Lamplite Acres Green Streets Scoping Study
Williston, Vermont

November 2012
Final Scoping Report
The preparation of this document has been financed through transportation planning funds provided by the U.S. Department of Transportation and matching funds provided by Chittenden County’s 18 municipalities and the Vermont Agency of Transportation. The views and opinions expressed do not necessarily state or reflect those of the U.S. Department of Transportation.

Submitted by:
Stantec Consulting Services Inc.
55 Green Mountain Drive
So. Burlington, VT 05403
(802) 864-0223
This study is the result of the support and strong interest of the Project Committee Members. Much of the background, history, local input, existing conditions, and consensus documented in the study is attributed to the Committee member's involvement. The study's quality and success is due to their contributions.
## Contents

1.0 **Introduction**  
2.0 **Existing Conditions**  
   2.1 Project Area  
   2.2 Roadways and Right-of-Way  
   2.3 Bicycle and Pedestrian Facilities  
   2.4 Soil Conditions  
   2.5 Roadway Flooding  
   2.6 Utilities  
      2.6.1 Stormwater  
      2.6.2 Water & Sewer  
      2.6.3 Gas  
      2.6.4 Electric/Telecommunications  
   2.7 Natural and Cultural Resources  
      2.7.1 Natural Resources  
      2.7.2 Cultural Resources  
3.0 **Local Concerns Meeting**  
4.0 **Project Purpose and Need**  
5.0 **Alternatives**  
   5.1 What are Green Streets?  
      5.1.1 Infiltration Trenches  
      5.1.2 Rain Gardens  
      5.1.3 Stormwater Curb Extensions  
      5.1.4 Pervious Pavements  
   5.2 Areas of Need  
   5.3 Evaluation of Alternatives  
      5.3.1 Discarded Alternatives  
      5.3.2 Recommended Alternative  
   5.4 Sizing Recommended Alternative  
      5.4.1 Design Storm and Runoff Volume  
      5.4.2 Infiltration Trench/Rain Garden Length  
      5.4.3 Secondary Underground System Sizing  
   5.5 Concept Plans  
   5.6 Care and Maintenance Recommendations  
      5.6.1 Rain Garden Plantings/Infiltration Trenches  
      5.6.2 Secondary Underground Storage/Infiltration System  
   5.7 Estimated Costs  
6.0 **Concept Plan Presentation Meeting**  
7.0 **Selectboard Meeting**  

Appendices
Figure List

Figure 1 - Study area .........................................................................................................2
Figure 2 - Lamplite Acres neighborhood map .................................................................3
Figure 3 - Ponded water in the road ................................................................................4
Figure 4 - Ponded water in the road ................................................................................5
Figure 5 - Infiltration trench ...........................................................................................9
Figure 6 - Streetside rain gardens ..................................................................................10
Figure 7 - Stormwater curb extensions with roadway width reduction .......................10
Figure 8 - Pervious pavement ........................................................................................11
Figure 9 - Drainage area map .......................................................................................12
Figure 10 – Photosimulation of rain garden ................................................................13
Figure 11 - Photosimulation of rain garden ...................................................................14
Figure 12 - Typical section of recommended alternative ...............................................15
Figure 13 - Concept Plan Drainage Area A-1 ................................................................19
Figure 14 - Concept Plan Drainage Areas A-2, A-3 & A-4 .............................................20
Figure 15 - Concept Plan Drainage Areas A-5 & A-6 ....................................................21

Table List

Table 1 - Runoff volumes for design storm events .........................................................16
Table 2 – Recommended infiltration trench/rain garden lengths ....................................16
Table 3 – Recommended secondary underground system lengths ...............................17

Appendix List

Appendix A – Soils Mapping
Appendix B – Environmental Resource Review Memo
Appendix C – Local Concerns Meeting Notes
Appendix D – Basis of Runoff Estimation for Snowmelt Event
Appendix E – HydroCAD Modeling Results
Appendix F – Sizing Calculations
Appendix G – Opinion of Probable Costs
Appendix H – Concept Plan Presentation Notes
Appendix I – Selectboard Endorsement
Appendix J – Drainage/“Green Streets” Concept Plans
1.0 Introduction

The Lamplite Acres development in Williston, Vermont was constructed in the 1960’s with no storm sewer system or ditching along the roads. The sandy soils within the development allow storm runoff to infiltrate for much of the year; however flooding on the roads is common when the ground is frozen, during the spring melt and during large rain events. The roadway flooding creates slippery and potentially dangerous roadway conditions for residents especially during freeze-thaw cycles in the winter and early spring.

The Town of Williston obtained stormwater improvement planning assistance from the Chittenden County Regional Planning Commission (CCRPC) to study the feasibility of constructing “Green Streets” stormwater retrofits to alleviate or minimize the roadway flooding. “Green Streets” are described in greater detail in Section 5.0 of this report.

The study process is generally defined by the following outline:

- Investigating existing conditions (Section 2.0)
- Soliciting public input on existing conditions (Section 3.0)
- Establishing the project purpose and needs (Section 4.0)
- Evaluating alternatives and recommending a preferred alternative (Section 5.0)
- Soliciting public input on the preferred alternative (Section 6.0)
- Seeking Town Selectboard endorsement of the preferred alternative (Section 7.0)

This report summarizes the results of the study and includes recommended improvements to mitigate stormwater issues in the development. This report and the recommended improvements were unanimously accepted by the Town Selectboard. The Town intends to seek funding for final engineering and construction of the recommended improvements.
2.0 **Existing Conditions**

Existing physical and environmental conditions were documented to assist with identifying and evaluating alternative improvements. Team members researched and reviewed available information, solicited input from project committee members, and field reviewed the project area. This field review included recording conditions and taking numerous photographs. The following sections detail the results of these efforts.

### 2.1 Project Area

A location map showing the Lamplite Acres development is shown in Figures 1 and 2. Lamplite Acres is located to the east and off of North Brownell Road between Williston Road and Industrial Avenue. Proposed improvements will generally be located in the Town roadway right-of-way within the development.

![Figure 1 - Study area](image)
2.2 Roadways and Right-of-Way

The Lamplite Acres neighborhood contains four roads: Aspen Lane, White Birch Lane, Lamplite Lane and Pine Lane; and is accessed from Brownell Road via Aspen Lane, White Birch Lane and Pine Lane as shown in Figure 2. Existing roadways are paved and the roadway widths are 24’ wide throughout the neighborhood. Right-of-way width is 49.5’ wide centered on the roadway centerlines. There is approximately 13’ of green space between the roadway right-of-way and the edge of existing pavement throughout the neighborhood. This green space consists of lawns that are generally at the same grade as the road or in some cases, slopes towards the road.

2.3 Bicycle and Pedestrian Facilities

No dedicated bicycle or pedestrian facilities exist within the neighborhood. Residents ride bikes or walk on the roadways. Comments received at the Local Concerns Meeting suggest that sidewalks and/or dedicated bicycle facilities are unnecessary in the neighborhood.

2.4 Soil Conditions

Existing soils within the Lamplite Acres development consist primarily of Adams and Windsor loamy sands as determined from Natural Resource Conservation Service Web Soil Survey for Chittenden County. A soil map of the project area is contained in the appendix.
Adams and Windsor loamy sands are classified as Hydrologic Soil Group A. Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. Group A soils have a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands.

2.5 Roadway Flooding

Due to the lack of storm sewer infrastructure in the development, runoff flows to the side of the road and ponds on the pavement at the low points in the road. The ponded water remains in the road until it infiltrates into the lawn areas or evaporates. This is especially problematic during freeze/thaw cycles in the winter and early spring when plowed snow melts onto the road and then re-freezes in the road. At times, the ponded water in the road has been significant enough to enter into homes as noted at the Local Concerns Meeting.

![Figure 3 - Ponded water in the road at the intersection of Lamplite Lane and White Birch Lane. Lack of storm sewer infrastructure makes this especially problematic during winter and spring freeze/thaw cycles.](image-url)
2.6 Utilities

2.6.1 Stormwater
Stormwater infrastructure generally consists of a small number of dry wells scattered throughout the development. Some of these drywells are positioned so that they don’t receive any runoff. During spring snow melt events, these drywells often become inundated resulting in roadway flooding.

There are two catch basins located on Pine Lane near the intersection with North Brownell Road. These catch basins capture a small drainage area and discharge across North Brownell Road to private property. Proposed improvements must not cause additional runoff to enter into these catch basins, otherwise downstream flooding or property damage may result.

2.6.2 Water & Sewer
The Town of Williston provides municipal water and sewer service to the development. The water and sewer lines within the development are owned by the Town. The sewer is a gravity system and generally runs down the center of the roadway. The water main generally is located on the side of the road just off of the pavement according to Town record drawings and GIS files.

2.6.4 Gas
Vermont Gas provides gas service to the development. The gas main is generally located on the side of the road just off of the pavement according to as-built files received from Vermont Gas Systems.
2.6.5 Electric/Telecommunications

Electric and telecommunications lines within the development are owned by Green Mountain Power and Fairpoint, respectively. These lines are generally located on the side of the road according to Town of Williston “Wastewater Collection & Transportation” as-built drawings dated July 1981.

2.7 Natural and Cultural Resources

2.7.1 Natural Resources

A field review of natural resources was conducted within the study area. The field review concluded that the project area does not include any significant natural resources. A summary of the field review is contained in the appendix.

In addition to the field review, the ANR Environmental Interest Locator was used to determine the presence of hazardous materials sites and ground water source protection areas and drinking water wells. There are no mapped hazardous waste areas or underground storage tanks and no source protection areas or private drinking water wells within the project area.

2.7.2 Cultural Resources

Archaeological and historic sites/districts: Given the nature of the project, there is likely to be little to no archaeological/historic impact. All improvements will be constructed within the Town roadway right-of-way, and will be constructed in areas previously disturbed by utility construction.

Assuming federal funds will eventually be pursued for design and construction, it is recommended that the State Historic Preservation Officer and Archeologist are contacted during the final engineering phase to determine if a complete review of cultural resources is necessary. If a complete review is necessary, Historic and Archaeological resources will be reviewed by qualified experts in those fields to determine potential impacts to those resources. For the Historic resources, the correct level of study for above-ground resources would be a reconnaissance-level survey. For Archaeology, the correct level of effort is an "Archaeological Resources Assessment" which involves no excavations, but is to determine where and how much of a proposed project area has "archaeologically sensitive" land.
3.0 Local Concerns Meeting

A Local Concerns Meeting was held at the Williston Municipal Conference Room on June 13, 2012. The purpose of the meeting was to present the need for the project, existing conditions within the project area, and solicit input from the public regarding the project. The meeting was a useful step in the data gathering phase and many public comments were insightful. Notes from this meeting are contained in the appendix. The most notable concerns from this meeting included:

• Pine Lane pavement has deteriorated rapidly presumably due to the lack of surface drainage.
• Pine & Lamplite intersection is prone to flooding and icing that is a safety concern. In extreme events, will pond high enough for water to enter houses. Also the lack of site distance and street parking is a problem at that intersection.
• Neighborhood would visually benefit from the addition of rain gardens.
• Walking is not a safety concern in the neighborhood. Residents don’t see a need for a sidewalk.
• Traffic and speeding is typically not a problem – not a “cut-through” neighborhood
• Concern what the real cost of the project will be and who will foot the bill.
4.0 Project Purpose and Need

The Purpose and Need statement summarizes what the study is intending to accomplish and for what reasons. The Purpose defines the problem to be solved. The Need provides the data to support the Purpose. The Purpose and Need Statement is a fundamental requirement for projects that will pursue federal funding; and sets the stage for developing alternative solutions to the transportation problem.

Working with the project committee; and using the input received at the Local Concerns meeting, the following Purpose and Need statement was developed.

**Purpose:**
The purpose of this project is to investigate the feasibility of using “Green Streets” concepts to alleviate surface stormwater ponding within the Town rights-of-way of the Lamplite Acres neighborhood in Williston, Vermont.

**Need:**
The project needs, as defined by the existing conditions and community input, include the following:

1. **Alleviate stormwater surface ponding.** Currently, a lack of adequate drainage infrastructure causes stormwater to pond at low points along the edge of neighborhood roads. Dry wells have been installed over the years to help alleviate the surface ponding; however these wells often become inundated or are not positioned correctly to receive runoff. During larger rainfall events and spring thaw, the Town pumps surface flooding into an existing catch basin to alleviate flooding. During the winter, the ponded water freezes on the road and in front of driveways and becomes a hazard for pedestrians and vehicles.

2. **Maintain current peak flow stormwater discharges from the neighborhood.** Existing stormwater discharges to nearby Allen Brook or adjacent property owners must not be increased with stormwater system improvements. Increasing peak flow discharges can lead to downstream property damage due to erosion and/or flooding.

