FUSS & O'NEILL

MEMORANDUM

TO: Maryellen Edwards, Town of Woodbury

FROM: Julianne Busa, PhD; Michael Soares; Sarah Hayden, MSc

DATE: August 26, 2020

RE: DCIA Reduction/Retrofit Plan

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1. Introduction

The Post-Construction Stormwater Management minimum control measure of the Connecticut MS4 General Permit requires that permittees implement a retrofit program to track and disconnect Directly Connected Impervious Area (DCIA). Fuss and O'Neill performed a planning-level assessment of potential stormwater retrofit sites where low-impact development (LID), green infrastructure (GI), and/or runoff reduction could be implemented throughout the Town of Woodbury to address these requirements and identify potential projects to enable the Town to meet its DCIA reduction goals. The Town is required to track and prioritize the removal of 1% of its Directly Connected Impervious Area (DCIA) Town-wide in years four (4) and five (5) of the permit, or 2% overall disconnection of DCIA by year five (5), to the Maximum Extent Practicable, with a continuing goal of one percent per year thereafter. DCIA is the impervious area that contributes stormwater directly into a waterbody or into stormwater drainage infrastructure that discharges to a waterbody.

Based on the DCIA analysis conducted in January, 2019, the DCIA disconnection goal for the Town is approximately 3.8 acres by the end of the 5-year permit, or 1.9 acres per year in Years 4 and 5. Implementing retrofit projects will improve or protect water quality by reducing pollutant loads to receiving waters; such projects may also increase flood resiliency by reducing runoff volumes and peak flows.

The terms stormwater retrofit, LID, and green infrastructure all refer to systems and practices that reduce surface water runoff through the use of vegetation, soils, and natural processes to manage water and create healthier urban and suburban environments (EPA, 2014). Stormwater retrofits can include a variety of stormwater management practices such as bioretention, engineered wetland systems, permeable pavement, green roofs, green streets, infiltration planters, tree boxes, and rainwater harvesting. These practices capture, manage, and/or reuse rainfall close to where it falls, thereby reducing stormwater runoff and keeping it out of drainage systems and receiving waters.

In addition to reducing polluted runoff and improving water quality, stormwater retrofits can improve flow conditions in streams and rivers by infiltrating water into the ground, thereby reducing peak flows during wet weather and sustaining or increasing stream base flow during dry periods, which can be important for aquatic habitat and fisheries. When applied throughout a watershed, stormwater retrofits can help mitigate flood risk and increase flood resiliency. At a smaller scale, stormwater retrofits can also reduce erosive velocities and streambank erosion.

Finally, stormwater retrofits have been shown to provide other social and economic benefits relative to reduced energy consumption, improved air quality, carbon reduction and sequestration, improved property values, recreational opportunities, overall economic vitality, and adaptation to climate change.

2. Methods and Findings

Development of the stormwater retrofit plan consisted of three major tasks:

1. **Screening-level assessment** to quickly identify areas within the community with the greatest feasibility for and potential benefits from stormwater retrofits to reduce DCIA,
2. **Field inventories** of the most promising stormwater retrofit opportunities identified from the screening step,
3. **Stormwater retrofit concept designs** for selected retrofit sites, including anticipated reductions in DCIA and planning level costs.

This retrofit plan documents the methods and findings of the screening-level assessment, as well as field inventories and concept designs for selected retrofit sites.

2.1 Site Screening Evaluation

Sites were selected and analyzed using Geographic Information System (GIS) mapping and associated geospatial data and aerial imagery. GIS allows for rapid evaluation of specific land-based attributes that are important for assessing the feasibility of stormwater retrofit practices. The assessment used the following site evaluation criteria[1] and data sources.

- **Land Ownership** – Publicly-owned (e.g., municipal) sites are most favorable because they avoid the cost of land acquisition and provide direct control over stormwater retrofit construction, maintenance, and monitoring by the municipality. Both parcel-specific practices and linear BMPs in municipal right of ways or easements were considered. Other publicly-owned sites such as schools and state-owned property (road right of ways, parks, etc.) are also potential stormwater retrofit candidates.

  An initial list of Town-owned buildings and parcels was generated in conjunction with the Town's Land Use/Planning and Public Works departments. Additionally, open space GIS data was utilized to identify State and Town-owned parks, which were incorporated into the Town-owned facility parcel data.

- **Priority Area –** Under the MS4 Permit, the Town's "Priority Area" includes the urbanized area, local basins with DCIA greater than 11%, and areas that discharge directly to impaired waters. Woodbury does not have any CTDEEP-mapped local basins with DCIA greater than 11%; therefore the Town's Priority Area consists of the urbanized area and the local basin associated

[1] Other site-specific factors such as land area, impervious area, drainage area, subsurface utilities, subsurface contamination, and storm drainage system capacity are also important considerations for stormwater retrofits.

with the impaired Weekeepeemee River (**Figure 1**). Locations within or immediately adjacent to the Priority Area were given preference when identifying potential retrofit sites.

- **Subsurface Conditions** – Subsurface conditions are key considerations for infiltration-based stormwater retrofits. Soil infiltration capacity, depth to groundwater, depth to restrictive layers (bedrock, dense till), soil bulk density, and inundation of soils due to flooding are important soil-based characteristics that can affect the feasibility of infiltration-based stormwater retrofits. For the purposes of this screening evaluation, Natural Resources Conservation Services (NRCS) soil classifications and the Soil Survey Geographic (SSURGO) database were used to initially assess the feasibility of infiltration practices at a given site. The following describes the soils criteria used in the evaluation:

    - Drainage Class – The soil drainage classes, as defined by the NRCS, "refer to the frequency and duration of wet periods in conditions similar to those under which the soil formed." NRCS has mapped the soil drainage classes ranging from "excessively drained" to "very poorly drained."

    - Hydrologic Soil Group – Hydrologic Soil Groups (HSGs) mapped by the NRCS provide an initial estimate of infiltration rate and storage capacity of soils on a site. Group A soils have the lowest runoff potential (highest infiltration rates) and Group D soils have the highest runoff potential (lowest infiltration rates) when thoroughly wet. Soils with higher infiltration capacities are generally better suited for stormwater retrofits. HSG mapping provides an initial estimate of infiltration potential; field investigations are necessary to verify soil conditions for final feasibility determinations and design purposes.

- **100-Year Floodplain** – Practices installed within the 100-year floodplain are more likely to fail due to inundation during large floods. For this screening-level analysis, sites outside the 100-year floodplain were given preference wherever possible.

- **Impervious Cover** – Water quality impacts are known to occur in surface waters within drainage basins that have a high degree of impervious cover due to changes in watershed hydrology and pollutant sources that result from development of the landscape with hard surfaces. Sites with higher amounts of impervious cover generate more runoff and have greater potential for runoff reduction through the use of stormwater retrofits. Further, as the purpose of this MS4 Permit requirement is to develop a list of priority projects to meet the Town's DCIA disconnection goal, areas with a high degree of development and impervious surfaces (i.e., existing DCIA) were considered high priority for stormwater retrofits.

- **Prior Planning** – The site screening also considered previous planning efforts. The Pomperaug River Watershed Based Plan (Fuss & O'Neill, 2019) was reviewed for any recommendations that would result in disconnection of DCIA in Woodbury. The Town's 2015 "Creating a Sustainable Main Street" Sustainable Design Assessment Team (SDAT) report was also reviewed to ensure that retrofit recommendations would dovetail with other sustainability planning initiatives and future long-term visions for Woodbury's public parcels.

The site screening process described above was performed by applying each of the screening criteria in succession to identify areas where favorable conditions overlapped. Additional input from the Town was obtained relative to:

- planned capital improvements
- existing drainage systems
- available space relative to existing utilities/septic systems

2.2 Site Screening Results

A total of 30 sites were identified from the GIS-based screening evaluation (**Figure 1; Table 1**). This list included 14 Town-owned properties, 15 potential opportunities in Town right of way, and one privately-owned parcel of protected land. The list of sites was provided to the Town for review and comment before proceeding with the field investigation. Comments on the proposed sites were also obtained from the Pomperaug River Watershed Coalition. The comments provided information to further inform focus areas within the sites and preferred BMP types for various sites, but did not change the overall site list.

