STATE OF VERMONT
AGENCY OF TRANSPORTATION

Scoping Report

FOR

Chester BF 0134(50)
VT ROUTE 11, BRIDGE 51 over UNNAMED BROOK

October 13, 2017

I. Contents

I. Site Information

Bridge 51 is a culvert located in a rural area along VT Route 11 approximately 0.30 miles south of TH- 52, Cummings Road, and approximately 1.6 miles north of the intersection with VT 103, South Main St. The culvert is located on a curved segment of VT 11 at approximately mile marker 6.8. The depth of cover on top of the culvert is approximately 5'-6'. The existing conditions were gathered from a combination of the Inspection Report, the Route Log and the existing Survey. See correspondence in the Appendix for more detailed information.

Roadway Classification	Rural Major Collector
Culvert Type	10'-8" wide x 6'-11" high Corrugated Galvanized Multi-Plate Pipe Arch
Culvert Span	11 feet
Culvert Length	86 ft.
Skew	15 degrees
Year Built	1965
Ownership	State of Vermont
County	Windsor
VTrans Maintenance District	2

Need

The following is a list of the deficiencies of Bridge 51 and VT Route 11 in this location.

1. This culvert has a rating of 3 "Serious" and is suffering significant corrosion and section loss at the invert. Bolt line cracking and perforations exist throughout.

2. The existing culvert meets the Hydraulic Standard but not the Bank Full Width. The culvert is located in Zone A of a Flood Insurance Study.

3. There are no known roadway geometric deficiencies.

Traffic

A traffic study of this site was performed by the Vermont Agency of Transportation. The traffic volumes are projected for the years 2017 and 2037.

TRAFFIC DATA	2018	2038
AADT	4,100	4,600
DHV	470	520
ADTT	300	460
%T	5.5	7.6
%D	51	51

Design Criteria

The design standards for this bridge project include:

1. AASHTO. *A Policy on Geometric Design of Highways and Streets.* Association of State Highway and Transportation Officials, Washington, DC, 2011. ("The Green Book").

2. AASHTO. *Roadside Design Guide.* Association of State Highway and Transportation Officials, Washington, DC, 2011.

3. Vermont State Standards, dated October 22, 1997. Minimum standards are based on an ADT > 2000 and a design speed of 50 mph.

Design Criteria	Source	Existing Condition	Minimum Standard	Comment
Approach Lane and Shoulder Widths	VSS Table 5.3	12'/7' (38')	11'/3' (28')	
Bridge Lane and Shoulder Widths	VSS Table 5.3	12'/7' (38')	11'/3' (28')	
Clear Zone Distance	VSS Table 5.5	Shielded	20' fill / 12' cut (1:3), 14' cut (1:4)	
Banking	VSS Section 5.13	4.1% at culvert location	8% (max), 6% at side roads	
Speed	VSS Section 5.3	50 mph (Unposted)	50 mph (Design)	
Horizontal Alignment	AASHTO Green Book Table 3-10b	R= 2922'	R_{min} = 2890' for 3.8% bank	
Vertical Grade	VSS Table 5.6	Roadway centerline slopes at 2.4%. approx. 185' beyond culvert	8% (max) for rolling terrain	
K Values for Vertical Curves	VSS Table 5.1	883	100 crest / 90 sag	
Vertical Clearance Issues	VSS Section 5.8	None noted	14'-3" (min)	
Stopping Sight Distance	VSS Table 5.1	1453'	400'	
Bicycle/Pedestrian Criteria	VSS Table 5.8	7' Shoulder	3' Shoulder[1]	
Bridge Railing	Structures Manual Section 13	Steel Beam Guardrail	Steel Beam Guardrail	N.A. unless non-buried structure is proposed
Hydraulics	VTrans Hydraulics Section	• HW depth = 3.3' at 2% (50-year storm) annual exceedance probability (AEP) • No roadway overtopping up to 1% AEP • BFW: 10'-8"	• Pass Q_{50} storm event without exceeding 1.2X diameter, and Q_{100} without exceeding 1.5X diameter. No roadway overtopping below Q_{100}. • BFW: 14'	Meets standard for Q_{50} storm event but not Bank Full Width.
Structural Capacity	SM, Ch. 12	Unknown	Design Live Load: HL-93	Structurally Inadequate

[1] Table 5.8 of the Vermont State Standards requires an additional foot of shoulder for shared use on bridges. If a complete bridge replacement was chosen and a non-buried structure installed, lane and shoulder widths then would be 11'/4'.

Inspection Report Summary

Culvert Rating	3 Serious
Channel Rating	6 Satisfactory

From the most recent Inspector's Report:

*"11/08/2016 - * Culvert has heavy corrosion along the invert, and needs replacement. During highwater flow rates, the pipe has the potential for drastic distortion. Could pour invert now to save, though pipe is settling, and has distorted to some degree. ~ MJ/AC"*

"04/22/2016 - Special inspection to monitor distress. Pipe has high potential for progressive deformation due to extensive invert deterioration. Slight dip noted along western side of roadway. Culvert needs extensive invert repair or full pipe replacement soon. ~ MJ/SP"

"12/3/2015 Culvert is in poor condition due to the boltline cracking and the rusting of the invert. Culvert should be evaluated for a possible concrete invert in the near future. Scour hole on the outlet should be filled. ~ FRE/TJB"

*"09/23/2014 - *Pipe has significant reversal due to invert failure and needs replacement soon. ~MJ/JS"*

*"12/03/2013 - **Pipe is in poor condition due to extensive corrosion with the invert rusted out. Pipe has approximately a foot of reversal. The pipe needs replacement. ~ MJ/JS"*

9/28/2012 "Culvert should be evaluated for a concrete invert. FRE/JAS"

10/26/2010 – "Poor condition – pipe continues to deteriorate and needs repair or replacement soon. Heavy tree debris at outlet and needs to be removed as deep scouring is occurring along cradle. Inlet needs to be cleaned also." ~MK/RF

Hydraulics

A Preliminary Hydraulics Report was done for this site and can be seen in the Appendix. The existing pipe arch culvert configuration meets the hydraulic standard but not the Bank Full Width. There is a Flood Insurance Study for this stream, which indicates that the 1% AEP water surface elevations should not be raised. There is a small vertical drop at the outlet end of the culvert, possibly inhibiting Aquatic Organism Passage (AOP) at this location.

Recommendations

The Preliminary Hydraulics Report recommends that no increase in surface water elevations be proposed since the existing culvert is undersized and there are nearby buildings in the floodplain. Therefore, the report does not make a recommendation for culvert repair or rehabilitation.

Several possible solutions are offered if the culvert is replaced:

- An open bottom precast concrete frame or similar 3-sided structure with a 14' minimum clear span (measured perpendicular to the channel) and a 6' minimum clear height above the average channel bottom.
- A 14'1" x 8'9" corrugated metal pipe arch with buried invert and 12" bed retention sills.
- A concrete box with a 14' wide by 8' inside opening. The box would need to be buried 3' below stream bed, so the waterway area would be 70 sq. ft. minimum. Bed retention sills as sized and spaced by the Hydraulics Unit are recommended.

Other scenarios may be possible with input from the Hydraulics Section.

Utilities

Underground:

There are no municipal buried water or wastewater utilities near the site.

Aerial:

There are overhead utility lines near the project site, but these are not expected to be impacted by construction work.

Right of Way

At the project site, the Right-of-Way width varies and can best be described graphically as shown on the Resource Site Plan found in the Appendix. It is anticipated that additional Right-of-Way will only be required if a temporary bridge is used to maintain traffic during construction.

Resources

The resources present at this project are shown on the Resource Site Plan Sheet found in the Appendix, and are as follows:

Biological:

Wetlands/Watercourses

"The project carries VT Route 11 over an unnamed brook via Bridge 51. The structure appears to be undersized and is considered a barrier to aquatic organism passage. The outlet is currently perched.

A small wetland in the NW quadrant was mapped using a GPS and is in the natural resources geodatabase."

Wildlife Habitat

"This project has large wooded areas within the general vicinity. There is a large mapped deer wintering area to the west of the project site. This area should be mostly avoided during construction.

Providing a natural, or simulated natural bottom to the stream under VT Route 11 would provide access to multiple aquatic organisms.

This area would benefit from a larger structure to help minimize wildlife-vehicle collisions. This is a rural area and wildlife likely cross along VT Route 11 regularly. Providing dry shelves during normal flows should help with this concern."

Rare, Threatened and Endangered Species

"There are no mapped rare, threatened or endangered species within the project area.

That said, the entire state of Vermont is potential habitat for the federally threatened Northern Long-Eared Bat. This project is not likely to impact habitat for the Northern Long-Eared Bat, but this may change if a large amount of trees need to be cut. The structure itself is not considered habitat."

Agricultural Soils

"There are no mapped agricultural soils within the project area."

Archaeological:

No Archaeological Resources have been identified at the site.

Historic:

Input from VTrans Historic staff indicates that no historically significant resources have been identified at the site.

Hazardous Materials:

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

Stormwater:

There are no known stormwater concerns for this project.

II. Safety

The project area is not within a high crash section of VT 11. Roadway geometric standards are met in this segment of roadway, and there is good sight distance.

III. Alternatives Discussion

The existing roadway at the culvert location meets standards in terms of roadway geometry and safety features. No work on the existing roadway alignment is anticipated. The project site is not in a high crash location. The alternatives presented here are based on improvement of the condition of the culvert and channel.

There are two basic approaches to this project; replacement and rehabilitation.

- A replacement project could be designed to resolve all of the deficiencies that exist today at the project site. They include structural deterioration, BFW, AOP, and maintenance of flood elevations.
- A rehabilitation project would restore some degree of structural integrity to the culvert, but would leave several desirable features unresolved including BFW and AOP, and would have a lower design life than a replacement. Hydraulic and flood capacity could even be reduced.

It is recognized that some projects will not get funded for full replacements that meet all standards and resource requirements. Therefore, rehabilitation alternatives will be discussed in this report as a measure to extend the life of this culvert to the point where a replacement can be completed.

No Action

This alternative would involve leaving the culvert in its current condition. There are two ways used to evaluate whether a "No Action" alternative is appropriate - one is to determine whether the existing structure can stay in place without any work being performed on it during the next 10 years. The other is the ratings of all of the elements of a bridge or culvert, with the goal that all elements rated 4 or less are to be removed or rehabilitated. In this case, the culvert will likely require work within the next 10 years, due to the condition of the invert. Also, given the 3 (serious) rating on this culvert, it is not acceptable to leave it as is. Therefore, the No Action alternative is not recommended.

Structure Replacement with an Integral Abutment Bridge

The integral bridge concept was not developed for this project because it is generally more economical to construct a buried structure for short spans where there is adequate cover for the structure. A buried structure in this location will also be more protected from de-icing salts and will require less maintenance.

Structure Replacement Using Trenchless Methods

Trenchless methods, as defined in this scoping report, include jack and bore, pipe ramming, and similar methods of installing a new pipe without open excavation. A replacement of the existing culvert adjacent to the current location was considered. It is unlikely that these methods of pipe replacement would be cost competitive for this project, where the vertical cover over the pipes is so shallow. These methods will not be considered further in this report.

Alternative 1: Rehabilitation

Rehabilitation is usually considered for any culvert project. Normally on a project with the hydraulic characteristics seen here (constricts the stream and would raise Q_{100} flood elevations if lined), rehabilitation would be discounted, and a replacement project would be recommended. However, two conditions suggest including a discussion of rehabilitation in this report. The first is that economic considerations are becoming a higher priority on many projects, and second, it may be possible for short term improvements to be made in a manner that prevents raising the flood elevations.

Rehabilitation options considered:

a: Invert Repair/Replacement (15-year design life)
b: Pipe Liner (50-year design life)
c: Cured In Place Pipe (40-year design life)
d: Spray-on Lining (30-year design life)

All rehabilitation options would employ the use of hydro-blasting or hydro-demolition to appropriately clean the existing pipe interior prior to rehabilitation. In addition to cleaning, some grouting would be needed to plug holes in the pipe and fill all voids on the outside of the pipe. Curing in dry conditions would be required in most cases, necessitating a re-routing of the stream flow during the work and for a prescribed curing period (usually 24 hours). A headwall with beveled inlets would be recommended for all rehabilitation alternatives.

a. Invert Repair or Replacement

The condition of the galvanized metal above the ordinary water line in the culvert is good, suggesting that there is significant service life remaining in that portion of the pipe. There are different types of invert repair that can be utilized on corrugated steel pipe. The following were considered:

- Bituminous concrete paving is not recommended for this situation because it is ineffective where structural capacity needs to be replaced.
- Reinforced concrete can also be used to form the new invert. This does restore some of the structural integrity of the culvert and extends the life of the culvert.
- VTrans' Construction and Maintenance Bureau (Technical Section) is experimenting with a project which uses phased plate replacement to accomplish the invert repair. Since this project is likely to be bundled with up to 3 other projects on VT 11, this project is probably not a good choice for a pilot project. Plate replacement will not be considered further in this report.
- To provide the maximum possible waterway area, a configuration of the new invert using reinforced concrete that is lower than the existing pipe bottom could be considered. Provision of AOP and avoidance of higher flood elevations should be considerations.

b. Pipe Liner

Adding a pipe liner, also called sliplining, consists of pulling a complete new pipe into the existing culvert, then grouting the space between the two. Sliplining can be done using several different types of pipe material including corrugated steel, aluminum, reinforced concrete, and polyethylene, and can restore the structural integrity of the culvert. There are two drawbacks to sliplining: one is that the waterway area is always reduced when sliplining is done; and two, it can be difficult to get the new liner installed, especially if there is distortion of the original host pipe as would be possible on this project. Another drawback is that it does not enhance AOP. Actions that raise the water surface elevations in Flood Insurance Zones or flood plains are prohibited without additional modelling of the waterway to show no detrimental effects. Crucial to the success of this method would be surveying the interior of the existing CMP to insure that a rigid liner can be installed in the pipes. In the case of a pipe arch, it may be possible to procure a slightly smaller pipe arch to use as a liner, but it will be costly to produce the matching arch shape and will reduce further the already inadequate waterway area. Pipe lining with an interior liner will not be considered further in this report.

c. CIPP (Cured In Place Pipe)

CIPP is another way of providing a new lining to the interior of an existing pipe. A resin-saturated felt or fiber tube is inserted into the pipe in a folded configuration, and is then expanded to be in contact with the entire interior surface of the existing culvert. Curing takes place by heating the resin using hot water, steam, or UV light. This method of culvert repair is not considered further in this report because a literature search on the subject yields no data on CIPP of the size required. Therefore, although it is expected that this method of culvert repair will be used in the future in Vermont, it is not considered to be a feasible solution for this project.

d. Spray-On Liners

Spray-On liners provide a new rigid interior surface for the pipe and use either cementitious materials (polymer-enhanced cement mortar) or polyurea. These liners are spray applied either by hand or machine, although some users have had better quality control with hand-applied methods. Cementitious liners installed by these methods can provide full structural support, depending on thickness applied. Proper curing is essential to using spray-on liners to avoid bond failures. There could be water quality impacts associated with the application of these liners, their degree of impact related to selection of materials and adherence to curing requirements. If a spray-on liner is selected, the polymer-enhanced cement mortar is recommended for environmental and safety reasons.

Advantages: A repair alternative using methods b, c, and d would address the structural deficiencies of the existing culvert pipes with minimum upfront costs. Very minimal impacts on traffic flow would be expected. Additional Right-of-Way would not be required for any of the rehabilitation alternatives.

Disadvantages: The biggest disadvantage with the rehabilitation solution is that in all cases described above, an already substandard hydraulic condition is in fact made slightly worse by making the waterway area slightly smaller. A remaining service life of approximately 15 to 50 years would be gained, and slight temporary water quality impacts may be seen. Aquatic Organism Passage and wildlife connectivity would not be improved.

Alternative 2 & 3: Structure Replacement with a Buried Structure

This option involves removing the existing structure, and replacing it with a new buried structure with a minimum 14-foot span. Since there is only an average of 5 feet of fill above the existing culvert, there would not have to be an extremely large amount of earthwork, making this a good site for a new precast buried structure. The preliminary hydraulics report suggests several possible configurations for a new structure, including an open bottom precast concrete arch or frame, a box culvert, of a corrugated metal pipe arch.

A concrete structure is preferred to a metal structure due to an increased design life. A box culvert would have a design life of 75 years, and an open bottom precast concrete arch or frame would have a design life of 100 years. Both structure types will be considered as viable options.

Any new structure should have flared wingwalls and headwalls extending down at least four feet, at the inlet and outlet to make a smooth transition between the channel and the culvert. The various considerations under this option include: the roadway width, structure type, culvert length and skew, and roadway alignment.

a. Roadway Width

The current roadway width is 38-feet. This exceeds the minimum standard of 28-feet. Since a new 80+ year structure is being proposed, the roadway geometry should meet the minimum standards. A 38-foot width roadway will be proposed through the project area to match the existing.

b. Structure Type

The most common structure types for the recommended hydraulic opening are a 4-sided concrete box culvert, or a 3-sided open bottom concrete structure.

Concrete Box Culvert (Alternative 2):

A concrete box culvert would be 14-feet wide x 8-feet high (inside opening). This includes 3 feet for a buried invert, such that the clear waterway area would be 14-feet x 5-feet. Bed retention sills would be recommended for Aquatic Organism Passage. This type of structure would provide protection against scour and undermining, and would require less excavation than an open bottomed structure, since footings would not have to be placed six feet below the stream bed. A design life of 75-years would be expected for this structure type.

Precast Concrete Arch (Alternative 3):

A precast concrete arch 14’ wide by 6’ high would be adequate as well. This would have a natural channel bottom and would need to have 1’ of freeboard for the 2% AEP. Additionally, footings would have to be placed six feet below the stream bed, requiring more excavation then the box option and a longer construction duration. A design life of 100-years would be expected for this structure type.

c. Culvert Size, Length and Skew

The existing culvert has a minimum span of 10-feet 8-inches, which constricts the natural channel width. Hydraulics has recommended a bank full width of at least 14-feet, as described above in section b. Either of the configurations described (the 4-sided concrete box or the 3-sided open bottom structure) will meet all hydraulic standards. The culvert currently has a skew of 76-degrees to the roadway. A skew of 75-degrees to the roadway to match the existing skew of the channel is recommended. In order to accommodate a 38-foot wide roadway with that culvert skew, the proposed barrel length would be approximately 72-feet long.

d. Roadway Alignment

The existing horizontal and vertical alignments meet current geometric standards, and as such will remain unchanged.

e. Maintenance of Traffic

Either an off-site detour, phased construction, or a temporary bridge would be appropriate measures for traffic control at this site. The temporary bridge option would require additional Right-of-Way acquisition.

Advantages: A new buried structure would resolve all structural deficiencies at this site and offer at least a 75-year service life. It would provide the full waterway area required to meet the hydraulic standard and BFW, as well as AOP.

Disadvantages: This alternative would have the largest initial cost of the alternatives considered and would have the largest impact in terms of traffic disruption and excavation.

IV. Maintenance of Traffic

The Vermont Agency of Transportation performs some bridge and culvert projects through its Accelerated Bridge Program, which focuses on faster delivery of construction plans, permitting, and Right of Way, as well as faster construction of projects in the field. One practice that will help in this endeavor is closing bridges for portions of the construction period, rather than providing temporary bridges. In addition to saving money, the intention is to minimize the closure period with faster construction techniques and incentives to contractors to complete projects early. The Agency will consider the closure option on most projects where rapid reconstruction or rehabilitation is feasible. The use of prefabricated elements in new bridges will also expedite construction schedules. This can apply to decks, superstructures, and substructures. Accelerated Construction should provide enhanced safety for the workers and the travelling public while maintaining project quality. The following options have been considered:

Option 1: Off-Site Detour

This option would close the bridge and reroute traffic onto an official, signed State detour, which detours traffic from the intersection of VT 11 and VT 106 in Springfield north on VT 106 to the intersection of VT 106 and VT 10 in North Springfield. Then the detour heads west on VT 10 to VT 103, south on VT 103 to Chester, and then back onto VT 11.

Thru distance:	7.1 miles	9 minutes
Detour distance:	13 miles	19 minutes
Added distance for Thru Traffic:	5.9 miles	10 minutes
End to end distance:	20.1 miles	28 minutes

The times listed assume no delays due to traffic congestion.

An alternate detour exists routing traffic to the south of the project:

Starting at the intersection of VT 106 and VT 11 in Springfield, travel southeast on VT 11 to I-91, then south on I-91 to Exit 6 in Rockingham. From Exit 6, travel northwest on VT 103 to Chester, then back to VT 11.

Thru distance:	7.1 miles	9 minutes
Detour distance:	20 miles	23 minutes
Added distance for Thru Traffic:	12.9 miles	14 minutes
End to end distance:	27.1 miles	22 minutes

Again, no delays for congestion are included in the travel times above.

There are some opportunities for local bypasses, but they are few and not ideal. The first potential bypass discussed was TH-52 (Cummings Road), a Class 3 town highway which comes off VT 11 approximately one third of a mile north of the project site. This route then travels southwest toward the Chester-Depot Urban Compact. This route was discounted as a possibility however because it is narrow with poor sight distance and is unpaved. There is also a portion of Class 4 highway near the Urban Compact line. This bypass route would be inappropriate for through trucks and for the volume of additional traffic that would be using it.

