
Lamoille County Road Erosion Assessment

A project funded by the Vermont Watershed Grants Program and conducted by the Lamoille County Planning Commission with assistance from Watershed Consulting Associates, LLC.

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Introduction

In 2013 the Lamoille County Planning Commission, with assistance from Watershed Consulting Associates, conducted an analysis to map, inventory, prioritize, and prepare repair designs for Class 3 and 4 road erosion sites within the towns of Cambridge, Elmore and Wolcott. The purpose of the project was to 1) better understand the scope of the erosion problems along Class 3 and 4 roads, 2) to provide an inventory of erosion sites, 3) prioritize the erosion sites for impact to water quality by sedimentation, 4) provide a simple site map and erosion treatment techniques for the highest priority erosion sites, and 5) share the results of the study and discuss the erosion treatment techniques with the towns. The project was funded through a Grant provided by the Vermont Department of Fish and Wildlife Watershed Grants Program.

Methodology

GIS Analysis

Prior to fieldwork, a geographic constraints analysis of Class 3 and 4 town roads was conducted using ArcGIS 10.1 to identify areas prone to erosion that are likely to have an impact on water quality, to prioritize these areas for field assessment. The presence or absence of five factors – stream/road intersections, proximity of a road to stream (within 50 feet), proximity of a road to wetland (within 50 feet), steep slopes and erodible soils - was evaluated to quantify the potential for erosion likely to impact water quality. The road network within the three towns was divided into 100-foot segments, and for each segment the presence or absence of the five constraints was analyzed. Road segments having 3 or more constraints were prioritized for subsequent field surveys. Then, for each road, the number of constraints was totaled. Highlighting the overall road scores was useful for identifying general road locations where

erosion and water quality impact may be present. Identifying specific points was useful for pinpointing the potential trouble spots. Maps displaying the areas prioritized for field surveys are shown in Appendix A. Field crews visited all point locations with 3 and greater constraints and all roads with a total constraints score of 90 and greater. Table 1 below provides a summary of the constraint values considered in the GIS analysis.

Constraint	Criteria	Data Source
Stream Crossings	Road / Stream intersection	Vermont Hydrography Dataset (VHDCARTO, 2010)
Stream Buffer Width	50 feet	Vermont Hydrography Dataset (VHDCARTO, 2010)
Class II Wetland Buffer	50 feet	Vermont Significant Wetlands Inventory (VSWI, 2010)
Slope	rise/run > 15%	Vermont Hydrography Dataset DEM (ElevationDEM_VTHYDRODEM, 2005)
Soil Erodibility	"Highly erodible soils"	Natural Resource Conservation Service (NRCS) Soil Survey (Geologic_SO, 2011)

Table 1: GIS constraints analysis parameters

Field Priority Indicators

After the completion of the GIS desktop analysis, a series of field priority indicators and a scoring matrix developed previously by others¹, were used by field crews to rank each erosion area impact to water quality during the field mapping effort. These priority indicators included volume of runoff expected through the erosion area, the steepness of the buffer area downstream of the erosion area and upstream of the receiving water, the condition of the ground cover of the buffer area, and the opportunity for sediment deposition in the buffer area. Individual erosion areas were scored in the field as high, medium, and low, for each of these indicators. Following the field data collection, scoring for each of the field indicators was imported into an excel spreadsheet to calculate total scores for each area. Each high, medium, and low score was assigned a value of 3, 2, or 1, respectively. In the case of the opportunity for deposition indicator, percentages of 30%, 20%, or 10% were assigned to a high medium or low score, given that depositional areas were assumed to have a weighted importance. A summary table of the field priority indicators is provided in Table 2 below. The complete scoring matrix is provided in Appendix B.

¹ Watershed Consulting Associates, 2012. Mad River Valley Erosion Study. Available at http://www.friendsofthemadriver.org/documents/MRV_Road_Erosion_Study_Report.pdf

Priority Indicators	Score	Description	Note
Volume	Low	small channel, headwater area	Volume indicator refers to the condition at and upstream of the erosion area
	Medium	medium channel, middle of watershed	
	High	large channel, close to receiving water	
Velocity/Steepness	Low	low slope, <5%	Velocity/Steepness indicator refers to the condition at and downstream of the erosion area
	Medium	moderate slope, >5% and < 15%	
	High	steep slope, > 15%	
Soil Cover	Low	stone	Soil Cover indicator refers to the condition downstream of the erosion area
	Medium	vegetation	
	High	bare	
Deposition	Low	sheet flow over well vegetated terrain/ channel with turnouts to vegetated terrain	Deposition indicator refers to the condition downstream of the erosion area
	Medium	channel flow with defined break in slope with some deposition before stream	
	High	channel flow with no slope breaks, obvious in stream deposition	

Table 2. Priority indicators for water quality scoring.

Data Collection and Reduction

Field crews walked/drove each priority road segment during the 2013 field season, with the exception of the southernmost portion of Eagle Ledge Road (past the intersection of Tallman Rd), which was virtually inaccessible due to large beaver ponds engulfing the roadway. Field crews carried a Trimble GeoXT GPS unit capable of 1-meter accuracy and a digital camera. The roadway surface, shoulders, and ditches were scanned for areas of erosion. The geographic location and extent of each erosion area was recorded by the GPS as a line along the road. The digital camera was used to take photos of the erosion sites. Field priority indicators were imported into the GPS unit as a data dictionary. This allowed customized drop down menus to be used to log the data, which significantly increased data collection efficiency. In addition to the collection of the priority indicators data, descriptive data for the erosion areas was also recorded. This included the general category of the erosion, where the erosion areas were located relative to the road, and in the case of erosion at culvert locations, specific data about the culvert. Each erosion area was assigned a unique ID that correlated with the road name. The descriptor data is summarized in Table 3.

Descriptors	Type	Notes
General Erosion Category	Rill	small channel that could be graded
	Incision	medium channel that could be graded
	Gully	larger channel that could not be repaired by grading
	Slump	failure of road edge or surface
	Stream/Ditch Scour	Carving of stream bank or ditch side slopes
Erosion Location	Roadway	
	Roadway Shoulder	
	Ditch	
	Ditched Stream	
	Culvert Headwall	
	Culvert Endwall	
Culvert Data (Culvert Sites Only)	Diameter	inches
	Material	metal/plastic/concrete
	Condition	poor/fair/good
	Ownership	Town/Private

Table 3. Erosion area descriptors.

GPS data was exported to ESRI shapefile format. A line shapefile was produced that included all mapped erosion areas. The overall priority score of each erosion area was included as a field in the shapefile.

Results

A total of 151 erosion areas were mapped across the three towns. The summary of all mapped sites is included in Appendix C. Sites having the highest priority scores in each Town were organized into a spreadsheet and evaluated. A total of 36 sites were included on this reduced list, shown in Table 4. Of the 36 sites, it was determined that several of the sites will require full engineering design for repair, given the complexity of the likely design solution. The need for an engineering design on these sites was noted in the GIS database. For several other sites, it was determined that a repair had been completed or was being initiated since the time the erosion areas were first mapped. The remaining 23 sites were selected for a design repair. Design repairs, completed by Watershed Consulting Associates, consisted of simple site plans that provide locations of the erosion area and a reference to a corresponding construction detail. The site plans also provide construction material quantity information to allow Town crews to price the specified materials. Site plans for all of the final design sites are provided in Appendix D. Construction details are provided in Appendix E.

Site ID	Road Name	Town	Erosion Category	Erosion Location	Priority
CF1	CountyFarm Rd	Cambridge	GULLY/INCISION	DITCH	High – engineering site
CF3	County Farm Rd	Cambridge	STREAM/DITCH SCOUR	CULVERT ENDWALL	High – engineering site
CY1	Canyon Rd	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	High – engineering site
CY1a	Canyon Rd	Cambridge	GULLY/INCISION	DITCH	High – engineering site
CY2	Canyon Rd	Cambridge	SLUMP	ROADWAY SHOULDER	High – engineering site
CY3	Canyon Rd	Cambridge	GULLY/INCISION	DITCH	High – engineering
CY4	Canyon Rd	Cambridge	GULLY/INCISION	DITCH	High – engineering site
WF2	West Farm Rd	Cambridge	SLUMP	ROADWAY SHOULDER	High – engineering site
AND4	Andrews Rd	Cambridge	SLUMP	ROADWAY SHOULDER	High
AND3	Andrews Rd	Cambridge	SLUMP	ROADWAY SHOULDER	High
TPS1	Thompson Rd	Cambridge	RILL	ROADWAY SHOULDER	High
RO1	Robinson Rd	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	Medium – engineering site
RO2	Robinson Rd	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	Medium – engineering site
BAH1a	Bartlett Hill Rd	Cambridge	GULLY/INCISION	DITCH	Medium
TAN4	Tanner Rd	Cambridge	GULLY/INCISION	DITCH	Medium
SM3	Simmons Mill Rd	Elmore	STREAM/DITCH SCOUR	DITCHED STREAM	High – engineering site
BH2	Brown Hill Rd	Elmore	GULLY/INCISION	DITCH	High – engineering site
BH2a	Brown Hill Rd	Elmore	GULLY/INCISION	DITCH	High
BH3	Brown Hill Rd	Elmore	SLUMP	ROADWAY SHOULDER	High
BCH NEW	Beach Rd	Elmore	STREAM/DITCH SCOUR	DITCH	High
EG2	Earl Gray Rd	Elmore	SLUMP	ROADWAY SHOULDER	High

EM1	Elmore Mountain Rd	Elmore	GULLY/INCISION	DITCH	High
EM2	Elmore Mountain Rd	Elmore	GULLY/INCISION	DITCH	High
SM4	Simmons Mill Rd	Elmore	GULLY/INCISION	DITCH	Medium
T NEW	Tallman Rd	Elmore	SLUMP	CULVERT ENDWALL	Medium
EH NEW	East Hill Rd	Wolcott	STREAM/DITCH SCOUR	CULVERT HEADWALL	High
KLR8	Keeler Pond Rd	Wolcott	SLUMP	DITCHED STREAM	High
KLR10a	Keeler Pond Rd	Wolcott	RILL	IN ROADWAY	High
MH1	Morey Hill Rd	Wolcott	RILL	IN ROADWAY	High
SH1	Sand Hill Rd	Wolcott	RILL	ROADWAY SHOULDER	High
SH1a	Sand Hill Rd	Wolcott	RILL	ROADWAY SHOULDER	High
SH3	Sand Hill Rd	Wolcott	GULLY/INCISION	DITCH	High
SH3a	Sand Hill Rd	Wolcott	RILL	ROADWAY SHOULDER	High
WH3	West Hill Rd	Wolcott	RILL	IN ROADWAY	High

Table 4: High priority sites

The erosion site database, site plans, construction details, and photo log was provided to each Town, and LCPC staff met with the road foremen to discuss the erosion sites and repair designs. The data will serve to help the Towns track erosion area problems, and to repair the final design sites using the Town road crews. For the sites that require full engineering design to repair, the Towns can use this information to help inform future decisions on hiring a design firm to address these areas as funding becomes available. The repair designs can also be used as supplementary documentation for future grant applications.

Conclusion and Recommendations

The Lamoille County Road Erosion Assessment accomplished the following objectives for the participating Towns: 1) an increased understanding of the scope of erosion problems along Class 3 and 4 roads, 2) an inventory of erosion sites, prioritized for impact to water quality by sedimentation, and 3) simple erosion treatment techniques for the highest priority erosion sites. The identification and prioritization of road erosion sites along with the repair designs will

help the Towns budget for and implement the necessary repairs. This will reduce sedimentation to water resources, while also reducing the need for repeated maintenance by road crews.

It should be noted that the repair designs focused on Class 3 roads, even though there were many sections of Class 4 roads that scored high on the priority indicators, and thus were considered to have a detrimental impact on water quality. Class 4 roads were excluded from designs as they are largely maintained by private landowners. Should municipalities or other private entities express interest in improving Class 4 roads, grant funding should be pursued to develop designs and implement repairs for the high priority Class 4 roads.

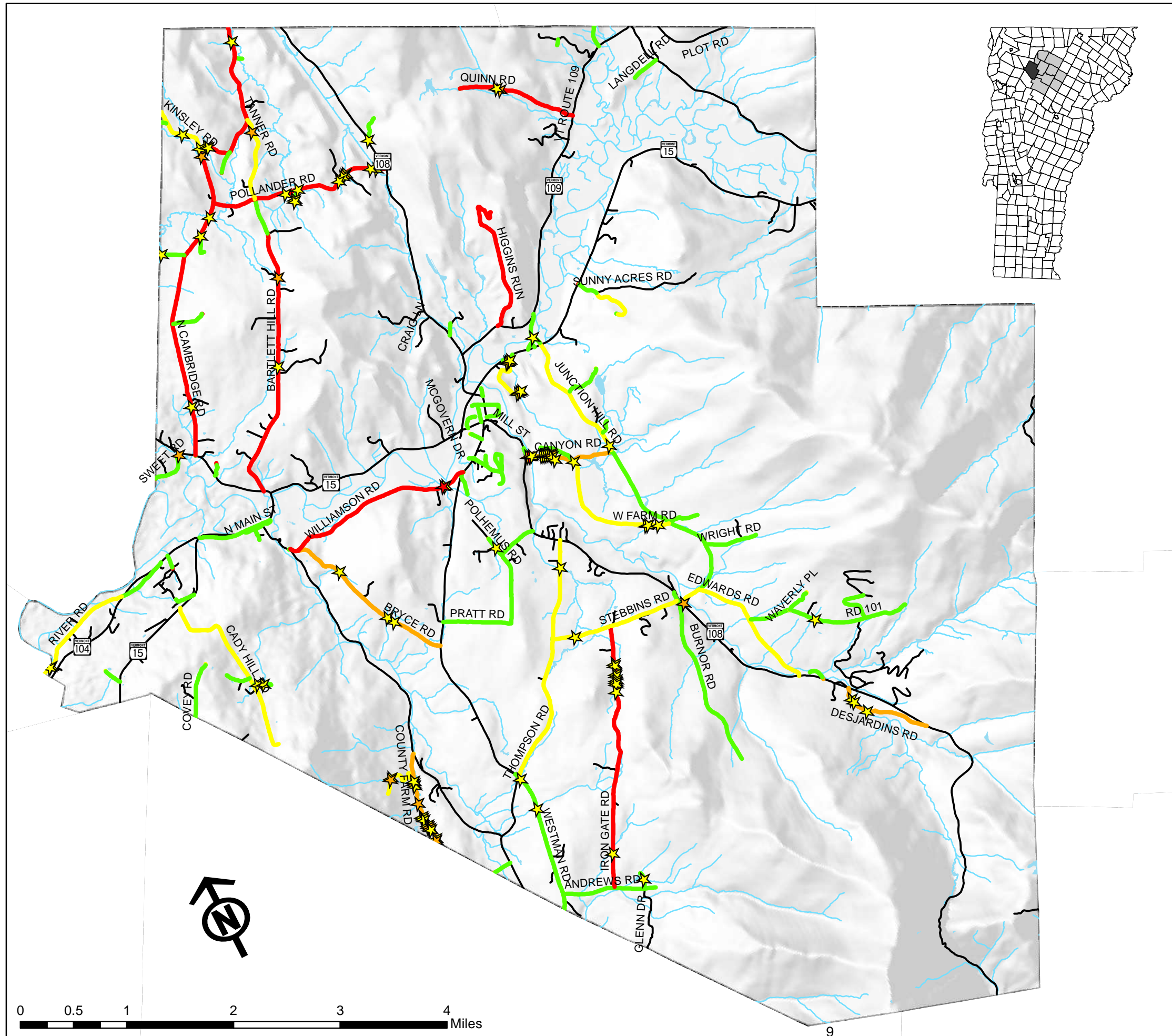
Local roadways that were not highlighted in the GIS desktop analysis were not evaluated, and therefore it can be expected that additional unmapped erosion areas exist on local roads in the three Towns. The GIS inventory of the erosion sites should be updated periodically to reflect repairs made to the drainage system. Once the initial 23 sites have been addressed, additional mapped sites could be targeted for repair based on the priority scoring. Sites identified for a full engineering design should also be reviewed by the Towns and prioritized for inclusion in Capital Budgets.

This project was funded in part by a Vermont Watershed Grant and the Conservation License Plate Program.



Appendix A – GIS Constraints Analysis Maps

Class 3 and 4 Road Erosion Assessment GIS Constraints Analysis Cambridge, Vermont



Road Erosion Priority Ranking - Sum of Constraints

- Low Impact (30 or Less Constraints)
- Moderate Impact (31 - 60 Constraints)
- High Impact (61-90 Constraints)
- Very High Impact (> 90 Constraints)

Road Sites with

- ★ 5 Constraints
- ★ 4 Constraints
- ★ 3 Constraints

— Other Roads

— Streams

■ Waterbody

Town Boundary

This map was created as part of LCPC's Watershed Grant to conduct an assessment of erosion on Class 3 and 4 town roads in Wolcott.

The map represents the GIS analysis of Class 3 and 4 town roads to prioritize road areas for field assessment. The results show the priority ranking of roads based on the presence of these constraints: road/stream intersections, roads near streams, roads near wetlands, erodible soils and steep slopes.

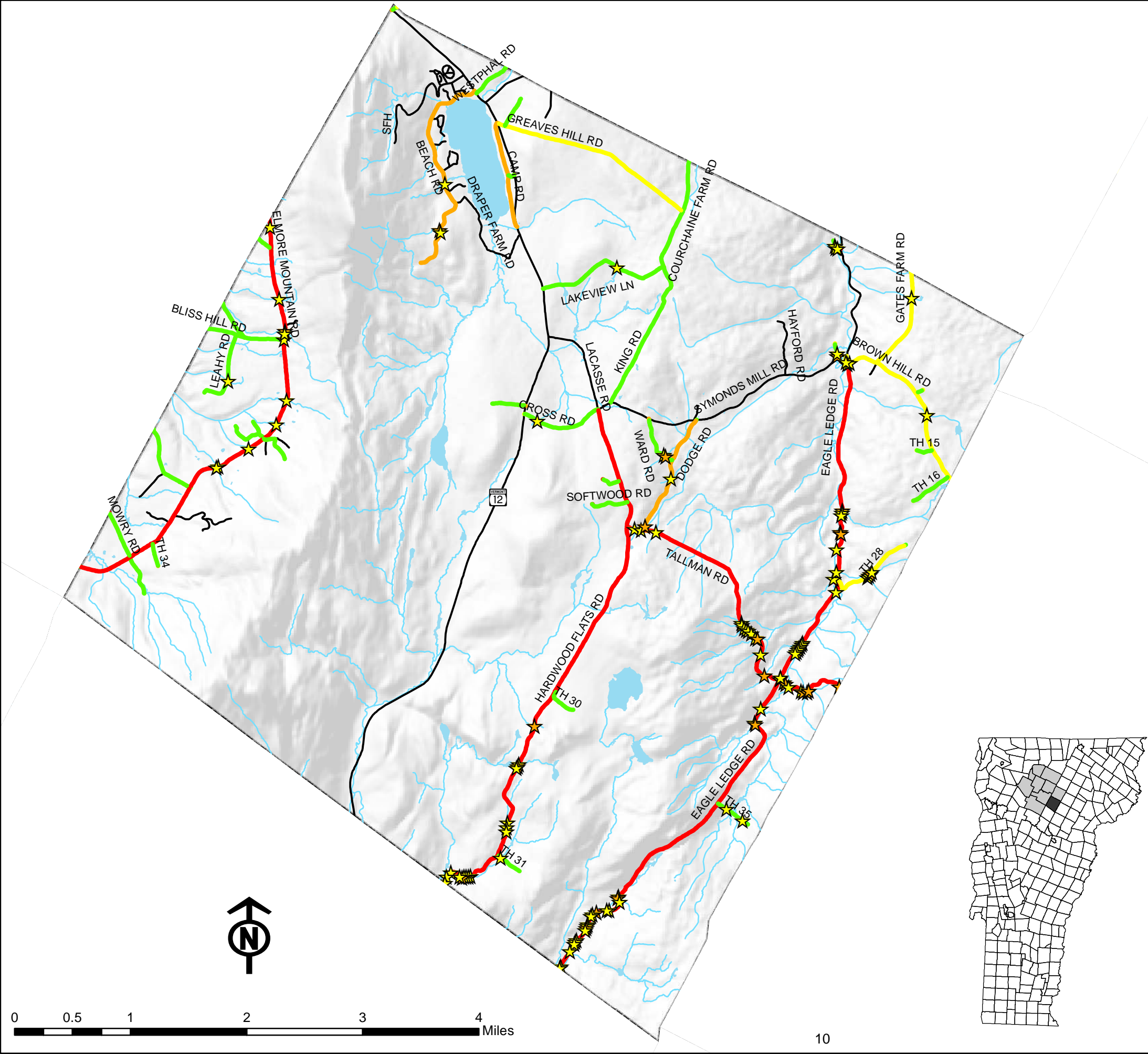
DATA SOURCES:

ROAD EROSION PRIORITY SITES: LCPC, 2013.
POLITICAL BOUNDARIES: 1:24000 USGS Quadrangles, VCGI, 1991.
ROADS: 1:5000 E-911 Road Data, 2012.
SURFACE WATER: On-screen digitized from 1:5000 digital orthophotos using USGS 7 1/2' quadrangles and 1:20000 color infrared aerial photography as additional source material, VCGI for VHD-USGS, 2001.

Map created by LCPC, 2013.

For planning purposes only. Not for regulatory interpretation.

Class 3 and 4 Road Erosion Assessment
GIS Constraints Analysis
Elmore, Vermont



**Road Erosion Priority Ranking -
Sum of Constraints**

- Low Impact (30 or Less Constraints)
- Moderate Impact (31 - 60 Constraints)
- High Impact (61-90 Constraints)
- Very High Impact (> 90 Constraints)

Road Sites with

- 5 Constraints
- 4 Constraints
- 3 Constraints
- Other Roads
- Streams
- Waterbody
- Town Boundary

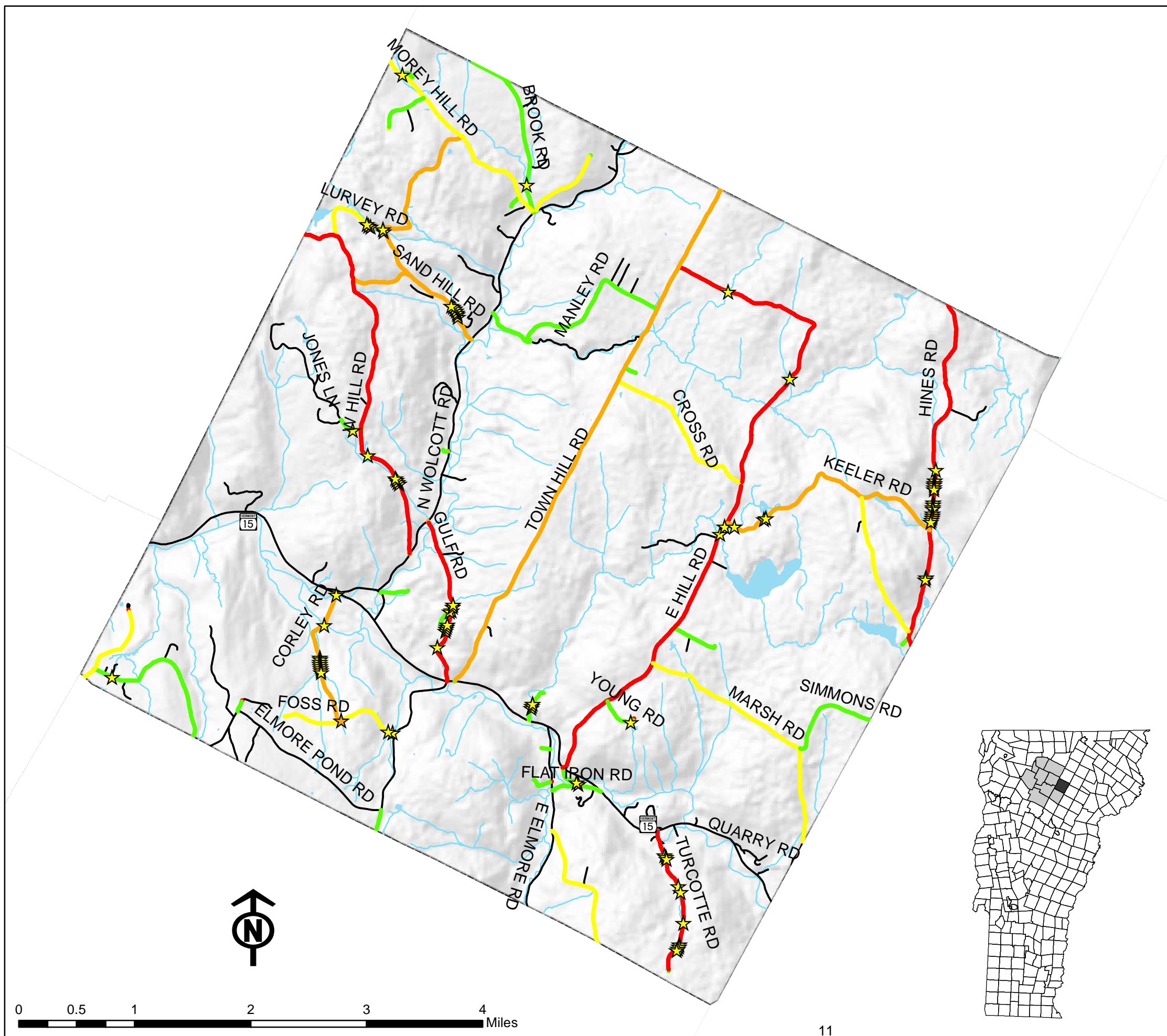
This map was created as part of LCPC's Watershed Grant to conduct an assessment of erosion on Class 3 and 4 town roads in Wolcott.

The map represents the GIS analysis of Class 3 and 4 town roads to prioritize road areas for field assessment. The results show the priority ranking of roads based on the presence of these constraints: road/stream intersections, roads near streams, roads near wetlands, erodible soils and steep slopes.

DATA SOURCES:
ROAD EROSION PRIORITY SITES: LCPC, 2013.
POLITICAL BOUNDARIES: 1:24000 USGS Quadrangles, VCGI, 1991.
ROADS: 1:5000 E-911 Road Data, 2012.
SURFACE WATER: On-screen digitized from 1:5000 digital orthophotos using USGS 7 1/2' quadrangles and 1:20000 color infrared aerial photography as additional source material, VCGI for VHD-USGS, 2001.

Map created by LCPC, 2013.
For planning purposes only. Not for regulatory interpretation.

Class 3 and 4 Road Erosion Assessment GIS Constraints Analysis Wolcott, Vermont



Road Erosion Priority Ranking - Sum of Constraints

- Low Impact (30 or Less Constraints)
- Moderate Impact (31 - 60 Constraints)
- High Impact (61-90 Constraints)
- Very High Impact (> 90 Constraints)

Road Sites with

- ★ 5 Constraints
- ★ 4 Constraints
- ★ 3 Constraints
- Other Roads
- Streams
- Waterbody
- Town Boundary

This map was created as part of LCPC's Watershed Grant to conduct an assessment of erosion on Class 3 and 4 town roads in Wolcott.

The map represents the GIS analysis of Class 3 and 4 town roads to prioritize road areas for field assessment. The results show the priority ranking of roads based on the presence of these constraints: road/stream intersections, roads near streams, roads near wetlands, erodible soils and steep slopes.

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Map created by LCPC, 2013.

For planning purposes only. Not for regulatory interpretation.

