STATE OF VERMONT
AGENCY OF TRANSPORTATION

Scoping Report

FOR

Searsburg BF 010-1(50)

VT Route 9, BRIDGE 20 OVER UNNAMED BROOK

February 26, 2016

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I. Site Information

Bridge 20 is a State owned bridge located on VT Route 9 approximately 1.1 miles west of the junction with VT Route 8. The existing corrugated metal pipe is in poor condition. There is approximately 30 feet of fill above the culvert. There are wetlands located on both the inlet and outlet ends of the culvert. The existing conditions were gathered from a combination of a Site Visit, the Inspection Report, the Route Log and the existing Survey. See correspondence in the Appendix for more detailed information.

Roadway Classification	Rural Principal Arterial
Bridge Type	Corrugated Galvanized Metal Plate Pipe (CGMPP)
Culvert Length	174 feet
Culvert Span	7 feet
Year Built	1965
Ownership	State of Vermont

Need

Bridge 20 carries VT Route 9 across an unnamed brook. The following is a list of deficiencies of Bridge 20 and VT Route 9 in this location:

1. The existing culvert is rated as poor and there is evidence of squashing at the midspan.

2. The culvert has a Steel Culvert Corrosion Indicator of 2, which indicates that there are perforations throughout the culvert that are greater than 2 inches in width.

3. The bottom of the culvert is heavily rusted and rotted out.

4. The culvert constricts the natural channel width for hydraulics.

5. The ends of the culvert are mitered, which can lead to structural failure.

6. The shoulders on VT 100 are substandard by 1.5 feet throughout the project area where there is guardrail.

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	2017	2037
AADT	3,200	3,400
DHV	490	520
ADTT	540	750
%T	15.2	19.9
%D	54	54

Design Criteria

The design standards for this bridge project are the Vermont State Standards, dated October 22, 1997. Minimum standards are based on an ADT of 3,400, a DHV of 520, and a design speed of 50 mph for a Principal Arterial.

Design Criteria	Source	Existing Condition	Minimum Standard	Comment
Approach Lane and Shoulder Widths	VSS Table 3.3	12'/8.5' (41')	12'/10' (44')[1]	Substandard
Bridge Lane and Shoulder Widths	VSS Table 3.3	12'/8.5' (41')	12'/10' (44')[1]	Substandard
Clear Zone Distance	VSS Table 3.4	No Issues Noted	20' fill / 12' cut (1:3 slopes) 14' cut (1:4 slopes)	
Banking	VSS Section 3.13	e_{left} = -6.0% e_{right} = +3.2%	8% (max)	
Speed		50 mph (Posted)	50 mph (design)	
Horizontal Alignment	AASHTO Green Book Table 3-10b	R = 1,910	R_{min} = 1,930' @ e = 5.2%	Substandard
Vertical Grade	VSS Table 3.5	4.6478% (max)	5% (max) for rolling terrain	
K Values for Vertical Curves	VSS Table 3.1	K_{sag} = 100	110 crest / 90 sag	
Vertical Clearance	VSS Section 3.8	No Issues Noted	16'-3" (min)	
Stopping Sight Distance	VSS Table 3.1	485'	400'	
Bicycle/Pedestrian Criteria	VSS Table 3.7	8.5' shoulder	5' Shoulder	
Bridge Railing	Structures Design Manual Section 13	N/A	TL-4	
Hydraulics	VTrans Hydraulics Section	1. Culvert passes Q_{100} storm event with no roadway overtopping 2. Clearspan = 7' 3. HW/D <1.5 at Q_{100} storm event	1. Roadway not overtopped at Q_{50} storm event 2. $BFW_{calculated}$ = 10' 3. HW/D<1.5 at Q_{100} storm event	Substandard BFW
Structural Capacity	SM, Ch. 3.4.1	Unknown	Design Live Load: HL-93	

[1] 2 feet added to the shoulder width in guard rail areas on principal arterials where the DHV is over 400 vehicles per hour.

Inspection Report Summary

Culvert Rating	4 Poor
Channel Rating	7 Good

10/16/2013 – The invert has scattered holes throughout that are no larger than 2", and there are a couple random spots with 6" sized holes. The outlet end has dropped about 1' and there is also a slight sag at mid span. ~JM/JW

12/17/2012 – The invert area throughout the pipe is continuously corroding rending future possibilities of piping effects or heavy settlement to occur in some sections. Soil infiltration or exfiltration occurrences are occurring moderately in scattered spots throughout. Addition of a concrete in fill along the invert may help extend the longevity of this structure. This inspection is now changing from a 24 month inspection to a 12 month inspection. ~PLB

Hydraulics Report Summary

Our calculations, field observations and measurements indicate the existing structure does meet the current standards of the VTrans Hydraulic Manual. Additionally, the pipe does not meet the state stream equilibrium standards for bankfull width (span length). The ANR Department of Fish and Wildlife has identified the need for aquatic organism passage at this site.

<u>Recommendations from the Hydraulics Unit</u>

1. A corrugated liner with a 6' inside diameter with a 1' baffle will meet hydraulic standards. The baffle design will be slightly more complex, but there is some room to work out these design details with minimal risk of not meeting hydraulic standards. With the addition of a beveled inlet headwall, the impacts to the water surface elevations will be less than 8" upstream at all flows we checked up to the design AEP of 2%. Most of the 8" will be a result of raising the invert elevation, not the reduction in waterway area. It will be beneficial to keep the invert as low as possible. The contractor may be able to form the pipe into a vertical ellipse which would not only increase the waterway area but also keep the invert as low as possible.

   In order to accommodate AOP, this option will require downstream weirs to backwater the last baffle inside the culvert. For preliminary design considerations, downstream rock weirs should be spaced at 10' intervals with 7-9" drop which results in 3 rock weirs affecting 40 feet downstream of the outlet. Please note that these are preliminary estimates only.

2. A concrete box with a 10' wide by 7' high inside opening, with 12" high bed retention sills (baffles) in the bottom. The box invert should be buried 24" with material graded to match stream bed material, so the top of the sills will be buried 12" and not be visible. That will result in a 10' wide by 5' high waterway opening above streambed, providing 50-sq. ft. of waterway area.

3. An 11' diameter CMPP with the invert buried 3', with 12" high sills built and buried as described above. This structure will provide 74.0' of waterway area.

4. Any similar structure with a minimum clear span of 10' and at least 50 sq. ft. of waterway area, that fits the site conditions, could be considered. Any 4-sided structure should have bed retention sills and a buried invert as described above. A structural plate arch was not recommended due to the fill height at this site.

See the Preliminary Hydraulics Report as well as the Preliminary Hydraulics Memo in the Appendix for more information.

Utilities
The existing utilities are shown on the Existing Conditions Layout Sheet, and are as follows:

Municipal Utilities

- There are no municipal water or sewer mains in this vicinity of the bridge.

Public Utilities (Aerial)

- There are single phase electric lines and 3 communication cables within the project area, but in the vicinity of Bridge 20, the aerial route of these facilities is along Old VT Route 9. These aerial facilities are approximately 250 feet south of the inlet for Bridge 20.

Public Utilities (Underground)

- There are no buried utilities in the project area.

It is anticipated that no relocation of utilities will be necessary for construction.

Right Of Way

The existing Right-of-Way is plotted on the Existing Conditions Layout Sheet. Both the inlet and the outlet of the existing culvert are just within the Right-of-Way and it is anticipated that additional rights will be necessary regardless of the alternative selected.

II. Resource Identification

The environmental resources present at this project are shown on the Existing Conditions Layout Sheet, and are as follows:

Biological:

Wetlands

There is a large Class II wetland complex on the south side of VT Route 9 and the boundary was picked up using GPS. Wetlands are also present downstream of the existing structure, but there is a small, upland gap between the outlet and the edge of wetlands. Impacts to this resource will necessitate both State Wetland Permit and a Section 404 permit.

Species/Habitats of Special Concern

A plant species of special concern is known to occur in nearby wetlands. Although it is not known to occur in the vicinity of Bridge 20, any impacts to the wetland would necessitate further coordination with the Agency of Natural Resources.

Watercourses

The crossing is a direct tributary of Rake Brook. Rake Brook contains a cold water fishery and this structure was assessed by ANR Fisheries Biologist in 2006 and he recommended the provision for aquatic organism passage.

Permitting Recommendations

Per Ken Cox's 2006 recommendation, aquatic organism passage should be a provision of this project, and any increase of the structure's size would also be a benefit to facilitating wildlife passage.

Hazardous Materials:

According to the Vermont Agency of Natural Resources (VANR) Vermont Hazardous Sites List, there is one hazardous waste site located in the project area. It is anticipated that this site will not be disturbed as part of this project. See the Appendix for the hazardous sites map.

Historic:

Bridge 20 is not a historic bridge and there are no historic properties within the project area.

Archaeological:

There are no areas of archaeological sensitivity within or adjacent to the project area.

Stormwater:

There are no stormwater concerns for this project.

III. Alternatives Discussion

Bridge 20 has a poor culvert rating, with perforations greater than 2 inches throughout the invert and several six inch perforations on the culvert sides. The culvert is slightly squashed at midspan. The ends are mitered, which can lead to failure. Additionally, the shoulders on the roadway are too narrow.

No Action

This alternative would involve leaving the culvert in its current condition. The existing culvert is in poor condition; although the culvert is not in imminent danger of collapse, it will eventually not be able to safely support all associated loads. If a bridge is expected to last at least another 10 years, then the No Action alternative may be considered a viable option. However, the large perforations throughout the culvert and the deformation and continued deterioration lead to the conclusion that something will have to be done in the near future. In the interest of safety to the traveling public, the No Action alternative is not recommended.

Alternative 1: Culvert Rehabilitation

Since the minimum hydraulic opening would be substandard for all options, and any rehabilitation will reduce the waterway area, it is assumed that an improved beveled inlet would be required for each option to optimize hydraulic performance and to funnel the stream into the culvert.

The options are as follows:

a. Invert Repair
b. 72 inch (min) Pipe Liner

a. Invert Repair

This option involves removal of the degraded invert just below the existing reinforcing steel, and pouring a 2 to 3 inch thick section of concrete in its place. Additionally, there would be repair of

a number of large holes along the circumference of the pipe. This option would have the least impacts to the hydraulic capacity of the existing culvert. While this option is a good solution to the current degradation of the culvert invert, it adds little structural stability to the current structure, which has shown evidence of squashing.

b. Pipe Liner:

A pipe liner involves inserting a culvert liner into the existing culvert, and grouting between the two. The outside diameter of the pipe used for sliplining is generally specified to be at least 4 inches smaller than the inside diameter of the host pipe to allow the grout to be injected into the annular space between the two pipes. A greater reduction would be required at this site since the existing pipe has deformed at midspan. Therefore, type of liner chosen should have a minimum inner diameter of 72 inches. The reduced waterway would have a substandard bankfull width, but would still pass the design flood event with no roadway overtopping. A liner option is anticipated to have the longest life expectancy of the rehabilitation alternatives, since the grout provides an increased structural capacity, prevents liner collapse, prevents fatigue failure, stabilizes the pipe, extends the design life from uncertainty to at least 30 years, and resists temperature changes.

Advantages: The rehabilitation alternative would be the most cost efficient option. It would have minimal impacts to resources, and would not interrupt traffic.

Disadvantages: The rehabilitation alternative is only a repair and not a new structure. The life span of the repair work is estimated to be 15 to 30 years. Also, the existing culvert does not meet the hydraulic standard, and the rehabilitation option would have a smaller hydraulic opening. This option would not satisfy aquatic organism passage requirements without construction of several weirs downstream. The existing substandard roadway width would remain unchanged for any culvert rehabilitation option.

Maintenance of Traffic: The rehabilitation alternative does not affect traffic. Traffic will remain open during the duration of the project.

Alternative 2: Culvert Replacement with a Precast Reinforced Concrete Box

This option involves removing the existing Corrugated Galvanized Metal Plate Pipe and replacing it with a new precast structure having a waterway opening of at least 50 square feet and a span of 10 feet. Since there is approximately 24 feet of fill above the existing culvert, there would be a considerable amount of earthwork. Any new structure should have flared wingwalls 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.
The existing roadway currently has 12 foot wide lanes and 8.5 foot wide shoulders, this not meet the minimum standard of 12 foot lanes with 10 foot shoulders. Additionally, the banking is not sufficient for the horizontal curve present. For the open cut method, the roadway could be brought up to standards in regards to width and horizontal alignment.

a. Roadway Width

The current roadway width is 41 feet. This does not meet the minimum standard of 44 feet. Since a new 80+ year structure is being proposed, the roadway geometry should meet the minimum standards. A 44 foot width roadway will be proposed through the project area.

b. Structure Type

The most common structure types for the recommended hydraulic opening are a 4-sided concrete box culvert, a 3-sided open bottom concrete structure, or a structural plate arch. A plate arch is not recommended at this site, since it would have a reduced design life compared to a reinforced concrete structure.

It is preferred that the structure be a precast 4-sided concrete box culvert. This type of structure would provide protection against scour and undermining, and would require less excavation than an open bottomed structure. Additionally, it would have a shorter construction duration compared to an opened bottom structure, since footings would not have to be placed six feet below the stream bed.

c. Culvert Size, Length and Skew

The existing culvert has a span of 7 feet, which constricts the natural channel width. If a new structure is chosen Hydraulics has recommended a box with a 10 foot wide and 7 foot high inside opening, with 12 inch high bed retention sills spaced no more than 8 feet apart. The top of the sills should be buried 12 inches, resulting in a waterway opening with a rise of 5 feet. This culvert will have no roadway overtopping up and including the Q_{100} design flow. In order to accommodate a 44 foot wide roadway, the proposed barrel length will be 175 feet long. The culvert will have a skew of 90 degrees to the roadway to match the existing skew of the channel.

d. Roadway Alignment

The existing horizontal curve can be brought up to standard within the project limits by modifying the existing banking. Additionally, the existing vertical alignment meets current geometric standards, and as such will remain unchanged.

e. Maintenance of Traffic

Either an off-site detour, or a temporary bridge would be appropriate measures for traffic control at this site.

Advantages: This alternative would be a new structure with an estimated life span of 80 years. The hydraulic capacity of the structure would be improved and the increased road width would meet Vermont State Standards, making the bridge crossing safer for bikes and pedestrians.

Disadvantages: This alternative would require Right-of-Way acquisition and have impacts to adjacent properties.

Alternative 3: New Steel Pipe Culvert using Trenchless Technology

This option would replace the existing culvert with a brand new culvert installed next to the existing pipe, on the eastern side of the existing. The new pipe would be installed using one of several trenchless technologies while traffic maintained on the road above. Regardless of the method used, the new pipe would be a steel casing and have a design life of 80 years and a diameter of 132 inches, which would meet the hydraulic standard. Additionally each option would include headwalls and wingwalls at the inlet and outlet, as well as a beveled inlet.

The options are as follows:

a. Pipe Jacking
b. Pipe Ramming
c. Microtunneling

a. Pipe Jacking:

Pipe Jacking is a method for installing a steel casing through the ground using a jack, or hydraulic thrusters, behind the pipe. The thrust power of the hydraulic jack forces the pipe forward through the ground as the fill at the front of the pipe is being excavated. Generally, 6 to 8 foot segments of casing are jacked at a time, and subsequent segments are welded onto the installed pipe. Pipes installed using jacking are limited to a total length of 300 feet and a maximum diameter of 168 inches. Existing ground conditions, including soil type, presence of groundwater and possible obstructions such as boulders can significantly limit the use of pipe jacking.

b. Pipe Ramming:

Pipe Ramming is a method for hammering a steel casing through the ground using a Grundoram, or pneumatic hammers, behind the pipe. The spoils stay in the pipe and are mechanically removed when the drive is completed. Pipes installed using ramming are limited to a total length of 300 feet and a maximum diameter of 168 inches. Pipe ramming preferred when the fill contains obstructions such as boulders, as the casing will usually break up obstructions, shallow them into the casing, or push them aside as it continues through the embankment

c. Microtunneling:

Microtunneling is very similar to Pipe jacking, however, the machinery is operated remotely and continuous support is provided to the excavation face.

Five independent systems are incorporated into Microtunneling systems. They are as follows:
• Microtunnel boring machine
• Jacking or propulsion system
• Spoil removal system
• Laser guidance and remote control system
• Pipe lubrication system

There is a wide variety of Microtunnel boring machine cutter head attachments that can be tailored to different soil conditions. Therefore, it is important to know soil properties prior to construction, so that the appropriate cutter head can be chosen. Microtunneling may be chosen as the best alternate when driving accuracy is import, as it is the most accurate technology of the trenchless options discussed here.

Advantages: The trenchless pipe methods would have minimal impact to traffic. This alternative would meet hydraulic standards.

Disadvantages: Trenchless techniques are generally more cost effective with 60 inch diameter pipes and smaller, with pipes being driven into favorable soil conditions. This alternative is costly, since a 132 inch diameter pipe is needed for hydraulics. Additionally, the preliminary geotechnical report has indicated that there are most likely boulders present, which could make trenchless technologies more costly.

Maintenance of Traffic: The trenchless alternatives do not affect traffic. Traffic will remain open during construction.

Alternative 4: New Integral Abutment Bridge

The current alignment does not meet current standards; however, it can be brought up to standards with adjustment of the roadway banking. Therefore, any new structure will be placed on the existing horizontal alignment in order to minimize project limits and impacts to adjacent properties and environmental resources.

This alternative would replace the existing bridge with a new superstructure as well as a new substructure at the existing location. The various considerations under this option include: the bridge width and length, skew, superstructure type and substructure type.

a. Bridge Width

The existing lane widths and shoulders on the bridge are 12 feet wide and 8.5 feet wide respectively; this does not meet the minimum standard of 12 feet and 10 feet respectively. Since a new 80+ year bridge is being proposed, the bridge geometry should meet the minimum standards. A 44 foot width bridge will be proposed.

b. Bridge Length and Skew

The existing culvert has a 7 foot span with no skew. The calculated bankfull width is 10 feet. A 0 degree skew matches the existing channel, and is within the preferred limit of 20 degrees for integral abutments. The preferred substructure type is an integral abutment for scour protection. Based on the layout procedures for integral abutments and hydraulic requirements, the appropriate span at this location for no skew is 100 feet. The bridge would have no skew, and a span of 100 feet.

c. Superstructure Type

A precast structure will be the preferred choice, due to decreased construction time. The possible 100' length bridge types that are most commonly used in Vermont are box beams with a structural overlay, and steel beams with a composite concrete deck (Precast Bridge Units). The superstructure depth is not critical for hydraulics; therefore, the beam depth is not a controlling factor in choosing a superstructure type.

d. Substructure Type

There is no visible bedrock in the location of the project. Available information on nearby water wells indicates that the site may be comprised of 5 to 25 feet of glacial till and boulders overlying bedrock. Borings should be taken at the project site, to determine if the subsurface is conducive for an integral abutment at this location. This type of substructure would provide the best scour protection for this scour critical bridge location. If it is determined that driving piles will be difficult, then the substructure should be reinforced concrete abutments on spread footings. Any rapid construction alternative should have sufficient subsurface information to verify the in-situ conditions. In order to reduce construction time, precast abutment components may be used where possible. The preliminary geotechnical report can be found in the Appendix.

e. Maintenance of Traffic:

Either a temporary bridge or an offsite detour could be utilized for traffic control.