Another possible bypass follows TH-78 (Pleasant Valley Road) southward into the Town of Rockingham until it eventually joins VT 103. TH-78 is a Class 3 Town Road and is nearly as long as the possible southern State-signed detour route.

Other bypass routes may be available. Access to driveways and town highways would be maintained. A map of the primary detour route can be found in the appendix.

Advantages: Utilizing an off-site detour would eliminate the need to use a temporary bridge or phase construction to maintain traffic. This would decrease the cost and amount of time required to plan and construct a project in this location. The impacts and amount of temporary rights required to construct a project in this location would also be reduced for this option. The safety of both construction workers and the travelling public will be improved by removing traffic from the construction site.

Disadvantages: Traffic flow would not be maintained through the project corridor during construction. The available bypass routes and those residing on them would be negatively impacted by increased traffic volumes and decreased safety.

Option 2: Phased Construction

Phased construction is the maintenance of one lane of alternating traffic on the existing bridge while building one lane at a time of the proposed structure. Once the first half of the project is completed, traffic is shifted to the new lane, and work proceeds on the second lane. This allows keeping the road open during construction, while having minimal impacts to resources and adjacent property owners.

There is a large amount of Right-of-Way though the project area, and it is anticipated that phased construction would not require additional Right-of-Way. Based on the traffic volumes, it is reasonable to close one lane of traffic, and maintain one lane of traffic, both ways, with a traffic signal. Delays will still occur as speed will be reduced through the work zone.

The phasing for this site could be done with 2 phases. The layout of this phasing sequence can be found in the appendix. The following is a description of the phases:

- Phase 1: A single lane open to traffic on the upstream side of the road, over the existing culvert. During this phase, approximately five precast culvert sections would be installed on the downstream side of the road.

- Phase 2: A single lane open to traffic on the downstream side of the road, over the new culvert sections that were placed in Phase 1. During this phase, approximately five more precast culvert sections would be installed on the upstream side of the road. The channel flow would be established in the new culvert at this time.

The excavation to install a 3-sided frame or arch would be approximately 20'-21' deep to reach the recommended footing scour depth, or 14'-15' for a box culvert. Phasing would require a fairly deep braced excavation immediately adjacent to a live traffic lane while the work is performed. Conventional cantilever sheet pile retaining walls would probably not be feasible due to shallow depth to bedrock.

Advantages: Traffic flow would be maintained through the project corridor during construction. Also, this option would have minimal impacts to adjacent properties, surrounding wetlands and wooded areas.

Disadvantages: Phased construction generally involves higher costs and complexity of construction. Costs are usually higher and construction duration is longer, since many construction activities have to be performed two times. Additionally, since cars are traveling near construction activity, there is decreased safety. There would be some delays and disruption to traffic, since the road would be reduced to one-way traffic.

Option 3: Temporary Bridge

A two-way temporary bridge, would be appropriate based on the daily traffic volumes and sight distance. A downstream temporary bridge would be difficult to place from a constructability and permitting standpoint. On the downstream side, the brook runs closely and parallel to the road making a temporary bridge difficult to place. Additionally, there are wetlands located on the downstream side of the culvert, which would be adversely affected by a temporary bridge. As this is a forested area, many mature trees would be lost as well. Therefore, any temporary bridge should be placed on the upstream side of the road. A two-way upstream temporary bridge would require additional Right-of-Way acquisition.

Advantages: Traffic flow can be maintained through the project corridor during construction.

Disadvantages: A two-way temporary bridge would require some Right-of-Way acquisition, which would lengthen the project development phase. This option would have impacts to adjacent properties and to adjacent wooded areas. Compared to removing traffic from the construction site, there would be decreased safety to the workers and to vehicular traffic, because of cars driving near the construction site, and construction vehicles entering and exiting the construction site. This traffic control option would be costly, and time consuming, as construction activities would take a second construction season, in order to set up the temporary bridge. A temporary bridge on the east side of VT 11 would be placed very close to a single family residence there.

V. Alternatives Summary

Based on the existing site conditions, culvert condition, and recommendations from hydraulics and others, the following alternatives are offered:

Alternative 1a: Culvert Rehabilitation using Invert Replacement, with traffic maintained with periodic short term delays.

Alternative 1b: Culvert Rehabilitation using Spray-on Liner with traffic maintained with periodic short term delays.

Alternative 2a: Full Culvert Replacement with a Precast Concrete Box with traffic maintained on an Off-Site Detour.

Alternative 2b: Full Culvert Replacement with a Precast Concrete Box with traffic maintained via Phased Construction.

Alternative 2c: Full Culvert Replacement with a Precast Concrete Box with traffic maintained on a Temporary Bridge.

Alternative 3a: Full Culvert Replacement with an Open Bottom Precast Concrete Arch or Frame with traffic maintained on an Off-Site Detour.

Alternative 3b: Full Culvert Replacement with an Open Bottom Precast Concrete Arch or Frame with traffic maintained via Phased Construction.

Alternative 3c: Full Culvert Replacement with an Open Bottom Precast Concrete Arch or Frame with traffic maintained on a Temporary Bridge.

VI. Cost Matrix[2]

Chester BF 0134(50)		Alt 1a	Alt 1b	Alt 2a	Alt 2b	Alt 2c	Alt 3a	Alt 3b	Alt 3c
		Invert Replacement	**Spray-on Liner**	**Precast Concrete Box**			**Open Bottom Precast Concrete Arch or Frame**		
		Minor Traffic Impacts		**Offsite Detour**	**Phased Construction**	**Temporary Bridge**	**Offsite Detour**	**Phased Construction**	**Temporary Bridge**
	Bridge Cost	$287,000	$129,000	$375,500	$422,600	$375,500	$589,000	$665,200	$589,000
	Removal of Structure	$0	$0	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
	Roadway	$125,000	$125,000	$133,000	$142,000	$133,000	$147,000	$159,000	$147,000
	Maintenance of Traffic	$25,000	$25,000	$47,250	$129,500	$235,440	$47,250	$129,500	$235,440
	Construction Costs	$437,000	$279,000	$575,750	$714,100	$763,940	$803,250	$973,700	$991,440
	Construction Engineering + Contingencies	$149,000	$81,000	$173,000	$215,000	$230,000	$241,000	$293,000	$298,000
	Total Construction Costs w CEC	$586,000	$360,000	$748,750	$929,100	$993,940	$1,044,250	$1,266,700	$1,289,440
	Preliminary Engineering[3]	$131,000	$70,000	$149,750	$185,820	$198,788	$208,850	$253,340	$257,888
	Right of Way	$0	$0	$0	$0	$65,000	$0	$0	$65,000
	Total Project Costs	**$717,000**	**$430,000**	**$898,500**	**$1,114,920**	**$1,257,728**	**$1,253,100**	**$1,520,040**	**$1,612,328**
	Project Development Duration[4]	2 years	2 years	3 Years	3 Years	3 Years	3 Years	3 Years	3 Years
	Construction Duration	2 months	2 months	4 months	6 months	9 months	4 months	6 months	9 months
	Closure Duration (If Applicable)	NA	NA	7 Days	NA	NA	21 Days	NA	NA
	Typical Section - Roadway (feet)	38’	38’	38’	38’	38’	38’	38’	38’
	Typical Section - Bridge (feet)	7-12-12-7	7-12-12-7	7-12-12-7	7-12-12-7	7-12-12-7	7-12-12-7	7-12-12-7	7-12-12-7
	Geometric Design Criteria	No Change	No Change	No Change	No Change	No Change	No Change	No Change	No Change
	Traffic Safety	Improved	Improved	Improved	Improved	Improved	Improved	Improved	Improved
	Alignment Change	No	No	No	No	No	No	No	No
	Bicycle Access	No Change	No Change	No Change	No Change	No Change	No Change	No Change	No Change
	Hydraulic Performance	Meets Standard Does not Meet BFW	Meets Standard Does not Meet BFW	Meets Standard	Meets Standard	Meets Standard	Meets Standard	Meets Standard	Meets Standard
	Pedestrian Access	No Change	No Change	No Change	No Change	No Change	No Change	No Change	No Change
	Utility	No Change	No Change	No Change	No Change	No Change	No Change	No Change	No Change
	ROW Acquisition	No	No	No	No	Yes	No	No	Yes
	Road Closure	No	No	Yes	No	No	Yes	No	No
	Design Life	15 years	30 years	75 years	75 years	75 years	100 years	100 years	100 years
ANNUALIZED COST	(Total Project Cost) / (Design Life)	$47,800	$14,330	$11,980	$14,865	$16,770	$12,530	$15,200	$16,125

[2] Costs are estimates only, used for comparison purposes.
[3] Preliminary Engineering costs are estimated starting from the end of the Project Definition Phase.
[4] Project Development Durations are staring from the end of the Project Definition Phase.

VII. Conclusion

Alternative 2b is recommended; replace the existing culvert with a precast 4-side box while maintaining traffic with phased construction.

This alternative has the lowest upfront and annualized cost for the replacement options that maintain traffic on-site during construction.

Structure:
Since the culvert is rated as being in serious condition, it is reasonable to assume that a replacement structure is needed. Additionally, the culvert does not meet bank full width requirements, further warranting a full replacement.

The new culvert will be a 14-foot x 8-foot precast concrete box culvert, as per the VTrans Hydraulic Section's recommendation. The new precast box will have bed retention sills, to allow for a natural channel bottom to form, accommodating aquatic organism passage. Since the precast culvert will have a closed bottom, it will be protected from scour. In order to satisfy the AOP needs, the culvert invert should be buried 3-feet and stone should be placed along the length of the channel bottom through the culvert, resulting in a 5-foot high waterway opening. The new culvert should have headwalls that extend four feet below the channel bottom at the inlet and the outlet to prevent undermining. This structure will have no roadway overtopping below the Q_{100} storm event.

Traffic Control:
The recommended method of traffic control is to maintain traffic in phases. Since there is an average of five feet of fill above the culvert, which is relatively low, it will not be extremely costly to retain the soil between phases, making this site a good candidate for phased construction. A detour for this project location would have an end-to-end distance of 20 miles, and take 30 minutes to drive. Additionally, there are no local bypass routes available that would significantly reduce the detour travel time. It seems unreasonable to send 4,100 vehicles a day on a detour of that distance, when the option to phase traffic at a slightly higher cost is a viable option.

The cost and construction duration to maintain traffic on a temporary bridge is comparable to maintaining traffic in phases and would be an acceptable method of traffic control as well. However, since the temporary bridge option would have greater impacts to adjacent properties, it is recommended that traffic is maintained in phases.

Additional Considerations:
Due to the similarity of scope and proximity of Culvert 51 in Chester and Culverts 57 and 60 in Springfield to each other, it is recommended that the three projects be combined for the Project Development and Construction Phases.

Appendix A: Site Pictures

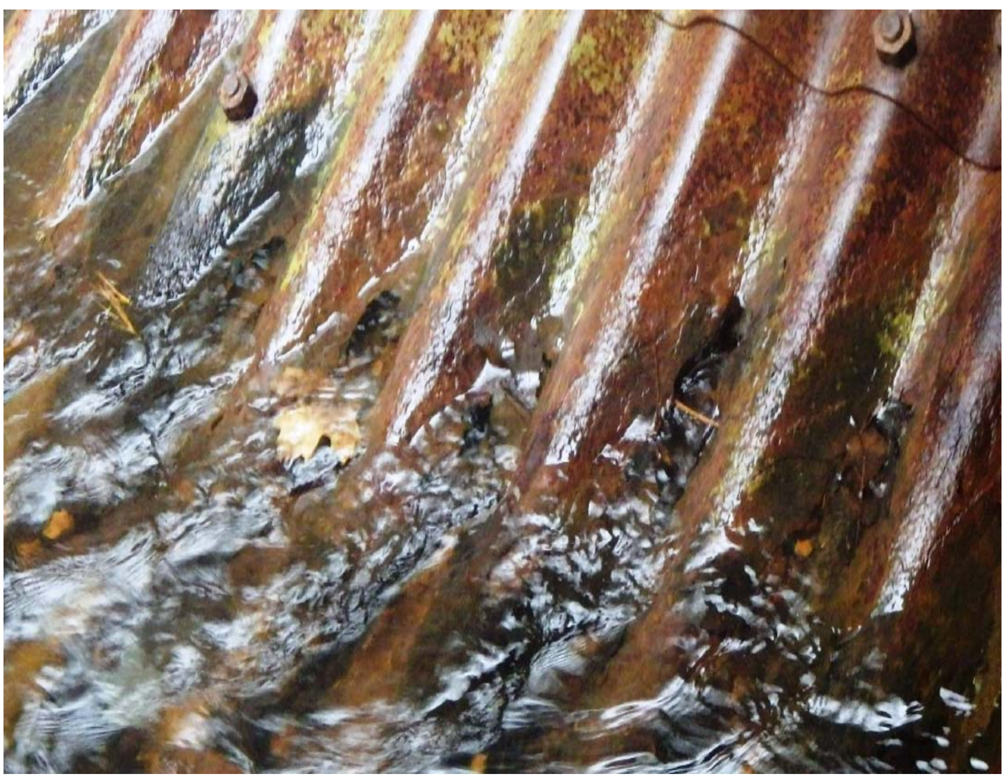

VT 11 looking west


VT 11 looking east

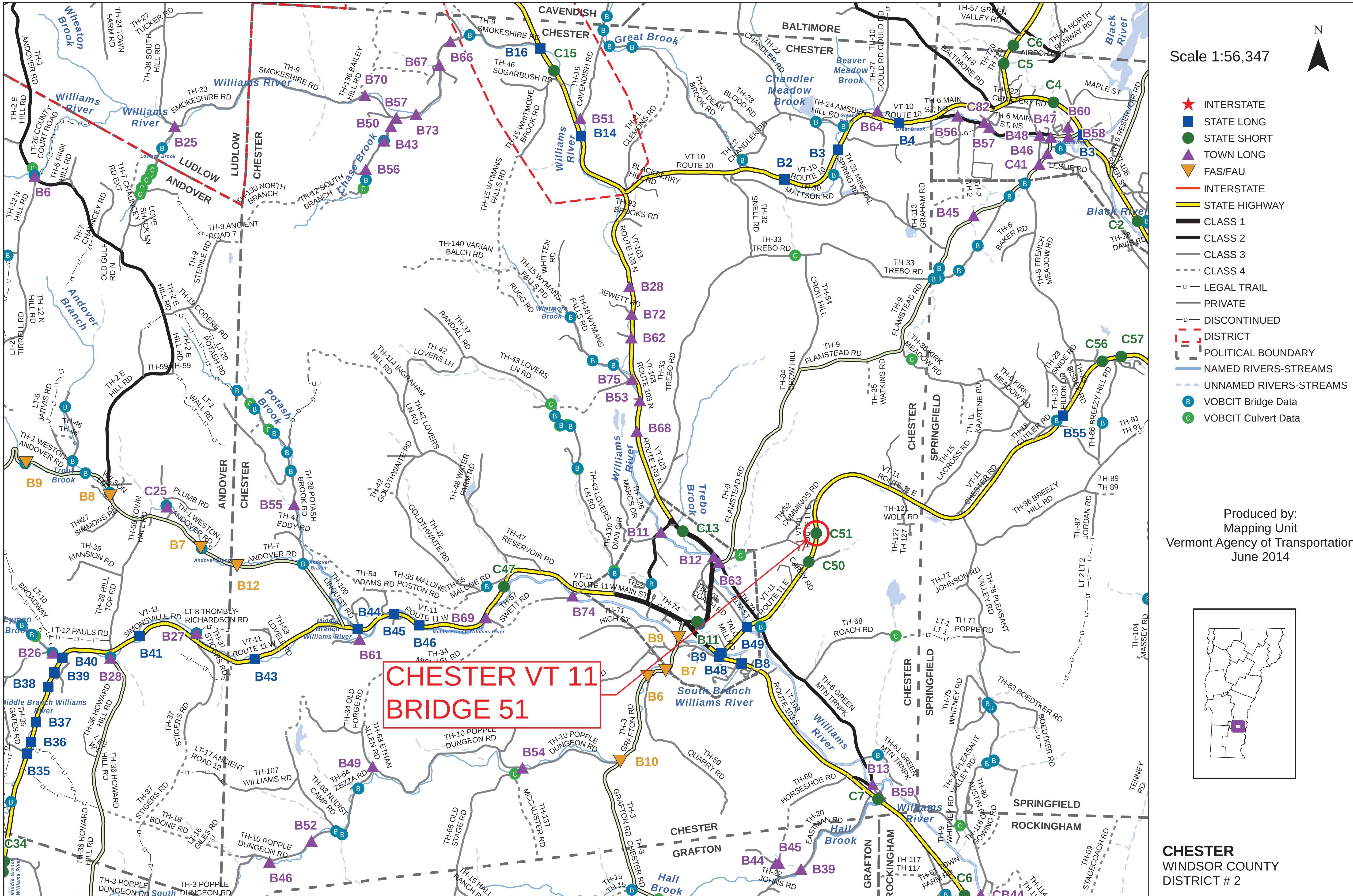

Culvert Inlet


Culvert outlet


Culvert Interior


Corrosion and Perforations

Appendix B: Town Map


Scale 1:56,347
N
INTERSTATE
STATE LONG
STATE SHORT
TOWN LONG
FAS/FAU
INTERSTATE
STATE HIGHWAY
CLASS 1
CLASS 2
CLASS 3
CLASS 4
LEGAL TRAIL
PRIVATE
DISCONTINUED
DISTRICT
POLITICAL BOUNDARY
NAMED RIVERS-STREAMS
UNNAMED RIVERS-STREAMS
VOBCIT Bridge Data
VOBCIT Culvert Data
Produced by:
Mapping Unit
Vermont Agency of Transportation
June 2014
CHESTER
WINDSOR COUNTY
DISTRICT # 2
CHESTER VT 11
BRIDGE 51
C51
CAVENDISH
BALTIMORE
CHESTER
LUDLOW
ANDOVER
SPRINGFIELD
ROCKINGHAM
GRAFTON
Williams River
South Branch Williams River
Middle Branch Williams River
Black River
Trebo Brook
Potash Brook
Andover Branch
Great Brook
Chandler Meadow Brook
Hall Brook
VT-11 ROUTE 11 W MAIN ST
VT-103 ROUTE 103 N
VT-10 ROUTE 10
VT-11 ROUTE 11 E

Appendix C: Bridge Inspection Report

STRUCTURE INSPECTION, INVENTORY and APPRAISAL SHEET

Vermont Agency of Transportation ~ Structures Section ~ Bridge Management and Inspection Unit

Inspection Report for CHESTER | **bridge no.:** 0051 | **District:** 2

Located on: VT11 **over** BROOK | **approximately** 1.6 MI E JCT VT 103 | **Maintained By:** STATE

CONDITION

Deck Rating: N NOT APPLICABLE
Superstructure Rating: N NOT APPLICABLE
Substructure Rating: N NOT APPLICABLE
Channel Rating: 6 SATISFACTORY
Culvert Rating: 3 SERIOUS
Federal Str. Number: 300134005114071

AGE and SERVICE

Year Built: 1965 **Year Reconstructed:** ____
Type of Service On: 1 HIGHWAY
Type of Service Under: 5 WATERWAY
Lanes On the Structure: 02
Lanes Under the Structure: 00
Bypass, Detour Length (miles): 4
ADT: 4000 **Year of ADT:** 1996

GEOMETRIC DATA

Length of Maximum Span (ft): 11
Structure Length (ft): 11
Lt Curb/Sidewalk Width (ft): 0
Rt Curb/Sidewalk Width (ft): 0
Bridge Rdwy Width Curb-to-Curb (ft): 0
Deck Width Out-to-Out (ft): 0
Appr. Roadway Width (ft): 40
Skew: 15
Bridge Median: 0 NO MEDIAN
Feature Under: FEATURE NOT A HIGHWAY OR RAILROAD
Min Vertical Underclr (ft): 07 FT 00 IN

STRUCTURE TYPE and MATERIALS

Bridge Type: CGMPPA
Number of Main Spans: 1
Kind of Material and/or Design: 3 STEEL
Deck Structure Type: N NOT APPLICABLE
Type of Wearing Surface: N NOT APPLICABLE
Type of Membrane: N NOT APPLICABLE
Deck Protection: N NOT APPLICABLE

CULVERT GEOMETRIC DATA and INDICATORS

Culvert Barrel Length (ft): 86
Average Cover Over Culvert (ft): 06
Waterway Area Through Culvert (sq.ft.): 58
Wingwall/Headwall Rating: 7 GOOD CONDITION

APPRAISAL

Appr. Rdwy. Alignment: 8 EQUAL TO DESIRABLE CRITERIA

INSPECTION

Inspection Date: 112016 **Inspection Frequency (months):** 12

INSPECTION SUMMARY and NEEDS

11/08/2016 - * Culvert has heavy corrosion along the invert, and needs replacement. During highwater flow rates, the pipe has the potential for drastic distortion. Could pour invert now to save, though pipe is settling, and has distorted to some degree. ~ MJ/AC

04/22/2016 - Special inspection to monitor distress. Pipe has high potential for progressive deformation due to extensive invert deterioration. Slight dip noted along western side of roadway. Culvert needs extensive invert repair or full pipe replacement soon. ~ MJ/SP

12/3/2015 Culvert is in poor condition due to the boltline cracking and the rusting of the invert. Culvert should be evaluated for a possible concrete invert in the near future. Scour hole on the outlet should be filled. ~FRE/TJB

09/2/32014 - * Pipe has significant reversal due to invert failure and needs replacement soon. ~ MJ/JS

12/03/2013 - ** Pipe is in poor condition due to extensive corrosion with the invert rusted out. Pipe has approximately a foot of reversal. The pipe needs replacement. ~ MJ/JS

9/28/2012 Culvert should be evaluated for a concrete invert. FRE/JAS

Appendix D: Preliminary Hydraulics Report

VT AGENCY OF TRANSPORTATION PROGRAM DEVELOPMENT DIVISION

HYDRAULICS UNIT

TO: Jennifer Fitch, Structures Project Manager

FROM: Leslie Russell, P.E., Hydraulics Project Manager

DATE: 29 August 2016

SUBJECT: Chester BF 0134(50) – VT 11 BR 51 over Kingdom Valley Brook
Preliminary Hydraulics

We have completed our preliminary hydraulic study for the above referenced site, and offer the following information for your use:

Existing Conditions

The existing structure is a 10' – 8" x 6' – 11" CGMPPA that provides waterway opening of 58 sq. ft. It was built in 1965. The pipe invert has rust and holes throughout it. Bridge inspection reports say that the pipe has high potential for progressive deformation due to the extensive invert deterioration. It also notes a slight dip along the western edge of the roadway.