Appendix B – Scoring Matrix

Scoring Matrix

Volume	add	Steepness ~ Velocity	add	Soil Cover	add	Opportunity for Deposition	add	Total
High Vol	3	Steep	3	Bare	3	Much Depo	30%	11.7
	3		3		3	Some Depo	20%	10.8
	3		3		3	Low Depo	10%	9.9
	3		3	Veg	2	Much Depo	30%	10.4
	3		3		2	Some Depo	20%	9.6
	3		3		2	Low Depo	10%	8.8
	3		3	Stone	1	Much Depo	30%	9.1
	3		3		1	Some Depo	20%	8.4
	3		3		1	Low Depo	10%	7.7
	3	Moderate	2	Bare	3	Much Depo	30%	10.4
	3		2		3	Some Depo	20%	9.6
	3		2		3	Low Depo	10%	8.8
	3		2	Veg	3	Much Depo	30%	10.4
	3		2		2	Some Depo	20%	8.4
	3		2		2	Low Depo	10%	7.7
	3		2	Stone	1	Much Depo	30%	7.8
	3		2		1	Some Depo	20%	7.2
	3		2		1	Low Depo	10%	6.6
	3	Shallow	1	Bare	3	Much Depo	30%	9.1
	3		1		3	Some Depo	20%	8.4
	3		1		3	Low Depo	10%	7.7
	3		1	Veg	2	Much Depo	30%	7.8
	3		1		2	Some Depo	20%	7.2
	3		1		2	Low Depo	10%	6.6
	3		1	Stone	1	Much Depo	30%	6.5
	3		1		1	Some Depo	20%	6
	3		1		1	Low Depo	10%	5.5
Med Vol	2	Steep	2	Bare	3	Much Depo	30%	9.1
	2		2		3	Some Depo	20%	8.4
	2		2		3	Low Depo	10%	7.7
	2		2	Veg	2	Much Depo	30%	7.8
	2		2		2	Some Depo	20%	7.2
	2		2		2	Low Depo	10%	6.6
	2		2	Stone	1	Much Depo	30%	6.5
	2		2		1	Some Depo	20%	6
	2		2		1	Low Depo	10%	5.5
	2	Moderate	1	Bare	3	Much Depo	30%	7.8
	2		1		3	Some Depo	20%	7.2
	2		1		3	Low Depo	10%	6.6
	2		1	Veg	2	Much Depo	30%	6.5
	2		1		2	Some Depo	20%	6
	2		1		2	Low Depo	10%	5.5
	2		1	Stone	1	Much Depo	30%	5.2
	2		1		1	Some Depo	20%	4.8
	2		1		1	Low Depo	10%	4.4

Scoring Matrix

Volume	add	Steepness ~ Velocity	add	Soil Cover	add	Opportunity for Deposition	add	Total
	2	Shallow	0	Bare	3	Much Depo	30%	6.5
	2		0		3	Some Depo	20%	6
	2		0		3	Low Depo	10%	5.5
	2		0	Veg	2	Much Depo	30%	5.2
	2		0		2	Some Depo	20%	4.8
	2		0		2	Low Depo	10%	4.4
	2		0	Stone	1	Much Depo	30%	3.9
	2		0		1	Some Depo	20%	3.6
	2		0		1	Low Depo	10%	3.3
Low Vol	1	Steep	1	Bare	3	Much Depo	30%	6.5
	1		1		3	Some Depo	20%	6
	1		1		3	Low Depo	10%	5.5
	1		1	Veg	2	Much Depo	30%	5.2
	1		1		2	Some Depo	20%	4.8
	1		1		2	Low Depo	10%	4.4
	1		1	Stone	1	Much Depo	30%	3.9
	1		1		1	Some Depo	20%	3.6
	1		1		1	Low Depo	10%	3.3
	1	Moderate	0	Bare	3	Much Depo	30%	5.2
	1		0		3	Some Depo	20%	4.8
	1		0		3	Low Depo	10%	4.4
	1		0	Veg	2	Much Depo	30%	3.9
	1		0		2	Some Depo	20%	3.6
	1		0		2	Low Depo	10%	3.3
	1		0	Stone	1	Much Depo	30%	2.6
	1		0		1	Some Depo	20%	2.4
	1		0		1	Low Depo	10%	2.2
	1	Shallow	0	Bare	3	Much Depo	30%	5.2
	1		0		3	Some Depo	20%	4.8
	1		0		3	Low Depo	10%	4.4
	1		0	Veg	2	Much Depo	30%	3.9
	1		0		2	Some Depo	20%	3.6
	1		0		2	Low Depo	10%	3.3
	1		0	Stone	1	Much Depo	30%	2.6
	1		0		1	Some Depo	20%	2.4
	1		0		1	Low Depo	10%	2.2

Appendix C – Mapped Erosion Sites

Site ID	Road Name	Class	Town	Erosion Category	Erosion Location	VOLUME	STEEPNESS	SOIL COVER	DEPOSITION	Total Score	Culvert Material	Culvert Owner	Culvert Condition	COMMENT
AND2	Andrews Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Incised ditch. Low deposition to stream. Sunken road.
AND3	Andrews Rd	3	Cambridge	SLUMP	ROADWAY SHOULDER	LOW	STEEP >15	BARE	HIGH	9.10				Road shoulder slump direct to stream. Upstream culvert partially plugged.
AND3a	Andrews Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Incised ditch with evidence of sediment transport. Potentially good trap location
AND4	Andrews Rd	3	Cambridge	SLUMP	ROADWAY SHOULDER	LOW	STEEP >15	BARE	HIGH	9.10				Culvert armoring slumping. Ditch in good shape - vegetated.
BAH1	Bartlett Hill Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	MOD 5-15	BARE	LOW	6.60				Ditch eroding to old road bed. Bare earth. Low sediment transport to stream.
BAH1a	Bartlett Hill Rd	3	Cambridge	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	LOW	5.50				Incised ditch to culvert w/scoured outlet creating channel. Potentially good trap site
BAH2	Bartlett Hill Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Incised ditch to vegetated swale to culvert. Low concern of sediment transport to stream.
BRY1	Bryce Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	MOD 5-15	VEGETATION	LOW	5.50				Vegetated ditch in good shape. Culvert outlets to wooded gully. Low concern.
CF1	CountyFarm Rd	3	Cambridge	GULLY/INCISION	DITCH	MEDIUM	LOW <5	BARE	MEDIUM	7.20				Uphill stream overflows to ditch/culvert w/direct channel to stream.
CF3	CountyFarm Rd	3	Cambridge	STREAM/DITCH SCOUR	CULVERT ENDWALL	HIGH	LOW <5	BARE	HIGH	9.10	HDPE	TOWN	GOOD	Uphill stream to triple 2' culverts. Scoured at endwall. Needs outlet protection
CY1	Canyon Rd	3	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	HIGH	MOD 5-15	BARE	MEDIUM	9.60				Erosion occurring down established hiking trail. Needs dam/steps. Possible partnership w/state
CY1a	Canyon Rd	3	Cambridge	GULLY/INCISION	DITCH	HIGH	STEEP >15	VEGETATION	HIGH	10.40				Incised ditch to culvert. Outlet creating incisin in bank. Inadequate armoring. Good site.
CY2	Canyon Rd	3	Cambridge	SLUMP	ROADWAY SHOULDER	HIGH	LOW <5	BARE	HIGH	9.10				Engineering site. No GPS point (Could not obtain satellite lock). Road slumping into stream.
CY3	Canyon Rd	3	Cambridge	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	MEDIUM	6.00				Engineering site. No GPS point (Could not obtain satellite lock). Incised ditch to culvert direct to stream.
CY4	Canyon Rd	3	Cambridge	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	MEDIUM	6.00	CMP	TOWN	FAIR	Incised ditch to culvert direct to stream. Evidence of deposition in stream. Good trap location
DJ1	Desjardins Rd	3	Cambridge	STREAM/DITCH SCOUR	DITCH	MEDIUM	LOW <5	VEGETATION	HIGH	6.50	HDPE	TOWN	FAIR	
DJ2	Desjardins Rd	3	Cambridge	RILL	ROADWAY SHOULDER	LOW	LOW <5	BARE	LOW	5.50				No outlet to stream. Minor erosion
HU1	Huntley Rd	3	Cambridge	GULLY/INCISION	DITCH	MEDIUM	MOD 5-15	VEGETATION	LOW	6.60				Road shoulder/ditch eroding to large trap/culvert. N Cam. Rd contributing. Low erosion to water
IG1	Iron Gates Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Eroded ditch. Outlets to vegetated swale before wetland. Low concern.
IG2	Iron Gates Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Incised ditch. Outlets to vegetated swale. Small sediment basin in place. Low concern
IG3	Iron Gates Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Incised ditch. Outlets to vegetated swale before culvert to wetland. Potentially good trap site
NC3	N. Cambridge Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Vegetated ditch to 3' Hdpe culvert. Streamgoes through culvert. Possible trap location
NC5	N. Cambridge Rd	3	Cambridge	STREAM/DITCH SCOUR	DITCH	LOW	LOW <5	BARE	LOW	5.50	HDPE	TOWN	GOOD	Minor erosion on road shoulder. No sediment transport to stream.
PO3	Pollander Rd	3	Cambridge	RILL	ROADWAY	LOW	LOW <5	BARE	LOW	6.00	HDPE	PRIVATE	POOR	Culvert blocked
PO6	Pollander Rd	3	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				Ditch incised - outlets to vegetated field before wetland. Low sediment transport.
RF1	Rushford Rd	3	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	MEDIUM	LOW <5	STONE	LOW	4.40				Some erosion @ intersection. Ditch stone-lined. Little/no evidence of sediment transport.
RO1	Robinson Rd	3	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	MEDIUM	MOD 5-15	VEGETATION	LOW	6.60				Road runoff creating channel in woods. Sediment plume to lower ditch. Road regrade?
RO2	Robinson Rd	3	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	HIGH	LOW <5	STONE	LOW	5.50				Incised ditch to new stone swale. Evidence of deposition thru culvert across road in wetland.
TAN1	Tanner Rd	3	Cambridge	GULLY/INCISION	ROADWAY SHOULDER	LOW	LOW <5	VEGETATION	LOW	4.40				Incised ditch to vegetated swale. Likely no sediment transport.
TAN4	Tanner Rd	3	Cambridge	GULLY/INCISION	DITCH	MEDIUM	MOD 5-15	STONE	HIGH	6.50				Incised ditch to stream. Evidence of deposition. Good site.
TPS1	Thompson Rd	3	Cambridge	RILL	ROADWAY SHOULDER	MEDIUM	MOD 5-15	VEGETATION	MEDIUM	7.20				Sediment plume in ditch, incised channel to stream. Rill erosion alongThompson Rd.
WF2	West Farm Rd	4	Cambridge	SLUMP	ROADWAY SHOULDER	LOW	STEEP >15	BARE	MEDIUM	8.40				Road slumping direct to stream.
WF2a	West Farm Rd	4	Cambridge	GULLY/INCISION	DITCH	LOW	LOW <5	STONE	HIGH	3.90				
BCH NEW	Beach Rd	3	Elmore	STREAM/DITCH SCOUR	DITCH	LOW	MOD 5-15	BARE	MEDIUM	7.20				NEW? New ditch deposits direct to stream. Ev. of incision in ditch.
BCH1	Beach Rd	3	Elmore	RILL	ROADWAY SHOULDER	LOW	LOW <5	VEGETATION	MEDIUM	4.80				ditch repaired and inlet point rock armored. ditch outlets to small wetland and stream.
BCH2	Beach Rd	3	Elmore	RILL	ROADWAY SHOULDER	LOW	LOW <5	BARE	MEDIUM	6.00				fixed. stone lined catchment at stream inlet.
BCH3	Beach Rd	3	Elmore	RILL		LOW	LOW <5	BARE	LOW	5.50				Fixed . no evidence of erosion . Ditch in good shape.
BCH4	Beach Rd	3	Elmore	RILL		LOW	LOW <5	BARE	LOW	5.50				Fixed. Ditch in good shape, no erosion. grade reversal in ditch for sediment/flow control.
BCH5	Beach Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	MEDIUM	8.40				
BCH6	Beach Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	STEEP >15	BARE	MEDIUM	9.60				
BCH7	Beach Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	LOW <5	BARE	HIGH	7.80				
BH1	Brown Hill Rd	3	Elmore	RILL	ROADWAY SHOULDER	LOW	MOD 5-15	VEGETATION	LOW	5.50				low
BH2	Brown Hill Rd	3	Elmore	GULLY/INCISION	DITCH	HIGH	LOW <5	VEGETATION	MEDIUM	7.20	RCP			engineering site
BH2a	Brown Hill Rd	3	Elmore	GULLY/INCISION	DITCH	HIGH	STEEP >15	BARE	HIGH	11.70				direct q to stream entire road section high priority - engineering site
BH3	Brown Hill Rd	3	Elmore	SLUMP	ROADWAY SHOULDER	HIGH	STEEP >15	BARE	HIGH	11.70				Slump incision ditched stream maybe eng fix
CR1	Cross Rd	4	Elmore	RILL	ROADWAY SHOULDER	LOW	MOD 5-15	VEGETATION	LOW	5.50				Some road erosion - torn up from logging. Vegetated ditch to stream. Little /no sediment in ditch
EG2	Earl Gray Rd	3	Elmore	SLUMP	ROADWAY SHOULDER	LOW	STEEP >15	BARE	HIGH	9.10				
EL1	Eagle Ledge Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.1				trail completely flooded by beaver ponds.
EL2	Eagle Ledge Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.1				
EL3	Eagle Ledge Rd	4	Elmore	INCISION	IN ROADWAY	HIGH	MOD 5-15	BARE	HIGH	10.4	HDPE	Town	Good	new culvert
EL4	Eagle Ledge Rd	4	Elmore	SLUMP	IN ROADWAY	MEDIUM	LOW <5	BARE	LOW	6.6				
EL5	Eagle Ledge Rd	4	Elmore	SLUMP	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.1	Metal	Town	POOR	
EL6	Eagle Ledge Rd	4	Elmore	SLUMP	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.1				trail completely flooded
EL7	Eagle Ledge Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.1				trail completely flooded by beaver ponds.
EL8	Eagle Ledge Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.1				
EM1	Elmore Mountain Rd	3	Elmore	GULLY/INCISION	DITCH	MEDIUM	STEEP >15	BARE	HIGH	10.40				good fix
EM2	Elmore Mountain Rd	3	Elmore	GULLY/INCISION	DITCH	MEDIUM	MOD 5-15	VEGETATION	HIGH	7.80				
EM7	Elmore Mountain Rd	3	Elmore	GULLY/INCISION		LOW	MOD 5-15	BARE	HIGH	7.80				
HF1	Hardwoods Flat Rd	4	Elmore	GULLY/INCISION	ROADWAY SHOULDER	MEDIUM	MOD 5-15	BARE	HIGH	9.10				
HF2	Hardwoods Flat Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	LOW	LOW <5	BARE	LOW	5.50				
HF3	Hardwoods Flat Rd	4	Elmore	GULLY/INCISION	ROADWAY SHOULDER	LOW	MOD 5-15	BARE	MEDIUM	7.20				
HF4	Hardwoods Flat Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	LOW	LOW <5	BARE	LOW	5.50				

Site ID	Road Name	Class	Town	Erosion Category	Erosion Location	VOLUME	STEEPNESS	SOIL COVER	DEPOSITION	Total Score	Culvert Material	Culvert Owner	Culvert Condition	COMMENT
HF5	Hardwoods Flat Rd	4	Elmore	STREAM/DITCH SCOUR	IN ROADWAY	LOW	LOW <5	BARE	HIGH	6.50	Metal	Town	Fair	
HF6	Hardwoods Flat Rd	4	Elmore	SLUMP	IN ROADWAY	LOW	LOW <5	BARE	HIGH	6.50	Metal	Town	Fair	old culvert is too short and road sinking where it ends; new 18 inch culvert put in 50 feet away., in good condition
HF7	Hardwoods Flat Rd	4	Elmore	RILL	IN ROADWAY	LOW	LOW <5	BARE	MEDIUM	6.00				
HF9	Hardwoods Flat Rd	4	Elmore	SLUMP	DITCH	MEDIUM	MOD 5-15	VEGETATION	LOW	6.60				steep sided deep ditch
HF12	Hardwoods Flat Rd	3	Elmore	GULLY/INCISION	IN ROADWAY	LOW	MOD 5-15	BARE	LOW	6.60				
ML1	Mitchell Lane	3	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	MOD 5-15	BARE	HIGH	10.40				
SM NEW	Simmons Mill Rd	3	Elmore							0.00				Unmapped Raw ditch bank.
SM1	Simmons Mill Rd	3	Elmore	GULLY/INCISION	ROADWAY SHOULDER	MEDIUM	STEEP >15	VEGETATION	LOW	7.70				
SM2	Simmons Mill Rd	3	Elmore	GULLY/INCISION	ROADWAY SHOULDER	LOW	LOW <5	VEGETATION	LOW	4.40				
SM3	Simmons Mill Rd	3	Elmore	STREAM/DITCH SCOUR	DITCHED STREAM	HIGH	LOW <5	VEGETATION	HIGH	7.80				engineeering site
SM4	Simmons Mill Rd	3	Elmore	GULLY/INCISION	DITCH	HIGH	LOW <5	STONE	HIGH	6.50				Deep ditch. Good trap location.
T NEW	Tallman Rd	3	Elmore	SLUMP	CULVERT ENDWALL	LOW	LOW <5	BARE	MEDIUM	6.00	HDPE	PRIVATE	POOR	bare ditch slopes erosion at road pipe discharge incision from private dr
T1	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	STEEP >15	BARE	MEDIUM	10.80				
T2	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	LOW <5	BARE	MEDIUM	7.20				
T3	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	LOW <5	BARE	LOW	6.60				
T4	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	MEDIUM	8.40				
T5	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	HIGH	LOW <5	BARE	HIGH	9.10	Metal	Town	POOR	culvert crushed. in middle and not touching water at inlet, bridge. Or boardwalk needed.
T6	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	MEDIUM	8.40				
T7	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	HIGH	9.10	Metal	Town	Good	2 culverts, one in very poor condition and completely plugged, buried.
T8	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	MEDIUM	8.40	Metal	Town	POOR	culvert crushed at outlet and completely exposed in roadbed.
T9	Tallman Rd	4	Elmore	GULLY/INCISION	IN ROADWAY	LOW	LOW <5	BARE	HIGH	6.50				
T10	Tallman Rd	3	Elmore	GULLY/INCISION	ROADWAY SHOULDER	MEDIUM	LOW <5	VEGETATION	LOW	5.50	Metal	Town	Fair	double culvert. 18 and 24 incb.
T11	Tallman Rd	3	Elmore	STREAM/DITCH SCOUR	DITCH	LOW	MOD 5-15	BARE	MEDIUM	7.20	HDPE	Town	Fair	ditch erosion, lots of sediment. Sides of road starting to erode. Cross culverts needed? Undersized.
BB1	Baldwin Brook Rd	3	Wolcott	GULLY/INCISION	ROADWAY SHOULDER	LOW	STEEP >15	BARE	LOW	7.70				
BB2	Baldwin Brook Rd	3	Wolcott	INCISION	ROADWAY SHOULDER	MEDIUM	LOW <5	BARE	MEDIUM	7.20	HDPE	Town	Poor	
BB3	Baldwin Brook Rd	3	Wolcott	RILL	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40	Concrete	Town	Good	
BB NEW 3	Baldwin Brook Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	3.30				no depo minor
BRK1	Brook Rd	3	Wolcott	RILL	ROADWAY SHOULDER	LOW	LOW <5	STONE	LOW	3.30				minor erosion low priority
COR1	Corlley Rd	4	Wolcott	INCISION	IN ROADWAY	LOW	MOD 5-15	BARE	MEDIUM	7.20				well vegetated ditches both sides of road, no visible culverts.
COR2	Corlley Rd	4	Wolcott	INCISION	IN ROADWAY	LOW	STEEP >15	BARE	MEDIUM	8.40				evidence of road erosion, lots of gravel dumped and spread recently.
COR3	Corlley Rd	4	Wolcott	GULLY/INCISION	ROADWAY SHOULDER	LOW	STEEP >15	BARE	HIGH	9.10				
COR4	Corlley Rd	4	Wolcott	SLUMP	ROADWAY SHOULDER	LOW	MOD 5-15	BARE	MEDIUM	7.20	Metal	Private	Poor	
EH NEW	East Hill Rd	3	Wolcott	STREAM/DITCH SCOUR	CULVERT HEADWALL	HIGH	LOW <5	BARE	HIGH	9.10	HDPE			new erosion mapped by WCA
EH1	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	3.30				minor
EH2	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				
EH3	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40	RCP			
EH4	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	HIGH	6.50				instream scour at q
EH4a	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	LOW	5.50				
EH5	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	LOW	5.50				
EH5a	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				
EH6	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40	Metal	Town	Fair	
EH7	East Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				v minor
FS1	Foss Rd	4	Wolcott	GULLY/INCISION	IN ROADWAY	LOW	MOD 5-15	BARE	MEDIUM	7.20	Metal	Town	Poor	
FS2	Foss Rd	4	Wolcott	INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	LOW	7.70				
FS3	Foss Rd	4	Wolcott	INCISION	IN ROADWAY	MEDIUM	MOD 5-15	BARE	MEDIUM	8.40				
FS4	Foss Rd	4	Wolcott	SLUMP	IN ROADWAY	MEDIUM	LOW <5	BARE	HIGH	7.80	HDPE	Town	Good	
FS5	Foss Rd	4	Wolcott	SLUMP	IN ROADWAY	LOW	LOW <5	BARE	MEDIUM	7.20	Metal	Town	Good	
JR1	Jones Rd	3	Wolcott	RILL	ROADWAY SHOULDER	LOW	MOD 5-15	STONE	LOW	4.40				possible trap
JR2	Jones Rd	3	Wolcott	RILL	ROADWAY SHOULDER	LOW	MOD 5-15	VEGETATION	MEDIUM	6.00				stream close but not lots ofdelivery
KLR5	Keeler Pond Rd	3	Wolcott	RILL	IN ROADWAY	LOW	LOW <5	VEGETATION	LOW	4.40				
KLR6	Keeler Pond Rd	3	Wolcott	GULLY/INCISION	DITCH	MEDIUM	LOW <5	VEGETATION	LOW	5.50				significant ditch but good capture
KLR6a	Keeler Pond Rd	3	Wolcott	RILL	IN ROADWAY	LOW	LOW <5	VEGETATION	LOW	4.40				minor build up rd and crown
KLR7	Keeler Pond Rd	3	Wolcott	INCISION	ROADWAY SHOULDER	LOW	LOW <5	VEGETATION	LOW	3.30				
KLR8	Keeler Pond Rd	3	Wolcott	SLUMP	DITCHED STREAM	LOW	STEEP >15	BARE	HIGH	9.10				some rilling off rd too. sheet from rd causing slump
KLR9	Keeler Pond Rd	3	Wolcott	RILL	ROADWAY SHOULDER	LOW	LOW <5	VEGETATION	LOW	4.40				
KLR10	Keeler Pond Rd	3	Wolcott	RILL	IN ROADWAY	LOW	MOD 5-15	BARE	LOW	6.60				
KLR10a	Keeler Pond Rd	3	Wolcott	RILL	IN ROADWAY	LOW	MOD 5-15	BARE	MEDIUM	7.20				green ridge should be depressed
KLR11	Keeler Pond Rd	3	Wolcott	RILL	IN ROADWAY	LOW	LOW <5	VEGETATION	LOW	4.40				minor
MH1	Morey Hill Rd	3	Wolcott	RILL	IN ROADWAY	LOW	STEEP >15	BARE	HIGH	9.10	Metal	Town	Fair	fix cut high grass berm for sheetflow
MH2	Morey Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	LOW	LOW <5	VEGETATION	LOW	4.40				
SH1	Sand Hill Rd	3	Wolcott	RILL	ROADWAY SHOULDER	HIGH	LOW <5	BARE	LOW	7.70				drains to trap
SH1a	Sand Hill Rd	3	Wolcott	RILL	ROADWAY SHOULDER	HIGH	LOW <5	VEGETATION	MEDIUM	7.20				high dep to dry wetland

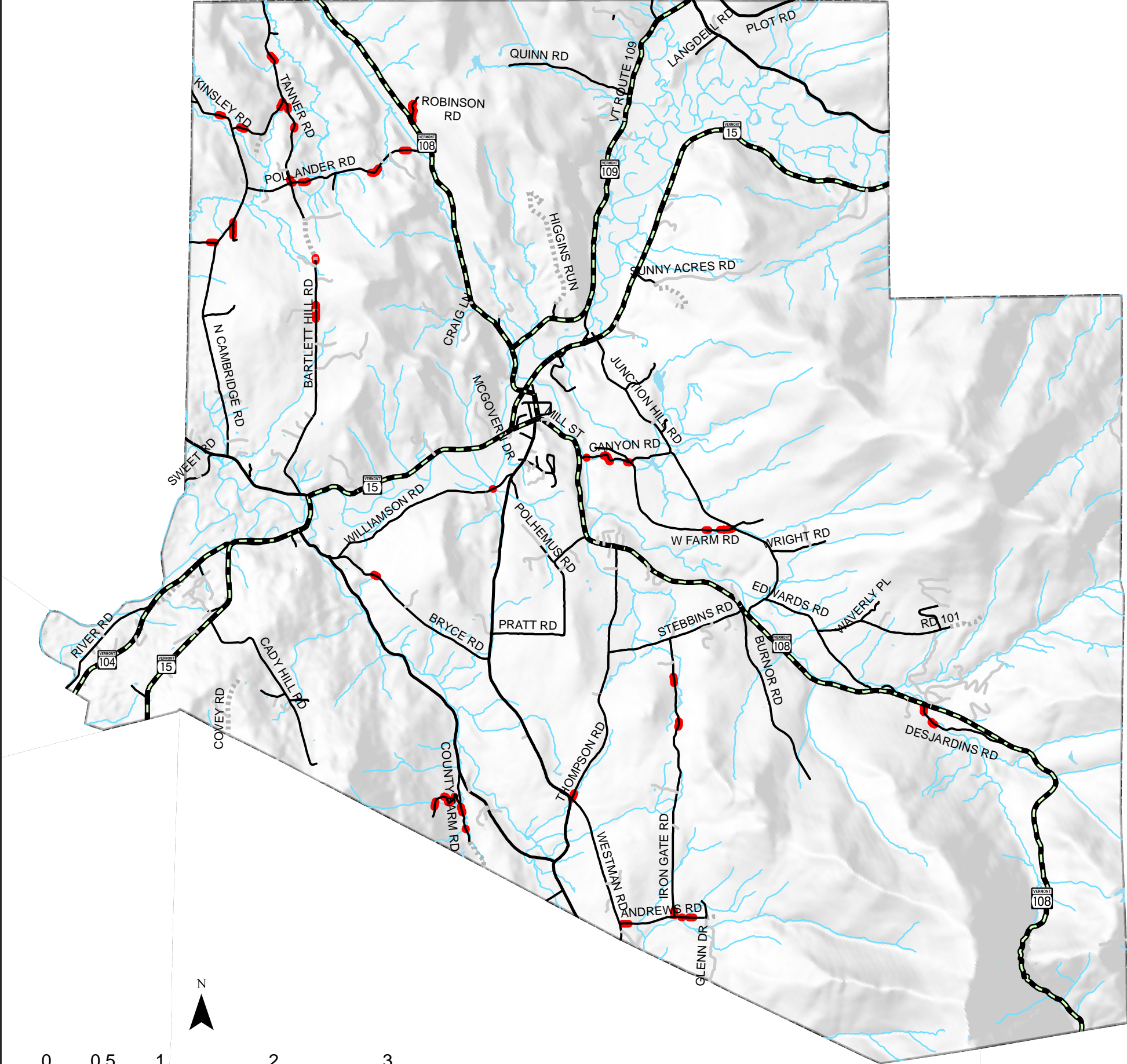
Site ID	Road Name	Class	Town	Erosion Category	Erosion Location	VOLUME	STEEPNESS	SOIL COVER	DEPOSITION	Total Score	Culvert Material	Culvert Owner	Culvert Condition	COMMENT
SH3	Sand Hill Rd	3	Wolcott	GULLY/INCISION	DITCH	MEDIUM	MOD 5-15	BARE	HIGH	9.10				ditch stoned last 15ft no stone eroded
SH3a	Sand Hill Rd	3	Wolcott	RILL	ROADWAY SHOULDER	MEDIUM	MOD 5-15	BARE	HIGH	9.10				good spot for trap
SH4	Sand Hill Rd	3	Wolcott	RILL	ROADWAY SHOULDER	MEDIUM	LOW <5	VEGETATION	LOW	5.50				both sides of rd
SH4a	Sand Hill Rd	3	Wolcott	RILL	ROADWAY SHOULDER	LOW	LOW <5	VEGETATION	MEDIUM	4.80				depo to pond erosion not severe
TCT1	Turcotte Rd	4	Wolcott	GULLY/INCISION	IN ROADWAY	MEDIUM	MOD 5-15	VEGETATION	MEDIUM	7.20				
TCT2	Turcotte Rd	4	Wolcott	STREAM/DITCH SCOUR	DITCH	MEDIUM	MOD 5-15	BARE	HIGH	9.10				
TCT4	Turcotte Rd	4	Wolcott	INCISION	ROADWAY SHOULDER	MEDIUM	MOD 5-15	STONE	MEDIUM	6.00				
TCT5	Turcotte Rd	4	Wolcott	INCISION	ROADWAY SHOULDER	MEDIUM	STEEP >15	STONE	MEDIUM	7.20	Metal	Town	Fair	
WH1	West Hill Rd	4	Wolcott	GULLY/INCISION	ROADWAY SHOULDER	LOW	MOD 5-15	BARE	LOW	6.60				
WH2	West Hill Rd	3	Wolcott	GULLY/INCISION	ROADWAY SHOULDER	LOW	MOD 5-15	BARE	LOW	6.60				
WH3	West Hill Rd	3	Wolcott	RILL	IN ROADWAY	MEDIUM	STEEP >15	VEGETATION	LOW	7.70				lower grass edge for sheet

highest priority sites (score > 7.0)

lower priority sites with design provided

full engineering fix required

Class 3 and 4 Road Erosion Assessment
Mapped Road Erosion Sites
Cambridge, Vermont



- Mapped Road Erosion Sites
- State Highway
- Class 1 and 2 Roads
- Class 3 Roads
- Class 4 Roads
- Private Roads
- Waterbodies
- Streams
- Town Boundary

This map was created as part of LCPC's Watershed Grant to conduct an assessment of erosion on Class 3 and 4 town roads in Cambridge, Wolcott and Elmore.

