Concept Plan for the

# BOLIN CREEK GREENWAY
# Phase III

Town of Chapel Hill, North Carolina
May 21, 2007

**Prepared for:**
Chapel Hill Town Council

*Concept Plan*
*For*

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**Prepared for:**
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# Project Overview

This Concept Plan represents the first step toward the realization of Phase III of the Bolin Creek Greenway, a critical component of the Town of Chapel Hill Greenways system. The Concept Plan presents and discusses various alternatives for routing the greenway, as well as issues relating to constructability, cost, environmental impact, land ownership, and the experiential value of each trail alternative. The Concept Plan is intended as a tool to help public officials make fully informed decisions regarding establishment of project budgets and schedules, acquisition of land and/or easements, and coordination with planned public infrastructure improvements by OWASA and others.

Phase III of the Bolin Creek Greenway would be located in the west central portion of Chapel Hill, and would extend the existing greenway network westward from Martin Luther King Jr. Boulevard to Umstead Park and from there south to the Northside neighborhood and northwest to Seawell School Road. The general alignments for the greenway and the alternatives discussed in this Concept Plan are consistent with the *Chapel Hill Greenways Comprehensive Master Plan*, adopted by the Town Council in January 2006.

The Concept Plan corridor is approximately 1.9 miles in length, and begins at the western terminus of the existing Bolin Creek Greenway, immediately south of the police station on the east side of Martin Luther King Jr. Boulevard (Historic Airport Road, or NC Highway 86). The corridor generally follows Umstead Drive and Bolin Creek to the west, before reaching Seawell School Road. The Concept Plan area also encompasses a portion of the Tanyard Branch Greenway, an existing natural surface trail that connects Umstead Park with the Northside Neighborhood. The Concept Plan provides specific recommendations for routing and construction of a paved 10 foot wide multi-use path designed to accommodate recreational and non-motorized modes of transportation.

**CONNECTIVITY**

As a shared pedestrian and bicycle facility, Phase III of the Bolin Creek Greenway would extend a critical east-west connection across Chapel Hill, linking points east of the NC 86 corridor with Umstead Park and the Town of Carrboro. Once constructed to its northern terminus at Seawell School Road, the facility could also provide a vital link between many residential, educational, and commercial destinations in northwest Chapel Hill and the University's planned Carolina North development on the Horace Williams tract.

An improved Tanyard Branch trail system could also extend the paved bicycle and pedestrian network to the Village West and Northside neighborhoods and the Town of Carrboro. Trailhead connections at McMasters Street and Caldwell Street would deliver trail users south to Hargraves Park, Carrboro's Baldwin Park, and the Rosemary and Franklin Street retail district via the existing network of public streets and sidewalks.

This segment is a key link in a proposed 9 mile long trail that is envisioned to eventually have a terminus at Millhouse Road in northwest Chapel Hill and its other terminus at Pinehurst Road in southeast Chapel Hill. We anticipate that this short stretch will be one of the most challenging and expensive greenway segments that the Town will ever undertake. However, failure to

develop this short portion of greenway would result in a severing of the bicycle and pedestrian greenway network envisioned by the Town's Comprehensive Plan. The effectiveness of the system would be especially compromised because, without this segment, the future Carolina North Campus of the University of North Carolina would have no effective bicycle and pedestrian link with the rest of the Town.

## DESIGN CRITERIA

Guidelines used to assess the technical feasibility of Phase III of the Bolin Creek Greenway include the 1994 *North Carolina Bicycle Facilities Planning and Design Guidelines* by the North Carolina Department of Transportation (NCDOT), and the 1999 third edition of the *Guide for the Development of Bicycle Facilities*, published by the American Association of State Highway and Transportation Officials (AASHTO).

Final design, including exact route selection, horizontal and vertical alignment, trail cross-sections, pavement markings, signage and signalization should adhere to the most current applicable NCDOT and AASHTO guidelines in place at the time of design. Trail access points and street crossings should be located and designed to ensure adequate site distances and to minimize conflicts with vehicular traffic.

Connections to existing public sidewalks and rights-of-way should be made wherever practical, with at-grade street crossings occurring at controlled intersections, particularly on busier streets. Longitudinal slopes in excess of 1:20 (5%) should be avoided, and should in no case exceed the maximum gradient of 8% present on the existing facility. Cross-slope or pavement crown should not exceed 1/4" per foot (2%). Bridge footings, abutments and pavement sections should be designed by a North Carolina licensed Geotechnical or Structural Engineer in consideration of localized soil conditions, potential for frequent inundation, and - in instances where the trail could share OWASA or other utility corridors – to withstand heavy vehicular traffic

## ENVIRONMENTAL IMPACT

Much of the proposed trail would lie within 100-year flood limits and the Town's Resource Conservation District (RCD). However, impacts upon the storage capacity of the floodplain would be minimal. **Preliminary flood modeling confirming the general feasibility of the alternatives outlined in the Concept Plan is presented later in the Concept Plan. However, a more detailed analysis of the final alignments, cross-sections, and bridge structures would be required as part of the eventual design review and permitting process.**

Although localized clearing of vegetation, including some larger trees, would be required, it appears that impacts to higher quality stands of mature trees can be largely avoided, particularly where existing utility corridors can be utilized. No jurisdictional wetlands, endangered or threatened plants, animals, or their habitats were identified within a one-mile radius of the Concept Plan area. Any proposed impacts or disturbance to the stream channel of Bolin Creek would fall within the review authority of the US Army Corps of Engineers. Construction would be required to utilize Best Management Practices for minimizing erosion and controlling sediment-laden runoff during construction in accordance with North Carolina Department of Environment and Natural Resources regulations.

The State Historical Preservation Office (SHPO) was also contacted in order to determine potential impacts as a result of the proposed greenway corridor to any nearby areas of historical significance. According to Ms. Renee Gledhill-Earley at SHPO, and as described in her letter dated January 26, 2006, there are no nearby areas of historical significance that would be impacted by the proposed work.

## GENERAL CONSTRUCTION ISSUES

Given the corridor's riparian location, the primary construction challenges would involve navigating steep terrain on creek banks, conveying storm drainage runoff under or over the trail, and addressing issues related to stability of the underlying soils. Due to the presence of poor alluvial silty soils and the likelihood of periodic flooding of several portions of the trail, most of the facility would likely be constructed of reinforced cast-in-place concrete. The use of geotechnical fabrics and increased thickness of stone base to bridge highly plastic soils would also be anticipated.

In order to accommodate existing surface drainage patterns, some lower-lying portions of the trail immediately adjacent to Bolin Creek would be placed virtually at existing grade to allow unimpeded sheet flow across the surface. Trail segments situated higher topographically would require uphill swales to collect stormwater runoff and reinforced concrete pipes to divert it under the trail to the creek.

Where the trail must pass close to the banks of Bolin Creek, streambank stabilization techniques will be utilized to ensure a long-lasting trail that does not contribute to bank erosion. Techniques such as root wadding, tree staking, timber crib walls, boulder retaining walls, and other "soft" construction techniques will be explored in the design phase.

## LANDSCAPE TREATMENT

In open areas, the greenway should receive a uniform cover of grass to stabilize its shoulders. Ground or shredded wood mulch may also be used in particularly shady areas not suited to lawn establishment. Natural regeneration of woodland vegetation should be encouraged along the trail shoulders in areas outside utility easements. Plantings should also be designed at trailheads to enhance and identify the areas where the greenway interfaces with public roads. Appropriate landscape buffers should be provided where needed to protect the privacy of adjacent homeowners. A mix of low-maintenance native evergreen and deciduous shrubs and trees should be used in order to visually blend with the surrounding vegetation and to better tolerate periods of both drought and inundation. Suggested plant materials to be used for screening purposes could include species such as American holly, inkberry, witch hazel, and wax myrtle.

## TRAIL AMENITIES

Directional and regulatory signage should be provided throughout the length of the trail, conforming to the current edition of the Manual of Uniform Traffic Control Devices (MUTCD). Trailheads should also include standardized signs to identify the trail and to outline Town greenway regulations and hours of use, as well as benches, bike racks, and trash receptacles (where they can be readily accessed by Solid Waste vehicles for collection.) Proposed site furnishings should incorporate recycled materials wherever practical. Bollards should be used to restrict vehicular traffic at appropriate locations, including street crossings and trailheads. Where appropriate, bollards should be hinged or collapsible to allow emergency and maintenance vehicles access to the trail.

# Project Goals

The following are the major goals of the Bolin Creek Greenway Concept Plan, with a brief discussion of the effectiveness of this Plan in meeting those goals:

**A. Design a trail that avoids at-grade road crossings wherever feasible.**

Martin Luther King Jr. Boulevard: The existing culvert at Martin Luther King, Jr. Blvd is recommended to carry the trail beneath that roadway.

Umstead Drive and Pritchard Avenue: The use of existing culverts as underpasses at Umstead Drive and Pritchard Avenue is also recommended. Although using existing culverts would be more expensive than at-grade crossings in these locations, the separation of trail users from these relatively busy roads for the sake of safety may be worth the additional expense. These expenses include modification of existing culvert structures, relocation of a water line, and purchase of additional easements and properties. We recommend that the Umstead Drive underpass be built in a future phase.

Village Drive: A tunnel crossing of Village Drive is also possible, but not recommended because the amount of traffic on Village Drive is small, steep slopes would be encountered, two additional bridges would have to be added, and a new tunnel would be required.

At Estes Drive, a new tunnel or highway bridge is recommended to route the trail beneath the roadway and avoid an at-grade crossing there.

**B. Design a trail that would result in no rise in regulatory flood flows in Bolin Creek, and avoids the necessity of submitting a Letter of Map Revision (LOMR).**

Preliminary HEC-RAS modeling by Soil & Environmental Consultants of three bridge crossings and culverts have yielded results that indicate that these proposed improvements would most likely not create a significant rise in regulatory flood levels, and that a LOMR can be avoided.

**C. Maintain a 10-foot width of trail with a maximum 5% slope to the greatest extent possible.**

This criterion would be met through most of the trail corridor. However, some limited segments of trail with slopes up to 8% may be required near the Martin Luther King, Jr. Boulevard culvert, near McMasters Street, and north of Estes Drive where the trail must climb out of the creek valley.

**D. Avoid the need to acquire easements on private property to the greatest extent possible.**

The recommended alignment would require acquisition of additional easements by the Town in four areas and the Town of Carrboro in one area:

- On the south side of Bolin Creek near the Greene Street intersection where a single-family residential house now exists

- Along some properties between Umstead Road and Pritchard Avenue on the south side of Bolin Creek
- At the University Gardens Condominiums on the south side of Bolin Creek near Pritchard Avenue
- Along the north side of Bolin Creek between Village Drive and Estes Drive Extension.
- Along Bolin Creek west of Estes Drive Extension

To address concerns about siting of the trail in new easements, the Concept plan recommends maximum horizontal separation, fencing, and screening as appropriate.

**E. Avoid disturbance to Bolin Creek, Tanyard Branch, and other tributaries to the greatest extent possible.**

The recommended alignment utilizes existing sewer easements, sidewalks, and trails to avoid introducing new impacts where possible. Substantial impacts to Bolin Creek and its banks are anticipated in the vicinity of existing culverts under Martin Luther King, Jr. Blvd., Umstead Drive, and Pritchard Avenue. At these locations, the recommended trail alignment would place the trail streamside of the top-of-bank line. On either side of each of these locations, the trail would climb away from the creek along its existing banks, which is expected to result in the loss of some trees on the bank. These impacts should be mitigated to the maximum extent possible in the design and construction phase using a variety of stream restoration techniques, including bank stabilization with native rock and plant materials such as boulders, root wads, and willow and alder stakes.

**F. Avoid the loss of large trees to the greatest extent possible.**

As in Goal "E" above, the trail is to be sited preferentially along existing trails and easements that currently lack trees, with the exceptions noted above. The trail layout is anticipated to be based somewhat on individual trees. However, experience with greenway trail construction at other locations has shown that some tree loss would be unavoidable.

**G. Avoid the need to relocate existing infrastructure improvements.**

The recommended alignment leaves existing bridges, culverts, and water and sewer lines in place, with the exception of the following recommended measures:

- The removal of one pedestrian bridge and replacement of one pedestrian bridge in Umstead Park;
- The relocation of one water line in Pritchard Avenue to provide vertical clearance in either a new tunnel or an existing culvert; and
- The possible enlargement of one of the compartments in the existing culvert beneath Umstead Drive.

**H. Minimize the impact of the trail on adjacent residents.**

Because the trail's alignment would utilize existing easements, parkland, and rights of way, most of the proposed trail is sited away from existing residential areas. However, south of Bolin Creek and along Umstead Drive the alignment runs sixty to eighty feet behind six existing houses. In addition to this horizontal separation, the trail would be twenty to forty feet below these houses in

elevation. The final design would provide screening of the trail from adjacent properties where necessary.

The recommended use of the Umstead Drive culvert as an underpass requires that the trail use the site currently occupied by a house north of the Umstead Road and Greene Street intersection. This proximity would make necessary the acquisition of this property (see sketch plans).

The recommended use of the existing culvert at Pritchard Avenue and alignment of the trail on the south side of the creek would impact adjacent condominium properties and the use of their pool area. Appropriate fencing and screening could mitigate these impacts to some extent.

During the detail design phase we would meet with individual landowners to address privacy issues on a lot-by-lot basis to the greatest extent possible.

**I. Utilize cost-effective design.**

The recommended alignment of the Bolin Creek Greenway utilizes existing facilities, park properties, easements, and rights of way in a cost-effective manner while addressing the issues of safety, impacts to the site, and privacy of neighbors. While some other options might be accomplished at a lower cost, the recommended route would allow the trail to be built in a safe and sustainable manner while being reasonably cost-effective. Some savings would occur with this option including:

- The use of existing culverts at Martin Luther King, Jr. Blvd and Pritchard Avenue obviate the need to install new tunnels;
- The use of a proposed easement between Pritchard Avenue and Umstead park makes an additional bridge and roughly 250 feet of road realignment unnecessary;
- The use of a widened sidewalk along Umstead Drive avoids expensive trail development in steep and wooded terrain;
- The use of concrete as the trail material would avoid costly maintenance and upkeep costs as compared to asphalt, particularly in flood-prone areas.

# Greenway Alternatives and Recommendations

Phase III of the Bolin Creek Greenway may be divided into nine distinct trail segments.

1) **Existing Bolin Creek Trail to Umstead Drive**
2) **Umstead Drive Crossing to Pritchard Avenue**
3) **Pritchard Avenue Crossing to Umstead Park**
4) **Umstead Park**
5) **Umstead Park to Village Drive**
6) **Village Drive to Estes Drive Extension**
7) **Estes Drive Extension to Seawell School Road**
8) **Tanyard Branch Trail**
9) **Estes Drive Connections**

Each has a specific character and unique site conditions, and therefore requires a distinct design response. For each trail segment, several options were considered, and the recommended option is described in detail below. **For discussion of Alternative Routing Options by segment, see Appendix D.**

### SEGMENT 1 – EXISTING BOLIN CREEK TRAIL TO UMSTEAD DRIVE

The initial greenway segment begins at the terminus of the existing Bolin Creek Greenway, south of the police station on Martin Luther King Jr. Boulevard (Historic Airport Road, hereafter referred to as Martin Luther King Jr. Boulevard). Segment 1 encompasses the crossing of Martin Luther King Jr. Boulevard and the approach of Umstead Drive to the West.

#### Existing Site Conditions

The existing Bolin Creek greenway is a ten-foot wide asphalt trail. It approaches Martin Luther King Jr. Boulevard from the east, crossing an 80 foot long prefabricated weathered steel bridge with a wood deck, and tees into the sidewalk on the east side of the road. Longitudinal grades on the path immediately west of the bridge are approximately eight percent (1 vertical foot in 12.5 horizontal feet). Topography on both sides of the trail is substantial, with steep slopes rising quickly towards the police station to the north, and falling away sharply towards Bolin Creek to the south. Several above ground concrete OWASA sanitary sewer manholes and a major concrete stormwater outfall occupy the north creek bank, complicating any construction efforts in that area.

Martin Luther King, Jr. Boulevard is a five-lane arterial roadway (NC Highway 86) consisting of two northbound and two southbound through lanes and a two-way left-turn lane. The posted speed limit is 35 mph. Sidewalks are present on both sides of the street, although connectivity is better, and the sidewalk wider, on the east side. The sidewalk on the west side of Martin Luther King Jr. Boulevard ends approximately 1/3 mile north of the greenway. Numerous overhead and below-ground utilities share the Martin Luther King Jr. Boulevard corridor, and must be considered in any option for crossing it.

A report prepared for the Town of Chapel Hill by the Highway Safety Research Center of the University of North Carolina in August 2004 studied the entire Martin Luther King Jr. Boulevard corridor. This report includes a detailed analysis of conditions and traffic patterns in the corridor,

and identifies several factors that contribute to a disjointed and often hazardous situation for pedestrians and bicyclists, particularly in the vicinity of the Bolin Creek Greenway entrance. Pertinent observations from the Concept Plan are paraphrased below:

- High traffic volumes and excessive motor vehicle speeds, combined with the wide cross-section of the roadway, make Martin Luther King Jr. Boulevard unsafe for bicyclists and pedestrians to negotiate and difficult to cross, particularly at mid-block or unsignalized intersections.
- Steep gradients along Martin Luther King Jr. Boulevard, curves in the roadway, dense vegetation and other visual obstructions limit sight distances and further complicate street crossings.
- Wrong-way and sidewalk bicycling have contributed to crashes in the corridor, and may result in part because the Bolin Creek Greenway can only be accessed from the sidewalk on the east side of the road.

The area west of Martin Luther King Jr. Boulevard and immediately north of Bolin Creek consists of a high flat terrace bordered by steep rock outcroppings to the north. This cleared grassy corridor was formerly the site of Umstead Drive before it was re-routed to align with Hillsborough Road to the south, and remains a public right-of-way. Numerous utilities, including overhead power lines and sanitary sewer structures, share this corridor, which terminates on the outside of a sharp curve at Umstead Drive. The two parcels on the south side of Bolin Creek are privately owned, and include two residential buildings.

Bolin Creek flows eastward, crossing under Martin Luther King Jr. Boulevard in a 37-foot-wide by 16-foot high concrete pipe arch culvert. Flow through the Martin Luther King Jr. Boulevard culvert is divided by an abandoned concrete beam - possibly remaining from a previous structure - with dominant low flow on the north side of the beam. While the stream channel in this portion of the Concept Plan area appears stable both horizontally and vertically, it is severely incised, with steep side slopes and significant elevational change from the flow line of the channel to the top of both banks.