The stream is poorly aligned with the pipe inlet. Part of the inlet is blocked by the stream bank and the stream flows into the headwall on the other side. There is a drop at the outlet into a scour pool.

The site is included in Zone A of a flood insurance study. There is also a home upstream of the pipe that is lower than the roadway. Therefore, it is important that the water surface elevations not be raised with a new structure. Aquatic organism passage is also a concern at this site.

Our calculations, field observations and measurements indicate the existing structure meets the current standards of the VTrans Hydraulic Manual. However, it does not meet state stream equilibrium standards for bankfull width (span length). The existing structure constricts the channel width, resulting in an increased potential for debris blockage.

This structure results in a water surface elevation of 707.6' (HW depth = 3.3') at 2% AEP and 708.2' (HW depth = 3.9') at 1% AEP.

Replacement Recommendations

In sizing a new structure we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards with regard to span length and opening height, and allow for roadway grade and other site constraints.

Based on the above considerations and the information available, we recommend any of the following structures as a replacement at this site:

1. A concrete box with a 14' wide by 8' high inside opening. The box invert should be buried 3'. That will result in a 14' wide by 5' high waterway opening above streambed, providing 70 sq. ft. of waterway area. Bed retention sills should be added in the bottom. Sills should be 12" high across the full width of the box. So the top of the sills will be buried 12" and not be visible. Sills should be spaced no more than 8'-0" apart throughout the structure with one sill placed at the inlet and one at the outlet. The box should be filled up to the stream bed level with stone graded to

match the natural stream bed material. This structure will result in a water surface elevation of 705.8' (HW depth = 3.3') at 2% AEP and of 706.3' (HW depth = 3.9') at 1% AEP, with no roadway overtopping up to 1% AEP.

2. A 14'-1" wide by 8'-9" high corrugated metal pipe arch, with the invert buried 3' and 12" high bed retention sills and fill added as described for the box above. That will result in a 14'-1" wide by 5'-9" high waterway opening above streambed, providing about 59.8 sq. ft. of waterway area. This structure will result in water surface elevations of 706.6' (HW depth = 4.1') at 2% AEP and of 707.2' (HW depth = 4.8') at 1% AEP, with no roadway overtopping up to 1% AEP.

3. Another option could be a precast concrete arch that has a clear span of 14' x 6' high. This will provide approximately 78 sq. ft. of waterway area. If you chose this open bottom structure, it will need to provide 1' of freeboard at the 2% AEP. We can look more closely at this option if you decide you would like to pursue it. If stone fill is added in to protect the footings and abutments, this structure may need to be slightly wider. The channel would also need to be rebuilt with this option using the E-stone fill specified by ANR.

General Comments

If a new box is installed, we recommend it have full headwalls at the inlet and outlet. The headwalls should extend at least four feet below the channel bottom, or to ledge, to act as cutoff walls and prevent undermining.

If the pipe arch is installed, concrete headwalls should be constructed at the inlet and outlet. The headwalls may be either half height or full height. The headwalls should extend at least four feet below the channel bottom or to ledge, to prevent undermining of the structure.

It is always desirable for a new structure of this size to have flared wingwalls at the inlet and outlet, to smoothly transition flow through the structure, and to protect the structure and roadway approaches from erosion. The wingwalls should match into the channel banks. Any new structure should be properly aligned with the channel, and constructed on a grade that matches the channel. A new structure should span the natural channel width.

Stone Fill, Type III should be used to protect any disturbed channel banks or roadway slopes at the structure's inlet and outlet, up to a height of at least one-foot above the top of the opening. The stone fill should not constrict the channel or structure opening. E-stone Type E3 should be used to fill the structure chosen.

Please contact us if you have any questions or if we may be of further assistance.

LGR

cc: Hydraulics Project File via NJW

Appendix E: Preliminary Geotechnical Memo

AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Jennifer Fitch, P.E., Structures Project Manager

ZMH CEE

From: Zachary Haffenreffer, Technician Apprentice IV, via Callie Ewald, P.E., Geotechnical Engineering Manager

Date: June 24th, 2016

Subject: Chester BF 0134(50) Preliminary Geotechnical Information

1.0 INTRODUCTION

We have completed our preliminary geotechnical investigation for the replacement of Bridge No. 51 on Vermont Route 11 in the town of Chester, VT. Bridge No. 51 is located approximately 1.6 miles East of the junction of VT Route 11 and VT Route 103. The subject project consists of replacing or repairing the existing corrugated galvanized metal plate pipe (CGMPP) culvert. This review included the examination of as-built record plans, historical in-house bridge boring files, water well logs and hazardous site information on-file at the Agency of Natural Resources, USDA Natural Resources Conservation soil survey records, published surficial and bedrock geologic maps, and photos taken during a site visit.

2.0 SUBSURFACE INFORMATION

2.1 Previous Projects

Record plans were available for this project from the construction in 1962. The plans included details of the existing culvert elevation, the plate pipe arch, and typical sections of the above roadway. Details of the plans did not include any subsurface information and there is no reference to shallow bedrock in the existing plan set.

The Geotechnical Engineering Section maintains a GIS based historical record of subsurface investigations, which contains electronic records for the majority of borings completed in the past 10 years. An exploration of this database revealed three nearby projects within a 2-mile radius. For projects approximately 1.4 and 1.6 miles away, boring logs indicated sand, silt, and gravel present with bedrock encountered at depths as shallow as 20 feet and as deep as 60 feet.

2.2 Water Well Logs

The Agency of Natural Resources (ANR) documents and publishes all water wells that are drilled for residential or commercial purposes. Published online, these logs can be used to determine general characteristics of the soil strata in the area. The soil description given on the logs is done in the field, by unknown personnel, and as such, should only be used as an approximation. Figure 1 contains the subject project as well as surrounding well locations found using the ANR Natural Resources Atlas. Five water wells within an approximate 800-foot radius of the project were used to get an estimate of the depth to bedrock likely to be encountered for Bridge No. 51 and are highlighted below with red boxes.

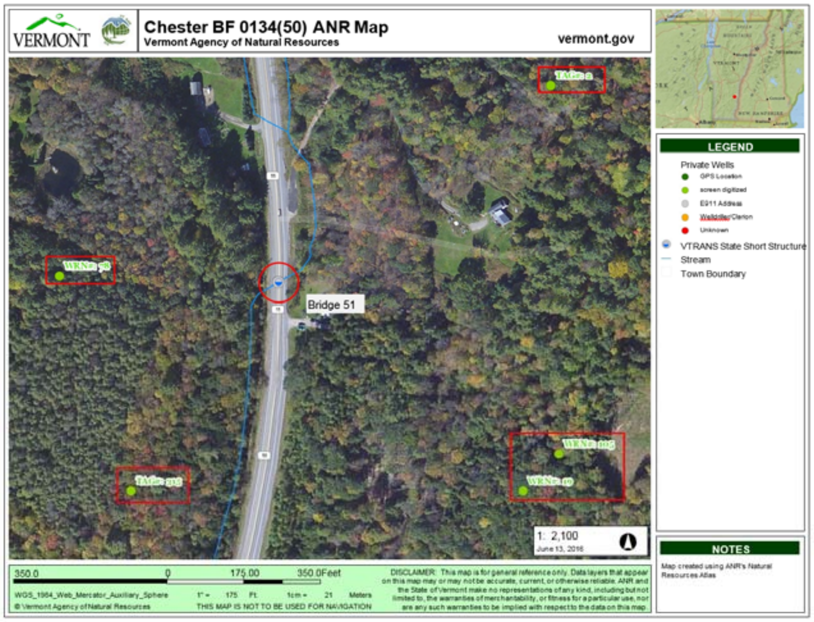


Figure 1. Highlighted Well Locations near Subject Project

Table 1 lists the well sites used in gathering the surrounding information. Wells are listed with the distance from the bridge project, depth to bedrock, and overburden material encountered.

Table 1. Depths to Bedrock of Surrounding Wells

Well ID	Approx. Distance From Project (feet)	Approx. Depth To Bedrock (feet)	Overburden Material
2	770	36	Gravel & Sand
78	510	5	Dirt, Soil, Topsoil, & Loam
315	590	7	Clay & Till
105	760	52	Gravel, Boulders, Hardpan, and Clay
19	740	14	Hardpan

2.3 Hazardous Materials and Underground Storage Tanks

The ANR Natural Resource Atlas also maps the location and information of known hazardous waste sites and underground storage tanks. The location of this project is not on the Hazardous Site List. No underground storage tanks are located within a 1-mile radius and no impact from other hazardous waste sites is anticipated.

2.4 USDA Soil Survey

The United States Department of Agriculture Natural Resources Conservation Service maintains an online surficial geology map of the United States. According to the Web

Soil Survey, the stratum directly underlying the project site consists of Peru, Skerry, and Colonel soild with a depth to groundwater of approximately 20 inches.

2.5 Geologic Maps of Vermont

According to the 2011 Bedrock Map of Vermont, published by the USGS and State of Vermont, the project site is underlain with Carbonaceous Phyllite and Limestone.

3.0 BRIDGE INSPECTION

An inspection of the culvert was done in December of 2015 by the Bridge Inspection unit. This inspection recommended an evaluation for a possible concrete invert in the near future. It also recommended that the scour hole of the outlet should be filled.

5.0 RECOMMENDATIONS FOR SUBSURFACE INVESTIGATION

We recommend a minimum of two borings be taken from the roadway surface on opposite sides of the roadway, near the inlet and the outlet. The inlet and outlet appear to be difficult to access with a drill rig, and the proximity to the edge of the roadway may make borings in the roadway only sufficient for design. The borings will be performed to more fully assess the subsurface conditions at the site including, but not limited to, the soil properties, groundwater conditions, and depth to bedrock (if applicable).

If shallow bedrock is encountered during drilling operations, additional borings will likely be required to profile the bedrock elevation across the footprint of the proposed structure. Additionally, if soft or loose soils are encountered, an effort to access closer to the inlet and outlet for headwall and wingwall design may be necessary.

Based on the information known at this point, possible foundation options for a bridge replacement include the following:

- Precast or steel arch bridge with spread footings founded on rock or soil
- Reinforced concrete box culvert with new headwalls and wingwalls

6.0 CONCLUSION

When an alternative as well as preliminary alignment has been chosen, the Geotechnical Engineering Section can assist in determining a subsurface investigation that efficiently gathers adequate information for the alternative chosen.

If you have any questions or would like to discuss this report, please contact us by phone at (802) 828-2561, or via email at zachary.haffenreffer@vermont.gov.

Appendix F: Geotechnical Data Report

AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Jennifer Fitch, P.E., Structures Project Manager

SPM CEE

From: Stephen Madden, Geotechnical Engineer via Callie Ewald, P.E., Geotechnical Engineering Manager

Date: October 18, 2016

Subject: Chester BF 0134(50) – Subsurface Investigation

1.0 INTRODUCTION

We have completed our geotechnical and geological subsurface investigation for the culvert located on Vermont RT 11 located approximately 1.6 miles east of the intersection of VT RT 11 and VT RT 103 in Chester, Vermont. The borings were completed to determine the soil strata and depth to bedrock to aid in design for a replacement structure. Contained herein are the results of our field sampling and testing, laboratory analyses of soil and rock samples, as well as boring logs.

2.0 FIELD INVESTIGATION

The field investigation was conducted between September 9 and September 15, 2016. Four standard penetration borings were drilled to determine the existing subsurface strata. A summary of the location of each boring and corresponding ground surface elevation can be found in Table 1 as well as in the attached Boring Location Plan. The values for the Northings and Eastings are based on the Vermont State Plane Grid Coordinate System NAD 83, and were located by a handheld GPS. Elevations for the borings were then taken off a VTrans survey file. The locations and elevations of the borings should be considered accurate only to the degree implied by the method used to determine them.

Table 1: Boring Locations and Elevations

Boring Number	Station	Offset(ft)	Northing (ft)	Easting (ft)	Ground Surface Elevation (ft)	Top of Bedrock Elevation (ft)
B – 101	359+00	-25	282685.36	1622038.88	712.5	692.5
B – 102	359+00	25	282684.97	1622088.88	714.3	696.3
B – 103	359+25	-25	282710.14	1622038.97	713.0	695.0
B – 104	359+30	25	282715.23	1622088.96	713.9	689.9

The borings were performed in general accordance with AASHTO T206, *Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils.* During boring operations, for boring B-101, split spoon samples and standard penetration tests (SPT) were taken continuously until 18.5 feet. A boulder was encountered between a depth of 13.6 and 17.2 feet. When bedrock was encountered at 20 feet, two five-foot long NX rock cores were taken to confirm the presence of bedrock. For boring B-102, split spoon samples and SPTs were taken continuously to 16 feet when split spoon refusal was encountered. When bedrock was encountered at 18 feet, two five-foot NX rock core runs were taken to confirm the presence of bedrock. For boring B-103, split spoon samples and SPTs were taken continuously to 16.4 feet when split spoon refusal was encountered. When bedrock was encountered at 18 feet, two five-foot NX rock core runs were taken to confirm the presence of bedrock. For boring B-104, split spoon samples and SPTs were taken continuously to 22 feet. When bedrock was encountered at 24 feet, two five-foot NX rock core runs were taken to confirm the presence of bedrock.

Soil samples were visually identified in the field and SPT blow counts were recorded on the boring logs when applicable. Soil and rock samples were preserved and returned to the Construction and Materials Bureau Central Laboratory for testing and further evaluation. Upon completion of the laboratory testing, the boring logs were revised to reflect the results of the laboratory classification analysis.

3.0 FIELD AND LABORATORY TESTING

The standard penetration resistance of the in-situ soil is determined by the number of blows required to drive a 2 inch OD split barrel sampler into the soil with a 140 pound hammer dropped from a height of 30 inches, in accordance with procedures specified in AASHTO T206. During the standard penetration test (SPT), the sampler is driven for a total length of 2 feet, while counting the blows for each 6 inch increment. The SPT N-value, which is defined as the sum of the number of blows required to drive the sampler through the second and third increments, is commonly used with established correlations to estimate a number of soil parameters, particularly the shear strength and density of cohesionless soils. The N-values provided on the boring logs are raw values and have not been corrected for energy, borehole diameter, rod length, or overburden pressure. The VT Agency of Transportation has determined a hammer correction value, C_E, to account for the efficiency of the SPT hammer on the drill rig. For all of the borings, a CME 55 Track Rig was used, with a hammer energy correction factor of 1.41. This value, included on the boring logs, should be used in calculations to determine soil parameters. Laboratory tests were conducted on all samples to evaluate grain size, moisture content, and percent finer than No. 200 sieve. Results from this testing can be found on the attached boring logs.

A detailed description of the rock cores is presented on the boring logs including run length, drill times, recovery, and Rock Quality Designation (RQD). Recovery is defined as the length of core obtained expressed as a percentage of the total length cored. In accordance with ASTM D6032, RQD is the total length of core pieces, 4 inches or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams, jointing and bending planes. The Rock Mass Rating (RMR) is also included on the logs. RMR is AASHTO's (LRFD Bridge Design Specification) recommended method of classifying rock, and is based on five different parameters that all have relative ratings which combine to form the RMR. These parameters include rock strength, RQD, joint spacing, joint condition, and groundwater (AASHTO Section 10.4.6.4).

4.0 RECOMMENDATIONS

Based on this information, we believe steel sheet piles can be driven to a depth of approximately 10 to 24 feet below the roadway surface in order to retain the roadway if phased construction is selected. Broken rock was encountered within all of the borings, signifying the presence of larger particle sizes such as gravel, cobbles, or possibly boulders. A layer of weathered rock was also encountered in boring B-103 directly above the bedrock. These subsurface conditions, coupled with the shallow depth of bedrock, are not ideal for driving sheets and could prove very difficult in the field. The shallow bedrock may also eliminate the option of using piles to support a foundation depending on the pile cap or footing elevation. These recommendations are based on the information encountered at the boring locations and it should be noted that site conditions can vary across the project site.

In the previous scoping report dated June 24, 2016, a precast arch bridge on spread footings or a reinforced concrete box culvert with new headwalls and wingwalls were possible options for the replacement of the culvert. Based on the findings of this geotechnical investigation, we believe these remain feasible options. Once this project moves further along in the design phase, we would be happy to assist with any foundation design required.

5.0 CONCLUSION

If you have any questions, or you would like to discuss this report, please contact us at (802) 828-2561. The boring logs are attached as available in the *M:Projects\16b069\MaterialsResearch* folder.

Enclosures: Boring Location Plan (1 page)
Boring Logs (4 pages)

cc: Gary Sweeny
Electronic Read File/DJH
Project File/CEE
SPM

Z:\Highways\CMB\GeotechEngineering\Projects\Chester BF 0134(50)\REPORTS\Chester BF 0134(50) Geotechnical Data Report.docx

SOIL CLASSIFICATION

AASHTO

A1	Gravel and Sand
A3	Fine Sand
A2	Silty or Clayey Gravel and Sand
A4	Silty Soil - Low Compressibility
A5	Silty Soil - Highly Compressible
A6	Clayey Soil - Low Compressibility
A7	Clayey Soil - Highly Compressible

ROCK QUALITY DESIGNATION

R.Q.D. (%)	ROCK DESCRIPTION
<25	Very Poor
25 to 50	Poor
51 to 75	Fair
76 to 90	Good
>90	Excellent

SHEAR STRENGTH

UNDRAINED SHEAR STRENGTH IN P.S.F.	CONSISTENCY
<250	Very Soft
250-500	Soft
500-1000	Med. Stiff
1000-2000	Stiff
2000-4000	Very Stiff
>4000	Hard

CORRELATION GUIDE OF "N" TO DENSITY/CONSISTENCY

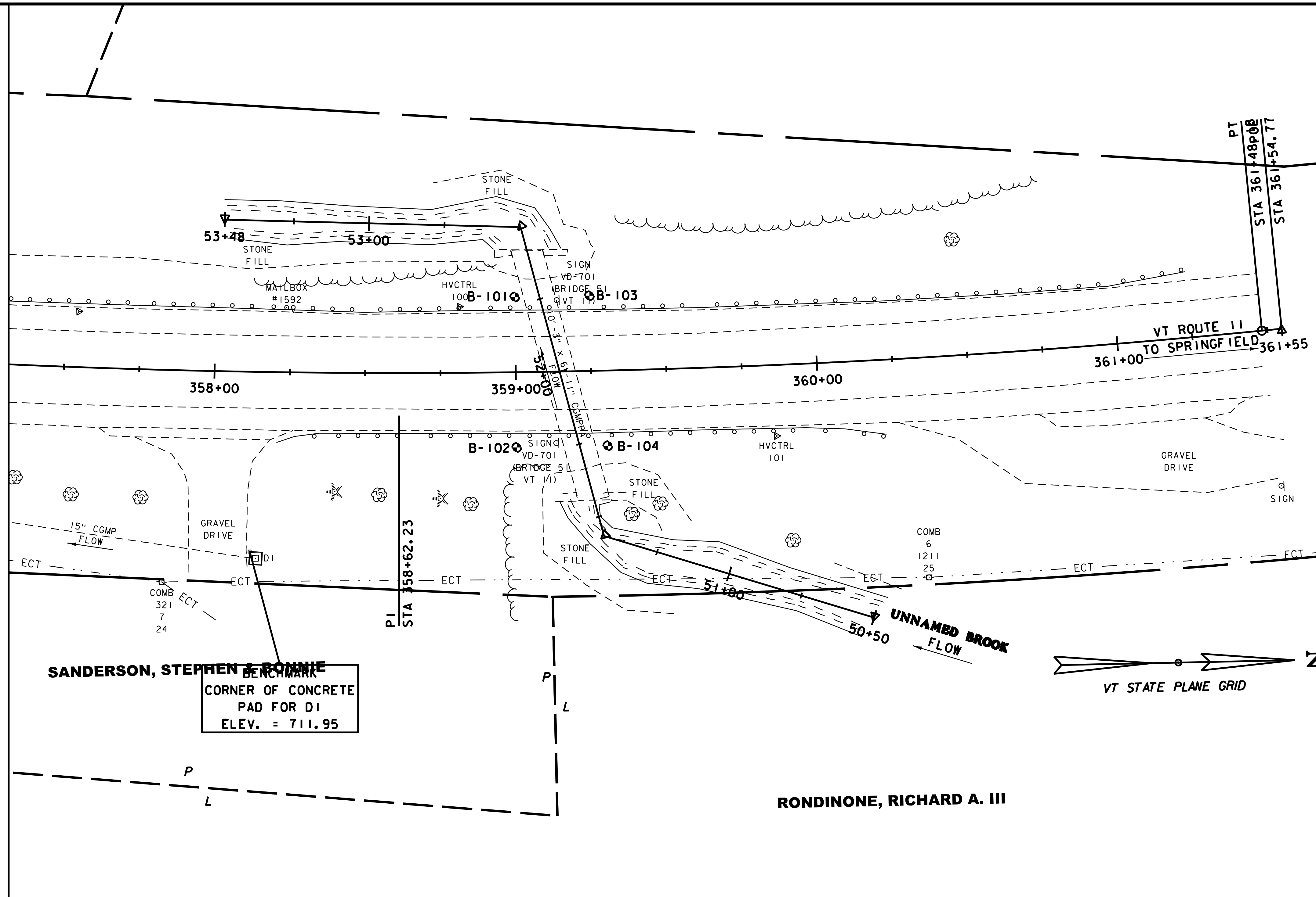
DENSITY (GRANULAR SOILS)		CONSISTENCY (COHESIVE SOILS)	
N	DESCRIPTIVE TERM	N	DESCRIPTIVE TERM
<5	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-24	Med. Dense	5-8	Med. Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

