The Stratton Corporation

Stratton Master Plan
Water Quality Remediation Plan

May 20, 1999

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WATER QUALITY REMEDIATION PLAN

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EXECUTIVE SUMMARY

1. The Vermont Agency of Natural Resources (ANR) has listed certain segments of streams in the vicinity of the Stratton Mountain Resort as "Impaired Waters" in accordance with Section 303(d) of the Clean Water Act. Generally the impairments are due to sediment loading and hydrologic alteration. The listed waters are Styles Brook and Tributary 1 to Stratton Lake. Tributary 2 to Stratton Lake has also been determined to be impacted, but currently meets ANR Class B biocriteria. North Branch Brook below Stratton Lake has shown to meet Class B biocriteria in 1998, following the completion of remedial work performed by the Stratton Corporation in 1996 at Stratton Lake.

2. Following the purchase of the resort by Intrawest, Stratton has prepared a Master Plan to guide future mountain and residential/commercial development at the resort and submitted it to the District 2 Environmental Commission for review. Key elements of the master planning have been the identification and avoidance of environmentally sensitive areas, the clustering of development, the redevelopment of existing disturbed areas, and the remediation of existing water quality impacts.

3. A plan for the remediation of water quality conditions in the impaired waters has been prepared, with the goal of meeting Class B criteria. Included is a description of the condition of the waters that are impaired, the known impairments within these waters, and the remedial measures to be implemented to restore water quality conditions in the targeted impaired segments.

4. Existing conditions within Styles Brook indicate significant impacts associated with sedimentation. Existing facilities that have been identified as significant sediment sources are parking lot #5 and the maintenance/sand storage facility. The loading of sediment from these sources to Styles Brook has resulted in instability of the channel bed and banks.

5. Within Tributary 1, developments constructed by previous owners of the resort have resulted in substantial increases in projected peak runoff rates, in comparison to the nearby Kidder Brook watershed, which contains only ski trails and wooded lands. In addition, substantial volumes of sediment export have occurred from existing developed areas that do not currently have stormwater treatment or control systems in place. Impacts

resulting from existing activities have principally included channel instability and sedimentation.

6. Within Tributary 2, inadequate stream buffers within the Stratton Mountain Golf Course currently exist. This, combined with previous management practices, has resulted in impacts to water quality within this tributary.

7. Below Stratton Lake, North Branch Brook has shown significant water quality improvement since the completion of improvements to the Lake in 1996. Biologic data collected by ANR in 1998 has found conditions to be within acceptable ranges with respect to Class B biocriteria.

8. Remedial measures have been specifically designed to address existing non-point sources of pollution within the targeted impaired watersheds. These measures include stormwater control and management, riparian buffer restoration, instream habitat remediation, and implementation of a series of Best Management Practices.

9. An implementation schedule for these measures is proposed, beginning in 1999 and continuing through 2002. Major water quality remediation actions are slated early on during the plan implementation, to provide time and opportunity for streams to respond.

10. Measurable benchmarks and targets for water quality remediation have been established for the impaired waters. These targets consist of aquatic biota and sediment metrics. The biota targets are consistent with ANR Class B biocriteria, with 2005 set as a target date for achievement of these values in both Styles Brook and Tributary 1.

11. An extensive monitoring plan to track the progress of water quality remediation is proposed for implementation. Monitoring parameters include water chemistry, temperature, sediment, aquatic habitat and stream geomorphology. The results of this monitoring will be summarized and provided in an Annual Report, to be prepared for each year of plan implementation. The Annual Report will also contain recommendations for modifications to implementation measures or targets.

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1.0 INTRODUCTION

1.1 Overview

The Vermont Agency of Natural Resources (ANR) has included segments of certain streams in the vicinity of the Stratton Mountain Resort (Stratton) on the biannual listings of "Impaired Waters" submitted to the U.S. E.P.A. as required under section 303(d) of the Clean Water Act (ANR 1996a, ANR 1998a). The impairments are principally due to sediment loading and hydrologic alterations.

Concurrently, Stratton has been developing a multi-year Master Plan, which includes on-mountain and resort village development projects. Stratton has agreed to undertake the development and implementation of the remediation plan with the explicit goal of restoring water quality in the impaired waters to meet applicable Vermont Water Quality Standards. Pioneer Environmental Associates, LLC. (Pioneer) has been charged by Stratton with the responsibility of preparation of this plan.

Since its acquisition of Stratton Mountain Resort in November 1994, Intrawest has undertaken to make major changes in the direction of future development at the resort. Specifically, the Stratton Mountain Master Plan (Stratton 1997) focuses on the redevelopment of existing disturbed sites and clustering proposed development in the vicinity of existing resort facilities. In concert with these planning efforts, measures have been identified to abate and eliminate water quality problems associated with resort activities, which predated Intrawest's ownership of the property.

Intrawest recognized early on in its master planning efforts that certain activities and operations at the Stratton Mountain Resort which pre-dated Intrawest ownership resulted in adverse water quality impacts, even though these facilities were constructed and operated in accordance with the regulatory programs in effect at the time. However, in order to enable improvements in water quality, planning efforts focused on identifying ways to correct these existing problem conditions while avoiding new water quality impacts as future development projects move forward.

The key components of the Stratton Master Plan with respect to water quality remediation are as follows:

- Hydrologic Modeling: A watershed-wide hydrologic model has been prepared by Pioneer, using the Natural Resources Conservation Service TR-20 methodology. The results of this analysis were provided as a part of the Stratton Master Plan filing for Land Use Permit application #2W0519-10 (Stratton 1997). All watersheds in the vicinity of the resort have been divided into subwatersheds based on existing drainage characteristics, and existing land use, slope, soil type, and other factors to enable computation of composite runoff hydrographs for selected design storms. A map showing the locations of all watersheds and subwatersheds in the vicinity of the resort has been prepared (see Appendix, page 1). By utilizing a watershed-wide model, the impacts of proposed land cover or drainage changes can be evaluated in terms of overall changes to the composite runoff hydrograph. This is a much more comprehensive analysis than only examining peak discharge rates from a particular site, as required by the ANR Stormwater Procedures. The advantage of this approach is that it allows for the determination of potential adverse hydrologic impacts from a proposed action, and the use of this information to design measures to prevent such impacts from occurring.

- Remediation of Existing Impacts: As each project moves forward, existing Stratton activities in the vicinity are assessed to determine the need for remediation of existing impacts as a component of construction for new projects. This approach minimizes the duration and extent of earth-disturbing activities, while ensuring that existing problem areas are addressed. Further water quality remediation measures are proposed independent of development projects.

- Avoidance and Minimization: All of the proposed development sites within the Master Plan have been selected to avoid or minimize impacts to waters, including perennial and intermittent streams, wetlands, and ponds. Where water features are present on individual sites, the approach has been to maintain and enhance the protection that these features currently receive. Where impacts are unavoidable, every effort has been made to minimize impacts and consider design elements, to achieve water quality protection in consultation with the Agency.

The development of a Master Plan for the Stratton Mountain Resort is part of Intrawest's long-term commitment to improvements in water quality by identifying existing water quality impacts and implementing restoration measures as a part of the overall redevelopment of the resort. The projects proposed as a part of the Master Plan provide the regulatory and financial means to correct existing non-point source pollution associated with activities or operations at the resort. In fact, numerous actions have already been undertaken by Stratton to achieve their water quality remediation goals. In addition, the Master Plan projects will be specifically designed to meet, and, where possible, exceed current regulatory requirements for stormwater control and treatment to prevent new non-point sources of pollution.

This document provides a review of existing known impairments in the subject streams, as well as a brief summary of the activities already undertaken to improve water quality at Stratton Mountain Resort. Using existing information from these watersheds and current scientific practice with respect to stream restoration, a plan has been developed to bring water quality conditions in the vicinity of the resort into compliance with Vermont Water Quality Standards.

The format of this plan, consistent with the recommendations of the Vermont Agency of Natural Resources (ANR 1999), is as follows:

- Identification of impaired waters and perceived impairments
- Identification of pollutants within impaired waters
- Development of strategy to remediate problems
- Preparation of schedule for implementation or remedial measures
- Water quality monitoring plan to evaluate plan implementation

The plan sets forth the measures to be implemented over a period of time by Stratton to restore the biological integrity as well as the dynamic stability of currently impaired streams in the vicinity of the resort. This plan should be considered as a work in progress.

An important element of plan implementation will be the evaluation of the remediation measures and subsequent adaptation of the plan, as needed. The format of the plan has been prescribed by ANR and the following sections are based upon this format (ANR 1999).

1.2 Regional Setting

An overall watershed map of the resort vicinity has been prepared and is included on page 1 of the Appendix. All waters within the vicinity of the Stratton Mountain Resort are within the West River basin. All waters in the basin above 2500 feet in elevation are designated as Class A in the Vermont Water Quality Standards

(VWQS). This includes portions of watersheds A, B, and C at the resort. In addition watersheds F and G which are Kidder Brook (G) and its principal tributary, Sun Bowl Brook (F) were reclassified to Class A in 1989. A portion of the upper Winhall River watershed was reclassified to Class A in 1991. All other waters in the resort vicinity are designated Class B.

The principal tributary in the vicinity of the resort is the North Branch of Ball Mountain Brook. Stratton Lake is a man-made reservoir located at the Stratton Mountain Golf Course that was originally constructed as an onstream pond with respect to the North Branch. Watersheds A, B, and D drain to Stratton Lake, although inflow from watersheds A and B bypasses the lake via a pipe installed during 1996, as discussed further in section 3.4 of this plan. Downstream tributaries to the North Branch include Styles Brook (watershed C), Brazer's Brook (watershed E), and Kidder Brook (watershed G).

Further downstream, a segment of the North Branch, at Pikes Falls in the town of Jamaica has been designated as an Outstanding Resource Water by the Vermont Water Resources Board.

2.0 IDENTIFICATION OF WATERS CURRENTLY IMPAIRED AND PERCEIVED IMPAIRMENTS

Principally, water quality impacts to streams in the vicinity of the Stratton Mountain Resort have resulted from hydrologic change and sediment loading. These impacts have been most pronounced in Tributary 1 (watershed B) and Styles Brook (watershed C). Particularly within watershed B, the hydrologic regime has been altered as a result of impervious areas constructed by previous owners of the resort without control measures that would be required under current-day regulations. In addition, sediment, originating from impervious surfaces, overland flow, stream channel erosion, and construction sites has resulted in alterations of aquatic habitat, thus impairing the biologic community. Another set of impacts to North Branch Brook below Stratton Lake was the result of the presence of Stratton Lake as an onstream man-made reservoir. A bypass pipe was voluntarily installed by Stratton in 1996, in accordance with approvals issued by ANR, the Army Corps of Engineers, and the District 2 Environmental Commission. Subsequent monitoring has documented the restoration of water chemistry in accordance with acceptable targets and aquatic biota to within class B biocriteria.

The first step in determining appropriate measures to restore water quality conditions in the vicinity of Stratton Mountain Resort has been to assess existing conditions in the impaired watersheds. This information has been used to assess potential impacts resulting from existing facilities and operations of the resort and to identify specific problem areas and opportunities for improvement.

The evaluation of existing conditions includes the following elements:

- Existing Land Uses
- Hydrology
- Erosion and Sediment Yield
- Riparian Vegetation
- Channel Processes
- Water Quality
- Aquatic Habitat

These elements must be considered in the development of a stream restoration plan (Federal Interagency Stream Restoration Working Group 1998). Available information or analysis that describe these conditions within the targeted impaired waters are described below.

2.1 Styles Brook

2.1.1 Existing Land Uses

The Styles Brook watershed is largely forested, although the following activities or facilities are also located within this drainage basin.

- ski trails and lifts
- mountain work roads
- existing residential developments (Shatterack, Styles Brook, Crown Point)
- maintenance facility
- parking lot #5
- winter sand storage
- water supply reservoir
- Stratton Mountain Road
- portion of Stratton Sports Center
- Stratton Springs development (under construction)
- Stratton Mountain School campus (under construction)

A summary of existing land uses within the Styles Brook watershed is provided below. A detailed listing of existing land cover conditions, as well as the other watersheds in the vicinity of the resort, is included on page 2 of the Appendix.

Land Cover	Total Area (square miles)	Percent of Watershed
Wooded	0.747	70.0%
Gravel[1]	0.035	3.3%
Impervious[2]	0.037	3.5%
Ski Trails	0.191	17.9%
Open Areas[3]	0.050	4.7%
Water	0.006	0.6%

The impervious and gravel categories represent the portion of the watershed that is relatively impervious, which equals 6.8%. Within these categories, the principal land uses, which result in significant impervious areas, are parking lot #5 and the Stratton maintenance facility. These existing developments were constructed by previous owners of the resort, prior to the requirement for Stormwater Discharge Permits for such projects. Therefore, these facilities do not have measures in place to treat or control stormwater runoff.

The two projects within the Styles Brook watershed that are currently under construction (Long Trail House, Stratton Springs) have been designed in accordance with current stormwater management procedures (ANR 1997a). Stormwater discharge permits have been issued for each of these projects by ANR (ANR 1998b, ANR 1998c).

2.1.2 Hydrology

As a part of Stratton's Master Plan analyses, hydrologic modeling using the TR-20 model has been performed (NRCS 1986). The total modeled drainage area of Styles Brook is 1.07 square miles, which extends downstream to the confluence with the North Branch of Ball Mountain Brook (The North Branch). The resulting projected peak discharge rates are shown below, in comparison to the largely undeveloped Kidder Brook watershed. These values are also provided on page 3 of the Appendix. To provide a uniform basis for comparison, peak discharge rates are expressed as unitized flows of cubic feet per second per square mile (csm).

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1 Includes private roads, parking areas, staging areas, etc.

2 Includes building roofs, paved roads and walkways.

3 Includes lawns, gardens, golf course areas.

Storm Event (24 hour duration)	Styles Brook	Kidder Brook	Percent Difference
2 year	194 csm	148 csm	31.0%
5 year	342 csm	289 csm	18.3%
10 year	448 csm	390 csm	14.8%
25 year	515 csm	454 csm	13.3%
100 year	982 csm	830 csm	18.3%

Given the similarities in watershed characteristics and the proximity of the two basins, it is reasonable to expect relatively similar magnitudes of peak flow rates from these watersheds, given similar levels of development. However, it is not possible to state that unitized peak discharge rates would be exactly equivalent for the two watersheds, given a relatively undeveloped condition such as currently exists in Kidder Brook. However, these results do suggest that a relatively modest increase in peak discharge rates has occurred in the Styles Brook watershed as a result of the existing facilities listed above. Within the Styles Brook watershed, higher peak flow rates and total runoff amounts are noted in subwatersheds C3 and C6 (see Appendix, pages 4 through 6). Subwatershed C3 includes existing condominium developments, such as Shatterack and Obertal. Located within subwatershed C6 are parking lot #5 and other condominium developments (Styles Brook, Vantage Point).

The magnitude of the increases in peak flow rates do not appear to be sufficient to result in substantial changes in channel morphology. The implications of this finding with respect to design of remediation measures are reviewed below.

2.1.3 Erosion and Sediment Yield

Previous assessments of Styles Brook have indicated that the principal impairment is sedimentation. This has been evidenced by high substrate embeddedness, low densities, and absence of sediment-intolerant organisms. The results of prior habitat and biota surveys are further discussed in section 2.1.7.

Given the relatively modest increase in peak flow rates that has occurred as a result of prior development, it is likely that increases in peak velocities during storm events have been modest, and therefore, not significant enough to result in significant stream channel, bed or bank erosion. The sediment observed in Styles Brook, therefore, appears to originate from existing disturbed areas within the watershed, resulting in export of sediment into the stream during storm events.

Observations within the watershed have indicated the presence of localized areas of sediment movement into the stream (SAC 1998). These areas include mountain work roads, the Obertal and Shatterack developments, Stratton Mountain Road, the Stratton maintenance facility and sand storage area, and parking lot #5. Plumes of sediment from the runoff leaving parking lot #5 and from melting of snow, which are deposited on the steep bank at the edge of the lot, are readily observed at the site.

Therefore, observed impairments to Styles Brook appear to be due to excessive sediment supply from disturbed areas of the watershed where inadequate controls are in place to prevent erosion from impervious areas primarily (roads and parking lots) or to collect sand used for winter road de-icing operations.

2.1.4 Riparian Vegetation

The Styles Brook watershed is generally forested. There are a minimal number of existing crossings within the primary resort property, which includes the mountain work road and Stratton Mountain Road.

Further downstream, near the North Branch Brook confluence, Pikes Falls Road crosses the Brook and some buffer encroachment at the Stratton Golf School has occurred historically.

Existing vegetation in the riparian zone is principally a mixed northern hardwood forest, with minimal shrub under story. Removal of riparian vegetation and encroachment within the riparian corridor adjacent to Styles Brook does not appear to be a significant contributor to existing impairments.

