Road Safety Audit Report

NH Route 43 at Raymond Road

NH Route 27 at Raymond Road

Candia, NH

RSA Conducted: May 2, 2014

Final Report: December 10, 2014

Strategy Updates:

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1. Introduction

1.1. Objectives of Study

The objective of this study was to complete a road safety audit (RSA) for the New Hampshire Department of Transportation (NHDOT) in the Town of Candia, NH. The study area includes the intersections of NH Route 43 (Old Candia Road/Main Street) at Raymond Road as shown in Figure 1 and NH Route 27 (High Street) at Raymond Road as shown in Figure 2.

Figure 1: Study Intersection #1

Figure 2: Study Intersection #2

1.2. Background

NH 43 is a two-lane, rural arterial that runs north-south from Northwood to Candia. NH 43 provides the major north-south route for several bedroom communities with traffic flowing from Northwood through Deerfield and Candia to the limited access arterial NH 101, which serves as the major highway between Manchester and the New Hampshire Seacoast. NH 43 and NH 107 run together for approximately four miles between Candia and Deerfield, where they split with NH 107 heading toward Concord and NH 43 heading toward Northwood. The other major highway in Candia is NH 27, another two-lane, rural arterial that runs east-west from Hooksett to Hampton. NH 27 is now primarily a collector road for local communities since NH 101 has taken over NH 27's historical role of the regional east-west arterial. There is a high percentage of commuting traffic along these routes as NH 101 provides easy access for nearby bedroom communities to the economic centers of the Merrimack River Valley Region to the west and the Seacoast to the east.

Study Intersection #1 is an unsignalized, four-legged intersection located one quarter of a mile south of the signalized village center of Candia. Main Street is bisected by Old Candia Road and Raymond Road. NH 43 is routed from NH 101 Exit 3 approximately two miles to the south, following Old

Candia Road through this intersection. NH 43 is then rerouted northbound on Main Street through the village center to Deerfield. Old Candia Road changes name to Raymond Road as it passes through the intersection and is also known as NH 101 Business, although there is no signing as such, as this was NH 101 before the expressway was built. There is an overhead flashing beacon at the intersection, but Main Street is stop-controlled from both approaches while the other two approaches are free-flow.

Study Intersection #2 is an unsignalized, three-legged (tee) intersection one quarter of a mile east of the signalized village center. High Street is the local name for NH 27, beginning on the west border of Candia and terminating at this study intersection. High Street is stop-controlled and Raymond Road is free-flow. NH 27 continues east through Raymond terminating at the Seacoast. The intersection is neighbored by several small businesses that are frequented by large trucks.

The Town of Candia identified the Raymond Road intersections at NH 43 (Main Street) and NH 27 (High Street) for the RSA. A fatality occurred in a crash at the intersection of NH 43 and Raymond Road in May of 2003. As part of the RSA application, a collision diagram was provided for the intersection of NH 43 and Raymond Road, which included crashes from 2009 – 2012. Supplemental crash data were provided for the years 2005 – 2012 along with the data from the fatality in May 2003. There were no crash data provided for the intersection of NH 27 and Raymond Road. The purpose of this RSA was to identify safety issues that may be contributing to the reported crashes, identify safety issues that could result in future crashes, and identify potential measures to mitigate these issues.

The RSA was conducted by a team represented by members with expertise in planning, design, operations, and safety. The RSA team consisted of the following members:

Name	Organization	Name	Organization
Michelle Marshall	NHDOT – Highway Safety	Michael McGillen	Town of Candia, Chief of Police
Michael Dugas	NHDOT – Highway Design	Ron Severino	Abutter / Resident
Peter Crouch	NHDOT – Traffic	Scott Komisarek	Abutter
Chuck Flanders	NHDOT – District 5	Frank Gross	VHB
Julie Chen	Southern New Hampshire Regional Planning Commission	Jason Hilton	VHB
Richard Snow	Town of Candia, Selectman	Evan Drew	VHB

1.3. RSA Framework

The eight-step RSA process detailed in the Federal Highway Administration's (FHWA's) *Roadway Safety Audit Guidelines* (FHWA, 2006) was utilized for conducting this RSA. This included a kickoff meeting with the RSA team to review existing information and identify concerns, followed by a field review to verify concerns and identify other potential safety issues. Based on the field review and crash analysis, the team has suggested improvements to address the identified safety issues. The suggestions have been categorized as near-term, intermediate, long-term, and proactive

improvements. Near-term improvements can typically be implemented through maintenance forces, while intermediate and long-term improvements often require additional planning, design, and funding. Proactive improvements were identified to address potential safety issues that have not manifested in crashes. Conceptual drawings were developed for each study intersection, and a benefit-cost analysis was conducted for each alternative. Construction costs were estimated from the NHDOT Weighted Average Unit Prices (NHDOT, 2013) and national averages. Expected benefits were based on crash modification factors (CMFs) obtained from the Highway Safety Manual (AASHTO, 2010), FHWA CMF Clearinghouse (www.cmfclearinghouse.org), and other related resources. Crash costs were based on the NHDOT 2013 Highway Safety Improvement Program Guidelines and FHWA Crash Cost Estimates by Maximum Police-Reported Injury Severity within Selected Crash Geometries (FHWA-HRT-05-051).

The following is a list of possible funding sources to complete the identified improvements. Note that factors considered in determining potential improvement funding sources and levels include: ownership of roadway, magnitude of cost, safety benefits anticipated, and priorities of the program.

Highway Safety Improvement Program (HSIP).

- Eligible projects [§1109; 23 USC 504(e)]:
  - A highway safety improvement project is any strategy, activity or project on a public road that is consistent with the data-driven State Strategic Highway Safety Plan (SHSP) and corrects or improves a hazardous road location or feature or addresses a highway safety problem. MAP-21 provides an example list of eligible activities, but HSIP projects are not limited to those on the list.
  - Workforce development, training, and education activities are also an eligible use of HSIP funds.
- Factors in determining if HSIP funds can be used to support improvements:
  - Benefit-cost ratio must exceed 1.0 for all project costs, including PE, right-of-way, and construction costs.
  - Demands on the funds for other safety improvements being considered in other locations around the State.

Statewide Transportation Improvement Program (STIP)

- The Ten Year Plan is developed through the cooperative efforts of: Local Governments, Regional Planning Commissions (RPC's) and Metropolitan Planning Organizations (MPOs), New Hampshire Department of Transportation (NHDOT), Governor's Advisory Commission on Intermodal Transportation (GACIT), the Governor, and the New Hampshire Legislature. Throughout the Ten Year Plan development there are also numerous opportunities for public involvement and input.

Transportation Alternatives Program (TAP).

- Funding limitations include:
  - Minimum project limit is $200,000 (total) - $160,000 (federal funds).
  - Maximum project limit is $800,000 (total) - $640,000 (federal funds).
  - Project will require at least a 20% match provided by the applicant.
  - Note that projects can exceed the $800,000 cap if other funding sources are added to the project. Projects can also request less than the minimum cap as long as other funding sources are added to keep a minimum of $200,000 for the total project cost.
- Eligible activities include:
  - Construction, planning and design of on-road and off-road trail facilities for pedestrians, bicyclists, and other non-motorized forms of transportation.
  - Construction, planning and design of infrastructure-related projects and systems that will provide safe routes for non-drivers, including children, older adults, and individuals with disabilities to access daily needs.
  - Conversion and use of abandoned railroad corridors for trails for pedestrians, bicyclists, or other non-motorized transportation users.
  - Eligible Safe Routes to School program infrastructure activities under Sections 1404 of SAFETEA-LU (20% match required).

2. Existing Conditions

2.1. Geometric Conditions

2.1.1. NH 43 at Raymond Road and Main Street

All approaches are two-lane, undivided roads. Old Candia Road is posted at 55 mph to the west of the RSA study area and 45 mph within the RSA study area. Raymond Road is posted at 45 mph between both study intersections. Main Street is posted at 35 mph. The pavement width along Old Candia Road and Raymond Road is approximately 36 feet with 12-foot lanes and 6-foot shoulders. Main Street has 11-foot lanes with variable shoulder widths along both approaches. Pavement markings include a centerline and edge lines along all approaches. There is a passing zone for southbound vehicles on Old Candia Road just west of the study intersection. There are nearby residential and commercial driveways on all approaches. Nearby commercial and recreational properties include the Manchester Bible Church, Candia Youth Athletic Association, Holbrook Cemetery, and proposed businesses that include a farm stand. There is an entrance to the Holbrook Cemetery into the intersection. Although this driveway is gated, it does not have any other form of traffic control or signing. The vertical alignment along NH 43 is varied with rolling terrain. There are grade differences between all four approaches. The horizontal alignment is straight on the Old Candia Road approach and both Main Street approaches. Raymond Road gradually curves between the two intersections (NH 43 and NH 27).

2.1.2. NH 27 at Raymond Road

Raymond Road continues from the first study intersection through NH 27 (High Street) and remains a two-lane, undivided road with a posted speed limit of 45 mph in the RSA study area. At the study intersection, Raymond Road joins NH 27 and is posted at 45 mph east of the study area. NH 27 (High Street) is a two-lane, undivided road posted at 35 mph. The pavement width along Raymond Road is approximately 36 feet with 12-foot lanes and 6-foot shoulders, narrowing to 11-foot lanes and variable shoulder widths to the east of the study intersection as it joins with NH 27. The pavement width along NH 27 (High Street) is 26 feet with variable shoulder dimension. Pavement markings include a centerline and edge lines along High Street and Raymond Road. There are nearby driveways on both major road approaches that provide access to residential and commercial properties. Nearby commercial properties include Viking Propane and several other businesses involving oil transportation, heavy equipment sales, maintenance, and storage. The vertical alignment along High Street and Raymond Road is relatively flat within the study area. The horizontal alignment is straight along High Street, but the intersection is at the end of a horizontal curve along Raymond Road.

2.2. Traffic Data

Annual average daily traffic (AADT) estimates were obtained from the Southern New Hampshire Planning Commission (SNHPC). The AADT values are illustrated in Appendix A, Figure A.1. In 2012, the AADT was 10,000 vehicles per day on NH 43/Old Candia Road, 5,100 vehicles per day on NH 43/Main Street, 4,100 vehicles per day on Raymond Road (between the focus intersections), and 740 vehicles per day on Main Street. In 2012, the AADT was 1,800 vehicles per day on NH 27/High Street, 4,100 vehicles per day on Raymond Road (between the focus intersections), and 5,400 vehicles per day on NH 27/Raymond Road. Detailed turning movements were also provided for the two study intersections by SNHPC and are provided in Appendix A, Figure A.2 and Figure A.3.

2.3. Crash Analysis

Crash data were obtained from the NHDOT crash database. The SNHPC developed a collision diagram for the intersection of NH 43/Main Street and Raymond Road based on crash data from 2009 – 2012. The collision diagram is provided in Appendix B. There were a total of 17 crashes at the intersection from November 2009 to September 2012. Based on the four years of data, there are approximately four crashes per year on average. This section presents the results of the crash analysis by month, type, day of week, and time of day.

Figure 3 shows the distribution of the 17 identified crashes by month. There appears to be a peak in the fall months (September – November), which coincides with the Deerfield Fair in late September and fall tourism of the region. The Henry W. Moore School, serving the Candia community with Kindergarten through 8th Grade classes, is located north of the study intersection on NH 43/Main Street. The peak in crashes also corresponds with the beginning of the school year.

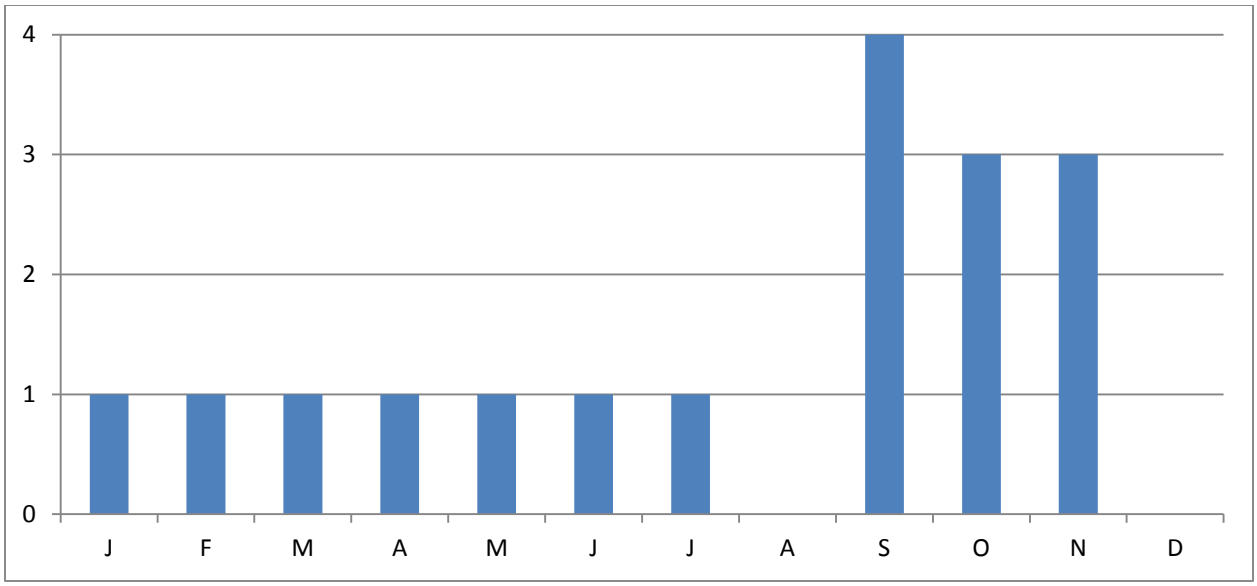


Figure 3: Summary of Crashes by Month

Figure 4 shows the distribution of reported crashes by type. There were 13 rear end crashes, which represent more than 75 percent of the crashes reported from 2009 - 2012.

