Colrain Road Safety Planning Study

Massachusetts Department of Transportation - District 1

Road Safety Planning Study - Colrain, MA

E2X69147 - Colrain Road Safety Planning Study | 4

August 5, 2019

Project #608987, Contract #77870, Assignment #47

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1. Introduction

The Massachusetts Department of Transportation (MassDOT) – Highway Division is seeking a review of safety on Greenfield Road in the Town of Colrain following two recent truck crashes. In both instances heavy vehicles lost control as they descended the steep and windy approach into the town center, resulting in one fatality and one injury as well as the loss of property. In addition to these most recent crashes, the Town of Colrain has identified additional crashes involving heavy vehicles losing control on Greenfield Road that have occurred over many years.

This study identifies potential treatment options aimed at preventing heavy vehicles from losing control on Greenfield Road. The study also reviews current proposals for Complete Streets improvements in the town center. Recommendations have been provided with both short and long-term improvement alternatives.

1.1 Site Description

Colrain town center is located at the intersection of Main Road (State Highway – Route 112), Jacksonville Road (Route 112), and Greenfield Road (Figure 1). The town center includes residential, municipal and civic uses such as the Department of Public Works (DPW) garage, library, post office, a former church and a former restaurant, all located near this main intersection. The Colrain Central School is located to the north over the river on Jacksonville Road within walking distance of the center of town.

Figure 1 - Locus Plan

Greenfield Road is a Town road that approaches the intersection from the south down a steep grade that increases half way down the hill from 5% to 11%. Towards the top of the hill is a series of reverse curves that shield the steepest part of the hill from drivers of heavy vehicles.

1.2 Strategic Context

1.2.1 Regional Role

Greenfield Road is the most direct route connecting Deerfield and I-91 to Colrain and southern Vermont.

Alternative, less direct state routes include Route 112, which is a rural State Highway from just west of the Colrain town center to Route 2 at Shelburne Falls. Route 112 has no grade issues as it follows the North River. The section of Route 112 heading north from Colrain (Jacksonville Road) is a Town road and continues to the Vermont State Line where it becomes Vermont State Route 112. In 2004, Route 112 was designated as a Scenic Byway Corridor through the Town of Colrain and other surrounding towns.

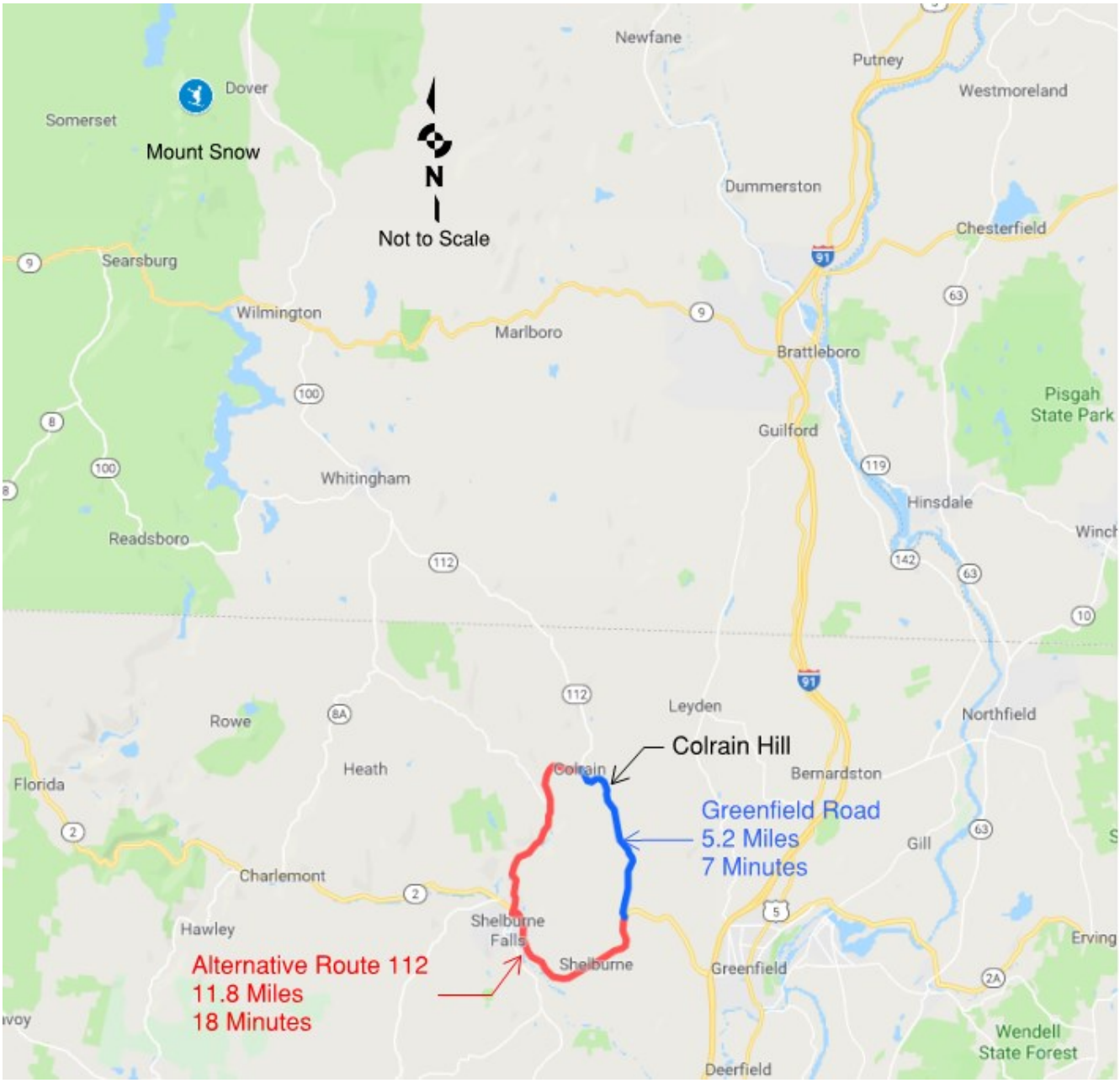


Figure 2 - Regional Context

1.2.2 Franklin County Bikeway

Route 112 is part of the Franklin County Bikeway. It is part of a frequently used 11.3-mile route, “The Shelburne – Vermont Connector,” that is classified as an intermediate level route on the Western Franklin County Bikeway Routes Map. The route connects western Franklin County to bike routes in Vermont using Route 112 beginning in the Town of Shelburne, traveling through Colrain and continuing to the Vermont border.

1.2.3 Vermont Ski Fields

In winter, Greenfield Road is used by traffic destined for Mount Snow in Vermont as it offers a quicker and shorter route than following I-91 further north to Brattleboro, Vermont. As a result, traffic volumes increase significantly on weekends during winter, particularly northbound on Friday night and southbound on Sunday.

1.3 Background

1.3.1 Heavy Vehicle Crash History

During 2017, two crashes involving trucks unable to maintain a safe speed on Greenfield Road have resulted in a fatality and an injury as well as the loss of property. The two most recent crashes involving trucks losing control on Greenfield Road are described as follows:

Table 1-1 Recent Crash History involving Trucks

Date	Type	Conditions	Description	
7/7/2017 Friday 2:42 PM Serious Injury	Single vehicle crash	Daylight Clear Dry	Truck coming downhill from Greenfield Road, lost its brakes, knocked down a utility pole in front of #6 Jacksonville Road, tipping over and losing the load of gravel.	
8/15/2017 Tuesday 7:50 AM Fatality	Single vehicle crash	Daylight Wet	Dump truck traveling downhill from Greenfield Road, crossed the double yellow center line exited the western edge of the roadway and into the vacant residence located north west of the Rt.112 at Greenfield Road intersection.	

In addition to these most recent crashes, at least four similar crashes have occurred since 1985. Each of these historic crashes involved a truck losing control on the descent into Colrain and crashing into properties within the Town.

The property at 4 Jacksonville Road in Colrain became locally known as the “Truck Stop” on the basis that it was struck on more than one occasion. This property has since been demolished due to the damage sustained. The Town of Colrain provided a series of newspaper articles on crashes involving trucks as detailed below:

Table 1-2 Historic Crashes involving Trucks

Date	Type	Conditions	Description	
5/7/1985 Tuesday 12:10PM Serious Injury	Single vehicle crash		A truck carrying 40,000 pounds of rayon for Kendall Mills lost its brakes and crashed into 4 Jacksonville Road taking out the front porch.	
5/8/1994 Sunday 11:11AM	Single vehicle crash		A tractor-trailer carrying bales of cotton crashed into 4 Jacksonville Road. Inadequate brakes were named as a contributing factor by the State Police.	
5/28/1999	Single vehicle crash		A truck driving a load of asphalt for Felton Construction crashed through the front yard of 4 Jacksonville Road and ripped off the porch of the house at 6 Jacksonville Road.	
8/18/2004 Wednesday 6:25AM	Single vehicle crash	Dry, Daylight, Clear	A tractor-trailer, carrying 50,000 pounds of loam and mulch, lost its brakes and crashed into a utility pole before sliding into two houses at 4 and 6 Jacksonville Road — both of which were vacant.	

1.3.2 Road Safety Audit

Following the two most recent crashes in 2017, MassDOT engaged McMahon Associates (McMahon) to carry out a Road Safety Audit (RSA). The RSA was completed for the intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112) in the Town of Colrain on September 14, 2017. The RSA considered all crashes over the last 7 years (2010 – 2017) within several miles of the town center and therefore was not restricted to crashes descending Greenfield Road. Suggested improvements raised by the RSA have been considered in this report.

A copy of the Road Safety Audit Report prepared by McMahon is included in Appendix A.

1.4 Related Projects

MassDOT currently has two projects in the immediate vicinity of this study as follows:

1.4.1 Route 112 Bridge Replacement Project (MassDOT Project 606551)

MassDOT recently replaced the bridge over the North River which is located a short distance to the north of the town center as shown in Figure 1. The bridge replacement included reconstruction of a section of Jacksonville Road immediately to the south of the bridge and north of the town center. Included in the project were two pedestrian crossings and sidewalks on both sides of Jacksonville Road. Jacobs has obtained CAD design files and survey from MassDOT. Construction was completed in 2018.

1.4.2 Colrain Complete Streets Project (MassDOT Project 607538)

In 2015, the Town of Colrain engaged Weston & Sampson to design a reconstruction/realignment of Route 112 in the town center. At that time, Colrain had limited sidewalks mostly in poor condition with poorly defined pedestrian crossings. In 2018, sidewalks and crossings were installed on Jacksonville Road north of the town center as part of the Route 112 Bridge Replacement Project as described in Section 1.4.1.

The Complete Streets project aims to improve the intersection in the town center as well as providing further facilities for pedestrians and bicycles.

Preliminary designs and reports are now available for this project which proposes to reconstruct the intersection to improve traffic flow, safety and sight distance including an accessible network of sidewalks, ramps, and crosswalks to link village center locations.

Jacobs has obtained CAD design files and survey from Weston & Sampson. A review by Jacobs of the 25% plans as part of the scope of this study is included in Section 6.

2. Existing Conditions

2.1 Road Conditions

Greenfield Road is classified as a Rural Minor Arterial and runs in a north – south direction linking the Colrain Town Center with Route 2 in neighboring Shelburne to the south. Land use along Greenfield Road within the Town of Colrain is single family residential with a school, post office, and other services within the town center, and a more rural/agricultural setting towards the top of the hill.

2.1.1 Speed Limit

The speed limit for the majority of Greenfield Road from Route 2 to Colrain is posted at 45 mph with reduced speed limits at certain locations. The speed limit as you approach the hill from the south is 45 mph reducing to 30 mph approximately halfway down the hill. This 0.5 miles from the town center and immediately after the grade steepens to 11%. A “30 MPH AHEAD” sign is located approximately 300’ ahead of the reduced speed limit sign. The speed limit further reduces to 20 mph approximately 600’ from the center of town.

2.1.2 Cross Section

The pavement width is approximately 30’, with 12’ wide travel lanes and painted shoulders.

2.1.3 Intersections

West Leyden Road intersects Greenfield Road from the east approximately 500’ north of the crest of the hill. West Leyden Road is stop-controlled and provides access to the Chandler Hill Cemetery and a telecommunications tower, located on the northeast quadrant of the intersection.

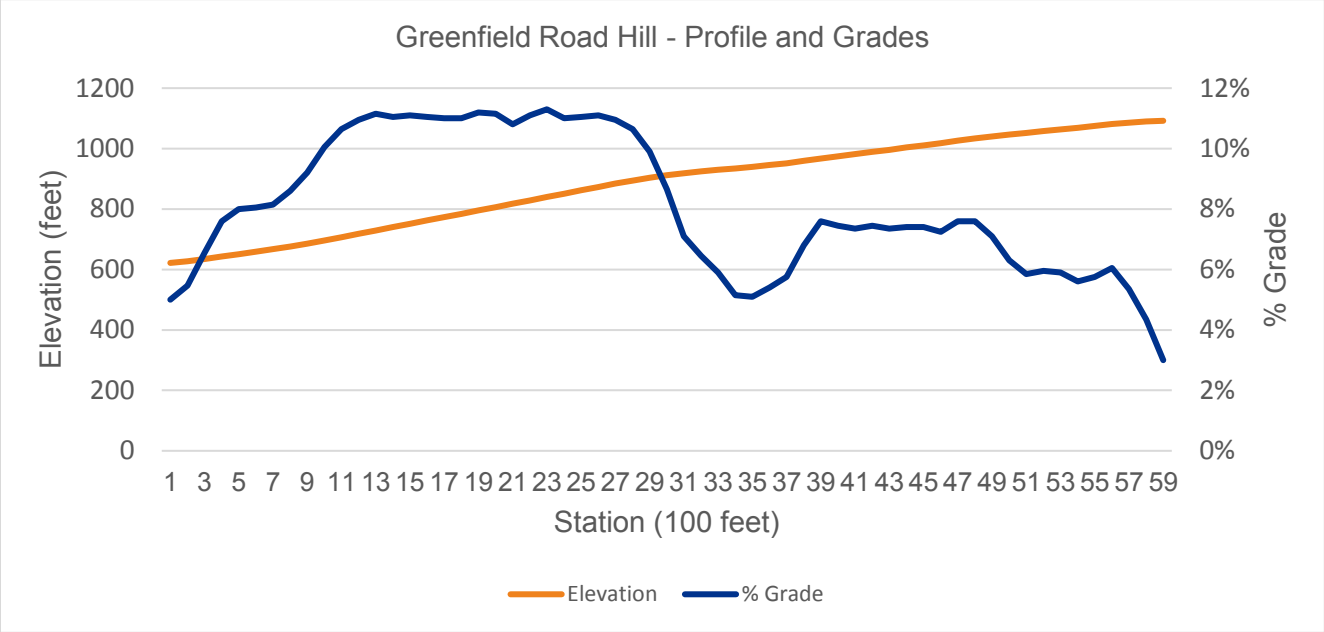
Route 112/Main Road intersects Greenfield Road and Route 112/Jacksonville Road from the west forming a T-Intersection in the center of town as shown in Figure 3. Route 112/Main Road is stop-controlled. The Greenfield Road – Jacksonville Road alignment includes a sharp curve with poor sight distance. This sharp curve and intersection has caused several trucks to roll over or leave the roadway and crash as they descend the hill at speed. This intersection and approaches is the subject of a Complete Streets Project being carried out by Weston & Sampson which has reached 25% design.

Figure 3 - Route 112/Main Road-Greenfield Road-Jacksonville Road Intersection

2.1.4 Grades

Greenfield Road descends 470’ from the top of the hill to the intersection in town over 5,800’. The steepest grades are not encountered until trucks reach the bottom half of the hill. At the top of the hill the grade quickly steepens to 8% before flattening off approximately half way down the hill to 5% for a short section. At Station 29+00 (Curve 4), the grade steepens to 11% and as the driver takes the bend, the town soon comes into view. It is at this point that truck drivers are most likely to realize that they are in the wrong gear or that their brakes are overheated or do not work. Figure 4 shows the approximate profile of the hill with the grades superimposed on the second axis. Note that Station 1+00 is at the Town Center and Station 59+00 is at the top of the hill. The flatter section is between Station 29+00 and 37+00.

Figure 4 - Greenfield Road Profile & Grade Summary



2.1.5 Horizontal Geometry

The hill section of Greenfield Road is accentuated by a series of horizontal curves making an 'S' curve as the road follows a natural gully. A set of alignment plans was recreated using available information from MassGIS and is shown in Appendix B. The accuracy of the contours was limited to 10' intervals. Cross slope at each of the curve locations has been estimated using the available contour information.

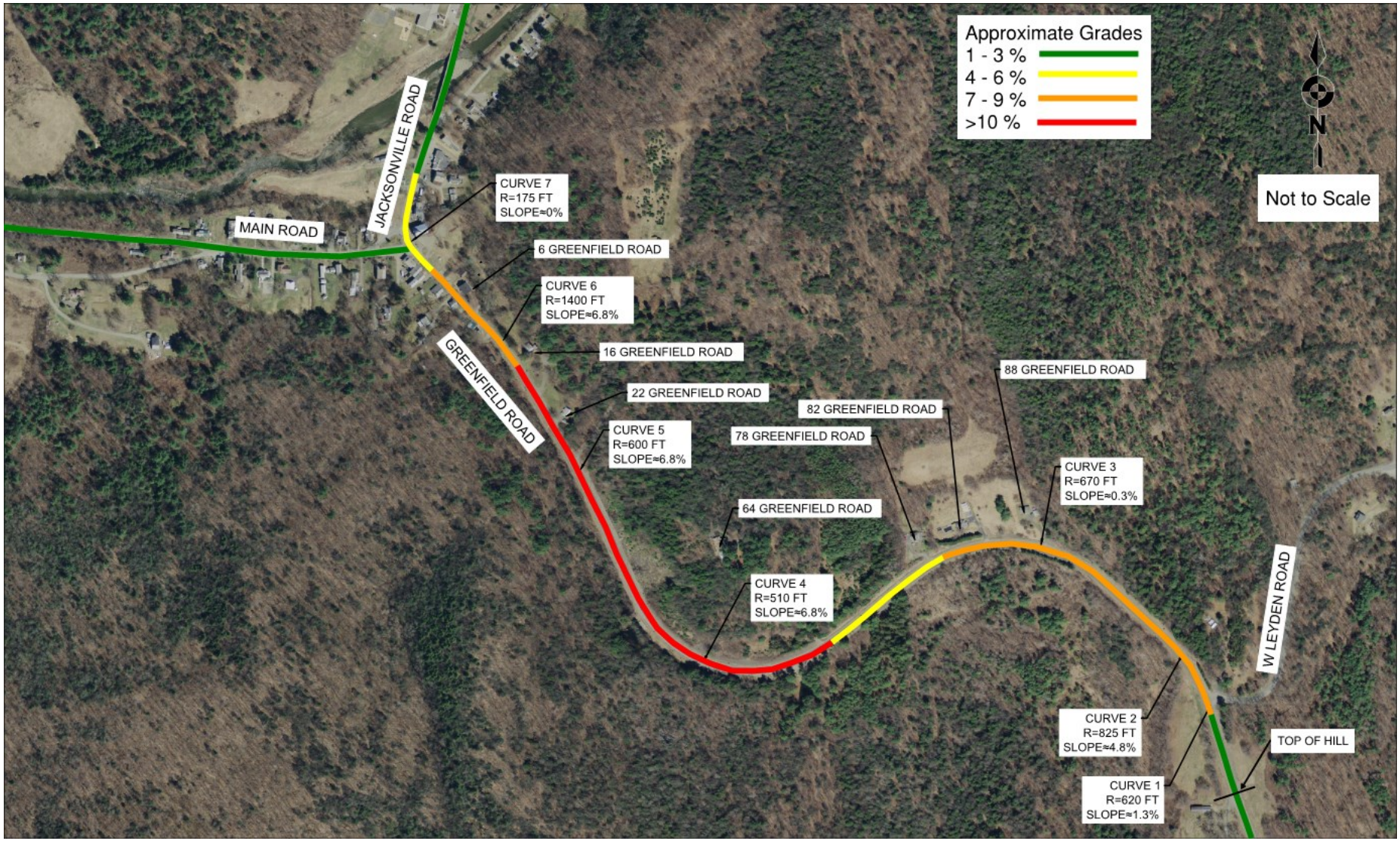
The curves are numbered beginning at the top of the hill with the final curve in the center of town as shown in Figure 5 below. There are seven (7) horizontal curves in total with Curves 3 and 4 being the long curves that make the shape of the 'S'. Estimated curve data is shown in Table 2-1 below.

Table 2-1 Greenfield Road Curve Data

Curve	Radius (feet)	Cross Slope (%)	Design Speed (mph)
1	620	1.3	15 mph
2	825	4.8	35 mph
3	670	0.3	15 mph
4	510	6.8	40 mph
5	600	6.8	40 mph
6	1400	6.8	60 mph
7	175	0	15 mph

The road enters a rock cutting for Curve 4. The terrain begins to flatten outside #26 Greenfield Road which is some 1,400' from the intersection in the town center. There are several properties on the eastern side of the route with houses at #6, #16, #22, #64, #78, #82 and #88 Greenfield Road as shown in Figure 5.

Figure 5 - Greenfield Road Existing Conditions



2.1.6 Warning Signs

The existing warning signage scheme on the hill was mapped and is shown in Figure 6. The existing warning signage scheme includes the minimum recommended types of signage including signs warning of steep grades and for trucks to use a lower gear. Signs also advise of the curve and intersection in town and the speed limit is reduced from 45mph to 30mph halfway down the hill. A more detailed description is as follows:

2.1.6.1 Vertical Grade Warning Signs

Hill warning signs are placed along the route with the two being placed just prior to the crest of the hill. Two additional signs are used as repeaters on the descent. The signs meet the minimum requirements of Section 2C.16 of the MUTCD but could provide further advice as trucks approach the steepest section of the road.

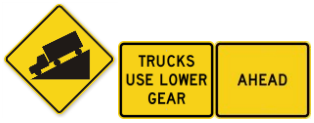
- The first hill warning sign is located approximately 200' from the crest of the hill. This sign has an LED flashing perimeter and was more recently installed by the Town of Colrain as an additional warning sign following the truck crashes in 2017.

W7-1

- A second hill warning sign shortly after the LED flashing sign includes a supplemental grade % sign which reads 5% to 11% grade next mile. This sign is located on the crest of the hill.

W7-1 W7-3bP

- A follow up hill warning sign is located shortly after the descent commences. This sign includes supplemental "Trucks Use Lower Gear" and "Ahead" signs.



W7-1 W7-2bP W16-9P

- The last of the hill warning signs includes a repeat "Trucks Use Lower Gear" supplemental sign. This sign is in advance of the reduced speed limit sign and immediately before the grade steepens to 11%.

W7-1 W7-2bP

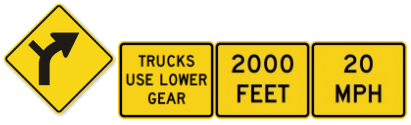
2.1.6.2 Curve Warning Signs

The two longer curves (Curves 3 and 4) are not signed. These curves present tight geometry on sustained curves and shield the driver's view from the descent. Curves 1 and 2 form a compound curve with West Leyden Road intersecting on the back of this curve. This curve and intersection are signed along with the sharp curve at the bottom of the hill in the town center which is provided with two advance warning signs.

- The first curve warning sign associated with the hill section warns the driver of the intersection of West Leyden Road on the back of Curves 1 and 2. The sign is located 900' from the West Leyden Road intersection at the crest of the hill.

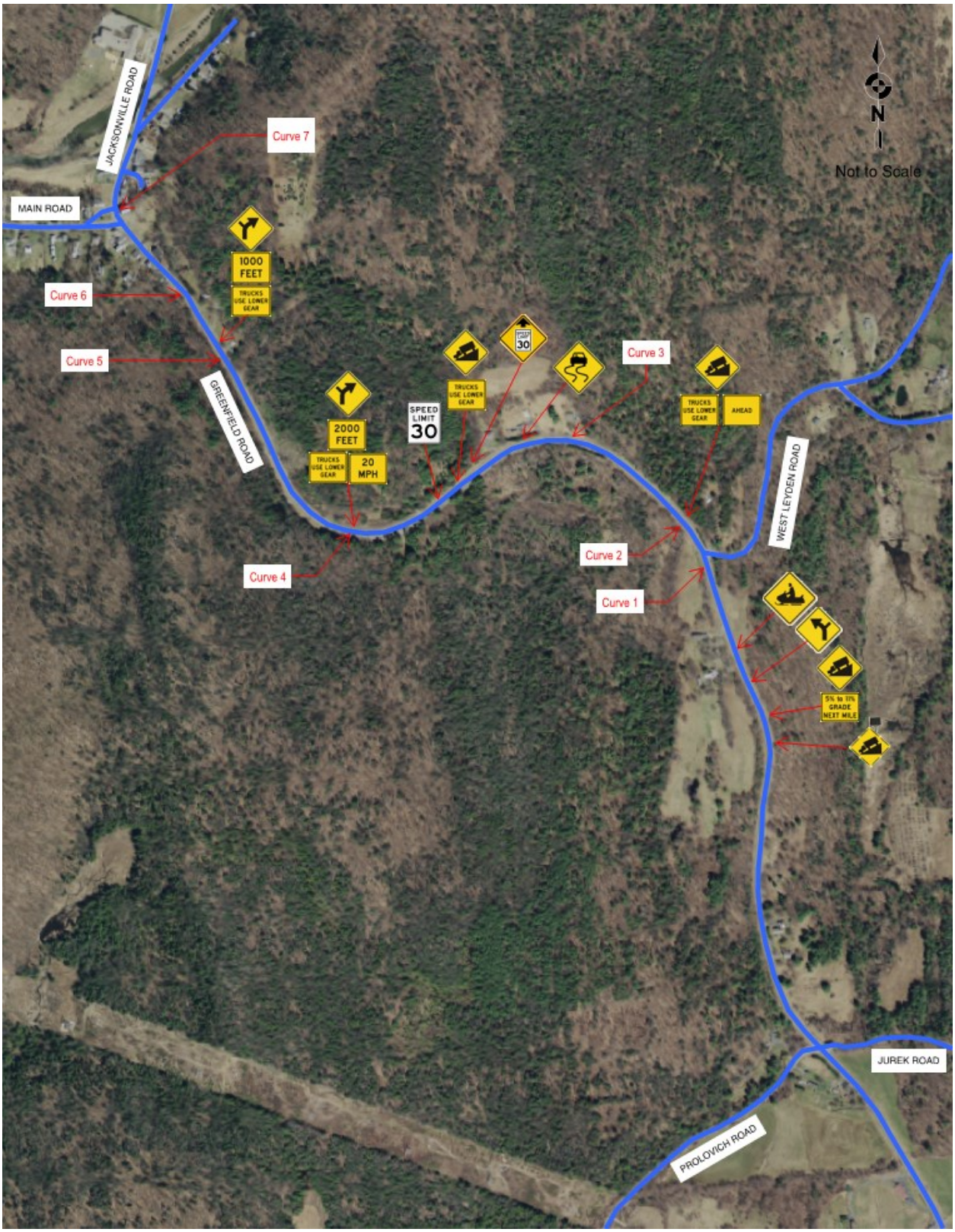
W1-10 (L)

- The first of two signs that provide advanced warning of curve 7 in town is located 2000' from the town center at curve 4. The sign is placed after the speed has reduced to 30 mph and after the hill has steepened to 11%. Supplemental signs include 20 mph, trucks use lower gear and 2000' ahead.

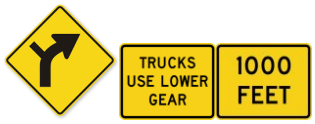


W1-10 (R) W7-2bP W16-2P W13-1P

Figure 6 - Existing Signage



- The second curve warning is placed 1000' from the town center and advises trucks to use a lower gear. The advisory 20 mph supplemental sign used on the earlier warning sign is not included at this location, however the speed limit reduces to 20 mph shortly after this warning sign.



W1-10 (R) W7-3bP W16-2P

2.1.6.3 Other Signs

Several other signs are included on the descent which include a 30 mph speed limit ahead sign, a sign advising of slippery conditions and a snowmobile crossing warning sign at the crest of the hill.

W3-5 W8-5 W11-6

2.1.7 Pedestrian & Bicycle Facilities

The hill section of Greenfield Road does not have pedestrian or bicycle facilities. North and west of the intersection in the town center, Route 112 is part of the Franklin County Bikeway as noted in Section 1.2.2.

Previously, very few pedestrian and bicycle facilities existed within the town center. The Bridge Replacement project installed sidewalks, two pedestrian crossings and 5' shoulders usable by bicycles on Jacksonville Road. The western sidewalk continues over the bridge to the school. A section of sidewalk also exists on the south side of Main Road. The Complete Streets Project proposes additional pedestrian facilities and 5' shoulders for use by bicycles on Main Road, Jacksonville Road and Greenfield Road.

Figure 7 - New sidewalks and shoulders – Colrain Bridge Project

2.2 Traffic Conditions

Weston & Sampson, as part of their Colrain Complete Streets Project, carried out intersection turning movement counts (TMCs) at the intersection of Route 112 (Main Road/Jacksonville Road) at Greenfield Road. These counts were taken during two different months to capture typical weekday conditions, as well as seasonally influenced weekend traffic (ski season) as follows:

- Typical School Day - Thursday, October 2, 2014 – AM Peak Period from 7 AM to 9 AM, Midday Period from 11 AM to 1 PM, and the PM Peak Period from 4 PM to 6PM.
- Typical Ski Season Weekend - Friday, March 6, 2015 – PM Peak Period from 4 PM to 8:30 PM, and on Sunday evening, March 8, 2015 – PM Peak Period from 4 PM to 7 PM.

Weston & Sampson also carried out 2014 Automatic Traffic Recorder (ATR) counts at the following locations:

- Jacksonville Road (Route 112)
- Main Road (Route 112)
- Greenfield Road

The Ski Season counts show a significant increase in PM Peak Volumes using Greenfield Road to pass through Colrain on their way to/from Mount Snow. This is most pronounced with vehicles returning home from Vermont on Sunday evening with 379 southbound peak hour movements compared with a typical weekday southbound volume of 84. This is consistent with discussion at the Community Meeting on April 19, 2018 of significant increases in traffic during the ski season on weekends.

Two historic traffic counts were also available on Route 112 (Jacksonville Road) 0.3 miles north of the river in 2003 and 2007. Average Daily Traffic (ADT) volumes are listed in Table 2-2. Summary diagrams prepared by Weston & Sampson showing existing turning movement counts are included in Appendix C.

Table 2-2 Average Daily Traffic (ADT) Volumes

Location	2003	2007	2014
Route 112 (Main Road)			1,960
Route 112 (Jacksonville Road)	1,500	1,600	1,760
Greenfield Road			2,800

2.3 Crash Data

In addition to Section 1.3.1, Heavy Vehicle Crash History, and the Road Safety Audit carried out by McMahon & Associates, Weston & Sampson also carried out a crash analysis for the five-year period 2009 – 2013. This analysis concluded that crash rates at the intersection in the Town of Colrain and its approaches including Greenfield Road were below Massachusetts state average crash rates for the period analyzed. A copy of the Road Safety Audit Report is included in Appendix A.

Table 2-3 Colrain Crash Rates (2009 - 2013)[1]

Location	Crash Rate	
	Calculated	State Average
Intersection of Route 112 (Main Road/Jacksonville Road) at Greenfield Road	0.39	0.60
Route 112 (Main Road)	0.39	1.61
Route 112 (Jacksonville Road)	0.00	0.90
Greenfield Road	0.33	0.90

Note: Intersection crash rates are per Million Entering Vehicles, roadway segment crash rates are per Million Vehicle Miles Traveled.

2.4 Cultural Resources

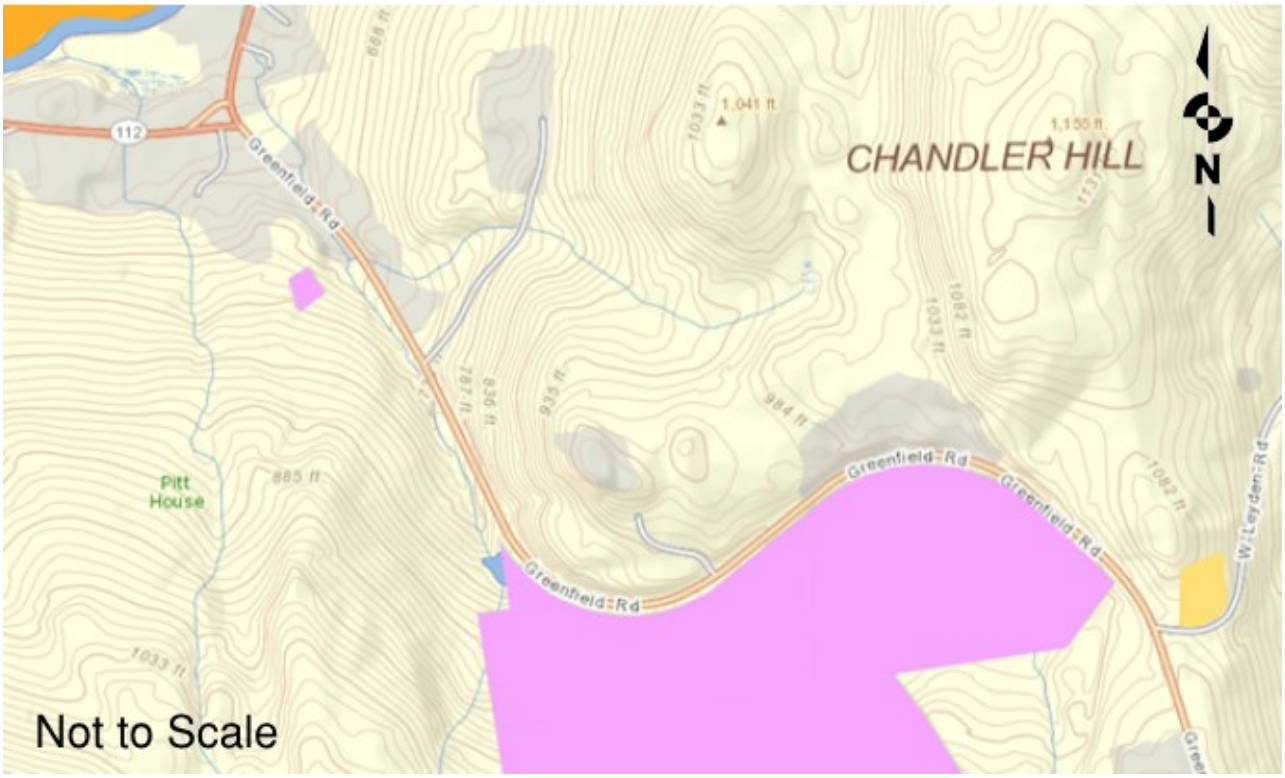
The town center is to the west of the intersection of Main Road and Greenfield Road. The town center includes the town hall, police station, library, post office, fire department, and several private residences.

The Pitt House, on the south side of Main Road, is an 1840s home owned by the Town and is the home of the Colrain Historical Society. The Pitt House lies within the Colrain Historic District and is listed in the MACRIS register. It is unlikely that any recommendations made in this study would impact the Pitt House.

The Colrain Central School is north of the town center on Jacksonville Road, north of the river. There is a historical marker on the landscaped island at the intersection in the center of town. The Colrain DPW Garage is immediately north of the intersection on the east side of the road. On the east side of the intersection is an unused church. Land use along Greenfield Road south of the town center is low density, single family residential. The Town of Colrain owns parcels of land for water supply as shown in pink in Figure 8 below. There is no other open space in the area that would be impacted by this project.

[1] Functional Design Report, Route 112 at Greenfield Road Colrain, Massachusetts, Weston & Sampson 2016

Figure 8 - Open Space by Ownership



Source: MassGIS OLIVER;

2.5 Historical/Archaeological Federal Section 106 and State Chapter 254

The Massachusetts Historical Commission MACRIS database, lists Colrain Center as an Historic District. The district is also listed on the National Register of Historic Places. There are 55 historic points within the district. 125 Greenfield Road, near the top of the hill, is an inventoried property (MACRIS ID #COL.7). Some of the study recommendations propose work on land across the road but will not impact the 125 Greenfield Road parcel.

The Chandler Hill Cemetery is the site of the original settlement of Colrain and dates to 1743 when the land was set aside for a burial ground. The cemetery is located near the corner of Greenfield Road and West Leyden Road and is shown in yellow in Figure 8. The cemetery is actively maintained and includes many headstones dating from the 1700s as shown in Figure 9 and Figure 10.

Figure 9 - Chandler Hill Cemetery

Figure 10 - Chandler Hill Cemetery Entrance

2.6 Environmental Conditions

2.6.1 Waterways

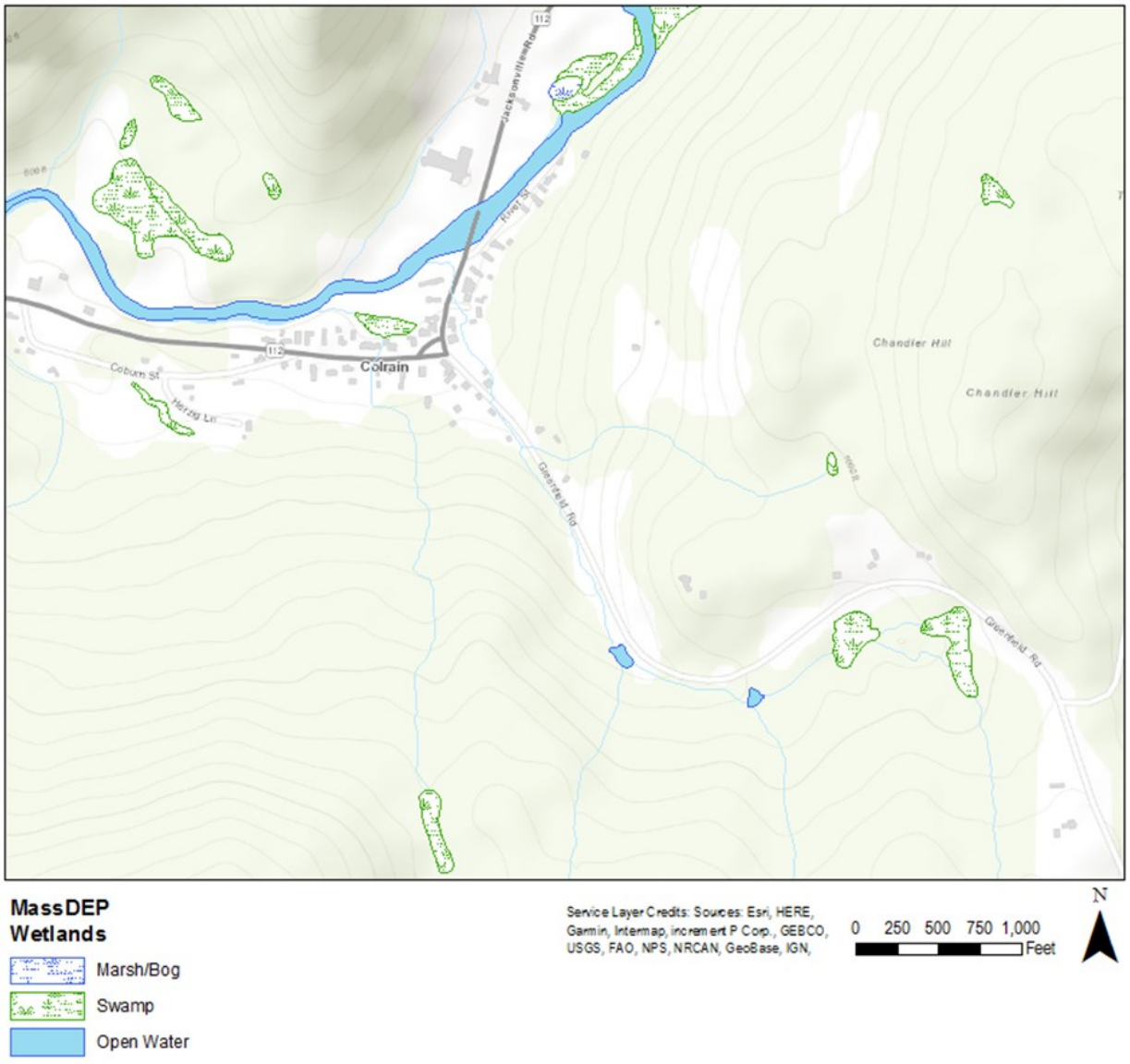
Colrain is located in a valley within a mountainous region. The North River lies to the north of the intersection, and there are streams in the area, as shown in Figure 11.

A waterway follows the alignment of Greenfield Road crossing beneath the house at #6 Greenfield Road before passing behind the church and connecting to the North River near the town center. A tributary to this stream crosses the road through an existing culvert outside #16 Greenfield Road.

2.6.2 Hazardous Materials Research/Review

There are no underground storage tanks nor oil, and/or hazardous material sites listed by the Massachusetts Department of Environmental Protection within or proximate to the study area.

Figure 11 - Waterbodies



2.6.3 Environmental Considerations

GIS and the MassGIS online mapping tool, OLIVER, were used to determine if the project occurs within or adjacent to sensitive environmental resources. Using the MassDOT 25% Design Submission Checklist for Early Environmental Coordination as a guide, Table 2-4 summarizes the findings and indicates the source used for the analysis. Where resources were identified as present, maps were developed in GIS to indicate their location and extent (Appendix D).

Table 2-4 Summary of Environmental Resources Present within the Study Area

Resource	Status	Data Source
Outstanding Resource Waters	• Public Water Supply Watershed: Mountain Spring Reservoir, Deerfield	• OLIVER • GIS: MassDEP Watersheds Layer
Stormwater "critical areas" defined as: Cold water fisheries, Zone IIs, public swimming beaches, shellfish growing areas and drinking water reservoir watersheds	• The East Branch of the North River is a DFW Coldwater Fisheries Resource • Zone IIs: none • Public swimming beaches: none • No shellfish growing areas • Drinking water reservoir watersheds: Mountain Spring Reservoir, Deerfield	• GIS: Massachusetts Division of Fisheries and Wildlife Coldwater Fisheries Resources Layer • OLIVER
Areas of Critical Environmental Concern (ACECs)	None	• OLIVER
Natural Heritage & Endangered Species Program (NHESP) designated endangered species habitat and certified/potential vernal pools	• Priority Habitat ID #1415 • Estimated Habitat ID #1081 • No Natural Communities • No Certified Vernal Pools	• GIS: NHESP Data Layers • OLIVER
Impaired Waterbodies	• East Branch North River is Category 2: Unimpaired for some uses and not assessed for others	• MassDEP 2012 Integrated List of Waters (305(b)/303(d)) • http://gis.massdot.state.ma.us/maptemplate/wqdf • OLIVER
Regulated Wetland Resources	*See map (*Figure 11*)*	• GIS: MassDEP Wetlands Layer
FEMA Delineated Floodways	None	• OLIVER
Wild & Scenic Rivers	None	• https://www.rivers.gov/massachusetts.php • https://www.nps.gov/subjects/rivers/massachusetts.htm
High Quality Streams	• Insignificant barrier (Survey ID 34891) on Tributary to East Branch North River on Jacksonville Road near the Colrain Garage and Highway Department	• North Atlantic Aquatic Connectivity Collaborative https://streamcontinuity.org/assessing_crossing_structures/prioritzing_streams.htm
Outstanding Resource Waters	• Public Water Supply Watershed: Mountain Spring Reservoir, Deerfield	• OLIVER • GIS: MassDEP Watersheds Layer

There are no activity use limitation (AUL) deed restrictions located within or adjacent to the project limits.

3. Study Purpose and Methodology

3.1 Project Purpose

The purpose of this study is to identify and define improvements that will help prevent heavy vehicles from losing control while descending the steep grades on Greenfield Road thus reducing the number of out-of-control heavy vehicle crashes in the Colrain town center.

3.2 Project Need

As noted in Section 2.1.4, the southern approach to Colrain via Greenfield Road is steep with variable grades. The first section of the descent (2000') quickly steepens to 8%, followed by a section (1000') where the grade has flattened off to approximately 5%. Approximately half way down the hill the grade steepens to 11% until it reaches the town center (2900'). On the hill section, the road has several tight radius curves and intersects with Main Road and Jacksonville Road at the bottom of the hill in the Colrain town center.

The alignment of the through movement along Greenfield Road transitioning into Jacksonville Road in the center of town has a particularly tight curve with a radius of 175' and posted speed of 20 mph. The change in grade half way down the hill creates a false sense of security for drivers who are not familiar with the road conditions, likely resulting in many drivers selecting the wrong gear for the descent and therefore having to rely on brakes to control speed for the remainder of the descent and through the Town.

In 2017, two (2) heavy vehicles lost control on the Greenfield Road hill and were unable to safely negotiate the sharp curve in the center of town, resulting in crashes. The most recent of these crashes in August 2017 resulted in a truck crashing into a house, claiming the life of the driver. As noted in Section 1.3.1, at least four (4) additional trucks have lost control on this same stretch of road since 1985 resulting in similar crashes into buildings within the town. Additional crashes have been referred to in news articles and anecdotally, however, data on these crashes has not been identified.

3.3 Analysis of Heavy Vehicle Crash History

An analysis of the heavy vehicle crash history was carried out to identify common themes, causes and contributing factors. The following were identified from the six heavy vehicle crashes descending Greenfield Road into Colrain:

- Trucks were all carrying heavy loads
- Vehicles lost the ability to maintain a safe speed
- Reported overheated or loss of brakes
- One reported a missed gear when trying to get into a lower gear at a higher speed
- Excessive speed when descending the hill and entering the town
- Vehicles overturned or lost control on the sharp curve at the intersection with Route 112 in the town center, resulting in the vehicles crashing or nearly crashing into buildings near the intersection
- Poor geometry of curve, including steep grades and a 175' radius curve at the intersection contributed to the trucks crashing

A review of the above common factors and the current conditions has identified five (5) fundamental deficiencies as described below. This study will make recommendations to improve safety for heavy vehicles and reduce property damage on this section of road.

- Inadequate advance warning to inform drivers about alternative routes
- Inadequate warning of the grades and road geometry to prevent drivers from getting out-of-control
- Lack of facilities, such as a Brake Check Area to control the speed of heavy vehicles

- Lack of a facility to catch out-of-control vehicles before they enter the town
- Poor roadway geometry within the town center to allow out-of-control vehicles to safely pass through the town and onto flat terrain

The first four of these deficiencies are related to preventing out-of-control vehicles from entering the Town, while the fifth is aimed at mitigating the impacts of an out-of-control vehicle that has made it into the town center.

3.4 Goals and Objectives

According to the California Department of Transportation, Design Guide for Truck Escape Ramps (1986)[2], "*a sequential approach, even if leading to the eventual installation of a truck escape ramp, may be the most effective. First, review the signing. Are appropriate curve and grade warning signs in place? Is a posted downhill truck speed limit needed? Will it be enforced? If these measures are implemented and prove to be ineffectual, then a roadside brake inspection area at the top of the grade is worth considering. The effectiveness of the inspection area may be enhanced if the California Highway Patrol uses it to periodically conduct truck inspections. If these measures are not effective, then install a truck escape ramp. Last, if none of these measures prove to be effective in reducing runaway truck incidents, a final, but highly controversial consideration would be banning trucks from the route or grade.*"

Similarly, the Institute of Transportation Engineers (ITE) issued Guidelines for Truck Escape Ramps in 1989[3] which suggested a similar staged approach of implementing progressive improvements before building escape ramps such as:

- Signing
- Speed controls
- Mandatory pull-off areas

This sequential approach to addressing the problem is useful in that many of these crashes are not caused by a single factor and several "levels of intervention" would assist in reducing "runaway" truck incidents. This approach also allows for treatments to be progressively implemented or implemented as a "package" to deal more holistically with the problem. This approach also addresses the factors contributing to the truck crashes in Colrain by recommending treatments in the following order:

- Improve warnings and signage
- Control speed through speed limits or brake check area
- Install a truck escape ramp
- Minimize heavy vehicles on the route

The goals and objectives will assist in identifying treatments that can be implemented in a similar descending order of hierarchy or need. For example, if truck drivers are more aware of the hazard ahead, they are more likely to drive in an appropriate manner and be able to descend the hill safely (meaning a truck escape ramp would not be needed). Similarly, if trucks are made to comply with truck speed limits or are forced to stop and check brakes at the top of the hill, then they are also more likely to drive in a more appropriate manner thus minimizing the need for a truck escape ramp. A Brake Check Area will also provide drivers an opportunity to identify any issues with their vehicle such as gears or brakes before they commence the descent.

Identifying common themes and causes of the heavy vehicle crashes has enabled the identification of deficiencies in the road system. To overcome these deficiencies and to assist in the identification of treatment options, the five (5) deficiencies noted above were identified as Project Goals. As noted above, the first four directly address the cause of the crash and are aimed at preventing an out-of-control vehicle from entering the

[2] Tye, E.J., "Design Guide for Truck Escape Ramps," Traffic Bulletin No. 24, California Business, Transportation and Housing Agency, Sacramento, California (1986)
[3] Institute of Transportation Engineers. 1989. Truck escape ramps: recommended practice. Washington, DC: Institute of Transportation Engineers.

town center. The fifth deficiency/Project Goal does not directly improve safety for trucks descending Greenfield Road but rather mitigates the vehicle's impact on the surrounding property. Each Project Goal has a set of objectives, which serve as the steps to achieve the outcomes as shown in Table 3-1.

Table 3-1 Project Goals and Objectives

Project Goals	Objectives	Outcomes
1. Inform truck drivers about road conditions	• Improve warning signs including: – Provide advance warning of steep descent and town center located at bottom of hill – Provide warnings of grades, appropriate speeds, curves, road conditions along route – Provide reminder warning signs • Actively warn truck drivers of hazards ahead using ITS technology – Provide signage that targets truck drivers – Provide signage that actively advises drivers of conditions ahead	• Heavy vehicle drivers are informed about road conditions. • Messaging actively targets truck drivers
2. Heavy vehicles descend the hill at a safe speed	• Require heavy vehicles to stop at top of the hill: – Provide facility that requires heavy vehicles to stop at the top of the hill forcing trucks to descend at a safe speed – Provide opportunity for vehicles to check brakes • Advise heavy vehicles to travel at a safe speed – Provide information to drivers to enable them to travel at a safe speed	• Trucks have an opportunity to check brakes • Information is provided to truck drivers • Trucks descend the hill at a safe speed
3. Prevent out-of-control heavy vehicles from entering the town center	• Safely stop out-of-control vehicles before they reach town – Provide a facility to catch out-of-control vehicles	• Out-of-control vehicles are brought safely to a stop before reaching the town
4. Minimize heavy vehicles from using Greenfield Road	• Require or encourage heavy vehicles to take an alternative route • Heavy vehicle drivers are advised of road conditions prior to taking route • Provide a truck turnaround facility	• Less trucks use Greenfield Road • Trucks have an opportunity to turn around
5. Out-of-control vehicles can pass through town safely	• Improve road geometry in the town center to reduce crashes – Improve sharp curve to cater for higher truck speeds	• Heavy vehicles do not crash in town and are able to regain control

3.5 Evaluation Criteria

Figure 12 below provides an overview of the evaluation process used for this study. First, improvement options were developed to address the study goals and objectives. The improvement options also consider the Road Safety Audit recommendations and community input where appropriate.

The improvement options were then evaluated to assess how well/effectively they met the project goals. This resulted in a "shortlist" of improvement options that advanced to additional evaluation. The shortlisted options were then evaluated to identify the series of options that provide the best overall outcome. This evaluation was based on criteria to assess effectiveness at solving the problem, impacts to the environment, and impacts to the community. The evaluation criteria (shown in Table 3-2) were used where appropriate to assess the benefits and impacts of the improvement options.

Figure 12 - Option Evaluation

Table 3-2 Evaluation Criteria

Evaluation Criteria	Measures of Effectiveness
Safety	• Effectiveness in preventing out-of-control heavy vehicles on Greenfield Road hill • Effectiveness in preventing out-of-control heavy vehicles in town center
Environmental Effects	• Impacts on environmental resources
Community	• Impacts on land • Impacts on buildings • Level of community support

Constructability and cost criteria as shown in Table 3-3 were used to classify recommended improvements as short, medium or long-term solutions.

Table 3-3 Short, Medium & Long-Term Projects

Constructability Time Frame		Costs	
Short	<1 Year	Low	<$10,000
Medium	1 – 3 Years	Medium	$10,001 - $50,000
Long	>3 Years	High	>$50,000

4. Improvement Options

With every road safety improvement project, it is important to identify improvement options that directly address the identified project purpose and needs. It is also important that a range of treatment types are considered.

For Colrain, a process of identifying, shortlisting and assessing improvement options has been utilized as described in Section 3.5.

4.1 Analysis of Existing Truck Safety Systems

To assist in identifying suitable improvement options for Colrain, Jacobs researched examples of systems in place in communities that have experienced similar problems. The study identified several sites that had similarities to Colrain. The analysis deliberately focused on two lane roads that had stop or town center conditions at the bottom the hill. Truck safety systems on Interstate Highways were ignored. Sites that formed part of the research include:

4.1.1 Route 93 East - Nesquehoning, PA

Road Conditions	• Length: 2¼ Miles • Grade: 9% • Bottom of hill: T-Intersection with Route 209 in the Town of Nesquehoning, PA
Truck Safety Elements	• Advance warning signs • Truck ban > 102” wide • Required truck stop & brake check area > 21,000 lbs • Detailed road information available to trucks • Truck speed limits • Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Truck ramp – gravel • Overhead signs
Relevance to Colrain	• Two lane highway • Long steep descent into a valley and a T-Intersection

This site provided a wide array of truck safety elements including a Truck Stop Bay, comprehensive advance warning signs, a truck speed limit, and truck escape ramp. However, three recent crashes in early 2018 have resulted in Route 93 being banned for heavy vehicles wider than 102”. This indicates that despite all the warnings, there is a driver element which is hard to control. Intelligent Transportation Systems (ITS) could be used to provide a more active form of warning which may obtain a better response to the conditions from drivers. The truck stop bay at this location is a widened area of pavement that requires heavy vehicles to stop before continuing.

