North Hero–Grand Isle
DRAWBRIDGE

SCOPING REPORT

No. Hero-Grand Isle Bridge BHF 028-1(26)

Vermont Agency of Transportation

Montpelier, Vermont

March 27, 2015

April 7, 2015

Mr. Danny Landry, Project Manager
Structures-Project Development Division
Vermont Agency of Transportation
National Life Building, Drawer 33
Montpelier, VT 05633-50010

Re: North Hero-Grand Isle BHF028-1(26)
Final Scoping Report

Dear Danny:

Enclosed with this letter please find a revised copy of the Final Scoping Report addressing all the comments that we received on the final submission of the scoping report for your files.

In the mean time please do not hesitate to call with any questions or comments as you conduct your review:

Very truly yours,

HDR, Inc.

Chad

Charles Swanson, P.E.

PD/chs
Enclosures

hdrinc.com

TABLE OF CONTENTS

Introduction 1
Purpose and Need Statement 2
Problem Description and Location Maps 4
Problem Description 4
Vermont Location Map 6
Local Towns Location Map 7
USGS Location Map 8
Roadway Information 9
Design Criteria 9
Terrain 9
Existing Roadway Conditions 10
Roadway Width 10
Horizontal Alignment 10
Vertical Alignment 11
Sight Distance 11
Residential and Commercial Drives 12
Utilities 12
Accidents 13
Hydraulic Information 14
Right-of-Way Information 14
Traffic Data 14
Sign Inventory 16
Intermodal/Multi-modal Uses 16
Temporary Ferry Service 17
Alternative Alignments 17
Geotechnical Conditions 19
Resource Information 22
Wetland and Water Resources/Army Corp of Engineers and US Coast Guard Involvement 22
Significant Plant and Animal species 22
Fisheries 22

Wildlife Habitat 22

Rare, Threatened, and Endangered Species 22

Land Use Resources 23

Sections 4(f)/6(f) Resources 23

Other Natural Resource Considerations 23

Historic Resources 24

Archaeological Sites 24

Historic Sites and Structures 25

Agricultural Resources 25

Agricultural Lands 25

Local and Regional Concerns 26

Alternatives 27

General 27

No Build – Existing Condition 27

Alternative I – Rehabilitation 28

Alternative II – New Movable Structure on Existing Alignment 29

Alternative III – New Movable Structure Off-Alignment 31

Life Cycle Cost Analysis 33

Evaluation Matrix 34

Recommendations 35

Introduction 35

Recommendation - Alternative II – Option B 35

Appendix A – Roadway, Traffic and Accident Data

Appendix B – Existing Conditions Report

Appendix C – Life Cycle Cost Analysis Report

Appendix D – Geotechnical Engineering Report

Appendix E – Marine Data

Appendix F – Cultural Resources Report

Appendix G – Water Resources

Appendix H – Resource Agency Correspondence

Appendix I – Meetings (Local Concerns/Alternatives Presentation)

Appendix J – Local Concerns Survey by VTrans

Appendix K – Conceptual Cost Estimates

Appendix L – VHB Draft Scoping Report (2002)

Appendix M – Detailed Plans (11" x 17")

Appendix N – Photos

Introduction

This scoping report is presented by HDR to develop alternatives that address the deficiencies of Bridge Number 8 along US Route 2 linking the towns of North Hero and Grand Isle (South Hero Island).

This structure is a double leaf bascule drawbridge and is the only working highway drawbridge in the State of Vermont. Bridge Number 8 provides the only vehicular connection between North Hero and Grand Isle and the only unrestricted height passage for marine traffic traveling into the "Gut" on Lake Champlain. The movable bridge, built in 1953 and rehabilitated in 1996 with additional repairs performed in 2007, requires an increasing amount of maintenance to continue safe and reliable operation.

Photo showing the draw bridge opening

HDR has developed several alternatives that provide varying level of improvement to the structure and the connecting roadway. These alternatives were developed utilizing data gathered from an extensive information search of VTrans records, structural inspection, various resource agencies, and from several site surveys. Additionally, public input was sought via Local Concern Meeting and a survey sent to the North Hero and Grand Isle residents. All information was considered and integrated into the scoping process to produce the proposed alternatives. This report presents the gathered information, identifies project issues, and evaluates solutions to satisfy the project Purpose and Need Statement. The recommendations made are based on safety, environmental resources, historical and cultural setting, public and agency input and cost-effectiveness.

Purpose and Need Statement

Purpose

The purpose of this project is to enhance and maintain the mobility and safety of vehicle, bicycle, pedestrian traffic traveling across and the bridge structure along US Route 2 between the towns of Grand Isle (South Hero Island) and North Hero and vessel traffic transiting into the "Gut".

Need

The causeway/movable bridge provides the only vehicular connection between North Hero and Grand Isle along US Route 2, local connectivity within the island, and regional connectivity between New York and Vermont. The water channel provides one of the most important east-west crossing points for Lake Champlain marine traffic. Due to the increasing amount of vehicle traffic along US Route 2 and vessel traffic through the channel, the mobility of both modes of transportation is inhibited by the condition and operational reliability of the movable bridge.

Numerous concerns and deficiencies regarding the bridge support the purpose. These concerns include:

Traffic

Increases in the amount of marine traffic result in more frequent and longer open drawbridge time periods, thus increasing the delay for vehicular traffic traveling along US Route 2.

The average annual daily traffic (AADT) for the current year is estimated at 3000 vehicles per day. AADT is projected to increase to approximately 3050 vehicles per day during the design year (2026). Average daily truck traffic is predicted to be 495 trucks per day in the design year versus 485 trucks per day currently.

Structural Deficiencies

Deck

The open steel grid deck has developed numerous holes and pits through the main and secondary grating bars. The open deck has exacerbated the accumulation of debris on the structural elements accelerating corrosion.

Superstructure

All of the bascule girders have areas of deep pitting and pack and surface rust. The floor beams in the lift spans are in poor condition with significant section loss at the connections to the bascule girders. These beams were previously patched to correct heavy section loss while some have small rust holes through the beams. The paint system, applied in 1996, is failing in all locations of the bascule span.

Mechanical

The machinery supports and their anchors to the pier are exhibiting significant section loss in numerous locations. The span operating machinery gears sets have excessive backlash and plastic flow of gear teeth. The span lock machinery has excessive clearance resulting in live load being carried throughout the span drive machinery. The front live load shoes are not in full contact and allow vehicles to apply excess impact to the span and may be restricting full closure of the bridge.

Electrical

Motor and machinery brakes are approaching the end of their useful life. Span drive motors have low insulation readings indicating that they are at the end of their useful life. Other electrical conditions include exposed and improperly terminated conductors within each submarine cable cabinet, and through out the bridge which are a reliability concern. The layout of the electrical equipment is not in compliance with National electrical Code requirements for access and arc-flash protection. The control system safety interlocks are not redundant as required by code and current design practices which poses a significant safety risk to both VTrans staff and the Public.

Maintenance Concerns

The drawbridge, originally constructed in 1953 and rehabilitated in 2008, requires enhanced and increasingly costly maintenance to prolong reliable operation.

Pedestrian and Bicycle Access

This crossing is utilized by increasing numbers of pedestrians and bicycles and provisions should be considered for the safety and mobility of these modes of transportation.

Problem Description and Location Maps

Problem Description

In the summer of 2007 VTrans bridge inspectors determined that the bridge was unsafe for two way traffic. Closing the bridge and thereby shutting down this section of Route 2 to traffic would have created a detour of approximately 70 miles one direction. Moreover the drawbridge is essential to navigation as it is the only access point for large boats to reach what is called the inland sea, the waterway which reaches to St. Albans and other parts of Franklin County and Milton. Recognizing the importance of this bridge, VTrans conducted emergency repairs on the 54 year old bridge. The repairs included replacement of floor beams and diaphragms, decking with new galvanized members, installation of bascule locking mechanisms, and minimal removal of lead paint. Once the repairs were completed in 2008, VTrans decided to reevaluate the condition of the structure and place the scoping study on hold. In 2013, VTrans developed an RFP to finalize the draft scoping study. The Team was selected to finalize the scoping study and develop conceptual drawings.

The Bridge Number 8 along US Route 2 linking the towns of North Hero and Grand Isle (South Hero Island) consists of a twin leaf bascule span that was constructed in 1953. This is the only active highway movable bridge in Vermont. VTrans has been expending valuable resources and dollars on maintenance and operations of this bridge for the last decade. The machinery is antiquated and the electrical system is old, unsafe, and deteriorating quickly. The bridge structure is in poor condition due to the configuration the bascule backspan enters the water everytime the bridge opens, which allows direct contact of water with the structural steel repetitively. This repetitive contact with water and the open deck system allowing salt/debris laden water to pass through the deck has accelerated the deterioration of the structural steel.

The HDR inspection team documented existing conditions and developed an existing conditions report that is included in appendix B. The inspection noted several areas of concern that will need to be addressed immediately and within the next 3 to 5 years if the replacement doesn't occur within that time frame.

Structural repairs: Rehabilitate live load shoes (Replace shims)

Mechanical repairs: Clean all bearings and gears, reset bearing clearances, dress gear teeth as required, replace grease fittings, lubricate machinery; repair machinery anchor bolts, adjust span lock clearances and replace pins as required.

