




Low Impact Development Opportunities in Waitsfield, Vermont

Vermont Department of Environmental Conservation
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Final Report
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1. Project Overview

This Ecosystem Restoration Program project examines opportunities for implementing Low Impact Development (LID) stormwater treatment practices in the town of Waitsfield, Vermont. University of Vermont (Principal Investigator Stephanie Hurley), in collaboration with the Winooski Natural Resources Conservation District (WNRCD) and Friends of the Mad River, and with assistance from Watershed Consulting Associates, LLC, conducted and completed this work during the year 2011.

Urban development is a major contributor of sediment and phosphorus, among other pollutants, to waterways in Vermont. Although the many of Vermont's towns are not generally considered "urban," evidence of "urbanization" is present in these towns in the forms of impervious surfaces and storm drainage infrastructure on the land, erosion and sedimentation along stream channels, and eutrophication of downstream water bodies, including local reservoirs and Lake Champlain.

LID design and planning techniques include the reduction of impervious surfaces and the use of systems of soils and vegetation to absorb, retain, and filter stormwater runoff from developed sites. There is tremendous potential for this type of "green infrastructure" to be implemented in commercial, industrial, and residential areas in Vermont to help ameliorate water quality and flooding problems. The town of Waitsfield was selected for this research project, but the lessons learned in analyzing runoff issues in Waitsfield can also help inform stormwater planning in other Vermont towns. Like other towns in Vermont, Waitsfield hosts both a historic district and areas of newer development, some areas of which are prone to flooding and which are under pressure for additional commercial development.

We conducted our analysis of opportunities to implement LID in Waitsfield at two different scales: the "community planning scale" and the "site scale." Our community planning scale methods included site visits, watershed delineation, and mapping with GIS, and stormwater modeling (with SLAMM, the Source Loading and Management Model v. 9.4, PV & Assoc., 2009). We examined two main districts in Waitsfield (the historic Waistfield Village and the Irasville commercial area) at this broader scale. Within the Mad River Watershed, which includes the town of Waitsfield, particular "subwatersheds" (sub-areas within watersheds that discharge water to a single location either through surface flow or storm sewer pipe infrastructure) had previously been identified as concerns for stormwater inputs (Smythe and Pease, VTANR, 2009). This, and other previous studies (see Data Sources below), provided a starting point for identifying priority areas at the broader community planning scale.

From the community scale analysis, priority areas were identified for further examination at the site scale. The site scale analysis included the consideration of potential LID projects that would be appropriate at each site, outreach to property owners and property managers to educate them about LID and gauge their interest, and additional modeling to evaluate the potential improvements to stormwater flow reduction and water quality that might result from green infrastructure retrofits at our identified high priority sites. Ultimately, we recommend sites where the implementation of an LID project would be highly beneficial for water quality and stormwater flow reductions and present detailed survey maps for these sites. We recommend that further evaluation should be conducted in 2012, ideally with the implementation of LID retrofits soon to follow.

2. Project Tasks & Timeline, January-December 2011

Table 1. Projects tasks, 2011.

Project Tasks	January	February	March	April	May	June	July	August	September	October	November	December
Site Visits												
Data Collection												
Subwatershed Delinieation												
Community Scale GIS Analysis												
PI meets with Waitsfield Planning Commission												
SLAMM Modeling for Existing Conditions												
Ranking of High Priority Sites for Site Scale Analysis												
Selection of Potential LID Project Types for Each Site												
Development of Materials to Share with Property Owners												
Property Owner Outreach												
Stormwater Modeling of High Priority Sites												
Selection of Highest Priority Project Sites												
Formal Surveys of Most Promising Sites												

3. Waitsfield Village and Irasville

Waitsfield Village (Figure 1) is listed on the National Register of Historic Places as a Historic District and was the town's primary center of commercial activity (Waitsfield Town Plan, Waitsfield Planning Commission, 2010). The Irasville District (Figure 2) has been the center of commercial growth in Waitsfield for the past 30 years, and is heavily used by residents of Waitsfield's neighboring towns as well (Waitsfield Town Plan, 2010). Route 100 (Figure 3) is a major roadway that passes through both Waitsfield Village and Irasville.

Figure 1. Images of Historic Waitsfield Village, Waitsfield, VT.

Figure 2. Images of Irasville District in Waitsfield, VT.


Figure 3. Route 100 between Waitsfield Village and Irasville.

4. Data Sources

For this project, we obtained data from the following sources:

- Vermont Center for Geographic Information (VCGI): major GIS layers and orthophotos.
- VT DEC, "Towns of Waitsfield, Waterbury, Stowe, and Richmond. Stormwater Mapping Projects," Collin Smythe and Jim Pease, 2009: storm sewer info and GIS layers from project.
- Stone Environmental, Inc. "Assessment of Decentralized Wastewater Options: A Survey of Needs, Capacity and Solutions for Historic Waitsfield Village and Irasville, Vermont," 2011: Maps and GIS layers showing existing and proposed wastewater disposal sites and drinking water sources in Waitsfield.
- Waitsfield Planning Commission: Waitsfield Town Plan, history and land use information.
- Friends of the Mad River: connections with property owners and local stakeholders
- WinSLAMM, PV and Assoc.: Vermont rainfall data and typical pollutant loadings for commercial areas.
- USDA, NRCS, Soil Series Data for Washington County, Vermont.

5. Community Planning Scale Analysis

At the community planning scale, we aimed to create a priority list of sites in the subwatersheds of Waitsfield's historic village district and Irasville district where LID stormwater management practices will have the most positive impact on downstream waters in terms of reducing stormwater volume, and sediment and phosphorus loads.

We began by delineating six separate subwatersheds that convey stormwater runoff from Waitsfield Village and Irasville to the Mad River (Figure 4). In order to effectively employ the stormwater runoff model SLAMM[1] (Source Loading and Management Model, Version 9.4, PV and Associates, 2009), it was necessary to exclude large tracts of undeveloped forested land. Accordingly, although the boundaries between each subwatershed shown are topographically accurate, the outer-boundaries of several

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[1] SLAMM is a widely used model, with attributes that make it particularly user-friendly for urban planners dealing with stormwater issues. It was developed by Robert Pitt and John Voorhees in the late 1970s for stormwater modeling and has been continually updated with new editions to improve its accuracy and precision. SLAMM is a "continuous simulation model" that relies upon field data and observations, rather than theory, for modeling urban and suburban sites. Users of SLAMM can model watersheds with no stormwater retention structures and then comparatively evaluate the expected water quality benefits associated with adding stormwater BMPs such as detention basins, infiltration practices and biofiltration systems (EPA 2005). It is unique in its emphasis on "small storm hydrology," with programming that acknowledges the aggregate water quality affects of small storms (Pitt and Voorhees 2003). The model also enables calculations for dissolved and particulate pollutants from different land uses, based on the calibration with field data that describes pollutant movement from source area to outfall.
SOURCES:
- EPA (U.S. Environmental Protection Agency) 2005. Handbook for Developing Watershed Plans to Restore and Protect Our Waters -DRAFT. Washington, DC: Office of Water, Nonpoint Source Control Branch.
- Pitt, R. and J. Voorhees. 2003. SLAMM, the Source Loading and Management Model. In *Wet Weather Flow in the Urban Watershed: Technology and Management* [Field and Sullivan, Editors], CRC Press.
- Voorhees, John. 2008. SLAMM programmer, PV & Associates. WinSLAMM Instructional Course at State University of New York (Albany) and Personal Communications via phone and email.

subwatersheds were altered and appear as straight lines (Figure 5). In addition, we eliminated subwatersheds southeast of the Mad River, on the opposite bank from the commercial developments of Irasville and Waitsfield Village, resulting in the six subwatersheds shown in Figure 5, upon which all modeling and further aspects of the research was based.

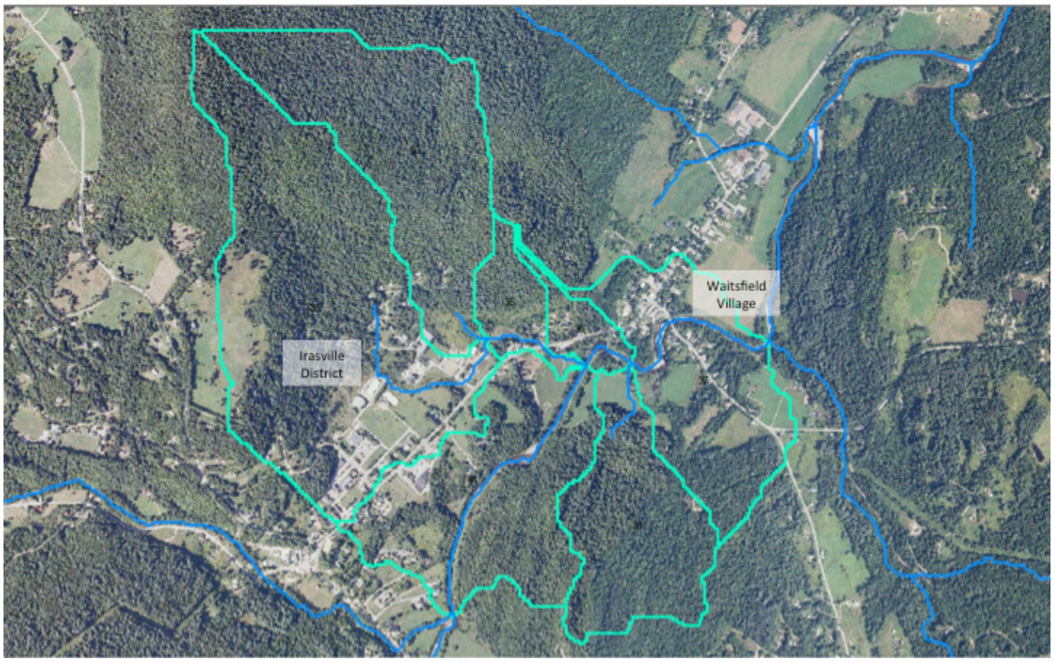


Figure 4. Subwatersheds of the Mad River Watershed that drain to the Mad River in the vicinity Waitsfield's Irasville District and Historic Waitsfield Village.