A GIS analysis of Class 3 and 4 town roads was conducted to prioritize road areas for field assessment. The presence or absence of five factors - stream intersections, distance to streams, distance to wetlands, steep slopes and erodible soils - was evaluated to determine probable areas of erosion with an impact on water quality. These areas were selected for field surveys.

The map represents the erosion areas documented during field surveys on prioritized road segments. Surveys were limited to Class 3 and 4 gravel roads and the areas thought to have an impact on water quality; as a result there are areas of road erosion not included on this map.

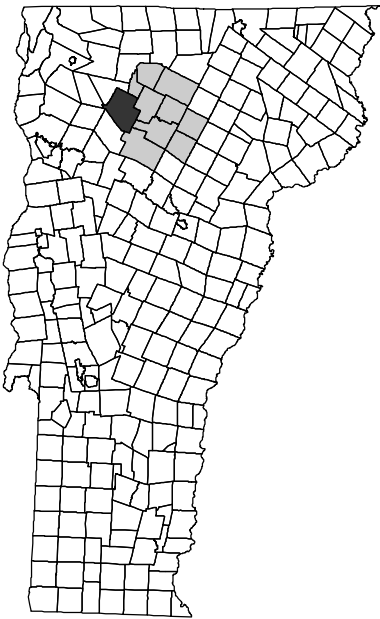
DATA SOURCES:

ROAD EROSION SITES: LCPC, 2013.

POLITICAL BOUNDARIES: 1:24000
USGS Quadrangles, VCGI, 1991.

ROADS: 1:5000 E-911 Road Data,
2012.

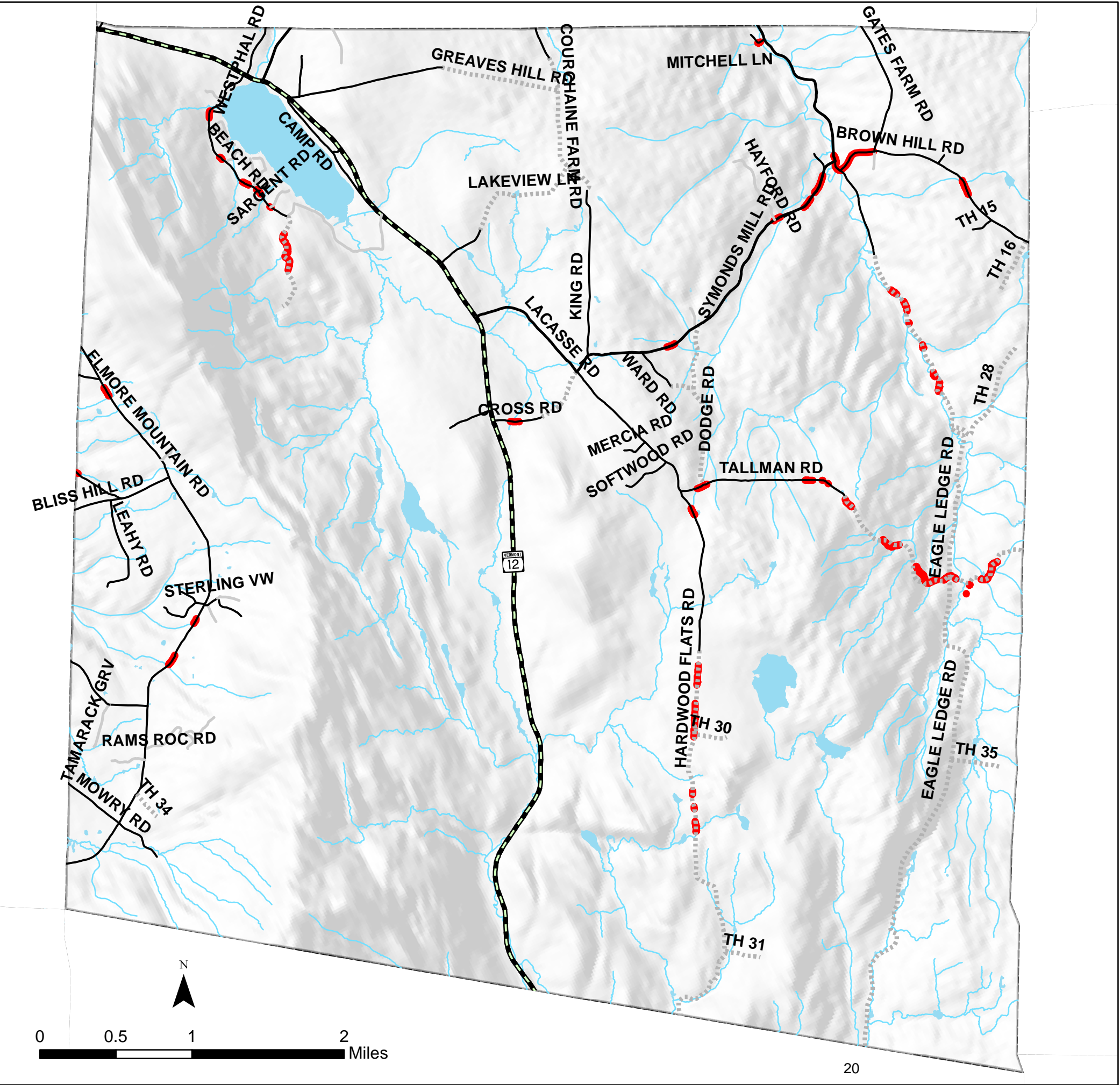
SURFACE WATER: On-screen digitized
from 1:5000 digital orthophotos using
USGS 7 1/2' quadrangles and 1:20000
color infrared aerial photography as
additional source material, VCGI for
VHD-USGS, 2001.



Map created by LCPC, 2013.

For planning purposes only. Not for regulatory interpretation.

Class 3 and 4 Road Erosion Assessment
Mapped Road Erosion Sites
Elmore, Vermont



- Mapped Road Erosion Sites
- State Highway
- Class 1 and 2 Roads
- Class 3 Roads
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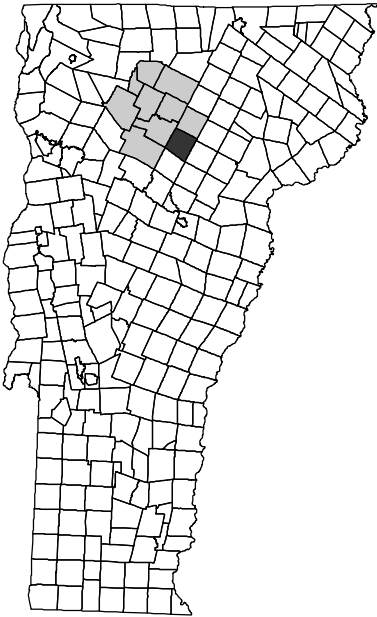
DATA SOURCES:

ROAD EROSION SITES: LCPC, 2013.

POLITICAL BOUNDARIES: 1:24000
USGS Quadrangles, VCGI, 1991.

ROADS: 1:5000 E-911 Road Data,
2012.

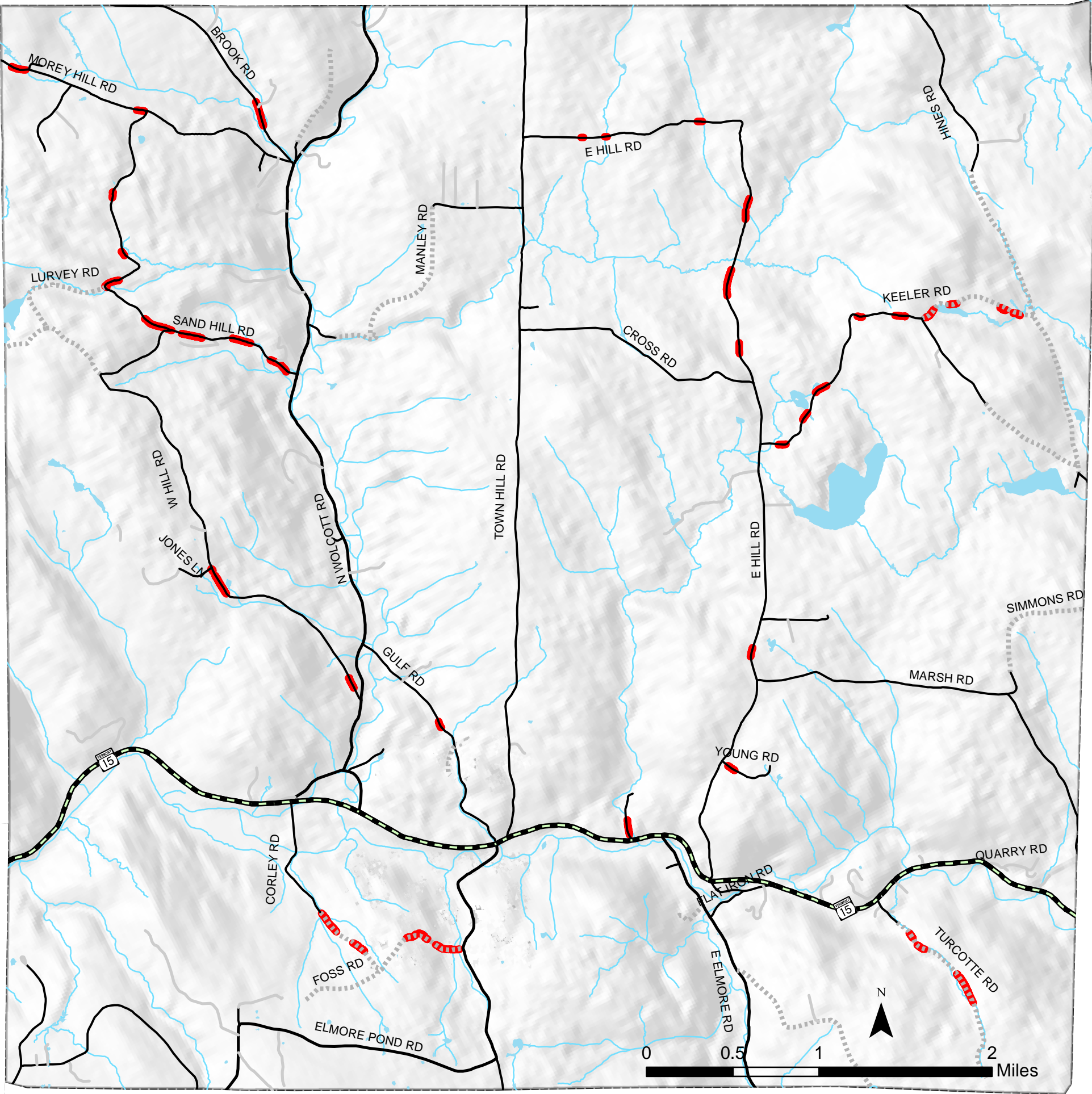
SURFACE WATER: On-screen digitized
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color infrared aerial photography as
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VHD-USGS, 2001.












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Class 3 and 4 Road Erosion Assessment
Mapped Road Erosion Sites
Wolcott, Vermont



-  Mapped Road Erosion Sites
-  State Highway
-  Class 1 and 2 Roads
-  Class 3 Roads
-  Class 4 Roads
-  Private Roads
-  Waterbodies
-  Streams
-  Town Boundary

This map was created as part of LCPC's Watershed Grant to conduct an assessment of erosion on Class 3 and 4 town roads in Cambridge, Wolcott and Elmore.

A GIS analysis of Class 3 and 4 town roads was conducted to prioritize road areas for field assessment. The presence or absence of five factors - stream intersections, distance to streams, distance to wetlands, steep slopes and erodible soils - was evaluated to determine probable areas of erosion with an impact on water quality. These areas were selected for field surveys.

The map represents the erosion areas documented during field surveys on prioritized road segments. Surveys were limited to Class 3 and 4 gravel roads and the areas thought to have an impact on water quality; as a result there are areas of road erosion not included on this map.

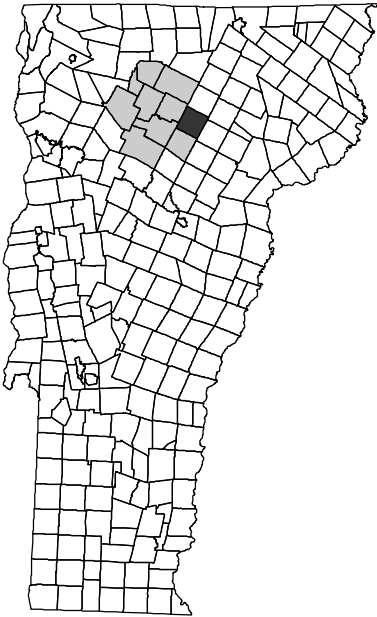
DATA SOURCES:

ROAD EROSION SITES: LCPC, 2013.

POLITICAL BOUNDARIES: 1:24000
USGS Quadrangles, VCGI, 1991.

ROADS: 1:5000 E-911 Road Data,
2012.

SURFACE WATER: On-screen digitized
from 1:5000 digital orthophotos using
USGS 7 1/2' quadrangles and 1:20000
color infrared aerial photography as
additional source material, VCGI for
VHD-USGS, 2001.

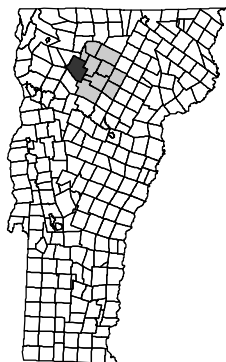
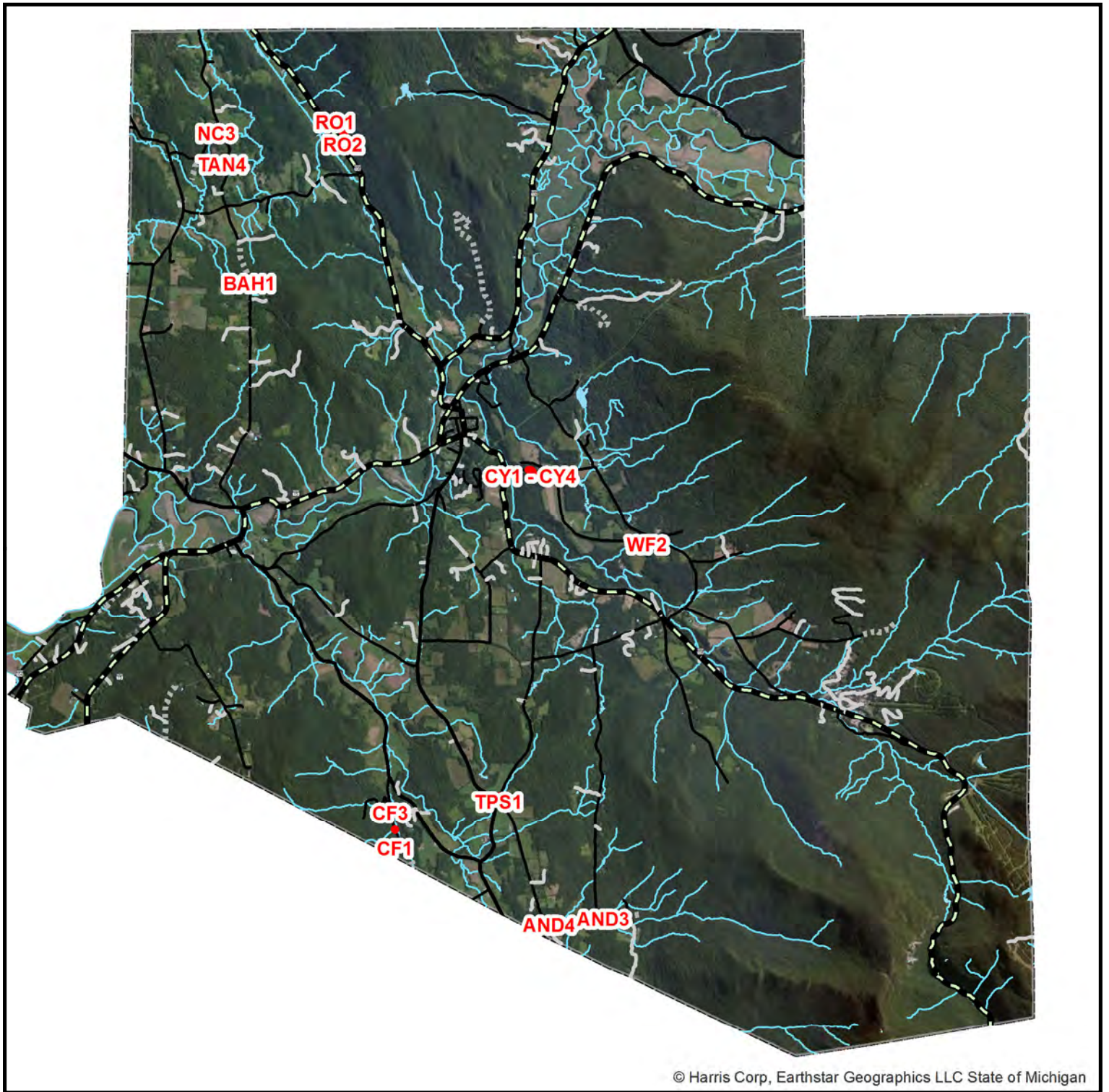


Map created by LCPC, 2013.

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Appendix D – Final Design Plans

Cambridge, Vermont - Road Erosion Repair Designs Site Locations

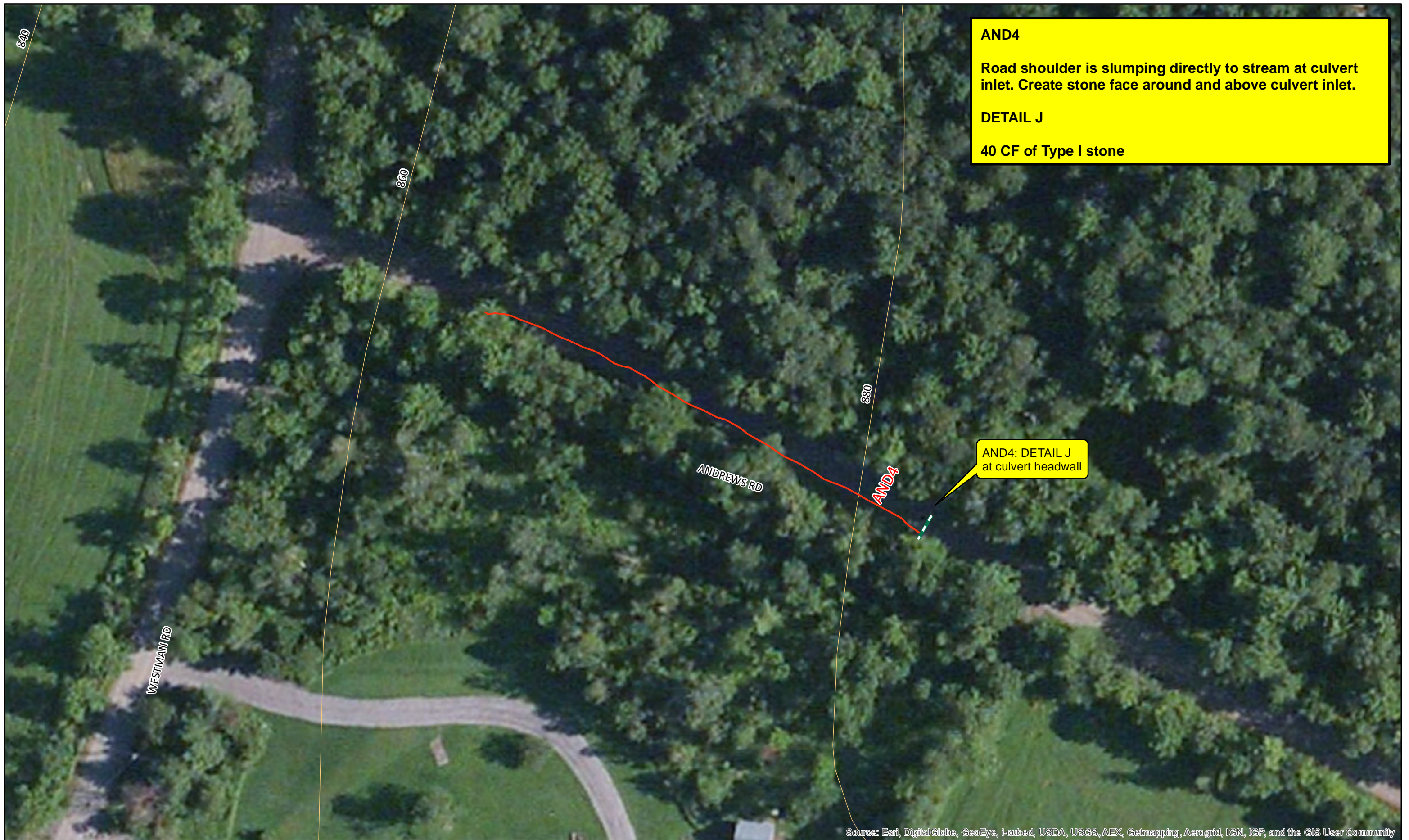


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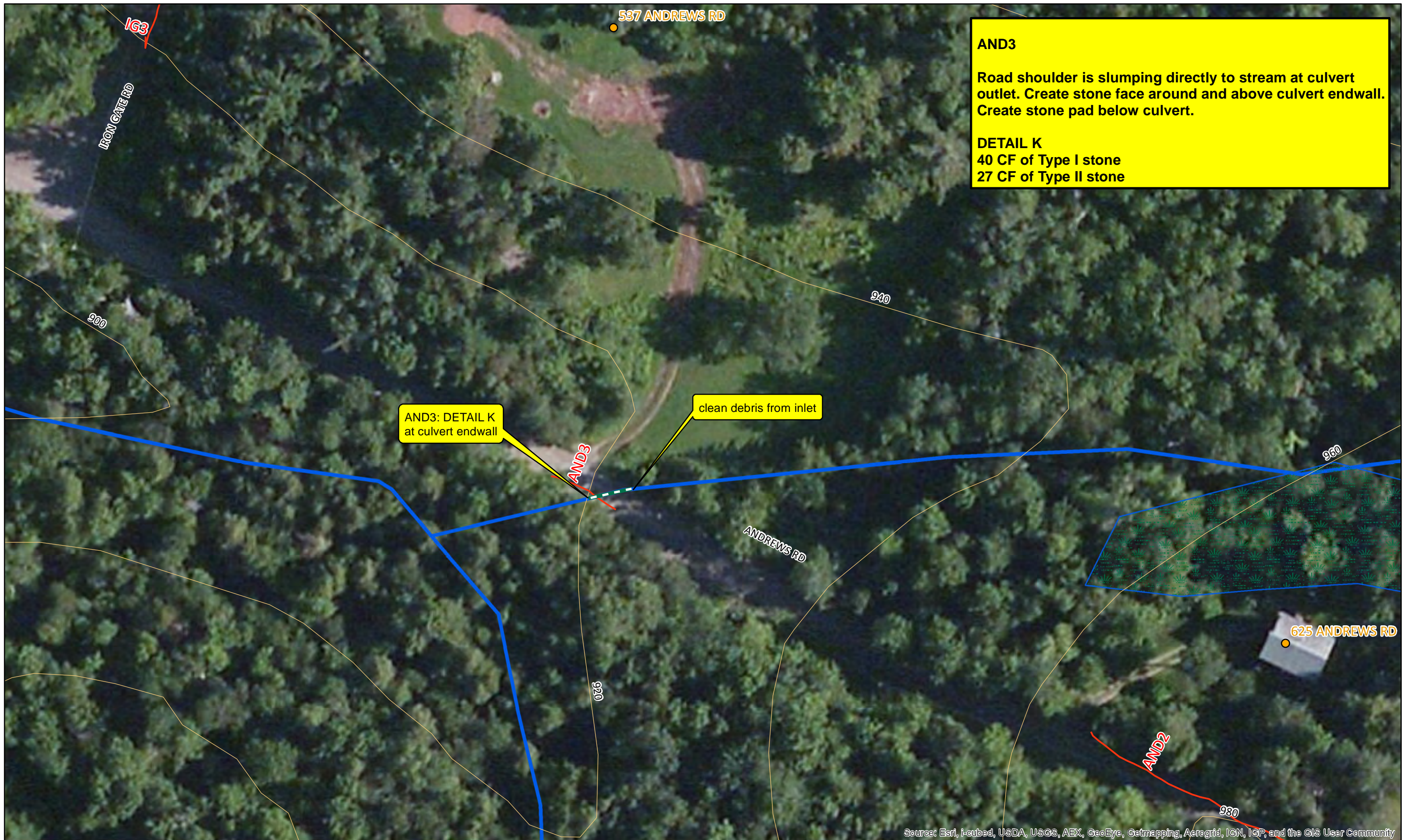
0 0.5 1 2 3 Miles

Legend

- XX#** Cambridge Site Locations
- State Highway
- Class 1 and 2 Roads
- Class 3 Roads
- Class 4 Roads
- Private Roads
- Waterbodies
- Streams







AND3

Road shoulder is slumping directly to stream at culvert outlet. Create stone face around and above culvert endwall. Create stone pad below culvert.

