Urban Ecological Landscape Design– A Case Study for a Novel Design Process in Burnaby, BC

Kristina Zalite
March 2015

ER390 Final Project
Restoration of Natural System
School of Environmental Studies
University of Victoria, British Columbia

"It is not a choice of either the city or the countryside; both are essential, but today it is nature, beleaguered in the country, too scarce in the city which has become precious" (McHarg, 1992, p.5).

"It is important to recognize that when we make a plan for a piece of land, or even when we alter it in seemingly minor ways – like landscaping a backyard, for example – we are designing an ecosystem." (Lyle, 1985. P.3).

"The ecological view requires that we look upon the world, listen and learn. The place, creatures and men were, have been, are now and are in the process of becoming. We and they are here now, co-tenants of the phenomenal world, unit in its origins and destiny" (McHarg, 1992. P.29).

Table of Contents

List of Figures

List of Tables

Appendix

INTRODUCTION

Abstract

Urban ecological restoration is a discipline that shares a knowledge base with landscape architecture. This project carefully studies the crossover between the design processes of landscape architecture and restoration ecology, with the aim to find where there can be increased sharing of ecological information that may be useful to the landscape design process.

This project is a case study for a landscape design process in an urban setting. The case study follows a design exercise through a number of stages in ecological restoration, with the final outcome of an exemplary urban design for ecological function. This project may contribute to the fields of landscape architecture and ecological restoration by contributing toward the development of a new *system or process* for ecologically-functioning urban landscape design. At minimum, this work can offer a number of criteria that may be added to the landscape architecture design process for increased ecological success.

Background

I was initially trained at the University of British Columbia in the Studio Fine Arts program as a visual artist, where I learned a design process for drawing, sculpture, and a variety of different printmaking graphics. My final years included a wondrous discovery of eco-revelatory art, which steered me towards a study of landscape architecture at the University of Guelph. There, I learned a design process by which to create a novel landscape.

The landscape architecture that I learned incorporated ecology into its practice. Outside of academia, however, there can be a paradox between the urban built environments and ecological functioning systems, where urban environments are often shaped by economic goals rather than environmental or social (Hough, 1984). In urban settings there is a requirement for the landscape to be extremely multi-functional. Urban environments must often meet economic, ecological, and social objectives. To that end, healthy ecological function of urban settings is often suppressed to increase the economic and social functioning of a site. This paradox has led me towards a study of restoration of natural systems, and to inquire if the design process of ecological restoration has any additional information that can improve a standard design process in landscape architecture.

In the Sustainable Sites Initiative, an initiative in part by the American Society of Landscape Architects, the word sustainability is defined as the “design, construction, operations, and maintenance practices that meet the needs of the present without compromising the ability of the future generations to meet their own needs” (8, 2009). Harkening to the Brundtland Report’s definition, the Sustainable Sites Initiative has pinpointed four specific parts of the landscape architecture discipline that can work towards sustainability. These four areas are construction material, operations, maintenance method, and design process. While great strides have taken place in improving the first three areas of, the design process has been largely ignored from critique. This case study looks toward the design process as an area for improving sustainability.

Methodology

The methodology for this project begins with a review of literature about the landscape architectural design process, including texts that support landscape design with ecology in mind. Following the initial literature review there is a case study design exercise, outlining each step towards urban design. The third step in the methodology includes a review of ecological restoration literature about restoration design process, and a review of restoration literature that may inform this specific case study. The final step is applying the ecological restoration literature to the case study, essentially refining the urban design process through the lens of restoration ecology. The two design processes are essentially amalgamated in what could become an ameliorated ecological urban design process. The results of the project highlight the implementation process, the limitations of the project, and some final recommendations. The final summary aims to answer the question, “Is there a novel process for urban ecological design”?

THE DESIGN PROCESS OF LANDSCAPE ARCHITECTURE: Literature Review I

Landscape architecture is a widely encompassing field of work and study, covering topics such as engineering, psychology, biology, fine art, geography, zoology, history and more. To navigate through these topics while creating a responsive site design, the discipline of landscape architecture has created a design process. The overall goal of the process is to determine the best use of the land, and to show the land spatially so that a client can understand the intended use (Booth, 283).

The design process is systematized and linear, similar to the scientific hypothesis method for rigorous problem solving. The design process is universally taught and followed by landscape architects and designers, with some variation that will become evident throughout this literature review. Classic texts such as Basic Elements of Landscape Architectural Design (Booth, 1983), Cities and Natural Process, Towards a New Urban Vernacular (Hough, 1994), Design with Nature (McHarg, 1992), Introduction to Landscape Design (Motloch, 1991), People Places: Design Guidelines for Urban Open Space (Cooper Marcus, 1998), as well as newly interpreted landscape architecture guides such as Sustainable Landscape Construction (Thompson and Sorvig, 2008) and the Sustainable Sites Initiative (ASLA, 2009) all accept the same landscape architecture design process.

There are key steps that can be followed to sequence through a design exercise, with the obvious goal of building of a newly improved outdoor space. Sometimes a process will be categorized into six or seven or eight steps, and sometimes they contain feedback loops where steps are repeated, while sometimes the process does not seem altogether linear. However, it is widely accepted in classic and newly interpreted landscape architecture texts that there are sequential steps that allow the designer to proceed categorically from the initial design challenge through to final design and implementation. These steps are outlined in Table 1.0.

Design Steps	**Components**
Design Challenge	Client Interview
Site Inventory & Analysis	Prepare base plan
	Site inventory
	Site analysis
	Determine program requirements, and list of opportunities and constraints
Design	Diagramming to show functional relationships
	Incorporate Conceptual Design Principles
	Conceptual/Schematic plan
	Final Design: Master plan
Construction Drawings	Layout plan, grading plan, planting plan, detail drawings
	Specifications and/or maintenance plan
Implementation	Building stage

	Post construction evaluation
	Maintenance
	As-built drawing set

Table 1.0 Design Process in Landscape Architecture

The design steps, in brief, seek to (1) understand the design goal, or challenge, or problem to be solved, (2) analyze the site and it's context, (3) move from conceptual and functional design to a final design idea (4) produce construction drawings, and (5) implement the design. With each step the designer moves closer to being able to realize the building of a new outdoor environment. Within each step there are components, or detailed steps, to complete the problem-solving process.

(1) Design Challenge

At the outset of a design project, one starts by understanding the goal that is being sought. The goal is most often driven by the client, who may be a private homeowner, a representative for a corporation, or an architect who has subcontracted a landscape design. Often there is a client meeting where the problem, the budget, the maintenance requirements, and desired outcomes are explained.

Many landscape architecture texts also explain that a deep understanding of landscape processes should be established prior to conducting a design process. These texts often describe characteristics of water, climate, landforms, and plant materials to be considered (Booth, Hough, Lyle, Marsh). Some texts also go further to instill an environmental ethic that should be intrinsic to any design project, which can be achieved if ecosystems are to be protected and/or regenerated (ASLA, McHarg, Thompson and Sorvig).

(2) Site Inventory and Analysis

Early in the design process, the site must be rigorously inventoried. This is potentially the most critical step in the design process, when biophysical information is gathered from a wide variety of sources. The information gathered should be scientific as well as qualitative. In his seminal textbook from 1983, Norman Booth lists key information to be gathered. Booth's list is summarized in Table 2 below.

Site Inventory	**Items**
Legal information	Property lines
	Easements
	Private holdings
	Zoning ordinances, Local policy
Utilities	Underground sanitary & stormwater pipes
	Underground & overhead power lines
	Power poles

Climate & microclimate	Precipitation & humidity
	Temperature
	Slope, aspect, & orientation
	Wind patterns
Geographic features	Topography with contour lines
	Landforms
	Soils
	Geology
	Water bodies
Vegetation	Hedgerows, woodlands, savannah, wetland species, farmland species
Wildlife	Mammals, birds, amphibians, etc.
Cultural features	Buildings, structures, foundations, exterior lights, hose bibs
	Circulation, roads, bridges, pathways, walls, fences, parking
	Archaeology, heritage & historical items
	Future cultural uses
Off-site elements	(to include all of the above)
Other	Smells, sounds, spatial patterns, lines, forms, textures, colors, scales.

