

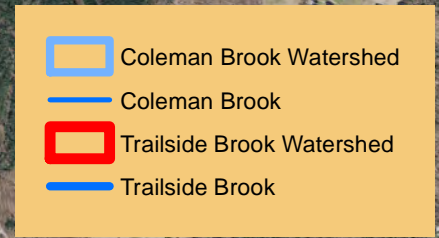
Coleman and Trailside Brooks, Ludlow, Vermont

Coleman Brook and Trailside Brook in Ludlow, Vermont have been found to be stressed by stormwater runoff as measured by the chemistry and biology of the stream. There are 19 smaller stormwater discharges to Coleman and 8 smaller stormwater discharges to Trailside from the developed lands of Okemo Mt Ski Area. Many of these are permitted by the state and some are older treatment systems. The discharges are combined into 5 subdrainages. The recommended course of action for stormwater impacted streams is to install treatment structures that that infiltrate runoff back into the ground and help control both the water quality volume and the channel protection volume from these discharges. A map showing the location of possible retrofit locations is provided. A cost estimate (excluding land costs) is provided. A Stormwater Master Plan (SWMP) was completed in 2017 that contains projects for Trailside Brook.

Addressing the large discharges of stormwater to the brook will reduce contamination and stream channel erosion and will help prevent the stream from becoming declared stormwater impaired on the state of Vermont's 303d list of impaired waters. It will also reduce nitrogen currently being discharged to the Connecticut River and Long Island Sound.

MOUNT HOLLY

LUDLOW





Monitoring Site Summary - River/Stream

Coleman Brook

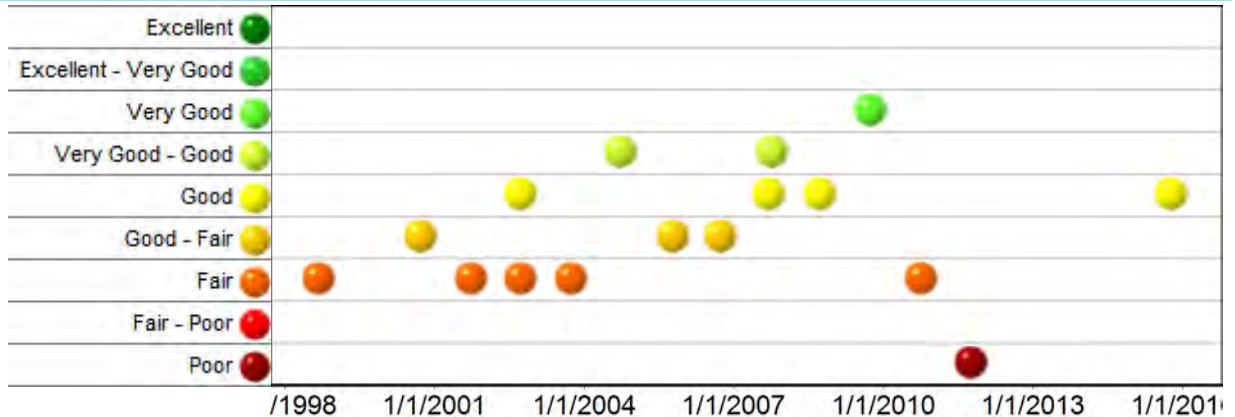
River Mile: 0.4

Located above new access road crossing about 500m.

Ludlow, VT (43.42148, -72.71752)

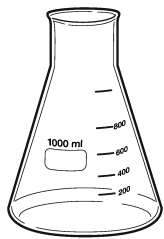
Macroinvertebrate Assessment

Macroinvertebrate population Assessments are a measure of the biological integrity of the macroinvertebrate community and an indicator of the health of the aquatic biota. (For More Details)



Water Quality Measurements

Chemical and physical parameters provide a “snapshot” of current conditions and are used to detect changes in water quality and to make determinations about a waterbody and its watershed. (For More Details)



Characteristic	Description	Trend	Max	Mean	Min
Chloride (mg/L)	At elevated values mostly from deicing		16.1	16.0	16.0
Conductivity (umho/cm)			220.0	115.1	21.5
Nitrogen (mg/L)	Nutrient that may fuel algae blooms		0.2	0.2	0.2
pH	Acidity		7.2	6.6	6.0
Phosphorus (ug/L)	Nutrient that may fuel algae blooms		5.0	5.0	5.0
Turbidity (NTU)	Measure of suspended sediment		0.8	0.4	0.2

Habitat Observations

Observations on the physical condition of the waterbody can be useful in determining the habitat type present and if watershed stressors have degraded its ability to support a healthy community of aquatic biota. (For More Details)

