

Town of Randolph, Massachusetts
Water Quality Limited Waterbodies Requirements
*MS4 Permit Year 5
August 2023*

BMP RETROFIT SITE INVESTIGATIONS



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BMP RETROFIT SITE INVESTIGATIONS

Prepared by: BETA GROUP, INC.
Prepared for: Town of Randolph

August 2023

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1.0 INTRODUCTION

This memorandum is a follow-up to the previous report sent on June 30, 2022, entitled Nutrient Source Identification Report (NSIR) in accordance with the 2016 MS4 General Permit requirements to meet water quality standards for discharges to certain water quality limited waters subject to additional requirements, Section 2.2.2 and Appendix H. Under these requirements, all permittee-owned properties identified in the NSIR that are within the drainage area of the impaired water or its tributaries are required to be reviewed for feasibility to implement Best Management Practices (BMPs) that will reduce the frequency, volume, and pollutant loads of stormwater discharges to and from the Town's MS4 system. In addition, the Town is required to plan and install a minimum of one structural BMP as a demonstration project within the drainage area of water quality limited water (in this case both Nitrogen and Phosphorus) with high load potential by the end of Year 6 of the permit (June 30, 2024).

This NSIR identified a list of Town owned properties that potentially could be retrofitted. Since providing this list, BETA added 10 additional locations for a total of twenty-one sites considered in this investigation.

BETA conducted a site visit for each location in Table 1 below on July 5, 2023, to investigate suitability for BMP retrofit installation. Section 2 provides a summary for each site visited, including a site map with conceptual design elements and major observations made in the field, and a tabulated field investigation form with site photographs.

Based on field observations, photographs and other data collected, existing stormwater infrastructure data, and current site uses, BETA ranked the viable sites from highest (1) to lowest feasibility in carrying out a demonstration project within the next year. Rank is based on the calculated total potential nutrient load removal (in lb/yr) based on retrofit BMPs identified at each site. See Table 1 below.

Table 1 - Potential BMP Retrofit Locations

Ranking	Address	Within a or Tributary to Nutrient Impaired Watershed?	Potential BMPs	Access for Maintenance	Permitting Required	Total Potential Treatment Area (U.S. Acres)	Potential Phosphorus Load Removal (lb/yr)	Potential Nitrogen Load Removal (lb/yr)	Estimated Costs (Low to High)	Planned Retrofit Installation Date	Comments	
1	Elizabeth G. Lyons School	60 Vesey Road	Great Pond → Farm River	<ul style="list-style-type: none"> Infiltration Basin Subsurface Infiltration System 	Yes	No	19.73	11.48	170.17	\$287,100 – \$3,160,300	Future Redevelopment	The main opportunity is to install a subsurface infiltration basin for the roof drainage and two additional catch basins of stormwater infrastructure. Two other opportunities on the property to install infiltration basins: 1. Off Clark Street by existing drainage ditch in woods and 2. Off Beverly Circle in open space by baseball field to treat flow from infrastructure on Vesey Road and Beverly Circle.
2	Randolph Highway Department	4 Carlino Way	Glovers Brook → Cochato River	<ul style="list-style-type: none"> Subsurface Infiltration System 	Yes	Yes	10.73	9.27	138.40	\$231,700 – \$2,570,300	June 2024	Installation of a subsurface infiltration system in the open parking lot by eastern entrance to site is recommended. The system should be modified to exclude water from inlets entering the subsurface infiltration basin.
3	Joseph J. Zapustas Ice Arena	240 North Street	Glovers Brook → Cochato River	<ul style="list-style-type: none"> Infiltration Trench Subsurface Infiltration System 	Yes	Yes	6.03	3.75	47.13	\$93,800 – \$875,200	Future Redevelopment	Options include installing a subsurface infiltration system to treat upstream stormwater runoff from existing drainage infrastructure or to install infiltration trenches or filter strips adjacent to Glovers Brook to treat sheet flow from impervious parking lot.
4	Joseph J. Hunt Memorial Park	Corner of Pleasant Street and North Street	Glovers Brook → Cochato River	<ul style="list-style-type: none"> Infiltration Basin Infiltration Trench 	Yes	Yes	1.62	2.19	31.28	\$54,650 – \$581,000	Future Redevelopment	Retrofitting the existing drainage infrastructure on Pleasant Street that extends to the Randolph Housing Authority with the installation of an infiltration basin within the open space located west of the parking lot would provide the best opportunity for nutrient removal.
5	Cochato Camp House and Park	Near 40 Park Street	Glovers Brook → Cochato River	<ul style="list-style-type: none"> Infiltration Trench Infiltration Basin 	Yes	Yes	4.04	2.12	29.33	\$53,100 – \$544,800	Future Redevelopment	Modification to the existing stormwater infrastructure in the parking lot located off Allen Street by installing infiltration trenches with connection to infiltration basin is the recommended retrofit option.
6	Martin E. Young School	30 Lou Courtney Drive	Mary Lee Brook → Glovers Brook → Cochato River	<ul style="list-style-type: none"> Infiltration Trench Infiltration Basin Subsurface Infiltration System 	Yes	Yes	1.78	2.25	32.60	\$56,150 – \$605,400	Future Redevelopment	Demonstration project options include installation of an infiltration trench along back side of tennis courts or infiltration basin at edge of pavement within the rear parking lot on property. The other opportunity is to install a subsurface infiltration system to treat the roof drain stormwater.
7	JF Kennedy Elementary Jr High	20 Hurley Drive	Glovers Brook → Cochato River	<ul style="list-style-type: none"> Infiltration Trench 	Yes	No	2.16	2.09	30.03	\$52,350 – \$557,800	Future Redevelopment	Infiltration trench practices recommended throughout site, primarily along edge of pavement by school entrances. The other opportunity is for a bioretention rain garden in the grass inside the roundabout at the school entrance.
8	Open Space Adjacent to Great Pond	West of 300 Pond Street	Great Pond → Farm River	<ul style="list-style-type: none"> Subsurface Infiltration System 	Yes	Yes	0.46	0.21	3.03	\$5,300 – \$56,250	Future Redevelopment	Main opportunity is to convert existing northern most drain manhole on site into a leaching basin or subsurface infiltration system.
9	Woods at End of S. Windemere Avenue	South of 11 S Windemere Avenue	Lake Holbrook → Mary Lee Brook → Glovers Brook → Cochato River	<ul style="list-style-type: none"> Infiltration Basin 	Yes	Yes	0.96	0.47	7.02	\$11,850 – \$130,400	Future Redevelopment	Outfall located within Town easement at end of street within the woods. Roadway requires repair due to existing pothole at the dead end. Should the Town include this repair as a future Capital Improvement Project there is opportunity to formalize the wooded area into an infiltration basin.

Table 1 - Potential BMP Retrofit Locations

Ranking	Address	Within a or Tributary to Nutrient Impaired Watershed?	Potential BMPs	Access for Maintenance	Permitting Required	Total Potential Treatment Area (U.S. Acres)	Potential Phosphorus Load Removal (lb/yr)	Potential Nitrogen Load Removal (lb/yr)	Estimated Costs (Low to High)	Planned Retrofit Installation Date	Comments
---	Town Property Adjacent to Grove Avenue	Adjacent to 167 Pond Street									BETA personnel were not able to visit this site within Year 5 due to vegetation overgrowth. This facility will be included as part of the Year 6 investigations.
---	Open Space, Great Pond Water Dept. Land	North of 137 Oak Street									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.
---	Lokitis Conservation Area	Behind 28 Stoughton Street									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.
---	Margaret L. Donovan School	123 Reed Street									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.
---	Reed Street Apartments	Behind 20 Reed Street									BETA personnel were not able to visit this site due to ongoing construction in the area. This site will be included as part of Year 6 investigations.
---	Randolph Dog Park	East of 259 West Street									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.
---	Fin Fur Feather Conservation Area	Adjacent to 27 State Street									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.
---	Forest Area Across from St. Mary's Cemetery	Across from 18 Roycroft Drive									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.
---	Woodland off Root Street	Adjacent to 3 Root Street									Site deemed unviable for BMP retrofits due to high groundwater observed during the site investigation.
---	Tower Hill School	6 Adams Street									Appears as though the site is only used for school bus storage and there is only one catch basin on-site limiting opportunities available for BMPs at site.
---	Residential Neighborhood, Drain Culvert	Land adjacent to 72 Johnson Drive									BETA personnel were not able to visit this site within Year 5. This facility will be included as part of the Year 6 investigations.

2.0 BMP RETROFIT SITE INVESTIGATION FINDINGS

2.1 ELIZABETH G. LYONS SCHOOL

- The school property has space to recharge groundwater from the adjacent roadway stormwater infrastructure located west of the property.
- The main opportunity is to modify existing stormwater infrastructure to install a subsurface infiltration system to treat the roof drainage from the school and the two catch basins at the top of the system. This system can overflow into the existing stormwater structure if necessary.
- There are two opportunities for BMP retrofits at this location.
 1. The first opportunity is the installation of an infiltration basin to receive roadway stormwater runoff from a portion of Beverly Circle and Vesey Road. The basin would be located on the maintained open field along Beverly Circle. The drain manhole that connects to the school's stormwater infrastructure is shallow, which makes an infiltration basin a viable option for this location. An outlet control structure could be implemented to allow overflow to enter the school's existing infrastructure.
 2. The second opportunity is to modify the stream flowing along the north edge of the property into an infiltration basin. This infiltration basin would receive roadway stormwater runoff through outfall OF-435 from Clark Street, Green Street, and a portion of Essiembre Road and Orchard Street. The existing stream is deep, so the required storage capacity could be met by implementing an outlet control structure at the desired length of the stream with minimal alterations to the area.
- Implementing these BMP retrofits would help reduce the potential adverse impacts of stormwater roadway runoff that typically discharges through the Stetson Brook and into the Great Pond Upper Reservoir.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.
- Additional details are provided in Sections 2.2.1 and 2.2.2.

2.1.1 ELIZABETH G. LYONS SCHOOL SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Elizabeth G Lyons School
Address: 60 Vesey Road

Opportunity to modify the stream's swale into an infiltration basin to recharge the stormwater from outfall OF-435 at the northwestern corner of the property. An OCS can be added to overflow into the stream if necessary.

Opportunity to modify stormwater infrastructure to add a subsurface infiltration system in the parking lot to treat roof drainage and some surface stormwater on site. An overflow option can be added to overflow into the stormwater infrastructure if necessary.

Surface water flows into swale off of the roadway

12" RCP
Invert In: 34"

12" RCP
Invert In: 46"

8" RCP
Invert Out: 48"

Opportunity to modify stormwater infrastructure to add an infiltration basin in the maintained lawn along the western edge of the property. An OCS can be added to overflow into the stormwater infrastructure if necessary.

Map Legend

	Proposed BMP Retrofit Location		No Rating
	Existing BMP		A
	Catch Basin		A/D
	Drain Manhole		B
	Outfall		B/D
	Inlet		C
	Drain Pipe		C/D
	Private Drain Manhole		D
	Private Catch Basin		BMP Retrofit Catchments
	Hydrologic Connection		BMP Retrofit Area
	Open Water		
	Wetland		

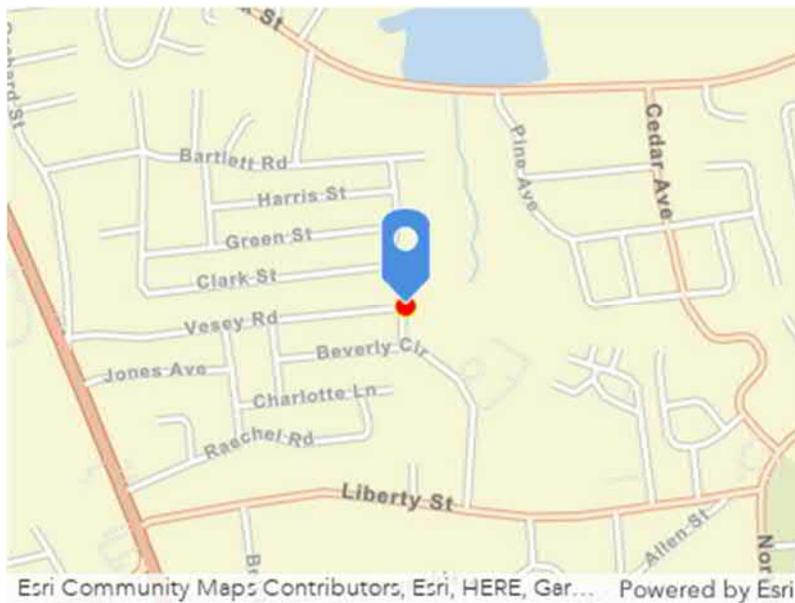
***MassDEP 2018/2020 Integrated List of Waters**

- Rivers: Category 4A
- Lakes, Estuaries: Category 4A
- Rivers: Category 4C
- Lakes, Estuaries: Category 4C
- Rivers: Category 5
- Lakes, Estuaries: Category 5

2.1.2 ELIZABETH G. LYONS SCHOOL BMP RETROFIT OBSERVATIONS FORM

Site Name:	Elizabeth G. Lyons School		
Address:	60 Vesey Road	Date/Time:	July 5, 2023 1:38 PM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 87 °F		

2.1.2.1 BMP RETROFIT LOCATION MAP



2.1.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A, B	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Infiltration Basin	If "Other":	
Site Observation Notes:	Two opportunities were identified at the elementary school. The first option is to install an infiltration basin off Clark Street where OF-435 exists. The second recommendation is to install an infiltration practice off an existing manhole located on Beverly Circle west of the school building within the open space by the baseball field.		