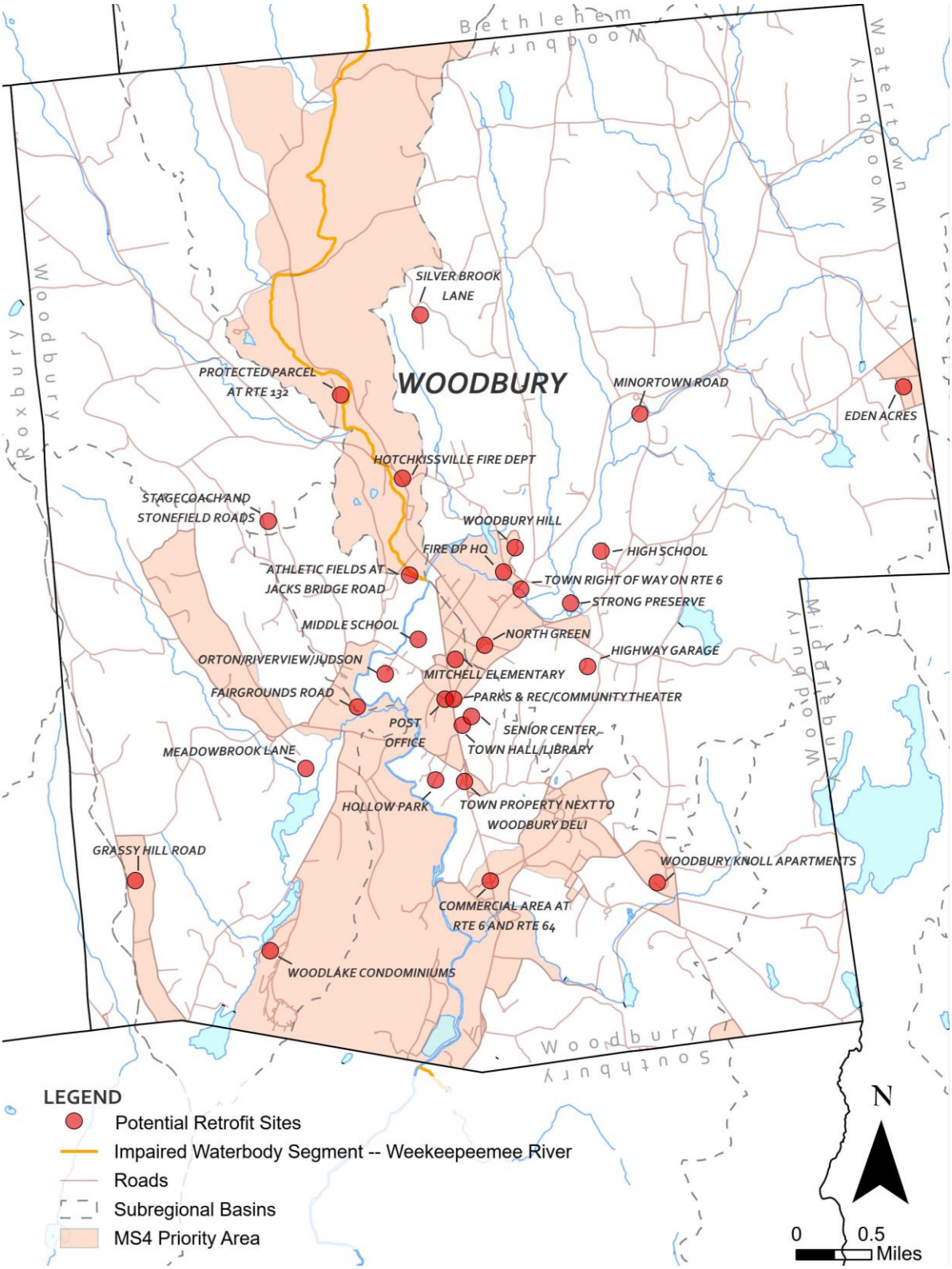


Figure 1. Map of potential retrofit sites selected for assessment in the Town of Woodbury.

Table 1. Potential retrofit sites and initial recommendations.

Woodbury Potential Stormwater Retrofit Sites					
	Site Number	Site Name	Hydrologic Soil Group	Priority Area	Initial Retrofit Recommendations
Town-Owned Properties	1	Athletic fields @ Jacks Bridge Road	A/B	yes/no	Implement recommendations from Pomperaug River Watershed Plan. Consider additional linear bioretention area between Washington Road and upper parking lot.
	2	Fire HQ (Orengug Fire Company)	A/B	yes	Not a priority site for GI retrofits. This site could be pursued, but both outfalls appear to have ample room to infiltrate in the floodplain with substantial buffer to the river. This site would not have significant DCIA or runoff/ pollution reduction value.
	3	Hollow Park	A/B (some C)	no (adjacent)	Consider paving upper parking area to prevent gravel movement. Install concrete sediment trap at corner where gravel washout accumulates; overflow to vegetated basin or swale along fenceline if irrigation line allows sufficient space. Linear bioretention at downgradient edge of upper parking lot to spread flow and prevent erosion/gullying.
	4	High School	A/B	no	Treatment stormwater BMP present at west edge of school-- confirm that this receives all stormwater from the school's catch basins and that maintenance is being performed to ensure full function. Install rain garden as demonstration system at front of building adjacent to greenhouses with surface swale to overflow to existing catch basin. At southwest corner of existing front entry drive/courtyard, install sinuous swale with checkdams among existing native plantings to reduce erosion and sediment transport into downgradient catch basin.
	5	Middle School	A/B	no (adjacent)	Site has 5 large drywells existing in lawn along Washington Ave and additional dry wells in field north of the school. Per Region 14 employee, these receive runoff from a majority of the parking area and roof leaders before overflowing to Town stormwater system. Other portions of parking area and driveways surface flow to surrounding grass and woodlots. Site impervious area is largely disconnected; no additional recommendations at this time.
	6	Mitchell Elementary	A/B	yes	Vegetated swales at edge of parking areas along length of School Street and Washington Ave. Utilize triangular areas of existing parking islands for treebox filters. Redirect roof leaders to narrow linear rain gardens on either side of entrance at south side of building. Create two large rain gardens joined by surface swale in lawn along Washington Ave to receive runoff from upper and lower parking areas. Install rain garden at north edge of building to receive roof runoff. Replace catch basin in maintenance access area with infiltrating catch basin.
	7	Senior Center	C	yes	Senior Center drainage is connected to a large retention basin. Site impervious area is largely disconnected; no additional recommendations at this time.
	8	Town Hall/Library complex	A/B	no (adjacent)	Redirect roof runoff from Boyd building to rain garden/bioretention areas in lawn area to the North of building, utilizing existing catch basins as overflow. Partner with Pomperaug Valley Garden Club for maintenance. Consider vegetated swale and curbcuts along north driveway if buried electrical does not conflict. Consider linear bioretention in grassed area between Main Street and sidewalk. Increase maintenance of existing catch basins, particularly in upper lot; correct erosion from hill to limit sediment transport. Consider replacing existing catch basins with infiltrating catch basins. Determine status of existing 1000 gallon aboveground storage tank; dispose if no longer in use. Determine parking needs for lot north of dog pound. Convert parking spaces in downgradient corner to bioretention to reduce and disconnect parking lot impervious area.
	9	Hotchkissville Fire Department	A/B	no (adjacent)	If lot is repaved in the future, it could be regraded to slope toward Quassak Road. Existing grass/tree area could be modified to create bioretention.
	10	North Green (6 @ 47)	A/B	yes	Series of rain gardens linked by surface swales along Main Street to integrate with treed landscape; curbcuts/grading to direct water off of Main Street to BMPs. Buried electrical for tree lighting may need to be re-routed. Larger rain garden with sediment forebay at corner of Main Street and Pleasant Street to address existing erosion at catch basin. Swale with check dams on east side of Green Circle.
	11	Town properties in front of Post Office and adjacent green space at church property (Judson/Main Street/Washington)	A/B	yes	Install vegetated swale between Main Street and side walk, with curb cuts to direct flow from Main Street into swale. Regrade grass edge at corner of Judson and Main to eliminate grass berm and allow stormwater to flow into tree-lined open space. Consider bioretention basin in natural depression at south end of the church property.
	12	Highway Garage	A/B (east side), D (west side)	no (adjacent)	Consider bioretention on east side of Ash Swamp Rd at intersection with White Deer Rock Road to intecept runoff from White Deer Rock Rd and out of Highway Garage driveway. Increase vegetated buffers between Highway Garage operations and stream. Increase containment measures to prevent erosion and transport of material from stockpiles.
	13	Strong Preserve	A/B (some D)	no (adjacent)	Not a recommended site for GI retrofits due to steep slope and inadequate space.
	14	Parks and Recreation Department/Community Theater	A/B	no	Direct roof leaders from both buildings to bioretention basin/rain garden in lawn South of Parks & Rec offices along Mountain Road. Vegetated swale with check dams along edge of Community Theater parking area and west edge of Theater building to intercept road/parking area runoff and roof leaders and slow flow before it traverses the steep slope down to Main St. Consider replacing existing catch basins with infiltrating catch basins.
Right of Way Opportunities	15	Town property at end of Meadowbrook Lane	A/B	no	Install bioretention just upgradient of existing stormwater outfall to infiltrate and treat existing discharge. Consider locating near forest edge currently dominated by invasives to maintain appearance of lawn, but maintain some buffer from forest to avoid having invasives overwhelm the basin.
	16	Town property at end of Fairgrounds Road	A/B	yes	Replace existing catch basin at cul-de-sac with infiltrating basin/dry well.
	17	Town property adjacent to Woodbury Catering & Deli	A/B	no (adjacent)	Not a recommended site for GI retrofits due to steep slope and inadequate space.
	18	Minortown Rd @ Minortown Rd Extension	A/B	no	Not a recommended site for GI retrofits due to steep slope and inadequate space.
	19	Commercial Center at 6 & 64	A/B	yes	Large bioretention basin at natural depression in extended ROW at northeast corner of Rtes 6 and 64; curb cuts from both roadways and grate under sidewalk. Series of bioretention practices at locations along Rte. 6 between Rte. 64 and Middle Quarter Road. Some BMPs may require partnership with adjacent businesses.
	20	Orton Lane/Judson/Riverview Lane	A/B	no (adjacent)	Crescent shaped-bioretention/rain garden in existing cul-de-sac island to intercept existing stormwater pipe; curb-cuts to receive surface runoff from circle.
	21	Woodbury Knoll Apartments	mostly A/B; some C and D	yes	Not a recommended site for GI retrofits due to limited ability to disconnect impervious area.
	22	Silver Brook Lane	A/B	no	Linear bioretention immediately northeast of double outfall located at northmost curve on Plumb Brook Lane; buried utilities appear to be constrained to south edge of road.
	23	Stagecoach and Stonefield Roads	A/B	no	Bioretention/rain garden in existing cul-de-sac island on Stonefield Road to intercept existing stormwater pipe. Add curb cuts to receive surface runoff.
	24	ROWs in vicinity of The Gardens (private nursery)	A/B	yes	Convert lower (gravel) portion of triangle at Rte. 6 and Scratchville Road to bioretention. Bioretention at both corners of intersection of Rte. 6 and Middle Road Turnpike.
	25	Eden Acres	C/D	no	Bioretention at corner of Quassapaug Road and Edward Ave and corner of Quassapaug Road and Soucy Road. Soils testing necessary to confirm infiltration potential. Per Pomperaug Watershed Plan, ensure that wetland limits have been respected throughout neighborhood. Note that there are known septic problems at this location.
	26	Woodbury Hill Neighborhood	A/B	yes	Confirm whether these are Town-maintained roads or private. Potential for bioretention in natural depression near corner of Quassuck Road and northern intersection with Woodbury Hill Road.
	27	Woodlake Condominium Complex	A/B	yes	Linear bioretention along main drive north of gazebo, using existing catch basins as overflow structures. Consider replacing catch basins upgradient of outfalls near the pond with infiltrating catch basins.
	28	Woodbury Post Office	A/B	yes	Bioretention basin on south side of post office lawn to intercept water along existing flow path (informal swale); overflow to existing catch basin on Judson Ave.
	29	Upper Grassy Hill and Grassy Hill Roads	Mostly C, some D	yes	Bioretention basins with sediment forebays at southeast corner of intersection of Upper Grassy Hill Road and North Road and southwest corner of intersection of North Road and Grassy Hill Road. Apparent stormwater basin observed at south side of Carriage Lane; confirm and adjust initial DCIA accordingly if this system is offline.
Protected Land	30	Protected Parcel @ Rt. 132/ Weekeepeemee Road east of Paper Mill Road	A/B	yes	Not a recommended site for GI retrofits due to steep slope and inadequate space.