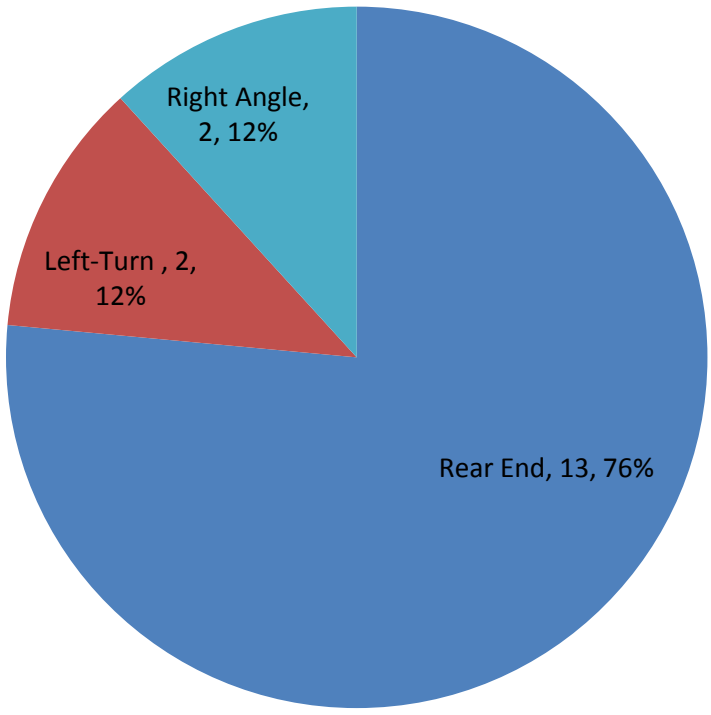


Figure 4: Summary of Crashes by Type

Figure 5 shows the distribution of reported crashes by the day of the week. There appears to be a peak on Tuesdays and during the weekend. The RSA team did not have an explanation for the peak of crashes on Tuesdays.

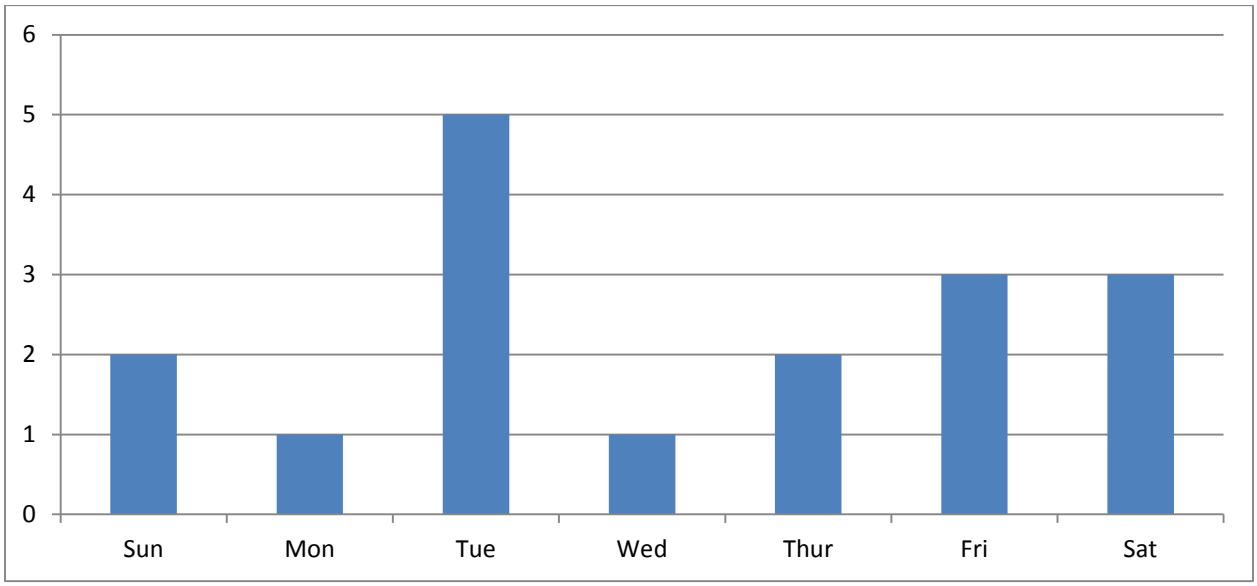


Figure 5: Summary of Crashes by Day of Week

The crash distribution by time of day is shown in Figure 6. There is a lunchtime peak from 11am – 1pm, but more than half of the reported crashes (53 percent) occurred during evening commute or nighttime hours.

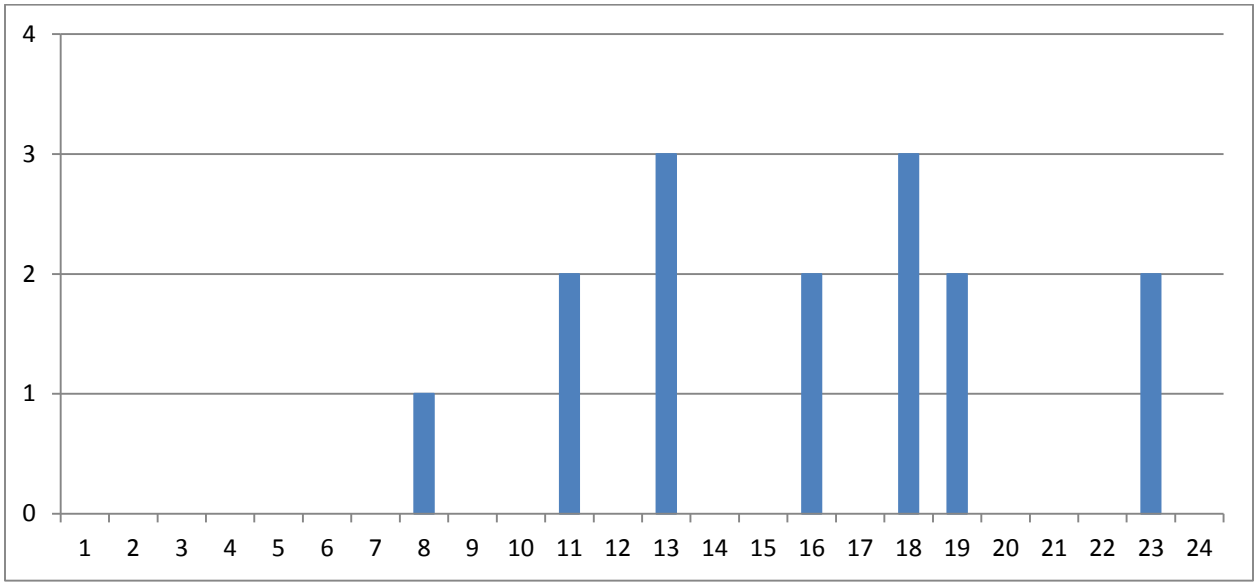


Figure 6: Summary of Crashes by Time of Day (24 Hr Clock)

3. Assessment Findings

3.1. Safety Benefits of Existing Roadway Features

There are notable benefits provided by existing roadway features that are described below:

- **Positive Attitude and Multi-Agency Collaboration** – Throughout the course of the RSA process, the Town of Candia, SNHPC, NHDOT, Candia Police, and local residents provided support and were open to suggestions to enhance safety and improve communication and collaboration. This attitude will help to maintain a long-term commitment to improving safety for residents and guests of the Town.
- **Flashing Beacon** – There is a flashing beacon at the intersection of NH 43 and Raymond Road. This helps to improve driver awareness of the intersection from all approaches.
- **Pavement Markings** – Centerline and edgeline pavement markings are provided on all roadways in the study area. Stop bars are also provided on most of the approaches. Pavement markings define the appropriate path for vehicles and help drivers to navigate, particularly at night.
- **Paved Shoulders** – There are relatively wide (5 -6 feet) paved shoulders on Raymond Road. This provides room for vehicles to maneuver or recover in the event of a lane departure. The wide shoulders also provide an opportunity for bicyclists to separate themselves from motor vehicle traffic.
- **Lighting** – Intersection lighting is provided at the intersection of NH 43 and Raymond Road as well as the intersection of NH 27 and Raymond Road. This helps to define the intersection at night.

3.2. Identified Safety Issues and Suggestions for Improvement

Despite the existing safety measures to improve road safety at the intersections, the RSA team identified five general issues at the intersection of NH 43 and Raymond Road and five general issues at the intersection of NH 27 and Raymond Road. The RSA team prioritized the issues based upon their perceived importance in the study area. The prioritized list of issues is summarized in Table 3.1 with a qualitative risk assessment. The qualitative assessment is based on the expected crash frequency and severity. Expected crash frequency is qualitatively estimated on the basis of expected exposure and probability. Exposure is related to how many road users will likely be exposed to the identified safety issue. Probability conveys how likely it is that a collision will result from the identified issue. Expected crash severity is qualitatively estimated on the basis of factors such as anticipated speeds, expected collision types, and the likelihood that vulnerable road users will be exposed. The two risk elements, frequency and severity, are then combined to obtain a qualitative risk assessment on the basis of the matrix shown in Table 3.2.

Table 3.1 Summary of Potential Safety Issues

Location	Identified Issues	Expected Crash Frequency	Expected Crash Severity	Qualitative Risk Assessment
NH 43 at Raymond Road	Roadway Geometry	Frequent	Serious	Highest
	Driver Behavior	Occasional	Moderate	Moderate-High
	Pavement Markings	Infrequent	Moderate	Moderate
	Roadside Hazards	Rare	Serious	Moderate
	Nearby Access Points	Rare	Moderate	Low
NH 27 at Raymond Road	Roadway Geometry	Infrequent	Serious	Moderate-High
	Driver Behavior	Infrequent	Moderate	Moderate
	Signing and Markings	Infrequent	Moderate	Moderate
	Nearby Access Points	Rare	Serious	Moderate
	Drainage Issues	Rare	Moderate	Low

Table 3.2 Crash Risk Assessment Matrix

Frequency Rating	Severity Rating			
	Minor	**Moderate**	**Serious**	**Fatal**
Frequent	Moderate-High	High	Highest	Highest
Occasional	Moderate	Moderate-High	High	Highest
Infrequent	Low	Moderate	Moderate-High	High
Rare	Lowest	Low	Moderate	Moderate-High

The remainder of this section provides a detailed discussion of the issues along with the RSA Team's suggestions to correct or mitigate the identified issues. Conceptual drawings are provided in Appendix C and cost estimates for those alternatives are provided in Appendix D. Appendix E provides a benefit-cost analysis for suggested intermediate and long-term improvements that are associated with crashes during the study period. Appendix F provides a complete summary of suggested improvements.

NH 43 at Raymond Road

ISSUE 1: ROADWAY GEOMETRY

The RSA team identified safety issues related to the roadway geometry at the intersection. The specific issues include the following:

- **The intersection is "skewed"**, which means that the roads do not intersect at 90 degrees. This creates several potential safety issues.
    - First, drivers on Main Street must look back over their left shoulder or use their side mirror to look for approaching vehicles on the mainline. This can be difficult, particularly for older drivers, and draws the drivers' attention away from the direction of travel. This is compounded by the various objects (e.g., signs, poles, and concrete barriers) located in the sight triangle. Based on the narrative in the police crash reports, it is apparent that the skew is contributing to several rear-end crashes on the southbound Main Street approach. Specifically, the first driver edges forward as they are making a right turn and driver two assumes that driver one has cleared as they look over their shoulder for traffic on Raymond Road. A rear-end occurs when driver two proceeds, but driver one is still waiting for a gap. There were a total of 13 reported rear-end crashes in a three-year period.
    - The skew also allows drivers on eastbound NH 43 to turn left (north) onto Main Street at a high speed. The same is true for westbound drivers on Raymond Road turning left (south) onto Main Street.
    - Finally, the skew creates a wide area of pavement within the intersection. This creates a scenario where left-turning drivers from NH 43 and Raymond Road actually need to pass each other before making the left-turn onto Main Street. This can create confusion because the left-turn movements at a typical (non-skewed) intersection cross in front of each other.
- **There is a crest vertical curve** to the north of the intersection that limits sight distance. The crest curve limits sight distance from the intersection for drivers turning at the intersection. It also limits sight distance to the intersection for drivers approaching the intersection from Raymond Road. The vegetation on the inside of the horizontal curve (east side of Raymond Road) further limits sight distance. While the crest curve "limits" sight distance, the available stopping sight distance is approximately 450 feet and the available intersection sight distance is approximately 750 feet, which both exceed the AASHTO Green Book minimum sight distances for the posted speed (AASHTO, 2011). [Note that for a 45 MPH major road posted speed, the AASHTO Green Book indicates a 360 ft. stopping sight distance and 500 ft. intersection sight distance for left-turning vehicles from a stop.] There were two right-angle crashes at the intersection during the three-year study period, both involving southbound drivers on Main Street and westbound drivers on Raymond Road. There were also two left-turn crashes during the study period, which involved an

eastbound left-turning vehicle on NH 43 and a westbound through vehicle on Raymond Road. In addition to the reported crashes, members of the RSA team noted several near misses at the intersection.

- **There are no turn lanes** for eastbound and westbound drivers on NH 43 and Raymond Road. As such, turning vehicles must wait in the through lane until there is an acceptable gap. This creates potential conflicts between the through movements and turning movements on the same approach. The queue waiting to turn left onto Main Street from eastbound NH 43 can also create a sight obstruction for drivers on southbound Main Street. Members of the RSA team noted that this is a particular concern during the evening peak. Additionally, the skew of the approaches results in a gap in the mainline double yellow centerline that is over 100 feet long. This adds to the confusion of the appropriate location to stop/yield on left turns from the mainline.

View from southbound Main Street approach looking north toward Raymond Road. The photo shows the severe skew of the intersection. Photo also shows the limited sight distance created by the crest curve.

View of the intersection looking north. Photo shows the limited sight distance from northbound Main Street created by the vegetation and crest curve. The photo also shows the lack of turn lanes and a driver waiting in the through lane to turn left onto Main Street.

The following is a list of potential mitigation measures related to these issues:

Near-Term

1.1 Move the stop bar on southbound Main Street closer to the edge line to discourage drivers from double-stopping.

1.2 Close the northbound Main Street approach. This could be done as a temporary closure as part of the Deerfield Fair. Under this scenario, the church could be provided access to Old Candia Road either directly via a new driveway or indirectly via Main Street and Adams Road.

Intermediate

1.3 Consider realigning the intersection, moving the westbound Raymond Road approach to the north and switching the stop-control from the southbound Main Street approach to the westbound Raymond Road approach. This is illustrated in Appendix C.1. Under this scenario, the through movement from eastbound NH 43 onto Raymond Road could remain. The stop-controlled approach from Raymond Road could incorporate a right-turn slip-lane. This will provide better sight distance from the stop-controlled approach and create a more perpendicular intersection. This also better facilitates the predominant traffic movements. A potential drawback is that the Raymond Road approach is currently the through movement and it would take additional education and warning devices to notify drivers of the change in traffic control.

1.4 Consider realigning the intersection, moving the southbound Main Street approach to the east. This will provide better sight distance and create a more perpendicular intersection as illustrated in Appendix C.2.

