# A Valuation of Mystic Vale's Ecosystem Services


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Prepared for Dr. Valentin Schaefer

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*All photographs were taken by Sacha Doucet*

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# Abbreviations

CV: Contingent Valuation

ESV: Ecosystem Services Valuation

GIS: Geographic Information Systems

HP: Hedonic Pricing

NPV: Net Present Value

NTFPs: Non-timber forest products

PF: Production Function

TCM: Travel Cost Method

WTP: Willingness to Pay

# Abstract

Mystic Vale, a 4.7 hectare (11.6 acre) patch of second growth forest located on University of Victoria grounds, was valuated for its ecosystem services. To do so, the ecosystem services of Mystic Vale were identified and correlated with an economic model to assess these values in monetary terms. An estimate using CITYgreen GIS software was also used to augment the replacement/restoration cost economic valuation method.

A monetary estimate was given for the services provided by the vale in 1 year, and also for the cumulative value of services since its perpetually protected status in 1993. The overall value of Mystic Vale's ecosystem services for 1 year is $256,254.96; and since 1993, $4,641,253.56. The purpose of this report was to assign a dollar value to the values that are not observable, and to demonstrate that this natural area is worth something more beyond a proposed sale price.

# 1.0 Objective

The stunning presence of Grant-firs and Douglas-firs, ever-so characteristic of the Coastal Douglas-fir biogeoclimatic zone, tower over large sword ferns - some reaching over 2 meters in diameter - making the area look almost prehistoric. The spiny-edged Dull Oregon-grape also lay prominent in the understory vegetation along with Salal's tough and leathery leaves.  The gentle sound of the stream flowing only gives way to the songbirds' tune.

Since its acquisition by the University of Victoria in 1993, Mystic Vale has been a reprieve for city dwellers and students alike. The trail system within Mystic Vale gives the illusion of being much further away from urban life than it really is. Dogs are also known to take a liking to the area.

But what is the true value of this university property? Further analysis into the 4.7 hectare (ha) area of natural coniferous woodland shows the value goes far beyond recreational enjoyment. The Douglas-firs and Grand-firs are not just trees of beauty; they are great at capturing carbon and filtering other air pollutants. Sword fern, Dull Oregon-grape, and Salal have all been used for cultural purposes, along with the current economic benefit derived from these non-timber forest products (NTFPs). And while the flow of the stream and the songbirds' calls are pleasing to hear, the stream serves a greater purpose of regulating storm water, and the songbirds indicate a level of biodiversity and ecosystem health.

However, the importance of Mystic Vale providing these benefits – also known as ecosystem services –is persistently undervalued. Runoff from surrounding homes is still finding its way into the vale, compaction and erosion of soil still remains an issue, and invasive species continue their valiant fight against the area's native species and the manual labour attempting to remove them. And the vale's health will continue to be strained as long these services remain unaccounted.

The objective of this report is to provide a monetary estimate of the ecosystem services that Mystic Vale provides. It also my hope to cultivate a deeper understanding and appreciation for the value that the natural environment offers, and to bring to light that these values that we take for granted are invaluable to our very livelihood.

# 2.0 Introduction

Recognizing ecosystem services valuation (ESV) as a vital part of public policy is gaining traction with decision makers worldwide (Olewiler, 2009). This is most famously demonstrated in New York's decision to maintain the Catskills/Delaware watershed over building costly water treatment and filtration infrastructure to replace the watersheds' services (Appleton, 2002). Canada, however, has been criticized for undervaluing ecosystem services in the market economy, and for the lack of economic instruments to recognize these services (OECD, 2004). Most notably, natural capital and the resultant ecosystem services are not included in the gross domestic product (GDP), or any national accounts. While some progress has been made in recent years, as demonstrated by the valuation research poured into the Biodiversity Conservation Strategy of Vancouver (AXYS, 2005) and others, accounting for our natural capital is still widely overlooked in Canada's assets (DUC, 2007).

Though the complexity of this issue on the national level is beyond the scope of this report, the valuation of Mystic Vale's natural capital and the services provided can certainly be useful at the local level. This point is further reinforced because Greater Victoria has never performed such a valuation on any of the city's green spaces - or this is not widely publicized. The benefit of performing an ESV on Mystic Vale is that it can be used as a framework by local decision makers and land use planners in other undeveloped areas of the city whose values may not be plainly obvious. This report can be further be used to support Aqua-Tex Scientific Consulting Ltd.'s (Aqua-Tex) 5 year Hobbs Creek/Mystic Vale restoration plan.

## Defining Ecosystem Services

Ecosystem services cannot be defined in the absence of natural capital; mainly because natural capital is the very lifeblood of this earth. Natural capital refers to the earth's land, water, atmosphere and resources. In British Columbia, the province has been gifted with many forms of natural capital, including forests, fresh water, wetlands, rivers, the ocean, and more (Fraser, 2007). The different types of natural capital then merge to form the array of available resources and ecosystem services.

Ecosystem services, adapted from Luck *et al.* (2009), Wallace (2007), and Chee (2004) are: the benefits that humans derive from ecosystems that support, directly or indirectly, to sustain and fulfill human life from the local community level to a global scale. Ecosystems services can be divided into four broad categories (MEA, 2005):

1) Provisioning services**:** the products and goods produced or provided by ecosystems
2) Regulating services**:** the benefits obtained from the regulation of ecosystem processes
3) Cultural services: the non-material benefits people obtain from ecosystems
4) Supporting services: ecosystem services that are necessary for the production of all other ecosystem services.

While provisioning services is included as an ecosystem service in the United Nations Millennium Ecosystems Assessment (MEA) report (2005) and by Costanza *et al.* (1997), this is occasionally a separate consideration in other literature (Wallace, 2007; Brown *et al.*, 2007). The rationale is that provisioning services, also known as ecosystem goods, are the products we consume on a regular basis. Unlike the other ecosystem services, provisioning services/ecosystem goods are easily quantifiable and have also been recognized as a key element of wealth (Brown *et al.*, 2007).

The disadvantage of lumping provisioning services into ecosystem services is because it "…blurs the distinction between the functional nature of ecosystem services and the concrete nature of ecosystem goods" (Brown *et al.*, 2007). In the case of Mystic Vale, the area does have features that could be considered provisioning services/ecosystem goods, such as the plants that could be valuable NTFPs. However, the vale is not actively exploited for these resources and does not provide economic gain for the University or the City of Victoria. For this reason, Mystic Vale's provisioning services/ecosystem goods will be grouped under ecosystem services. For a list of ecosystem services, refer to Table 1.

Table 1. Ecosystems Services. Adapted from Brown *et al.* (2007), TEEB (2010), and MEA (2005). All except 'Provisioning Services' apply to Mystic Vale.

| Provisioning services | Regulating services | Cultural services | Supporting services |
|---|---|---|---|
| Food | Air and water quality regulation | Aesthetic values | Maintenance of life cycles of migratory species; |
| Water | Climate regulation; moderation of temperature extremes and the force of winds and waves | Opportunities for recreation and tourism | Maintenance of genetic diversity |
| Raw materials | Moderation of extreme events | Inspiration for culture, art, and design | Soil Formation |
| Genetic resources | Regulation of water flows | Spiritual experience and enrichment | Dispersal of seeds |
| Medicinal resources | Waste treatment | Information for cognitive development | Biomass production |
| Ornamental resources | Erosion prevention | Cultural diversity | Nutrient cycling |
| Fiber | Maintenance of soil fertility | Religious values | Water cycling |
| NTFPs (cultural, hobby) | Pollination | | Photosynthesis |
| | Disease regulation/pest control | | |

## The Importance of Ecosystem Services Valuation

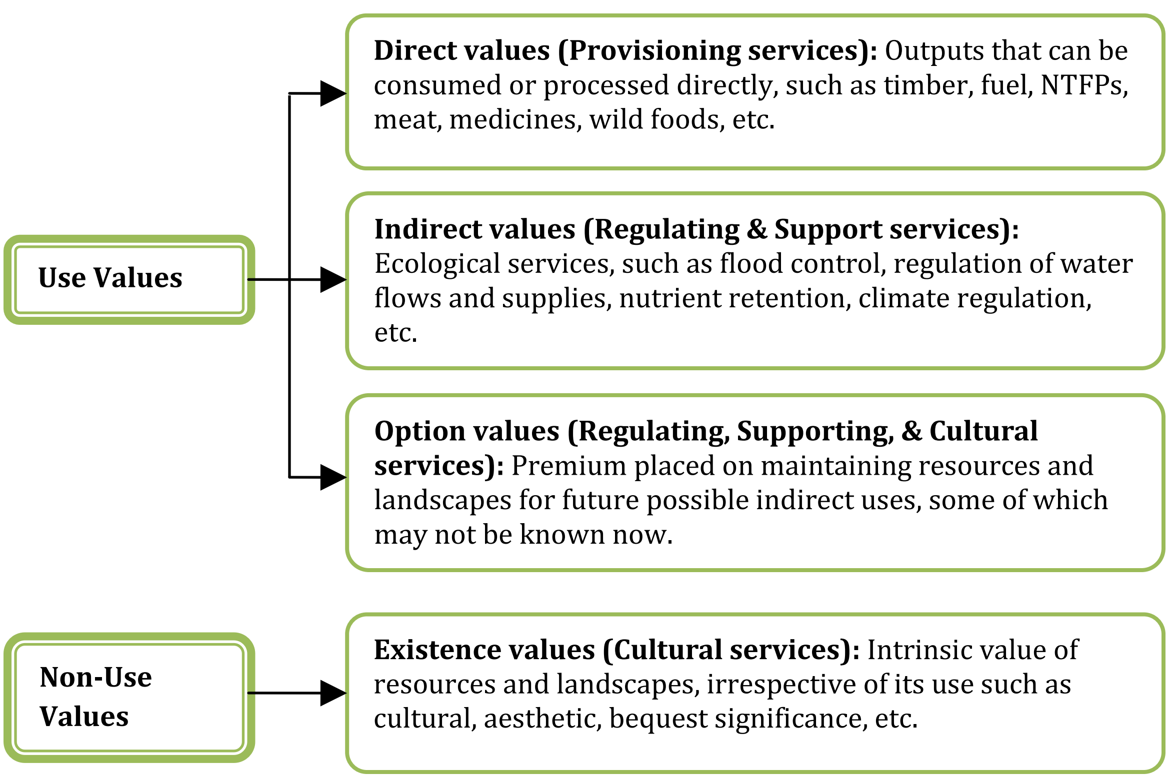
Economic theory indicates that there are 4 kinds of capital – human, financial, manufactured, and natural – and economies worldwide have so far used the first 3 to transform natural capital (Chee, 2004). This has been made possible because there is little incentive to consider ecosystem services or mitigate impacts in development. Natural capital and the services they provide generally fall under open access or public goods, so it is difficult to monitor their health and function. Moreover, MEA report found that humans have changed the earth's ecosystems more rapidly, and extensively, over the last 50 years than any other point in human history (2005), and 60 percent of ecosystem services are degrading at an unsustainable pace (TEEB, 2010).

