

Preliminary Design Report

Bolton Greenway Extension

Bolton, CT

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1.0 Introduction

The East Coast Greenway is an ongoing project to create a nearly 3,500 mile urban path linking almost 30 major cities of the Atlantic coast of the United States, from Calais, Maine, to Key West, Florida, for non-motorized human transportation. Locally, it will link Boston, Worcester, Providence, Hartford, New Haven, and New York City. Within Connecticut there are six sections of the East Coast Greenway. Two of those sections are local to the Town of Bolton. The Hop River State Park Trail from Columbia to Bolton Notch and the Charter Oak Greenway which currently runs from Porter Street in Manchester to East Hartford.

The Connecticut Department of Transportation (ConnDOT) is currently constructing Project 76-217, which will extend the Charter Oak Greenway Shared Use Path from its current terminus across from Porter Street to Finley Street in Manchester. This segment is expected to complete construction in the fall of 2016. The next segment, ConnDOT Project 12-96, will continue the path from Finley Street in Manchester to the existing parking area of Bolton Notch State Park in Bolton where it will connect with the Hop River Trail. This project is scheduled to begin construction in late 2016 / early 2017 and be completed in 2018.

1.1 Project Background

With the expectation that the East Coast Greenway in the vicinity of Bolton would be completed in the near future, the Town proactively identified the chance to further enhance both local and regional multimodal and recreational opportunities by extending the Greenway east along the Route 44 corridor to Indian Notch Park and points beyond such as the University of Connecticut campus. This extension would provide recreational opportunities for residents and encourage local tourism as well as provide connectivity for those users interested in alternative modes of transportation.

With that goal in mind, the Town formed the Trails Committee to explore the feasibility of the Bolton Greenway Extension Project. The Trails Committee was successful in obtaining a CT Department of Energy and Environmental Protection's (DEEP) Recreational Trails Program grant which provided the means to complete this study.

The Town of Bolton Trails Committee consists of the following members: First Selectman Robert Morra; Selectman Gwen Marrion; Selectman Robert Lessard; Administrative Officer Joyce Stille; Director of Community Development Patrice Carson, AICP; and Lance Dimock, Supervisor of the Highway Department.

To assist the Town of Bolton Trails Committee, BSC Group (BSC) provided this analysis of existing conditions along potential routes, assessed whether any of the potential routes might be feasible, and prepared a preliminary design with a conceptual layout of the preferred alternative facility.

In preparing this report, BSC reviewed the following projects and reports done by others which are integral but separate from this project:

1. The Connecticut Department of Transportation's State Project Number 76-217 & 12-96, the Charter Oak Greenway Extension from Porter Street in Manchester, CT to the existing parking area at Bolton Notch State Park. This is the missing link for the connection of the existing Charter Oak Greenway (coming from the west) to the existing Hop River Trail (running north and south) at Bolton Notch.
2. The Council of Governments Eastern Gateway Subarea of NextGen CT Pathways to UConn: Coordinated Sustainable Intermodal Study Proposal referred to as NextGen UConn. This is a transportation study for the Route 44 corridor to the east including a portion of this Bolton Greenway Extension trail (if available in time for this project).
3. The 2008 Route 44 Strategic Corridor Plan by Fitzgerald & Halliday.
4. The 2013 Route 6 Hop River Corridor Transportation Study by Clough Harbour & Associates, LLP.
5. The 2010 Route 6 Hop River Corridor Economic and Development Strategy and Master Plan Study by LADA, PC.
6. The Connecticut Department of Transportation as a separate project from State Project Number 12-96 will be responsible for the design from the existing Hop River Trail at Bolton Notch to the intersection of Route 44 and Quarry Road.

1.2 Project Overview

Early coordination with ConnDOT representatives identified that the segment of the Bolton Greenway Extension that would connect to the Charter Oak Greenway and Hop River Trail from the Quarry Road area would continue to be included as part of the planning efforts of the Route 6 / Route 44 Interchange Study. As a result the focus of this study begins at the intersection of Route 44 and Quarry Road.

The Town of Bolton Greenway Extension traverses the Route 44 corridor for 1.44 miles from the east side of Quarry Road to the Coventry town line. The project also includes a 0.32 mile spur along Tolland Road to a proposed greenway parking area located at the entrance to Indian Notch Park. The total distance of the Bolton Greenway Extension is approximately 1.76 miles.

See Figure 1 for a project location map.

1.3 Project Goals & Objectives

The goal of this project included the following components:

- Provide an analysis of existing conditions along potential routes.
- Ascertain whether any of the potential routes might be feasible.
- Prepare a preliminary design with a conceptual layout of the preferred alternative facility.

2.0 Mapping and Data Collection

Mapping and data collection was conducted to compile and review available information regarding the project corridor.

2.1 Mapping

Mapping of the project area was gathered from available Town resources, GIS data layers, and publicly-available State of Connecticut resources. This mapping was digitally compiled to provide a base map for feasibility analysis and preliminary design efforts.

2.1.1 Survey Mapping

The Town completed a sewer installation project that included most of the project corridor. Base mapping from this project was provided to BSC by the Town's designer for the sewer project, Fuss and O'Neill, of Manchester, Connecticut. BSC was provided with three map files in electronic (.DWG) format. These files consisted of a corridor base map and two additional electronic files. The first supplemental file provided additional information regarding the steep slope that is located along the northern side of Route 44 from Quarry Road to Vernon Road. The second supplemental file provided topographic information for the area located between Route 44, Tolland Road, and Lower Bolton Lake. BSC compiled the three files to create one base map for the project.

2.1.2 Connecticut Department of Transportation, Rights of Way Mapping

Upon receiving the survey files noted in section 2.1.1, BSC surveyors requested Right of Way (ROW) mapping of the project corridor from the Connecticut Department of Transportation's Office of Central Surveys. The relative accuracy of ROW information indicated on the Town provided sewer project survey was assessed by comparing the mapping to ROW lines indicated on the ConnDOT mapping. It was determined that the ROW mapping included in the Town provided survey information was similar, and utilization of the ROW delineation included in the Town provided survey was appropriate.

