*SB-80-1 Forested Wetlands and Intermittent Watercourse West of Main Stem (Parcel 0839100, 0839200).*

At the location where Stony Brook is piped beneath I-95, there is a small intermittent watercourse with a narrow band of associated forested wetland. The roadway is close by, and the area is noisy due to the highway. Some fill, dumping, and invasive species were observed on the access road side, but the northern wetland edge is well buffered with a mature woodland of tulip poplar, birches, mixed oaks, and hickories with an understory of mountain laurel. Red maple, ash, and yellow birch line the intermittent watercourse, which is moderately steep and rocky. Mountain laurel, witch hazel, high bush blueberry, spicebush, poison ivy, and grape occupy the wetland understory. Wildlife in the wetland area is sparse due to the proximity of the highway and better habitat nearby.

The wetland here stabilizes the intermittent watercourse. There are flatter areas within the wetland where it broadens out and sediment becomes entrapped. Local wildlife habitat exists but no vernal pools were observed and no fishery habitat exists. Recommendations for this wetland include:

- Protect water quality within wetlands
- Occasionally, inspect road margins and remove debris from wetlands
- Maintain base flow to intermittent watercourse

*SB-80-1a and SB-80-1b Forested Wetlands (Parcel 0839200)*

Two isolated forested wetland pockets were observed within parcel 0839200. Neither wetland system appeared to support amphibian breeding. The overstory within these wetlands consisted of red maple, black birch, and yellow birch; and the understory consisted of spicebush, mountain laurel, sweet pepperbush, and winterberry. The forested upland areas bordering these wetlands appear to have been logged several years

ago. The primary function and value of these forested wetlands is limited wildlife habitat. Recommendations for these wetlands include:

- Protect water quality within wetlands

### 5.5.3 Watershed SB-70

The SB-70 watershed is primarily undeveloped; however, former land uses west of the commercial development on Cross Road (between Foster Road and I-95) have had negative impacts upon the wetland margins. Watershed SB-70 is depicted on Figure 5-4. The SB-70 watershed is predominately mixed upland hardwood forests, forested wetlands, scrub-shrub wetlands, and commercial developments. The surficial materials within this watershed consist of a mix of stratified drift and till deposits. Wetlands are primarily underlain by stratified drift with the exception of the wetlands located to the west, which are underlain by till.

The dominant wetland soil types within the watershed are the poorly drained Raypol series, very poorly drained Timakwa and Natchaug complex, the very poorly drained Scarboro muck series, and poorly drained Aquents. Ground water and surface waters within these wetland systems flow into an unnamed perennial watercourse (T2/T3). The perennial watercourse serves as a tributary to Stony Brook. This watershed also supports a critical resource area discussed later under Section 5.8.

*SB-70-1 Forested Wetland Corridor (Parcels 0224600 Plus 0147700, 0147800, 0148000, 0148200, 0148100, 0148300, and 0148500)*

This wetland system is one of the largest within the Stony Brook watershed. It is comprised of one large parcel (0224600) plus several smaller and developed parcels. The predominant cover type is a palustrine forest, red maple swamp; however, extensive areas are dominated by a shrub swamp community. A channelized, intermittent watercourse (T2) drains this system. It flows beneath Foster Road, east of the old radio tower clearing.

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This wetland occupies a topographic depression and is hydrologically supported by shallow ground water, seeps, and surface runoff from adjoining uplands including runoff from developed parcels and perhaps Cross Road drainage as well. The soils are poorly drained at the margins and very poorly drained in the interior swamp. Conditions are seasonally saturated and seasonally flooded (at least) in many places.

Vegetation density is high. The swamp canopy is overwhelmingly red maple trees of small diameter, subject to frequent blowdown. This results in a varied, hummocky topography that encourages the development of a dense shrub and herbaceous layer including high bush blueberry, winterberry, sweet pepper bush, arrow-wood, spicebush, clammy azalea, Japanese barberry, multiflora rose (these two invasive species are mostly confined to disturbed edges along the eastern border), greenbriar, false hellebore, skunk cabbage, soft rush, marsh marigold, meadowsweet, sensitive fern, Canada mayflower, and tussock sedge.

Wildlife habitat values are very good. Several vernal pools were observed supporting high numbers of wood frogs and spotted salamanders (Tier 1 pools). Dead and dying trees provide birds and small animals with abundant perches, feeding areas, and nest/roost cavities. Mostly suburban species were observed including American robin, blue jay, American goldfinch, blue-gray gnatcatcher, black and white warbler, Northern cardinal, tufted titmouse, Carolina wren, prairie warbler (cleared field edges), and ruby-throated hummingbird. Habitat for turtles and snakes is very good as well.

Despite the disturbed edges, significant wetland functions and values include flood flow alteration, water quality renovation, production export, and wildlife habitat. Recommendations for this wetland system include:

- Preserve forested buffer around the wetland to protect amphibians
- Manage invasive species along wetland margins
- Protect water quality within wetlands
- Maintain base flow to intermittent watercourses and wetlands

*SB-70-2 (a-d) Palustrine Forested, Emergent Marsh, and Scrub-Shrub Wetland Corridor (Parcel 0224700)*

These wetland systems are located at the former WNLC radio tower parcel accessed from Foster Road. The wetlands consist of a nutrient-poor emergent marsh and wet meadow bordered by a scrub-shrub system. Forested wetlands are also located on the parcel. This wetland system has been significantly disturbed in the past as evidenced by the fill piles and existing ATV trails. In fact, this parcel had been used for sand and gravel mining. When the radio tower was present, the surrounding wetlands were continually maintained via burning, clearing, cutting, and herbicide application. The soils consist of both poorly and very poorly drained soils. Hydrology feeding this wetland system includes hillside seeps and surface water runoff from abutting upland mixed hardwood forests. The hydrologic regime of the wetlands includes seasonally saturated, semipermanently saturated, and temporarily flooded.

Varying vegetation communities exist within this wetland system. Forested wetland areas are dominated by red maple, sweet pepperbush, and skunk cabbage. The scrub-shrub wetlands are dominated by black willow, speckled alder, maleberry, highbush blueberry, swamp azalea, sheep laurel, meadowsweet, and common reed. The nutrient-poor emergent marsh and wet meadow wetlands are dominated by swamp laurel, sheep laurel, maleberry, steeplebush, cattail, marsh marigold, Nuttall's reed grass, rough boneset, bog clubmoss water sedge, wool sedge, and American burreed.

Previous flora surveys conducted by other environmental consulting firms identified a *Carex aquatilis* within the emergent marsh. This is a species of special concern. Other surveys have identified rose pogonia, grass pink, *Iris prismatica*, *Eleocharis tuburculosa*, *Rynchospora capitata*, and *Drosera rotundifolia* within these wetlands.

The diversity of wetland cover types within this wetland system increases its wildlife habitat value. Depressional pools found within the scrub-shrub portion of wetlands provide breeding habitat for spotted salamanders and wood frogs. The wet meadow and emergent marsh wetlands provide habitat for a variety of amphibians, insects, and birds. Observed species included red-winged blackbird, song sparrow, American goldfinch, Eastern towhee, Northern cardinal, white-eyed vireo, and several foraging swallows. A female mallard was found incubating a nest full of eggs nearby. Spring peepers and a northern water snake were also found within this wetland.

There is a high degree of alteration and disturbance within this wetland system, which must once have been predominantly a palustrine forested system. Large fill piles and a road bed are present in the wetland. Invasive species are common along the eastern margins, near the commercial development. The concrete platform for the radio tower is a prominent feature. Dumping and ATV traffic is an ongoing problem due to unrestricted access and is heavily impacting the existing wetland vegetation. However, the natural hydrologic regime and altered conditions have combined to enable the development of a very unusual wetland cover type. It will be very interesting to follow its progress. The area is ripe for wetland restoration, but caution should be exercised when evaluating proposals. Potential restoration efforts for this wetland include removal of anthropogenic debris and *Phragmites* management control and reestablishment of native wet meadow and emergent marsh wetland communities.

Overall, this large wetland system provides several important functions and values including nutrient removal (nutrient rich wetland areas), toxicant retention, and wildlife habitat (amphibian breeding).

Based on the diversity of wetland communities, plant diversity, wildlife habitat and its connection to large unfragmented natural areas, this wetland has been identified as a critical wetland system (CWS-1) within the Stony Brook watershed. This designation is

described in greater detail in Section 5.8. Recommendations for this wetland system include:

- Preserve/enhance forested buffer around vernal pool to protect amphibians
- Protect water quality within wetlands
- Maintain base flow to wetlands and intermittent watercourses
- Restore wetlands colonized by invasive species
- Eliminate ATV use within wetlands and repair damage

*SB-70-3 Palustrine Scrub-Shrub and Forested Wetland (Parcel 0146500)*

This wetland system occupies the low-lying land west of the commercial development on Cross Road, north of I-95. It is contiguous with wetlands to the north described above and the eastern tributary to Stony Brook described below. The bordering uplands are steeply sloped and terraced with old-field regeneration species such as red cedar and field grasses dominating the dry landscape. The toe of the slope flattens and is crisscrossed by old roadways. Several large fill piles occur in wetlands, and there is at least one excavated farm pond. The disturbed wetland edges have been heavily colonized by invasive species; however, beyond this disturbed edge, excellent wetland habitat is preserved.

This wetland is a palustrine forested and scrub-shrub system dominated by a red maple canopy. Common shrubs are high bush blueberry, sweet pepper bush, and silky dogwood. The wetland edges are thick with oriental bittersweet, multiflora rose, Japanese barberry, and greenbriar, resulting in a virtually impenetrable tangle. Microtopography is pronounced, and the hummocks support skunk cabbage and a variety of sedges and mosses. The wetland is semipermanently to seasonally flooded, which further limits accessibility. The wetland is in a topographic depression with dispersed through-flow toward a tributary to Stony Brook. Soils are poorly to very poorly drained.

Wildlife habitat is very good in this area due to the vegetative diversity and varied topography. Green frogs, spotted salamanders, wood frogs, and red-spotted newts were observed. Habitat for snakes and turtles appears excellent as well. Apart from the common suburban birds expected along an old field edge, pileated woodpecker, white-eyed vireo, and common grackle were observed within the swamp community.

Wetland functions and values include ground water recharge/discharge, flood flow alteration, pollutant renovation (sediment / toxicant retention and nutrient removal), production export, and fish/wildlife habitat. Recommendations for this wetland system include:

- Preserve/enhance forested buffer around vernal pool to protect amphibians
- Protect water quality within wetlands
- Maintain base flow to wetlands and intermittent watercourses
- Restore wetlands colonized by invasive species and control invasive plant species along upland margins
- Increase native tree species within uplands bordering wetlands.
- Monitor water quality near former landfill
- Remove fill from wetlands and restore natural conditions

*SB-70-4 Palustrine Forested, Scrub-Shrub and Emergent Marsh Wetland Corridor (Parcels 0838300, and 0146500, 0146600)*

This wetland system consists of several vegetative cover types including forested, scrub-shrub, and small sections of open-canopy emergent marsh wetlands. These wetlands have been significantly impacted by bordering commercial development, a utility line corridor, and proximity to I-95 and Cross Road. The wetland soils consist of poorly drained soils. Palustrine forested wetlands are primarily located along the east side of Cross Road. These wetlands receive stormwater runoff from Cross Road. Dominant

hydrophytic vegetation includes red maple, yellow birch, spicebush, highbush blueberry, and skunk cabbage.

The forested wetlands transition into a swampy scrub-shrub and emergent marsh wetland. Organic muck soils (very poorly drained) are dominant with hummocky topography present. Small shallow open water depressions with vegetated islands dominate this system. The primary hydrology to this wetland is ground water discharge. Vegetation included speckled alder, silky dogwood, buttonbush, highbush blueberry, broad leaved and narrow leaved cattail, purple loosestrife, common reed, sphagnum moss, skunk cabbage, marsh fern, and royal fern. Surface water is conveyed towards the northwest within a man-made channel. This channel is conveyed west under Cross Road and into a large scrub-shrub/forested wetland. This wetland has diverse vegetation structure; however, its ability to serve as good wildlife habitat is limited by its isolation, existing barriers (primarily roads), and a heavily developed contributing watershed.

In addition to the wetlands described above, a *Phragmites*-dominated emergent marsh is located within an existing utility line corridor. The plant diversity is low and available wildlife habitat is limited although green frogs were heard calling from within the stands of *Phragmites*. Overall, this wetland system is providing several important functions and values including nutrient removal and renovation, sediment and toxicant retention, floodwater storage, and limited wildlife habitat. Recommendations for this wetland system include:

- Occasionally monitor water quality at Cross Road to evaluate pollutant renovation
- Maintain base flow to wetlands
- Restore wetlands colonized by invasive species

*SB-70-5 Eastern Tributary (Parcel 0838600)*

Stony Brook is joined by a large tributary (T3) from the east, approximately 500 feet above the I-95 culverts. This watershed consists of an expanse of palustrine, mixed-class wetlands with large tracts of undisturbed habitat. However, the wetlands in the southern section (near I-95) adjoin a commercial development (Parcel 0838600) that has had an impact upon the wetlands. Much of the edge habitat in this area has been negatively impacted by clearing, cut/fill operations, and construction of parking lots and driveways. There are also ponds that were excavated, in wetlands. As a result, the wetland edges are heavily infested with invasive species, particularly Japanese barberry and multiflora rose.

The wetland system near the tributary's confluence with Stony Brook is more representative of the nonimpacted expansive wetland than the disturbed edges. The red color of the water is very noticeable in the tributary watershed, in contrast to Stony Brook which is uncolored. Additional water quality monitoring is recommended (see additional discussion in Section 4.4). A rough dirt path and a stone wall cross perpendicular to the tributary.

The lower section of the channel has a step-pool pattern with a cobble bottom as it drops to the lower elevation of Stony Brook. The channel is approximately two feet deep and 10 feet across. A short distance upstream, the wetland is semipermanently flooded, broadening out into a forested swamp with dense shrub and herbaceous layers. The bordering uplands are relatively undeveloped apart from the dirt roads and occasional small forest clearings. ATV use was apparent, and the area has also been recently logged. The wetland extension (southeastward) back toward the commercial development along the highway access road included several vernal pools but the edge habitat was badly degraded.

The forested swamp consists of red maple, black tupelo, ash, and ironwood with mixed oaks, maples, and birches at the upland edge. Dominant shrubs are sweet pepper bush,

high-bush blueberry, common winterberry, and mountain laurel with some invasives and greenbriar. The stream supported aquatic vegetation, and small fish were observed. Spotted salamander egg masses, adult wood frogs, and green frogs were present in the backwater pools. Deer browse was heavy.

This is an important wetland system, not just for its excellent wildlife habitat, including vernal pool obligate species, but for production export, flood flow alteration, ground water interaction, and removal/renovation of pollutants.

Recommendations for this wetland system include:

- Remove trash and debris from wetlands near Parcel 0838600
- Enhance forested buffer around vernal pools to protect amphibians
- Protect water quality within wetlands from commercial site runoff
- Maintain base flow to wetlands and intermittent watercourses
- Manage invasive species along wetland edges

*SB-70-6 Stony Brook Upstream of I-95 Culverts (Parcels 0838600, 0839100)*

Stony Brook at this location (from the I-95 culverts upstream/northward to the confluence with a tributary (T2/T3) from the east) has a step-pool pattern, with boulder steps and pools. The width is approximately 30 feet; the depth is variable, averaging about two feet deep. Away from the highway culverts is a wide, naturally vegetated riparian area, with a floodplain to the east. Vegetation and stones stabilize the channel. No serious erosion or scouring impacts were observed. Water quality is good but has a reddish tint, presumably iron oxide or tannins originating from the eastern tributary (T2/T3), which is swampier and marshier than the main stem. The water is cool and well oxygenated. Benthic invertebrates are well represented, and fish were observed.

The banks are primarily a mature upland forest of mixed maples, hickories, and oaks, plus American beech and tulip poplar. The shrub layer is moderately dense with sweet pepper bush, mountain laurel, high-bush blueberry, spice bush, and witch hazel present. Herbaceous growth is less dense under the canopy, but false hellebore and skunk cabbage occupied wetter areas, and Canada mayflower and a variety of ferns and sedges are present in drier areas. Wildlife habitat is very good, beginning with the brook itself, a cold water fishery. The brook side had small mammal tracks and scat. Both forest birds and suburban species were well represented including Eastern phoebe, a typical streamside nester.

