Site Name: Spencer Water Department
Site Number: 21

0 20 40 80
Feet

N

Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 22	
DATE: 12/5/18	ASSESSED BY: RW HF	CAMERA ID:	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Spencer Fairgrounds
Address: Smithville Rd.

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☑ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☑ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☑ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☑ No ☐ Possible
If Yes, Describe:

Existing chainlink fence surrounding fair grounds in disrepair at top of slope overlooking W parking lot. Steep slopes not well vegetated / stable.

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Two large parking areas on either side of main entrance road to fairgrounds. 2-3 acres W side, ~~of~~ 3-5 acres E side entrance road. Both slope toward Smithville Road, and contains slopes varying from 3% to 12-18% (near embankment of fair grounds site). 3-5 acre, lower lot flanks Seven Mile River, and probs drains to it from some areas. Approx 200' of road frontage (Smithville) appears to be utilized for vehicular access to 2 lots and Fair grounds entrance. "Free for all" parking regimen.

PROPOSED RETROFIT

Purpose of Retrofit:
☑ Water Quality ☑ Recharge ☑ Channel Protection ☑ Flood Control
☐ Demonstration / Education ☐ Repair ☐ Other:_____

Proposed Treatment Option:
☐ Extended Detention ☐ Wet Pond ☐ Created Wetland ☑ Bioretention
☐ Filtering Practice ☑ Infiltration ☐ Swale ☐ Other:_____

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Bioretention basins in ROW of Smithville Rd strategically located to frame/delineate entrances/exits to main access road and 2 parking areas. Possibly another b.r.b. in back of lower parking to intercept runoff headed to Seven mile river. Current grading supports concepts propose slope stabilization plantings on embankment of four grounds for when existing chainlink fence gets replaced/upgraded

SITE CONSTRAINTS

Adjacent Land Use:
☑ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☑ Park
☑ Undeveloped ☐ Other:_____
Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No
If Yes, Describe:

Access:
☐ No Constraints
Constrained due to
☑ Slope ☐ Space
☑ Utilities ☐ Tree Impacts
☑ Structures ☑ Property Ownership
☑ Other: Smithville Rd

Conflicts with Existing Utilities:
☐ None
☑ Unknown

Yes	Possible	
☐	☐	Sewer
☐	☑	Water
☐	☐	Gas
☐	☐	Cable
☐	☐	Electric
☐	☐	Electric to Streetlights
☐		Overhead Wires
☐	☐	Other:_____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☑ Not Probable
Impacts to Wetlands	☑ Probable	☐ Not Probable
Impacts to a Stream	☑ Probable	☐ Not Probable
Floodplain Fill	☐ Probable	☑ Not Probable
Impacts to Forests	☐ Probable	☑ Not Probable
Impacts to Specimen Trees	☐ Probable	☑ Not Probable

How many?_____
Approx. DBH_____

Other factors:_____

Soils:

Soil auger test holes:	☐ Yes	☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

A/B

Unique Site ID: 22

SKETCH

DESIGN OR DELIVERY NOTES

Green Infrastructure should be styled to match the vernacular of Fair Grounds. Still utilized for education & enjoyment/ public amenity thanks to town, but needs to blend in with overall feel of site as well as spatial uses.

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- [x] Confirm property ownership
- [ ] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [x] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [x] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [x] Confirm soil types
- [ ] Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

SITE CANDIDATE FOR FURTHER INVESTIGATION:	[x] YES	[ ] NO	[ ] MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	[ ] YES	[x] NO	[ ] MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	[ ] YES	[ ] NO	[ ] MAYBE

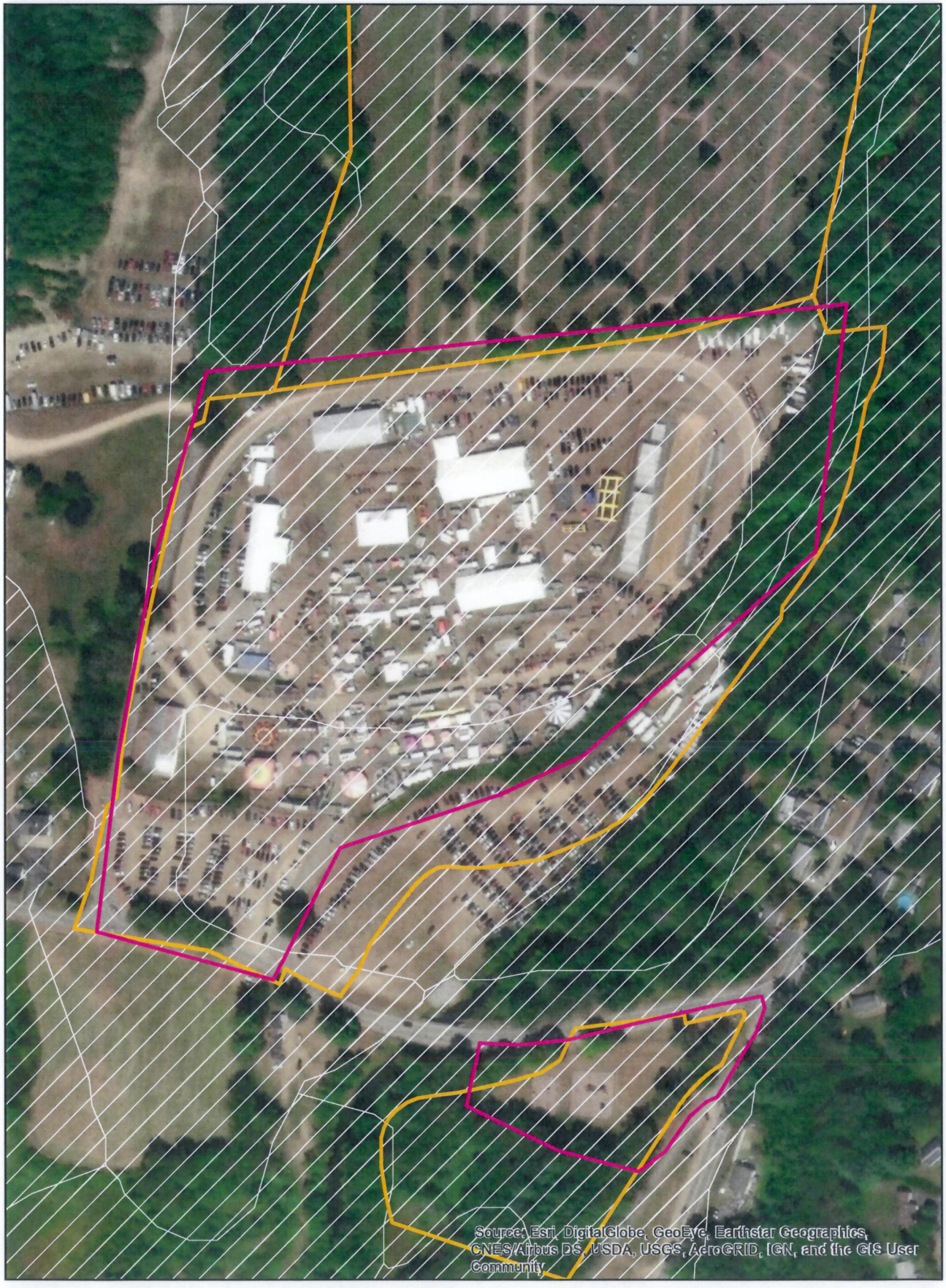
IF YES, TYPE(S):_____

Unique Site ID: 22

Site Name: Spencer Fairgrounds
Site Number: 22

0 120 240 480 Feet

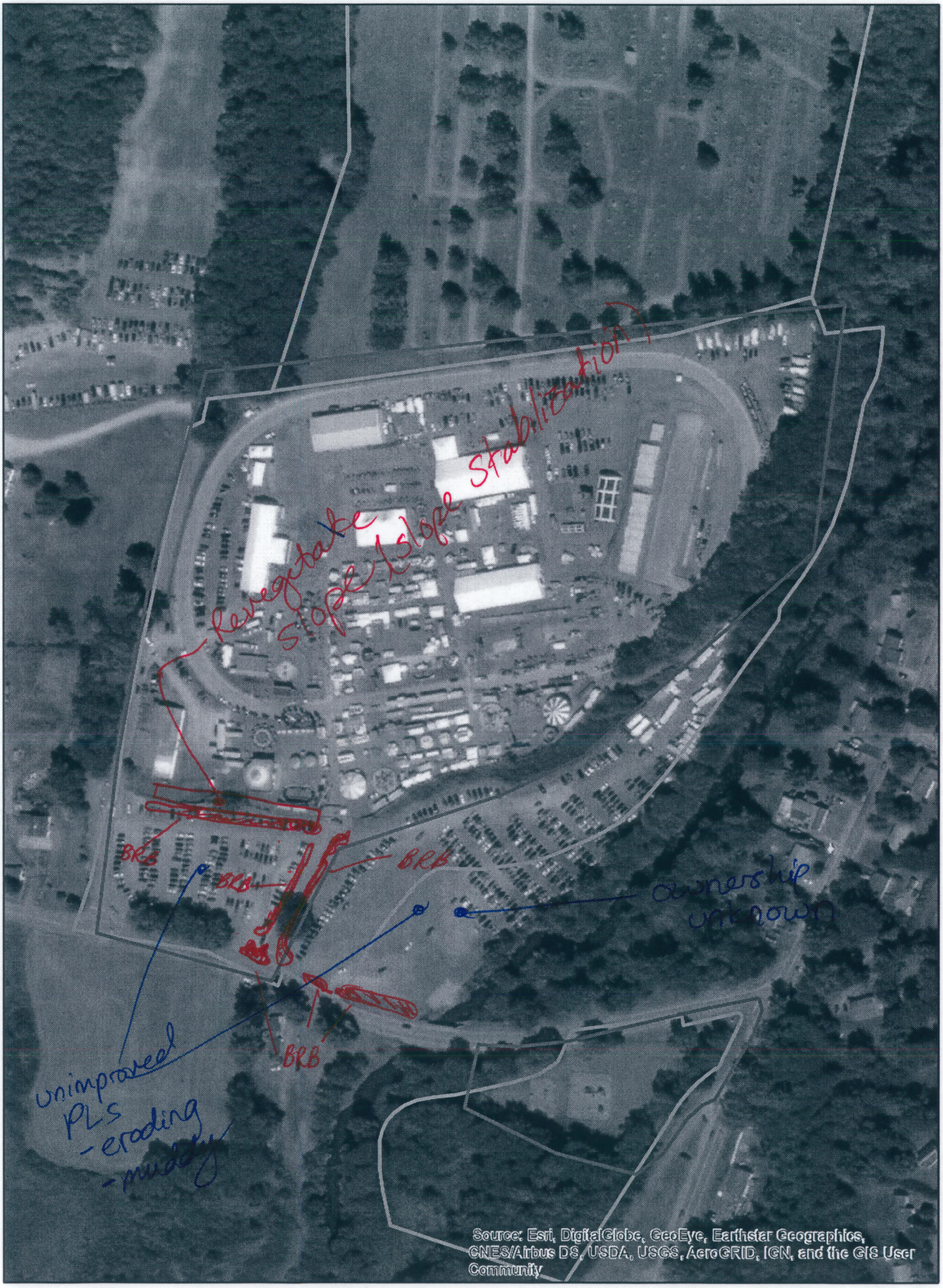
N



Site Name: Spencer Fairgrounds
Site Number: 22

0 120 240 480
Feet

N



Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 23	
DATE: 12/12/18	ASSESSED BY: RW HF	CAMERA ID: 2	PICTURES: after 10:53
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Knox Trail Junior High
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☒ Small Parking Lot s
- ☐ Individual Street
- ☐ Underground
- ☒ Individual Rooftop
- ☐ Small Impervious Area
- ☒ Landscape / Hardscape
- ☒ Other: fields

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☒ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☒ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

peastone along building fills w/ water
gutters + downspout don't work the way they're supposed to
North side + water pools along gym; garden on that side; gutters clogg
Western lawn - very green, receives a lot of water + not heavily used
- possibility to renaturalize steeper parts farther from building?

Unique Site ID: 23

PROPOSED RETROFIT

Purpose of Retrofit:

- [x] Water Quality
- [x] Demonstration / Education
- [ ] Recharge
- [ ] Repair
- [ ] Channel Protection
- [x] Flood Control
- [ ] Other:

Replace culvert + improve inlet to reduce seepage from spring through road

Proposed Treatment Option:

- [ ] Extended Detention
- [ ] Filtering Practice
- [ ] Wet Pond
- [x] Infiltration
- [ ] Created Wetland
- [ ] Swale
- [x] Bioretention
- [x] Other: forest buffer extension, cistern, Rain Barrels

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Bioretention practices to help infiltrate water close to building (roof drainage)

Infiltration when parking lot(s) repaved to infiltrate water from fields + lots (focus on infilt in lower lot if gw not too high - better

Rain barrels - elevated - to use for watering garden
- use bioretention as overflow

extend forest buffer on north side of school

SITE CONSTRAINTS

Adjacent Land Use:

- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [ ] Park
- [x] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No

If Yes, Describe:

Access:

- [ ] No Constraints

Constrained due to

- [x] Slope
- [ ] Space
- [x] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property Ownership
- [x] Other: Bedrock, wetlands

Conflicts with Existing Utilities:

- [ ] None
- [ ] Unknown

Yes	Possible	
[x]	[ ]	Sewer
[x]	[ ]	Water
[x]	[ ]	Gas
[ ]	[ ]	Cable
[ ]	[ ]	Electric
[ ]	[ ]	Electric to Streetlights
[ ]		Overhead Wires
[ ]	[ ]	Other:

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[ ] Not Probable
Impacts to Wetlands	[x] Probable	[ ] Not Probable
Impacts to a Stream	[ ] Probable	[ ] Not Probable
Floodplain Fill	[ ] Probable	[ ] Not Probable
Impacts to Forests	[ ] Probable	[ ] Not Probable
Impacts to Specimen Trees	[ ] Probable	[ ] Not Probable

How many?

Approx. DBH

Other factors:

Soils:

Soil auger test holes:	[ ] Yes	[ ] No	Marked A/B soils but wetlands adjacent
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No	
Evidence of shallow bedrock:	[x] Yes	[ ] No	
Evidence of high water table (gleying, saturation):	[x] Yes	[ ] No	wetlands

SKETCH

~~Contact~~ Plan to connect to gas main + remove gas tanks that are located in front lawn area

- possible loc'n for bioretention/filtering if contamination isn't an issue

DESIGN OR DELIVERY NOTES

Field currently irrigated
Lots of exposed/dumped bedrock

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☒ Confirm soil types
- ☐ Other: confirm bedrock

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

- School serves as town's emergency shelter
- NE parking lot drains to wetland
  - not much room for a practice
- repaving not planned for several years; needs to go on capital plan

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☒ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☒ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):_____

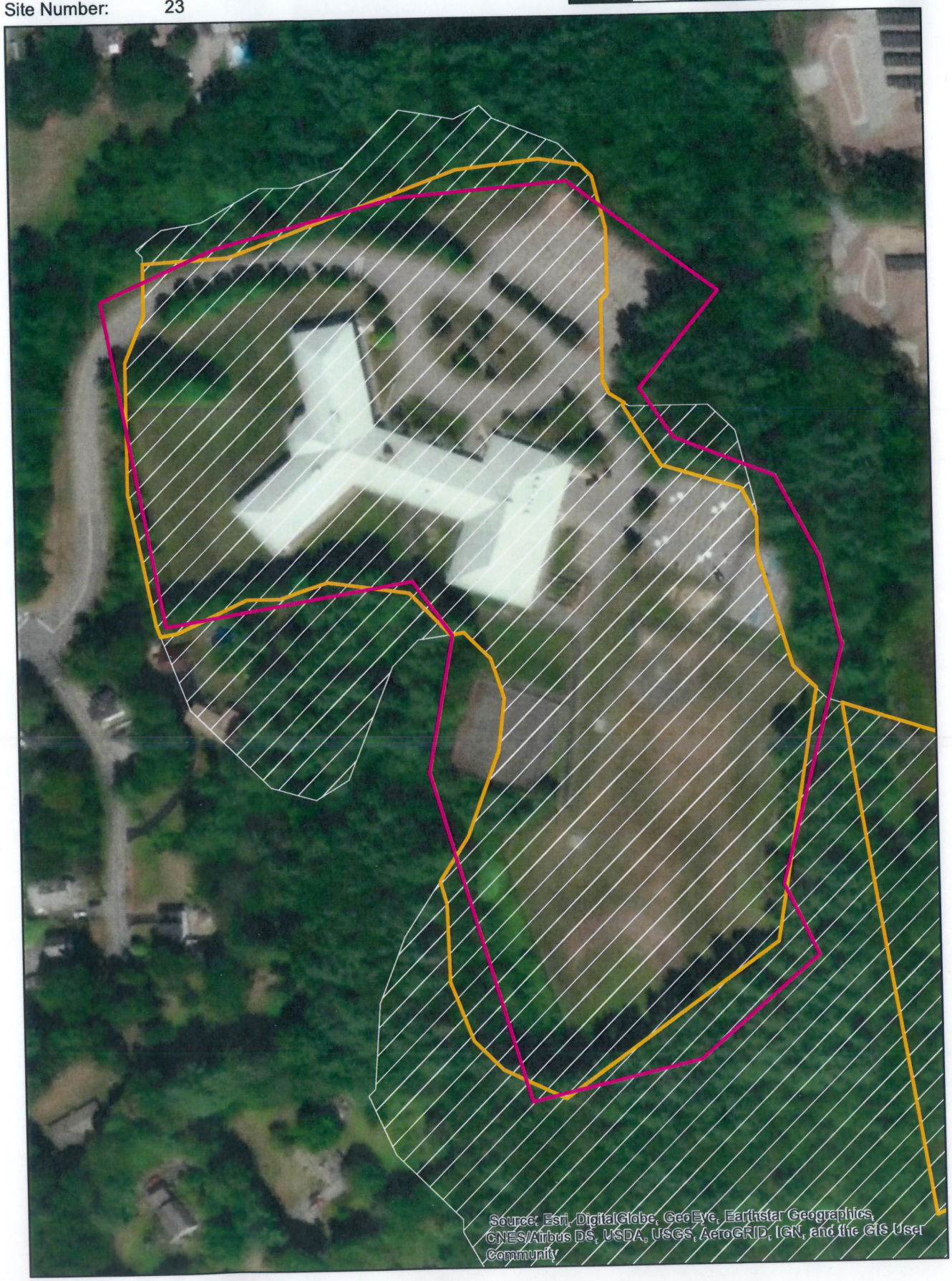
Unique Site ID: 23

Site Name: Knox Trail Junior High School

Site Number: 23

0 80 160 320 Feet

N



Site Name: Knox Trail Junior High School
Site Number: 23

Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spicer	SUBWATERSHED:	UNIQUE SITE ID: 24	
DATE: 12/5/18	ASSESSED BY: RW HF	CAMERA ID:	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Luther Hill + Laurel Hill Parks
Address:

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☑ In Road ROW
- ☐ Other:
- ☑ Above Roadway Culvert
- ☐ In Conveyance System
- ☑ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☑ Small Parking Lot
- ☑ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☑ Small Impervious Area
- ☑ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈
Imperviousness ≈ %
Impervious Area ≈

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☑ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Medium steepness, 5-14% sloped access road from wooded upland park area containing frisbee golf course curves down to public beach area @ waters edge. (Lake Whittemore). Stormwater currently runs off open space upslope of road, meets road runoff @ seam of road & embankment & travels to culvert inlet @ road side which outlets to Lake. Large beach area, boardwalk, picnic tables, & small structures including bathrooms / concession stand / changing room. Large mound upslope of road is raised septic from bathrooms.