2.1.3 Connecticut Department of Energy and Environmental Protection, Natural Diversity Database

An environmental review of the project area was conducted to identify areas of special environmental concern such as critical habitats that would affect layout of the greenway options. Connecticut Department of Energy and Environmental Protection (DEEP) data residing in a Geographic Information System (GIS) was reviewed to screen for areas of special environmental concern such as wetland soils, flood plains, flood zones and water bodies.

The western portion of the project corridor, beginning in the vicinity of Quarry Road and extending approximately 1,000 linear feet (LF) to the east, is located within an area designated by DEEP as an area containing “State and Federal Listed Species and Significant Natural Communities”. The DEEP mapping is included in Appendix A.

2.2 Data Gathering

BSC researched and gathered data available from public sources such as ConnDOT for traffic data and roadway classification information and the Connecticut Crash Data Repository for accident history data. This information was compiled and analyzed to gain a better understanding of the project corridor. More specific detail as well as a summary of the data can be found in Section 3.0 and Appendix B.

2.3 Field Observations

Several field visits were conducted within the project corridor to observe the physical layout, existing physical features, scale, opportunities, and obvious constraints associated with the Route 44 project corridor. These visual assessments were used to generally verify (where possible) digital mapping data such as roadways, buildings, topography, etc. specific to opportunities and obvious constraints that would affect potential greenway layouts. Photographs taken during field observations are included as part of the Existing Conditions Analysis Plans provided in Appendix B. Each of these plans depicts the existing conditions with select photographs of key elements considered with respect to opportunities and obvious constraints that were considered. Additional information gathered during field observations is included in Section 3.0.

3.0 Existing Conditions Assessment

An existing conditions assessment was conducted to understand and identify issues with potential impact on selection of greenway layout alternatives. Additionally, the existing conditions assessment served to identify constraints as well as points of interest.

Assessment of the project corridor included an on-site examination of the infrastructure and associated improvements. The assessment considered general site topography; Route 44 corridor characteristics, available ROW, potential utility conflicts, and points of interest. During the project development discussions with stakeholders identified that design should strive to stay within the available ROW and minimize the number of crossings of Route 44.

3.1 Route 44 Corridor Characteristics

Route 44 is both an important east-west commuter link for the greater Hartford area as well as a common connector route for the University of Connecticut campus in Storrs. This section of roadway is characterized by relatively high volume, high speed traffic with substantial peak hour increases in the morning and evening.

3.1.1 Roadway Classification

Route 44 is classified as a Minor Arterial per the ConnDOT Functional Classification map last updated April 23, 2015. See Appendix B.

Chapter 6 of the ConnDOT Highway Design Manual, 2003 Edition, states, “In rural areas, minor arterials will provide a mix of interstate and interregional travel service. In urban areas, minor arterials may carry local bus routes and provide intracommunity connections, but they will not, for example, penetrate neighborhoods. When compared to the principal arterial system, the minor arterials provide lower travel speeds, accommodate shorter trips and distances and lower traffic volumes but provide more access to property.”

3.1.2 Travel Lane and Shoulder Widths

The assembled base plan show the travel lanes as fairly consistent in width at 12'. However, field observations often recorded widths greater than 12' such as in the vicinity of the Vernon Road intersections. Wider travel lanes often contribute to higher vehicle speeds.

The majority of the existing paved shoulder is 4' to 5' but varies from as little as 2' in the vicinity of the Quarry Road intersection to 10' in select areas such as the area to the west of the boat launch driveway and in the vicinity of the culvert crossing located 900' west of the Tolland Road intersection.

3.1.3 Pavement Condition

Overall, the Route 44 corridor pavement condition can be considered to be in good to very good condition as a result of field observations. The bituminous pavement surface is generally free of significant surface defects, surface deformations, or cracking and is smooth with few bumps or depressions within the project area. Bituminous curb is present in multiple locations and all shoulders have good support beyond the edge of pavement. A mix of open and closed drainage is used to collect and convey stormwater. Standard ConnDOT Type “C” and Type “C-L” Catch Basins are utilized at various locations on both sides of the roadway.

3.1.4 Traffic Volumes

Route 44 is a heavily travelled corridor with an Average Daily Traffic (ADT) count of over 15,000 vehicles per day according to ConnDOT 2013 Traffic Volumes. See Appendix B.

3.1.5 Posted Speed

The posted speed limit through the project corridor is 40 mph. However field observations and anecdotal information from project stakeholders indicate that drivers often fail to adhere to the posted speed limit and drive at higher speeds.

3.1.6 Accident History

The Connecticut Crash Data Repository (CTCDR) is a web tool designed to provide access to select crash information collected by state and local police. This data repository enables users to query, analyze and print/export the data for research and informational purposes. The CTCDR is comprised of crash data from two separate sources; the Department of Public Safety (DPS) and ConnDOT.

For the period covering 2010 until 2015, there was a total of 122 reported crashes within the project corridor. A review of the data indicates that there were 0 Fatal Crashes, 26 Injury Crashes, and 96 Property Damage Crashes. Of the 122 total crashes, 62 were rear-end type collisions with the contributing cause listed as following too closely. This trend in crash type may be the result of high traffic volumes paired with high speeds and driver inattentiveness. See Appendix B for a summary of the accident data.

3.1.7 Intersections

Roadway intersections present specific design and safety challenges that need to be considered during the selection and design process of the greenway extension. When a greenway facility encounters an intersection, conflict points with vehicles are introduced and need to be mitigated to provide a safe and pleasant user experience.

3.1.7.1 Signalized Intersections

There are 2 signalized intersections located within the project limits. Signal modifications may be required to accommodate the addition of greenway traffic within the project corridor. Changes to signal timings as well additional detection equipment for pedestrian and/or bicycle use will need to be evaluated as part of the final design development. Signalized intersections are located at:

- Quarry Road
- South Road – it should be noted that the signal equipment at South Road is currently being replaced by ConnDOT and the base plan should be revised upon the receipt of as-built information.

3.1.7.2 Un-signalized Intersections

There are 8 unsignalized intersections located within the project corridor. All of the intersections listed are currently T-intersections that are stop controlled from the minor road. Issues such as intersection sight distance will need to be considered and evaluated during the final design process with respect to the addition of a greenway facility. Locations of the intersections are listed below along with which side of Route 44 the side road intersects the project corridor.

