*

SUBJECT: Local Concerns Meeting

PREPARED BY: N. Raub, EIT - Hoyle, Tanner
Hoyle, Tanner No. 910909

DISTRIBUTION: Tom DiPietro – South Burlington, Lisa Schaeffler – Town of Williston, Ross Gouin – VTrans MAB

Project Introduction –by B. Hoar and T. DiPietro
The project, known as the Muddy Brook Culvert Replacement Project, is a joint project between the Town of Williston and City of South Burlington with funding provided by the VTrans Municipal Assistance Bureau (MAB) for the replacement of the Kimball/Marshall Ave Muddy Brook Culvert. Hoyle, Tanner is the Design Firm responsible for completing the Scoping Study that will consider replacement alternatives that incorporate multi-modal facilities.

Project Description – by J. Olin
J. Olin provided a brief powerpoint presentation that included the following:

- General Project Location – Kimball/Marshall Ave crossing of Muddy Brook from Community Drive / Gregory Drive to Shunpike Rd.
- General Project Schedule
  i. Currently in Scoping Phase with upcoming milestones including: October 2018 Alternatives Presentation Meeting, and December 2018 Project Definition Report
  ii. Anticipate 3 – 6 years following the complete of the Scoping Phase to complete Project Funding Acquisition, Design & Permitting, and Construction
- Project Background Culvert – existing 15' diameter culvert failed in 2017 leading to install of the 150' temporary bridge
- Project Background Roadway – Class II Town Highway, Major Collector – Federal Aid, Posted speeds (40 MPH – Kimball, 30 MPH – Marshall), existing Bike & Ped Facilities west of crossing (sidewalk on North side, 10' shared use path on South side)
- Presented 2 maps – Project Base Map 1 – Close view of Culvert, Project Base Map 2 – General Site Plan
- Purpose of Local Concerns Meeting: Solicit Public feedback to better define the problem

Public Comment:

1. W. Burnett inquired about cause of culvert failure and typical life expectancy.
   J. Olin noted that corrosion is the likely cause of failure and the lifespan for this existing metal pipe culvert is not uncommon (original construction 1970 – 48 years).
   Report Note: original construction was 1986, not 1970 as mentioned in meeting.
2. W. Burnett inquired about potential future bridge option being made of concrete or steel and the estimated 3-6-year project schedule.
   J. Olin noted that the options are open at this point of the project; based on the minimum 32' span, a replacement option would likely be concrete or steel. J. Olin also noted the project is in the study phase and the schedule will depend on funding availability and project development requirements of the eventual funding program.

3. B. Rose noted this is a crucial bike/pedestrian crossing that is currently lacking with the Muddy Brook presenting a barrier for east/west bike & ped connectivity. B. Rose also noted this project location is an important connection of systems for the Cross Vermont Trail East to West project; that South Burlington and Williston have good bike path

networks but the connection between the two is dangerous and stressful, based on experience. B. Rose expressed that this project presents a golden opportunity to create a safer crossing as part of the project scope, beyond just a culvert replacement.
J. Olin noted the support of considering bicycle & pedestrian facilities as part of this project scope as well as consideration of potential roadway geometry/sight distance improvements. J. Olin inquired to B. Rose about anticipated long-term Cross Vermont Trail usage and on/off road path preference.
B. Rose noted the Cross Vermont Trail Association is open to both on and off-road paths, and that the primary objective is safe facilities for cyclists and pedestrians with connectivity east-west across Vermont. Future use type is uncertain, but expectations that usage of facilities will greatly increase if facilities are constructed.

4. L. Bresee noted that he agreed with B. Rose. L. Bresee also noted that people may perceive existing low usage of this connection (vehicles and pedestrian) which is likely due to existing issues, and improvements will attract users; project limits should be Gregory Drive to Shunpike Road; the 6-year project schedule is discouraging; the current temporary bridge is okay for confident cyclists, like himself, however over the winter the pavement has deteriorated and will need repeated attention within the 6-year wait time. L. Bresee recommended off-road facility for future use, and noted that recently installed stop signs installed at Gregory Drive improved the bike situation.
   J. Olin inquired to L. Bresee about cyclist traffic on the northern edge being off-road. L. Breese noted that it is challenging to cross form the north side to the south side shared use path.

5. C. LaRose noted that she agreed with the connection importance of the project and that she has additional written comments from the South Burlington Bike and Ped Committee for J. Olin for both on and off-road facilities. **Action Item: C. LaRose to provide J. Olin with written comments from the committee.** C. LaRose also noted that she would like to see bike shoulders continue across on both sides, but pedestrian should remain off-road; a lot of commercial research space is to be built in the area, which will attract commuters; almost 40 new housing units were recently built up the street, which will attract commuter and recreational use; and an increase in future traffic numbers will make this an important connection for the future.

6. B. Rose noted that long distance bikers will stay on the road in shoulders because it's easier than crossing to the shared use path. B. Rose noted that in addition to the off-road path, there needs to be a design on Marshall Ave. to accommodate shoulder users.

7. J. Olin noted that increased roadway width and shared use path will have environmental and right-of-way impacts, as well as increase cost, which will be considered with the alternatives analysis.

8. L. Bresee noted that crossing back and forth to access paths is a safety hazard, and requested that catch basin grates not installed in the bike lanes as it constricts the lane width that cyclists can use, pushing them closer to vehicular traffic.

9. T. Zittritsch inquired whether bike lanes are currently located on both sides of the bridge.
   C. LaRose noted that there are widened shoulders on Kimball Ave, and the request from South Burlington Bike and Ped Committee for long term bike/ped facilities is to have a separated off-road pedestrian facility with on-road bike lanes on both sides connecting to Williston. C. LaRose noted that the definition of "separation" is not clear, but the ultimate goal is protection.

10. W. Burnett inquired about the current Right-of-Way on Marshall Ave.
    J. Olin noted that it is possibly 3 rod (49.5'), however the GIS data he has may not be completely accurate and would need to be confirmed.
    B. Hoar corrected that Marshall Ave. has 66' (100 ft in place) of Right-of-Way.

11. J. Fehrs inquired about the limits of the project.
    J. Olin noted that the project limits are currently Gregory Drive to Shunpike Road.

12. J. Fehrs inquired about what the ideal bike/pedestrian crossing would look like.
    L. Bresee noted that ideal option would be 2 traffic lanes with 4-5 ft shoulders on each side with clear markings for on-road bike accommodation, or, a minimum 2 ft separation of curb and grass space with an 8-10 ft shared use path, or, up to a separate bike/pedestrian bridge crossing. L. Bresee noted that he expects a few alternatives in that range.

13. C. Forde noted that the options need to be protected.
    J. Olin showed examples of various on and off-road facilities and crossing structures. J. Olin noted that a combined bridge with widened shoulders and on-bridge barriers presents maintenance challenges with plowing. J. Olin noted that the options vary based on a buried or bridge structure, and alternatives will consider durability, cost, maintenance, constructability, etc.

14. B. Rose noted that Shunpike Road and Marshall Ave. are not arteries for cars but they are for cyclists. B. Rose noted that the more decisions a cyclist has to make when crossing to a pathway, the more dangerous, and that cheaper alternatives are acceptable, with regards to the striping option, as long as markings and signage are clear to cars and bikers to provide ample protection.

15. J. Fehrs inquired about the protected pedestrian crossing being necessary on just one side or two.

C. LaRose noted that one protected side is acceptable and that the users prefer the more aesthetic and wide shared use path on the south side, but that widened shoulders still remain a priority.

16. J. Fehrs inquired about people going form Williston to South Burlington having a difficult time crossing to the shared use path.
    C. LaRose noted it is easy for pedestrians to cross at the 4-way stop, however it is less easy for cyclists trying to keep up with traffic.
    J. Olin noted that the 4-way stop at Gregory/Community Drive is within the scope of the project.

If the contents of these meeting notes are incomplete or not to your understanding of the meeting, please contact the preparer at Hoyle, Tanner & Associates as soon as possible.

Prepared by:
Nicole L. Raub, EIT
Hoyle, Tanner & Associates, Inc.

KIMBALL AVE / MARSHALL AVE MUDDY BROOK CULVERT REPLACEMENT - STP MM18(3)

LOCAL CONCERNS MEETING

JUNE 19, 2018, 8:00 P.M.

WILLISTON TOWN HALL

Joint Project For:

