SECTION 9000 Greenway Construction

9001 Greenway Design Plans

Greenway designs shall be on a separate plan and profile sheet. Plan view grading shall be at a maximum scale of 1"=30' with 1' contours shown. The length of each trail section with a running slope in excess of 5% shall be indicated, and the overall percentage of the designed trail that exceeds 8.33% shall be indicated. All trail amenities, fences, storm drainage, proximate utilities, details, notes and any other requirements shall be shown on these plans.

Record drawings will be required prior to acceptance of routine maintenance/warranty of the greenway by Cary. See Section 10000. Easements not providing a minimum 5' shoulder on trail or not including swales or appurtenances shall be corrected via recorded plat.

All required certifications, geotechnical reports etc. and approvals for any variances from approved plan, shall be submitted to Cary staff prior to Cary's acceptance of routine maintenance/warranty of the greenway by Cary.

All easements, encroachments, and/or permits required for on-site and off-site facilities, must be obtained by applicant prior to beginning work.

The following notes shall be included on all greenway design plans:

Typical Greenway Construction Plan Notes

1. Trail shall be constructed per plans and according to all other pertinent details and specifications.
2. Contractor shall confine construction activity within limits of construction.
3. Contractor shall retain a North Carolina Professional Land Surveyor to stake centerline of the trail as shown on the Layout Plan. The trail is to be staked at 50' intervals in the field.
4. Staked centerline of the trail is to be approved by a Cary Project Manager for Cary capital projects.
5. Erect tree protection fence along limit of construction for inspection by Cary site inspector.
6. Install required erosion control measure prior to construction.
7. Contractor to call for utility locations prior to construction.
8. All trails, 10' or narrower shall maintain a 3' wide grassed shoulder with a 2% cross slope unless otherwise noted on plans. Trails wider than 10' shall maintain 2' wide grassed shoulders at 2% cross slope. Trails that do not incorporate the specified grassed shoulders capable of being maintained with a standard lawn mower will not be accepted by Cary.

9. Proposed pavement shall meet existing pavement flush.
10. Trail to exhibit 2% cross slope towards creek or low area, except on longitudinal slopes that exceed 5% where cross slope shall be to inside of downhill curve.
11. Side slope shall be 3:1 maximum and 2% minimum slope except where otherwise noted. Fill slopes steeper than 3:1 shall be engineered. Split rail fencing or safety railing (as per plans or standard specifications), shall be located minimum 2' off trail edge in areas that side slopes exceed a 3 to 1 slope.
12. All disturbed areas shall be seeded per specification.
13. Grade side slopes and adjacent ground to drain. Ensure that there is no standing water on the uphill side of the trail. Install diversion ditch as needed to direct water to culverts.
14. Additional culverts will be added as needed during construction to prevent erosion and slick spots on greenway trail.
15. Drainage culverts shall be concrete and have a flared end section or concrete headwall on both ends. A class B rip-rap dissipater with filter fabric shall be installed at the pipe out-flow.
16. Trees shall be limbed up a vertical distance of 10 feet from the forest floor, within 5 feet from the outside edge of the trail. Remove dangerous tree limbs hanging over trail as directed by the landscape architect or other Cary staff. Dead trees that present a danger to pedestrians utilizing the trail shall be removed during construction.
17. Cary Field Technician shall inspect proof roll of Cary-maintained greenway trails prior to placement of fabric and 6'' of crushed stone. The trail shall also be proof rolled prior to paving. A minimum of 100% compaction is required. All private greenway trails shall be proof rolled by a geo-technician with geo-tech reports turned into Zoning Compliance Officers and Facilities Planning staff.
18. All trails that intersect with a curbed road shall have a Cary Greenway Driveway Apron (Detail 9200.02) or Greenway Curb Ramp (9200.01), as specified on plans. Ramp widths shall be same width as trail, and include a level landing at top of ramp in accordance with standard detail. If intersecting a road with no curb and gutter, a raised dome strip shall be installed in accordance with Cary detail. The centerline of all curb ramps perpendicular to roadway shall align with centerline of trail.
19. Dual curb ramps shall be installed wherever greenways come to a roadway intersection, in accordance with Cary Greenway Curb Ramp detail 9200.01.
20. All trails that intersect with roads or parking lots shall be secured with bollards if and when specified by the plans or Transportation and Facilities staff.
21. The first 50 feet of all trails that intersect with a road which will utilize a mid-block crossing shall incorporate 50' of stamped concrete starting at the edge of the driveway apron, or immediately behind a crossing sidewalk.

