



Drainage Alternatives Study

Bolger Hill Road Drainage Improvement Project Jericho, Vermont

Prepared for:
Town of Jericho, Vermont
and
Chittenden County Regional Planning Commission

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

January 2020

Technical Memo

**Bolger Hill Road
Jericho, VT**

Prepared for

Chittenden County Regional Planning Commission

January 2020

Prepared by



"The preparation of this report has been financed in part through grant[s] from the Federal Highway Administration and Federal Transit Administration, U.S. Department of Transportation, under the State Planning and Research Program, Section 505 [or Metropolitan Planning Program, Section 104(f)] of Title 23, U.S. Code. The contents of this report do not necessarily reflect the official views or policy of the U.S. Department of Transportation."

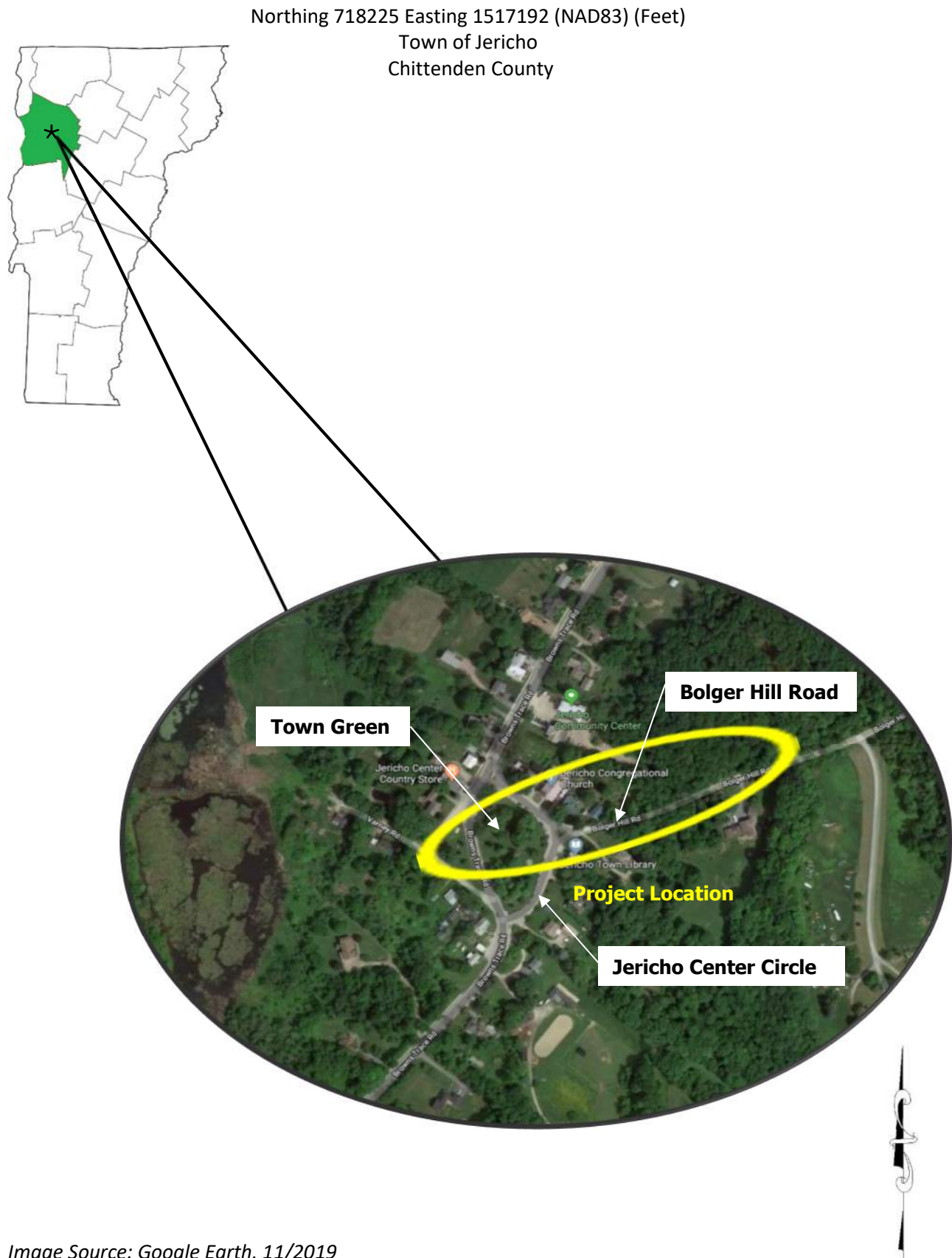
TABLE OF CONTENTS

LOCATION MAP	2
1 PROJECT DESCRIPTION	3
2 EXISTING CONDITIONS AND CAUSATION ASSESSMENT.....	3
3 RECOMMENDED IMPROVEMENTS ALTERNATIVES	5
3.1 Alternative 1	6
3.2 Alternative 2.....	6
3.3 Alternative 3.....	7
3.4 Alternative 4.....	8
4 CONSTRUCTION AND ROW CONSIDERATIONS	8
5 ENVIRONMENTAL CONSIDERATIONS	9
6 CULTURAL RESOURCE CONSIDERATIONS.....	10
7 UTILITY CONSIDERATIONS.....	10
8 HYDRAULICS.....	11
9 CONCLUSIONS AND RECOMMENDATIONS	11

APPENDICES

- A. Plans of Proposed Improvements
- B. Engineer's Estimate of Probable Construction Costs
- C. Project Photos
- D. Hydraulic Calculations

Figure 1 – Location Map
Bolger Hill Road



1 PROJECT DESCRIPTION

In accordance with the agreement between the Town of Jericho, the Chittenden County Regional Planning Commission (CCRPC), and Hoyle, Tanner & Associates, Inc., this Scoping Study - Technical Memo (Study) has been prepared to investigate four (4) alternatives for roadway drainage and erosion solutions for Bolger Hill Road within the existing roadway ROW and Town parcels. As this is a technical study, no public meeting was held, however the following general purpose and need statements has been developed based on our meeting with Town and CCRPC Staff.

Purpose

The purpose for this Study is to provide roadway and drainage alternatives to reduce the erosion that is currently occurring along Bolger Hill Road and to reduce the sediment accumulation at its intersection with Jericho Center Circle.

Need

The need for the project is to reduce the gravel, which comes from Bolger Hill Road, that gets washed into the Town Green and abutters properties after large storm events. The Town would like to improve the water quality in this area through the construction of Best Management Practices (BMPs) within this project.

2 EXISTING CONDITIONS AND CAUSATION ASSESSMENT

Existing Conditions

Bolger Hill Road is an approximately one (1) mile long, Class 3 gravel road within the Town of Jericho. It intersects Jericho Center Circle at the Town Green and runs northeasterly to a 90-degree bend, then southeasterly to a dead end. Approximately 90 linear feet of Bolger Hill Road at Jericho Center Circle is paved. Traffic on Bolger Hill Road operates under free flow conditions for the entire length with a posted speed limit of 25 mph.

The Bolger Hill Road horizontal alignment represents a gradual “S” curve that is relatively tangent within the project limits. The roadway profile is upgradient from Jericho Center Circle with a grade of approximately 10 to 15%. The roadway profile levels off near station 105+75 (House #12) before the upgrade increases again outside the project limits.

The existing roadway along Bolger Hill Road is narrow and consists of a total travel way of approximately 16'. There is no defined crown along the roadway and gravel has been continuously removed, likely due to maintenance operations, lowering the roadway with respect to its side slope embankments. The north embankment side slope of the roadway consists of fill slopes to a woodland area. Ditch lines are present along the south side of the roadway between stations 101+75 and 104+75 within the project limits, with two culverts at stations 104+90 and 105+85 carrying stormwater beneath the roadway towards the north woodland area. Between stations 100+90 and 101+75 (toward Jericho Center Circle), the ditch line disappears and is replaced with a berm created by the maintenance of the gravel roadway and the presence of a house with a level lawn at #4 Bolder Hill Road (House #4). There is a drive culvert beneath a woods drive at station 102+00, between House #12 and House #4. This culvert was full of gravel during a site visit by Hoyle, Tanner and outlets into a ditch line that ended at the established lawn area of House #4.

Causation Assessment

The project begins at Jericho Center Circle and extends approximately 650 linear feet along Bolger Hill Road to a relatively flat section of roadway just past the upper drive to House #12 (station 105+75). A causation assessment to establish the origin of the gravel that gets washed onto Jericho Center Circle during large rain events was performed for the project area and is summarized as follows. Generally, we found two likely sources for the washed gravel: the drive to House #4, and the non-compacted shoulder gravel along the project section of Bolger Hill Road.

During a site visit in September 2019, Hoyle, Tanner observed gravel on the pavement of the lower portion of Bolger Hill Road near the intersection of Jericho Center Circle. Review of the area indicates potential sources of the gravel include the drive to House #4, shown in Photo A. This drive is constructed of loose gravel and leaves Bolger Hill Road at a steep upgrade. There are no ditch lines along the driveway and during rain events, it appears stormwater flows down the drive and onto Bolger Hill Road, likely dislodging fine gravel in the process. This gravel would collect where the roadway levels off, at the intersection between Bolger Hill Road and Jericho Center Circle.



Photo A: Bolger Hill Road at Drive to House #4 drive



Photo B: Loose Shoulder Gravel

There is also evidence that loose gravel along the shoulders of Bolger Hill Road (Photo B) contribute to the issue of the deposits found in the Town Green. This material is looser than the material typically traveled by the vehicles and is more easily picked up in stormwater and conveyed downstream. This was evident by the minimal rill erosion present within the traveled way and the more extensive rill erosion present within the shoulders (see Photo C). Photo B shows the more compacted and less erodible gravel within the travel way and the looser, more erodible gravel along the shoulder. This is indicated by the different colors of the gravel.

The southern roadside ditch line ends at the beginning of the established lawn for House #4 (station 101+50), which also marks the start of the roadside berms on this side of the road due to the maintenance of the gravel road (maintenance berm – Photo D). Where maintenance berms are present the stormwater cannot leave the roadway surface and therefore is likely to pick up gravel particles and convey them downstream and into the intersection. With no outlet (or continuation) to the ditch line, if the stormwater cannot infiltrate quickly enough, it will overtop the ditch line and run along the edge of the roadway shoulder.



