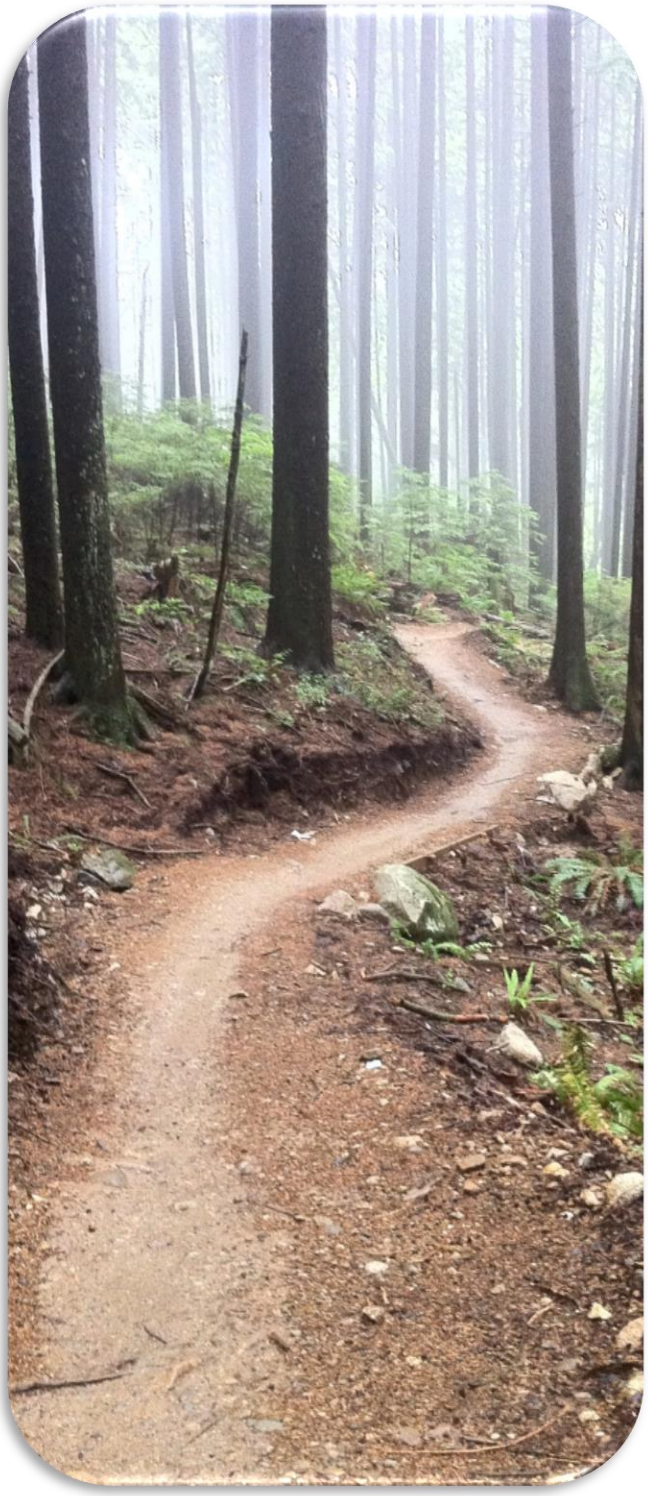
District of North Vancouver
Fromme Mountain Trails
Environmental Assessment

February 21, 2015



Submitted to:

District of North Vancouver
355 West Queens Road
North Vancouver BC
V7N 4N5

Submitted by:

DIAMOND HEAD
CONSULTING LTD.

342 West 8th Ave.
Vancouver, BC
V5Y3X2

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1 Executive Summary

When the Fromme Mountain Trails Study (Trails Study) was adopted in 2008, it set a community direction to support recreation including mountain biking in the Fromme Mountain Area. As in any natural park area, it can be expected that the construction and use of recreation amenities will cause some level of impact to the environment. The Trails Study provides guidelines and best management practices (BMPs) that were developed with the intention of minimizing these environmental impacts.

One of the principles of the Trails Study was a commitment to adaptive management to support sustainable trail use. This principal calls for a monitoring function to evaluate the effectiveness of initiatives, the modification of actions as required, and the incorporation of new approaches and decision-making processes as necessary. As part of their response to this commitment, the District of North Vancouver (DNV) undertook this environmental assessment of representative trails in 2014.

The network of trails on Fromme is extensive and recreation use has been increasing since 2008. Quantitative data was collected in the field and has shown that new trail building and maintenance standards adopted as a part of the Trails Study have improved environmental conditions on the trails that have been focused on. However there has not been enough resources to apply them on a consistent and ongoing basis to the entire trail system. This report identifies opportunities to improve environmental conditions by updating certain BMPs and provides recommendations to prioritize resources.

Before and after photos of upgrades to Expresso (left) and Executioner (right).

The Fromme Mountain Trail Classification Study (Trails Study) was approved by Council in 2008. It has guided trail maintenance and upgrades, identified which trails to manage, consolidate or close and provides best management practices (BMPs) for trail construction and maintenance. Work has been carried out since 2008 in partnership between DNV, the North Shore Mountain Bike Association (NSMBA) and other independent trail builders.

Following a commitment to managing these trails using an adaptive management approach, the District has commissioned this independent environmental assessment of a sample of representative trails. The purpose of this environmental assessment is to provide an analysis of the current trail conditions, their impacts to the environment and an evaluation of the effectiveness of the BMPs and management recommendations adopted in the Trails Study.

For this environmental assessment, eight representative trails were studied in the field. These include newly built trails, trails that have been upgraded and older trails that have not been managed to the current standards. A total of 9180 m of trails were assessed representing approximately 18% of the total length of the recognized trail system (DNV Geo Web Data) on Fromme Mountain. 459 plot measurements were collected. Professional judgement was used to assess non-measurable impacts.

In park natural areas that are managed for recreation, the risk of environmental impacts typically increases with the level of use (Parks Canada 2010). Management of these park areas must achieve a balance between supporting the demand for recreation and minimizing the impacts on the environment. Environmental impacts resulting from trail management and use include direct impacts on environmental features and functions, as well as the indirect impacts resulting from recreation use. Sources of environmental impacts that have been identified from the trail on Fromme Mountain include:

- Damage to tree roots;
- Loss of ground vegetation;
- Spread of invasive species; and,
- Cutting of trees and stumps;
- Changes to natural hydrology;
- Soil erosion;
- Creation of borrow pits;
- Human and dog trampling of vegetation;
- Development of unauthorized trails;
- Reduced use by wildlife.

The eight trails studied vary in their recreation uses and condition. Dominant recreation uses in the study area include hiking, dog walking and mountain bike trails. Some trails have been recently built or ungraded to the standards specified in the Trails Study, while others have had limited maintenance. This variable condition allows for comparison between building and maintenance standards and levels of usage.

New and upgraded trails are being constructed differently that older trails. Trail design includes gentler grades, strategic alignment and features that prevent the concentration of surface water flow. Also trail surfaces are built up with rocks and mineral soil as opposed to creating cuts down into the topsoil horizon.

Fromme mountain experiences a high volume of rainfall. Subsequently, the greatest environmental risk observed from the trails is a result of changes to natural water flow patterns. Older trails generally are follow fall lines (aligned downslope). When subject high rain falls, these become channelized causing soil erosion. Newer trail design and construction methods avoid cuts that intercept ground water flows and incorporate features to manage surface water flow. The data collected shows that trails maintained to the Trails Study standards are causing less environmental impacts related to water flow.

Trails that are built up over natural grades provide more protection for tree roots and cause less cutting of structural roots. However, this method requires that high volumes of mineral soil be sourced from “borrow pits.” These are holes in the ground that are 1 to 3m in diameter and up to 1.5m deep. Ground vegetation is removed and permanent depressions are made in the forest floor. The impacts of these borrow pits required for recommended trail construction are balanced against lower environmental impacts to trees, ground water flows, water quality and erosion. The impacts of these pits can be reduced through improved standards for their location and restoration.

The Trails Study BMPs require that all creek crossings comply with the BC Riparian Assessment Regulation and that an assessment report be completed by a Qualified Environmental. The newer and pre-existing creek crossings assessed generally do not comply with the BMPs which would require larger protection zones. Most have been constructed to the top of bank with little protection through the riparian zone. Steep slopes leading down to creeks cause surface water flow which along with skidding of bikes causes sedimentation into the creeks.

Creek crossings on the lower Baden Powell Trail

It has been recommended that all creek crossing structures extend to a sufficient distance beyond the creek banks. Also they should be designed to prevent people and dogs from accessing the creek bed. Trails within 30m from significant creeks should be made a priority for upgrading. These measures will greatly reduce the risk to water quality and better protect riparian habitat.

The level of recreation use on Fromme Mountain has increased dramatically since the 2008 Trails Study was adopted. Mountain biking, as a sport, has increased in popularity. In addition, new trail construction standards and maintenance of older trails has provided trail conditions more accessible to beginner and intermediate riders increasing the range of users. There are

now many families with children that use these trails. It is expected that the level of use will continue to grow.

As a part of this study, stakeholders representing local stewardship groups and recreation users were contacted. Most were concerned about the environmental impacts from the trails. Key concerns expressed were erosion, impacts on water flows and water quality in creeks and wetlands. A consistent message heard from stakeholders was that there are too many non-sanctioned trails that exist and continue to be constructed. These trails are not built to the standards in the Trails Study or follow BMPs and stakeholders have concerns that they are causing environmental impacts. Most stakeholders requested that there be better enforcement of illegal trail building and decommissioning of unauthorised trails.

Although outside the scope of the environmental assessment, consultation with stakeholders highlighted the importance of building trails for a wide range of user groups. The majority of the trails are currently used by mountain bikers. Hikers and dog walkers expressed their concern for the lack of trails designated for foot traffic only.

This assessment included a review of the management systems and working relationship between the District, the NSMBA, volunteer trail builders and volunteers. The working relationship established between the NSMBA and the DNV provides access to numerous volunteers and corporate sponsors. There is opportunity to build on this model to increase the level of volunteer involvement. Already, recognized volunteer trail builders provide guidance and oversee all work ensuring it is consistent with the Trails Study. However, there needs to be continued involvement of District staff to ensure permits are issued and work is monitored to ensure BMPs are followed and quality and safety standards are met.

With increased recreation use, the risk of impacts to natural features and function increases. To manage this risk, additional resources are needed for trail maintenance, monitoring and enforcement of non-sanctioned activities. Overall the trail condition data shows that new and maintained trails have had fewer environmental impacts compared to older trails that have not been upgraded or maintained. However, there are opportunities to better mitigate environmental impacts and improve the BMPs from the original Trails Study. Specific recommendations have been made in this assessment report including the following three priorities:

1. Upgrades to crossings of high value creeks;
2. Decommissioning of unauthorised trails; and,
3. Upgrading of all trails within 30m of significant creeks.

1.1 Summary of Recommendations

Table 1 provides a summary of recommendations made in this report. These are categories into the components of the Trails Study that were evaluated (Valued Ecosystem Components and Best Management practices).

Table 1 Summary of Recommendations

VEC/BMP	Summary of Findings and Recommendations
Streams, wetlands, riparian areas	**Findings** Fromme Mountain experiences a high amount of rainfall. This has created a large number of creeks. Primary tributaries are well defined within channels and ravines. In addition there are numerous smaller ephemeral and intermittent creeks found throughout the forest. The Trails Study BMPs require that all creek crossings comply with the BC Riparian Assessment Regulation (RAR) and that an assessment report be completed by a Qualified Environmental. A typical standard for protecting creeks following the RAR simple method would include 15m protection zones from high water mark from all creeks. No creek crossings were in compliance with this standard. One of the highest environmental impacts identified in this study was to creeks and water quality. Areas of greatest concern included trails with steep grades extending down to creek crossings. Skidding and surface water flow result in erosion and carry sediment to the crossing and often around its banks and into the creek. This problem is compounded where dogs and people walk down to the creek edges. **Recommendations** • Upgrade the requirements for creek crossings to the following: All creeks that are >30cm wide (at high water flow) should be protected by a clear-span boardwalk/bridge. The structure footings should be well anchored to an area at least 1m back from the top of bank of the creek. The entrance and exit of the bridge should extend a minimum 3m back for creeks 30cm to 1m wide and 5m back for creeks that are >1m wide. These structures should include design features (e.g., railings etc.) to prevent access down to the creeks. Creeks <30cm wide can be managed with culvert crossings as long as the inlet and outlet are well protected from trail impacts. • Where ever possible, new trails should be located further than 15m from all creeks that are greater than 1m wide. • All trails within 30m of creeks should be prioritised for upgrading and maintenance. • Disposal bins and dog waste disposal bags should be provided at the new parking facility and along the BP trail in Mountain View Park.
Old Growth Trees	**Findings** The only old growth trees (>250 years old) found during this study are growing along upper Dreamweaver. This is recommended to be primarily a hiking trail. There were no old growth trees identified near any of the other trails assessed. **Recommendations** • No additional trail building is recommended in the area of Mosquito creek which supports old growth trees. • All non-sanctioned trails that run through the old growth stand in the Mosquito creek area should be aggressively decommissioned. • The upper section of Dreamweaver should be rerouted further than 6m from the base of any old growth trees. • No old growth trees should be cut or pruned for hazard tree mitigation.

VEC/BMP	Summary of Findings and Recommendations
Structural Diversity	**Findings** Most stands on Fromme Mountain are even aged with a high canopy cover restricting sunlight from reaching the forest floor. These forests generally have a low structural diversity with few large canopy openings. There is a low cover of ground vegetation and a low density of trees in the understory. Trail construction generally requires no removal of mature trees and therefore the impacts on the forest canopy are minimal. There have been however the removal of suppressed western redcedar trees and dead standing trees that are used for boardwalks and TTFs. **Recommendations** • Avoid the removal of large dead standing trees (wildlife trees); these provide high habitat value to wildlife. • The cutting of any live trees for trail construction materials should not be permitted. • Under the direction of a biologist and the District community forester, consider creating small stand openings to enhance structural diversity and create wildlife trees.
Species at Risk	**Findings** The species listed by the Species at Risk Act (SARA) are continually changing and should be updated regularly. Impacts caused by the trails on Fromme to unique habitat features required by species at risk are generally associated with water quality in creeks and wetlands, as well as the loss of high value wildlife trees. Increased presence of human activity on Fromme also likely has a negative impact on these species. In particular the use of unauthorized trails further fragments the forest area and reduces the amount of refuge areas. **Recommendations** • A qualified Professional Biologist should review all new trail construction to ensure it does not impact habitat for species at risk. • Amend and enforce creek crossing standards to protect water quality. • Protect all high value wildlife trees that are not rated as a high risk to trails. • Prioritise the deactivation of trails within 30m of creeks or wetlands.
Off Trail Impacts	**Findings** Off trail impacts from older trails are primarily related to damage from water flow. These trails tend to be steep, making water control difficult. Skidding bikes rut trails, further channeling water. Visible impacts of trail from this water flow includes soil and gravel deposits. Newer trails built at gentler slopes and with frequent reverse grades have shown to manage surface water flow. Trails with the least impact are built up on grade without digging down into the soil profile preserving natural ground water flows. New trail construction methods require mineral soil to build up the trail surface. This is taken from areas adjacent to the trail called borrow pits which cause localized impacts to understory vegetation and some damage to the structural roots of nearby trees. Other off trail impacts observed include hikers walking on trial edges and staging areas near TTF where riders stop for viewing. **Recommendations** • Continue to upgrade older trails to new trail standards to reduce erosion and off trail water impacts. • Aggressively rehabilitate all off trail impacts including non-sanctioned trails. • Upgrade standards for borrow pits including location from trail, maximum size, graded edges and restoration requirements.

VEC/BMP	Summary of Findings and Recommendations
Surface Water Flow	**Findings** Impacts from surface water flow increases significantly with the grade of a trail. Upgraded trails have a gentler grade and are constructed with characteristics and features to better manage water flow. Trails with deep cut slopes had greater surface water flow as they intercept more ground water. Construction of trails above grade showed less impacts as they allow for more natural ground flows to continue below the trails surface. **Recommendations** • Upgrade older trails to new trail design standards that manage surface water flow. • Avoid or minimize the depth of cut slopes during construction. • Prioritise the upgrading and maintenance of trail sections that are within 30m of any creeks.
Tread Wear	**Findings** Tread wear general increases with the level of use and the steepness of the trail. Older mountain bike trails tend to be steeper and have the highest impacts from tread wear. Newer trails have a gentler grade and subsequently bikes do not skid as frequently and the tread wear is much lower. The areas that do show signs of tread wear include short sections before TTFs and steep corners. Placing obstacles strategically before these areas has been effective at slowing riders to prevent them from skidding. Traffic levels and experience level of riders play a large factor in tread wear. Popular trails such as Bobsled and Expresso experience high volumes of bikers and are impacted quicker. Problem areas on these trails require frequent maintenance. **Recommendations** • Continue to promote new trail design standards that control and reduce bike skidding • Increase resources for maintenance of trails that experience high wear and tear
Vegetation Impacts	**Findings** The trail surface itself amounts to a permanent loss of growing area. Creation of borrow pits also results in the loss of understory vegetation. The most common impact observed to vegetation was to trees. This includes the cutting and exposing of tree roots during trail construction. Old and steeper trails have high tread wear exposing and damaging the roots of trees adjacent to the trail. Upgraded trails did not have as deep a cut slope and were built up more on the pre-existing grade. This allows for surface roots to be protected by armoring them with rock and covering with mineral soil. Generally trail construction requires little direct cutting of mature trees. Understory cedar trees have been cut along trails for construction of TTFs. The spread of invasive species in the forest and away from Mountain Hwy is limited to primarily holly and laurel. The risk of spread of other invasive species will increase with use of these trails. The District is currently developing a **Recommendations** • Continue to promote building methods that minimize cut slopes and build up over existing grades to protect tree roots. • Only remove hazard trees that pose an extreme risk. The cutting of any live trees for trail construction materials should not be permitted. Post signage that trails should not be used during high wind storm events.

VEC/BMP	Summary of Findings and Recommendations
	• The Trails Study requires that trails be aligned out of the dripline of trees. Due to the density of the forest this is not possible. Amend the BMP to require that trails be located as far as possible away from mature healthy trees and so that trails are constructed above grade without severing or suffocating roots.
Wildlife	**Findings** The even aged second growth stands that dominate most of the Fromme Mountain area provide low habitat diversity and support a relatively lower level of wildlife species diversity compared to old forests and open shrub communities. Important habitat features for wildlife include patches of dense understory vegetation, large woody debris cover, large mature trees, large dead standing trees, streams, wetlands and their riparian areas. There was only one significant wetland observed in the study area in Mountain View Park. This is the only area observed that provides breeding for aquatic amphibians. The presence of trails and the increased presence of humans throughout the Fromme Mountain area causes habitat fragmentation and will have a negative impact on wildlife species that are not tolerant of human activity. **Recommendations** • Protect large dead standing conifer trees (wildlife trees). • Amend and enforce creek crossing standards. • Aggressively decommission non sanctioned trails. • Consider a long term wildlife behavior impact assessment from the trails
Use of Native Materials	**Findings** Native materials required for the construction of the trails include wood, mineral soil and rocks. New construction standards include trail surfaces that are built up with rocks and mineral soil as opposed to creating cuts down into the topsoil horizon. This provides more protection of tree roots and reduces ground water interception but also requires a high volumes of mineral soil sourced from "borrow pits." These are holes in the ground that create permanent depressions in the forest floor. Most are restored and covered with logs and organic debris. Due to the density of trees, most pits are within the drip line of trees. Also due to difficulty of transportation, most are within 5m of trails. Trail construction and maintenance requires the use of wood for boardwalks and retaining features. Western redcedar is used primarily as it is most resistant to rot. This has been sourced from dead standing trees, recently fallen trees, understory trees and heritage stumps. Live trees that are impacted include mostly smaller cedar trees that are growing under the canopy of the mature forest. **Recommendations** • Amend the BMP to allow borrow pits within dripline of trees but >2m from the trunk. Excavation towards the tree should stop as soon as roots >5cm are encountered. • No pits can be within 15m of creeks. • Pits should be located greater than 3m from trails edges. • The District should provide a source of cedar for structures being built. • Cedar snags that remain in the forest have heritage value and must be protected. • The cutting of any live trees for trail construction materials should not be permitted.

VEC/BMP	Summary of Findings and Recommendations
Technical Trail Features	**Findings** Technical Trails Features (TTFs) include obstacles requiring concentrated negotiation. These can be natural and man made. Many are constructed of wood but do not include boardwalks and creek crossings. Most TTFs are found on trails that are designed to be moderate or difficult. New trails that have been constructed have fewer TTFs and were built to include easily accessible ride-arounds. Where no alternative routes are provided, off trail impacts were observed. Viewing areas for high use TTFs on busier trails have caused off trail impacts due to users leaving the trail. **Recommendations** • As TTFs are built or reconstructed, ensure safe alternative routes are provided • Design and construct TTFs using wood that is not from native sources • Provide appropriate viewing areas for high use TTFs
Management Systems and Resources	**Findings** There is a Trail Maintenance Service Agreement in place between the DNV and the NSMBA. The District staff and recognized trail builders oversee all work on Fromme. All proposed work is presented to the DNV in the field and in work plans. The NSMBA works with the Trail Adoptees to prepare and submit a trail work plan to the DNV for review and approval. The management agreement in place allows for a large amount of volunteer resource to be used in a cost effective way under the supervision of an NSMBA recognized trail builder. This program is well established and has the potential to greatly enhance the trail system on Fromme. However, stakeholders raised concerns about the resources available for DNV to oversee all trail work and to evaluate the cost effectiveness of the TAP program. There is ongoing construction of non sanctioned trails. These include builders that are not a part of the NSMBA or any other organization approved by the District. There are great concerns from the NSMBA and the DNV about this illegal activity and the resulting environmental impacts. **Recommendations** • The DNV should work together with the NSMBA and other volunteers to establish a template for all proposed trail work. This should build on the proposals submitted and include targets and budgets that will allow for easy follow up monitoring. • Once complete, a follow up report should be submitted with a summary of targets achieved, changes to the original scope and resources used (volunteers hours, materials etc). Photos plots should be included in each to show before and after images. • Follow up monitoring should be completed by the NSMBA and submitted to the DNV. • The TAP program is a cost effective program that should be expanded to improve the trail network on Fromme. • Provide resources and funding to construct creek crossings on all managed trails. These should be completed as a separate program to TAP. Building materials should not be sourced from Fromme Mountain. • DNV, the NSMBA and other volunteers should work to enforce rules against illegal trail building. Signs should be posted of fines that will be issued if caught. District bylaw officers should patrol the Fromme Mountain area and/or respond to reports of illegal activity. • An ongoing understanding of the level of usage will continue to help the District to manage the trails more effectively. Counters should continue to be used to monitor trail usage. • For high use trails that are prone to damage during the rain season, temporary closures should be considered. This should be determined by DNV staff, the NSMBA and other volunteers based on ongoing assessments of trail conditions. • There should be more defined trail uses. Hiker only trails should include barriers to better communicate with riders. Enforcement by DNV bylaw officers should be considered to keep riders off of trails designated for hiking only.

2 Introduction

The Fromme Mountain Trail Classification Study (Trails Study) was approved by Council in 2008 and is the trail framework that has guided trail maintenance and upgrades. The study established the "baseline" trail conditions and provided an evaluation of all existing "unauthorized" trails on Fromme, with recommendations for trails to be decommissioned, upgraded or realigned. In addition, the Trails Study provided Environmental Best Management Practices and Trail Construction Guidelines on how trail work would be conducted to ensure a balance between environmental protection, trail sustainability and public safety. The study recommendations have been implemented year by year since 2008, as funding and/or volunteers became available.

The Trails Study incorporated an adaptive management framework (AMF) to evaluate and improve the BMPs. A sufficient period of time has passed (five years) since the Trails Study was adopted. The District has committed to an independent environmental assessment of key trails. This assessment evaluates the current state of eight key trails in relation to the Trail Study's environmental goals and objectives including Valued Ecosystem Components[1] (VECs) and Best Management Practices (BMPs) for trail maintenance and upgrades.

2.1 Project Objectives

1. Apply a scientific methodology to evaluate the impacts of trail use on park areas and natural processes;
2. Provide a framework that permits repeated measurement (quantitative and qualitative) for long-term monitoring;
3. Provide a quantitative assessment of the condition of eight trails in relation to the BMPs specified in the Trail Study;
4. Provide an assessment of the impacts that trails are having on the VECs identified in the Trail Study.
5. Engage stakeholders to understand their concerns regarding the trail system on Fromme.

2.2 Project Limitations

- Only the eight trails specified were assessed as part of this study;
- This assessment provides an understanding of the trails current condition;
- Certain environmental impacts including those to wildlife behavior could not be accurately assessed within the scope of this study;

[1] The environmental element of an ecosystem that is identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance. Valued ecosystem components that have the potential to interact with trails are included in the assessment of environmental effects.

3 Methods

Targeted trails selected by District staff were assessed to gain an understanding of trail conditions on Fromme Mountain and to evaluate the BMPs and VECs from the Trails Strategy. Eight trails were assessed including:

1. Dreamweaver
2. Executioner
3. Espresso
4. Floppy Bunny
5. Bobsled
6. Lower Griffen
7. The New Lower Griffen Ascent Trail
8. Baden Powell south of Mountain Highway

Consultation with stakeholders was carried out to gain an understanding of their concerns as well as management systems used for the trail network. A field assessment was completed to evaluate the physical trail characteristics and their relationship to the BMPs. The evaluation framework includes measurable BMPs and VECs from the Trails Study that are relevant for environmental assessment:

Table 2. Summary of data collected

Assessed at 20 m intervals[2]	Inventoried throughout	VEC impact assessment[3]
Off Trail Impacts	Wetland and stream crossings	Riparian Corridors
Surface Water Flow	Technical trail features	Species at Risk
Tread Wear	Off trail water impact	Old growth forests
Vegetation Impacts	Other intersecting trails	Structural Diversity
Environmentally Sensitive Areas - Streams, wetlands and riparian areas.	Borrow pits	

Detailed methods and ratings of this impacts assessment are summarized in Appendix B.

[2] Using a measuring tape, the assessors walked along each trail stopping every 20m. The section of trail 5m ahead of this point was assessed using the evaluation framework. In total, 25% of the trails were inventoried and evaluated using this method. Plots were recorded spatially and assessment criteria were inventoried using field computers to ensure consistency and quality of data management. Photos were taken at each assessment point.

[3] The four VECs identified in the Trails Study were assessed relative to the observations made during the field assessments.