22. The edges of paved trails shall be a minimum of 4’ from the edge of raised manholes.
23. No greenway trails or easements shall be co-located within any BMP’s or stormwater control devices or stormwater control structure access easements, except private trails as approved by Cary Stormwater staff.
24. No shrub or tree plantings, or private fences are allowed within the greenway easement.
25. The developer’s contractor shall ensure that all access points leading to the trail are posted with signs that read Trail Closed For Construction. Barriers shall be installed at the ends of any incomplete greenway segments that have a longitudinal slope greater than 3:1, or other hazardous conditions.
26. Private and Public Greenways shall be constructed and approved as part of the infrastructure for the phase. Greenway easements to be dedicated with the first plats submitted for the phase.
27. All required certifications, geotechnical reports etc. shall be submitted to Cary prior to Cary’s acceptance of routine maintenance/warranty on greenway.
28. Record drawings will be required prior to acceptance of routine maintenance/warranty of the greenway by Cary. See Section 10000. Easements not providing a minimum 5’ shoulder on trail or not including swales or appurtenances shall be corrected via recorded plat.
29. Asphalt technicians on site receiving asphalt tickets, running densities or asphalt compaction, shall verify asphalt depth and provide certification in writing to Cary Field Technician. Asphalt technicians shall be NCDOT Asphalt Quality Management System (QMS) Roadway certified.
30. All greenway bridges and boardwalks will require Cary building permits.
31. All trail intersections with roadways, sidewalks or other trails shall include a minimum 5’ radius on both sides of intersections.
32. One trash receptacle and one bench with concrete slab per Details 9300.01, 9300.02, & 9300.03 shall be field located by **Facilities Planner** after trail has been paved, with installation prior to trail acceptance by Cary.
33. No utility surface covers/plates (e.g. waterline valve covers, blowoffs, manholes, utility handholds, etc.) shall be located within trails and shall be minimum 3’ off trail edge.
34. Trails along roadways shall meander but shall be minimum 5’ off back of curb.
35. Developer/applicant shall obtain County and NCDOT Rail Division approval for trail connections and alterations within the American Tobacco Trail corridor; if any changes are requested by County or NCDOT, these changes must be reviewed and approved by Cary also.

9002 Greenway Trails

Trail standards were developed to clearly establish minimum trail requirements and to establish criteria for matching trail types to corridors based on anticipated use, and to account for bicycle travel up to 15 mph which is the current speed limit on Cary Greenways. Trails, public and private, shall be constructed to the following specifications.

Consideration shall be given to emergency vehicle access to the greenways, including appropriately located driveway aprons and an appropriate vehicle carrying capacity for all structures.

Consideration shall also be given to construction and maintenance access points for public trails. On a case-by-case basis, some connections to neighborhoods, as required per the Land Development Ordinance, shall be made publicly owned and maintained 8' wide trails within 20' wide Cary Greenway Easements in order to meet this need. Easements shall be located within common open space.

Trail construction shall adhere to the most current version of AASHTO Bicycle and Shared Use Path standards, and applicable Americans with Disabilities Act requirements, for design items not specifically referenced in this document or where the most current version of AASHTO or applicable Americans with Disabilities Act requirements contains more restrictive design standards.

Greenways are intended to work cohesively with on-road bicycle and pedestrian facilities for seamless alternate transportation options. Curb ramps, driveway aprons and/or bike access ramps shall be used where appropriate to facilitate connections between these systems.

Greenway Trails – 12', 10', or 8' Paved Trail

(See Details 9100.01, 9100.02, 9100.03, 9100.06)

Cary Greenways are 10'-12' wide and are intended to accommodate multiple user types including pedestrians, bicyclists, and rollerbladers among others. Privately owned greenways are typically 8' wide and also accommodate multiple user types. The following specifications apply to all paved greenways. Street-Side Trails are addressed separately below.

- 12', 10', or 8', wide paved trail, with minimum grassed shoulders (2' shoulders for 12' trails; 3' shoulders for 10' and 8' trails) on both sides of the trail
- 1% Minimum and 2% maximum cross slope with slope to low or creek side, except cross slopes shall be to the inside of downhill curves that exceed a 5% running slope

- 2-inch minimum asphalt surface course, Type S9.5B in accordance with the Division 6 of the most current version of the NCDOT Standard Specifications
- 6-inch minimum Aggregate Base Course in accordance with Section 520 of the most current version of the NCDOT Standard Specifications
- Geotextile Fabric below ABC. The engineering fabric shall be a woven fabric, specified for use on roadway subgrade, having the following properties:

	Typical	Test
Tensile Strength, lbs.	200	ASTM D4632-86
Elongation at Break, %	15	ASTM D4632
Puncture, Strength, lbs.	100	ASTM D0751
Mullen Burst, psi	400	ASTM D0751/3786
Trapezoid Tear, lbs.	75	ASTM D4533

- Beyond the grassed shoulders, side slopes shall be maximum 3:1.
- Longitudinal slopes on all constructed trails should meet the following requirements; trails should be designed 0.5% below the maximum slopes where possible, in order to allow room for any necessary field adjustments:
    - Maximum Longitudinal slope of 5% except where terrain makes 5% impractical
    - Slopes greater than 5% and up to max 8.33% allowed for a maximum of 200’ before requiring a 10’ long landing with max 2% slope in all directions
    - Slopes greater than 8.33% and up to max 10% for a maximum of 30’ before requiring a 10’ long landing with max 2% slope in all directions
    - Slopes greater than 10% and up to 12% for a maximum of 10’ before requiring a 10’ long landing with max 2% slope in all directions
    - No more than 30% of a greenway may exceed 8.33%
- Longitudinal slopes at approaches to road crossings or path intersections shall be minimized to 5% or less for minimum 10’ prior to trail intersection or back of landings associated with curb ramps
- Longitudinal slopes shall be minimized in curves, and cross slopes shall be to inside of curves where longitudinal slope exceeds 5%
- Trees shall be limbed up a vertical distance of 10 feet from the forest floor, within 5 feet from the outside edge of the trail. Remove dangerous tree limbs hanging over trail. Dead trees within the project limits that present a danger to pedestrians utilizing the trail shall be removed during construction
- The edge of the trail shall be a minimum distance of 5 feet from trees (10’ preferred), and 4’ from raised manholes and other raised utilities
- A grassed swale shall be required along the uphill side of trails directing drainage to culverts. Swales shall not encroach into specified level

shoulders on trail, and shall be minimum 1' deep, and deeper where required per stormwater calculations which are to be included in approved plan sets