Table 2.0 Site Inventory Items in Landscape Design Process

John Lyle describes two types of site-specific inventory that are known to landscape architects (1985). Lyle calls these the Gestalt Inventory, which is used on small sites to identify the character across the whole landscape; and the Short-term Inventory, which inventories specific details of the site [such as in Table 2.0]. A designer is likely to use both of these inventory systems to understand micro and macro site characteristics.

Many British Columbia landscape architects will be familiar with the Ministry of Environment's Develop with Care manual, which includes a long list of items to identify in a site inventory. Although the manual was developed to assist in large-scale site design, the inventory is an up-to-date list of inventory values. The list includes items such as species-at-risk, areas with potential for wildlife conflicts, areas where there is First Nation's interests, and any other local inventories of species and ecosystems such as Traditional Ecological Knowledge (2-13, MOE, 2006).

Accurate analysis of these inventory items is important. "Analysis of the site may reveal other reasons for protecting certain features, for example, a common and one-too-beautiful tree may need to be protected because it acts as a windbreak or moderates solar gain" (42, Thompson and Sorvig). Landscape architecture offers a few different methods of analysis, which are all complimentary.

The most common method of analysis is the ranking system developed by Ian McHarg as described in his book, Design With Nature (1992). The ranking of various processes and factors is shown on maps, which are layered to create a composite map. These layered maps are called overlays. McHarg then describes how physical, biological, and social processes can be represented as values that are to be ranked using the composite maps (108, 1992). Once ranked, the values are chosen for their optimal land use, some of which fall into the categories of passive recreation, active recreation, residential, commercial-industrial (113). An example of McHarg's mapping system are displayed in Figure 1.

Marsh echoes this method of assessment when he recommends categorizing the landscape features in flow-systems that occupy different levels or strata of space. The landscape flow systems can be above, below, or at the surface level (62, Marsh). For example, the flow system can include a connective tree canopy, subterranean soils, and presence of wildlife movement patterns. An example of Marsh's flow systems is displayed in Figure 2.

To finish an analysis, the designer may create a programmatic list, which can be as general as a list of required elements for the final design, or can be as detailed as square footage requirements for open space. Or a designer may create a written strategy for the design, with specific objectives that are to be met through the design process. In Michael Hough's seminal book, City Form and Natural Processes, he provides a list of strategies that landscape architects should include in their urban design projects (1984). Hough advises landscape architect's to (a) bring the landscape back to productive use (for example, to design for nutrient cycles, wildlife habitats, urban farms, recreation amenities) and to (b) increase biological and social diversity (for example, to integrate recreational amenities with conservation and environmental options).

At this point, the objectives and program requirements are contextualized to a site by creating a list of project-specific opportunities and constraints. This list helps the designer to set a balanced framework for decision-making during the design process. For example, a client's budget may be an opportunity or a constraint that will influence the upcoming steps in the design. Similar to McHarg's ranking system, a list of opportunities and constraints will help to identify uses that are more suitable for the site or for specific areas of a site. In a work setting, this list is often not documented other than lodged in the designer's mental database.

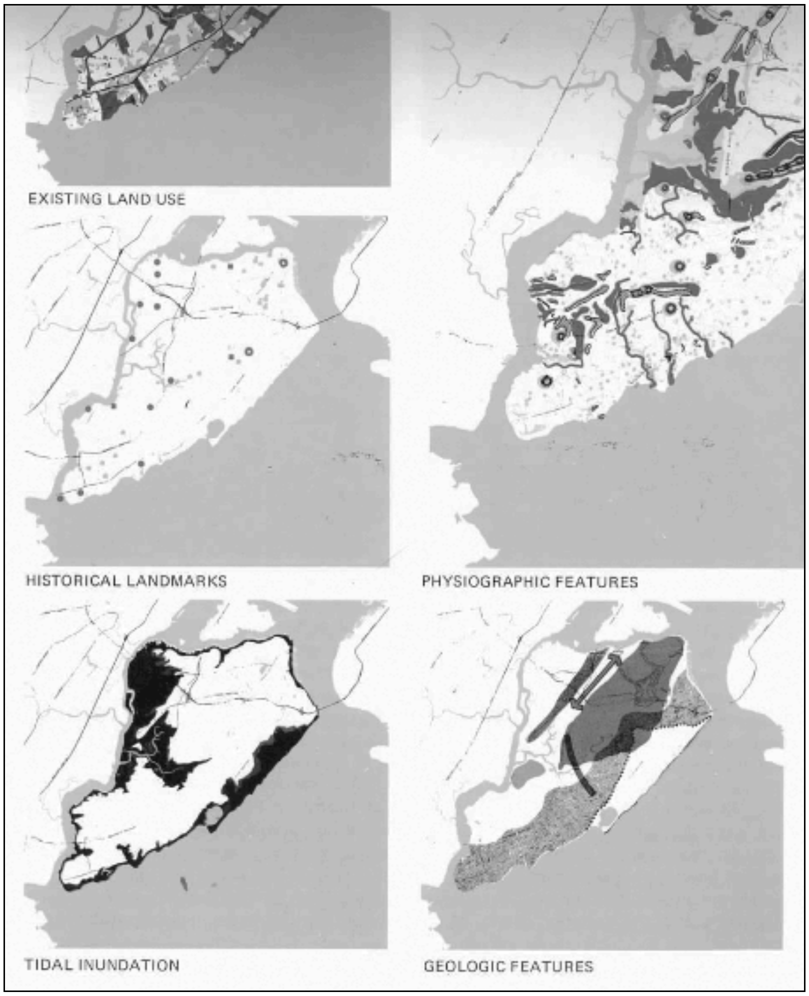


Figure 1.0 Example of Ian McHarg Overlay Mapping

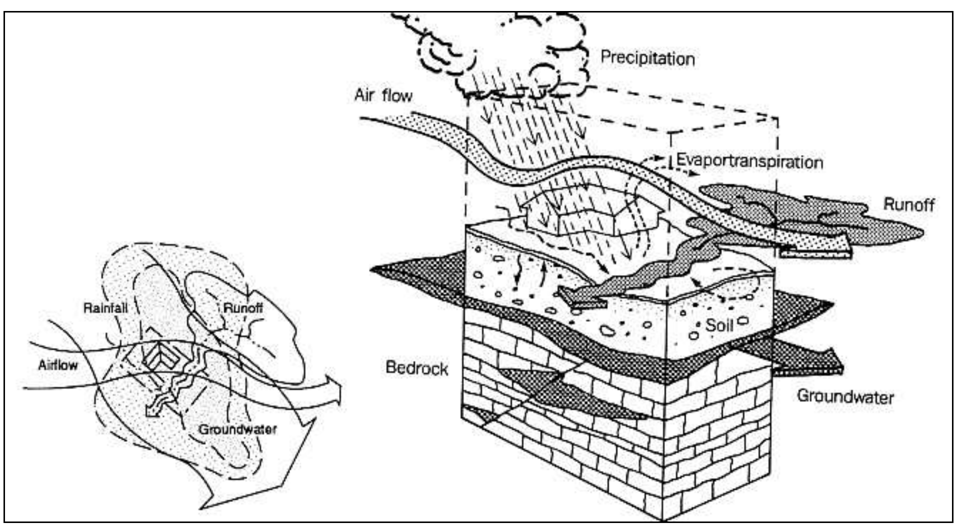


Figure 2.0 Example Of Several Important Flow Systems

(3) Design Stages

Functional Design

The functional design stage is a synthesis of the site analysis with the project goals. This is the step where relationships are sought between similar functions, or where separation is distinguished between dissimilar functions. It is at this step where circulation routes are drawn, and spaces are identified for future uses. In an academic setting, this stage is clearly defined and demonstrated through the use of functional diagrams. In a work setting, this stage is blended into a site analysis and/or a conceptual diagram. Often, in a work setting, all of the steps up to this point can go unrecorded and simply exist as a bank of knowledge that the designer maintains in their memory. A designer may only start recording on paper at the fourth step, the Concept Design.