4 Planning Context 2004 - 2014

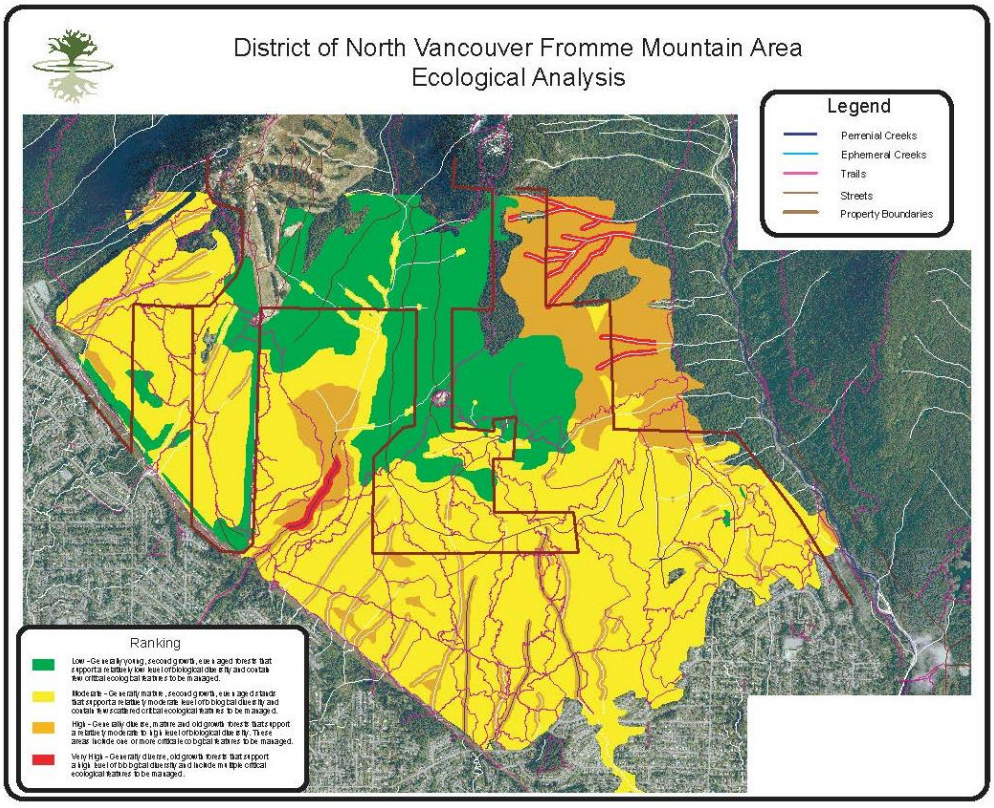
Prior to adopting the Trails Study in 2008 the DNV carried out extensive data collection and analyses to inform the plan.

4.1 Ecosystem Analysis and Mapping 2004

Diamond Head Consulting completed an Ecosystem Analysis for the Fromme Mountain Area. The objective of the study was to compile a baseline inventory of ecological values to help inform the planning process for managing recreation on the mountain. Environmental features that were included in this study included:

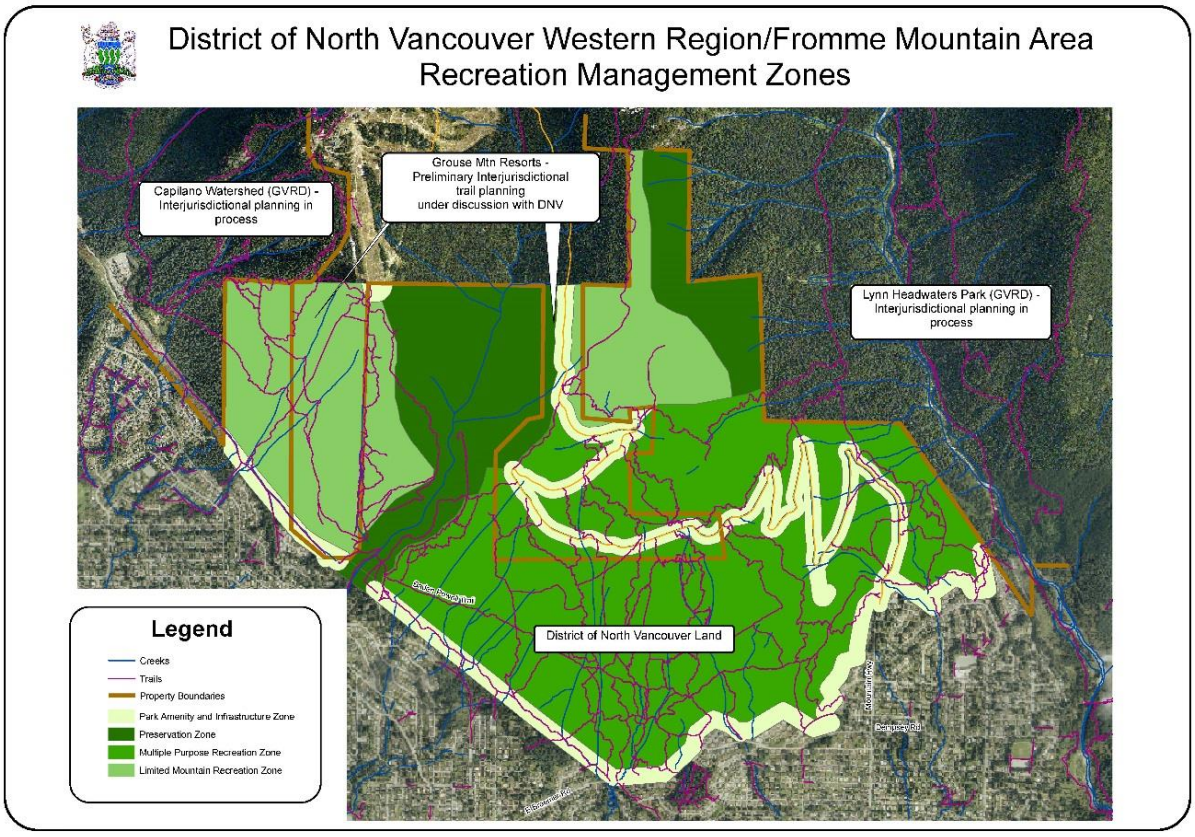
- Forest Structural Stage
- Leading tree species
- Creeks and Riparian Habitat
- Significant Trees
- Wildlife Trees
- Coarse Woody Debris
- Steep Slopes
- Rare and Endangered Wildlife Species

These critical factors were given a numeric ranking that increased relative to their ecological value or sensitivity. All of the individual maps were then overlaid and their ranking added together to produce a final map.



4.2 Recreation Management Zones 2005

The ecosystem analysis lead to the designation of recreation management zones. The goals and objectives of these zones were used to inform the development of the Trails Study.



4.3 Alpine Recreation Strategic Study 2003 - 2007

The Alpine Recreation Strategic Study was initiated in 2003 and completed in 2007. The vision for Alpine Recreation in the DNV was to:

- Become a model of sustainable recreational management;
- Achieve a balance between environmental stewardship and recreation opportunities; and,
- Protect mountain ecology with social, recreation and economic benefits for the community.

This study covered the entire North Shore Mountains and provided the foundation for the Trails Study.

4.4 Fromme Mountain Trail Classification Study 2008

The Trails Study integrated findings from previous studies and provided an evaluation of all existing “unauthorized” trails on Fromme, with recommendations for trails to be decommissioned, upgraded or realigned. Environmental BMPs, Trail Construction Guidelines and VECs were also described and this document has guided all approved trails work completed between 2008 and 2014.

4.5 Planning and Operational Work 2008 - 2014

Fromme Mountain trails have been the focus of much effort in planning and operational work by both the DNV and volunteers since the Trails Study was adopted by Council in 2008. The North Shore Mountain Bike Association (NSMBA) is the most active volunteer group assisting in annual trail maintenance and upgrades within a District Park Permit framework. There are also other individuals and small groups of volunteers that have worked under the guidance of the District.

In 2012, the NSMBA in partnership with the District proposed a community driven model for sustainable trail maintenance to the District. The objective of this program was to work towards a formalized memorandum of agreement between NSMBA and DNV that would include a Trail Adoption Program (TAP). Currently there are up to 22 NSBMA Trail Adoptees involved in helping to maintain and modify the trails. In 2012, the TAP program accounted for 42 trail maintenance days, and surpassed over 7000 hours of volunteer hours.

Over the past 6 years, the trails system has had ongoing upgrades substantially improving their condition pre-2008. Rerouting of “fall trails” has improved public safety, reduced erosion, and created sustainable routes that require less annual maintenance. In one example, 6 kilometers of trail was decommissioned because it could not be made sustainable. There are 62 kilometres of trails on Fromme mountain and physical trail improvements will continue to be made annually. The District continues to partner with the NSMBA and other trail adopters to improve trail condition with the long term goal of establishing an environmentally sustainable trail network.

Figure 1. Photos of before and after upgrades in sections of Executioner (left) and Expresso (right).

In 2010 and 2011, the District upgraded trails using a grant that was awarded through the Recreation Infrastructure Canada. Trails were inventoried and a trails map was created. Three new staging kiosks at Skyline, Braemar and Mtn Highway with trail maps and information were established. Over 100 signs were placed throughout the Fromme Mountain area to identify the recognized trail network. District crews constructed Bobsled and to upgraded the Baden Powell Trails. Over 40 stairs, bridges and boardwalks were rebuilt. Also 6km of trails and two old skid roads were deactivated.

Other initiatives achieved include a Hydrological Study (2005) which identified creeks and the impacts of roads and their ditches. Forest enhancement initiatives have been completed which included the thinning of small stand openings to promote biodiversity. Also high risk invasive plants have been targeted for removal.

4.6 Timeline of the Fromme Mountain Trail Program

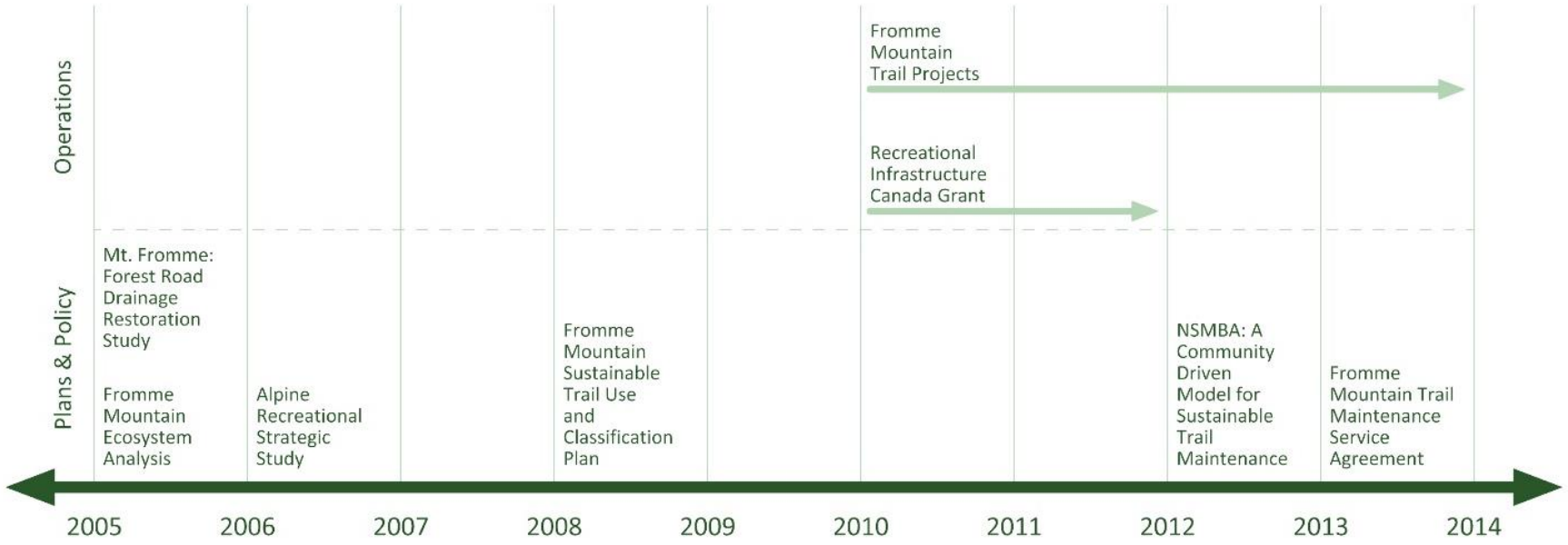


Figure 2 Timeline illustrating significant works programs on Fromme Mountain

5 History of the Trail Network and Usage

The trail network on Fromme Mountain was well established prior to the adoption of the Trails Study in 2008. There were historic hiking trails as well as newly constructed trails for mountain biking. The NSMBA documented these trails and in 2003 published a map showing this network and difficulty rating specific to Mountain Biking (Figure 3).

The Trails Study was developed in partnership between the District and the NSMBA. It formalized the trail network that would be maintained and identified the remainder for decommission or consolidation (Figure 4).

The trail network that is used today by the Mountain Bike community is illustrated in Figure 5. This network is published on the website “Trail Forks.com”. Riders use GPS to identify trails that they ride and publish them on the website’s mapping application. Figure 5 is a good indication of the trails that were popular and active in 2014. These include both approved and unauthorized trails and illustrates the importance of closing trails that are not part of the approved network.

Trail usage has increased in intensity over the past ten years; this was expressed by most stakeholders interviewed. In addition to increased numbers of users, there has been a change in the demographic of the users. As trails have been upgraded and easier trails have been built, more beginners and intermediate skilled riders, and youth are using Fromme.

Rider intensity was measured by the District during the summer of 2011. TRAFx mountain bike trail counters were installed on four high use trails (Ladies Only, Baden Powell, Bobsled and Mountain View Park) between April 25, 2011 and September 04, 2011. On average, over 300 riders per week, with peaks reaching up to 1100 riders per week, were using these four trails.

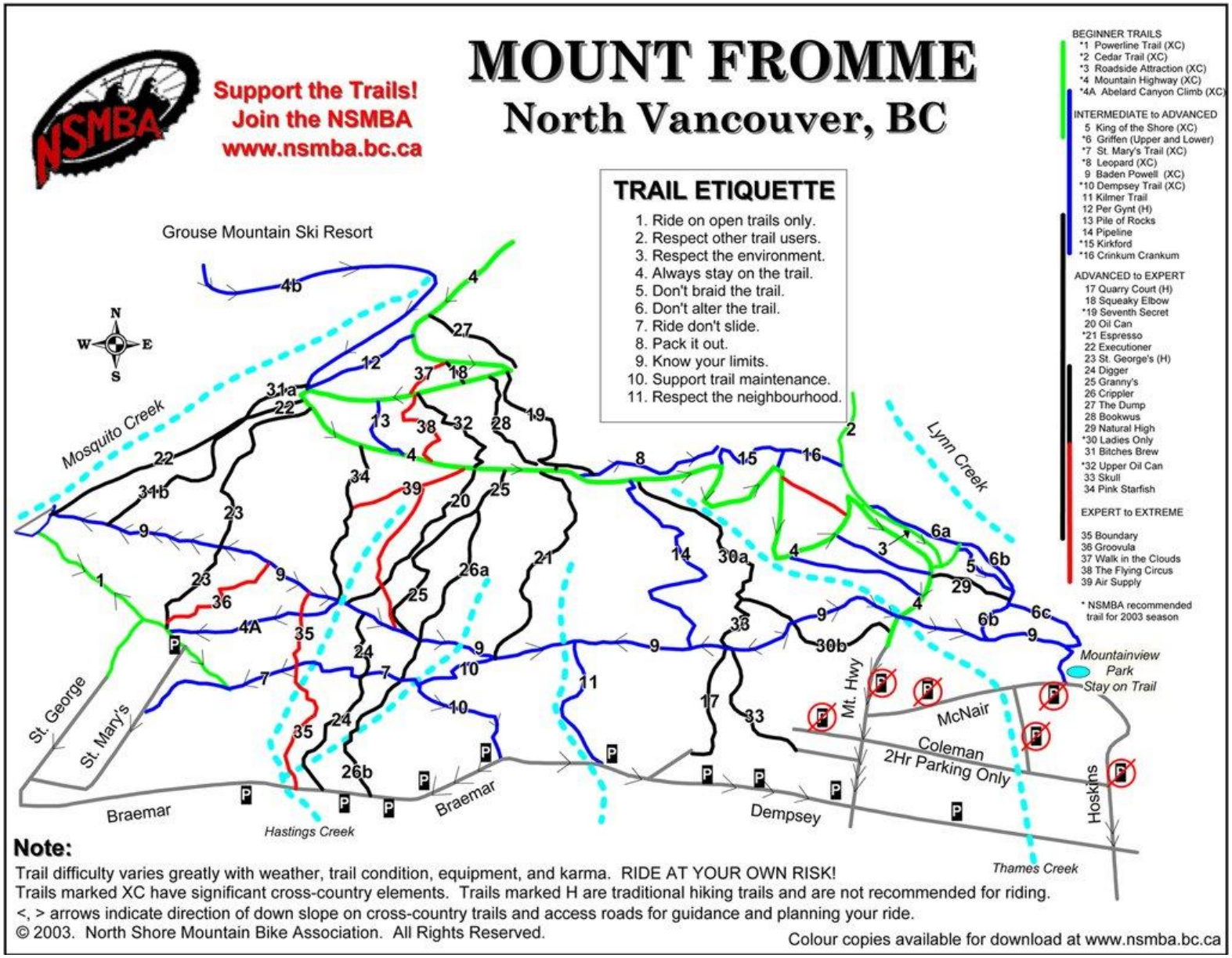


Figure 3. NSMBA Mountain Biking map (2003)

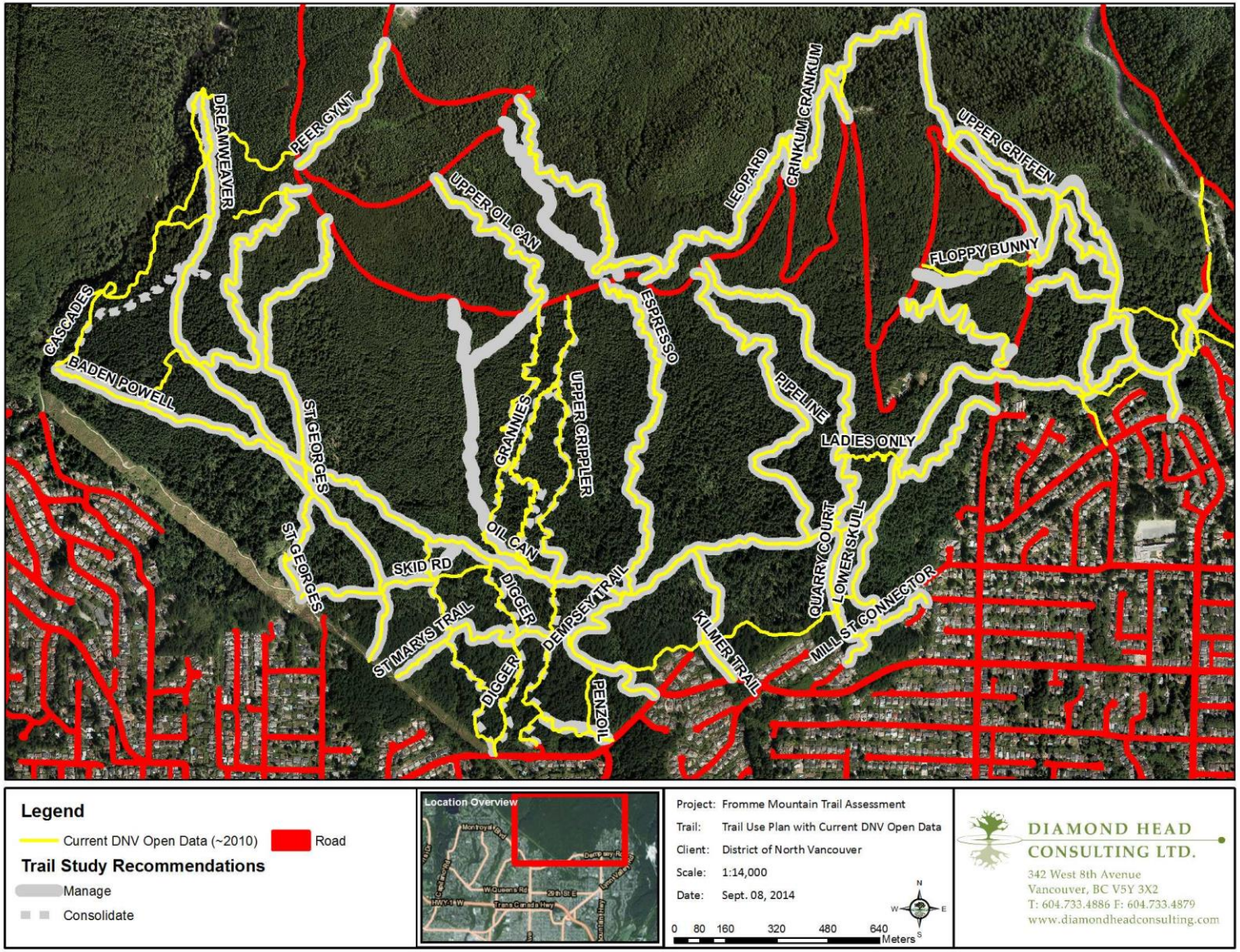


Figure 4. Map illustrating the trails network adopted in the Trails Study (Grey) as well as trails published by the DNV on Geoweb (yellow).

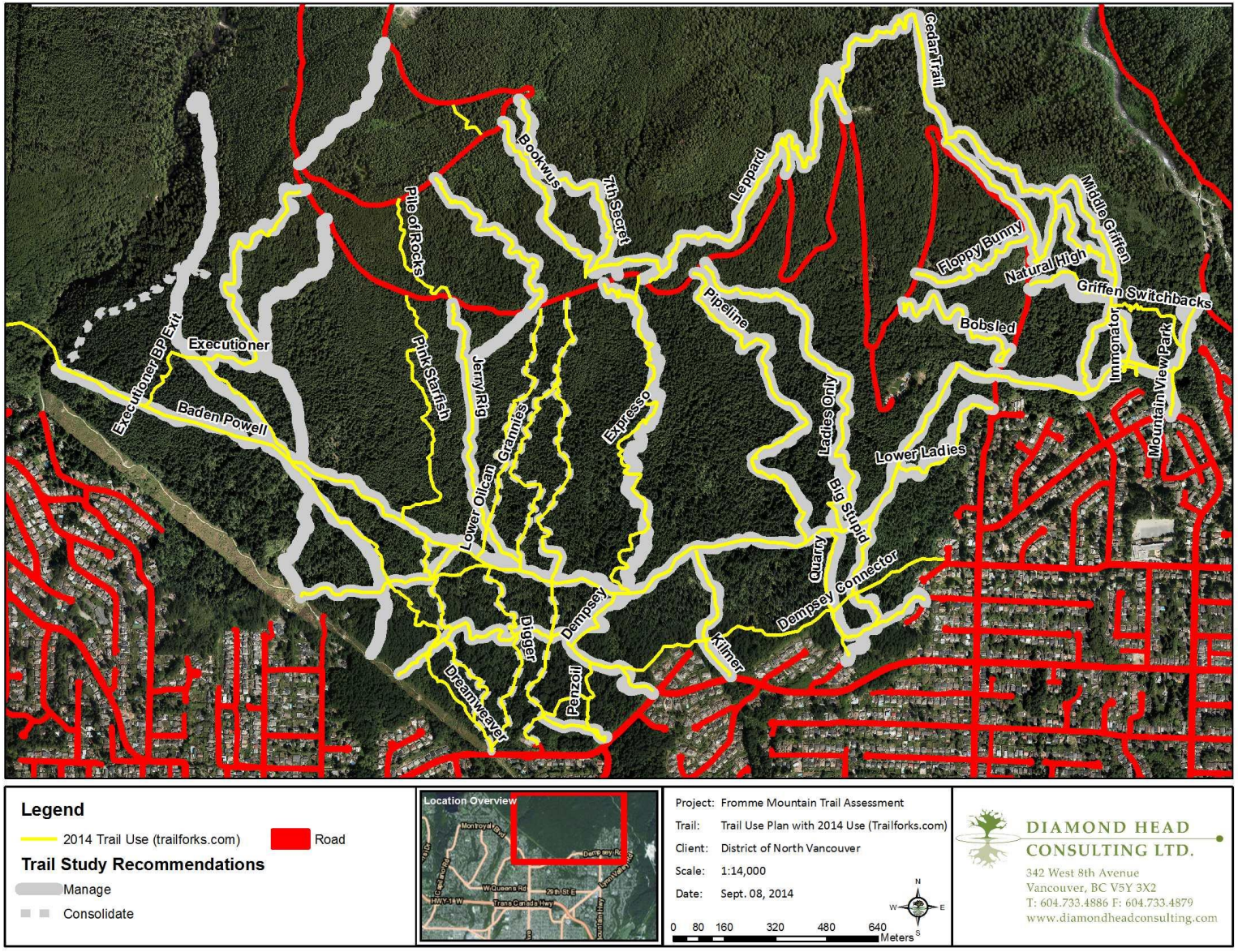


Figure 5. Map illustrating the trails network adopted in the Trails Study (Grey) as well as trails that have been published on "Trail Forks" (2014).

6 Summary of Findings

A total of 459 plots were established along 9180m of trail. The area assessed represents ¼ of the trail distance (~2295m). Table 4 provides score card summaries of the condition of each trail as they relate to BMPs. Table 3 provides a summary of all trails collectively. This provides an idea of the proportional impact assessment of all trails. The methodology for scoring is provided in Appendix B. Ratings from low to high have been provided to help interpret the data collected. Rating that are none or low are considered to be meeting the expectations of the BMPs in the Trails Study. Ratings of moderate or high require improvement. Detailed findings for each trail are provided in Appendix A.

Table 3. Summary of trail condition by BMPs for all trails collectively

BMP	Combined summary of all trail conditions
Off Trail Impacts	73% of trails had low to none off trail impacts 24% had a moderate impact rating 3% had a high impact rating
Surface Water Flow	81% of trails had low to none off trail impacts. 17% had a moderate impact rating 2% had a high impact rating
Tread Wear	68% of trails had low to none off trail impacts. 31% had a moderate impact rating 1% had a high impact rating
Impacts to Vegetation	73% of trails had low to none off trail impacts. 26% had a moderate impact rating 1% had a high impact rating
Impacts to streams, wetlands and riparian areas	91% of trails are not within riparian areas and therefore are causing no impacts. 9% of the trails are within 15 of a creek. No creek crossings met the requirements of the BMPs. All of the trail segments that are within 15m of a creek had a moderate or high impact rating.