2.1.5 Channel Processes

Given the modest increases in peak stream flows and velocities, no significant streamflow-related alterations of channel processes are suggested. This is supported by visual observation of the channel, which indicates no significant changes to channel dimensions, shape, profile or pattern upstream of the areas previously described, where sediment is introduced to Styles Brook.

Downstream of these areas, some changes as a result of increased sediment loading are believed to have occurred. The following relationship has been proposed for assessing the direction of change in channel characteristics resulting from an increase in sediment discharge (Federal Interagency Stream Restoration Working Group 1998):

$$Q_s+ \approx b+, d-, L+, S+, P-$$

Where:

Q_s = sediment discharge
b = width
d = depth
L = meander wavelength
S = channel gradient
P = sinuosity

Of the variables described above, those most likely to be subject to alteration in the Styles Brook watershed as a result of increased sediment discharge are width, which would be expected to increase and depth, which would be, expected to decrease. Changes in meander wavelength, sinuosity, or channel gradient would not be expected in the Styles Brook watershed due to the presence of significant bedrock control over the channel configuration. Nonetheless, some bank or bed instability is evident, as a result of the stream attempting to adjust to the increased sediment load. The expected adjustments would be towards a wider, straighter channel.

2.1.6 Water Quality

There is no existing water quality data available for Styles Brook. However, there are no existing sewage disposal systems or other significant potential sources of contamination other than those facilities previously described which result in sediment export to the stream. Thus, the collection of water chemistry data is not necessary.

2.1.7 Aquatic Habitat

Biological sampling of Styles Brook was performed by ANR in 1993, 1994, and 1998. Sampling was performed at a single location, in the lower part of the watershed, about 0.8 miles upstream of the mouth. This location is downstream of the activities listed above. In each case, the biologic integrity of the stream was found to be fair, with sediment loading apparently responsible for the degraded condition. According to a 1994 ANR memorandum:

> "The overall biologic integrity was rated fair due to an unacceptable high percent composition of *Oligochaeta*, a low density, and a poor habitat embeddedness rating due to a large amount of sand and silt in the substrate both years sampled." (ANR 1994).

Subsequently, in 1998 following re-sampling of the stream at the same location, similar findings were made, with respect to sediment impacts to Styles Brook. Steve Fiske of ANR performed kick net sampling in 1998. His field notes and the macroinvertebrate data suggest that Styles Brook is very embedded. Mr. Fiske has given the embeddedness a rating of 2 (50-75%) and estimates that 10% of the substrate is sand.

Observations by Pioneer personnel in 1998 confirm the ANR findings. In addition, these observations indicate significant bank instability within the lower reach of Styles Brook. This instability is likely due to the increased sediment load, as described above, which results in ongoing channel disequilibrium.

The macroinvertebrate kick net data for 1998 do not meet Class B biocriteria. Mr. Fiske's numbers are based on one replicate only. EPT Richness was 15 and is below the acceptable level of 18. In addition, EPT/Richness was 0.39, which does not meet the cutoff of greater than 0.45. The low EPT Richness in this case indicates that sedimentation is an issue on Styles Brook. It appears that EPT taxa are under-represented because of the impact of sedimentation. These EPT organisms are extremely sensitive to silt because their gills become clogged.

The macroinvertebrate data from Mr. Fiske provides further indication that Styles Brook has a siltation and sedimentation problem. The percentage of _Oligochaeta_ (worms) was 28.5%, which is extremely high for a brook such as Styles, which would be expected to have a very low percentage of worms (less than several percent). The high collector-gatherer component (78.6%) suggests that the food base in the stream is largely influenced by sedimentation. Typically, collectors do not dominate upland streams. The majority of the organisms in the Styles Brook kick net sample were depositional feeders, which feed upon fine particulate organic material (FPOM) and bacteria. These collector gatherers colonize on or within the interstitial spaces where sand accumulates. Therefore, the dominance of collector gatherers is a strong indication of impacts from sedimentation. The approach to addressing these impacts in Styles Brook is described further in section 4.1 of this plan.

2.2 Tributary 1, North Branch Brook

Tributary 1 (watershed B) is the second largest of three tributaries to Stratton Lake with a drainage area of 0.609 square miles. Two main branches of Tributary 1 have been identified and are referenced in the following discussions of existing conditions. These are the East Branch, which includes approximately 38% of the drainage area and the Main Branch, which includes the remaining 62% of the watershed.

2.2.1 Existing Land Uses

Tributary 1 of North Branch Brook, above Stratton Lake is a heavily developed watershed, which includes a wide range of existing land uses. Significant existing land uses within this watershed are summarized below.

- ski trails, mountain bike trails, lifts
- mountain work roads
- existing base area development (Village commercial street, main base lodge, hotels, shops, outdoor assembly areas)
- parking garage structure
- Base Lodge (Snyder) onstream pond
- parking lots #2, #3, and #4
- existing lodging facilities (Stratton Mountain Inn, Liftline Lodge, Birkenhaus)
- existing residential developments (Obertal, Village Watch)
- existing residential lots, houses, driveways and private roads
- other existing developed lands (Stratton Mountain School)
- Stratton Mountain Road
- portion of Snowbridge residential development
- small portion of Stratton Mountain Golf Course
- 1972 (original) spray irrigation site (decommissioned)
- Stratton Wastewater Treatment Plant and access drive
- streamflow maintenance building

golf course

A summary of existing land uses within the Tributary 1 watershed is provided below, and also listed by subwatershed on page 2 of the Appendix.

Land Cover	Total Area (square miles)	Percent of Watershed
Wooded	0.258	42.4%
Gravel	0.042	7.0%
Impervious	0.083	13.7%
Ski Trails	0.150	24.5%
Open Areas	0.074	12.2%
Water	0.001	0.2%

For Tributary 1, the total of impervious and gravel categories as listed above, indicates that 20.7% the total watershed area is relatively impervious. The principal existing land uses within this impervious area are existing parking areas, base area facilities, and other development in the base area.

2.2.2 Hydrology

As described above, hydrologic modeling of the Stratton Mountain Resort area using the TR-20 model (NRCS 1986) has been performed as a part of the Stratton Master Plan submittals. The resulting projected peak discharge rates are shown below in comparison to the largely undeveloped Kidder Brook watershed. To provide a uniform basis for the comparison, peak discharge rates are expressed as unitized flows of cubic feet per second per square mile (csm).

Storm Event (24 hour duration)	Tributary 1, North Branch Brook	Kidder Brook	Percent Difference
2 year	414 csm	148 csm	180%
5 year	663 csm	289 csm	129%
10 year	829 csm	390 csm	113%
25 year	932 csm	454 csm	105%
100 year	1481 csm	830 csm	78.4%

As previously discussed, peak discharge rates for these two watersheds would be generally expected to be similar, given a similar magnitude of development in these watersheds. Thus, the simulation results for Tributary 1 suggest that a substantial increase in peak discharge rates has occurred in this watershed as a result of the existing facilities listed above. This hydrologic change is not surprising, given the large amount of impervious area, as well as the absence of stormwater treatment and control measures for developments constructed by previous owners of the resort many years ago.

A breakdown of peak flow rates and total runoff volumes by subwatershed is provided for a 2 year storm on pages 4 through 6 of the Appendix. The subwatershed information clearly indicates that disproportionately high peak runoff volumes and rates occur from subwatershed B3, which includes the base Lodge, Village commercial area, parking garage, and outdoor assembly areas. In fact, this subwatershed, which represents only 4% of the total area of subwatershed B, results in 10.5% of the runoff volume. The peak flow rate for B3, in a 2 year storm, is equal to approximately 25% of the total peak flow for watershed B.

Subwatersheds B5 and B6 also have somewhat elevated peak flows and runoff volumes. Within these subwatersheds are parking lots #2, #3, and #4, as well as other development. The implications of these findings with respect to design of remediation measures are reviewed below.

2.2.3 Erosion and Sediment Yield

Field observations have been made throughout the watershed of Tributary 1 which document numerous areas of sediment export to the stream. Specific areas where existing problems have been noted are as follows:

- Road crossings (West Hill Road, Stratton Mountain Road, Maple Hill Road, North Branch Road, Middle Ridge Road)
- Stratton Wastewater Treatment Plant Access Drive
- Ditch below Liftline Lodge
- Diversion weir at Stratton Lake (removal of accumulated sediments)
- Existing parking lots #2, #3 and #4
- Vicinity of Stratton Mountain Inn
- Vicinity of Birkenhaus and Stratton Mountain School

Erosion of the stream channel has been observed at several locations within Tributary 1, in the form of streambank erosion and channel widening, and is considered to be a result of other alterations and impacts rather than a cause of impairment. This is discussed further in section 2.2.5.

The lower 500 foot segment of the East Branch of Tributary 1 is a location where a significant amount of erosion is occurring which is clearly the result of direct human intervention. This erosion appears to be largely due to the rerouting of streamflow from a portion of Tributary 1 to the east at the base of Maple Hill Road. This rerouting was done many years ago to optimize the performance of the original spray site. However, by rerouting this flow into a channel segment, which was not equilibrated to this volume of runoff, significant instability in the channel was created. Because this spray site is no longer in operation, redirecting the flow to the original channel is recommended, as discussed in section 4.2.8.

2.2.4 Riparian Vegetation

Generally, much of Tributary 1 flows through forested areas, with minimal disturbance to the stream channel or riparian buffer zone. These areas provide excellent protection from nearby potential sources of contamination. Specific areas where existing buffers have been noted to be inadequate include:

- Channel segment behind Liftline Lodge (East Branch)
- Snyder Pond (Base Lodge) vicinity (Main Branch)
- Treatment Plant Access Drive (Main Branch)
- Segment along Golf Course fairway L5 (Main Branch)
- Segment crossing and along Golf Course fairway L6 (Main Branch)
- Segment crossing between tees of Golf Course hole L7 (Main Branch)
- Segment to west of tennis courts (Main Branch)

2.2.5 Channel Processes

In the case of Tributary 1, increases to both sediment discharge and streamflow have occurred as a result of activities and previous development in the watershed. Their potential impacts are described by the following equation (Federal Interagency Stream Restoration Working Group 1998):

$$Q_w + Q_s + \approx b+, d+/-, L+, S+/-, P-$$

Where:

Q_w = streamflow
Q_s = sediment discharge
b = width
d = depth
L = meander wavelength
S = channel gradient
P = sinuosity

Of the variables described above, those most likely to be subject to alteration within Tributary 1, as a result of increased streamflow and sediment discharge are width, which could increase, and depth, which would be expected to increase or decrease. Some changes in meander wavelength, sinuosity, or channel gradient have occurred in on the East Branch of Tributary 1 and the Main Branch of Tributary 1.

The East Branch of Tributary 1 above the Stratton Mountain Access Road is stable and is predominantly a bedrock streambed. Below the Access Road and behind the Liftline Lodge the East branch lacks bedrock control. The East Branch is aggraded and has poor bank stability for much of the reach between Liftline Lodge and the confluence of Tributary 1. In some areas the channel form had changed substantially to result in decreased sinuosity. Decreased sinuosity or channel straightening is also evident on Tributary 1 within the Golf Course.

2.2.6 Water Quality

Significant historical water quality data has been collected in Tributary 1, as required in the original (1972) permits for the spray irrigation site at Stratton. During the time period these stations were sampled, some increased concentrations of nutrients including nitrate and phosphorus were observed in the surface waters. These nutrient concentrations are documented with respect to sampling stations 1 and 6, as described in annual water quality evaluations for 1992 and prior years (WH&N 1993). In addition, biological sampling indicated a Significant Alteration of the Aquatic Biota (SAAB) downgradient of the site. Upon upgrade of the wastewater treatment and disposal system, Stratton was required by ANR to discontinue use of this site in 1992. No further sampling of Tributary 1 has been performed. Therefore, the extent to which residual nutrient leaching from the relict spray site may be occurring is not known. However, significant water quality data collection on the North Branch below Stratton Lake is currently ongoing as required by the Stratton Lake Water Quality Certification (ANR, 1996b). Data collected at the Lake bypass outlet do not suggest elevated nutrient levels in the combined flow from Tributaries 1 and 2 (Pioneer 1998a).

Within the upper portion of the watershed, water quality impacts are suspected as a result of the Snyder Pond. These impacts include release of fine sediment, iron and manganese modifications and release, and thermal alteration (warming) of the waters of Tributary 1. Although no stream chemistry monitoring has been performed at this location, a large area of iron seep is found just below the pond and observations of turbid water below the pond have been made. Proposed actions to address remediation of these impacts are described in section 4.2.9.

2.2.7 Aquatic Habitat

A memorandum dated November 7, 1997 from Steve Fiske of ANR describes the results of kick net sampling of macroinvertebrates (aquatic insects) of Tributary 1 to Stratton Lake in a single occasion during fall 1997. The sampling location was near the bottom of this Tributary, approximately 0.2 miles upstream of Stratton Lake. Using this sampling data, various biologic indices were computed, and compared against "reference Class biocriteria" for similar types of streams. From these computed values, it was concluded that Tributary 1 fell outside of the expected values for the biologic indices due to sedimentation and nutrient enrichment (ANR 1997b):

> "...the biologic integrity [of Tributary 1] is poor, and does not meet the minimum Class B biological criteria presently applied by the VTDEC. The community biometrics indicate that the community is being impaired by both habitat degradation from sand/silt and nutrient enrichment. The habitat evaluation from the stream indicates that there is a high sediment bedload (both sand and silt), the substrate embeddedness rating is fair (50 - 75%), and filamentous algae is prolific."

In July 1998, Pioneer performed a comprehensive inspection of the tributaries to the North Branch of Ball Mountain Brook above Stratton Lake. Observations made at that time are summarized in a memorandum dated July 6, 1998 and accompanying photographs (Pioneer 1998b).

2.3 Tributary 2, North Branch Brook

2.3.1 Existing Land Uses

Tributary 2 of North Branch Brook, above Stratton Lake includes a wide range of existing land uses. Major land uses within this watershed are summarized below.

- ski trails, mountain bike trails, and lifts
- mountain work roads
- existing residential lots, houses, driveways and private roads
- Stratton Mountain Road
- portion of Snowbridge residential development
- most of Stratton Mountain Golf Course
- small existing onstream ponds on Golf Course

A summary of the total area of all existing land uses within the Tributary 2 watershed is provided below.

Land Cover	Total Area (square miles)	Percent of Watershed
Wooded	0.758	60.0%
Gravel	0.051	4.1%
Impervious	0.077	6.1%
Ski Trails	0.153	12.1%
Open Areas	0.223	17.6%
Water	0.001	0.1%

Within the Tributary 2 watershed, impervious areas, which are comprised of the gravel and impervious areas listed above are 10.2% of the total watershed area. These surfaces consist of roadways and single-family houses. There are no large, interconnected impervious areas within this watershed. Because the impervious cover is made up of small unconnected areas which are widely spread out through the watershed, impervious surface area is not believed to be a significant issue.

2.3.2 Hydrology

The watershed area of Tributary 2 to Stratton Lake is 1.26 square miles or 809 acres. The hydrology of this watershed has been modeled using the TR-20 model (NRCS 1986), as part of the Stratton Master Plan submittals.

The resulting projected peak discharge rates are shown below, in comparison to the largely undeveloped Kidder Brook watershed. To provide a uniform basis for the comparison, peak discharge rates are expressed as unitized flows of cubic feet per second per square mile (csm).

Storm Event (24 hour duration)	Tributary 2, North Branch Brook	Kidder Brook	Percent Difference
2 year	221 csm	148 csm	49.4%
5 year	394 csm	289 csm	36.4%
10 year	510 csm	390 csm	30.8%
25 year	582 csm	454 csm	28.2%
100 year	985 csm	830 csm	18.7%

These results are generally similar to those for Styles Brook, with respect to the magnitude of change in peak discharge rates compared to Kidder Brook. The fact that these changes in peak flows are substantially less than those projected for Tributary 1 is due to the absence of large connected impervious areas in the watershed of Tributary 2.

2.3.3 Erosion and Sediment Yield

There are numerous areas along Tributary 2 as it flows through the Stratton Mountain Golf Course where significant stream bank erosion can be observed. These areas appear to have resulted from the removal of riparian vegetation, along the reach of the stream passing through the Golf Course, as described in section 2.3.4.

Tributary 2 is moderately impacted by sediment. However, there is no evidence of excessive sediment loading to this tributary. This observation is consistent with the results of biological sampling performed by ANR, as described in section 2.3.7

2.3.4 Riparian Vegetation

Extended lengths of Tributary 2 and the smaller watercourses, which drain into Tributary 2 are located within the Stratton Mountain Golf Course. There are many locations at which stream buffers have historically been inadequate, following the initial construction of the Golf Course. The removal of native vegetation has occurred, and mowing/brush removal has been performed directly adjacent to the edge of the streams. These practices have resulted in numerous areas of erosion within the Golf Course.