Alternatives Summary

Based on the existing site conditions, culvert condition, and recommendations from hydraulics, there are several viable alternatives:

- Alternative 1: Culvert Rehabilitation with Traffic Maintained on Existing Culvert
    a. Invert Repair
    b. 60 inch (min) Culvert Liner
    c. Cured-In-Place Culvert Liner
- Alternative 2a: New Precast Box (Open Cut) with Traffic Maintained on an Offsite Detour
- Alternative 2b: New Precast Box (Open Cut) with Traffic Maintained on a Temporary Bridge
- Alternative 3: New Pipe Culvert (Trenchless Technology) with Traffic Maintained on Existing Culvert
    a. Pipe Jacking
    b. Pipe Ramming
    c. Microtunneling
- Alternative 4a: New integral abutment bridge with Traffic Maintained on an Offsite Detour
- Alternative 4b: New integral abutment bridge with Traffic Maintained on a Temporary Bridge

A cost evaluation for each of the alternatives is shown below.

IV. Maintenance of Traffic

The Vermont Agency of Transportation reviews each new project to determine suitability for the 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 sooner. 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 to traffic during construction and reroute through traffic around the project location. This detour would require traffic traveling eastbound from Bennington to detour south onto VT Route 7 into Massachusetts. This is the only available detour route for this location. The official detour is appropriate for and chosen based on the volume and type of traffic which will be diverted during construction and the currently existing traffic volumes and composition. The detour has an end-to-end distance of 50 miles and is 24 miles of additional travel for through traffic.

Old VT Route 9 is a local road parallel to the project site. It is likely that this road will experience an increase in traffic as local commuters familiar with the area will choose to disregard the signed traffic detour and use this as a bypass to the road closure.

Safety is a major concern that is considered during the development of a project. Not only the safety of the travelling public and construction workers affected by the construction activities, but also the ability of fire and rescue personnel to reach all areas of a town during construction. Thus, all possible detour

routes are also evaluated to determine if they may be used by service vehicles and first responders to respond to emergencies during a road closure. Fire and rescue personnel will be impacted very slightly due to a road closure here as they will be able to utilize Old VT Route 9 in order to bypass the road closure.

A map of the 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 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. Many times by decreasing the impacts and area of additional right of way required, the length of time to develop the project can be decreased. 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.

Option 2: Temporary Bridge

From a constructability standpoint, a temporary bridge could be placed either upstream or downstream of the existing structure. Both an upstream and downstream temporary bridge would have impacts to wetlands, however the impacts on the upstream side would be more significant. Both an upstream and downstream temporary bridge alignment would have limits outside the existing Right-of-Way.

Additional costs would be incurred to use a temporary bridge, including the cost of the bridge itself, installation and removal, restoration of the disturbed area, and the time and money associated with the temporary Right-of-Way.

If a temporary bridge was chosen for the new precast box option, it should be a two-way bridge to accommodate the traffic volumes along with the long temporary approaches that would be required at this site. The bridge is surrounded by wooded areas, both upstream and downstream. A number of trees would need to be cut down for this temporary condition. Additionally, a two-way temporary bridge would increase the cost of the project by about $250,000. See the Temporary Bridge Layout Sheet in the Appendix.

Advantages: Traffic flow can be maintained along the VT Route 9 corridor.

Disadvantages: This option would require additional Right-of-Way acquisition. This option would have adverse impacts to surrounding resources. 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.

Option 3: Phased Construction

Phased construction is the maintenance of traffic on the existing bridge while building one lane at a time of the proposed structure. This allows keeping the road open during construction, while having minimal impacts to adjacent property owners and environmental resources.

While the time required to develop a phased construction project would remain the same, the time required to complete a phased construction project increases because some of the construction tasks have to be performed multiple times. In addition to the increased design and construction costs

mentioned above, the costs also increase for phased construction because of the inconvenience of working around traffic and the effort involved in coordinating the joints between the phases. Another negative aspect of phased construction is the decreased safety of the workers and vehicular traffic, which is caused by increasing the proximity and extending the duration that workers and moving vehicles are operating in the same confined space. Phased construction is usually considered when the benefits include reduced impacts to resources and decreased costs and development time by not requiring the purchase of additional ROW.

Based on the current traffic volumes, it is acceptable to close one lane of traffic, and maintain one lane of traffic, both ways, with a traffic signal. However, due to vertical constraints, this option will not be considered. There is approximately 30 feet of vertical fill over the existing culvert; it would be extremely tricky and costly to hold back this amount of fill for phased construction.

Statewide Model Analysis

To analyze the traffic impacts from short term road closure the "Vermont Travel Model" was applied by the University of Vermont's Transportation Research Center. A travel demand model includes elements such as roadway and transit network, and population and employment date to calculate the expected demand for transportation facilities. These models are used to estimate travel behavior and travel demand for a specific future time frame based on a number of assumptions. The results of the analysis can be found in Appendix M.

V. Cost Matrix[2]

Searsburg BF 010-1(50)		Do Nothing	Alt 1: Culvert Rehabilitation		Alt 2: New Precast Box using Open Cut construction		Alt 3: New Pipe using Trenchless Technology			Alt 4: New Integral Abutment Bridge	
			a. Invert Repair	b. Culvert Liner			a. Pipe Jacking	b. Pipe Ramming	c. Microtunneling		
			Short Term Lane Closures		a. Offsite Detour	b. Temporary Bridge	Short Term Lane Closures			a. Offsite Detour	b. Temporary Bridge
COST	Bridge Cost	$0	$247,000	$259,000	$692,000	$692,000	$1,762,000	$1,285,000	$1,395,000	$1,359,000	$1,359,000
	Removal of Structure	$0	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
	Roadway	$0	$95,000	$195,000	$224,000	$224,000	$234,000	$234,000	$234,000	$228,000	$228,000
	Maintenance of Traffic	$0	$30,000	$30,000	$80,000	$584,000	$40,000	$40,000	$40,000	$40,000	$544,000
	Construction Costs	$0	$392,000	$404,000	$1,016,000	$1,520,000	$2,056,000	$1,579,000	$1,689,000	$1,647,000	$2,151,000
	Construction Engineering + Contingencies	$0	$118,000	$122,000	$305,000	$456,000	$617,000	$474,000	$507,000	$495,000	$646,000
	Total Construction Costs w CEC	**$0**	**$510,000**	**$526,000**	**$1,321,000**	**$1,976,000**	**$2,673,000**	**$2,053,000**	**$2,196,000**	**$2,142,000**	**$2,797,000**
	Preliminary Engineering[3]	**$0**	**$179,000**	**$185,000**	**$331,000**	**$494,000**	**$401,000**	**$308,000**	**$330,000**	**$536,000**	**$700,000**
	Right of Way	**$0**	**$28,000**	**$29,000**	**$72,000**	**$107,000**	**$144,000**	**$111,000**	**$119,000**	**$116,000**	**$151,000**
	Total Project Costs	$0	$717,000	$740,000	$1,724,000	$2,577,000	$3,218,000	$2,472,000	$2,645,000	$2,794,000	$3,648,000
	Annualized Costs	$0	$47,800	$18,500	$21,600	$32,300	$40,300	$30,900	$33,100	$35,000	$45,600
SCHEDULING	Project Development Duration[4]		4 years	4 years	4 years	4 years	4 years	4 years	4 years	4 years	4 years
	Construction Duration		2 months	2 months	6 months	18 months	6 months	6 months	6 months	6 months	18 months
	Closure Duration (If Applicable)		N/A	N/A	2 weeks	N/A	N/A	N/A	N/A	4 weeks	N/A
ENGINEERING	Typical Section - Roadway (feet)	41'	41'		44'		41'			44'	
	Typical Section - Bridge (feet)	N/A	N/A		N/A		N/A			10 – 12 – 12 – 10	
	Geometric Design Criteria	Substandard width and horizontal curve	Substandard width and banking		Meets Criteria		Substandard width and banking			Meets Criteria	
	Traffic Safety	No Change	Improved		Improved		Improved			Improved	
	Alignment Change	No	No		No		No			No	
	Bicycle Access	No Change	No Change		Improved		No Change			Improved	
	Hydraulic Performance	Substandard	Substandard		Meets Criteria		Meets Criteria			Meets Criteria	
	Pedestrian Access	No Change	No Change		Improved		Improved			Improved	
	Utility	No Change	No Change		Relocation		No Change			Relocation	
OTHER	ROW Acquisition	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Road Closure	No	No	No	Yes	No	No	No	No	Yes	No
	Design Life	<10 years	15 Years	40 years	80 years		80 years			80 years	

[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 starting from the end of the Project Definition Phase.

VI. Conclusion

Alternative 1b is recommended; to line the existing culvert with a new culvert liner while maintaining traffic on VT Route 9. The estimated initial costs are significantly less than the cost of a complete replacement, and both offer some replacement of structural integrity. In addition to the liner, a beveled headwall should be constructed at the inlet in order to improve flow. The headwall should consider future widening of the existing roadway and be of adequate size and structural capacity to support additional fill. To meet AOP requirements, baffles will need to be installed inside the culvert along with several rock weirs downstream to ensure the movement of aquatic species.

Traffic Control:
It is recommended that traffic be maintained on VT Route 9 without any planned closures. Slight speed reductions may be used and occasional short and minor delays may be experienced as construction vehicles enter and leave the project sight.

ROW Impacts:
Small impacts to adjacent properties are expected as some Right-of-Way will be needed for work space and installation of the Rock weirs. Early coordination with the property owners Lynn and James Marra is encouraged to maintain the project schedule.

Design Criteria:
VT Route 9: VT Route 9 currently has the following substandard design features: The horizontal alignment and roadway shoulder width are substandard through the project area. The proposed alternative will not improve these features and will require a design exception for any substandard geometric design features.

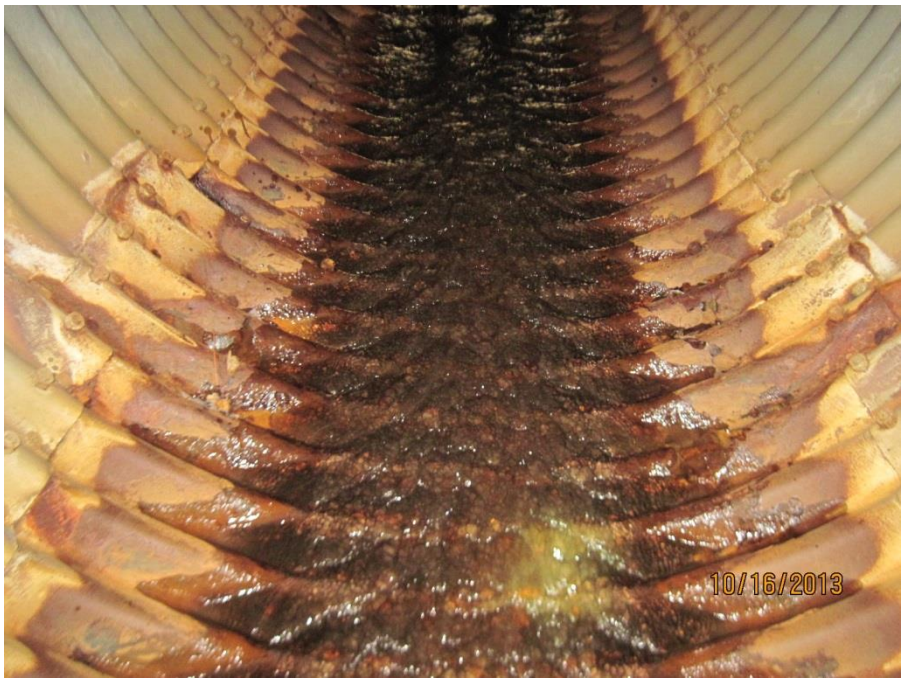
VII. Appendices

Appendix A: Site Pictures

Pipe Inlet

Perforations

Section Loss



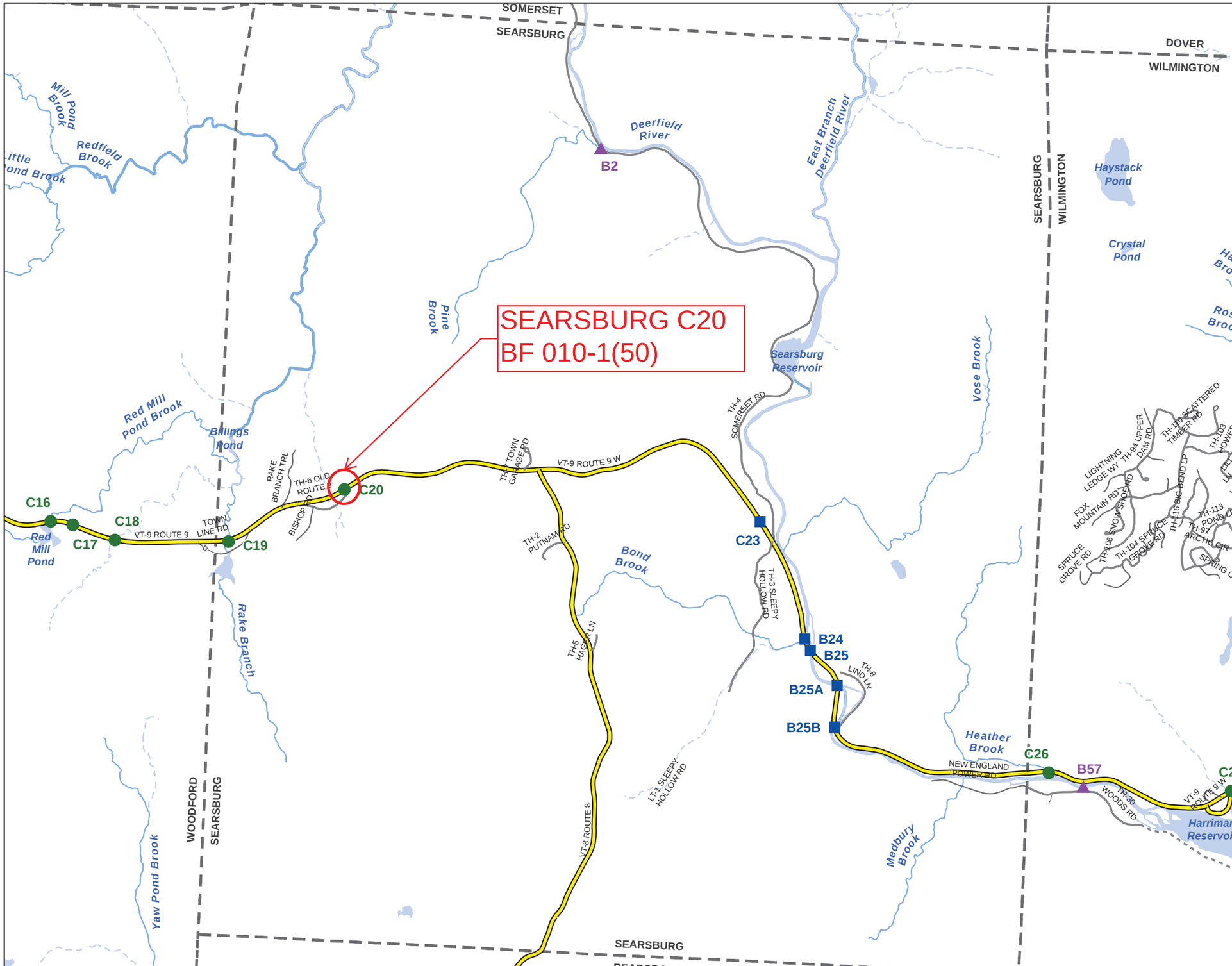
Invert

Pipe Outlet

Looking East

Looking West

Appendix B: Town Map

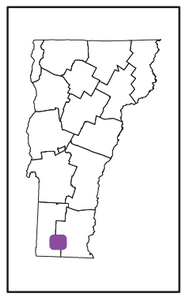


Scale 1:32,678

N

- INTERSTATE
- STATE LONG
- STATE SHORT
- TOWN LONG
- FAS/FAU
- FAS/FAU HWY
- INTERSTATE
- STATE HIGHWAY
- CLASS 1
- CLASS 2
- CLASS 3
- CLASS 4
- LEGAL TRAIL
- PRIVATE
- DISCONTINUED
- DISTRICT
- POLITICAL BOUNDARY
- NAMED RIVERS-STREAMS
- UNNAMED RIVERS-STREAMS

Produced by:
Mapping Unit
Vermont Agency of Transportation
August 2011



SEARSBURG
BENNINGTON COUNTY
DISTRICT # 1

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 **SEARSBURG** *bridge no.:* **0020** *District:* **1**

Located on: **VT09** *over* **BROOK** *approximately* **1.1 MI W VT 8** *Maintained By:* **STATE**

CONDITION

Deck Rating: **N NOT APPLICABLE**

Superstructure Rating: **N NOT APPLICABLE**

Substructure Rating: **N NOT APPLICABLE**

Channel Rating: **7 GOOD**

Culvert Rating: **4 POOR**

Federal Str. Number: **300010002002121**

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): **21**

ADT: **2500** *Year of ADT:* **1996**

GEOMETRIC DATA

Length of Maximum Span (ft): **7**

Structure Length (ft): **7**

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): **41**

Skew: **0**

Bridge Median: **0 NO MEDIAN**

Feature Under: **FEATURE NOT A HIGHWAY OR RAILROAD**

Min Vertical Underclr (ft): **07 FT 06 IN**

STRUCTURE TYPE and MATERIALS

Bridge Type: **CGMPP**

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): **174**

Average Cover Over Culvert (ft): **40**

Waterway Area Through Culvert (sq.ft.): **38**

Culvert Wing/Header Rating: **6 SATISFACTORY CONDITION**

Steel Culvert Corrosion Indicator: **2 PERFORATIONS > 2" THROUGHOUT, CULVERT**

Multi Plate Culvert Bolt Line Crack Indicator: **0 NO BOLT LINE CRACKS PRESENT**

APPRAISAL

Appr. Rdwy. Alignment: **8 EQUAL TO DESIRABLE CRITERIA**

INSPECTION

Inspection Date: **092014** *Inspection Frequency (months):* **12**

INSPECTION SUMMARY and NEEDS

10/16/13 The invert has scattered holes throughout that are no larger than 2", and there are a couple random spots with 6" sized holes. The outlet end has dropped about 1' and there is also a slight sag at mid span. JM JW

12/17/2012 The invert area throughout the pipe is continuously corroding rending future possibilities of piping effects or heavy settlement to occur in some sections. Soil infiltration or exfiltration occurrences are occurring moderately in scattered spots throughout. Addition of a concrete in fill along the invert may help extend the longevity of this structure. This inspection is now changing from a 24 month inspection to a 12 month inspection. PLB

Appendix D: Hydraulics Memo

VT AGENCY OF TRANSPORTATION PROGRAM DEVELOPMENT DIVISION

HYDRAULICS UNIT

TO: Chris Williams, Structures Project Manager

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

DATE: 22 July 2014

SUBJECT: Searsburg BF 010-1(50) VT 9 BR 20 – Preliminary Hydraulics

---

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

Existing Conditions

The existing structure was built in 1965. It is an 84" CGMPP with mitered ends. It is 174' long and under approximately 25' of fill. The structure provides a waterway area of 38.5 sq. ft. The bridge inspection reports do not indicate any hydraulics problems. However, they do comment on the holes throughout the invert. Also, the outlet end has dropped about 1' and there is a slight sag at midspan. There is a large scour hole at the outlet.