Conceptual Design

A conceptual design is the beginning stage of a complete landscape design, and can only be produced by making many loose, rough, sketch diagrams. It is at this step that different uses for the site are given dimension so that they can be located accurately.

Another significant part of this step in the design process is the incorporation of design principles into the design. Design principles guide how a space is organized. Some examples of design principles are listed in Table 3.0 below. The precise moment in the design process when design principles are examined is not distinct. The principles can enter the process at the beginning of the design, when the design challenge is established, but they certainly become more defined as the site analysis is complete, and as the conceptual diagramming unfolds.

Design Principles	Line	Form	Shape	Heirarchy
	Texture	Composition	Colour	Structure
	Weight	Harmony	Network	Juxtaposition
	Balance	Size	Metaphor	Diversity
	Education	Process		

Table 3.0 Landscape Architecture Design Principles

The preference for certain design principles can be attributed to the particular site, such as when there is an historical event that occurred on the site that can be referenced in the new design. Or the principles may be driven by a certain trend, such as the popular ‘West Coast Design’ which is known for it’s strong, clean, horizontally-balanced lines and choices of natural materials. Design principles tend to follow a designer’s personal preference and can indicate where the emotional attachment lies between the designer and the project. For example, some designers have a strong preference for principles of modernity, such as order, symmetry, and axis. Likewise, an influential client can steer a designer towards or away from specific principles.

Some designers have a strong preference for principles of ecology, and will therefore employ principles of network, structure, and composition. In City Form and Natural Processes, Hough reminds the designer to be conscious of the effects of human activity on the original landscape, and provides a series of principles that can aid the designer in bringing landscapes back to health. These principles include: process, change, efficiency, diversity, and integration (25, 1984). Of these principles, efficiency can be a guiding principle throughout the design process. In this case, the designer may wish to assert the goal of creating a closed-loop energy system in order to make the overall design more energy-efficient. Ecological design principles could also include natural succession or structural composition, for example. At this point in the overall process, the designer may look towards the site as having a “landscape personality”, where local knowledge about the site can create an overall distinctiveness (Nov 21, 2000 class notes). The final outcome of the conceptual design stage is a conceptual design showing the relationship between all elements in the design.

Final Design

When a final concept design is drawn, it can be developed to show material selection, site furnishings, and final dimension. This is called the Final Design, Schematic Design, or Master Plan. This plan has detailed content and graphic representation, showing form and composition based on the design principles. In the work setting, this plan is prepared for the client for their final review.

(4) Construction Drawings

When a Master Plan is complete, a set of construction drawings is created so that a contractor can build the site as the designer intends. Depending on the level of detail required, the construction drawings set will include a site preparation plan, a layout and dimension plan, a grading plan, a planting plan, and a details plan. The site preparation plan can ensure a healthy site by containing key information about how to avoid survey damage, how to minimize utility damage, how to physically protect the site during construction, how to preserve healthy topsoil, how to protect trees, and where to locate machinery and vehicles during construction (Thompson and Sorvig). The site preparation plan is often a component of a Civil Engineer’s Environmental Servicing & Construction Plan. The entire drawing set can act as a guideline that will initiate an ecologically responsive construction site. “It has now been more than thirty-five years since landscape architect Ian McHarg published his epochal book, Design with Nature. Since that time many books have dealt with ecological assessment, planning, and design. But even if these planning and design principles are sensitively followed, inappropriate construction methods and materials can still lead to unnecessary environmental destruction” (Thompson and Sorvig). In other words, a drawing set must demonstrate how to construct a site to avoid environmental destruction.

Legally, a construction contractor and all the subcontractors are obligated to follow the Specifications of a project. The Specifications are a document that describes the level of construction quality, including levels of environmental protection and ecologically responsive material and construction methods. The Specifications may also include a maintenance plan to describe how the landscape should be managed as time progresses. The maintenance plan can outline long-term and short-term goals for sustainable landscape care. The BCLNA provides a chapter on Landscape Maintenance, outlining the trade standard for six levels of maintenance. The most appropriate level of maintenance for naturalized or restored areas is Level 5 Background & Natural Areas, which has the objective to "preserve habitat and ecosystem functioning while accommodating low intensity activities". BCLNA recommends creating unique site maintenance programs which may include inspection forms, program summaries, and monthly reports (pp. 166-168, 2008). BCLNA also recommends procedures and frequencies for each of the levels of maintenance. Figure 3 shows Level 5 procedures.

BC Landscape Standard • Seventh Edition — 14 - Landscape Maintenance

Table 14-19: Recommended Maintenance Procedures & Frequencies - Level 5 Background & Natural Areas

Maintenance Level 5 - Background & Natural Areas													
Procedure	**Schedule (Month)**												**Frequency**
	J	F	M	A	M	J	J	A	S	O	N	D	
General:													
Inspection				/			/			/			3 times per year
Litter Removal													As required
Reporting				/			/			/			3 times per year
Invasive plant eradication and control					/								Annual
Repair													As required
Tree hazard assessment and abatement													Every five years or when reported
Fire management				••	••	••	••	••	••				To reduce the risk of ignition
Pest control													To prevent loss of rare, endangered, and threatened ecosystem or plant community.
Native tree and shrub planting													As compensation for invasive plant removal or hazard tree removal
	J	F	M	A	M	J	J	A	S	O	N	D	

/ indicates required maintenance procedures • indicates maintenance procedures to be done if necessary

Figure 3.0 BCLNA's Recommended Maintenance Procedures & Frequencies – Level 5 Background and Natural Areas.

Depending on local Bylaws, the construction drawings are issued to the municipality in the form of Development Permit drawings and Building Permit drawings. Once permitting is issued, the drawings go to tender for bidders to complete the construction. Once tendered, a complete set of construction drawings is printed for the installing landscape contractor to conduct the construction.

(5) Implementation

After construction and occupancy, an evaluation may be conducted to determine how the site functions over time. Clare Cooper-Marcus has outlined a few different methods for landscape architect's to conduct a post-occupancy evaluation in her book, People Places: Design Guidelines for Urban Open Spaces (1998). The essential features of the post-occupancy evaluation are the evaluation of the design objectives, a drawing or map of the site, and description of how the site has changed over time. A more detailed evaluation can include a Participant Observation report, which assesses how people are using a site, and their level of satisfaction in different areas of the site. Sometimes the observations will extend to interviews before creating a final written report.

Outside of the academic world, site evaluation will fall within the scope of a Substantial Review, Final Review, and an Occupancy Review, conducted at time of substantial completion, final completion, and after 1 year of completed construction, respectively. The content of these reviews is at the discretion of the landscape architect, and will go to the owner for their discretionary response and follow-up. The Substantial Review will usually go to the Municipality for their information. Finally, if the client requests, a set of completed As-Built drawings is provided with marked up changes that have taken place during construction. These drawings will become necessary for any future construction on the same site.