3. **Maintain stormwater quality.** Allen Brook is considered impaired for stormwater by the State of Vermont. Improvements must maintain or better the water quality of discharges from the neighborhood.

4. **Provide a model stormwater project for Williston and other municipalities in Chittenden County.** Given increased concerns with the water quality of Chittenden County streams, “Green Streets” concepts have been identified as potential solutions to mitigate stormwater issues within public right-of-ways.
5.0 Alternatives

Various “Green Streets” and conventional system alternatives were evaluated to determine if they could satisfy the project purpose and need as defined in Section 4.

5.1 What are Green Streets?

Green Streets are an innovative and effective way to restore watershed health. Green Streets mimic natural conditions by managing stormwater runoff on the surface and at its source. They protect water quality in rivers, brooks and streams; they manage stormwater from impervious surfaces and often are more cost efficient than installing a conventional storm sewer system. Green Streets can provide many benefits such as:

- Enhancing neighborhood livability
- Increasing community and property values
- Helping the Town meet regulatory requirements for pollutant reduction and watershed resource management

Types of Green Street improvements considered in this study include infiltration trenches, streetside rain gardens, stormwater curb extensions, streetside rain gardens, and permeable surfaces. This study investigates areas within the development that will benefit most utilizing one or several of these types of “Green Streets” approaches.

5.1.1 Infiltration Trenches

Infiltration trenches are simply graded depressions that temporarily store runoff from impervious surfaces until the runoff infiltrates into the ground. Infiltration trenches improve water quality through filtration of pollutants through the ground. They also recharge groundwater. Figure 5 shows an example of an infiltration trench.

![Figure 5 - Infiltration Trench](image)
Infiltration trenches situated alongside the roads in Lamplite Acres will provide storage off of the road for stormwater runoff until it has a chance to infiltrate into the ground. They will also provide additional storage volume for plowed snow.

### 5.1.2 Rain Gardens

Rain gardens are similar to infiltration trenches with the main difference being they include landscaping within the depression, and are generally more aesthetically pleasing. Rain gardens promote infiltration of surface runoff from impervious surfaces into the ground. Rain gardens improve water quality through absorption of pollutants from the plant roots and filtration of pollutants through the ground. They also recharge groundwater. Figure 6 shows examples of rain gardens used in parking lots and alongside residential streets.

![Figure 6 - Streetside Rain Gardens](http://www.lowimpactdevelopment.org/greenstreets/practices.htm)

### 5.1.3 Stormwater Curb Extensions

Stormwater curb extensions are landscaped depressions that project out into the road from the existing edge of pavement or curb. Figure 7 shows an example of a stormwater curb extension. They manage stormwater runoff in the same manner as rain gardens by promoting filtering and absorption of pollutants. Stormwater curb extensions have the added benefit of providing localized traffic calming on low-volume residential streets by narrowing the street width.

![Figure 7 - Stormwater curb extensions with roadway width reduction in Portland, Oregon](http://www.asla.org/sustainablelandscapes/greenstreet.html)
5.1.4 Pervious Pavements

Pervious pavements are street surfaces that allow stormwater to flow through the pavement surface and into the ground rather than flow along the surface, concentrating pollutants, and discharging into the nearest drainage system. Figure 8 shows an example of a pervious pavement installation in St. Albans, Vermont. Pervious pavements can be practical for low-volume surfaces such as sidewalks, recreation paths and shoulders on low-volume residential streets.

![Figure 8 - Pervious pavement in Taylor Park, St. Albans, Vermont (photo courtesy of Jenna Calvi, VT Agency of Natural Resources)](image)

5.2 Areas of Need

Three main areas of need within the neighborhood were identified through field observation, discussions with the Town and input received from the Local Concerns Meeting. These areas are:

1. Along both sides of Lamplite Lane from the intersection with Pine Lane to the bend located at the north end of the road.

2. Along the north side of White Birch Lane in front of houses 21, 31 and 47.

3. Along both sides of White Birch Lane from the bend in the road to the intersection with Lamplite Lane.

These three areas experience significant surface ponding during major runoff events. The project steering committee decided to focus on improvements for these three areas of need.

The three areas of need were further broken down into six separate drainage areas that are divided by the crown in the existing roadway. The areas are shown in Figure 9.
5.3 Evaluation of Alternatives

The various types of Green Streets improvements identified in Section 5.1, as well as conventional systems, were evaluated to determine which improvements best satisfy the purpose and need of the project for the areas of need described in Section 5.2. The following summarizes the evaluation of the discarded alternatives and the recommended alternative.

5.3.1 Discarded Alternatives

Stormwater Curb Extensions
Stormwater curb extensions can be effective in providing a place for stormwater to pond temporarily until it can infiltration into the ground. This type of improvement relies on infiltration and does not require an outlet; and therefore does not degrade water quality or increase stormwater discharges from the neighborhood. The curb extensions can be installed within the Town right-of-way. This alternative however was discarded from further consideration because the streets within Lamplite Acres are uncurbed, traffic calming was not a concern for residents, and infiltration trenches/rain gardens can provide the same function without the need for curbing.

Pervious Pavements
Pervious Pavements can be effective in reducing the roadway ponding from large rainfall events. Pervious pavements are relatively expensive to construct, require frequent maintenance and have had a questionable long-term performance history in Vermont. Pervious pavements were discarded from further consideration as a primary alternative for mitigating ponding issues for...
these reasons. If the Town would like to install and study the effectiveness of a pervious pavement installation in the neighborhood, it is recommended that it is installed on a small-scale.

**Conventional Storm Systems**

Conventional storm sewer systems are effective in removing runoff from the roads and discharging to a nearby stream or stormwater treatment practice. Since the neighborhood virtually has no discharges from the site, these types of systems could lead to downstream property damage and flooding issues. In addition, a conventional storm sewer system will be expensive to install due to the flat grade of the neighborhood. These systems do not meet the project purpose and need because of these issues, and therefore were discarded from further consideration. Mechanical systems, such as a permanent pump station that discharges runoff out of the neighborhood, were also considered but discarded as an alternative for the same reasons.

### 5.3.2 Recommended Alternative

**Infiltration Trenches and Roadside Rain Gardens**

A shallow infiltration trench or rain garden installed alongside the road will provide a place for runoff to pond off of the road temporarily until it infiltrates into the ground. This type of improvement relies on infiltration and does not require an outlet; and therefore does not degrade water quality or increase stormwater discharges from the neighborhood. The trenches or rain gardens can be installed within the Town right-of-way. Figures 10 and 11 are photo simulations depicting rain gardens within the Lamplite Acres development.

*Figure 10 – Photo simulation of rain garden on White Birch Lane (in front of #21 and #31) near intersection with Brownell Road.*
Maintenance of infiltration trenches consists of regular mowing; and can be easily completed by property owners. Maintenance of rain gardens is more intensive but can be more aesthetically attractive than an infiltration trench if maintained.

Depending on maintenance preference, property owners can choose to have an infiltration trench or rain garden installed on their frontage since both types of improvements function the same.

A secondary storage system located under the trench/rain garden is recommended to accommodate larger runoff events (i.e. spring thaw) that may overwhelm the primary system. The trench/rain garden will temporarily store runoff from the road during most rain events. A drainage structure installed in the trench/rain garden will provide overflow into an underground perforated pipe during large storm events. The perforated pipe has no outlet and will temporarily store runoff until it can infiltrate into the ground. During snowmelt events where plowed snow has filled the ditch to the point where water is ponding alongside the road, a secondary structure installed at the edge of the road will provide overflow into the underground perforated pipe. Figure 12 graphically depicts a typical section of the trench/rain garden with overflow structures and underground perforated pipe.
5.4 Sizing Recommended Alternative

The recommended size of the infiltration trenches (length, width, depth) and underground perforated pipe storage (length, pipe diameter) was determined based on a number of factors including the amount of runoff to be stored, available land, property owner impacts and cost.

5.4.1 Design Storm and Runoff Volume

The first step in the sizing was to determine the volume of runoff the trench/rain garden and secondary piping system should accommodate. The trenches/rain gardens should be sized to handle the runoff volume from typical rainfall events, and the secondary underground piping system should be sized to handle larger runoff events (i.e. spring thaw).

Typically, infiltration trench or rain gardens are sized to store the water quality volume storm event as defined by *The Vermont Stormwater Management Manual for Watershed Improvement Permits*. The water quality volume storm event represents ~90% of all rainfall events in Vermont and is equivalent to 0.9 inches of rain in a 24 hour period. The water quality storm event is the recommended design storm event for the trenches/rain gardens; and is herein referenced as a typical rainfall event.

Given the issues with roadway flooding during the spring flood, the secondary underground piping system should be sized to handle the rainfall equivalent from a large scale snowmelt event plus a typical rainfall event, herein referenced as a spring thaw event. The spring thaw event is estimated to be equivalent to 2.3 inches of rain in a 24 hour period. This is equivalent to the 2-
year design storm in Chittenden County. The 2-year design storm has a 50% probability of occurring in any given year. The basis for determining the magnitude of the spring thaw event is contained in the appendix.

Using the hydrological characteristics in each drainage area shown on Figure 9, the runoff volumes for the typical rainfall event and the spring thaw event were determined using HydroCAD Stormwater Modeling software. HydroCAD results are contained in the appendix. Runoff volumes for each design event and drainage area are summarized in Table 1.

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Drainage Area (acres)</th>
<th>Typical Rainfall (0.9”)</th>
<th>Spring Thaw (2.3”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>3.21</td>
<td>302</td>
<td>1340</td>
</tr>
<tr>
<td>A-2</td>
<td>2.32</td>
<td>227</td>
<td>1078</td>
</tr>
<tr>
<td>A-3</td>
<td>3.24</td>
<td>353</td>
<td>1491</td>
</tr>
<tr>
<td>A-4</td>
<td>6.45</td>
<td>529</td>
<td>1681</td>
</tr>
<tr>
<td>A-5</td>
<td>5.37</td>
<td>478</td>
<td>1683</td>
</tr>
<tr>
<td>A-6</td>
<td>3.74</td>
<td>479</td>
<td>1932</td>
</tr>
</tbody>
</table>

Table 1 - Runoff Volumes for Design Storm Events

5.4.2 Infiltration Trench/Rain Garden Length

Lengths of infiltration trenches/rain gardens required in each drainage area were determined by dividing the runoff volume for a typical rainfall event by the trench/rain garden cross-sectional area. The trench/rain garden geometry assumes a 1’ swale depth, 6” ponding depth, 2’ swale bottom width and 1:4 side slopes. This geometry allows the trenches/rain gardens to be installed entirely within the Town right-of-way. Recommended lengths for each drainage area are summarized in Table 2. Sizing calculations are contained in the appendix. The sizing for each rain garden assumes that the entire runoff volume from a typical storm event can be stored in the trench; and does not account for runoff that will infiltrate into the underlying soils. It is recommended that design infiltration rates be determined through infiltration testing during final engineering to further refine system sizing.

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Trench Length (linear feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>216</td>
</tr>
<tr>
<td>A-2</td>
<td>161</td>
</tr>
<tr>
<td>A-3</td>
<td>251</td>
</tr>
<tr>
<td>A-4</td>
<td>377</td>
</tr>
<tr>
<td>A-5</td>
<td>341</td>
</tr>
<tr>
<td>A-6</td>
<td>341</td>
</tr>
</tbody>
</table>

Table 2 – Recommended infiltration trench/rain garden lengths for each drainage area
5.4.3 Secondary Underground System Sizing

Lengths of secondary underground system piping were determined by dividing the runoff volume for a snow melt event by the underground piping cross-sectional area assuming a 30” pipe diameter. A 30” pipe diameter resulted in pipe lengths that were most closely matched with the trench lengths to minimize the amount of excavation required during installation. Recommended lengths for each drainage area are summarized in Table 3. Sizing calculations are contained in the appendix. The sizing for each underground system assumes that the entire runoff volume from a snow melt event can be stored in the pipe; and does not account for runoff that will infiltrate into the underlying soils. It is recommended that design infiltration rates be determined through infiltration testing during final engineering to further refine system sizing.

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>30” Dia. Pipe Length (linear feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>216</td>
</tr>
<tr>
<td>A-2</td>
<td>161</td>
</tr>
<tr>
<td>A-3</td>
<td>251</td>
</tr>
<tr>
<td>A-4</td>
<td>377</td>
</tr>
<tr>
<td>A-5</td>
<td>343</td>
</tr>
<tr>
<td>A-6</td>
<td>341</td>
</tr>
</tbody>
</table>

Table 3 – Recommended secondary underground system lengths for each drainage area

5.5 Concept Plans

Given the required lengths of trenches/rain gardens and secondary underground system, Concept Plans for each drainage area were developed showing recommended locations of trenches/rain gardens. The trenches/rain gardens were located to avoid impacting to the extent practicable existing features such as fences, landscaping and mature trees that are currently within the Town right-of-way. Figures 13-15 are the Concept Plans developed for each drainage area.