- Greenway Easements shall be minimum 20-25' wide including a minimum 5' shoulder on both sides of trail and shall include swales and culverts so that Cary can maintain
- 50 linear feet of stamped concrete as per detail 9200.05 shall be required where public, off-road 8', 10' and 12' greenways intersect with roadways
- NCDOT High-Visibility Crosswalk shall be used wherever a greenway crosses a roadway

Street-Side Trails (See Details 9100.04 & 9100.05)

- Street-side trails are 10'-12' wide asphalt or concrete paths (material to be determined by Cary during development review process) that are located adjacent to roads. Their primary purpose is to provide pedestrian connectivity to Cary's greenway system and to enhance pedestrian and bicycle opportunities along roadways. Street-side trails are often located in densely developed areas where constructing an off-road greenway trail is impractical. These trails will typically replace sidewalks that would be required.
- Street-side trails shall be 10'-12' wide except where determined to be impractical, in which case the Transportation Director may approve an 8' width for the constrained area. Minimum width shall be 8'.
- Street-side trails shall meander and shall have a minimum 5' separation from back of curb except where greater separation may be required by NCDOT. In rare cases where a 5' minimum separation is unobtainable a reduction to no less than 3' may be approved with inclusion of a vehicle-rated guard rail or barrier (as per AASHTO/NCDOT standards) between trail and back of curb in accordance with AASHTO standards. These provisions will be subject to Cary and NCDOT approval on a case-by-case basis.
- Typically, street-side trails will not fit entirely within the road right of way, and a Cary Greenway Easement is required to be dedicated. Greenway Easements for 10' or 12' wide trails shall be minimum 25' wide centered on trail; retrofit and hardship areas can be considered for a minimum 20' wide easement.
- Street-side trails on roadway bridges shall be buffered from adjacent vehicular traffic and maintain minimum clearance between vertical barriers/railings that is equal to trail width plus 2'. Rail/barrier heights shall be meet minimum standards as specified in Cary Standard Detail 3100.10.
- No plantings or private utilities, private signs or monuments or associated easements, irrigation infrastructure or fences will be allowed within greenway easements. Private greenway easements may include private infrastructure in accordance with the approved plan.

- No raised utilities, manholes, valve covers or other surface utilities/plates/covers shall be allowed within the trail, and shall be a minimum 3' off trail edge.
- Street-Side Trails shall be constructed to Cary standards.
- When the street-side trail is to be constructed with asphalt the contractor shall utilize the standard paved trail detail, 9100.04. When the street-side trail is to be constructed with concrete, detail 9100.05 shall be used. Material shall be specified on plans.
- Longitudinal slopes for street-side trails shall not exceed the greater of 5%, or the longitudinal slope of the adjacent roadway in accordance with the most current version of Americans with Disabilities Act standards.
- Longitudinal slopes shall be minimized at approaches to road crossings and path intersections to 5% or less for minimum 10' prior to intersection or to back of landing associated with a curb ramp.
- Longitudinal slopes shall be minimized in curves, and cross slopes shall be to inside of curves where longitudinal slope exceeds 5%.
- NCDOT High-Visibility Crosswalk shall be used wherever a greenway crosses a roadway.

9003 Proof-rolling of Subgrades for Greenways

- Cary Field Technician shall proof-roll the public greenway trail. Private greenway trail shall be proof-rolled by a NC-licensed Geotechnical Engineer and a report submitted to Cary Zoning Compliance Officer for acceptance. Trail proof-rolling shall be performed on the exposed sub-grade soils along the full length of the proposed paved greenway trail after clearing, grubbing, and topsoil removal are complete.
- Proof-rolling shall be performed using a loaded tandem-axle dump truck with minimum 10-ton static weight or equipment approved by geotechnical engineer. Cary Field Technician for public trails, or Geotechnical Engineer for private trails, shall address problems concerning rutting, deflection or "pumping" of the sub-grade soils. Field technician may require a geo-technician in evaluating the need for remedial measures. The Field Technician or Geotechnical Engineer shall determine if the sub-grade soils are suitably firm to allow compaction of the planned ABC layer with the planned geo-textile fabric placement, keeping in mind that the planned use of the trail will include only limited vehicular traffic.
- The aggregate base course surface shall also be proof-rolled prior to asphalt or concrete pavement placement. A minimum of 100% compaction is required.