COMMONLY USED SYMBOLS

▼	Water Elevation
⊘	Standard Penetration Boring
⊕	Auger Boring
⊙	Rod Sounding
S	Sample
N	Standard Penetration Test Blow Count Per Foot For: 2" O.D. Sampler 1 3/8" I.D. Sampler Hammer Weight Of 140 Lbs. Hammer Fall Of 30"
VS	Field Vane Shear Test
US	Undisturbed Soil Sample
B	Blast
DC	Diamond Core
MD	Mud Drill
WA	Wash Ahead
HSA	Hollow Stem Auger
AX	Core Size 1 1/8"
BX	Core Size 1 5/8"
NX	Core Size 2 1/8"
M	Double Tube Core Barrel Used
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
NP	Non Plastic
w	Moisture Content (Dry Wgt. Basis)
D	Dry
M	Moist
MTW	Moist To Wet
W	Wet
Sat	Saturated
Bo	Boulder
Gr	Gravel
Sa	Sand
Si	Silt
Cl	Clay
HP	Hardpan
Le	Ledge
NLTD	No Ledge To Depth
CNPF	Can Not Penetrate Further
TLOB	Top of Ledge Or Boulder
NR	No Recovery
Rec.	Recovery
%Rec.	Percent Recovery
ROD	Rock Quality Designation
CBR	California Bearing Ratio
<	Less Than
>	Greater Than
R	Refusal (N > 100)
VTSPG	NAD83 - See Note 7

COLOR

blk	Black	pnk	Pink
bl	Blue	pu	Purple
brn	Brown	rd	Red
dk	Dark	tn	Tan
gry	Gray	wh	White
gn	Green	yel	Yellow
lt	Light	mltc	Multicolored
or	Orange		



Note: Boring positions revised to show as-drilled locations

BORING LAYOUT

SCALE 1" = 20'-0"

20 0 20

DEFINITIONS (AASHTO)

BEDROCK (LEDGE) - Rock in its native location of indefinite thickness.

BOULDER - A rock fragment with an average dimension > 12 inches.

COBBLE - Rock fragments with an average dimension between 3 and 12 inches.

GRAVEL - Rounded particles of rock < 3" and > 0.0787" (#10 sieve).

SAND - Particles of rock < 0.0787" (#10 sieve) and > 0.0029" (#200 sieve).

SILT - Soil < 0.0029" (#200 sieve), non or slightly plastic and exhibits no strength when air-dried.

CLAY - Fine grained soil, exhibits plasticity when moist and considerable strength when air-dried.

VARVED - Alternate layers of silt and clay.

HARDPAN - Extremely dense soil, cemented layer, not softened when wet.

MUCK - Soft organic soil (containing > 10% organic material.

MOISTURE CONTENT - Weight of water divided by dry weight of soil.

FLOWING SAND - Granular soil so saturated (loose) that it flows into drill casing during extraction of wash rod.

STRIKE - Angle from magnetic north to line of intersection of bed with a horizontal plane.

DIP - Inclination of bed with a horizontal plane.

GENERAL NOTES

1. The subsurface explorations shown herein were made between .... and .... by the Agency.

2. Soil and rock classifications, properties and descriptions are based on engineering interpretation from available subsurface information by the Agency and may not necessarily reflect actual variations in subsurface conditions that may be encountered between individual boring or sample locations.

3. Observed water levels and/or conditions indicated are as recorded at the time of exploration and may vary according to the prevailing rainfall, methods of exploration and other factors.

4. Engineering judgment was exercised in preparing the subsurface information presented herein. Analysis and interpretation of subsurface data was performed and interpreted for Agency design and estimating purposes. Presentation of the information in the Contract is intended to provide the Contractor access to the same data available to the Agency. The subsurface information is presented in good faith and is not intended as a substitute for personal investigation, independent interpretation, independent analysis or judgment by the Contractor.

5. Pictorial structure details shown on the boring plan layout or soils profile are for illustrative purposes only and may not accurately portray final contract details.

6. Terminology used on boring logs to describe the hardness, degree of weathering, and spacing of fractures, joints and other discontinuities in the bedrock is defined in the AASHTO Manual on Subsurface Investigations, 1988.

7. Northing and Easting coordinates are shown in Vermont State Plane Grid North American Datum 1983 in meters and survey feet.

BORING CHART

HOLE NO.	SURV. STATION	OFFSET	NORTHING	EASTING
B-101	359+00	25.0LT	282685.36	622038.88
B-102	359+00	25.0RT	282684.97	622088.88
B-103	359+25	25.0LT	282710.14	622038.97
B-104	359+30	25.0RT	282715.23	622088.96

PROJECT NAME: CHESTER
PROJECT NUMBER: BF 0134(50)

FILE NAME: l6b069/sl6b069boring.dgn	PLOT DATE: $$$$DATE$$$
PROJECT LEADER: J.FITCH	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
BORING INFORMATION SHEET	SHEET $S*$ OF $T*$

VTrans Working to Get You There — Vermont Agency of Transportation STATE OF VERMONT AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	**BORING LOG** **Chester** **BF 0134(50)** **VT 11 Culv. 51**	Boring No.: **B-101** Page No.: 1 of 1 Pin No.: 16b069 Checked By: MLM

Boring Crew: Garrow, Judkins, Emerson
Date Started: 9/13/16 Date Finished: 9/13/16
VTSPG NAD83: N 282685.36 ft E 1622038.88 ft
Station: 359+00 Offset: -25.00
Ground Elevation: 712.5 ft

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:		Auto/AWJ
Rig:	CME 55 TRACK	C_E = 1.41

Groundwater Observations

Date	Depth (ft)	Notes
09/13/16	11.2	W.T. during drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		A-1-b, GrSa, brn, Moist, Rec. = 0.8 ft				1-1-1-3 (2)	5.0	41.2	50.9	7.9
		A-1-b, SaGr, brn, Moist, Rec. = 0.8 ft				2-3-4-8 (7)	4.2	48.8	39.4	11.8
5		A-4, SiSa, brn, Moist, Rec. = 1.3 ft Field Note:, NXDC, Cleaned out casing				5-4-9-4 (13)	9.1	14.7	49.1	36.2
		A-4, SiSa, brn, Moist, Rec. = 1.3 ft Field Note:, NXDC, Cleaned out casing				19-4-5-6 (9)	13.6	18.3	42.3	39.4
		A-4, SaSi, gry, Moist, Rec. = 1.1 ft Field Note:, NXDC, Cleaned out casing				10-5-6-8 (11)	15.3	8.6	39.2	52.2
10		A-4, SaSi, gry, Moist, Rec. = 1.2 ft, Lab Note: Pieces of wood and broken rock were within sample Field Note:, NXDC, Cleaned out casing				9-5-7-9 (12)	14.3	18.6	38.6	42.8
		A-1-b, GrSa, brn, Moist, Rec. = 1.1 ft				10-10-14-R@1" (24)	11.0	43.6	45.0	11.4
15		Field Note:, NXDC, Cleaned out casing, Boulder								
		Field Note:, NXDC, Cleaned out casing								
		A-1-b, SaGr, white-brn, Moist, Rec. = 0.5 ft, Lab Note: Broken rock was within sample Field Note:, NXDC, Cleaned out casing				R@6" (R)	10.5	50.3	37.5	12.2
20		20.0 ft - 25.0 ft, White/light gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown/tan staining along joints. Hard, Very slightly weathered, Fair rock, NX, RMR=57	1 (50)	88 (41)	4 2 2 2 2	Top of Bedrock @ 20.0 ft				
25		25.0 ft - 27.1 ft, White/light gray to dark gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown staining along joints. Hard, Very slightly weathered, Fair rock, NX, RMR=50 27.1 ft - 30.0 ft, White/light gray to dark gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown staining along joints. Medium hard, Moderately weathered, Fair rock, RMR=50	2 (50)	66 (55)	3 2 4 2 2					
30		Hole stopped @ 30.0 ft								

Remarks:
Hole collapsed at 16.3 feet.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.

VTrans Working to Get You There — Vermont Agency of Transportation	STATE OF VERMONT AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	**BORING LOG** **Chester** **BF 0134(50)** **VT 11 Culv. 51**

Boring No.: **B-102**
Page No.: 1 of 1
Pin No.: 16b069
Checked By: SPM

Boring Crew: Garro, Judkins, Emerson
Date Started: 9/15/16 Date Finished: 9/15/16
VTSPG NAD83: N 282684.97 ft E 1622088.88 ft
Station: 359+00 Offset: 25.00
Ground Elevation: 714.3 ft

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 55 TRACK	C_E = 1.41

Groundwater Observations

Date	Depth (ft)	Notes
09/15/16	11.7	W.T. after drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		A-1-b, GrSa, brn, Moist, Rec. = 0.4 ft				1-2-4-3 (6)	2.5	30.3	57.8	11.9
		A-1-b, SiGrSa, brn, Moist, Rec. = 1.2 ft, Lab Note: Broken rock was within sample				3-3-6-3 (9)	6.2	31.1	47.0	21.9
5		A-2-4, GrSiSa, brn, Moist, Rec. = 0.9 ft				6-5-4-3 (9)	6.6	22.0	54.2	23.8
		A-1-b, GrSa, brn, Moist, Rec. = 0.7 ft, Lab Note: Broken rock was within sample				3-6-8-8 (14)	3.9	43.6	44.6	11.8
		A-1-b, GrSa, brn, Moist, Rec. = 1.1 ft, Lab Note: Broken rock was within sample Field Note:, NXDC, Cleaned out casing				7-7-R@2.5" (R)	5.8	35.0	52.2	12.8
10		A-1-b, SaGr, brn, Moist, Rec. = 0.8 ft, Lab Note: Broken rock was within sample Field Note:, NXDC, Cleaned out casing				25-17-20-20 (37)	11.5	47.8	38.0	14.2
		A-1-b, GrSa, brn-gry, Moist, Rec. = 0.4 ft, Lab Note: Broken rock was within sample Field Note:, NXDC, Cleaned out casing				R@5" (R)	13.9	41.1	42.4	16.5
15		A-1-b, SaGr, gry-blk, Moist, Rec. = 0.7 ft Field Note:, NXDC, Cleaned out casing Field Note:, No Recovery Field Note:, NXDC, Cleaned out casing				17-22-28-R@1" (50) R@0" (R)	9.1	54.0	30.7	15.3
20		18.0 ft - 23.0 ft, White to gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown staining on joints. Seam noted during drilling 20.7 feet to 21.5 feet. Hard, Very slightly weathered, Good rock, NX, RMR=66	1 (40)	80 (78)	2 2 1 1 2	Top of Bedrock @ 18.0 ft				
25		23.0 ft - 28.0 ft, White to gray, Biotite-muscovite-quartz-plagioclase GNEISS, with faint brown/tan staining along joints. Hard, Unweathered, Good rock, NX, RMR=74	2 (50)	100 (100)	3 2 2 2 2					
30		Hole stopped @ 28.0 ft Remarks: Hole collapsed at 10.5 feet.								

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.

BORING LOG 2 CHESTER BF0134(50).GPJ VERMONT AOT.GDT 10/11/16

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

Chester
BF 0134(50)
VT 11 Culv. 51

Boring No.: **B-103**

Pin No.: 16b069
Checked By: SPM

Boring Crew: Judkins, Garrow, Gomes
Date Started: 9/14/16 Date Finished: 9/14/16
VTSPG NAD83: N 282710.14 ft E 1622038.97 ft
Station: 359+25 Offset: -25.00
Ground Elevation: 713.0 ft

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 55 TRACK	C_E = 1.41

Groundwater Observations

Date	Depth (ft)	Notes
09/14/16	8.1	W.T. during drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		A-1-b, GrSa, brn, Dry, Rec. = 0.6 ft, Lab Note: Pieces of wood and plant material were within sample				WH-WH-2-2 (2)	6.7	32.4	55.5	12.1
		A-2-4, GrSiSa, brn, Moist, Rec. = 1.3 ft				3-4-3-4 (7)	8.7	26.4	43.5	30.1
5		A-2-4, SiGrSa, brn, Moist, Rec. = 1.5 ft, Lab Note: Asphalt pavement was within sample				3-5-10-4 (15)	11.3	30.9	38.5	30.6
		A-2-4, GrSiSa, brn, Moist, Rec. = 0.6 ft Field Note:, NXDC, Cleaned out casing				7-2-3-5 (5)	13.6	28.6	40.3	31.1
		A-1-b, SaGr, brn, Moist, Rec. = 0.2 ft, Lab Note: Broken rock was within sample				3-4-14-5 (18)	16.4	53.4	37.8	8.8
10		A-2-4, GrSa, Dk/brn, Moist, Rec. = 0.2 ft, Lab Note: Some organic material was within sample. Insufficient sample size for organic testing				WH-WH-1-3 (1)	43.0	30.4	54.9	14.7
		A-1-b, GrSa, Dk/brn, Moist, Rec. = 0.4 ft, Lab Note: Decomposing wood was within sample Field Note:, NXDC, Cleaned out casing					38.6	33.0	57.6	9.4
		A-1-a, SaGr, gry, Moist, Rec. = 0.7 ft, Lab Note: A lot of broken rock was within sample Field Note:, NXDC, Cleaned out casing				21-28-16-10 (44)	11.9	59.2	32.5	8.3
15		A-4, SiSa, gry, Moist, Rec. = 1.2 ft				9-15-14-9 (29)	18.3	11.2	45.0	43.8
		A-2-4, GrSa, brn-gry, Moist, Rec. = 0.4 ft, Lab Note: Broken and weathered rock was within sample Field Note:, NXDC, Cleaned out casing				R@5" (R)	7.7	29.1	51.7	19.2
20		18.0 ft - 23.0 ft, White to dark gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown and orange staining along joints. Moderately hard, Slightly weathered, Fair rock, NX, RMR=49	1 (50)	86 (42)	4 4 3 3 4	Top of Bedrock @ 18.0 ft				
25		23.0 ft - 28.0 ft, White to dark gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown staining along joints and micaceous foliation. GREENSTONE inclusion at 25.8 feet to 26.0 feet. Medium hard, Slightly weathered, Fair rock, NX, RMR=42	2 (50)	78 (15)	4 3 3 3 4					
30		Hole stopped @ 28.0 ft Remarks: Hole collapsed at 28.0 feet.								

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.

STATE OF VERMONT AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	BORING LOG **Chester** **BF 0134(50)** **VT 11 Culv. 51**	Boring No.: **B-104** Page No.: 1 of 1 Pin No.: 16b069 Checked By: MLM

Boring Crew: Emerson, Garrow, Gomes
Date Started: 9/09/16   Date Finished: 9/12/16
VTSPG NAD83: N 282715.23 ft E 1622088.96 ft
Station: 359+30   Offset: 25.00
Ground Elevation: 713.9 ft

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 55 TRACK	C_E = 1.41

Groundwater Observations

Date	Depth (ft)	Notes
09/12/16	12.4	W.T. before drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		A-2-4, Sa, brn, Dry, Rec. = 0.2 ft, Lab Note: Plant roots were within sample				1-1-1-2 (2)	10.9	14.5	73.9	11.6
		A-2-4, GrSiSa, brn, Moist, Rec. = 1.0 ft				3-4-1-2 (5)	8.0	27.0	44.9	28.1
5		A-2-4, SiSa, brn, Moist, Rec. = 1.3 ft Field Note:, NXDC, cleaned out casing				2-2-3-10 (5)	9.0	19.4	47.4	33.2
		A-1-b, GrSa, brn, Moist, Rec. = 0.6 ft Field Note:, NXDC, cleaned out casing				3-4-4-3 (8)	11.9	35.7	46.4	17.9
		Field Note:, No Recovery				4-3-3-4 (6)				
10		A-1-b, GrSa, brn, Moist, Rec. = 0.8 ft Field Note:, NXDC, cleaned out casing				5-6-4-5 (10)	11.3	41.4	50.6	8.0
		A-1-a, SaGr, gry-brn, Moist, Rec. = 0.6 ft, Lab Note: Broken rock was within sample Field Note:, NXDC, cleaned out casing				4-11-14-9 (25)	10.8	56.8	30.1	13.1
15		A-1-b, SaGr, gry, Moist, Rec. = 0.5 ft Field Note:, NXDC, cleaned out casing, Cobbles				8-23-R@1" (R)	8.4	51.6	33.8	14.6
		A-4, SaSi, gry, Moist, Rec. = 1.6 ft, Lab Note: Some clay was wtihin sample. Sample tested non-plastic Field Note:, NXDC, cleaned out casing				8-18-19-20 (37)	12.4	16.6	34.3	49.1
20		A-4, SaSi, gry, Moist, Rec. = 1.8 ft, Lab Note: A small amount of clay was within sample. Sample tested non-plastic.				11-17-33-38 (50)	10.1	17.3	37.7	45.0
		Field Note:, NXDC, cleaned out casing								
25		24.0 ft - 29.0 ft, White/gray, Biotite-muscovite-quartz-plagioclase GNEISS, with brown/tan staining along joints. Hard, Very slightly weathered, Good rock, NX, RMR=66	1 (40)	80 (90)	3 4 4 3 3	Top of Bedrock @ 24.0 ft				
30		29.0 ft - 34.0 ft, White/gray, Biotite-muscovite-quartz-plagioclase GNEISS, with vertical brown/tan stained joints from 32.1 feet to 32.4 feet. Moderately hard, Slightly weathered, Fair rock, NX, RMR=54	2 (50)	100 (52)	2 2 2 2 2					
35		Hole stopped @ 34.0 ft								

Remarks:
Hole collapsed at 6.7 feet.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.

Appendix G: Natural Resources ID

State of Vermont
Program Development Division
One National Life Drive
Montpelier, VT 05633-5001
vtrans.vermont.gov

[phone] 802-279-2562
[fax] 802-828-2334
[ttd] 800-253-0191

Agency of Transportation

To: Lee Goldstein, VTrans Environmental Specialist

From: James Brady, VTrans Environmental Biologist

Date: July 15, 2016
Subject: Chester BF 0134(50) - Natural Resource ID

I have completed my natural resource report for the above referenced project. My evaluation has included wetlands, wildlife habitat, agricultural soils, and rare, threatened and endangered species. A site visit was conducted on June 15, 2016.

Wetlands/Watercourses
The project carries VT Route 11 over an unnamed brook via Bridge 51. The structure appears to be undersized and is considered a barrier to aquatic organism passage. The outlet is currently perched.

A small wetland in the NW quadrant was mapped using a GPS and is in the natural resources geodatabase.

Wildlife Habitat
This project has large wooded areas within the general vicinity. There is a large mapped deer wintering area to the west of the project site. This area should be mostly avoided during construction.

Providing a natural, or simulated natural bottom to the stream under VT Route 11 would provide access to multiple aquatic organisms.

This area would benefit from a larger structure to help minimize wildlife-vehicle collisions. This is a rural area and wildlife likely cross along VT Route 11 regularly. Providing dry shelves during normal flows should help with this concern.

Rare, Threatened and Endangered Species
There are no mapped rare, threatened or endangered species within the project area.