CASE STUDY

(1) Criteria

The criteria used to select a site for this case study falls into three areas – scale, suitability, and contribution. Landscape architects often work on a regional or neighbourhood scale. This project, however, looks at one legal boundary to keep a straightforward decision-making process. With fewer stakeholders involved in the design, the process is likely to be quicker and more efficient. With varying ecological and legal boundaries, the case study location lies at the paradox of urban ecological design, and as such is a very typical landscape architecture design challenge. In other words, the design project seeks to find the best *ecological* solution for a legal boundary, in spite of the fact that nature and the built environment do not operate at the same scale (Thompson, 2008). As McHarg has noted,

> "Urbanization proceeds by increasing the density within and extending the periphery, always at the expense of open space. As a result – unlike other facilities – open space is most abundant where people are scarcest. This growth, we have seen, is totally unresponsive to natural processes and their values. Optimally, one would wish for two systems within the metropolitan region, one the pattern of natural processes preserved in open space, the other the pattern of urban development." (p. 57. McHarg, 1992).

And one may also wish for a design system that considers the patterns of natural processes as well as urban development. Suitability is therefore important in site selection. Some sites have a more suitable 'fit' for ecological design. Thompson and Sorvig have listed a number of site types that have historically shown to be more apt to sustainable design and building (29, 2008). The list includes campuses, cemeteries, ski areas, eco-parks, 'exceptional wild landscapes', and walkable communities. Incidentally, this is compared to large 'spec' builders who are slowest to adopt sustainable techniques because of their lack of providing profit (Thompson, 13).

Finally, this case study was also chosen for its contribution to the disciplines of landscape architecture and ecological restoration. A site has been chosen that is a landscape architecture project within the offices of Jonathan Losee Ltd, where I work on many landscape design projects. The design work that we do must always meet the standards of the British Columbia Landscape and Nursery Association (BCLNA), which have a strict code of conduct for design and implementation of landscapes. Furthermore, as practitioners, we are always seeking how to generate plans that meet the expectations of the client while improving landscape ecological function.

(2) Design Challenge

The design site is a parcel of land located within the District of Burnaby, British Columbia. The parcel of land is slated for development to become a business-industrial complex, with some areas protected for recreation and conservation. The owners of the land are a development company called Adera Group of Companies, a large development that aims to balance budget with innovation. Adera is the winner of many building awards and has a number of multi-family homes and commercial projects in the design and construction process at any given time. Adera provided Jonathan Losee Ltd with the challenge to provide a landscape design for the Eastlake business-industrial complex on a realistic budget. The District of Burnaby issued a second challenge when they requested a detailed restoration prescription for the recreation and conservation areas at the Eastlake development.

The site scale for this parcel is 6.5 ha (65,135 square meters). The entire recreation and conservation area is uncharacteristically large for a Metro Vancouver urban development, and borders onto a BC Hydro Right of Way that connects to existing conservation parkland. For this project, a portion of this parcel is studied where it meets the BC Hydro ROW and existing protected conservation lands. The study area is 0.3 ha (3,000 square meters), or 4.6% of the overall parcel.

(3) Site Inventory and Analysis

The design site is situated on the south side of Burnaby Mountain and is within a parcel of land that is bounded on 3 edges by light-industrial development and on 1 edge by The Forest Grove Area, a District park that has 4.2km of walking trails through forest, residential neighborhoods, a sports field, and a regional water reservoir. The Forest Grove Area joins up to the Burnaby 200 Conservation Area, a large recreation park on Burnaby Mountain with trails for cycling, pedestrian, and equestrian use. Adjoining the study area to the east and west are natural watercourses slated to become conservation areas that are protected with fencing and, where necessary, retaining walls. The design study area is a sloped hill vegetated with invasive plants and including a BC Hydro Right Of Way. The study area adjoins a heavily used walking trail.

The site is situated in the Pacific Maritime Coastal Western Hemlock ecozone, with elevation changes and high precipitation dictating the plant communities. The climate of the Metro Vancouver area shows a daily mean temperature of 10 degrees celcius, with high summer temperatures around 20 degrees and low winter temperatures around 5 degrees. The largest factor is the climate is an abundance of rainfall in the winter, with an annual rainfall of 1.15 meters and snowfall of 48cm.

Vegetation on the study site is predominantly invasive species of Himalayan blackberry (Rubus armeniacus), Scotch broom (Cytisus scoparius) and grasses. These invasives are arresting the succession of the vegetation. There are patches of volunteer black cottonwood (Populus balsamifera), red alder (Alnus rubra), and sword fern (Polystichum munitum), indicating an early pioneer forest ecology. The Eastlake Environmental Review Application includes an inventory of potential birds that are associated with Cottonwood stands, which are raptors, downy and pileated woodpeckers, American robins, warbling vireos, and orange-crowned warblers (Pottinger Gaherty 2012). Blackberry thickets are also noted to be associated with small mammals such as opossum, shrews, cottontail rabbits, Pacific jumping mouse, deer mouse, raccoon, and coyote. The study area, however, is disturbed and provides minimal habitat value as compared to the riparian areas. There are no environmentally sensitive habitats known on the site (Pottinger Gaherty 2012). Invasive species management is clearly a challenge to some of the neighbouring properties. The BC Hydro ROW on the north side is overrun with Himalayan blackberry (Rubus armeniacus), Scotch broom (Cytisus scoparius) and non-native grasses. Likewise, the Forest Grove neighbourhood and Burnaby 200 Conservation Area in the further-flung northern area has significant invasive species.

The original soil order is Podzolic, the Great Group is Humo-Ferric, and the Subgroup may show cemented layer variations (Soils of Canada[2]). Soil Series for this site are not available but nearby sites showing the same aspect and topographical features have Buntzen-Cannell and Buntzen-Steelhead Soil Series. These soils have morainal and colluvial surficial deposits, drain moderately well to imperfect (with perched water tables in Steelhead soils), and have moderately coarse textured glacial till (Zalite, 2012). The site's soil characteristics have been altered by development, and geotechnical test plots show between 1.2m and 5.0 of mostly glacial till fill on existing slopes (GeoPacific 2012, Amec 2008). Underlying the fill to 8.4m is a silty sand, with some gravel, subangular to subrounded till (Amec 2008). Test bore holes determined that the fill contained trace rootlets and small woody pieces, but that the moisture content was low and indicates a low organic content (Amec 2008). The density of the fill varies from loose to compact with occasional dense areas (Amec 2008). On the northern side of the site [ie. on the project study area], the test holes showed no water seepage, with groundwater levels from 6 to 10 meters below ground surface (Amec 2008).

The geotechnical report states that the native materials are suitable for building foundations, but that the slopes with fill materials are known to be unstable in seismic conditions (Pottinger Gaherty 2012, GeoPacific 2012). The Slope Stability report that has been issued for the proposed development states that the fill slopes are far enough away from proposed buildings to not be an impact to the structures, but that the addition of landscaping will increase the surface stability of the slopes (GeoPacific 2012). The Geotechnical Report states that, "Permanent cut slopes should be construction no steeper than 2H:1V. An erosion protection system such as hydroseeding, erosion resistant mats or geosynthetic products should be placed on permanent slopes. Appropriate drainage systems must be placed to direct over land surface flow away from slopes and to appropriate discharge areas" (6, Amec 2012).

The inventory and analysis results are documented as the following items:

- Appendix A Site Context
- Appendix B Study Area Boundaries and Adjacent Features
- Appendix C Study Area Inventory & Analysis
- Appendix D Study Area Photographs

(4) Functional Design

The design challenge to provide recreational and conservation areas requires two levels of development. Light development is needed in areas for light recreation, whereas no development is necessary in areas where the site has forest with a natural watercourse. The light recreation for this site can be walking or jogging, and can be enhanced by connecting to existing regional trails adjacent to the study site. On the other hand, an existing adjoining conservation area is to be protected and fenced off to keep people away from the nearby natural watercourse area. The conservation areas are under assessment for ecological restoration by Pottinger Gaherty Environmental Consultants Ltd. Likewise, adjoining development on the southern side of the study site is being designed by a team of architects and engineers. The uphill side or the northern side of the study site is a BC Hydro ROW and must be designed to meet BC Hydro guidelines. These outside goals influence the functions of the study site. In combination with the site inventory & analysis, a very clear direction is set for the goals of the site.
Three main goals emerge:

- Design a low-impact pedestrian walkway to connect the parcel with existing trails
- Restore ecological communities (plants, soil, fauna)
- Restore slope stability

These programmatic items are documented in a functional diagram in Appendix E.