At this location, the brook provides many important wetland functions and values beyond the expected fish and wildlife habitat, ground water discharge/recharge, shoreline stabilization, and production export. This location has reasonable public access possibilities so that visual and aesthetic values become important. Access also allows for active and passive recreation and educational values. Recommendations for this wetland system include:

- Preserve forested buffer along Stony Brook for thermal protection and allochthonous material inputs
- Protect water quality within Stony Brook
- Maintain base flow to Stony Brook
- Occasionally, inspect this area for dumping and remove accumulated trash and debris

## 5.6 Mid-Watershed – Wetlands South of I-95

### 5.6.1 Watershed SB-60

Watershed SB-60 is located south of I-95 and is comprised primarily of undeveloped parcels and residential properties. Watershed SB-60 is depicted on Figure 5-5. The undeveloped parcels consist of mature growth mixed hardwood forests. A former auto salvage business was also located within this watershed. Based on field investigations, debris from this operation has been removed.

The wetlands in SB-60 consist of forested wetlands, open water, unnamed perennial tributary (T6), and several intermittent watercourses. Stratified drift deposits consist of a sand and gravel as well as alluvial deposits beneath the Stony Brook corridor. Land areas to the west are underlain by till. The wetland soil types within this watershed include the very poorly drained Timakwa and Natchaug complex, the Ridgebury, Leicester, and Whitman soils complex, and the poorly drained Walpole series.

*SB-60-1 Gurley Road Headwaters (Parcels 0280900, 0075700)*

This wetland is at the western boundary of the watershed near I-95. The surroundings are forested and relatively undeveloped except for a former farm and existing residential development accessed from Gurley Road. Old farm ponds, stone walls, access roads, and some fill were noted in this area. This headwater wetland is a palustrine forested wetland and includes an intermittent watercourse (T6). The tree stratum is dominated by red maple, yellow birch, tupelo, ash, American beech, mixed oaks, and tulip poplar. The upland forest is mature, and many of the trees are large. Predominant shrubs are spice bush, sweet pepper bush, mountain laurel, and witch hazel. The herbaceous growth is diverse due to the rocky, hummocky terrain and consists of skunk cabbage, false hellebore, jewelweed, trillium, Jack-in-the-pulpit, and mixed ferns and sedges. Where disturbance was noted especially near clearings and fill areas, multiflora rose and particularly Japanese barberry were common invasive species.

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Wildlife was diverse, reflecting the nearby field habitat, wetlands, and mature upland forest. Blue jays, American goldfinch, Eastern towhee, Baltimore oriole, gray catbird, tufted titmouse, yellow warbler, and red-bellied woodpecker are typical in these areas and were recorded. Forest species such as wood peewee, scarlet tanager, red-eyed vireo, rose-breasted grosbeak, great-crested flycatcher, and white-breasted nuthatch were observed. Near the former farm property, an excavated pond supported spotted salamander and wood frog, the common vernal pool obligate species in this region. Green frogs were common in and around the watercourse and small pools.

The soils are rocky and the stream channel is sinuous with good vegetative diversity and stable banks. Backwater pools and isolated hummocks from fallen trees add topographic relief. Ground water seeps are present. The result is a good mix of hydrophytes, facultative, and upland plants in close proximity. Nearby ledges and outcrops provide additional shelter for wildlife.

As the stream flows southeastward, flow becomes more persistent and is likely perennial. The auto salvage site has cleared the landscape of vegetation to (at least) the wetland edge. This has the potential to cause long-term negative impacts to the wetland as seems to have occurred on the opposite side of the property near the Post Road (SB-60-2, below). However, apart from the shift from native species to invasive species near the clearing and fill areas, there was little direct impact noted within the wetland or the watercourse itself.

The watercourse flows into a larger, flat forested wetland system that is part of the Stony Brook main stem riparian wetland system. Here a series of small intermittent watercourses convey flow to the primary watercourse as described above. Wetland vegetation is similar to what was previously described. It appears that a former sand and gravel quarry bordered this wetland's southern boundary.

Overall, this wetland system provides several important functions and values including wildlife habitat, nutrient removal, sediment retention, and limited flood flow alteration. Recommendations for this wetland system include:

- Preserve forested buffer around vernal pool
- Preserve forested buffer along unnamed tributary to Stony Brook for thermal protection and allochthonous material inputs
- Protect water quality within wetland and perennial watercourse
- Manage invasive species colonization of wetland edges near clearings
- Maintain base flow to perennial watercourse

*SB-60-2 Boston Post Road (West) (Parcels 0078200, 0076900, 0081513, et al)*

This small wetland trough is isolated by the Boston Post Road, residential development, and by a large cleared site (former auto salvage yard) at its upper limit. The wetland is predominantly forested, but flow constrictions near the Boston Post Road result in semipermanently flooded conditions and open marsh areas. The common tree is red maple with a moderately dense understory of shrubs including the invasive species Japanese barberry and multiflora rose throughout. A luxuriant stand of skunk cabbage occupies the very poorly drained central marsh area. Fill was observed along the wetland margins especially at the Boston Post Road and upgrade at the former auto salvage site. The wetland may be affected by leachate as heavy orange (oxidized iron) discoloration was noted throughout the wetland.

Although heavily impacted by the surrounding development and possibly by pollutants, this wetland system is buffered by a young stand of woodland on the north side. This woodland borders another wetland and watercourse (T6) that is a tributary to Stony Brook. The associated connectivity increases what would be at best modest wildlife habitat in the Boston Post Road wetland. Otherwise, the wetland has very limited functions and values, except to the extent that it is now functioning as a sediment trap and

renovates pollutants. Further investigation into the water quality issue at this location is warranted. Recommendations for this wetland system include:

- Increase vegetated upland buffer along wetlands at the former auto salvage yard
- Monitor water quality within wetland specifically iron and manganese

### 5.6.2 Watershed SB-50

Watershed SB-50 is located south of I-95 and consists of primarily undeveloped parcels and residential properties. Watershed SB-50 is depicted on Figure 5-6. The undeveloped parcels consist of young and mature growth mixed hardwood forests as well as maintained hay fields. The wetlands consist of forested floodplain, wet meadow, emergent marsh, open water and scrub-shrub wetlands. Stratified drift deposits consisting of sand and gravel are found beneath the Stony Brook corridor while land areas to its east and west are underlain by till. The wetland soil types within this watershed include the very poorly drained Timakwa and Natchaug complex, the Ridgebury, Leicester, and Whitman soils complex, and the poorly drained Walpole series.

This section of the Stony Brook main stem has limited wood and overall channel heterogeneity and lacks features such as beneficial undercut banks and instream boulders. The cobble bottom was 60% to 70% embedded with sand and gravel. Hydraulic diversity is lower within this reach as fast-deep and slow-deep habitats are absent.

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SOURCE:

DATE:

SCALE:

SHEET:

*SB-50-1 Stony Brook Corridor South of I-95 (Parcels 0075700, 0840100, 0074700, 0074200, & 0074400)*

This wetland system consists of several wetland cover types including palustrine forested, scrub-shrub, emergent marsh, and wet meadow. A tributary to Stony Brook originates near Waterford Parkway South Road. A stormwater outfall from this road discharges water into a flat forested wetland system. The wetland also receives ground water discharges from the forested hillside located to its west. The wetlands substrate consists of extremely stony poorly drained soils and has a muddy surface with stained leaves. The dense overstory consisted of red maple and American elm. The sparse shrub layer consists of spicebush and highbush blueberry. The herbaceous stratum consists of poison ivy, sensitive fern, skunk cabbage, grasses, and sedges.

Ground water and surface water from this forested wetland drains to the south and into a man-made drainage ditch/intermittent watercourse. Soils within the drainage ditch/intermittent watercourse are classified as very poorly drained Aquents, and its bordering uplands are classified as pasture lands. This drainage ditch/intermittent watercourse has approximately 90% herbaceous cover and supports a diverse assemblage of emergent marsh and wet meadow hydrophytes. The dominant species observed within this emergent marsh/wet meadow wetland includes sensitive fern, marsh fern, royal fern, cinnamon fern, narrow-leaved cattail, woolgrass, soft stem bulrush, soft rush, spike rush, green bulrush, jewelweed, fringed sedge, lurid sedge, blue flag iris, violets, skunk cabbage, water plantain, and small clumps of swamp rose and multiflora rose. An adult green frog and a pickerel frog were observed within this wetland. This ditch does not support amphibian breeding. It drains into the forested floodplain wetlands of Stony Brook.

The main channel of Stony Brook is located east of the tributary described above. The channel has likely been straightened at this location. The right (facing downstream) bank of the river may have been armored during channelization when stones were taken from the farm field. Cobbles line the right (field) side of the channel. The left bank of the

river is steep, held together with a thick root layer from the trees. Portions of this channel are mowed to within a few meters of the top of bank. The lack of vegetation allows more sun to reach the channel, fostering the growth of filamentous algae and large aquatic plants in the channel. This section of stream has limited woody debris and overall channel heterogeneity, lacking features such as beneficial undercut banks and instream boulders. The cobble bottom was 60% to 70% embedded with sand and gravel.

Stony Brook flows into a forested floodplain wetland. Ground water seeps are present on both the east and west sides of this wetland system. The wetland canopy has approximately 85% cover and consists of red maple, yellow birch, black birch, American elm, and black tupelo. The dense understory consists of eastern hornbeam, spicebush, highbush blueberry, Japanese barberry, multiflora rose, skunk cabbage, false hellebore, sensitive fern, and jewelweed. Stony Brook has a braided channel through portions of this wetland corridor. Land use bordering this wetland corridor includes mixed hardwood forest, pastureland, and a single-family residence. An adult coyote was observed walking within this wetland.

The forested floodplain wetlands of Stony Brook flow into a scrub-shrub wetland system located north of Route 1. This wetland consists of very poorly drained soils and has a high shrub stem density. The shrub stratum consists of speckled alder, silky dogwood, highbush blueberry, common winterberry, swamp azalea, northern arrowwood, and spicebush. The herbaceous stratum consists of skunk cabbage, marsh marigold, sensitive fern, royal fern, purple loosestrife, water willow, grasses, and sedges.

Another unnamed tributary (T4) to Stony Brook is located to the east and originates from the wetland system located near the I-95 off ramp. This wetland is described below under SB-50-2 and SB-50-3.

As the watercourse flows west away from the forested and open water wetlands, it becomes channelized. It flows through open pastures, a wet meadow, and is heavily

vegetated. The boarding wet meadow wetland has a diversity of herbaceous plants including soft rush, skunk cabbage, blue flag iris, spike rush, and fringed sedge. This wetland is mowed annually as evidenced by the tractor tire ruts and lack of shrubby vegetation. Within the channel, a diversity of emergent marsh and wet meadow hydrophytes were observed including sensitive fern, marsh fern, royal fern, cinnamon fern, narrow-leaved cattail, woolgrass, soft stem bulrush, soft rush, spike rush, green bulrush, jewelweed, fringed sedge, lurid sedge, blue flag iris, violets, and skunk cabbage.

A small forested wetland depression is located south of the wet meadow wetland described above. This wetland appears to be a man-made depression and is supported by ground water discharges and overland runoff from bordering forested uplands. The depression wetland supports amphibian breeding as evidenced by the presence of both wood frog and spotted salamander larvae. The wetland depression has a tree canopy of approximately 50%. The lack of a dense tree canopy allows filamentous algae to grow within the wetland depression. The wetland has a sparse understory that consists of spicebush, royal fern, sensitive fern, and skunk cabbage.

Recommendations for this wetland system include:

- Preserve forested buffer along unnamed tributary to Stony Brook and Stony Brook main stem for thermal protection and allochthonous material inputs
- Enhance streamside plantings along Stony Brook main stem
- Protect water quality within wetland and perennial watercourses
- Maintain base flow and restrict any peak flow increases to Stony Brook
- Manage invasive species within wetlands and along the Stony Brooks riparian zone

## Farm Property South of I-95 - Cross Road Side

*SB-50-2 Woodland at Intersection of I-95 and Cross Road (Parcel 0840100)*

Highway runoff is routed to the interchange wetland, which has an outlet to the southeast into a wet depression at the junction with Cross Road. This wetland is flat and forested. It appears to flood at least occasionally and probably seasonally. Dominant trees are red maple, yellow birch, and ash. The shrub layer is moderately thick with sweet pepper bush, high bush blueberry, mountain laurel, greenbriar, Japanese barberry, and multiflora rose being common species. The herbaceous cover is also thick except for the open water pools. The terrain is hummocky, and there are many small, isolated pools in which wood frog tadpoles and green frogs were observed. Mainly suburban bird species were present such as Northern cardinal, red-bellied woodpecker, Carolina wren, tufted titmouse, and common grackle being representative. The small patches of forest remaining in the surroundings support wood thrush and red-eyed vireo. White-tailed deer and turkey tracks were observed.

This wetland is a headwater location for a tributary (T4) to Stony Brook. It accepts highway runoff and temporarily retains it, allowing for added pollutant removal and renovation. It also provides very good local wildlife habitat due to the diversity of wetland classes here and nearby.

Recommendations for this wetland system include:

- Monitor and manage invasive species within wetlands
- Be aware of potential impacts from additional flow detention in the interchange zone from increases in impervious surfaces

*SB-50-3 Man-Made Pond and Outlet Stream (Parcel 0840100)*

This 1.5-acre impoundment was partly excavated and partly dammed to support the once active farm operation. The outlet is via a cross culvert under a farm access road. The pond is moderately deep, perhaps six to eight feet, and grades back into the forested wetland described above. The margins are thickly vegetated with trees and shrubs upgrade and open fields and thin wood lots near the outlet. A thick herbaceous margin of sedges, rushes, and ferns provides excellent habitat for amphibians and reptiles. Warm-water fish species were observed. Rooted aquatic plants are present as well. Green herons were observed hunting along the banks, and swallows searched for insects over the open water.

Ponds such as this one in a mixed land use area add a great deal to habitat diversity. However, the warm, shallow nutrient-rich water leads to luxuriant plant and algae growth. This accumulation of organic matter plus the warm temperatures often results in shifts in downstream waterbodies, which may negatively impact cold-water fishery habitat.

The outlet stream from this pond is likely intermittent as the thick forested zone above the pond and evaporation from the pond itself may result in a no-flow condition during the summer months. The stream is at the farm field edge protected by a stone wall in places and shaded for the most part by residual forest. The banks are steeply incised, and some seeps were noted which, together with the tree cover, may help cool water temperatures somewhat. Invasive species were common here as expected so near the cleared fields.

Recommendations for this wetland system include:

- Preserve forested upland buffer along pond and wetlands
- Determine thermal impact, if any, of the pond upon Stony Brook
- Protect water quality within pond, intermittent watercourse, and wetland

- Maintain base flow to intermittent watercourse and pond
- Inspect cross culvert occasionally for deterioration or blockage to protect the impoundment from overtopping and erosion

*SB-50-4 Intermittent Watercourse (T5) From Small Farm on Cross Road (Parcels 0074200, 0073100, 0145400, et al)*

This wetland is nearby and very similar to the wetland trough described under SB-40-3 below. It is differentiated mainly by the condition of the upland buffer at the headwater area of the intermittent watercourse. This wetland is bordered by a small, active farm operation with livestock and an excavated pond, with an abundance of bare soil. Runoff from such areas, unless scrupulous housekeeping practices are maintained, tends to be high in nutrients and sediment. Fortunately, there is an intact stone wall with a dense hedgerow acting as a barrier and buffer.

Wetland functions and values include good local wildlife habitat support and opportunities for sediment retention, nutrient removal, and pollutant renovation from the nearby farm and residential development.

Recommendations for this wetland system include:

- Preserve forested upland buffer around vernal pool and along unnamed tributary to Stony Brook for thermal protection and allochthonous material inputs
- Preserve stone walls around wetlands as a physical barrier to encroachment
- Protect water quality within wetland and watercourse by encouraging BMPs on the farm
- Maintain base flow to Stony Brook
- Manage invasive species within wetlands

*SB-50-5 Isolated Wetlands on Parkway Road South (Parcels 0840000, 0146400, 0839800, & 0839900)*

There are two wetland pockets located east of Cross Road and border Parkway Road South. The first wetland pocket is classified as a palustrine forested depressional wetland system. This wetland is bordered by residential property to the west and a commercial property to the east. The hydrologic regime of this wetland includes seasonally saturated, semipermanently saturated, and temporarily flooded. The wetlands vegetation is dominated by red maple, spicebush, highbush blueberry, and sweet pepperbush. This wetland does provide significant functions and values including wildlife habitat and nutrient and toxicant retention.