4.1.2 Route 28 North, Vickerman Hill - Herkimer, NY

Road Conditions	• Length: 2+ miles • Grade: 10% • Bottom of hill: Towns of Mohawk and Herkimer at bottom of grade
Truck Safety Elements	• Advance warning signs • Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Required truck stop, brake check area & truck turnaround facility • Detailed road information • Truck ramp – gravel & sand filled crash barriers • Overhead signs • Truck speed limits
Relevance to Colrain	• Two lane highway • Long steep descent into the Mohawk River Valley with the Town of Mohawk at the bottom • History of truck crashes • Truck escape ramp is on a down slope due to geometry constraints

Similar to the site at Nesquehoning in Pennsylvania, Vickerman Hill provides a broad suite of truck safety elements. The advance warning signs here are on gantries making them more visible and effective. The truck stop bay is significantly improved from the site at Nesquehoning as it returns heavy vehicles to the highway at a right-angled T-Intersection with a second stop sign.

4.1.3 Route 2 West - North Adams, MA

Road Conditions	• Length: 4+ miles • Grade: 7% • Sharp hairpin turns • Bottom of hill: Town of North Adams
Truck Safety Elements	• Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Overhead gantry sign
Relevance to Colrain	• Two lane highway • Long steep descent into a valley with the Town of North Adams at the bottom • Local to Colrain

This site is not very far from Colrain and is well known to many who live in the area. This site is a little different in that there is no town or intersection at the bottom of the hill, however there is a 180° hairpin bend halfway down that vehicles should be warned of before they commence their descent. The descent is particularly long at over 4 miles with grades consistently at 7%.

This site makes use of a large overhead gantry sign which is very conspicuous and raises the driver's awareness to the road conditions ahead.

4.1.4 Route 2 East - Williamstown, MA

Road Conditions	• Length: 4+ miles • Grade: 7% • Bottom of Hill: T-Intersection with Route 7 in the Williamstown, MA
Truck Safety Elements	• Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Truck speed limit • Truck ramp – gravel & impact absorption catch wire system • Pull off areas on descent • Overhead gantry sign with flashing lights
Relevance to Colrain	• Two lane highway • Long steep descent into a valley with the Town of Williamstown at the bottom • Local to Colrain

This site, located on Route 2 in the western part of the State, is also very familiar to many in Colrain. This site does have areas for trucks to pull off at the top of the hill (in NY) and at various locations down the hill. None of these pull off areas require heavy vehicles to stop. The descent is particularly long at over 4 miles with grades consistently at 7%.

Overhead gantry signs are used on the approach to the runaway truck ramp and include flashing lights. The flashing lights appear to be permanently on (rather than actuated by heavy vehicles). The truck ramp is a gravel friction-based ramp but also has a mechanical catch wire system which was installed later to ensure heavy vehicles do not make it out onto Route 7 if they are travelling at high speeds.

4.1.5 Route 12 North - New Hartford, NY

The site at New Hartford in New York descends a steep hill into the Mohawk River Valley like the site at Vickerman Hill, however at this location there is no truck stop bay and no overhead advance warning signs at the top of the hill. Advance warning for the signalized T-intersection is provided, however, these signs are located partway down the hill. There are several warning signs are on the descent itself including repeated warnings about the truck escape ramp which includes the overhead gantry signs as one approaches the ramp.

Road Conditions	• Length: 2+ miles • Grade: unknown • Bottom of hill: signalized T-Intersection in the Town of New Hartford
Truck Safety Elements	• Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Truck ramp – gravel & sand filled crash barriers • Overhead signs
Relevance to Colrain	• Two lane highway • Long steep descent into a valley. Town of New Hartford at the bottom • History of truck crashes • Truck escape ramp is on a down slope due to geometry constraints

4.1.6 Route 57 West - Sandisfield, MA

Road Conditions	• Length: 1 mile • Grade: 12% • Bottom of hill: T-Intersection with Route 8 in Sandisfield MA
Truck Safety Elements	• Advance warning - overhead gantry sign • Steep grade warning signs on descent • Truck advisory speed warning signs • Truck ramp – gravel
Relevance to Colrain	• Two lane highway • Long steep descent into a valley with a T-Intersection in Sandisfield, MA • Local to Colrain

This location has a relatively short descent, but with grades of 12% is very steep with a T-intersection and village at the bottom of the hill. An overhead gantry sign is in advance of the descent with a truck ramp prior to the intersection at the bottom of the hill. Queuing at the intersection may affect the ability of trucks to enter the escape ramp. There are repeat warning signs on the descent, however, these are limited until closer to the ramp. Drivers would be unaware of the ramp until they reached that part of the descent.

4.1.7 Gordon Mountain Road - Gordon, PA

Road Conditions	• Length: 1¾ mile • Grade: 9% • Bottom of hill: T-Intersection with Biddle St
Truck Safety Elements	• Advance warning signs • Truck ban over 19 tons • Required truck stop & brake check > 21,000 lbs • Detailed road information available to trucks • Truck speed limits • Steep grade warning signs on descent • Truck advisory speed warning signs • Steep grade warning signs on descent • Trucks use low gear warning signs on descent
Relevance to Colrain	• Two lane highway • Local road • Long steep descent into a valley with a T-Intersection in Gordon, PA

The site in Gordon, PA is similar to Nesquehoning in that it provides a truck stop lane and advance warning. A truck speed limit of 20 mph is also in place. This site has a T-intersection at the bottom of the hill and a truck ramp has not been provided. The road geometry is friendly perhaps encouraging trucks to travel at a higher speed. Ongoing crashes have resulted in vehicles heavier than 19 tons being banned from this route.

4.1.8 Avon Mountain/Route 44 – Avon, CT

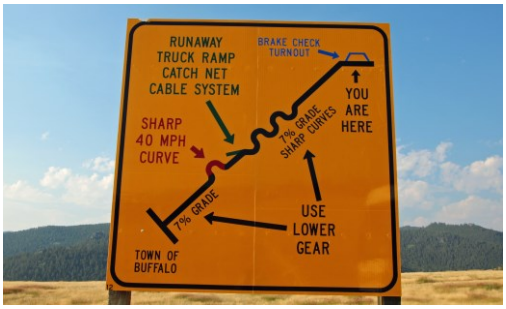
Road Conditions	• Length: 1½ mile • Grade: 10% • Bottom of hill: signalized intersection • Four lane divided highway
Truck Safety Elements	• Advance warning signs • Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Truck escape ramp utilizing a dragnet® truck arrestor system on a downslope • Heated truck escape ramp to remove snow and ice during winter • Sand barrel impact attenuation system for additional safety
Relevance to Colrain	• Long steep descent into a valley with an intersection at the bottom of the grade • Heavily constrained for space to fit a conventional gravel truck escape ramp

The site in Avon, CT is particularly relevant given the lack of space and continuing downgrade which made installation of a traditional gravel filled truck escape ramp difficult. Also of relevance is the location within New

England and the exposure to winter weather and in particular the accumulation of snow. Truck escape ramps only remain effective if they are cleared of snow, allowing runaway vehicles to access the ramp. This ramp at Avon was retrofitted with electric heating coils within the pavement. The heating system was designed to melt snow at up to 4” per hour and performed well during the winter of 2008-09 melting 14” of snow that fell in a 72-hour period. The snow melt area includes the road approach and also the drainage outlet system to ensure the snow melt is able to runoff.

4.1.9 US Route 16 - Buffalo, WY

Road Conditions	• Length: 5 miles • Grade: 7% • Section with sharp curves on descent • Rural two-lane road
Truck Safety Elements	• Advance warning signs • Steep grade warning signs on descent • Trucks use low gear warning signs on descent • Truck escape ramp utilizing a Dragnet® truck arrestor system on a downslope • Overhead gantry sign at entrance to truck escape ramp
Relevance to Colrain	• Long steep descent with sharp curves • Mechanical arrestor system escape ramp utilized on a downslope • Use of detailed truck information signs • Use of brake check area



This site near Buffalo, Wyoming is relevant as it one of the more recently installed mechanical arrestor systems. This site also makes use of advanced and detailed warning signs to bring the road conditions to the attention of drivers. The location does have a town at the bottom of the hill, however the grades flatten out before the town is reached. The primary safety concern on this descent is a series of sharp curves towards the bottom of the descent which have resulted in a series of truck crashes following the loss of brakes.

4.1.10 Route 22 - Jackson, WY

This site near Jackson, Wyoming on the Teton Pass Highway has the most recent of the mechanical arrestor systems installed. The catch net system supplements an existing gravel / gravity escape ramp, however this ramp was on the left-hand side making it more difficult to use. The town of Wilson, WY is at the bottom of the hill creating safety issues for out-of-control trucks. This site uses a combination of measures to warn and advise truck drivers, including active warning signs, brake check areas and an advisory heavy vehicle speed limit.

Road Conditions	• Length: 5 miles • Grade: 10% • Section with sharp curves on descent • Town at bottom of hill • Rural two-lane road
Truck Safety Elements	• Advance warning signs • Steep grade warning signs on descent • Truck advisory speed signs • Active warning signs – flashing lights • Trucks use low gear warning signs on descent • Truck escape ramp utilizing a Dragnet® truck arrestor system on a downslope • Overhead gantry sign at entry to escape ramp • Truck escape ramp – gravel on left hand side • Truck turnout facilities on descent
Relevance to Colrain	• Long steep descent into a valley town at the bottom. Mechanical Arrestor System utilized on a downslope

4.1.11 Summary

Table 4-1 provides a summary of the key Truck Safety System features at each of the analyzed locations.

Table 4-1 Summary of Truck Safety Systems

Location	Truck Ban	Advance Warning Signs	Advance Overhead Signs	Suggested Truck Detour	Required Truck Stop	Brake Check Area	Truck turnaround facility	Detailed road information	Truck Ramp – Gravel	Truck Ramp – Mechanical	Overhead Signs	Truck Warning Signs	Truck Speed Limit	Flashing Lights
SR 28, Herkimer, NY		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓
SR 12, New Hartford, NY									✓		✓	✓		
SR 2, North Adams, MA		✓	✓								✓	✓		
SR 2, Williamstown, MA						✓			✓	✓	✓	✓	✓	✓
SR 93, Nesquehoning, PA	✓			✓	✓	✓		✓	✓			✓		
SR 57, Sandisfield, MA		✓	✓						✓		✓	✓		
Gordon Mountain Road, Gordon, PA	✓	✓			✓	✓		✓				✓	✓	
RT 44, Avon, CT		✓								✓		✓		✓
US 16, Buffalo, WY		✓				✓		✓		✓	✓	✓		✓
SR 22, Jackson, WY		✓				✓			✓	✓	✓	✓		✓

4.1.12 Key Findings

Key learnings from this analysis include:

- All sites analyzed took steps to actively warn heavy vehicles of the road conditions. Several forced vehicles to stop.
- Truck speed limits were used at several sites, including in Massachusetts, to require trucks to travel at a lower speed.
- Advance warning signs provide more effective warning to drivers at a location that enables them to take action. More overt signs such as those on gantries or equipped with flashing lights emphasize the importance of the warning and appear more effective in communicating with drivers.
- Truck stopping lanes or bays provide an opportunity to check brakes and, most importantly, force heavy vehicles to come to a complete stop and recommence their journey in a lower gear.
- Truck stopping lanes or bays provide an opportunity to provide information on the entire descent on a single sign. This equips the driver with all the information needed prior to commencing the descent.
- Truck escape ramps are typically installed towards the bottom of the hill and are aimed at catching vehicles that are already out of control. In this sense, they are a fall back measure or second line of defense.
- Despite providing adequate warnings and infrastructure, a safe descent still requires drivers to heed the advice and for their vehicles to be in safe condition. More overt signage and requiring trucks to stop increases the chance of the advice being taken.
- None of the sites analyzed appeared to have taken steps to improve road geometry at the bottom of the hill. However, all had provided warning to truck drivers with some providing truck escape ramps to catch trucks that lose control.
- Even after installing safety systems, two sites in Pennsylvania continued to experience heavy vehicle crashes, and subsequently instituted bans on certain types of heavy vehicles.
- Truck arrestor systems have proven to be very effective when space is constrained, and the topography continues to slope downwards.

4.2 Identification of Improvement Options

To assist in identifying a suite of potential improvement options, Jacobs has considered a range of sources including the recently completed Road Safety Audit, community input, and Jacobs' own research of similar projects as detailed in Section 4.1.

The improvement option identification process combined these three groups into a single list of potential solutions.

4.2.1 Road Safety Audit Recommendations

The recently completed Road Safety Audit for Colrain identified several potential improvements that have been incorporated in this study. All measures included in the Road Safety Audit have been included in the initial list of potential improvements.

The Road Safety Audit was quite broad in its review and covered all crashes within a mile of the Colrain Town center and thus included many improvement options that are valid in a broad road safety review but do not achieve the goals of this study.

4.2.2 Community Input

In April 2018, Jacobs met with Colrain officials and members of the community to commence the study, but more importantly to seek feedback on the safety issues and potential solutions. Complete meeting notes are

provided in Appendix E. The meeting noted that crashes at the study intersection are largely influenced by the grade coming down Greenfield Road, contributing to vehicles losing control.

The meeting provided support for many of the measures included in the Road Safety Audit and indicated that solutions should focus on treatments that slow vehicles at the top of the hill on Greenfield Road so that they remain in control, rather than on geometry improvements and roadway realignments in the Town.

Meeting participants recommended the following treatments:

- Improved high visibility signs at the top of the hill.
- Brake check area at the top of hill. This would encourage trucks to pull in before the descent, check equipment, and consider turning back to the designated truck route.
- Truck escape ramp – traditional or catch wires
- Signage on Route 2 advising heavy vehicles of the steep grades and alternative routes such as 112.

4.2.3 Truck Safety Systems Analysis

The truck safety system analysis in Section 4.1 identified several elements that will be included in the improvement options for analysis. These include:

- Provide advance warning signs with strong reinforcement over the entire journey
- Provide a truck stopping lane/bay with sufficient information for the driver
- Consider suitable locations for a truck emergency ramp
- Consider more overt/active warning signs through the use of ITS and overhead gantries to increase the likelihood that the warning messages are understood and heeded by truck drivers.
- Consider truck bans or partial bans
- Implement a Truck Speed Limit

4.3 Shortlisted Improvement Options

To achieve the right outcomes, the list of improvement options was put through a shortlisting process so that those improvement options that addressed the Project Goals were investigated in more detail. The shortlisting process involved classifying each of the preliminary improvement options according to the five Project Goals.

In addition to the five Project Goals, several improvement options identified as part of the Road Safety Audit which do not relate to the issue of heavy vehicles getting out-of-control on Greenfield Road were collated.

These improvement options are shown in Section 4.3.6. This also included suggestions that are best evaluated by the Town such as enforcement and maintenance issues. Maintenance and enforcement options were not shortlisted on the basis that the Town of Colrain DPW and Police are the departments to decide if these options could be justified or provided a safety benefit.

As many of the preliminary Improvement Options had similarities, these were grouped together to assist in the analysis. Once the improvement options were classified by project goal, each option was assessed for merit and its ability to achieve the project purpose. This final Improvement Options Shortlist was advanced for further development and analysis.

The complete results of this shortlisting process including a list of all improvement options identified is shown in Appendix F with a summary of the results shown below.

4.3.1 Goal #1: Inform truck drivers about road conditions

Treatment Option	Grouping	Source
Upgrade signage and pavement marking within the Hill Section of Greenfield Road and approaches - review to include speed limits, warning signs, reflective pavement markers, guardrail reflectors, pavement marking. Bring in line with current standards and to suit the road conditions.	Improve Existing Signage	Jacobs
Consider adding warning signs along Greenfield Road southbound and replacing existing signs along Greenfield Road northbound to adequately warn drivers of roadway curves and grades.	Improve Existing Signage	RSA
Evaluate regulatory, guide, and warning signs within the study area, considering placement, condition, and mounting height.	Improve Existing Signage	RSA
Consider installing a “Trucks Test Brakes” sign at top of hill on Greenfield Road northbound, prior to changes in the roadway grade.	Improve Existing Signage	RSA
Install improved high visibility signs at the top of the hill.	Improve Visibility of Signage	Community
Evaluate existing advisory speed limit warning signs (yellow only) for visibility, particularly under nighttime conditions, and consider replacing them with new MUTCD compliant signs if necessary.	Improve Visibility of Signage	RSA
Consider adding object markers to guardrails for increased visibility.	Improve Delineation	RSA
Consider installing chevron signs at all curves.	Improve Delineation	RSA
Consider installing reflective pavement markers in the whole area to provide better visibility at night.	Improve Delineation	RSA
Evaluate and replace pavement markings in the study area.	Improve Delineation	RSA
Provide advance warning signs with strong reinforcement over the entire journey	Advanced Warning Signs	Jacobs
Consider more overt/active warning signs through the use of ITS and overhead gantries to increase the likelihood that the warning messages are understood and heeded by truck drivers.	Overt / Active Signs	Jacobs
Consider installing overhead warning signs and/or signs with beacons or LED flashers triggered by vehicle height detectors along Greenfield Road to alert northbound drivers of grade changes in a more conspicuous manner.	Overt / Active Signs	RSA

4.3.2 Goal #2: Require heavy vehicles to descend the hill at a safe speed

Treatment Option	Grouping	Source
Provide a truck stopping lane/bay and brake check area with sufficient information for the driver.	Truck Stopping Bay / Brake Check	Jacobs
Provide a brake check area at the top of hill. This would encourage trucks to pull in before the descent, check equipment, and consider turning back to the designated truck route.	Truck Stopping Bay / Brake Check	Community

Treatment Option	Grouping	Source
Install a special truck roadway designed to return heavy vehicles to the study area roadways in a lower gear.	Truck Stopping Bay / Brake Check	Community
Implement a Truck Speed Limit.	Speed Limits	Jacobs
Consider adding a speed limit sign near 78 Greenfield Road to remind drivers of the posted speed limit for this roadway section and consider installing speed feedback signs on approaches to the intersection.	Speed Limits	RSA
Provide additional stopping bays on descent where feasible.	Additional Pull Off Bays	Jacobs

4.3.3 Goal #3: Prevent out-of-control heavy vehicles from entering the town center

Treatment Option	Grouping	Source
Consider suitable locations for a truck emergency ramp.	Truck Escape Ramp	Jacobs
Install a runaway truck ramp or a mechanical wire system along Greenfield Road to address runaway trucks.	Truck Escape Ramp	Community
Evaluate feasibility of installing a runaway truck ramp or a mechanical wire system along Greenfield Road to provide a means for runaway trucks travelling downgrade at high speeds to safely leave the roadway.	Truck Escape Ramp	RSA

4.3.4 Goal #4: Minimize heavy vehicles from using Greenfield Road

Treatment Option	Description	Source
Signage on Route 2 advising heavy vehicles of the steep grades and alternative routes such as 112.	Truck Ban / Advisory	Community
Install advisory signs on Route 2 warning of steep grades and advising trucks to take 112. (Not a Ban)	Truck Ban / Advisory	Community
Consider truck bans or partial bans.	Truck Ban / Advisory	Jacobs
Consider adding a truck exclusion zone on Greenfield Road due to the roadway grades.	Truck Ban / Advisory	RSA
Provide opportunities for trucks to turn around.	Turn Around Opportunities	Jacobs

4.3.5 Goal #5: Out-of-control vehicles are able to pass through town safely

Treatment Option	Description	Source
Consider removing the church or other properties at this intersection, to allow the roadway horizontal alignment to be improved through the intersection.	Horizontal Geometry	RSA
Evaluate centerline and cross section profiles of approaching roadways and consider redesigning approach roadways to improve grades and drainage.	Profile & Cross Section	RSA

4.3.6 Not considered further

Each of the following improvement options has some merit to improve safety in Colrain, however none of these specifically address the project goals and have not been considered further as part of this process. Many of these have, however, been considered in our review of the Colrain Complete Streets Project in Section 6.

Treatment Option	Description	Source
Install soft wide gravel shoulders to slow heavy vehicles on descent.	Soft Shoulders	Community
Consider adding bicycle amenities (such as bicycle lanes) and related regulatory and warning signs to alert roadway users to the potential presence of bicycle traffic.	Not Related to Project Goals	RSA
Consider adding signage or other landscaping amenities to create a gateway treatment for drivers approaching the intersection in order to evoke lower speeds on the approach and entrance to the community.	Not Related to Project Goals	RSA
Consider adding yellow warning beacons or rectangular rapid flashing beacons (RRFB's) to the proposed pedestrian crossings adjacent to the bridge on Jacksonville Road (Route 112) to improve visibility of crossing pedestrians.	Not Related to Project Goals	RSA
Consider installing a warning sign for Coburn Street to warn of post office parking lot traffic.	Not Related to Project Goals	RSA
Consider installing rapid rectangular flashing beacons (RRFB's) at crosswalks to increase pedestrian visibility.	Not Related to Project Goals	RSA
Consider installing rumble strips on Greenfield Road to address driver fatigue and prevent runoff crashes. The evaluation should consider noise impacts to adjacent properties.	Not Related to Project Goals	RSA
Consider installing warning signs for Jacksonville Road (Route 112) southbound to warn of approaching curve and grade, as well as upgrading existing signs.	Not Related to Project Goals	RSA
Consider installing warning signs to alert drivers approaching the town garage.	Not Related to Project Goals	RSA
Consider pedestrian desire lines and provide pedestrian accommodations, such as sidewalks, pedestrian ramps, and crosswalks.	Not Related to Project Goals	RSA
Consider relocating the existing school bus stop to a more visible location in the vicinity of the intersection.	Not Related to Project Goals	RSA
Evaluate existing pedestrian crossing signs for MUTCD compliance.	Not Related to Project Goals	RSA
Evaluate the feasibility of restricting exiting left turns at the church parking lot due to sight distance constraints north of the church.	Not Related to Project Goals	RSA
Consider installing flashers alerting drivers of approaching school zones.	Not Related to Project Goals	RSA
Consider adding gravel treatment below guardrails to prevent future vegetation growth.	Maintenance	RSA
Consider clearing vegetation near and on guardrails and performing annual maintenance to control vegetation.	Maintenance	RSA

Treatment Option	Description	Source
Evaluate the use of salt and sand on Greenfield Road and consider pretreatment of the roadways using liquid magnesium chloride.	Maintenance	RSA
Consider installing high friction road treatments to reduce vehicle runoff crashes.	Maintenance	RSA
Consider increasing police enforcement for speeding vehicles.	Enforcement	RSA
Evaluate and possibly eliminate the one-way frontage road that services Jacksonville Road (Route 112) southbound right turns onto Main Road, to discourage use as a channelized right-turn lane.	Achieved as part of WSE project	RSA
Evaluate the lighting condition of the area and then consider installing additional LED street lights to improve visibility around the intersection.	Lighting	RSA

5. Improvement Option Analysis

Alternatives that have been considered for each of the Project Goals are discussed and evaluated in the following sections.

5.1 Inform Truck Drivers about Road Conditions

When road conditions are not expected or present additional risk, it is important to provide information to drivers about these conditions. The conveying of these messages is often done with signs. Delineation and pavement markings also assist in ensuring that the message is seen.

Section 2A.06 of the MUTCD, notes that the “basic requirements of a sign are that it be legible to those for whom it is intended and that it be understandable in time to permit a proper response. Desirable attributes include high visibility by day and night; and high legibility”. It is also important to ensure that signs are placed in appropriate locations to maximize the effect of the sign.

5.1.1 Improve Existing Signage

5.1.1.1 Existing Signage – Key Observations

Jacobs carried out a review of the existing signage on Colrain Hill and noted that existing signs are generally compliant with the MUTCD for the type of sign, spacing and use of supplemental signs, however several observations have been made about the overall signage scheme and potential improvements that may be made. Key findings from the review of the existing signage include:

- There are two hill warning signs near the crest of the hill that provide 0’ - 200’ of warning prior to the descent commencing. The first of these signs is a solar powered LED flashing sign that was installed by the Town of Colrain in response to the truck crashes in 2017. A daylight inspection showed that the flashing LEDs were not very visible, and a different LED design could improve the sign’s visibility. The sign could also be moved to be further in advance of the hill to provide drivers with earlier warning.
- There is only one sign that specifically mentions % grades to guide the driver. This sign is located at the crest of the hill and advises that grades are 5% to 11%. No other signs advise drivers of what the % grades are on the hill.
- No advance warning is provided prior to the descent that there is a hill with steep grades and a town center with a sharp curve and intersection at the bottom of the hill.
- No advice is provided to drivers before they turn onto Greenfield Road of the steep grades ahead.
- The hill warning signs correctly advise trucks to use a lower gear and also advise of grades, however they do not remind drivers of this when the grade steepens to 11% halfway down the hill.
- The speed limit is placed halfway down the hill immediately prior to when the grade steepens to 11% making it more difficult for drivers of heavy vehicles to reduce their speed at this location, particularly when they have not been advised of the steepening grades at that point. Consideration should be given to moving the reduction in speed to the top of the hill or to introduce a Truck Speed Limit on the hill section.
- The “Reduced Speed Limit Ahead” sign does not provide sufficient warning to drivers of the change in speed ahead. The warning sign is approximately 300’ in advance of the reduced speed limit and is located halfway down the hill and immediately prior to where the grades steepen to 11%. This does not inform truck drivers early enough to enable them to choose a gear suitable for the 11% grade and a 30 mph speed limit. The “Reduced Speed Limit Ahead” sign should be moved in advance of the crest of the hill with a supplemental distance sign and repeaters to give truck drivers adequate warning of the change in speed.
- The advanced warning signs advising of the sharp horizontal curve (Curve 7) in the center of town provide good warning, however, they are placed shortly after the grade has steepened to 11% and the

speed has reduced to 30 mph. Due to the location of these signs, truck drivers receive this message too late and when they have moved onto the steepest section where it more difficult to slow down. To be more effective, advanced warning of the sharp horizontal curve (Curve 7) and town center should occur at the top of the hill and prior to the descent, warning vehicles of what is ahead of them while they manage the steep grade and descend at a safe speed. While the advanced curve warning signs advise of the curve and intersection, it is not clear to drivers that the curve is in the center of town, with poor sight distance and that there is a risk of heavy vehicles overturning if taken at too high a speed. In summary, these signs should provide better advice of the severity of the curve at the bottom of the hill and warnings should commence prior to the descent allowing vehicles to travel at a safe speed suitable to the conditions.

- Drivers are not advised of the town and intersection at the bottom of the hill until it is too late. The road geometry, surrounding topography and vegetation hide the town center from the driver's view until vehicles are approximately 1500' from the intersection. At this point, heavy vehicles are on the steepest part of the descent at 11% grades making it difficult to adjust their speed to the conditions that are now visible.
- Mounting height of the signs appears to comply with the MUTCD minimum 5' above road level, however consideration could be given to raising the truck warning signs to provide better visibility to truck drivers.
- There is poor delineation on the hill section with many of the pavement markings worn. There are few object markers and no retro-reflective pavement markers on this section of road. This makes travelling this section of road in dark conditions more difficult due to the inability to visually gauge changes in geometry or grade.
- There is no warning given to the two long curves that make the "S" bend in the road.

5.1.1.2 Proposed Signage Improvements

Based on our review, several signage improvements are proposed. Several signage improvements to complement other safety improvements such as truck escape ramps, brake check areas and alternative routes are discussed separately in each of those sections. This section focuses solely on improvements to the signage scheme that could be implemented in the short term to improve truck safety on Colrain Hill in the absence of any other improvements. These are schematically shown in Figure 13 and briefly described below:

a) Advanced Warning Signs

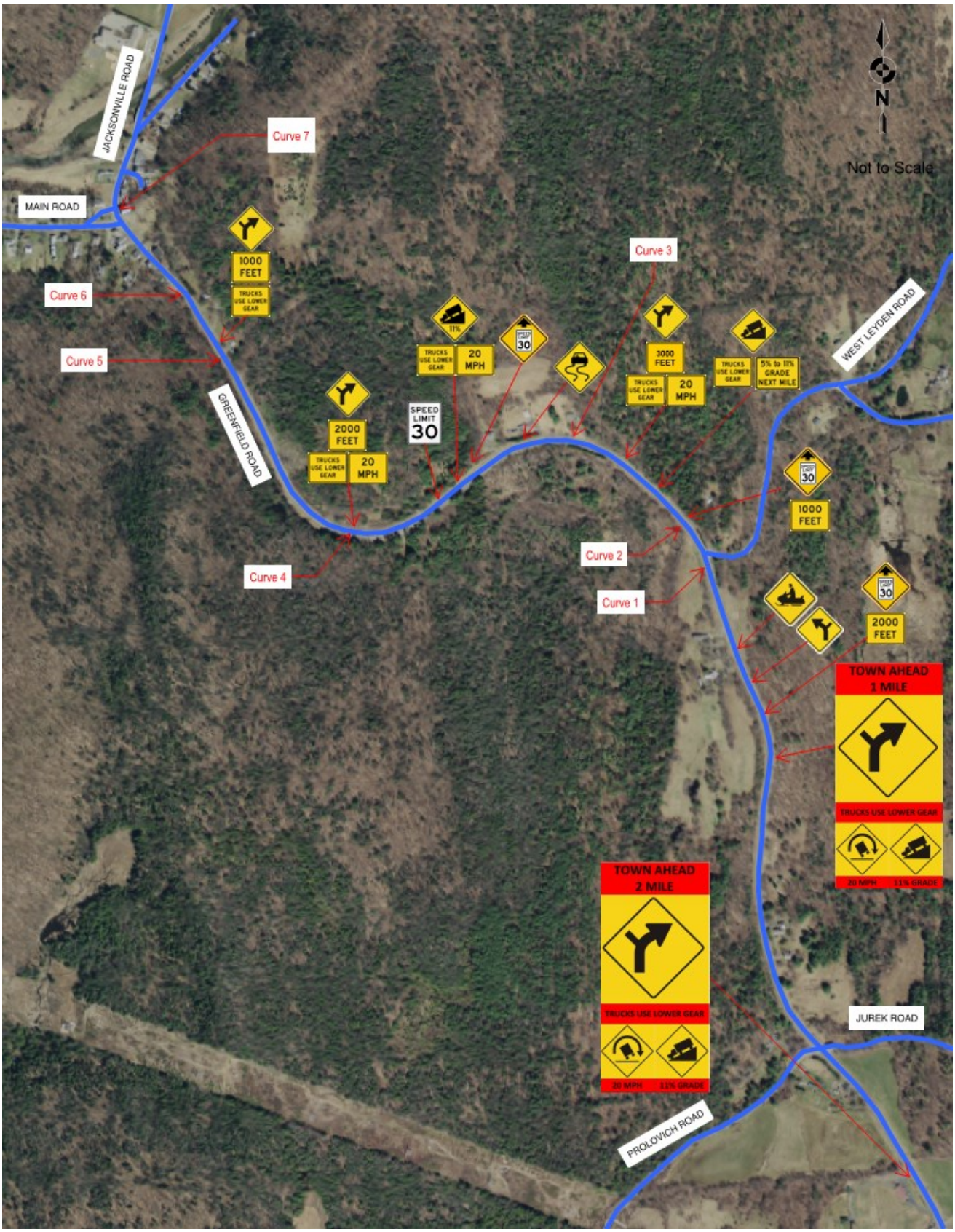
Description: Advance warning signs are often used to bring a driver's attention to a particular hazard, which may be unexpected, or of changes to the road conditions and geometry. Advanced warning signs are placed in advance of the hazard to provide a driver sufficient time to react and avoid or reduce the risk.

Effectiveness: Advance warning signs if placed appropriately and with the right messaging are highly effective in alerting drivers to conditions ahead.

Design Development: At Colrain, it is important that trucks can safely pass through the intersection at the bottom of the hill. Trucks that are travelling too fast are at risk of running of the road, overturning or both.

Given the steepness of the descent, it is important that drivers are advised of the steep grades, curves and the town center at the bottom of the descent well before the crest of the hill, so that they may prepare by adjusting their speed and selecting an appropriate gear for the descent and road conditions at the bottom.

Figure 13 - Proposed Base Signage Scheme



Currently minimal advanced warning is provided to the road conditions ahead. To enhance a driver's knowledge of the road conditions, it is considered that advance warning signs should be placed 1 mile and 2 miles in advance of the town. These signs would coincide with 1 mile in advance of the hill and the commencement of the descent into Colrain. For Colrain, an advanced warning sign should include messaging to advise drivers of the following:

- Town Ahead
- Steep Grades – 11% (W7-1a)
- Sharp Curve and intersection (W1-10R)
- Trucks Use Lower Gear (W7-2bP)
- Overturning Trucks (W1-13R)
- 20 mph Advisory Speed (W13-1P)

Figure 14 - Example Advanced Combination Warning Sign

Given the number of incidents that have occurred in Colrain over a sustained period and the high level of risk associated with heavy vehicles crashing in the town, it is considered that a non-standard approach is warranted. To raise awareness of the important messaging, the advanced warning sign should include bold warnings and incorporate the messages into a single customized sign.

An example of how such a combination could be designed is shown in Figure 14. This example includes all the key messages with the use of standard and bold colors to emphasize key messages and separate each of the warnings. The use of standard symbols and retention of the diamond shape is important as required by the MUTCD. The combination of these elements into a single sign ensures drivers receive all messages at once rather than in discrete elements as they pass a series of signs.

The size of the sign and bold bands highlighting key messages will highlight the importance of the information and level of risk on the descent.

This sign should be repeated at the crest of the hill, approximately one mile from the town. The one-mile repeater sign would replace the existing hill warning signs at the top of the hill.

Community Impact: It is expected that sufficient room exists within the right-of-way to erect advanced warning signs. The community is strongly supportive of the installation of targeted advanced warning signs

Environmental Impact: Some minor removal of vegetation may be required depending on the final location of these signs after detailed design. No environmental impacts are expected.

Discussion: It is important to note that advanced warning signs should not be used in isolation and that they work best when reinforced by further warning signs and repeated messaging over the entire journey through the hazard zone. This increases awareness of the road conditions and heightens the importance, resulting in greater compliance with warnings.

Suitably located advanced warning signs may also enable drivers to choose an alternate route or turn around. Advanced warning signs on Route 2 to enable route choice decisions to be made is discussed in Section 5.4.1.

Combination signs are commonly used in high risk situations and are often incorporated into an overhead gantry sign or supplemented with flashing beacons, LED elements or ITS technology. These treatments will be discussed further in Section 5.1.4.

Recommendation: It is recommended that combination advanced warning signs similar to the example shown in Figure 14 are installed: the first sign at two miles from the center of town and the second one mile from the center of town at the top of the hill.

b) Hill Warning Signs

Description: Hill Warning Signs are diamond shaped yellow warning signs showing a heavy vehicle on a grade. These signs may be reinforced by supplemental signs such as “Trucks Use Lower Gear” or % Grades. These signs are defined as W7-1 in the MUTCD.

W7-1a **W7-3bP** **W7-2bP**

Effectiveness: As part of an overall hill warning signage scheme, grade warnings are highly effective at informing drivers of the road conditions ahead.

Design Development: In addition to the advanced warning signs, hill warning signs should be repeated on the descent the existing. The first of these located near West Leyden Road should indicate that the grade steepens during the descent.

The second hill warning repeater sign should be placed in advance of the where the grade steepens to 11% to reinforce the message and advise of the change in grade. It is important to note that immediately prior to the steepest section with 11% grades, the road profile flattens to 5% for a short distance, potentially giving drivers a false sense of security. A repeat sign at this location will reinforce the steepness of the grade.

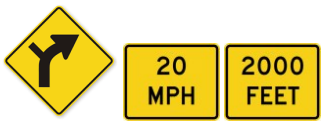
Community Impact: Replacement signs can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Replacement signs can be installed within the existing right-of-way with little or no vegetation clearing required. No environmental impacts are expected.

Recommendation: It is recommended that hill warning signs be installed on the hill as shown in Figure 13.

c) Curve Warning Signs

Description: Curve Warning Signs are diamond shaped yellow warning signs showing a curve. These signs may include an intersection shown as part of the diagram and may be reinforced by supplemental signs such as an advisory speed, distance ahead or “Trucks Use Lower Gear.” These signs are defined as the W1 series of signs in the MUTCD.



W1-10 (R) **W13-1P** **W16-2P**

Effectiveness: As part of an overall warning signage scheme, curve warnings are highly effective at informing drivers of the road conditions ahead.

Design Development: Curve warning signs similar to the proposed advanced warning signs should be repeated on the descent into the town at 3000’, 2000’ and 1000’ from the intersection. This will reinforce the conditions at the bottom of the hill and supplement the repeat grade warnings.

Existing signs are placed at 2000’ and 1000’ from the town center. As well as the combination advanced warning signs, a repeater at 3000’ is warranted as the sign at 2000’ is on the final long curve and partly obscured by the batter slope and is placed after the grade has steepened to 11%. The addition of a sign at 3000’ will provide further warning in a location that enables drivers to adjust their speed and / or gear.

Discussion: To simplify messaging but also to advise of the long curves on the descent, chevron curve markers should be installed on curves 3 and 4. This is discussed further in Section 5.1.3.4.

Community Impact: Curve Warning signs can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Curve Warning signs can be installed within the existing right-of-way with little or no vegetation clearing required. No environmental impacts are expected.

Recommendation: It is recommended that curve warning signs be installed as shown in Figure 13.

d) Trucks Test Brakes

Discussion: A sign advising "Trucks Test Brakes" is not a standard MUTCD sign and is therefore not recommended. Vehicles should not check their brakes unless they are at a safe pull off area. Installation of a safe area to pull over for trucks to check their brakes is discussed in Section 5.2.1. In this instance the use of "Brake Check Area" signage as defined by MUTCD is warranted.

D5-14

e) Speed Limit Signs

Description: Speed Limit signs are regulatory signs used to advise motorists of the legal speed limit and are commonly used to enforce a safe speed for the road conditions. These signs are often supplemented by Speed Limit Ahead signs particularly where advance warning of a reduction in the speed limit is warranted.

R2-1 W3-5 W16-2P

Effectiveness: Speed Limit signs are required to be followed by law and are highly effective at controlling vehicle speed.

Discussion: While moving the speed limit reduction to the top of the hill may assist, this would also require light vehicles to obey the reduced speed limit. In this case it is only trucks that should descend the hill at a lower speed due to the safety risks involved with heavy vehicles. Enforcing a reduced limit for all vehicles may become problematic.

Alternatives to moving the speed zone are:

- Implementing a truck speed limit
- Improving the advanced warning of the speed reduction

A truck speed limit for the hill section would need to be enforced. Speed activated speed limit warning signs may result in greater compliance. A truck speed limit is discussed in Section 5.2.2.

To increase compliance with the 30mph speed limit halfway down the hill, it is recommended that the speed limit ahead signs be relocated to a location that enables trucks to comply. It is recommended that the speed limit ahead sign be placed 2000' ahead of the reduced speed limit on top of the hill with repeaters placed 500' and 1000' in advance of the reduced speed limit. For prominence and to ensure the message is understood, the sign on top of the hill may require to be oversized, on both sides of the road, reinforced with speed detection devices or a combination of all of these. Speed activated speed limit signs are discussed further in Section 5.1.4.

Community Impact: Signs can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Signs can be installed within the existing right-of-way with little or no vegetation clearing required. No environmental impacts are expected.

Recommendation: It is recommended that Speed Limit and Speed Limit Ahead signs be installed as shown in Figure 13.

5.1.2 Improve Visibility of Signage

The Road Safety Audit (RSA) raised several issues regarding visibility and condition of the existing signage. Jacobs carried out a visual inspection in April 2018 which supported the RSA's view that the visibility of signage should be improved. Providing suitable signage that is easy to read in both day and night conditions and provides warning in time to allow drivers to respond is a key component of any signage scheme. Signs that are not visible due to incorrect placement, incorrect sizing or through a loss of reflectivity means that those signs are unable to provide the information required in a complete variety of conditions. The following sections discuss the visibility of signage:

5.1.2.1 Night Time Visibility

Description: Signage plays an important role in conveying messages to drivers. Important messages to be understood on the Colrain Hill include signs warning of steep grades, curves and the approaching town center of Colrain. While night time visibility is not represented in the crash statistics, signage should be legible and able to convey the required messaging in all conditions.

Effectiveness: Retro-reflective signs improve night time driving and reduce the risk of crashes by reflecting light back toward the driver. This makes the signs appear brighter and easier to see and read. Retroreflective properties of signs deteriorate over time meaning that regular inspections and maintenance of signs is required to ensure they remain clearly visible at night.

Design Development: The requirements for sign retro-reflectivity are contained in Section 2A.08 of the of the MUTCD, which requires that minimum reflectivity standards are maintained.

Community Impact: Signs can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Signs can be installed within the existing right-of-way with little or no vegetation clearing required. No environmental impacts are expected.

Recommendation: All new signs that are installed should meet current retro-reflectivity standards. All other signs should be checked and replaced if below the MUTCD requirements for retro-reflectivity.

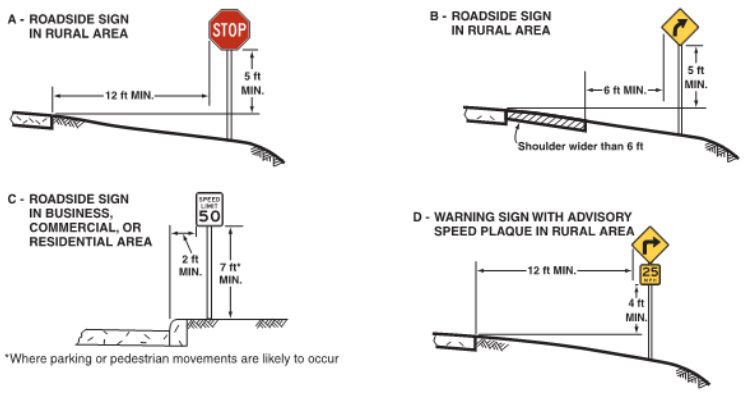
5.1.2.2 Suitable Height for Trucks

Description: To ensure that signs can be read by all drivers it is important that they comply with recommended mounting heights above the pavement surface.

Effectiveness: While it is important that signs are not obscured and that there is uniformity in the height of signs, there is little to suggest that truck drivers are unable to read signs that are installed in accordance with MUTCD. It is expected that raising the height of truck warning signs will bring marginal benefits.

Design Development: The MUTCD does not contain any specific provision for mounting heights of truck signs. The MUTCD does however require that the minimum height of signs above the edge of pavement in rural areas shall be 5’ or where the view of the sign may be obstructed shall be 7’ as shown in Figure 15.

Figure 15 - MUTCD Figure 2A-2 – Sign Mounting Height



The use of the word “minimum” implies that signs may be placed higher but not lower. Where supplemental signs are used, the bottom of the supplemental sign shall be a minimum of 4’ above the edge of pavement.

Community Impact: Signs can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Signs can be installed within the existing right-of-way with little or no vegetation clearing required. No environmental impacts are expected.

Recommendation: To increase the visibility of truck warning signs by truck drivers on Colrain Hill it is recommended that the bottom of signs be 7’ or where supplemental signs are used, 6’.

5.1.2.3 General Sign Visibility

The RSA raised several issues regarding visibility and condition of the existing signage. Jacobs carried out a visual inspection in April 2018 which supported the RSA’s view that the visibility of signage should be improved. In addition to the night time visibility issues discussed in Section 5.1.2.1, the RSA also raised the issue of

vegetation becoming overgrown, obscuring object markers and signage. Issues regarding maintenance have been excluded from this study and are referred to the Town of Colrain for further consideration.

5.1.3 Improve Delineation

The RSA raised several issues of faded pavement markings as well as a lack of visible delineation markers. Delineation is important on Colrain Hill due to the steep grades and curves on the descent. A clearly defined path of travel allows the driver to visualize changes in alignment and grade more effectively allowing for a safe speed to be more easily maintained.

5.1.3.1 Pavement Markings

Description: Pavement markings are a standard method to guide drivers and to identify the roadway alignment during day and nighttime conditions.

Effectiveness: The use pavement markings is an effective way to improve both daytime and night time visibility.

Design Development: It is important that pavement markings are maintained for retro-reflectivity but also that faded and worn markings are replaced in an appropriate time.

To ensure consistent application, pavement markings are described in the MUTCD. Section 3A.03 of the MUTCD requires longitudinal pavement markings to be maintained to a minimum level of retro-reflectivity.

Community Impact: Pavement markings can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Pavement markings can be installed within the existing right-of-way with no vegetation clearing required. No environmental impacts are expected.

Recommendation: It is recommended that the pavement markings on the hill section of Greenfield Road are upgraded to meet the requirements of MUTCD Section 3A.03.

5.1.3.2 Raised Pavement Markers

Description: Raised pavement markers (RPMs), are often combined with pavement markings to inform drivers of alignment changes in the road ahead. RPMs are markers that are attached to or in the pavement. In areas subject to winter conditions and the use of snow plows it is common to recess the pavement markers such that the marker remains visible but below the surrounding pavement level.

Effectiveness: The use of RPMs is an effective way to supplement pavement markings for night time visibility. RPMs are especially helpful during wet weather or in darkness when pavement markings can become obscured.

Design Development: Recessed RPMs are primarily used to protect pavement markers from snowplow damage. By grooving the road surface and recessing the marking in the groove, plows cannot scrape the markers off the surface.

Community Impact: Recessed RPMs can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Recessed RPMs can be installed within the existing right-of-way with no vegetation clearing required. No environmental impacts are expected.

Recommendation: It is recommended that recessed RPMs are installed on the hill section of Greenfield Road.

5.1.3.3 Object markers & Delineators

Description: Similar to raised pavement markers, object markers and delineators also assist in providing night time guidance to drivers of alignment changes in the road ahead. Object markers and delineators may be attached to guide posts or guardrail or other items of roadside furniture.

Effectiveness: The use of object markers and delineators on guardrail is an inexpensive and effective way to supplement pavement markings for night time visibility.

Design Development: Due to the frequent use of snow plows in New England, the use of guide posts is not common place. Delineators are typically attached to guardrail installations in accordance with the MUTCD. Object markers are used to mark other obstacles either in the roadway or adjacent to it.

It is also noted that to remain effective, vegetation overgrowth must be removed from guardrails on a regular basis so that the effectiveness of object markers and delineators is not reduced.

Community Impact: Object markers and delineators can be installed within the existing right-of-way and create no community impacts.

Environmental Impact: Object markers and delineators can be installed within the existing right-of-way with no vegetation clearing required. No environmental impacts are expected.

Recommendation: It is recommended that object markers and delineators be installed on all guardrail installations on the hill section of Greenfield Road.

5.1.3.4 Chevron Markers

The RSA raised the issue of installing Chevron Curve Markers. This was also briefly discussed in Section 5.1.1.2 as an effective way of providing curve delineation without adding additional warning signs.

Description: Chevron Alignment signs emphasize and guide drivers through a change in horizontal alignment. Because of their pattern, size, and placement with at least two of the signs in view of the motorist, chevron markers define the direction and sharpness of the curve for drivers.

W1-8 (L) W1-8 (R)

Effectiveness: The Crash Modification Factors (CMF) Clearinghouse [4] lists crash reductions of up to 25% when chevrons are installed on rural highway curves. There are even greater reductions when chevron installations are combined with advance curve warning signs and/or flashing beacons. In addition, according to *NCHRP Report 559*[5], chevrons have been shown to reduce vehicle encroachments onto the centerline in curves where the degree of curvature is more than seven degrees.

Design Development: The use of chevron alignment signs shall be in accordance with the MUTCD. Chevrons may be used instead of or in addition to standard delineators. Chevrons are installed as a series of signs on the outside of a curve, positioned in line with approaching traffic. The spacing of chevrons is based on the advisory speed and radius of the curve. Sketch plans have been developed showing the use of chevrons on curves 3 and 4 as a way of supplementing the signage scheme.

Community Impact: Signs can be installed within the existing right-of-way and create no community impacts.

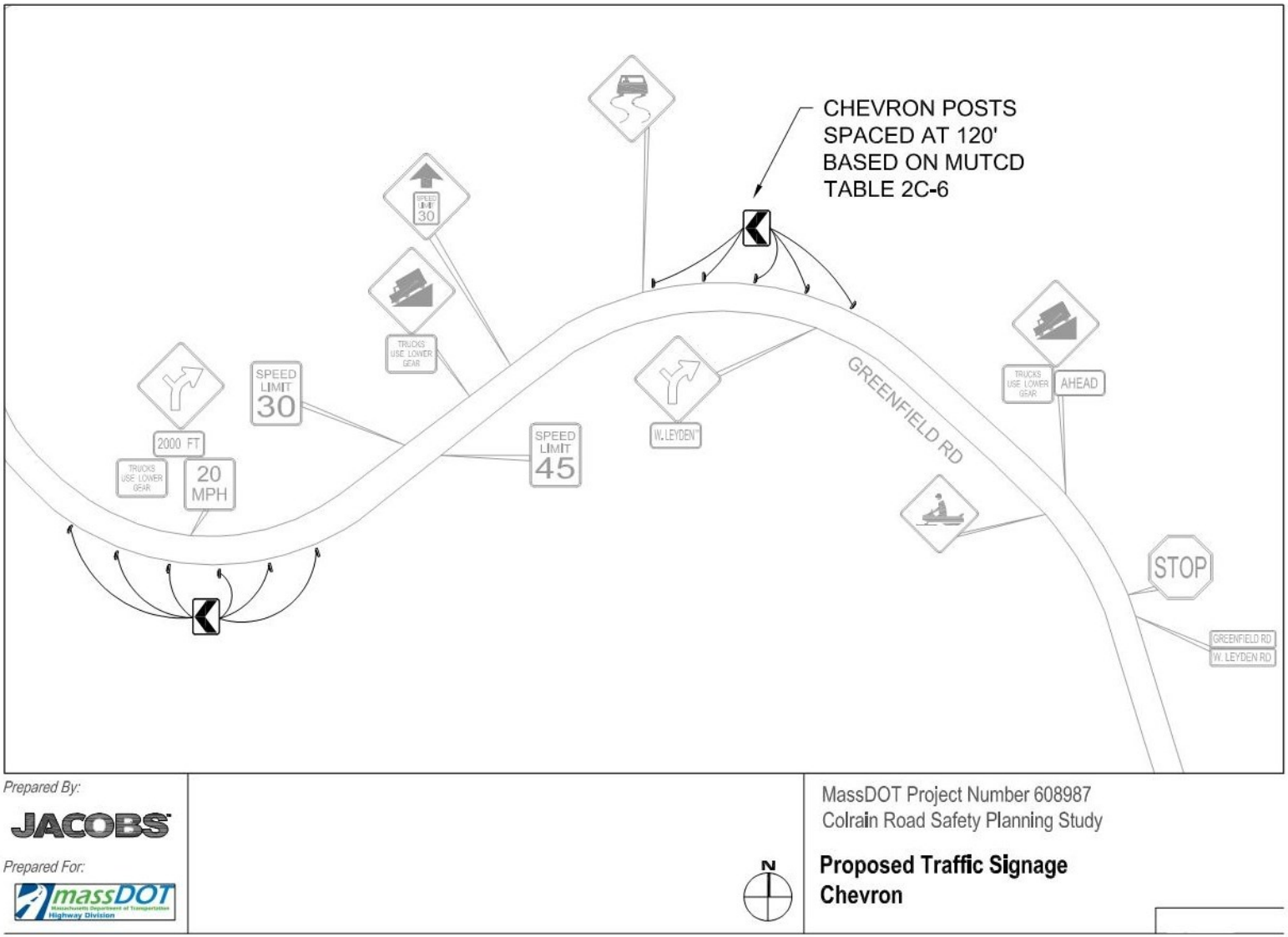
Environmental Impact: Signs can be installed within the existing right-of-way with little or no vegetation clearing required. No environmental impacts are expected.

Discussion: The installation of chevron markers is low cost and effective when combined with a larger signage scheme. The use of chevrons rather than curve warning signs on these curves restricts the curve warning signs to highlighting the tight curve at the bottom of the hill.

Recommendation: It is recommended that chevron alignment signs be installed similar to the concept shown in Figure 16.

[4] http://www.cmfclearinghouse.org/study_detail.cfm?stid=160
[5] Lyles, R. W, William C Taylor, 2006. Communicating Changes in Horizontal Alignment. NCHRP Report, 559.

Figure 16 - Proposed Chevron Signage



5.1.4 Overt / Active Signs

5.1.4.1 Overhead Warning Signs

Description: Overhead signs located directly over the roadway are used to provide the traveling public with clear messages under a variety of conditions. The use of such signs is typically restricted to multi-lane highways where the visibility of standard roadside signs may be obstructed. However, overhead signs are also used to bring attention to specific driver messaging or to guide drivers to safety facilities such as a Truck Escape Ramp or Brake Check Area. Overhead signs are used in truck safety locations where it is deemed necessary to highlight advanced warning of safety issues. Overhead signs can also be combined with flashing beacons and ITS elements to further target heavy vehicles and bring a higher level of awareness to the road conditions ahead.

Effectiveness: The use of overhead signs is highly effective in drawing attention to particular road conditions and influencing driver behavior.

The review of truck safety systems identified several locations where overhead signage was utilized to bring attention to the road conditions or safety facilities ahead. The use of overhead signs raises awareness that the road conditions ahead are not standard and / or there are facilities ahead which drivers need to be aware of. Overhead signs have been incorporated into the advanced warning signing at Herkimer, NY, Sandisfield, MA and North Adams, MA.