2.3.5 Channel Processes

Based on the absence of major hydrological alterations, as well as evidence for a lack of excessive sediment loading to Tributary 2, significant changes to channel processes are not believed to have occurred. Indeed, aside from the riparian buffer issues described above, observations of Tributary 2 are consistent with this conclusion.

2.3.6 Water Quality

There is no recent water quality data for Tributary 2. Some information was collected during 1988 and 1989 by ANR (ANR 1991), which showed somewhat elevated concentrations of certain constituents, including chloride, conductivity, and calcium, as well as dissolved and total metals (iron, manganese). Nonetheless, these concentrations were significantly less than those observed at Tributary 1.

More recent sampling below Stratton Lake, following the construction of the bypass pipe has shown that target concentrations for the mixed outflow from Tributaries 1 and 2 are being met. As noted by the ANR, nutrient enrichment does not appear to be as significant a factor in Tributary 2 as in Tributary 1 (ANR 1997b). This suggests that use of fertilizers on the Golf Course is being properly managed to minimize water quality impacts to Tributary 2.

2.3.7 Aquatic Habitat

As with Tributary 1, kick net sampling of aquatic insects and an assessment of habitat conditions were performed by the ANR at Tributary 2. This sampling, completed in October 1997, was done at a single location approximately 0.1 miles upstream of Stratton Lake. Based on this sampling, Tributary 2 was found to be within the expected range of the Class B biocriteria. The ANR report concludes that:

> "The biological assessment and habitat evaluation for Tributary 2 is that the stream community integrity is still good but has been moderately changed from its natural condition."

Therefore, although some impacts have been noted in Tributary 2, monitoring data have show shown that the ANR Class b biocriteria are currently being met.

2.4 North Branch Brook below Stratton Lake

2.4.1 Existing Land Uses

Below Stratton Lake, the only existing land use controlled by Stratton is a portion of the Golf Course. As with the segment of Tributary 2 within the Golf Course, there are areas of inadequate riparian buffer zones. Areas of iron seeps have also been observed along portions of this stream segment.

An indirect discharge of treated effluent from the "1984 spray field" occurs within this reach of North Branch Brook, which is managed by Winhall-Stratton Fire District #1, in accordance with Indirect Discharge Permit ID.-0019/9-0044.

2.4.2 Stratton Lake Bypass

The first major example of Stratton's water quality improvement efforts was the installation of a bypass pipe at Stratton Lake in 1996 which allowed waters of the tributary streams to bypass directly to the North Branch of Ball Mountain Brook. This effort was completed to eliminate downstream chemical and biologic impairments in the brook that were directly attributable to the presence of the lake as an onstream pond (ANR 1991). A monitoring study required by ANR as a part of the Water Quality Certification issued for the project is underway and has shown dramatic improvements in downstream water quality in North Branch Brook (Pioneer 1998a, Pioneer 1999, ANR 1998d). Since the inception of this monitoring, water quality conditions have exceeded target performance levels specified prior to the completion of the work.

With respect to the North Branch of Ball Mountain Brook, current conditions are summarized in the documents listed below.

1. A letter of November 12, 1997 from Jeffrey A. Nelson, Pioneer to Jeffrey R. Cueto, ANR, which provides an update on water quality monitoring results following the bypass installation at Stratton Lake. (Pioneer 1997);

2. "1997 Annual Report, North Branch of Ball Mountain Brook, Monitoring Below Stratton Lake" by Pioneer, which reports on water quality monitoring through the end of 1997 associated with the lake bypass, dated March 31, 1998, (Pioneer 1998a);

3. "1997 Summer Biomonitoring Study, North Branch of Ball Mountain Brook and Winhall River," by Pioneer, dated March 5, 1998, (Pioneer 1998c);

4. A memorandum dated May 11, 1998 from Steve Fiske of ANR to John Akielaszek of ANR reviewing the 1997 biomonitoring data (ANR 1998e); and,

5. A memorandum dated November 18, 1998 from Steve Fiske and Rich Langdon of ANR reviewing the 1998 ANR sampling data for the North Branch of Ball Mountain Brook below Stratton Lake (ANR 1998d).

6. "1998 Annual Report, North Branch of Ball Mountain Brook, Monitoring Below Stratton Lake" by Pioneer, which summarizes water quality monitoring conducted through 1998, dated May 14, 1999 (Pioneer 1999)

These documents summarize existing water quality conditions below the lake. In essence, the conclusion that has been drawn to date is that the bypass pipe has been successful, as predicted, in achieving marked water quality improvement downstream of the lake. In fact, based on the Fall 1998 data, the ANR has concluded that all Class B biocriteria are met at all four sampling locations on North Branch Brook below the lake. The November 1998 ANR memorandum states, in part:

> "The macroinvertebrate community assessments indicated good biological integrity at all three RMs [river miles] assessed. At RMs 2.2 and 3.9 the macroinvertebrate community was of similar integrity to the last previous assessments in the years 1992 and 1997 respectively. At RM 4.3 [closest station to Stratton Lake] the community indicates a marked improvement since the last assessment performed by the Stratton Corporation in 1997 and the VTDEC in 1986 when it was rated as poor. The fish community assessments indicated increased stream productivity as total densities at both stations was greater than observed during 1989 and 1986. The overall biologic integrity at all four sites was determined to meet the Class B water quality standard as presently applied by the VTDEC for aquatic life."

Currently, this stream segment remains on the draft 1998 303(d) listing as an impaired water body. According to ANR, this listing is based on aesthetics criteria of VWQS, due to the continued presence of black rocks in the streambed below the lake. Given that the recommended improvement measures have been implemented by Stratton, and restoration of water chemistry and aquatic biota has occurred, no further actions are recommended.

Beyond the improvements which have been achieved to date, Stratton is proposing to implement further measures to enable additional water quality improvements in this segment of North Branch Brook, as described in section 4.3 of this plan.

3.0 IDENTIFICATION OF POLLUTANTS WITHIN IMPAIRED WATERS

3.1 Styles Brook

As previously described, the principal pollutant resulting in the observed impairment within the Styles Brook watershed is sediment. Specific sources of sediment loading to Styles Brook are described in greater detail in section 2.1. In addition, isolated areas of iron seeps are located within the Styles Brook watershed.

3.2 Tributary 1, North Branch Brook

Within Tributary 1 (watershed B), sediment is also a principal pollutant which has contributed to the existing impairments. This is described in greater detail in section 2.2. In addition, some residual contribution of nutrients from the discontinued spray irrigation site may be occurring. Snyder Pond also results in water quality impairments, including thermal alterations, release of fine sediment, and iron seeps. Scattered areas of iron seeps are located within the watershed of Tributary 1.

3.3 Tributary 2, North Branch Brook

Tributary 2 (watershed A) is not impacted by a specific "pollutant" to the degree of Styles Brook or Tributary 1. As described in section 2.3, the principal impairment within this watershed is the lack of vegetation within the riparian zone along the stream and its tributaries within the Golf Course area. In addition, minor sediment contribution and isolated areas of iron seeps within the watershed of Tributary 2 are present.

3.4 North Branch Brook below Stratton Lake

The most recent sampling data from 1998 demonstrate that Class B biocriteria are being met in North Branch Brook below Stratton Lake. As described previously, the efforts undertaken by Stratton to take the Lake offstream have resulted in the elimination of pollutants reaching this segment of North Branch Brook. The eliminated pollutants included iron, manganese, nutrients, and fine sediment. Although this segment remains included on the draft 1998 303(d) listing of impaired waters, the listing is due to aesthetic impacts associated with black staining which remains on rocks in the streambed through this reach. No further remedial measures recommended.

3.5 Other Sediment Sources

Previous sections of the plan have described observed impacts due to modifications to the sediment load of streams in the vicinity of the resort. Several potential sources of sediment specific to individual watersheds have been described previously. Another sediment source that is present on a watershed-wide basis, as well as throughout northern climates, is sand applied to roads, drives, and parking areas as an abrasive for vehicle traction and pedestrian safety, during icy or snowy conditions. Stratton Corporation is responsible for the winter maintenance of the Stratton Mountain Road, existing parking lots and private roads in the vicinity of the resort. Stratton personnel report that the typical annual winter sand usage for these areas is approximately 9000 tons, distributed as shown below.

Location	Percent of Total
Stratton Mountain Road	50%
Existing Parking Lots	35%
Private Roads	15%

A large portion of the Stratton Mountain Road, including the steeper segments, is outside the watershed of the North Branch. Based on distance alone, 54% of the Stratton Mountain Road is within the watershed of the North Branch (approximately 13,000 feet). The existing parking lots and private roads listed above are entirely within the watershed. Thus, the adjusted amounts of winter sand application are estimated to be the following:

Location	Sand Usage (tons per year)
Stratton Mountain Road	2430 tons
Existing Parking Lots	3150 tons
Private Roads	1350 tons

In addition to these sources, the Village commercial area and individual condominium projects are managed separately. The Village receives an annual sand application of approximately 63 tons. No data are available on the amount of winter sand application at individual condominium projects or private residences.

In terms of identification of the magnitude of winter sand application within the various watersheds at the resort, estimates have been made based on distances of roads and locations of parking areas, as shown below.

Location	Watershed A	Watershed B	Watershed C	Watershed F
Stratton Mountain Road	1029 tons	735 tons	667 tons	-
Existing Parking Lots	-	1338 tons	729 tons	1083 tons
Private Roads*	608 tons	473 tons	68 tons	-
Other (Village)**		13 tons	50 tons	
Total	1637 tons	2559 tons	1514 tons	1083 tons

* Approximately 15% of private roads are in watersheds D and H (High Meadow) and are not listed in this table

** It is estimated that 80% of winter sand from the Village is transported to parking lot #5 (watershed C) with snow removed from the Village. The remaining 20% stays in the Village area.

Although not all the winter sand that is applied reached streams, this analysis shows that watersheds A, B, and C receive heavy loadings of winter sand. Since a significant portion of this sand may reach the streams under current conditions, this is a likely source of the observed sediment impacts.

4.0 STRATEGIES TO REMEDIATE PROBLEMS

In order to prioritize the implementation of potential measures to bring about improvements in water quality in the vicinity of the resort, a ranking system has been developed for each of the impaired watersheds. The impact ranking is based on field observations and measurements which consider the significance of each of the water quality impact factors previously identified in chapter 2 of this plan. This ranking and schedule of implementation of remedial measures is provided on page 7 of the Appendix. Along with the ranking of potential impacts is the date that implementation of corrective measures or practices is proposed to occur. The proposed implementation steps are described in chapter 5.

For each of the impaired watersheds, as well as Tributary 2 (watershed A), specific measures that are proposed to bring about the water quality remediation goals previously described are listed below. Large-scale measures specific to the watershed areas of particular impaired waters, are described in sections 4.1 to 4.4. The remaining sections, 4.5 to 4.12 describe other measures and best management practices to be more generally implemented on resort lands in multiple watersheds.

4.1 Styles Brook (Watershed C)

4.1.1 Parking Lot #5/Maintenance Facility

Stratton proposes to undertake the design, permitting, and construction of a stormwater collection, treatment, and control facility to handle runoff from parking lot #5 and the maintenance facility. In addition, this structure would provide treatment for sediment-laden snow from the resort base area that is currently trucked and deposited off the eastern edge of this parking lot. Specific design elements and routing of runoff from existing disturbed areas must still be determined. However, a tentative site for the proposed control and treatment system has been identified east (downslope) of the existing toe of the slope of parking lot #5 fill. It is also expected that some drainage ditching and culverting will be required to route stormwater to the treatment area.

4.1.2 Golf School Stream Buffer

The area of Styles Brook adjacent to the Stratton Mountain Golf School will be field evaluated to identify areas within which stream buffers can be enhanced without adversely impacting the ongoing operations at the Golf School. Based on this assessment, recommendations will be made in the form of a specific plan for buffer enhancement.

4.2 Tributary 1, North Branch Brook (Watershed B)

4.2.1 Runoff Treatment at Existing Parking Areas

In the past, day skier parking at the resort has been provided at a parking structure (Lot 1) near the base lodge, four gravel-surfaced parking lots (Lots #2, #3, #4, and #5), and the Sun Bowl parking lot. The four gravel surface lots 2 - 5, were constructed in the 1960s to 1970s by a previous owner of the resort in accordance with regulations in effect at the time. However, no provision was made for the treatment of pollutants (principally sediment) or the control of peak discharge rates from these facilities. Therefore, over time these parking lots have resulted in the export of significant quantities of sediment as well as peak discharge alterations to streams below these sites.

Specific plans have already been developed to address the treatment and control of stormwater runoff from four of the five existing gravel parking areas at the Stratton Mountain Resort. The implementation of these improvements is underway at two of these parking lots (#3 and #4), while regulatory review of proposed improvement measures is underway for the other two (#2 and the Sun Bowl).

It is important to recognize that it is the implementation of the Intrawest Master Plan at Stratton that provides the means for achieving these improvements. This is true both from the standpoint of providing a regulatory opportunity for the review of these pre-existing facilities and also from a financial standpoint because the completion of these efforts is only possible in concert with major capital expenditures. Without the redevelopment of these previously disturbed areas associated with the implementation of the Master Plan, the resulting water quality improvements would be unlikely to occur in a timely manner. The specific areas of activity are described below.

4.2.2 Parking Lot #3 Elimination (Long Trail House)

The Long Trail House project, now under construction following issuance of Land Use Permit #2W0519-11 (January 30, 1998) by the District 2 Environmental Commission, will result in the elimination of more than two acres of gravel parking area (lot #3) which contributed sediment and high runoff flow rates to the downstream tributary of North Branch Brook. The completed project will eliminate the sediment source, provide landscaped grounds, incorporate stormwater treatment systems, and bring about substantial reduction in downstream peak flow rates.

The Long Trail House project will result in significant water quality remediation for the following reasons:

- The site previously contained more than two acres of gravel parking area with no runoff control or treatment measures.
- The project will decrease overall impervious area by about an acre, with this land becoming landscaped buffers.
- Peak flow rates will decrease as a result of decreased impervious area.
- Underground parking will minimize generation of sediment-laden runoff, as well as other contaminants from vehicles.
- Grassed swales will provide treatment (sediment removal) from additional nearby roadway areas.
- Elimination of unvegetated gravel surfaces will dramatically reduce sediment export from the site.

4.2.3 Parking Lot #4 Modification

The Stratton Springs project, also currently under construction, following the issuance of Land Use Permit #2W0519-14 (September 3, 1998) by the District 2 Environmental Commission, has resulted in improvements to parking lot #4 such that stormwater treatment and peak discharge control measures exceed the ANR requirements for new construction. As with other projects proposed under the Master Plan, planning of the Stratton Springs project included an assessment of measures to address existing impacts to water quality from prior development. In the case of the proposed Stratton Springs project, improvements to impacts of runoff from parking lot #4 have been achieved. These improvements include grading and drainage modifications to the parking lot, as well as the construction of a multi-cell stormwater treatment system.

The design approach for the Stratton Springs project included water quality remediation as a project objective, as described below. In addition to onsite measures to control stormwater and provide treatment from the Stratton Springs development in accordance with the specifications of the current ANR Stormwater Procedures (ANR 1997a), the following additional measures have been implemented. The project site is adjacent to existing parking Lot #4, a 2.5 acre (+/-) gravel surfaced lot with no stormwater control or treatment measures, because its construction predated such requirements by the Vermont ANR. Therefore, to achieve improvements in downstream water quality, the collection and treatment of runoff from this lot was voluntarily included by Stratton, in the design of the stormwater management system proposed for the project.

A combination of shallow swales and berms are used to direct runoff from the parking lot to a newly constructed multi-cell wetland/pond system between the parking lot and the project site. The initial cell (forebay) of the treatment system receives runoff from the parking area and serves to allow for settling of heavier sand-sized particles. This area is also designed to allow easy access for removal of accumulated sediment from this portion of the treatment system. A combination permeable berm and weir system is used to convey water from the forebay into the wetland component of the treatment system, which is located largely within the existing class three wetland designated as BH-7. This treatment system takes advantage of principals of "bioretention" which is recognized as an effective and state-of-the-art mechanism for maximizing pollutant removal from stormwater runoff through filtering, nutrient uptake, and extended detention times.

The result of this effort will be substantial water quality remediation within this portion of the watershed of Tributary 1 to Stratton Lake. This is true with respect to both water quality and quantity, because sediment and other contaminants will be removed from the runoff and peak discharge rates will be reduced significantly from existing conditions. Again, the achievement of water quality improvements as built into the Stratton Springs project is an integral part of the Master Plan improvements at the resort.

4.2.4 Parking Lot #2 Modification and other NPS elimination

As a part of the Commons Phase II project, currently under review by the

District 2 Environmental Commission, numerous water quality remediation measures are proposed, including the modification of parking lot #2. This site is also located within the watershed of Tributary 1 to Stratton Lake. Similar to the other projects previously described, the Commons Phase II project will result in improvements to existing parking lot #2 such that stormwater treatment and peak discharge control measures will exceed the ANR requirements for new construction.