The second wetland pocket is associated with the power line corridor. This wetland has been significantly disturbed in the past. The wetlands communities consist of scrub-shrub and emergent marsh communities. Dominate vegetation includes silky dogwood, speckled alder, and *Phragmites*. This wetland has limited functions and values because of the disturbances. Recommendations for this wetland system include:

- Protect water quality within wetland
- Manage invasive species within wetlands

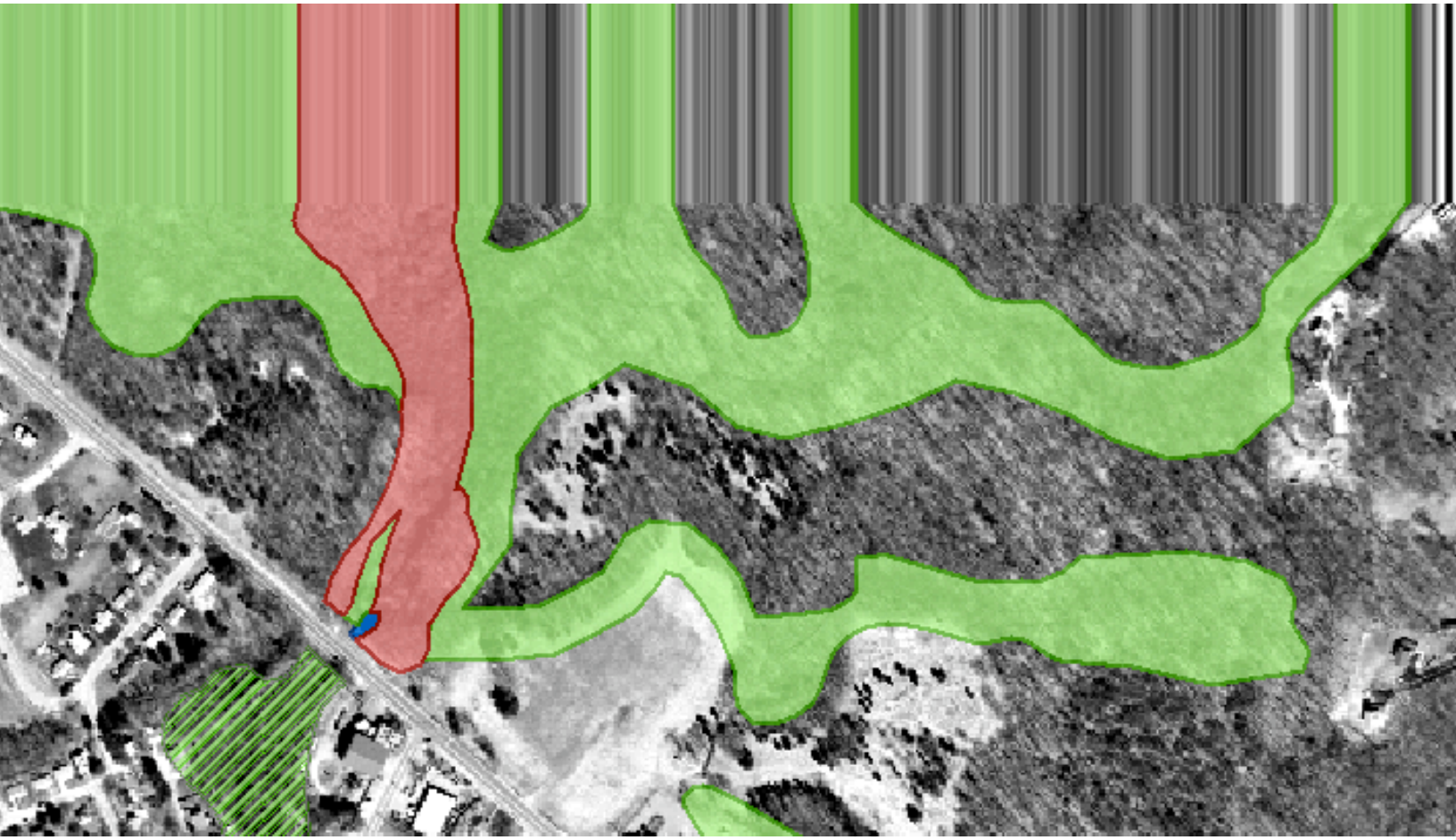
## 5.7 Lower Watershed – Wetlands Near and South of Route 1

### 5.7.1 Watershed SB-40

The SB-40 watershed is located along the Route 1 corridor. Watershed SB-40 is depicted on Figure 5-7.

Land use within this subwatershed is a mix of residential, neighborhood retail, recreational fields, old fields, and mixed hardwood forests. Wetlands include forested and scrub-shrub wetlands, open water, intermittent watercourses, and the Stony Brook main stem. A deteriorating concrete and stone dam was observed upstream of the Route 1 culvert crossing. Large deposits of stratified drift are located along Stony Brook main stem corridor including wetland and upland areas. Glacial till deposits are located along the west and east portions of this watershed. Wetland soil types include the very poorly drained Timakwa and Natchaug complex, the Ridgebury, Leicester, and Whitman soils complex, and the poorly drained Walpole series.

Based on the diversity of wetland communities, plant diversity, wildlife habitat and its connection to large unfragmented natural areas, wetlands within this watershed have been selected as a critical wetland system (CWS-3).



**West of Stony Brook**

*SB-40-1 Oswegatchie School (Parcel 0075200)*

This wetland system is beyond the school building, parking lots, and ball fields at Oswegatchie School. It is a palustrine wetland of mixed classes including a permanent open water pool several feet in depth. The margins and tussocks support a diverse shrub layer of high-bush blueberry, sweet pepper bush, and clammy azalea. Greenbriar is quite thick, and the edge habitat includes multiflora rose as well. The forested areas are predominately red maple saplings. Many trees have been toppled by wind throw, creating a system of hummocks. The herbaceous layer includes many sedges and ferns including large stands of royal fern. Skunk cabbage is thick in the very poorly drained areas, soft rush in poorly drained areas, and water lilies occupy the standing water pool.

Typical suburban wildlife species were observed. The mix of forested swamp, open water pool, flooded shrub zone and open grassy fields provide an abundant edge habitat. The pool was heavily populated by wood frog larvae despite the likelihood that warm-water fish species are also present. The pool drains via an intermittent watercourse (T10) through a culvert pipe at Stony Brook Drive. Homes with lawns press close upon the small watercourse.

There is a small trail network from the school with a series of bird houses and bat boxes. The remains of a wood boardwalk were also noted. Wetland values like education and passive recreation are available here due to the proximity of the school with parking and public access opportunities. Other functions are pollutant/nutrient renovation and wildlife habitat.

Recommendations for this wetland system include:

- Preserve forested upland buffer around permanent pool.
- Protect water quality within wetland and intermittent watercourse. Carefully review management of the school's playing fields, roof drains and parking lots to prevent wetland impacts.
- Increase educational outdoor classroom opportunities within wetland.
- Encourage restoration of vegetative buffers near home sites along outfall stream.
- Exercise caution regarding changes to roadway drainage in the area to avoid affecting water surface elevations in the pool.
- Manage invasive species within wetlands.

*SB-40-2 Stony Brook Drive Subdivision (Parcels 0075200, 0096812, 0096807, et al)*

This wetland system is in close proximity to the Oswegatchie School wetland and is similar in character. It is less forested and more shrub dominated. Instead of one large central pool, there is a series of smaller pools and backwater troughs. These provide the same opportunity for amphibian breeding but without the presence of fish as potential predators. The natural drainage discharge pattern may have naturally joined with the outfall from Oswegatchie School, but a small secondary ditch seems to have been excavated that flows directly toward the cove via a culvert at Oswegatchie Road. Other evidence of encroachment includes earthen fill and brush piles, wood road runoff, and edges heavily infested with invasive species.

These two wetland systems, when viewed as a single unit interspersed with mature, forested uplands and well buffered to the west and south, provide many important local functions and values. The area is designated as CWS-3.

Recommendations for this wetland system include:

- Protect water quality within wetland and intermittent watercourse
- Restrict further encroachment, tree cutting and filling near wetland edges

- Investigate hydrology to determine the effect of secondary drainage ditch
- Manage invasive species within wetlands and along watercourse

**East of Stony Brook**

*SB-40-3 Intermittent Watercourse (T9) From Residences on Cross Road (Parcels 0073100, 0074200, et al)*

This wetland is a narrow, seasonally saturated, rocky trough that begins near residential development on Cross Road. It is widely buffered from impacts by unmaintained grassland with scattered trees and shrubs plus an intact stone wall along the wetland border. The watercourse flows through a palustrine, forested wetland system dominated by red maple, yellow birch, and ash with mature oaks and tulip poplars along the upland margin. Common shrubs are spice bush, common winterberry, and mountain laurel. There is a modest percentage of the invasive species Japanese barberry and multiflora rose, especially near the open fields and old rock walls where prior disturbances have taken place. The herbaceous layer is well developed and includes skunk cabbage, false hellebore, and mixed ferns and sedges. Overall, vegetation density is high in each stratum.

As the stream is intermittent, there is no fishery habitat, but where the topography flattens out, several vernal pools were observed. The large adjoining tract of forest provides suitable habitat for rose-breasted grosbeak, wood thrush, scarlet tanager, wood peewee, ovenbird, and American robin, all of which were recorded. The nearby field edge habitat supports suburban species such as Northern cardinal, Caroling wren, common yellowthroat, and tufted titmouse.

Wetland functions and values include good local wildlife habitat support and opportunities for sediment retention, nutrient removal and pollutant renovation from nearby fields and residential development.

Recommendations for this wetland system include:

- Preserve forested upland buffer along unnamed tributary to Stony Brook for thermal protection and allochthonous material inputs
- Preserve stone walls near wetlands as physical barriers to encroachment
- Protect water quality within wetland and watercourse
- Maintain base flow to intermittent watercourse
- Manage invasive species within wetlands.

*SB-40-4 Forested Wetland Opposite Arrowhead Court (Parcels 0073100, 0073700, 0072200, et al)*

This is a system of loosely connected, seasonally saturated wetlands north of the Post Road and opposite the new Arrowhead Court cul-de-sac. The wetland is primarily forested but clearing has taken place at the eastern and western margins where development encroaches upon the wetland. The central section is in better condition. It is forested with an intermittent watercourse that may once have drained southward. Now, it appears that drainage is to the west, parallel to the Post Road and joining the intermittent watercourse flowing from the residential sites along Cross Road to Stony Brook.

The dominant species are red maple and yellow birch with large mixed oaks and tulip poplar in the adjoining upland forest. The stream margins support witch hazel, common winterberry, spice bush, and the two common invasive shrubs, Japanese barberry and multiflora rose. These seem to gain a toehold when clearing occurs along the wetland periphery. The herbaceous layer is moderately dense and moderately diverse. The wetland is physically protected by a stone wall that separates it from the upland parcel along the Post Road frontage. Suburban species were observed including chipmunk, raccoon, Northern cardinal, tufted titmouse, and green frog. A wood thrush was heard calling from the upland forest attesting somewhat to the size and integrity of the upland

buffer to the north of this wetland. Local wildlife habitat and some opportunity for pollutant renovation to take place are the main wetland functions and values.

Recommendations for this wetland system include:

- Preserve existing stone walls as limits-of-disturbance along Post Road
- Protect water quality within wetland by preserving or restoring forested buffers
- Manage invasive species within wetlands

### 5.7.2 Watershed SB-30

The SB-30 watershed is located along the southwestern portion of the Stony Brook watershed and drains into Keeny Cove. Watershed SB-30 is depicted on Figure 5-8. Land use within this watershed includes residential, old field, and mixed hardwood forests.

Wetlands consist of forested, scrub-shrub, open water wetlands, and an intermittent watercourse. Most of the watershed is underlain by glacial till deposits with the exception of the southeast corner were stratified drift is present. Wetland soil types include very poorly drained Timakwa and Natchaug complex and the poorly drained Walpole series.

*SB-30-1 Mixed Class Wetlands Off Shawandassee Road (Parcel 0548200)*

Several fallow farm fields border Shawandassee Road. A series of low dams impounds runoff and creates several small pools just north of the fields. Discharge flows to Keeny Cove via a culvert beneath Oswegatchie Road. Other abandoned farm ponds were also observed in woodlands northwest of the fields nearer Shawandassee Road. Although the wetland system is rather large and semipermanently flooded, the discharge watercourse appears to be intermittent.

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This is a palustrine system, primarily forested, but with open water pools (described above) and areas of flooded, scrub-shrub wetlands. Ground water seeps and surface runoff supply the wetland's hydrology. The forested sections are dominated by red maple. The understory shrub layer is diverse and often very dense with high bush blueberry, common winterberry, sweet pepper bush, northern arrowwood, and mountain laurel. Button bush was present in the shallow ponds. Greenbriar was dense in many areas. The herbaceous layer includes skunk cabbage, Jack-in-the-pulpit, Canada mayflower, trillium, jewelweed, and a variety of ferns, sedges and mosses. The density of the herbaceous layer is variable depending upon light penetration. Microtopography was pronounced providing stratification for both plants and animals. Tree-throws were common in the flooded scrub-shrub areas. Near the abandoned fields, multiflora rose and Japanese barberry were problematic. Away from disturbed areas, invasive species were uncommon.

The surrounding uplands are forested with a good representation of large diameter oaks, maples, hickories, and tulip trees. The mixed habitat supports a representation of forest interior species such as wood peewee, scarlet tanager, wood thrush, and great-crested flycatcher. Red-shouldered hawk, formerly a state-listed species, was observed here. It requires larger forested wetland systems such as this one as nesting habitat. Common suburban species are present as well. The man-made ponds and backwater pools provide good habitat for warm-water fish, aquatic invertebrates, amphibians, and reptiles. Vernal pool obligate species are likely to be present.

Soils here are both poorly drained and very poorly drained based upon duration of saturation. Areas of wetland fill, including dam construction and pond excavation, were observed. The lower reaches of the watercourse have been channelized but appear stable. Current and former cleared areas have invasive species management problems.

This wetland's diversity of classes increases its ecological value. Further, the linkage of this wetland with the nearby CWS-3 wetland system elevates its importance to the

surrounding area. The primary functions and values within this watershed are flood flow alteration, sediment retention, pollutant renovation, production export, and wildlife habitat. As discharge is directly to Keeny Cove, water quality protection measures should be maintained and improved. For example, although the man-made ponds provide varied habitat, the warm shallow water results in luxurious algae growth with discharge to the cove.

Observations of this watershed's outflow should be recorded seasonally and after heavy rains or snowmelt. These observations should be accompanied by sampling for nutrients (nitrogen and phosphate), suspended solids, and temperature. This data should be correlated to see if, in fact, the man-made ponds are a significant threat to water quality in Keeny Cove. For example, although water may be warm and nutrient laden in summer, output may be so low as to be of no consequence. In spring, suspended solids may be high due to the eroded outlet controls and bare soils in the surrounding area.

### 5.7.3 Watershed SB-20

Subwatershed SB-20 is located along the southeast portion of Stony Brook watershed and is depicted on Figure 5-9. Land use within the watershed includes residential, patches of upland forests, and forested wetlands. A large parcel of Town-owned open space is located within the central portion of this watershed.

Wetland cover types are predominantly palustrine forested wetlands, open water, and an intermittent watercourse. The surficial geology of this watershed is predominantly stratified drift; however, a swath of glacial till is located along its northeast corner. The wetland soils within this watershed include very poorly drained Timakwa and Natchaug complex and the Ridgebury, Leicester, and Whitman soils complex.

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*SB-20-1 Wetlands at Locust Court (Parcels 0072700, et al)*

This is a small, somewhat isolated wetland area between residential development along Locust Court and the new subdivision on Arrowhead Court. Parcel 0072700 is designated as Open Space and the associated wetlands on this parcel are restricted from future development and/or encroachment. The contributory watershed is small, and the wetland is supported by the discharge of shallow infiltrated ground water and surface runoff. It is only seasonally saturated. The area is rocky and forested with the beginnings of an intermittent watercourse that discharges under Locust Court joining a similar waterway from the end of Fulmore Drive. Flow is then directly to Keeny Cove.

This is a palustrine forested wetland with an overstory of red maple, yellow birch, and white ash surrounded by a mature upland forest of mixed oaks. The shrub and herbaceous layers are somewhat sparse and include spice bush, witch hazel, skunk cabbage, Jack-in-the-pulpit, false hellebore, and jewelweed. Invasive species, particularly Japanese barberry and multiflora rose, are common along the disturbed wetland edges adjacent to the cul-de-sac.

The wetlands support local wildlife, which consists primarily of suburban species such as Northern cardinal, tufted titmouse, chickadee, American robin, Virginia opossum, chipmunk, skunk, and deer. The wetland has a moderately well-developed upland buffer on its northern edge toward Arrowhead Court while buffering is limited along Locust Court where roadside fill, trash, debris, and invasive species are readily observed.

In headwater areas such as this one, it is important to prevent pollutants and nutrients from reaching the watercourse, which will readily transport material to more sensitive receptors, in this case Keeny Cove.

This wetland area provides local wildlife habitat and drainage conveyance. It is important to prevent added disturbance along Locust Court and to preserve a mature woodland buffer along its northern edge.