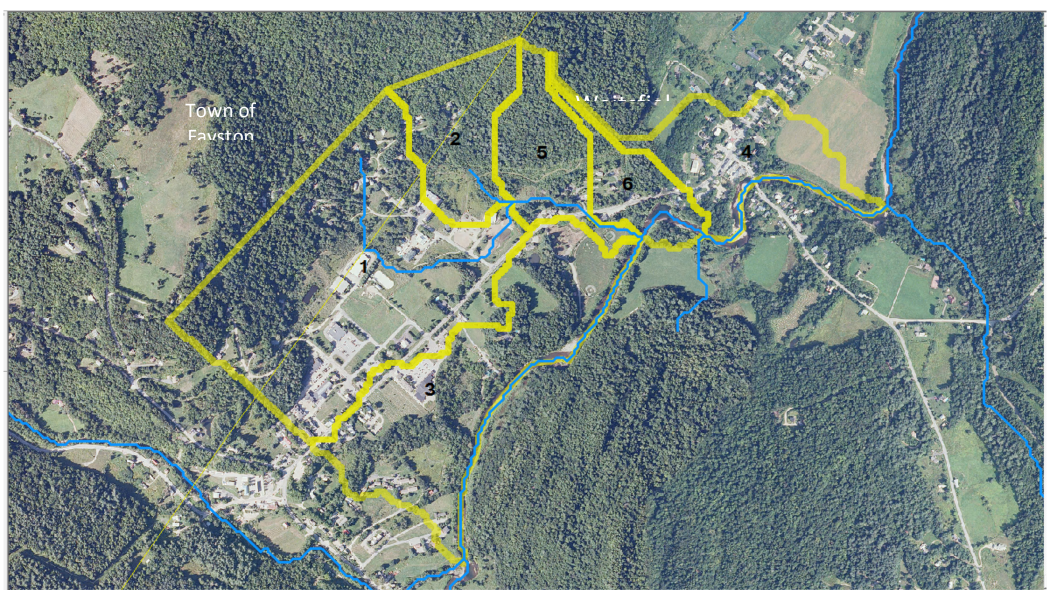


Figure 5. Six subwatersheds evaluated in this study. The Mad River flows northeast and bounds the southeast border of the study along subwatersheds 6 and 4. Note that subwatersheds 1 and 2 were cropped to eliminate large tracts of undeveloped forested area (see explanation in text).

As part of the SLAMM modeling process, we used NRCS soil maps and soil series data to categorize the soil types in Irasville and Waitsfield Village based on their drainage capacity, from excessively well drained to poorly drained (Figure 6). Using the GIS data from various sources (see Data Sources in Section 4 above), we calculated areas of various types of impervious and pervious cover in each of the six watersheds and entered this information into SLAMM. Figure 7 shows an example of the various textures of stormwater runoff "source areas," which include rooftops, parking areas, roads, driveways, and landscaped areas. We used the GIS data from the VT DEC 2009 study to determine which sites in the subwatersheds were drained by some form of piped stormwater infrastructure as opposed to ditches and other forms of surface drainage (Figure 8).

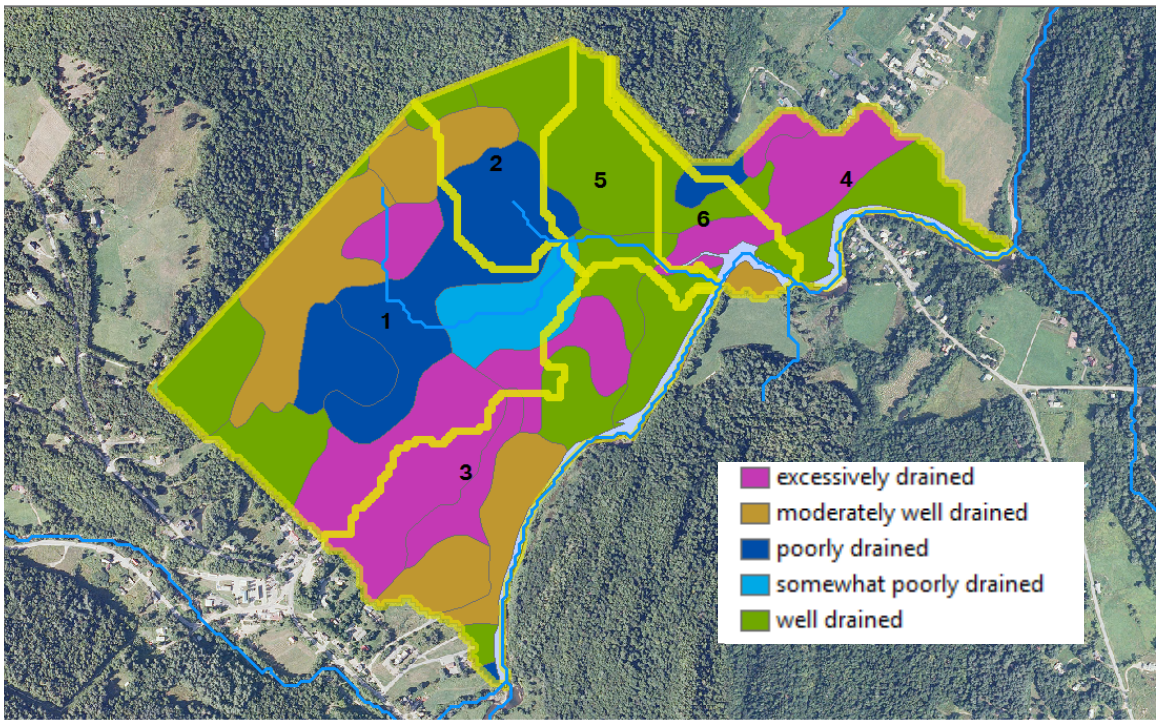


Figure 6. Soil drainage categories in study subwatersheds based on NRCD Soil Series data for Washington County.

Figure 7. Selected portion of study area in Irasville showing buildings, roads, driveways, parking lots, and landscaped areas for which areas were calculated and attributes documented in the process of SLAMM modeling (buildings data layer from Stone Environmental, Inc.; GIS calculations for other source areas by Winooski Natural Resources Conservation District).

Figure 8. Selected portion of the study area in Irasville showing various types of storm runoff drainage (from VT DEC 2009 data).

SLAMM was used to calculate the contribution of stormwater runoff volume emanating from each of the six subwatersheds and from the specific source areas within each subwatershed. We compared the overall contribution of stormwater runoff volume from residential and commercial land uses within each subwatershed (Figure 9).

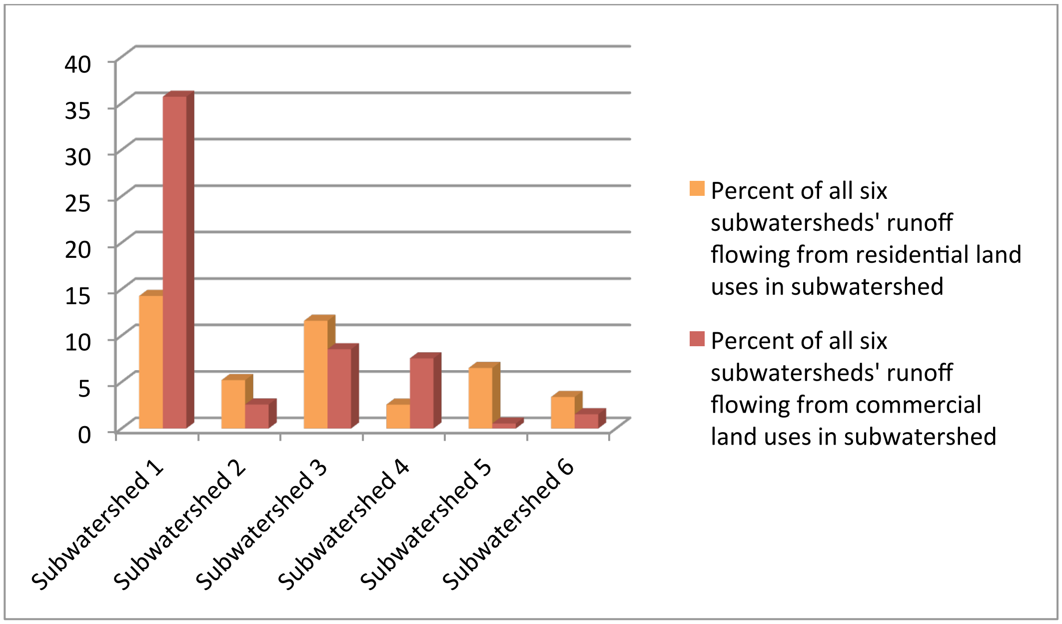


Figure 9. Comparison of residential (left-hand bars) and commercial (right-hand bars) land use contributions to stormwater runoff across the study site as modeled with SLAMM. 35% of all runoff in the study area originates in commercial areas within Subwatershed 1.

We next compared the percentages of runoff coming from each source area in the respective subwatersheds with the amount of total land area within that sub watershed occupied by the source area (Figures 10-15). In Figures 10-15, note that the source areas for which percentage of runoff exceeds percent land area (blue, left-hand bar is taller than red, right-hand bar), the particular source area is contributing a proportionally higher runoff volume than other source areas. In some cases, due to variability in soil type and textural attributes associated with particular source areas, relatively small land areas contribute large volumes of runoff where large land areas contribute little runoff.

Based on the relative contributions of runoff from particular source areas and land uses, we prioritized subwatersheds for LID implementation in the following order (Subwatershed 1, 3, 4, 5, 2, 6). We then examined runoff contributions within each subwatershed (Figures 10-15), and selected specific source areas for further analysis. Based on the modeling data and field visits, the source areas for which LID implementations were considered are included in Table 2 (11"x17" format, at end of report). In an ideal world, LID retrofits would be incorporated at all of the sites listed in Table 2.

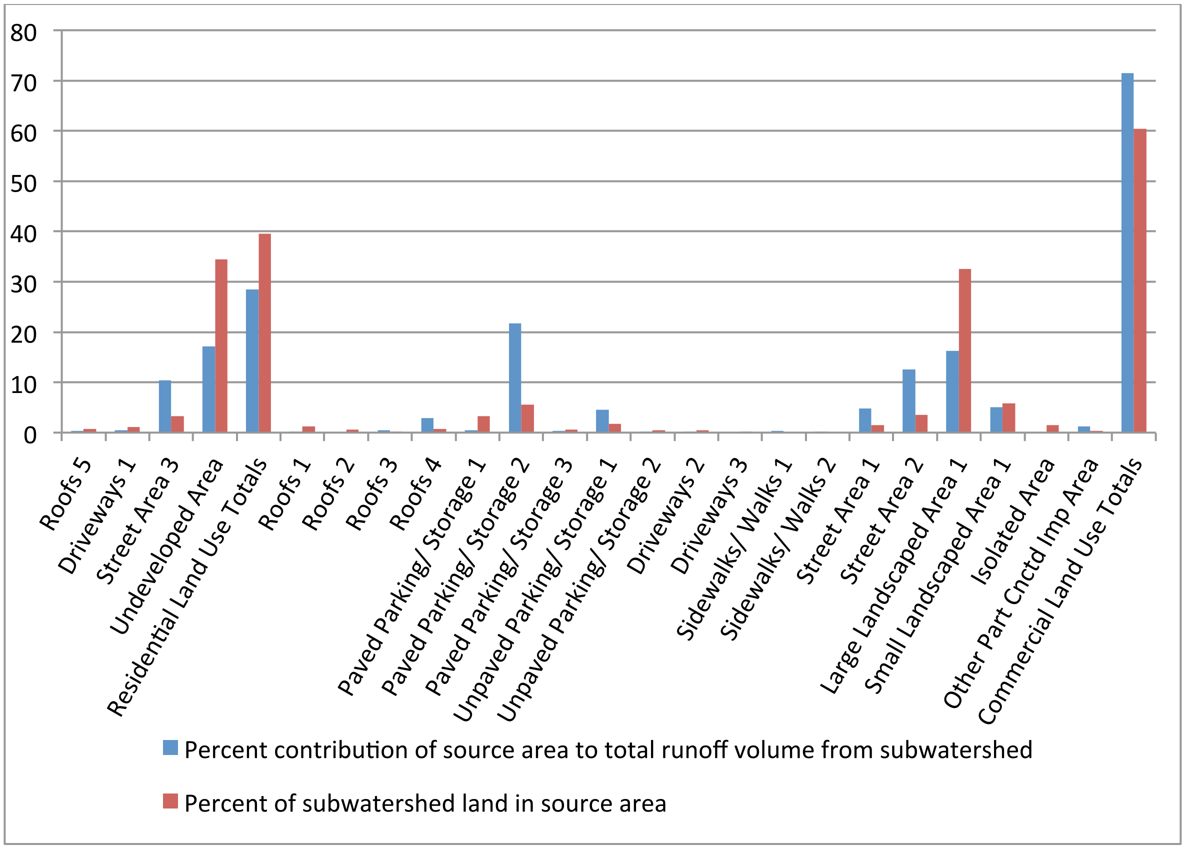


Figure 10. Runoff contributions from separate source areas as well as residential and commercial land uses in Subwatershed 1.