3. Field Inventories, Site Selection, and Conceptual Designs

3.1 Field Inventories

Field visits were conducted of the selected sites on April 15 and April 20, 2020. The sites and adjacent street areas were walked and visually inspected for potential stormwater retrofit opportunities (i.e., impervious surfaces connected to the on-site drainage system, available green space to accommodate new stormwater retrofits, and drainage features that could be enhanced or improved) and physical site characteristics such as site configuration, drainage patterns, current use, slope, landscaping, subsurface utilities, design complexity, and maintenance access considerations. Field notes on potential stormwater retrofit sites were recorded using the "Retrofit Reconnaissance Investigation" forms developed by the Center for Watershed Protection. Site photographs were taken to document site conditions/drainage features/etc.

The primary types of stormwater retrofits considered generally included:

- Bioretention/bioswales, including roadside bioswales or linear bioretention.
- Tree boxes and tree planting (primarily streetscape applications)
- Infiltrating catch basins

The following were not considered due to concerns expressed by the Town regarding their internal maintenance capabilities with available labor and equipment:

- Belowground infiltration systems, or linear infiltration systems.
- Permeable pavement (sidewalks, on-street and parking lot parking spaces, and low-traffic areas).

3.2 Sites Selected for Concept Designs

Based on the findings of the field inventories, potential stormwater retrofit opportunities were identified at 22 of the sites visited (see **Table 1** for potential retrofit suggestions); of these, 12 were presented to the Town as being among the stronger candidate sites. The list was further narrowed down with input from the Town Planner, DPW Director and Pomperaug River Watershed Coalition to select five top priority sites for further development of concept designs. These sites were selected because they: (1) have the greatest feasibility for stormwater retrofits, (2) provide the best opportunities to infiltrate (i.e., reduce) or filter runoff and reduce DCIA, and (3) were considered the most likely candidates for implementation by the Town. Many of the sites are also in highly visible, public locations and therefore provide good demonstration value. The five sites are listed in **Table 2** with a summary of the proposed retrofit elements, estimated costs, and associated DCIA reduction.

Table 2. Sites selected for development of stormwater retrofit design concepts.

Site Name	Stormwater Retrofit BMP Type	Project Cost Estimate[1]	Estimated DCIA Reduction
Mitchell Elementary	• Vegetated Swales • Rain Gardens • Tree Box Filters • Infiltrating Catch Basin	$169,000	1.87 acres
Town Hall/Library Complex	• Bioretention/Rain Gardens • Vegetated Swale • Improved Catch Basin Maintenance[2] • Pavement Removal	$24,000	0.20 acres
North Green	• Integrated Rain Gardens/Seating Areas • Vegetated Swale with Check Dams	$86,000	0.87 acres
ROW on Rte 6 and Scratchville Road	• Bioretention	$61,000	0.72 acres+
Woodbury Post Office and Adjacent Properties	• Bioretention • Vegetated Swale	$44,000	0.41 acres
TOTAL		**$384,000**	**4.07 acres**

[1] Planning level opinion of cost. Includes estimated costs for engineering design, permitting, and construction. Excludes operation and maintenance costs.

[2] Not included in cost estimate.

3.3 Design Concepts

Stormwater retrofit design concepts were prepared for the selected sites. The design concepts reflect opportunities for infiltration and/or water quality treatment at each site. Opportunities were also evaluated to manage additional runoff from on-site and off-site drainage areas. BMPs were sited and sized to meet the water quality and DCIA disconnection requirements contained in the MS4 Permit: sites that are currently developed with 40% or more DCIA must retain on-site one-half of the Water Quality Volume (WQV) for the site; sites with less than 40% DCIA must capture and infiltrate/treat the full 1-inch Water Quality Volume (WQV). At most of the selected sites, there is sufficient physical space to build a practice that would treat larger storms. Given the increasing frequency of heavy precipitation events associated with climate change impacts, the Town may wish to consider taking advantage of available space to implement retrofit designs with additional treatment capacity to manage additional flow/accommodate larger storms and thereby address other goals such as increasing flooding resilience and climate resilience. Note that this approach would increase implementation costs, although these increases are often more favorable than a 1:1 ratio of increased size to cost due to economies of scale.

The retrofit design concepts, including planning-level costs and estimated reduction in DCIA, are presented on the following concept sheets. Each concept sheet includes a general site description, the proposed retrofit concept, field images, example images of similar completed retrofit opportunities (where available) or typical details of recommended BMPs. Sizing calculations for the recommended practices are provided in **Attachment A**.

Preliminary, planning-level costs were estimated for the site-specific concepts based upon unit costs derived from published sources, engineering experience, and the proposed design concepts. A 30% contingency is used to account for the costs of design and permitting. A more detailed breakdown of estimated costs, including operation and maintenance costs and total annualized costs based on the anticipated design life of each practice, is provided in **Attachment B**. Final costs will be determined during the design phase, and must take into consideration more detailed, site-specific data gathering, especially related to soils and the location of utilities.