1.5 Consider installing left-turn lanes on the mainline to separate turning traffic from through traffic. This could include defined left-turn lanes at the intersection or a continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27. The TWLTL may also help to indicate a change in land use and activity, changing the drivers' perception of the area as illustrated in Appendix C.2.

Long-Term

1.6 Consider installing a roundabout at the intersection as illustrated in Appendix C.3. There would be a high cost and impact to private property under this scenario, but roundabouts traditionally greatly reduce angle crashes. The severe skew of the approaches would make the design (i.e., tying at least three approaches into a low-speed roundabout) very difficult.

ISSUE 2: DRIVER BEHAVIOR

The RSA team identified driver behavior issues, including the following:

- **Drivers are exceeding the posted speed limit** on the mainline (NH 43 and Raymond Road). A formal speed study has not been conducted, but members of the RSA team, including Candia Police, indicated that speeds often exceed 45 mph. This is both a driver behavior and geometric design issue. The speed limit changes along the corridor, but roadway character does not change. As such, there are no cues that drivers should reduce their speed in the sections where the posted speed is lower. Another factor contributing to higher speeds is the overall design of the roadway. The roadway was designed to relatively high standards as it was formerly the primary route between Manchester and the Seacoast. The higher standards (e.g., wider lanes and shoulders) typically encourage higher speeds. The Candia Police also noted that it is difficult to enforce speeds along the corridor (between Candia and Hookset) because the posted speed limit changes so frequently. This area represents the commercial district of Candia, so the posted speed limit is reduced from 50 mph to 45 mph.
- **Driver distraction/inattention** is a potential contributing factor to some of the police-reported crashes. Specifically, the RSA team observed several drivers using a cell phone while driving. This detracts from the driving task and could be a contributing factor in several of the rear-end crashes on the southbound Main Street approach. While the roadway geometry is likely the primary contributing factor, other distractions reduce the amount of information that a driver will process from the roadway.
- **Drivers are not stopping completely at the stop sign.** The RSA team observed several drivers performing rolling stops on the southbound Main Street approach. This can lead to safety issues if the trailing driver assumes the first driver is proceeding and continues to move forward as the first driver stops due to a conflicting vehicle on the mainline.

The following is a list of potential mitigation measures related to these issues:

Near-Term

2.1 Conduct a speed study to identify the relative magnitude of the "speeding" issue and determine the appropriate speed limit. From a law enforcement standpoint, it would be preferable to post the speed consistently between Candia and Hooksett. Note that if the desire is to reduce speeds through the corridor, changing the posted speed alone has little impact on vehicle speeds without additional enforcement or changes in the roadway characteristics. Also consider that a speed study may suggest a higher speed limit than is currently posted.

2.2 Communicate results of the speed study with local courts so they can better understand the reason for posting the speed lower in the study area.

Intermediate

2.3 Consider installing a continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27 (see suggestion 1.5). The TWLTL may help to indicate a change in land use, changing the drivers' perception of the area as illustrated in Appendix C.2.

ISSUE 3: SIGNING AND PAVEMENT MARKINGS

The RSA team identified the following safety issues related to pavement markings:

- **There is a wide break in the centerline** at the intersection. Pavement markings define the appropriate path for vehicles and help drivers to navigate, particularly at night. The wide break reduces guidance within the intersection, which can lead to potential safety issues. For example, the RSA team observed eastbound drivers traveling on NH 43 cutting the corner as they made a left turn and encroaching on the southbound lane of Main Street.
- **The edgeline is not continuous** around the corner radius from eastbound NH 43 onto southbound Main Street. This makes it difficult for westbound drivers on Raymond Road to determine the limits of the lane as they turn left onto Main Street. Similarly, it makes it difficult for southbound drivers on Main Street to determine the limits of the lane as they cross the intersection onto Main Street. This issue is mirrored on the northeast corner of the intersection (Raymond Road westbound onto northbound Main Street).
- **There is a passing zone on NH 43** southbound that starts at the intersection. While this has not manifested in crashes based on a review of the crash history, the passing zone may encourage higher speeds.

The following is a list of potential mitigation measures related to these issues:

Near-Term

3.1 Consider extending the centerlines and continuing the edgeline around the corner radius of NH 43 (eastbound) onto Main Street (southbound) and Raymond Road (westbound) onto Main Street (northbound).

3.2 Consider extending the no passing zone further west on NH 43.

View of the intersection looking south from Main Street. Photo shows the extensive pavement within the intersection that is not defined by pavement markings.

View of the intersection looking north from Main Street. Photo shows the discontinued edgeline from eastbound NH 43 onto southbound Main Street.

ISSUE 4: ROADSIDE HAZARDS

The RSA team identified the following safety issues related to roadside hazards.

- **There are exposed drainage structures** along the roadside.
- **There are utility poles and other fixed objects** (i.e., concrete barrier) in close proximity to the roadway.

While there were no recent crashes involving roadside fixed objects, there is the potential for drivers to leave the roadway. The design and placement of roadside features can influence the probability of a crash occurring if a vehicle leaves the road, and also impacts the severity of the crash if a vehicle strikes a roadside object. The AASHTO Roadside Design Guide notes the following, in order of preference, for addressing roadside hazards (AASHTO, 2011).

1. Remove the obstacle.
2. Redesign the obstacle so it can be safely traversed.
3. Relocate the obstacle to a point where it is less likely to be struck.
4. Reduce impact severity by using an appropriate breakaway device.
5. Shield the obstacle with a longitudinal traffic barrier designed for redirection or use a crash cushion.
6. Delineate the obstacle if the above alternatives are not appropriate.

View of northbound approach on Main Street. Photo shows one of the two exposed drainage structures along the east side of the intersection.

View of Main Street (left) and Raymond Road (right), looking north. Photo shows several roadside hazards including utility poles and concrete median barrier that is being used to discourage drivers from using the grass area as an unofficial intersection.

The following is a list of potential mitigation measures related to these issues:

Near-Term

4.1 Delineate fixed objects that are close to the roadway using retroreflective tape or object markers.

Intermediate

4.2 Consider removing, redesigning, or relocating fixed objects that are within the clear zone, particularly along the outside of curves. This would include the redesign of the drainage structures so they are traversable. The realignment of the intersection (see Issue 1) should eliminate the need for the sections of concrete median barrier that are placed near the intersection.

Long-term

4.3 Consider relocating utility poles to the inside of horizontal curves, where they are less likely to be struck.

ISSUE 5: PROXIMITY TO ACCESS POINTS

There are several access points within close proximity to the intersection. Access points create additional conflict points and increase the potential for crashes. When access points are located near intersections, it increases the complexity of the driving environment as drivers have more information to observe and process. The specific access points include:

1. Access to the cemetery, which forms an informal fifth leg of the intersection.
2. Church driveway along the northbound approach of Main Street.
3. Access to the Candia Youth Athletic Association (CYAA), which is located approximately 500 feet east of the intersection along Raymond Road.
4. Access to the truck/storage property, which is located approximately 800 feet east of the intersection along Raymond Road.

View of the intersection looking north toward Main Street (top left) and Raymond Road (top right). Photo shows the proximity of the access to the cemetery (left).

The following is a list of potential mitigation measures related to these issues:

Near-Term

5.1 Consider leaving the gate to the cemetery closed with access for emergency only and for funerals with police special detail traffic control required. It is expected that the Candia Cemetery Committee would need to approve the closure and it may be necessary to install a sign noting that the entrance is closed to public access.

NH 27 at Raymond Road

ISSUE 1: ROADWAY GEOMETRY

The RSA team identified safety issues related to the roadway geometry at the intersection. The specific issues include the following:

- **The intersection is "skewed"**, which means that the roads do not intersect at 90 degrees. While there were no reported crashes at this intersection during the study period, the skew creates several potential safety concerns.
    - First, drivers on High Street must look over their right shoulder to look for vehicles approaching from the west on Raymond Road. This can be difficult, particularly for older drivers, and draws the drivers' attention away from the direction of travel.
    - The skew also allows drivers on westbound NH 27 to turn right onto High Street at a high speed. The alignment of the intersection actually makes this movement look like a through movement rather than a right turn. Members of the RSA team noted that drivers continuing on Raymond Road will often use their left-turn blinker to indicate their desired movement to drivers waiting to turn from High Street.
    - Finally, the skew makes it difficult for drivers to turn left from Raymond Road onto High Street. The angle is so sharp that even smaller passenger cars track into the opposing lane of traffic on High Street. This issue is even more pronounced for larger vehicles, particularly trucks. The RSA team observed drivers using an unofficial dirt area to the west of the actual intersection to make turns.
- **There is a horizontal curve on Raymond Road** to the southwest of this intersection. The curve, in combination with vegetation on the inside of the curve, limits sight distance to and from the intersection of NH 27 and Raymond Road. While the horizontal curve "limits" sight distance, the available stopping sight distance is approximately 400 feet and the available intersection sight distance is approximately 625 feet, which both exceed the AASHTO Green Book minimum sight distances for the posted speed (AASHTO, 2004). [Note that for a 45 MPH major road posted speed, the AASHTO Green Book indicates a 360 ft. stopping sight distance and 500 ft. intersection sight distance for left-turning vehicles from a stop.]
- **There are no turn lanes** for eastbound drivers on Raymond Road. As such, turning vehicles must wait in the through lane until there is an acceptable gap. This creates potential conflicts between the through movements and turning movements on the same approach.

View from eastbound High Street approach looking east toward NH 27 and Raymond Road. The photo shows the severe skew of the intersection. Photo also shows a passenger car tracking into the opposing lane as it turns left from Raymond Road.

View of the High Street intersection looking west. Photo shows the skew of the intersection and limited sight distance to the southwest along Raymond Road due to the horizontal curve. The photo also shows a truck using an unofficial dirt path between High Street and Raymond Road to turn left from Raymond Road.

The following is a list of potential mitigation measures related to these issues:

Near-Term

1.1 Restripe the centerline and stop bar on High Street to encourage drivers to position their vehicle more perpendicular to Raymond Road.

Intermediate

1.2 Consider realigning the intersection, moving the High Street approach to the west. This will provide better sight distance and create a more perpendicular intersection. The RSA team identified two options for the realignment.

1. Shift all movements from the current location as illustrated in Appendix C.4. This would create a formal right turn movement from westbound NH 27 onto High Street rather than allowing a free flow at high speed.
2. Allow a free flow westbound movement from NH 27 onto High Street into the village of Candia similar to current operations, and provide a second perpendicular intersection for eastbound drivers to turn left from Raymond Road and to serve drivers on High Street. This is illustrated in Appendix C.5.

1.3 Consider installing a left-turn lane on Raymond Road to separate turning traffic from through traffic. This could include a defined left-turn lane at the intersection or a continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27 (see Issue 1 under NH 43 and Raymond Road). The TWLTL may also help to indicate a change in land use, changing the drivers' perception of the area.

ISSUE 2: DRIVER BEHAVIOR

The RSA team identified the following driver behavior issue.

- **Drivers are exceeding the posted speed limit** on the mainline (NH 27 and Raymond Road). A formal speed study has not been conducted, but members of the RSA team, including the Candia Police, indicated that vehicle speeds often exceed the posted speed of 45 mph. This is both a driver behavior and geometric design issue. The speed limit changes along the corridor, but roadway character does not change. As such, there are no cues that drivers should reduce their speed in the sections where there is a lower posted speed. The Candia Police also noted that it is difficult to enforce speeds along the corridor (between Candia and Hookset) because the posted speed limit changes so frequently. This area represents the commercial district of Candia, so the posted speed limit is reduced from 50 mph to 45 mph.

The following is a list of potential mitigation measures related to these issues:

Near-Term

2.1 Conduct a speed study to identify the relative magnitude of the "speeding" issue and determine the appropriate speed limit. From a law enforcement standpoint, it would be preferable to post the speed consistently between Candia and Hooksett. Note that if the desire is to reduce speeds through the corridor, changing the posted speed alone has little impact on vehicle speeds without additional enforcement or changes in the roadway characteristics. Also consider that a speed study may suggest a higher speed limit than is currently posted.

2.2 Communicate results of the speed study with local courts so they can better understand the reason for posting the speed lower in the study area.

Intermediate

2.3 Consider installing a continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27 (see suggestion 1.5 under NH 43 and Raymond Road). The TWLTL may help to indicate a change in land use, changing the drivers' perception of the area.

ISSUE 3: SIGNING AND PAVEMENT MARKINGS

The RSA team identified the following safety issues related to signing and pavement markings:

- **The existing intersection warning sign is located too far in advance** of the intersection and does not convey the location of the intersection relative to the curve. The photo below shows the existing intersection warning sign for High Street as seen traveling eastbound on Raymond Road. The intersection is actually positioned after the midpoint of the curve (near the point of tangency). This sign is also located too far in advance of the intersection to serve as an effective warning. Specifically, the sign is approximately 1,300 feet in advance of the intersection, which drivers will likely forget by the time they approach the intersection. There is not an advance warning sign for High Street traveling west on NH 27.
- **There is a wide break in the centerline and edgeline** at the intersection. Pavement markings define the appropriate path for vehicles and help drivers to navigate, particularly at night. The wide break reduces guidance within the intersection, which can lead to potential safety issues. The edgeline along the north side of NH 27 continues from NH 27 onto High Street, which gives the appearance that the through movement is from westbound NH 27 onto High Street.
- **The intersection approach on High Street is not well defined** by the current layout of the stop bar and centerline on High Street. Specifically, there is a long stop bar and the centerline follows the skewed alignment of the intersection. Some drivers are positioning their vehicle more perpendicular to the mainline (as shown in the photo below), but others are not.

View of Raymond Road looking northeast toward High Street. Photo shows the existing intersection warning sign for High Street that is incorporated with the curve warning sign.

View of the intersection looking southwest toward Raymond Road (left) and High Street (right). Photo shows the wide expanse of pavement without markings within the intersection. Photo also shows the edgeline continuing from westbound NH 27 onto High Street.

View of the intersection looking southwest from High Street. Photo shows the extended length of the stop bar and alignment of the centerline.

The following is a list of potential mitigation measures related to these issues:

Near-Term

3.1 Remove the tape from the curve warning sign (indicating an intersection ahead) and install a separate intersection warning sign at a distance appropriate for the speed of the roadway. Note that District 5 is conducting a sign improvement program for intersections and curves and this should be addressed during that effort.

3.2 Consider realigning the centerline and stop bar to narrow the width of the approach and better align vehicles perpendicular to the intersection.

3.3 Consider installing white skip marks along the north side of NH 27 across High Street to connect the edgeline to Raymond Road.