Riparian areas can be characterized as disturbed Mesic Mixed Hardwood forests, and are dominated by various oak and hickory species, poplar, and American beech trees. Other species such as sycamore, Ironwood and maple are also present, along with invasive/exotics including Chinese privet, bamboo and English ivy. According to the Orange County Soil Survey, soils closest to the creek are predominantly Chewacla loam, with Wedowee sandy loam and Tatum silt on the adjacent upland and floodplain areas.

**Routing Recommendations:**

The existing Bolin Creek greenway would traverse the steep slope down the north creek bank to a stream-level crossing in the north side of the existing culvert (see Figure 1) and then climb back up the steep creek bank on the west side of Martin Luther King Jr. Boulevard. Longitudinal trail slopes would be kept at or below the 8% maximum gradient of the existing greenway.

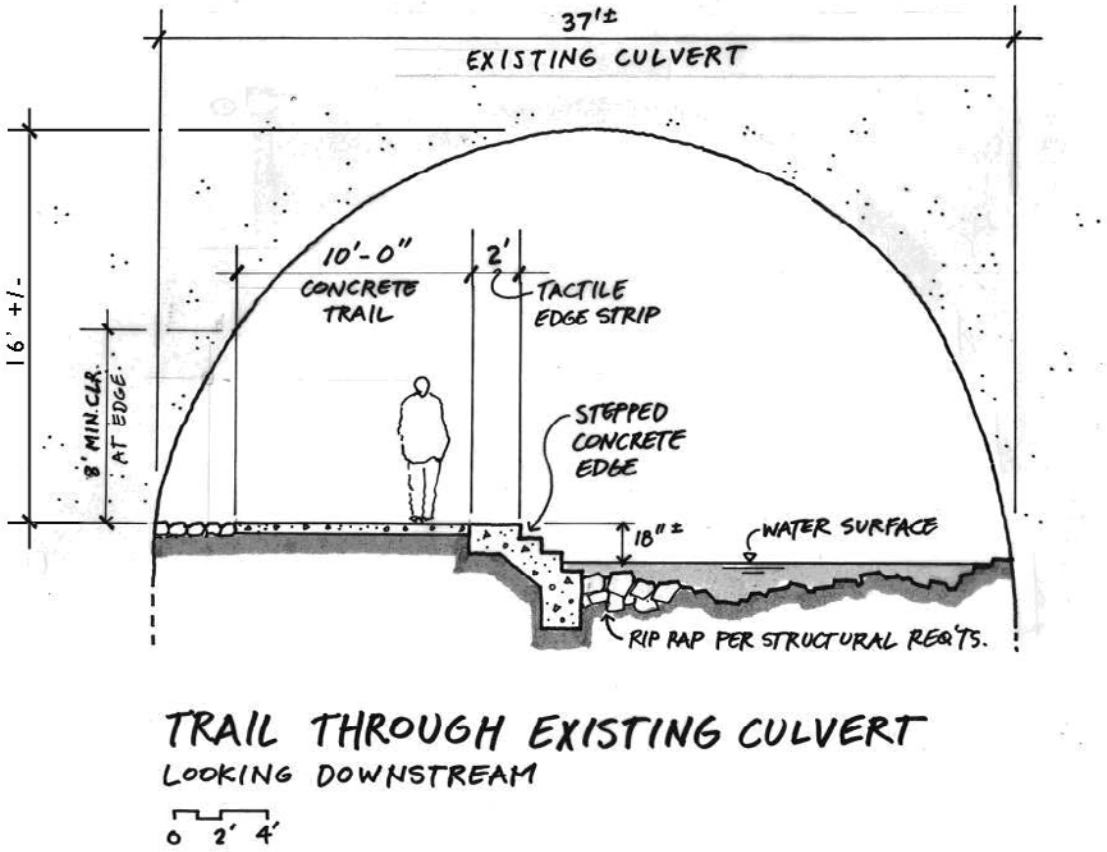



**Figure 1**

**SEGMENT 2 – UMSTEAD DRIVE CROSSING TO PRITCHARD AVENUE**

This segment of the greenway includes approximately 1,700 lineal feet of streamside trail from the Martin Luther King, Jr. culvert west to Pritchard Avenue.

**Existing Site Conditions:**

At Umstead Drive, Bolin Creek passes beneath the roadway in a four-barrel concrete box culvert. Between this culvert and the one at Martin Luther King, Jr. Drive, the creek channel is characterized by a steep bank on the north side and a variable bank on the south, where two residential properties abut the creek in this reach. Upstream from the Umstead Drive culvert, the creek is much less incised than further downstream, with lower banks, and a low, narrow floodplain along its south edge. Umstead Drive runs roughly parallel to the north stream bank, and is situated elevationally above the floodway and the Resource Conservation District. An OWASA sanitary sewer line parallels the south side of the stream. Channel bed and banks appear generally stable, although isolated areas along the north stream bank are overly steep, with localized erosion, exposed tree roots, and undermining of the existing sidewalk. Channel bed material typically consists of boulders, cobble, and gravel.

The surrounding riparian areas between Umstead Drive and Pritchard Avenue consist predominately of disturbed Mesic Mixed Hardwood Forests dominated by various oak and hickory species, poplar and American beech trees. Other species such as sycamore, Iron wood, and maple exist along the stream banks. Invasive / Exotic species such as Chinese privet, bamboo and English ivy also exist. The soil types as indicated on the Orange County Soil Survey include predominately Chewacla loam closest to the creek and Wedowee sandy loam further from the creek.

**Routing Recommendations:**

Cross Bolin Creek with a bridge downstream of the Umstead Drive culvert and cross Umstead Drive at grade in the first phase of development. In a future phase, route the trail beneath Umstead Drive in a reconfigured or new concrete box culvert. Align the trail on the south side of Bolin Creek upstream to Pritchard Avenue.

Although one of the chief goals of this Concept Plan is "to avoid grade crossings where possible," private land ownership in the vicinity of the Umstead culvert must also be taken into account. Figure 2 depicts a short-term grade crossing of Umstead and a longer-term view of acquiring the property at Greene St and Umstead Drive and using the Umstead culvert as an under crossing. See Appendix D for alternative routing options.

The longer-term loop is needed in this option to overcome the grade difference between the top of the bank and the bottom of culvert elevation. The bridge would not have to be relocated when an underpass connection is made in the future.

In order to protect the safety of trail users at the Umstead at-grade crossing in the short term, the design must include various traffic-calming measures, such as a pedestrian activated traffic light, a "speed table," pavement marking, warning flashers, and signage. Sight distances must also be preserved by maintaining existing vegetation, and a redesign of the wooden railing along the existing sidewalk should be considered.

The southernmost barrel of the existing box culvert measures nine by nine feet. When the design is extended to the culvert underpass in the future, the culvert will have to be modified or replaced to provide a horizontal clearance of 14 feet. Despite these cost drawbacks, use of the existing culvert under Umstead Drive is recommended in the long term in order to remove the at-grade and mid-block crossing of Umstead Drive. A preliminary on-site meeting with the US Army Corps Agent for this district has indicated that using the southernmost culvert barrel would likely not constitute work within the "active channel." Thus, this part of the project would probably not trigger an USACE Individual Permit application.


**Figure 2**

**Trail alignment on south side of Bolin Creek**

The route would continue along the existing cleared OWASA corridor from Umstead Drive along the south side of the creek, climbing up from the floodplain at Pritchard Avenue.

## SEGMENT 3 - PRITCHARD AVENUE CROSSING TO UMSTEAD PARK

**Routing Recommendation:**

**T**he trail would be constructed under Pritchard Avenue, and then along the south side of Bolin Creek, across what is currently private property, between an existing swimming pool and Bolin Creek (see Figure 3).

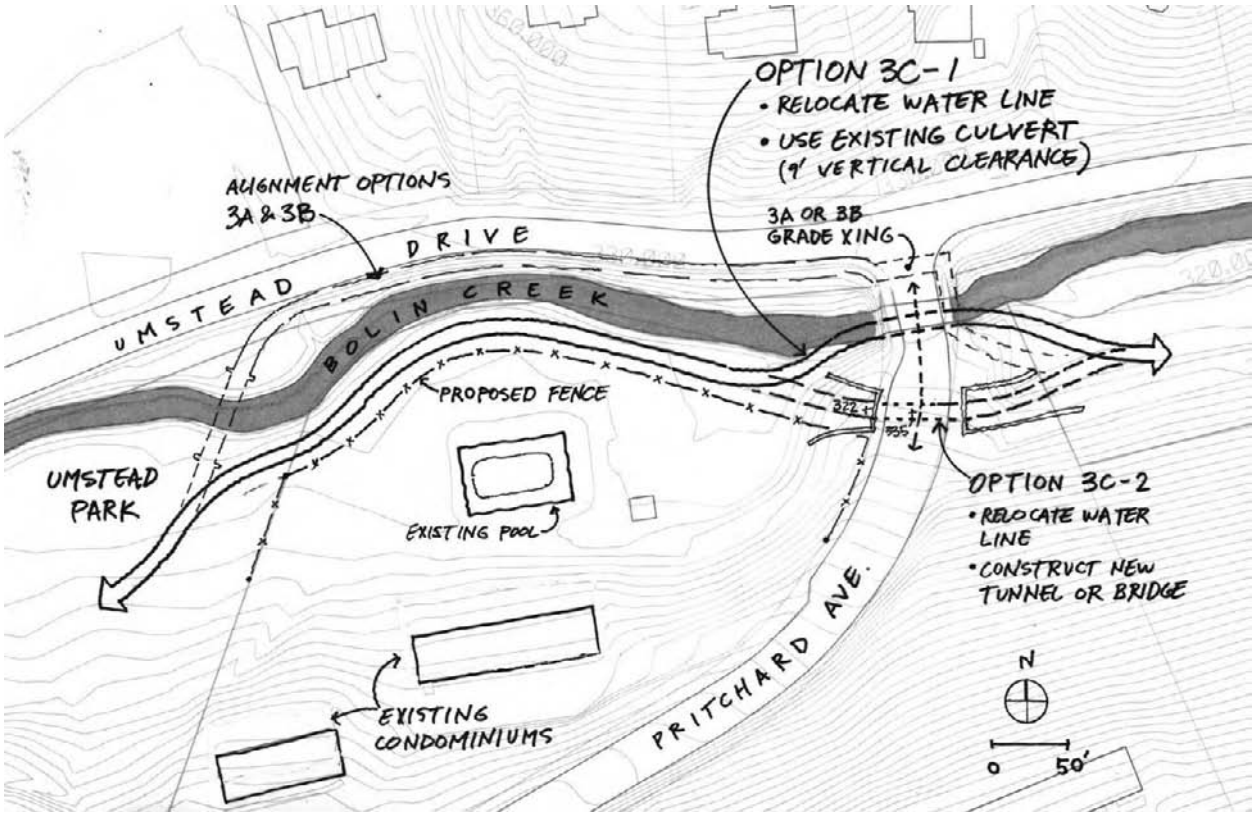



**Figure 3**

**SEGMENT 4 – UMSTEAD PARK**

This portion of the trail includes the approach of Umstead Park from the East, removal of two existing bridge structures, and construction of a new bridge linking an improved Tanyard Branch trail to the south with the extended Bolin Creek trail to the north and west.

**Existing Site Conditions**

Bolin Creek flows northeasterly through the 35-acre Umstead Park, approximately bisecting the park and separating naturalized wooded areas to the south and west from active play, picnic and parking facilities to the north and east. An existing wooden footbridge connects the parking area at the northeast corner of the park to the natural surface Tanyard Branch trail that follows the OWASA easement on the south side of Bolin Creek. A steel and concrete footbridge is located further upstream at the confluence with the Tanyard Branch tributary. Both bridges are frequently submerged in intense storm events, and create barriers to the flow of debris through the channel.

Some severe localized erosion was observed along the southern stream bank at a piped outfall from a small tributary to the south, and along an existing island just downstream of the concrete bridge. The tributary would most likely be classified as an intermittent stream by the United States Army Corps of Engineers (USACE) and the State Division of Water Quality (DWQ), and any impacts would require compliance with existing Nationwide Permits and General Water Quality Certifications.

Although a piped crossing of the tributary would probably be acceptable to the agencies, a bridge at this location could avoid the impact and associated permit compliance issues.

The stream channel in the vicinity of the concrete bridge (just downstream of confluence of Tanyard Branch) is very wide and the stream banks are not well defined. Riprap and other debris are present along channel bed and banks. A gravel streambed crossing is located immediately upstream of the concrete bridge. The aerial sewer line crossing Tanyard Branch at this location was observed in disrepair.

The surrounding riparian areas between Pritchard Avenue and Umstead Park and within the Park property predominately consist of disturbed Mesic Mixed Hardwood Forests dominated by various oak and hickory species, poplar and American beech trees. Other species such as sycamore, Iron wood, and maple exist along the stream banks. Invasive / Exotic species such as Chinese privet, bamboo and English ivy also exist. The soil types as indicated on the Orange County Soil Survey include predominately Chewacla loam closest to the creek and Wedowee sandy loam further from the creek.

**Routing Recommendations:**

The Concept Plan recommends the demolition of the two existing pedestrian bridges in Umstead Park.

The trail would extend from the northeast end of Umstead Park south of Bolin Creek to the existing OWASA sewer line corridor and natural surface trail to the west, before crossing back over Bolin Creek in the vicinity of the existing wood footbridge to connect with the existing park facilities. This bridge would delineate the junction of the Bolin Creek Greenway (turning to the north through Umstead Park) and the Tanyard Branch Greenway (continuing to the southwest).

## SEGMENT 5 – UMSTEAD PARK TO VILLAGE DRIVE

This portion of the Concept Plan follows Umstead Drive west and north from Umstead Park to the Village Drive intersection.

**Existing Site Conditions**

Umstead Drive curves northward away from Bolin Creek, which runs through several privately owned tracts. Town-owned land parallels the creek on its west side, but this land is steep and heavily wooded.

Following Bolin Creek upstream to the west and north, the stream channel appears to be fairly stable, with a predominately cobble, boulder and bedrock substrate. The surrounding riparian areas predominately consist of disturbed Basic Mesic Forests dominated by various oak and hickory species, poplar and American beech trees. As elsewhere along the stream corridor, other species such as sycamore, Ironwood, and maple exist alongside invasive/exotic species such as Chinese privet, bamboo and English ivy. The soil types as indicated on the Orange County Soil Survey include predominately Chewacla loam closest to the creek and Wilkes gravelly loam further from the creek.

**Routing Recommendation:**

Between Umstead Park and Village Drive, the only feasible alternative appears to be widening the existing sidewalk along the south side of Umstead Drive. Other routes were investigated and discarded because they would involve either extensive clearing of dense woods, significant acquisition of private land, or navigation of excessively steep grades along Village Drive. The widened sidewalk would follow Umstead Drive to an at-grade crossing at the intersection with Village Drive.

Using an expanded sidewalk, the trail would run from Umstead Park to a grade crossing at Village Drive. The existing stop sign and possible other traffic calming measures such as pedestrian crossing signs would likely be sufficient to alert drivers and bicyclists of the grade crossing.

## SEGMENT 6 –VILLAGE DRIVE TO ESTES DRIVE EXTENSION

This portion of the Concept Plan area follows Umstead Drive west and north from Village Drive and encompasses the Bolin Creek corridor and the Estes Drive Extension crossing.

**Existing Site Conditions**

West of Village drive, Umstead Drive curves northward away from Bolin Creek, bisecting an 11.8-acre private tract before teeing into Estes Drive. Although the roadway lacks curb and gutter, a recently constructed five-foot wide sidewalk parallels the roadway from Village Drive to Estes Drive. Estes Drive is a higher-speed, higher-volume two-lane arterial roadway with 12-foot-wide graded shoulders, no sidewalks and little adjacent development. Grades on Estes Drive fall away sharply to both sides, particularly as the road crosses Bolin Creek and approaches the railroad line (also the Town limits) to the west.

**Routing Recommendation:**

This route would utilize the existing OWASA clearing on the north stream bank. Completely separate from vehicular traffic, and easily the most attractive portion of the Concept Plan corridor, this segment would provide a pleasant experience for trail users. The below-grade under crossing of Estes Drive, however, would likely be technically difficult and very expensive - see discussion next segment

## SEGMENT 7 - ESTES DRIVE EXTENSION TO SEAWELL SCHOOL ROAD

Because construction of this leg of the greenway is considered to be far more long-range in nature, the feasibility analysis is more general and less technical than for the other trail segments.

**Existing Site Conditions**

Following Bolin Creek upstream to the west and north from Estes Drive Extension, the stream channel appears to be fairly stable, with a predominately cobble, boulder and bedrock substrate. Between Village Drive and Estes Drive, an OWASA corridor occupies a flat, cleared area along the

north creek bank through a privately owned parcel. The utility access terminates at a nearly vertical fill slope beneath Estes Drive, which sits approximately 30 feet above the creek. A triple box culvert conveys Bolin Creek under Estes Drive. Side slopes up to at-grade crossing on Estes are also steep.

North of Estes Drive, the greenway corridor and Bolin Creek emerge into a low valley, defined by a steep railroad fill slope to the west, and a steeper slope leading up to the Ironwood Neighborhood to the east. A heavy-timbered railroad trestle crosses Bolin Creek, providing an opportunity for a trail connection west into the Town of Carrboro. The stream in this area is poorly defined, with a wide flat floodplain and a trickle of normal low flow that can be easily crossed on foot.

The surrounding riparian areas predominately consist of disturbed Basic Mesic Forests dominated by various oak and hickory species, poplar and American beech trees. As elsewhere along the stream corridor, other species such as sycamore, Ironwood, and maple exist alongside invasive/exotic species such as Chinese privet, bamboo and English ivy. The soil types as indicated on the Orange County Soil Survey include predominately Chewacla loam closest to the creek and Wilkes gravelly loam further from the creek.

**Routing recommendation:**

At the trail crossing location, Estes Drive is a two-lane graded roadway with 12-foot shoulders on an embankment that is approximately 30 feet high. The trail would cross near the bottom of this embankment, requiring construction of a tunnel approximately 100 feet in length or a new highway bridge. As with the Martin Luther King Jr. Boulevard crossing, a tunnel of this length presents perceived and real safety and security issues, which must be weighed against the other issues presented. Tunnel construction methods, costs, and related concerns are explored in greater detail in Parsons Brinkerhoff's technical brief (Appendix B).

North of Estes Drive, the trail would meander through a 77.5-acre privately owned tract. This option would cross into the Town of Carrboro's jurisdiction beneath the existing railroad trestle, turning north along Bolin Creek, and follow the contours of the tract north to Seawell School Road. The Town of Carrboro has indicated that they would have great interest in pursuing this option. This Plan recommends that this option be given priority consideration by both Chapel Hill and Carrboro.