Our calculations, field observations and measurements indicate the existing structure does meet the current standards of the VTrans Hydraulic Manual. However, the pipe does not meet the state stream equilibrium standards for bankfull width (span length). The existing structure constricts the channel width, resulting in scour at the outlet and increased potential for debris blockage. The ANR Department of Fish and Wildlife has identified the need for aquatic organism passage at this site.

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:

5. A concrete box with a 10' wide by 7' high inside opening, with 12" high bed retention sills (baffles) in the bottom. The box invert should be buried 24" with material graded to match stream bed material, so the top of the sills will be buried 12" and not be visible. That will result in a 10' wide by 5' high waterway opening above streambed, providing 50-sq. ft. of waterway area. 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. Sills should be cast straight across the box. This structure will result in a headwater depth at Q50 = 2.6' and at Q100 = 3.0', with no roadway overtopping up to Q100.

6. An 11' diameter CMPP with the invert buried 3', with 12" high sills built and buried as described above. This structure will provide 74.0' of waterway area and will result in headwater depths of approximately 2.9' at Q50 and 3.3' at Q100. The pipe needs to be this wide in order to meet the bankfull width requirement inside the structure.

7. Any similar structure with a minimum clear span of 10' and at least 50 sq. ft. of waterway area, that fits the site conditions, could be considered. Any 4-sided structure should have bed retention sills and a buried invert as described above. A structural plate arch was not recommended due to the fill

height at this site.

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 round pipe option 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. We recommend a minimum cover of 3' over all pipe structures. Obtaining the minimum cover of 3' should be no problem at this site.

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.

Stone Fill, Type II 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. Stone fill in the stream should be Stone Fill, Type E2 with a minimum embeddedness of 24".

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

LGR

cc: Hydraulics Project File via NJW
Hydraulics Chrono File

VT AGENCY OF TRANSPORTATION PROGRAM DEVELOPMENT DIVISION

HYDRAULICS UNIT

TO: Jon Griffin, P.E., Scoping Engineer

FROM: Nick Wark, P.E., Hydraulics Engineer

DATE: February 9, 2016

SUBJECT: Searsburg BF 010-1(50) VT 9 BR 20 – Preliminary Hydraulics – Rehab Option

---

In addition to the replacement options detailed in our Preliminary Hydraulics Memo dated July 22, 2014 there may be an opportunity to rehabilitate the existing structure as follows:

A corrugated liner with a 6' inside diameter with a 1' baffle will meet hydraulic standards. The baffle design will be slightly more complex, but there is some room to work out these design details with minimal risk of not meeting hydraulic standards. With the addition of a beveled inlet headwall the impacts to the water surface elevations will be less than 8" upstream at all flows we checked up to the design AEP of 2%. Most of the 8" will be a result of raising the invert elevation, not the reduction in waterway area. It will be a benefit to keep the invert as low as possible. They may be able to form the pipe into a vertical ellipse which would not only increase the waterway area, but also keep the invert as low as possible.

In order to accommodate AOP, this option will require downstream weirs to backwater the last baffle inside the culvert. For preliminary estimates, weirs can result in a 7-9" drop in water per unit and should be spaced at approximately 20'.

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

NJW

cc: Hydraulics Project File

Appendix E: Preliminary Geotechnical Information

AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Chris Williams, Project Manager, Structures

TDE CCB

From: Thomas D. Eliassen, Transportation Geologist via Christopher C. Benda, Soils and Foundations Engineer

Date: March 10, 2014

Subject: Searsburg BF 010-1(50) Preliminary Geotechnical Information Report

---

In an effort to assist the Structures Section with their bridge type study, the Soils and Foundations Unit within the Materials and Research Section has completed a review of available geological data near Bridge No. 20 on Vermont Route 9 in Searsburg, Vermont. The location of the subject bridge (CGMPP culvert) is depicted in Figure 1. Figure 2 shows a photograph of the inlet of the subject culvert.

Figure 1 Location of Bridge 20.

Figure 2 Photograph of inlet of the subject CGMPP Culvert.

This review included observations made during a site visit, the examination of historical in-house bridge boring files, as-built record plans, USDA Natural Resources Conservation soil survey records, published surficial and bedrock geologic maps and water well logs on-file at the Agency of Natural Resources.

A site visit was performed on January 31, 2014 for the purposes of assessing topographic and geologic conditions that may impact the design and/or construction of the proposed bridge. Observations were also made of existing utility locations and logistical site access conditions.

The bridge project site occupies a marshy area which drains toward the north and northwest. No aboveground or indications of underground utilities were observed in the area of the culvert and access for drilling borings appears favorable. Both northern and southern grassy slopes from roadway level to the marshy area appear fairly steep.

No boring records were found in the Soils & Foundations in-house historical boring log records nor were there any found within the historical record plans maintained by the Agency.

Drilling logs from private drinking water wells in the area of a project can be helpful in anticipating what may be encountered in the subsurface. The Agency of Natural Resources Private Well Locator interactive map was reviewed for these purposes.

Four water wells are present in the area of the subject project. These well locations and drill log lithologic descriptions are depicted on Figure 3. Generally, the subsurface can be characterized as 5 to 25 feet of glacial till with gravel and boulders overlying bedrock.

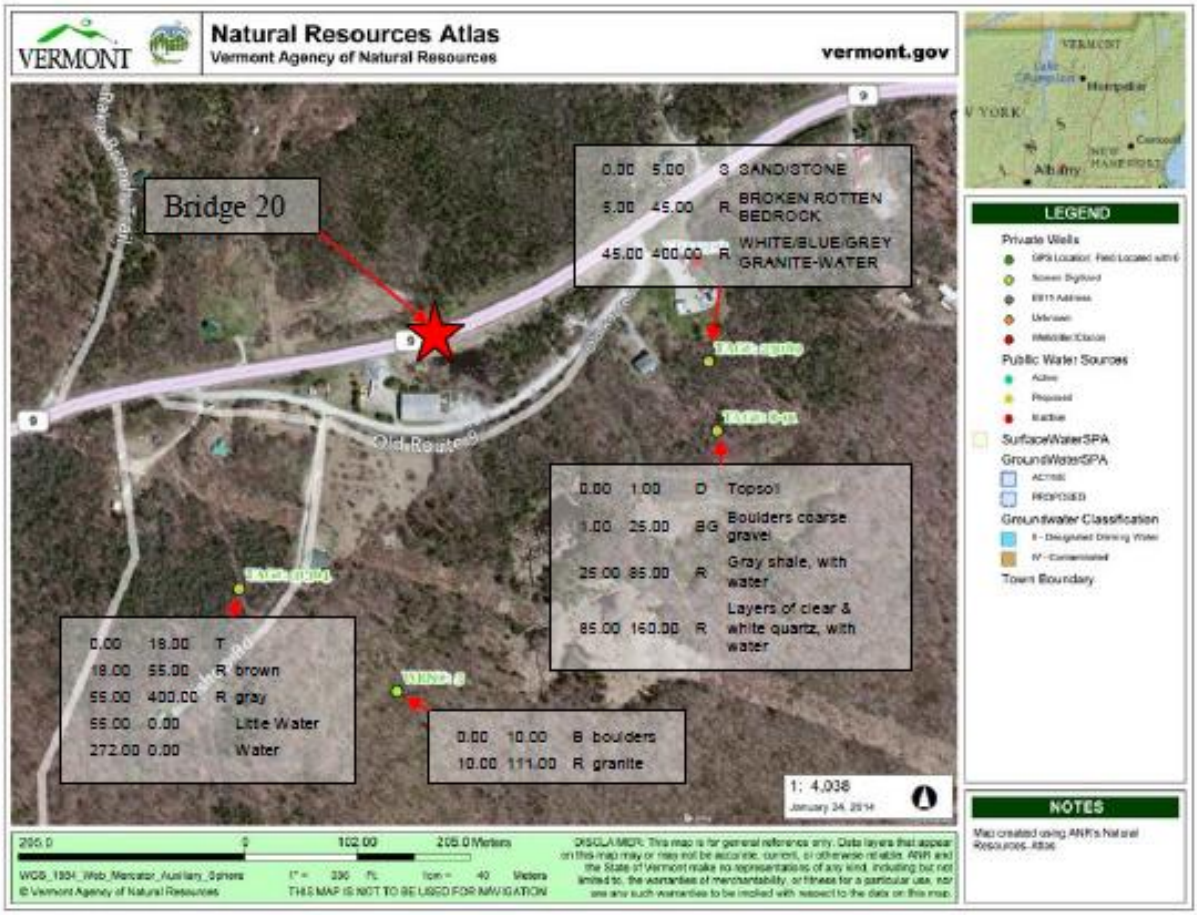


Figure 3 Map showing water well locations in the vicinity of Bridge 20. Also listed on this map are the driller well log notes referencing the statigraphy encountered.

Surficial mapping conducted for the 1970 Surficial Geologic Map of Vermont indicates that the subject area is underlain by glacial till. This is consistent with lithologies reported on the well boring logs.

USDA Natural Resources Conservation soil survey records indicate that surficial soils in the area of the bridge consist of Wilmington-Mundal association, undulating, very stony soils. Figure 4 shows a portion of the NRSC soil survey map in the project area. Wilmington-Mundal deposits are labeled 932B on the map.

Figure 4 USDA Soil Map showing the distribution of soil types at the subject project site.

According to the 2011 bedrock map of Vermont, the project area is underlain by bedrock consisting of Precambrian aged rocks described as "Medium- to coarse-grained hornblende dioritic-appearing gneiss and Medium-dark-gray to light-gray diopside-phlogopite-scapolite-calcite marble, phlogopite-tremolite-talc schist, and dark-gray diopside-hornblende (actinolite)-plagioclase calc-silicate gneiss".

Because the condition of the subsurface in the area of the culvert is unknown (no previous borings, test pits or nearby water well records are available), we recommend conducting two borings (one located adjacent to each end of the existing culvert). These borings should be performed in the shoulder area between the travel lanes and guardrail. Borings should be drilled to a depth of 25 feet and samples should be collected for characterizing the soil column. Sampling should be performed using Standard Penatration Test (SPT) and undisturbed sampling techniques if soft clayey material is encountered. Because marshy deposits are suspected, testing may include in-situ shear vane and/or laboratory direct shear and organic testing methods. If bedrock is encountered above 25 feet the boring should be extended 10 feet into sound bedrock.

It is expected that the existing culvert will be replaced by a newer one, most likely constructed as round corrugated steel pipe, structural plate pipe, horizontally ellipsed SPCSP or concrete box structure with appropriate headwalls.

If you have any questions, please feel free to contact us at 828-6916.

c: WEA/Read File
CCB/Project File

Appendix F: Natural Resources Information

AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

TO: Jeff Ramsey, Environmental Specialist

FROM: John Lepore, Transportation Biologist

DATE: May 13, 2014

SUBJECT: Searsburg B_F 010-1 (50)
VT 9, Bridge 20 over Rake Brook
Natural Resource ID & Comments

The initial resource identification for this project was conducted on 5-MAY-2015. Based on that site visit, I have concluded that the following:

Wetlands
There is a large Class II wetland complex on the south side of VT 9 and the boundary was picked up using GPS. Wetlands are also present downstream of the existing structure, but there is a small, upland gap between the out and the edge of wetlands. Impacts to this resource will necessitate both State Wetland Permit and a Section 404 permit.

Species/habitats of Special Concern
A plant species of special concern is known to occur in nearby wetlands. Although it is not known to occur in the vicinity of Br. 20, any impacts to the wetland would necessitate further coordination with the Agency of Natural Resources.

Watercourses
Rake Brook contains a cold water fishery and this structure was assessed by ANR Fisheries Biologist in 2006 and he recommended the provision for aquatic organism passage.

Permitting Recommendations
Per Ken Cox's 2006 recommendation, aquatic organism passage should be a provision of this project, and any increase of the structure's size would also be a benefit to facilitating wildlife passage. Temporary impacts can be avoided and/or minimized by using the old Route 9 roadbed as a detour during construction.

If you have any questions about this, call me at 828-3963.

Appendix G: Archeology Memo

VERMONT

Jeannine Russell
VTrans Archaeology Officer
State of Vermont
Environmental Section
One National Life Drive
Montpelier, VT 05633-5001
www.aot.state.vt.us

[phone] 802-828-3981
[fax] 802-828-2334
[ttd] 800-253-0191

Agency of Transportation

To: Lee Goldstein, Environmental Specialist

From: Jeannine Russell, VTrans Archaeology Officer

Date: April 29, 2014

Subject: Searsburg BF 010-1(50) – Archaeological Resource ID

The scope of this project has not yet been determined but includes the area surrounding Culvert 20 on VT RT 9 in Searsburg. For the purposes of this resource ID, a 200 foot radius around the culvert was used as the project area.

The VTrans Archaeology Officer visited the project area on 4-28-14. The landscape slopes steeply from VT 9 on both sides of the road. The areas beyond the toes of slope contain wetlands. There are no areas of archaeological sensitivity within or adjacent to the project area.

A formal clearance will be issued once plans are available for review.

Please contact me if you have any questions.

Thank you,
Jen Russell
VTrans Archaeology Officer

Cc: Chris Williams, Project Manager

VTrans Working to Get You There

Appendix H: Historic Memo

Ramsey, Jeff

From: Newman, Scott
Sent: Tuesday, February 04, 2014 11:00 AM
To: Ramsey, Jeff
Cc: O'Shea, Kaitlin; Williams, Chris
Subject: CW Bridges Resource ID's

Jeff –

I have completed the resource ID for the following bridge projects:

Londonderry BF 016-1(33)
Searsburg BF 010-1(50)
Weathersfield STP 0146(16)

None of the above bridges are historic, and none of the project areas contain any above-ground historic or Section 4(f) resources. When these projects come in for NEPA they will be processed as NHPA for 106 and n/a for 4(f)

Thanks,
Scott

Appendix I: Hazardous Sites Map

Hazardous Waste Site Map

Appendix J: Local Input

Local & Regional Input Questionnaire

Project Name: _____ **Project Number:**

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. No
2. Is there a "slow season" or period of time from May through October where traffic is less? No
3. Please describe the location of emergency responders (fire, police, ambulance) and emergency response routes. Wilmington fire and Deerfield Valley Rescue respond to Searsburg
4. Where are the schools in your community and what are their schedules? No school
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. No
6. Are there any businesses (including agricultural operations) that would be adversely impacted either by a detour or due to work zone proximity? Not aware of any
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? No
8. Are there any town highways that might be adversely impacted by traffic bypassing the construction on another local road? Our town road is south of the project
9. Are there any other municipal operations that could be adversely impacted if the bridge is closed during construction? If yes, please explain. No
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. None
11. Is there a local business association, chamber of commerce or other downtown group that we should be working with? Not in Searsburg

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? Have to consult the highway dept in Searsburg
2. Are there any concerns with the width of the existing bridge? Same answer as to #1

3. What is the current level of bicycle and pedestrian use on the bridge? Not sure

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?

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. No

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? No

7. Are there any special aesthetic considerations we should be aware of? No

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

9. Does the location have a history of flooding? If yes, please explain. Do not know

10. Are you aware of any nearby Hazardous Material Sites? No

11. Are you aware of any historic, archeological and/or other environmental resource issues? NO

12. Are there any other comments you feel are important for us to consider that we have not mentioned yet?

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

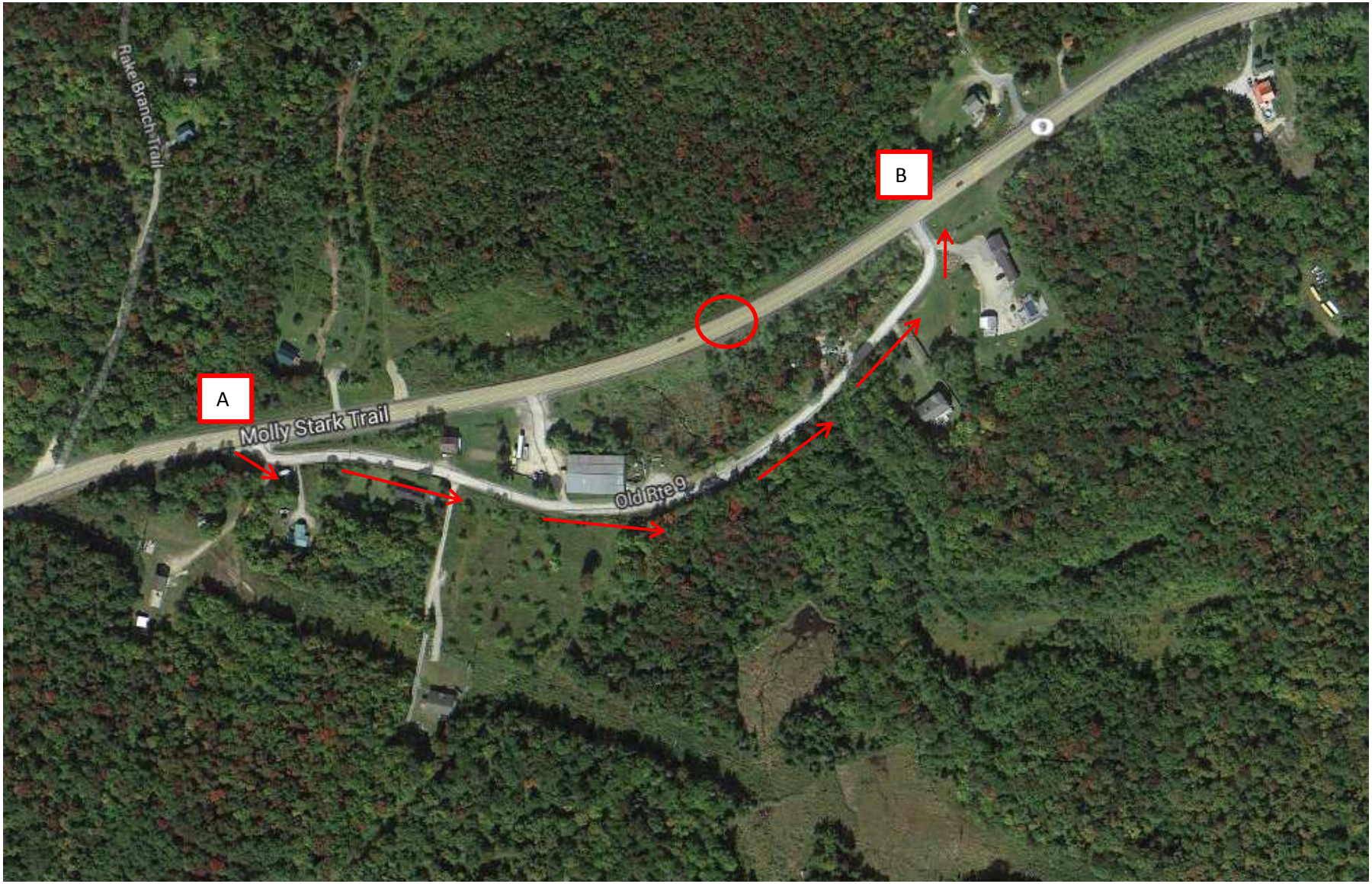
1. Does your municipal land use plan reference the bridge in question? If so please provide a copy of the applicable section or sections of the plan. Have no plan