ISSUE 4: PROXIMITY TO ACCESS POINTS

There are several access points within close proximity to the intersection. Access points create additional conflict points and increase the potential for crashes. When access points are located near intersections, it increases the complexity of the driving environment as drivers have more information to observe and process. The specific access points include:

1. Access to the garage along Raymond Road.
2. Access to the boat storage, propane, and oil companies along High Street.
3. Access to local houses.

View of NH 27 looking west toward High Street. Photo shows two access points, one on either side of the road, that are located within the intersection.

The following is a list of potential mitigation measures related to these issues:

Near-Term

4.1 The Town and NHDOT should coordinate their reviews to ensure that appropriate access management is incorporated in all new developments. For future development, consider offering guidance to direct property owners to narrow, limit, and better define access points. This guidance would be offered through the site plan review process. The town planning board can send the project to the NHDOT for review when appropriate (e.g., review of driveway permits). In other cases (e.g., no change of use), the planning board could make suggestions.

ISSUE 5: DRAINAGE ISSUES

The RSA team identified the following safety issues related to drainage.

- **There is standing water in the sight triangle** between High Street and Raymond Road. The RSA was conducted soon after a rain event and the water was flooding onto the roadway at the High Street approach.

While there were no recent weather-related crashes at the intersection, standing water on the roadway is a safety issue because it reduces friction, increasing stopping distance, and can cause hydroplaning although this is not likely at low speeds where the current water is ponding.

View of High Street looking east toward NH 27. Photo shows standing water on and along the intersection approach several hours after a rain event.

The following is a list of potential mitigation measures related to these issues:

Near-Term

5.1 Identify location of drainage features from existing plans or based on field reviews.

Intermediate

5.2 Address drainage issues during next construction project at the intersection. This could be incorporated with the realignment of the intersection, which would impact the current location where water is ponding along the roadway.

4. Conclusions

There were five major safety issues identified by the RSA team at the intersection of NH 43 and Raymond Road, including:

- Roadway Geometry
- Driver Behavior
- Pavement Markings
- Roadside Hazards
- Nearby Access Points

There were five major safety issues identified by the RSA team at the intersection of NH 27 and Raymond Road, including:

- Roadway Geometry
- Driver Behavior
- Signing and Markings
- Nearby Access Points
- Drainage Issues

Suggestions for improvements have been identified and are described in the report. The suggestions have been categorized as near-term, intermediate, and long-term improvements. Five alternative concepts were prepared based on the suggested improvements, including three for the intersection of NH 43 and Raymond Road and two for the intersection of NH 27 and Raymond Road. Conceptual drawings for those alternatives are provided in Appendix C and corresponding cost estimates are provided in Appendix D. Appendix E provides a benefit-cost analysis for suggested intermediate and long-term improvements that are associated with crashes during the study period. Appendix F provides a complete summary of suggested improvements.

5. References

1. American Association of State Highway and Transportation Officials (AASHTO). *A Policy on the Geometric Design of Highways and Streets*, 6th Edition, Washington, DC, 2011.
2. American Association of State Highway and Transportation Officials (AASHTO). *Highway Safety Manual, 1st* Edition, Washington, DC, 2010.
3. American Association of State Highway and Transportation Officials (AASHTO). *Roadside Design Guide*, 4th Edition, Washington, DC, 2011.
4. Council, F., Zaloshnja, E., Miller, T., and Persaud, B. *Crash Cost Estimates by Maximum Police-Reported Injury Severity within Selected Crash Geometries*. Publication FHWA-HRT-05- 051, Federal Highway Administration, McLean, VA, 2005. Available online at: http://www.fhwa.dot.gov/publications/ research/safety/05051/.
5. Crash Modification Factors (CMF) Clearinghouse. Federal Highway Administration. Available online at: www.cmfclearinghouse.org
6. Federal Highway Administration, *Road Safety Audit Guidelines*, Report No. FHWA-SA-06-06, Washington, DC, 2006.
7. New Hampshire Department of Transportation (NHDOT). *Highway Safety Improvement Program Guidelines*, 2013.
8. New Hampshire Department of Transportation (NHDOT). *Weighted Average Unit Prices*, 2013.

Appendix A: Traffic Volume Data

Figure A.1: Average Annual Daily Traffic near Study Intersections

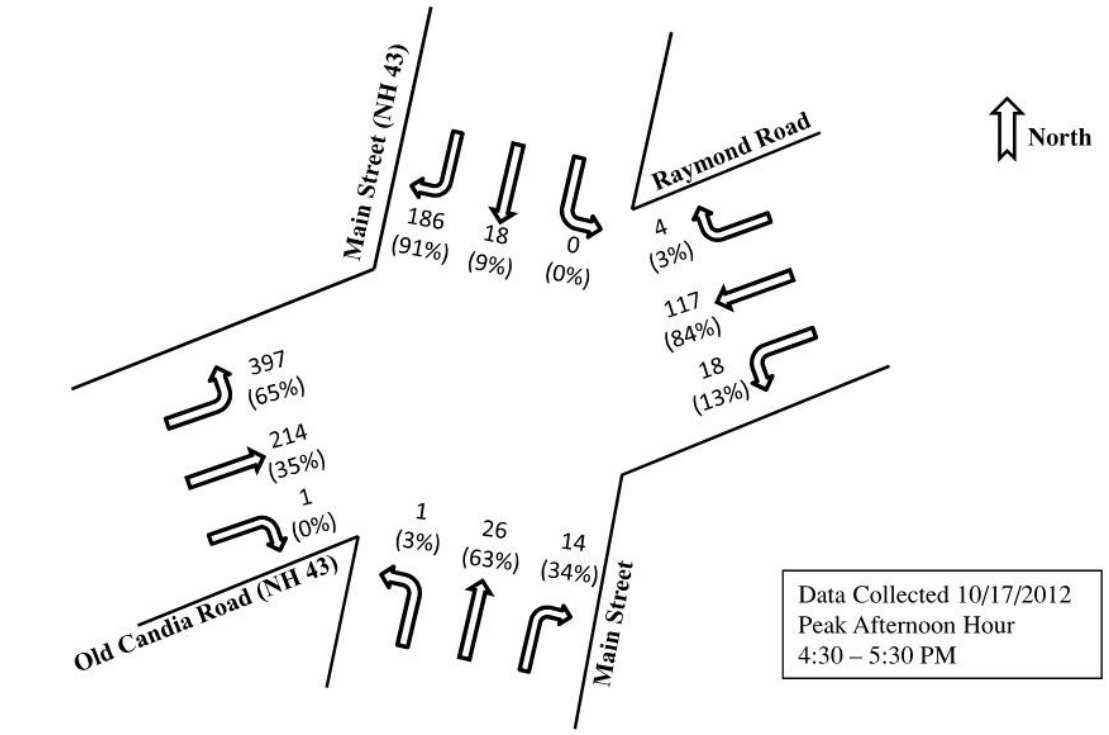


Figure A.2: Evening Peak Hour Turning Movement Count for NH 43 at Main St/Raymond Rd

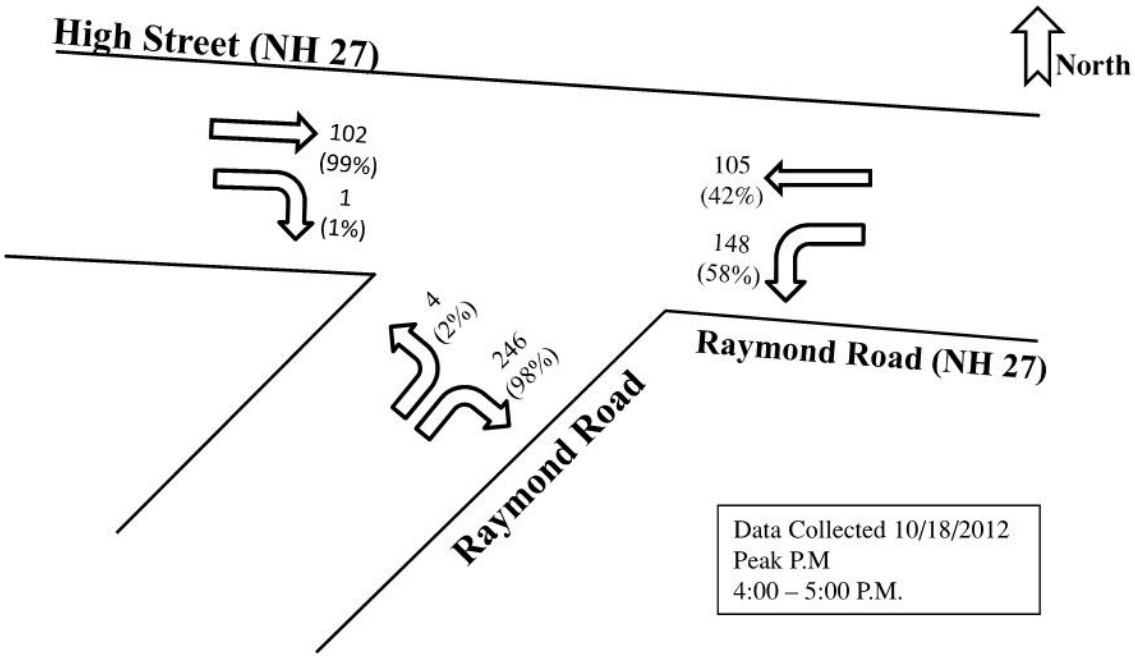
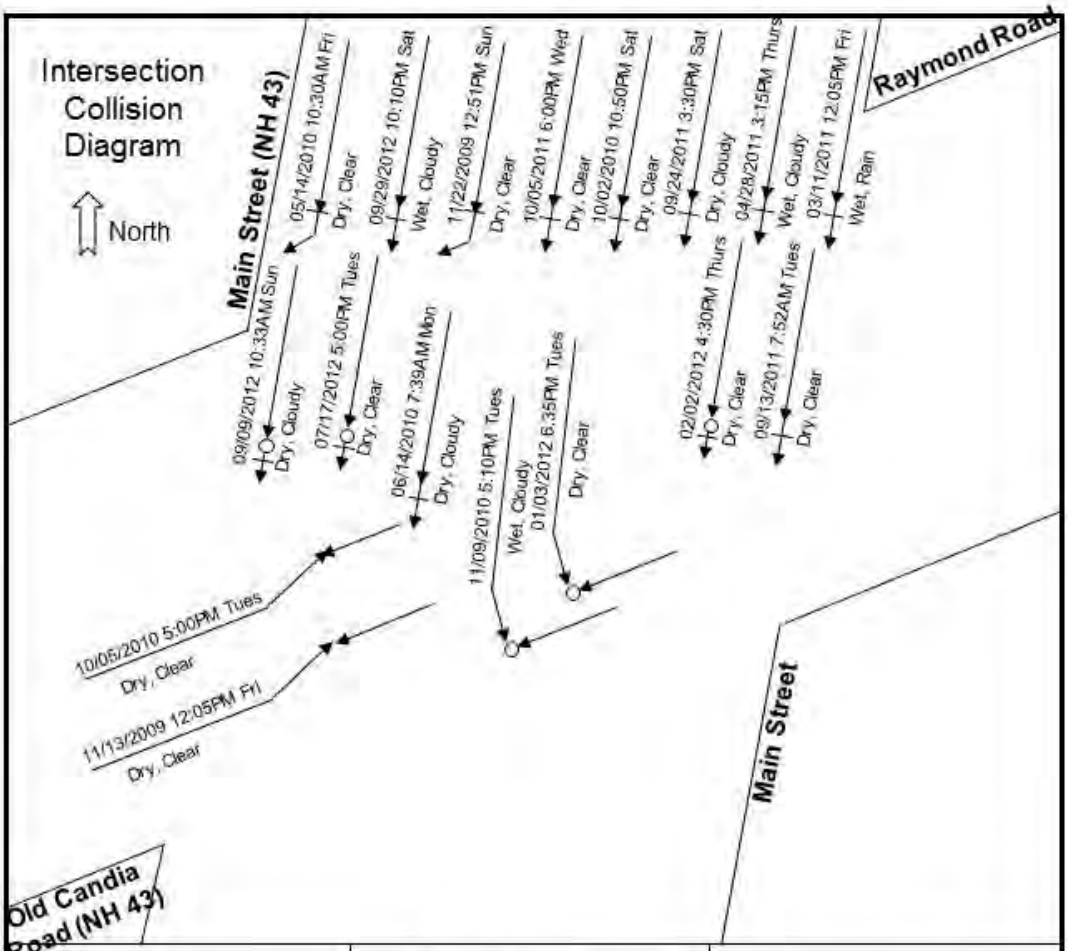


Figure A.3: Evening Peak Hour Turning Movement Count for NH 27/High St at Raymond Rd

Appendix B: Crash Diagram



Appendix C: Conceptual Drawings

Conceptual drawings are included in Appendix C to help determine the feasibility of the RSA Team's suggestions, and to estimate potential impacts and construction costs. Section 3: Assessment Findings provides a detailed discussion of the safety issues identified by the RSA team and potential mitigation strategies for each issue. The concepts can aid in visualizing these suggestions as well as the potential benefits and impacts.

Existing Conditions

The existing conditions for Old Candia Road, Main Street, Raymond Road, and High Street roadways are described in Section 2 of this report.

Design Criteria/Controls

The following table presents the design criteria and controls assumed for the layout of the concepts.

Design Speed	45 mph, 35 mph, 45 mph, and 35 mph posted speed, as noted within the RSA report, for Old Candia Road, Main Street, Raymond Road and High Street, respectively. Note all five concepts are for intersection realignments which generally allow for stop control where design speeds vary for each approaching roadway.
Typical Section	Proposed Improvements: Old Candia Road - 12' Travel Ways, 6' Shoulders Raymond Road – 12' Travel Ways, 6' Shoulders Main Street – C1 – 12' Travel Ways, 6' Shoulders Main Street – C2 – 11' Travel Ways, 4' Shoulders Main Street – C3 – 11' Travel Ways, 1' Shoulders High Street – 11' Travel Ways, 2' Shoulders See Figures C1 – C5 for additional width information.
Landscaping	Landscaping should be considered within Concept 1 and Concept 2 to provide screening and to better delineate the realignment and dead ending of Main Street. The landscaping would protect against vehicles from trying to cross over the grassed areas to the church driveway.
Drainage & Stormwater Treatment	There is limited existing drainage within the project locations. There is no existing curb and stormwater runoff is generally conveyed along the edge of the roadway in existing grassed ditch lines. Open drainage would apply to all the concepts except the roundabout where a closed system would need to be proposed to drain the curbed roundabout area. A drainage culvert is noted in Concepts C1, C2 and C3 to maintain existing flow patterns. There is a small closed system located along the edge of Main Street in front of the church and along the opposite side of the road in front of the cemetery. There are two existing catch basins with concrete tops and inlet style openings. These structures should be replaced in Concept C1 and Concept C3. In Concept C2 one structure will need to be relocated in front of the church to account for the roadway widening for the two-way left-turn lane. In Concept C1 and Concept C3 the catch basin in front of the cemetery would need to be relocated. At the High Street intersection there is an existing drainage culvert located under Raymond Road. This culvert would need to be relocated further south due to the relocation of High Street. Also, to maintain existing drainage patterns, a new culvert is proposed under the relocated High Street. Cost estimates have included the potential scope of drainage improvements for the immediate area, but do not include improvements beyond the study area.