Unique Site ID: 24

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [x] Recharge
- [ ] Repair
- [ ] Channel Protection
- [ ] Other:_____
- [ ] Flood Control

Proposed Treatment Option:
- [ ] Extended Detention
- [ ] Filtering Practice
- [ ] Wet Pond
- [x] Infiltration
- [ ] Created Wetland
- [x] Swale
- [x] Bioretention
- [ ] Other:_____

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

linear diversion, conveyance & infiltration bioswales btm access road & green space @ toe of slope

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [x] Park
- [x] Undeveloped
- [ ] Other:_____

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No

If Yes, Describe:

Access:
- [ ] No Constraints

Constrained due to
- [x] Slope
- [x] Space
- [ ] Utilities
- [x] Tree Impacts
- [x] Structures
- [ ] Property Ownership
- [ ] Other:_____

Conflicts with Existing Utilities:
- [ ] None
- [ ] Unknown

Yes	Possible	
[ ]	[x]	Sewer
[ ]	[x]	Water
[ ]	[ ]	Gas
[ ]	[ ]	Cable
[ ]	[x]	Electric
[ ]	[ ]	Electric to Streetlights
[ ]		Overhead Wires
[ ]	[ ]	Other:_____

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[x] Probable	[ ] Not Probable
Impacts to a Stream	[ ] Probable	[x] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[ ] Probable	[x] Not Probable

How many?_____

Approx. DBH_____

Other factors:_____

Soils:

Soil auger test holes:	[ ] Yes	[ ] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[ ] No
Evidence of shallow bedrock:	[ ] Yes	[ ] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[ ] No

C/D & urban

Unique Site ID: 24

SKETCH

See aerial

DESIGN OR DELIVERY NOTES

- if septic produces seepage, may not be a good place for BMP
  - may need to focus on fixing THAT problem

- BMP may be too close to lake, but since same drainage currently discharges directly to lake, could be argued as improvement

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☒ Obtain utility mapping septic
- ☐ Confirm storm drain invert elevations
- ☒ Confirm soil types ~~Maybe~~ on boundary of soils types
- ☐ Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☒ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☒ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):_____

Unique Site ID: 24

Site Name: Luther Hill and Laurel Hill Park

Site Number: 24

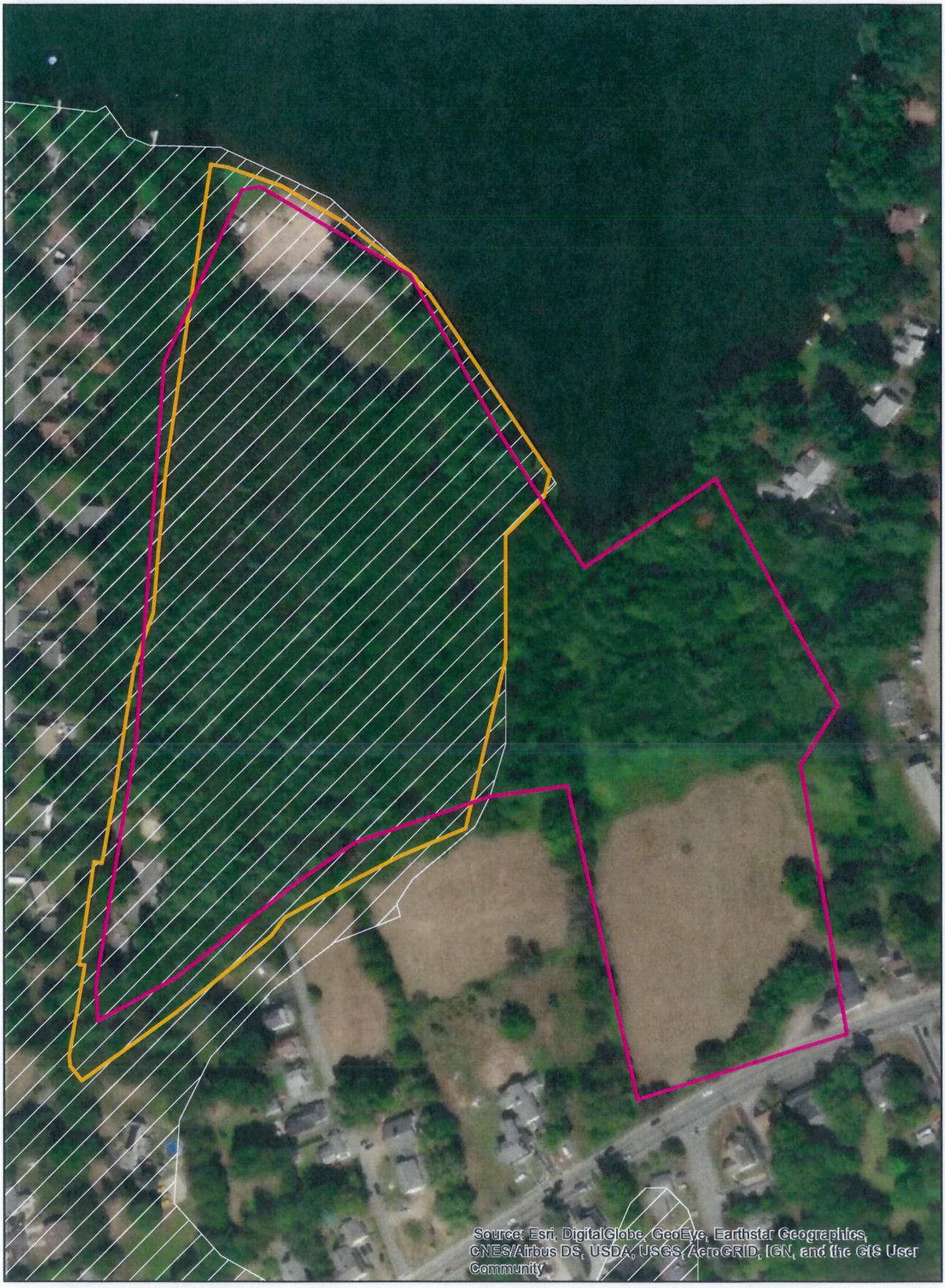
0 105 210 420 Feet

N

Site Name: Luther Hill and Laurel Hill Park
Site Number: 24

0 105 210 420 Feet

N



Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 25	
DATE: 12/4/18	ASSESSED BY: RW NF	CAMERA ID: 2	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Lake St School
Address: Lake St

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☒ Small Parking Lots
- ☐ Individual Street
- ☐ Underground
- ☒ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☒ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Large site draining in multiple directions. 2 Storm sewers on site (one in northern loop + one in eastern lot/entrance). Large paved + roof area.

PROPOSED RETROFIT

Purpose of Retrofit:
☒ Water Quality ☒ Recharge ☐ Channel Protection ☐ Flood Control
☒ Demonstration / Education ☐ Repair ☐ Other:_____

Community garden - raised beds
- in central courtyard.
- Amenity for residents
- Reduce paved surface
- add green space

Proposed Treatment Option:
☐ Extended Detention ☐ Wet Pond ☐ Created Wetland ☒ Bioretention
☐ Filtering Practice ☐ Infiltration ☐ Swale ☒ Other: Pavement removal, communit gardens

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
Consider removing portion of front parking lot & replacing w/ treatment, as well as installing linear bioretention along other side of lot; use both options to take stormwater offline from existing drainage system (~~use~~ use weir catch basins)
Multiple other potential sides for BRBs to treat + infiltrate roof + parking lot/road runoff (see aerial)

SITE CONSTRAINTS

Adjacent Land Use:
☒ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☒ Undeveloped ☐ Other:_____
Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No
If Yes, Describe:

Access:
☐ No Constraints + elevations
Constrained due to
☒ Slope ☒ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☒ Property Ownership agreement
☐ Other:_____

Conflicts with Existing Utilities:
☐ None
☐ Unknown

Yes	Possible	
☐	☒	Sewer
☐	☒	Water
☐	☒	Gas
☐	☐	Cable
☐	☒	Electric
☐	☐	Electric to Streetlights
☐		Overhead Wires
☐	☐	Other:_____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☒ Not Probable
Impacts to Wetlands	☐ Probable	☒ Not Probable
Impacts to a Stream	☐ Probable	☒ Not Probable
Floodplain Fill	☐ Probable	☒ Not Probable
Impacts to Forests	☐ Probable	☒ Not Probable
Impacts to Specimen Trees	☐ Probable	☒ Not Probable

How many?_____
Approx. DBH_____

Other factors:_____

Soils:

Soil auger test holes:	☐ Yes	☒ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☒ No
Evidence of shallow bedrock:	☒ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

A/C
upper portions of property

SKETCH

see aerial

DESIGN OR DELIVERY NOTES

~~Need~~ Parking capacity needed for planned redevelopment unknown. Some suggested BRB sites outside of ~~planned~~ "public amenity" portion of property in front area. Front area tough for BMPs due to elev, slope, long distance from paved areas to low areas of site

Possible to treat road runoff using BRB swales along east + south edges of site?

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- [x] Confirm property ownership arrangement
- [x] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [x] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [x] Obtain utility mapping
- [x] Confirm storm drain invert elevations
- [x] Confirm soil types
- [ ] Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

See above

SITE CANDIDATE FOR FURTHER INVESTIGATION:	[x] YES	[ ] NO	[ ] MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	[x] YES	[ ] NO	[ ] MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	[ ] YES	[ ] NO	[ ] MAYBE

IF YES, TYPE(S):_____

Site Name: Lake Street School
Site Number: 25

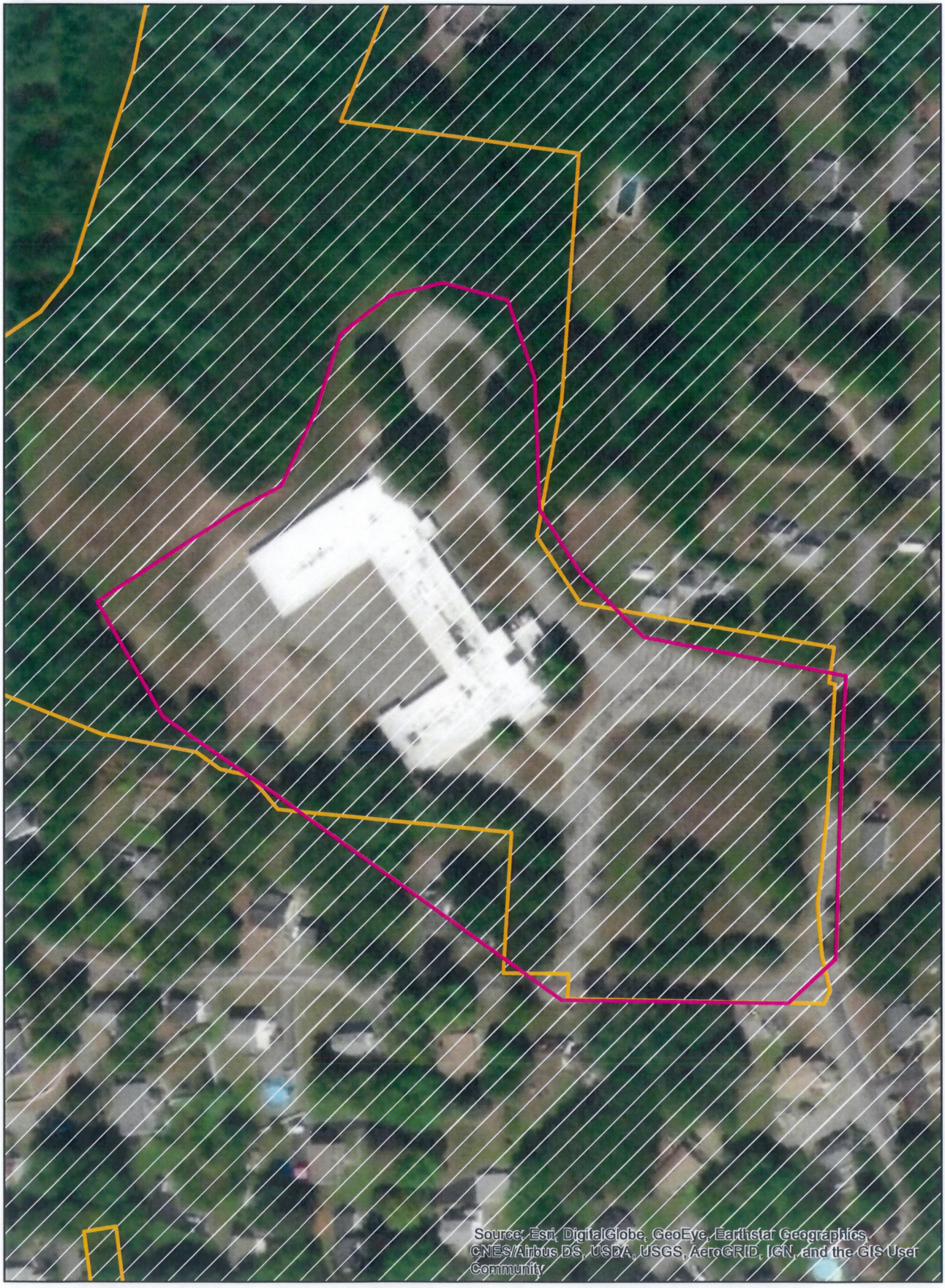
0 70 140 280 Feet

N

Site Name: Lake Street School
Site Number: 25

0 70 140 280 Feet

N



Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 27	
DATE: 12/12/18	ASSESSED BY: RW HF	CAMERA ID: 2	PICTURES: after 11
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Wire Village School
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☒ Yes ☐ No ☐ Possible
If Yes, Describe:

Detention ponds - 2 @ school + 1 @ athletic fields
- O+M plan pending (see back)

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Limited storm drains; all downspouts into ground
Water treated in large detention basins.
Large parking lot out front - islands RAISED + irrigated; CBs @ NW end
Site surrounded by wetlands; Bridge crosses wetlands

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [x] Recharge
- [ ] Repair
- [ ] Channel Protection
- [ ] Other:
- [ ] Flood Control

Proposed Treatment Option:
- [ ] Extended Detention
- [x] Filtering Practice
- [ ] Wet Pond
- [x] Infiltration
- [ ] Created Wetland
- [x] Swale
- [x] Bioretention ?
- [x] Other: cistern for irrigation storage

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Sites not selected yet
- many possibilities but ltd sites

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [ ] Park
- [x] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [x] Yes [ ] No

If Yes, Describe: wetlands surround school

Access:
- [ ] No Constraints

Constrained due to
- [x] Slope
- [x] Space
- [x] Utilities
- [x] Tree Impacts
- [x] Structures
- [ ] Property Ownership
- [ ] Other:

Conflicts with Existing Utilities:
- [ ] None
- [ ] Unknown

Yes	Possible	
[x]	[ ]	Sewer
[x]	[ ]	Water
[x]	[ ]	Gas
[x]	[ ]	Cable
[x]	[ ]	Electric
[x]	[ ]	Electric to Streetlights
[x]		Overhead Wires
[ ]	[ ]	Other:

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[x] Probable	[ ] Not Probable
Impacts to a Stream	[ ] Probable	[x] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[x] Probable	[x] Not Probable

How many? ____ → some sites

Approx. DBH ____

Other factors: ____

Soils:

Soil auger test holes:	[ ] Yes	[ ] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[x] Yes	[ ] No

AB soils may be limited to athletic field parking lot, if even present

wetlands surrounding

Unique Site ID: 27

SKETCH

School district maintenance crew
- 2 full time
- looking to hire one part-time this year
- hiring one more full-time next year

- some maint. shared w/ town ~~(eg~~

Erie working on maint plan ~~for~~ detention basins
- will utilize correctional inmates (community service) for maint. tasks

Parking lot runoff to detention~~s~~ basins
- addit. treatment considered too redundant?
- find way to repurpose water instead of infiltrating?
  - may require additional treatment/filtering
    - test basin water for ~~oil~~ oil, salt, nutrients, carcinogens,

Focus on using roof runoff for irrigation? (lower pollutant load)
- would only be a supplement

Unique Site ID: 27

DESIGN OR DELIVERY NOTES

wetlands around edge of school property?

Rec fields
- football, soccer + softball
  - HS + town
  - irrigated from 4" main?

Path thru wetland connects school to fields

Wetlands in rel. good shape - lots of natives, few invasives observed

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☒ Confirm soil types
- ☐ Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

School built 2004?

parking lot - heavily sanded + salted

Heavy irrigation use

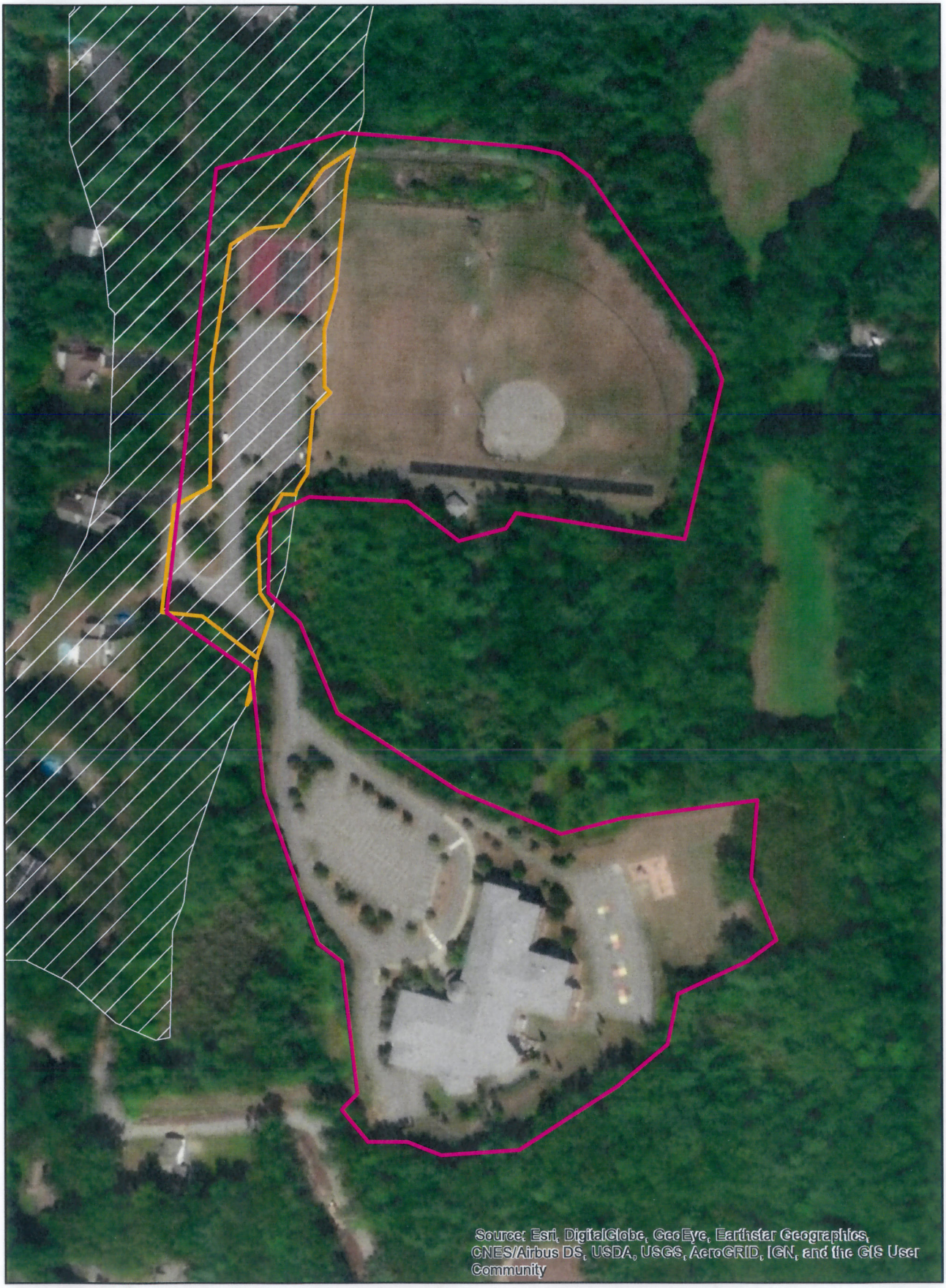
SITE CANDIDATE FOR FURTHER INVESTIGATION:	☒ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☒ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):_____

Site Name: Wire Village School
Site Number: 27

0 95 190 380 Feet

N



Site Name: Wire Village School
Site Number: 27

0 95 190 380 Feet

N

bury cistern or other water storage device for irrigation

fire dept. water tank

Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 28	
DATE: 12/5/18	ASSESSED BY: RW HF	CAMERA ID:	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Powder Mill Park
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☒ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☒ Landscape / Hardscape
- ☒ Other: Park

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☒ Residential
  - ☒ SFH (< 1 ac lots)
  - ? ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☒ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Storm drains collect water from large length of roads + residential - discharge directly to Mile river immed U/S of Smithville Rd Bridge.