Specifically, the following measures will result in water quality enhancement:

1. The site is located immediately adjacent to the Long Trail House project (Commons Phase I), which is currently under construction at what was formerly parking lot #3. This gravel parking area, dating from the 1960s had no stormwater control or treatment measures in place, and is believed to have been a major contributor of sediment to the watershed. As found by the District Commission in Land Use Permit #2W0519-11, the Long Trail House project will result in reduced peak discharge rates and improved water quality from this area.

2. The design of Commons Phase II has been undertaken to complement and extend the efforts previously approved for the Long Trail House with respect to stormwater control and management. This includes the construction of a new channel to safely convey runoff from upslope areas without resulting in erosion (Stratton 1998, Tab 5).

3. Oversized stormwater retention ponds are proposed on the site to reduce peak discharge rates from the project, as well as to further reduce peak flows from upslope developed areas. The result is that peak discharge rates are projected to decline by 11 to 14% below existing conditions (Stratton 1998, Tab 7).

4. In addition, the construction of the Commons Phase II project will eliminate several existing non-point sources of sediment which are currently unmanaged. These include gravel parking areas at the Birkenhaus, Stratton Mountain School, Provisions General Store, and Village Chalet Condominiums. Further, existing gravel roadways on the site and poorly designed and maintained roadside ditches along Middle Ridge Road will be eliminated as a result of the project.

5. Stratton has proposed to include as a part of the Commons Phase II project, a collection and treatment system for stormwater runoff from existing parking lot #2, which is located adjacent to the site. This lot is another existing non-point source contributor of sediment within the watershed.

Due to the measures included in the project design to control stormwater volumes, as well as the elimination of numerous non-point sources of sediment within and adjacent to the project area, the overall objective of watershed remediation for Tributary 1 to Stratton Lake would be significantly enhanced by the construction of the Commons Phase II project as proposed.

4.2.5 Village Commercial Area

The existing village core area, which includes the Stratton Base Lodge, the village commercial street, the Welcome Center, the parking deck, and a portion of the Village Watch condominium development is a compact area of existing development with a large amount of impervious surface, within subwatershed B3. These impervious areas include roofs, parking areas, walks, and open paved/concrete outdoor spaces. Since these developments predate current ANR requirements for stormwater treatment or control, no existing measures are present. From the hydrologic modeling that has been performed, this area, designated subwatershed B-3, makes an inordinately high contribution to peak flow rates in watershed B. In fact, for a two year storm, the peak flow rate for this subwatershed, which represents only 4% of the area of watershed B, equals approximately 25% of the peak flow rate for the entire watershed.

Given the extent of existing development in this subwatershed, implementation of stormwater treatment and control will require innovative or off-site measures. Therefore, Stratton is implementing and evaluating several measures to achieve water quality restoration in Tributary 1. These include:

- Implementation of best management practices to reduce sediment export (see section 4.10)

- Investigation of a radiant heat snow-melting system for the Village commercial street to eliminate the use of winter sand and salt in this area.

- Providing off-site stormwater treatment and control for a portion of the Village as part of the Commons II project (see section 4.2.4., item 3)

- Evaluation of the feasibility of pretreatment of stormwater runoff from this subwatershed followed by routing this water by pipe for a distance of over one mile (along existing rights-of-way) to Stratton Lake for retention.

It is expected that the investigation of alternatives will be completed during

1999, with reporting on the results of this work provided in the 1999 Annual Report, and implementation of alternatives by 2001.

Given the measures underway or proposed for other subwatersheds in watershed B, it is anticipated that the 2 year peak flow rate can be reduced significantly from existing conditions. As described previously, the projected peak rate is currently 180% greater than the baseline value, based on Kidder Brook projections. Given the implementation of stormwater controls, it is likely that a future peak flow rate of 120% to 140% of baseline can realistically be achieved for watershed B.

4.2.6 Golf Course Stream Buffers

A small portion of the existing Stratton Mountain Golf Course is located within the watershed of Tributary 1. Measures proposed for implementation to address suspected water quality impacts are described in section 4.3.1., with respect to Tributary 2, since most of the Golf Course is located in that watershed. However, as depicted on the Technicon plan (see map pocket 3) measures are proposed for implementation in the watershed of Tributary 1 as well. For a specific discussion of the Golf Course work to be performed, the reader is referred to section 4.3.1 of this plan.

4.2.7 Wastewater Treatment Facility Access Drive

As described in section 2.2.3, a segment of Tributary 1 is located quite close to the existing access drive to the wastewater treatment facility. Given the need for access to the building by large trucks for sludge removal, limited space is available for implementation of stream buffer improvements. However, a detailed plan showing measures to be implemented has been prepared by Mr. Edward H. Floyd, P.E. using a description previously prepared by Stratton (Rawson 1998a). The proposed implementation plan is included in map pocket 2. This drawing is a Technicon plan titled "The Stratton Corporation, Stream Improvements Site Plan" last revised May 10, 1999.

4.2.8 Sprayfield Stream Relocation

As described in section 2.2.3, a segment of Tributary 1 was relocated many years ago to enhance the operation of the then operational original spray field in that area. Because that spray field is no longer operational and the relocation of flow from this original channel has resulted in significant erosion to the alternate channel, the relocation of the stream to its original channel is proposed. To accomplish this a new culvert will need to be designed to cross North Branch Road at the corner of Maple Hill Road, along with appropriate energy dissipation on the outlet of this culvert.

4.2.9 Snyder (Base Lodge) Pond

An existing onstream pond located to the north of the Main Base Lodge and gondola terminal, known as "Snyder Pond" is believed to result in a significant contribution to downstream water quality impairments within Tributary 1. This pond is a man-made structure that was constructed many years ago as a water source for firefighting purposes, but is no longer in use for that purpose. It currently serves as a discharge point for the Snowbridge project, as described in Stormwater Discharge Permit #1-1236, and also receives drainage from snowmaking water lines. It is proposed that this pond be eliminated and a design be prepared to address the continuing functions the pond currently performs, and enable the improvement of downstream water quality.

4.3 Tributary 2, North Branch Brook and Lower North Branch Brook

4.3.1 Golf Course Stream Buffers

A field meeting was held at the Stratton Mountain Golf Course on June 16, 1998 with representatives of Stratton and consultants (Pioneer, Technicon), ANR, VNRC, and SACC. The principal objective of the visit was to examine areas for potential improvements to unstable stream banks and to improve stream buffers on the course.

The Golf Course was constructed in phases from the 1960s through the 1980s, in accordance with permitting requirements and guidance available at the time, and in a similar manner to other golf courses constructed during this period. Under current ANR policy, there are areas of the Golf Course with inadequate stream buffers, which can result in water quality impacts such as increased temperature, decreased bank stability, and reduced filtration and trapping of nutrients, sediment and other pollutants. Therefore, the focus of the Golf Course assessment has been to identify problem areas that can be corrected without impairing the ongoing use of the facility. A memorandum summarizing the results of the assessment visit was prepared by Steve Fiske (ANR 1998e).

As with numerous golf courses located in Vermont and elsewhere, there are many locations at the Stratton Golf Course where stream buffers are not considered optimal for water quality protection. There are also other activities on the Golf Course that have the potential to impact water quality, including unstable stream banks and runoff from cart paths. Stratton has been working proactively with Agency staff and local citizens to develop a plan for modifications to the Golf Course to address these issues, to the extent practical, without impairing use of the Golf Course.

Based on the results of the June 1998 site visit, Stratton has developed a plan for measures to be implemented at the Golf Course to improve stream buffers and address existing problem areas with respect to erosion. Some of this work has already been implemented during 1998, and additional efforts are planned in 1999. This plan is summarized in a memorandum prepared by Ralph Rawson of Stratton (Rawson 1998b), and site plan prepared by Technicon, P.C., and entitled "The Stratton Corporation, Golf Course Stream Improvements Site Plan", last revised May 10, 1999 (see map pocket 3)

4.3.2 Golf Course Onstream Ponds

As described above, there are several small onstream ponds located on the Golf Course. These ponds may result in water quality impacts within Tributary 2. An evaluation is planned of each of these ponds to determine the feasibility of modifications that would enable these ponds to be taken offstream. In addition, consideration of the relative water quality benefits and risks of taking the ponds offstream will be completed.

4.4 On-mountain Measures

The principal issues associated with on-mountain activities are soil erosion and runoff from ski trail and work road construction, isolated iron seeps resulting from disturbance of saturated soils, and inadequate revegetation (in places) of cleared or disturbed areas. Problem conditions may be particularly acute in areas where streams are close to disturbed sites.

In order to ensure that existing areas of impact are adequately addressed and that new areas of impact are avoided in the future, the following approach is proposed:

1. During summer 1999, a walkover and inventory of all existing ski trails, work roads, and utility corridors within the ski area portion of the resort will be performed by Stratton and Pioneer personnel. This walkover will focus on those areas within 200 feet of existing streams. Any problem conditions, including erosion, iron seeps, inadequate vegetation, and water management (water bars, culverts) will be identified and mapped.

2. Based upon the walkover an action plan will be prepared to describe remedial measures to be undertaken to address the identified areas of impact.

3. The plan will be included in the 1999 Annual Report, which will be provided to the ANR, the District 2 Environmental Commission, SACC and other interested parties for review prior to implementation (see section 5.5).

4. All future trail and lift construction will be performed in accordance with the *Class A Watershed Ski Trail BMPs*, or other equivalent documents in effect at the time.

The objective of these measures is to ensure that soils on the ski mountain are adequately stabilized to prevent erosion and further sediment loading to the downstream channel segments.

4.5 Modification of On-stream Ponds

In addition to Stratton Lake, which was taken offstream in 1996, there are several smaller onstream ponds at Stratton Mountain Resort, that may play a role in water quality degradation in the vicinity of the resort. These include Snyder Pond (also known as Base Lodge Pond) and three small onstream ponds at the Stratton Mountain Golf Course. Although the specific water quality alterations associated with these ponds have not been studied in detail, it is reasonable to conclude that impacts to water quality including temperature, turbidity, and nutrient alterations are occurring at these sites.

Stratton is currently investigating the potential opportunities, as well as regulatory issues, associated with voluntarily taking some or all of these existing onstream ponds above offstream. The results of these analyses will be provided as a basis for review of potential future measures at these sites.

4.6 Non-point Source Control and Elimination

There are many non-point sources that are not directly under the control of Stratton Mountain Resort in the vicinity of the resort. These include a number of existing paved and gravel-surfaced roads, as well as hundreds of privately-owned lots, many of which have houses, driveways and lawns. Similarly, existing private roads which access residential housing in the vicinity are located within existing rights-of-way and provide little or no opportunity for drainage modifications, without impacting existing homeowners. In addition, there are also several commercial facilities such as inns, lodges, stores, and restaurants in the vicinity that are not owned or controlled by Stratton. There are numerous existing condominium projects in the vicinity of the resort, which have private associations that determine the management practices to be implemented at these individual sites. Finally, the Stratton Mountain Road, an existing town road in Winhall and Stratton with contaminants including sand and road salt used for winter de-icing is likely a significant contributor to water quality impacts.

There are a number of properties located in the impaired watersheds that may be contributing to the impairment, such as being siltation sources, but are not owned or controlled by Stratton Corporation. These include existing condominium developments, such as Shatterack, Obertal, and Vantage Point. We recommend that these areas be examined in the summer of 1999 in a site tour including representatives of Stratton and the Agency of Natural Resources, and property managers to the extent feasible. Where the Agency deems it appropriate, the

Agency will seek voluntary cooperation by the property owners and managers to address the situation. Where that is unsuccessful, the Agency will act pursuant to its authority, including 10 VSA section 1272, to order abatement or such other action as it deems appropriate. This partnership approach is important to the overall success of the remediation efforts because these are contributing sources of impairment over which Stratton Corporation has no legal authority or control.

It is unrealistic to expect that Intrawest can succeed in obtaining cooperation from all affected landowners to make changes in ongoing operations to reduce or abate all existing water quality impacts in the area. However, as assessment continues, efforts have been and will continue to be made to identify off-property actions that could enable further water quality improvements within the targeted impaired waters. In addition, Intrawest is committed to working with private homeowners and condominium associations to provide technical assistance and guidance in the implementation of maintenance and management practices which minimize water quality impacts. To this end, Stratton will work with the Agency to develop and implement a specific outreach and education effort to alert other landowners in the watershed of the importance of their activities with respect to water quality management.

During the on-mountain reconnaissance work scheduled for summer 1999, private roads in the area will also be systematically inspected to locate problem areas with respect to erosion, sediment export to streams, and iron seeps. The results of this inspection with recommended action areas will be included in the 1999 Annual Report.

4.7 In-stream Habitat Remediation

The assessment work performed to date suggests that at certain locations within the tributaries to Stratton Lake instream habitat remediation efforts may be warranted. This could include efforts such as redirecting streamflow into natural channels where prior diversions have occurred, as described in section 4.2.8. In addition, the placement of log dams to control sediment that is already in motion within the stream system is a measure, which should be considered selectively. Finally, the stabilization of eroding banks and other similar types of activities may be justified in certain areas where past hydrologic changes have occurred.

Prior to implementation of any such work, a detailed field assessment of stream channel morphology and characteristics using the methodology of Rosgen (Rosgen 1996) would be performed. This would involve site specific assessment of numerous factors including sensitivity to disturbance, recovery potential, sediment supply, streambank erosion potential and influence of vegetation. The field work is proposed for completion during summer 1999. From this information, a specific plan will be developed for inclusion in the 1999 Annual Report, and appropriate regulatory reviews completed.

4.8 Remediation Opportunities at Stratton Lake

To better understand the dynamics of Stratton Lake with the pipe installed and operational, a limnological assessment of the lake has recently been performed (Folt 1998). This analysis was conducted by Carol L. Folt, Ph.D. in Limnology, of Dartmouth College. Dr. Folt's analysis concludes that the lake is likely mesotrophic under current conditions and several measures are recommended to improve water quality conditions in the future. Stratton will proceed with the implementation of measures described in the report to further evaluate conditions within Stratton Lake and identify future remediation opportunities.

4.9 Existing Areas of Iron Seeps

In the past, observations have been made at various areas within the Stratton Resort Development relating to the occurrence of iron staining. As has been observed elsewhere in Vermont, the iron precipitation occurrences are associated with areas where low-pH, iron-rich glacial till soils have been disturbed and placed as fill materials at/or beneath the water table. These conditions constitute anoxic, or oxygen poor conditions. Under these conditions, iron contained in the soil materials is converted from an insoluble (ferric) form to a highly soluble (ferrous) form. The resulting mobilization of iron and its subsequent conversion mediated by bacterial action to an insoluble form results in the brightly colored iron seeps which have been observed. Thus, this occurrence is dependent on the presence of iron as well as low pH and low Eh (oxygen reduction potential) conditions.

The remediation of existing iron seeps is considerably more difficult than the prevention of new ones, because the exact point at which the seep is originating (i.e. the point of contact between native iron-rich glacial till soils and the water table) is often unknown or inaccessible. Therefore, the removal of material to eliminate the source of the seepage is not always possible. However, significant areas within the impaired watersheds have been identified for evaluation and implementation of iron seep controls:

- Below Stratton Lake along fairway L8 of Golf Course
- Embankment below Stratton Mountain Inn along roadside
- Swale below Liftline Lodge
- Area between Stratton Lake and diversion pond
- Adjacent to Tributary 2 above diversion pond
- Between fairways F2 and F8 on Golf Course

As other areas are identified, implementation of iron seep controls at these locations will be evaluated.

4.10 Other BMPs to be Implemented

In addition to the measures or modifications previously described, there are several management and maintenance type changes that are recommended to be consistent with Stratton's objectives of water quality remediation, and most importantly the continuation of practices that minimize the potential for future water quality degradation. Generally, these are termed "Best Management Practices" or BMPs, and should be considered for implementation at all applicable locations within the resort property. Some of these practices are already be underway and will be continued. However, it is important that a single individual at the resort be charged with the ongoing responsibility of overseeing the implementation and maintenance of the following BMPs:

- Regular catch basin cleaning
- Regular detention basin cleaning
- Regular lake weir cleaning
- Re-use and/or proper disposal of dredged materials
- Street and paved area sweeping
- Fertilizer management (lawns)
- Fertilizer and pesticide management (Golf Course)
- Litter control and cleanup

In addition, review of several existing practices at the resort will be made with the objective of making modifications to these practices if possible to minimize potential water quality impacts.

- Review of snow plowing practices → ongoing / urgent
- Review of sand grain size used for winter sanding → coarsest mat'l
- Evaluation of alternate grass seed mixes for ski trails → revised summer 2000

To begin the effort of implementation of these BMPs, Stratton has assigned Bill Nupp, Permit and Planning Manager, with the task of overseeing this work. Implementation of these measures has already begun, and will continue on an ongoing basis.