(5) Conceptual Design

Conceptually, the principle of **connectivity** is important because it demonstrated the larger-scale linkages between this site and other existing trails and natural areas. For instance, this development site is connected to the ecological units in the nearby Coastal Western Hemlock forest ecosystem. Additionally, the principle of **form** is important because it will be the form of earth-shaping that give slopes more stability, as well as the form of soil and vegetative cover that will provide further slope stabilization. Also, the form or makeup of the plants and soil will be important to creating ecological communities.

(6) Final Design

The final design shows material selection and notes. It has sufficient information to be submitted to the client and the District of Burnaby for review. Over the course of 2 years, designs were further developed as they went from Rezoning applications to Public Hearing review, then onto Preliminary Plan Approval and finally to Building Permit application. On January 7, 2014 the final design drawings (in the form of Preliminary Plan Approval) were submitted to the District of Burnaby for their review. The final design drawing is documented in Appendix F.

Subsequent drawings that will be required are for Building Permit, Tender, and Construction. It is the Preliminary Plan Approval drawings, however, that are upheld by the City of Burnaby and the subsequent drawings cannot stray too far once they have been approved by the City.

(7) Construction Drawings and Specifications

A set of construction documents enables the contractor to build the site as designed by describing the layout, grades, planting, and detailed information. This information is documented in Appendices H and G. From time to time, a set of construction documents will be supported by maintenance plan. Most often the maintenance requirement for an urban site will extend for 55 days after the construction is complete. Due to the restoration component of this site, this project has included a maintenance regime that extends to 3 years. The document covers 3 different restoration areas, including the northern steep slope or Restoration Area B. The maintenance plan states requirements for watering, weeding, litter removal, and reporting requirements. The maintenance plan is documented in Appendix I. At this point in the design process, the landscape architecture design is complete and the construction will be monitored through site visits.

THE DESIGN PROCESS OF ECOLOGICAL RESTORATION: Literature Review II

Similar to landscape architecture, ecological restoration uses a design process to understand and prescribe the transformation of a site. Dissimilar to landscape architecture, ecological restoration has an inherent goal to restore the ecological function of a specific site. The aim of restoration includes stabilizing an ecosystem and it's species so that they integrate into the larger landscape and they withstand future disturbances (SER 2004).

Literature that has described the restoration process include Restoring the Pacific Northwest, The Art and Science of Ecological Restoration in Cascadia (2006), Ecological Restoration: Principles, Values, and Structure of an Emerging Profession (2013), The SER International Primer on Ecological Restoration (2004), Guidelines for Developing and Managing Ecological Restoration Projects, 2nd Ed (2005), Restoring Disturbed Landscapes, Putting Principles into Practice (2011), and the online Ministry publication Ecological Restoration Guidelines for BC. Additionally, notes from Restoration of Natural Systems classes have been useful in pulling together an understanding of the restoration process. This includes classes ER311 Principles and Concepts of Restoration, ER 312a Field Study in Ecological Restoration, and ER312b Advanced Field Study in Ecological Restoration.

Further literature that can inform this project's case study includes the topics of slope stabilization/bioengineering. These two topics were reviewed in texts such as Slope Stabilization and Stabilization Methods, Urban Biodiversity: Exploring Natural Habitat and its Value in Cities (2000-2004), Ground Bioengineering Techniques for Slope Protection and Erosion Control (1992), and class notes from ER330 Bioengineering, ER331 Urban Restoration and ER334 Soil Conservation and Restoration.

In brief, the design process for ecological restoration is a goal-oriented series of steps. In reading the above-mentioned texts, I have created a list of steps for planning and conducting ecological restoration projects (see Table 4.0). The major steps in the design approach are (1) identifying project goals and understanding the site through an in-depth inventory; (2) planning the tasks necessary to achieve the goals; (3) creating the implementation, maintenance, and monitoring plans; (4) implementing the plans; (5) conducting post-implementation tasks; and (6) evaluating.

Design Steps		**Components**
Conceptual Planning	Set goals	Identify list of goals specific to the restoration project. Identify rationale for ecological restoration. Identify resources and schedule.
	Site Inventory	Site Inventory Identify stressors in the environment.
	Design Solutions	Identify the degree of recovery anticipated. Establish reference ecosystem. Identify how the proposed restoration will integrate into the landscape.
		Apply Design Principles.

Preliminary Tasks	Planning tasks	Prepare methods and strategies. Prepare strategies for long-term protection, maintenance, monitoring. Prepare list of objectives. Prepare performance standards (design criterion or success criterion). Install infrastructure for implementation. Train personnel. Appoint restoration team, budget.
Implementation	Implementation Planning	Create implementation plan for site preparation, installation, and post-installation activities. Prepare schedule. Prepare budget. Obtain resources required (equipment, supplies).
	Implementation Tasks	Stake out boundaries. Install monitoring fixtures. Implement restoration tasks.
	Post-Implementation Tasks	Protect site against vandalism. Perform maintenance. Perform monitoring.
Adaptive Procedures		Identify & implement adaptive management procedures.
Evaluation	Assess project objectives and goals.	Assess monitoring data. Conduct ecological evaluation. Determine if goals were met. Publicize final report.

Table 4.0 Restoration Planning Approach.

(1) Conceptual Planning

Conceptual planning involves setting goals, taking inventory of the site, and identifying design solutions. Apostol and Sinclair state that the …”goals should be stated broadly and focused on restoration of composition and structure, species, functions, or ecosystems processes” (19, 2006). The goals should indicate the desired function of the landscape, which could be a natural pristine state or simply an acceptable level of functionality (Apostol and Sinclair, 2006).

A restoration inventory should always include ecological processes, where an ecological process is the dynamic feature of an ecosystem that includes interactions between organisms and their environment (SER, 2004). These processes, or functions, help the landscape become self-reliant as it moves through cycles such as seed dispersal, nutrient cycling, evapo-transpiration, pollination, and other cycles. By identifying processes as part of the site inventory, goals can be set out to correct imbalances in the ecological process. All goals need to be stated in measurable terms, so that later progress can be measured.

External processes, or stressors, should be identified in the site inventory. Clewell and Aronson explain that the identification of stressor is important because, if for any reason, “these ecological drivers are not expected to continue indefinitely once active restoration activities at the project site have been completed, the project should be abandoned or its vision changed” (171, 2013). They continue that, “There is no reason to undertake restoration if the restored ecosystem if not self-sustaining or if there is little probability for long-term management, such as conducting prescribed burning" (171, Clewell and Aronson, 2013). In this situation, ecological function is at the forefront of project goals. Where the ecological stressors are present but not prohibitive for conducting restoration, the stressors can give an indication of the degree of recovery anticipated. If the threats or stressors are eliminated or reduced, the ecosystem can be put on a path toward recovery. These stressors should also be measurable so that later progress can be measured.

Ecological restoration projects require a reference ecosystem as a checkpoint for success. The reference ecosystem is a model of a fully functioning ecosystem that can be used later to evaluate the success or failure of the restoration design exercise (SER 2004). Clewell and Aronson describe a reference model, which may not be an actual site, but can reflect one or more reference sites that usually consist of intact ecosystems of the kind being restored. "The vision, whatever its inspiration in nature, is commonly called the restoration target and represents the intended long-term outcome of ecological restoration" (138, Clewell and Aronson, 2013). The target reference may be more difficult in urban restoration projects where attempting the duplication of a perfect replica ecosystem may be challenging. Clewell goes on to say that in areas of intensive human land use, that no reference site exists and professional judgement and imagination are required to produce the concept of a reference model. A reference model can be created with a "composite of the species composition and other biophysical characteristics of more than one local ecosystem of the same type, landscape position, and general site characteristics as the impaired ecosystem undergoing restoration" (145, Clewell and Aronson, 2013). The reference model would include keystone species as well as environmental drivers and stressors.

