Bartlett Brook Watershed Study
South Burlington, Vermont

May 1998

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Prepared for:

Town of South Burlington

June 8, 1998

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1.0 INTRODUCTION

The study of Bartlett Brook and North Brook flow characteristics commenced in the early 1980's. Heindel and Noyes undertook a study of the Bartlett Brook watershed area in response to complaints of excessive erosion in the streambed, and sediment releases from new construction.

To examine the relatively complex flow characteristics created by the urbanization of these watersheds, a computer model was developed to simulate the response of culverts and key stream sections to various storm events. By accurately simulating pre- and post- development conditions, the model was used to predict the effect of development on runoff volume, flow velocity, and the adequacy of existing and proposed drainage structures.

The original model has been in place for the past 14 years, the use of which has been incorporated into the town of South Burlington's planning process through the development of an Overlay District (See Appendix 4, pages 1-2). The model has been maintained and updated as new developments within the watershed have occurred. To date, approximately fourteen projects have been modeled.

The purpose of the current study is to evaluate the efficacy and assess the value of the overall watershed control and management program in place in the Bartlett Brook and North Brook watersheds. A direct comparison of the runoff characteristics of the streams in pre-development (1950) and post-development (1984-1997) condition is used to examine the cumulative effects of land use changes over the last 14 years on stream flow and velocity. Coupled with updated field observations from 1997, model output data is used to confirm and predict sections of the streams that are susceptible to erosion and provide an assessment of existing runoff and erosion control devices.

2.0 BACKGROUND

2.1 The Watersheds

Two watersheds were studied in this evaluation (See Appendix A for Watershed Location Map):

Bartlett Brook Watershed**:** The headwaters of this watershed are in the vicinity of Spear Street, in the southeast corner of the town of South Burlington. Two major forks flow westward; the north fork drains the UVM Horticultural Farm and surrounding areas, passing under Route 7 near Shearer Chevrolet; the south fork drains the Allen Road area, passing under Route 7, entering Lake Champlain in Bartlett Bay, south of Bartlett Bay Road. The total watershed encompasses 1.01 square miles.

North Brook Watershed**:** The headwaters of this small watershed (0.19 square miles) are in the Twin Orchards Development area. It passes under Route 7 near Goss Dodge, and enters Lake Champlain approximately 100 feet north of the mouth of Bartlett Brook.

2.2 Soils

Soils in both watersheds are primarily silts and clays, originating from ancient lakes and seas that occupied the Champlain Valley immediately after the continental ice sheet retreated northward. A small area of sandier soil exists in the center of the Bartlett Brook watershed, but the stream has, for the most part, cut down through these sands to the underlying silts.
These soils are moderately erodible in the stream channel (velocities in the range of 6 feet per second are likely to

cause streambed erosion), and are highly susceptible to sheet erosion normally associated with construction projects. Appendix 2 (pages 1-2) provides a map and a table of soils found in the watershed areas.

2.3 Development of Watershed Models

To examine the flow characteristics in these watersheds, the computer model was updated, using new improvements in software to simulate the response of culverts and key stream sections to various storm events. The steps necessary to mathematically simulate past, existing and future flow conditions are described in the original Heindel and Noyes study report ("Bartlett Brook Study", 1984). The steps are listed below:

1. Extensive Field Survey
2. Determine Soil Runoff Characteristics (See Appendix 2, page 4, for calculations)
3. Hydraulics Analysis
4. Mathematical Model Development using TR-20
5. Storm Response Analysis
6. Model Calibration
7. Erosion Evaluation

3.0 METHODS

The 1997 Bartlett Brook Watershed Study consisted of three key components: a detailed reconnaissance of the entire watershed to compare erosion problems documented in 1983 with those that exist today; an update of the original DOS version TR-20 computer program to a Windows 95 format; and a candid assessment of the value of the watershed management program (Overlay District).

The first component of the study was to conduct a detailed reconnaissance of both Bartlett and North Brooks. The stream survey included two separate events. The first, during October 30-31, 1997, included a detailed reconnaissance of both Brooks from the mouth to the headwaters. This trip was conducted during a low- flow period, when streambanks were readily visible for inspection. Physical properties of the streams were evaluated along the entire reach of both Brooks. Channel dimensions, degree of streambed sedimentation, turbidity and streambank erosion problems were evaluated. Physical stream data included in Appendix 2, page 3.

