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GREENE TRACT ENVIRONMENTAL ASSESSMENT & SUITABILITY ANALYSIS

PREPARED FOR:

ORANGE COUNTY PLANNING AND INSPECTIONS DEPARTMENT

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JULY 29, 2020

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1.0 EXISTING ENVIRONMENTAL CONDITIONS

1.1 Introduction and Site Description

The Greene Tract project site is located 3.4 miles NNW of downtown Chapel Hill, in southeastern Orange County NC (Figure 1). The site comprises two parcels: The northern parcel (PIN # 9870-85-5283, approximately 60.0 acres) known as the Headwaters Preserve is owned by Orange County (Figure 2). The southern parcel (PIN # 9870-73-9888) is jointly owned by Orange County, Town of Chapel Hill, and Town of Carrboro, and is split by the Headwaters Preserve into a southern portion (99.3 acres) and a northeast portion (4.7 acres).. The combined project site (approximately 164 acres) is almost entirely forested, except for several dirt roads and trails, a power line right-of-way across the northeast side of the site, and a gas line right-of-way along the northern edge.

Southern Railway lies along the eastern border of the site. The surrounding major roads include Weaver Dairy Road Extension to the east, Homestead Road to the south, Rogers Road to the west, and Eubanks Road to the north. None of these roads is adjacent to the Greene Tract. Road access into the site is from the eastern ends of Purefoy Drive and Lizzie Lane, off Rogers Road west of the Greene Tract, and from the north end of Merin Road, off Homestead Road, south of the Greene Tract. The site is less than one mile from the intersection of two major highways, NC-86 and Interstate-40, in the rapidly developing area along the northern edge of Chapel Hill and Carrboro.

This Environmental Assessment was prepared by SynTerra under contract to Orange County as a planning tool for the three local government owners in developing and evaluating potential development plans for the site. It includes updates to a similar study 20 years earlier (R.J. Goldstein & Assoc., 2000) and several conceptual site layout alternatives based on expected development needs, in accordance with recent resolutions and agreements among the three local governments. The target land use areas specified in the Request for Proposals, following the inter-local agreement, are 82 acres for natural area preservation (60 plus 22 acres), 16 acres for an elementary school site and recreational fields, and 66 acres for residential and/or mixed residential and commercial development. While the northern 60-acre parcel is currently designated for natural area preservation, and contains much of the oldest forests, for this study we have combined the two parcels and re-assessed the conservation value of all areas, selecting the most environmentally sensitive 82 acres for preservation.

1.2 Geology and Geography

The Greene Tract site is in the Carolina Slate Belt of the Piedmont physiographic province, in the New Hope River sub-watershed of the Cape Fear River basin (USGS HUC 03030002-06). The center coordinates of the site are latitude 35.9603, longitude -79.0732. Elevations on the site range from approximately 500 feet (NAVD-88) where streams exit at the southwest and northwest corners to a peak of 577 feet along the east-west ridge across the central portion of the site, as depicted on the USGS topographic quadrangle of Chapel Hill, NC. This ridge forms the watershed divide

between Old Field Creek to the north, Booker Creek to the east, and Bolin Creek to the south, and is the source of the name “Headwaters Preserve” for the northern parcel (Figure 2). Streams on the Greene Tract are all unnamed headwater tributaries of Old Field Creek, Bolin Creek, or Booker Creek, but are referenced throughout this report without the “unnamed tributary of” qualifier, for simplicity.

Elevation profiles from north to south across the site are provided in Figure 3. Slopes are mostly in the 3 to 10 percent range on the southern two-thirds of the site (Bolin Creek and Booker Creek watersheds) and mostly 3 to 20 percent on the northern portion. Some areas along the south bank of Old Field Creek have 20 to 30 percent slopes (Figure 4).

Due to their small watersheds (0.1 to 0.2 square mile), these streams do not carry dangerously high stormflows, and are not subject to federal or state regulation as flood hazard areas. Federal Emergency Management Agency (FEMA) floodplain regulations typically apply to streams with at least 1.0 square mile of drainage basin area. The nearest FEMA regulated floodplains are more than 1500 feet downstream of the Greene Tract.

Geology of the site is mapped as felsic metavolcanic rock and metamorphosed granitic rock, both of which produce acidic soils upon weathering (NC Division of Land Resources, 1985). More recent mapping shows greenish to gray diorite, including hornblende and plagioclase, as the predominant geology on the northern 80 percent of the Greene Tract (Figure 6). The southern 20 percent is predominately whitish-gray granodiorite with inclusions of pinkish feldspar and greenish plagioclase (Bradley et al., 2004). Small outcrops of quartzite and granitic bedrock occur on hilltops and slopes in several areas, and loose quartzite rock piles - presumably removed from farm fields - are common. However, streams on the site have predominantly sand, silt, and gravel beds, with minimal cobble or larger rock.

1.3 Land Use

The site is almost entirely forested at present, except for the dirt roads, powerline, and gas line rights-of-way. During the early 1900s roughly half of the site was cleared land, most likely cropland or pasture. The railroad between Hillsborough and Chapel Hill which borders the eastern edge of the site is depicted on an 1891 map. The earliest available aerial image (1938) shows the site approximately 55 percent forested. There are remains of two old homesites on the property, constructed in the mid- to late-1800s, as depicted on the 1918 Soil Map of Orange County. A 1955 aerial image shows the Byrd House site - a cluster of buildings near the center of the property - and a single building 1,100 feet to the south --the Potts House (Figures 7A-7C). These homesites and other cultural artifacts were evaluated in a previous study (TRC Garrow, 2000) and are discussed in section 1.10.

By 1955 much of the farmland had been replanted with pines. Approximately 25 percent of the site remained cleared in 1955, mostly along the east-west road through the middle of the site, plus a few acres in the southeast corner near Merin Road. A

1975 aerial image shows nearly the entire site reforested; both homesites were abandoned by this time. A dirt road and several utility boxes remain on the southeast corner of the site from an abandoned subdivision project started prior to 1975. The powerline across the northeast corner of the site was installed sometime between 1975 and 1990, and the gas line along the northern boundary was installed in 2013, based on aerial imagery. Orange County continues to maintain the historic roads in roughly the same locations as shown on the old maps. In recent years, mountain biking enthusiasts have created a network of bike trails and bridges throughout the site. These trails are not sanctioned by the County or the Towns, and were installed without owner permission.

Adjacent land uses include low-density rural residential and forest land to the north and south; medium-density residential land to the west (Rogers Road and Purefoy Drive neighborhood) and east (Weaver Dairy Road neighborhood); and the Orange County landfill to the northwest. New residential and commercial development is occurring along Homestead Road to the south and Eubanks Road to the north. The Greene Tract is less than one mile southwest from the intersection of NC-86 (Martin Luther King Jr. Blvd, formerly known as Airport Road) and Interstate-40 in a rapidly growing part of Orange County.

1.4 Soils

Appling sandy loam (ApB and ApC) is the predominant mapped upland soil, covering 68 percent of the Greene Tract, as mapped in the Soil Survey of Orange County (Dunn, 1977; Figure 5). Helena sandy loam (HeB) covers 25 percent of the site, in a broad valley with small streams and seeps in the Bolin Creek watershed on the southern portion of the site. The remaining 7 percent of the site is mapped as Cecil fine sandy loam (CfC), Georgeville silt loam (GeB and GeC), and Tarrus silt loam (TaD) on the northern portion of the site, where each soil occupies 2 to 3 three percent of the total property.

The cultural resources report (TRC Garrow, 2000) noted that “erosion is evident across much of the tract, and in some areas, little is left of the A horizon”. This is a common trend across much of North Carolina due to poor farming practices from the beginning of European settlement until the 1930s when the United States Department of Agriculture (USDA) Soil Conservation Service was created to develop and promote less destructive methods. The scarcity of cobble and larger rock in Old Field Creek and Bolin Creek on the site may be due to natural conditions, or it may be due in part to burial with sediment eroded off the surrounding land. After the site was reforested, sometime between 1955 and 1975, further erosion was mitigated. The remaining soils on the site today are essentially stable with good vegetative cover. Localized spots of minor soil erosion persist along the roads, bike trails, and powerline.

The HeB and ApB soils are USDA-designated prime farmland soils, and all other soils mapped on the site (ApC, CfC, GeB, GeC, TaD) are North Carolina Department of Agriculture (NCDA)-designated soils of statewide importance. All are acidic soils, with

pH values typically ranging from 4.5 to 6.0. The Appling, Cecil, Georgeville, and Tatum series are classified as well drained soils with moderate permeability and few if any hydric inclusions. Helena soils are moderately well drained, slowly permeable, and often have hydric inclusions. None of these is classified as a flood-prone soil. The Bolin Creek and Booker Creek streams and wetlands are entirely within the area mapped as HeB, and the Old Field Creek streams and wetlands are within the northern area mapped as ApC. Streams and wetlands are discussed further in section 1.5. Suitability of the soils for development is discussed in section 2.2.

1.5 Streams, Wetlands, and Water Resources

The Greene Tract lies on the watershed divide between Old Field Creek, which drains the northern 64 acres of the project site, Booker Creek, which drains the eastern 16 acres, and Bolin Creek, which drains the southern 85 acres (Figure 2). Bolin Creek and Booker Creek join four miles southeast of the Greene Tract to form Little Creek (USGS HUC 03030002-0603), which flows into B. Everett Jordan Lake five miles southeast of Chapel Hill. Old Field Creek flows into New Hope Creek (USGS HUC 03030002-0601), which also flows into Jordan Lake just east of Little Creek. Perennial and intermittent streams in the Jordan Lake watershed are subject to North Carolina Department of Environmental Quality – Division of Water Resources (NCDEQ-DWR or DWR) riparian buffer protection and stormwater management rules adopted to reduce excessive nutrient loading into the lake, which was designated “nutrient-sensitive waters” in 1983 soon after the lake was built. All streams on the site are designated Class WS-V-NSW by the (DWR).

SynTerra scientists delineated and mapped streams and wetlands throughout the Greene Tract during May 1 to 13, following a period of average rainfall (approximately 4 inches between April 14 and May 13) based on an average of four nearby CoCoRaHs rain gauges. Wetlands were identified following the Eastern Piedmont and Mountains Regional Supplement (2012) to the Army Corps of Engineers (ACE) Wetland Delineation Manual. Streams were identified following both Army Corps of Engineers guidance and the DWR Stream Identification Method, version 4.11 (2010). Stream and wetland boundaries were marked with sequentially numbered survey flagging and flag locations were mapped using Trimble Geo XT and Garmin GPS units. Transition points between perennial, intermittent, and ephemeral stream reaches were mapped based on stream determinations in 2016-2017 by local government staff with delegated authority to implement DWR riparian buffer rules. Field observations by SynTerra in 2020 generally agree with those transition points. Streams and wetlands on the site are summarized by reach in Table 1 and mapped in Figures 8A-C. Stream identification data forms are provided in Appendix A.

The NC Stream Assessment Method (NCSAM) was performed on the perennial reaches of Bolin Creek and Old Field Creek to evaluate stream habitat quality. Old Field Creek rated “high” in all primary categories (hydrology, water quality, and habitat) and all applicable sub-categories. Bolin Creek also rated “high” in all primary categories, but rated “medium” in the hydrology sub-category of streamside flood

attenuation due to its partial channelization and moderate channel incision. NCSAM data and rating forms are provided in Appendix B.

A Preliminary Jurisdictional Request (PJD) package was prepared and submitted to ACE on June 1, 2020, and a copy sent to Orange County. The PJD includes wetland and upland delineation data forms, stream identification forms, aquatic resource mapping and tables, and other supporting documentation. SynTerra will meet with ACE agents as needed to verify the stream and wetland limits. DWR verification of stream reaches for Jordan Lake buffer applicability is unnecessary, as local government staff have delegated authority for implementing these buffer rules. Local government riparian buffer protections extend beyond those required by DWR. Buffers applicable to the Greene Tract, as agreed upon based on the most protective rules among the three jurisdictions, are 150 feet wide along perennial streams, 80 feet wide along intermittent streams, 15 feet wide along ephemeral streams, and 80 feet wide along wetlands. Where wetlands are adjacent to streams, whichever buffer extends out farther takes precedence. Additional wetland buffers extending out to 150 feet are recommended based on NC Wildlife Resources Commission guidance, due to the presence of rare salamanders that breed and nest in headwater seep wetlands but live in adjacent upland forests outside of the breeding season and larval period.

1.5.1 Old Field Creek

The lower 985 feet of Old Field Creek, from flag GF-26 downstream to the gas line at the northwest property corner (reach A1), is perennial and has a more-or-less natural stream pattern, profile, and cross-section, with numerous small riparian wetlands extending 10 to 60 feet beyond the stream banks (Figure 8A). The stream channel varies from 2 to 6 feet wide, and the stream bed is predominantly sand with accumulations of silt and organic debris in pools and small patches of gravel in the riffles, and minimal cobble or larger rock. This reach is slightly incised, with good floodplain access. From flag GF-26 upstream to flag RV-5, reach A2 (390 feet) is intermittent, 2 to 4 feet wide, with a bed of sand, silt, and detritus, abundant riparian wetlands, and slight to moderate incision. The stream banks are well-vegetated with trees and shrubs, and relatively stable throughout both reaches.

The riparian wetlands along stream reaches A1 and A2 (total 1375 feet) receive seepage flow from the uplands plus over-bank flow from the stream during and after rain events. These wetlands are unmapped hydric soil inclusions with the mapped upland soil series Appling sandy loam and Georgeville silt loam. In some areas hydric soils extend a few feet in elevation above the floodplain, indicating long-term saturation. Several of the wet depressions adjacent to the stream hold sufficient water to serve as breeding habitat for toads, chorus frogs, cricket frogs, gray treefrogs, spotted salamanders, and four-toed salamanders (observed by SynTerra biologists and/or Allison Weakley of Chapel Hill Stormwater Division). Wetland vegetation includes a variety of sedges, grasses, ferns, herbs, vines, shrubs, and trees, including many obligate wetland plant

species (Table 2). The surrounding forest is mostly mature hardwood over 100 years old, as indicated by large trees evident in the 1938 aerial photo.

From flag RV-5upstream to flag RV-11, reach A3 (315 feet) is intermittent and channelized, probably in the 1800's or early 1900's. This channel is 2 to 3 feet wide, with a bed of sand, silt, and detritus, and minimal riparian wetlands. Based on the presence of relict hydric soils beyond the stream channel, it appears that portions of this reach may originally have been headwater seep wetlands rather than a stream. At present it is impossible to determine where exactly the stream head began prior to channelization, but based on the DWR stream identification method the current intermittent-ephemeral transition point is at flag RV-11. Upstream of flag RV-11, the uppermost 755 feet (reach A4) is an ephemeral channelized ditch through a headwater seep wetland. While the "stream" channel in this reach may be man-made, it currently qualifies as an ephemeral stream as determined by local government staff.

Channel erosion and sediment deposition in reaches A1 to A4 may have been severe a century ago, but are now largely stabilized. Wetlands along the channelized upper reaches A3 and A4 (total 1070 feet) receive seepage flow from adjacent uplands, but the ditched channel effectively lowers the water table such that these wetlands have no significant ponding and probably have low value as amphibian breeding habitat. Plant diversity is also lower, and dominated by facultative species, with few of the obligate wetland plants and Sphagnum moss that are abundant in the more intact wetlands downstream. The surrounding forest contains a mix of hardwoods and pines, becoming increasingly pine-dominated farther upstream. This area was forested in 1938, but the trees appear younger than those along the downstream reaches.

A wetland seep (reach B1, flags PA-1 to PA-16) with an ephemeral stream 425 feet long flows northward through mature mixed hardwood-pine forest and joins Old Field Creek just upstream of the perennial-intermittent transition point. No standing water was present in this seep during our field investigations, and the vegetation suggests that it probably does not pond water for extended periods. This seep appears to be more-or-less natural, although slightly eroded, and is not channelized.

1.5.2 Bolin Creek

The lower 1,245 feet of Bolin Creek, from flags RA-22 and RB-6 downstream to the southwest property corner (reach C1), is perennial, moderately incised, and may have been partially channelized, as suggested by its less sinuous pattern than the lower reach of Old Field Creek (Figure 8B). Most of the north bank (right bank) appears cleared in the 1938 aerial photo, except for the lower 200 feet which was forested. Riparian wetlands extend 10 to 60 feet beyond the stream banks, similar to those along Old Field Creek. The stream channel varies from 2 to 6 feet wide, and the stream bed is predominantly sand with frequent

gravel patches on riffles, and accumulations of silt and organic debris in pools. Cobble and larger rock are infrequent. This reach is moderately incised, with reduced floodplain access. The stream banks are mostly well-vegetated with trees and shrubs, and relatively stable, despite the steep angle of the banks. Minor erosion is present where trees have fallen and at bike trail crossings. From flag RA-22 upstream to flag AA-5, reach C2 (530 feet) is intermittent, 2 to 4 feet wide, slightly incised, with a bed of sand, silt, and detritus. It is slightly incised due to erosion, but has a more-or-less natural stream pattern and does not appear to have been channelized. The Bolin Creek wetlands are unmapped hydric soil inclusions with the mapped soil series Helena sandy loam, and extend a few feet above the floodplain in many areas, similar to those along Old Field Creek. Riparian wetlands along reaches C1 and most of reach C2 have many areas of standing water and obligate wetland vegetation. Extensive patches of Sphagnum moss are common, indicating prolonged saturation and steady seepage from uplands. Sphagnum moss provides nesting habitat for the rare four-toed salamander, discussed in section 1.8. Larval frogs, toads and salamanders were observed by SynTerra in many of these wet depressions and also in the stream channel along reach C1. The surrounding forest is mostly pine-dominated on the north side (right bank), 70 to 80 years old, and mixed hardwood and pine at least 90 years old on the south side (left bank), based on age-interpretation from aerial photos.

The uppermost 150 feet of reach C2 was mostly dry during the field visit, with few obligate wetland plants, and probably does not sustain surface water long enough for larval salamanders to metamorphose. However, it is important for maintaining baseflow, thermal stability, and nutrient processing into the downstream reaches. Like the lower reaches, the surrounding forest is mostly pine-dominated on the north side, and older mixed hardwood and pine on the south side.

Three tributary seeps flow southward into Bolin Creek. The western tributary is 650 feet long and 20 to 60 feet wide, including a slightly incised intermittent stream (reach D1, 485 feet) and a headwater seep above (reach D2, 250 feet) with an indistinct channel. This seep was mostly dry during the field visit, with few obligate wetland plants. The forest surrounding this seep is mixed hardwood and pine at least 90 years old on the west side (right bank), and younger pine-dominated forest on the east side (left bank).

The middle tributary is 830 feet long and 20 to 50 feet wide, including a slightly incised perennial stream (reach E1, 405 feet), an incised intermittent stream (reach E2, 125 feet), and a headwater seep above (reach E3, 300 feet) with an indistinct ephemeral channel. The upper reach was relatively dry, but the lower reach E1 had extensive wet areas and standing water suitable for amphibians, which were observed in both the wetland pools and in the stream channel. The forest surrounding this seep is mostly pine to the west, 45 to 65 years old, and

pine 65 to 80 years old to the east. The east side of the uppermost reach has mixed hardwood and pine 80 to 100 years old.

The eastern tributary is entirely seep wetland with no distinct channel, 760 feet long and 40 to 70 feet wide, including a lower linear reach (reach F1, 590 feet) and an isolated headwater depression (reach F2, 80 feet) approximately 100 feet above reach F1. It appears the headwater depression (F2) may have been artificially isolated by fill for an old road or dam, which has also increased its capacity for ponding water. Both reaches F1 and F2 have extensive Sphagnum and obligate wetland plants, and support amphibian breeding. One of the reported four-toed salamander nesting sites is on the upper portion of this seep (Weakley, 2017). The forest surrounding reach F1 is pine-dominated to the east, and older mixed hardwood and pine to the west. Reach F2 is surrounded by mixed hardwood and pine to the west and older hardwood forest to the east, adjacent to the Booker Creek watershed.

1.5.3 Booker Creek

Two headwater tributaries of Booker Creek drain eastward under the railroad along the eastern property boundary (Figure 8C). Both are seep wetlands; neither has a distinct stream channel west of the railroad. The southern tributary comprises two wetland "fingers" (reaches G1 and G2, 530 feet and 260 feet long), that join along the toe of the railroad embankment just before their combined drainageway flows into a culvert. These two reaches have mixed hardwood and pine forest at least 90 years old, and the adjacent upland forest is similar in age but is pine-dominated. Both have obligate wetland plants, but ponded water was present only at their confluence near the railroad. The water here appeared dark with a slight oily sheen, and may be contaminated by the railroad. Just east of the railroad, Booker Creek flows through two more culverts in a residential area within 350 feet. Cricket frogs were observed on site, but it appears this wetland may not sustain surface water long enough for salamander larvae to complete their metamorphosis. Multiple culverts and residential development to the east may also limit amphibian passage, especially for salamanders.

The northern tributary of Booker Creek (reach G3) is under the powerline and is a small mowed shrub/scrub seep wetland 120 feet long. It had flowing and ponded water during the field visit, but likely dries up later in summer, and is isolated from stream and wetland habitat downstream by a culvert under the railroad. Cricket frogs were observed here, but we suspect this wetland is unsuitable for salamanders due to its limited hydrology, lack of forest canopy, and railroad influence. The plant community in this seep includes stump sprouts of mowed trees, wetland shrubs, and diverse graminoids and herbs as described in section 1.7.3.

1.6 Aquatic Wildlife Communities

The headwater streams and seeps on the Greene Tract, while perennial along their lower reaches, are likely to dry up for a few weeks during years with prolonged droughts. This limits their suitability for fishes, river mussels, and other animals that require permanent standing or flowing water. The only fish observed during the field study were creek chubs (*Semotilus atromaculatus*), a headwater specialist that either retreats downstream when drought conditions occur, or survives in isolated puddles in the stream channel, often in scour holes where the stream channel has undercut beneath a tree. The 2000 study reported creek chubs and rosyside dace (*Clinostomus funduloides*), another headwater specialist. Fish were observed in May 2020 in the lowermost 500 feet of Bolin Creek and the lowermost 300 feet of Old Field Creek.

Headwater streams do however provide important habitat for invertebrates and amphibians, which burrow into sand or gravel stream beds and use hyporheic flow to survive during droughts. Aquatic macroinvertebrates observed in Bolin Creek and Old Field Creek include crustaceans (isopods, amphipods, crayfish), mayflies (Ephemeroptera), midges (Chironomidae), craneflies (Tipulidae), diving beetles (Dysticidae), and dragonflies and damselflies (Odonata). Amphibians observed in streams and seeps on site during this study include southern two-lined salamander (*Eurycea cirrigera*), northern dusky salamander (*Desmognathus fuscus*), spotted salamander (*Ambystoma maculatum*), northern cricket frog (*Acris crepitans*), spring peeper (*Pseudacris crepitans*), green frog (*Rana clamitans*), leopard frog (*Rana utricularia*), and Fowler's toad (*Bufo fowleri*). Four-toed salamander (*Hemidactylium scutatum*) nests were observed at three sites in the Bolin Creek drainage and one site along Old Field Creek during 2017-2018 (A. Weakley, Chapel Hill Stormwater Division). Cricket frogs and toads were observed in perennial, intermittent, and ephemeral reaches in 2020; other frogs and salamanders were seen only in the perennial reaches.

The forested headwaters help maintain natural flow patterns and water quality in stream reaches downstream of the site. DWR monitoring of fish and macroinvertebrate communities in Bolin Creek one mile downstream of the site and New Hope Creek 2.5 miles downstream were rated "good" or "good-fair" during 2001 to 2003 (Figure 9). A DWR "special study" macroinvertebrate sample from Booker Creek in 2007 one mile downstream of the site was not rated, but showed lower species diversity than in Bolin Creek or New Hope Creek, possibly due to urban development in the upper watershed.

Chapel Hill Stormwater Management staff with Larry Eaton Scientific have monitored macroinvertebrates in all three streams downstream of the Greene Tract since 2011 (Eaton Scientific, 2018). The three sample sites closest downstream are: Booker Creek at Martin Luther King, Jr. Blvd. ("Booker Creek 2"); Old Field Creek at Town Operations Center; and Bolin Creek above Village Drive ("Bolin Creek 4"). During the last two years for which data are reported on the Town's website (2017 and 2018), Booker Creek received a "Fair" and a "Good-Fair" rating, Bolin Creek received "Fair" ratings in both years, and Old Field Creek received "Fair" ratings in both years. DWR uses five bioclassifications: Excellent, Good, Good/Fair, Fair, or Poor.

1.7 Terrestrial Vegetation Communities

SynTerra scientists mapped plant communities on the Greene Tract during May 2020 using soil maps, Orange County topographic mapping, Google Earth aerial photography, and a Trimble GeoXT GPS unit (Figure 10). Community types are distinguished and mapped based on the NC Natural Heritage Program classification (Schafale and Weakley, 1990) to the extent that they apply, approximate canopy tree ages based on aerial imagery, and other descriptors as needed for disturbed, non-natural communities. Common plants in each community type are listed below, and more comprehensive plants lists are provided in Table 2.

1.7.1 Seeps and Alluvial Forests

Low-elevation Seep (Schafale and Weakley, 1990) communities occur at the heads of all drainageways on the site. Large portions of these seeps are jurisdictional wetlands. The downstream reaches of seeps gradually develop into ephemeral or intermittent stream channels, and continuing downstream the streams gradually develop a floodplain, with additional small seeps where floodplain edges meet adjacent upland slopes. The floodplains support Alluvial Forest communities (Schafale and Weakley, 1990). Floodplains on the site are narrow due to the small drainage basin areas (approximately 65 acres for Old Field Creek and 85 acres for Bolin Creek). Due to the inter-mingling of Seep and Alluvial Forest communities on the site, they are combined and mapped as "stream / wet seep" or "head seep" in Figure 10. "Stream / wet seep" is used for areas with prolonged standing and/or flowing water that are likely to support a diverse mix of obligate wetland plants and aquatic wildlife, including amphibians. The term "head seep" is used for reaches upslope with less sustained hydrology; these areas had little or no surface water during early May 2020 despite normal antecedent rainfall (approximately four inches during the preceding 30 days). Head seep areas are important for regulating flow, water quality, and nutrient inputs to downstream reaches with more permanent flow, but are less useful for aquatic life other than species with very short aquatic larval periods.

Alluvial Forest and Low-elevation Seep communities on the Greene Tract have a forest canopy dominated by sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), American elm (*Ulmus americana*), tulip poplar (*Liriodendron tulipifera*), loblolly pine (*Pinus taeda*), white oak (*Quercus alba*), willow oak (*Quercus phellos*), and northern red oak (*Quercus rubra*). Less common canopy tree species include green ash (*Fraximus pennsylvanica*), sugarberry (*Celtis laevigata*), shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), American beech (Fagus grandifolia), and black walnut (*Juglans nigra*). Understory trees and shrubs include black gum (Nyssa sylvatica), sourwood (*Oxydendron arboreum*), spicebush (*Lindera benzoin*), persimmon (*Diospyros virginiana*), black cherry (*Prunus serotina*), musclewood (*Carpinus caroliniana*), hazelnut (*Corylus americana*), Chinese privet (*Ligustrum sinense*), American holly (*Ilex opaca*), and red mulberry (*Morus rubra*). Some of these trees and

shrubs are upland species rooted on adjacent mesic slopes, and overhang the narrow seeps and floodplains.

Vines and groundcover include muscadine grape (*Vitis rotundifolia*), common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), crossvine (*Bignonia capreolata*), blueberries (*Vaccinium stamineum* and *V. tenelllum*), sedges (*Carex*, *Rhychospora* species), rushes (*Juncus* species), sphagnum moss (*Sphagnum* species), lizards tail (*Saururus cernuus*), false nettle (*Boehmeria cylindrica*), bugleweed (*Lycopus virginicus*), turtleheads (*Chelone glabra*), knotweed (*Persicaria* species), Jack-in-the-pulpit (*Arisaema triphyllum*) netted chain-fern (*Woodwardia areolate*), sensitive fern (*Onoclea sensibilis*), royal fern (Osmunda regalis), and cnnamon fern (*Osmunda cinnamomeum*).

The upper reach of Old Field Creek appears to have been ditched in an effort to drain the seep wetland, probably over a century ago, and the forest in this area is pine-dominated with low plant diversity. The middle and lower reaches of Old Field Creek and most of the seeps and streams in the Bolin Creek and Booker Creek watersheds are relatively intact, with some channel incision due to erosion, but do not appear channelized. These forests are relatively mature and have a more diverse mix of hardwoods among the pines, and diverse shrubs, vines, and groundcover.