Linking ecosystems with human benefits by implementing the practice of ESV is useful in assessing the trade-offs involved in the loss of ecosystems. Some of these trade-offs include ecological, economic, cultural, historical, and monetary gains (TEEB, 2010). Also, assessing ecosystem services spatially and temporally aligns well within the context of making economic decisions, and can provide a more complete picture to decision makers. This, in turn, could spur the discussion of management cost-sharing for the benefit of all parties utilizing ecosystem services.

## Valuation Methods

Valuation has typically been limited to provisioning services; or in economic terms, direct values. However, economists have broadened their scope to integrate other values which has been useful in marrying the fields on economics and ecology (Daily *et al.*, 2000). The others are; indirect values, option values, and existence values. These economic values can be correlated with ecosystem services values (see Figure 1).

*Figure 1 – Combining Economic Values and Ecosystem Services.* Adapted from Perrot-Maître (2005) & Adamowicz *et al.* (2005)



Depending on the value, a different valuation method is required (Daily *et al.,* 2000; Chee, 2004; Olewiler, 2009). The five main techniques to assess ecosystem services in monetary terms are: replacement/restoration cost, the travel cost method, hedonic pricing, contingent valuation, and production function analysis. All of these valuation methods apply to performing an ESV on Mystic Vale, except for production function analysis. This is because goods are not extracted from the area for capital gains. A summary of the advantages and disadvantages of all 5 valuation methods can be found on Table 2.

## *Replacement/Restoration Cost Technique*

The replacement/restoration cost method estimates ecosystem services values on either the costs of replacing ecosystem services (e.g. land acquisition), costs to restore an ecosystem to a functional state, or the cost of providing substitute services (e.g., maintaining the Catskills/Delaware watershed versus building a water treatment facility in New York). This method is used when the goal is to reinstate indirect values (Chee, 2004), and therefore does not supply strict measures of economic values. Instead, the replacement/restoration cost method assumes the full cost of replacing or restoring an ecosystem will be equal to the willingness to pay (WTP) for an ecosystem service.

The benefit of using the replacement/restoration cost method is it is generally easier to measure the costs of producing ecosystem service benefits than the benefits themselves. This can certainly be useful when ecosystem goods, services, and benefits are non-marketed (King and Mazzotta, 2000). Resultantly, this valuation method is less data intensive than other methods.

The WTP on a proponent's behalf is one of the limitations of the replacement/restoration method because it assumes the full cost to replace or restore an ecosystem will be sought (Chee, 2004, Turner *et al.*, 2010). It has been suggested that this approach should only be used after a project has been approved and the WTP has been established in some way, such as viewing the project's proposed replacement or restoration expenditures (Turner *et al.*, 2010). This method also does not consider social preferences for ecosystem services, or behaviours in the absence of those services (Barbier, 2007).

Another drawback of this method can be demonstrated in the New York example: the presence of the Catskills/Delaware watershed reduces the cost of water treatment because it filters city water. It is therefore using the cost of an alternative treatment method, such as a water treatment plant, to represent the value of the wetland's natural water treatment system. As such, the replacement/restoration cost method does not measure the direct benefit derived from the wetland's water treatment. Rather, the ratio of 1:1 implies the 'costs' of replicating a wetland are equated with 'benefit' of the wetlands themselves, when in fact the ecosystem services being replaced or restored probably represent only a portion of the full range of services (Barbier, 2007). The benefits of protecting or restoring ecosystem services could therefore be understated.

### *Using CITYgreen GIS Software*

An interesting addition to the ESV discipline is CITYgreen GIS software. Developed by American Forests, this application can be used alongside the replacement /restoration cost technique in particular because it gives an accurate monetary value of an intact ecosystem. CITYgreen provides "…quantitative information concerning how much treed and other green land covers are worth in terms of their ability to both provide increased health and well being for urban residents and reduce municipal infrastructure costs" (AXYS, 2005). This value can then be compared to the replacement or substitution cost, providing land-use planners and policy makers much more insight into decision making.

CITYgreen is an extension of ESRI's ArcGIS products – and version 9.2 or higher must be used for CITYgreen to work. The software bases the value of stormwater runoff, air quality, water quality, and carbon storage and sequestration on land cover data that is provided by the user. The source of the land cover dataset can also be derived from aerial photography or satellite imagery. One of its often touted strengths is its easy to read reports, and ability to perform complex ecological analysis. The main limitation to CITYgreen is the uploaded images must be in colour and of high quality for CITYgreen to recognize the data. It also only works with Windows-based computers.

## *Travel Cost Method*

The travel cost method (TCM) is used to calculate cultural environmental values that enhance individuals' enjoyment, recreation, and/or tourism. The survey-based TCM technique can be used to calculate a constant price for a facility or park, and the cost of travel and associated products to use at a site (Chee, 2004; Olewiler, 2009). The advantage of this method is its relative ease to calculate and interpret. Also, this is not a hypothetical WTP method: the TCM calculates the price of actual behavior. Additionally, surveys are relatively inexpensive to design.

The issue with the TCM is its implicit assumption that an individual takes a trip for a single purpose. Therefore if a trip has more than one function for someone, the value of the site may be overestimated (Olewiler, 2009). Also, those who live close to the site may have low travel costs and use the site frequently; however the TCM does not capture the high value for nearby residents (King and Mazzotta, 2000).

The other criticism of TCM is that it does not integrate opportunity cost, or the cost to forego one activity in favour of visiting the site of interest in monetary terms (Barbier, 2007). Even if opportunity cost were to be added to a survey by some measure, it can become problematic – especially if a person enjoys travel time, or their wage rate is not a reflection of how they value time. This method is also only used for recreation studies (Olewiler, 2009).

### *Hedonic Pricing*

The hedonic pricing (HP) method is used to estimate economic values for ecosystem services that directly affect market prices. An example of this is one identical property is chosen over another because one is closer to scenic beauty. The benefit of an ecosystem service is then calculated as the differential cost between the two houses (Turner *et al.*, 2010). The HP method is calculated when real estate is the main concern, and aspects such as aesthetic view, proximity to recreational sites, and environmental quality could be reflected in the price of the housing market (Chee, 2004; King and Mazzotta, 2000).

The main benefit of using the HP method is that it can estimate values based on actual choices. Property characteristics and data on sales are also available and highly reliable. It has also been noted that the HP method can adapt to consider other interactions between market goods and environmental quality (King and Mazzotta, 2000).

The main limitation to the HP method is it only considers the perceived differences in ecosystem services (King and Mazzotta, 2000). This may undervalue ecosystem services that may not look as scenic but perform meaningful functions. For this reason, it is difficult to find suitable parameters for measurement, and estimates can be highly inaccurate. This method also assumes that home buyers have the opportunity to select the features they prefer; however, the housing market is also affected by many external forces such as taxes and interest rates.

## *Contingent Valuation*

The contingent valuation (CV) method is used to estimate economic values for many environmental services, and can be used to estimate all use and non-use value (King and Mazzotta, 2000). The CV method uses the survey technique by asking people directly their WTP for ecosystem services. This can come in the form of asking how much a person would be willing to be taxed to maintain an area, or compensation they would be willing accept to maintain an area themselves, or how much compensation they would be willing to accept to give up an ecosystem service all together (Olewiler, 2009; Turner *et al.*, 2010). The WTP relies solely upon a specific hypothetical scenario.

Contingent valuation is one of the only ways to assign dollar values to indirect, option, and existence values to the environment, or values that do not involve market purchases. One example of CV survey was with Red Deer residents and their WTP to protect Red Deer Brook wetland which retains a significant amount of sedimentation from entering Lac La Biche (Olewiler, 2009). The prevention of eutrophication of the lake was determined to worth an additional $70/year in taxes, and an additional $3.08 per night in camping fees for non-residents.

However, the CV method is solely based on hypothetic scenarios in a survey – not actual behavior. This can present a host of problems. The first is that respondents may "give" varying amounts depending on type of payment; e.g. taxes versus donations. This does not answer how much an ecosystem service is worth to an individual, but rather respondents give a low value if dealing with the idea of increased taxation, or donate according to what their "fair share" contribution is (King and Mazzotta, 2000). The order in which information has been presented has also affected the WTP of respondents (Chee, 2004). Additionally, respondents can be biased if they are forced to value something when they either have little or no information and experience, or give a high value for the "warm glow effect" of feeling socially responsible (King and Mazzotta, 2000).

Although the CV method is highly controversial, it is still the method most often used and has been for the last 2 decades (King and Mazzotta, 2000). It is flexible, and can be applied across many different ecosystem services and economic values. Analyzing the results of a CV method survey is also fairly easy to describe. Plus, the information can be usefully disseminated to be presented by mean or median income, per household, or per capita. While not perfect, the CV method has some of the most research poured into it to make improvements.

## *Production Function Analysis*

Production function (PF) analysis determines the benefits that regulating and supporting ecosystem services provide through their protection of properties. These indirect values must be directly measurable, such as monitoring water quality to ensure fish harvesting, or water flow regulation of forest ecosystems for hydro-electric power production. In other words, when ecosystem services augment economic activity or protect economic activity from losses, the PF analysis is used.

To perform a PF analysis, three types of data must be collected: costs of production for the final good; supply and demand for the final good; and supply and demand for any other factors of production (Chee, 2004; Barbier, 1994). This information is translated to link the effects of changes in the quantity or quality of the ecosystem service to changes in consumer surplus and/or producer surplus. In turn, this estimates the economic benefit of indirect values.

The methodology to collect data is straightforward, and is one of PF analysis' strengths. Even more so, the amount of data required is limited in comparison to other valuation methods. It is also relatively inexpensive to apply a PF analysis (Chee, 2004; Turner *et al.*, 2010).

However, while the method to collect data is clear, it can be difficult to ascertain the cause and effect link between ecosystem services and a marketed commodity (Daily *et al.*, 2000). This issue is compounded if any changes in any other production inputs are observed. Furthermore, this method of valuation relies heavily of the market forces of supply and demand, so applying PF analysis can be questionable if a market does not value ecosystem services adequately (Chee, 2004).