2.1.2.3 PHOTOS

	<p>Outfall off Clark Street discharges to drainage ditch. This ditch area could be retrofitted into a formalized infiltration basin with an outlet control structure.</p>
	<p>Shallow 4ft deep manhole on Beverly Circle. Opportunity to take the 8" RCP outlet pipe and daylight to open space located east of the road where a surface infiltration basin could be installed. See next photo.</p>



Open space off Beverly Circle is an ideal location for a BMP infiltration practice.

2.2 RANDOLPH HIGHWAY DEPARTMENT

- The Randolph Highway Department drainage infrastructure captures stormwater from a large impervious surface area for the entire property as well as the Amvets Post No. 51 facility and a section of the Randolph InterGenerational Center. The property's infrastructure also has inlets receiving stormwater from large catchment areas to the north and the west of the property.
- The main opportunity is to install a subsurface infiltration system in the open parking lot directly before outfall OF-92, which could include an overflow pipe entering the stream that outfall OF-92 discharges into. Depending on the water table level and the utilities within the proposed area, there may be limited space for the required storage volume so the Town should modify the existing stormwater structure to prevent the water from the north and west inlets entering the subsurface infiltration system.
- Sediment is often observed accumulating around the catch basin directly upstream from outfall OF-92. A water quality structure or other pretreatment structure could be installed before the proposed subsurface infiltration system to help mitigate sediment concerns and reduce future maintenance costs.
- Implementing these BMP retrofits would help mitigate the potential adverse impacts of stormwater runoff from the parking lots and roadways, promoting improved water quality and reduced nutrient loads entering Glovers Brook.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.
- Additional details are provided in Sections 2.1.1 and 2.1.2.

2.2.1 RANDOLPH HIGHWAY DEPARTMENT SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Randolph Highway Department
Address: 4 Carlino Way

Existing outfall has unknown upstream connectivity.

Opportunity to modify stormwater infrastructure to add a subsurface infiltration system in the paved eastern entrance of the property. The infiltration system can overflow into the stream from outfall OF-92. Connectivity should be modified to exclude the water from the inlets on the north and west edge of the property.

Existing catch basin has sediment build-up observed on pavement.

Existing fire hydrant and water infrastructure observed during field investigations.

Existing catch basin has unknown connectivity.

Map Legend

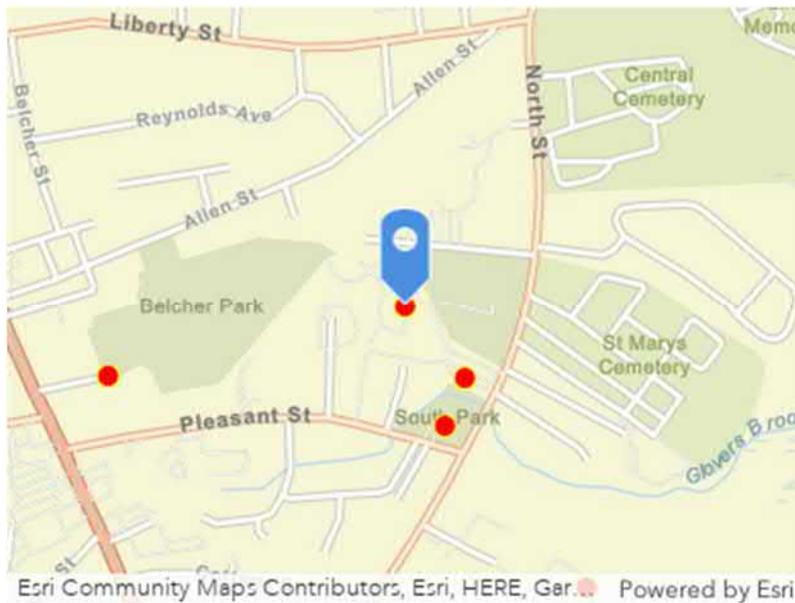
	Proposed BMP Retrofit Location
Stormwater Structures	
	Existing BMP
	Catch Basin
	Drain Manhole
	Outfall
	Inlet
	Drain Pipe
	Private Drain Manhole
	Private Catch Basin
Hydrography	
	Hydrologic Connection
	Open Water
	Wetland
	BMP Retrofit Catchments
	BMP Retrofit Area
Hydrologic Soil Group	
	No Rating
	A
	A/D
	B
	B/D
	C
	C/D
	D
*MassDEP 2018/2020 Integrated List of Waters	
	Rivers: Category 4A
	Lakes, Estuaries: Category 4A
	Rivers: Category 4C
	Lakes, Estuaries: Category 4C
	Rivers: Category 5
	Lakes, Estuaries: Category 5



2.2.2 RANDOLPH HIGHWAY DEPARTMENT BMP RETROFIT OBSERVATIONS FORM

Site Name:	Randolph Highway Department		
Address:	4 Carlino Way	Date/Time:	July 5, 2023 9:23 AM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 77 °F		

2.2.2.1 BMP RETROFIT LOCATION MAP



2.2.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pits required
BMP Options:	Infiltration Chamber/Pipe, Leaching CB, Other	If "Other":	Subsurface infiltration system (leaching manholes)
Site Observation Notes:	Opportunity to install subsurface infiltration system within impervious parking lot/access roadway to Highway Department. Existing stormwater infrastructure should be modified to prevent water from the north and west inlets entering the subsurface infiltration system. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.		

2.2.2.3 PHOTOS

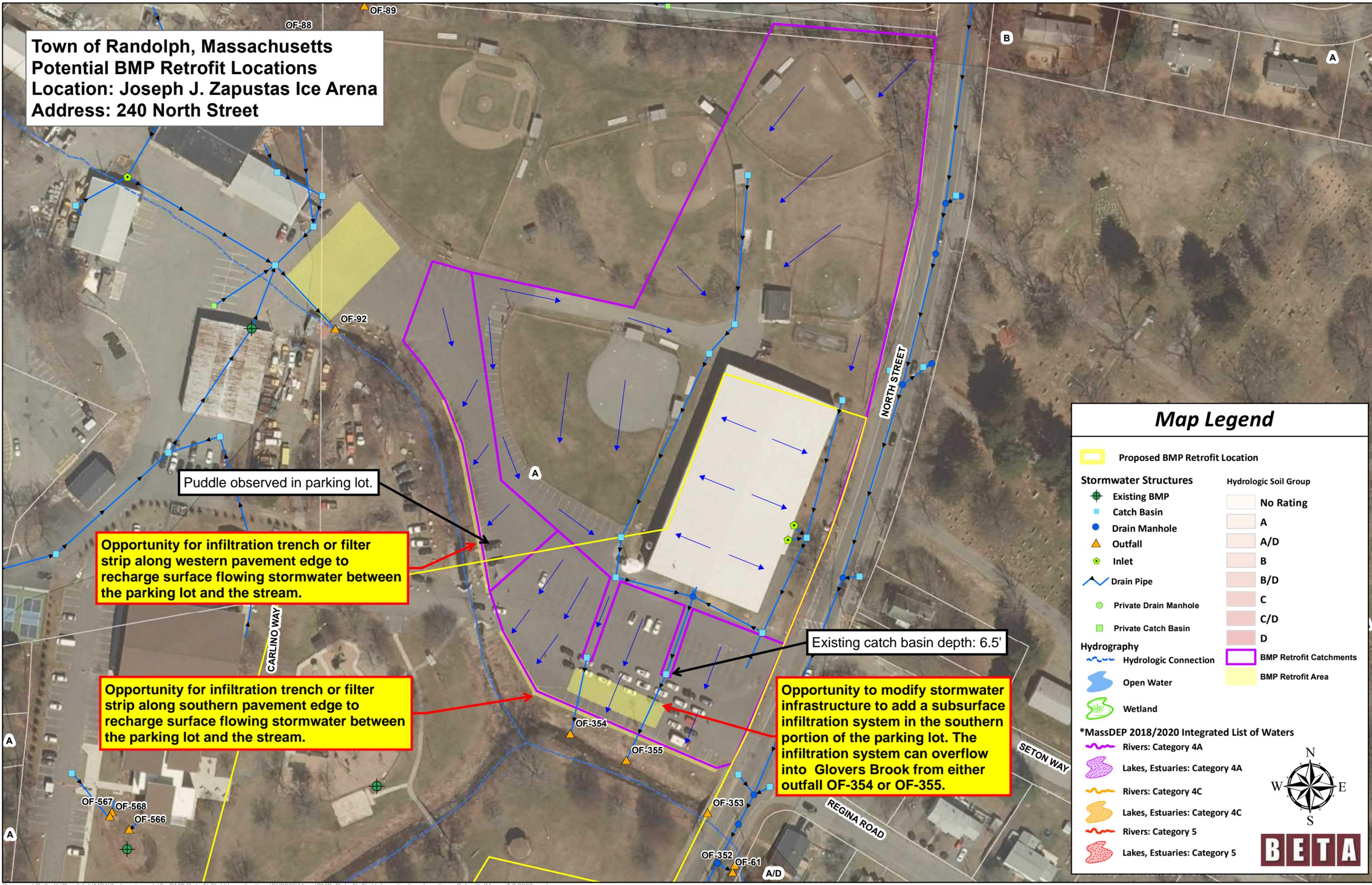
	<p>Large impervious area where a subsurface infiltration system could be installed to treat all upstream runoff.</p>
	<p>View of open area looking at upstream catch basin.</p>

2.3 JOSEPH J. ZAPUSTAS ICE ARENA

- The stormwater infrastructure catchment area for this site is mainly comprised of 4 baseball fields, an ice rink, and a large, paved parking lot. The stream that conveys drainage from the Randolph Highway Department flows along the west edge of the property then enters Glovers Brook running along the south edge of the parking lot. It appears that most of the stormwater associated with the impervious parking lot flows directly into the stream and brook.
- The first opportunity is to install infiltration trenches or filter strips along the west and south edge of the parking lot. A puddle was observed along the west edge of the parking lot, so a regrade of the parking lot would be beneficial for the installation of the infiltration trench or filter strip between the parking lot and the stream. The grass that separates the parking lot from the stream and Glovers Brook has adequate space for the installation of the infiltration trenches or filter strips with minimal disturbance to the site. This could help treat the significant portion of sheet flow from the impervious surface parking lot and reduce the pollutants entering Glovers Brook.
- The second opportunity is to install a subsurface infiltration system in the open parking lot to treat upstream stormwater runoff from existing drainage infrastructure. BETA personnel observed the two catch basins within the parking lot that are upstream from the outfalls OF-345 and OF-355 to determine whether a subsurface infiltration system could be installed in the parking lot. The depth of the two catch basins is roughly 6.5 ft deep without sumps, which makes a subsurface infiltration system difficult to achieve without modifying the existing stormwater infrastructure. If this option is determined to be viable, then the infiltration system could either have OF-345 or OF-355 as an overflow option into Glovers Brook.
- An alternative to the subsurface infiltration system could be retrofitting the two upstream catch basins into leaching catch basins. This option would require modification of the inlet and outlet drainage pipes of the catch basins based on their inverts. The location of other underground utilities would be a determining factor in whether leaching catch basins would be a better option than the subsurface infiltration system.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.
- Additional details are provided in Sections 2.3.1 and 2.3.2.

2.3.1 JOSEPH J. ZAPUSTAS SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Joseph J. Zapustas Ice Arena
Address: 240 North Street



Puddle observed in parking lot.

Opportunity for infiltration trench or filter strip along western pavement edge to recharge surface flowing stormwater between the parking lot and the stream.

Opportunity for infiltration trench or filter strip along southern pavement edge to recharge surface flowing stormwater between the parking lot and the stream.