During the stream investigation, measurements were taken of culverts and additional structures (such as detention ponds) which were not previously incorporated into the 1984 model. Culvert measurements were verified and adjusted to actual field conditions. Measurements of existing wet and dry ponds were estimated in the field or from orthophotographs. Observations related to the efficacy of the new storage structures were also noted in the field. Global Positioning System (GPS) instrumentation was used to locate all culverts, erosional features, and erosion control structures on a USGS map with an accuracy of +/- 5 meters. All plotted locations are shown on the Watershed Overlay Map included in Appendix 1.

Field observations of stream ecology and erosion problems collected during the stream study serve to indicate the effectiveness of erosion control features within the watershed. A comparison of erosion problems present in 1984 and in 1997 is used to evaluate the overall effectiveness of the watershed control and management program.

On January 8, 1998, a second reconnaissance was made to assess the effectiveness of erosion control features during a high flow period. As would be expected with greater runoff volumes and flow velocities, turbidity was much greater in both North and Bartlett. The likely sources of the increased sediment load in the streams are runoff from parking lots, erosion of disturbed soils (such as construction sites) and sloughing of unstabilized streambanks.

The second component of the study was to convert the DOS version TR-20 model developed in 1983 into a Windows 95 format. The Windows version of TR-20 is recognized for speed, organization and ease of use. The new model has had a number of improvements, including the capability of modeling both wet and dry ponds, which more closely model actual watershed conditions. Additional natural and man made features not mapped in 1984 were incorporated into the updated model and the model was re-calibrated to a known storm event. The model was assessed for accuracy and cost effectiveness of output.

The final component of the study was to candidly assess the effectiveness of the watershed control and management program in place in the Bartlett Brook watershed area. Information collected during the detailed stream reconnaissance of the Brooks, observations about stream ecology, erosion problems and erosion control features, and output data from model simulations of storm events for existing conditions were used in combination to assess the efficacy of the existing program in controlling and preventing deleterious impacts to the stream from development.

4.0 RESULTS

4.1 Stream Reconnaissance

A detailed reconnaissance of both Bartlett Brook and North Brook was conducted in the fall of 1997. The Brooks were walked in their entirety during a low flow period to allow for the identification of erosional areas and sediment deposits on the streambed, and for the measurement of culverts and additional features (such as detention ponds). The Bartlett Brook reconnaissance began at the mouth at Lake Champlain and ended at the headwaters just east of Spear Street. Along the reach of Bartlett Brook, approximately 40 stations were marked on a USGS map from GPS location data. Stream station locations are indicated on the Watershed Overlay Map in Appendix 1. The stations represent the locations of all culverts on and confluences of the Brook. All culverts and additional features were measured for incorporation in the TR-20 model.

In addition to gathering information about new structures, a key component of the stream reconnaissance was to identify areas along the Brook that have significant erosional problems on streambanks and sediment deposits on the streambed. See photolog included in Appendix 3. A comparison was made between the number and degree of erosional areas identified in 1983 and 1997. In general, the areas that had erosion problems in the first study still had erosion problems in the recent study. The degree of erosion in many of the historically documented problem areas has increased and several new problem areas have manifested over the years.

Erosion Problem Areas

Stream Reach	**1983 Field Observations**	**1997 Field Observations**
North Fork of Main Branch		
Downstream of Overlook Condos	No erosion observed	Moderate Erosion
Upstream of upper UVM Pond	No erosion observed	Significant Erosion
Reach between upper and lower UVM Ponds	No erosion observed	Significant Erosion
Downstream of lower UVM Pond	No erosion observed	Significant Erosion
Tributary draining Keari Lane	No erosion observed	Significant Erosion
Tributary draining Pheasant Lane	No erosion observed	Significant Erosion
Tributary draining Quayle Run	No erosion observed	Significant Erosion
Downstream of Bay Court Condos	Moderate Erosion	Significant Erosion
Downstream of Green Mt. Power	Minor Erosion	Minor Erosion
South of Howard Johnsons	Significant Erosion	Significant Erosion
Downstream of Shearer Culvert	Significant Erosion	Significant Erosion
Downstream of culvert at back of Shearer property	Significant Erosion	Significant
Upstream of railroad tracks, west of Shelburne Road	Moderate Erosion	Significant
South Fork of Main Branch		
Upstream of Shelburne Road	Significant Erosion	Varying degrees of erosion extending further upstream
Upstream of railroad tracks, west of Shelburne Road	Significant Erosion	Significant Erosion

Erosional areas on Bartlett Brook identified in the 1983 study were concentrated along the north fork of the main branch east of the railroad tracks and west of Pheasant Lane. Erosion of streambanks was observed below Bay Court Condos (moderate erosion), below Green Mountain Power (minor erosion), below Howard Johnsons (significant erosion), below the Shearer culvert at Shelburne Rd (significant erosion), below the Shearer culvert at the back of the Shearer property (significant erosion), and upstream of the railroad tracks, west of Shelburne road (moderate erosion). Also identified were erosion problem areas on the south fork of the main branch. These areas included streambanks upstream of Shelburne road (significant erosion) and upstream of the railroad tracks, west of Shelburne road (significant erosion).