## SEGMENT 8 - TANYARD BRANCH

This portion of the Concept Plan involves the existing Tanyard Branch trail, a natural surface facility that begins in Umstead Park and terminates at Caldwell Street, near the offices of the Chapel Hill Housing Authority.

**Existing Site Conditions:**

The Tanyard Branch trail follows the Tanyard (or Tan Bark) Branch, a tributary of Bolin Creek from Umstead Park west and south to the North Side Neighborhood. OWASA sanitary sewer lines, some of which have visible damage and are slated for rehabilitation and/or reconstruction, also occupy much of the corridor. The Tanyard Branch trail passes through dense woods, consisting primarily of disturbed Mesic Mixed Hardwood Forests dominated by American beech, various oak and hickory species, and poplar. Other species such as sycamore, Ironwood, and maple, are found along the

stream banks. Particularly within Umstead Park, numerous large diameter trees were observed, including several mature American beeches. A tree survey of this area should be conducted prior to design so that disturbance to these specimens can be avoided. Invasive / exotic species such as Chinese privet, Kudzu, bamboo, Wisteria and English ivy also exist, particularly in previously cleared areas utilized by OWASA. Streambed material in the Tanyard Branch typically consists of boulders, cobble, and gravel along the run of channel observed. Soil types as indicated on the Orange County Soil Survey include predominately Wedowee sandy loam.

Approximately 400 feet upstream from the Umstead Park boundary, a series of timber steps climb a small ridge immediately south of the stream. The stream channel in this area is quite close to the toe of slope, with very steep adjacent banks. Exact horizontal and vertical trail alignment must be carefully designed in this area to minimize impacts to large trees and the stream bank. Some retaining walls would likely be required.

Tanyard Branch splits into two tributaries north of McMasters Street. This area presents a good opportunity for development of a trail spur via a bridge crossing to the west, providing connectivity to the Village West housing development and the Town of Carrboro. The existing Tanyard Branch trail turns south, following the OWASA sanitary sewer lines and the southern tributary. This open, kudzu- and bamboo-covered ravine is accessible from the end of McMasters Street. The existing natural surface trail continues along the stream to the south, through a very narrow and highly eroded corridor.

**Routing Recommendations:**

The improved Tanyard Branch Greenway would follow the same alignment as the existing facility from Umstead Park to just below the end of McMasters Street, where it would climb to the public right-of-way. The trail would follow along the south edge of McMasters Street approximately 250 feet, before turning to the south through an 8.7-acre parcel owned by Orange County. Following the existing contours, and avoiding individual specimen trees, the trail would terminate at a trailhead on Caldwell Street, across from the offices of the Chapel Hill Housing Authority. From there, the existing network of residential streets and public sidewalks could provide connectivity to the North Side Neighborhood, Hargraves Park, Carrboro's Baldwin Park, and the Rosemary and Franklin Street retail districts to the south.

## SEGMENT 9 – ESTES DRIVE SEGMENT

Along Estes Drive Extension, Town-owned land adjacent to the road right-of way presents an opportunity to create greenway connections leading northeast and southwest from Bolin Creek (see Figure 4).

A connection along Estes Drive Extension to the planned Carolina North development (the former Airport property) is possible from near the intersection of Umstead Drive and Estes Drive. This trail could run along the south side of Estes Drive in land currently owned by the town close to the road right of way. A few side-slope areas would require shoring in this stretch, and a small bridge may be required at an existing drainage. Just northeast of the intersection of Estes Drive and Seawell School Road, Estes Drive lies on a high embankment relative to the surrounding grade. From south of Estes Drive, a tunnel could be sited through this causeway to

allow access to the old Airport site (Carolina North). Further along Estes, the possibility of a greenway link to Martin Luther King Jr. Boulevard should be explored in more detail.

In order to make a connection from Bolin Creek along Estes Drive to the west, one possible trail route would run along the north side of Estes Drive from the valley of Bolin Creek up the bank via an existing access road. After passing into Carrboro this alignment would utilize the road right of way and an existing 30'OWASA easement to access Wilson Park.

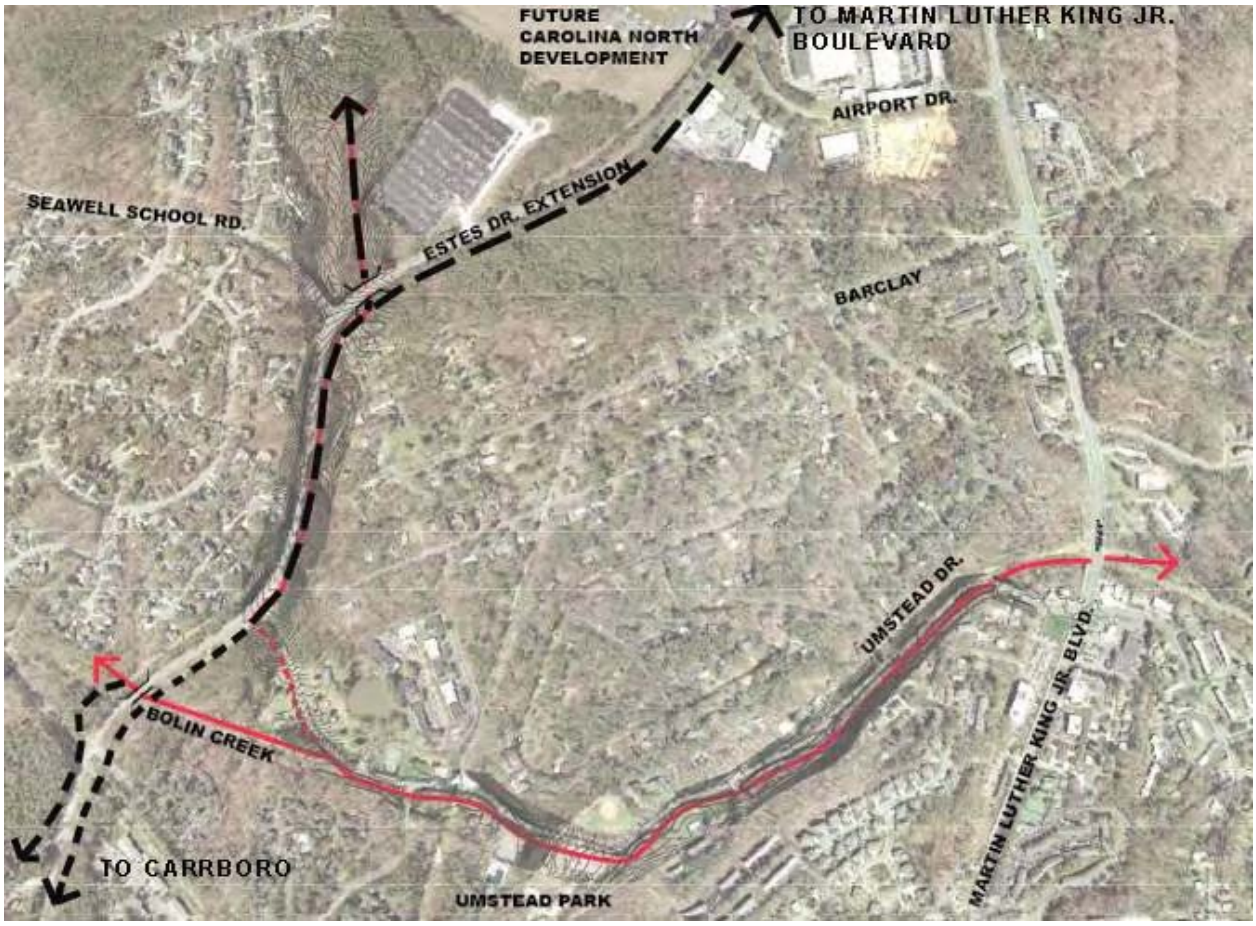
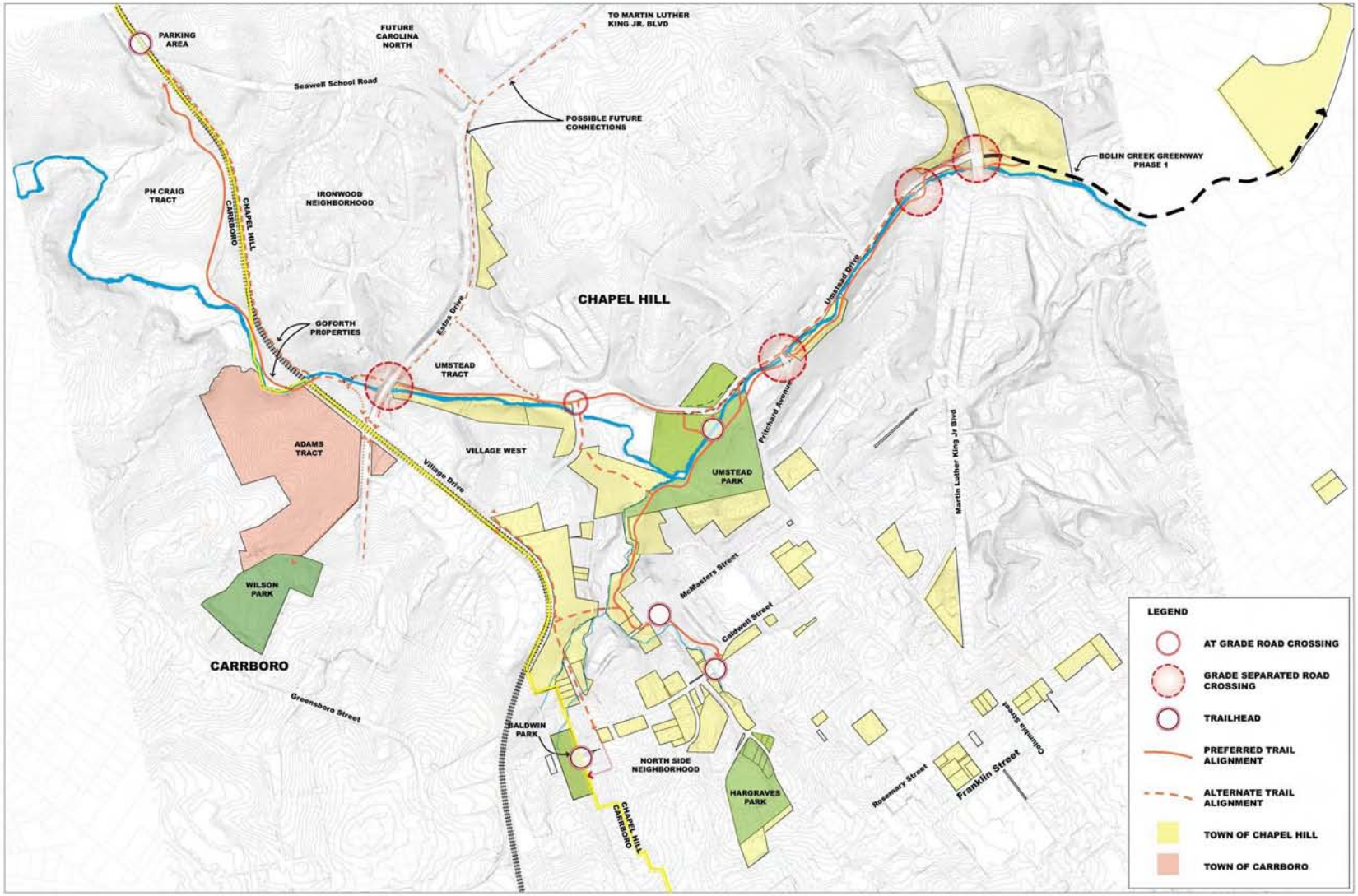



**Figure 4: Connections along Estes Drive Extension**

# Exhibits:

Overall Greenway Plan
Sheet 1: Martin Luther King Jr. Boulevard to Pritchard Avenue
Sheet 2: Pritchard Avenue to Village Drive
Sheet 3: Umstead Park to Ironwood Neighborhood
Sheet 4: Ironwood Neighborhood to Seawell School Road
Sheet 5: Tanyard Branch

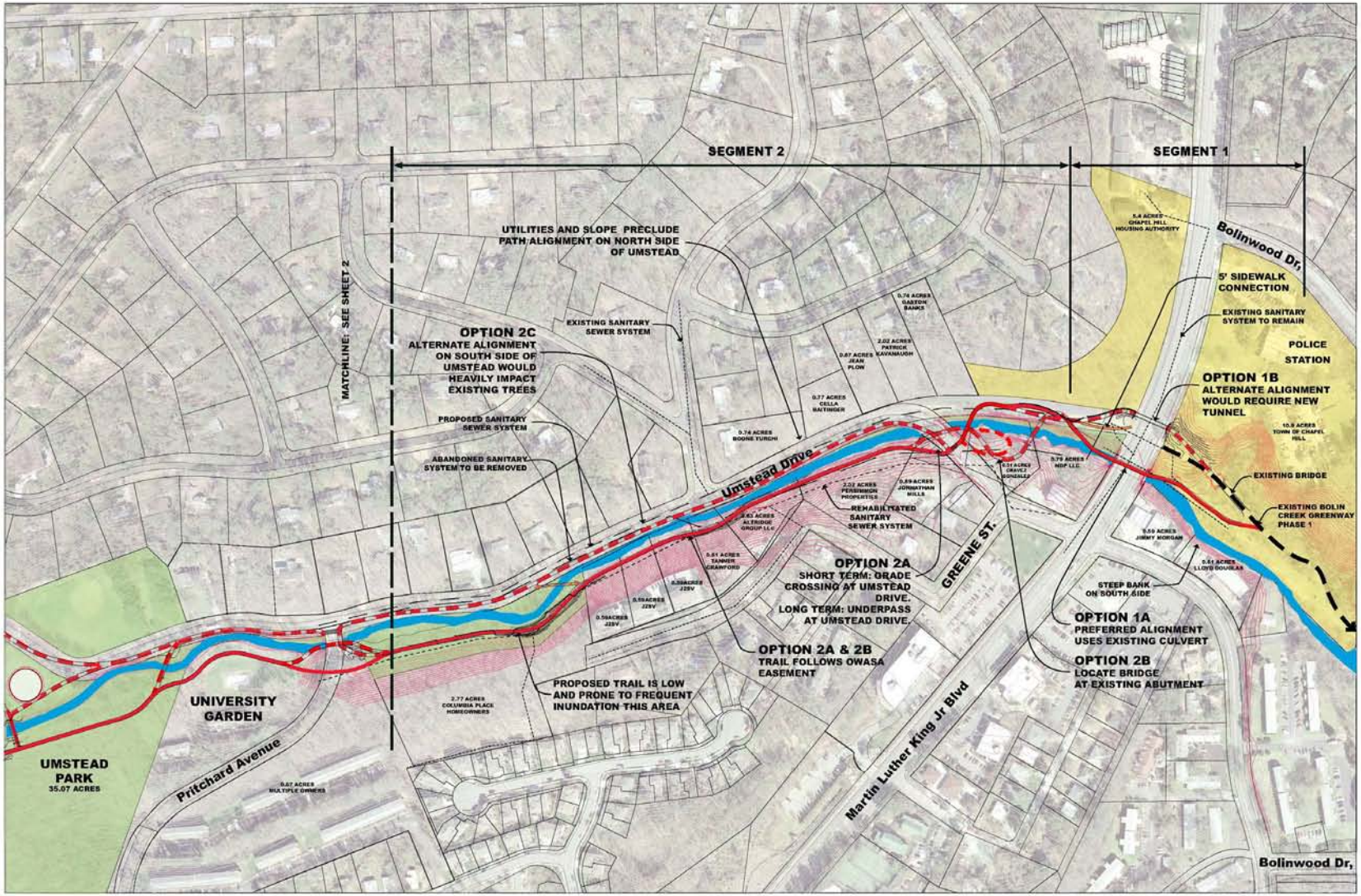



# BOLIN CREEK GREENWAY PHASE III
## CONCEPT PLAN

MAY 2007

LHPA
Lappas + Havener, PA
LANDSCAPE · ARCHITECTS

SCALE: 1"=100'-0"



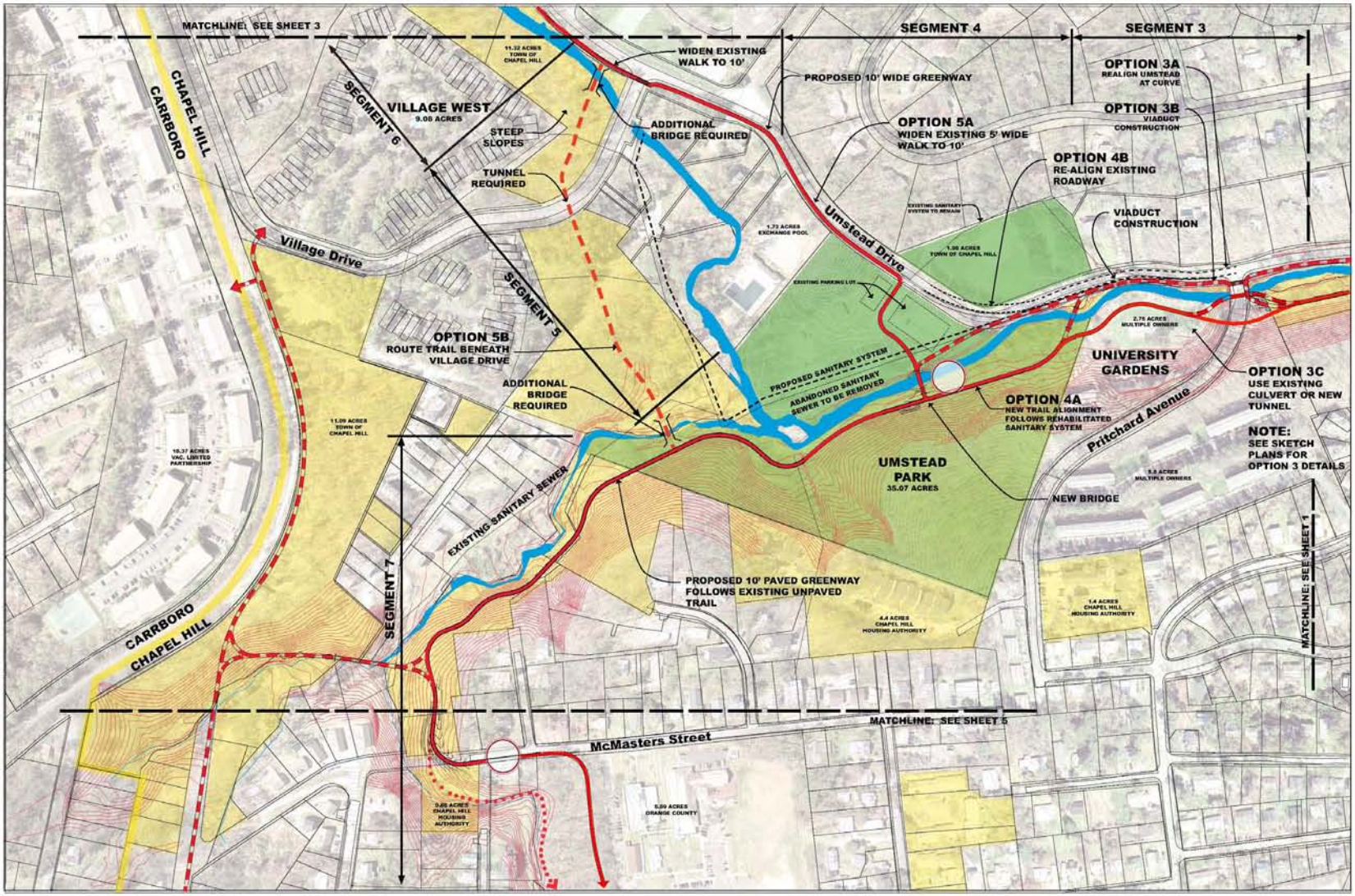

# BOLIN CREEK GREENWAY PHASE III
# CONCEPT PLAN

MAY 2007

LHPA
Lappas + Havenar, PA
LANDSCAPE ARCHITECTS

## SHEET 1 - MLK DRIVE TO PRITCHARD AVENUE

SCALE: 1"=100'-0"