4.11 Future Development Controls

An important component of the water quality remediation plan is to ensure that following the implementation of the measures described herein future development of new projects at the resort not result in new non-point source pollution that would create new impairments.

The specifics of the approach used in the design of Master Plan projects, which will take advantage of opportunities to make water quality improvements, are as follows:

- Identification of appropriate sites for future development which respect natural resource constraints, sensitive areas, and generally represent either redevelopment of previously disturbed sites, or "in-fill" between existing development at the resort.

- Applying current state-of-the-art technologies to proposed development projects (strict erosion control during construction, runoff control and treatment which exceed requirements, iron seep management)

- Addressing existing problem areas as an integral component in the design of new projects.

Specific methodologies have been used in the Master Plan analyses to ensure that cumulative impacts are considered and remediation opportunities are identified. With respect to stormwater runoff evaluation and management, the methodology:

- uses a watershed-wide approach
- considers soils, slopes, vegetative cover, management practices
- details assessment of individual subwatersheds (60 +/-)
- evaluates a broad range of storms (2, 10, 25 year)
- provides a more comprehensive analysis than simply looking at general percent impervious cover
- provides a basis for planning, design, and management
- meets or exceeds ANR Stormwater Management Procedures

4.12 Future Iron Seep Management

To avoid the occurrence of iron seeps in the future, resulting from disturbance, reworking or fill placement in areas of saturated soils at the resort, the following measures will be implemented as a part of future development projects at Stratton. The most important premise is that low pH iron-rich glacial till soils must not be used as fill materials within portions of proposed development sites where saturated ground conditions are to be expected.

The implementation of the Iron Seep Control Plan is as follows:

1. At risk areas will be identified in the field prior to construction and as construction proceeds within each specific development area. Generally, these areas will include locations of wet soils, seeps and springs, and areas of water ponding where the placement of fill is proposed.

2. Following identification of these areas, confirmation of the necessity and extent of special fill treatment will be made with project erosion control specialist.

3. Within each of these areas, native topsoil materials will be removed to a depth of at least 2 feet below native ground surface.

4. These zones will then be backfilled with crushed limestone of 2 inch or smaller size to original ground surface elevation.

5. As needed, provisions will be made for the drainage of groundwater within the soil replacement area. This will be determined on a case-by-case basis and may include a gravel pad, additional crushed limestone, or drainage pipe downslope of the treatment area.

6. A continuous layer of geotextile fabric will then be placed over the limestone materials throughout each treatment area.

7. Common fill material will then be placed to achieve grades as specified by proposed site plans.

The implementation of this plan will ensure the avoidance of the key element which leads to the occurrence of iron seeps, namely the placement of iron-rich fill materials below the water table where iron transformations and release can occur.

On an overall basis, the methodologies and approaches described above are geared toward ensuring that no increased non-point source pollution will result from the development of Master Plan projects.

5.0 SCHEDULE OF IMPLEMENTATION

5.1 Implementation of Remedial Measures

An overall schedule for remedial measure implementation is provided on page 7 of the Appendix. This schedule will be updated and refined on an annual basis as annual performance reports are prepared. For the first year of implementation the following more specific schedule of remedial measures is proposed:

Date	Action
Already complete	Elimination of parking lot #3
Already complete	Implementation of parking lot #4 treatment measures
June-October 1999	Implement first set of controls on existing iron seeps

Date	Action
June-October 1999	Implement 1999 work plan for Golf Course buffer improvements
July 1999	Complete Styles Brook buffer assessment at Stratton Mountain Golf School
August 1999	Complete design of parking lot #5/maintenance facility stormwater treatment facility
September 1999	Complete design/construction of sprayfield stream relocation to original channel
September 1999	Complete wastewater treatment plant access drive improvements
October 1999	Complete mountain and private road walkovers
October 1999	Complete implementation of instream habitat remediation measures
December 1999	Physical habitat and biological monitoring and data analysis
February 2000	Complete assessment of feasibility and alternatives for stormwater management from Village
May 2000	Complete Annual Report on 1999 implementation and monitoring results

These dates are dependent upon the ability of Stratton to obtain permits as needed for the proposed measures, and in some cases, to obtain permission from other landowners. The 1999 Annual Report will provide modified or adjusted dates, as appropriate, for the subsequent years of implementation of the plan.

5.2 Master Plan Implementation

Included in map pocket 1 is a drawing which depicts all elements of Stratton's proposed master plan. This includes real estate development projects that have been built, are under construction, are currently being reviewed, or have not yet been designed. In addition, on mountain components, including new and replacement lift alignments and the proposed 220 acres of additional ski trails are shown on this drawing.

A summary of the implementation status of all proposed master plan projects, as well as large scale water quality remediation projects, is provided on page 8 of the Appendix. The summary is arranged by watershed, and, in general, chronologically within each watershed. The specific timing of future real estate or on-mountain development projects cannot be firmly established by Stratton because the implementation of these projects are subject to economic constraints, and thus Stratton cannot accurately state when such projects will go forward. However, as shown previously, the implementation of water quality remediation measures is tied to specific dates as are the estimated water quality targets. The plan is "front loaded" to address major sources of impairment early in the master plan buildout, to ensure that at the conclusion of the master plan development period water quality remediation has been achieved.

5.3 Proposed Water Quality Targets

Water quality restoration targets have been established for Styles Brook and Tributary 1, which are currently on Vermont's 303(d) list of impaired, impacted and endangered waters. The purpose of the target goals is to provide numerical benchmarks for water quality improvement as remedial measures are implemented and Master Plan developments are constructed. Water quality targets are specified for the aquatic biota and sediment. Because the past aquatic biota information has been used by the ANR as a basis for inclusion of these waters on the 303(d) list, the use of biocriteria will provide the most direct indication of the results of remedial measure implementation. Sediment targets have also been specifically provided, since much of the currently impaired condition is due to sediment loading, and documentation of improvements is expected to go hand in hand with the response of the biologic community.

5.3.1 Aquatic Biota Targets

The class B biocriteria as implemented by ANR, which provide the water quality attainment levels for the targeted streams, are as follows:

Biometric	Class B Criterion
Density	> 500
Richness	$\geq$ 30
EPT	$\geq$ 18
EPT/Richness	> 0.45
Biotic Index	< 2.75
EPT/EPT & c	> 0.45
% Dominance	< 40%

Incremental target goals have been established for the third through fifth year following the completion of remediation activities within the watershed of Styles Brook and Tributary 1. Five years was set as a reasonable time period to achieve water quality standards. This allows for time for remediation activities to be put in place and modified if needed. It also allows for time for sediment which is currently in transport in the streams to be removed from the stream system.

Macroinvertebrate kick net data will be evaluated to determine if Styles Brook and Tributary 1 are meeting Class B biocriteria. Sampling of the aquatic biota is a useful tool because macroinvertebrates provide an overall representation of water quality conditions in a stream, and yet respond relatively quickly to changes in water quality. Samples will be collected using the two minute kick net procedure. Macroinvertebrate sampling will take place during the fall of each year. Replicate kick net samples will be collected in riffle habitat at a representative location in the vicinity of current ANR historical sampling stations.

5.3.2 Sediment Targets

Styles Brook and Tributary 1 are currently impaired due to sedimentation. The percent Oligochaeta (worms), percent embeddedness, and the pebble count procedure will be used to track the reduction in sedimentation over time. Therefore, both a biological and physical benchmark for monitoring sediment will be provided. A summary of the sediment restoration targets is provided below.

Sediment Index	Target Value
Embeddedness	< 25%
% *Oligocheata*	< 5%
Pebble Count	To be determined

The biological component of sediment monitoring will involve determining the percentage of *Oligochaeta* in each kick net sample. Kick net sampling will be performed at Styles Brook RM 0.8 and Tributary 1 RM 0.2. Oligochaeta (worms) are collector gatherers, and are an important group to study to evaluate sediment impacts. Collector gatherers are depositional feeders which colonize on or within the interstitial spaces where sand accumulates.

Two physical measures of sedimentation will be monitored at the ANR biological sampling stations. These parameters include substrate embeddedness (percent fines) and percentage of small particles using the pebble count procedure. During the summer or fall of each year, substrate embeddedness will be estimated to the nearest quartile following Bovee (1986).

The Pebble Count Procedure assesses the composition of stream channel materials. Shifts in small particle sizes will be evaluated using the Pebble

Count procedure outlined in Bevenger and King (1995). A zig-zag pattern of moving upstream from bankfull to bankfull across all habitat features will be employed. Styles Brook and Tributary 1 will be compared to target goals developed from reference streams within the Stratton Area. Reference streams will be selected to match assessment sites (Styles Brook and Tributary 1) in terms of valley type, valley slope, channel slope, and substrate. The Pebble Count Procedure will be employed at reference sites and assessment sites during Summer/Fall 1999 to determine the portion of small particles within each sampling reach. Three replicates of 100 pebble samples will be collected within each reach. A cut-off such as 8 mm will be used to define small particles. Target goals will be set to be a percentage of small particles which are an acceptable deviation from reference conditions.

5.3.3 Styles Brook Water Quality Goals

Macroinvertebrate kick net data collected from Steve Fiske (ANR) and Catherine Szal of Pioneer have demonstrated that currently Styles Brook at river mile 0.8 does not meet the statewide Class B biocriteria. The community assessment for each of the four sampling events resulted in fair.

As shown in the table below, density and EPT Richness were less than Class B biocriteria in all years sampled and are the primary metrics which should be targeted to track water quality improvement. Two other metrics Species Richness and EPT/Richness did not meet the Class B biocriteria on every occasion. Species Richness was less than the cut-off of greater than or equal to 30 organisms on one of the four sampling dates. The ratio of EPT/Richness was just slightly below the cut-off of less than 0.45 on one of the four sampling dates. The low densities and EPT Richness coupled with the high percent of *Oligochaeta* (worms) and the embeddedness rating provide strong evidence that sedimentation is impacting the aquatic community of Styles Brook.

Styles Brook
Biomonitoring Data From River Mile 0.8
Kick Net Results

Biometric	Sampling Date				Class B Biocriteria
	10/05/93 ANR	10/03/94 ANR	9/14/98 ANR	10/2/98 Pioneer	
Density	**167**	**214**	**397**	**140**	>500
Species Richness	30	30.5	38.0	**24**	≥30
EPT Richness	**16.0**	**15.0**	**15.0**	**13.0**	≥18
EPT/Richness	0.53	0.49	**0.39**	0.54	>0.45
Bio Index	1.31	1.52	2.21	1.61	<2.75

Styles Brook Biomonitoring Data From River Mile 0.8 Kick Net Results (continued)					
Biometric	Sampling Date				Class B Biocriteria
	10/05/93 ANR	10/03/94 ANR	9/14/98 ANR	10/2/98 Pioneer	
EPT/EPT&C	0.85	0.83	0.84	0.68	>0.45
% Dominant Taxa	18	20	25	24	<40
Community Assessment	fair	fair	fair	fair	
Sediment Indicators:					
% Oligochaeta	12.9	28.3	28.5	6.2	Not applicable
Embeddedness	50-75%	50-75%	50-75%	50-75%	Not applicable
Bold - indicates that biometric did not achieve Class B criterion					

In the Styles Brook watershed, it is anticipated that remediation activities will be completed by the end of 2000. Target metrics for Class B biocriteria include density, Species Richness, EPT Richness, and EPT/Richness. No interim water quality goals have been set for the other Class B biometrics which include Bio Index, Diversity, EPT/EPT&C, and percent Dominant Taxa. These other metrics currently meet or exceed Class B standards and are expected to respond positively to plan implementation.

Water Quality Targets - Aquatic Biota Styles Brook (Watershed C)				
Year	Biocriteria			
	Density	Species Richness	EPT Richness	EPT/Richness
2001	monitor[1]	monitor	monitor	monitor
2002	monitor	monitor	monitor	monitor
2003	>350	≥30	≥16	>0.45
2004	>400	≥30	≥17	>0.45
2005[2]	>500	≥30	≥18	>0.45

[1]No target goals set for the first two years following construction and remediation activities
[2]Target to meet Class B biocriteria by 2005

Percent Oligochaeta, Substrate Embeddedness, and the Pebble Count are listed in the table below, with the incremental target values for years 3 through 5, following the completing of construction/implementation of measures designed to improve water quality. As described above, the goals for the Pebble Count Procedure will be developed during Summer/Fall 1999 after data on reference and assessment sites are collected. Target goals for sediment specify that the percentage of Oligocheata in a kick net sample will be less than 5% and substrate embeddedness will be reduced to less than 25%.

Water Quality Targets - Sediment Styles Brook (Watershed C)			
Year	**% Oligocheata**	**Substrate Embeddedness**	**Pebble Count**
2001	monitor[1]	monitor	monitor
2002	monitor	monitor	monitor
2003	<15%	<50%	TBD[2]
2004	<10%	<50%	TBD
2005	<5%	<25%	TBD

[1]No target goals set for the first two years following construction and remediation activities
[2]Baseline data to be collected and goals to be developed during summer/fall 1999.

As remedial measures are implemented and monitoring data are collected within the targeted impaired waters, some modification of these target dates may be required in the future. Progress in comparison to targets will be discussed in annual reports, along with any recommended schedule modifications.

5.3.4 Tributary 1 Water Quality Targets

Aquatic macroinvertebrate data was collected by Steve Fiske, ANR at river mile 0.2 on the main branch of Tributary 1 in October 1997. The results of the October 1997 sampling and current Class B biocriteria are compared in the table below. The community assessment resulted in an outcome of poor. Tributary 1 was low in terms of density and EPT Richness. Pollution tolerant taxa were found to dominate the community as reflected by the metrics EPT/Richness and EPT/EPT&C. The Bio Index of 2.76 indicates the site is enriched for a stream of this type, but is close to meeting the Class B biocriteria (less than 2.75) for this metric. The low percentage of water quality sensitive EPT organisms and the high percentage of Oligochaeta (31%) is a reflection of habitat degradation due to sedimentation. The substrate was estimated by the ANR to be greater than 75% embedded.

Inlet Streams to Stratton Lake ANR Biomonitoring Data From Tributary 1 October 1997 Kick Net Results		
Biometric	**Tributary 1**	**Class B biocriteria**
Density	**299**	>500
Species Richness	41	>30
EPT Richness	**11**	>18
EPT/Richness	**0.27**	>0.45
Bio Index	**2.76**	<2.75
EPT/EPT&C	**0.20**	>0.45
% Dominant Taxa	21 (Cricotopus)	<40
Community Assessment	poor	
Other Indicators:		
% Oligochaeta	31	Not applicable
Embeddedness	>75%	Not applicable
Bold - indicates that biometric did not achieve Class B cut-off.		

Remediation activities are expected to be competed in Watershed B (Tributary 1) by 2001. Interim water quality goals have been established for 3 and 4 years following these activities with the intent of meeting Class B biocriteria by year 5. Target metrics include: Density, EPT Richness, EPT/Richness, and EPT/EPT&C. Class B metrics which are currently met are Species Richness and percent Dominant Taxa. Bio Index has not been included as an interim target because the October 1997 value was borderline for meeting Class B biocriteria. The metrics which currently meet or exceed Class B biocriteria are expected to remain the same or improve as a result of plan implementation.

Water Quality Targets - Aquatic Biota Tributary 1 (Watershed B)				
	Class B Biocriteria			
Year	Density	EPT Richness	EPT/ Richness	EPT/ EPT&C
2001	monitor[1]	monitor	monitor	monitor
2002	monitor	monitor	monitor	monitor
2003	>350	≥14	>0.35	>0.25
2004	>400	≥16	>0.40	>0.35
2005[2]	>500	≥18	>0.45	>0.45

[1] No target goals set for the first two years following construction and remediation activities
[2] Target to meet Class B biocriteria by 2005

Target sediment goals for Tributary 1 have also been set for percent Oligocheata, substrate embeddedness, and the percentage of small particle sizes as determined by the Pebble Count Procedure. By 2005, the percentage of Oligocheata is expected to be less than 5%, and substrate embeddedness is targeted to be less than 25%. As discussed above, target goals for small particles will be developed this summer after the channel material has been sampled using the Pebble Count Method at both reference and assessment sites.

Water Quality Targets - Sediment Tributary 1 (Watershed B)			
Year	% Oligocheata	Substrate Embeddedness	Pebble Count
2001	monitor[1]	monitor	monitor
2002	monitor	monitor	monitor
2003	<20%	<75%	TBD[2]
2004	<10%	<50%	TBD
2005	<5%	<25%	TBD

[1] No target goals set for the first two years following construction and remediation activities
[2] Baseline data to be collected and goals to be developed during summer/fall 1999

As remedial measures are implemented, and monitoring data are collected within the targeted impaired waters, modification of these target dates may be required. Progress in comparison to targets will be discussed in annual reports, along with any recommended schedule modifications.