South Burlington VERMONT

Williston VERMONT

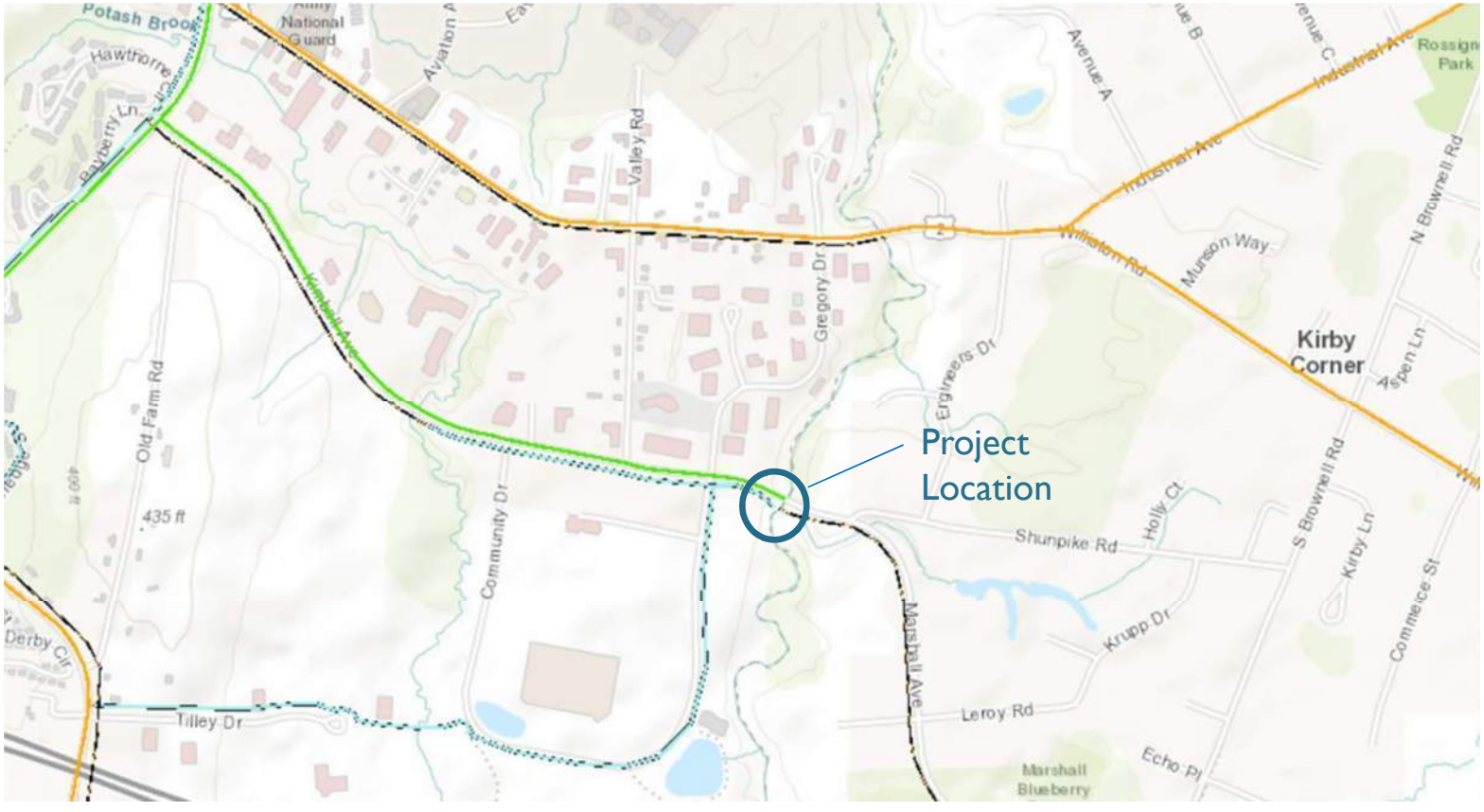
Funding Provided By:

VERMONT AGENCY OF TRANSPORTATION

Design Team:

Hoyle, Tanner & Associates, Inc.

PROJECT LOCATION



PROJECT SCHEDULE (ESTIMATED)

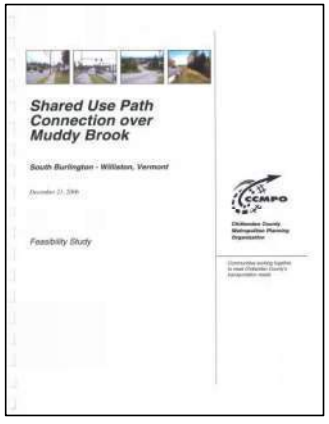
- Study Phase
  - ✓ **June 2018** - Local Concerns Meeting
  - **October 2018** – Alternatives Presentation Meeting
  - **December 2018** - Project Definition Report
- Project Funding Acquisition: Best Case - December 2018 - December 2019
  (Typical – 3 years for Procurement _ December 2021)
- Design Phase: Best Case - January 2020 - January 2021
  (Typical – 2 year Design & Permitting Phase _ December 2023)
- Construction: Best Case - July 2021 – October 2021
  (Typical – 1 year Construction Complete by _ October 2024)

Note: Project funding, design, and construction phases are assumed and largely dependent on funding availability, and permitting/ROW clearance.

PROJECT BACKGROUND - CULVERT

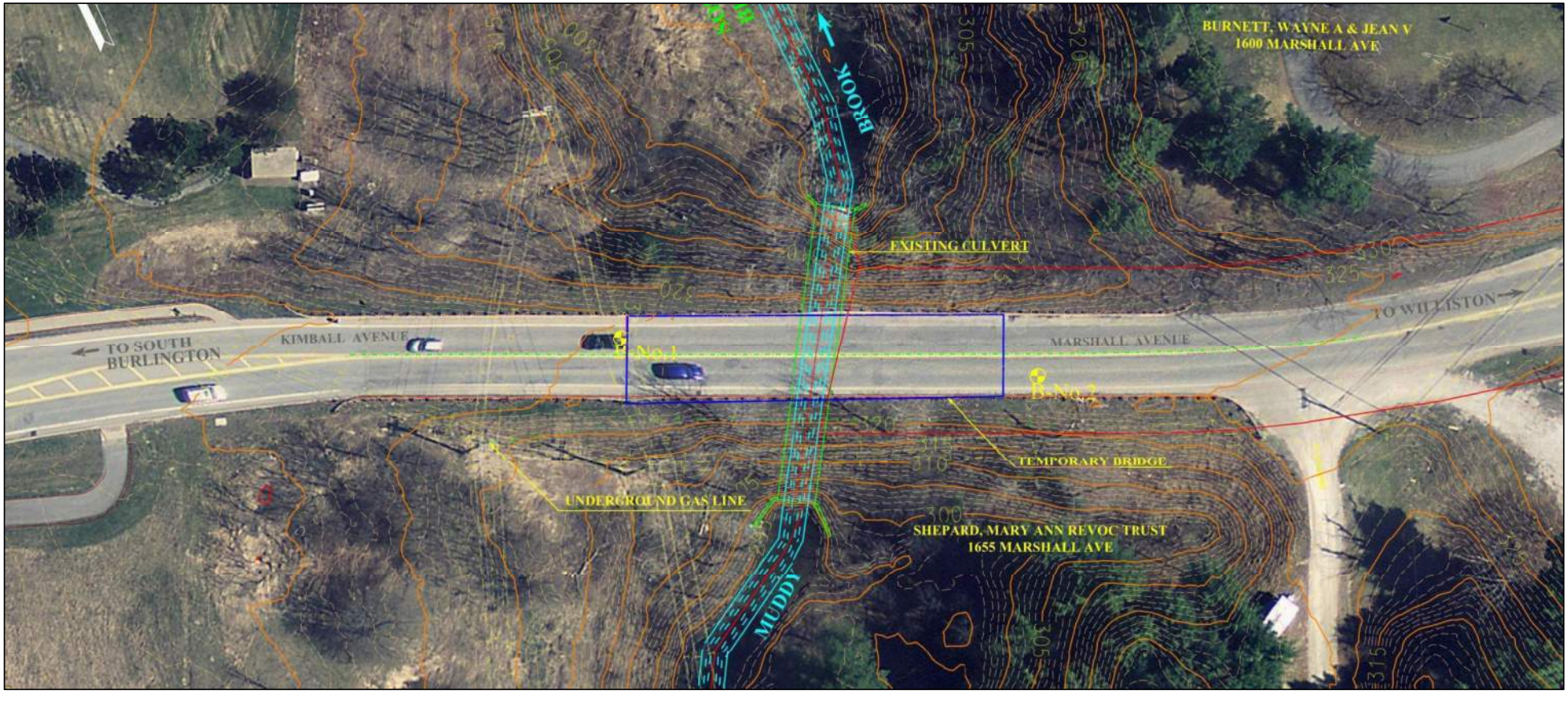
- Existing 15’ Diameter Metal Pipe Installed in 1970
- Heavy Corrosion Causes Pipe Buckling & the Road Closure in the Spring of 2017
- 150’ Temporary Bridge Installed in August 2017 (VTrans Rental)
- 2009 Muddy Brook Geomorphic Assessment Report (Fitzgerald Environmental)
- Measured Bankfull Width = 32’
- Depth of Road to Streambed = ~30’