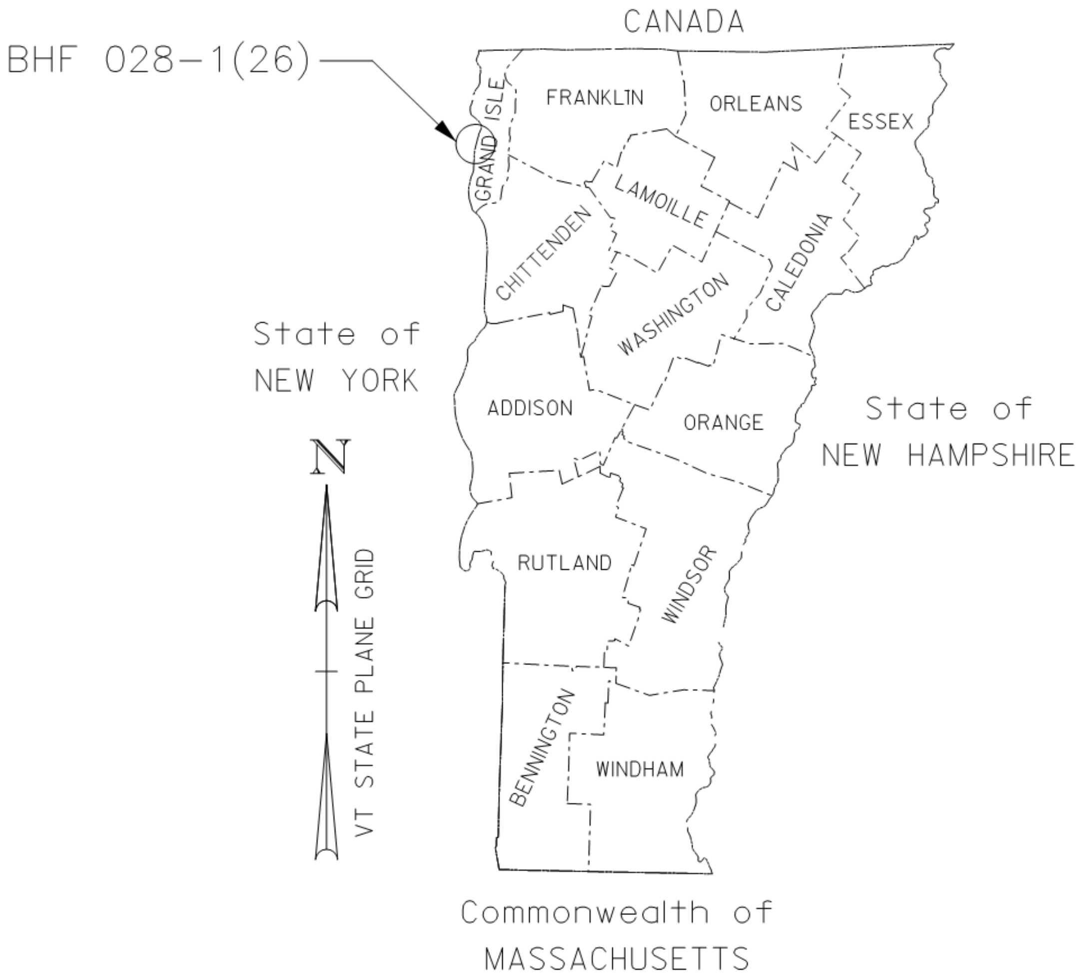
Electrical repairs: Repair traffic gate warning lights and gongs, replace navigation lights, rehabilitate droop cable and all open/broken conduits and cables, replace and adjust all limit switches.

Estimated Construction Costs			
Work	labor	Materials	Total
Structural	$ 19,360	$ 20,563	$ 39,923
Mechanical	$ 49,280	$ 45,000	$ 94'280
Electrical	$ 45,760	$ 35,000	$ 80,760
Sub Total	$ 100, 560	$ 114,403	$ 214,963
Mobilization (10%)			$21,500
Total Project			$ 236,463

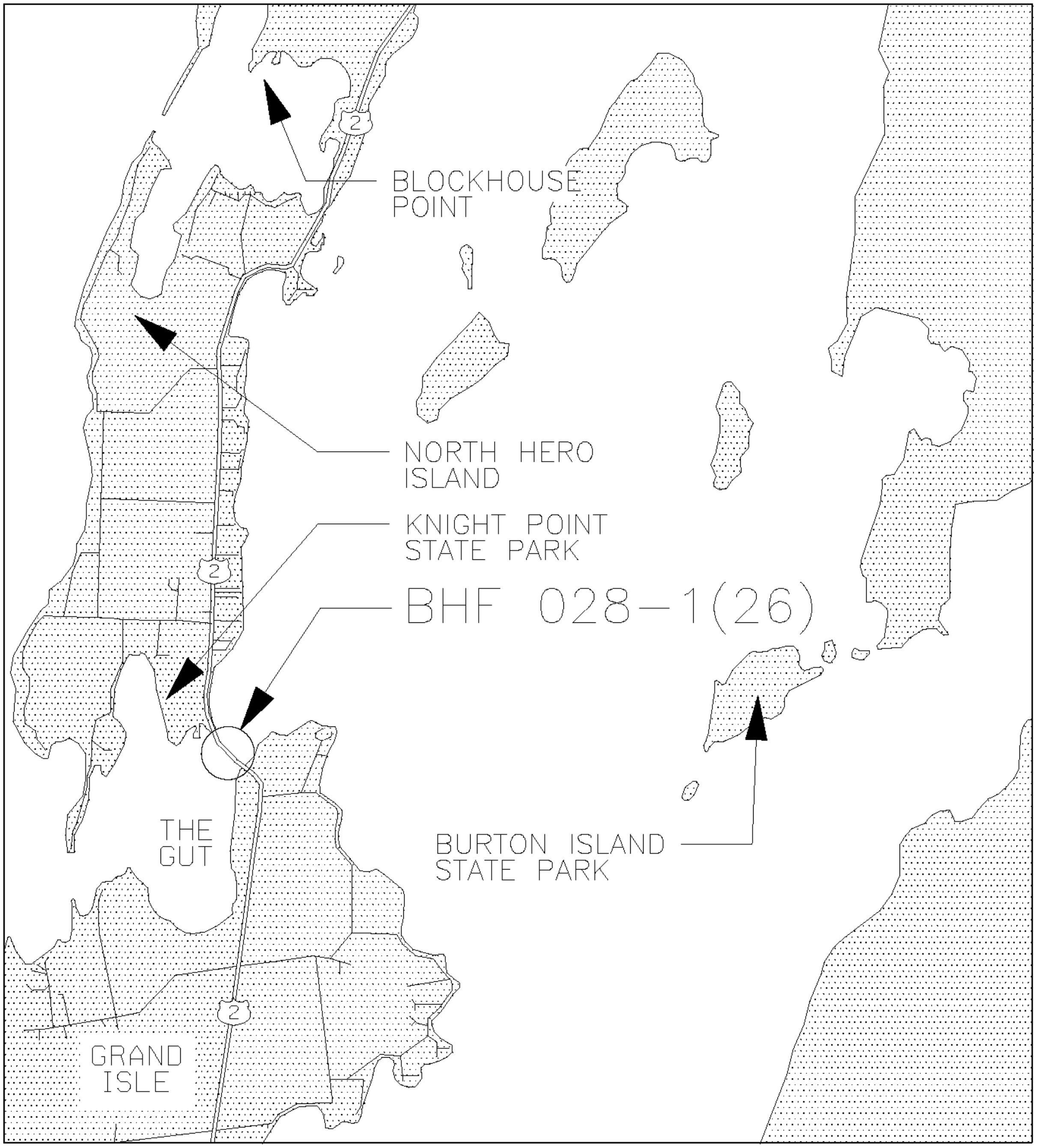
Note: Electrical costs do not include replacement of a drive motor ($ 55,000)

Engineering design and contract document development costs for this effort are not included.

Vermont Location Map



Local Towns Location Map



USGS Location Map

Roadway Information

Design Criteria

The Team has prepared this scoping report based on the following state and federal standards:

Vermont State Standards

Vermont Agency of Transportation Structures Manual

AASHTO LRFD Bridge Design Specifications

AASHTO A Policy on Geometric Design of Highways and Streets

Manual on Uniform Traffic Control Devices (MUTCD)

AASHTO LRFD Movable Bridge Design Specifications

AASHTO Manual for Bridge Evaluation

Terrain

The North Hero-Grand Isle project includes the causeway and Bridge Number 8 crossing Lake Champlain on US Route 2 between the Towns of North Hero and Grand Isle. The terrain within the project area is considered "rolling" with Lake Champlain on each side of the causeway. Lake Champlain is very large and wide so the bridge structure and causeway is exposed to all the elements with no protection.

Photo showing the causeway is exposed, rolling, and open

Existing Roadway Conditions

Roadway Width

US Route 2 in the project area is classified as a rural minor arterial roadway with a posted speed limit of 50 mph. The existing typical roadway section approaching the bridge consists of an 11-foot travel lane in each direction with 5-foot paved shoulders. The existing side slopes are generally 1-1.5 (vertical-horizontal) or flatter along the causeway and are protected by steel beam guardrail. There are no sidewalks in the project area.

The existing lane and shoulder dimensions satisfy the minimum design criteria set forth in the *Vermont State Design Standards* for the roadway classification and ETC+20 design year (2037) traffic volumes. Additionally, the 5-foot paved shoulders satisfy the minimum requirements for use by bicyclists and pedestrians.

The pavement condition is generally good on both bridge approaches with the most recent resurfacing projects completed by VTrans in 2013 (western approach) and 2014 (eastern approach).

Horizontal Alignment

As illustrated in Figure 1, the horizontal alignment of US Route 2 in the project area consists of three main features (described traveling in the eastbound direction):

(1) 1910-foot radius curve superelevated down left at approximately 7.7%.