DETAIL K

40 CF of Type I stone

27 CF of Type II stone

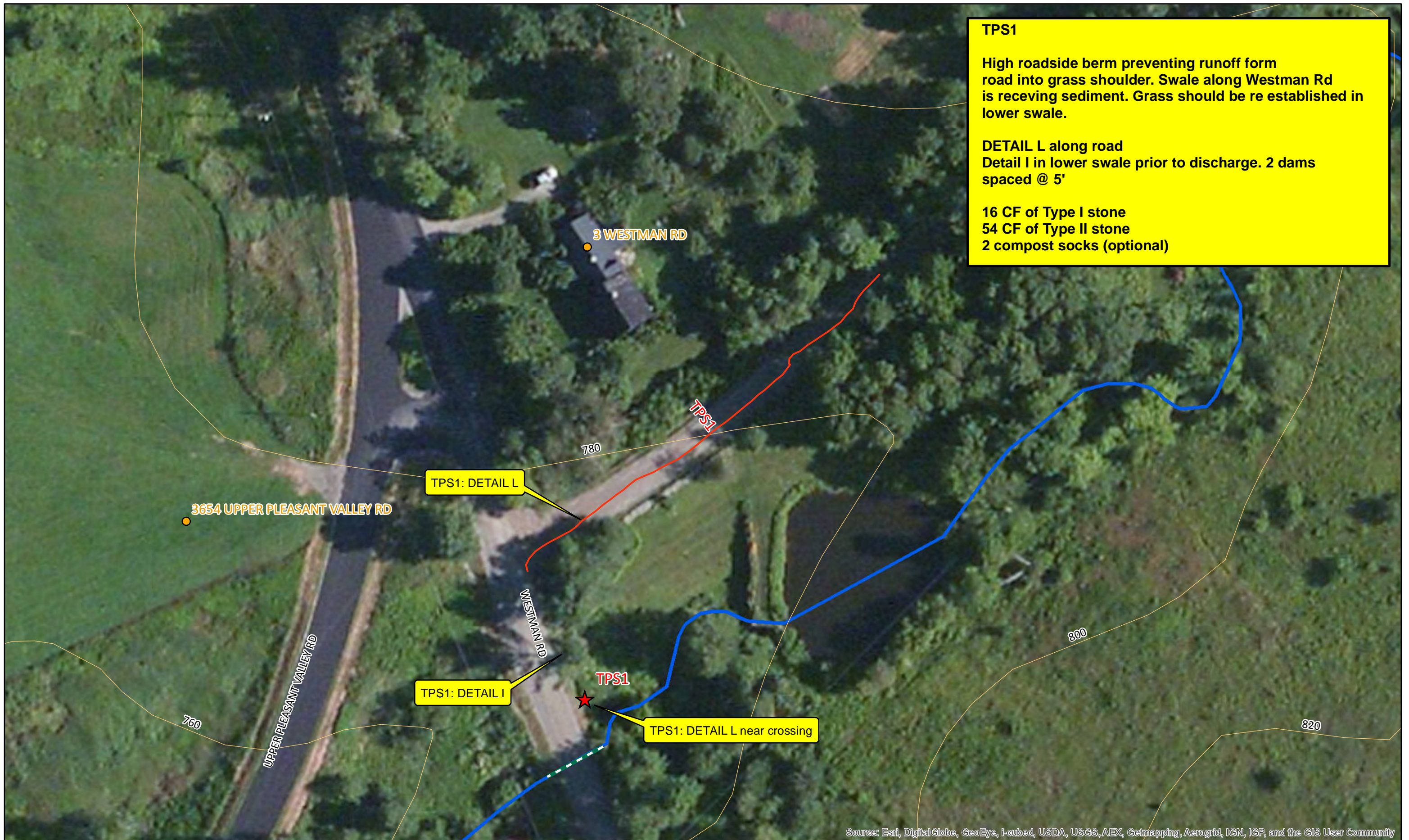
AND3: DETAIL K
at culvert endwall

clean debris from inlet

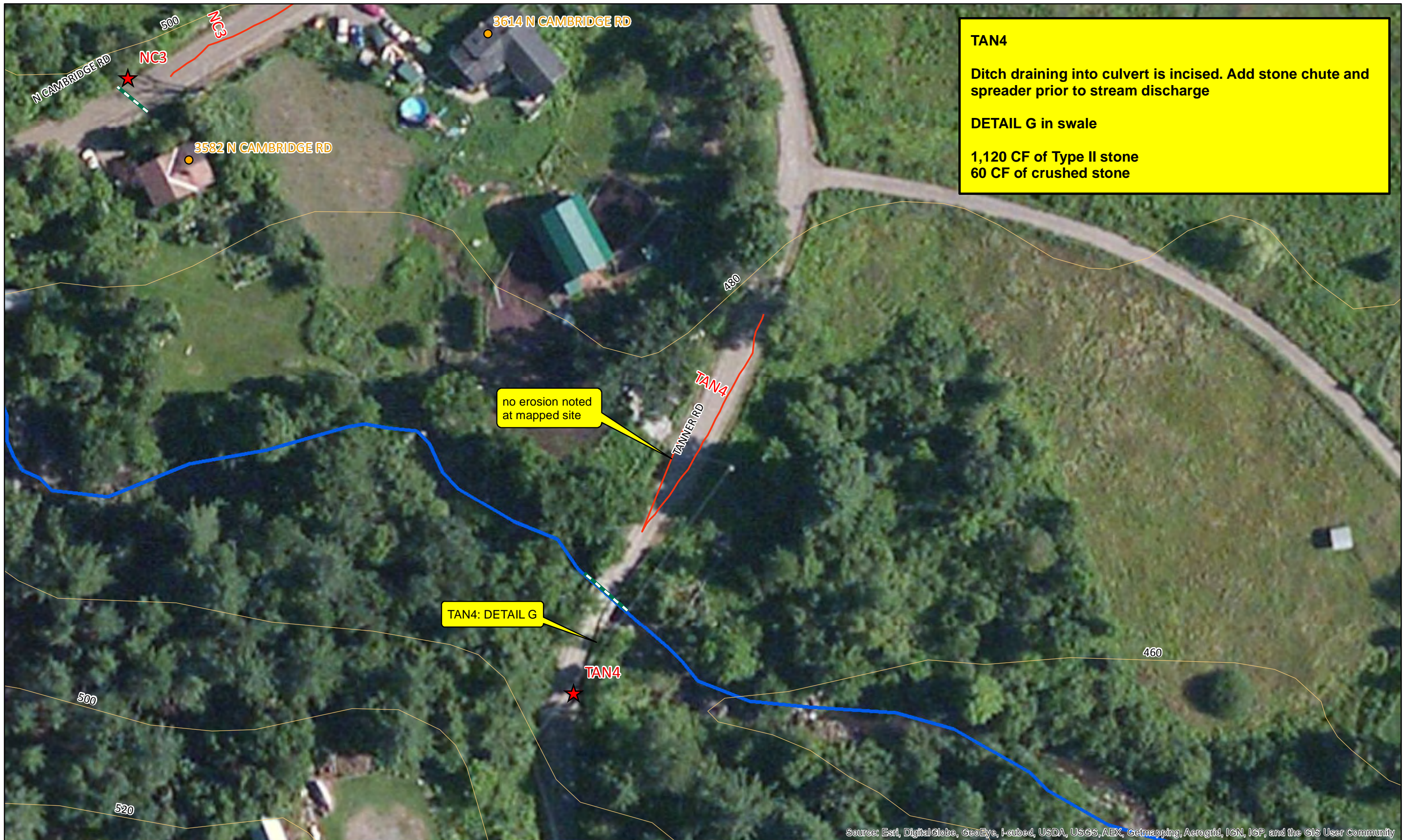
625 ANDREWS RD

Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community









TAN4

Ditch draining into culvert is incised. Add stone chute and spreader prior to stream discharge

DETAIL G in swale

1,120 CF of Type II stone
60 CF of crushed stone

no erosion noted
at mapped site

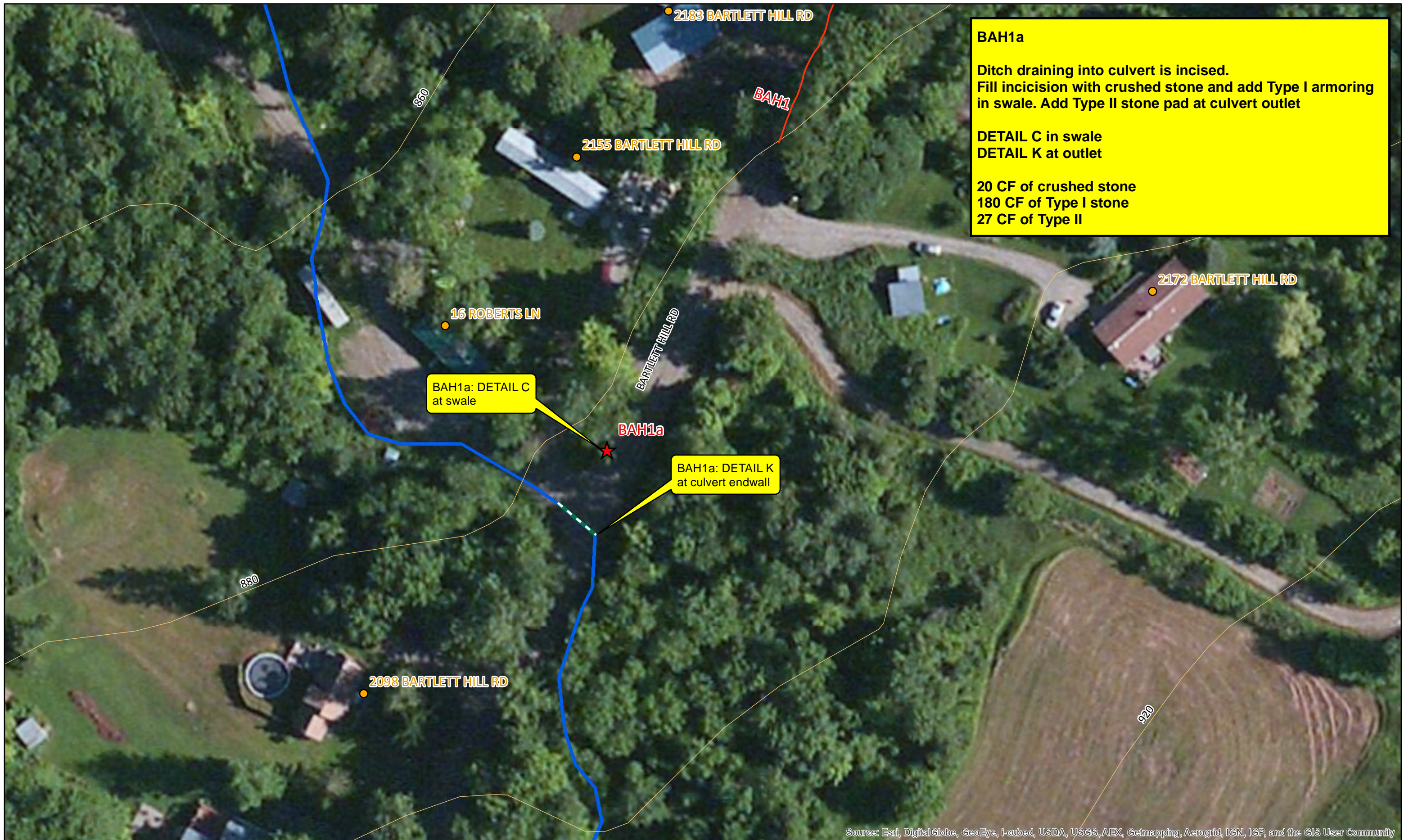
TAN4: DETAIL G

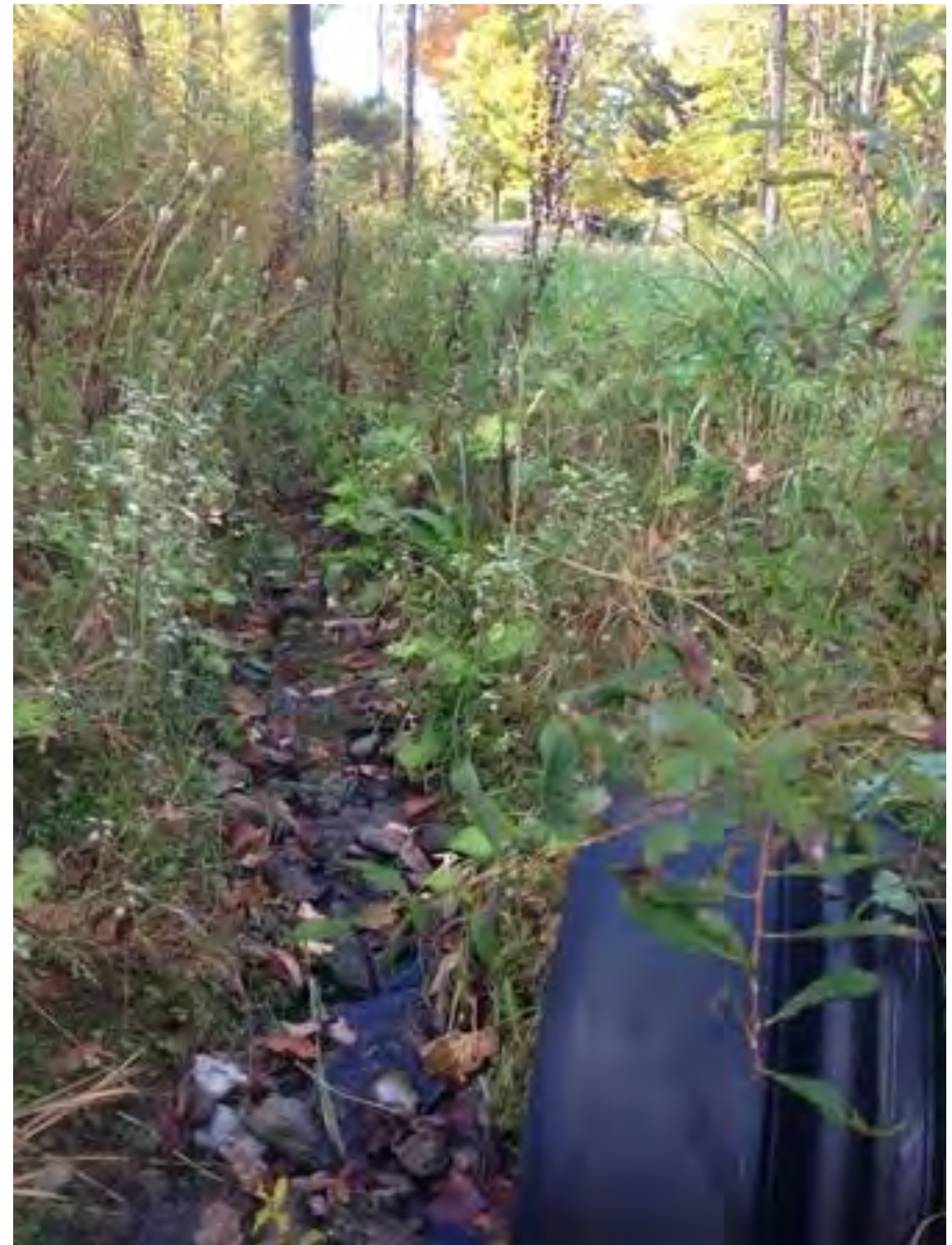
TAN4

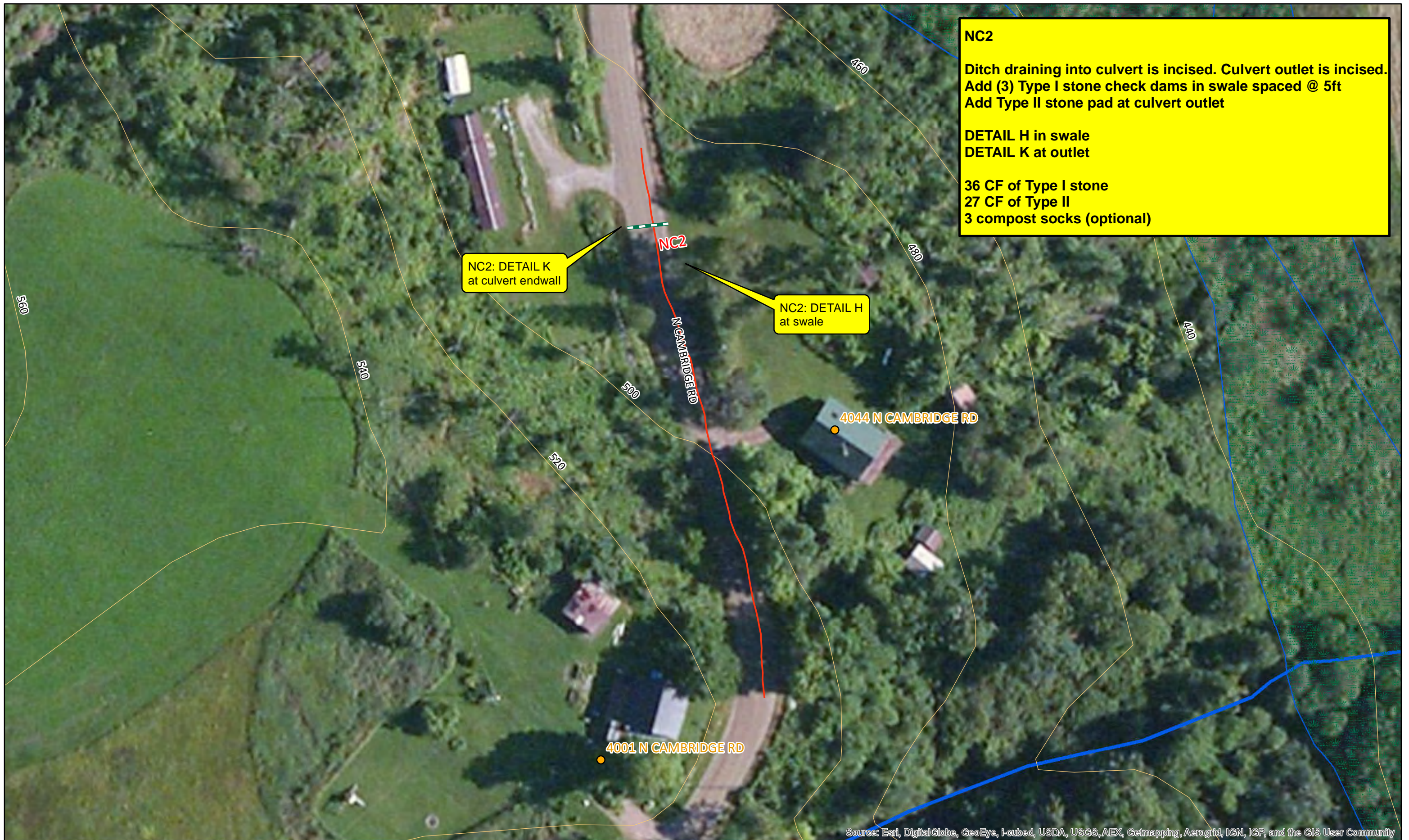
Lamoille County Erosion Study
October 15, 2013

Town: Cambridge
Site: TAN4

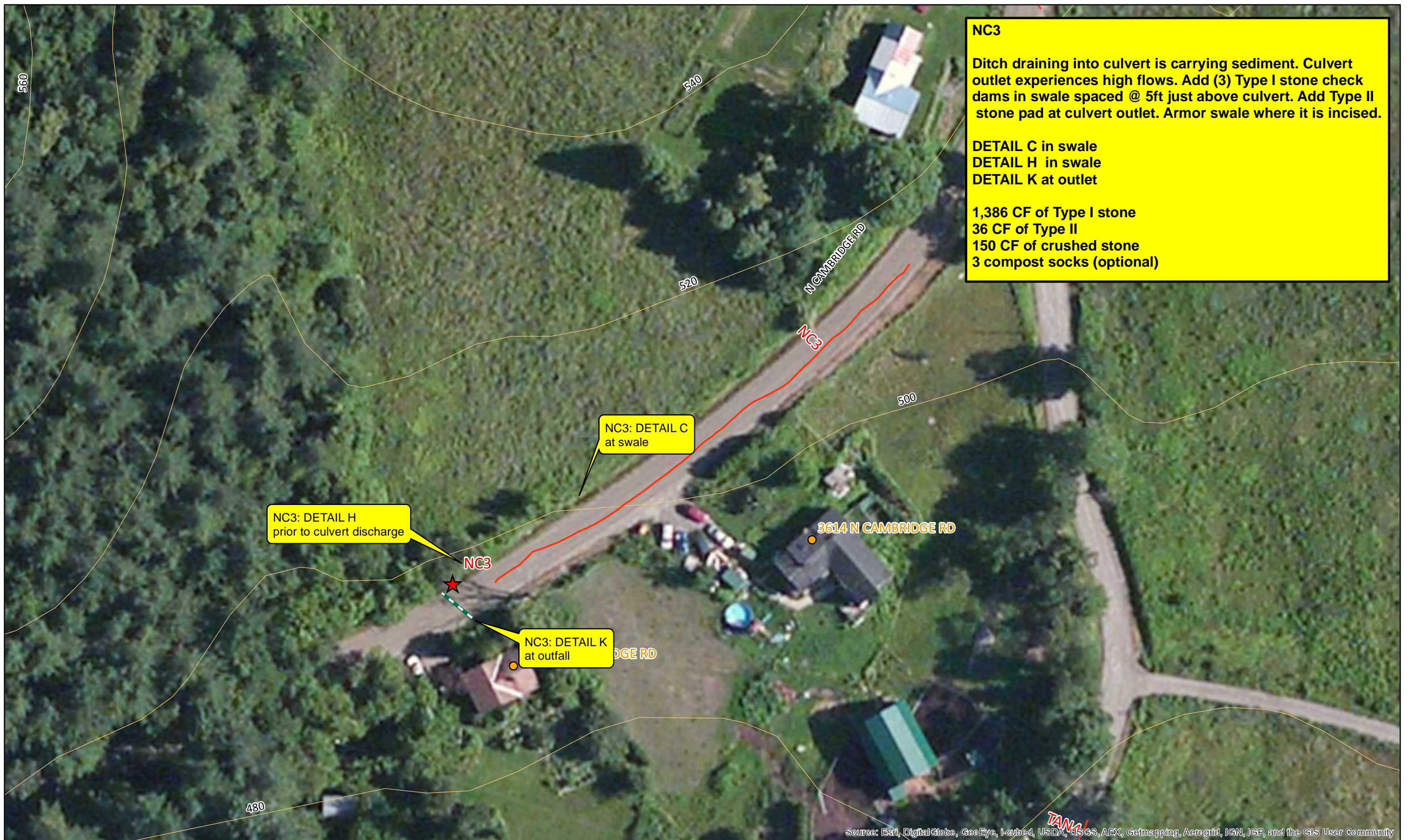














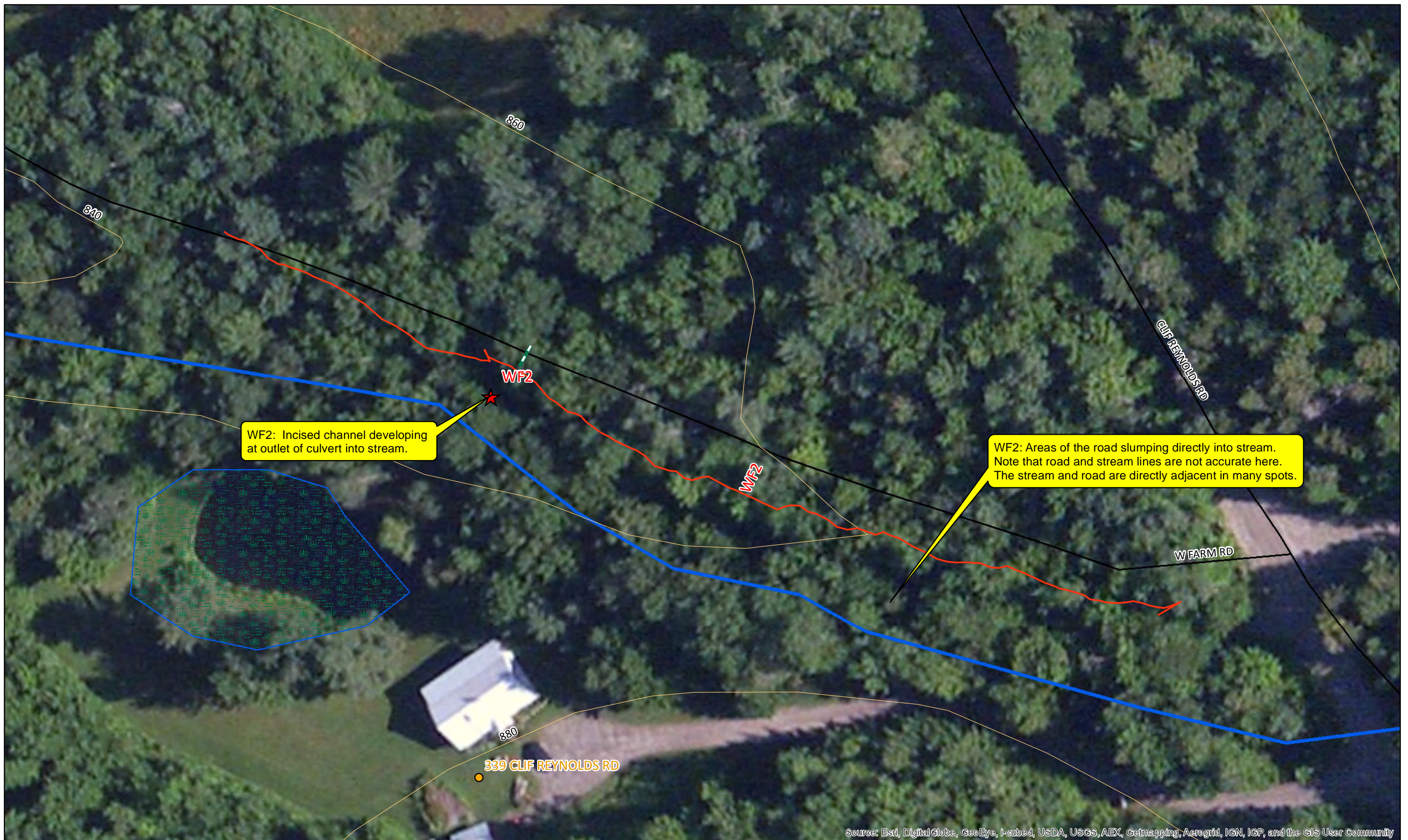


Lamoille County Erosion Study
October 15, 2013

Engineering Sites - Cambridge

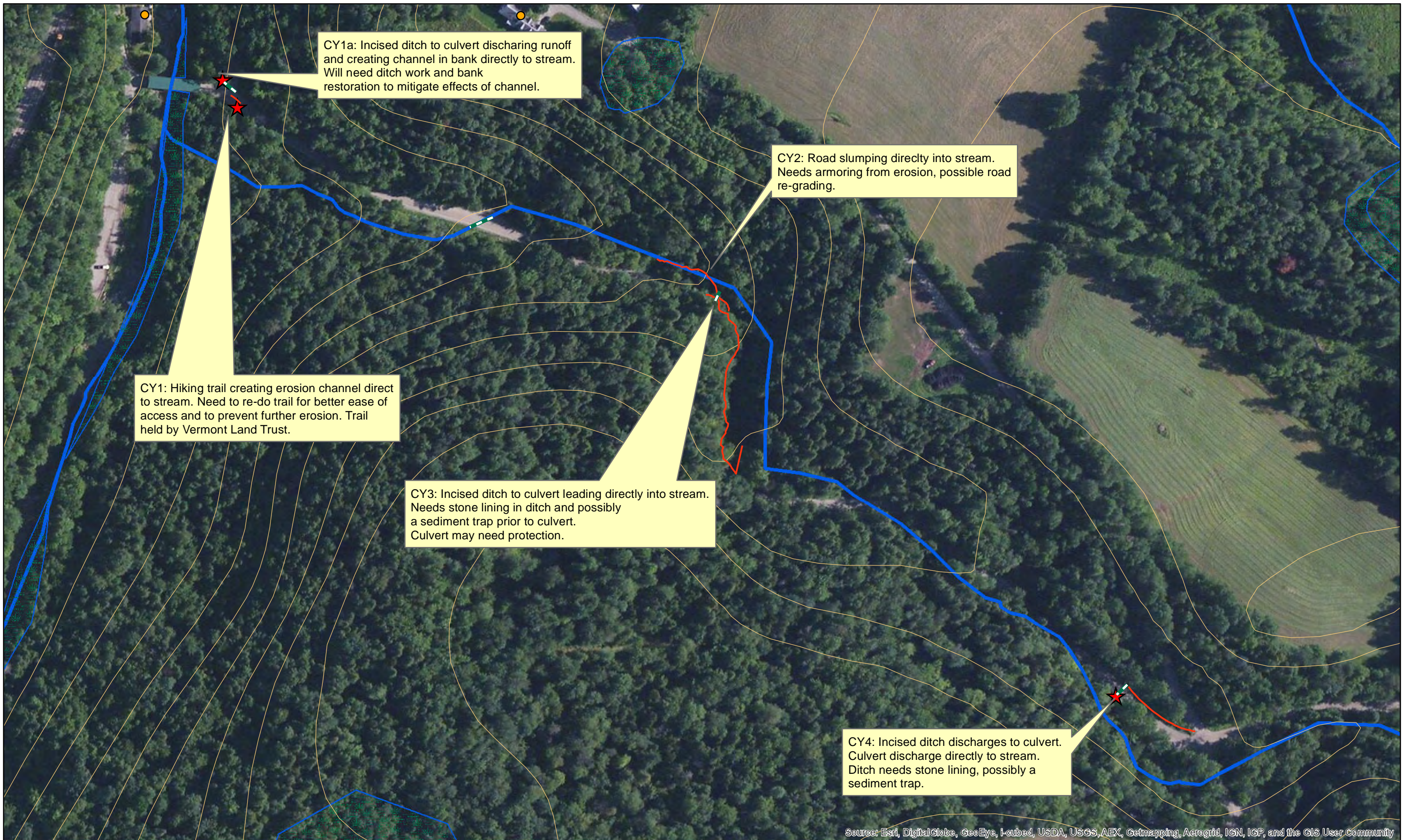






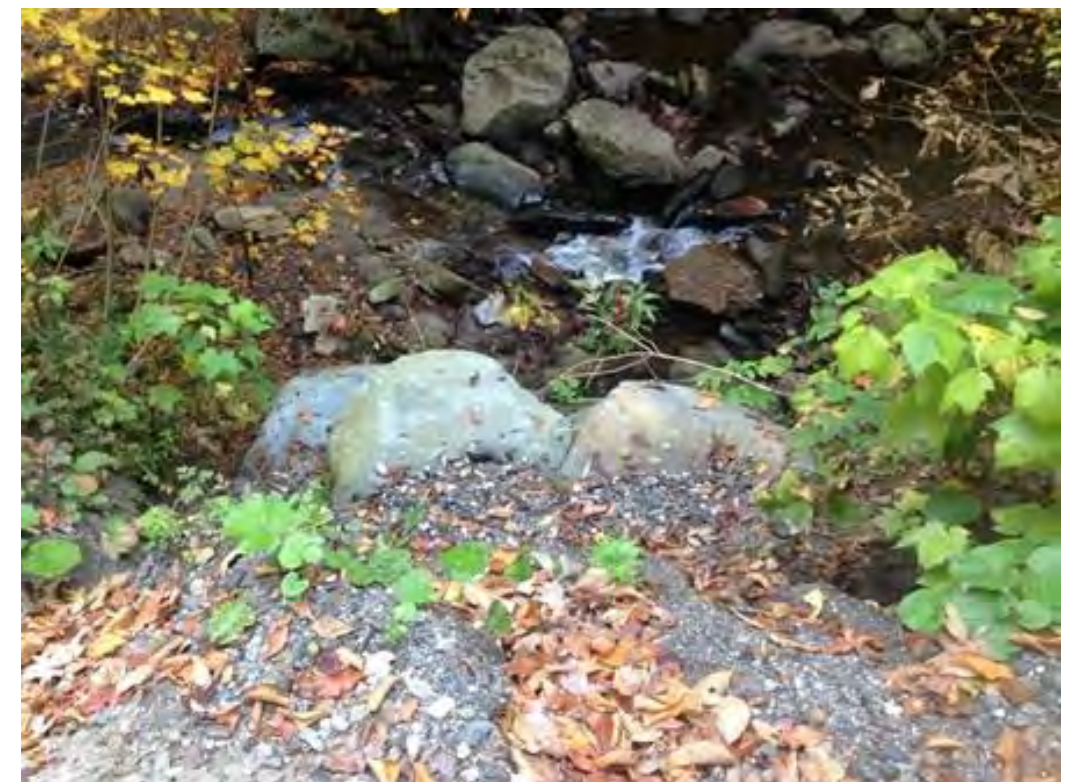
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