Another aspect of the original study was to analyze sediment deposition on the streambed. Areas identified with silty substrates in the 1983 stream reconnaissance include the stream reach below Green Mountain Power, the area below Bay Court Condos, and reaches below the lower UVM pond, Allenwood Condos, and Pillsbury Manor.

Erosion problem areas were seen to increase in severity and number in the 1997 stream reconnaissance. The stream has become heavily incised at various locations along the corridor between the railroad tracks and Pheasant Lane. Specifically, the reach below Bay Court and Harbor Heights Condos exhibits significant erosion of stream banks. Tributaries draining Keari Lane, Quayle Run and Pheasant Roads were seen to be significantly eroding. The erosion from these tributaries evidences itself as sediment on the streambed and in culverts of the north fork of the main branch. Not seen in the 1983 study, are the erosion problems downstream of the Overlook Condos located north of the UVM ponds. At the time of the 1997 study significant erosion of streambanks was observed on the north fork above the upper UVM pond, between the upper and lower UVM ponds, and downstream of the lower UVM pond. See Watershed Overlay Map in Appendix 1 for erosion problem zones.

Erosion problem areas are observed to have extended further up the south fork of the main branch. A corridor, defined by the railroad tracks to the west and Howard Johnsons to the east, exhibits varying degrees of erosion of streambanks. In 1983 this segment of the stream was relatively stable with erosion only noted at Shelburne Road and just to the east of the railroad tracks.

Erosion control features on streambanks and below culvert outfalls were assessed during the stream reconnaissance. As would be expected, there are a mix of both poorly maintained and inadequate controls along with maintained and effective controls. In general, culvert outfalls are lacking sufficient erosion control to prevent incision and erosion of the streambed. As a consequence of this several reaches of streambank are unstable and eroding.

Primitive erosion controls were identified on the north fork west of the Shearer culvert. Erosion controls consisted of willow wottles staked into the collapsing streambank. There was also a small quantity of riprap stabilizing the toe of slope. Based on the degree of growth of the willow wottles, these erosion controls were likely installed within the last 5 years. These measures were assessed to be inadequate to address the significant erosion problem present.

Revetments, willow wottles, rip rap, and wood scour dams were identified on the north reach immediately above the upper UVM pond. This appears to be the remains of a possible experiment or a demonstration project of different erosion control techniques. Based on the degree of deterioration, these structures were most likely installed within the last 5 to 10 years. This section of the Brook is heavily eroded and the controls in place are not effectively addressing the problem.

The culvert outfall at the Nissan dealership is a clear example of ineffective erosion control. A meager attempt at erosion control, the placement of brush and screen in the channel, has failed to stabilize the streambanks and substrate below this culvert. Significant erosion was observed at the culvert outfall.

An example of effective erosion control can be seen at the Green Mountain Power culvert. Erosion control features at the culvert included filter fabric and extensive riprap. These controls appeared to be effective in stabilizing the bank directly below the culvert. While the streambed below this area was silty, the stream banks were stable and minimal erosion was observed. The erosion controls appear to be working in this area.

The newer developments, Pillsbury Manor and Allenwood Condos, have made use of rip rap, mesh and filter fabric for erosion control at culvert outfalls. The areas lacking adequate controls are older, established businesses. Installation of appropriate erosion controls at culvert outfalls will prevent erosion and sedimentation, especially if flow velocities increase in the watershed.

Sediment observed on the substrate of the stream and within culverts, is entrained from multiple sources. In an urban watershed, such as Bartlett Brook, a major contributor tends to be construction sites. The control of sediment entrainment from construction sites most often takes the form of silt fences. Such a fence has been installed at the bottom of an embankment by the parking lot of the Nissan dealer. Unfortunately, the use of silt fences and mulching of disturbed soils is not widespread in the watershed.

Observed at Pillsbury Manor were unprotected slopes draining to the stream. Construction protocol does not appear to include the maintenance of erosion control features. Exposed soils have not been mulched and maintained. Riprap has not been installed in a quantity sufficient to prevent the incision of the channel and erosion of the stream banks.