Observation Date: 10/19/2015

Habitat Type: Riffle

Embeddedness Estimated %: 5

Canopy %: 100



Monitoring Site Summary - River/Stream

Coleman Brook

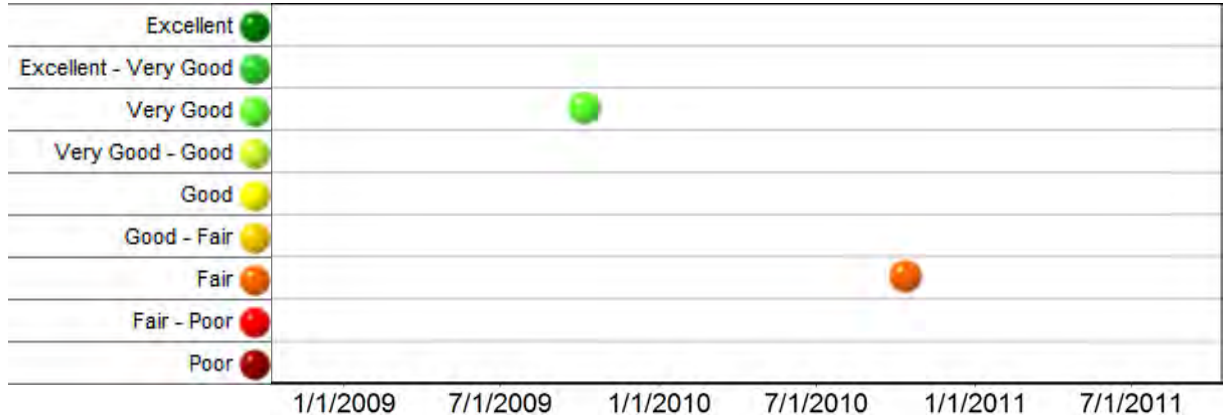
River Mile: 0.8

located approximately 100m above rail road bridge.

Ludlow, VT (43.42306, -72.72278)

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Habitat Observations

Observations on the physical condition of the waterbody can be useful in determining the habitat type present and if watershed stressors have degraded its ability to support a healthy community of aquatic biota. (For More Details)

Observation Date: 10/14/2010

Habitat Type: Riffle

Embeddedness Estimated %: 5



Monitoring Site Summary - River/Stream

Trailside Brook

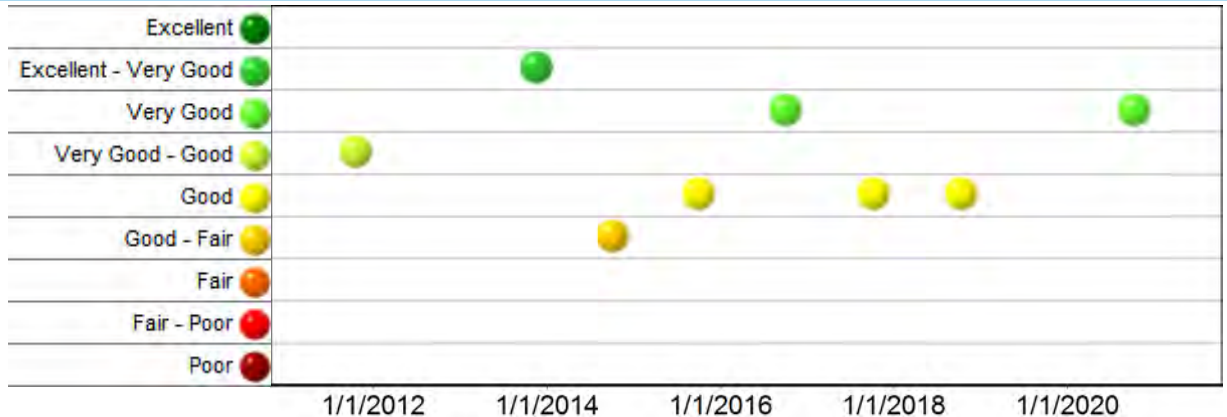
River Mile: 0.8

Located above reservoir.

Ludlow, VT (43.39154, -72.71538)

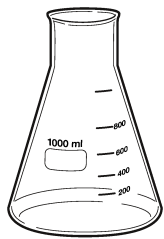
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Water Quality Measurements

Chemical and physical parameters provide a “snapshot” of current conditions and are used to detect changes in water quality and to make determinations about a waterbody and its watershed. (For More Details)



Characteristic	Description	Trend	Max	Mean	Min
Chloride (mg/L)	At elevated values mostly from deicing		73.0	48.0	26.0
Conductivity (umho/cm)			330.4	208.7	124.6
E. Coli Bacteria (#/100ml)	Indicator of pathogens		920.0	313.7	4.1
pH	Acidity		7.6	7.2	6.9
Phosphorus (ug/L)	Nutrient that may fuel algae blooms		27.0	15.7	7.0
Turbidity (NTU)	Measure of suspended sediment		1.5	0.7	0.0