1.7.2 Mesic and Dry-Mesic Forests

Two types of upland hardwood forest communities occur on the Greene Tract: Mesic Mixed Hardwood forest and Dry-Mesic Oak/Hickory forest (Schafale and Weakley, 1990). Mesic forests occur on the lower portions of slopes adjacent to seeps, streams, and floodplains, where soil water movement from farther upslope maintains greater moisture levels. This was probably the predominant community type in much of the area mapped as Helena sandy loam in the southern portion of the Greene Tract prior to clearcutting and planting with pines. The Mesic forest community grades into Dry-Mesic forest upslope. Dry-Mesic forests occur on the ridges and upper portions of slopes that dry out more between rainfall events. A 30-acre stand on the north-central portion of the Greene Tract and a few small stands (5 acres or less) on the eastern side have Mesic Mixed Hardwood and Dry-Mesic Oak/Hickory forests 80 to over 100 years old that closely match the NC Natural Heritage Program (NHP) community descriptions. The remainder of the site has an unnaturally high proportion of loblolly pine (*Pinus taeda*) planted on previously cleared land. The natural hardwood community may eventually reclaim dominance in these areas if left undisturbed.

Canopy trees in Mesic Mixed Hardwood forests on the site are similar to those listed above in Alluvial Forests, due to the narrow width of the Alluvial Forests.

Additional trees and shrubs include mockernut hickory (*Carya tomentosa*), pignut hickory (*Carya glabra*), post oak (*Quercus stellata*), downy serviceberry (*Amelanchier arborea*), sourwood (*Oxydendron arborea*), fringe tree (*Chionanthus virginicus*), and hop-hornbeam (*Ostrya virginiana*). Common vines and groundcover in these stands are greenbriers (*Smilax* species), muscadine grape (*Vitis rotundifolia*), deerberry (*Vaccinium stamineum*), spotted wintergreen (*Chimaphila maculata*), rattlesnake orchid (*Goodyera pubescens*), elephant's-foot (*Elephantopus* tomentosus), arrowleaf ginger (*Hexastylis arifolia*), partridgeberry (*Mitchella repens*), running-cedar (*Diphasiastrum digitatum*), and various unidentified upland grasses and sedges.

Canopy trees in Dry-Mesic Oak/Hickory forest are limited to the more drought-resistant species including sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), white oak (*Quercus alba*), post oak (*Quercus stellata*), black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*), chestnut oak (*Quercus montana*), bitternut hickory (*Carya cordiformis*), mockernut hickory (*Carya tomentosa*), pignut hickory (*Carya glabra*), shortleaf pine (*Pinus echinata*), and Virginia pine (*Pinus virginiana*). Understory trees and shrubs are similar to those in Mesic Mixed Hardwood forests, and include black gum (*Nyssa sylvatica*), sourwood (*Oxydendron arboreum*), persimmon (*Diospyros virginiana*), black cherry (*Prunus serotina*), and hop-hornbeam (*Ostrya virginiana*). The vines and groundcover species are also similar, but are generally sparse in coverage.

The boundary between Mesic Mixed Hardwood forest and Dry-Mesic Oak/Hickory forest on the Greene Tract is indistinct in most areas due to past land uses and conversion to pine forest 50 to 100 years ago. Loblolly pine (*Pinus taeda*) is presently the dominant canopy tree in both Mesic Mixed Hardwood and Dry-Mesic Oak/Hickory forests on approximately 70 percent of the Greene Tract.

1.7.3 Non-Forested Mowed Areas

The powerline right-of-way traversing the northeast side of the Greene Tract is mowed periodically and supports a non-persistent plant community of tree seedlings, stump sprouts, low shrubs, vines, and herbaceous groundcover, some of which were probably planted as seed for erosion control when the powerline was installed sometime after 1975. Most of the powerline right-of-way is upland, except for a small seep wetland at the southeast end where it crosses the railroad.

Tree seedlings, stump sprouts and shrubs under the powerline include sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), loblolly pine (*Pinus taeda*), southern red oak (*Quercus falcata*), persimmon (*Diospyros virginiana*), black cherry (*Prunus serotina*), black gum (*Nyssa sylvatica*), sourwood (*Oxydendron arboreum*), tick-trefoil (*Desmodium* species), blackberry (*Rubus pensilvanica*), and groundsel-tree (Baccharis halimifolia). Groundcover herbs and grasses include muscadine grape (*Vitis rotundifolia*), common greenbrier (*Smilax*

rotundifolia), Japanese honeysuckle (*Lonicera japonica*), trumpet creeper (*Campsis radicans*), fescue (*Lolium arundinaceum*), broomstraw (*Andropogon virginicus*), switchgrass (*Panicum virgatum*), English lawn daisy (*Bellis perennis*), rabbit tobacco (*Pseudognaphalium obtusifolium*), dog fennel (Eupatorium capillifolium), late-flowering thoroughwort (*Eupatorium serotinum*), wingstem (*Verbesina occidentalis*), and narrowleaf sundrops (*Oenothera fruticosa*).

The seep wetland at the southeast end of the powerline, adjacent to the railroad (Reach H1), has a sparse shrub layer of sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), swamp fetterbush (*Eubotrys racemosus*), winterberry holly (*Ilex verticillata*), and blackberry (*Rubus pensilvanica*), and a dense herb layer of goldenrod (*Solidago* species), knotweed (*Persicaria* species), lizards tail (*Saururus cernuus*), sedges (*Carex* species), rushes (*Juncus* species), unidentified grasses (Poacea), turtleheads (*Chelone glabra*), and netted chain-fern (*Woodwardia areolata*).

The gas line right-of-way along the northern boundary of the Greene Tract was installed in 2013 and contains predominantly grasses and legumes seeded for erosion control. Because it is narrower than the powerline right-of-way and is shaded by the mature forest to the south, it is unlikely to develop extensive plant diversity in the coming years.

1.7.4 Significant Trees

Significant trees (specimen trees) are defined by Orange County and the towns as pines with a trunk diameter at breast height (dbh) of 36 inches or more, other large canopy tree species with a dbh of 18 inches or more, and smaller tree species with a dbh of 12 inches or more. Small tree species include *Aesculus, Amelanchier, Asimina, Carpinus, Cercis, Chionanthus, Cornus, Crataegus, Diospyros,Fagus, Halesia, Hamamelis, Ilex, Juniperus, Ostrya, Oxydendron, Sassafras*, and *Tsuga*. Also included are trees with historic significance, national and state champion trees, and uncommon tree species.

SynTerra scientists located significant trees using GPS and aerial imagery, and most were measured with a forestry dbh tape measure; others were visually estimated. The largest pines measured on the site were 32 inches dbh; none of the measured pines met the 36-inch specimen tree criterion. Hardwood trees exceeding 18 inches dbh are abundant over most of the Greene Tract, comprising an estimated 5 to 10 percent of all hardwoods. With an estimated average density of 100 hardwood stems per acre, there are approximately 16,000 hardwood trees on the site. Consequently, we used the Town of Chapel Hill's significant hardwood tree criterion of 24 inches dbh.

Sixty-five significant trees are mapped in Figures 11A-B. Tree species and diameters are provided separately in a GIS file. White oak and willow oak comprise the majority, with smaller numbers of sweetgum, southern red oak, northern red oak, post oak, scarlet oak, tulip poplar, and hickory. Many

additional significant trees occur along the streams and wetland corridors; we did not map most of these, as they are unlikely to be disturbed by virtue of their occurrence within wetlands or protected riparian buffers. The mapping effort was mainly focused on upland areas farther from streams where development impacts are likely.

1.8 Wildlife and Protected Species

The extensive forested area and diversity of habitat types on the Greene Tract make it potentially suitable for a wide variety of invertebrate, amphibian, reptile, bird, and mammal species, especially species that use headwater seep wetlands and upland forests. In its current state, the site has sufficient forest area to support animals that characteristically inhabit forest interiors or require large tracts of undisturbed land, such as bobcat (*Felis rufus*), turkey (*Meleagris gallopavo*), pileated woodpecker (*Dryocopus pileatus*), ovenbird (*Seiurus aurocapilla*), hooded warbler(*Setophaga citrina*), and eastern hognose snake (*Heterodon platyrhinos*) (Sather and Hall, 1988). Wildlife species that require large streams, rivers, open woodlands, and extensive scrub and field habitats are unlikely to persist here.

1.8.1 Wildlife Habitats and Typical Species

Typical amphibians observed or expected to occur on the Greene Tract based on habitat availability include white-spotted slimy salamander (*Plethodon cylindraceus*), two-lined salamander (*Eurycea cirrigera*), three-lined salamander (*Eurycea guttolineata*), four-toed salamander (*Hemidactylium scutatum*), spotted salamander (Ambystoma maculatum), Cope's gray treefrog (*Hyla chrysoscelis*), green treefrog (*Hyla cinerea*), spring peeper (*Pseudacris crucifer*), upland chorus frog (Pseudacris triseriata), Fowler's toad (*Bufo woodhousei*), American toad (*Bufo americanus*), green frog (*Rana clamitans*), and southern leopard frog (*Rana utricularia*). Reptiles may include eastern box turtle (*Terrapene carolina*), eastern mud turtle (*Kinosternon rubrum*), common snapping turtle (*Chelydra serpentina*), five-lined skink (*Eumeces fasciatus*), eastern fence lizard (*Sceloporus undulatus*), Carolina anole (*Anolis carolinensis*), black rat snake (*Elaphe obsoleta*), black racer (*Coluber constrictor*), eastern garter snake (*Thamnophis sirtalis*), copperhead (*Agkistrodon contortrix*), and eastern kingsnake (*Lampropeltis getulus*).

Common native birds observed or expected to occur on the site include Cooper's hawk (*Accipiter cooperi*), red-shouldered hawk (*Buteo lineatus*), downy woodpecker (*Picoides pubescens*), yellow-bellied sapsucker (*Sphyrapicus varius*), ruby-crowned kinglet (*Regulus calendula*), blue jay (*Cyanocitta cristata*), common crow (*Corvus brachyrhynchos*), and numerous warblers (Parulidae) and finch and sparrow species (Fringillidae). Common native mammals may include raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), red bat (*Lasiurus borealis*), evening bat (*Nycticeius humeralis*), short-tailed shrew (*Blarina carolinensis*), southern flying squirrel (*Glaucomys volans*), woodchuck (*Marmota*

monax), white-tailed deer (*Odocoileus virginianus*), gray fox (*Urocyon argenteus*), and coyote (*Canis latrans*).

The adjacent forests north and south of the Greene Tract add to its current wildlife habitat value. Protection of forested corridors off-site where Old Field Creek and Bolin Creek leave the property will be crucial in maintaining long-term habitat connectivity for wildlife between the Greene Tract and other conservation lands. Wildlife travel to and from the east along the Booker Creek corridor may be limited by the existing railroad and multiple parallel road crossings in that area. Off-site conservation lands are discussed further in section 1.9.

1.8.2 Federal Protected Species

The NHP lists 45 rare plant and animal species known to occur in Orange County, as of May 2020. These include seven species listed or proposed for listing under the Federal Endangered Species Act or the Bald and Golden Eagle Protection Act (BGPA), and 38 additional species that are protected by state laws but are not federally listed under the Endangered Species Act. The six federal-listed (or proposed) species include three aquatic animals and three terrestrial plants, as follows:

Neuse River waterdog (*Necturus lewisi*) -- Federal Proposed Threatened -- This salamander occurs in larger streams and rivers in the Neuse River basin in the northern half of Orange County. It does not occur in the Cape Fear River basin, nor in small headwater creeks.

Dwarf wedgemussel (*Alasmidonta heterodon*) -- Federal Endangered -- This river mussel occurs in larger streams and rivers in the Neuse River basin in the northern half of Orange County. It does not occur in the Cape Fear River basin, nor in small headwater creeks.

Atlantic pigtoe mussel (*Fusconaia masoni*) -- Federal Proposed Threatened --- This river mussel occurs in larger streams and rivers in both the Neuse River and Cape Fear River basins in Orange County. It does not occur in very small headwater creeks such as those on the Greene Tract, but it does occur in New Hope Creek below the confluence with Old Field Creek, less than three miles downstream (northeast) of the Greene Tract. The record at this site is “current”, last reported in 2018. There is no record of Atlantic pigtoe in Bolin Creek or Booker Creek downstream of the Greene Tract.

Smooth coneflower (*Echinacea laevigata*) -- Federal Endangered -- This plant occurs in open-canopy woodlands and glades on high pH soils weathered from mafic bedrock. The few remaining populations are often along powerline rights-of-way or roadside embankments. There are a few old records in the Chapel Hill vicinity, including one along Booker Creek in 1922. There is no current record in Orange County, where smooth coneflower is believed extirpated (other than plantings in gardens). The acidic soils and closed-canopy forests on the Greene

Tract do not appear suitable for this plant. Biologist Gerald Pottern searched woodland edge habitats and the powerline right-of-way in May 2020 for Smooth coneflower and did not find any specimen.

Pondberry (*Lindera melissifolia*) -- Federal Endangered -- This plant occurs in Carolina Bays and similar depression wetlands, mainly in the southern Coastal Plain counties (Bladen, Cumberland, Sampson, Onslow). The only record of pondberry in Orange County was along Morgan Creek in the 1800s. There is no current record in any Piedmont County. Biologist Gerald Pottern searched seep habitats on the site and did not find pondberry, although its close relative spicebush (*Lindera benzoin*) was common.

Michaux's sumac (*Rhus michauxii*) -- Federal Endangered -- This plant occurs in open-canopy woodlands and forest edges, usually on sandy soils in the Piedmont and Sandhills regions. The few remaining populations are often along powerline rights-of-way or roadside embankments. The last report of Michaux's sumac in Orange County was in 1964 near Efland; it is believed extirpated from the County. The closed-canopy forests on the Greene Tract do not appear suitable for this plant. Biologist Gerald Pottern searched woodland edge habitats and the powerline right-of-way in May 2020 for Michaux's sumac and did not find any specimen.

Bald eagle (*Haliaetus leucocephalus*) -- BGPA -- The bald eagle was de-listed from the Federal Endangered Species Act but remains federally protected under the Bald Eagle & Golden Eagle Protection Act. Eagles in the Piedmont region roost and nest near large rivers and lakes, including sites along Jordan Lake, Cane Creek Reservoir, and the Haw River. There is no large water body to attract eagles within several miles of the Green Tract. Eagles may occasionally stop to rest on or near the site while traveling, but are unlikely to remain here for extended periods.

In summary, no federally protected species is likely to occur on the Greene Tract on a frequent basis. The Atlantic pigtoe mussel occurs a few miles downstream in New Hope Creek and could be affected by urban runoff from development on the Greene Tract.

1.8.3 State Protected Species

The 38 additional state-protected species reported in Orange County include ten invertebrates, two fish, two salamanders, two birds, and 22 plants, listed in Table 3 along with their protection status and brief habitat descriptions. These animals are plants are protected as Endangered, Threatened, or Special Concern under state laws (NC Wildlife Resources Commission and NC Department of Agriculture), but are not federally listed under the Endangered Species Act. Unlike the federal ESA, the state laws do not prohibit destruction of these species or their habitats during otherwise lawful land development

activities.These species are discussed below in groups based on their biology and habitat requirements:

Invertebrates -- The ten state-protected invertebrate species include one copepod (Diacyclops jeanneli) and nine river mussels (*Alasmidonta, Lampsilis, Lasmigona, Strophitus, Toxolasma*, and *Villosa* species). The copepod was reported only once in Orange County, in 1942 in a well south of Chapel Hill. We did not attempt to sample the well on the middle of the Greene Tract, at the Byrd House historic site. Six of the nine mussel species are reported to occur in New Hope Creek below its confluence with Old Field Creek, along with the federally proposed Atlantic pigtoe. These are the brook floater (*Alasmidonta varicosa*), Savannah lilliput (*Toxolasma pullus*), Carolina creekshell (*Villosa vaughaniana*), eastern lampmussel (*Lampsilis* radiata), creeper mussel (Strophitus undulata), and notched Rainbow (Villosa constricta). No protected mussel species are reported from Bolin Creek or Booker Creek. Not all reaches of these streams have been thoroughly surveyed for mussels, and unknown populations may occur in larger perennial segments of Bolin Creek or Booker Creek downstream. The creeks on the Greene Tract are too small to support these species, with less than 0.25 square mile of drainage basin area. No mussel survey was conducted for this project.

Amphibians -- The mole salamander (Ambystoma talpoideum) and the four-toed salamander (Hemidactylium scutatum) live in forests, both in uplands and floodplains, and breed in seeps, depression wetlands, and floodplain pools where their gilled aquatic larvae live for several weeks (four-toed salamander) or months (mole salamander). Four toed salamanders were found in 2017 and 2018 at four sites on the Greene Tract: three sites in the Bolin Creek watershed and one site in the Old Field Creek watershed. The mole salamander has not been reported within three miles of the Greene Tract. Biologists found larvae of the related spotted salamander (Ambystoma maculatum) in standing pools and flowing water along the lower reaches of both streams in May 2020, but did not find mole salamander larvae. Four-toed salamander larvae require standing water until their gills are resorbed and they become terrestrial, usually in June to July (Meyer, 2008). Streams and wetlands that dry up before June in most years will probably not sustain these salamanders long-term. Potential development impacts on seeps and salamanders are discussed in section 2.5.

Birds -- Henslow’s sparrow (Ammodramus henslowii) and Bachman's sparrow (Peucaea aestivalis) live in open-canopy woodlands, glades, savannahs, pocosins, and scrubby fields. Neither has been reported within three miles of the Greene Tract, and both are listed as “historic” in Orange County. Henslow’s sparrow was last reported near Chapel Hill in 1936, and Bachman's sparrow has not been reported in Orange County since the late 1800s. The powerline right-of-way is the only feature on the Greene Tract where these sparrows might occur; neither was observed during the field study.

Plants of Glades and Open Woodlands -- Ten of the 22 state-protected plants are species that are typically restricted to glades and open-canopy woodlands with high pH soils derived from mafic rocks, similar to the habitat of Smooth coneflower. Neither open-canopy woodlands nor suitable soils occur on the Greene Tract, and none of these species is known to occur with one mile of the Greene Tract.

Plants of Rich Slopes and Bottomlands -- Seven of the 22 state-protected plants are species typically restricted to rich slopes and bottomland forests. Rich slopes generally have pH values of 6.0 or greater, and bottomlands occur along larger streams with well-developed floodplains, neither of which occurs on the Greene Tract. The plants recorded along the narrow valleys and adjacent slopes on the site are indicative of acidic, non-rich soils. Some of these species are known from sites along New Hope Creek a few miles downstream of the Greene Tract and along Morgan Creek.

Plants of Dry Pine and Oak Woods -- Four of the 22 state-protected plants are species that typically occur on ridges and bluffs in dry pine or oak forests, and are not restricted to high pH soils. These species (creamy tick-trefoil, sweet pinesap, Appalachian golden-banner, and Chapman's redtop grass) could possibly occur on the Greene Tract based on the presence of potentially suitable habitat. Sweet pinesap is the only one of these species reported within three miles of the site; it was last reported in 1976. Biologists searched for these species along ridges and hilltops but did not find any specimens. Chapman's redtop grass would not be distinguishable from other *Tridens* species until later in the year, but it is unlikely to occur here and was last seen in Orange County in the late 1800s. Some of these species could possibly occur on or adjacent to the Greene Tract; further surveys during appropriate seasonal “windows” would be needed to better assess their likely presence or absence.

Other Rare Species -- Three additional rare species recognized as “significantly rare” by NHP but not protected by state or federal law are known from sites within a few miles of the Greene Tract. Bush’s sedge (*Carex bushii*) occurs in a wetland beneath a powerline on a Duke Forest preserve 0.2 mile east of NC 86, less than two miles from the site. We did not find this sedge in the powerline wetland on the Greene Tract. Buttercup phacelia (*Phacelia covillei*) is reported from a Triangle Land Conservancy preserve along New Hope Creek, on the floodplain and adjacent slopes. We did not find this plant on the Greene Tract. The Carolina ladle crayfish (*Cambarus davidi*) is reported in Bolin Creek and New Hope Creek downstream from the Green Tract. This crayfish can live in small headwater creeks and might occur on the Greene Tract; no survey for crayfishes was conducted for this study.

1.9 Public Lands and Open Space

The Greene Tract is currently used by local residents for hiking and mountain biking, although it is not a public park and is not officially open for public use. The northern 60-acre parcel is a dedicated natural area, the Headwaters Preserve. Orange County, Chapel Hill and Carrboro have agreed to swap some of this land with environmentally sensitive lands on the southern portion of the Greene Tract with the goal of optimizing protection of stream corridors, wetlands, and sensitive habitats. Adjacent forested lands to the north and south are mostly in private ownership and may be developed in the future. Much of the adjacent lands to the east and west are already developed.

Greenways trails in the vicinity of the Greene tract are shown in Figure 13B. There are currently no public trails on or immediately adjacent to the Greene Tract, but the Town of Chapel Hill has tentative plans to convert the railroad right-of-way along the eastern boundary of the Greene Tract into a greenway trail if and when this railroad segment is no longer needed and the tracks can be removed.

Several large parcels of conservation lands owned by Duke University (Duke Forest), Triangle Land Conservancy (TLC), Orange Water and Sewer Authority (OWASA), and Orange County are within two miles of the Greene Tract (Figure 13A). The nearest of these is 0.6 miles from the site. The Henry J. Oosting Natural Area, New Hope Creek Bluffs, Blackwood Mountain, Meadow Flats, and Bald Mountain are NHP-registered natural heritage areas within Duke Forest. The Johnston Mill Preserve along New Hope Creek is owned by Triangle Land Conservancy and protected by conservation easement. These areas combined total several hundred acres of upland and floodplain forest for recreational use and ecological preservation, mostly to the northeast and northwest of the site. The Bolin Creek Natural Area is the only recognized large natural area to the south; various parcels are owned by the University of North Carolina, local governments and multiple private owners., UNC has placed a conservation easement on significant portions of the Carolina North property, and Carrboro has done so for the Adams property. The multiple private parcels the comprise the rest of the natural area are mostly unprotected. The location of the Greene Tract along the watershed divide between the New Hope Creek and Bolin/Booker Creek watersheds provides connectivity for wildlife movement between these watersheds. Headwater connection parcels such as the Greene Tract are rarely preserved, as they are considered “prime” areas for residential and commercial development. Weakley (2017) and Tuttle et al. (2019) provide recommendations for protecting large habitat patches and wildlife travel corridors among these various natural areas on and around the Greene Tract.

1.10 Cultural and Historical Resources

TRC Garrow Associates, Inc., performed a cultural and archaeological survey of the Greene Tract during January to February 2000 to locate and evaluate any significant cultural resources that might be affected by future development. The archaeologists excavated shovel test pits (STPs) on a 30-meter grid across the entire site, plus additional close-order STPs near artifact find locations to determine whether they represented an archaeological site or an isolated find. A total of 706 STPs was

excavated during this survey. Visible surface features including fieldstone piles, quarry pits, and modem historic debris clusters were also mapped.

The study revealed two prehistoric and two historic sites, plus one historic and three prehistoric isolated find locations. The prehistoric material is rhyolite, including one temporally diagnostic artifact - a Late Archaic Savannah River projectile point. The study concludes that the prehistoric finds do not appear to represent significant cultural resources, and does not recommend any further investigation for prehistoric sites.

The Byrd homestead site is located near the center of the Greene Tract, along the east-west road that follows the ridge between the Old Field Creek and Bolin Creek watersheds. It appears to have been developed in the mid-1800s, and occupied into the mid-1900s. The site contains the remnants of an I-House, a detached kitchen hearth, and a stone-lined well. At least six buildings are visible on a 1955 aerial image (Figure 7B). Several large oaks 40 inches or more in diameter at breast height are present along the road among the building remains. The trees and historic remnants are now (in 2020) severely overgrown with Asian wisteria vine.

The Potts homestead site is 1,100 feet south of the Byrd homestead site, close to a small tributary of Bolin Creek. All that remains is the stone foundation and stone chimney of a small log structure, and twenty artifacts that suggest domestic occupation from the mid-1800s to early-1900s. Background research indicates that this was the residence of Johnson and Rebecca Potts. The site in 2020 appears essentially the same as it did in photos in the 2000 report.

The Byrd and Potts homestead sites both contain archaeological deposits and architectural remnants in a moderate to high degree of integrity. The report concludes that additional information could be gained from further study of these remains and artifacts, which provide an opportunity to compare two adjacent contemporary households on different scales. It also concludes that more intensive background research, including oral history, would benefit the interpretation of these sites.

2.0 SUITABILITY ANALYSIS FOR DEVELOPMENT

2.1 Ecological Preservation Areas

Preservation of the entire 164 acres would be the optimal alternative for ecological integrity and connectivity, and has been requested by local residents who currently use the site for mountain bike riding and hiking. Preserving forest cover would gradually rebuild lost topsoil, improving soil structure and hydrologic functions (infiltration and water storage), helping to ensure adequate long-term baseflow into the seeps and streams for four-toed salamander larvae and other amphibians and insects that require standing water until summer. Pine-dominated forests on the site would likely transition to hardwood-dominated as the old loblolly pines senesce and decay. Wildlife species that require large contiguous forested tracts to survive long-term would likely persist, and the forested connection across the watershed divide between Old Field Creek, Bolin Creek, and Booker Creek would remain safely passable for small terrestrial animals.

However, ongoing development of other private and public parcels surrounding the Greene Tract will likely continue, and will likely reduce the habitat quality of connection corridors with off-site habitat areas. Ecologically-sensitive project design strategies and enforcement of riparian buffer rules on surrounding lands will be crucial in keeping these corridors suitable for wildlife passage, in addition to on-site preservation.

The full preservation alternative does not meet the local governments' perceived need for developable land, including affordable and mixed-income housing and an elementary school site; it was rejected by the Orange County Commissioners in favor of a 50/50 split for preservation and development. Preservation areas were selected based on the presence of streams, wetlands, riparian buffers, rare species, plant community maturity and diversity, steep slopes, and habitat connectivity. In the interest of keeping the non-preservation area shapes suitable for development uses, some areas of mature hardwood forest in the central portion of the site were excluded from the preservation areas.

The first priority for preservation is the streams, wetlands, and riparian buffers, which includes the four-toed salamander breeding habitat. Buffers are applied as follows, as per agreement among the three local governments: Perennial stream buffers = 150 feet wide; Intermittent stream buffers = 80 feet wide; Ephemeral stream buffers = 15 feet wide; Wetland buffers = 80 feet wide. The ephemeral streams are all within wetlands, so there is no need to show 15-foot buffers. The total proposed buffer area containing all streams and most wetlands is 40.3 acres (Figure 11A-B). We did not include a buffer around the small wetland in the powerline right-of-way, which is frequently mowed.

Local environmental staff recommend additional wetland buffers extending out to 150 feet for enhanced protection of four-toed salamanders, which breed in wet seep habitats and live as adults in the surrounding hardwood and mixed pine-hardwood forests. The regulatory buffers mapped in Figures 11A-B do not include this recommendation, but

the suggested preserve areas do encompass 150 feet or more beyond those wetlands with an extended hydroperiod likely to hold water long enough for four-toed salamander larvae to complete their metamorphosis (blue areas in Figure 10).

The additional 41.7 acres beyond the buffers recommended as preservation areas to reach the target total of 82 acres were selected based on forest species diversity, stand age, steep slopes, and proximity and connectivity to other significant habitats onsite and offsite. The Eno-New Hope Landscape Conservation Plan (Tuttle et al., 2019, Figure 12), the 2018 planning maps provided by Orange County, and the Town of Chapel Hill's Green Tract Conservation report Weakley (2017) provided guidance for this task.

Preserve alternative A (Figure 11A) is most similar to the 2018 maps developed by the three local governments, with most of the non-buffer preservation lands along Old Field Creek and in the watershed divide area between the three creeks. A small proportion is along Bolin Creek tributaries to provide the 150-foot recommended buffer around areas identified as most suitable for four-toed salamanders. The preserve area along the northeast side of Bolin Creek reach C2 is reduced by two acres (compared with the Green Tract Conservation report and 2018 plan) to accommodate the school and recreational fields, if the southern portion of the site is selected for these facilities.

Preserve alternative B (Figure 11B) includes less of the upland hardwood forest along the central ridge, and more mixed pine-hardwood forest around Bolin Creek to the south, compared with alternative A. This alternative protects more upland habitat for salamanders in the Bolin Creek watershed, where potential habitat for salamanders is more extensive (blue areas in Figure 10).

Preserve alternative C (Figure 11C) depends on the County acquiring two undeveloped parcels totaling approximately 3.0 acres of pine-dominated forest adjacent to the southeast corner of the Greene tract, immediately south of the Booker Creek wetland. This alternative would shift approximately two acres of developable land to the east side of Merin Rd, and preserve more hardwood forest between the Bolin Creek and Booker Creek watersheds. It would also increase the developable area north of Bolin Creek.

The total preserve area shown in each alternative is 83.5 acres, which includes 1.5 acres extra to allow for two road crossings along the watershed divides: one east-west crossing between the Old Field Creek and Bolin Creek headwaters. and one north-south crossing between the Bolin Creek and Booker Creek headwaters. The 2018 concept plans did not show road access for developing the eastern portion of the site, Design recommendations for minimizing impacts of road segments crossing through preserve areas are discussed in section 2.3 below.

2.2 Topography and Soils

As shown in Figure 4, the majority of the site topography is level to gentle (0-10% slopes) with some strong to steep slopes (20-33+ slopes) present along the existing wetlands. The majority of these strong to steep slopes are incorporated into the recommended preserve areas. Therefore, the majority of developable areas on the site

included level to gentle slopes, which would be favorable for potential developments in the future.