Table 2. Summary of Advantages and Disadvantages of the 5 Valuation Methods.

| Method | Ecosystem Service Valued | Advantage | Disadvantage |
|---|---|---|---|
| Replacement/Restoration Cost Technique | Regulating and supporting | Site restored to pre-disturbed functional state; accurate valuation if GIS is used | Assumes proponent is willing to pay full cost; assumed cost/benefit is 1:1 |
| Travel Cost Method (TCM) | Cultural services - Recreation | Easy to calculate; inexpensive | Only used for recreation studies; does not include opportunity cost |
| Hedonic Pricing (HP) | Cultural, supporting, and regulating (solely pertaining to real estate prices) | WTP comes from actual behaviour & not hypothetical scenario; data required is accurate | Does not account for external influences such as taxes; may undervalue ecosystem services |
| Contingent Valuation (CV) | All (provisioning, regulating, supporting, and cultural services) | Flexible; estimates an individual's own value | Bias of WTP is strongly affected by income, education, prior knowledge, & survey design |
| Production Function (PF) Analysis | Regulating and supporting | Data easier to obtain than other methods | Difficult to find cause & effect link; only applies to indirect values |

# 3.0 Mystic Vale

While the application of economic valuation to ecosystem services was mentioned throughout section 2.0, the value of Mystic Vale's services in particular becomes apparent when various factors and the interplay between them are assessed. The area's land use, restoration efforts, hydrology, species composition, and threats all contribute to ecosystem services. All of these elements make a valuation of Mystic Vale that much more colourfully complex.

## Geographic Context & History

The study area of Mystic Vale is located at 48°46'04"N, -123°30'28"W on the University of Victoria grounds, and is part of the Hobbs Creek watershed in the District of Saanich (Aqua-Tex, 2009). The 4.7 ha (or 11.6 acre) area is characterized by second-growth forest and has moderately steep slopes ranging from 20° to 30° (Lucey *et al.* 2002). Mystic Vale lies within the CDFmm/13 biogeoclimatic (BEC) zone, or the Coastal Douglas-fir zone moist maritime subzone, site series 13 (Western redcedar –Indian plum). This BEC has mild, wet winters and warm dry summers. See Figure 2 for a map of Mystic Vale.

Originally used by the Senchalhen and Lekwungen peoples, Mystic Vale was a sacred site for many rituals (Turner, 2000). Some of these include; a place thought to increase fertility, a ceremony site for pubescent girls to 'become' women, and a collection site for medicinal plants. As the years passed and ownership changed hands, much of Mystic Vale was logged, farmed, and built on.

The eventual proposed sale of Mystic Vale in the early 1990's by Sherwood Oak and Bay Meadows Estates became contentious at the possibility of clearing the area to erect a new subdivision (M'Gonigle & Starke, 2006). A student led petition pointed out the University of Victoria's rights under the University Act to expropriate the land. The petition succeeded when the University, in conjunction with the District of Saanich, purchased Mystic Vale for $2.7 million (M'Gonigle & Starke, 2006) to be protected in perpetuity (University of Victoria, 2003; see Appendix A).

*Figure 2 – Map of Mystic Vale.* (CRD, 2012)

Mystic Vale now acts as a "…buffer between the urban and the riparian environment, and provides connectivity to other ecosystems while promoting the spread of biodiversity" (Harrop-Archibald, 2007). However, the main corridor to connect Mystic Vale to other forested areas does not have perpetually protected status. The adjoining 11.5 ha (28.5 acre) South Woods that allows for a contiguous habitat and gives the vale many of its ecosystem services only has a 10 year moratorium protecting it from any kind of development (University of Victoria, 2003). The moratorium ends next year (2013). Although the campus plan notes that South Woods and other natural areas "are environmentally important, contribute substantially to UVic's visual image, and have been actively used by the faculty as a resource for teaching and research", the policy does not comment further on the proposed activities after the moratorium comes to close (University of Victoria, 2003). As many of Mystic Vale's valued attributes are not only supported, but dependent on the South Woods, developing this area would be contradictory to the goal of protecting the vale in perpetuity.

## Restoration Efforts

Because of Mystic Vale's importance as a teaching and research tool, there have been many studies suggesting how to restore Mystic Vale along with restoration attempts themselves. The most detailed of this is Aqua-Tex's 5 year restoration plan for Mystic Vale and Hobbs Creek. The restoration tasks deemed 'urgent' by this plan are; relocating 50m of trail to prevent slope failure and flooding downstream, installing page wire along the existing canoe pond fence to prevent trampling, and installing fencing along other areas to stop erosion, among many others (Aqua-Tex, 2009). Page wire along canoe pond has already been installed and has succeeded in keeping dogs out of this sensitive habitat.

Hobbs Creek, which formed and encompasses Mystic Vale, has not been so lucky with restoration attempts. The creek is "regularly flooded by water from storm drains which has left the upper part of the creek uninhabited by fish, [and has] created major slope stability issues and silted the lower reaches of the creek" (Schaefer, 2012). Aqua-Tex has outlined and already taken steps to mitigate these impacts, but the creek still requires a $10,000/year silt clean up (Valentin Schaefer, personal communication, March 12, 2012).

However, there are some encouraging restoration results in Mystic Vale; one of which is the installation of waddles. Made from Red Osier Dogwood (*Cornus sericea*), Hooker's Willow (*Salix hookeriana*) and Black Cottonwood (*Populus trichocarpa*), the purpose of the waddles is to regulate storm water, and has so far been successful (Valentin Schaefer, personal communication, March 12, 2012). Native to the region, the aforementioned trees and shrubs were chosen to increase biodiversity by attracting various songbirds.

Other activities have been suggested to help restore Mystic Vale's health. The most common have been to increase signage, fund public awareness measures, and explore the University's ability to apply for grants and programs (Aqua-Tex, 2009; Oliver, 2011; Chanoine *et al.*, 2009). It has even been suggested to create a community watch to report litter bugs (Harrop-Archibald, 2008).

## Hydrology

Mystic Vale lies within one of the 4 watersheds present on campus: Hobbs Creek. The boundaries of Hobbs Creek, along with the other 3 watersheds (Finnerty, Cadboro, and Bowker) can be viewed in Appendix B. As of 2003, these watersheds are covered with 31% impermeable services, compared to 1956's 0% (Lloyd, 2004). This has left a highly confined flood plain and creek channel prone to flooding as the runoff volume from campus lands has doubled since 1956 (Lloyd 2004; Appendix C). Aqua-Tex's 5 year restoration report also notes "severe undercutting of stream banks" within Mystic Vale (2009).

Measures to mitigate these impacts began in 2000 after complaints from neighbourhood residents of sedimentation in downstream ponds caused by Hobbs Creek. The University and the District of Saanich collaborated with Aqua-Tex to form a restoration plan. The following spring, 30 weirs were installed in Hobbs creek to "...create riffle pool geomorphology, hydraulic diversity, increased dissolved oxygen levels and flood plain utilization, reduce headcutting, and dissipate energy within the stream channel to enhance the existing stream channel geomorphology" (Aqua-Tex, 2009). This helped to temporarily stabilize some bank erosion, stabilize headcuts, and reduce sedimentation downstream.

The 2004 designation as a Type 1 watershed, which restricts stormwater discharge from development sites, has reduced storm water runoff rates equivalent to 5L/s per ha of land, and storage must be $200m^3$/ha of impervious surface (Aqua-Tex, 2009). However, "extensive stream bank instability" in Mystic Vale's banks still exists, and is primarily caused by a shortage of riparian plant biomass from trampling, and insufficient Large Woody Debris (LWD) within the stream channel. Pollutants such as pesticides and fertilizers from urban runoff and rainwater have also contaminated Hobbs Creek. The restoration attempts still have much progress to be made to improve water quality, flood management, and providing the biodiversity and habitat protection it is capable of.

## Species

### *Plants*

Home to over 75 different native plant species, the upper edges of Mystic Vale's steep slopes have many shrubs and understory species, such as Salal (*Gaultheria shallon),* Indian Plum *(Oemleria cerasiformis*)*,* Snowberry *(Symphoricarpos albus*) and Dull Oregon-grape (*Mahonia aquifolium*) (Harrop-Archibald, 2008). Species such as Skunk cabbage (*Lysichiton americanus*) and false lily-of-the-valley (*Maianthemum bifolium*) can be seen closer to the moister ravine edges, along with an overwhelming number of Sword ferns (*Polystichum munitum*). However, invasive species such as English Ivy (*Hedera helix*), English Holly (*Ilex aquifolium*), and Trailing Blackberry (*Rubus ursinus)* have overrun the area.

Lying in the rain shadow of the Olympic Mountains and the mountains of Vancouver Island, Mystic Vale supports Douglas-firs (*Pseudotsuga menziesii*), Grand-firs (*Abies grandis*), and Big-leaf maples (*Acer macrophyllum)* (CRD, 2011)*.* According to Harrop-Archibald, the vale's flood plains and moist conditions should support Western red cedars, though none were recorded (2008). For a complete list of Mystic Vale's plant, refer to Appendix D.

### *Animals*

Animal residents of the ravine include Black-tailed deer (*Odocoileus hemionus columbianus*), raccoons (*Procyon lotor)*, gray squirrels (*Sciurus carolinensis*), and several varieties of bats (Lucey *et al.*, 2002). Even the elusive cougar (*Felis concolor*) has been spotted in Mystic Vale. The trees are also home to the nests of Bald Eagles (*Haliaeetus leucocephalu*), Cooper's Hawk (*Accipiter cooperii*) and the Great Horned Owl (*Bubo virginianus*), among the woodpeckers (*Dryocopus pileatus)* and many song birds (Harrop-Archibald, 2008). Rodents that have been recorded in Mystic Vale include the deer mouse (*Peromyscus maniculatus*), house mouse (*Mus musculus*), and Norway rat (*Rattus norvegicus*).

# Threats to Mystic Vale

## *Invasive Species*

Invasive species have overtaken much of Mystic Vale, causing the area to lose some of its native species composition and biodiversity. Native plants are tasked with competing with these invaders for soil nutrients and sun light, and can be crowded out completely. English Ivy (*Hedera helix)* in particular is prominent throughout the vale, and can be seen as either a thick blanket in the understory vegetation (see Figure 3), or creeping up tree. Once up a tree, the weight of mature ivy vines can make infested trees susceptible to blow-over during storms (Tree Canada, 2007). Furthermore, ivy can transmit bacterial leaf scorch, which threatens maples trees. Ivy also out-competes deeper rooting native vegetation, and destabilized banks. This has also created a restoration issue, in which the ivy is pulled but not immediately replaced with native vegetation, causing further bank degradation.