*SB-20-2 Wetlands at Fulmore Drive (Parcels 0477500, 0313801, 0230900, et al)*

This is a moderately sized, mixed class wetland that includes an intermittent watercourse. The wetlands located on Parcel 0313801 are part of the Open Space associated with the Ina Boulevard subdivision. Hydrology is supplied by overland runoff and shallow infiltrated ground water. The area is seasonally flooded with seasonally saturated margins. Outflow joins the discharge from the Locust Court wetland system described above. Drainage is directly to Keeny Cove. Although residential subdivisions closely border the wetland on the north (Paula Lane) and the south (Fulmore Drive), there is a substantial forest of mature trees around the wetland, which increases its habitat value and buffers water quality impacts. There is evidence of disturbance within the wetland including trails, dirt roads, an excavated pond, some fill piles, stone walls, trash, and invasive species.

The wetland is predominately a palustrine forested system but includes some open water as well as a very poorly drained marsh area and a poorly drained shrub area. Red maple, yellow birch, ash, and black birch are common trees in and around the wetland. Japanese barberry, multiflora rose, spice bush, sweet pepper bush, and common winterberry are representative of the understory shrubs. Herbaceous species include skunk cabbage, jewelweed, trillium, Jack-in-the-pulpit, false hellebore, arrowhead with mixed ferns, sedges, and grasses.

Wildlife in this system is typical of wetlands in suburban settings with common yellowthroat, Northern cardinal, tufted titmouse, downy woodpecker, American goldfinch, and gray catbird, but the surrounding upland forest was large enough to support ovenbird, great-crested flycatcher, red-eyed vireo, wood peewee, and red-

shouldered hawk (formerly state-listed). Small mammal tracks were noted along the watercourse. This undeveloped wetland corridor provides an important habitat link all the way to Keeny Cove. Several of the pools and an impoundment may provide breeding habitat for vernal pool obligate species, although it was late in the season for satisfactory field observations.

This wetland area provides good wildlife habitat with a link to other nearby wetland systems and good upland habitat as well. Other important functions are drainage conveyance and pollutant/nutrient renovation. It is important to prevent additional disturbance along the existing residential developments and to preserve much of the bordering mature woodland. Headwater wetlands such as this one are crucial links in water quality preservation. It is important to buffer small watercourses to prevent pollutants from being transported to more sensitive receiving waters such as Keeny Cove.

### 5.7.4 Watershed SB-10

Sub watershed SB-10 is the smallest watershed within this study area and is depicted on Figure 5-10. The watershed is located along the southern tip of Stony Brook watershed. Land use includes a mix of upland forested lands, residential, and forested wetlands. Wetland cover types within this watershed include palustrine scrub-shrub, forested wetlands, and an intermittent watercourse. This watershed drains directly into Keeny Cove. Glacial till dominates most of this watershed; however, patches of stratified drift are located along its periphery. The wetland soils within this watershed include poorly and very poorly drained the Ridgebury, Leicester, and Whitman soils complex.

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*SB-10-1 Wetlands Along Niantic River Road (Parcels 0474400, 0473900, 0562401, 0473400, 0473200, 0473100, 0472800, 0481914)*

The wetland is bordered to the west by Niantic River Road and to the north, east, and south by residential properties. This wetland is classified as a palustrine forested and scrub-shrub wetland system. The wetland has both poorly and very poorly drained soils. The hydrologic regime of this wetland includes seasonally saturated, semipermanently saturated, and temporarily flooded. Microtopography is present within the wetland with vegetated hummocks consisting of highbush blueberry, sweet pepperbush, and winterberry. Saplings of red maple, yellow birch, elm, and black tupelo are also found scattered throughout the wetland. In addition to live trees, there are several large snag trees that provide habitat for cavity nesters also present within the wetland. This wetland may also support amphibian breeding for species such as wood frogs and spotted salamanders.

Overall, this wetland provides several important functions and values including wildlife habitat, nutrient removal, and toxicant retention. Recommendations for this wetland system include:

- Preserve forested upland buffer around amphibian breeding habitat
- Protect water quality within wetland
- Maintain contributing watershed to wetland
- Manage invasive species within wetlands

## 5.8 Critical Resource Area Identification and Mapping

Mapping and analysis of critical environmental resources provides a baseline of information from which good planning can follow. This is true for individual sites and projects as well as for broad-scale planning at the municipal, regional, or statewide level. It is difficult for planning boards, regulatory commissions, and local officials to fully

evaluate the merit and/or potential impact of an action when it is out of context of the broader environment in which it is to take place.

A basic question that comes to bear is "*What constitutes a critical or unique environmental resource?*" The answer to that question can be rather complex. Inland wetlands, vernal pools, unfragmented forested habitat, riparian corridors, native fisheries, prime agricultural land, unique land forms, free flowing rivers, and critical habitat areas that support threatened or endangered species are all contenders. Other possibilities could include privately held "490" open space lands, open space near schools for educational training, aquifer protection areas, mineral resources, cultural or historic resources, or scenic ridgeline protection areas.

The inventory, mapping, and habitat analysis conducted for the Stony Brook watershed is expected to have multiple applications as follows:

- to help guide and prioritize open space land acquisition
- to serve as an active reference tool for the Waterford Conservation Commission in reviewing applications
- to provide the basis for comparison in the review of the applicability and adequacy of current zoning designations
- to distinguish a hierarchy of protection for natural resources based on their function and value in their respective ecological communities

Given the anticipated application of this Watershed Management Plan by the Conservation Commission, a hierarchy of wetland types and resources has been developed to distinguish critical resources that by their nature and function may warrant controls and protection that are above and beyond what is appropriate for other resources. These are described in the narrative that follows.

### 5.8.1 Critical Wetland and Watercourse Systems

Through decades of well-documented research, it has become clear that wetlands and watercourses provide a host of important physical and chemical functions as well as a suite of beneficial societal values. These functions and values operate at all scales, from the microscopic up to the local and regional landscape. While most wetlands perform some, or even many, of these functions and values, some wetlands, because of their geology, location, vegetation, aesthetics, prior impacts, or their history, are inherently more valuable than others. The identification of critical wetland and watercourse systems was completed to provide assistance in development of management practices and guidelines that would be applied to land-use decisions and conservation practices to protect these important resources within this watershed.

Within this management plan, these special wetlands and watercourses have been referenced as "critical wetland systems." Two objectives were established for identifying critical wetland systems within the Stony Brook watershed. These objectives included (1) establishing a network of wetland systems that fully represented a diversity of wetland types and that performed key ecological and hydrological functions on a local and regional scale; and (2) ensuring local and regional wetland biodiversity through designation and management of critical wetland systems.

Several data sets were used to help establish Stony Brook's critical wetlands. These data sources included field data collection and data forms, personal communications with Town staff, NRCS soil surveys, 2004 aerial photographs, national wetland inventory maps, 2007 Natural Diversity Database maps, vernal pool surveys, Town-provided topographic maps, aquifer protection maps, and additional historical environmental and wetland assessment reports provided by Waterford.

This management plan identifies three critical wetland systems (CWS) within the Stony Brook watershed. These wetland systems include forested, scrub-shrub, and emergent

wetlands which provide important functions including preservation of biodiversity, flood flow alteration, and water quality protection and renovation. The critical resource areas within the Stony Brook watershed are presented in Table 5-1. In addition, Figure 5-11 illustrates the critical resource areas.

**TABLE 5-1**
**Critical Wetland Systems**

| *Critical Wetland System* | *Watershed ID* | *Size (acres)* | *Dominant Wetland Cover Types* | *Important Functions* |
|---|---|---|---|---|
| CWS-1 | SB-70<br>SB-90 | 40.2 | PFO and PSS | Biodiversity<br>Nutrient retention<br>Flood flow alteration<br>Production export<br>Fishery habitat |
| CWS-2 | SB-70 | 64.3 | PFO, PSS, PEM | Biodiversity<br>Flood flow alteration<br>Nutrient retention |
| CWS-3 | SB-30 | 5.0 | PFO, PSS, POW | Biodiversity<br>Pollutant Renovation |

PFO = Palustrine Forested Wetlands
PSS = Palustrine Scrub-shrub Wetlands
PEM = Palustrine Emergent Marsh
POW = Palustrine Open Water

***CWS-1*** – This wetland system is one of the largest contiguous wetlands within the Stony Brook watershed. It is a palustrine wetland of mixed vegetative classes including several open water depressional pools as well as an intermittent watercourse. The wetland margins exhibit well-developed microtopography that supports a diverse herbaceous and shrub layer. Red maple trees dominate the canopy in forested areas. Many trees have been toppled by wind-throw creating a system of hummocks and small pools. Scrub-shrub communities are abundant and provide diverse habitat for wildlife. Large contiguous blocks of upland forest border this wetland providing unfragmented natural corridors for wildlife. Breeding amphibians and reptiles are abundant throughout this wetland system including vernal pool obligate species such as spotted salamander and wood frog. Another important attribute of this wetland is that it serves as one of the major headwater areas to the main stem of Stony Brook.

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***CWS-2*** – This wetland system is the largest contiguous wetland system within this watershed. Similar to CWS-1, CWS-2 is a palustrine wetland of mixed vegetative classes. This wetland also includes the former radio tower site which as described previously has a diverse wet meadow assemblage. This large wetland also contributes significant base flow to the Stony Brook main stem. There is some development along the eastern and southern borders, but disturbance is limited to the wetland edges, not the interior portions of the wetlands.

The forested wetland areas are dominated by red maple. The scrub-shrub wetland systems are dominated by spicebush, winterberry, speckled alder and highbush blueberry. Many trees have been toppled by wind-throw creating a system of pools and hummocks. Scrub-shrub communities are abundant and provide diverse habitats for wildlife. Large contiguous upland forests also border this wetland to the north and west providing unfragmented natural corridors for wildlife. Breeding amphibians and reptiles are abundant throughout this wetland system including the vernal pool obligate species spotted salamander and wood frog.

***CWS-3*** – This wetland system occupies a topographic depression south of Oswegatchie School and the cul-de-sac at Stony Brook Drive. It is a palustrine wetland of mixed classes including several open water pools. The margins and tussocks support a diverse herbaceous and shrub layer. Red maple dominates the canopy. Many trees have been toppled by wind-throw creating a system of hummocks. Rooted aquatic plants, including water lilies, add to the aesthetic appeal. Fingers of upland forest separate the wetland systems creating a more diverse habitat mosaic beneficial to wildlife. The two nearby rivers, Stony Brook and the Niantic River, create a natural peninsula here with development along the Post Road forming the northern boundary.

The proximity of the school and public parking adds wetland values such as passive recreation and education to other wetland functions including flood flow alteration, pollutant renovation, production export, and wildlife habitat.

### 5.8.2 Unfragmented Areas of High or Unique Resource Value

Large unfragmented areas of natural or even altered habitat are often a critical component in conserving biodiversity on a local and regional scale. Biodiversity encompasses the richness of life at all levels, from the genetic level of species, metapopulations, natural communities, and ecoregion levels. In most cases, biodiversity is at its highest in unfragmented natural areas.

It is important to identify these resource areas in order to maintain and protect biodiversity, natural connectivity, and dispersal opportunities for sensitive native species. Unfragmented areas, including riparian corridors along streams and rivers, often serve as important migratory corridors. They facilitate the dispersal of plants and animals among habitats, thereby maintaining gene pools and preventing local extinctions.

The most effective corridors are not narrow linear strips of land between habitat islands. Instead they tend to be broad swaths of unfragmented land connecting various habitats. Wider corridors permit the development of interior habitat conditions, which allows for movement within the corridor and provides better habitat for so-called "area-sensitive" species. In addition, wider corridors provide better cover from predators, reduce incursions of domestic animals, and limit impacts from human disturbance.

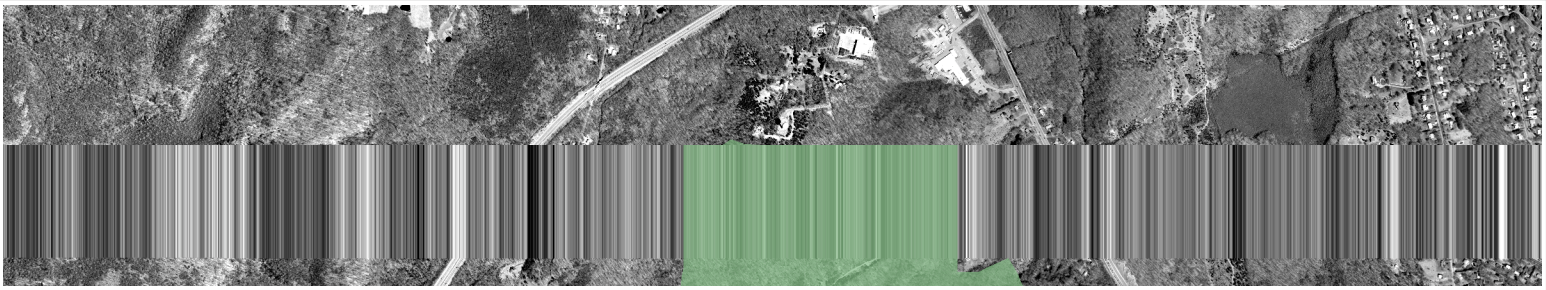
There are many benefits to maintaining these unfragmented areas. Healthy, ecologically diverse systems that are unfragmented perform important natural, abiotic processes such as decomposition of organic matter, soil and sediment creation, filtration of ground and surface water, air cleansing, pollutant renovation, and nutrient retention. In addition, these unfragmented lands provide educational and recreational opportunities to the public such as bird watching, hiking, skiing, hunting, and fishing.

As part of this study, a preliminary assessment was made of the unfragmented areas within the Stony Brook watershed. One of the goals in conducting this assessment was to aid the Town's land use planning agencies in their efforts to conserve and protect natural areas. Several resources were used to identify unfragmented natural areas including 2004 aerial photography, the DEP Natural Diversity Database, field investigations, and discussions with the Town staff. Unfragmented natural areas are shown on Figure 5-12.

Virtually the entire Stony Brook watershed north of I-95 can be viewed as an unfragmented area of high resource value. Only narrow strips of development exist, and these are, for the most part, closely confined to Cross Road and the access road north of the highway. Otherwise, the area is comprised of mixed-age hardwood forest stands with only small woods roads incursions and widely spaced clearings where logging has taken place. There were once even broader links to undeveloped forest lands to the north, including the adjoining watershed lands of the Niantic River and its major tributary, Oil Mill Brook. Construction of I-395 and Route 85 has negatively affected this link but not eliminated it. Clearly, these large tracts of unfragmented natural areas north of I-95 are protecting Stony Brook's wetland biodiversity, its water quality, hydrology, and fishery resources.

Similarly, the lands south of I-95 and north of the Post Road are largely undeveloped. As viewed here, the "natural" state of the fallow farm fields, farm ponds, and wooded hedgerows adds diversity to the landscape and provides opportunities for wildlife not found in the forested sections of the watershed. Additionally, they offer easier access and vantage points for public enjoyment. Forested lands border the farm fields across Stony Brook, westward toward Gurley Road. There are broad expanses of open space to the east, just beyond the narrow residential band on Cross Road.

On a smaller scale, valuable undeveloped lands occur south of the Post Road. These include the high resource value wetlands near Oswegatchie School and beyond Fulmore Drive. The undeveloped woodlands that border these two wetland systems greatly increase the overall resource value although on a more local scale than areas to the north.

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**MXD:**

**SOURCE:**

**DATE:**

**SCALE:**

**SHEET:**

### 5.8.3 Probable and Observed Vernal Pool Identification

As part of the wetland assessment and spring field investigations, MMI wetland scientists identified probable and observed vernal pool areas within the Stony Brook Watershed. Observed vernal pool areas were those wetland areas that had evidence of amphibian breeding, which included adults chorusing, spermatophores, egg masses, and/or larvae. Probable vernal pool areas were those wetland areas that appeared to have conditions suitable for amphibian breeding; however, MMI had visited these areas after breeding activities occurred or did not have conclusive evidence of amphibian breeding. The observed and probable amphibian breeding areas identified by MMI are represented on Figure 5-13. It should be noted that the MMI surveys are general in nature, and more detailed amphibian breeding surveys would be required if a regulatory action was proposed near such areas.