As shown in Figure 5, the majority of the site is mapped as Appling and Helena soils with minor areas of Georgeville, Cecil and Tarrus soils. Appling sandy loam (ApC) soils occur along steeper and wetland areas whereas Appling (ApB) are more apparent along level to gentle sloped areas.

Soil suitability ratings for sanitary facilities, buildings, road construction, and recreational uses are classified in the USDA Soil Survey (Dunn, 1977). The Appling, Cecil, and Georgeville soil series have moderate to severe limitations for septic absorption fields due to slow percolation rates and clayey texture. All three series are rated fair to poor for use as landfill cover soil due to their clayey texture, and fair as roadbed fill due to their low strength. They have slight to moderate limitations for low density residential development, light-duty roads, and low-intensity recreational uses, but moderate to severe limitations for high-density residential or commercial development. The Helena series has high shrink-swell potential, slow percolation, low strength, and is too clayey for most uses. It is poorly suited for septic absorption, landfill cover soil, buildings, roads, or construction fill material, and moderately suitable for recreational uses (camping, picnic areas, playgrounds, and trails) provided that a more permeable soil (or sewer) is available nearby for sanitary waste disposal.

2.3 Roads and Utilities

Orange County planning staff requested that we investigate onsite and off-site road connections to the northeast, southeast, and west sides of the Greene Tract. The 2018 conceptual plans did not include any roadway to access the potential development areas on the northeast portion of the site. Our attached conceptual site plans (Figures 14A-D) include access from all three directions plus an option to the east across the railroad right-of-way, which may be feasible at some future time if the railroad is either retired and the track removed, or if Norfolk Southern and the University of North Carolina at Chapel Hill (UNC), for which the rail serves, comes to a mutual agreement with the client to allow rail crossing.

The proposed roadways are sized at 24 feet width and assumed to be designed with light-duty asphalt for regular passenger traffic. As shown in Figures 14A-D, the roadway was laid out with some important considerations:

- Maximize developable area;
- Do not intrude into the Headwaters Preserve or any wetlands buffer, or if intrusion is necessary, then minimal intrusion required only for road accessibility;
- Do not intrude into the Duke Energy right-of-way on the eastern portion of the site, or if intrusion is necessary, then minimal intrusion required only for road accessibility for development across the right-of-way;

- Do not cross the off-site Norfolk Southern railroad along the eastern portion of the site; and
- Allow future roadway connections throughout the site for thorough and convenient ingress and egress.

Merin Road and the unknown road north of Lizzie Lane were determined to be the primary points of ingress and egress for the site. This was determined based on the location of existing traffic pattern and flow, and underground utilities (water and sewer). Three future road connections were also proposed for the roadway: one leading to Purefoy Drive along the western side of the site, one leading to Weaver Dairy Road Ext east of the site, and the other leading to Genestu Drive north of the site. Based on the existing underground water and sewer infrastructure near the site, extending or upgrading this infrastructure for the site will be necessary depending on development type and ownership. A sewer force main will most likely be required for the school development along the southern portion of the site due to site encumbrances such as wetlands, private residential properties, and the Norfolk Southern railroad.

Where proposed road segments pass through the preserve areas between watersheds, these segments should be constructed and maintained to minimize impacts to adjacent natural areas. Their construction corridor and pavement should be kept as narrow as is feasible, with minimal mowed shoulder width. Arch culverts or bridges should be provided to allow terrestrial animals to pass safely under the road.

Utility lines can be mostly installed along roadsides or beneath the pavement (for road segments crossing preserve connection areas), except for gravity sewer segments that must follow topographic relief. The suggested sewer collection system alignments shown in Figures 14A-D were selected by Orange County engineering staff and SynTerra engineers to minimize impacts to wetlands and preserve areas. Pump stations may be required to serve certain areas, including the northeast development area, where gravity line installation would be difficult or would require extensive disturbance in preserve areas.

2.4 Site Layout Alternatives

Alternative site layouts are shown in Figures 14A-14D and are generally based on the previous layouts that were considered in 2018 and subsequent discussions with the local governments. Site Layout Alternative A (Figures 14A-14B) includes four off-site road connection points, and alternative B (Figures 14C and 14D) includes a fifth possible off-site road connection point eastward to Weaver Dairy Rd Ext. Each road layout alternative is overlayed on each of the two preserve alternatives. Differences and design considerations are as follows:

- The Headwaters Preserve was kept the same, as developed by Orange County staff, and isolated the eastern portion of the site, which were then considered undevelopable since access was not allowed through the Preserve;

- The proposed roadway had future connections to the unknown road immediately north of Lizzie Lane and Merin Road to the south;
- The proposed roadway would cross the southern wetland and potentially require some form of culvert, earthen dam, or bridge;
- The southern development (for elementary school and recreational area) were separated by the roadway and required some form of safe access for children to cross;
- The southern development would require a sewer force main due to the topography and site encumbrances in the area. The force main would connect to the proposed sewer gravity main along the primary roadway;
- Approximately +/-1.5 to 2.4-acres of Headwaters Preserve would be impacted based on the necessity of roadway and utilities through the site; and
- The proposed roadway connection to Weaver Dairy Road Ext would require a railroad crossing across the Norfolk Southern railroad, which would require some form of mutual engagement and permitting between Norfolk Southern, UNC, and the Client.

2.5 Development Impacts to Cultural Sites

The local governments have identified protecting and preserving the two historic homestead sites as a goal in developing plans for the Greene Tract. The Potts site is included within the Bolin Creek ecological preserve area in each of the site layout alternatives. The Byrd site is excluded from the ecological preserve areas, as it is densely overgrown with Asian wisteria and has relatively low ecological value. This area, including the cluster of large oaks among the building remains and along the road, should be treated to remove the wisteria and prevent its spread into the natural areas, and preserved as a historical site within the developed area. Structural and cultural integrity of the remains will need to be considered in removing the vines. Signage should be installed to explain the significance of these sites and dissuade vandalism.

2.6 Development Impacts to Preservation Area Ecology

When upland forests are cleared and graded to accommodate buildings, roads, and utilities, it is inevitable that some sediment will be transported downslope into the preservation area wetlands and streams, even with approved and well-managed erosion control measures. This impact will likely be temporary during the construction phase, but could damage sensitive headwater seep area plant and animal communities.

After development, the urbanized lands will infiltrate and store less soil water, and baseflow into the seeps will likely decrease during dry weather. Stormwater control measures can mitigate pollutants and erosion due to rapid runoff, but they do not replace the baseflow storage and slow release functions of undisturbed forest soils. The duration that streams and seeps in the preservation areas hold surface water will

likely decrease, and surface water features will likely dry up earlier in the year, on average, than under present conditions. This may in turn reduce the survival of aquatic invertebrates and amphibians that require several weeks or months before transforming to their terrestrial stage, including the four-toed salamander.

Development may also have indirect effects on the ecological balance of the area due to forest fragmentation and increased forest edge habitat. Wildlife species that require forest interiors or require large tracts of undisturbed land will likely decline, and those that prefer or tolerate edge habitats and smaller forest patches (urban tolerant wildlife) may increase in abundance (Sather and Hall, 1988). Meyer (2008) suggests that the four-toed salamander also prefers extensive contiguous forest, and may decline where forest tracts are fragmented. The width of uninterrupted forest canopy on the site will be reduced to 25 to 35 percent of its current dimension, based on the site layout options.

Invasive exotic plants including *Ligustrum, Microstegium, Lonicera, Elaeagnus, Youngia, Pyrus,* and others are likely to spread from construction sites and developed lands into the preservation areas. Combined with fertilizers and pet waste, invasives may outcompete the existing natives, including *Sphagnum* moss which is essential for the four-toed salamander. Predation from domestic and feral cats and wildlife species that thrive near developed areas (rats, raccoons, opossums) will likely increase. Flushing of fire hydrants, lawn-care chemicals, car washing and other outdoor cleaning activities, vehicle fluid leaks, pavement sealants, paints and solvents, and other potentially toxic materials are especially damaging in headwater seeps due to their naturally low flow and low rate of sediment transport.

Gravity sewer line construction and maintenance through the preserve areas adjacent to Bolin Creek and Old Field Creek tributaries will result in reduced riparian forest canopy. Forest canopy reduction combined with runoff from roofs and paved surfaces will likely raise summer water temperatures in the seeps, especially during brief summer thunderstorms falling on hot surfaces. These thermal impacts may be hazardous to four-toed salamander larvae, especially in the NC Piedmont region which is in the southern portion of their range. Alternatively, a pumped sewer collection system could be installed in selected areas to avoid construction near the creeks and seeps.

Strategies for minimizing adverse impacts of urban development to adjacent wildlife habitats are provided in a Best Management Practices guidance document by the NC Wildlife Resources Commission in Appendix C. These principles and others from the Eno-New Hope Conservation Plan should be used to create a development standards and guidance document for the Greene Tract with special requirements for stormwater management, landscaping, protection of significant tree clusters, and other activities to minimize adverse impacts and maximize protection of the remaining preserve areas. The document should also include educational outreach about the environmental and cultural features of the site to help residents and visitors understand the special significance and sensitivity of the preserve.

3.0 REFERENCES

Bradley, P.J., C.M. Phillips, N.K. Gay, R. and S.J. Fuemmeler. 2004, Geologic map of the Chapel Hill 7.5-minute quadrangle, Orange and Durham Counties, North Carolina, N.C. Geological Survey Open-file Report 2004-01, Revision- 02 (2008).

Dunn, J. 1977. Soil Survey of Orange County, North Carolina. US Department of Agriculture, Soil Conservation Service, Raleigh, N.C. 93 pp.

Eaton Scientific. 2018. Biological Monitoring of Chapel Hill Streams, North Carolina. Edited by A.S. Weakley, Town of Chapel Hill, Stormwater Management. https://www.townofchapelhill.org/government/departments-services/public-works/stormwater-management/water-quality/biological-monitoring

Meyer, Rachelle. 2008. Hemidactylium scutatum. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: www.fs.fed.us/database/feis/animals/amphibian/hesc/all.html

NC Division of Land Resources. 1985. Geologic map of North Carolina. NC Dept of Natural Resources & Community Development, Geological Survey, Raleigh NC.

Robert J. Goldstein and Associates, Inc. March 2000. Biological Resources Survey of the Greene Tract -- Orange County Regional Landfill, Orange Co, NC. Report to Town of Chapel Hill Dept of Solid Waste Management, Chapel Hill, NC.

Sather, D. and S. Hall. 1988. Inventory of Natural Areas and Wildlife Habitats for Orange County, North Carolina. Updated 2004 by Bruce Sorrie and Rich Shaw. NC Natural Heritage Program, Raleigh NC. 279 pp

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina - Third Approximation. North Carolina Natural Heritage Program, Raleigh, N.C. 325 pp.

TRC Garrow and Associates, Inc. February 2000. Cultural Resource Survey of the Greene Tract, Orange County, NC. 54 pp.

Tuttle, J., B. Massa, O. Munzer, R. Shaw, S. Childs, and J. Randall. 2019. A Landscape Plan for Wildlife Habitat Connectivity, December 2019. Eno-New Hope Landscape Conservation Group -- UNC Botanical Garden, NC Wildlife Resources Commission, and Orange County. 79 pp.

Weakley, Allison S. 2017. Greene Tract Conservation (Draft). Town of Chapel Hill Stormwater Division, Chapel Hill, NC. 11pp.

FIGURES

Science & Engineering Consultants

Figure 1. Project vicinity map, USGS Topographic Quadrangle, Chapel Hill NC, with Greene Tract boundary.

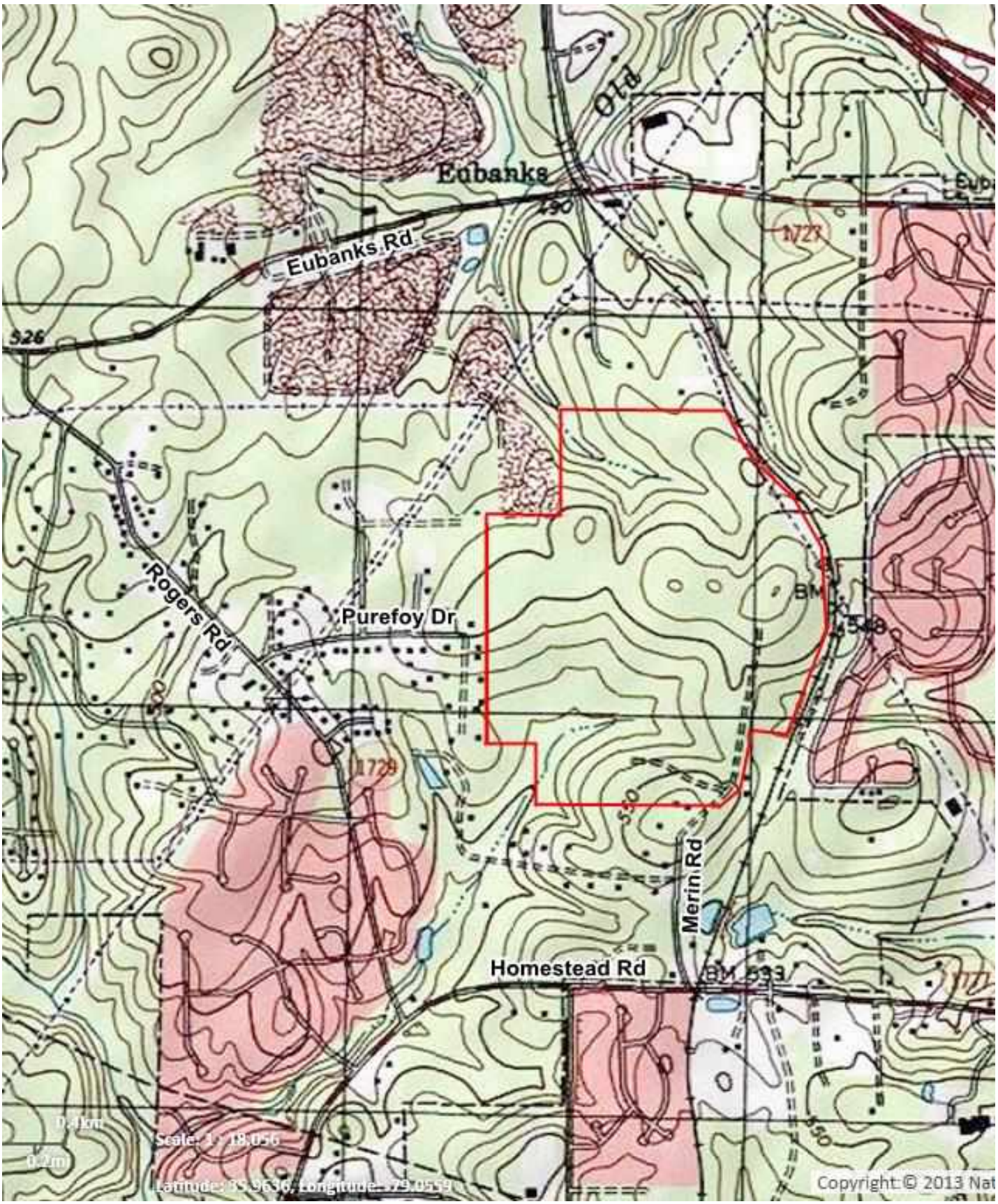

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Figure 2. Greene Tract parcel map with topography and hydrology, from NC One Map.

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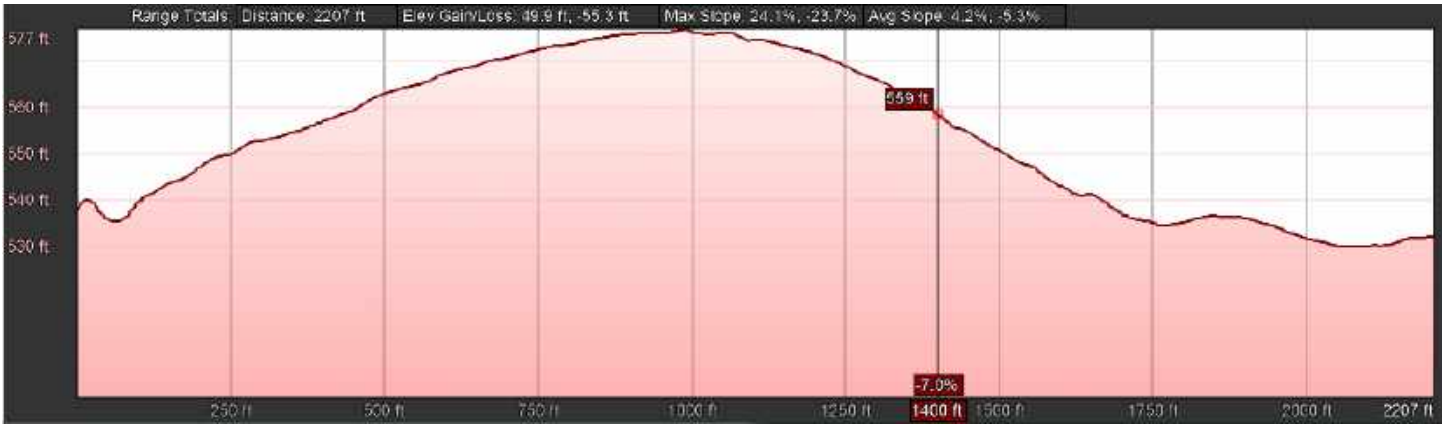
Figure 3. Elevation Profiles on the Greene Tract, from Google Earth. Transects run from North to South, and are numbered in sequence from East to West.

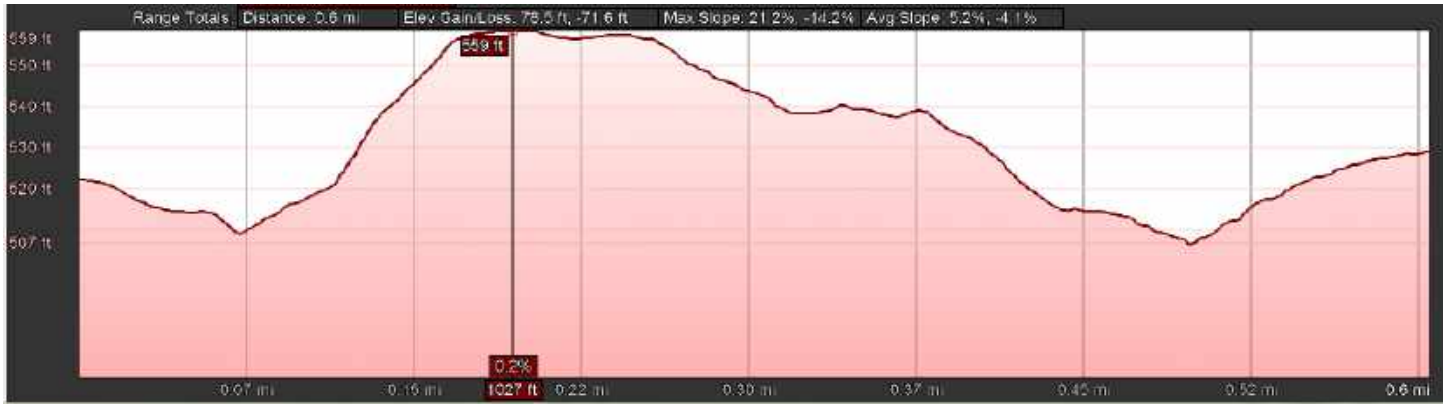
Transect 1: North end (Left) = 35.96298, -79.06952. South end (Right) = 35.95716, -79.06970.



Transect 2: North end (Left) = 35.96482, -79.07117. South end (Right) = 35.95607, -79.07142.

Transect 3: North end (Left) = 35.96478, -79.07312. South end (Right) = 35.95603, -79.07347.

Transect 4: North end (Left) = 35.96477, -79.07439. South end (Right) = 35.95601, -79.07494.



Transect 5: North end (Left) = 35.96474, -79.07567. South end (Right) = 35.95598, -79.07651.

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Figure 4. Steep slopes on the Greene Tract

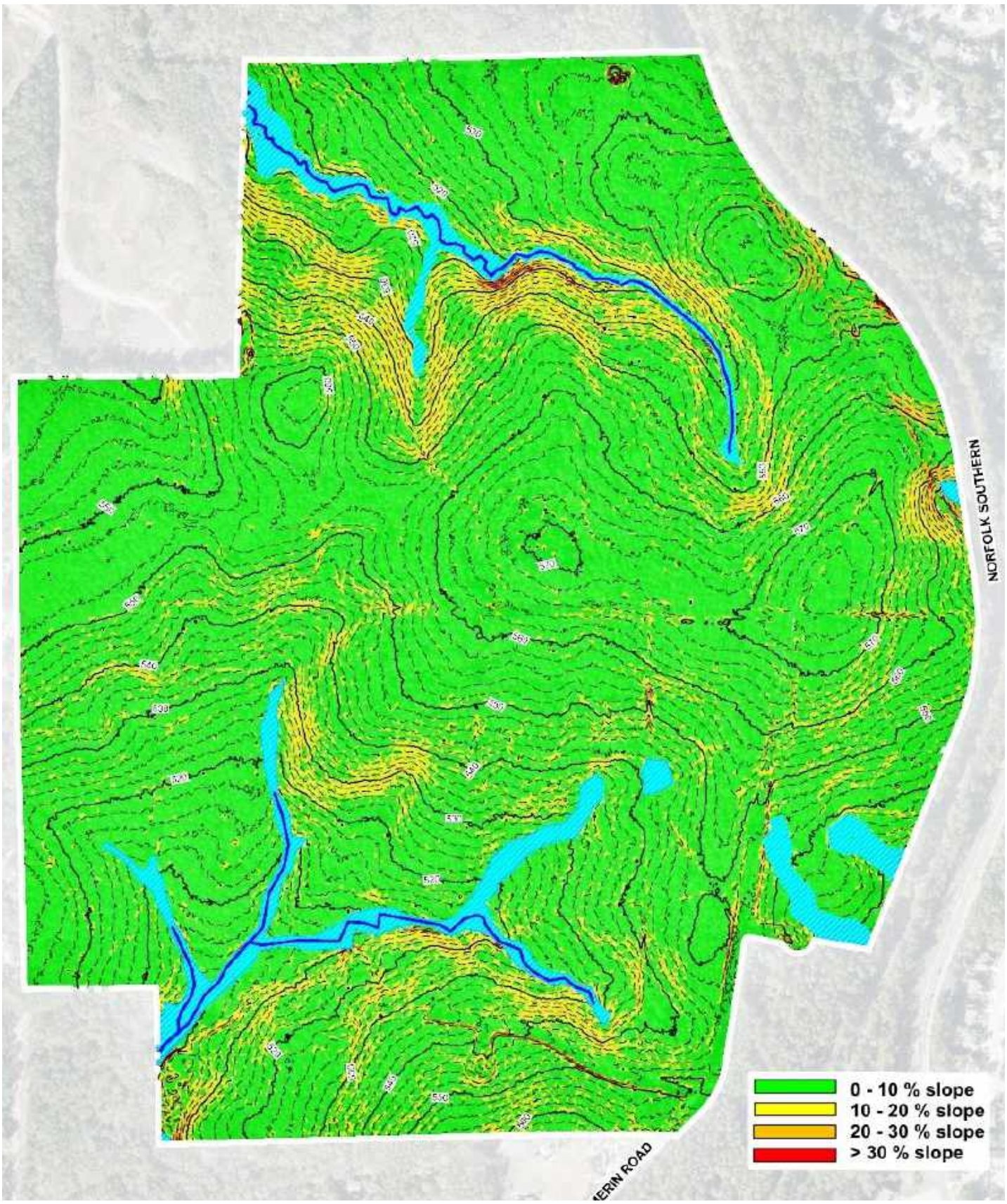
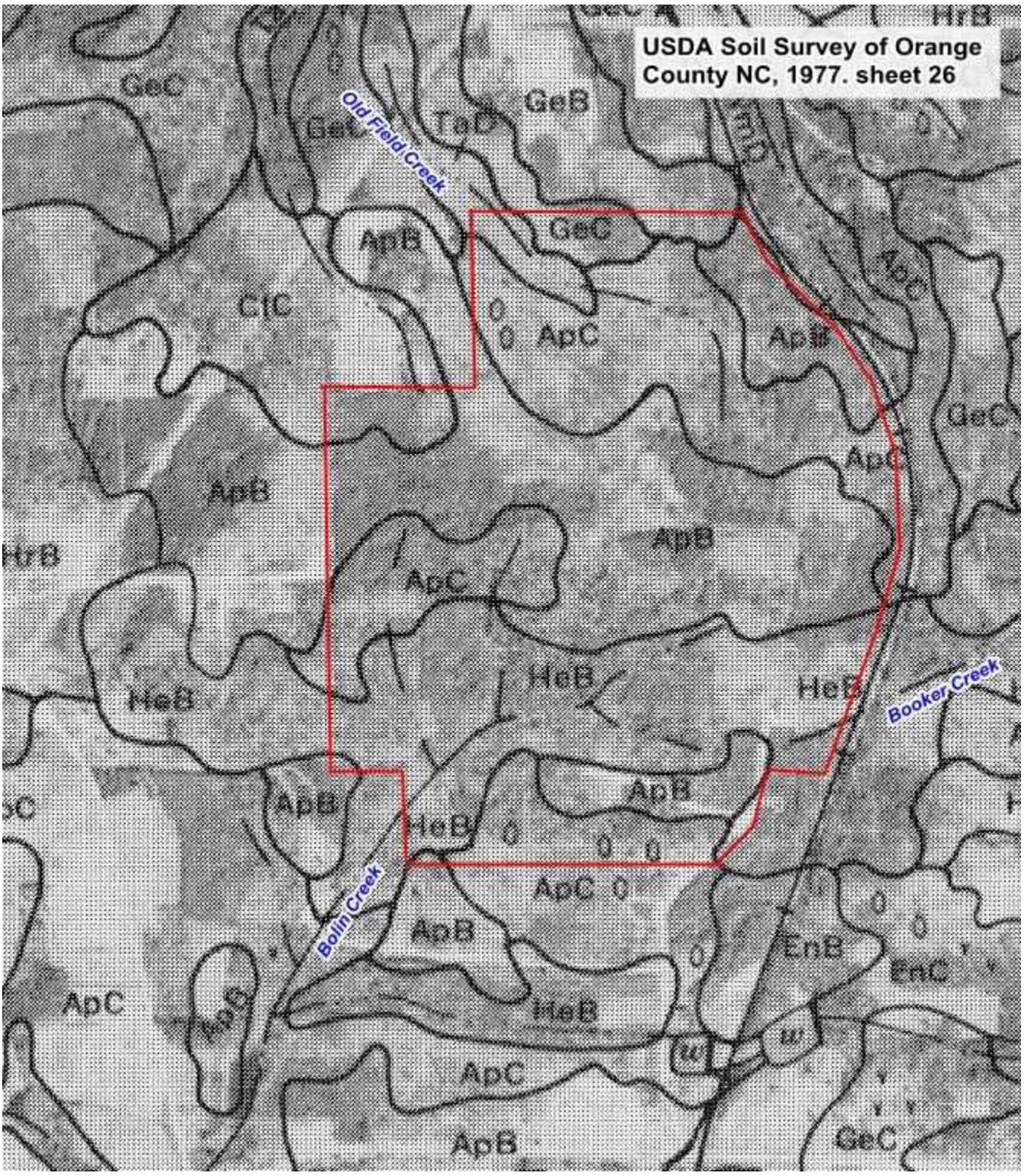
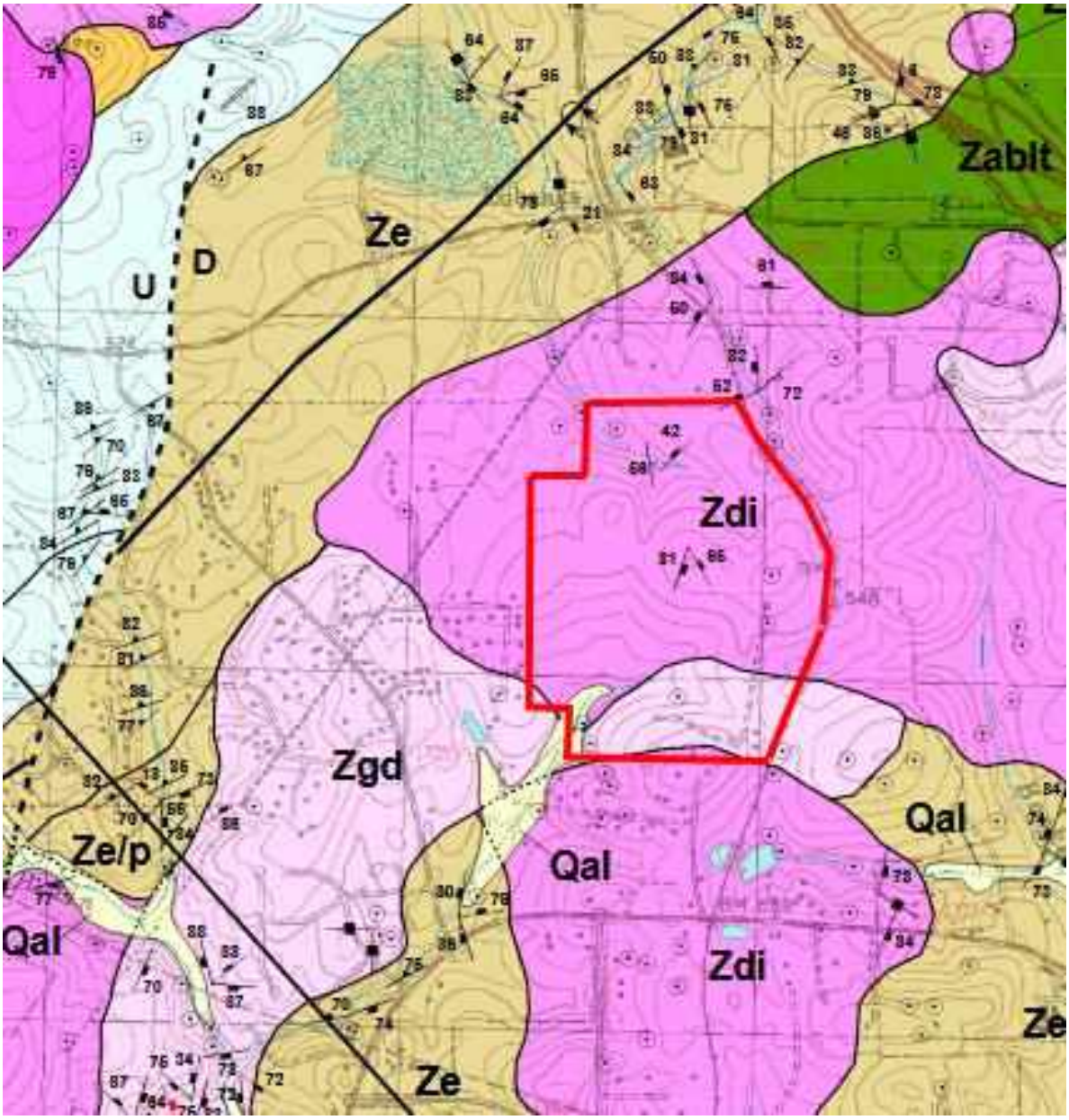


Figure 5. USDA Soil Survey of Orange County, 1977, with Greene Tract boundary.