Existing catch basin depth: 6.5'

Opportunity to modify stormwater infrastructure to add a subsurface infiltration system in the southern portion of the parking lot. The infiltration system can overflow into Glovers Brook from either outfall OF-354 or OF-355.

Map Legend

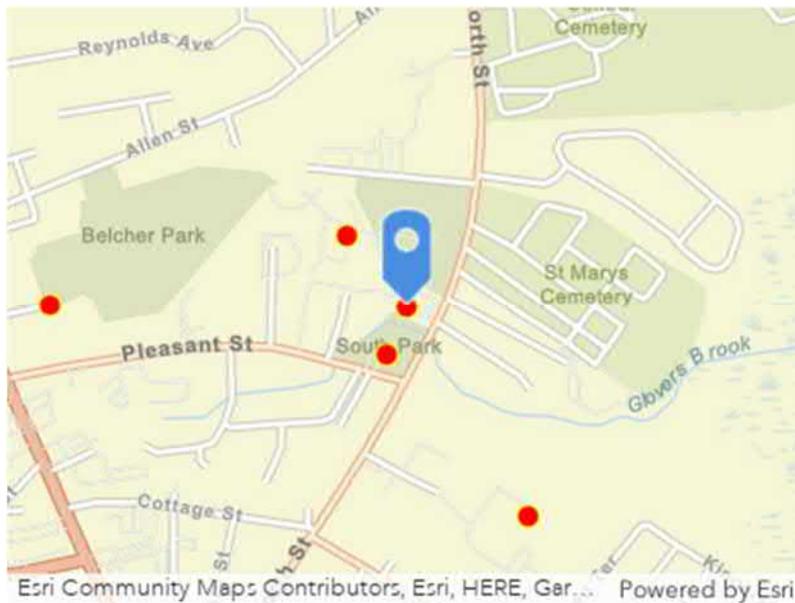
- Proposed BMP Retrofit Location
 - Stormwater Structures**
 - Existing BMP
 - Catch Basin
 - Drain Manhole
 - ▲ Outfall
 - ◆ Inlet
 - Drain Pipe
 - Private Drain Manhole
 - Private Catch Basin
 - Hydrography**
 - Hydrologic Connection
 - Open Water
 - Wetland
 - Hydrologic Soil Group**
 - No Rating
 - A
 - A/D
 - B
 - B/D
 - C
 - C/D
 - D
 - Hydrology**
 - BMP Retrofit Catchments
 - BMP Retrofit Area
- *MassDEP 2018/2020 Integrated List of Waters**
- Rivers: Category 4A
 - Lakes, Estuaries: Category 4A
 - Rivers: Category 4C
 - Lakes, Estuaries: Category 4C
 - Rivers: Category 5
 - Lakes, Estuaries: Category 5



2.3.2 JOSEPH J. ZAPUSTAS ICE ARENA BMP RETROFIT OBSERVATIONS FORM

Site Name:	Joseph J. Zapustas Ice Arena		
Address:	240 North Street	Date/Time:	July 5, 2023 9:38 AM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 77 °F		

2.3.2.1 BMP RETROFIT LOCATION MAP



2.3.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Infiltration Trench, Leaching CB, Other	If "Other":	Subsurface infiltration system
Site Observation Notes:	Multiple opportunities available at this site. The Town may consider installing a subsurface infiltration system upstream of OF-355 or OF-354 to treat upstream stormwater associated with the large parking lot and site building. Other option would be to install an infiltration trench or filter strip along edge of pavement adjacent to Grovers Brook.		

2.3.2.3 PHOTOS

	<p>Opportunity for infiltration trench along parking lot edge. View towards North Street.</p>
	<p>View of parking lot edge towards the Highway Department and Community Center.</p>



Depth of upstream infrastructure is roughly 6.5 ft. Catch basin does not have any sump. Retrofitting system with a subsurface leaching would be difficult to achieve.

2.4 JOSEPH J. HUNT MEMORIAL PARK

- The property has an existing small impervious surface parking lot that exhibits split grading, with the northern section sloping towards the maintained lawn of the park, while the southern half slopes towards the stormwater system on Pleasant Street.
- The first option is to retrofit existing stormwater infrastructure by installing an infiltration basin on the west side of the parking lot in the grassed area. Any stormwater from the southern half of the parking lot acts as sheet flow towards the drainage infrastructure on Pleasant Street. The drainage system upstream of the catch basin, where half of the runoff discharges to from the Memorial Park parking lot, has a large catchment area that also includes the north portion of the Randolph Housing Authority on Pleasant Street and a section of the roadway on Pleasant Street and North Street. BETA personnel observed that the outlet pipe invert for the catch basin on the north edge of Pleasant Street is roughly 3 ft, which is shallow enough to implement an infiltration basin in the open space before outfall OF-91. An outlet control structure could be implemented to allow overflow to enter Glovers Brook through outfall OF-91.
- The second opportunity is to install infiltration trenches along the north and northwest edges of the parking lot to recharge the groundwater. Any stormwater on the northern half of the parking lot acts as sheet flow towards the maintained lawn to the north and the west of the parking lot. Puddles were observed in the northwest corner of the parking lot and in the grass along the north edge of the parking lot so a regrade of the parking lot would be beneficial for the installation of infiltration trenches along the edge of the parking lot. The infiltration trenches can be connected to each other with an overflow pipe connecting to the proposed infiltration basin if necessary.
- A leaching catch basin exists near Imagination Station Playground on the other side of the Glovers Brook, which is a good indication that the hydrologic soil and water level table are adequate for infiltration.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further.
- Additional details are provided in Sections 2.4.1 and 2.4.2.

2.4.1 JOSEPH J. HUNT MEMORIAL PARK SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
 Location: Joseph J Hunt Memorial Park
 Address: Off Pleasant Street

Opportunity for infiltration trench along the parking lot's northwestern corner pavement edge to treat sheet flow.

Opportunity for infiltration trench along the parking lot's northeastern corner pavement edge to treat sheet flow.

Opportunity for infiltration basin in open space on the west side of the parking lot. An OCS can be added to overflow into the stream from outfall OF-91.

Puddle observed in parking lot.

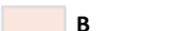
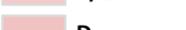
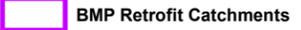
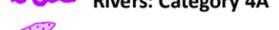
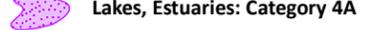
Puddle observed along parking lot.

Existing catch basin depth: 3'

Existing roof leaders discharge underground.

Existing roof leaders discharge underground.

Map Legend

	Proposed BMP Retrofit Location		
Stormwater Structures		Hydrologic Soil Group	
	Existing BMP		No Rating
	Catch Basin		A
	Drain Manhole		A/D
	Outfall		B
	Inlet		B/D
	Drain Pipe		C
	Private Drain Manhole		C/D
	Private Catch Basin		D
	Private Catch Basin		BMP Retrofit Catchments
	Hydrologic Connection		BMP Retrofit Area
	Open Water		
	Wetland		
*MassDEP 2018/2020 Integrated List of Waters			
	Rivers: Category 4A		
	Lakes, Estuaries: Category 4A		
	Rivers: Category 4C		
	Lakes, Estuaries: Category 4C		
	Rivers: Category 5		
	Lakes, Estuaries: Category 5		

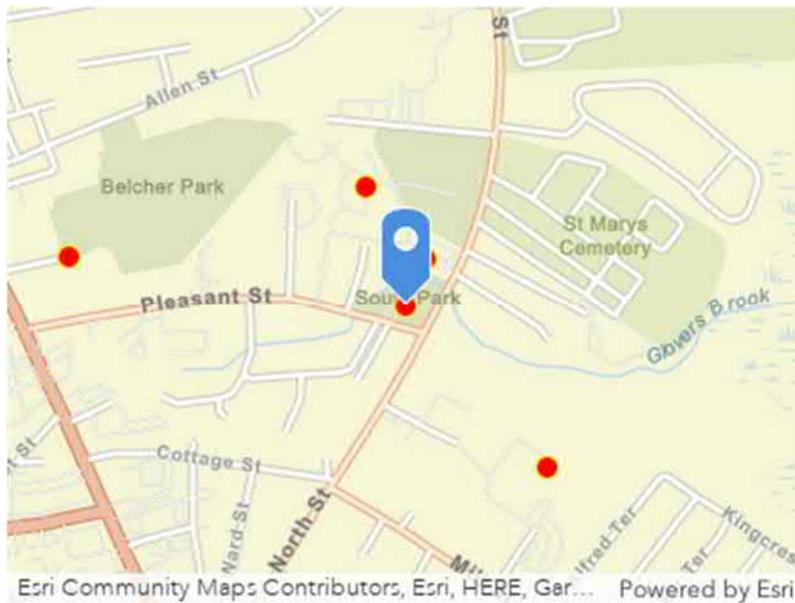




2.4.2 JOSEPH J. HUNT MEMORIAL PARK BMP RETROFIT OBSERVATIONS FORM

Site Name:	Joseph J. Hunt Memorial Park		
Address:	Corner of Pleasant Street & North Street	Date/Time:	July 5, 2023 9:53 AM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 77 °F		

2.4.2.1 BMP RETROFIT LOCATION MAP



2.4.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Infiltration Trench, Infiltration Basin	If "Other":	
Site Observation Notes:	Several options for BMP retrofits. Main opportunity would be to modify existing stormwater infrastructure off Pleasant Street where OF-91 is located in the park. Town could install an infiltration basin within the open space between catch basin and outfall. This would treat a portion of stormwater from the Housing Authority and Pleasant Street. Other opportunities include installing infiltration trenches along the north and northwestern portions of the parking lot to treat sheet flow.		

2.4.2.3 PHOTOS

	<p>Catch basin on Pleasant Street could be retrofitted downstream to discharge to a formalized infiltration basin in the open space of the park. Invert is shallow at roughly 3ft below surface. See next photo.</p>
	<p>Large open space in park is an ideal location for a formalized infiltration basin. Test pits would be required to confirm depth to water.</p>

	<p>Standing water in parking lot from recent rainfall. Town could regrade parking lot and install a formalized infiltration trench along northwestern corner of parking area.</p>
	<p>Opportunity for infiltration trench along northern edge of pavement to treat a quarter of parking lot area.</p>

2.5 COCHATO CAMP HOUSE AND PARK

- This site consists primarily of maintained fields and open space and has several opportunities for implementing infiltration BMPs for the various impervious surfaces. The main parking lot for the Cochato Camp House and Park is off Allen Street and presents a couple options for BMP implementation.
- The first opportunity is for an infiltration basin to be installed before outfall OF-50 for the small stormwater system on Allen Street. The infiltration basin could have an OCS to overflow into the stream via outfall OF-50.
- The second option is to install infiltration trenches along the perimeter of the Allen Street parking lot. The surface runoff from the Allen Street parking lot saturates the dirt walkway and grass located at the bottom of the parking lot. There is ample space on the sides of the parking lot to install infiltration trenches along the western, eastern, and southern edges of the impervious surface. The west trench could be connected to the east trench with an overflow pipe along the south edge of the lot. The east trench could then have an overflow pipe into the proposed infiltration basin. These trenches could help reduce puddling and saturation of the dirt walkway at the bottom of the parking lot.
- The third opportunity is to install an infiltration basin before Scum Pond on the west side of the property. Scum Pond appears to be a highly polluted waterbody, where BETA observed high turbidity and algae growth which exits through an outlet structure at the southeastern corner of the pond. There are three outfalls entering the pond, but there is minimal open space around the perimeter which makes the implementation of a BMP difficult. The outfall OF-8 appears to have the most viable area for implementing an infiltration basin before entering the pond. The infiltration basin could have an OCS to overflow into Scum Pond through outfall OF-8. This catchment area consists of Park Street and a small parking lot at the bottom of the street. There is also an inlet that receives stormwater from the forest to the south of Park Street.
- The last opportunity is to install infiltration trenches around the basketball court. The basketball court located at the south of the property is on a hill that flows towards Scum Pond. The basketball court is graded for surface water to flow towards the north and west edge of the court before flowing over the hillside and into Scum Pond. This area presents an opportunity to install an infiltration trench along the northern and western edges of the court to reduce the sheet flow carrying potential contaminants and nutrients on the way to the pond.
- Implementing these BMP retrofits would help mitigate the potential adverse impacts of stormwater runoff from the parking lots, roadways and other impervious surfaces, promoting improved water quality and drainage practices entering Scum Pond and the stream that flows to the Randolph Highway Department.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further.
- Additional details are provided in Sections 2.5.1 and 2.5.2.

2.5.1 COCHATO CAMP HOUSE AND PARK SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Cochato Camp House and Park
Address: Near 40 Park Street

Opportunity for infiltration trench along the east edge of parking lot on Allen Street. The trench can have an overflow pipe connecting to the infiltration basin.