- Howard Road – Southern side of Route 44
- Vernon Road - North side of Route 44
- Lakeside Lane - North side of Route 44
- Keeney Drive - North side of Route 44
- Boat Launch - North side of Route 44
- North Road - North side of Route 44
- Tolland Road - North side of Route 44
- Old Coventry Road - South side of Route 44

3.2 Tolland Road Characteristics

Tolland Road is a rural two-lane local road that has a posted speed limit of 30 MPH. Traffic volumes have been observed to be relatively low (>1500 vehicles per day). The portion of Tolland Road that is contained within the project corridor begins at the intersection with Route 44 and extends approximately 1,700' north to the entrance of Indian Notch Park. Tolland Road continues north and serves as access to residential areas associated with the Bolton Lakes. Roadway geometry within the project area consists of a horizontal tangent with a small vertical grade increase (> 3%) from Route 44 to Indian Notch Park. The Tolland Road cross section currently consists of two 12' travel lanes with a small paved shoulder (2' or less). The existing pavement condition can be considered to be fair. Pavement patching is evident along the western side of the road as a result of the sewer installation project recently completed. Additionally, transverse cracking and associated joint sealing is present throughout the length of the roadway.

3.3 Right-of-Way (ROW)

The ROW varies considerably in width throughout the length of the Route 44 corridor. The portion of the corridor from Quarry Road to 450' east of the Vernon Road Intersection is approximately 100' wide at which point it begins to narrow to less than 80' in the vicinity of Lakeside Lane. Along the Quarryville Cemetery parcel, which is located on the south side of Route 44 immediately across from Lakeside Lane, the ROW is suddenly reduced by 20' and reaches its minimum width (less than 60') as delineated by the existing stone wall. Continuing to the east, the ROW continues to vary but maintains at least 70' in width.

The Tolland Road ROW is a consistent 40' width.

3.4 Utilities

3.4.1 Overhead Utilities

Overhead utilities exist throughout the project corridor and will potentially be in conflict with greenway extension alternatives and/or represent a design constraint in many areas. The location of utility poles should be carefully considered during the alternative evaluation.

3.4.2 Underground Utilities

As indicated earlier, the Town of Bolton recently completed a sewer installation project that traverses the project corridor along the northern edge of the project corridor.

Underground Fiber Optic utilities including conduit and structures are located along the south side of the Route 44 corridor.

No other indications of underground utilities were observed.

3.5 Points of Interest

One of the goals of the greenway extension, in addition to providing a safe multi-modal corridor that links destinations, will be to incorporate points of interest along the project corridor. Below is a short list of some of the identified destinations and points of interest.

- Lower Bolton Lake Boat Launch and Dam located near South Road
- Indian Notch Park located along Tolland Road
- Potential Lake View located near the Vernon Road intersection
- Quarryville Cemetery located immediately across from Lakeside Lane

3.6 Site Assessment Plans

BSC developed project site assessment plans that combine photo documentation with a graphical color representation of project constraints such as steep slopes, rock faces, stone walls, and observed wet areas in conjunction with points of interest and favorable slopes.

These plans were used to aid the evaluation of greenway extension alternatives and are provided in Appendix B.

4.0 Future Conditions Assessment

Using the existing conditions assessment plans prepared as described in Section 3.0, various greenway options and routes were contemplated within the project area. Ultimately, routing alternatives were reduced to two practical options for the Route 44 corridor and a single option for the Tolland Road portion.

4.1 Route 44 Corridor

4.1.1 Design Criteria

Design Criteria established for the Route 44 Corridor:

- Strive to stay within the available right-of-way
- Minimize the number of crossings of Route 44.
- Minimize utility pole impacts
- Incorporate points of interest

A review of the existing conditions assessment plans developed in Section 3.0, adherence to the design criteria, and discussions with the Trails Committee members led to the final evaluation of two alternatives for the Route 44 Corridor:

1. Alternative 1 – On-Road - Dedicated Bicycle Lane – a dedicated bicycle lane that is located on the existing roadway facility.
2. Alternative 2 – Off-Road - Shared Use Side Path – a shared use path that is located within the existing ROW but separated from the existing roadway. A Shared Side Path can accommodate both bicycle users as well as pedestrian users.

4.1.2 Alternative 1 – On-Road - Dedicated Bicycle Lane

A dedicated bicycle lane would be established to accommodate one bicycle travel lane in both the eastbound and westbound direction on Route 44. Generally, the existing travel lane widths would be maintained with some modifications required in the areas of reduced shoulder width. The existing 4” white edge of travel lane line would be eradicated and replaced with a 6” painted line. The recommended width of the bike lane is a minimum of 5’ with a preferred width of 6’ including the 6” painted line. Additional pavement width would be required in locations where the existing shoulder width is not adequate.

See Appendix C for a sample cross section.

Positive Attributes

- Constructability - simple construction that utilizes existing roadway facility.
- Cost - less expensive as it requires only pavement marking and signing.

Negative Attributes

- Safety - proximity to motorized vehicles presents potential conflicts and reduced safety.
- Users – accommodates bicycle but not pedestrian friendly.

4.1.3 Alternative 2 - Off-Road - Shared Use Side Path

A Shared Use Side Path is a multi-modal facility located within the roadway ROW but is physically separated from the roadway, and in turn, motorized vehicular traffic by an open space or barrier. Typical side path widths range from 10' to 14' and can accommodate two-way use by various user types including bicycles and pedestrians.

See Appendix C for a sample cross section.

Positive Attributes

- Safety – separation from motorized vehicles reduces potential conflicts and increases safety.
- Users - accommodates both bicycle and pedestrian use.

Negative Attributes

- Constructability – complex construction.
- Cost – more expensive as it requires constructing a separate facility.
- Driveway / side road crossings – vehicles entering or exiting side roads and driveways present conflict points with side path users. A vehicle has the potential to block the side path while waiting to merge into traffic on the main roadway.