Soil Series: Appling sandy loam (ApB and ApC) = 68 percent; Helena sandy loam (HeB) = 25 percent; Cecil fine sandy loam (CfC) = 2 percent; Georgeville silt loam (GeB and GeC) = 3 percent; Tarrus silt loam (TaD) = 2 percent.

Figure 6. Geologic Map of the Chapel Hill 7.5-Minute Quadrangle, Orange County NC. Bradley et al., 2004



Qal – Alluvium: Unconsolidated clay, silt, sand and gravel to cobble-sized clasts, subrounded to angular, deposited in drainages.

Zgd – Granodiorite: Leucoractic to mesocratic, fine- to medium-grained, equigranular to porphyritic granodiorite. In the northern portion of the quadrangle, the granodiorite is mainly pinkish hued, fine- to medium-grained with dark green to black <1 mm to 4 mm clots of mafic minerals interpreted to be biotite and amphibole masses. Chlorite growth on biotite and amphibole is present. Medium-grained, with light pink to pinkish white alkali feldspars (up to 5 mm diameter), porphyritic granodiorite is intermingled in the northern portion of the quadrangle. In the central and southern portions of the quadrangle the granodiorite is mainly whitish-gray, fine- to medium-grained, biotite, +/- hornblende granodiorite with minor pink-colored alkali feldspar. Plagioclase grains are often sericitized and saussuritized and exhibit a greenish color throughout the unit.

Zdi – Diorite: Mainly greenish-gray to gray, mesocratic, medium-grained, equigranular diorite. Major minerals include plagioclase and hornblende. Greenish-white plagioclase crystals compose up to 50% of the rock and are typically sericitized and saussuritized. Individual stocks contain varying amounts of tonalite and quartz diorite. Hornblende is typically altered to chlorite and actinolite masses. Weathered cobbles and boulders typically display a "bleached" weathering rind of white to grayish-white.

Figure 7A. Aerial photography of the Greene tract, April 1938.

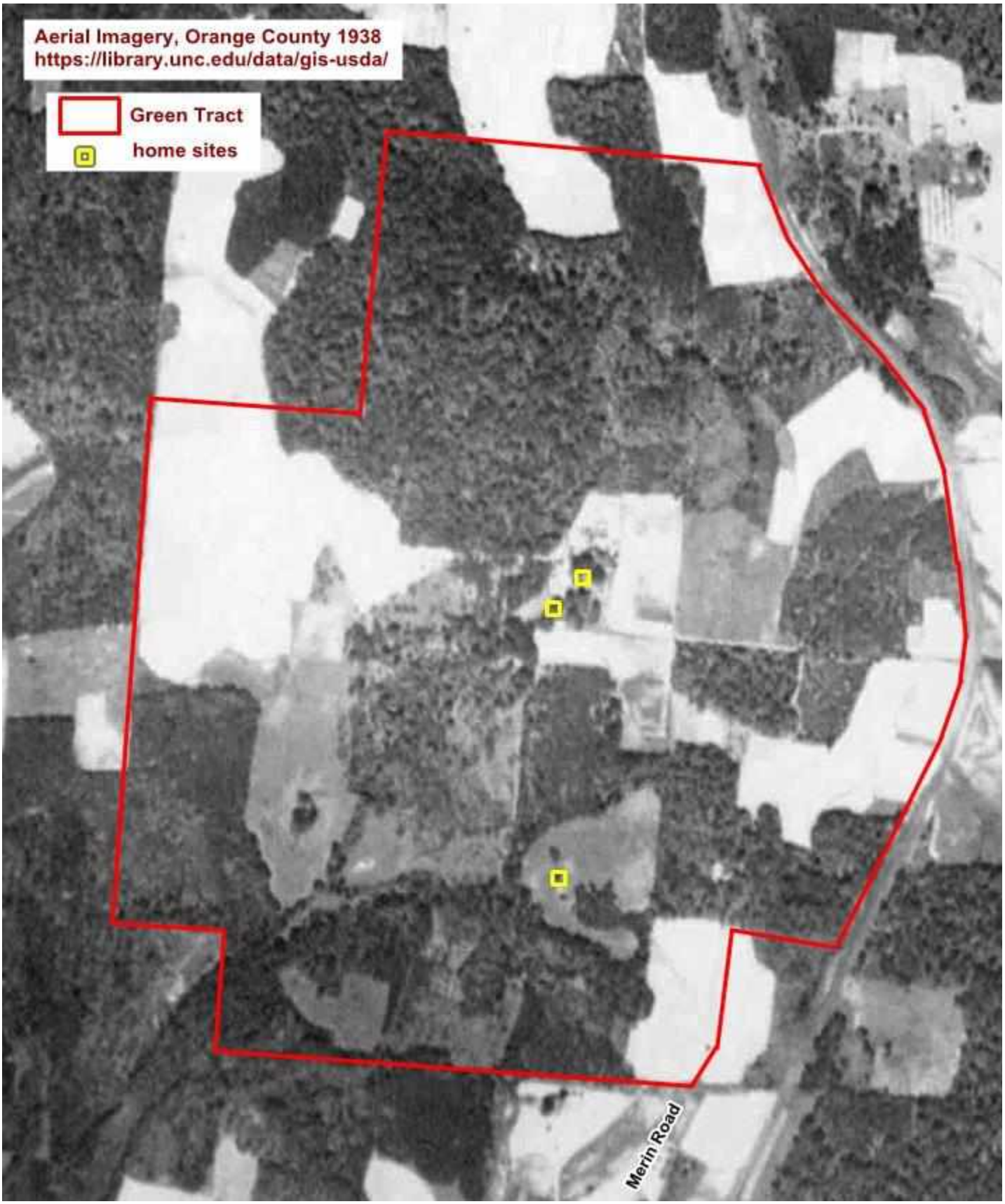


Figure 7B. Aerial photography of the Greene tract, March 1955.

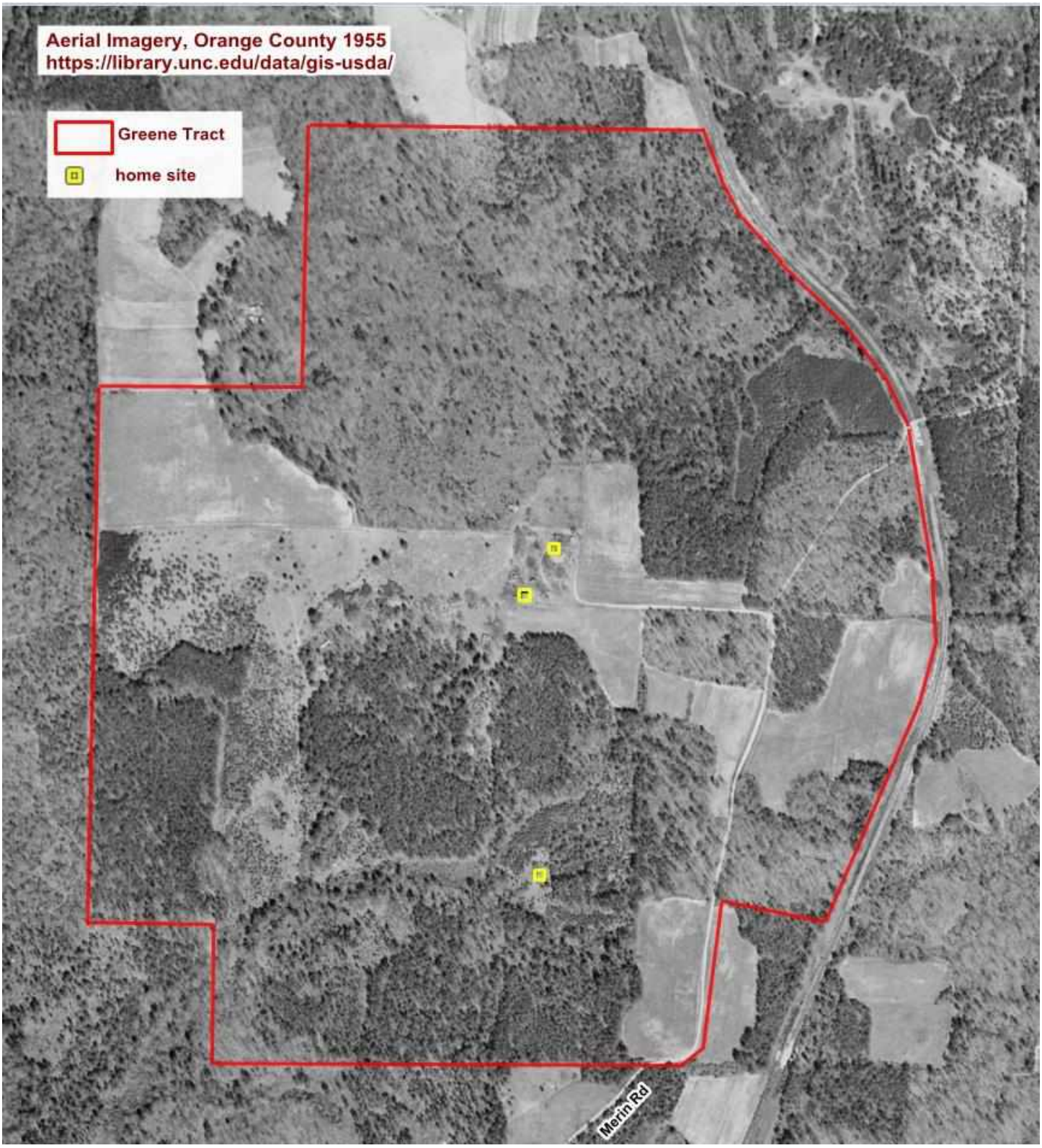


Figure 7C. Aerial photography of the Greene tract, November 1975.

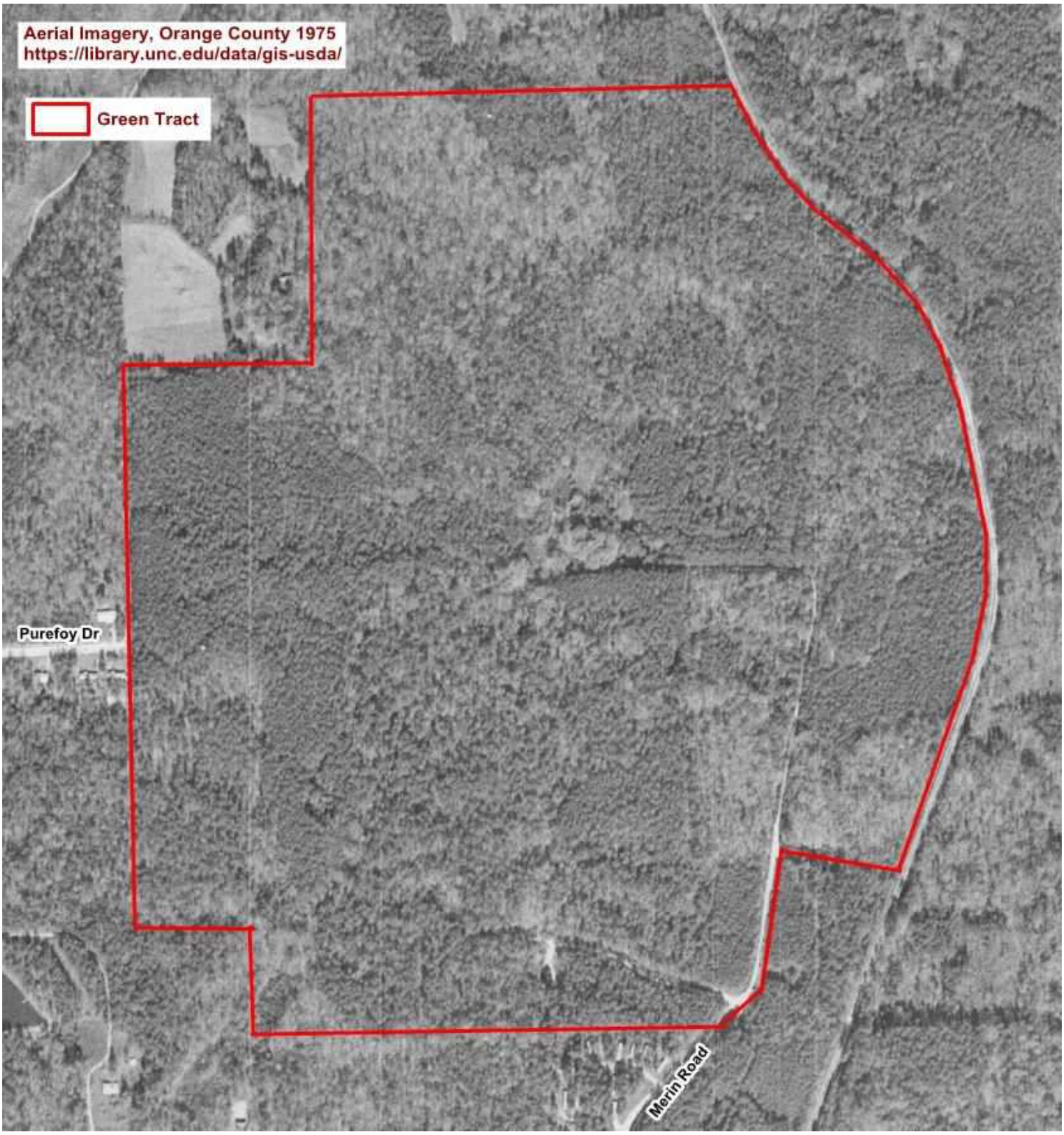


Figure 8A. Streams, wetlands, and regulated buffers, northern section, Old Field Creek watershed. Stream transition points from Town of Chapel Hill.

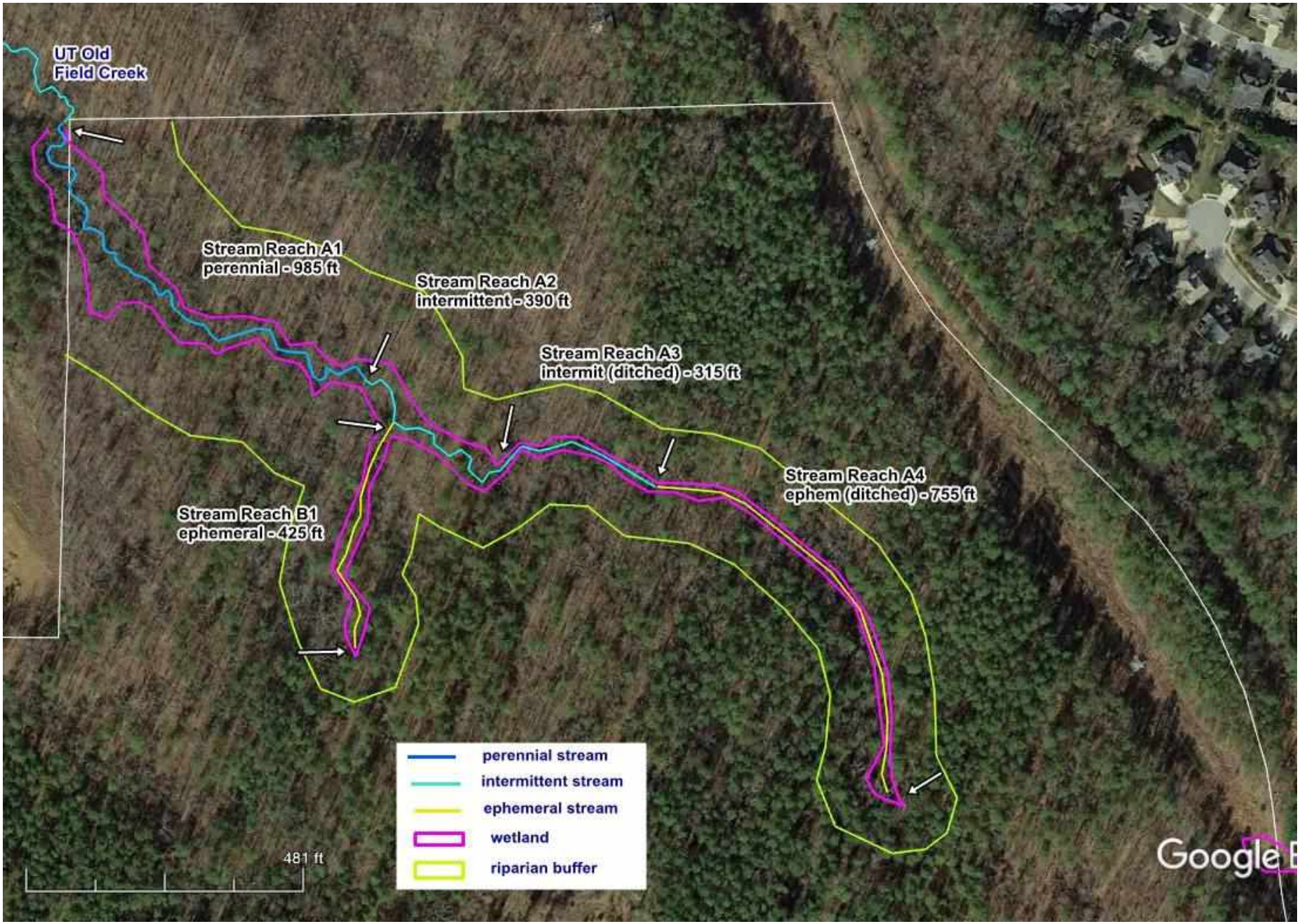


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Figure 8B. Streams, wetlands, and regulated buffers, southern section, Bolin Creek watershed. Stream transition points from Town of Chapel Hill.

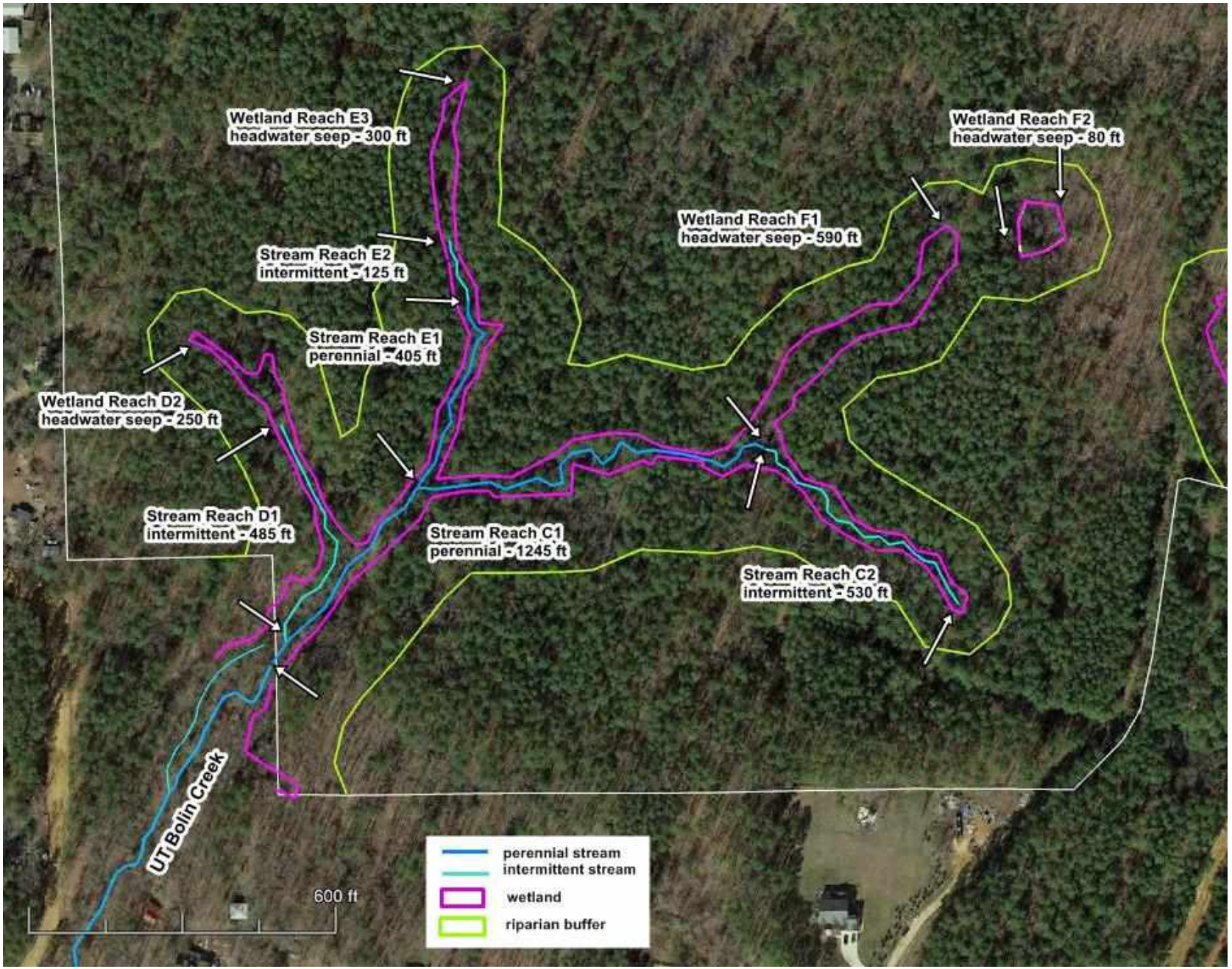

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Figure 8C. Streams, wetlands, and regulated buffers, eastern section, Booker Creek watershed. Stream transition points from Town of Chapel Hill.

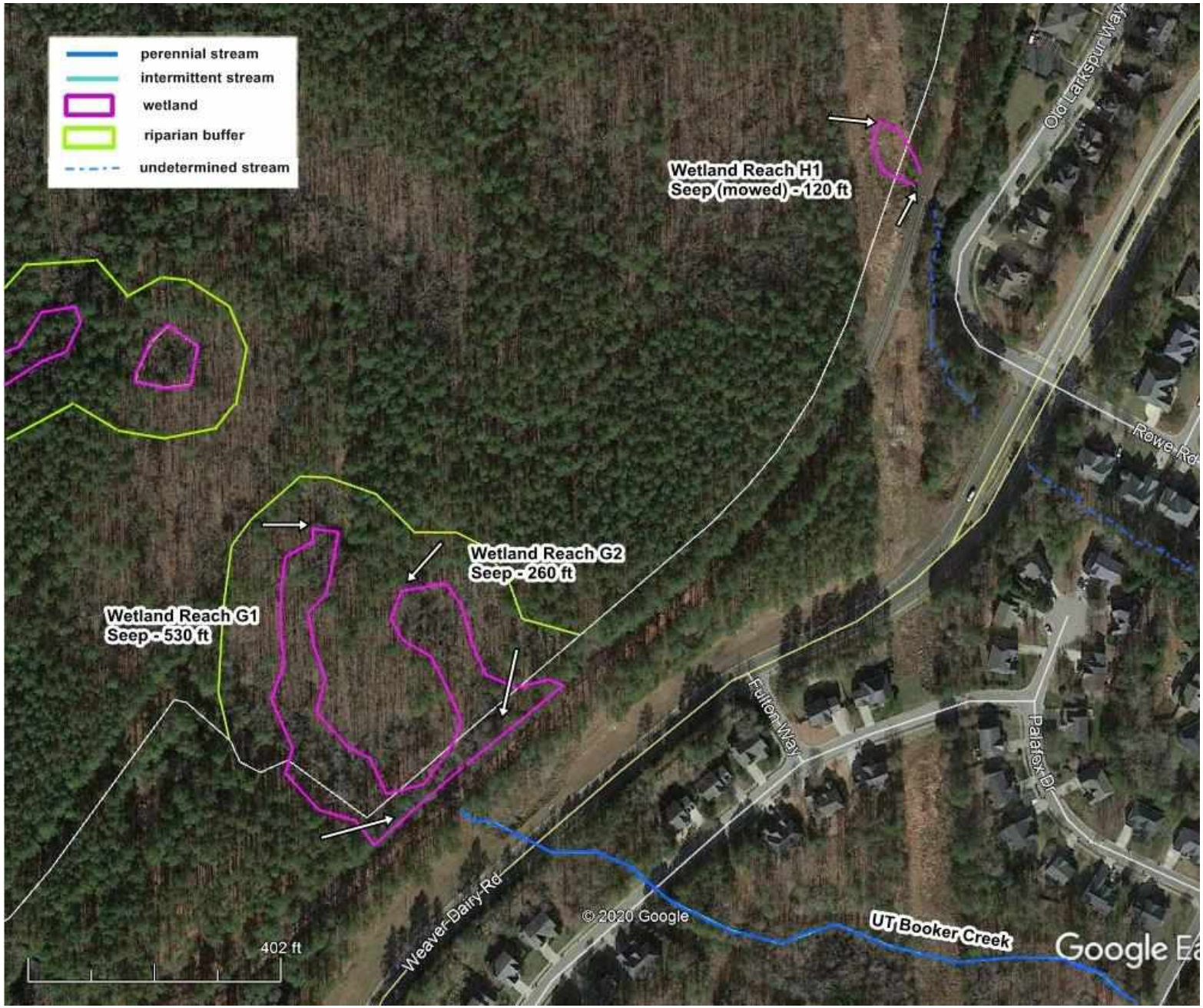

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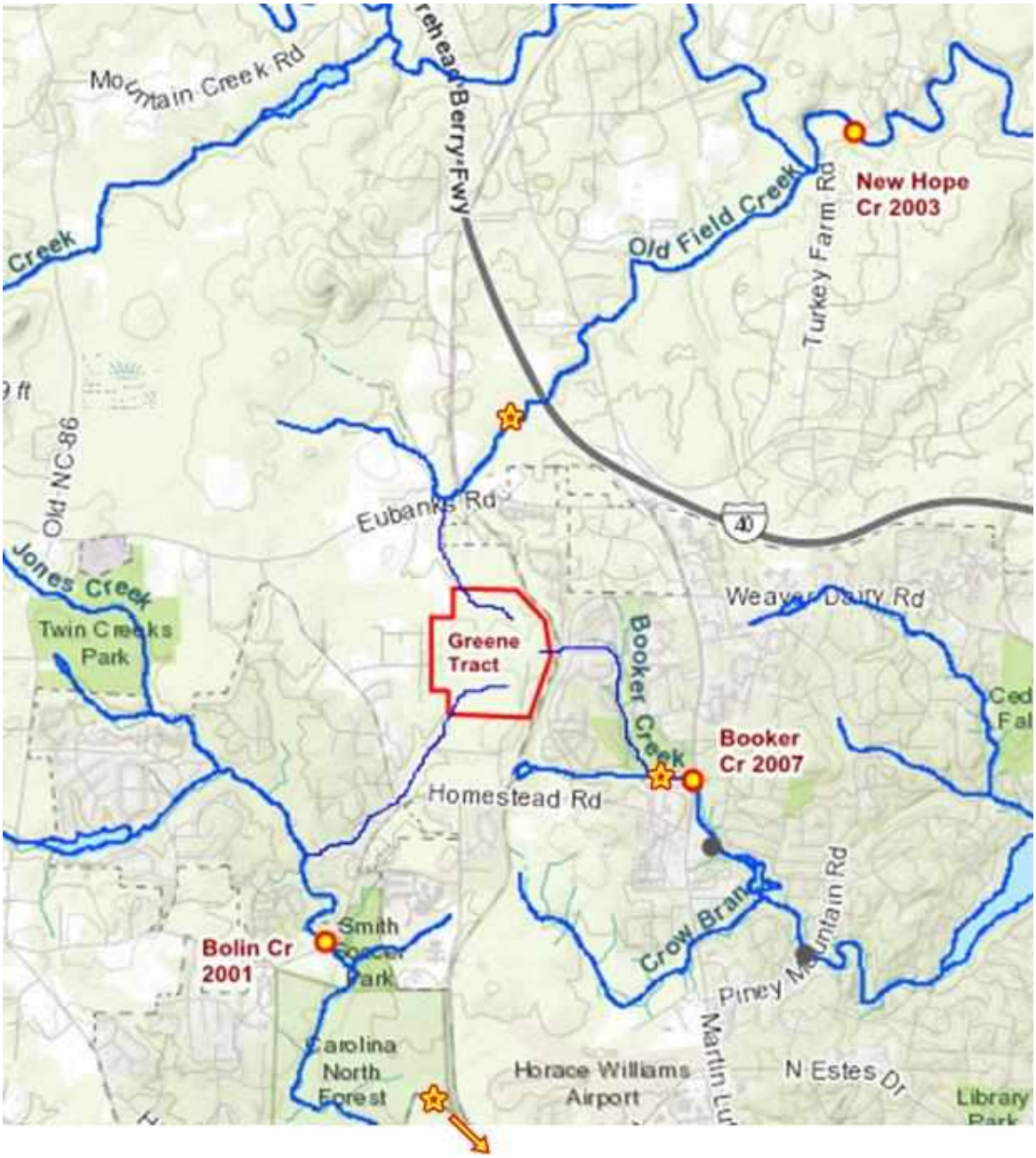
Figure 9. NC Division of Water Resources and Town of Chapel Hill biological samples downstream of Greene Tract.