Environment	No environmental review was conducted for the RSA or concept development.
Right-of-Way	Limited existing research was provided for the RSA and concept development. Town GIS maps and tax maps were used within the concepts. Also the NH 27 realignment plans were utilized to determine the existing ROW along NH 27 and Main Street. The existing ROW for the Raymond Road corridor was found to be approximately 100' (6 Rod.) Main Street and High Street ROW appear to be 66' wide (4 rod). During final design, the ROW should be fully reviewed. Descriptions of potential ROW needs for each concept are noted below. **Concept 1** • Fee taking for the realignment of Raymond Road Parcel 409-204. • Temporary construction and slope easements may be needed for driveway grading and roadway side slopes parcels 409-208 and 409-207. **Concept 2** • Fee taking for the realignment of Raymond Road Parcel 409-204. • Temporary construction and slope easements may be needed for driveway grading and roadway side slopes parcels 409-208, 409-207. **Concept 3** • Fee taking for the realignment of Raymond Road Parcel 409-204. • Fee taking for the roundabout parcel 409-91. • Temporary construction and slope easements may be needed for driveway grading and roadway side slopes parcel 409-207. **Concept 4** • Fee taking for the realignment of High Street Parcel 409-198 and 409-198-1. **Concept 5** • Fee taking for the realignment of High Street Parcel 409-198 and 409-198-1.
Traffic Control Plan (TCP)	TCP was not evaluated for the RSA or concept development. However, all five concepts require realignment of existing roadways. If work is planned to be undertaken at both intersections, the work should be sequenced so only one intersection may be under construction at a time. Road closures or diversions of traffic would require the traffic signal at the Main Street and High Street intersection to be reviewed for signal timing.
Utilities	No formal existing utility review was conducted for the RSA or concept development. Aerial and underground utilities are present within this area, and aerial utilities will conflict with the proposed improvements shown in Concepts 1 thru 5.
Survey	No survey was conducted for the RSA or concept development.
Lighting	One existing street light was found within the intersection of Main Street and Raymond Road on a utility pole. Two existing street lights were found on one utility pole within the intersection of High Street and Raymond Road. Lighting design was not conducted for the RSA or concept development.
Soils	No geotechnical review was conducted for the RSA or concept development.
Crashes	See Section 2 and Appendix B for crash data.
Traffic	Traffic information was received for the purpose of the RSA; however, an in-depth analysis was not performed to establish lane usage and layout for the RSA or concept development. See Section 2 and Appendix A for traffic data.
Estimate	See Appendix D for Conceptual Construction Costs.
Funding	Highway Safety Improvement Program Funding is considered for this project.
Traffic Signal	The existing flashing beacon at the intersection of Old Candia Road, Main Street and Raymond Road is proposed to be removed as part of Concepts 1, 2 and 3.
Turning Radius	All intersections were designed to accommodate a WB-62 turning movement.

Conceptual Designs and Considerations

The alternatives provided are conceptual representations of mitigation strategies highlighted in Section 3. The concepts are two-dimensional sketches overlaid on aerial photography without horizontal and vertical alignments; therefore, actual footprints could be different if the design progresses from concept to final design. The primary focus of the concepts is to address safety issues related to roadway geometry. The five concepts are presented below in Figures C1 – C5.

C.1 Concept 1

Concept 1 involves the realignment of the existing skewed intersection between Raymond Road, Main Street, and Old Candia Road to create two tee intersections and change the stop-control from southbound Main Street to Raymond Road. Specifically, the westbound approach (Raymond Road) would be realigned to provide a stop-controlled tee intersection with Main Street. The realignment of the northbound approach of Main Street as it intersects with Old Candia Road is also proposed within concept 1. The geometry between Old Candia Road and Main Street would be improved to provide proper curvature and superelevation in support of the new thru movement. Miscellaneous drainage, driveway, utility, and retaining wall improvements and relocations are also required with the proposed intersection. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
Old Candia Road	Realign Old Candia Road and Main Street to have a uniform thru movement. Provide designated right turn lane onto Raymond Road.	Skewed intersection, lack of turn lanes, high-speed turns, wide break in centerline, expansive pavement within the intersection, and proximity of access points (cemetery gate).	1, 2, 3, 5
Main Street	Remove skewed intersection and create new thru movement to Old Candia Road.	Skewed intersection, crossing vehicles, improper stopping behavior, and discontinued edgeline, expansive pavement within the intersection, roadside hazards, and proximity of access points (church).	1, 2, 3, 4, 5
Raymond Road	Realign Raymond Road to provide tee intersection with Main Street. Provide left turn and right turn lanes from Raymond Road.	Skewed intersection, lack of turn lanes, high speeds, high-speed turns, wide break in centerline, and expansive pavement within the intersection.	1, 2, 3

C.2 Concept 2

Concept 2 involves the realignment of Main Street as it intersects with Raymond Road. A stop-controlled tee intersection is proposed with Raymond Road remaining as the primary thru movement. The existing northbound approach of Main Street is proposed to be dead ended with a hammerhead turnaround. Manchester Bible Church would be provided with a new driveway to Old Candia Road. Raymond Road would be widened by 12' to provide a center two-way left-turn lane between the Main Street and High Street intersections. Miscellaneous drainage, driveway, and utility improvements and relocations are also required with the proposed intersection. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
Old Candia Road	Remove skew intersection. Provide designated left turn pocket and thru lane to Raymond Road.	Skewed intersection, crest curve, lack of turn lanes, high-speed turns, wide break in centerline, expansive pavement within the intersection, and proximity of access points (cemetery gate).	1, 2, 3, 5
Main Street	Remove skew intersection and realign Main Street to provide a tee intersection with Raymond Road. Close northbound Main Street approach and provide a hammerhead turnaround. No access to Old Candia Road.	Skewed intersection, improper stopping behavior, discontinued edgeline, expansive pavement within the intersection, roadside hazards, and proximity of access points (church).	1, 2, 3, 4, 5
Raymond Road	Provide center two-way left-turn lane between Main Street and High Street intersections.	Skewed intersection, lack of turn lanes, high speeds, high-speed turns, wide break in centerline, and expansive pavement within the intersection.	1, 2, 3

C.3 Concept 3

Concept 3 proposes to build a roundabout at the intersection of Old Candia Road, Main Street, and Raymond Road. Old Candia Road and Raymond Road are realigned to intersect with the proposed roundabout. This work includes the removal of the existing skewed intersection between Raymond Road, Main Street, and Old Candia Road. Miscellaneous drainage, driveway and utility improvements and relocations are also required with the proposed intersection. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
Old Candia Road	Construct roundabout intersection and remove skew intersection. Realign Old Candia Road to approach the roundabout closer to a 90 degree angle.	Skewed intersection, crest curve, lack of turn lanes, high speeds, high-speed turns, wide break in centerline, expansive pavement within the intersection, and proximity of access points (cemetery gate).	1, 2, 3, 5
Main Street	Construct roundabout intersection and remove skew intersection.	Skewed intersection, improper stopping behavior, discontinued edgeline, expansive pavement within the intersection, and roadside hazards.	1, 2, 3, 4
Raymond Road	Construct roundabout intersection and remove skew intersection. Realign Raymond Road to approach the roundabout closer to a 90 degree angle.	Skewed intersection, lack of turn lanes, high speeds, high-speed turns, wide break in centerline, and expansive pavement within the intersection.	1, 2, 3

C.4 Concept 4

Concept 4 involves the realignment of High Street as it intersects with Raymond Road. This work includes the removal of the old skewed intersection between High Street and Raymond Road. Raymond Road would be widened by 12' to provide a center two-way left-turn lane between the Main Street and High Street intersections. Miscellaneous drainage, driveway, and utility improvements and relocations are also required with the proposed intersection. A portion of the existing High Street roadway would be reused to provide driveway access to Raymond Road. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
Raymond Road	Provide two-way left-turn lane and protected left-turn pocket to High Street. Remove skew intersection.	Skewed intersection, lack of turn lanes, high speeds, high-speed turns, and wide break in centerline and edgeline, and proximity of access points.	1, 2, 3, 4
High Street	Realign High Street to provide a tee intersection and remove skew intersection.	Skewed intersection, definition of intersection approach, proximity of access points, and drainage issues.	1, 2, 3, 4, 5

C.5 Concept 5

Concept 5 involves the realignment of High Street as it intersects with Raymond Road. The existing intersection between High Street and Raymond Road would be re-designated as a one-way stop controlled access to High Street westbound. Miscellaneous drainage, driveway and utility improvements and relocations are also required with the proposed intersection.

The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
Raymond Road	Remove skew intersection.	Skewed intersection, wide break in centerline and edgeline, and proximity of access points.	1, 3, 4
High Street	Realign High Street to provide a tee intersection and remove skew intersection. Provide one-way only access from Raymond Road to High Street in the westbound direction.	Skewed intersection, definition of intersection approach, and drainage issues.	1, 3, 5

Appendix D: Conceptual Cost Estimates

Conceptual cost estimates are provided for each of the five concepts. NHDOT's Weighted Average Unit Costs were used to establish project unit costs and quantities calculations were performed for the major items in each concept.

The following assumptions were made in the development of cost estimates for each concept:

1. 5" pavement depth in pavement removal locations.
2. 1.5" pavement depth in cold plane and overlay locations.
3. 2" pavement depth for driveway locations.
4. 8" crush gravel, 8" gravel, and 8" sand in full depth and step box construction locations for all roadways.
5. Earthworks were estimated based on ground elevations assumed using Google Earth.
6. Percentages are accounted for based on previous projects and previous VHB estimate experience.
7. Loam and seed areas were assumed to be a 6" depth for excavation.
8. 4" concrete islands with sloped granite curbing.

Concept 1:

1. Step box widening of Old Candia Road and Main Street.
2. Realignment of Raymond Road full depth construction.
3. Realignment of Main Street.
4. Major changes to vertical alignments are not anticipated.

Concept 2:

1. Step box widening of Raymond Road with cold plane and overlay.
2. Full depth construction for Main Street realignment.
3. Major changes to vertical alignments are not anticipated.

Concept 3:

1. Roundabout new construction.
2. All approaches are full depth construction.
3. Splitter islands are 4" concrete islands with sloped vertical granite curb.
4. 6" concrete apron with sloped granite curbing.
5. Grassed island with sloped granite curbing.

Concept 4:

1. Step box widening of Raymond Road with cold plan and overlay.
2. Realignment of High Street full depth construction.
3. Major changes to vertical alignments are not anticipated.

Concept 5:

1. Realignment of High Street full depth construction.
2. Cold plan and overlay Raymond Road and High Street.
3. Major changes to vertical alignments are not anticipated.

The following table provides a summary of construction costs, which are detailed in the following sections. Preliminary engineering costs are also provided based on the following assumptions: 20 percent of the construction cost for Concepts 1 – 3, and 25 percent of the construction cost for Concepts 4 and 5. Due to the unfavorable B/C ratios, right-of-way costs were not estimated. Right-of-way costs would need to be considered if any of these concepts are pursued.

Cost Components	**Concept 1**	**Concept 2**	**Concept 3**	**Concept 4**	**Concept 5**
Conceptual Construction Cost	$1,035,000	$955,000	$1,375,000	$715,000	$540,000
Right-of-Way	TBD	TBD	TBD	TBD	TBD
Preliminary Engineering	$207,000	$191,000	$275,000	$178,750	$135,000
Total (without ROW)	$1,242,000	$1,146,000	$1,650,000	$893,750	$675,000

D.1 Concept 1: Cost Estimate

CONSTRUCTION COST ESTIMATE

PROJECT : RSA

LOCATION Candia, NH

STATE PROJECT NO.

FEDERAL PROJECT NO.