The final stage of conceptual planning involves incorporating design principles. The principles are presented by Tongway and Ludwig in "Restoring Disturbed Landscapes, Putting Principles into Practice" (2011), as assumptions or laws about the way the ecosystems work. Unlike landscape architecture, these are not design principles that are chosen by the designer, but rather they are principles of restoration that can help designers achieve their goals. The principles are presented as useful tools to understand the situation better, and create a more suitable plan for the situation (see Table 5.0). Used properly, these principles will inform every step of the restoration design process, including evaluation.

Principle	Description
1. Analyze the causes of landscape dysfunction.	Systematically identify which processes have become ineffective within the landscape system, and which have retained significant function.
2. Restore ineffective processes sequentially.	Apply physical technologies first, then biological technologies.
3. Monitor indicators reflecting landscape processes.	Apply simple, qualitative indicators of processes over time to provide data on how well the landscape is functioning.
4. View landscape functionality as a continuum.	Each process responds to disturbance in a different way at a different rate. Assess responses to disturbance along a continuum of functionality.

Table 5.0 Principles for Restoring Landscape Functionality, from Tongway & Ludwig. 2011.

These principles can be seen as reminders to include information about ecological drivers and stressors as they relate the ecological processes. Similarly, ecological attributes have been documented in most ecological restoration literature as important factors in understanding the state or condition of a landscape. The attributes will become important is creating a reference model and performance standards. Clewell and Aronson's list of attributes is noted in Table 6.0 as reminders of goal's in any restoration project. While some attributes can be directly implemented by the restorationist, some attributes are by-products of good design.

Attribute	Description
1. Species Composition	A comprehensive and appropriate plant species composition. Plant minimum same number of species in restored ecosystem as preimpairment ecosystem.
Co-adapted Species	Reassemble co-adapted species at restoration sites.
Functional Groups	Introduce species that play certain functional roles. Urban restoration may preclude some functional roles. Eg. Some plants are introduced for their nitrogen-fixing role, or some plants are introduced for their fire-related plant traits.
Redundant Species	Functional ecosystem appears to have far more species necessary to carry out ecological processes.
Alien Species	Project planners, clients must decide on tolerable numbers of alien species. Some noninvasive alien species can be ignored, others cannot.
2. Community Structure	Physical structure of the ecosystem (three dimensional) is present.
3. Abiotic Environment	Physical abiotic environment is present. Eg. Proper hydrological structures or composition of soils.
4. Landscape Context	Flows and exchanges with nearby landscapes.
5. Ecological Functionality	Interaction of organisms and their abiotic environment. Restorationists can set the stage for good processes to allow the interactions to take place between organisms. Indication of functionality can be monitored in terms of growth and reproduction of organisms.
6. History Community	Reconnect the ecosystem to its ecological trajectory to reestablish the historic continuity.
7. Ecological Complexity	The ecosystem can further create complex structure and complexity of species. Eg. Plant vegetation close to streams to facilitate root growth to bind the soil.
8. Self Organization	One process can reinforce or influence another process (ie. Feedback loops). More diverse organisms needed to support each other.
9. Resilience	Self-recovery from stress.
10. Self-Sustainability	Ability of ecosystem to persist on its own.
11. Biosphere Support	Ecosystems contribute toward a larger improvement of environmental quality.

Table 6.0 Ecological Attributes of Restored Ecosystems, after Clewell.

(2) Preliminary Tasks

Preliminary tasks are the step-by-step plans that are necessary to meet the project goals. They are the strategies that will lead to a restoration activity, including a design for long-term protection and maintenance of restored sites. While plans are being chosen, the project goals should be reviewed to determine if they are realistic or if they need to be adjusted.

Methods and strategies for achieving the goals of this case study include roadside verge restoration, ground stabilization techniques, bioengineering, soil restoration, and urban restoration. The methods and strategies are described in the following Chapter.

The performance standards are a list of criteria or success standards that set out to meet a specific degree of recovery. Performance standards require measurable criteria, often taken from the reference model or reference ecosystem. Measurement of the criteria can tell if the project goals are being met. Project goals can also be measured by assessing the ecological attributes (Table 6.0).

Landscape architecture literature and ecological restoration literature recommend on-going maintenance of a site, as well as protection of sensitive landscapes. Ecological restoration literature, however, offers an abundance of information on site monitoring.

Monitoring looks for indicators to assess specific landscape or general ecosystem function. Or, alternatively, monitoring can identify, assess, and analyze the processes that are *not* performing in a landscape (137, Tongway and Ludwig, 2011). Some examples of monitoring include sampling soil chemistry, plant cover, and species composition; measuring erosion; and comparing the site with the reference site over time (Nuzzo and Howell, 1990). For monitoring of slope stabilization, Apostol and Sinclar recommend to examine lower edges of slopes for deposits of sediments, examine upper edges of slopes for rills and gullies, look for causes of erosion, look at plant success to see if plants have rooted and are protecting surfaces as well as aesthetically pleasing, and examine for stability of the mulch between plants (2006).

(3) Implementation and Adaptive Procedures

Implementation of a restoration plan involves preparing and conducting the restoration activities. Plans are drawn up, descriptions of tasks are itemized, budgets are written up, and the schedule is set into place. The schedule for restoration includes sequencing the work with the growing season or with cycles of a certain species. Monitoring protocols are put into place so that the project can be tracked over time.

Once the implementation plans are complete, the physical on-site work occurs. Over time, maintenance and management are performed that may assist in a project's goals. If monitoring proves that the goals are not being met, mid-course corrections need to be noted. Tongway and Ludwig advocate an "Adaptive Procedure" to restoration that allows for changes to be made during the treatment or implementation stage (2011).

(4) Evaluation

Evaluation of a restoration plan involves assessing the monitoring data, conducting an evaluation of the ecological unit, and determining if the goals were met. Finally, reports may be publicized to provide information to the world of restoration practitioners. The evaluation stage may occur years after a project has been implemented, depending on the time frame and scale of the project. The goals of a restoration project may not be immediately quantifiable, especially when compared to the goals of a landscape architecture project. Outside of the academic arena, landscape architecture design processes usually come to an end when the landscape is installed and the site is functional for use by its intended users (usually humans). However, a restoration project's end goals may take years to come to fruition.

APPLICATION OF ECOLOGICAL RESTORATION DESIGN PROCESS TO THE CASE STUDY

In the last chapter, design components were identified that have explicit restoration characteristics. These six components are applied to this case study in this chapter.

1) Identification of degree of recovery anticipated
2) Identification of reference ecosystem or reference model
3) Identification of how the restoration integrates into the landscape
4) Preparation of methods and strategies (for restoration tasks)
5) Preparation of performance standards
6) Preparation of strategies for long-term protection, maintenance, and monitoring

(1) Degree of Recovery Anticipated

This study area has historically been heavily impacted by construction, and is covered with non-native fill material. During the commercial development construction phase, the study area will undergo additional impacts from construction when it is cut back to allow for further phasing of development. It is desired that the study area recover sufficiently so that it does not pose any safety threat from erosion events. This requires physical stabilization of the slope's surface through soil application, revegetation, and other means such as erosion control blankets.

It is desired that the study site become a natural buffer between an urban landscape and a restored forest area. "Buffer areas are managed to retain some ecological functions but permit a greater range of compatible lands uses such as low-impact recreation" (57, Apostol and Sinclair, 2006). Recovery is desired to the extent that there will be sufficient plant cover and healthy soil.