Table 4. Summary of trail conditions and BMP Score Card (ratings of medium and high do not meet the BMP standards)

Trail Name	Bobsled		Espresso		Ascent Trail (Griffen Uphill)		Floppy Bunny		Lower Griffen	
Difficulty Rating	Green (Easy)		Blue		Blue		Black Diamond		Blue	
Length (m)	920		1680		140		400		860	
Main Use	Biking (Downhill)		Biking (Downhill)		Biking (Uphill)		Biking (Downhill)		Biking (Downhill)	
Average Width (m)	1.8		1.1		1.6		1.5		1	
Maximum Width (m)	3.2		4		2.3		3		1.2	
Average Slope (%)	10.5		12.1		8.9		10.9		16.4	
Maximum Slope (%)	35		32		13		20		35	
Trail Description (TTF = Technical Trail Features)	% Soil	91%	% Soil	88%	% Soil	100%	% Soil	80%	% Soil	81%
	% Boardwalk	7%	% Boardwalk	1%	% Boardwalk	0%	% Boardwalk	0%	% Boardwalk	16%
	% TTF	1%	% TTF	9%	% TTF	0%	% TTF	20%	% TTF	2%
	% Armored	0%	% Armored	2%	% Armored	0%	% Armored	0%	% Armored	0%
	% Bedrock	0%	% Bedrock	0%	% Bedrock	0%	% Bedrock	0%	% Bedrock	0%
Off Trail Impacts	%None	0%	%None	9%	%None	0%	%None	10%	%None	14%
	%Low	49%	%Low	80%	%Low	57%	%Low	80%	%Low	18%
	%Medium	49%	%Medium	10%	%Medium	43%	%Medium	10%	%Medium	18%
	%High	2%	%High	1%	%High	0%	%High	0%	%High	2%
Surface Water Flow	%None	2%	%None	35%	%None	0%	%None	30%	%None	16%
	%Low	78%	%Low	65%	%Low	100%	%Low	70%	%Low	58%
	%Medium	20%	%Medium	0%	%Medium	0%	%Medium	0%	%Medium	26%
	%High	0%	%High	0%	%High	0%	%High	0%	%High	0%
Tread Wear	%None	11%	%None	9%	%None	14%	%None	15%	%None	16%
	%Low	69%	%Low	70%	%Low	71%	%Low	50%	%Low	37%
	%Medium	20%	%Medium	21%	%Medium	14%	%Medium	35%	%Medium	44%
	%High	0%	%High	0%	%High	0%	%High	0%	%High	2%
Impacts to Vegetation	%None	0%	%None	2%	%None	0%	%None	5%	%None	21%
	%Low	27%	%Low	90%	%Low	86%	%Low	90%	%Low	40%
	%Medium	69%	%Medium	7%	%Medium	14%	%Medium	5%	%Medium	37%
	%High	4%	%High	0%	%High	0%	%High	0%	%High	2%
Impact to streams, wetland and riparian areas	%None	89%	%None	95%	%None	100%	%None	90%	%None	79%
	%Low	0%	%Low	0%	%Low	0%	%Low	5%	%Low	0%
	%Medium	9%	%Medium	5%	%Medium	0%	%Medium	5%	%Medium	21%
	%High	2%	%High	0%	%High	0%	%High	0%	%High	0%
Number of Borrow Pits	Active	10	Active	32	Active	0	Active	2	Active	4
	Restored	5	Restored	68	Restored	0	Restored	3	Restored	1
Number of Constructed	10		16		0		18		20	

Trail Name	Dream Weaver-Lower		Excecutioner		Dream Weaver-Upper		Baden Powell (Upper)		Baden Powell (Lower)	
Difficulty Rating	Blue		Black Diamond		Blue		Blue		Green	
Length (m)	1560		1360		1320		620		320	
Main Use	Biking (Downhill)		Biking (Downhill)		Hiking		Multi-Use (Biking/Hiking)		Hiking	
Average Width (m)	1.2		1		1.3		1.5		1.6	
Maximum width (m)	2.8		1.5		2.2		2.4		2.3	
Average Slope (%)	14.1		23.7		13.3		12		8.9	
Maximum Slope (%)	35		40		38		27		13	
Trail Description (TTF = Technical Trail Features)	% Soil	96%	% Soil	98%	% Soil	97%	% Soil	89%	% Soil	75%
	% Boardwalk	1%	% Boardwalk	1%	% Boardwalk	3%	% Boardwalk	7%	% Boardwalk	17%
	% TTF	3%	% TTF	0%	% TTF	0%	% TTF	0%	% TTF	8%
	% Armored	0%	% Armored	0%	% Armored	0%	% Armored	4%	% Armored	0%
	% Bedrock	0%	% Bedrock	1%	% Bedrock	0%	% Bedrock	0%	% Bedrock	0%
Off Trail Impacts	%None	23%	%None	3%	%None	37%	%None	14%	%None	25%
	%Low	50%	%Low	69%	%Low	40%	%Low	32%	%Low	67%
	%Medium	24%	%Medium	28%	%Medium	18%	%Medium	46%	%Medium	0%
	%High	3%	%High	0%	%High	5%	%High	7%	%High	8%
Surface Water Flow	%None	51%	%None	1%	%None	20%	%None	7%	%None	33%
	%Low	40%	%Low	49%	%Low	66%	%Low	46%	%Low	67%
	%Medium	9%	%Medium	41%	%Medium	14%	%Medium	43%	%Medium	0%
	%High	0%	%High	9%	%High	0%	%High	7%	%High	0%
Tread Wear	%None	6%	%None	16%	%None	3%	%None	4%	%None	25%
	%Low	68%	%Low	37%	%Low	65%	%Low	32%	%Low	75%
	%Medium	23%	%Medium	44%	%Medium	32%	%Medium	61%	%Medium	0%
	%High	3%	%High	2%	%High	0%	%High	4%	%High	0%
Impacts to Vegetation	%None	5%	%None	3%	%None	31%	%None	14%	%None	17%
	%Low	76%	%Low	87%	%Low	40%	%Low	32%	%Low	42%
	%Medium	19%	%Medium	10%	%Medium	29%	%Medium	50%	%Medium	42%
	%High	0%	%High	0%	%High	0%	%High	4%	%High	0%
Impacts to streams, wetland and riparian areas	%None	92%	%None	74%	%None	91%	%None	79%	%None	75%
	%Low	0%	%Low	18%	%Low	3%	%Low	7%	%Low	17%
	%Medium	5%	%Medium	9%	%Medium	2%	%Medium	7%	%Medium	8%
	%High	3%	%High	0%	%High	5%	%High	7%	%High	0%
Number of Borrow Pits	Active	5	Active	2	Active	0	Active	0	Active	0
	Restored	6	Restored	5	Restored	0	Restored	2	Restored	0
Number of Constructed Feat.	11		10		2		7		6	

7 Valued Ecosystem Components

The Trails Study identified four specific valued ecosystem components (VECs) that are to be protected. These include environmental features and functions that support high levels of biodiversity, are significant or important to stakeholders and are difficult to measure. A discussion of impacts to VECs is provided based on observations in the field and professional understanding of these elements.

7.1 Riparian Corridors

Riparian corridors include areas adjacent to creeks or wetlands. Fromme Mountain receives high rainfall and supports many creeks. The riparian areas associated with these creeks help to protect water quality and provide value habitat for wildlife. Riparian areas typically support the highest levels of biodiversity on a landscape. The BMPs in the Trails Study require that all creek crossings be safe and in compliance with the Provincial Riparian Areas Regulation, which requires a protected area that extends up to 15m on both sides of the creek (using the RAR simple method). This width is also consistent with the District Streamside Protection DPA. None of the creek crossings assessed in this study were in compliance with this standard. Many crossings were constructed to just the top of the creeks banks, which increases the risk of soil erosion, impacts to sensitive habitat and allows access for dogs and people. Areas of greatest concern were trails with steep grades extending down to a creek crossing causing skidding and resulting in surface water-flows that carry sediment around its banks and into the creek.

Recommendations for Riparian Corridors:

The BMPs for creek crossings in the Trails Study should be rewritten to enhance the protection of creeks, wetlands and their riparian areas. However, the current BMP requirement for a 15m wide protection zone of both sides of every creek is too wide for the numerous small creeks on Fromme Mountain. Also submitting a RAR assessment for every creek encountered along the trails would be onerous. It is recommended that a creek crossing standard be adopted for the Fromme Mountain area. Applications to construct or upgrade creek crossings should be submitted to and approved by the District. Recommended standards to be adopted include the following:

- Upgrade the requirements for creek crossings to the following: All creeks that are >30cm wide (at high water flow) should be protected by a clear-span boardwalk/bridge. The structure footings should be well anchored to an area at least 1m back from the top of bank of the creek. The entrance and exit of the bridge should extend a minimum 3m back for creeks 30cm to 1m wide and 5m back for creeks that are >1m wide. These structures should include design features (e.g., railings etc.) to prevent access down to the creeks. Creeks <30cm wide can be managed with culvert crossings as long as the inlet and outlet are well protected from trail impacts.

- Where ever possible, new trails should be located further than 15m from all creeks that are greater than 1m wide.
- All trails within 30m of creeks should be prioritised for upgrading and maintenance.
- Disposal bins and dog waste disposal bags should be provided at the new parking facility and along the BP trail.

7.2 Old Growth Trees

The Trails Study specifies that trails should be located away from all old growth trees (>250 years old) at a distance of 1.5 times the drip line-to-trunk distance. Where old growth trees present an unavoidable attraction, boardwalks are to be constructed to allow access for trail users without adverse impact to the root network. The only old growth trees (>250 years old) found near the eight trails assessed were along upper Dreamweaver. This section of trail is recommended to be primarily a hiking trail and had low tread wear. There were a small number of old growth trees that were close or adjacent to the trail. There were no old growth trees identified near any of the other trails assessed. Concerns have been raised of unauthorised trail building in Mosquito Creek which supports a stand of old growth trees. However, no trails in that area were assessed as part of this assessment.

Recommendations to Protect Old Growth Trees:

- No additional trail building is recommended in the area of Mosquito creek which supports old growth trees.
- All non-sanctioned trails that run through the old growth stand in the Mosquito creek area should be aggressively decommissioned.
- The upper section of Dreamweaver should be rerouted further than 6m from the base of any old growth trees.
- No old growth trees should be cut or pruned for hazard tree mitigation.

7.3 Structural Diversity

The Fromme Mountain area supports relatively healthy mature forest plant communities. The majority of the area regenerated naturally after clear cut harvesting and broadcast burning ~100 years ago. These forests now support mature second growth stands dominated by western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*). There are also scattered individual and small pockets of younger pioneer deciduous species dominated by red alder (*Alnus rubra*). Many of the mature conifer trees are large in size with some reaching diameters of greater than 100 cm and heights of up to 50 m.

Most stands have moderate to high canopy cover and have formed a dense crown, restricting sunlight from reaching the forest floor. These forests generally have a low structural diversity with few canopy gaps. Understory vegetation cover varies in cover from as low as 10% under dense canopies to 60% in open areas. Common shrub species include sword fern (*Polystichum munitum*), vine maple (*Acer circinatum*), salal (*Gaultheria shallon*), red huckleberry (*Vaccinium parvifolium*), dull Oregon grape (*Mahonia nervosa*), and spiny wood fern (*Dryopteris expansa*).

Areas that provide the greatest structural diversity have canopy gaps, usually caused by windthrow or disease, that allow light to reach the forest floor. In these areas the edge trees tend to have branches extending to the ground and ground cover is dense providing forage and cover for wildlife.However, these are not common on Fromme. Other features that provide structural diversity include large dead standing trees. These “wildlife trees” provide forage and nesting sites for a variety of cavity nesting birds and small mammals. In areas where the DNV has carried out ecosystem restoration projects good structural diversity and higher levels of biodiversity are beginning to develop. For example, dead standing trees (wildlife trees) on these sites are now showing signs of use by cavity nesters.

Trail construction generally requires no mature tree removal. None of the trails assessed had caused a significant change in the overstory canopy structure. Along some trails suppressed western redcedar trees have been removed and used for boardwalks and technical trail features (TTFs). It was difficult to determine how many trees had been removed. However the removal of any live trees in the understory will reduce the structural diversity of these forests.

Recommendations to Protect Structural Diversity:

- Avoid the removal of large dead standing trees (wildlife trees); these provide high habitat value to wildlife.
- The cutting of any live trees for trail construction materials should not be permitted.
- Under the direction of a biologist and community forester, consider creating small stand openings to enhance structural diversity and create wildlife trees.

7.4 Species at Risk

The Trails Study recommends that, prior to trails works, the area be reviewed to ensure no habitat that is critical to any species at risk will be impacted. This includes species and their habitat that are at risk of extinction or extirpation. The BC Conservation Data Center collects and disseminates information on species considered to be extirpated, endangered, or threatened (Red listed) and of special concern (blue listed).

A detailed inventory of wildlife species requires extensive observation and trapping to be completed throughout all seasons. This type of comprehensive review including plants and ecosystems is beyond the scope of this study. Instead, this assessment focused on the presence of critical habitat for wildlife species at risk that are likely to inhabit the Fromme Mountain area. The wildlife species and their habitat requirements are summarised in Table 5. The species identified are those known to occur in habitat areas similar to those that exist on the North Shore.

The forest on Fromme Mountain is primarily closed with low light levels at the forest floor. The diversity of plants is generally low. This type of habitat is not suitable for most plant species that are considered at risk.

Table 5. Wildlife Species at Risk and Habitat Requirements that potentially inhabit Fromme Mountain

Species	Critical Habitat Requirements
Keen's Long-Eared Myotis (*Myotis keenii)* Red Listed	• Roost sites include tree cavities, loose bark, rock crevasses and small caves
Pacific Water Shrew (Sorex bendirii) Red Listed	• Low elevation streams, marches, wetlands • Riparian habitat with forest and shrub cover • Abundant coarse woody debris • Abundant fine forest floor litter
Coastal Tailed Frog (*Ascaphus truei*) Blue Listed	• Low to mid elevation streams, marches, wetlands • Cool well shaded ponds or slow streams for breeding • Riparian habitat with forest and shrub cover
Red-legged frog (*Rana aurora*) Blue Listed	• Low to mid elevation slow moving streams, marches, wetlands and ponds. • Shallow ponds for breeding. • Riparian habitat with forest and shrub cover
The Western Screech Owl (*Megascops kennicottii kennicottii*) Blue Listed	• Old woodpecker holes and other tree cavities • Open woodlands, along the edges of open fields or wetlands
Band-tailed Pigeon (*Patagioenas fasciata)* Blue Listed	• Coniferous and mixed forests and woodlands • Nests in mature trees preferring Douglas-fir
Trowbridge's Shrew (*Sorex trowbridgii*) Blue Listed	• Loose leaf litter • Coarse woody debris • Abundant organic debris
Olive-sided flycatcher *(Contopus cooperi)* Blue Listed	• Mature and old growth forest • Semi open forests cover • Wetlands and riparian habitat • Standing dead trees
Townsend's Big-eared Bat (*Corynorhinus townsendii*) Blue Listed	• Roost sites include tree cavities, loose bark, caves and buildings. • Forested areas for foraging

The species listed by the Species at Risk Act (SARA) are continually changing and should be updated regularly. Impacts caused by the trails on Fromme to unique habitat features required by species at risk are generally associated with water quality in creeks and wetlands, as well as the loss of high value wildlife trees. The BMPs of the Trails Study as well as the updates recommended in this report will help to protect many of these critical habitat features.

Trail related impacts to unique habitat features required by species at risk are generally associated with the loss of high value wildlife trees and reduced water quality in creeks and wetlands. Increased human activity on Fromme will also have a negative impact on species at risk. The use of unauthorized trails further fragments the forest area and reduces the area available for refuge.

Recommendations to Protect Species at Risk:

- A qualified Professional Biologist should review all new and modified trail building activity to ensure it does not impact habitat for species at risk.
- Amend and enforce creek crossing standards to protect water quality.
- Protect all high value wildlife trees that are not rated as a high risk to trails.
- Prioritise the deactivation of trails within 30m of creeks or wetlands.

8 Trail Characteristics

The trial plots provide an assessment of the general trail characteristics. Trail width was similar between trails; however maximum width on newer trails was higher. These trails experience higher use and wider sections are found on some turns and above and below TTFs were riders will stop for viewing. Trail grades are generally lower on new trails and steepest on older trails. Older trails tended to follow fall lines and were not constructed cross slope.

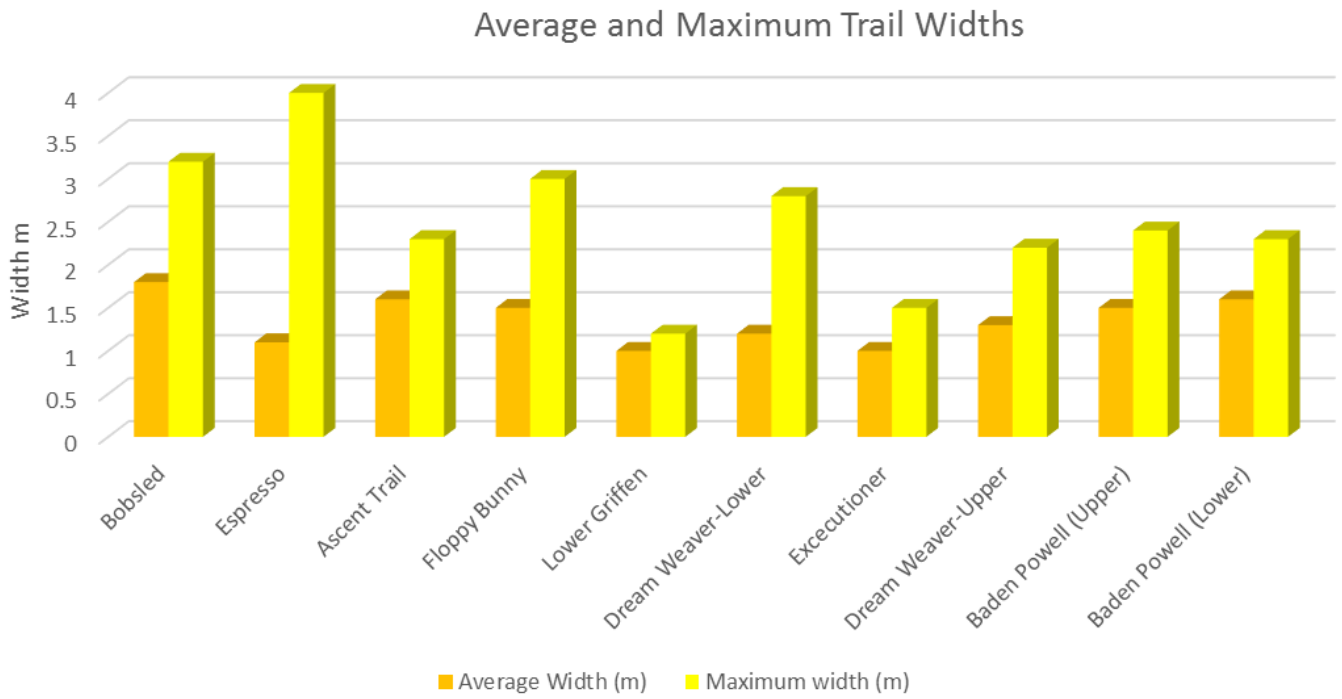


Figure 6. Average and maximum trail widths

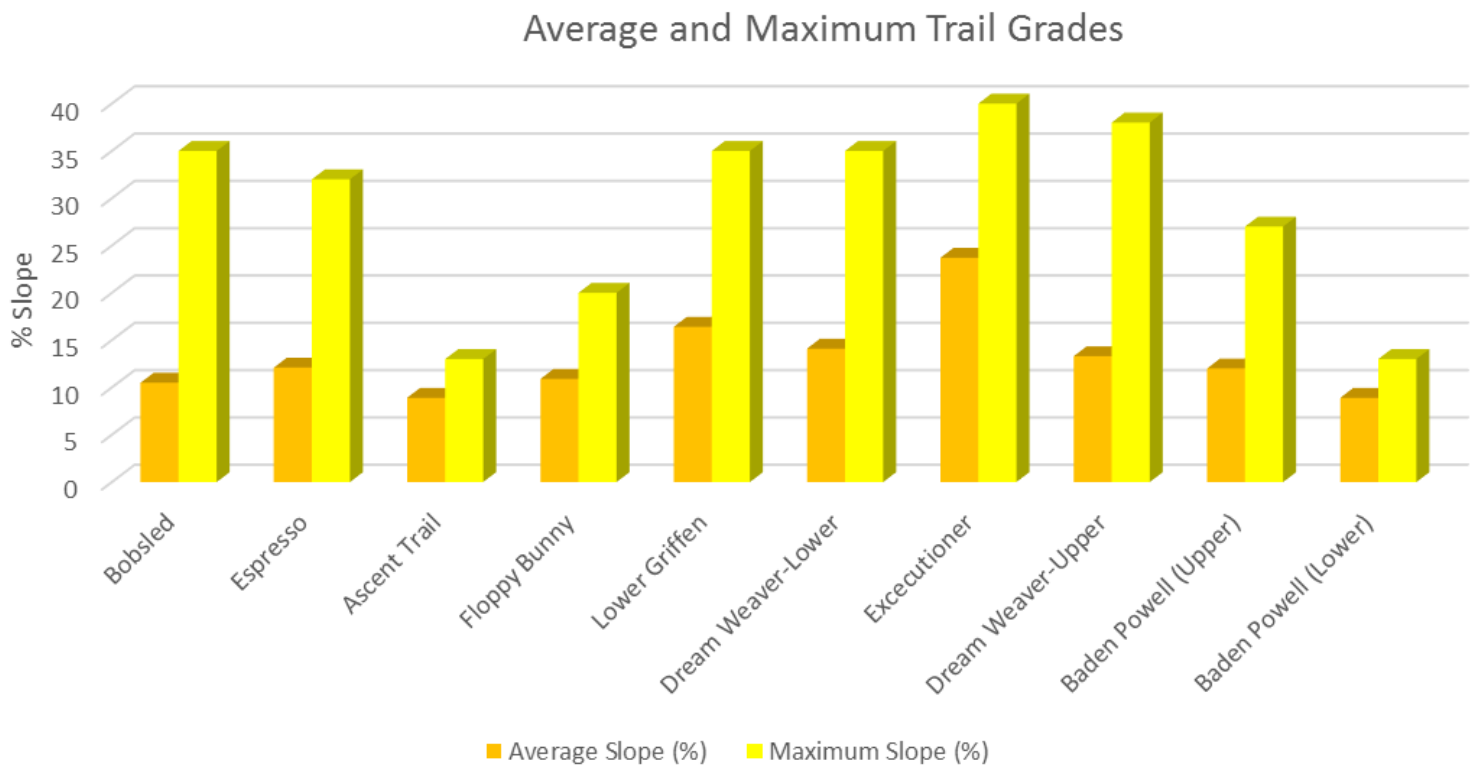


Figure 7. Average and maximum trail grades

9 Review of Best Management Practices

The analysis of measurable trail characteristics provides some insight into the relationships between the Trail Study BMPs and the environmental impacts of the trails. The following is a summary of each BMP from the Trails Study. The trails characteristics, observations and findings from the consultation process have been used to evaluate the impacts of each trail and to make management recommendations. The order of BMPs follows that of the Trails Study.

At the beginning of each section a summary is provided of the BMPs as they are stated in the Trails Study. These area the standards that are to be complied with. This provides and understanding of the benchmark that is being evaluated. The next section provides a discussion of the findings from the field assessment. Compliance of the trails is discussed and supported by data collected in the field. The final section includes a summary of how well the BMPs are being complied with and recommendations for improvement. Recommendations include both assessment and operational practices on the ground as well as amendments to the BMP standards.

9.1 BMP - Off Trail Impacts

9.1.1 **Summary of off trail impacts BMPs from the Trails Study**

Off trails impacts include degradation caused by water, soil erosion and users going off trail. BMPs from the Trails Study include:

- Sustainable trail design will minimize trail tread displacement and eliminate high concentrations of diverted water flow. Design flaws to focus on include reducing tread wear and water flow on the trail.
- Sustainable and harmonious design, which incorporates interesting features and good flow, combined with regular maintenance will ensure that staying on the trail is more appealing than leaving it.
- Avoid placing trails and trail segments within view of each other as this encourages short-cutting. Maintain a minimum 30 m buffer between trails where feasible and incorporate natural physical barriers (rocks, vegetation, logs, etc) where trails converge or intersect.
- Physical barriers (logs, rocks, plantings) may also be used strategically throughout the trail to corral users on the trail; however, care must be taken to ensure that barriers do not prevent the natural sheet flow of surface water from exiting the trail.
- Situate more difficult feature TTFs (where spectators congregate and users will make multiple attempts) in appropriate locations, such as on flat skid roads or other areas with low VEC value.
- Switchbacks should have a sufficient turning radius to accommodate all trail users and incorporate a physical barrier to short-cutting.
- TTFs shall not be situated in environmentally sensitive areas, such as riparian areas, wetlands, old growth tree stands, etc.

- Challenging TTFs shall have a ride-around option. These include all expert TTFs and TTFs with a difficulty rating higher than that of the overall trail difficulty rating.
- Dogs can be managed through policies such as enforcing on-leash requirements and prohibitions. Bridges over wetlands and streams should be “dog-friendly”. Fencing of significant environmentally sensitive areas may be required.

9.1.2 **Off Trail Impacts - Discussion of findings**

Off trail impacts from older trails are primarily related to damage from water flow. These trails tend to be fall line trails that are steep, making water control difficult. Skidding bikes rut trails further channeling water. During heavy rains, water runs down the trail surface, eroding soils and causing off trail impacts where it eventually sheds off. Visible impacts off trail include soil and gravel deposits that are 1-4m long. Some of the old trails that have been decommissioned have developed into creeks with high seasonal surface flow. On average, the off trail impacts from water flow dissipated within 5 m of the trail.

New and upgraded trails tend to have less off-trail impacts related to water. Strategic trail alignments built at gentler slopes and with reverse grades have proven to effectively manage surface water flow. Upgraded trails also have strategically placed ditches to help manage water flow onto the trail. Trails with the least impact are built up on grade without digging down into the soil profile. This helps preserve natural surface water flows.

New and upgraded trails have more off trail impacts related to construction and high traffic. On newly constructed trails, there is mineral soil present on the fill slope where vegetation has not yet established. These trails require a large amount of mineral soil. This is taken from areas adjacent to the trail called borrow pits. Most of these are within 5m of the trail. These cause localized impacts to understory vegetation and some damage to the structural roots of nearby trees. No signs of slope instability or water damage was observed related to these borrow pits.

Users leaving the trail accounts for a large part of off-trail impacts as well. Users are leaving the trail to ride around sections they find too difficult, to ride around wet areas, to follow old trails, top take breaks and wait for other riders. These off trail impacts are greatest on trails that experience high use such as Bobsled.

On hiking trails, off trail impacts include primarily expansion of the trail surface. This occurs where the main trail surface is steep and rocky. Hikers will walk up the sides of the trails in these areas. In these areas, forest floor is eroded and tree roots are often exposed.