(2) 1980-foot tangent section over the bridge.

(3) 920-foot radius curve superelevated down right at approximately 6.0% on the high side (consistent with VTrans design guidance for superelevation at a side road intersection) and 8% on the low side.

For a rural minor arterial roadway and a maximum superelevation rate (e_{max}) of 8%, both existing horizontal curves in the project area

Figure 1. Top: Project Area Map illustrating location of existing US Route 2 horizontal alignment features. Bottom: Site photos corresponding to numbered features on Project Area Map.

exceed the minimum standards for the proposed 50 mph design speed.

Vertical Alignment

As illustrated in Figure 2, the vertical alignment of US Route 2 in the project area consists of the following features:

(1) 600-foot sag vertical curve with entering and exiting tangent grades of approximately -1.2% and +1.5% providing a headlight sight distance (HSD) exceeding 1000 feet and a K value of 222.

(2) 700-foot crest vertical curve with entering and exiting tangent grades of approximately +1.5% and -0.01% with a stopping sight distance (SSD) exceeding 1000 feet and a K value of 463.

(3) 600-foot sag vertical curve with entering and exiting tangent grades of approximately -0.01% and +3.0% with a HSD of approximately 875 feet and a K value of 199.

(4) 500-foot crest vertical curve with entering and exiting grades of approximately +3.0% and +1.4% with a SSD of approximately 920 feet and a K value of 313.

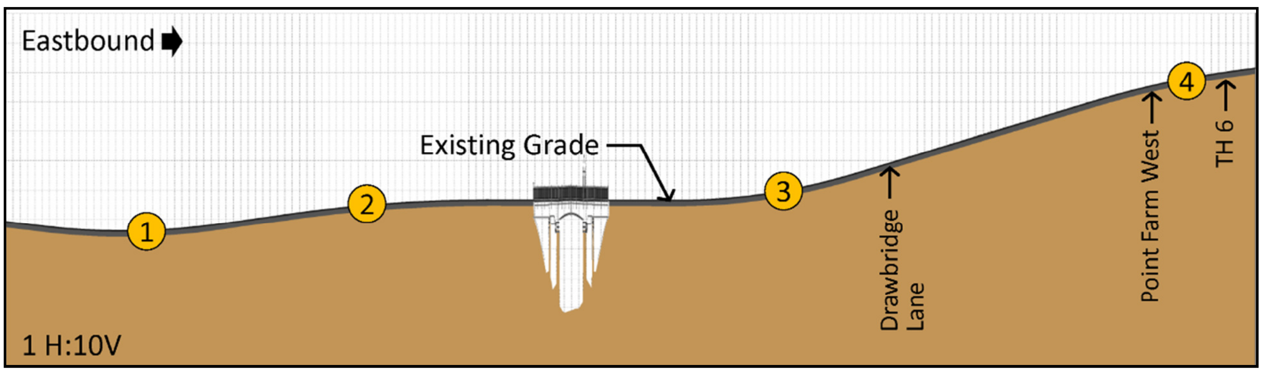


Figure 2. Existing US Route 2 profile illustrating location of existing vertical alignment features (not to scale).

For a rural minor arterial roadway with rolling terrain and a design speed of 50 mph, the *Vermont State Design Standards* specify the following vertical alignment design values:

- Maximum grade of 5%
- Minimum SSD of 400-475 feet
- Minimum K value for crest vertical curves of 110-160
- Minimum K value for sag vertical curves of 90-110

The existing US Route 2 profile in the project area satisfies the above design values.

Sight Distance

As presented in the *Vertical Alignment* section, the existing US Route 2 profile provides sight distances on all four vertical curves in the project area that exceed the minimum stopping sight distance (SSD) of 400-475 feet, as set forth by the *Vermont State Design Standards* for a rural minor arterial roadway and a design speed of 50 mph.

Relative to horizontal sight distance along the two horizontal curves in the project area, the minimum SSD of 400 feet is provided through both curves. More specifically:

- The 1910-foot radius curve west of the bridge requires a clear sightline with a horizontal sightline offset of approximately 10.5 feet measured from the center of the travel lane to provide the minimum SSD. Traveling westbound through the curve, the sightline passes along the existing shoulder and reaches a maximum offset located approximately 1 foot in front of the face of guardrail with no obstructions (assuming roadside vegetation is maintained and not encroaching on the shoulder).

- The 955-foot radius curve east of the bridge requires a clear sightline with a horizontal sightline offset of approximately 21 feet measured from the center of the travel lane to provide the minimum SSD. Traveling eastbound through the curve, the sightline passes outside the existing edge of pavement in a fill section and reaches a maximum offset located approximately 8.5 feet beyond the pavement with no sightline obstructions.

Residential and Commercial Drives

There are several drives providing residential, commercial, and recreational access to and from US Route 2 in the project area. These include:

- A gravel drive located just west of the causeway in North Hero that provides access to a recreational boat ramp on the westbound side of US Route 2. There is a gravel parking area located just east of this drive along the westbound shoulder; the parking area is approximately 12-20 feet wide by 400 feet long and can accommodate approximately 8 passenger vehicles with boat trailers parked end-to-end. The boat launch is located within State rights-of-way and is maintained by personnel from Knight's Point State Park.
- Three residential drives located just west of the eastern project limit on the eastbound side of US Route 2.
- One private drive ("Landing Lane") is located approximately 500 feet east of the causeway on the westbound side of US Route 2. This drive provides access to a marina, and a gravel access road located parallel to US Route 2 that serves the operator's house on the eastern end of the bridge.

Utilities

There are aerial utilities and submarine cables that were identified during the field inspections. The aerial utilities, consisting of telephone, electric and cable, exist on both sides of US Route 2 at the beginning of the project area and then consolidate to the north side at the beginning of the 1910 foot horizontal curve. The aerials remain on the north side of US Route 2 throughout the remainder of the project area. In the area of the drawbridge, the cables travel down the poles and into a submarine cable buried beneath the channel. The communication submerged cable is a straight line between the two poles and approximately 20 feet below the lake bottom. There are two electrical submarine cables that start at each pole north and south of the bascule bridge and are not located in a straight line to make sure that the cables do not put stress on the shore line poles. The high voltage submarine cable is owned by Vermont Electric Coop and provides power to the Island and the low voltage submarine cable is part of the bridge structure and it provides power to the north pier machinery. The approximate location of the electrical submarine cable is shown in the following sketch.

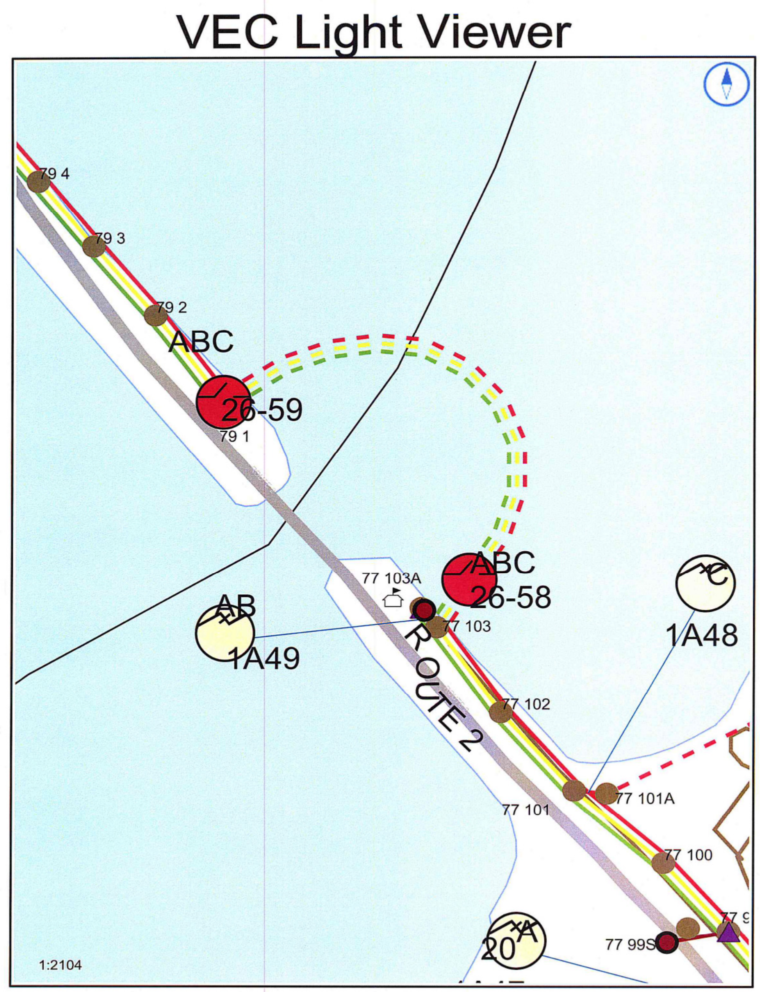


Figure 3 Approximate location of the electrical submarine cable

The low voltage submarine cable will removed or replaced based on the alternative selected. The impacts to the low voltage submarine cable impacts are discussed within the alternatives section of this report.

Accidents

An accident analysis was performed using the accident records compiled from VTrans' High Accident Location Report for the five-year period of January 2008 to December 2012. The report showed a total of thirteen accidents occurring within the ±1.5 mile project area.

Of the thirteen documented accidents in the project area, approximately four (31%) of the accidents were personal injury accidents, and the remaining nine (69%) were property damage only accidents. There were no fatalities.

The predominant accident types were single vehicle (8), followed by sideswipe in same direction (3), and head-on (2) accidents. Eleven of the accidents involved inattention; failing to yield right-of-way; driving too fast; and disregard of traffic signs, signals and road markings. One involved a motorist being under the influence of drugs or alcohol and another accident involved the motorist falling asleep. The remaining two accidents had no identified contributing factor.