The stormwater retrofit concepts presented in this retrofit plan provide potential on-the-ground projects for future implementation. They also serve as examples of the types of projects that could be implemented at similar sites throughout the Town. It is important to emphasize that these design concepts are not detailed designs and that further evaluation will be necessary to determine the ultimate feasibility of these designs, as well as conduct full design and permitting for these and similar site-specific concepts.

Mitchell Elementary School
Vegetated Swales, Rain Gardens, Tree Box Filters, and Infiltrating Catch Basin
14 School Street, Woodbury, Connecticut

Site Description

Mitchell Elementary School is a Town-owned school serving the children and families of Woodbury. The property is located at the intersection of School Street and Washington Avenue, in downtown Woodbury. Parking areas are located adjacent to both streets. Buried roof leaders from the west side of the main building roof outlet into the grass into a natural depression.

Proposed Concept

- Install a vegetated swale in the grassed area between Washington Avenue and School Street and the adjacent main parking area. Remove the curbing from this section of parking lot to allow sheet flow into the swale. Raise existing catch basin structure(s) to serve as an overflow. The swale can be designed as an aesthetic feature to provide interest and screening from the roadway, or planted with grass and mowed for a low-maintenance solution.
- A pair of rain gardens connected by a short swale are proposed for the north lawn along Washington Avenue. The northern, upgradient rain garden will receive surface runoff from the north parking area via a curbcut and short swale under the existing wood fence/guard rail. From the upgradient basin, a swale will carry overflow into a second rain garden, skirting around the existing large tree. The second rain garden will be designed to exaggerate the existing natural depression in the site topography where buried roof leaders from the west side of the building already outlet into the grass. The existing downgradient catch basin on Washington Avenue will be used as an overflow structure. In addition to stormwater benefits, the rain gardens will provide aesthetic interest at the school and serve as a potential curricular element for student education.
- Two tree box filters are proposed in the existing parking islands to provide additional infiltration capacity, as well as shade for the main parking area.
- Three narrow, linear rain gardens are proposed—two of approximately 10 ft by 35 ft on either side of the doorway at the south building entrance, and one at the north side of the building to receive water from the roof leaders on the adjacent portions of the building.
- At the rear/maintenance entrance, the existing catch basin is proposed to be replaced with an infiltrating catch basin.
- As desired, basic rain garden maintenance activities (watering, pruning, and plant care) can be integrated with curricular programming.

Image 1 (Above): Approximate location of the proposed rain gardens and swales in the lawn along Washington Avenue.

Image 2 (Right): Approximate location of vegetated swale that wraps along Washington Avenue and School Street. Removal of the parking lot curb and curbcuts along the roadway will allow stormwater runoff to enter from both sides of the practice.

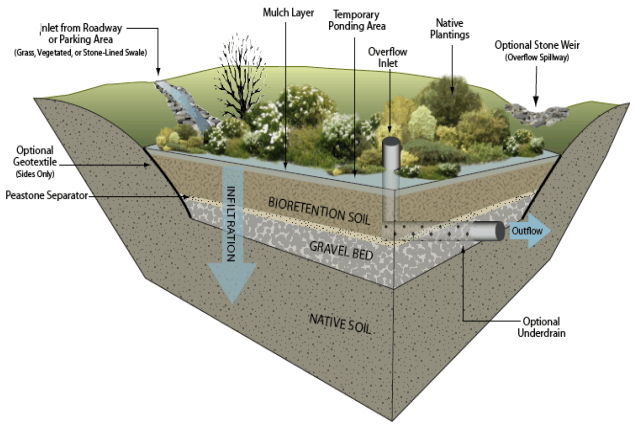


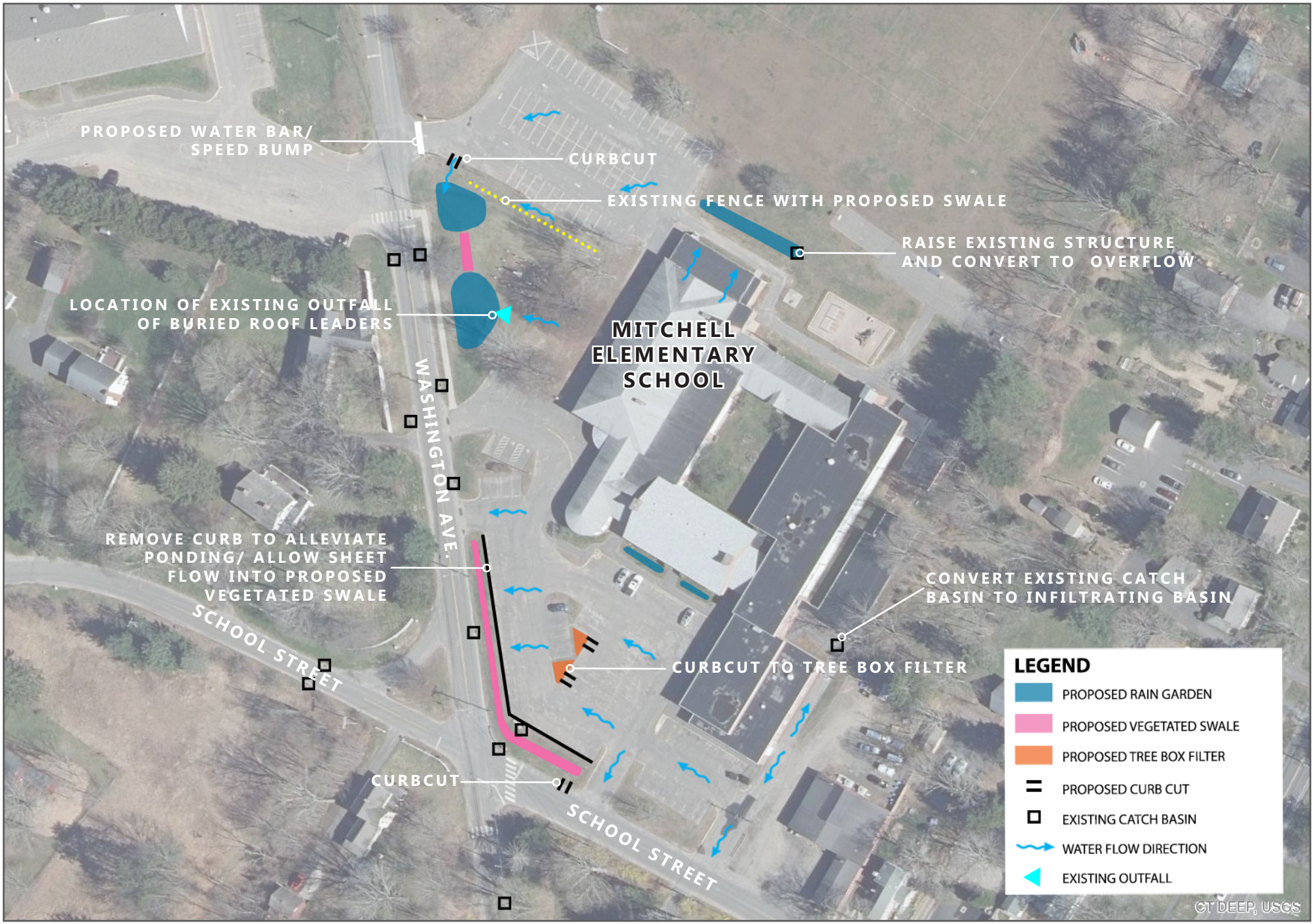
Image 3: Diagram of a typical bioretention basin.
Image source: MA Clean Water Toolkit.

Retrofit Concept Summary

Impervious Area Treated: 1.87 acres
Design Storage Volume: 5,999 ft^3
Runoff Capture Depth: 0.88 inches
Required WQV for Disconnection: 3,234 ft^3

Disconnected DCIA: 1.87 acres
Rain Gardens & Surface Swales: 0.91 acres
Tree Box Filters: 0.14 acres
Vegetated Swale Along Parking: 0.68 acres
Infiltrating Catch Basin: 0.14 acres

Estimated Cost: $169,000
Rain Gardens & Surface Swales: $78,000
Tree Box Filters: $18,000
Vegetated Swale along Parking: $52,000
Infiltrating Catch Basin: $21,000



MITCHELL ELEMENTARY SCHOOL, WOODBURY CT

0 25 50 100 Feet

N W E S

FUSS & O'NEILL
1550 Main Street, Suite 400
Springfield, MA 01103
413.452.0445 | www.fando.com

Town Hall/Library Complex
Rain Garden, Vegetated Swale, Pavement Removal
275 Main Street S., Woodbury, Connecticut

Site Description

Woodbury's municipal complex encompasses the Town Hall and municipal offices, Library, and Police Station, as well as access to Orenaug Park. The Senior Center is located further up the hill on a separate parcel but is accessed by the same main driveway. The site is highly developed with many site constraints, including utility connections and the presence of septic system components in many of the remaining open lawn areas. Two existing dry wells located in the grass on the north side of the main driveway already receive stormwater flows from the catch basins that drain several of the parking areas and most of the main driveway.