Monitoring Site Summary - River/Stream

Trailside Brook

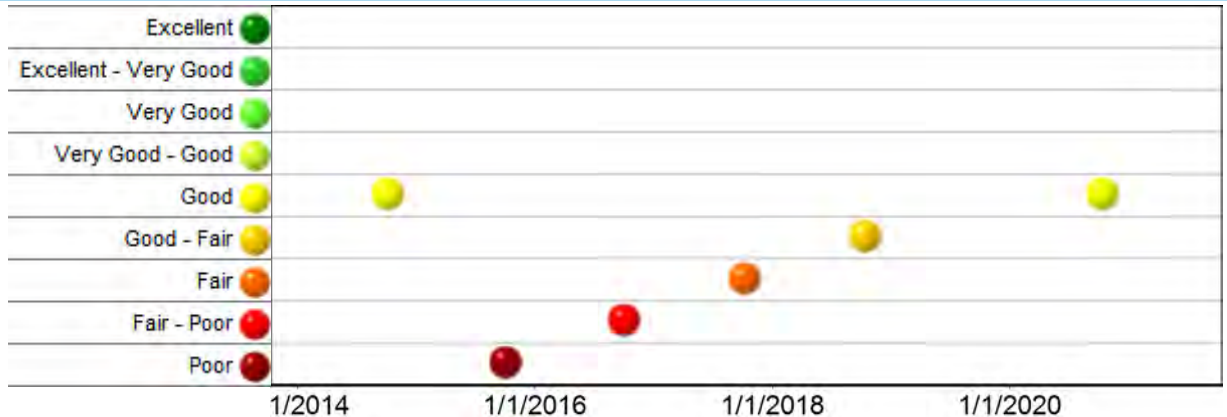
River Mile: 1.7

Located below Trailside road, this is new loaction in 2014

Ludlow, VT (43.39661, -72.73032)

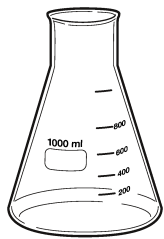
Macroinvertebrate Assessment

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Water Quality Measurements

Chemical and physical parameters provide a “snapshot” of current conditions and are used to detect changes in water quality and to make determinations about a waterbody and its watershed. (For More Details)



Characteristic	Description	Trend	Max	Mean	Min
Chloride (mg/L)	At elevated values mostly from deicing		58.0	37.7	15.0
Conductivity (umho/cm)			206.2	158.9	73.9
E. Coli Bacteria (#/100ml)	Indicator of pathogens		1100.0	514.7	4.1
pH	Acidity		7.8	7.1	6.7
Phosphorus (ug/L)	Nutrient that may fuel algae blooms		55.0	34.3	6.0
Turbidity (NTU)	Measure of suspended sediment		19.5	7.7	0.0

Watershed Number	Action List #	Proposed Action	Proposed or Existing Stormwater Treatment Practice	Permit Number	Watershed Area (Acres)	Percent Mapped Impervious Area (MLA)	EIA Equation (RANK)	Sediment Load with Current Reductions (lbs.)	Sediment Load with Priority Action (lbs.)	Nitrogen Load with Current Reductions (lbs.)	Nitrogen Load with Priority Action (lbs.)	Water Quality Volume (ft ³)	Channel Protection Volume (ft ³)	Estimated Basin Construction Cost	Estimated Other BMP Construction Cost	Cost of Sediment Removal Per Pound (based on annual sediment load)	Cost of Nitrogen Removal Per Pound (based on annual nitrogen load)	Assistance Program	# LID-Roof Raingardens to Treat Water Quality Volume	IF Landuse is residential AND receiving water is small: number of raingardens needed to treat CPv	Raingarden Cost
39 Ludlow			OF/GS		30.35	10.4	1	3225	3225	26.9	26.9	7949.2	0.0					CWIP,SRF	91	0	50
52 Ludlow			OF/GS/WP		46.65	9.0	5	3540	3540	29.5	29.5	8724.1	20047.1					CWIP,SRF	100	230	\$105,849
54 Ludlow	1	Implement SWMP LT-06 and LT-07 on West Hill Rd	IRA/Ws/GS/EDP/WP/CB/PP	3924-9010/ 3924-9015/ 3214-9010/ 3378-9010	840.66	4.0	5	57312	NA	477.6	NA	141248.2	160532.5		\$19,600	\$27	\$12,174	CWIP,SRF	1621	1843	\$847,612
63 Ludlow	1	Add infiltration basin at top of slope in front of Jackson Gore Hotel	IB/CB/GS/WP	3970-9010	307.85	10.1	5	24125	14475	201.0	160.8	59456.8	0.0		\$60,000	\$6	\$1,492	CWIP,SRF	682	0	50
64 Ludlow	1	Add infiltration basin along Okemo Ridge Rd to capture runoff from residential area above. Sized to 10% of WQv.	IB/CB/GS/EDP(2)	3491-9010/ 3491-9015	752.64	5.1	5	10437	6262	260.9	208.7	128617.3	182592.1	\$270,096		\$65	\$1,194	CWIP,SRF	1476	0	50

Target Maps

*Showing Priority Action List
Drainage Areas*

And Potential Retrofit Locations

Subwatershed: 63, 64
Action List: 1

76 Ludlow

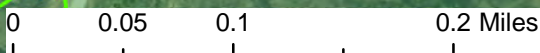


Add infiltration basin at top of ski slope

64 Ludlow

Add infiltration basin along Okemo Ridge Rd

63 Ludlow



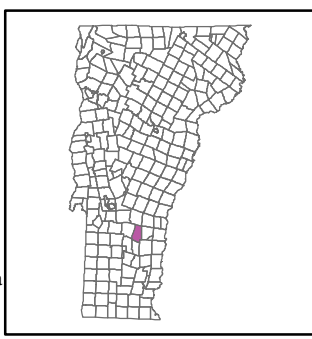
VCGI

Ludlow VT

DEC Stormwater Infrastructure Mapping Project

This map shows high priority subwatersheds which are ranked by connectedness, percent of impervious cover, field observations, and potential retrofit measures and locations.