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

3. Are there any existing, pending or planned development proposal that would impact future transportation patterns near the bridge? If so please explain. Not aware of any

4. Is there any planned expansion of public transit service in the project area? If not known please contact your Regional Public Transit Provider. No

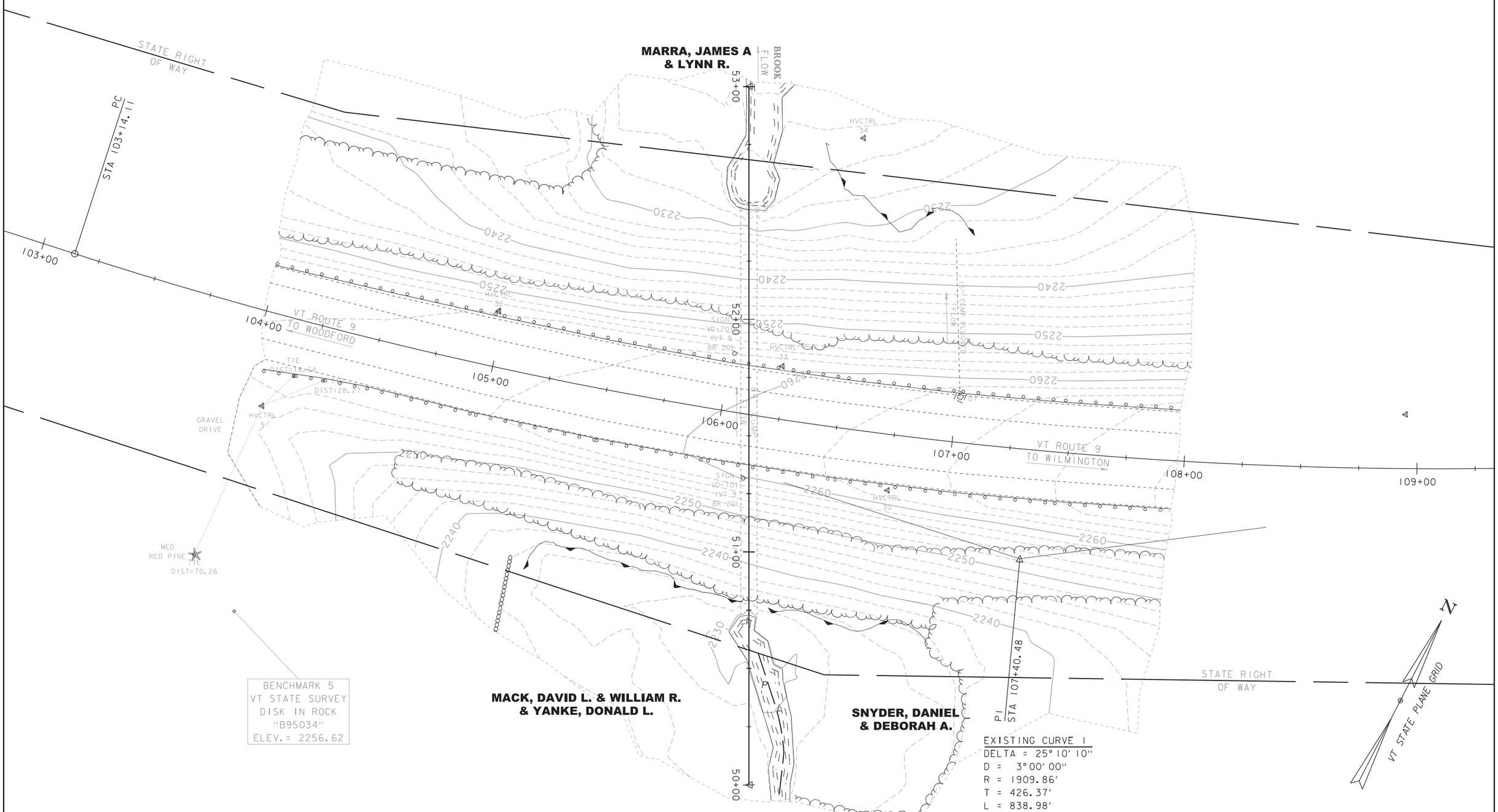
Appendix K: Detour Map



1. Detour Route
VT Route 9, to Old VT Route 9, back to VT Route 9

A – B Through Route: 0.3 Miles
A – B Detour Route: 0.3 Miles
Added Miles: 0 Miles
End-End Distance: 0.6 Miles

Appendix L: Plans



EXISTING CURVE 1
DELTA = 25° 10′ 10″
D = 3° 00′ 00″
R = 1909.86′
T = 426.37′
L = 838.98′
E = 47.01′

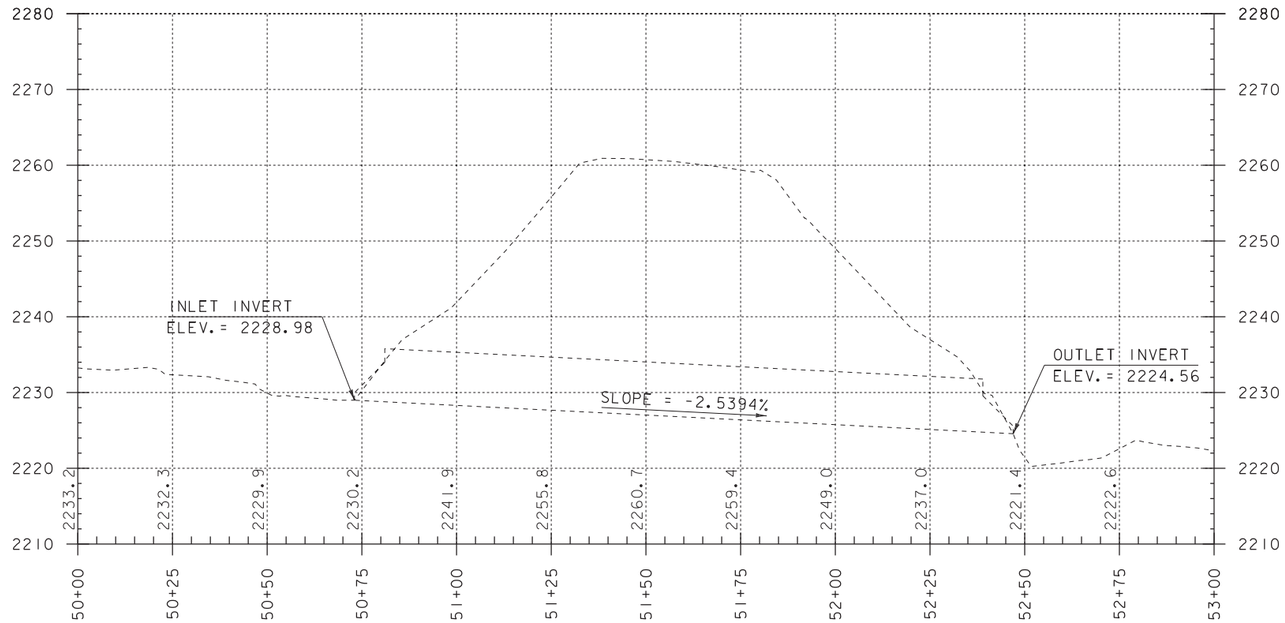
EXISTING 7′ CGMPP
174′ LONG, BUILT 1965
40′ AVERAGE COVER

EXISTING CONDITIONS

SCALE 1" = 20′-0"

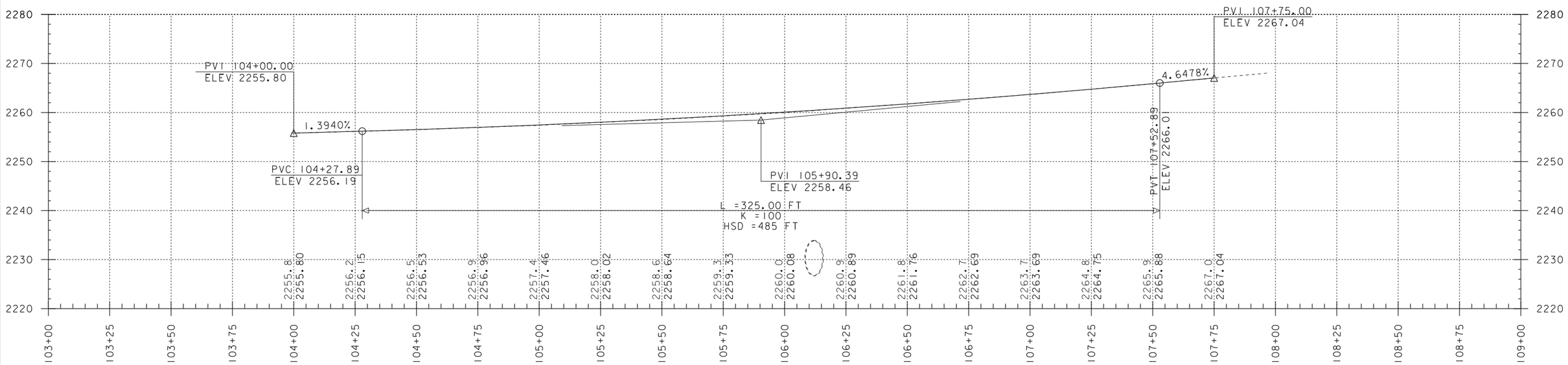
20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/s13b332border.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
EXISTING CONDITIONS	SHEET 1 OF 20



CULVERT 20 EXISTING PROFILE

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

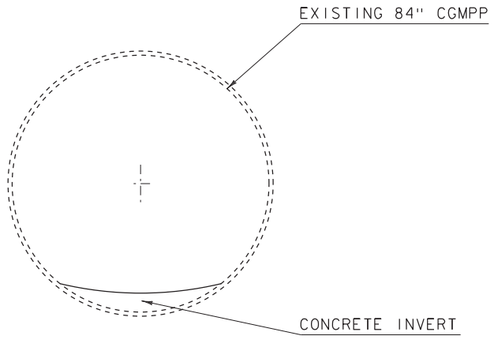


VT ROUTE 9 EXISTING PROFILE

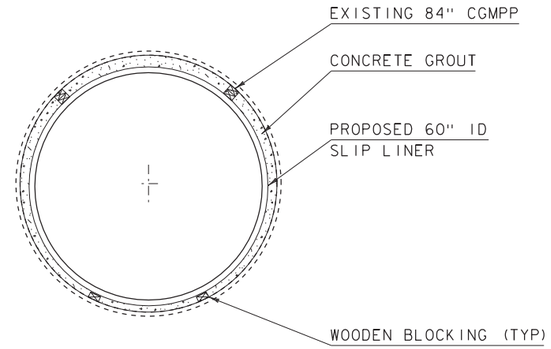
SCALE: HORIZONTAL 1"=20'-0"
VERTICAL 1"=10'-0"

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

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332profile.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
PROFILE SHEET	SHEET 2 OF 20



ALTERNATIVE IA TYPICAL SECTION



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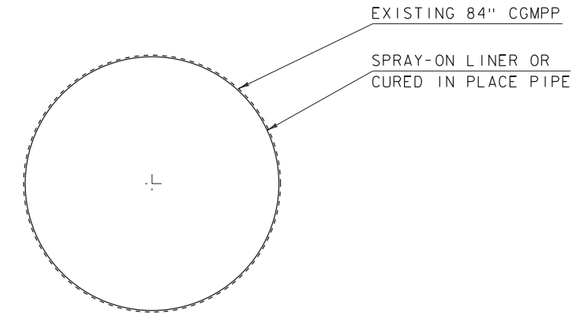

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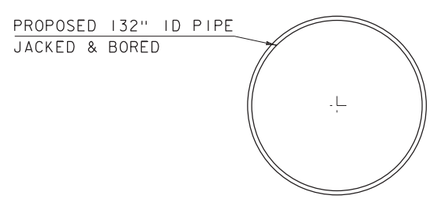
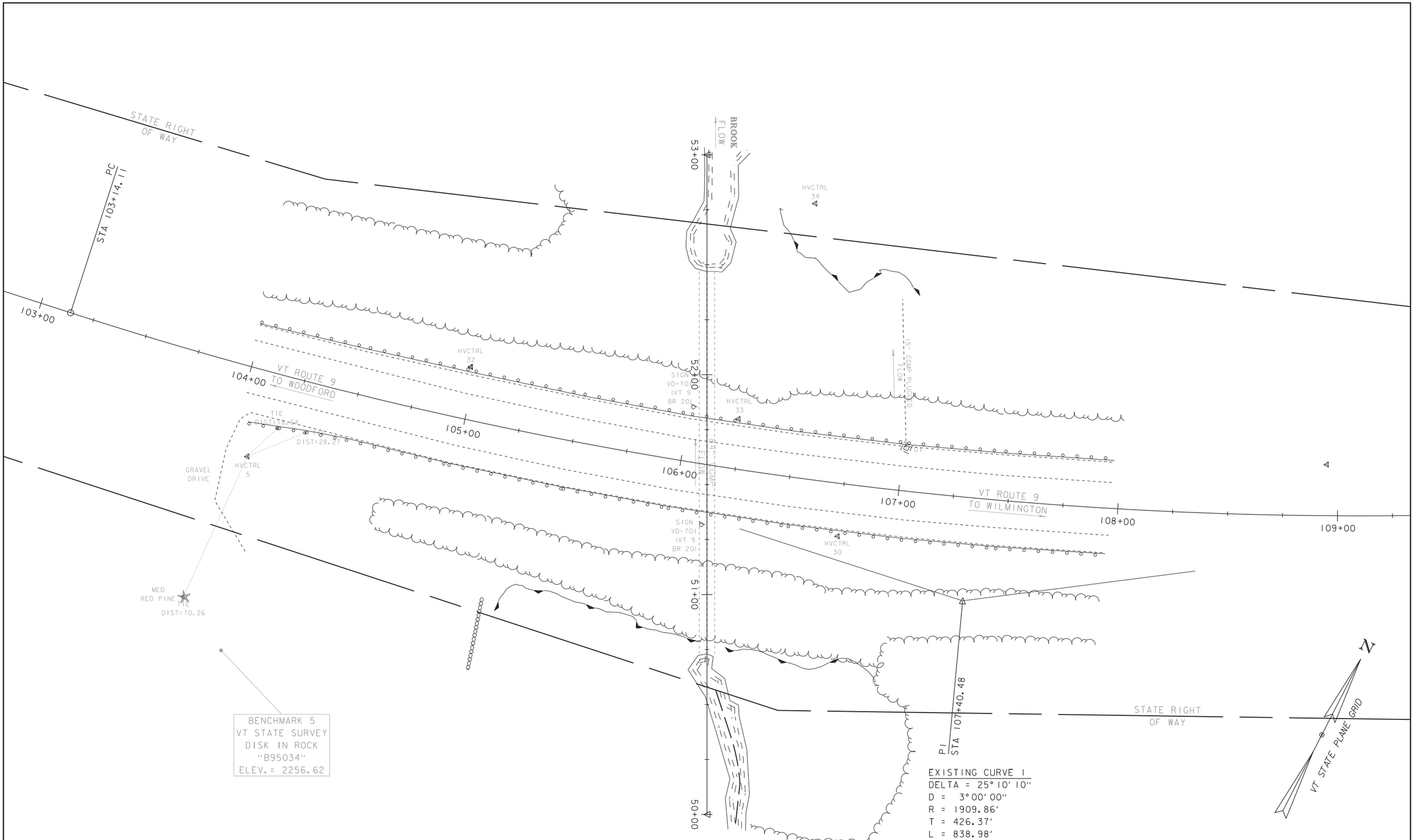


ALTERNATIVE 3 TYPICAL SECTION

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332typical.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
TYPICAL SECTIONS	SHEET 3 OF 20



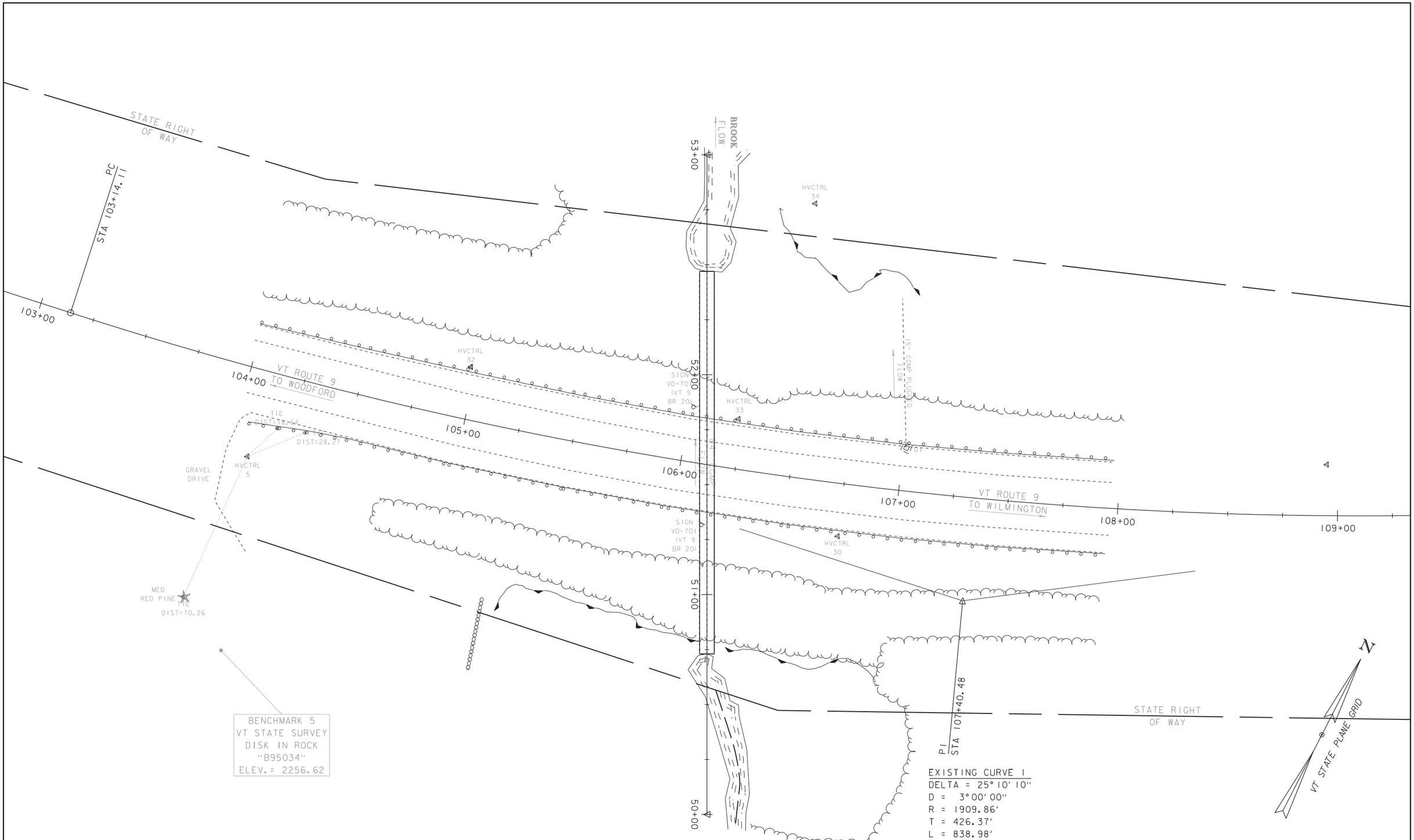
EXISTING 7' CGMPP
174' LONG, BUILT 1965
40' AVERAGE COVER