The Concept Plans are provided to show recommended locations of trenches/rain gardens and secondary underground systems only. Locations may be adjusted during final engineering.

In Drainage Area A-1, infiltration trenches/rain gardens and secondary systems are recommended to be installed in locations shown on Figure 13. The Town water main is located on the same side of the road as the recommended improvements. If ground cover over the water line is reduced, the water line should be insulated if practical, or the swale should be located so that cover over the water line is not reduced. The secondary underground system can be located to avoid requiring water line relocation. This system should be located a minimum 5’ horizontally from the water line. Water services can either be relocated as necessary or the underground system can be capped on either end of the water service to avoid relocation.

In Drainage Area A-2, infiltration trenches/rain gardens and secondary systems are recommended to be installed in locations shown on Figure 14. On White Birch Lane, the Town water main is located on the same side of the road as the recommended improvements. The same water line recommendations for Area A-1 apply to Area A-2. On Lamplite Lane, underground electric and gas lines are located on the same side of the road as the recommended improvements. During
final engineering, the proposed improvements will need to be reviewed by these utilities to
determine if relocation by the utility companies is necessary.

In Drainage Area A-3, infiltration trenches/rain gardens and secondary systems are recommended
to be installed in locations shown on Figure 14. The Town water main is located on the same side
of the road as the recommended improvements. The same water line recommendations for Area
A-1 apply to Area A-3.

In Drainage Area A-4, infiltration trenches/rain gardens and secondary systems are recommended
to be installed in locations shown on Figure 14. Underground electric and gas lines are located on
the same side of the road as the recommended improvements. Typically, these utilities are buried
3’ below ground and may be impacted by secondary system construction. During final
engineering, the proposed improvements will need to be reviewed by these utilities to determine
if relocation by the utility companies is necessary. The Town gravity sewer line is also located on
the same side of the road as the recommended improvements. The Town sewer line is relatively
deep in this location and is not likely to be impacted by construction of the secondary system.
The underground system can be capped on either end of sewer services if necessary.

In Drainage Area A-5, infiltration trenches/rain gardens and secondary systems are recommended
to be installed in locations shown on Figure 15. The Town water main is located on the same side
of the road as the recommended improvements. The same water line recommendations for Area
A-1 apply to Area A-5.

In Drainage Area A-6, infiltration trenches/rain gardens and secondary systems are recommended
to be installed in locations shown on Figure 15. Underground electric and gas lines are located on
the same side of the road as the recommended improvements. Typically, these utilities are buried
3’ below ground and may be impacted by secondary system construction. During final
engineering, the proposed improvements will need to be reviewed by these utilities to determine
if relocation by the utility companies is necessary.
Figure 13 - Concept Plan showing recommended locations for infiltration trenches/rain gardens in Drainage Area A-1.
Figure 14 - Concept Plan showing recommended locations for infiltration trenches/rain gardens in Drainage Areas A-2, A-3 & A-4
Figure 15 - Concept Plan showing recommended locations for infiltration trenches/rain gardens in Drainage Areas A-5 & A-6
5.6 **Care and Maintenance Recommendations**

Care and maintenance of the infiltration trenches/rain gardens will be a shared responsibility between the Town and the homeowners within the development.

### 5.6.1 Rain Garden Plantings/Infiltration Trenches

Homeowner maintenance involves watering, removing weeds and dead plant material regularly during first the 2 years. After 2 years, weeds should be removed as necessary after and plantings watered only in drought. Plantings do not need fertilizers or winter protection. It is recommended that the Town provide guidance to homeowners on best maintenance practices to maximize the success of the plantings. Homeowner maintenance for infiltration trenches involves mowing the grass regularly. Town care and maintenance involves monitoring drawdown rate in observation wells semi-annually. Roadway sanding and salting should be limited to the extent practicable to minimize frequency of maintenance.

### 5.6.2 Secondary Underground Storage/Infiltration System

The Town will be responsible for maintenance of the underground storage system. Pipes and structures are recommended to be inspected annually as part of the Town’s MS4 program. Sediment accumulation can be flushed and vacuumed similar to conventional storm systems. Secondary surface drains should remain free of debris or obstructions and to allow drainage into the underground piping.

5.7 **Estimated Costs**

Construction cost estimates were developed for the recommended alternative on a linear foot basis with an assumed construction year of 2015. The construction cost estimates per linear foot are as follows:

- Infiltration Trench = $42/LF
- Rain Garden = $56/LF
- Secondary Underground System = $160/LF

Construction cost estimates to install rain gardens and secondary underground systems for each drainage area as shown on the Concept Plans are as follows:

- A-1 = $31,000
- A-2 = $44,000
- A-3 = $58,000
- A-4 = $54,000
- A-5 = $90,000
- A-6 = $87,000

The estimated construction cost to retrofit all identified problem areas = $364,000.

Note these construction cost estimates assume all homeowners will elect to have rain gardens installed. If infiltration trenches are installed, construction cost estimates can be expected to be less. The estimated costs do not include costs for preliminary engineering, right-of-way and construction inspection. A detailed breakdown of costs is included in the appendix.
6.0 Concept Plan Presentation Meeting

A Concept Plan Presentation Meeting was held at the Williston Municipal Conference Room on August 15th, 2012. The purpose of the meeting was to update the homeowners on status of the project; present the alternatives considered, the recommended alternative, the Concept Plan, care and maintenance considerations, and estimated construction costs; and answer questions/concerns regarding this information. Notes and the presentation from this meeting are contained in the appendix. The homeowners present at the meeting expressed overall support for the recommended alternative.
The recommended improvements detailed in Section 5 of this report were presented to the Town Selectboard on September 24th, 2012. The purpose of the meeting was to obtain Selectboard endorsement of the recommended improvements. At this meeting, the Town elected to withhold their decision until a future meeting to give members more time to consider the benefits and considerations of the recommended improvements. On October 22nd, 2012, the Selectboard voted unanimously to accept the recommended improvements of roadside rain gardens and infiltration trenches that are detailed in Section 5. The minutes of this meeting are in the appendix.

With Selectboard acceptance in hand, the Town can utilize this report to pursue funding for final engineering and construction of the recommended improvements as described in Section 5.
Appendices
Appendix A
Hydrologic Soil Group–Chittenden County, Vermont

MAP LEGEND

<table>
<thead>
<tr>
<th>Area of Interest (AOI)</th>
<th>Area of Interest (AOI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soils</td>
<td>Soils Map Units</td>
</tr>
<tr>
<td>Soil Ratings</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>A/D</td>
</tr>
<tr>
<td>B</td>
<td>B/D</td>
</tr>
<tr>
<td>C</td>
<td>C/D</td>
</tr>
<tr>
<td>D</td>
<td>Not rated or not available</td>
</tr>
<tr>
<td>Political Features</td>
<td>Cities</td>
</tr>
<tr>
<td>Water Features</td>
<td>Streams and Canals</td>
</tr>
<tr>
<td>Transportation</td>
<td>Rails</td>
</tr>
<tr>
<td></td>
<td>Interstate Highways</td>
</tr>
<tr>
<td></td>
<td>US Routes</td>
</tr>
<tr>
<td></td>
<td>Major Roads</td>
</tr>
<tr>
<td></td>
<td>Local Roads</td>
</tr>
</tbody>
</table>

MAP INFORMATION

Map Scale: 1:7,020 if printed on A size (8.5" × 11") sheet.
The soil surveys that comprise your AOI were mapped at 1:15,840.

Warning: Soil Map may not be valid at this scale.
Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Coordinate System: UTM Zone 18N NAD83
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.
Soil Survey Area: Chittenden County, Vermont
Survey Area Data: Version 15, Jan 19, 2010
Date(s) aerial images were photographed: 8/20/2003
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.
# Hydrologic Soil Group

<table>
<thead>
<tr>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdA</td>
<td>Adams and Windsor loamy sands, 0 to 5 percent slopes</td>
<td>A</td>
<td>52.8</td>
<td>42.5%</td>
</tr>
<tr>
<td>AdB</td>
<td>Adams and Windsor loamy sands, 5 to 12 percent slopes</td>
<td>A</td>
<td>27.3</td>
<td>21.9%</td>
</tr>
<tr>
<td>AdD</td>
<td>Adams and Windsor loamy sands, 12 to 30 percent slopes</td>
<td>A</td>
<td>26.5</td>
<td>21.3%</td>
</tr>
<tr>
<td>AdE</td>
<td>Adams and Windsor loamy sands, 30 to 60 percent slopes</td>
<td>A</td>
<td>1.1</td>
<td>0.9%</td>
</tr>
<tr>
<td>Au</td>
<td>Au Gres fine sandy loam</td>
<td>B</td>
<td>2.4</td>
<td>2.0%</td>
</tr>
<tr>
<td>DdA</td>
<td>Duane and Deerfield soils, 0 to 5 percent slopes</td>
<td>B</td>
<td>7.9</td>
<td>6.3%</td>
</tr>
<tr>
<td>EwA</td>
<td>Enosburg and Whately soils, 0 to 3 percent slopes</td>
<td>D</td>
<td>4.1</td>
<td>3.3%</td>
</tr>
<tr>
<td>Gpi</td>
<td>Pits, sand and Pits, gravel</td>
<td></td>
<td>2.1</td>
<td>1.7%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td></td>
<td><strong>124.2</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition
Component Percent Cutoff: None Specified
Tie-break Rule: Higher
Memo

To: Greg Goyette
   South Burlington, VT
File: Lamplite Acres Green Street Retrofit Scoping Study
195310758

From: Polly Harris
   South Burlington, VT
Date: August 9, 2012

Reference: Lamplite Acres Green Street Retrofit Scoping Study
Natural Resource Review

As requested, on August 8, 2012, Stantec Consulting (Stantec) evaluated the natural resources present within the Lamplite Acres Green Street Retrofit Scoping Project study area in Williston, Vermont. Lamplite Acres is an approximately 60-acre housing development located to the east and off of North Brownell Road between Williston Road and Industrial Avenue. The study area consists of the roadways within the Lamplite Acres development, as shown in Figures 1 and 2. It is anticipated that proposed improvements will generally be located in the Town roadway right-of-way within the development. The Town right-of-way for each road in the development is 49.5’ (3 rods) centered on the roadway centerline.

Specifically, as part of this investigation, Stantec identified and characterized observable rare, threatened or endangered (RTE) species, wetlands, streams, wildlife habitat, agricultural land, and conservation zones. Wetland boundaries under state and federal jurisdiction were determined using the technical criteria described in the 2012 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0). Following is a summary of our findings.

General Site Description

The Lamplite Acres study area includes the existing roadways and roadsides of the housing development. Vegetation within the study area consists of primarily maintained lawns and ornamental plantings (see Photos 1 - 4).

Natural Resource Review Summary

Review of Existing Materials
According to the Natural Resource Conservation Service (NRCS) Web Soil Survey\(^1\) for Chittenden County, Vermont, soils are mapped as Adams and Windsor loamy sands, 0-5% slopes, 5-12% slopes, and 12-30% slopes; and Duane and Deerfield soils, 0-5% slopes. None of these soils types are considered hydric. The Adams and Windsor, 0-5% slopes, Adams and Windsor, 5-12% slopes, and Belgrade/Eldridge, 0-5% slopes soils are considered farmland soils of statewide importance.

Stantec

August 9, 2012
Greg Goyette – Lamplite Acres Green Street Retrofit Scoping Project
Page 2 of 5

Reference: Lamplite Acres Green Street Retrofit Scoping Project Natural Resource Review

Stantec used the Vermont Agency of Natural Resources (ANR) Environmental Interest Locator program to assess the likelihood of the presence or absence of mapped Vermont Significant Wetland Inventory (VSWI) wetlands and rare, threatened, and endangered (RTE) plant and animal species. According to this program, there are no VSWI wetlands, RTE species, or significant natural communities mapped within the project area (see attached ANR Map).

Wetlands and Streams
No wetlands or streams were identified within the project corridor. The northeastern portion of the study area is located within the Allen Brook watershed, an area identified as a stormwater impaired watershed by ANR. Total Maximum Daily Loads (TMDLs) have been established for this stream, and any required stormwater permit will take this into consideration.

RTE Species
Stantec identified no RTE plant species during the August 8, 2012 site visit. Because the majority of the area has been disturbed by development, it is unlikely that any RTE plant species occur within the roadside study area.

Wildlife and Wildlife Habitat
The study area is a relatively narrow corridor along existing roads, flanked by residential developments and their parking areas. This narrow corridor has limited wildlife habitat value. It likely supports occasional use by transient songbirds and small mammals.