The data shown on this map is only as accurate as the available sources and field observations allowed and should be used as a basic planning level tool only.



Stormwater points

- Pipe Cross (not connected)
- Catchbasin
- Dry Well
- Drop Inlet
- Grate/Curb Inlet
- Yard drain
- CB tied to sanitary sewer
- Junction Box
- Stormwater Manhole
- Outfall
- Culvert inlet
- Culvert outlet
- Control Structure
- Treatment feature (see notes)
- Retrofit
- Unknown Point
- Information Point

Stormwater line

- Storm line
- Storm line (old Sanitary line)
- Tunnel (storm)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Infiltration pipe
- French drain
- Trench drain
- Emergency spillway
- Stream
- Overland flow

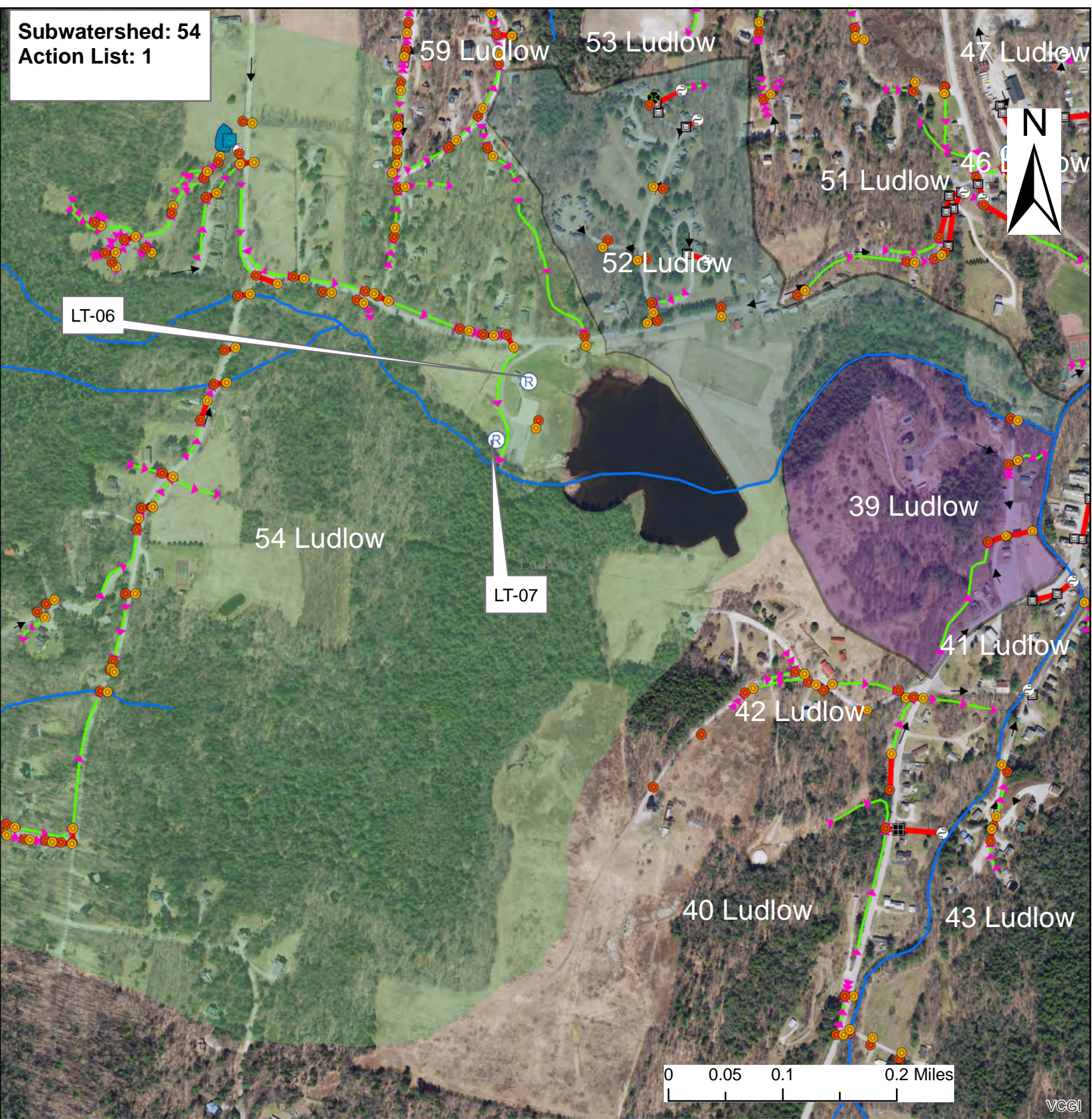
SubwatershedID

- Priority Subwatershed
- Stormwater Treatment Area
- Potential Stormwater Treatment Area

NRCS Soils

Creator: Jim Pease, David Ainley
 DEC - WID - Clean Water Initiative Program
 Plotted Date: 10/15/2021
 Data Sources: VTRANS Roads data, VT Hydrography data set, DEC Stormwater database, NRCS soils survey
 Imagery Source: VCGI Best Available Imagery