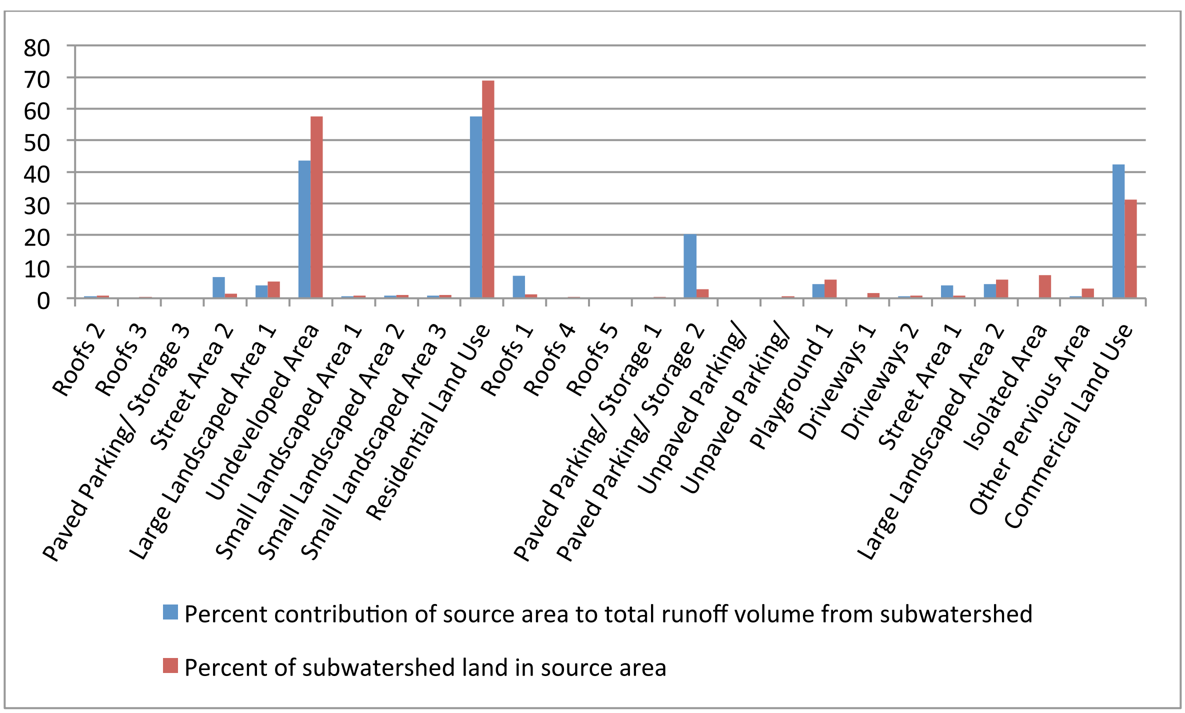


Figure 11. Runoff contributions from separate source areas as well as residential and commercial land uses in Subwatershed 2.

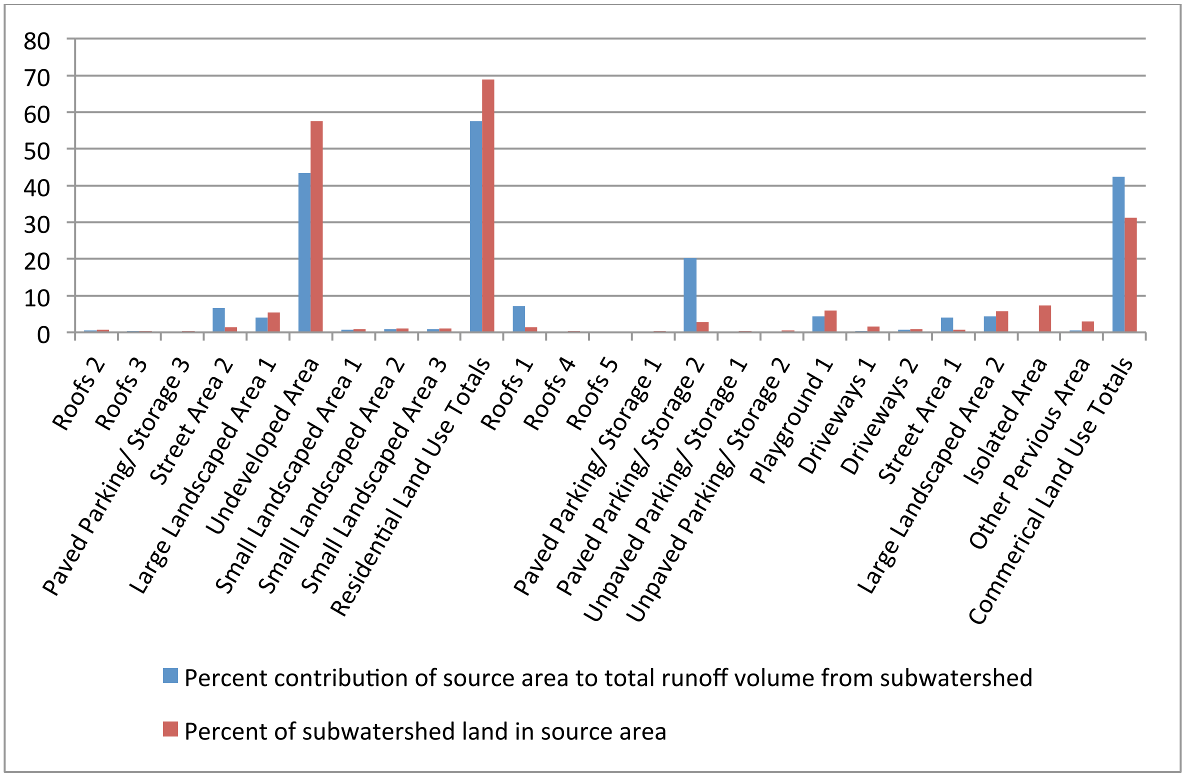


Figure 12. Runoff contributions from separate source areas as well as residential and commercial land uses in Subwatershed 3.

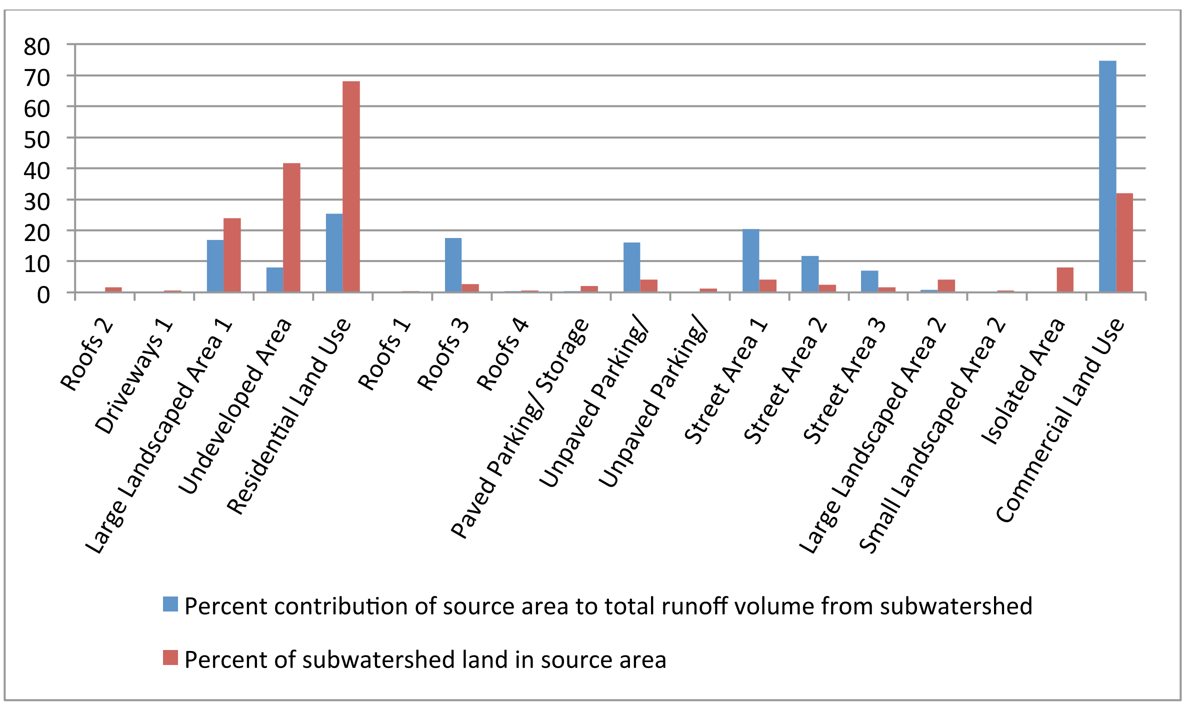


Figure 13. Runoff contributions from separate source areas as well as residential and commercial land uses in Subwatershed 4.

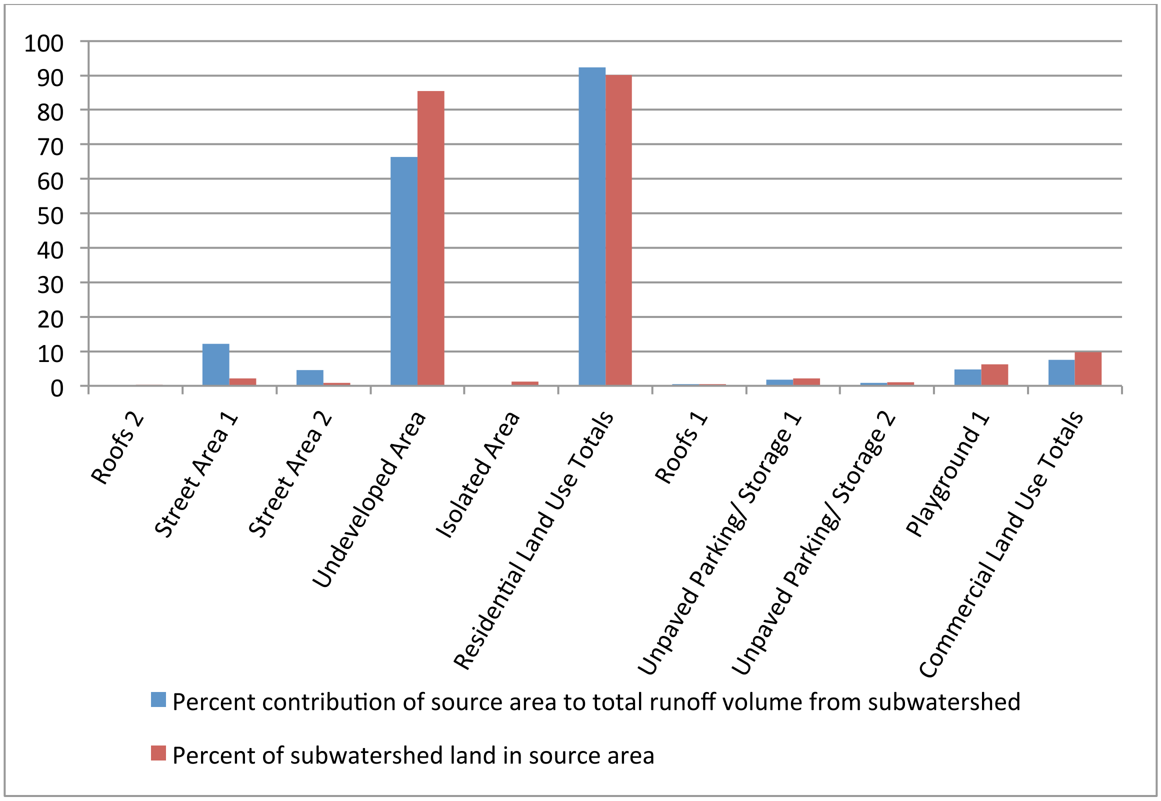


Figure 14. Runoff contributions from separate source areas as well as residential and commercial land uses in Subwatershed 5.