Opportunity for infiltration trench along the west edge of parking lot on Allen Street. The trench can have an overflow pipe connecting to the infiltration basin.

Opportunity for infiltration basin in open space on the east side of the parking lot on Allen Street. An OCS can be added to overflow into the stream through outfall OF-50.

Opportunity for infiltration basin in open space on the northeast side of the small parking lot on Park Street. An OCS can be added to overflow into the stream from outfall OF-8 before entering Scum Pond.

OSC observed exiting Scum Pond. Water quality in the pond is poor.

Opportunity for infiltration trench along the north and west edge of basketball court.

Puddling observed on dirt walkway.

Limited space for retrofit.

Existing drain inlet was mostly buried in sediment.

Map Legend

	Proposed BMP Retrofit Location		No Rating
	Existing BMP		A
	Catch Basin		A/D
	Drain Manhole		B
	Outfall		B/D
	Inlet		C
	Drain Pipe		C/D
	Private Drain Manhole		D
	Private Catch Basin		
	Hydrologic Connection		BMP Retrofit Catchments
	Open Water		BMP Retrofit Area
	Wetland		

***MassDEP 2018/2020 Integrated List of Waters**

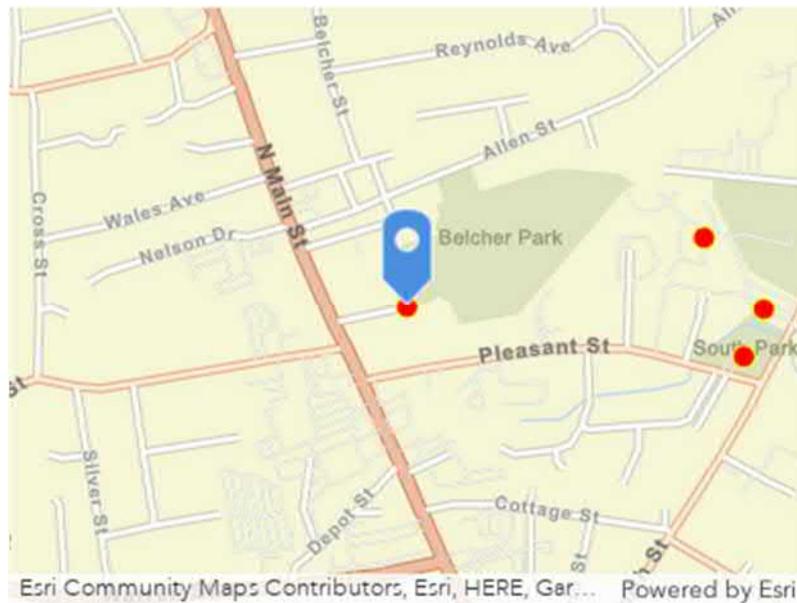
- Rivers: Category 4A
- Lakes, Estuaries: Category 4A
- Rivers: Category 4C
- Lakes, Estuaries: Category 4C
- Rivers: Category 5
- Lakes, Estuaries: Category 5




2.5.2 COCHATO CAMP HOUSE AND PARK BMP RETROFIT OBSERVATIONS FORM

Site Name:	Cochato Camp House and Park		
Address:	Near 40 Park Street	Date/Time:	July 5, 2023 12:57 PM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 83 °F		

2.5.2.1 BMP RETROFIT LOCATION MAP



2.5.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Infiltration Trench, Infiltration Basin	If "Other":	
Site Observation Notes:	Site could be retrofitted with infiltration trenches along the basketball court and parking lot edges located off Allen Street. This parking lot also has existing stormwater infrastructure in place where a formalized infiltration basin could be installed upstream of OF-50. There is a basketball court on site that also allows for a potential BMP retrofit. The northwestern and western edges of the court are open areas where the installation of an infiltration trench is possible.		

2.5.2.3 PHOTOS

		<p>Opportunity to install infiltration trench along the northwestern and western edges of basketball court pavement.</p>
		<p>Outlet control structure of existing pond on site. High turbidity and algae growth within pond area.</p>

	<p>Large impervious parking lot that grades towards the southeastern edge of pavement. Depending on depth to water and soils this may be a future BMP retrofit location. Either an infiltration trench or surface infiltration basin could be installed to treat stormwater runoff from existing parking lot and stormwater infrastructure in place on Allen Street.</p>
	<p>Opportunity for infiltration trench along southwestern edge of parking lot. Option to connect with pipe to proposed trench and basin on the southeast side of parking lot located off Allen Street.</p>

2.6 MARTIN E. YOUNG SCHOOL

- The Martin E. Young School consists of a mulch playground, a maintained lawn around the tennis court, a forest with a couple streams that flow into Mary Lee Brook, and impervious surfaces for the parking lots, driveway, and play area on the west side of the building.
- The main opportunity is to implement a surface infiltration basin on the south edge of the large rear parking lot on the east side of the school. An infiltration trench is an alternative option depending on the available space along the parking lot. Most of the rear parking lot has surface runoff that flows down to this grassy area and BETA observed tree and yard debris dumped along the edge of the forest in this location while completing field investigations.
- The second option is to implement an infiltration trench or a water quality swale on the south edge of the small southern parking lot. A trench will reduce the stormwater surface runoff that flows through the grass before reaching the stream.
- The third option is to modify the existing stormwater infrastructure for the roof drainage to implement a subsurface infiltration system in the paved play area between the school and the mulch playground. The subsurface infiltration system can have an overflow into the system of outfall OF-102. The catch basin in the paved play area with unknown connectivity can be connected into the subsurface infiltration system as well.
- The last opportunity is to implement an infiltration trench on the north edge of the tennis court. The Town could consider retrofitting the space with a BMP at the same time as the tennis courts are refinished. A trench will reduce the stormwater surface runoff that flows through the grass before reaching the local wetland.
- The drain manhole upstream of outfall OF-102 is too deep to implement a BMP retrofit in the maintained lawn. This would be a great location to treat a large portion of the remaining impervious surface but would require adjusting the rest of the upstream stormwater infrastructure.
- By implementing these BMP retrofits, the site can improve its stormwater management practices, reducing runoff volumes, promoting natural filtration, and minimizing potential environmental impacts. The first two measures contribute to a sustainable water management approach and can help reduce pollution to the Mary Lee Brook which is considered a category 5 impaired waterbody by the EPA.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further.
- Additional details are provided in Sections 2.6.1 and 2.6.2.

2.6.1 MARTIN E. YOUNG SCHOOL SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Martin E. Young School
Address: 30 Lou Courtney Drive

Existing catch basin found in impervious recess area with unknown connectivity and discharge point. This can be modified to connect to the proposed subsurface infiltration basin.

Existing catch basins with unknown connectivity and discharge point.

Opportunity for infiltration trench or infiltration basin in the southeast corner of the parking lot to treat significant portion of impervious area.

Tree and yard waste dumped on the edge of the forest.

Opportunity for infiltration trench along the north edge of the tennis courts.

Opportunity to modify stormwater infrastructure to add a subsurface infiltration system for roof drainage in the paved play area between the school and the mulch playground. The infiltration system can overflow into the system of outfall OF-102.

Existing drain manhole depth: 7.25'

Opportunity for infiltration trench along the south edge of the southern parking lot.

Map Legend

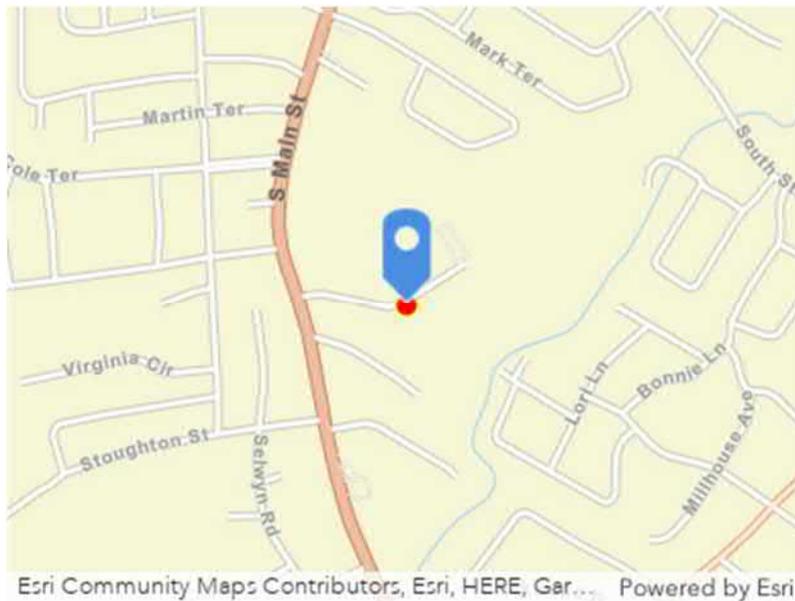
	Proposed BMP Retrofit Location
Stormwater Structures	
	Existing BMP
	Catch Basin
	Drain Manhole
	Outfall
	Inlet
	Drain Pipe
	Private Drain Manhole
	Private Catch Basin
	Hydrologic Connection
	Open Water
	Wetland
	Rivers: Category 4A
	Lakes, Estuaries: Category 4A
	Rivers: Category 4C
	Lakes, Estuaries: Category 4C
	Rivers: Category 5
	Lakes, Estuaries: Category 5
	No Rating
	A
	A/D
	B
	B/D
	C
	C/D
	D
	BMP Retrofit Catchments
	BMP Retrofit Area



2.6.2 MARTIN E. YOUNG SCHOOL BMP RETROFIT OBSERVATIONS FORM

Site Name:	Martin E. Young School		
Address:	30 Lou Courtney Drive	Date/Time:	July 5, 2023 12:04 PM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 83 °F		

2.6.2.1 BMP RETROFIT LOCATION MAP



2.6.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Infiltration Trench	If "Other":	
Site Observation Notes:	Numerous BMP retrofit considerations at this site. Options include retrofitting the existing parking located along southern portion of property with an infiltration trench. The rear parking lot area currently discharges directly to woodlands located to the southeast. Opportunity to install a roadway infiltration trench along edge of pavement or a surface infiltration basin. Opportunity to modify the roof drain stormwater infrastructure to install a subsurface infiltration basin.		

2.6.2.3 PHOTOS

		<p>Parking lot sheet flow discharges directly to open space/grass area. Opportunity to install an infiltration trench along the southeastern paved edge of lot.</p>
		<p>Rear parking lot is graded towards southeast corner of paved edge. Opportunity for either a roadway infiltration trench or formalized surface infiltration basin. Town to confirm soil types and depth to water. See next photo for catchment area.</p>



Observed catchment area for rear parking lot BMP infiltration practice.



Upstream manhole to OF-102 has an invert of 7.25ft to surface. This is not a good candidate for BMP retrofits.

	<p>Installation of infiltration trench along the northern edge of tennis court would be a good opportunity for Town as it appears the tennis court already requires resurfacing in the near future. The Town could consider retrofitting the space with a BMP at the same time as the tennis courts are refinished.</p>
--	---

2.7 JF KENNEDY ELEMENTARY JR. HIGH

- The JF Kennedy Elementary Jr. High School impervious area primarily consists of driveways and parking lots with the Hurley Drive entrance located to the south and the Thompson Drive exit to the west. All existing stormwater infrastructure on this site discharges to the wetlands upstream of Glovers Brook. Stormwater infrastructure on-site is deep, over 6 feet without sump area, which leaves little to no opportunity for large scale BMP retrofits. However, there is opportunity for several infiltration trenches to manage the stormwater surface runoff.
- The first option is to install infiltration trenches along the east and west edge of the paved driveway at the Hurley Drive entrance. An infiltration trench could be installed along the full length of the west edge of the entrance between the driveway and the sidewalk. Two more infiltration trenches can be installed along the east edge of the entrance, separated by the driveway that goes down to the eastern parking lots. The trenches could be incorporated with the existing catch basins and have an overflow pipe that enters the existing stormwater infrastructure. These retrofit measures would effectively treat the stormwater runoff associated with the driveway and the sidewalk for the Hurley Drive entrance.
- The second opportunity is to retrofit the Thompson Drive school exit roadway with an infiltration trench along the north edge of the impervious surface that spans from the chain link fence at the edge of the property all the way down to the western driveway that leads to the rear of the school. Another infiltration trench could be installed along the east edge of the western driveway. Both infiltration trenches can have an overflow option to enter the existing stormwater infrastructure downstream, if necessary. These retrofit measures would effectively treat the stormwater runoff associated with the driveway for the Thompson Drive exit and the parking spaces along the basketball courts.
- The third option is the installation of another infiltration trench along the paved area near the mulch playground at the northeast corner of the school. This infiltration trench would have a small catchment area, but an overflow pipe can run under the mulch playground and enter the existing stormwater infrastructure, if necessary.
- The fourth option is to install a bioretention rain garden in the grass inside the roundabout at the entrance of the school. This option could be an educational attraction for students entering the school.
- The last opportunity includes retrofitting an existing catch basin into a leaching catch basin located at the southeast corner of the main parking lot. BETA personnel observed a large amount of sediment located at the low point in the parking lot by the southeast corner of the property. The Town could remove the sediment and modify the catch basin into a leaching catch basin to treat and reduce impervious runoff to the existing outfall.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.
- Additional details are provided in Sections 2.7.1 and 2.7.2.