Subwatershed: 54
Action List: 1

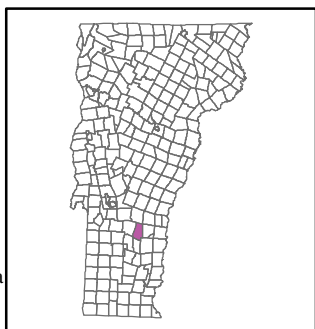


Ludlow VT

DEC Stormwater Infrastructure Mapping Project

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SubwatershedID

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Project: LT-6		Problem Area Summary
Location	West Hill Rd. West Hill Recreation Area	
Land Ownership	Town of Ludlow	
BMP Type	Rain Garden	
Drainage Area/Impervious	1.89/0.43 acres	
% Impervious	23%	
Estimated Project Cost	\$ 16,000	
P Efficiency (\$/lb removed)	\$ 23,680	
Project Priority	Medium	

Site Description: Existing stormwater treatment system along parking lot does not receive any runoff due to grading. Green space north of parking lot receives runoff from portion of parking lot, gravel road, and building



Photo 1: Open space along runoff flow path suitable for rain garden installation.



Photo 2: Swale along east side of parking lot that does not receive runoff due to poor site grading

BMP Description: Direct drainage into a rain garden or bioretention swale

BMP Volume (cf)	P Load (lbs)	P Reduction (lbs)	Sed Reduction	%WQv/CPv	Gully/Erosion	Maintenance
800	1.8*	0.68	Low	46/11	None	Mod

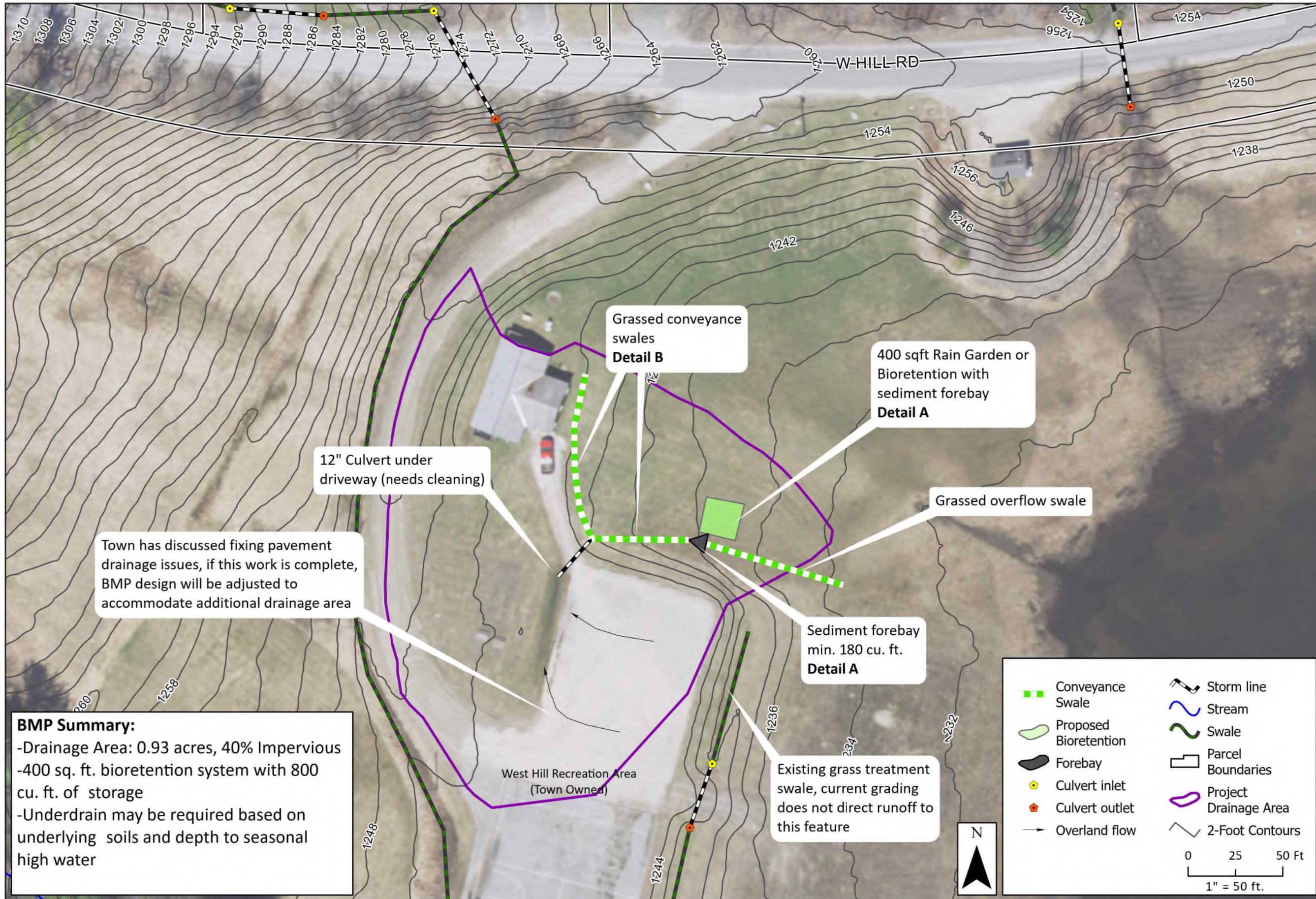
Feasibility Comments: Town property and open space could make this project very feasible.