Figure 17 - Overhead Signage – Sandisfield, MA

Overhead signs tend to be more noticeable since they are over the road and therefore in the driver's eye. This implies a higher level of importance and allows for larger signs and sign combinations.

Design Development: The use of overhead signs to warn of road conditions ahead is not specifically covered by the MUTCD, however given the higher level of risk and the number of crashes over a sustained period in Colrain, their use would be warranted in this instance. An overhead sign could also incorporate flashing beacons for increased visibility as shown in Figure 18.

Figure 18 - Overhead Signage - Williamstown, MA

Many truck safety locations have provided overhead signs to guide truck drivers to safety facilities including:

- Vickerman Hill on Route 28 North – Herkimer, NY
- Route 2 East – Williamstown, MA
- Route 12 North – New Hartford, NY
- US Route 16 East – Buffalo, WY
- Route 22 East – Jackson, WY

In each of these instances, overhead signs are placed over the lanes that lead to Truck Escape Ramps. The use of overhead signs in these instances provides better guidance to drivers so that they can better locate the entrance to the ramp. The use of overhead signs also highlights the specific use of the facility to inform other drivers to keep out. An overhead sign would more clearly alert drivers as to the location of the ramp entrance.

Further examples were identified where overhead signs direct heavy vehicles to brake check areas such as Herkimer, NY (Figure 19).

A sketch of an example overhead gantry sign is shown in Figure 20.

This example makes use of the MassDOT standard drawings for overhead sign supports and could be tailored to include a range of messaging and ITS technology.

At Colrain, an overhead gantry sign would replace the advance warning sign described in Section 5.1.1.2 a). Such a sign would convey a similar combination of messaging but located overhead. A suitable location for an overhead sign is on the straight section of Greenfield Road south of Jurek Road and just to the north of the Pine Hill Orchard. This site provides a section of straight highway with no surrounding vegetation enabling the overhead sign to be highly visible. This site is approximately 2 miles from the town center (1 mile from the crest of the hill) providing optimal advanced warning of the conditions ahead. The overhead sign should incorporate flashing warning beacons that only flash when an oncoming heavy vehicle is detected.

Figure 19 - Overhead Signage - Herkimer, NY

A second overhead sign could also be placed at 1 mile from the town (top of the hill). This site would also replace the combination advanced warning sign at this location but should also include active speed feedback as part of the overhead signage to advise drivers of their speed as they approach the crest of the hill.

If a brake check area at the top of the hill is constructed, “Brake Check Area Ahead” signs could also be incorporated into the overhead gantry for greater impact.

Community Impact: Depending on the location of the installation, a small amount of right-of-way may need to be acquired, however overhead signs are expected to be able to be installed within the existing right-of-way with no community impacts.

The community is very supportive of having an overhead gantry sign installed to provide advance warning of the road conditions on Colrain Hill.

If flashing beacons or other ITS technology is used, choosing a site that will not create a light pollution issue or become a nuisance for nearby homes should be considered.

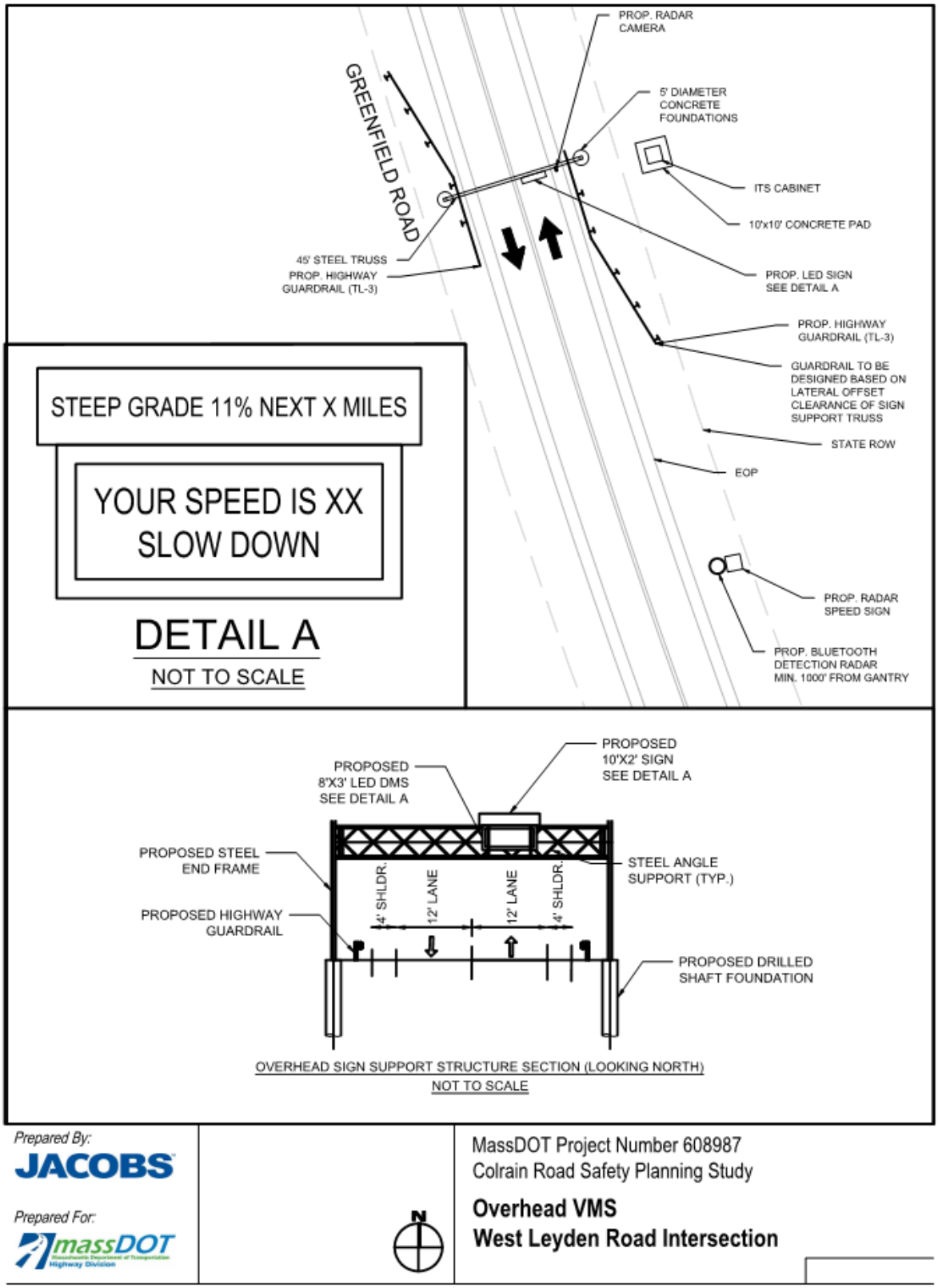
Environmental Impact: Overhead signs will need suitable foundations. As such some ground disturbance will be required. Vegetation will need to be cleared from the surrounding area, however this will not be a large footprint. It is expected that the removal of vegetation would be confined to within the existing right-of-way.

Discussion: The installation of an overhead gantry will come at an increased cost when compared with regular post mounted signs. Design will also need to be completed for the structural elements before construction could commence. The increased cost and preconstruction activities required makes the installation of an overhead gantry a medium-term improvement.

Recommendation: It is recommended that an overhead gantry sign be installed in the medium term to replace and upgrade the combination advanced warning sign located 2 miles from the center of town.

Consideration should be given to installing a further overhead gantry 1 mile from the center of town to provide further advice at the top of the hill including leading trucks into a potential brake check area at this location.

Figure 20 - Overhead Gantry Sign - Variable Message Sign Example



5.1.4.2 ITS Enhancements

The use of ITS technology to actively alert drivers of the dangerous road conditions ahead was an item that was raised in the RSA. Many types of ITS technology exist that would bring some benefit to Colrain. These range from flashing lights to more sophisticated systems.

The key to using ITS technology is to have the system detect vehicles that are more likely to have trouble descending and provide interactive messaging to those vehicles based on their speed, weight or size. ITS elements could be mounted on signs at the side of the road or on overhead gantries. Both would increase the likelihood that the warning messages are understood and heeded by truck drivers.

To be effective, ITS technology needs ongoing maintenance and operations support with regular testing to ensure that elements are in working order. More complex installations such as dynamic message signs should be monitored through MassDOT operations. Relative to installation cost of these costs can be significant but would be much less than the cost of infrastructure solutions.

Power supply for ITS solutions needs to be considered. With improvements in solar and battery technology, many ITS technologies are able to run with a small solar panel installed. Larger installations such as dynamic message signs will require connection to mains power. Backup power supply in the event of a failure will also need to be considered. Detailed design of ITS elements will need to consider the power supply needs of each treatment. Specific ITS treatments that have been considered as part of this project are described as follows:

a) Warning Sign Beacons

Description: Warning sign beacons are regularly used to accent warning signs that convey critical information and are often used in truck safety systems on steep downgrades. In its simplest form these are simply flashing lights that constantly flash to draw attention to a situation or sign. With modern ITS technology available, these beacons can be tailored to only flash when a heavy vehicle approaches the sign, or when a heavy vehicle is speeding. These installations can also be integrated with variable message boards to reinforce the message being delivered. Examples of flashing signs are shown in Figure 21 and Figure 22.

Figure 21 - Flashing Warning Sign Beacons

Effectiveness: Flashing beacons can be a cost-effective safety improvement, especially for lower cost, non-actuated installations. The beacons draw attention to the sign messaging. The effectiveness of these signs increases when the use of the flashing beacon is targeted to specific situations or approaching vehicles of a certain type such as heavy vehicles of a certain size and speed.

Design Development: Flashing beacons are typically used with warning signs where safety issues exist. While there are no published guidelines for when they should be used, it is reasonable to consider their use when other countermeasures have not worked. A factor limiting the use of beacons is the availability of an accessible power source, however the use of solar power panel systems makes their use much more affordable.

Beacons are typically the circular yellow sections from a standard traffic signal and they may be used in a single or multi-beacon arrangement. Beacons can be designed to flash either alternately or simultaneously. To prevent the flashing light from masking the sign message, it is recommended that the beacon signal housing is at least 12 inches outside of the nearest edge of the sign.

Figure 22 - Active Ice Warning Sign

Beacons can be mounted on standard signage or incorporated into an overhead gantry sign and are available with solar powered options. Serviceability of solar powered signs during winter months should be confirmed with manufacturers prior to installation otherwise hard-wired signs should be installed.

Community Impact: The community strongly supports the installation of measures such as flashing lights that will reduce heavy vehicle crashes in Colrain. No additional right-of-way will be required as they will be installed on signs. Advanced detection equipment will be required to detect trucks. The location of the sign and beacons need to consider surrounding properties so that flashing lights don't become a nuisance.

Environmental Impact: Some minor removal of vegetation may be required depending on the final location of these signs after detailed design. No environmental impacts are expected.

Recommendation: It is recommended that warning sign beacons that only flash when trucks are approaching be incorporated into the two advanced warning signs located 2 miles and 1 mile from the center of Colrain.

b) Speed Feedback Signs

Description: A speed feedback sign is an interactive sign that displays a vehicle's speed as well as the posted speed limit sign. The purpose of these signs is to slow vehicles down by making drivers aware that they are driving at speeds above the posted limits or recommended speeds. This type of technology can be used with either posted speed limits or advisory speed warning signs.

Speed feedback signs and their potential use at Colrain are discussed in more detail in Section 5.2.3.

c) Overhead Dynamic Message Signs

Description: Overhead Dynamic Message Signs (DMS) are often paired with beacons or LED flashers triggered by vehicle height detectors (or Weigh in Motion (WIM), traffic sensors and/or video with analytics).

Effectiveness: Effective at slowing vehicles. Highly visible to drivers. In Virginia, speed-activated DMS with warning messages reduced speeding vehicles by 50 percent or more in work zones.[6] In Colorado, a down grade warning system integrated a WIM system with a DMS system to advise drivers of safe descent speeds as they approached a steep mountain grade on I-70 decreasing truck use of runaway ramps by 24 percent. In addition, there was a 13 percent drop in crashes involving excessive truck speeds.

Design Development: The large size of the DMS infrastructure may be intrusive to some neighbors in a rural area. In addition to the capital cost of the DMS and trigger devices, there would be ongoing power and maintenance costs. The DMS should focus on safety messages such as "SLOW DOWN 11% GRADES" and follow the MUTCD and MassDOT DMS Specifications and Guidelines.

Figure 23 - Dynamic Overhead Warning Signs

Community Impact: Depending on the location of the installation, a small amount of right-of-way may need to be acquired, however overhead signs are expected to be able to be installed within the existing right-of-way with no community impacts.

The community is very supportive of having an overhead gantry sign installed to provide advance warning of the road conditions on Colrain Hill.

Because flashing beacons and other ITS technology is used, choosing a site that will not create a light pollution issue or become a nuisance for nearby homes should be considered.

Environmental Impact: Overhead signs will need suitable foundations. As such some ground disturbance will be required. Vegetation will need to be cleared from the surrounding area, however this will not be a large footprint. It is expected that the removal of vegetation would be confined to within the existing right-of-way.

[6] https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/0/E03F81943EA3961C852572600075418A?OpenDocument&Query=Home

Discussion: DMS provides flexibility because they can be used for several purposes. The system could be focused on freight drivers and/or address weather conditions. Flashing beacons can be added to grab drivers' attention. DMS have a large footprint on the roadway. Operation and maintenance of the trigger technology such as WIM, wireless traffic sensors and/or video analytics can be significant.

Overhead dynamic message signs have a high visibility to drivers and are proven to be effective as noted above. The DMS may also be used in emergency situations or congestion to alert drivers. Combing a DMS with a system triggered to focus on freight drivers, the sign is able to slow the driver down prior to the steep decline. Another option are signs with flashing beacons to grab driver's attention. Compared to the DMS, the static signs and flashing beacons are single purpose.

Recommendation: It is recommended that when overhead signs are installed that the signage incorporate dynamic messaging elements that target heavy vehicles providing warning of the grades, the intersection and truck safety facilities.

d) Highway Advisory Radio

Description: Highway Advisory Radio (HAR) broadcasts a prerecorded message to drivers over in-vehicle radio. It can be used to deliver a message to encourage drivers to slow speeds in advance of the hill section. During emergencies the prerecorded message could be changed depending on the situation or to alert drivers if there is a crash ahead.

Effectiveness: Because HAR requires freight drivers to actively change the radio station in their vehicle, this tool would only be moderately effective in changing behavior. Majority of DOTs have moved away from installing and maintaining HAR technology.

Design Development: There is a high capital cost to purchase the HAR device such as a radio and power source, message recording and management system and signage as well as maintenance cost. Many agencies are moving away from HAR technology as they are hard to maintain and other intelligent technologies (such as smart phones) communicate with drivers. In the future, DSRC radios and equipped vehicles are thought to become prevalent with autonomous and connected vehicles. These radios and equipped vehicles will be able to proactively send traffic engineering data about the roadways and speed warnings without engaging the driver.

Community Impact: It is expected that sufficient room exists within the right-of-way to HAR signs, so no additional land would be required.

Environmental Impact: Some minor removal of vegetation may be required depending on the final location of these signs after detailed design. No environmental impacts are expected.

Discussion: An HAR system could serve multiple purposes (notices about weather, emergency, etc.) and could be used in conjunction with other communications tools and/or infrastructure improvements. It is noted that the same information would be delivered faster on a static or dynamic sign. HAR also requires a capital investment for the signage, radio and support equipment as well as power considerations and ongoing maintenance.

Figure 24 - Highway Advisory Radio Sign

HAR requires freight drivers to actively change the radio station in their vehicle and then change behavior based on the message. The same information may be displayed on a static or dynamic sign and delivered faster to the drivers. HAR also requires a capital investment for the signage, radio and support equipment as well as power considerations and ongoing maintenance.

Recommendation: With more effective technology now available and the reliance on drivers to actively tune into the station, installation of a HAR system is not recommended in Colrain.

e) Braking Detection

Description: In-pavement sensors or infrared cameras detect brake temperature, a key indicator that brakes are malfunctioning or have been used heavily and may lead to "brake fade." Brake temperature detection is used in combination with a feedback sign for drivers to alert them of brake issues prior to the downhill slope.

Effectiveness: The technology is proven effective at Weigh-in-Motion (WIM) stations but is unproven in its ability to change driver behavior while on the roadway. While this is promising technology, it has not been employed in enough locations to provide sufficient data on its effectiveness. The technology has potential as an effective tool in determining brake problems. In a four state study, an evaluation of infrared brake screening systems at weigh stations indicated the technology increased the percentage of vehicles placed out of service because of brake problems by 250 percent.[7]

Discussion: Infrared braking detection is new technology that can be used to detect overheating brakes on freight vehicles. There should also be feedback mechanisms such as dynamic signage or LED/beacon to alert the truck driver if the brakes are overheating.

Similar to a "Trucks Test Brakes" sign, braking detection should be paired with a truck brake check area or runaway truck ramp and signs to allow trucks a safe place to go if their brakes are overheating and not functioning. An advantage of this technology is that it may be used in combination with feedback signs for drivers to alert them of brake issues prior to the downhill slope.

The technology is proven effective at WIM stations but is unproven in an installation to change driver behavior while on the roadway. Another disadvantage may be driver panic if there is no readily available freight runaway ramp if they receive a brake overheating message.

Recommendation: Due to unproven results at any similar installation, braking detection is not recommended for trial at Colrain.

5.2 Require Heavy Vehicles to Descend the Hill at a Safe Speed

If heavy vehicles can descend the hill into Colrain at a safe speed, the likelihood of a truck losing control is greatly reduced. Three methods of controlling a truck's speed have been explored as described below:

5.2.1 Brake Check Area

Description: A brake check area is a facility located at or near the top of a hill that allows truck drivers to pull off the road and check their vehicle's brakes. The speed at which a truck descends a hill can be directly related to the speed at which a vehicle travels over the crest of a hill. Controlling a vehicle's speed as it approaches and passes the crest of the hill can greatly impact its ability to maintain a safe speed on the descent. Brake check areas at the top of the hill ensures that trucks start down the grade from a stopped condition and are a common way of ensuring that heavy vehicles descend at a safe speed.

Figure 25 - Brake Check Area, Route 28N - Herkimer, NY

[7] https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/0/92CACF4296FA37AD85256A810062FF62?OpenDocument&Query=Home

The California Department of Transportation Design Guide for Truck Escape Ramps (1986) [8] notes that:

"Brake inspection areas, although not a specific part of a truck escape ramp, play an important part in the use of such ramps. Speed down a grade is related to the speed at which a vehicle crests the grade. Thus, if truckers are provided a facility at or near the crest of a grade to pull off and inspect their vehicles' brakes, the trucks will at least start out at zero speed. This is practically assured if the brake inspection is made mandatory and enforced.

Another facet of brake performance is brake temperature. As the temperature of truck brakes exceeds 500 degrees (F) they lose their ability to slow a truck down. Thus, stopping to inspect brakes allows the brakes to cool somewhat and improves their braking ability.

Figure 26 - Brake Check Area - Route 93 - Nesquehoning, PA

A feature that provides value at a brake inspection area is a sign panel that describes the grade ahead and the location of the escape ramp. Another valuable part of such a sign would be information on the adjustment of slack-adjusters on truck brakes. Incidentally, such a sign could increase the time a trucker spends at an inspection area thereby allowing the brakes to cool further."[9]

Effectiveness: Truck brake check areas are a highly effective method of controlling a vehicle's speed, particularly when made mandatory for vehicles over a certain weight and enforced. They have been used effectively in many truck safety systems in many states in the USA.

Design Development: A good example of such a facility that requires heavy vehicles to stop at the top of the hill is at Vickerman's Hill in Herkimer, NY. This facility requires trucks to stop at a specially constructed turnout before descending the grade ensuring that transmissions are in low gear at the start of the descent. A separate truck lane is developed which then diverges from Route 28 further splitting into 2 lanes that come to a stop sign as shown in Figure 25. At the location where trucks are required to stop, a diagrammatic sign of the hill is placed in clear view of the driver providing information on the road conditions ahead.

Similar facilities have been constructed in Nesquehoning, PA and Gordon, PA, however these installations are much simpler in concept. The two Pennsylvania installations involve a widening of the pavement to create a truck lane with a stop sign where trucks are required to stop as shown in Figure 26. A diagrammatic sign such as in Figure 29 is also used at these two locations.

Figure 27 - Brake Check Area – Route 16 - Buffalo, WY

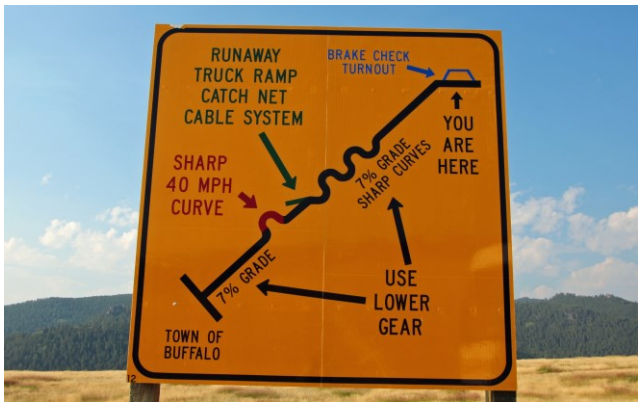


Figure 28 - Driver Information Sign - Buffalo, WY

[8] Tye, E.J., "Design Guide for Truck Escape Ramps," Traffic Bulletin No. 24, California Business, Transportation and Housing Agency, Sacramento, California (1986)
[9] Tye, E.J., "Design Guide for Truck Escape Ramps," Traffic Bulletin No. 24, California Business, Transportation and Housing Agency, Sacramento, California (1986)

A non-mandatory brake check area has been installed on Route 16 near Buffalo, WY as a mitigation measure for steep grades and is a designated area where trucks can pull off the highway to check their brakes and let them cool. The layout is similar in style to those in Pennsylvania but provides greater separation from traffic with a grassed verge area between the pullout and roadway as shown in Figure 27.

Similar to the other examples, a diagrammatic sign (Figure 28) is located at the brake check area to provide information to the driver on the road conditions ahead. Driver information signs provide a range of useful information to the driver including:

Figure 29 - Driver Information Sign - Nesquehoning, PA

- Information on grades
- Truck Speed Limit (or advisory)
- Length of descent
- Road geometry and curves
- Location of truck safety facilities including escape ramps
- Conditions at the bottom the descent

Greenfield Road near the top of the hill runs along a ridge with the terrain quickly dropping off on the east side. Two brake check area concepts have been developed on land at the top of the hill immediately southeast of West Leyden Road. The buildings on the opposite side of Greenfield Road are classified as historic. The Chandler Hill Cemetery is located on the north side of West Leyden Road.

The two concepts provide similar facilities to those at Nesquehoning, PA, Buffalo, WY and Herkimer, NY including:

- Safe area for trucks to pull of road and check their brakes
- Advanced warning
- Driver information sign
- Parking area for heavy vehicles
- Located at crest of hill with easy ingress and egress

To increase the effectiveness of the facility, it is recommended that the brake check area be made mandatory. The “Brake Check Area Ahead” sign should therefore be reinforced with messaging stating that vehicles over 20,000 lbs (10 tons) must exit and stop. Approach warning signs will need to be installed for either concept as follows:

D5-14

D5-13

D13-1

The brake check area in Herkimer, NY requires all trucks, buses and cars with trailers to stop. The facilities in Pennsylvania require all vehicles over 21,000 lbs to stop. The brake check area near Buffalo, WY does not require heavy vehicles to stop but does provide advanced warning of the brake check area and advises trucks to check their brakes.

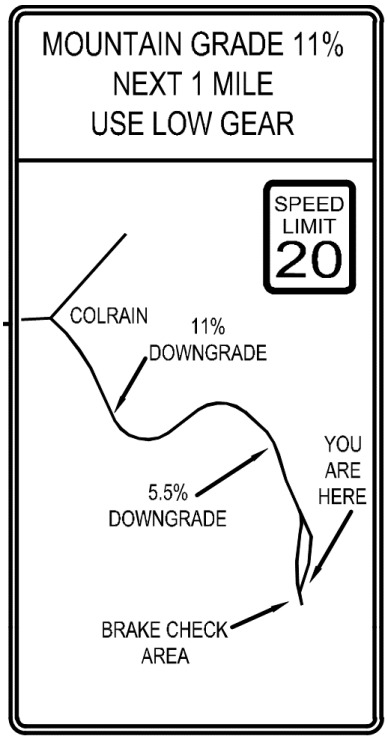
Discussion: The two Colrain concept sketches are shown in Figure 31 and Figure 32 and are described in more detail below.

5.2.1.1 Concept 1 – Widened Roadway

Concept 1 is based on the Nesquehoning, PA example but provides a greater level of separation by introducing a 10' hatched buffer zone between the roadway and the brake check area. The brake check area develops into two traffic lanes, one for through vehicles and a second for vehicles that wish to stop and let their brakes cool before descending the hill into Colrain. A stop sign is provided part way along the travel lane along with a driver information sign. The need to complete the merge in advance of West Leyden Road has resulted in the entrance and diverge taper being moved further to the south. This places the approach tapers and deceleration zone on an upslope which will assist trucks in coming to a safe stop.

The cross section in Figure 32 shows that minimal earthwork is required to support the brake check area. The concept design is largely contained within two parcels of land on the eastern side of Greenfield Road with some of the approach tapers able to be constructed within the existing right-of-way. After stopping at the Stop Sign, trucks re-enter Greenfield Road using a merge taper. The merge point is prior to West Leyden Road after the crest of the hill, ensuring that trucks re-enter the roadway at a safe speed. Sight distances have been checked using the limited 10' contour information available and would need to be re-considered during detail design.

Figure 30 - Driver Information Sign



Community Impact: The community is very supportive of a brake check area being installed at the top of the hill with the town raising this in a 1994 article in the Springfield Union-News. This concept will require land to be acquired from two parcels on Greenfield Road. A house and farm at 125 Greenfield Road is located across the road from the proposed brake check area site. Efforts will need to be made in the detailed design to minimize visual and noise impacts of the truck facility from the adjacent property.

Environmental Impact: Relative to Concept 2, this alternative creates less overall environmental impact. This is largely due to the footprint requiring less overall area and the brake check area being adjacent to the existing highway. This concept is able to utilize a large area of cleared pasture land at the top of the hill further reducing the amount of vegetation clearing required. The location of the facility maintains a good separation to the Chandler Hill Cemetery on West Leyden Road.

Drainage from the site will need to be designed in a manner that any contaminates, oils or fuel from trucks may be treated prior to being allowed to drain into the waterway on the eastern side of the hill. This would involve all runoff from the site being captured and treated in a detention pond prior to release. Noise will be generated with trucks decelerating and accelerating in and out of the facility. Noise attenuation may need to be considered as part of the detailed design.

The property located opposite the facility at 125 Greenfield Road is an inventoried historic property (MACRIS ID #COL.7). Although this property is not directly affected, consideration may be required to minimizing, visual, noise and vibration from the truck facility.

5.2.1.2 Concept 2 – Truck Turnout facility

Concept 2 is based on the Herkimer, NY example providing a separate roadway and truck pull off area to enable heavy vehicle drivers to check their brakes before descending in to Colrain. Concept 2 also develops two traffic lanes enabling truck drivers to stop and let their brakes cool without blocking traffic.

Due to the increased separation from Greenfield Road, vehicles will re-enter Greenfield Road via the existing intersection with West Leyden Road. It was not possible to create a second intersection so close to West Leyden Road. There will be some interaction with local traffic at this point, however volumes are very low. This concept requires additional stopping points before entering Greenfield Road ensuring that trucks descend at a safe speed. Concept 2 also allows for the creation of a truck turnaround facility enabling vehicles to head back to Route 2 by utilizing a small turnaround on the western side of Greenfield Road.

Community Impact: The community is very supportive of a brake check area being installed at the top of the hill with the town raising this in a 1994 article in the Springfield Union-News. This concept will require more land from one of the parcels as well as land from the second to provide adequate deceleration zone and approach tapers. Overall Concept 2 will require more right-of-way to be acquired than Concept 1. Additional land would be required on the western side of Greenfield Road if the truck turnaround facility is pursued.

A house and farm at 125 Greenfield Road are located across the road from the proposed brake check area site. Efforts will need to be made in the detailed design to minimize visual and noise impacts of the truck facility from the adjacent property. Concept 2 is separated from Greenfield Road providing visual screening opportunities, however this may create security issues and discourage drivers from using the facility if it became secluded.

Concept 2 makes use of West Leyden Road for trucks to re-enter Greenfield Road. While traffic volumes are low, this will create some interaction between truck traffic and local traffic movements. A walking trail commences at the entrance to the Chandler Hill Cemetery. The area near the intersection of West Leyden Road is sometimes used by hikers and visitors to the cemetery for parking.

Environmental Impact: Relative to Concept 1, this alternative creates more overall environmental impact. This is largely due to the footprint requiring more overall area and the brake check area being located away from Greenfield Road. This pushes the facility further down the steep slope requiring significant earthwork as shown in the cross section in Figure 34. This concept is unable to utilize a large area of cleared pasture land at the top of the hill further increasing the amount of vegetation clearing required. The location of the facility closer to the Chandler Hill Cemetery on West Leyden Road and will interact with traffic at this location.

Drainage from the site will need to be designed in a manner that any contaminates, oils or fuel from trucks may be treated prior to being allowed to drain into the waterway on the eastern side of the hill. This would involve all runoff from the site being captured and treated in a detention pond prior to release. Noise will be generated with trucks decelerating and accelerating in and out of the facility. Noise attenuation may need to be considered as part of the detailed design.

The property located opposite the facility at 125 Greenfield Road is an inventoried historic property (MACRIS ID #COL.7). Although this property is not directly affected, consideration may be required to minimizing, visual, noise and vibration from the truck facility.

Figure 31 - Brake Check Area Concept 1 - Roadway Widening

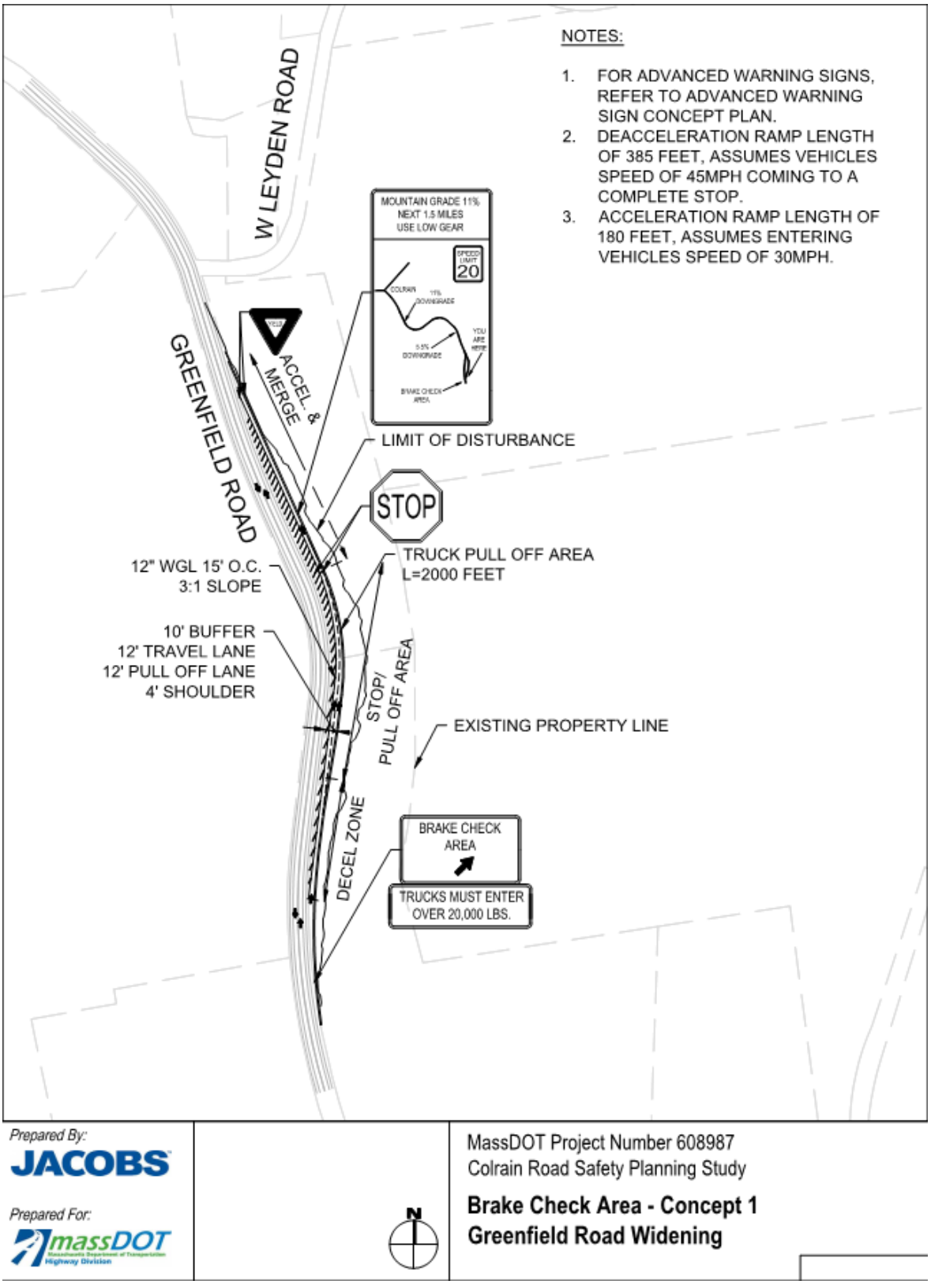


Figure 32 - Brake Check Area Concept 1 - Cross Section

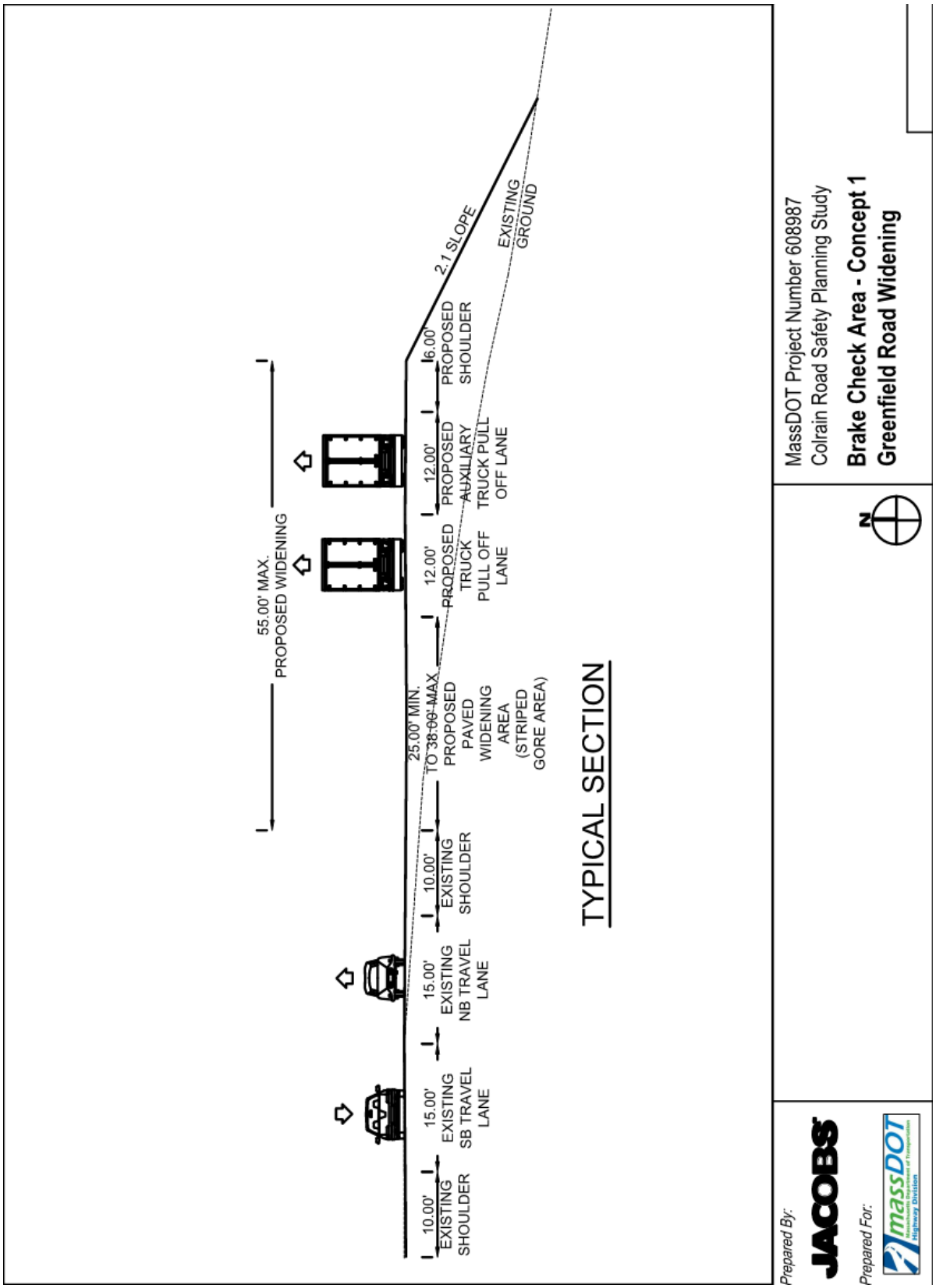


Figure 33 - Brake Check Area Concept 2 - West Leyden Rd Intersection

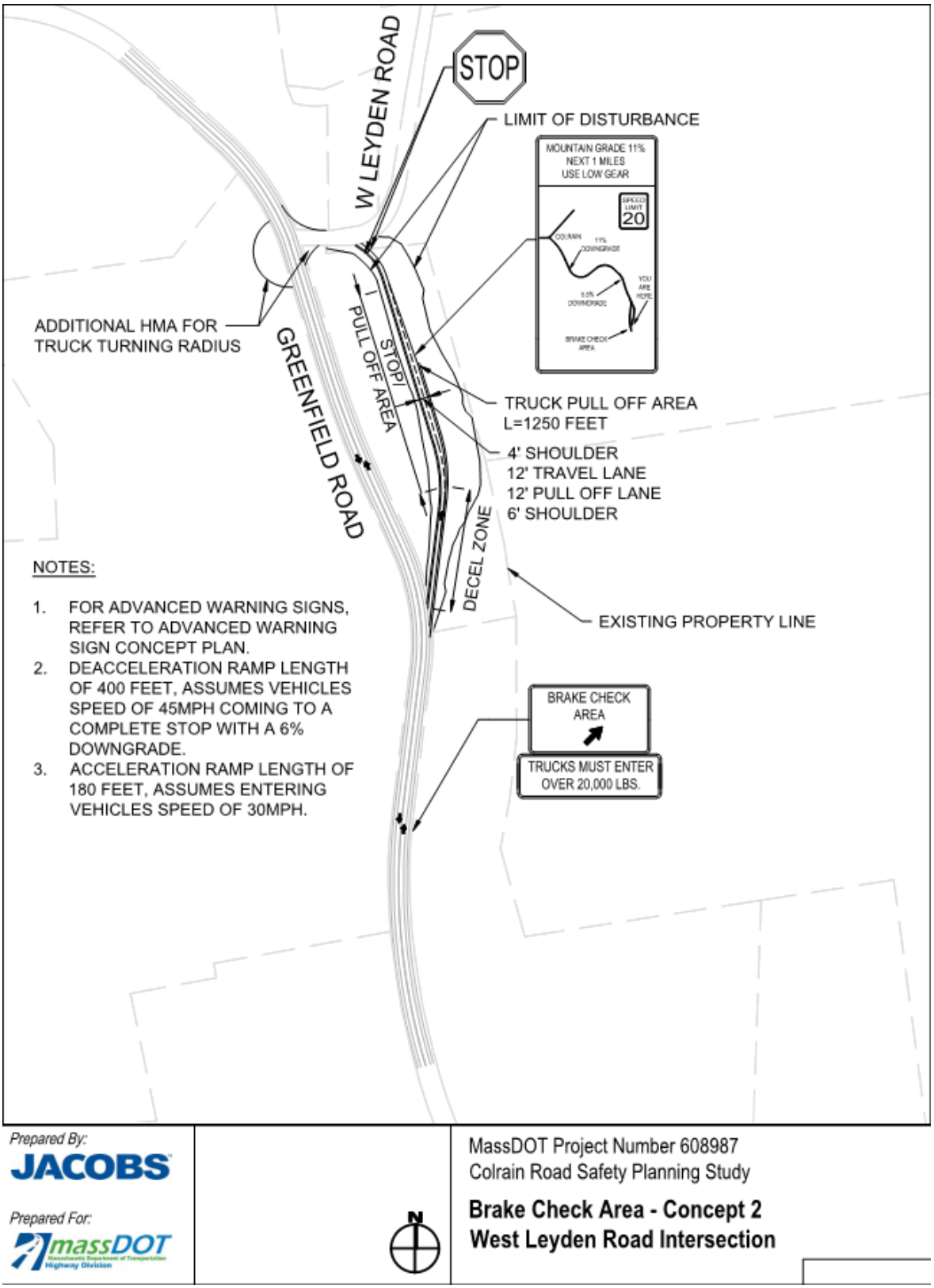
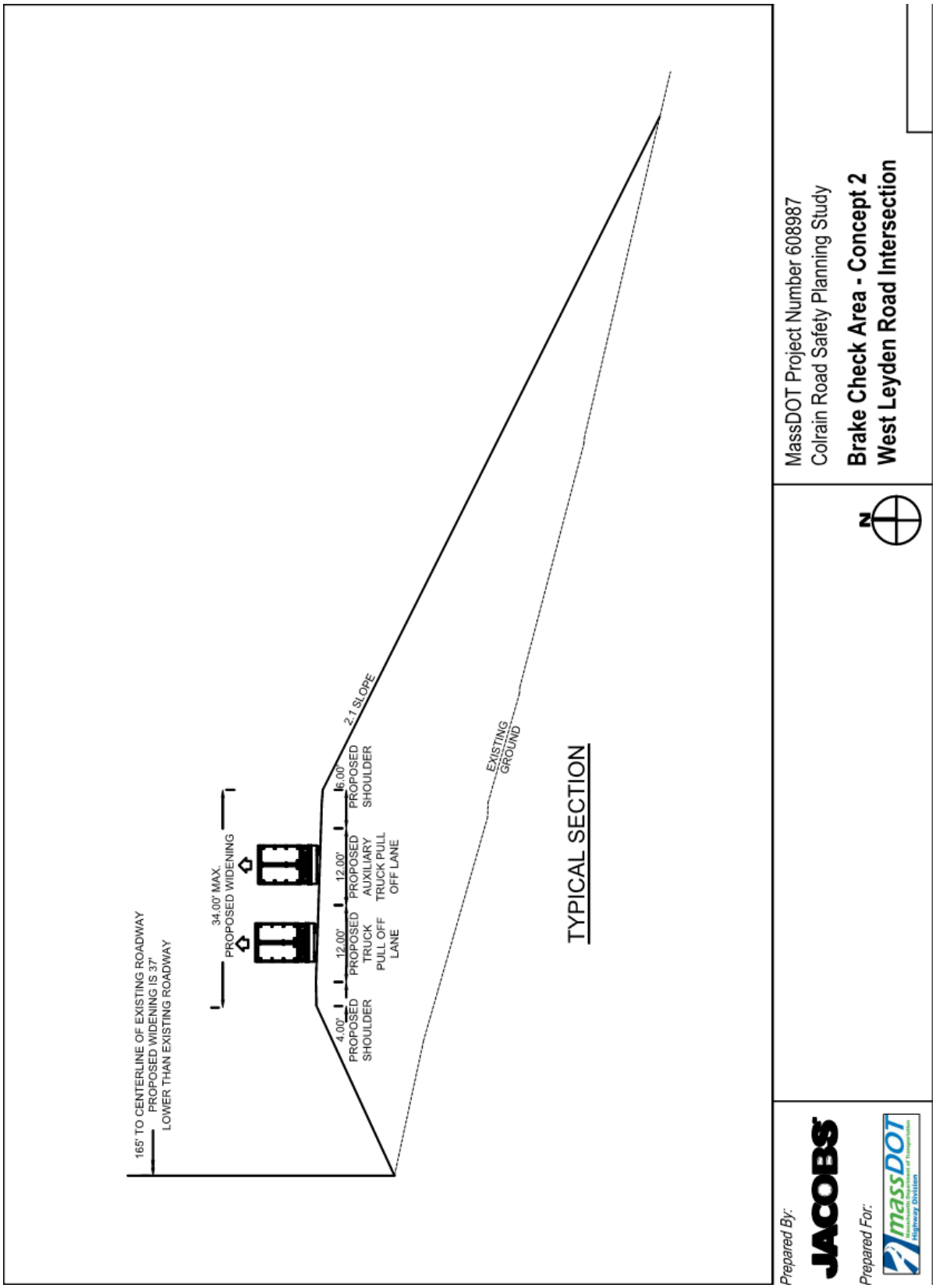


Figure 34 - Brake Check Area Concept 2 - Cross Section



Discussion: Concept 1 has some distinct advantages over Concept 2. These include less environmental impacts including less removal of vegetation as well as the need to acquire less right-of-way for the brake check area. Additionally, Concept 1 does not impact traffic using West Leyden Road and is further away from the Chandler Hill Cemetery than Concept 2. Both concepts will require the treatment of runoff and will create noise and visual impacts to the historic property at 125 Greenfield Road.

Due to the additional earthwork, Concept 2 will require additional land, is closer to the Chandler Hill Cemetery and would cost considerably more to construct.

Recommendation: Both concepts would provide a significant benefit to trucks descending the hill into Colrain with Concept 2 requiring more stops and greater truck pull off areas. Given the additional environmental impacts, additional construction cost and right-of-way required as well as indirect impacts on the Chandler Hill Cemetery and West Leyden Road it is recommended that Concept 1 be implemented. It is further recommended that use of the brake check area be made mandatory for all vehicles over 20,000 lbs.

5.2.2 Truck Speed Limit

Description: A truck speed limit is a separate, legally enforceable speed limit on a section of road that only applies to trucks and is often associated with steep grades over longer lengths.

Discussion: Typically, a speed limit applies to all vehicles on a section of road. Occasionally, conditions exist that warrant the creation of a separate speed zone for heavy vehicles. MassDOT has installed a truck speed limit of 30 mph (40 mph other vehicles) on Route 2 East as it descends into Williamstown, MA. This particular route is considerably longer than Colrain at 4 miles from the summit to the intersection with Route 7 at the bottom of the hill compared to 1 mile.

The FHWA supports the use of truck speed limits noting that “speeds are normally posted on the basis of all motorized traffic. It is permissible, and in some cases desirable, for trucks and other heavy commercial vehicles to have different (i.e., lower) maximum speeds than passenger cars. The need for a lower speed limit for trucks is primarily demonstrated as necessary by an engineering study considering factors such as magnitude and length of roadway grades, horizontal curvature, etc. Where different speed limits are prescribed for trucks and passenger cars, both limits shall be posted. A Truck Speed Limit sign (R2-2) may be combined with or installed below the standard Speed Limit (R2-1) sign.” [10]

The FHWA report[8] further notes that *“The safety effectiveness of differential speed limits for trucks is inconclusive.”* This is likely to be largely based on the need for enforcement and the fact that drivers typically drive at a speed that they feel comfortable based on their perceived level of risk.

In its 1998 report, the Transportation Research Board[11], notes that “motorists continually make decisions about appropriate driving speeds by factoring in the amount of risk they are willing to accept.”

If speed limits are not enforced, then drivers are likely to drive at a speed they feel comfortable. With safe speeds being the ultimate goal, and a lack or readily available resources to enforce a truck speed limit in Colrain, it is worth considering other methods of controlling speed behaviors for heavy vehicles.

The use of warning signs and active information systems such as speed feedback signs is more likely to result in a higher level of compliance given that the information is targeted at specific vehicles and provides feedback information on actual speeds that is relevant to the associated warning signage.

Speed feedback signs are discussed in Section 5.1.4.2 a) and on a short grade like the one in Colrain are more likely to influence driver behavior without the need for enforcement.

Recommendation: The use of a truck speed limit at Colrain is not recommended in lieu of speed feedback signs being installed.

[10] Federal Highway Administration. Methods and Practices for Setting Speed Limits (FHWA-SA-12-004). Washington, DC, 2012. http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/

[11] Transportation Research Board. TRB Special Report 254: Managing Speed—Review of Current Practice for Setting and Enforcing Speed Limits. Washington, D.C., 1998. http://onlinepubs.trb.org/onlinepubs/sr/sr254.pdf

5.2.3 Speed Feedback Signs

Description: A speed feedback sign is an interactive sign that displays a vehicle's speed as well as the posted speed limit. The purpose of these signs is to slow vehicles down by making drivers aware that they are driving at speeds above the posted limits or recommended speeds. This type of technology can be used with either posted speed limits or advisory speed warning signs.

Figure 35 - Speed Limit Feedback Sign

At Colrain, speed feedback signs could be combined with truck detection technology such as weight, axle count or height sensors to provide speed feedback messaging to heavy vehicles as they approach and also descend the hill into Colrain. Paired with a truck speed limit, this type of technology would be very effective at alerting truck drivers if their speed on the descent is over the speed limit or the recommended speed of 20 mph.

These types of signs typically flash the vehicles actual speed when the speed is exceeded and could be combined with other variable messages such as "Your Speed," "Speed Limit," and "Slow Down," which can be programmed based on vehicle speed. These signs can be mounted on standard signage poles as shown in Figure 35 or incorporated into an overhead gantry sign and are available with solar powered options.

Effectiveness: Speed feedback signs are effective at slowing vehicles. Surveys of truck drivers in California showed that 72% had reduced speed to the recommended speed limit displayed. Studies in the US have found radar speed signs to effectively slow traffic down[12,13]. Although the overall speed reductions are generally less than those resulting from physical measures, the signs have the greatest effect on those drivers that are exceeding the posted speed or traveling within speed transition zones[14].

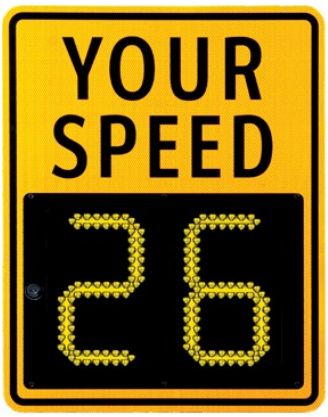


Figure 36 - Speed Warning Feedback Sign

Several years of safety data collected at multiple sites show that road geometry warning systems can eliminate rollover crashes and the impacts are sustainable. Downhill speed warning systems have proven effective at mitigating risk to large trucks in areas with steep terrain. At problem sites in Oregon and Colorado these systems have decreased truck crashes by up to 13 percent.[15]

***Design Development*:** Serviceability of solar powered signs during winter months should be confirmed with manufacturers prior to installation otherwise hard-wired signs should be installed.

Engineering plans including the placement of any speed feedback sign should be designed following FHWA and MassDOT specifications as well as the MUTCD. Advanced signs should be far enough away from the downhill for drivers to change their behavior prior to the descent into Colrain. Each sign will need capital cost to purchase the site components (radar speed detector, an electronic LED display that provides real time feedback to the drivers, pole), power considerations and regular maintenance. Solar powered versions of these signs are typically less than $5,000, however additional cost is required if truck specific signage is installed including the cost of detectors and sensors.

[12] Veneziano, David; Hayden, Larry; Ye, Jared (December 2010). Effective Deployment of Radar Speed Signs (PDF). Bozeman, Montana: Western Transportation Institute, Montana State University.
[13] Rose, Elisabeth R.; Ullman, Gerald L. (September 2003). Evaluation of Dynamic Speed Display Signs (PDF). College Station, Texas: Texas Transportation Institute, Texas A&M University System.
[14] Sandburg, Wayne; Schoenecker, Ted; Sebastian, Kristi; Soler, Dan (2006). Long-Term Effectiveness of Dynamic Speed Monitoring Displays (DSMD) for Speed Management at Speed Limit Transitions (PDF). Minnesota, USA: Washington County, Dakota County, and Ramsey County Departments of Transportation. p. 10.
[15] https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/ID/3E417EC229AF6288852573DA00578A60?OpenDocument&Query=Home

Discussion: Speed feedback signs haven a proven record of changing driver behavior leading to lower traveling speeds and improving safety on vulnerable areas such as curves in the roadway and construction zones. The Center for Transportation Research and Education at Iowa State University conducted a national demonstration project to evaluate the effectiveness of two different Dynamic Speed Feedback Signs (DSFS) on reducing speed and crashes on curves on rural two-lane roadways. There were 35 percent fewer crashes per quarter for all vehicles in the direction of the sign, and 49 percent fewer crashes per quarter for just single-vehicles in the direction of the sign.[16] In Alaska, speed feedback signs led to a reduction in the percentage of vehicles speeding by 57 percent on a Highway.[17]

Speed feedback signs have moderate initial cost along with some ongoing maintenance and operations costs. They require access to a local power source or alternative such as solar power. Additional disadvantages may be drivers speed up to see how fast they can go or becoming immune to them if overused. Targeting freight vehicles in particular may combat these potential issues.

Community Impact: The community supports the installation of speed feedback signs. No additional right-of-way will be required as these signs will be installed adjacent to the roadway as part of other sign installations. Advanced detection equipment will be required to detect trucks.

Environmental Impact: Some minor removal of vegetation may be required depending on the final location of these signs after detailed design. No environmental impacts are expected.

Recommendation: Install speed feedback signs that target trucks on all speed limit signs and truck speed advisory signs.