PROJECT BACKGROUND - ROADWAY

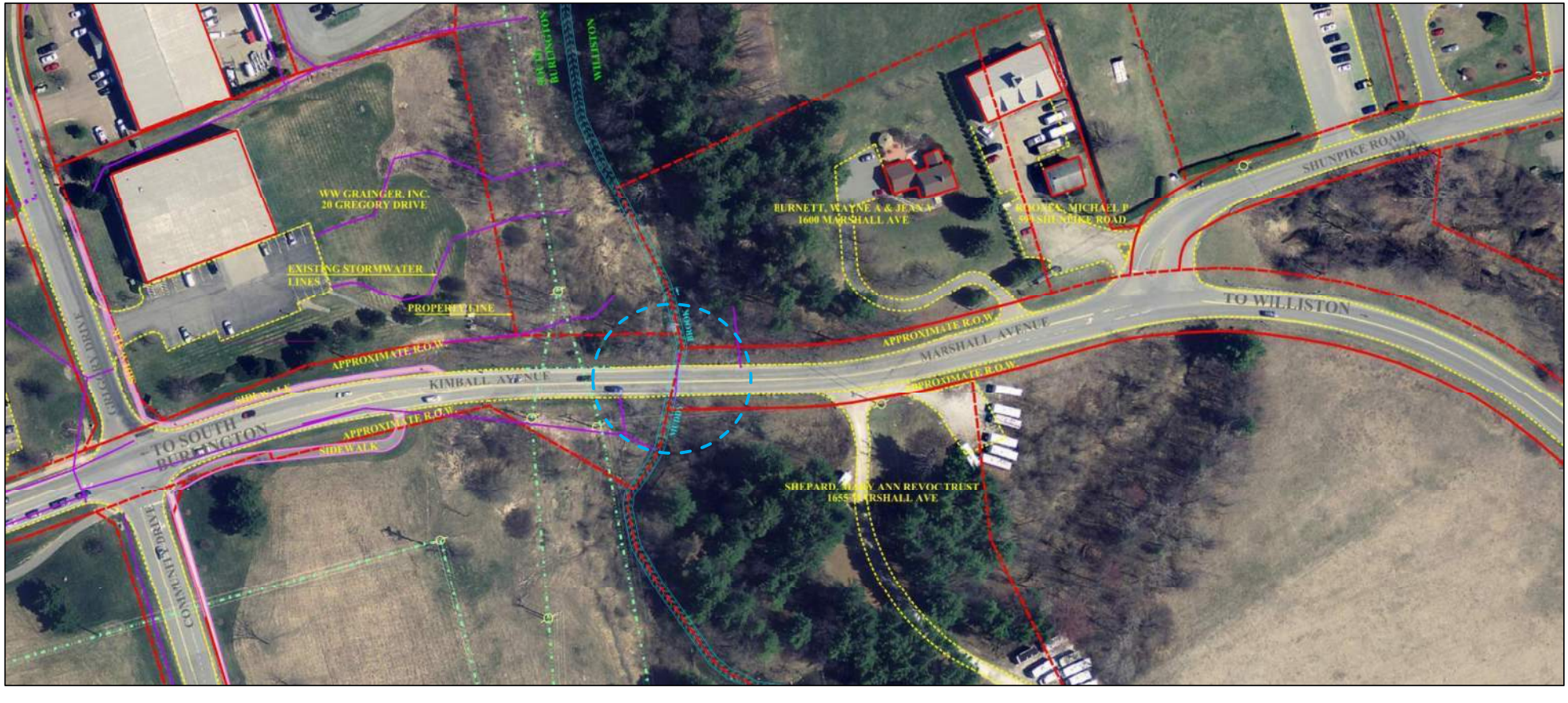


- Class II Town Highway
- Major Collector (Federal-aid Hwy)
- Posted Speed Limits:
- 40 MPH (Kimball Ave)
- 30 MPH (Marshall Ave)
- Bicycle & Pedestrian Facilities:
  - Sidewalk on North Side of Kimball Ave (West of Project)
  - 10' Shared Use Path on South Side of Kimball Ave (West of Project)
  - 2006 Shared Use Path Study with 2010 Update

PROJECT BASE MAP 1: CULVERT



PROJECT BASE MAP 2: SITE



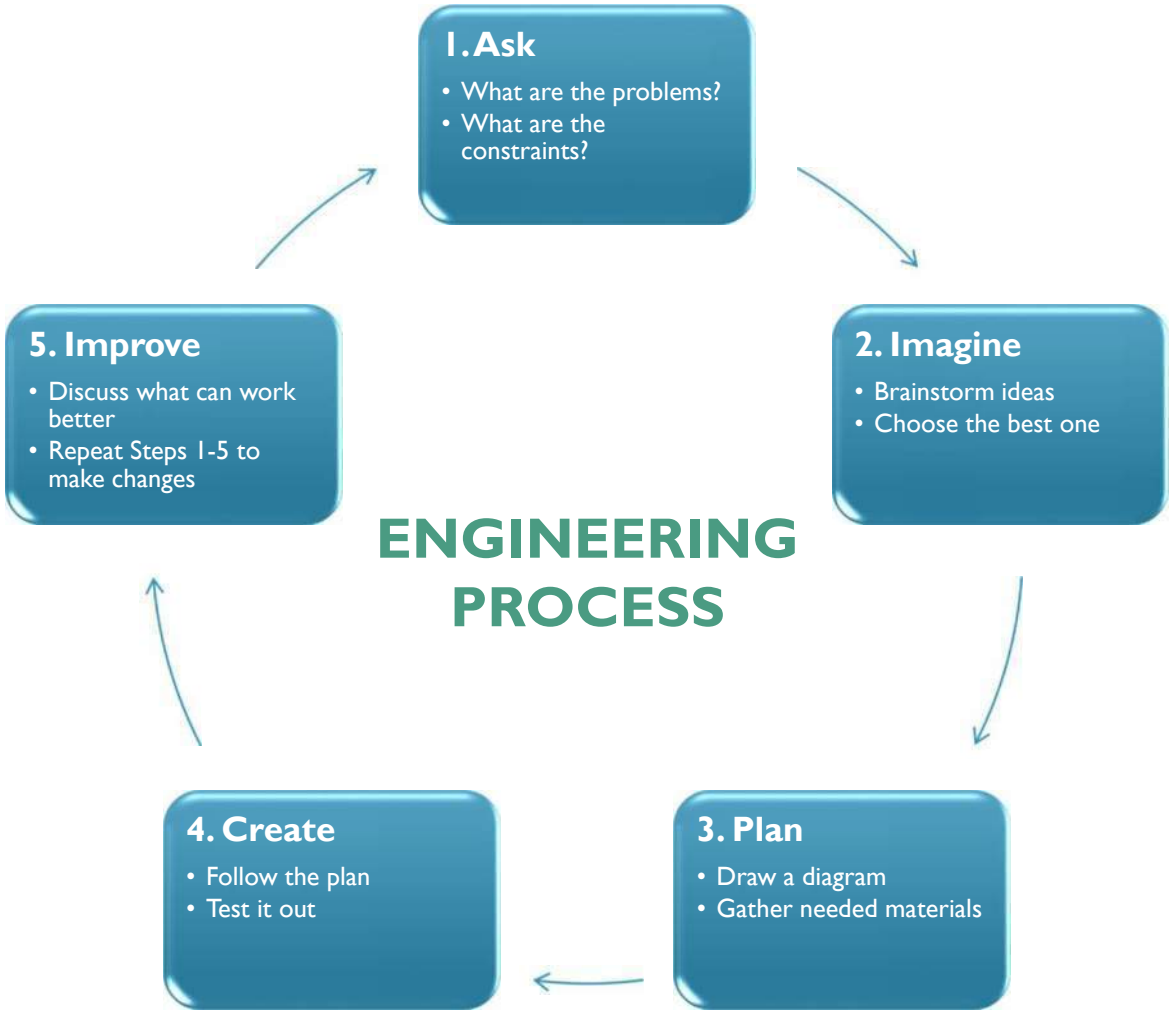
COMMENTS

LOCAL CONCERNS MEETING – SOLICIT PUBLIC FEEDBACK TO BETTER DEFINE THE PROBLEM

CONTACT

Jon Olin, PE
Project Manager
(802) 860-1331 x 314
jolin@hoyletanner.com

Hoyle, Tanner & Associates, Inc.
www.hoyletanner.com



APPENDIX J

Public Information Meeting Minutes and Presentation

Hoyle, Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, Vermont 05401
802-860-1331
www.hoyletanner.com

MEETING NOTES

PROJECT: Muddy Brook Culvert Replacement
STP MM18(3)

MEETING DATE: October 16, 2018

LOCATION: Williston Town Hall

ATTENDEES:
J. Fehrs, *Williston Selectboard*
T. Zittritsch, *Williston Selectboard*
J. Limoge, *Williston Selectboard*
T. Macaig, *Williston Selectboard*
R. McGuire, *Williston Town Manager*
E. Wells, *Assistant to the Williston Town Manager*

L. Schaeffler, *Town of Willison Assistant Public Works Director*
T. DiPietro, *South Burlington Deputy Director of Public Works, Municipal Project Manager*
E. Cherington, *South Burlington Public Works*
C. Forde, *CCRPC Senior Transportation Planner*
J. Olin, *Hoyle, Tanner Vice President, Vermont Transportation Group Manager*
B. Rose, *Williston Village Resident, Cross Vermont Trail Assoc.*
M. Boulaye, Williston Resident
S. Goddard, South Burlington Bike/Ped Committee
R. Leslie, Williston Resident
J. Borg, VT ANR
P. Scofred, South Burlington Resident

SUBJECT: Public Information Meeting (Alternatives Presentation)

PREPARED BY: Jon Olin - Hoyle, Tanner
Hoyle, Tanner No. 910909

DISTRIBUTION: Tom DiPietro – South Burlington, Lisa Schaeffler – Town of Williston, Ross Gouin – VTrans MAB

Project Introduction –by T. DiPietro

The project, known as the Muddy Brook Culvert Replacement Project, is a joint project between the Town of Williston and City of South Burlington with funding provided by the VTrans Municipal Assistance Bureau (MAB) for the replacement of the Kimball/Marshall Ave Muddy Brook Culvert. Hoyle, Tanner is the Design Firm responsible for completing the Scoping Study that will consider replacement alternatives that incorporate multi-modal facilities. The purpose of this meeting is to present the alternatives prepared with the goal of the selection of a preferred alternative to advance through design.

Project Description – by J. Olin

J. Olin provided a brief powerpoint presentation that included the following:

- General Project Location – Kimball/Marshall Ave crossing of Muddy Brook from Community Drive / Gregory Drive to Shunpike Rd.
- General Project Schedule
- Project Background Culvert & Rdwy/Bike & Ped
- Review of Purpose & Need Statement developed
- Overview of hydraulics analysis of the existing and proposed culvert opening for the design 50-year storm event. It was noted that with a larger opening which is required for permitting to meet bank-full width the velocities at the 50-year event are increased upstream. Design will need to assess potential toe of bank stabilization in key areas identified in hydraulics analysis.
- Presentation of structure type alternatives (reference pdf of presentation for matrix)
- Presentation of roadway and bike/ped facilities alternatives (reference pdf of presentation for images and matrix)

Public Comment:

1. A question was presented whether the study investigated whether this area of Muddy Brook is a mapped Wildlife Travel Corridor and how that would impact this crossing.
   J. Olin noted that the project team reached out to conservation committees in South Burlington and Williston and that no special requirements were identified for this crossing, and the final report will recommend further consideration during the preliminary design phase as the Willison Comprehensive Plan identifies Muddy Brook as a Wildlife Travel Corridor. It's possible that the internal height of the culvert may need to be increased slightly from the currently proposed 8'-0".

2. A question was received whether the bridge removal was included in the cost of the replacement structure.
   J. Olin noted that the estimates do include this cost.

3. A public comment was made that, during the Local Concerns Meeting in June, the need for an improved crossing from westbound bicycle traffic onto Shunpike is needed.
   J. Olin and T. DiPietro explained that the Shunpike Road crossing is outside of the study limits. The study is focused primarily on the culvert replacement. This needs to remain

on its own schedule and the Shunpike Intersection and future path connectivity needs to be evaluated as a separate project.