In summary, the following schedule for restoration of water quality is envisioned, consistent with the VWQS and the current Class B biocriteria applied by ANR:

Stream Name	Target Date
North Branch below Lake (watershed H)	Bypass implemented, water chemistry and biota restored, continue monitoring
Tributary 2 (watershed A)	Currently meets VWQS, further improvements by Fall 2003
Styles Brook (watershed C)	Fall 2005
Tributary 1 (watershed B)	Fall 2005

5.4 Monitoring Approach

Following approval of this plan, a detailed Quality Assurance/Quality Control (QA/QC) plan describing the specific monitoring locations, parameters, and methodologies will be submitted to the ANR Water Quality Division. The purpose of this monitoring effort would be to obtain a reliable baseline documenting existing conditions, and to track future changes in water quality resulting from implementation of this plan. Data collection would occur for 5 years, beginning in 1999. The results of this data collection would be submitted to ANR in the form of an annual performance report to be completed for each year from 2000 through 2005.

The following information provides an outline of the approach to be used to fulfill the monitoring requirements of this plan.

5.4.1 Water Quality Monitoring Locations

A total of 25 monitoring locations are identified in this plan as part of the Stratton Mountain Resort Master Plan monitoring program. Eleven of these monitoring stations are currently sampled as part of the ANR biomonitoring program, the Indirect Discharge Permit Program, and the 401 monitoring program. However, the frequency of monitoring, the length of monitoring programs, and the number of monitoring parameters have been increased at existing stations as part of this Water Quality Remediation Plan, and are detailed in section 5.4.2. A total of 14 new stations have been added to facilitate the tracking of water quality improvements brought about through implementation of this plan. The rationale for station selection is provided below.

Watershed A - Tributary 2	
Station Description	**Rationale for Station Locations**
Below Ski Trails and Work Roads	Downgradient of ski trails and work roads; monitor improvements in on the mountain operations and erosion control
Above Golf Course	Upgradient of Stratton Golf Course
Below Golf Course- (ANR RM 0.1)	**Compliance point on Tributary 2 for Class B biocriteria).** Also, downgradient monitoring location for Golf Course improvements

Watershed B- Tributary 1	
Station Description	**Rationale for Station Locations**
Main Branch - Below Ski Trails and Work Roads (above Snyder Pond)	Downgradient of ski trails and work roads; monitor improvements in on the mountain operations and erosion control
Main Branch -Below Snyder Pond	Document influence of Snyder Pond on water chemistry and temperature regime; monitor improvements to Tributary 1 by taking Snyder Pond off stream in 2001
Main Branch - Below Stratton Mountain Access Road	Monitor reduction in sediment loading by improving erosion control along access road
Station Description	**Rationale for Station Locations**
Main Branch - Below WWTF and above Golf Course	Monitor reduction in sediment loading through implementation of erosion control measures in 1999 adjacent to WWTF drive; upgradient temperature monitoring location for Golf Course
Main Branch - Above confluence of East Branch (RM 0.2)	**Compliance point #1 on Tributary 1 for Class B biocriteria;** downgradient monitoring location for Golf Course improvements
Middle Branch - Above Confluence with Main Branch	Monitor reduction in sediment loading as result of Village Center/Commercial Development work. Document possible changes in nutrients levels from relocating stream through old spray field.
East Branch - Below Ski Trails and work roads	Downgradient of ski trails and work roads; monitor improvements in on the mountain operations and erosion control
East Branch between Quarter Mile Road and Maple Hill Road	Upper watershed monitoring location directly below village and existing parking lots slated for remediation
East Branch - Above confluence with Main Branch	**Compliance point #2 on Tributary 1 for Class B biocriteria;** downgradient monitoring location for Golf Course improvements

Watershed C - Styles Brook	
Station Description	**Rationale for Station Locations**
Below Ski Trails and Work Roads and above maintenance area	Downgradient of ski trails and work roads; monitor improvements in on the mountain operations and erosion control
Below maintenance area	Monitor sediment reduction in sediment loading by improving erosion control and operations of maintenance facility and sand storage area
ANR RM 0.8	**Compliance point #1 on Styles Brook for Class B biocriteria** - ANR historical biomonitoring station
Above Confluence with North Branch	**Compliance point #2 on Styles Brook for Class B biocriteria;** downgradient of Stratton Glen Project

Watershed E - Brazer's Brook	
Station Description	**Rationale for Station Locations**
ANR RM 0.7	**Compliance point on Brazer's Brook for Class B biocriteria** - ANR historical biomonitoring station
Watershed H - Lower North Branch Brook	
Station Description	**Rationale for Station Locations**
Stratton Lake - surface	401 monitoring[1]
NB1	401 monitoring
Station 8 - IDP Above 1984 Spray Site	IDP monitoring[2]
Station 9 - IDP Below 1984 Spray Site	IDP monitoring
NB2 (RM 3.9)	**Compliance point #1 on North Branch for Class B biocriteria;** 401 monitoring
NB3 (RM 2.2) - just above Kidder Brook confluence	**Compliance point #2 on North Branch for Class B biocriteria;** 401 monitoring
Pikes Falls	Outstanding Resource
Watershed G - Kidder Brook	
Kidder Brook - ANR Station	Reference site

[1] evaluates water quality improvements in North Branch Brook following bypass construction
[2] required by Indirect Discharge Permit #9-0019/0044

The final selection of individual sites will be discussed in the QA/QC plan and subject to field verification with the ANR staff. Discontinuation of monitoring at individual sites over time will be evaluated in consultation with the Agency.

5.4.2 Monitoring Parameter Rationale

Described below are the types of monitoring data to be collected as plan implementation occurs. The rationale for each type of data collection is provided and a summary table depicting the proposed sampling network design is included.

<u>Water Chemistry</u>

Sampling for nutrients and metals is proposed for the main branch of Tributary 1 above and below Snyder Pond (also known as Base Lodge Pond). Snyder Pond is scheduled to be eliminated or taken off stream in 2001. Monitoring of Tributary 1 above and below Snyder Pond will help define the influence of the pond on the chemistry of Tributary 1, and will be valuable in tracking expected water quality improvements in nutrient and metals after the pond is taken off stream.

Water chemistry monitoring at several locations on the inlet streams to Stratton Lake provides useful information about nutrient enrichment to these streams and loading of nutrients to Stratton Lake and the North Branch below Stratton Lake. Nutrient sampling is scheduled to occur directly above the Lake on Tributary 2, the Main Branch of Tributary 1 and the East Branch of Tributary 1. A station on the Middle Branch, directly below the Village will be sited to monitor possible nutrient loading from developed areas and improvements in water chemistry brought about by the remediation of the Village Center/Commercial Development.

An additional station on the Middle Branch will be sited to assess nutrient levels after the stream is relocated. Years ago the Middle Branch was culverted and flow was diverted around the original spray site. The original spray site is no longer in operation and there is a proposal to relocate the stream so that it once again flows through the old spray site.

Nutrient monitoring of Pikes Falls, designated as an Outstanding Resource Water (ORW), will be conducted to address concerns raised about possible excessive algal growth from nutrient enrichment.

Monitoring below Stratton Lake is required by condition U of the Water Quality Certification dated May 8, 1996, issued to The Stratton Corporation for their snowmaking project as part of the 401 permit. The North Branch monitoring program was designed to collect post-bypass monitoring data for three years (1997 through 1999) following Stratton Lake being taken off stream. As part of this monitoring program for the Stratton Master Plan, the North Branch monitoring is being extended five years, with the last year of data collected expected to take place in 2005. Monitoring stations, parameters, and frequency of sampling is the same as has been outlined in the QA/QC plan for the project dated December 27, 1996. Samples will continue to be collected from Stratton Lake, NB1, NB2, and NB3.

Sediment

The assessment of substrate composition using the Pebble Count Procedure and percent embeddedness will be an important component of the monitoring plan. Both Styles Brook and Tributary 1 are currently on the Vermont 303(d) list with sediment cited as an water quality impairment. The sediment monitoring will be used to track improvements brought about through implementation of the Master Plan Water Quality Remediation Plan and to monitor construction activity.

A total of 21 locations have been identified for sediment monitoring. Many of these sediment monitoring stations coincide with locations where kick net sampling and habitat surveys will take place. Sediment information will be used in conjunction with other habitat data and the biological data to track improvement and identify impairments in the watershed. Locations have been selected to monitor sediment directly below ski trails and work roads in Watersheds A, B, and C. Improved erosion control on the Mountain is scheduled to be implemented beginning in 1999.

Sediment monitoring stations will also be sited above and below the Stratton Golf Course on both Tributary 1 and 2 to monitor reductions in sediment as a result of stream bank stabilization, maintenance of no mow zones, erosion control through more appropriately spaced water bars, paving of Golf Course paths, riparian planting of native shrubs, and other activities to improve water quality. Golf Course improvements are scheduled to be implemented in 1999 through 2000.

Sediment monitoring locations have been selected to monitor the following specific remediation activities:

- Stratton Access Road (ongoing)
- WWTF drive (1999)
- Maintenance Facility/Sand Storage Area

Temperature

Water temperature monitoring will be conducted at paired locations above and below identified structures or activities which may result in warming of streams. Monitoring locations identified in the table include:

- Tributary 2 upstream and downstream of Golf Course
- Tributary 1 upstream and downstream of Snyder Pond
- Tributary 1 upstream and downstream of Golf Course
- North Branch directly below Stratton Lake

Water temperature monitoring will also be conducted on Kidder Brook to serve as a reference. One data logger will be used to monitor air temperature during each summer of the seven year study. This will be valuable in comparing data collected year to year.

Macroinvertebrate Kick Net Sampling and Habitat Surveys

Aquatic biomonitoring locations have been identified at historical ANR monitoring locations, as indicated in table below. Additional sampling locations have been added just above the mouth of major branches. Kick net sampling conducted as part of the Indirect Discharge Permit monitoring program at North Branch stations 8 and 9 will also be used as part of this monitoring program. Macroinvertebrate kick net sampling and habitat surveys will be conducted at stations yearly during September or October. The ANR biological monitoring station on Kidder Brook will be used as a reference to track unusual physical and biological conditions brought about by a major natural upset, such as drought, flood, etc.

Monitoring Parameter Rationale				
Watershed A - Tributary 2				
Station Description	**Water Chemistry**	**Sediment**	**Temperature**	**Kick net sampling and habitat survey**
Below Ski Trails and Work Roads		✓		
Above Golf Course		✓	✓	
Below Golf Course - (RM 0.1)	nutrients	✓	✓	✓
Watershed B - Tributary 1				
Station Description	**Water Chemistry**	**Sediment**	**Temperature**	**Kick net sampling and habitat survey**
Main Branch - Below Ski Trails and Work Roads (above Snyder Pond)	nutrient, metals	✓	✓	
Main Branch -Below Snyder Pond	nutrient, metals		✓	
Main Branch - Below Stratton Mountain Access Road		✓		
Main Branch - Below WWTF and above Golf Course		✓	✓	
Main Branch - Above confluence of East Branch (RM 0.2)	nutrients	✓	✓	✓
Middle Branch - Above Confluence with Main Branch	nutrients	✓		
East Branch - Below Ski Trails and work roads		✓		
East Branch between Quarter Mile Road and Maple Hill Road		✓		
East Branch - Above confluence with Main Branch	nutrients	✓		✓

Watershed C - Styles Brook

Station Description	Water Chemistry	Sediment	Temperature	Kick net sampling and Habitat survey
Below Ski Trails and Work Roads and above maintenance area		✓		
Below maintenance area		✓		
RM 0.8		✓		✓
Above Confluence with North Branch		✓		✓

Watershed E - Brazer's Brook

Station Description	Water Chemistry	Sediment	Temperature	Kick net sampling and Habitat survey
RM 0.7		✓		✓

Watershed H - Lower North Branch Brook

Station Description	Water Chemistry	Sediment	Temperature	Kick net sampling and Habitat survey
Stratton Lake	401 monitoring			
NB1	401 monitoring		✓	
Station 8 - IDP Above 1984 Spray Site	IDP monitoring			IDP monitoring
Station 9 - IDP Below 1984 Spray Site	IDP monitoring	✓		IDP monitoring
NB2 (RM 3.9)	401 monitoring	✓		✓
NB3 (RM 2.2) - just above Kidder Brook confluence	401 monitoring	✓		✓
Pikes Falls	nutrients			

Watershed G - Kidder Brook

Kidder Brook - ANR Reference Station		✓	✓	✓

Rainfall Data

A recording rain gauge will be installed in the vicinity of the Stratton Base Lodge (watershed B) and maintained during the summer months. Daily rain gauge information collected at the resort will provide an understanding of the magnitude of storm events, as well as general wetness or dryness of climate conditions.

Hydrologic Data

A rating curve developed at Station 9 as part of the Indirect Discharge Permit monitoring program will be used to provide streamflow information. Water level readings at the weir below Stratton Lake will also be used to provide streamflow estimates.

5.4.3 Specific Monitoring Parameters

The following discussion and summary provides additional details on the monitoring parameters to be included for each of the sampling matrices described previously.

Water Chemistry

Monitoring parameters for water chemistry sampling are shown below.

Water Chemistry Sampling				
Parameter	**Nutrients**	**Metals**	**401 Monitoring**	**IDP Monitoring**
pH (s.u.)	✓		✓	✓
chloride (mg/L)	✓		✓	✓
ammonia, nitrogen (mg/L)	✓			✓
nitrite, nitrogen (mg/L)	✓			✓
nitrate, nitrogen (mg/L)	✓			✓
total Kjeldahl nitrogen (mg/L)	✓			✓
total phosphorus (mg/L)	✓		✓	✓
total dissolved phosphorus (mg/L)	✓		✓	✓
biological oxygen demand -BOD_5 (mg/L)				✓

Water Chemistry Sampling (continued)				
Parameter	Nutrients	Metals	401 Monitoring	IDP Monitoring
alkalinity (mg/L)	✓			✓
total suspended solids (mg/L)			✓	
turbidity (mg/L)			✓	✓
conductivity (umhos)	✓		✓	
temperature (°C)	✓	✓	✓	✓
total iron (mg/L)		✓	✓	
total dissolved iron (mg/L)		✓	✓	
total manganese (mg/L)		✓	✓	
total dissolved manganese (mg/L)		✓	✓	

Sediment

Two physical measures of sediment will be monitored at each of the sediment monitoring stations. These sediment parameters include an estimate of substrate embeddedness (percent fines) and percentage of small particles using the pebble count procedure. During the summer or fall for each of the seven monitoring years, substrate embeddedness will be estimated to the nearest quartile following Bovee (1986). The pebble count procedure assesses the composition of stream channel materials.

Habitat Surveys

Habitat conditions will be observed and recorded each fall at each of the biomonitoring sites within the study segment. Habitat data to be collected will include:

- percent substrate composition - using Wolman Pebble Count (Harrelson et al. 1994)
- percent embeddedness (Bovee 1986)
- percent canopy cover
- streambank stability (Platts et al. 1983)
- percent periphyton cover/type
- habitat type (e.g. pool, riffle, falls, run, etc.)
- pool depth
- riparian zone width and vegetation

The information will be recorded on a field sheet similar to that provided on pages 9 and 10 of the Appendix.

Stream Geomorphology

Stream geomorphic characteristics will be measured following Rosgen (1994 and 1996) to provide a level II assessment of stream reaches within watersheds A-E and H. The parameters will include:

- entrenchment
- width/depth ratio
- sinuosity
- channel materials
- slope
- steam width
- stream depth

5.4.4 Initial Monitoring Schedule

The following initial schedule is proposed, subject to finalization and revision within the QA/QC plan.

SCHEDULE OF TASKS AND PRODUCTS	
Date	**Task**
May 1999	Submit draft monitoring plan to ANR
June 1999	Select monitoring station in field with input from ANR and other groups
June - August 1999	Rosgen classification of stream reaches
June 1999	Install temperature data loggers
July 1999	First round of water chemistry samples at nutrient and metals sampling locations
August 1999	Second round of water chemistry samples at nutrient and metals sampling location
September 1999	Third round of water chemistry samples
September/October 1999	Macroinvertebrate Kick net sampling Habitat surveys Collect temperature data loggers
October 1999	Fourth round of water chemistry samples
May 2000	Submit 1999 Annual Report

5.5 Reporting

To provide a status report on the progress of plan implementation and monitoring results over time, it is proposed that an annual performance report be prepared for each year that the plan is in effect (1999 - 2005). The Annual Report will be completed in May, to cover all activities for the prior calender year. The specific components of the plan will include:

- Summary of monitoring data
- Implementation update of measures to be undertaken
- Update on feasibility and details of specific measures
- Status report with respect to water quality targets
- Revisions to targets or target dates (if needed)

As noted in section 5.4.4 the first Annual Report will be prepared in May 2000, for the activities and monitoring undertaken during 1999.