ALTERNATIVE 1A LAYOUT

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/s13b332border.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 1A LAYOUT	SHEET 4 OF 20



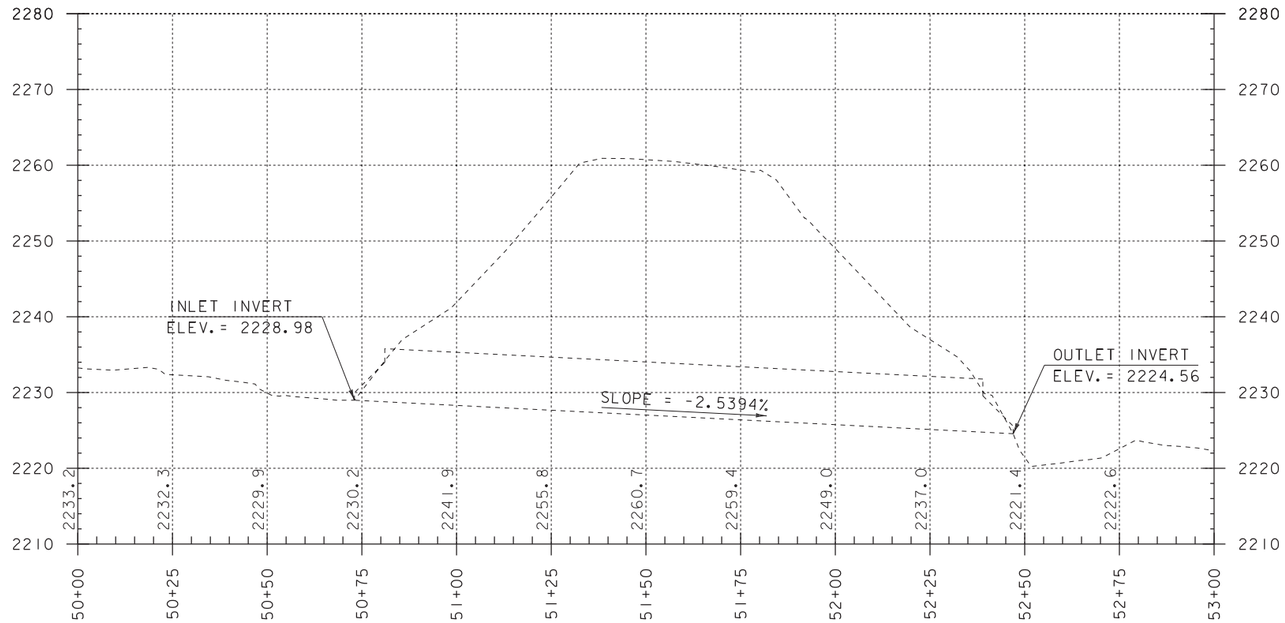
EXISTING 7' CGMPP
174' LONG, BUILT 1965
40' AVERAGE COVER

ALTERNATIVE 1B LAYOUT

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/s13b332border.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 1B LAYOUT	SHEET 5 OF 20

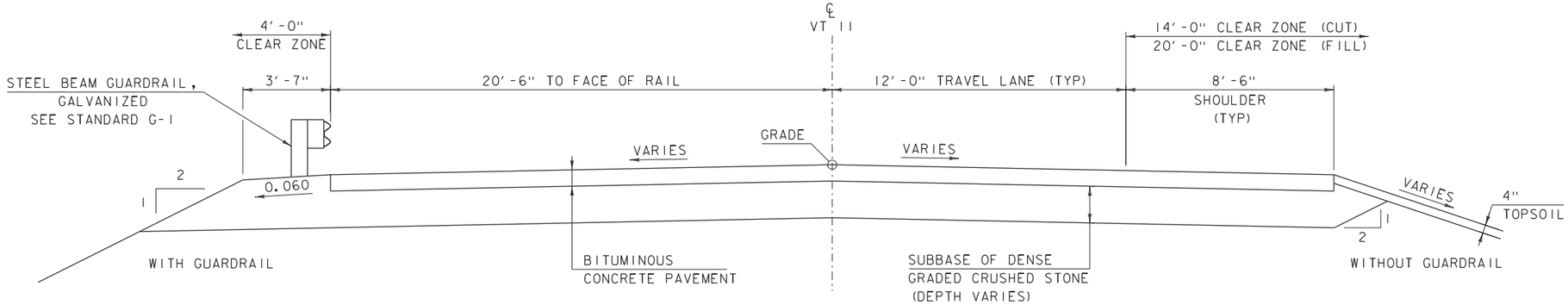


ALTERNATIVE 1 PROFILE

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

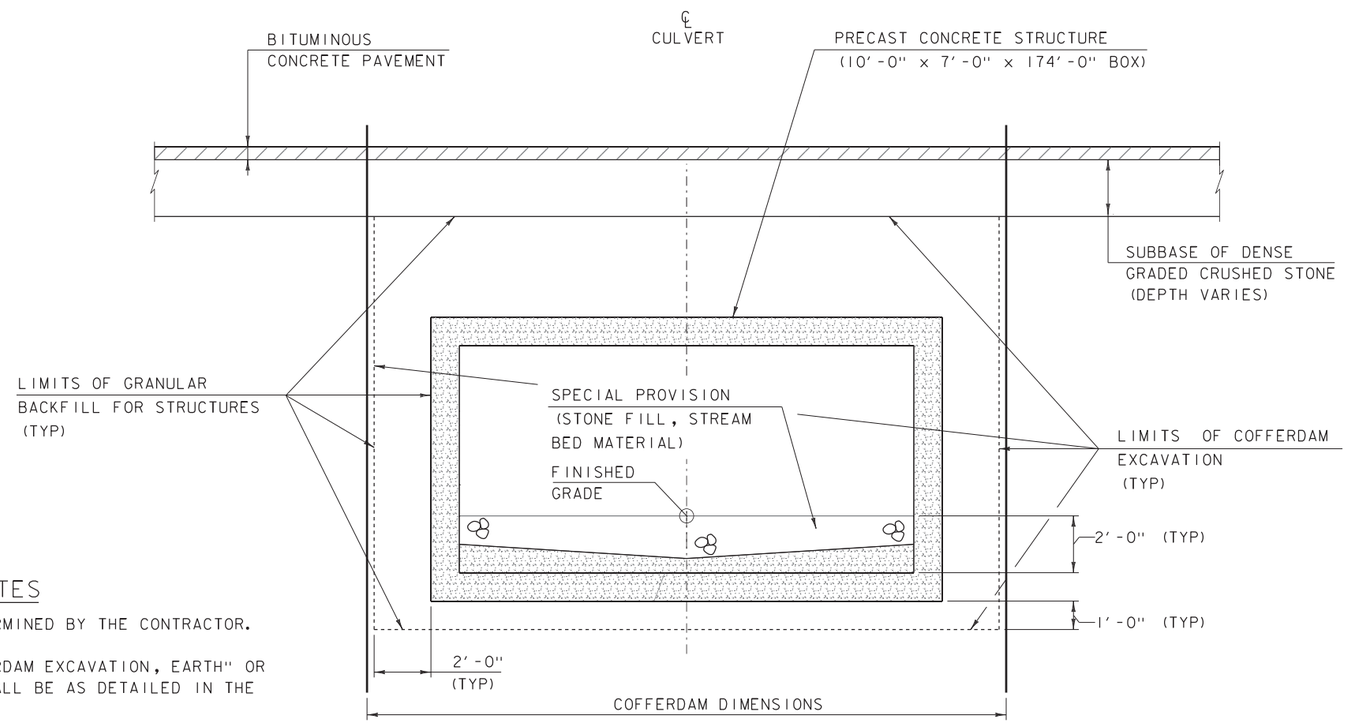
NOTE:
GRADES SHOWN TO THE NEAREST TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332profile.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 1 PROFILE SHEET	SHEET 6 OF 20



EXISTING VT 11 TYPICAL SECTION

SCALE 3/8" = 1'-0"



ALTERNATIVE 2

N.T.S.

COFFERDAM NOTES

1. COFFERDAM DIMENSIONS TO BE DETERMINED BY THE CONTRACTOR.
2. THE PAY LIMITS OF EITHER "COFFERDAM EXCAVATION, EARTH" OR "COFFERDAM EXCAVATION, ROCK" SHALL BE AS DETAILED IN THE TYPICAL SECTION.
3. IF A COFFERDAM IS CONSTRUCTED WHICH IS LARGER THAN DETAILED ABOVE, NO MEASUREMENT AND PAYMENT WILL BE MADE FOR COFFERDAM EXCAVATION AND GRANULAR BACKFILL FOR STRUCTURES OUTSIDE THOSE PAY LIMITS.

MATERIAL TOLERANCES

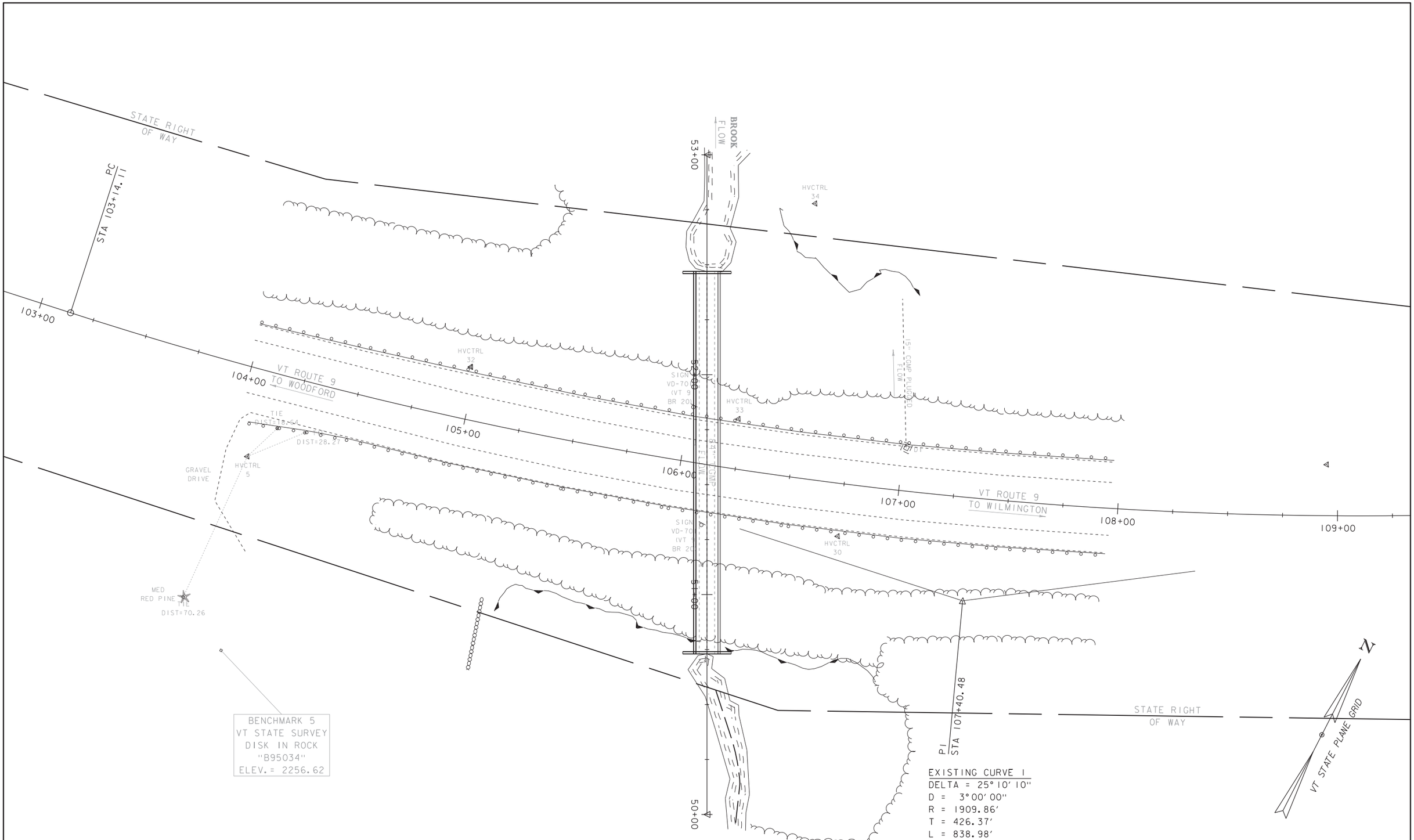
(IF USED ON PROJECT)

SURFACE	
- PAVEMENT (TOTAL THICKNESS)	+/- 1/4"
- AGGREGATE SURFACE COURSE	+/- 1/2"
SUBBASE	+/- 1"
SAND BORROW	+/- 1"

PROJECT NAME: SEARSBURG
PROJECT NUMBER: BF 010-1(50)

FILE NAME: 13b332\s13B332typical.dgn
PROJECT LEADER: K.HIGGINS
DESIGNED BY: L.J.STONE
TYPICAL SECTIONS

PLOT DATE: 05-NOV-2014
DRAWN BY: D.D.BEARD
CHECKED BY: L.J.STONE
SHEET 7 OF 20



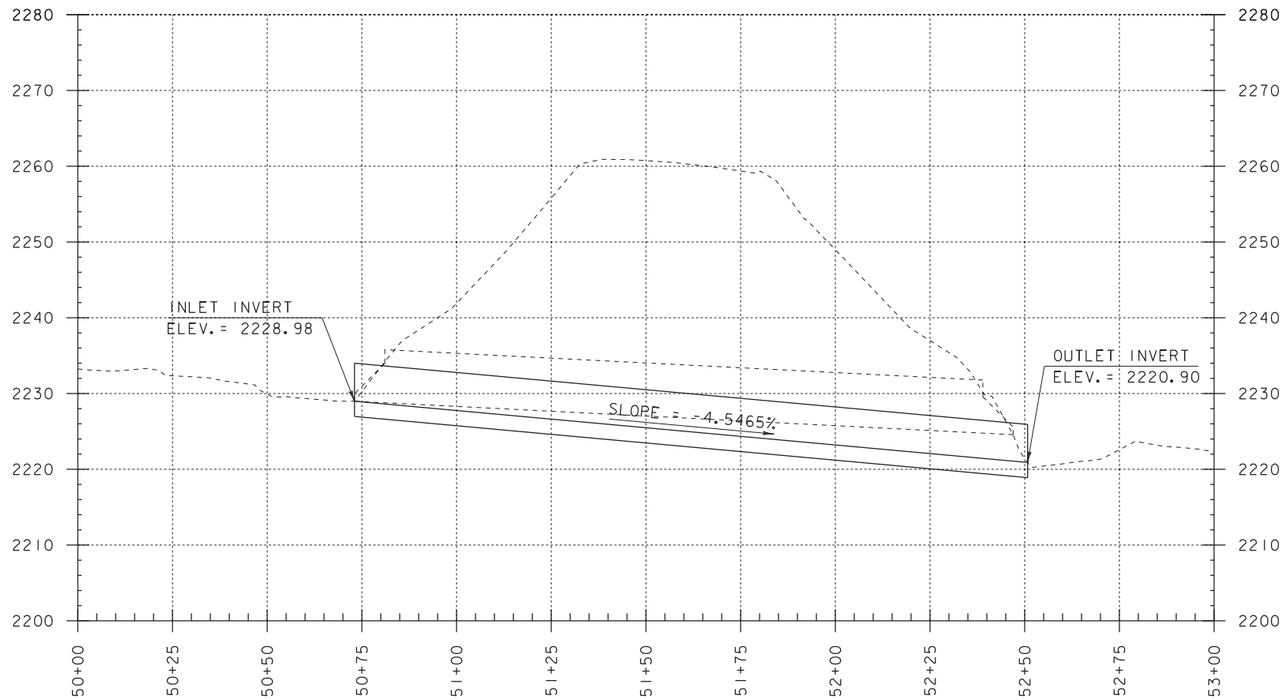
EXISTING 7' CGMPP
174' LONG, BUILT 1965
40' AVERAGE COVER

ALTERNATIVE 2 LAYOUT

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/s13b332border.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 2 LAYOUT	SHEET 8 OF 20



ALTERNATIVE 2 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: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332profile.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 2 PROFILE SHEET	SHEET 9 OF 20

STATE RIGHT OF WAY

PC
STA 103+14.11

103+00

104+00

VT ROUTE 9
TO WOODFORD

105+00

106+00

107+00

VT ROUTE 9
TO WILMINGTON

108+00

109+00

BROOK
FLOW

53+00

52+00

51+00

50+00

HVCTRL 34

HVCTRL 32

HVCTRL 33

HVCTRL 30

HVCTRL 5

SIGN
VD-70
(VT 9
BR 20)