2.7.1 JF KENNEDY ELEMENTARY JR. HIGH SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: JF Kennedy Elementary Jr. High
Address: 20 Hurley Drive

Opportunity for infiltration trench along the edge of the school's exiting impervious surface.

Opportunity for infiltration trench along the edge of the driveway's impervious surface towards the back of the school.

Existing catch basin depth: 6'

Existing drain manhole depth: 6'

Existing drain manhole depth: 10.5'

Opportunity for infiltration trench along the edge of the impervious surface at the northeast corner of the school.

Opportunity for bioretention rain garden in the grass inside the roundabout at the entrance of the school.

Opportunity for infiltration trench along the edge of the west of the school's entrance between Hurley Drive and the sidewalk. The trench can overflow into a catch basin to enter the stormwater infrastructure.

Opportunity to modify the catch basin into a leaching catch basin.

Existing catch basin buried in sediment

Opportunity for infiltration trench along the edge of the northeast of the school's entrance on Hurley Drive. The trench can overflow into a catch basin to enter the stormwater infrastructure.

Opportunity for infiltration trench along the edge of the southeast of the school's entrance on Hurley Drive. The trench can overflow into a catch basin to enter the stormwater infrastructure.

Map Legend

	Proposed BMP Retrofit Location		No Rating
	Existing BMP		A
	Catch Basin		A/D
	Drain Manhole		B
	Outfall		B/D
	Inlet		C
	Drain Pipe		C/D
	Private Drain Manhole		D
	Private Catch Basin		BMP Retrofit Catchments
	Hydrologic Connection		BMP Retrofit Area
	Open Water		
	Wetland		

***MassDEP 2018/2020 Integrated List of Waters**

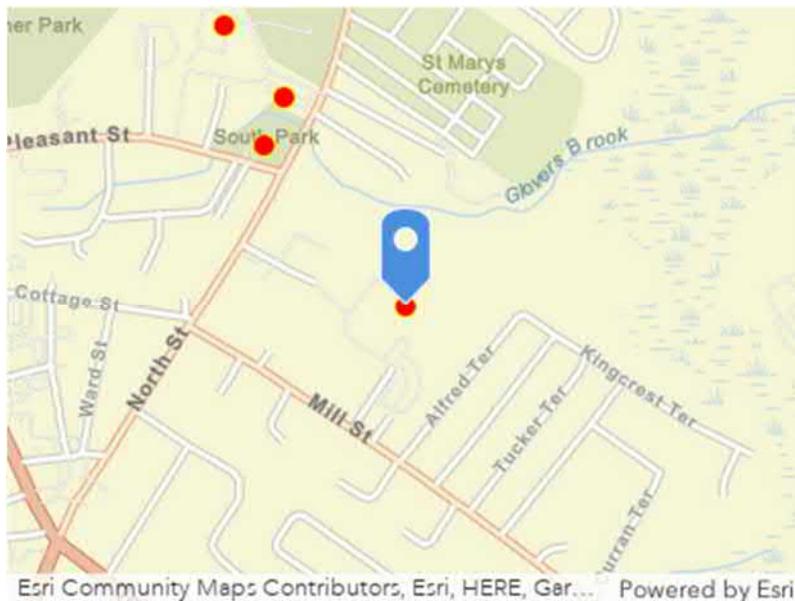
-  Rivers: Category 4A
-  Lakes, Estuaries: Category 4A
-  Rivers: Category 4C
-  Lakes, Estuaries: Category 4C
-  Rivers: Category 5
-  Lakes, Estuaries: Category 5




2.7.2 JF KENNEDY ELEMENTARY JR. HIGH BMP RETROFIT OBSERVATIONS FORM

Site Name:	JF Kennedy Elementary Jr. High		
Address:	20 Hurley Drive	Date/Time:	July 5, 2023 10:17 AM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 80 °F		

2.7.2.1 BMP RETROFIT LOCATION MAP



2.7.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pits required
BMP Options:	Infiltration Trench	If "Other":	
Site Observation Notes:	Stormwater infrastructure on-site is deep, over 6 feet without sump area. This leaves little to no opportunity for large scale BMP retrofits. BETA personnel did identify smaller BMP options that include installing infiltration trenches throughout site to treat segments of impervious roadway. An opportunity to implement a bioretention rain garden in the grass inside the roundabout at the school entrance.		

2.7.2.3 PHOTOS

	<p>Upstream manhole by playground is 10.5ft to invert, making BMP retrofits difficult to install in this area. See next photo for next manhole that is just upstream of OF-94.</p>
	<p>Upstream manhole from OF-94 is roughly 6ft deep to invert. Installation of BMP in open field is likely not feasible due to depth of inverts.</p>

	<p>Opportunity for infiltration trench by school playground area. Photo shows erosion likely from stormwater runoff. View is looking southeast towards baseball field and parking lot.</p>
	<p>Open spaces adjacent to edges of pavement could be regraded and installed with infiltration trenches to treat runoff from impervious roadway. See next photo.</p>

	<p>Option to install formal infiltration trench along pavement edge adjacent to baseball field. This could connect to trenches recommended in previous photo.</p>
	<p>Opportunity to install infiltration trench along both paved edges of Hurley Drive school main entrance. See next photo.</p>

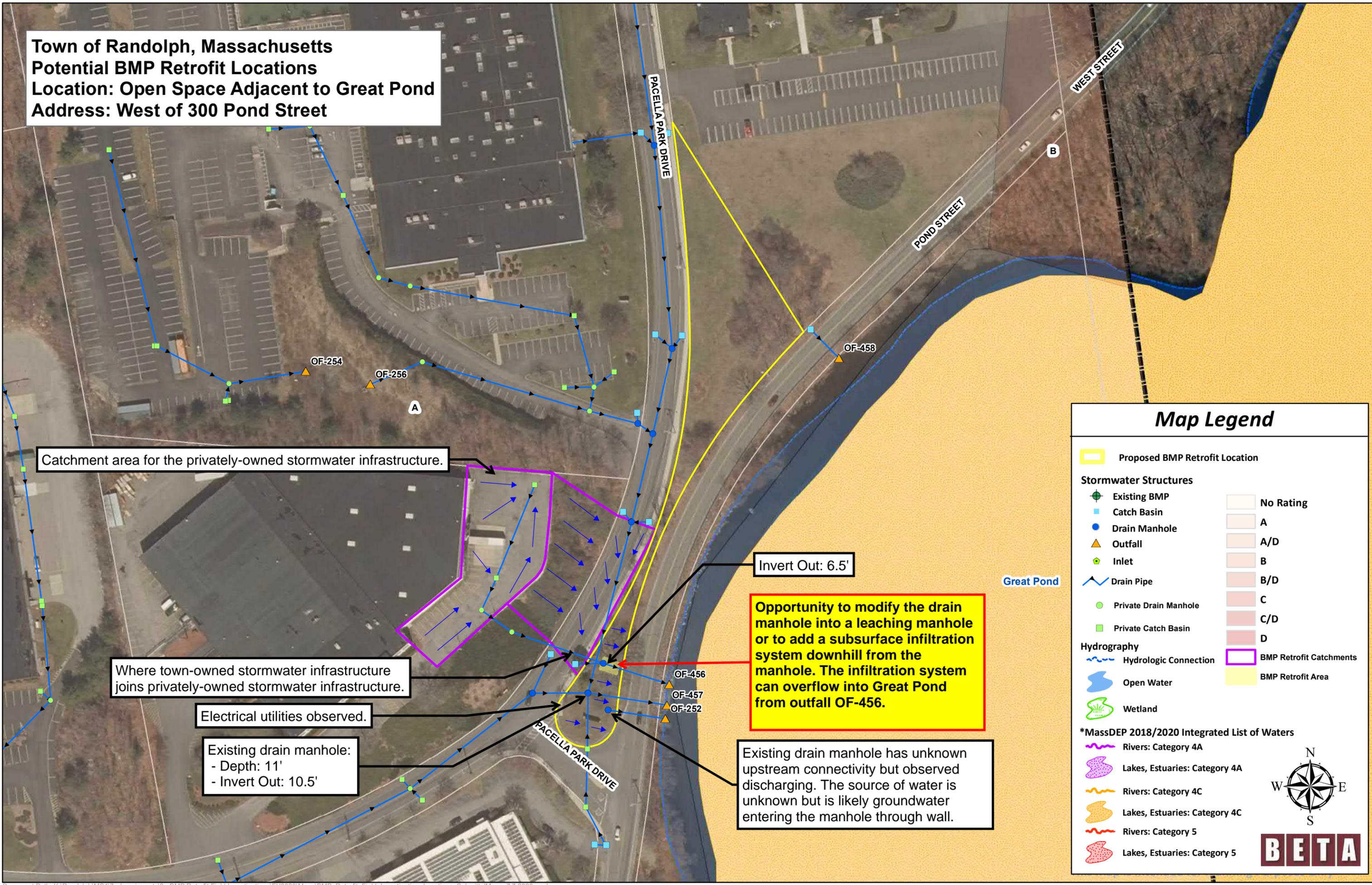
	<p>Town would need to remove berm and cover the existing catch basins to capture sheet runoff for half the roadway on Hurley Drive. Soil testing would be required to confirm infiltration feasibility.</p>
	<p>Town GIS data indicates that a catch basin is located at the low point by southeast corner property. BETA personnel were not able to locate the basin as the area is full of sediment and debris. Town could remove sediment and modify catch basin into a leaching basin to treat and reduce impervious runoff to outfall.</p>

2.8 OPEN SPACE ADJACENT TO GREAT POND

- This site is primarily an open space lawn area separating Pacella Park Drive and Pond Street. BETA personnel observed three drain manholes in this area and found limited opportunities for BMP retrofits. The northern most drain manhole in this area is the best candidate for an installation of a BMP retrofit.
- The main opportunity is to install a subsurface infiltration basin downgradient from the northern drain manhole, with an overflow pipe that discharges into Great Pond through the existing outfall OF-456. The northern drain manhole on this site has a catchment area that includes the rear parking lot of the Emerson Swan Warehouse on 55 Pacella Park Drive and a small portion of roadway stormwater infrastructure on Pacella Park Drive. The Emerson Swan Warehouse's stormwater infrastructure is designated as privately-owned on GIS. If underground utilities or the water table are found to not interfere with the northern manhole, the Town has the option to either modify the drain manhole into a leaching manhole or into a series of leaching manholes.
- The middle drain manhole on this site is too deep to be a good candidate for a BMP retrofit and is in closest proximity to the observed electrical utilities. This middle drain manhole has the largest catchment area of the three and discharges into Great Pond through existing outfall OF-457. The southern most drain manhole has no upstream drain infrastructure observed but it appears groundwater is entering the drain manhole and discharging into Great Pond through existing outfall OF-252.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.
- Additional details are provided in Sections 2.8.1 and 2.8.2.

2.8.1 OPEN SPACE ADJACENT TO GREAT POND SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Open Space Adjacent to Great Pond
Address: West of 300 Pond Street



Map Legend

	Proposed BMP Retrofit Location
Stormwater Structures	
	Existing BMP
	Catch Basin
	Drain Manhole
	Outfall
	Inlet
	Drain Pipe
	Private Drain Manhole
	Private Catch Basin
	Hydrologic Connection
	Open Water
	Wetland
	BMP Retrofit Catchments
	BMP Retrofit Area
*MassDEP 2018/2020 Integrated List of Waters	
	Rivers: Category 4A
	Lakes, Estuaries: Category 4A
	Rivers: Category 4C
	Lakes, Estuaries: Category 4C
	Rivers: Category 5
	Lakes, Estuaries: Category 5

2.8.2 OPEN SPACE ADJACENT TO GREAT POND BMP RETROFIT OBSERVATIONS FORM

Site Name:	Open Space Adjacent to Great Pond		
Address:	West of 300 Pond Street	Date/Time:	July 5, 2023 2:42 PM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 88 °F		

2.8.2.1 BMP RETROFIT LOCATION MAP



2.8.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Other	If "Other":	Subsurface infiltration system (leaching manhole)
Site Observation Notes:	Limited opportunity for BMP retrofits. Existing stormwater infrastructure that passes through this site has deep inverts. Only option would be to retrofit the northern most manhole on site into a subsurface leaching manhole or infiltration system.		