Photo C: Rill Erosion Along the

Along the northern side of the roadway, the Town has created turnouts in the maintenance berm to divert the stormwater which is flowing along the shoulders, off the roadway and over the roadside fill slopes. This, however, causes the concentrated flow to erode the side slopes and the land of the abutting properties.

The steepness of the roadway profile and lack of roadway cross slopes also affect the stormwater's ability to leave the roadway surface. Photo D shows the lower portion of the roadway, near the intersection, where there are no ditch lines and a maintenance berm is present.



Photo D: Maintenance Berms by
House #4

3 RECOMMENDED IMPROVEMENTS ALTERNATIVES

Four (4) alternatives have been considered within this Study. Alternative 1 consists of a "No Build" alternative. Alternative 2 includes a raise in grade of Bolger Hill Road near Jericho Center Circle and paving of Bolger Hill Road from this intersection to the top of the hill at the project limits. Alternative 3 builds upon Alternative 2 and includes a closed drainage system and stormwater detention pond approximately half way up the hill. It also includes a small underground infiltration system or above ground bioretention system within the Town Green. Alternative 4 builds off Alternative 2 as well and includes a closed drainage system and a larger underground infiltration system or above ground bioretention system in the Town Green. Each alternative is explained in more detail below.

Each alternative was established considering the following design standards:

- Town Road and Bridge Standards (2019)
- 2017 Vermont Stormwater Management Manual (VSWMM)
- The Orange Book (2017-2019) by VTrans
- VTrans Road Design Manual

- VTrans Better Roads Program

3.1 Alternative 1

Alternative 1 consists of a “No Build” scenario. The proposed work within this alternative is strictly maintenance activities that can be performed by the Town. Work efforts consist of regrading the gravel roadway, adding gravel as needed, to establish 5% cross slopes. This will improve drainage flow off the roadway by providing a positive grade toward the shoulders. This alternative does not meet the project purpose and need. Erosion issues along the roadway are not addressed in this alternative nor is the accumulation of gravel at the Jericho Center Circle intersection. Conceptual level estimating was not completed for this Alternative as it is strictly a maintenance activity.

Maintenance

Maintenance for this alternative would consist of the current maintenance practices the Town performs on the roadway, including regrading of the roadway and cleanup of the washed-up gravel in the intersection. Maintenance would also include maintaining the existing cross culverts and drive pipe and repair of erosion along the roadway and side slopes.

3.2 Alternative 2

Alternative 2 consists of removing the existing short length of Bolger Hill Road pavement and adding gravel as needed to raise the grade near the intersection with Jericho Center Circle, then paving Bolger Hill Road from the Circle to the project limits (approximately 650 linear feet). The reason for the raise in grade is to increase the roadway elevation providing a low point within the drive of House #4 and paving the drive from the roadway to the right-of-way line. The purpose of the low point within the drive is to capture the stormwater from the drive and outlet it to the lawn area prior to it reaching Bolger Hill Road. Paving the drive will also reduce the amount of gravel that is picked up in the stormwater that flows down the drive. Alternative 2 proposes to replace the existing corrugated metal pipe culverts near House #12 with reinforced concrete (R.C.) pipe culverts. No additional drainage improvements are proposed.

Conceptual level construction cost estimating was completed for this alternative. The total estimated project construction cost is \$134,550 in 2019 dollars.

This alternative partially meets the project purpose and need. The paved roadway and driveway will help reduce the amount of gravel that is conveyed toward Jericho Center Circle and accumulates in the intersection, however it does not provide improved drainage along the roadway. In this alternative stormwater will continue to flow down the ditch line along the southern roadway edge toward the lawn of House #4 with no outlet. There will still be stormwater flow along both edges of pavement near the bottom of the hill, in front of House #4, and the drive low point will also have no outlet. Flow along the edge of pavement will, over time, cause deterioration of the pavement surface.

Maintenance

Maintenance for this alternative would consist of general pavement maintenance with repaving as

required due to normal wear and tear. Additional maintenance may be required in front of House #4 as the stormwater flow along the edge of pavement is likely to cause pavement deterioration over time. Cleanup of the washed-up gravel in the intersection would also still be required. Additionally, maintenance of the new R.C. cross culverts and existing drive pipe would be required.

3.3 Alternative 3

Alternative 3 builds upon Alternative 2 and includes the raise in profile grade at the intersection, paving of Bolger Hill Road within project limits, and the reconstruction of the drive for House #4. In addition, Alternative 3 proposes a closed drainage system consisting of catch basins and drain pipe from the upper project limit, along the southern roadway ditch line to approximately the midpoint of the project (station 103+80). The system would collect eastbound roadway stormwater in the southern ditch line and convey it beneath Bolger Hill Road toward a Best Management Practice (BMP) stormwater treatment system at the back of the Jericho Congregational Church (Community Center) property. The BMP would consist of a detention pond and pretreatment forebay sized to treat the design storm.

Additionally, this alternative proposes a closed drainage system near the drive of House #4 to collect stormwater from the extended southern ditch line. Catch basins are proposed on both sides of the drive. A catch basin is also proposed on the northern edge of pavement across from the drive to House #4. Bituminous curb running up the hill from this catch basin and along the edge of pavement, to where the slopes change from cut slopes to fill slopes (approximately 80 feet) will convey the roadway stormwater to the new catch basin, protecting the abutting property of House #5. These catch basins will outlet in the Town Green in an underground infiltration system or above ground bioretention system.

The underground infiltration system would consist of underground chambers to provide detention of the stormwater while allowing, at minimum, the water quality volume to infiltrate into the ground. The above ground bioretention system would consist of filter media that then allows the stormwater to infiltrate into the ground and underdrain for release of larger storms. An overflow structure and pipe would be provided for both systems, to discharge larger storm events, and connect to a downstream catch basin on the northern side of the Town Green. The outlet pipe would run beneath the Town Green, with limited impact to the existing trees. Pretreatment would be provided for the stormwater flowing to the system. During the design phase, a capacity analysis of the existing downstream drainage system would be required.

Travelway widths are proposed to match existing with 8-foot lanes. Average Annual Daily Traffic (AADT) has not been established or observed for this roadway, however due to the dead end, traffic is assumed to be minimal and include only those that live on the roadway. Based on Vermont State Design Standards (1997) when AADT is low and the design speed is 25 mph, 8-foot lanes are permitted. The Town has not indicated issues with maintenance or accessibility of the roadway with the current 8-foot lanes.

Conceptual level construction cost estimating was completed for this alternative. The total estimated project construction cost is \$253,000 in 2019 dollars.

This alternative meets the project purpose and need. The paved roadway and driveway will help reduce the amount of gravel that is conveyed toward Jericho Center Circle and accumulates in the intersection.

The closed drainage system near the top of the hill will maintain the existing stormwater flow patterns and provide some treatment. The closed drainage system near House #4 will, along with the proposed ditch line, address the existing ditch line outlet issue and provide additional stormwater treatment.

Maintenance

Maintenance for this alternative would consist of general pavement maintenance with repaving as required due to normal wear and tear. Additionally, semi-annual maintenance of the closed drainage system and infiltration system would be required utilizing pressurized jets of water and vacuum trucks. Maintenance of a bioretention system would consist of periodic replacement of the filter media and maintenance of the above ground vegetation. The stormwater detention pond would require routine maintenance to remove woody vegetation and to keep the side slope embankments mowed. The sediment in the forebay would require removal and the rate of the removal would depend on the rate of the accrual of the sediment.

3.4 Alternative 4

Alternative 4 is similar to Alternative 3 with the difference that the closed drainage system near the top of the hill outlets at station 104+30 to the ditch line along the southern roadway edge instead of to the Alternative 3 BMP on the other side of Bolger Hill Road. In this alternative, all the eastbound stormwater is collected and treated in an underground infiltration system or above ground bioretention system in the Town Green. For this alternative, that system will be larger than the system proposed in Alternative 3.

Conceptual level estimating was completed for this alternative. The total estimate project construction cost is \$207,000 in 2019 dollars.

This alternative also meets the project purpose and need for the same reasons as Alternative 3. This alternative, however, would mean no disturbance or tree cutting on the Church (Community Center) property. Additionally, the cost for this alternative would be less than Alternative 3 due to construction of only one BMP, the underground infiltration system or above ground bioretention system.

Maintenance

Maintenance for this alternative would consist of general pavement maintenance with repaving as required due to normal wear and tear. Additionally, semi-annual maintenance of the closed drainage system and infiltration system would be required utilizing pressurized jets of water and vacuum trucks. Maintenance of a bioretention system would consist of periodic replacement of the filter media and maintenance of the above ground vegetation.

4 CONSTRUCTION AND ROW CONSIDERATIONS

Bolger Hill Road would remain open during construction to allow access to the residences up the hill from the project limits. With the minimal profile raise near the intersection and the majority of the drainage work located off the edge of the roadway, single lane closures using flaggers can be utilized during construction. The roadway would be open to full width every evening.

All alternatives presented in this Study propose work within the Town's right-of-way or on Town owned properties including those of the Congregational Church and the Town Green. This project does not propose construction easements or land takings.

5 ENVIRONMENTAL CONSIDERATIONS

As part of this Study a desktop environmental review of the project area was performed to identify any potential resources that may require coordination and or permitting during the design phase of the project. The following are the results of our review.

Bolger Hill Road is the area of interest in Jericho Center which was outlined in the Jericho Vermont Stormwater Master Plan (SWMP) Final Report (April 19, 2017) prepared by Watershed Consulting Associates, LLC for the Town and CCRPC. That report noted that Site 4, the small grassed island across from the Town Green and between Jericho Center Circle and Browns Trace Road, is a good location for an infiltration basin to improve the drainage in that area. The report calls this area "a designated problem area consisting of poorly drained soils and little existing stormwater infrastructure in the upper-extent slopes. Alternatives 3 and 4 above would complement the proposed infiltration basin proposed at Site 4 in the SWMP as it would provide treatment and infiltration of the stormwater from the upper-extent slopes of Bolger Hill Road therefore helping to reduce the size of this required infiltration basin. As noted above, the downstream infrastructure would require evaluation if stormwater flows from Bolger Hill Road were directed toward it through an overflow structure and pipe from the proposed underground infiltration system or above ground bioretention system in the Town Green. Site 4 is located in the island across from the Town Green in Jericho Center and would be the outlet of the system proposed in Alternatives 3 and 4. Further evaluation on the impact this project would have on the Site 4 location would occur during the design phase of this project.