The Route 44 corridor was investigated by the design team to determine where a shared use side path could feasibly be implemented. Utilizing the Site Assessment plans discussed in Section 3, the corridor was analyzed to determine where site constraints allowed for the shared use side path to be accommodated on the north side and/or south side. This analysis showed that the corridor could support a shared use side path in numerous locations on both the north or south side. However at the conclusion of this analysis, the north side of Route 44 was selected as the preferred location of the side path due to the following design considerations:

- *Incorporating Points of Interest* – The potential lake view near the Vernon Road intersection, the boat launch and dam area, as well as the Tolland Road Spur that leads to Indian Notch Park are all located on the north side of the corridor which minimizes having the side path cross Route 44.
- *ROW* – The ROW width through the corridor varies but generally supports the placement of the paved path on either side of the corridor with one notable exception, the ROW width in the vicinity of the Quarryville Cemetery is substantially reduced (less than 60'). In this location there is insufficient ROW width to accommodate a side path located on the southern side of Route 44 between the existing edge of pavement and the ROW. This constraint would require the side path to cross to the north side of Route 44 or potentially impact the cemetery parcel which is a historic property. This conflicts with the design goal to stay within the ROW as noted above.
- *Historic Quarryville Cemetery* – Although the cemetery is located on the south side of the corridor and can be considered a point of interest, it is a historic parcel and any impact to the area for the construction of the path would be problematic. Coupled with the ROW limitations in the area, it was determined that the north side of the corridor was the more feasible choice for a side path in this location.
- *Utility Pole Impacts* – There are utility poles located along both sides of the Route 44 Corridor, however the southern side contains more occurrences that would be impacted by a side path. In an effort to minimize the number of utility pole relocations the north side was chosen as the more feasible location for the side path.
- *Underground Fiber Optic Utilities* – Discussion with Town representatives indicate that there is the presence of underground fiber optic conduit and structures on the south side of the corridor. In order to avoid impacts to this facility, the north side was chosen as the more feasible location for the side path.
- *Driveways* – With the exception of the Lakeside Lane area, the north side of Route 44 generally has fewer driveways that would be impacted by a side path. To minimize driveway crossings and in turn conflict points for side path users, the north side was chosen as the more feasible location for the side path.
- *Steep Slopes* – The Route 44 corridor bisects an area of steep slopes located between Quarry Road and Vernon Road. The north side of the corridor is characterized by large cut slopes rising away from the edge of the westbound travel lane. Depending on its integrity, the presence of exposed rock on the north side may support the construction of steep proposed cut slopes (1 horizontal to 1 vertical or steeper) which will reduce overall slope impacts. Conversely, the south side of the corridor includes large fill or embankment slopes that fall away from the eastbound travel lane. Constructing large embankment slopes steeper than 2:1 is not recommended without geotechnical reinforcement which can lead to additional construction costs. As a result the north side of the corridor was selected as the more feasible location for the side path.

4.2 Tolland Road

4.2.1 Design Criteria

Design Criteria Established for Tolland Road:

- Strive to stay within the available right-of-way
- Avoid utility pole impacts
- Incorporate points of interest – Indian Notch Park

The existing ROW width of Tolland Road is 40' and the existing roadway width is approximately 25'. The roadway is centered within the ROW which results in approximate 7.5' of remaining width on either side of the roadway. This width is characterized by open drainage swales and earth slopes required to match the grading of the residential homes in the area.

The 7.5' width from the edge of pavement to the ROW is not sufficient when compared to the desired 15' width (10' width and 5' separation width) needed to support a shared use side path.

The existing 25' roadway width of Tolland Road does not support the incorporation of a dedicated bike lane without the addition of pavement. A roadway width of 32' would be desired to support 11' vehicle travel lanes with a 5' bike lane in both directions and the cost of widening Tolland Road was determined not to be practical.

Considering these facts coupled with the low speeds and volumes led the design team to explore the use of an on-road shared roadway facility.

4.2.2 On-Road Shared Roadway

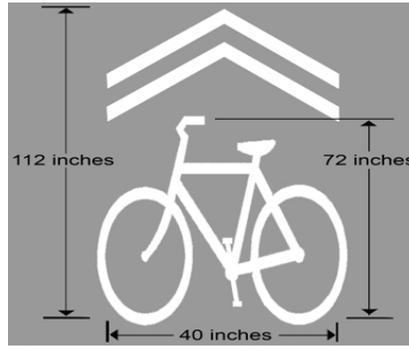
Bicycles may be operated on all roadways except where prohibited by statute or regulation. Implementing an On-Road - Shared Roadway design approach simply alerts motorists that bicycles may be encountered and that they should be mindful and respectful of the bicyclist. This can be accomplished through the use of bicycle specific pavement markings and signing.

Positive Attributes

- Constructability - simple construction that utilizes existing roadway facility.
- Cost - less expensive as it requires only pavement marking and signing.
- Avoids utility pole impacts

Negative Attributes

- Safety - proximity to motorized vehicles presents potential conflicts and reduced safety.
- Users – accommodates bicycle use but not pedestrian friendly.



Example of a Shared Lane marking, also known as a “Sharrow”



Example of Share the Road Signs

4.3 Selection of Preferred Alternatives

Throughout the design process BSC communicated with the Trails Committee as well as coordinated with ConnDOT representatives. Using this collaborative approach, BSC was able to develop the design alternatives listed above and present this information in a public meeting.

A Public Information Meeting was conducted on January 29, 2015 to accomplish two goals:

- Present the existing conditions assessment plans and proposed design alternatives.

- Gather the public input and support required to make the final selection of the preferred alternatives.

During the Public Information Meeting and for a two week period following the meeting, public feedback was gathered by the design team. This feedback was then compiled and analyzed. As a result, it was clear that the public did not support Alternative 1 - On-Road Dedicated Bicycle Lane as the preferred facility due to safety concerns and lack of pedestrian accommodation.

Preferred Alternative Recommendations:

- Route 44 Corridor – Alternative 2 - Off Road – Shared Use Side Path - North Side
- Tolland Road – Shared Roadway

5.0 Preliminary Design Plans

Following the selection of the Preferred Alternatives discussed in Section 4.0, a Preliminary Design was developed that reflects an Off-Road Shared Use Side Path located along the north side of Route 44 and On-Road Shared Roadway along Tolland Road.