2.8.2.3 PHOTOS

	<p>Manhole that receives water from Pacella Park Drive is roughly 10.5 ft to invert. Modifying this manhole is not ideal for BMP retrofits.</p>
	<p>Manhole receives stormwater from portion of Pacella Park Drive and parking lot from 55 Pacella Park Drive (Emerson Swan Warehouse). Opportunity for Town to convert manhole into a leaching basin or subsurface infiltration system. Depending on catchment area, multiple subsurface basins may be necessary.</p>

2.9 WOODS AT END OF S. WINDEMERE AVENUE

- The site primarily consists of the S. Windemere Avenue roadway with stormwater infrastructure that is designated as privately-owned on GIS. Residents on this road mentioned that there has been drainage infrastructure construction performed relatively recently and they noted that there is a large pothole at the dead end that could be repaired if a BMP retrofit installation occurs. A fire hydrant was observed at the dead end in front of 11 S. Windemere Avenue.
- The main opportunity for a BMP retrofit would be to formalize the wooded open space into a surface infiltration basin in the Town easement. The existing outfall OF-24 was observed protruding from large rocks which appear to be retaining this wooded open space. An outlet control structure could be implemented for an overflow option through existing outfall OF-24 that discharges into a wetland. The upstream catch basin has a depth and pipe invert that is shallow enough for this BMP retrofit to be a good candidate. The existing outfall drops off roughly 7 ft from the proposed BMP retrofit space to the wetland. There is a significant drop off between the existing outfall and upstream catch basin but appears as though the wooded space is only slightly graded. If the Town has plans for Capital Improvement Projects on this street, they may consider including BMP retrofits within the wooded area.
- It is recommended the Town confirm hydrological soil group (HSG) and water table level before any BMP retrofits could be scoped further. Town would need to confirm location of other underground utilities (water, sewer, gas) prior to design of a BMP retrofit.
- Additional details are provided in Sections 2.7.1 and 2.7.2.

2.9.1 WOODS AT END OF S. WINDEMERE AVENUE SITE MAP

Town of Randolph, Massachusetts
Potential BMP Retrofit Locations
Location: Woods at End of S Windemere Avenue
Address: South of 11 S Windemere Avenue

Catchment area for the privately-owned stormwater infrastructure.

Large pothole observed at dead end of S. Windemere Avenue.

Fire hydrant observed at dead end of S. Windemere Avenue.

Existing catch basin:
 - Depth: 6.5'
 - Invert Out: 4.5'

Opportunity for infiltration basin in open space between the end of South Windemere Avenue and outfall OF-24. An OCS can be added to overflow into the wetland through outfall OF-24.

The height difference between the elevation of the open space and the wetland is roughly 7 ft. The 12" RCP outlet pipe end emerges through the large rocks that are retaining the open space.

Map Legend

- Proposed BMP Retrofit Location
- Stormwater Structures**
- Existing BMP
- Catch Basin
- Drain Manhole
- Outfall
- Inlet
- Drain Pipe
- Private Drain Manhole
- Private Catch Basin
- No Rating
- A
- A/D
- B
- B/D
- C
- C/D
- D
- BMP Retrofit Catchments
- BMP Retrofit Area
- Hydrography**
- Hydrologic Connection
- Open Water
- Wetland

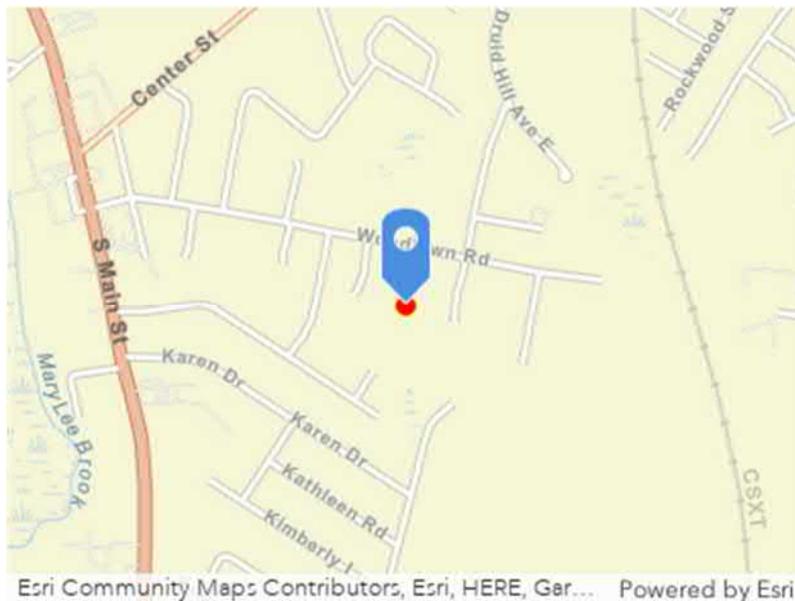
- *MassDEP 2018/2020 Integrated List of Waters**
- Rivers: Category 4A
 - Lakes, Estuaries: Category 4A
 - Rivers: Category 4C
 - Lakes, Estuaries: Category 4C
 - Rivers: Category 5
 - Lakes, Estuaries: Category 5



2.9.2 WOODS AT END OF S. WINDEMERE AVENUE BMP RETROFIT OBSERVATIONS FORM

Site Name:	Woods at End of S. Windemere Avenue		
Address:	South of 11 S. Windemere Avenue	Date/Time:	July 5, 2023 11:22 AM
Inspector	Chris Brainard & David Stuczynski (BETA)		
Current Weather:	Sunny -- 80 °F		

2.9.2.1 BMP RETROFIT LOCATION MAP



2.9.2.2 OBSERVATION DETAILS

BMP Retrofit(s) Viable: **Yes**

Most Prevalent Soils:	A	Estimated Depth to Water (If Possible):	Test pit required
BMP Options:	Infiltration Basin	If "Other":	
Site Observation Notes:	<p>Outfall for site is located off roadway in Town easement. There is space between roadway dead end and outfall. Significant drop off between outfall and upstream catch basin but appears as though the wooded space is only slightly graded. During the investigation, residents of South Windemere Avenue came out to discuss that the roadway needs repair, as a portion of the roadway is sinking with the observation of a pothole by the end of the road. If the Town has plans for Capital Improvement Projects on this street, they may consider including BMP retrofits within the wooded area. There is an opportunity to formalize the wooded space into an infiltration basin with an outlet control structure before the outfall.</p>		

2.9.2.3 PHOTOS

	<p>Wooded space at dead end of S. Windermere Avenue. Downstream outfall significantly drops off past the rocks shown in the photo. The wooded area is slightly graded, but should not impact the installation of an infiltration basin.</p>
	<p>Outfall drops off roughly 7 ft from proposed BMP retrofit space to wetland.</p>

APPENDIX A

- Calculations for Potential Nutrient Load Removal at BMP Retrofit Locations

Randolph Phosphorus Load Summary Calculations

BMP Retrofit Location	Total Area (Acres)	Total Impervious Area (Acres)	Percent Impervious (%)	Total Directly Connected Impervious Area (DCIA) (Acres)	Percent DCIA (%)	Total Pervious Area (Acres)	Percent Pervious (%)	Pload Directly Connected Impervious Area (DCIA) (lb/yr)	Nload Directly Connected Impervious Area (DCIA) (lb/yr)	Pload Pervious Area (lb/yr)	Nload Pervious Area (lb/yr)	Pload Disconnected Impervious Area (lb/yr)	Nload Disconnected Impervious Area (lb/yr)	Total Avg. Annual Phosphorus Load (lb/yr)	Potential Phosphorus Load Removal (lb/yr) ¹	Total Avg. Annual Nitrogen Load (lb/yr)	Potential Nitrogen Load Removal (lb/yr) ¹
Randolph Highway Department	10.73	6.53	61	5.48	51	4.21	39	9.74	145.80	0.43	3.89	0.12	4.09	10.30	9.27	153.77	138.40
Joseph J. Zapustas Ice Arena	6.03	3.41	57	2.60	43	2.62	43	4.06	48.63	0.08	0.81	0.03	2.91	4.17	3.75	52.36	47.13
Joseph J. Hunt Memorial Park	1.62	1.18	73	1.11	68	0.44	27	2.33	33.44	0.09	0.99	0.013	0.33	2.43	2.19	34.76	31.28
JF Kennedy Elementary Jr High	2.16	1.55	72	1.31	61	0.61	28	2.29	32.29	0.03	0.25	0.011	0.83	2.33	2.09	33.37	30.03
Martin E. Young School	1.78	1.52	85	1.43	80	0.27	15	2.48	35.84	0.01	0.08	0.00	0.30	2.50	2.25	36.22	32.60
Elizabeth G. Lyons School	19.73	9.12	46	6.51	33	10.61	54	12.34	176.55	0.33	3.25	0.09	9.27	12.76	11.48	189.08	170.17
Cochato Camp House and Park	4.04	1.46	36	1.06	26	2.58	64	2.11	29.84	0.23	1.55	0.023	1.20	2.36	2.12	32.59	29.33
Woods at end of S Windemere Avenue	0.96	0.40	42	0.26	27	0.56	58	0.51	7.13	0.02	0.17	0.00	0.51	0.53	0.47	7.80	7.02
Open Space Adjacent to Great Pond	0.46	0.19	40	0.12	25	0.28	60	0.21	3.14	0.01	0.08	0.02	0.14	0.24	0.21	3.36	3.03
TOTAL	47.52	25.35	53	19.77	42	22.18	47	36.07	512.66	1.22	11.08	0.30	19.58	37.60	33.84	543.32	488.99
kg/yr								16.36	232.54	0.55	5.03	0.14	8.88	17.05	15.35	246.45	221.80
¹ BMP retrofits were estimated to provide 90% nutrient removal.																	

Phosphorus Load Directly Connected Impervious Area (DCIA) Calculations

BMP Retrofit Location	Land Use	Covername	Total Acres (US Acres)	Impervious Area (US Acres)	Percent Impervious	SutherLand Coefficient A	SutherLand Coefficient B	DCIA (%)	DCIA (US Acres)	Phosphorus Loading Export Rate (lb/ac/yr)	Phosphorus Export Load (lb/yr)	Nitrogen Loading Export Rate (lb/ac/yr)	Nitrogen Export Load (lb/yr)
Randolph Highway Department	Commercial	Impervious	0.29	0.04	13.76	0.1	1.5	5.11	0.01	1.78	0.03	15	0.39
	Industrial	Impervious	8.45	6.25	74.00	0.1	1.5	63.66	5.38	1.78	9.57	15	143.62
	High Density Residential	Impervious	0.00	0.00	0.00	0.4	1.2	0.00	0.00	2.32	0.00	14.1	0.00
	Medium Density Residential	Impervious	0.04	0.04	93.17	0.1	1.5	89.93	0.04	1.96	0.07	14.1	1.02
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	1.09	0.09	8.25	0.01	2	0.68	0.01	1.52	0.01	11.3	0.13
	Open Land	Impervious	0.87	0.11	12.24	0.1	1.5	4.28	0.04	1.52	0.06	11.3	0.64
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			10.73	6.53	61%			51%	5.48		9.74	
Joseph J. Zapustas Ice Arena	Commercial	Impervious	0.00	0.00	100.00	0.1	1.5	100.00	0.00	1.78	0.00	15	0.02
	Industrial	Impervious	0.42	0.42	99.34	0.1	1.5	99.02	0.42	1.78	0.74	15	11.10
	High Density Residential	Impervious	0.00	0.00	0.00	0.4	1.2	0.00	0.00	2.32	0.00	14.1	0.00
	Medium Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	Open Land	Impervious	5.61	2.99	53.30	0.1	1.5	38.91	2.18	1.52	3.32	11.3	37.51
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			6.03	3.41	57%			43%	2.60		4.06	
Joseph J. Hunt Memorial Park	Commercial	Impervious	0.42	0.39	93.43	0.1	1.5	90.31	0.38	1.78	0.67	15	10.09
	Industrial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	High Density Residential	Impervious	1.09	0.67	61.91	0.4	1.2	56.52	0.62	2.32	1.43	14.1	20.13
	Medium Density Residential	Impervious	0.12	0.12	99.69	0.1	1.5	99.53	0.12	1.96	0.23	14.1	3.22
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	Open Land	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.52	0.00	11.3	0.00
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			1.62	1.18	73%			68%	1.11		2.33	
JF Kennedy Elementary Jr High	Commercial	Impervious	1.22	0.95	78.02	0.1	1.5	68.91	0.84	1.78	1.50	15	22.45
	Industrial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	High Density Residential	Impervious	0.00	0.00	0.00	0.4	1.2	0.00	0.00	2.32	0.00	14.1	0.00
	Medium Density Residential	Impervious	0.31	0.20	64.83	0.1	1.5	52.20	0.16	1.96	0.32	14.1	4.52
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.04	0.03	58.35	0.01	2	34.05	0.01	1.52	0.02	11.3	0.25
	Open Land	Impervious	0.58	0.37	63.40	0.1	1.5	50.49	0.29	1.52	0.45	11.3	5.07
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			2.16	1.55	72%			61%	1.31		2.29	
Martin E. Young School	Commercial	Impervious	1.21	1.19	98.26	0.1	1.5	97.40	1.18	1.78	2.10	15	31.49
	Industrial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	High Density Residential	Impervious	0.00	0.00	0.00	0.4	1.2	0.00	0.00	2.32	0.00	14.1	0.00
	Medium Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.08	0.08	98.30	0.01	2	96.64	0.07	1.52	0.11	11.3	1.27
	Open Land	Impervious	0.50	0.25	50.79	0.1	1.5	36.19	0.18	1.52	0.27	11.3	3.08
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			1.78	1.52	85%			80%	1.43		2.48	