# BOLIN CREEK GREENWAY PHASE III

## CONCEPT PLAN

MAY 2007

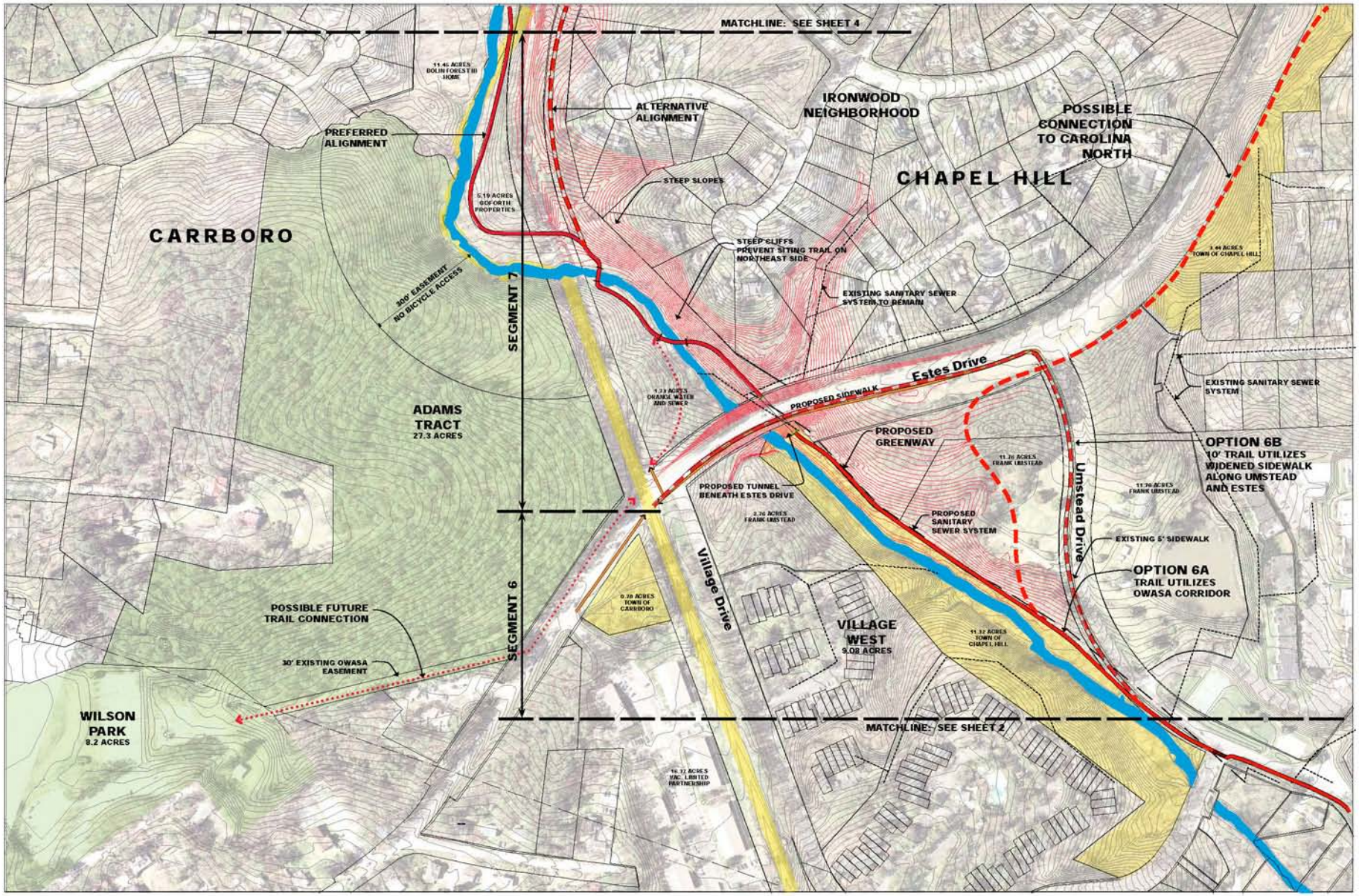
LHPA

Lappas + Havenar, PA

LANDSCAPE ARCHITECTS

## SHEET 2 - PRITCHARD AVENUE TO VILLAGE DRIVE

SCALE: 1"=100'-0"




# BOLIN CREEK GREENWAY PHASE III
# CONCEPT PLAN

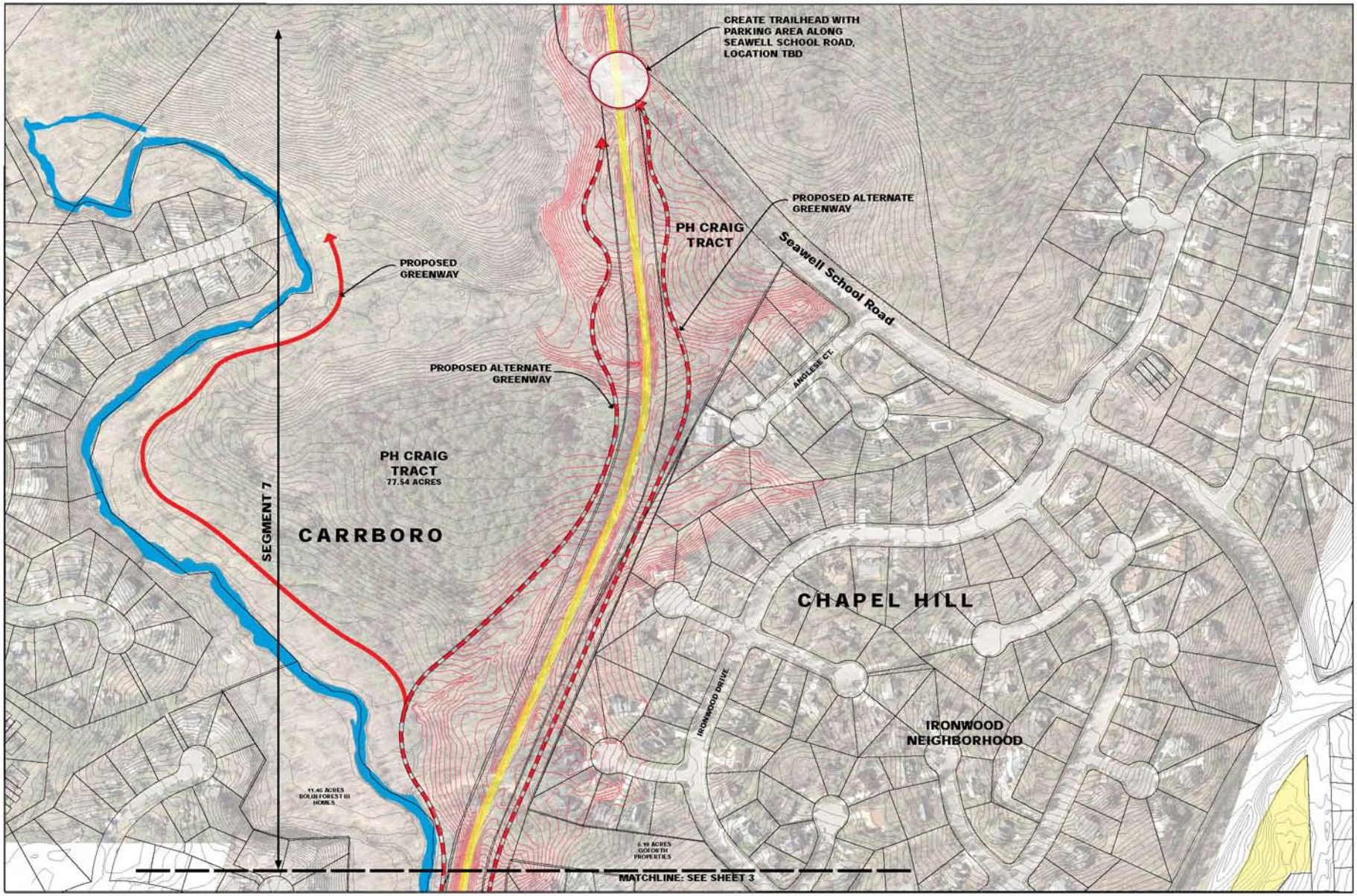
MAY 2007

LHPA

Lappas + Havener, PA
LANDSCAPE ARCHITECTS

## SHEET 3 - UMSTEAD PARK TO IRONWOOD NEIGHBORHOOD

SCALE: 1"=100'-0"



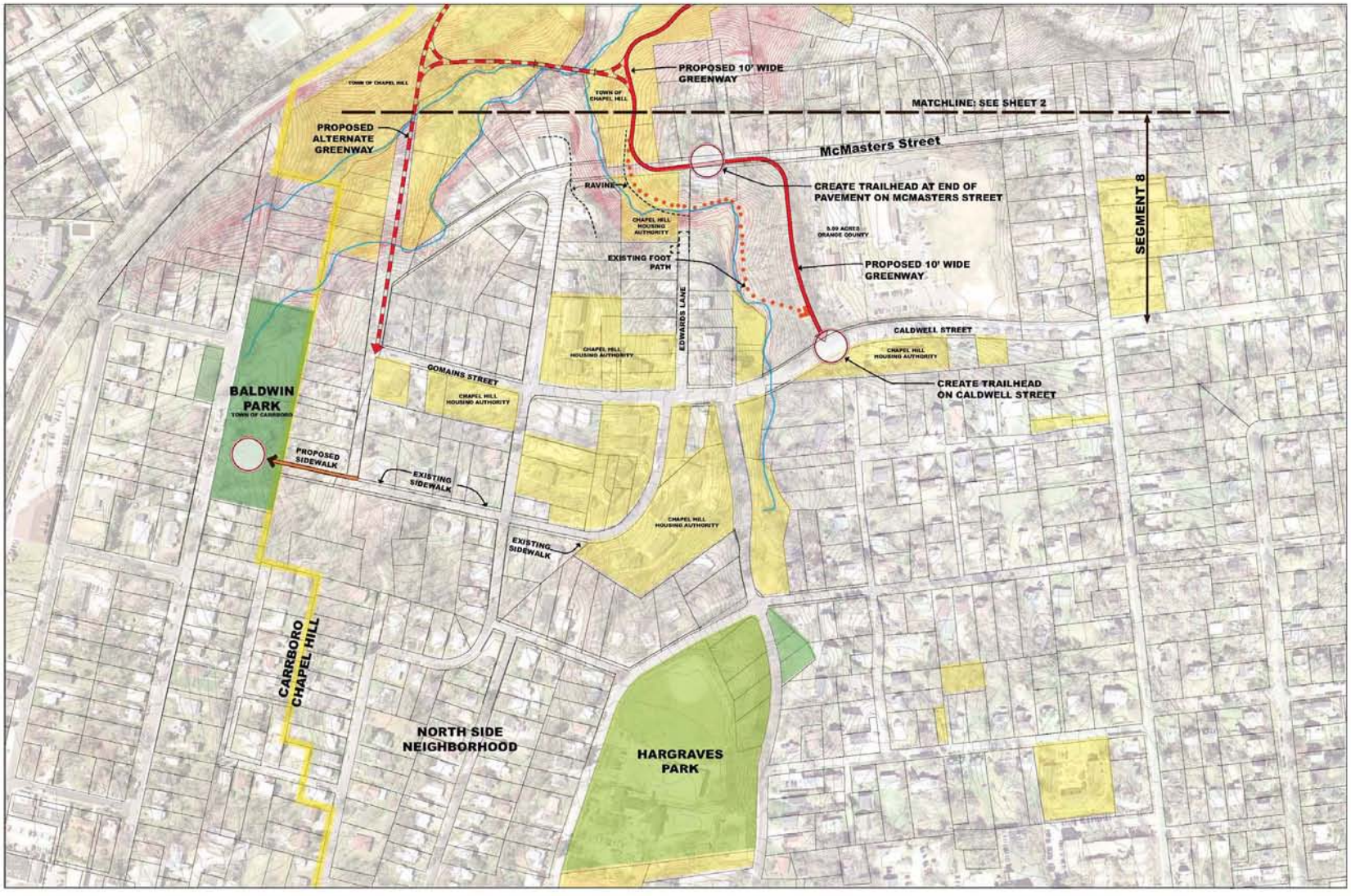

# BOLIN CREEK GREENWAY PHASE III
## CONCEPT PLAN

MAY 2007

LHPA
Lappas + Havener, PA
LANDSCAPE ARCHITECTS

## SHEET 4 - IRONWOOD NEIGHBORHOOD TO SEAWELL SCHOOL RD

SCALE: 1"=100'-0"




# BOLIN CREEK GREENWAY PHASE III
## CONCEPT PLAN

MAY 2007

LHPA
Lappas + Havenar, PA
LANDSCAPE ARCHITECTS

## SHEET 5 - TANYARD BRANCH

SCALE: 1"=100'-0"

*Appendices*
*For*

# BOLIN CREEK GREENWAY

Phase III

**Appendix A: Technical Brief by S&EC**

**Appendix B. Technical Brief by Parsons Brinkerhoff**

**Appendix C. Preliminary Construction Cost Projection**

**Appendix D. Alternative Routing Options**

# Appendix A

## Technical Brief by Soil and Environmental Consultants and Lappas and Havener on Flood Model Results


### Abstract

In order to determine the impact of several trail-related improvements on flood levels in Bolin Creek, Soil and Environmental Consultants performed HEC-RAS modeling at five locations in the creek channel. These locations were based on the placement of four proposed bridges and one underpass in the viaduct at Martin Luther King, Jr. Boulevard.

S&EC has determined through preliminary modeling that the four bridges and one underpass proposed by the model will most likely result in a “no-rise” condition for flood levels in Bolin Creek. Preliminary results suggest that schematic placements of these items are within range of a no-rise condition, and that as the design of these items is more closely determined, and as surveyed cross-sections are added to the HEC-RAS model, no-rise certification will be achieved.

As this Concept Plan has developed, two of the crossings modeled by S&EC are no longer part of the recommended options for the Bolin Creek Greenway: one bridge just upstream of Pritchard has been recommended to be replaced with the use of the existing culvert and avoidance of that crossing; and the bridge immediately downstream of Pritchard is likewise made unnecessary by the recommended Pritchard underpass option.

As design proceeds on the Bolin Creek Greenway, the recommended underpasses at Umstead, Pritchard, and Martin Luther King, Jr. Boulevard, in addition to the remaining bridge crossings, must be modeled using the HEC-RAS method, using surveyed cross-sections, to ensure that the design meets no-rise criteria.

**Evaluation Performed by:**
**Soil & Environmental Consultants, PA**
**Raleigh, NC**

Available Data Sources:

1. GIS Topographic Data, Town of Chapel Hill (through L&H)
2. Effective Models (Preliminary), NC Floodplain Mapping Program
3. Proposed Crossing Locations and Types (by L&H)
4. Various Site Visits by S&EC and others

Modeling Means:

1. Hydrologic Engineers Center, River Analysis System (HEC-RAS)
2. Effective Model, Corrected Effective Model, Proposed Conditions Model
3. 100-year Floodplain Evaluation (with and without Floodway Encroachments)
4. Integration of proposed crossings cross-sections and bridge dimensions
5. No modifications to Hydrology Data
6. Running of hydraulic models to simulate resultant water surface elevations
7. Comparison of existing (existing corrected conditions) with proposed conditions water surface elevations to evaluate water surface changes

Evaluation Specifics:

1. Study Reach from just upstream of the Estes Drive crossing to just downstream of the MLK crossing (model cover a considerably longer reach)
2. A total of four (4) new pedestrian stream crossings and one (1) “through-pipe” elevated greenway pier (upstream to downstream):
    a. Replacement of an existing wooden bridge in Umstead Park
    b. New bridge crossing between Umstead Park and Pritchard Road

c. New bridge crossing immediately downstream of the Pritchard Road

d. New bridge crossing downstream of Umstead Drive crossing

e. "Through-pipe" greenway routing at MLK crossing

3. Preliminary Modeling (integrating available topography and proposed crossing specifications) finalized

4. Final Model (based on field surveyed topographic data) pending

Preliminary Results:

1. Positive results for three (3) upstream crossings and MLK "through-pipe"

2. Crossing downstream of Umstead Drive crossing complicated and required additional cross-sections to be added to Effective Model (creating the Corrected Effective Model), modified and provided more positive results

Outstanding Issues:

1. Confirmation of select portions of Effective Model data

2. Field Survey of necessary cross-sections (NCFMP provider)

3. Coordination with Town representative for results format and submittal requirements

Following are **PRELIMINARY RESULTS** transmitted by Soil and Environmental Consultants to Lappas and Havener based on initial modeling of the channel with proposed improvements in place. S&EC is currently confirming model data and adjusting the model based on preliminary results.

1. We have re-run the current "Effective Model" provided to us (by L&H) from Bill Webster (from Watershed Concepts).

2. The Effective Model for Bolin Creek covers the stream from river Station 433+26.9 to river Station -1+82.0 (or 182 feet downstream of the confluence…this sounds strange, but it's not, likely made to make the stationing work out correctly in the model).

3. The Effective Model appears to have run fine and produced similar results to those listed in the Flood Insurance Study (FIS) and the select flood data listed on the Flood Insurance Rate Map (FIRM). Not all data listed in the FIS or on the FIRM is specific to a modeled cross-section, some are interpolated off of the water surface profile.