5.2.4 Supplemental Pull Off Bays

Description: Supplemental pull off bays are safe areas for vehicles to pull off the road during a long or steep descent. They serve a similar purpose to brake check areas but are less formal and are located at various locations on the hill offering supplemental areas to pull off the highway.

Effectiveness: Supplemental pull off bays are not specifically designed for trucks and are often designed to suit available space or other purposes making them less effective in providing safe places for trucks to pull over on the descent. The shortness of the hill at Colrain also limits their effectiveness.

Discussion: The review of Truck Safety Systems in Section 4.1 identified one location where supplemental stopping bays were provided on the descent allowing vehicles further opportunities to check brakes or let brakes cool down. The truck safety system on Route 16 near Buffalo, WY has provided several additional stopping bays that also serve other purposes. These include:

- An interpretive site for tourist information and views.
- Three small pullout areas where drivers can pull off the roadway completely, if necessary.
- A small pullout area for viewing geologic formations.
- A game-check station.
- A road closure turnaround (used to close the road during winter storms and redirect drivers back to Buffalo).

The mitigative safety effect of these pullout areas is that they give drivers a place to completely pull off the roadway if they get into difficulties while they are descending a highway with steep, mountainous terrain.

A review of the steep descent into Colrain did not identify any suitable locations to provide additional stopping bays that could provide safe parking for heavy vehicles. This is largely due to the surrounding terrain, adjacent

[16] https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/ID/F42A89A6EDBE5A5E85257E60004C302F?OpenDocument&Query=Home
[17] https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/ID/D17023C2F7CA65D3852581F5006F6912?OpenDocument&Query=Home

properties, a stream that follows the road on the western side and long sections of rock cutting. The descent into Colrain is also relatively short, meaning additional pull of bays are less likely to be required.

Recommendation: On the basis that the descent into Colrain is short and no suitable locations have been identified, the provision of additional stopping bays on the descent is not recommended.

5.3 Prevent Out-of-Control Heavy Vehicles from Entering the Town Center

Trucks that get out-of-control on steep grades have the potential to become deadly. When trucks lose control, it is often because the vehicle has gained speed on the descent and does not have the capacity to stop or slow down to a safe speed. Many of these crashes are caused by a lack of braking capacity, overheating brakes or an inability to change into a lower gear to take advantage of engine braking. In these situations, trucks lose the ability to stop and often attain speeds above what is safe for the road conditions. Trucks that get out-of-control often crash into other vehicles or infrastructure at the bottom of the hill which is the exact problem that has occurred over several years in Colrain.

Solutions for bringing out-of-control vehicles to a safe stop essentially focus on truck emergency ramps with several types of ramp worth considering. Truck emergency ramps are an important tool in preventing crashes involving runaway trucks. Such an installation would have been effective in providing an option to drivers of trucks that have crashed in Colrain over recent years.

A truck emergency ramp needs to be designed to cater to the largest of trucks at the maximum possible speed while not stopping the truck so suddenly that the load is dislodged or worse, the vehicle's occupants are subjected to deceleration forces resulting in trauma.

The recommended design criteria used by several agencies for truck emergency ramps is to stop a 90,000 lb truck entering the ramp at 90 mph maintaining a deceleration force of 0.8 "G" or less.

5.3.1 Truck Escape Ramps

Description: A truck emergency ramp is a traffic device that enables vehicles which have lost control to safely stop. These ramps use a variety of mechanisms to bring the vehicle to a stop and are typically a contained ramp adjacent to the downhill travel lane designed to accommodate large vehicles. The ramp seeks to dissipate the vehicle's kinetic energy using uphill grades, soft sand or gravel, or a mechanical arrestor system.

The primary types of truck emergency ramps that are used in the United States are:

- Arrestor bed: a deep gravel-filled ramp adjacent to the road that uses rolling resistance to stop the vehicle. The required length of the bed depends on the mass and speed of the vehicle, the grade of the arrestor bed, and the rolling resistance provided by the gravel. An arrestor bed is able to work on a downhill grade but requires a longer gravel bed due to the inability to utilize gravity to bring vehicles to a stop.
- Gravity escape ramp: a long, upwardly inclined path parallel to the road which relies on gravity to bring the vehicle safely to a stop. A substantial length of uphill grade adjacent to the downhill roadway is required. Control can be difficult for the driver: problems include rollback after the vehicle stops and safe removal of the vehicle having to reverse down a steep slope back to the highway.
- Mechanical arrestor system: a proprietary system of stainless-steel nets transversely spanning a paved ramp to engage and bring a runaway vehicle to a stop. Ramps of this type are typically shorter than gravity ramps and work well when on a downhill grade. These systems have been extensively crash tested and tend to be more expensive but have proven very effective in many states including Massachusetts, Connecticut and Wyoming.

Effectiveness: Truck emergency ramps are highly effective at safely stopping trucks that have lost control on steep descents. There have been many escape ramps installed with many uses over a long period of time. Without these ramps these uses would have resulted in crashes likely involving the loss of life. Each type of ramp has been effective; however, mechanical arrestor systems have been becoming more widely used and provide a more controlled stop in a shorter amount of space.

5.3.2 Ramp Location

Due to hilly or mountainous terrain, it is often difficult to find a suitable site for a truck emergency ramp. The ramps should be placed in an area that is able to provide the most benefit. As such these ramps should be placed in those areas where vehicles have a history of losing control in order to be in the right place to catch them.

There also needs to be sufficient right-of-way available as these ramps can take up a considerable amount of space. Ideally the surrounding terrain is flat or an uphill grade that can reduce the amount of energy that needs to be dissipated through friction or mechanical means.

A review of several design guidelines indicated that there is no consensus on where ramps should be located and that it often relies on engineering judgement with consideration given to several factors as outlined below.

5.3.2.1 Design Guidelines

A 1992 NCHRP report[18] on the suitable location of truck emergency ramps notes that topography is often a key driver in determining the location of the ramp, however crash data can also be used in the location analysis. A review of crash data studies for ramps in Colorado observed the following:

- The ramp should be located at a position on the grade that will allow it to intercept the largest number of runaway trucks.
- There is a probable point on a steep grade where trucks running out-of-control attain a speed that may create catastrophic crashes.
- Crashes near the summit of a grade tend to be less severe.
- Ramps should be built in advance of roadway curves that cannot be negotiated by an out-of-control vehicle.

California's *Design Guide for Truck Escape Ramps* (1986)[19] states the following:

“The location of a truck escape ramp, whether it is an arrestor bed or gravity ramp, is controlled largely by the terrain. In general, an escape ramp should only be considered on the lower half of a grade because this is where the need becomes most apparent to the operator of the runaway truck and they would then be more willing to use the ramp. An exception would be on long, sustained downgrades.

Escape ramps should not be located on curves. This adds to the problems of control that already face the driver of a runaway truck. Also, a tangent ramp off a curve can, under some conditions, appear as the through roadway. It is much better to locate an escape ramp along a tangent section of roadway.”

The AASHTO Green Book[20] states that “Truck Escape Ramps should be on the right side, generally on tangent alignments, in advance of populated areas and curves that cannot be safely negotiated.”

The following are also seen as good practice in determining a suitable site for truck emergency ramps.

- Prior to a site which requires a stop or slow-speed turn at the bottom of the grade.
- Ramp entrance requires very little deflection for runaway trucks to enter.
- Entire ramp visible from uphill.
- Available space for installation, minimize earthwork and construction cost.

While there do not appear to be clear guidelines for identifying locations for truck emergency ramps, common factors in selecting sites include terrain, alignment, visibility, location relative to hazards and distance from the top of grade.

[18] Witheford, David K, Truck Escape Ramps, national Cooperative Highway Research Program (NCHRP), May 1992
[19] Tye, E.J., “Design Guide for Truck Escape Ramps,” Traffic Bulletin No. 24, California Business, Transportation and Housing Agency, Sacramento, California (1986)
[20] American Association of State Highway and Transportation Officials. (2018). A policy on geometric design of highways and streets. Washington, D.C.: American Association of State Highway and Transportation Officials.

5.3.2.2 Ramp Location Alternatives – Colrain

The hill section of Greenfield Road from the intersection in the town center to the top of the hill is 5800’ or a little over 1 mile in total length. The vertical geometry of the hill is such that the worst grades are not encountered until trucks have rounded the final bend at Curve 4 where the grade has steepened to more than 11%.

As described in Section 2.1.4, drivers experience a steepening of the grades to 8% in the first half mile of the descent after which the road flattens briefly to 5% before steepening again to 11% immediately prior to Curve 4. In identifying suitable locations for a ramp, the geometry of the downhill grade was considered as well as the surrounding topography and impact on adjacent properties.

The existing roadway has many rock cuttings limiting the range of suitable locations. As the road approaches town, the topography on the eastern side adjacent to the downhill lane opens providing opportunities for the location of an arrester bed. This is approximately 1400’ from the intersection in the town center, leaving little room for truck emergency ramp alternatives. Two suitable locations were identified that provide a straight run-off the back of existing curves in the roadway as shown in Figure 37.

- **Alternative Location 1:** Commences immediately to the north of the driveway access to 16 Greenfield Road and while closer to town this location does not impede access to 16 and 22 Greenfield Road but does pass behind an uninhabited structure at 6 Greenfield Road.
- **Alternative Location 2**: Commences approximately 300’ to the south and is located higher up the hill with a departure trajectory that provides greater separation from the town center. This location directly affects access to two houses; 16 and 22 Greenfield Road.

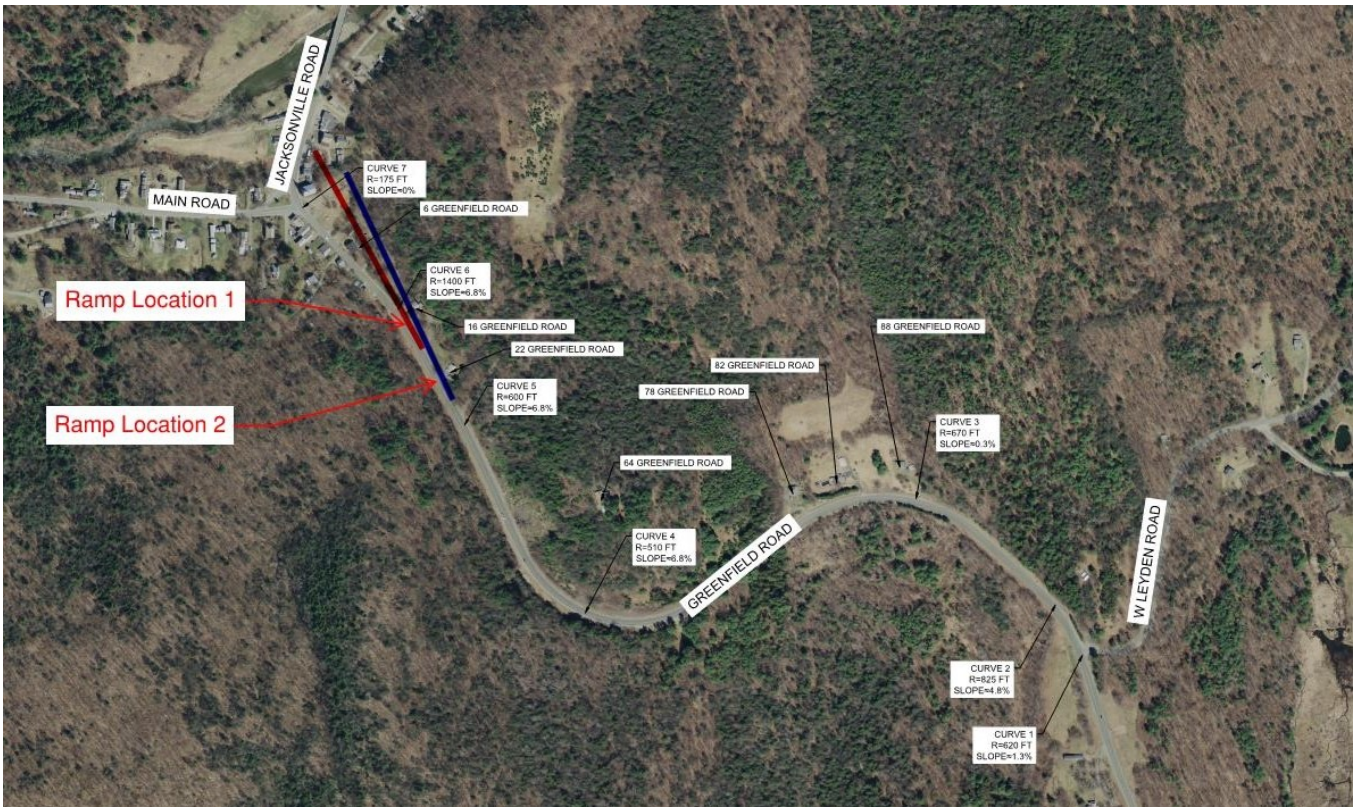


Figure 37 - Truck Emergency Ramp Locations

These two locations provide the basis for alternatives considered for each of the truck emergency ramps that have been considered, however, neither provides an opportunity to take advantage of natural contours and

uphill grades, meaning that any grade influences will need to be constructed with earthwork and retaining walls.

5.3.3 Ramp Type Alternatives - Colrain

No suitable sites were identified for a gravity escape on Greenfield Road due to the surrounding topography and geology as well as the need to have the ramp on the east side of the road so that out-of-control vehicles do not have to cross in front of southbound traffic to access the emergency ramp. As such two alternatives have been considered for Colrain:

- **Alternative Type 1:** Gravel Filled Arrestor Bed
- **Alternative Type 2:** Mechanical Arrestor System

Both alternatives have been considered at the two distinct ramp locations described above.

5.3.3.1 Alternative Type 1: Gravel Filled Arrestor Bed

Description: Alternative 1 is a concrete-encased ramp filled with a soft gravel that uses rolling resistance to stop the vehicle. The required length of the bed depends on the mass and speed of the vehicle, the grade of the arrestor bed, and the rolling resistance provided by the gravel. An arrestor bed can work on a downhill grade but requires a longer gravel bed due to the inability to utilize gravity to bring vehicles to a stop.

Effectiveness: Gravel arrestor beds are highly effective in bringing vehicles to a stop and have been used in many locations across the US.

Design Development: In further developing design concepts for gravel arrestor beds, alternatives were considered for Colrain at each ramp location.

Pea gravel is the recommended material for gravel-filled arrestor beds as it provides the greatest level of rolling resistance. Pea gravel produces higher decelerations than the more angular crushed aggregate because the truck sinks into the pea gravel more, transferring more energy to the stones over a shorter distance.

The AASHTO publication “A Policy on Geometric Design of Highways and Streets”[21] provides a formula (below) to calculate the length of an arrestor bed. This formula has been adopted by many states in their design guidelines including California and Washington. Lengths for the escape ramps were calculated using -5% (downgrade), 0% (flat) and 5% (upgrade) as shown in Table 5-1. In developing the concepts included in this report, we adopted a bed width and depth of 30’ and 42” respectively as recommended by AASHTO[21].

$$L = \frac{V^2}{((30 \times (R + G))}$$

Where:

L = Stopping Distance required for truck ramp (feet)

V = Entering Speed (mph)

R = Rolling resistance of gravel

G = Grade of escape ramp (%)

Table 5-1 Calculated Arrestor Bed Lengths

Grade (%)	Length (feet)
-5% (downgrade)	1350
0% (flat)	1080
5% (upgrade)	900

Straight alignments were developed as they ensure that the end of the ramp is visible and do not require the driver to steer the vehicle. The California Design Guide for Truck Escape Ramps (1986)[22] does not support the

[21] American Association of State Highway and Transportation Officials. (2018). A policy on geometric design of highways and streets. Washington, D.C.: American Association of State Highway and Transportation Officials.

[22] Tye, E.J., “Design Guide for Truck Escape Ramps,” Traffic Bulletin No. 24, California Business, Transportation and Housing Agency, Sacramento, California (1986)

use of curved alignments noting that *"arrestor beds should not be curved as any excessive steering maneuver could cause an articulated truck to jack-knife and overturn."*

However, a curved alternative was considered to see if any benefit was gained by following the contours of the terrain, which may reduce overall length. The curve was developed using a 90-mph design speed. Due to the high design speed, very little curvature was introduced and no significant benefits from following the contours were able to be achieved. Given that the benefits of using a curved alignment were insignificant and their use is not supported by design guidelines, the curved alignment alternative was discarded.

Figure 38 and Figure 39 show the straight alignment at Ramp Location 1 and the curved alternative at Ramp Location 2, respectively. It can be seen from these figures that the lengths of the ramps at either location result in the ramp encroaching on several buildings, crossing Jacksonville Road, or ending up with excessive fill heights. Table 5-2 summarizes the outcomes for the gravel arrestor beds below.

Table 5-2 Summary of Gravel Arrestor Beds

Alternative	Ramp Location 1 – Straight	Ramp Location 2 – Curved
-5% (downgrade) 1350'	• Fill Height: 35' • Impacts: Demolishes several buildings and crosses Jacksonville Road.	• Fill Height: 28' • Impacts: Blocks access to 2 properties; demolishes several buildings
0% (flat) 1080'	• Fill Height: 64' • Impacts: Demolishes several buildings and crosses Jacksonville Road.	• Fill Height: 87' • Impacts: Blocks access to 2 properties
5% (upgrade) 900'	• Fill Height: 73' • Impacts: Demolishes several buildings and crosses Jacksonville Road.	• Fill Height: 107' • Impacts: Blocks access to 2 properties

Other design elements that need to be considered in the design of a gravel filled arrestor bed include:

Vehicle Extraction: A service road located adjacent to the arrestor bed is recommended so that tow and maintenance vehicles can use it without becoming trapped in the bedding material. The typical width of this road is 10'. Also essential is the installation of a concrete anchor block in front of the bed to act as an anchor point for the tow vehicle used for truck extraction.

Bed Drainage: The bed needs to be properly drained so that water does not stand in the bed. To achieve this, the base needs to be designed with a low point and a free draining lower layer of gravel. Design guides recommend a 12" layer of large diameter (3"+) crushed aggregate. This drainage layer should be wrapped in geotextile fabric to separate the drainage layer and arrestor bed gravel.

End Protection: Sand filled barrels should be placed at the end of the ramp in case a vehicle is in danger of overshooting the ramp. This provides an additional factor of safety.

Maintenance: After each use and on a periodic basis, it is important that the gravel in the arrestor bed is graded and "fluffed" to ensure that the desired drag affect occurs when next used. Over time, "fines" tend to contaminate the arrestor bed gravel causing a level of compaction. The infiltration of fine particles potentially hold water and freeze in cold weather, reducing the ramp's ability to control runaway trucks. Fine particles typically come from the existing ground, surface run-off, vehicles and the breakdown of the gravel over time. Frequent use will crush the gravel creating fines leading to a loss of effectiveness.

Snow clearing: The clearing of snow and ice in winter is difficult. The common approach used by most agencies is to manage the infiltration of fine materials and to provide good drainage to minimize the effects of freezing in winter months.

Figure 38 - Gravel Arrestor Bed - Ramp Location 1

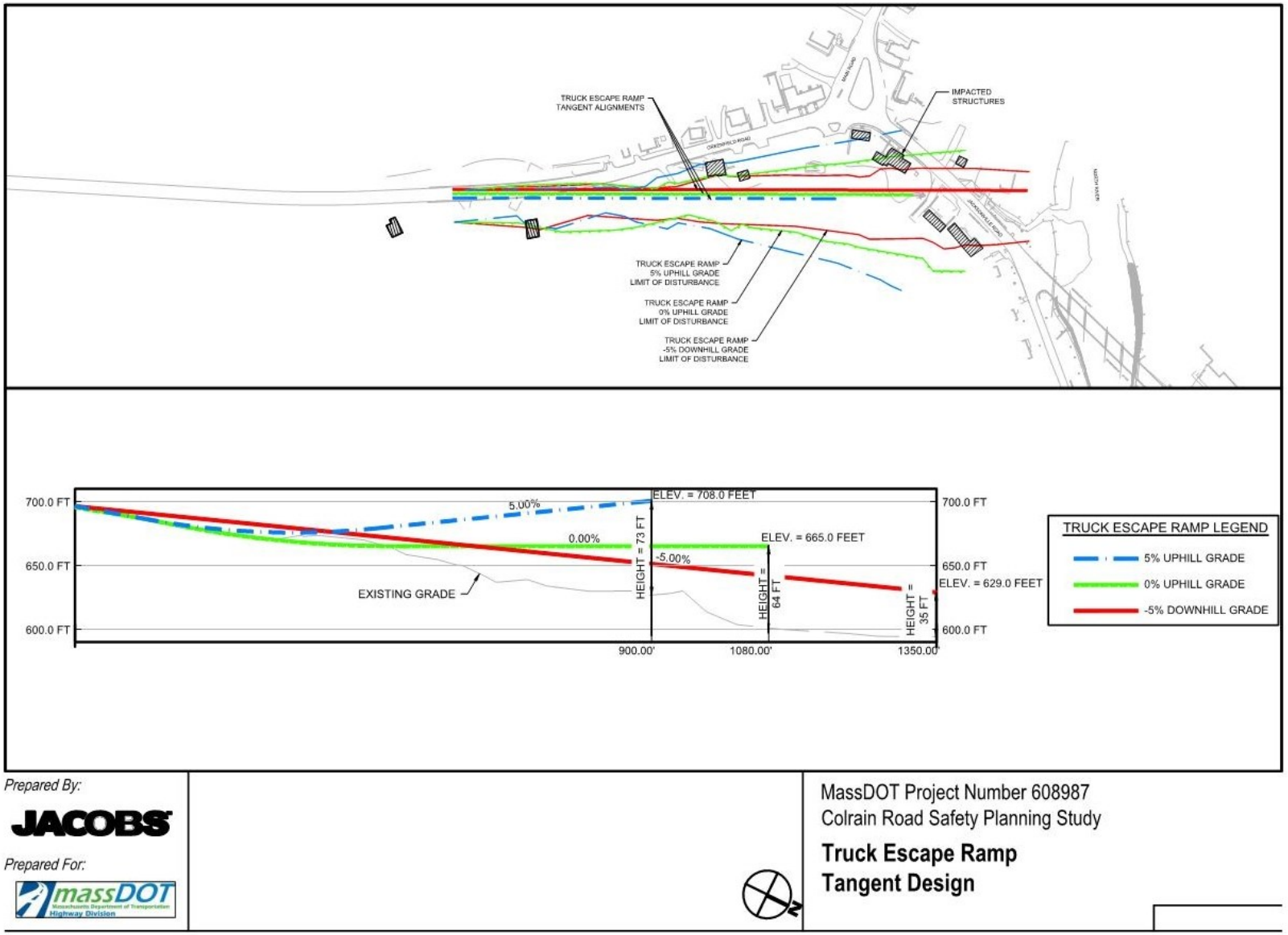
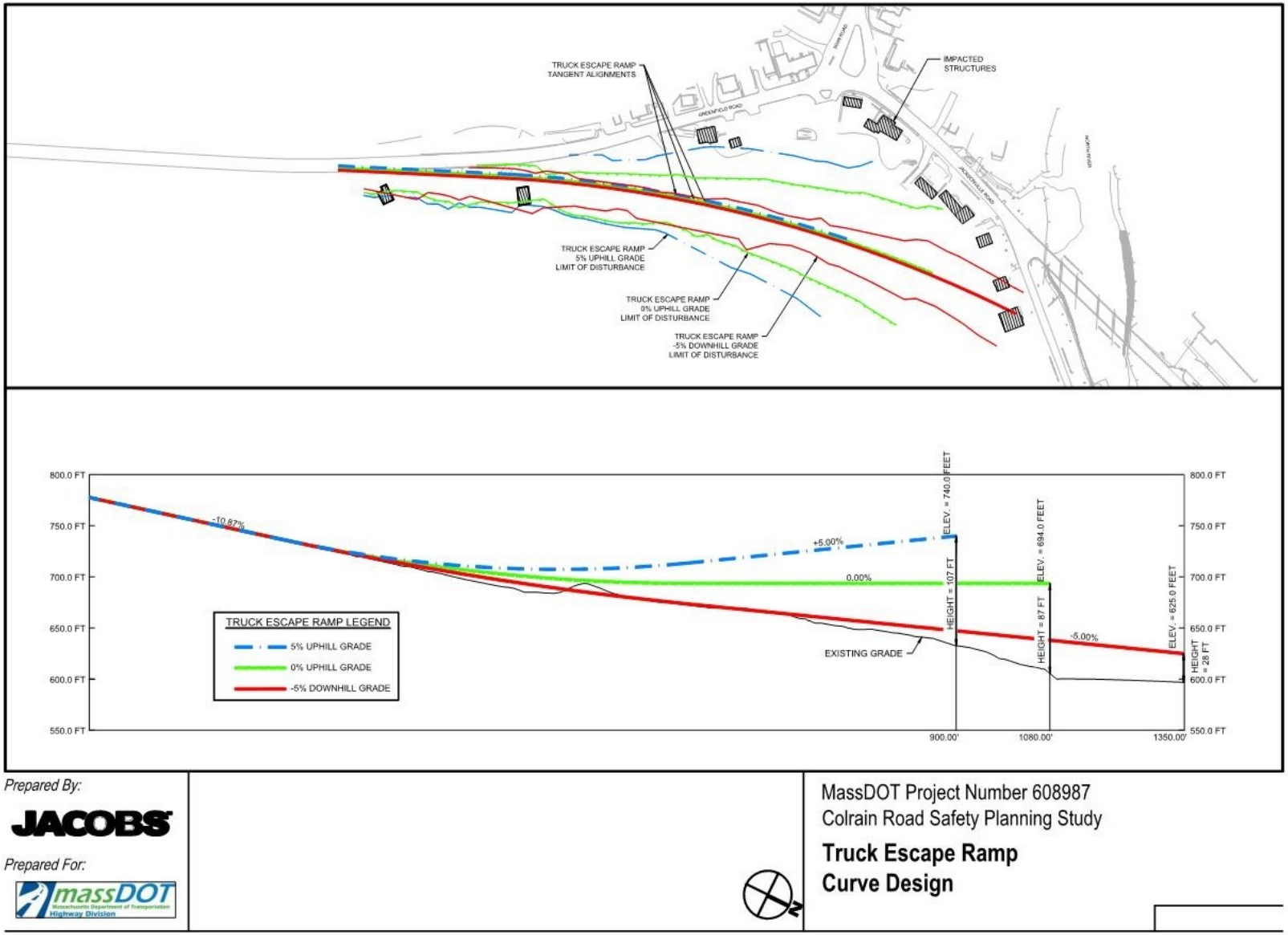


Figure 39 - Gravel Arrestor Bed - Ramp Location 2



5.3.3.2 Alternative Type 2: Mechanical Arrestor System

Description: A mechanical arrestor system is a proprietary system of stainless-steel nets that transversely span a paved ramp to engage and bring to stop a runaway vehicle. The technology was first used by the Navy to stop aircraft landing on aircraft carriers and was adapted and tested for highway applications in the early 1970's. Ramps of this type are typically shorter than gravity ramps or gravel arrestor beds and work well when on a downhill grade.

The arrestor system most commonly used for catching runaway trucks is the Dragnet® Emergency Truck Escape Ramp. The Dragnet® system consists of a series of barrier nets connected to energy absorbers mounted in concrete barriers on each side of the truck escape ramp. The length of the ramp and the number, spacing and load rating of the energy absorbers can be adjusted to catch vehicles within the truck ramp while maintaining deceleration 'G' forces within acceptable levels. Dragnet® Truck Escape Systems have been designed to stop a wide range of vehicles weighing up to 90,000 lbs and traveling up to 90 mph.

When an out-of-control truck enters the ramp, the vehicle will sequentially engage the restraining nets which are attached to energy absorbers. Each energy absorber is comprised of a stainless-steel chamber with an enclosed steel tape up to 200' long. The energy absorbers use a metal bending process for absorbing energy, which provides the means to stop vehicles of varying weights and speeds. The absorbers are comprised of a chamber, a length of metal tape and a series of offset pins. As the metal tape is pulled through the series of offset pins, the tape is bent back and forth beyond its yield point. The process of bending the metal beyond its yield point is the principal mechanism for absorbing the energy of impact. The force in the system increases until sufficient kinetic energy is absorbed to bring the truck to a safe stop.

The first net in the series is typically set to impart a lower stopping force from the balance of the nets used in the system as it is also designed to stop out-of-control automobiles as well as contribute to the stopping of trucks. Trucks will typically need to engage multiple nets to come to a safe stop which is dependent on the truck speed and weight. Once the absorbers have been deployed, the system can be quickly returned to service by replacing the metal tapes. It should be noted that the steel tapes must be replaced after each vehicle impact.

The Dragnet® system has been extensively tested by independent transportation research organizations meeting the structural adequacy, occupant risk and vehicle trajectory evaluation criteria of the National Cooperative Highway Research Program Report 350 (NCHRP 350) and TL-3 Head-On Impact. While typically more expensive, these systems have proven very effective in many locations including Canada, France, Hawaii, Massachusetts, Connecticut and Wyoming.

Effectiveness: Mechanical arrestor beds are highly effective in bringing vehicles to a stop and are becoming increasingly used across the US as more systems are installed and the benefits are more widely understood.

Design Development: Given the shorter ramp lengths it is important that the ramp geometry be kept as straight as possible. This keeps the ramp visible to drivers and does not require any maneuvering of the vehicle after it has entered the ramp. A concept design for a mechanical arrestor system was considered at the two alternative ramp locations. A third alternative that was immediately adjacent to the roadway, similar to the installation at Jackson and Buffalo in Wyoming, was also considered.

- Alternative A – Ramp Location 1 – Straight
- Alternative B – Ramp Location 2 – Straight
- Alternative C – Ramp Location 1 – Parallel to existing road

The concepts considered the known dimensions and capacities of several recently installed systems as shown in Table 5-3. Of these examples, the installations at Jackson, WY and Avon, CT provide the most relevant examples with both being contained within a relatively short distance (330' – 450'). The differences between the two systems relate to design speed, design vehicle, and grade.

It is worth noting that the Avon, CT example is a shorter length which would assist at Colrain. However, it is also designed for a maximum speed of 60 mph (which is below the recommended design speeds for truck emergency ramps) and a design vehicle load of 80,000 lbs (which is less than the recommended 90,000 lbs). Given the relatively short length of the hill at Colrain, a reduced design speed may be acceptable, however further consideration of the design parameters during detail design will be required. It should also be noted that any further design development will require input from the manufacturer of the system and that as a result the number of nets and overall dimensions may change from those shown in the design concepts below.

Concepts were developed for Colrain using the dimensions and net configuration from Jackson, WY as this caters for the maximum design load and speed while keeping the overall length to 450'.

Table 5-3 Dragnet® Installations

Location	Design Speed	Design Vehicle	Overall Length	Width	Grade	Nets & Location
Avon, CT	60 mph	80,000 lbs	330'	20'	-6.5%	5 Nets 5', 55', 65', 75', 85'
Buffalo, WY	90 mph	90,000 lbs	920'	20'	-7%	9 nets 5', 65, 95', 115', 255', 345', 365', 505', 585', 605'
Jackson, WY	90 mph	90,000 lbs	450'	20'	-10%	8 Nets 40', 80', 90', 100', 230',270', 280', 290'
Example from Dragnet Design Guide	60 mph	Not Known	400'	20'	-6%	8 Nets 0', 40', 50', 60', 70', 200', 240', 250'

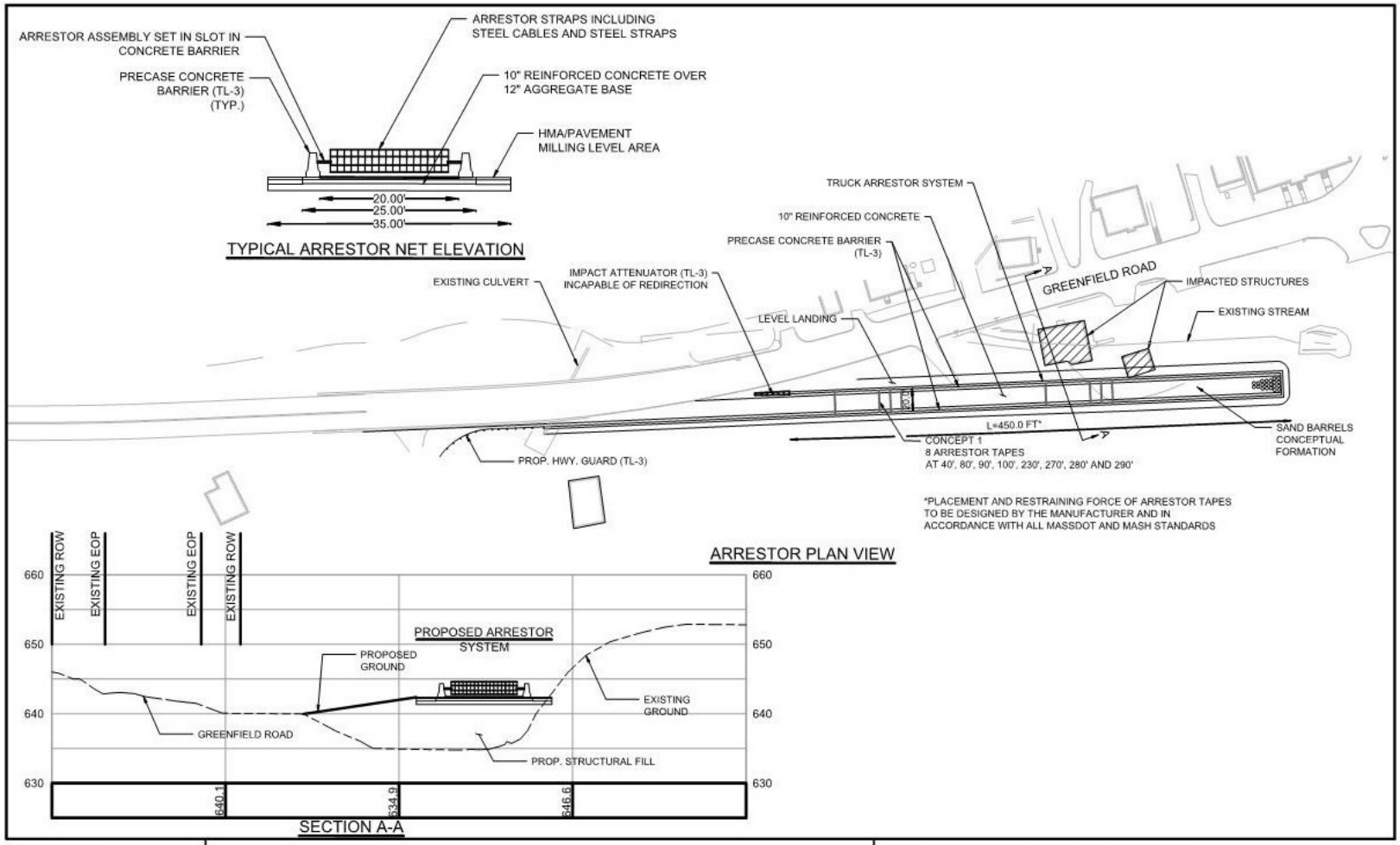
Alternative A – The mechanical arrestor system concept at Location 1 is shown in Figure 40. This concept adopts a grade similar to the existing road, terminating in the rear of the church carpark at or near the existing grade. In this sense it minimizes visual impact. The concept design also includes provision for a 15 sand-barrel crash impact system at the ramp end. The installation at Avon, CT has a similar end-treatment to provide psychological assurance for drivers entering the ramp by visually shielding the concrete wall at the end of the ramp.

Alternative B – A mechanical arrestor system at Location 2 was also considered, however as shown in the development of alternatives for the gravel arrestor bed, a ramp at Location 2 blocked access to the two houses at 16 and 22 Greenfield Road with the only benefit being the ramp being slightly further up the hill. The overall concept considered was otherwise identical to Alternative A.

As a suitable mechanical arrestor system for Colrain would only require 450', the need to consider Location 2 blocking access to the two properties is no longer required. On this basis Alternative B was discarded from further consideration.

Alternative C – To keep the escape ramp straight, this alternative would normally be installed on a straight stretch of road. However, with the need to terminate the ramp before the church carpark, the ramp entrance needs to be located at curve 6. This results in the need to curve the ramp approach and include significant cross slope to get the trucks safely into the escape ramp, which would make it more difficult for drivers to navigate. This concept also encroaches well into the church parking as the 450' ramp length could not start until after the curve. This creates significant visual impacts at the intersection in the center of town. For these safety and visual impact reasons, Alterative C was discarded from further consideration.

Figure 40 - Mechanical Arrestor System – Ramp Location 1



5.3.4 Maintenance Issues

Mechanical arrestor systems do not typically require maintenance with the exception of 1) resetting the system after it has been deployed, and 2) clearing snow and ice. Snow and ice can build up limiting the effectiveness of the ramp or blocking access to the ramp. The installation at Avon, CT installed an electrically heated pavement surface to prevent snow and ice accumulation. The short length of the ramp and confined end treatment make it suitable for a snow-melt system.

The Avon sub-surface heating system maintains near-bare pavement conditions during snow/ice events, melting snow at up to 4 inches per hour to accommodate heavy New England snowstorms. The system also heats the ramp's entry area and the drainage outlet to allow melting runoff from the ramp to flow freely to the catch basin. The system automatically activates when a temperature/moisture sensor indicating the conditions for freezing precipitation are present and remains on throughout the duration of the weather event.

The Connecticut DOT reports[23] that for the Avon ramp, *"Maintenance of the Dragnet® system is simple and straight-forward. Normal operation requires virtually no maintenance, only to make sure the ramp stays clear of debris and an annual test of the heating system. If a runaway vehicle event should occur, the runaway vehicle is extracted either under its own power or by tow vehicles. Then the expended metal tapes and tape cartridges are detached from both the nets and removed. Replacement tape cartridges are carried as stock in the Department's inventory or available from the manufacturer.*

New cartridges are reattached to both the net and side wall for each of the affected nets, and the system is ready for use. Total time for complete turnaround is anticipated to be under a day. Approximate full-cost replacement is about $90,000 per event, with less cost if not all nets are deployed. The heating system is billed on a special demand electric utility rate that charges a low fee during the non-heating season, and a higher kW/hr fee the rest of the year. Although each activation of the system may cost several hundred dollars, the savings in traffic protection costs alone if the ramp were to be mechanically cleared more than offset this charge."

The cost of replacement cost of cartridges could be pursued through the truck driver's insurance.

5.3.5 Comparison of Alternatives

In comparing the range of alternatives considered and concepts developed, there are three basic questions that need to be answered:

- Where should the escape ramp be located?
- What alignment should the ramp have?
- Should the escape ramp be a gravel arrestor bed or a mechanical arrestor system?

5.3.5.1 Truck Escape Ramp Location

Two locations were considered as discussed in Section 5.3.2, both provide good approach sight distance, and both are located at curves on the descent into Colrain.

Location 2 is 300' further south creating additional space to fit a truck escape ramp in before the town center. Location 2 blocks access to two properties at 16 and 22 Greenfield Road making it virtually impossible to maintain access. Both properties are occupied and are in good condition. Visual and amenity impacts to these properties would be severe should a truck emergency ramp be constructed at this location.

Location 1 is closer to the town center and directly impacts the property at 6 Greenfield Road. This property is currently unoccupied and "boarded up" following a fire several years ago.

Location 1 results in less overall impacts.

[23] R. Hanley, "Connecticut Department of Transportation's Truck Escape Ramp (TER) - Avon, CT," Connecticut Department of Transportation, Rocky Hill.

5.3.5.2 Truck Escape Ramp Alignment

Design guidelines repeatedly note that escape ramps should be designed on a straight alignment. While a curved alignment was investigated with a 90 mph design speed, this did not result in any significant benefits.

A third alignment considered placed the truck emergency ramp immediately adjacent to the existing road, following the same grade and alignment. The existing road geometry on the approach to the town center required that this alignment be developed on the curve at Ramp Location 1. This resulted in less than desirable entrance geometry into the ramp and pushed the end of the ramp closer to the town center, creating significant visual impacts.

A straight alignment is safer and results in less impacts.

5.3.5.3 Truck Escape Ramp System

Gravel arrestor bed systems require an overall ramp length that is 2-3 times that of a mechanical arrestor system. Downgrade options would cross Jacksonville Road; flat or upgrade ramp would create high embankments that will be difficult to maintain and create significant visual impacts. The gravel bed needs regular maintenance and drainage to prevent the buildup of fines. Winter conditions typically result in a frozen crust at the top of the gravel layer reducing the overall performance of the ramp. None of the developed alternatives provide good outcomes, with very long ramps that impact buildings and infrastructure or need very high fill heights. In addition, the extraction of vehicles is difficult following an incident, ongoing maintenance is required, and these types of truck emergency ramps are susceptible to snow and ice buildup, decreasing their effectiveness in stopping out-of-control trucks.

Mechanical arrestor systems have been proven in many locations and are more effective in providing stopping resistance. They are shorter in length, and grades are less of an influence meaning they work in a greater variety of locations. The extraction of vehicles after an incident is easier, and many vehicles are able to drive away compared with a significant tow operation for a gravel arrestor bed. As the truck emergency ramp is fully paved, this area can be heated to prevent the build-up of snow and ice.

While the Dragnet® system is expensive, savings can be made with the supporting infrastructure. This is due to the overall shorter length, less earthwork and the fact that service lanes and tow anchors are not required. The cost of installing a mechanical arrestor system at Colrain would be in the order of $4-5M based on known costs for recent installations in Wyoming and Connecticut. Based on the Avon, CT experience, resetting the system after an incident costs about $90,000 per event.

A mechanical arrestor system is the preferred system type.

5.3.5.4 Community Impacts

The community is very supportive of having a truck emergency ramp installed and has been lobbying for such a facility for many years. The gravel arrestor bed options all create major impacts on property and houses in the town. This is due to their much longer overall length and need to introduce uphill grades to fit a gravel bed into the available space. The introduction of upslopes while resulting in a shorter ramp and less property impacts creates very high fills which would dominate the landscape in the area behind the church. Such a facility would change the character of the town. The mechanical arrestor system can be contained within 450’ with a downslope that is similar to the existing highway grade. This results in a ramp that terminates at existing ground level in the parking area behind the church. Only one house is directly affected, and that building is currently unoccupied and boarded up following a fire some years ago at 6 Greenfield Road. All alternatives at Ramp Location 2 block access to the houses at 16 and 22 Greenfield Road without providing any additional benefit.

From a community perspective the mechanical arrestor system at Location 1 is the preferred alternative.

5.3.5.5 Environmental Impacts

Similar to the brake check area at the top of the hill, both the gravel bed and mechanical arrestor system will need to provide a drainage system that can detain and treat runoff before discharging back into the stream and ultimately the North River. This would involve all runoff from the site being captured and treated in a detention pond prior to release. The key difference between the two systems will be that the gravel bed system will need

to positively drain the bottom of the gravel bed whereas the mechanical arrestor system will only need to catch and treat surface runoff.

Both systems are on the same alignment at Location 1, the key difference being the overall length and grades. The mechanical arrestor system requires less overall area and can be constructed on a downslope terminating at or near existing grades. This results in far less clearing and earthwork. Noise attenuation may need to be considered as part of the detailed design, however the mechanical arrestor system will be located further from existing houses.

The entire village of Colrain is designated as an historic district. With the mechanical arrestor system requiring less length and following the grade of the existing highway, this will result in far less impacts on the heritage and social fabric of the Town. Consideration, however may be required to minimizing, visual, noise and vibration from the truck facility.

5.3.6 Recommendation

Based on the above discussion and consideration of the impacts, it is recommended that a mechanical arrestor system at ramp location 1 be further developed as a longer-term consideration for Colrain.

5.4 Minimize Heavy Vehicles on Greenfield Road

The aim of this strategy is to have trucks take alternate routes thus reducing the number of heavy vehicles on Greenfield Road. Two improvement options have been considered:

- Establishing an alternate route for trucks
- Providing a truck turnaround facility

Figure 41 shows Greenfield Road in Blue and the Alternate Route 112 via Shelburne Falls in Red.

5.4.1 Alternate Route

Implementing a full or partial truck ban on Greenfield Road would potentially reduce or eliminate the use of this route by heavy vehicles.

This would have a positive effect on crash rates due to there being fewer heavy vehicles on Greenfield Road. If some or all of the heavy vehicles travelling north through Colrain took an alternate route, the number of vehicles losing control on the hill would decrease.

The suggested alternate route is to follow Route 2 past Greenfield Road into Shelburne Falls, then taking Route 112 north to Colrain. The alternate route adds an additional 6.6 miles and approximately 11 minutes as shown in Figure 41.

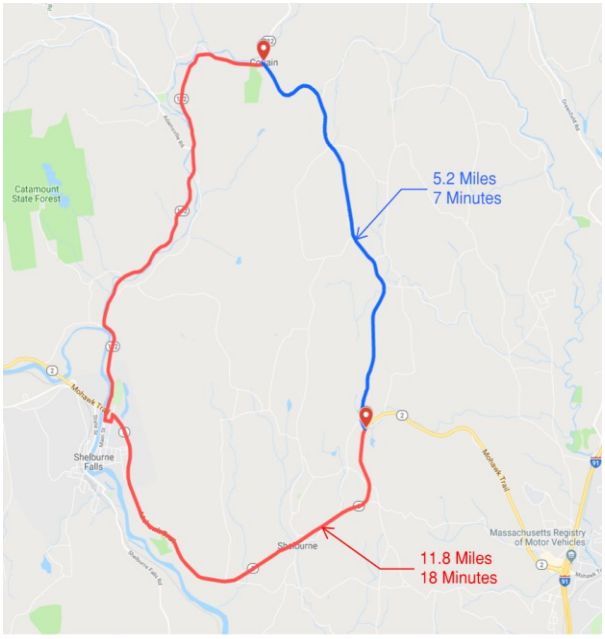


Figure 41 - Alternate Route to Colrain via Route 112 and Shelburne Falls (source: Google Maps)

The alternate route passes through the villages of Shattuckville, Griswoldville and Lyonsville before reaching Colrain. Each of these is a collection of houses and some have a reduced speed limit.

The alternate route generally has good geometry and has relatively flat grades, however there are several intersections with 90-degree turns in Shelburne Falls that would need to be checked for suitability of heavy vehicles. There are two alternative methods of applying the alternate route:

- **Alternative 1:** Heavy Vehicle Commercial Exclusion – Implement a ban on trucks over 26,000 lbs from using Greenfield Road
- **Alternative 2:** Advisory Alternate Route

The key difference between these alternatives is that one is a mandatory ban on certain types of vehicles, while the other is a suggested alternate route. Community feedback noted that most trucks that use Greenfield Road are logging and construction trucks related to power line construction as well as drivers returning to Canada.

The community meeting in April 2018 advised that liquid gas and propane trucks destined for factories along Main Rd in Colrain do not use Greenfield Road and instead access these locations using Route 112 via Shelburne Falls. This is an informal arrangement put in place by the companies delivering and receiving these goods and is supported by the Town. The most recent crashes in Colrain involved dump trucks carrying loads of construction-related materials.

It was also noted at the community meeting that as a result of recent improvements at the intersection of Greenfield Road and Route 112, the community had a perception that the widening of the intersection had made this short cut even more appealing for trucks.

Vehicle Classifications – Gross Vehicle Weight Rating

To implement a ban on certain types of vehicles, it is first important to consider which vehicles should be banned. FHWA classifies vehicles as Class 1 through 8, the most common categorization used in the fleet industry. The classes are based on a gross vehicle weight rating (GVWR), which is the maximum operating weight of the vehicle, measured in pounds. GVWR is set by the manufacturer and includes the total vehicle weight plus fluids, passengers, and cargo. Classes 1 to 3 are light vehicles or cars.

Weight classifications for classes 4 through 8 are shown in Figure 42. Vehicles involved in recent crashes were class 8. Any ban or alternate route advisory should apply to classes 7 and 8 only meaning that only articulated vehicles, heavy dump trucks and other heavy vehicles would be affected.

It is noted that Massachusetts Amendments to the MUTCD states that “Exclusions shall not apply to heavy commercial vehicles going to or coming from places upon said streets for the purpose of making deliveries of goods, materials, or merchandise to or similar collections from abutting land or buildings or adjacent streets or ways to which access cannot otherwise be gained; or to vehicles used in connection with the construction, maintenance and repair of said streets or public utilities therein; or to Federal, State, Municipal or public service corporation owned vehicles.

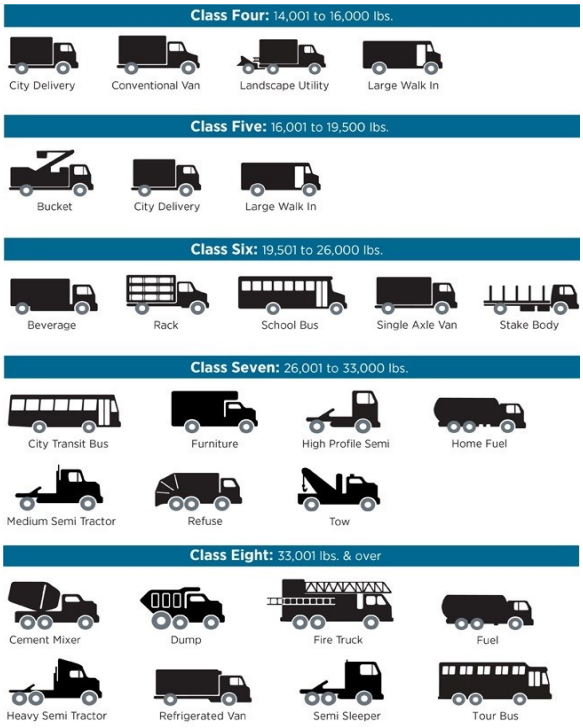


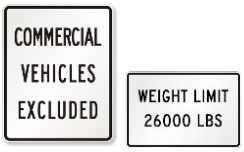
Figure 42 - FHWA Gross Vehicle Weight Rating

This would mean that school buses, emergency vehicles, farm deliveries and local delivery vehicles would not be impacted. A ban should also include vehicles that are over dimensioned or permitted including vehicles carrying dangerous goods such as liquid gas or petroleum.

5.4.1.1 Alternate Route Alternative 1 – Heavy Commercial Vehicle Exclusion

Description: This alternative would directly exclude heavy commercial vehicles over 26,000lbs from using Greenfield Road. The ban would only apply to vehicles travelling north through Colrain on Greenfield Road.

Signage required includes a Commercial Vehicles Excluded sign accompanied by a 26,000lbs weight limit supplemental sign.



R4-5 R12-1

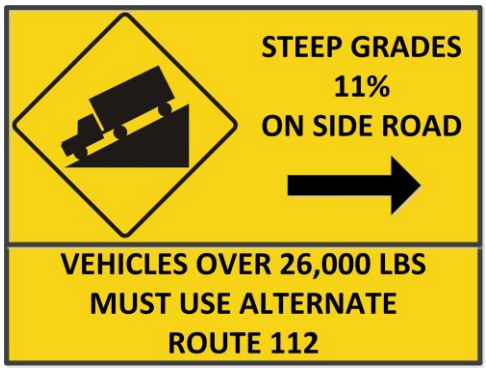
Exceptions to this requirement are set out in the Massachusetts Amendments to the MUTCD as noted above.

Advisory signs are not usually provided in advance of Heavy Commercial Vehicle Exclusion Signs, however given the unique circumstances of this section of road and the safety reasons behind the exclusion, it is recommended that consideration be given to providing non-standard warning signs on Route 2, in advance of the Greenfield Road intersection. These signs should provide advanced warning and some reasoning as to why heavy vehicles are excluded. Accordingly, signs similar to the example shown in Figure 43 are recommended rather than standard MUTCD hill warning signs.

As per normal Massachusetts practice, it would be incumbent on drivers to find their way once the alternate route has been taken.

Effectiveness: Highly effective but only if regularly enforced and obeyed by truck drivers

Figure 43 - Truck Ban Alternate Route Sign Example



Discussion: While this alternative would in theory eliminate heavy vehicles from using Greenfield Road, it also relies heavily on enforcement. The differences in distance and travel time serve as a clear incentive for truck drivers to use Greenfield Road rather than Route 112.

The alternate route more than doubles the distance and time needed to get to Colrain from Shelburne Falls. Colrain is a small community with limited police resources and relies on support from the State Police stationed at the Shelburne Falls Barracks. With limited resources available for enforcement, it is expected that some percentage of heavy vehicles would take the risk and use the shorter route along Greenfield Road.

The use of Route 112, while diverting heavy vehicles away from the Greenfield Road hill, also diverts heavy vehicle traffic into the town of Shelburne Falls. The connection to Route 112 from Route 2 diverts traffic via Mechanic Street, Hope Street and Main Street, all residential areas in Shelburne Falls as shown in **Error! Reference source not found.**.

This requires heavy vehicles to make 90-degree turns which may necessitate some improvements to ensure all heavy vehicles are able to make these turns. It is known that many heavy vehicles currently use this route without issue accessing the industrial areas currently in Griswoldville.

The diversion of heavy vehicles through this area may be met with some community opposition however as Route 112 is a numbered route, input from the communities and residents would not be required.

A Heavy Commercial Vehicle Exclusion would need to be applied for in accordance with Section 10-A9 of the Massachusetts Amendments to the MUTCD.

Due to the risk of being ignored, a heavy commercial vehicle exclusion would need to be considered as part of a package of treatments rather than a stand-alone solution.

Enforcement would most likely require State Police participation.