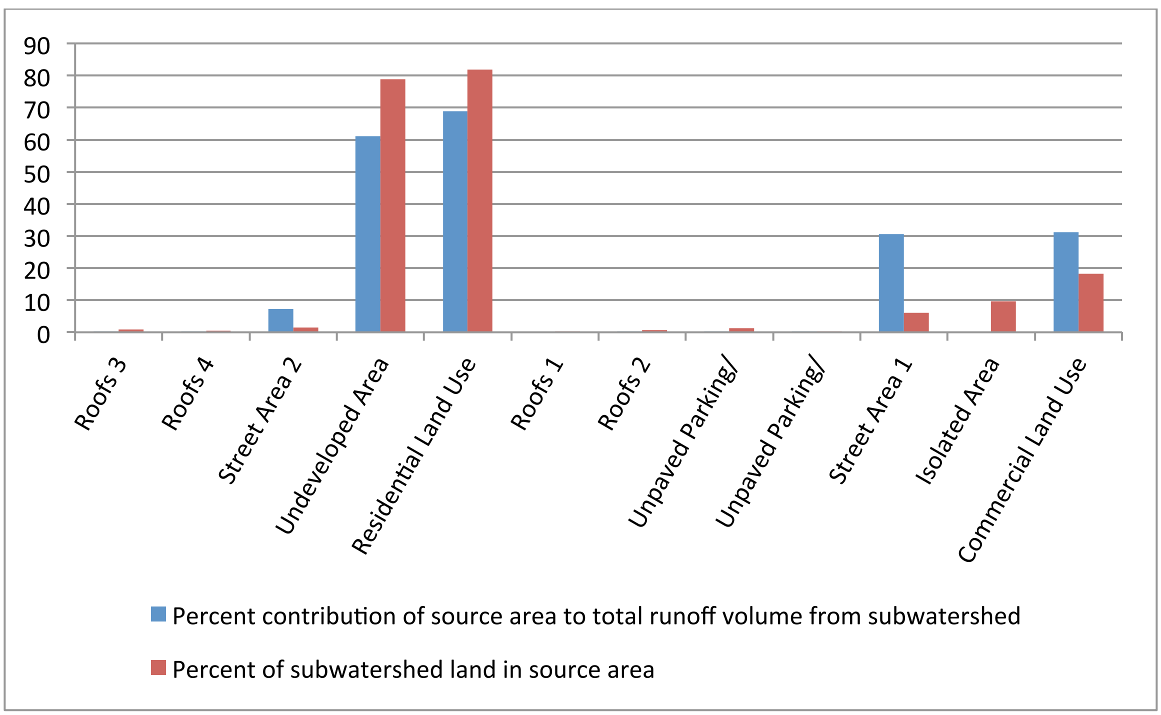


Figure 15. Runoff contributions from separate source areas as well as residential and commercial land uses in Subwatershed 6.

6. High Priority Sites for LID retrofits

Of the source areas and sites presented in Table 2 (see end of report), select sites were examined in further detail at the site scale. All of these "high priority" sites, were in Subwatershed 1 (Irasville), Subwatershed 3 (Irasville), or Subwatershed 4 (Waitsfield Village); Subwatersheds 2, 5, and 6 had fewer impervious surfaces and less of an impact in terms of overall stormwater runoff contribution. For seven high priority sites, a site analysis was conducted and schematic proposal was created showing potential LID interventions that would reduce stormwater flow and suspended solids and nutrient pollution (see Figures 16-22 and accompanying text below). Existing septic and wastewater infrastructure is shown on each map in order to avoid conflicts between stormwater and wastewater systems (GIS data from Stone Environmental, Inc.). Anticipated stormwater volume and pollution reductions associated with introducing bioretention/biofiltration cells (aka raingardens) were modeled using SLAMM for each of the high priority sites by comparing existing conditions to modeled future conditions with these stormwater treatment practices in place. Water quality improvements expected with these LID retrofits are described in Table 3.

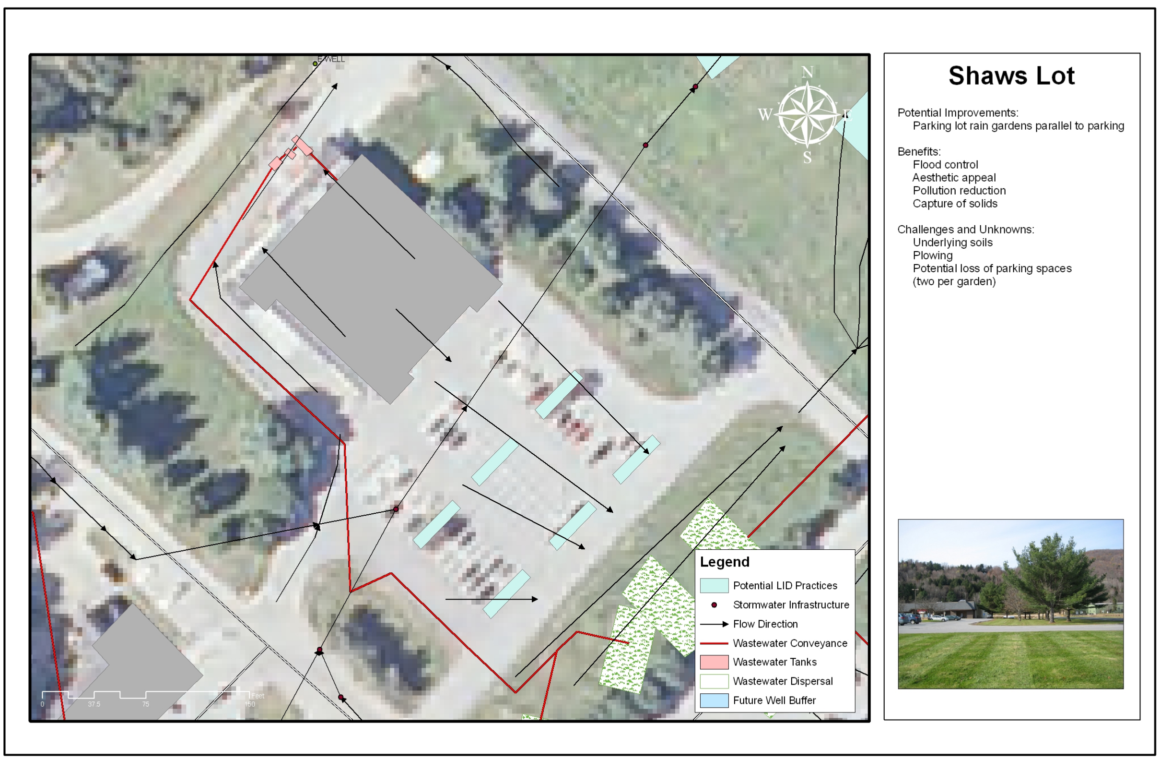


Figure 16. Shaws Supermarket Parking Lot, Subwatershed 1.

Location 1: Shaws Parking Lot, Subwatershed 1

Recommended Practices: Parking lot bioretention cells /raingardens

Notes: In the Shaws location, parking lot raingardens will likely be the most effective means of controlling and treating stormwater. The existing slope of the parking lot lends itself well to installation of raingardens perpendicular to the stormwater flow path. It's likely that only 6-12 parking spaces would be lost in the introduction of these bioretentionareas. Additionally, this configuration would be designed to be compatible with snow plowing and storage.

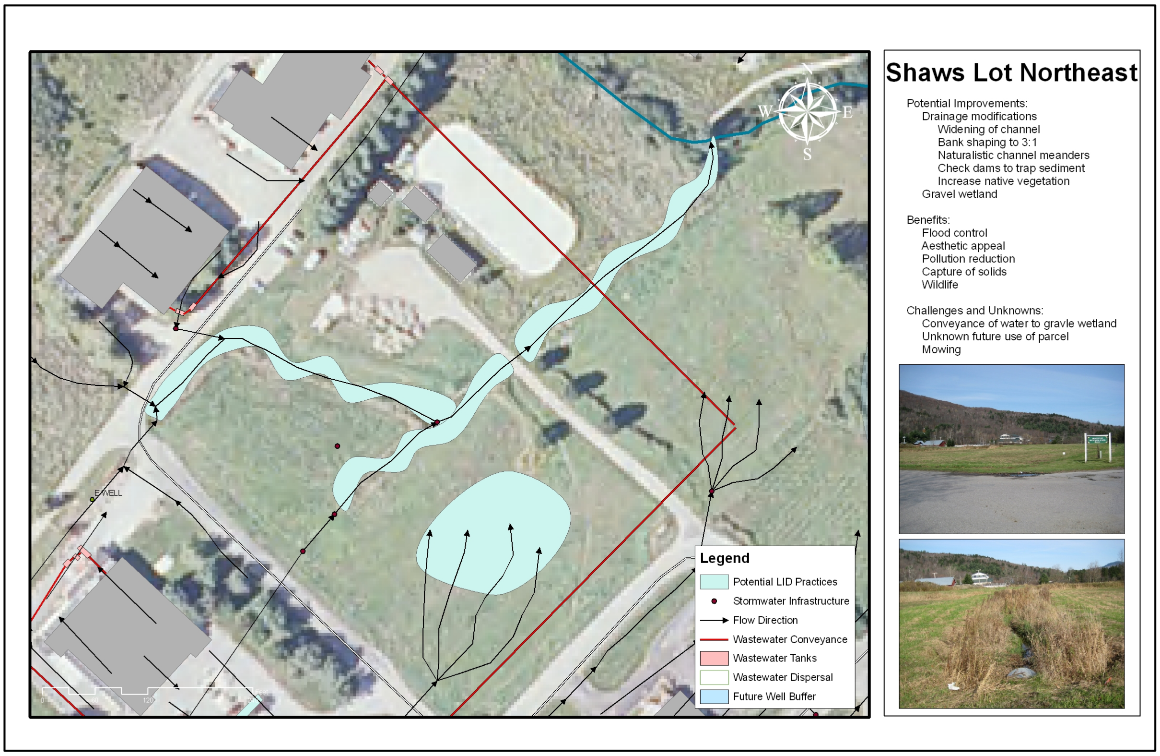


Figure 17. Shaws Parking Lot Northeast, Subwatershed 1.