5.1 Design Standards

Design standards utilized in the Preliminary Design included:

- American Association of State Highway and Transportation Official (AASHTO) “Guide for the Development of Bicycle Facilities”, 2012 (Fourth Edition).
- ConnDOT Standard Specifications for Roads, Bridges and Incidental Construction, Form 816.
- ConnDOT, Office of Engineering, Highway Standard Details.
- ConnDOT, Office of Engineering, Traffic Standard Details.

5.2 Design Approach

The Bolton Greenway Extension project is proposed to begin from Quarry Road and continue east 1.44 miles to the Coventry town line. At the time of the preliminary design, ConnDOT has undertaken the design and construction the remaining portions of the Charter Oak Greenway to the west that will connect it with the Hop River Trail at Bolton State Park.

Early coordination with ConnDOT representatives identified that the segment of the Bolton Greenway Extension that would connect to the Charter Oak Greenway and Hop River Trail from the Quarry Road area would continue to be included as part of the planning efforts of the Route 6 / Route 44 Interchange Study. Therefore the current project begins on the east side of the Quarry Road intersection to allow for future flexibility in the location of the missing connection.

The initial design iteration of the side path, as presented to the Trails Committee on May 20, 2015, was to establish the proposed path edge of pavement at a constant 16’ offset from Route 44 centerline. This approach aided in the identification of design constraints with regard to available ROW width as well as initial slope impacts.

Utilizing a similar approach, a second iteration was completed that refined the initial iteration and created an independent side path alignment that allowed the path to be manipulated to better utilize the available ROW width while avoiding design constraint features such as utility poles. This iteration is the basis of the preliminary design plans.

5.3 Design Challenges

During development of the Preliminary Design, several challenges have been identified which will require further consideration and analysis during the Final Design phase. These items are briefly discussed below:

1. Base Map - An updated and more complete base map should be created using field-obtained topography to support Final Design. This base map should also reflect complete existing drainage and utility systems. A more detailed ground model will enable the final horizontal and vertical geometry that will minimize the impacts beyond the ROW to be determined. The path geometry currently shown in the plans should be refined during the final design phase to smooth the alignment and profile.
2. Geotechnical Investigation Program – An investigation of the existing rock ledge located between Quarry Road and Vernon Road should be completed, along with a geotechnical engineer’s recommendations on the allowable steepness of the proposed cut slope. Currently, the plans and estimate reflect 2:1 slopes with a 1:1 alternative. However, rock ledges can often sustain slopes steeper than 1:1 which would substantially reduce the slope impacts and required rock excavation.
3. Reduced Path Width Areas – The side path is typically 10’ in width which the minimum width that allows for the two-way bicycle and pedestrian traffic. The separation distance from the side path to the face of the Route 44 curb is typically 5’ which is the minimum recommended. However, there are two locations within the project corridor where the path width and separation width are both reduced.
 - a. Station 37+25 to 38+75 - Lakeside Lane Area – ROW Constraint – the side path width is reduced to 8’ from 10’ and separation distance is reduced from 5’ to 2’ to avoid side path impacts beyond the limited ROW that is available in this area. A guide rail is recommended between the side path and Route 44 when the separation distance is less than 5’ however there are five existing driveways located within this area and will make this installation extremely difficult.
 - b. Station 55+00 to 57+25 - Culvert Crossing – the side path width is reduced to 8’ from 10’ and separation distance is reduced from 5’ to 2’ to avoid impacts to the steep slope and large culvert. Bicycle appropriate railing will be required on the left of the side path to protect users from the steep slope. A guide rail is recommended between the side path and Route 44 when the separation distance is less than 5’ however the existing driveway at Station 57+45 makes this installation difficult.
4. Separation Distance – The current design incorporates a 5’ typical separation distance from the face of the proposed curb of Route 44 to the near edge of the side path pavement. Fixed obstacles such as roadway and side path signing or mailboxes should ideally be located 2’ from both the curb as well as the side path. This presents a challenge that needs to be discussed during final design as placing signing and mailboxes off the far edge of side path pavement may not be practical.

5. Retaining Walls – One of the project goals is to minimize impacts beyond the existing ROW, however existing ground topography in certain locations makes this goal unattainable. There are two locations where small retaining walls should be investigated as a design alternative to the avoid ROW impacts. A plan and cross section has been provided for these locations in the preliminary plans.
 - a. Station 38+65 to 41+00 – East of Lakeside Lane – a retaining wall with an approximate height of 4’ would be required to retain impacts within the ROW. The existing stone wall in this area that would be impacted by construction. A temporary construction easement would most likely be required to complete construction of a retaining wall.
 - b. Station 72+00 to 73+00 – Cropley’s Landscaping – a small retaining wall with an approximate height of 2’ would be required to retain impacts within the ROW. A temporary construction easement would most likely be required to complete construction of a retaining wall. Existing landscaping within the ROW would be impacted.
 - c. Station 77+00 to 78+00 – Vicinity of the Coventry Town Line – a small retaining wall with an approximate height of 2’ would be required to retain impacts within the ROW. A temporary construction easement would most likely be required to complete construction of a retaining wall. Existing landscaping within the ROW would be impacted.
6. ROW – One of the design criteria as noted in Section 4.1.1 was to strive to stay within the available right-of-way. The preliminary plans maintain the pavement of the shared use side path within the available Route 44 ROW however there are instances where encroachment beyond the ROW would be required as outlined below. An estimated cost to secure these encroachments has been provided in the project estimate.
 - a. Temporary construction easements to allow for the construction of earth slopes or reconstruction of driveway aprons will be required in numerous locations along the project corridor.
 - b. Permanent slope easements for steeper slopes such as those between Quarry Road and Vernon Road will be required to construct and maintain these slopes.
 - c. Permanent Sight Line Easements will be required to maintain clear sight triangles for side roads and driveways.
 - d. Property Acquisition is one option to alleviate ROW constraint issues for areas such as the Lakeside Lane segment where the path width and separation have been reduced to minimums. This subject will need to be investigated in more depth during final design.