Parking area @ Park unimproved

Large ROW likely to have few utility conflicts outside of park fence.

Park, appears heavily used; bordered on back side by woods; wetlands (+playground) visible thru trees

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [x] Recharge
- [ ] Repair
- [x] Channel Protection
- [ ] Other:
- [x] Flood Control

→ Also include native plantings + assoc. sign for complete "suite" of topics

Proposed Treatment Option:
- [ ] Extended Detention
- [ ] Filtering Practice
- [ ] Wet Pond
- [ ] Infiltration
- [ ] Created Wetland
- [ ] Swale
- [x] Bioretention (successive) some linear
- [ ] Other:

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance: Smithville Meadow

Install 3 large BRBs in ROW to take stormwater from roads + parking area offline & treat/recharge before entering Emile river.
Install BRBs outside park fence to leave space for play
Include educational signage inside park fence (facing road (part of suites around fenceline - include signage for woods + wetland areas too)

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [x] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [ ] Park
- [x] Undeveloped
- [ ] Other: Fairgrounds

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [x] No

If Yes, Describe:

Access:
- [x] No Constraints

Constrained due to
- [ ] Slope
- [ ] Space
- [ ] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property Ownership
- [ ] Other:

Conflicts with Existing Utilities:
- [ ] None
- [ ] Unknown

Yes	Possible	
[ ]	[ ]	Sewer
[ ]	[ ]	Water
[ ]	[ ]	Gas
[ ]	[ ]	Cable
[ ]	[ ]	Electric
[ ]	[ ]	Electric to Streetlights
[x]	[ ]	Overhead Wires
[ ]	[x]	Other: Utility Poles

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[x] Probable	[ ] Not Probable
Impacts to a Stream	[x] Probable	[ ] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[x] Probable	[x] Not Probable

How many?
Approx. DBH

Other factors:

Soils:

Soil auger test holes:	[ ] Yes	[ ] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[x] No

A/B soils

Unique Site ID: 28

SKETCH

see aerial

DESIGN OR DELIVERY NOTES

better if part of a larger park design process
- more maintenance effort likely to be put in
- get some group to adopt + volunteer to maintain

- Native plantings - part of eagle scout or other local project? (w/ consultant)
- local nursery as sponsor?

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☒ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☒ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☒ Confirm soil types
- ☐ Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

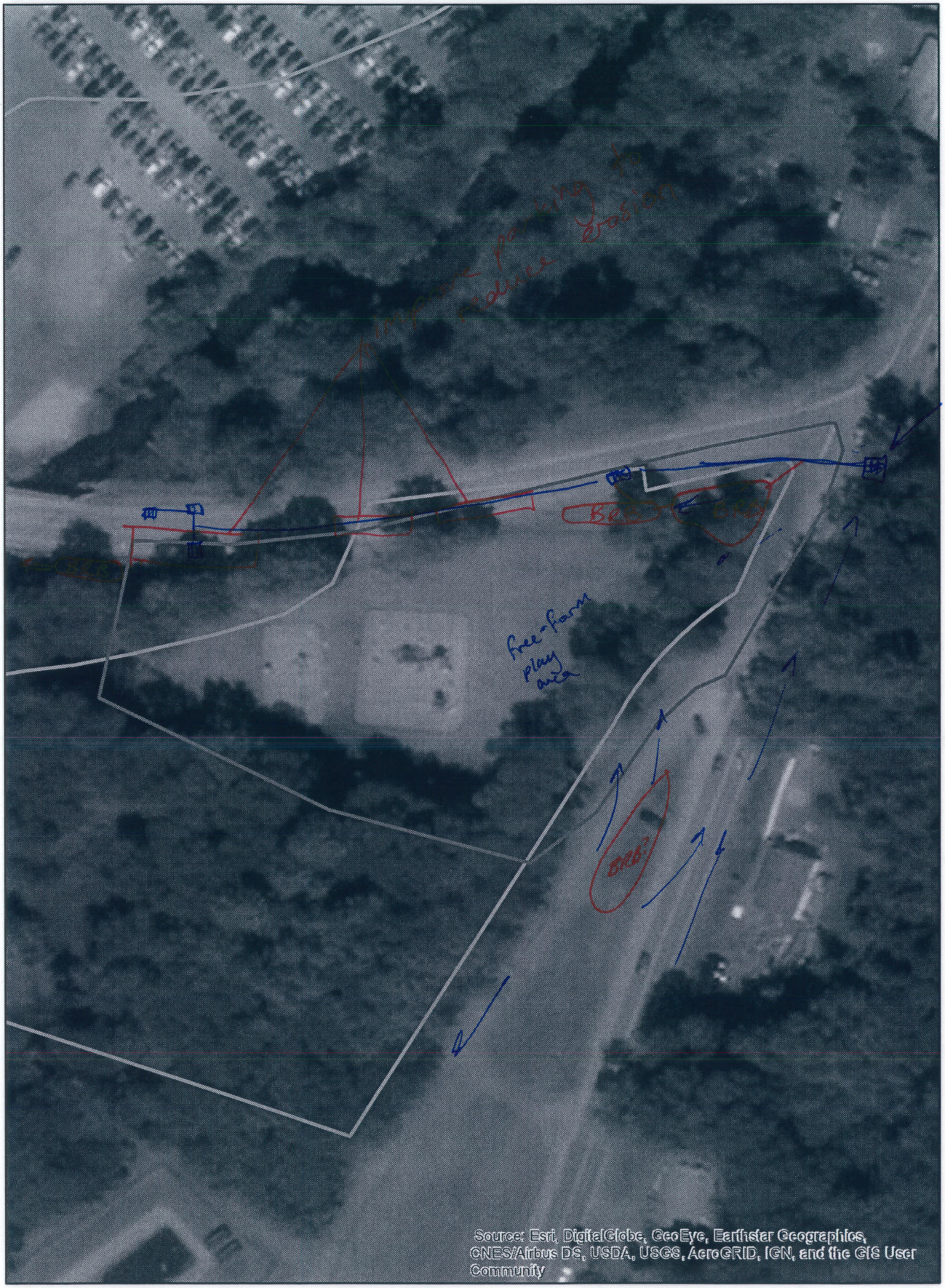
SITE CANDIDATE FOR FURTHER INVESTIGATION:	☒ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☒ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):_____

Site Name: Powder Mill Park
Site Number: 28

0 45 90 180 Feet

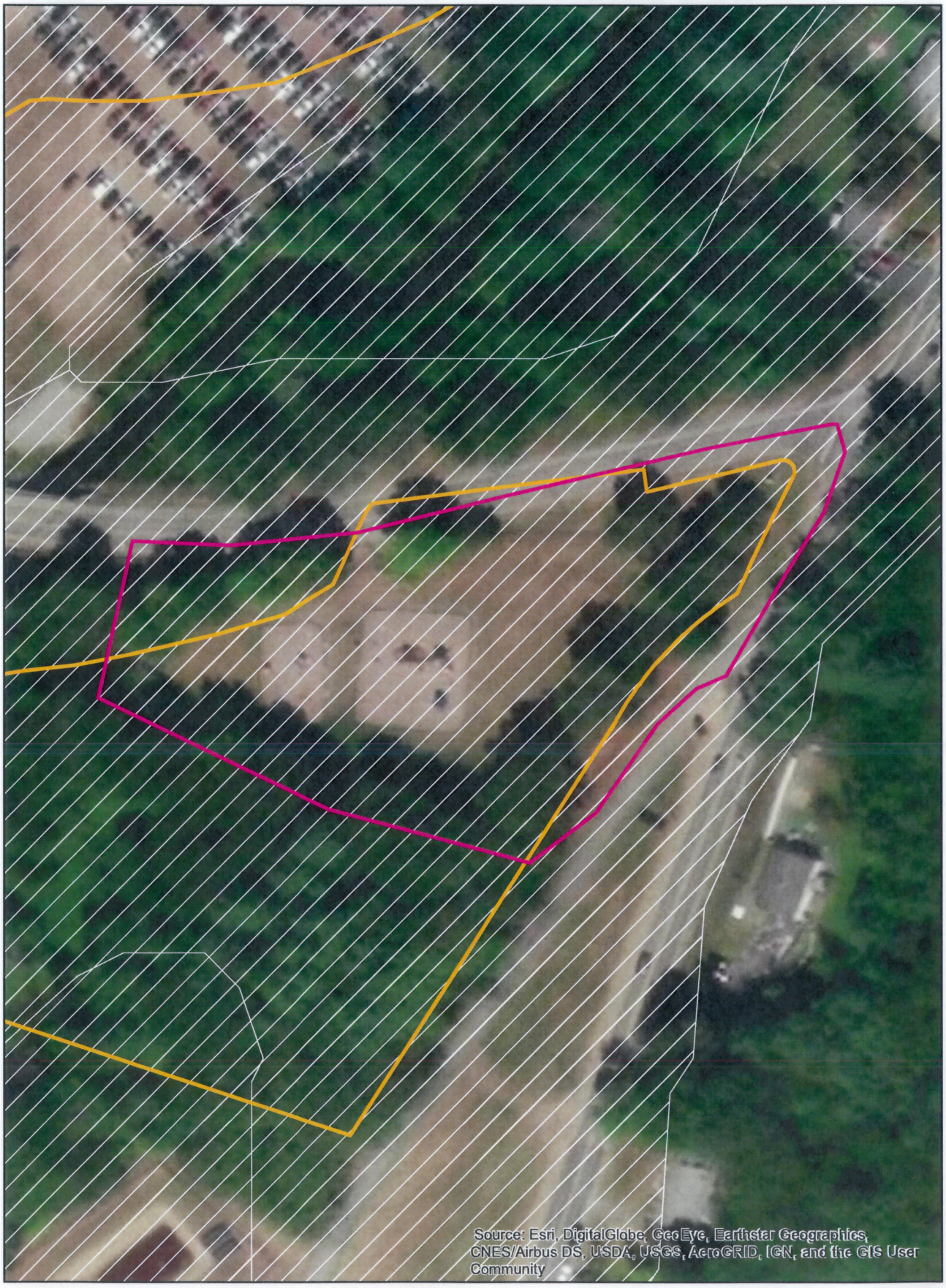
N



Site Name: Powder Mill Park
Site Number: 28

0 45 90 180 Feet

N



Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 29	
DATE: 12/4/18	ASSESSED BY: RW HF	CAMERA ID: 2	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: O'Gara Park
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ? ☒ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☒ Landscape / Hardscape
- ☒ Other: Large parking lot

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☒ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

No exist

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

No existing site drainage apparent
Parking lot half paved (upgradient portion), half unpaved (down gradient portion) w/ mulch + soil berm pushed/plowed up along boundary of unpaved portion.
Donuts driven in unpaved area.
Ball field above lot, appears uniformly flat, surrounded by locked chain link fence w/ broken barbed wire along top.
~~Other~~ Site rundown, eyesore,

Unique Site ID: 29

PROPOSED RETROFIT

Purpose of Retrofit:

☒ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☒ Demonstration / Education ☐ Repair ☐ Other:_____

Install bioretention @ north edge + northwest corner of ball field?

Proposed Treatment Option:

☐ Extended Detention ☐ Wet Pond ☐ Created Wetland ☒ ~~Bioretention~~ ?
☐ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other: Remove pavement

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Remove parking lot + revegetate edges, especially along edges

Pave unpaved portion of parking lot

SITE CONSTRAINTS

Adjacent Land Use:

☒ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☒ Undeveloped ☐ Other:_____

Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No

If Yes, Describe:

Access:

☐ No Constraints

Constrained due to

☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property Ownership
☒ Other: U+F plans

Conflicts with Existing Utilities:

☐ None
☐ Unknown

Yes	Possible	
☐	☑	Sewer ?
☐	☑	Water ?
☐	☐	Gas
☐	☐	Cable
☑	☐	Electric
☐	☐	Electric to Streetlights
☐		Overhead Wires
☐	☐	Other:_____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☒ Not Probable
Impacts to Wetlands	☒ Probable	☐ Not Probable
Impacts to a Stream	☒ Probable	☐ Not Probable
Floodplain Fill	☐ Probable	☒ Not Probable
Impacts to Forests	☐ Probable	☒ Not Probable
Impacts to Specimen Trees	☐ Probable	☒ Not Probable

How many?_____

Approx. DBH_____

Other factors:_____

Soils:

Soil auger test holes:	☐ Yes	☒ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☒ No
Evidence of shallow bedrock:	☐ Yes	☒ No
Evidence of high water table (gleying, saturation):	☐ Yes	☒ No

Urban or C/D soils

SKETCH

See aerial

DESIGN OR DELIVERY NOTES

could be relatively low cost + may be supported by permitting agency (as a restoration project)

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☒ Other: Determine U+f planned site improvements

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

Unknown U+f plans for site

Opportunity for "reclaiming" site

Check previous use of site - industrial?
- hot spot?

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☒ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☒ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S): _____

Unique Site ID: 12479

Site Name: O'Gara Park
Site Number: 29

0 55 110 220 Feet

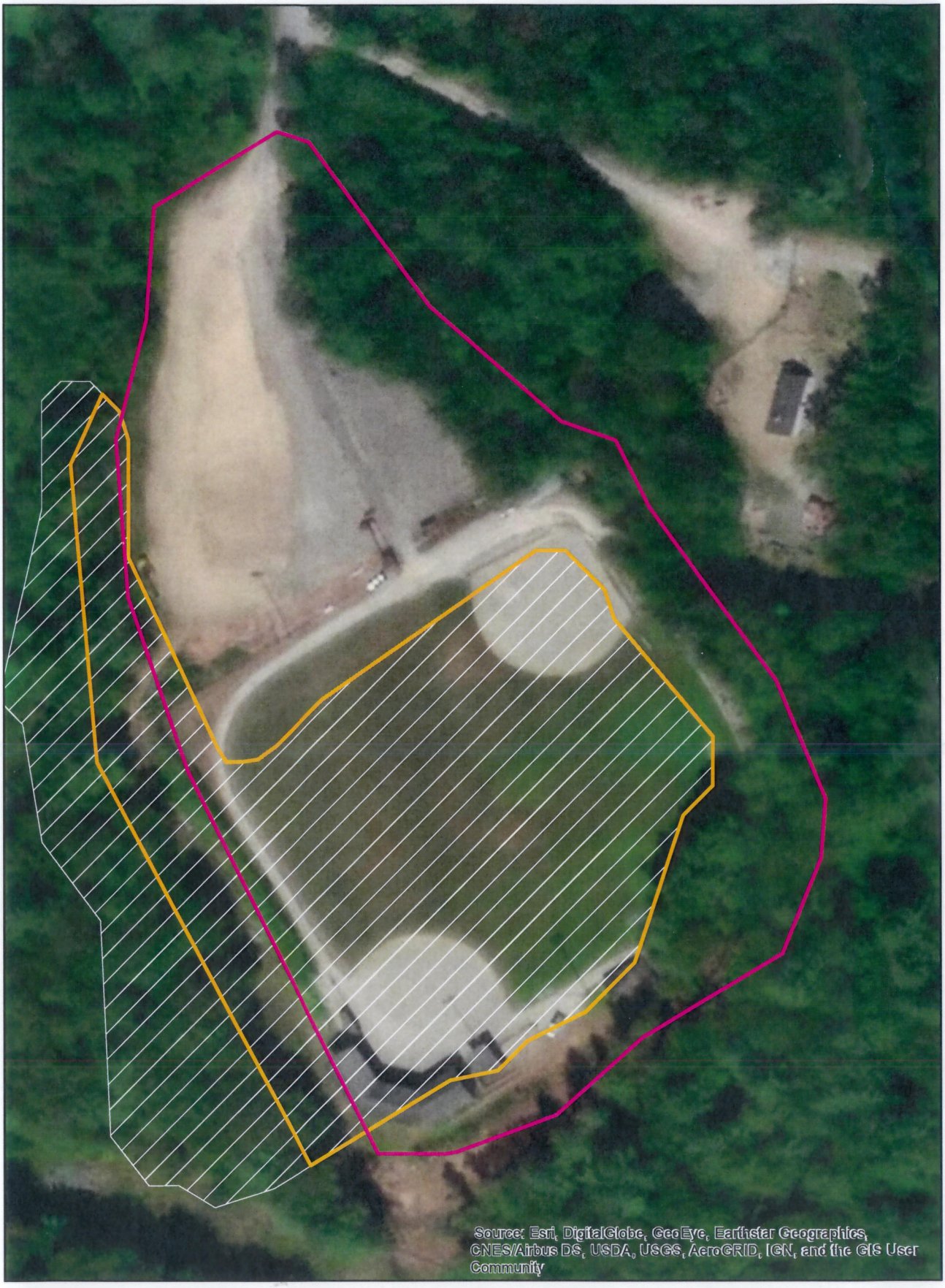
N

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Site Name: O'Gara Park
Site Number: 29

0 55 110 220 Feet

N



Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Charlton	SUBWATERSHED:	UNIQUE SITE ID: 30	
DATE: 12/13/18	ASSESSED BY: RW HF	CAMERA ID: 2	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Park in Front of Charlton Town Hall
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☒ In Road ROW
- ☐ Other: Adjacent to library road
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☒ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☒ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈
Imperviousness ≈ %
Impervious Area ≈

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☒ Institutional
- ☐ Industrial
- ☒ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☐ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Highly public park btwn Town Hall + library contains flagpoles, pavilion, xmas decorations
Area is raised 6" above adjacent road + PL by curbs

Unique Site ID: 30

PROPOSED RETROFIT

Purpose of Retrofit:

- [x] Water Quality
- [x] Demonstration / Education
- [ ] Recharge
- [ ] Repair
- [ ] Channel Protection
- [ ] Other:
- [ ] Flood Control

Proposed Treatment Option:

- [ ] Extended Detention
- [ ] Filtering Practice
- [ ] Wet Pond
- [ ] Infiltration
- [ ] Created Wetland
- [ ] Swale
- [ ] Bioretention
- [ ] Other: N/A

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

None - see conflicts

SITE CONSTRAINTS

Adjacent Land Use:

- [ ] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [ ] Park
- [ ] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No

If Yes, Describe:

Access:

- [ ] No Constraints

Constrained due to

- [ ] Slope
- [ ] Space
- [ ] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property Ownership
- [ ] Other:

Conflicts with Existing Utilities:

- [ ] None
- [ ] Unknown

Utilities criss-cross site

Yes	Possible	
[ ]	[x]	~~Sewer~~
[x]	[ ]	Water
[ ]	[x]	Gas
[x]	[x]	Cable
[x]	[ ]	Electric
[ ]	[ ]	Electric to Streetlights, ~~etc~~
[ ]		Overhead Wires
[ ]	[ ]	Other:

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[ ] Not Probable
Impacts to Wetlands	[ ] Probable	[ ] Not Probable
Impacts to a Stream	[ ] Probable	[ ] Not Probable
Floodplain Fill	[ ] Probable	[ ] Not Probable
Impacts to Forests	[ ] Probable	[ ] Not Probable
Impacts to Specimen Trees	[ ] Probable	[ ] Not Probable

How many?