A road and culvert inventory was completed in the Town of Jericho in 2015 and Bolger Hill Road was considered a non-project road which means there was no evidence the erosion problems on these roads would have any influence on water quality because they are not in close proximity to a stream/river or body of water.

Under the Municipal Roads General Permit (MRGP) – Road Erosion Inventory (REI) conducted by CCRPC in 2016, Bolger Hill Road, within the project area, is listed as not "hydrologically connected", meaning that the MRGP Standards do not apply, however it is noted that the 2019 adopted Town Road and Bridge Standards does apply the Municipal Road Standards to both Hydrologically and Non-Hydrologically Connected road segments. The area of Jericho Center Circle near Wilder Road is hydrologically connected and is likely the reason for the Site 4 project noted above. Proposed stormwater quality improvements to Bolger Hill Road will improve downstream water quality. The Town should note that the proposed alternatives 3 and 4 will make this segment of road a hydrologically connected segment for consideration in their MRGP permit and mapping.

A search utilizing the State of Vermont, Agency of Natural Resources (ANR), Natural Resources Atlas was performed to identify the presence of any known state endangered species or significant communities. Results of the desktop review indicate there are no state endangered species or significant communities within the project area.

The US Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) online tool

was utilized to determine the potential for impacts to federally-listed species and their habitat. Species identified include the federally-threatened northern long-eared bat (*Myotis Septentrionalis*). Tree removal activities will require coordination with USACE and may have restrictions on when they can be removed or require a biologist investigation to determine if trees are free of roosts and can be cleared.

A search utilizing the State of Vermont, Agency of Natural Resources (ANR), Natural Resource Atlas was performed to identify any known hazardous sites within 1000' of the project area. There is one underground fuel oil tank (Facility ID 8994593 / 2000-gallon capacity / Installed 1971) located within the small grassed median at the base of Bolger Hill Road. This has been noted and will be investigated further during the design phase of the project. While this tank is not listed as a Hazardous Site or Waste Generator, there may be restrictions on the proximity of ground stormwater infiltration. This will be investigated further during the design phase of this project.

A search utilizing the USFWS National Wetlands Inventory (NWI) Mapper and ANR mapping indicates there are no wetlands or streams associated with the culverts within the project area. However, based on visual observations it is likely that the detention pond area defined in Alternative #3 will yield wetlands when surveyed by a wetlands scientist.

Funding sources for this project are still being investigated. Should the Town of Jericho receive federal funding, a National Environmental Policy Act (NEPA) document will need to be prepared. Preparation of this document will require more extensive environmental coordination with State and Federal Agencies.

Soil impacts are expected to be under 1 acre and therefore a National Pollutant Discharge Elimination System Construction General Permit and Vermont DEC Construction General Permit 3-9020 would not be required.

6 CULTURAL RESOURCE CONSIDERATIONS

The southwestern portion of the project is located within the Jericho Center Historic District, National Register #83003207. Coordination with the Vermont Division for Historic Preservation (VDHP) that serves as the State Historic Preservation Officer (SHPO) will be initiated in the design phase of the project to identify any additional concerns regarding protected historic/cultural/archaeological resources and, if required, to resolve concerns regarding potential effects on the Historic District as a result of the project. Because work will be mostly contained within the ROW, it is not expected that SHPO would have concerns.

7 UTILITY CONSIDERATIONS

Existing overhead utility lines are present within the project area. A utility pole located within the small grassed median at the base of Bolger Hill Road redirects the overhead lines from Jericho Center Circle and up the southern side of Bolger Hill Road. The lines cross over to the northern side at the project limits. Utility coordination, if required, will be completed during the design phase of the project.

8 HYDRAULICS

The project area has been divided into two subcatchment areas for conceptual modeling purposes. The bottom section (Subcatchment 1) collects stormwater from the front lawn of House #4 and the woods below House #12. In the proposed conditions, this area will be collected in the underground infiltration system or above ground bioretention system (Alternatives 3 and 4). The top section (Subcatchment 2) collects stormwater from the front lawn of House #12 in addition to some adjacent woods area. In Alternative 3, this stormwater will be directed toward the detention pond behind the Community Center. This stormwater will be conveyed toward the underground infiltration system or above ground bioretention system in the Town Green in Alternative 4. Conceptual level hydraulics were performed utilizing the Rational Method ($Q=CiA$). The flows calculated were 1.8 cfs and 3.1 cfs for Subcatchments 1 and 2 respectively. Calculations are provided in Appendix D.

9 CONCLUSIONS AND RECOMMENDATIONS

Based on the information contained herein, Hoyle, Tanner recommends Alternative 4 for improvements to Bolger Hill Road. Although Alternative 3 also meets the purpose and need of the project, Alternative 4 has less impact to adjacent properties and less environmental impacts including less tree removal. Additionally, more stormwater flow is directed toward the proposed infiltration basin or above ground bioretention system in the Town Green, allowing for more groundwater recharge. By collecting the stormwater, paving the roadway, and reconstructing the drive to House #4, less gravel will be conveyed along the roadway which would previously collect in the intersection with Jericho Center Circle.

Roadway features include:

- Approximately 650 linear feet of new pavement
- Approximately 80 linear feet of bituminous curb
- Reconstructed drive for House #4
- New closed drainage systems
- Stormwater treatment facilities
- Approximately 340 linear feet of new stone-lined ditch

Stormwater treatment features include:

- Underground Infiltration System or Above Ground Bioretention System
- Groundwater recharge
- Overflow outlet to eliminate ponding at the intersection
- Underground storage for larger storm events
- Stormwater pretreatment

The matrix below comprises a project alternatives comparison and summarizes cost, impacts, right-of-way, permitting, and purpose and need for the alternatives.

Scoping Study - Technical Memo
Bolger Hill Road
Jericho, VT

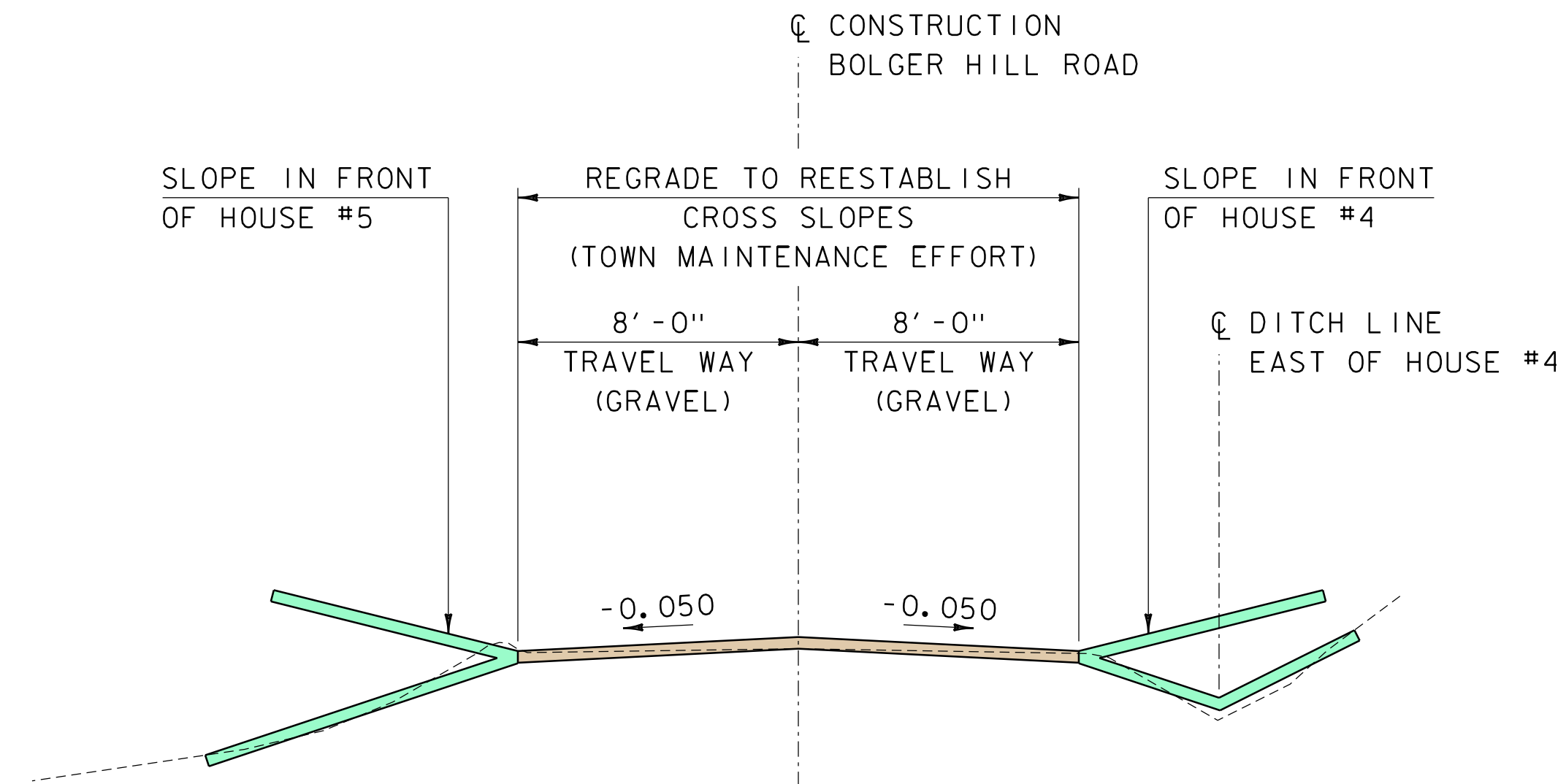
Category		Alternative 1: No Build	Alternative 2: Pavement	Alternative 3: Pavement, Stormwater Pond, Infiltration Basin (or Bioretention)	Alternative 4: Pavement, Infiltration Basin (or Bioretention)
Cost	Total Construction Cost	\$0	\$126,500	\$253,000	\$207,000
Impacts	Overhead Utility	None			
	Resource	None			
	Ag. Lands	None			
	Archaeological	None	Potential		
	Historic	Potential			
	Hazardous Materials	None		Potential	Potential
	Floodplains	None			
	Fish & Wildlife	None			
	Rare, Threatened & Endangered Species	None	Northern Long-Eared Bat – Tree Clearing Impacts (More impact with Alternative 3)		
	Public Lands – Sect. 4(f)	None	Town Green - Potential		
	LWCP – Sect. 6(f)	None	Potential		
	Noise	Temporary from Construction			
	Wetlands	None	None	Potential	None
ROW	Private Property	None	None	None	None
	Town Property	None	None	Yes (Town Green and Church - Community Center)	Yes (Town Green)
Permits	ACT 250	No			
	401 Water Quality	No			
	404 USACE	No			
	Stream Alteration	No			
	State Individual Wetland Permit	No			
	Storm Water Discharge	< 1 acre - No			
	Lakes & Ponds	None			
	T & E Species	None	Coordination with USFWS – Likely no tree clearing from 4/15-10/31		
	Historic/Archaeological Resources	None	Potential		
Meets Purpose & Need		None	Partial	Yes	
Other Considerations		- Does not meet project purpose and need	- Does not provide outlet for existing drainage ditch line	- Extensive clearing for Detention Pond	- Limited clearing for project - Addresses Drainage and Erosion Concerns