ESTIMATE TYPE: Conceptual Cost Estimate

DATE PREPARED: 7/9/2014

ESTIMATED BY: JMH

CHECKED BY: SPH

Candia RSA

Concept 1 - T-Intersection Raymond Rd to Main St

ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
	MATERIAL ITEMS (ROADWAY)					
201.1	CLEARING AND GRUBBING (F)	A		$8,000	1.2	$9,600
203.1	COMMON EXCAVATION	CY		$8	7200	$57,600
203.2	ROCK EXCAVATION	CY	ASSUME 1% OF COMMON EXCAVATION	$30	72	$2,160
203.6	EMBANKMENT-IN-PLACE (F)	CY		$6	450	$2,700
206.1	COMMON STRUCTURE EXCAVATION					
206.19	COMMON STRUCTURE EXCAVATION EXPLORATORY	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			$8,964
206.2	ROCK STRUCTURE EXCAVATION					
207.2	UNCLASSIFIED CHANNEL EXCAVATION					
304.1	SAND	CY		$18	1700	$30,600
304.2	GRAVEL (F)	CY		$24	1500	$36,000
304.3	CRUSHED GRAVEL (F)	CY		$24	1300	$31,200
403.11	HOT BITUMINOUS PAVEMENT,MACHINE METHOD	TON		$80	2210	$176,800
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD (Drives)	TON		$130	80	$10,400
403.99	TEMPORARY BITUMINOUS PAVEMENT	TON				$0
411.43	PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON				$0
417	COLD PLANING BITUMINOUS SURFACES (F)	SY		$5	540	$2,700
606.14	BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF				$0
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)					
606.1452	BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			$0
606.147	BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS					
608.12	2" BITUMINOUS SIDEWALK	SY				$0
608.24	CONCRETE SIDEWALK (F)	SY		$40	70	$2,800
609.01	STRAIGHT GRANITE CURB	LF				$0
609.02	CURVED GRANITE CURB	LF				$0
609.21	STRAIGHT GRANITE SLOPE CURB	LF		$20	180	$3,600
609.22	STRAIGHT GRANITE SLOPE CURB WITH RADIAL JOINTS	LF				
609.811	BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY			$0
609.5	RESET GRANITE CURB	LF				$0
214	FINE GRADING	LS	20% OF TOTAL SUB BASE COST			$19,560
	SUBTOTAL A					$394,684
	MISCELLANEOUS ITEMS (ROADWAY) (SAMPLE ITEMS BELOW)					
	FILL ABANDONED PIPE	CY				
	CLEARING FOR FENCE LINES (F)	A				
	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
	REMOVAL OF GUARDRAIL (F)	LF				
	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
	Geotextile fabrics	SY				
	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
	DROP INLET SEDIMENT TRAP OUTLET	EA				
	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
	CONCRETE STAIRS	U				
	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
	DELINEATORS WITH POST	EA	USE 60% OF SUBTOTAL "A" COST			
	STEEL WITNESS MARKERS, BOUNDS	EA				
	SAWED PAVEMENT	LF				
	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
	LOAM & HUMAS	CY				
	FERTILIZER	TON				
	GRASS SEED, TYPE 82	LB				
	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
	TURF ESTABLISHMENT	SY				
	BARK MULCH MATERIAL	CY				
	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	$				
	FIELD OFFICE TYPE & LAB	MON				
	TRAFFIC SIGN TYPE A,B,C;AA,BB,CC	SF				
	MICELLANEOUS COST SUBTOTAL					$236,810
	SUBTOTAL B					$631,494
	DRAINAGE COSTS (SAMPLE ITEMS BELOW)					
	STONE FILL, CLASS B,C,D	CY				
	PIPE	LF				
	STEEL END SECTIONS	EA	CONSIDER		15%	
	CATCH BASINS	U	1-10% MINOR IMPROVEMENTS			
	DRAINAGE MANHOLES	U	10% RECONST NON URBAN			
	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	15% NEW NON URBAN			
	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	20% FULL DEPTH RECONSTRUCT URBAN			
	UNDERDRAIN FLUSHING BASINS	EA	20% NEW URBAN			
	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	25% COMPLEX URBAN			
	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
	DRAINAGE COST SUBTOTAL					$94,724
	SUBTOTAL C					$726,219
	PERMANENT TRAFFIC CONTROL (SAMPLE ITEMS BELOW)					
	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE $600/LF	$600		$0
	OVERHEAD SIGN STRUCTURES SPAN	EA	USE $800/LF	$800		$0
	RRFB (Rectangular Red Flashing Beacon)	U		$15,000		$0
	TRAFFIC SIGNALS	EA	USE $150K/ INTERSECTION	$150,000	0	$0
	TRAFFIC SIGNAL COORDINATION	EA	USE $50K/ ADDITIONAL INTERSECTION	$50,000	0	$0
	LIGHT POLES AND BASES (est 2/300 feet)	EA	USE $4500/ POLE	$4,500	0	$0
	PERMANENT TRAFFIC CONTROL COST SUBTOTAL					$0
	SUBTOTAL D					$726,219
	TEMPORARY TRAFFIC CONTROL (SAMPLE ITEMS BELOW)					
	UNIFORMED OFFICERS WITH VEHICLE		USE 1.0 TIMES MAINT OF TRAFFC COST			$19,734
	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			$5,920
	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF				
	MAINTENANCE OF TRAFFIC	UNIT	USE 5% OF SUBTOTAL A			$19,734
	MISCELLANEOUS TRAFFC CONTROL					
	PORTABLE CHANGEABLE MESSAGE SIGN-					
	TEMPORARY CONSTRUCTION SIGNS					
	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 30% OF MAINTENANCE OF TRAFFIC			
	IMPACT ATTENUATION DEVICE					
	MISCELLANEOUS TRAFFC CONTROL SUBTOTAL					$5,920
	TEMPORARY TRAFFIC CONTROL COST SUBTOTAL					$51,309
	EROSION, SEDIMENT & POLLUTION CONTROL					
	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
	SILT FENCE	LF	USE 5% OF SUBTOTAL A			
	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U				
	MONITORING EROSION AND SEDIMENT CONTROL	HR				
	TEMPORARY PROJECT WATER POLLUTION CONTROL	$				$19,734
	EROSION, SEDIMENT & POLLUTION CONTROL SUBTOTAL					$19,734
	SUBTOTAL E					$797,262
	ADDITIONAL ITEMS OF CONSIDERATION					
	ITS			$0	0	$0
	RETAINING WALLS	SF	USE $50/SF	$50	0	$0
	SOUND WALL	SF	USE $25 /SF	$25	0	$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 5% OF SUBTOTAL E			$39,863
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	$100,000	0	$0
	LANDSCAPING		ASSUME $20.65/LF	$20.65	0	$0
	UTILITY ADJUSTMENTS		ASSUME $1000/LF	$0	0	$0
	STRUCTURES			$0	0	$0
	ADDITIONAL ITEMS COST SUBTOTAL					$39,863
	SUBTOTAL F					$837,125
	MOBILIZATION		USE 4% OF SUBTOTAL F			$33,485
	CONTINGENCIES		USE 10% OF SUBTOTAL F			$83,712
	CONSTRUCTION SUBTOTAL					**$954,322**
	CONSTRUCTION ENGINEERING		USE 8% OF CONSTRUCTION TOTALS			$76,346
	CONSTRUCTION TOTAL					**$1,035,000**

D.2 Concept 2: Cost Estimate

CONSTRUCTION COST ESTIMATE

PROJECT : RSA

LOCATION Candia, NH

STATE PROJECT NO.

FEDERAL PROJECT NO.

ESTIMATE TYPE: Conceptual Cost Estimate

DATE PREPARED: 7/9/2014

ESTIMATED BY: JMH

CHECKED BY: SPH

Candia RSA

Concept 2 - T-Intersection Main St to Raymond Rd

ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
	MATERIAL ITEMS (ROADWAY)					
201.1	CLEARING AND GRUBBING (F)	A		$8,000	0.6	$4,800
203.1	COMMON EXCAVATION	CY		$8	6500	$52,000
203.2	ROCK EXCAVATION	CY	ASSUME 1%OF COMMON EXCAVATION	$30	65	$1,950
203.6	EMBANKMENT-IN-PLACE (F)	CY		$6	100	$600
206.1	COMMON STRUCTURE EXCAVATION					
206.19	COMMON STRUCTURE EXCAVATION EXPLORATORY	LS	ADD 15%OF TOTAL COST of COM. EXC. & ROCK EXC. COST			$8,093
206.2	ROCK STRUCTURE EXCAVATION					
207.3	UNCLASSIFIED CHANNEL EXCAVATION					
304.1	SAND	CY		$18	1700	$30,600
304.2	GRAVEL (F)	CY		$24	1500	$36,000
304.3	CRUSHED GRAVEL (F)	CY		$24	1350	$32,400
403.11	HOT BITUMINOUS PAVEMENT,MACHINE METHOD	TON		$80	1660	$132,800
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD (Drives)	TON		$130	30	$3,900
403.99	TEMPORARY BITUMINOUS PAVEMENT	TON				$0
411.43	PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON				$0
417	COLD PLANING BITUMINOUS SURFACES (F)	SY		$5	6100	$30,500
606.14	BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF				$0
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)					
606.1452	BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40%OF COST OF GUARD RAIL			$0
606.147	BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS					
608.12	2" BITUMINOUS SIDEWALK	SY				$0
608.24	CONCRETE SIDEWALK (F)	SY		$40	170	$6,800
609.01	STRAIGHT GRANITE CURB	LF				$0
609.02	CURVED GRANITE CURB	LF				$0
609.21	STRAIGHT GRANITE SLOPE CURB	LF		$20	260	$5,200
609.22	STRAIGHT GRANITE SLOPE CURB WITH RADIAL JOINTS	LF				
609.811	BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25%OF GUARD RAIL QUANTITY			$0
609.5	RESET GRANITE CURB	LF				$0
214	FINE GRADING	LS	20%OF TOTAL SUB BASE COST			$19,800
	SUBTOTAL A					$365,443
	MISCELLANEOUS ITEMS (ROADWAY) (SAMPLE ITEMS BELOW)					
	FILL ABANDONED PIPE	CY				
	CLEARING FOR FENCE LINES (F)	A				
	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
	REMOVAL OF GUARDRAIL (F)	LF				
	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
	Geotextile fabrics	SY				
	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
	DROP INLET SEDIMENT TRAP OUTLET	EA				
	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
	CONCRETE STAIRS	U				
	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
	DELINEATORS WITH POST	EA	USE 60%OF SUBTOTAL "A" COST			
	STEEL WITNESS MARKERS, BOUNDS	EA				
	SAWED PAVEMENT	LF				
	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
	LOAM & HUMAS	CY				
	FERTILIZER	TON				
	GRASS SEED, TYPE 82	LB				
	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
	TURF ESTABLISHMENT	SY				
	BARK MULCH MATERIAL	CY				
	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	$				
	FIELD OFFICE TYPE & LAB	MON				
	TRAFFIC SIGN TYPE A,B,C,AA,BB,CC	SF				
	MICELLANEOUS COST SUBTOTAL					$219,266
	SUBTOTAL B					$584,708
	DRAINAGE COSTS (SAMPLE ITEMS BELOW)					
	STONE FILL, CLASS B,C,D	CY				
	PIPE	LF				
	STEEL END SECTIONS	EA	CONSIDER		15%	
	CATCH BASINS	U	1-10% MINOR IMPROVEMENTS			
	DRAINAGE MANHOLES	U	10% RECONST NON URBAN			
	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	15% NEW NON URBAN			
	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	20% FULL DEPTH RECONSTRUCT URBAN			
	UNDERDRAIN FLUSHING BASINS	EA	20% NEW URBAN			
	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	25% COMPLEX URBAN			
	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
	DRAINAGE COST SUBTOTAL					$87,706.20
	SUBTOTAL C					$672,414
	PERMANENT TRAFFIC CONTROL (SAMPLE ITEMS BELOW)					
	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE $600/LF	$600		$0
	OVERHEAD SIGN STRUCTURES SPAN	EA	USE $800/LF	$800		$0
	RRFB (Rectangular Red Flashing Beacon)	U		$15,000		$0
	TRAFFIC SIGNALS	EA	USE $150K/ INTERSECTION	$150,000	0	$0
	TRAFFIC SIGNAL COORDINATION	EA	USE $50K/ ADDITIONAL INTERSECTION	$50,000	0	$0
	LIGHT POLES AND BASES (est 2/300 feet)	EA	USE $4500/ POLE	$4,500	0	$0
	PERMANENT TRAFFIC CONTROL COST SUBTOTAL					$0
	SUBTOTAL D					$672,414
	TEMPORARY TRAFFIC CONTROL (SAMPLE ITEMS BELOW)					
	UNIFORMED OFFICERS WITH VEHICLE		USE 1.0 TIMES MAINT OF TRAFFIC COST			$18,272
	FLAGGERS		USE 30%OF UNIFORMED OFFICER COST			$5,482
	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF				
	MAINTENANCE OF TRAFFIC	UNIT	USE 5% OF SUBTOTAL A			$18,272
	MISCELLANEOUS TRAFFIC CONTROL					
	PORTABLE CHANGEABLE MESSAGE SIGN-					
	TEMPORARY CONSTRUCTION SIGNS					
	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 30%OF MAINTENANCE OF TRAFFIC			
	IMPACT ATTENUATION DEVICE					
	MISCELLANEOUS TRAFFIC CONTROL SUBTOTAL					$5,482
	TEMPORARY TRAFFIC CONTROL COST SUBTOTAL					$47,508
	EROSION, SEDIMENT & POLLUTION CONTROL					
	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
	SILT FENCE	LF	USE 5%OF SUBTOTAL A			
	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U				
	MONITORING EROSION AND SEDIMENT CONTROL	HR				
	TEMPORARY PROJECT WATER POLLUTION CONTROL	$				$18,272
	EROSION, SEDIMENT & POLLUTION CONTROL SUBTOTAL					$18,272
	SUBTOTAL E					$738,194
	ADDITIONAL ITEMS OF CONSIDERATION					
	ITS			$0	0	$0
	RETAINING WALLS	SF	USE $50/SF	$50	0	$0
	SOUND WALL	SF	USE $25 /SF	$25	0	$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 5%OF SUBTOTAL E			$36,910
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	$100,000	0	$0
	LANDSCAPING		ASSUME $20.65/LF	$20.65	0	$0
	UTILITY ADJUSTMENTS		ASSUME $1000/LF	$0	0	$0
	STRUCTURES			$0	0	$0
	ADDITIONAL ITEMS COST SUBTOTAL					$36,910
	SUBTOTAL F					$775,104
	MOBILIZATION		USE 4%OF SUBTOTAL F			$31,004
	CONTINGENCIES		USE 10%OF SUBTOTAL F			$77,510
	CONSTRUCTION SUBTOTAL					**$883,618**
	CONSTRUCTION ENGINEERING		USE 8%OF CONSTRUCTION TOTALS			$70,689
	CONSTRUCTION TOTAL					**$955,000**

D.3 Concept 3: Cost Estimate

CONSTRUCTION COST ESTIMATE

PROJECT : RSA

LOCATION Candia, NH

STATE PROJECT NO.

FEDERAL PROJECT NO.