4. The area of interest for our study (and model modifications) is generally from just upstream of Estes Drive (river Station 189+39.2) downstream to just below the MLK

crossing (river Station 115+00.0). Note the model refers to the MLK crossing as the Hillsborough crossing. Based on our review of the modeling data, the FIS and the FIRM this is just an error in the descriptor in the model. The stationing clearly identifies this area as the MLK crossing. We didn't modify any model data outside of our area of concern but the model (Proposed Conditions Model) still covers the entire length of Bolin Creek.

5. Since there have been no updates in the model (as we understand it as these models were just approved) there is no "Corrected Effective Model" to be run or checked. I need to confirm this understanding with Fred Royal of Chapel Hill.

6. Based on the data provided by L&H we have prepared a preliminary "Proposed Conditions Model" which incorporates the proposed new and replacement bridges (type and location) and the walkway through the MLK pipe.

7. For the time being we have left the upstream existing bridge within Umstead Park in the updated model (this is the steel and concrete bridge just downstream of the confluence of Bolin Creek and Tanyard Branch). This bridge is located at river Station 159+41.2. We understand that this crossing will eventually be removed, again this needs to be discussed with Fred Royal.

8. The new (or replacement) crossings we've modeled are as follows:

    a. The replacement of the wooden bridge in Umstead Park just downstream of the one described above with a new bridge at the same river Station of 154+85.5. This is configured as proposed by L&H with the low chord (bridge bottom) at an elevation of 328.67 feet and a top of railing elevation of 333.00 feet (This is a total height of 4.33 feet or 52 inches. We understand the bridge thickness is 42 inches and the beam below is an additional 10 inches for a total of 52 inches from the high chord to the low chord of the bridge) and tying in at both ends to the 328 foot contour. Please confirm this assumption based on your grading. Preliminary modeling indicates a minor decrease (0.03 feet) in the 100-Year water surface elevation with this new bridge in place.

    b. The installation of a new bridge (configured as L&H proposes) at a river Station of 150+33.25. This will have a similar low chord elevation of 328.67 feet and a top of railing elevation of 333.00 feet (see above) and will tie in on both ends to the 328 foot contour. Please confirm this assumption based on your grading. Remember that no specific cross-section existed in the Effective Model at this river Station. Preliminary modeling indicates a minor increase (0.11 feet) in the 100-Year water surface elevation with this new bridge in place.

    c. The installation of a new bridge immediately downstream of Pritchard Avenue at river Station 145+17.1. This bridge will be parallel to the downstream end of the box culverts under Pritchard and configured as proposed by L&H. It's low chord is set at elevation 330.17 feet and it's high chord is at 334.50 feet. The bridge contour at elevation 330 feet at both ends. This bridge is an odd condition in that as L&H has shown it on the CAD drawings it acts basically as an extension of the deck of the Pritchard Avenue culverts. But since it's low chord is higher (over 3 feet) than the low chord of the Pritchard Avenue box culverts and it's high chord is lower that the high chord of the Prichard Avenue guard rail (about 2.5 feet), the new bridge is effectively masked by the existing (immediately upstream) crossing at Pritchard Avenue. I need to confirm this modeling approach with Fred Royal of Chapel Hill since I've not seen this kind of condition in the past. Preliminary modeling indicates a minor increase (0.03 feet) in the 100-Year water surface elevation with these modifications.

d. The installation of a new bridge (configured as proposed by L&H) downstream of the existing Umstead Drive crossing at river Station 126+62.5. This bridge, also configured as L&H proposes will have a low chord elevation of 315.17 feet and a high chord elevation of 319.50 feet, and ties to the 315 contour on both ends. This crossing is giving us problems and preliminary indications are that it is effecting water surface elevations (increasing them considerably) at the Umstead culvert crossing. We need to dig into this issue further.

9. The final changes to the model should occur at the MLK crossing at river Station 122+20.7. We've attempted to model the proposed walkway through the pipe in the form of pier close to one side of the pipe. Unfortunately based on the cross-sections used in the model just upstream and just downstream of the bridge opening the pier (or walkway) as we describe it in the model is sub-grade. I've got concerns about how this crossing is being modeled in the first place as the model shows a square-top culvert rather than the arched-pipe crossing which we've all walked through. This may have been a simplification on the part of the original modelers (Watershed Concepts) but it seems odd to me that it was modeled in this fashion. I also need to discuss this issue with Fred Royal later today.

10. We've kept similar Manning's roughness coefficients, expansion and contraction coefficients, ineffective flow limits, etc. in an attempt to be consistent with the previous modeling methods.

11. We've integrated our new cross-sections (from topographic data provided by L&H) into the old model river stationing (from the Effective Model). We've adjusted distances to downstream cross-sections accordingly in our Proposed Conditions Model.

12. Our comparisons of water surface elevation (WSE) have been based on direct comparison of WSE's at identical river stations whenever possible. In cases where no cross-sections previously existed (ie. the new bridge downstream of Umstead Park) we've interpolated WSE's from the Effective Model to compare with those generated at our new crossing stations.

Please remember all this data is PRELIMINARY.

Regards,

Patrick

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**Fx. (919) 846-9467**
**psmith@sandec.com**
**www.sandec.com**

## Viaduct/Cantilever Issues along Umstead Road

The following are issues associated with the construction of a viaduct edge on the south side of Umstead Drive near Pritchard Road. Though this is not the recommended option, this information is presented for informational purposes.

The crucial issue is whether the edge construction, whether piers or a turned-down edge, will land streamward of the top of bank. The top of bank will have to be surveyed. If proposed construction falls landward of the top of bank, a permit is not required for that part of the project. If the construction falls on the stream side of the top of bank, that part of the project definitely triggers a permit. However, we will already need a permit for the MLK underpass segment. On MLK, there's a good chance we can do a Nationwide permit by limiting the impacted length to less than 300 feet. The addition of channel impact at the viaduct portion would push the total length over 300 feet and require an Individual permit, I believe. By the way, shading by a cantilever is not counted as an impact within the top of bank. In this context, the permits that would be required are Section 404 CWA / US Army Corps of Engineers Permit and Section 401 CWA / NC DWQ Water Quality Certification, and not other required approvals (such as E&S permits, etc.). Also, even though the cantilever/viaduct would not directly impact Waters of the US (assuming that you are able to avoid fill within the stream channel (bank to bank), the agencies would have the authority to look at it in regards to cumulative impacts associated with the "project" if written concurrence or approval is required (as will be if you still intend to run the trail thru the MLK culvert. As such, they may request minimization to riparian vegetation and demonstrate that stream stability and functions will not be compromised for any design that includes significant disturbance near the stream.

Survey will be required to determine where the top of bank is or exactly how far the proposed construction would go into the top of bank. If we wished to explore this option S&EC would need at least two weeks to do the survey, integrate the cross-sections, and run the model. I think they would probably need some additional time to schedule the survey crew.

If the proposed construction cannot pass a "no-rise" test, then LOMR is required. Survey is required to determine this question.

Finally, with the viaduct and/or cantilever option, the visual impacts on roughly 150-180 feet of the channel would be significant. The P/B details call for either a continuous wall, or piers placed 10' on center. Also significant would be the carpet of rip-rap placed against the wall or pier footings. This would result in numerous destroyed trees and an armored look that the Town would likely not be happy with. A good contractor might be able to install a wall more delicately than most, but this I believe will be low-bid construction.

# Appendix B

**TECHNICAL BRIEF ON**
**FEASIBILITY STUDY OF BOLIN CREEK GREENWAY PHASE 'E'**

March 15, 2006

## Tunnel Construction Options

All the below subsurface discussions are based on site visits and visual evidence on the surface. Additional subsurface investigation will be necessary before final design is completed.

There are basically two ways to construct tunnels- cut-and-cover and bored. The method of tunnel construction is typically determined by the engineer, in association with the owner.

Cut-and-cover tunnel construction consists of a reinforced concrete box culvert (RCBC) in an open excavation then backfilling the excavation and covering the tunnel. Depending on the length and depth of the tunnel, cut-and-cover tunnel construction is typically less expensive than bored tunnel construction, particularly if temporary excavation support is not required to maintain traffic. However the land area or roadway above the tunnel is not useable during construction and must be reconstructed afterwards.

Bored tunnel construction consists of installing ground support, excavating the ground within the support system, and constructing the tunnel liner. Excavation is performed by drilling (boring) or by conventional hand or small equipment excavation. Depending on the depth of the tunnel, bored tunnels have the advantage of minimally disturbing the land area above the tunnel. A simple example of bored tunnel construction is to jack or drive a large diameter pipe horizontally along the grade and alignment of the proposed tunnel and excavate the soil within the pipe. Tunnels as large as 12 feet in diameter have been constructed using this technique. Another construction technique for tunnels through soil is to jack several interlocking small diameter pipes to create an arch shape that serves as the ground support.

Martin Luther King Drive (MLK) Tunnel
At the trail crossing location, MLK Drive is a five-lane curb and gutter roadway and is only slightly higher than the existing terrain. Because of the low embankment height, there is insufficient soil cover to construct a bored tunnel.

Therefore, the tunnel must be constructed by the cut-and-cover method. The construction will have to be staged in order to maintain traffic on MLK Drive with one or more lane closures required during each stage.

On each side of MLK Drive, the trail grade will have to be cut down approximately 10 feet to get under the roadway. The approximate length of tunnel is 90 feet, and depending on the steepness of the trail grade, may require extended wing walls to transition the lower tunnel grade back up to the higher trail grade approaching the tunnel entrances. Temporary excavation support is required to facilitate the staged construction.
It should be noted that the geologic conditions at MLK Drive are such that a significant portion of the excavation for the tunnel will be in rock, which may require the use of explosives to excavate.

TIP No. County: **ORANGE**
Route
From
Typical Section **Pedestrian Box Culvert**

| CONSTR. COST |
|---|
| $215,000 |

Priced By: Doug Lane 03/14/06
Requested By: Chris Ray, PE 268-2155 03/14/06
raych@pbworld.com

| Line Item | Des | Sec No. | Description | Quantity | Unit | Price | Amount |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | Remove Existing Pavement | 217 | SY | $ 8.00 | $ 1,736.00 |
| | | | Remove Existing Sidewalk | 17 | SY | $ 10.00 | $ 170.00 |
| | | | | | | | |
| | | | New Pavement | 200 | SY | $ 70.00 | $ 14,000.00 |
| | | | 2'-6" Concrete Curb and Gutter | 60 | LF | $ 40.00 | $ 2,400.00 |
| | | | 4" Concrete Sidewalk | 17 | SY | $ 50.00 | $ 850.00 |
| | | | | | | | |
| | | | Erosion Control | 0.04 | Acres | $ 20,000.00 | $ 800.00 |
| | | | | | | | |
| | | | Traffic Control | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| | | | Thermo and Markers | 1 | LS | $ 600.00 | $ 600.00 |
| | | | | | | | |
| | | | **Pedestrian Box Culvert (W/Conduit for Lighting)** | | | | |
| | | | 1@10x10-90'-3'F-90Skew | 90 | LF | $ 1,447.00 | $ 130,230.00 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | Misc & Mob 10% Ped Culv | 1 | LS | | $ 13,214.00 |
| | | | Misc & Mob 35% Roadway | 1 | LS | | $ 11,000.00 |
| | | | | | | **Contract Cost** | $ 185,000.00 |
| | | | | | | **E. & C. 15%** | $ 30,000.00 |
| | | | | | | **Construction Cost** | **$ 215,000.00** |

The approximate total cost of constructing the tunnels, including excavation support and reconstructing the roadway is estimated at $235,000 to $250,000, depending on the amount of rock excavation, including temporary excavation support, reconstruction of the roadway, traffic control, etc. This cost does not include the cost of constructing the extended portions of the wing walls if required. The above table produced for Parsons Brinckerhoff by NCDOT reflects a typical situation and does not include temporary excavation support.

**Estes Drive Tunnel**

At the trail crossing location, Estes Drive is a two-lane graded roadway with 12 foot shoulders on an embankment that is approximately 30 feet high. The trail will cross near the bottom of the embankment. This tunnel could be constructed using either the bored or cut-and-cover methods. However, the cut-and-cover method will require substantial temporary excavation support structures, lane closures and reconstruction of the roadway. This site is a good candidate for bored tunnel construction using a single large diameter driven pipe. The ground elevation at the bottom of the embankment is slightly lower on the east side of Estes than on the west side. Therefore, to minimize the tunnel cost, the tunnel grade on the east approach should be ramped up utilizing low height retaining walls as needed.

Approximate bored tunnel cost: $410,000 -includes wing walls.

Approximate Cut-and-cover tunnel cost: $445,000 -includes temporary excavation support, reconstruction of the roadway, traffic control, etc.

**Bridge Superstructures**

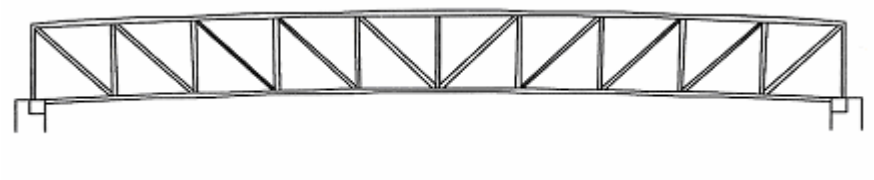
There are two types of bridges commonly used on local greenways, the Half-Through Pony System and the Bowstring System. Both of these systems are very efficient for short span bridges. There are also other types that work well for spans longer than 120 feet, but it is not foreseen that longer spans will be needed on this project.

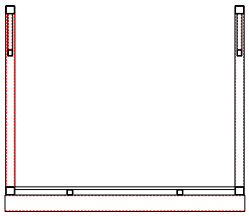
The Half-Through Pony System is a very cost effective option for bridge spans up to 80 feet. Side trusses act as the handrail system, allowing an unobstructed view with no overhead members. Typical handrail heights (distance from top of deck to top of top chord) are either 42” or 54”. The system is constructed utilizing an under-hung floor beam. That is, the top of the floor beam is directly welded to the bottom of the bottom chord. This system offers the minimal top of deck to

underside of steel dimension. The bridge is usually shipped in one piece for spans up to 80 feet. Installation requires removing the bridge from the truck and setting into place.

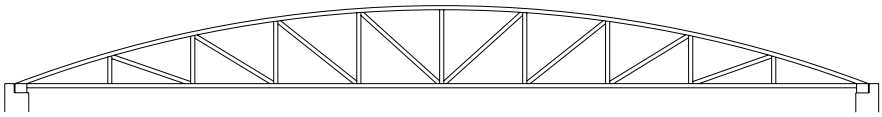
The Bowstring System is effective for bridge spans from 80 feet to 180 feet. Side trusses act as the handrail system. The truss height varies along the length of the bridge, following the camber of the top chord. Model BS1-U is constructed utilizing an under-hung floor beam. That is, the top of the floor beam is directly welded to the bottom of the bottom chord. This model is typically used for spans less than 100 feet. Continental Bridge Model BS1-H is constructed utilizing a floor beam that is welded into the side face of the truss verticals. This system is an excellent choice for aesthetic reasons. A Bowstring System is usually more expensive option than the Half-Through Pony System.

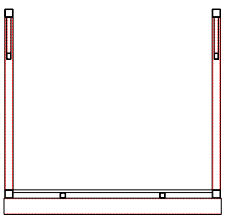
HALF-THROUGH PONY SYSTEM



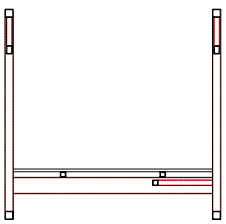


BOWSTRING SYSTEM





MODEL: BS1–U



MODEL: BS1–H

APPROXIMATE SUPERSTRUCTURE COSTS

| Span Length | Half-Through Pony System | The Bowstring System |
|---|---|---|
| 30 feet | $ 22,000 | $ 28,000 |
| 40 feet | $ 26,000 | $ 33,000 |
| 50 feet | $ 31,000 | $ 39,000 |
| 60 feet | $ 35,000 | $ 44,000 |
| 70 feet | $ 41,000 | $ 52,000 |
| 80 feet | $ 56,000 | $ 70,000 |
| 90 feet | $ 65,000 | $ 82,000 |
| 100 feet | $ 72,000 | $ 90,000 |
| 110 feet | $ 83,000 | $ 104,000 |
| 120 feet | $ 93,000 | $ 117,000 |

APPROXIMATE TURNKEY ESTIMATE ON A $60,000 BRIDGE AT BOLIN CREEK GREENWAY

**Bolin Creek Typical Bridge Cost**

| Item No. | Item Description | Quantity | Unit | Unit Price | Extended Price |
|---|---|---|---|---|---|
| 1 | Mobilization (10%) | 1 | LS | $ 20,000.00 | $ 20,000 |
| 2 | Borrow Excavation | 100 | CY | $ 15.00 | $ 2,000 |
| 3 | Removal of Existing Pavement | 715 | SY | $ 5.00 | $ 4,000 |
| 4 | Collapsable Bollards | 6 | EA | $ 1,000.00 | $ 6,000 |
| 5 | Sediment and Erosion Control | 1 | AC | $ 15,000.00 | $ 9,000 |
| 6 | Seeding and Mulching | 0 | AC | $ 2,000.00 | $ 1,000 |
| 7 | Landscaping - Shrubs | 30 | EA | $ 30.00 | $ 1,000 |
| 8 | Landscaping - Small Trees | 15 | EA | $ 700.00 | $ 11,000 |
| 9 | Construction Surveying | 1 | LS | $ 10,000.00 | $ 10,000 |
| 10 | Civil Design Fee | 1 | LS | $ 5,000.00 | $ 5,000 |
| 11 | Preliminary Surveying | 1 | LS | $ 8,000 | $ 8,000 |
| | | | | | |
| 12 | Continental Pre-Engineered Bridge | 1 | LS | $ 60,000.00 | $ 60,000 |
| 13 | Erection of Bridge | 1 | LS | $ 10,000.00 | $ 10,000 |
| 14 | Personnel Guardrail (Pipe Railing) | 80 | LF | $ 25.00 | $ 2,000 |
| 15 | Class A Concrete (Substructure) | 13 | CY | $ 550.00 | $ 7,000 |
| 16 | Reinforcing Steel Bridge (Substructure) | 2667 | LB | $ 0.63 | $ 2,000 |
| 17 | Expansion Joint Seals (2"-4") | 20 | LF | $ 50.00 | $ 1,000 |
| 18 | 4" Slope Protection | 100 | SY | $ 6.00 | $ 1,000 |
| 19 | Structural Design Fee | 1 | LS | $ 60,000.00 | $ 60,000 |
| 20 | CEI | 1 | LS | $ 10,000 | $ 10,000 |
| | | | | | |
| 21 | Stake Holder Involvement | 1 | LS | $ 8,000.00 | $ 8,000 |
| | | | | Subtotal | $ 238,000 |
| | | | | | |
| | | | | Contingency (20%) | $ 47,600 |
| | | | | | |
| | | | | **Total** | **$ 285,600** |

## Bridge Foundations

Pedestrian bridges can be founded on shallow spread footings or drilled shafts at the abutments and the interior piers. Driven piles are not an option on this project due to the presence of shallow rock. Drilled shafts are more expensive to construct than spread footings, require heavy specialized equipment to install, but offer the advantage of minimal disturbance of the stream bed. Due to the lower construction cost, spread footings should be utilized wherever possible. If located in the stream bed, the footings should be embedded a minimum of one foot into non-erodible rock. Rock is present at or near the stream bed elevations throughout the project.