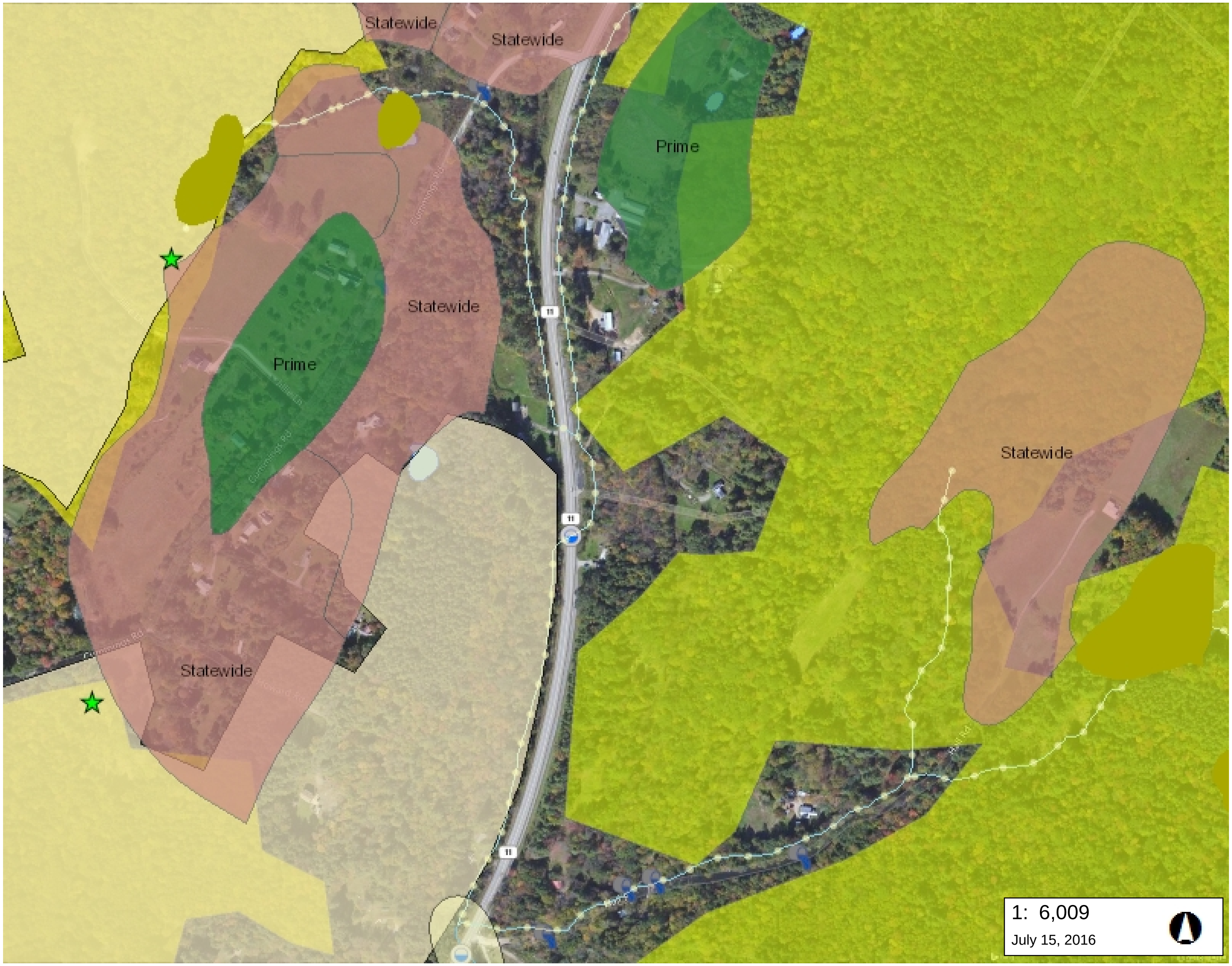
That said, the entire state of Vermont is potential habitat for the federally threatened northern long-eared bat. This project is not likely to impact habitat for the northern long-eared bat, but this may change if a large amount of trees need to be cut. The structure itself is not considered habitat.

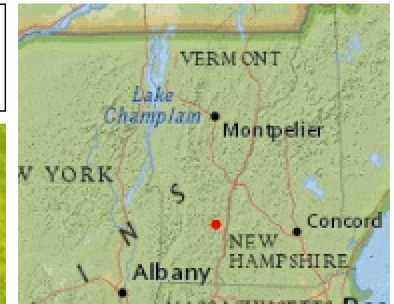
Agricultural Soils:
There are no mapped agricultural soils within the project area.

Chester BF 0134(50)

Vermont Agency of Natural Resources

vermont.gov





LEGEND

- Wetland Projects
- Wetlands - VSWI
  - Class 1 Wetland
  - Class 2 Wetland
- Wetlands Advisory Layer
- River Corridors (Jan 2, 2015)
- Small Streams - 50ft Setback
- Soils - Prime Agricultural
  - Local
  - Local (b)
  - Not rated
  - Prime
  - Prime (b)
  - Prime (f)
  - Statewide
  - Statewide (a)
  - Statewide (b)
  - Statewide (c)
- Rare Threatened Endangered
  - Threatened or Endangered
  - Rare
- Uncommon Species and Other
  - Animal
  - Plant
  - Natural Community
- Deer Wintering Areas
- Habitat Blocks

NOTES

Map created using ANR's Natural Resources Atlas

305.0 0 152.00 305.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 501 Ft. 1cm = 60 Meters

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THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

OFFICE MEMORANDUM

AOT - PDB - ENVIRONMENTAL SECTION

RESOURCE IDENTIFICATION COMPLETION MEMO

TO: Jennifer Fitch, Project Manager
FROM: Julie Ann Held, Environmental Specialist 802-828-3963
DATE: July 19, 2016
Project: **Chester BF 0134(50)**

ENVIRONMENTAL RESOURCES:

Resource	Yes	No	Comments
Wetlands:	X		See Natural Resource ID Memo Issued: 07/15/2016- A small wetland is located in the NW quadrant of project area.
Historic/Historic District:		X	See Historic Resource ID Memo Issued: 06/20/2016
Archaeological Site:		X	See Archaeological Resource ID Memo Issued: 06/16/2016
4(f) Property:		X	
6(f) Property:		X	
Agricultural Land:		X	ANR Atlas Mapped on 05/24/2016
Fish & Wildlife Habitat:	X		Mapped deer wintering area to the west of the project area that should be avoided. Also, a larger structure is suggested to help minimize wildlife-vehicle collisions in this rural area. The structure should provide dry shelves during normal flows to help with wildlife crossing. See Natural Resource ID issued on 07/15/2016.
Endangered Species:	X		NLEB Consideration
Hazardous Waste:		X	ANR Atlas Mapped on 05/24/2016
Contaminated Soils:		X	ANR Atlas Mapped on 05/24/2016
Stormwater:		X	Stormwater permitting is not likely needed.
USDA-Forest Service Lands:		X	ANR Atlas Mapped on 05/24/2016
Wildlife Habitat Connectivity:		X	
Scenic Highway/Byway:		X	
Act 250 Permits:		X	
FEMA Floodplains:	X		Type A Flood Hazard Area Mapped on ANR Atlas on 05/24/2016
Flood Hazard Area/ River Corridor:	X		Type A Flood Hazard Area Mapped on ANR Atlas on 05/24/2016
Invasive Species:		X	ANR Atlas Mapped on 05/24/2016
US Coast Guard:		X	
Lakes and Ponds:		X	
Landscaping:		X	
Environmental Justice:		X	
303D List/ Class A Water/ Outstanding Resource Water		X	
Source Protection Area:		X	
Other:		X	

Thanks,

cc: Jennifer Fitch
Project File

Appendix H: Archaeological Memo

VERMONT

Brennan Gauthier
VTrans Archaeologist
Vermont Agency of Transportation
Project Delivery Bureau
Environmental Section
1 National Life Drive
Montpelier, VT 05633
tel. 802-279-1460
Brennan.Gauthier@vermont.gov

To: Julie Ann Held, VTrans Environmental Specialist
From: Brennan Gauthier, VTrans Archaeologist
Date: 6/16/2016
Subject: Chester BF 0134(50) Archaeological Resource ID

Julie Ann,

I have completed my background review and field investigation of Bridge 51 along VT Route 11 in Chester, Windsor County, Vermont; there are no archaeologically sensitive areas present within the APE, and the project can be cleared when project plans are formalized. Although the area is devoid of resources, I've taken the time to explain my findings below.

Bridge 51, really a large CMP culvert, is located in a tight valley in the eastern section of Chester. Steeply sloped, rocky and densely wooded, the general area scores low on the VDHP environmental predictive model for Precontact Native American presence. Upgraded in the 1960s, Bridge 51 appears to have, at one time, been a laid up stone box culvert, as evidenced by large slabs of flat granite near the concrete wingwalls. A common practice by recent highway crews, these relics of the stone culvert era give us a glimpse of the highway infrastructure improvements of the post-WWII generation. Riprap and angular stone along the steep roadway slope direct an unnamed brook along the base of the adjacent valley edge.

Historic research has revealed that this area was never settled in the 18th and 19th centuries, likely due to the tight valley and lack of suitable space to erect a homestead. Early settlers to the region focused on well-drained soils and agriculturally advantageous properties. A census of 1771 shows 152 inhabitants populating the northern and central portion of the town. At the time, VT Route 11 was an improved cart path linking Springfield with western towns. The project APE is unlikely to yield significant historic archaeological resources based on observed disturbance and lack of documented habitation and settlement.

Scoring a negative value in the VDHP environmental predictive model, the project APE is a highly disturbed, steep and poorly drained segment of a linear historic transportation corridor that shows evidence of routine construction maintenance. Soil core sampling in the general project area confirmed the suspected disturbance.

In conclusion, Chester Bridge 51 can be cleared as NHPA when the NEPA clearance request is submitted. As always, feel free to contact me with questions or concerns that may arise.

Best,
Brennan

VTrans Working to Get You There
Vermont Agency of Transportation

<u>Images and Illustrations</u>

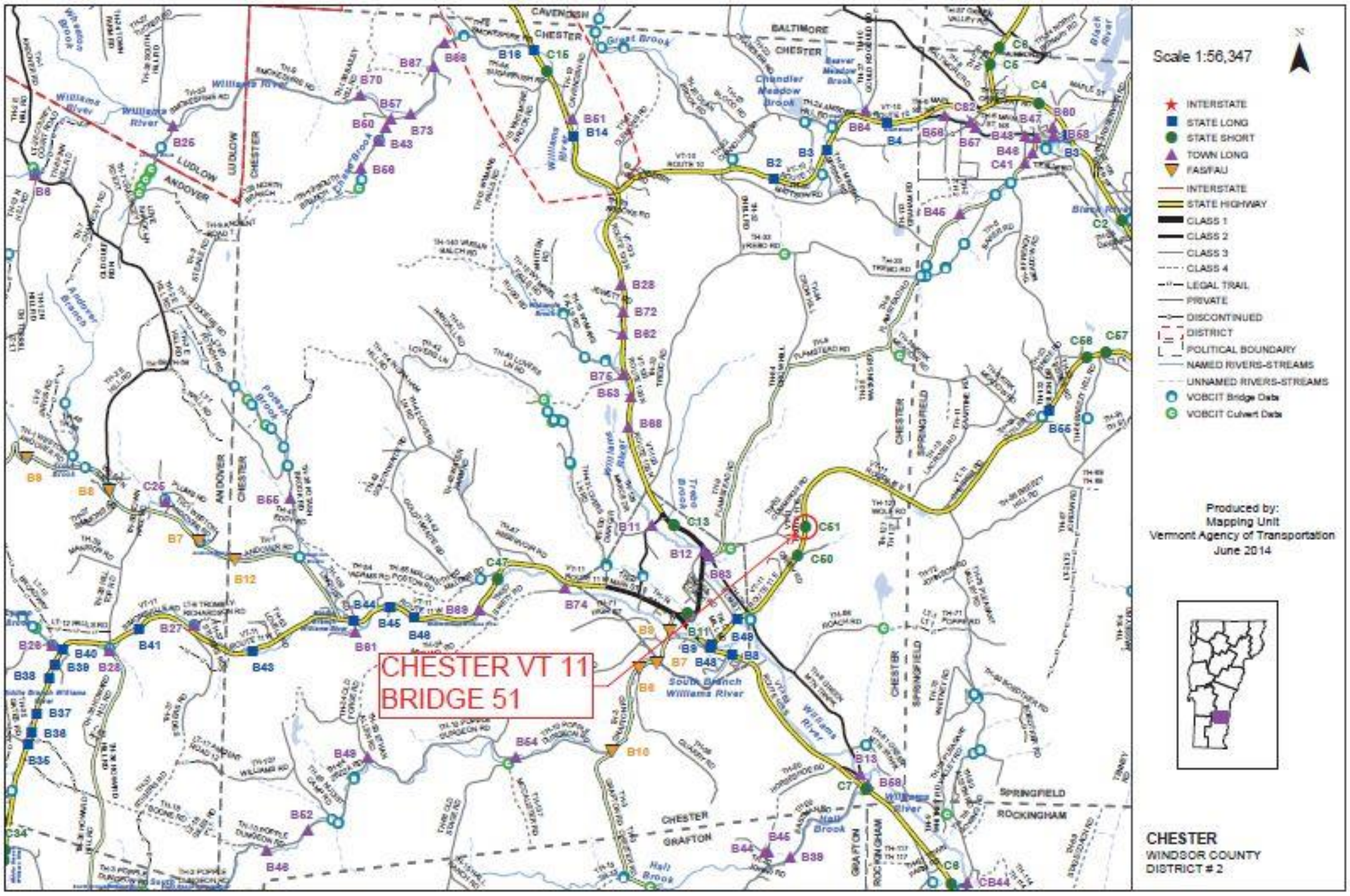


Figure 1: Project Location Map

Figure 2: Ca. 1870 Beers Map

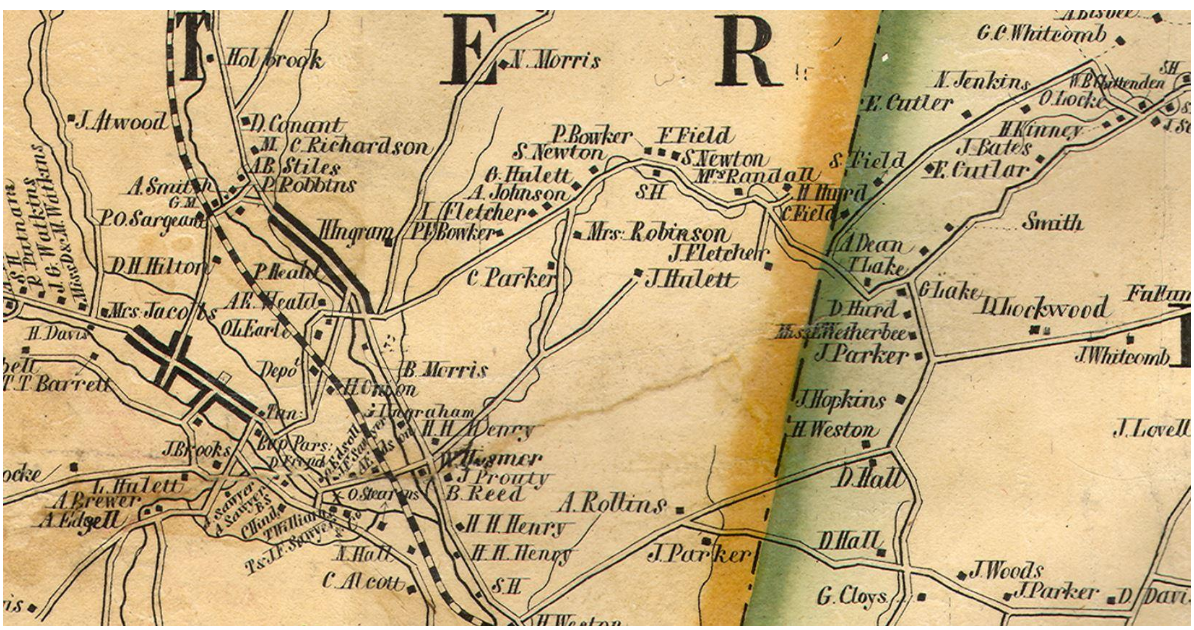


Figure 3: Ca. 1860 Wallings Map

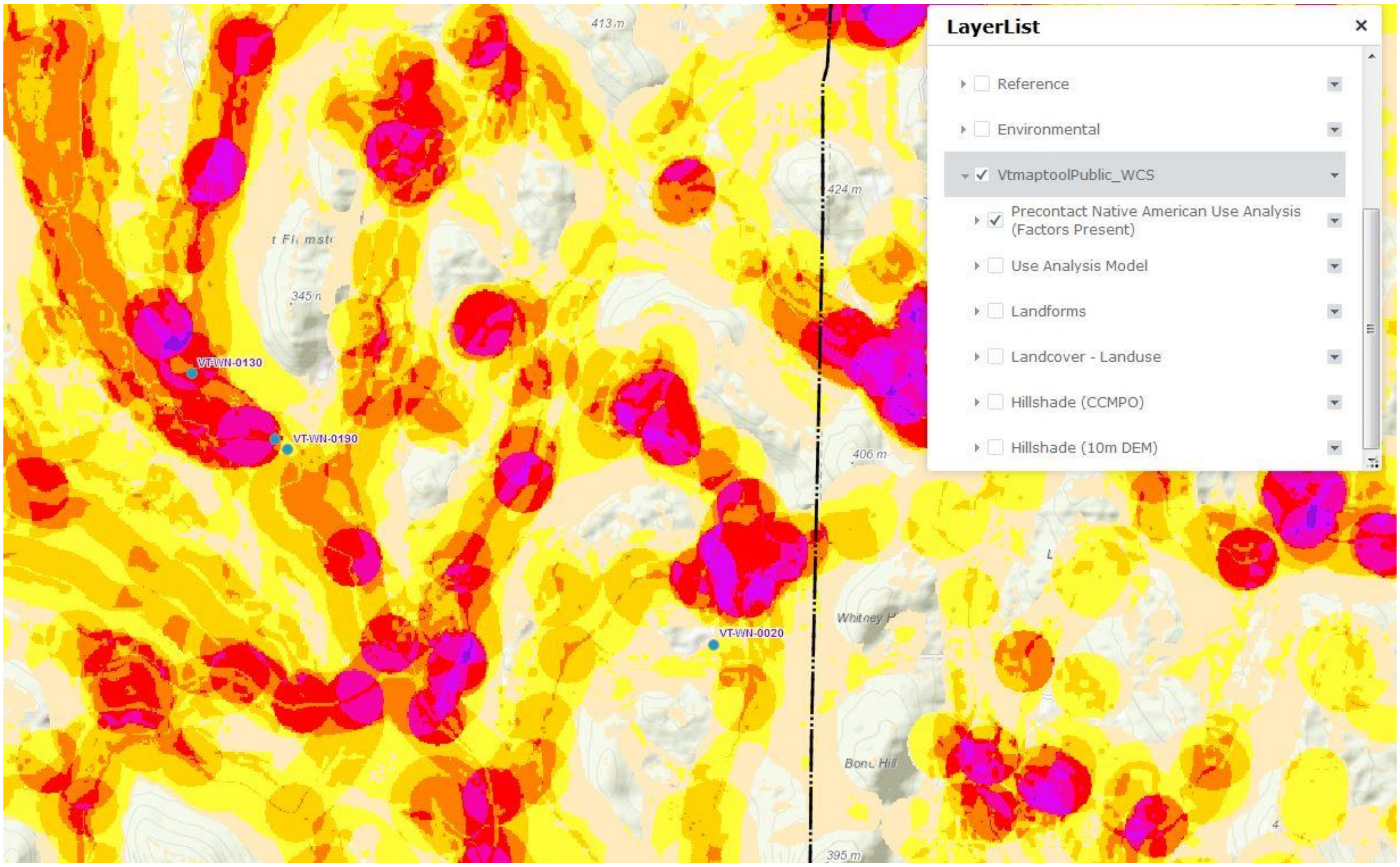


Figure 4: VDHP Predictive Model

Appendix I: Historic Memo

Kyle Obenauer
Historic Preservation Specialist

Vermont Agency of Transportation

kyle.obenauer@vermont.gov
802.279.7040
www.vtrans.vermont.gov

Project Delivery Bureau - Environmental Section
One National Life Drive
Montpelier, VT 05633-5001

Historic Preservation Resource Identification Memo

To: Julie Ann Held, Environmental Specialist
Via: Judith Ehrlich, VTrans Historic Preservation Officer
Cc: Jen Russell, VTrans Archaeology Officer
Karen Spooner, Administrative Assistant
Date: June 20, 2016

Subject: Chester BF 0134(50)

I have completed a Resource Identification (ID) for Chester BF 0134(50). This project may include replacing Bridge 51 on VT Route 11 in Chester, Windsor County, Vermont (Figure 1). All work will be contained within the existing right of way.

Constructed around 1965, 1.6 miles east of the Route 103-Route 11 junction, Bridge 51 runs beneath VT Route 11 and is a large, corrugated metal culvert with flat, cast concrete wing walls at its outlet (Figure 2). VTrans has determined that Bridge 51 does not appear eligible for inclusion in the National Register of Historic Places individually or as a contributing resource to a current or potential historic district. Although over 50 years of age, this culvert is unremarkable architecturally and historically.

Please, contact me with any questions. Additional background information and documentation can be provided upon request.