Areas susceptible to erosion, identified during the initial reconnaissance, were revisited during a rainstorm event on January 8, 1998. The following observations were made during this reconnaissance. Runoff from the Shearer parking lot was seen flowing through an eroding gully directly into Bartlett Brook. The Shearer culvert continues to have significant erosion at the outfall. The stream reaches carrying stormwater runoff from Keari Lane and Pheasant Lane were at bank full and the water highly turbid. Stormwater runoff from the Bay Court Condos was flowing directly into Bartlett Brook, circumventing the detention pond. Streambanks directly below the culvert outfall from Bay Court are significantly eroded. At Pillsbury Manor, stormwater runoff was observed traveling over a disturbed hillslope (with no mulching, silt fence or hay bales present) and into Bartlett Brook.

As in 1983, North Brook exhibits the most significant erosion just upstream of the mouth at Lake Champlain. Erosion controls, in the form of rip rap and bank enforcements are in place in areas but severely cut banks are prevalent north of Bartlett Bay Road. The 1997 stream reconnaissance again identified the lower reaches of the Brook to be the most heavily eroded. A majority of the stream is channelized through culverts or grassy swales throughout the watershed. It is after the stream has flowed through these structures that it has a short reach of natural channel before reaching the Lake.

4.2 Model Update

The second component of this study was to update the TR-20 model to a Windows 95 format and to incorporate new structures not previously incorporated. The Windows 95 format allows for improved data entry, organization, and interpretation. Upgrading the model to this new format and incorporating more watershed features allows for more accurate and effective analysis.

Data from the Dos TR-20 model and from the stream reconnaissance was entered into the Windows platform. As a result of the stream reconnaissance additional features of the watershed have been incorporated into the existing computer model. Having entered the necessary input data, the model was next calibrated. A stage/discharge curve for a selected stream station was determined by salt dilution gaging of stream flows. A gaging station was constructed at the Brigham Road culvert to record stage levels during three different storm events. A data recorder was used to record stage measurements. The stage/discharge curve was used to determine discharge measurements throughout the storm events. Of the three storm events, data from a 1.05" 24-hour precipitation event was selected for calibration of the model. Stream gaging data is included in Appendix 2, pages 24-33.

Gaged data showed a peak flow of 13.33 cfs for a 1.05" precipitation event of a 24-hour duration at the Brigham Road culvert. Because a total of 0.55 " of precipitation had fallen within the preceding five days of the gaged event, average soil moisture conditions were assumed for modeling purposes. An antecedent moisture condition (AMC) of II was used for determination of runoff curve numbers. Model output for a simulated 1.05" precipitation event of a 24-hour duration storm rendered a peak flow of 13.8 cfs at the Brigham Road culvert. This is an excellent correlation between modeled and actual discharge measurements. Model output data is included in Appendix 2, pages 5-23.

After having calibrated the updated model to an actual storm event, the model was next run to simulate the runoff that would result from a series of storm events, the 2-yr, 10-yr and 25-yr 24 hour storms (Model output data included in Appendix 2). The results of these simulations are compared with the stream discharge predicted by the original model for 1950 and 1983 watershed conditions.

Storm Flow Characteristics

Section #	**1950 Q (cfs)**	**V (fs)**	**1978 Q (cfs)**	**V (fs)**	**1984 Q (cfs)**	**V (fs)**	**1997 Q (cfs)**	**V (fs)**
2 year 24 hour Storm								
4	7.6	0.3	3.62	1.9	4.9	2.4	7.4	19.68
6	8.5	2.2	26.1	2.9	33.5	3.1	20.52	16.23
8	9.5	1.7	29.7	2.4	37.1	2.5	49	18.74
12	32.1	2.8	53.6	3.1	55	3.2	24.1	NA
13	NA	NA	NA	NA	NA	NA	38.79	5.66
14	36.7	4.1	71.6	5.1	80.7	5.2	49.2	18.74
10 year 24 hour Storm								
4	7.6	2.2	33.6	10	34.5	10.5	33.33	29.01
6	38	3.2	71.8	3.9	86.5	4.1	41.5	22.17
8	43	2.6	88.4	3.2	105.9	3.4	102.1	39.86
12	106.3	3.7	143.8	4	151.5	4	61.48	NA
13	114	7	151	7.1	153.4	7.1	63.52	0.52
14	134.7	6	220	6.7	239	6.9	104	24.98
25 year 24 hour Storm								
4	15	5.8	53.1	14	57	17	68.8	29.05
6	50.42	3.62	99.27	4.3	116.98	4.47	69.9	22.44
8	60.4	2.9	125.3	3.6	139.4	3.7	145	43.44
12	143.9	4	188.1	4.2	197.8	4.4	98.25	NA
13	154.4	7.1	197.5	7.4	200.1	7.4	92.58	0.47
14	190.4	6.5	293.9	7	311.5	7.1	144.6	27.22