Location 2: Shaws Parking Lot Northeast, Subwatershed 1
Recommended Practices: Drainage modifications, gravel wetland

Notes: The area to the northeast of the Shaws lot is a great location to do some additional stormwater control and treatment. The existing drainage channels could be improved by installing natural meanders, decreasing the bank slopes, increasing vegetative buffers around the drainage channels, and adding check dams. This combination of things would slow runoff and provide additional treatment. A sizeable gravel wetland could be installed in the southern portion of the lot to capture runoff from Shaws and adjacent buildings and parking lots. Gravel wetlands are capable of removing phosphorus as well as nitrogen due to their anaerobic design.

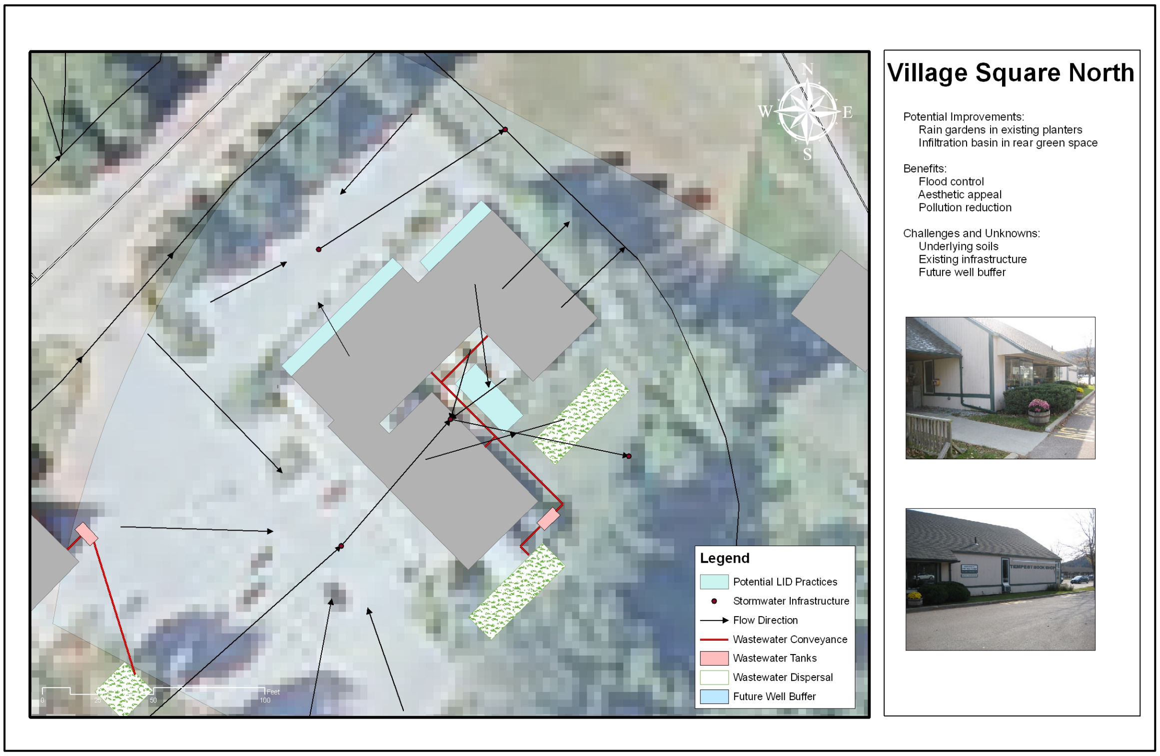


Figure 18. Village Square North, Subwatershed 1.

Location 3: Village Square North, Subwatershed 1.

Recommended Practices: Bioretention cells/raingardens, stormwater planters or cistern

Notes: Two raingardens or stormwater planters could be installed at the northwest entrance of the building near the natural food store. Both areas are currently landscaped and are receiving roof runoff. The existing plants and soils would need to be retrofitted and an overflow mechanism added. This would likely keep runoff from most storms from entering the stormdrain located in the nearby parking lot. On the east side of the building, another planter or cistern could be installed. The cistern may be useful for watering plants around the building. It could collect water from the numerous roof lines draining to this location. And overflow system could be connected to the existing stormdrain.

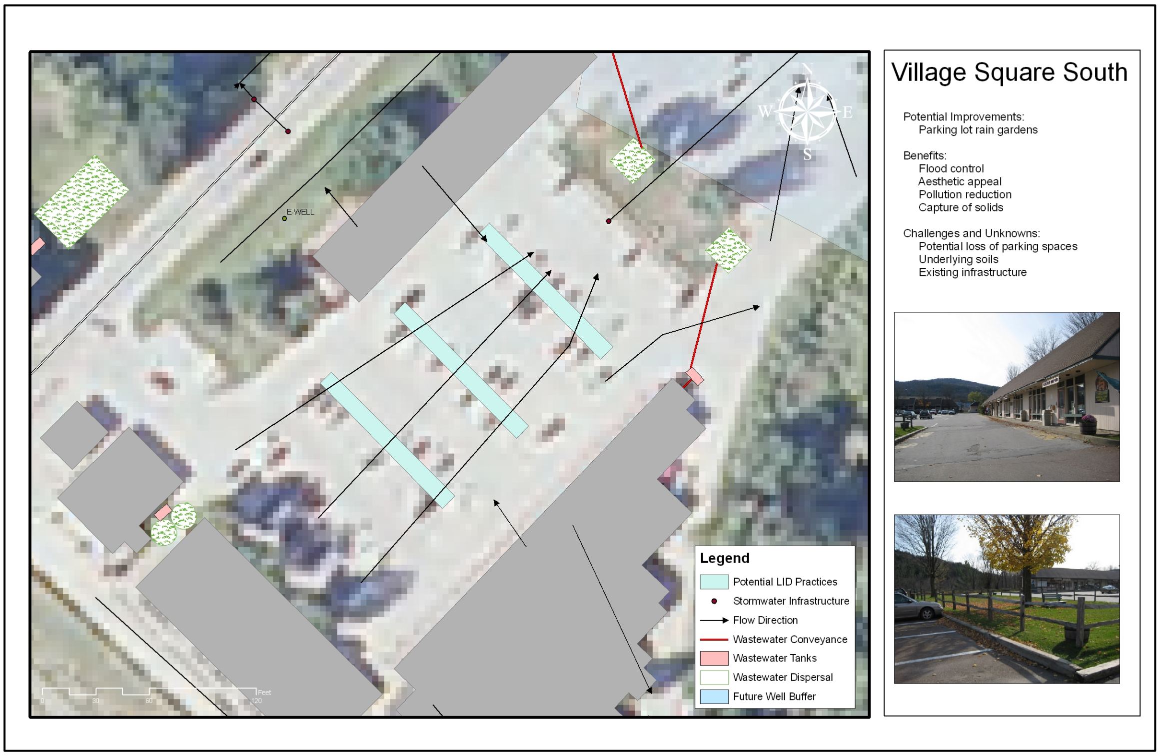


Figure 19. Village Square South, Main Parking Lot, Subwatershed 3 (note that Village Square North is in Subwatershed 1).

Location 4: Village Square South, Main Parking Lot, Subwatershed 3.
Recommended Practices: Parking lot bioretention cells /raingardens

Notes: Stormwater runoff at this location flows directly to a stormdrain at the northeastern portion of the parking lot. This runoff could easily be intercepted by raingardens perpendicular to the flow of runoff. They would be inset with curb cuts to receive water and would be planted with low shrubs and grasses. We would recommend three of these bioretention cells; however, if there are concerns with snow plowing regimes, an alternative option is to implement one large bioretention cell surrounding the primary stormdrain inlet. This may amount to a loss of 10-12 spaces but should accommodate snow plowing.

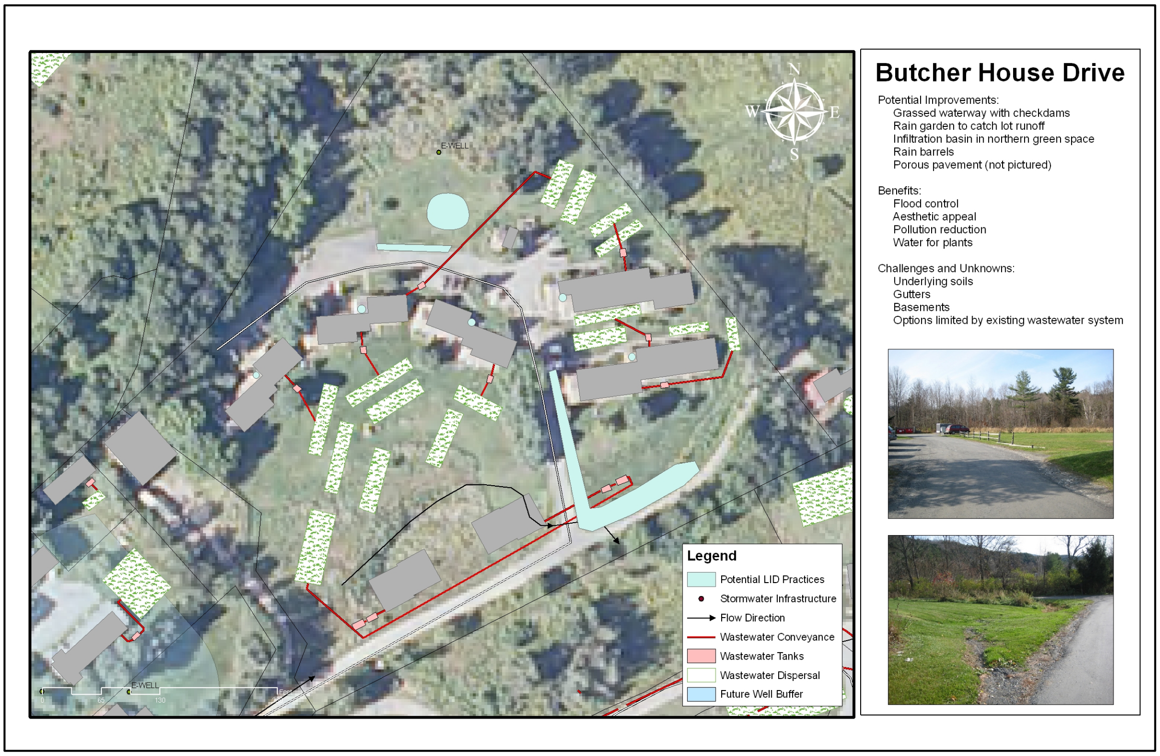


Figure 20. Butcher House Drive, Subwatershed 3.