15" CMP PLUGGED
FLOW

TIE
DIST=18.04

TIE
DIST=28.27

GRAVEL
DRIVE

MED
RED PINE
TIE
DIST=70.26

BENCHMARK 5
VT STATE SURVEY
DISK IN ROCK
"B95034"
ELEV. = 2256.62

PI
STA 107+40.48

STATE RIGHT
OF WAY

EXISTING CURVE 1
DELTA = 25° 10′ 10″
D = 3° 00′ 00″
R = 1909.86′
T = 426.37′
L = 838.98′
E = 47.01′

N

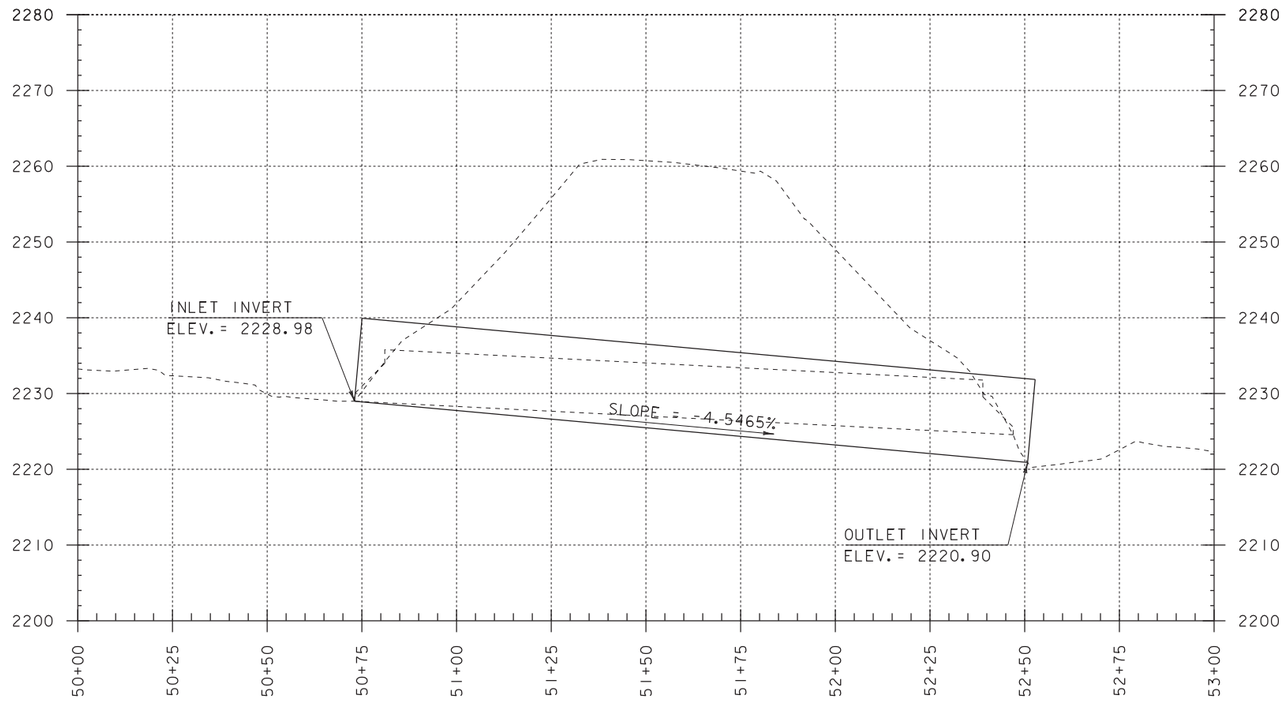
VT STATE PLANE GRID

EXISTING 7′ CGMPP
174′ LONG, BUILT 1965
40′ AVERAGE COVER

ALTERNATIVE 3 LAYOUT

SCALE 1" = 20′-0"
20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332border.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 3 LAYOUT	SHEET 10 OF 20

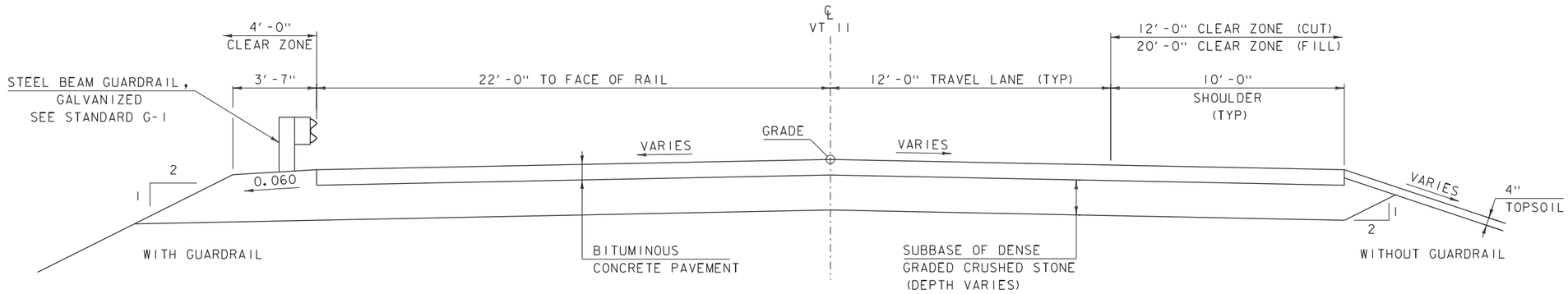


ALTERNATIVE 3 PROFILE

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

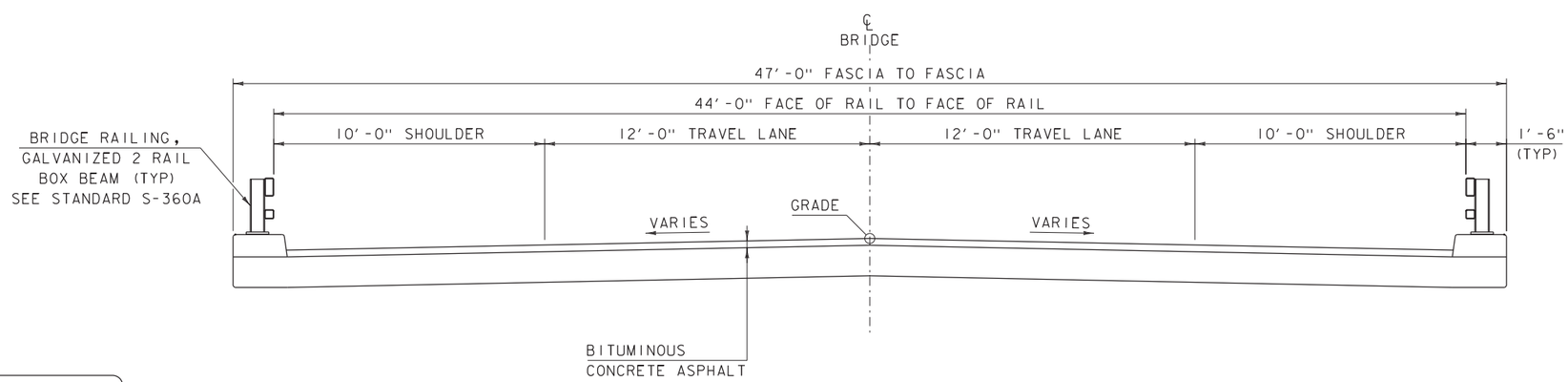
NOTE:
GRADES SHOWN TO THE NEAREST TENTH ARE EXISTING GROUND ALONG ℄
GRADES SHOWN TO THE NEAREST HUNDREDTH ARE FINISH GRADE ALONG ℄

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332profile.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 3 PROFILE SHEET	SHEET 11 OF 20



ALTERNATIVE 4 PROPOSED VT 11 TYPICAL SECTION

SCALE 3/8" = 1'-0"



FLOW

PROPOSED BRIDGE TYPICAL SECTION

SCALE 3/8" = 1'-0"

MATERIAL TOLERANCES

(IF USED ON PROJECT)

SURFACE	
- PAVEMENT (TOTAL THICKNESS)	+/- 1/4"
- AGGREGATE SURFACE COURSE	+/- 1/2"
SUBBASE	+/- 1"
SAND BORROW	+/- 1"

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332\sl3b332typical.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 4 TYPICAL SECTIONS	SHEET 12 OF 20

STATE RIGHT OF WAY

PC STA 103+14.11

103+00

104+00

105+00

106+00

107+00

108+00

109+00

VT ROUTE 9 TO WOODFORD

VT ROUTE 9 TO WILMINGTON

BROOK FLOW

53+00

52+00

51+00

50+00

HVCTRL 34

HVCTRL 32

HVCTRL 33

HVCTRL 30

HVCTRL 5

15" CMP PLUGGED FLOW

TIE DIST=18.04

TIE DIST=28.27

GRAVEL DRIVE

MED RED PINE

TIE DIST=70.26

BENCHMARK 5
VT STATE SURVEY
DISK IN ROCK
"B95034"
ELEV. = 2256.62

PI STA 107+40.48

STATE RIGHT OF WAY

N

VT STATE PLANE GRID

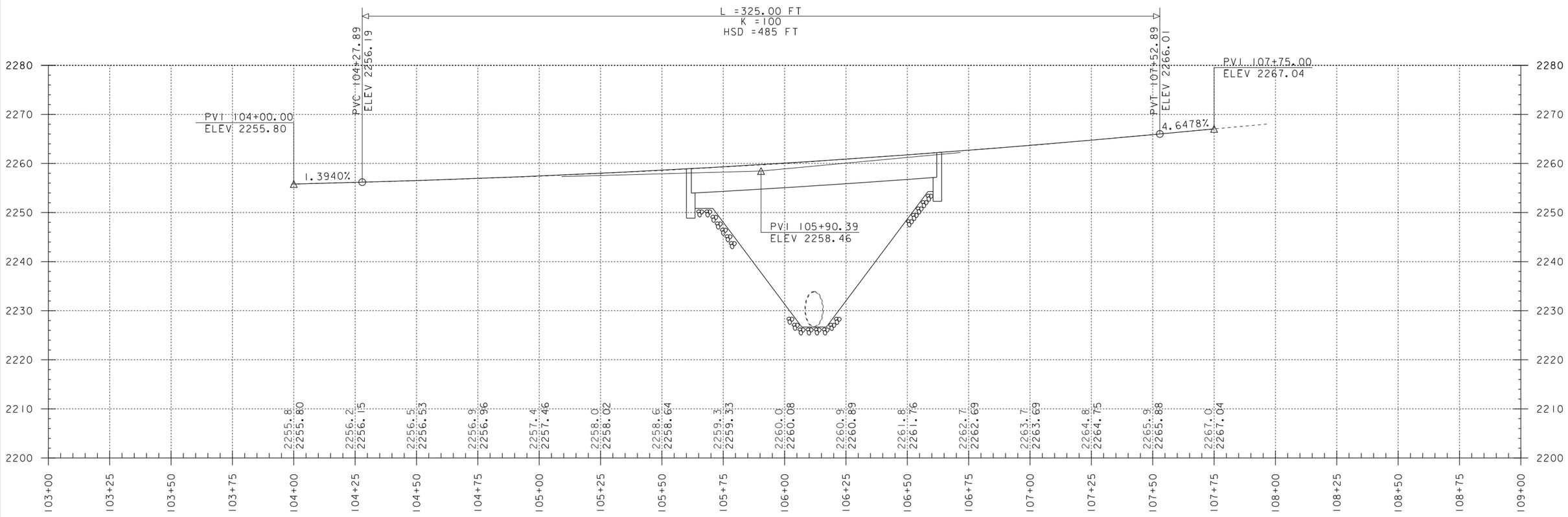
EXISTING CURVE 1
DELTA = 25° 10′ 10″
D = 3° 00′ 00″
R = 1909.86′
T = 426.37′
L = 838.98′
E = 47.01′

EXISTING 7′ CGMPP
174′ LONG, BUILT 1965
40′ AVERAGE COVER

ALTERNATIVE 4 LAYOUT

SCALE 1″ = 20′-0″
20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332border.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 4 LAYOUT	SHEET 13 OF 20

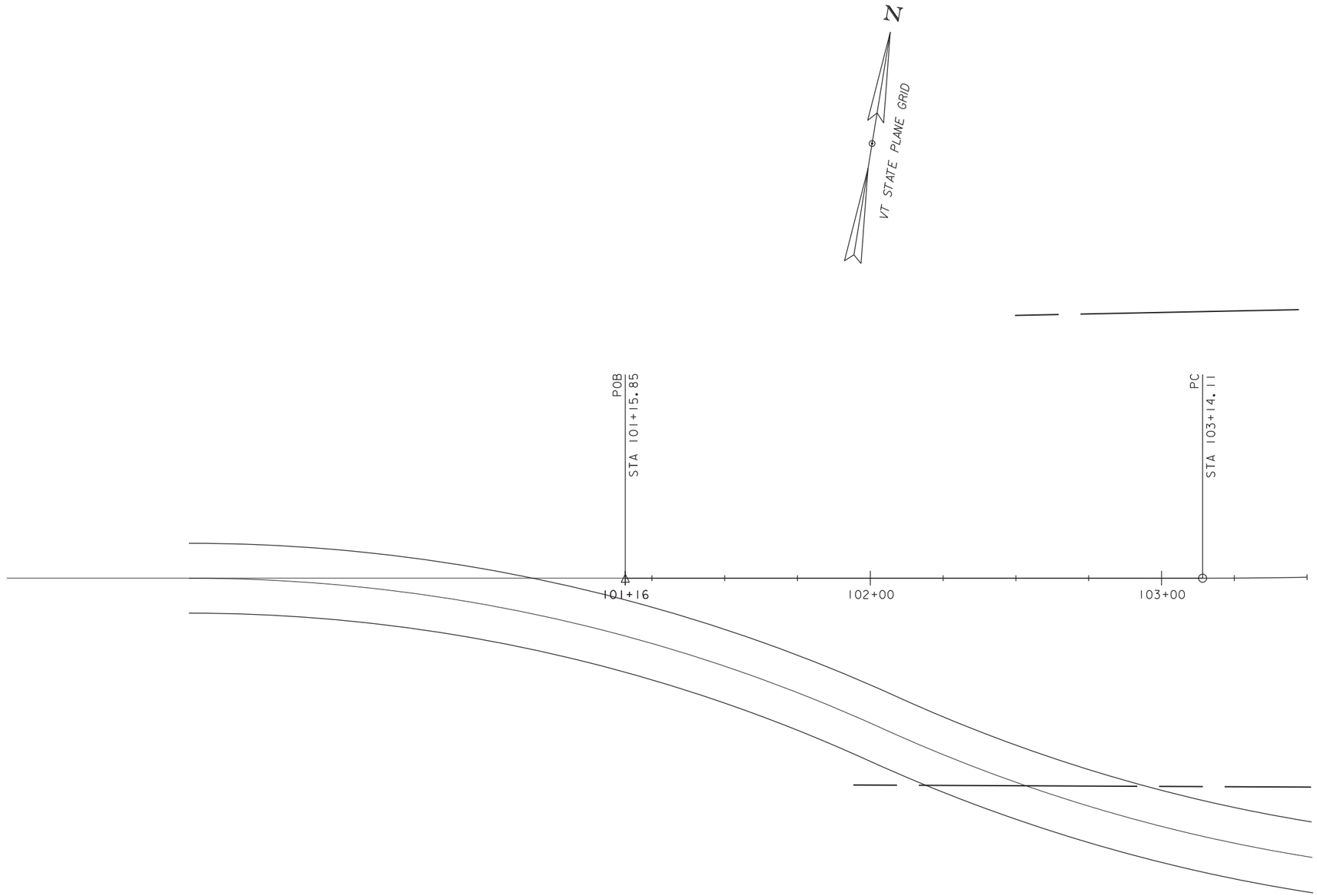


ALTERNATIVE 4 PROFILE

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: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332profile.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
ALTERNATIVE 4 PROFILE SHEET	SHEET 14 OF 20

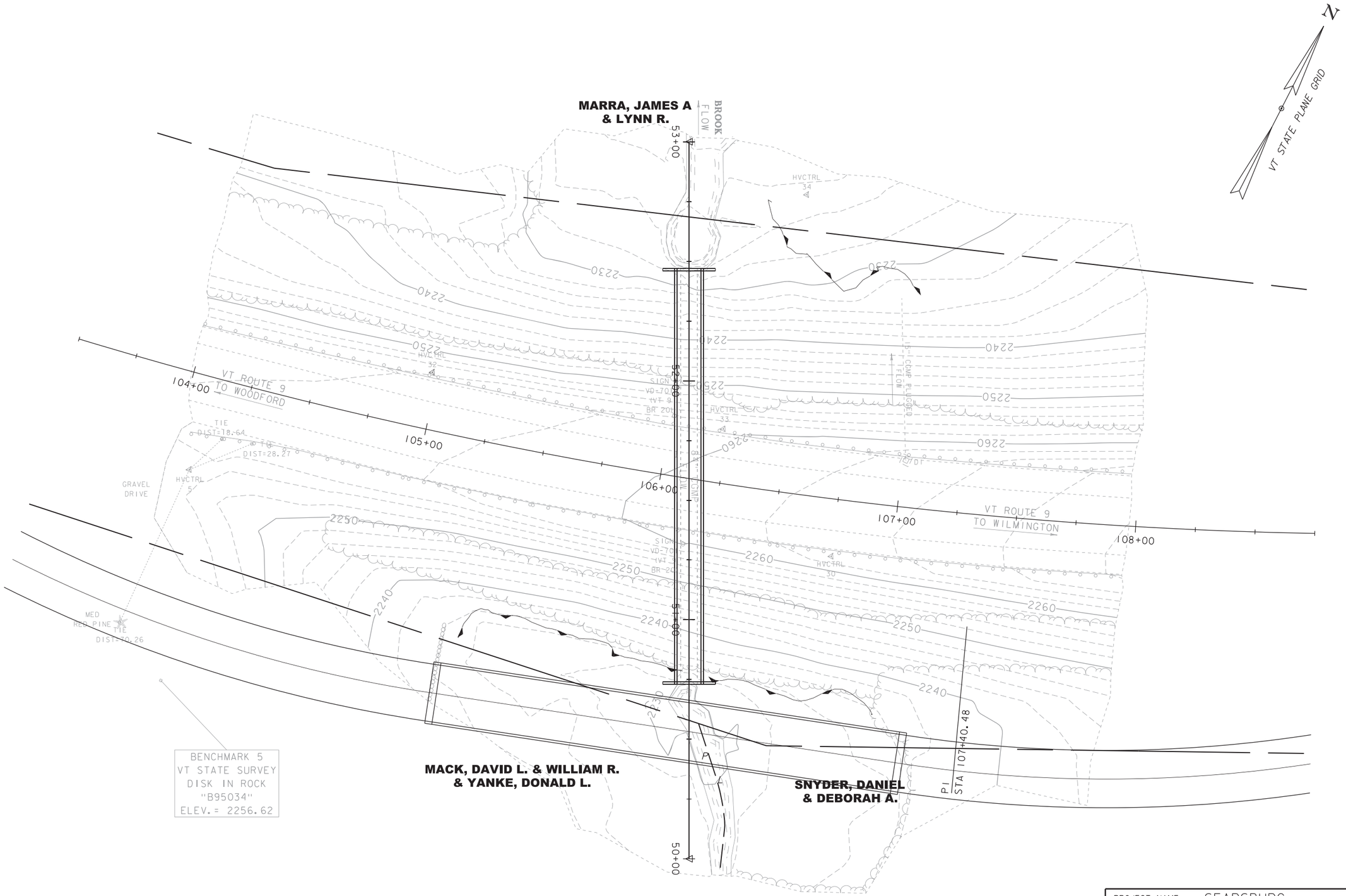


UPSTREAM TEMPORARY BRIDGE 1

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/s13b332tcborder.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
UPSTREAM TEMPORARY BRIDGE SHEET 1	SHEET 15 OF 20