9004 Curvature

- The minimum radius of curvature for greenway trails will be 50 feet and shall exceed 50 feet wherever there is sufficient room to do so. Exceptions to this standard will be reviewed on a case-by-case basis when constraints are present which would preclude meeting the minimum radius. Private trail curvature will meet these standards to the maximum extent possible and mitigations shall be addressed on the plans where minimum standard cannot be met.
- In accordance with AASHTO standards, wherever trail curve radius is less than 60', a "curves ahead" sign per Details 9700.01 or 9700.02 will be installed.
- When longitudinal slopes approaching curves exceed 5%, a wider radius will be required in accordance with AASHTO standards.
- Curve widening may help mitigate tight curve radii but must be in accordance with current AASHTO standards.

9005 Trail Drainage

- Because of safety concerns and erosion, site drainage should be collected on the uphill side of the trail and piped under the trail.
- A diversion ditch shall be cut on the uphill side of the trail to direct water to the creek or to storm drainage culverts to allow drainage to flow under the trail. The edge of the ditch shall begin outside of the specified level shoulder.
- Drainage culverts shall be reinforced concrete pipes, according to Cary standards, with concrete flared end sections or headwalls on both sides of the pipe. Culverts shall be a minimum Class III reinforced concrete pipe, sized appropriately but a minimum 15" diameter as per Detail 9600.01.
- Minimum coverage on culverts shall be in accordance with Section 8000.
- A class B rip-rap dissipater with filter fabric below shall be installed at the pipe out-flow.
- Yard Inlets and Catch Basins shall be in accordance with Cary Standard Details.
- When culverts are located within the TOC 100' buffer area, properly sized RCP Culverts will be permitted to address natural swale and drainage draws. RCP culverts can also be utilized to pass discharges of less than 1 cfs. If a RCP is used and does not meet these requirements then a level spreader will be required at the point of discharge. In certain circumstances such as non-tree covered areas a grassed swale on the uphill side of the trail will be reviewed as a possible solution.
- BMP outlets/culverts shall be extended under greenways located at toe of slope of BMPs with a yard inlet/catch basin installed on the uphill side of the greenway to pick up swale. Culverts shall be extended such that specified level shoulders and 3:1 side slopes can be maintained on trails (Detail 9600.01).

- When dealing with drainage situations that cannot meet the requirements stated above due to topography or regulatory issues then a series of 8" HDPE pipes per Detail 9600.02 may be considered on a case-by-case basis to achieve diffuse flow within the buffer. Concrete headwalls shall be constructed/installed on both ends of all 8" HDPE pipes.

9006 Safety Railings

- Safety railings a minimum of 48" high with openings no greater than 4", are required along trails with a side slope steeper than 2:1 within 5' of trail edge, along bridges, crossings over large culverts, and on retaining walls within 5' of trail edge with greater than a 1' drop. Plans may call for safety railings in other situations considered potentially hazardous. In high hazard situations a 54 inch height may be required.
- Split rail fencing is required along trails with a side slope greater than 3:1 within 5' of trail edge. Split rail fencing is also required above rip-rap dissipater pads adjacent to the trail.
- Split rail fencing or safety railings may be required where trails are in close proximity to bodies of water, have steep slopes into curves, or other potentially hazardous situations.
- All railings and fences shall be minimum 2 feet off edge of trail.
- Railings and fences shall begin prior to and extend beyond the area of need.

9007 Greenway Entrances and Intersections

- All greenway trails that intersect with a public or private road shall provide access for bicycles, and on public greenways, Cary maintenance vehicle access shall be provided.
- 10' & 12' trails (and in some cases 8' trails) shall provide a Greenway Curb Ramp or concrete Greenway Driveway Apron as indicated on Plans. (See Details 9200.01 and 9200.02)
- All Greenway Curb Ramps shall include ramp widths that match trail width and include raised dome strips that extend the width of the ramp. Dual curb ramps shall be provided wherever greenways cross at roadway intersections. (See Detail 9200.01)
- All ramps and trail connections, as well as trail and sidewalk junctures, should include a minimum 5' radius on both sides for bicycle ingress/egress.
- A raised dome strip shall be installed across full width of trails that tie to roads without curb and gutter. (See Detail 9200.03)
- Greenway trailheads shall be secured with bollards where deemed necessary to prevent unauthorized vehicles from accessing the trail. Bollards shall be set minimum 30' off road edge, or crossing sidewalk edge if present, so that a maintenance vehicle can pull sufficiently out of the flow of traffic before getting out to remove the bollard. Where 50' of stamped

concrete is called for on trails, bollards shall be set just beyond the 50' of stamped concrete. (See Detail 9200.04)

- All trailheads or trail segments shall have one bench and one trash receptacle which shall be located by Cary Facilities Planner or Landscape Architect once the trail has been paved. See descriptions below on benches and trash receptacles.
- All trail entrances, intersections and trailheads (constructed as a Cary capital project) shall utilize the appropriate signs as illustrated within Cary, Comprehensive Sign Plan completed by Lose & Associate, Inc. in 2007.
- Adequate sight distance for trail users at trail entrances and intersections shall be addressed in designs.

9008 Trail Amenities

Benches

- Benches shall be sited on a concrete slab which abuts the asphalt greenway trail. (See Details 9300.01 & 9300.02)
- Benches shall be 6' long, and constructed of recycled plastic, redwood color. (See Detail 9300.01) Benches shall be a DuMor Product #88 Series PL or equivalent

  Carolina Recreational Products, Inc.
  PO Box 29242
  Greensboro, NC 27429
  (336) 288-9083 (800) 542-2887
- Benches shall be sited by Cary staff (as designated in the Greenway Construction Notes) once the trail alignment is cleared and graded but prior to acceptance of trail maintenance/warranty by Cary.