Approximate footing sizes are 12 ft x 3 ft and 2 ft thick at the abutments. The interior bents will have two piers supported by 2 ft x 2 ft x 1 ft footings. The cost to construct the footings is approximately $600 per cubic yard of concrete.

Abutment footing cost = $1,700 per abutment
Interior footing cost = $1,600 per bent

## Cut and Fill Slopes

Fill slopes may be constructed at 2:1 (horizontal: vertical). Fill slopes that would be exposed to the action of water should be protected from erosion with rip rap. Fill slopes permanently inundated with water may need to be constructed entirely of rip rap. Cut slopes along the hillside south of Bolin Creek west of Pritchard Avenue may be constructed on 1.5:1 (H:V).

## Retaining Walls

The type of retaining walls to be used depends on the geometric and geologic characteristics of the particular site and aesthetic criteria of the project. Retaining walls may be needed at bridge approaches, tunnel entrances, and along the hillside above the creek.

Retaining walls supporting embankments are considered 'fill' walls and may be cast-in-place concrete (CIP) or modular block (MBRW). MBRW retaining walls are typically less expensive and more aesthetically pleasing than CIP walls and can be constructed without the use of heavy equipment. The Keystone® retaining wall system is one example of the many different MBRW systems available. Unreinforced CIP retaining walls are called Gravity walls and are competitive in price with MBRW's. However, additional cost is incurred to improve aesthetics. Fill walls may also be used in shallow cut situations provided there is sufficient space to excavate behind the wall face.

Retaining walls supporting excavations are considered 'cut' walls and may be soldier pile and lagging (with or without tiebacks) or soil nail walls. These wall types have the advantage of requiring only minimal excavation behind the wall face. Tieback and soil nail walls have underground inclusions extending behind the wall face which must be protected from disturbance by permanent underground easements. The length of inclusions varies from 6 feet to 40 feet depending on the wall height. Soldier pile and lagging walls can be constructed of combinations of timber, steel and concrete and do not require tiebacks if the wall height is less than 10 feet. Soil nail walls can be used for any height cut.

Considering the nature of the project, MBRW walls would be most suitable for fill walls of any height and cut walls that are less than 4 feet ± due to their ease of construction, low cost and aesthetic appearance. Soldier pile and lagging walls with square timber piles and timber lagging are best suited aesthetically for deeper cuts.

Retaining wall costs are commonly reported as the cost per square foot of wall face area.

The unit prices do not include excavation support, appurtenances such as fences or guardrail, or special aesthetic treatments.

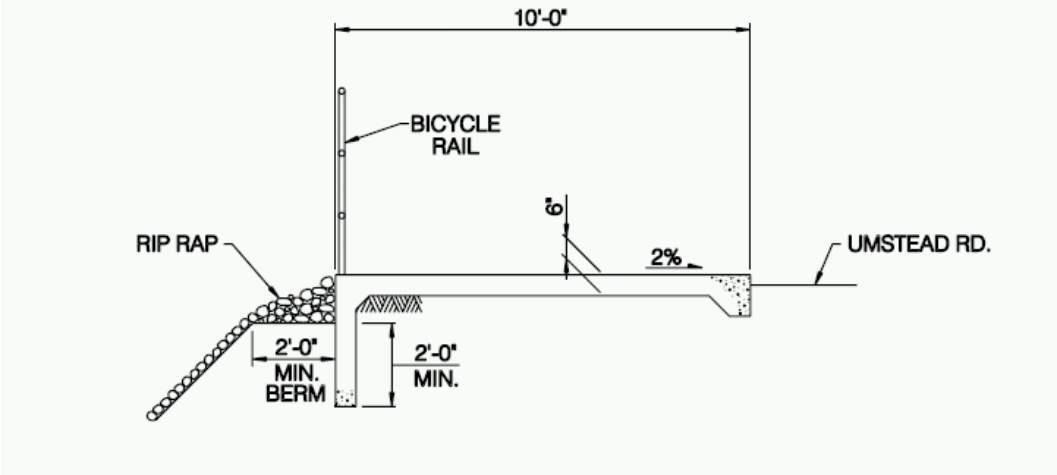
| Retaining Wall Selection Table | | | |
|---|---|---|---|
| Type | Typical Height Range | Typical Application | Unit Cost |
| Gravity (unreinforced concrete) | 0 to 8 feet | fills and shallow cuts | $50/sf |
| CIP (reinforced concrete) | any height | fills | $65/sf |
| Soldier Pile & Lagging | 0 to 10 feet | cuts | $60/sf |
| Tieback Soldier Pile & Lagging | greater than 10 feet | cuts | $90/sf |
| Soil Nail | any height | cuts | $75/sf |
| MBRW | any height | fills and shallow cuts | $45/sf |

**Viaduct Construction**

The typical viaduct construction will be similar in many cases to the price per lineal foot of a short bridge. Because of the steep bank of the creek along Umstead Road, using this scenario would drive the cost of the greenway up significantly. It should also be noted that many trees and bushes on the bank would need to be removed, which may detract from the natural aesthetics the creek presently offers. There would likely be a lane closure for the construction of the viaduct. A similar type of construction could be used through the tunnel underneath MLK Boulevard if the hydraulic studies support this possibility.

**Viaduct Construction on slopes flatter than 4:1**

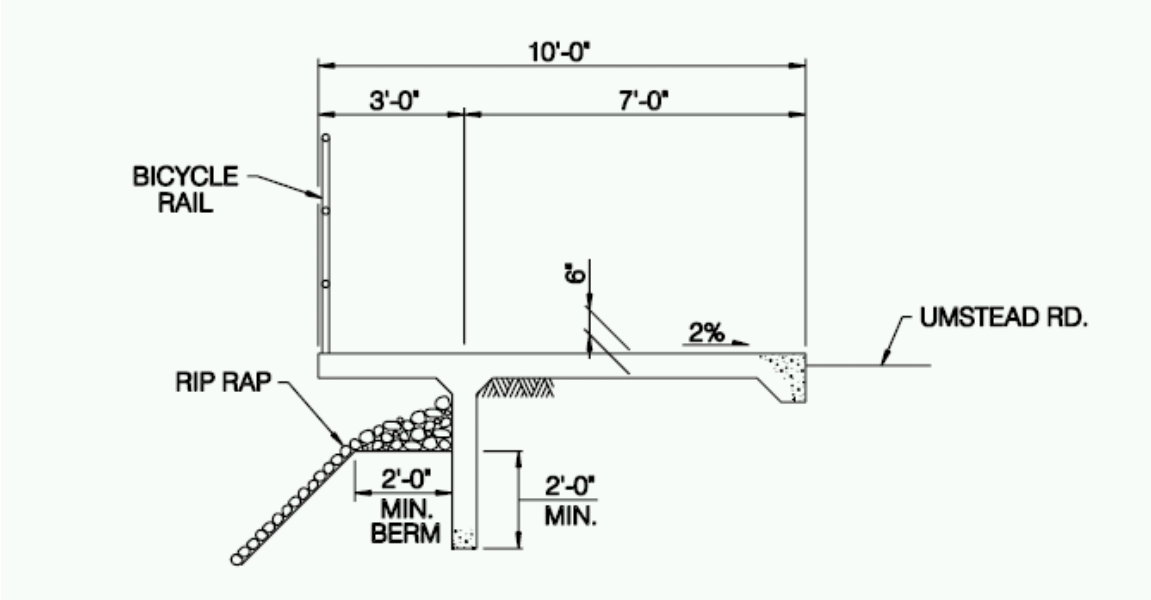
This construction involves using a reinforced concrete sidewalk with a turned down edge on the downhill side. Below the turn downed edge is a two foot berm which is level and meets the slope down to natural ground. Rip rap will be required along the berm and down the slope to prevent scouring of the turned down part of the sidewalk in the even of a significant storm event.




The approximate cost of this construction for a sidewalk 10 feet wide is $145 per lineal foot.

**Viaduct Construction on slopes steeper than 4:1**

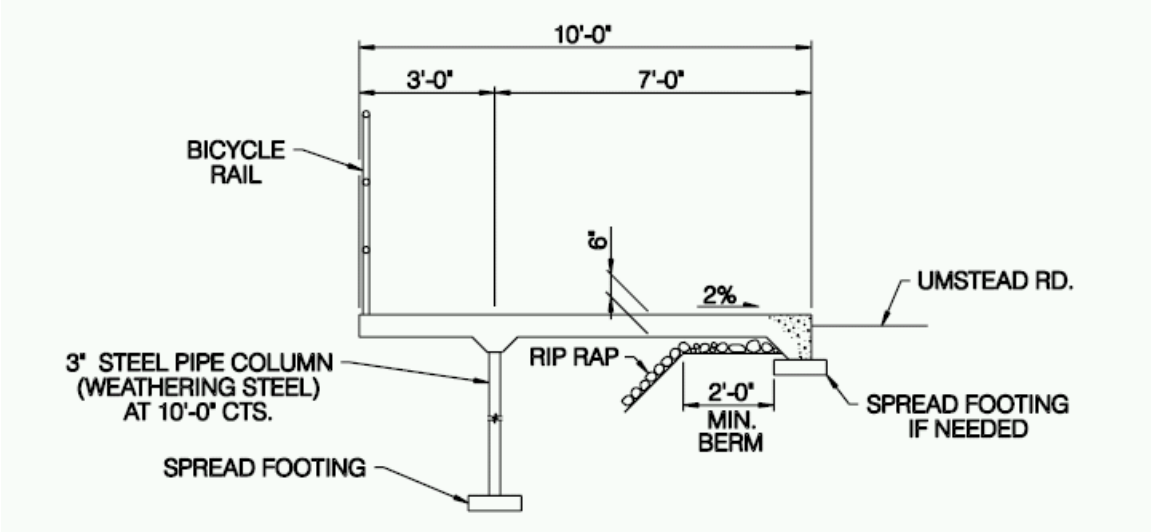
This construction involves using a reinforced concrete sidewalk with a continuous wall column three feet in from the cantilevered edge of the walkway. The area between the wall column and the road would be supported on grade. On the creek side of the wall column underneath the overhang, there would be a two-foot wide berm which is level and meets the slope down to natural ground. Rip rap will be required along the berm and down the slope to prevent scouring of the turned down part of the sidewalk in a significant storm event.




The approximate cost of this construction for a sidewalk 10 feet wide is $155 per lineal foot.

**Viaduct Construction using Aerial Structure**

This construction involves using a reinforced concrete sidewalk designed to have the capacity to be supported on one side by the existing ground and on the other side with a post and beam system. The beam would either be a reinforced concrete section or a steel 'I' beam section running longitudinally along the walk. This would be supported by a steel pipe column and would rest on a spread footing. On the edge that is supported by the existing ground, there would be a two-foot berm which is level and meets the slope down to natural ground. Rip rap will be required along the berm and down the slope to prevent scouring of the turned down part of the sidewalk in a significant storm event.



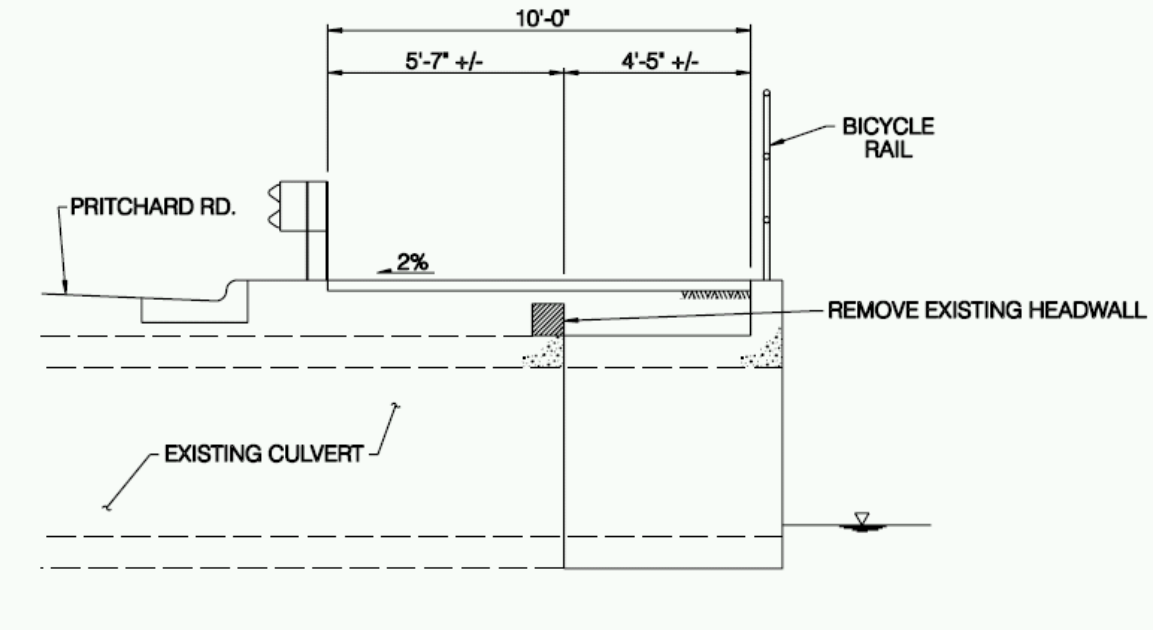

The approximate cost of this construction for a sidewalk 10 feet wide is $180 per lineal foot.

Table of Costs (l represents amount of slab which is not cantilevered)

| Length, l (ft) | Volume of Concrete ($ft^3$) | Premium for Construction* | Cost of Concrete | Weight of Rebar (lbs) | Cost of Rebar | Total Cost per Linear Foot** |
|---|---|---|---|---|---|---|
| 10.00 | 0.213 | 100.0% | $117.13 | 20.59 | $15.44 | $145.83 |
| 9.67 | 0.213 | 103.7% | $121.48 | 20.59 | $15.44 | $150.61 |
| 9.33 | 0.213 | 105.3% | $123.39 | 17.11 | $12.83 | $171.89 |
| 9.00 | 0.213 | 106.7% | $124.94 | 17.11 | $12.83 | $173.59 |
| 8.67 | 0.213 | 107.8% | $126.32 | 17.11 | $12.83 | $175.11 |
| 8.33 | 0.213 | 108.9% | $127.61 | 13.36 | $10.02 | $173.43 |
| 8.00 | 0.213 | 110.0% | $128.84 | 13.36 | $10.02 | $174.79 |
| 7.67 | 0.213 | 111.0% | $130.05 | 13.36 | $10.02 | $176.12 |
| 7.33 | 0.213 | 112.1% | $131.26 | 13.36 | $10.02 | $177.45 |
| 7.00 | 0.213 | 113.1% | $132.47 | 13.36 | $10.02 | $178.78 |
| 6.67 | 0.213 | 114.1% | $133.69 | 13.36 | $10.02 | $180.13 |
| 6.33 | 0.213 | 115.2% | $134.95 | 13.36 | $10.02 | $181.52 |
| 6.00 | 0.213 | 116.3% | $136.26 | 13.36 | $10.02 | $182.95 |

**Conventional Culvert Extension option**

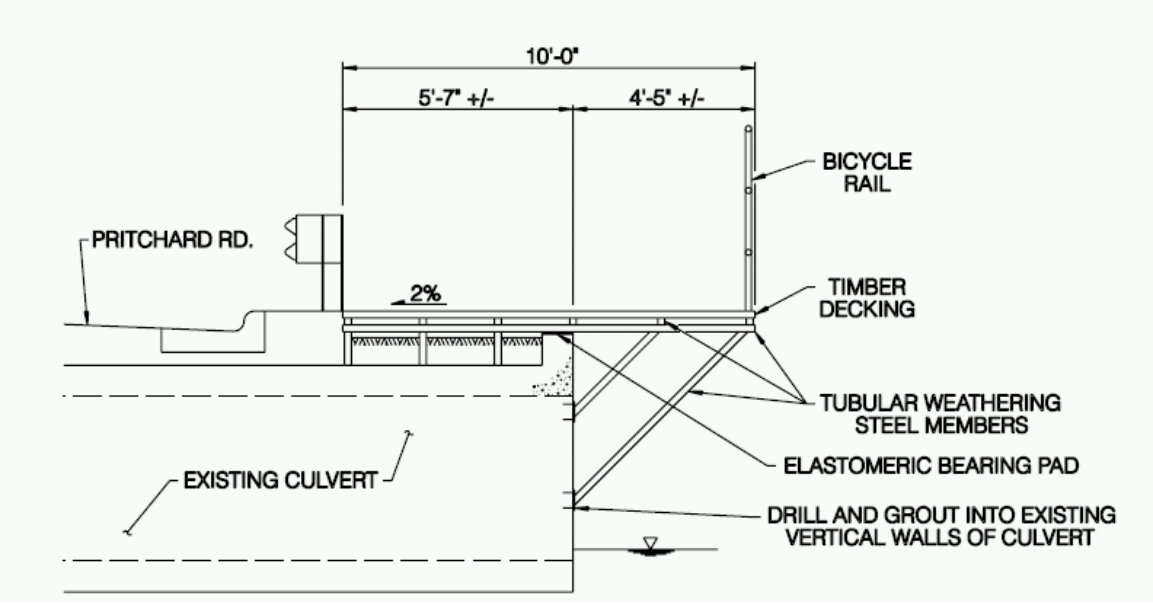
Typically, NCDOT would simply extend the culvert when widening a road or otherwise needing a wider crossing above a stream. The construction may have some impact on the traffic and possibly require a lane closure. The two options for a culvert extension are either a cast-in-place culvert or a precast culvert. The precast option will have a shorter construction period cost approximately 50% more than a cast-in-place culvert.




The approximate cost of an extension is $8,700 per linear foot.

**Cantilever Walkway off Headwall of Culvert**

A less conventional method of creating a path beside the culvert would be to have a diagonal bracket support the overhanging section of the walk and transferring the load into the vertical wall of the culvert. This solution creates a load path transferring the pedestrian load directly to the foundation of the culvert. This would likely have no impact on traffic.