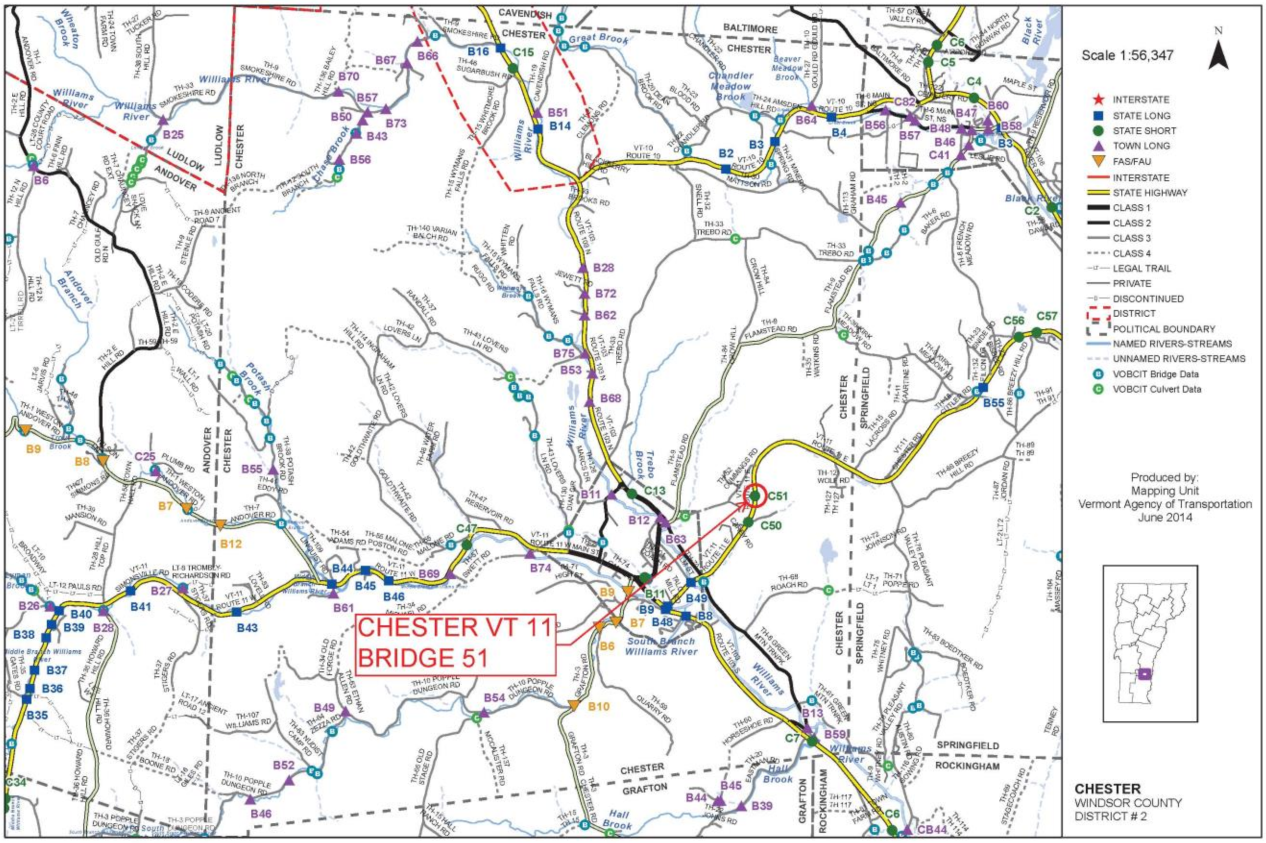


Figure 1. Potential project location.

Figure 2. Bridge 51 beneath VT Route 11, looking north.

Appendix J: Local Input

Project Name: Springfield Culverts 57 and 60 on VT-11
Project Number: Springfield BF 0134(43) and Springfield BF 0134(45)

Please note that answers apply to both C57 and C60, unless otherwise noted.

Attachments to give context to answers uploaded at
https://drive.google.com/folderview?id=0B2jtfm2nTjt4LUxBR2FYeWU2TUU&usp=sharing :

- Land Use Map
- Context Map (includes sidewalks and some land use)
- Future Land Use Map
- Current Land Use Map
- Base Features Map (includes water and sewer lines)
- Public Transit Route Map
- Regional Transportation Map

Community Considerations

1. Are there any scheduled public events in the community that will generate increased traffic (e.g. vehicular, bicycles and/or pedestrians), or may be difficult to stage if the bridge is closed during construction? Examples include: a bike race, festivals, cultural events, farmers market, concerts, etc. that could be impacted? If yes, please provide date, location and event organizers' contact info.
   High School Alumni Day Parade (2nd or 3rd weekend in June)

2. Is there a "slow season" or period of time from May through October where traffic is less?
   No particular slow season. Very high traffic all year round.

3. Please describe the location of emergency responders (fire, police, ambulance) and emergency response routes.
   Springfield Police. 201 Clinton Street, Springfield, VT. Phone: (802)885-2113. Chief Douglas Thompson douglas.johnston@state.vt.us

   Springfield Fire and Ambulance. 77 Hartness Avenue, Springfield, VT. Phone 802-885-4546. Fire Chief Russ Thompson

4. Where are the schools in your community and what are their schedules?
   Elm Hill Primary School (K-2) – 10 Hoover Street, Springfield, Vermont 05156
   Union Street Elementary School (3-5) – 43 Union Street, Springfield, Vermont 05156
   Riverside Middle School – 13 Fairground Road, Springfield, Vermont 05156
   Springfield High School – 303 South St, Springfield, Vermont 05156

   School District summer dates approx 4th week in June through 3rd week of August

5. In the vicinity of the bridge, is there a land use pattern, existing generators of pedestrian and/or bicycle traffic, or zoning that will support development that is likely to lead to significant levels of walking and bicycling? Please explain.

Residential and commercial land use. Near to Middle School, Hospital and several residential areas. This is a major through road carrying significant truck traffic. Sidewalks already exist (see map).

6. Are there any businesses (including agricultural operations) that would be adversely impacted either by a detour or due to work zone proximity?
   Many local businesses that have truck traffic travelling through the Town would be affected. See map for locations of businesses in town.

7. Are there any important public buildings (town hall or community center) or community facilities (recreational fields or library) in close proximity to the proposed project?
   Riverside Middle School, Springfield Hospital (main campus), Springfield Hospital (Rehabilitation Center).

8. Are there any town highways that might be adversely impacted by traffic bypassing the construction on another local road?
   Several town roads would be affected. No local roads could accommodate volume of traffic diverted.

9. Are there any other municipal operations that could be adversely impacted if the bridge is closed during construction? If yes, please explain.
   All operations in town would be adversely affected if bridge closed – due to large volume of traffic.

10. Please identify any local communication channels that are available—e.g. weekly or daily newspapers, blogs, radio, public access TV, Front Porch Forum, etc. Also include any unconventional means such as local low-power FM.
    Newspaper of record – Springfield Reporter

    Springfield Reporter – Weekly newspaper
    Eagle Times – Daily newspaper

    News updates emailed from Town Website - http://www.springfieldvt.govoffice2.com/

    Facebook (Town) - https://www.facebook.com/townofspringfieldvermont?fref=ts
    Facebook (Police Dept) - https://www.facebook.com/pages/Springfield-Police-Department-Springfield-VT/133631763326692?fref=ts
    Facebook (Springfield Regional Chamber of Commerce) - https://www.facebook.com/pages/Springfield-Regional-Chamber-of-Commerce/320106738039513?fref=ts
    Facebook (Springfield On The Move) - https://www.facebook.com/pages/Springfield-On-The-Move/168814006467688?ref=stream

11. Is there a local business association, chamber of commerce or other downtown group that we should be working with?
    Springfield Regional Chamber of Commerce – Jen Johnson spfldcoc@vermontel.net

Springfield Regional Development Corporation (SRDC) – Bob Flint
bobf@springfielddevelopment.org

Springfield On The Move (Downtown Organization) – Carol Lighthall som@vermontel.net

Design Considerations

1. Are there any concerns with the alignment of the existing bridge? For example, if the bridge is located on a curve, has this created any problems that we should be aware of?
   No particular concerns

2. Are there any concerns with the width of the existing bridge?
   No particular concerns

3. What is the current level of bicycle and pedestrian use on the bridge?
   Some pedestrians on the sidewalk

4. If a sidewalk or wide shoulder is present on the existing bridge, should the new structure have one? Are there existing bicycle and/or pedestrian facilities on the approaches to the bridge?
   Retain or widen shoulder width and area for sidewalk where possible.

5. Does the Town have plans to construct either bicycle or pedestrian facilities leading up to the bridge? Please provide a copy of the planning document that demonstrates this (e.g. scoping study, master plan, corridor study) Please explain and provide documentation.
   Existing sidewalk shown on map attached. Currently no plans for bike lane.

6. Does the bridge provide an important link in the town or statewide bicycle or pedestrian network such that you feel that bicycle and pedestrian traffic should be accommodated during construction?
   Important connection in sidewalk network from Downtown to residential neighborhoods in southeast part of town.

7. Are there any special aesthetic considerations we should be aware of?
   Not aware of any

8. Are there any traffic, pedestrian or bicycle safety concerns associated with the current bridge? If yes, please explain.
   No particular safety concerns known.

9. Does the location have a history of flooding? If yes, please explain.
   No known history

10. Are you aware of any nearby Hazardous Material Sites?
    None known

11. Are you aware of any historic, archeological and/or other environmental resource issues?
    None known

12. Are there any other comments you feel are important for us to consider that we have not mentioned yet?
    No

Land Use & Public Transit Considerations – to be filled out by the municipality or RPC.

1. Does your municipal land use plan reference the bridge in question? If so please provide a copy of the applicable section or sections of the plan.
   No specific mention of bridges in municipal land use plan

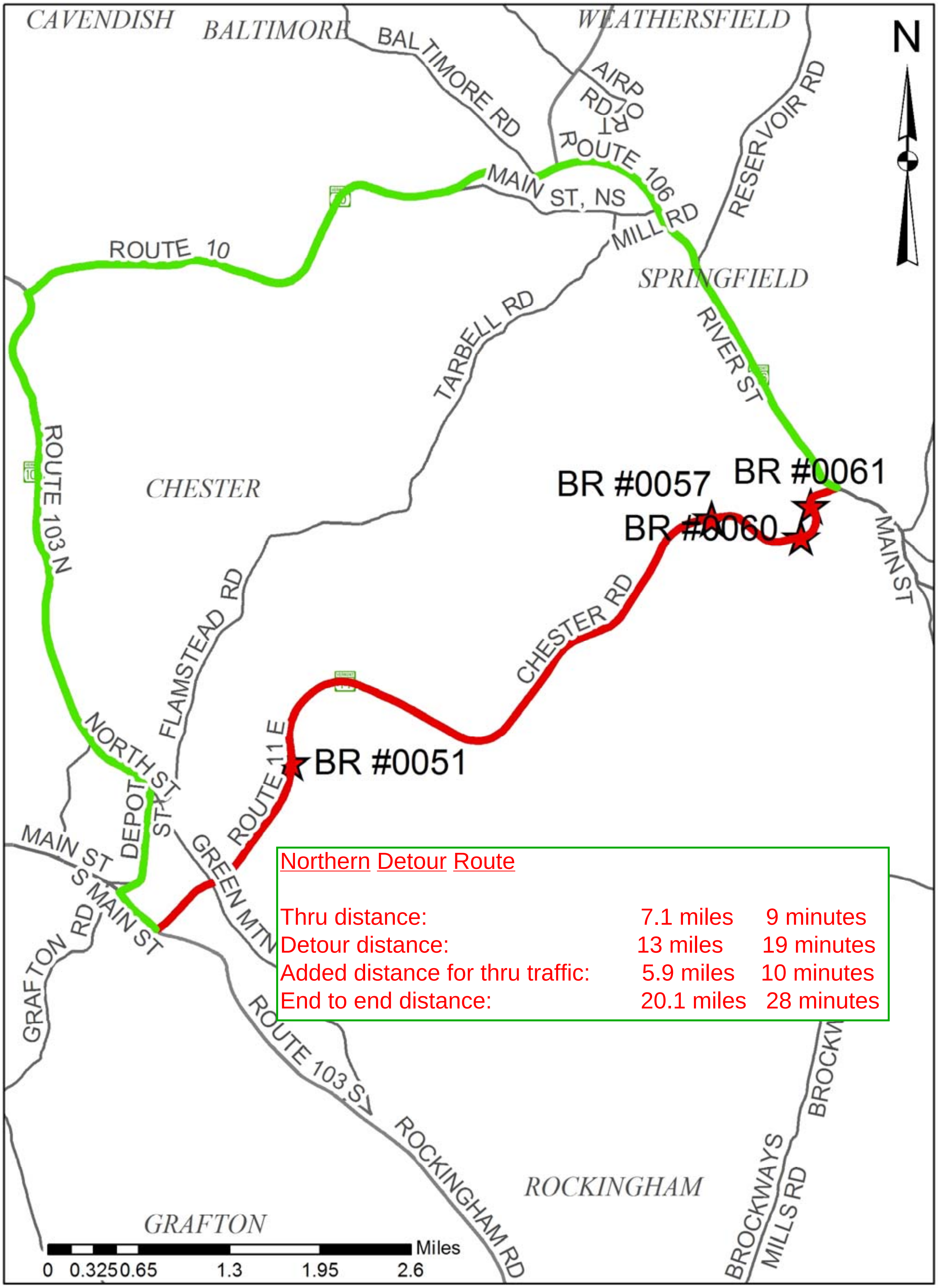
2. Please provide a copy of your existing and future land use map, if applicable.
   Attached

3. Are there any existing, pending or planned development proposal that would impact future transportation patterns near the bridge? If so please explain.
   None. But traffic will increase over time. VT-11 is a route over the Green Mountains which carries significant truck traffic.

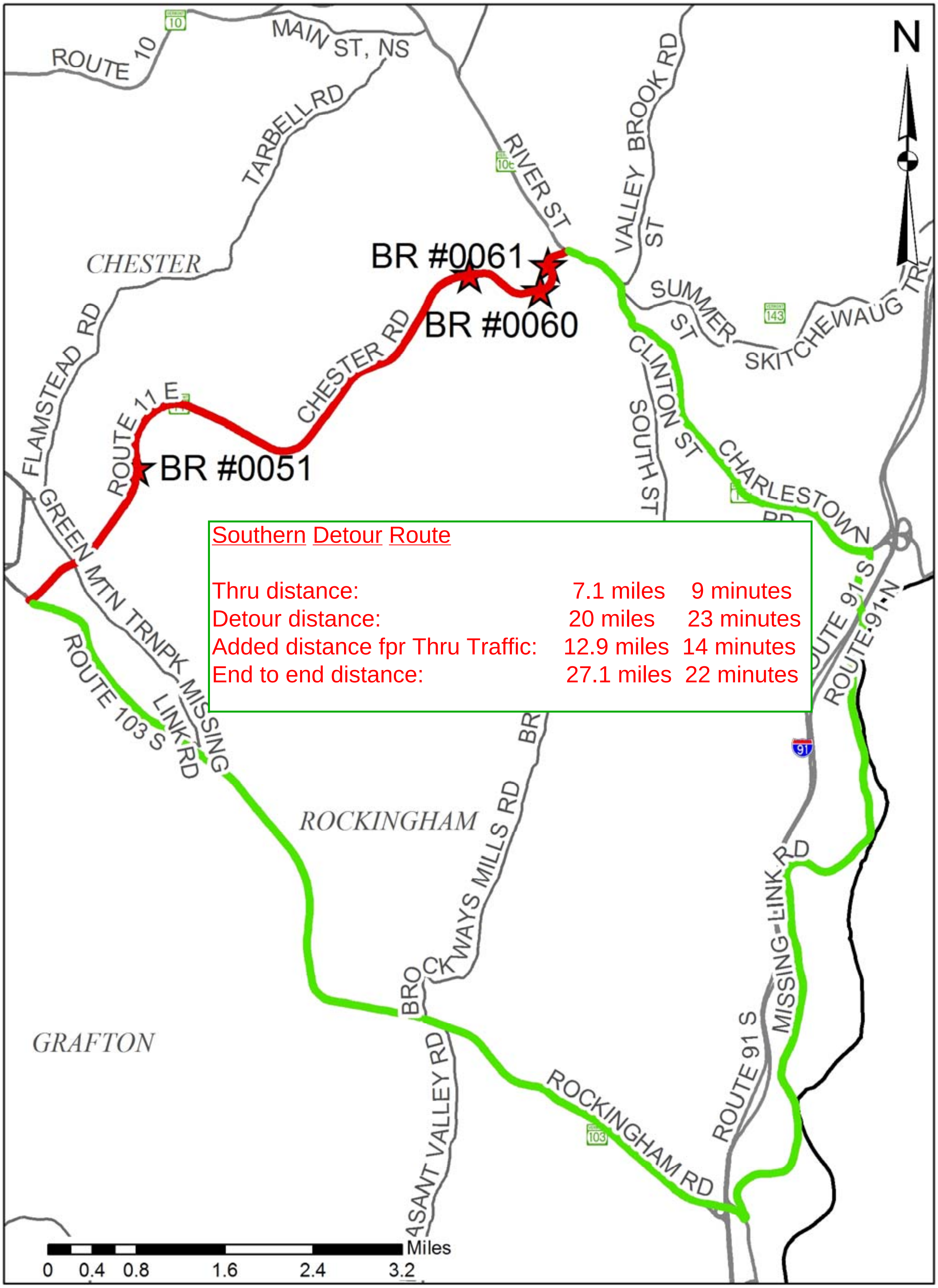
4. Is there any planned expansion of public transit service in the project area? If not known please contact your Regional Public Transit Provider.
   None known expansion of public transit route known. Does not affect Fixed Route Transit Service (see map attached) but would affect Dial-A-Ride service – which covers the entire town of Springfield.

   For more information contact Rebecca Gagnon at Connecticut River Transit (The Current) who provides all transit services – rgagnon@crtransit.org

Appendix K: Detour Map



CAVENDISH
BALTIMORE
BALTIMORE RD
WEATHERSFIELD
AIRPORT RD
ROUTE 106
RESERVOIR RD
N
MAIN ST, NS
MILL RD
ROUTE 10
SPRINGFIELD
TARBELL RD
RIVER ST
ROUTE 103 N
CHESTER
BR #0057
BR #0061
BR #0060
MAIN ST
FLAMSTEAD RD
CHESTER RD
ROUTE 11 E
BR #0051
NORTH ST
DEPOT ST
MAIN ST
S MAIN ST
GREEN MTN
GRAFTON RD
ROUTE 103 S
ROCKINGHAM RD
ROCKINGHAM
BROCKWAYS MILLS RD
GRAFTON
Miles
0 0.325 0.65 1.3 1.95 2.6
Northern Detour Route
Thru distance: 7.1 miles 9 minutes
Detour distance: 13 miles 19 minutes
Added distance for thru traffic: 5.9 miles 10 minutes
End to end distance: 20.1 miles 28 minutes


Southern Detour Route
Thru distance: 7.1 miles 9 minutes
Detour distance: 20 miles 23 minutes
Added distance fpr Thru Traffic: 12.9 miles 14 minutes
End to end distance: 27.1 miles 22 minutes
BR #0061
BR #0060
BR #0051
N
CHESTER
ROCKINGHAM
GRAFTON
ROUTE 10
MAIN ST, NS
TARBELL RD
RIVER ST
VALLEY BROOK RD
ST
SUMMER ST
SKITCHEWAUG TRL
CLINTON ST
SOUTH ST
CHARLESTOWN RD
FLAMSTEAD RD
ROUTE 11 E
CHESTER RD
GREEN MTN TRNPK
ROUTE 103 S
LINK RD
MISSING
ROUTE 91 S
ROUTE 91 N
BROCKWAYS MILLS RD
MISSING LINK RD
PLEASANT VALLEY RD
ROCKINGHAM RD
Miles
0 0.4 0.8 1.6 2.4 3.2

Appendix L: Plans

EXISTING BRIDGE INFORMATION
10'-8" X 6'-11" CGMPPA
86' LONG, BUILT 1965
6' AVERAGE COVER
58 SF WATERWAY AREA

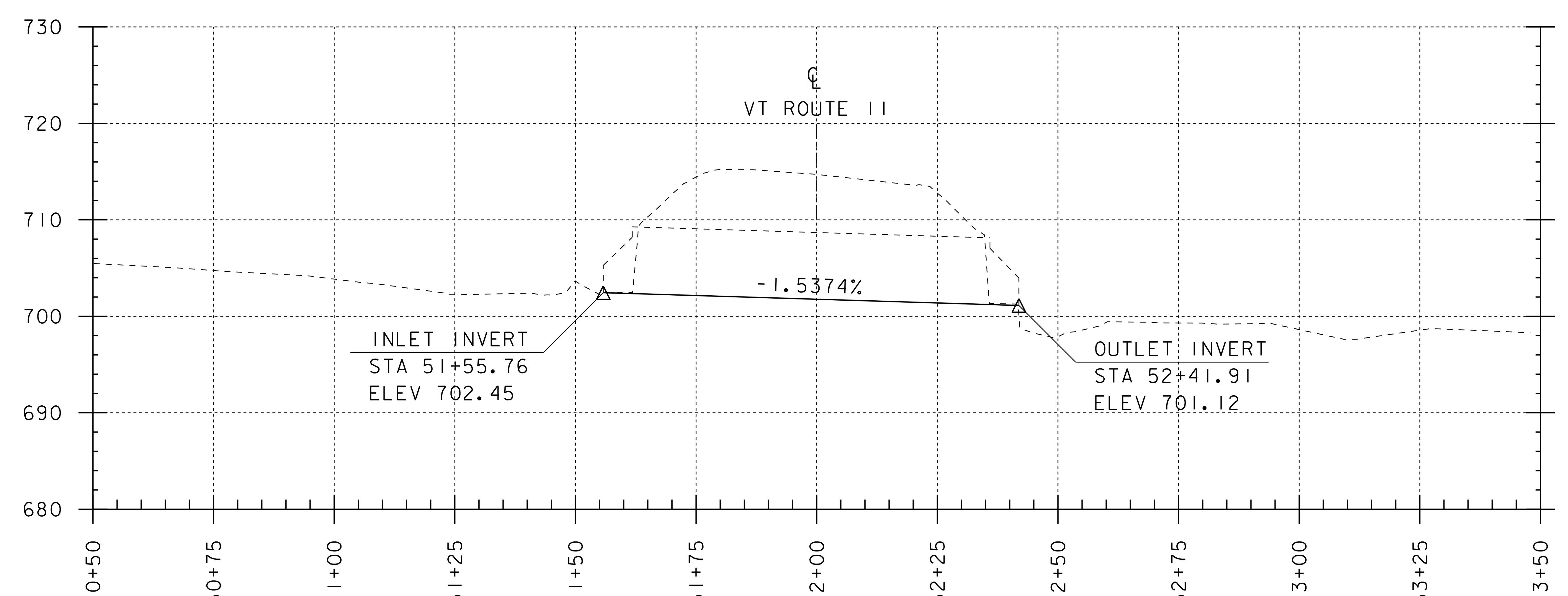
RESOURCE SITE PLAN

SCALE 1" = 20'-0"
20 0 20

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069bdr.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
RESOURCE SITE PLAN	SHEET 1 OF 16