Other Considerations/Benefits: Potential educational benefits for installing a BMP in a public park.

*P load (annual) is estimated from land cover values for each lake segment.

**Estimates include additional P loading from erosion or other sources.





BMP Summary:
 -Drainage Area: 0.93 acres, 40% Impervious
 -400 sq. ft. bioretention system with 800 cu. ft. of storage
 -Underdrain may be required based on underlying soils and depth to seasonal high water

Town has discussed fixing pavement drainage issues, if this work is complete, BMP design will be adjusted to accommodate additional drainage area

12" Culvert under driveway (needs cleaning)

Grassed conveyance swales
Detail B

400 sqft Rain Garden or Bioretention with sediment forebay
Detail A

Grassed overflow swale

Sediment forebay min. 180 cu. ft.
Detail A

Existing grass treatment swale, current grading does not direct runoff to this feature

Conveyance Swale	Storm line
Proposed Bioretention	Stream
Forebay	Swale
Culvert inlet	Parcel Boundaries
Culvert outlet	Project Drainage Area
Overland flow	2-Foot Contours

0 25 50 Ft
 1" = 50 ft.

Fitzgerald Environmental Associates, LLC.
 18 Severance Green, Suite 203
 Colchester, VT 05446
 Tel: 802.876.7778
 www.fitzgeraldenvironmental.com

DUFRESNE GROUP
 CONSULTING ENGINEERS
 1996 Depot Street
 Manchester, VT 05255

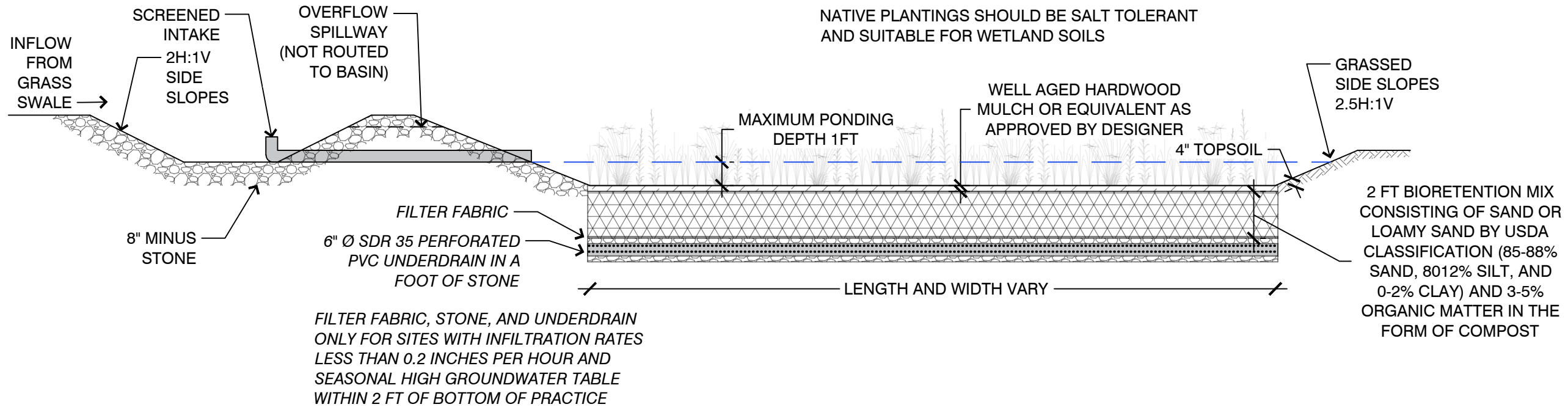
Notes:
 -Depth to groundwater and soil infiltration must be verified prior to construction
 -Contours based on 0.7-M LIDAR DEM
 -Project locations and drainage areas based on field visits by FEA during summer and fall of 2020

30% Conceptual Design
Project LT-06
Ludlow SWMP

FCP	JHB
Drawn	Checked
1" = 50 ft.	
Scale	4/13/2021
Date	Project LT-06
Sheet 1	
SHEET NO.	

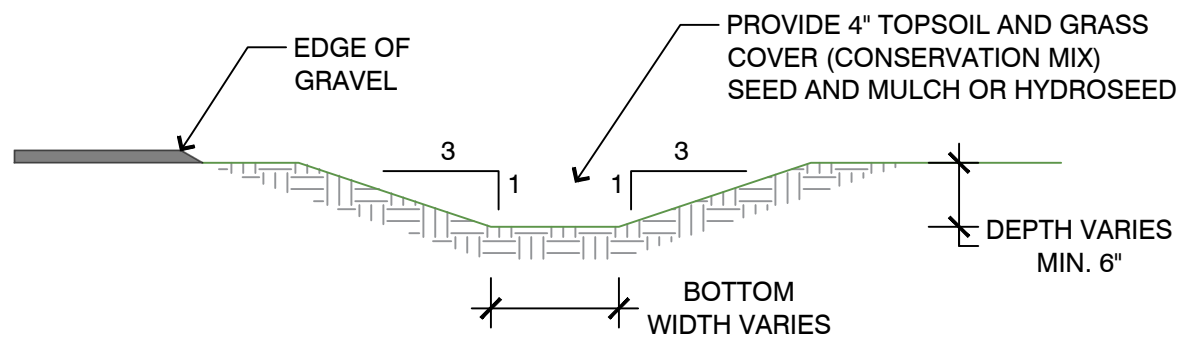
Detail A: Rain Garden or Bioretention Feature with Sediment Forebay Typical Profile