Phosphorus Load Directly Connected Impervious Area (DCIA) Calculations

BMP Retrofit Location	Land Use	Covername	Total Acres (US Acres)	Impervious Area (US Acres)	Percent Impervious	SutherLand Coefficient A	SutherLand Coefficient B	DCIA (%)	DCIA (US Acres)	Phosphorus Loading Export Rate (lb/ac/yr)	Phosphorus Export Load (lb/yr)	Nitrogen Loading Export Rate (lb/ac/yr)	Nitrogen Export Load (lb/yr)
Elizabeth G. Lyons School	Commercial	Impervious	2.37	2.19	92.32	0.1	1.5	88.71	2.10	1.78	3.74	15	56.10
	Industrial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	High Density Residential	Impervious	0.22	0.13	56.39	0.4	1.2	50.52	0.11	2.32	0.26	14.1	3.70
	Medium Density Residential	Impervious	16.80	6.56	39.06	0.1	1.5	24.41	4.10	1.96	8.04	14.1	113.37
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.18	0.10	55.75	0.01	2	31.08	0.05	1.52	0.08	11.3	0.94
	Open Land	Impervious	0.16	0.15	92.08	0.1	1.5	88.36	0.14	1.52	0.22	11.3	2.45
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			19.73	9.12	46%			33%	6.51		12.34	
Cochato Camp House and Park	Commercial	Impervious	0.48	0.12	24.15	0.1	1.5	11.86	0.06	1.78	0.10	15	1.53
	Industrial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	High Density Residential	Impervious	0.18	0.12	66.35	0.4	1.2	61.42	0.11	2.32	0.26	14.1	3.60
	Medium Density Residential	Impervious	1.79	1.07	60.16	0.1	1.5	46.67	0.83	1.96	1.63	14.1	23.02
	Low Density Residential	Impervious	0.52	0.12	23.97	0.1	1.5	11.74	0.06	1.96	0.12	14.1	1.68
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	1.07	0.02	2.01	0.01	2	0.04	0.00	1.52	0.00	11.3	0.01
	Open Land	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.52	0.00	11.3	0.00
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	TOTAL			4.04	1.46	36%			26%	1.06		2.11	
Woods at end of S Windemere Avenue	Commercial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	Industrial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	High Density Residential	Impervious	0.00	0.00	0.00	0.4	1.2	0.00	0.00	2.32	0.00	14.1	0.00
	Medium Density Residential	Impervious	0.96	0.40	41.76	0.1	1.5	26.99	0.26	1.96	0.51	14.1	7.13
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	Open Land	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.52	0.00	11.3	0.00
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
TOTAL			0.96	0.40	42%			27%	0.26		0.51		7.13
Open Space Adjacent to Great Pond	Commercial	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.78	0.00	15	0.00
	Industrial	Impervious	0.46	0.19	40.17	0.1	1.5	25.46	0.12	1.78	0.21	15	3.14
	High Density Residential	Impervious	0.00	0.00	0.00	0.4	1.2	0.00	0.00	2.32	0.00	14.1	0.00
	Medium Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Low Density Residential	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.96	0.00	14.1	0.00
	Highway	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.95	0.00	10.5	0.00
	Forest	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
	Open Land	Impervious	0.00	0.00	0.00	0.1	1.5	0.00	0.00	1.52	0.00	11.3	0.00
	Agriculture	Impervious	0.00	0.00	0.00	0.01	2	0.00	0.00	1.52	0.00	11.3	0.00
TOTAL			0.46	0.19	40%			25%	0.12		0.21		3.14

Phosphorus Load Pervious Area Calculations

BMP Retrofit Location	Land Use	COVERNAME	Pervious HSG Area (US Acres)						Phosphorus Export Loading Rate (lb/ac/yr)					Phosphorus Load (lb/yr)					Nitrogen Export Loading Rate (lb/ac/yr)					Nitrogen Load (lb/yr)							
			A	B	C	C/D	D	Total	A	B	C	C/D	D	A	B	C	C/D	D	Total	A	B	C	C/D	D	A	B	C	C/D	D	Total	
Randolph Highway Department	Commercial	Pervious	0.25	0.00	0.00	0.00	0.00	0.25	0.03	0.12	0.21	0.29	0.37	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.30	1.2	2.40	3.1	3.6	0.07	0.00	0.00	0.00	0.00	0.07
	Industrial	Pervious	1.04	0.00	1.16	0.00	0.00	2.20	0.03	0.12	0.21	0.29	0.37	0.03	0.00	0.24	0.00	0.00	0.27	0.27	0.30	1.2	2.40	3.1	3.6	0.31	0.00	2.77	0.00	0.00	3.09
	High Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Medium Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Low Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Highway	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Forest	Pervious	0.84	0.00	0.16	0.00	0.00	1.00	0.13	0.13	0.13	0.13	0.13	0.11	0.00	0.02	0.00	0.00	0.13	0.13	0.50	0.50	0.50	0.50	0.50	0.42	0.00	0.08	0.00	0.00	0.50
	Open Land	Pervious	0.76	0.00	0.00	0.00	0.00	0.76	0.03	0.12	0.21	0.29	0.37	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.30	1.2	2.40	3.1	3.6	0.23	0.00	0.00	0.00	0.00	0.23
Agriculture	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL			2.89	0.00	1.32	0.00	0.00	4.21	0.17	0.00	0.26	0.00	0.00	0.43	0.43	0.43	0.43	0.43	0.43	1.04	0.00	2.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.89
Joseph J. Zapustas Ice Arena	Commercial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Industrial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	High Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Medium Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Low Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Highway	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Forest	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
	Open Land	Pervious	2.59	0.03	0.00	0.00	0.00	2.62	0.03	0.12	0.21	0.29	0.37	0.08	0.00	0.00	0.00	0.00	0.08	0.08	0.30	1.2	2.40	3.1	3.6	0.78	0.04	0.00	0.00	0.00	0.81
Agriculture	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL			2.59	0.03	0.00	0.00	0.00	2.62	0.08	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.08	0.08	0.08	0.78	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81
Joseph J. Hunt Memorial Park	Commercial	Pervious	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.01	0.00	0.00	0.00	0.00	0.01
	Industrial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	High Density Residential	Pervious	0.01	0.00	0.41	0.00	0.00	0.41	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.09	0.00	0.00	0.09	0.09	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.98	0.00	0.00	0.98
	Medium Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Low Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Highway	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Forest	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
	Open Land	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL			0.034	0.000	0.409	0.000	0.000	0.443	0.001	0.000	0.086	0.000	0.000	0.087	0.087	0.087	0.087	0.087	0.087	0.01	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99
JF Kennedy Elementary Jr High	Commercial	Pervious	0.27	0.00	0.00	0.00	0.00	0.27	0.03	0.12	0.21	0.29	0.37	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.30	1.2	2.40	3.1	3.6	0.08	0.00	0.00	0.00	0.00	0.08
	Industrial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	High Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Medium Density Residential	Pervious	0.04	0.07	0.00	0.00	0.00	0.11	0.03	0.12	0.21	0.29	0.37	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.30	1.2	2.40	3.1	3.6	0.01	0.09	0.00	0.00	0.00	0.10
	Low Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Highway	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Forest	Pervious	0.02	0.00	0.00	0.00	0.00	0.02	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.01	0.00	0.00	0.00	0.00	0.01
	Open Land	Pervious	0.21	0.00	0.00	0.00	0.00	0.21	0.03	0.12	0.21	0.29	0.37	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.30	1.2	2.40	3.1	3.6	0.06	0.00	0.00	0.00	0.00	0.06
Agriculture	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL			0.54	0.07	0.00	0.00	0.00	0.61	0.02	0.01	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.16	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Martin E. Young School	Commercial	Pervious	0.02	0.00	0.00	0.00	0.00	0.02	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.01	0.00	0.00	0.00	0.00	0.01
	Industrial	Pervious	0.0																												

Phosphorus Load Pervious Area Calculations

BMP Retrofit Location	Land Use	COVERNAME	Pervious HSG Area (US Acres)						Phosphorus Export Loading Rate (lb/ac/yr)					Phosphorus Load (lb/yr)						Nitrogen Export Loading Rate (lb/ac/yr)					Nitrogen Load (lb/yr)						
			A	B	C	C/D	D	Total	A	B	C	C/D	D	A	B	C	C/D	D		Total	A	B	C	C/D	D	A	B	C	C/D	D	Total
Woods at end of S Windemere Avenue	Commercial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Industrial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	High Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Medium Density Residential	Pervious	0.56	0.00	0.00	0.00	0.00	0.56	0.03	0.12	0.21	0.29	0.37	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.30	1.2	2.40	3.1	3.6	0.17	0.00	0.00	0.00	0.00	0.17
	Low Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Highway	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Forest	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
	Open Land	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	
	TOTAL		0.56	0.00	0.00	0.00	0.00	0.56	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02						0.17	0.00	0.00	0.00	0.00	0.17
Open Space Adjacent to Great Pond	Commercial	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Industrial	Pervious	0.28	0.00	0.00	0.00	0.00	0.28	0.03	0.12	0.21	0.29	0.37	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.30	1.2	2.40	3.1	3.6	0.08	0.00	0.00	0.00	0.00	0.08
	High Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Medium Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Low Density Residential	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Highway	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
	Forest	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
	Open Land	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.21	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.2	2.40	3.1	3.6	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	Pervious	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	
	TOTAL		0.28	0.00	0.00	0.00	0.00	0.28	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01						0.08	0.00	0.00	0.00	0.00	0.08

Estimated Phosphorus Load Reduction Costs							
Land Use	Nload Export Rate	Pload Export Rate	Pload Reduction Costs		Ratio	Nload Reduction Costs	
			Low	High		Low	High
COM/IND	15.0	1.78	\$ 25,000.00	\$ 100,000.00	0.12	\$ 2,966.67	\$ 11,866.67
Residential	14.1	1.96 - 2.32			0.16	\$ 4,113.48	\$ 16,453.90
HWY	10.5	1.95			0.19	\$ 4,642.86	\$ 18,571.43
FOR	11.3	1.52			0.13	\$ 3,362.83	\$ 13,451.33
OPEN	11.3	1.52			0.13	\$ 3,362.83	\$ 13,451.33
AG	11.3	1.52			0.13	\$ 3,362.83	\$ 13,451.33
					Avg. =	0.15	\$ 3,635.25
			Min =	0.12	\$ 2,966.67	\$ 11,866.67	
			Max =	0.19	\$ 4,642.86	\$ 18,571.43	