Approx. DBH

Other factors:

Soils:

Soil auger test holes:	[ ] Yes	[ ] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[x] No

C/D soils

Unique Site ID: 30

SKETCH

DESIGN OR DELIVERY NOTES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

Many utilities, trees, xmas decorations, pavilion, benches, height compared to pavement

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☒ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☒ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☒ MAYBE

IF YES, TYPE(S): portions could be planted w/ native plants for birds, butterflies, etc. for habitat & aesthetics; rain garden plants would require little maintenance

Unique Site ID: 36

Site Name: Park in Front of Charlton Town Hall

Site Number: 30

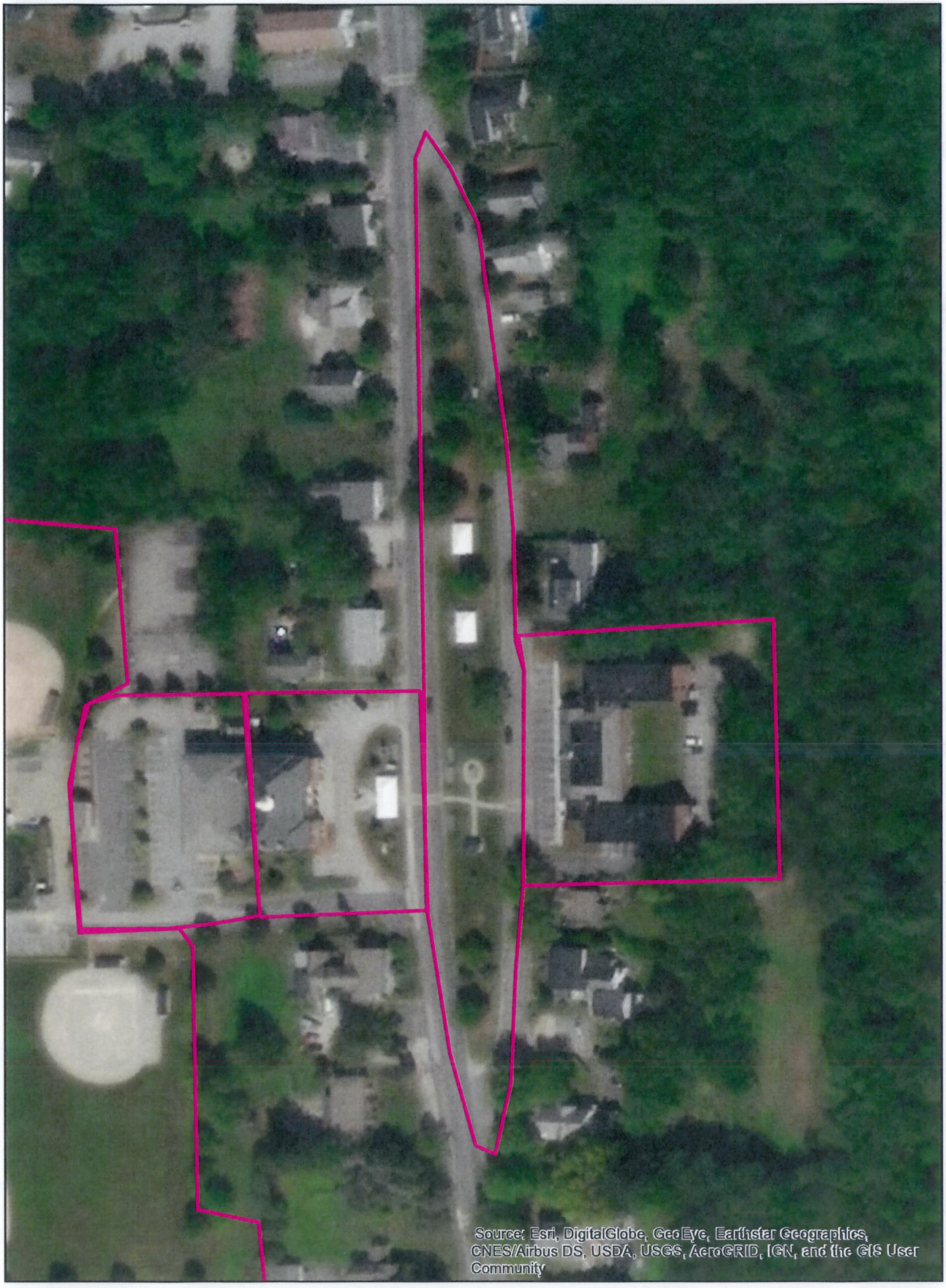
0 65 130 260 Feet

N

Site Name: Park in Front of Charlton Town Hall
Site Number: 30

0 65 130 260
Feet

N



Filled out after return to office

Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 33	
DATE: 12/12/18	ASSESSED BY: RW HF	CAMERA ID: 2	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Intersection of Wall & Lloyd Dyer Streets
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☒ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site (nearby)
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈
Imperviousness ≈ %
Impervious Area ≈

Notes:

Drainage Area Land Use:
- ☒ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☒ Multi-Family
- ☒ Commercial
- ☐ Institutional
- ☐ Industrial
- ☒ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Lloyd dyer St pavement requires repair; same for Wall St (N-S)
Wall st (E-W) in better shape; ~~total~~
Lloyd Dyer crosses ~~stream~~ buried stream right before it daylights @ Lloyd Dyer
(buried stream is likely outflow from Mudge Meadow Dam)
Private: Park, multi family housing, historic train depot, warehouse line street
wide street, fairly short in length
National grid? gas tanks @ end of street.
Street sides used for parking
One mun. lot @ corner of W+LD streets - gravel, used for parking
one mun. lot nearby on cross-street

Unique Site ID: 33

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [ ] Recharge
- [ ] Repair
- [ ] Channel Protection
- [x] Other: traffic calming
- [ ] Flood Control

Proposed Treatment Option:
- [ ] Extended Detention
- [x] ~~Filtering Practice~~
- [ ] Wet Pond
- [ ] Infiltration
- [ ] Created Wetland
- [ ] Swale
- [x] Bioretention
- [x] Other: green street

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

BRB - @ existing municipal lot - make a small "park"/green space
- tie in w/ proposed stormwater on main street (visually, not drainage wise) to "extend" treatment into neighborhood + make it feel linked w/ Main Street

Green street - entire street could be a demonstration green street (short but fairly wide)
- traffic calming bioretention bump-outs w/ delineated parking spaces between

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [x] Commercial
- [ ] Institutional
- [x] Industrial
- [ ] Transport-Related
- [ ] Park
- [ ] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No

If Yes, Describe:

Access:
- [ ] No Constraints

Constrained due to
- [x] Slope
- [x] Utilities
- [ ] Structures
- [ ] Space
- [ ] Tree Impacts
- [ ] Property Ownership
- [ ] Other:

Conflicts with Existing Utilities:
- [ ] None
- [ ] Unknown

Yes	Possible	
[x]	[ ]	Sewer
[x]	[ ]	Water
[x]	[ ]	Gas
[ ]	[x]	Cable
[x]	[ ]	Electric
[ ]	[ ]	Electric to Streetlights
[x]		Overhead Wires
[ ]	[ ]	Other:

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[ ] Probable	[x] Not Probable
Impacts to a Stream	[x] Probable	[ ] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[ ] Probable	[x] Not Probable

How many? _____

Approx. DBH _____

Other factors: possible contam. from Lloyd Dyer or National Grid Gas?

Soils:

Soil auger test holes:	[ ] Yes	[x] No
Evidence of poor infiltration (clays, fines):	[x] Yes	[ ] No – C/D or urban soils on map
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[x] No

Unique Site ID: 33

SKETCH

Unique Site ID: 33

DESIGN OR DELIVERY NOTES

CDVG grant funding (see below) may not be sufficient for complete green street
- ~~consider~~ may be limited to intersection (would be a lost opportunity, as street would not be redone for years)
- design should be visually tied in w/ local history (e.g. train depot) + main street so that improvements start to expand thru whole town.

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☒ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☒ Confirm soil types
- ☐ Other: _____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

RFP about to be awarded for roadwork @ this site
- recommendations for stormwater drainage + LID will be factored if provided in time
- CDVG funding

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☒ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☒ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☒ MAYBE

IF YES, TYPE(S): River restoration along Lloyd Dyer property? Stream daylighting?

Unique Site ID: 33

Site Name: Intersection of Wall & Lloyd Dyer Streets

Site Number: 33

0 40 80 160

Feet

N

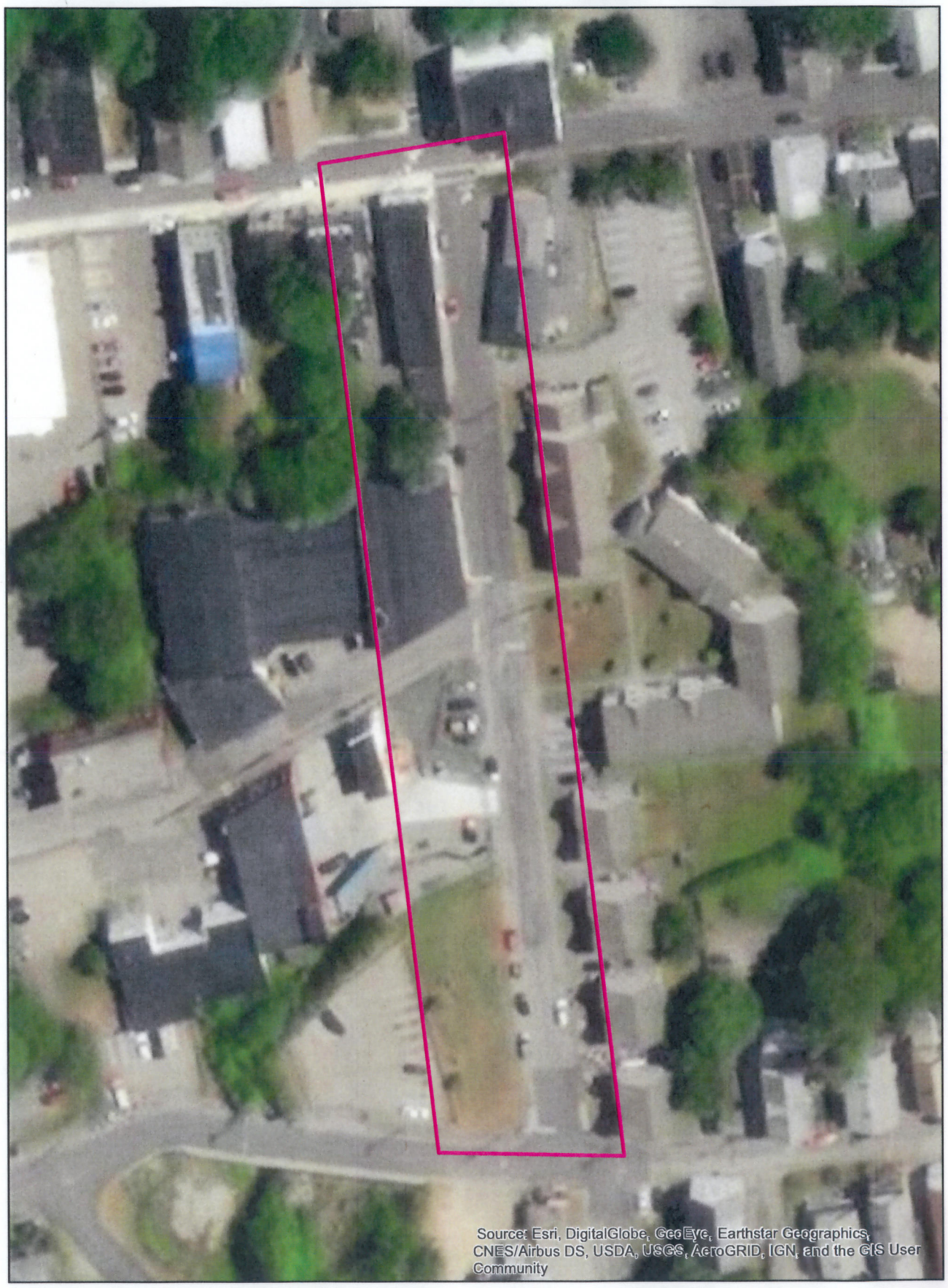
Site Name: Intersection of Wall & Lloyd Dyer Streets

Site Number: 33

0 40 80 160

Feet

N



Filled out after return to office

Retrofit Reconnaissance Investigation **RRI**

WATERSHED: Spencer	SUBWATERSHED:	UNIQUE SITE ID: 34	
DATE: 12/12/18	ASSESSED BY: RW HF	CAMERA ID: 2	PICTURES:
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Clark St outfall to Muzzy Meadow Pond
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☒ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _____
Imperviousness ≈ _____ %
Impervious Area ≈ _____

Notes:

Drainage Area Land Use:
- ☒ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Roads w/ no storm drains except @ outfall
Outfall directly into U/S end of pond

Unique Site ID: 34

PROPOSED RETROFIT

Purpose of Retrofit:
☒ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☒ Demonstration / Education ☐ Repair ☒ Other: traffic calming

Proposed Treatment Option:
☒ Extended Detention ☐ Wet Pond ☐ Created Wetland ☒ Bioretention
☒ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other:_____

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Green street treatment w/ bumpouts for bioretention
-will encourage parking on sides of street

Aqua swirl for filtering stormwater inflows

SITE CONSTRAINTS

Adjacent Land Use:
☒ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☒ Park
☐ Undeveloped ☐ Other:_____
Possible Conflicts Due to Adjacent Land Use? ☒ Yes ☐ No
If Yes, Describe:

Access:
☐ No Constraints
Constrained due to
☐ Slope ☒ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property Ownership
☐ Other:_____

Conflicts with Existing Utilities:
☐ None
☐ Unknown

Yes	Possible	
☐	☒	Sewer
☐	☒	Water
☐	☒	Gas
☐	☒	Cable
☐	☐	Electric
☐	☐	Electric to Streetlights
☐		Overhead Wires
☐	☐	Other:_____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☒ Not Probable
Impacts to Wetlands	☒ Probable	☐ Not Probable
Impacts to a Stream	☒ Probable	☐ Not Probable
Floodplain Fill	☐ Probable	☒ Not Probable
Impacts to Forests	☐ Probable	☒ Not Probable
Impacts to Specimen Trees	☐ Probable	☒ Not Probable

How many?_____
Approx. DBH_____

Other factors:_____

Soils:

Soil auger test holes:	☐ Yes	☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

Unique Site ID: 34

SKETCH

Unique Site ID: 34

DESIGN OR DELIVERY NOTES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:_____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

Parking on sides of street currently not allowed (reason unknown)
- Road may be too narrow for bioretention in ROW

Beaver activity in pond

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☒ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☒ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):_____

Site Name: Clark Street Outfall to Muzzy Meadow Pond

Site Number: 34

0 37.5 75 150

Feet

N

Site Name: Clark Street Outfall to Muzzy Meadow Pond

Site Number: 34

0 37.5 75 150

Feet

N

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Attachment C

Spreadsheet of Potential Green Infrastructure Retrofit Sites

Summary of Green Infrastructure Site Recommendations

Site Number	Site Name	Address	Owner	Potential Retrofit Options
Town of Charlton				
1	Charlton Police Department	37 Main Street	Town of Charlton	Sand Filter, Vortex Separator
2	Charlton Municipal Offices (Charlton Town Hall)	Route 31 Right-of-Way	Town of Charlton	Bioretention, Roof Runoff Capture and Reuse for Community Garden
3	Open Space in Front of Charlton Town Hall	No parcel data available; Town appears to use for displays	Dudley-Charlton Regional School District	
4	Heritage School	34 Oxford Road	Dudley-Charlton Regional School District	Bioretention, Roof Runoff Capture and Reuse, Regrade and Consider Elevating Access Road
5	Charlton Middle School	2 Oxford Road	Charlton Little League, Charlton Youth Soccer Inc.	Green Roof, Bioretention, Roof Runoff Capture and Reuse
6	Charlton Little League	50 Bond Road and 106 Bond Road	Town of Charlton	Bioretention
7	Prindle Lake Park	0 Prindle Hill Road	Southern Worcester County	Bioretention
8	Bay Path Vocational School	15 Old Muggett Hill Road	Town of Charlton	
9	Charlton Public Library	40 Main Street	Town of Charlton	
10	Fields Behind Charlton Public Library	0 Main Street	Dudley-Charlton Regional School District	Bioretention
11	Charlton Elementary School	9 Burlingame Road	Commonwealth of Massachusetts	Bioretention, Underground Infiltration
12	Glen Echo Lake Access	0 City Depot Road	David Peters	
13	United States Post Office	56 North Main Street	R&D Alliance LLC (leased to USPS)	
14	United States Post Office	9 Power Station Road	Town of Charlton	Bioretention
15	Charlton Garage	54 North Main Street	Town of Charlton	
16	Charlton Fire Department Headquarters	10 Power Station Road	Town of Charlton	
17	Maynard Farms Recreation Area	12 Dresser Hill Road and 0 Burlingame Road	Town of Charlton	Bioretention
Town of Spencer				
18	Howe State Park	51 Howe Road	Commonwealth of Massachusetts	Bioretention, Pavement Removal
19	David Prouty High School and Spencer-East Brookfield Regional HS Athletic Fields	302 Main Street	Town of Spencer	Bioretention, Roadside Swales
20	Spencer Town Hall	157 Main Street	Town of Spencer	Biorention, Pavement Removal, Improved Pedestrian Access
21	Powder Mill Park	Meadow Road	Town of Spencer	Bioretention
22	Spencer Police Department	9 West Main Street	Town of Spencer	
	Spencer Fire Department Headquarters	11 West Main Street	Town of Spencer	
	Spencer Rescue & Emergency Squad	6 Bixby Road	Spencer Rescue & Emergency Squad	
23	Richard Sugden Library	117 Main Street	Town of Spencer	Bioretention, Permeable Pavers
24	Spencer Water & Sewer Department	3 Meadow Hill Road	Town of Spencer	
25	Spencer Fairgrounds	46 Smithville Road	Town of Spencer	Riparian Buffer, Bioretention
26	O'Gara Park	Valley Street	Town of Spencer	Riparian Buffer
27	Knox Trail Junior High School	73 Ash Street	Town of Spencer	Bioretention, Roof Runoff Capture and Reuse for Irrigation
28	Luther Hill Park	19 Park Street	David P. Durgan	
	Laurel Hill Park	269 Main Street	Town of Spencer	
29	Lake Street School (public amenity portion)	17 Lake Street and 42 Highland Avenue	Town of Spencer	Pavement Removal, Bioretention
30	Wire Village School	60 Paxton Road	Town of Spencer	Bioretention, Roof Runoff Capture and Reuse for Irrigation
31	Intersection of Lloyd Dyer and Wall Streets	Wall Street and Lloyd Dyer Street	Town of Spencer	Green Street
32	Clark Street Outfall to Muzzy Meadow Pond	Clark Street	Town of Spencer	
33	Mechanic Street Parking Lot	14, 18, and 20 Mechanic Street	Town of Spencer	Bioretention, Underground Infiltration, Permeable Pavers

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Attachment D

Retrofit Design Concepts

Site 1 – Heritage School
Bioretention, Water Reuse for Irrigation, and Elevation of Access Road
Oxford Road, Charlton, Massachusetts

Site Description

The proposed retrofits are located at the Heritage School on Oxford Road. Runoff from the parking lots is currently drained via catch basins into low areas surrounding the school, which may include wetland areas. The area surrounding the school eventually drains into the South Charlton Reservoir. The western access road (Heritage Drive) drops in elevation as it passes through the surrounding low areas and is a known location for repeat flooding.