Agricultural Land
As described above, according to the NRCS Web Soil Survey for Chittenden County, Vermont, some soils within the study area are considered farmland soils of statewide importance. However, the project area is not used for agriculture, and the narrow strip alongside the existing pavement does not provide agricultural value as the affected land is already in urban use.

Conservation Zones
No designated state or town conservation zones are present within the narrow project corridor. According to a review of Land & Water Conservation Fund (LWCF) Projects from 1965-2011, no areas within the corridor were purchased with LWCF funds. Therefore, there are no “Section 4(f)” or “Section 6(f)” public lands present.

Summary
In summary, the narrow project corridor does not include any significant natural resources. The northeastern portion of the corridor is located within the Allen Brook stormwater impaired watershed. TMDLs have been established for this stream, and any required stormwater permit will take this into consideration.

STANTEC CONSULTING SERVICES INC.

Polly Harris
Environmental Project Manager
Polly.Harris@stantec.com

2 http://maps.vermont.gov/imf/sites/ANR_NATRESViewer/jsp/launch.jsp
Reference: Lample Acres Green Street Retrofit Scoping Project Natural Resource Review

Figure 1 - Study Area

Figure 2 - Lamplite Acres Neighborhood
Photo 1. The Lamplite Acres Green Streets Scoping Project study area includes existing roads, lawns, and ornamental plantings. 8/8/12

Photo 2. View of residential development, landscaping, and utility corridors within the study corridor. 8/8/12
The roads within the study area have no curbs or stormwater drains. 8/8/12

Maintained lawns and some mature trees are present within the study corridor. 8/8/12
Appendix C
Meeting Notes

Local Concerns Meeting
Lamplite Acres, Williston VT  J-195310758

Date/Time: June 13, 2012 6:30 PM
Place: Town of Williston
Next Meeting: N/A
Attendees: Lisa Sheltra, Bryan Davis, Dan Albrecht, Karl Richardson, Greg Goyette, Interested residents (list attached).
Distribution: Lisa Sheltra, Bruce Hoar, Bryan Davis, Dan Albrecht

Item:
OPENING REMARKS:
Lisa called a start to the meeting and introduced the members of the project committee in attendance. She gave some history about why and how this study came to fruition, as well as the funding source that is covering the cost of the study. Lisa explained the study is limited to the issues within the Town ROW, and it is not a goal of the study to address private property stormwater problems. Lisa then turned the meeting over to Stantec to provide more specifics about the project.

PRESENTATION:
Greg gave an outline of the scoping study process and where in the process this project is. Greg explained the draft Purpose and Needs of the project that will be used to define the goals of the study. Maps and photos of the neighborhood were presented depicting the information gathered to date and the observations that have made by the project committee. Example “green streets” improvements were presented that have been utilized in other areas of the state and country to address similar stormwater issues.

PUBLIC INPUT:
Many people in attendance had questions and comments regarding the project as summarized below:

- Q) Does this problem only occur in the Lamplite neighborhood or are there other neighborhoods in Chittenden County that are similar? A) Lisa noted that she is aware of one other neighborhood with similar problems. The majority of
other developments have stormwater systems in place.

- More stormwater issues seem to occur in the southern part of the neighborhood then in the northern areas.

- 2011 was an exceptionally bad year for flooding in many parts of the neighborhood.

- Pavement overlay projects have raised the road grade that has exacerbated driveway flooding problems.

- Pine Lane pavement has deteriorated rapidly presumably due to the lack of surface drainage.

- Pine & Lamplite intersection is prone to flooding and icing that is a safety concern. In extreme events, will pond high enough for water to enter houses. Also the lack of site distance and street parking is a problem at that intersection.

- Q) Is this project being mandated by the State? Can the State change specifications that could affect the project design? A) Explanation was that this is a Town project and the project is not expected to trigger any State permits.

- Q) Is a project in the neighborhood going to affect property taxes? A) Lisa explained that funding for the project has not been determined. Currently stormwater funds for the Town come from the General Fund. The Town is currently looking at funding options for all stormwater in Town.

- Q) Is this a test case? Is it the first area being considered for green streets? A) The project committee is aware of other projects in various levels of design and construction, and this project will provide another source of data.

- Rain gardens need specific varieties of plantings that will thrive in those conditions.

- Neighborhood would visually benefit from the addition of rain gardens.

- Q) Will the Town force anything onto the community? A) Lisa explained that while the Town has the right to do construction within the ROW, it will only do as much as necessary to address maintenance issues, with the hope that the community is in support of the project.

- Rotary Club may help with maintenance.

- Walking is not a safety concern in the neighborhood. Residents don’t see a need for a sidewalk.

- Traffic and speeding is typically not a problem – not a “cut-through”
neighborhood.

- Not interested in drastic changes in the neighborhood, don’t see a problem.

- Q) Is there a plan to resurface the streets as part of this project? A) This is a study to investigate possible solutions only. If a construction project materializes as a result of the study, it is possible that some paving will be necessary in localized areas.

- Neighborhood once had an active HOA, but was abandoned due to lack of issues to be addressed.

- Concern what the real cost of the project will be and who will foot the bill.

- Q) Is the Town building a stormwater fund? A) The Town is currently conducting a study to determine the best solution to fund stormwater throughout.

- Q) Do rain gardens work in the winter? A) When the ground is frozen the infiltration rate will decrease, but there will still be a benefit as the runoff will have a place to collect off the pavement surface.

CONCLUSIONS:
Greg stated the next steps of the study will be to develop alternate solutions for the project and the public will have a chance to review and provide comments at the next public presentation expected to be held in August, 2012.

The meeting adjourned at 8:00 PM.
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

STANTEC CONSULTING SERVICES INC.

[Signature]
# Local Concerns Meeting
**Lamplite Acres Stormwater Improvements**

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>E Camille House, Ed</td>
<td>354 Lamplite Ln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>409 Lamplite Ln</td>
<td></td>
</tr>
<tr>
<td>Bobbi &amp; Ray Brown</td>
<td>409 Aspen Lane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>109 Aspen Lane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 Lamplite Ln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>481 White Birch Ln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>528 White Birch Ln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>170 Lamplite Ln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76 Aspen Ln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>248 Lamplite Ln</td>
<td></td>
</tr>
<tr>
<td>Dick Ransom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dawna Peterson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarah Mason</td>
<td></td>
<td></td>
</tr>
<tr>
<td>John Boucher</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Estimating Runoff from Spring Melt

In light of reports that spring melt is a major cause of flooding along the roadways, an estimate of the water volume caused by snowpack melting in the spring was determined. Literature on modeling runoff due to snowmelt was found to be for large watersheds and therefore inappropriate to this exercise. Instead, the determination was based on historical data and reasonable assumptions that produced an approximate storage volume required to contain runoff from snowmelt during a water quality volume (0.9-inch) rain event.

According to data from the National Oceanic and Atmospheric Administration going back to 1896, the largest average depth of snowpack in Burlington during the month of March was 19.6 inches. This loosely translates into 1.5 feet of snowpack in March in Williston, which, based on previous experience with Vermont winters, seems to be a conservative estimate. The National Resource Conservation Service states that spring snowpack usually has a density of 30%-50%, so a density of 40% was assumed. It was also assumed that during a rain event, about 20% of snow would melt over a 24-hour period. Therefore, the volume of water from snowmelt in watershed inches is calculated as follows:

\[18 \text{ inches snowpack} \times 40\% \text{ density} \times 20\% \text{ melting per day} = 1.44 \text{ watershed-inches of snowmelt}\]

If this volume is added to the water quality volume storm of 0.9 inches, the resulting volume is 2.34 watershed-inches, which is close to the 2-year storm event of 2.3 inches. To simplify calculations, the volume of water produced during the combination of a spring melt and a water quality volume storm is assumed to be approximately equal to the 2-year storm in Williston. It is also assumed that the conditions under which TR-55 may be applied are satisfied in this scenario. Although infiltration may be hampered due to the earth being frozen, the additional runoff will be trapped by snowpack, so the end result will be approximately equivalent.

Given these assumptions, the 2-year storm event was modeled in HydroCAD to determine the runoff volume that would need to be contained.
Appendix E
## Area Listing (selected nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
<th>Subcatchment-numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>843,757</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
<td>(7S,8S,9S,10S,11S,12S)</td>
</tr>
<tr>
<td>44,867</td>
<td>98</td>
<td></td>
<td>(1S,2S,3S,4S,5S,6S)</td>
</tr>
<tr>
<td>170,755</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
<td>(7S,8S,9S,10S,11S,12S)</td>
</tr>
<tr>
<td>1,059,379</td>
<td></td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
## Soil Listing (selected nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil</th>
<th>Group</th>
<th>Subcatchment</th>
</tr>
</thead>
<tbody>
<tr>
<td>843,757</td>
<td>HSG A</td>
<td>7S, 8S, 9S, 10S, 11S, 12S</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>215,622</td>
<td>Other</td>
<td>1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S</td>
<td></td>
</tr>
<tr>
<td><strong>1,059,379</strong></td>
<td><strong>TOTAL AREA</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Subcatchment 1S: A1 Road  
Runoff Area=0.120 ac  100.00% Impervious  Runoff Depth=2.07" 
Tc=5.0 min  CN=98  Runoff=0.40 cfs  903 cf

Subcatchment 2S: A2 Road  
Runoff Area=0.090 ac  100.00% Impervious  Runoff Depth=2.07" 
Tc=5.0 min  CN=98  Runoff=0.30 cfs  677 cf

Subcatchment 3S: A4 Road  
Runoff Area=0.140 ac  100.00% Impervious  Runoff Depth=2.07" 
Tc=5.0 min  CN=98  Runoff=0.46 cfs  1,053 cf

Subcatchment 4S: A4 Road  
Runoff Area=0.210 ac  100.00% Impervious  Runoff Depth=2.07" 
Tc=5.0 min  CN=98  Runoff=0.70 cfs  1,579 cf

Subcatchment 5S: A5 Road  
Runoff Area=0.280 ac  100.00% Impervious  Runoff Depth=2.07" 
Tc=5.0 min  CN=98  Runoff=0.93 cfs  2,106 cf

Subcatchment 6S: A6 Road  
Runoff Area=0.190 ac  100.00% Impervious  Runoff Depth=2.07" 
Tc=5.0 min  CN=98  Runoff=0.63 cfs  1,429 cf

Subcatchment 7S: A1 Non-Road  
Runoff Area=3.090 ac  19.09% Impervious  Runoff Depth=0.04" 
Tc=5.0 min  CN=54  Runoff=0.01 cfs  438 cf

Subcatchment 8S: A2 Non-Road  
Runoff Area=2.220 ac  21.62% Impervious  Runoff Depth=0.05" 
Tc=5.0 min  CN=55  Runoff=0.01 cfs  401 cf

Subcatchment 9S: A3 Non-Road  
Runoff Area=3.090 ac  19.74% Impervious  Runoff Depth=0.04" 
Tc=5.0 min  CN=54  Runoff=0.01 cfs  438 cf

Subcatchment 10S: A4 Non-Road  
Runoff Area=6.240 ac  11.38% Impervious  Runoff Depth=0.00" 
Tc=5.0 min  CN=49  Runoff=0.01 cfs  102 cf

Subcatchment 11S: A5 Non-Road  
Runoff Area=5.100 ac  16.67% Impervious  Runoff Depth=0.02" 
Tc=5.0 min  CN=52  Runoff=0.01 cfs  394 cf

Subcatchment 12S: A6 Non-Road  
Runoff Area=3.550 ac  19.15% Impervious  Runoff Depth=0.04" 
Tc=5.0 min  CN=54  Runoff=0.01 cfs  503 cf

Reach 13R: A1 swale  
Inflow=0.40 cfs  1,340 cf  
Outflow=0.40 cfs  1,340 cf

Reach 14R: A2 swale  
Inflow=0.30 cfs  1,078 cf  
Outflow=0.30 cfs  1,078 cf

Reach 15R: A3 swale  
Inflow=0.46 cfs  1,491 cf  
Outflow=0.46 cfs  1,491 cf

Reach 16R: A4 swale  
Inflow=0.70 cfs  1,681 cf  
Outflow=0.70 cfs  1,681 cf
Reach 17R: A5 swale
Inflow=0.93 cfs  2,500 cf
Outflow=0.93 cfs  2,500 cf

Reach 18R: A6 swale
Inflow=0.63 cfs  1,932 cf
Outflow=0.63 cfs  1,932 cf

Total Runoff Area = 1,059,379 sf  Runoff Volume = 10,021 cf  Average Runoff Depth = 0.11"
79.65% Pervious = 843,757 sf  20.35% Impervious = 215,622 sf
Summary for Subcatchment 1S: A1 Road