4. A question was received whether the design team considered the path on the North Side of Kimball/Marshall Ave.
   J. Olin noted that the design team considered this, but it presented more resource impacts and would be a ROW challenge with the property at the corner of Marshall and Shunpike. It was also identified that the current shared use path is on the south side of Kimball Ave and there is a facility on the south side of Marshall Ave at South Brownell Rd. The Williston Comprehensive Plan identifies a future connection along Marshall Ave on the Bike and Ped Map.
   L. Schaeffler noted that the Town is investigating alternatives for path connectivity potentially on the south side of Shunpike. This would impact the preferred bicycle crossing near Shunpike and that for the crossing of Muddy Brook it is recommended to match the facility on the south side of Kimball Ave allowing future path extensions to consider the best Shunpike intersection considerations beyond.

5. There was general public support for Alternative #3 – 10' shared use path with the 10' greenspace. Commuting cyclists who may choose the 4' shoulder were in favor of no catch basins in the shoulder area and, though it's not a designated bike lane, the 4' shoulder was viewed as a significant improvement for cyclists who choose to use the road.

Alternative Selection:

The Selectboard voted unanimously for the preferred alternative to advance into design as:

- Roadway Alternative #3 – 10' Shared-use Path with a 10' Greenspace and Structure Alternative #2 – Precast Concrete Arch Culvert.

If the contents of these meeting notes are incomplete or not to your understanding of the meeting, please contact the preparer at Hoyle, Tanner & Associates as soon as possible.

Prepared by:
Jon A. Olin, P.E.
Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner & Associates, Inc.
125 College Street, 4th Floor
Burlington, Vermont 05401
802-860-1331
www.hoyletanner.com

MEETING NOTES

PROJECT: Muddy Brook Culvert Replacement
STP MM18(3)

MEETING DATE: November 5, 2018

LOCATION: South Burlington City Hall

ATTENDEES:
H. Riehle, *City Council Chair*
M. Emery, *City Council Member*
T. Barritt, *City Council Member*
T. Chittenden, *City Council Member*
D. Kaufman, *City Council Member*
K. Dorn, *City Manager*
J. Rabidoux, *PW Director*
T. DiPietro, *South Burlington Deputy Director of Public Works, Municipal Project Manager*
J. Olin, *Hoyle, Tanner Project Manager*
Members of the Public, *names not recorded*

SUBJECT: Public Information Meeting (Alternatives Presentation)

PREPARED BY: Jon Olin - Hoyle, Tanner
Hoyle, Tanner No. 910909

DISTRIBUTION: Tom DiPietro – South Burlington, Lisa Schaeffler – Town of Williston, Ross Gouin – VTrans MAB

Project Introduction –by T. DiPietro
The project, known as the Muddy Brook Culvert Replacement Project, is a joint project between the Town of Williston and City of South Burlington with funding provided by the VTrans Municipal Assistance Bureau (MAB) for the replacement of the Kimball/Marshall Ave Muddy Brook Culvert. Hoyle, Tanner is the Design Firm responsible for completing the Scoping Study that will consider replacement alternatives that incorporate multi-modal facilities. The purpose of this meeting is to present the alternatives prepared with the goal of the selection of a preferred alternative to advance through design.

Project Description – by J. Olin
J. Olin provided a brief powerpoint presentation that included the following:

- General Project Location – Kimball/Marshall Ave crossing of Muddy Brook from Community Drive / Gregory Drive to Shunpike Rd.
- General Project Schedule
- Project Background Culvert & Rdwy/Bike & Ped
- Review of Purpose & Need Statement developed
- Overview of hydraulics analysis of the existing and proposed culvert opening for the design 50-year storm event. It was noted that with a larger opening which is required for permitting to meet bank-full width the velocities at the 50-year event are increased upstream. Design will need to assess potential toe of bank stabilization in key areas identified in hydraulics analysis.
- Presentation of structure type alternatives (reference pdf of presentation for matrix)
- Presentation of roadway and bike/ped facilities alternatives (reference pdf of presentation for images and matrix)

Public Comment:

1. Only one comment was received from City Council regarding whether lighting was considered for the pathway at the project location. Hoyle, Tanner noted that it will be added to the report for consideration during preliminary design.

Alternative Selection:

The City Council voted unanimously for the preferred alternative to advance into design as:

- Roadway Alternative #3 – 10’ Shared-use Path with a 10’ Greenspace and Structure Alternative #2 – Precast Concrete Arch Culvert.

If the contents of these meeting notes are incomplete or not to your understanding of the meeting, please contact the preparer at Hoyle, Tanner & Associates as soon as possible.

Prepared by:
Jon A. Olin, P.E.
Hoyle, Tanner & Associates, Inc.

KIMBALL AVE / MARSHALL AVE MUDDY BROOK CULVERT REPLACEMENT - STP MM18(3)

PUBLIC INFORMATIONAL MEETING

OCTOBER 16, 2018, 8:00 P.M.

WILLISTON TOWN HALL

Joint Project For:

southburlington VERMONT

Williston VERMONT

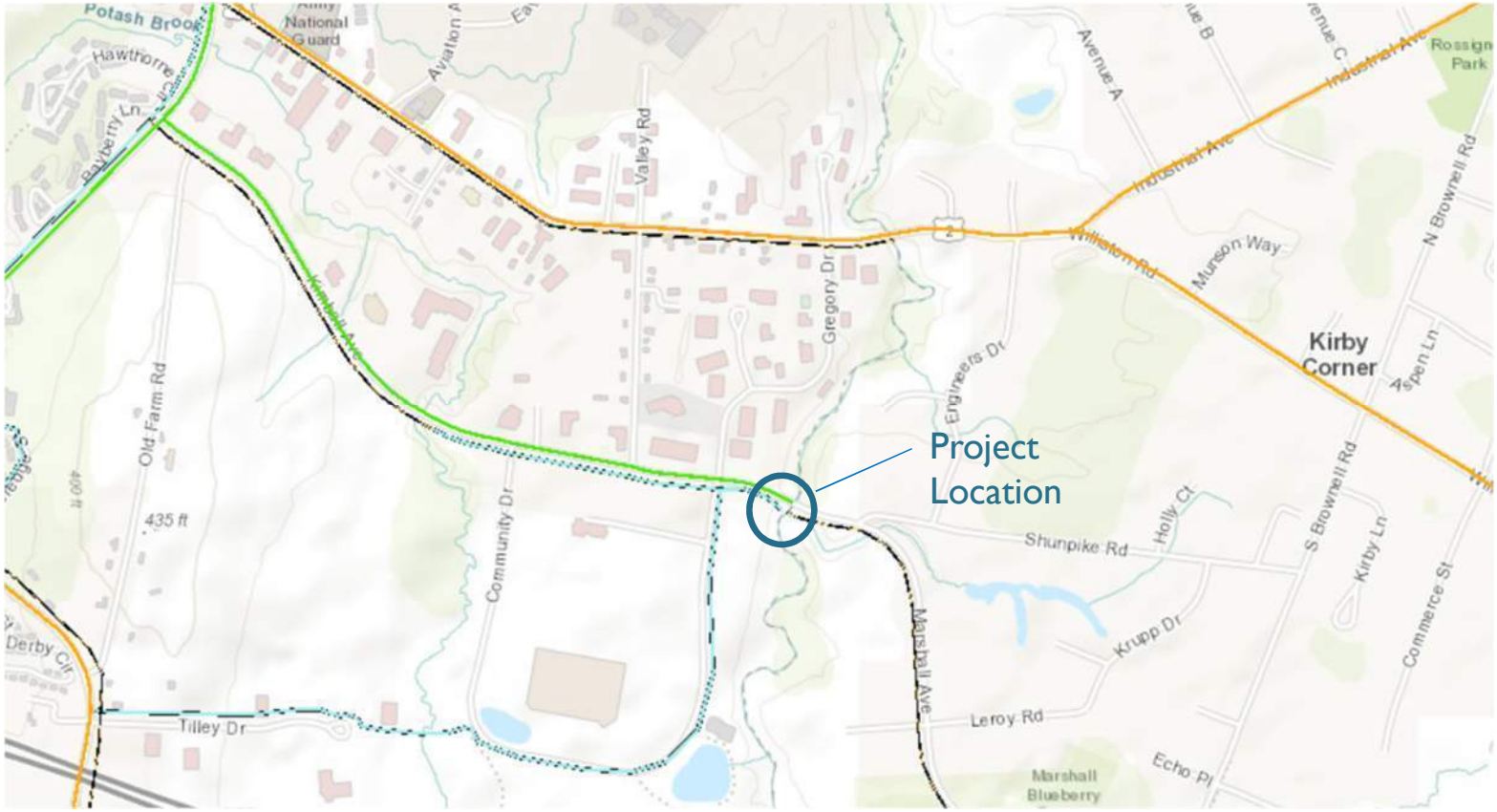
Funding Provided By:

VERMONT AGENCY OF TRANSPORTATION

Design Team:

Hoyle, Tanner & Associates, Inc.

PROJECT LOCATION



Hoyle, Tanner & Associates, Inc.

PROJECT SCHEDULE (ESTIMATED)

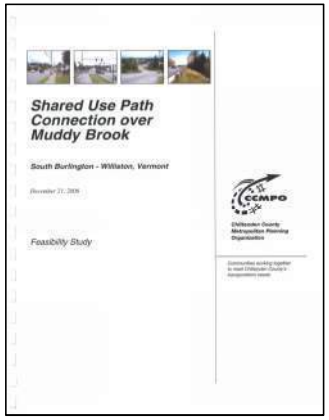
- Study Phase
  - ✓ **June 2018** - Local Concerns Meeting
  - ✓ **October 2018** – Alternatives Presentation Meeting
  - **December 2018** - Project Definition Report
- Project Funding Acquisition: Best Case - December 2018 - December 2019
  (Typical – 3 years for Procurement _ December 2021)
- Design Phase: Best Case - January 2020 - January 2021
  (Typical – 2 year Design & Permitting Phase _ December 2023)
- Construction: Best Case - July 2021 – October 2021
  (Typical – 1 year Construction Complete by _ October 2024)

Note: Project funding, design, and construction phases are assumed and largely dependent on funding availability, and permitting/ROW clearance.