Circles = NC-DWR Samples (table below); Stars = Town of Chapel Hill Samples (EA text section 1.6)

Stream Name	Road Name	Road #	Mo-Year	Taxa	EPT	Taxa-BI	EPT-BI	WQ Rating
Benthic Macroinvertebrate samples								
Booker Creek	MLKing /Airport Rd	NC-86	May 2007	39	4	5.92	4.94	not rated
Bolin Creek	Homestead Rd	SR-1777	July 2001	87	24	5.85	5.14	Good-Fair
New Hope Cr	Turkey Farm Rd	SR-1730	Jun 2003	79	16	5.46	4.80	Good-Fair
Fish Community samples								
Bolin Creek	Homestead Rd	SR-1777	Oct 2001	13				Good

Taxa = All species; EPT = Ephemeroptera, Plecoptera, & Trichoptera species; BI = Biotic Index.
Biotic Index values range from 1 to 10, with lower values indicating more pristine conditions.

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Figure 10. Habitat map of the Greene Tract, with appproximate ages of forest stands.

Upland Hardwood forests (Mesic Mixed Hardwood and Dr-Mesic Oak/Hickory forests), mixed Pine-Hardwood forests, and Pine-dominated forest ages are estimated based on aerial photography from 1938, 1955, and 1975. Upland habitats are labelled in red. Stream and wetland habitats are labelled in blue. "Stream / Wet seep" habitats (blue outline) have prolonged standing and/or flowing water making them suitable for aquatic life, including amphibian breeding sites. "Head seep" habitats (yellow outline) had little or no surface water in May 2020 despite normal rainfall, and appear too dry to sustain salamander larvae through metamorphosis which occurs in June to July.

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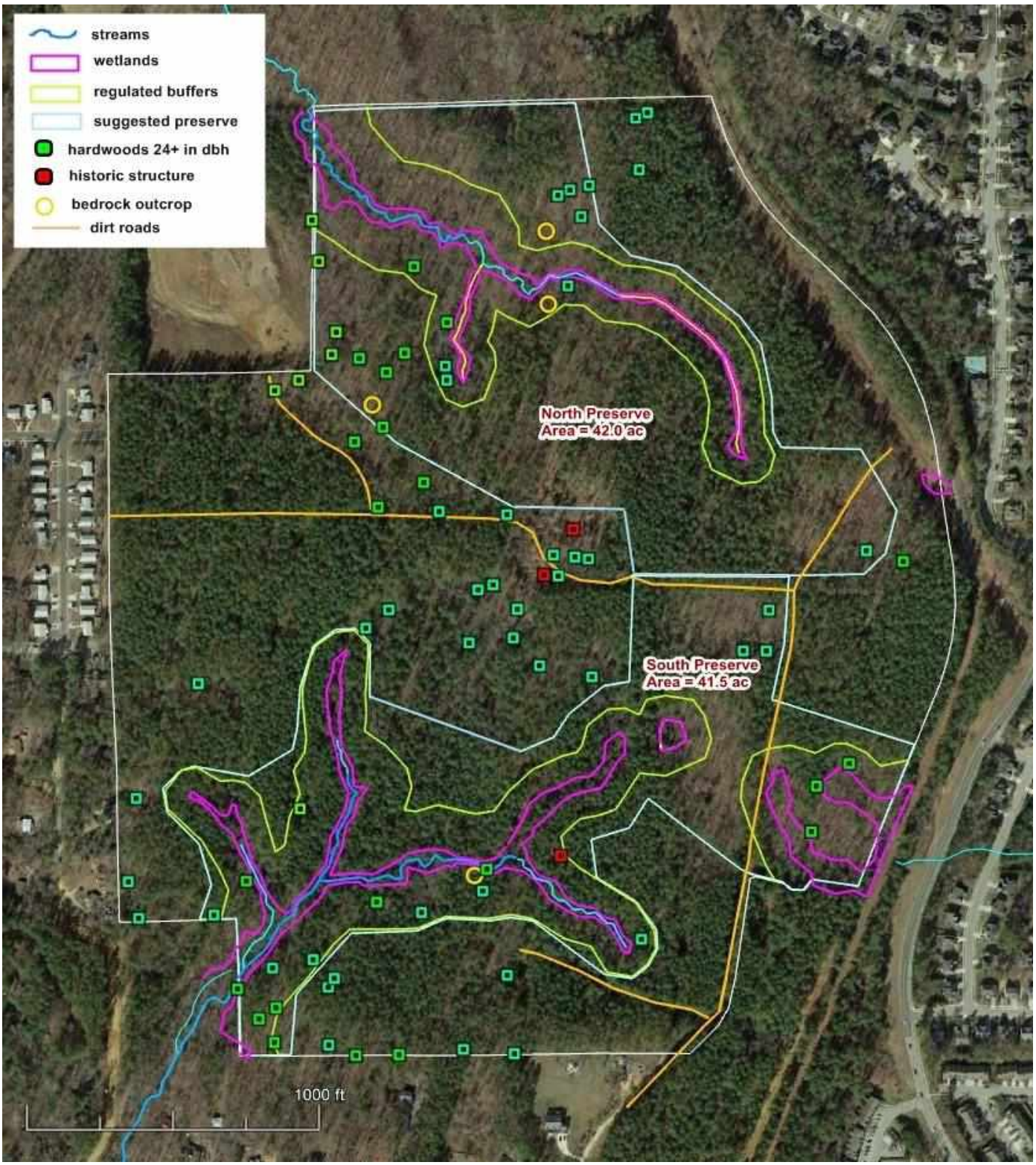
Figure 11A. Existing natural and cultural features and suggested preserve areas, Alternative A.



Preserve area layout A is based on the 2018 maps developed by Orange County and the Towns of Chapel Hill and Carrboro. Regulated buffer areas (pale green) total 40.3 acres. Buffers are 150 ft along perennial streams and 80 ft around wetlands. Buffers along intermittent streams (80 ft) and ephemeral streams (15 ft) are contained within the wetland buffers. Preserve areas (pale blue) include 150 ft or wider buffers around all wetlands identified as suitable four-toed salamander breeding habitat. Total preserve area is 83.5 acres, including 1.5 acre for roadway impacts.

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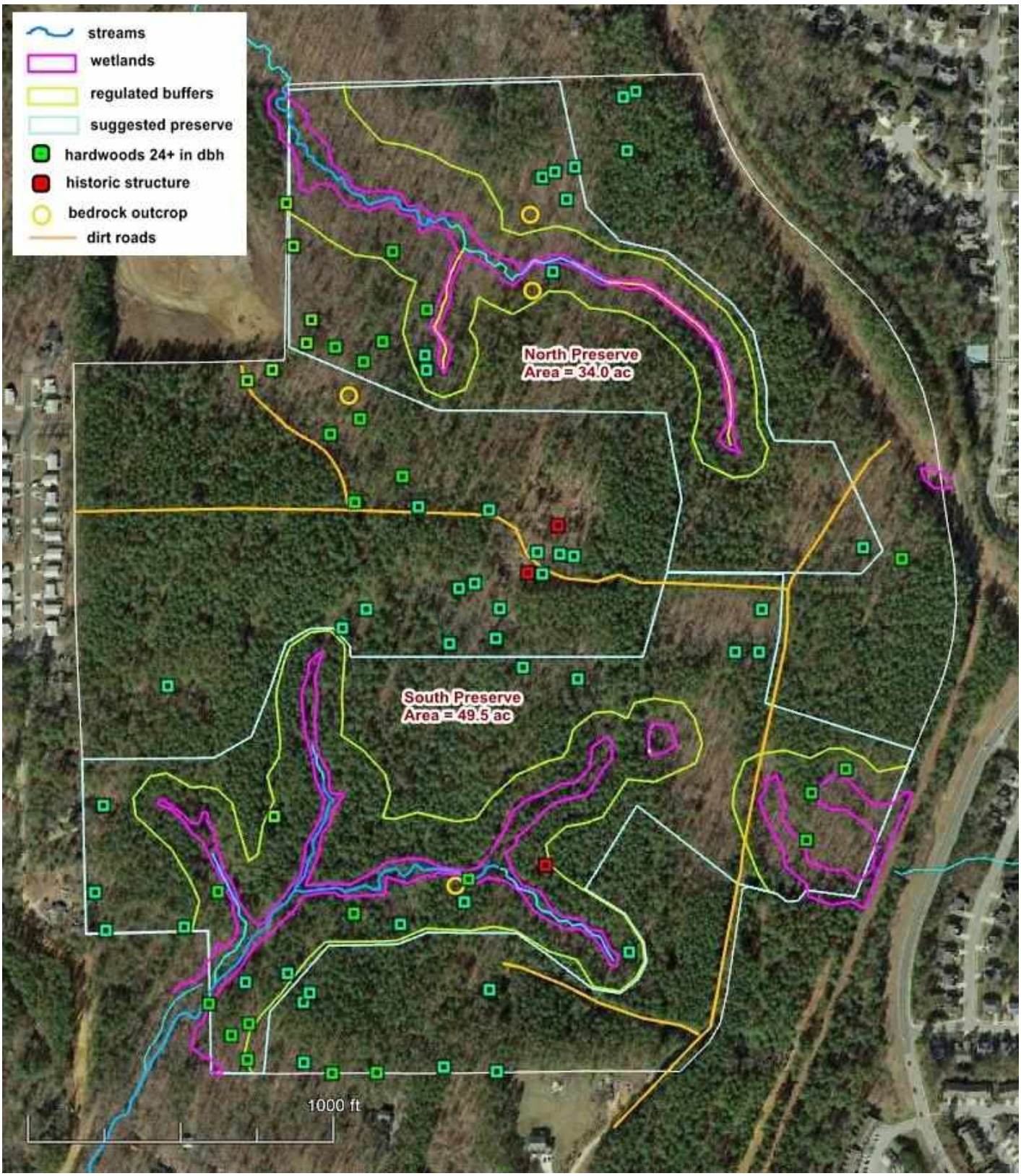
Figure 11B. Existing natural and cultural features and suggested preserve areas, Alternative B.



Preserve area layout B preserves less upland hardwood forest along the central ridge, and more pine-hardwood forest around Bolin Creek tributaries to the south, compared with layout A. Regulated buffer areas (total 40.3 acres) are the same as in layout A. Total preserve area shown is 83.5 acres, including 1.5 acre for roadway construction impacts.

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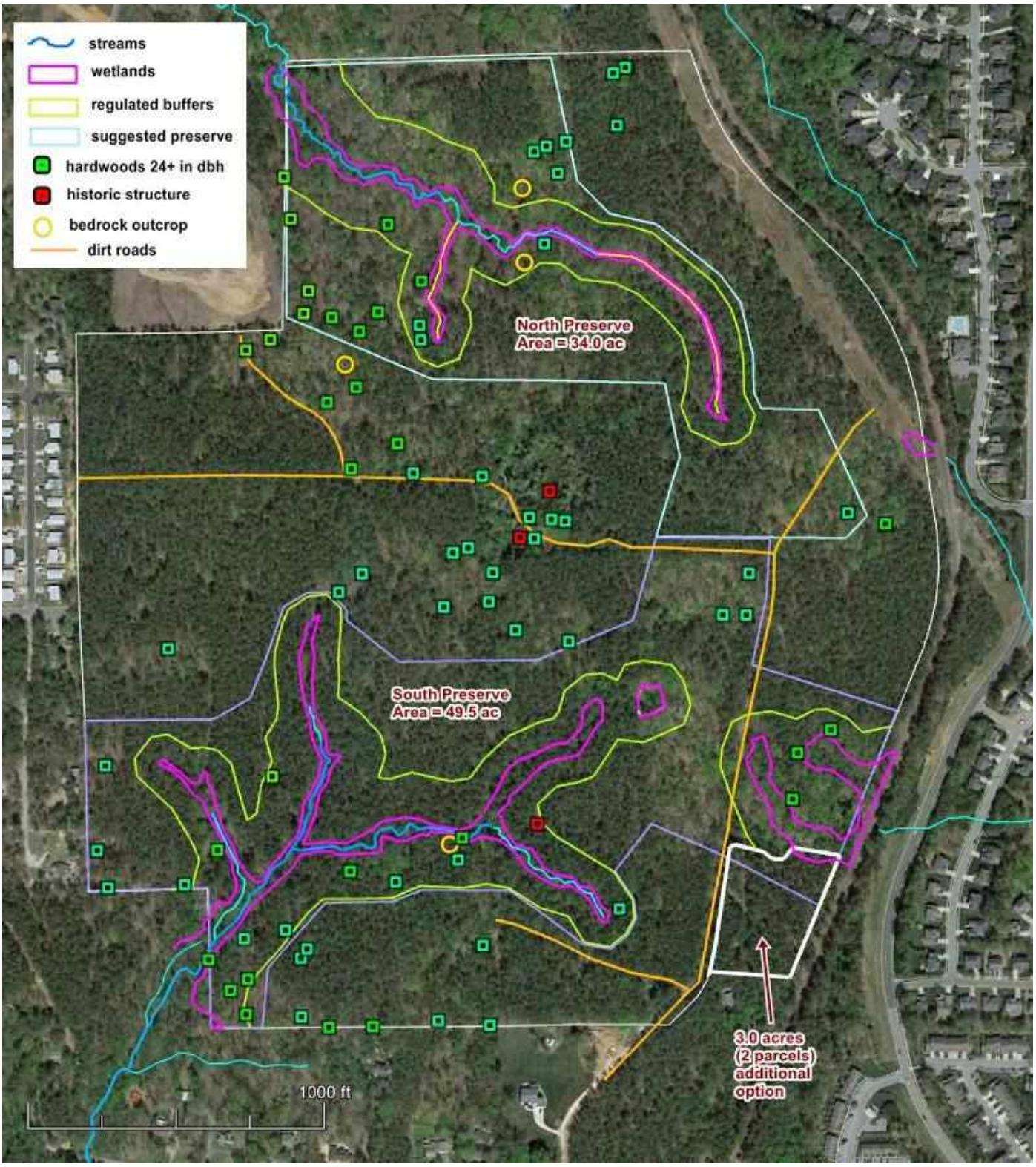
Figure 11C. Existing natural and cultural features and suggested preserve areas, Alternative C.



Preserve area layout C may be feasible if Orange County can acquire the two undeveloped parcels (totaling approximately 3.0 acres) adjacent to the southeast corner of the Greene Tract. This alternative would preserve more hardwood forest between the Bolin Creek and Booker Creek watersheds, in exchange for an equivalent area of developable land along the central ridge north of Bolin Creek. Regulated buffer areas (total 40.3 acres) are the same as in layout A. Total preserve area shown is 83.5 acres, including 1.5 acre for roadway construction impacts.

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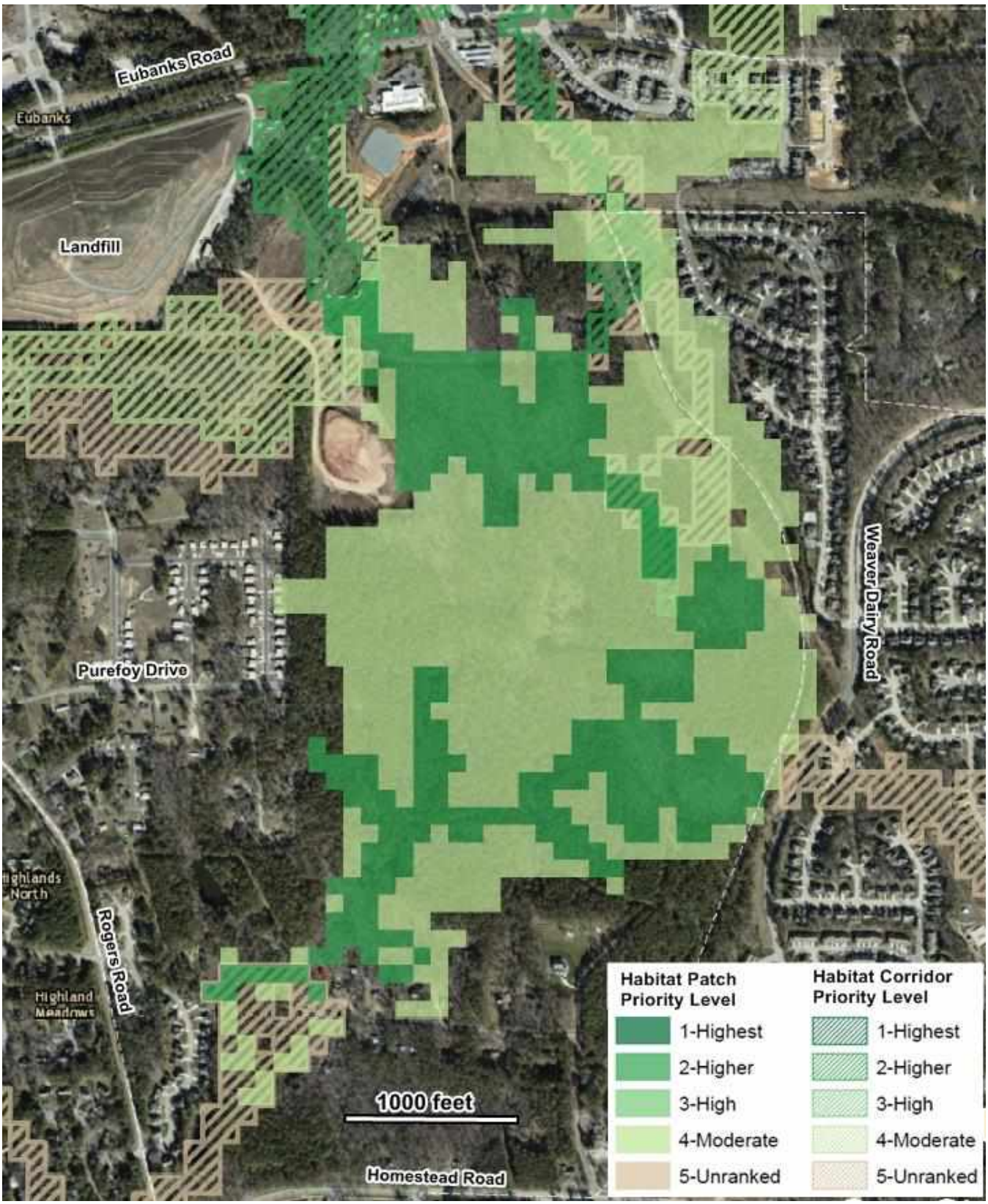
Figure 12. Priority habitat conservation areas and wildlife corridors.



Source: Tuttle et al., 2019. A Landscape Plan for Wildlife Habitat Connectivity in the Eno River and New Hope Creek Watersheds, December 2019. Eno-New Hope Landscape Conservation Group: UNC Botanical Garden, NC Wildlife Resources Commission, and Orange County.

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Figure 13A. Natural areas and open space in the vicinity of the Greene Tract. Unlabeled green areas are Town parks and open space lands.

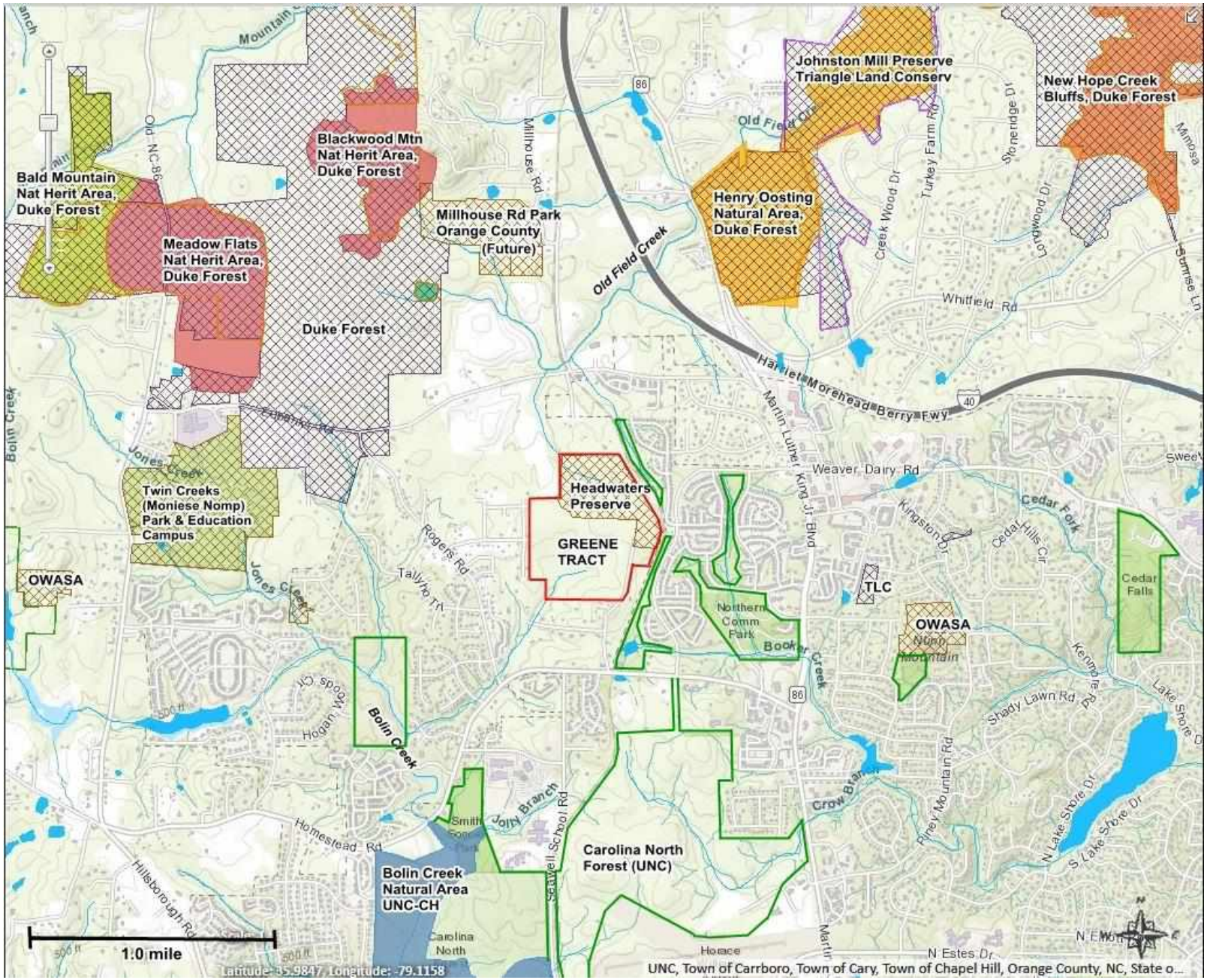

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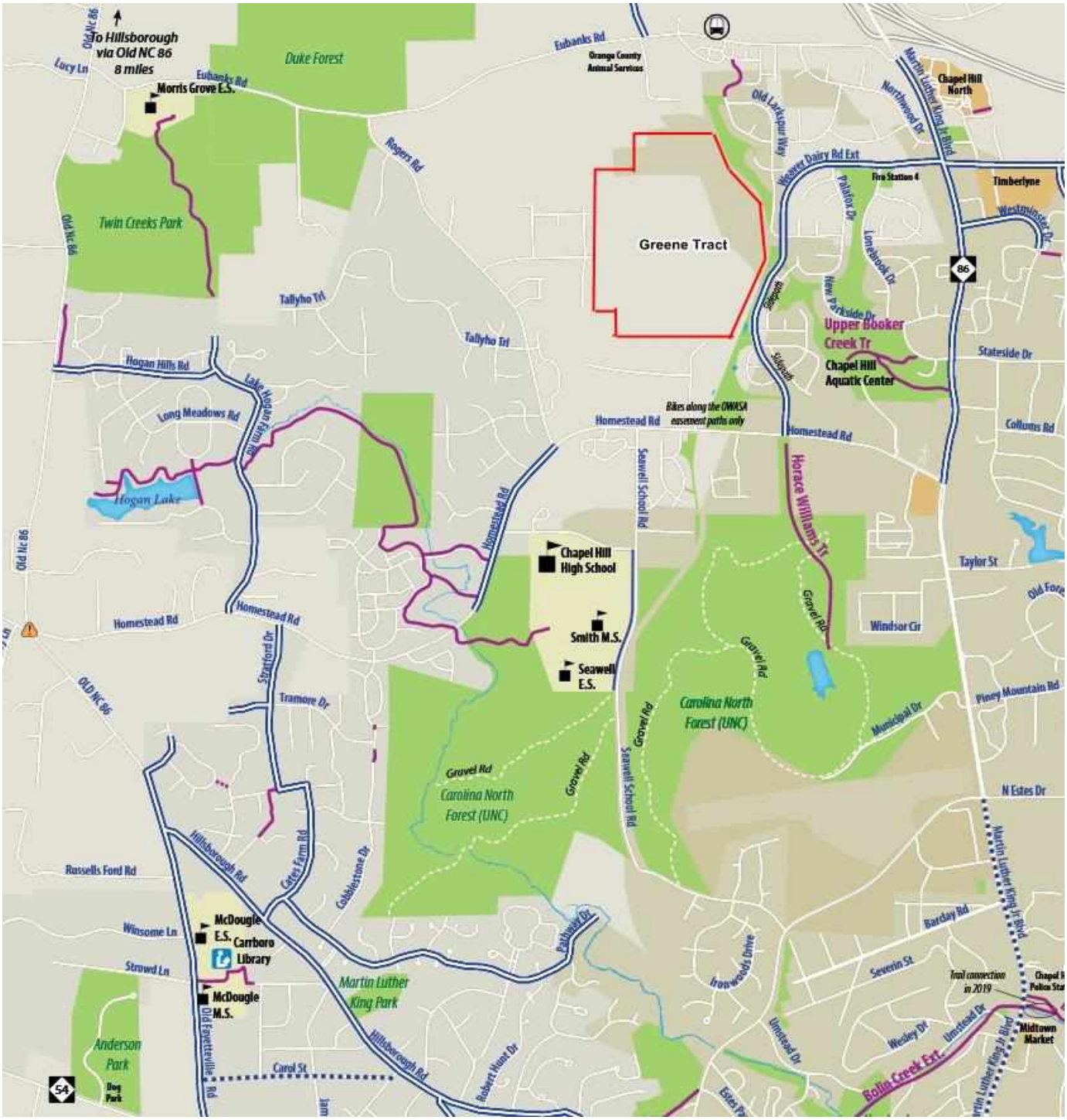
Figure 13B. Greenway trails (purple lines) in the Greene Tract project vicinity, from Town of Chapel Hill.



The Town of Chapel Hill has tentative plans to convert the railroad right-of-way along the eastern boundary of the Greene Tract into a greenway trail if and when this railroad segment is no longer needed.