Hoyle, Tanner met with the Town and CCRPC on January 7, 2020 to discuss the alternatives proposed above. The Town and CCRPC were in agreement with Alternative 4 as the preferred alternative. Alternatives 1 and 2 did not meet the purpose and need of the project because they did not improve water quality treatment and Alternative 1 didn't improve the reduction of sediment accumulation. Alternatives 1 and 2 were therefore removed from consideration. Alternatives 3 and 4 both reduced erosion, improved stormwater flow, and treated the stormwater, however Alternative 4 was selected based on the lower cost and the less environmental and abutter impacts associated with that alternative.

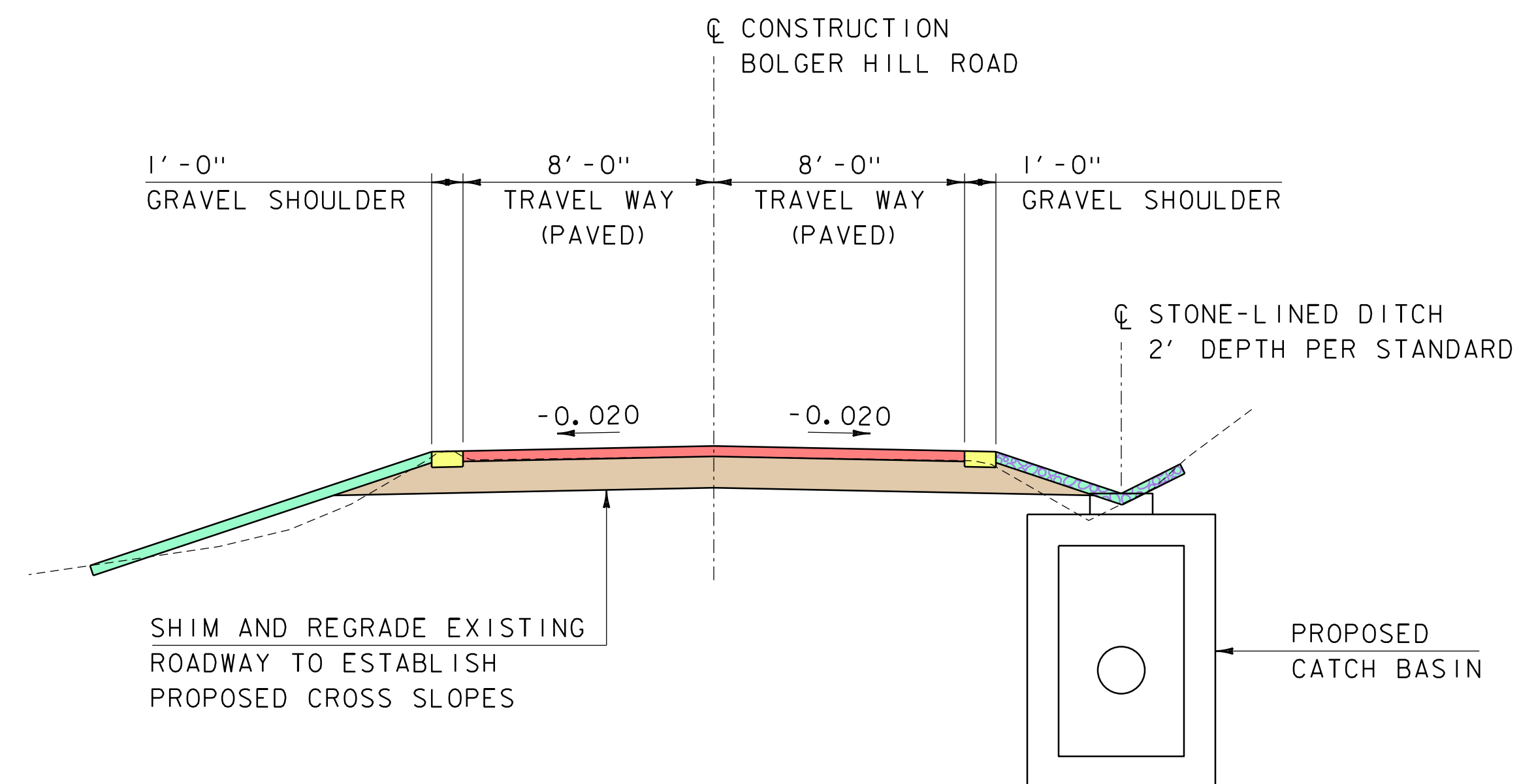
This Study has been completed utilizing information available as of December 2019. This information may include the Design Criteria listed in Appendix A, permitting requirements, field data obtained by Hoyle, Tanner and reports or survey information prepared by others, which are subject to change. The condition of an existing roadway can change rapidly by 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 Improvement



ALTERNATIVE 1
TYPICAL SECTION

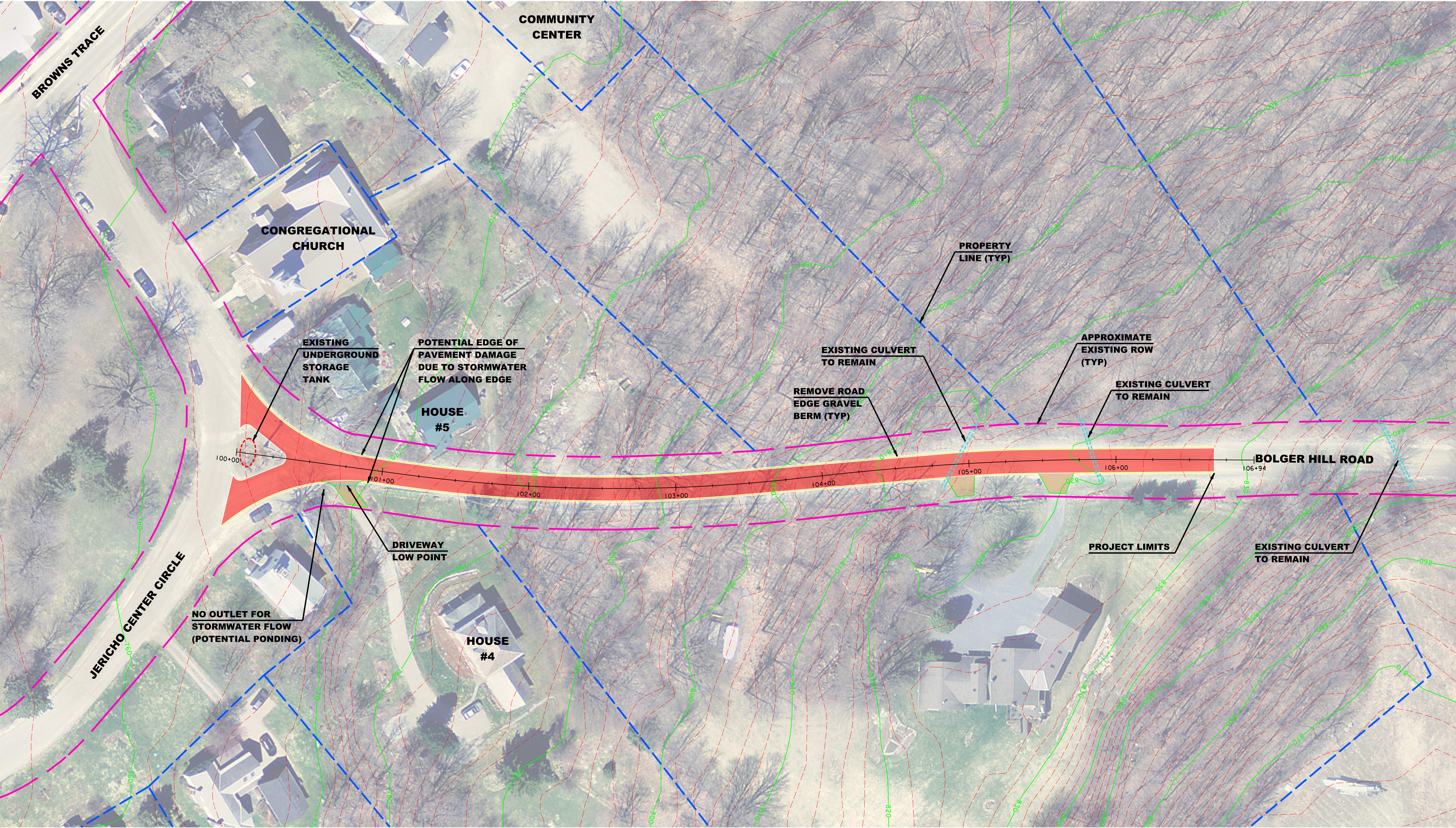


ALTERNATIVES 2, 3 & 4
TYPICAL SECTION

LEGEND

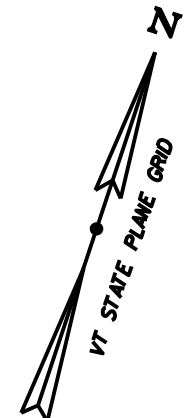
- PAVED ROADWAY**
- GRAVEL SHOULDER**
- GRAVEL SUBGRADE**
- LOAM & SEED**
- STONE-LINED SWALE**