1984 Study Cross Section Number	1997 Study Reach ID	Location
4	I	Tributary to North Fork, at Bartlett-LTH Property
6	E	North Fork at Green Mt. Power
8	B	North Fork below Shearer Culvert
12	AE	South Fork above Rt. 7
13	Z	South Fork just above confluence with North Fork
14	A	Main Branch just above Lake Champlain

A comparison of discharge and velocity data at six cross sections of Bartlett Brook show that development in the watershed over the last 40 years to results in increases in both velocity and volume from an equivalent storm event.. Simulations run with the updated model predict that the peak flow entering the Lake during each of the analyzed storm events has decreased. This is an indication that recent development and surface runoff controls, such as dry and wet ponds, have been effective in dampening the overall flood discharge from the watershed. While discharge data show a control of quantity of water, velocity data paints a clearer picture of the erosion problems in the watershed.

Data for specific cross sections show that peak and average flow velocities have significantly increased over the last 40 years. Average velocities resulting from the 2-year storm flow are 4 to 8 times greater than those predicted in 1984. In general, the velocities through the analyzed cross sections are well above the cited permissible velocity of 6 feet per second.[1] The results of the most recent modeling show that stream flows for even minor storm events (2" precipitation in a 24-hr period) are at such a velocity to cause continual, or chronic, erosion of the stream. Increased velocities have resulted in an increase in the occurrence and severity of erosion along the stream as observed in the detailed stream reconnaissance.

A component of the model update process was to review and include all of the small-scale development projects that have occurred in the watershed over the last 14 years. These projects were not required to participate in the watershed control and management program if the converted development area was less than 15,000 square feet. Modeling of the new small developments in the watershed helps to assess the magnitude of impact on stream flow characteristics that has resulted from minor projects. As demonstrated by the output data from the updated model, small-scale development projects have increased the area of impermeable surface in the watershed, leading to increased storm water runoff and increased flow velocities in the stream. While the small projects may have a small individual effect, the data show that a more significant cumulative effect is contributing to the erosion problems still evident in the watershed.

Larger development projects have incorporated dry and wet ponds to collect storm water runoff and dampen flood waves through the watershed. The recent round of modeling revealed that some of these features are not working effectively in the watershed. Specifically, the ponds constructed to retain water from the Overlook Condos development are likely undersized. Model output shows that these ponds will overtop during even the smaller rainfall events (2-3"). A site visit was made during a minor storm event to observe the holding capacity of these ponds. As predicted by the model, the ponds were at maximum capacity and close to overtopping. It is evident that the ponds would not be able to contain the runoff associated with a major flood event and that the influx of water to the stream would result in more acute erosional events downstream.

4.3 Watershed Control and Management Program Evaluation

The final component of this study is to assess the efficacy of the South Burlington Overlay District. The town of South Burlington implemented a watershed control and management program for the Bartlett Brook watershed in 1984. The objective of the program was to control stormwater runoff and prevent the worsening of erosion problems already experienced within the Bartlett Brook and North Brook watersheds. It was the intent of the program to require that all land development within the two watersheds incorporate appropriate stormwater management design to ensure that development would not adversely impact the stormwater flow characteristics of the stream. Included in Appendix 4 is a copy of the watershed control and management program.

The Windows 95 TR-20 model has been updated and re-calibrated to accurately reflect current conditions in both the Bartlett and North Brook watersheds. Approximately 14 development projects have been modeled over the past 14 years. Erosion control devices such as wet and dry ponds have been incorporated into stormwater management designs for these projects. Developers are following the rules as established in the program. With all of this, the stream continues to flow faster and erode more significantly. Is the program working?

The answer to this question is two part. The program is working because developers are now designing projects taking into account the impacts of development on the stream. Erosion control devices are being installed to minimize the entrainment of sediment into the stream and flood control structures are being constructed to dampen flood waves. Large scale projects are at least starting out on sound footing to control stormwater runoff and prevent additional erosion of the stream.