## 5.9 Recommendations

### 5.9.1 Framework for Recommendations

The protection and preservation of the wetland systems in the Stony Brook watershed are entrusted to the Conservation Commission of the Town of Waterford. The Commission's regulations comprise a framework for balancing the Town's need for economic development to maintain, preserve, and enhance the functions and values of diverse wetland systems. Tools to protect wetlands and watercourses from unnecessary and unwarranted negative impacts include a variety of engineering methods. These include erosion control techniques as described in the *Connecticut Guidelines for Soil Erosion and Sediment Control* (2002) and water quality renovation methods described in the *CT DEP 2004 Stormwater Quality Manual.*

Another well-documented and well-researched method to provide protection for wetlands and watercourses is the use of buffers, particularly vegetated buffers. These strips of land, whether natural, restored, or enhanced, provide a host of benefits that both protect wetlands and augment their functioning. Among these are:

→ preserving water quality by intercepting and renovating pollutants
→ improving wildlife habitat by creating corridors and upland safety zones
→ stabilizing soil and stream banks thereby reducing erosion and sedimentation into wetlands
→ providing a steady source of fine and coarse organic material that serves as fuel for the wetland ecosystem
→ Moderating conditions of temperature, moisture, and light penetration that might cause an imbalance in the wetland or watercourse. For example, thermal impacts to cold-water fishery resources, or colonization by non-native invasive species
→ Protecting downstream areas from serious storms and meltwater by storing and slowly releasing floodwaters

The width of an effective wetland buffer zone depends upon many biotic and abiotic factors including:

→ the relative importance (functions and values) of the wetland under consideration
→ the sensitivity of the wetland ecosystem to various types of disturbance
→ physical factors in the buffer area such as slope, soil permeability, soil erodibility, and the density and types of existing vegetation

In general, the longer it takes for runoff to reach the wetland or watercourse and the more dispersed it is, the more opportunity there will be to mitigate its potentially harmful effects.

There is no shortage of published recommendations for wetland buffer widths. Many sources suggest fixed-width buffers. These make regulatory review and permitting easier for both the Commission, municipal staff, and the public. This is a great advantage in determining what projects require permit review and when enforcement actions are warranted. Once a wetland boundary is determined in the field or provided on a resource map, there is little excuse for wetland impacts due to encroachment. However, with appropriate scientific study, there is a case to be made for variable-width buffers that refine a fixed-width upland review area. This separates the review zone from the buffer zone and offers a better opportunity to balance wetland protection with development potential.

The subject study has evaluated many of the factors described above on a wetland-by-wetland basis. It also recommends consideration of three wetland systems to be afforded additional protection as CWS. Detailed below are the recommendations for incorporating upland review areas and vegetated buffers into management practices for protection of wetland resources in the Stony Brook watershed. Also noted are areas in or adjacent to wetlands that would benefit from restoration efforts and other areas that merit additional scrutiny, particularly with regard to water quality.

### 5.9.2 Recommendations for Upland Review Areas and Natural or Enhanced Vegetative Buffers

The varying upland vegetated buffer distances and recommendations that are presented in this section have been developed to give the Waterford Conservation Commission the ability to provide upland protection zones for wetlands and watercourses. For all wetlands, the existing 100-foot upland review area is appropriate. In addition, extending the upland review area to 150 feet is recommended for those wetlands that contain a vernal pool and/or other high priority amphibian breeding habitat. The extended review area is consistent with the regulations where activities are likely to impact wetlands and watercourses beyond the 100-foot upland review area.

Maintenance of a vegetated upland buffer area between proposed development and the edge of a wetland and/or watercourse is recommended to protect the diversity of wetland communities, the integrity of instream habitats and channel characteristics, and to preserve water quality features including turbidity, dissolved oxygen, and temperature. The width of this vegetated buffer area should be determined based upon the following factors:

→ the quality of the wetland or watercourse, i.e., the functions and values it provides
→ water quality features
→ fishery resources
→ designation of critical wetland habitats
→ the sensitivity of the wetland to potential impacts from development
→ the merits, benefits, and particular risks of the proposal, including alternatives to the suggested action and available remedial measures

The following discussion provides suggested upland review areas from wetlands and/or watercourse resources along with suggested vegetated buffer limits. Factors for consideration when determining the appropriate upland vegetated buffer width are provided under each recommendation. The following upland vegetated buffer width recommendations are but one important measure for protecting wetlands and watercourses from adverse impacts associated with changes in adjacent land use. Other important measures for protecting wetlands and watercourses that should be considered include:

→ appropriate site planning given existing landscape variables
→ design, installation, monitoring, and maintenance of proper sediment and erosion control measures
→ design, installation, monitoring, and maintenance of stormwater control and treatment measures in keeping with the state's Stormwater Quality Manual
→ use of appropriate LID design practices

In areas where the existing conditions within the riparian buffer zone or upland vegetated buffer zone do not meet all of the suggested guidelines for the criteria below (for example, areas where slopes exceed 15%), then additional buffer widths may be warranted; or, additional protection measures may be implemented; or, supplemental plantings may be considered. Such a determination should be made by the Commission or its staff based upon a site-specific review and evaluation of the wetland factors discussed above in this section and the potential wetland "risks" of the proposed action. In no case should a steep, natural slope be deconstructed or any attempt be made to modify existing soils to satisfy the criteria below.

1. *Protection of the Stony Brook main stem and riparian zone (see map for limit): 100-foot review area and 100-foot upland vegetated buffer.*

   To maintain the Stony Brook main stem biodiversity, all 100-foot proposed riparian zones (vegetated buffer) should meet all of the following conditions:

   → Exhibit slopes less than 15%.
   → Existing upland tree canopy coverage within 50 feet of the wetland or watercourse, whichever is closer to the proposed development, should equal or exceed 90% (the other 50 feet may consist of a naturalized meadow, stormwater management basins, and/or shrub thicket).
   → Existing upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the wetland or watercourse edge should equal or exceed 70%.
   → The published K factor of upland soils bordering the wetland or watercourse should be less than 0.25.
   → The area under review should not be a primary corridor link between critical wetland systems as identified in this report.

2. *Protection of Critical Wetland Systems (CWS): 100-foot review area and 100-foot upland vegetated buffer*

   To maintain biodiversity within the Critical Wetland Systems, the proposed vegetated buffer should meet all of the following conditions:

   → Exhibit slopes less than 15%.
   → If presently forested, the existing upland tree canopy coverage within 50 feet of the CWS edge should equal or exceed 90%, (the other 50 feet may consist of a naturalized meadow, stormwater management basins, and/or shrub thicket).
   → Upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the CWS edge should equal or exceed 70%.
   → The published K value of upland soils bordering the CWS should be less than 0.25.
   → The area under review should not be a primary corridor link between Critical Wetland Systems as identified in this report.

3. *Protection of vernal pools and high priority breeding habitat for vernal pool obligate species: 150-foot review area and 100-foot forested vegetated buffer from the edge of the vernal pool or other breeding habitat.*

   For upland vegetated buffer limits that are greater than 100 feet and less than 150 feet from the edge of identified vernal pool or other high priority *breeding habitat for vernal pool obligate species*, all of the following conditions should be met:

   → No disturbance within 100 feet except that forest enhancement or restoration may be considered.
   → Limit disturbance (both temporary and permanent) in the zone between 100 feet to 150 feet. To the extent practicable, such disturbance should be targeted upon recently disturbed or other nonforested areas.

→ The use of Cape Cod curbing should be considered where disturbances are proposed within 100 feet to 150 feet as specified in Calhoun and Klemens 2002.
→ If stormwater quality basins are proposed within 100 feet to 150 feet of the vernal pool edge, the basin will be ringed with amphibian exclusion fencing as specified in Calhoun and Klemens 2002.

4. *Protection of first order streams: 100-foot review area and 50-foot to 100-foot vegetated buffer.*

   For upland vegetated buffer limits less than 100 feet from the watercourse, all of the following conditions should be met:

→ Exhibit slopes less than 15%.
→ If presently forested, the upland tree canopy coverage within 50 feet of the watercourse should be greater than 90%.
→ Upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the watercourse should equal or exceed 70%.
→ The published K value of upland soils bordering the watercourse should be less than 0.25.

5. *Protection of intermittent watercourses or other wetlands <u>without</u> watercourses, CWS or VPs: 100-foot review area and 50-foot vegetated buffer.*

   A proposed upland vegetated buffer within 50 feet of an intermittent watercourse or other wetland should meet all of the following conditions:

→ Exhibit slopes less than 15%.
→ If presently forested, the upland tree canopy coverage within 25 feet of the wetland should be greater than 90% (the other 25 feet may consist of a naturalized meadow, stormwater management basins, and/or shrub thicket).

→ Upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the wetland should equal or exceed 70%.

→ The published K factor of upland soils bordering the wetland should be less than 0.25.

In the determination of effective vegetated buffer widths, the Commission must also take into consideration the existing and proposed land use and type of alteration. Factors including changes to vegetation cover, soil disturbance, wildlife corridor connectivity, alterations of surface and ground water hydrology and discharges, pollutant loading to surface waters, and probable impacts to water quality and wetland functions should be evaluated.

### 5.9.3 Recommendations for Potential Restoration of Disturbed Wetlands and/or Buffer Areas

1. The eastern edge of the radio tower site wetland (Parcel 0224700) on Foster Road is overrun by *Phragmites* and has several areas of fill.

2. The power line cut through wetlands near I-95 and Cross Road is also infested by *Phragmites* (Parcels 0838200 and 0838000).

3. South of the tower site and behind the mixed commercial uses on Cross Road, there are several fill areas, some erosion problems, and an infestation of invasive species (Parcel 0146500).

4. The small farm operation (Parcel 0145400) on Cross Road just south of I-95 would benefit from implementation of several of the water quality improvement measures recommended by the USDA – NRCS.

5. The main stem of Stony Brook has several areas (Parcel 0840100) that would benefit from the restoration of a tree canopy to shade the brook and stabilize its banks.

### 5.9.4 Recommendations for Follow-up Investigations and/or Problem Areas

1. Red-tinged water draining from the eastern tributary into the main stem of Stony Brook just above I-95.

2. Red-tinged water draining from the wetland alongside the Post Road near the former auto salvage parcel.

3. Ending the ATV traffic and dumping at the tower site on Foster Road.

4. The out-of-use farm ponds and impoundments near Shawandassee Road are a potential source of pollutants to Keeny Cove.

5. ATV traffic is negatively impacting the wetlands on Parcels 0115100, 0839100, and 0224700.

# 6.0 WATERSHED MANAGEMENT AND LOW IMPACT DEVELOPMENT ANALYSIS

## 6.1 Introduction

Watershed management, stormwater management, and low impact development are integrally related and so have been grouped together for the purposes of this discussion. This report section describes watershed management, stormwater management, and low impact development principles, and explores their potential application in the Stony Brook watershed.

Traditional approaches to river management are often limited in scope, prohibitively expensive, and environmentally unsound. Such approaches have often included physical measures such as placing concrete or riprap along eroding banks or channelizing streams and rivers in underground piping. The concept of managing the watershed and river corridor to maintain the quality of the river system provides an alternate approach that allows each river function to be managed at an appropriate level.

Effective watershed management involves a multifaceted approach that encompasses land uses (past, present, and future); stream and wetland buffers; responsible development through adequate site selection, design, and maintenance; stormwater best management practices; control of nonstormwater discharges; control of destructive and unnatural erosion and sedimentation; and watershed stewardship programs that have the ability to span corporate boundaries and governmental divides.

Surface and ground water resources are best managed by considering three geomorphic and spatial scales (watershed, stream corridor, and river) as well as geospatial boundaries that are formed by municipal and state boundaries.

*Watershed Planning and Regulation* – The largest geographic planning element is that of a river's watershed, consisting of all land that contributes runoff to a specified point of interest. The importance of watershed scale planning is directly related to the river's hydrology and water quality. For example, it is difficult to have healthy streams if they are overwhelmed by frequent flood runoff and cumulative pollutants and sediment from upland activities. Stream management is thus dependent upon watershed land management.

*Riparian Corridor Planning and Regulation* – The second spatial scale to be addressed for comprehensive watershed management is the riparian corridor. This is a transition zone between uplands and waterbodies. It includes inland wetlands, floodplains, stratified drift ground water aquifers that are hydrologically connected to surface waters, and buffer zones.

*River Planning and Regulation* – The final spatial scale of concern is that of the actual stream channel that lies between the top of the stream banks.

Existing local, state, and federal programs do address all three spatial scales of watershed and watercourse management. However, the watershed level could benefit from stronger programs. The greatest weakness is in the lack of mandatory low impact drainage practices in contrast to "end-of-pipe" detention and sediment basin type practices. Waterford has an opportunity to do this at the local level through low impact development as described later in this section.

## 6.2 Stormwater Management

It is well documented that changes to the land's surface associated with land development and other activities can alter hydrologic conditions by modifying the way water moves over, through, and from the land. Watershed deforestation for lumber, firewood, charcoal, and farming was the first impact of colonial settlers. Subsequent drainage of

wetlands, channelization, and gravel mining modified watershed runoff through the 19th century. During the 20th century, watershed modifications included increased impervious cover (often the result of construction of residential subdivisions, roads, retail stores, and the like) and storm drains with direct discharges to surface water bodies.

In broad classification, typical impacts to wetlands and water resources due to the alteration of hydrologic conditions associated with land development and other activities include (1) degraded water quality; (2) unnatural stream channel geomorphic changes; and (3) increased frequency and severity of flooding. All of these potential impacts may also impact aquatic systems and can result in habitat loss and degradation and decreased biodiversity.

The practice of stormwater management is intended to mitigate hydrologic impacts resulting from changes to the land's surface. On a watershed scale, the controls used to manage stormwater can be classified in the following three categories:

*Land Use Controls* involve the regulatory processes, including zoning, that govern land development and other activities.

*Source Controls* are intended to reduce potential pollutants at their source by identifying and either prohibiting or conditioning land uses or activities that are known to have a high risk to generate pollutants.

*Treatment Controls* are both nonstructural and structural practices that are designed to mitigate the impacts of hydrologic condition changes that have occurred or will occur as a result of land development or other activities.

Examples of each type of control are given in Table 6-1.

**TABLE 6-1**
**Stormwater Management Controls**

| *Land Use Controls* | *Source Controls* | *Treatment Controls* |
|---|---|---|
| Stream Buffer Requirements | Public Education | Settling Practices |
| Floodplain Restrictions | Illicit Discharge Elimination | Infiltration Practices |
| Wetland Protection | Spill Prevention and Clean-up | Filtering Practices |
| Steep Slope Area Restrictions | Dumping Prevention | |
| Open Space | Materials Management | |
| Cluster Development | Street and Parking Area Cleaning | |
| Erosion and Sediment Control | Storm Drainage System Maintenance | |

Stormwater controls commonly used in land development design can be categorized as storage controls, infiltration controls, or end-of-pipe controls (Ontario Ministry of the Environment, 2003). Some can be considered applicable to more than one category and some may provide multiple functions or benefits. Examples of these techniques are listed in Table 6-2.

**TABLE 6-2**
**Controls Used in Land Development Design Practice**

| *Storage Controls* | *Infiltration Controls* | *End-of-Pipe Controls* |
|---|---|---|
| Rooftop Storage | Lot Grading to Create Ponding Areas | Oil/Grit Separators |
| Parking Area Storage | Roof Water Collection and Infiltration | Dry Ponds |
| Storm Sewer Storage | Vegetated Swales or Channels | Wet Ponds |
| Detention Facilities | Vegetated Buffer Areas | Constructed Wetlands |
| | Infiltration Storm Sewers | Filtering Practices |
| | Infiltration Basins or Structures | Infiltration Practices |

*Storage Controls* are intended to reduce the increased peak discharge rates and timing modifications of stormwater runoff resulting from development by temporarily holding runoff and releasing it at prescribed rates of discharge.

*Infiltration Controls* are intended to mitigate the effects that changes to the land surface have on the water balance portion of the hydrologic cycle by directing stormwater runoff into the ground.

*End-of pipe Controls* are located at the end of a conveyance system (e.g., a storm sewer or channel) and treat stormwater runoff before discharging it either to the ground or to receiving surface waters. End-of-pipe controls can also provide storage and infiltration functions, peak discharge attenuation, stream channel protection, and overbank and extreme flooding protection.

## 6.3 Low Impact Development (LID)

In LID, land development design practices for stormwater management make use of creative site planning and design tools that are intended to preserve or reduce the changes to a site's hydrology rather than simply providing "end of pipe" treatment or highly engineered management systems. LID techniques and practices are intended to preserve natural systems and protect resources and their buffer areas through design of drainage systems that mimic natural systems. The following goals are common to LID:

→ protect existing vegetation
→ minimize changes in surface water drainage patterns
→ avoid excessive site grading
→ reduce the area of impervious and managed surface coverage
→ encourage the disconnection of impervious surfaces
→ promote temporary storage of stormwater runoff
→ promote infiltration of stormwater runoff
→ reduce or mitigate increases in the volume of stormwater runoff as well as changes in magnitude, frequency, and duration of stormwater discharges to receiving waters

The use of these planning and design tools can often times reduce or even eliminate the requirement for more costly and sometimes obtrusive storage, infiltration, or end-of-pipe structural practices for the management of stormwater runoff. They can also result in development proposals that better fit the existing characteristics of a site, are aesthetically pleasing, and protect the environment.