Hydraulic Information

Within the study area, there are no observed or surveyed culverts or storm drain appurtenances. Throughout a majority of the project limits, the roadway storm water simply runs off the shoulder and is treated as it flows through the roadside grass growth. This vegetation also serves to slow the velocity of the storm water to avoid concentrated flow and erosion. Outside the causeway section, some shallow roadside ditches serve to convey the runoff downgrade toward the lake, while the majority of the runoff travels overland at the bottom of the roadway fill slope.

The hydraulic conditions at the bridged opening in the causeway were not formally analyzed during this study. According to information supplied by the VTrans Hydraulic Unit, the existing bridge is adequate hydraulically. The existing minimum bottom of beams elevation is about 110.0 feet, providing approximately 8 feet of freeboard over the Q100 elevation on the lake of 102.0 feet. The proposed alternatives all raise the minimum bottom of beam elevation to approximately 111.9 feet, thus increasing the freeboard. The bridge has had no observed scour or bank erosion problems, but if the new alignment alternative is chosen then fill slopes will need to be protected against erosion from wave action.

There was no analysis completed by VTrans regarding an expanded opening and the effects a larger opening in the causeway may have on the hydraulics of the project area. The size of a new bridge in this area, and the causeway opening, is more likely to be governed by environmental and navigational concerns than by hydraulic conditions.

Right-of-Way Information

VTrans Right-of-Way Section provided right-of-way information for US Route 2 in the area of the project. The information consists of three (3) sets of plans, dated from 1936 through 1953. According to the information contained within these plans, the right-of-way varies from a minimum of approximately 28 feet to 50 feet on the south side of US Route 2 and from 25 feet to 125 feet on the north side. These limits are approximated on the alternatives plans.

Alternatives I and II can be constructed within the State owned right of way and no additional right-of-way or permanent easements will be necessary. Alternative III will require additional right-of-way takings as well as permanent easements in order to construct the new bridge off alignment. Alternatives I and II may require a temporary easement for the replacement of the submarine cable.

Traffic Data

The existing Annual Average Daily Traffic (AADT) volumes were obtained from VTrans 2012 (Route Log) AADTs for State Highways, May 2013, which shows that the existing (2012) AADT for the US Route 2 within the project area is 3,000 vehicles per day (vpd).

The existing (2012) design hourly volume (DHV) was estimated by applying the "K" factor shown for the continuous traffic count station P6G025 located near the project area to the AADT, in accordance with VTrans' Continuous Traffic Counter Grouping Study and Regression Analysis, February 2014, (the Red Book). Using the 2013 Automatic Vehicle Classification Report, the average daily and peak average truck traffic for rural minor arterials is approximately 8.96% and 8.2%, respectively. These truck percentages were assumed to apply to the future design year condition analyses.

Also using the Red Book, the future AADT and DHV for the estimated time of completion (ETC) and ETC+30 conditions were developed by applying the growth factors shown for rural primary and secondary highway group.

Existing and Forecast Traffic Volumes		
Condition	**AADT**	**DHV**
Existing (2012)	3,000	485
ETC (2017)	3,030	490
ETC+30 (2047)	3,120	500

Capacity analyses were performed using the procedures outlined in the 2010 Highway Capacity Manual (HCM), published by the Transportation Research Board, to determine the levels of service (LOS) for the Existing (2012), ETC (2017), and ETC+30 (2047) conditions for this two-lane highway.

Level of service (LOS) is presented as a letter from A to F with A representing free flowing, unimpeded traffic with little or no delay and F representing highly congested traffic flow with long delays. The LOS for this type of roadway is defined in terms of percent time spent following (PTSF). PTSF represents the freedom to maneuver and the comfort and convenience of travel. PTSF values represent the average percentage of time that vehicles must travel in platoons behind slower vehicles due to the inability to pass. The LOS thresholds for two-lane highways are as follows:

HCM Two- Lane Highway LOS Standards for Automobile Modes	
LOS	**PTSF[1]**
A	≤40
B	>40-55
C	>55-70
D	>70-85
E	>85

1: PTSF = Percent time spent following (%)

Traffic operations were analyzed for each direction of travel with the results summarized as follows:

Condition	Direction 1		Direction 2	
	LOS	[PTSF][1]	LOS	[PTSF][1]
Existing (2012)	C	[63.5]	B	[46.4]
ETC (2017)	C	[64.1]	B	[47.0]
ETC+30 (2047)	C	[64.2]	B	[47.7]

1: PTSF = Percent time spent following (%)

As shown in these analyses, the existing and future operating conditions on US Route 2 in the project area are LOS B and LOS C, which describe operations where vehicles are traveling in platoons and a reduction in speed is noticeable. The existing and future LOS B and LOS C operations suggest that the volumes can be adequately accommodated by a two-lane facility.

The moveable bridge operates on a regular 30-minute schedule (on the hour and half-hour), subject to actual vessel traffic, which is variable. The amount of time that the bridge is in an "up" position to allow vessels to pass through the channel is also variable based on the number and sizes of boats queued. Typically, it takes approximately four minutes to accommodate each bridge opening, from the time the gates are down and vehicle, pedestrian, and bicycle traffic is stopped to the time the gates are up and the road is re-opened to traffic. The bridge remains in a "down" position (open to vehicular/pedestrian/bicycle traffic) in cases where there is no marine demand at the time of a scheduled raising.

Using the existing DHV of 485 vehicles per hour (vph) and a uniform arrival rate, it is estimated that approximately 5 vehicles travel in one direction every minute; or 20 vehicles every four minutes. Thus, when traffic is stopped to accommodate boats passing through, an existing queue of 20 vehicles in one direction could be observed. Applying this same methodology to the ETC+30 condition also yields a queue of 20 vehicles over a four minute period indicating that the future queues in ETC+30 will be comparable to existing conditions. Informal observations of traffic patterns suggest that local drivers will schedule their travel to avoid the potential bridge delays at the half-hours, which reduces the occurrence of significant queuing.

Sign Inventory

Signal and signage for this project shall follow the MUTCD standards for movable bridges. The sign inventory for this project area will contain the appropriate warning and regulatory signage and signaling for a movable bridge. "No parking" signs will also be posted along the project areas.

Intermodal/Multi-modal Uses

US Route 2 in the project area is part of *The Champlain Bikeway*, a 1,400 mile bicycle network in the Champlain region of Vermont, New York, and Quebec. Based on accounts of local residents, bicycle traffic is relatively frequent during the fair weather and summer months.

Pedestrian traffic in the project area is generally limited, with occasional use by sport fishermen and other recreational users.

The existing shoulder widths in the project area are approximately 5 feet (paved) along the roadway and 4 feet on the bridge. There are no sidewalks. The shoulder widths meet or exceed the minimum width of 4 feet needed to accommodate shared use by bicyclists, as set forth by the *Vermont State Design Standards* for a rural minor arterial roadway, and pedestrians, as specified in the latest *Americans with Disabilities Act Accessibility Guidelines* (ADAAG, 2010).

Temporary Ferry Service

HDR investigated implementing a temporary ferry service during the replacement of the North Hero Grand Isle Bridge. The bascule bridge operates only during the summer months. During the winter months the channel underneath the bridge rarely freezes over, but the bays on both sides of the causeway are subject to freezing and this would be a cause of concern for running the ferry systems all year round.

HDR worked with VTrans to identify potential locations for the ferry docks both north and south of the bridge. The proposed dock locations will require dredging in order to establish a deep enough berth to dock a ferry boat.

The ferry boat dock locations will need to be permitted, which will add additional costs and time to the project. The team will need to develop permits for Lake Encroachment, coast guard, water quality and wetlands. These permits will take up to a year to obtain and will be required in order to construct and install the temporary ferry service.

Each of the ferry docks will require infrastructure improvements that will consist of design and construction of additional causeway. The ferry dock will require piles to support the dock system.

The estimated cost for the temporary ferry services is based on the temporary ferry service costs for the Champlain Bridge Project. The cost per day included design, infrastructure improvements, and operation of the temporary ferry service. The cost was $111,027.12 per day of operation and the estimated construction schedule for the North Hero-Grand Isle bridge project will require at least two construction seasons. This would equate to approximately 7 months of service for each year times 30 days per month for a total of $46,000,000 dollars.

The cost to add a temporary ferry service to this project is very costly and requires extensive permitting. HDR and VTrans met and discussed the inclusion of the temporary ferry service to this project and determined that it was too costly and burdensome to proceed with this alternative versus the benefits, reduced cost, time, and permitting of the staged construction alternative.

Alternative Alignments

Two alternative alignments were developed to assess "on-line" and "off-line" replacement of the existing bridge. Both alternatives incorporate new full-depth approaches to the proposed 257-foot long moveable structure. The proposed approach roadway width is 32-feet consisting of two 11-

foot travel lanes and 5-foot paved shoulders. The paved shoulder width meets requirements for shared use by bicyclists and satisfies criteria specified in the *Vermont State Design Standards* (VTrans, 1997) for a rural minor arterial roadway and DHV over 400 vph. Details of the alternative alignments are described in this section; figures are provided in Appendix N.

Alternative II New Movable Structure on Existing Alignment

The proposed horizontal alignment for Alternative II provides a 2-foot easterly shift of the centerline tangent across the bridge. The shift creates adequate space to accommodate temporary sheeting between the proposed structure and existing structure during phased construction. The centerline shift is achieved by introducing reversing curves on both bridge approaches. The curves have large radii (11,000 feet and greater) and allow for normal crown to be maintained through the curves and across the proposed bridge.