Not to Scale



Detail B: Grass Conveyance Swale Typical Section

Not To Scale



Preliminary Cost Opinion

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	\$ 1,000	\$ 1,000
Common Excavation and Soil Amendment	50	CY	\$ 25	\$ 1,250
Trucking	50	CY	\$ 20	\$ 1,000
Topsoil/Compost	10	CY	\$ 50	\$ 500
Bioretention Media	20	CY	\$ 50	\$ 1,000
Grass Swale	250	LF	\$ 10	\$ 2,500
Stone (8" minus)	10	CY	\$ 40	\$ 400
Plantings	20	EA	\$ 15	\$ 300
Laborer	16	HR	\$ 40	\$ 640
Misc. Erosion Control	1	LS	\$ 2,000	\$ 2,000
Culvert Cleanout	1	LS	\$ 500	\$ 500
Final Design & Permitting			\$	\$ 3,000
Construction Oversight			\$	\$ 2,000
			Subtotal	\$ 16,090
			Contingency (20%)	\$ 3,220
			Total	\$ 19,310

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1996 Depot Street
Manchester, VT 05255

30% Conceptual Design
Project LT-06

Ludlow SWMP

EHB
DRAWN

JHB
CHECKED

As Shown
SCALE

4/21/2021
DATE

PROJECT LT-06
SHEET 2

SHEET NO.

Stormwater Master Plan - Town of Ludlow
Unified Prioritization Project Table
May 19, 2021