LID techniques have been integrated into land use regulatory programs in some creative jurisdictions throughout the Untied States. A wealth of literature and other application tools, including LID design practice manuals, can be found on the World Wide Web. The basic techniques can be categorized into site planning, hydrologic analysis, erosion and sediment control, integrated management practices, and public outreach practices. Specific LID techniques are described in greater detail in the ensuing text.

### 6.3.1 Site Planning for LID

The goal of LID site planning techniques is to maintain hydrologic functions while allowing full development of the property. The traditional approach to stormwater management is to drain water from the site as quickly and efficiently as possible. LID site planning begins by understanding the essential hydrologic functions of the site, including the streams, wetlands, buffer areas, floodplains, steep slopes, high permeability soils, and conservation zones. The remaining site area is the "development zone," the area where development activities will have the least impact on hydrologic function.

Successful LID requires the micromanagement of site watersheds and hydrology. This means addressing stormwater control on a lot-by-lot basis. "On-lot" stormwater management may include "microstorage," functional landscaping, open swale drainage systems, reduction in impervious cover, increased runoff travel time, and depression storage (Prince George's County Maryland, 1999).

Since the watershed areas and stormwater runoff volumes being managed are much smaller, the range of available management techniques increases. For instance, use of a rain garden would not be possible to control runoff from an 11-lot subdivision and associated roadway. However, placement of rain gardens on a lot-by-lot basis may be feasible.

Often the first step in LID planning is to assess local land use regulations to determine the site development requirements. In many Connecticut communities, zoning and subdivision regulations effectively preclude the use of LID techniques because hard and fast design requirements are mandated. For instance, one town in the greater Hartford area requires that all roads and parking lots have a minimum six-inch high curb. This regulation prevents the use of curbless roadway or parking lot designs that would increase sheet flow and infiltration. The following site design elements incorporate LID:

1. Reduce paved areas to the extent possible. This may include reducing the width of paved roadways and cul-de-sac diameters, eliminating on-street parking, promoting use of common driveways, or using narrower driveway widths (perhaps nine or 10 feet).
2. Use permeable pavement materials such as grass pavers, whenever possible.
3. Avoid compaction of high permeability soils.
4. Minimize the area dedicated for construction easements and stockpile areas.
5. To the extent possible, plan site activities to limit the removal of trees and vegetation.
6. Disconnect impervious areas. Do not connect roof drains and footing drains into a piped drainage system (consider drywells or other infiltration devices). Provide curbless roads to allow sheet flow.
7. Maintain existing topography to the extent possible. The intent is to maintain runoff travel distances, slopes, roughness, and channel shapes whenever possible.
8. Maximize the use of open drainage systems such as grass swales.
9. Alter front yard setbacks to move houses forward on a lot to reduce driveway lengths.

Once these elements have been incorporated, then hydrologic analysis should be completed and then storage and treatment technologies can be considered to address any increases in peak flow or water quality concerns that remain.

### 6.3.2 LID Techniques for Development

In assessing site designs that incorporate LID techniques, hydrologic analysis is a key consideration. Land use regulations often stipulate the design storm to be analyzed. In Waterford, no specific design storm is specified for analysis. Instead, Section 25 of the Waterford Zoning Regulations requires that stormwater systems be designed "to prevent the collection and stagnation of water and the protection of watercourses, streams, ponds, and wetlands from pollution, siltation and erosion." These requirements are flexible and allow development of sites to occur in a manner appropriate for the area, instead of forcing a "one size fits all" approach to stormwater management.

For sites using LID, a design storm must be selected to evaluate hydrologic conditions at the site. Table 6-3 lists the typical analysis applied when evaluating different design storms.

**TABLE 6-3**
**Typical Design Storm Analyses**

| Design Storm Frequency | Typical Analysis and Evaluations That Should be Performed |
|---|---|
| First Flush (first one inch of runoff) | Stormwater Quality |
| 2-Year Storm Event | Erosion and Sediment related impacts to receiving streams and wetlands |
| 10-Year Storm Event | Conveyance Capacity |
| 100-Year Storm Event | Flooding Potential |

Once the predevelopment and postdevelopment hydrologic conditions are evaluated, specific site management practices can be incorporated as needed. The design considerations discussed earlier are intended to minimize site impacts, but some additional stormwater controls may be necessary. This is the point at which the designer

begins to evaluate specific Best Management Practices (BMPs). The following is a list of preferred BMPs, specific to different zoning designations and land uses.

**TABLE 6-4**
**Preferred Best Management Practices**

| ***Residential*** | ***Retail/Industrial*** | ***Both*** |
|---|---|---|
| Rain Gardens or Barrels | Pervious Parking | Grass Swales |
| Infiltration Basins or Trenches | Green Roof Storage | Deep Sump Catch Basins in Roads and Parking Areas |
| Dry Wells | Single Sidewalks | Hydrodynamic Separators |
| Reduced Roadway Widths | Reduction in Building Footprint | Oil/Water Separators |
| Curbless Roadways | Parking Lot Storage | Created Wetland Systems |
| Retention/Detention | Decentralized Parking | Bioretention Facilities |
| | Bioretention at Parking Lot Islands | Detention Basins |

The selection of specific BMPs varies from site to site. Some applications, such as infiltration systems, may not be appropriate for all land uses or all sites. For instance, the use of infiltration basins or trenches at an industrial facility that houses hazardous chemicals may not be prudent regardless of the soil conditions. Once the appropriate BMPs have been selected, the postdevelopment hydrologic analysis can be reevaluated to determine if precondition runoff rates and volumes are preserved.

### 6.3.3 LID Application in the Stony Brook Watershed

The type and scope of LID techniques used in the Stony Brook watershed may vary from subwatershed to subwatershed and site to site depending, not only on the proposed land use, but on the geology and topography of the site. Other factors, such as depth to water and depth to bedrock, will also need to be a consideration. Table 6-5 presents a summary of BMPs that could be used within the Stony Brook watershed.

## TABLE 6-5
## Considerations of Use of LID BMPs

| *BMP Type* | *Watershed Size* | *Space Requirements* | *Site Considerations* | *Maintenance* |
|---|---|---|---|---|
| Rain Barrels | Limited to roof area. Provide multiple barrels to accommodate larger roof areas. | Limited | None | Low |
| Infiltration Basins | Basins: 25 acres maximum; 10 acres recommended. | Varies with watershed size. Minimum 20 square feet. | Do not use at properties with high potential for sediment load. Keep minimum of 50' from slopes 15% or greater; bottom of unit >3' to water; 75' min from wells and septic. Basins require construction at the surface and may increase total land disturbances. | Moderate to high |
| Infiltration Trenches | Trenches: 5 acres maximum; 2 acres recommended. | Varies with watershed size. Minimum 20 square feet. | Do not use at properties with high potential for sediment load. Keep minimum of 50' from slopes 15% or greater; bottom of unit >3' to water; 75' min from wells and septic. Trenches can be constructed underground and may reduce land disturbances. | Moderate to high |

## TABLE 6-5 (Cont.)
## Considerations of Use of LID BMPs

| | | | | |
|---|---|---|---|---|
| Dry Wells | < one acre | Varies with watershed size. Minimum 20 square feet. | Not for use where rooftop may contribute pollutants. Bottom of unit 3' above water, 4' above bedrock; 75' min from wells and septic. | Low |
| Pervious Pavement | Traffic volume <500 ADT | Not applicable | Min. infiltration of underlying soils 0.3 in/hr, but less than 5.0 in/hr; no use in aquifer recharge areas except in approved "clean" applications; no use on slopes greater than 15%; depth to water – 3' min. depth to bedrock – 4' min. 75' min from wells. | Moderate |
| Green Roof Storage | Generally limited to roof area | Varies with size of roof | Depending on materials used, structural considerations may be needed. | Low |
| Bioretention/Rain Gardens | 5-10 acres; rooftop area for rain gardens | 200 sq. ft. min; 25 sq. ft. rain garden. | Slopes 6% or less; 3' from bottom of structure to water. | Low |
| Grass Swales | As space permits for swale construction | 2' min bottom width | Avoid steep slopes to prevent erosion. | Low |
| Oil/Water or Hydrodynamic Separators | <1 acre impervious cover | None. Below grade structure | None | Low |
| Created Wetlands | 25 acre min. | Proportional to watershed size | Must intersect ground water if unlined; not appropriate for land uses generating large amounts of contamination; must have base flow into system; steep slopes not appropriate. | Moderate to high |
| Detention Basins | 1 acre min. | Proportional to watershed size | Must intersect ground water if unlined and wet basin; not appropriate for land uses generating large amounts of contamination; must have base flow into system; steep slopes not appropriate. | Moderate |

The percentage of imperviousness in a watershed is often linked to water quality impairment. In the absence of other overriding factors, at levels of imperviousness less than 10%, water quality and habitat is generally considered to be unimpaired, and species present are typically those that are sensitive to impairment. Between 10% and 25% imperviousness, water quality and habitat are often viewed as impaired; and at levels of over 25%, severe impairment is often observed. It is important to acknowledge that these are general trends and not hard and fast rules.

Topography is another important issue to consider when evaluating LID uses. Slopes through the central floodplain portion of the Stony Brook are relatively flat, at 0 to 3%. Some steeper slopes (e.g., rock outcrops) do exist in the western and northern parts of the watershed. These steeper slope areas may not be suitable for LID techniques, and all construction in general on slopes in excess of 15% should be carefully considered as they would be more prone to erosion.

Zoning within the Stony Brook watershed can be classified into three broad categories: residential, commercial, and industrial. For residential properties, any LID technique is appropriate, provided site soil conditions are suitable to the application. In industrial and commercial areas, the proposed use of the property must be considered before the appropriate LID activities can be determined. Typically, infiltration practices are of most concern since the use of infiltration trenches or basins has the potential to introduce pollutants directly to ground water if the site is not managed properly.

Table 6-7 is a summary of allowable land uses in the Stony Brook watershed, where LID practices such as infiltration should be carefully reviewed for potential stormwater impacts.

**TABLE 6-7**
**Land Uses Where the Use of Infiltration Practices Should be Carefully Evaluated**

| Permitted or Special Permit Use of Concern |
|---|
| Public Utility Building or Structure |
| Shop |
| Printing and Publishing Facilities |
| Laboratory for Medical Research |
| Commercial Greenhouses and Garden Supply Centers |
| Service Stations |
| Car Washes |
| Laundry |
| Truck, Boat, and Automobile Repair Shops |
| Yard for Fuel, Lumber and Building Materials |
| Warehousing Facility and Distribution Center |
| Manufacturing Centers |
| Trucking Companies |
| Research and Testing Laboratory |
| Textile Dyeing Facilities |
| Septic Tank and/or Solid Waste Disposal Areas |
| Manufacture of Asphalt, Cement, Cinder Block Materials |
| Wholesale Storage of Petroleum, Oil, Chemicals, and Similar Materials |

As previously indicated, LID practices can be incorporated into proposed developments in any zone, provided soil types and other site conditions are favorable for the proposed LID application. The most important consideration is the ability to capture and collect pollutants in the event of a release. For this reason, the use of infiltration in business and industrial zones needs to be carefully considered based on the proposed use of the property.

## 6.4 Areas Unsuitable for Septic Systems

The Town's existing sanitary sewer system mapping and other septic suitability publications were reviewed in evaluating this watershed's septic suitability, including the NRCS publication entitled *"Soil Potential Ratings Subsurface Sewage Disposal Systems for Single Family Residences"* dated April 2006. Portions of this watershed are already served by the municipal sewer system. Sanitary sewer locations and soil septic suitability ratings are provided in Figure 6-1.

*Engineering,*
*Landscape Architecture*
*and Environmental Science*

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**LOCATION:**

**MMI#:**

**MXD:**

**SOURCE:**

**DATE:**

**SCALE:**

**SHEET:**

Parcels with frontage on the roads listed in Table 6-8 are either served by sanitary sewers or have the potential to be served today.

**TABLE 6-8**
**Sanitary Sewer Service Areas**

| | |
|---|---|
| Route 1 (aka Boston Post Road) | Valerie Street |
| Shawandassee Road | Deborah Street |
| Oswegatchie Road | Raymond Lane |
| Niantic River Road | Foster Road |
| Fulmore Drive | East part of Waterford Parkway North |
| Locust Court | Sunnieside Court |
| Miss Vans Court | Sunniecrest Drive |
| Wilcox Court | Rockridge Road |
| Splithead Road | Marilyn Road |
| Stone Street | Pamela Way |
| Doyle Road | Brooks Street |
| Cross Road | |

Parcels with frontage on Gurley Road, Waterford Parkway South, the western portion of Waterford Parkway North, and interior lots located north of I-95 are not located in close proximity to the existing sanitary system, but it may be feasible in the future for sanitary sewer lines to be extended to these roads and parcels.

The NRCS publication includes ratings of soil mapping units for subsurface sewage system suitability for a four-bedroom single-family house. Five soil characteristics are evaluated including slope, soil percolation rates, depth to seasonal high ground water, depth to bedrock, and flood susceptibility. Soils are rated as follows:

→ Extremely Low Potential Soils have multiple major limitations that are extremely difficult to overcome.

→ Very Low Potential Soils have major limitations that would require extensive design and site preparation.

→ Low Potential Soils have one or more limitations that would require extensive design and site preparation.

→ Moderate Potential Soils have significant limitations that are generally overcome by using commonly acceptable design criteria.

→ High Potential Soils have the best combination of characteristics or may have limitations that can be easily overcome using standard installation practices.

*Extremely Low Potential Soils* – In general, wetland soils have extremely low potential for septic suitability because of their seasonally high water table. Within the Stony Brook watershed, these soils would include the Scarboro series, Raypol series, Walpole series, Ridgebury series, Catden and Freetown complex, Ridgebury, Leicester, and Whitman soil complex, and Timakawa and Natchaug soils complex.

*Very Low Potential Soils* – The very low potential soils within the Stony Brook watershed are located within the northern part of the watershed where steep slopes and shallow bedrock are present. These soils belong to the Hollis-Chatfield rock outcrop complex.

*Low Potential Soils* – Low potential soils are located throughout the watershed and consist of a variety of soil types. The steeply sloped well drained Charlton-Chatfield complex is rated as low potential. The excessively drained Hinckley soil has a very high percolation rate and, therefore, has a rating of low potential. Also there are soils having low potential due to seasonally high water table including the Woodbridge series, Ninigret and Tisbury complex, Sutton series, and Sudbury series.

*Moderate Potential Soils* – Moderate potential soils are somewhat limited within this watershed. Small inclusions of these soils are found along the southeast, west, northwest, and northeast parts of the watershed. The moderate potential soils include the Canton

and Charlton complex and the Paxton and Montauk complex. The Canton – Charlton soils are limited by steep slopes and the Paxton-Montauk soils by low percolation rate.

*High Potential Soils* – High potential soils within this watershed are found within glacial till and stratified drift soils. The glacial till based soils include the low to moderately sloped Canton and Charlton complex and Narragansett series. The stratified drift soils include the Merrimac series, Agawam series, and Haven and Enfield soils complex.

Based on the soil septic suitability data, the Stony Brook watershed varies in the potential for subsurface septic systems. Approximately 54% of the watershed has soils rated low to extremely low potential. Some of the larger tracts of undeveloped land have predominantly low septic suitability ratings, and many either abut or include critical wetland systems. Having the ability to service future development within the watershed with sanitary sewers is extremely important for maintaining water quality within the Stony Brook main stem and critical wetland systems.

Theoretically speaking, a septic system is designed to work forever if the soils are good, the system is designed and constructed properly, and it is routinely maintained. However, not all septic systems work forever, whether it be from lack of maintenance, poor design and construction, or other contributing factors. Byproducts such as nitrates, nitrites, total Kjeldahl nitrogen, *e. coli*, and phosphorous can all degrade water quality within surface waters. The State Department of Public Health code precludes new septic systems from being constructed within 50 feet of a watercourse.

# 7.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

## 7.1 Summary of Findings

1. The Town of Waterford has placed a high priority on identifying, protecting, and managing its natural resources within the Stony Brook watershed. The Stony Brook watershed includes several large, valuable wetland and watercourse systems. The more than 306 acres of wetlands in the watershed represent several ecological categories including palustrine open water, forested, scrub-shrub, and emergent marsh/wet meadow systems. These wetland systems, in conjunction with their neighboring uplands, are critical in maintaining a clean and adequate supply of surface and ground water.

   The Stony Brook watershed is unusual in that the northern portion of the watershed is relatively undeveloped with large wetland systems that are natural and unfragmented while the central and southern portions of the watershed are more disturbed, developed, and fragmented. These differences in land use influence wetland cover types, water quality/quantity and wetland functions and values such as flood control, pollutant renovation, aesthetics, recreational opportunities, and wildlife habitat, among others.