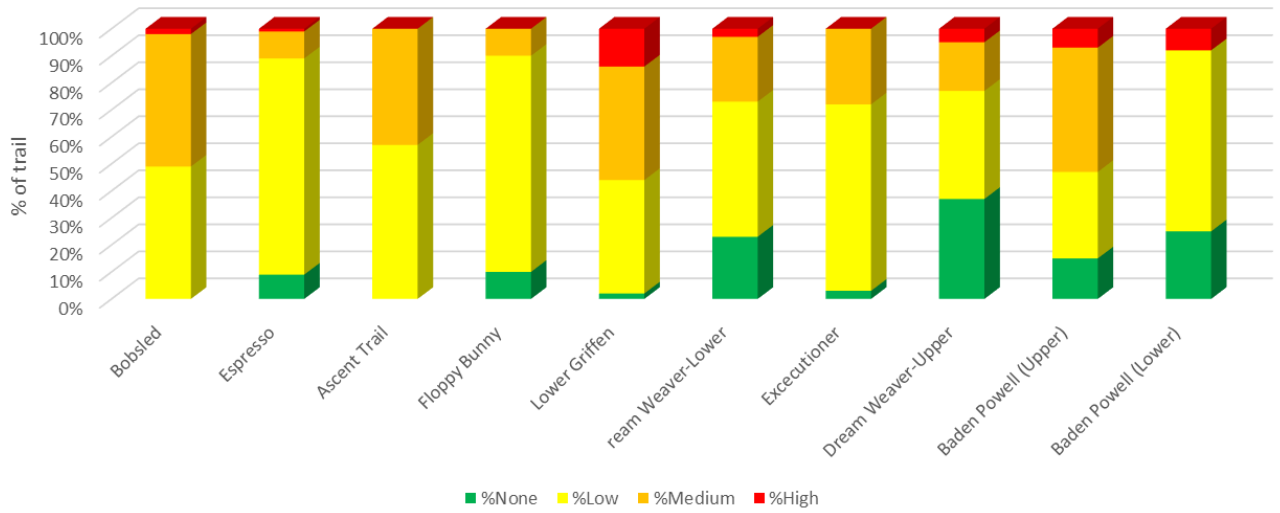


Figure 8. Off trail impacts (See Appendix B for methodology)

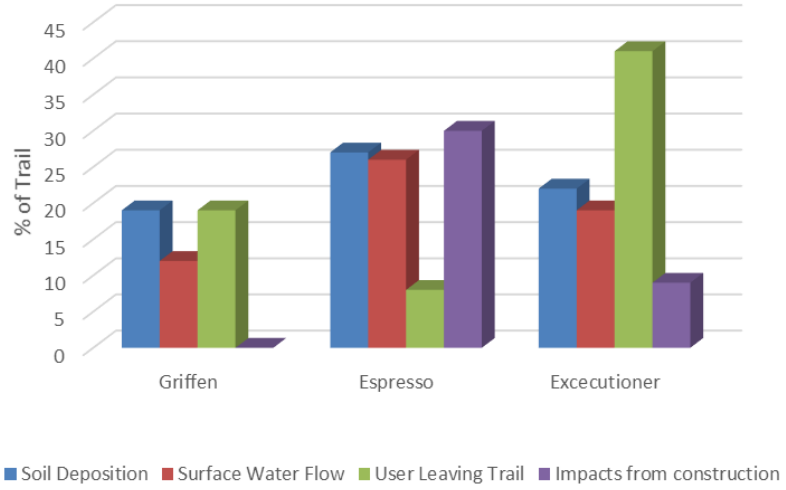


Figure 9. Causes of off trail impacts for three representative trails (moderate and high impacts only)

Figures 8 and 9 illustrates the causes of off trail impacts from three representative trails. Griffin represents a trail that existed prior to 2007 but has been upgraded and worked on extensively. Espresso have been realigned and significantly upgraded since the Trails Study was adopted. It is a good example of a trail that has been managed following the BMPs in the Trails Study. Executioner is an older trails that was inherited as part of the trail network. It tends to follow fall lines, is steep and has the least amount of upgrading compared to other trails in this study. These are used as representative trails in the subsequent discussions of BMP.

9.1.3 **Recommendations to Mitigate Off Trail Impacts:**

- Continue to upgrade older trails to new trail standards to reduce erosion and off trail water impacts.
- Aggressively rehabilitate all off trail impacts including non-sanctioned trails.
- Upgrade standards for borrow pits including location from trail, maximum size, graded edges and restoration requirements

9.2 BMP - Surface Water Flow

9.2.1 **Summary of Surface Water Flow BMP from the Trails Study**

Trails intercept and channel natural surface water and intercepted ground water flow. Unmanaged surface flow can erodes the trail surface. BMPs from the Trails Study include:

- Sustainable trail design will mitigate the effects of diverted surface water flow. This includes minimizing tread watersheds, minimizing tread lengths (particularly in flat and fall line orientations), incorporating boardwalks and bridges where near surface water tables and drainage features are anticipated, and orienting trails beneath a thick canopy to protect from direct rain impact.
- The essential design element required to manage surface water flow is ensuring that trails are aligned perpendicular to any significant surface or subsurface water flow, and that wherever such intersections occur, it is at the low point (dip) of a trail watershed (IMBA 2004 p 178).
- The most effective design solution to eliminate surface water from the trail tread on DNV trails is the grade reversal dip (IMBA 2004 p 67).
- Various other water crossing techniques (IMBA 2004 pp 179-182), and drainage solutions (IMBA 2004 pp 201-206) can be effective in specific situations, however, given the high levels of both precipitation and trail use in the Fromme area, these will not substitute for effective design. Rerouting or bridging are often the best options.
- Culverts are not recommended as they are prone to clogging, high maintenance and inevitable failure. Should culverts be used, the minimum recommended width is 30 cm (12 inches) and their locations should be recorded for future monitoring and maintenance.

9.2.2 **Surface Water Flow - Discussion of findings**

Impacts from surface water flow increases significantly with the grade of a trail. This is a result of accumulating water flowing faster and having more energy to erode soils. Older trails that follow fall lines for long stretches experience high tread wear from bikes skidding. This erodes soil from the trail creating ruts down the trail surface. During high rain fall, water runs down these sections eroding mineral soil and exposing roots and rocks. Where water eventually leaves the trail, there is often evidence of off trail impacts from water scour.

As previously discussed, newer and upgraded trails have gentler grades and are constructed to manage water flow. Surface water flow was greater on trails with a deep cut slope. This intercepts surface water flows increasing the amount of water flowing onto the trail. Construction of trails above grade allows for more natural ground flows to continue below the trails surface.

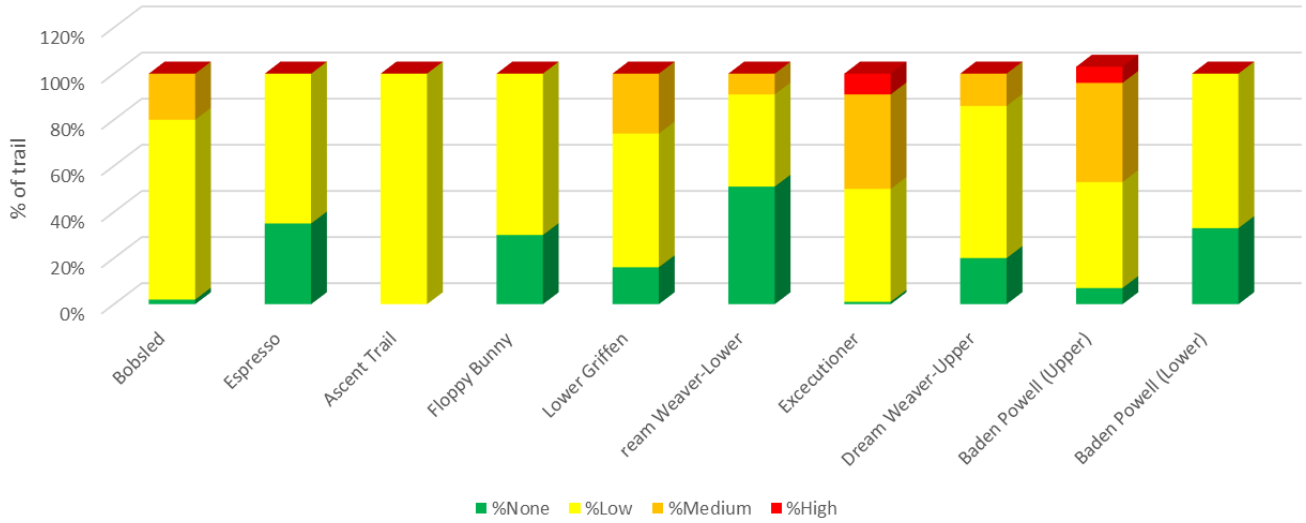


Figure 10. Surface Water Flow Impacts (See Appendix B for methodology)

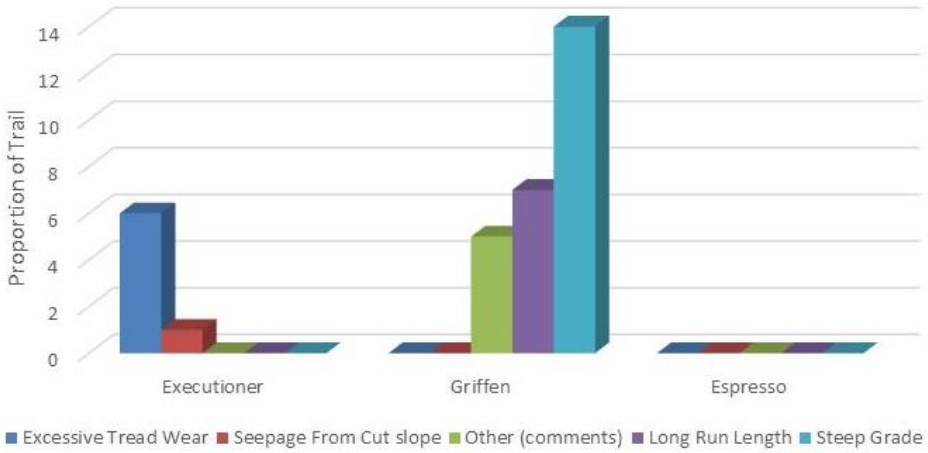


Figure 11. Causes of surface water flow for three representative trails (moderate and high impacts only)

9.2.3 **Recommendations to Mitigate Surface Water Flow:**

- Upgrade older trails to new trail design standards that manage surface water flow.
- Avoid or minimize the depth of cut slopes during construction.
- Prioritise the upgrading and maintenance of trail sections that are within 30m of any creeks.




9.3 BMP - Tread Wear

9.3.1 **Summary of tread wear BMP from the Trails Study**

Tread wear includes the physical change to the trail surface material. Impacts alter the trails capacity for drainage, resistance to compaction and soil displacement. BMPs from the Trails Study include:

- Where the design of the trail is essentially unsustainable, the ongoing maintenance requirement will be significant and endless, as water flow will undermine even the most well-constructed rock armouring. Rock armouring does not adequately mitigate erosion caused by surface water. The requirement for a constant supply of soil that is continually displaced adjacent to the trail is unsustainable and unacceptable. Rerouting of the trail is favoured under these circumstances
- There are local trail builders who have considerable experience and skill in rock armouring techniques, specific to local circumstances. Their expertise should be recognized and if possible disseminated amongst staff and volunteers.
- Imported rock is preferred; however, this is only feasible for sections of trail with nearby vehicle access. Prior to sourcing on-site rock for trail armouring, one should consider potential adverse impacts on the environment as described in the Wildlife BMP and the Use of Native Materials BMP.

9.3.2 **Tread Wear - Discussion of findings**

Tread wear typically increases with the level of use and the steepness of the trail. Steeper trails and those with more TTFs have the highest impacts from tread wear. This is a result of bikers skidding which in turn causes rutting and increases surface water flow and erosion of mineral soils on the trail surface. Traffic levels and riders ability play a large role in tread wear. Popular trails such as Bobsled and Expresso experience high volumes of bikers and are more heavily impacted. Novice riders tend to skid more while more experienced riders are better at managing their speed without skidding. On hiking trails, tread wear is caused by boots slipping at steep sections.

Where tread wear is high, surface roots or trees are often exposed and impacted. Armoring has been used as a method of preventing tread wear on highly impacted trails. There was not a lot of armouring used on the eight trails assessed with the exception of steeper sections of Executioner and the Baden Powell trail.

Newer trails tend to have a gentler grade and subsequently bikes do not skid as frequently and the tread wear was lower. The areas that do show signs of tread wear on newer trails include the sections before TTFs and steep corners. Placing obstacles strategically before these areas has been effective at slowing riders to prevent them from skidding.

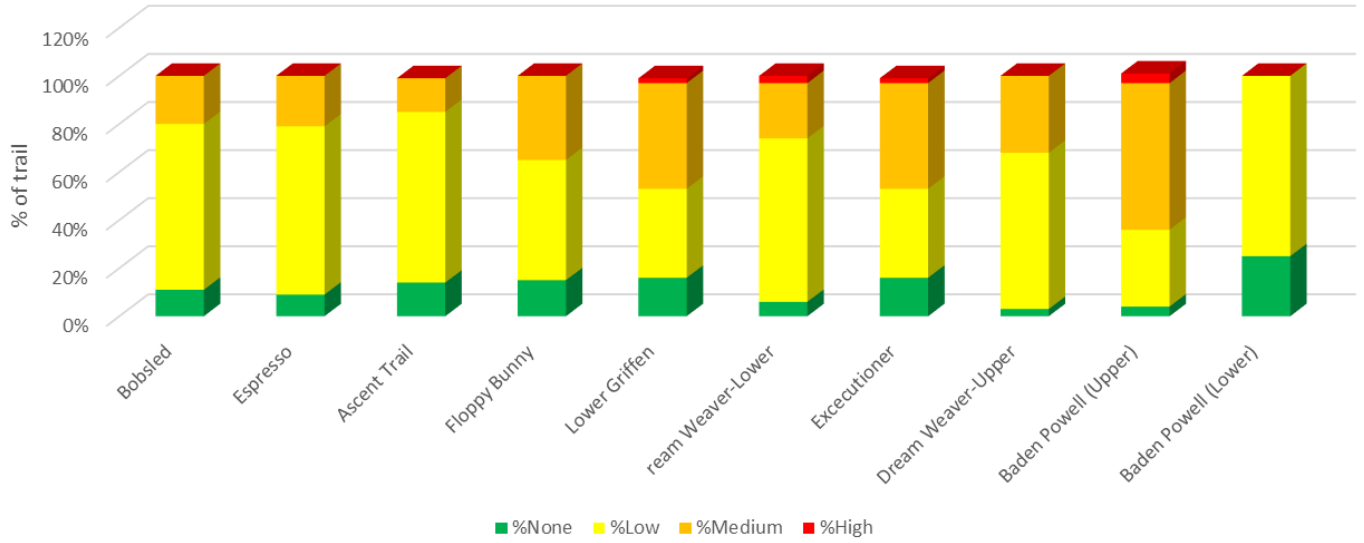


Figure 12. Tread Wear (See Appendix B for methodology)

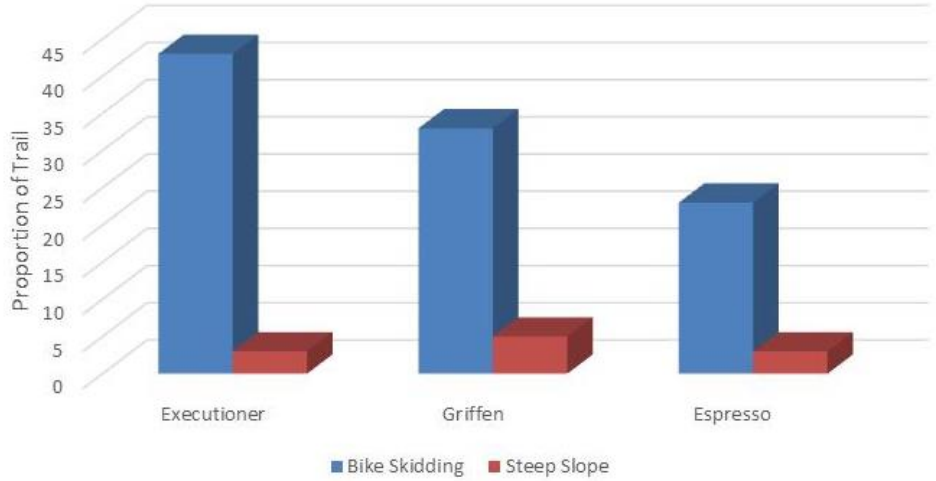


Figure 13. Causes of tread wear for three representative trails (Moderate and High tread wear)

9.3.3 **Recommendations to reduce Tread Wear:**

- Continue to promote new trail design standards that control and reduce bike skidding.
- Increase resources for maintenance of trails that experience high wear and tear.




9.4 BMP - Vegetation Impacts (trees, invasive species, understory plants)

9.4.1 **Summary of vegetation impacts BMPs from the Trails Study**

Vegetation impacts caused by trails includes damage to exposed tree roots, soil loss causing destabilization of trees, and the degradation of trail-side understory vegetation. BMPs from the Trails Study include:

- Keep trail users on the trail and minimize soil displacement, compaction in root zones, and vegetation trampling (see the Off-trail Impacts BMP).
- Locate (or re-locate) trails away from all old growth trees at a distance of 1.5x the drip line to trunk distance. Where old growth trees present an unavoidable attraction, use boardwalks/steps to provide intimate access for trail users without adverse impact to the root network.
- Locate the trail away from the drip line of mature trees. Where this is not possible, as is often the case in the DNV, favour trails on the uphill side of trees, close to the trunk, to minimize impact to the more delicate feeder root system. Preventive rock armouring or boardwalks should be used where future adverse impacts are anticipated.
- Use rock armouring techniques to protect large roots exposed on the trail tread. Bridges and boardwalks may also be incorporated.
- Prune exposed secondary roots using a saw or equivalent do not break by hand, ax or shovel etc.
- Ensure that pruning practices cause no further damage (infection) to the tree by cutting only outside the branch collar.
- Invasive plant species removal should be incorporated into trail maintenance under the guidance of the DNV Trail and Habitat Cocoordinator to ensure proper disposal and reduce the risk for further colonization. (*See Appendix E for a list of key species of concern*). Care should be given to prevent cross-contamination via workers boots, clothing, and equipment.
- Do not attach TTFs to live trees. TTFs must be constructed to be stable and free-standing.
- Where the design of the trail is essentially unsustainable, the ongoing maintenance requirement will be significant and endless, as water flow will undermine even the most well-constructed rock armouring. Rock armouring does not adequately mitigate erosion caused by surface water. The requirement for a constant supply of soil that is continually displaced adjacent to the trail is unsustainable and unacceptable. Rerouting of the trail is favoured under these circumstances
- There are local trail builders who have considerable experience and skill in rock armouring techniques, specific to local circumstances. Their expertise should be recognized and if possible disseminated amongst staff and volunteers.
- Imported rock is preferred; however, this is only feasible for sections of trail with nearby vehicle access. Prior to sourcing on-site rock for trail armouring, one should consider potential adverse impacts on the environment as described in the Wildlife BMP and the Use of Native Materials BMP.

9.4.2 **Vegetation Impacts - Discussion of Findings**

Trails impact vegetation in a number of ways. The trail surface itself amounts to a permanent loss of growing sites for the duration that the trail is active. The soil that is deposited on the trail fill slope can be replanted or will revegetate naturally over time if left undisturbed. BMPs for trail construction include the replanting of disturbed trail edges and this is evident in many places where mosses and ferns have been planted. Revegetation is difficult where off trail use has caused compaction of these soils.

The most frequent impact to vegetation was related to mature trees. It is difficult to avoid impacts to trees on the Fromme Mountain area as the forest is dense with continuous tree cover. Old and steeper trails have high tread wear and loss of mineral soil from surface water flow. This exposes the roots of trees adjacent to the trail. In many areas large structural roots are exposed and are damaged. This includes the wear of root bark at the trail surface. From observations in the field, mature trees appear to be able to recover when less than about 1/3 of their roots are impacted. The greatest impacts to trees include smaller intermediate and suppressed trees that tend to have a smaller root system and are struggling to survive in the understory. Some tree mortality was observed when trails cut roots within 1m of these smaller trees.

Generally trail construction requires no direct cutting of mature trees. Subsequently, the trails have caused very little impact on the overall canopy of Fromme Mountain. Hazard tree mitigation can cause significant impacts to the ecology of a forest. Some of the most valuable habitat features include large dead and dying trees (wildlife trees). They provide forage and nesting sites for birds and roosting areas for bats. The removal of numerous large trees was evident along the lower Baden Powell Trail in Mountain View Park.

On trails that are constructed with deep cut slopes (such as Bobsled), tree roots are difficult to avoid. The extent of roots cut depends on the depth of the cut slope. Bobsled is an example of a trail that was cut deeper into the soil profile. This caused high impacts to tree roots. The cutting and exposing of tree roots was the most significant impact recorded to vegetation.

Many newer and modified trails (such as Expresso) did not have as deep a cut slope and were built up more on the pre-existing grade. This allows for surface roots to be protected by armoring them with rock and covering with mineral soil. This method however requires borrow pits to be created for placement of mineral soil.

Along other trails, there was evidence of cutting of understory cedar trees to be used for construction of TTFs. It was difficult to quantify how many of these have been cut for trail construction and when this took place in relation to the adoption of the Trails Study.

Borrow pits for new trail construction causes the loss of ground vegetation and can impact roots of adjacent trees. Each borrow pit is a small, isolated disturbance area; however in large numbers the collective impact on ground vegetation could become significant.

Invasive species are distributed into the Fromme mountain areas primarily through seed dispersal. This is caused by wildlife eating berries, feces of dogs and seeds dispersing on the vehicles up mountain highway or people and bikes traveling on the trails. Overall invasive species are found mainly along the Mountain highway road. Invasive plant observed along the trail edges include English Holly and a very small amount of laurel. These are found throughout the forest and are distributed mostly by birds.

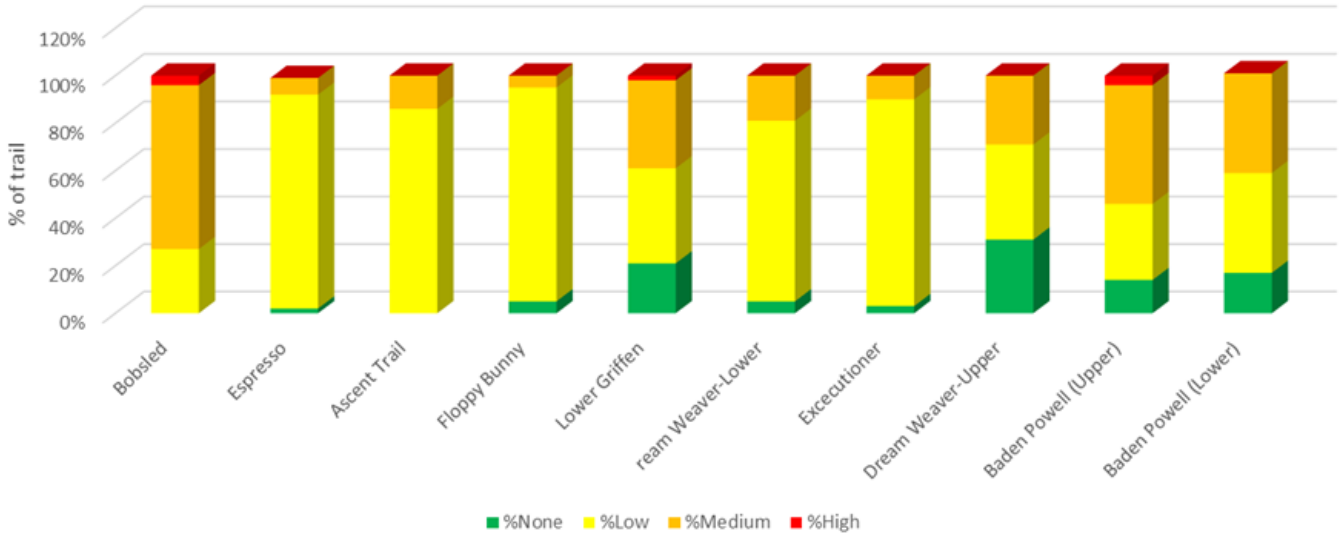


Figure 14. Vegetation Impacts (See Appendix B for methodology)

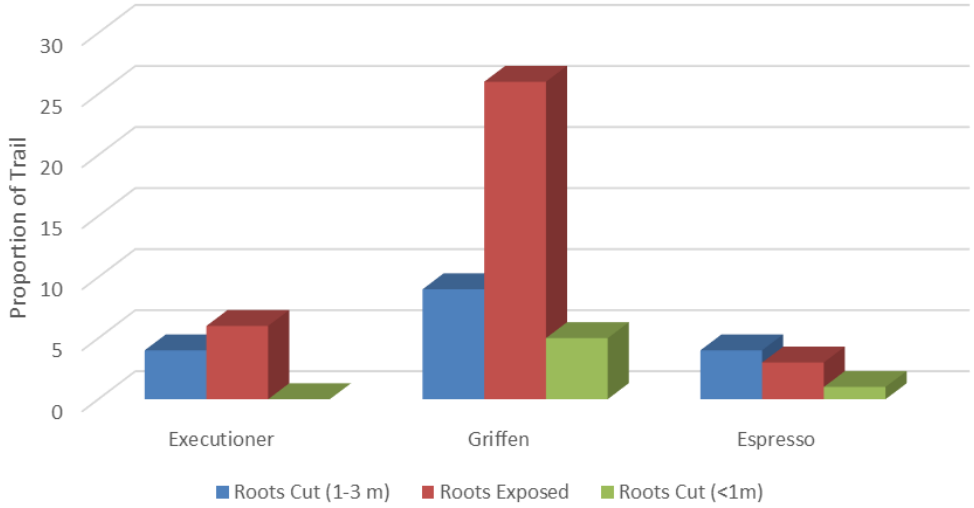


Figure 15. Causes of impacts to vegetation for three representative trails (moderate and high only).

9.4.3 **Recommendations to Mitigate Vegetation Impacts:**

- Continue to promote building methods that minimize cut slopes and build up over existing grades to protect tree roots.
- Only remove hazard trees that pose an extreme risk. The cutting of any live trees for trail construction materials should not be permitted. Post signage that trails should not be used during high wind storm events.
- The Trails Study requires that trails be aligned out of the dripline of trees. Due to the density of the forest this is not possible. Amend the BMP to require that trails be located as far as possible away from mature healthy trees and so that trails are constructed above grade without severing or suffocating roots.

9.5 BMP - Streams, Wetlands, Riparian Areas

9.5.1 **Summary of BMP for Streams, Wetlands and Riparian Areas from the Trails Study**

The Trails Study requires that all wetlands, streams and their riparian areas are protected following the provincial Riparian Areas Regulation standards. BMPs from the Trails Study include:

- Construction of trails and disturbance of the soil are considered “developments” falling under BC Riparian Assessment Regulation. They require an Assessment Report be completed by a Qualified Environmental Professional prior to development.
- A Riparian Area should be established according to the assessment methodology of the BC Riparian Area Regulation. A simple assessment of the riparian area was conducted in developing these BMPs, establishing a default riparian area of 30m adjacent to the top of bank for both permanent and non-permanent streams.
- Riparian Areas should be avoided through the re-routing of trails where feasible; however total avoidance is impossible given the perpendicular orientation of streams to the contour.
- Trail segments within riparian areas should receive priority for maintenance and monitoring.
- Trail maintenance within Riparian Areas should be conducted with adherence to these BMPs.
- Keep trail users on the trail and minimize soil displacement (see BMP Offtrail Impacts).
- Trail footprint (tread length and width) should be minimized. This can be achieved by re-routing where and when feasible and approaching stream crossings at right angles.
- TTFs should not be located in riparian areas.
- Sourcing of natural materials (soil, rock, live and dead wood) for trail construction and maintenance is not permitted in riparian areas.

- Bridges are considered as “developments” therefore falling under BC Riparian Assessment Regulation and requiring an Assessment Report be completed by a Qualified Environmental Professional prior to development.
- All stream crossings require bridges to keep users out of streams and off the adjacent stream banks.
- Locate bridges to minimize disturbance, on straight sections of stream, and where the banks are stable.
- Bridges should be oriented perpendicular to the stream and span from top of bank to top of bank where possible.
- Bridges need be high enough above the stream channel to prevent debris from becoming trapped by the bridge.
- Bridges should be of low technical difficulty and “dog-friendly” to encourage use and discourage incursion into the stream and riparian area.
- Bridges on trails with mountain bike use should not include sharp turns or steps.
- Trails that approach a stream should be low angled and as short as possible to minimize sediment run-off into the stream. This can be achieved by having the trail gain elevation as it approaches the stream on both sides, or by incorporation of a grade reversal dip prior to the stream. Furthermore, trail approaches to bridges should be the focus of maintenance and designed to eliminate mud and water that may be transported by users. Rock armouring and boardwalks can be an effective means (see *TreadWear* BMP).
- Chemically treated timber (CCA or creosote) should not be used within streams to avoid leaching of toxic chemicals (BC Parks policy).
- Culverts are not generally recommended due to the in-stream disturbance required and additional monitoring and maintenance to prevent clogging.
- Follow construction guidelines included in the Trail Guidelines (*Chapter2*).