Jericho, VT
Typical Sections
Bolger Hill Road Drainage Improvement Project

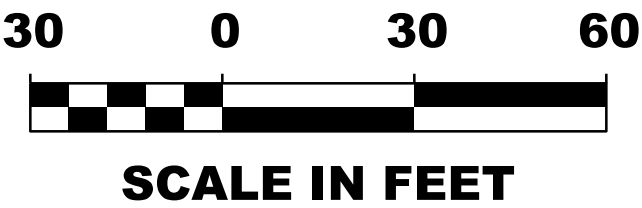


LEGEND

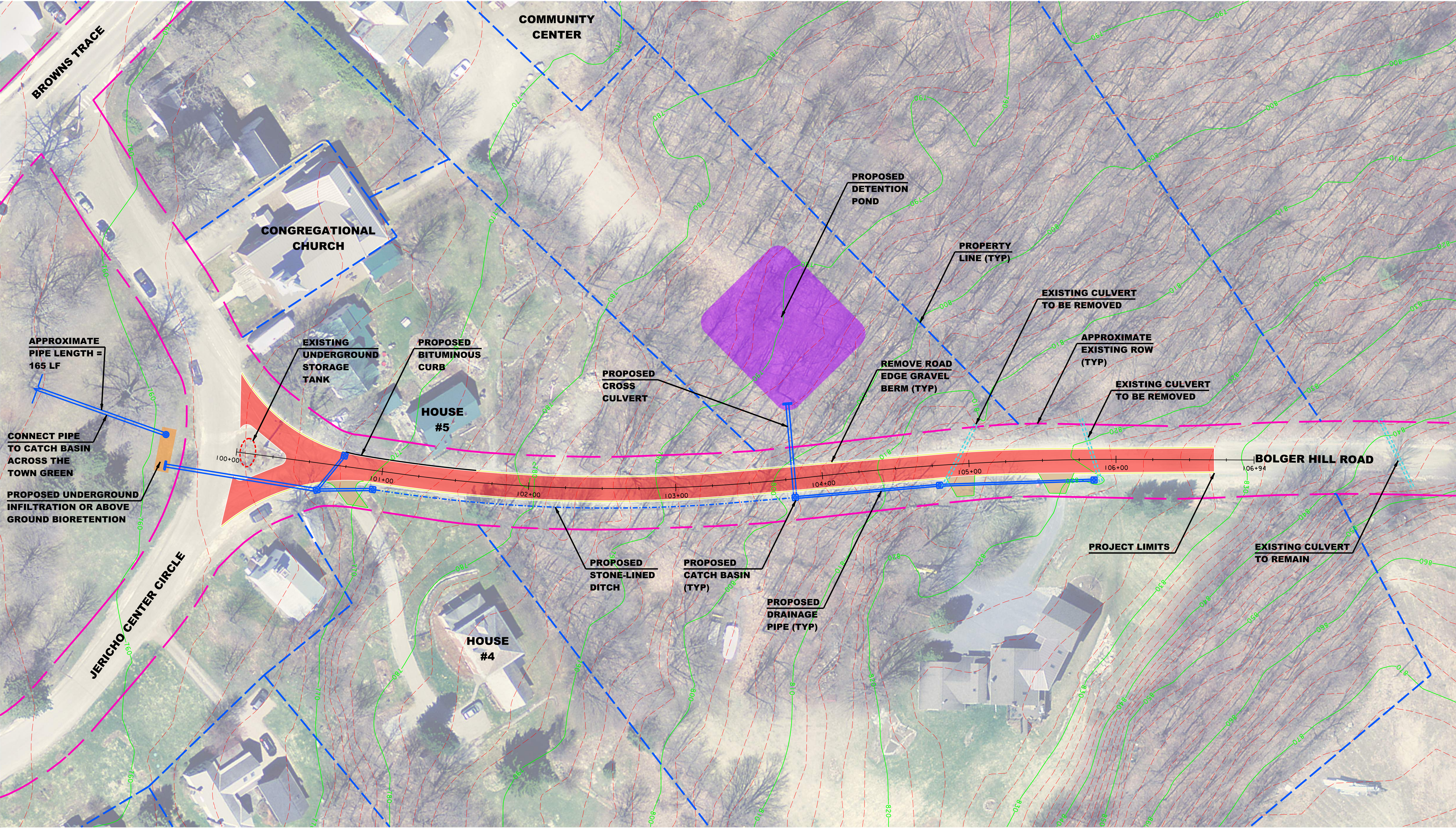
- ROADWAY
- SHOULDER
- DRIVEWAY
- DETENTION POND
- UNDERGROUND INFILTRATION



Jericho, VT
Alternative 2
Bolger Hill Road Drainage Improvement Project

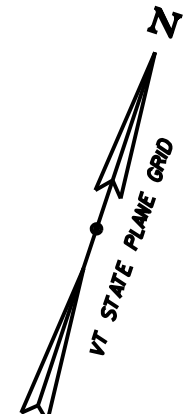


Hoyle, Tanner
& Associates, Inc.

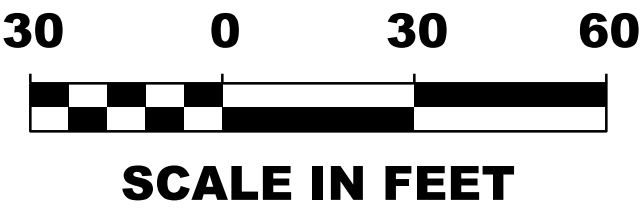


LEGEND

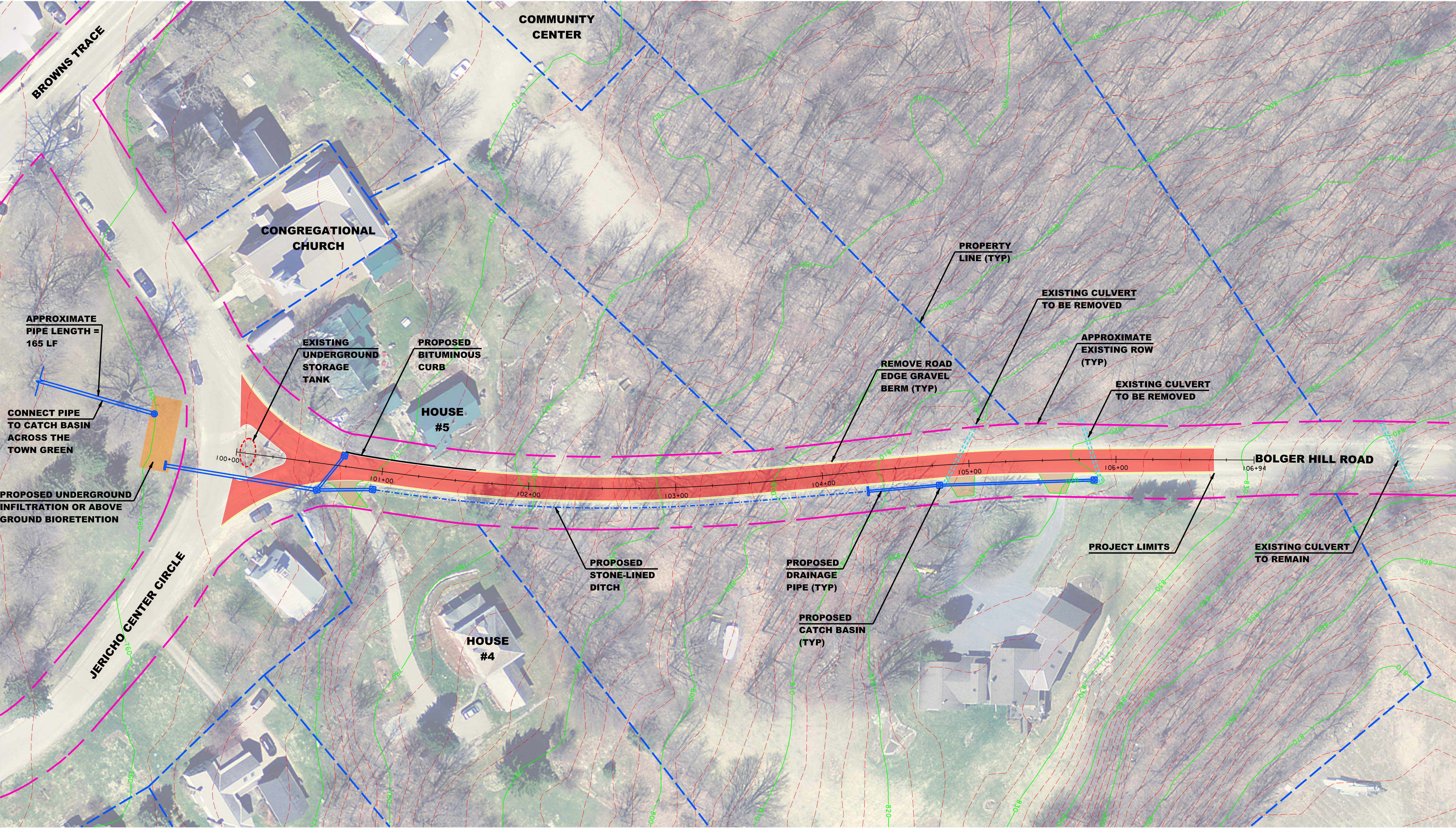
- ROADWAY
- SHOULDER
- DRIVEWAY
- DETENTION POND
- UNDERGROUND INFILTRATION



Jericho, VT
Alternative 3
Bolger Hill Road Drainage Improvement Project

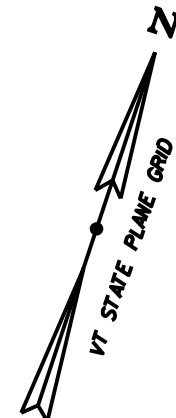


Hoyle, Tanner
& Associates, Inc.