PROJECT BACKGROUND - CULVERT

- Existing 15’ Diameter Metal Pipe Installed in 1970
- Heavy Corrosion Caused Pipe Buckling & the Road Closure in the Spring of 2017
- 150’ Temporary Bridge Installed in August 2017 (VTrans Rental)
- 2009 Muddy Brook Geomorphic Assessment Report (Fitzgerald Environmental)
- Measured Bankfull Width = 32’
- Depth of Road to Streambed = ~30’

PROJECT BACKGROUND - ROADWAY



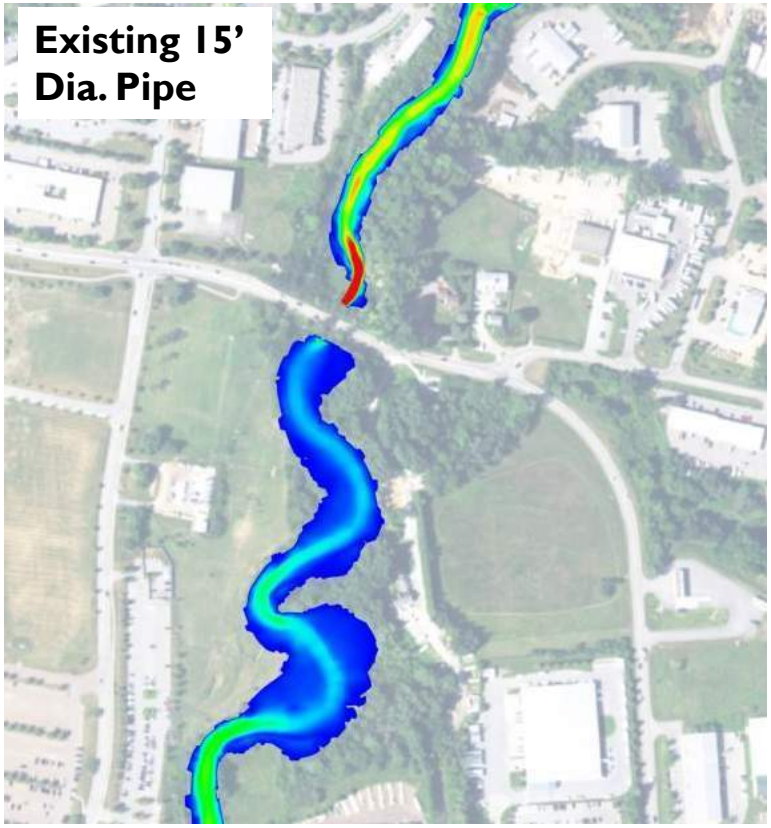
- Class II Town Highway
- Major Collector (Federal-aid Hwy)
- Posted Speed Limits:
- 40 MPH (Kimball Ave)
- 30 MPH (Marshall Ave)
- Bicycle & Pedestrian Facilities:
  - Sidewalk on North Side of Kimball Ave (West of Project)
  - 10’ Shared Use Path on South Side of Kimball Ave (West of Project)
  - 2006 Shared Use Path Study with 2010 Update

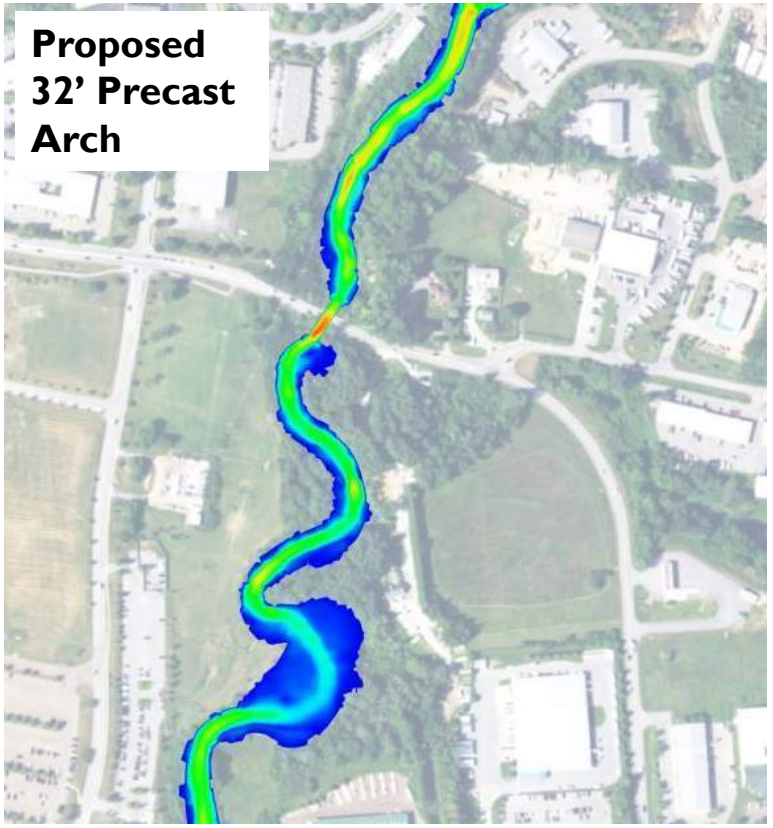
PURPOSE AND NEED STATEMENT

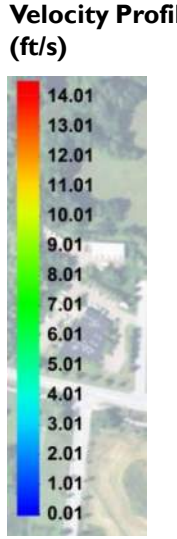
Purpose & Need Statement (abbreviated)

- Replace the failing culvert and temporary bridge for the Kimball/Marshall Ave roadway over Muddy Brook with a permanent crossing structure
- Provide solutions / treatments that will improve the water quality of Muddy Brook
- Minimize resource impacts
- Provide safe facilities for all users including bicyclists and pedestrians across Muddy Brook from Community Drive to Shunpike Rd (extent of the Study Limits)
- Improve connectivity between existing and proposed bicycle and pedestrian facilities in Williston and South Burlington