9.5.2 **Streams, Wetlands, Riparian Areas Impacts - Discussion of Findings**

Fromme Mountain experiences a high amount of rainfall and has numerous creeks. Primary tributaries are well defined within channels and ravines. In addition there are numerous smaller ephemeral and intermittent creeks found throughout the forest. Many of these are only active during high rainfall events.

BMPs for creek crossings include the installation of safe crossings and protection of their riparian zones. Recommended widths of these protection areas follow the methods of the Provincial Riparian Areas Regulation. None of the creek crossings assessed in this study were in compliance with these standards. The required crossings for creeks would be 15m on both sides. Most crossings are constructed across the creek and to either of its banks. They rarely extended further than 2m beyond the creek’s banks.

One of the highest environmental impacts identified in this study was to creeks and water quality (ie sedimentation from soil erosion). Areas of greatest concern included trails with steep grades extending down to a creek crossing. Skidding and surface water flow carry sediment to the crossing and often around its banks and into the creek. This problem is compounded were dogs and people walk down to the creek edges.

The impact of feces from dogs and humans is difficult to assess. Dog walkers are required to pick up after their dogs. There were low numbers of bags of dog feces that were found disposed of off trail. These are primarily along hiking trails including the BP and Mountain View Park trails. It is difficult to determine impacts of feces on water quality however it is expected to be low due to the high level of dilution during high rainfall events.

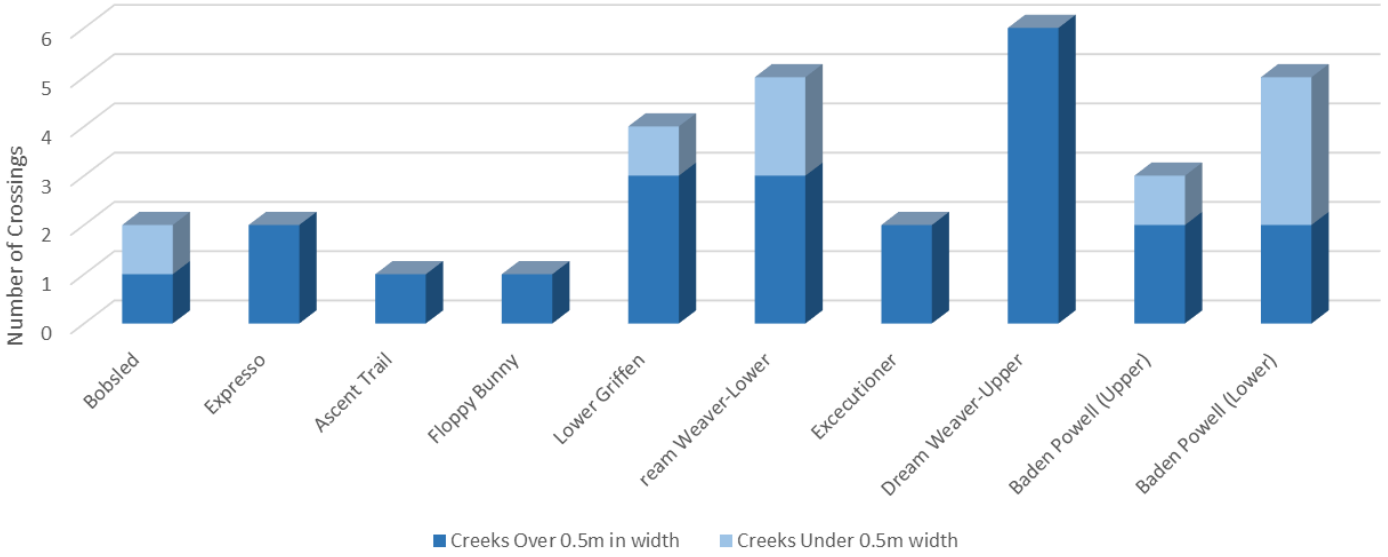


Figure 16. Number of creek crossings

9.5.3 **Recommendations to Mitigate Impacts to Streams and Wetlands:**

The BMPs for creek crossings should be amended to enhance the protection of creeks, wetlands and their riparian areas. The requirements for a 15m wide protection zone of both sides of every creek is difficult to achieve for the numerous small creeks on Fromme Mountain. Also submitting a RAR assessment for every creek encountered along the trails would be onerous. It is recommended that a creek crossing standard be adopted for the Fromme Mountain area. Applications to construct or upgrade creek crossings should be submitted to and approved by the District. Recommended standards to be adopted include the following:

- Upgrade the requirements for creek crossings to the following: All creeks that are >30cm wide (at high water flow) should be protected by a clear-span boardwalk/bridge. The structure footings should be well anchored to an area at least 1m back from the top of bank of the creek. The entrance and exit of the bridge should extend a minimum 3m back for creeks 30cm to 1m wide and 5m back for creeks that are >1m wide. These structures should include design features (e.g., railings etc.) to prevent access down to the creeks. Creeks <30cm wide can be managed with culvert crossings as long as the inlet and outlet are well protected from trail impacts.
- Where ever possible, new trails should be located further than 15m from all creeks that are greater than 1m wide.
- All trails within 30m of creeks should be prioritised for upgrading and maintenance.
- Disposal bins and dog waste disposal bags should be provided at the new parking facility and along the BP trail in Mountain View Park.

9.6 BMP - Wildlife

9.6.1 **Summary of wildlife BMPs from the Trails Study**

Impacts to wildlife include direct and indirect impacts from trail construction and human presence. BMPs from the Trails Study specific to all wildlife include:

- Support, monitor and encourage any bird inventory projects for the mountain.
- Trails within forest edge habitat and riparian areas should receive the highest level of sustainability due diligence. When and where possible accentuate these areas with indigenous berry bushes to provide more food resources.
- Retain and enhance coarse woody debris and brush pilings on forest floors for core forest nesters in conjunction with trail maintenance activities.
- Construction or maintenance around any identified active raptor nest is not permitted from March through late July.
- Removal of wildlife trees is not permitted unless they represent a safety hazard. A wildlife tree is a tree that is either dead or dying and contains one or more holes or cavities that could be used by wildlife for a variety of purposes including nesting, and raising young, denning, roosting, resting, feeding, catching food, escaping predators, and hibernating (T.R.E.E.S., 1994).

- Apply BMPs for wetlands and riparian areas.
- Retain and avoid, where possible, an abundance of coarse woody debris necessary for microclimate protection and cover.
- Retain and avoid, where possible, trees with loose bark in forested and riparian areas.
- Retain and avoid, where possible, areas of dense herbaceous and/or shrub layers, and forest litter

BMPs from the Trails Study specific to amphibians and reptiles include:

- Trails should avoid rock outcropping where possible. There is a balance to be achieved here as outcroppings do provide very sustainable trail treads and are attractive features to users.
- Cobbles and boulders in outcropping microhabitats should be avoided where possible. There is a balance to be achieved here as cobbles and boulders are a valuable trail building resource.
- Apply BMPs for wetlands and riparian areas.
- During maintenance of trails, limit forest harvest or salvage in order to minimise habitat destruction off the trail systems. Where possible, place slash onto off trail areas in canopy breaks of riparian areas or other open canopy locations to create better escape habitat during the active herpetifaunal season.

9.6.2 **Wildlife Impacts - Discussion of findings**

The habitats encountered were similar for most trail assessments and even-aged, second growth stands of mostly conifer tree species were most common. These stands generally have high crown closure and low diversity of ground vegetation cover, which limits habitat for species that prefer more protective cover. The stand structural diversity is generally low with most trees occupying the upper canopy. These types of stands provide minimal cover habitat in the lower and mid canopy levels. There is a moderate level of large woody debris on the ground which provides cover for small mammal travel. Understory vegetation cover is generally moderate and discontinuous with low diversity of species.

Generally these types of stands support a relatively lower level of wildlife species diversity compared to old forests and open shrub communities. Large mature trees provide nesting opportunities for raptors including hawks and owls. There are scattered high value wildlife trees that have developed from mature conifers. There is extensive evidence by primary and secondary cavity users in some of the wildlife trees observed during the assessment.

These forest stands support a diversity of small mammals including squirrels, voles, shrews, and mice. Burrows and runs were observed under coarse woody debris. Medium and large sized mammals that may inhabit this area (as part of a larger range) include short-tailed weasel (*Mustela ermine*), marten (*Martes americana*), raccoon (*Procyon lotor)*, skunk (*Mephitis mephitis)*, coyote (*Canis latrans)*, black-tailed deer (*Odocoileus hemionus)* and black bear (*Ursus americanus)*.

Along the trails that were assessed, there was limited habitat observed for amphibian species. The only vernal pool that provides suitable habitat for breeding and larval development is in Mountain View Park which is protected by fencing. Most creeks observed along the trails are ephemeral and do not provide a year round water source. Terrestrial amphibians (e.g. ensatina and western redback salamanders) can potentially inhabit the assessment areas. The impacts of trails on amphibian movement cannot be adequately explored within the scope of this study. No creeks in or near the assessment areas support fish.

The presence of trails and the increased presence of humans throughout the Fromme Mountain area causes habitat fragmentation and will have a negative impact on wildlife species that are not tolerant of human activity. Wildlife behavior is difficult to predict and a more detailed and long term assessment. Generally the building of trails causes a loss of ground cover. This may alter the movement of some species that require ground cover across the forest floor. The increasing presence human activity and their pets may result in habitat avoidance or alter nesting and feeding behavior.

The Fromme Mountain area is connected to an extensive forested landscape to the north. There are no unique habitat features that are found in the Fromme Mountain area that are not found in these less impacted adjacent areas. As such the impact of these trails on wildlife populations on a regional scale are expected to be low.

9.6.3 **Recommendations to Mitigate Impacts to Wildlife:**

- Protect large dead standing conifer trees (wildlife trees).
- Amend and enforce creek crossing standards.
- Aggressively decommission non sanctioned trails.
- Consider a long term wildlife behavior impact assessment from the trails

9.7 BMP - Use of Native Materials

9.7.1 **Summary of BMPs for the use of native materials from the Trails Study**

Native materials required for the construction of the trails include wood, mineral soil and rocks. BMPs for managing soils from the Trails Study include:

- Import soil when practical. Favour pit-run native soils. Beware of invasive species and other contaminants (know your source).
- All imported soils are to be authorized by the DNV staff.
- Cobbles and boulders may be used but not sourced from riparian areas, wetlands or other ESAs.
- Cobbles and boulders in outcropping microhabitats should be avoided where possible and may only be sourced upon completion of a snake/reptile assessment.

- Sourcing rock from bedrock outcropping and erratics (very large boulders) with a rock drill is not permitted in the interest of preserving natural history.
- Minimizing the effective trail tread will minimize the soil resources required for construction and maintenance.

BMPs for managing borrow pits from the Trails Study include:

- Locate borrow pits well off the trail for safety and aesthetic considerations.
- Scout for suitable soil deposits with a hand auger; look for above average grade deposits (mounds) with a minimal organic layer and interfering vegetation.
- Fewer, larger pits are preferable to multiple smaller pits. Use low impact techniques such as zip-lines to transport the material over large distances.
- Stockpile organic soils for later decommissioning of exhausted borrow pits.
- Create only a single access trail to the borrow pit to minimize off trail impact. Flag access route if necessary (particularly on trail days).
- Flag and record locations of active borrow pits for future use and eventual restoration.
- Restore borrow pit when exhausted by grading area and covering with stockpiled organic soil. Either transplant native species from areas of abundance or import native species from nursery stock.
- Borrow pits are not permitted in riparian areas, wetlands, or ESAs.
- Avoid sub-grade excavations (deep holes).
- Do not locate borrow pits adjacent to tree root-balls due to adverse impact to trees.
- Do not disturb soils from tipped up root-balls of fallen trees as they provide micro-habitats for small mammals and increase structure and plant diversity.

BMPs for managing wood from the Trails Study include:

- Cedar is the only timber suitable for trail building due to its natural rot resistance. The rot resistance increases with the age of the wood.
- Import timber whenever practical. Consider developing a volunteer wood salvage program for tree removal in DNV urban and interface areas including the DNV Hazard Tree removal program.
- Favour sourcing Cedar trees from areas where Cedar is the dominant tree species.
- Sourcing Cedar trees from areas with low tree species diversity (Cedar <5%) is prohibited.
- Only source Cedar trees to a maximum 25% of like-age Cedar trees in the local area.
- Favour stunted Cedar trees shaded out by other dominant trees.

- Consider use of mature Cedar trees with synergies for positive forest management gains (i.e. enhanced gap-replacement, promotion of understory) and bring to the attention of the DNV Arborist for approval.
- Leave future dominant trees.
- Sourcing of trees is not permitted in riparian areas, wetlands, or other ESAs.
- Felled trees not used in construction should be cut into smaller sections and distributed throughout the forest interior; placement should be in areas that either “create” or “accentuate” micro habitats for wildlife (for example, brush piles for ground nesting birds).
- Encourage utilization of standing dead trees removed for tree-hazard concerns.
- Avoid use of standing dead wood when possible.
- Removal of wildlife trees is not permitted unless they represent a safety hazard. A wildlife tree is a tree that is either dead or dying and contains one or more holes or cavities that could be used by wildlife for a variety of purposes including nesting, and raising young, denning, roosting, resting, feeding, catching food, escaping predators, and hibernating (T.R.E.E.S.
- 1994)
- Always check for dry-rot (unsuitable).
- Sourcing of trees is not permitted in riparian areas, wetlands, or ESAs.
- Large woody debris (LWD) can be high value wildlife habitat. Discretion is required when using this resource. Large sections of old-growth cedar are favoured for use as decking on bridges and TTF’s due to its straight grain and excellent strength and rot resistance.
- Use imported wood, live trees, standing dead trees or recent windfall trees where possible.
- Approximately 50% of seasonal windfall may be harvested from the trail vicinity, with the rest left as a future nutrient and habitat source.
- Use of nurse trees (fallen trees with new tree re-growth) is not permitted.
- Sourcing of LWD is not permitted in riparian areas, wetlands, or other ESAs.

9.7.2 **Use of Soil and Borrow Pits - Discussion of findings**

Building trails to the standards of the Trails Study requires high volumes of mineral soil sourced from “borrow pits.” These are holes in the ground that are 1 to 3m in diameter and up to 1.5m deep. These remove immediate ground vegetation and create permanent depressions in the forest floor. Most are restored and covered with logs and organic debris. Due to the density of trees, most pits are within the drip line of trees. Also due to difficulty of transportation, most are within 5m of trails.

9.7.3 **Recommendations for Borrow Pits:**

- Amend the BMP to allow borrow pits within dripline of trees but >2m from the trunk. Excavation towards the tree should stop as soon as roots >5cm are encountered.
- No pits can be within 15m of creeks.
- Pits should be located greater than 3m from trails edges.

9.7.4 **Use of Wood - Discussion of findings**

Trail construction and maintenance requires the use of wood for boardwalks and retaining features. Western redcedar is used primarily as it is most resistant to rot. This has been sourced from dead standing trees, recently fallen trees, understory trees and heritage stumps. Live trees that are impacted include mostly smaller cedar trees that are growing under the canopy of the mature forest. These trees represent the next generation of trees that will replace the existing trees as they die. There are remaining dead standing cedar trees that remained from the old growth stand. These range in height from 2 to 8m. Most have hollow centers and are burnt on the inside. These are being cut for the construction of boardwalks and bridges.

Recommendations for the use of Native Materials:

- The District should provide a source of cedar for structures being built.
- Cedar snags that remain in the forest have heritage value and must be protected.
- The cutting of any live trees for trail construction materials should not be permitted.

9.8 BMP - Technical Trail Features

9.8.1 **Summary of BMPs for TTFs from the Trails Study**

Technical Trails Features (TTFs) include obstacles requiring concentrated negotiation. These can be natural and man made. Many are constructed of wood but do not include boardwalks and creek crossings. BMPs from the Trails Study include:

- TTFs are not permitted in riparian areas, wetlands, or ESAs.
- Situate more difficult TTFs (where spectators congregate and users will make multiple attempts) in appropriate locations, such as on flat skid roads and areas with low VEC occurrence. Physical barriers may be used to limit the footprint of areas prone to disturbance from congregating.
- TTFs should be of appropriate difficulty with respect to the trail, to keep the majority of users on their bikes.
- Provide alternatives to advanced TTFs such as an easier TTF or a ridearound.
- Ensure the approach to TTFs is free of mud and water as mud and water increase the likelihood of users failing to negotiate the TTF.
- Do not attach TTFs to live trees. TTFs must be constructed to be stable and free-standing

9.8.2 **TTFs - Discussion of findings**

Most TTFs are found on trails that are designed to be moderate or difficult. New trails that have been constructed have fewer TTFs and were built to include easily accessible ride-arounds. Where no alternative routes are provided, off trail impacts were observed. Viewing areas for high use TTFs on busier trails have caused off trail impacts due to users leaving the trail.



9.8.3 **Recommendations for Technical Trail Features:**

- As TTFs are built or reconstructed, ensure safe alternative routes are provided.
- Design and construct TTFs using wood that is not from native sources.
- Provide appropriate viewing areas for high use TTFs.

10 Assessment of Management Systems and Resources

There is a Trail Maintenance Service Agreement in place between the DNV and the NSMBA. The District staff and recognized trail builders oversee all work on Fromme. All proposed work is presented to the DNV in the field and in work plans. The NSMBA works with the Trail Adoptees to prepare and submit a trail work plan to the DNV for review and approval. Some work plans include photos, a description of the problems, the proposed solution, budget, priority and timeline to complete. The DNV reviews these applications and upon approval provides a Parks Maintenance Permit. The NSMBA requires that all volunteers working under their program must attend trail construction training through the ”NSMBA Trails Academy Program.”

The management agreement in place allows for a large amount of volunteer resource to be used in a cost effective way under the supervision of an NSMBA recognized trail builder. This program is well established and has the potential to greatly enhance the trail system on Fromme. However, stakeholders raised concerns about the resources available for DNV to oversee all trail work and to evaluate the cost effectiveness of the TAP program.

There is ongoing construction of non sanctioned trails. These include builders that are not a part of the NSMBA or any other organization approved by the District. There are great concerns from the NSMBA and the DNV about this illegal activity and the resulting environmental impacts.

10.1.1 **Recommendations for Trail Management and Resources:**

- The DNV should work together with the NSMBA and other volunteers to establish a template for all proposed trail work. This should build on the proposals submitted and include targets and budgets that will allow for easy follow up monitoring.
- Once complete, a follow up report should be submitted with a summary of targets achieved, changes to the original scope and resources used (volunteers hours, materials etc). Photos plots should be included in each to show before and after images.
- Follow up monitoring should be completed by the NSMBA and submitted to the DNV.
- The TAP program is a cost effective program that should be expanded to improve the trail network on Fromme.
- Provide resources and funding to construct creek crossings on all managed trails. These should be completed as a separate program to TAP. Building materials should not be sourced from Fromme Mountain.
- DNV, the NSMBA and other volunteers should work to enforce rules against illegal trail building. Signs should be posted of fines that will be issued if caught. District bylaw officers should patrol the Fromme Mountain area and/or respond to reports of illegal activity.
- An ongoing understanding of the level of usage will continue to help the District to manage the trails more effectively. Counters should continue to be used to monitor trail usage.
- For high use trails that are prone to damage during the rain season, temporary closures should be considered. This should be determined by DNV staff, the NSMBA and other volunteers based on ongoing assessments of trail conditions.
- There should be more defined trail uses. Hiker only trails should include barriers to better communicate with riders. Enforcement by DNV bylaw officers should be considered to keep riders off of trails designated for hiking only.

11 Appendix A - Trail Descriptions

Eight trails were assessed between July and September of 2014. Their locations are illustrated in Figure 17. Each trail and its condition is described in the same format. The first section is a summary of the trail description and its management recommendation according to the Trails Study. The second section is a summary of the work that has been completed on the trail since 2008. This includes work competed by the District as well as work completed by the NSMBA and other volunteers. The third section includes general observations made by DHC staff in the field. Trails condition statistics, a trail map and representative photos are then provided.

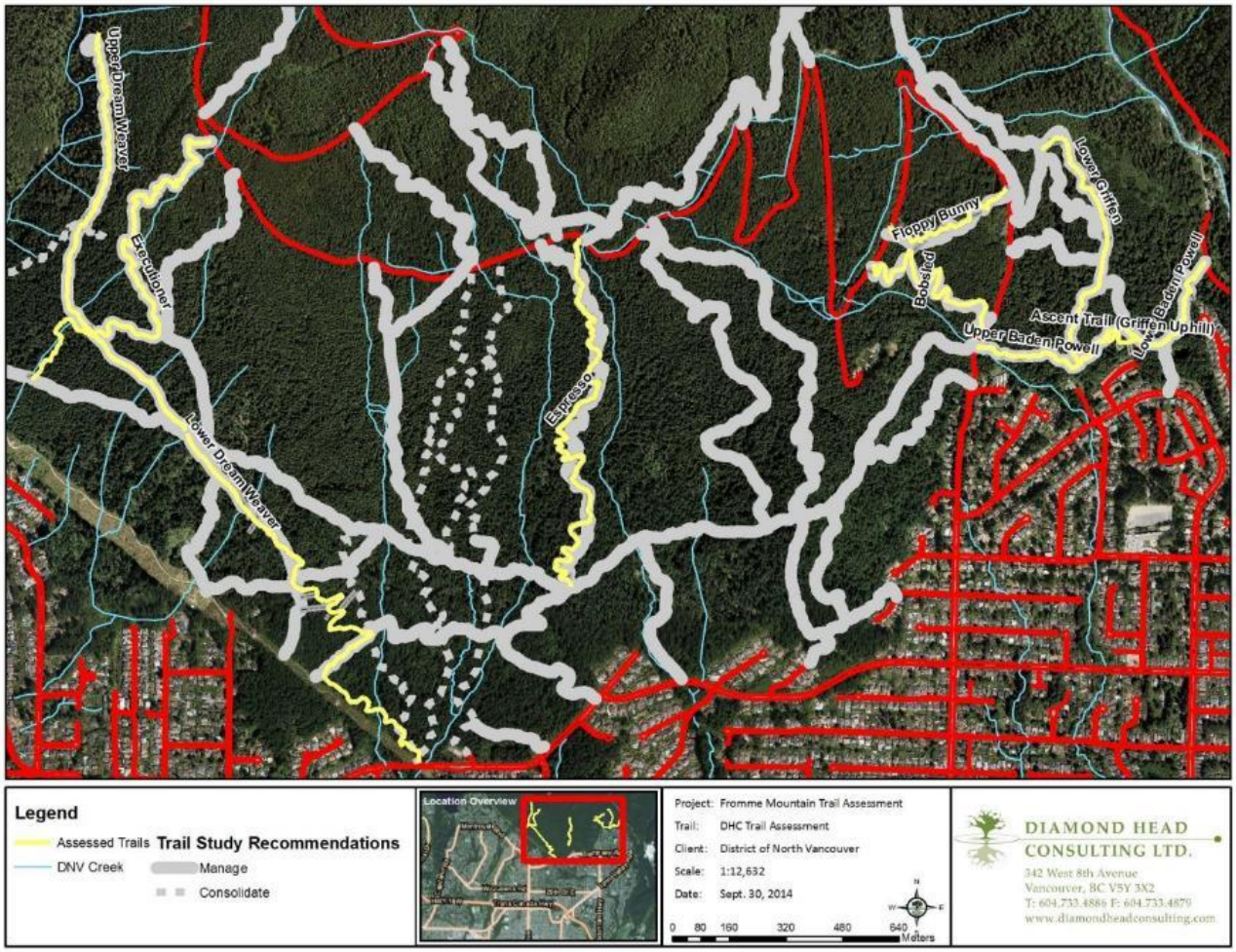


Figure 17. Map illustrating the trails (yellow) that were assessed as part of this study. The grey lines are the adopted trail network.