The cost of this alternative would be approximately $30,000.

**Bridge Across Stream near Culvert**

The third option is to build abutments near the culvert and span between them with a bridge. This option would be very similar to any other bridge crossing along the greenway. The cost per linear foot would increase compared to the other options as the bridge requires a longer span.

## Schematic Cost Estimate

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

### SEGMENT 1: MARTIN LUTHER KING, JR. BOULEVARD UNDERPASS TO UMSTEAD DRIVE

### Option 1A. Stream-level crossing under MLK Blvd*

**DEMOLITION**

| Item | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site** | | | | |
| Clearing and Demolition | 53000 | 0.25 | sf | $13,250 |
| | | | Sub-Total | $13,250 |
| | | ADD 6% FOR DUMPING FEES | | $795 |
| | | TOTAL FOR DEMOLITION | | $14,045 |

**GENERAL CONSTRUCTION**

**Site work**

| Material | Qty. | Cost/ | unit | Subtotal | |
|---|---|---|---|---|---|
| Surveying | 1 | 2000 | ls | $2,000 | |
| Grading | 40 | $9.50 | cy | $380 | |
| 4" Concrete Trail | 333 | $70.00 | sy | $23,310 | |
| 6" Concrete Trail under culvert | 200 | $200.00 | lf | $40,000 | |
| Impact fees for permit | 1 | $40,000.00 | ls | $40,000 | |
| **Planting** | | | | | |
| Allow | 1 | $4,000.00 | ls | $4,000 | |
| | **SITE CONSTRUCTION TOTAL** | | | $109,690 | |
| | **DEMOLITION** | | | $14,045 | |
| | | Subtotal | | $123,735 | |
| Contractor Overhead and Profit | | $123,735 | 0.1 | $12,373.50 | |
| Contractor Mobilization and bonds | | $136,108.50 | 0.04 | $5,444 | |
| 15% Contingency | | $141,552.84 | 0.15 | $21,233 | |
| **Total Cost Option 1A** | | | | **$162,786** | $3.07 per SF |

### Option 1B. Construct new underpass beneath MLK Blvd.

| | |
|---|---|
| Delete Trail under culvert | ($35,000) |
| Delete some In-stream impact fees | ($35,000) |
| Add underpass tunnel (assume sitework similar) | $400,000 |
| Net cost increase/(reduction) | $330,000 |
| **Total Cost with Option 1B** | **$492,786** |

Note: Permit fees for in-channel work under Option 1A (USACE nationwide permit) may be up to $40,000 given extent of impacted area. These fees would be substantially offset in Option 1B, though the project as a whole will require permitting by USACE in any event.

*** Recommended Option, included in Summary Sheet at end of estimate.**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

**SEGMENT 1: MARTIN LUTHER KING, JR. BOULEVARD UNDERPASS TO UMSTEAD DRIVE**

**Option 1C. Use existing culvert to pass beneath Umstead Drive***

As shown in Sketch Plan 1A.4

| | |
|---|---|
| Modify existing culvert to provide clearance [1] | $60,000 |
| Acquire property for trail siting on south bank [2] | $141,000 |
| Additional demolition (house and site), south bank | $40,000 |
| **Net cost increase/(reduction)** | **$241,000** |
| Base Cost, Option 1A | $162,786 |
| **Total Cost with Option 1C*** | **$403,786** |

**Notes:** 1. If culvert must be replaced and not modified, cost for replacing culvert may be in the $600-800,000 range. 2. Tax value shown; market value is often substantially higher than tax value.

*** Recommended Option, included in Summary Sheet at end of estimate.**

**Bolin Creek Greenway Phase II**
**Schematic Cost Estimate**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SEGMENT 2: UMSTEAD DRIVE TO PRITCHARD AVENUE

### Option 2A: Alignment on south side of creek *

**DEMOLITION**

| Item | Qty. | Cost/ unit | Subtotal |
|---|---|---|---|
| **Site** | | | |
| Clearing and Demolition | 40000 | 0.25 sf | $10,000.00 |
| | | Sub-Total | $10,000.00 |
| | ADD 6% FOR DUMPING FEES | | $600.00 |
| | TOTAL FOR DEMOLITION | | $10,600.00 |

**GENERAL CONSTRUCTION**

**Site work**

| Material | Qty. | Cost/ unit | Subtotal |
|---|---|---|---|
| Surveying | 1 | $5,000.00 ls | $5,000.00 |
| Grading | 370 | $9.50 cy | $3,515.00 |
| 4" Concrete Trail | 1333 | $70.00 sy | $93,310.00 |
| Class A Rip Rap | | | |
| 70' Ped Bridge with abutments | 1 | $250,000.00 ea | $250,000.00 |
| Modular Block Retaining Wall | 480 | $45.00 ff | $21,600.00 |
| **Erosion Control** | | | |
| Allow | 1 | $4,000.00 ls | $4,000.00 |
| **Planting** | | | |
| Allow | 1 | $2,000.00 ls | $2,000.00 |
| | **SITE CONSTRUCTION TOTAL** | | $379,425.00 |
| | **DEMOLITION** | | $10,600.00 |
| | Subtotal | | $390,025.00 |
| Contractor Overhead and Profit | $390,025 | 0.1 | $39,002.50 |
| Contractor Mobilization and bonds | $429,027.50 | 0.04 | $17,161.10 |
| 15% Contingency | $446,188.60 | 0.15 | $66,928.29 |
| **Total Option 2A** | | | **$513,116.89** |

$12.83 per SF

### Option 2B: Alignment on north side of creek

| | | | |
|---|---|---|---|
| Delete Bridge | 1 | ($250,000.00) ea | ($250,000.00) |
| Delete Culvert Ext at Pritchard | 1 | ($30,000.00) ea | ($30,000.00) |
| Add clearing of trees, north side | 1 | $25,000.00 ls | $25,000.00 |
| Add traffic control | 1 | $20,000.00 ls | $20,000.00 |
| Add traffic barrier | 1600 | $100.00 lf | $160,000.00 |
| Add culvert extension at Umstead | 1 | $40,000.00 ls | $40,000.00 |
| Add differential cost for viaduct | 6000 | $10.00 sf | $60,000.00 |
| Net cost increase/(reduction) | | | ($105,000.00) |
| **Total Cost with Option 1B** | | | **$408,116.89** |

**Note:** Option 2B may result in higher costs than shown here due to its proximity to Umstead Drive roadway. Option 2B will also result in substatially higher impacts to creek and is therefore not recommended.

*** Recommended Option, included in Summary Sheet at end of estimate.**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SEGMENT 3: PRITCHARD AVENUE TO UMSTEAD PARK

### Option 3A: Realign Umstead Drive immediately west of Pritchard

**Site**

| | | | | |
|---|---|---|---|---|
| Clearing and Demolition | 12000 | 0.5 | sf | $6,000 |
| | | | Sub-Total | $6,000 |
| | | ADD 6% FOR DUMPING FEES | | $360 |
| | | TOTAL FOR DEMOLITION | | $6,360 |

**GENERAL CONSTRUCTION**

**Site work**

| **Material** | **Qty.** | **Cost/** | **unit** | **Subtotal** |
|---|---|---|---|---|
| Surveying | 1 | $5,000.00 | ls | $5,000 |
| Grading | 400 | $9.50 | cy | $3,800 |
| Retaining Walls, N side Umstead | 225 | $45.00 | sff | $10,125 |
| Add roadway design fee | 1 | $30,000.00 | ls | $30,000 |
| New roadway | 1333 | $50.00 | sy | $66,650 |
| Extension of Culvert at Pritchard | 1 | $30,000.00 | ls | $30,000 |
| Ped Bridge with abutments | 1 | $250,000.00 | ea | $250,000 |
| 4" Concrete Trail | 167 | $70.00 | sy | $11,690 |
| 4" Concrete Trail w/ turned edge | 200 | $175.00 | lf | $35,000 |
| **Storm Drainage** | | | | |
| Storm Drainage -RCP Pipe | 100 | $40.00 | lf | $4,000 |
| **Erosion Control** | | | | |
| Allow | 1 | $2,000.00 | ls | $2,000 |
| **Planting** | | | | |
| Allow | 1 | $2,000.00 | ls | $2,000 |
| | **SITE CONSTRUCTION TOTAL** | | | $450,265 |
| | **DEMOLITION** | | | $6,360 |
| | | Subtotal | | $456,625 |
| Contractor Overhead and Profit | | $456,625 | 0.1 | $45,662.50 |
| Contractor Mobilization and bonds | | $502,287.50 | 0.04 | $20,092 |
| 15% Contingency | | $522,379.00 | 0.15 | $78,357 |
| **Total Option 3A** | | | | **$600,736** |

$50.06 per SF

### Option 3B: Viaduct construction, limited road work

| | | | | |
|---|---|---|---|---|
| Delete Retaining Walls, N side rd | 1 | ($10,125.00) | ea | ($10,125.00) |
| Delete roadway work | 1 | ($66,650.00) | ea | ($66,650.00) |
| Add tree clearing, N side creek | 1 | $20,000.00 | ls | $20,000.00 |
| Add differential cost for viaduct | 200 | $45.00 | lf | $9,000.00 |
| Net cost increase/(reduction) | | | | ($47,775.00) |
| **Total Cost with Option 3B** | | | | **$552,960.85** |

**Note**: Roadway redesign fees would be incurred under Option 3A. However, Increased impacts to creekside trees under 3B, and potential enhanced safety associated with road realignment, recommend 3A as the preferred option-see report text.

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

**SEGMENT 3 (CONTINUED): PRITCHARD AVENUE TO UMSTEAD PARK**

**Option 3C: Route trail through existing culvert along south side of creek.*** As shown in Sketch 3C.

| | | | | |
|---|---|---|---|---|
| Relocate Water Line | 1 | $25,000.00 | ea | $25,000.00 |
| Acquire additional easement [1] | 1 | $110,200.00 | ea | $110,200.00 |
| Add 4" Concrete trail (instead of turned edge trail) | 250 | $70.00 | sy | $17,500.00 |
| Delete one trail bridge across creek | | | | ($250,000.00) |
| Delete Retaining walls N side Umstead | | | | ($10,125.00) |
| Delete roadway design fee | | | | ($30,000.00) |
| Delete new roadway | | | | ($66,650.00) |
| Delete 4" Conc trail w/turned edge | | | | ($29,000.00) |
| Net cost increase/(reduction) | | | | ($233,075.00) |
| Cost Option 3A (from above) | | | | $600,735.85 |
| **Total Cost with Option 3C** | | | | **$367,660.85** |

Note: 1. Cost shown assumes fee simple acquisition of 40' wide corridor measured from centerline of creek at a cost of $300,000 per acre. Accurate cost and feasibility of such a transaction is conjectural at this time. Legal and transaction fees should also be anticipated.

*** Recommended Option, included in Summary Sheet at end of estimate.**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SEGMENT 4: UMSTEAD PARK

### Option 4A: Enter park south of Bolin Creek*

**DEMOLITION**

| Item | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site** | | | | |
| Clearing and Demolition | 28000 | 0.25 | sf | $7,000 |
| Removal of 2 bridges | 1 | 6000 | ls | $6,000 |
| | | | Sub-Total | $13,000 |
| | | ADD 6% FOR DUMPING FEES | | $780 |
| | | TOTAL FOR DEMOLITION | | $13,780 |

**GENERAL CONSTRUCTION**

**Site work**

| Material | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| Surveying | 1 | $5,000.00 | ls | $5,000 |
| Grading | 520 | $9.50 | cy | $4,940 |
| 4" Concrete Trail | 1555 | $70.00 | sy | $108,850 |
| Ped Bridge with abutments | 1 | $250,000.00 | ea | $250,000 |
| Modular Block Retaining Wall | 0 | $45.00 | ff | $0 |
| **Erosion Control** | | | | |
| Allow | 1 | $3,000.00 | ls | $3,000 |
| **Planting** | | | | |
| Allow | 1 | $5,000.00 | ls | $5,000 |
| | **SITE CONSTRUCTION TOTAL** | | | $376,790 |
| | **DEMOLITION** | | | $13,780 |
| | | Subtotal | | $390,570 |
| Contractor Overhead and Profit | | $390,570 | 0.1 | $39,057.00 |
| Contractor Mobilization and bonds | | $429,627.00 | 0.04 | $17,185 |
| 15% Contingency | | $446,812.08 | 0.15 | $67,022 |
| **Total Option 2A** | | | | **$513,834** |

$18.35 per SF

### Option 4B: Enter park north of Bolin Creek

| | | | | |
|---|---|---|---|---|
| Add roadway design fee | 1 | $60,000.00 | ls | $60,000.00 |
| Add traffic control | 1 | $10,000.00 | ls | $10,000.00 |
| Add roadway demo | 10500 | $0.50 | sf | $5,250.00 |
| Add sitework for roadway | 1000 | $9.50 | cy | $9,500.00 |
| Add new roadway | 1170 | $30.00 | sy | $35,100.00 |
| Net cost increase/(reduction) | | | | $119,850.00 |
| **Total Cost with Option 4B** | | | | **$633,683.89** |

*** Recommended Option, included in Summary Sheet at end of estimate.**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SEGMENT 5: UMSTEAD PARK TO VILLAGE DRIVE

### Option 5A: Trail follows widened sidewalk across Village Drive*

**DEMOLITION**

| Item | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site** | | | | |
| Clearing and Demolition | 10000 | 0.25 | sf | $2,500 |
| | | | Sub-Total | $2,500 |
| | | ADD 6% FOR DUMPING FEES | | $150 |
| | | TOTAL FOR DEMOLITION | | $2,650 |

**GENERAL CONSTRUCTION**

**Site work**

| Material | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| Surveying | 1 | $4,000.00 | ls | $4,000 |
| Grading | 300 | $9.50 | cy | $2,850 |
| 4" Concrete Trail | 480 | $70.00 | sy | $33,600 |
| **Erosion Control** | | | | |
| Allow | 1 | $3,000.00 | ls | $3,000 |
| **Planting** | | | | |
| Allow | 1 | $2,500.00 | ls | $2,500 |
| | **SITE CONSTRUCTION TOTAL** | | | $45,950 |
| | **DEMOLITION** | | | $2,650 |
| | Subtotal | | | $48,600 |
| Contractor Overhead and Profit | | $48,600 | 0.1 | $4,860.00 |
| Contractor Mobilization and bonds | | $53,460.00 | 0.04 | $2,138 |
| 15% Contingency | | $55,598.40 | 0.15 | $8,340 |
| **Total Option 5A** | | | | **$63,938** |

$6.39 per SF

### Option 5B: Route trail through Town-owned land and beneath Village Drive

**DEMOLITION**

| Item | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site** | | | | |
| Clearing and Demolition | 22000 | 0.5 | sf | $11,000 |
| | | | Sub-Total | $11,000 |
| | | ADD 6% FOR DUMPING FEES | | $660 |
| | | TOTAL FOR DEMOLITION | | $11,660 |

**GENERAL CONSTRUCTION**

**Site work**

| Material | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| Surveying | 1 | $12,000.00 | ls | $12,000 |
| Grading | 1200 | $9.50 | cy | $11,400 |
| 4" Concrete Trail | 1222 | $70.00 | sy | $85,540 |
| Ped Bridge with abutments | 2 | $250,000.00 | ea | $500,000 |
| Culvert beneath Village Dr. | 1 | $300,000.00 | ea | $300,000 |

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

**Option 5B, continued**

| | | | | | |
|---|---|---|---|---|---|
| **Erosion Control** | | | | | |
| Allow | 1 | $6,000.00 | ls | $6,000 | |
| **Planting** | | | | | |
| Allow | 1 | $2,500.00 | ls | $2,500 | |
| | | **SITE CONSTRUCTION TOTAL** | | $917,440 | |
| | | **DEMOLITION** | | $11,660 | |
| | | Subtotal | | $929,100 | |
| Contractor Overhead and Profit | | $929,100 | 0.1 | $92,910.00 | |
| Contractor Mobilization and bonds | | $1,022,010.00 | 0.04 | $40,880 | |
| 15% Contingency | | $1,062,890.40 | 0.15 | $159,434 | |
| **Total Option 5B** | | | | **$1,222,324** | $55.56 per SF |

Note: A higher unit cost for Option 5B demolition reflects higher site condition constraints in that Option.

*** Recommended Option, included in Summary Sheet at end of estimate.**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SEGMENT 6: VILLAGE DRIVE TO SEAWELL SCHOOL ROAD

### Option 6A: Trail follows OWASA Corridor*

**DEMOLITION**

| Item | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site** | | | | |
| Clearing and Demolition | 116000 | 0.25 | sf | $29,000 |
| | | | Sub-Total | $29,000 |
| | | ADD 6% FOR DUMPING FEES | | $1,740 |
| | | TOTAL FOR DEMOLITION | | $30,740 |

**GENERAL CONSTRUCTION**

| Material | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site work** | | | | |
| Surveying | 1 | $15,000.00 | ls | $15,000 |
| Grading | 2400 | $9.50 | cy | $22,800 |
| 4" Concrete Trail | 6520 | $70.00 | sy | $456,400 |
| Estes Drive underpass | 1 | $445,000.00 | ls | $445,000 |
| 50' Ped Bridge with abutments | 2 | $250,000.00 | ea | $500,000 |
| **Erosion Control** | | | | |
| Allow | 1 | $5,000.00 | ls | $5,000 |
| **Planting** | | | | |
| Allow | 1 | $5,000.00 | ls | $5,000 |
| | **SITE CONSTRUCTION TOTAL** | | | $1,449,200 |
| | **DEMOLITION** | | | $30,740 |
| | Subtotal | | | $1,479,940 |
| Contractor Overhead and Profit | $1,479,940 | | 0.1 | $147,994.00 |
| Contractor Mobilization and bonds | $1,627,934.00 | | 0.04 | $65,117 |
| 15% Contingency | $1,693,051.36 | | 0.15 | $253,958 |
| **Total Option 6A** | | | | **$1,947,009** |

$16.78 per SF

### Option 6B: Widened sidewalk option

Note: This option would delete the cost of the Estes underpass, and add some net cost by routing the trail along Umstead and Estes instead of the OWASA easement. Since this work is farther in the future than Segments 1-4, only the preferred option cost is provided here.