The program is not working because it fails to incorporate small development projects in a watershed, which has no reserve stormwater capacity, and because most projects lack a maintenance component. The model can only be as accurate as the data that is incorporated within it. Over time as the number of small scale projects increases and as these projects continue to be omitted from the modeling process, the overall modeling procedure becomes less accurate. As discussed, the new Windows version of the model makes for easier data entry and more effective analysis of output. Even if the small scale developers are not required to participate in the program, the development needs to be incorporated into the model to maintain the integrity of the process. At this point the model can be used to specifically identify problem areas, these areas can be monitored during storm events, and plans can be developed and implemented that correct ineffective stormwater runoff and erosion control measures.

The program is not working for a second reason: lack of maintenance. The program does an excellent job in requiring developers to plan, design and implement stormwater and erosion control features. But it does not address the necessity of maintaining these devices. As observed during the watershed reconnaissance, some of the

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[1] An earlier study by Heindel and Noyes references studies by Chow (1959) and Lane (1955 and 1937) when establishing a maximum permissible velocity (6 feet/sec) at which time the stream will cause scour and erosion. Heindel and Noyes Report: "Bartlett Brook Study", 1984.

ponds that were designed to retain storm water are undersized for even the smaller more frequent storm events. Erosion control devices such as silt fences, filter fabric, and fabric bales need to be monitored for continued effectiveness. Silt fences are easily damaged and/or destroyed by natural causes or by human activity over a period of time. Sediment from construction sites can continue to be a problem long after the physical construction has ended and the developers have vacated the site. The sediment is entrained in storm water runoff and then deposited in the stream. In the event that disturbed areas are not monitored, vegetation can be slow in establishing and sediment loss can continue to be a problem.

The continued observance of silt and sediment deposits on the stream beds of both Bartlett Brook and North Brook is a strong indication that erosion control features are not completely effective on construction sites. Sediment deposits are also a result of erosion of streambanks upstream. The combination of entrained sediment from construction sites and from streambank erosion have resulted in the degradation of the streambed on various reaches of the Brook.

5.0 CONCLUSIONS

Heindel and Noyes has completed an investigation which involved a detailed stream reconnaissance, an update of the Dos TR-20 model to a Windows 95 format, and an evaluation of the efficacy of the watershed control and management program in place for the Bartlett Brook and North Brook watersheds.

Both Brooks were walked in their entirety, with an evaluation of physical features and structures recorded. Approximately 55 locations, including culverts, confluences and ponds, were mapped on a USGS map using Global Positioning System (GPS) technology. Observations of stream bank erosion problems and stream bed sediment deposits were compared to observations made in 1983. The stream reconnaissance revealed that new areas of erosion have occurred and that pre-existing areas have become more severe. Also observed on the stream reconnaissance was the presence of erosion control features and storm control structures that are not functioning properly due to the apparent lack of monitoring and maintenance. Observations and data collected during the stream reconnaissance were used to update the existing TR-20 model.

The model that was created in 1983 to model the stream flow characteristics of pre-- and post- development scenarios has been used successfully for 14 development projects. As a component of this study, the model was converted to a Windows 95 platform to provide an environment for efficient data entry and effective analysis of output. The model was updated with new features in the watershed that were not previously mapped and then re-calibrated to a gaged storm event. The result of the re-calibration process is a model ready to be used for future development projects.

For the existing conditions in the watershed, the model predicts that certain control structures, dry and wet ponds, are not appropriately sized for anticipated demand. Model simulations for the 10 yr. and 25 yr. storm events show that several ponds, specifically in the area of Overlook Condos, need to be resized or redesigned to handle flood level events.

The model output data also shows that stream velocities are higher today than any time in the past. The higher stream velocities are the cause of increased erosion problems observed during the stream reconnaissance. Increased velocities are a further indication that the designed stormwater control features are not adequately handling additional runoff created by development of previously undeveloped land surfaces. In short, there are more impermeable surfaces in the watershed and stormwater is reaching the stream faster and eroding the streambanks.

The watershed control and management program is effective in handling large development projects but has failed to control the impact of small scale development in the watershed. Small scale projects are not required to participate in the management program and while the individual effect of a project may be small the cumulative effect has been a significant increase in stream velocities and resultant erosion.

A key component to the success of the Bartlett Brook planning and management program lies in the maintenance of stormwater and erosion control devices. As land is developed on an on-going basis, detention ponds may need to be modified to handle increased runoff amounts. Routine monitoring can be a proactive means of problem solving before significant problems evolve. Maintenance of culverts and erosion control devices is also necessary to prevent further degradation of the stream banks and stream bed.

6.0 RECOMMENDATIONS

To address the ongoing problems in the Bartlett Brook and North Brook watersheds, Heindel and Noyes recommends the following:

A. Incorporate into the existing watershed control and management program a requirement for modeling small scale development projects. At the very least a mechanism should be put in place to incorporate the information about small scale development so as to maintain the accuracy of the model.