Location 5: Butcher House Drive, Subwatershed 3.
Recommended Practices: Grassed waterways, check dams, bioretention cells/raingardens, infiltration basin, rain barrels, porous pavement

Notes: Butcher House Drive is a site that could benefit from many different interventions. The majority of stormwater flows from the northern parking lot down to a drainage ditch and then through a culvert onto the adjacent property to the south. Evident erosion of the drainage ditch suggests that stormwater flows from this site must have fairly high velocity and volume. A small raingarden could be placed at the northern parking area to capture some of the runoff. Depending on the amount being captured and the soils, runoff could also be conveyed to an infiltration basin. The ditch itself could be improved with vegetation and adequately spaced check dams. The dams would slow the water, promote some infiltration, and reduce erosion. This could then drain into a large bioretention area in the southern area of the site, with an overflow across the street if needed. Rain barrels along building downspouts could also be a good solution. Spaced throughout the development they could provide minimal stormwater storage and water for irrigation. Porous pavement could also be used in this location for some parking spaces; re-grading and paving would need to be done elsewhere in the parking area to make this treatment option effective.

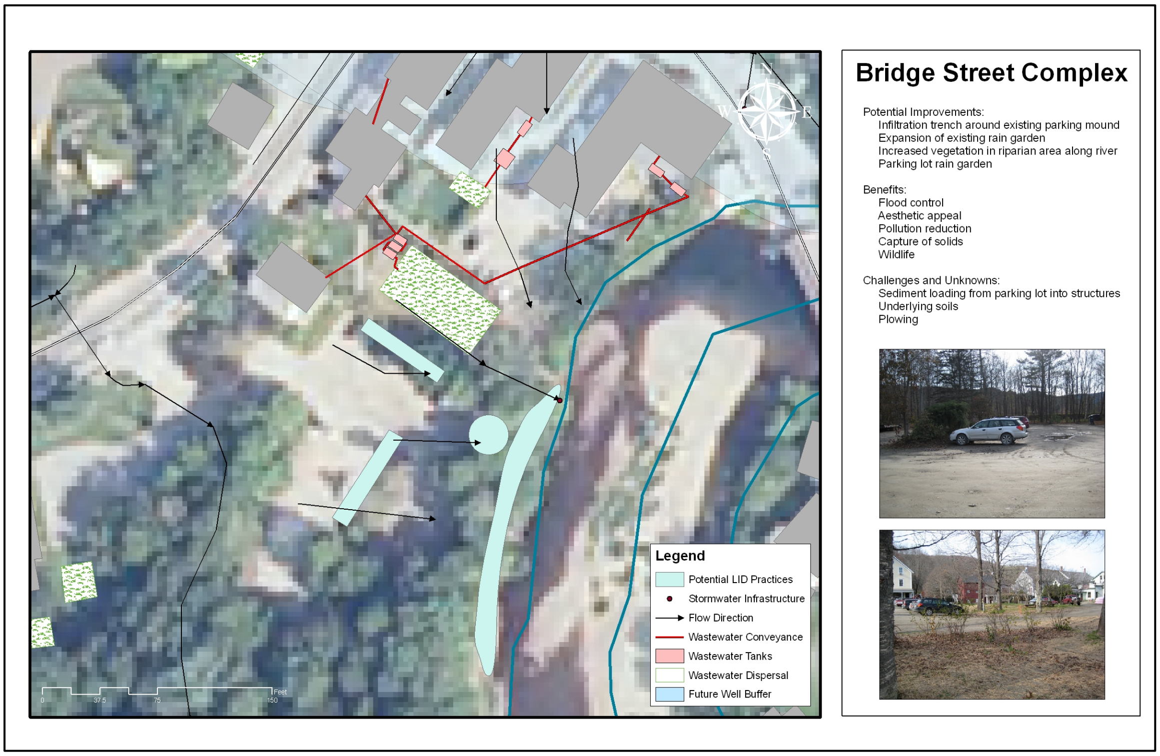


Figure 21. Bridge Street Complex Parking Lot, Subwatershed 4.

Location 6: Bridge Street Complex Parking Lot, Subwatershed 4.
Recommended Practices: Infiltration trenches, bioretention cells/raingardens, enhanced buffers, porous pavement, cisterns or rain barrels

Notes: The Bridge Street Complex site could be modified in a number of ways to increase retention and treatment of stormwater using LID practices. The existing dirt parking lot drains directly to the river and has although surrounded by vegetation, runoff patterns do not currently direct flows into vegetated areas which could trap sediment and filter pollutants. Together, multiple bioretention cells in different zones of the parking lot could capture a fair amount of stormwater runoff. The rest could be captured by the existing raingarden (circle in Figure 21), which is functional, but undersized for the amount of runoff produced by the site. The riverbank could also be improved through enhanced buffer plantings of native trees and shrubs. Potentially, the entire parking lot could be paved in order to more accurately direct runoff flow paths. This would reduce sediment (as well as extensive puddles that form each year in this area) but may increase overall stormwater volume. Accordingly, porous pavement would be a logical choice. Additionally, building owners could install large cisterns (250-500 gallons) either above or below ground to catch roof runoff. If there is not a need for reuse of water, the cisterns could have a low flow drain roughly ¼" in diameter. These would capture much of the volume of smaller storms, releasing water downstream at a slow rate.

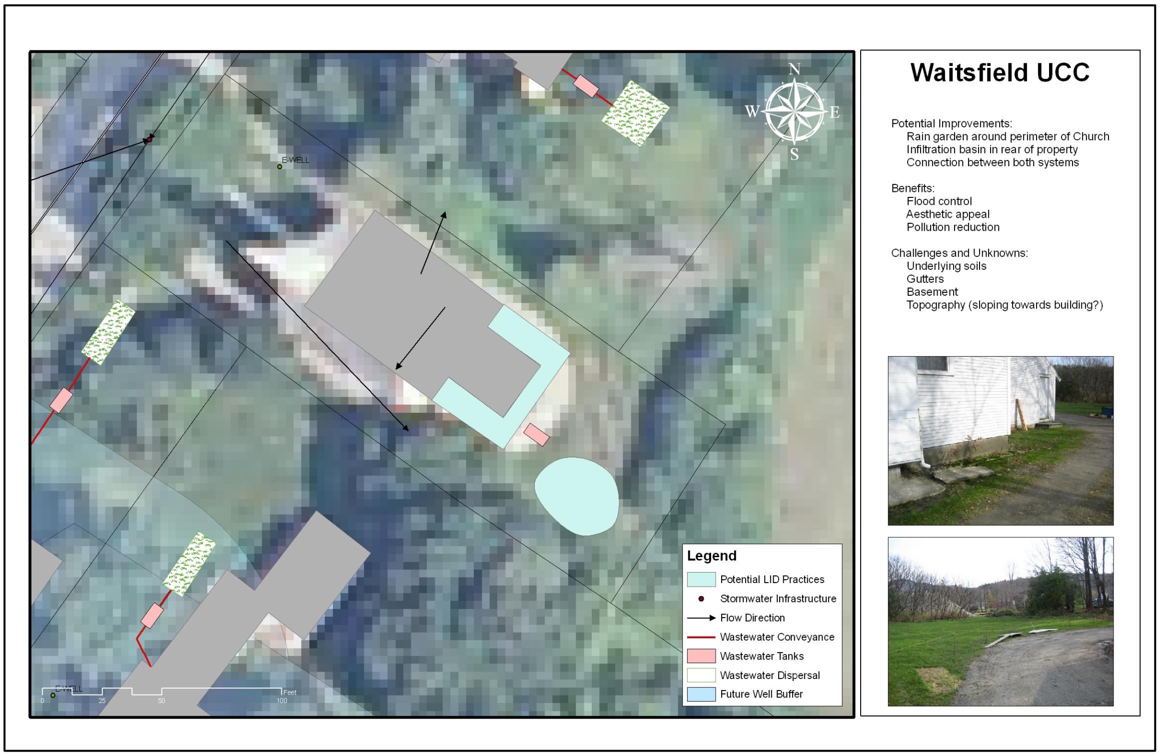


Figure 22. Waitsfield United Church of Christ (UCC), Subwatershed 4.

Location 7: Waitsfield United Church of Christ, Subwatershed 4.
Recommended Practices: Bioretention cells/raingardens, infiltration basin

Notes: The Waitsfield United Church of Christ is a sizeable building with a large steeply pitched roof. Many of the downspouts drain directly to the base of the building in the rear. Raingardens could be installed around the back to capture and treat most of this water. If additional capacity was needed, an infiltration basin could be constructed in the southeastern portion of the property. This would be a deeply dug basin filled with gravel wrapped in landscaping cloth and topped with soil. Runoff would be retained here and slowly released. Changes to this site's stormwater management could accompany existing proposals to add more parking behind the church.

Table 3. SLAMM results for high priority LID retrofit sites in Waitsfield. "Runoff VOL Average" = average runoff volume; "Flow Wtd Avg" = Flow-weighted Average; "TP"= total phosphorus; "Biofiltration units of 500 sf" refers to surface area (500 square feet) of individual bioretention cells / raingardens modeled.

SITE AND PARAMETERS MODELED	PERCENT REDUCTION FOR LID DESIGN DESCRIBED	
SHAWS PARKING LOT, SUBWATERSHED 1, IRASVILLE	with 3 biofiltration units 500 sf each	with 5 biofiltration units of 500 sf each
Runoff VOL Average	4.66	7.66
Total Solids yield Flow Wtd Avg	13.39	17.41
TP yield Flow Wtd Avg	18.18	25.0
VILLAGE SQUARE NORTH, SUBWATERSHED 1, IRASVILLE	with 3 biofiltration units 500 sf each	with 3 biofiltration units at parking lot and ONE PLANTER at roof
Runoff VOL Average	8.85	8.90
Total Solids yield Flow Wtd Avg	29.17	29.64
TP yield Flow Wtd Avg	25.0	40.0
VILLAGE SQUARE SOUTH, SUBWATERSHED 3, IRASVILLE	with 3 biofiltration units 500 sf each	with 5 biofiltration units of 500 sf each
Runoff VOL Average	38.05	49.64
Total Solids yield Flow Wtd Avg	17.65	27.50
TP yield Flow Wtd Avg	22.06	32.35
BUTCHER HOUSE ROAD, SUBWATERSHED 3, IRASVILLE	with 3 biofiltration units 500 sf each	with 5 biofiltration units of 500 sf each
Runoff VOL Average	82.61	84.56
Total Solids yield Flow Wtd Avg	61.36	75.46
TP yield Flow Wtd Avg	67.57	79.73
UNITED CHURCH OF CHRIST (UCC), SUBWATERSHED 4, WAITSFIELD VILLAGE	with ONE biofiltration unit or PLANTER of 500 sf	with ONE biofiltration unit or PLANTER of 50 sf
Runoff VOL Average	0.49	0.04
Total Solids yield Flow Wtd Avg	13.79	8.09
TP yield Flow Wtd Avg	23.81	9.52
BRIDGE STREET COMPLEX PARKING LOT, SUBWATERSHED 4, WAITSFIELD VILLAGE	with 3 biofiltration units 500 sf each	with 5 biofiltration units 500 sf each
Runoff VOL Average	53.47	62.95
Total Solids yield Flow Wtd Avg	20.97	28.44
TP yield Flow Wtd Avg	24.81	32.56

Runoff volume reductions ranged across the different sites and LID designs modeled from less than 1% (UCC, with one stormwater planter) to nearly 85% (Butcher House Road, with 5 biofiltration units). For the same LID designs and sites, total solids yield reductions ranged from 8% (UCC) to 75% (Butcher House Road); and total phosphorus yield reductions ranged from 9% (UCC) to 80% (Butcher House Road). Promising SLAMM modeling results from the other sites included that Shaws Parking Lot, with 5 biofiltration units, had a 25% TP reduction; Village Square North, with 3 biofiltration units and one planter, had a 40% TP reduction and nearly 30% total solids reduction; Village Square South, with 5 biofiltration units had reductions of 50% for runoff, 27% for total solids and 32% for TP; and the Bridge Street Complex, with 5 biofiltration units, had reductions of 65% for runoff, 28% for total solids, and 32% for TP. The variations in modeled performance can be attributed to differences in site properties, soil types, and the particular LID designs we chose to model. Notably, in this site-scale modeling process, we were modeling identical biofiltration cells, predominantly with surface areas of 500 square feet and four (4) feet deep. However, if biofiltration cells were actually going to be designed for any individual site, they would be sized—and the number of total cells determined—according to the amount of impervious area on the site, existing and proposed drainage infrastructure, native soil types, and characteristics of adjacent source areas. Note also in Table 3 that in some cases the use of three biofiltration units versus five biofiltration units shows a negligible difference in percent reduction runoff volume, total solids, and (e.g., see Average Runoff Volume reductions for Village Square North and Butcher House Road). This suggests that for some locations a total of 1500 square feet of bioretention/biofiltration/raingarden units may be more than enough; little water quality or flood storage benefit is gained from adding additional green infrastructure in these cases.