EXISTING VT ROUTE 11 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

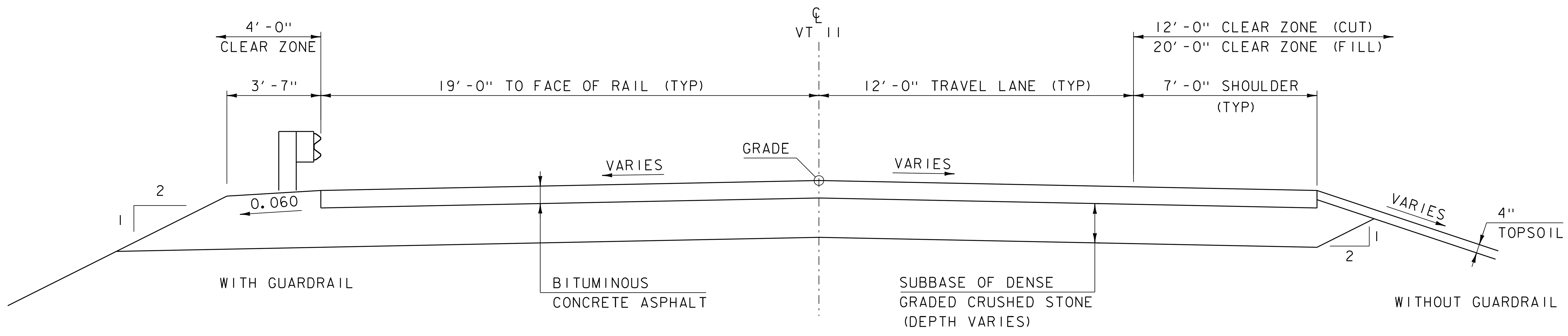


EXISTING BRIDGE 51 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

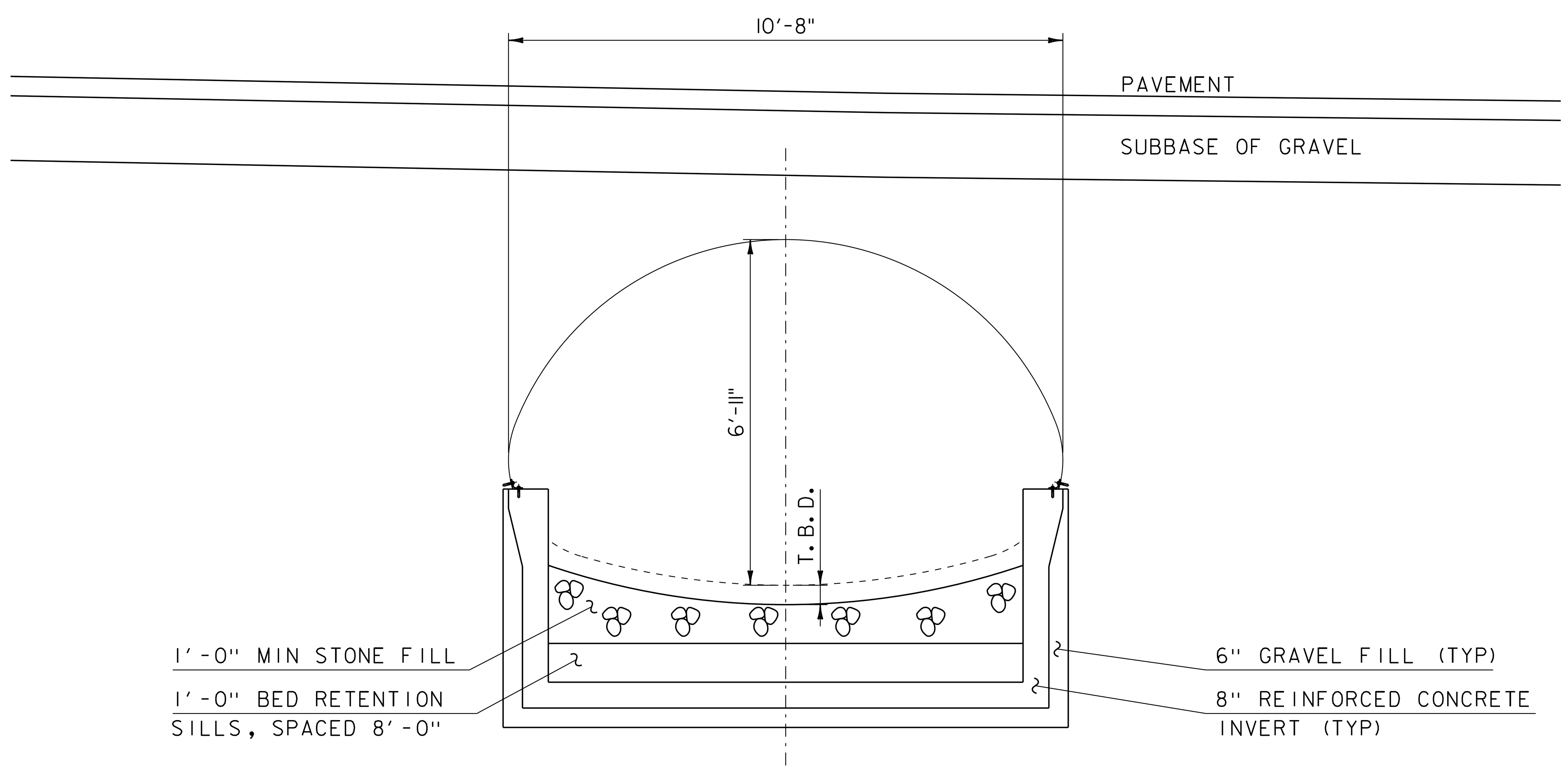
NOTE:
GRADES SHOWN TO THE NEAREST
TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST
HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069profile.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: ------	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
EXISTING PROFILE SHEET	SHEET 2 OF 16



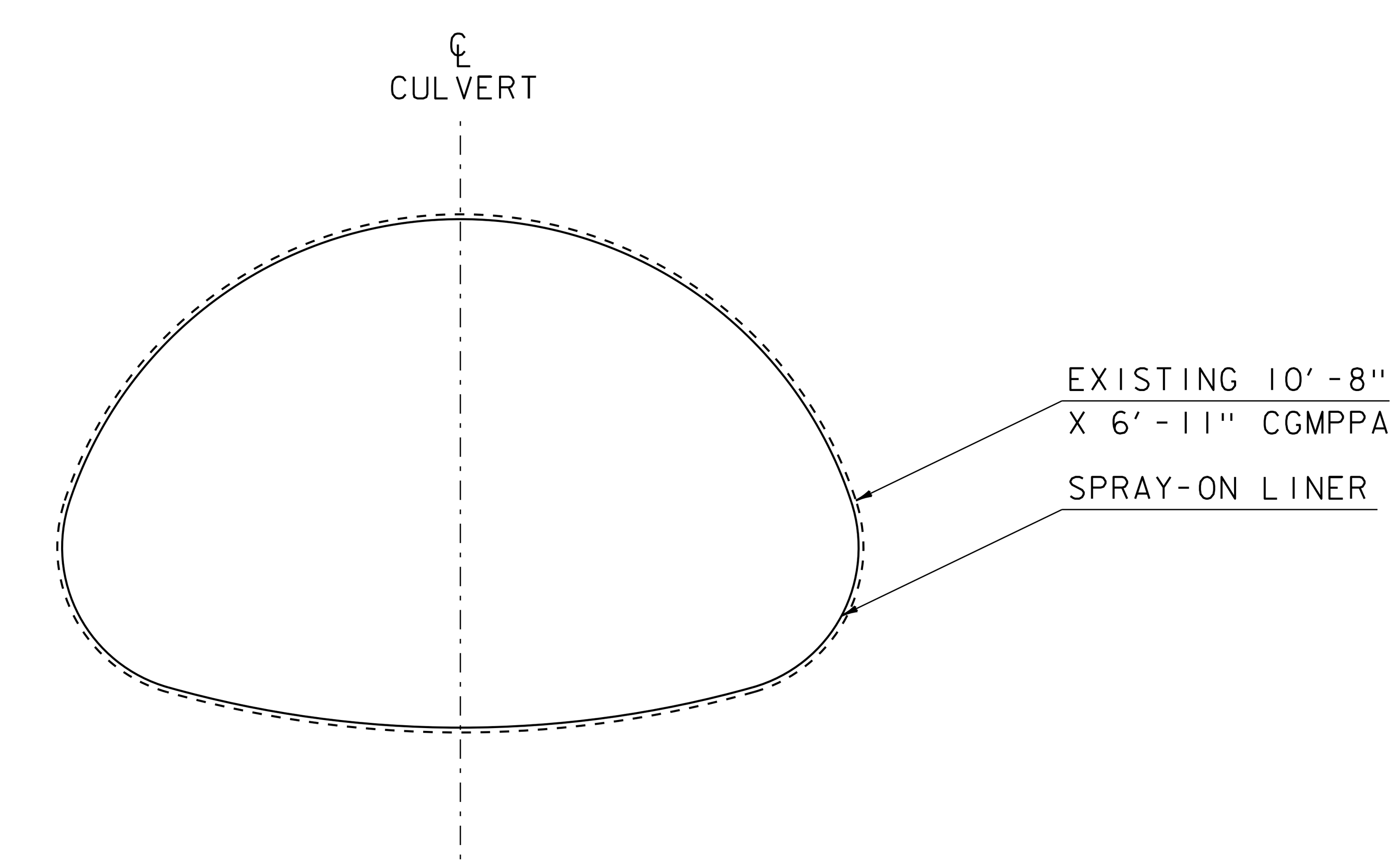
PROPOSED VT 11 ALTERNATIVE 1 TYPICAL SECTION

SCALE 3/8" = 1'-0"



ALTERNATIVE 1A TYPICAL SECTION

N.T.S.



ALTERNATIVE 1B TYPICAL SECTION

N.T.S.

NOTES:
1) CONCRETE INVERT, RETENTION SILLS, AND OTHER MATERIALS NOT YET DESIGNED.
2) THE INTENT IS TO RETAIN THE SAME OR SLIGHTLY LARGER WATERWAY AREA TO AVOID RISE IN THE 50 & 100 YEAR FLOODS
3) REINFORCED CONCRETE INVERT MAY BE CAST IN PLACE OR PRECAST
4) CONTRACTOR TO DETERMINE THE LENGTH OF CULVERT TO BE REMOVED AT ANY ONE TIME.

PROJECT NAME: CHESTER
PROJECT NUMBER: BF 0134(50)

FILE NAME: 16b069\s16b069typical.dgn
PROJECT LEADER: N.WARK
DESIGNED BY: G.SWEENY
ALTERNATIVE 1 TYPICAL SECTIONS

PLOT DATE: 03-JUL-2017
DRAWN BY: D.D.BEARD
CHECKED BY: G.SWEENY
SHEET 3 OF 16

CURVE (1)
DELTA = 11°15′02″
D = 1°57′39″
R = 2922.00′
T = 287.81′
L = 573.76′
E = 14.14′

EXISTING BRIDGE INFORMATION
10′-8″ X 6′-11″ CGMPPA
86′ LONG, BUILT 1965
6′ AVERAGE COVER
58 SF WATERWAY AREA

ALTERNATIVE 1 LAYOUT

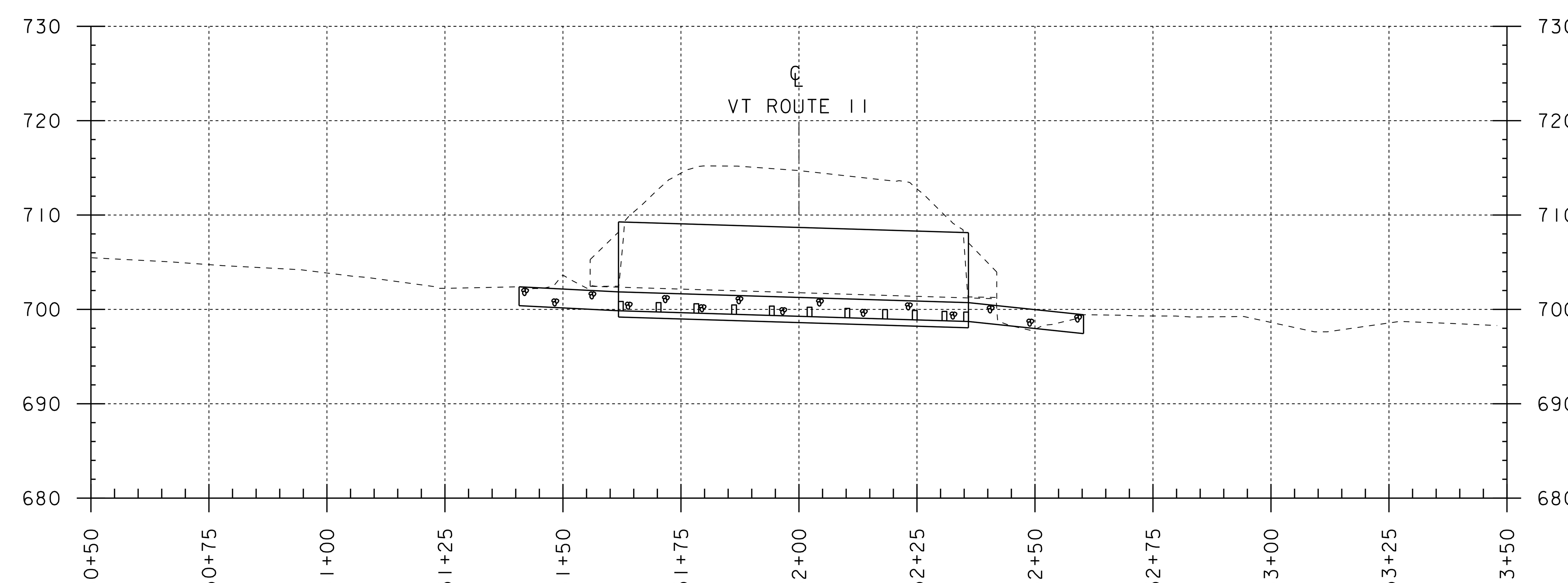
SCALE 1″ = 20′-0″

PROJECT NAME: CHESTER
PROJECT NUMBER: BF 0134(50)

FILE NAME: 16b069/s16b069bdr.dgn
PROJECT LEADER: N.WARK
DESIGNED BY: G.SWEENY
ALTERNATIVE 1 LAYOUT SHEET
PLOT DATE: 03-JUL-2017
DRAWN BY: D.D.BEARD
CHECKED BY: G.SWEENY
SHEET 4 OF 16

ALTERNATIVE 1A VT ROUTE 11 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"



ALTERNATIVE 1A BRIDGE 51 PROFILE

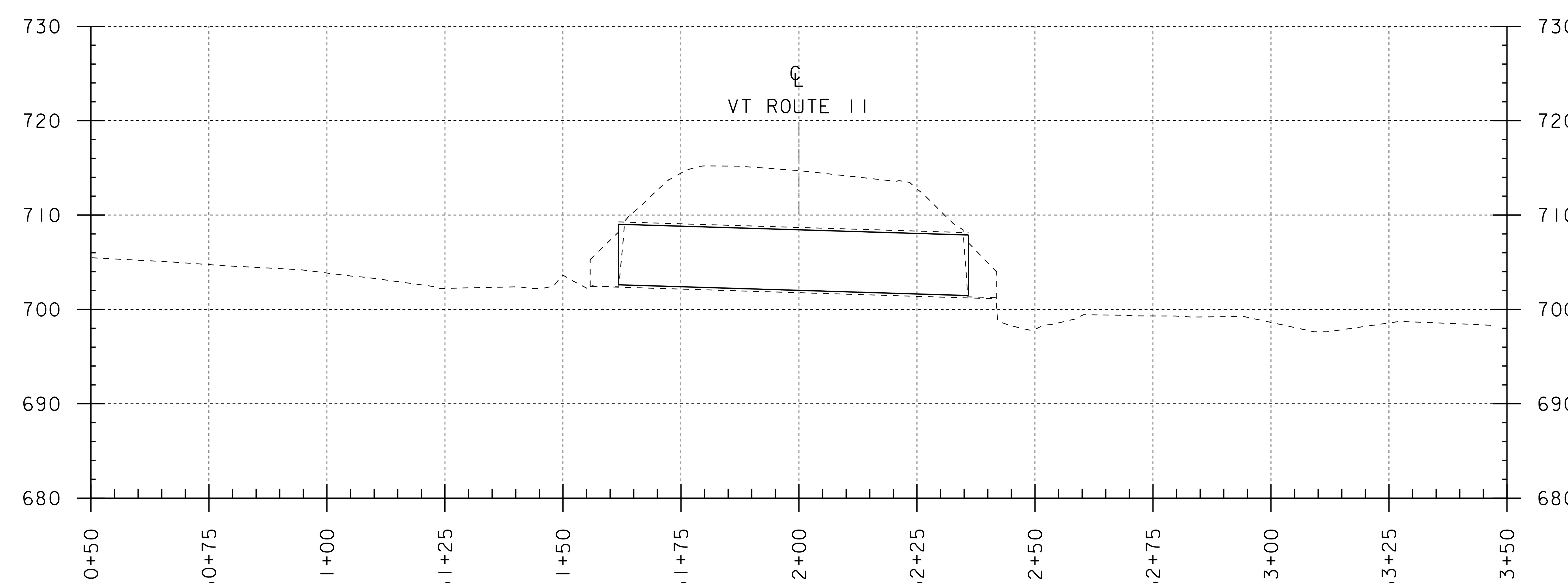
SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

NOTE:
GRADES SHOWN TO THE NEAREST TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069profile.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: ------	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 1A PROFILE SHEET	SHEET 5 OF 16

ALTERNATIVE IB VT ROUTE 11 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

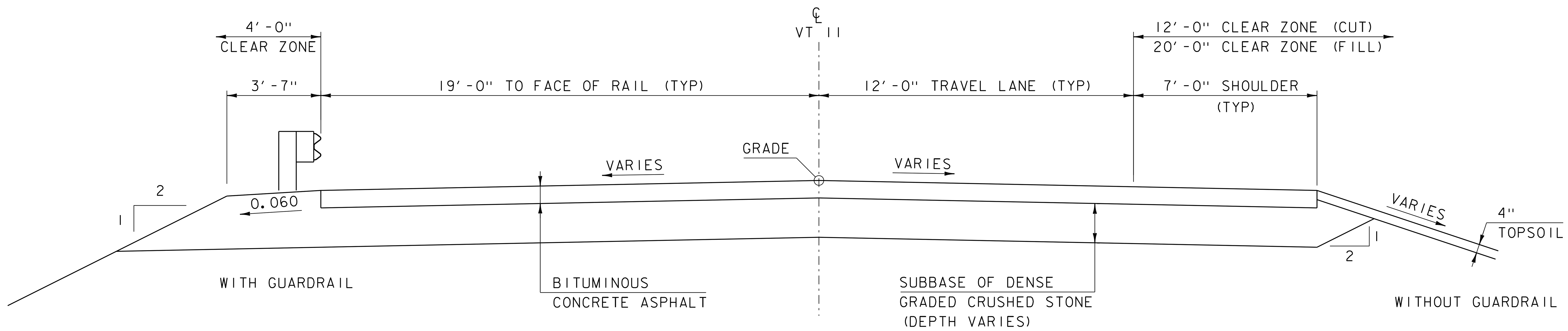


ALTERNATIVE IB BRIDGE 51 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

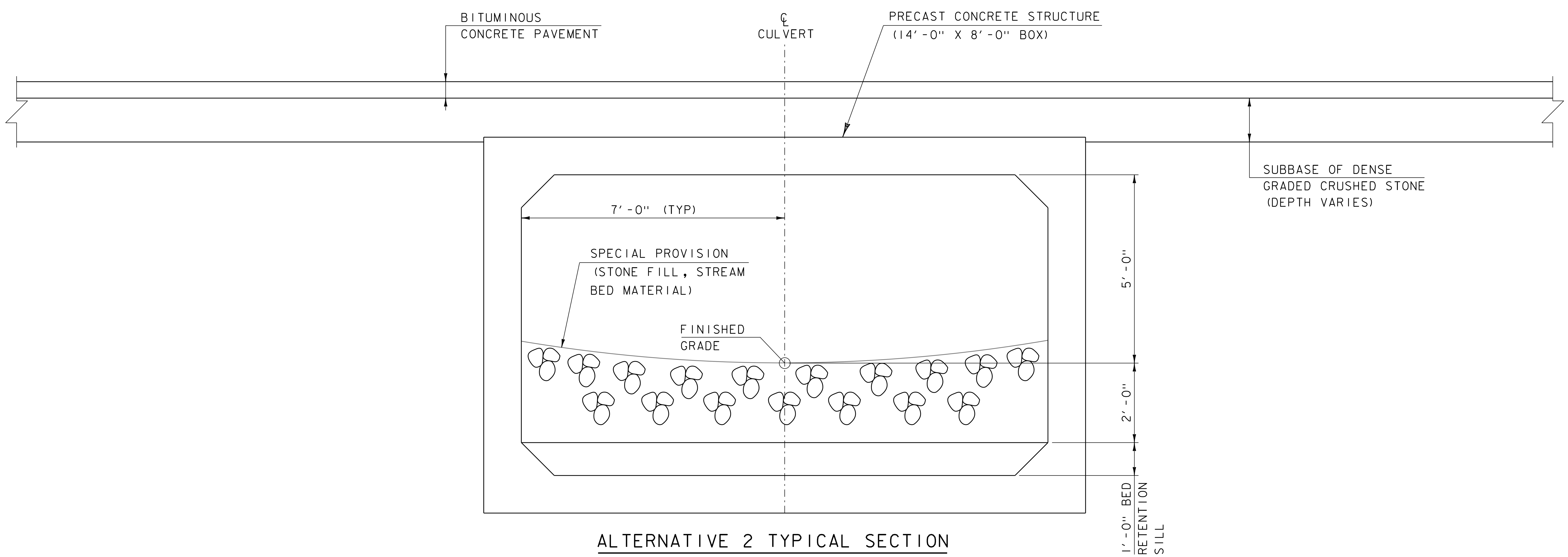
NOTE:
GRADES SHOWN TO THE NEAREST TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069profile.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: ------	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 1B PROFILE SHEET	SHEET 6 OF 16



PROPOSED VT 11 ALTERNATIVE 2 TYPICAL SECTION

SCALE ⅜" = 1'-0"



ALTERNATIVE 2 TYPICAL SECTION

N.T.S.