REGULATED WETLAND & STREAM RIPARIAN BUFFERS		
WATERBODY	**TYPE**	**REGULATED BUFFER (FT)**
STREAM	PERENNIAL	150
STREAM	INTERMITTENT	80
STREAM	EPHEMERAL	15
WETLAND	FRESHWATER	80

PROPOSED ROAD CONNECTION TO GENESTU DRIVE

PROPOSED 8" UNDERGROUND, SANITARY SEWER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED 8" UNDERGROUND WATER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED UNDERGROUND NATURAL GAS LINE (PUBLIC SERVICE COMPANY OF NC)

PROPOSED UNDERGROUND POWER (DUKE ENERGY)

PROPOSED UNDERGROUND TELECOM OPTIC LINE (AT&T - MOST POTENTIAL CLIENT*)

EXISTING 8" WATER

EXISTING 8" GRAVITY

EXISTING 2" WATER

OLD LARKSPUR WAY

WEAVER DAIRY ROAD EXT

EXISTING RESIDENTIAL STRUCTURE & APPURTENANCES

DUKE ENERGY RIGHT-OF-WAY

UNNAMED ROAD

PROPOSED ROAD CONNECTION PUBLIC RIGHT-OF-WAY REQUIRED FOR TIE-IN TO *UNNAMED ROAD* (PARCEL 987-075-1483)

PROPOSED 8" GRAVITY

PROPOSED 8" GRAVITY

PROPOSED FORCE MAIN

LIMITED DEVELOPABLE AREA (SEE NOTE 8) ±4.80-AC

EXISTING 12" WATER

EXISTING 8" GRAVITY

EXISTING 16" WATER

LIZZIE LANE

EDGAR STREET

GRACIE CIRCLE

PHOENIX DRIVE

EXISTING 6" WATER

EXISTING 8" GRAVITY

HEADWATERS PRESERVE ±83.50-AC

TIE-IN POINT OF FORCE MAIN TO GRAVITY MAIN

DEVELOPMENT AREA (WEST) ±42.17-AC

PROPOSED ROAD CONNECTION TO PUREFOY DRIVE

DEVELOPMENT AREA (EAST) ±17.12-AC

EXISTING 8" WATER

PUREFOY DRIVE

SANDBERG LANE

EXISTING 4" WATER

EXISTING 8" GRAVITY

NORFOLK SOUTHERN

WEAVER DAIRY ROAD EXT

WORSHAM DRIVE

DUKE ENERGY RIGHT-OF-WAY

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0716)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

DEVELOPMENT AREA (SOUTH) ±16.34-AC

PROPOSED FORCE MAIN

TIE-IN POINT OF FORCE MAIN TO GRAVITY MAIN

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0062)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

MERIN ROAD

EXISTING 8" GRAVITY

PROPOSED ROAD CONNECTION TO MERIN ROAD

LEGEND

- EXISTING CONTOUR (2' INTERVAL)
- EXISTING CONTOUR (10' INTERVAL)
- EXISTING UNDERGROUND WATER LINE
- EXISTING UNDERGROUND SEWER LINE
- EXISTING STREAM (PERENNIAL)
- EXISTING STREAM (INTERMITTENT)
- EXISTING STREAM (EPHEMERAL)
- EXISTING WETLAND (FRESHWATER)
- PROPOSED REGULATORY RIPARIAN BUFFER (SEE TABLE)
- PROPOSED HEADWATERS PRESERVE (±83.5-ACRES)
- PROPOSED LIMITS-OF-DISTURBANCE (±10.8-ACRES)
- PROPOSED LIMITED DEVELOPABLE AREA (±4.80-ACRES)
- PROPOSED UNDERGROUND WATER LINE
- PROPOSED UNDERGROUND SEWER LINE (GRAVITY)
- PROPOSED UNDERGROUND SEWER LINE (FORCE)
- PROPOSED UNDERGROUND POWER LINE
- PROPOSED UNDERGROUND NATURAL GAS LINE
- PROPOSED TELECOM FIBER/COPPER OPTIC LINE

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
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5. EXISTING WETLANDS BASED ON A WETLANDS SURVEY PERFORMED BY SYNTERRA ON MAY 1, 2020 AND ARE APPROXIMATE.
6. PROPOSED HEADWATERS PRESERVE AREA APPROXIMATELY SIZED FOR 83.5-ACRES. APPROXIMATELY 1.5-ACRES OF PRESERVE AREA IS PROPOSED TO BE USED FOR ROADWAY CROSSING.
7. PROPOSED RIPARIAN BUFFERS BASED ON THE MOST CONSERVATIVE REGULATIONS FROM THE JURISDICTIONS OF ORANGE COUNTY, TOWN OF CARRBORO, AND TOWN OF CHAPEL HILL. SEE TABLE ABOVE FOR ADDITIONAL INFORMATION.
8. DEVELOPMENT ACROSS THE DUKE ENERGY EASEMENT IS ALLOWED BUT MUST ADHERE TO THE DUKE ENERGY ELECTRIC TRANSMISSION RIGHT-OF-WAY GUIDELINES & RESTRICTIONS FOR NORTH CAROLINA AND SOUTH CAROLINA 2020.

GRAPHIC SCALE
200 0 200 400
1 INCH = 400 FEET

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DRAWN BY: J. LEE DATE: 07/25/2020
CHECKED BY: D. WARRICK
PROJECT MANAGER: R. MOGENSEN
LAYOUT: GREENE - FIG 14A - ALTERNATIVE I

FIGURE 14A - ALTERNATIVE I
CONCEPTUAL SITE PLAN
FOR THE ±164.1-ACRE GREENE TRACT LOCATED ALONG PUREFOY DRIVE AND MERIN ROAD ORANGE COUNTY, TOWN OF CHAPEL HILL, AND TOWN OF CARBORRO
PARCEL #: 987-073-9888, 987-085-5283, 987-073-9888

\\SYNI-S-APP1\PROJ\ORANGE COUNTY, NC\14801 ORANGE CO. ENVIRONMENTAL ASSESS\01.ENVIRONMENTAL ASSESSMENT\FIGURES\CAD\GREENE - FIG 14A - ALTERNATIVE I.DWG

REGULATED WETLAND & STREAM RIPARIAN BUFFERS		
WATERBODY	**TYPE**	**REGULATED BUFFER (FT)**
STREAM	PERENNIAL	150
STREAM	INTERMITTENT	80
STREAM	EPHEMERAL	15
WETLAND	FRESHWATER	80

PROPOSED ROAD CONNECTION TO GENESTU DRIVE

PROPOSED 8" UNDERGROUND, SANITARY SEWER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED 8" UNDERGROUND WATER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED UNDERGROUND NATURAL GAS LINE (PUBLIC SERVICE COMPANY OF NC)

PROPOSED UNDERGROUND POWER (DUKE ENERGY)

PROPOSED UNDERGROUND TELECOM OPTIC LINE (AT&T - MOST POTENTIAL CLIENT*)

EXISTING 8" WATER

EXISTING 8" GRAVITY

EXISTING 2" WATER

OLD LARKSPUR WAY

WEAVER DAIRY ROAD EXT

EXISTING RESIDENTIAL STRUCTURE & APPURTENANCES

DUKE ENERGY RIGHT-OF-WAY

UNNAMED ROAD

PROPOSED ROAD CONNECTION PUBLIC RIGHT-OF-WAY REQUIRED FOR TIE-IN TO *UNNAMED ROAD* (PARCEL 987-075-1483)

PROPOSED 8" GRAVITY

PROPOSED FORCE MAIN

LIMITED DEVELOPABLE AREA (SEE NOTE 8) ±4.80-AC

EXISTING 12" WATER

EXISTING 16" WATER

LIZZIE LANE

EDGAR STREET

GRACIE CIRCLE

PHOENIX DRIVE

EXISTING 6" WATER

DEVELOPMENT AREA (WEST) ±41.32-AC

HEADWATERS PRESERVE ±83.50-AC

DEVELOPMENT AREA (EAST) ±17.61-AC

TIE-IN POINT OF FORCE MAIN TO GRAVITY MAIN

PROPOSED ROAD CONNECTION TO PUREFOY DRIVE

PUREFOY DRIVE

SANDBERG LANE

EXISTING 4" WATER

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0716)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

DEVELOPMENT AREA (SOUTH) ±15.77-AC

NORFOLK SOUTHERN

WEAVER DAIRY ROAD EXT

WORSHAM DRIVE

DUKE ENERGY RIGHT-OF-WAY

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0062)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

MERIN ROAD

PROPOSED ROAD CONNECTION TO MERIN ROAD

LEGEND

- EXISTING CONTOUR (2' INTERVAL)
- EXISTING CONTOUR (10' INTERVAL)
- EXISTING UNDERGROUND WATER LINE
- EXISTING UNDERGROUND SEWER LINE
- EXISTING STREAM (PERENNIAL)
- EXISTING STREAM (INTERMITTENT)
- EXISTING STREAM (EPHEMERAL)
- EXISTING WETLAND (FRESHWATER)
- PROPOSED REGULATORY RIPARIAN BUFFER (SEE TABLE)
- PROPOSED HEADWATERS PRESERVE (±83.5-ACRES)
- PROPOSED LIMITS-OF-DISTURBANCE (±10.8-ACRES)
- PROPOSED LIMITED DEVELOPABLE AREA (±4.80-ACRES)
- PROPOSED UNDERGROUND WATER LINE
- PROPOSED UNDERGROUND SEWER LINE (GRAVITY)
- PROPOSED UNDERGROUND SEWER LINE (FORCE)
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- PROPOSED UNDERGROUND NATURAL GAS LINE
- PROPOSED TELECOM FIBER/COPPER OPTIC LINE

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GRAPHIC SCALE
200 0 200 400
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CHECKED BY: D. WARRICK
PROJECT MANAGER: R. MOGENSEN
LAYOUT: GREENE - ALTERNATIVE A1

FIGURE 14B - ALTERNATIVE II
CONCEPTUAL SITE PLAN
FOR THE ±164.1-ACRE GREENE TRACT LOCATED ALONG PUREFOY DRIVE AND MERIN ROAD ORANGE COUNTY, TOWN OF CHAPEL HILL, AND TOWN OF CARBORRO
PARCEL #: 987-073-9888, 987-085-5283, 987-073-9888

\\SYNI-S-APP1\PROJ\ORANGE COUNTY, NC\1480-01 ORANGE CO ENVIRONMENTAL ASSESS\01 ENVIRONMENTAL ASSESSMENT\FIGURES\CAD\GREENE - FIG 14B - ALTERNATIVE II.DWG

REGULATED WETLAND & STREAM RIPARIAN BUFFERS		
WATERBODY	**TYPE**	**REGULATED BUFFER (FT)**
STREAM	PERENNIAL	150
STREAM	INTERMITTENT	80
STREAM	EPHEMERAL	15
WETLAND	FRESHWATER	80

PROPOSED ROAD CONNECTION TO GENESTU DRIVE

PROPOSED 8" UNDERGROUND, SANITARY SEWER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED 8" UNDERGROUND WATER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED UNDERGROUND NATURAL GAS LINE (PUBLIC SERVICE COMPANY OF NC)

PROPOSED UNDERGROUND POWER (DUKE ENERGY)

PROPOSED UNDERGROUND TELECOM OPTIC LINE (AT&T - MOST POTENTIAL CLIENT*)

EXISTING RESIDENTIAL STRUCTURE & APPURTENANCES

DUKE ENERGY RIGHT-OF-WAY

UNNAMED ROAD

PROPOSED ROAD CONNECTION PUBLIC RIGHT-OF-WAY REQUIRED FOR TIE-IN TO *UNNAMED ROAD* (PARCEL 987-075-1483)

EXISTING 8" WATER

EXISTING 8" GRAVITY

EXISTING 2" WATER

EXISTING 12" WATER

EXISTING 16" WATER

OLD LARKSPUR WAY

WEAVER DAIRY ROAD EXT

LIZZIE LANE

GRACIE CIRCLE

EDGAR STREET

PHOENIX DRIVE

EXISTING 6" WATER

PROPOSED ROAD CONNECTION TO PUREFOY DRIVE

PUREFOY DRIVE

SANDBERG LANE

EXISTING 4" WATER

PROPOSED 8" GRAVITY

PROPOSED FORCE MAIN

LIMITED DEVELOPABLE AREA (SEE NOTE 8) ±4.80-AC

HEADWATERS PRESERVE ±83.50-AC

DEVELOPMENT AREA (WEST) ±42.17-AC

DEVELOPMENT AREA (EAST) ±17.12-AC

DEVELOPMENT AREA (SOUTH) ±16.34-AC

TIE-IN POINT OF FORCE MAIN TO GRAVITY MAIN

POTENTIAL FUTURE RAILROAD CROSSING (SEE NOTE 9)

POTENTIAL FUTURE ROAD CONNECTION TO WEAVER DAIRY ROAD EXT

NORFOLK SOUTHERN

WORSHAM DRIVE

DUKE ENERGY RIGHT-OF-WAY

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0716)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0062)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

MERIN ROAD

PROPOSED ROAD CONNECTION TO MERIN ROAD

LEGEND

- EXISTING CONTOUR (2' INTERVAL)
- EXISTING CONTOUR (10' INTERVAL)
- EXISTING UNDERGROUND WATER LINE
- EXISTING UNDERGROUND SEWER LINE
- EXISTING STREAM (PERENNIAL)
- EXISTING STREAM (INTERMITTENT)
- EXISTING STREAM (EPHEMERAL)
- EXISTING WETLAND (FRESHWATER)
- PROPOSED REGULATORY RIPARIAN BUFFER (SEE TABLE)
- PROPOSED HEADWATERS PRESERVE (±83.5-ACRES)
- PROPOSED LIMITS-OF-DISTURBANCE (±10.8-ACRES)
- PROPOSED LIMITED DEVELOPABLE AREA (±4.80-ACRES)
- PROPOSED UNDERGROUND WATER LINE
- PROPOSED UNDERGROUND SEWER LINE (GRAVITY)
- PROPOSED UNDERGROUND SEWER LINE (FORCE)
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9. POTENTIAL FUTURE ROAD CONNECTION TO WEAVER DAIRY ROAD EXT IS CONTINGENT UPON THE USAGE AND NECESSITY OF ENERGY NEEDS OF THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL (UNC).

GRAPHIC SCALE
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1 INCH = 400 FEET

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DRAWN BY: J. LEE DATE: 07/25/2020
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LAYOUT: GREENE - FIG 14C - ALTERNATIVE III

FIGURE 14C - ALTERNATIVE III
CONCEPTUAL SITE PLAN
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REGULATED WETLAND & STREAM RIPARIAN BUFFERS		
WATERBODY	**TYPE**	**REGULATED BUFFER (FT)**
STREAM	PERENNIAL	150
STREAM	INTERMITTENT	80
STREAM	EPHEMERAL	15
WETLAND	FRESHWATER	80

PROPOSED ROAD CONNECTION TO GENESTU DRIVE

PROPOSED 8" UNDERGROUND, SANITARY SEWER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED 8" UNDERGROUND WATER LINE (ORANGE WATER & SEWER AUTHORITY)

PROPOSED UNDERGROUND NATURAL GAS LINE (PUBLIC SERVICE COMPANY OF NC)

PROPOSED UNDERGROUND POWER (DUKE ENERGY)

PROPOSED UNDERGROUND TELECOM OPTIC LINE (AT&T - MOST POTENTIAL CLIENT*)

EXISTING 8" WATER

EXISTING 8" GRAVITY

EXISTING 2" WATER

OLD LARKSPUR WAY

EXISTING 12" WATER

EXISTING 8" GRAVITY

WEAVER DAIRY ROAD EXT

EXISTING RESIDENTIAL STRUCTURE & APPURTENANCES

DUKE ENERGY RIGHT-OF-WAY

UNNAMED ROAD

PROPOSED ROAD CONNECTION PUBLIC RIGHT-OF-WAY REQUIRED FOR TIE-IN TO *UNNAMED ROAD* (PARCEL 987-075-1483)

PROPOSED 8" GRAVITY

PROPOSED FORCE MAIN

DUKE ENERGY RIGHT-OF-WAY

LIMITED DEVELOPABLE AREA (SEE NOTE 8) ±4.80-AC

EXISTING 8" WATER

EXISTING 8" WATER

LIZZIE LANE

EXISTING 8" GRAVITY

EDGAR STREET

GRACIE CIRCLE

EXISTING 6" WATER

EXISTING 8" GRAVITY

PHOENIX DRIVE

EXISTING 6" WATER

EXISTING 6" WATER

HEADWATERS PRESERVE ±83.50-AC

PROPOSED ROAD CONNECTION TO PUREFOY DRIVE

DEVELOPMENT AREA (WEST) ±42.17-AC

TIE-IN POINT OF FORCE MAIN TO GRAVITY MAIN

EXISTING 16" WATER

EXISTING 12" WATER

DEVELOPMENT AREA (EAST) ±17.12-AC

EXISTING 8" WATER

PUREFOY DRIVE

POTENTIAL FUTURE RAILROAD CROSSING (SEE NOTE 9)

POTENTIAL FUTURE ROAD CONNECTION TO WEAVER DAIRY ROAD EXT

SANDBERG LANE

EXISTING 4" WATER

EXISTING 8" GRAVITY

PROPOSED 8" GRAVITY

NORFOLK SOUTHERN

WEAVER DAIRY ROAD EXT

WORSHAM DRIVE

DUKE ENERGY RIGHT-OF-WAY

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0716)

TIE-IN POINT OF FORCE MAIN TO GRAVITY MAIN

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

PROPOSED 8" GRAVITY

DEVELOPMENT AREA (SOUTH) ±16.34-AC

PROPOSED FORCE MAIN

20' UTILITY EASEMENT REQUIRED FOR SEWER TIE-IN (PARCEL 987-093-0062)

PROPOSED SEWER TIE-IN POINT TO EXISTING 8" GRAVITY

MERIN ROAD

EXISTING 8" GRAVITY

PROPOSED ROAD CONNECTION TO MERIN ROAD

LEGEND

- EXISTING CONTOUR (2' INTERVAL)
- EXISTING CONTOUR (10' INTERVAL)
- EXISTING UNDERGROUND WATER LINE
- EXISTING UNDERGROUND SEWER LINE
- EXISTING STREAM (PERENNIAL)
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- PROPOSED REGULATORY RIPARIAN BUFFER (SEE TABLE)
- PROPOSED HEADWATERS PRESERVE (±83.5-ACRES)
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DRAWN BY: J. LEE DATE: 07/25/2020
CHECKED BY: D. WARRICK
PROJECT MANAGER: R. MOGENSEN
LAYOUT: GREENE - FIG 14C - ALTERNATIVE III

FIGURE 14D - ALTERNATIVE IV
CONCEPTUAL SITE PLAN
FOR THE ±164.1-ACRE GREENE TRACT LOCATED ALONG PUREFOY DRIVE AND MERIN ROAD ORANGE COUNTY, TOWN OF CHAPEL HILL, AND TOWN OF CARBORRO
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\\SYN1-S-APP1\PROJ\ORANGE COUNTY, NC\1480\01 ORANGE CO. ENVIRONMENTAL ASSESS\01.ENVIRONMENTAL ASSESSMENT\FIGURES\CAD\GREENE - FIG 14D - ALTERNATIVE IV_.DWG

TABLES

Science & Engineering Consultants

Table 1A. Stream Reaches, Seeps, Wetland Delineation Flags, and Wetland & Upland Data Sample Points on the Greene Tract.

stream reach	stream or wetland	natural vs disturbed	linear feet	Flag Series		Reach Lower End		Reach Upper End		Data Pt Map #	wetl flag	Wetland Data Point		Upland Data Point	
				Left Bank	Right Bank	LATIT	LONGIT	LATIT	LONGIT			LATIT	LONGIT	LATIT	LONGIT
Old Field Creek															
A1	peren	natural	985	GF1-26	GE1-16, RV35-36	35.96472	-79.07573	35.96351	-79.07392	**DP-5**	GF5	35.96414	-79.07556	35.96372	-79.07557
A2	interm	natural	390	GF26-RV5	RV31-36	35.96351	-79.07392	35.96308	-79.07311						
A3	interm	ditched	315	RV5-11	RV29-31	35.96308	-79.07311	35.96298	-79.07219						
A4	ephem	ditched	755	RV11-22	RV22-29	35.96298	-79.07219	35.96152	-79.07080	**DP-7**	RV19	35.96161	-79.07087	35.96172	-79.07096
B1	ephem	natural	425	PA1-9	PA10-16	35.96327	-79.07376	35.96218	-79.07396	**DP-6**	PA6	35.96274	-79.07399	35.96275	-79.07418
Bolin Creek															
C1	peren	minor incis	1245	GB1-9, RA1-22	GA1-10, GA38-43, RB6-17	35.95663	-79.07659	35.95780	-79.07335	**DP-4**	GA6	35.95700	-79.07644	35.95708	-79.07652
C2	interm	minor incis	530	RA22-AA5	RB2-6, AA5-11	35.95780	-79.07335	35.95695	-79.07208	**DP-9**	AA3	35.95718	-79.07226	35.95709	-79.07229
D1	interm	minor incis	485	GA34-38	GA11-15	35.95689	-79.07633	35.95857	-79.07528						
D2	seep WTL	natural	250	GA23-34	GA15-22	35.95773	-79.07639	35.95841	-79.07706						
E1	peren	minor incis	405	RB17-24	GA43-44, RC2-6	35.95761	-79.07562	35.95857	-79.07528	**DP-3**	RC3	35.95839	-79.07519	35.95842	-79.07539
E2	interm	natural	125	RB24-RBC2	RC2-RBC11	35.95857	-79.07528	35.95889	-79.07539	**DP-2**	RBC9	35.95934	-79.07543	35.95928	-79.07562
E3	seep WTL	natural	300	RBC2-6	RBC7-11	35.95889	-79.07539	35.95972	-79.07530						
F1	seep WTL	natural	590	RB6a-k	RB6-l-v	35.95787	-79.07341	35.95892	-79.07212	**DP-8**	RB6k	35.95881	-79.07219	35.95875	-79.07201
F2	seep WTL	natural	80	GG1-3	GG4-7	35.95888	-79.07172	35.95907	-79.07148						
Booker Creek															
G1	seep WTL	natural	530	VC1-12	VB1-10	35.95765	-79.06939	35.95862	-79.07044						
G2	seep WTL	natural	260	VA1-7	VA8-13	35.95816	-79.06915	35.95853	-79.06986	**DP-1**	VA5	35.95846	-79.06964	35.95867	-79.06955
H1	seep WTL	mowed	120	GD5-7	GD1-4	35.96120	-79.06841	35.96132	-79.06986	**DP-10**	GD4	35.96127	-79.06864	35.96139	-79.06873

Table 1B. Total Stream Lengths and Wetland Areas

Watershed	Perennial stream, feet	Intermittent stream, feet	Ephemeral stream, feet	Total stream length, feet	Non-stream seep length, feet	Total wetland, acres
Old Field Cr	985	705	1180	2870	0	2.05
Bolin Cr	1650	1140	0	2790	1220	3.41
Booker Cr	0	0	0	0	910	1.29
Greene Tract	2635	1845	1180	5660	2130	6.75

Table 2. Plant Species Recorded on the Greene Tract, Apr-May 2020, Orange County, NC.

Trees and Shrubs > 1 meter tall		Seep & Alluvial	Mesic Forest	Dry-mesic Forest	mowed easemt		exotic
Acer floridanum	Florida Maple	1	1				
Acer rubrum	Red Maple	3	3	3			
Acer negundo	Box Elder Maple	1	1		1		
Alnus serrulata	Tag Alder	1			1		
Amelanchier arborea	Downy Serviceberry		1	1			
Baccharis halimifolia	Groundsel-tree				2		
Betula nigra	River Birch	1			1		
Carpinus caroliniana	Musclewood	2	2	1			
Carya cordiformis	Bitternut Hickory	2	2	1			
Carya glabra	Pignut Hickory		2	2			
Carya ovata	Shagbark Hickory	1	1				
Carya tomentosa	Mockernut Hickory		1	2			
Celtis laevigata	Sugarberry	1	1				
Cephalanthus occidentalis	Buttonbush	1			1		
Cornus amomum	Silky Dogwood	1			1		
Cornus florida	Flowering Dogwood	1	2	2			
Elaeagnus umbellata	Autumn Olive	2	2	1			exotic
Eubotrys racemosus	Swamp Fetterbush	1			1		
Euonymus americana	Strawberry-bush	1	2	1			
Fagus grandifolia	American Beech	2	2	1			
Fraxinus pennsylvanica	Green Ash	2	1				
Ilex decidua	Deciduous Holly	1	2	1			
Ilex opaca	American Holly	2	2	2	1		
Ilex verticillata	Winterberry Holly	2	1		1		
Itea virginica	Virginia Sweetspire	1			1		
Juniperus virginiana	Eastern Red Cedar		2	2			
Ligustrum sinense	Chinese Privet	3	2	2			exotic
Lindera benzoin	Northern Spicebush	2	2				
Liquidambar styraciflua	Sweetgum	3	3	3			
Liriodendron tulipifera	Tuliptree	2	3	2			
Magnolia grandiflora	Southern Magnolia		1				
Magnolia virginiana	Sweetbay Magnolia	1					
Morella cerifera	Southern Bayberry	1	1				
Nyssa sylvatica	Black Gum	2	2	2			
Ostrya virginiana	American Hop-hornbeam		2	2			
Oxydendrum arboreum	Sourwood	2	3	3			
Pinus echinata	Shortleaf Pine			1			
Pinus taeda	Loblolly Pine	3	3	3			
Pinus virginiana	Virginia Pine		1	2			
Platanus occidentalis	Sycamore	1			1		
Prunus serotina	Black Cherry	2	2	2			
Quercus alba	White Oak	2	3	3			
Quercus coccinea	Scarlet Oak	1	2	2			
Quercus falcata	Southern Red Oak	3	3	3			
Quercus marilandica	Blackjack Oak		1	2			
Quercus michauxi	Swamp Chestnut Oak	1	1	1			
Quercus montana	Chestnut Oak			1			
Quercus nigra	Water Oak	2	2	2			
Quercus phellos	Willow Oak	3	3	2			
Quercus rubra	Northern Red Oak	2	3	1			

Quercus stellata	Post Oak		2	2			
Quercus velutina	Black Oak		1	1			
Rhododendron periclymenoides	Pinxter Azalea	1	1				
Rhus copallina	Winged Sumac	1	2	2			
Sambucus canadensis	Common Elderberry	1	1		1		
Symplocos tinctoria	Horse Sugar, Sweetleaf		1	1			
Ulmus alata	Winged Elm	2	3	3			
Ulmus americana	American Elm	2	2	1			
Vaccinium arboreum	Sparkleberry	2	2	2			
Viburnum dentatum	Southern Arrowwood	2	1				
Viburnum nudum	Possumhaw Viburnum	2					
Viburnum prunifolium	Blackhaw Viburnum	1	2				
Viburnum rafinesqianum	Downy Arrowwood		1	1			
3 = abundant; 2 = common; 1 = uncommon to rare							
Vines & Groundcover, includes shrubs < 1 meter tall		**Seep & Alluvial**	**Mesic Forest**	**Dry-mesic Forest**	**mowed easemt**		**exotic**
Andropogon virginicus	Broomsedge				2		
Arisaema triphyllum	Jack-in-the-Pulpit	3	2				
Arundinaria tecta	River Cane	1					
Asplenium platyneuron	Ebony Spleenwort		2	1			
Athyrium asplenioides	Southern Lady Fern	2	2				
Bellis perennis	Eurpoean Lawn Daisy				2		exotic
Bignonia capreolata	Crossvine	2	2				
Boehmeria cylindrica	False Nettle	2					
Campsis radicans	Trumpet Creeper	2	2	2	3		
Carex crinita	Fringed Sedge	2					
Carex lurida	Sallow Sedge	3					
Carex radiata	Eastern Star Sedge	3					
Chelone glabra	White Turtlehead	1			1		
Cypripedium acaule	Pink Lady's-slipper			1			
Desmodium species	Tick-trefoil				3		
Dichanthelium clandestinum	Deer-tongue Witchgrass	2	1		1		
Dichanthelium dichotomum	Cypress Witchgrass	2	2	1			
Dioscorea villosa	Wild Yam		1				
Eupatorium capillifolium	Dog-fennel				2		
Eupatorium rotundifolium	Roundleaf Thoroughwort				1		
Eupatorium serotinum	Late-flowering Thoroughwort				2		
Eutrochium fistulosum	Hollow-stem Joe-Pye-weed	1					
Gelsemium sempervirens	Yellow Jessamine	2	2	2			
Goodyera pubescens	Downy Rattlesnake-plantain		1	1			
Hexastylis arifolia	Little Brown Jug		2	2			
Hexastylis virginica	Virginia Heartleaf	1	1				
Hypericum hypericoides	St. Andrew's-cross				2		
Impatiens capensis	Common Jewelweed	2					
Juncus effusus	Soft Rush	2			2		
Lespedeza cuneata	Sericea Lespedeza				2		exotic
Lilium michauxii	Carolina Lily			1			
Lindernia dubia	False Pimpernel	1			1		
Lobelia cardinalis	Cardinal flower	1					
Lolium arundinaceum	Tall Fescue	2	1	1	3		exotic