Trash Receptacles

- Trash receptacle support post shall be set in a 12"x24" concrete footer. (See Detail 9300.03)
- Trash receptacles shall have a 32" metal liner.
- Trash receptacles shall be constructed of recycled plastic, redwood color. Trash receptacles shall be a DuMor Product #88 Series #40-32 PL or equivalent

  Carolina Recreational Products, Inc.
  PO Box 29242
  Greensboro, NC 27429
  (336) 288-9083 (800) 542-2887
- Trash receptacles have a dome cover DuMor Product #88 Series #47-30 PL or equivalent
- Trash receptacles shall be located as per plans or field located by Facilities Planner, and shall allow for clear 2' shoulder on trail.

9009 Signage

- Trail regulatory and warning signs shall be located where necessary and according to the approved plans, and outside of the road right of way.
- Signs shall be in accordance with standard details.
- Stop signs (Details 9700.01 and 9700.02) shall be installed wherever a public greenway intersects a roadway (except for Street-Side Trails), and shall be installed for private greenways as indicated on plans.
- Steep slope signs (Details 9700.01 and 9700.02) shall be located at the approach to any greenway with downhill slopes that exceed 5%.
- Curves ahead signs (Details 9700.01 and 9700.02) shall be used for any curves with less than a 60' radius, and for trails with longitudinal slopes greater than 5% slope and radii that do not meet AASHTO standards, and in other situations deemed necessary.
- Coordination with Cary staff is required to determine vehicular signs for all trail crossings of roadways.

9010 Street Crossings

The most important aspect of all road crossings is pedestrian safety.

When greenway trails have to cross a road, it is preferred that the crossing occurs at a signalized intersection with a crosswalk or via a grade-separated crossing. This may require that the trail be extended a longer distance than would typically be required to connect with the intersection crossing.

There are certain circumstances where a pedestrian mid-block crossing cannot be avoided. These situations require additional planning to ensure pedestrian safety. Greenways crossing mid-block shall be approved only on a case-by-case basis, and shall be located in accordance with the Parks, Recreation & Cultural Resources Master Plan, and in accordance with Cary policies and standard procedures. The optimal solution for these locations is a grade-separated crossing that utilizes a bridge or pedestrian underpass. Grade-separated crossings should be carefully considered during the planning of all new roads that will bisect a primary greenway corridor.

Listed below are mid-block trail crossing types that should be utilized based on the speed limit for the road. Final greenway mid-block crossing designs shall be approved by the Transportation Department. For trail type crossing details refer to PRCR Master Plan.

Adequate sight distance for trail users at mid-block and at-grade road crossings shall be addressed in designs.

Midblock Trail Crossing, 2- and 3-Lane Roads

- Warning and stop signs at trail approaches to road
- Change of pavement surface on the approach of the trail crossing
- 10'-12' wide longitudinal crosswalk (High-Visibility Crosswalk per NCDOT standard detail), across road with curb ramps at each end
- Fluorescent yellow-green warning signs along road at approaches to trail crossing

Recommended 35 mph or less / Required over 35 mph

- Alternative pavement surfaces
- Rumble strips (in non-residential areas), speed tables (in residential areas) or pavement markings at approaches
- Pedestrian-activated rectangular rapid flashing beacons (all) or traffic signals (only over 35 mph)

Required if median present and 6+ feet in width

- Planted median in place of center lane; +/- 200 ft. long (each side of trail crossing)
- Trail crossing – striped or imprinted asphalt; flush through median
- Angle crosswalk in median to orient pedestrian toward on-coming traffic

Midblock Trail Crossing, 4- and 5- Lane Roads (45 mph or less)

- Warning and stop signs at trail approaches to road
- 10'-12' wide longitudinal crosswalk, across road with curb ramps at each end
- Fluorescent yellow-green warning signs along road at approaches to trail crossing
- Alternative pavement surface
- Rumble strips (in non-residential areas) or pavement markings at approaches
- Pedestrian-activated rectangular rapid flashing beacons (all) or traffic signals (only over 35 mph)

Required if median present and 6+ feet in width

- Planted median in place of center lane; +/- 200 ft. long (each side of trail crossing)
- Trail crossing – striped or imprinted asphalt; flush through median
- Angle crosswalk in median to orient pedestrian toward on-coming traffic

Grade-Separated Crossings

Grade-separated crossings such as pedestrian tunnels and bridges are required when crossing Controlled Access Facilities such as interstates and highways and are strongly recommended when the crossing involves following conditions:

- A significant greenway corridor with high user volumes
- Crossing of any facility with a design speed higher than 45 miles per hour

- Crossing four lanes or more
- Crossing a road with poor horizontal or vertical site distances

9011 Retaining Walls

Building permits for retaining walls must be obtained in accordance with local permitting authorities.

For all walls over 5' in height, a sealed certification by the same NC-licensed engineer designing the wall, shall be provided to Cary's Field Technician certifying that the wall was constructed in accordance with the sealed design, prior to Cary's acceptance of routine maintenance/warranty for greenway.