*Figure 3 – English Ivy (Hedera Helix) in the understory of Mystic Vale*

Other common invaders found within Mystic Vale include English Holly (*Ilex aquifolium*), Daphne-laurel *(Daphne laureola)*, Himalayan blackberry (*Rubus armeniacus*), English Hawthorn (*Crataegus laevigata*), and Scotch Broom (*Cytisus scoparius*). Most of these plants had been introduced by European settlers when bringing a piece of home with them to Canada. However, without the native predators or insects to keep them in check, these invasives have grown unhindered and continue to pose a threat even beyond the boundaries of Mystic Vale, and into the Capital Regional District.

## *Resource Shortage*

The lack of financial resources has caused restoration efforts in Mystic Vale to be inconsistent and at times sporadic (Harrop-Archibald, 2008). Aqua-Tex's restoration plan suggests applying for multiple funding opportunities (2009); however, no follow-up to these suggestions could be found. Compounding this issue is the fact that there is not an Environmental Coordinator position or volunteer committee to write funding proposals, amalgamate all previous researched information and restoration efforts, and ensure follow through with the proposed restoration activities.

## *Disturbance*

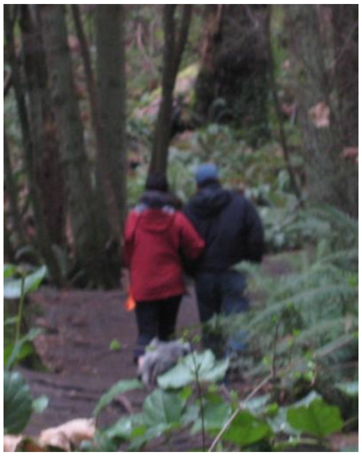


*Figure 4 – A couple strolling through Mystic Vale. Not pictured: their off-leash dog*

Many runners, walkers, birders, and dog walkers utilize Mystic Vale, and the resultant compaction of erosion has compromised the biological integrity of the vale. Off-leash dogs, in particular, have eroded and disturbed the stream banks (as previously mentioned in Hydrology). These canine comrades have trampled native plant species, contributing to the undercutting of banks which then increases water turbidity and builds sediment concentration in the creek. The fencing of Canoe Pond has greatly diminished the disturbance at the entrance of Mystic Vale; however, there are still many areas where dogs or people can easily walk through this sensitive area.

When it comes to the compacted trails, native plant species have a difficult time establishing. The high amount of impervious surfaces and increased runoff from surrounding areas limits root depth, making it difficult for native plant species to establish. Further fragmenting Mystic Vale, these gaps in ecosystem connectivity can increase tree susceptibility to disease and infestations, and therefore blow-over.

## *Erroneously Designed Trail System*

The Mystic Vale trail system comes too close to the creek causing trampling, soil compaction, and a lack of riparian vegetation (Aqua-Tex, 2009). As a result, the area floods in the wetter winter months, and trail users bypass the area in favour of walking through the dryer, native vegetation – compounding the issue of soil compaction and erosion. Mountain bikers have also been attracted to the area due to the vale's steep slopes, and have created make- shift trails, further eroding the banks and damaging vegetation. Aqua-Tex (2009) has suggested many solutions to this issue:

1. Add brush to the top of the mountain biking trail to make access difficult
2. Plant prickly bushes close to the stream bank to detract anyone from entering the area; this will also help to stabilize the stream bank
3. Shift the trails 10-15 meters, away from the creek

All of these measure to manage storm water would alleviate some of the stress to riparian vegetation, reduce erosive water flows, and assist in the reparation of the creek's health overall.

## *Lack of Community Awareness & Education*


*Figure 5– Mystic Vale's current signage*

Because of the sporadic nature of restoration attempts, there has been a lack of consistency to bring forth the message of Mystic Vale's ecological importance and health. Signs have been added but have largely been ignored (Aqua-Tex, 2009). However, it may be more effective to have one suggestion per sign as opposed to multiple bullet points as seen in Figure 5. The sign reads:

*Mystic Vale is an environmental sensitive area. Please respect the land:*

- *Keep your pet on a leash*
- *Clean up after your pet*
- *Stay on the designated trails*
- *No mountain biking*

*In case of emergency, contact campus security at (250) 7217599*

In addition to the current signage, a more straight forward sign, such as "All dogs must be kept on a leash" (Figure 6), should be placed at each entrance of Mystic Vale. Aqua-Tex has also given some improved signage suggestions, such as pinpointing a particular species to be featured, or drawing a trail map and how it relates to the greater watershed encompassing Mystic Vale (2009).


*Figure 6 –Signage suggestion for Mystic Vale*

# 4.0 Methods

## Replacement/Restoration Cost Technique

The replacement/restoration cost technique, in its basic form, does not rely on modeling or observational data. Rather, it is a calculation of difference between recreating Mystic Vale's ecosystem services elsewhere, or leaving the vale intact and calculating the cost avoided and therefore the benefit derived from its presence. As this method applies to indirect values (regulating and supporting services), it can be used to asses Mystic Vale's contribution to air and water quality, climate regulation, and storm water management. To calculate:

Assuming option 1: leaving the vale intact; option 2: clearing Mystic Vale–

$C_1/B_1$: is the cost/benefit of option 1
$C_2/B_2$: the cost/benefit of option 2

When the benefit of option 1, $B_1$, cannot be directly measured, this method uses the cost of the second option, $C_2$, as a measure for $B_1$.

This is because $C_2$ is considered a proxy for $B_1$ if the following conditions hold:

$B_2 \geq C_2$ (The benefit of clearing Mystic Vale is greater than the cost)
$B_2 \leq B_1$ (The benefit of clearing Mystic is less than the benefit of leaving the vale intact)

Therefore, if these conditions hold, $B_1 \geq C_2$ (the benefit of leaving the vale intact is greater than the cost of clearing it). (Brown *et al.*, 2007; Adamowicz *et al.*, 2005).

### *CITYgreen Analysis*

CITYgreen is an application that can accurately value *some* components of $B_1$ - this does not give the complete value of ecosystem services (see 5.0 Valuation). The GIS software takes land cover information and can produce the following valuations:

## Stormwater Management

CITYgreen assesses how land cover percentages in combination with soil type, rainfall distribution, slope, and average precipitation affect stormwater runoff volume (AXYS, 2005). It calculates the volume of runoff in a two year 24-hour storm event that would need to be contained by stormwater facilities, in cubic feet, if trees were removed. This volume is multiplied by local construction costs to calculate the dollars saved by the tree canopy. It can also model different precipitation and land cover scenarios to help determine best management practices for conservation initiatives.

## Water Quality

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. The CITYgreen water quality model uses values from the U.S. Environmental Protection Agency (EPA) and Purdue University's L-thia spreadsheet water quality model to calculate this value (Midwestern Urban Tree Canopy Project, 2011). The water quality model estimates the change in the concentration of the pollutants in runoff during a typical storm event given the change in the land cover. The model estimates concentrations in (AXYS, 2005):

- Nitrogen
- Phosphorus
- Suspended Solids
- Zinc, Lead
- Copper
- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand (BOD)

Pollutant values are shown as a percentage of change when the land cover is altered - no valuation is provided.

## Air Quality

CITYgreen estimates the annual air pollution removal rate of trees within a study area for these pollutants (AXYS, 2005):

- nitrogen dioxide ($NO_2$)
- sulfur dioxide ($SO_2$)
- ozone ($O_3$)
- carbon monoxide (CO)
- Particulate matter less than 10 microns ($PM_{10}$)

While economics use 'externality' costs, or indirect costs from society (such as rising health care costs or reduced tourism revenue) to calculate the effects on these pollutants, CITYgreen uses land cover information to calculate the average leaf coverage, and their performance of absorbing and filtering pollutants.

## Carbon Storage and Sequestration

CITYgreen's carbon storage and sequestration model quantifies the role of urban forests in removing atmospheric carbon dioxide and storing the carbon (AXYS, 2005). Based on tree attribute data on trunk diameter, CITYgreen estimates the age distribution of trees within a given site and assigns one of three age distribution types (Midwestern Urban Tree Canopy Project, 2011). For forest patches, CITYgreen uses data on the dominant diameter class to calculate carbon benefits. The economic benefits can be applied to whichever economic valuation method is being used.

Estimating urban carbon storage and sequestration requires the study area (in acres), the percentage of crown cover, and the tree diameter distribution. Sequestration multipliers are assigned to three tree diameter distribution types:

- Type 1 (Young population) 0.00727
- Type 2 (Moderate age population, 10-20 years old) 0.00077
- Type 3 (Even distribution of all classes) 0.00153
- Average (Average distribution) 0.00335

(Carbon storage multipliers were not found.)

The equation to estimate carbon storage in a study area:

Study area (acres) x Percent tree cover x Carbon Storage Multiplier = Carbon Storage Capacity

The equation to estimate carbon sequestration:

Study area (acres) x Percent tree cover x Carbon Sequestration Multiplier = Carbon Sequestration Annual Rate

## Travel Cost Method

As Mystic Vale is well known as an area for walkers, runners, and dog walkers, it is in the best interest to value recreation to gain a complete picture of an ESV. In the case of Mystic Vale, part of the TCM survey could be the cost of public transportation, or vehicle costs such as gas price, amortization, and insurance required to arrive on site. The other is how often walkers, runners, and dog walkers utilize the area in a year. Other potential TCM survey questions include:

- location of the visitor's home, and how far they traveled to the site
- the length of the trip
- the amount of time spent at the site
- Other travel expenses (e.g. if a birder bought new binoculars to look at the birds on site)
- other locations visited during the same trip, and amount of time spent at each
- other reasons for the trip (is the trip only to visit the site, or for several purposes?)
- perceptions of environmental quality or quality
- substitute sites that the person might visit instead of this site

(Adapted from King and Mazzotta, 2000)

## Hedonic Pricing

The assumptions of the HP model is that the value of a house is affected by a combination of characteristics that it possesses, and the given properties with better qualities demand higher prices as compared to properties with lower qualities. The price of a house will therefore be affected by:

- Structural characteristics of the house (s1, s2, s3...) e.g. number of rooms, size of the house and yard
- Characteristics of the locality/neighbourhood (n1, n2, n3...) e.g. good reputation, proximity to schools and shopping
- Environmental characteristics (e1, e2, e3...) e.g. air quality, proximity to recreation

So, Price Function (P) = f(s1, s2, s3...; n1, n2, n3,...; e1, e2, e3,...)