7. Driveway Lakeside Lane Area / Parcel 976 – In the vicinity of Lakeside Lane, Station 37+50 to 38+50 (as shown on the Preliminary Design plans and cross sections) the side path profile matches the existing ground grade and in turn the existing driveway apron (the separation distance and path width is also reduced in this area, see Item 3 above). The separation island is proposed to be a raised island encircled with curbing. A detail has been provided in the preliminary plans for review and discussion that illustrates the layout as well as vehicle turning movements for the driveway and garage. The raised island limits shown are approximately the same in the current condition. The turning templates illustrate that the vehicle will be in conflict with the side path when entering and exiting both the drive as well as the garage. There are several instances of sight distance deficiencies associated with this driveway as well as the Lakeside Lane Driveway with respect to the proposed side path.

Several options to mitigate the conflict between the path and the existing driveway and garage have been discussed with Town representatives. The options listed below involve substantial cost and will need to be investigated further during final design to determine the most appropriate action. Options include:

- Rotate the garage 90 degrees to exit on Lakeside Lane.
- Relocate the garage back so that it is flush with the existing house to increase the offset from the ROW.
- Relocate the existing garage to another location on the parcel.
- Acquire land from the parcel on the east side of Lakeside Lane and relocate the garage.
- Acquire the entire parcel.

The subject parcel measures approximately 0.32 acres and includes approximately 65' of frontage along Route 44. According to Town of Bolton Assessor online GIS information, the property's 2014 appraisal value is \$210,400. As a conservative approach, the current project estimate includes the full value of the property to provide for full acquisition of the parcel.

8. Project Drainage

- a. Existing Drainage – Several existing drainage culverts and structures will need to be extended or relocated to accommodate the construction of the side path. The locations have been noted on the preliminary plans, however, additional information as discussed above in Item 1 (Base Map) will be required to complete the design. During Final Design a more detailed inspection of the pipe condition should also be completed to determine if extension or full replacement should be considered. For the Preliminary Design, it has been assumed that the existing pipe is in satisfactory condition and will be extended or relocated as required.
 - Station 68+50 – The existing base map appears to lack appropriate detail with respect to the presence of an existing cross culvert. Updated topography and invert information are required to complete the final design

of this area. Extending the culvert will be difficult due to the presence of the sewer facilities as well as available ROW width.

- b. Proposed Drainage – A complete hydrologic and hydraulic analysis should be completed as part of the final design development. The proposed side path includes the construction of bituminous lip curb for the length of the project corridor. Roadway runoff will be collected and concentrated along the proposed curb and will most likely need to be discharged through the use of a closed drainage system. Currently the project corridor is a mix of curbed and uncurbed sections of roadway.

9. Side Road Intersections

- a. Sight Distance Triangles / Sight Line Easements – Sight distance triangles for the side road crossings have been investigated and due to the increase in the driver setback as a result of the shared use side path a number of the sight distance triangles encroach on private property. Sight line easements will need to be established to support safe turning movements. Estimated costs of these easements has been provided in the overall project estimate.
- b. Recessed Side Path Crossing - The final configuration of the shared use side path crossings at side roads should be coordinated with ConnDOT during the final design. The preliminary plans currently show a recessed crossing of the side road when the ROW width allows. A recessed crossing increases the distance of the side path from the edge of the main road pavement. This configuration provides adequate storage distance for a left turning car from the main road to stop before encroaching on the side path but remain outside the through travel lane of the main road. In turn, this layout places the stop bar for the side road at an increased distance from the main road and results in larger sight distance triangles.

10. Signalized Intersections

- a. Quarry Road – The proposed project begins on the east side of the Route 44 / Quarry Road intersection to provide flexibility for the connection with the Charter Oak Greenway and Hop River Trail to the west. At the present time, ConnDOT staff have not designed the connection but are investigating several alternatives that may connect in a myriad of different locations and configurations. During the final design development, continuing coordination with ConnDOT will be important in order to establish the best alternative to connect the trails and address the bicycle and pedestrian movement through the Quarry Road intersection. The Preliminary Design Estimate includes a design alternative cost to modify the Quarry Road Signal.
- b. South Road – During the summer of 2015, ConnDOT initiated a traffic signal upgrade project at the intersection of Route 44 and South Road. The current design reflects the desired side path alignment but would require relocation of portions of the newly installed equipment. An alternative layout that avoids the signal

equipment has been provided in the details of the preliminary plan set. This layout is less desirable as it uses minimum horizontal geometry. It is recommended that as-built information of the signal project be obtained to gain a clearer understanding of the potential impacts and costs associated with the current path design as well as feasible alternative layouts. The Preliminary Design Estimate includes a design alternative cost to modify the South Road Signal.

11. Sewer structure impacts – The Town has recently completed a sewer installation project within the project corridor. The proposed side path will impact some of the sewer structures and will require reconstruction or resetting of the frame and cover.
12. Pavement trimming – The current design assumes that pavement in areas that exceed 16', as measured from the existing double yellow centerline, would be saw cut and removed to allow for the construction of the side path. This approach aids to minimize impacts beyond the ROW and provides a consistent travel lane and shoulder width through the project corridor. BSC has previously discussed this approach with ConnDOT staff who agreed with the design intent but wanted to review the specific impacts before approval. Plans showing the limits of the trimming have been prepared and included with the preliminary plans.
13. Utility Poles – There are currently 14 utility poles within the immediate vicinity of the proposed side path alignment. Eight of these poles have been noted to be relocated because they are either within direct conflict with the proposed path or within two feet of the edge of the path.
14. Areas of Archeological Concern – During discussions with Town representatives it was conveyed that the town sewer improvement project included areas of archeological concern that may overlap with the proposed location of the shared use side path. Costs for further investigation at a screening level and reporting on the limits of these concerns have been included in the estimate for the project. The extent of the areas of archeological concern and their associated impacts to the path layout are unknown at this time but could impact construction costs if unusual measures are required.
15. Eastern Project Limits - The intent of this study and the associated preliminary design plans was to investigate the feasibility of placing a greenway extension through the entire limits of the identified corridor. As currently shown on the plans, the side path would terminate at the Bolton / Coventry Town line. This eastern project limit lacks an definitive terminus point such as a greenway parking area or specific point of interest. Recognizing this issue the Town of Bolton has proactively conducted discussions with representatives from the Town of Coventry to determine a logical terminus point as well as the potential of extending the Greenway further in Coventry.