HYDRAULICS ANALYSIS – 50 YEAR STORM EVENTS





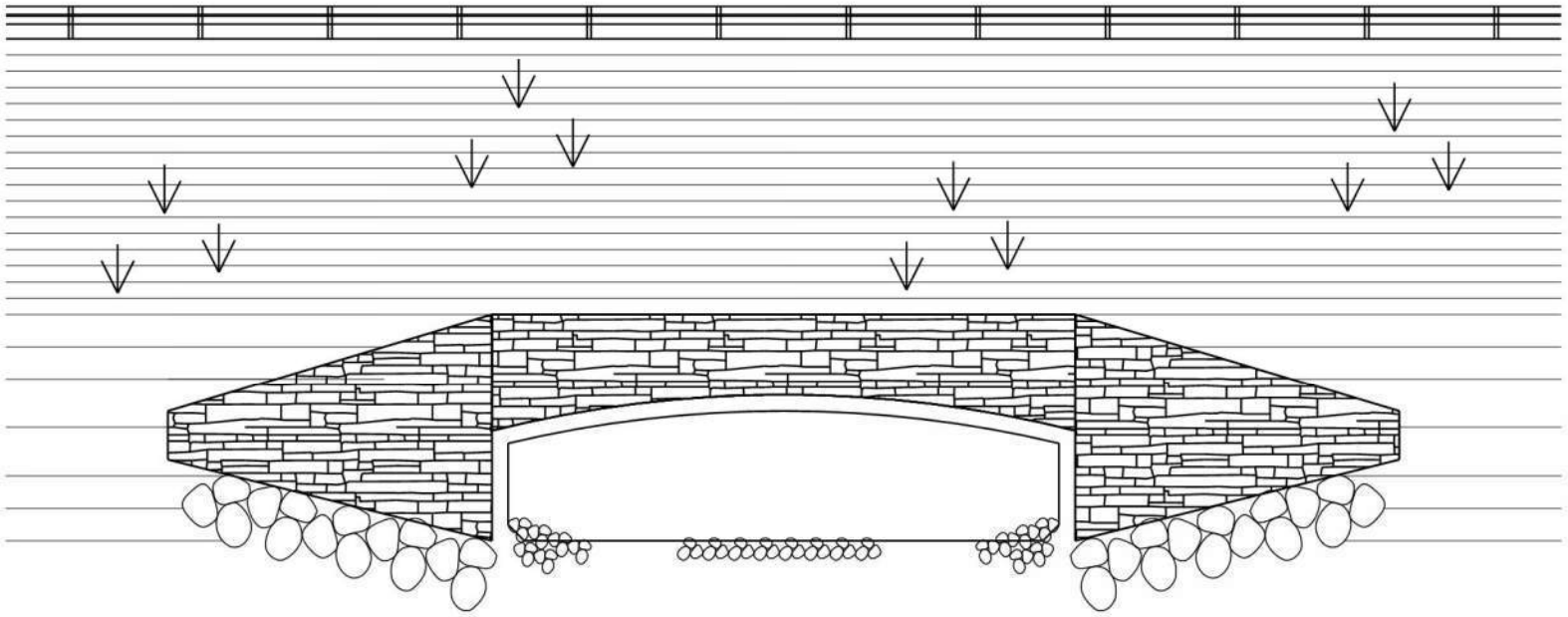


PROPOSED CROSSING

50 YEAR FLOOD EVENT

PARTICLE TRACE

STRUCTURE ELEVATION



STRUCTURE ELEVATION

NOTE: ROAD ALT 3/STRUCTURE ALT 2 SHOWN

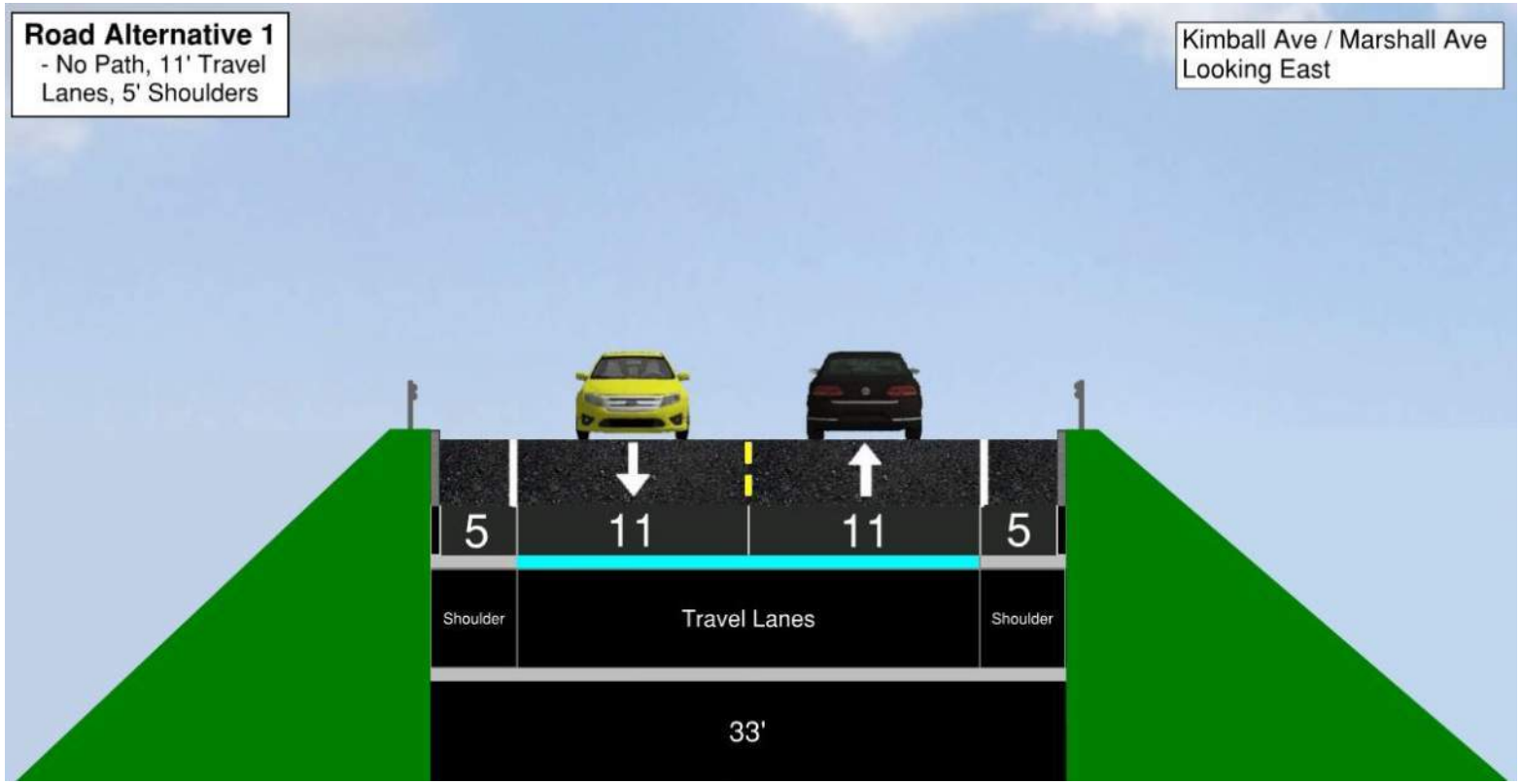
Precast Concrete
Rigid Frame
Structure Shown
Span = 34’
Rise = 8’

STRUCTURE ALTERNATIVES MATRIX

	Meets Purpose & Need	Road Closure Duration (min. standard construction)	Durability	Cost
Struct Alt 1: No Build	No Does not provide a new permanent crossing	None	-	$0
Struct Alt 2: Precast Arch	Yes	7 Weeks	High	$1,227,000
Struct Alt 3: CIP Rigid Frame	Yes	12 Weeks	High	$1,244,000
Struct Alt 4: Multi-Plate Arch	Yes	7 Weeks	Medium	$1,127,000
Struct Alt 5: Bridge	Not Evaluated. Due to depth of crossing buried structures present better cost, lower maintenance, higher durability, and better options for utility and bike/ped facilities than a bridge alternative			

Note: All of the proposed structures evaluated below are open-bottom crossing structures with similar Resource, ROW, and Utility Impacts.

ROAD ALTERNATIVE 1 - ELEVATION



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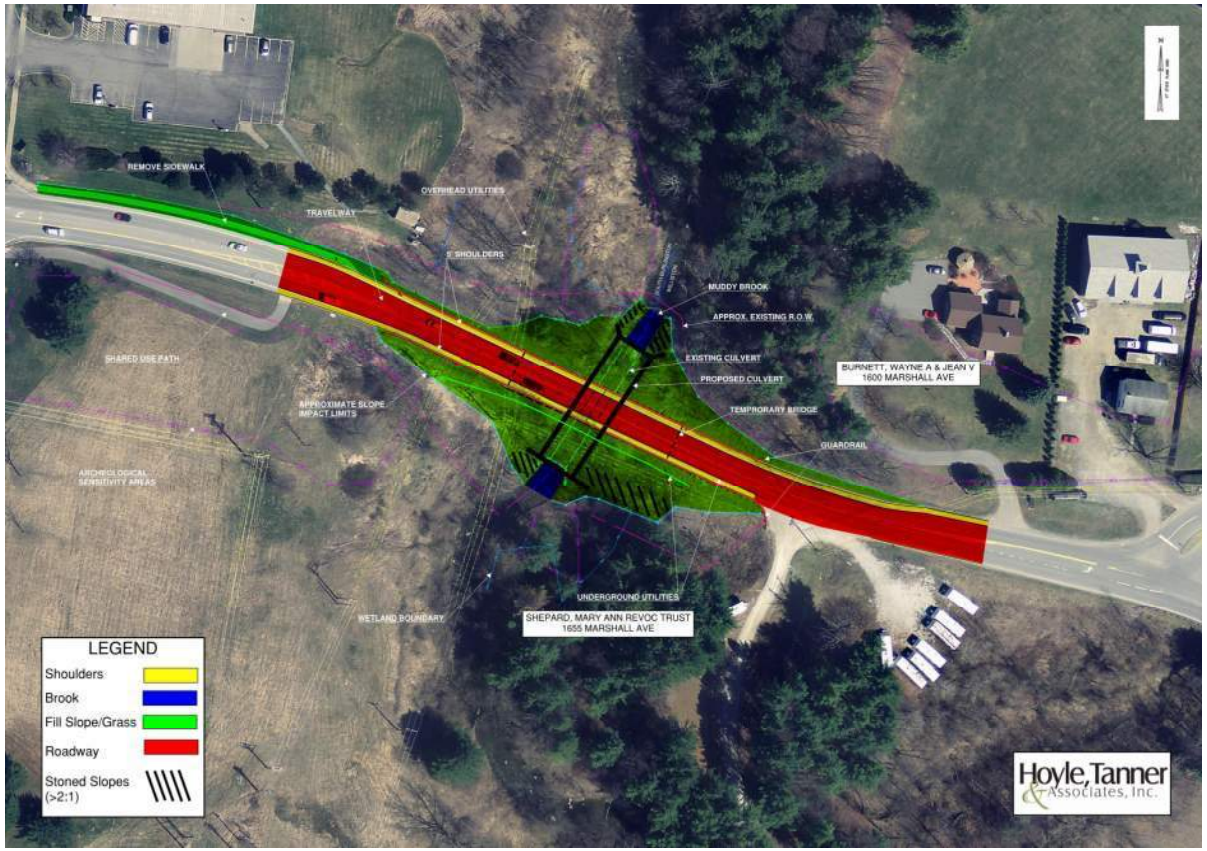
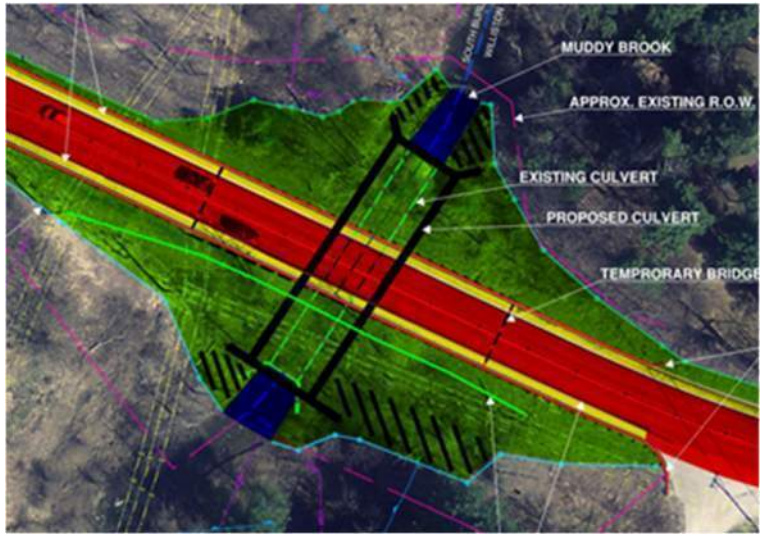
ROAD ALTERNATIVE 1 – ON-ROAD FACILITIES