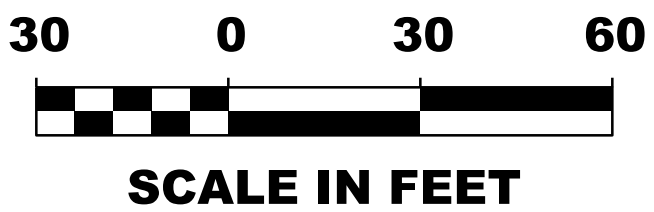


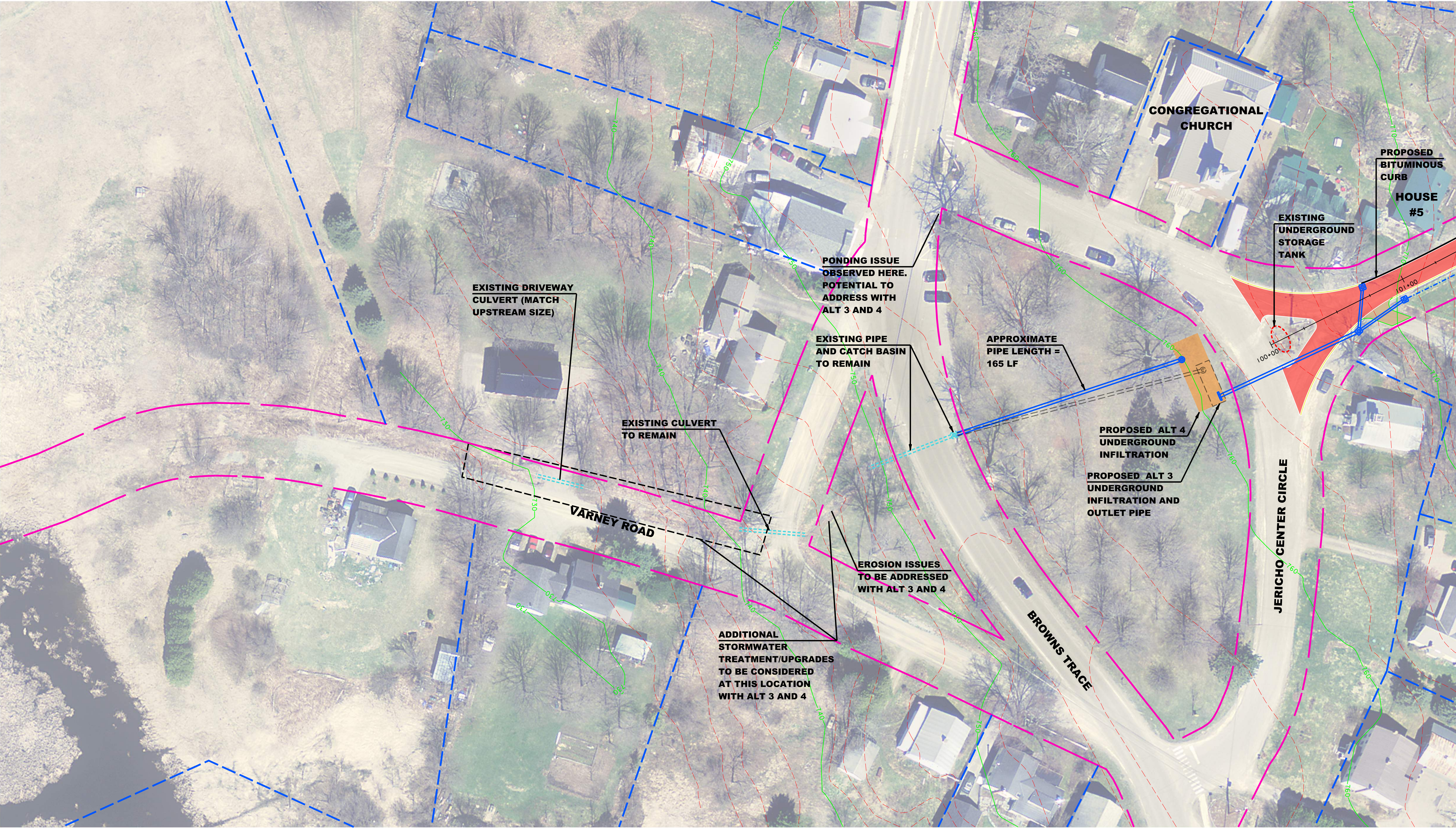
LEGEND

- ROADWAY
- SHOULDER
- DRIVEWAY
- DETENTION POND
- UNDERGROUND INFILTRATION



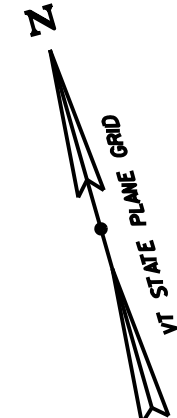
Jericho, VT
Alternative 4
Bolger Hill Road Drainage Improvement Project



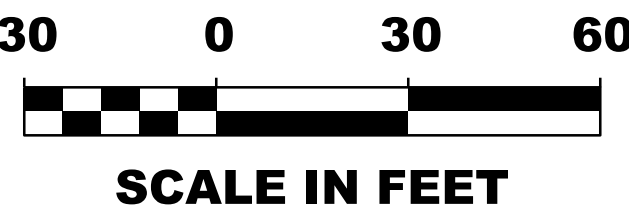


LEGEND

- ROADWAY
- SHOULDER
- DRIVEWAY
- DETENTION POND
- UNDERGROUND INFILTRATION



Jericho, VT
Alternatives 3 & 4 Outlet Across Town Green
Bolger Hill Road Drainage Improvement Project



APPENDIX B

Engineer's Estimate of Probable Construction Costs

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

CONCEPTUAL ESTIMATE - ALTERNATIVE 2

[illegible]

SIGNS, MARKINGS, LOAM/HUMUS, ETC.	10%	\$	7,354.08
	SUBTOTAL B	\$	80,894.88

PIPES, UNDERDRAIN, CB's, MH's, ETC.	0%	\$ -
SUBTOTAL C		\$ 80,894.88

ITEM NO.	DESCRIPTION	UNIT	QTY	UNIT COST	COST
621.90	TEMPORARY TRAFFIC BARRIER	LF	0	\$ 20.00	\$ -
630.10	UNIFORMED TRAFFIC OFFICERS	HR	0	\$ 56.00	\$ -
630.15	FLAGGERS	HR	160	\$ 30.00	\$ 4,800.00
641.10	TRAFFIC CONTROL	LS	1	\$ 4,000.00	\$ 4,000.00
	MISCELLANEOUS TRAFFIC CONTROL		10% OF ABOVE TOTAL		\$ 880.00
			SUBTOTAL D	\$	90,574.88

EROSION, SEDIMENT, AND POLLUTION CONTROL (HAY BALES, SILT FENCE, SWPPP, TEMP. WATER POLL. CONTROL, ETC.)	30% OF DRAINAGE*	\$ 5,000.00
*ADD \$5,000 FOR EROSION CONTROL	SUBTOTAL E	\$ 95,574.88



125 College Street, 4th Floor
Burlington, VT 05401
(802) 860-1331

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project
Engineers Estimate of Probable Construction Costs
Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE - ALTERNATIVE 2

SECTION F - MOBILIZATION

ROADWAY MOBILIZATION	15%	\$	14,336.23
SUBTOTAL F		\$	109,911.11

SECTION G - ADDITIONAL ITEMS

SUBTOTAL G	\$	109,911.11
ROUNDED CONSTRUCTION SUBTOTAL:	\$	110,000.00
CONTINGENCY 15%	\$	16,500.00
HOYLE, TANNER CONSTRUCTION ENGINEERING		0
CONSTRUCTION (CON) TOTAL FOR PLANNING	\$	126,500.00
RIGHT OF WAY (ROW)		
TAKES		\$0.00
EASEMENTS		\$0.00
RIGHT OF WAY (ROW) TOTAL		\$0.00
PRELIMINARY ENGINEERING (PE)		
ENGINEERING STUDY		\$0.00
PRELIMINARY DESIGN		\$0.00
AMENDMENT NO.1		\$0.00
FINAL DESIGN		\$0.00
BID		\$0.00
PRELIMINARY ENGINEERING (PE) TOTAL		\$0.00
PROJECT TOTAL COST (CON, ROW, PE)		\$126,500.00

SEE ADDITIONAL SHEET FOR ASSUMPTIONS MADE WHILE COMPILING THIS ESTIMATE.

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA'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 noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.



125 College Street, 4th Floor
Burlington, VT 05401
(802) 860-1331

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project

Engineers Estimate of Probable Construction Costs

Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE (ALT 2) - 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 noted 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. ITEM 201.11 - 315 LF ON SOUTH SIDE OF ROAD, 485 LF ON NORTH SIDE OF ROAD, BY 5' WIDE
2. ITEM 203.15 - 13,000 SF ROAD AREA BY 6" DEPTH, ADD ADDITIONAL 25 CY FOR DRIVES
3. ITEM 203.16 - SOME LEDGE ON SITE, ASSUME 10 CY
4. ITEM 203.30 - ASSUME 5 SF PER FOOT FOR A LENGTH OF 800 FEET
5. ITEM 301.26 - ASSUME 4 INCHES FOR COMPLETE PROJECT ROADWAY AREA AND DRIVES
6. ITEM 406.25 - SAME AREA AS ITEM 301.26, 4" THICK
7. ITEM 613.10 - 400 LF ON S. ROADSIDE, ASSUME 3:1 SIDE SLOPES 1' DEEP SO USE 6' WIDE, 1' THICK
- 8.
- 9.
- 10.