As the Bolton Greenway Extension project progresses to final design and construction, coordination with ConnDOT, Town of Bolton, and Town of Coventry representatives will be required to determine the final limits of the current project. If at the time of final design and construction, a mutually agreeable terminus point has not been determined

then a potential alternative would be to eliminate the portion of the greenway from Tolland Road to the Coventry town line and utilize the proposed parking area at Indian Notch Park as the eastern terminus point.

Additionally, BSC recommends that an overall master planning effort for the continued greenway extension be considered. This effort would identify alternatives for the continuation of the greenway from a regional perspective.

5.4 Preliminary Design Plans

See Appendix D for the Preliminary Design Plans.

6.0 Cost Estimates

Based on the preferred alternative presented in Section 5.0, planning-level construction cost estimates were prepared for each segment (Route 44 and Tolland Road). Summaries of these cost estimates are presented in this Section, and a detailed cost sheet is included Appendix E.

6.1 Cost Estimating Process

The Unit Quantity Method was utilized to develop the cost estimate for each phase. In this method, the work is divided into the various individual operations or items that collectively “build” the end product. Cost estimates were developed in a four-step process:

6.1.1 Develop Project Model

To develop the project model, BSC identified each operations and/or material type anticipated for the preferred alternative and assigned them to appropriate Construction Specifications Institute (CSI) numeric divisions. Identification of these operations or materials (“Items”) was completed based on the alignment and planning-level assumptions regarding the physical content of the phase. Additionally, “Soft Costs” were included to account for design, permitting, and similar professional services. An appropriate unit of measurement was then assigned to each Item based on its specific nature such as linear-foot (“l.f.”), square-foot (“s.f.”), per-Item basis (“each”), etc.

6.1.2 Assign Quantities

Once the project model was completed and the content of the preferred alternative was defined, an appropriate unit of measurement was assigned to each Item based on its specific nature. The quantity of each Item was then estimated based on the particular alignment and planning-level assumptions regarding its physical content and incorporated into the model.

6.1.3 Assign Unit Prices

Unit prices were assigned to each of the individual Items in the Project Model. Unit prices were obtained from a variety of sources, including published ConnDOT pricing, recent public projects and direct contractor or supplier inquiries. When no unit cost data was available for a particular item, unit costs were compiled by using Department of Labor rates for labor coupled with actual material costs or lump sum values were assigned based on historical benchmarking, ratio allocation, or anticipated level-of-effort.

6.1.4 Calculation

Once the Project Model was populated with Items, Quantities, and Unit Prices, the cost of the assembled Items was calculated. Construction costs were supplemented with Lump Sum Items such as mobilization and construction layout, which were

carried as a percentage of the total cost of the assembled Items. If applicable, lump sum allowances were also included as distinct line items. Since the estimates are for planning purposes, a contingency was added to account for the variability and uncertainty within each estimate.

6.2 Estimated Cost

Cost estimates for the preferred alternative are summarized below. Detailed cost sheets are included in Appendix E. Since these costs are based on preliminary design data, they must be updated continuously as the project moves forward through the final design phase. These numbers should be used with caution, as they are based on limited information and are intended for budgeting purposes only.

At the request of the Town of Bolton, BSC has provided a breakdown of costs that are anticipated to be remaining for the Greenway Extension from the close of the preliminary design until the completion of the greenway. Costs are estimated and may vary greatly depending on items such as the final funding source and associated design process, role of ConnDOT during the final design and construction phases, ROW process / final impacts, and selected intensity of construction inspection and oversight.

Cost Estimate Summary

Estimated Cost of Bolton Greenway Extension Construction	\$1,830,000
Estimated Cost of ROW Impacts	\$ 490,000
Estimated Cost of Legal Expenses	\$ 200,000
Estimated Cost of Final Design Cost including Surveying and Permitting	\$ 100,000
Estimated Cost of Geotechnical Investigations for Rock Slope	\$ 20,000
Estimated Cost of Environmental Investigations – Screening Level (Archeological / Historic / Hazardous Material / Wetland Delineation)	\$ 22,000
Total	\$2,662,000

APPENDIX E
COST ESTIMATES

TOWN OF BOLTON
GREENWAY EXTENSION PROJECT

PRELIMINARY DESIGN - OPINION OF PROBABLE COSTS - SUMMARY

Project: Town of Bolton - Greenway Extension
Project #: N/A
Project #: 83570.00
Location: Route 44 and Tolland Road
Location: Bolton, CT

Computed By: RLP
Checked By: MS
Date: 11/19/15
Revised: 12/11/15

Estimated Cost of Bolton Greenway Extension Construction	\$ 1,830,000.00
Estimated Cost of ROW Impacts	\$ 490,000.00
Estimated Cost of Legal Expenses	\$ 200,000.00 *
Estimated Cost of Final Design Cost including Surveying and Permitting	\$ 100,000.00
Estimated Cost of Geotechnical Investigations for Rock Slope	\$ 20,000.00
Estimated Cost of Environmental Investigations – Screening Level (Archeological / Historic / Hazardous Material / Wetland Delineation)	\$ 22,000.00
<hr/>	
Total	\$ 2,662,000.00

* - Based on Town of Bolton previous project experience

**TOWN OF BOLTON
GREENWAY EXTENSION PROJECT**

PRELIMINARY DESIGN - OPINION OF PROBABLE COSTS - CONSTRUCTION

Project: Town of Bolton - Greenway Extension
 Project #: N/A
 Project #: 83570.00
 Location: Route 44 and Tolland Road
 Location: Bolton, CT