5.6 Amendment of Plan

As further data collection and assessment is performed, this plan will be amended as needed to reflect the updated information.

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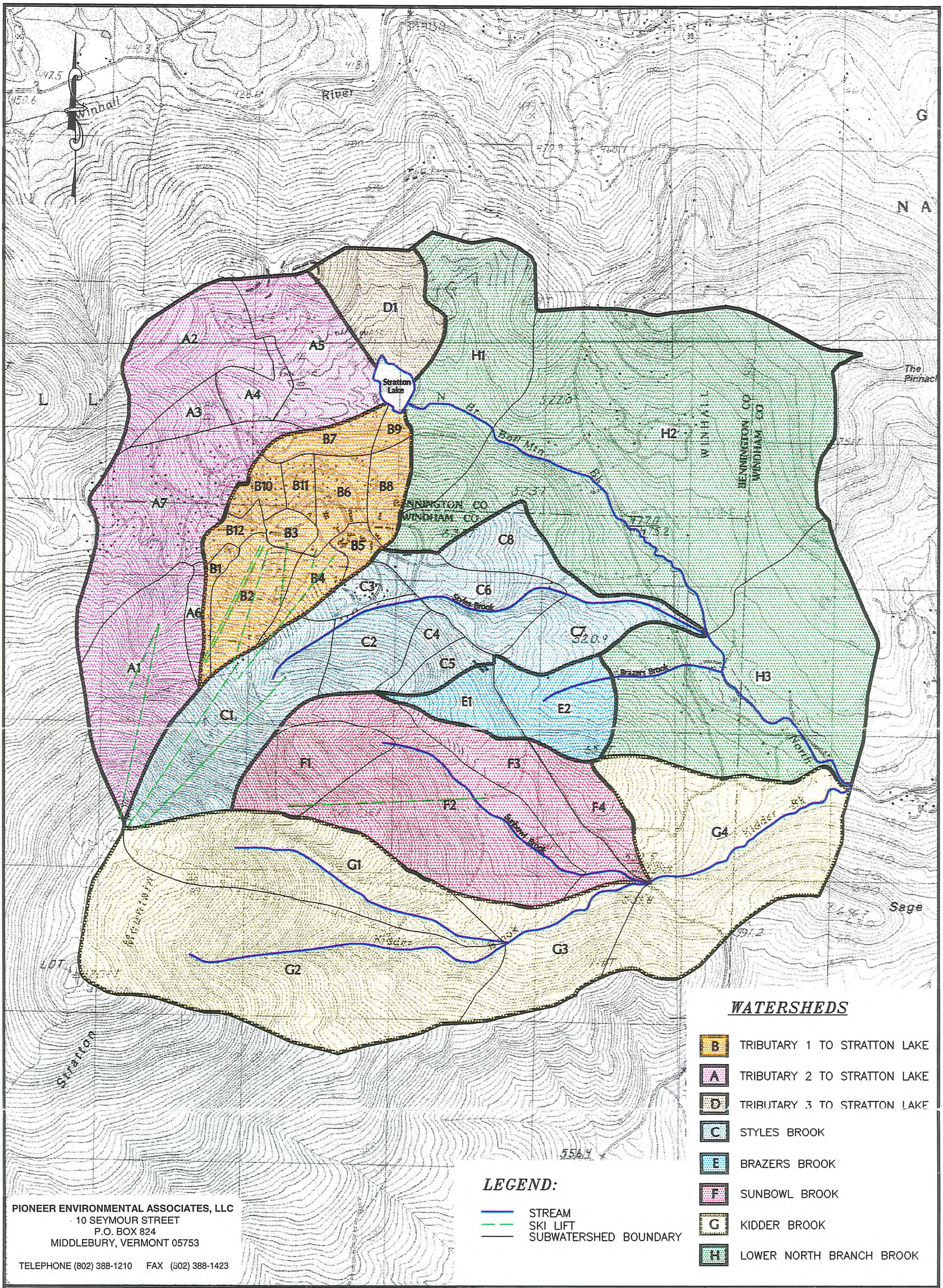
APPENDIX



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STRATTON MASTER PLAN

STRATTON, VERMONT

OVERALL SUBWATERSHED MAP - POST DEVELOPMENT

SCALE: 1" = 2000'

FILE: C:\STRATTON\SHEDS

DATE:	APRIL 2, 1999
PROJECT NO.	97802
DRAWN BY:	S. Smith
PROJ. MGR:	W. Suhr
APPROVED:	J. Nelson

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Stratton Master Plan
Subwatershed Land Use Characteristics
Summary-Existing Conditions

Subwatershed	Area	Wooded		Gravel		Impervious		Ski Trails		Open Area		Water	
	sq.miles	sq.miles	%	sq.miles	%	sq.miles	%	sq.miles	%	sq.miles	%	sq.miles	%
TRIBUTARY 2													
A1	0.282	0.167	59.0%	0.006	2.0%	0.003	1.0%	0.107	38.0%	-	-	-	-
A2	0.243	0.204	84.0%	0.002	1.0%	0.007	3.0%	0.017	7.0%	0.012	5.0%	-	-
A3	0.053	0.049	92.0%	0.001	1.0%	0.002	4.0%	-	-	0.002	3.0%	-	-
A4	0.069	0.032	46.0%	0.001	1.0%	0.002	3.0%	-	-	0.034	50.0%	-	-
A5	0.216	0.095	44.0%	0.004	2.0%	0.006	3.0%	-	-	0.110	51.0%	-	-
A6	0.023	0.016	70.0%	-	-	-	-	0.006	26.0%	-	-	0.001	4.0%
A7	0.378	0.196	52.0%	0.038	10.0%	0.057	15.0%	0.023	6.0%	0.064	17.0%	-	-
TOTAL A	1.263	0.758	60.0%	0.051	4.1%	0.077	6.1%	0.153	12.1%	0.223	17.6%	0.001	0.1%
TRIBUTARY 1													
B1	0.063	0.030	48.0%	0.003	4.0%	0.005	8.0%	0.023	36.0%	0.003	4.0%	-	-
B2	0.124	0.042	34.0%	0.001	1.0%	0.002	2.0%	0.077	62.0%	-	-	0.001	1.0%
B3	0.027	-	-	0.001	5.0%	0.024	91.0%	-	-	0.001	4.0%	-	-
B4	0.086	0.015	18.0%	0.003	4.0%	0.010	12.0%	0.050	58.0%	0.007	8.0%	-	-
B5	0.028	0.008	28.0%	0.009	32.0%	0.006	23.0%	-	-	0.005	17.0%	-	-
B6	0.081	0.030	37.0%	0.015	18.0%	0.019	23.0%	-	-	0.018	22.0%	-	-
B7	0.073	0.049	67.0%	0.001	2.0%	0.002	3.0%	-	-	0.021	28.0%	-	-
B8	0.034	0.028	82.0%	0.001	2.0%	0.001	4.0%	-	-	0.004	12.0%	-	-
B9	0.026	0.013	49.0%	0.003	13.0%	0.002	7.0%	-	-	0.008	31.0%	-	-
B10	0.034	0.022	64.0%	0.002	7.0%	0.005	16.0%	-	-	0.004	13.0%	-	-
B11	0.033	0.021	64.0%	0.002	7.0%	0.005	16.0%	-	-	0.004	13.0%	-	-
TOTAL B	0.609	0.258	42.4%	0.042	7.0%	0.083	13.7%	0.150	24.5%	0.074	12.2%	0.001	0.2%
STYLES BROOK													
C-1	0.361	0.195	54.0%	0.007	2.0%	0.004	1.0%	0.155	43.0%	-	-	-	-
C-2	0.128	0.113	88.0%	-	-	0.003	2.0%	0.013	10.0%	-	-	-	-
C-3	0.050	0.021	43.0%	0.002	5.0%	0.007	15.0%	0.006	12.0%	0.006	12.0%	0.006	13.0%
C-4	0.040	0.023	58.0%	0.002	5.0%	0.002	4.0%	0.013	33.0%	-	-	-	-
C-5	0.033	0.023	70.0%	0.003	9.0%	0.002	5.0%	0.004	12.0%	0.001	4.0%	-	-
C-6	0.183	0.123	67.0%	0.018	10.0%	0.011	6.0%	-	-	0.031	17.0%	-	-
C-7	0.138	0.121	87.7%	0.002	1.4%	0.009	6.6%	-	-	0.006	4.3%	-	-
C-8	0.133	0.128	95.8%	0.000	0.1%	0.000	0.1%	-	-	0.005	4.0%	-	-
TOTAL C	1.066	0.747	70.0%	0.035	3.3%	0.037	3.5%	0.191	17.9%	0.050	4.7%	0.006	0.6%
TRIBUTARY 3													
D-1	0.197	0.138	70.0%	-	-	0.008	4.0%	-	-	0.051	26.0%	-	-
TOTAL D	0.197	0.138	70.0%	-	-	0.008	4.0%	-	-	0.051	26.0%	-	-
BRAZER'S BROOK													
E-1	0.090	0.062	69.0%	0.001	1.5%	0.003	3.5%	0.021	23.0%	0.003	3.0%	-	-
E-2	0.179	0.171	95.5%	-	-	0.006	3.5%	-	-	0.002	1.0%	-	-
TOTAL E	0.269	0.233	86.6%	0.001	0.5%	0.009	3.5%	0.021	7.7%	0.004	1.7%	-	-
SUNBOWL BROOK													
F-1	0.136	0.103	76.0%	-	-	-	-	0.033	24.0%	-	-	-	-
F-2	0.582	0.433	74.5%	0.017	3.0%	0.003	0.5%	0.116	20.0%	0.012	2.0%	-	-
F-3	0.166	0.137	83.0%	0.010	6.0%	0.002	1.0%	0.013	8.0%	0.003	2.0%	-	-
F-4	0.113	0.106	94.0%	-	-	0.007	6.0%	-	-	-	-	-	-
TOTAL F	0.996	0.780	78.3%	0.027	2.7%	0.011	1.1%	0.162	16.3%	0.015	1.5%	-	-
KIDDER BROOK													
G-1	0.435	0.344	79.0%	-	-	-	-	0.091	21.0%	-	-	-	-
G-2	0.921	0.921	100.0%	-	-	-	-	-	-	-	-	-	-
G-3	0.292	0.291	99.6%	-	-	0.001	0.4%	-	-	-	-	-	-
G-4	0.636	0.621	97.7%	0.004	0.7%	0.004	0.6%	-	-	0.006	1.0%	-	-
TOTAL G	2.284	2.177	95.3%	0.004	0.2%	0.005	0.2%	0.091	4.0%	0.006	0.3%	-	-
LOWER NORTH BRANCH													
H-1	0.440	0.308	70.0%	0.013	3.0%	0.009	2.0%	-	-	0.110	25.0%	-	-
H-2	1.621	1.354	83.5%	0.032	2.0%	0.021	1.3%	-	-	0.214	13.2%	-	-
H-3	0.832	0.726	87.3%	0.017	2.0%	0.010	1.3%	-	-	0.079	9.5%	-	-
TOTAL H	2.894	2.388	82.5%	0.062	2.2%	0.040	1.4%	-	-	0.403	13.9%	-	-
TOTAL	9.579	7.479	78.1%	0.224	2.3%	0.272	2.8%	0.768	8.0%	0.827	8.6%	0.009	0.1%