The implicit prices are then regressed against the actual quantities and qualities chosen by the home buyer in order to attain the WTP for the amenity. The results of this analysis will indicate the changes in property values for a unit change in each characteristic, given that all the other characteristics are constant (Adamowicz *et al.* , 2005; King and Mazzotta, 2000). To assess Mystic Vale with HP, the price of a house bordering Mystic Vale would be compared against a comparable house not bordering Mystic Vale.

## Contingent Valuation

As with the WTP survey given to Red Deer residents to protect Red Deer Brook wetland, a similar survey could be given to Greater Victoria residents to estimate the amount of tax they would pay to fund restoration programs to restore ecosystem services in Mystic Vale. The first process to creating a CV survey is to provide a fact sheet to give residents. An example of Mystic Vale's could be:

- Over 75 species of native plant and wildlife species are found within Mystic Vale
- Many of the trees are 100-150 years old, while some are estimated to be 350-500 years old
- Thousands of students and community members access the area each year for both recreational and academic purposes
- Mystic Vale, part of Hobbs Creek, helps to maintain water flows and prevent flooding
- Mystic Vale is recognized as a corridor to the maintenance of health of other UVic forested regions, such as South Woods

The second process is to create a questionnaire. An example survey concerning Mystic Vale (Adapted from Olewiler, 2009):

1) Do you support mechanisms to pay the University of Victoria and the District of Saanich to protect Mystic Vale? Yes/No

If Yes: would you be willing to pay $20 annually into a fund to pay the University of Victoria and the District of Saanich to permanently protect Mystic Vale? Yes/No

If No: What is the primary reason?

- The preservation of Mystic Vale is not important to me
- I do not think I should have to pay for Mystic Vale's preservation
- Other:

Local government plays a major role in determining land uses within a community. Imagine a situation where there is a proposal to use all 4.7 ha of Mystic Vale's natural coniferous woodland for urban development. The reason for changing the land use is to increase tax revenues. The increased tax revenue may postpone a future increase in residential property taxes.

2) Would you prefer to maintain Mystic Vale? Yes/No

If Yes: would you be willing to pay $50 each year in addition to property taxes to preserve Mystic Vale? Yes/No

If No: What is the primary reason?

- The preservation of Mystic Vale is not important to me
- I do not think I should have to pay for Mystic Vale's preservation
- Other:

Suppose that there are 300 ha of natural coniferous woodland in Greater Victoria. Would you be willing to pay $50 each year in addition to property taxes to preserve the 4.7 ha of Mystic Vale? Yes/ No

Now suppose the 4.7 ha of Mystic Vale's coniferous woodland was the **only** remaining coniferous woodland in Greater Victoria. Would you be willing to pay $50 each year in addition to property taxes to preserve the 4.7 ha of Mystic Vale? Yes/No

Based on the outcome of the survey, policy decisions can be made. If the area is designated as a 'natural area' (no development zone), then land conservation techniques would be considered. Some of these include conservation easements, land use regulations, and expropriation (as seen with Mystic Vale). If the land use decision is not to maintain a 'natural area', it would therefore become 'status quo' – or retaining existing land use management policies (Olewiler, 2009).

# Considerations

## *Timeline*

An ESV on Mystic Vale is based on its current state of ecological function. However, if many or all of Aqua-Tex's restoration suggestions are implemented to mitigate the impacts of the Threats to Mystic Vale, the ecosystem services values could change significantly. Dodds *et al.* (2008) suggested the calculation:

$$RI_{r/n} = ES_r/ES_n$$

Where:

$RI_{r/n}$ : ratio of value production rates of restored to native ecosystems (the restoration index)

$ES_r/ES_n$: ratio of value production rates of restored to native rates of ecosystem services

The ratio $ES_r/ES_n$ depends on what ecosystem service is being valued. For example, if calculating the flood control value of Mystic Vale, the restoration index would be based on the current value of flood control (in terms of costs avoided from flooding), compared to the flood control provided by a native system. This would give some percentage of how well flood control is functioning in Mystic Vale (e.g. flood control is at 50% capacity) (Dodds *et al.,* 2008). This ratio can then be reassessed in year 2014 (the end of Aqua-Tex's restoration timeline) to calculate the change in flood control productivity.

Dodds *et al.* suggested using the timeline of 10 years to compare values; however, some values require different amounts of time to recover (2008). This also assumes restoration attempts always have a positive benefit on an ecosystem. As seen in Mystic Vale's English Ivy pulling, this is not always the case. While ridding the area of invasive species, pulling Ivy has also destabilized the soil, creating further erosion in Mystic Vale.

## *Relation*

With 4 possible valuation methods to be used to assess Mystic Vale's ecosystem value, it is also important to consider surrounding areas as many of the vale's ecosystem services are related to its proximity to other forested areas. If combined with other forested areas encircling Ring Road, the habitat patch size would move from a habitat refuge (2-20 ha) to habitat reservoir (30-200 ha) (AXYS, 2005). This alone would increase the biodiversity value, and also be considered an area that maintains genetic diversity and support a greater range of species.

Furthermore, a 20% loss in land does not necessarily correlate to a 20% loss in ecosystem services. Depending on the habitat size and health, a 20% loss in land cover could mean only a 5% loss in biodiversity (Figure 7); conversely, another circumstance of a 20% loss could create a dramatic impact (Schaefer *et al.*, 2004). This likelihood of having a dramatic impact increases as the patch size of a habitat becomes smaller.

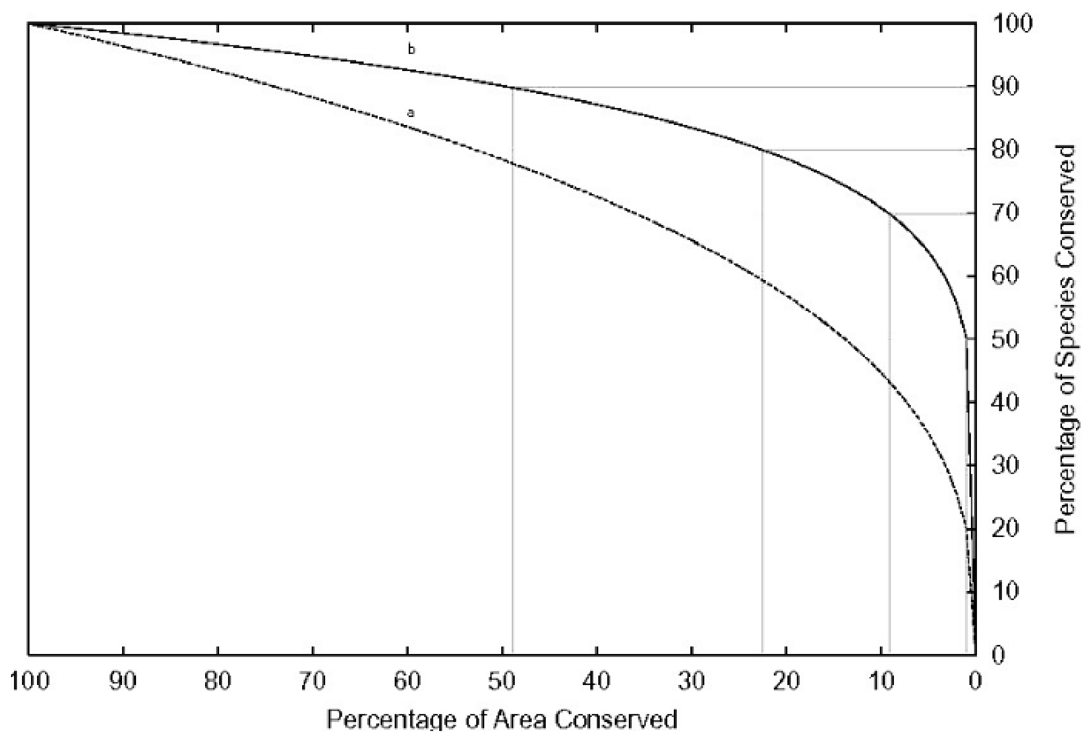



*Figure 7 – Species-Area Curve. WICE, 2011.*

# 5.0 Valuation

## Replacement/Restoration Cost Technique

As previously mentioned in section 4.0:

Option 1: leaving the vale; option 2: clearing Mystic Vale intact –

$C_1/B_1$: is the cost/benefit of option 1
$C_2/B_2$: the cost/benefit of option 2

*Note: The value will be calculated from the proposed sale in 1993 to the present (2012).*

## Leaving Mystic Vale Intact

$C_1$: $10,000/year to silk Hobbs Creek. If done since 2004;

Table 3. Valuation of Silting Hobbs Creek

| Year | Amount ($10k in 2012 discounted at inflationary rate) |
|---|---|
| 2004 | $8,539.60 |
| 2005 | $8,721.12 |
| 2006 | $8,910.89 |
| 2007 | $9,092.41 |
| 2008 | $9,257.43 |
| 2009 | $9,389.44 |
| 2010 | $9,537.95 |
| 2011 | $9,744.22 |
| 2012 | $10,000.00 |
| **TOTAL** | **$83,193.06** |

**$C_1$ =$83,193.06/year**

$B_1$ : Estimating costs using CITYgreen GIS models:

## Carbon Storage and Sequestration

Assuming the average tree age is 101-250:

508 tonnes of carbon stored/hectare (Wilson, 2010)

=508 tC/ha x 4.7 ha

=2,387.6 tC/year in Mystic Vale

Or;

= 2,387.6 tC/year x 19 years

=45,364.4 tC stored in Mystic Vale since 1993

The cost of carbon based on the impacts of climate change is $52 (in 2005) per tonne of carbon (e.g., environmental, economic and social costs) (Wilson, 2010)

Discounted from 1993 to present value, the Net Present Value (NPV) of carbon storage in Mystic Vale is:

**=**$2,387,545.41 (See Appendix E)

Sequestration is valued at $7492/ha per year:

Since 1993:

NPV **=** $674,023.90 (See Appendix F)

Total carbon storage and sequestration:

**NPV = $3,061,569.31 since 1993**

## Air Quality

Wilson's analysis of Greater Vancouver showed that the average forested area on the mainland removes 100 kilograms of pollutants per hectare and the value is $495/ha (2010):

Table 4. Value of Air Pollutant Filtration (Wilson, 2010)

| Pollutant | Value/kg | Kg/ha | Value/ha |
|---|---|---|---|
| Carbon monoxide | $0.94 | 6 | $5.64 |
| Ozone | $6.77 | 33 | $223.31 |
| Nitrogen dioxide | $6.77 | 15 | 101.51 |
| Particulate matter | $4.52 | 31 | 140.06 |
| Sulfur dioxide | $1.65 | 15 | 24.8 |
| **Total** | **$4.95** | **100** | **$495.31** |

Mystic Vale's air pollution filtration is therefore:

=$495.31 x 4.7 ha

=$2,327.96/year

**NPV = $44,555.58 since 1993** (see Appendix G)

### Stormwater Management/Water Quality

The economic value of water regulation by forests is calculated as a replacement value using the CITYgreen software, which has been determined to be:

=$1502/ha per year (Wilson, 2010)

= $1502 x 4.7

=$7,059.40/year

**NPV=$135,128.67 since 1993** (see Appendix H)

Therefore, **part of $B_1$= $3,241,253.56**

However, many values such as erosion control, nutrient cycling, support for migratory species, and intrinsic values of nature are not captured.