(2) Reference Ecosystem or Reference Model

A reference model can be envisioned for this entirely new buffer ecosystem that is a very early stage successional forest ecosystem. This reference model is urban grassland, which is dominated by grass-only herbaceous vegetative cover. "Grass-only grasslands are found within a few years of a site being disturbed. When only grass is present, the site is usually in an early successional stage, as only pioneering grass species are present" (131, Schaefer et al., 2000-2004). It is expected that the reference model has good surface stability, good water infiltration capacity, and good nutrient cycling potential (127, Tongway and Ludwig, 2011). It is expected that the reference model has soil conditions similar to the adjacent forest, with a lower acidity and fertility range. The reference model is expected to have a specific grass species to allow it to tolerate particular conditions (131, Schaefer et al., 2000-2004).

(3) Integration into the Landscape

It is intended that this site integrate into the landscape by continuing its gradual advancement towards a Coastal Western Hemlock forest ecosystem. The impacts from landscape degradation are to be eliminated and strategies for physical and biological restoration are to be implemented so that natural regeneration can take place. Tongway and Ludwig describe this stage as a “Steadily Establishing Landscape”, where the attributes are development of soil and vegetation, declining erosion, and presence of active biophysical feedback loops (163, 2013). This stage is a foundation in building up towards the ultimate goal of having a fully functional landscape with resilience, diversity of habitat, and predictable responses to stressors. The biophysical feedback loop that Tongway and Ludwig refer to include, for example, soil formation (via storing of organic materials and cycling of nutrients through pulses of plant growth), plant persistence (via seed reserves), transfer of water (via patches), or infiltration of water (via storage capacity) (2013). In this case study, therefore, the study site is deemed to be integrated into the landscape when it is showing signs of soil development, vegetation development, declining erosion, and evidence of feedback loops. If these factors are present, then the site is on a path towards positive rehabilitation.

(4) Methods and Strategies for Restoration

The methods and strategies for restoration aim to provide surficial slope stabilization and to create a grassland ecosystem. The case study inventory revealed that the substrate is stable and that only surficial soil protection is required. Hydro-seeding was documented in ecological restoration literature as an excellent and cost-effective method for surficial slope stabilization. Additional techniques to increase the root mass and vegetative cover, as well as other additional methods and strategies include the following.

- Plant trees and shrubs around the perimeter of the grassland to act as a barrier to creeping of invasive plant material. Plant an edge around the seeded area to “seal the edge”. “The idea is to intentionally plant the very places where natural reproduction is most likely and displacing other undesirable plants by shading and occupying the space available” (293, Sauer, 1998).
- Plant at the toe of the slope (See Figure 13.0). The slope can be seeded and planted with stakes during construction of the sloped sub-surface. The plants and stakes are inserted into the slope through cuts made to the erosion control blanket. As there is a limited height to this method, the planted area is to be maximum 2.0m above the toe of slope. The plants can be live cuttings that are 1 year old or older stems of willow species, This planting or staking resembles a buttress of free-draining rock that acts as a gravity structure. Plant at 1 meter on centre and mulch following planting.
- Plant iconic species that will provide habitat for native birds and amphibians (Apostol, 2006).
- Plant fast-growing trees and shrubs to shade out light-requiring invasive plants, stabilize locally for erosion-prevention, and provide deeper root penetration.
- Add course woody debris to the soil surface to initiate forest succession.
- Complete mulch application within one week of final grading and planting, and prior to any large rain events. Mulch to cover 100% of exposed soils.
- Do not add mulch to slopes greater than 1:2.

- Encourage soil microorganisms by adding a final mulch treatment (1" thick). Do not apply mulch to wet ground. Reapply mulch as necessary. Use chips only from tree species found in Coastal Western Hemlock forest. Alternately, use bonded fiber mulch, made of gypsum mixed with wood fiber and sprayed onto the surface.
- Seed to be germinated and well established prior to winter or lack of vegetation may cause water quality problems during thaw and spring runoff.
- Add seeds of broadleaved and coniferous tree species.
- Add seeds that are treated with root fungi inoculants.

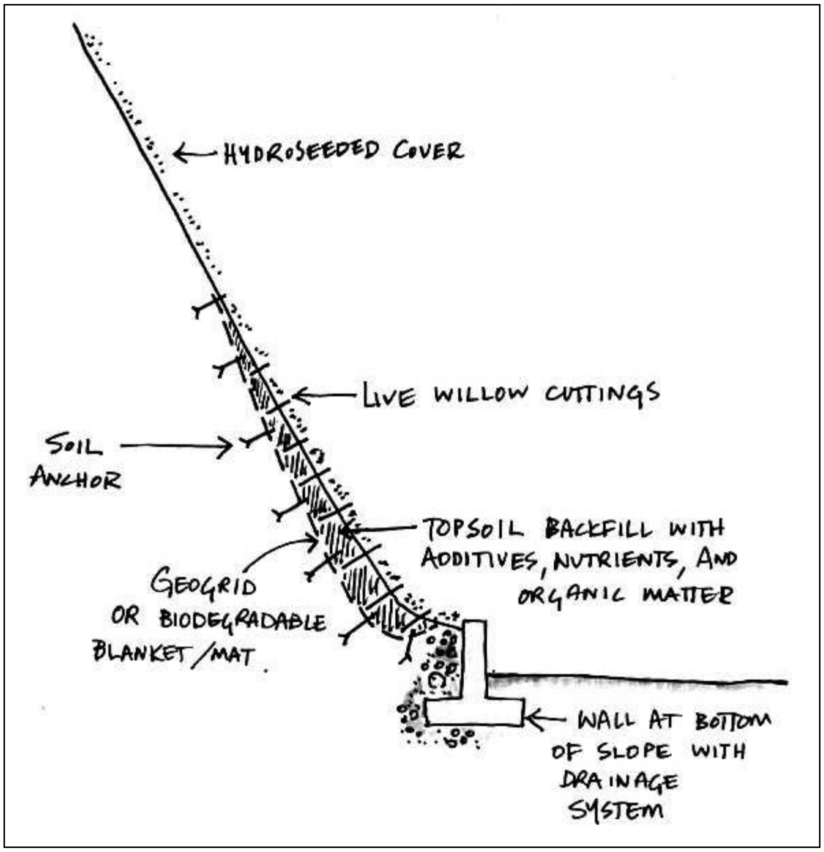


Figure 4.0 Planting at Toe of Slope, after Schiechtl and Stern, 1992.

(5) Performance Standards

After 3 years of establishment, the study site's performance should meet the following standards.

- Decline of surficial erosion
    - No rills or gullies are greater than 12" wide.
    - No sedimentation from dislodged soil particles at toe of slope.
- Soil development is present.
    - Soil has high infiltration rate.

    - Soil has high fertility.
    - Soil chemistry is within normal ranges.
- Plant development is present.
    - 90% of site is vegetated by planted species and/or naturally regenerating vegetation.
    - Less than 10% cover by invasive plant species.
    - Plants are aesthetically pleasing (not dead, not uprooted).
- Feedback loops are evident.
    - Organic materials are present.
    - Plant growth is evident.
    - Plant persistence is evident.
    - Patches of plants are good.
    - Infiltration is high.

(6) Long-Term Protection, Maintenance, and Monitoring

The long-term protection of the study site is required to keep people and dogs out of the study area. The design includes a vegetative barrier on all four sides of the slope, with only one opening that includes a walkway and stairs. The vegetative barrier is provided to indicate the no-go zone of the area. The installation of the trail helps to localize traffic on the main path of travel and off the restoration area.