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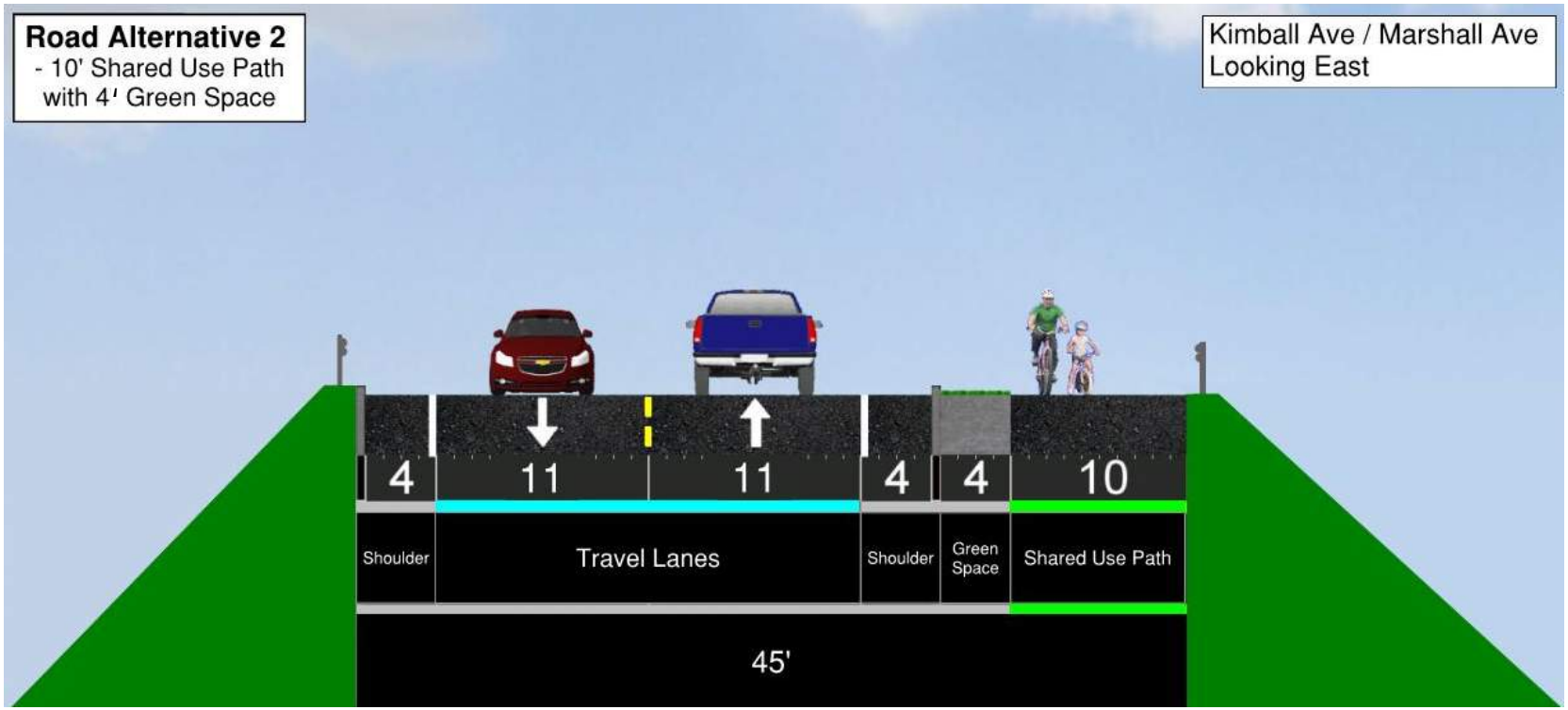
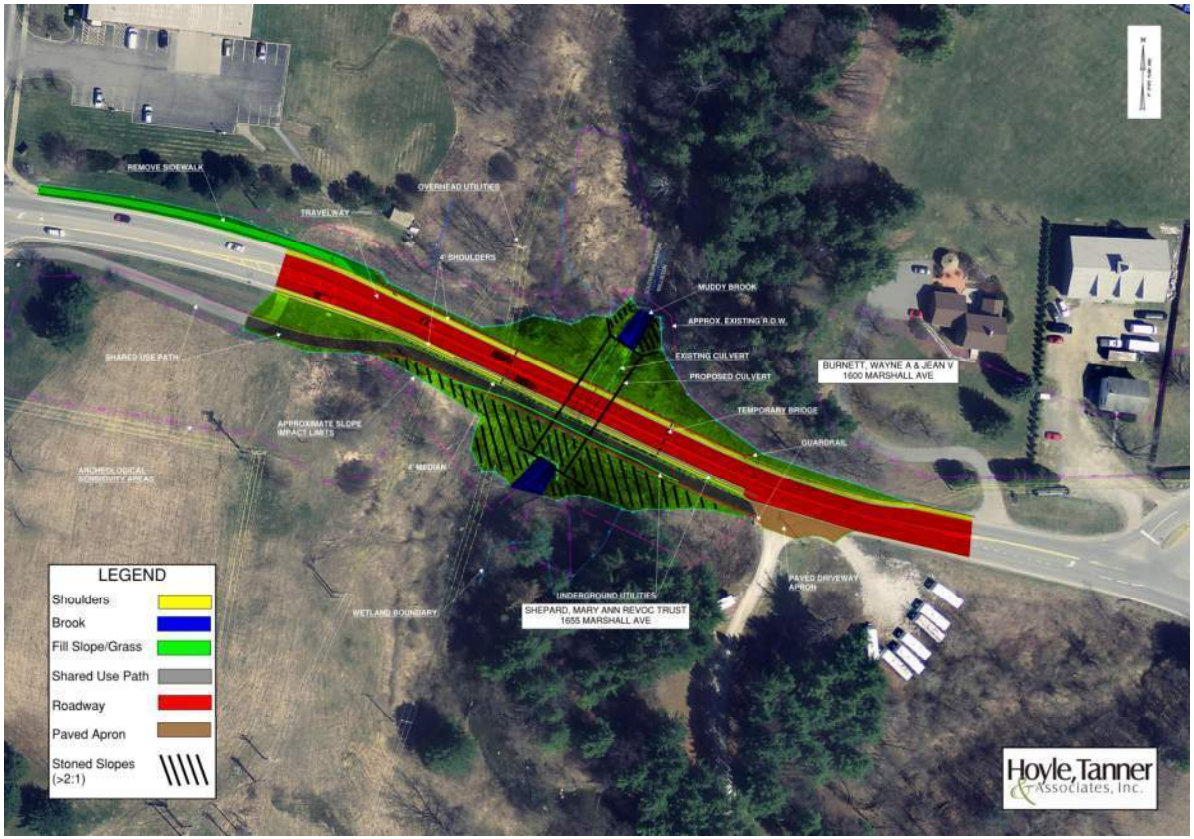
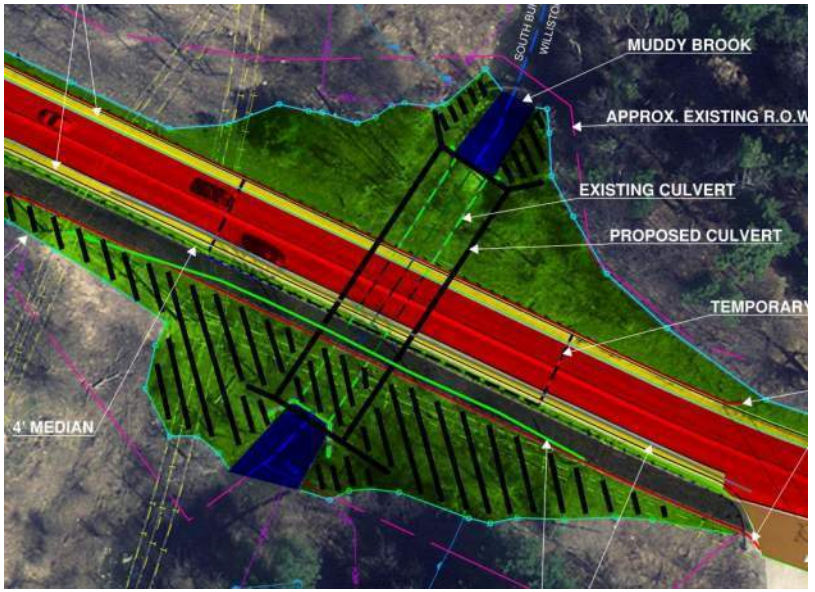
ROAD ALTERNATIVE 2 - ELEVATION