11.1 Bobsled

Trail Study Description (2007)

- Recommendation: Manage
- MTB descent (multiple TTFs)
- Single-track
- Moderate level of use
- Multi-use trail
- Rated intermediate with advanced options
- Moderate level of volunteer stewardship (TTF maintenance)
- Very poor condition (erosion and worn TTFs, Fall-line orientation)
- Low harmony

Summary of work completed since 2008

Fromme Mountain Trail Projects Review, District of North Vancouver (2010-2011)/ Information provided by DNV Trails and Habitat Coordinator

- Bobsled has been converted into a flowing switchback trail of beginner/ intermediate difficulty
- Re-routing, structure/feature construction
- Decommissioning and restoration of old trail
- Extensive drainage upgrades
- A large portion of the trail was completed by District's trail crew using a small back-hoe
- Large side ramp built using material sourced from old heritage cedar stumps
- BCIT students restored and replanted the old decommissioned sections

North Shore Mountain Bike Associating Trail Project- Concept Plan for Bobsled Trail (October 25, 2013)

- Bridge Re-decking- widening of two bridges on the trail to a width of 48" to accommodate riders with 36" wide three wheeled bikes, bridges are 30' and 40' in length
- Bridge removal - A 17' bridge required widening. Proposed removal of the bridge and turnpike the area
- Remove a bridge with a blind corner and create a safer sustainable solution

- Realignment of trail and reduce grade to create a trail that is suitable for beginner riders and mitigate erosion

Information provided by Graham Knell -District of North Vancouver

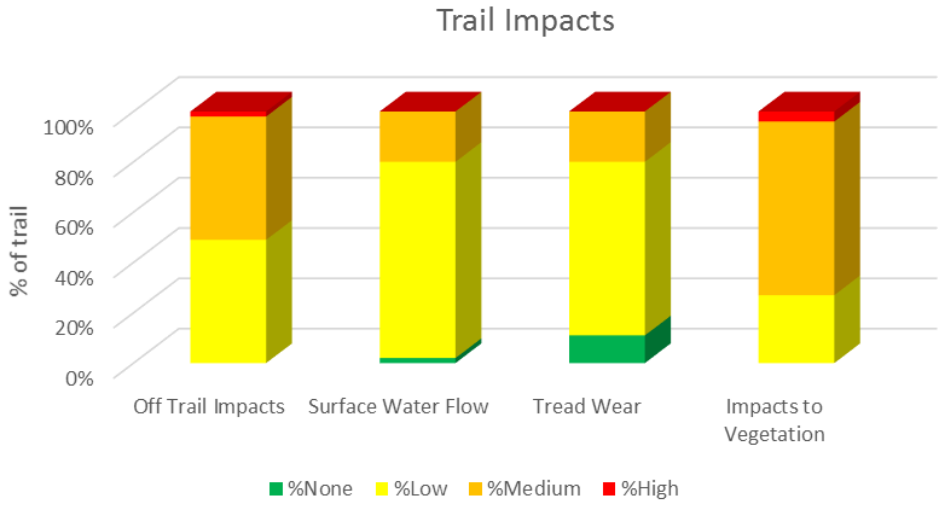
- NSMBA has focussed on soil work & drainage to address erosion
- large side ramp was constructed by DNV trail crew
- NSMBA has addressed approximately 60% of trail

DHC Ltd. Observations 2014:

- This is a well used trail by a range of riders including many youth
- Many mountain bike courses and youth riding camps use this trail for training
- This is the widest trail in the study with moderate grades
- The trail design allows for fast riding
- Steeper sections and areas just before turns or technical trail features (TTFs) experience high tread wear due to skidding
- There are a small number of technical trail features (TTFs) that are well constructed, safe and designed with ride arounds
- Trail widening is often due to riders waiting for others before and after TTFs
- The original Bobsled trail is visible but has been restored
- Off trail environmental impacts are generally low and include mostly soil deposition from construction and viewing areas near TTFs
- The cut slope is deep causing extensive damage to tree roots and intercepts ground water flows
- Surface water is managed effectively on most of the trail

Table 6 – Trail Characteristics of Bobsled

Trail Name	**Bobsled**
Difficulty Rating	Green (easy)
Length (m)	920
Main Use	Biking (Downhill)
Average Width (m)	1.8
Maximum width (m)	3.2
Average Slope (%)	10.5
Maximum Slope (%)	35
Trail Description	
% Soil	91%
% Boardwalk	7%
% TTF	1%
% Armored	0%
% Bedrock	0%
Number of Constructed Feat	10
Number of Borrow Pits	
Active	10
Restored	5



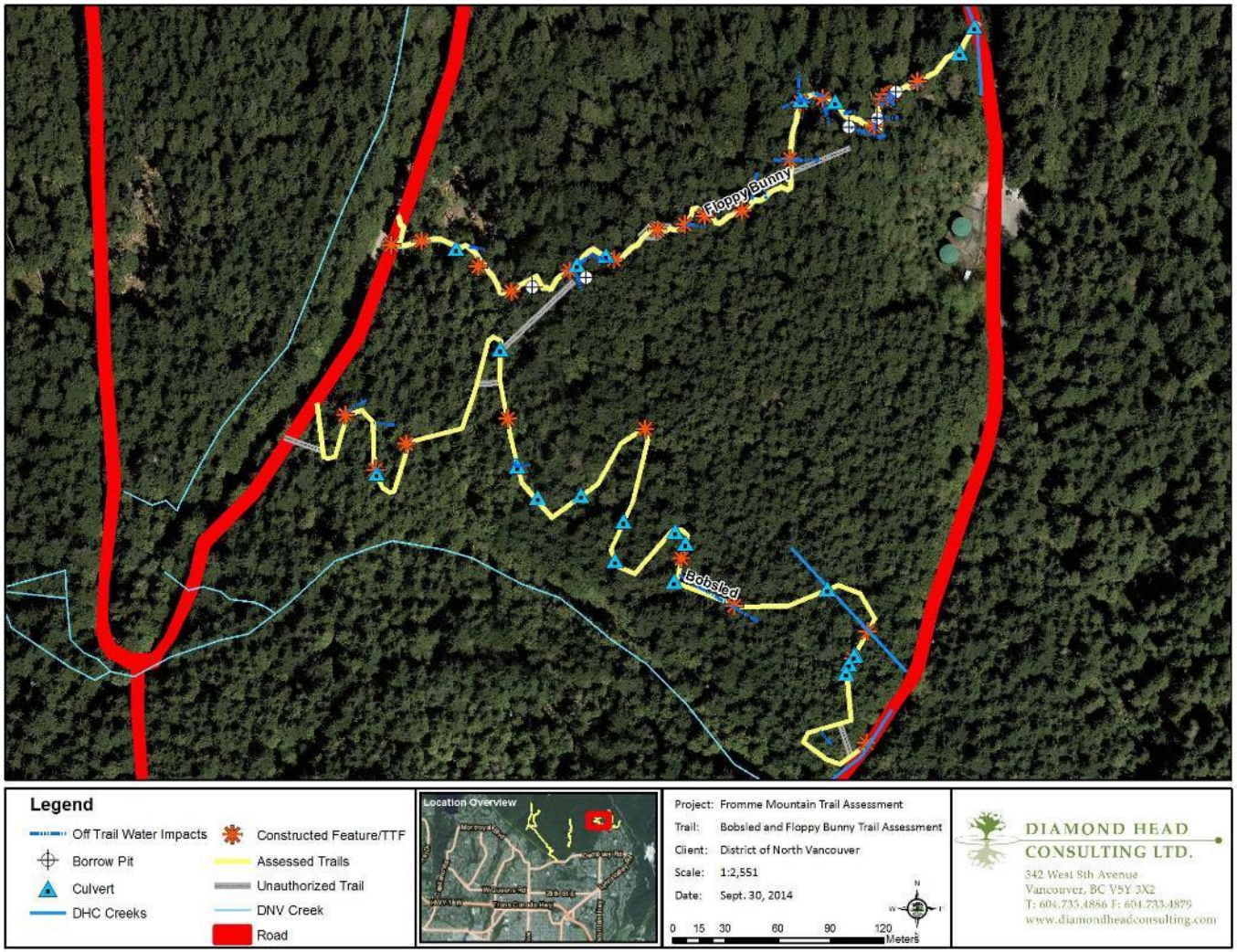


Figure 18. Bobsled trail map

Figure 19. Representative Photos of Bobsled

11.2 Espresso

Trail Study Description (2007)

- Recommendation: Manage
- MTB descent (multiple TTFs)
- Single Track
- MTB trail
- Rated Advanced
- High level of volunteer stewardship (rock armouring, TTF maintenance)
- Fair condition (erosion, worn TTFs)
- Moderate harmony
- Partially situated on private property (Grouse Mountain)

Summary of work completed since 2008

Information provided by DNV Trails and Habitat Coordinator

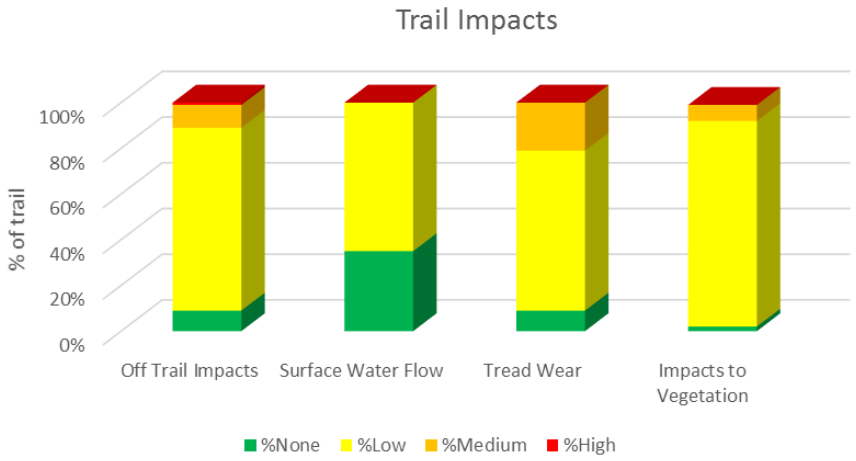
- District Trail Crews took down the last of TFC's that were in disrepair and dangerous
- In 2013 Todd Fiander (NSMBA) adopted Expresso. This carried over into 2014
- Extensive work rerouting trail from a fall line trail and old logging skid road to a meandering trail that is now easy to maintain and water is dispersed effectively
- The amount of work required to sustainably realign this trail has been colossal including two corporate adopters led by 3 trail builders over the course of 3 years with approximately 7000+ hours of work. There are now over 3000 users/month using this trail.
- With the heightened traffic, a solution for exit from the Baden Powell needs to be instituted. Currently there are new unauthorised, unsustainable trails arising below the Baden Powell.
- The trail builder administered environmental care to build over tree roots and naturalize surrounding area to minimize impact

DHC Ltd. Observations 2014:

- Well used trail by a wide range of riders including many youth
- Relatively narrow width with moderate grades and few technical features
- Allows for fast riding
- New TTFs are well constructed and safe
- Old trail is visible, many parts of it are not restored
- Tread wear is low with the exception of sections before TTFs and steep grades where bikes skid to slow down
- This trail was built up above grade reducing impacts to tree roots and reducing interception of ground flows
- Off trail impacts include mostly soil deposition from construction
- There is a high number of borrow pits adjacent to the trail, some of which are not restored
- Surface water is managed effectively

Table 7 – Trail Characteristics of Espresso

Trail Name	Espresso
Difficulty Rating	Blue
Length (m)	1680
Main Use	Biking (Downhill)
Average Width (m)	1.1
Maximum width (m)	4
Average Slope (%)	12.1
Maximum Slope (%)	32
Trail Description	
% Soil	88%
% Boardwalk	1%
% TTF	9%
% Armored	2%
% Bedrock	0%
Number of Constructed Features or TTF	16
Number of Borrow Pits	
Active	32
Restored	68



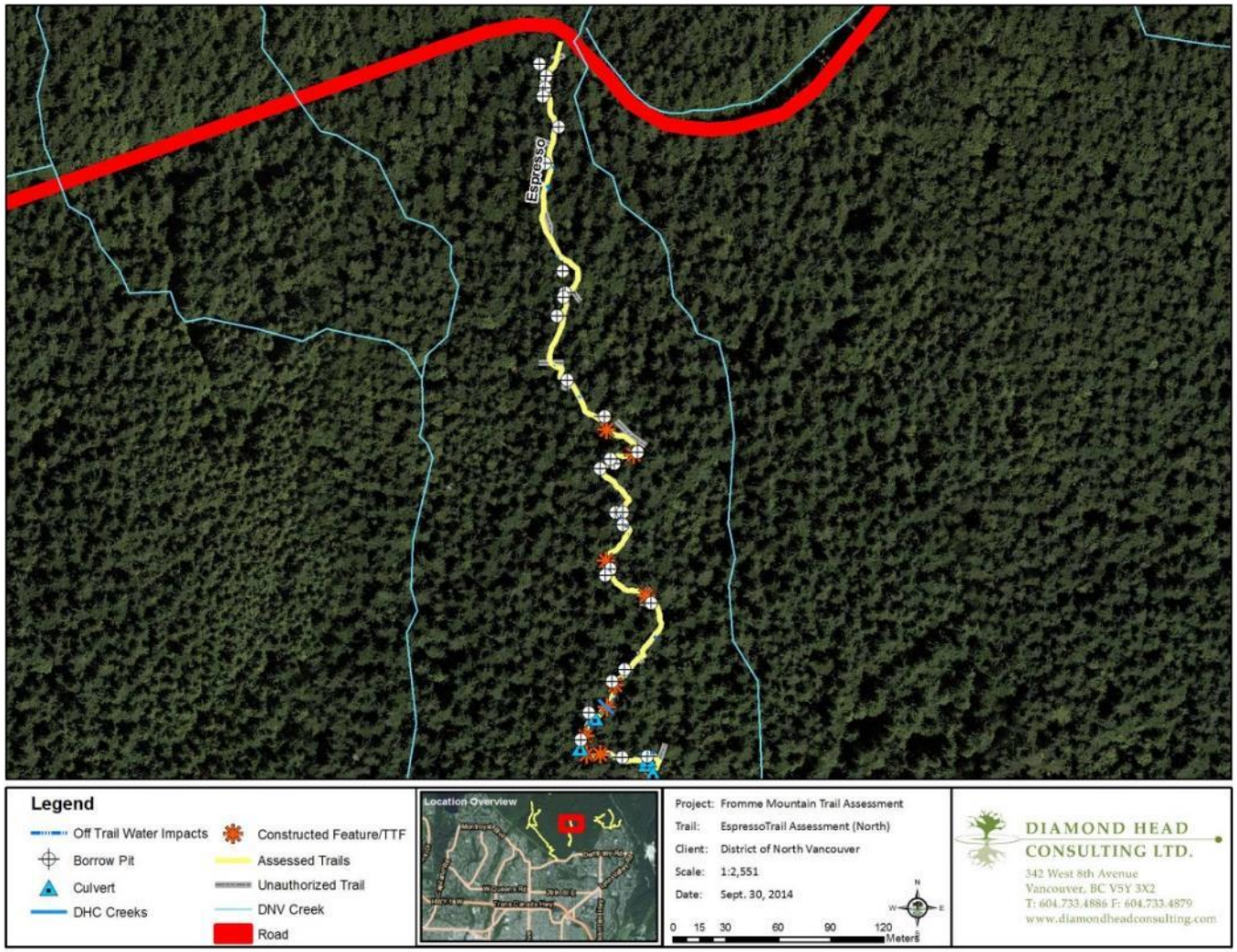


Figure 20. North section of Expresso trail map

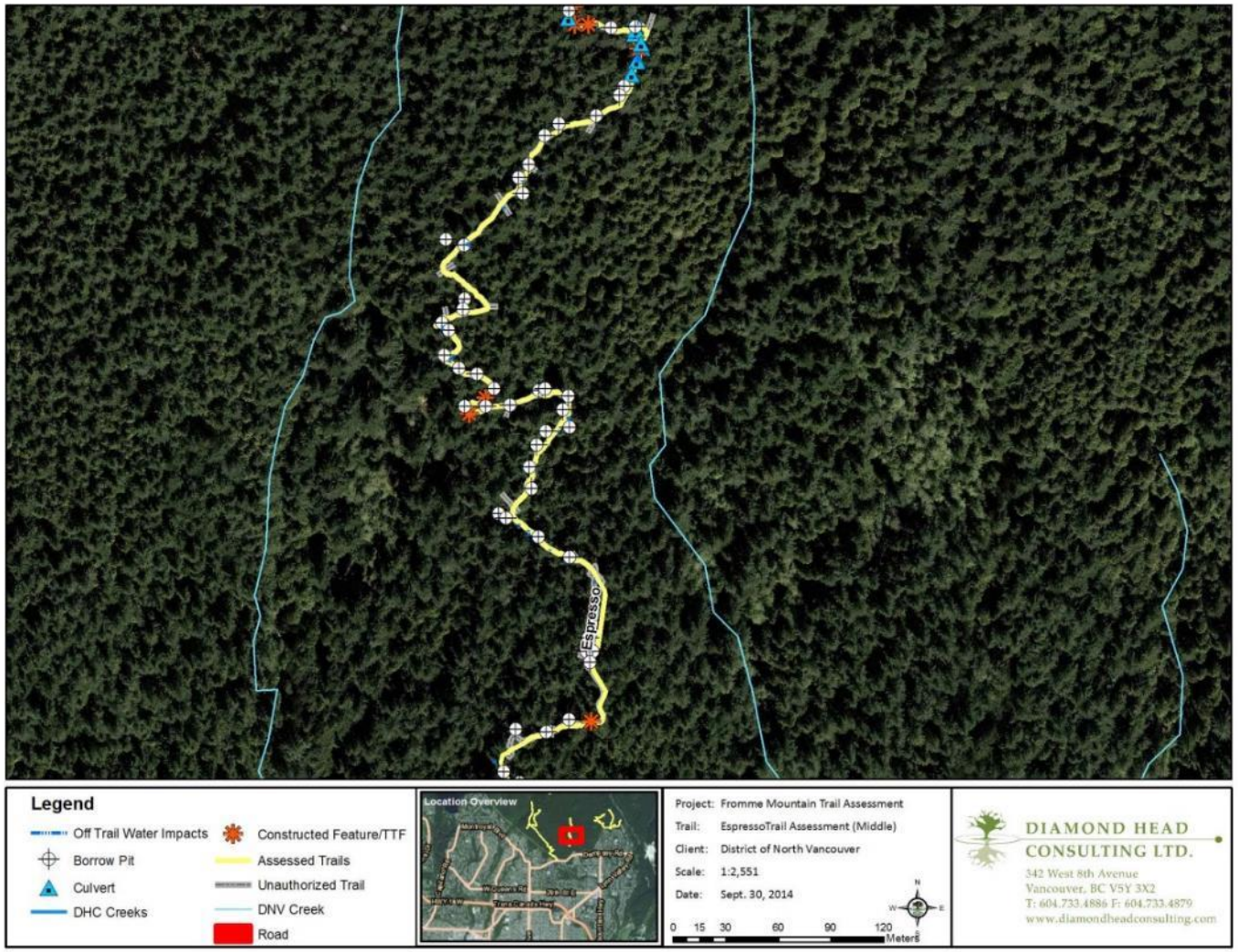


Figure 21. Middle section of Expresso trail map

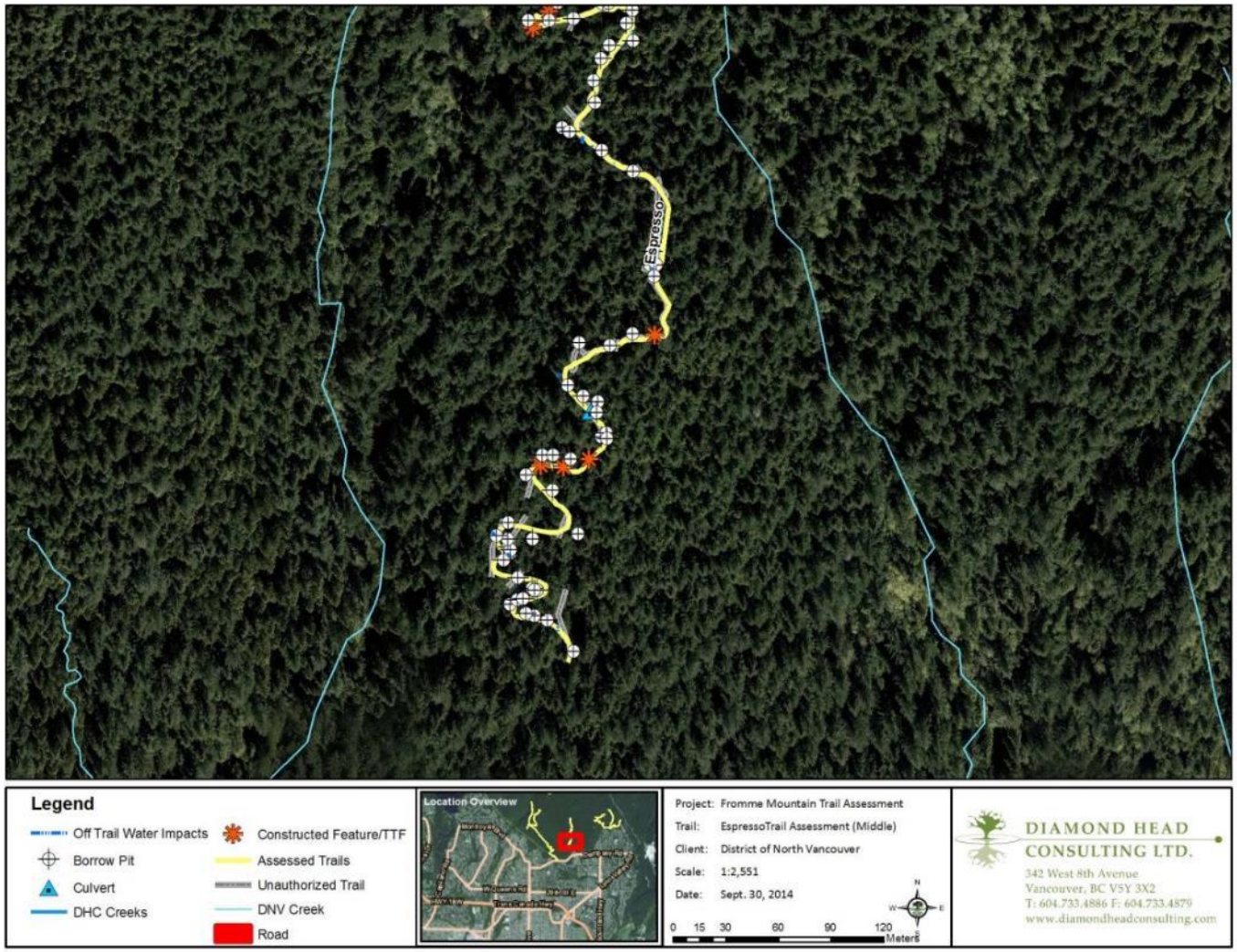


Figure 22. South section of Expresso trail map

Figure 23. Representative Photos of Expresso

11.3 Lower Griffen Ascent Trail

Trail Study Description (2007)

- N/A – This trail did not exist in 2007 and was not planned yet in the Trails Study

Summary of work completed since 2008

- This trail was constructed by the NSMBA in 2014

Information provided by DNV Trails and Habitat Coordinator

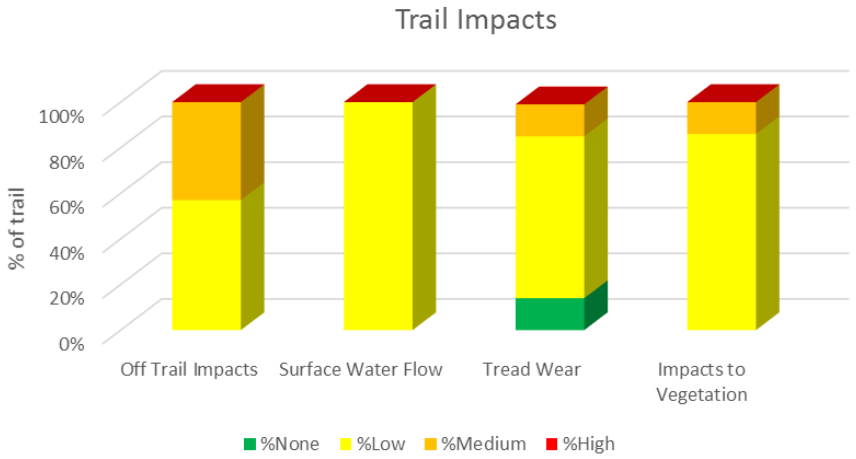
- The NSMBA worked with the DNV to solve the issue of unauthorised trail development in the private back yards below

DHC Ltd. Observations 2014:

- Trail has low grades and runs cross slope
- There is low tread wear and little evidence of bikes riding downslope
- Surface water is managed effectively
- Off trail environmental impacts are low and mostly related to recent construction
- There is an established trail that still has moderate use and intersects this ascent trail

Table 8 – Trail Characteristics of Lower Griffen Ascent Trail

Trail Name	**Ascent Trail**
Difficulty Rating	Blue
Length (m)	140
Main Use	Biking (Uphill)
Average Width (m)	1.6
Maximum width (m)	2.3
Average Slope (%)	8.9
Maximum Slope (%)	13
Trail Description	
% Soil	100%
% Boardwalk	0%
% TTF	0%
% Armored	0%
% Bedrock	0%
Number of Constructed Features or TTF	0
Number of Borrow Pits	
Active	0
Restored	0



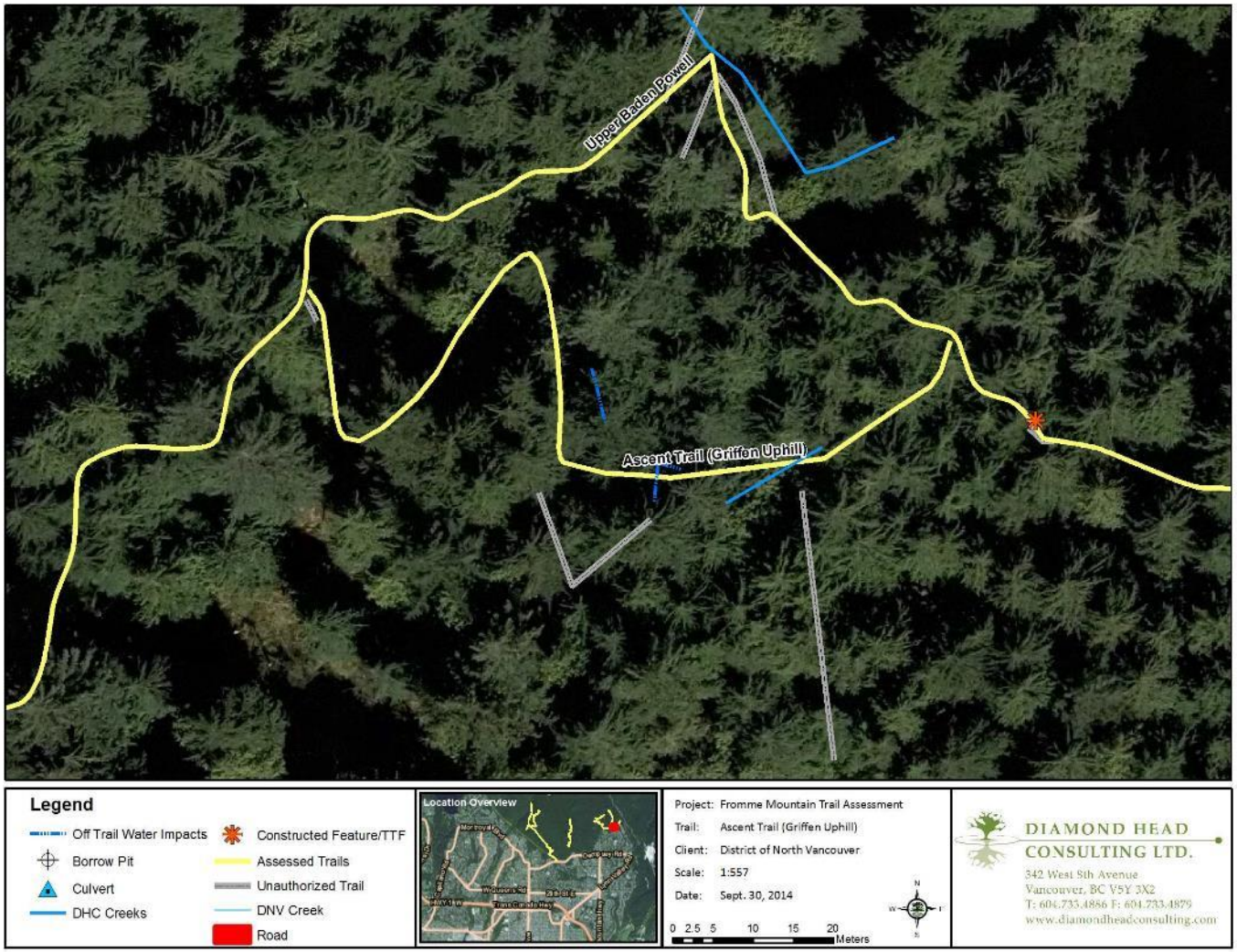


Figure 24. Ascent trail map

Figure 25. Representative Photos of New Ascent Trail

11.4 Floppy Bunny

Trail Study Description (2007)

- Recommendation: Manage
- MTB descent (some TTFs)
- Single-track
- Low level of use
- Multi-use trail
- Rated intermediate with advanced options
- Low level of volunteer stewardship (TTF maintenance)
- Fair condition (erosion and worn TTFs)
- Low harmony