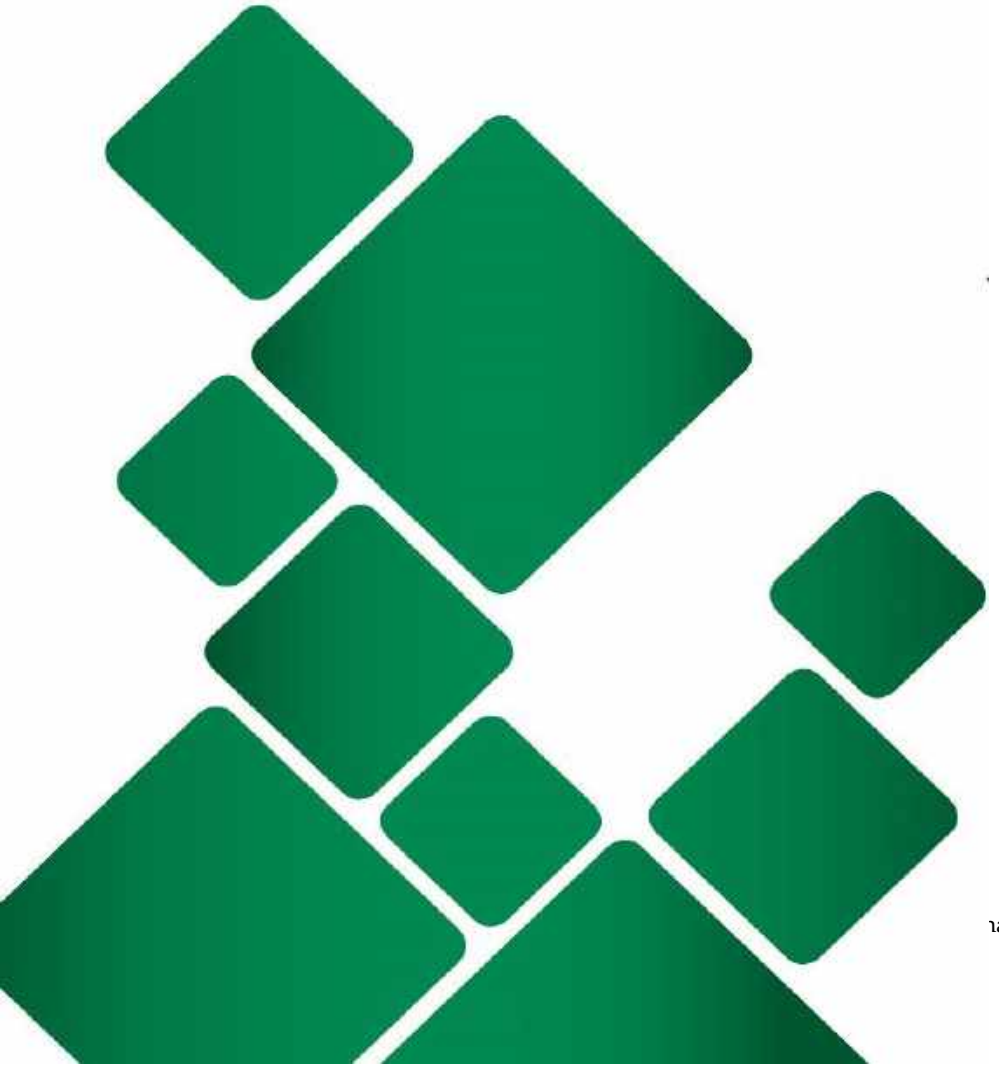
Lonicera japonica	Japanese Honeysuckle	3	2	2	3		exotic
Microstegium vimineum	Japanese Stilt-grass	2	2	1	2		exotic
Nabalus serpentarius	Lion's-foot Rattlesnake-root		2	2			
Oenothera fruticosa	Narrowleaf Sundrops				2		
Osmunda cinnamomeum	Cinnamon Fern	2					
Osmunda regalis	Royal Fern	2					
Packera aurea	Golden Ragwort				2		
Panicum virgatum	Switchgrass				2		
Parthenocissus quinquefolia	Virginia Creeper	3	3	3	2		
Persicaria punctata	Dotted smartweed	3			2		
Pilea pumila	Clearweed	2					
Polystichum acrostichoides	Christmas Fern	2	2	1			
Pteridium aquilinum	Bracken Fern		1	1			
Rubus pensilvanicus	Pennsylvania Blackberry	2	2	2	3		
Saururus cernuus	Lizard's-tail	3			1		
Sisyrinchium angustifolium	Narrow-leaf Blue-eyed-grass				1		
Smilax bona-nox	Saw Greenbrier	1	2	1	2		
Smilax glauca	Whiteleaf Greenbrier	1	2	1			
Smilax rotundifolia	Common Greenbrier	3	3	2	3		
Solidago altissima	Tall Goldenrod				3		
Solidago gigantea	Giant Goldenrod				2		
Solidago rugosa	Wrinkle-leaf Goldenrod				2		
Sphagnum spp	Sphagnum mosses	3					
Symphyotrichum puniceum	Purplestem Aster	1			1		
Tipularia discolor	Cranefly Orchid		2	2			
Toxicodendron radicans	Poison Ivy	2	2	2			
Vaccinium corymbosum	Highbush Blueberry	1	1		1		
Vaccinium stamineum	Deerberry	2	3	3			
Vaccinium tenellum	Low Black Blueberry	2	2				
Valerianella species	Cornsalad				1		
Verbesina occidentalis	Yellow Crownbeard				3		
Vinca minor	Common Periwinkle	1	2	2			exotic
Vitis rotundifolia	Muscadine Grape	3	3	3	3		
Wisteria x formosa	Asian Wisteria		1	2			exotic
Woodwardia areolata	Netted Chain-fern	2	1				
3 = abundant; 2 = common; 1 = uncommon to rare							

Table 3. Federal and State Protected Species Reported from Orange County: NC Natural Heritage Program, May 2020.						
Taxonomic Group	Scientific Name	Common Name	NC List	Federal Listed	Orange Co Status	NC-NHP Habitat Description
Amphibian	Ambystoma talpoideum	Mole Salamander	SC		Current	breeds in fish-free semipermanent woodland ponds; forages in adjacent woodlands
Amphibian	Hemidactylium scutatum	Four-toed Salamander	SC		Current	pools, bogs, and other wetlands in hardwood forests
Amphibian	**Necturus lewisi**	**Neuse River Waterdog**	**SC**	**PT**	**Current**	rivers and large streams in Neuse and Tar drainages (endemic to North Carolina)
Bird	Ammodramus henslowii	Henslow's Sparrow	E		Historical	clearcut pocosins and other damp weedy fields [breeding season only]
Bird	**Haliaeetus leucocephalus**	**Bald Eagle**	**T**	**BGPA**	**Current**	mature forests near large bodies of water (nesting); rivers, lakes, and sounds (foraging)
Bird	Peucaea aestivalis	Bachman's Sparrow	SC		Historical	open longleaf pine forests, old fields [breeding evidence only]
Crustacean	Diacyclops jeanneli putei	Carolina Well Diacyclops	SC		Historical	well in Orange County (endemic to North Carolina)
Mussel	**Alasmidonta heterodon**	**Dwarf Wedgemussel**	**E**	**E**	**Historical**	Tar and Neuse drainages, mainly near Fall Line
Mussel	Alasmidonta undulata	Triangle Floater	T		Current	Roanoke, Chowan, Tar, Neuse, Cape Fear drainages
Mussel	Alasmidonta varicosa	Brook Floater	E		Current	Cape Fear drainage, and Blue Ridge escarpment of Catawba and Yadkin-Pee Dee drainages
Mussel	**Fusconaia masoni**	**Atlantic Pigtoe**	**E**	**PT**	**Current**	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee drainages
Mussel	Lampsilis cariosa	Yellow Lampmussel	E		Current	Chowan, Roanoke, Neuse, Tar, Cape Fear, Lumber, Yadkin-Pee Dee drainages
Mussel	Lampsilis radiata	Eastern Lampmussel	T		Current	Chowan, Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee drainages
Mussel	Lasmigona subviridis	Green Floater	E		Current	New, Watauga, Roanoke, Tar, Neuse and Yadkin-Pee Dee drainages
Mussel	Strophitus undulatus	Creeper	T		Current	Roanoke, Tar, Neuse, Cape Fear, Pee Dee, Catawba, Broad, and French Broad drainages
Mussel	Toxolasma pullus	Savannah Lilliput	E		Current	Cape Fear, Lumber, and Yadkin-Pee Dee drainages
Mussel	Villosa constricta	Notched Rainbow	T		Current	Roanoke, Tar, Neuse, Yadkin-Pee Dee, and Catawba drainages
Mussel	Villosa vaughaniana	Carolina Creekshell	E		Current	Cape Fear, Yadkin-Pee Dee, and Catawba drainages
Mussel	Etheostoma collis	Carolina Darter	SC		Current	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee, and Catawba drainages
Mussel	Notropis volucellus	Mimic Shiner	T		Historical	New, French Broad, Little Tennessee, Tar, and Neuse drainages
Plant	Anemone berlandieri	Southern Anemone	E		Current	thin soils around rock outcrops, usually on basic soil
Plant	Baptisia aberrans	Prairie Blue Wild Indigo	E		Historical	glades and open forests on basic soils
Plant	Berberis canadensis	American Barberry	SC		Historical	open forests and glades on basic soils
Plant	Betula cordifolia	Mountain Paper Birch	SC		Current	high elevation forests and landslide scars
Plant	Buchnera americana	American Bluehearts	E		Historical	glades, open forests, streambanks, probably primarily over mafic or calcareous rocks
Plant	Cardamine douglassii	Douglass's Bittercress	T		Historical	bottomlands, rich lower slopes
Plant	Desmodium ochroleucum	Creamy Tick-trefoil	SC		Historical	sandy or rocky woodland openings
Plant	**Echinacea laevigata**	**Smooth Coneflower**	**E**	**E**	**Historical**	glades, woodlands, and open areas over mafic rocks
Plant	Enemion biternatum	Eastern Isopyrum	SC		Historical	rich bottomlands, levees, and lower slopes
Plant	Gillenia stipulata	Indian Physic	T		Historical	forests and open woods, mainly over mafic rocks

Plant	**Lindera melissifolia**	**Pondberry**	**E**	**E**	**Historical**	Carolina bays and seasonally wet depressions
Plant	Monotropsis odorata	Sweet Pinesap	SC		Current	dry forests and bluffs
Plant	Panicum flexile	Wiry Panic Grass	T		Historical	glades and openings over mafic rocks
Plant	Platanthera peramoena	Purple Fringeless Orchid	T		Current	bogs, forests
Plant	Primula meadia	Shooting-star	T		Historical	mafic cliffs, dry coniferous woodlands, and associated nutrient-rich alluvial forests
Plant	Ranunculus ambigens	Water-plantain Spearwort	SC		Historical	open wet areas
Plant	**Rhus michauxii**	**Michaux's Sumac**	**E**	**E**	**Historical**	sandhills, sandy forests, woodland, woodland edges
Plant	Ruellia purshiana	Pursh's Wild-petunia	SC		Current	glades and woodlands, mostly over mafic or calcareous rocks
Plant	Scutellaria australis	Southern Skullcap	E		Historical	alluvial forests
Plant	Scutellaria leonardii	Shale-barren Skullcap	E		Current	diabase glades
Plant	Symphyotrichum concinnum	Narrow-leaf Smooth Aster	T		Historical	forests, woodland borders especially over mafic rocks
Plant	Thermopsis mollis	Appalachian Golden-banner	SC		Current	dry ridges and open woodlands
Plant	Tradescantia virginiana	Virginia Spiderwort	T		Current	rich woods on circumneutral soils
Plant	Trichostema brachiatum	Glade Bluecurls	E		Historical	diabase glades, other dry calcareous or mafic outcrops
Plant	Tridens chapmanii	Chapman's Redtop	T		Historical	dry pine and oak woods, sandy roadsides
Protection Status: E = Endangered, T = Threatened, SC = Special Concern, PT = Proposed Threatened, BGPA = Bald and Golden Eagle Protection Act.						
Federal listed species in bold typeface.						

APPENDIX A

DWR STREAM IDENTIFICATION DATA FORMS AND SAMPLE SITE MAP



synTerra

Science & Engineering Consultants

NC Division of Water Quality – Stream Identification Form version 4.11 Sept 2010
Methodology for Identification of Intermittent and Perennial Streams and Their Origins

Date: May 13, 2020	**Project / Site**: Old Field Cr @ Greene Tract	**Latitude:** 35.960 (center of site) **Longitude:** -79.073
Evaluator: Gerald Pottern SynTerra Corporation	**City/County:** Chapel Hill, Orange County	**Topo Quad:** Chapel Hill

Stream evaluation reach ID #	A1 Old Fi	A2 Old Fi	A3 Old Fi		*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**
Latitude:	35.9635	35.9631	35.9627		
Longitude:	-79.0739	-79.0731	-79.0713		
Total Points A+B+C	40.5	27.75	18.25		
Ephemeral, Intermittent, or Perennial	Per	Int	Eph		
T= topo map, S=soil map, TS = both	TS	TS	S		

A. Geomorphology	**Stream Metric Score**				**Absent**	**Weak**	**Moderate**	**Strong**
1. Continuity of channel bed and bank	3	2	2		0	1	2	3
2. Sinuosity of channel along thalweg	3	3	1		0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	2	1	1		0	1	2	3
4. Particle size of stream substrate	2	1	1		0	1	2	3
5. Active/ relict floodplain	2	2	1		0	1	2	3
6. Depositional bars or benches	2	2	1		0	1	2	3
7. Recent alluvial deposits	1	1	1		0	1	2	3
8. Headcuts	2	1	2		0	1	2	3
9. Grade control	1	.5	.5		0	0.5	1	1.5
10. Natural valley	1.5	1	1		0	0.5	1	1.5
11. Second or greater order channel	0	0	0		No = 0		Yes = 3	
A. Geomorphology subtotal	19.5	14.5	11.5					
B. Hydrology								
12. Presence of Baseflow	3	2	1		0	1	2	3
13. Iron oxidizing bacteria	2	2	1		0	1	2	3
14. Leaf litter	1	.5	.5		1.5	1	0.5	0
15. Sediment on plants or debris	1	.5	.5		0	0.5	1	1.5
16. Organic debris lines or piles	1	1	.5		0	0.5	1	1.5
17. Soil-based evidence high water table	3	3	0		No = 0		Yes = 3	
B. Hydrology subtotal	11	9	3.5					
C. Biology								
18. Fibrous roots in streambed	2	1	1		3	2	1	0
19. Rooted upland plants in streambed	2	1	1		3	2	1	0
20. Macrobenthos (diversity and abund)	2	1	0		0	1	2	3
21. Aquatic Mollusks	0	0	0		0	1	2	3
22. Fish	0	0	0		0	0.5	1	1.5
23. Crayfish	1	0	0		0	0.5	1	1.5
24. Amphibians	1	.5	.5		0	0.5	1	1.5
25. Algae	.5	0	0		0	0.5	1	1.5
26. Wetland plants in streambed	1.5	.75	.75		FACW = 0.75	OBL = 1.5	Other = 0	
C. Biology subtotal	10	4.25	3.25					

* Perennial streams may also be identified using other methods. See p. 35 of manual. Artificial ditches are not rated.

Notes / Sketch: See attached map of Old Field Creek stream sample points.

NC Division of Water Quality – Stream Identification Form version 4.11 Sept 2010
Methodology for Identification of Intermittent and Perennial Streams and Their Origins

Date: May 13, 2020	**Project / Site**: Bolin Creek @ Greene Tract	**Latitude:** 35.960 (center of site) **Longitude:** -79.073
Evaluator: Gerald Pottern SynTerra Corporation	**City/County:** Chapel Hill, Orange County	**Topo Quad:** Chapel Hill

Stream evaluation segment ID #	C1 Bolin	C2 Bolin	C3 Bolin	E1 Bolin	*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**
Latitude:	35.9576	35.9577	35.9572	35.9584	
Longitude:	-79.0751	-79.0732	-79.0722	-79.0752	
Total Points A+B+C	37.25	27.75	18.25	28.5	
Ephemeral, Intermittent, or Perennial	Per	Int	Eph	Int	
T= topo map, S=soil map, TS = both	TS	TS	S	S	

A. Geomorphology	**Stream Metric Score**				**Absent**	**Weak**	**Moderate**	**Strong**
1. Continuity of channel bed and bank	3	2	2	2	0	1	2	3
2. Sinuosity of channel along thalweg	3	3	2	1	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	1	1	1	1	0	1	2	3
4. Particle size of stream substrate	1	1	1	1	0	1	2	3
5. Active/ relict floodplain	2	2	1	2	0	1	2	3
6. Depositional bars or benches	1	2	0	1	0	1	2	3
7. Recent alluvial deposits	1	1	1	1	0	1	2	3
8. Headcuts	1	1	1	1	0	1	2	3
9. Grade control	1	.5	.5	.5	0	0.5	1	1.5
10. Natural valley	1.5	1	.5	1	0	0.5	1	1.5
11. Second or greater order channel	0	0	0	0	No = 0		Yes = 3	
A. Geomorphology subtotal	15.5	14.5	10	11.5				
B. Hydrology								
12. Presence of Baseflow	3	2	0	2	0	1	2	3
13. Iron oxidizing bacteria	2	2	0	2	0	1	2	3
14. Leaf litter	1	.5	1	.5	1.5	1	0.5	0
15. Sediment on plants or debris	1	.5	.5	1	0	0.5	1	1.5
16. Organic debris lines or piles	1	1	1	1	0	0.5	1	1.5
17. Soil-based evidence high water table	3	3	3	3	No = 0		Yes = 3	
B. Hydrology subtotal	11	9	5.5	9.5				
C. Biology								
18. Fibrous roots in streambed	3	1	1	1	3	2	1	0
19. Rooted upland plants in streambed	2	1	1	2	3	2	1	0
20. Macrobenthos (diversity and abund)	2	1	0	1	0	1	2	3
21. Aquatic Mollusks	0	0	0	0	0	1	2	3
22. Fish	0	0	0	0	0	0.5	1	1.5
23. Crayfish	1	0	0	.5	0	0.5	1	1.5
24. Amphibians	1	.5	0	1	0	0.5	1	1.5
25. Algae	1	0	0	.5	0	0.5	1	1.5
26. Wetland plants in streambed	.75	.75	.75	1.5	FACW = 0.75 OBL = 1.5 Other = 0			
C. Biology subtotal	10.75	4.25	2.75	7.5				

* Perennial streams may also be identified using other methods. See p. 35 of manual. Artificial ditches are not rated.

Notes / Sketch: See attached map of Bolin Creek stream sample points.

Figure A-1. USGS Topographic Quadrangle, Chapel Hill NC, with Greene Tract boundary.

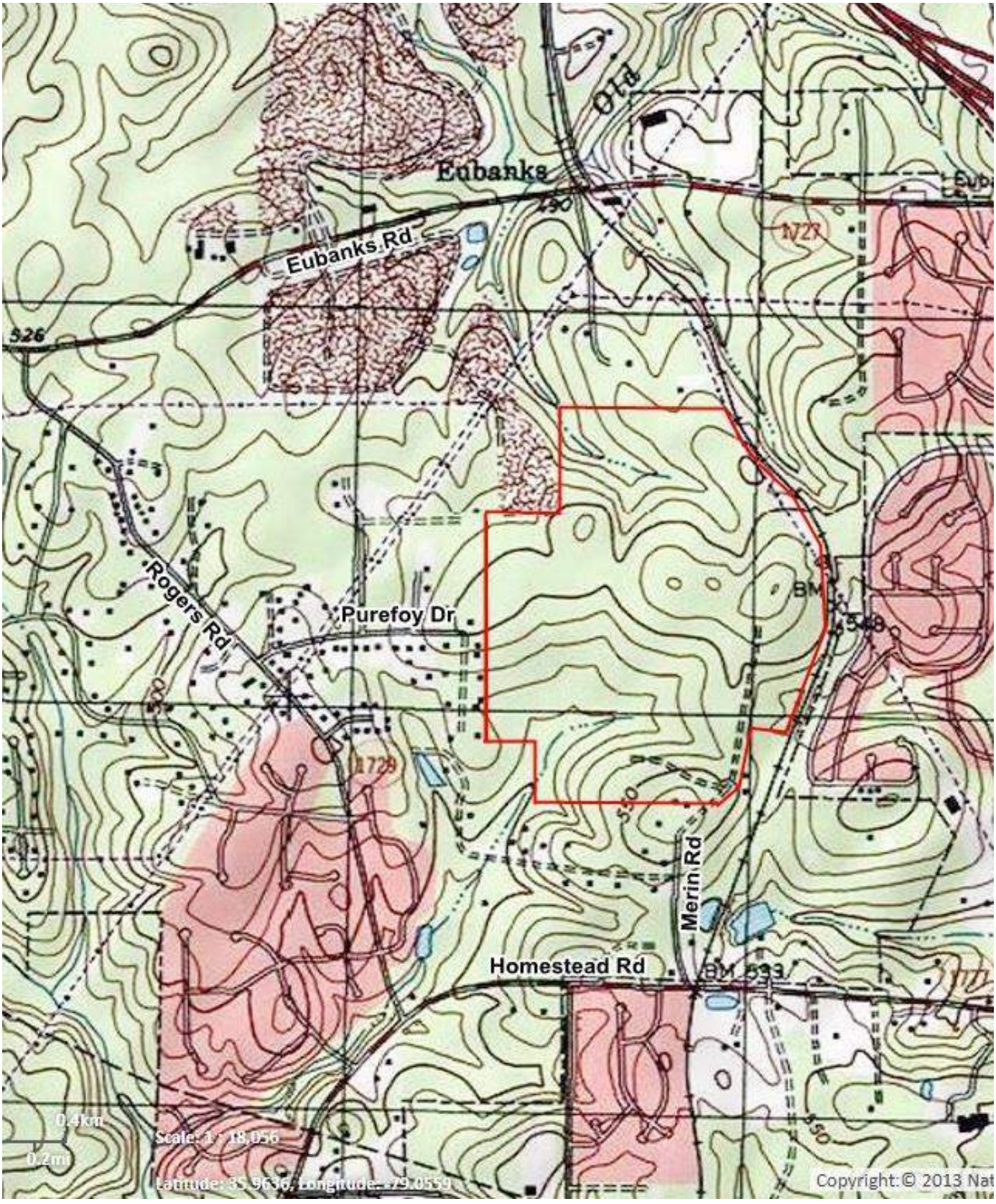
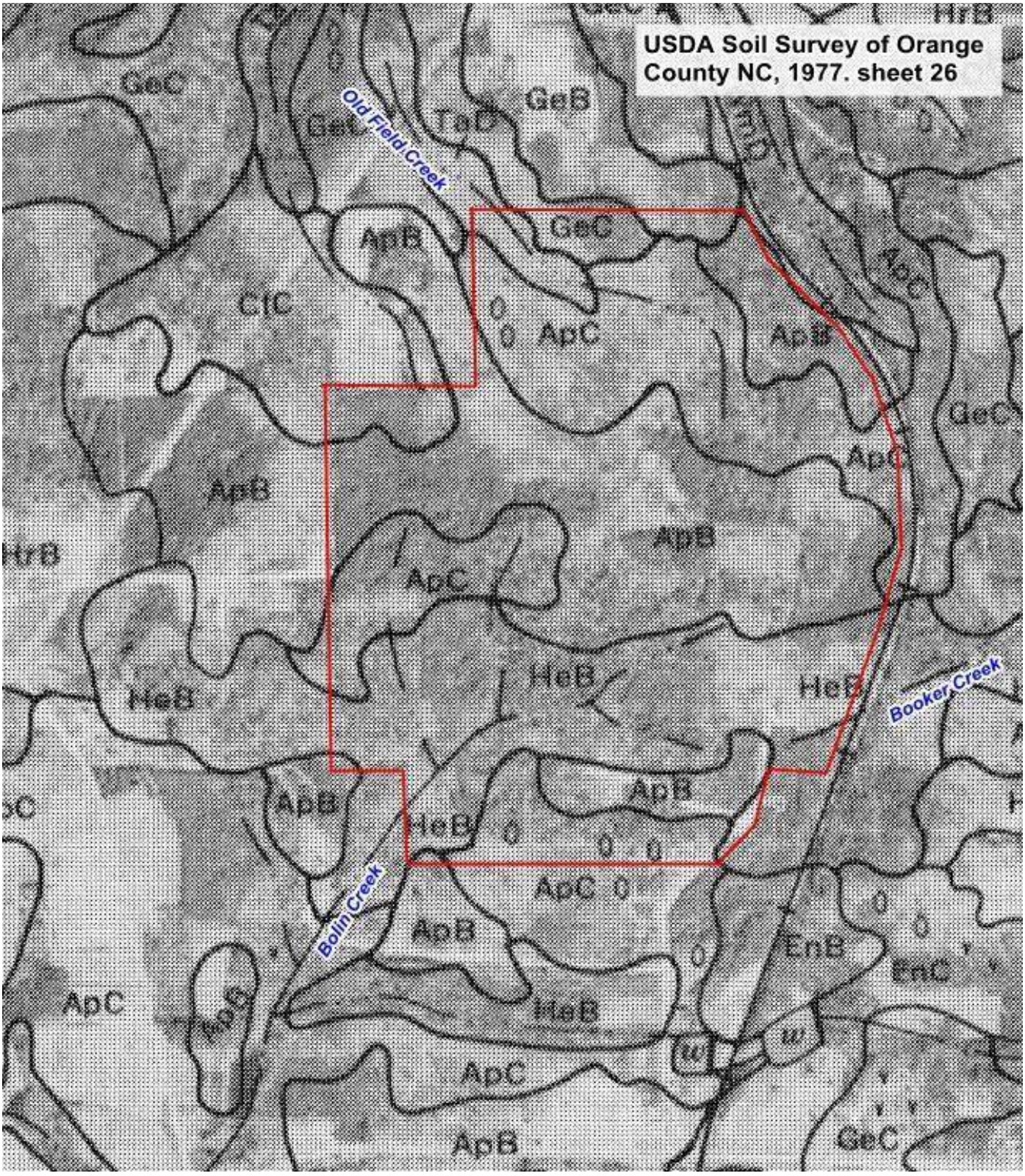
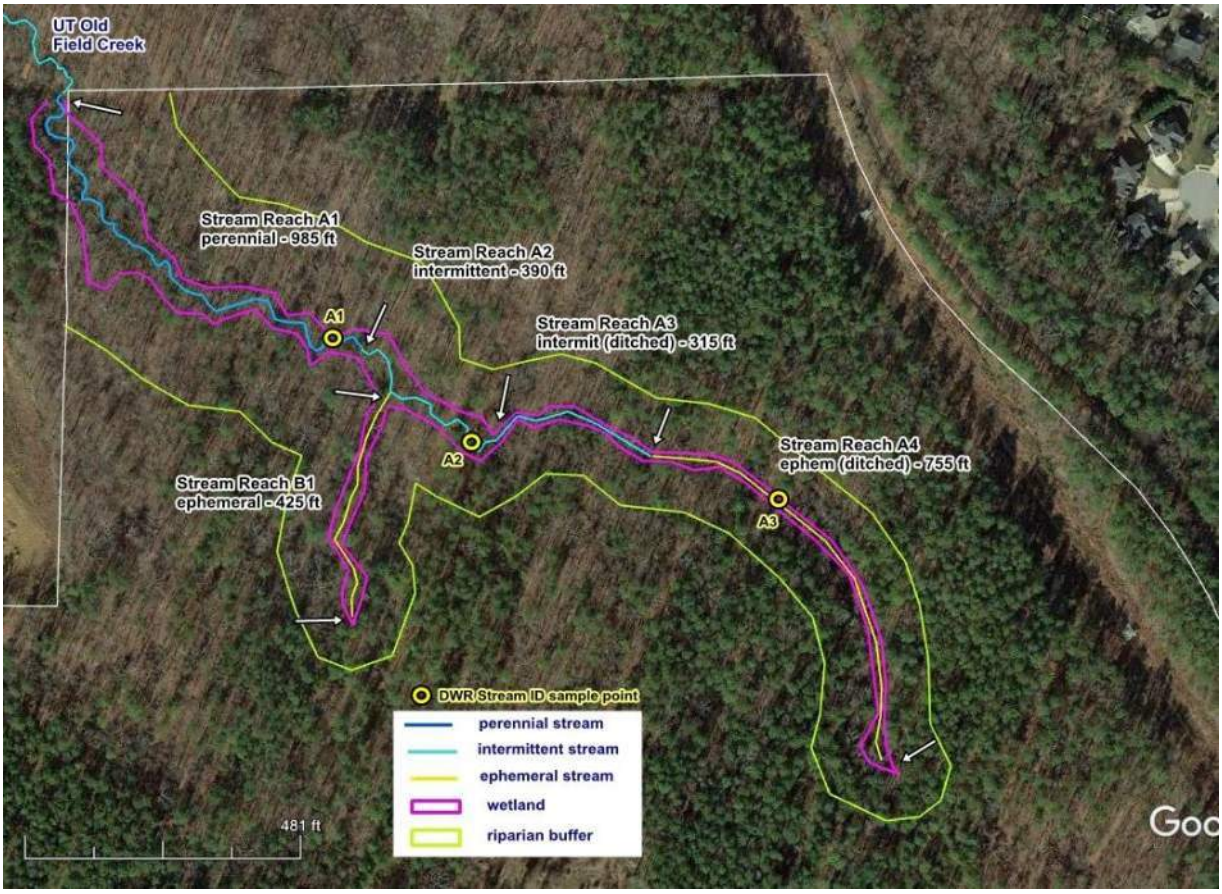


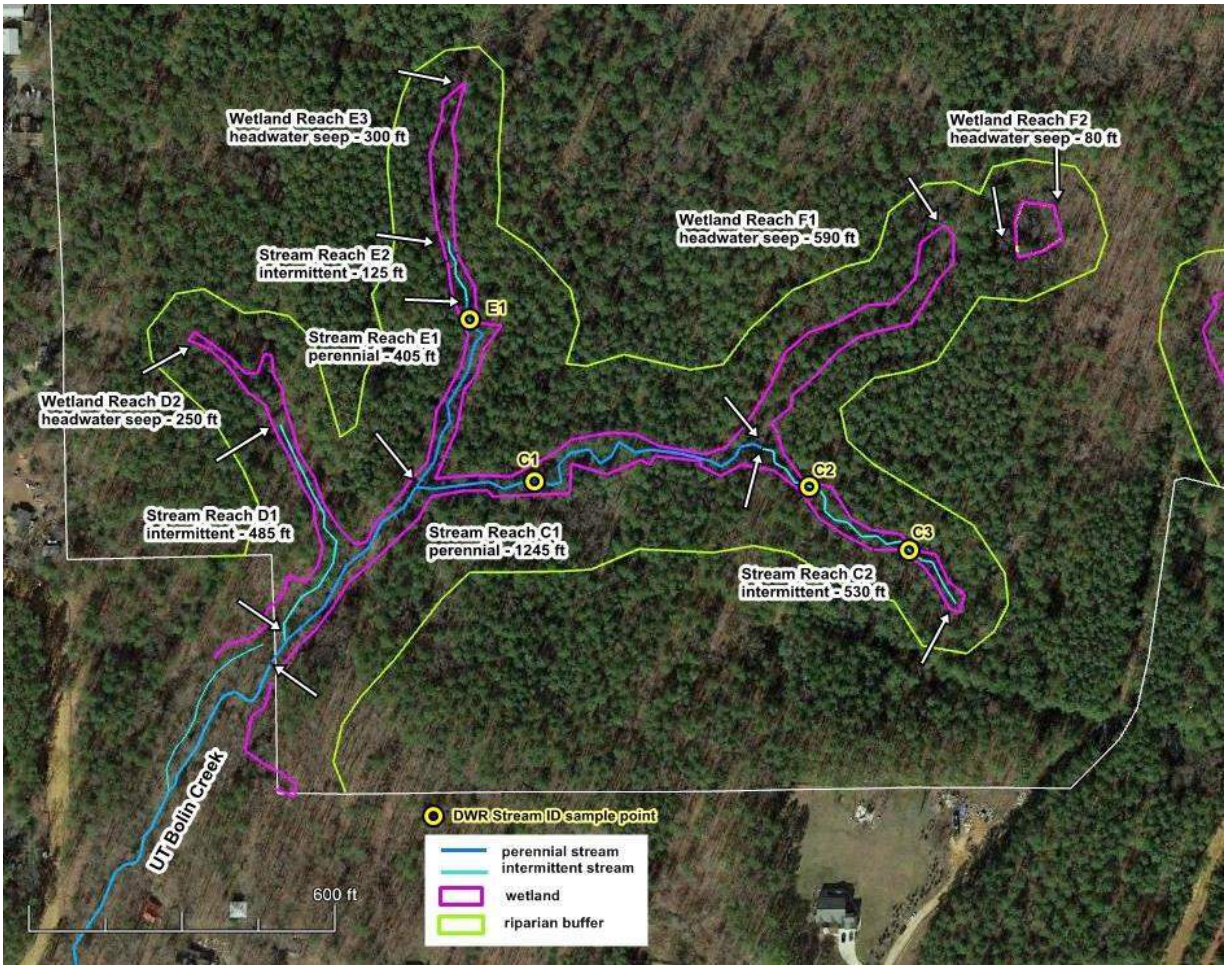
Figure A-2. USDA Soil Survey of Orange County, 1977, with Greene Tract boundary.