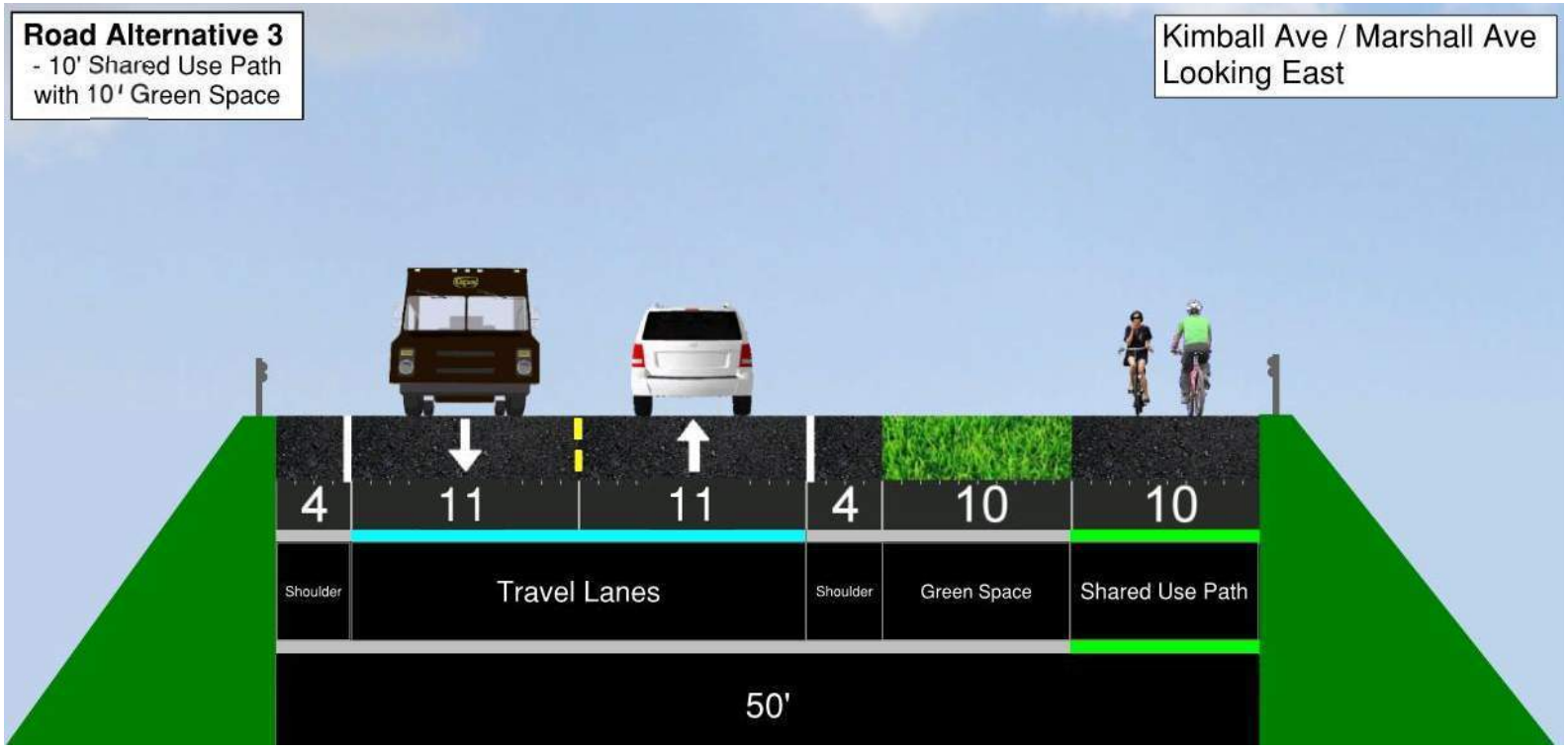


ROAD ALTERNATIVE 2 – 4' GREENSPACE WITH CURBS

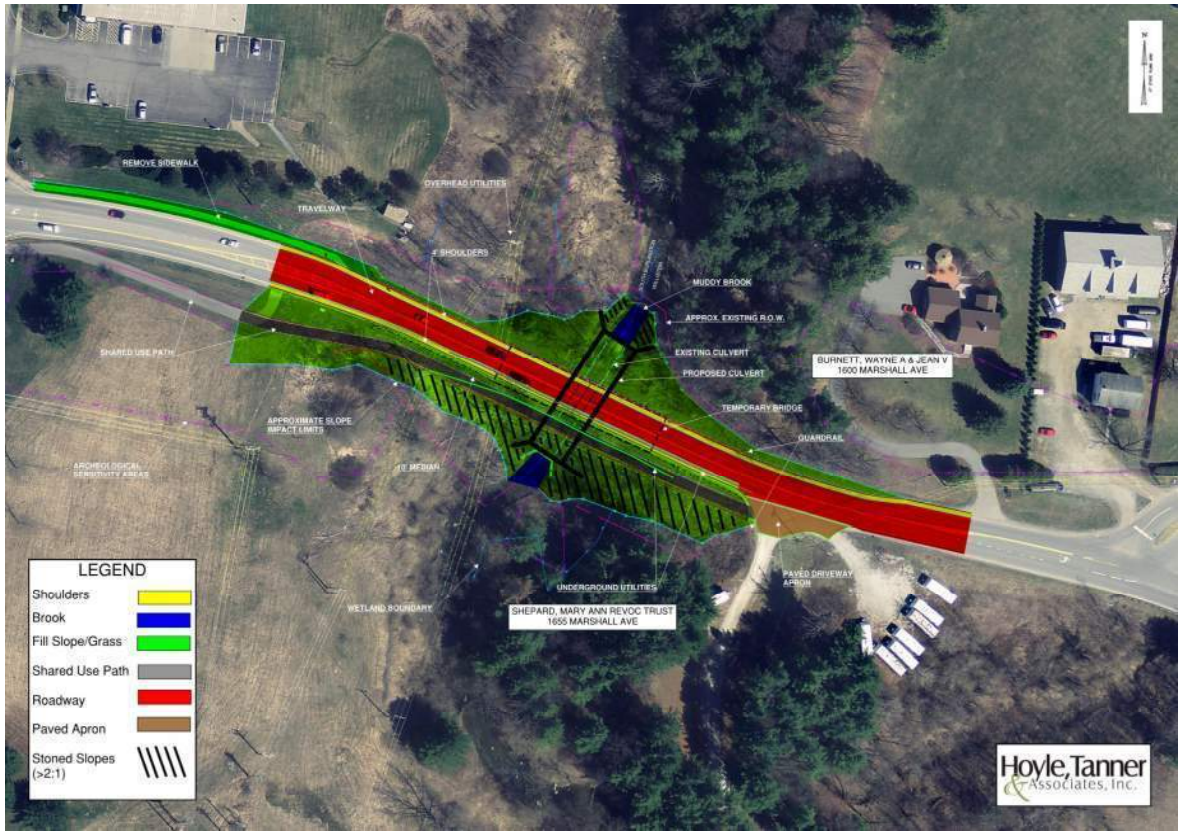


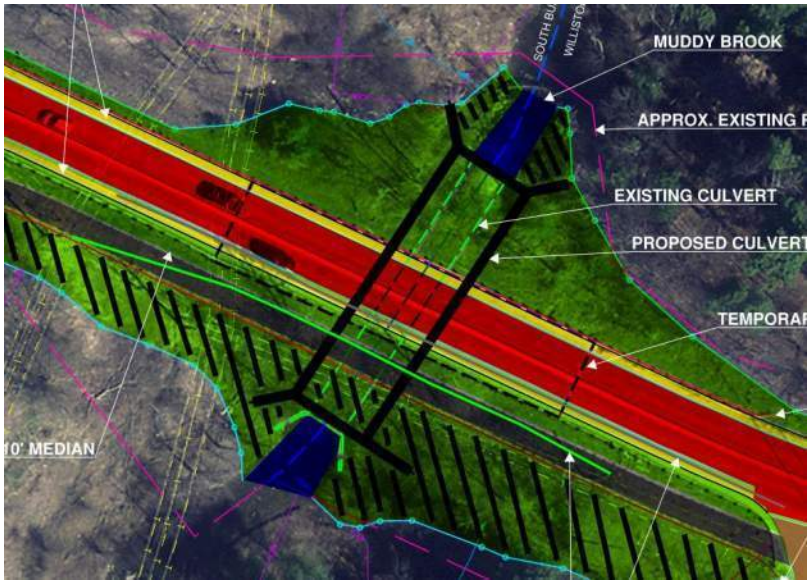


ROAD ALTERNATIVE 3 - ELEVATION



ROAD ALTERNATIVE 3 – 10’ GREENSPACE





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ROAD ALTERNATIVES MATRIX

	Bike/Ped Accommodations	Other Considerations	Meets Purpose & Need	ROW Impacts	Utility Impacts	Resource Impacts	Cost (Including Struct Alt 2)
Road Alt 1: No Path	• 5' Marked Shoulders EB and WB (On-Road Facility)	• Does not provide separation of Bike/Ped from Vehicles	Partial On-Road Facility	None	None	Temporary	$1,689,000
Road Alt 2: 4' Greenspace	• 4' Shoulders EB and WB • 10' Separated Shared Use Path		Yes	Minimal for Path	Potential Pole Relocation	Temporary	$1,791,000
Road Alt 3: 10' Greenspace	• 4' Shoulders EB and WB • 10' Separated Shared Use Path	• Best Bike/Ped Safety and User Comfort • Greenspace provides snow storage and SW Treatment • No CB grates in Roadway Shoulders	Yes	Minimal for Path	Potential Pole Relocation	Potential Tributary and Wetland Impacts – Field Survey Required	$1,806,000

Notes:

1. Temporary Traffic: All alternatives were developed based on a full bridge closure during construction with a roadway detour on US Route 2 Williston Road from Kennedy Drive to South Brownell Road.
2. Utility Impacts: All alternatives have underground utility impacts to Telecom and Gas lines during structure replacement.

COMMENTS

PUBLIC INFORMATIONAL MEETING – GOAL TO SELECT THE PREFERRED ALTERNATIVE

CONTACT

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Hoyle, Tanner & Associates, Inc.
www.hoyletanner.com

APPENDIX K

Design Criteria

Kimball / Marshall Ave
Muddy Brook Crossing Culvert Replacement
STP MM18(3)

Design Criteria

Roadway Design

ROADWAY FUNCTIONAL CLASS:	Class II Town Highway, Major Collector
DESIGN SPEED:	40 MPH
DESIGN MANUALS:	1) AASHTO "A Policy on Geometric Design of Highways and Streets", 2011, 6th Edition. 2) AASHTO "Roadside Design Guide", 2011, 4th Edition. 3) VTrans Roadway Design Manual, 1998 Edition. 4) Manual on Uniform Traffic Control Devices, 2009 Edition.
CONSTRUCTION SPECIFICATIONS:	1) 2018 Standard Specifications for Construction
DESIGN GUIDELINES:	1) NCHRP Report 480; "A Guide to Best Practices for Achieving Context Sensitive Solutions", 2002. 2) AASHTO "A Guide for Achieving Flexibility in Highway Design", May 2004. 3) VTrans Pedestrian and Bicycle Facility Design Manual, 2002.

Structure Design

DESIGN LOADING:	HL-93
DESIGN MANUALS:	1) VTrans Structures Design Manual, 2010 2) VTrans Hydraulics Manual, May 28, 2015
DESIGN SPECIFICATIONS:	1) AASHTO LRFD Bridge Design Specifications 8th Edition
CONSTRUCTION SPECIFICATIONS:	1) 2018 Standard Specifications for Construction
DESIGN GUIDELINES:	1) Guidelines for the Design of Stream/Road Crossings for Passage of Aquatic Organisms in Vermont, March 2009