Summary of work completed since 2008

Information provided by DNV Trails and Habitat Coordinator

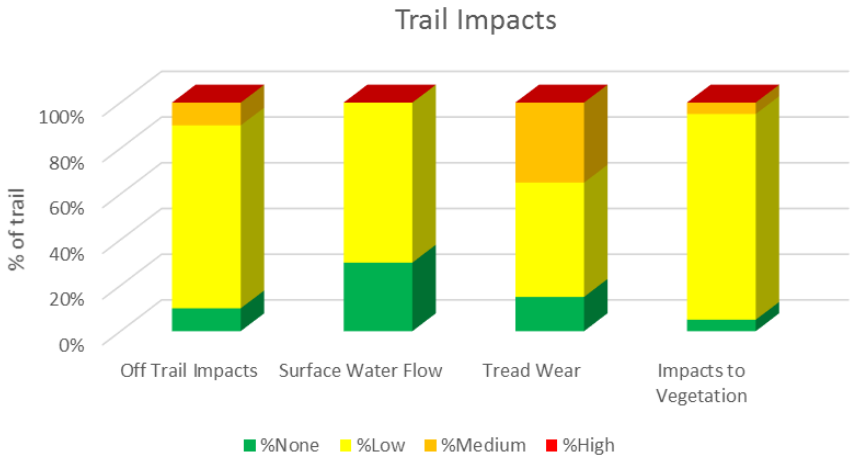
- Trail was in relatively good condition at time of adoption, therefore required little upgrading by the District Trail Crew
- From 2009-2012 the trail was maintained by Pat Podolski
- In 2013, the last section of the trail was rerouted away from the water towers.
- Decommissioned section was replanted and restored by BCIT nad West Vancouver students
- Reduced the continual erosion that was taking place along the old fall-line section of the trail
- The District placed a large culvert at the end of the trail so that riders could enter Mountain Hwy

DHC Ltd. Observations 2014:

- Well used trail by the widest range of riders
- Numerous borrow pits were identified along the trail
- Steeper sections and areas just before turns or technical features experience high tread wear due to high use and level of riders
- Allows for fast riding
- New TTFs are well constructed and safe
- Surface water is managed effectively

Table 9 – Trail Characteristics of Floppy Bunny

Trail Name	**Floppy Bunny**
Difficulty Rating	Black Diamond
Length (m)	400
Main Use	Biking (Downhill)
Average Width (m)	1.5
Maximum width (m)	3
Average Slope (%)	10.9
Maximum Slope (%)	20
Trail Description	
% Soil	80%
% Boardwalk	0%
% TTF	20%
% Armored	0%
% Bedrock	0%
Number of Constructed Features or TTF	18
Number of Borrow Pits	
Active	2
Restored	3



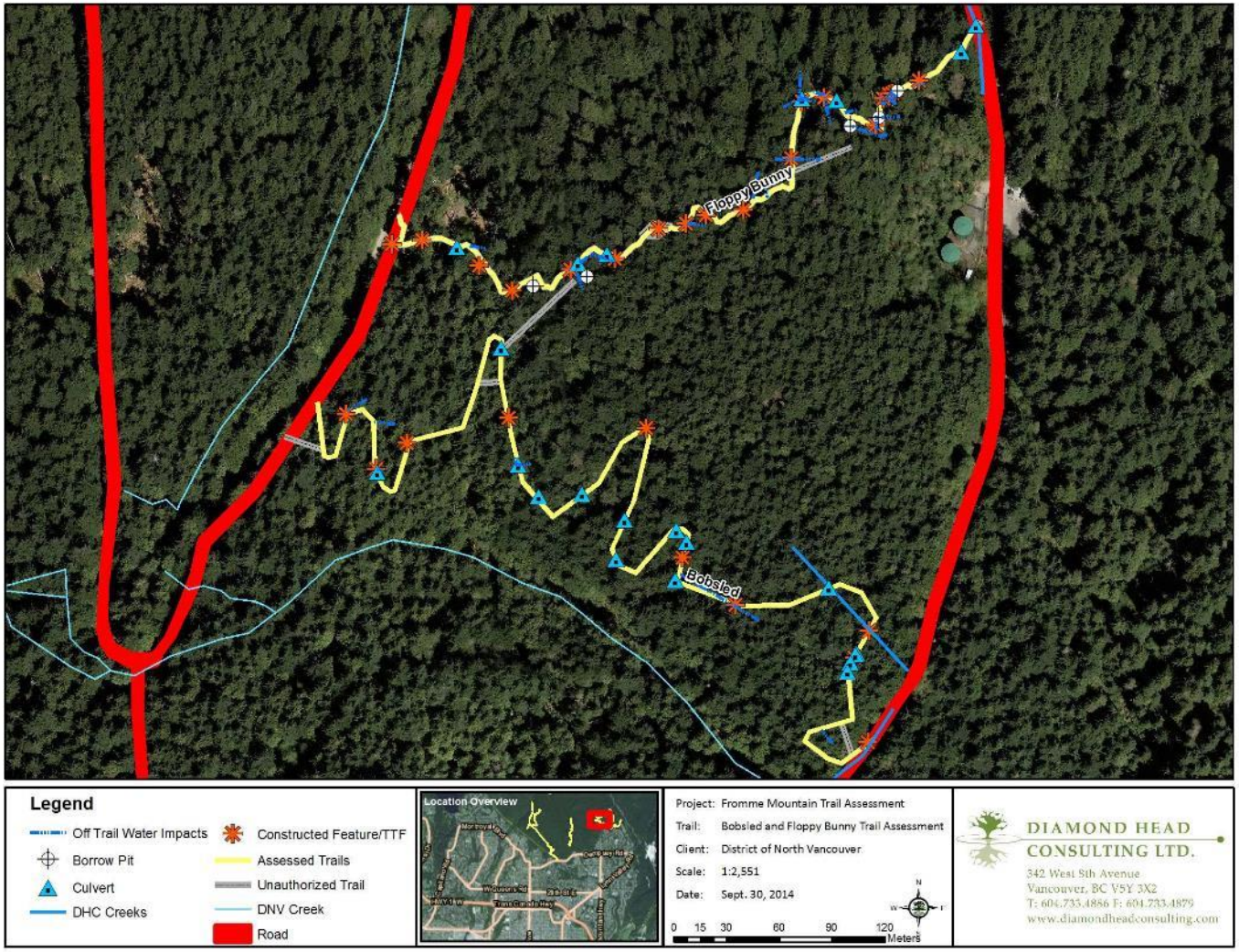


Figure 26. Floppy Bunny trail map

Figure 27. Representative Photos of Floppy Bunny

11.5 Lower Griffen

Trail Study Description (2007)

- Recommendation: Manage and upgrade. Install signs for dogs-on-leash in Mountain View Park Area.
- MTB XC/decent (some TTFs)
- Single-track
- High level of use
- Multi-use trail (Youth/beginner MTB trail for study area), hikers and dog walkers
- Rated intermediate
- Moderate level of volunteer stewardship (rock armouring and drainage)
- Poor condition (erosion and worn TTFs)
- Sustainable alignment
- Bridges required for creek crossing(s)
- Moderate harmony

Summary of work completed since 2008

Fromme Mountain Trail Projects Review, District of North Vancouver (2010-2011)

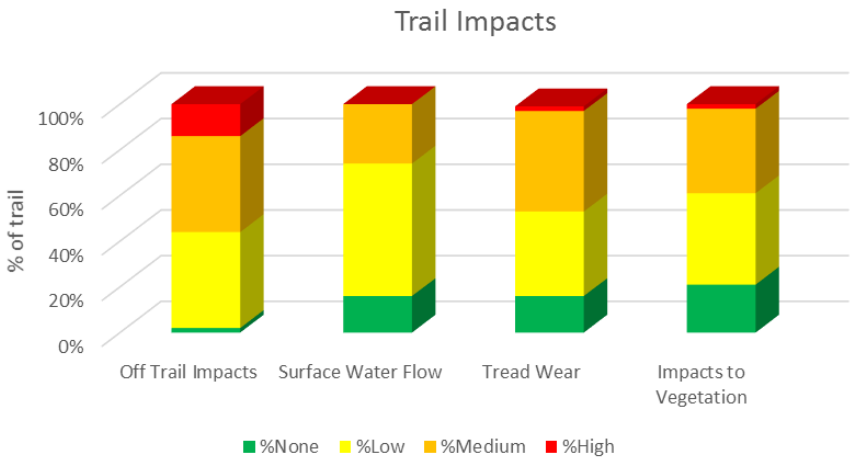
- Extensive drainage improvements
- Construction of eight new bridges/boardwalks (including Upper Griffen) and multiple TTF's
- Extension of trail to Mountain View Park region of Baden Powell
- Trail tread armouring and improvement

DHC Ltd. Observations 2014:

- This is a long trail that exists with a range of conditions
- Section of this trail that have not been upgraded have moderate impacts due to tread wear and poor surface water control
- Some older TTFs exists that are in poor condition
- Some boardwalks are still narrow and causing ride around
- Middle section follows an old logging road
- Riparian crossings of significant creeks are not protecting water quality adequately

Table 10 – Trail Characteristics of Lower Griffen

Trail Name	**Lower Griffen**
Difficulty Rating	Blue
Length (m)	860
Main Use	Biking (Downhill)
Average Width (m)	1
Maximum width (m)	1.2
Average Slope (%)	16.4
Maximum Slope (%)	35
Trail Description	
% Soil	81%
% Boardwalk	16%
% TTF	2%
% Armored	0%
% Bedrock	0%
Number of Constructed Features or TTF	20
Number of Borrow Pits	
Active	4
Restored	1



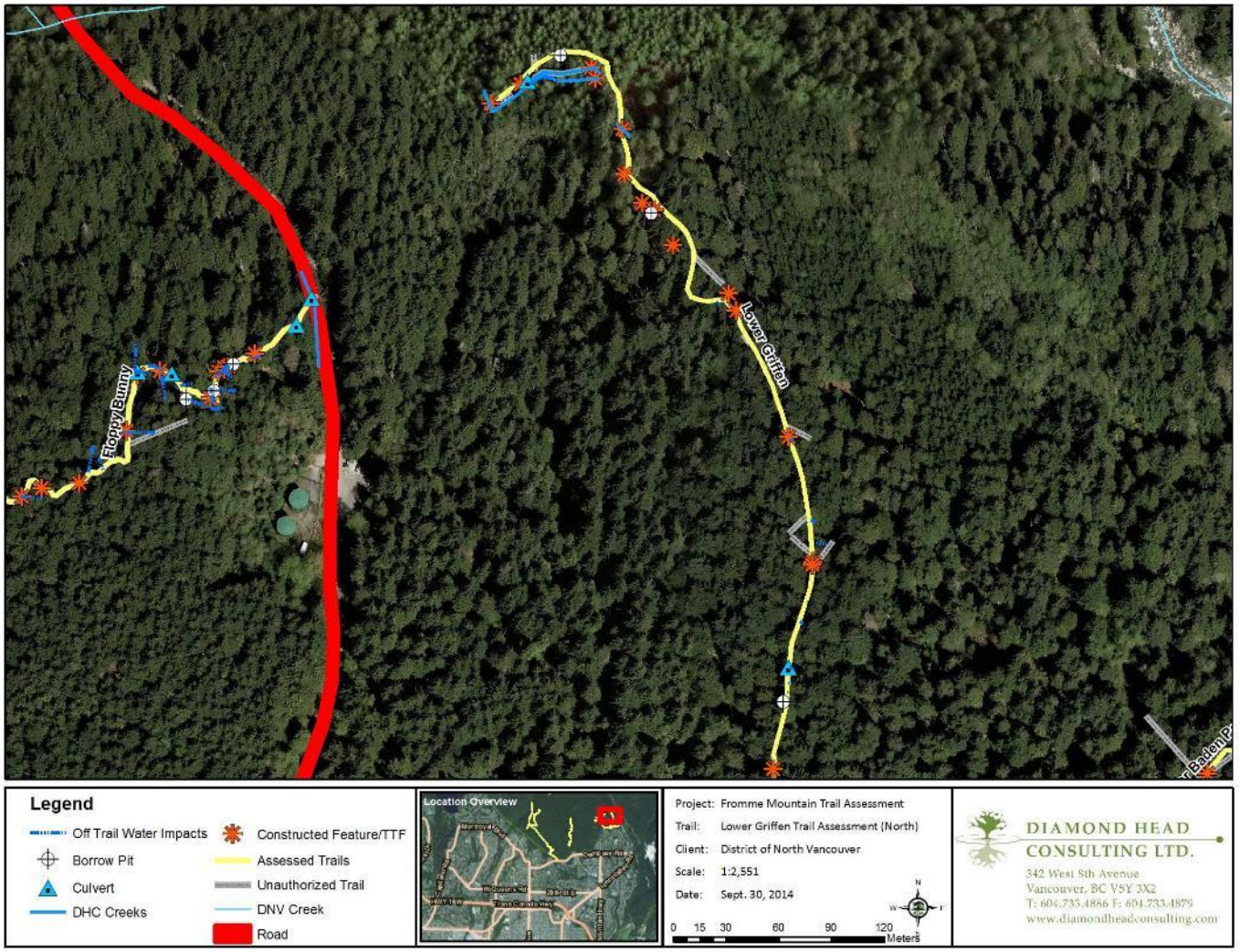


Figure 28. Lower Griffen trail map (north)

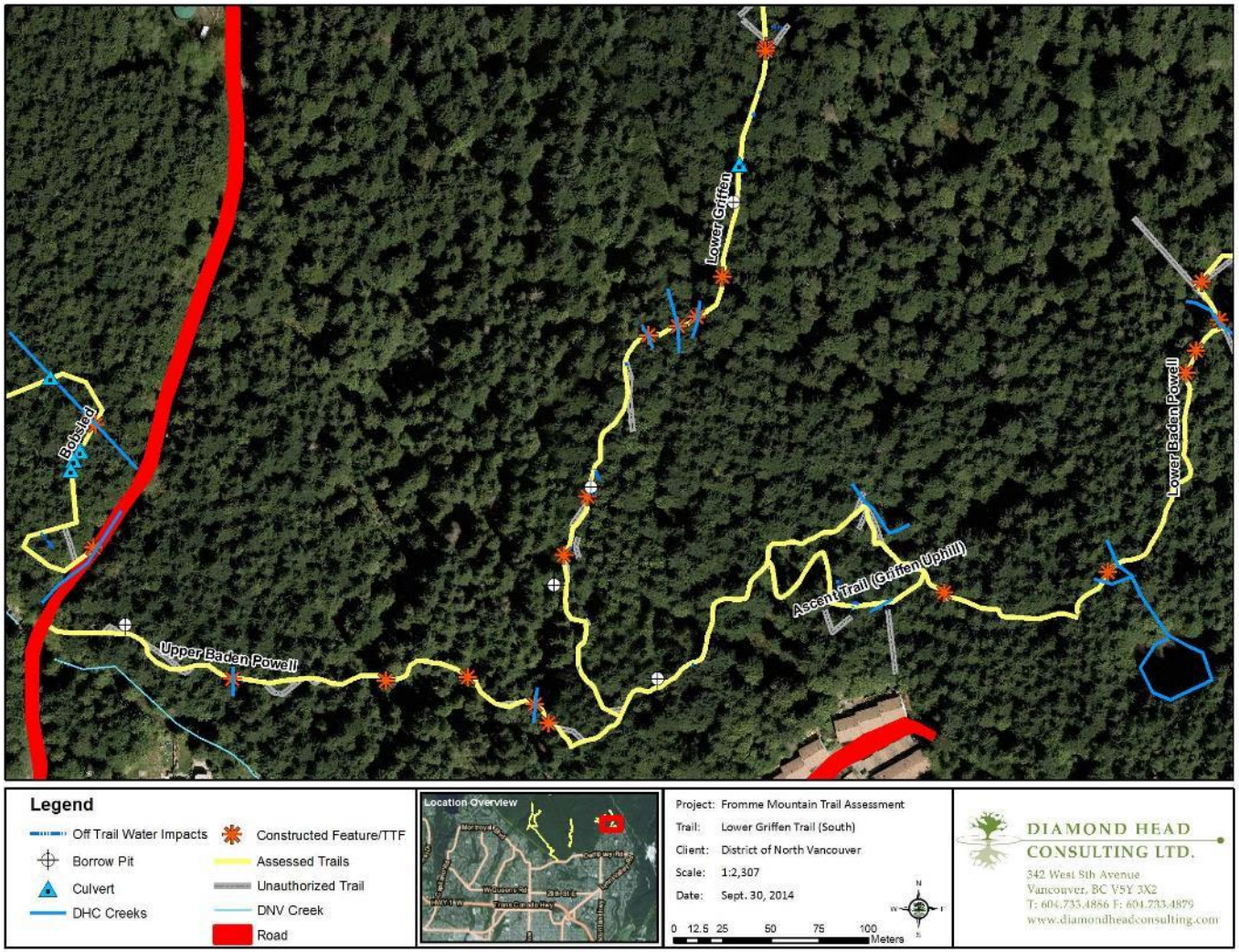


Figure 29. Lower Griffen trail map (south)

Figure 30. Representative Photos of Lower Griffen

11.6 Dreamweaver

Trail Study Description (2007)

- Recommendation: Manage. Upgrade creek crossing.
- Lower Dreamweaver
- Single-track
- High Level of Use
- Multi-use trail
- Rated intermediate
- High level of volunteer stewardship (tread maintenance)
- Good condition
- Multiple bridge with high exposure
- High harmony
- Well-designed contour trail with appropriate trail watersheds

Summary of work completed since 2008

Fromme Mountain Trail Projects, District of North Vancouver (2010-2011)

- Construction of two new bridges that are 21m long. Located north of the Baden Powell Trail

Information provided by DNV Trails and Habitat Coordinator

- The NSMBA has worked with Arc'teryx through the Trail Adoption Plan investing over 1500 hours to realign unsustainable sections of this trail over the past 3 years. The work continues as only approximately 60% of the trail length has been addressed.

DHC Ltd. Observations 2014:

- Both sections have moderate grades and relatively narrow widths
- Upper Dreamweaver used mostly by hikers
- Upper Dreamweaver runs through the only old growth stands identified in this study
- Upper Dreamweaver runs across a steep side slope with numerous seepage areas and small creeks

- Lower Dreamweaver experiences moderate use
- There are older trails intersecting lower Dreamweaver with unmaintained TTFs
- Alignment of lower Dreamweaver is unclear
- Creek crossings relatively new and well built but need to be widened beyond top of banks.
- Low to moderate impacts from bikes skidding mostly in steeper sections
- Water flow managed well with the exception of steeper sections

Table 11 – Trail Characteristics of Lower Dreamweaver

Trail Name	**Dream Weaver-Lower**
Difficulty Rating	Blue
Length (m)	1560
Main Use	Biking (Downhill)
Average Width (m)	1.2
Maximum width (m)	2.8
Average Slope (%)	14.1
Maximum Slope (%)	35
Trail Description	
% Soil	96%
% Boardwalk	1%
% TTF	3%
% Armored	0%
% Bedrock	0%
Number of Constructed Features or TTF	11
Number of Borrow Pits	
Active	5
Restored	6

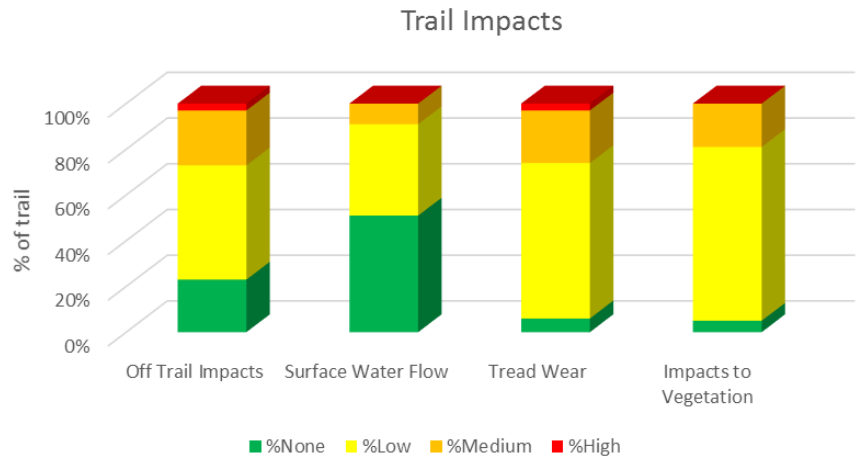
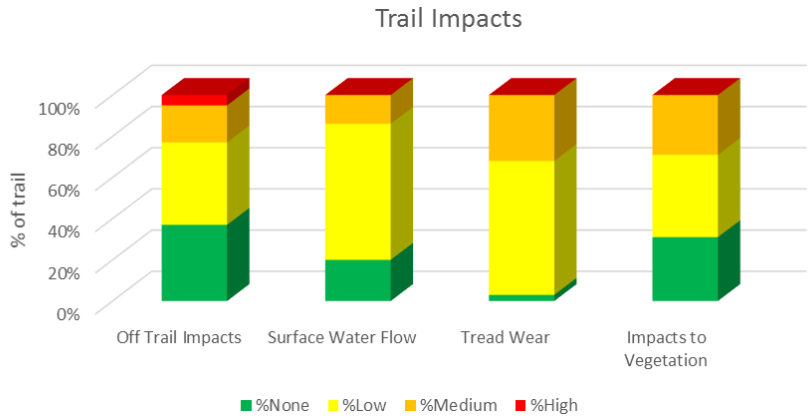


Table 12 – Trail Characteristics of Upper Dreamweaver

Trail Name	Dream Weaver-Upper
Difficulty Rating	Blue
Length (m)	1320
Main Use	Hiking
Average Width (m)	1.3
Maximum width (m)	2.2
Average Slope (%)	13.3
Maximum Slope (%)	38
Trail Description	
% Soil	97%
% Boardwalk	3%
% TTF	0%
% Armored	0%
% Bedrock	0%
Number of Constructed Features or TTF	2
Number of Borrow Pits	
Active	0
Restored	0



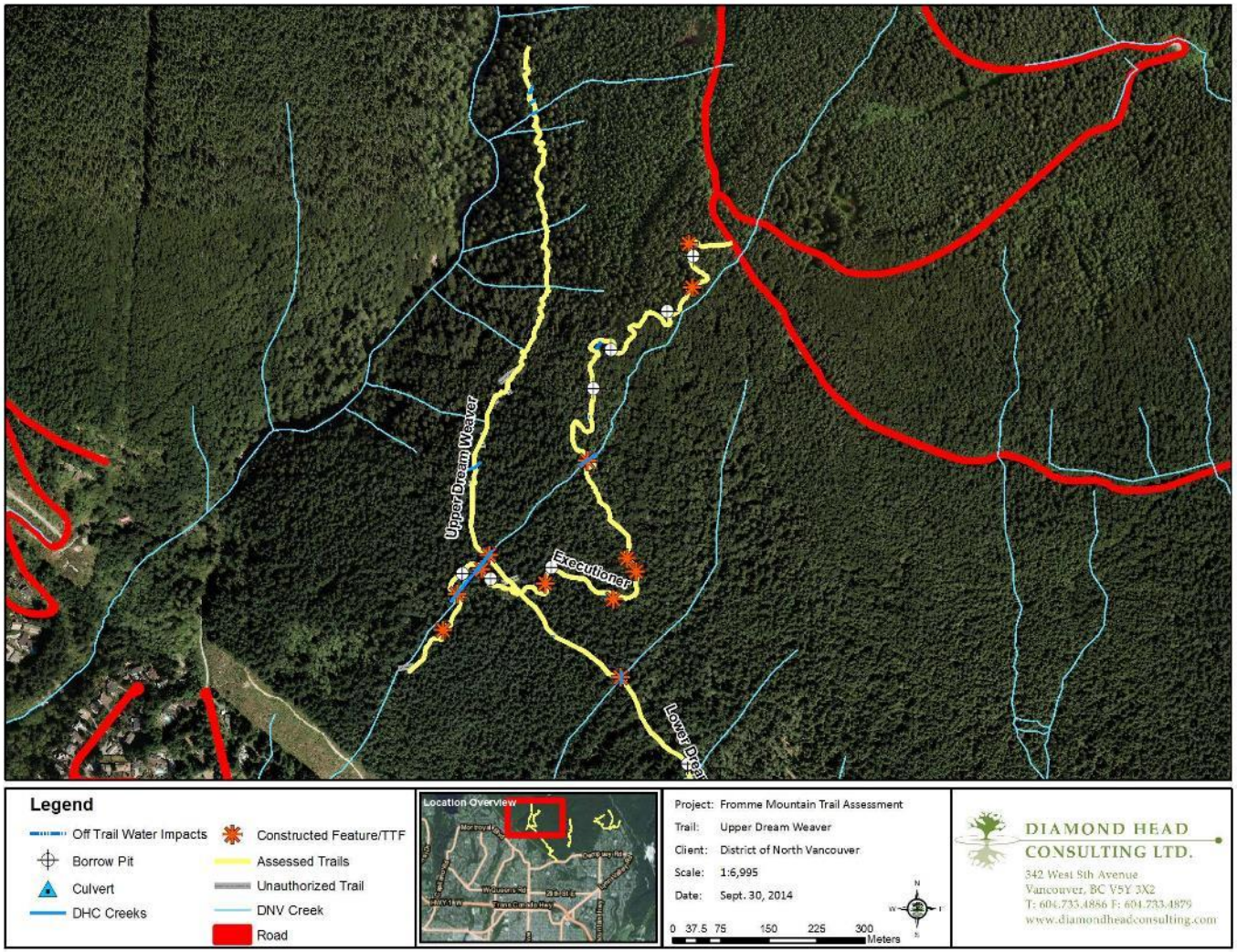


Figure 31. Upper Dream Weaver trail map

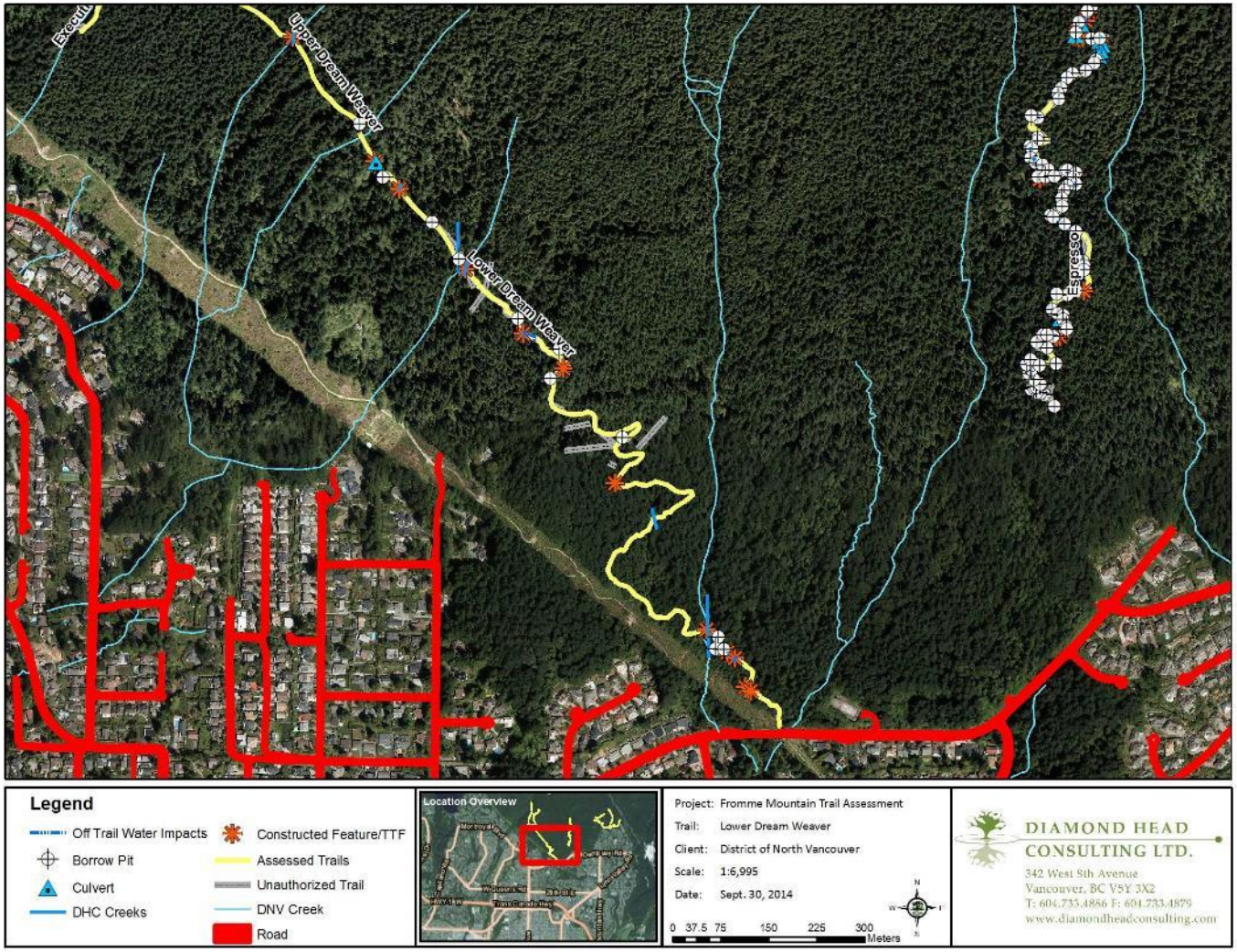


Figure 32. Lower Dream Weaver trail map

Figure 33. Representative Photos of Dreamweaver

11.7 Executioner

Trail Study Description (2007) - In the Trails Study, Executioner was divided into two sections (Upper executioner and Lower Executioner)

Upper Executioner

- Recommendation: Manage and upgrade. Re-route onto sustainable alignment for multi-use.
- MTB descent (some TTFs).
- Single-track.
- Low level of use.
- Lots of recent windthrow.
- MTB trail.
- Rated expert.
- Low level of volunteer stewardship.
- Poor condition (erosion and worn TTFs).
- Partially situated on private property (Grouse Mountain).
- Low harmony.