ESTIMATE TYPE: Conceptual Cost Estimate

DATE PREPARED: 7/9/2014

ESTIMATED BY: JMH

CHECKED BY: SPH

Candia RSA

Concept 3 - Roundabout - Main St, Old Candia Rd, Raymond Rd

ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
	MATERIAL ITEMS (ROADWAY)					
201.1	CLEARING AND GRUBBING (F)	A		$8,000	0.8	$6,400
203.1	COMMON EXCAVATION	CY		$8	9300	$74,400
203.2	ROCK EXCAVATION	CY	ASSUME 1% OF COMMON EXCAVATION	$30	93	$2,790
203.6	EMBANKMENT-IN-PLACE (F)	CY		$6	200	$1,200
206.1	COMMON STRUCTURE EXCAVATION					
206.19	COMMON STRUCTURE EXCAVATION EXPLORATORY	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			$11,579
206.2	ROCK STRUCTURE EXCAVATION					
207.3	UNCLASSIFIED CHANNEL EXCAVATION					
304.1	SAND	CY		$18	2500	$45,000
304.2	GRAVEL (F)	CY		$24	2300	$55,200
304.3	CRUSHED GRAVEL (F)	CY		$24	2100	$50,400
403.11	HOT BITUMINOUS PAVEMENT,MACHINE METHOD	TON		$80	1950	$156,000
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD (Drives)	TON		$130	40	$5,200
403.99	TEMPORARY BITUMINOUS PAVEMENT	TON				$0
411.43	PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON				$0
417	COLD PLANING BITUMINOUS SURFACES (F)	SY		$5	540	$2,700
606.14	BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF				$0
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)					
606.1452	BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			$0
606.147	BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS					
608.12	2" BITUMINOUS SIDEWALK	SY				$0
608.24	CONCRETE SIDEWALK (F) 4"	SY		$40	280	$11,200
608.26	CONCRETE SIDEWALK (F) 6"	SY		$60	560	$33,600
609.01	STRAIGHT GRANITE CURB	LF				$0
609.02	CURVED GRANITE CURB	LF				$0
609.21	STRAIGHT GRANITE SLOPE CURB	LF		$20	1950	$39,000
609.22	STRAIGHT GRANITE SLOPE CURB WITH RADIAL JOINTS	LF				$0
609.811	BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY			$0
609.5	RESET GRANITE CURB	LF				$0
214	FINE GRADING	LS	20% OF TOTAL SUB BASE COST			$30,120
	SUBTOTAL A					$524,789
	MISCELLANEOUS ITEMS (ROADWAY)					
	(SAMPLE ITEMS BELOW)					
	FILL ABANDONED PIPE	CY				
	CLEARING FOR FENCE LINES (F)	A				
	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
	REMOVAL OF GUARDRAIL (F)	LF				
	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
	Geotextile fabrics	SY				
	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
	DROP INLET SEDIMENT TRAP OUTLET	EA				
	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
	CONCRETE STAIRS	U				
	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
	DELINEATORS WITH POST	EA	USE 60% OF SUBTOTAL "A" COST			
	STEEL WITNESS MARKERS, BOUNDS	EA				
	SAWED PAVEMENT	LF				
	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
	LOAM & HUMAS	CY				
	FERTILIZER	TON				
	GRASS SEED, TYPE 82	LB				
	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
	TURF ESTABLISHMENT	SY				
	BARK MULCH MATERIAL	CY				
	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	$				
	FIELD OFFICE TYPE & LAB	MON				
	TRAFFIC SIGN TYPE A,B,C,AA,BB,CC	SF				
	MICELLANEOUS COST SUBTOTAL					$314,873
	SUBTOTAL B					$839,662
	DRAINAGE COSTS					
	(SAMPLE ITEMS BELOW)					
	STONE FILL, CLASS B,C,D	CY				
	PIPE	LF				
	STEEL END SECTIONS	EA	CONSIDER		15%	
	CATCH BASINS	U	1-10% MINOR IMPROVEMENTS			
	DRAINAGE MANHOLES	U	10% RECONST NON URBAN			
	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	15% NEW NON URBAN			
	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	20% FULL DEPTH RECONSTRUCT URBAN			
	UNDERDRAIN FLUSHING BASINS	EA	20% NEW URBAN			
	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	25% COMPLEX URBAN			
	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
	DRAINAGE COST SUBTOTAL					$125,949.24
	SUBTOTAL C					$965,611
	PERMANENT TRAFFIC CONTROL					
	(SAMPLE ITEMS BELOW)					
	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE $600/LF	$600		$0
	OVERHEAD SIGN STRUCTURES SPAN	EA	USE $800/LF	$800		$0
	RRFB (Rectangular Red Flashing Beacon)	U		$15,000		$0
	TRAFFIC SIGNALS	EA	USE $150K/ INTERSECTION	$150,000	0	$0
	TRAFFIC SIGNAL COORDINATION	EA	USE $50K/ ADDITIONAL INTERSECTION	$50,000	0	$0
	LIGHT POLES AND BASES (est 2/300 feet)	EA	USE $4500/ POLE	$4,500	0	$0
	PERMANENT TRAFFIC CONTROL COST SUBTOTAL					$0
	SUBTOTAL D					$965,611
	TEMPORARY TRAFFIC CONTROL					
	(SAMPLE ITEMS BELOW)					
	UNIFORMED OFFICERS WITH VEHICLE		USE 1.0 TIMES MAINT OF TRAFFIC COST			$26,239
	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			$7,872
	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF				
	MAINTENANCE OF TRAFFIC	UNIT	USE 5% OF SUBTOTAL A			$26,239
	MISCELLANEOUS TRAFFIC CONTROL					
	PORTABLE CHANGEABLE MESSAGE SIGN-					
	TEMPORARY CONSTRUCTION SIGNS					
	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 30% OF MAINTENANCE OF TRAFFIC			
	IMPACT ATTENUATION DEVICE					
	MISCELLANEOUS TRAFFIC CONTROL SUBTOTAL					$7,872
	TEMPORARY TRAFFIC CONTROL COST SUBTOTAL					$68,223
	EROSION, SEDIMENT & POLLUTION CONTROL					
	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
	SILT FENCE	LF	USE 5% OF SUBTOTAL A			
	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U				
	MONITORING EROSION AND SEDIMENT CONTROL	HR				
	TEMPORARY PROJECT WATER POLLUTION CONTROL	$				$26,239
	EROSION, SEDIMENT & POLLUTION CONTROL SUBTOTAL					$26,239
	SUBTOTAL E					$1,060,073
	ADDITIONAL ITEMS OF CONSIDERATION					
	ITS			$0	0	$0
	RETAINING WALLS	SF	USE $50/SF	$50	0	$0
	SOUND WALL	SF	USE $25 /SF	$25	0	$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 5% OF SUBTOTAL E			$53,004
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	$100,000	0	$0
	LANDSCAPING		ASSUME $20.65/LF	$20.65	0	$0
	UTILITY ADJUSTMENTS		ASSUME $1000/LF	$0	0	$0
	STRUCTURES			$0	0	$0
	ADDITIONAL ITEMS COST SUBTOTAL					$53,004
	SUBTOTAL F					$1,113,076
	MOBILIZATION		USE 4% OF SUBTOTAL F			$44,523
	CONTINGENCIES		USE 10% OF SUBTOTAL F			$111,308
	CONSTRUCTION SUBTOTAL					**$1,268,907**
	CONSTRUCTION ENGINEERING		USE 8% OF CONSTRUCTION TOTALS			$101,513
	CONSTRUCTION TOTAL					**$1,375,000**

D.4 Concept 4: Cost Estimate

CONSTRUCTION COST ESTIMATE

PROJECT : RSA

LOCATION Candia, NH

STATE PROJECT NO.

FEDERAL PROJECT NO.

ESTIMATE TYPE: Conceptual Cost Estimate

DATE PREPARED: 7/9/2014

ESTIMATED BY: JMH

CHECKED BY: SPH

Candia RSA

Concept 4 - T-Intersection High St. to Raymond Rd.

ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
	MATERIAL ITEMS (ROADWAY)					
201.1	CLEARING AND GRUBBING (F)	A		$8,000	0.2	$1,600
203.1	COMMON EXCAVATION	CY		$8	4750	$38,000
203.2	ROCK EXCAVATION	CY	ASSUME 1% OF COMMON EXCAVATION	$30	48	$1,425
203.6	EMBANKMENT-IN-PLACE (F)	CY		$6	100	$600
206.1	COMMON STRUCTURE EXCAVATION					
206.19	COMMON STRUCTURE EXCAVATION EXPLORATORY	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			$5,914
206.2	ROCK STRUCTURE EXCAVATION					
207.2	UNCLASSIFIED CHANNEL EXCAVATION					
304.1	SAND	CY		$18	1350	$24,300
304.2	GRAVEL (F)	CY		$24	1200	$28,800
304.3	CRUSHED GRAVEL (F)	CY		$24	1050	$25,200
403.11	HOT BITUMINOUS PAVEMENT,MACHINE METHOD	TON		$80	1020	$81,600
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD (Drives)	TON		$130	125	$16,250
403.99	TEMPORARY BITUMINOUS PAVEMENT	TON				$0
411.43	PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON				$0
417	COLD PLANING BITUMINOUS SURFACES (F)	SY		$5	4300	$21,500
606.14	BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF				$0
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)					
606.1452	BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			$0
606.147	BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS					
608.12	2" BITUMINOUS SIDEWALK	SY				$0
608.24	CONCRETE SIDEWALK (F)	SY		$40	140	$5,600
609.01	STRAIGHT GRANITE CURB	LF				$0
609.02	CURVED GRANITE CURB	LF				$0
609.21	STRAIGHT GRANITE SLOPE CURB	LF		$20	350	$7,000
609.22	STRAIGHT GRANITE SLOPE CURB WITH RADIAL JOINTS	LF				
609.811	BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY			$0
609.5	RESET GRANITE CURB	LF				$0
214	FINE GRADING	LS	20% OF TOTAL SUB BASE COST			$15,660
	SUBTOTAL A					$273,449
	MISCELLANEOUS ITEMS (ROADWAY) (SAMPLE ITEMS BELOW)					
	FILL ABANDONED PIPE	CY				
	CLEARING FOR FENCE LINES (F)	A				
	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
	REMOVAL OF GUARDRAIL (F)	LF				
	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
	Geotextile fabrics	SY				
	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
	DROP INLET SEDIMENT TRAP OUTLET	EA				
	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
	CONCRETE STAIRS	U				
	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
	DELINEATORS WITH POST	EA	USE 60% OF SUBTOTAL "A" COST			
	STEEL WITNESS MARKERS, BOUNDS	EA				
	SAWED PAVEMENT	LF				
	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
	LOAM & HUMAS	CY				
	FERTILIZER	TON				
	GRASS SEED, TYPE 82	LB				
	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
	TURF ESTABLISHMENT	SY				
	BARK MULCH MATERIAL	CY				
	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	$				
	FIELD OFFICE TYPE & LAB	MON				
	TRAFFIC SIGN TYPE A,B,C;AA,BB,CC	SF				
	MICELLANEOUS COST SUBTOTAL					$164,069
	SUBTOTAL B					$437,518
	DRAINAGE COSTS (SAMPLE ITEMS BELOW)					
	STONE FILL, CLASS B,C,D	CY				
	PIPE	LF				
	STEEL END SECTIONS	EA	CONSIDER		15%	
	CATCH BASINS	U	1-10% MINOR IMPROVEMENTS			
	DRAINAGE MANHOLES	U	10% RECONST NON URBAN			
	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	15% NEW NON URBAN			
	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	20% FULL DEPTH RECONSTRUCT URBAN			
	UNDERDRAIN FLUSHING BASINS	EA	20% NEW URBAN			
	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	25% COMPLEX URBAN			
	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
	DRAINAGE COST SUBTOTAL					$65,627.70
	SUBTOTAL C					$503,146
	PERMANENT TRAFFIC CONTROL (SAMPLE ITEMS BELOW)					
	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE $600/LF	$600		$0
	OVERHEAD SIGN STRUCTURES SPAN	EA	USE $800/LF	$800		$0
	RRFB (Rectangular Red Flashing Beacon)	U		$15,000		$0
	TRAFFIC SIGNALS	EA	USE $150K/ INTERSECTION	$150,000	0	$0
	TRAFFIC SIGNAL COORDINATION	EA	USE $50K/ ADDITIONAL INTERSECTION	$50,000	0	$0
	LIGHT POLES AND BASES (est 2/300 feet)	EA	USE $4500/ POLE	$4,500	0	$0
	PERMANENT TRAFFIC CONTROL COST SUBTOTAL					$0
	SUBTOTAL D					$503,146
	TEMPORARY TRAFFIC CONTROL (SAMPLE ITEMS BELOW)					
	UNIFORMED OFFICERS WITH VEHICLE		USE 1.0 TIMES MAINT OF TRAFFC COST			$13,672
	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			$4,102
	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF				
	MAINTENANCE OF TRAFFIC	UNIT	USE 5% OF SUBTOTAL A			$13,672
	MISCELLANEOUS TRAFFC CONTROL					
	PORTABLE CHANGEABLE MESSAGE SIGN-					
	TEMPORARY CONSTRUCTION SIGNS					
	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 30% OF MAINTENANCE OF TRAFFIC			
	IMPACT ATTENUATION DEVICE					
	MISCELLANEOUS TRAFFC CONTROL SUBTOTAL					$4,102
	TEMPORARY TRAFFIC CONTROL COST SUBTOTAL					$35,548
	EROSION, SEDIMENT & POLLUTION CONTROL					
	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
	SILT FENCE	LF	USE 5% OF SUBTOTAL A			
	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U				
	MONITORING EROSION AND SEDIMENT CONTROL	HR				
	TEMPORARY PROJECT WATER POLLUTION CONTROL	$				$13,672
	EROSION, SEDIMENT & POLLUTION CONTROL SUBTOTAL					$13,672
	SUBTOTAL E					$552,366
	ADDITIONAL ITEMS OF CONSIDERATION					
	ITS			$0	0	$0
	RETAINING WALLS	SF	USE $50/SF	$50	0	$0
	SOUND WALL	SF	USE $25 /SF	$25	0	$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 5% OF SUBTOTAL E			$27,618
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	$100,000	0	$0
	LANDSCAPING		ASSUME $20.65/LF	$20.65	0	$0
	UTILITY ADJUSTMENTS		ASSUME $1000/LF	$0	0	$0
	STRUCTURES			$0	0	$0
	ADDITIONAL ITEMS COST SUBTOTAL					$27,618
	SUBTOTAL F					$579,985
	MOBILIZATION		USE 4% OF SUBTOTAL F			$23,199
	CONTINGENCIES		USE 10% OF SUBTOTAL F			$57,998
	CONSTRUCTION SUBTOTAL					**$661,183**
	CONSTRUCTION ENGINEERING		USE 8% OF CONSTRUCTION TOTALS			$52,895
	CONSTRUCTION TOTAL					**$715,000**

D.5 Concept 5: Cost Estimate

CONSTRUCTION COST ESTIMATE

PROJECT : RSA

LOCATION Candia, NH

STATE PROJECT NO.

FEDERAL PROJECT NO.