The proposed vertical alignment for Alternative II is designed to raise the grade across the bridge approximately 4.5 feet above the existing grade. Each of the three proposed vertical curves satisfies the minimum requirements for SSD/HSD and K value.

The total project length is 875 feet, including approximately 264 feet and 354 feet of full-depth roadway reconstruction on the western and eastern sides of the bridge, respectively. Additionally, 100 feet of approach work is provided beyond the project limits to transition from the existing roadway section to the proposed full-depth pavement structure.

The permanent roadway work associated with Alternative II is generally accommodated within the footprint of the existing causeway. The typical causeway embankment slopes are 1-1.5 (vertical-to-horizontal) consistent with the steeper embankment slopes along the existing causeway.

Alternative III New Movable Structure Off-Alignment

The proposed horizontal alignment for Alternative III provides a 40-foot easterly shift of the centerline tangent across the bridge. The shift provides adequate space for off-line construction of the proposed bridge while maintaining traffic on the existing bridge. A new 1300-foot radius curve ties the shifted centerline to the existing tangent section of US Route 2 near the western project limit. A new 1380-foot radius curve ties the shifted centerline to the existing 920-foot radius curve near the eastern project limit, creating a compound curve with a curve radius ratio of 1.5:1.

The proposed vertical alignment for Alternative III is designed to raise the grade across the bridge approximately 4.5 feet above the existing grade, similar to Alternative #1. Each of the four proposed vertical curves satisfies the minimum requirements for SSD/HSD and K value.

The total project length is 3350 feet, including approximately 1396 feet and 1697 feet of full-depth roadway construction on the western and eastern sides of the bridge, respectively. Additionally, 100 feet of approach work is provided beyond the project limits to transition from the existing roadway section to the proposed full-depth pavement structure.

In general, the permanent roadway work associated with Alternative III expands the footprint of the existing causeway into Lake Champlain. The toe of the proposed 1-1.5 embankment slope along the westbound side of US Route 2 is located up to 40 feet or more beyond the existing edge of water. Along the eastbound side, the proposed side slope is graded down (at 1-4 or flatter) across the existing roadway section to the existing causeway embankment without encroaching on the edge of water; this configuration precludes channelization of stormwater runoff from the proposed pavement.

Geotechnical Conditions

The Team is considering four possible alternatives for the rehabilitation or replacement of the existing North Hero-Grand Isle Bridge, including both on and off existing alignment options. The objectives of this scoping report were to evaluate the feasibility of each alternative; including assessing the site geotechnical conditions and the implications those conditions have on each of the four bridge alternatives. To meet the project objectives, the Team reviewed available existing subsurface information, including:

- The Draft Scoping Report prepared by Vanasse Hangen Brustlin, Inc.;
- GeoDesign's "North Hero-Grand Isle BRF 028-1(26) SC, Bridge No. 8, U.S. Route 2 over Lake Champlain, Geotechnical Engineering Report," dated October 1, 2001 (included in the Draft Scoping Report as Appendix D);
- As-built construction plans from the 1994 rehabilitation project; and
- Archived construction plans from 1946 and 1950.

The 1950 as-built plans indicate that existing bridge foundations consist of timber pile supported stub abutments. The plans indicate the piles are treated timber with cast steel shoes, with a design capacity of 18 tons. The four existing pier foundations are shown to bear directly on rock with pier footings excavated approximately 5 feet below the top of bedrock.

The existing embankments were originally constructed in the early 1900's and modified to the current alignment and grades in the 1950s. GeoDesign's review of construction record documents from the 1950s indicated that the embankments likely consist of VTrans Item 102, Borrow, expected to be shale fill similar to the materials facing the slopes. An approximately two-foot-thick layer of large stone rip rap was shown on the plans for the embankment side slopes. The side slopes are reportedly currently covered with weathered shale and generally appear stable.

Subsurface Information

The following is a summary of our review of the existing subsurface information within the project area. The subsurface conditions presented below are based on the Team's review of the available data, including as-built construction plans, limited test borings along both existing and proposed alignments, and Ground Penetrating Radar (GPR) survey traverses in the vicinity of the proposed alignments. GeoDesign's complete report from 2001 is included in Appendix D.

Mapped surficial and bedrock data for the region indicates the site generally is underlain by relatively thin overburden soils, consisting of soft sediments, clay, and glacial till, overlying bedrock. Bedrock in the region is mapped as part of the Stony Point Formation, which is generally, described as thinly laminated shale.

Archived construction plans, dated 1946 to 1950, indicated approximately one to nine feet of overburden soil was encountered before terminating the borings on "apparent ledge," "ledge," or in "gravel" or "hard packed material." The 34 subsurface probe explorations were performed with an unspecified sampler. Bedrock was not cored in these explorations nor were Standard Penetration Tests performed. Overburden soils were classified as muck, clay, sand, and gravel.

GeoDesign completed a preliminary subsurface investigation for the project in May and June of 2001. The program included three test borings designated G-1 through G-3, drilled to depths from approximately 33.5 to 52 feet below ground surface, and two GPR survey traverses. Borings G-2 and G-3 and the GPR traverses were completed in the water, approximately 200 feet from the south and north shores of the existing causeway, respectively. Test boring G-1 was drilled approximately 30 feet southwest of the existing bridge operator's house.

Subsurface conditions encountered in the three borings were generally described as embankment fill (at the abutments), muck (lake bottom sediments), clay and silt, and glacial till, overlying bedrock. The thickness of these layers varies slightly between the northern and southern alignments, with the thicker deposits being found generally along the southern profile.

Implications of Subsurface Conditions

Based on a review of the referenced plans and existing subsurface exploration data, the implications of the subsurface conditions are summarized below.

Embankment Fill

The existing embankment fill appears to consist of rock fill material, comprised of cobbles and boulders estimated to be up to approximately two feet in diameter, consistent with the record drawings. Large stone rip rap is also present at each embankment, approximately two feet thick and consisting of weathered shale. Approximately 24 feet of embankment fill was encountered in test boring G-1, and consisted of black, fine to coarse sand-sized fractured shale, with some gravel-sized fragments recovered. The SPT N-values ranged from 7 to 16, indicating the fill was loose to medium dense.

The existing embankment fill is not considered suitable for support of spread footing foundations for new bridge abutments due to the absence of documentation of fill composition and placement within the causeway and the corresponding potential for erratic and non-uniform foundation settlements.

Driven H-pile foundations may also be problematic due to the potential presence of cobbles and boulders in the embankment fill creating obstructions to driving piles to bedrock. Drilled shaft foundations are feasible; however, they will likely provide more capacity than is required. Drilled micropile foundations are currently judged by the team to be the preferred foundation system to support new bridge abutments on the existing alignment. The composition of the embankment fill and its impact on pile selection will be reevaluated during the final design exploration program.

Lake Sediment

Very soft and weak lake bottom sediments, ranging between 2 and 10 feet in thickness, were encountered at the mud line in test borings G-2 and G-3 drilled in the water. Although relatively thin, these layers are very soft and weak. Options considered should avoid a weak layer at the bottom of new embankment fill for alternatives being considered on a new alignment. A recommended method of constructing a new embankment will likely be staged construction using rock fill placed on top of these sediments and progressively graded and choked as the embankment rises in elevation, with settlement platforms to assess whether settlement has occurred prior to final paving.

Clay and Silt

The clay and silt layer encountered was approximately 5 to 7 feet thick. The clay and silt along the north alignment was generally stiff and described as moderately plastic, therefore compressibility is not expected to be a significant concern. Preliminary embankment stability evaluations conducted by GeoDesign indicate that the clay and silt layer does not significantly impact the final stability of proposed approach embankments. Final design explorations should include sampling and testing of the strength and compressibility of the clay and silt deposit for use in stability and settlement assessments.

Glacial Till

This stratum has favorable engineering properties as a foundation material for the proposed embankments. Since this stratum is generally thin and of varying thickness, the pier foundations will likely need to bear on/ in the underlying bedrock to achieve uniform bearing and achieve the required bearing resistance.

Given the relatively thin overburden soils at the pier locations (total thickness on the order of 10 to 13 feet in thick), driven piles would likely not have sufficient embedment to be feasible for pile supported foundations without predrilling rock sockets. Drilled foundations, such as micropiles or drilled shafts, will likely be more effective in providing axial and lateral foundation support.

Bedrock

Bedrock encountered in the 2001 test borings was described as black, hard, thinly laminated Shale with generally near horizontal bedding. Modified Rock Quality Designation (RQD) ranged from 23 to 80 percent, with an average of 57 percent, indicating fair quality rock. A zone of weathered rock was reported at one test boring location and in the GPR findings, and was generally on the order of 3 feet thick. The bedrock is expected to provide sufficient foundation bearing capacity relatively near its surface. The thickness of weathered and/ or fractured zones needs to be evaluated during the final design exploration program to evaluate the bearing resistance of rock.

Final Design Phase Explorations

A detailed geotechnical subsurface program will be required for both on and off alignment options. The Team anticipates a minimum of two borings will be required at each new abutment and pier location for either on or off alignment options selected for evaluation. Each of these borings should be drilled into bedrock a minimum of 10 feet to assess bedrock quality for foundation design. Compressive testing will be performed on samples of rock core recovered for use in developing estimates of side and bearing resistance of rock.