Proposed Concept

- To further disconnect impervious area on the site, stormwater runoff from portions of the site not yet receiving treatment will be directed to two practices on the north side of the site.
- A bioretention area or rain garden is proposed in the lawn north of the Boyd Building to receive redirected runoff from the buried roof leaders. Existing catch basins can be used for overflow. On-site signage indicates that members of the Pomperaug Valley Garden Club are already partnering with the Town to maintain plantings at other locations on the site. It is recommended that this partnership be expanded to allow the Town to create a rain garden feature with minimal maintenance burden for Town staff.
- A vegetated swale is proposed along the driveway at the north edge of the site to infiltrate runoff from the driveway exiting the police station. Roof runoff along the north edge of the library building appears to be already infiltrating into a gravel trench at the drip line.
- Increase maintenance of existing catch basins, particularly in the upper parking area leading to Orenaug Park. During site visits, several catch basins were observed to be clogged with sediment. Address upgradient erosion and stabilize slope to prevent excessive sedimentation of the stormwater structures.
- Determine the extent of parking needs/utilization in the small upper lot north of the dog pound at the top of the hill. Convert two to three parking spaces in the downgradient corner of the lot to bioretention to infiltrate stormwater where runoff already ponds during precipitation events. Consider pavement removal to decrease the impervious area. Determine the status of the existing 1,000 gallon aboveground storage tank; dispose if no longer in use.

Image 1: Existing 1,000 gallon aboveground storage tank and proposed area for bioretention at the upper parking lot. Field observations indicate that stormwater runoff currently ponds in this corner of the parking lot.

Image 2: Significant sediment accumulation at an existing catch basin at the upper end of the site indicates a potential erosion problem on the upgradient hillside.

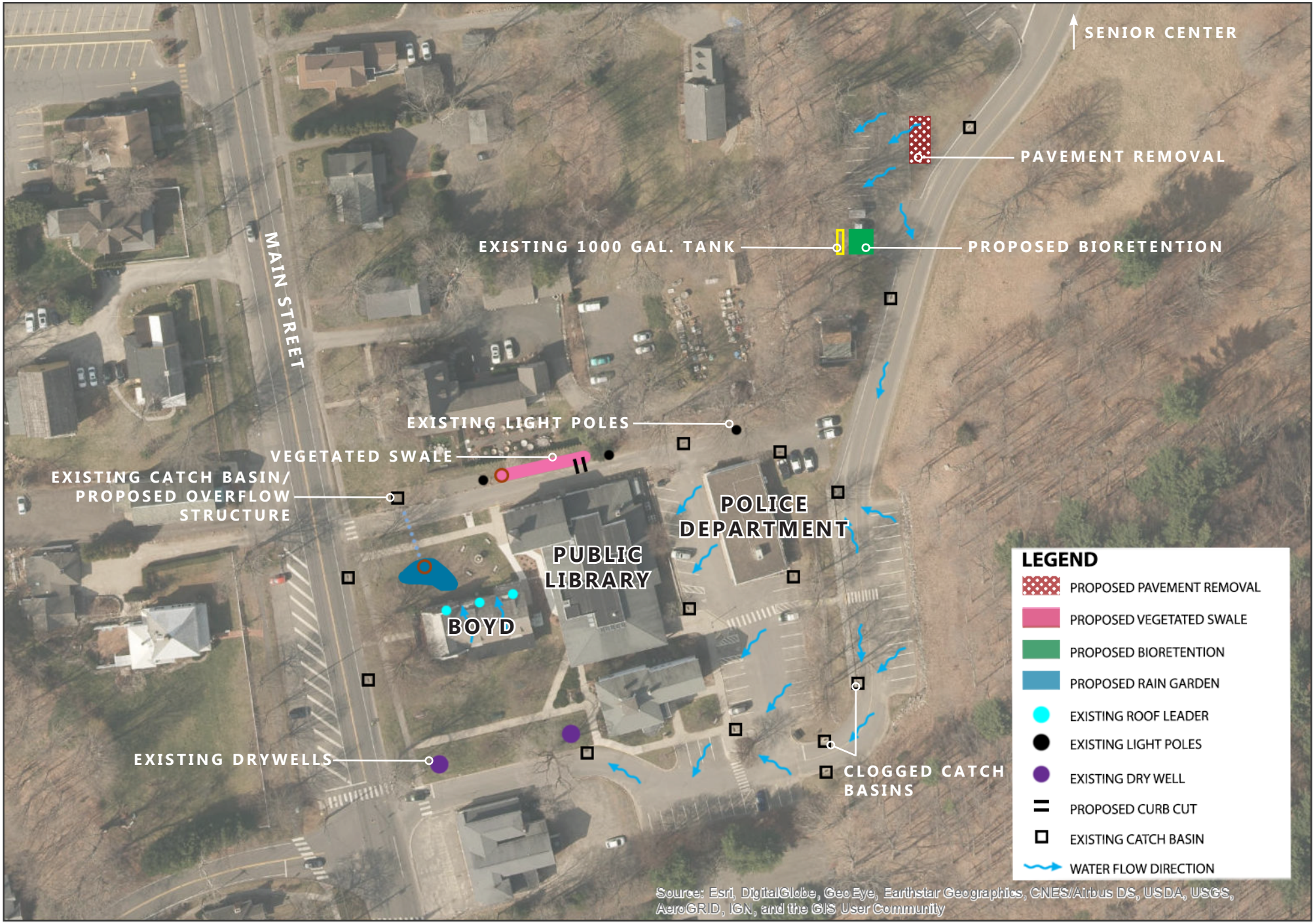
Image 3 (Right): Location of proposed vegetated swale along the north edge of the site. Note the evidence of ponding along the existing curb.

Retrofit Concept Summary

Impervious Area Treated: 0.20 acres
Design Storage Volume: 734 ft^3
Runoff Capture Depth: 0.94 inches
Required WQV for Disconnection: 369 ft^3

Disconnected DCIA: 0.20 acres
Bioretention Area, Upper Parking Lot: 0.08 acres
Pavement Removal, Upper Parking Lot: 0.01 acres
Rain Garden, North Lawn: 0.03 acres
Vegetated Swale: 0.08 acres

Estimated Cost: $24,000
Bioretention Area, Upper Parking Lot: $9,000
Pavement Removal, Upper Parking Lot: $3,000
Rain Garden, North Lawn: $4,000
Vegetated Swale: $10,000



TOWN HALL, WOODBURY CT

0 20 40 80 Feet

N W E S

FUSS & O'NEILL
1550 Main Street, Suite 400
Springfield, MA 01103
413.452.0445 | www.fando.com

North Green
Integrated Rain Gardens/Seating Areas, Vegetated Swale with Check Dams
Intersection of Main Street and Pleasant Street, Woodbury, Connecticut

Site Description

North Green is a triangular public green space at the intersection of Main Street and Pleasant Street, toward the north end of Woodbury. The space currently has a gazebo and some scattered benches. Trees frame the space, particularly along Main Street. The Town's 2015 Sustainable Design Assessment Team (SDAT) report has proposed more formalized café seating, food truck events, and other programming to make the space a more inviting gathering space.

Proposed Concept

- A series of rain gardens linked by shallow surface swales is proposed along Main Street; the stormwater features will be interwoven among the trees to create a cohesive landscape aesthetic and integrated with new seating to create dispersed, welcoming spaces throughout the North Green.
- Stormwater will be channeled into the rain gardens at the intersection with Pleasant Street, where a sediment forebay or pre-treatment structure is proposed to capture loose material coming off of the roadway (currently this material spreads through the grass at the north end of the green). The existing catch basin which is in poor condition will be replaced and raised to serve as an overflow structure at the north end of the rain garden system.
- A series of curbcuts along Main Street will allow stormwater runoff from the roadway to enter the rain garden system. If a new sidewalk is installed along Main Street, per the SDAT report, trenches in the walkway covered with ADA-compliant grates will allow water to be conveyed under the sidewalk and into the rain gardens. An existing catch basin in the grass at the south end of the green will be raised to serve as an overflow at the southern end of the system.
- A vegetated swale with check dams is proposed along the east edge of Green Circle to infiltrate and slow stormwater runoff coming down the slope before it overflows to the existing catch basin in the grass.
- The proposed stormwater concept maintains full access to Green Circle for food trucks or other event staging, as proposed in the SDAT report. The stormwater features will also accommodate a proposed café seating area adjacent to the gazebo. Existing electrical conduit for tree lighting will likely need to be relocated to accommodate the stormwater features.