BMP Retrofit Location	Total Area (Acres)	Potential Phosphorus Load Removal (lb/yr)	Potential Nitrogen Load Removal (lb/yr)	Estimated Pload Reduction Cost (Low)	Estimated Pload Reduction Cost (High)	Estimated Nload Reduction Cost (Low)	Estimated Nload Reduction Cost (High)
Randolph Highway Department	10.73	9.27	138.40	\$ 231,698.91	\$ 926,795.64	\$ 410,574.69	\$ 2,570,210.77
Joseph J. Zapustas Ice Arena	6.03	3.75	47.13	\$ 93,772.34	\$ 375,089.36	\$ 139,809.04	\$ 875,209.06
Joseph J. Hunt Memorial Park	1.62	2.19	31.28	\$ 54,635.09	\$ 218,540.37	\$ 92,812.01	\$ 581,006.19
JF Kennedy Elementary Jr High	2.16	2.09	30.03	\$ 52,317.62	\$ 209,270.49	\$ 89,097.92	\$ 557,755.83
Martin E. Young School	1.78	2.25	32.60	\$ 56,140.82	\$ 224,563.30	\$ 96,708.86	\$ 605,400.56
Elizabeth G. Lyons School	19.73	11.48	170.17	\$ 287,084.02	\$ 1,148,336.08	\$ 504,837.23	\$ 3,160,297.29
Cochato Camp House and Park	4.04	2.12	29.33	\$ 53,117.94	\$ 212,471.75	\$ 87,023.13	\$ 544,767.59
Woods at end of S Windemere Avenue	0.96	0.47	7.02	\$ 11,842.73	\$ 47,370.93	\$ 20,829.84	\$ 130,395.48
Open Space Adjacent to Great Pond	0.46	0.21	3.03	\$ 5,314.30	\$ 21,257.21	\$ 8,984.07	\$ 56,240.58
Total =	47.52	33.84	488.99	\$ 845,923.78	\$ 3,383,695.13	\$ 1,450,676.80	\$ 9,081,283.34

APPENDIX B

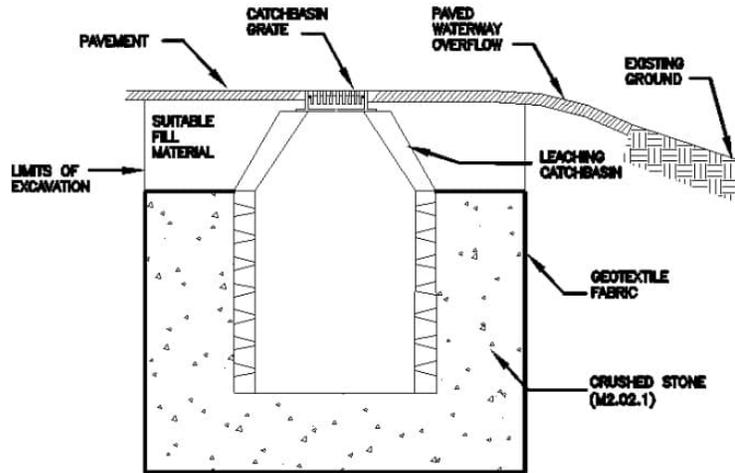
- BMP Retrofit Design Examples

☐ Infiltration Catchbasin/Manhole

- ❖ Pretreatment difficult, Shorter lifecycle – Can add sump for maintenance & pretreatment

Addressing

- ✓ Recharge
- ✓ TSS
- ❖ LUHPPL
- ❖ Critical
- ✓ Redevelop
- ✓ Pollutants
- ✓ Maintenance



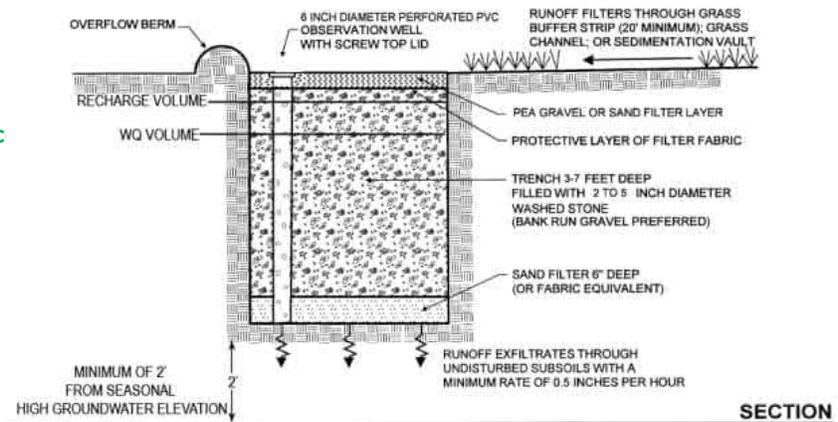
adapted from the MassHighway Department

☐ Infiltration Trench

- Flexible, Ideal for roadway edge
- Pipe/stone system doubles for conveyanc

Addressing

- ✓ Peak Flow
- ✓ Recharge
- ✓ TSS
- ❖ LUHPPL
- ❖ Critical
- ✓ Redevelop
- ✓ Pollutants
- ✓ Maintenance



Example of Infiltration Trench

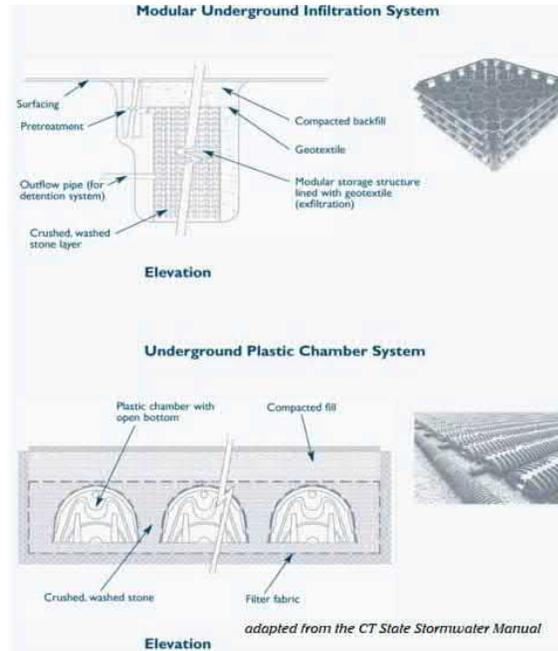
adapted from the University of New Hampshire

Subsurface Infiltration

- Flexible options
- ❖ Out of sight, High \$, Maintenance

Addressing

- ✓ Peak Flow
- ✓ Recharge
- ✓ TSS
- ❖ LUHPPL
- ❖ Critical
- ✓ Redevelop
- ✓ Pollutants

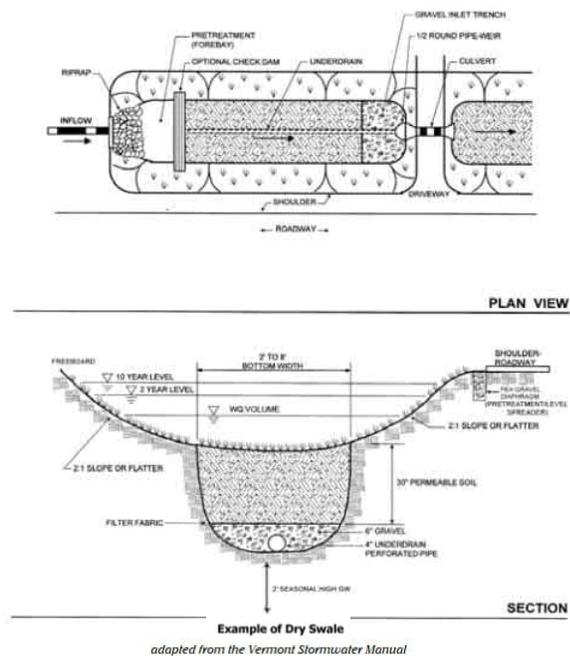


WATER QUALITY SWALE (DRY)

- Low maintenance \$
- ❖ Little to no peak flow, recharge

Addressing

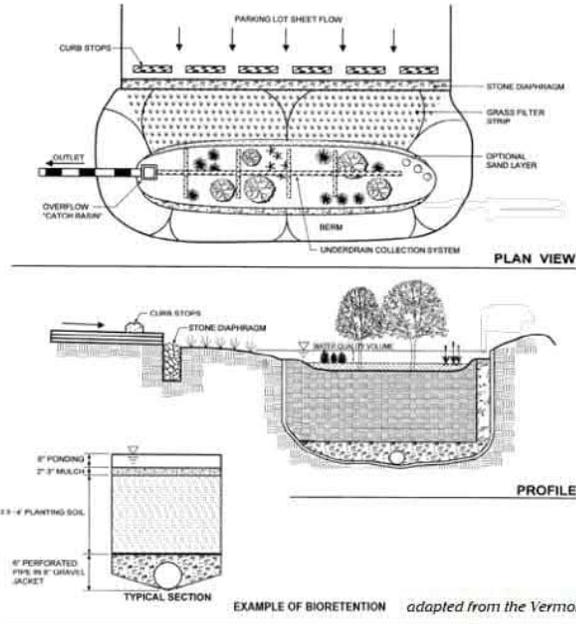
- ❖ Peak Flow
- ❖ Recharge
- ✓ TSS
- ❖ LUHPPL
- ❖ Critical
- ✓ Redevelop
- ✓ Pollutants
- ✓ Maintenance



BIORETENTION (RAIN GARDEN)

- LID, High treatment
- Option for Poor Soil
- ❖ Landscaping
- ❖ Maintenance
- ❖ For Small Area

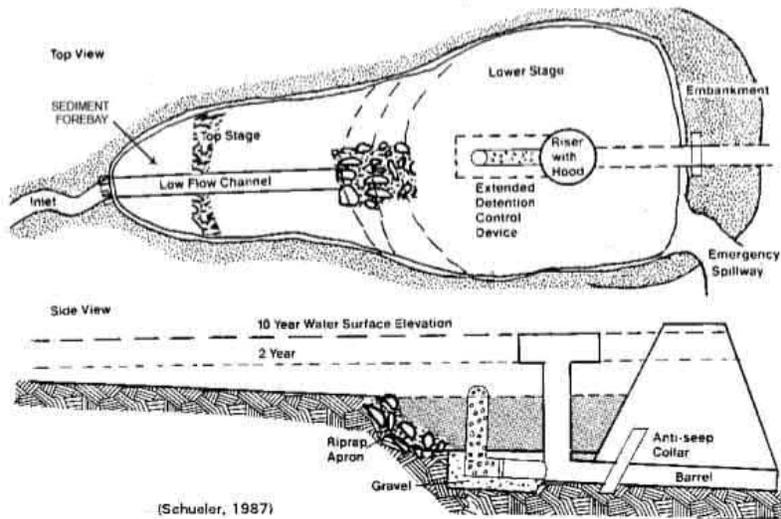
- ❖ Peak Flow
- ❖ Recharge
- ✓ TSS
- ❖ LUHPPL
- ❖ Critical
- ❖ Redevelop
- ✓ Treatment



adapted from the Vermont Stormwater Manual

EXTENDED DRY DETENTION BASIN

- ☐ Peak flow, some treatment
- ❖ No recharge credit



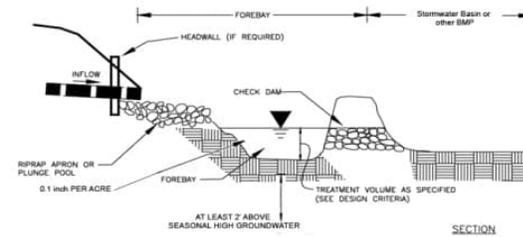
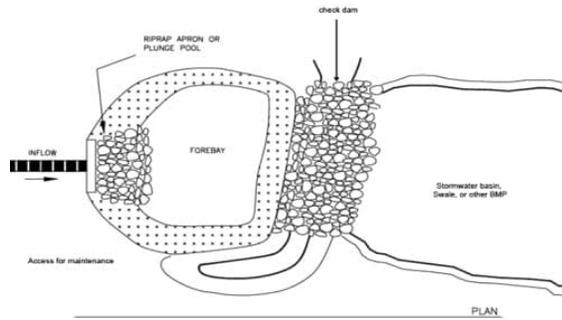
adapted from Controlling Urban Runoff, Schueler 1987

☐ Sediment Forebay

- Low \$, Easy to create
- Consider solid bottom
- ❖ Size 0.1 in/acre of pavement, Lined for LUHPPL

Addressing

- ✓ TSS
- ✓ Maintenance



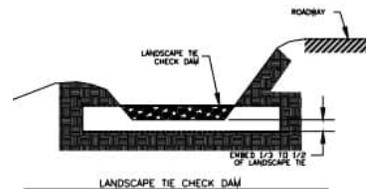
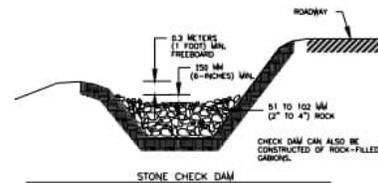
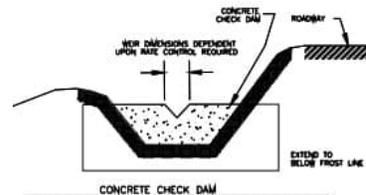
adapted from the Vermont Stormwater Handbook

☐ Check Dam

- Low \$
- Excellent for swales
- Consider solid bottom

Addressing

- ❖ Recharge
- ✓ TSS
- ✓ Redevelop
- ✓ Maintenance



Examples of Check Dams