At the time of the site visit in December 2018, the school anticipated switching its water supply from an on-site well to municipal water within 6 months. Irrigation is not currently used but is desired to maintain a field at the rear of the school. A greenhouse and raised garden beds are located at the rear of the school for use by students.

Proposed Concept

- Install bioretention basins in the existing landscape islands in the main parking lot to filter water before it enters the wetland complex.
- Regrade and consider elevating Heritage Drive between the Heritage School and the turn off to Charlton Middle School to reduce the risk of flooding.
- Capture runoff from the roof for irrigation of fields and the greenhouse and raised beds, to reduce use of treated town water for irrigation.
- Install educational signage to inform students and visitors about the function and benefits of green stormwater infrastructure and low impact development.
- Incorporate stormwater concepts into the school's curriculum, using the proposed retrofits as real-world examples and sites for hands-on learning.

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.

Bioretention Concept Summary
Total Impervious Area: 2.2 acres
Treated Water Quality Volume: 8,100 ft^3

Estimated Cost
Bioretention Area: $208,000
Elevation of Access Road: $305,000
- Cost savings may be achieved in road is regraded when the new water main is installed along Heritage Drive

Water Reuse for Irrigation: cost not calculated

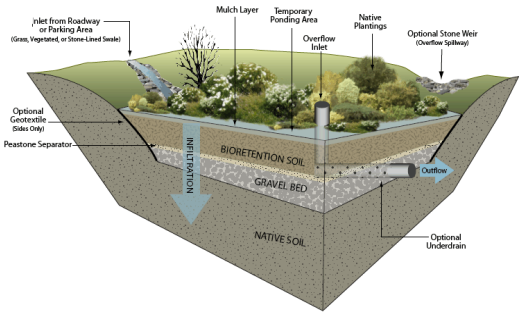


Image 2: Typical parking lot with bioretention and diagram of a bioretention basin. Image source: MA Clean Water Toolkit.

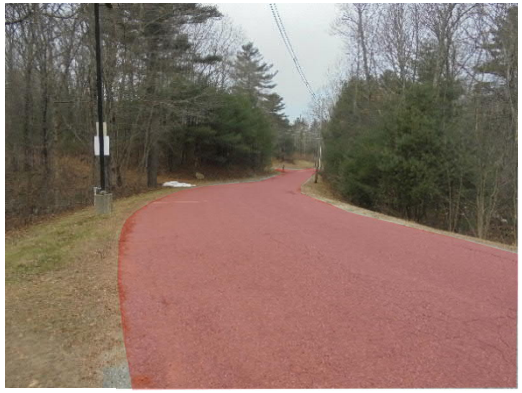
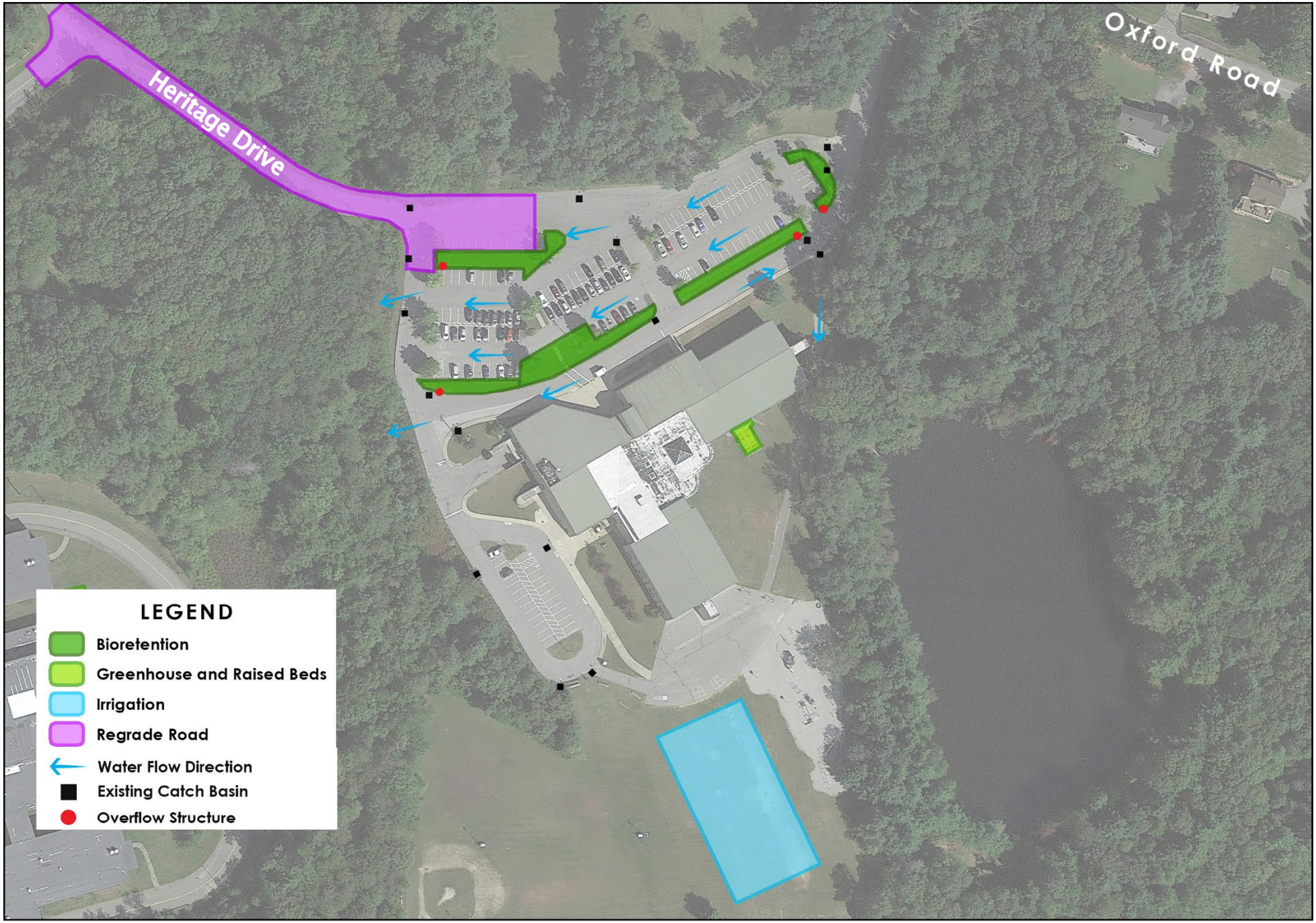


Image 3: Portion of access road to be regraded and potentially elevated.

Image 4: Greenhouse and raised garden beds at the rear of the school that could be irrigated using captured roof runoff.



Heritage School, Charlton, MA

Site Number: 1 May 2019

0 75 150 300 Feet

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Springfield, MA 01103
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Site 2 – Charlton Middle School
Green Roof, Bioretention, and Water Reuse for Irrigation
Oxford Road, Charlton, Massachusetts

Site Description

The proposed retrofits are located at the Charlton Middle School on Oxford Road. Much of the site's runoff is treated by existing stormwater treatment basins, which are fenced off for safety. However, runoff from one parking lot south of the school, which provides parking for the athletic fields, drains via catch basins directly into a wetland complex that feeds into the South Charlton Reservoir. In addition, the school roof is in poor condition, resulting in frequent leaks into the building and requiring frequent patching.

At the time of the site visit in December 2018, the school anticipated switching its water supply from an on-site well to municipal water within 6 months. Irrigation is currently supplied to plantings in the front of the building. A greenhouse and raised garden beds are located at the rear of the school for use by students.

Proposed Concept

- Install a bioretention basin along the western edge of the south parking lot to capture runoff before it enters the wetland complex. Construct the western embankment of the bioretention basin as a level spreader to evenly distribute rather than concentrate overflows.
- Replace the school roof and install an "extensive" type green roof on the front portion of the school building, above the main entrance.
- Capture runoff from the remaining portion of the roof for use in irrigation of landscape plantings and the greenhouse and raised beds, to reduce use of treated town water for irrigation
- Install educational signage to inform students and visitors about the function and benefits of green stormwater infrastructure and low impact development.
- Incorporate stormwater concepts into the school's curriculum, using the proposed retrofits as real-world examples and sites for hands-on learning.

Image 1: Typical installation of green roof system. Image © Green Roof Service LLC

Bioretention Concept Summary
Total Impervious Area: 1.6 acres
Treated Water Quality Volume: 5,700 ft^3

Estimated Cost
Green Roof: $328,000
Bioretention Area: $98,000
Water Reuse for Irrigation: cost not calculated

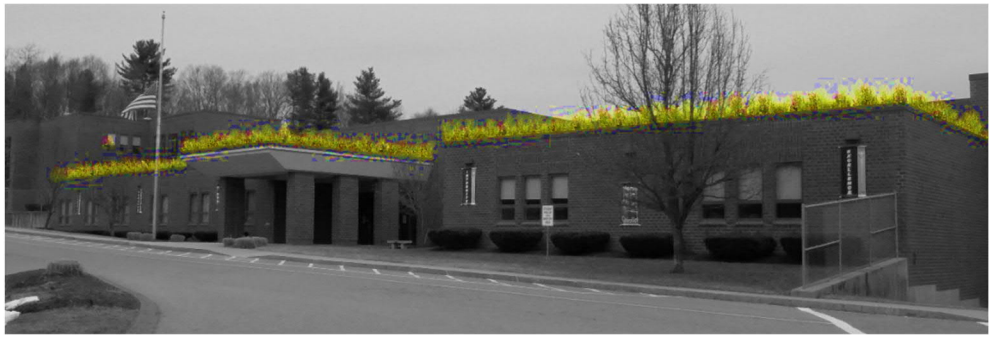

Image 2: Green roof rendering of Charlton Middle School

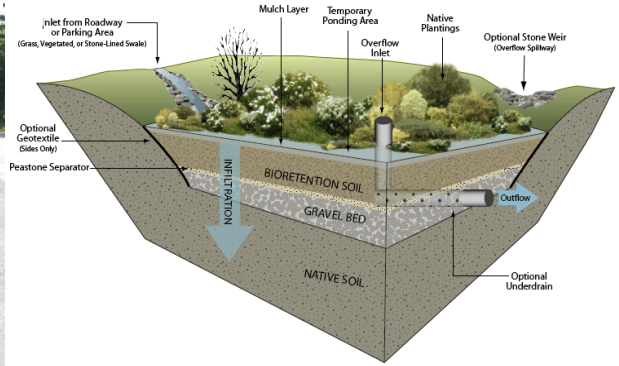

Image 3: Example of a parking lot with bioretention and diagram of a bioretention basin. Image source: MA Clean Water Toolkit.

Charlton Middle School, Charlton, MA

Site Number: 2 May 2019

0 125 250 500 Feet

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Site 3 – Charlton Elementary School
Bioretention, Infiltration, and Native Plantings
Burlingame Road, Charlton, Massachusetts

Site Description

The proposed retrofit concept is located at the Charlton Elementary School on Burlingame Road. Much of the site's runoff is currently collected by catch basins and drained down the hill to the southwest. Runoff currently causes wet conditions in the playground at the rear of the school building and erosion along the stairs from the access road to an adjacent field. This field was once used as a septic system and is therefore expected to have high infiltration rates. Runoff at the front of the building currently drains into municipal storm sewers along Burlingame Road via catch basins.

Proposed Concept

- Install a bioretention basin in the island between the front parking lot and Burlingame Road to capture runoff before it enters the municipal storm sewer system.
- Install educational signage to inform students and visitors about the function and benefits of green stormwater infrastructure and low impact development.
- Install a drain along the south edge rear access road between the road and the playground fence to divert runoff away from the playground and stairs, where it is causing wet playground conditions. Install an underground infiltration system beneath the field to infiltrate the diverted water. Perform infiltration testing before committing funds to this practice, to confirm adequate infiltration rates.
- Plant native plantings, including wildflowers, ground cover, and/or shrubs at strategic locations to stabilize soils and limit erosion while providing an aesthetic benefit.
- Incorporate stormwater concepts into the school's curriculum, using the proposed retrofits as real-world examples and sites for hands-on learning.

Image 1: Location of proposed native plantings.

Bioretention Concept Summary
Total Impervious Area: 0.2 acres
Treated Water Quality Volume: 560 ft^3

Estimated Cost
Bioretention Area: $20,000
Drain and Infiltration Practice: $26,000
Native Plantings: $3,000

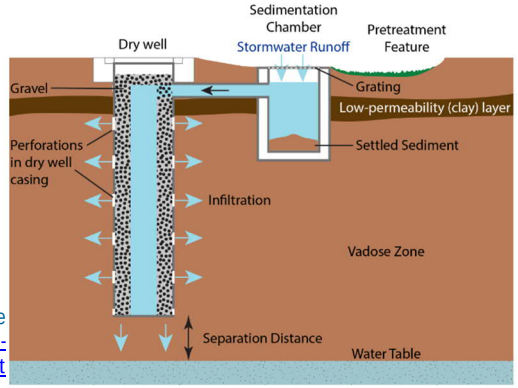

Image 2: Conceptual diagram of a dry well. Image source: https://www.americangeosciences.org/critical-issues/factsheet/dry-wells-stormwater-management

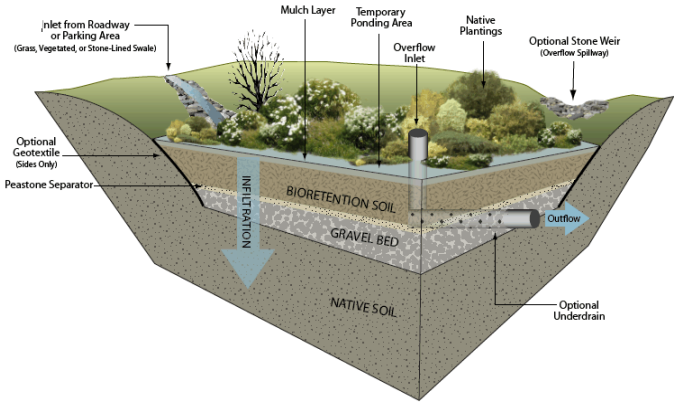

Image 3: Example of a parking lot with bioretention and diagram of a bioretention basin. Image source: MA

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Charlton Elementary School, Charlton, MA

Site Number: 3 May 2019

0 25 50 100 Feet

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Springfield, MA 01103
413.452.0445 | www.fando.com

Site 4 – Prindle Lake Park
Bioretention
Prindle Hill Road, Charlton, Massachusetts

Site Description

The proposed retrofit is located at the existing parking lot at Prindle Lake Park, along the north shore of Prindle Lake in Charlton. The site consists of a paved asphalt parking lot with no drainage system. Runoff from the site flows down a steep slope into Prindle Lake. A guardrail separates the lot from the slope below. Prindle Hill Road contributes runoff to the site.

Proposed Concept

- Install a bioretention basin along the southwestern edge of the parking lot to capture stormwater before it flows down the steep slope toward Prindle Lake. Construct the southwestern embankment of the bioretention basin as a level spreader to evenly distribute rather than concentrate overflows.
- Include a sediment forebay or similar pretreatment structures like the one shown in Image 3 to improve treatment and extend the lifespan of the bioretention basin.
- Install educational signage to inform visitors about the function and benefits of green stormwater infrastructure and low impact development.

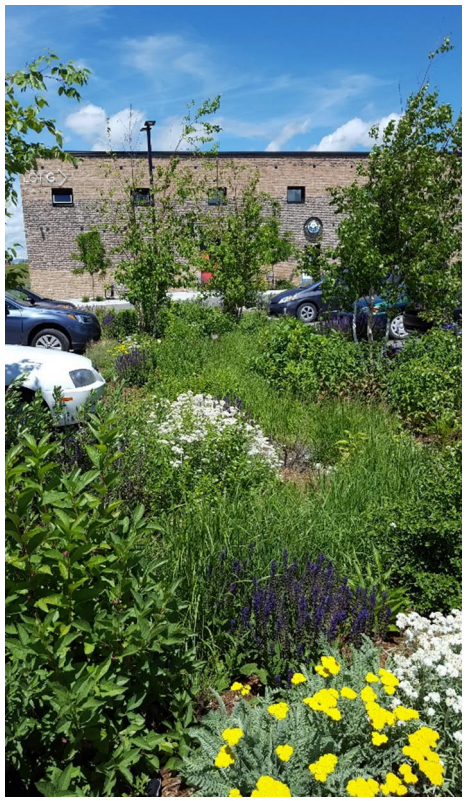

Image 2: Example of an established bioretention basin.

Bioretention Concept Summary
Total Impervious Area: 0.4 acres
Treated Water Quality Volume: 1,600 ft^3

Estimated Cost
Bioretention: $28,000

Image 3: View of current parking lot and proposed bioretention area.

Image 1: Example of a parking lot with bioretention and diagram of a bioretention basin. Image source: MA Clean Water Toolkit.