Runoff = 0.40 cfs @ 11.96 hrs, Volume = 903 cf, Depth = 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.120</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
<tr>
<td>0.120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tc (min)  Length (feet)  Slope (ft/ft)  Velocity (ft/sec)  Capacity (cfs)  Description
5.0        |              |                      |                |                        | Direct Entry, Assumed |

Subcatchment 1S: A1 Road

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=0.120 ac
Runoff Volume=903 cf
Runoff Depth=2.07"
Tc=5.0 min
CN=98
Summary for Subcatchment 2S: A2 Road

Runoff = 0.30 cfs @ 11.96 hrs, Volume= 677 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.090</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 2S: A2 Road

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=0.090 ac
Runoff Volume=677 cf
Runoff Depth=2.07"
Tc=5.0 min
CN=98
Summary for Subcatchment 3S: A4 Road

Runoff = 0.46 cfs @ 11.96 hrs, Volume = 1,053 cf, Depth = 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.140</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 3S: A4 Road

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=0.140 ac
Runoff Volume=1,053 cf
Runoff Depth=2.07"
Tc=5.0 min
CN=98
Summary for Subcatchment 4S: A4 Road

Runoff = 0.70 cfs @ 11.96 hrs, Volume = 1,579 cf, Depth = 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr 2-year Rainfall = 2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.210</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 4S: A4 Road

Hydrograph

Type II 24-hr 2-year Rainfall = 2.30"
Runoff Area = 0.210 ac
Runoff Volume = 1,579 cf
Runoff Depth = 2.07"
Tc = 5.0 min
CN = 98
Summary for Subcatchment 5S: A5 Road

Runoff = 0.93 cfs @ 11.96 hrs, Volume= 2,106 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.280</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 5S: A5 Road

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=0.280 ac
Runoff Volume=2,106 cf
Runoff Depth=2.07"
Tc=5.0 min
CN=98
Summary for Subcatchment 6S: A6 Road

Runoff = 0.63 cfs @ 11.96 hrs, Volume= 1,429 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.190</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
<tr>
<td>0.190</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 6S: A6 Road

Hydrograph

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=0.190 ac
Runoff Volume=1,429 cf
Runoff Depth=2.07"
Tc=5.0 min
CN=98
Summary for Subcatchment 7S: A1 Non-Road

Runoff = 0.01 cfs @ 15.20 hrs, Volume = 438 cf, Depth = 0.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr 2-year Rainfall = 2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.500</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.590</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>3.090</td>
<td>54</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>2.500</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.590</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc = 5.0 min

Subcatchment 7S: A1 Non-Road

Flow (cfs) vs Time (hours)

Type II 24-hr 2-year Rainfall = 2.30"
Runoff Area = 3.090 ac
Runoff Volume = 438 cf
Runoff Depth = 0.04"
Tc = 5.0 min
CN = 54
Summary for Subcatchment 8S: A2 Non-Road

Runoff = 0.01 cfs @ 14.83 hrs, Volume = 401 cf, Depth = 0.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr 2-year Rainfall = 2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.740</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.480</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>2.220</td>
<td>55</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>1.740</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.480</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs)
5.0

Subcatchment 8S: A2 Non-Road

Type II 24-hr 2-year Rainfall = 2.30"
Runoff Area = 2.220 ac
Runoff Volume = 401 cf
Runoff Depth = 0.05"
Tc = 5.0 min
CN = 55
Summary for Subcatchment 9S: A3 Non-Road

Runoff = 0.01 cfs @ 15.20 hrs, Volume= 438 cf, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.480</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.610</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>3.090</td>
<td>54</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>2.480</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.610</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 9S: A3 Non-Road

Hydrograph

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=3.090 ac
Runoff Volume=438 cf
Runoff Depth=0.04"
Tc=5.0 min
CN=54
Summary for Subcatchment 10S: A4 Non-Road

Runoff = 0.01 cfs @ 24.00 hrs, Volume = 102 cf, Depth = 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.530</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.710</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>6.240</td>
<td>49</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>5.530</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.710</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc = 5.0 min

Subcatchment 10S: A4 Non-Road

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=6.240 ac
Runoff Volume=102 cf
Runoff Depth=0.00"
Tc=5.0 min
CN=49
Summary for Subcatchment 11S: A5 Non-Road

Runoff = 0.01 cfs @ 18.20 hrs, Volume= 394 cf, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.250</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.850</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>5.100</td>
<td>52</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>4.250</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.850</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc = 5.0 min

Subcatchment 11S: A5 Non-Road

Hydrograph

Type II 24-hr 2-year Rainfall=2.30"
Runoff Area=5.100 ac
Runoff Volume=394 cf
Runoff Depth=0.02"
Tc=5.0 min
CN=52
Summary for Subcatchment 12S: A6 Non-Road

Runoff = 0.01 cfs @ 15.20 hrs, Volume= 503 cf, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-year Rainfall=2.30"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.870</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.680</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>3.550</td>
<td>54</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>2.870</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.680</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Subcatchment 12S: A6 Non-Road

Hydrograph

- Type II 24-hr 2-year Rainfall=2.30"
- Runoff Area=3.550 ac
- Runoff Volume=503 cf
- Runoff Depth=0.04"
- Tc=5.0 min
- CN=54
Summary for Reach 13R: A1 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 139,828 sf, 22.12% Impervious, Inflow Depth = 0.12” for 2-year event

Inflow = 0.40 cfs @ 11.96 hrs, Volume= 1,340 cf
Outflow = 0.40 cfs @ 11.96 hrs, Volume= 1,340 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Summary for Reach 14R: A2 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 100,624 sf, 24.68% Impervious, Inflow Depth = 0.13” for 2-year event
Inflow = 0.30 cfs @ 11.96 hrs, Volume= 1,078 cf
Outflow = 0.30 cfs @ 11.96 hrs, Volume= 1,078 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs

Reach 14R: A2 swale

Inflow Area=100,624 sf

Hydrograph
Summary for Reach 15R: A3 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 140,699 sf, 23.22% Impervious, Inflow Depth = 0.13” for 2-year event
Inflow = 0.46 cfs @ 11.96 hrs, Volume= 1,491 cf
Outflow = 0.46 cfs @ 11.96 hrs, Volume= 1,491 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs

Reach 15R: A3 swale
Summary for Reach 16R: A4 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 280,962 sf, 14.26% Impervious, Inflow Depth = 0.07" for 2-year event
Inflow = 0.70 cfs @ 11.96 hrs, Volume= 1,681 cf
Outflow = 0.70 cfs @ 11.96 hrs, Volume= 1,681 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Summary for Reach 17R: A5 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 234,353 sf, 21.00% Impervious, Inflow Depth = 0.13” for 2-year event
Inflow = 0.93 cfs @ 11.96 hrs, Volume= 2,500 cf
Outflow = 0.93 cfs @ 11.96 hrs, Volume= 2,500 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs

Reach 17R: A5 swale

Hydrograph
Summary for Reach 18R: A6 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 162,914 sf, 23.26% Impervious, Inflow Depth = 0.14” for 2-year event

Inflow = 0.63 cfs @ 11.96 hrs, Volume= 1,932 cf
Outflow = 0.63 cfs @ 11.96 hrs, Volume= 1,932 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Drainage Diagram for Lamplite Road Separate

Prepared by (enter your company name here), Printed 10/26/2012
HydroCAD® 8.50 s/n 001592 © 2007 HydroCAD Software Solutions LLC
### Area Listing (selected nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
<th>Subcatchment-numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>843,757</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A (7S,8S,9S,10S,11S,12S)</td>
<td>(7S,8S,9S,10S,11S,12S)</td>
</tr>
<tr>
<td>44,867</td>
<td>98</td>
<td>(1S,2S,3S,4S,5S,6S)</td>
<td>(1S,2S,3S,4S,5S,6S)</td>
</tr>
<tr>
<td>170,755</td>
<td>98</td>
<td>Paved parking &amp; roofs (7S,8S,9S,10S,11S,12S)</td>
<td>(7S,8S,9S,10S,11S,12S)</td>
</tr>
<tr>
<td>1,059,379</td>
<td></td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
## Soil Listing (selected nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>843,757</td>
<td>HSG A</td>
<td>7S, 8S, 9S, 10S, 11S, 12S</td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
</tr>
<tr>
<td>215,622</td>
<td>Other</td>
<td>1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S</td>
</tr>
<tr>
<td>1,059,379</td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
### Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<table>
<thead>
<tr>
<th>Subcatchment</th>
<th>Runoff Area</th>
<th>Impervious Area</th>
<th>Runoff Depth</th>
<th>Tc</th>
<th>CN</th>
<th>Runoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S: A1 Road</td>
<td>0.120 ac</td>
<td>100.00%</td>
<td>0.69”</td>
<td>5.0 min</td>
<td>98</td>
<td>0.14 cfs 302 cf</td>
</tr>
<tr>
<td>2S: A2 Road</td>
<td>0.090 ac</td>
<td>100.00%</td>
<td>0.69”</td>
<td>5.0 min</td>
<td>98</td>
<td>0.11 cfs 227 cf</td>
</tr>
<tr>
<td>3S: A4 Road</td>
<td>0.140 ac</td>
<td>100.00%</td>
<td>0.69”</td>
<td>5.0 min</td>
<td>98</td>
<td>0.17 cfs 353 cf</td>
</tr>
<tr>
<td>4S: A4 Road</td>
<td>0.210 ac</td>
<td>100.00%</td>
<td>0.69”</td>
<td>5.0 min</td>
<td>98</td>
<td>0.25 cfs 529 cf</td>
</tr>
<tr>
<td>5S: A5 Road</td>
<td>0.280 ac</td>
<td>100.00%</td>
<td>0.69”</td>
<td>5.0 min</td>
<td>98</td>
<td>0.33 cfs 706 cf</td>
</tr>
<tr>
<td>6S: A6 Road</td>
<td>0.190 ac</td>
<td>100.00%</td>
<td>0.69”</td>
<td>5.0 min</td>
<td>98</td>
<td>0.23 cfs 479 cf</td>
</tr>
<tr>
<td>7S: A1 Non-Road</td>
<td>3.090 ac</td>
<td>19.09%</td>
<td>0.00”</td>
<td>5.0 min</td>
<td>54</td>
<td>0.00 cfs 0 cf</td>
</tr>
<tr>
<td>8S: A2 Non-Road</td>
<td>2.220 ac</td>
<td>21.62%</td>
<td>0.00”</td>
<td>5.0 min</td>
<td>55</td>
<td>0.00 cfs 0 cf</td>
</tr>
<tr>
<td>9S: A3 Non-Road</td>
<td>3.090 ac</td>
<td>19.74%</td>
<td>0.00”</td>
<td>5.0 min</td>
<td>54</td>
<td>0.00 cfs 0 cf</td>
</tr>
<tr>
<td>10S: A4 Non-Road</td>
<td>6.240 ac</td>
<td>11.38%</td>
<td>0.00”</td>
<td>5.0 min</td>
<td>49</td>
<td>0.00 cfs 0 cf</td>
</tr>
<tr>
<td>11S: A5 Non-Road</td>
<td>5.100 ac</td>
<td>16.67%</td>
<td>0.00”</td>
<td>5.0 min</td>
<td>52</td>
<td>0.00 cfs 0 cf</td>
</tr>
<tr>
<td>12S: A6 Non-Road</td>
<td>3.550 ac</td>
<td>19.15%</td>
<td>0.00”</td>
<td>5.0 min</td>
<td>54</td>
<td>0.00 cfs 0 cf</td>
</tr>
</tbody>
</table>

### Inflow and Outflow

<table>
<thead>
<tr>
<th>Reach</th>
<th>Inflow</th>
<th>Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>13R: A1 swale</td>
<td>0.14 cfs 302 cf</td>
<td>0.14 cfs 302 cf</td>
</tr>
<tr>
<td>14R: A2 swale</td>
<td>0.11 cfs 227 cf</td>
<td>0.11 cfs 227 cf</td>
</tr>
<tr>
<td>15R: A3 swale</td>
<td>0.17 cfs 353 cf</td>
<td>0.17 cfs 353 cf</td>
</tr>
<tr>
<td>16R: A4 swale</td>
<td>0.25 cfs 529 cf</td>
<td>0.25 cfs 529 cf</td>
</tr>
</tbody>
</table>
Reach 17R: A5 swale

Inflow=0.33 cfs  706 cf
Outflow=0.33 cfs  706 cf

Reach 18R: A6 swale

Inflow=0.23 cfs  479 cf
Outflow=0.23 cfs  479 cf

Total Runoff Area = 1,059,379 sf  Runoff Volume = 2,596 cf  Average Runoff Depth = 0.03"  
79.65% Pervious = 843,757 sf  20.35% Impervious = 215,622 sf
Summary for Subcatchment 1S: A1 Road

Runoff = 0.14 cfs @ 11.96 hrs, Volume= 302 cf, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.120</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc = 5.0 min