Additional embankment test borings will also be required if a new alignment or significant grade raise is planned. Embankment test borings will be spaced every 200 feet on alternating sides of the proposed embankment to evaluate the thickness of sediment, clay and silt, and glacial till overlying bedrock. Laboratory testing will be performed including index properties, strength and compressibility testing for use in assessing slope stability and settlement. Field shear vane testing may also be performed to evaluate the strength characteristics of the lake sediment and clay and silt deposits. The embankment borings will be advanced to refusal or bedrock, whichever occurs first.

Resource Information

Wetland and Water Resources/Army Corp of Engineers and US Coast Guard Involvement

The 'Lake Shale Beach' communities found along the lower edges of the causeway and at the northern and southern extents of Grand Isle and North Hero respectively are not considered wetlands and would not be regulated as such by the Vermont Agency of Natural Resources (ANR) or the US Army Corp of Engineers (ACOE). They do have wetland characteristics, support common wetland plant species, and are often intermixed with jurisdictional wetland habitat. Based on a field visit to the project area in July 2014, the area within the project that appeared to most likely support jurisdictional wetland habitat occurred in the northwestern quadrant. Additional investigation and delineation by a qualified wetland scientist will be needed.

The structure is over Lake Champlain which is a navigable waterway and regulated by the US ACOE and the US Coast Guard. These agencies will need to provide input on the design and proposed construction schedule of the project to ensure that the final structure and construction will not have an undue impact on commerce or the boating public.

Significant Plant and Animal species

Fisheries

Shoreline and watercraft fishing in the vicinity is considered to be very good by the VT Department of Fish and Wildlife due to the depth and current at the crossing location. Impacts to the fisheries resource here is avoidable if Best Management Practices are followed to safeguard water quality during construction.

Wildlife Habitat

The Lake Champlain ecosystem and its associated shores provide some of Vermont's most unique habitat. The remnant natural community type that occurs around the project area is best described as a 'Lake Shale Beach'. The existing Route 2 crossing and structure occurs on a causeway built up with man-made fill. It would be expected to encounter many types of resident and migratory waterfowl, birds of prey, freshwater fish, reptiles, and amphibians throughout the project area.

All areas of the causeway support similar mix of weedy roadside herbaceous plant species and native shoreline shrubs (Salix and Cornus spp.) and trees (Populus deltoides, Acer saccharinum, and Ulmus americana) common of lake shore habitats. The eastern side of the causeway appears to be routinely cleared of woody vegetation due to overhead utility lines that parallel the roadway. The only mature over-story trees are found in the southwestern quadrant of the project area.

Rare, Threatened, and Endangered Species

The spiny soft shell turtle is a listed species in Vermont (Threatened) and is known to occur in the northeastern portion of Lake Champlain, specifically the lower reach and mouth of the Lamoille

River and the greater Missisquoi Bay. Recent coordination (June 2012) between VTrans Biologists and the VT Fish and Wildlife Department determined that the species is not known to occur in the project area, and that a survey for the species would not be required.

Based on the surrounding aquatic habitat and the coordination referenced above, it is reasonable to assume that there may be freshwater mussels species with legal status found in the project area. Depending on the scope of the project and the amount of disturbance within the lake (below an elevation of approximately 98') an inventory of by a freshwater aquatic biologist would likely be required to determine the presence and abundance of mussels in the project area.

Three plant species considered 'Rare' in Vermont could occur in the project area: Juncus alpinoarticulatus, Artemisis campestris, and Carex viridula var. viridula. VTrans policy has generally been to avoid impacts to 'Rare' species during projects if possible, although they have no legal status.

Land Use Resources

Sections 4(f)/6(f) Resources

Section 4(f) of the U.S. Department of Transportation Act requires that federally funded transportation projects avoid impacts to public parks, public recreation areas, wildlife refuges, and historic properties unless it can be demonstrated that no other feasible alternatives are possible. Section 4(f) involves the review of these projects for their effect on historic properties eligible for or listed in the National Register of Historic Places.

In addition to the potentially historic sites listed above, a public boat launch exists in the northeast quadrant of the project area. This facility would qualify as a 4(f) resource and require that any unavoidable impacts to it be mitigated in some fashion.

Section 6(f) of the Land & Water Conservation Act allows for the allocation of Land and Water Conservation Funds (LWCF) for purchase and improvement of recreational lands, wildlife and waterfowl refuges, and such resources to preserve, develop, and assure the quality and quantity of outdoor recreation resources for present and future generations. Lands purchased with LWCF are protected from conversion to "non-public" outdoor recreational uses and require approval by the Secretary of the Interior.

Other Natural Resource Considerations

During the evaluation of the project's construction alternatives, any alternatives that allow all or a majority of the existing causeway to be removed (an elevated roadway on piers for example) should be weighed to reflect a potential improvement in seasonal water quality in Lake Champlain. The algal blooms that have become common in Missisquoi and St. Alban's Bays are due, in part, to the limited mixing of their waters with the rest of the lake. The US Route 2 causeway between North Hero and Grand Isle directly impedes this mixing process. Restoring historical flows through this narrow and others in the vicinity would encourage mixing and could feasibly improve long-term water quality in the northeastern part of the lake.

Historic Resources

Archaeological Sites

An Archeological Resource Assessment of the bridge project was recently completed by Hartgen Archeological Associates, Inc. to comply with Section 106 of the National Historic Preservation Act. The archeological assessment entailed a site file search, field reconnaissance, and study of current bridge plans in order to update a 2002 Cultural Resource Investigation report based on an earlier version of the bridge rehabilitation project (Werner 2002). The current bridge plans and its Area of Potential Effects (APE) were studied to determine possible project impacts to historic and precontact cultural resources.

During the research and site file search, no recorded historic or precontact archaeological sites were identified within the project area. Knight's Tavern, the brick structure on the northwest quadrant of the bridge, is listed on the State Register of Historic Sites. The bridge, the control tower of the bridge (lifthouse) and operator's house located east of the bridge are considered eligible for listing on the National Register (Scott Newman, personal communication, in Werner 2002).

Photo showing the Operator's house

The brick Knight's Tavern structure, located on the northwest corner of the bridge, is located outside of the project area. However the front and southern yard areas of the tavern are located within the APE and are considered archaeologically sensitive. There is potential for historic archaeological deposits dating from as early as 1780 to be present in these yard areas.

The environmental setting of the project APE, situated on level terrain on the lakeshore near natural coves, as well as the presence of nearby known sites, indicates a high archaeological sensitivity for the presence of precontact sites. The field reconnaissance indicated that while there are some isolated areas of disturbance within the project area, including development of the marina on the southeast side of the bridge, and residential development on the southwest side, that all four (quadrant) areas adjacent to the bridge are considered to be archaeologically sensitive for precontact resources.

The Archaeological Resource Assessment recommended that Phase IB shovel testing be conducted in the archaeological sensitivity areas where ground disturbance is proposed.

Historic Sites and Structures

The historic resource identification was undertaken by the Team and the report detailing our findings is provided in Appendix F.

The historic resource identification report found the following above-ground historic resources in the project area: the 1953 North Hero-Grand Isle Bridge, as well as its associated Operator's House and Control Tower, and the causeways leading to the bridge from the north and south, and the Knight's Point Tavern, which is located in Knight's Point State Park at the north end of the north causeway.

The bridge and its associated features are eligible for the State and National Registers of Historic Places. The bridge is the only remaining highway bascule (drawbridge) bridge in Vermont and is an excellent example of its type and an engineering landmark. The bridge meets Criterion A of the National Register for its contribution to Vermont's history of transportation and Criterion C as an excellent and intact example of a movable bridge. The Knight's Point Tavern is listed in the National Register of Historic Places. Although archaeological resources were not under the purview of the historic resource report, it should be noted that the surviving northern abutment from the adjacent 1892 bridge is also considered a historic resource.

The National Historic Resister was reviewed and no structures in the project vicinity are currently listed. Prior coordination with the VT SHPO in 2001 determined that the tavern building on the west side of US Route 2 at the northern end of the project corridor (now associated with Knight's Point state park), and the drawbridge with it's associated out-buildings, are eligible for listing on the National Register. Remains of buildings associated with the old ferry crossing also contribute to the sensitivity of the project area for historic resources. Additional coordination with the SHPO will be required once the conceptual design of the replacement structure has been further advanced.

Agricultural Resources

Agricultural Lands

There are no known agricultural soils or farm operations in the project area.

Local and Regional Concerns

A Local Concerns Meeting was held on May 29, 2014 at the North Hero Elementary School gymnasium. The purpose of the meeting was to solicit public opinions regarding the project (moveable bridge, causeway, and US Route 2 roadway approaches) to take into account in developing alternatives. Other topics that were discussed included: project background, VTrans Project Development Process, project constraints, and public outreach efforts throughout the scoping phase of the project. Specific comments and questions regarding these topics are included within the minutes of meeting.

In summary, the local concerns were focused on the following elements:

- *Having the bridge remain a moveable structure,*
- *Impacts to traffic during construction,*
- *Visual and noise impacts from the bridge (both temporary and permanent),*
- *Timing and duration of the project,*
- *Automatic controls vs. live gate keeper operating the bridge, and*
- *Safety in regards to speeding and traffic control.*

In an effort to better understand local concerns, a survey was prepared and mailed to approximately 1700 postal patron boxes within North Hero and Grand Isle. To date, approximately 300 surveys have been returned yielding a 17% return rate. This return rate is typical for this type of survey. The results are being compiled, and will be submitted to VTrans in the Fall of 2014.

Additionally, a project website was created as a central web-based platform for the public to receive project information and contact the Public Outreach Manager directly with comments that they may have.

According to the annual Project Prioritization report put out by the NRPC Transportation Advisory Committee (TAC), the North Hero-Grand Isle Bridge is ranked third (3rd) for the VTrans Capital Program for FY 2016.