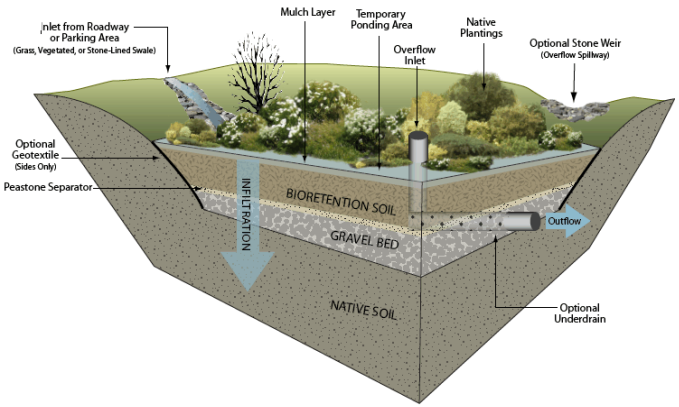

Image 4: Example of an established bioretention basin with a concrete curb cut and concrete pretreatment structure to remove sediment before runoff enters the planted portion of the basin.

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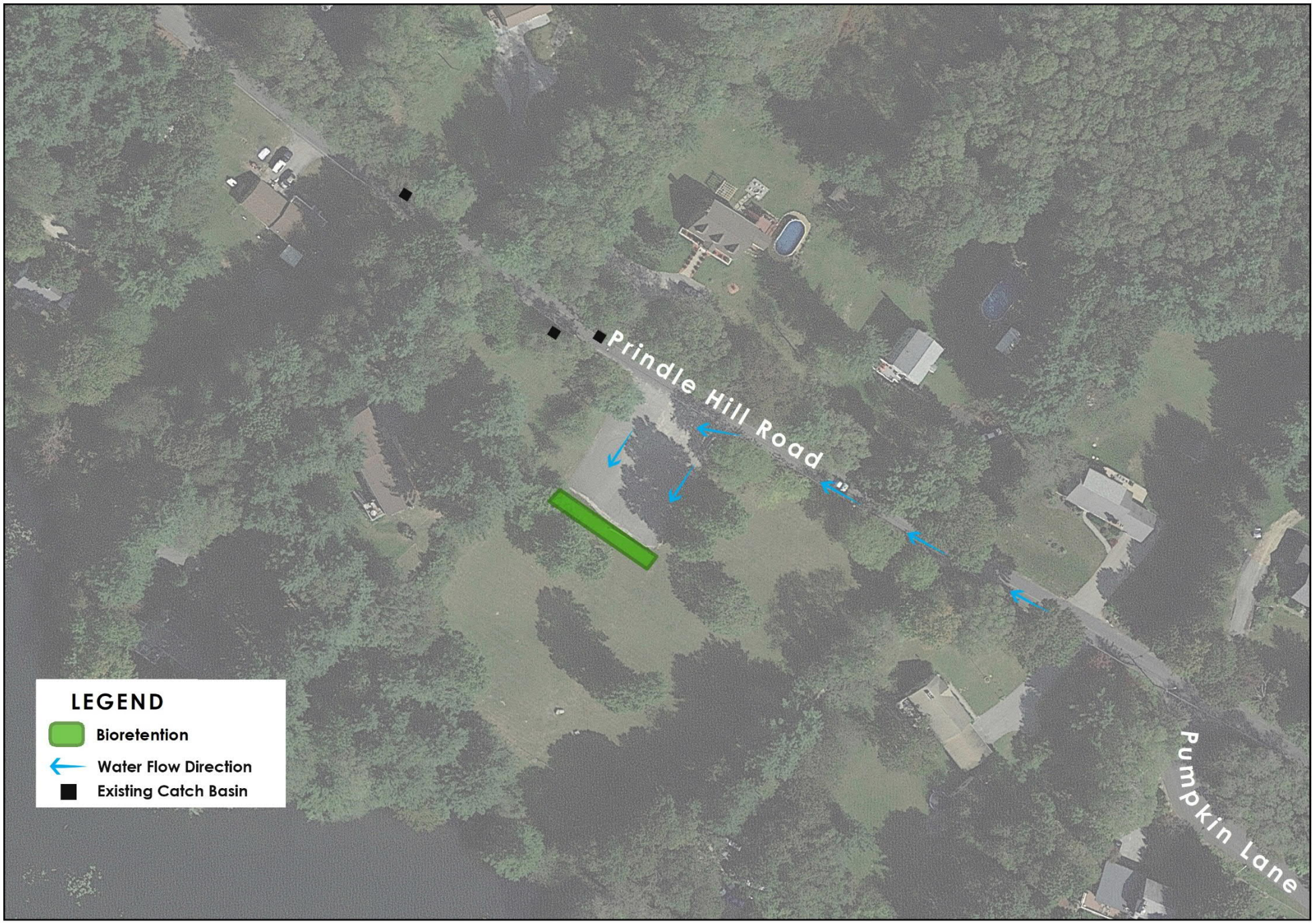

Prindle Lake Park, Charlton, MA

Site Number: 4 May 2019

0 25 50 100 Feet

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Site 5 – Maynard Farm Recreation Area Bioretention

Route 31/Dresser Hill Road, Charlton, Massachusetts

Site Description

The proposed retrofit is located at the largest and most heavily used parking lot at the Maynard Farm Recreation Area. Three parking lots serve the facility. The largest parking lot (the first lot when entering the site from Dresser Hill Road) is paved but the asphalt is in poor condition and the parking lot requires repaving. Runoff from the lot drains to an existing armored swale along the southern edge of the lot. The runoff concentrates at several locations before entering the swale, which has led to rilling and erosion at the edge of the lot. The swale discharges to a wetland/pond south of and downslope from the swale via an eroded ravine that has been armored with stone. Existing storm sewers along Route 31 do not capture runoff from the parking lots.

Proposed Concept

- Retrofit the existing swale to create a series of bioretention basins connected by the swale. Move the southern edge of the lot approximately 5-10 feet as needed to provide room for the bioretention basins. Install a curb along the southern edge of the lot with curb cuts to allow water to enter the bioretention basin at discrete sites (especially if the basin is constructed before the lot is repaved). Include sediment forebays or similar pretreatment structures at each curb cut, as shown in Image 4, to improve treatment and extend the lifespan of the bioretention basin.
- Install overflow drains to convey high flows to the municipal storm sewer beneath Route 31, or construct the southern edge of the basin as a level spreader to disperse rather than concentrate overflows into the forest along the southern edge of the lot.
- If possible, repave the lot concurrently with bioretention basin installation, but prevent runoff from the lot from entering the bioretention basin until the lot is completely stabilized. Runoff should be handled using an alternate method until the site is stabilized to prevent sediment from clogging the basin.
- Adjust snowplowing practices to prevent plowing of snow into the bioretention basin during winter months. Plowing snow into the bioretention basin would cause it to fail. Snow should be plowed toward the north, west, or east sides of the lot.
- Install educational signage to inform visitors about the function and benefits of green stormwater infrastructure and low impact development.

Image 1: Existing swale and runoff forming concentrated flow over the embankment into the swale.

Image 2: Severe erosion at the outlet of the existing swale.

Bioretention Concept Summary
Total Impervious Area: 1.4 acres
Treated Water Quality Volume: 4,900 ft^3

Estimated Cost
Bioretention: $44,000

Image 3: Example of an established bioretention basin with a concrete curb cut and pretreatment structure to remove sediment before runoff enters the planted portion of the basin.

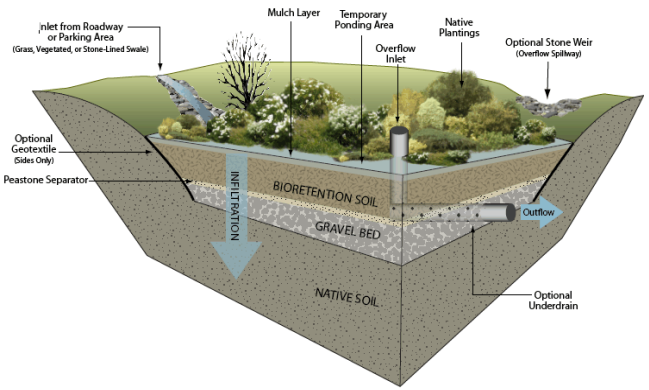

Image 4: Example of a parking lot with bioretention and diagram of a bioretention basin. Image source: MA Clean Water Toolkit.

Maynard Farm Recreation Area, Charlton, MA

Site Number: 5

May 2019

0 25 50 100 Feet

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Site 6 – Howe State Park
Bioretention and Pavement Removal
Howe Road, Spencer, Massachusetts

Site Description

The proposed retrofit site is the parking lot to the east of Howe Mill Pond in Howe State Park, which is owned by the Massachusetts Department of Conservation and Recreation (DCR). The parking lot consists of four paved asphalt parking bays connected by access driveways on the eastern and western sides of the bays. Runoff from the parking bays is collected by catch basins (1 per bay) and is discharged to the Cranberry River via an outlet located north of Howe Road. The parking lot is surrounded on three sides by tall pines, which drop needles into the parking lot. These needles and other debris have covered and clogged the catch basin inlets to the point of obscuring their location.

Proposed Concept

- Assess parking utilization during periods of peak usage and consider reducing impervious cover at the site by removing parking. Consider converting a portion of the existing excess parking spaces to an alternate use (wooded, picnic, playground) or to permeable parking (grass parking, permeable pavers, or similar permeable material suitable for low-traffic applications). In parking bays that have been completely removed, also remove catch basins and other stormwater infrastructure that is no longer needed.
- After removing unneeded parking areas, install bioretention areas to treat runoff from the remaining paved areas. Working from below the first parking bay (between the parking lot and the Howe Road) and proceeding uphill, convert one or more of the existing grass islands into bioretention basin. Direct overflow into the existing storm drainage system via overflow outlet structures or the existing catch basins.
- Plant the bioretention basins with trees, shrubs, and herbaceous vegetation that is acid tolerant, due to the heavy concentration of fallen pine needles. In addition to contributing to stormwater quality, trees will help shade and cool the lot during hot weather.
- Install educational signage to inform park visitors about the function and benefits of green stormwater infrastructure and low impact development and the benefit to the natural environment of the park.
- The proposed retrofits offer an opportunity for collaboration between the Town of Spencer and MADCR.

Image 1: View of existing grass island between first and second (northernmost) bays of parking lot.

Bioretention Concept Summary
Total Impervious Area: 0.7 acres
Treated Water Quality Volume: 2,500 ft^3

Estimated Cost
Bioretention: $44,000
Pavement Removal: $7,000

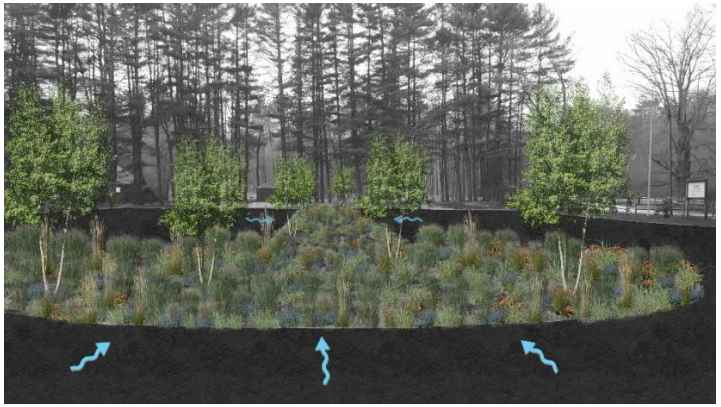

Image 2: Rendering of completed bioretention basin retrofit as it might appear once vegetation has filled in.

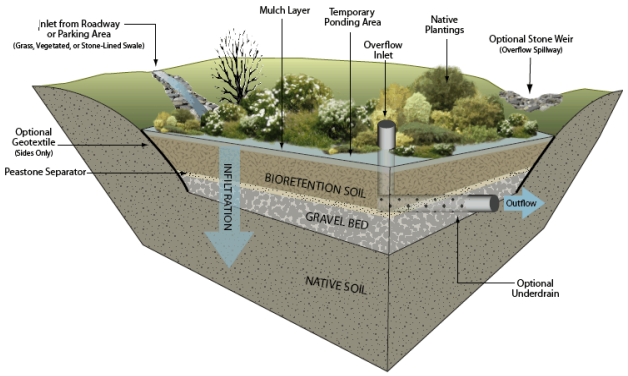

Image 3: Example of a parking lot with bioretention and diagram of a bioretention basin. Image source: MA Clean Water Toolkit.

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Howe State Park, Spencer, MA

Site Number: 6 May 2019

0 50 100 200 Feet

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Site 7 – Mechanic Street Parking Lot
Bioretention, Underground Infiltration, and Permeable Pavers
Mechanic Street, Spencer, Massachusetts

Site Description

The proposed redevelopment site is located at 14, 18, and 20 Mechanic Street in downtown Spencer, MA. An existing municipal parking lot occupies 14 Mechanic Street, while the structures at 18 and 20 Mechanic Street have been demolished in preparation for redevelopment of all three lots into a single municipal parking lot. Runoff currently drains toward Mechanic Street where it enters the storm drainage system via catch basins.

Proposed Concept

- Design the parking lot with integrated bioretention basins to capture and filter parking lot runoff. Select vegetation to shade and cool the parking area while creating an aesthetically pleasing site.
- Install an underground infiltration system to allow treated rainwater to infiltrate beneath the parking lot.
- Incorporate permeable pavers into pedestrian walkways.
- Install educational signage to inform visitors about the function and benefits of green stormwater infrastructure and low impact development.

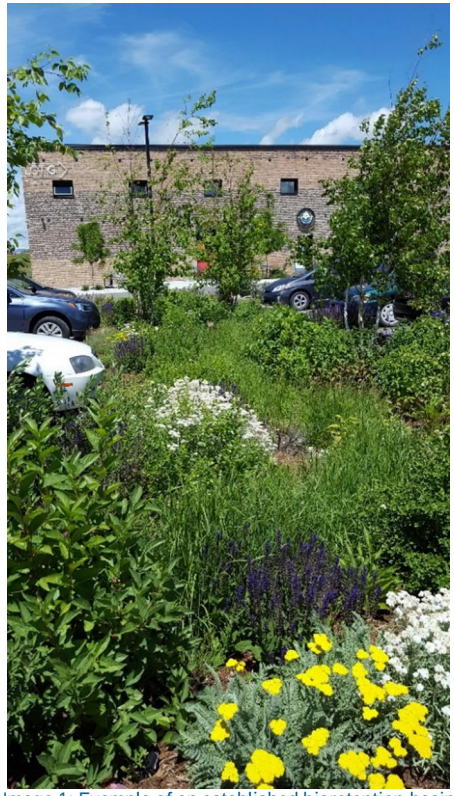

Image 1: Example of an established bioretention basin.

Concept Summary
Total Impervious Area: 0.7 acres
Treated Water Quality Volume: 2,500 ft^3

Estimated Cost
Parking Lot Redevelopment with Bioretention, Underground Infiltration, and Permeable Pavers: $495,000

Image 3: Typical installation of underground infiltration system below an existing parking lot. Image source: stormtech.com

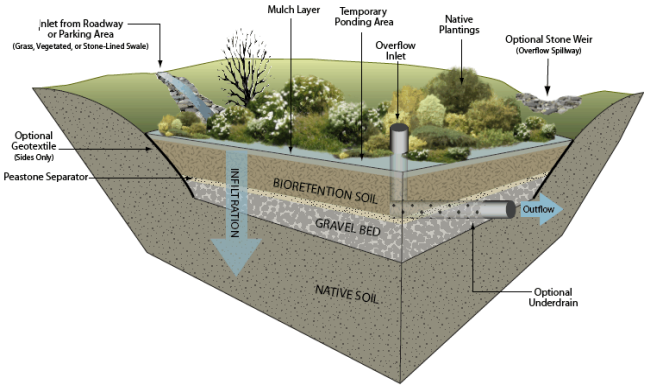

Image 2: Example of a parking lot with bioretention and diagram of a bioretention basin. Image source: MA Clean Water Toolkit.

Image 4: Typical installation of permeable paver walkway in a municipal parking lot. Image Source: Fuss & O'Neill.

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Mechanic Street, Spencer, MA

Site Number: 7

May 2019

0 50 100 200 Feet

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Site 8 – Spencer Town Hall
Bioretention, Pedestrian Access Improvements, Native Plantings, and Pavement Removal
Route 9/Main Street, Spencer, Massachusetts

Site Description

The proposed retrofit concept is located at the rear of the Town Hall in Spencer, MA. The existing site consists of an upper and a lower parking lot separated by an unutilized area with no pedestrian access between the two parking lots, which are separated by a height of approximately 6-8 feet. As a result, the smaller lower parking lot is often overcrowded while the larger upper parking lot is often underutilized. Runoff from the site flows down the hill toward the commercial parking lot off Main Street, or toward the back of the upper parking lot. The site also receives runoff from upgradient properties, including the church parking lot adjacent to the upper lot. The back portion of the upper lot is used for snow storage during the winter months.

Image 1: Area of proposed pavement removal.