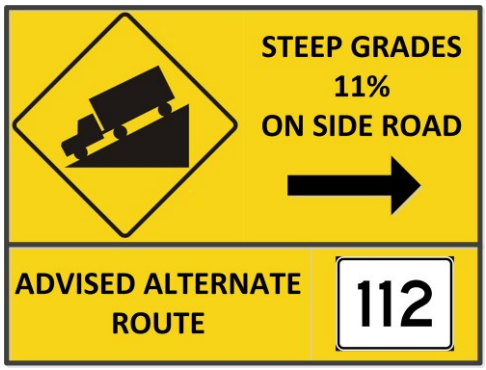
Figure 44 - Shelburne Falls connection to Route 112

5.4.1.2 Alternate Route Alternative 2 – Advisory Alternate Route

Description: An advisory alternate route would be the same as a heavy commercial vehicle exclusion however the alternate route would be advisory only and not enforceable. As such, Regulatory "Commercial Vehicles Excluded" signs would not be required

An advisory alternate route is being encouraged to limit the number of heavy commercial vehicles that need to descend the steep hill on Greenfield Road. To maximize the number of vehicles that elect to take the alternate route, it is recommended that non-standard advanced warning signs be placed on Route 2 in advance of the Greenfield Road intersection. These signs should provide sufficient information to advise truck drivers of the road conditions ahead such that an informed choice of route is able to be made prior to the intersection on Route 2. Accordingly, non-standard combination signs similar to the example shown in Figure 45 are recommended rather than standard MUTCD hill warning signs. Reinforcement signs should also be placed just north of the intersection of Greenfield Road.

Figure 45 - Advisory Alternate Route Sign Example



As per normal Massachusetts practice, it would be incumbent on drivers to find their way once the alternate route has been taken. The alternate route would only be suggested to vehicle's travelling north through Colrain on Greenfield Road.

Effectiveness: Less effective than a fully enforced truck ban due to the voluntary nature of the alternate route.

Discussion: While this alternative would not be as effective as a fully enforced truck ban, it would be an important part of an overall safety improvement system. Advisory signs on Route 2 east of the Greenfield Road intersection would serve to alert drivers well in advance of the hill, providing effective information of the road conditions ahead and offering a safe alternative prior to reaching the turn-off. This alternative, given its voluntary nature, would likely be more broadly supported by the communities of Shelburne and Colrain and would formalize existing voluntary arrangements for certain businesses. This alternative would also provide some effectiveness without the need for enforcement.

Similar to Alternative 1, the advisory alternate route would be part of a package of treatments. Alternative 2 provides strong benefits in the overall goal to improve safety on the Greenfield Road hill without the need for a sustained level of enforcement. This alternative still requires consultation but to a lesser extent than the truck ban and would be an effective part of a suite of safety improvements. Enforcement would not be required.

5.4.1.3 Comparison of Alternatives

A complete ban on trucks using Greenfield Road would require significant consultation with neighboring Shelburne Falls and many residents who live along Greenfield Road. There will also be many who feel that the alternate route is too long and would be too much of an imposition on those who are familiar with and regularly travel the hill into Colrain. A ban would require significant police enforcement resources over a sustained period to be effective. Successful implementation of a truck ban resulting in 100% compliance is unlikely to be achieved.

An advisory alternate route would be met with much less resistance and would not need enforcement, making it much easier to achieve. This alternative would realize some of the benefits and would result in additional advance warning signs being placed on Route 2.

5.4.1.4 Recommendations

Given the lack of enforcement resources, the extensive community consultation and the potential for heavy vehicles to ignore the truck ban, it is recommended that advisory signage similar to Figure 45 be erected.

5.4.2 Truck Turnaround Facility

Another supportive measure to minimize heavy vehicles on Greenfield Road is to establish a truck turnaround facility.

Description: A truck turnaround facility is a paved area that allows large vehicles to turn around and head back to Route 2 if they choose not to descend the hill into Colrain.

Benefits: Benefits are likely to be minimal given that most vehicles, once fully informed of the road conditions, would choose to descend the hill at a safe speed rather than return to Route 2 and take the alternate route.

Design Development: It can be difficult to find a place that has sufficient turning radius to allow large vehicles to turn around in a single movement. At Colrain, construction of a brake check area would provide such an opportunity, however, only Alternative 2, the truck turnout facility described in Section 5.2.1.2, would provide the required turning radius. The design concept for this facility includes an additional paved area on the western side of Greenfield Road that could be used by vehicles exiting the brake check area to head back to the south rather than continue down the hill into Colrain. This design concept would need to be checked for sight distances once detailed survey information is available.

Discussion: The brake check area Alternative 2 (Section 5.2.1.2) has not been recommended on the basis that it would cost more and create more environmental and historic impacts. The recommended alternative for the brake check area is not able to provide a truck turnaround facility. While the additional cost to construct a turn around facility would be relatively small, this facility is likely to be underutilized and is not possible unless the brake check area Alternative 2 is constructed in the future.

Recommendation: It is recommended that a truck turnaround facility not be constructed unless a larger brake check area capable of providing the required turning radius is constructed in the future and that consultation with the trucking industry indicates a level of demand.

5.5 Enable Out-of-Control Vehicles to Pass through Town Safely

This option improvement seeks to improve the road geometry in the town center such that heavy vehicles can pass through without leaving the roadway, crashing and/or overturning.

The existing geometry in the center of Colrain consists of a sharp right-hand curve with very little sight distance and little to no cross slope. This curve is currently posted at 20 mph with an existing curve radius of 175’ and is not able to safely cater for high speed out-of-control trucks. The current Complete Streets Project does not significantly improve the horizontal geometry at this intersection due to the constraints in the center of town which include several historic buildings. Potential improvements to the Complete Streets Project 25% Design are included in Section 6.

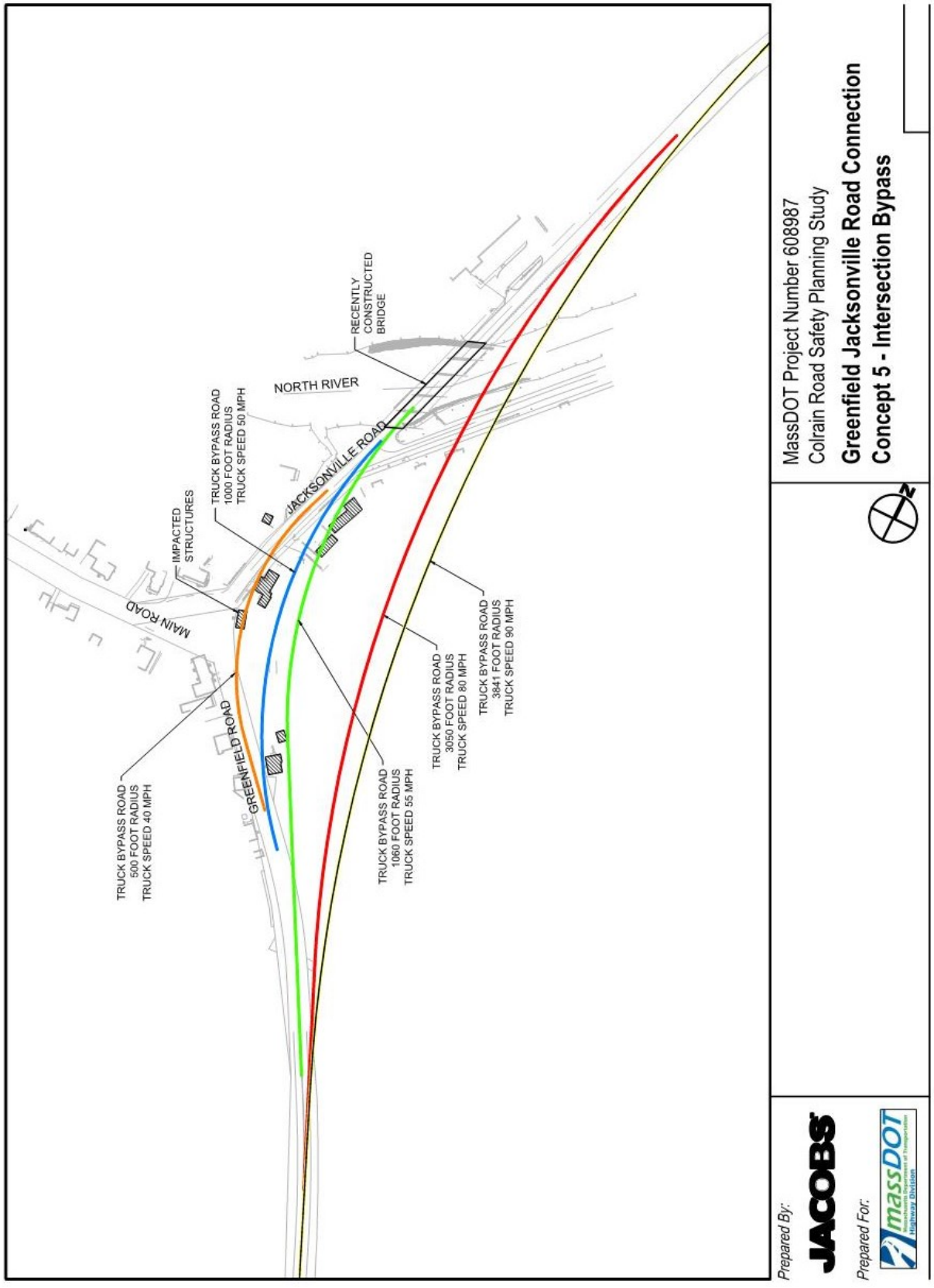
Description: This option seeks to improve the horizontal geometry in the center of town so that high speed trucks can negotiate the intersection safely. This will involve increasing the radius of the sharp curve so that the design speed better matches the speed of an out-of-control truck.

Effectiveness: Improving the horizontal geometry to increase the design speed is not seen as effective as it does not solve the problem of trucks getting out-of-control on the descent into Colrain. It simply mitigates the risk of them crashing once trucks reach the bottom of the hill at speed. Improving the geometry however does not mitigate the risk of an out-of-control truck crashing into another vehicle or pedestrians in the town. Further, none of the alternatives are able to provide the required design speed to cater for out-of-control trucks.

Design Development: Several alternatives (shown in Figure 46) have been developed at a range of design speeds, as follows.

- Alternative 1 - 40 mph 500’ radius
- Alternative 2 - 50 mph 1000’ radius
- Alternative 3 - 55 mph 1060’ radius
- Alternative 4 - 80 mph 3050’ radius
- Alternative 5 - 90 mph 3841’ radius

Figure 46 - Colrain Realignment Alternatives



Discussion: As noted in the discussion of truck escape ramps, 90 mph is the speed that is potentially reached by an out-of-control heavy vehicle. Accordingly, the design speed of the road through the town should also be 90 mph. However, given the heavily constrained town center this would be difficult to achieve. The North River Bridge Project was completed in 2018 and provides further constraints to potential geometry improvements.

The Weston & Sampson Complete Streets Design proposes to slightly decrease the curve radius, significantly increase cross slope, and marginally improve sight distance. The overall design speed is proposed to be increased to 30 mph.

As seen in Figure 46, three of the five alternatives are able to use the recently constructed replacement bridge, while two alternatives require a new bridge.

Each of the alternatives impacts several buildings with alternatives 1 to 3 impacting the church, the recently constructed DPW garage and several houses. Alternatives 4 and 5 pass behind the buildings that face Jacksonville Road but directly impact several buildings on River Road.

It is noted in Section 3.5 the Massachusetts Historical Commission MACRIS database lists the entire Colrain Center as an Historic District. The district is listed on the National Register of Historic Places with 55 historic inventory points within the district.

Each of the alternatives considered impact several structures changing the character of Colrain permanently. Only Alternative 5 is able to provide the recommended design speed for an out-of-control truck, however this alternative requires a completely new bridge on a new alignment. This alternative would also require significant earthwork, significant right-of-way acquisition, and clearing of vegetation. Given that a new bridge was just completed in 2018 at a cost of $10m, it is not recommended that a new alignment requiring a new bridge be constructed.

The maximum design speed that can be achieved by making use of the recently reconstructed bridge over the North River is 55 mph.

The maximum design speed that can be achieved without affecting any buildings in the town center is 30 mph in accordance with the Complete Streets Design carried out by Weston & Sampson.

Recommendation: None of the alignment alternatives provide acceptable outcomes. As such it is recommended that the road be maintained within its existing right-of-way boundaries and the Weston & Sampson Complete Streets Design be reviewed to see if safety for out-of-control vehicles can be improved.

6. Review of Colrain Complete Streets Project

Jacobs has reviewed the Complete Streets Project currently proposed for the town center in Colrain. The review considered safety and design issues that would improve the Complete Streets Project as well as complementing the outcomes of this Road Safety Planning Study.

The review considered several issues including road design and geometry, Complete Streets outcomes and other issues raised by the Road Safety Audit. The following documents were reviewed:

- Functional Design Report - Colrain Intersection Improvements: Main Road, Jacksonville Road (Route 112) & Greenfield Road – Weston & Sampson February 2016
- Design Exceptions Report - Colrain Intersection Improvements: Main Road, Jacksonville Road (Route 112) & Greenfield Road – Weston & Sampson August 2017
- 25% Design Plans - Colrain Intersection Improvements: Main Road, Jacksonville Road (Route 112) & Greenfield Road – Weston & Sampson June 2017
- MassDOT Comments - Colrain Intersection Improvements: Main Road, Jacksonville Road (Route 112) & Greenfield Road – MassDOT October 2017
- Road Safety Audit - Main Road/Jacksonville Road (Route 112) & Greenfield Road, Town of Colrain – McMahon Associates October 2017
- Franklin County Complete Streets Project Report – Franklin Regional Council of Governments September 2012

6.1 Road Design

6.1.1 Road Geometry

The alignment of Jacksonville Road and Greenfield Road through Colrain includes a sharp curve at the intersection with Main Road. The curve currently has a radius of 175' with no cross slope. The intersection is heavily constrained with numerous buildings adjacent to the roadway including an historic church at the intersection. The primary constraint to improving the road geometry at this location is the existing historic church located at #1 Jacksonville Road with improvements potentially requiring the removal of the steps leading to the front door of the church or worse, partial or full demolition.

Figure 47 - Colrain Church

Weston & Sampson[24] investigated three minor improvements to the curve geometry that result in differing degrees of impact on the historic church. Two alternatives increased the curve radius and a third decreased the curve radius but was able to increase sight distance by shifting the alignment further away from the church. This third alternative was recommended by Weston & Sampson on the basis that the separation between the roadway and the front door of the church is increased improving sight distance, pedestrian safety and protection for the church building.

Alternative 1 – This alternative provides a 200' curve radius shifting the centerline approximately 6' towards the church building. This requires the removal of the front steps to the church but maintains the raised walkway in front of the church as shown in Figure 47. The line of sight would be obstructed by the walkway but is improved to provide 178' of stopping sight distance. If the walkway was modified at the northern end, further improvements to the stopping sight distance may be achieved.

[24] Design Exceptions Report - Colrain Intersection Improvements: Main Road, Jacksonville Road (Route 112) & Greenfield Road – Weston & Sampson August 2017

Alternative 2 – This alternative further increases the curve radius to 250’ shifting the centerline a further 3’ towards the church building. Such a design requires removal of the front steps and the entire walkway in front of the church eliminating any access to the front door. Sight distance is improved to 192’ but would still be restricted by the corner of the church building. Any further improvements to radius or sight distance would require demolition of the church building. The edge of the road would be about 9’ and the back of the sidewalk 3’ away from the corner of the church, meaning a portion of the church property would need to be acquired. The structural stability of the church would need to be investigated with structural improvements to the church foundations likely if this alternative were constructed.

Alternative 3 – This alternative provides a curve radius of 160’ a decrease of 15’ from the existing. Stopping sight distance has been increased from the existing 141’ to 170’ by shifting the centerline away from the church building to the west and decreasing the curve radius. This alternative is the current recommended design for the Complete Streets improvements.

Jacobs Alternatives – In addition to the above three alternatives, Jacobs investigated several larger scale changes to the road geometry. These alternatives are discussed in Section 5.5 but all result in the demolition of the church or other properties within the historic town center of Colrain. The assessment concluded that the impacts to the town were considerable and that when combined with the recently constructed bridge, sufficient benefits were unable to be realized. It was therefore recommended that the curve should be improved as much as possible without impacting any buildings.

The three alignments investigated by Weston & Sampson are shown in Figure 48 and Figure 49. The additional alignment alternatives investigated by Jacobs are shown in Figure 46. A summary of the existing conditions and alternatives considered by Weston & Sampson is shown in Table 6-1.

Table 6-1 Curve Improvement Alternatives

Design Element	Existing	Alternative1	Alternative 2	Alternative 3 Proposed
Curve Radius	175’	200’	250’	160’
Curve Length	175’	201.81’	252.26’	161.45’
Stopping Sight Distance	141’	178’	192’	170’

As noted in section 2.5, many of the buildings including the church in the town center are historic. While improvements to curve radius and stopping sight distance are important a balance is required between these competing elements. While the Complete Streets design has considered many issues, it has assumed that vehicles will be complying with the posted speed limit of 20 mph.

It is known however that on several occasions, including twice during 2017, that heavy vehicles have lost control of their vehicles while descending the steep grades into Colrain. This has resulted in these vehicles being unable to safely negotiate the curve in the center of town at higher speeds. Since these vehicles have lost control before they reach the intersection, changes to increase stopping sight distance will not be effective at preventing such crashes, and changes to reduce the curve alignment may exacerbate such crashes. Effort should therefore be made to increase the radius as much as possible while maintaining the structural and historic integrity of the church building.

It is noted that Weston & Sampson Alternative 1 in some detail, however investigations concluded that the front steps and walkway to the church could not be altered due to historic concerns.

Improvement #1 – Due to the historic constraints and desire to increase the speed rating of the curve, it is recommended that the Complete Streets design be modified to increase the curve radius as much as possible without affecting the fronts steps and walkway to the church.

Figure 48 - Curve Improvement Alternative 1

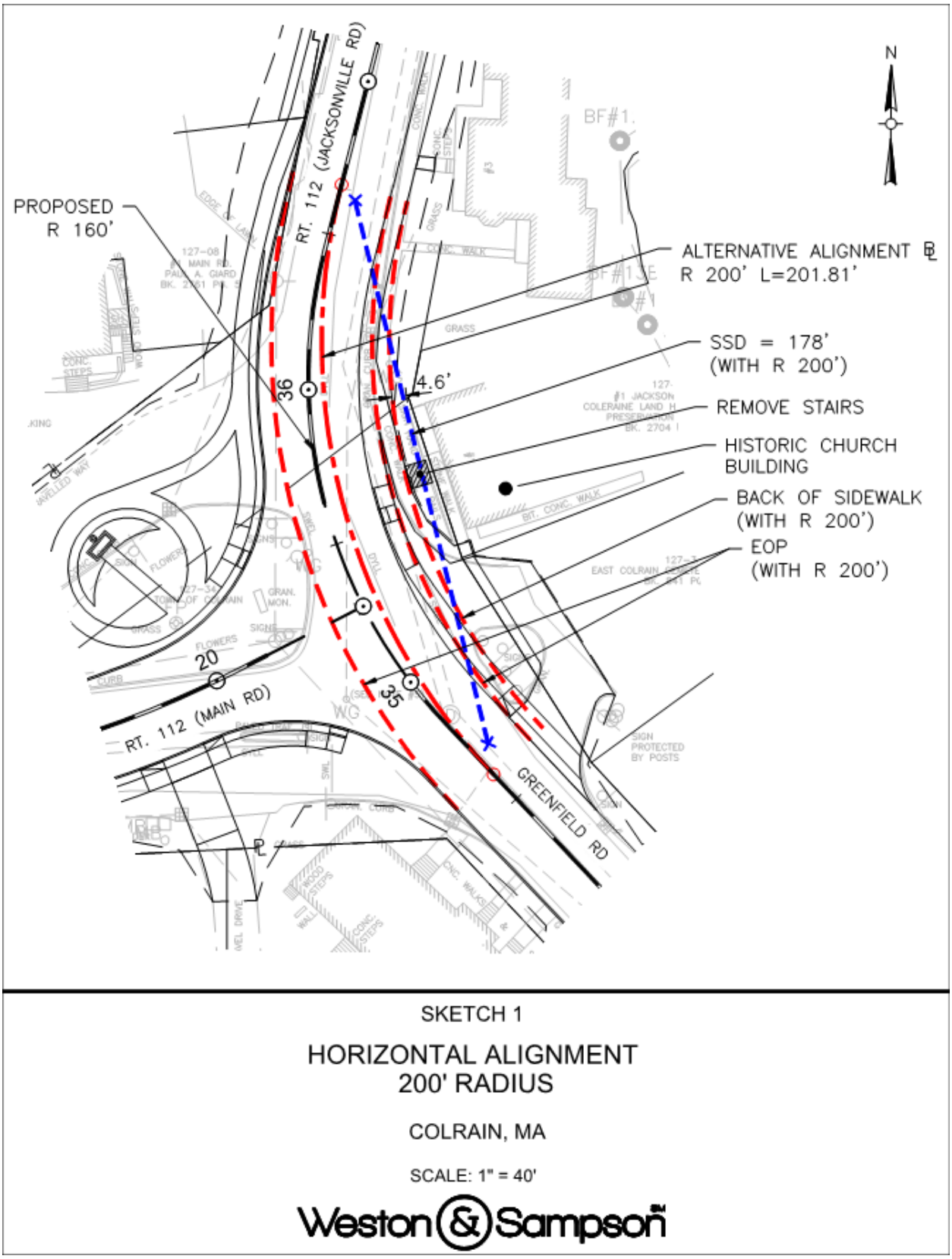
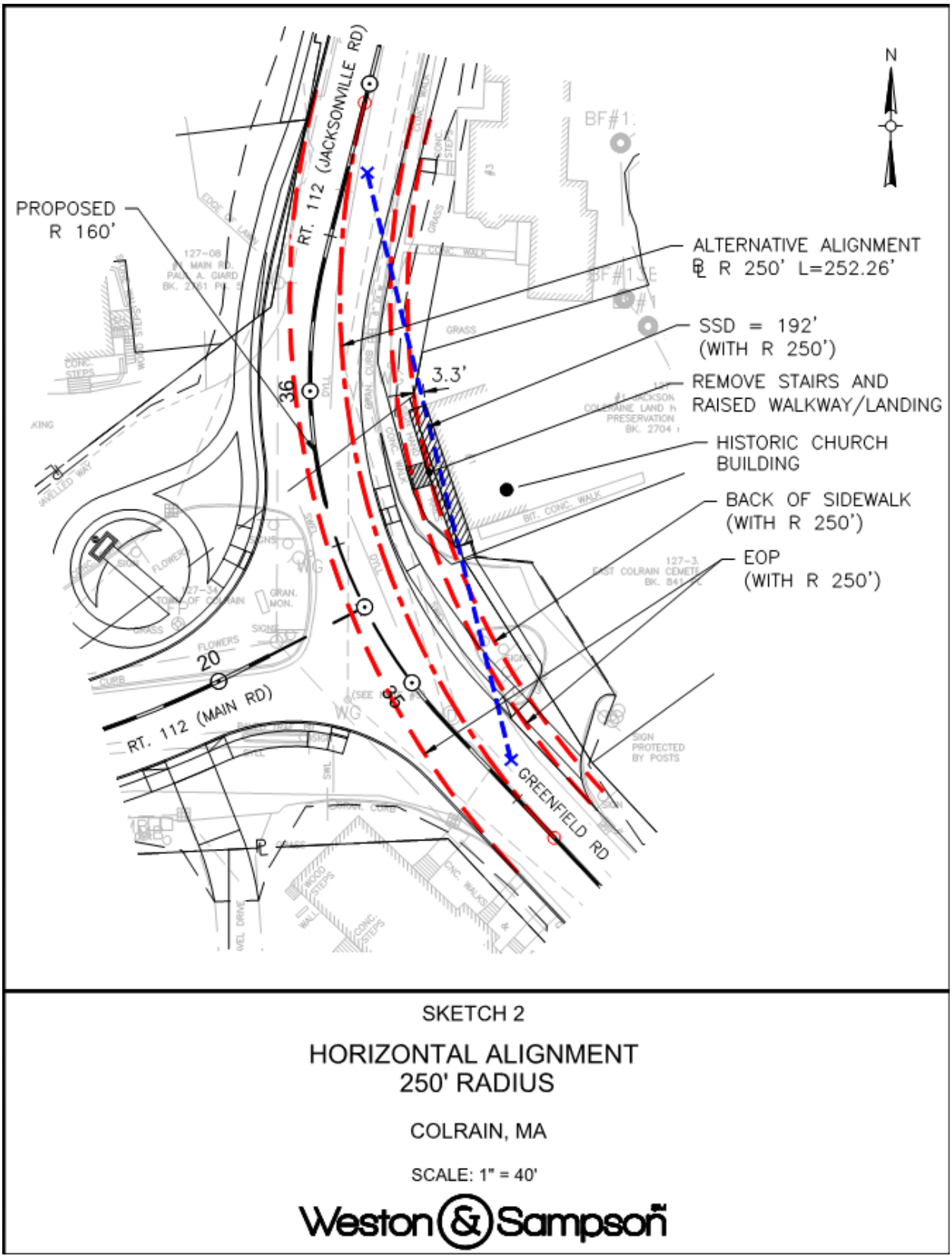


Figure 49 - Curve Improvement Alternative 2



6.1.2 Road Profile

The road profile through the town center on Greenfield Road and Jacksonville Road is relatively steep with grades of up 9% outside the church building.

With the roadworks completed for the new bridge and existing constraints including adjacent buildings, driveways and the intersection with Main Road there is little that can be done to improve the vertical profile in the center of town. The Complete Streets design proposes little change to the existing conditions. Given the constraints improvements to the road profile are not recommended.

Improvement #3 – It is recommended that pavement surface contours be reviewed on Greenfield Road and Jacksonville Road to ensure that drainage is effective at removing surface runoff from the roadway.

6.1.3 Cross Section

Both the bridge replacement project and the Complete Streets project have adopted the same typical cross section. The typical proposed roadway width provides a 32’ wide section, (11’ wide lanes, 5’ wide shoulders). Normal travel lane and shoulder cross slopes will be 2%. To maximize the design speed of the curve at the intersection, the Complete Streets design proposes a 6% Cross slope.

Improvement #4 – The break in cross slope should be located 1’ within the shoulder and not on the shoulder line as shown in the 25% design drawings.

Sidewalks of 5’ width are proposed. Granite curbing with a 6” reveal is proposed along both sides of the project roadways, as well as, a 4’ wide grass shelf in areas without sidewalks. This cross section is suitable for the proposed design and provides consistency along Main Road, Greenfield Road and Jacksonville Road.

Improvement #5 – Consideration should be given to widening the 4’ wide grass shelf to allow for the construction of additional sidewalks in the future with little need for earthworks or right of way acquisition.

6.2 Complete Streets

Complete Streets are defined as streets for everyone providing safe and accessible options for people of all ages and abilities across all travel modes including walking, biking, transit, and vehicles. Complete Streets are easy to cross, walk to places, and bicycle to school. Designing streets with these principles contributes toward the safety, health, economic viability and quality of life in a community by improving the pedestrian and vehicular environments and providing safer, more accessible and comfortable means of travel between home, school, work, recreation and retail destinations. A complete street is designed to balance safety and convenience for everyone using the road.

In 2012, the Franklin Regional Council of Governments (FRCOG) identified Colrain as one of 8 locations within Franklin County as a potential site for Complete Streets. It was chosen as it was known for having multiple types of transportation users and as well as accessibility issues for pedestrians and/or bicycles. In response to the FRCOG report, the Town of Colrain engaged Weston & Sampson to prepare a Preliminary Design for the Route 112 (Main Road and Jacksonville Road) and Greenfield Road Transportation Improvement Project (TIP).

The recently completed Colrain Bridge Replacement project also incorporated Complete Streets elements including sidewalks, sealed shoulders and pedestrian crossings. Once the Complete Streets project is constructed, these two projects combined will have provided significant improvements to pedestrian and bicycle infrastructure in the town center of Colrain.

6.2.1 Sidewalks

The bridge replacement project constructed 5’ sidewalks on both sides of Jacksonville Road from the southern limit of work to River Road. The sidewalk on the western side of Jacksonville Road continues over the new bridge providing pedestrian connection to the school.

The current 25% design for the Complete Streets project includes new sidewalks along the west side of Jacksonville Road and the southern side of Main Road. The proposed sidewalks are 5’ wide with a 3’ wide grass strip between the edge of the sidewalk and the face of the curb. The existing sidewalk along the easterly side of Route 112 (Jacksonville Road) will also be replaced with a 5’ wide sidewalk adjacent to the curb.

Pedestrian connectivity could be further improved with the following suggested improvements:

Improvement #6 – A total of 7 dwellings exist on the north side of Main Road between Jacksonville Road and the Post Office. At least one of these homes appears to be a multi-family home. Construction of a sidewalk on the northern side of Main Road would provide additional pedestrian accessibility to these areas providing greater connectivity within the town.

Improvement #7 – Currently the sidewalk is proposed to terminate at the parking lot at the US Post Office. The front of the Post Office includes parking for several cars including a handicapped space and a space for delivery trucks to collect and deliver mail.

The current design could be improved by extending the sidewalk past current parking spaces, connecting to the steps and ramp that access the Post Office terminating on the south east corner of Coburn Road providing a much safer space for pedestrians without the need to walk behind parked cars and formalizing the parking spaces at this location.

This would also provide a pedestrian connection to Coburn Road which can then be used as an off-highway pedestrian connection to the Town Hall, Police Department, Fire Department and playing fields located further to the west at the intersection of Coburn Road and Main Road.

Improvement #8 – The proposed sidewalk on the southern side of Main Road is currently proposed to terminate at Greenfield Road where it connects to a pedestrian crossing heading north across Main Road. It is recommended that the proposed sidewalk be extended south along Greenfield Road around the southwest corner of the intersection to connect with the three existing steps and paths that currently project into the roadway from # 3 Greenfield Road.

These suggested improvements are shown in Figure 55.

Figure 50 - Northern side of Main Road

Figure 51 - Parking at Colrain Post Office

Figure 52 - Pedestrian Connections #3 Greenfield Road

6.2.2 Pedestrian Crossings

Colrain previously did not have marked crosswalks, however crosswalk signs were placed indicating a crosswalk across Greenfield Road at the Church.

The bridge replacement project installed two pedestrian crosswalks south of the bridge on Jacksonville Road approximately 320’ apart. The first of these is located at the corner of River Road with the second located to the south at #3 Jacksonville Road. The Complete Streets project proposes a third crossing of Jacksonville Road at the intersection at the front of the church. This third crossing is located approximately 180’ further south of the second crossing.

Being at the apex of the curve, the new third crossing at the intersection will provide better sight distance to a pedestrian in the middle of the crosswalk than the second crossing which will be obscured by the church building for vehicles travelling north.

Improvement #9 – With three crossings within a space of 500’ it is recommended that the middle crossing which is obscured from view by the church for northbound vehicles be removed once the Complete Streets project is complete. This is a potentially unsafe location for people to cross the street due to visibility constraints.

Improvement #10 – To improve visibility and driver awareness of the crosswalks, high visibility warning devices such as a Rectangular Rapid Flashing Beacon (RRFB) could be used. This would be particularly beneficial on Jacksonville Road where approach sight distance is restricted by the church building on the inside of the tight curve at the intersection. Improving the warning and visibility of the crossing particularly when it is in use will increase the likelihood of vehicles stopping to allow pedestrians to cross safely.

RRFB's are activated manually by a push button or passively by video or infrared detection. These signs are often solar powered but can also be hardwired to power source. RRFBs use an irregular flash pattern similar to emergency flashers and have been shown to increase driver yielding behavior significantly. Sherbutt et al (2008)[25] studied the effects of RRFB's on the yielding behavior of drivers and found that installing rapid flashing beacons increased yielding behavior from 18 to 81%.

Figure 53 - Rectangular Rapid Flashing Beacon

Improvement #11 – Construction of an additional sidewalk on the northern side of Main Road was discussed in Section 6.2.1. If this sidewalk is constructed, it is recommended that an additional crosswalk be installed connecting the northern and southern sidewalks at the Post Office.

Improvement #12 – Wheelchair ramps are proposed with tactile markings at each of the crosswalks. It is noted that the proposed wheelchair ramps at the intersection do not line up directly with the path of pedestrian travel and have the potential to push people into the middle of the intersection. Tightening of the curb radii at the intersection would assist with this, however turning movements for large vehicles also needs to be considered. It is recommended that where possible, the wheelchair ramps be re-aligned to line up directly with the path of pedestrian travel on the crosswalks.

The existing and proposed crosswalks along with recommended improvements are shown in Figure 55.

6.2.3 Bicycle Facilities

Colrain previously did not have sealed shoulders or bicycle facilities, however Route 112 is part of the Franklin County Bikeway which connects western Franklin County to bike routes in Vermont using Route 112. The roadway cross section for the bridge replacement project includes 5' sealed shoulders for use by bicycles. This same cross section is proposed for use on the Complete Streets Project.

Improvement #13 – To highlight the use of Route 112 by cyclists bringing this to the attention of drivers, it is recommended that the 5' shoulders also include the bicycle symbol with warning signs also included on the approaches to town.

6.3 Parking

Currently sufficient space exists in front of the Griswold Memorial Library for parking. The area is partially paved and not marked but does provide space for two to three vehicles to park clear of traffic.

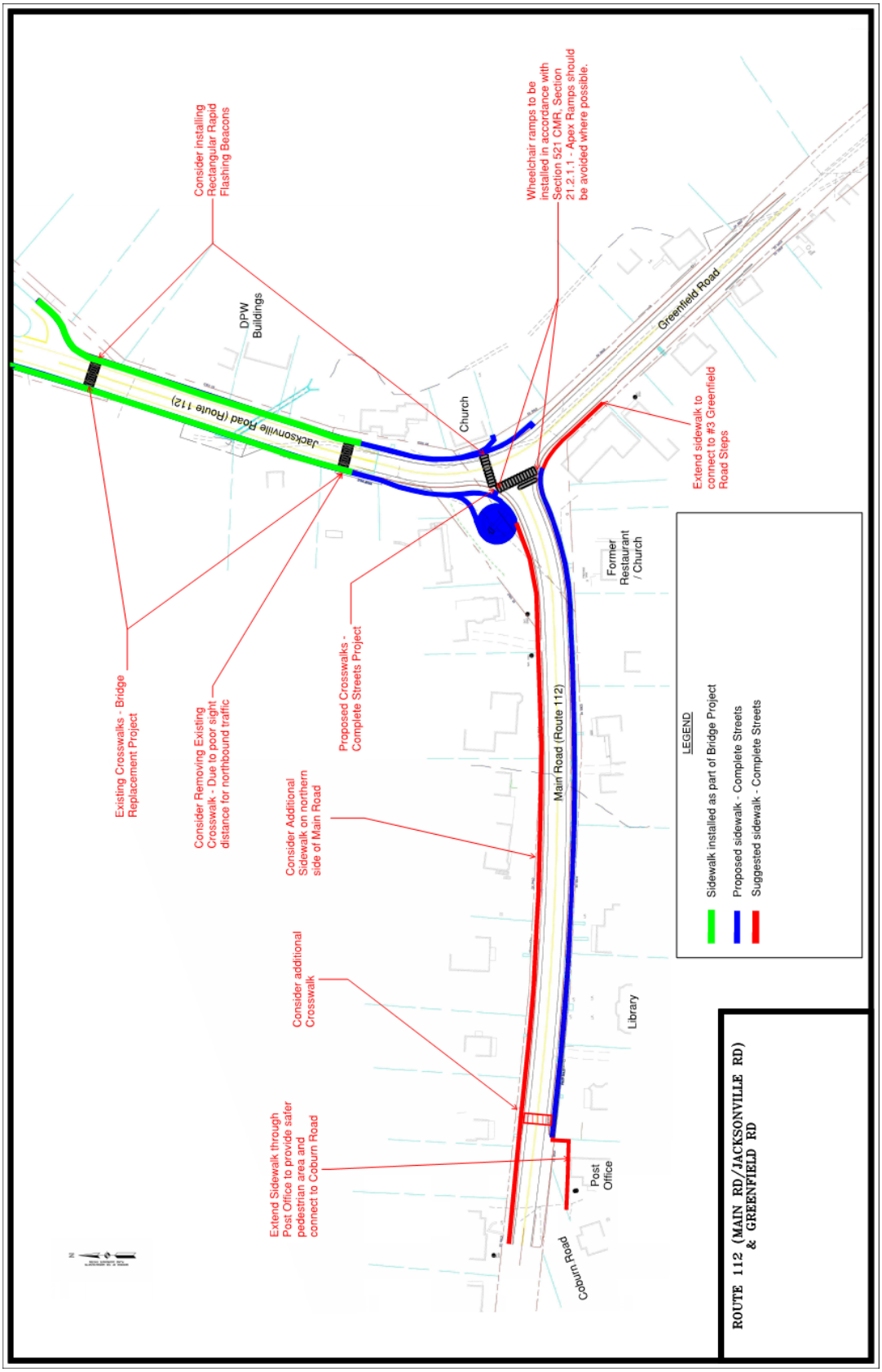
The current proposed design for the Complete Streets Project does not provide equivalent parking.

Improvement #14 - Consider replacing existing parking in front of the Griswold memorial library as part of the Complete Streets Project.

Figure 54 - Existing parking in front of Library

[25] Sherbutt, J., R. Van Houten, and S. Turner. "An Analysis of the Effects of Stutter Flash LED Beacons to Increase Yielding to Pedestrians Using Multilane Crosswalks." Presented at the Transportation Research Board Annual Meeting, Washington, DC, 2008.

Figure 55 - Complete Streets Improvements



6.4 Other issues raised by Road Safety Audit

As noted in Section 4.3.6, several potential improvements were raised in the Road Safety Audit but not considered as part of the Colrain Hill Safety Review part of this report. Several of these improvements are however discussed in the following sections.

6.4.1 Coburn Street Intersection

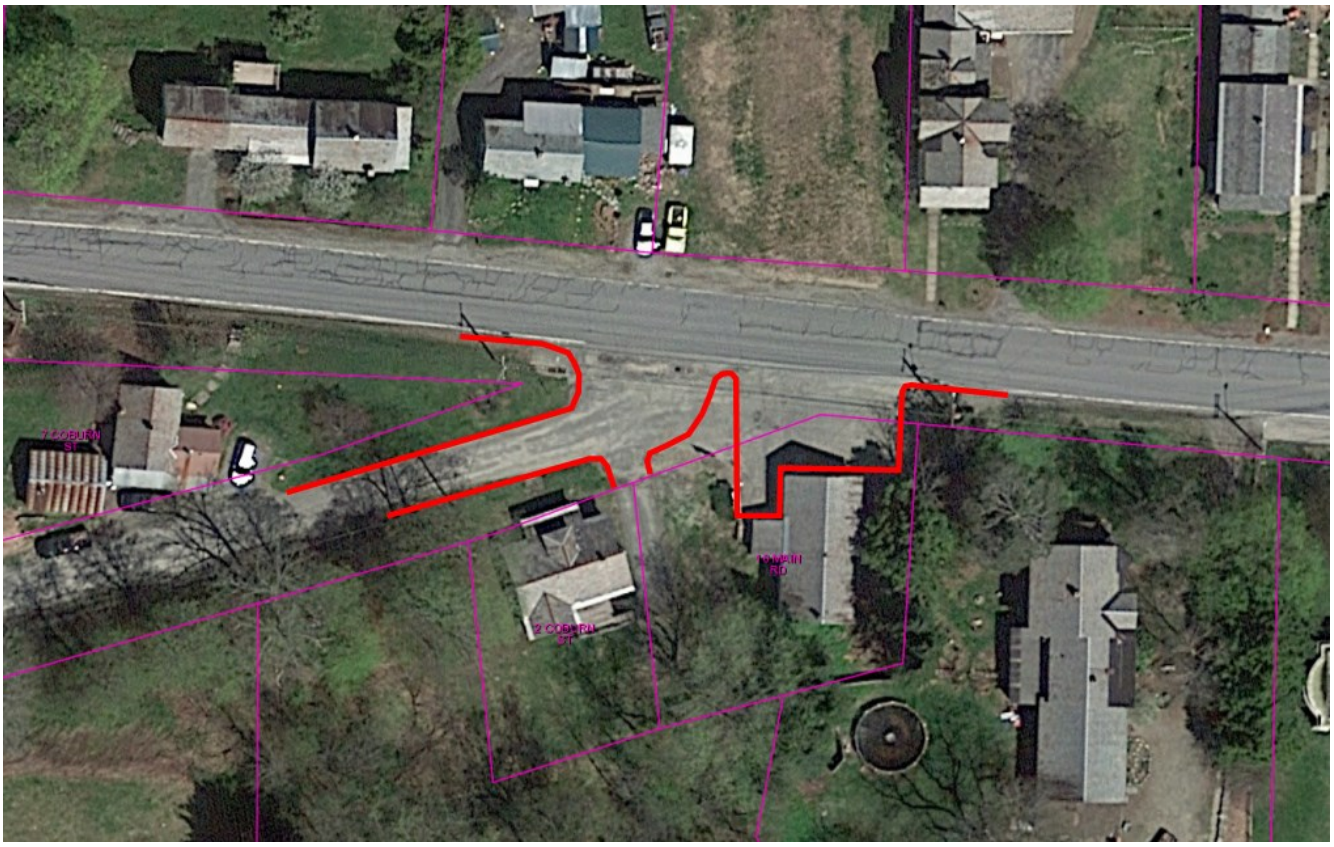
The Road Safety Audit raised the issue of traffic exiting and entering Coburn Street conflicting with vehicles exiting or entering the parking spaces at the front of the Post Office. The Road Safety Audit also noted that visibility is restricted for vehicles reversing out of parking spaces if adjacent spaces are occupied.

Currently there is little definition between what are parking spaces in front of the post office and what is the Coburn Street roadway.

Improvement #15 – To provide better definition in this area, it is recommended that curbing and pavement marking be installed to bring Coburn Street to a T-intersection with Main Road as shown in Figure 56. As discussed in Section 6.2.1, the proposed sidewalk on the southern side of Main Road should also be continued through to Coburn Street in front of the parking spaces.

Improvement #16 – Warning signs could also be placed on the Coburn Street and Main Road approaches to the post office advising of reversing vehicles however there is not a standard MUTCD sign for this purpose.

Figure 56 - Coburn Street at Colrain Post Office



6.4.2 Southbound Traffic

There are currently no signs warning southbound traffic of the sharp curve in the center of town or of the steep grades climbing to the top of Colrain Hill. The RSA recommends installation of these signs.

The MUTCD does not provide for a steep grades sign for vehicles travelling uphill unless this is associated with an overtaking lane. As such steep grade signs are not recommended for the southbound movement.

Improvement #17 – It is however recommended that the Complete Streets project include a curve warning sign for southbound traffic advising of the sharp curve and intersection. This sign should be similar to the curve warning signs used for northbound traffic and incorporate an advisory 20 mph plaque. Advance warning is not required due to the flat conditions and ability for vehicles to maintain a safe speed on the southbound approach

W1-10 (L) W13-1P

6.4.3 DPW Garage

The Town of Colrain recently constructed a new facility for the Highway Department and Department of Public Works. This includes a new garage and office facility on Jacksonville Road north of the intersection with Main Road.

Improvement #18 – With the frequent movement of trucks from this facility and the short sight distance on both approaches due to the vertical profile on the bridge and sharp curve at the church, it is recommended that truck warning signs be placed on the approaches to the DPW garage.

W11-10

6.4.4 Lighting

The center of Colrain currently has several light fixtures mounted on utility poles. These are located as follows:

- 1 light on Main Road at the Post Office
- 1 light on Main Road at the Public Library
- 1 light at each end of the traffic island on Main Road at the intersection in the center of town.
- 1 light at the rear of the church at the intersection in the center of town
- 2 lights on the northbound approach to the intersection on Greenfield Road
- 1 lights on the southbound approach to the intersection on Jacksonville Road
- 1 light at the intersection with River Road
- 1 light at the entrance to the school parking lot

The Road Safety Audit recommended evaluation and consideration be given to improving lighting around the intersection in the center of town.

A review of the crash statistics shows that there were no crashes that could be attributed to poor lighting. Given that there is a total of nine street lights within the study area and there are no attributable accidents to a lack of lighting, improvements to lighting are not recommended at this time.

6.4.5 School Bus

The Road Safety Audit recommends relocating the existing bus stop to a more visible location near the intersection. It is not apparent where the bus currently stops, however given the sight distance and grade issues on Greenfield Road, it is not recommended that the bus pick up students at the intersection.

Improvement # 19 – It is however recommended that the Town of Colrain review the current bus routes and relocate the bus stop to a location where it is safe for a bus to stop. It is possible that a bus pullout area could be constructed near the library as part of the Complete Streets Project. This could be incorporated into the recommended parking improvements at the library and would create a safe area for students and the bus away from the intersection. An alternative site for a school bus stop would be at the landscaped area in the center of town as shown in Figure 58. The suitability, of these or any other site is dependent on current and future bus routes from Colrain to the Mohawk Regional Schools and needs to be assessed by the Town of Colrain, Mohawk Regional Schools and the bus transportation company.

6.4.6 School Speed Zones

The Road Safety Audit recommended that Flashing Beacons be installed on the school speed zones.

The Colrain Elementary School does not have a school speed zone.

The school however does lie within a permanent 20 mph speed zone that applies to the entire center of town. Flashing Beacons provide reinforcement to the speed limit sign and could be activated by a speed radar gun to advise drivers when they are approaching too fast.

At Colrain, the 20 mph zone includes a school, a sharp curve and an intersection. The sharp curve also limits sight distance to pedestrian crossings. It is therefore considered more appropriate to alert drivers of their speed to increase the level of compliance with the speed limit.

Figure 57 - Speed Feedback Sign

Speed Feedback signs as discussed in Section 5.2.3 are an excellent method of informing drivers of their speed and increasing compliance with speed limits. As feedback signs alert drivers to their actual speed, the level of compliance is likely to be higher than a flashing beacon.

Improvement #20 – Given the number of issues in the town center including school, historic district, intersection, pedestrian crosswalks, tight radius curve and steep grades it is considered warranted that speed feedback signs be installed. This will increase the level of compliance with the speed limit, creating a safer zone for pedestrians, cyclists and motorists.

These signs should be installed on the southern, northern and western approaches to the 20mph speed zone on the center of Colrain.

6.4.7 Landscaping / gateway to town

The Road Safety Audit recommends the creation of an “entrance” to town to highlight to drivers that they have now entered with the aim of encouraging lower speeds on the northbound approach on Greenfield Road. The creation of a gateway would provide a visual trigger that vehicles are now within the village but is not guaranteed to evoke lower speeds. As such this is an initiative that should be further investigated by the Town.

Improvement #21 – If a Truck Escape Ramp is constructed as recommended in Section 5.3.6, the ramp would leave a triangle of land that could be utilized by the Town of Colrain for such purposes as shown in Figure 58. This is an issue that the Town should consider further if suitable land becomes available in the future.

6.4.8 Church Parking Lot

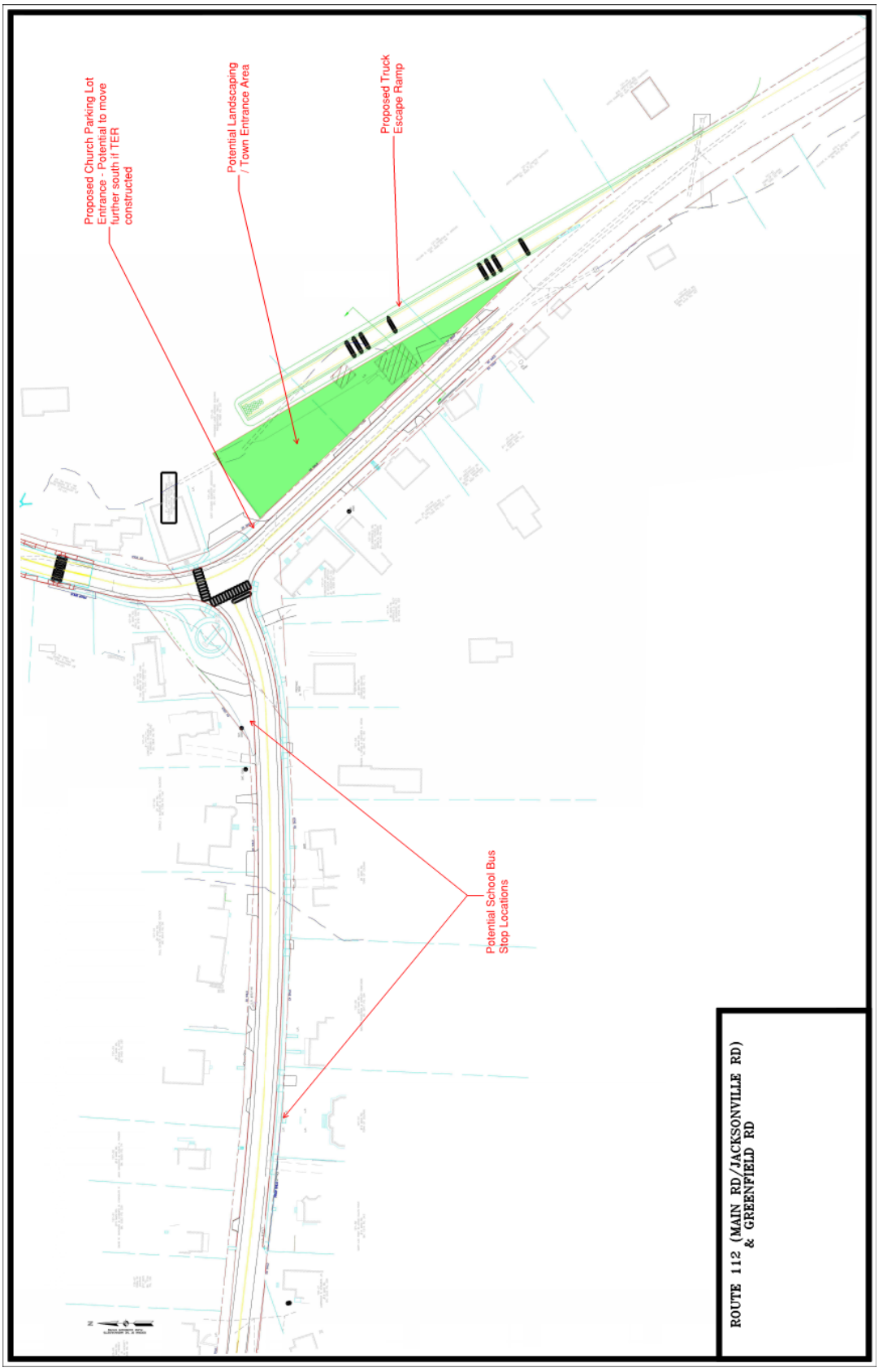
Visibility to the north for vehicles exiting the Church parking lot is heavily restricted making left turns out of the parking lot difficult. The Road Safety Audit recommends banning left turns.

The parking lot currently has two exit locations. The proposed Complete Streets concept plans show the northern exit being closed with exit/entry being restricted to the more suitable southern entrance. The entrance has been relocated as far south as possible without the need for an easement onto neighboring land. Should the Truck Escape Ramp be constructed as recommended in Section 5.3.6, the ramp would leave a triangle of land that could be utilized by the Town of Colrain to relocate the church parking lot entrance further to the south increasing sight distance for vehicles exiting to the south.

If right turn only exits are implemented, vehicles would need to travel north and turn around at the school or at River Road which would create additional conflict points.

Improvement #22 – It is recommended that the church parking lot entrance be maintained in its current location. The parking lot entrance could then be relocated further to the south if a Truck Escape Ramp is constructed in the future as shown in Figure 58.

Figure 58 - Church Parking Lot Entrance, Bus Stops & Landscaping



7. Conclusions and Recommendations

Following a comprehensive review, it is recommended that a staged approach to improving safety for trucks on Colrain Hill be adopted. Recommendations have been set out in order of short, medium and long-term improvements. Short-term improvements should be implemented straight away, followed by those improvements that will require further design and investigation, and those that will likely require design, investigation and approvals. Funding will also be required for each improvement. Those improvements that cost the least can be considered in the short term, while those that are more expensive are considered longer-term improvements as demonstrated by Table 7-1.

Table 7-1 Short, Medium & Long-Term Projects

Time Frame		Costs	
Short	<1 Year	Low	<$10,000
Medium	1 – 3 Years	Medium	$10,001 - $50,000
Long	>3 Years	High	>$50,000

The following sections provide an overview of recommendations followed by a more detailed summary of recommendations in Summary of Recommendations 7.5.

7.1 Data Gathering

To assist in determining if safety related improvements have been successful, it is important to establish some baseline data. Crash statistics are an important set of data, however many of the recommended treatments are aimed at either diverting trucks onto alternate routes or having trucks descend the hill in a safe manner.

It is therefore recommended that classification counts be carried out on Greenfield Road and alternate routes to establish a baseline of heavy vehicle volumes. The classification counts should also include speed survey information to again set a baseline of speed behavior on the hill section descending into Colrain. As improvements are made to Greenfield Road speed surveys should again be carried out to determine what effects the improvements have had on driver behavior.

ITS technology could be utilized to establish a permanent data logger on Greenfield Road to provide real time feedback on road safety upgrades. This could be as simple as a data logger attached to a speed feedback sign which can be accessed remotely to provide speed data for heavy vehicles. This data will assist in determining whether additional phases or improvements are warranted and therefore implemented in the longer term.

7.2 Short Term

In the short term, consideration should be given to improving the base level signage scheme. Improvements should improve advance warning and bring more attention to the town center at the bottom of the hill, along with reminders of road and speed conditions ahead. This should be complemented by overall improvements to sign visibility, installation of chevron markers, and improved delineation and pavement marking. Baseline data should be gathered to better understand heavy vehicle speed behavior on Greenfield Road and to fully understand volumes of heavy vehicles on Greenfield road and alternate routes. This will assist in the planning of each phase of improvements and to understand the impact that these improvements have had on driver behavior.