B. Incorporate into the Overlay District Ordinance a section on monitoring and maintenance of stormwater and erosion control features. A requirement needs to be put in place for developers to document routine maintenance and monitoring activities.

C. Monitor and improve existing erosion problem areas identified in this study. Each problem area may require a unique solution to the erosion problem. It would be appropriate to investigate alternative streambank stabilization techniques, including the planting of native vegetation and installation of revetments.

D. Further Study: 1. Determine the appropriateness of requiring developers to design stormwater runoff and erosion control features for the smaller precipitation events (2 yr. 24 hour). This study would include the evaluation of chronic and acute erosion in the watershed. 2. Assess whether regional catch basins are needed and feasible to control stormwater runoff from residential and commercial development in the watershed.

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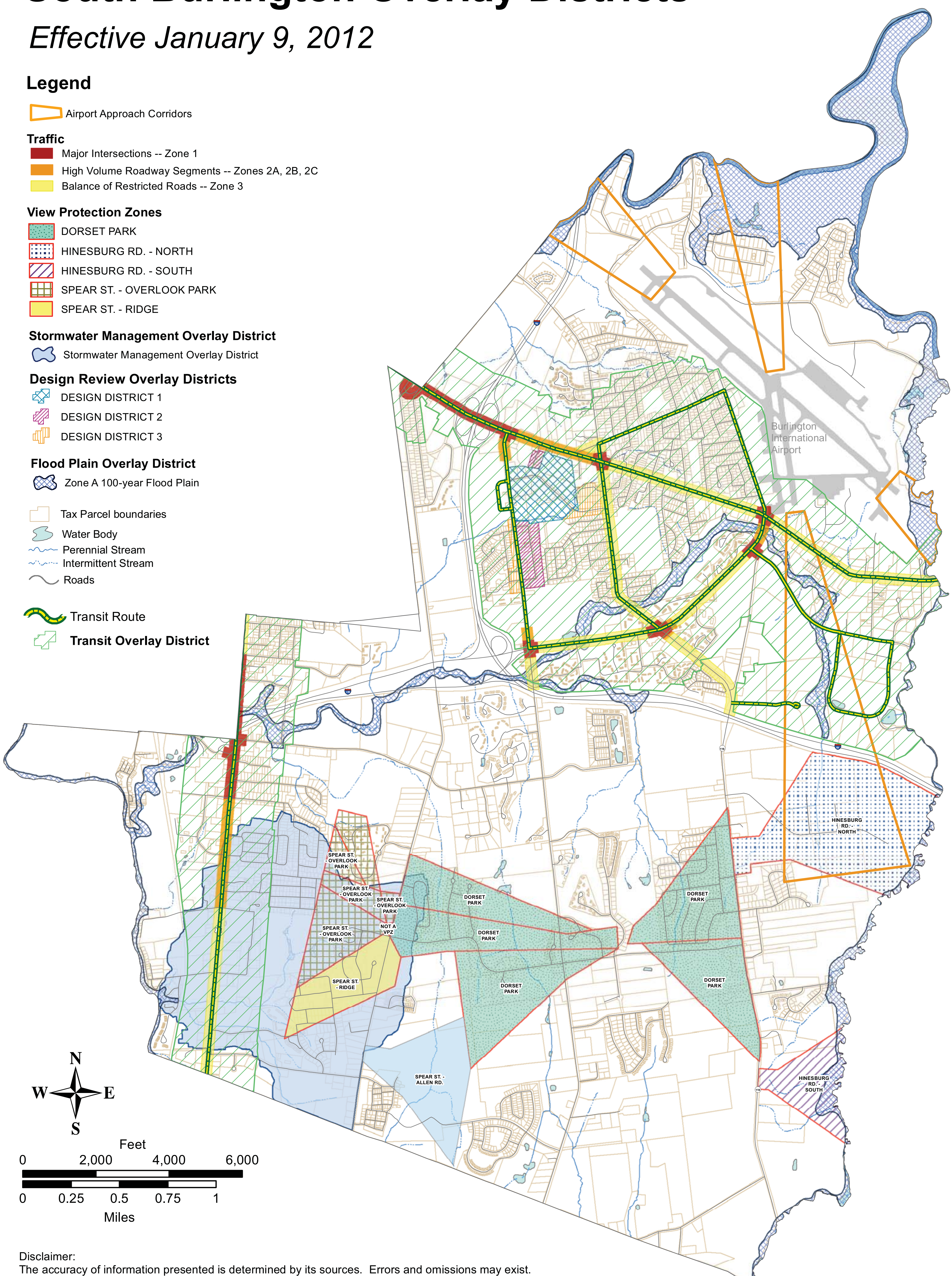
South Burlington Overlay Districts