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project
Engineers Estimate of Probable Construction Costs
Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE - ALTERNATIVE 3

SECTION A - MAJOR ITEMS

ITEM NO.	DESCRIPTION	UNIT	QTY	UNIT COST	COST
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRE	0.1	\$ 23,200.00	\$ 2,320.00
203.15	COMMON EXCAVATION	CY	266	\$ 20.00	\$ 5,320.00
203.16	SOLID ROCK EXCAVATION	CY	30	\$ 100.00	\$ 3,000.00
203.30	EARTH BORROW	CY	150	\$ 15.00	\$ 2,250.00
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	168	\$ 33.00	\$ 5,544.00
406.25	MARSHALL BITUMINOUS CONCRETE PAVEMENT	TON	345	\$ 130.00	\$ 44,850.00
613.10	STONE FILL, TYPE I	CY	90	\$ 48.00	\$ 4,320.00
				\$	-
				\$	-
				\$	-
				\$	-
				\$	-
				\$	-
				\$	-
				\$	-
				\$	-
				\$	-
	MISCELLANEOUS ROADWAY		10% OF ABOVE TOTAL	\$	13,520.80
			SUBTOTAL A	\$	81,124.80

SECTION B - MISCELLANEOUS ITEMS

SIGNS, MARKINGS, LOAM/HUMUS, ETC.	10%	\$ 8,112.48
	SUBTOTAL B	\$ 89,237.28

SECTION C - MISC DRAINAGE ITEMS


PIPES, UNDERDRAIN, CB's, MH's, ETC.	55%	*	\$	49,080.50
*APPROX 6 CB, 465 LF PIPE	SUBTOTAL C			\$ 138,317.78

SECTION D - TRAFFIC CONTROL

ITEM NO.	DESCRIPTION	UNIT	QTY	UNIT COST	COST
621.90	TEMPORARY TRAFFIC BARRIER	LF	0	\$ 20.00	\$ -
630.10	UNIFORMED TRAFFIC OFFICERS	HR	0	\$ 56.00	\$ -
630.15	FLAGGERS	HR	160	\$ 30.00	\$ 4,800.00
641.10	TRAFFIC CONTROL	LS	1	\$ 4,000.00	\$ 4,000.00
	MISCELLANEOUS TRAFFIC CONTROL		10% OF ABOVE TOTAL		\$ 880.00
			SUBTOTAL D		\$ 147,997.78

SECTION E - EROSION AND SEDIMENT CONTROL

EROSION, SEDIMENT, AND POLLUTION CONTROL (HAY BALES, SILT FENCE, SWPPP, TEMP. WATER POLL. CONTROL, ETC.)	8% of Subtotal C	\$ 11,065.42
	SUBTOTAL E	\$ 159,063.21

	125 College Street, 4th Floor Burlington, VT 05401 (802) 860-1331	Calc. By:	AGB	Date:	12/3/2019
		Chck. By:	SBH	Date:	12/6/2019
		Chck. By:		Date:	
		Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project
Engineers Estimate of Probable Construction Costs
Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE - ALTERNATIVE 3

SECTION F - MOBILIZATION

ROADWAY MOBILIZATION	10%	\$	15,906.32
SUBTOTAL F		\$	174,969.53

SECTION G - ADDITIONAL ITEMS

Additional pavement

Stormwater Pond	LS	1	\$	30,000.00	\$	30,000.00
Infiltration Basin	LS	1	\$	15,000.00	\$	15,000.00

SUBTOTAL G \$ 219,969.53

ROUNDED CONSTRUCTION SUBTOTAL: \$ 220,000.00

CONTINGENCY 15% \$ 33,000.00

HOYLE , TANNER CONSTRUCTION ENGINEERING 0

CONSTRUCTION (CON) TOTAL FOR PLANNING \$ 253,000.00

RIGHT OF WAY (ROW)

TAKES \$0.00

EASEMENTS \$0.00

RIGHT OF WAY (ROW) TOTAL \$0.00

PRELIMINARY ENGINEERING (PE)

ENGINEERING STUDY \$0.00

PRELIMINARY DESIGN \$0.00

AMENDMENT NO.1 \$0.00

FINAL DESIGN \$0.00

BID \$0.00

PRELIMINARY ENGINEERING (PE) TOTAL \$0.00

PROJECT TOTAL COST (CON, ROW, PE) \$253,000.00

SEE ADDITIONAL SHEET FOR ASSUMPTIONS MADE WHILE COMPILING THIS ESTIMATE.

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA'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 noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.



125 College Street, 4th Floor
Burlington, VT 05401
(802) 860-1331

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project

Engineers Estimate of Probable Construction Costs

Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE (ALT 3) - 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 noted 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. ITEM 201.11 - 315 LF ON SOUTH SIDE OF ROAD, 485 LF ON NORTH SIDE OF ROAD, BY 5' WIDE
2. ITEM 203.15 - 13,000 SF ROAD AREA BY 6" DEPTH, ADD ADDITIONAL 25 CY FOR SWALES/DRIVES
3. ITEM 203.16 - SOME LEDGE ON SITE, ASSUME 30 CY DUE TO PIPE EXCAVATION
4. ITEM 203.30 - ASSUME 5 SF PER FOOT FOR A LENGTH OF 800 FEET
5. ITEM 301.26 - ASSUME 4 INCHES FOR COMPLETE PROJECT ROADWAY AREA AND DRIVES
6. ITEM 406.25 - SAME AREA AS ITEM 301.26, 4" THICK
7. ITEM 613.10 - 400 LF ON S. ROADSIDE, ASSUME 3:1 SIDE SLOPES 1' DEEP SO USE 6' WIDE, 1' THICK
8. STORMWATER POND
9,200 SF CLEARING

STORMWATER POND (APPROX. COSTS):

CLEARING	\$ 5,000.00
EXCAVATION	\$ 16,000.00
LOAM	\$ 3,500.00
SEEDING	\$ 500.00
MISC DRAIN	\$ 5,000.00
	<u>\$ 30,000.00</u>

INFILTRATION BASIN (APPROX. COSTS):

PIPE	\$ 110,000.00
STONE	\$ 23,000.00
EXCAVATION	\$ 5,000.00
MISC	\$ 10,000.00
	<u>\$ 16,444.00</u> divide total by 9 to convert to size of this structure

Costs from Ammon Drive (size is approximately 1/9th of that project)

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

CONCEPTUAL ESTIMATE - ALTERNATIVE 4


[illegible]

SIGNS, MARKINGS, LOAM/HUMUS, ETC.	10%	\$ 8,112.48
	SUBTOTAL B	\$ 89,237.28

PIPES, UNDERDRAIN, CB's, MH's, ETC.	40%	\$ 35,694.91
*APPROX 5 CB, 335 LF PIPE	SUBTOTAL C	\$ 124,932.19

ITEM NO.	DESCRIPTION	UNIT	QUANTIT	UNIT COST	COST
621.90	TEMPORARY TRAFFIC BARRIER	LF	0	\$ 20.00	\$ -
630.10	UNIFORMED TRAFFIC OFFICERS	HR	0	\$ 56.00	\$ -
630.15	FLAGGERS	HR	160	\$ 30.00	\$ 4,800.00
641.10	TRAFFIC CONTROL	LS	1	\$ 4,000.00	\$ 4,000.00
	MISCELLANEOUS TRAFFIC CONTROL		10% OF ABOVE TOTAL		\$ 880.00
			SUBTOTAL D		\$ 134,612.19

EROSION, SEDIMENT, AND POLLUTION CONTROL (HAY BALES, SILT FENCE, SWPPP, TEMP. WATER POLL. CONTROL, ETC.)	8% of Subtotal C	\$ 9,994.58
	SUBTOTAL E	\$ 144,606.77

	125 College Street, 4th Floor Burlington, VT 05401 (802) 860-1331	Calc. By:	AGB	Date:	12/3/2019
		Chck. By:	SBH	Date:	12/6/2019
		Chck. By:		Date:	
		Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project
Engineers Estimate of Probable Construction Costs
Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE - ALTERNATIVE 4

SECTION F - MOBILIZATION

ROADWAY MOBILIZATION	10%	\$	14,460.68
SUBTOTAL F		\$	159,067.44

SECTION G - ADDITIONAL ITEMS

Additional pavement

Infiltration Basin	LS	1	\$	20,000.00	\$	20,000.00
--------------------	----	---	----	-----------	----	-----------

SUBTOTAL G \$ 179,067.44

ROUNDED CONSTRUCTION SUBTOTAL: \$ 180,000.00

CONTINGENCY 15% \$ 27,000.00

HOYLE , TANNER CONSTRUCTION ENGINEERING 0

CONSTRUCTION (CON) TOTAL FOR PLANNING \$ 207,000.00

RIGHT OF WAY (ROW)

TAKES \$0.00

EASEMENTS \$0.00

RIGHT OF WAY (ROW) TOTAL \$0.00

PRELIMINARY ENGINEERING (PE)

ENGINEERING STUDY \$0.00

PRELIMINARY DESIGN \$0.00

AMENDMENT NO.1 \$0.00

FINAL DESIGN \$0.00

BID \$0.00

PRELIMINARY ENGINEERING (PE) TOTAL \$0.00

PROJECT TOTAL COST (CON, ROW, PE) \$207,000.00

SEE ADDITIONAL SHEET FOR ASSUMPTIONS MADE WHILE COMPILING THIS ESTIMATE.

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA'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 noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.



125 College Street, 4th Floor
Burlington, VT 05401
(802) 860-1331

Calc. By:	AGB	Date:	12/3/2019
Chck. By:	SBH	Date:	12/6/2019
Chck. By:		Date:	
Chck. By:		Date:	

Bolger Hill Road Drainage Improvement Project

Engineers Estimate of Probable Construction Costs

Hoyle, Tanner Project No. 924702

CONCEPTUAL ESTIMATE (ALT 4) - 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 noted 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. ITEM 201.11 - 315 LF ON SOUTH SIDE OF ROAD, 485 LF ON NORTH SIDE OF ROAD, BY 5' WIDE
2. ITEM 203.15 - 13,000 SF ROAD AREA BY 6" DEPTH, ADD ADDITIONAL 25 CY FOR SWALES/DRIVES
3. ITEM 203.16 - SOME LEDGE ON SITE, ASSUME 30 CY DUE TO PIPE EXCAVATION
4. ITEM 203.30 - ASSUME 5 SF PER FOOT FOR A LENGTH OF 800 FEET
5. ITEM 301.26 - ASSUME 4 INCHES FOR COMPLETE PROJECT ROADWAY AREA AND DRIVES
6. ITEM 406.25 - SAME AREA AS ITEM 301.26, 4" THICK
7. ITEM 613.10 - 400 LF ON S. ROADSIDE, ASSUME 3:1 SIDE SLOPES 1' DEEP SO USE 6' WIDE, 1' THICK
- 8.