7.3 Medium Term

In the medium term, consideration should be given to installing an overhead gantry sign 2 miles from the town center or approximately 1 mile from the top of the hill. Flashing warning beacons should be installed that are activated by oncoming heavy vehicles as well as speed feedback signs to provide information to truck drivers on their speed as they approach and descend the hill. Consideration should also be given to including dynamic messaging on the overhead gantry with warnings and information targeted specifically at trucks as well as installing advisory alternative route signs following a period of appropriate consultation.

Improvements in the medium term should also include completion of the Complete Streets project. This includes recommendations made in this report to be included in that Project, such as speed feedback signs on the approaches to town, improvements to road geometry and improvements to pedestrian and bicycle facilities.

7.4 Long Term

Long term improvements will require more significant survey, design, approvals and funding. Recommended longer term improvements include the construction of a brake check area at the top of the hill and a truck escape ramp using a mechanical arrestor system on the edge of town.

7.5 Summary of Recommendations

The tables below provide a summary of recommendations made throughout the report. Each improvement considered has been categorized as short-term, mid-term, or long-term based on the definitions shown above and include the potential safety payoff, as well as likely timeframe and cost. The safety payoff is a qualitative judgment of the effectiveness of the improvement.

Each recommendation includes a statement of what agency would be responsible for implementing it. “Complete Streets Project” refers to improvements that are assumed to be included or could reasonably be accommodated as part of the Complete Streets Project.

Cost indications are based on broad order of magnitude estimates for the purposes of categorizing and are not based on detailed estimates, designs or quantity take-offs.

7.6 Responsibility

Greenfield Road is under the jurisdiction of the Town of Colrain and as such the Town will be responsible for implementing all recommended improvements. Subject to project eligibility, approval and support from the community, the Town of Colrain may wish to apply for support from MassDOT in the form of funding and project oversight so that certain recommendations can be implemented in the medium and longer term.

7.6.1 Inform Trucks about Road Conditions

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Improve Signage	Install combination advance warning signs at 2 miles and 1 mile	Medium	Short	Low	Town of Colrain
Improve Signage	Upgrade Hill Warning signs – all should state % grades	Medium	Short	Low	Town of Colrain
Improve Signage	Add curve/intersection warning sign at 3000' – all signs should state 20mph and trucks use lower gear	Medium	Short	Low	Town of Colrain
Speed Limits	Add speed limit ahead signs at 2000' ahead, 1000' ahead and 5000' ahead of 30 mph speed reduction	Medium	Short	Low	Town of Colrain
Improve Visibility	Replace all signage on hill with new signs that meet-retro reflectivity standards	Low	Short	Low	Town of Colrain
Improve Visibility	Upgrade all truck warning signs to 7' above pavement level to improve visibility	Low	Short	Low	Town of Colrain
Improve Delineation	Upgrade all pavement markings on the hill section to meet current retro-reflectivity standards	Medium	Short	Low	Town of Colrain
Improve Delineation	Install recessed retro-reflective pavement markers on hill section and approaches	Medium	Short	Low	Town of Colrain
Improve Delineation	Install object markers on all guardrail installations on the hill section and approaches	Medium	Short	Low	Town of Colrain
Improve Delineation	Install chevron curve markers on curves 3 & 4 to improve visibility and highlight curves	Medium	Short	Low	Town of Colrain
Overt / Active Signs	Install overhead sign gantry at 2 miles – place combination messaging on overhead gantry	High	Medium	Medium	Town of Colrain
Overt / Active Signs	Install active warning sign beacons on advance warning signs at 2 miles and 1 mile	High	Medium	Medium	Town of Colrain
Overt / Active Signs	Install speed feedback signs that target trucks on all speed limit signs and truck speed advisory signs	High	Medium	Medium	Town of Colrain
Overt / Active Signs	Replace advance warning sign at 1 mile (top of hill) with dynamic overhead warning sign that advises trucks of speed at top of hill	High	Medium	Medium	Town of Colrain

7.6.2 Require Heavy Vehicles to Descend at a Safe Speed

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Brake Check Area	Construct brake check area – Concept 1	High	Long	High	Town of Colrain
Brake Check Area	Install driver information sign at brake check area	High	Long	High	Town of Colrain
Brake Check Area	Install “Brake Check Area Ahead” signs at 1 mile, ½ mile and entrance	High	Long	High	Town of Colrain
Speed Feedback Signs	Install speed feedback signs that target trucks on all speed limit signs and truck speed advisory signs.	High	Medium	Medium	Town of Colrain

7.6.3 Prevent Out-of-Control Vehicles from Entering Town Center

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Truck Escape Ramp	Construct a mechanical arrestor – truck escape ramp at location 1 similar to the Dragnet® system installed at Avon, CT	High	Long	High	Town of Colrain
Truck Escape Ramp	Install pavement heating system to keep facility snow and ice-free during winter	High	Long	High	Town of Colrain
Truck Escape Ramp	Install associated truck escape ramp ahead signage	High	Long	High	Town of Colrain

7.6.4 Minimize Heavy Vehicles from Using Greenfield Road

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Alternative Route	Install advisory alternate route signs on Route 2	Low	Medium	Low	MassDOT

7.6.5 Enable Out-of-Control Vehicles to Pass through Town Safely

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Horizontal Geometry	Increase radius of curve in town center to maximum possible without impacting church steps or walkway	Low	Medium	High	Complete Streets Project
Cross Section	Introduce cross slope at curve in town center to increase design speed rating of curve	Medium	Long	High	Complete Streets Project

7.6.6 Other Recommended Safety Improvements

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Road Design - Profile	Review design pavement surface contours on Greenfield Road and Jacksonville Road to ensure that drainage is effective at removing surface runoff from the roadway.	Medium	Medium	Medium	Complete Streets Project
Road Design – Cross Section	Move the break in cross slope to be located 1’ within the shoulder and not on the shoulder line.	Low	Medium	Low	Complete Streets Project
Road Design – Cross Section	Widen the 4’ wide grass shelf to allow for easier construction of additional sidewalks in the future.	Low	Medium	Low	Complete Streets Project
Complete Streets - Sidewalks	Construct a sidewalk on the northern side of Main Road.	Low	Long	High	Complete Streets Project
Complete Streets - Sidewalks	Extend the sidewalk past the Post Office, terminating on the south east corner of Coburn Road.	High	Medium	Medium	Complete Streets Project
Complete Streets - Sidewalks	Extend the sidewalk to connect with the three sets of steps that project into the roadway from # 3 Greenfield Road.	Medium	Medium	Medium	Complete Streets Project
Complete Streets - Crosswalks	Remove the middle crosswalk on Jacksonville Road due to close spacing and sight distance.	High	Medium	Low	Complete Streets Project
Complete Streets - Crosswalks	Install Rectangular Rapid Flashing Beacon (RRFB) at the crosswalks on Jacksonville Road.	High	Medium	Medium	Complete Streets Project
Complete Streets - Crosswalks	If a sidewalk is constructed on the northern side of Main Road, install an additional crosswalk at the Post Office.	Medium	Long	Low	Complete Streets Project
Complete Streets - Crosswalks	Realign wheelchair ramps to line up directly with the path of pedestrian travel on the crosswalks.	Low	Medium	Low	Complete Streets Project
Complete Streets - Bicycles	Install bicycle symbols in the 5’ shoulders with warning signs also included on the approaches to town.	Medium	Medium	Low	Complete Streets Project
Complete Streets - Parking	Consider replacing existing parking in front of the Griswold memorial library as part of the Complete Streets Project.	Low	Medium	Low	Complete Streets Project
Other Issues – Post Office	Install curbing and pavement marking to bring Coburn Street to a T-intersection with Main Road.	Medium	Medium	Medium	Complete Streets Project
Other Issues – Post Office	Consider installing non-standard signs on the Coburn Street and Main Road approaches to the Post office advising of reversing vehicles.	Low	Medium	Low	Complete Streets Project

Category	Potential Safety Enhancement	Safety Payoff	Timeframe	Cost	Responsibility
Other Issues – Southbound Traffic	Install a curve warning sign for southbound traffic advising of the sharp curve and intersection.	Low	Medium	Low	Complete Streets Project
Other Issues – DPW Garage	Install truck warning signs on the approaches to the DPW garage.	Medium	Medium	Low	Complete Streets Project
Other Issues – School Buses	Relocate the existing school bus stop in consultation with the School District and Town. Suggested sites include the Library and memorial.	Medium	Medium	Medium	Complete Streets Project
Other Issues – Speed Feedback Signs	Install speed feedback signs on the southern, northern and western approaches to the 20mph speed zone on the center of Colrain.	High	Medium	High	Complete Streets Project
Other Issues – Landscaping	Utilize area adjacent to potential Truck Escape Ramp to landscape and create a southern gateway to the town.	Low	Long	Medium	Town of Colrain
Other Issues – Church Parking Lot	It is recommended that the church parking lot entrance be maintained in its proposed location or moved further south if a Truck Escape Ramp is constructed in the future.	Low	Long	Medium	Town of Colrain

Appendix A. Road Safety Audit – McMahon & Associates

ROAD SAFETY AUDIT

Main Road/Jacksonville Road (Route 112) & Greenfield Road

Town of Colrain

October 2017

Prepared For:
MassDOT

Prepared By:
McMahon Associates, Inc.
350 Myles Standish Blvd. Suite 103
Taunton, MA 02780

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Background

The Federal Highway Administration (FHWA) defines a Road Safety Audit (RSA) as the formal safety examination of an existing or future road or intersection by an independent, multidisciplinary team. The purpose of an RSA is to identify potential safety issues and possible opportunities for safety improvements considering all roadway users. This RSA evaluates the unsignalized intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112) in Colrain, MA, as shown in Figures 1 and 2.

A safety audit was scheduled for this high crash intersection at the request of MassDOT as part of an ongoing intersection improvement project at this location. The intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112) was identified as a high risk intersection due to its history of truck-related crashes, including one crash in August 2017 that resulted in a fatality.

A key objective of the RSA is to identify both short-term and long-term safety improvements that can be made at the subject intersection and incorporated in potential improvements of this intersection.

Project Data

An RSA was completed for the intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112) in the Town of Colrain on September 14, 2017. As shown below in Table 1, the audit team consisted of a multidisciplinary team with representatives from state, regional and local agencies providing expertise in the engineering, planning, maintenance and emergency response fields. Contact information for the RSA attendees is provided in Appendix A of this report.

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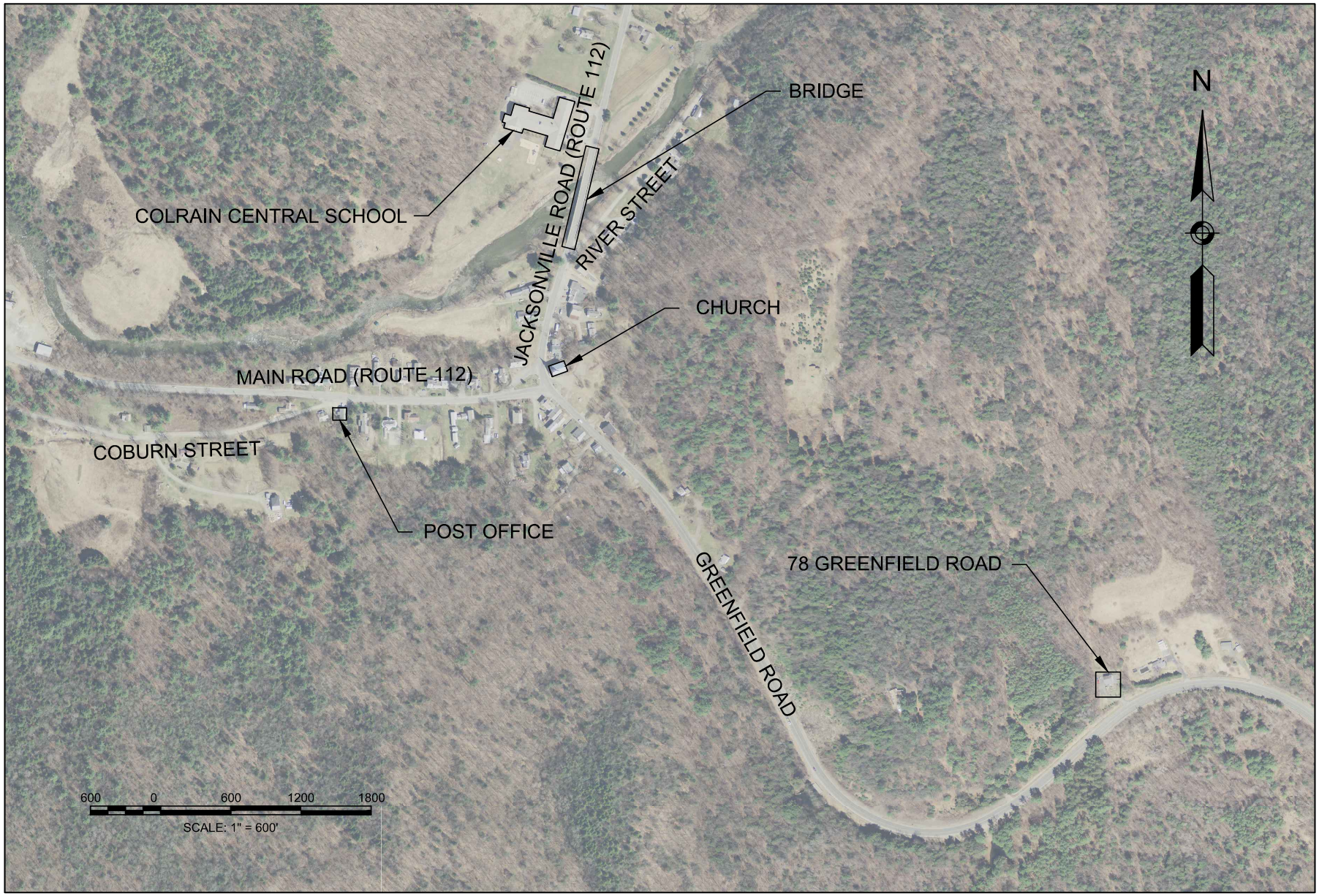
McMAHON
TRANSPORTATION ENGINEERS & PLANNERS

FIGURE 1
SITE LOCATION MAP – INTERSECTION DETAIL
ROAD SAFETY AUDIT
COLRAIN, MA

J:\Analysis\Mass DOT\MassDOT 81246 Statewide - Road Safety Audits Program\2200 Assignment 22 - Colrain (Route 112-Greenfield Rd)\Meetings\Graphics\McMahon - RSA Location_Colrain.dwg 10/20/17



McMAHON
TRANSPORTATION ENGINEERS & PLANNERS

FIGURE 2
SITE LOCATION MAP – EXPANDED AREA
ROAD SAFETY AUDIT
COLRAIN, MA

Table 1. Participating Audit Team Members

Audit Team Member	Agency/Affiliation
Alan Nafis	Weston & Sampson
Michelle Deng	MassDOT Traffic Safety
Elsa Chan	MassDOT Traffic Safety
Laurie Scarbrough	Franklin Regional Council of Governments (FRCOG)
Mark Moore	MassDOT District 1
Pat Tierney	MassDOT District 1
Francisca Heming	MassDOT District 1
Sonja Gray	MassDOT District 1
Kevin Fox	Town of Colrain Town Administrator
Mark Thibodeau	Town of Colrain Select Board
Nick Anzuoni	Town of Colrain Fire Department
Eileen Sauvageau	Town of Colrain Select Board
Scott Sullivan	Town of Colrain Highway Department
Jonathan Bates	Massachusetts State Police
Daniel Gale	Massachusetts State Police
Chris Lannon	Town of Colrain Police Department
Lisa Slonus	Weston & Sampson
Paul Furgal	McMahon Associates
Phil Viveiros	McMahon Associates

Within the email invitation sent on September 7, 2017 to each participant in the RSA, background material was provided. This information included a collision diagram and MassDOT crash data summary for the intersection. Additionally, information for the intersection was also distributed to audit participants prior to the meeting. During the RSA meeting, these materials were reviewed as a group prior to the field visit to the intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112). During the RSA field visit, various safety issues were observed and identified. Following the RSA field visit, the team returned to discuss additional concerns and potential solutions for the existing safety issues.

Project Location and Description

Study Area Roadways

As shown in Figure 1, Main Road (Route 112) is a two-way, two-lane roadway that generally extends in the east-west direction through the Town of Colrain. Main Road (Route 112) is classified as a rural major collector, under MassDOT jurisdiction. Main Road (Route 112) is primarily abutted by residential land uses adjacent to the study area, as well as the Town post office and library. There are neither sidewalks nor dedicated bicycle amenities provided on either side of the roadway around the intersection. The posted speed limit on Main Road (Route 112) is 20 miles per hour (mph) within the project area, but increases to 30 mph west of the intersection, and then to 40 mph west of Coburn Street.

Jacksonville Road (Route 112) is a two-way, two-lane roadway that extends in the north-south direction through the Town of Colrain. Jacksonville Road (Route 112) is classified as a rural minor arterial under Town jurisdiction north of the study area intersection. Jacksonville Road (Route 112) is primarily abutted by residential land uses adjacent to the study area, as well as the Colrain Central School. A sidewalk is present on the east side of Jacksonville Road (Route 112) for approximately 200 feet north of the study area intersection. No dedicated bicycle amenities are provided on Jacksonville Road (Route 112) within the study area intersection. The posted speed limit on Jacksonville Road (Route 112) is 20 miles per hour (mph) in the vicinity of the study area intersection

Greenfield Road is generally a two-way, two-lane roadway that extends in the north-south direction through the Town of Colrain under Town jurisdiction. Greenfield Road is classified as a rural minor arterial to the south of its intersection with Main Road and Jacksonville Road, and there is a downgrade in slope as Greenfield Road approaches the intersection from the south. Neither sidewalks nor dedicated bicycle amenities are present on Greenfield Road at the study area intersection. The posted speed limit on Greenfield Road is 20 miles per hour (mph) in the vicinity of the study area intersection, but increases to 35 mph heading south from the intersection.

Study Area Intersection

The unsignalized intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112) is located between Foundry Village Road to the west and West Layden Road to the east. At the study area intersection, the eastbound approach on Main Road (Route 112) provides a single general purpose lane under stop control. The northbound approach on Greenfield Road at the study area intersection also consists of a single general purpose lane. The southbound approach on Jacksonville Road (Route 112) consists of a single general purpose lane that allows for right turns and through movements, as well as a one-way roadway, identified in this report as the frontage road, that drivers are currently using for right turns onto Main Road (Route 112). Although no painted crosswalks or pedestrian ramps currently exist at the intersection, signage indicates that pedestrian traffic across the northern and southern legs of the intersection may be present. In addition, pedestrian amenities across Main Road (Route 112) currently do not exist within the study area.

Crash Data

Crash data was received from the Town of Colrain Police Department for the years 2010-2017. Based on this data, there were a total of 12 crashes reported from the beginning of 2010 through the end of 2017 at the intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112). Of the 12 crashes that occurred in the time period reviewed, seven crashes were single vehicle crashes, two crashes were rear-end collisions, and two crashes were sideswipe collisions. A total of four crashes were due to vehicles traveling too fast, and three were due to poor roadway conditions. Overall, one crash resulted in a fatality, two crashes resulted in personal injury, and the remaining nine resulted in property damage only. In addition, at least one large truck crash has occurred within the study area in 2017.

A detailed crash diagram of the study area intersection is provided in Appendix B.

Road Safety Audit Observations and Potential Improvements

During the RSA meeting prior to the field visit, a brief introduction of the RSA process and a summary of the crash information were presented to the audit participants. Following this brief presentation, the members of the audit team were asked to discuss the existing issues that may affect safety at the intersection of Main Road (Route 112) at Greenfield Road and Jacksonville Road (Route 112). The audit team then visited the study area intersection as a group, at which time observations of various safety concerns and deficiencies were identified and documented. Provided below is a list of the safety concerns that were identified during the RSA for the intersections and the potential enhancements identified during the RSA.

Safety Issue #1: Roadway Geometry

Observations:

View of the varying grades within the study area intersection

Audit team members noted that the current roadway curve radii at the intersection results in limited line of sight for drivers on Greenfield Road. Due to the grades present on Greenfield Road, participants indicated that drivers are traveling at high speeds approaching the intersection, which has been a contributing factor to the crashes at this intersection. Members of the audit team also noted that the poor grade transitions that exist at the intersection may be difficult to see in lower lighting. The radius of Greenfield Road at the intersection of Jacksonville Road (Route 112) is also of concern for its sharpness; some members of the audit team felt that this curve might not be compliant with current design standards. Of particular concern is the church property on this curve. Due to the position of the church relative to the edge of roadway, southbound drivers have poor sight lines onto Greenfield Road, and northbound drivers have poor sight lines onto Jacksonville Road. Drivers in either direction have had a hard time seeing oncoming traffic due to the layout of this curve.

As previously discussed, the frontage road attached to Jacksonville Road (Route 112) had, until recently, been used as a channelized right-turn lane by drivers onto Main Road (Route 112); at the time of the audit, the frontage road was closed due to the August 2017 fatal crash. This is resulting in unfavorable traffic scenarios at the study area intersection, as the frontage road is primarily intended for use to access the adjacent properties. During the audit, team members made note that there were limited shoulders

present on the study area intersection, with the exception of the south side of Main Road (Route 112). Due to the lack of shoulders, the wide lanes may encourage higher vehicle speeds, and bicyclists are required to ride in mixed traffic within the vicinity of the study area.

As discussed in the crash data provided by MassDOT, several crashes have occurred within the study area intersection during inclement weather conditions or on poor pavement conditions. One contributing factor to wet roads discussed during the audit is thought to be the existing road crown, which may limit drainage during storms. In addition, drivers taking southbound right turns tend to take right turns onto the frontage property at higher speeds than is safe. Southbound right turning trucks that attempt this turn often creep into adjacent lanes to make the turn. Approximately 4,000 feet south of the study area intersection, it was noted by the audit team that two curves around the location of 78 Greenfield Road are noticeably sharp, particularly for the downhill slope that exists along this road.

The bridge along Jacksonville Road (Route 112), just north of the study area, was also identified as a critical location of interest. This bridge, which was actively under construction at the time of the audit, rests at a higher elevation than the approaching roadways. Some audit participants noted that this presents visibility issues for drivers, particularly for the proposed pedestrian crossings that will be installed at each end of the bridge.

Enhancements:

- Consider removing the church or other properties at this intersection, to allow the roadway horizontal alignment to be improved through the intersection.
- Evaluate and possibly eliminate the one-way frontage road that services Jacksonville Road (Route 112) southbound right turns onto Main Road.
- Evaluate centerline and cross section profiles of approaching roadways and consider redesigning approach roadways to improve grades and drainage.
- Evaluate the use of salt and sand on Greenfield Road and consider pretreatment of the roadways using liquid magnesium chloride.
- Consider installing additional LED street lights to improve visibility around the intersection.
- Consider adding yellow warning beacons or rectangular rapid flashing beacons (RRFB's) to the proposed pedestrian crossings adjacent to the bridge on Jacksonville Road (Route 112) to improve visibility of crossing pedestrians.

Safety Issue #2: Traffic Operations

Observations:

Several members of the audit team noted during the field visit that they perceived driver speeds to be higher than the posted speed limits. As previously discussed, the radii and grade transitions present at the Jacksonville Road (Route 112) and Greenfield Road approaches make it dangerous for vehicles, especially larger trucks, to travel at high speeds through the intersection, which increases the risk of overturning or runaway vehicles. As discussed, a grade transition from 5% to 11% exists approximately 4,000 feet south of the study area intersection, starting just south of West Layden Road. The sudden grade change may be a contributing factor in crashes occurring at the study area, and may have played a role in

brake failures in larger trucks. Another consequence of the roadway geometry is that truck drivers have a difficult time maintaining the momentum to travel uphill on Greenfield Road heading south. Therefore, trucks have a tendency to accelerate around the corner from Jacksonville Road (Route 112) to Greenfield Road in order to gain enough speed to make the climb; one crash in the study period analyzed can be directly attributed to this behavior. Audit members also noted that driver fatigue may play a contributing role in crashes involving larger trucks, perhaps lowering some drivers' awareness when traveling along the grade changes at the study area intersection.

According to town officials, access management is an ongoing problem within the study area. For instance, drivers exiting the church are known to attempt left turns, but experience traffic issues on Greenfield Road due to limited sight distance exiting the church parking lot, which is located on the inside of the horizontal curve within the intersection. It was also brought to the audit group's attention that a new Town DPW garage is currently under construction approximately 300 feet north of the study area intersection, which may result in an increase in trucks traveling through the intersection to access the garage. During the field visit, audit team members also identified the Town of Colrain Post Office, located approximately 800 feet west of the study area intersection. It had been discussed that the driveway to the post office is adjacent to Main Road (Route 112) and therefore creates potential safety issues when drivers attempt to back out of the lot. Visibility for drivers attempting to leave the lot is especially poor if multiple parking spots are occupied.

Exit to one-way frontage road used by drivers for southbound right turns

Representatives from the Town of Colrain explained that traffic through the study area intersection increases during the winter months due to skiers traveling to Mount Snow in Vermont. The higher volumes of traffic through the intersection paired with the presence of black ice can potentially increase the risk of collisions at the study area. Town officials also noted that trucks traveling through Colrain, and through the study area in particular, are often on routes that avoid Shelburne, MA, regardless of whether or not an alternative route would be quicker. It is thought that perhaps GPS systems are causing the drivers to take Greenfield Road rather than the highway routes that circumnavigate the study area, which audit participants noted are less steep in grade.

In addition to the road surface and manner of collision, the MassDOT-provided crash data discusses the average age of drivers involved in the crashes at this study area. It had been noted that 47% of drivers involved in collisions at the intersection were between the ages of 21 and 29. Due to this trend in driver age, audit participants discussed whether the inexperience of drivers and their possible unfamiliarity with the intersection as a "village center" may play a role in collisions at this intersection.

Enhancements:

- Consider installing a runaway truck ramp or a mechanical wire system along Greenfield Road to address runaway trucks.
- Consider adding a truck exclusion zone on Greenfield Road due to the roadway grades.
- Consider installing a special truck roadway designed to return heavy vehicles to the study area roadways on a lower gear.
- Consider installing rumble strips on Greenfield Road to address driver fatigue and prevent runoff crashes.
- Consider increasing police enforcement for speeding vehicles.
- Consider adding a speed limit sign near the address of 78 Greenfield Road to remind drivers of the posted speed limit for this roadway section, and consider installing speed feedback signs on approaches to the intersection.
- Evaluate existing speed limit warning signs for visibility, particularly under nighttime conditions, and consider replacing them with MUTCD compliant fluorescent yellow-green signs.
- Consider installing high friction road treatments to reduce vehicle runoff crashes.
- Consider installing a warning sign for Coburn Street to warn of post office parking lot traffic.
- Consider adding signage or other landscaping amenities to create a gateway treatment for drivers approaching the intersection in order to evoke lower speeds on the approach and entrance to the community.
- Consider installing warning signs to alert drivers approaching the town garage.
- Evaluate the feasibility of restricting exiting left turns at the church parking lot due to sight distance constraints north of the church.

Safety Issue #3: Traffic Control Devices

Observations:

Signage warning truck drivers of approaching grade change

As discussed, the one-way frontage road from Jacksonville Road (Route 112) to Main Road (Route 112) is being utilized by drivers to take southbound right turns. It was noted during the field visit that signage indicating that either the road is intended for use by residents only or that southbound right turns should be made directly from Jacksonville Road (Route 112) onto Main Road (Route 112) is not present. Signage in the general area of the intersection was noted to be lacking in general. In particular, there is a lack of truck route signage to help drivers navigate to more appropriate routes. Another area of concern with respect to signage is located near 78 Greenfield Road, which is further south of the intersection. This stretch of Greenfield Road contains several sharp curves, as previously discussed. Some audit participants questioned whether there is adequate signage for this stretch of Greenfield Road

due to the limited visibility of the intersection for vehicles approaching from Jacksonville Road to the north; there is currently no signage to warn southbound drivers approaching from Jacksonville Road of the sharp curves or grade incline. In addition, existing signs around this location for northbound drivers suffer from being worn out or covered in foliage, as well as being mounted too low for drivers to have adequate advance notice. Existing signage warning truck drivers of the grade in this area is particularly worn, and is installed at a height that appears low for truck drivers to adequately see. The guard rail that sits along these curves also sits low and much of it is covered by vegetation as well.

Enhancements:

- Consider installing overhead warning signs and/or signs with beacons or LED flashers triggered by vehicle height detectors along Greenfield Road to alert northbound drivers of grade changes in a more conspicuous manner.
- Consider adding warning signs along Greenfield Road southbound and replacing existing signs along Greenfield Road northbound to adequately warn drivers of roadway curves and grades.
- Evaluate regulatory, guide, and warning signs within the study area, considering placement, condition, and mounting height.
- Consider installing warning signs for Jacksonville Road (Route 112) southbound to warn of approaching curve and grade, as well as upgrading existing signs.
- Consider installing chevron signs at all curves.
- Consider installing flashers alerting drivers of approaching school zones.
- Evaluate and replace pavement markings in the study area.
- Consider installing reflective pavement markers to provide better visibility at night.
- Consider adding object markers to guardrails for increased visibility.
- Consider clearing vegetation near and on guardrails.
- Consider adding gravel treatment below guardrails to prevent future vegetation growth.
- Consider installing a “Trucks Test Brakes” sign at top of hill on Greenfield Road northbound, prior to changes in the roadway grade.

Safety Issue #4: Pedestrian and Bicycle Accommodations

Observations:

Audit team members noted that school buses stop in the vicinity of the church, in the middle of the intersection, to pick up and drop off students. This is an area of limited visibility for pedestrians due to the curvature of the roadway and limited sight distance. In roughly the same location as the bus stop, signage is present indicating the pedestrian crossing, and advance warning signage is also present on each approach. However, while such signs exist to indicate the crossing, no crosswalk or pedestrian ramps exist at the signed crossing location. Students and pedestrians are forced to cross the road wherever and whenever they feel safest, without any painted crossing or ADA-compliant ramps to guide pedestrians and mark the crossing location for roadway users. In addition, sidewalks are not present anywhere within the study area.

Audit team members noted that bicycles tend to travel in groups when riding through the Town of Colrain, and that there is regular bicycle use through the intersection. As previously discussed, most of the study area intersection has narrow shoulders. For this reason, bicyclists on Jacksonville Road (Route 112) or Greenfield Road are forced to ride in mixed traffic. Bicycle amenities, such as dedicated bike lanes or signs indicating bike routes, are not present the study area intersection.

Pedestrian crossing signs without ADA-compliant ramps or crosswalk

Enhancements:

- Consider adding pedestrian accommodations throughout the intersection, such as sidewalks, pedestrian ramps, and crosswalks.
- Consider relocating the existing school bus stop to a more visible location in the vicinity of the intersection.
- Consider installing rapid rectangular flashing beacons (RRFB's) at crosswalks to increase pedestrian visibility.
- Evaluate existing pedestrian crossing signs for MUTCD compliance.
- Consider adding bicycle amenities (such as bicycle lanes) and related regulatory and warning signs to alert roadway users to the potential presence of bicycle traffic.

Recommendations

After the site visit, audit participants returned to discuss the safety issues and consider various improvements. The audit participants were encouraged to consider both short and long-term improvements for each of the existing safety issues. Each improvement considered has been categorized as short-term, mid-term, or long-term based on the definitions shown in Table 2. Additionally, a cost category has been assigned to each improvement based on the parameters set forth in Table 2.

Table 2. Estimated Time Frame and Costs Breakdown

Time Frame		Costs	
Short-Term	<1 Year	Low	<$10,000
Mid-Term	1-3 Years	Medium	$10,001-$50,000
Long-Term	>3 Years	High	>$50,000

Summary of Road Safety Audit

A summary of the potential recommendations discussed by the RSA audit team are summarized in Table 3. The recommendations are summarized based on the potential safety payoff, time frame, approximate cost and responsible agency. The safety payoff is a subjective judgment of the potential effectiveness of the safety recommendations listed below.

Table 3. Potential Safety Enhancement Summary

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Roadway Geometry	Consider removing the church or other properties at this intersection, to allow the horizontal alignment to be improved through the intersection.	High	Long-Term	High	Town of Colrain
Roadway Geometry	Evaluate and possibly eliminate the one-way frontage road.	Medium	Mid-Term	Medium	Town of Colrain
Roadway Geometry	Evaluate centerline and cross section profiles of approaching roadways and consider redesigning approach roadways to improve grades and drainage.	High	Long-Term	High	Town of Colrain
Roadway Geometry	Evaluate the use of salt and sand on Greenfield Road and consider pretreatment of the roadways using liquid magnesium chloride.	High	Short-Term	Medium	Town of Colrain
Roadway Geometry	Consider installing additional LED street lights to improve visibility around the intersection.	Medium	Mid-Term	Medium	Town of Colrain
Roadway Geometry	Consider adding yellow warning beacons or rectangular rapid flashing beacons (RRFB's) to the proposed pedestrian crossings adjacent to the bridge on Jacksonville Road (Route 112).	Medium	Short-Term	Low	Town of Colrain
Traffic Operations	Consider installing a runaway truck ramp or a mechanical wire system along Greenfield Road to address runaway trucks.	High	Long-Term	High	Town of Colrain
Traffic Operations	Consider adding a truck exclusion zone on Greenfield Road due to the roadway grades.	High	Short-Term	Low	Town of Colrain
Traffic Operations	Consider installing a special truck roadway designed to return heavy vehicles to the study area roadways on a lower gear.	High	Long- Term	High	MassDOT/Town of Colrain
Traffic Operations	Consider installing rumble strips on Greenfield Road to address driver fatigue and prevent runoff crashes.	Medium	Short-Term	Low	Town of Colrain

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Traffic Operations	Consider increasing police enforcement for speeding vehicles.	High	Mid-Term	High	Town of Colrain
Traffic Operations	Consider adding a speed limit sign near the address of 78 Greenfield Road to remind drivers of the posted speed limit for this roadway section, and consider installing speed feedback signs on approaches to the intersection.	Medium	Short-Term	Low	Town of Colrain
Traffic Operations	Evaluate existing speed limit warning signs for visibility, particularly under nighttime conditions, and consider replacing them with MUTCD compliant fluorescent yellow-green signs.	Medium	Short-Term	Low	Town of Colrain
Traffic Operations	Consider installing high friction road treatments to reduce vehicle runoff crashes.	High	Mid-Term	Medium	MassDOT/Town of Colrain
Traffic Operations	Consider installing a sign for Coburn Street to warn of post office parking lot traffic.	Low	Short-Term	Low	MassDOT/Town of Colrain
Traffic Operations	Consider adding signage or other landscaping amenities to create a gateway treatment for drivers approaching the intersection in order to evoke lower speeds on the approach and entrance to the community.	Low	Mid-Term	Medium	Town of Colrain
Traffic Operations	Consider installing warning signs to alert drivers approaching the town garage.	Low	Short-Term	Low	Town of Colrain
Traffic Operations	Evaluate the feasibility of restricting exiting left turns at the church due to sight distance constraints north of the church.	Medium	Short-Term	Low	Town of Colrain
Traffic Control Devices	Consider installing overhead warning signs and/or signs with beacons or LED flashers triggered by vehicle height detectors along Greenfield Road to alert northbound drivers of grade changes in a more conspicuous manner.	Medium	Mid-Term	Medium	Town of Colrain
Traffic Control Devices	Consider adding warning signs along Greenfield Road southbound and replacing existing signs along Greenfield Road northbound to adequately warn drivers of roadway curves and grades.	Medium	Short-Term	Low	Town of Colrain

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Traffic Control Devices	Evaluate regulatory, guide, and warning signs within the study area, consider placement, condition, and mounting height.	Medium	Short-Term	Low	Town of Colrain
Traffic Control Devices	Consider installing warning signs for Jacksonville Road (Route 112) southbound to warn of approaching curve and grade, as well as upgrading existing signs.	High	Short-Term	Low	MassDOT
Traffic Control Devices	Consider installing chevron signs at all curves.	High	Short-Term	Low	Town of Colrain
Traffic Control Devices	Consider installing flashers alerting drivers of approaching school zones.	High	Mid-Term	Medium	Town of Colrain
Traffic Control Devices	Evaluate and replace pavement markings in the study area.	Medium	Mid-Term	Low	MassDOT/Town of Colrain
Traffic Control Devices	Consider installing reflective pavement markers to provide better visibility at night.	High	Mid-Term	Low	MassDOT/Town of Colrain
Traffic Control Devices	Consider adding object markers to guardrails for increased visibility.	Low	Short-Term	Low	Town of Colrain
Traffic Control Devices	Consider clearing vegetation near and on guardrails.	Low	Short-Term	Low	Town of Colrain
Traffic Control Devices	Consider adding gravel treatment below guardrails to prevent future vegetation growth.	Low	Mid-Term	Medium	Town of Colrain
Traffic Control Devices	Consider installing a “Trucks Test Brakes” sign at top of hill on Greenfield Road northbound, prior to changes in the roadway grade.	Medium	Short-Term	Low	Town of Colrain
Pedestrian and Bicycle Accommodations	Consider adding pedestrian accommodations throughout the intersection, such as sidewalks, pedestrian ramps, and crosswalks.	High	Mid-Term	High	Town of Colrain
Pedestrian and Bicycle Accommodations	Consider relocating the existing school bus stop to a more visible location in the vicinity of the intersection.	High	Short-Term	Low	Town of Colrain
Pedestrian and Bicycle Accommodations	Consider installing rapid rectangular flashing beacons (RRFB’s) at crosswalks to increase pedestrian visibility.	Medium	Mid-Term	Medium	Town of Colrain
Pedestrian and Bicycle Accommodations	Evaluate existing pedestrian crossing signs for MUTCD compliance.	High	Short-Term	Low	MassDOT/Town of Colrain

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Pedestrian and Bicycle Accommodations	Consider adding bicycle amenities (such as bicycle lanes) and related regulatory and warning signs to alert roadway users to the potential presence of bicycle traffic.	High	Long-Term	Medium	MassDOT/Town of Colrain

Appendix A. RSA Audit Team Contact List

Participating Audit Team Members

Date: September 14, 2017 Location: Town of Colrain Offices (55 Main Road), Colrain, MA

Audit Team Members	Agency/Affiliation	Email Address	Phone Number
Alan Nafis	Weston & Sampson	nafisa@wseinc.com	860-616-6607
Laurie Scarbrough	FRCOG	lscarbrough@frcog.org	413-774-3167
Mark Moore	MassDOT District 1	Mark.moore@state.ma.us	413-637-5750
Pat Tierney	MassDOT District 1	Patrick.tierney@dot.state.ma.us	413-637-5220
Francisca Heming	MassDOT District 1	Francisca.heming@dot.state.ma.us	413-637-5704
Sonja Gray	MassDOT District 1	Sonja.gray@state.ma.us	413-637-5751
Elsa Chan	MassDOT Traffic Safety	Elsa.chan@state.ma.us	857-368-9648
Michelle Deng	MassDOT Traffic Safety	Michelle.deng@state.ma.us	857-368-9637
Kevin Fox	Town of Colrain Town Adminstrator	bos@colrain-ma.gov	413-624-6306
Mark Thibodeau	Town of Colrain Select Board	N/A	413-624-3232
Nick Anzuoni	Town of Colrain Fire Department	firechief@colrain-ma.gov	413-325-6727
Eileen Sauvageau	Town of Colrain Select Board	eileencabales@gmail.com	413-624-3294
Scott Sullivan	Town of Colrain Highway Department	colrainroadboss@gmail.com	413-624-6306
Jonathan Bates	Massachusetts State Police	Jonathan.bates@massmail.state.ma.us	413-244-0599
Daniel Gale	Massachusetts State Police	Daniel.gale@massmail.state.ma.us	413-625-6311
Chris Lannon	Town of Colrain Police Department	police@colrain-ma.gov	413-768-7997
Lisa Slonus	Weston & Sampson	slonusl@wseinc.com	860-616-6610
Philip Viveiros	McMahon Associates	pviveiros@mcmahonassociates.com	508-823-2245
Paul Furgal	McMahon Associates	pfurgal@mcmahonassociates.com	860-602-8700

Appendix B. Detailed Crash Data

massDOT
Massachusetts Department of Transportation
Highway Division

CRASH DIAGRAM

SYMBOLS

Moving Vehicle
Backing Vehicle
Non–Involved Vehicle

Involved	Non–Involved	
		Pedestrian
		Bicycle
		Animal
		Direction of Motion
		Parked Vehicle
		Fixed Object

TYPE OF CRASH

Head on
Rear End
Angle
Turning Movement
Sideswipe
Out of Control
Night Time Crash

SEVERITY

(#) Injury
(#) Fatal
Property Damage Only

COLRAIN, MA

MAIN ROAD AND JACKSONVILLE ROAD (RT.112) AT GREENFIELD ROAD

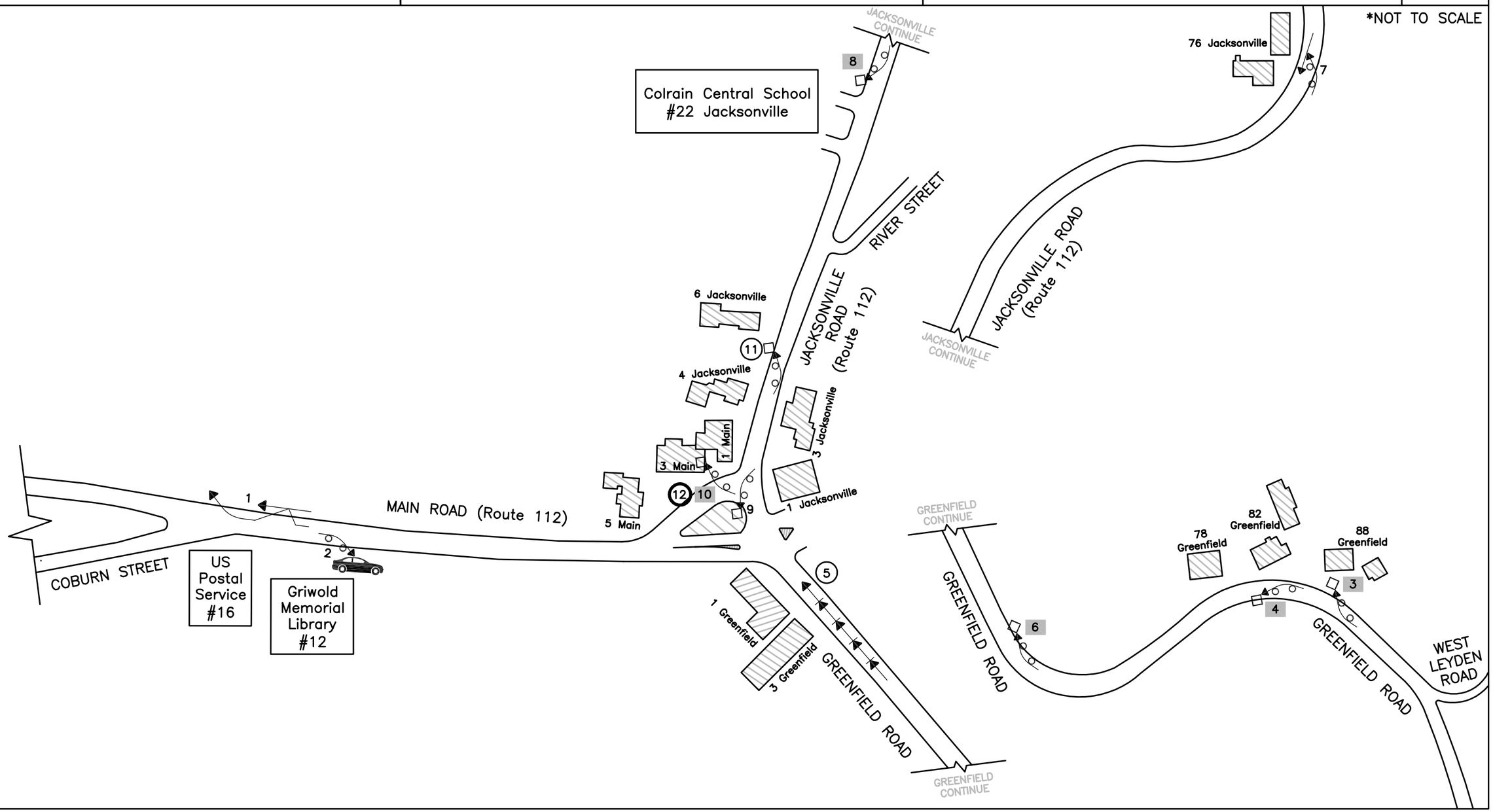
REGION: FRCOG

TIME PERIOD ANALYZED: 2010–2017
SOURCE OF CRASH REPORTS: COLRAIN AND STATE POLICE DEPARTMENT
DATE PREPARED: 08/30/2017
PREPARED BY: MD

SHEET 1 OF 1

N

*NOT TO SCALE



Crash Data Summary Table

Main Road (Rt.112) at Jacksonville Road (Rt.112) and Greenfield Road, Colrain, MA
2010 - 2017

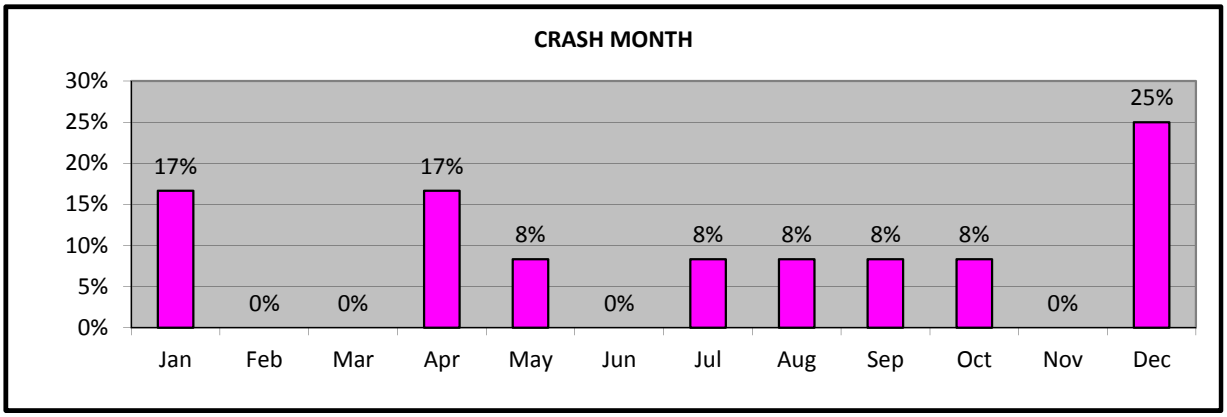
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	Driver Ages					Comments
	mm/dd/yy		*hh:mm*	*Type*	*Type*	*Type*	*Type*	*Type*	*D1*	*D2*	*D3*	*D4*		
1	1/16/2010	Saturday	4:00 PM	Sideswipe, same direction	Daylight	Clear	Dry	Unknown	48	20				WB V1 thought V2 in front of him was pulling to the right side of the road, while V1 trying to pass V2 from the left, V2 start turn left going into the post office and struck V1.
2	9/22/2010	Wednesday	7:26 AM	Sideswipe, same direction	Daylight	Clear	Dry	Distracted	18	66				EB V1 operator looked down to move something off her lap, drifted over the fog line and over corrected due to sun glare blinded her vision , strucked V2 who parked off the road. Crash occurred near #10 Main Road.
3	4/23/2011	Saturday	11:34 PM	Single vehicle crash	Dark - roadway not lighted	Rain	Wet	Driving too fast for conditions	21					Vehicle trying to avoid a deer, lost control and coming to rest in a ditch on the side of the road. Crash occurred by 88 Greenfield Road.
4	4/23/2011	Saturday	11:54 PM	Single vehicle crash	Dark - roadway not lighted	Rain	Wet	Driving too fast for conditions	24					V1 was traveling NB on Greenfield Road. Operator was trying to get up of speed and lost it, over corrected and crossed the center line, then struck the corner of the roadway. Crash occurred by 88 Greenfield Rd around a blind corner of the earlier crash.
5	10/29/2011	Saturday	4:30 PM	Rear-end	Daylight	Snow	Wet	Visibility obstructed	30	21	37	21	49	5 vehicles rear-ended by the Main Rd at Greenfield Rd intersection, heavy snow and slippery road surface.
6	12/5/2011	Monday	6:05 AM	Single vehicle crash	Dark - roadway not lighted	Sleet, hail, freezing rain	Ice	No improper driving	29					Vehicle traveling NB on Greenfield Rd, hit a patch of black ice while going around the curve, sliding off the road to the left then sliding back into the right lane, the vehicle then hit the curb and overturned. Crash occurred near #26 Greenfield Road.
7	12/5/2011	Monday	6:58 AM	Angle	Daylight	Rain	Ice	Driving too fast for conditions	28	26				V1 traveling SB on Jacksonville Road (near #76) seeing black ice as she rounded a curve, V1 then lost control and crossed to the NB lane strucking V2.
8	1/6/2013	Sunday	5:30 PM	Rear-end	Dark - lighted roadway	Cloudy	Wet	Swerving or avoiding due to wind, slippery surface, vehicle, object, non-motorist in roadway, etc.	49					V1 was traveling SB on Jacksonville Rd by Colrain central school, operator indicated an oncoming motor vehicle on the NB was in the SB lane, the headlights were blinding V1 operator swerved right to avoid the oncoming car and struck the utility pole.
9	12/24/2013	Tuesday	12:00 PM	Single vehicle crash	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	71					Vehicle was traveling SB on Jacksonville Rd, operator stated he "Yawned" and temporarily lost control. The vehicle then left the roadway and struck the street sign and fire hydrant at the intersection median.
10	5/28/2016	Saturday	10:14 PM	Single vehicle crash	Dark - lighted roadway	Clear	Dry	Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner	21					Vehicle was traveling NB on Greenfield Rd at a high rate of speed. Vehicle lost control while approaching the Rt.112 at Greenfield Rd intersection, ran over the grass median and continue hitting the porch, bulkhead and foundation of #3 Main Road.
11	7/7/2017	Friday	2:42 PM	Single vehicle crash	Daylight	Clear	Dry	Operating defective equiptment	34					Truck coming downhill from Greenfield Road, lost its brakes, knocked down a utility pole in front of #6 Jacksonville Road, tipping over and losing the load of gravel. Investigation indicated 20% of vehicle brakes not operational, and vehicle was over loaded without permit.
12	8/15/2017	Tuesday	7:50 AM	Single vehicle crash	Daylight		Wet							Dump truck traveling down hill from Greenfield Road, crossed the double yellow center line exited the western edge of the roadway and struck into the vacant residence located north west of the Rt.112 at Greenfield Rd intersection.

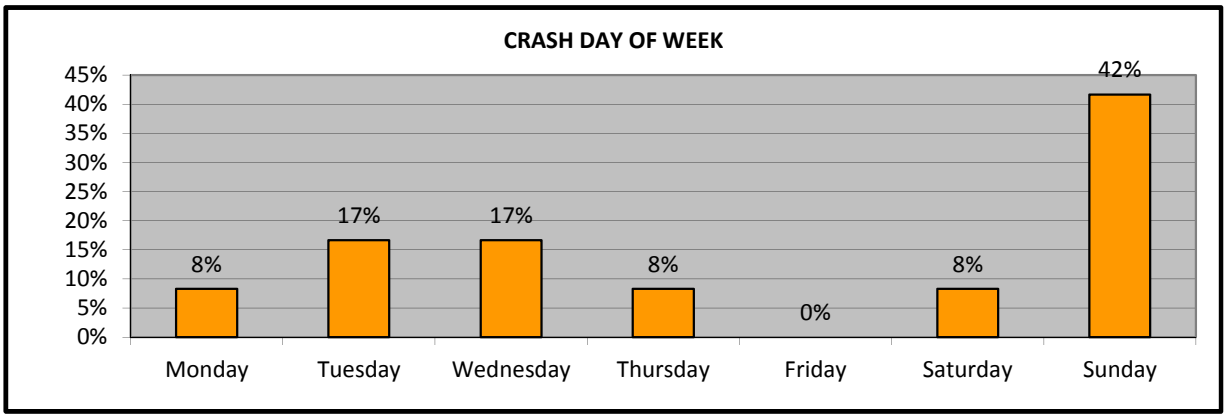
*Courtesy Crash - A term used to describe a crash that occurs subsequent to a non-involved mainline driver who gives the right of way, contrary to the rules of the road, to another driver.

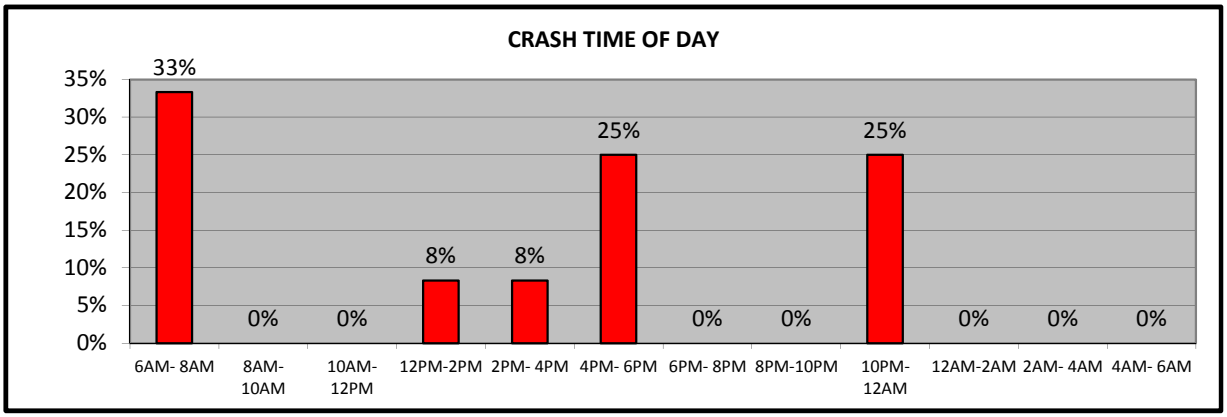
Summaries based on crash reports obtained from the Colrain and State Police Department.