7. Connecting with Property Owners

Once high priority sites in Waitsfield Village and Irasville were identified and potential LID retrofits were analyzed with SLAMM, we contacted property owners and managers to discuss our project. In some cases, individuals recognized stormwater problems but were unfamiliar with the concept of low impact development. We developed a two-page handout describing LID concepts and stormwater treatment practices, as well as our project's analysis and findings. This outreach material can be found in Appendix 1. As of the time of this writing, and specifically through the efforts of Friends of the Mad River, we were able to contact and discuss our project with several property owners in Irasville and Waitsfield Village. Table 4 shows our contact list and notes up to December 2011.

Table 4. Contact Information and Communication Notes for Organizations Affiliated with Irasville and Waitsfield Village High Priority Sites.

Site Name	Contact Name	Organization	Notes
Shaws Lot	Dick Brothers	Brothers Building	Sent Pat Thompson an e-mail to forward to Dick. He is in FL until May. Called Pat 12/1 to follow up
Village Square	Marion Baraw	Mountain Associates Real Estate	Met with Marion 2pm Monday 11/21--is interested--follow up with plow guy
Butcher House Road, Fiddler's Green	Jason Myers	CVCLT	Spoke with on cell phone (917-3937) on 12/20, asked me to send e-mail about project
United Church of Christ	Vince Gauthier	Chair, UCC	Met with on 11/30 at 4pm--is interested, but changes to site are pending
Bridge Street Complex Lot	Norm Abend	Owner; Historic Waitsfield Village Condominium Association (HWVCA)	Met on 11/27 at 1pm-is interested
Bridge St Lot	Jason Guilsano	Owner; HWVCA	Have not spoken with Jason directly
Bridge St Lot	Craig Goss	Owner; HWVCA	Attended 11/27 meeting--is interested
Bridge St Lot	David Darr	Owner	Left message 11/22; spoke with him 11/30--he is interested in collaborating
Bridge St Lot	Chris Pierson	Owner	Spoke with Chris 12/16--is interested

8. Selecting the Top Two LID Retrofit Priority Sites

During the course of the 2011 project, funding was proposed and obtained for a 2012 follow-up project. In 2012, one or more LID retrofits will be built in Waitsfield using funds from VT DEC's Ecosystem Restoration Grant Program. With this in mind, we determined two top candidate sites for LID implementation in Waitsfield.

Early community-scale modeling results suggested that Subwatersheds 1, 3, and 4, were high priorities for introducing LID stormwater management in Waitsfield. Later site-scale modeling results showed that significant reductions in runoff volume and improvements in water quality could be achieved at many of the sites. In addition, we recognized that implementation of one or more LID projects in Waitsfield could have an important positive visual impact on the community; pilot projects are more likely to be replicated when they are located in higher traffic (or foot traffic) areas and can be exhibited and interpreted for the public. With consideration of the visibility of potential LID demonstration projects, as well as our site-scale modeling results, site visits during multiple seasons, and communications with property owners, we ultimately narrowed down our list of high priority sites to the top two retrofit priorities: Village Square (North and South), Subwatersheds 1 and 3, in Irasville and the Bridge Street Complex Parking Lot, Subwatershed 4, in Waitsfield Village.

The other sites are still considered to be high priority for retrofits, but were ruled out for further study for various reasons. For the Shaws site, modeled runoff and pollutant reductions were less than for other sites and it was difficult to contact the property owners. For the Butcher House Road site, the modeled runoff and pollutant reductions associated with the introduction of 3 or 5 biofiltration units were consistently higher than for other sites; however, the site is comparatively low visibility. The UCC site, being the smallest of those studied, had the least runoff and pollution to begin with; accordingly, the introduction of LID techniques had little effect on stormwater flow and water quality. Nonetheless, the UCC site presents an excellent stewardship opportunity and a simple LID project, such as a rain barrel system or porous pavement test area, could be successful in this location. Although these sites have been eliminated for further study at this stage, there is great potential to employ LID at each of them.

After identifying the Village Square and Bridge Street Complex sites as our top priorities, we hired Watershed Consulting Associates, LLC, of Waitsfield, VT to conduct a detailed survey of the sites and create basemaps for 2012 design and construction work. Property manager and landowner permission was obtained prior to conducting the survey. Figures 23 and 24 show the completed survey plans.

Figure 23. Survey Plan for Village Square, December 2011.

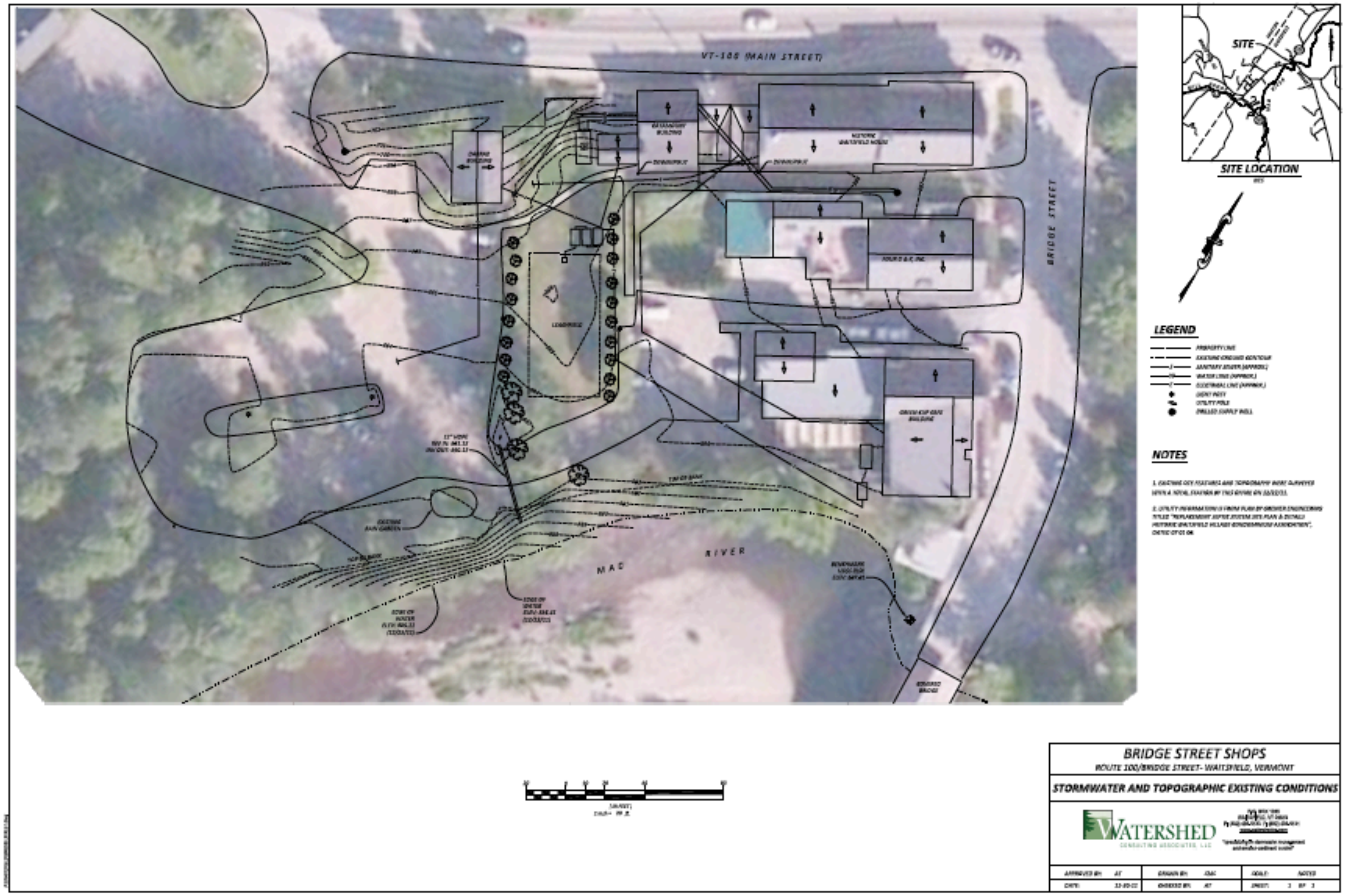


Figure 24. Survey Plan for Bridge Street Complex, December 2011.

9. Conclusions

The town of Waitsfield, Vermont offers a blend of historic and contemporary buildings and lots, containing commercial and residential land uses and impervious areas interspersed with open space. Road networks, rooftops large and small, paved and unpaved parking lots, and an array of soil drainage conditions create a landscape where stormwater runoff has few places to go. Existing development and the health of the Mad River are affected by both seasonal and 100-year flood events, as well as daily rainfall and snowmelts that carry with them high velocity runoff flows and sediment and nutrient pollutants. These issues are typical of development-altered hydrologic systems and Waitsfield holds them in common with countless other towns in Vermont and beyond. LID stormwater treatment practices can help address these problems. In the course of this research, we have analyzed stormwater contributions from Waitsfield Village and Irasville development at two different scales, identified priority areas for implementation, introduced new audiences to LID concepts and practices, and conceptualized ways in which LID can be integrated with existing sites. We hope that this process, or a similar one, can be replicated in other towns and we look forward to the construction of LID projects in the town of Waitsfield in the near future.

Table 2. Source Areas within each subwatershed that contribute significant runoff volume and potential LID practices that could be employed in each source area. (Table 2 is meant to be printed in 11"x17" landscape format and is 3 pages in length.)