In this case, as discussed in Methods, $B_1$ is measured by the cost of the second option, $C_2$.

## Clearing Mystic Vale

**$B_2$**: Unknown. M'Gonigle and Starke (2006) noted that Mystic Vale was slated for a subdivision development, however, the number of properties, and the type of properties are unknown.

**$C_2$:** The full cost of $C_2$ also cannot be accurately estimated because of construction costs. However, two variables are given for $C_2$: the initial property purchase ($2.7 million) + $B_1$ (as this method assumed the proponent is willing to pay a 1:1 ratio for the lost benefit).

So, $2,700,000 + $3,241,253. 56 + X million construction costs
**$C_2$ = $5,941,253.56 + X million**

Therefore;
**$B_1$ = $5,941,253.56 + X million**

Tis would also assume that the proposed buyer would not develop a subdivision at a known loss.

Therefore, the condition of $B_2 \geq C_2$ (the benefit of developing a subdivision is greater than the cost) holds. For this reason, $B_2 \leq B_1$ also holds (the benefit of leaving Mystic Vale intact is greater than what the benefit of the proposed development would have been).

## Travel Cost Method

Assume that out of the 4,000 people/year visit Mystic Vale (M'Gonigle & Starke, 2006), 3500 are off-campus students or people who require transportation to arrive on site. While it was not mentioned how often these people visit Mystic Vale, it can be assumed that a large number of visitors are students and near-by residents. Therefore, assuming 10 visits/year per person would not be a stretch because of the close proximity to the University.

If these 3,500 all paid $2.50 for a bus ticket each time they visited, it would cost $25/year to visit Mystic Vale ($2.50 x 10).

So; 3500 people x $25

=$87,500/year

=**<u>$1,400,000 since 1993</u>**

(Assuming bus tickets cost $1.50 in 1993, and the price increased $.25 every 5 years)

## Hedonic Pricing

In the case of Mystic Vale, it could be noted that the properties directly on the border of the vale are likely worth more than those across the street, without a direct view of the forest. However, no properties were found for sale or for rent around Mystic Vale while researching real estate and rental properties. The companies explored for house sales included Remax, Royal LePage, and Properties in Victoria; and usedvictoria.com, Victoria.kijiji.com, and padmapper.com for rental properties.

However, a comparison was performed between 2 units for rent close to Swan Lake. Both were 1 bedroom top floor units in a house, 600 square feet, and boasted hardwood floors and utilities included. However, 1 unit was directly across Swan Lake while the other was within 1 block. The first unit rented for $925/month; the second for $740/month. This translates to $18.5 sq/ft per year in the first unit, $14.8 sq/ft per year in the second. While the discrepancy in price can be partially attributed to the view, it is uncertain as to how much per square foot this is valued when other factors could have been at play. These include advertisement style, picture quality, friendliness of landlords, yard size, and many others.

Because no properties were found around Mystic Vale, and the information on each unit near Swan Lake was limited in comparison to the information required to perform a regression analysis comparing two properties, using the HP method to calculate Mystic Vale's ecosystem services is too speculative at present time.

## Contingent Valuation

The CV method requires survey responses detailing the WTP for Mystic Vale's ecosystem services. For this reason, a valuation of Mystic Vale ecosystem services using this method will not be performed.

# 6.0 Discussion

## Overview

Some of Mystic Vale's regulating and supporting services were able to be calculated using the values from of a CITYgreen valuation in Greater Vancouver (Wilson, 2010), along with the cultural value of recreation by using bus ticket prices as a baseline. The total benefit of these ecosystem services combining the replacement/restoration cost method and TCM is:

> \$7,341,253.56 ($B_1$=\$5,941,253.56 + TCM value of \$1.4 million) + X million (costs avoided in development) from the time of the proposed sale of Mystic Vale in 1993 to present day (2012).

The relatively minor cost of \$83,193.06 to silt Hobbs Creek pales in comparison to the multimillion dollar price tag a proponent would have had to pay to replace the area's ecosystem services. The monetary benefit derived for a few developers hardly seems worth the loss of cleaner air, water, flood regulation, and recreational enjoyment. The time frame was chosen to show what the University of Victoria and the District of Saanich gained when deciding to enact the right to expropriate Mystic Vale nearly 20 years ago, but more importantly, what could have been lost along with Mystic Vale.

Though an ESV of Mystic Vale would have likely had a higher value if hedonic pricing and contingent valuation were possible, it is better to calculate a baseline value with the given variables rather than to simply assign a value of zero dollars. This estimated value is therefore likely to be a conservative estimate, especially as additional values not been accounted for. As previously mentioned, these include the other cultural values of history and culture, and the greater services of nutrient cycling, erosion control, and the role played in supporting migratory species.

Table 5. Summary of the Valuation of Mystic Vale's Ecosystem Services (does not include $2.7 million cost avoided)

| Ecosystem Service | Value/Year | Total Value Since 1993 |
|---|---|---|
| Carbon Storage | $124,155.20 | $2,387,545.41 |
| Carbon Sequestration | $35,212.40 | $674,023.90 |
| Air Quality Management | $2,327.96 | $44,555.58 |
| Stormwater Management/Water Quality | $7,059.40 | $135,128.67 |
| Recreation | $87,500.00 | $1,400,000.00 |
| **TOTAL** | **$256,254.96** | **$4,641,253.56** |

## Limitations of Ecosystem Valuation

The main limitations of conducting ecosystem services valuation research have been pointed out by many since Robert Costanza first popularized the idea of ecosystem valuation and assigned an $18 trillion value to global ecosystem services (1997). One of the main concerns is the data gap in ecological information. The interactions of species with their biotic and abiotic environments are incomplete and can, at times, be difficult to extrapolate upon (Diaz *et al*., 2007)

Natural capital, and the goods and services it provides, can also have vastly different values depending on the scale of scope of the research question. The carbon storage and sequestration of Mystic Vale is certainly beneficial, but what is the role of this small green space when looking at Vancouver Island overall? British Columbia? All of Canada? This brings to light another issue - it is difficult to assess one section of land when its importance may only become apparent when another area is developed.

Another limitation of ecosystem valuation is that the current monetary estimates are likely an undervaluation (Brown *et al*., 2007; Diaz *et al*., 2007; Wilson, 2010). Because of the incomplete understanding of all benefits provided by nature, values are based on the economic system built around nature and not on the intrinsic value of nature itself. The value of our natural world is also very likely to increase over time as service such as clean water become increasingly scarce due to climate change and demands from a growing population take its toll.

The probability of double counting is also noted. In the case of Mystic Vale, it may be undervalued as only some of the replacement/restoration cost and travel cost method were used; likewise, the vale may have been overvalued if hedonic pricing and/or contingent valuation were thrown into the mix. One of the main crossovers is with hedonic pricing; it accounts not only for scenic beauty, but air quality as well. While air quality valuation was already observed in the replacement/restoration cost method's CITYgreen analysis, hedonic pricing would give another value of perceived improved air quality. The same is true when using the travel cost method if also assessing other cultural services, as one person may visit the site for 2 or more purposes.

Finally, CITYgreen GIS software provides a reasonable estimate of a forest's capability to deliver regulating and supporting services. However, the numbers provided in this report are an estimate. The value of 508 tC/ha is given for coastal forests for trees with an average age of 101-250 years, but others have calculated it to be 423 tC/ha while some are as high as 642 tC/ha (Wilson, 2010). The same variation is true for the calculation of air quality, water quality, and stormwater management.

Also, the average of 101-250 was assumed because of the high number of old trees in Mystic Vale by observation. Yet, the average could very well be lower when accounting for the young big leaf maples, pacific yews, and willow trees.  These values from CITYgreen can be made more accurate in Mystic Vale is a GIS analysis is performed. Even so, based on a thorough literature review and the application of economic valuation methods, I am confident that these estimates are meaningful. The valuation of Mystic Vale's ecosystem services provide an opportunity to assess the current benefits of the vale, and what benefits can be expected in the future.

# 7.0 Conclusion

We are all directly dependent on natural capital for the services that ecosystems provide. Some of these benefits include clean air, clean water, flood control, and the experience of nature. In Mystic Vale's case, those services are worth over $250,000/year or $4.64 million since the establishment of perpetual protection in 1993. This ecosystem service valuation of Mystic Vale not only confirms that the University's and the District of Saanich's decision to expropriate the vale's land was the right one, but also emphasizes the need to ensure effective restoration to improve these services.

The valuation also demonstrates that developing even a small part of a Costal Douglas-fir ecosystem can have a large impact. Furthermore, proposed developments on like-areas should have a similar assessment attached to decision making. These findings can also be helpful to establish priorities to invest in natural capital and to ensure our natural surroundings continue to yield benefits. Hindsight is always 20/20; but luckily many had the foresight to fight and save this small parcel of land. The value of Mystic Vale's ecosystem services shows that it was definitely worth the effort.