   Wetland cover types north of the interstate are predominantly forested and scrub-shrub wetlands. South of the interstate, where anthropogenic disturbances are numerous, wetland cover types diversify from forested and scrub-shrub wetlands to include wet meadow, emergent marsh, and some open water wetlands. With the exception of a few wetlands such as (CWS-3) and Stony Brook itself, MMI observed that the overall wetland quality declines south of the interstate. Evidence of more recent disturbances (particularly commercial and residential development), invasive species colonization, and lower water quality all contribute to the decline of these wetlands. However, that is not to say that the wetlands south of the interstate do not still provide important functions and values that merit continued protection.

2. Based on the water quality data collected by the Town of Waterford from 1999 to 2006 and the rapid field water quality assessment performed by MMI in June 2007, Stony Brook appears, for the most part, to be meeting its Class A water quality designation. However, some data and field observations indicate that some water quality issues exist that warrant further investigation. In summary, Stony Brook has:

   a. Cool water temperatures.
   b. Slightly acidic pH.
   c. Low specific conductivity.
   d. Low chloride concentrations.
   e. High dissolved oxygen.
   f. Low *E. Coli* concentrations.
   g. Low phosphorus and nitrogen concentrations.
   h. Metals data suggests the potential for both acute and chronic toxicity to aquatic life due to high lead and copper concentrations. However, the data may be inaccurate due to the use of nonstandardized techniques with high detection limits. Further testing, after inspections, is likely warranted.

   Our field observations indicate some areas of departure from the Class A water quality. For example, the instream bioassessment data indicates a limited abundance and diversity of macroinvertebrates within Stony Brook. MMI also noted strong red-colored surface waters within the upper, eastern subwatersheds (tributaries T2 and T3) that appear to be excessive given the underlying watershed geology. Thus, there may be sources of contamination. These few instances of potential water quality problems warrant further study because Stony Brook is a high quality watercourse and provides an important fishery resource. It should be carefully protected and maintained through appropriate watershed management and careful land-use planning.

3. It is critical that management efforts extend beyond the banks and flowing water of Stony Brook. Upstream land uses can have significant hydrologic impacts such as increases or decreases in runoff volumes and peak discharge rates as well as nonpoint source pollution. Based on our field observations, Stony Brook does experience low-flow impairments, and it is important to maintain recharge capabilities within its watershed. Wetland filling that reduces the detention/retention capability in the watershed can increase water surface elevations at upstream properties and increase erosion downstream as water velocities increase in direct response to the loss in conveyance area. Loss of riparian buffers and/or wetlands can impact habitat quality and also increase water temperatures as shade-providing vegetation is removed as was observed south of I-95.

4. This study provides important mapping and analysis tools of critical environmental resources in the Stony Brook watershed. It provides a baseline of information from which good planning can follow. This is true for individual sites and projects as well as for broad-scale planning at the municipal, regional, or statewide level. It is difficult for planning boards, regulatory commissions, and local officials to fully evaluate the merit and/or potential impact of an action when it is out of context of the broader environment in which it is to take place.

5. MMI identified three critical wetland systems (CWS) within the Stony Brook watershed. These wetland systems include forested, scrub-shrub, and emergent wetlands, which provide important functions including preservation of biodiversity, flood flow alteration, and water quality protection and renovation. The critical resource areas within the Stony Brook watershed are presented in Table 7-1 and described further in Section 5.8.1.

**TABLE 7-1**
**Critical Wetland Systems**

| *Critical Wetland System* | *Watershed ID* | *Size (acres)* | *Wetland I.D.* | *Dominant Wetland Cover Types* | *Important Functions* |
|---|---|---|---|---|---|
| CWS-1 | SB-70<br>SB-90 | 40.2 | SB-70-1<br>SB-90-4<br>SB-90-5 | PFO and PSS | Biodiversity<br>Nutrient retention<br>Flood flow alteration<br>Production export<br>Fishery habitat |
| CWS-2 | SB-70 | 64.3 | SB-70-2<br>SB-70-3<br>SB-70-5 | PFO, PSS, PEM | Biodiversity<br>Flood flow alteration<br>Nutrient retention |
| CWS-3 | SB-30 | 5.0 | SB-40-1 | PFO, PSS, POW | Biodiversity<br>Pollutant renovation |

PFO = Palustrine Forested Wetlands
PSS = Palustrine Scrub-shrub Wetlands
PEM = Palustrine Emergent Marsh
POW = Palustrine Open Water

6. The Stony Brook watershed includes several large tracts of land that have been classified in this report as unfragmented natural areas. Each area is described in Section 5.8.2. Unfragmented natural areas are a critical component in the conservation of biodiversity on a local and regional scale, and they provide and protect essential water supplies. Virtually the entire Stony Brook watershed north of I-95 can be viewed as an unfragmented area of high resource value. Only narrow strips of development exist; and these are, for the most part, closely confined to Cross Road and the access road north of the highway.

   Similarly, the lands south of I-95 and north of the Post Road are largely undeveloped. As viewed here, the "natural" state of the fallow farm fields, farm ponds, and wooded hedgerows adds diversity to the landscape and provides opportunities for wildlife not found in the forested sections of the watershed. Additionally, they offer easier access and vantage points for public enjoyment.

   On a smaller scale, valuable undeveloped lands occur south of the Post Road. These include the high resource value wetlands near Oswegatchie School and beyond Fulmore Drive. The undeveloped woodlands that border these two wetland systems greatly

increase the overall resource value, although on a more local scale than areas to the north.

7. Vernal pool obligate species such as spotted salamanders and wood frogs were found within numerous wetlands in the Stony Brook watershed. Based on the field investigations, there is a higher concentrations of breeding habitat north of I-95. This is most likely attributed to the fact that the wetland and upland habitats north of the interstate have remained natural and unfragmented. South of I-95, the occurrence of amphibian breeding habitat lessens due to the overall change in land use which is predominantly agricultural, residential, and commercial.

8. Effective watershed management within the Stony Brook watershed involves a multifaceted approach that encompasses land uses (past, present, and future); stream and wetland buffers; responsible development through adequate site selection, design, and maintenance; stormwater best management practices; control of nonstormwater discharges; and control of destructive and unnatural erosion and sedimentation.

9. Unchecked or unregulated development within a watershed like Stony Brook can have profound negative impacts on the surrounding environment in the form of changes to stream flow, flooding, erosion and sedimentation, and deteriorated water quality in streams, ponds, and wetlands. Many communities have attempted to address these issues through local zoning or subdivision regulations that prohibit increases in peak stormwater runoff rates. However, regulation is only one aspect of the zero-extra runoff concept. Of equal importance is consideration of the individual watershed(s) in which stormwater detention is proposed. Depending on the specific hydrology, detention could actually be detrimental to the watershed and even exacerbate downstream flooding impacts.

10. In low impact development, land development design practices for stormwater management make use of creative site planning and design tools that are intended to

preserve or reduce the changes to a site's hydrology, rather than simply providing "end of pipe" treatment or highly engineered management systems. Low impact development techniques and practices are intended to preserve natural systems and protect resources and their buffer areas through design of drainage systems that mimic natural systems. The selection of specific BMPs varies from site to site. Some applications, such as infiltration systems, may not be appropriate for all land uses or all sites.

## 7.2 Summary of Recommendations

1. Based upon field investigations of Stony Brook, the watercourse is susceptible to low flow impairment and should be managed to increase infiltration. Fortunately, the main stem (and much of the watershed below I-95) has a significant extent of stratified drift deposits along the watercourse, so that infiltration and recharge of the aquifers would be relatively easy. The Town may wish to require an assessment by developers of the feasibility of incorporating infiltration and recharge into the design of new development in areas underlain by stratified drift.

2. Any future regulations that control the quantity and timing of stormwater runoff should be carefully crafted to account for the complex hydrologic and hydraulic processes occurring in this watershed. In watersheds with alluvial streams, a zero increase in peak flow does not preclude channel erosion. Sensitive streams are also stressed by increased stormwater volume and flow duration, even if peak flows are equalized. Accordingly, each of these components should be considered in the development and application of stormwater management regulations.

   In addition, the Town should implement the use of more stringent stormwater treatment measures within this watershed. This can be accomplished through the Zoning Regulations by mandating that all proposed development within this watershed follow the guidelines set forth in the CTDEP 2004 Stormwater Quality Manual. For example, all proposed large-scale development within this watershed

should be required to demonstrate a minimum 80% removal efficiency of suspended solids from stormwater before it is discharged into riparian uplands or into a wetland and/or watercourse.

3. The inventory, mapping, and habitat analysis conducted under this Watershed Management Plan should be utilized by the Town and its regulatory boards as an active reference tool in reviewing applications, to provide the basis for comparison in the review of the applicability and adequacy of current zoning designations, and to distinguish a hierarchy of protection for natural resources based on their function and value in their respective ecological communities.

4. This plan supports the Town's existing 100-foot upland review area along all wetlands and watercourses that have not been identified as having vernal pools and/or other amphibian breeding habitat. For wetland areas designated as having vernal pools and/or other amphibian breeding habitat, a 150-foot upland review area is recommended from the edge of the pool and/or breeding habitat.

   Maintenance of a upland vegetated buffer area between proposed development and the edge of a wetland is recommended to protect the diversity of the wetland plant communities, the integrity of instream habitats and channel characteristics, and to preserve water quality features including turbidity, dissolved oxygen, and temperature. Suggested buffer widths range between 50 and 100 feet based upon the quality of the wetland resource, the functions and values the resource provides, water quality and vulnerability to land use changes, fishery resources, critical wetland habitats, and the resource sensitivity to proposed development.

5. Guidance and suggestions are included in this plan for the promotion of LID in the Stony Brook watershed. The type and scope of LID techniques used may vary from subwatershed to subwatershed and site to site depending, not only on the proposed land use, but on the geology and topography of the site. Other factors such as depth

to water and bedrock and the presence of highly pervious soil layers are also considerations when evaluating LID application.

6. The Town may wish to consider a program to protect its unfragmented natural areas within the Stony Brook watershed through land acquisition, where possible, and through its land use planning processes. There are many benefits to maintaining unfragmented natural areas. Healthy, ecologically diverse systems that are unfragmented perform important natural, abiotic processes such as decomposition of organic matter, soil and sediment creation, filtration of ground and surface water, air cleansing, pollutant renovation, and nutrient retention. In addition, these unfragmented lands provide educational and recreational opportunities to the public such as bird watching, hiking, skiing, hunting, and fishing.

7. The Town should perform a full stream walk of tributaries T2 and T3 to visually identify the source or sources of discolored water. Perform additional chemical tests as needed to determine a suitable course of corrective action. Conduct additional stream sampling of metals, especially copper and lead, at select locations to determine the accuracy of earlier studies. The sampling should include an upstream-downstream comparison of copper concentrations in subwatershed SB-70 where an underground copper wire antennae at the old WNLC property is said to exist. A macroinvertebrate biomonitoring study should be conducted to support the continued water quality investigation. These organisms are sensitive to water quality parameters and changes, and they typically live in the stream for at least three years as larvae and thus serve as a long-term monitoring tool.

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# APPENDIX A

## Time of Concentration Computation Worksheets

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 10 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | |
|---|---|---|---|
| Segment ID | | **A-B** | |
| 1. Surface description (Table 3-1) | | FRST | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | |
| 5. Land slope, s | ft./ft. | 0.037 | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 0.521 | = 0.521 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | **B-C** | | **C-D** | | **D-E** | | **E-F** | |
| 7. Surface description | | GRSS | | FRST | | GRSS | | IMP | |
| 8. Manning's roughness coeff., n | | 0.080 | | 0.100 | | 0.080 | | 0.010 | |
| 9. Paved or unpaved | | UNPVD | | UNPVD | | UNPVD | | PVD | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | 0.40 | | 0.40 | | 0.20 | |
| 11. Flow Length, L | ft. | 191.0 | | 1626.0 | | 523.0 | | 567.0 | |
| 12. Watercourse slope, s | ft./ft. | 0.0314 | | 0.0431 | | 0.0260 | | 0.0705 | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 1.79 | | 1.68 | | 1.63 | | 13.53 | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.030 | + | 0.269 | + | 0.089 | + | 0.012 | = 0.399 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | **F-G** | | **G-H** | | **H-I** | | **I-J** | |
| 15. Channel Bottom width, b | ft. | | | | | | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | | | | | | | | |
| 17. Depth of flow, d | ft. | | | | | | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| 19. Wetted perimeter, $P_w$ | ft. | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| 21. Channel slope, s | ft./ft. | | | | | | | | |
| 22. Manning's roughness coeff., n | | | | | | | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| 24. Flow length, L | ft. | | | | | | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.000 | + | 0.000 | + | 0.000 | + | 0.000 | = 0.000 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | hr. | | | | | | | | 0.921 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | A-B | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.040 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 0.503 | = | 0.503 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | B-C | | C-D | | | | | |
| 7. Surface description | | GRSS | | FRST | | | | | |
| 8. Manning's roughness coeff., n | | 0.080 | | 0.100 | | | | | |
| 9. Paved or unpaved | | UNPVD | | UNPVD | | | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | 0.40 | | | | | |
| 11. Flow Length, L | ft. | 479.0 | | 1306.0 | | | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0543 | | 0.0337 | | | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 2.36 | | 1.48 | | | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.056 | + | 0.244 | + | | + | | = 0.301 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | D-E | | E-F | | F-G | | G-H | |
| 15. Channel Bottom width, b | ft. | 3.00 | | 4.00 | | 5 | | 3 | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 2.00 | | 0.40 | | 0.5 | | 0.1 | |
| 17. Depth of flow, d | ft. | 0.10 | | 0.30 | | 0.4 | | 0.4 | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.32 | | 1.24 | | 2.08 | | 1.22 | |
| 19. Wetted perimeter, $P_w$ | ft. | 3.45 | | 4.65 | | 5.89 | | 3.80 | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.09 | | 0.27 | | 0.35 | | 0.32 | |
| 21. Channel slope, s | ft./ft. | 0.0268 | | 0.0214 | | 0.0178 | | 0.0100 | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.040 | | 0.040 | | 0.010 | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 1.25 | | 2.26 | | 2.48 | | 6.97 | |
| 24. Flow length, L | ft. | 559.0 | | 1307 | | 675 | | 51 | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.124 | + | 0.161 | + | 0.076 | + | 0.002 | = 0.363 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 1.167 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 10 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | A-B | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.007 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 1.011 | = | 1.011 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | B-C | | C-D | | D-E | | | |
| 7. Surface description | | FRST | | | | | | | |
| 8. Manning's roughness coeff., n | | 0.100 | | | | | | | |
| 9. Paved or unpaved | | UNPVD | | | | | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | | | | | | |
| 11. Flow Length, L | ft. | 1015.0 | | | | | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0230 | | | | | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 1.23 | | | | | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.230 | + | | + | | + | | = 0.230 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | E-F | | F-G | | G-H | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | 50.00 | | 3 | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 1.00 | | 0.05 | | 0.05 | | | |
| 17. Depth of flow, d | ft. | 0.20 | | 5.00 | | 0.4 | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.44 | | 251.25 | | 1.21 | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.57 | | 60.01 | | 3.80 | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.17 | | 4.19 | | 0.32 | | | |
| 21. Channel slope, s | ft./ft. | 0.0079 | | 0.0100 | | 0.0257 | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.030 | | 0.040 | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 1.02 | | 12.90 | | 2.78 | | | |
| 24. Flow length, L | ft. | 380.0 | | 211 | | 974 | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.103 | + | 0.005 | + | 0.097 | + | | = 0.205 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 1.446 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | A-B | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.017 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 0.715 | = | 0.715 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | B-C | | C-D | | D-E | | E-F | |
| 7. Surface description | | FRST | | FRST | | FRST | | FRST | |
| 8. Manning's roughness coeff., n | | 0.100 | | 0.100 | | 0.100 | | 0.100 | |
| 9. Paved or unpaved | | UNPVD | | UNPVD | | UNPVD | | UNPVD | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | 0.40 | | 0.40 | | 0.40 | |
| 11. Flow Length, L | ft. | 85.0 | | 472.0 | | 205.0 | | 410.0 | |
| 12. Watercourse slope, s | ft./ft. | 0.0353 | | 0.0254 | | 0.1073 | | 0.0244 | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 1.52 | | 1.29 | | 2.65 | | 1.26 | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.016 | + | 0.102 | + | 0.021 | + | 0.090 | = 0.229 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | F-G | | G-H | | H-I | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | 3.00 | | 5 | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 0.50 | | 1.00 | | 2 | | | |
| 17. Depth of flow, d | ft. | 0.20 | | 0.30 | | 0.5 | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.42 | | 0.99 | | 3.00 | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.45 | | 3.85 | | 7.24 | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.17 | | 0.26 | | 0.41 | | | |
| 21. Channel slope, s | ft./ft. | 0.0166 | | 0.0123 | | 0.0066 | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.040 | | 0.040 | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 1.48 | | 1.67 | | 1.68 | | | |
| 24. Flow length, L | ft. | 1328.0 | | 1304 | | 1214 | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.249 | + | 0.217 | + | 0.201 | | | = 0.667 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 1.611 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | A-B | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.007 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 1.031 | = | 1.031 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | B-C | | C-D | | D-E | | | |
| 7. Surface description | | FRST | | FRST | | FRST | | | |
| 8. Manning's roughness coeff., n | | 0.100 | | 0.100 | | 0.100 | | | |
| 9. Paved or unpaved | | UNPVD | | UNPVD | | UNPVD | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | 0.40 | | 0.40 | | | |
| 11. Flow Length, L | ft. | 211.0 | | 1306.0 | | 356.0 | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0474 | | 0.0540 | | 0.0506 | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 1.76 | | 1.88 | | 1.82 | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.033 | + | 0.193 | + | 0.054 | + | | = 0.281 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | E-F | | | | | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | | | | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 0.50 | | | | | | | |
| 17. Depth of flow, d | ft. | 0.30 | | | | | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.65 | | | | | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.67 | | | | | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.24 | | | | | | | |
| 21. Channel slope, s | ft./ft. | 0.0268 | | | | | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | | | | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 2.36 | | | | | | | |
| 24. Flow length, L | ft. | 2836.0 | | | | | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.333 | + | | + | | + | | = 0.333 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 1.645 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | A-B | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.017 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 0.715 | = | 0.715 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | B-C | | C-D | | D-E | | | |
| 7. Surface description | | FRST | | FRST | | FRST | | | |
| 8. Manning's roughness coeff., n | | 0.100 | | 0.100 | | 0.100 | | | |
| 9. Paved or unpaved | | UNPVD | | UNPVD | | UNPVD | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | 0.40 | | 0.40 | | | |
| 11. Flow Length, L | ft. | 1853.0 | | 1306.0 | | 356.0 | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0543 | | 0.0540 | | 0.0506 | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 1.88 | | 1.88 | | 1.82 | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.273 | + | 0.193 | + | 0.054 | + | | = 0.521 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | E-F | | F-G | | | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | 4.00 | | | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 0.50 | | 0.40 | | | | | |
| 17. Depth of flow, d | ft. | 0.20 | | 0.30 | | | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.42 | | 1.24 | | | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.45 | | 4.65 | | | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.17 | | 0.27 | | | | | |
| 21. Channel slope, s | ft./ft. | 0.0078 | | 0.0214 | | | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.040 | | | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 1.01 | | 2.26 | | | | | |
| 24. Flow length, L | ft. | 772.0 | | 704 | | | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.211 | + | 0.087 | + | | + | | = 0.298 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 1.533 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | **A-B** | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.007 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 1.031 | = | 1.031 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | **B-C** | | | | | | | |
| 7. Surface description | | FRST | | | | | | | |
| 8. Manning's roughness coeff., n | | 0.100 | | | | | | | |
| 9. Paved or unpaved | | UNPVD | | | | | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | | | | | | |
| 11. Flow Length, L | ft. | 152.0 | | | | | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0132 | | | | | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 0.93 | | | | | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.046 | + | | + | | + | | = 0.046 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | **C-D** | | **D-E** | | **E-F** | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | 3.00 | | 3.00 | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 0.50 | | 0.40 | | 0.40 | | | |
| 17. Depth of flow, d | ft. | 0.20 | | 0.30 | | 0.30 | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.42 | | 0.94 | | 0.94 | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.45 | | 3.65 | | 3.65 | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.17 | | 0.26 | | 0.26 | | | |
| 21. Channel slope, s | ft./ft. | 0.0041 | | 0.0023 | | 0.0190 | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.040 | | 0.040 | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 0.74 | | 0.73 | | 2.08 | | | |
| 24. Flow length, L | ft. | 1935.0 | | 856 | | 1209 | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.727 | + | 0.327 | + | 0.162 | + | | = 1.215 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 2.292 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | **A-B** | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.047 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 0.473 | = | 0.473 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Segment ID | | **B-C** | | | | | | |
| 7. Surface description | | FRST | | | | | | |
| 8. Manning's roughness coeff., n | | 0.100 | | | | | | |
| 9. Paved or unpaved | | UNPVD | | | | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | | | | | |
| 11. Flow Length, L | ft. | 1742.0 | | | | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0436 | | | | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 1.69 | | | | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.286 | + | | + | | + | = 0.286 |