Image 1: Example of an established bioretention basin with a concrete curb cut and concrete pretreatment structure to remove sediment before runoff enters the planted portion of the basin.

Image 2 (Above): Example of an established rain garden and swale system with integrated pathways.

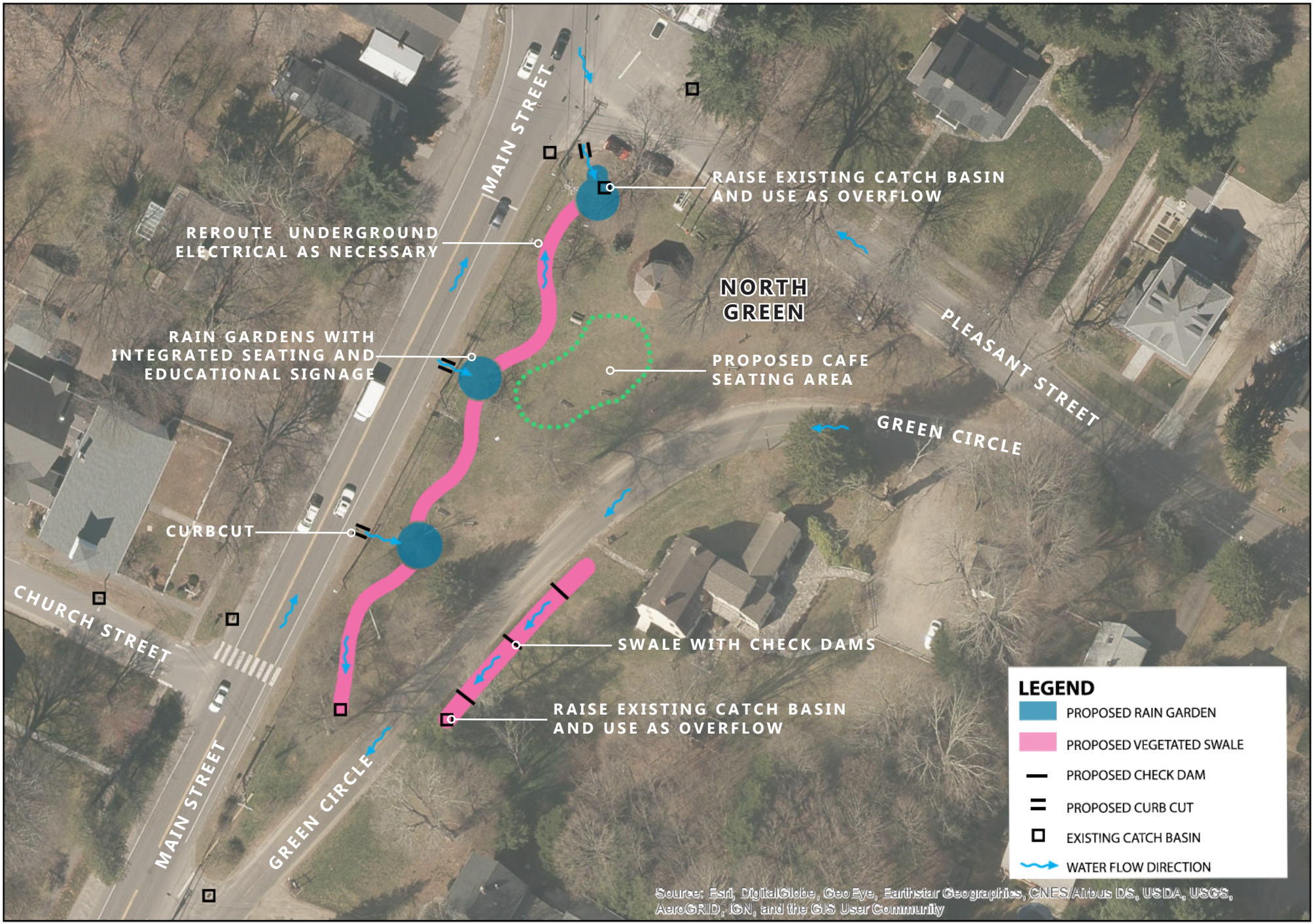
Image 3 (Right): Example of swale with check dams to slow and infiltrate water.

Retrofit Concept Summary

Impervious Area Treated: 0.87 acres
Design Storage Volume: 2,853 ft^3
Runoff Capture Depth: 0.91 inches
Required WQV for Disconnection: 1,523 ft^3

Disconnected DCIA: 0.87 acres
Rain Gardens & Surface Swales: 0.26 acres
Vegetated Swale with Check Dams: 0.61 acres

Estimated Cost: $86,000
Rain Gardens & Surface Swales: $68,000
Vegetated Swale with Check Dams: $18,000



NORTH GREEN, WOODBURY CT

0 15 30 60 Feet

N W E S

FUSS & O'NEILL
1550 Main Street, Suite 400
Springfield, MA 01103
413.452.0445 | www.fando.com

Town Right of Way
Bioretention Practices
Rte. 6, Middle Road Turnpike, and Scratchville Road, Woodbury, Connecticut

Site Description

Rte. 6 crosses the Nonnewaug River just north of Middle Road Turnpike. Stormwater outfalls are located along the east side of Rte. 6 on both the north and south banks of the river. Adjacent land uses include a large privately-owned nursery (The Gardens), agricultural land, Woodbury's main fire station, and several commercial establishments. At the intersection of Rte. 6 and Scratchville Road, stormwater flows down a steep slope, bypassing an existing catch basin as it flows toward the dirt road portion of Scratchville Road. Significant buildup of sand and sediment was noted during field evaluations in April, 2020.

Proposed Concept

- A bioretention area is proposed at the eastern-most, flat section of the triangle formed by the intersection of Rte. 6 and Scratchville Road. This area is currently neither paved nor vegetated and is itself a source of sediment, as well as a collection point for sand and other material that accumulates on the roadway. The proposed bioretention area will collect surface runoff flowing southward along Rte. 6 toward Scratchville Road.
- Bioretention areas are proposed on the east side of Rte. 6 on both the north and south sides of Middle Road Turnpike to collect and infiltrate stormwater runoff from the eastern half of the roadway, providing treatment before overflow is conveyed to the stormwater outfall on the south side of the Nonnewaug River.

Above: Existing conditions on Rte. 6 just north of Scratchville Road (looking South). Sediment and debris accumulation indicates ponding and bypassing of existing catch basin during high-intensity precipitation events.

Retrofit Concept Summary

Impervious Area Treated: 0.72 acres
Design Storage Volume: 2,491 ft^3
Runoff Capture Depth: 0.96 inches
Required WQV for Disconnection: 1,235 ft^3

Disconnected DCIA: 0.72 acres+
Bioretention area at Scratchville Road: 0.32 acres
Bioretention areas at
Middle Road Turnpike: 0.4 acres *

*Preliminary field information suggests that the existing stormwater drainage pipe network along Rte. 6 could be intercepted and directed into the proposed practice. This would increase the disconnection credit for DCIA, but may require increasing the size (and cost) of the BMPs.

Estimated Cost: $61,000
Bioretention area at Scratchville Road: $28,000
Bioretention areas at
Middle Road Turnpike: $33,000

Left: Proposed location of bioretention area at the northeast corner of Rte. 6 and Middle Road Turnpike.

Right: Bioretention basin under construction. The sediment forebay seen at bottom left of the image provides pre-treatment to minimize maintenance of the basin.

Far Right: A raised outlet structure conveys overflow to the storm drainage system.

TOWN RIGHT OF WAY, WOODBURY CT

0 25 50 100 Feet

N W E S

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1550 Main Street, Suite 400
Springfield, MA 01103
413.452.0445 | www.fando.com

Post Office and Adjacent Town Properties
Bioretention/Rain Garden and Vegetated Swales
1 Washington Avenue, Woodbury, Connecticut

Site Description

The Woodbury post office is privately owned, but the Town has reason to believe that the property owner would be amenable to partnering with the Town to develop a stormwater retrofit project at the site and in the adjacent Town-owned green spaces. The existing green space east of the post office green currently features several planting areas and mature trees. Within the post office green, existing surface stormwater flows have created an informal swale which cuts across the lawn to drain into the back-side of an existing catch basin.

Proposed Concept

- Formalize the existing pattern of stormwater runoff through the post office green along the informal, eroded swale. In the open lawn, add a bioretention area to allow time and space for stormwater infiltration. Use the existing catch basin as an overflow structure.
- At the intersection of Judson Avenue and Main Street, an elevated grass berm at the northwest corner currently deflects water out of the green space and westward along Judson Avenue. Regrade the grassed berm to allow sheet flow into the green space where stormwater can be captured in the natural depression of the topography, infiltrated, and taken up for use by existing trees and plantings.
- Install curb cuts and a shallow vegetated swale on the west side of Main Street between the roadway and the sidewalk.
- A natural depression at the south end of the church property north of the post office site may allow additional opportunity for bioretention/rain gardens. Consider a partnership with the property owners to utilize this space for stormwater retrofits.