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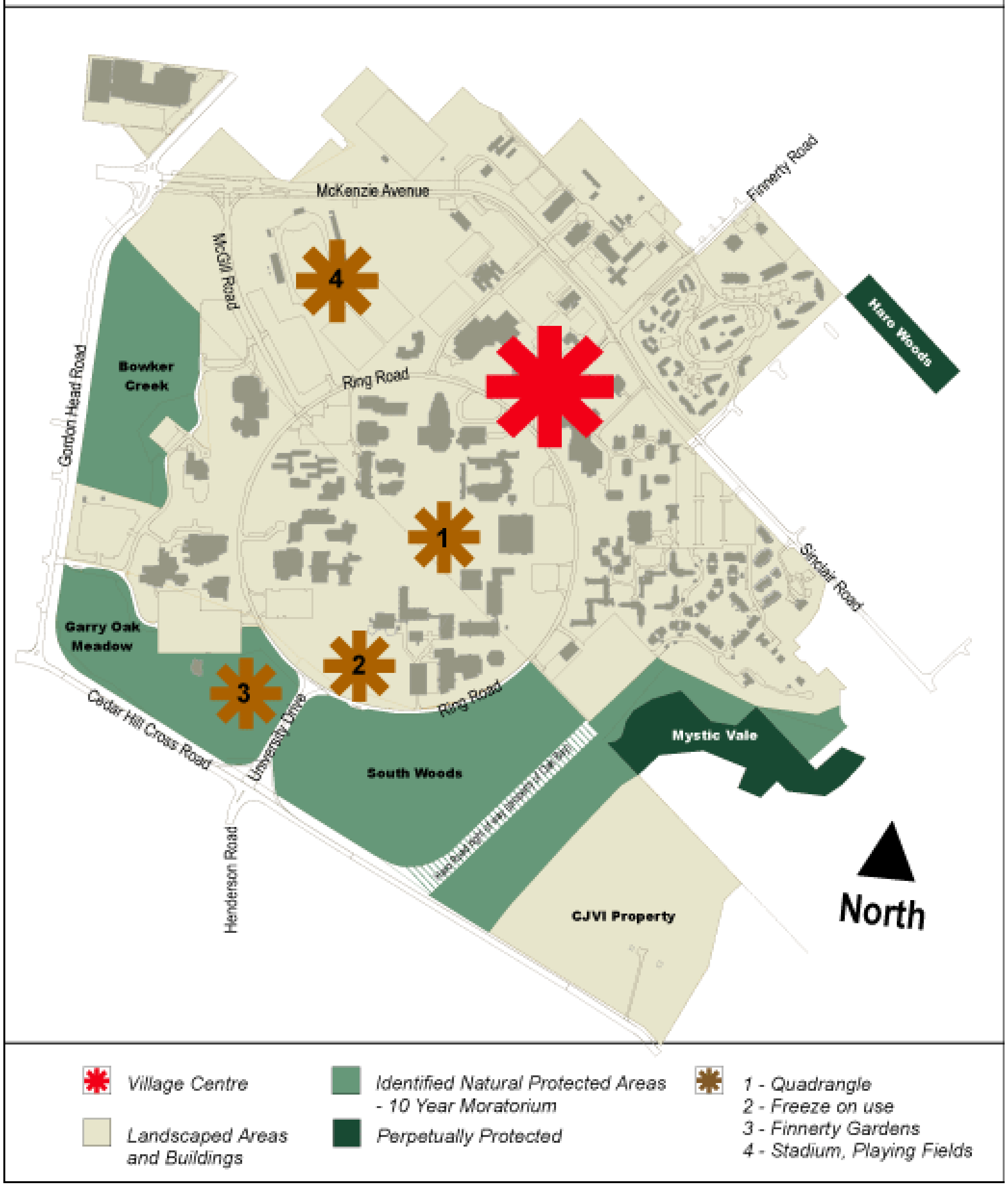
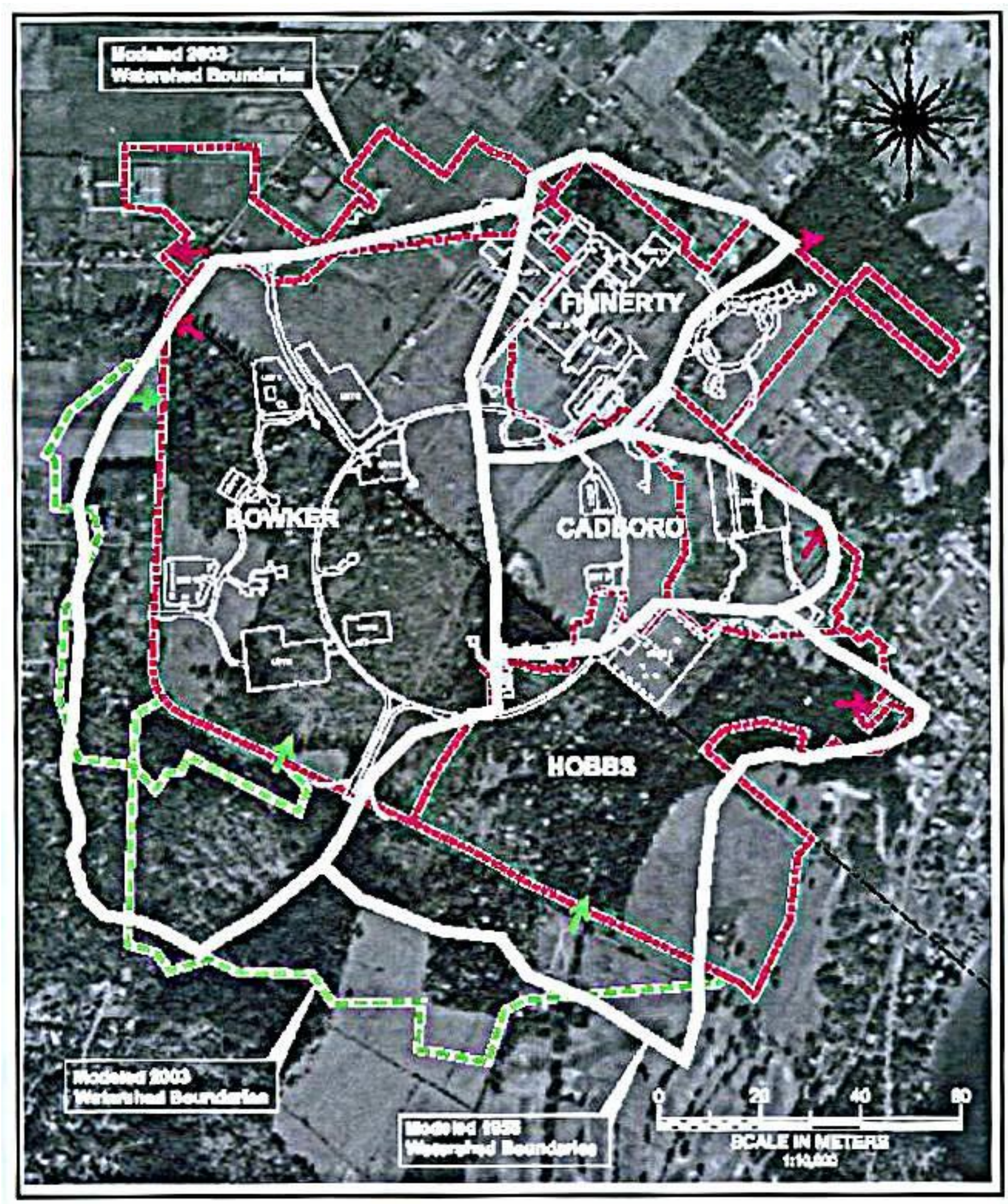
# 9.0 Appendices

## Appendix A: University of Victoria Campus plan of 2003

**Figure 3: Concept Plan**



## Appendix B: University of Victoria's Watershed Boundary Map




Source: Lloyd, 2004.

# Appendix C: Changes in Hydrological Characteristics

**Table 2.5.** Predevelopment To 2003 Changes In Hydrologic Characteristics

| Watershed | Drainage Area (ha) | | % Impervious Area | | Remarks |
|---|---|---|---|---|---|
| | 1956 | 2003 | 1956 | 2003 | |
| Bowker | 92.9 | 100.4 | 1.6 | 51 | Some areas within the campus now drain to Bowker Creek |
| Hobbs | 50.7 | 66.8 | 0 | 31 | Areas south of Cedar Hill Cross Road now drain to Hobbs |
| Finnerty | 21.8 | 20.6 | 48 | 61 | Little change |
| Cadboro | 21.9 | 9.1 | 0 | 55 | Loss of drainage area to Bowker Creek |

The hydrologic effects of the change in drainage areas and the increase in impervious areas on runoff rates and volumes are illustrated in the bar graphs (Figure 2.6) for each watershed. The Hydrologic Summary Table 2.2 presents the numeric values of runoff volumes and flow rates. Comparisons of the runoff hydrographs are provided in Appendix B.

Source: Lloyd, 2004.

## Appendix D: List of Native Plants in Mystic Vale

**NATIVE PLANTS OF MYSTIC VALE, SAANICH, BRITISH COLUMBIA**
Nancy J. Turner and Brett Heneke January 20, 1993 (updated Environmental Studies Program March, 1993). From Harrop-Archibald, 2008.
University of Victoria

**TREES**
Grand fir (*Abies grandis* )
Broadleaf maple (*Acer macrophyllum* )
Red alder (*Alnus rubra* )
Arbutus (*Arbutus menziesii* )
Black cottonwood (*Populus balsamifera* ssp. *trichocarpa* )
Bitter cherry (*Prunus emarginata* )
Douglas-fir (*Pseudotsuga menziesii* )
Cascara (*Rhamnus purshiana* )
Hooker's willow (*Salix hookeriana* )
Scouler's willow (*Salix scouleriana* )
Sitka willow (*Salix sitchensis* )
Western red-cedar (*Thuja plicata* )
Pacific yew (*Taxus brevifolia* )

**SHRUBS**
Saskatoon berry (*Amelanchier alnifolia* )
Red-osier dogwood (*Cornus stolonifera ;* syn. *Cornus sericea*)
Salal (*Gaultheria shallon* )
Oceanspray (*Holodiscus discolor* )
Orange-flowered honeysuckle (*Lonicera ciliosa* )
Hairy honeysuckle (*Lonicera hispidula* )
Tall Oregon-grape (*Mahonia aquifolium;* syn. *Berberis aquifolium* )
Common Oregon-grape (*Mahonia nervosa ;* syn. *Berberis nervosa*)
Indian-plum (*Oemleria cerasiformis* )
False box (*Pachistima myrsinites* )
Mock-orange (*Philadelphus lewisii* )
stink currant (*Ribes bracteosum* )
black gooseberry (*Ribes divaricatum* )
Red-flowering currant (*Ribes sanguineum* )
Dwarf wild rose (*Rosa gymnocarpa* )
Nootka rose (*Rosa nutkana* )
Thimbleberry (*Rubus parviflorus* )
Salmonberry (*Rubus spectabilis* )
Trailing wild blackberry (*Rubus ursinus* )
Red elderberry (*Sambucus racemosa* )
Snowberry, or waxberry (*Symphoricarpos albus* )

Red huckleberry (*Vaccinium parvifolium* )