*** Recommended Option, included in Summary Sheet at end of estimate.**

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SEGMENT 7: TANYARD BRANCH

**DEMOLITION**

| Item | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| **Site** | | | | |
| Clearing and Demolition | 38000 | 0.25 | sf | $9,500 |
| | | | Sub-Total | $9,500 |
| | | ADD 6% FOR DUMPING FEES | | $570 |
| | | TOTAL FOR DEMOLITION | | $10,070 |

**GENERAL CONSTRUCTION**

**Site work**

| Material | Qty. | Cost/ | unit | Subtotal |
|---|---|---|---|---|
| Surveying | 1 | $5,000.00 | ls | $5,000 |
| Grading | 700 | $9.50 | cy | $6,650 |
| 4" Concrete Trail | 2100 | $70.00 | sy | $147,000 |
| Modular Block Retaining Wall | 200 | $45.00 | ff | $9,000 |
| **Erosion Control** | | | | |
| Allow | 1 | $2,000.00 | ls | $2,000 |
| **Planting** | | | | |
| Allow | 1 | $3,000.00 | ls | $3,000 |
| | **SITE CONSTRUCTION TOTAL** | | | $172,650 |
| | **DEMOLITION** | | | $10,070 |
| | | Subtotal | | $182,720 |
| Contractor Overhead and Profit | | $182,720 | 0.1 | $18,272.00 |
| Contractor Mobilization and bonds | | $200,992.00 | 0.04 | $8,040 |
| 15% Contingency | | $209,031.68 | 0.15 | $31,355 |
| **Total Segment 7** | | | | **$240,386** |

$6.33 per SF

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

## SUMMARY OF COSTS BY SEGMENT

| Item | | |
|---|---|---|
| **Segment 1. Stream-level crossing of MLK Blvd and use of existing culvert at Umstead Drive** | | |
| | 2006 Cost | **$403,786** |
| | 2007 Cost Escalation | $436,089 |
| | 2008 Cost Escalation | $470,976 |
| | 2009 Cost Escalation | $508,654 |
| | 2010 Cost Escalation | $549,346 |
| **Segment 2. Alignment on South side of creek** | | |
| | 2006 Cost | **$513,117** |
| | 2007 Cost Escalation | $554,166 |
| | 2008 Cost Escalation | $598,500 |
| | 2009 Cost Escalation | $646,380 |
| | 2010 Cost Escalation | $698,090 |
| **Segment 3. Use existing culvert at Pritchard and acquire additional easement between Pritchard and Umstead Park** | | |
| | 2006 Cost | **$367,661** |
| | 2007 Cost Escalation | $397,074 |
| | 2008 Cost Escalation | $428,840 |
| | 2009 Cost Escalation | $463,147 |
| | 2010 Cost Escalation | $500,199 |
| **Segment 4. Enter Umstead park south of Bolin Creek** | | |
| | 2006 Cost | **$513,834** |
| | 2007 Cost Escalation | $554,941 |
| | 2008 Cost Escalation | $599,336 |
| | 2009 Cost Escalation | $647,283 |
| | 2010 Cost Escalation | $699,065 |
| **Segment 5. Trail follows widened sidewalk to Village Drive** | | |
| | 2006 Cost | **$63,938** |
| | 2007 Cost Escalation | $69,053 |
| | 2008 Cost Escalation | $74,577 |
| | 2009 Cost Escalation | $80,544 |
| | 2010 Cost Escalation | $86,987 |

**NOTE:** Costs shown are preliminary, order-of-magnitude estimates intended for planning purposes only.

**SUMMARY OF COSTS, CONTINUED**

**Segment 6. Village Drive to Seawell School Road**

| | |
|---|---|
| 2006 Cost | **$1,947,009** |
| 2007 Cost Escalation | $2,102,770 |
| 2008 Cost Escalation | $2,270,991 |
| 2009 Cost Escalation | $2,452,671 |
| 2010 Cost Escalation | $2,648,884 |

**Segment 7. Tanyard Branch trail**

| | |
|---|---|
| 2006 Cost | **$240,386** |
| 2007 Cost Escalation | $259,617 |
| 2008 Cost Escalation | $280,387 |
| 2009 Cost Escalation | $302,818 |
| 2010 Cost Escalation | $327,043 |

**GRAND TOTAL ALL SEGMENTS**

| | |
|---|---|
| 2006 Cost | **$4,049,731** |
| 2007 Cost Escalation | $4,373,710 |
| 2008 Cost Escalation | $4,723,606 |
| 2009 Cost Escalation | $5,101,495 |
| 2010 Cost Escalation | $5,509,614 |

Note: Escalation is based on 8% increase per year.

# Alternative Routing Options

## SEGMENT 1 – BOLIN CREEK TRAIL TO UMSTEAD DRIVE

NCDOT generally discourages midblock pedestrian crossings and would be unlikely to approve either a striped crosswalk or a new pedestrian actuated signal at Martin Luther King Jr. Boulevard. Furthermore, most greenway users would be unlikely to travel almost 300 feet out of their way to use a signalized crossing at the Umstead/Hillsborough Intersection. An elevated crossing or overpass would also be unlikely to be used - particularly by those on bicycles – and would require unsightly switchback ramps or costly mechanical lifts on both sides of the road. In our opinion, these options do not merit further discussion in the Concept Plan. However, the following alternative to the Martin Luther King Jr. Boulevard culvert crossing was considered.

**Option 1B: Construct new underpass north of existing greenway.**

This alternative would connect to the existing greenway west of the existing bridge, providing a northern spur that would cross beneath Martin Luther King Jr. Boulevard in a separate culvert. The greenway would emerge on the west side of the road, following the existing utility easement to approach Umstead Drive.

Benefits associated with this option include:

- A new tunnel would completely avoid impacts to the stream channel and floodway, and would substantially reduce the amount of clearing and grading required on steep riparian slopes.

Specific issues or concerns associated with this option include:

- A tunnel would likely not be more than ten feet in clear width or height, but would approach 100 feet in length. Even with interior lighting and emergency call boxes, poor visibility at tunnel entrances and exits, and lack of natural daylight inside the tunnel could be perceived as a safety concern from a security standpoint.
- Open, or “cut and cover” tunnel construction would impact traffic on Martin Luther King Jr. Drive and would almost certainly affect major trunk utility lines, including natural gas, sanitary sewer, and water. The lack of convenient detours available to handle traffic volumes would necessitate partial roadway closures and late night construction.
- Bored or jacked tunnel construction could minimize roadway and utility impacts, but would likely be extremely expensive.

## SEGMENT 2 – UMSTEAD DRIVE CROSSING TO PRITCHARD AVENUE

**Option 2B: Align trail on north side of Bolin Creek.**

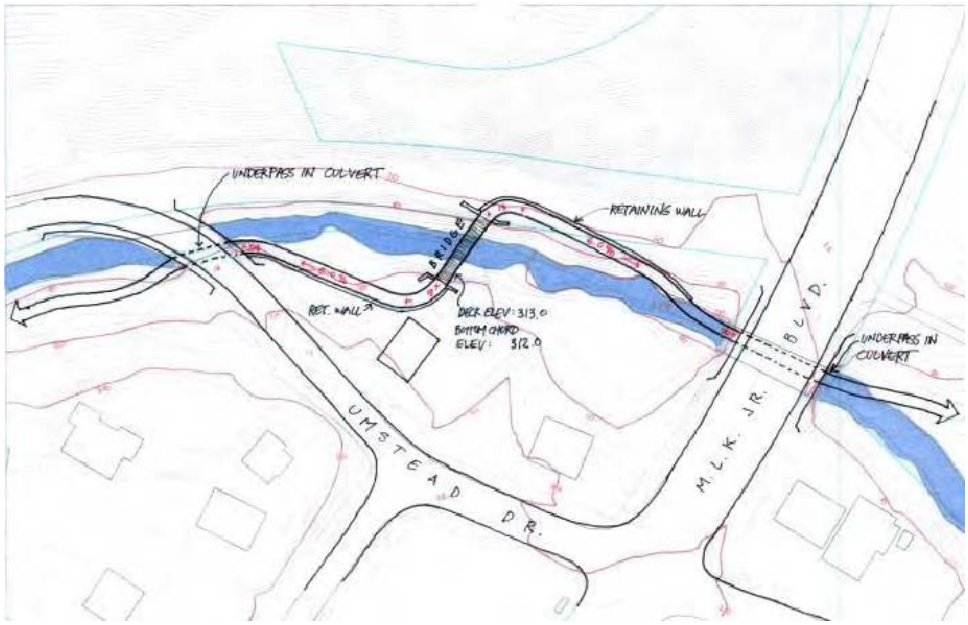
This alternative would parallel Umstead Drive along the north side of Bolin Creek as an enlargement of the existing sidewalk. This option might require that Umstead Drive be moved to the north by about 5-10 feet if a cantilevered trail in this segment proves to be not permittable under FEMA regulations.

Benefits associated with this option include:

- Elevational separation from the flood plain would make the trail less susceptible to flooding, reducing maintenance concerns.
- There would be no disturbance at all on the south bank of the stream.
- Because all of the required land is already in right-of-way or Town ownership no easements would be required.

Specific issues or concerns associated with this option include:

- Minimal separation from adjacent vehicular traffic could be unsafe or unpleasant for trail users.
- Extensive clearing of north creek bank would be required in order to provide adequate trail width, including removal of large numbers of mature shade trees.
- Stream impacts requiring extensive modeling and permitting would most likely be required.
- A cantilevered sidewalk or viaduct type construction on piers would likely be prohibitively expensive.
- The realignment of about 1,700 lineal feet of Umstead Drive would likely be prohibitively expensive.
- Shifting Umstead Drive further north to create space for a ten-foot wide trail for 1,700 lineal feet would affect property owners on the north side of the road, and would require extensive relocation of private driveways, overhead utilities, rock removal, and substantial storm drainage improvements.




**Option 2B**

## SEGMENT 3 - PRITCHARD AVENUE CROSSING TO UMSTEAD PARK

To cross Pritchard Avenue from the south bank of Bolin Creek, the trail must either go up to the level of the road, cross the creek on an extension of the existing culvert, and cross Pritchard Avenue at grade, or pass directly beneath Pritchard in the existing culvert or new tunnel. In order to meet a primary project goal of avoiding grade crossings of roads, the underpass option is the recommended option.

In the alternative option, the existing sidewalk north of the creek must be widened by about seven feet to accommodate the trail. This sidewalk widening would compel either viaduct construction of the trail from the existing curb southward, or realignment of the roadway to move the new trail and road cross-section farther away from the creek. A discussion of this alternative follows.

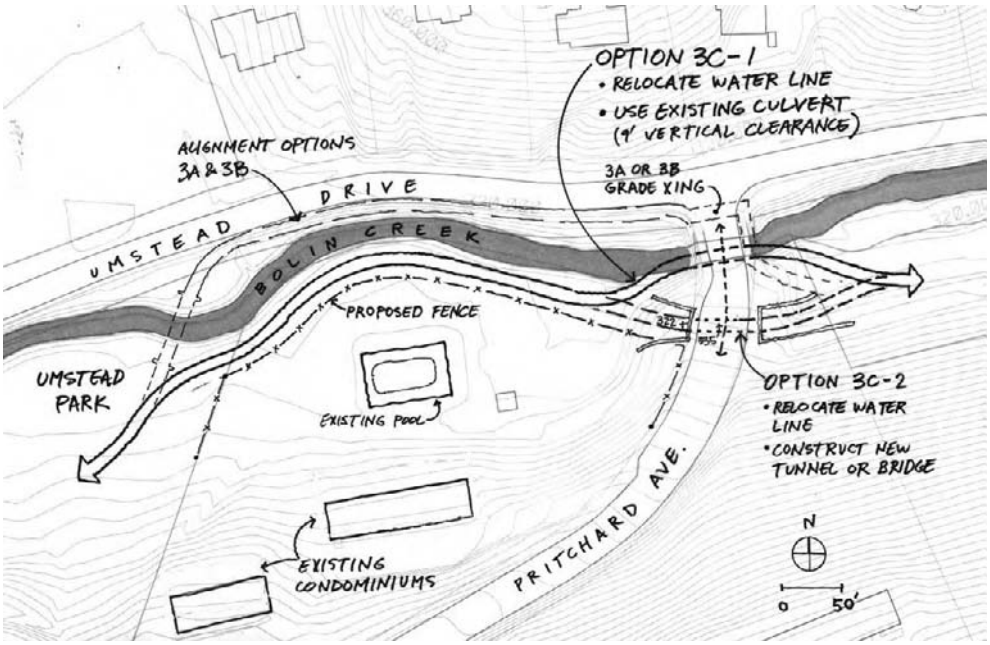
**Option 3A: Realign Umstead Drive**: OWASA will be demolishing much of this part of Umstead Drive in the process of replacing the sanitary sewer system. If the road, which is owned by the Town of Chapel Hill, can be moved seven to 10 feet to the north in this stretch, it would allow the trail to be sited away from the banks of the creek (see Figure below)

Benefits associated with this option include:

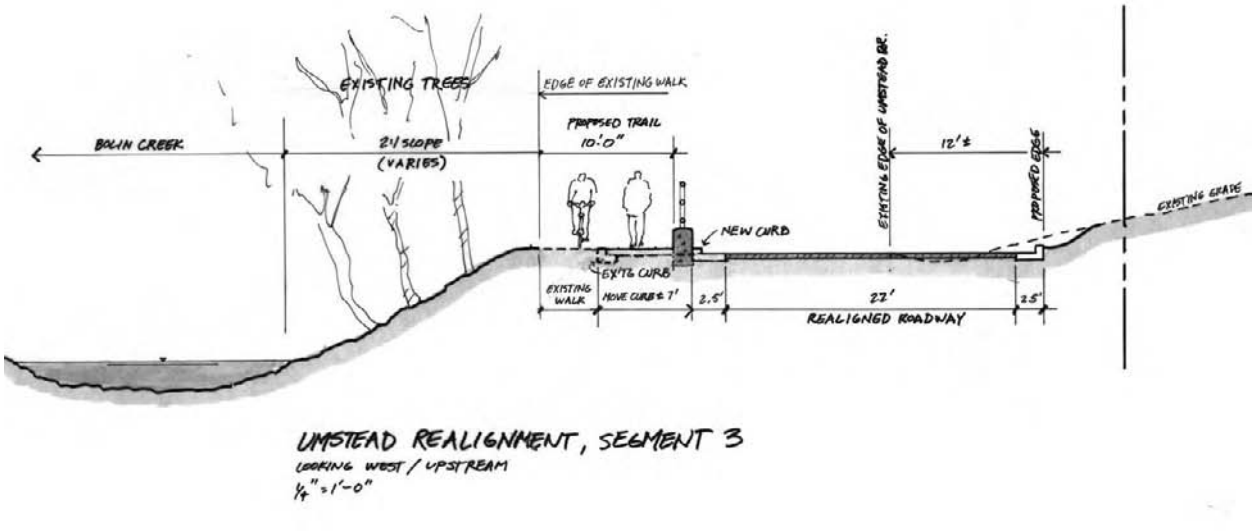
- Fewer impacts to the creek.
- Less of an impact on flood levels and models.
- Less expensive construction using a turned-down concrete edge rather than a viaduct.
- Safer roadway design with improved car/pedestrian separation and sight distances.

Specific issues or concerns associated with this option include:

- This option would require a new roadway design for about 400 feet (200 feet of relocated roadway plus 100 feet transition on each side).
- Some retaining wall construction may be required on the north side of Umstead Drive to meet grade.
- It is not presently known how much right of way is available on the north side for such realignment (though City data indicate up to 15 feet may be available).
- This option may impact utilities whose locations are not yet known.
- Some landowners would be affected because the road would be moved closer to their homes. Some driveways might be affected.




**Options 3A, 3B, and 3C**




**Option 3B**

**Option 3B: Construct viaduct along Umstead Drive to achieve required width.**

For a length of about 150 feet, the existing sidewalk is close enough to an already steepened creek bank to require viaduct construction to accommodate a trail and barrier width of 10-12 feet.

Benefits associated with this option include:

- No realignment of Umstead Drive in this stretch would be required.

Specific issues or concerns associated with this option include:

- Viaduct construction would be relatively expensive and disruptive of some trees on the creek banks,
- This option would have to be studied with flood models, since the piers would be constructed within the floodway. Floodway issues may eliminate this as an option.

**SEGMENT 4 – UMSTEAD PARK**

**Option 4B: Enter Umstead Park North of Bolin Creek.**

This route would follow the south side of Umstead Drive on a widened sidewalk, entering the park at the existing parking area, where a trailhead could be developed. This option would involve relocating approximately 350 lineal feet of Umstead Drive. A new pedestrian bridge would connect across Bolin Creek to the improved Tanyard Branch Greenway.

Benefits associated with this option include:

- The route would avoid an extra stream crossing, and the permitting and clearing associated with it.
- The route would enter the park immediately adjacent to the existing parking facility, creating opportunities for trailhead development.
- The required relocation of Umstead Drive would be present an opportunity to partially flatten a dangerous curve in the road thus improving safety.
- Fewer large trees would be affected.

Specific issues or concerns associated with this option include:

- Because insufficient room exists to construct a 10’ wide trail on the north creek bank, either a partial re-alignment of Umstead Drive or an expensive cantilevered construction would be required.
- Re-aligning Umstead Drive to make room for the trail and to improve the existing roadway geometry would reduce the size of the youth ballfield in Umstead Park; however, that field is no longer used by the Town for programs.

**SEGMENT 5 – UMSTEAD PARK TO VILLAGE DRIVE**
**Option 5B: Route trail through Town-owned land and beneath Village Drive.**

This option, compared to Option 5A, would require two more bridge crossings, a culvert beneath Village Drive, traversing of steep slopes, and extensive clearing of existing trees. Because of these additional cost and environmental impacts, and because the amount of traffic on Village drive is small, this option is not currently recommended.

**SEGMENT 6 –VILLAGE DRIVE TO ESTES DRIVE EXTENSION**

**Option 6B: Continue along Umstead Drive and Estes Drive as a widened sidewalk**.

Although the less expensive option to construct and maintain, a roadside trail would be much less attractive and potentially less safe than one utilizing a separate corridor. Particularly along Estes Drive, proximity to vehicular traffic would be a major concern. Grades along Umstead Drive are steeper than desired. Steep side slopes along Estes Drive could also pose a significant expense to trail construction. Given that the construction of this segment of the greenway facility is most likely a long-term proposition, there may be a potential to incorporate bicycle facilities into the eventual widening of Estes Drive, a project that has been long discussed by NCDOT, but is presently not funded or designed. An at-grade crossing of Estes Drive, immediately east of the railroad tracks would navigate a steep slope down to the level of Bolin Creek. The obvious safety concerns include proximity to an active railroad, and high traffic volumes and speeds along Estes Drive.

This option presents the better opportunity for short-term connectivity to the Town of Carrboro. Both Carrboro and Chapel Hill have current plans to construct sidewalks along the south side of Estes, meeting at the corporate limits. An existing OWASA easement along the south edge of the 27.3-acre publicly owned Adams tract presents an additional opportunity for a future connection to that parcel and to Wilson Park further to the west.