Image 1: Grassed berm at corner of Judson Avenue and Main Street currently directs water around the green space and down Judson Avenue into the MS4.

Image 2 (Above): Proposed location of vegetated swale between Main Street and existing sidewalk. Curb cuts would allow stormwater to enter the swale from the roadway.

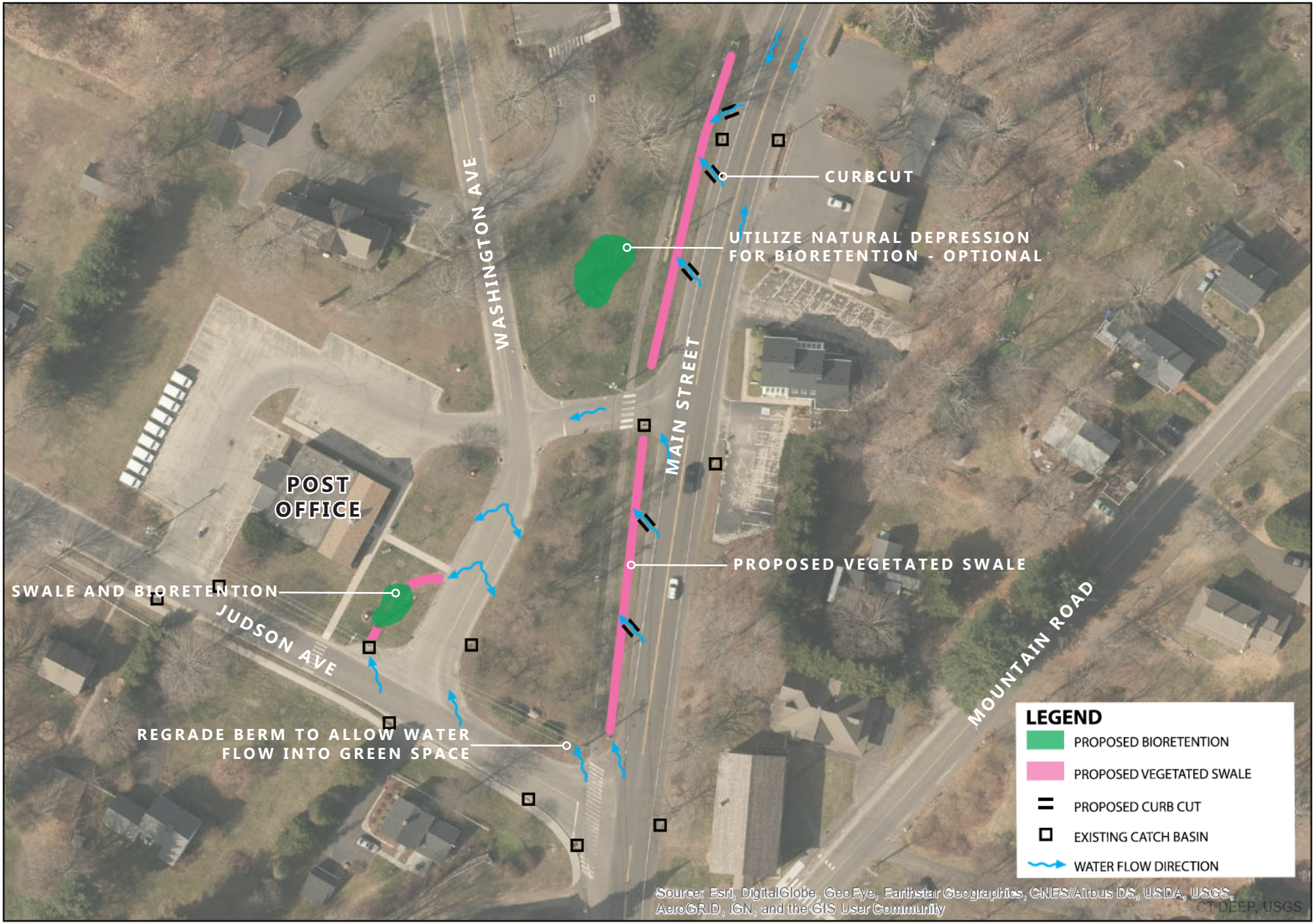
Retrofit Concept Summary

Impervious Area Treated: 0.41 acres
Design Storage Volume: 1,470 ft^3
Runoff Capture Depth: 1.0 inches
Required WQV for Disconnection: 706 ft^3

Disconnected DCIA: 0.41 acres
Vegetated Swales Along Main St: 0.31 acres
Bioretention: 0.1 acres

Estimated Cost: $44,000
Vegetated Swales Along Main St: $35,000
Bioretention in Post Office Green: $9,000

Image 3 and 4 (Above, Left): Examples of vegetated swale receiving roadway runoff via curb cuts.



POST OFFICE, WOODBURY CT

0 20 40 80 Feet

N W E S

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Springfield, MA 01103
413.452.0445 | www.fando.com

3.4 Retrofit Schedule

As noted above, based on Woodbury's initial DCIA analysis, the Town has a disconnection goal of approximately 3.8 acres by the end of the 5-year permit, or 1.9 acres per year in Years 4 and 5. Based on the estimated DCIA reduction associated with each of the proposed concept designs, the following schedule is proposed to meet these goals (**Table 3**).

Year 4

The retrofits at Mitchell Elementary are recommended as the initial Year 4 project because the resulting DCIA disconnection from the project is alone sufficient to meet the Town's Year 4 goal. The Mitchell Elementary school project also has the benefit of being highly visible, incorporating aesthetic elements that will enhance the school landscape, and providing a multitude of curricular opportunities along with quantifiable stormwater benefits.

Year 5

Similarly, retrofits at North Green serve multiple goals of stormwater management, MS4 permit compliance, and enhancement of a public green space to increase its aesthetic value and functionality for the community. The proposed retrofit concept was designed to integrate with other planning concepts for this space. As noted in the concept sheets, the estimated DCIA reduction associated with the proposed retrofit at the ROW on Rte. 6 and Scratchville Roads is assumed to be underestimated, as preliminary field information suggests that the proposed bioretention basins can be constructed to intercept flow from the existing stormwater drainage pipes on Rte. 6, which would increase the area treated and acreage of DCIA disconnected. Given this assumption, it is presumed that the North Green project and ROW project at Rte. 6 would collectively meet the Year 5 DCIA reduction goal.

Table 3. Proposed retrofit implementation schedule to meet DCIA disconnection goals.

Site Name	Proposed Installation Timeline	Estimated DCIA Reduction
Mitchell Elementary	• Year 4	1.87 acres
North Green	• Year 5	0.87 acres
ROW on Rte 6 and Scratchville Road	• Year 5	0.72 acres+
Woodbury Post Office and Adjacent Properties	• Year 6	0.41 acres
Town Hall/Library Complex	• Year 6	0.20 acres
TOTAL ACREAGE OF DCIA DISCONNECTED		**4.07 acres**

Year 6

Retrofits at the Post Office and Town Hall/Library Complex will result in smaller DCIA reductions per project. Notably, a large portion of the stormwater runoff from the Town Hall/Library complex already

receives treatment via two dry wells on site. Similarly, stormwater from the Senior Center up the hill from the Town Hall is directed into an on-site bioretention basin. Collectively, these practices treat approximately 1.75 acres of drainage area; however because these practices were installed prior to 2012 (the baseline year as specified in the MS4 Permit), the Town cannot take credit for the associated DCIA disconnection toward meeting its DCIA disconnection goal. Additional project recommendations from Table 1 can be further developed to meet the Year 6 disconnection goal and beyond.

3.5 Conclusion

Compliance with the Year 4 and Year 5 DCIA disconnection goals is proposed to be met through implementation of three retrofit projects, located at Mitchell Elementary; North Green; and a municipal right-of-way retrofit project at Rte. 6, Middle Road Turnpike, and Scratchville Roads. The recommended initial retrofit projects are estimated to cost approximately $316,000. A number of additional project recommendations have been identified through this retrofit plan that can be further developed into detailed project concepts as the Town continues to work toward meeting its DCIA disconnection goals.