INFILTRATION BASIN (APPROX. COSTS):

PIPE	\$ 110,000.00
STONE	\$ 23,000.00
EXCAVATION	\$ 5,000.00
MISC	\$ 10,000.00
	<u>\$ 16,444.00</u>

divide total by 9 to convert to size of this structure

Costs from Ammon Drive (size is approximately 1/9th of that project)

APPENDIX C

Project Photos



Bolger Hill Road at Jericho Center Circle



Gravel on Bolger Hill Road at Intersection



Pavement Limit and House #4 Drive



Pavement Limit (Looking East)



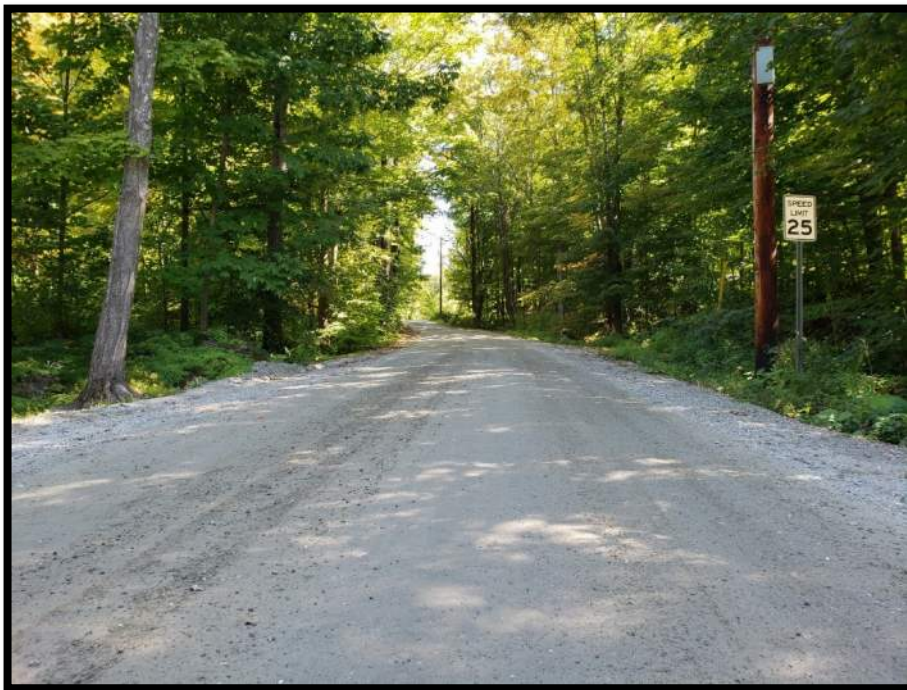
Rilling in Shoulder Gravels



Drive Pipe and Rilling along Shoulder



Proposed Stormwater Pond Location (Behind Community Center)



Along Bolger Hill Road (Looking East)



Western Drive to House #12



Outlet to an Existing CMP



Eroded Outlet to an Existing CMP

APPENDIX D

Hydraulic Calculations

Project: Bolger Hill Drainage
HTA Project # 924702
Location: Jericho Vermont
Task: Subcatchment Area Flows
Calculated By: AGB
Checked By: SBH

Date: 12/3/2019
Date: 12/6/2019

NOTES

Conceptual sizing of potential treatment practices

Q=CiA

C = 0.95 Impervious
C = 0.2 Pervious
i = 5.73 NRCC Rainfall Data IDF curve for Tc = 8 min (50 Year - 24 Hour)

Water Quality Treatment Standard (WQTS) - 2017 Vermont Stormwater Management Manual

WQv = [(P) (Rv) (A)] / 12

P = 1 in (Across Vermont)

I = Site impervious (expressed as a whole number percent)

Rv = [0.05 + 0.009(I)]

Subcatch ID	Location	Total (A)	Area (SF)		C	i	Q (cfs)
			Impervious	Pervious			
1	Bottom Hill	44847	5889	38958	0.30	5.73	1.77
2	Top Hill	70517	12635	57882	0.33	5.73	3.06

Subcatch ID	I (%)	Rv	WQv	
			(acre-feet)	(cf)
1	13	0.167	0.0143	624.1
2	18	0.212	0.0286	1245.8

From 2017 Vermont Stormwater Management Manual

Section 4.3.1.4 (Bioretention Treatment)

$$A_f = \frac{(T_v)(d_f)}{(k)(h_f + d_f)(t_f)}$$

A_f = Surface area of filter bed (ft²)

T_v = Treatment volume (ft³)

d_f = Filter bed depth (ft)

k = Coefficient of permeability of filter media (ft/day)

h_f = Average height of water above filter bed (ft)

t_f = Design filter bed drain time (days)

(2 days is the recommended maximum t_f for bioretention)

Subcatch ID	Tv (cf)	df	k	hf	tf	Af (sf)
1	624.1	2	1	0.5	2	249.65
2	1245.8	2	1	0.5	2	498.32

Combined: Af = 747.97
747.97 Check

NOTES

Conceptual sizing of potential treatment practices

$$A_p = \frac{T_v}{n d_t + f_c T / 12}$$

From 2017 Vermont Stormwater

Section 4.3.3.5 (Infiltration Treatment)

Where: A_p = practice surface area (ft²)
 T_v = design treatment volume (e.g., WQ_v , CP_v , or Q_p) (ft³)
 n = porosity (assume 0.33)
 d_t = trench depth (feet), maximum of four feet and separated from SHGWT as required
 f_c = design infiltration rate (in/hr) (i.e. soils below floor of practice)
 T = time to fill trench (hours), assumed to be 2 hours for design purposes

Subcatch ID	T_v (cf)	n	d_t	f_c	T	A_p
1	624.1	0.33	4	2	2	377.49
2	1245.8	0.33	4	2	2	753.51

Combined: A_p = 1131.00
 1131.00 Check

Stormwater Wet Pond

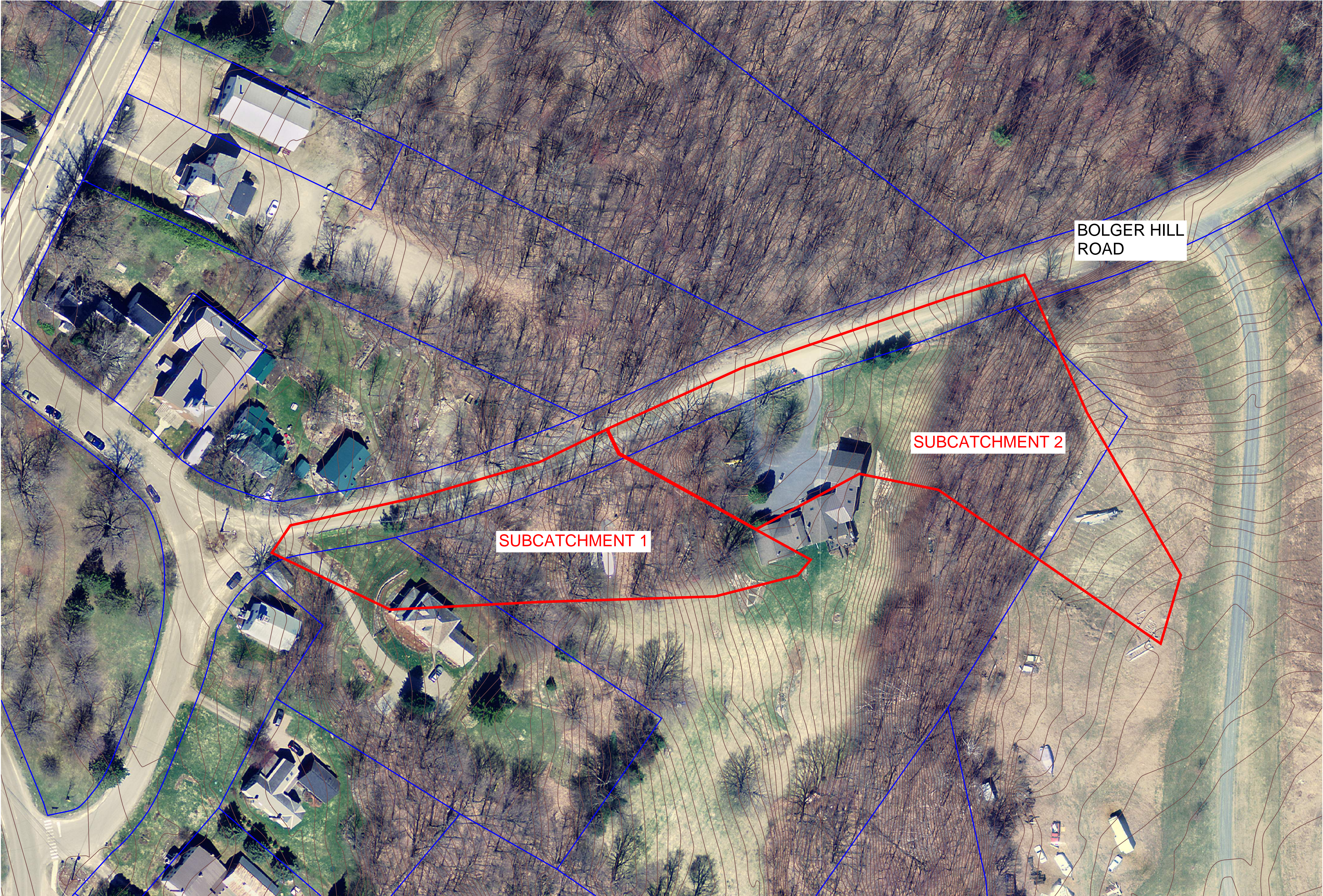
WQ_v at 1' deep to get size of bottom of pond

WQ_v = 1245.8 cf
 L = 36 ft
 W = 36 ft
 Bottom Area = 1296 sf

Depth = 6 ft (1' WQ_v , 4' storage, 1' freeboard)

Assume 3:1 side slopes

Top L = 72 ft
 Top W = 72 ft
 Top Area = 5184 sf



TOWN OF JERICHO JERICHO, VERMONT		Hoyle, Tanner & Associates, Inc.		This document is prepared as an instrument of service and shall remain the property of Hoyle, Tanner. It may not be used, reproduced, disseminated or transferred in any manner, including electronically, for any other purpose than this project, without the written permission of Hoyle, Tanner.	
BOLGER HILL ROAD DRAINAGE IMPROVEMENTS		PROJECT NO. 924702		NHDOT BRIDGE NO. ???	
PROPOSED SUBCATCHMENT AREAS		FIGURE		FILENAME \$FILES\$ DESIGNER XXX MODEL NAME XXX DRAWN \$FILES\$ SCALE AS SHOWN CHECKED \$FILES\$ DATE SUBDATES	



CORPORATE HEADQUARTERS

150 Dow Street
Manchester, NH 03101

BRANCH OFFICES

Pease International Tradeport
100 International Drive, Suite 360
Portsmouth, NH 03801

50 High Street, 4th Floor, Suite 49
North Andover, MA 01845

106 Lafayette Street, Unit 2D
Yarmouth, ME 04096

125 College Street, 4th Floor
Burlington, VT 05401

95 E. Mitchell Hammock Road, Suite 200
Oviedo, FL 32765