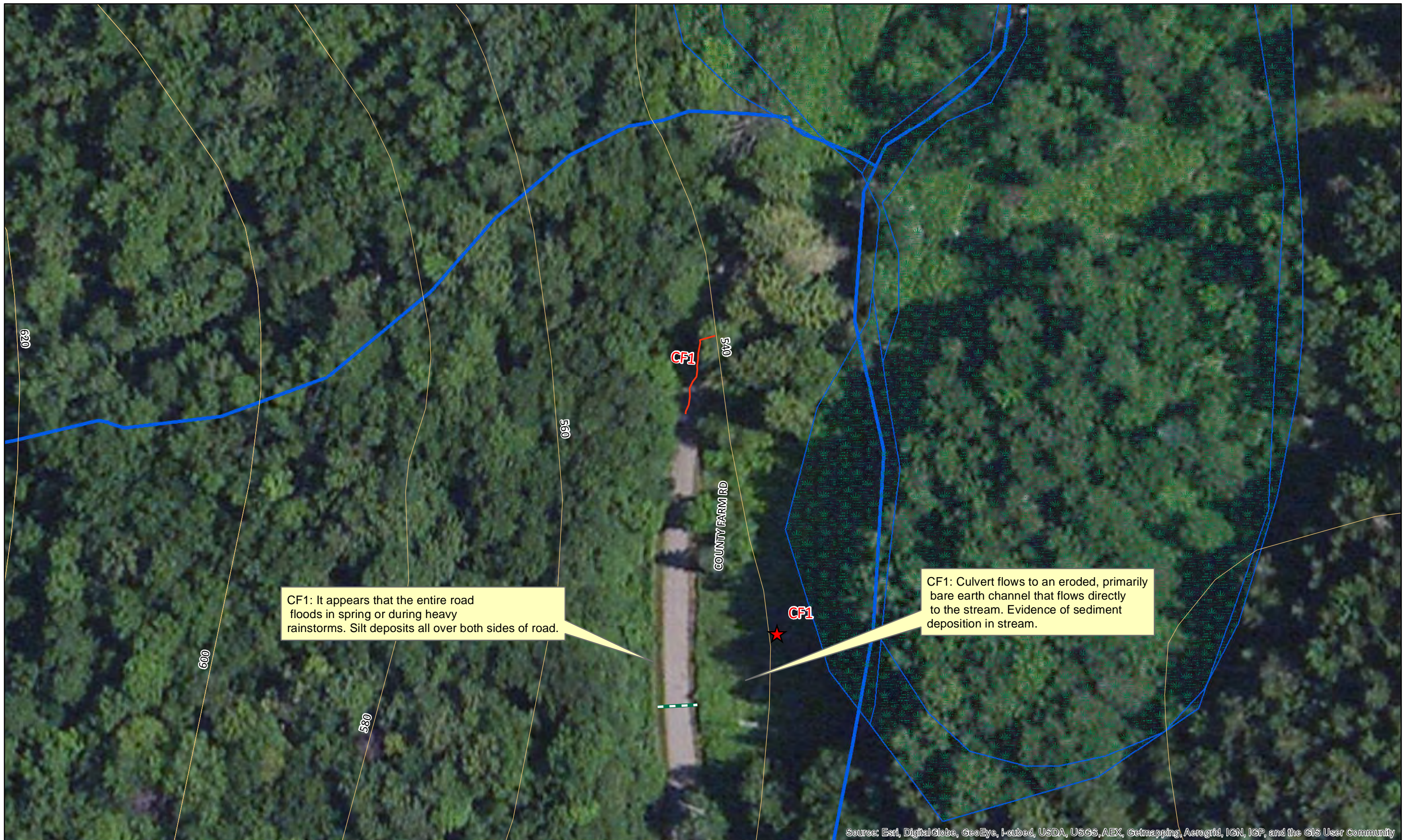












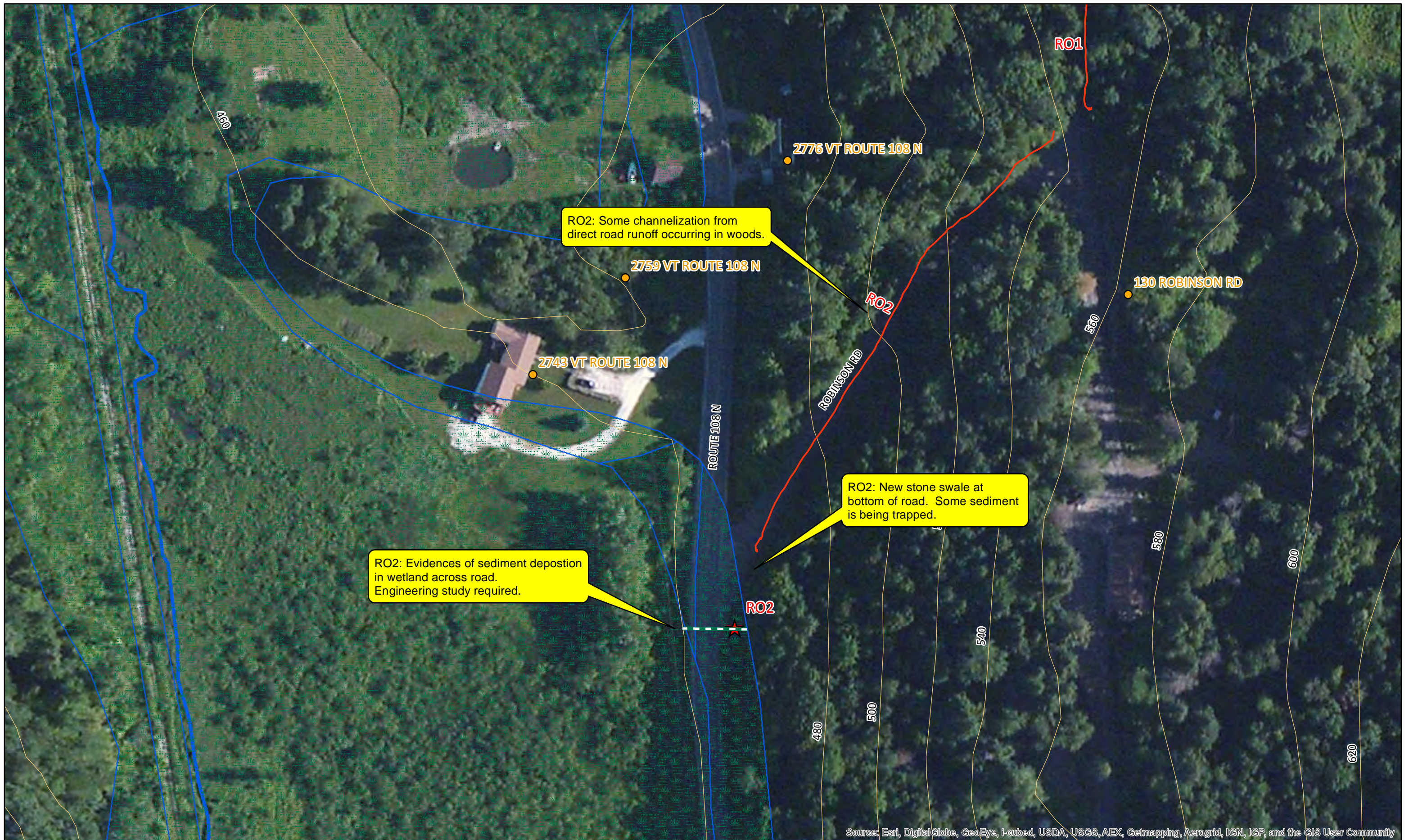




Lamoille County Erosion Study
October 15, 2013

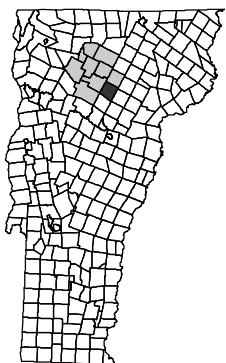
Town: Cambridge
Site: RO1







Elmore, Vermont - Road Erosion Repair Designs Site Locations

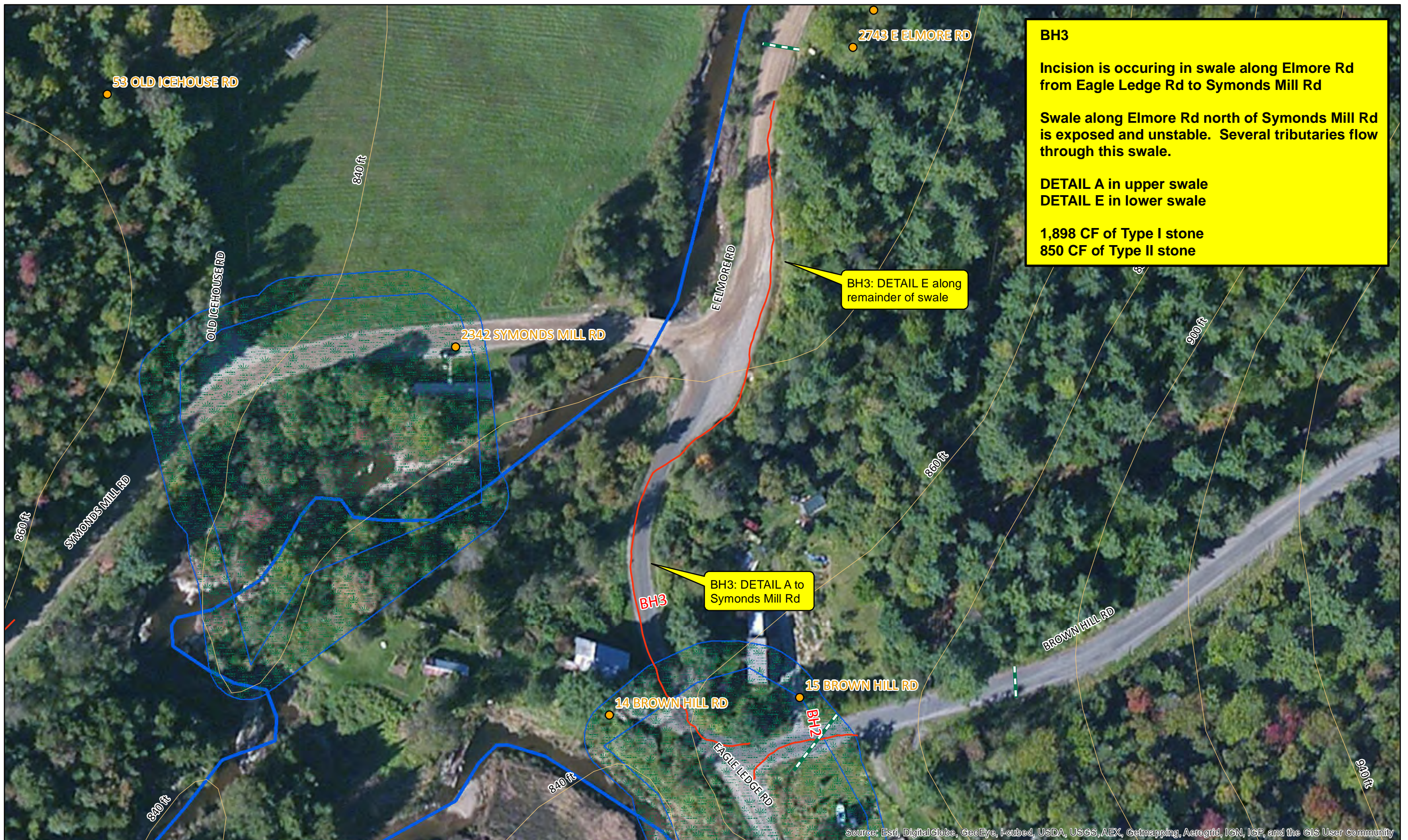


1:55,000

0 0.5 1 2 Miles

Legend

- XX#** Elmore Site Locations
- State Highway
- Class 1 and 2 Roads
- Class 3 Roads
- Class 4 Roads
- Private Roads
- Waterbodies
- Streams







EM1

Incision is occurring in roadside swale and sediment is being deposited in stream. Armor swale and create stone spreader

DETAIL G

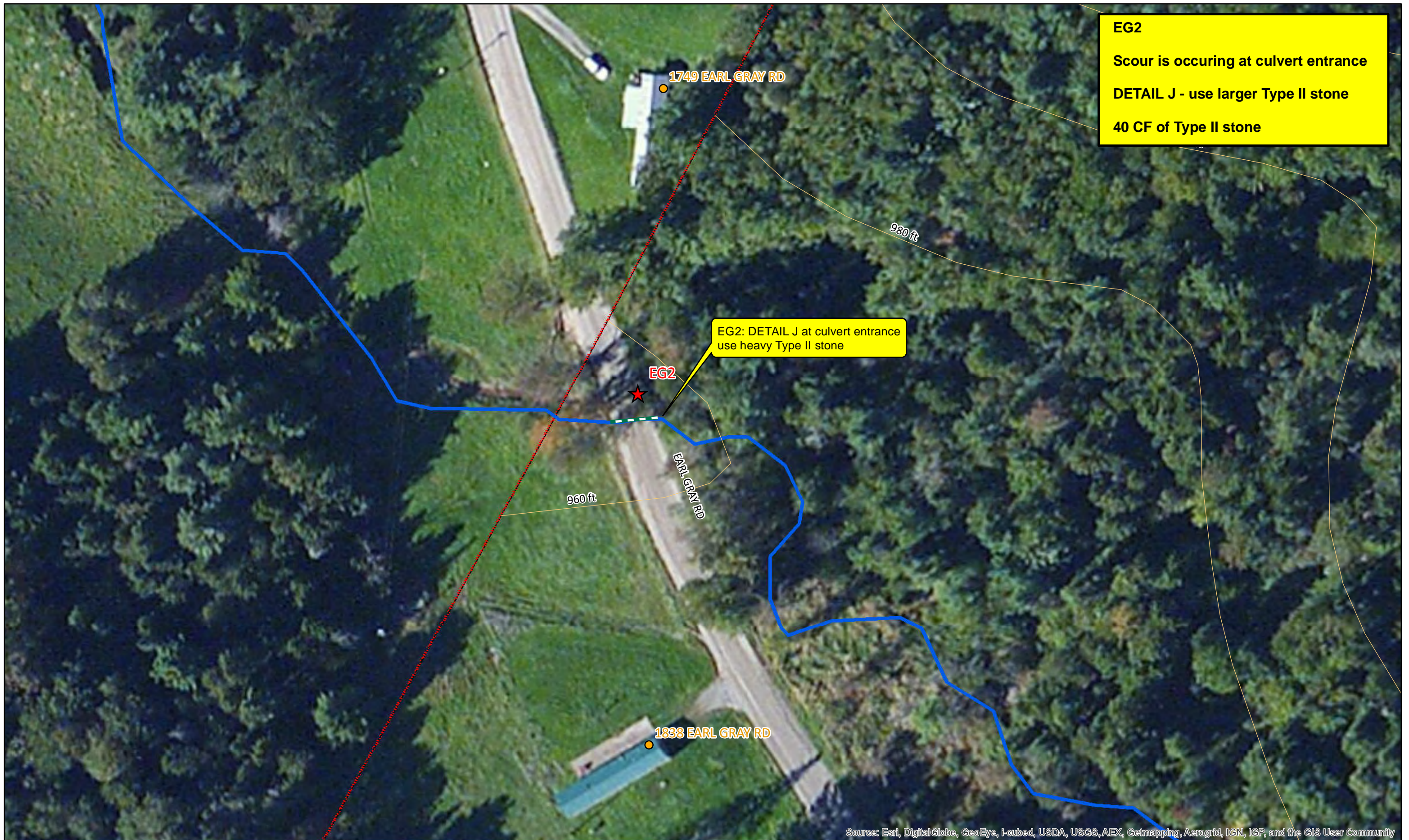
**2,560 CF of Type II stone
150 CF of crushed stone**

EM1: DETAIL G

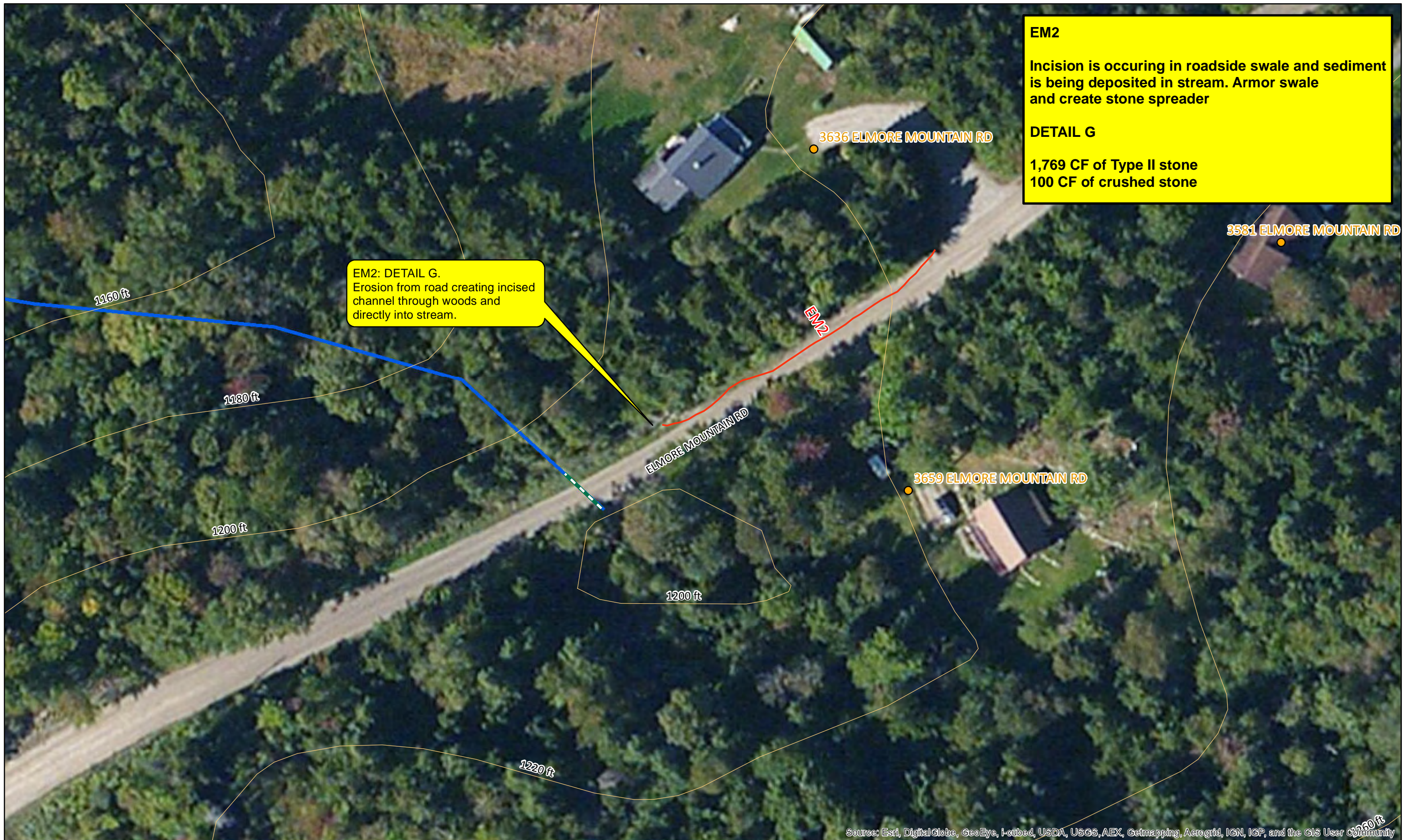
ELMORE MOUNTAIN RD

Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



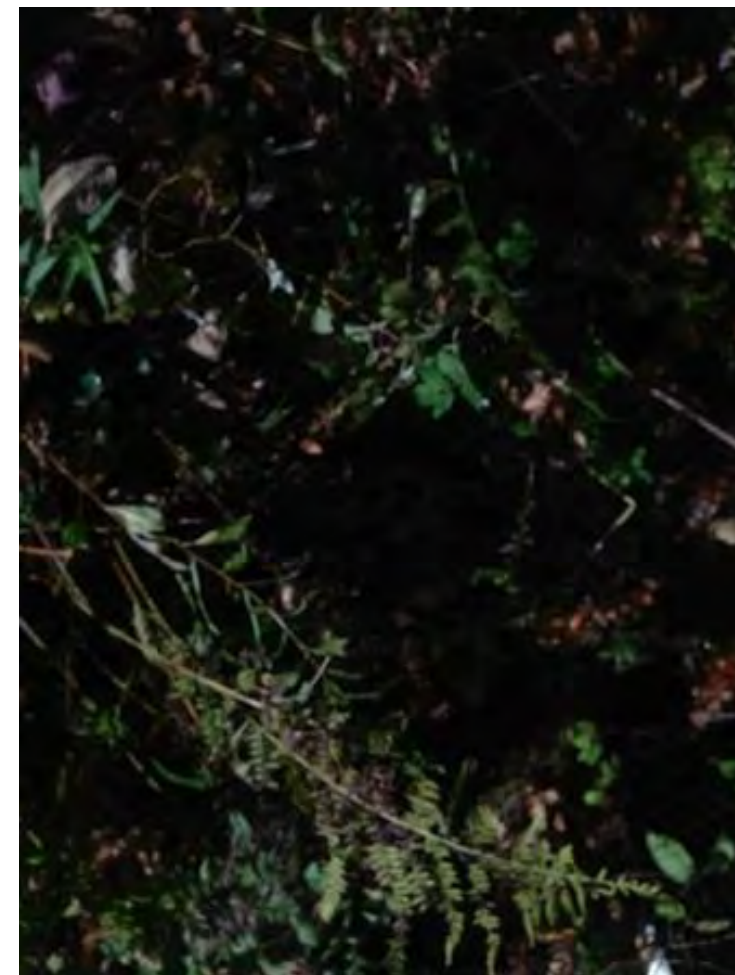


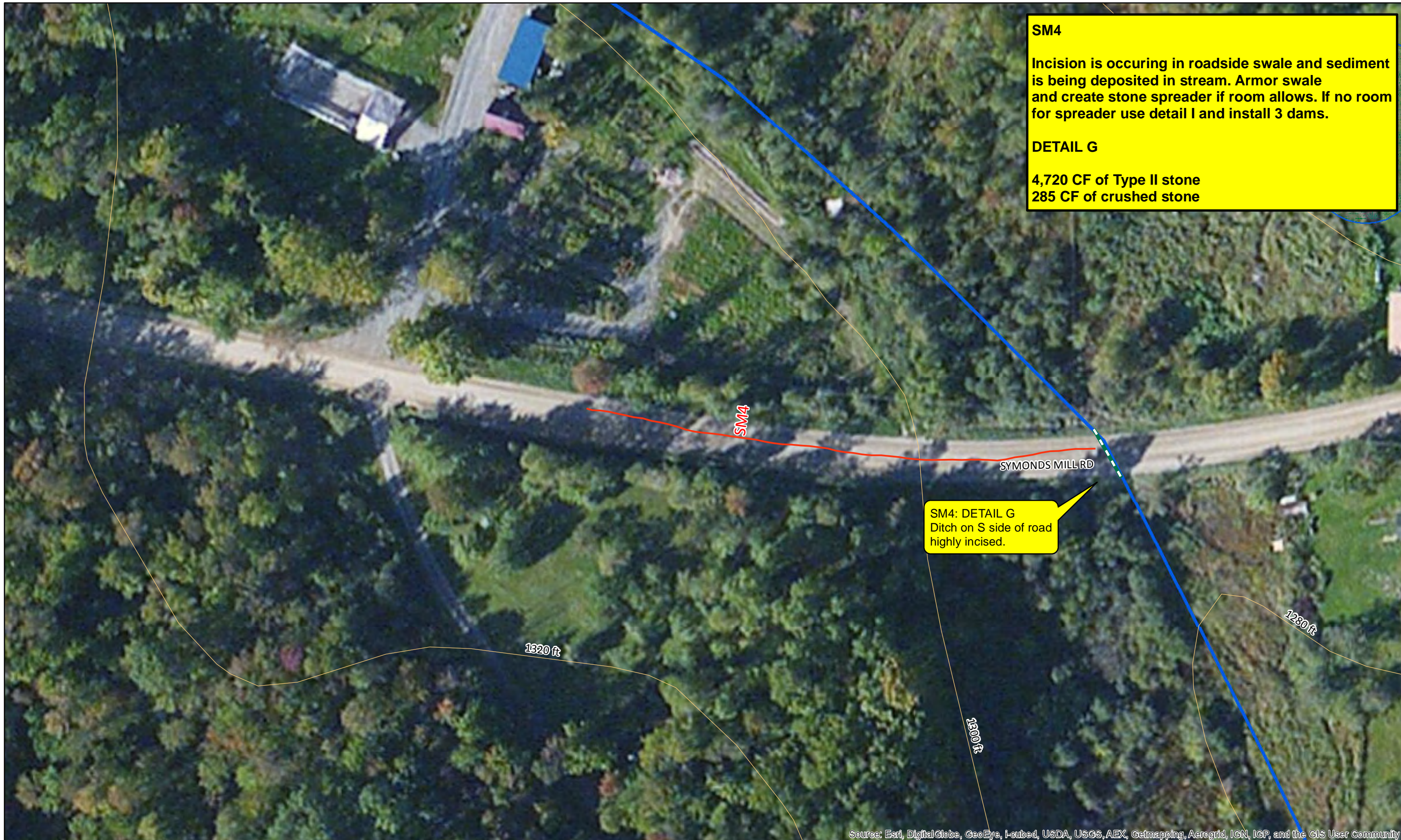












SM4

Incision is occurring in roadside swale and sediment is being deposited in stream. Armor swale and create stone spreader if room allows. If no room for spreader use detail I and install 3 dams.