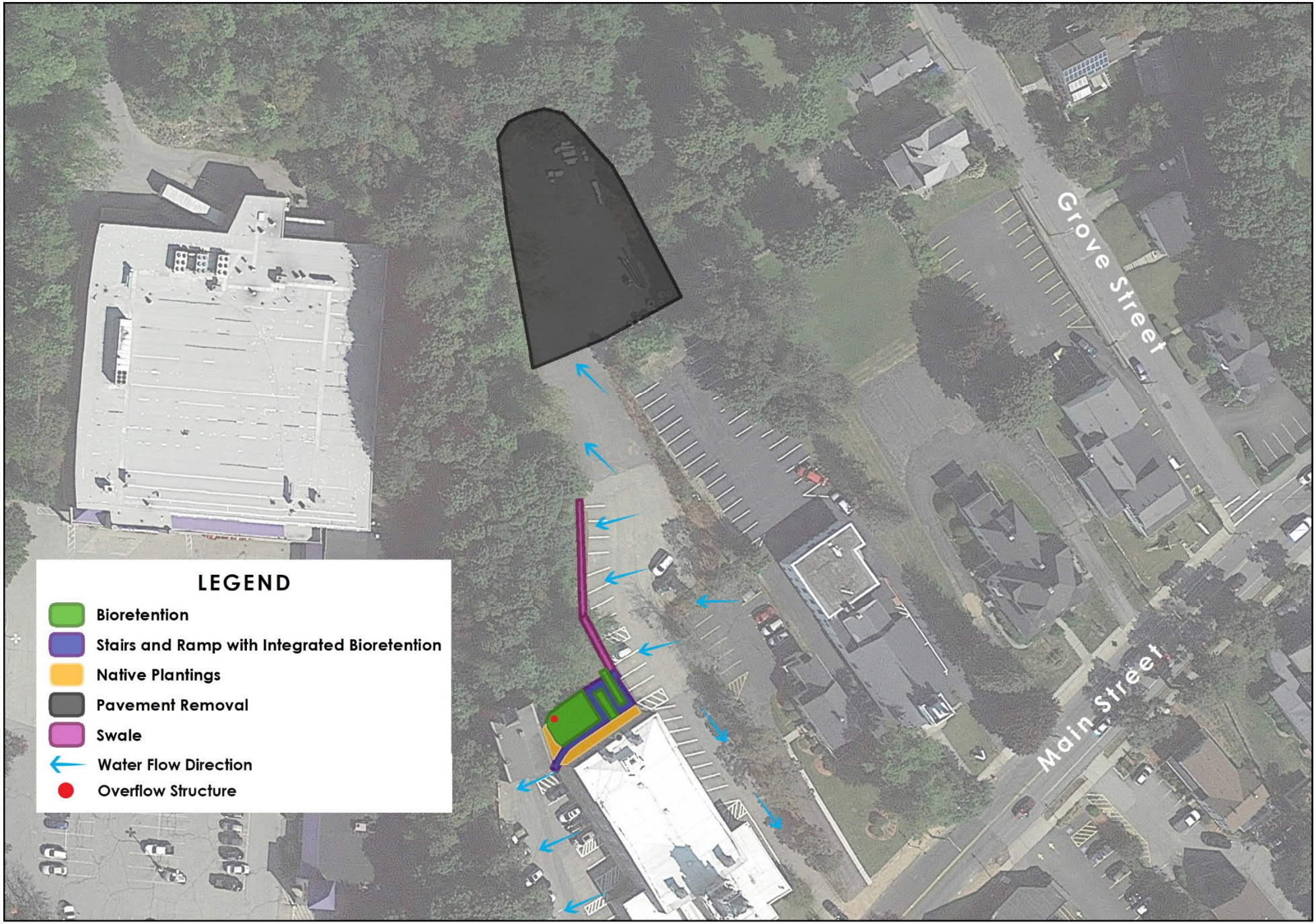
Bioretention Concept Summary
Total Impervious Area: 0.4 acres
Treated Water Quality Volume: 2,500 ft^3

Estimated Cost
Bioretention Area and Pedestrian Access Improvements (assuming installation of pedestrian ramp): $385,000
Bioretention Swale: $34,000
Pavement Removal: $20,000
Native Plantings: $2,000

Proposed Concept

- Install an ADA accessible pedestrian ramp and/or stairway with integrated, terraced bioretention to allow pedestrian access between the upper and lower parking lots. Solicit input from Town Hall staff and the public to select a ramp and/or stairway design that meets the needs of its intended users. Note that the cost of implementation will vary depending on the design selected.
- Supplement the bioretention areas with native plantings in areas that cannot be used for bioretention (e.g., due to proximity to the foundation of the Town Hall).
- Assess parking utilization of the upper lot during periods of peak usage and consider reducing impervious cover at the site by removing parking. Consider converting a portion of the upper parking lot to an alternate use or to pervious parking (grass parking, permeable pavers, or similar permeable material suitable for low-traffic applications).
- Install educational signage to inform visitors about the function and benefits of green stormwater infrastructure and low impact development.

Image 2: Rendering of proposed ADA accessible pedestrian ramp with integral bioretention between the upper and lower parking lots.



Spencer Town Hall, Spencer, MA

Site Number: 8 May 2019

0 25 50 100 Feet

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Site 9 – Richard Sugden Library
Bioretention and Permeable Pavers
Route 31/Pleasant Street, Spencer, Massachusetts

Site Description

The proposed retrofit concept is located at the Richard Sugden Library on Pleasant Street in downtown Spencer, MA. The site includes the library building, the lawn and sidewalk at the front of the building, and a parking area at the rear of the building with access drives on both the north and south side of the library. Runoff from the site generally drains to the southeast corner of the lot. Front and rear entry doors provide access to the library building. At the eastern edge of the parking lot, stairs climb the slope to the Price Chopper parking lot, providing access to the library for patrons of stores in the shopping plaza.

Proposed Concept

- Install bioretention basins in the lawn area in front of the main entrance of the library. Sawcut the sidewalk leading to the front entry and install a drain allowing overflows from the north basin to flow into the south basin beneath the sidewalk. Install a decorative grate over the drain to allow library patrons to see the flow of water beneath the great and to facilitate maintenance of the drain.
- Install permeable pavers to form a crosswalk from the base of the stairs at the edge of the parking lot to the top of the ramp leading to the rear door of the library. If feasible, continue the installation of the permeable pavers down the ramp to the library door. Design the pavers with a color scheme and shape that helps convey their role in stormwater treatment and infiltration. The pavers would reduce stormwater runoff and may increase pedestrian safety in the parking lot.
- Install educational signage to inform visitors about the function and benefits of green stormwater infrastructure and low impact development. Programs could also be developed at the library integrating stormwater practices as real-world and hands-on learning opportunities.

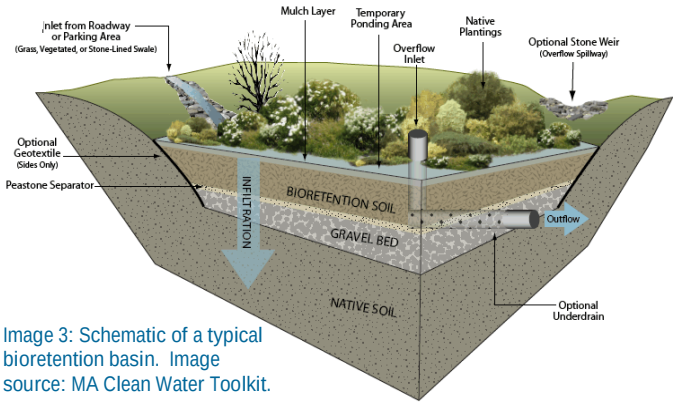

Image 3: Schematic of a typical bioretention basin. Image source: MA Clean Water Toolkit.

Image 1: View of existing ramp with proposed area of permeable pavers.

Bioretention Concept Summary
Total Impervious Area: 0.1 acres
Treated Water Quality Volume: 190 ft^3

Estimated Cost
Bioretention: $10,000
Permeable Pavers: $10,000

Image 2: Rendering of proposed bioretention basins.

Image 4: Typical installation of a permeable paver walkway in a municipal parking lot. Image Source: Fuss & O'Neill.

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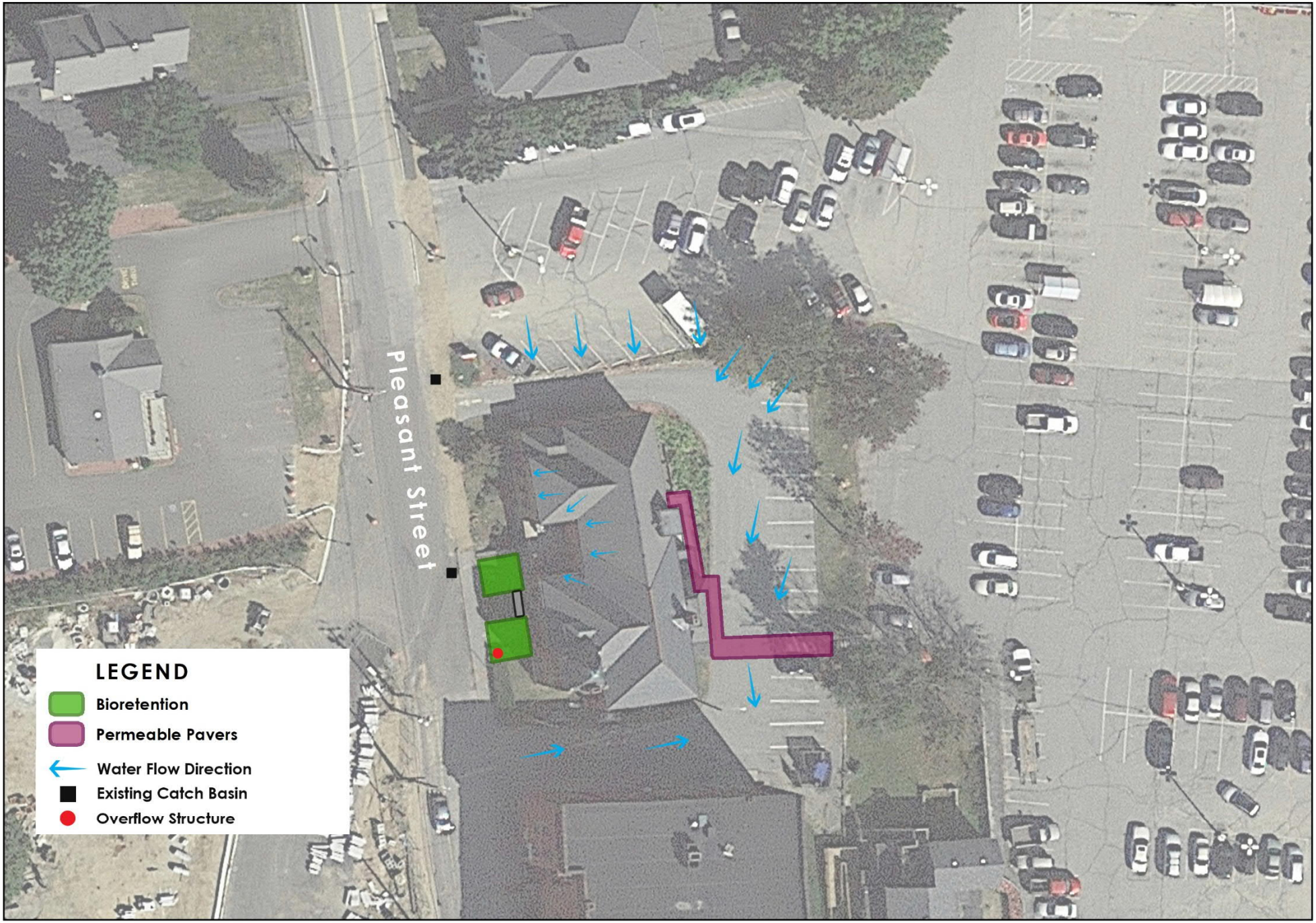

Richard Sugden Library, Spencer, MA

Site Number: 9 May 2019

0 25 50 100 Feet

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Site 10 – O'Gara Park
Wetland Buffer Restoration and Native Plantings
Valley Street, Spencer, Massachusetts

Site Description

The proposed retrofit concept is located at O'Gara Park at the south end of Valley Street in Spencer, MA. The site consists of an athletic field and a partially paved parking and snow storage area separated from the athletic field by a chain link fence and a steep slope. The snow storage area is unpaved and is directly adjacent to a large wetland complex located to the west. A berm of soil, mulch, and other materials has built up along the edge of the lot between the wetland and the lot by the plowing of snow toward the edge of the lot. At the north end of the lot, runoff discharges directly to a stream on the east side of Valley Street that then flows west under Valley Street and enters the wetland complex to the west.

Proposed Concept

- Plant trees and other salt-tolerant riparian vegetation in an approximatley 40-foot-wide strip along the western edge of the parking lot to help filter runoff from the parking lot before it enters the wetland, particularly melting snow during the winter and spring. If space is available and additional treatment is desired, expand the width of the buffer.
- Install native plantings along the slope between the athletic field and the parking lot to help stabilize the soil and provide aesthetic and ecological benefits.
- Consider regrading the northern end of the parking lot to redirect runoff (that currently discharges directly to the stream) to the restored vegetated buffer for enhanced filtration, pollutant removal, and flow attenuation.

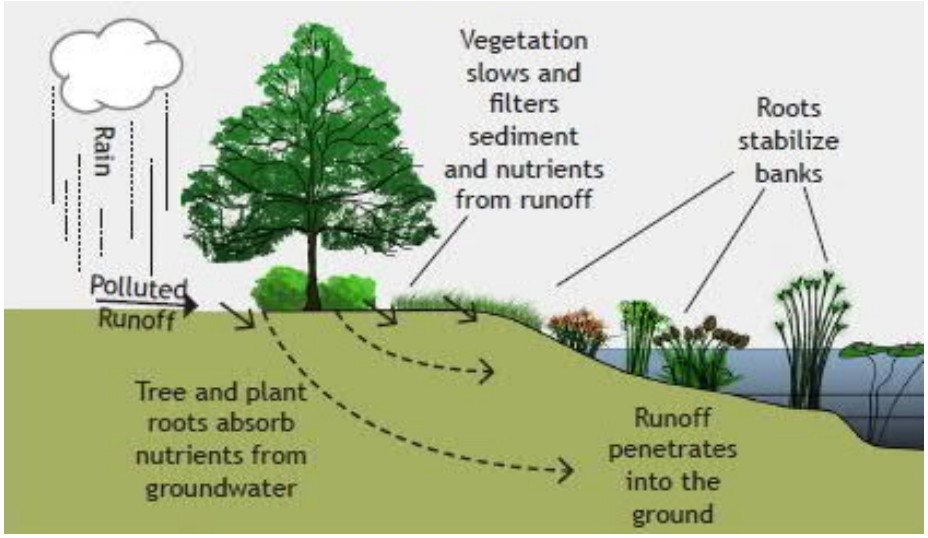

Image 1: Conceptual Diagram of a Riparian Buffer. Image source: https://www.catawbariverkeeper.org/2017/04/25/nc-senate-passes-bill-eliminates-catawba-river-buffer-protection-prevents-local-water-quality-buffers/

Buffer Restoration Concept Summary
Buffer Area Restored: 0.5 acres

Estimated Cost
Riparian Restoration: $8,000
Native Plantings: $3,000

Image 2: Berm of plowed material at the edge of the parking lot.

Image 3: Stream at the north end of the project site.

O'Gara Park, Spencer, MA

Site Number: 10 May 2019

0 75 150 300 Feet

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Attachment E

Bioretention Practice Sizing Calculations

Bioretention Practice Sizing

Site Number	Site Name	Impervious Area (sf)	Impervious Area (ac)	Hydrologic Soil Group	Water Quality Volme (ft^3)	Sizing for (in)	Filter Depth (df, ft)	Coefficient of Permeability (k, ft/day)	Average Ponding Depth (hf, ft)	Filter Bed Drain Time (tf, days)	Area of filter (Af, ft^2)
Town of Charlton Sites											
1	Heritage School	97,243	2.2	B	8,103.6	1	2.5	1	0.5	2	4,051.8
2	Charlton Middle School	68,352	1.6	A	5,696.0	1	2.5	1	0.5	2	2,848.0
3	Charlton Elementary School	6,749	0.2	C	562.4	1	3	1	0.5	2	289.2
4	Prindle Lake Park	19,117	0.4	B	1,593.1	1	2.5	1	0.5	2	796.5
5	Maynard Farm Recreation Area	58,976	1.4	C	4,914.7	1	3	1	0.5	2	2,527.5
Town of Spencer Sites											
6	Howe State Park	30,373	0.7	A	2,531.1	1	2.5	1	0.5	2	1,265.5
7	#18 and #20 Mechanic Street	29,767	0.7	C	2,480.6	1	3	1	0.5	2	1,275.7
8	Spencer Town Hall	15,741	0.4	C	1,311.8	1	3	1	0.5	2	674.6
9	Richard Sugden Library	2,282	0.1	C	190.2	1	3	1	0.5	2	97.8

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Attachment F

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 (Bioretention Only)	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
	Town of Charlton Sites																
1	Heritage School	Bioretention	$13.10	CF Runoff Treated	1.5	8,104	$159,292	30%	$47,790	$208,000	$146,000	$312,000	20	$15,310	4%	$610	$15,920
	Heritage School	Regrade Access Road	$400.00	LF		585	$234,000	30%	$70,200	$305,000	$214,000	$458,000	20	$22,440	1%	$220	$22,660
2	Charlton Middle School	Bioretention Swale	$13.10	CF Runoff Treated	1.0	5,696	$74,640	30%	$22,390	$98,000	$69,000	$147,000	20	$7,210	4%	$290	$7,500
	Charlton Middle School	Green Roof	$25.21	SF		10,000	$252,080	30%	$75,620	$328,000	$230,000	$492,000	25	$21,000	4%	$840	$21,840
3	Charlton Elementary School	Bioretention	$13.10	CF Runoff Treated	2.0	562	$14,739	30%	$4,420	$20,000	$14,000	$30,000	20	$1,470	4%	$60	$1,530
	Charlton Elementary School	Native Plantings	$40.00	EA		30	$1,200	130%	$1,560	$3,000	$2,000	$5,000	10	$370	4%	$10	$380
	Charlton Elementary School	Infiltration	$20.00	CF Runoff Treated		1,000	$20,000	30%	$6,000	$26,000	$18,000	$39,000	15	$2,340	4%	$90	$2,430
4	Prindle Lake Park	Linear Bioretention	$13.10	CF Runoff Treated	1.0	1,593	$20,875	30%	$6,260	$28,000	$20,000	$42,000	20	$2,060	4%	$80	$2,140
5	Maynard Farm Recreational Area	Linear Bioretention	$13.10	CF Runoff Treated	1.0	2,528	$33,120	30%	$9,940	$44,000	$31,000	$66,000	20	$3,240	4%	$130	$3,370
									Subtotal	***$1,060,000***	***$744,000***	***$1,591,000***					
	Town of Spencer Sites																
6	Howe State Park	Bioretention	$13.10	CF Runoff Treated	1.0	2,531	$33,166	30%	$9,950	$44,000	$31,000	$66,000	20	$3,240	4%	$130	$3,370
	Howe State Park	Pavement Removal	$10.00	SY		470	$4,700	30%	$1,410	$7,000	$5,000	$11,000	N/A	$0	4%	$0	$0
7	Mechanic Street Parking Lot*	Bioretention (Surface Feature)	$13.10	CF Runoff Treated	3	2,481	$97,533	30%	$29,260	$127,000	$89,000	$191,000	20	$9,340	4%	$370	$9,710
8	Spencer Town Hall	Bioretention	See project-specific cost estimate							$385,000	$270,000	$578,000	75	$16,260	0%	$0	$16,260
	Spencer Town Hall	Bioretention Swale	$13.10	CF Runoff Treated	1.5	1,312	$25,789	30%	$7,740	$34,000	$24,000	$51,000	20	$2,500	4%	$100	$2,600
	Spencer Town Hall	Pavement Removal	$10.00	SY		1,500	$15,000	30%	$4,500	$20,000	$14,000	$30,000	N/A	$0	4%	$0	$0
	Spencer Town Hall	Native Plantings	$40.00	EA		20	$800	30%	$240	$2,000	$1,000	$3,000	10	$250	4%	$10	$260
9	Richard Sugden Library	Bioretention	$13.10	CF Runoff Treated	3	190	$7,477	30%	$2,240	$10,000	$7,000	$15,000	20	$740	4%	$30	$770
	Richard Sugden Library	Permeable Pavers	$10.96	SF		650	$7,124	30%	$2,140	$10,000	$7,000	$15,000	10	$1,230	4%	$50	$1,280
10	O'Gara Park	Riparian Buffer Restoration	$13,000.00	AC		0.47	$6,110	30%	$1,830	$8,000	$6,000	$12,000	30	$460	4%	$20	$480
	O'Gara Park	Native Plantings	$40.00	EA		50	$2,000	30%	$600	$3,000	$2,000	$5,000	10	$370	4%	$10	$380
									Subtotal	***$650,000***	***$456,000***	***$977,000***					
									Total	***$1,710,000***	***$1,200,000***	***$2,568,000***					

Notes:
Rate of Inflation used = 2%
Interest (discount) rate used = 6%
*A project is proposed for this location already. Costs estimated in this table are for adding ecological and water quality elements to the assumed original purpose of the proposed projects.
Costs are based on screening-level evaluations of site characteristics and should be used for planning purposes only. Construction costs could vary significantly.