Attachments: Attachment A: Retrofit Sizing Calculations
Attachment B: Planning Level Cost Estimates

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Attachment A

Retrofit Sizing Calculations

Retrofit Sizing Calculations

Retrofit Site	BMP Description	Contributing Drainage Area (Pervious and Impervious) (Sq Ft)	Impervious Cover in Drainage Area (Sq Ft)	DCIA (Acres)	Area of Proposed BMP (Sq Ft)	Water Quality Volume* (CF)	Design Storage Volume (CF)	%WQV treated	Runoff Capture Depth (inches)
Mitchell Elementary School	Rain Garden (Front Entrance)	3,556	3,556	0.08	70	282	286	102%	0.96
	Rain Garden (Western—Northern)	22,686	21,742	0.50	425	1,728	1,735	100%	0.96
	Rain Garden and Vegetated Swale(Western—Southern)	11,781	11,781	0.27	230	933	939	101%	0.96
	Rain Garden (Northern)	2,765	2,765	0.06	55	219	225	103%	0.97
	Infiltrating Catch Basin	7,072	6,170	0.14	36	492	374	76%	0.73
	Tree Boxes	6,121	6,121	0.14	200	485	280	58%	0.55
	Vegetated Swale (Parking Lot Island)	29,433	29,433	0.68	2,880	2,330	2,160	93%	0.88
North Green	Rain Gardens and Vegetated Swales	26,548	26,548	0.61	515	2,102	2,103	100%	0.95
	Vegetated Swale with Check Dams	23,677	11,266	0.26	1,000	944	750	79%	0.80
Post Office	Rain Garden and Vegetated Swale	8,011	4,256	0.10	90	353	368	104%	1.04
	Vegetated Swale(Northern)	6,995	6,995	0.16	740	554	555	100%	0.95
	Vegetated Swale(Southern)	6,395	6,395	0.15	680	506	510	101%	0.96
ROW	Bioretention Basin(RTE 6/Middle Rd Turnpike—North)	3,265	3,265	0.07	65	258	265	103%	0.98
	Bioretention Basin(Scratchville Rd)	17,880	14,060	0.32	280	1,129	1,143	101%	0.98
	Bioretention Basin(RTE 6/Middle Rd Turnpike—South)	13,664	13,664	0.31	265	1,082	1,082	100%	0.95
Town Hall	Bioretention Basin	3,694	3,694	0.08	75	292	306	105%	0.99
	Rain Garden	1,318	1,318	0.03	26	104	106	102%	0.97
	Vegetated Swale	3,667	3,667	0.08	360	290	270	93%	0.88
	Pavement Removal	3,694	653	0.01	653	52	52	100%	0.95

* As defined in the 2017 MS4 Permit, Water Quality Volume or WQV means the volume of runoff generated by one inch of rainfall on a site as defined in the Connecticut Stormwater Quality Manual.

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Attachment B

Planning Level Cost Estimates

Order of Magnitude Cost Estimates

Order of Magnitude Cost Range																	
Site Number	Location and BMP Type		Construction					Planning and Design		Cost Range			Life Cycle				
			Unit Cost	Unit	Adjustment Factor	Quantity	Base Cost	Allowance	Cost	Total Cost	-30%	50%	Lifespan (yrs.)	Annual Cost Over Lifespan	O&M (% Cost)	O&M ($/yr.)	Total Capitalized Cost/Year Over Lifespan
1	Mitchell Elementary	Tree Boxes	$6,744.00	EA	1.0	2.00	$13,488	30%	$4,050	$18,000	$13,000	$27,000	25	$1,150	4%	$50	$1,200
		Infiltrating Catch Basin	$15,690.00	EA	1.0	1.00	15,690	30%	$4,710	$21,000	$15,000	$32,000	20	$1,550	4%	$60	$1,610
		Rain Gardens (Front Entrance)	$12.31	CF design storage volume	1.5	286.00	$5,281	30%	$1,580	$7,000	$5,000	$11,000	20	$520	4%	$20	$540
		Rain Garden (Northern)	$12.31	CF design storage volume	1.5	225.00	$4,155	30%	$1,250	$6,000	$4,000	$9,000	20	$440	4%	$20	$460
		Rain Garden (Western—Northern)	$12.31	CF design storage volume	1.5	1735.00	$32,039	30%	$9,610	$42,000	$29,000	$63,000	20	$3,090	4%	$120	$3,210
		Rain Garden and Vegetated Swale (Western—Southern)	$12.31	CF design storage volume	1.5	939.00	$17,340	30%	$5,200	$23,000	$16,000	$35,000	20	$1,690	4%	$70	$1,760
		Vegetated Swale (Parking Lot Island)	$12.31	CF design storage volume	1.5	2160.00	$39,887	30%	$11,970	$52,000	$36,000	$78,000	20	$3,830	4%	$150	$3,980
2	North Green	Vegetated Swale with Check Dams	$12.31	CF design storage volume	1.5	750.00	$13,850	30%	$4,150	$18,000	$13,000	$27,000	20	$1,320	4%	$50	$1,370
		Rain Gardens and Vegetated Swales	$12.31	CF design storage volume	2.0	2103.00	$51,779	30%	$15,530	$68,000	$48,000	$102,000	20	$5,000	4%	$200	$5,200
3	Woodbury Post Office	Vegetated Swale (Northern)	$12.31	CF design storage volume	2.0	555.00	$13,665	30%	$4,100	$18,000	$13,000	$27,000	20	$1,320	4%	$50	$1,370
		Vegetated Swale (Southern)	$12.31	CF design storage volume	2.0	510.00	$12,557	30%	$3,770	$17,000	$12,000	$26,000	20	$1,250	4%	$50	$1,300
		Rain Garden and Vegetated Swale	$12.31	CF design storage volume	1.5	368.00	$6,796	30%	$2,040	$9,000	$6,000	$14,000	20	$660	4%	$30	$690
4	Right of Way on Route 6 and Scratchville Road	Bioretention Basin (Scratchville Rd)	$12.31	CF design storage volume	1.5	1143.00	$21,107	30%	$6,330	$28,000	$20,000	$42,000	20	$2,060	4%	$80	$2,140
		Bioretention Basin (RTE 6/Middle Rd Turnpike—Eastern)	$12.31	CF design storage volume	1.5	265.00	$4,894	30%	$1,470	$7,000	$5,000	$11,000	20	$520	4%	$20	$540
		Bioretention Basin (RTE 6/Middle Rd Turnpike—Western)	$12.31	CF design storage volume	1.5	1082.00	$19,980	30%	$5,990	$26,000	$18,000	$39,000	20	$1,910	4%	$80	$1,990
5	Town Hall/Library Complex	Bioretention Basin	$12.31	CF design storage volume	1.5	306.00	$5,651	30%	$1,700	$8,000	$6,000	$12,000	20	$590	4%	$20	$610
		Vegetated Swale	$12.31	CF design storage volume	2.0	270.00	$6,648	30%	$1,990	$9,000	$6,000	$14,000	20	$660	4%	$30	$690
		Rain Garden	$12.31	CF design storage volume	2.0	106.00	$2,610	30%	$780	$4,000	$3,000	$6,000	20	$290	4%	$10	$300
		Pavement Removal	$30.00	SY	1.0	73.00	$2,190	30%	$660	$3,000	$2,000	$5,000	20	$220	4%	$10	$230
									Total	***$384,000***	***$270,000***	***$580,000***					

Notes:
Rate of Inflation used = 2%
Interest (discount) rate used = 6%
Costs are based on screening-level evaluations of site characteristics and should be used for planning purposes only. Construction costs could vary significantly. Planning level opinion of costs include estimated costs for engineering design, permitting, and construction. Excludes operation and maintenance costs.
Quantities were determined through sizing calculations according to recommended formulas. BMP size may vary slightly on the concept sheets provided, as these images are provided for illustrative purposes only.
Cost formula and adjustment factors are based on EPA guidance: https://www3.epa.gov/region1/npdes/stormwater/ma/green-infrastructure-stormwater-bmp-cost-estimation.pdf
Unit Cost sources are as follows:
Bioretention/Rain Gardens/Swales: Mataleska, Karen, "MS4 Resource: BMP Cost Estimates" (2016). UNH Stormwater Center. 32.https://scholars.unh.edu/cgi/viewcontent.cgi?article=1031&context=stormwater
Tree Boxes: UNH Stormwater Center 2012 Biennial Report, adjusted based on professional judgement, inflation, and materials cost. https://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/docs/UNHSC.2012Report.10.10.12.pdf
Infiltrating Catch Basin: Wenck Associates--Middle Fork Crow River Watershed District, 2017. http://www.mfcrow.org/wp-content/uploads/2017/07/Final-MFCRWD-Water-Quality-Subwatershed-Assessment.pdf
Pavement Removal: MassHighway Weighted Bid Prices (All Districts) 5/2019-5/2020 "Old Pavement Excavation"https://hwy.massdot.state.ma.us/CPE/WeightedAverageBook.aspx