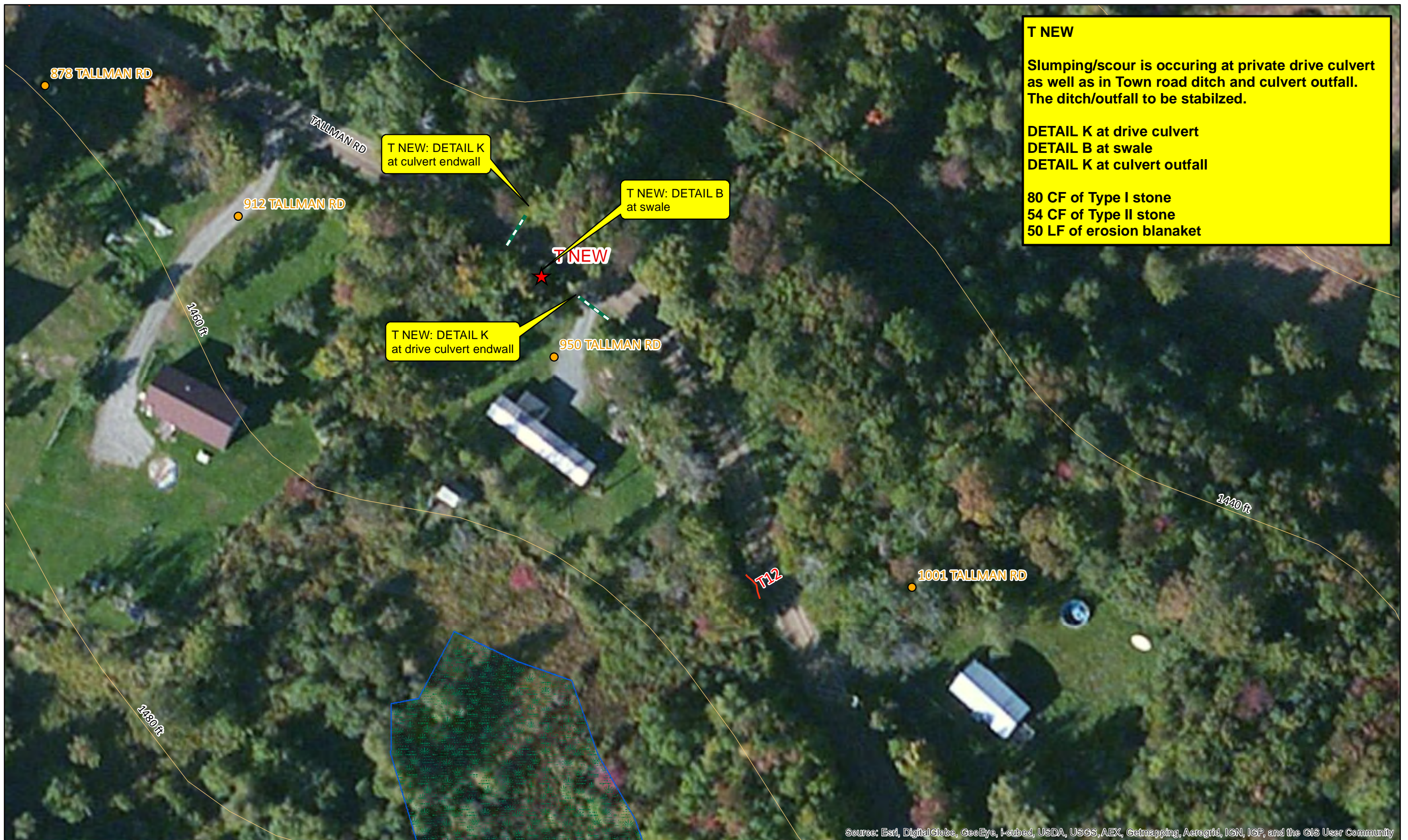
DETAIL G

4,720 CF of Type II stone
285 CF of crushed stone

SM4: DETAIL G
Ditch on S side of road
highly incised.

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



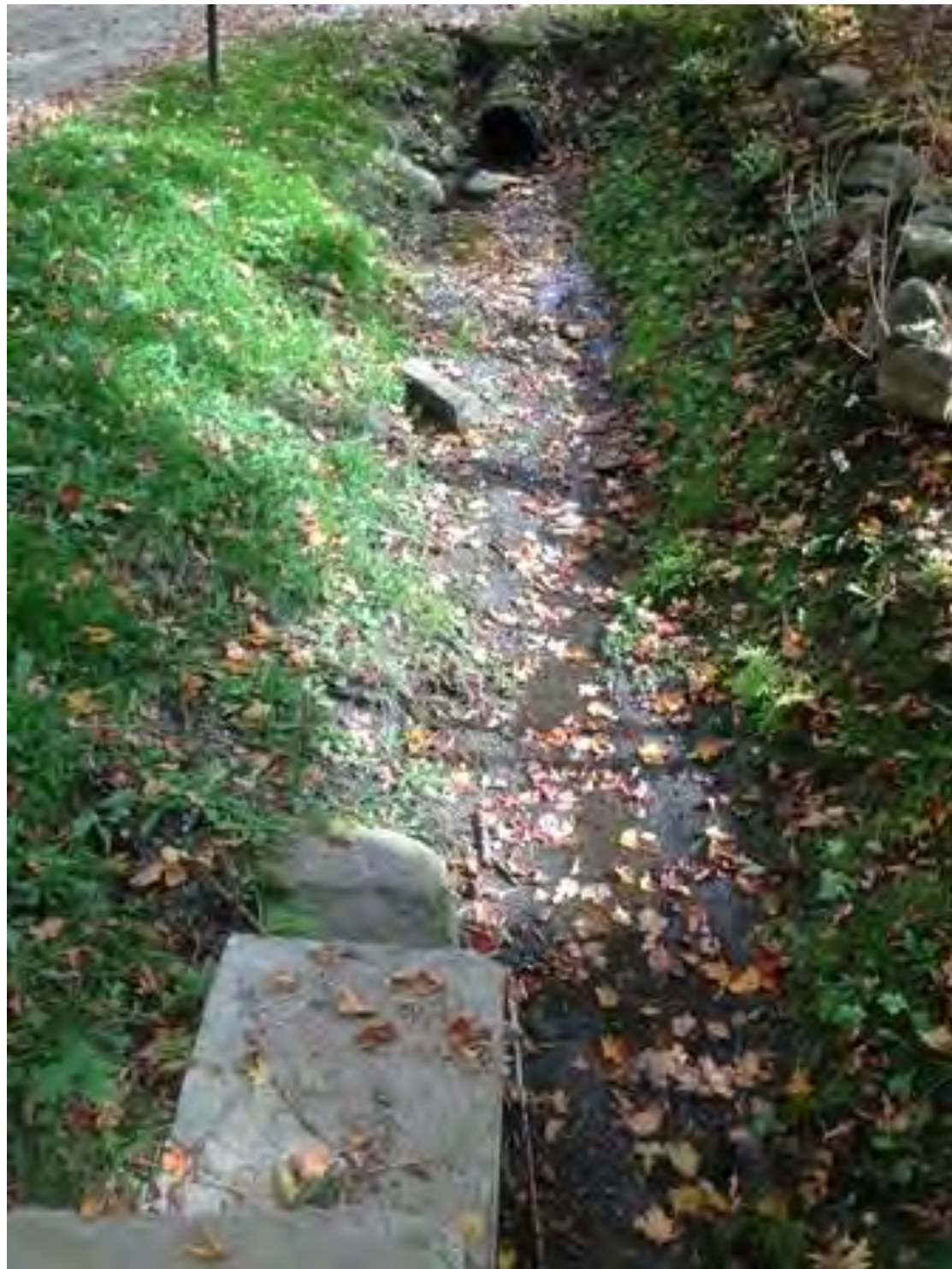


T NEW

Slumping/scour is occurring at private drive culvert as well as in Town road ditch and culvert outfall. The ditch/outfall to be stabilized.

DETAIL K at drive culvert
DETAIL B at swale
DETAIL K at culvert outfall

80 CF of Type I stone
54 CF of Type II stone
50 LF of erosion blanket





Lamoille County Erosion Study

October 15, 2013

Engineering Sites – Elmore





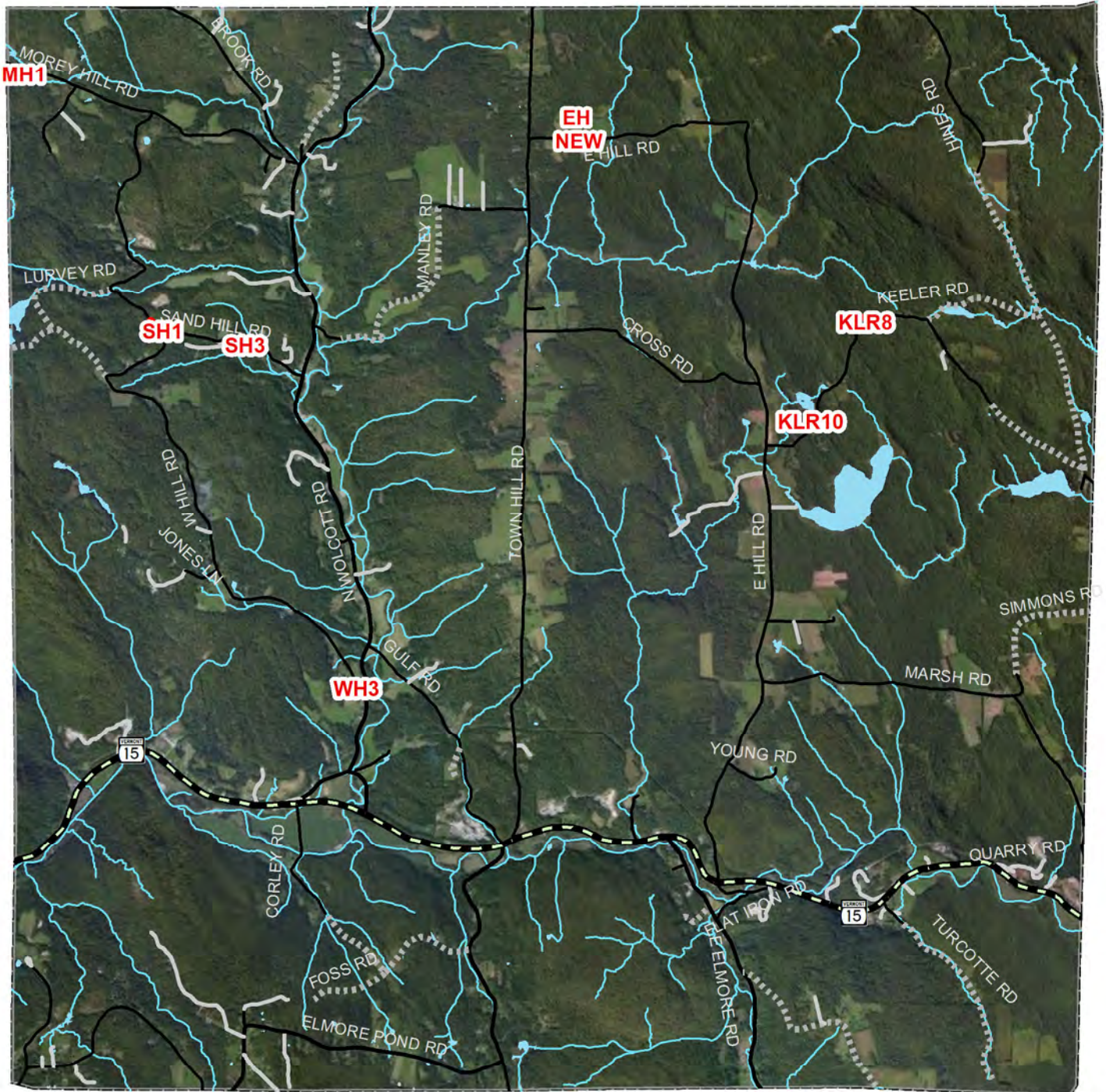




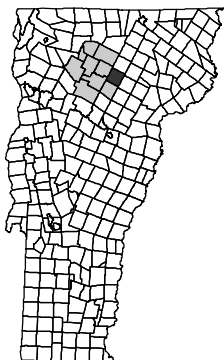




Wolcott, Vermont - Road Erosion Repair Designs Site Locations



© Harris Corp, Earthstar Geographics LLC State of Michigan

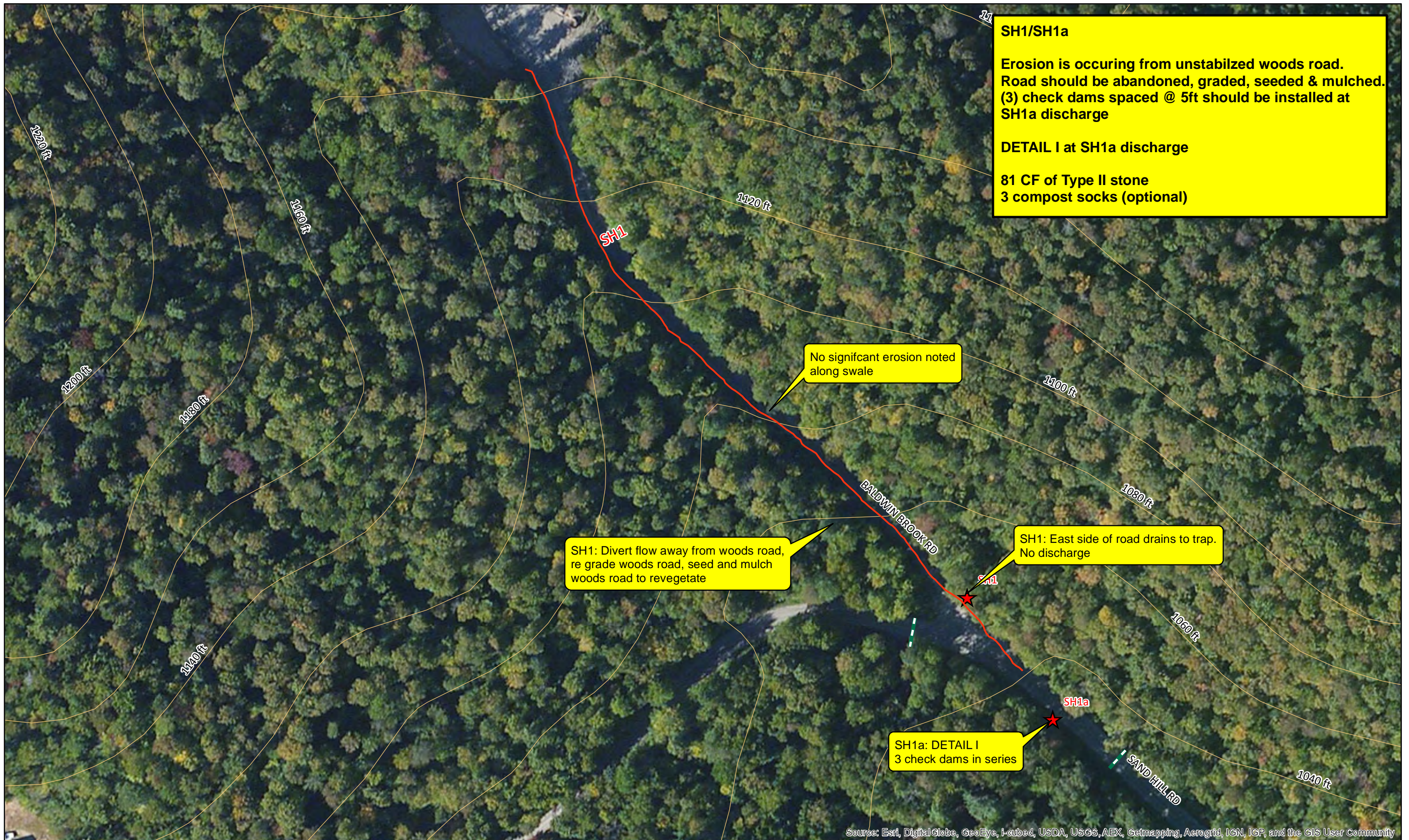


1:55,000

0 0.5 1 2 Miles

Legend

- XX#** Site Locations
- State Highway
- Class 1 and 2 Roads
- Class 3 Roads
- Class 4 Roads
- Private Roads
- Waterbodies
- Streams



SH1/SH1a

Erosion is occurring from unstabilized woods road.
Road should be abandoned, graded, seeded & mulched.
(3) check dams spaced @ 5ft should be installed at
SH1a discharge

DETAIL I at SH1a discharge

81 CF of Type II stone
3 compost socks (optional)

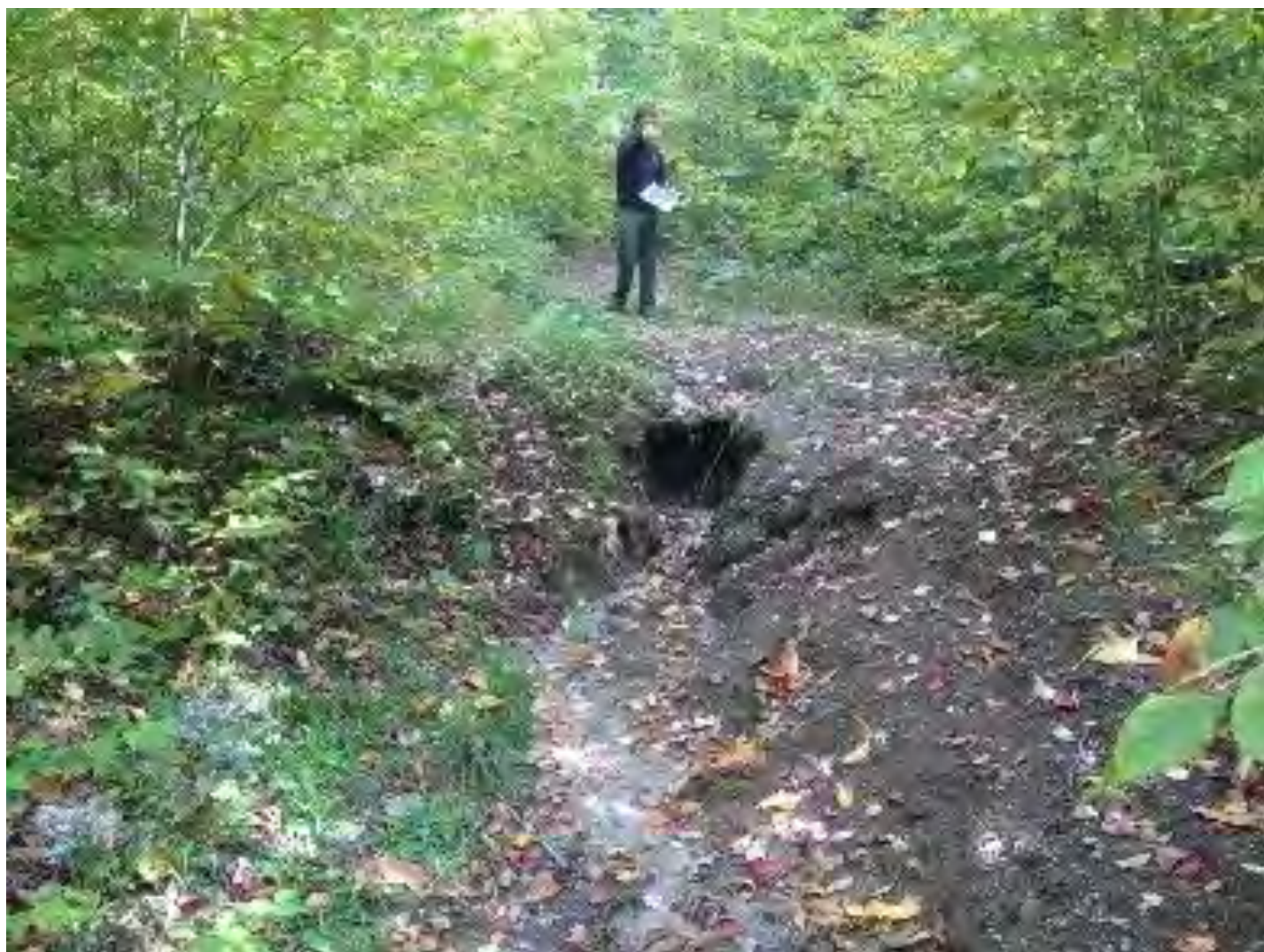
No significant erosion noted
along swale

SH1: Divert flow away from woods road,
re grade woods road, seed and mulch
woods road to revegetate

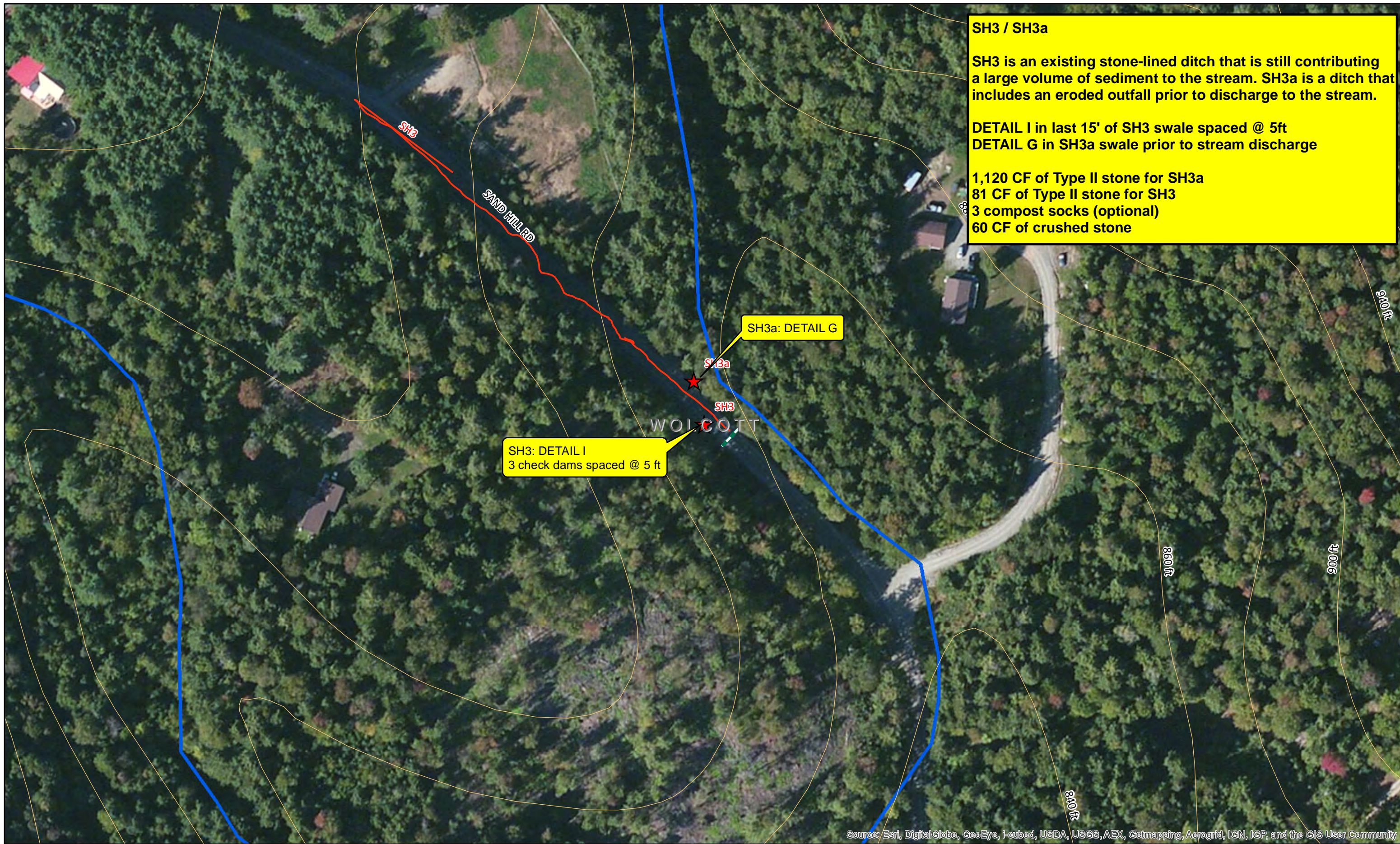
SH1: East side of road drains to trap.
No discharge

SH1a: DETAIL I
3 check dams in series

Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community







SH3 / SH3a

SH3 is an existing stone-lined ditch that is still contributing a large volume of sediment to the stream. SH3a is a ditch that includes an eroded outfall prior to discharge to the stream.