- The design of all retaining walls taller than 30" shall be sealed by a licensed North Carolina Professional Engineer.
- All retaining walls shall be installed at the lines, grades and depths as shown on the approved plans.
- The base block size shall be the commercial grade block. Compact, mini-block or garden size blocking is not acceptable. Block retaining walls shall have a cap unit on the top of the wall. The block color shall be light brown.
- The selected retaining wall system shall be joined, pinned and/or secured in accordance with the manufacturer's recommendations.
- Retaining walls which are 30" or taller, located adjacent to a trail shall have a 48" tall metal safety rail on top of the wall, with no opening greater than 4" (see Detail 9400.01). Rails shall be designed and installed with wall.
- Walls over 10' tall shall be poured in place concrete walls, or other type as appropriate for situation, and shall be approved by Cary.
- For retaining walls that require screening with plantings, no plantings shall be located such that they will encroach into the trail or specified level shoulders at plant maturity based on plant maximum anticipated width.
- Trails shall maintain specified level shoulders and max 3:1 side slopes down to tops of adjacent retaining walls.

9012 Greenway Boardwalks

All sealed boardwalk designs shall be included with the approved site/subdivision plan sets.

Cary building permit must be obtained, and approved site plans must be submitted with the building permit application.

All required geotechnical reports, and a sealed certification from boardwalk designer stating that boardwalk structures (including to outside ends of boardwalk approach ramps) were constructed in accordance with sealed

designs shall be submitted to Cary Field Technician prior to Cary's acceptance of routine maintenance/warranty of the greenway by Cary.
(See Details 9500.05, 9500.06, 9500.07, 9500.08, & 9500.10)

- Timber, composite and concrete boardwalks shall be designed in accordance with most current AASHTO Standard Specifications for Highway Bridges. Design Live Load shall be for an AASHTO H10 vehicle / a vehicle of 20,000 pounds. In some cases where paved turnarounds for emergency vehicles or other sufficient means of access for emergency vehicles (as approved by Cary) can be demonstrated, a boardwalk with a 5,000 pound vehicle capacity (2,500 pounds per axial with a minimum 96" wheel base) may be used.
- Metal plaques shall be permanently affixed to both ends of boardwalk indicating maximum weight capacity of structure, as well as inside clear width, manufacturer, and date of manufacture.
- Minimum pile penetration for piers shall be 10' feet or to a depth recommended by a North Carolina licensed Professional Engineer.
- All bolts, nuts, washers and hardware shall be hot dipped galvanized after fabrication, in accordance with ASTM A153.
- Fasteners should be 305 stainless steel, uncoated for sections of structure extending above water.
- Small members shall have pre-drilled holes to prevent splitting during construction. All members shall be bolted or screwed together.
- Treated timber and lumber shall be used and shall be in accordance with the most current NCDOT Standard Specifications for Roads and Structures, Section 1082 and shall be Southern Yellow Pine, Grade 2 or better.
- Composite material should provide a coefficient of friction rating of 0.7-0.8 or greater.
- Composite material should provide a minimum 10-year manufacture warranty
- Maximum slopes in any direction on boardwalks should not exceed 2%.
- Site soil properties are assumed to support foundation loads. Contractor shall provide geotechnical report to Cary Field Technician and building permit authorities, indicating that the soil properties can support the foundation loads, prior to construction.
- Joist hangers shall be capable of supporting a minimum working load of 8,000 pounds, or greater as appropriate for 20,000-pound boardwalks and a minimum working load of 3,150 pounds, or greater as appropriate for 5,000 pound boardwalks, and be galvanized.
- The bottom support beams shall be a minimum of 4' above normal water level and shall be above the 100 year storm elevation.
- All greenway boardwalks shall have minimum clearance between railings, handrails and ledgers that is 2' wider than the trails they serve. In cases where boardwalks are less than 50' in length, clearance matching the trail width may be approved on a case-by-case basis.

- Boardwalk structures shall be located a minimum of 15’ from the center of all existing sewer lines and shall be located outside of sanitary sewer easements over waterways.
- The ends of the boardwalk shall have a 10’ long concrete approach slab 6” thick. (See Detail 9500.05)
- Boardwalk railings shall be extended 15’ beyond the ends of all boardwalks. (See Detail 9500.08 and 9500.05)
- Metal handrails shall be installed on both sides of boardwalks that exceed a 5% running slope (approved only on a case-by-case basis), and handrails shall meet AASHTO and ADA requirements. Minimum inside clearances shall be measured between handrails in these cases.
- Structural Engineer shall size all lumber and composite material spacing appropriately to meet capacity requirements and shall provide a sealed certification to Cary that structure was constructed in accordance with plans and Cary specifications.

9013 Greenway Bridges

All sealed bridge designs shall be included with the approved site/subdivision plan sets.

All required geotechnical reports, and a sealed certification from bridge designer stating that bridge structures (including to outside ends of bridge approach ramps) were constructed in accordance with sealed designs shall be submitted to Cary Field Technician prior to Cary’s acceptance of routine maintenance/warranty of the greenway by Cary.

Cary utilizes two types of greenway bridges. Greenway bridges can either be constructed with a pre-engineered laminated beam construction (Detail 9500.02) or with structural steel with wooden decking and handrails as indicated in the detail (Detail 9500.03).