Subcatchment 1S: A1 Road

Hydrograph

Type II 24-hr WQV Rainfall=0.90"
Runoff Area=0.120 ac
Runoff Volume=302 cf
Runoff Depth=0.69"
Tc=5.0 min
CN=98
Summary for Subcatchment 2S: A2 Road

Runoff = 0.11 cfs @ 11.96 hrs, Volume= 227 cf, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.090</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 2S: A2 Road

Type II 24-hr WQV Rainfall=0.90"
Runoff Area=0.090 ac
Runoff Volume=227 cf
Runoff Depth=0.69"
Tc=5.0 min
CN=98
Summary for Subcatchment 3S: A4 Road

Runoff = 0.17 cfs @ 11.96 hrs, Volume= 353 cf, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.140</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs)
5.0

Direct Entry, Assumed

Subcatchment 3S: A4 Road

Type II 24-hr WQV
Rainfall=0.90"
Runoff Area=0.140 ac
Runoff Volume=353 cf
Runoff Depth=0.69"
Tc=5.0 min
CN=98
Summary for Subcatchment 4S: A4 Road

Runoff = 0.25 cfs @ 11.96 hrs, Volume= 529 cf, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs

Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.210</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Direct Entry, Assumed

Subcatchment 4S: A4 Road

Type II 24-hr WQV
Rainfall=0.90"
Runoff Area=0.210 ac
Runoff Volume=529 cf
Runoff Depth=0.69"
Tc=5.0 min
CN=98
Summary for Subcatchment 5S: A5 Road

Runoff = 0.33 cfs @ 11.96 hrs, Volume = 706 cf, Depth = 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.280</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 5S: A5 Road

Type II 24-hr WQV Rainfall=0.90"
Runoff Area=0.280 ac
Runoff Volume=706 cf
Runoff Depth=0.69"
Tc=5.0 min
CN=98
Summary for Subcatchment 6S: A6 Road

Runoff = 0.23 cfs @ 11.96 hrs, Volume = 479 cf, Depth = 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0.190</td>
<td>98</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc</th>
<th>Length</th>
<th>Slope</th>
<th>Velocity</th>
<th>Capacity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Assumed</td>
</tr>
</tbody>
</table>

Subcatchment 6S: A6 Road

Hydrograph

Type II 24-hr WQV
Rainfall=0.90"
Runoff Area=0.190 ac
Runoff Volume=479 cf
Runoff Depth=0.69"
Tc=5.0 min
CN=98

Flow (cfs)

Time (hours)
Summary for Subcatchment 7S: A1 Non-Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.500</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.590</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>3.090</td>
<td>54</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>2.500</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.590</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs)
5.0

Direct Entry, Assumed

Subcatchment 7S: A1 Non-Road

Type II 24-hr WQV
Rainfall=0.90"
Runoff Area=3.090 ac
Runoff Volume=0 cf
Runoff Depth=0.00"
Tc=5.0 min
CN=54
Summary for Subcatchment 8S: A2 Non-Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.740</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.480</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>2.220</td>
<td>55</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>1.740</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.480</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs) Direct Entry, Assumed
5.0

Subcatchment 8S: A2 Non-Road

Hydrograph

Type II 24-hr WQV Rainfall=0.90"
Runoff Area=2.220 ac
Runoff Volume=0 cf
Runoff Depth=0.00"
Tc=5.0 min
CN=55
Summary for Subcatchment 9S: A3 Non-Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.480</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.610</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>3.090</td>
<td>54</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>2.480</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.610</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc=5.0 min  
Length (feet)  
Slope (ft/ft)  
Velocity (ft/sec)  
Capacity (cfs)  
Description

Subcatchment 9S: A3 Non-Road

Type II 24-hr WQV  
Rainfall=0.90"
Runoff Area=3.090 ac  
Runoff Volume=0 cf  
Runoff Depth=0.00"
Tc=5.0 min  
CN=54
Summary for Subcatchment 10S: A4 Non-Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.530</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.710</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>6.240</td>
<td>49</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>5.530</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.710</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs)
5.0 Direct Entry, Assumed

Subcatchment 10S: A4 Non-Road

Type II 24-hr WQV
Rainfall=0.90"
Runoff Area=6.240 ac
Runoff Volume=0 cf
Runoff Depth=0.00"
Tc=5.0 min
CN=49
Summary for Subcatchment 11S: A5 Non-Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.250</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.850</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>5.100</td>
<td>52</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>4.250</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.850</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc = 5.0 min

Direct Entry, Assumed

Subcatchment 11S: A5 Non-Road

Type II 24-hr WQV Rainfall=0.90"
Runoff Area=5.100 ac
Runoff Volume=0 cf
Runoff Depth=0.00"
Tc=5.0 min
CN=52
Summary for Subcatchment 12S: A6 Non-Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume = 0 cf, Depth = 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-35.00 hrs, dt = 0.02 hrs
Type II 24-hr WQV Rainfall=0.90"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.870</td>
<td>43</td>
<td>Woods/grass comb., Fair, HSG A</td>
</tr>
<tr>
<td>0.680</td>
<td>98</td>
<td>Paved parking &amp; roofs</td>
</tr>
<tr>
<td>3.550</td>
<td>54</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>2.870</td>
<td></td>
<td>Pervious Area</td>
</tr>
<tr>
<td>0.680</td>
<td></td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc = 5.0 min

Subcatchment 12S: A6 Non-Road

Type II 24-hr WQV Rainfall=0.90"
Runoff Area=3.550 ac
Runoff Volume=0 cf
Runoff Depth=0.00"
Tc=5.0 min
CN=54
Summary for Reach 13R: A1 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 139,828 sf, 22.12% Impervious, Inflow Depth = 0.03" for WQV event
Inflow = 0.14 cfs @ 11.96 hrs, Volume= 302 cf
Outflow = 0.14 cfs @ 11.96 hrs, Volume= 302 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Summary for Reach 14R: A2 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 100,624 sf, 24.68% Impervious, Inflow Depth = 0.03" for WQV event
Inflow = 0.11 cfs @ 11.96 hrs, Volume = 227 cf
Outflow = 0.11 cfs @ 11.96 hrs, Volume = 227 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Summary for Reach 15R: A3 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 140,699 sf, 23.22% Impervious, Inflow Depth = 0.03" for WQV event
Inflow = 0.17 cfs @ 11.96 hrs, Volume= 353 cf
Outflow = 0.17 cfs @ 11.96 hrs, Volume= 353 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs

Reach 15R: A3 swale
Summary for Reach 16R: A4 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 280,962 sf, 14.26% Impervious, Inflow Depth = 0.02" for WQV event
Inflow = 0.25 cfs @ 11.96 hrs, Volume = 529 cf
Outflow = 0.25 cfs @ 11.96 hrs, Volume = 529 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Summary for Reach 17R: A5 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 234,353 sf, 21.00% Impervious, Inflow Depth = 0.04” for WQV event
Inflow = 0.33 cfs @ 11.96 hrs, Volume= 706 cf
Outflow = 0.33 cfs @ 11.96 hrs, Volume= 706 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Summary for Reach 18R: A6 swale

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 162,914 sf, 23.26% Impervious, Inflow Depth = 0.04” for WQV event
Inflow = 0.23 cfs @ 11.96 hrs, Volume = 479 cf
Outflow = 0.23 cfs @ 11.96 hrs, Volume = 479 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-35.00 hrs, dt= 0.02 hrs
Appendix F
Roadside rain garden swale

Determine length of swale required

Assumptions:
- Bottom width = 2 ft
- Side slopes = 1: 4
- Ponding depth = 0.5 ft
- Total depth = 1 ft

Drainage Area = A-1

Design Storm Runoff Volume (from HydroCAD)

<table>
<thead>
<tr>
<th>Storm Type</th>
<th>WQv</th>
<th>1 Year</th>
<th>2 Year</th>
<th>10 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>302 cf</td>
<td>1002 cf</td>
<td>1340 cf</td>
<td>3771 cf</td>
</tr>
</tbody>
</table>

Swale Length Calculation

<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Runoff Volume (cf)</th>
<th>Swale Unit Area (ft^2/ft)</th>
<th>Plantings as % of Available Unit Area</th>
<th>Effective Swale Unit Area (ft^2/ft)</th>
<th>Swale Length Required (ft)</th>
<th>Total Storage Volume (cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQv</td>
<td>302</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>216</td>
<td>865</td>
</tr>
<tr>
<td>1 Year</td>
<td>1002</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>716</td>
<td>2865</td>
</tr>
<tr>
<td>2 Year</td>
<td>1340</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>957</td>
<td>3831</td>
</tr>
<tr>
<td>10 Year</td>
<td>3771</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>2694</td>
<td>10776</td>
</tr>
</tbody>
</table>

Determine diameter and length of underground storage required

Underground Storage Length Calculation

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>Pipe Unit Area (ft^2/ft)</th>
<th>Length Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 Year (LF)</td>
</tr>
<tr>
<td>12</td>
<td>0.785</td>
<td>1276</td>
</tr>
<tr>
<td>18</td>
<td>1.767</td>
<td>567</td>
</tr>
<tr>
<td>24</td>
<td>3.142</td>
<td>319</td>
</tr>
<tr>
<td>30</td>
<td>4.909</td>
<td>204</td>
</tr>
<tr>
<td>36</td>
<td>7.069</td>
<td>142</td>
</tr>
</tbody>
</table>
Roadside rain garden swale

Determine length of swale required

Assumptions:

Bottom width = 2 ft
Side slopes = 1:4
Ponding depth = 0.5 ft
Total depth = 1 ft

Drainage Area = A-2
Design Storm Runoff Volume (from HydroCAD)

<table>
<thead>
<tr>
<th>Design Storm Volume (cf)</th>
<th>Runoff Area (ft^2/ft)</th>
<th>Swale Unit Area (ft^2/ft)</th>
<th>Plantings as % of Available Unit Area</th>
<th>Effective Swale Unit Area (ft^2/ft)</th>
<th>Swale Length Required (ft)</th>
<th>Total Storage Volume (cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQv</td>
<td>227</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>162</td>
<td>651</td>
</tr>
<tr>
<td>1 Year</td>
<td>804</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>574</td>
<td>2299</td>
</tr>
<tr>
<td>2 Year</td>
<td>1078</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>770</td>
<td>3082</td>
</tr>
<tr>
<td>10 Year</td>
<td>2969</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>2121</td>
<td>8485</td>
</tr>
</tbody>
</table>

Determine diameter and length of underground storage required

Pipe Diameter (in) | Pipe Unit Area (ft^2/ft) | 1 Year (LF) | 2 Year (LF) | 10 Year (LF) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.785</td>
<td>1024</td>
<td>1373</td>
<td>3780</td>
</tr>
<tr>
<td>18</td>
<td>1.767</td>
<td>455</td>
<td>610</td>
<td>1680</td>
</tr>
<tr>
<td>24</td>
<td>3.142</td>
<td>256</td>
<td>343</td>
<td>945</td>
</tr>
<tr>
<td><strong>30</strong></td>
<td><strong>4.909</strong></td>
<td><strong>164</strong></td>
<td><strong>220</strong></td>
<td><strong>605</strong></td>
</tr>
<tr>
<td>36</td>
<td>7.069</td>
<td>114</td>
<td>153</td>
<td>420</td>
</tr>
</tbody>
</table>
Roadside rain garden swale

Determine length of swale required

Assumptions:
- Bottom width = 2 ft
- Side slopes = 1:4
- Ponding depth = 0.5 ft
- Total depth = 1 ft

Drainage Area = A-3

Design Storm Runoff Volume (from HydroCAD)

<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Runoff Volume (cf)</th>
<th>Swale Unit Area (ft^2/ft)</th>
<th>Plantings as % of Available Unit Area</th>
<th>Effective Swale Unit Area (ft^2/ft)</th>
<th>Swale Length Required (ft)</th>
<th>Total Storage Volume (cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQv</td>
<td>353</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>252</td>
<td>1011</td>
</tr>
<tr>
<td>1 Year</td>
<td>1136</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>811</td>
<td>3248</td>
</tr>
<tr>
<td>2 Year</td>
<td>1491</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1065</td>
<td>4262</td>
</tr>
<tr>
<td>10 Year</td>
<td>3981</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>2844</td>
<td>11376</td>
</tr>
</tbody>
</table>

Determine diameter and length of underground storage required

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Unit Area (ft^2/ft)</td>
<td>0.785</td>
<td>1.767</td>
<td>3.142</td>
<td>4.909</td>
<td>7.069</td>
</tr>
<tr>
<td>Length Required (1 Year LF, 2 Year LF, 10 Year LF)</td>
<td>1446, 643, 362, 231</td>
<td>1898, 844, 475, 304</td>
<td>5069, 2253, 1267, 811</td>
<td>5069, 2253, 1267, 811</td>
<td>5069, 2253, 1267, 811</td>
</tr>
</tbody>
</table>
Roadside rain garden swale