Project ID	Project Type	Location	Description	Preliminary Recommendations	Total Acreage	Impervious Acreage	% Impervious	P Load (lb/yr)	WQv (cf)	BMP Type	BMP Volume (cf)	BMP P Reduction (lb/yr)	Erosion P Reduction (lb/yr)	Total P Reduction (lb/yr)	Gully Mitigation	Landowner	Project/Permitting Complexity	Infrastructure Conflicts	Total Cost	Project Efficiency \$/lb	Ease of O&M	Co-Benefits Sum	Total Score	Possible	Final Score %
LR-6	GSI	Red Bridge Road	Ditch along north/east side of Red Bridge Road spills across road at bend with moderate erosion, runoff continues along road to lake with moderate erosion down foot path to canoe/kayak access. Private landowner (Sperzel) is supportive of water quality projects	Improve ditch and install cross culvert at Sperzel driveway. Room for a sediment trap and small infiltration feature with some tree clearing. A soils	0.88	0.17	19%	0.78	710	Surface Infiltration	250	0.59	0.185	0.78	1	2	0	1	\$ 15,000	\$ 19,255	1	5	23	50	46%
LT-01	GSI	VTRANS facility on Route 100	Large grass swale/depression draining to a single catch basin that is directly connected to receiving water. Large drainage area including garage rooftop area and paved/gravel parking lot. North side of property drains to existing swale to catch basin. Steep slopes adjacent to swale. VTANR Stormwater Infrastructure Mapping Project - High priority project subwatershed 66	Install a large infiltration feature in grass area south of parking lot with an overflow to the existing catch basin. May need to line the downhill side. Enhance existing swale along north side.	4.68	1.61	34%	5.51	6,103	Subsurface Infiltration	6,200	5.23	0	5.23	0	3	2	1	\$ 52,400	\$ 10,019	2	4	35	50	70%
LT-04	GSI	Witalec Rd - Blue Lot	Catch basin directly connected to perennial stream drains a very large gravel parking lot (Town owned). Numerous gully and rill erosion features along concentrated flow paths through parking lot. VTANR Stormwater Infrastructure Mapping Project - High priority project subwatershed 50	Adjust grading and stabilize flow paths to direct runoff to a new infiltration feature near the existing catch basin. Surface or subsurface infiltration are feasible.	5.66	4.95	87%	12.53	17,201	Surface Infiltration	17,200	12.18	18.5	30.68	2	3	2	1	\$ 145,100	\$ 4,730	1	4	42	50	84%
LT-06	GSI	West Hill Recreation Area	Existing stormwater treatment system along parking lot does not receive any runoff due to grading. Green space north of parking lot receives runoff from portion of parking lot, gravel road, and building	Direct drainage into a rain garden or bioretention swale	0.93	0.37	40%	1.39	1,378	Rain Garden (no underdrain)	800	0.57	0.037	0.61	0	3	2	1	\$ 16,000	\$ 26,273	1	4	22	50	44%
LT-07	GSI	West Hill Recreation Area	Wetland swale getting at least half of basketball area	Improve/ upsize wetland swale according to drainage area	9.38	1.54	16%	7.77	6,728	Constructed Wetland	600	1.01	0	1.01	0	3	0	1	\$ 3,600	\$ 3,571	1	2	27	50	54%
LT-09	GSI	Town Garage	Sheet Erosion off of portion of parking lot flows to grassed area. Some erosion along edge of steep driveway from concentrated flow of parking lot. Buried electric nearby. Border of A/Unrated soils. VTANR Stormwater Infrastructure Mapping Project - High priority project subwatershed 51	Install a collection swale and infiltration basin	0.32	0.17	52%	0.49	604	Surface Infiltration	600	0.48	0.185	0.66	1	3	2	0	\$ 7,600	\$ 11,513	1	3	28	50	56%
LT-11	GSI	Town Garage	Outfall in lawn drains to train tracks then into a depression with no connection to surface water. Space for a larger feature but likely less opportunity for water quality improvement.	Infiltration basin or bioretention feature	1.31	1.03	78%	2.66	3,587	Surface Infiltration	1,500	2.13	0	2.13	0	3	2	0	\$ 12,700	\$ 5,957	1	2	29	50	58%
LT-13	GSI	Parker Ave	Filled in catchbasin presumably connected to culvert under house. Drains abandoned parking lot	Install dry well and/or remove pavement to allow for infiltration	0.43	0.38	90%	0.97	1,333	Subsurface Infiltration	600	0.85	0.185	1.03	0	0	2	1	\$ 5,100	\$ 4,936	1	3	28	50	56%
LT-14	GSI	Andover St.	Bad fill behind new wall has a big sinkhole gully. Runoff is from a smaller portion of road. Needs repair and is contributing sediment to jewel brook. Approx 30' long 3' deep 4' wide. Talked to property maintenance guy, it's the site of an old woolen mill with a big dye storage tank underground. Planned for condo/hotel but stalled.	Redirect system to empty lot and treat underground	0.28	0.13	48%	0.40	487	Subsurface Infiltration	400	0.37	0.74	1.11	2	0	0	0	\$ 19,000	\$ 17,065	1	5	25	50	50%
LT-15	GSI	Benson's Chevrolet	Existing wet pond with no stabilized outlet resulting in erosion into wetland. Drains all of subwatershed 46, gully erosion where water overflows pond. VTANR Stormwater Infrastructure Mapping Project High priority project subwatershed 46	Use existing wet pond as a forebay and make a new wet pond or gravel wetland, could also take portion of runoff from LT-16 (1 acre).	12.98	7.00	54%	20.74	25,225	Wet Pond	15,000	8.51	0.37	8.88	2	0	0	0	\$ 111,700	\$ 12,580	1	5	27	50	54%
LT-17	GSI	Behind Shaws on Main St.	Low point along back of parking area, catchbasin leading to outfall directly into black river. Sufficient room for a project	Install a Rain Garden to collect sheetflow	0.62	0.54	86%	1.36	1,867	Rain Garden (no underdrain)	500	0.99	0	0.99	0	0	0	1	\$ 15,700	\$ 15,918	1	3	19	50	38%
LT-18	GSI	Shaws front parking lot on Main St.	Corner of parking lot with poor drainage	Install dry well in pavement	0.31	0.31	100%	0.75	1,056	Subsurface Infiltration	800	0.72	0	0.72	0	0	2	0	\$ 13,000	\$ 18,027	1	3	19	50	38%
LT-19	GSI	Shaws front parking lot on Main St.	Buried culvert, eroding/filled swale along edge of parking lot. Large drainage area with minimal catch basins. Culvert under main street from Lamere Square is almost completely filled. Fire hydrant and likely other utilities. Possibly river corridor conflicts. VTANR Stormwater Infrastructure Mapping Project - High priority project subwatershed 44	Repair Swale and add another, Add forebay and bioretention feature, likely in adjacent lawn. Soils are unrated	1.88	1.49	79%	3.85	5,196	Rain Garden (no underdrain)	2,000	2.70	0.185	2.88	0	0	0	0	\$ 83,600	\$ 28,995	1	3	18	50	36%
LT-20	GSI	Municipal Parking lot on Main St.	Municipal parking lot low point drains into the river	Stabilize swales along parking lot, add rain garden in the corner to treat water before it enters the river, soils are unrated	0.82	0.67	83%	1.73	2,351	Rain Garden (no underdrain)	1000	1.28	0	1.28	0	3	0	1	\$ 31,300	\$ 24,502	1	4	22	50	44%
LT-21	GSI	High Street	Stormline with a large drainage area passes through an empty private lot. High Street has recent catchbasin and stormline upgrades, but no treatment.	Opportunity for a large underground infiltration feature. Flow split would be required at the final catch basin, or new catch basin. Would likely require an inline pre-treatment device (swirl separator). Pipe elevations surveyed and water elevation can't be raised in drainage network. Soils are unrated but neighbor says well drained	64.02	5.33	8%	42.93	29,045	Subsurface Infiltration	10,000	27.71	0	27.71	0	0	2	0	\$ 192,500	\$ 6,947	1	6	31	50	62%
LT-22	GSI	Bridge Street	Empty private lot with adjacent stormline system draining large steep area	Add a flow split in existing CB or in a new CB, install large underground infiltration. Would likely require an inline pre-treatment device (swirl separator).	21.15	2.52	12%	15.67	12,082	Subsurface Infiltration	5000	8.28	0	8.28	0	0	2	1	\$ 136,000	\$ 16,418	1	3	26	50	52%