Computed By: RLP
 Checked By: MS
 Date: 08/26/15
 Revised: 12/11/15

A. MAJOR ITEMS

Item #	Item Description	Units	Quantity	Unit Price	Cost
201001	CLEARING & GRUBBING	LS	1	\$5,000.00	\$5,000.00
201500	RESET MAILBOX	LS	1	\$1,000.00	\$1,000.00
21500X	RELOCATE MILE STONE MARKER	EA	1	\$250.00	\$250.00
202001	EARTH EXCAVATION	CY	2050	\$25.00	\$51,250.00
202103	ROCK EXCAVATION - 1:1 SLOPE OPTION	CY	2055	\$55.00	\$113,025.00
202103	ROCK EXCAVATION - 2:1 SLOPE OPTION (INCREASE FROM 1:1 SLOPE)	CY	3280	\$55.00	\$180,400.00
202201	CHANNEL EXCAVATION - EARTH	CY	20	\$30.00	\$600.00
202529	CUT BITUMINOUS CONCRETE PAVEMENT	LF	5755	\$3.00	\$17,265.00
202531	REMOVAL OF BITUMINOUS CONCRETE	SY	2710	\$7.00	\$18,970.00
205001	TRENCH EXCAVATION 0'-4' DEEP	CY	110	\$20.00	\$2,200.00
209001	FORMATION OF SUBGRADE	SY	8460	\$3.00	\$25,380.00
218001	SEDIMENTATION CONTROL BALES	LF	50	\$6.00	\$300.00
219001	SEDIMENTATION CONTROL SYSTEM - SILT FENCE	LF	5750	\$3.00	\$17,250.00
21900X	SEDIMENTATION CONTROL SYSTEM - CB FILTER SACK	EA	20	\$150.00	\$3,000.00
304002	PROCESSED AGGREGATE SUBBASE	CY	2400	\$42.00	\$100,800.00
406011	BITUMINOUS CONCRETE - CLASS 1 - SIDE PATH PAVEMENT	TON	1460	\$100.00	\$146,000.00
506090	DRY STACK RETAINING WALL SYSTEM	SF	870	\$55.00	\$47,850.00
507001	TYPE "C" CATCH BASIN	EA	15	\$2,750.00	\$41,250.00
507701	RESET TYPE "C" CATCH BASIN	EA	16	\$800.00	\$12,800.00
50770X	RESET SEWER MH	EA	20	\$800.00	\$16,000.00
507831	CONVERT CATCH BASIN TO MANHOLE	EA	14	\$1,500.00	\$21,000.00
651012	15" R.C. PIPE	LF	218	\$50.00	\$10,900.00
815001	BITUMINOUS CONCRETE LIP CURBING	LF	7365	\$6.50	\$47,872.50
815091	REMOVAL OF BITUMINOUS CONCRETE LIP CURBING	LF	2875	\$3.00	\$8,625.00
90500X	STONE WALL - 4' HIGH	LF	100	\$300.00	\$30,000.00
90500X	RESET WOODEN GATE	EA	1	\$2,500.00	\$2,500.00
905018	REMOVE AND REBUILD EXISTING STONEWALL	CY	14	\$250.00	\$3,500.00
91250X	REMOVE EXISTING GUIDE RAIL	LF	580	\$5.00	\$2,900.00
913969	PROTECTIVE FENCE (42" MIN HEIGHT)	LF	250	\$75.00	\$18,750.00
922501	BITUMINOUS CONCRETE DRIVEWAY	SY	374	\$36.00	\$13,464.00
944000	FURNISHING AND PLACING TOPSOIL	SY	2112.5	\$8.00	\$16,900.00
950005	TURF ESTABLISHMENT	SY	8450	\$2.00	\$16,900.00
971001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	\$20,000.00	\$20,000.00
970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	160	\$55.00	\$8,800.00
1118009	ADJUST EXISTING SIGNAL INSTALLATION @ QUARRY ROAD	LS	1	\$40,000.00	\$40,000.00
1118009	ADJUST EXISTING SIGNAL INSTALLATION @ SOUTH ROAD	LS	1	\$40,000.00	\$40,000.00
1206023	REMOVAL AND RELOCATION OF EXISTING SIGNS	LS	1	\$3,000.00	\$3,000.00
1208906	SIGN FACE - SHEET ALUMINUM - BRIGHT WIDE ANGLE RETROREFLECTIVE	EA	65	\$200.00	\$13,000.00
1209005	PAINTED PAVEMENT MARKINGS - 4" WHITE	LF	700	\$0.35	\$245.00
1209007	PAINTED PAVEMENT MARKINGS - 4" YELLOW	LF	1270	\$0.35	\$444.50
1209433	THERMOPLASTIC PAVEMENT LINE - 8" WHITE	LF	470	\$1.25	\$587.50
1209434	THERMOPLASTIC PAVEMENT LINE - 12" WHITE	LF	85	\$2.25	\$191.25
1209467	THERMOPLASTIC LEGENDS, ARROWS AND MARKINGS - SHARROW SYMBOLS	EA	16	\$75.00	\$1,200.00
1211001	REMOVAL OF PAVEMENT MARKINGS	SF	350	\$2.00	\$700.00

MAJOR ITEMS COST: \$1,122,069.75

B. LUMP SUM ITEMS (% OF "MAJOR ITEMS" AS INDICATED)

Item #	Item Description	Units	Quantity	Unit Price	Cost
975004	MOBILIZATION AND PROJECT CLOSEOUT	LS	1	6.50%	\$72,934.53
980001	CONSTRUCTION STAKING	LS	1	1.00%	\$11,220.70

LUMP SUM ITEMS COST: \$84,155.23

C. CONTINGENCY (10% OF A+B)

\$120,622.50

SUBTOTAL 1 (A+B+C) \$1,326,847.48

D. INCIDENTALS (25% of SUBTOTAL 1) - PER CONNDOT ESTIMATING GUIDANCE

\$331,711.87

SUBTOTAL 2 (SUBTOTAL 1 + INCIDENTALS) \$1,658,559.35

E. INFLATION ADJUSTMENT (5% ANNUAL, SIMPLE COMPOUND, 24 MONTHS)

\$165,855.93

TOTAL PROJECT COST: \$1,824,415.28

SAY: \$1,830,000

Legend

SY = Square Yard EA = Each
 CY = Cubic Yard LF = Linear Foot
 SF = Square Foot LS = Lump Sum
 HR = hour TON = Ton