Typically, the pre-engineered laminated beam bridges have been utilized at locations that have adequate access for a crane to set the bridge on the concrete abutments. Both styles of bridge shall be designed to meet or surpass the design requirements listed below.

All trail overpasses (over roadways and railways) shall meet current AASHTO and ADA standards, including ramp slopes that do not exceed 5% with landings at 400’ intervals, or 8.33% slopes with landings every 30 feet. Handrails must be of uniform height, no less than 34 inches and no more than 38 inches in height from the finish surface of the ramp slope.

All bridges crossing roads owned and maintained by the NC Department of Transportation must receive NCDOT approval prior to beginning any work within the right of way.

Greenways/street-side trails **on** roadway bridges shall be buffered from adjacent vehicular traffic and maintain minimum clearance between vertical barriers/railings that is equal to trail width plus 2'. Rail/barrier heights shall be meet minimum standards as specified in Cary Standard Detail 3100.10.

Bridge Design

- Greenway bridge plans and abutment details shall be signed and sealed by a registered North Carolina Professional Engineer.
- The bridge shall be designed for an evenly distributed load of 85 pounds per square foot as required by AASHTO Standard Specifications for Highway Bridges, 17th Edition (or most current) or a concentrated load of 20,000 pounds at mid-span.
- All greenway bridges shall have minimum clearance between railings, handrails and ledgers that is 2' wider than the trails they serve (except 12' trails may include 12' wide bridge as noted on plans).
- Metal plaques shall be permanently affixed to both ends of bridges indicating maximum weight capacity of structure, as well as inside clear width, manufacturer, and date of manufacture.
- Bridges shall have 42" wooden railings, or higher in high hazard situations.
- Bridge railings shall extend 15' beyond the ends of bridge. (See Details 9500.02, 9500.03, and 9500.04)
- Structural Lumber: Solid timber decking, posts and handrails shall be No. 1 Southern Pine. All lumber shall be pressure treated.
- All connectors shall be hot-dipped galvanized. This includes bolts, washers, screws and fabricated connections. All decking and railings shall be connected with bolts or screws.
- Manufacturer shall submit working drawings to Cary for review prior to manufacturing of the bridge. Working drawings shall be signed, sealed and dated by a North Carolina Professional Engineer.
- Field Technician may require additional certifications.

Bridge Clearance

- There shall be a minimum clearance of 4 feet from the lowest portion of all bridges to the normal water level.
- Bridge abutments cannot be located within the floodway and shall be located a minimum of 5' from the top of the stream bank.
- Bridges and abutments shall be located a minimum of 15' from the center of all existing sewer lines, and shall not be located within a sanitary sewer easement where crossing a waterway.

- The elevation of bridges (the lowest horizontal component of bridge) on Cary-maintained greenways shall be set above the 100-year storm elevation. Horizontal elements of private greenway bridges shall be set high enough to pass the 25-year storm and receive necessary FEMA approvals; when feasible elevation above the 100 year storm is recommended.
- Illustrate how high-water levels will pass without damaging bridge. Provide a section of the proposed bridge with the construction documents.

Bridge Footings and Wing Walls

- Bridge footings and wing walls shall be constructed with reinforced concrete as designed and sealed by the North Carolina Professional Engineer. A representative of the geotechnical engineer's staff shall approve the footing excavation bottoms prior to constructing bridge footings and placement of rebar and concrete.
- Tops of footings shall be 2' below adjacent creek bed elevation.

Concrete Bridge Approach (See Detail 9500.05)

- Greenway bridges shall have a 15' approach slab on both sides as indicated in bridge approach plan detail.
- Approach slabs and everything between slabs shall be included in all required bridge and boardwalk certifications and shall be considered part of bridge/boardwalk structure.
- Bridge railings shall extend 15' beyond the ends of bridges as per bridge details and bridge approach detail. (See Details 9500.02, 9500.03, and 9500.04)

Bridge Handrails

- Handrails shall be installed on both sides of bridges that exceed a 5% running slope (approved only on a case-by-case basis); handrails shall be designed and located in accordance with ADA and AASHTO requirements.

Pedestrian Bridges: Pre Engineered Laminated Beam Bridge
(See Detail 9500.02)

- These specifications are for a fully engineered clear span bridge of laminated lumber and solid sawn lumber construction and shall be regarded as minimum standards for design and construction as manufactured by a qualified bridge manufacturer. The manufacturer shall have a minimum of five years' experience in design and fabrication of pre-engineered pedestrian bridges.
- The bridge shall be designed for an evenly distributed load of 85 pounds per square foot as required by AASHTO Standard Specifications for Highway Bridges 17th Edition (or most current) and a concentrated load of 20,000 pounds at mid-span. The design of the laminated lumber bridge

components shall be in accordance with the “American Institute of Timber Construction”, “AITC 117-2001”, or latest edition.