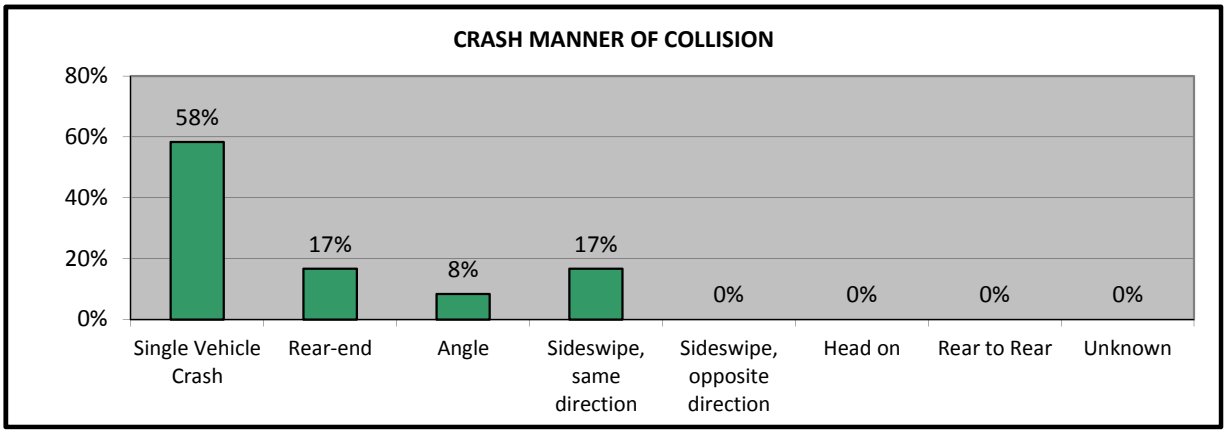
Crash Data Summary Tables and Charts

Main Road (Rt.112) at Jacksonville Road (Rt.112) and Greenfield Road, Colrain, MA



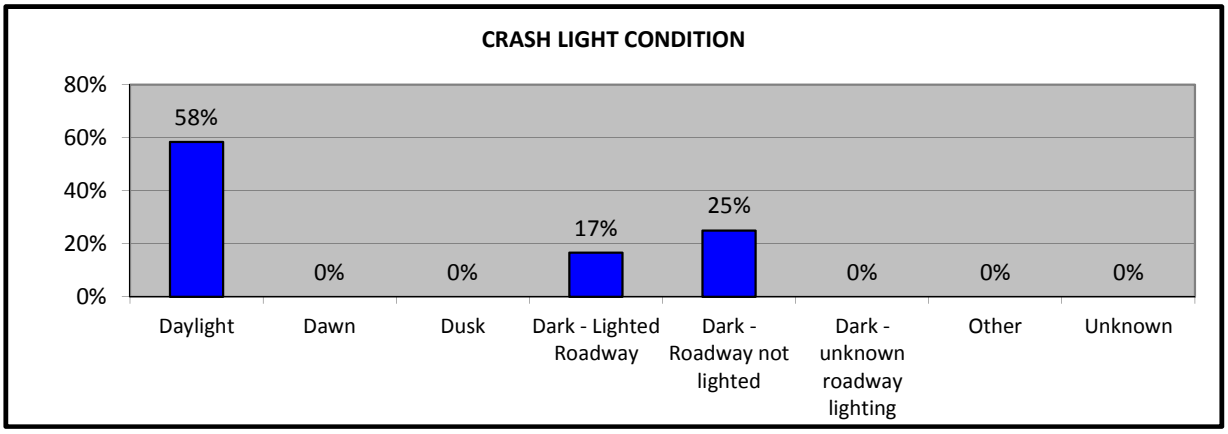


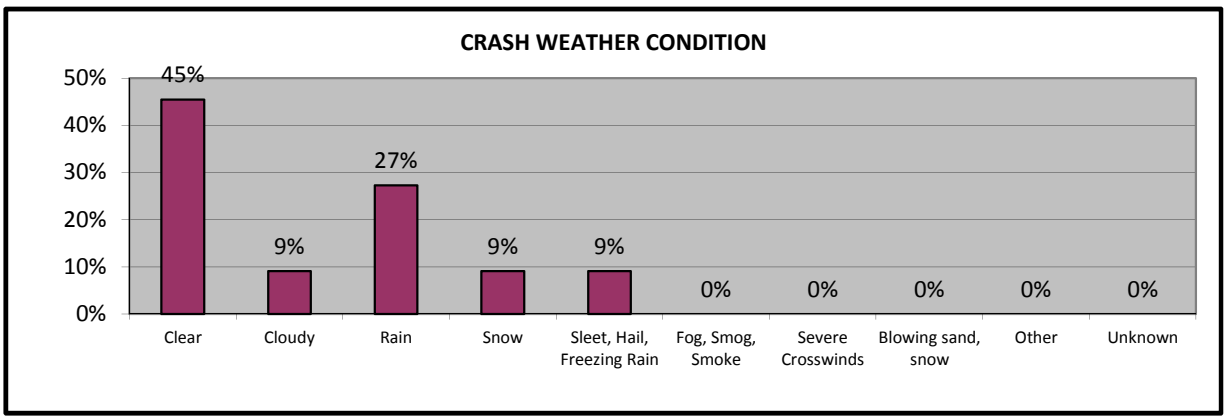


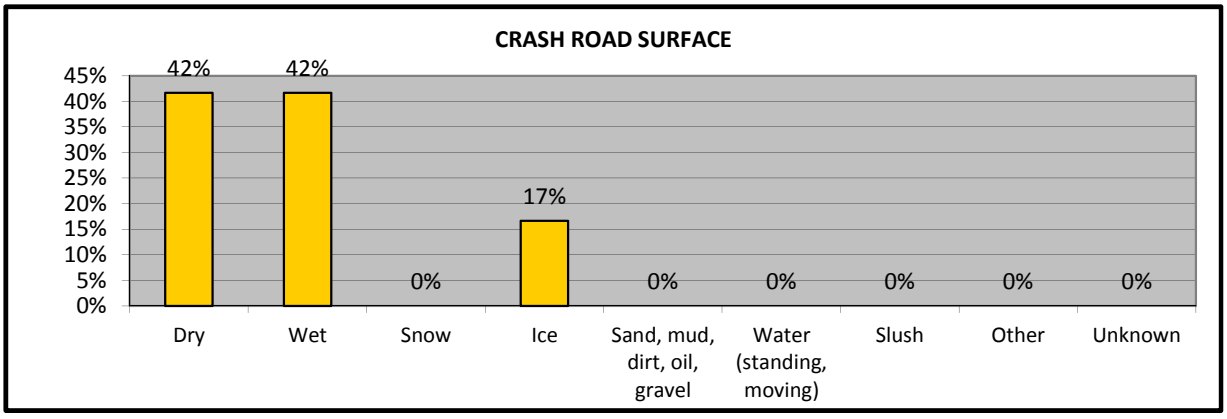


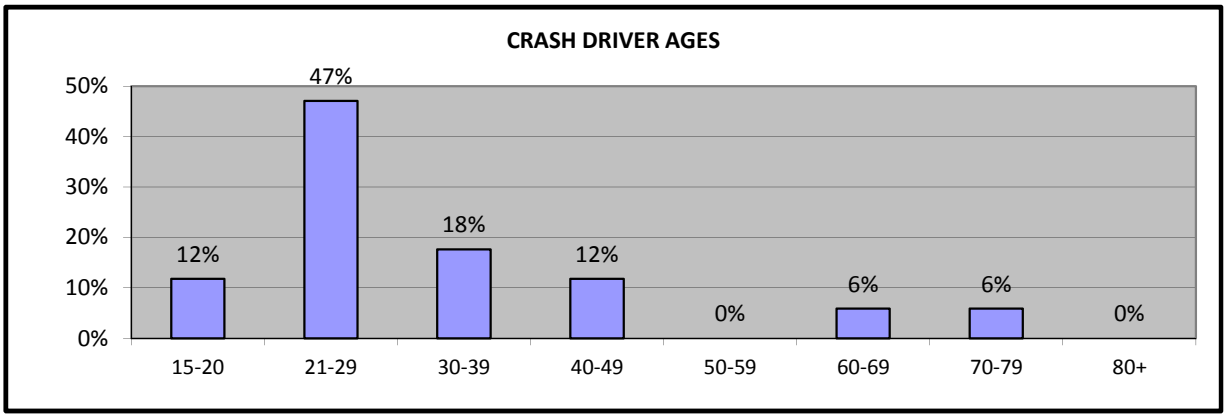
Crash Data Summary Tables and Charts

Main Road (Rt.112) at Jacksonville Road (Rt.112) and Greenfield Road, Colrain, MA









Appendix B. Alignment Plans – Greenfield Road Hill Section

CITY/TOWN
STREET/ROUTE # OR NAME

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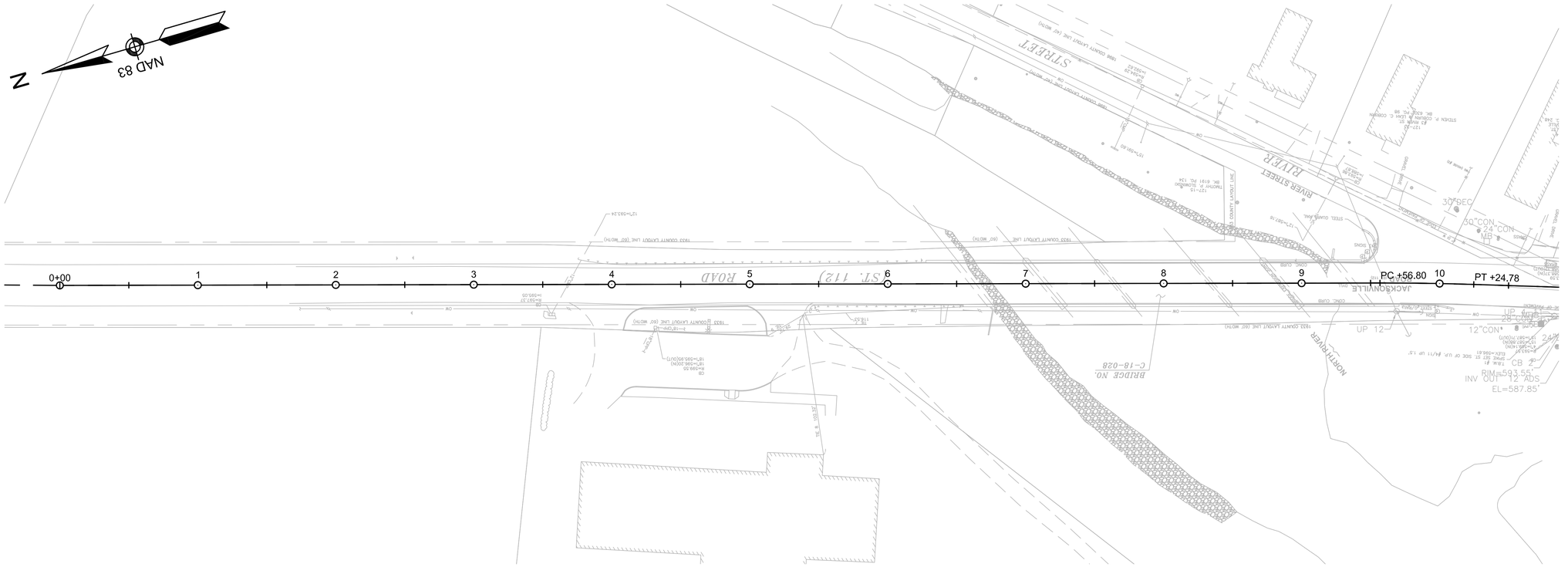
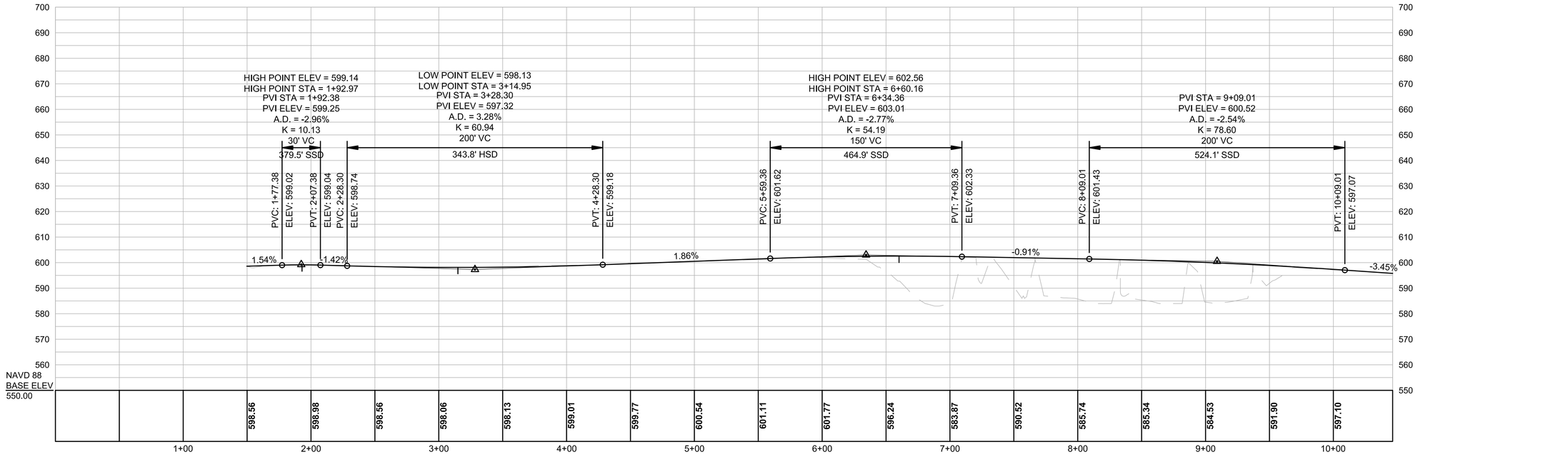
PROJECT FILE NO.	XXXXXX		

SHEET NAME





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SCALE: 1" = 40'

CITY/TOWN
STREET/ROUTE # OR NAME

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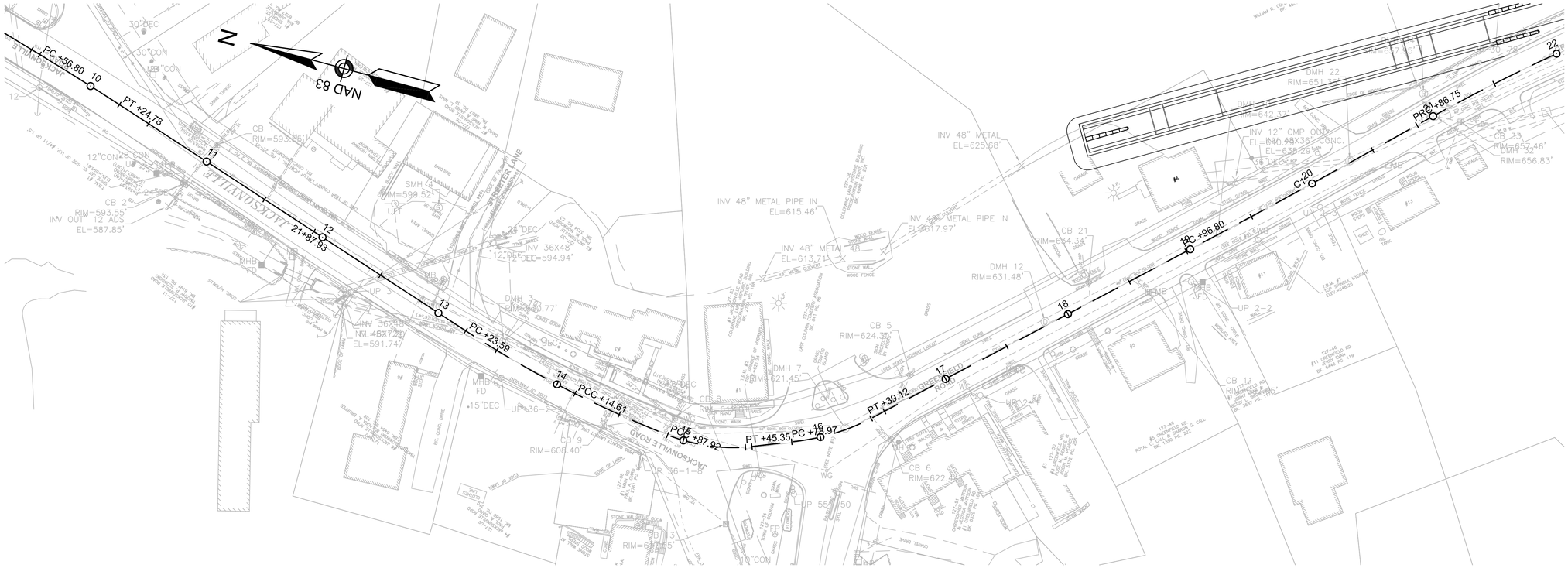
PROJECT FILE NO.	XXXXXX		

SHEET NAME



CITY/TOWN
STREET/ROUTE # OR NAME

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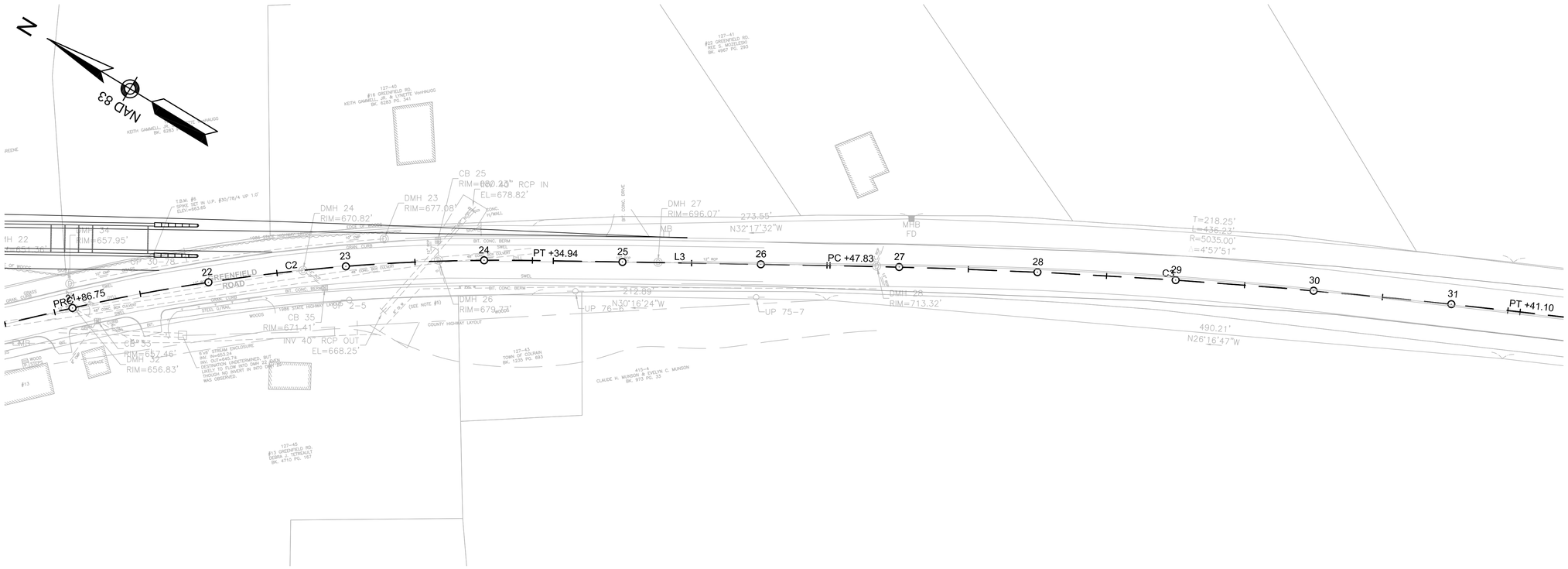
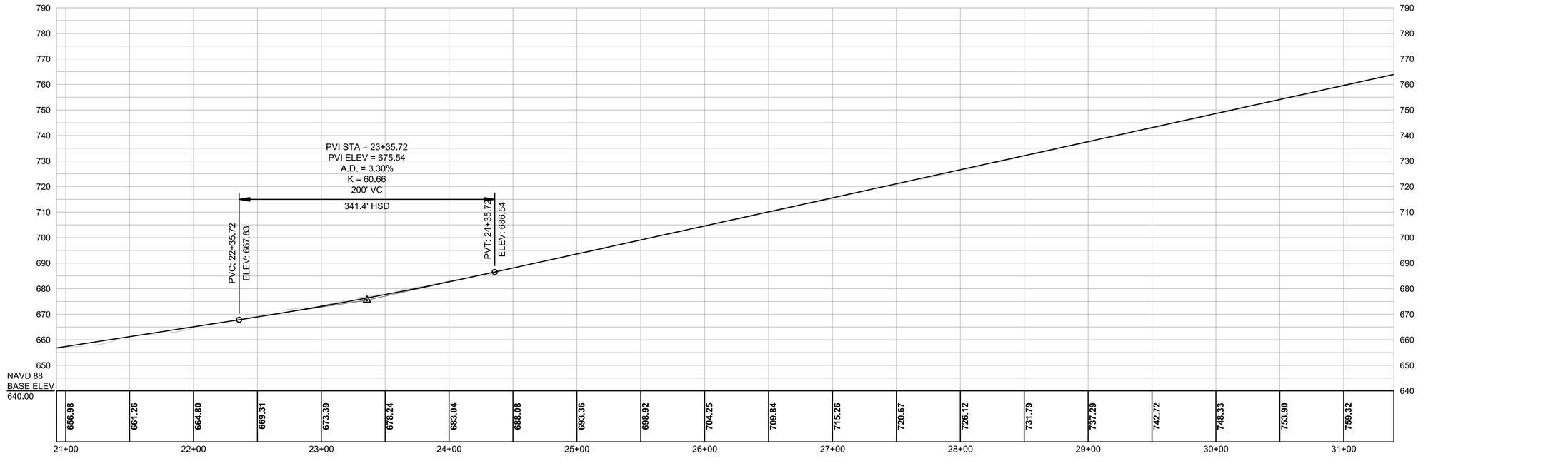
PROJECT FILE NO.	XXXXXX		

SHEET NAME





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GREENFIELD ROAD ALIGNMENT SHEETS.DWG Plotted on 30-Nov-2018 2:55 PM

CITY/TOWN
STREET/ROUTE # OR NAME

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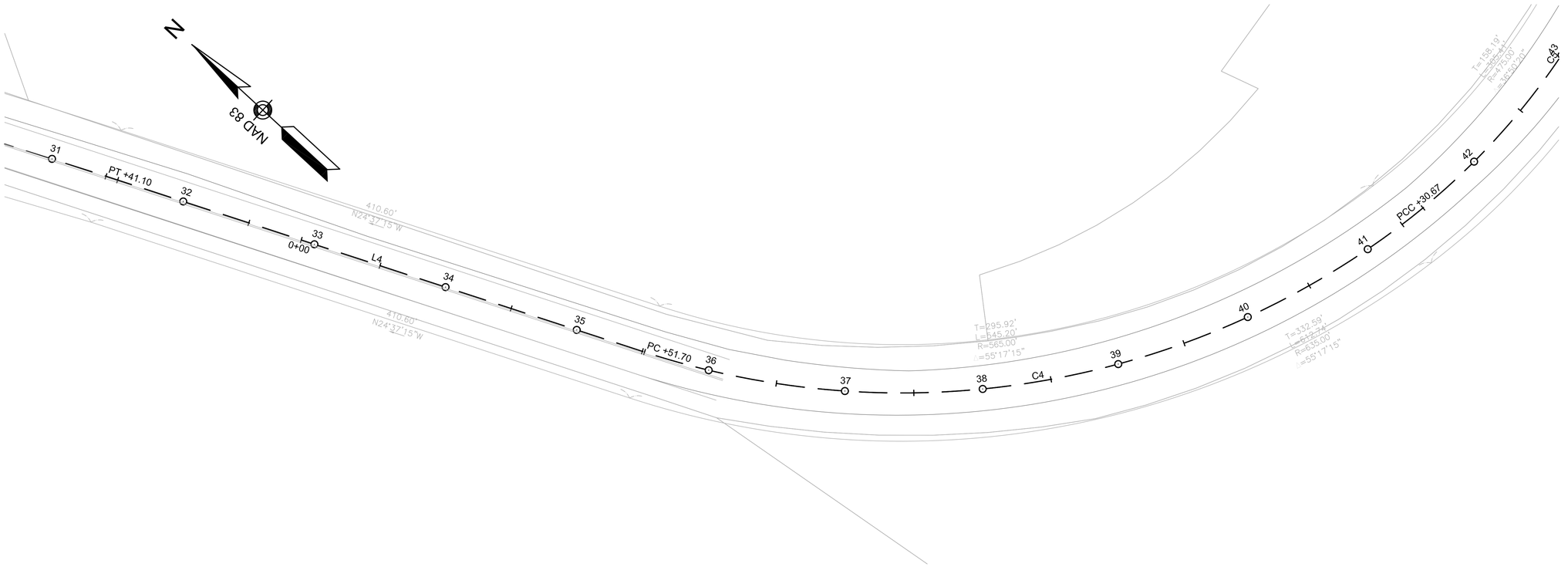
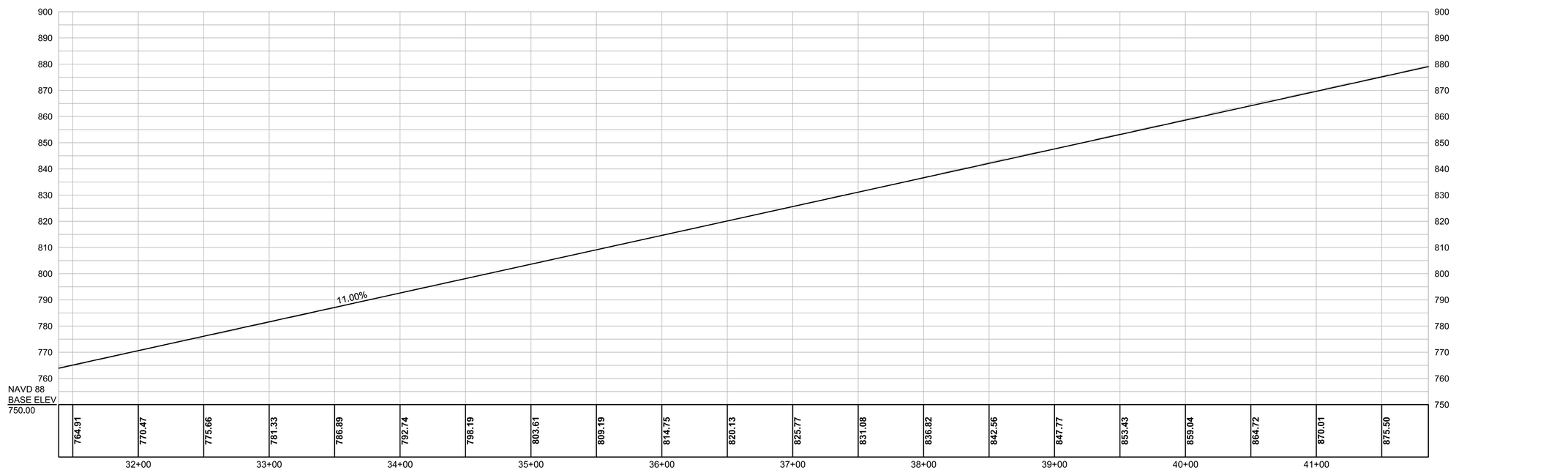
PROJECT FILE NO.	XXXXXX		

SHEET NAME





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CITY/TOWN
STREET/ROUTE # OR NAME

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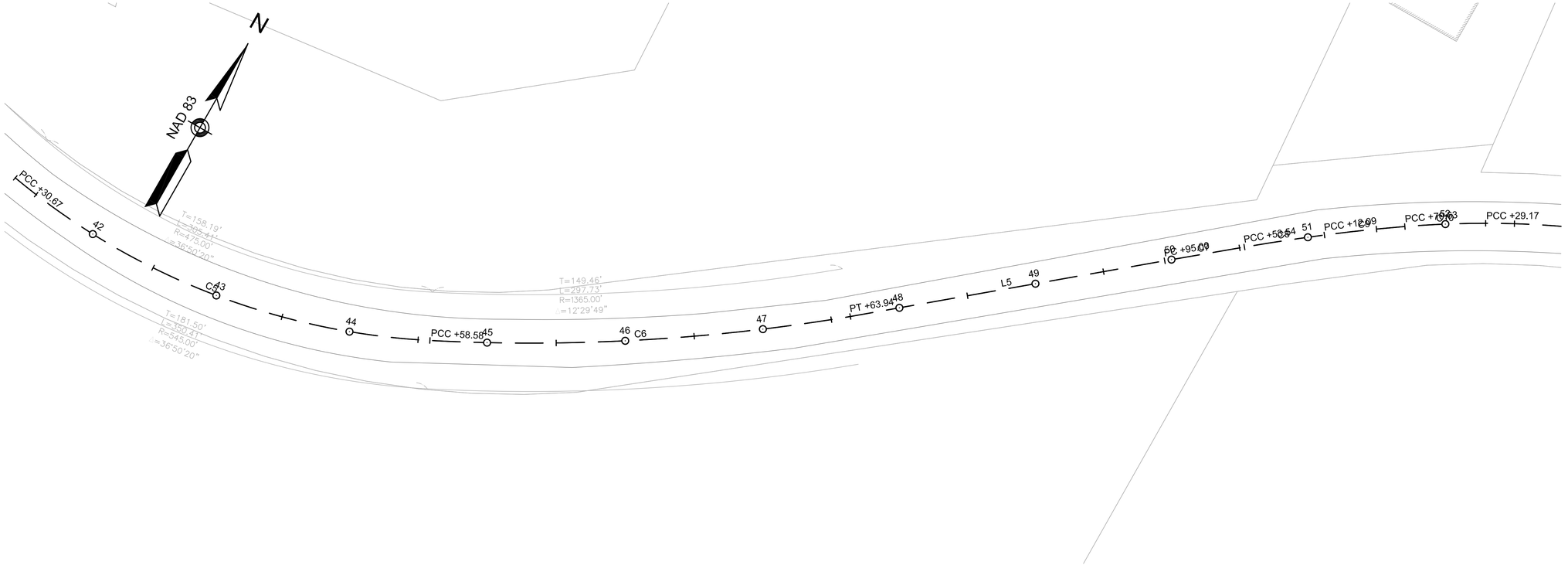
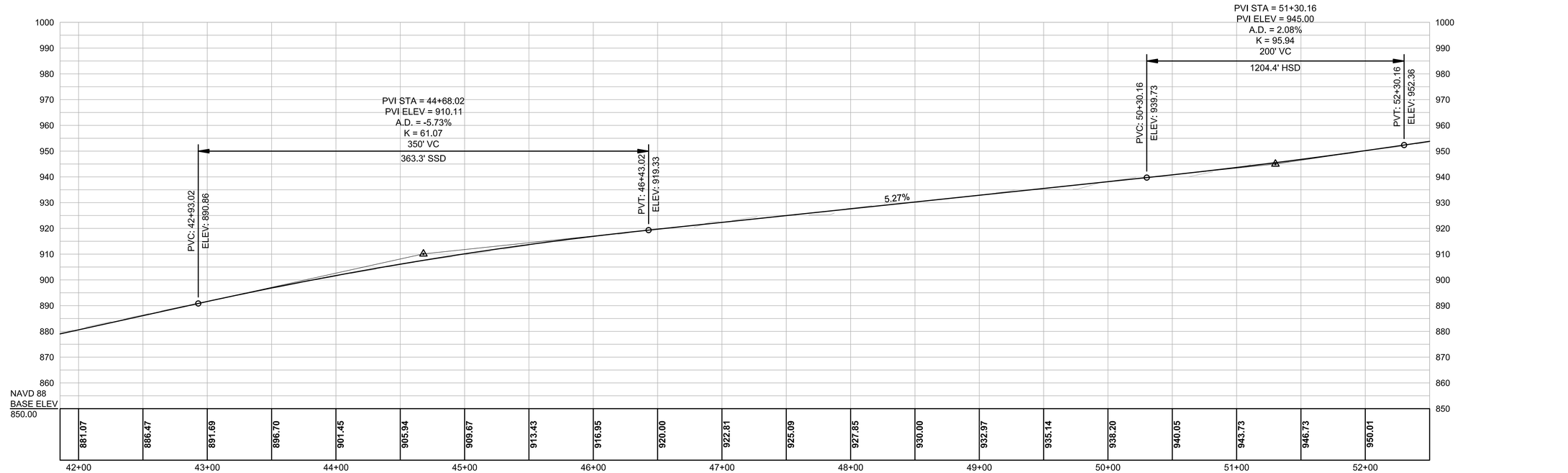
PROJECT FILE NO.	XXXXXX		

SHEET NAME





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CITY/TOWN
STREET/ROUTE # OR NAME

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PROJECT FILE NO.	XXXXXX		

SHEET NAME

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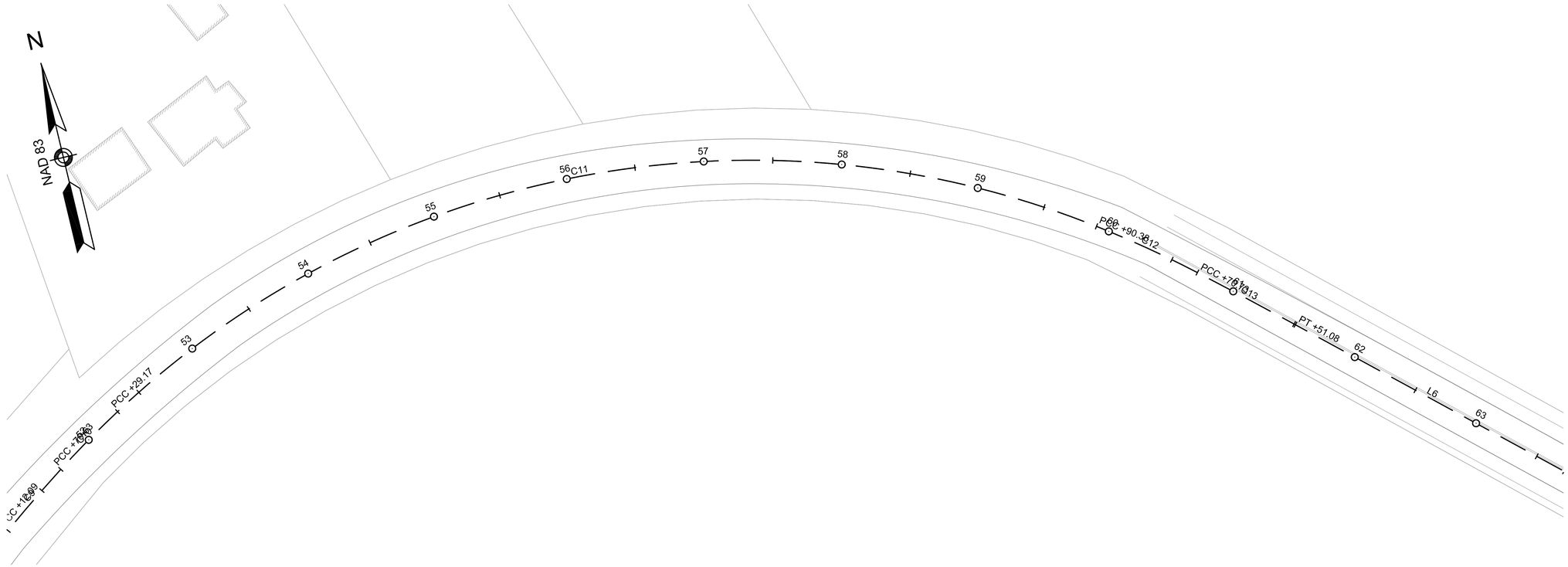

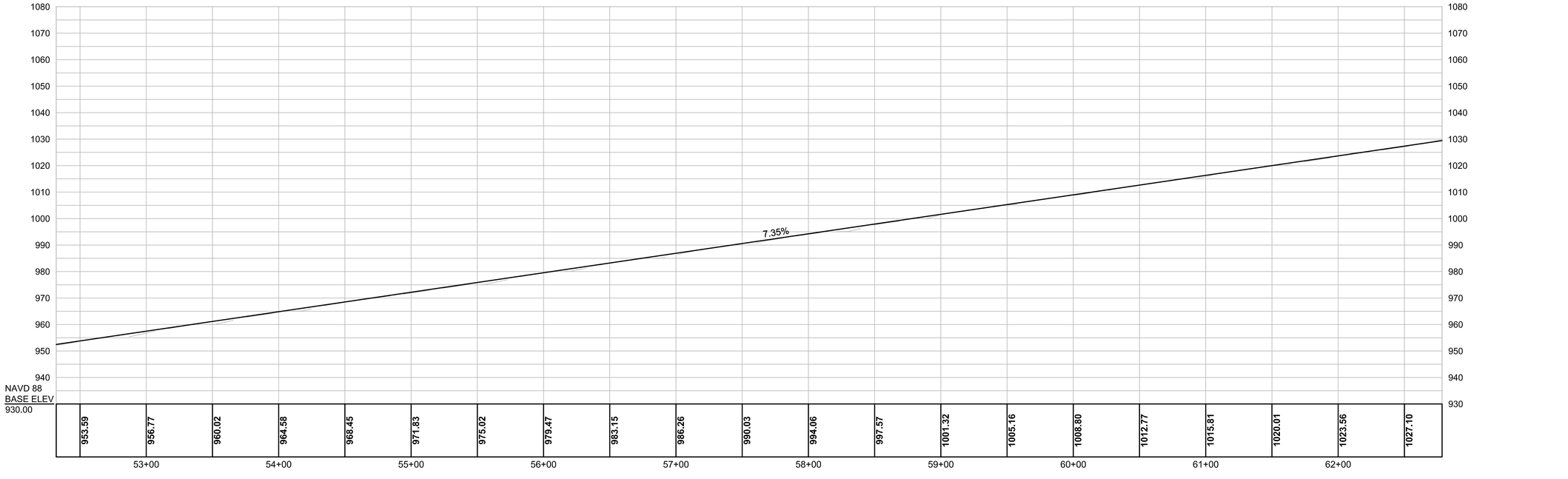

0 40 100 160

SCALE: 1" = 40'

CITY/TOWN
STREET/ROUTE # OR NAME

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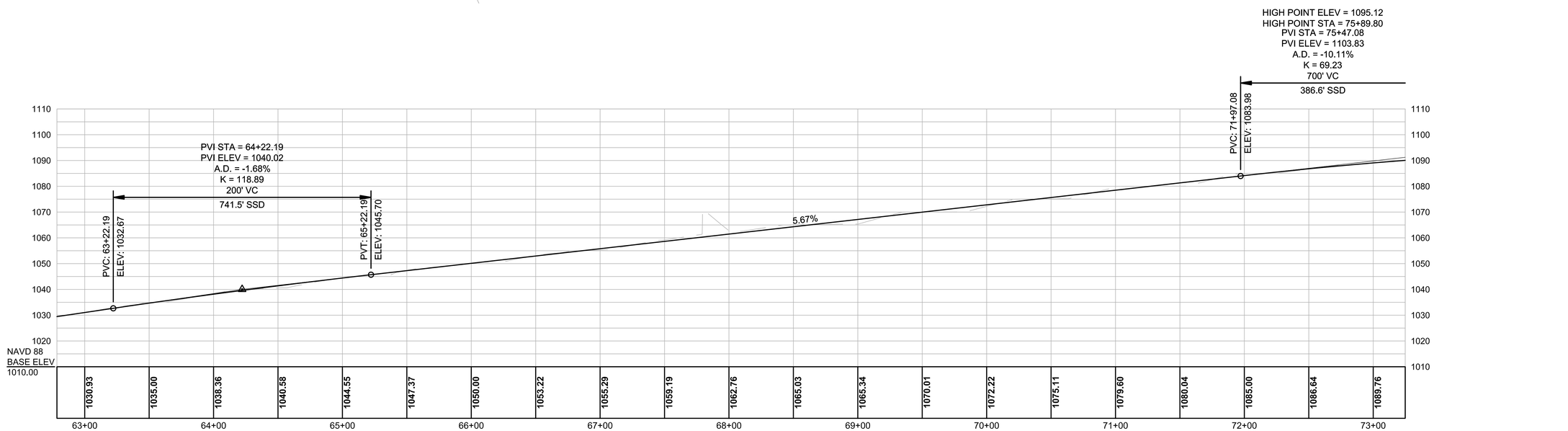
PROJECT FILE NO.	XXXXXX		

SHEET NAME



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SCALE: 1" = 40'

CITY/TOWN
STREET/ROUTE # OR NAME

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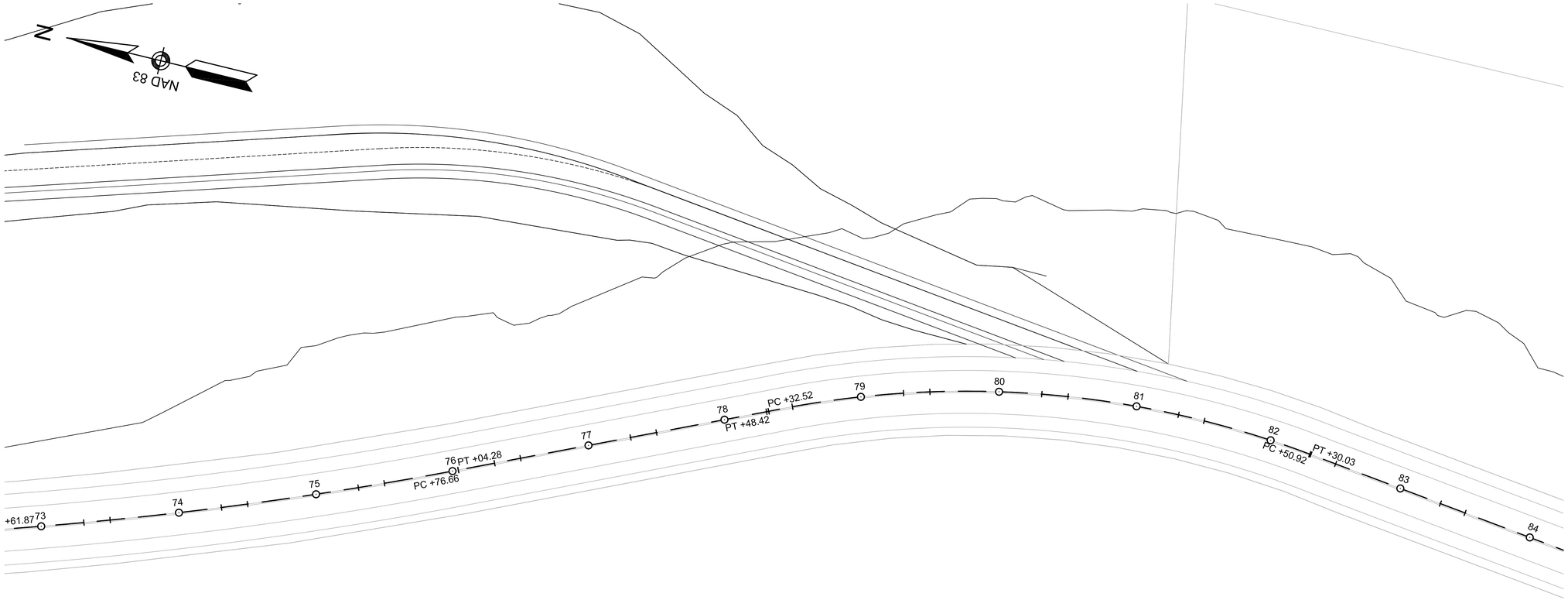
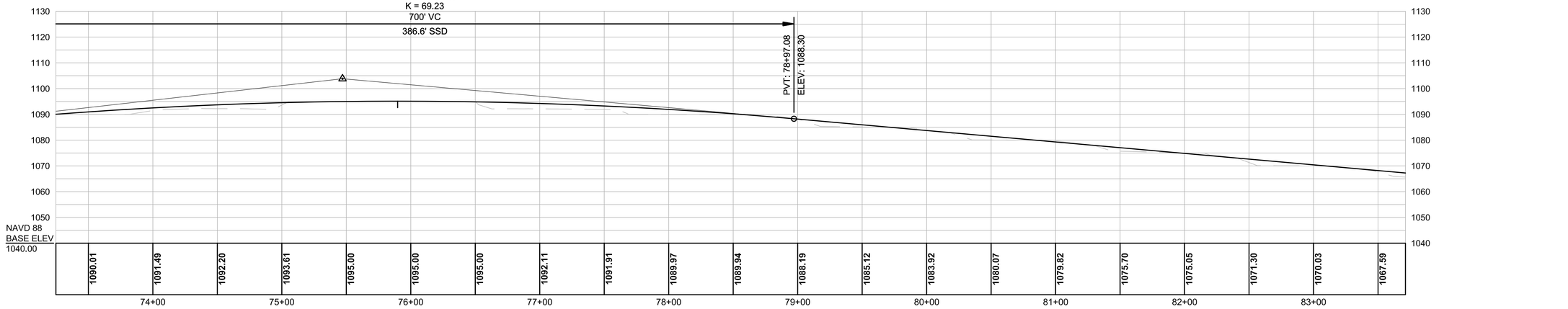
PROJECT FILE NO.	XXXXXX		

SHEET NAME



HIGH POINT ELEV = 1095.12
HIGH POINT STA = 75+89.80
PVI STA = 75+47.08
PVI ELEV = 1103.83
A.D. = -10.11%
K = 69.23
700' VC
386.6' SSD

PVT: 78+97.08
ELEV: 1088.30



0 40 100 160
SCALE: 1" = 40'

CITY/TOWN
STREET/ROUTE # OR NAME

STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
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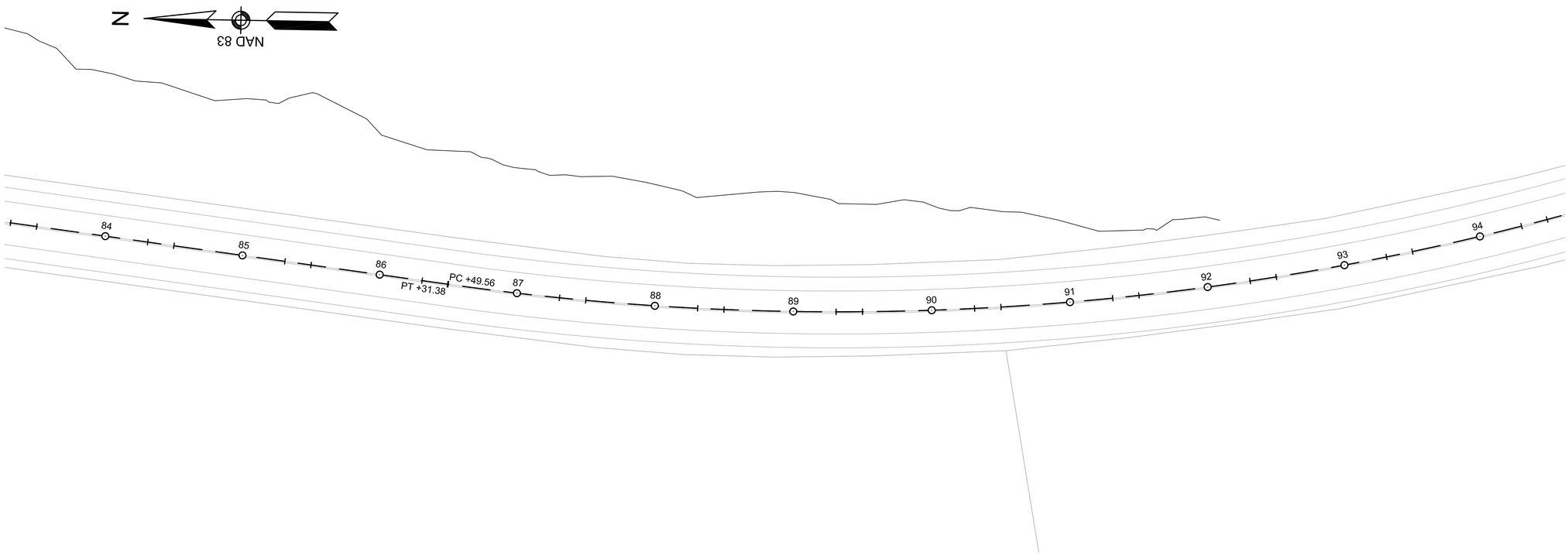
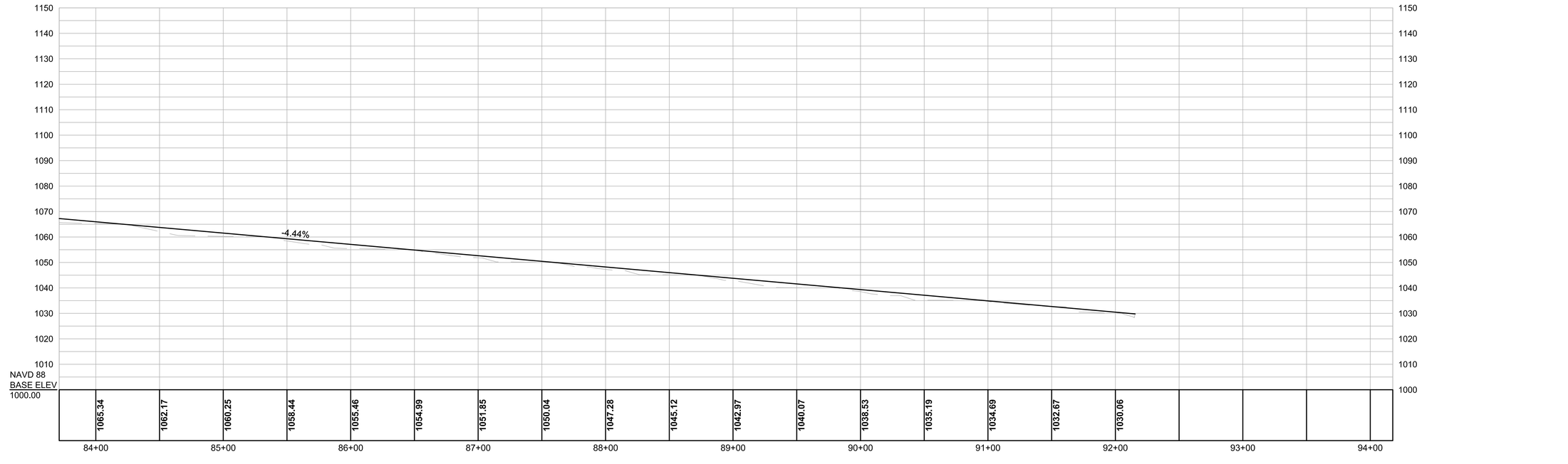
PROJECT FILE NO.	XXXXXX		

SHEET NAME





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SCALE: 1" = 40'

Appendix C. Turning Movement Count Summary – Weston & Sampson

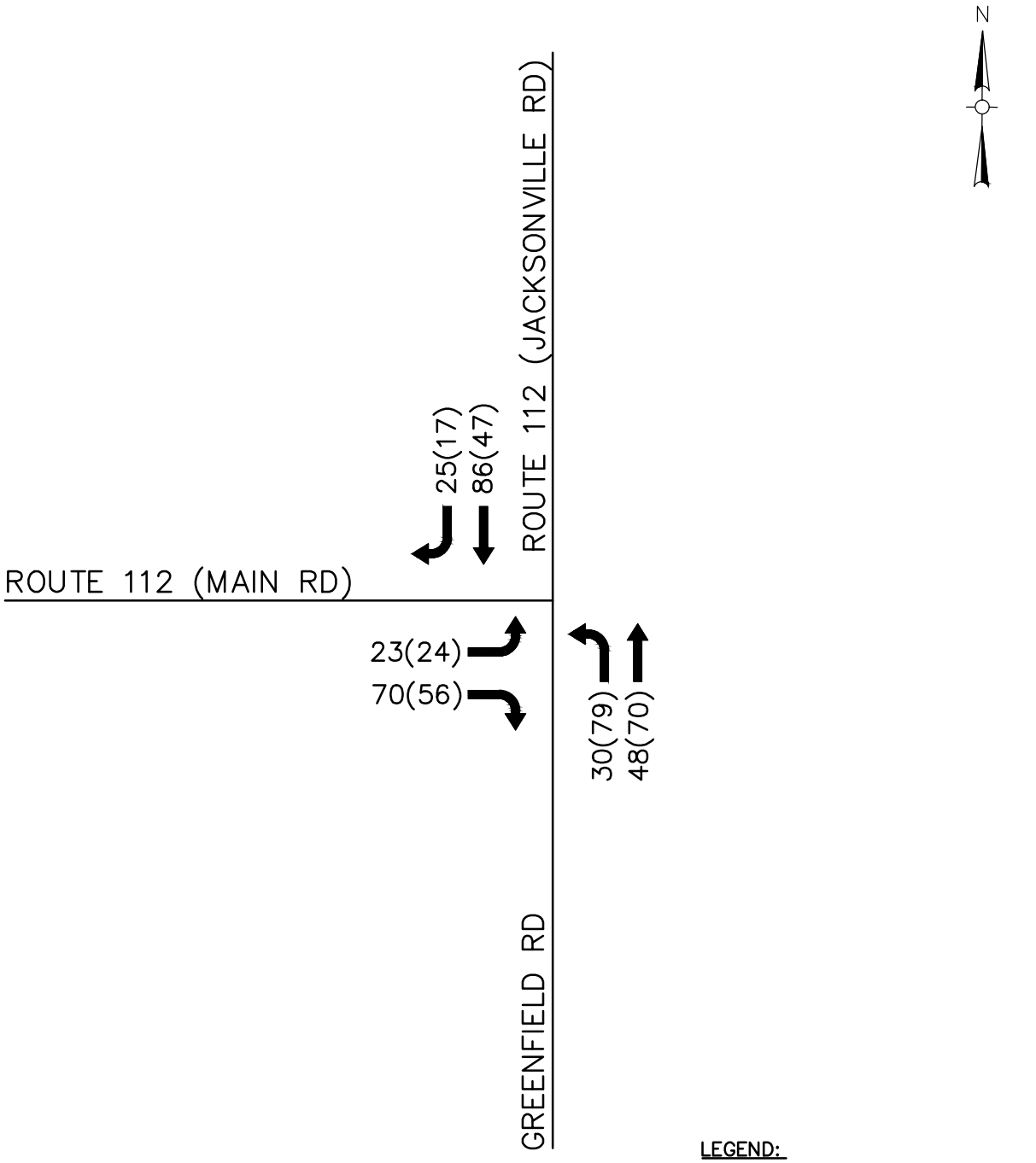


FIGURE 2

EXISTING
PEAK HOUR TRAFFIC VOLUMES

COLRAIN, MA

SCALE: N.T.S.