Subwatershed	**Source Area on Map**	**Description**	**Potential Low Impact Development Practices**									
			Wet Detention Pond (likely located at low point of site)	Constructed Wetland	Large or Linear Bioretention/ Biofiltration Area(s) (one or multiple per source area)	Small Raingarden or Planter (one or multiple per source area)	Gravel-based Infiltration Trenches	Grass Swales or BioSwales (roadside)	Rain Barrels or Cisterns	Downspout Disconnection	Hydrodynamic Device (subsurface)	Porous Pavement
Subwatershed 1	Parking Lots PP 3,6,7,8,9, & 11	Commercial/Light Industrial Area Paved Parking Lots, includes Shaws parking lot and northern portion of Village Square parking	X		X	X	X				X	X
	ST1	streets connecting Parking Lots throughout, including Street toward Big Picture			X	X	X				X	X
	ST2	multiple streets uphill to north and to west of Commercial area					X	X				
	RT 100	portion in this subwatershed			X		X	X				
Subwatershed 3	PP2	Main Lot at Village Square shopping plaza	X	X	X	X						
	Flat Building 1	Bldgs in Shopping Plaza, could have multiple treatments				X			X	X		
	Street 2	2 different Streets semi-residential, including Butcher House Drive off Fiddler's Green					X	X				
	RT 100	portion in this subwatershed					X	X				

Subwatershed	**Source Area on Map**	**Description**	**Potential Low Impact Development Practices**									
			Wet Detention Pond (likely located at low point of site)	Constructed Wetland	Large or Linear Bioretention/ Biofiltration Area(s) (one or multiple per source area)	Small Raingarden or Planter (one or multiple per source area)	Gravel-based Infiltration Trenches	Grass Swales or BioSwales (roadside)	Rain Barrels or Cisterns	Downspout Disconnection	Hydrodynamic Device (subsurface)	Porous Pavement
Subwatershed 4	RT 100	portion in this subwatershed					X	X				
	Pitched Bldg 3	multiple pitched roof buildings east of Rt.100 along 100 and Bridge St., incuding Bridge St. complex building, UCC church, and others				X			X	X		
	UP1	Unpaved Parking, large lot along Mad River in Waitsfield Village/Bridge St. complex area	X	X	X	X	X					X
	Street 2	Bridge St. plus the parking lot opposite Bridge St. across Rt 100.				X	X				X	X
	Street 3	Parsonage Lane			X	X	X	X				
Subwatershed 5	Street 1 (Rt. 100)	portion in this subwatershed					X	X				
	Street 2	Radcliffe Drive (portion)					X	X				
	UP 1,2	Unpaved Parking, adjacent to Rt 100				X	X	X			X	

Subwatershed	**Source Area on Map**	**Description**	**Potential Low Impact Development Practices**									
			Wet Detention Pond (likely located at low point of site)	Constructed Wetland	Large or Linear Bioretention/ Biofiltration Area(s) (one or multiple per source area)	Small Raingarden or Planter (one or multiple per source area)	Gravel-based Infiltration Trenches	Grass Swales or BioSwales (roadside)	Rain Barrels or Cisterns	Downspout Disconnection	Hydrodynamic Device (subsurface)	Porous Pavement
Subwatershed 2	Large Landscape 1	north of Big Picture Lot including trail system					X					
	Paved Parking 1	Big Picture Parking lot, Northeast end is in this watershed, Partially Paved?	X	X	X	X	X				X	X
	Bldg 28	Linear buildings surrounding courtyard				X	X			X	X	X
	Town Road	Residential Street, uphill					X	X				
Subwatershed 6	RT 100	portion in this subwatershed					X	X				
	Street 2	Radcliffe Drive (portion)					X	X				
	UP 1	Unpaved Parking Lots adjacent to Rt 100				X	X	X			X	

Appendix 1. Outreach material for property owners in Waitsfield (2 pages).

<u>Waitsfield, VT Low Impact Development Stormwater Project</u>
Funded by Vermont Department of Environmental Conservation
Ecosystem Restoration Grant Program

<u>Project Partners</u>

Stephanie Hurley, Assistant Professor, University of Vermont stephanie.e.hurley@uvm.edu
Justin Kenney, District Manager, Winooski Natural Resources Conservation District justin.kenney@vt.nacdnet.net
Caitrin Noel, Executive Director, Friends of the Mad River friends@madriver.com

<u>Stormwater in the Mad River Valley</u>

The Mad River, a tributary of the Winooski River in the Lake Champlain Basin, drains a 144 square mile watershed spanning the towns of Duxbury, Fayston, Moretown, Waitsfield, Warren, and Granville. The area is characterized by a steep-sided, narrow valley with a wide range of topographic relief, from an elevation of 650 feet in northern Waitsfield to over 4,000 feet on Lincoln Peak. The Mad River Valley is home to three ski areas, a contributing factor to the high growth rates experienced in recent history.

Though the area is rural in character, commercial development in the valley floor and resort development in the sensitive headwater areas of the watershed is a real and documented threat in the Mad River watershed. Watersheds with increased area of impervious surfaces without proper treatment can result in "flashier" flood events—where floodwaters rise higher faster.

<u>Planning for and Addressing Stormwater</u>

Stormwater runoff from impervious surfaces is a major contributor of sediment and phosphorus, among other pollutants to streams, rivers, and lakes. Both water quality and water quantity issues can be dramatically improved using low impact development (LID) design and planning techniques, which aim to mimic natural hydrology in developed areas.

In 2011, with funding from the Vermont Ecosystem Restoration Grant Program, our collaborative project team completed an analysis of stormwater runoff from selected watersheds in the town of Waitsfield with concentrations of commercial and rural development. The project goals included:

- Modeling of stormwater runoff from various impervious sites in Waitsfield Village and Irasville
- Prioritization of locations for LID implementation based on watershed-scale and site-scale analysis
- Recommending and developing schematic plans for specific LID projects
- Introducing the project to the Waitsfield Planning Commission, landowners and other stakeholders, plan for future collaboration & partnership

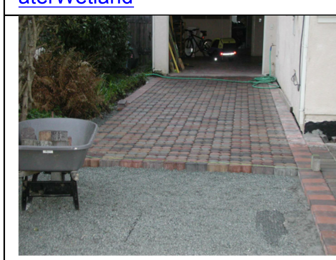
<u>Next Steps</u>

Potential projects identified during the first year of the project include infiltration trenches, bioretention systems, rain gardens, small constructed wetlands or detention ponds, porous pavement installations, downspout disconnections, rain barrels and cisterns (see next page for images and examples). In the second year of funding (2012), we will construct LID projects at priority sites that were identified through our analysis and stakeholder outreach process. The primary goal in selecting the "right" LID project(s) for implementation is maximizing stormwater treatment to reduce flooding and improve water quality. However, projects will only be constructed if they are cost-effective, aesthetically and contextually appropriate, and maintainable over time. Project partners are in the process of meeting with landowners to share ideas and introduce potential LID techniques that could be employed. Please contact a project partner (contact information above) with any questions.

<u>Sources for additional information about Low Impact Development techniques for treating stormwater</u>

1. Using Rainwater to Grow Livable Communities: http://www.werf.org/livablecommunities/
2. Builder's Guide to Low Impact Development: http://www.lowimpactdevelopment.org/lid%20articles/Builder_LID.pdf
3. Vermont Low-Impact Development Guide for Residential & Small Sites http://www.lowimpactdevelopment.org/lid%20articles/Builder_LID.pdf

Example Low Impact Development Practices

 Raingardens/bioretention cells without curbs allow stormwater runoff to sheet flow from paved surfaces into vegetated areas. Seattle's SEA Street, photo by Stephanie Hurley	 Raingardens/bioretention cells with curbs allow infiltration and treatment of stormwater while providing a barrier between vehicles and vegetated areas. http://www.co.monroe.in.us/stormwaterquality/bioretention.html
 Stormwater planter boxes decorate the edges of buildings and store and treat runoff. Lewis and Clark College campus; http://www.landscapeonline.com/research/article/5746	 Infiltration trenches store stormwater and allow it to percolate into nearby soils. City of Bellingham, Washington; www.cob.org
 Constructed stormwater wetlands can be small or large and may have a manicured aesthetic or be naturalistic in appearance. The shape of the wetland provides flood storage and its fine-stemmed vegetation filters pollutants from runoff. http://avery.ces.ncsu.edu/content/BannerElkConstructedStormwaterWetland	 Rain barrels collect and store rainwater from rooftops to use later for irrigation. http://www.uri.edu/ce/healthylandscapes/rainbsources.html
 Porous pavers create spaces within a "hardscape" area for runoff to pass through. Subsurface storage and infiltration helps reduce stormwater volumes and velocities downstream. Photo by Bill Wilson.	 Pervious pavement allows stormwater to soak through and infiltrate into the ground. Pervious pavement has significant internal surface area allowing the combined effects of oxygenation and bacterial action to cleanse water. http://www.tececo.com/technical.permecocrete.php

Appendix 2. Budget List and Maintenance Guidelines for Potential Low Impact Development Projects.

In 2012, additional site design details for an LID retrofit project will be developed and constructed during the course of a second project, which is a follow-up to this 2011 study. The project budget and maintenance needs will ultimately depend on the specific project that is built. However, the tables presented here, do provide an idea of the types of construction budget items and maintenance tasks that are needed to make LID projects successful for the "top two" priority LID sites that are described in Section 8 of this report.

The following list comprises the most common items that will be involved for implementation of LID bioretention projects in either the Bridge Street Complex or Village Square parking lot sites (See Section 8 of this report).

Construction- General	
Design	Y
Permitting	Y
Construction Labor	Y
Erosion and Sediment Control	Y
Site Prep	Y
Excavation	Y
Debris Removal	Y
Materials	
Inlets/CBs	?
Curbs	?
Underdrain (Subsurface Drain)	?
Rock (~2")	?
Gravel (~1/2"-1")	Y
Native Soil	?
Engineered Soil	Y
Compost during plant establishment phase	?
Mulch	?
Trees	?
Shrubs	?
Fine-stemmed vegetation (rushes, sedges, grasses)	Y
Groundcovers	?
Asphalt	?

Y = yes

? = Maybe, depends on final design

Maintenance of LID bioretention projects in either the Village Square or Bridge Street Complex parking lot sites will require greater investment of time, labor, and materials, in the first two years of vegetation establishment and seasonal maintenance activities going forward. In the course of the 2012 follow-up project, maintenance schedule will be described in detail. Meanwhile, the following serves as a general list of tasks that should take place post-construction.

- Inspection of plantings, erosion control systems (e.g. splash pools, rock pads) and drainage infrastructure (*at least six times per year*).
- Replacement of plant material that has not successfully established (*as needed, especially during first two years post-construction*).
- Seasonal weeding and off-site disposal of plant material (i.e., composting) to avoid reintroducing nutrients to the bioretention cells (*minimum of twice during the growing season; more frequently is recommended*).
- Pruning of larger plant material if shrubs and trees are planted (*once per growing season, as needed*).
- Development of a snow removal plan that is compatible with bioretention cell success and drainage management (*seasonal reminders to plow operators about project intent*).
- Catch Basin/inlet cleanout (*minimum four times per year; see also "Street/parking lot sweeping" below*).
- Street/parking lot sweeping (*minimum four times per year, especially during spring after end of winter sanding*).
- Trash and debris removal from cells (*as needed*).
- Clean and maintain educational and interpretive signage (*as needed*).
- Check-in with property owners/managers and neighbors to remind of project intent and report any problems or concerns (*at least once annually*).