ESTIMATE TYPE: Conceptual Cost Estimate

DATE PREPARED: 7/9/2014

ESTIMATED BY: JMH

CHECKED BY: SPH

Candia RSA

Concept 5 - T-Intersection High St to Raymond Rd, One Way Access WB Raymond Rd

ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
	MATERIAL ITEMS (ROADWAY)					
201.1	CLEARING AND GRUBBING (F)	A		$8,000	0.2	$1,600
203.1	COMMON EXCAVATION	CY		$8	2900	$23,200
203.2	ROCK EXCAVATION	CY	ASSUME 1% OF COMMON EXCAVATION	$30	29	$870
203.6	EMBANKMENT-IN-PLACE (F)	CY		$6	100	$600
206.1	COMMON STRUCTURE EXCAVATION					
206.19	COMMON STRUCTURE EXCAVATION EXPLORATORY	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			$3,611
206.2	ROCK STRUCTURE EXCAVATION					
207.2	UNCLASSIFIED CHANNEL EXCAVATION					
304.1	SAND	CY		$18	800	$14,400
304.2	GRAVEL (F)	CY		$24	700	$16,800
304.3	CRUSHED GRAVEL (F)	CY		$24	650	$15,600
403.11	HOT BITUMINOUS PAVEMENT,MACHINE METHOD	TON		$80	1050	$84,000
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD (Drives)	TON		$130	20	$2,600
403.99	TEMPORARY BITUMINOUS PAVEMENT	TON				$0
411.43	PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON				$0
417	COLD PLANING BITUMINOUS SURFACES (F)	SY		$5	4250	$21,250
606.14	BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF				$0
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)					
606.1452	BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			$0
606.147	BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS					
608.12	2" BITUMINOUS SIDEWALK	SY				$0
608.24	CONCRETE SIDEWALK (F)	SY		$40	140	$5,600
609.01	STRAIGHT GRANITE CURB	LF				$0
609.02	CURVED GRANITE CURB	LF				$0
609.21	STRAIGHT GRANITE SLOPE CURB	LF		$20	350	$7,000
609.22	STRAIGHT GRANITE SLOPE CURB WITH RADIAL JOINTS	LF				$0
609.811	BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY			$0
609.5	RESET GRANITE CURB	LF				$0
214	FINE GRADING	LS	20% OF TOTAL SUB BASE COST			$9,360
	SUBTOTAL A					$206,491
	MISCELLANEOUS ITEMS (ROADWAY)					
	(SAMPLE ITEMS BELOW)					
	FILL ABANDONED PIPE	CY				
	CLEARING FOR FENCE LINES (F)	A				
	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
	REMOVAL OF GUARDRAIL (F)	LF				
	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
	Geotextile fabrics	SY				
	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
	DROP INLET SEDIMENT TRAP OUTLET	EA				
	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
	CONCRETE STAIRS	U				
	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
	DELINEATORS WITH POST	EA	USE 60% OF SUBTOTAL "A" COST			
	STEEL WITNESS MARKERS, BOUNDS	EA				
	SAWED PAVEMENT	LF				
	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
	LOAM & HUMAS	CY				
	FERTILIZER	TON				
	GRASS SEED, TYPE 82	LB				
	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
	TURF ESTABLISHMENT	SY				
	BARK MULCH MATERIAL	CY				
	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	$				
	FIELD OFFICE TYPE & LAB	MON				
	TRAFFIC SIGN TYPE A,B,C;AA,BB,CC	SF				
	MICELLANEOUS COST SUBTOTAL					$123,894
	SUBTOTAL B					$330,385
	DRAINAGE COSTS					
	(SAMPLE ITEMS BELOW)					
	STONE FILL, CLASS B,C,D	CY				
	PIPE	LF				
	STEEL END SECTIONS	EA	CONSIDER		15%	
	CATCH BASINS	U	1-10% MINOR IMPROVEMENTS			
	DRAINAGE MANHOLES	U	10% RECONST NON URBAN			
	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	15% NEW NON URBAN			
	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	20% FULL DEPTH RECONSTRUCT URBAN			
	UNDERDRAIN FLUSHING BASINS	EA	20% NEW URBAN			
	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	25% COMPLEX URBAN			
	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
	DRAINAGE COST SUBTOTAL					$49,558
	SUBTOTAL C					$379,943
	PERMANENT TRAFFIC CONTROL					
	(SAMPLE ITEMS BELOW)					
	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE $600/LF	$600		$0
	OVERHEAD SIGN STRUCTURES SPAN	EA	USE $800/LF	$800		$0
	RRFB (Rectangular Red Flashing Beacon)	U		$15,000		$0
	TRAFFIC SIGNALS	EA	USE $150K/ INTERSECTION	$150,000	0	$0
	TRAFFIC SIGNAL COORDINATION	EA	USE $50K/ ADDITIONAL INTERSECTION	$50,000	0	$0
	LIGHT POLES AND BASES (est 2/300 feet)	EA	USE $4500/ POLE	$4,500	0	$0
	PERMANENT TRAFFIC CONTROL COST SUBTOTAL					$0
	SUBTOTAL D					$379,943
	TEMPORARY TRAFFIC CONTROL					
	(SAMPLE ITEMS BELOW)					
	UNIFORMED OFFICERS WITH VEHICLE		USE 1.0 TIMES MAINT OF TRAFFC COST			$10,325
	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			$3,097
	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF				
	MAINTENANCE OF TRAFFIC	UNIT	USE 5% OF SUBTOTAL A			$10,325
	MISCELLANEOUS TRAFFC CONTROL					
	PORTABLE CHANGEABLE MESSAGE SIGN-					
	TEMPORARY CONSTRUCTION SIGNS					
	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 30% OF MAINTENANCE OF TRAFFIC			
	IMPACT ATTENUATION DEVICE					
	MISCELLANEOUS TRAFFC CONTROL SUBTOTAL					$3,097
	TEMPORARY TRAFFIC CONTROL COST SUBTOTAL					$26,844
	EROSION, SEDIMENT & POLLUTION CONTROL					
	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
	SILT FENCE	LF	USE 5% OF SUBTOTAL A			
	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U				
	MONITORING EROSION AND SEDIMENT CONTROL	HR				
	TEMPORARY PROJECT WATER POLLUTION CONTROL	$				$10,225
	EROSION, SEDIMENT & POLLUTION CONTROL SUBTOTAL					$10,325
	SUBTOTAL E					$417,111
	ADDITIONAL ITEMS OF CONSIDERATION					
	ITS			$0	0	$0
	RETAINING WALLS	SF	USE $50/SF	$50	0	$0
	SOUND WALL	SF	USE $25 /SF	$25	0	$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 5% OF SUBTOTAL E			$20,856
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	$100,000	0	$0
	LANDSCAPING		ASSUME $20.65/LF	$20.65	0	$0
	UTILITY ADJUSTMENTS		ASSUME $1000/LF	$0	0	$0
	STRUCTURES			$0	0	$0
	ADDITIONAL ITEMS COST SUBTOTAL					$20,856
	SUBTOTAL F					$437,966
	MOBILIZATION		USE 4% OF SUBTOTAL F			$17,519
	CONTINGENCIES		USE 10% OF SUBTOTAL F			$43,797
	CONSTRUCTION SUBTOTAL					**$499,282**
	CONSTRUCTION ENGINEERING		USE 8% OF CONSTRUCTION TOTALS			$39,943
	CONSTRUCTION TOTAL					**$540,000**

Appendix E: Benefit-Cost Analysis

E.1 Near-Term Strategies

Near-term improvements are those that are lower cost and can generally be done with maintenance staff. For example, sign replacements are an inexpensive strategy and can generally be done as part of routine maintenance. As such, detailed benefit-cost analyses were not conducted for near-term improvements. Near-term strategies are summarized in Appendix F.

E.2 Proactive Strategies

The report identified proactive strategies that are not necessarily related to any crashes experienced in the 4-year study period from 2009 – 2012. Instead, these strategies are suggested based on field observations of potential safety issues. A benefit-cost analysis was not conducted for proactive measures because they are not directly related to any crashes experienced in the study period. Proactive strategies are summarized in Appendix F.

E.3 Benefit-Cost Analysis of Concepts 1 – 3

Detailed benefit-cost analyses were conducted for the three concepts related to the intersection of NH 43 and Raymond Road, including strategies that are associated with crashes reported during the study period. There were no reported crashes at the intersection of NH 27 and Raymond Road. As such, it is difficult to estimate the expected benefit in terms of a crash reduction, and a formal benefit-cost analysis is not provided. Instead, proactive strategies could be pursued on the basis of systemic treatments (i.e., those that could be implemented for relatively low cost at many sites with similar characteristics). The following tables present a summary of the benefit-cost analyses by concept for Concepts 1 - 3. Note that the benefit-cost (B/C) ratio is less than 1.0 for all concepts, indicating an unfavorable return on investment. As such, none of the concepts are eligible for HSIP funding. Instead, other funding sources should be explored, including those listed in Section 1.3.

Concept 1

Summary	Issue	Target Crashes	Individual Benefit	Total Benefit	Construction Cost	B/C Ratio
Realign intersection, moving WB Raymond Road approach to the north and switching stop-control from SB Main Street to WB Raymond Road.	1	Fatal/Injury	$472,514	$509,153	$1,242,000	0.41
		PDO	$36,639			

Concept 2

Summary	Issue	Target Crashes	Individual Benefit	Total Benefit	Construction Cost	B/C Ratio
Realign intersection, moving SB Main Street approach to the east.	1	Fatal/Injury	$472,514	$659,803	$1,146,000	0.58
		PDO	$36,639			
Install continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27.	1	All	$62,268			
Install left-turn lane on EB approach at the intersection.	1, 2	All	$88,381			

Concept 3

Summary	Issue	Target Crashes	Individual Benefit	Total Benefit	Construction Cost	B/C Ratio
Install roundabout	1	All	$1,212,226	$1,212,226	$1,650,000	0.73

Appendix F: Summary of Strategies

Appendix F provides a summary of suggested strategies. This can form the basis of the formal response letter, which is Step 7 of the FHWA RSA Process. The objective of the formal response letter is to document the decisions made by the project owner/design team with respect to the RSA findings. The response identifies those strategies that will be implemented and the responsible party. The response should also note any strategies that will not be implemented and why. The following are examples of why a strategy may not be selected:

- The strategy is not within the scope of the project.
- The strategy would lead to mobility, environmental, or other non-safety related issues.
- The strategy is not cost-effective and other alternatives will be explored.

NH 43 at Raymond Road

F.1 NH 43 at Raymond Road: Near-Term Strategies

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1	1.1 Move stop bar on SB Main Street closer to edge line.	NHDOT Bureau of Traffic	NHDOT Bureau of Traffic	Town needs to send a request to the Bureau of Traffic.
1	1.2 Close NB Main Street approach.	Town of Candia	Town of Candia	
2	2.1 Conduct speed study to determine appropriate speed limit.	NHDOT Bureau of Traffic	Not applicable	Town needs to send a request to the Bureau of Traffic.
2	2.2 Communicate results of speed study with local courts to support adjudication.	Town of Candia	Town of Candia	
3	3.1 Extend centerlines and continue edgeline around corner radius of NH 43 (EB) onto Main Street (SB).	NHDOT Bureau of Traffic	NHDOT Bureau of Traffic	Town needs to send a request to the Bureau of Traffic and find a funding source.
3	3.2 Extend no passing zone further west on NH 43.	NHDOT Bureau of Traffic	NHDOT Bureau of Traffic	Bureau of Traffic to evaluate and consider modifications for the next re-striping.
4	4.1 Delineate fixed objects near roadway using retroreflective tape or object markers.	Town of Candia	Town of Candia	
5	5.1 Leave gate to cemetery closed with access for emergency only and for funerals with police special detail traffic control required.	Town of Candia	Town of Candia	

F.2 NH 43 at Raymond Road: Intermediate and Long-Term Proactive Strategies

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
4	4.2 Remove, redesign, or relocate fixed objects within clear zone, particularly along outside of curves.	Town of Candia	Town of Candia	
4	4.3 Relocate utility poles to inside of horizontal curve.	TBD	TBD	Town needs to request this change.

F.3 NH 43 at Raymond Road: Intermediate Strategies Associated with Crashes

Issue(s)	Strategies	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1	1.3 Realign intersection, moving WB Raymond Road approach to the north and switching stop-control from SB Main Street to WB Raymond Road.	TBD	TBD	Town to identify and explore additional funding sources.
1	1.4 Realign intersection, moving SB Main Street approach to the east.	TBD	TBD	Town to identify and explore additional funding sources.
1	1.5 Install left-turn lanes on mainline at the intersection.	TBD	TBD	Town to identify and explore additional funding sources.
1, 2	1.5/2.3 Install continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27.	TBD	TBD	Town to identify and explore additional funding sources.

F.4 NH 43 at Raymond Road: Long-Term Strategies Associated with Crashes

Issue(s)	Strategies	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1	1.6 Install roundabout.	TBD	TBD	Town to identify and explore additional funding sources.

F.5 NH 27 at Raymond Road: Near-Term Strategies

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1, 3	1.1/3.2 Restripe centerline and stop bar on High Street to encourage drivers to position their vehicle perpendicular to Raymond Road.	NHDOT Bureau of Traffic	NHDOT Bureau of Traffic	Town needs to send a request to the Bureau of Traffic.
2	2.1 Conduct speed study to determine appropriate speed limit.	NHDOT Bureau of Traffic	NHDOT Bureau of Traffic	Town needs to send a request to the Bureau of Traffic.
2	2.2 Communicate results of speed study with local courts to support adjudication.	Town of Candia	Town of Candia	
3	3.1 Remove tape from curve warning sign and install separate intersection warning sign at a distance appropriate for speed of roadway.			This will be addressed in the sign improvement program in District 5 (currently underway).
3	3.3 Install white skip marks along north side of NH 27 across High Street.	TBD	TBD	Town to identify and explore additional funding sources.
4	4.1 Through the site plan review process, offer guidance to direct property owners to narrow, limit, and better define access points.	Town of Candia	Town of Candia	
5	5.1 Identify location of drainage features from existing plans or field reviews.	Town of Candia	Town of Candia	

F.6 NH 27 at Raymond Road: Intermediate and Long-Term Proactive Strategies

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1	1.2 Realign intersection, moving High Street approach to the west and allowing WB traffic from NH 27 to flow onto High Street similar to current operations. A second perpendicular intersection would be provided for EB drivers to turn left from Raymond Road and to serve drivers on High Street.	TBD	TBD	Town to identify and explore additional funding sources.
1	1.2 Realign intersection, moving High Street approach to the west and shifting all movements from current location. This would create a formal right turn movement from NH 27 onto High Street.	TBD	TBD	Town to identify and explore additional funding sources.
1	1.3 Install left-turn lane on Raymond Road at the intersection.	TBD	TBD	Town to identify and explore additional funding sources.
1, 2	1.3/2.3 Install continuous two-way left-turn lane (TWLTL) along Raymond Road between NH 43 and NH 27 (see Issue 1 for NH 43 and Raymond Road).	TBD	TBD	Town to identify and explore additional funding sources.
5	5.2 Address drainage issues during next construction project at the intersection.	TBD	TBD	Town to identify and explore additional funding sources.