Effective January 9, 2012



Disclaimer:
The accuracy of information presented is determined by its sources. Errors and omissions may exist.
The City of South Burlington is not responsible for these.
Questions of on-the-ground location can beresolved by site inspections and/or surveys by registered surveyors.
This map is not sufficient for delineation of features on the gound.
This map identifies the presence of features, and may indicate relationships between features,
but it is not a replacement for surveyed information or engineering studies.
Map updated by H. Shaw using ArcGIS 10.0. All data is in State Plane Coordinate System, NAD 1983.

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12.03 Stormwater Management Overlay District (SMO)

A. Purpose

The purpose of this section is:

(1) To promote stormwater management practices that maintain predevelopment hydrology through site design, site development, building design and landscape design techniques that infiltrate, filter, store, evaporate and detain stormwater close to its source;

(2) To protect water resources, particularly streams, lakes, wetlands, floodplains and other natural aquatic systems on the development site and elsewhere from degradation that could be caused by construction activities and postconstruction conditions;

(3) To protect other properties from damage that could be caused by stormwater and sediment from improperly managed construction activities and postconstruction conditions on the development site;

(4) To reduce the impacts on surface waters from impervious surfaces such as streets, parking lots, rooftops and other paved surfaces; and

(5) To promote public safety from flooding and streambank erosion, reduce public expenditures in removing sediment from stormwater drainage systems and natural resource areas, and to prevent damage to municipal infrastructure from inadequate stormwater controls.

B. Scope and Applicability

(1) These regulations shall apply to all land development within the Stormwater Management Overlay District (SMO) as shown on the Overlay Districts Map that:

(a) Disturbs an area of more than one-half acre of land as part of the proposed application and/or

(b) Results in a total impervious area of greater than one-half acre on an applicant's parcel.

(2) Exemptions:

(a) Any application that will increase the total impervious area on an applicant's parcel by less than five thousand (5,000) square feet.

C. Site Design Requirements

(1) The post-construction peak runoff rate for the one-year, twenty-four hour (2.1 inch) rain event shall not exceed the existing peak runoff rate for the same storm event from the site under current conditions. Low Impact Development (LID) practices, including but not limited to practices detailed in the "South Burlington Low Impact Development Guidance Manual", shall be incorporated into the site design as necessary to achieve the required runoff rate, and may be supplemented with structural measures, subject to the approval of the Stormwater Superintendent, to the extent necessary to achieve the required post-construction runoff rate.

D. Stormwater Management Plan

(1) Applicants shall submit a Stormwater Management Plan (SMP) for review by the Stormwater Superintendent that includes, at a minimum, the following

information:
(a) Existing conditions and proposed condition site plans including:
i. Site location
ii. Location, type and size of all proposed impervious areas (e.g. roofs, pavement, gravel drive, etc…)
iii. Location, type, size and specifications for all proposed LID installations
iv. Drainage ways, natural waterbodies, and sub-watershed boundaries, with sufficient information to determine the site's relationship to these features on surrounding properties
v. Existing and proposed stormwater collection systems, culverts, detention basins and other stormwater treatment practices
vi. Topography
vii. Soil types and/or hydrologic soil group
viii. Existing and proposed landscaping, including existing tree canopy and other vegetation and any proposed alterations thereto
ix. Delineated wetlands
(b) A brief description of the proposed LID techniques. Where LID design approaches are not proposed in the stormwater management plan (see Section C(1)), the applicant shall provide a full justification and demonstrate why the use of LID approaches is not practical before proposing to use conventional structural stormwater management measures.
(c) Prior to issuance of a zoning permit, a detailed maintenance plan for all proposed stormwater treatment practices, including the selected LID elements, as applicable, shall be submitted to the Stormwater Superintendent.
(d) Design details for culverts including:
i. Lengths
ii. Diameters
iii. Materials
iv. Slopes, and
v. Elevation
(e) Design details for detention basins and other stormwater treatment practices including:
i. Elevation of bottoms, spillways, inlets, and outlets
ii. Elevation volume curves, and
iii. Elevation storage discharge curves.
(f) Modeling results that show the existing and post-development hydrographs for the one-year, twenty-fourhour (2.1 inch) rain event. Any TR-55 based model shall be suitable forthis purpose, subject to the discretion of the Stormwater Superintendent.