Weston&Sampson

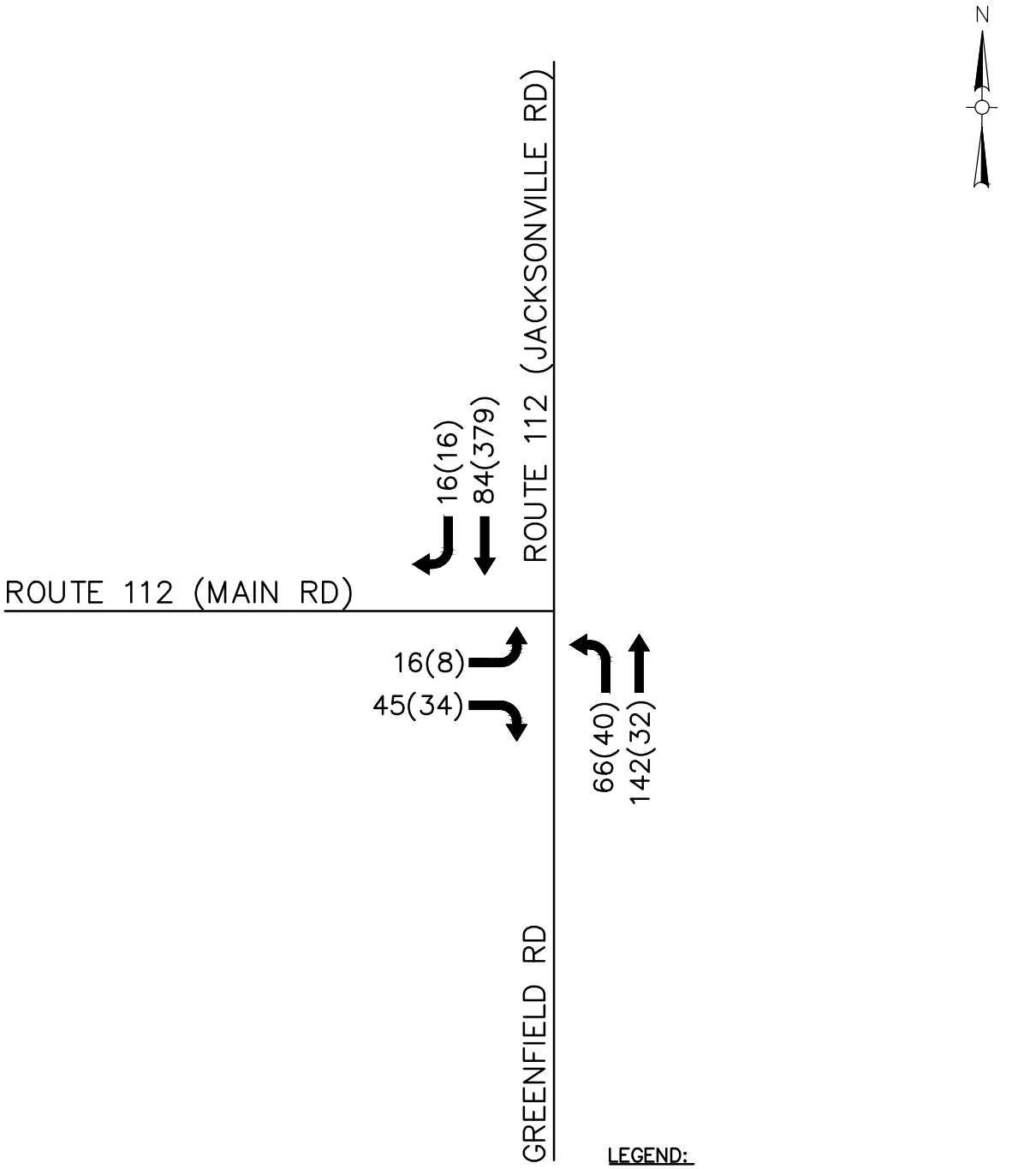


FIGURE 3

EXISTING SEASONAL PEAK HOUR TRAFFIC VOLUMES

COLRAIN, MA

SCALE: N.T.S.

Weston&Sampson

Appendix D. GIS Mapping

Figure 59 - Outstanding Resource Waters

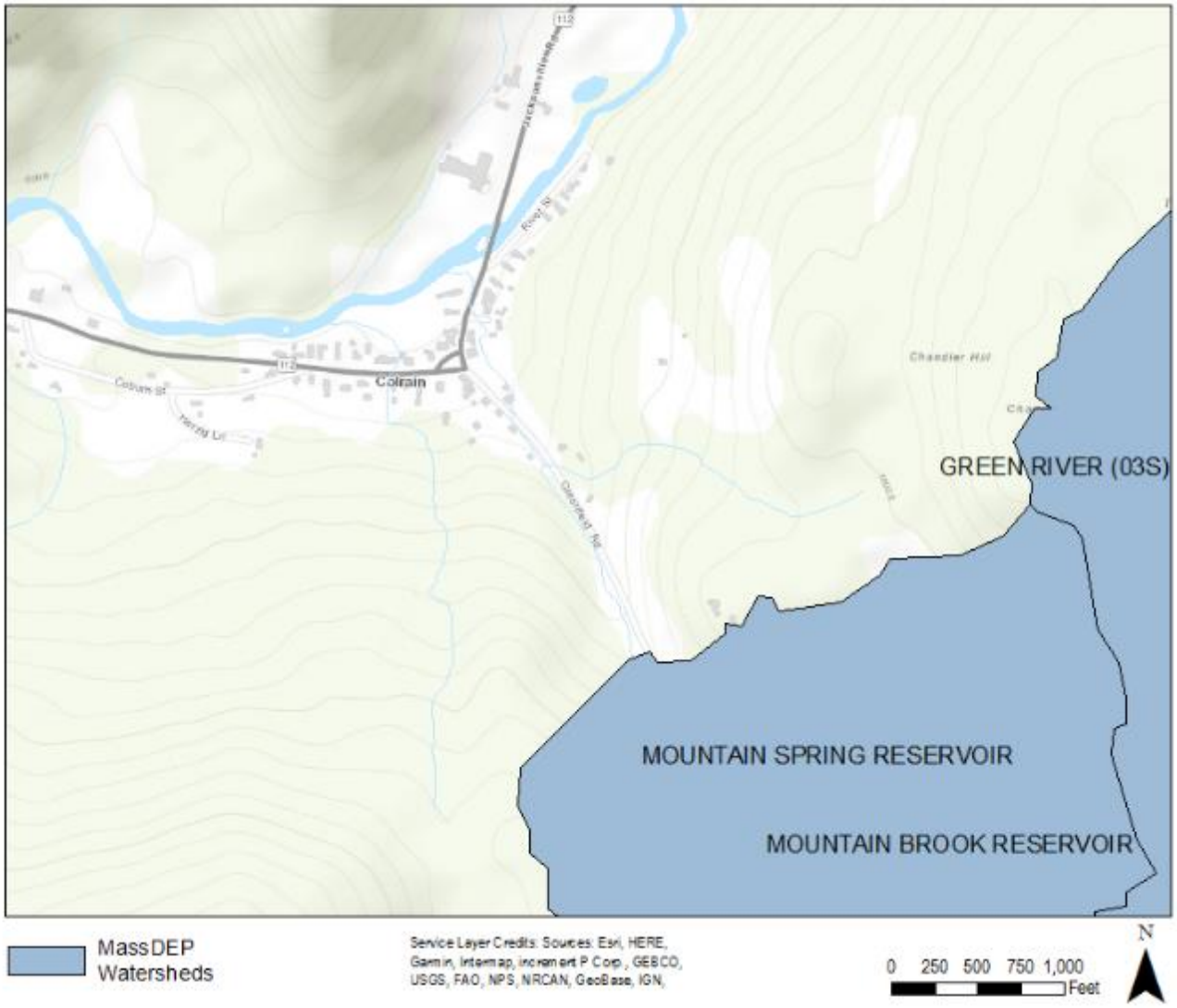


Figure 60 - Stormwater Critical Areas

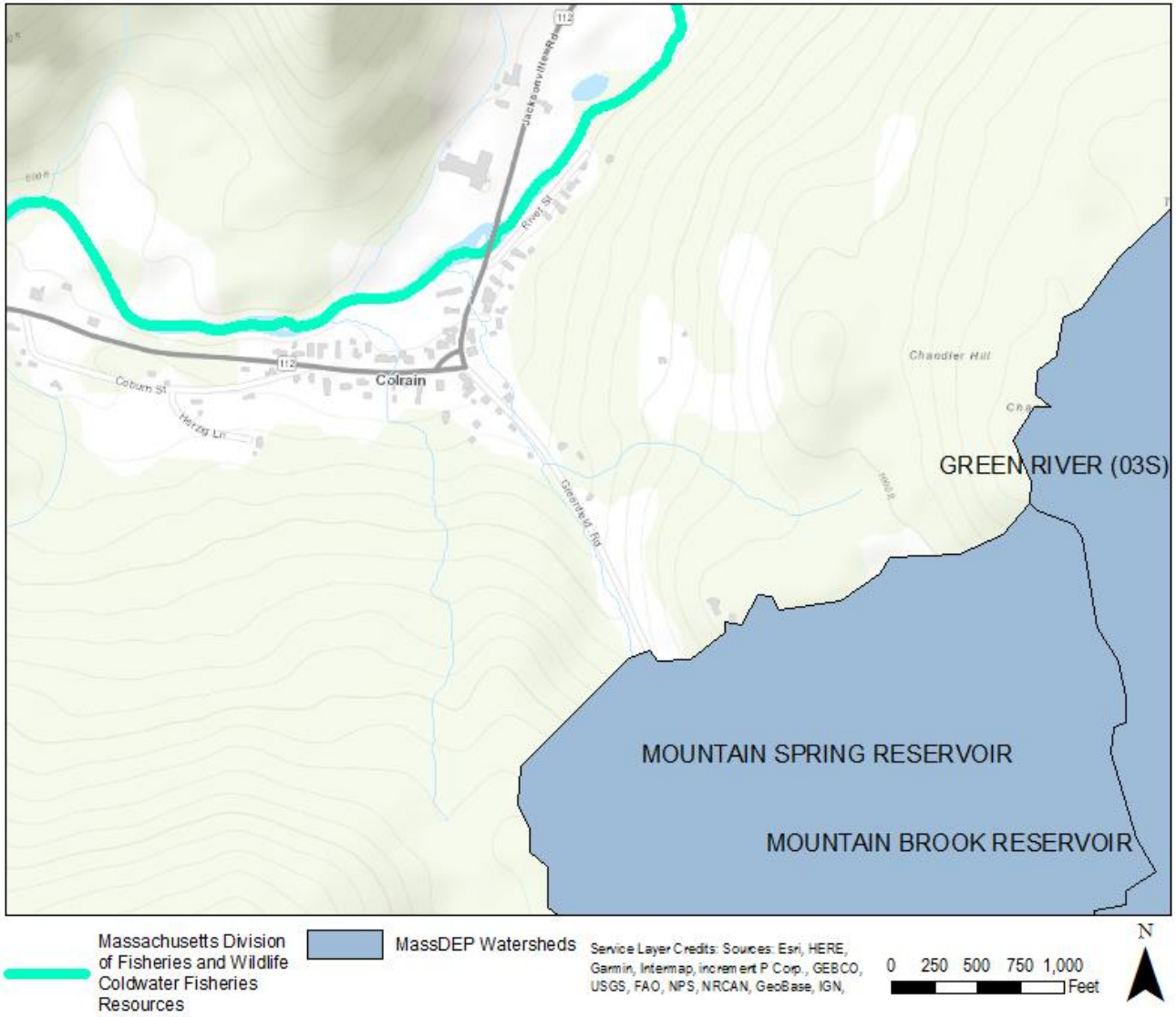


Figure 61 - Regulated Wetland Resources

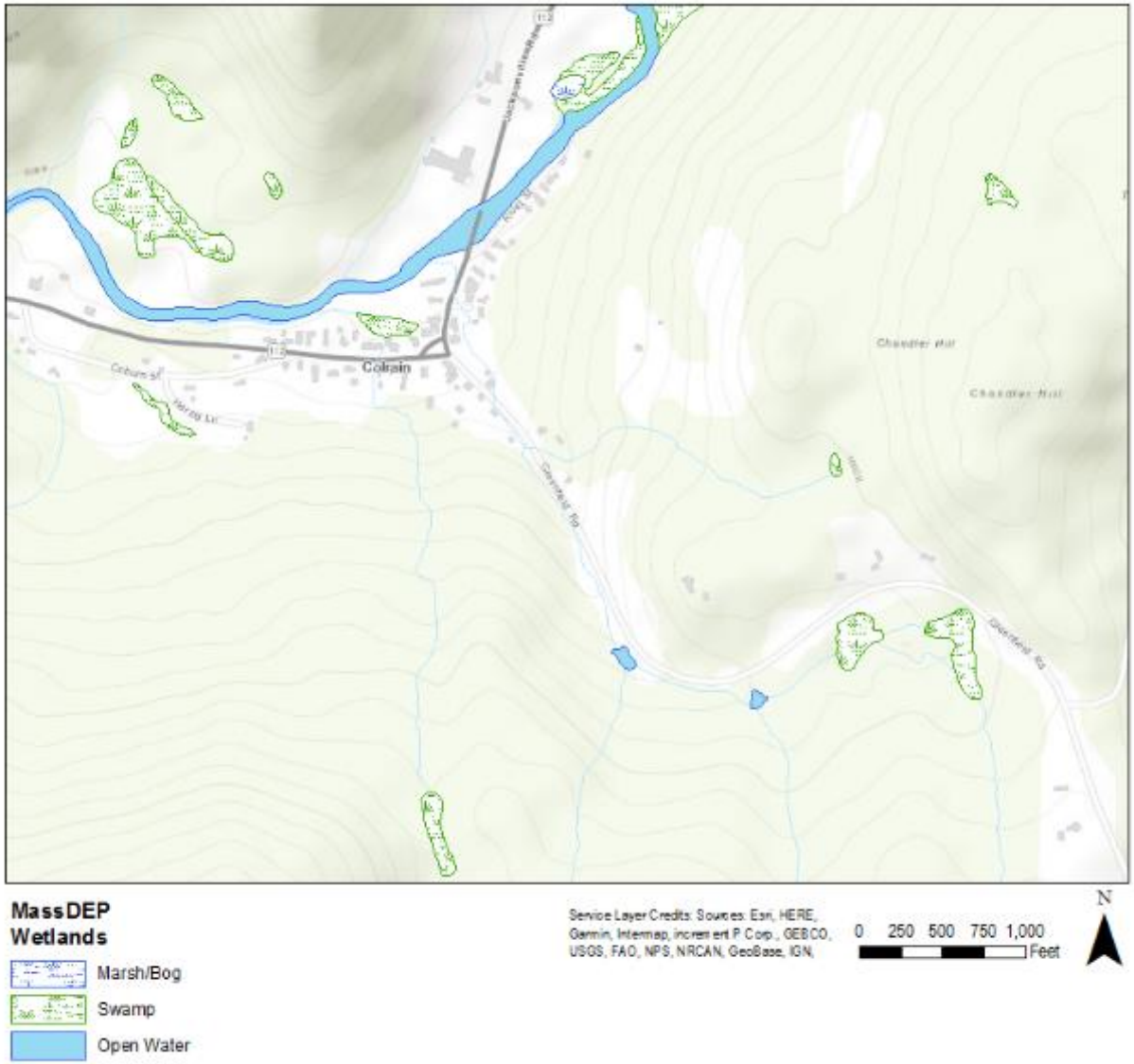


Figure 62 - NHESP Designated Species

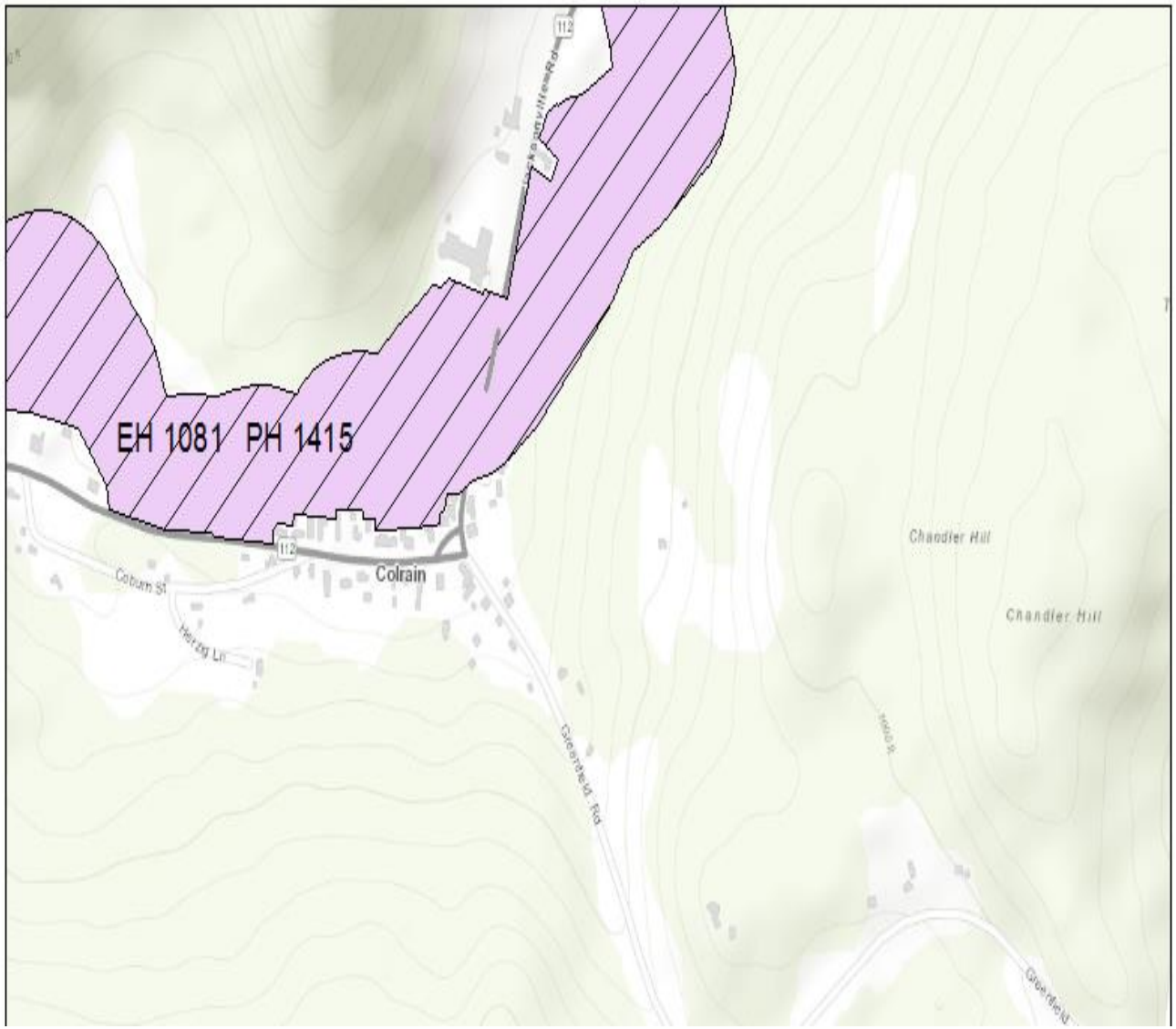
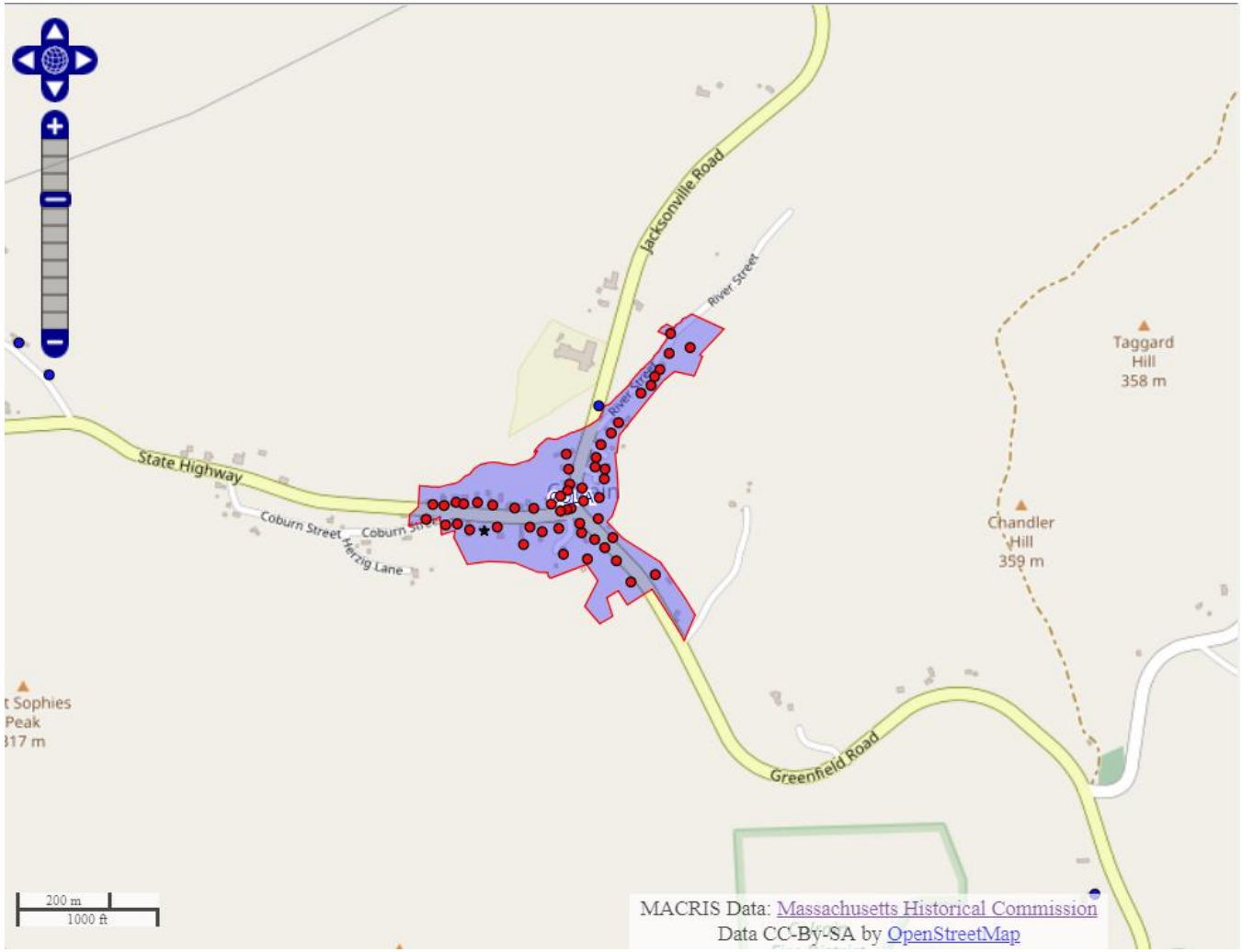


Figure 63 - Colrain Center Historic District



Appendix E. Community Meeting Notes

Meeting Minutes

120 Saint James Avenue
Boston, MA 02116

www.jacobs.com

Subject	**Consultation with Colrain Officials and Public**		
Project	Colrain Road Safety Planning Study		
Project No.	E2X269147	**Location**	Town Garage Meeting Room. 9 Jacksonville Rd.
Prepared by	Dieckmann Cogill, Jacobs	**Date/Time**	April 19, 2018, 6PM
Participants	**Jacobs:** Andrew White, Dieckmann Cogill **Colrain Select Board:** Eileen Sauvageau, Mark Thibodeaux **Town Officials:** Scott Sullivan, Highway; Kevin French, EMD; Chris Lannon, Police; Nicholas Anzuoni, Fire; Kevin Fox, Town Coordinator. **Resident:** Mike Slowinski, Jim Ryan, Laura Slowinski, **Sen. Rosenberg's Office:** Mary Jane Bacon		

Notes

1 **Welcome & Introductions**

Introduction of the Jacobs team and Town of Colrain Officials, representative from Sen. Rosenberg's Office, and members of the public.

2 **Overview of Scope of Jacobs Study**

Jacobs noted that as a result of the recent truck crashes in the town which involved heavy vehicles that had descended the Greenfield Rd Hill, MassDOT had engaged Jacobs to further investigate potential solutions to improve safety. This will build on the recent Road Safety Audit carried out in response to these accidents and will include a review of the current Complete Streets Project from a safety perspective.

3 **Review of Mapping of the area**

Jacobs noted that they had prepared base mapping showing environmental assets, contours, regional roads and the town center as well as noting issues and potential solutions raised during the recent Road Safety Audit.

It was noted that the hill on Greenfield Road has two distinct sections. The initial grade at the top of the hill is in the order of 5%. The grade steepens to 11% about half way down the hill. This steeper section is closest to the town. Many vehicles that use the hill do not appreciate that the grade steepens significantly.

4 **Constraints**

a) Historical

Jacobs asked for confirmation as to what Buildings were on Historic registers. It was noted that the general Town Center area is identified by the Commonwealth as a Historic District. It is also designated a scenic byway and a bicycle route.

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	Three buildings have been hit as a result of crashes. Two houses on the west side of Jacksonville Rd have already been demolished. The blue house damaged in the most recent truck crash is due to be demolished this spring. They are planning to retain the foundation as is and reconstruct in the same place. The yellow house on the south west corner of the Main Rd/Greenfield Rd intersection is listed on the National Register of Historic Buildings. However, it is not the whole structure, just a section in the back that is historic. The church at the corner is not designated a historic structure but is potentially valued in the community. **b) Environmental** It was noted that there is a substantial stream running adjacent to Greenfield Road on the west side. It crosses Greenfield Road and runs directly underneath the house up the hill from the church. This house is boarded up following a fire. The owners continue to pay taxes and hope to restore it at some point. **c) Other** There is a significant amount of solid rock and steep ledge along Greenfield Road with much of the road in rock cutting. This will significantly limit the potential locations of a runaway truck ramp.
5	**Traffic Volumes** Jacobs noted that they have access to the recent Turning Movement counts undertaken by Western & Sampson Engineers (WSE). Jacobs also asked if seasonal counts had been undertaken by the Town. The Town noted that FRCOG have a program of traffic counts and provided some recent counts to Jacobs at the Meeting. It was noted that there were roughly 600-700 vehicles per hour on a Friday and Sunday in the winter. This was seen as a significant increase from regular volumes during other times of the year. Traffic is heaviest in the winter ski season going up to Mt Snow. It was agreed that the Project team should consider movements to and from the school and in particular the location of bus routes and bus stops.
6	**Origin / Destination of Heavy Vehicles on Greenfield Rd** It was noted that trucks are mostly logging and construction trucks related to power line construction and Canadian drivers heading back to Canada. Liquid gas and propane trucks are destined for a location on Main Rd. By informal agreement, these trucks do not use Greenfield Road. **a) Truck Restrictions on Greenfield Rd** Jacobs asked if the Town had considered attempting to ban heavy vehicles from using the hill to descend into Colrain on Greenfield Rd and instead have them use State Route 112 via Shelburne Falls. This idea was supported by Ms L Slowinski. C. Lannon noted that this has been discussed. He believes such a move would require support from the neighboring town of Shelburne. This is seen as difficult because Route 112 passes through the Village of Shelburne Falls, an area with a significant population.

Notes	
	It was also noted that this would be an enforcement issue. That would be difficult to resource. **b) Route 2 Intersection** It was noted that MassDOT had improved the intersection of Greenfield Rd and Route 2. It was felt that the widening of intersection had made this short cut even more appealing for trucks.
7	**Recent Heavy Vehicle accidents** Jacobs requested local knowledge of the details from the recent crashes and the fatality. The causes of the crashes were discussed as follows: • 1st crash – Truck Rollover – Driver error, speed, brakes in poor condition and other mechanical issues • 2nd crash – Fatal – It is believed that the driver missed a gear and was unable to re-enage thus losing control. This was the drivers second trip down the hill that day so he was familiar with the climb. The driver avoided workers in the street before crashing into the blue house at the intersection of Main Road and Greenfield Road. A discussion followed on what an appropriate gear is to travel down the hill for heavy vehicles. The group agreed that one less gear than what is needed to climb the hill is the appropriate gear. If drivers don't get into the low gear at the top of the hill, they won't be able to do it once they start quickly descending. It was felt that better advanced warning signage could be installed to warn drivers of the steep grades and the town. The recently installed solar LED flashing sign did not have the desired impact on drivers.
8	**Other Accidents** The group discussed other vehicle accidents including a number which were caused by ice and skidding including one travelling up Greenfield Rd this past winter which slid off the road and crashed into a guardrail. The group also highlighted that the recent truck accidents are the latest in a long history of heavy vehicle accidents. K Fox stated that although the road safety audit only tracked collisions over the past 7 years, he has news clippings over many years of out of control truck collisions. He stated that he will provide those to the project team. One of the buildings that was previously demolished following accidents was nicknamed the "truck stop". There have been 6 crashes where the vehicle descending the hill had crossed over to the other side of the road in the town. There needs to be thought about how much worse these accidents could have been, had there been school children walking at the time, or others. These could have been much more disastrous and the planning needs to think of them as such. At the time of the truck fatality, there were numerous workers in the vicinity and it is understood that the driver steered to avoid them at the cost of his own life.
9	**Road Safety Audit & Recommendations** The group discussed the Road Safety Audit Report and some of the recommendations. Further discussion on specific recommendations is included in Section 11 below. The strong feeling from those present at the meeting is that the Town would like to catch or stop vehicles before they crash in the Town. In particular, the Town strongly supports a runaway truck ramp and overhead warning signs similar to those installed at other

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	locations along Route 2 including Williamstown and North Adams. It was also felt that the addition of guard rails to protect houses should also be considered.
10	**Complete Streets Project** The meeting briefly discussed the Complete Streets Project. Jacobs noted that they will review the design for safety improvements consistent with the rest of the study.
11	**Potential Solutions** a) **Road Alignment –** Those present at the meeting felt that geometry improvements and roadway realignments won't help the problem of out of control vehicles and are therefore not supported by the town. The town felt that changing the roadway geometry at the intersection won't do anything to stop an out of control truck. Their view is that the main problem is out of control trucks, not poor geometry. If the geometry were fixed it would just move the crash site closer to the bridge, bringing out of control trucks into the town and closer to the school. b) **Runaway Truck Ramp –** The group felt that this was a highly effective treatment and would be very pleased if this became a reality. J Ryan noted that when Greenfield Road was upgrade about 30 years ago the town suggested a runaway truck ramp. At the time, the MassDOT determined that they would not install a ramp, but would monitor the situation. J Ryan also asked what the best location for a truck ramp would be. Jacobs advised that based on experience these are normally in the second half of the hill to catch those trucks that have lost control. If too high on the hill, brake failures have not yet occurred. Jacobs also noted that they would discuss appropriate standards including potential locations with MassDOT. The road as it descends passes through significant areas of rock cutting leaving few places to locate a ramp. M Slowinski noted that there is a property owner about 2/3rd down the hill that would be amenable to consideration of a possible ramp. This is the solution that is considered most promising to the community. The meeting noted that there were examples of truck ramps on the Mass Pike, in the Town of Rowe, Petersburgh NY and Williamstown. The Truck ramp in Rowe is on a town road to the now decommissioned Yankee Nuclear Power Plant that is considered steeper. The Truck ramp in Williamstown at the intersection of Route 2 and Route 7 is on a downward slope and has a ramp and a wire rope catch system. c) **Overhead Sign proposal –** Improved high visibility signs at the top of the hill. Examples were noted in Florida MA, Petersburg NY, Williamstown MA, and RT2 at RT 7. It was suggested that the success rate of this signage be reviewed as part of this study. It was discussed that some active elements to the signage to alert heavy vehicles of the grade, particularly if they are travelling at higher speeds should be investigated. The overhead sign at North Adams for East bound travelers has active message components. Dave Nibbs owns both sides of the roadway at the top of the hill, but is amenable to large signs. It is believed that the road ROW extends approx. 12ft-25ft from edge of pavement. It was also noted that a cantilever style sign, rather than double pole banner style could be considered.

Notes	
	Some members of the meeting thought that MassDOT may have done some geotechnical investigation at the top of the hill which may be useful in designing foundations. It was noted that given the steepening of the grade to 11% halfway down the hill that a second overhead sign warning of this could be investigated. d) **Truck Pull off Area –** Pull off area at the top of hill to allow for turnarounds to get back on 112, and gear check. This would encourage trucks to pull in before the descent, check equipment, and consider turning back to the designated truck route. e) **Advanced Warning Signs –** Install advanced signage at the intersection with Rt 2 to encourage trucks to stay on 112 and warn of the steep grades ahead. f) **Rumble Strips –** These were not supported by the group. It was felt they would cause more accidents particularly for cyclists and motorbikes as well as creating noise. g) **Intersection Controls –** There is a strong objection to any stop control coming in the direction from the bridge or on Greenfield Road. This is due to difficulty keeping momentum going up the hill in the winter. h) **Soft Shoulders –** Ms L Slowinski suggested the Project Team investigate the use of soft shoulders on one side as a means of slowing vehicles down.
12	**Next Steps** Jacobs will initiate the next phase of the study and hopes to have draft findings and recommendations for consideration by July/August timeframe. The Town noted their desire to have some improvements made this coming Summer construction season.

Appendix F. Improvement Options Analysis

Colrain - Road Safety Planning Study

Improvement Options

RSA Category	Treatment Option	Goals	Section	Source	Shortlist	Why shortlisted?	Report Sections	How addressed
Traffic Control Devices	Upgrade signage and pavement marking within the Hill Section of Greenfield Road and approaches - review to include speed limits, warning signs, reflective pavement markers, guardrail reflectors, pavement marking. Bring in line with current standards and to suit the road conditions.	1.1	Improve Existing Signage	Jacobs	Yes	Improved signage provides better warning to the road conditions ahead making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.1.2 Proposed Signage Improvements	Proposed new signage scheme to incorporate improved curve warning, hill warning, advanced warning and intersection warning signs.
Traffic Control Devices	Consider adding warning signs along Greenfield Road southbound and replacing existing signs along Greenfield Road northbound to adequately warn drivers of roadway curves and grades.	1.1	Improve Existing Signage	RSA	Yes	Improved signage provides better warning to the road conditions ahead making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.1.2 Proposed Signage Improvements 6.4.2 Southbound Traffic	Proposed new signage scheme to incorporate improved curve warning, hill warning, advanced warning and intersection warning signs.
Traffic Control Devices	Evaluate regulatory, guide, and warning signs within the study area, considering placement, condition, and mounting height.	1.1	Improve Existing Signage	RSA	Yes	Improved signage provides better warning to the road conditions ahead making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.2 Improve Visibility of Signage	Recommend all new signs compliant with MUTCD at appropriate mounting heights.
Traffic Control Devices	Consider installing a “Trucks Test Brakes” sign at top of hill on Greenfield Road northbound, prior to changes in the roadway grade.	1.1	Improve Existing Signage	RSA	Yes	Is part of the Truck stop and brake check area.	5.2.1 Brake Check Area	Effectively part of Truck stop/check brakes area. Trucks Test Brakes sign is not recommended but installation of a Brake Check Area is.
Traffic Control Devices	Install improved high visibility signs at the top of the hill.	1.2	Improve Visibility of Signage	Community	Yes	Improved signage provides better warning to the road conditions ahead making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.1.2 Proposed Signage Improvements 5.1.4 Overt / Active Signs	Combination advanced warning signs considered as well as overhead signs and ITS / active signs.
Traffic Operations	Evaluate existing advisory speed limit warning signs (yellow only) for visibility, particularly under nighttime conditions, and consider replacing them with new MUTCD compliant signs if necessary.	1.2	Improve Visibility of Signage	RSA	Yes	Improved signage provides better warning to the road conditions ahead making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.2 Improved Visibility of Signs	Recommend all new signs compliant with MUTCD.
Traffic Control Devices	Consider adding object markers to guardrails for increased visibility.	1.3	Improve Delineation	RSA	Yes	Object markers improve delineation and visibility for drivers making it easier to understand the road conditions ahead.	5.1.3.3 Object markers & Delineators	Proposed installation of object markers, chevron markers, RPMs and reflective linemarking to improve delineation.
Traffic Control Devices	Consider installing chevron signs at all curves.	1.3	Improve Delineation	RSA	Yes	Chevron markers improve delineation and visibility for drivers making it easier to understand the road conditions ahead.	5.1.3.4 Chevron Markers	Proposed installation of object markers, chevron markers, RPMs and reflective linemarking to improve delineation.
Traffic Control Devices	Consider installing reflective pavement markers in the whole area to provide better visibility at night.	1.3	Improve Delineation	RSA	Yes	Pavement markers improve delineation and visibility for drivers making it easier to understand the road conditions ahead.	5.1.3.2 Raised Pavement Markers	Proposed installation of object markers, chevron markers, RPMs and reflective linemarking to improve delineation.
Traffic Control Devices	Evaluate and replace pavement markings in the study area.	1.3	Improve Delineation	RSA	Yes	Pavement markings can fade over time. Replacing line markings improves delineation and visibility for drivers making it easier to understand the road conditions ahead.	5.1.3.1 Pavement Markings	Proposed installation of object markers, chevron markers, RPMs and reflective linemarking to improve delineation.
Traffic Control Devices	Provide advance warning signs with strong reinforcement over the entire journey	1.4	Advanced Warning Signs	Jacobs	Yes	Advance warning signs provide better warning to the road conditions ahead making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.1.2 a) Advanced Warning Signs	Advanced warning signs 2 miles and 1 mile in advance of the town center are proposed with additional laternatives to use overhead signs and ITS technology for increased awareness and visibility.
Traffic Control Devices	Consider more overt/active warning signs through the use of ITS and overhead gantries to increase the likelihood that the warning messages are understood and heeded by truck drivers.	1.5	Overt / Active Signs	Jacobs	Yes	Overt and active signs are more effective at gaining the attention of drivers. ITS solutions can target heavy vehicles rather than all drivers. Increased awareness of road conditions making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.4.1 Overhead Warning Signs 5.1.4.2 ITS Enhancements	Advanced warning signs 2 miles and 1 mile in advance of the town center are proposed with additional laternatives to use overhead signs and ITS technology for increased awareness and visibility.
Traffic Control Devices	Consider installing overhead warning signs and/or signs with beacons or LED flashers triggered by vehicle height detectors along Greenfield Road to alert northbound drivers of grade changes in a more conspicuous manner.	1.5	Overt / Active Signs	RSA	Yes	Overt and active signs are more effective at gaining the attention of drivers. ITS solutions can target heavy vehicles rather than all drivers. Increased awareness of road conditions making it more likely that drivers will drive to the road conditions and descend the hill at a safe speed.	5.1.4.1 Overhead Warning Signs 5.1.4.2 ITS Enhancements	Advanced warning signs 2 miles and 1 mile in advance of the town center are proposed with additional laternatives to use overhead signs and ITS technology for increased awareness and visibility.
Traffic Operations	Provide a truck stopping lane/bay and brake check area with sufficient information for the driver.	2.1	Truck Stopping Bay / Brake Check	Jacobs	Yes	A truck stopping bay / brake check area requires trucks to stop and provides an opportunity to read detailed information signs and check brakes. Vehicles start descent from stopped condition making it more likely that they will descend the hill at a safe speed.	5.2.1 Brake Check Area	Two alternatives for a truck stopping bay and brake check area at the top of the hill have been evaluated. Both alternatives require vehicles to commence the descent from a stopped condition.
Traffic Operations	Provide a brake check area at the top of hill. This would encourage trucks to pull in before the descent, check equipment, and consider turning back to the designated truck route.	2.1	Truck Stopping Bay / Brake Check	Community	Yes	A truck stopping bay / brake check area requires trucks to stop and provides an opportunity to read detailed information signs and check brakes. Vehicles start descent from stopped condition making it more likely that they will descend the hill at a safe speed.	5.2.1 Brake Check Area	Two alternatives for a truck stopping bay and brake check area at the top of the hill have been evaluated. Both alternatives require vehicles to commence the descent from a stopped condition.
Traffic Operations	Install a special truck roadway designed to return heavy vehicles to the study area roadways in a lower gear.	2.1	Truck Stopping Bay / Brake Check	Community	Yes	A truck stopping bay / brake check area requires trucks to stop and provides an opportunity to read detailed information signs and check brakes. Vehicles start descent from stopped condition making it more likely that they will descend the hill at a safe speed.	5.2.1 Brake Check Area	Two alternatives for a truck stopping bay and brake check area at the top of the hill have been evaluated. Both alternatives require vehicles to commence the descent from a stopped condition.
Traffic Control Devices	Implement a Truck Speed Limit.	2.2	Speed Limits	Jacobs	Yes	Truck speed limits require vehicles to travel at a reduced speed. This is heavily reliant on enforcement.	5.2.2 Truck Speed Limit	Truck Speed Limits and Speed Feedback Signs have been considered to increase observance of safe speeds during the descent.
Traffic Operations	Consider adding a speed limit sign near 78 Greenfield Road to remind drivers of the posted speed limit for this roadway section and consider installing speed feedback signs on approaches to the intersection.	2.2	Speed Limits	RSA	Yes	Repeat signs increase awareness of speed limit. Speed feedback signs are highly effective at engaging drivers and evoking safe driving behaviors.	5.2.3 Speed Feedback Signs	Truck Speed Limits and Speed Feedback Signs have been considered to increase observance of safe speeds during the descent.
Traffic Control Devices	Provide additional stopping bays on descent where feasible.	2.3	Additional Pull Off Bays	Jacobs	Yes	Stopping bays on the descent provide additional places for heavy vehicles to stop and check or cool their brakes.	5.2.4 Supplemental Pull Off Bays	Additional pull off bays were considered although no suitable locations were identified.
Traffic Operations	Consider suitable locations for a truck emergency ramp.	3.1	Truck Escape Ramp	Jacobs	Yes	Truck escape ramps are highly effective at bringing out-of-control vehicles to a controlled stop on steep descents.	5.3.1 Truck Escape Ramps	Two locations ofr truck escape ramps have been considered.
Traffic Operations	Install a runaway truck ramp or a mechanical wire system along Greenfield Road to address runaway trucks.	3.1	Truck Escape Ramp	Community	Yes	Truck escape ramps are highly effective at bringing out-of-control vehicles to a controlled stop on steep descents.	5.3.1 Truck Escape Ramps	Two types of truck escape ramp including a gravel filled ramp and a mechanical arrestor syetm have been considered.
Traffic Operations	Evaluate feasibility of installing a runaway truck ramp or a mechanical wire system along Greenfield Road to provide a means for runaway trucks travelling downgrade at high speeds to safely leave the roadway.	3.1	Truck Escape Ramp	RSA	Yes	Truck escape ramps are highly effective at bringing out-of-control vehicles to a controlled stop on steep descents.	5.3.1 Truck Escape Ramps	Two types of truck escape ramp including a gravel filled ramp and a mechanical arrestor syetm have been considered.
Traffic Control Devices	Install soft wide gravel shoulders to slow heavy vehicles on descent.	3.2	Soft Shoulders	Community	No	Soft shoulders would create uneven deceleration forces and would pull vehicles off the road way when the passenger side of the vehicle leaves the roadway. This would lead to unsafe conditions and the potential for rollovers. Continued washing out or wear from vehicles would create an ongoing safety drop-off issue requiring ongoing maintenance issue.	Not Considered	Not Considered
Traffic Control Devices	Signage on Route 2 advising heavy vehicles of the steep grades and alternative routes such as 112.	4.1	Truck Ban / Advisory	Community	Yes	Advising drivers before they turn on to Greenfield Road would increase the likelihood of heavy vehicles taking an alternate route thus avoiding the hill altogether.	5.4.1 Alternate Route	Use of Route 112 through Shelburne Falls into Colrain has been considered as an alternate route.
Traffic Control Devices	Install advisory signs on Route 2 warning of steep grades and advising trucks to take 112. (Not a Ban)	4.1	Truck Ban / Advisory	Community	Yes	Advising drivers before they turn on to Greenfield Road would increase the likelihood of heavy vehicles taking an alternate route thus avoiding the hill altogether.	5.4.1 Alternate Route	Use of Route 112 through Shelburne Falls into Colrain has been considered as an alternate route.
Traffic Operations	Consider truck bans or partial bans.	4.1	Truck Ban / Advisory	Jacobs	Yes	Requiring or advising heavy vehicles to take an alternate route reduces the number of heavy vehicles descending the steep hill on Greenfield Road into Colrain.	5.4.1 Alternate Route	Use of Route 112 through Shelburne Falls into Colrain has been considered as an alternate route.

Colrain - Road Safety Planning Study

Improvement Options

RSA Category	Treatment Option	Goals	Section	Source	Shortlist	Why shortlisted?	Report Sections	How addressed
Traffic Operations	Consider adding a truck exclusion zone on Greenfield Road due to the roadway grades.	4.1	Truck Ban / Advisory	RSA	Yes	Requiring or advising heavy vehicles to take an alternate route reduces the number of heavy vehicles descending the steep hill on Greenfield Road into Colrain.	5.4.1 Alternate Route	Use of Route 112 through Shelburne Falls into Colrain has been considered as an alternate route.
Traffic Operations	Provide opportunities for trucks to turn around.	4.2	Turn Around Opportunities	Jacobs	Yes	Heavy vehicles are difficult to turn around and require a large turning radius. Provision of such an area provides an option to heavy vehicles should they need or wish to turn around.	5.4.2 Truck Turnaround Facility	One of the Brake check area alternatives provides for vehicles ti turn around.
Roadway Geometry	Consider removing the church or other properties at this intersection, to allow the roadway horizontal alignment to be improved through the intersection.	5.1	Horizontal Geometry	RSA	Yes	The road geometry is constrained by the church at the intersection in the town center. Removing the church would enable a high design speed road to be constructed reducing the risk of trucks crashing in town. This would not however provide a solution of trucks to descend the hill and pass through the town at a safe speed.	6.1.1 Road Geometry	Several alternate alignments to the curve geometry in the town center have been considered.
Roadway Geometry	Evaluate centerline and cross section profiles of approaching roadways and consider redesigning approach roadways to improve grades and drainage.	5.2	Profile & Cross Section	RSA	Yes	Adjusting the road profile may improve drainage or enable heavy vehicles to maintain control through the town center.	6.1.2 Road Profile	Improvements to the vertical profile have been considered.
Pedestrian and Bicycle Accommodations	Consider adding bicycle amenities (such as bicycle lanes) and related regulatory and warning signs to alert roadway users to the potential presence of bicycle traffic.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.2.3 Bicycle Facilities	Considered as part of review of Complete Streets
Traffic Operations	Consider adding signage or other landscaping amenities to create a gateway treatment for drivers approaching the intersection in order to evoke lower speeds on the approach and entrance to the community.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.7 Landscaping / gateway to town	Considered as part of review of Complete Streets
Roadway Geometry	Consider adding yellow warning beacons or rectangular rapid flashing beacons (RRFB's) to the proposed pedestrian crossings adjacent to the bridge on Jacksonville Road (Route 112) to improve visibility of crossing pedestrians.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.2.2 Pedestrian Crossings	Considered as part of review of Complete Streets
Traffic Operations	Consider installing a warning sign for Coburn Street to warn of post office parking lot traffic.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.1 Coburn Street Intersection	Considered as part of review of Complete Streets
Pedestrian and Bicycle Accommodations	Consider installing rapid rectangular flashing beacons (RRFB's) at crosswalks to increase pedestrian visibility.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.2.2 Pedestrian Crossings	Considered as part of review of Complete Streets
Traffic Operations	Consider installing rumble strips on Greenfield Road to address driver fatigue and prevent runoff crashes. The evaluation should consider noise impacts to adjacent properties.	6.1	Not Related to Project Goals	RSA	No	Community not in favor and not related to trucks losing brakes - fatigue based run off road accidents are not the issue.	Not considered	Not considered
Traffic Control Devices	Consider installing warning signs for Jacksonville Road (Route 112) southbound to warn of approaching curve and grade, as well as upgrading existing signs.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.2 Southbound Traffic	Considered as part of review of Complete Streets
Traffic Operations	Consider installing warning signs to alert drivers approaching the town garage.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.3 DPW Garage	Considered as part of review of Complete Streets
Pedestrian and Bicycle Accommodations	Consider pedestrian desire lines and provide pedestrian accommodations, such as sidewalks, pedestrian ramps, and crosswalks.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.2.1 Sidewalks 6.2.2 Pedestrian Crossings	Considered as part of review of Complete Streets
Pedestrian and Bicycle Accommodations	Consider relocating the existing school bus stop to a more visible location in the vicinity of the intersection.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.5 School Bus	Considered as part of review of Complete Streets
Pedestrian and Bicycle Accommodations	Evaluate existing pedestrian crossing signs for MUTCD compliance.	6.1	Not Related to Project Goals	RSA	No	Achieved as part of Complete Streets project	Not Considered	Achieved as part of Complete Streets Project
Traffic Operations	Evaluate the feasibility of restricting exiting left turns at the church parking lot due to sight distance constraints north of the church.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.8 Church Parking Lot	Considered as part of review of Complete Streets
Traffic Control Devices	Consider installing flashers alerting drivers of approaching school zones.	6.1	Not Related to Project Goals	RSA	No	Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.6 School Speed Zones	Considered as part of review of Complete Streets
Traffic Control Devices	Consider adding gravel treatment below guardrails to prevent future vegetation growth.	6.2	Maintenance	RSA	No	Maintenance issue for Town to consider	Not Considered	Maintenance issue for Town to consider
Traffic Control Devices	Consider clearing vegetation near and on guardrails and performing annual maintenance to control vegetation.	6.2	Maintenance	RSA	No	Maintenance issue for Town to consider	Not Considered	Maintenance issue for Town to consider
Roadway Geometry	Evaluate the use of salt and sand on Greenfield Road and consider pretreatment of the roadways using liquid magnesium chloride.	6.2	Maintenance	RSA	No	Maintenance issue for Town to consider	Not Considered	Maintenance issue for Town to consider
Traffic Operations	Consider installing high friction road treatments to reduce vehicle runoff crashes.	6.2	Maintenance	RSA	No	No pavement or loss of friction related accidents involving trucks. One accident involving snow and ice resulting in rear end accident. Not considered relevant to truck safety issues - Town to consider as part of any future resurfacing program.	Not Considered	Maintenance issue for Town to consider
Traffic Operations	Consider increasing police enforcement for speeding vehicles.	6.3	Enforcement	RSA	No	Enforcement issue for the Town to consider	Not Considered	Enforcement issue for the Town to Consider
Roadway Geometry	Evaluate and possibly eliminate the one-way frontage road that services Jacksonville Road (Route 112) southbound right turns onto Main Road, to discourage use as a channelized right-turn lane.	6.4	Achieved as part of WSE project	RSA	No	Achieved as part of Complete Streets project	Not Considered	Achieved as part of Complete Streets Project
Roadway Geometry	Evaluate the lighting condition of the area and then consider installing additional LED street lights to improve visibility around the intersection.	6.5	Lighting	RSA	No	No night time safety issues - Not related to truck safety and Project Goals - recommend this be considered as part of the Complete Streets project.	6.4.4 Lighting	Considered as part of review of Complete Streets

Objective	Description
1	Inform truck drivers about road conditions.
2	Require Heavy Vehicles to descend the hill at a safe speed.
3	Prevent out of control heavy vehicles from entering the town
4	Minimize heavy vehicles from using Greenfield Rd
5	Enable out of control vehicles to pass through town safely
6	Not relevant to truck safety on Colrain Hill.

Notes:

Lighting - 2 accidents occurred in the lit areas of town. Neither accident was caused or contributed to by a lack of lighting. 1st accident driver was blinded by oncoming headlights, 2nd accident was high speed and loss of control. Whilst improvements to lighting would be supported by the community - there is no crash history that justifies the installation of additional lights. Have Peter do a review of the lit area to see how compliant it is??

Pavement - 3 accidents related to loss of traction / skidding. Each of these involved ice and/or snow. It is not clear that pavement surface was a contributing factor - Inspection and photos to confirm. Recommend high friction wearing course for WSE and bridge projects within limits of work.

JACOBS