Soil Series: Appling sandy loam (ApB and ApC) = 68 percent; Helena sandy loam (HeB) = 25 percent; Cecil fine sandy loam (CfC) = 2 percent; Georgeville silt loam (GeB and GeC) = 3 percent; Tarrus silt loam (TaD) = 2 percent.

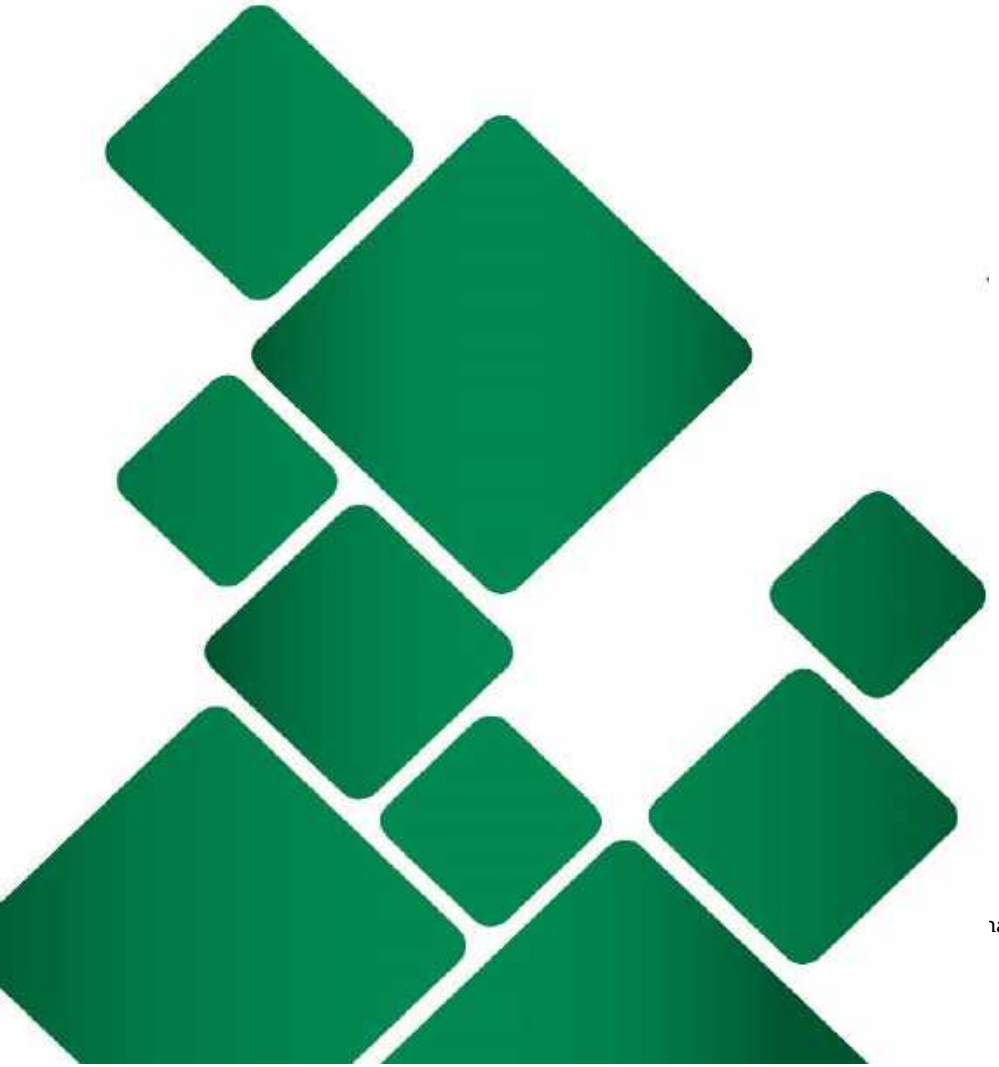
Figure A-3. Stream identification sample points and reaches.





APPENDIX B

DWR STREAM ASSESSMENT METHOD FORMS



synTerra

Science & Engineering Consultants

NC SAM FIELD ASSESSMENT RESULTS
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Greene Tract
2. Date of evaluation: 13 May 2020
3. Applicant/owner name: Orange County, Chapel Hill + Carrboro
4. Assessor name/organization: Gerald Pottern
5. County: Orange
6. Nearest named water body on USGS 7.5-minute quad: Old Field Creek
7. River basin: Cape Fear
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.9637, -79.0748

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): A1
10. Length of assessment reach evaluated (feet): 300
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.5 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 2 - 4 ft
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)
16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):
    ☐A  (more sinuous stream, flatter valley slope)
    ☒B  (less sinuous stream, steeper valley slope)
17. Watershed size: **(skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi²) ☒Size 2 (0.1 to < 0.5 mi²) ☐Size 3 (0.5 to < 5 mi²) ☐Size 4 (≥ 5 mi²)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☒Water Supply Watershed (☐I ☐II ☐III ☐IV ☒V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☒NCDWR Riparian buffer rule in effect
    - ☒Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☒Documented presence of a federal and/or state listed protected species within the assessment area.
      List species: four-toed salamander, NC special concern
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

- ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
- ☒B Not A

3. Feature Pattern – assessment reach metric

- ☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
- ☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

- ☐A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
- ☒B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

- ☒A < 10% of channel unstable
- ☐B 10 to 25% of channel unstable
- ☐C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☒A	☒A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ____________________ (explain in “Notes/Sketch” section)
- ☒J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☒D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

***********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*******************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☒	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☒	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: _____

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☒	Adult frogs
☐	☐	Aquatic reptiles
☐	☒	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☒	Beetles
☒	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☒	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☒	Damselfly and dragonfly larvae
☐	☒	Dipterans
☐	☒	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☒	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☒	Tipulid larvae
☐	☒	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A	Streams and/or springs (jurisdictional discharges)
☐B	Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C	Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☒D	Evidence of bank seepage or sweating (iron in water indicates seepage)
☒E	Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F	None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A	Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B	Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C	Urban stream (≥ 24% impervious surface for watershed)
☐D	Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E	Assessment reach relocated to valley edge
☒F	None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A	Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B	Degraded (example: scattered trees)
☐C	Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)

Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)

Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)

Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).

If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)

Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)

Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)

Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☒A	☒A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: _____

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Greene Tract	Date of Assessment	13 May 2020
Stream Category	Pb2	Assessor Name/Organization	Gerald Pottern

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**HIGH**	
(3) Streamside Area Attenuation	**HIGH**	
(4) Floodplain Access	**HIGH**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**HIGH**	
(4) Channel Stability	**HIGH**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**HIGH**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**HIGH**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**HIGH**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**HIGH**	

NC SAM FIELD ASSESSMENT RESULTS
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Greene Tract
2. Date of evaluation: 13 May 2020
3. Applicant/owner name: Orange County, Chapel Hill + Carrboro
4. Assessor name/organization: Gerald Pottern
5. County: Orange
6. Nearest named water body on USGS 7.5-minute quad: Bolin Creek
7. River basin: Cape Fear
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.9573, -79.0758

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): C1-C2
10. Length of assessment reach evaluated (feet): 300
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 2.0 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 3 - 4 ft
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)
16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):
    ☐A  (more sinuous stream, flatter valley slope)
    ☒B  (less sinuous stream, steeper valley slope)
17. Watershed size: **(skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi²) ☒Size 2 (0.1 to < 0.5 mi²) ☐Size 3 (0.5 to < 5 mi²) ☐Size 4 (≥ 5 mi²)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☒Water Supply Watershed (☐I ☐II ☐III ☐IV ☒V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☒NCDWR Riparian buffer rule in effect
    - ☒Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☒Documented presence of a federal and/or state listed protected species within the assessment area. List species: four-toed salamander, NC special concern
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

- ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
- ☒B Not A

3. Feature Pattern – assessment reach metric

- ☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
- ☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

- ☐A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
- ☒B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

- ☒A < 10% of channel unstable
- ☐B 10 to 25% of channel unstable
- ☐C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☒B	☒B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in "Notes/Sketch" section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: _____ (explain in "Notes/Sketch" section)
- ☒J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric
10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☒A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☒D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*********************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: _____

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☒	Adult frogs
☐	☐	Aquatic reptiles
☐	☒	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☒	Beetles
☐	☒	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☒	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☒	Damselfly and dragonfly larvae
☐	☒	Dipterans
☐	☒	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☒	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☒	Tipulid larvae
☐	☒	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A	Streams and/or springs (jurisdictional discharges)
☐B	Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C	Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☒D	Evidence of bank seepage or sweating (iron in water indicates seepage)
☒E	Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F	None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A	Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B	Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C	Urban stream (≥ 24% impervious surface for watershed)
☐D	Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E	Assessment reach relocated to valley edge
☒F	None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A	Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B	Degraded (example: scattered trees)
☐C	Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: _____

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

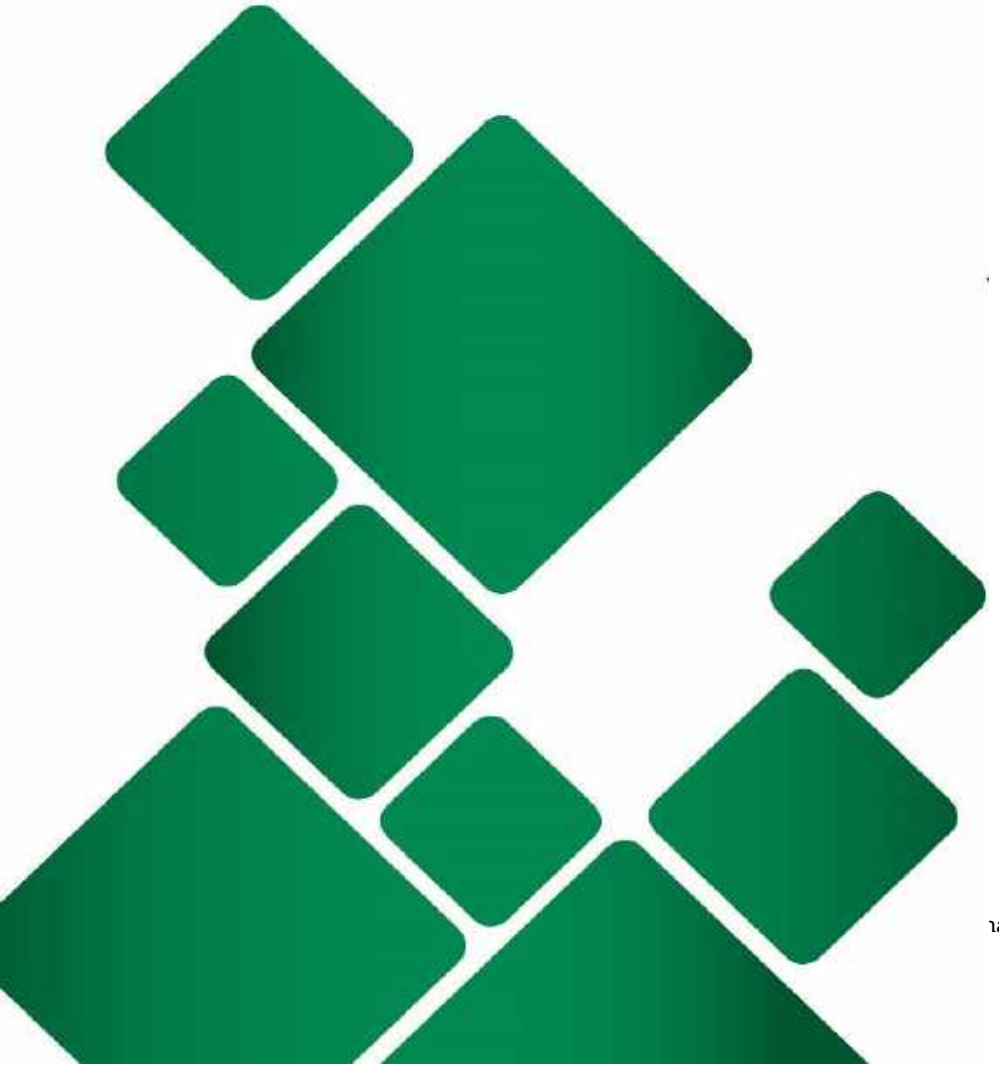
Stream Site Name	Greene Tract	Date of Assessment	13 May 2020
Stream Category	Pb2	Assessor Name/Organization	Gerald Pottern

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**HIGH**	
(3) Streamside Area Attenuation	**MEDIUM**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**HIGH**	
(4) Channel Stability	**HIGH**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**HIGH**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**HIGH**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**HIGH**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**HIGH**	

APPENDIX C

BMPS TO MINIMIZE IMPACTS OF DEVELOPMENT ON ADJOINING WILDLIFE AREAS



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Best Management Practices:
Minimize Impacts of Development on Adjoining Wildlife Areas

The NC Wildlife Resources Commission (NCWRC) recommends that sensitive wildlife habitats, such as Natural Heritage Natural Areas, be buffered from development by encouraging adjacent lands to remain in a rural land use. However, when development is going to occur on adjacent lands, we recommend clustering the buildings around existing infrastructure, and minimize clearing of the site to retain the maximum amount of buffer between developed land uses and natural areas. For more information on appropriate siting of development, see the *Preferred Development Design Guide*. Developments can also incorporate some best management practices into its construction, design, and use to minimize its impact on wildlife habitats and wildlife passage. The following recommendations are a compilation of best management practices for minimizing impacts in developments.

I. Minimize human conflict with wildlife.

A. Do not feed wildlife. Do not intentionally leave out human food, dog food, or any other food for the purpose of feeding wildlife.
    1. Discourage the use of bird feeders. If used: clean and disinfect them to prevent the spread of diseases between birds, provide fresh food, clean up loose seeds that attract rodents and squirrels.
B. Limit human access to natural areas to officially approved trailheads
    1. Co-locate new trails within existing right-of-ways.
C. Limit access of wildlife to trash
    1. Use secure garbage containers with tight-fitting lids; garbage cans can be secured with bungee straps, ratchet straps, or latches.
    2. Throw out garbage – particularly food waste -- on the morning of pick up, not the night before
D. Use traps instead of rodenticides to control rodent populations – these poisons can be transferred up the food chain to carnivores and scavengers.
E. Construct bat and bird boxes to provide roosting and nesting habitat.
F. Provide materials (booklets, programs, etc.) or a signage program that educates occupants and visitors on wildlife and how to reduce impacts to wildlife habitats. NCWRC can provide assistance in development of these materials.

II. Minimize lighting impacts

A. Plant dense native evergreen shrubs and trees around parking lots to block headlights shining into natural areas
B. Choose lighting fixtures that are low mounted with baffles that direct light downward and away from natural areas

C. Lights outside and within buildings should only be on when needed. Use motion-sensors to turn lights off when not needed and/or set lights to an automatic timer to turn off
D. Light should be no brighter than necessary for the application. Minimize blue light emissions (CCT should be < 3,000 K). Aim for no more than 1.25 lumens per square foot of hardscape.
   More information on minimizing light pollution can be found here: http://arlington.granicus.com/MetaViewer.php?view_id=44&event_id=1171&meta_id=166632 and https://www.darksky.org/light-pollution/light-pollution-solutions/

III. Minimize noise impacts and other disturbances related to human presence

A. Build solid walls/noise baffles between areas of high noise impacts, such as trash bins and loading docks, and the natural areas
B. Consider constructing parking lots on the sides of buildings located opposite the natural areas
C. Restore the native forest around the development to reduce the impacts of noise, lighting, and other disturbances to wildlife
D. Schedule timing and control of initial construction operations and subsequent operation and maintenance to minimize disruption of biological community structure and function. In general, avoid forest clearing in spring and summer, when young wildlife cannot disperse.
    1. Avoid clearing the proposed project during the migratory bird nesting season, roughly March to August, or conduct surveys for active nests prior to construction to avoid wounding or killing migratory birds.
    2. Due to the decline in bat populations, avoid tree clearing activities during the maternity roosting season for bats (May 15 – August 15).

IV. Minimize runoff and use of landscaping chemicals. NCWRC encourages stormwater management strategies that maintain post-development stormwater runoff conditions as close to pre-development conditions as possible. Low Impact Development (LID) techniques that preserve natural site features as a first step in site planning are encouraged.

A. Utilize engineered LID techniques in cases where natural features cannot be protected sufficiently, examples include: pervious pavement, grass swales, rain gardens, bioretention cells.
    1. Grassed swales should be used in place of curb and gutter for new developments, except in areas with >5% slope.

2. Check dams, level spreaders, and other associated best management practices should be used to minimize the effect of stormwater runoff entering the riparian buffer areas.
3. In areas where slopes exceed 5%, stormwater collected in piped conveyance systems should be directed away from surface waters and best management practices shall be employed at both the intake and the outlet areas.
4. Conduct periodic monitoring of (engineered) mitigation features to assure continuous operation.
   More information on LID techniques can be found here:
   http://www.onsiteconsortium.org/npsdeal/NC_LID_Guidebook.pdf
   https://www.epa.gov/nps/urban-runoff-low-impact-development

B. Use the following preferred methods of sediment and erosion control:
   1. Sediment and erosion control measures should be installed prior to any land-disturbing activity.
   2. The use of biodegradable and wildlife-friendly sediment and erosion control devices is strongly recommended. Silt fencing, fiber rolls and/or other products should have loose-weave netting that is made of natural fiber materials with movable joints between the vertical and horizontal twines.
   3. Silt fencing that has been reinforced with plastic or metal mesh should be avoided as it impedes the movement of terrestrial wildlife species.
   4. Regularly inspect erosion control measures throughout duration of use.
C. Control water pollution through best management practices. Do not direct any runoff into corridor and stream.
D. Do not place any engineered stormwater controls, such as bio-retention ponds, in natural areas.
E. Regrade disturbed areas to contours that provide optimal aquatic and terrestrial wildlife habitat value or approximate original contours.
F. Plant appropriate native shrubs and trees and other beneficial vegetation to speed recovery and provide pollinator habitat.
G. Avoid use of herbicides, except to control invasive species.
   1. Manage non-native, invasive species by pretreating the project site prior to construction, preventing spread during construction, and control non-native, invasive species throughout the monitoring period.
H. If pesticides or chemicals will be used for site maintenance, stormwater runoff from the site should be funneled to bio-retention areas prior to discharge to streams or wetlands.

V. **Restore appropriate native vegetation – particularly forest cover – in all areas surrounding development.** NCWRC can provide guidance on appropriate species.

A. Protect as much of a contiguous native canopy and understory as possible during construction to provide diverse, multi-age forest structure.
B. Plant a wide variety of native plants (select species that provide food, cover, and nesting habitat) that are appropriate for the site.
C. Avoid fescue-based mixtures because fescue is invasive and provides little benefit to wildlife.
D. Control invasive species that often gain a foothold on lands disturbed by grading and clearing

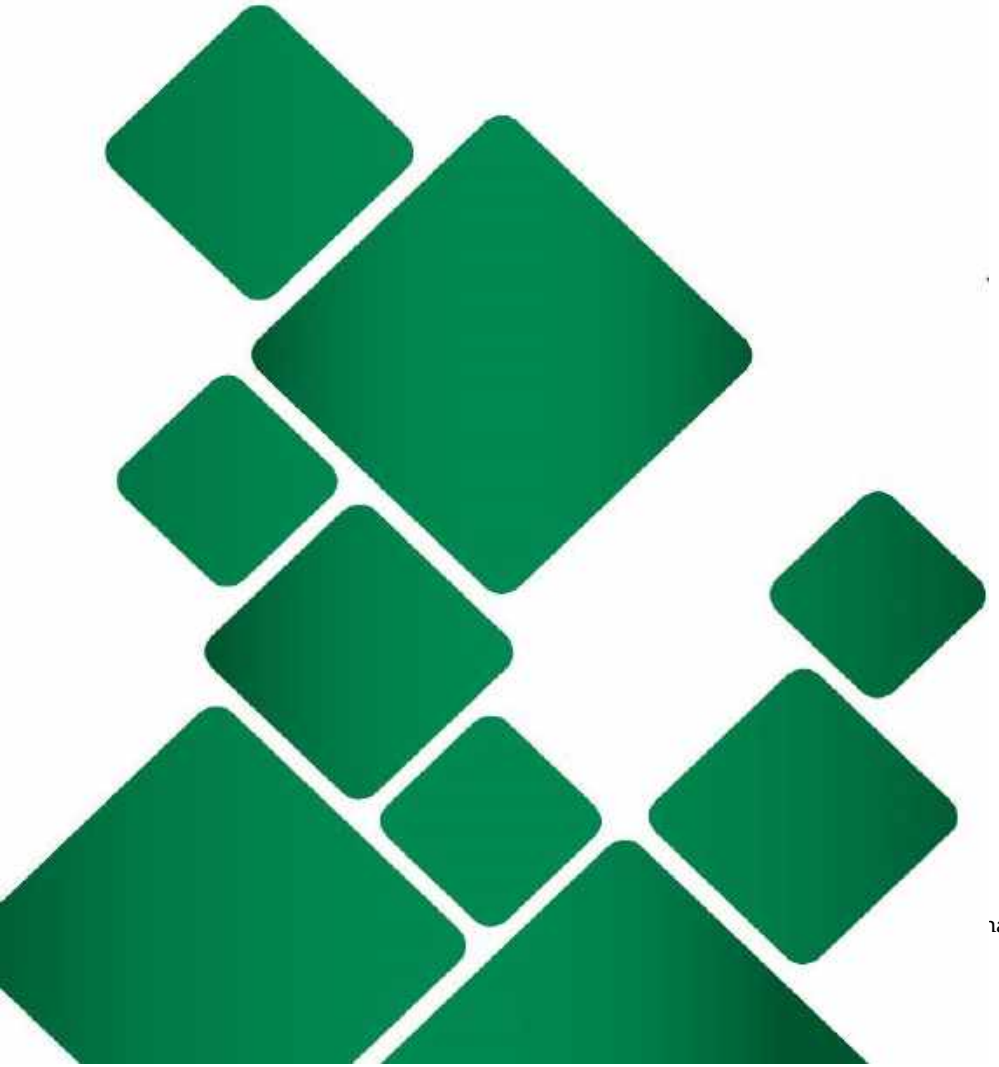
   More information on native and invasive species can be found here:
   http://nc-ipc.weebly.com/nc-invasive-plants.html
   https://ncwildflower.org/native_plants/why_natives

VI. **Minimize bird collision with building windows**

A. Use frosted or fritted glass facades, UV glass, art treatment of glass, netting, and screens, especially in the bird collision zone (from ground level up to 60'). See examples at:
   http://default.sfplanning.org/publications_reports/bird_safe_bldgs/Standards%20for%20Bird%20Safe%20Buildings%20-%2011-30-11.pdf
B. Plant trees either directly adjacent to windows to slow birds down on approach to window, or place them far enough away so that there is no reflection of vegetation in window

APPENDIX D

GREENE TRACT PHOTO LOG



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Orange County Greene Tract -- Site Photos May 2020

Bolin Creek Reach E1 Seep

Bolin Creek Reach E1 Seep

Bolin Creek Reach C1 Stream below E1

Bolin Creek Reach C1 Seep below D1

Orange County Greene Tract -- Site Photos May 2020

Bolin Creek Reach C1 Stream below D1

Bolin Creek Reach C1 Stream below D1

Bolin Creek Reach C3 Stream/Seep above F1

Bolin Creek Reach C1 Stream above E1

Orange County Greene Tract -- Site Photos May 2020

Booker Creek Reach G1 Seep

Booker Creek Reach G2 Seep

Booker Creek Reach G3 Seep @ powerline

Booker Creek Reach G3 Seep @ powerline

Orange County Greene Tract -- Site Photos May 2020

Old Field Creek Reach A3, incised/channelized

Old Field Creek Reach A3, incised/channelized

Rocky outcrop south of Old Field Creek Reach A3

Old Field Creek Reach A4

Orange County Greene Tract -- Site Photos May 2020

Old Field Creek Reach A2

Old Field Creek Reach A3/A4 transition

Old Field Creek Reach B1 Seep at A2 confluence

Old Field Creek Reach A2 Seep above B1

Orange County Greene Tract -- Site Photos May 2020

Old Field Creek Reach A2 Seep above B1

Old Field Creek Reach A1 Stream/Seep below B1

Old Field Creek Reach A1 at gas line crossing

Old Field Creek Reach A1 south of gas line

Orange County Greene Tract -- Site Photos May 2020

Entrance gate from Neville Tract near NW corner

Neville Tract, view north from Greene Tract gate near NW corner

Lilium michauxii @ 35.9620, -79.0759

Cypripedium acaule on ridge @ 35.9606, -79.0757

Orange County Greene Tract -- Site Photos May 2020

Hexastylis virginica? @ Old Field Cr Reach A2

Oenothera fruticosa under powerline

Chionanthus virginicus @ Bolin Creek Reach C1/D1 confluence

Potts homestead chimney remains, near Bolin Cr Reach C2/D1