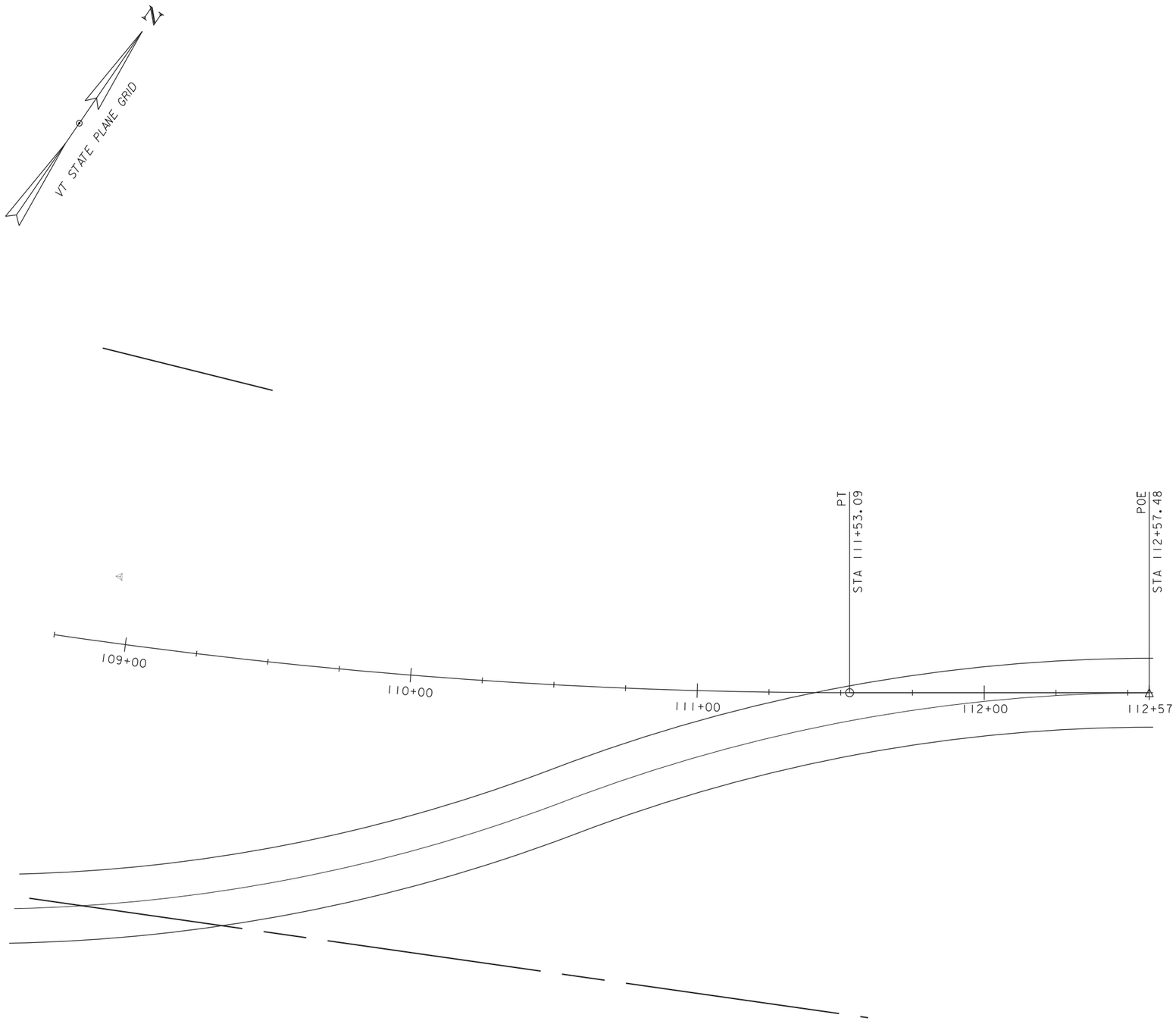


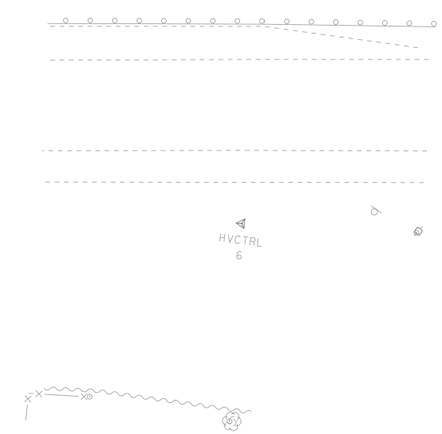
EXISTING 7' CGMPP
174' LONG, BUILT 1965
40' AVERAGE COVER

UPSTREAM TEMPORARY BRIDGE 2

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

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332tcborder.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
UPSTREAM TEMPORARY BRIDGE SHEET 2	SHEET 16 OF 20



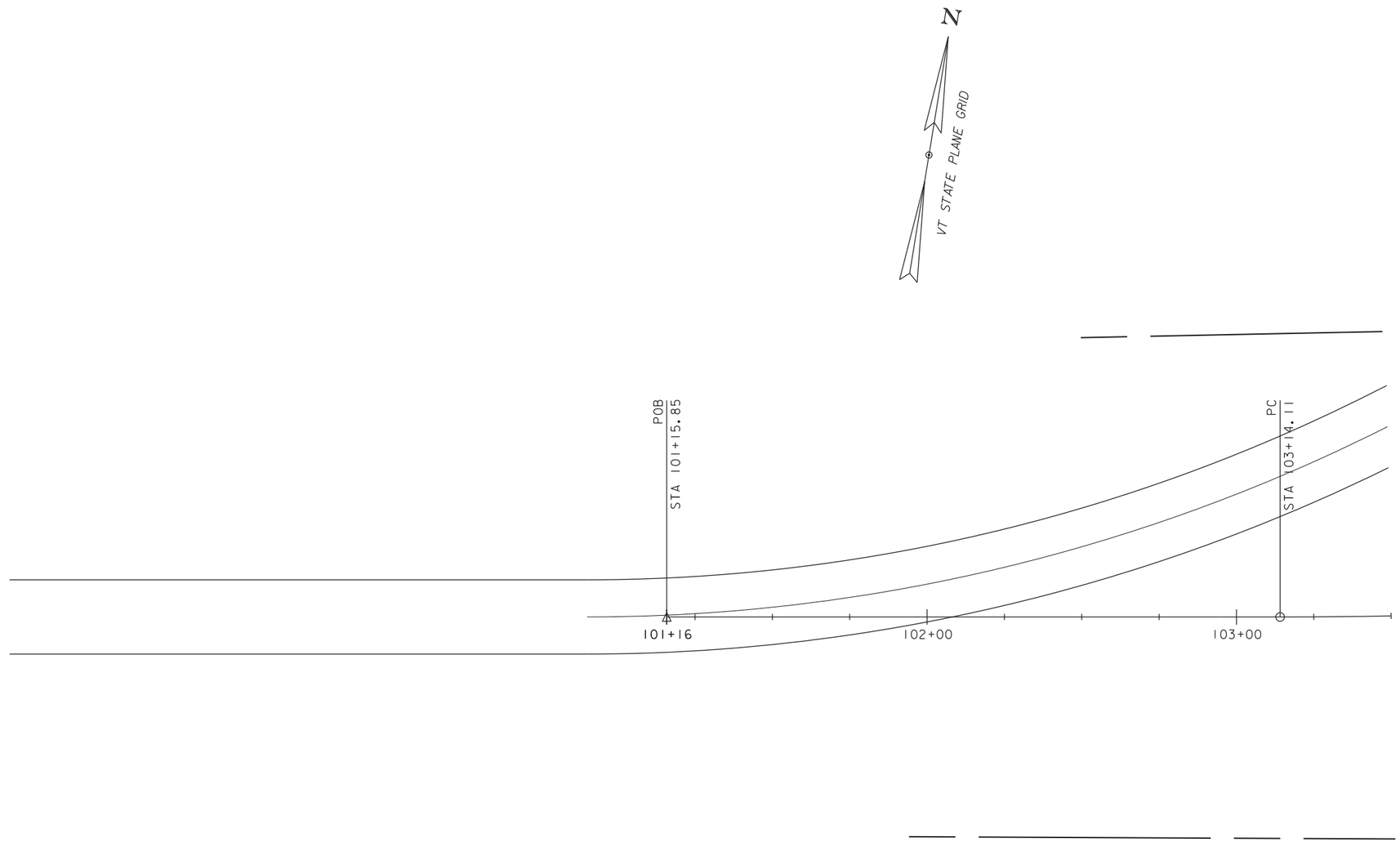


UPSTREAM TEMPORARY BRIDGE 3

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332tcborder.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
UPSTREAM TEMPORARY BRIDGE SHEET 3	SHEET 17 OF 20

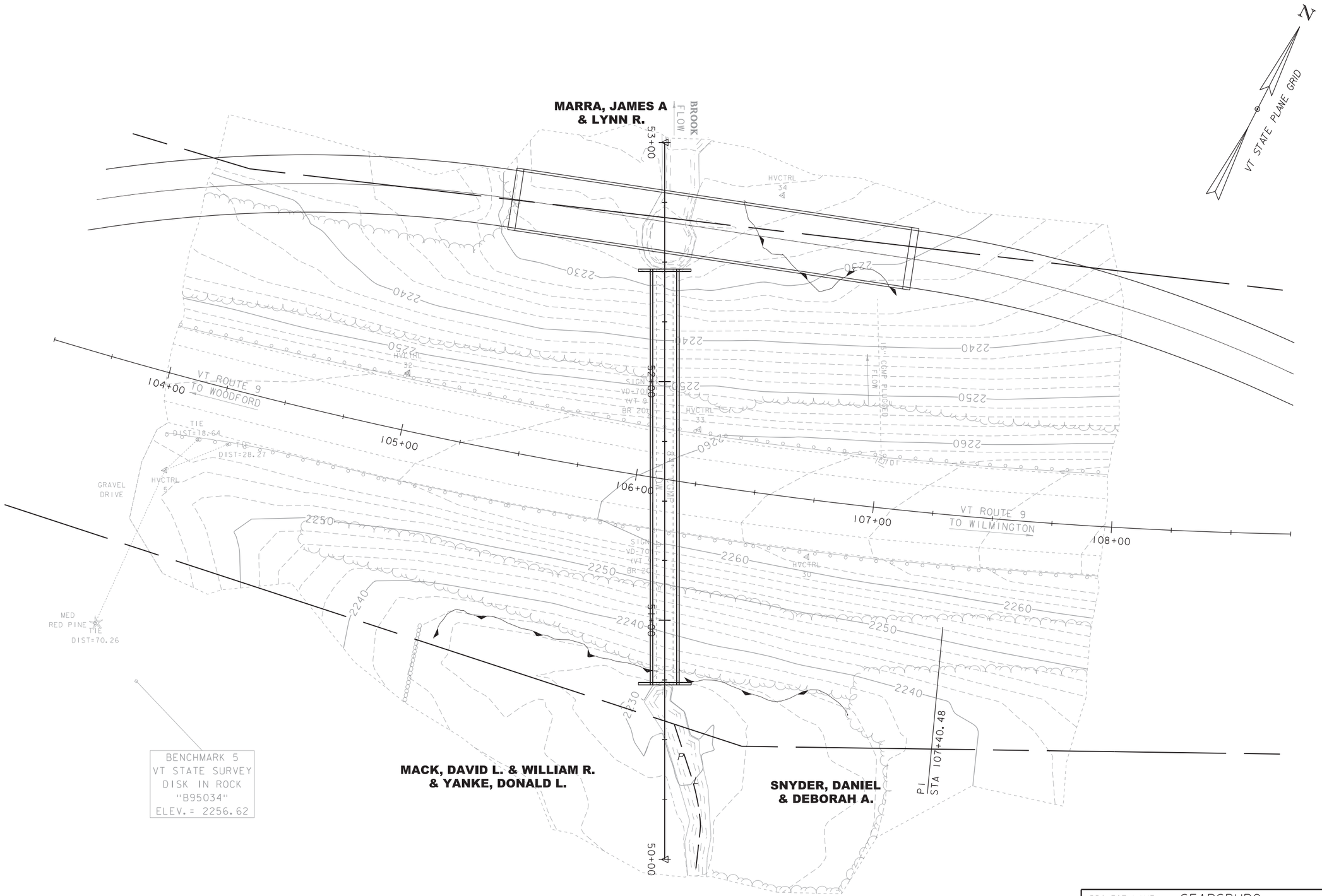


DOWNSTREAM TEMPORARY BRIDGE 1

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/s13b332tcborder.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
DOWNSTREAM TEMPORARY BRIDGE SHEET 1	SHEET 18 OF 20

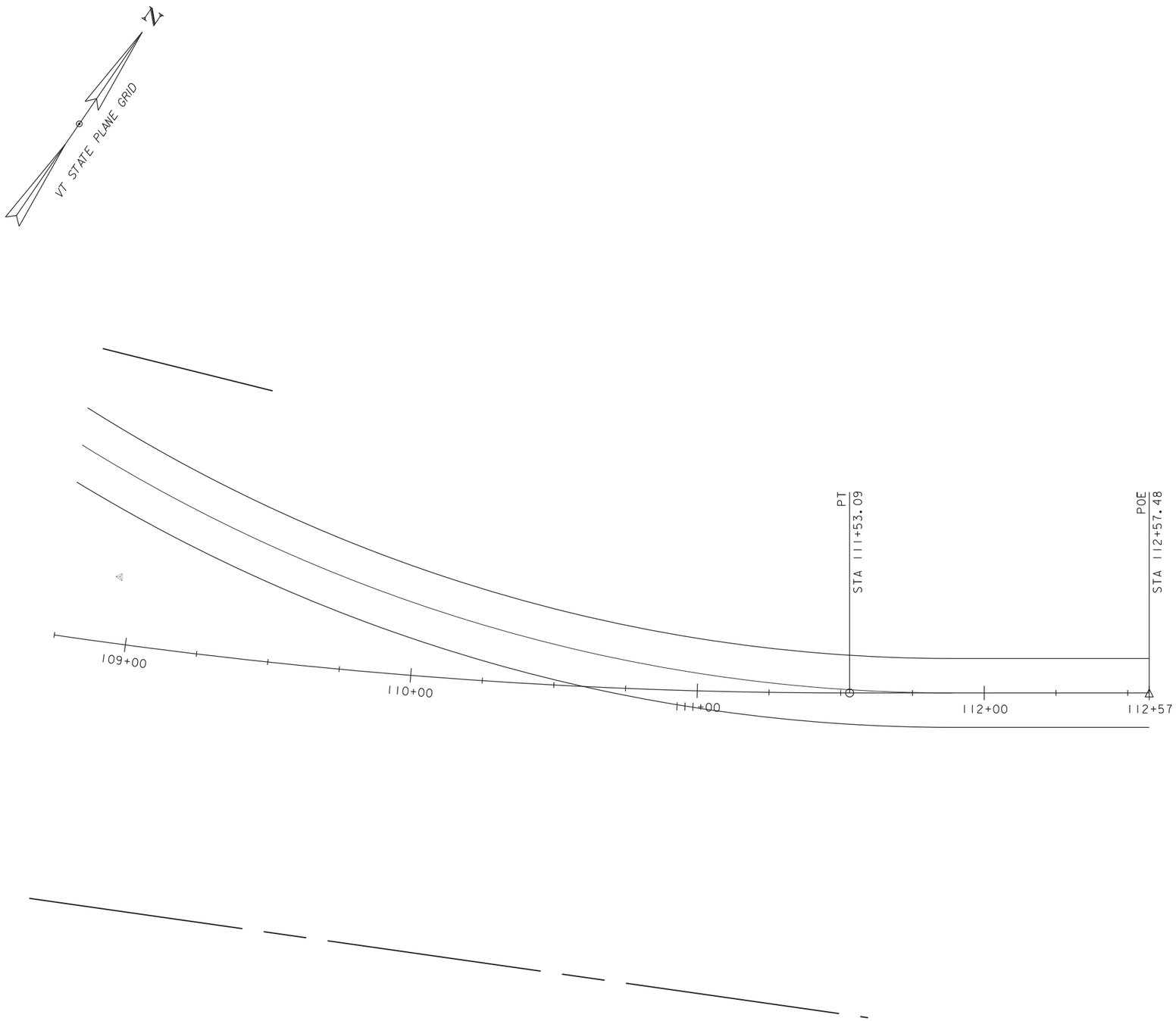


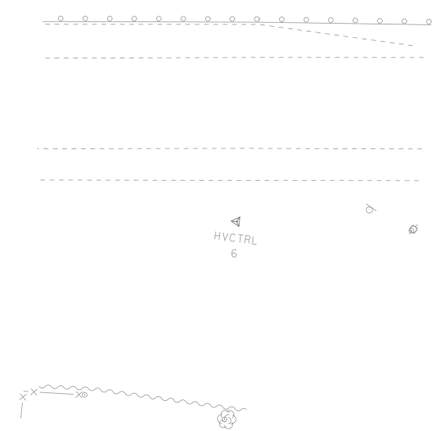
EXISTING 7' CGMPP
174' LONG, BUILT 1965
40' AVERAGE COVER

DOWNSTREAM TEMPORARY BRIDGE 2

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

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332tcborder.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
DOWNSTREAM TEMPORARY BRIDGE SHEET 2	SHEET 19 OF 20





DOWNSTREAM TEMPORARY BRIDGE 3

SCALE 1" = 20'-0"

20 0 20

PROJECT NAME: SEARSBURG	
PROJECT NUMBER: BF 010-1(50)	
FILE NAME: 13b332/sl3b332tcborder.dgn	PLOT DATE: 05-NOV-2014
PROJECT LEADER: K.HIGGINS	DRAWN BY: D.D.BEARD
DESIGNED BY: L.J.STONE	CHECKED BY: L.J.STONE
DOWNSTREAM TEMPORARY BRIDGE SHEET 3	SHEET 20 OF 20

Appendix M: State Wide Travel Model Report

TECHNICAL MEMO

To: Joe Segale, VTrans

From: Jim Sullivan, UVM TRC

cc: Jennifer Fitch, VTrans

Date: April 27, 2015

Re: Statewide Model Analysis to Support Construction Alternate-Route Planning for Culvert 20 in Searsburg

---

This memo documents the results of an application of the Vermont Travel Model ("the Model") to support alternate-route planning for Culvert 20, spanning Route 9 over an ephemeral drainage in Searsburg, Vermont. This work was performed under the "Operation of the Model" task of the Improvement and Operation of the Vermont Travel Model: Year 7 contract. The analysis consisted of a Model run with the link spanned by the culvert disabled to simulate the effects of an upcoming construction project on local and regional traffic. In addition, a select-link analysis was performed with this link at full capacity to better understand the communities that make use of it on a normal day in Vermont.

Specific direction for the scope of this Model application was received through an email from Jennifer Fitch on March 7, 2015 and approval to proceed was received in an email from Joe Segale on March 9, 2015.

Relating the Link to the Model

The link in the Model road network spanning Route 9 over the culvert is link ID 2189 (see Figure 1).