Stratton Master Plan

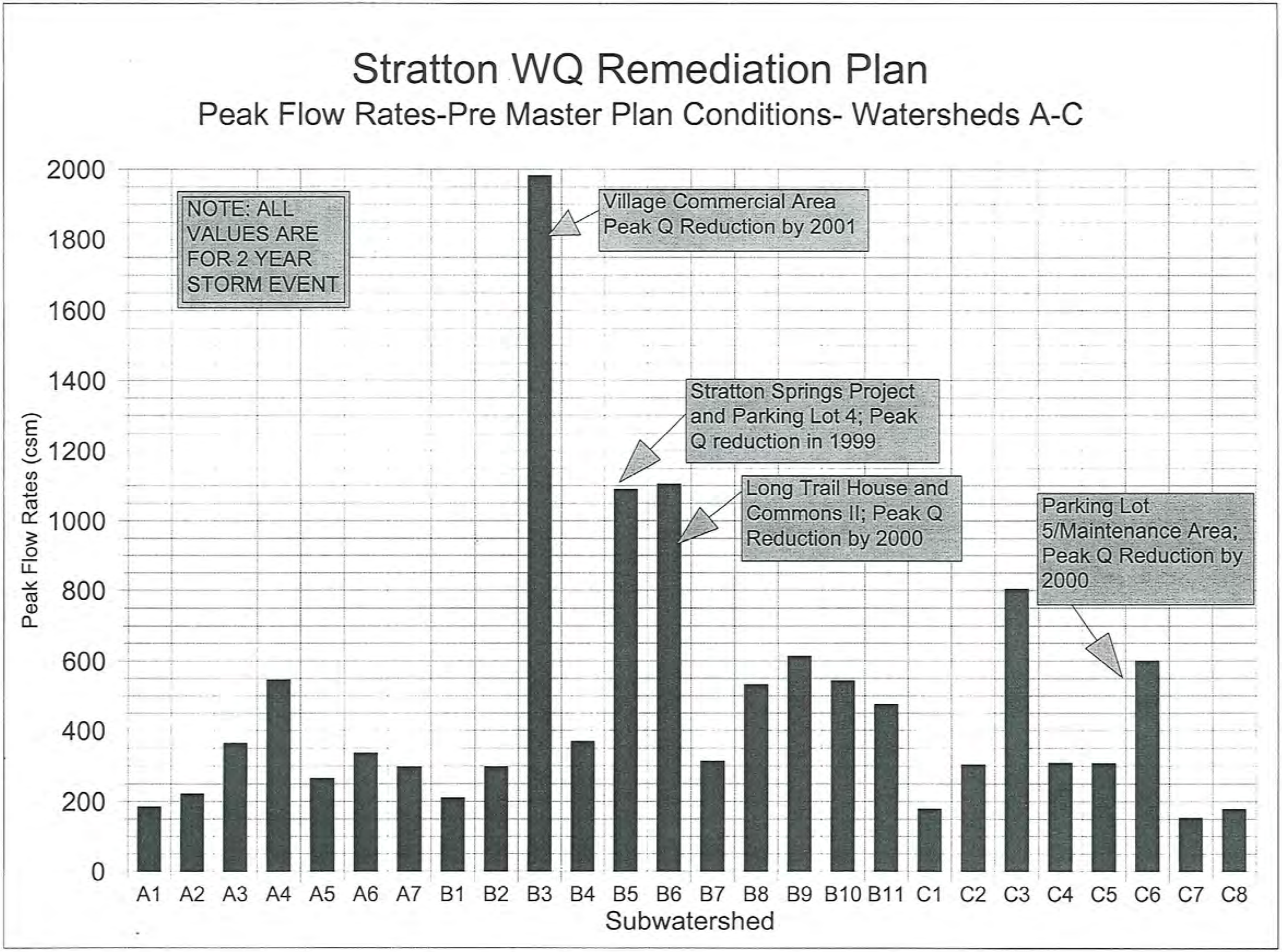
Summary of Stream Hydrology

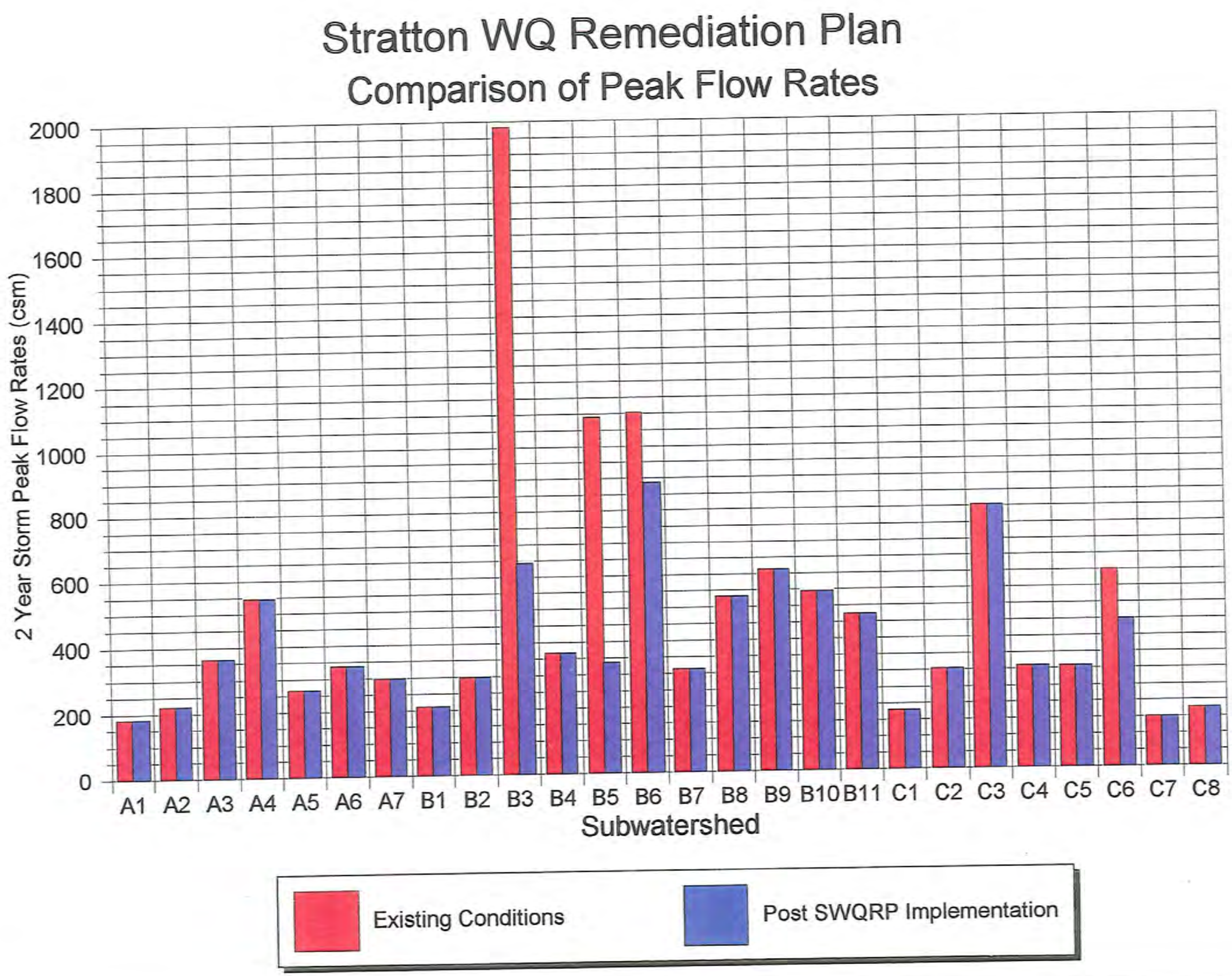
Existing Conditions

Stream Name	Subwatersheds	Drainage Area (sq mi.)	2 Year Storm		5 Year Storm		10 Year Storm		25 Year Storm		100 Year Storm	
			Q (cfs)	Q (csm)	Q (cfs)	Q (csm)	Q (cfs)	Q (csm)	Q (cfs)	Q (csm)	Q (cfs)	Q (csm)
Stratton Lake	A,B,D	2.07	206.6	99.8	390.1	188.5	462.6	223.5	495.3	239.3	927.1	447.9
Tributary 1	B	0.61	251.9	413.6	403.7	662.9	505.0	829.2	567.4	931.7	901.8	1480.8
% Difference from Kidder				179.6%		129.5%		112.7%		105.1%		78.4%
Tributary 2	A	1.26	278.4	221.0	496.4	394.0	642.7	510.1	733.6	582.2	1241.6	985.4
% Difference from Kidder				49.4%		36.4%		30.8%		28.2%		18.7%
Styles Brook	C1-C8	1.07	207.4	193.8	365.7	341.8	479.2	447.9	547.8	511.9	1036.9	969.1
% Difference from Kidder				31.0%		18.3%		14.9%		12.7%		16.8%
Brazer's Brook	E1, E2	0.27	111.8	414.1	199.9	740.3	260.0	962.9	297.5	1102.0	529.8	1962.2
% Difference from Kidder				227.5%		188.1%		172.6%		165.7%		151.6%
Kidder Brook	G1-G4, F1-F4	3.28	414.7	126.4	842.7	256.9	1158.4	353.2	1360.5	414.8	2558.3	780.0
	G1-G3, F1-F4	2.64	390.5	147.9	762.6	288.9	1029.5	389.9	1199.3	454.3	2191.1	830.0
North Branch (sum)	A-H	9.58	929.7	97.1	1870.9	195.3	2558.1	267.0	2986.4	311.7	5365.1	560.0

Stratton Master Plan
Summary of Hydrologic Analysis - Existing Conditions (2 year storm)
05/18/99

Subwatershed	Area (sq. miles)	Percent of Watershed Area	Peak Flow Rate (cfs)	Peak Flow Rate (csm)	Runoff Depth (inches)	Runoff Volume (Mgal)	Percent of Runoff Volume	Ratio of Percent Vol./Area
A1	0.282	22.35%	51.99	184.1	0.80	3.93	19.65%	0.88
A2	0.243	19.20%	53.74	221.5	0.84	3.54	17.73%	0.92
A3	0.053	4.22%	19.35	363.3	0.85	0.79	3.94%	0.93
A4	0.069	5.42%	37.44	546.4	0.88	1.05	5.25%	0.97
A5	0.216	17.13%	57.47	265.6	0.89	3.35	16.75%	0.98
A6	0.023	1.79%	7.63	336.6	0.82	0.32	1.62%	0.90
A7	0.378	29.89%	112.7	298.5	1.08	7.09	35.47%	1.19
TOTAL A	1.263	100.00%	278.43	220.4	0.91	19.98	100.39%	
B1	0.063	10.34%	13.23	210.1	0.91	1.00	8.96%	0.87
B2	0.124	20.40%	37	297.8	0.80	1.73	15.54%	0.76
B3	0.027	4.40%	53.14	1982.7	2.50	1.16	10.48%	2.38
B4	0.086	14.10%	31.67	368.6	0.95	1.42	12.76%	0.90
B5	0.028	4.63%	30.73	1090.5	0.84	0.41	3.70%	0.80
B6	0.081	13.36%	89.9	1105.1	1.26	1.78	16.03%	1.20
B7	0.073	12.02%	23.02	314.3	0.87	1.11	9.96%	0.83
B8	0.034	5.54%	17.93	531.8	0.87	0.51	4.59%	0.83
B9	0.026	4.22%	15.78	613.7	1.02	0.46	4.10%	0.97
B10	0.034	5.52%	18.28	543.5	1.07	0.63	5.63%	1.02
B11	0.033	5.48%	15.87	475.1	1.07	0.62	5.59%	1.02
TOTAL B	0.609	100.00%	251.89	413.5	1.05	11.11	97.32%	
C-1	0.361	33.86%	64.89	179.8	0.80	5.02	32.25%	0.95
C-2	0.128	12.04%	39.09	304.6	0.81	1.81	11.61%	0.96
C-3	0.050	4.66%	39.98	804.7	1.20	1.04	6.66%	1.43
C-4	0.040	3.75%	12.35	308.7	0.86	0.60	3.84%	1.02
C-5	0.033	3.07%	10.07	307.8	0.92	0.52	3.36%	1.10
C-6	0.183	17.18%	110.07	601.0	0.96	3.06	19.63%	1.14
C-7	0.138	12.92%	21.06	152.9	0.80	1.91	12.31%	0.95
C-8	0.133	12.52%	23.75	178.0	0.69	1.60	10.28%	0.82
TOTAL C	1.066	100.00%	207.39	194.5	0.84	15.56	99.94%	
D-1	0.197		66.37	337.2	0.86	2.94		
TOTAL D	0.197		66.37	337.2	0.86	2.94		
E-1	0.090	33.51%	24.12	267.7	0.84	1.32	33.91%	1.01
E-2	0.179	66.49%	108.87	609.0	0.83	2.58	66.49%	1.00
TOTAL E	0.269	100.00%	111.8	415.8	0.83	3.88	100.40%	
F-1	0.136	13.63%	36.91	271.8	0.78	1.84	16.88%	1.24
F-2	0.582	58.40%	64.26	110.4	0.60	6.07	55.62%	0.95
F-3	0.166	16.62%	10.04	60.6	0.48	1.38	12.66%	0.76
F-4	0.113	11.35%	35.14	310.8	0.77	1.51	13.87%	1.22
TOTAL F	0.996	100.00%	110.77	111.2	0.63	10.91	99.03%	
G-1	0.435	26.39%	80.25	184.4	0.78	5.90	28.99%	1.10
G-2	0.921	55.88%	193.71	210.3	0.79	12.65	62.17%	1.11
G-3	0.292	17.73%	11.01	37.7	0.32	1.63	7.99%	0.45
G-4	0.636	-	32.42	51.0	0.37	4.09	20.09%	-
TOTAL G1-G3	1.649	100.00%	279.8	169.7	0.71	20.34	99.16%	
H-1	0.440	15.21%	83.07	188.8	0.61	4.66		
H-2	1.621	56.03%	126.87	78.3	0.58	16.34		
H-3	0.832	28.76%	58.59	70.4	0.51	7.38		
TOTAL	9.579		929.59	97.0	0.70	116.52		


Stratton WQ Remediation Plan
Peak Flow Rates-Pre Master Plan Conditions- Watersheds A-C
NOTE: ALL VALUES ARE FOR 2 YEAR STORM EVENT
Village Commercial Area Peak Q Reduction by 2001
Stratton Springs Project and Parking Lot 4; Peak Q reduction in 1999
Long Trail House and Commons II; Peak Q Reduction by 2000
Parking Lot 5/Maintenance Area; Peak Q Reduction by 2000
Peak Flow Rates (csm)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
A1 A2 A3 A4 A5 A6 A7 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 C1 C2 C3 C4 C5 C6 C7 C8
Subwatershed



Stratton WQ Remediation Plan
Comparison of Peak Flow Rates
2 Year Storm Peak Flow Rates (csm)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
A1 A2 A3 A4 A5 A6 A7 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 C1 C2 C3 C4 C5 C6 C7 C8
Subwatershed
Existing Conditions
Post SWQRP Implementation

Stratton Master Plan
Ranking of Potential Water Quality Impacts and Remediation Implementation Schedule
05/20/99

JUNE 2000

Watershed Designation	Stream Name	Existing Activity	Water Quality Impact Ranking	Stratton Remediation Plan Implementation Year
A	Tributary 2	Golf Course	1	1999-2000
		Ski trails/work roads	2	Begin in 1999
		Onstream ponds (golf course)	3	2002
		Stratton Mtn. Road	4	Ongoing
		Single family housing	**	*
		Roads (private,public)	***	*
B	Tributary 1	Existing Parking Lots	1	1998-2000
		Village Center/Commercial Devel.	2	Full implementation by 2001
		Golf Course	3	1999-2000
		WWTF drive	4	1999
		Stratton Mtn. Road	5	Ongoing
		Stream relocation at old spray field	6	2001
		Onstream Pond (Snyder)	7	2001
		Ski trails/work roads	8	Begin in 1999
		Single family housing	**	*
		Roads (private,public)	***	*
		Condominium projects	**	*
C	Styles Brook	Existing Parking Lots	1	1999-2000
		Maintenance Facility/Sand Storage	2	1999-2000
		Ski trails/work roads	3	Begin in 1999
		Condominium projects	4	*
		Golf School stream buffer	5	2000
		Roads (private,public)	***	*
D	Tributary 3	Golf Course	**	1999-2000
		Roads (private,public)	***	*
E	Brazer's Brook	Ski trails/work roads	**	Begin in 1999
		Roads (private,public)	***	*
F	Sun Bowl Brook	Existing Parking Lots	1	2000
		Ski trails/work roads	***	Begin in 1999
		Roads (private,public)	***	*
G	Kidder Brook	Ski trails/work roads	***	2000
H	Lower North Branch Br.	Stratton Lake	**	Bypass implemented, continue monitoring
		Roads (private,public)	***	*
		Spray Irrigation Indirect Discharge	**	Continue IDR monitoring

* denotes existing activities/land uses that are not owned or controlled by Stratton Corp. (see section 4.6 of plan)
** denotes activities believed to have minimal water quality impacts.
*** areas/activities to be field-evaluated during 1999.
Shaded areas indicate 303(d) listed waters

Stratton Master Plan
Summary of Proposed Projects
05/20/99

Project Description	Watershed Designation	Current Status	Associated Water Quality Enhancements
Golf Course WQ Enhancements	A	Implementation underway	Increased stream buffers, streambank stabilization, plantings, sediment control
Welcome Center, including			
Welcome Center building	A	Under review	
Access Road improvements	-	Under review	Improved runoff/road sand management
Day skier parking	A	Not yet designed	
Golf Clubhouse Site	A	Not yet designed	Address onstream ponds
	A	Not yet designed	Implement using ski trail BMPs
Snowbridge (The Bridges)	B	Constructed 1997	Successful test case for iron seep mgmt.
Long Trail House (Commons I)	B	Under construction	Elimination of parking lot 3 Reduction of peak Q
Stratton Springs	B/C	Under construction	Parking lot 4 treatment/detention Reduction of peak Q
WWTF drive	B	1999 implementation	Sediment control
Golf Course WQ Enhancements	B	Implementation underway	Increased stream buffers, streambank stabilization, plantings, sediment control
Commons II	B	Under review	Elimination of several existing NPS Runoff control/treatment from parking lot 2 Reduction of peak Q
Lakeview	B	Not yet designed	Stream relocation to original channel
Village Expansion	B	Not yet designed	Existing Impervious area Multiple opportunities for NPS treatment
Parking Lot 5/Maintenance area stormwater control	C	Design in 1999, implement in 2000	Control major sources of sediment, address iron seeps, reduce peak flows.
Stratton Glen, including:			
Stratton Mtn. School	C	Under construction	Stormwater, fertilizer mgmt. in place
Spater Glen (Aff. housing)	C	Under review	
Stratton Glen	C	Not yet designed	
Ski Trail expansions	C	Not yet designed	Implement using ski trail BMPs
Valley View	E	Under review	Sun Bowl parking lot treatment
Snowleaf	E	Not yet designed	
Sun Bowl Parking Lot	F	Under review	provide runoff treatment, peak flow reduction
Ski Trail expansions	F,G	Not yet designed	Implement using ski trail BMPs

Note: Shading indicates projects located in 303(d) listed watersheds.

STREAM HABITAT INVENTORY

Observer:______________________________ Date: ______________________________
Stream: __________________ Flow:____________ Temperature: ______________________
Segment #: ____________________________ Location: ____________________________

Segment Length (ft): _____________________ Sampling Effort: ________________________

STREAM TYPE

Gradient - (circle one): Low Mod High Description - (circle one): Very steep; debris tranport; cascading (step-pool); riffle dominated; riffle/pool

Flow duration - (circle one): Ephemeral or Perennial

Transect No.	Stream Width (ft)	Chan-nel Width (ft)	Flood prone area width (ft)	Stream Depth (inches)				Bankfull Depth (inches)				
				1/4	1/2	3/4	Mean	1/4	½	3/4	Mean	Max
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
Mean												
Maximum Stream Depth =												

Channel width is bankfull width or ordinary high water mark.
Flood prone area is width measured at an elevation twice the maximum bankfull depth.

GRADIENT
valley slope (from topo map) ____________
sinuosity: ratio of stream length to valley length
stream length____________ valley length ______________________
valley slope/sinuosity = channel slope

Do stream survey - assume 20 channel widths in length.
Get habitat type, habitat length, pool depth (measured from control elev.)

STREAMBANK AND RIPARIAN ZONE

Bank Stability Rating (circle one):

Left: Ex. (0-25%), Good (26-50%), Fair (51-75%), Poor (76-100%)

Erosion Cause: Man Nat Other ________

Bank Slope: ________

Right: Ex. (0-25%), Good (26-50%), Fair (51-75%) Poor (76-100%)

Erosion Cause: Man Nat Other ________

Bank Slope: ________

Canopy (Crown closure) %: 100 90 80 70 60 50 40 30 20 10 0 Overhead: open/closed

Riparian Zone:

Left Width: ________ Overstory: ________

Understory: ________ Ground Cover: ________

Predominant surrounding land use________

Right Width: ________ Overstory: ________

Understory: ________ Ground Cover: ________

Predominant surrounding land use________

SUBSTRATE

Embeddedness (circle one): 0-25%, 26-50%, 51-75%, 76-100%

Pebble Count Technique:

Code*	Category	Size (in.)**	Size (mm)	Number
	organic			________
1	fines	0.002-0.08"	0.062 - 2	________
2	very fine gravel	0.08-0.15"	2-4	________
3	small gravel	0.15-0.3"	4-8	________
4	medium gravel	0.3-0.6"	8-16	________
5	coarse gravel	0.6"-1.25"	16-32	________
6	very coarse gravel	1.25"-2.5"	32-64	________
7	small and medium cobble	2.5"-5"	64-128	________
8	large cobble	5"-10"	128-256	________
9	small boulder	10"-20"	256-512	________
10	medium boulder	20"-40"	512-1024	________
11	large boulder	40"-80"	1024-2048	________
12	very large boulder	>80"	>2048	________
13	bedrock			________

*Wentworth substrate classification

** measured from the intermediate axes

Periphyton(%):

Diatom________ Filamentous green________ Moss________

Matted blue green________ Other________

Notes: ________

____

____

____