Determine length of swale required

Assumptions:
- Bottom width = 2 ft
- Side slopes = 1: 4
- Ponding depth = 0.5 ft
- Total depth = 1 ft

Drainage Area = A-4

Design Storm Runoff Volume (from HydroCAD)

- WQv 529 cf
- 1 Year 1408 cf
- 2 Year 1681 cf
- 10 Year 4668 cf

<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Runoff Volume (cf)</th>
<th>Swale Unit Area (ft^2/ft)</th>
<th>Plantings as % of Available Unit Area</th>
<th>Effective Swale Unit Area (ft^2/ft)</th>
<th>Swale Length Required (ft)</th>
<th>Total Storage Volume (cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQv</td>
<td>529</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>378</td>
<td>1513</td>
</tr>
<tr>
<td>1 Year</td>
<td>1408</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1006</td>
<td>4025</td>
</tr>
<tr>
<td>2 Year</td>
<td>1681</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1201</td>
<td>4805</td>
</tr>
<tr>
<td>10 Year</td>
<td>4668</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>3334</td>
<td>13339</td>
</tr>
</tbody>
</table>

Determine diameter and length of underground storage required

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>Pipe Unit Area (ft^2/ft)</th>
<th>Length Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 Year (LF)</td>
</tr>
<tr>
<td>12</td>
<td>0.785</td>
<td>1793</td>
</tr>
<tr>
<td>18</td>
<td>1.767</td>
<td>797</td>
</tr>
<tr>
<td>24</td>
<td>3.142</td>
<td>448</td>
</tr>
<tr>
<td><strong>30</strong></td>
<td><strong>4.909</strong></td>
<td><strong>287</strong></td>
</tr>
<tr>
<td>36</td>
<td>7.069</td>
<td>199</td>
</tr>
</tbody>
</table>
Roadside rain garden swale

Determine length of swale required

Assumptions:
- Bottom width = 2 ft
- Side slopes = 1:4
- Ponding depth = 0.5 ft
- Total depth = 1 ft

Drainage Area = A-5

Design Storm Runoff Volume (from HydroCAD)

<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Runoff Volume (cf)</th>
<th>Swale Unit Area (ft^2/ft)</th>
<th>Plantings as % of Available Unit Area</th>
<th>Effective Swale Unit Area (ft^2/ft)</th>
<th>Swale Length Required (ft)</th>
<th>Total Storage Volume (cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQv</td>
<td>706</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>504</td>
<td>2019</td>
</tr>
<tr>
<td>1 Year</td>
<td>2030</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1450</td>
<td>5802</td>
</tr>
<tr>
<td>2 Year</td>
<td>2500</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1786</td>
<td>7145</td>
</tr>
<tr>
<td>10 Year</td>
<td>6222</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>4444</td>
<td>17779</td>
</tr>
</tbody>
</table>

Determine diameter and length of underground storage required

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>Pipe Unit Area (ft^2/ft)</th>
<th>Length Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 Year (LF)</td>
</tr>
<tr>
<td>12</td>
<td>0.785</td>
<td>2585</td>
</tr>
<tr>
<td>18</td>
<td>1.767</td>
<td>1149</td>
</tr>
<tr>
<td>24</td>
<td>3.142</td>
<td>646</td>
</tr>
<tr>
<td>30</td>
<td>4.909</td>
<td>414</td>
</tr>
<tr>
<td>36</td>
<td>7.069</td>
<td>287</td>
</tr>
</tbody>
</table>
Roadside rain garden swale

**Determine length of swale required**

Assumptions:
- Bottom width = 2 ft
- Side slopes = 1:4
- Ponding depth = 0.5 ft
- Total depth = 1 ft

**Drainage Area**

A-6

**Design Storm Runoff Volume (from HydroCAD)**

<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Runoff Volume (cf)</th>
<th>Swale Unit Area (ft^2/ft)</th>
<th>Plantings as % of Available Unit Area</th>
<th>Effective Swale Unit Area (ft^2/ft)</th>
<th>Swale Length Required (ft)</th>
<th>Total Storage Volume (cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQv 479</td>
<td>479</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>342</td>
<td>1371</td>
</tr>
<tr>
<td>1 Year</td>
<td>1501</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1072</td>
<td>4291</td>
</tr>
<tr>
<td>2 Year</td>
<td>1932</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>1380</td>
<td>5522</td>
</tr>
<tr>
<td>10 Year</td>
<td>4881</td>
<td>2.00</td>
<td>30%</td>
<td>1.40</td>
<td>3486</td>
<td>13948</td>
</tr>
</tbody>
</table>

**Determine diameter and length of underground storage required**

**Underground Storage Length Calculation**

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>Pipe Unit Area (ft^2/ft)</th>
<th>1 Year (LF)</th>
<th>2 Year (LF)</th>
<th>10 Year (LF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.785</td>
<td>1911</td>
<td>2460</td>
<td>6215</td>
</tr>
<tr>
<td>18</td>
<td>1.767</td>
<td>849</td>
<td>1093</td>
<td>2762</td>
</tr>
<tr>
<td>24</td>
<td>3.142</td>
<td>478</td>
<td>615</td>
<td>1554</td>
</tr>
<tr>
<td>30</td>
<td>4.909</td>
<td>306</td>
<td>394</td>
<td>994</td>
</tr>
<tr>
<td>36</td>
<td>7.069</td>
<td>212</td>
<td>273</td>
<td>691</td>
</tr>
</tbody>
</table>
Appendix G
## Opinion of Probable Cost

**Lamplite Acres Stormwater Improvements**

Calculated by: DG 8/14/2012  
Checked by: GGG 8/15/2012

Unit costs obtained from VTrans Estimator assumes system length of: 250 Feet

### Infiltration Trench

<table>
<thead>
<tr>
<th>Width (ft)</th>
<th>Depth (ft)</th>
<th>Length (ft)</th>
<th>quant</th>
<th>conversion</th>
<th>amount</th>
<th>unit</th>
<th>$/unit</th>
<th>Price</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>649.41 Geotextile for underground trench around trench</td>
<td>16.0</td>
<td>perm.</td>
<td>250</td>
<td>1</td>
<td>0.111</td>
<td>SF=&gt;SY</td>
<td>444</td>
<td>SY</td>
<td>$3</td>
</tr>
<tr>
<td>651.35 Topsoil</td>
<td>10.2</td>
<td>0.5</td>
<td>250</td>
<td>1</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>47</td>
<td>CY</td>
<td>$28</td>
</tr>
<tr>
<td>656.80 Backfill trench with landscape backfill trench vol</td>
<td>5.5</td>
<td>2.5</td>
<td>250</td>
<td>1</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>120</td>
<td>CY</td>
<td>$52</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal: $8,912  
Mob/Demob (10%): $891  
Total for 250 LF Trench: $9,803 /250 LF Trench  
Add 2%/Year Inflation to 2015 (3 years): $10,403 /250 LF Trench  
Total per LF Trench: $42 /LF Trench

### Rain Garden

<table>
<thead>
<tr>
<th>Width (ft)</th>
<th>Depth (ft)</th>
<th>Length (ft)</th>
<th>quant</th>
<th>conversion</th>
<th>amount</th>
<th>unit</th>
<th>$/unit</th>
<th>Price</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Garden Plantings (includes inflation, mob/demob)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$14</td>
<td>$14 /LF Trench</td>
<td></td>
</tr>
<tr>
<td>Infiltration Trench Cost (from above)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$42</td>
<td>$42 /LF Trench</td>
<td></td>
</tr>
</tbody>
</table>

Total per LF Trench: $56 /LF Trench

### Secondary Underground System

<table>
<thead>
<tr>
<th>Width (ft)</th>
<th>Depth (ft)</th>
<th>Length (ft)</th>
<th>quant</th>
<th>conversion</th>
<th>amount</th>
<th>unit</th>
<th>$/unit</th>
<th>Price</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>204.20 Trench Excavation of Earth Swale</td>
<td>6.0</td>
<td>1</td>
<td>250</td>
<td>1</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>458</td>
<td>CY</td>
<td>$14</td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td>7</td>
<td>250</td>
<td>1</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>356</td>
<td>CY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.0</td>
<td>4.5</td>
<td>1</td>
<td>2</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>16</td>
<td>CY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>4.5</td>
<td>2</td>
<td>2</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>30</td>
<td>CY</td>
<td></td>
</tr>
<tr>
<td>406.25 pavement patch for road inlet structures pavement</td>
<td>7.0</td>
<td>0.5</td>
<td>7</td>
<td>2</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>2.0</td>
<td>ton</td>
<td>$175</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>0.5</td>
<td>2</td>
<td>2</td>
<td>0.037</td>
<td>CF=&gt;CY</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>601.2615 20' of pipe to connect inlet struct in rd to inlet in trench</td>
<td>20</td>
<td>1</td>
<td></td>
<td>20</td>
<td>LF</td>
<td>$35</td>
<td>$700</td>
<td>18' CPEP(SL)</td>
<td></td>
</tr>
<tr>
<td>601.2625 30&quot; perforated pipe</td>
<td>250</td>
<td>250</td>
<td>LF</td>
<td>$64</td>
<td>$16,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>604.18 2 inlet structures in trench</td>
<td>2</td>
<td>2</td>
<td>each</td>
<td>$1,000</td>
<td>$2,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>604.18 2 inlet structures in road</td>
<td>2</td>
<td>2</td>
<td>each</td>
<td>$2,400</td>
<td>$4,800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>629.23 Relocate water service</td>
<td>100</td>
<td>100</td>
<td>LF</td>
<td>$34</td>
<td>$3,400</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>649.41 Geotextile for underground trench around pipe</td>
<td>7.9</td>
<td>circum.</td>
<td>250</td>
<td>1</td>
<td>0.111</td>
<td>SF=&gt;SY</td>
<td>218</td>
<td>SY</td>
<td>$3</td>
</tr>
</tbody>
</table>

Subtotal: $34,322  
Mob/Demob (10%): $3,432  
Total for 250 LF Trench: $37,754 /250 LF Trench  
Add 2%/Year Inflation to 2015 (3 years): $40,065 /LF Trench  
Total per LF Trench: $160 /LF Trench
Appendix H
Meeting Notes

Concept Plan Presentation Meeting
Lamplite Acres, Williston VT  J-195310758

Date/Time: August 15, 2012 6:30 PM
Place: Town of Williston
Next Meeting: N/A
Attendees: Lisa Sheltra, Bruce Hoar, Bryan Davis, Dan Albrecht, Karl Richardson, Greg Goyette, Interested residents (list attached).
Distribution: Lisa Sheltra, Bruce Hoar, Bryan Davis, Dan Albrecht

Item:
PRESENTATION:
Greg gave an outline of the scoping study process and where in the process this project is. Greg reviewed the Purpose and Needs of the project and presented a summary of the comments obtained from the Local Concerns Meeting held on June 13, 2012. He then gave an overview of the various alternatives that were studied and provided a graphic of the evaluation matrix that was used to determine the recommended alternative. The recommended alternative is the use of infiltration trenches / rain gardens. For larger storm and snow melt events, underground storage pipes will be utilized and can be located generally below the rain gardens but has flexibility to be located elsewhere if existing underground utilities are in conflict.

PUBLIC INPUT:
Many people in attendance had questions and comments regarding the project as summarized below:

- Q) Was porous pavement considered?  A) Bruce and Greg gave some examples of first-hand experience with porous pavements and the durability and maintenance issues that exist. Better applications for porous pavements would be recreation paths and parking lots.

- Q) Who would be required to maintain the rain gardens?  A) Lisa explained that the homeowner would be asked to maintain the area within the Town ROW as is commonly done today. The homeowner would have the option of having a rain garden or an infiltration trench installed with the project and would enter into a maintenance agreement with the Town.

- Q) Would there be any liability issues created by this project?  A) Bruce did not see any liability issues as the entire facility will be located within Town ROW.

- Q) Will the existing dry wells be removed with this project?  A) The structures can be removed or retained and it would be on a case by case basis during
construction.

- Q) What are the maintenance concerns with the proposed improvements? A) Bruce noted that very little sand is used in the neighborhood during the winter so sediment should not be an issue. Greg noted that the storage pipes could be flushed periodically and structures would be located on each end of the pipes to facilitate this effort.

- Q) Can the Town install these systems? A) The Town does have the ability to install, but likely would not have the time due to regular maintenance commitments. The project would likely go through a public bid process.

- Lisa noted that the Town is currently investigating funding sources for the project, and hopes that the Town will be successful in obtaining a grant to fund the majority of construction. If a grant is not obtained, the project would need to be programmed into the capital improvement program and would likely be several years before construction could begin.