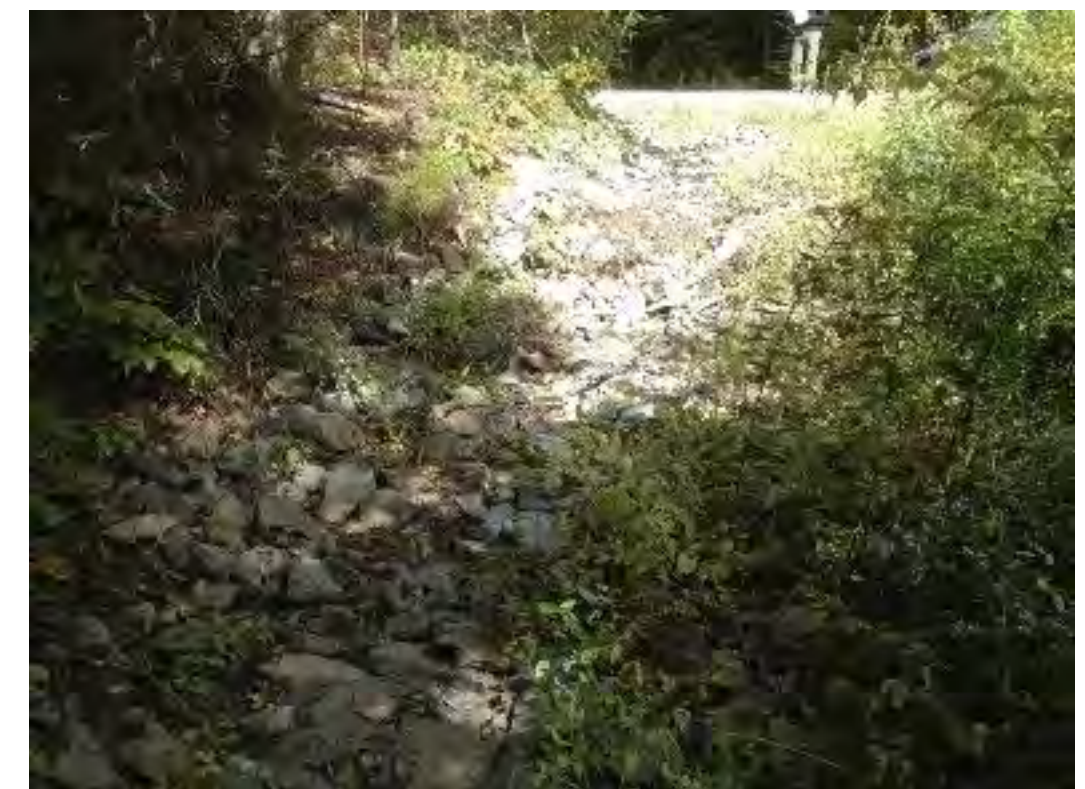
DETAIL I in last 15' of SH3 swale spaced @ 5ft
DETAIL G in SH3a swale prior to stream discharge

1,120 CF of Type II stone for SH3a
81 CF of Type II stone for SH3
3 compost socks (optional)
60 CF of crushed stone

SH3: DETAIL I
3 check dams spaced @ 5 ft

SH3a: DETAIL G

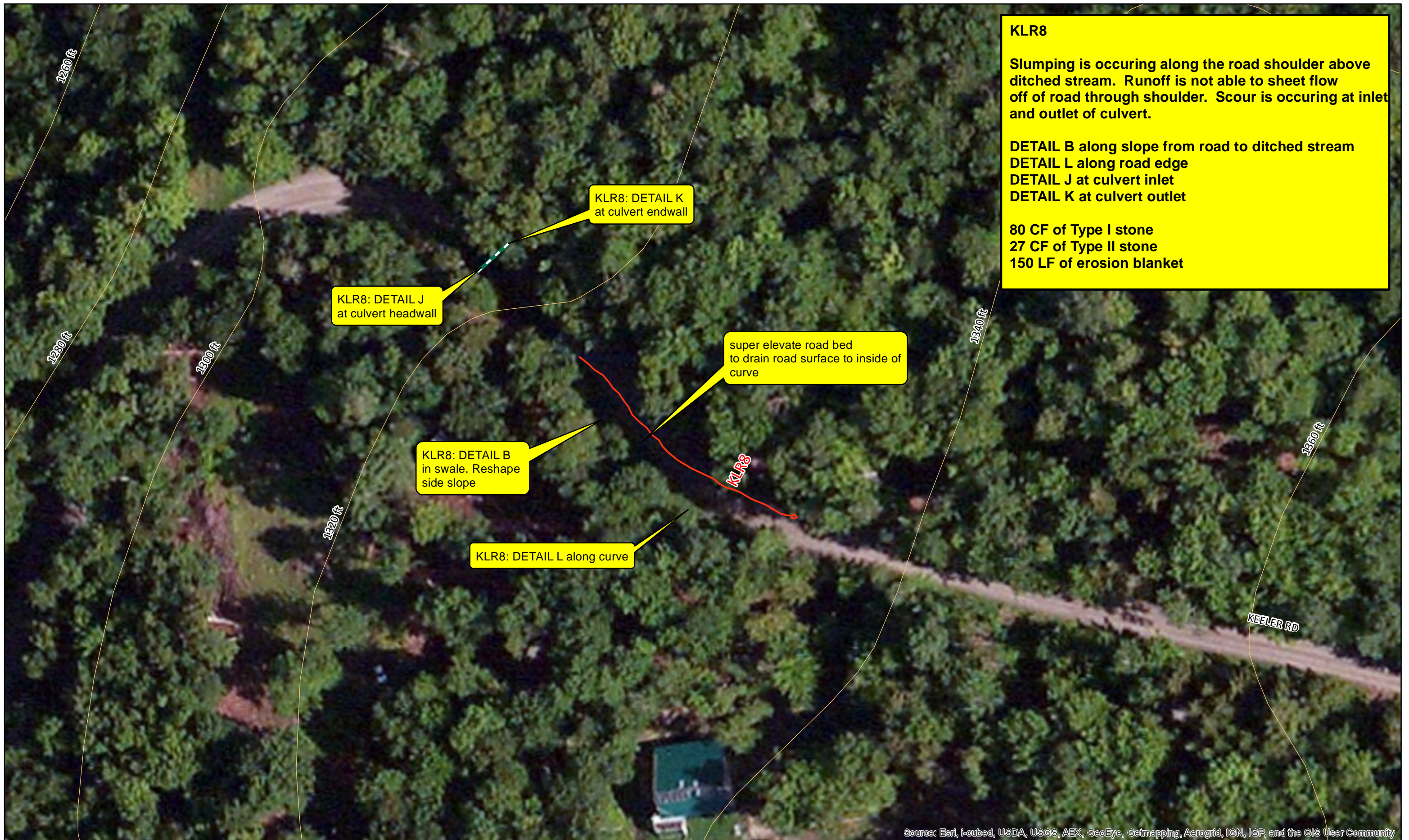
Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community









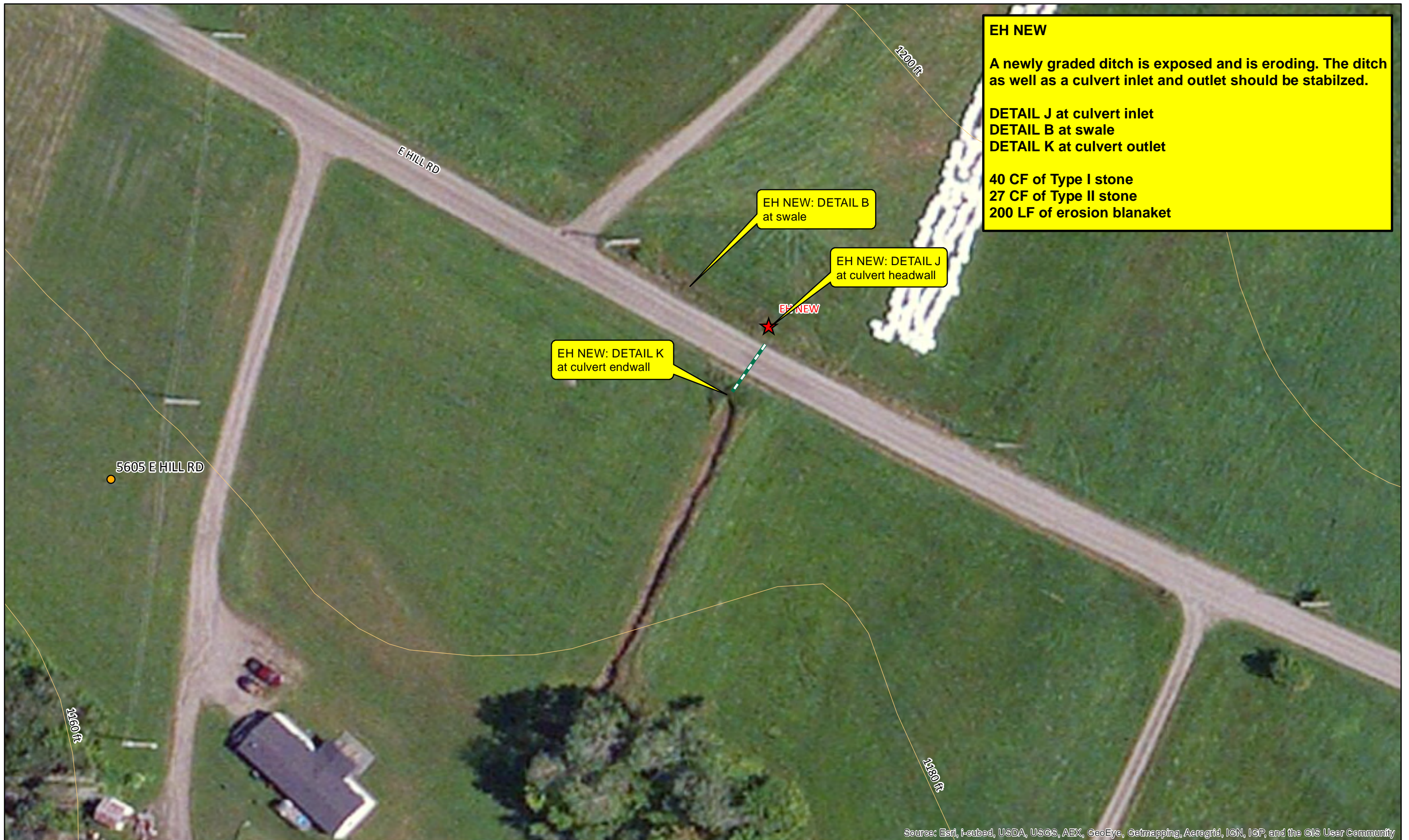






Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community





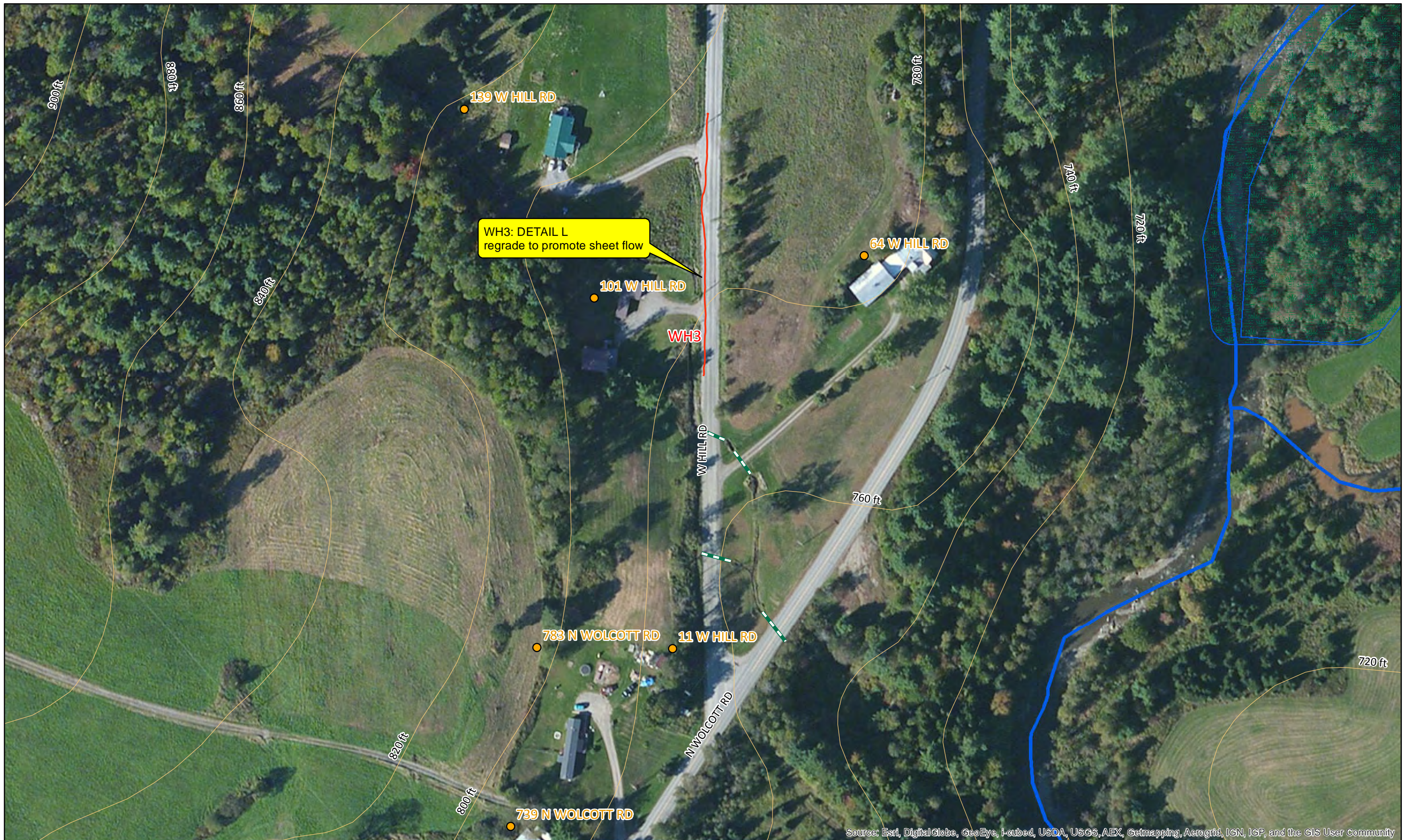
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



EH NEW A:



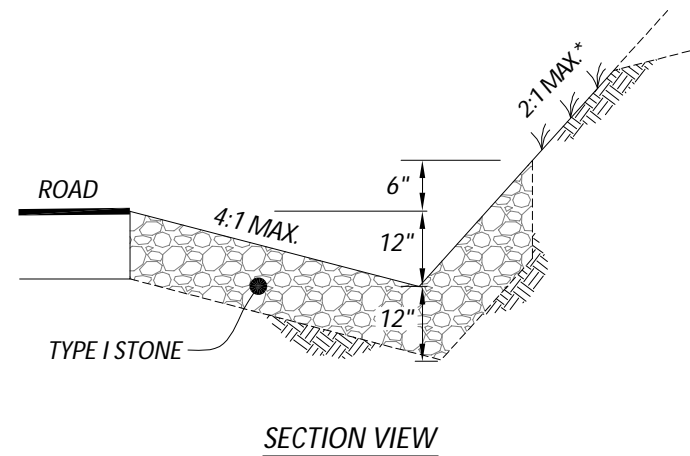
EH NEW B:





Appendix E – Final Design Construction Details

TYPE I STONE FILL
(VAOT SEC. 706.04(A))
THE LONGEST DIMENSION OF THE STONE SHALL VARY FROM 1 INCH TO 12 INCHES, AND AT LEAST 50 PERCENT OF THE VOLUME OF THE STONE IN PLACE SHALL HAVE A LEAST DIMENSION OF 4 INCHES.

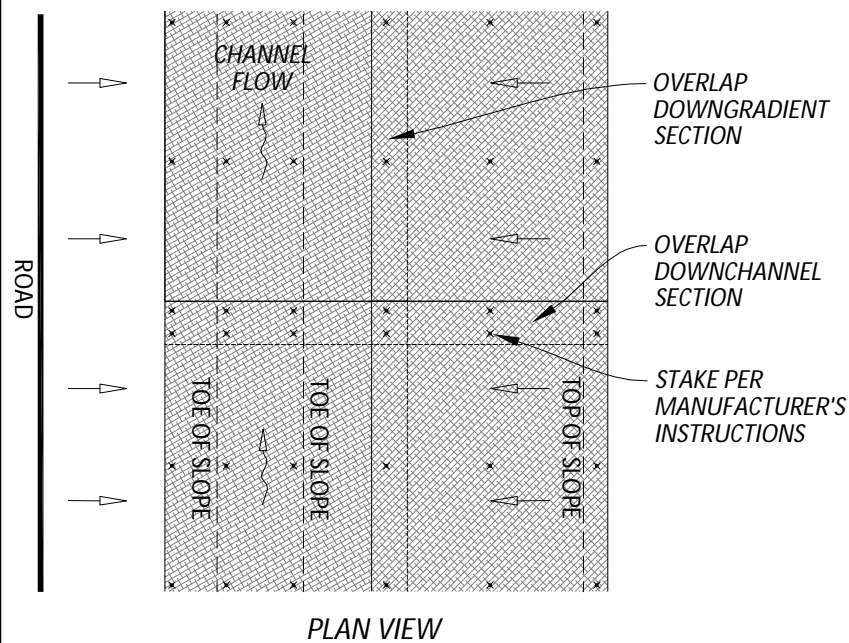


* IF EXISTING SIDE SLOPES ARE STEEPER THAN 2:1, BUT STABLE, DO NOT REGRADE SLOPE.
IF THERE IS INSUFFICIENT WIDTH FOR 2:1 SIDE SLOPES, USE A STEEPER SLOPE ON THE BACKSIDE OF THE SWALE, AWAY FROM THE ROAD, AND STABILIZE WITH NORTH AMERICAN GREEN S150 EROSION BLANKET (SEE DETAIL B).
IF STEE SLOPE IS SATURATED WITH GROUNDWATER, FACE WITH 2-4" DIA. CRUSHED STONE AT LEAST 6" DEEP.

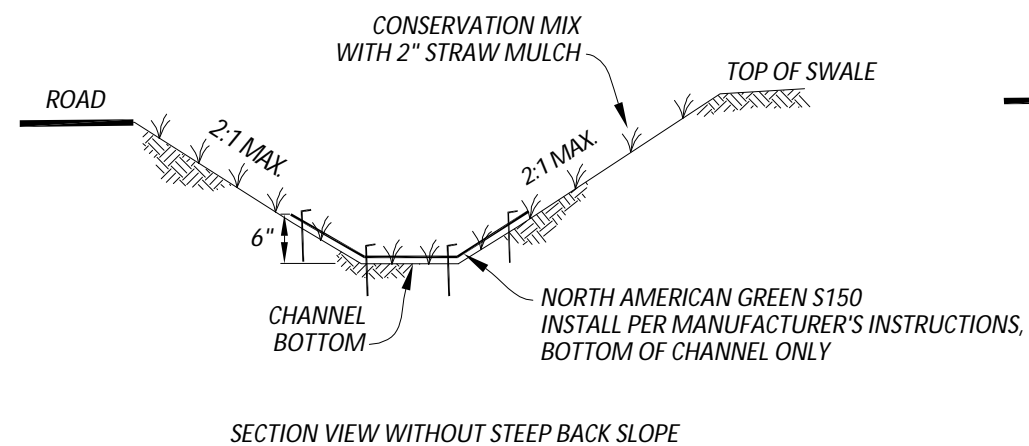
DETAIL A NARROW ROADSIDE SWALE STABILIZATION

NTS

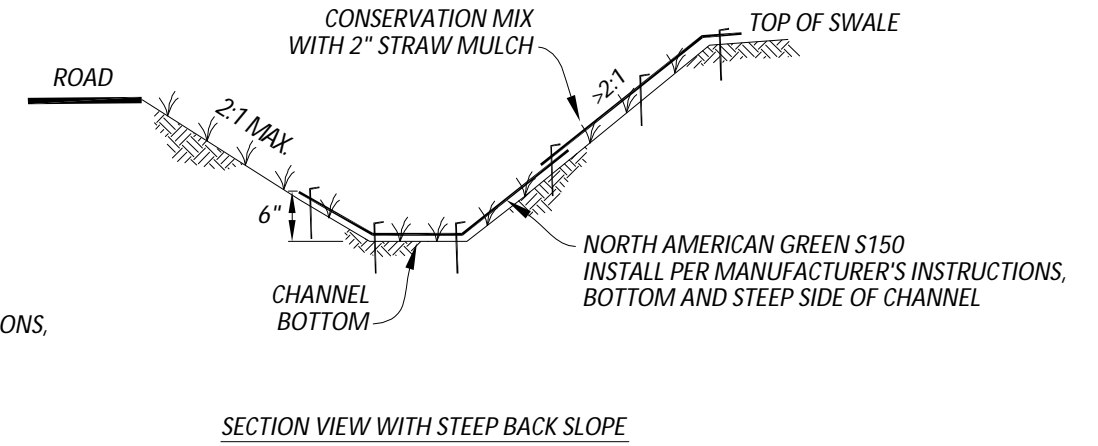
NOTE:
USE DETAIL A WHEN STABILIZED ROADSIDE SWALE IS "SQUEEZED" BETWEEN ROAD AND STEEP SIDE SLOPE.
INTENT IS THAT VEHICLES CAN RUN ONTO ADJACENT 4:1 SLOPE IN EMERGENCY.



PLAN VIEW



SECTION VIEW WITHOUT STEEP BACK SLOPE



SECTION VIEW WITH STEEP BACK SLOPE

DETAIL B VEGETATIVE CHANNEL STABILIZATION WITH AND WITHOUT EROSION BLANKET

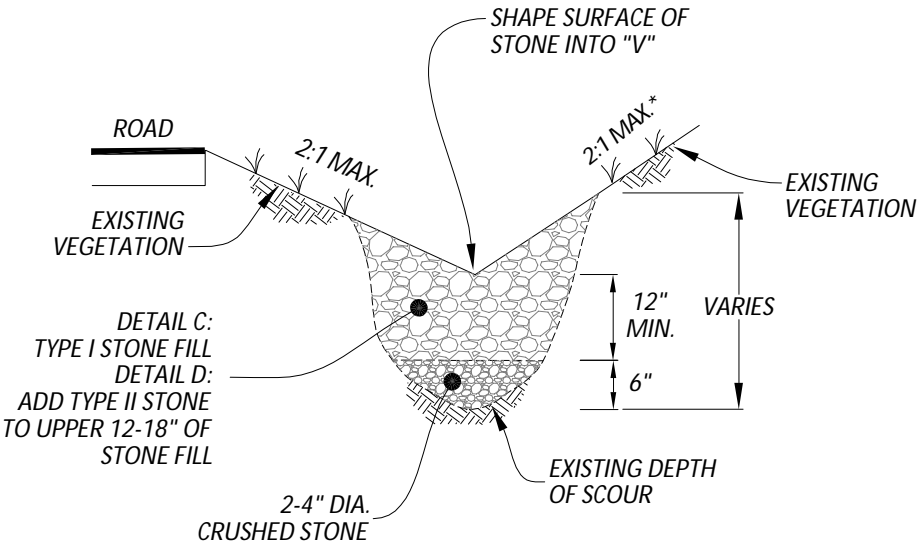
NTS

NOTE:
USE DETAIL B TO STABILIZE TYPICAL ROADSIDE SWALE.
USE EROSION BLANKET ON STEEP BACKSIDE SLOPES.

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TYPE I STONE FILL
(VAOT SEC. 706.04(A))
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TYPE II STONE FILL
(VAOT SEC. 706.04(A))
THE LONGEST DIMENSION OF THE STONE SHALL VARY FROM 2 INCHES TO 36 INCHES, AND AT LEAST 50 PERCENT OF THE VOLUME OF THE STONE IN PLACE SHALL HAVE A LEAST DIMENSION OF 12 INCHES.



DETAIL C/D SWALE SCOUR REPAIR

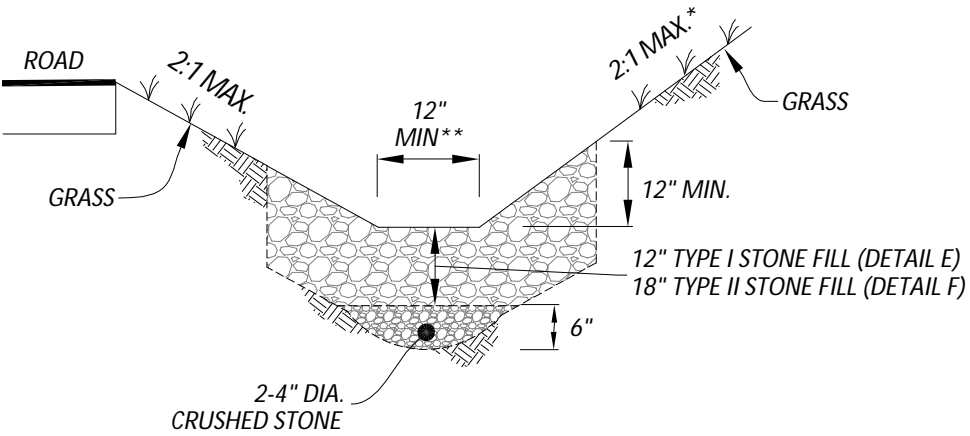
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* IF EXISTING SIDE SLOPES ARE STEEPER THAN 2:1, BUT STABLE, DO NOT REGRADE SLOPE.
IF THERE IS INSUFFICIENT WIDTH FOR 2:1 SIDE SLOPES, USE A STEEPER SLOPE ON THE BACKSIDE OF THE SWALE, AWAY FROM THE ROAD, AND STABILIZE WITH NORTH AMERICAN GREEN S150 EROSION BLANKET (SEE DETAIL B).

- NOTES:
1. USE DETAIL C/D TO REPAIR EXISTING GRASS SWALES WITH ACTIVE CUTTING.
 2. USE DETAIL C WITH ONLY TYPE I STONE FOR SWALES WITH SLOWER FLOW VELOCITIES.
 3. USE DETAIL D WITH TYPE II STONE FOR SWALES WITH HIGHER FLOW VELOCITIES.

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DETAIL E/F STONE SWALE

NTS

NOTE:
USE DETAIL E/F WHERE HIGHER FLOW VELOCITIES WILL ERODE GRASS SURFACE.

* IF >2:1, INSTALL NORTH AMERICAN GREEN S150 PER MANUFACTURER'S INSTRUCTIONS, BOTTOM AND STEEP SIDE OF CHANNEL (SEE DETAIL B)

** SHAPE STONE SUFACE AS "V" IF SPACE FOR SWALE IS TOO NARROW FOR FLAT SURFACE

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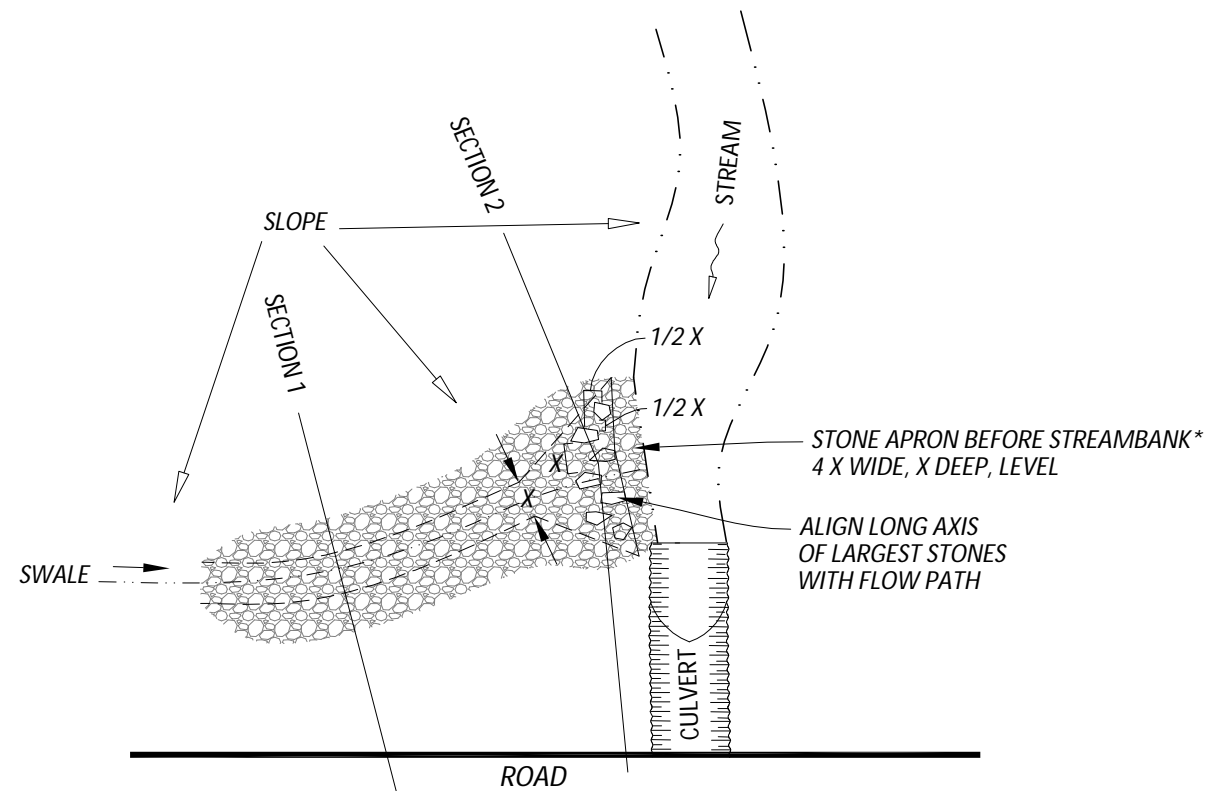
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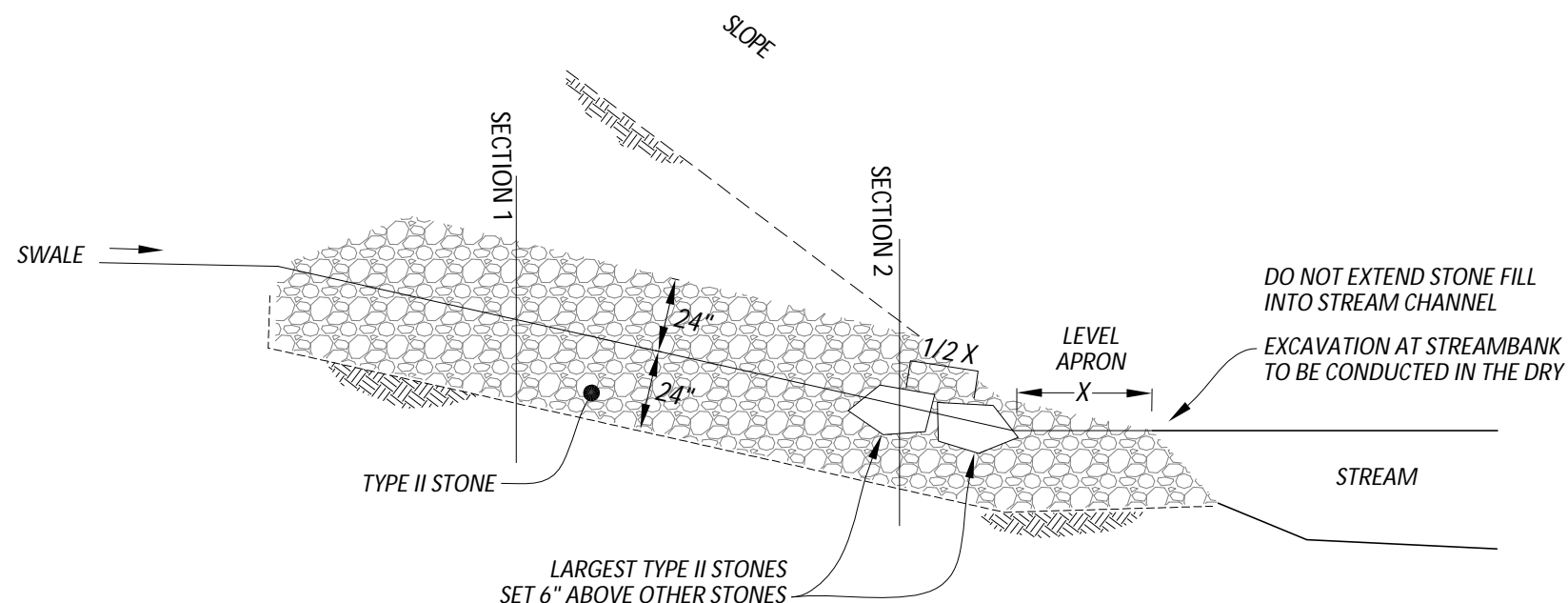