**Channel flow**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Segment ID | | **C-D** | | **D-E** | | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | 7.00 | | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 0.50 | | 1.00 | | | | |
| 17. Depth of flow, d | ft. | 0.20 | | 0.50 | | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.42 | | 3.75 | | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.45 | | 8.41 | | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.17 | | 0.45 | | | | |
| 21. Channel slope, s | ft./ft. | 0.0588 | | 0.2400 | | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.040 | | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 2.79 | | 10.65 | | | | |
| 24. Flow length, L | ft. | 918.0 | | 100 | | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.091 | + | 0.003 | + | | + | = 0.094 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | hr. | 0.854 |

# Worksheet 3: Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ )

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** $T_t$ | Subwatershed: WS 20 - Existing Conditions

**Sheet flow** (applicable to $T_c$ only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | **A-B** | | |
| 1. Surface description (Table 3-1) | | FRST | | |
| 2. Manning's roughness coeff. for sheet flow, n (Table 3-1) | | 0.300 | | |
| 3. Flow Length, L (< 300ft) | ft. | 300.0 | | |
| 4. Two-year 24-hr rainfall, $P_2$ | in. | 3.40 | | |
| 5. Land slope, s | ft./ft. | 0.013 | | |
| 6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$ | hr. | 0.781 | = | 0.781 |

**Shallow concentrated flow** (assume hyd. radius = depth of flow)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | **B-C** | | | | | | | |
| 7. Surface description | | FRST | | | | | | | |
| 8. Manning's roughness coeff., n | | 0.100 | | | | | | | |
| 9. Paved or unpaved | | UNPVD | | | | | | | |
| 10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) | ft. | 0.40 | | | | | | | |
| 11. Flow Length, L | ft. | 811.0 | | | | | | | |
| 12. Watercourse slope, s | ft./ft. | 0.0074 | | | | | | | |
| 13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$ | fps. | 0.70 | | | | | | | |
| 14. $T_t = \frac{L}{3600 * V}$ | hr. | 0.324 | + | | + | | + | | = | 0.324 |

**Channel flow**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Segment ID | | **C-D** | | **D-E** | | **E-F** | | | |
| 15. Channel Bottom width, b | ft. | 2.00 | | 7.00 | | 7.00 | | | |
| 16. Horizontal side slope component, z (z horiz:1 vert) | ft. | 0.50 | | 1.00 | | 1.00 | | | |
| 17. Depth of flow, d | ft. | 0.20 | | 0.50 | | 0.50 | | | |
| 18. Cross sectional flow area, A (assume trapazoidal) | $ft.^2$ | 0.42 | | 3.75 | | 3.75 | | | |
| 19. Wetted perimeter, $P_w$ | ft. | 2.45 | | 8.41 | | 8.41 | | | |
| 20. Hydraulic Radius, $R = \frac{A}{P_w}$ | ft. | 0.17 | | 0.45 | | 0.45 | | | |
| 21. Channel slope, s | ft./ft. | 0.0055 | | 0.0046 | | 0.0190 | | | |
| 22. Manning's roughness coeff., n | | 0.040 | | 0.040 | | 0.040 | | | |
| 23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$ | fps. | 0.85 | | 1.48 | | 3.00 | | | |
| 24. Flow length, L | ft. | 725.0 | | 3906 | | 1209 | | | |
| 25. $T_t = \frac{L}{3600 * V}$ | hr. | 0.236 | + | 0.735 | + | 0.112 | + | | = | 1.083 |
| 26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25) | | | | | | | | hr. | 2.188 |

# APPENDIX B

## Stony Brook Water Quality Data

| | | |
|---|---|---|
| **ok, Waterford Connecticut** | | |
| **07 Observed by: JSC, RKS** | | |
| **F, Light Breeze** | | |
| | | |
| | Stream name | Site description |
| | Stony Brook mainstem | ~100 m downstream from approximate source location |
| | Stony Brook mainstem | ~20 m upstream from the rock wall and dirt road crossing |
| | Stony Brook mainstem | ~80 m upstream from confluence of tributary T2/T3, which is ~270 m upstream from I-95 culvert |
| | Tributary T2 | upstream of dirt road at the end of Foster Road |
| | Tributary T2/T3 | eastern tributary ~100 m upstream from the confluence with mainstem, which is ~250 m upstream from the I-95 culvert |
| | Stony Brook mainstem | typical section ~130 m upstream of I-95 culvert |
| | Stony Brook mainstem | ~20 m upstream of I-95 culvert |
| | Stony Brook mainstem | ~140 m downstream of I-95 culvert next to farm field |
| | Stony Brook mainstem | upstream of confluence with tributary T4 from east |
| | Tributary T4 | eastern tributary from mid-watershed farming areas ~60 m upstream from the confluence with mainstem |
| | Tributary T6 headwaters | wetland downstream of car dump |
| | Tributary T6 | ~270 m upstream of driveway |
| | Tributary T6 | ~10 m upstream of driveway culvert |
| | Tributary T7/T8 | ~5 m upstream of driveway culvert |
| -1 | Tributary T6/T7/T8 | ~50 m from confluence with mainstem |
| | Stony Brook mainstem | ~30 m downstream of confluence with tributary T6/T7/T8, which is ~160 m upstream of US Route 1 |
| | Stony Brook mainstem | ~30 m upstream of US Route 1 Bridge and breached dam |
| | Stony Brook mainstem | ~50 m downstream of US Route 1 Bridge |
| | Stony Brook mainstem | ~5 m upstream of Oswegatchie Road Bridge |
| | Stony Brook mainstem | ~10 m downstream of Oswegatchie Road Bridge |

| | Temperature (deg C) | Disolved Oxygen (%) | Disolved Oxygen (mg/L) | Specific Conductance (microS) | Turbidity 1 | Turbidity 2 | Turbidity 3 | Turbidity Average | Salinity (ppt) | Water Depth (cm) | Bankfull Depth (cm) | Bankfull Width (m) | Stream Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13.1 | 69 | 6.9 | 51.6 | 2.5 | 2.7 | 2 | 2.4 | | 10 | | | |
| | 13.9 | 74 | 7.5 | 45.9 | 0.75 | 0.9 | 0.7 | 0.8 | | 10 | 25 | 5.0 | High Gradient |
| | 14.8 | 96 | 9.7 | 39.9 | 0.68 | 0.71 | 0.7 | 0.7 | | | 50 | 7.0 | High Gradient |
| 1 | 16.3 | 22 | 2.0 | 68.8 | 2.5 | 2.8 | 3.2 | 2.8 | | | | | |
| -1 | 15.4 | 79 | 7.9 | 139.1 | 1.3 | 1.28 | 1.32 | 1.3 | | | 55 | 4.5 | High Gradient |
| | 15.0 | 93 | 9.4 | 110.1 | 1 | 0.9 | 0.9 | 0.9 | | | 60 | 14.5 | High Gradient |
| | 15.0 | 70 | 7.0 | 114.4 | 1.3 | 1 | 1.1 | 1.1 | | | 76 | 10.0 | |
| | 15.1 | 95 | 9.6 | 116.6 | 1.06 | 1.13 | 1.14 | 1.1 | | | 70 | 4.0 | High Gradient |
| | 15.6 | 100 | 9.9 | 116.6 | 1 | 1 | 1 | 1.0 | | | | | Low Graidient |
| 1 | 15.8 | 77 | 7.6 | 123.4 | 2.9 | 2.9 | 2.3 | 2.7 | | | | | |
| | 15.0 | 6 | 0.5 | 122.6 | 50 | 50 | 55 | 51.7 | | | | | |
| | 14.7 | 102 | 10.2 | 119.7 | 0.8 | 0.6 | 0.75 | 0.7 | | | 34 | 4.9 | Low Gradient |
| 2 | 15.0 | 98 | 9.8 | 119.5 | 1.1 | 0.85 | 0.85 | 0.9 | | | | | |
| -1 | 15.3 | 95 | 9.4 | 111.7 | 4.1 | 4.2 | 4 | 4.1 | | | | | |
| 8-1 | 15.2 | 75 | 7.3 | 110.7 | 3.34 | 3.54 | 3.06 | 3.3 | | | | | |
| | 15.6 | 95 | 9.5 | 115.1 | 1.72 | 1.65 | 1.63 | 1.7 | | | 76 | 6.7 | Low Gradient |
| | 15.9 | 96 | 9.6 | 114.4 | 1.29 | 1.27 | 1.32 | 1.3 | | | | | |
| 0 | 14.7 | 18 | 1.8 | 270 | 15 | 13 | 13 | 13.7 | 0.1 | | | | |
| 1 | 16.5 | 96 | 9.0 | 5000 | 2 | 1.9 | 1.9 | 1.9 | 2.8 | | | | |
| 2 | 17.1 | 98 | 9.3 | 3566 | 2.2 | 2.3 | 2.8 | 2.4 | 1.9 | | | | |

| | RHA 1 Epifaunal Substrate/ Cover | RHA 2 Embeddedness / Pool Substrate | RHA 3 V/ D Regime / Pool Variability | RHA 4 Sediment Deposition | RHA 5 Channel Flow Status | RHA 6 Channel Alteration | RHA 7 Freq. Riffles / Channel Sinuosity | RHA 8 Bank Stability Left Bank | RHA 8 Bank Stability Right Bank | RHA 9 Vegetative Protection Right Bank | RHA 9 Vegetative Protection Left Bank | RHA 10 Riparian Zone Right Bank | RHA 10 Riparian Zone Left Bank | Total RHA Score out of 200 | RHA (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 14 | 18 | 18 | 18 | 16 | 13 | 10 | 10 | 10 | 10 | 10 | 10 | 177 | 8 |
| | 20 | 19 | 18 | 20 | 19 | 20 | 19 | 10 | 10 | 10 | 10 | 10 | 10 | 195 | 9 |
| 1 | 19 | 19 | 16 | 17 | 19 | 15 | 17 | 10 | 10 | 10 | 10 | 10 | 10 | 182 | 9 |
| | 20 | 18 | 18 | 20 | 20 | 19 | 18 | 10 | 10 | 9 | 9 | 10 | 10 | 191 | 9 |
| | 10 | 9 | 11 | 13 | 18 | 13 | 15 | 10 | 10 | 5 | 10 | 3 | 5 | 132 | 6 |
| | 16 | 14 | 14 | 14 | 19 | 20 | 16 | 9 | 9 | 10 | 10 | 10 | 10 | 171 | 8 |
| | 15 | 11 | 10 | 15 | 18 | 20 | 18 | 9 | 9 | 10 | 10 | 10 | 10 | 165 | 8 |
| 1 | | | | | | | | | | | | | | | |
| 8-1 | | | | | | | | | | | | | | | |
| | 15 | 13 | 13 | 13 | 20 | 20 | 14 | 8 | 8 | 8 | 8 | 10 | 10 | 160 | 8 |

# APPENDIX C

## Wetland System Photographs

**Stony Brook Watershed Management Plan**
**Wetlands Photo Log**

**SB-90 Headwater Wetland North of Power-line**

**SB-90 Headwater Wetland and Vernal Pool**

**SB-80 Western Tributary & Forested Wetland**

**SB-80 Stony Brook Main Stem above I-95**

**SB-70 Fill pile near headwater wetland**

**SB-70 Palustrine Forested Wetland Systems**

**SB-70 Palustrine Scrub Shrub Wetland System**

**SB-70 Palustrine Scrub Shrub and Emergent Marsh at Radio Tower Parcel**

**SB-70 Palustrine Wet Meadow and Emergent Marsh at Radio Tower Parcel**

**SB-60 Forested Wetlands abutting Former Auto Salvage Area**

**SB-60 Tributary and Forested Wetland**

**SB-50 Stony Brook Main Stem through farm fields**

**SB-50 Stony Brook Main Stem through Forested Wetlands**

**SB-50 Palustrine Wet Meadows and Emergent Marshes**

**SB-50 Manmade Pond**

**SB-40 Scrub Shrub Wetland near Stony Brook Drive**

**SB-40 Intermittent Watercourse and Forested Wetlands**

**SB-40 Stony Brook Main Stem north of Route 1**

**SB-30 Manmade Pond off Shawandasee Road**

**SB-30 Palustrine Scrub Shrub Wetlands**

**SB-20 Forested Wetlands**

**SB-20 Tributary to Keeny Cove**