- The total bridge dead load applied to the End Bent shall not exceed 37,000 pounds.
- All bridges shall be designed for a minimum wind load of 30 pounds (approximately 120 mph). The wind is calculated on the entire vertical surface of the bridge as is fully enclosed. All bridges shall be designed for seismic loads of the intensity required by local codes.
- Bridge camber at center of the bridge span shall be a maximum of 2-½% of the total bridge span. This should produce a localized deck slope of 1:12 or 8.8%. Bridge shall be cambered to offset full dead load deflections.
- Bridge span shall mean the distance from center to center of the bearings. The bridge being designed shall have bearing elevations that are equal.
- Manufacturer shall submit working drawings to the Engineer and Cary for review prior to manufacturing of the bridge. Working drawings shall be signed, sealed and dated by a North Carolina Professional Engineer.
- Manufacturer shall provide for one deck plank at each end of the bridge to span the one-inch gap as described below to prevent debris from falling through the gap. This deck plank shall match the decking of the bridge and shall be installed at the site after the backwall is installed (see plan detail).

Materials

- All structural members shall have minimum thickness of material of at least 2” nominal.
- Structural bridge components shall be fabricated from laminating lumber. Laminating lumber shall be Southern Pine Kiln Dried and graded to meet the requirements of standard specifications for structural glued laminated timber, AITC 117. Lumber combination shall be used for identification. Laminated components shall be per AITC architectural appearance grade.
- Miscellaneous solid sawn lumber for decking shall be Southern Pine graded in accordance with SPIB.
- Preservative treatment for glulam components shall consist of pressure treated laminated lumber (treated prior to gluing) with pentachlorophenol type C in accordance with AITC 109 and AWPA C28. Exterior stringers and all other glulam components shall be .6 pcf retention. Solid sawn decking shall be pressure treated in accordance with C2 for above ground use.
- Laminated lumber handrail posts shall be fastened to the exterior beam with galvanized steel carriage bolts. Handrails must be metal and meet current requirements as stated in the ADA Accessibility Guidelines (ADAAG).

- Adhesives shall be wet-use (waterproof) complying with ANSI/AITC A190.1 – latest edition.
- Each bearing and template shall be fabricated to accommodate one (1) ¾ inch diameter anchor bolt. Anchor bolts shall be aligned longitudinally with the bridge. All steel for bearing connection plates and shall be ASTM A36. Minimum yield (Fy) shall be greater than 36,000 psi. The manufacturer shall furnish all connecting steel and hardware. Decking shall be held down using stainless steel deck screws. Material shall be hot dipped galvanized. Pre-engineered bridge manufacturer is not responsible for the template, setting plates or anchor bolts.
- At the End Bents, the bridge shall be fabricated to produce a six (6) inch longitudinal distance from centerline of anchor bolts to end of beam. A one (1) inch open joint shall exist between the end of the bridge and the end bent backwall.

Fabrication

Workmanship, fabrication, and shop connections shall be in accordance with the latest version of American Institute of Timber Construction and all related Interim Specifications. Bridges may be assembled at the site or at the manufacturer.

Railings and Accessories

- The side railings shall be fabricated from laminated lumber. The railings shall have a smooth inside surface with no protrusions or depressions. Finished railing height shall be 42”, or higher in high hazard situations. All members, railings, corners, and ends of lumber shall be sanded smooth and edges eased.
- Maximum spacing of railings shall be such that a 3-1/2” sphere shall not pass between the members.

Finishes

All glulam materials to receive one factory applied coat of clear penetrating sealer.

Delivery and Erection

- Bridges or bridge components will be delivered by truck to a location nearest to the site accessible by roads.
- The contractor shall provide for the installation of anchor bolts to be installed. The information required to develop the template shall include the size, configuration, and spacing of the bolts as they shall be installed in the footing.

Quality

- The bridge manufacturer shall maintain records assuring that all timber, bolts, and materials used are in accordance with the material specified

and certified by a North Carolina Professional Engineer. (A copy of the records shall be provided with the bridge to the owner.)

- The bridge shall be identified and marked with a permanent nameplate showing the manufacturer's name, location, date of manufacture, load carrying capacity and inside clearance width. Structural materials shall be traceable to the bridge.

9014 Underpasses and Tunnels (Detail 9500.01)

All sealed designs for underpasses and tunnels shall be included with the approved site/subdivision plan sets.

All required geotechnical reports, and a sealed certification from tunnel designer stating that tunnel and all related structures were constructed in accordance with sealed designs shall be submitted to Cary Field Technician prior to Cary's acceptance of routine maintenance/warranty of the tunnel by Cary.

Power meter for tunnel lighting shall be located above 100- year flood elevation and minimum 10' above trail surface in accordance with Detail 9500.01.

All pedestrian underpasses and tunnels crossing roads owned and maintained by the NC Department of Transportation must receive NCDOT approval prior to beginning any work within the right of way.

- Greenway tunnels shall be 12' x 12' reinforced poured in place concrete structures as specified by NCDOT.
- Tunnels shall exhibit a 1% minimum longitudinal slope; 2% maximum cross slope.
- Headwalls with wing-walls are required at both ends of the tunnel.
- Special consideration shall be placed on the drainage design at the entrance to the tunnel. Where necessary trench drains should be incorporated at the tunnel entrance to intercept water from pooling within the tunnel. (See Detail 9600.03)
- Contractor/applicant shall be responsible for coordinating review and approval by NCDOT (where crossing NCDOT roadways) and for obtaining any required encroachment permits prior to beginning any work.
- All tunnels shall be lighted in accordance with Detail 9500.01.

END OF SECTION 9000