**HERBCEOUS FLOWERING PLANTS**
Vanilla-leaf (*Achyls triphylla* )
Sedge (*Carex* spp.)
Coralroot (*Corallorhiza maculata* )
Sweet-scented bedstraw (*Galium triflorum* )
Large-leaved avens (*Geum macrophyllum* )
Rattlesnake plantain orchid (*Goodyera oblongifolia* )
#Purple pea (*Lathyrus nevadensis* )
Twinflower (*Linnaea borealis* )
Wood-rush (*Luzula* sp.)
Skunk-cabbage (*Lysichitum americanum* )
Indian pipe (*Monotropa uniflora* )
#Siberian miner's-lettuce (*Montia sibirca* )
Nemophila (*Nemophila parviflora* )
Water-parsley (*Oenanthe sarmentosa* )
#Sweet cicely (*Osmorhiza ? purpurea* )
Sanicle (*Sanicula crassicaulis* )
Yerba buena (*Satureja douglasii* )
#False Solomon's-seal (*Smilacina racemosa* )
Hedge-nettle (*Stachys cooleyae* )
#Common twisted-stalk (*Streptopus amplexifolius* )
Tall fringecup (*Tellima grandiflora* )
Fringecup (*Tiarella trifoliata* )
Starflower (*Trientalis latifolia* )
Western trillium (*Trillium ovatum* )
Stinging nettle (*Urtica dioica* )
(NOTE: a number of grass species were also observed, but not identified)
# additional species from May, 1993

**FERNS AND FERN-ALLIES**
Lady fern (*Athyrium filix-femina* )
Spiny wood fern (*Dryopteris expansa* )
Common horsetail (*Equisetum arvense* )
Branchless horsetail (*Equisetum hiemale* )
Giant horsetail (*Equisetum telmateia* )
Licorice fern (*Polypodium glycyrrhiza* )
Sword fern (*Polystichum munitum* )
Bracken fern (*Pteridium aquilinum* )

**SOME MOSSES AND LIVERWORTS**
(NOTE: This list is very incomplete, representing only a fraction of the species occurring in the Vale)
Antitrichia moss (*Antitrichia curtipendula* )
Fork moss (*Dicranum scoparium* )

Hypnum moss(*Hypnum circinale* )
Stolon moss (*Isothecium myosuroides* ; syn. *I. stoloniferum* , *I. spiculiferum* )
Oregon feather moss (*Kindbergia oregana* ; syn. *Eurhynchium oreganum* )
Feather moss (*Kindbergia praelonga*; syn. *Eurhynchium praelongum* )
Palm-tree moss (*Leucopelis menziesii* )
Douglas neckera moss (*Neckera douglasii* )
Neckera moss (*Metaneckera menziesii*)
Mnium moss(*Plagiomnium insigne* )
Plagiothecium moss (*Plagiothecium undulatum* )
Leafy liverwort (*Porella navicularis* )
Mnium moss(*Rhizomnium glabrescens* )
Feather moss (*Rhytidiadelphus loreus* )
Triangle-leaved feather moss (*Rhytidiadelphus triquetrus* )
Leafy liverwort (*Scapania bolanderi* )

## Appendix E: Calculating Mystic Vale's Carbon Storage Value

| Year | Price per tC | Carbon stored/year | Total |
|---|---|---|---|
| 1993 | $40.77 | 2,387.60 | $97,342.45 |
| 1994 | $41.60 | 2,387.60 | $99,324.16 |
| 1995 | $42.46 | 2,387.60 | $101,377.50 |
| 1996 | $43.33 | 2,387.60 | $103,454.71 |
| 1997 | $44.21 | 2,387.60 | $105,555.80 |
| 1998 | $45.12 | 2,387.60 | $107,728.51 |
| 1999 | $46.04 | 2,387.60 | $109,925.10 |
| 2000 | $46.99 | 2,387.60 | $112,193.32 |
| 2001 | $47.95 | 2,387.60 | $114,485.42 |
| 2002 | $48.93 | 2,387.60 | $116,825.27 |
| 2003 | $49.93 | 2,387.60 | $119,212.87 |
| 2004 | $50.96 | 2,387.60 | $121,672.10 |
| 2005 | $52.00 | 2,387.60 | $124,155.20 |
| 2006 | $53.07 | 2,387.60 | $126,709.93 |
| 2007 | $54.15 | 2,387.60 | $129,288.54 |
| 2008 | $55.26 | 2,387.60 | $131,938.78 |
| 2009 | $56.39 | 2,387.60 | $134,636.76 |
| 2010 | $57.55 | 2,387.60 | $137,406.38 |
| 2011 | $58.73 | 2,387.60 | $140,223.75 |
| 2012 | $59.93 | 2,387.60 | $143,088.87 |

**TOTAL VALUE: $2,376,545.41**

Interest rate: 1.02048317
(2.05% annual)
Calculated using:

$$i = \left(\frac{FV}{PV}\right)^{\frac{1}{n}} - 1$$

with PV: $52; FV: $59.93
(Bank of Canada, 2012)

# Appendix F: Calculating Mystic Vale's Carbon Sequestration Value

| Year | $ Carbon Sequestration/ha | Hectares in Mystic Vale | Total |
|---|---|---|---|
| 1993 | $5,873.91 | 4.7 | $27,607.38 |
| 1994 | $5,994.23 | 4.7 | $28,172.88 |
| 1995 | $6,117.01 | 4.7 | $28,749.95 |
| 1996 | $6,242.31 | 4.7 | $29,338.86 |
| 1997 | $6,370.17 | 4.7 | $29,939.80 |
| 1998 | $6,500.65 | 4.7 | $30,553.06 |
| 1999 | $6,633.80 | 4.7 | $31,178.86 |
| 2000 | $6,769.69 | 4.7 | $31,817.54 |
| 2001 | $6,908.35 | 4.7 | $32,469.25 |
| 2002 | $7,049.86 | 4.7 | $33,134.34 |
| 2003 | $7,194.26 | 4.7 | $33,813.02 |
| 2004 | $7,341.62 | 4.7 | $34,505.61 |
| 2005 | $7,492.00 | 4.7 | $35,212.40 |
| 2006 | $7,645.46 | 4.7 | $35,933.66 |
| 2007 | $7,802.06 | 4.7 | $36,669.68 |
| 2008 | $7,961.87 | 4.7 | $37,420.79 |
| 2009 | $8,124.96 | 4.7 | $38,187.31 |
| 2010 | $8,291.38 | 4.7 | $38,969.49 |
| 2011 | $8,461.22 | 4.7 | $39,767.73 |
| 2012 | $8,634.53 | 4.7 | $40,582.29 |

**TOTAL VALUE:** **$674,023.90**

Interest rate: 1.02048
(2.05% annual)
Calculated using:

$$i = \left(\frac{FV}{PV}\right)^{\frac{1}{n}} - 1$$

PV: $7,492.00
FV: $8,634.53
(Bank of Canada, 2012)

## Appendix G: Calculating Mystic Vale's Air Pollution Filtration Value

| Year | Air Filtration Value/year | Hectares | Total |
|---|---|---|---|
| 1993 | $388.29 | 4.7 | $1,824.96 |
| 1994 | $396.24 | 4.7 | $1,862.33 |
| 1995 | $404.36 | 4.7 | $1,900.49 |
| 1996 | $412.64 | 4.7 | $1,939.41 |
| 1997 | $421.09 | 4.7 | $1,979.12 |
| 1998 | $429.72 | 4.7 | $2,019.68 |
| 1999 | $438.52 | 4.7 | $2,061.04 |
| 2000 | $447.50 | 4.7 | $2,103.25 |
| 2001 | $456.67 | 4.7 | $2,146.35 |
| 2002 | $466.02 | 4.7 | $2,190.29 |
| 2003 | $475.57 | 4.7 | $2,235.18 |
| 2004 | $485.31 | 4.7 | $2,280.96 |
| 2005 | $495.25 | 4.7 | $2,327.68 |
| 2006 | $505.39 | 4.7 | $2,375.33 |
| 2007 | $515.75 | 4.7 | $2,424.03 |
| 2008 | $526.31 | 4.7 | $2,473.66 |
| 2009 | $537.09 | 4.7 | $2,524.32 |
| 2010 | $548.09 | 4.7 | $2,576.02 |
| 2011 | $559.32 | 4.7 | $2,628.80 |
| 2012 | $570.78 | 4.7 | $2,682.67 |

**TOTAL VALUE:** **$44,555.58**

Interest rate: 1.0205
(2.05% annual)
Calculated using:

$$i = \left(\frac{FV}{PV}\right)^{\frac{1}{n}} - 1$$

PV: $495.25
FV: $570.78
(Bank of Canada, 2012)

## Appendix H: Calculating Mystic Vale's Storm Water Management/Water Quality Value

| Year | Storm water value/year | Hectares | Total |
|---|---|---|---|
| 1993 | $1,177.61 | 4.7 | $5,534.77 |
| 1994 | $1,201.73 | 4.7 | $5,648.13 |
| 1995 | $1,226.34 | 4.7 | $5,763.80 |
| 1996 | $1,251.46 | 4.7 | $5,881.86 |
| 1997 | $1,277.09 | 4.7 | $6,002.32 |
| 1998 | $1,303.25 | 4.7 | $6,125.28 |
| 1999 | $1,329.95 | 4.7 | $6,250.77 |
| 2000 | $1,357.19 | 4.7 | $6,378.79 |
| 2001 | $1,384.99 | 4.7 | $6,509.45 |
| 2002 | $1,413.36 | 4.7 | $6,642.79 |
| 2003 | $1,442.31 | 4.7 | $6,778.86 |
| 2004 | $1,471.85 | 4.7 | $6,917.70 |
| 2005 | $1,502.00 | 4.7 | $7,059.40 |
| 2006 | $1,532.77 | 4.7 | $7,204.02 |
| 2007 | $1,564.16 | 4.7 | $7,351.55 |
| 2008 | $1,596.20 | 4.7 | $7,502.14 |
| 2009 | $1,628.90 | 4.7 | $7,655.83 |
| 2010 | $1,662.26 | 4.7 | $7,812.62 |
| 2011 | $1,696.31 | 4.7 | $7,972.66 |
| 2012 | $1,731.05 | 4.7 | $8,135.94 |

Interest rate: 1.0205
(2.05% annual)
Calculated using:

$$i = \left(\frac{FV}{PV}\right)^{\frac{1}{n}} - 1$$

PV: $1,502.00
FV: $1,731.05
(Bank of Canada, 2012)

**TOTAL VALUE:** **$135,128.67**