Alternatives

General

The following describes the alternatives developed by the Team to address the Purpose and Need Statement. The alternatives developed take into consideration the background conditions, resource information and local concerns feedback, permitting realities and cost. The project alternatives were developed in accordance with the design standards listed previously.

As the Team developed and investigated multiply alternatives for the rehabilitation or replacement of the bridge. Based upon both internal and external review of the various alternatives, Three (3) options were identified. The selected options meet the requirements identified by the local concerns, vehicular impacts, marine impacts, maintenance, operation, and minimizes detour.

Through this development process, four feasible alternatives were chosen for presentation with three options each for Alternatives II & III:

No-Build

Alternative I – Rehabilitation of the existing structure

Alternative II – New Movable Structure on Existing Alignment

Option A – Twin Leaf Bascule

Option B – Single Leaf Bascule

Option C – Vertical Lift

Alternative III – New Movable Structure on New Alignment

Option A – Twin Leaf Bascule

Option B – Single Leaf Bascule

Option C – Vertical Lift

Beginning with the no-build solution, the alternatives are each investigated to determine if they address the goals and deficiencies stated in the Purpose and Need Statement. Information and discussions for each alternative are presented in the form of advantages and disadvantages. Detailed plans are found in Appendix N including typical sections, critical section and profiles for each alternative.

No Build – Existing Condition

The no-build alternative leaves the bridge and the alignment in their current condition, and assumes normal roadway maintenance and bridge maintenance will continue.

Advantages:

Low initial cost and no new direct environmental or social impacts result from the no-build option.

Disadvantages:

The no-build alternative does not meet the goals of the project's purpose and need statement. Several key objectives would be left unaddressed under this alternative including, no reduction of delays on US Route 2 and through the channel, no reduction in maintenance costs of the drawbridge, and no improvements of pedestrian and bicycle safety within the project area.

Alternative I – Rehabilitation

HDR investigated rehabilitating the current twin leaf bascule span in place and determined during the inspection that the structural steel needs extensive repairs and it would be more cost effective and beneficial to perform a replacement of the bascule leaves. HDR developed this alternative that will incorporate building the replacement twin leaf bascule spans remotely and then shipping the units to the project site. In an effort to reduce the impacts of construction on the traveling public, the replacement of the twin leaf bascule span would take place during the winter months over planned weekend outages. HDR estimates that the rehabilitation alternative would be completed over two construction seasons. The first season to rehab the approach spans while the new bascule spans are being fabricated. The bascule spans will be replaced during the winter months and then the next construction season the bridge structure rehabilitation will be completed.

Photo showing the drawbridge back spans in the water

Advantages:

This alternative allows VTrans to address the deterioration of the twin leaf bascule spans structural steel, mechanical, and electrical components. This alternative increases the remaining life of the bascule bridge structure. This rehabilitated alternative would eliminate the need for a detour or temporary bridge. The rehabilitation would likely satisfy the potential historic rehabilitation conditions. The operator's house and control tower would remain.

Disadvantages:

The rehabilitation option does not fully meet the purpose and need statement. This alternative will not raise the bascule bridge structure to eliminate the counterweights from entering the water during opening. The existing mechanical and electrical system will be repaired and not replaced which does not address the safety and long term reliability concerns. This alternative provides us the ability to address the bascule span for service life but does not allow us to address the service life of the mechanical and electrical systems.

The low voltage submarine cable would remain and as noted in the inspection report, the low ohms reading for the submarine cables shows signs of degradation and need for replacement.

Alternative II – New Movable Structure on Existing Alignment

This alternative constructs a new movable bridge in place of the existing drawbridge. This alternative would consist of removing and replacing the existing drawbridge in stages to allow for one-way vehicular and marine traffic to be maintained throughout the construction operations. There may be times when vehicular and boat traffic will need to be delayed for short periods of times for life safety issues that may arise while lifting bridge components. The approach spans, from the abutments to bascule pier, can be supported on corbels off the back of the bascule pier. The profile of the bridge surface will be raised approximately 4 ½ feet to prevent the end of the draw span from entering the water when open, thus reducing potential maintenance problems and improving navigational clearance. Raising the grade at the bridge center will require the roadway approaches to be reconstructed for approximately 300 feet to the east and west of the bridge. The team has investigated three movable bridge options within this alternative and they are the following:

a) Double Leaf Bascule
b) Single Leaf Bascule
c) Vertical Lift Bridge

With all these options listed above the concept is to build without disturbing vehicle and marine traffic during construction. Both options a) and b) will need to be completed in stages roughly half the bridge at a time to allow one lane of vehicular traffic and normal marine traffic to pass through the open bridge structure during construction. Option c) would be built above the traffic on a platform and then lowered down into place once it was completed.

Our traffic experts took a thorough look at the traffic operations in the vicinity of the moveable bridge during construction. We used SimTraffic to evaluate the impact of the alternating one-way traffic operations during construction on queueing and LOS. These analyses were used to analyze the operations for two scenarios: [1] alternating traffic operations without lift bridge operations, and [2] alternating traffic operations with the lift bridge operation. The basis of the analysis was the Existing Design Hour Volume of 485 vehicles with a 60/40 directional distribution. The assumed design speed for the work zone was 30 mph.

The analysis of the typical alternating one-way traffic operations (without the lift bridge operation) indicates that the levels of service in the design hour will be LOS C for both directions, with average delays of 21.5 seconds delay per vehicle in the peak direction and 24.1 seconds in the non-peak direction. The 95th percentile design queue is 200 feet in the peak direction and 155 feet in the non-peak direction.

The analysis of alternating one-way traffic operations with the lift bridge operations considered the following typical lift operations as documented in the Design Report:

- The lift bridge operates on a regular 30-minute schedule (on the hour and half-hour), subject to actual marine traffic, which is variable.
- The average amount of time to accommodate each bridge lift is 4 minutes.

The SimTraffic simulations of this scenario indicate average vehicle delays of 56.2 seconds in the peak direction and 56.0 seconds in the non-peak direction, with 95th percentile queues of 531 feet in the peak direction and 288 feet in the non-peak direction.

Other relevant metrics for the traffic operations with the lift bridge are the following:

- The max queue formed during the lift operations
- The time period needed to dissipate these queues and restore operations to typical alternating traffic

Based on the SimTraffic models, the max queue during the design hour is 666 feet (approximately 27 vehicles) in the peak direction and 368 feet (approximately 15 vehicles) in the non-peak direction during periods when the lift bridge is raised. The simulations show that the average time taken for these max queues to dissipate after the end of each lift bridge cycle will be approximately 5 minutes.

Based on these analyses, it is concluded that the alternating one way traffic management plan will accommodate the existing design hour traffic during construction with or without the lift bridge in operation.

All three options under this alternative meet the purpose and need statement and do not require any long term detours or closures.

Advantages:

A new and more efficient movable bridge structure would be designed to open/close the drawspan within the open/close time prescribed by AASHTO. This alternative meets the purpose and need statement for this project. Additionally, a new movable bridge structure requires less maintenance than the existing structure, effectively reducing the overall operating costs. The new drawbridge superstructure will be deeper and allow the installation of a walkway between the bascule girders to allow access from the pier to the span locks from the underside of the deck as well as keeping the counterweights from entering the water. This access will provide a safe area for the VTrans District personnel to access to the span locks at the middle of the bridge.

The first two options maintain a similar configuration to the existing bridge and will maintain the character of the area. The third option is a vertical lift bridge option that has two towers with a span in the middle that rises up and down to allow vessel traffic to pass.

All three options can be built without requiring a detour or temporary bridge structure.

The first two options can accomplish opening and closing of the drawbridge spans by either hydraulics or mechanical systems. During the design phase, the Consultant will work with VTrans to determine which lifting system will be used. The steel grid deck system will be replaced with a concrete filled steel grid deck system, thus reducing the rate of structural steel deterioration.

The low voltage submarine cable will be replaced under all options of this alternative. The first option will replace the low voltage submarine cable with another submarine cable, the second option would remove the submarine cable and be placed on the approach span substructure, and the third option will replace the existing submarine cable with an aerial system on the vertical lift bridge.

Disadvantages:

This alternative will prolong the construction duration of this project. We estimated that the construction would be completed over three construction seasons. In the first season the Contractor would demo and rebuild one half, second season the Contractor would demo and rebuild the remaining half, and then in the third construction season they would complete construction. The third construction season will consist of combining the two separate bridges together and this will be accomplished with temporary lane closures on the bridge. The bridge will be open to two way traffic in the third construction season. The new bascule options will need to be constructed as two separate bridges and then connected together. This new raised structure does not allow for an increase in height of boats allowed under without opening due to the increase in superstructure depth. An underwater archeological evaluation will need to be completed for this alternative based on the areas of impacts in Lake Champlain.

The control tower will need to be relocated and raised to provide the required visibility for the operator.

The vertical lift bridge option will require additional permitting time over the other two options within this alternative, due to the altering of the visual impact from a bascule bridge to a vertical lift bridge and receiving approval from SHPO.

Alternative III – New Movable Structure Off-Alignment

This alternative consists of building a new movable bridge adjacent to the existing and maintaining vehicular and marine traffic throughout the construction operations on the existing alignment and structure. There may be times when vehicular and marine traffic will need to be delayed for short period of times for life safety issues that may arise while lifting bridge components. The Team has investigated three movable bridge options within this alternative and they are the following:

a) Double Leaf Bascule
b) Single Leaf Bascule

c) Vertical Lift Bridge

With all these options listed above the general construction concept is to build a new structure off alignment and then modify the approach roadway alignments to incorporate the new movable bridge location.