Unit Costs

Unit Costs Table

Element	2018 Adjusted Cost	Unit	Cost	$YEAR	Source
Green Infrastructure Elements					
New Haven Curbside Bioswale	$ 15,000.00	ea			Actual construction cost provided by CFE for the Edgewood School bioswale construction (2014) $15,000 for contractor plus $5,000 of in-kind services provided by City of New Haven. Recent bids for West River Bioswales were approximately $15,000 per bioswale for up to 92 bioswales.
Large Bioretention Retrofit	$ 13.10	cfofrunoff treated	$ 10.50	2006	Center for Watershed Protection Urban Subwatershed Retrofit Manual 3 (2007), cost adjusted, Page E-3
Small Bioretention Retrofit (<0.5 acre)	$ 35.62	sf	$ 32.50	2012	District of Columbia Water and Sewer Authority, George S. Hawkins, General Manager, Green Infrastructure Summit 2012, February 29, 2012.
Rain Garden	$ 7.98	sf	$ 7.28	2012	Woodard & Curran - Route 1 Falmouth Commercial District Stormwater Management, 2012
Water Quality Swale	$ 10.96	sf	$ 10.00	2012	District of Columbia Water and Sewer Authority, George S. Hawkins, General Manager, Green Infrastructure Summit 2012, February 29, 2012.
Porous Asphalt	$ 3.07	sf	$ 2.80	2012	UNH Stormwater Center 2012 Biennial Report. Page 12
Permeable Pavers	$ 10.96	sf	$ 10.00	2012	Center for Watershed Protection Urban Subwatershed Retrofit Manual 3 (2007), cost adjusted, Page E-5
Reinforced Gravel Parking	$ 5.48	sf	$ 5.07	2013	http://www.boddingtonsonline.com/products/grass-ground-reinforcement/grass-reinforcement-protection/bodpave-85-permeable-gravel-pavers.php; Added $2/sf for installation
Subsurface Infiltration	$ 20.00	cfofrunoff treated	$ 20.00	2018	Fuss & O'Neill, City of Pawtucket Grant Application, 2018.
Green Roof	$ 25.21	sf	$ 23.00	2012	District of Columbia Water and Sewer Authority, George S. Hawkins, General Manager, Green Infrastructure Summit 2012, February 29, 2012.
Blue Roof	$ 5.48	sf	$ 5.00	2012	NYC Department of Environmental Protection (2012), Rooftop Detention: A Low-Cost Alternative for Complying with New York City's Stormwater Detention Requirements and Reducing Urban Runoff.
Subsurface Gravel Wetland	$ 23.93	cfofrunoff treated	$ 21.83	2012	Woodard & Curran - Route 1 Falmouth Commercial District Stormwater Management, 2012
Pond Retrofit	$ 13,852.80	impervious acre of runoff treated	$ 11,100.00	2006	Center for Watershed Protection Urban Subwatershed Retrofit Manual 3 (2007), cost adjusted, page E-2
French Drain/Infiltration Trench	$ 19.97	lf	$ 16.00	2006	Center for Watershed Protection Urban Subwatershed Retrofit Manual 3 (2007), cost adjusted, page E-11
Tree Box	$ 6,576.00	ea	$ 6,000.00	2012	UNH Stormwater Center 2012 Biennial Report, adjusted based on professional judgement, inflation, and materials cost.
Constructed Wetland	$ 5.08	sf	$ 4.07	2006	Center for Watershed Protection Urban Subwatershed Retrofit Manual 3 (2007), cost adjusted, page E-11
Restoration Elements					
Riparian Buffer Restoration	$ 12,166.62	ac	$ 10,543	2010	Oregon Department of Environmental Quality, 2010, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon. Page 20
Stream Channel Restoration	$ 14,232.28	ac	$ 12,333	2010	Oregon Department of Environmental Quality, 2010, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon. Page 20
Remove Invasive Species	$ 3,692.80	acre	$ 3,200	2010	Professional Engineering Experience
Tree Planting	$ 500.00	ea			Street tree cost
Landscape Shrub Plantings	$ 40.00	ea			
Construction Elements					
6" to 12" Rip Rap	$ 49.32	CY	$ 45.00	2012	Professional Engineering Experience
Outlet Structure	$ 4,500	ea	$ 4,500	2013	Professional Engineering Experience
Manhole	$ 2,500	ea	$ 2,500	2013	Professional Engineering Experience
Dam Removal	$ 19,848.80	ea	$ 17,200	2010	Selle, Andy (2010). Dam Removal – A Primer, Presentation; $17,200 is median for dams 1-3 feet high.
Educational Signage	$ 1,200	ea	$ 1,200	2013	Professional Engineering Experience

Inflation Rates Table

Inflation from	Inflation to	Percent
2006	2018	24.80%
2010	2018	15.40%
2011	2018	11.80%
2012	2018	9.6%
2013	2018	8.0%

Cost Adjustment Factors

BMP Type	Cost Adjustment Factors
New BMP in undeveloped area	1
New BMP in partially developed area	1.5
New BMP in developed area	2
Difficult installation in highly disturbed setting	3

Source: https://www3.epa.gov/region1/npdes/stormwater/ma/green-infrastructure-stormwater-bmp-cost-estimation.pdf

Spencer Town Hall - Order of Magnitude Cost Estimate

ORDER OF MAGNITUDE OPINION OF CONSTRUCTION COST	DATE PREPARED:		5/15/2019
PROJECT: TOWN OF SPENCER	BASIS: STAIRS AND RAMP WITH INTERGRATED BIORETENTION		
LOCATION: SPENCER TOWN HALL	ESTIMATOR:	JHB	CHECKED BY:
DESCRIPTION: ACCESSIBLE RAMP WITH GREEN STORMWATER BMPS	JOB NO.	20170390.C51	

This is an order of magnitude cost estimate, as defined by the American Association of Cost Engineers, that is expected to be within -30 to +50 percent of the actual project cost. Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others or market conditions. Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry. Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill.

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
CONCRETE WALKWAY (ASSUME 8")	CY	37	$45.00	$1,666.67
RETAINING WALLS WITH BRICK FAÇADE	LS	1	$150,000.00	$150,000.00
HANDRAILS	LF	400	$120.00	$48,000.00
PLANTING	LS	425	$60.00	$25,500.00
CONTROLLED DENSITY FILL	CY	260	$170.00	$44,200.00
BIORETENTION SOIL MIX	CY	261	$35.00	$9,135.00
BIORETENTION STONE	CY	262	$65.00	$17,030.00
			SUBTOTAL	$295,531.67
			SUBTOTAL (ROUNDED)	$296,000.00
			30% Contingency	$89,000.00
				$385,000.00

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Appendix F

Adaptation Recommendations Summary, Town of Charlton, MA

Adaptation Recommendations Summary
Town of Charlton, MA

The **Town of Charlton** is vulnerable to flood-related damages, as evidenced by historical and recent flooding events. The Town of Charlton, in collaboration with the Town of Spencer and Fuss & O'Neill, developed a **water infrastructure climate resiliency plan to** help mitigate the effects of future flooding events that will become more frequent and intense as a result of climate change. The following is a **summary of key findings and recommendations** of the town's plan.

Quick Facts – Charlton

- 131 road-stream crossings assessed
- 13 dams assessed
- 17 sites assessed for green infrastructure concept development
- 8 water and wastewater facilities identified as vulnerable

Road-Stream Crossings

131 road-stream crossings were assessed in Charlton:

- 60% of crossings are hydraulically undersized
- 31% of crossings have high geomorphic vulnerability
- 80% of crossings limit or restrict aquatic passage
- 47% were rated "critical" for structural condition
- 18% were classified as "high priority" for replacement

Recommendations:

- Replace and upgrade priority crossings (see table below) to meet flood resilience and aquatic organism passage (AOP) goals
- Consider other upstream and downstream crossings and dams on the same river system
- In general, replace downstream crossings first
- Perform site-specific data collection, geotechnical evaluation, hydrologic and hydraulic evaluation, and structure type evaluation to support design

High Priority Stream Crossings (Listed by Priority Ranking)

Road	Stream	Crossing Type
East Baylies Road	Unnamed	3' stone box inlet and 2' corrugated metal pipe outlet - culvert
Stafford Street	Unnamed	2.5' corrugated metal culvert
Blood Road	Unnamed	1.5' smooth plastic culvert
Center Depot Road	Unnamed	2' concrete culvert
Freeman Road	Unnamed	2.5' concrete culvert
Brookfield Road	Unnamed	Two (2) 3' corrugated metal culverts
Route 169/Southbridge Road	Unnamed	3.5' concrete culvert
City Depot Road	Cady Brook	10' concrete bridge
Saundersdale Road	Unnamed	25' concrete bridge
Southbridge Road	Unnamed	2.5' concrete culvert

Green Infrastructure

A screening-level assessment of potential green infrastructure (GI) retrofit sites was performed for 17 sites. Of these, 5 were selected for development of GI concepts. When applied throughout the watershed, GI can help mitigate flood risk resulting from outdated and undersized storm drainage systems and increase flood resiliency, as well as improve water quality.

Sites Identified for GI Concept Development:

- **Heritage School**
  - Recommendations: bioretention, roof runoff capture and reuse, regrade and consider elevating access road
  - Cost: $513,000*
- **Charlton Middle School**
  - Recommendations: green roof, bioretention, roof runoff capture and reuse
  - Cost: $426,000*
- **Charlton Elementary School**
  - Recommendations: infiltration, bioretention, and native plantings
  - Cost: $49,000
- **Prindle Lake Park**
  - Recommendation: bioretention
  - Cost: $28,000
- **Maynard Farm Recreation Area**
  - Recommendation: bioretention
  - Cost: $44,000

** Does not include costs for roof runoff capture and reuse for irrigation*

Rendering of proposed green roof at Charlton Middle School

Financial assistance was provided by the Executive Office of Energy & Environmental Affairs (EEA) under the FY18 Municipal Vulnerability Preparedness (MVP) Grant Program.

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Dams

13 dams were assessed: six were classified as "severe" failure risk, four as "moderate," one as "low," and two as "unknown" failure risk.

Name	Failure Risk	Recommendation
Glen Echo Dam	Moderate (Medium)	Repair/Maintain
Little Nugget Lake Dam	Low (Low)	Consider adding aquatic organism passage
Lambs Pond Dam	Moderate (Medium)	Remove to increase stream continuity and to address beaver problems, or repair and remove beaver debris
Ashworth Dam	Unknown (Unknown)	Remove or no action
Lower Sibley Pond Dam	**Severe (High)**	Remove
Wee Laddie Pond Dam	**Severe (High)**	Remove
Farm Pond Dam	Moderate (Medium)	Repair/Maintain and consider adding aquatic organism passage
Mcintyres Pond Dam	Unknown (Unknown)	Consider removal; more information needed
Rail Road Pond Dam	**Severe (High)**	Remove
Power Station Dam	**Severe (High)**	Remove
Carpenter Mill Pond Dam	Moderate (Medium)	Consider removal; more information needed
Dam 3 (Cady Brook)	**Severe (High)**	Remove
Dam 4 (Cady Book)	**Severe (High)**	Remove

Rail Road Pond Dam spillway structure (photo from 2015)

Water and Wastewater Infrastructure

Eight water and wastewater infrastructure sites in Charlton were deemed "vulnerable" due to their proximity to 100-year or 500-year flood zones or regulatory floodways.

Sites Identified as Vulnerable:

- **Old Worcester Pump Station**
  - Recommendation: build a four-foot barrier around the station to protect it from flooding
  - Cost: $34,000*
- **North Main Street Pump Station**
  - Recommendation: build a four-foot barrier around the station to protect it from flooding
  - Cost: $34,000*
- **Mugget Hill Road Pump Station**
  - Recommendations: raise electrical equipment and install drainage swales
  - Cost: $31,750*
- **South Sturbridge**
  - Recommendations: raise electrical equipment and install drainage swales
  - Cost: $25,000*
- **Stevens Park Road Pump Station**
  - Recommendations: redirect runoff, install drainage swales, re-set fencing and electrical panel on new concrete pad, and grading improvements
  - Cost: $61,000*
- **Route 20 (MTA 5E Pump Station)**
  - Recommendations: protective barrier around entrance to prevent flooding and watertight hatch over the access entrance
  - Cost: $30,000*
- **J Hammond Road MTA 6W) Pump Station**
  - Recommendations: seal penetrations between main and lower levels
  - Cost: $45,000*
- **Pressure Regulating Vault**
  - Recommendations: redirect runoff and modify the vault to minimize inflow
  - Cost: $33,500*

** Does not include contractor costs (e.g., building permits and contractor bonds)*

J Hammond Road (MTA 6W) Pump Station

Financial assistance was provided by the Executive Office of Energy & Environmental Affairs (EEA) under the FY18 Municipal Vulnerability Preparedness (MVP) Grant Program.

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Appendix G

Adaptation Recommendations Summary, Town of Spencer, MA

Adaptation Recommendations Summary
Town of Spencer, MA

The **Town of Spencer** is vulnerable to flood-related damages, as evidenced by historical and recent flooding events. The Town of Spencer, in collaboration with the Town of Charlton and Fuss & O'Neill, developed a **water infrastructure climate resiliency plan** to help mitigate the effects of future flooding events that will become more frequent and intense as a result of climate change. The following is a **summary of key findings and recommendations** of the town's plan.

Quick Facts – Spencer

- 107 road-stream crossings assessed
- 11 dams assessed
- 16 sites were assessed for green infrastructure concept development
- Five water and wastewater facilities assessed as vulnerable

Road-Stream Crossings

107 road-stream crossings were assessed in Spencer:

- 65% of crossings are hydraulically undersized
- 35% of crossings have high geomorphic vulnerability
- 84% of crossings limit or restrict aquatic passage
- 43% were rated "critical" for structural condition
- 25% were classified as "high priority" for replacement

Recommendations:

- Replace and upgrade priority crossings (see table below) to meet flood resilience and aquatic organism passage (AOP) goals
- Consider other upstream and downstream crossings and dams on the same river system
- In general, replace downstream crossings first
- Perform site-specific data collection, geotechnical evaluation, hydrologic and hydraulic evaluation, and structure type

High Priority Stream Crossings (Listed by Priority Ranking)

Road	Stream	Crossing Type
Elm Street	Unnamed	Two (2) 5' concrete box culverts
Wire Village Road	Unnamed	2' corrugated metal culvert
Water Street	Unnamed	4' concrete culvert
Mill Street	Unnamed	4' concrete culvert
May Street	Unnamed	Two (2) corrugated metal culverts: 1.5' and 3'
Valley Street	Unnamed	6.5' concrete box/bridge
Gold Nugget Road	Unnamed	1.5' smooth plastic culvert
Brooks Pond Road	Unnamed	4' smooth plastic culvert
Wire Village Road	Unnamed	3' corrugated metal culvert
Greenville Street	Unnamed	1.5' corrugated metal culvert
Marble Road	Unnamed	1.5' smooth plastic culvert

Green Infrastructure

A screening-level assessment of potential green infrastructure (GI) retrofit sites was performed for 16 sites. Of these, 5 were selected for development of GI concepts. When applied throughout the watershed, GI can help mitigate flood risk resulting from outdated and undersized storm drainage systems and increase flood resiliency, as well as improve water quality.

Sites Identified for GI Concept Development:

- **Howe State Park**
  - Recommendations: bioretention and pavement removal
  - Cost: $51,000
- **Mechanic Street Parking Lot**
  - Recommendations: bioretention, underground infiltration, and permeable pavers
  - Cost: $495,000
- **Charlton Elementary School**
  - Recommendations: infiltration, bioretention (with improved pedestrian access) and pavement removal
  - Cost: $441,000
- **Richard Sudgen Library**
  - Recommendations: bioretention and permeable pavers
  - Cost: $20,000
- **O'Gara Park**
  - Recommendation: riparian buffer restoration and native plantings
  - Cost: $11,000

Rendering of proposed bioretention basins at Richard Sudgen Library

Financial assistance was provided by the Executive Office of Energy & Environmental Affairs (EEA) under the FY18 Municipal Vulnerability Preparedness (MVP) Grant Program.

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Dams

11 dams were assessed: one was classified as "severe" failure risk, one as "moderate/severe," five as "moderate," two as "low/moderate," one as "low," and one as "low/unknown" failure risk.

Name	Failure Risk	Recommendation
Lac Marie Dam	Low	Consider adding AOP within limited space
Muzzy Meadow Dam	Moderate (Medium)	No Action
Moose Hill Pond Dam	Low/Moderate (Low/Medium)	Consider adding aquatic organism passage
Cranberry Meadow Pond Dam	**Severe (High)**	Repair
Lake Whittemore Dam	Low/Moderate (Low/Medium)	No Action
Sugden (Reservoir) Dam	Moderate (Medium)	Consider modifying to allow drawdown for additional flood capacity; consider adding AOP
Browning Pond Dam	Moderate (Medium)	Consider removal, or Repair/Maintain and add aquatic organism passage
Buck Hill Conservation Dam	**Moderate/Severe (Medium/High)**	Repair/Maintain and consider adding aquatic organism passage
Cedar Millpond Dam	Low/Unknown (Low)	More information needed
Howe Mill Pond Dam	Moderate (Medium)	Repair/Maintain
Howe Reservoir Dam	Moderate (Medium)	Study Removal to possibly address beaver problems and provide stream continuity

Cranberry Meadow Pond Dam Spillway

Water and Wastewater Infrastructure

Five water and wastewater infrastructure sites in Spencer were deemed "vulnerable" due to their proximity to 100-year or 500-year flood zones or regulatory floodways.

Sites Identified as Vulnerable:

- **Sevenmile River Wellfield**
  - Recommendation: raise the electrical equipment that provides the well power and control
  - Cost: $10,000*
- **Cranberry Wellfield**
  - Recommendations: Place a barrier at the door to minimize flooding and raise the main transformer and distribution box
  - Cost: $45,000*
- **Wastewater Pump Station on Meadow Road**
  - Recommendations: raise the generator and propane tank that are outside the facility and provide a barrier at the entrance to protect critical equipment below the flood zone
  - Cost: $40,000*
- **UV Disinfection System at the Discharge of the Wastewater Treatment Facility**
  - Recommendation: install barriers around the UV channel and equipment (also considering relocating the facility)
  - Cost: $20,000*
- **Pressure Regulating Vault**
  - Recommendations: install a level transducer to monitor waste levels and alert system operators if water levels are getting high and further analyze the outlet structure to determine if properly sized and if gates are operational
  - Cost: $33,500*

** Does not include contractor costs (e.g., building permits and contractor bonds)*

UV Disinfection System at the Discharge of the Wastewater Treatment Facility

Financial assistance was provided by the Executive Office of Energy & Environmental Affairs (EEA) under the FY18 Municipal Vulnerability Preparedness (MVP) Grant Program.

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BIORETENTION WITH NATIVE PLANTINGS
CAPTURES FLOW FROM ROOF RUNOFF
OVERFLOW DRAIN

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