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069\s16b069typical.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 2 TYPICAL SECTIONS	SHEET 7 OF 16

EXISTING BRIDGE INFORMATION
10'-8" X 6'-11" CGMPPA
86' LONG, BUILT 1965
6' AVERAGE COVER
58 SF WATERWAY AREA

PHASE 2 LAYOUT

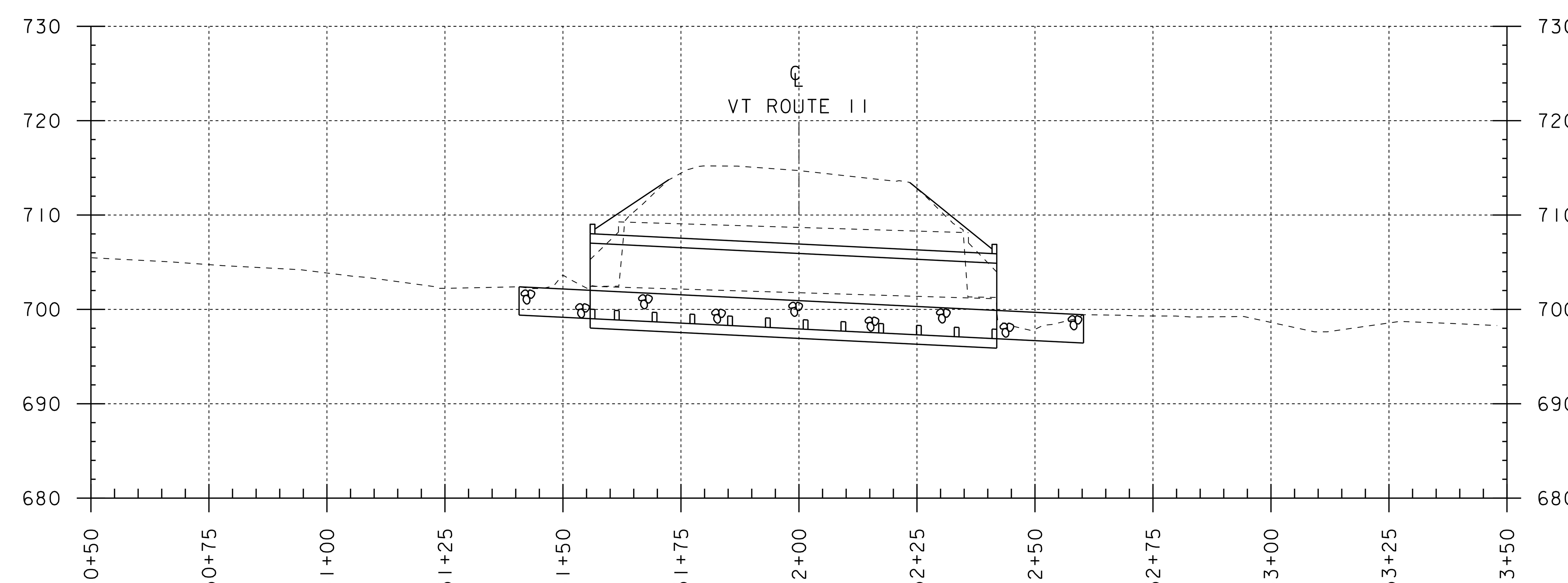
SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069bdr.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
PHASE 2 LAYOUT SHEET	SHEET 8 OF 16

ALTERNATIVE 2 VT ROUTE 11 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

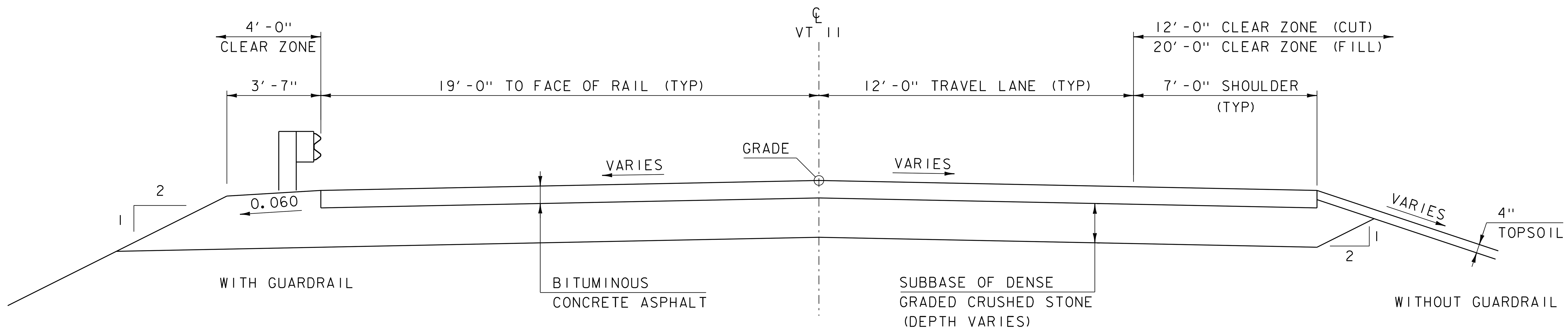


ALTERNATIVE 2 BRIDGE 51 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

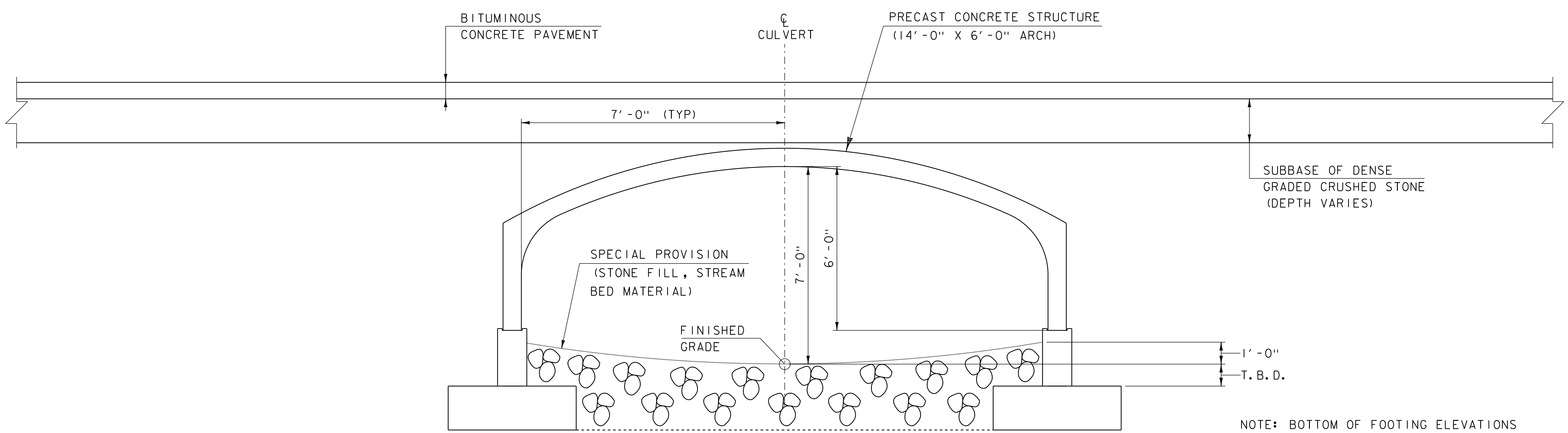
NOTE:
GRADES SHOWN TO THE NEAREST TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069profile.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: ------	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 2 PROFILE SHEET	SHEET 9 OF 16



PROPOSED VT 11 ALTERNATIVE 3 TYPICAL SECTION

SCALE 3/8" = 1'-0"



NOTE: BOTTOM OF FOOTING ELEVATIONS HAVE NOT BEEN DESIGNED.

ALTERNATIVE 3 TYPICAL SECTION

N.T.S.

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069\s16b069typical.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 3 TYPICAL SECTIONS	SHEET 10 OF 16

EXISTING BRIDGE INFORMATION
10'-8" X 6'-11" CGMPPA
86' LONG, BUILT 1965
6' AVERAGE COVER
58 SF WATERWAY AREA

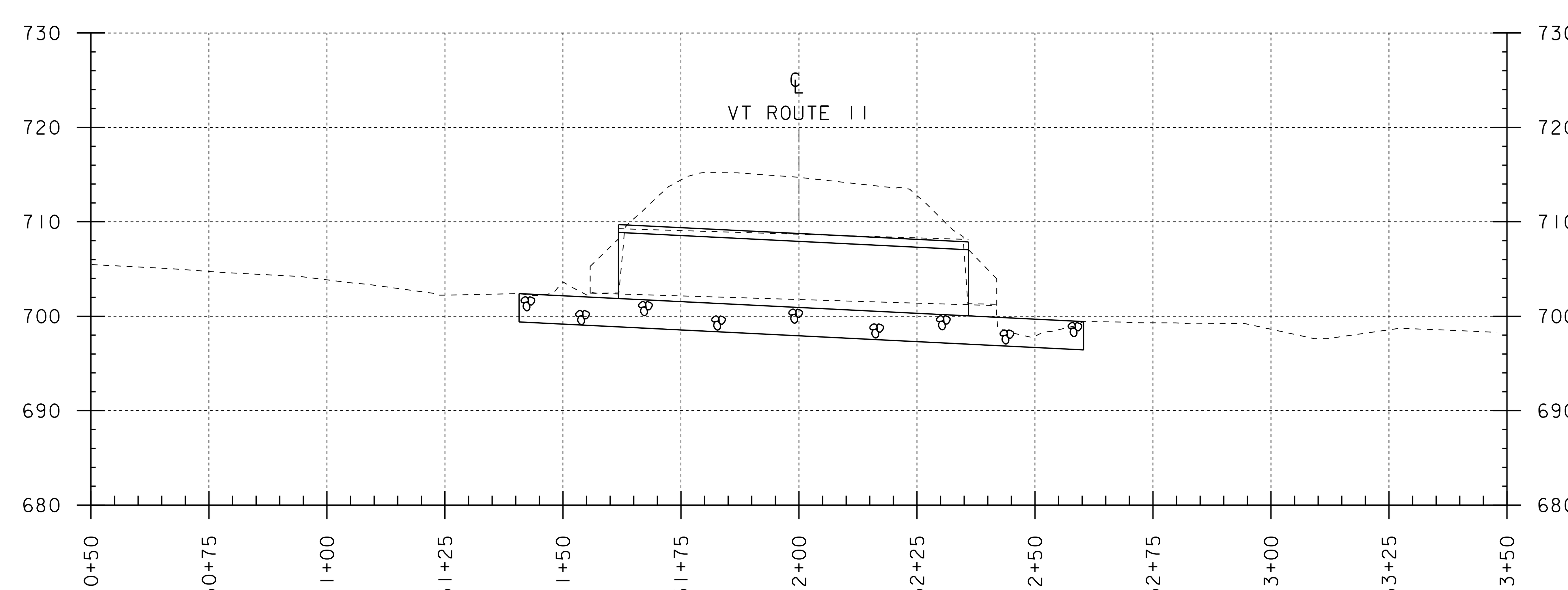
ALTERNATIVE 3 LAYOUT

SCALE 1" = 20'-0"
20 0 20

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069bdr.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 3 LAYOUT SHEET	SHEET 11 OF 16

ALTERNATIVE 3 VT ROUTE 11 PROFILE

SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

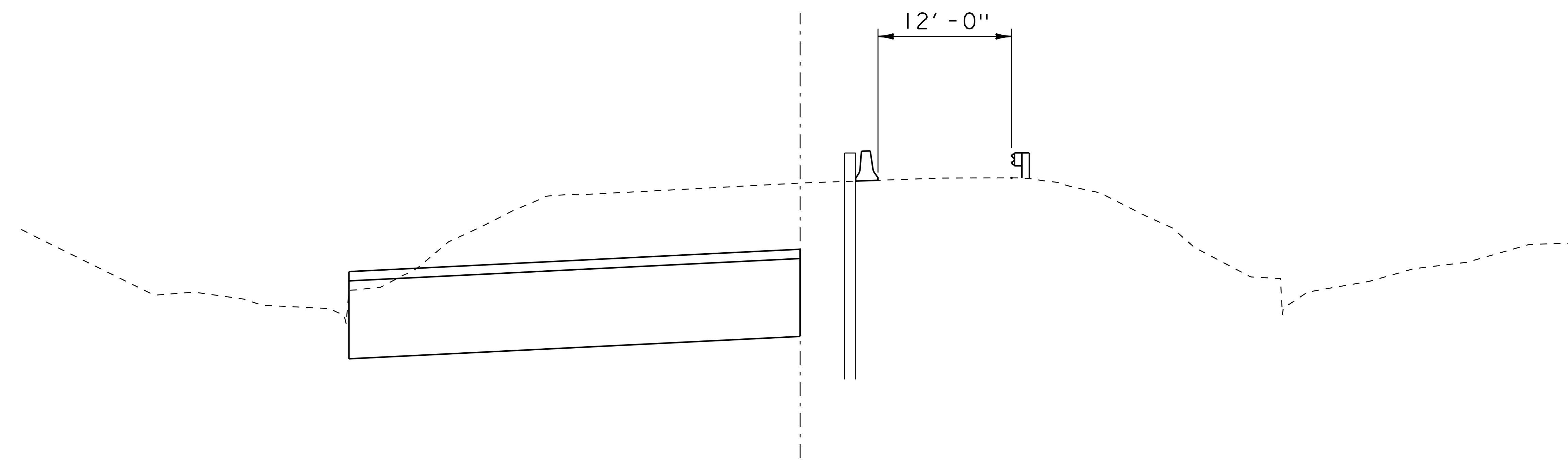


ALTERNATIVE 3 BRIDGE 51 PROFILE

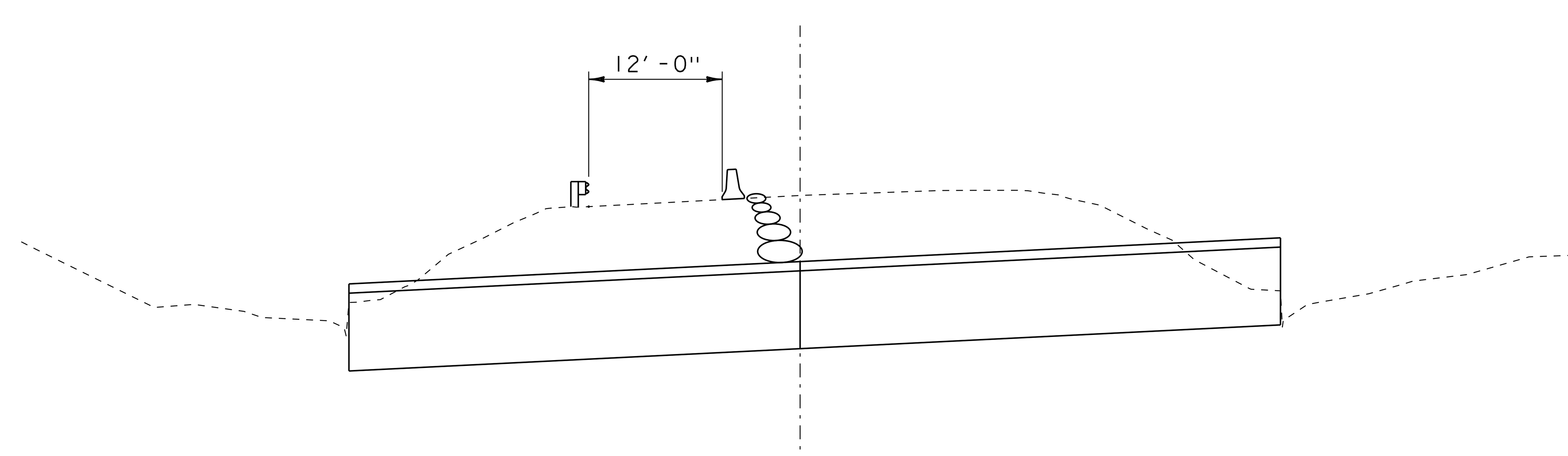
SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

NOTE:
GRADES SHOWN TO THE NEAREST TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069profile.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: ------	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
ALTERNATIVE 3 PROFILE SHEET	SHEET 12 OF 16



PHASE 1 SECTION



PHASE 2 SECTION

PROJECT NAME: CHESTER
PROJECT NUMBER: BF 0134(50)

FILE NAME: 16b069/s16b069phasing.dgn
PROJECT LEADER: ------
DESIGNED BY: G.SWEENY
PHASING TYPICAL SECTIONS

PLOT DATE: 03-JUL-2017
DRAWN BY: D.D.BEARD
CHECKED BY: G.SWEENY
SHEET 13 OF 16

BENCHMARK
CORNER OF CONCRETE
PAD FOR DI
ELEV. = 711.95

CURVE (1)
DELTA = 11°15'02"
D = 1°57'39"
R = 2922.00'
T = 287.81'
L = 573.76'
E = 14.14'

EXISTING BRIDGE INFORMATION
10'-8" X 6'-11" CGMPPA
86' LONG, BUILT 1965
6' AVERAGE COVER
58 SF WATERWAY AREA

PHASE 1 LAYOUT

SCALE 1" = 20'-0"
20 0 20

PROJECT NAME: CHESTER
PROJECT NUMBER: BF 0134(50)

FILE NAME: 16b069/s16b069bdr.dgn
PROJECT LEADER: N.WARK
DESIGNED BY: G.SWEENY
PHASE I LAYOUT SHEET

PLOT DATE: 03-JUL-2017
DRAWN BY: D.D.BEARD
CHECKED BY: G.SWEENY
SHEET 14 OF 16

EXISTING BRIDGE INFORMATION
10′-8" X 6′-11" CGMPPA
86′ LONG, BUILT 1965
6′ AVERAGE COVER
58 SF WATERWAY AREA

PHASE 2 LAYOUT

SCALE 1" = 20′-0"

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069bdr.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
PHASE 2 LAYOUT SHEET	SHEET 15 OF 16

EXISTING BRIDGE INFORMATION
10′-8" X 6′-11" CGMPPA
86′ LONG, BUILT 1965
6′ AVERAGE COVER
58 SF WATERWAY AREA

TEMPORARY BRIDGE LAYOUT

SCALE 1" = 20′-0"

20 0 20

PROJECT NAME: CHESTER	
PROJECT NUMBER: BF 0134(50)	
FILE NAME: 16b069/s16b069bdr.dgn	PLOT DATE: 03-JUL-2017
PROJECT LEADER: N.WARK	DRAWN BY: D.D.BEARD
DESIGNED BY: G.SWEENY	CHECKED BY: G.SWEENY
TEMPORARY BRIDGE SHEET	SHEET 16 OF 16