All three options under this alternative meet the purpose and need statement and do not require any long term detours or closures.

Advantages:

A new and more efficient movable bridge structure would be designed to open/close the drawspan within the open/close time prescribed by AASHTO. This alternative will meet the purpose and need statement for this project. Additionally, a new movable bridge structure would require less maintenance than the existing structure, effectively reducing the overall operating costs. The new drawbridge superstructure will be deeper and allow the installation of a walkway between the bascule girders to allow access from the pier to the span locks from the underside of the deck. This will provide a safe area for the VTrans District personnel to access to the span locks at the middle of the bridge.

The first two options maintain a similar configuration to the existing bridge and will maintain the character of the area. The third option is a movable bridge option that has two towers with a span in the middle that lifts up and down to open.

All three options can be built without requiring a detour or temporary bridge structure.

The first two options can accomplish opening and closing of the drawbridge spans by either hydraulics or mechanical systems. During the design phase, the Consultant will work with VTrans to determine which lifting system will be used. The steel grid deck system will be replaced with a concrete deck system, thus reducing the rate of structural steel deterioration.

The off alignment option allows the new structure to be built next to the existing and will not affect the traveling public. VTrans will have a new operations house structure.

The approach roadway improvements will extend for a length of 3,300 feet, not including the structure length. In addition, the profile of the bridge surface will be raised approximately 4 ½ feet, similar to alternative II, in order to prevent the same existing issues explained for alternative II in the section above.

The low voltage submarine cable will be replaced under all options of this alternative. The first option will replace the low voltage submarine cable with another submarine cable, the second option would remove the submarine cable and be placed on the approach span substructure, and the third option will replace the existing submarine cable with an aerial system on the vertical lift bridge.

Disadvantages:

This alternative will be more costly and require extensive design and permitting time. The construction of a new movable bridge off alignment will require the taking of lake shore and expanding the causeway. This alternative will mostly likely require an EA or EIS versus a CE and have greater impacts to historic and archeologically sensitive areas that would need approval prior to construction. This alternative will require ROW acquisitions that would require additional time and money. This alternative will be the most expensive and take the longest time to receive permit approvals prior to construction and this would require that VTrans spend significant funds repairing the existing movable structure to remain operational until the replacement is constructed.

The control tower will need to be relocated and raised to provide the required visibility for the operator.

In order for the new alignment to remain within the causeway the new off alignment structure would need to be located to the east of the existing structure. The operation house is located on the east side of the bridge and this will need to be moved. This structure is considered historic and any relocation will need to be reviewed and approved by SHPO. An underwater archeological evaluation will need to be completed for this alternative based on the areas of impacts in Lake Champlain.

The bridge replacement will require three construction seasons to complete. The first two construction seasons the new roadway and bridge would be constructed adjacent to the existing and then in the third construction season the traffic would be shifted onto the new roadway and bridge and then demolition of the existing would be completed.

Life Cycle Cost Analysis

The life-cycle analysis of the proposed alternatives/options showed that the single leaf bascule span was the lowest cost alternative/option, but the mathematical difference between al l the alternatives/options are so small that it becomes insignificant and the preferred alternative/option will be determined by other factors. A copy of life cycle analysis cost is included in Appendix C of this report.

Evaluation Matrix

Evaluation Matrix

		Do Nothing	Alternative I: Rehabilitation	Alternative II: New Movable Structure on Existing Alignment			Alternative III: New Movable Structure on New Alignment		
				Twin Leaf Bascule	Single Leaf Bascule	Vertical Lift	Twin Leaf Bascule	Single Leaf Bascule	Vertical Lift
COST	Roadway	0	$ 100,000.00	$ 450,000.00	$ 450,000.00	$ 450,000.00	$ 3,000,000.00	$ 3,000,000.00	$ 3,000,000.00
	Structure	0	$ 4,000,000.00	$ 7,500,000.00	$ 8,500,000.00	$ 8,000,000.00	$ 6,500,000.00	$ 7,500,000.00	$ 7,000,000.00
	Temporarary Structure and Roadway	0	$ 1,000,000.00	$ -	$ -	$ -	$ -	$ -	$ -
	Detour	0	Short Closure	Staged Const.	Staged Const.	Staged Const.	None	None	None
	Traffic & Safety	0	$ 150,000.00	$ 550,000.00	$ 550,000.00	$ 550,000.00	$ 1,000,000.00	$ 1,000,000.00	$ 1,000,000.00
	Mechanical	0	$ 3,225,000.00	$ 4,550,000.00	$ 4,150,000.00	$ 2,880,000.00	$ 4,550,000.00	$ 4,150,000.00	$ 3,000,000.00
	Electrical	0	$ 2,000,000.00	$ 3,300,000.00	$ 2,950,000.00	$ 3,100,000.00	$ 3,200,000.00	$ 2,700,000.00	$ 3,350,000.00
	Removal/Replacement of Buildings	0	$ -	$ -	$ -	$ -	$ 400,000.00	$ 400,000.00	$ 400,000.00
	Contingency & Engineering	0	$ 3,142,500.00	$ 4,905,000.00	$ 4,980,000.00	$ 4,494,000.00	$ 5,595,000.00	$ 5,625,000.00	$ 2,800,000.00
	Total	0	$ 13,617,500.00	$ 21,255,000.00	$ 21,580,000.00	$ 19,474,000.00	$ 24,245,000.00	$ 24,375,000.00	$ 20,550,000.00
ENGINEERING	Typical Sections	5-11-11-5	5-11-11-5	5-11-11-5	5-11-11-5	5-11-11-5	5-11-11-5	5-11-11-5	5-11-11-5
	Align. Change	0	0	2ft	2ft	2ft	40ft	40ft	40ft
	Bicycle Access	Shoulder	Shoulder	Shoulder	Shoulder	Shoulder	Shoulder	Shoulder	Shoulder
	Channel Width	No Change	No Change	No Change	No Change	No Change	Sufficient	Sufficient	Sufficient
	Utilities	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact
IMPACTS	Agricultural	None	None	None	None	None	None	None	None
	Archaeological	None	None	None	None	None	None	None	None
	Historic Structures, Sites & Districts	None	None	Yes, Control Tower	Yes, Control Tower	Yes, Control Tower	Yes, Control Tower & Operator's house	Yes, Control Tower & Operator's House	Yes, Control Tower & Operator's House
	Hazardous Materials	None	None	None	None	None	None	None	None
	Floodplains	None	None	None	None	None	None	None	None
	Fish & Wildlife	None	None	None	None	None	None	None	None
	Rare, Threatened & Endanged Species	None	None	None	None	None	Possible	Possible	Possible
	Public Langs - Sect 4(f)	None	None	None	None	None	Potential Impact	Potential Impact	Potential Impact
	LWCP - Sect. 6(f)	None	None	None	None	None	Potential Impact	Potential Impact	Potential Impact
	Noise	None	None	None	None	None	None	None	None
	Wetlands	None	None	None	None	None	None	None	None
LOCAL & REGIONAL ISSUES	Concerns	Bridge Failure	Partially	No	Partially	Yes	No	Partially	Yes
	Aesthetics	Unchanged	No	No	Changed	Changed	No	Changed	Changed
	Community Character	Unchanged	Unchanged	Unchanged	Changed	Changed	Unchanged	Changed	Changed
	Economic Impacts	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Conformance to Regional Transporation Plan	No	No	Yes	Yes	Yes	Yes	Yes	Yes
	Satisfies Purpose & Need Statement	No	No	Yes	Yes	Yes	Yes	Yes	Yes
PERMITS	ACT 250	No	No	No	No	Possible	No	No	Possible
	401 Water Quality	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	404 COE Permit	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Us Coast Guard	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Stream Alteration	No	No	No	No	No	No	No	No
	Vermont Wetlands	No	No	No	No	No	No	No	No
	Operational Stormwater Permit 3-9015	No	No	No	No	No	Possible	Possible	Possible
	Construction General Permit 3-9020	No	No	Yes	Yes	Yes	Yes	Yes	Yes
	Lakes & Ponds	No	No	Yes	Yes	Yes	Yes	Yes	Yes
	T & E Species	No	No	Possible	Possible	Possible	Possible	Possible	Possible
	NEPA	No	Yes	Yes	Yes	Yes	No	No	Yes
	Section 106	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SCHEDULE	Projected Build Year	N/A	2017	2017	2017	2018	2020	2020	2020
	Design Delays	No	No	No	No	Potential	Yes	Yes	Yes
	Permiting Delays	No	No	No	No	Potential	Yes	Yes	Yes
OTHER									

Recommendations

Introduction

The Bridge Number 8 along US Route 2 linking the towns of North Hero and Grand Isle is an important link between Grand Isle and North Hero. The Team investigated several different alternatives with additional options for some of the alternatives. The Team analyzed all the alternatives and took into consideration the information provided through the local concern meeting to determine the recommended alternative.

Recommendation - Alternative II – Option A

HDR recommends that the existing N Hero-Grande Isle Bridge be replaced with a new twin leaf bascule structure on the existing alignment. This option meets the purpose and need statement and meets the needs of the Historical Preservation requirements. The roadway elevation will be increased by 4.5 feet on the bascule span to allow accommodations for deeper bascule girders to provide for a platform from the pier to the span locks for maintenance personnel. The roadway deck will be an exodermic deck system with concrete wearing surface which will provide a smooth riding surface and improve safety. The construction of the new bridge will be staged such that single lane operation across the existing structure is maintained. This staging approach will address the local concern of emergency service equipment access and the length of the highway detour. The aesthetics of the bridge will be similar to the existing in the open and closed position.