- Q) Can tonight’s presentation be put on the Town web site? A) Lisa responded that she will look into posting the presentation.

CONCLUSIONS:

Greg stated the next steps of the study will be to finalize the plans, cost estimates and report and send it to the Town for review. The recommended alternative would then be presented to the Selectboard for endorsement. Final edits to the report would follow and then the project could move into final engineering once funding was secured. Greg thanked everyone for attending and providing there valuable input on the project.

The meeting adjourned at 8:00 PM.
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

STANTEC CONSULTING SERVICES INC.

Karl J. Richardson, P.E.
Karl.richardson@stantec.com
Appendix I
TOWN OF WILLISTON
SELECTBOARD
MINUTES OF MEETING
October 22, 2012

MEMBERS PRESENT: Terry Macaig (Chairman); Jeff Fehrs, Jay Michaud, Chris Roy, Debbie Ingram.
ADMINISTRATION: Rick McGuire, Town Manager; Bruce Hoar, Public Works Director; Ken Belliveau, Town Planner.
OTHERS PRESENT: Danielle Salant, Sam Sithiprasert, Dan Albrecht, Al Senesac, Scott Moody (CCTV-Ch. 17), Luke Baynes (Williston Observer).

1. Call to Order
Chairman Terry Macaig called the meeting to order at 7 PM.

2. Minutes
September 24, 2012
MOTION by Chris Roy, SECOND by Jay Michaud, to approve the minutes of September 24, 2012 with the following correction(s)/clarification(s):
Page 1, Item #4 (Appointments) – rewrites the first sentence to read: “The three candidates interviewed for a position on the Williston Historic and Architectural Advisory Committee...”
Page 2, Item #5 (Solar Panels), 2nd bullet, 2nd sentence – change “once the town fully owns the units” to “once the units are operational”;
Page 3, Item #6 (CTI Agreement), statement by Jeff Fehrs following the motion – rewrites to read: “Jeff Fehrs stated he is not completely certain of his support for or against the updates to the agreement.”

VOTING: unanimous (4-0)[Debbie Ingram not present for vote]; motion carried.

3. Public Comment
None.

4. Liquor License Applications
The liquor license applications by Vermont CVS Pharmacy and Honey Thai Restaurant were reviewed. Danielle Salant, Vermont CVS Pharmacy store manager, and Sam Sithiprasert, co-owner of Honey Thai Restaurant, each explained the training and policies of their establishments relative to selling/serving liquor, wine, beer, and/or tobacco products.

MOTION by Chris Roy, SECOND by Jay Michaud, to approve a First Class Restaurant Liquor License to Honey Thai Restaurant, LLC.
DISCUSSION: Jeff Fehrs stressed the need for the restaurant owner to have a good understanding of the regulations. Chris Roy pointed out the town relies on the Department of Liquor Control to provide oversight and if there are any violations the town can revoke the license.
VOTING: unanimous (4-0)[Debbie Ingram not present for vote]; motion carried.

MOTION by Chris Roy, SECOND by Jay Michaud, to approve a Second Class Liquor and Tobacco License to Vermont CVS Pharmacy, LLC. VOTING: unanimous (4-0)[Debbie Ingram not present for vote]; motion carried.

5. **Lease Agreement**
Rick McGuire explained the evolution of the land use agreement with the Conant Farm for use of town land for a corn crop from informal (verbal) to formal (written lease agreement). There was discussion of the 50’ buffer per town and state regulations, and the request by the Williston Conservation Commission for a 100’ buffer on the property. Chris Roy also noted the language in Item #6 in the agreement relative to erosion is too broad. Following further discussion the consensus of the Selectboard is to invite both parties to the next meeting for further discussion of the agreement.

6. **Sewer Allocation Extension Requests**
Bruce Hoar, Public Works Director, explained the requests for extension of sewer allocation for the Cottonwood Crossing and Finney Crossing projects. Permitting is in place except for administrative permits for the Cottonwood Crossing project. Finney Crossing is under construction. Both developers have been paying their sewer allocation fee since receiving allocation. It was noted there have been transfer of development rights with land on North Williston Road and the traffic light at Talcott Road was paid with impact fees from the projects. There was discussion of the extension criteria including proof of “working diligently’ on the project and having staff make the decision on the extension rather than the Selectboard. There was also discussion of Section 8.1 of the ordinance regarding residential and commercial allocation, and that sewer allocation is for a specific project and cannot be transferred.

MOTION by Chris Roy, SECOND by Debbie Ingram, to approve the request for a three year extension of sewer allocation approved for Phase 1 of the Finney Crossing project.

**DISCUSSION:** It was noted that once construction is started on a project it may no longer be necessary to request sewer allocation extensions.

VOTING: unanimous (5-0); motion carried.

MOTION by Debbie Ingram, SECOND by Chris Roy, to approve the request for a three year extension of sewer allocation approved for eight dwelling units for the Cottonwood Crossing development. VOTING: unanimous (5-0); motion carried.

7. **Lamplite Acres Green Street Scoping Study**
MOTION by Debbie Ingram, SECOND by Jay Michaud, to accept the Lamplite Acres Green Street Scoping Study and select the preferred alternative involving infiltration trenches and roadside rain gardens. VOTING: unanimous (5-0); motion carried.
8. **Revolving Loan Fund Applications**
   Jeff Fehrs disclosed that the state department where he works administers the revolving loan fund, but he is not involved in the process. No objections were raised by Board members concerning his participation in the discussion and voting on this issue.

   Rick McGuire explained the money being borrowed is for pump station improvement projects at River Cove and Industrial Avenue. The interest rate on the loan is 2% and there is a 15% grant associated with financing through the state that is not available through the municipal bond bank.

   **MOTION** by Chris Roy, **SECONd** by Debbie Ingram, to approve the application to the state revolving loan fund for financial assistance for the construction of the River Cove and Industrial Ave. pump station upgrades, Contract #2. **VOTING:** unanimous (5-0); motion carried.

9. **Affordable Housing Task Force**
   Ken Belliveau reviewed the draft charge of the affordable housing task force. The charge is for the task force to essentially assess the need for affordable housing in Williston and forward policy recommendations to the Selectboard. The task force will be comprised of six to 10 members including a member from the Selectboard, Planning Commission and/or Development Review Board, and representatives from a local nonprofit housing organization, residential house builder, and local housing finance experts. Staff will provide support. The committee can tighten up the language in the charge. There was discussion of having an emphasis on perpetually affordable housing and the role of the town in providing affordable housing. Language was added to the charge to address the issue. Typographical errors were noted.

   **MOTION** by Debbie Ingram, **SECONd** by Jay Michaud, to adopt the charge for creation of an affordable housing task force with correction of any typographical errors and the addition of the following statement:
   
   "Recommendations should specifically address the town’s role given the changing mechanisms in providing affordable housing."

   **VOTING:** unanimous (5-0); motion carried.

10. **Unified Development Code Amendments**
    Ken Belliveau, Town Planner, noted most of the changes in the code are ‘housekeeping’ items and typographical corrections. The following areas with proposed amendments were highlighted:
    - Nonconforming uses in structures;
    - Extensions of permits;
    - Requirement to pull a permit within one year of filing the final plan;
    - Allowances in the previous rules of growth management;
    - Requiring a survey on a split parcel under one ownership;
    - Commercial vehicle permits to park in residential areas;
    - Average setback exemptions;
Setbacks in the business park;
- Bed & breakfast establishments as an allowed use;
- Setbacks in the village;
- Industrial Zoning District East (IBM, Chittenden Solid Waste District)

MOTION by Chris Roy, SECOND by Debbie Ingram, to remand the proposed revisions to the unified development bylaws to the Planning Commission to provide input and recommendation with respect to a more comprehensive list to allow conditional uses in the Industrial Zoning District East to reflect potential development of that property going forward. VOTING: unanimous (5-0); motion carried.

Ken Belliveau showed the plaque the town received for the Williston Hill Trail Project.

11. Town Manager’s Report
Rick McGuire reported on the following:
- Financial statements show with 25% of the fiscal year complete revenues and expenditures are in line with the budget.
- The town’s solar panel project received approval from the Public Service Board. Approval from the Housing Conservation Board and Department of Environmental Conservation (wetlands permit) is anticipated.
- The quarterly report for departments has been distributed and is more uniform and consistent in format.
- Route 2A/James Brown Drive conceptual design is done and includes more sidewalk than expected and an extended third lane.
- Staff received training on the incident command system.
- The owner of a sliver of land along Muddy Brook is offering to donate the parcel to the town (the changing course of the river continues to move the location of the parcel from South Burlington to Williston). Staff will gather more information.
- The Manager recently attended the annual conference sponsored by the International City Management Association. A report is included.

12. Other Business
Catering Permit
MOTION by Debbie Ingram, SECOND by Chris Roy, to grant a catering permit to Balsteen, Inc. d/b/a Shanty on the Shore for an indoor open house event at 800 Marshall Ave. on November 8, 2012 by Windows and Doors. VOTING: unanimous (5-0); motion carried.

13. Adjournment and/or Executive Session
There was no further business before the Selectboard and the meeting was adjourned at 9:13 PM.

RScy: M.E.Riordan
Appendix J
GENERAL PLAN - AREA 1

AREA A-1 SUMMARY
- TOTAL LENGTH OF SWALES PROVIDED = 130'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 130'

INSULATE WATER LINE ADJACENT TO DRAINAGE STRUCTURES

PERFORATED STORAGE PIPE PLACED WITH A MINIMUM OF 5' HORIZONTAL CLEARANCE TO POTABLE WATER MAIN
CLEARANCE TO POTABLE WATER MAIN
WITH A MINIMUM OF 5' HORIZONTAL
PERFORATED STORAGE PIPE PLACED

AREA A-2 SUMMARY
- TOTAL LENGTH OF SWALES PROVIDED = 320'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 150'

AREA A-3 SUMMARY
- TOTAL LENGTH OF SWALES PROVIDED = 300'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 240'

AREA A-4 SUMMARY
- TOTAL LENGTH OF SWALES PROVIDED = 350'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 200'

WITHIN 6' OF SWALE BOTTOM
INSULATE WATER LINE IF IT IS
GAS & COMMUNICATION LINES
RELOCATE UNDERGROUND
- TOTAL LENGTH OF SWALES PROVIDED = 320'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 150'

RELOCATE UNDERGROUND
GAS & COMMUNICATION LINES
REMOVE PINE TREE

APPROPRIATE ACCESSURE CLEARANCE TO POTABLE WATER MAIN
PERFORATED STORAGE PIPE PLACED
WITH A MINIMUM OF 5' HORIZONTAL
CLEARANCE TO POTABLE WATER MAIN

GENERAL PLAN - AREA 2,3 & 4

RELOCATE GAS LINE
ADJUST GRADE OF
MANHOLE COVER

RELOCATE GAS LINE
ADJUST GRADE OF
MANHOLE COVER

Remove Pine Tree
Relocate Gas Line
Adjust Grade of Manhole Cover
Relocate Underground Gas & Communication Lines
Insulate Water Line If It Is Within 6' of Swale Bottom
Insulate Water Line If It Is Within 6' of Swale Bottom
- TOTAL LENGTH OF SWALES PROVIDED = 320'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 150'

- TOTAL LENGTH OF SWALES PROVIDED = 300'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 240'

- TOTAL LENGTH OF SWALES PROVIDED = 350'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 200'

- TOTAL LENGTH OF SWALES PROVIDED = 320'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 150'

- TOTAL LENGTH OF SWALES PROVIDED = 300'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 240'

- TOTAL LENGTH OF SWALES PROVIDED = 350'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 200'

- TOTAL LENGTH OF SWALES PROVIDED = 320'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 150'

- TOTAL LENGTH OF SWALES PROVIDED = 300'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 240'

- TOTAL LENGTH OF SWALES PROVIDED = 350'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 200'

- TOTAL LENGTH OF SWALES PROVIDED = 320'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 150'

- TOTAL LENGTH OF SWALES PROVIDED = 300'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 240'

- TOTAL LENGTH OF SWALES PROVIDED = 350'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 200'
AREA A-6 SUMMARY
- TOTAL LENGTH OF SWALES PROVIDED = 410'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 390'

AREA A-5 SUMMARY
- TOTAL LENGTH OF SWALES PROVIDED = 415'
- TOTAL LENGTH OF STORAGE PIPE PROVIDED = 390'

RELOCATE UNDERGROUND GAS AND COMMUNICATIONS (ALL SWALES ON WEST SIDE)

PERFORATED STORAGE PIPE PLACED WITH A MINIMUM OF 2' HORIZONTAL CLEARANCE TO POTABLE WATER MAIN

INSULATE WATER LINE ADJACENT TO DRAINAGE STRUCTURES