Lower Executioner

- Recommendation: Consolidate into one sustainable hiking only route. Actively decommission 35C.
- MTB descent (some TTFs). Braided into multiple routes.
- Single-track (with linking skid-roads).
- Low level of use.
- Multi-use trail.
- Rated expert.
- Low level of volunteer stewardship.
- Very poor condition (erosion and worn TTFs).
- Partially situated on private property (Grouse Mountain).
- Very low harmony.

Summary of work completed since 2008

Fromme Mountain Trail Projects, District of North Vancouver (2010-2011)

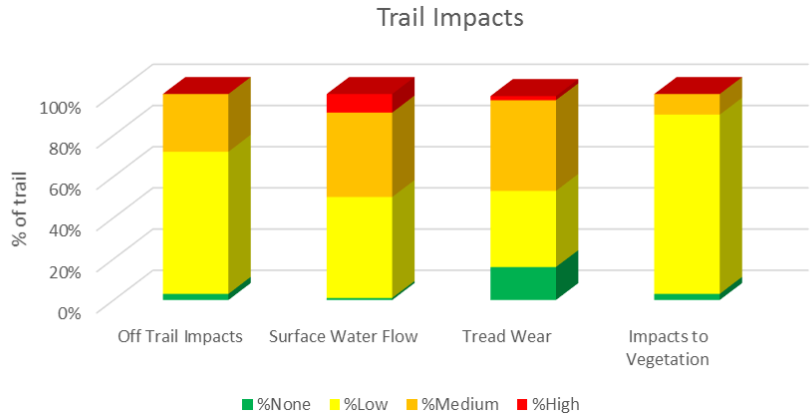
- Major reroute of entire trail to flow loam style downhill, this combined sections of the old Executioner and Bitches Brew.
- Construction of two bridges on lower portion of trail
- Major drainage and surfacing
- Decommissioning of unstable trail structures

DHC Ltd. Observations 2014:

- This is a steep fall line trail that was inherited from prior to 2007
- The lower section has high riparian zone impacts
- There is high tread wear on both sections due to steep slopes and skidding
- There is extensive surface water flow
- Recent cutting of hazard trees has taken place next to the trail
- Many TTFs have poor ride arounds causing increased trail widths

Table 13 – Trail Characteristics of Executioner

Trail Name	Excecutioner
Difficulty Rating	Black Diamond
Length (m)	1360
Main Use	Biking (Downhill)
Average Width (m)	1
Maximum width (m)	1.5
Average Slope (%)	23.7
Maximum Slope (%)	40
Trail Description	
% Soil	98%
% Boardwalk	1%
% TTF	0%
% Armored	0%
% Bedrock	1%
Number of Constructed Features or TTF	10
Number of Borrow Pits	
Active	2
Restored	5



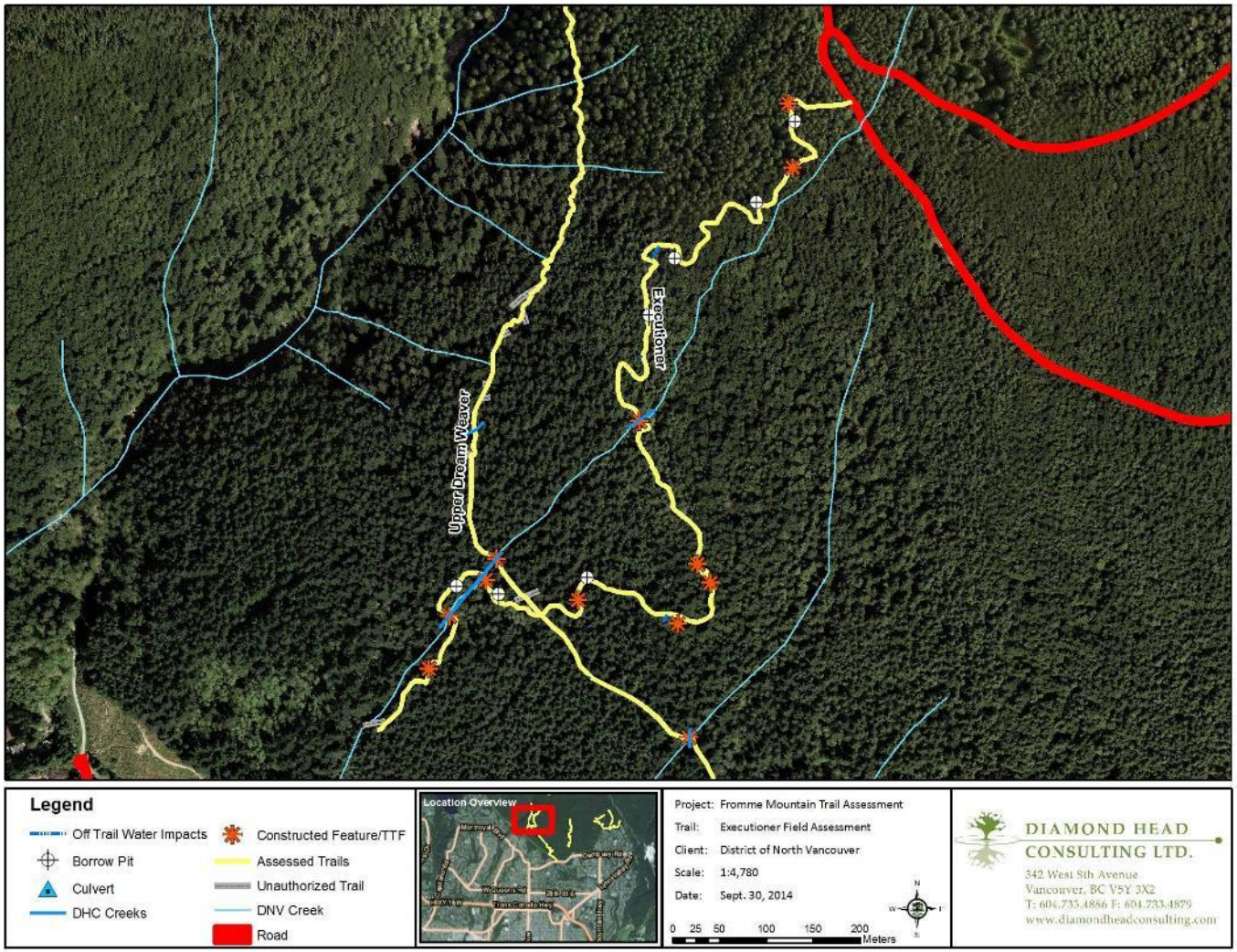


Figure 34. Executioner trail map

Figure 35. Representative Photos of Executioner

11.8 Baden Powell Trail

Trail Study Description (2007)

- Recommendation: Manage. Re-route on sustainable alignment. Install signs for dogs-on-leash in Mountain View Park Area
- Major destination and connecting trail
- Single-track
- High level of use
- Multi-use trail (stairs make unsuitable for MTB use)
- Rated intermediate
- Moderate level of volunteer stewardship (rock armouring)
- Poor condition (erosion)
- Invasive species (Holly)
- Moderate harmony

Summary of work completed since 2008

Fromme Mountain Trail Projects, District of North Vancouver (2010-2011)

- Extensive upgrades to two wooden staircases west of Mountain Highway
- Completion of rock steps west of Mountain Highway
- Drainage improvements east and west of Mountain Highway
- Trail tread armouring
- Completion of 14 new bridge/boardwalks east of Mountain Highway near Mountain View Park
- Improved MTB wood work along Baden Powell West of Mountain Highway- "Stairs of Despair" area
- Reduction of difficulty – sections of trail that were above intermediate riding levels have been reduced to meet intermediate Trail Difficulty standards- ride rounds and ramps were constructed, and rock armouring to prevent trail erosion was completed
- Re-route of MTB exit of Baden Powell onto Mountain Highway

DHC Ltd. Observations 2014:

Baden Powell trail has three distinct sections:

Upper Baden Powel below Mountain highway

- Where trails surface is rocky, walkers expanding trail edges
- Steeper with long sections with poor water control
- Braded trails beside this trail
- Moderate tread wear due to long time use
- Moderate impacts from water flow due to steep grades
- Scattered holly growing beside trail
- High number of hazard trees removed adjacent to trails
- Dog tracks evident in all wet areas adjacent to trail

Lower Baden Powel

- As BP extends down to the flatter sections of the park, most of trail has been restored with new gravel and hand rails to prevent access to the wetland area
- This section of trail is wide with low grades.
- There is little tread wear or surface water flow
- The two creak crossings should be widened beyond the top of banks
- High number of hazard trees removed adjacent to trails
- Two creek crossings
- Dog tracks evident in all wet areas including wetland

Lower stairway

- Steep slope down to Lynn Road (70-100%)
- Constructed stairs, top part with handrails
- There are wet seepage draws running down this slope
- Few off trail impacts due to stars and steep slopes

Table 14 – Trail Characteristics of Upper Baden Powell

Trail Name	Baden Powell (Upper)
Difficulty Rating	Blue
Length (m)	620
Main Use	Multi-Use (Biking/Hiking)
Average Width (m)	1.5
Maximum width (m)	2.4
Average Slope (%)	12
Maximum Slope (%)	27
Trail Description	
% Soil	89%
% Boardwalk	7%
% TTF	0%
% Armored	4%
% Bedrock	0%
Number of Constructed Features or TTF	7
Number of Borrow Pits	
Active	0
Restored	2

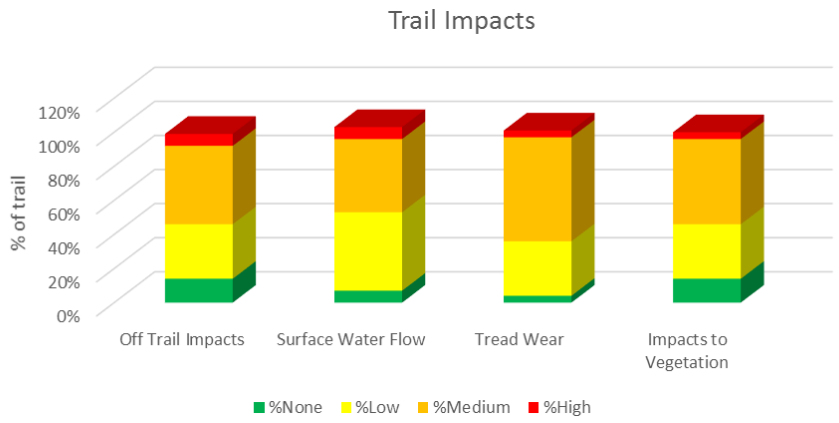
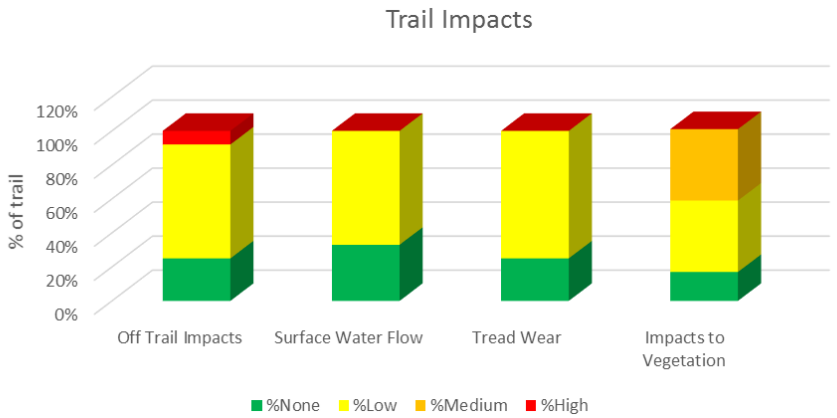


Table 15 – Trail Characteristics of Lower Baden Powell

Trail Name	Baden Powell (Lower)
Difficulty Rating	Green
Length (m)	320
Main Use	Hiking
Average Width (m)	1.6
Maximum width (m)	2.3
Average Slope (%)	8.9
Maximum Slope (%)	13
Trail Description	
% Soil	75%
% Boardwalk	17%
% TTF	8%
% Armored	0%
% Bedrock	0%
Number of Constructed Features or TTF	6
Number of Borrow Pits	
Active	0
Restored	0



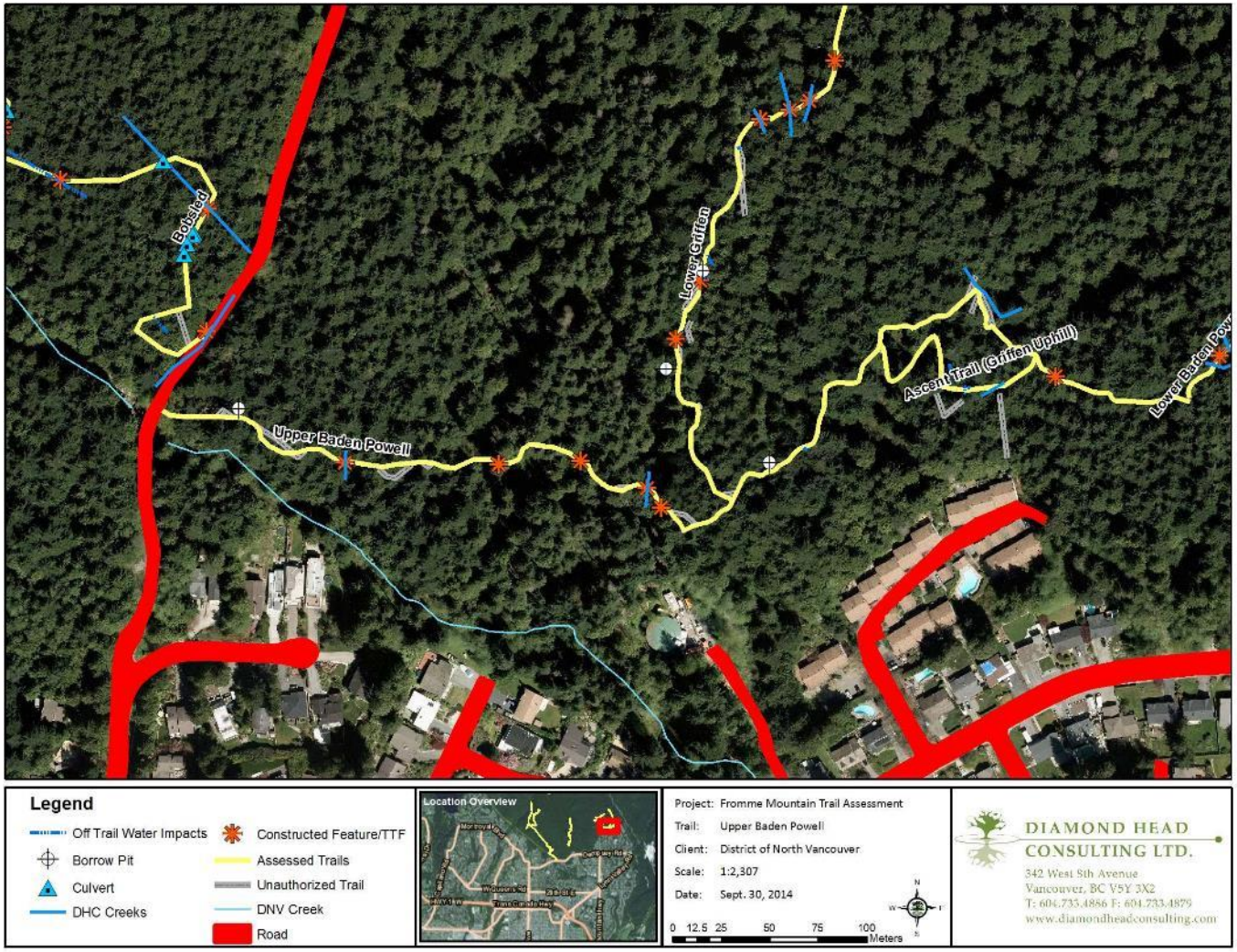


Figure 36. Upper Baden Powell trail map

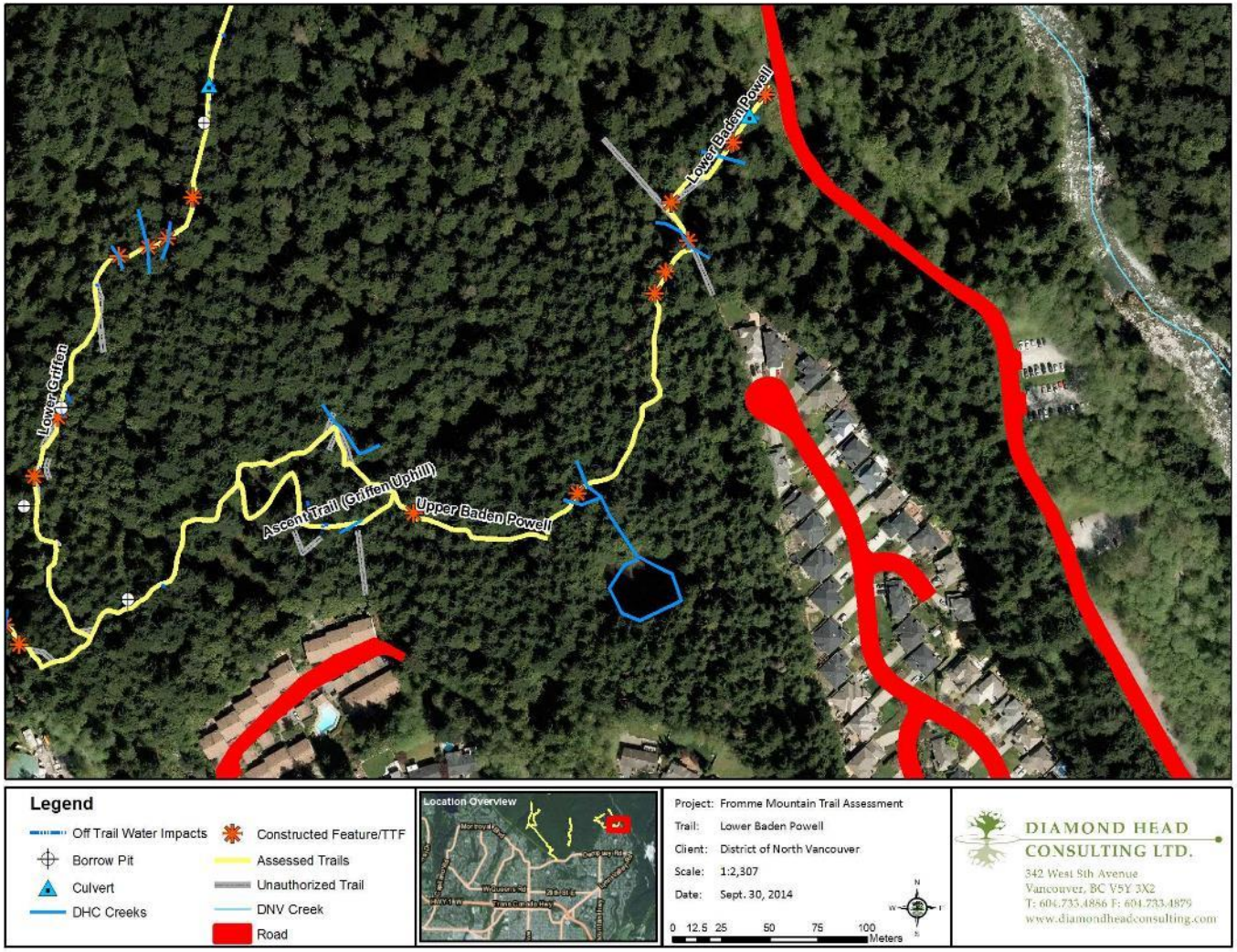


Figure 37. Lower Baden Powell trail map






Figure 38. Representative Photos of Baden Powell

12 Appendix B – Trail Assessment Methodology

The following tables summarise the trail features collected, impact ratings and root causes of these impacts. Detailed data for each plot is included in spatial shape files as well as KML files which can be viewed in Google Earth.

Trail Plots

Trail plots were established every 20m along the trails. At each plot, a 5m section was assessed. Trail conditions (table 16) and BMP impacts (table 17) were collected.

Table 16 – Trail condition

Field	Condition
Trail Description	- Soil surface - Armored with rock - TTF - TTF with ride around - Bedrock - Boardwalk
Average width	Enter width in cm
Average slope	Enter slope in %
Riparian Area	Within 15m from top of bank riparian setback? Yes or no.

Table 17 – BMP Impact Assessment

BMP/Field	Description	Impact				Primary Root causes
		None	Low	Medium	High	
Off Trail Impacts	Caused by water/soil erosion or users going off trail	Trail at constructed width	Impacts 0.5m from trail	Impacts 0.5m to 2m from trail	Impacts > 2m from trail edge	- Surface Water Flow - User Leaving Tail - Impacts from construction - Soil Deposition - Poor Alignment - Switchback with poor turning radius - TFF too challenging and no ride around - Surface erosion causing users to to ride around - Alternate feature drawing users from the trail - Short cutting between trails - Other (Explain in comments)
BMP/Field	Description	Impact				Primary Root causes
		None	Low	Medium	High	

Surface Water Flow	Trails intercept and channel natural surface water and intercepted ground water flow. Unmanaged surface flow erodes the trail surface.	No evidence of water flow	Surface rilling	Channelized flow	Incised channels causing significant soil displacement	- Impermeable surface (rock, armoring, till, compaction) - Long run length without water control (i.e.. Ross bar) - Steep grade - Seepage from cut slope - Trail not aligned perpendicular to natural water flow - Plugged or ineffective culvert/bar - Other (Explain in comments)
BMP/Field	**Description**	**Impact**				**Primary Root causes**
		None	**Low**	**Medium**	**High**	
Tread Wear	Physical wear of the trail surface material, its capacity for drainage, resistance to compaction and displacement.	No impacts to tread wear	Low tread wear	Moderate channelization of tread	Significant channelization of tread	- Steep slope - Lack of armoring - Bike skidding - Armoring failing/shifting - Armoring rocks too small - Other (Explain in comments)
BMP/Field	**Description**	**Impact**				**Primary Root causes**
		None	**Low**	**Medium**	**High**	

Vegetation	Soil loss causing destabilization of trees, damage to exposed tree roots. impacts to old growth trees. Degradation of trail-side understory vegetation.	No significant impacts to trees or vegetation	Minor impacts to trees and vegetation. No expected long term health concerns	Moderate impacts to trees and vegetation with impacts for health and/or stability	Severe impacts to tree structural roots or understory vegetation expected to have detrimental impacts to their health and/or stability	- Roots exposed and damaged on trail surface - Roots cut for trail construction (<1m from trunk of tree) - Roots cut for trail construction (1-3m from trunk of tree) - Roots cut for trail construction (3m to drip line from trunk of tree) - Trail within 1.5 m of old Growth tree - Structural roots pruned - Poor pruning of branches - Invasive Species next to trail - TTF attached to live trees - Other (Explain in comments)
BMP/Field	**Description**	**Impact**				**Primary Root causes**
		None	**Low**	**Medium**	**High**	

Environmentally Sensitive Areas - Streams, wetlands and riparian areas	Wetlands, streams, riparian areas with a default Riparian Areas Regulation Streamside Protection and Enhancement Area (SPEA) setback of 15m for ephemeral non fish bearing streams and 30m for all perennial and fish bearing streams.	Entire SPEA protected. No impacts to integrity of creek.	Creek/wetland crossing and some of SPEA protected.	Creek/wetland crossing protected only.	None of the SPEA or creek protected.	- SPEA not protected to designated width - Steam crossing not at right angle - TTF in riparian zone - Sourcing of natural materials within riparian zone - Bridges do not contain dogs from going off trail - Bridge contains sharp angles or steps - Trail approaching stream is steep (>30%) - Other (Explain in comments)

Table 18 – Borrow Pit Assessments

Field	Condition
Size	Area in m
Status	Active Restored
Within Drip Line of Mature trees?	Yes/No
Within ESA, Wetland, Riparian Area	Yes/No
Within 5m of Trail	Yes/No
Comments	General Comments

Table 19 – Trail Culvert Assessments

Field	Condition
Construction Material	Wood Plastic Metal Natural (Rocks, Logs, etc.)
Status	Plugged Open
Comments	General Comments

Table 20 – Constructed Features or Technical Trail Feature (TTF)

Field	Condition
Type	TTF Boardwalk Natural Feature Other (comments)
Distance	Enter length in m
Average width	Enter width in m
Located in SPEA	Yes/No

Table 21 – Off Trail Water Impacts

Field	Condition
Length (m)	Length of water impacts off of trail
Width (m)	Width of water scour
Cause of Impacts	- Human Constructed Ditch to help drainage - Scour of Fluvial Deposit - Plugged Culvert

Table 22 – Creek crossing trail

Field	Condition
Description	Brief description
Stream Type	- Perennial - Intermittent - Ephemeral
Width (m)	Width of creek

Table 23 – Unauthorized Trails

Field	Condition
Description	Brief description
Type	Significant (Trail over 1 m in width, no barriers to access)
	Insignificant (Trail under 1m in width, minor barriers to access
	Restored (No users and no access)
Rider Use	None (No use)
	Low (Minor use)
	Moderate (Moderate use)
	High (High use)

13 Appendix C – Terms of Reference