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* END APRON ON LEVEL OR GENTLY SLOPING FLOODPLAIN WITH STABLE VEGETATION IF POSSIBLE

PLAN VIEW



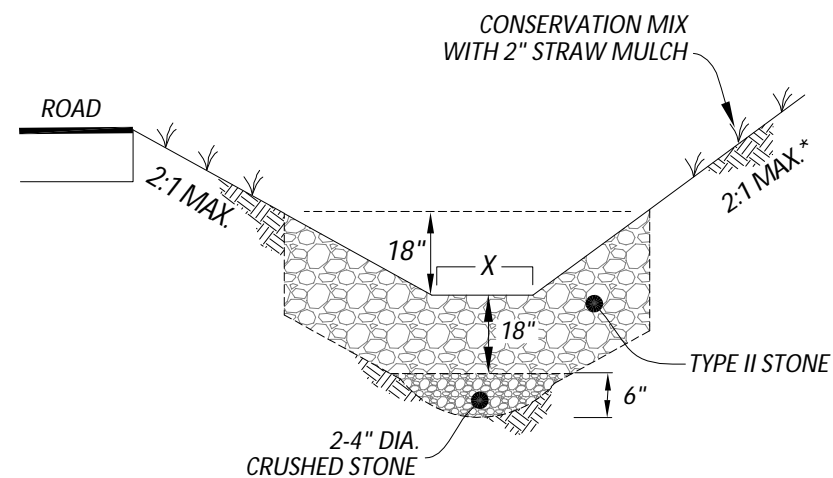
PROFILE VIEW

TYPE II STONE FILL
(VAOT SEC. 706.04(A))
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DETAIL G STONE CHUTE AND SPREADER

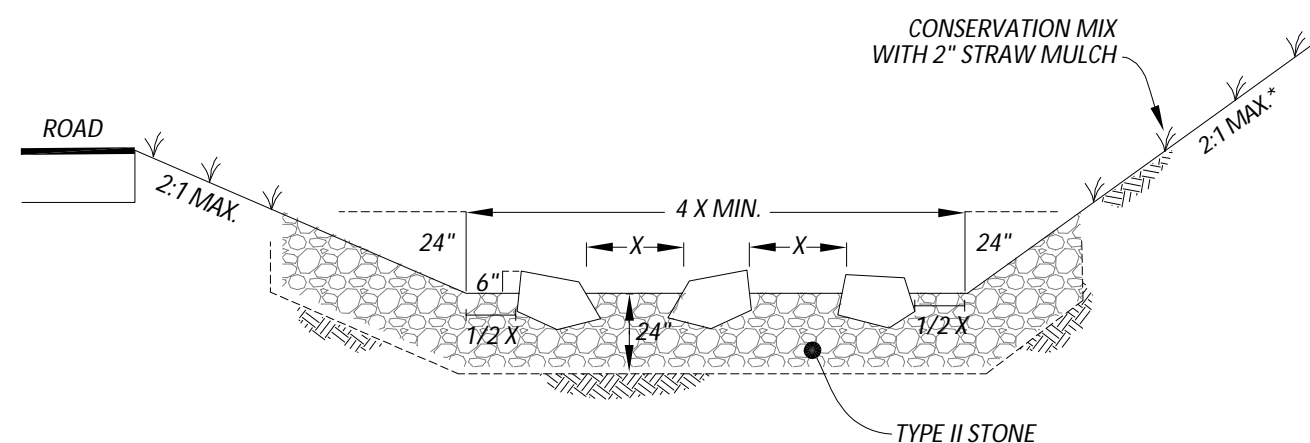
NTS

NOTE:
USE DETAIL G ALONG STEEPER SWALES, TYPICALLY DISCHARGING TO STREAMS OR FLOODPLAINS.
IF STREAMBANK IS UNSTABLE AND ERODING, CONDUCT MORE DETAILED ENGINEERING STUDY BEFORE USING DETAIL G.



SECTION 1 VIEW

NOTE:
DIMENSION X SPECIFIED BY DESIGNER FOR EACH SITE.



SECTION 2 VIEW

* IF EXISTING SIDE SLOPES ARE STEEPER THAN 2:1, BUT STABLE, DO NOT REGRADE SLOPE.
IF THERE IS INSUFFICIENT WIDTH FOR 2:1 SIDE SLOPES, USE A STEEPER SLOPE ON THE BACKSIDE OF THE SWALE, AWAY FROM THE ROAD, AND STABILIZE WITH NORTH AMERICAN GREEN S150 EROSION BLANKET (SEE DETAIL B).

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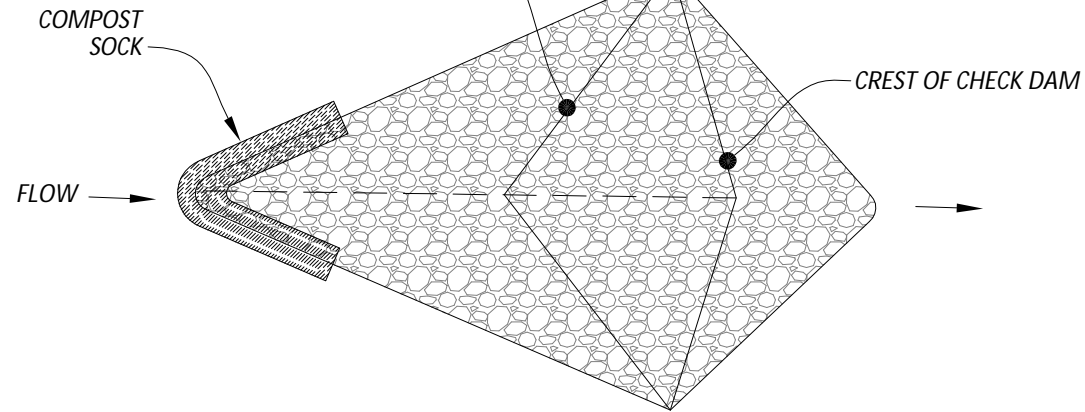
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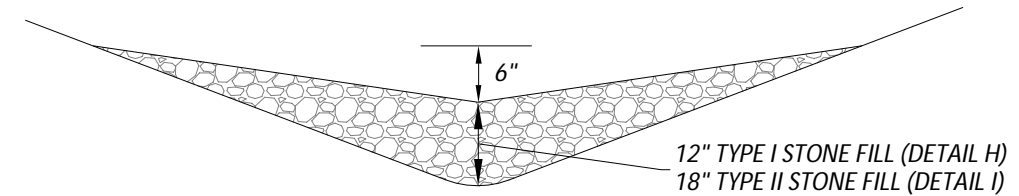


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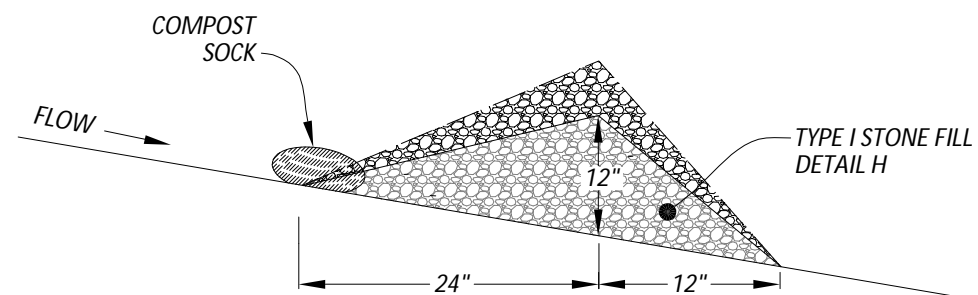
DIVISION BETWEEN STONE FILL TYPES (DETAIL I)



PLAN VIEW



SECTION VIEW

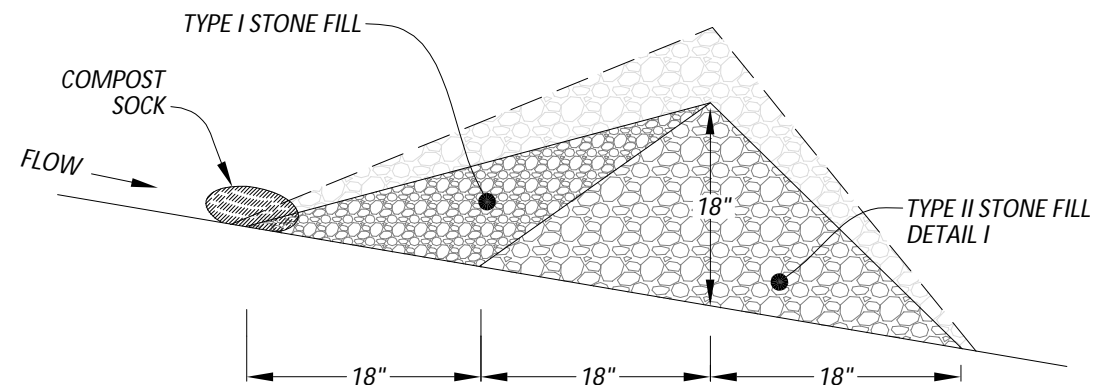


PROFILE VIEW - DETAIL H

NOTE:
SET SPACING OF CHECK DAMS TO ASSUME THAT
ELEVATIONS OF THE CREST OF THE DOWNSTREAM
DAM IS AT THE SAME ELEVATION OF THE TOE OF THE
UPSTREAM DAM"

DETAIL H/I STONE CHECK DAM

NTS



PROFILE VIEW - DETAIL I

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PERCENT OF THE VOLUME OF THE STONE IN PLACE SHALL
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TYPE II STONE FILL
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FROM 2 INCHES TO 36 INCHES, AND AT LEAST 50 PERCENT
OF THE VOLUME OF THE STONE IN PLACE SHALL HAVE A
LEAST DIMENSION OF 12 INCHES.

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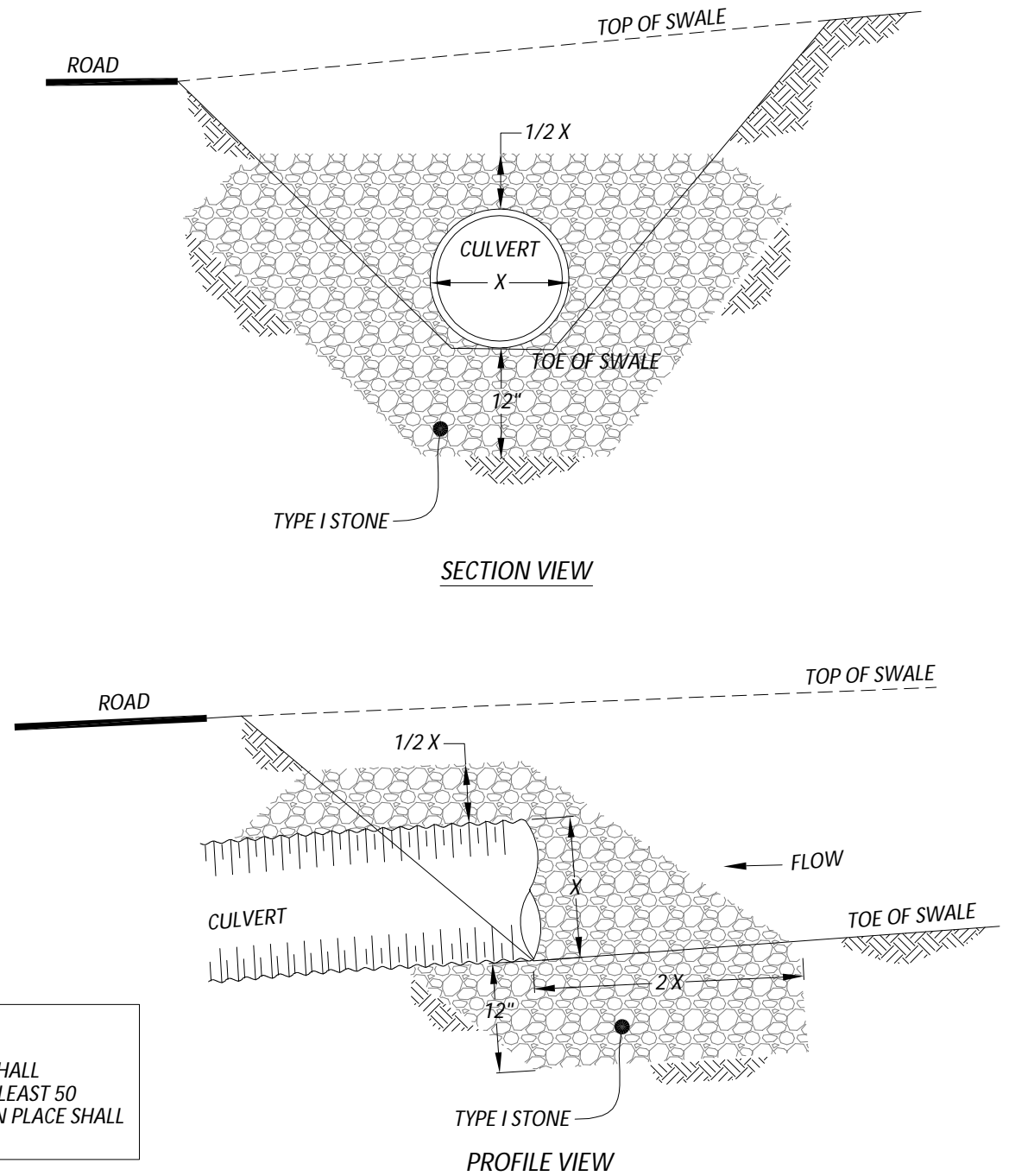
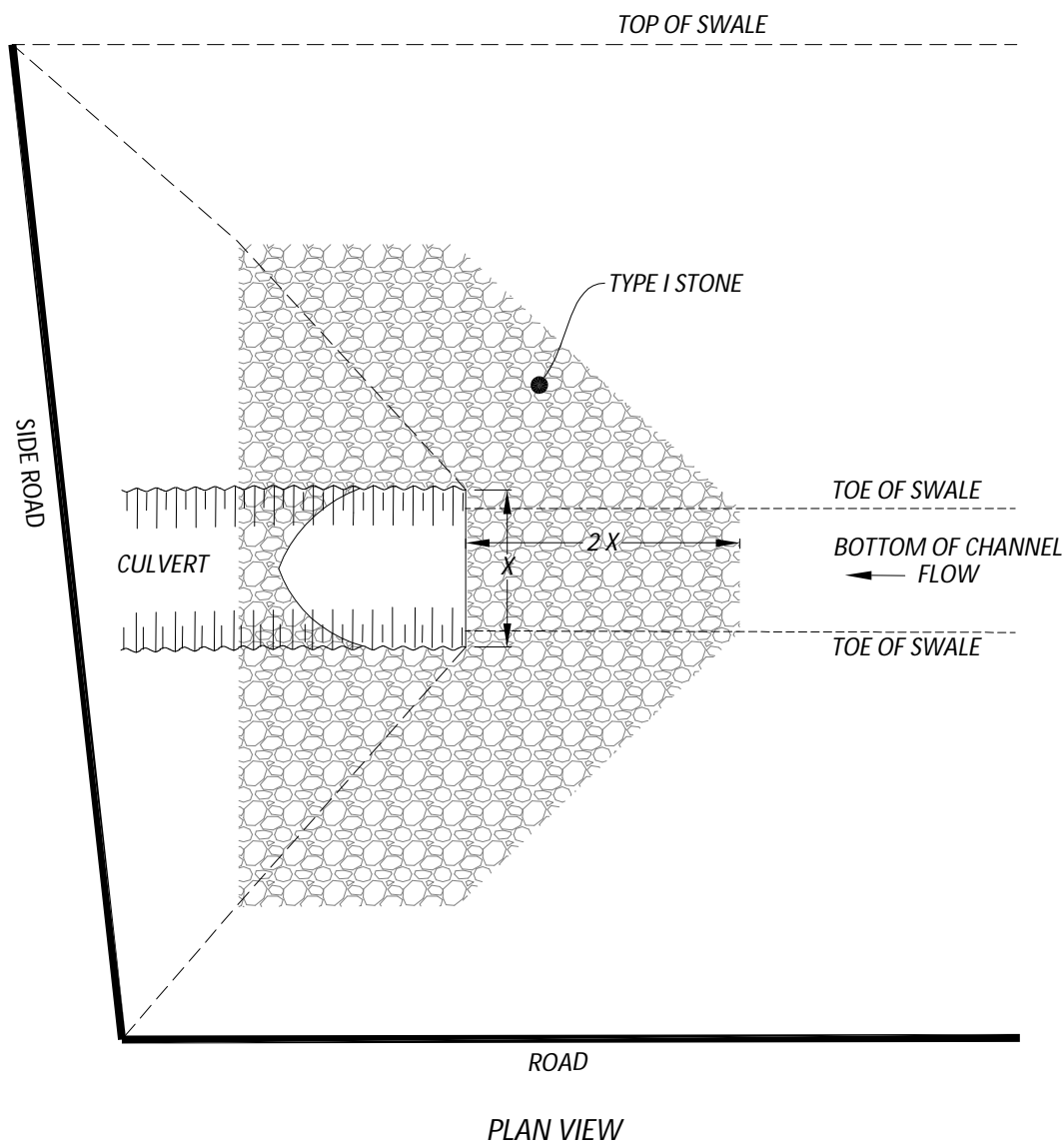
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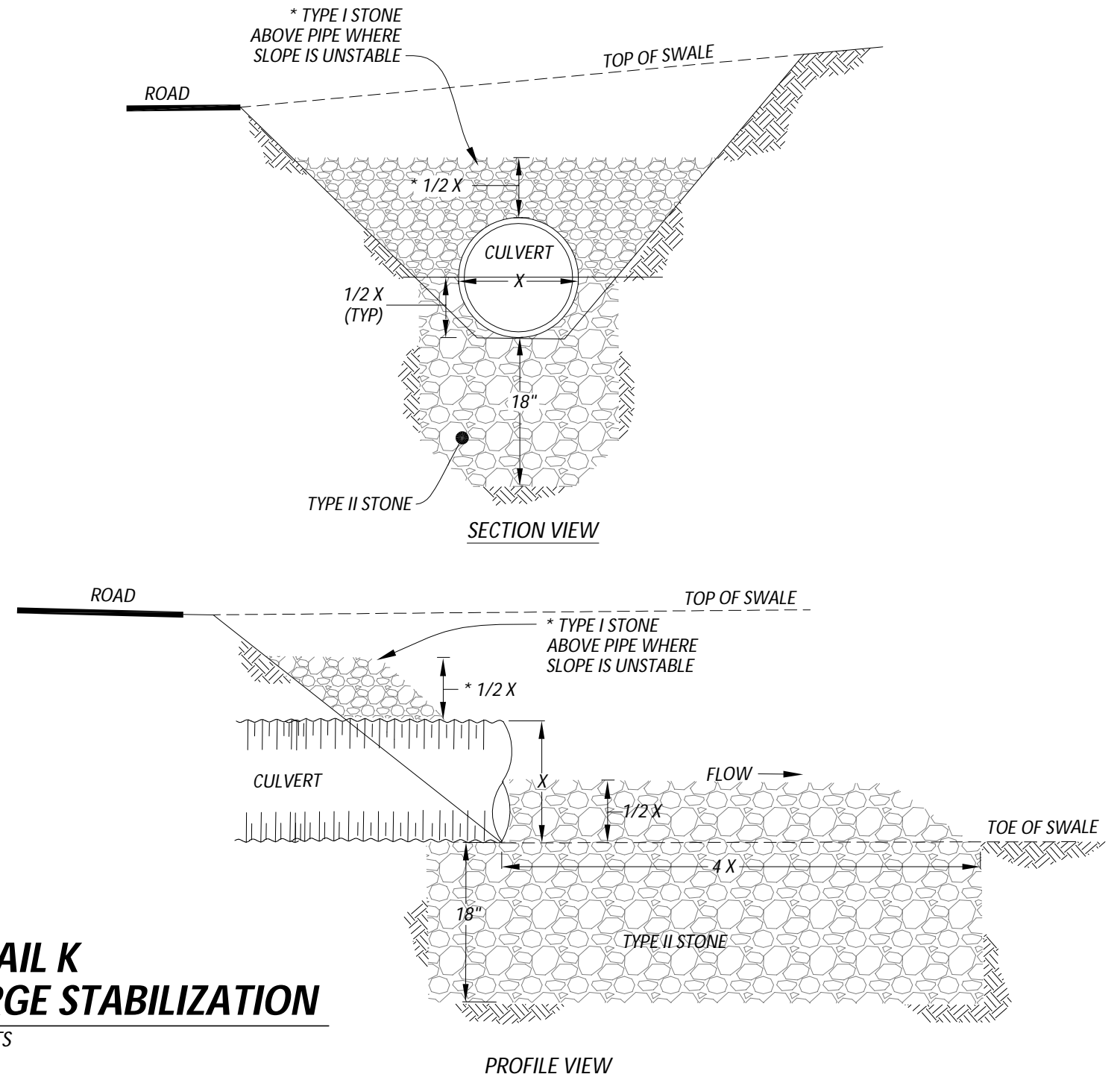
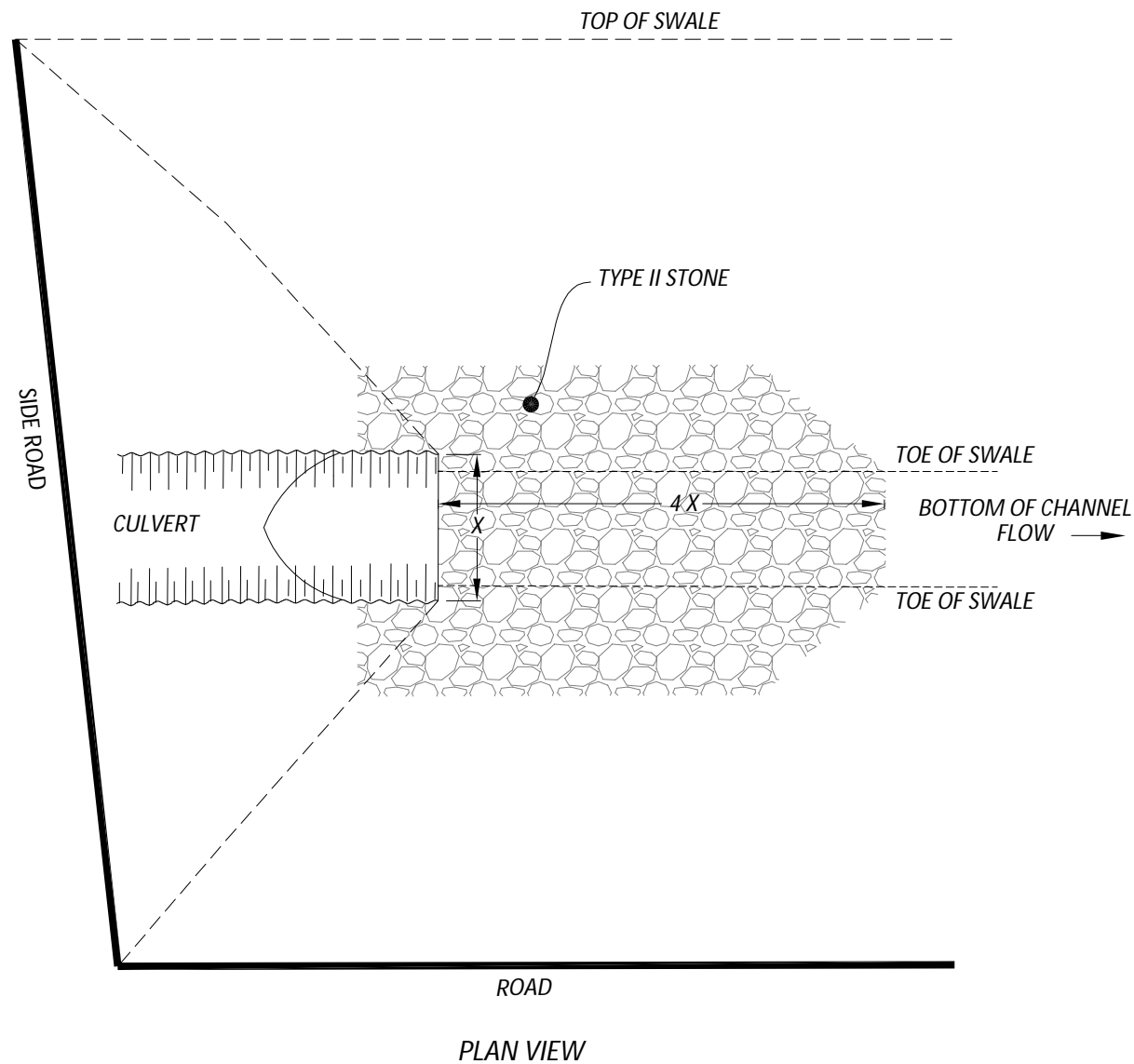
DETAIL J

CULVERT ENTRANCE STABILIZATION

NTS

NOTE:
USE DETAIL J IN LIEU OF CULVERT HEADWALL WHERE ENTERING FLOW IS SCOURING BOTTOM AND SIDES OF SWALE.

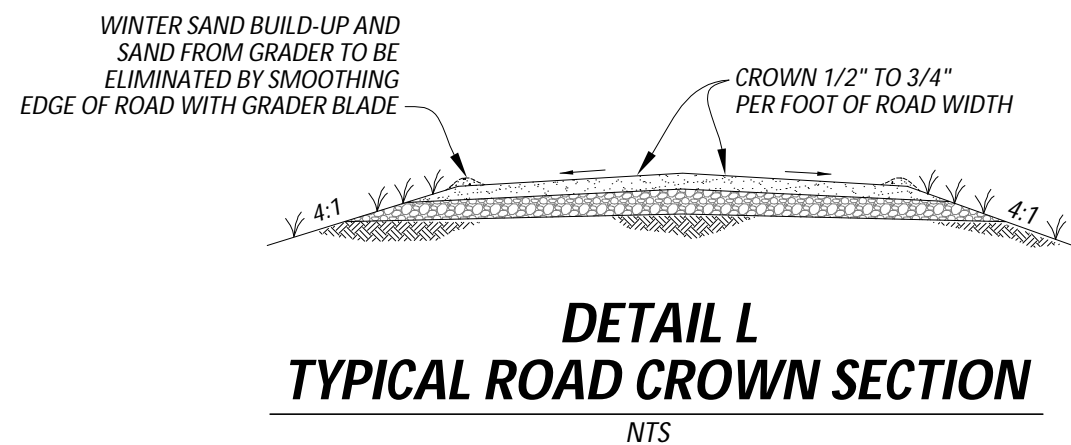
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DETAIL K CULVERT DISCHARGE STABILIZATION

NTS

NOTE:
USE DETAIL K WHERE EXITING FLOW IS SCOURING BOTTOM
OF DISCHARGE CHANNEL



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TYPE II STONE FILL
(VAOT SEC. 706.04(A))
THE LONGEST DIMENSION OF THE STONE SHALL VARY FROM 2 INCHES TO 36 INCHES, AND AT LEAST 50 PERCENT OF THE VOLUME OF THE STONE IN PLACE SHALL HAVE A LEAST DIMENSION OF 12 INCHES.

LAMOILLE COUNTY EROSION STUDY CAMBRIDGE, ELMORE & WOLCOTT, VERMONT	
EROSION PREVENTION & STABILIZATION DETAILS	
	
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specializing in stormwater management and erosion-sediment control	
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