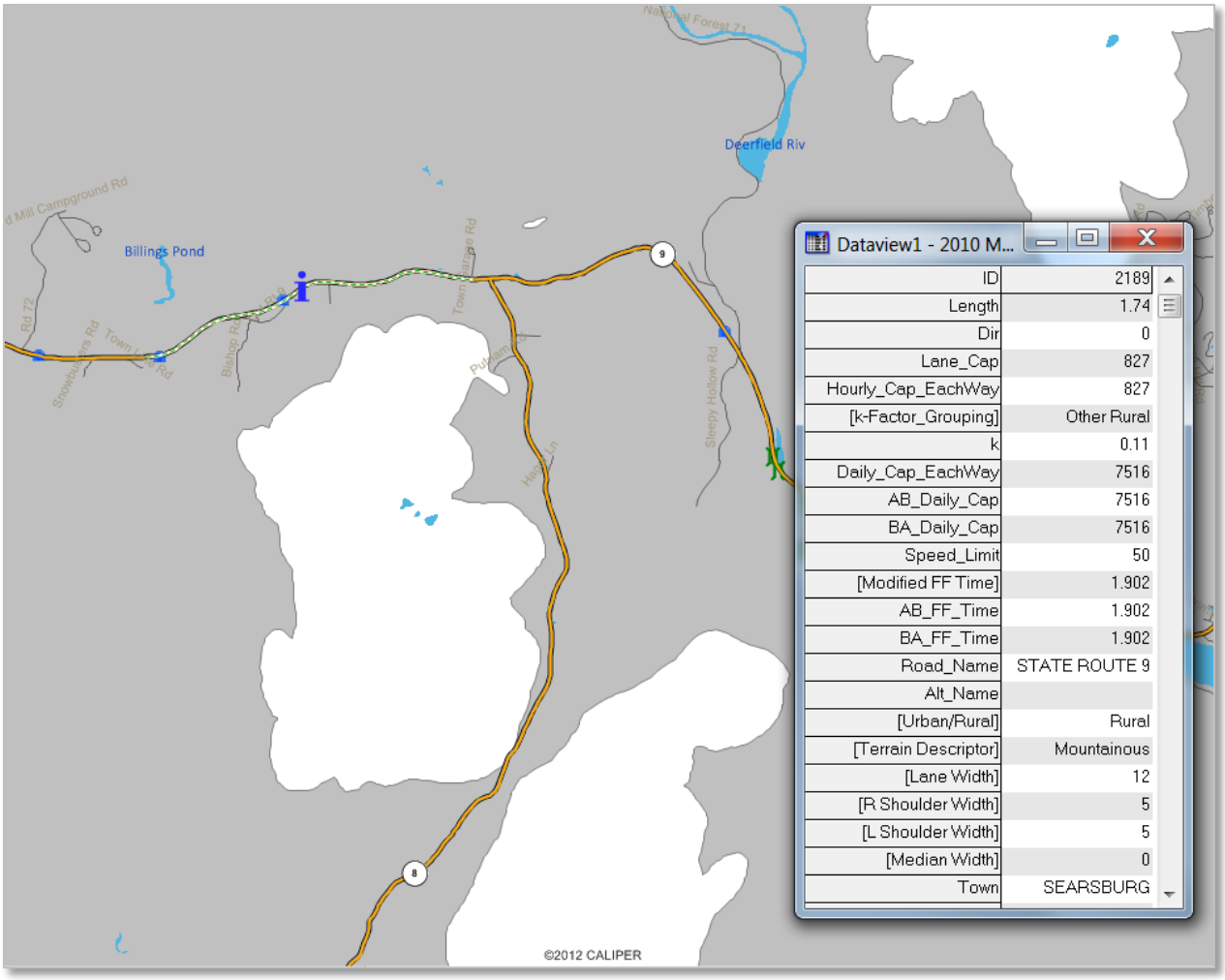


Figure 1 The Model road network at Culvert 20 in Searsburg, Vermont

Areas of elevation greater than 2,500 feet above msl are shown in white in the figure. The local area includes wetlands and other wildlife habitat on both sides of Route 9.

The daily capacity of this link each way is estimated in the Model at 7,500 vehicles/day, and the speed limit is 50 mph. Free-flow travel speeds on this link are estimated to be approximately 5 mph above the speed limit. Under normal ("Base") conditions, representing an annualized average day of travel in Vermont, the Model estimates 5,144 vehicles use the link. Since the AADT for the Model's base-year (2010) is 3,170 vehicles per day, the Model appears to substantially overestimate real-world travel on this link. Therefore, the conclusions of this study should be considered in light of this overestimation.

Travel on all of the Model links in this region seem to be overestimated when compared to AADTs for the same year. The reasons for this overestimation may represent the inability of the Model to account for through-traffic that would normally occur without entering the state. For example, vehicles entering the Model west of Bennington via the Bennington By-Pass might inadvertently be routed south down Route 7 into Massachusetts. In reality, those travelers would not be likely to enter Vermont at all, choosing to go directly from the Albany-Schenedectady

region to Massachusetts directly. However, without an adequate representation of network linkages outside Vermont, it is impossible for the Model to be used to forecast that type of travel.

Communities that Use the Link on a Typical Day

A select-link analysis was performed on link 2189 with the Model network intact, representing the current roadway conditions. The purpose of this analysis was to better understand the communities that use the link on a typical day in Vermont. Specific TAZ-based origins and destinations were aggregated to represent towns in Vermont and urban areas outside of Vermont. Table 1 shows the most common aggregated origins and destinations found to be using the link, as a % of its daily traffic total.

Table 1 Most Common Origins and Destinations Using Route 9 Over Culvert 20

Description of Traffic Stream				% of Total
Local traffic between	Wilmington	&	Woodford	3.5%
Through traffic between	Albany--Schenectady, NY (via Bennington By-Pass)	&	South Deerfield, MA; Greenfield, MA (via I-91)	1.7%
Regional traffic between	Brattleboro	&	Albany--Schenectady, NY (via Bennington By-Pass)	1.6%
Regional traffic between	Readsboro	&	Bennington	1.4%
Through traffic between	Albany--Schenectady, NY (via Bennington By-Pass)	&	Keene, NH; Concord, NH; Manchester, NH (via NH Route 9)	1.3%
Through traffic between	Albany--Schenectady, NY (via Bennington By-Pass)	&	New Hampshire via Route 123	1.3%
Local traffic between	Woodford	&	Searsburg	0.8%
Through traffic between	Lebanon--Hanover, NH—VT (via I-89)	&	Pittsfield, MA; Lee, MA; Williamstown, MA (via Route 7)	0.8%
Through traffic between	Keene, NH; Concord, NH (via NH Route 9)	&	Pittsfield, MA; Lee, MA; Williamstown, MA (via Route 7)	0.7%
Through traffic between	New Hampshire via Route 123	&	Pittsfield, MA; Lee, MA; Williamstown, MA (via Route 7)	0.7%
Local traffic between	Dover	&	Woodford	0.6%
Regional traffic between	Stamford	&	Bennington	0.6%
Regional traffic between	Wilmington	&	Albany--Schenectady, NY (via Bennington By-Pass)	0.5%
Regional traffic between	Dover	&	New York--Newark, NY--NJ--CT; Poughkeepsie--Newburgh, NY--NJ; Albany--Schenectady, NY (via Bennington By-Pass)	0.5%
Regional traffic between	Readsboro	&	New York--Newark, NY--NJ--CT; Poughkeepsie--Newburgh, NY--NJ; Albany--Schenectady, NY (via Bennington By-Pass)	0.5%
A**dditional uses under 0.5**% each are not shown				

The indication of the select-link analysis is that the link is most commonly used by local traffic between the communities of Wilmington and Woodford, then by through traffic (non-Vermonters) traveling between north-central Massachusetts (accessed via I-91) and points west of Bennington (accessed via the Bennington By-Pass). Regional traffic between Brattleboro and

points west of Bennington (accessed via the Bennington By-Pass) also represent a significant use of the link.

Another finding of the select-link analysis is that the uses of this link are widely varied, with each origin-destination pair occupying only a small % of the total travel, as indicated by the fact that the top 15 pairs represent only 16.5% of the total travel on the link. This situation arises from the lack of network connectivity around the link. Mountainous terrain to the east of Bennington creates natural restrictions to network connectivity, making Route 9 a critical east-west link in southern Vermont. Further inspection of the regional connectivity indicates that Route 9 is a critical bottleneck for regional travel between Brattleboro and Bennington with the nearest alternate routes far to the north (Kelley Stand Road) and to the south (Massachusetts' State Route 2) (Figure 2).

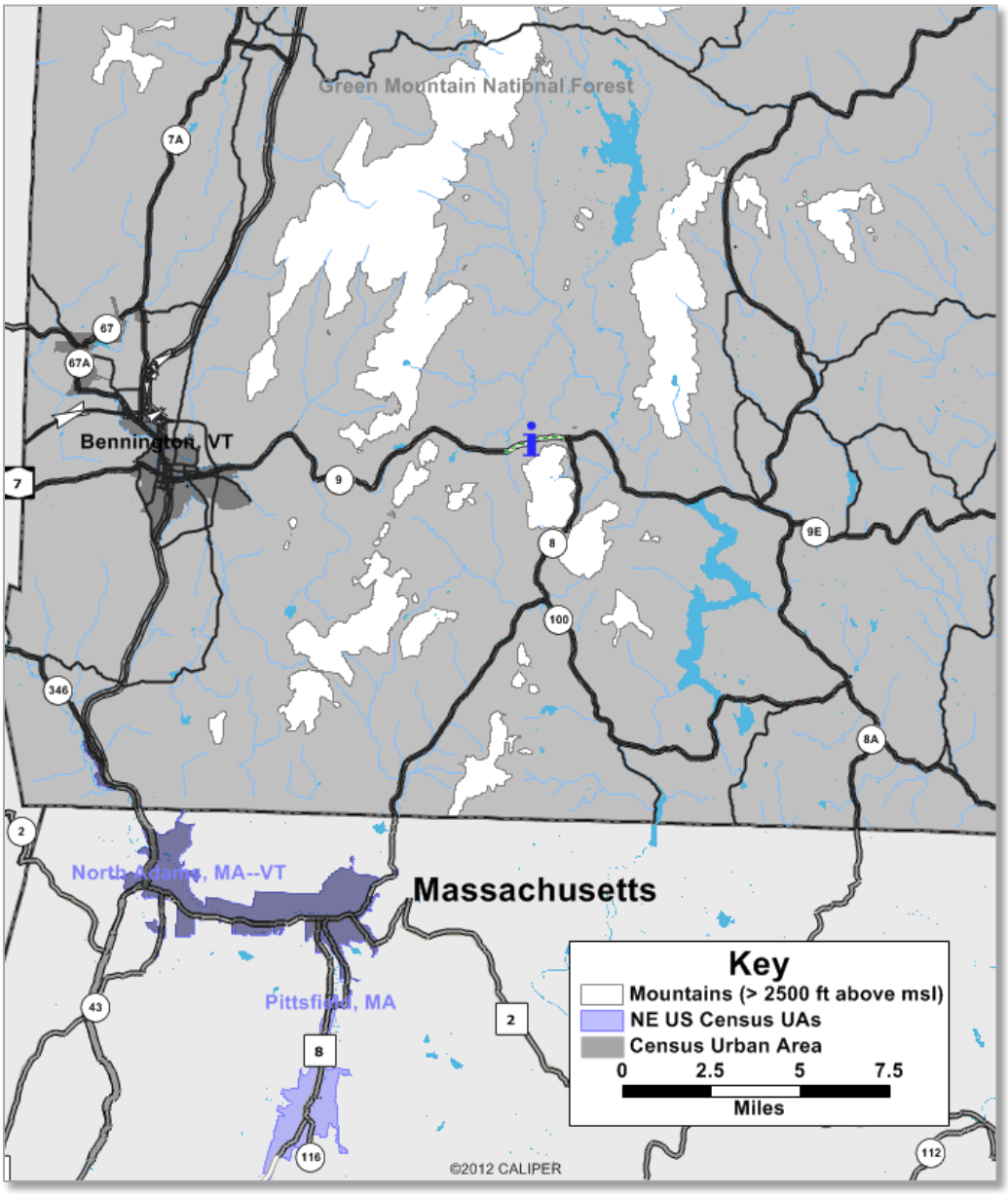


Figure 2 Regional Connectivity Around Route 9

Impact of Construction-Closure

In order to better understand the effects of closure of the link on traffic, the Model was run a second time with link 2189 disabled to represent a Construction-Closure Scenario. Figure 3 illustrates the changes in traffic volumes from the Base Scenario that occurred when the link was closed.

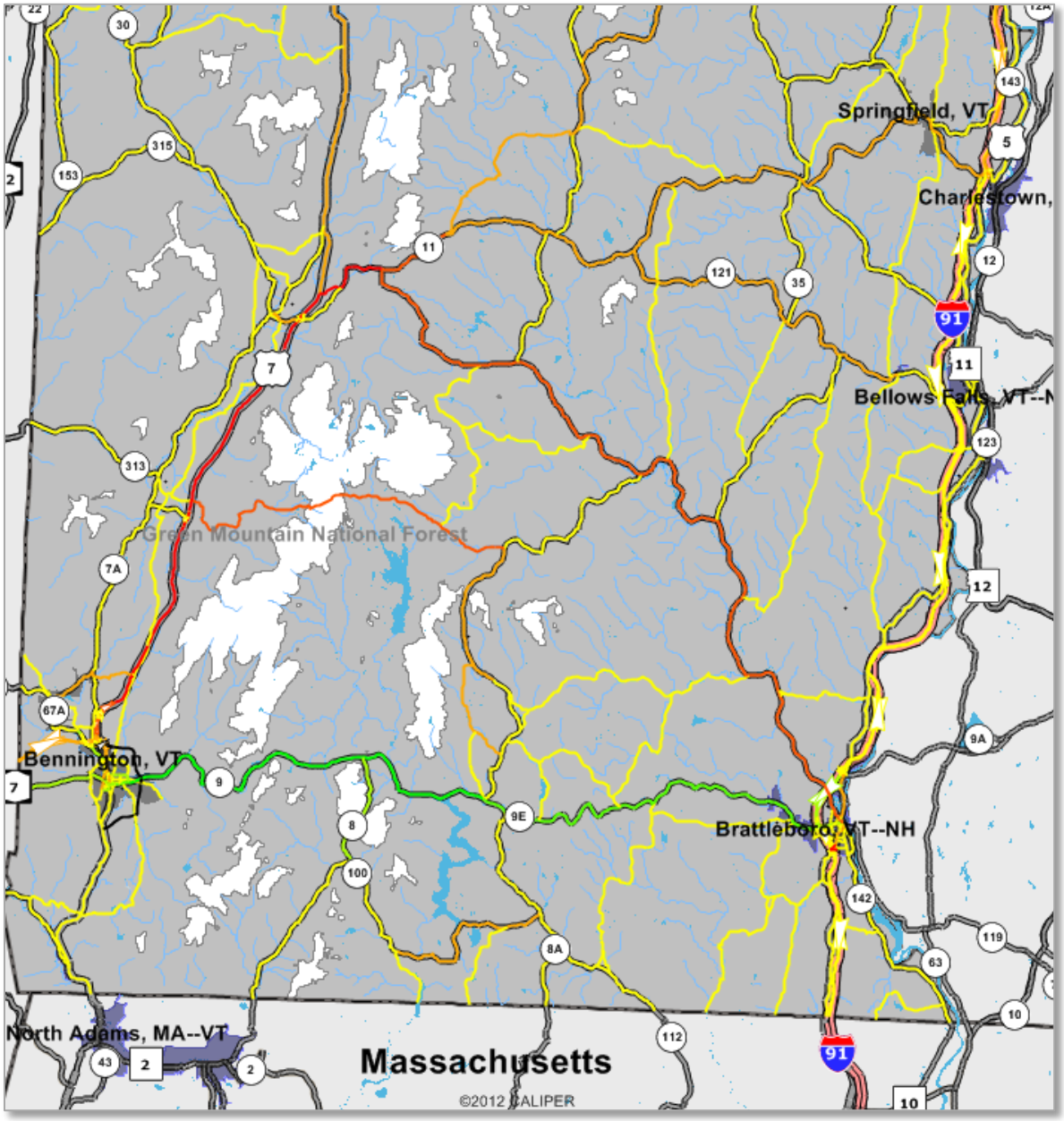
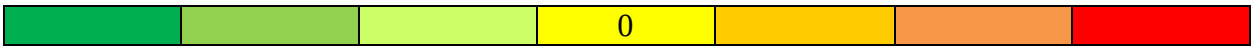


Figure 3 Changes in Traffic Volumes Between the Base Scenario and the Construction-Closure Scenario

In Figure 3, the more red links had the greatest increases in traffic volumes, while the more green links had the greatest decreases in traffic volumes. Links not included in the 2010 Model are shown in black (future segments of the Bennington By-Pass) or gray (external highways in bordering states). Most of the links experienced no change in volume, indicated by the most common yellow color:



As indicated in the Figure 3, the effects of the closure of Route 9 are widespread, rippling through all of the southern Vermont, as far north as Springfield. The largest increases are shown to occur on U.S. Route 7, with travelers choosing more northern routes (Route 30 and Kelley Stand Road) for east-west access across the state. Thankfully, none of the roads where these increased volumes are projected are near their daily capacity, so increased congestion will not be a problem, but increased travel times for travelers who normally use this link will be significant. Overall, the closure results in 71 additional vehicle-hours of travel (VHTs) statewide per day, corresponding to an estimated $4,300 daily impact on the Vermont economy.

These shifts are precipitated by the assumptions in the Model that users have perfect knowledge of the network and the closure, allowing them to plan accordingly.

Conclusions

It is important to note that all scenario Model runs assume that travelers have perfect information about the status of the network. **This means that the information about the construction closure must be communicated throughout the region for travelers who normally traverse Vermont's borders at the Bennington By-Pass, Route 9 in Brattleboro, and I-91 south of Brattleboro.** Communicating with these travelers before they reach these points is critical in order to alleviate the effects of the construction on individual users, and bring the network into equilibrium. Without this communication, the impacts will be worsened because unaware users might approach the closure before deciding on an alternate route, making the increase in their travel time even greater.

The importance of this regional communication cannot be understated. Many of the non-Vermonters who will be impacted by this closure will actually choose alternate routes that do not enter Vermont, particularly in northwestern Massachusetts. For travelers who normally travel into or through Vermont via I-91 and/or from the North Adams, MA—VT urban area, Massachusetts' State Route 2 will be the most likely alternate route for east-west travel. Unfortunately, this critical linkage is not part of the Vermont Travel Model network, so the potential benefits afforded by it as an alternate route are not included in the estimated impact of the closure of Route 9 described above. It is very likely that MA State Route 2 will decrease estimated impacts of the closure, but it is impossible for the Model to determine the extent of that decrease.

Another possible source of over-estimation of adverse impacts of this closure is that the Model seems to over-estimate travel on link 2189 in general, as described previously. This general over-estimation is also likely related to the Model's inability to account for travel on links outside of Vermont. Travelers between Bennington and Brattleboro have an out-of-state alternate route in MA State Route 2, and external travelers to/from these Vermont communities have a variety of out-of-state alternate routes in New York, Massachusetts, and New Hampshire. The Model currently does not include these important out-of-state linkages in accounting for route choices made by travelers in the Model.