Maintenance is to include the following:

- Regular watering, reseeding, remulching, and replanting.
- Removal of invasive species.
- On steep slopes, invasive species are to be evaluated regarding their aggressiveness, invasiveness, and their role in preventing erosion (125, Tongway and Ludwig, 2011). Less aggressive and invasive weeds are not to be removed if they are controlling overland flows.
- Herbicides are not to be used unless absolutely necessary.
- Soils are to be tested annually for stability and fertility.
- Natural disturbance processes are to be left in situ. For example, a tree that falls can be left on site, provided it is out of harm’s way and is not causing erosion of the slopes.
- No machinery is to be used on sloped areas.
- Monitoring of the on-going performance should take place, with actions taken, expected results, and remedial actions in the case of failure.

These six different restoration components are added into the landscape architecture design plans. The layout and detail for the construction are documented in Appendices J and K, while the amended maintenance plan is documented in Appendix L. This concludes the amended design drawing package.

RESULTS

The addition of six restoration components has improved the landscape architecture design process. Three of the new *conceptual* planning components help to identify measurable targets for ecosystem recovery. An additional three *preliminary* planning components provide technical data for the case study. The result is a landscape architecture design process for heightened ecological function. The novel design steps are outlined in Table 7.0.

Design Steps	**Components**
Design Challenge	Client Interview
Site Inventory & Analysis	Prepare base plan
	Site inventory
	Site analysis
	Determine program requirements, and list of opportunities and constraints
Identify Targets	Degree of Recovery Anticipated
	Reference Ecosystem
	Integration into landscape
Design	Diagramming to show functional relationships
	Incorporate Conceptual Design Principles
	Conceptual/Schematic plan
	Final Design: Master plan
Construction Drawings	Layout plan, grading plan, planting plan, detail drawings
	Specifications and/or maintenance plan
	Methods and strategies for restoration
	Performance standards (as part of maintenance plan)
	Long term protection, maintenance, and monitoring
Implementation	Building stage
	Post construction evaluation
	Maintenance
	As-built drawing set

Table 7.0 Novel Design Process for Urban Ecological Design

The identification of targets can be included at the same stage as site inventory and analysis, when the site and its context are being studied. The targets will obviously play a large role in the goals of the client. This new design step, at its core, invites the professional to consider the larger scale and the longer time frame. It invites the landscape architect to be more specific about how an urban parcel can fit into the larger landscape.

The technical data needed for restoration can be included in the stage of preparing construction documents, but should not be a surprise to any client who will need to consider costs and timing for a restored urban landscape. The client should know the requirements for a long-term maintenance plan at the outset of the design challenge so that they can budget for a larger overall project costs.

For this particular case study for a steep slope, the outcome has improved the landscape plan, design details, and maintenance & monitoring plan. The implementation of the new design product includes submitting the design to the City and to the property owner.

(1) Implementation

Designs were submitted to the site owner and the City of Burnaby on January 7, 2014. These drawings were amended a number of times for changes that did not concern the steep slope. However, as I gathered information from this report, I made changes to the plans that incorporated the new information discovered through this case study. The final plans were submitted on March 5, 2015. These plans contained all the information that is presented in this case study project. Meanwhile, the project began construction in October 2014, starting with some of the building foundations, parking areas, and associated retaining walls and stairs. At no time during the submission of the landscape drawings was there comment regarding the information on the northern steep slope. The construction of the urban ecological design is on track and in process.

However, during the implementation of the final design, I was met with some real-world challenges. In order to move the design from theory to practice, I needed to learn more about plant species. As I continued to learn about live willow stakes, I took an opportunity to change the willow stake species. For instance, I learned from a conversation with Peel’s Native Plant Nursery (February 2015) that the salix species I had originally specified was not readily available as cuttings. This prompted me to further research willow species and I changed the species to be a smaller variety, from Salix scouleriana to Salix exigua and Salix interior. Although the Salix interior is not a native to the Coastal Western Hemlock forest ecosystem, I chose this species because of the aspect of the steep slope, knowing it would receive full sunlight. Likewise, with diminishing rainfall due to local climate changes, I believe that choosing species that have lower water requirements is a growing need.

Another real-world challenge was finding a readily available seed source for tree species that could be mixed with the grassland seed mix. Likewise, detailed information about the type of root fungi inoculants for the seed mixture was not available. While there are a few different seed suppliers in the Vancouver area, each of the suppliers that I contacted was only able to provide a grassland mix that was chosen specifically for the aspect and location of the steep slope. It is hoped, and likely, that the restored forest right next to the steep slope will become a seed source for trees to move into the slope area.

A larger challenge during the implementation of this design was having the maintenance plan adopted. Maintenance of an urban landscape is typically 55 days, while this project has 5 years of maintenance, including ongoing monitoring and, if required, remediation. This site is unique to most urban landscape designs because it has two significant watercourses. A project Biologist prepared restoration plans for the two protected areas around the watercourses. In doing so, the Biologist developed a maintenance plan that lasted 5 years. Using the Biologist's plan as leverage, I ambitiously included a hefty maintenance plan and crossed my fingers that it would be accepted. Much to my surprise the owner, Adera Developments, agreed that the maintenance on the natural areas would be 5 years. It turns out that the City of Burnaby has accepted the Biologist's 5-year maintenance plan as a standard for this site, making it a requirement for the owner to follow through. An additional stroke of luck occurred when, in February 2015, I was charged with preparing the documentation for LEED (Leadership in Energy and Environmental Design) for the Canada Green Building Council. One of the LEED credits that the project is applying for requires a maintenance plan for the naturalized areas. I have included the amended maintenance plan that has been developed through this case study. I am satisfied that the maintenance plan is thorough yet realistic in it's goals.

The largest challenge to "landscape ecological restoration" can be getting acceptance from the property owner. This project was accepted for numerous reasons. First, the changes that were made were realistic and cost-effective. I was relieved that the outcome of this restoration study resulted in a construction that did not require any specific skills that would already be part of a typical landscape installation company's skill set. The cost of the final restoration design was marginally more than the initial design. A large jump in cost would have certainly been a limitation on implementing the improved restoration design. The City of Burnaby did not have any comment on the new design, in which case there were no changes needed to meet the City requirements. The more comprehensive plans were, therefore, acceptable to the City officials.

(2) Limitations

There were a number of limitations to this study. The study did not have invasive species management in its scope. Although invasive species management is a component of the maintenance plan, the reality is that this site is bordered on 3 sides by landscapes with no maintenance regime and existing invasive species problems. It is hoped that adjacent property owners or community groups may one day choose to restore their natural landscapes. In addition to the work of this report, it would be useful to study invasive species management in buffer landscapes and on steep slopes. Additional research that would be very useful would be an in-depth study about restoration maintenance and monitoring. Detailed and specific information about maintenance and monitoring of steep slopes is difficult to find in both landscape architecture and restoration literature. It would also be very useful to run another case study exercise using the same methodology but on another site with different conditions and a different client. This could include a few case studies for comparison, and, eventually, for the possible launch of a newly adapted design process with landscape architects and restorationist professionals in mind.

(3) Recommendations

Some specific recommendations for this case study site are to follow up in future years during establishment and during on-going maintenance, as well as after the 5-year maintenance period. It will be important to follow up with the landscape installers and maintenance crew to determine any difficulties they may be having on site. It will be useful to report to the City of Burnaby on the outcome of the installation. This will be a regular part of the completion stage, when City officials will be meeting on site to check that the installation was completed according to plan, and if any changes are required to fulfill the City requirements. Furthermore, it would be useful to report back the findings to restoration and landscape architecture professionals about the adapted design process, as well as the long-term findings of the slope stabilization and ecosystem restoration results. Restoration is increasingly part of landscape architecture, and hopefully this study will show some areas where landscape design can benefit from restoration planning approaches.

Landscape Architecture Design Process

AMEC Earth & Environmental. Preliminary Geotechnical Assessment 8335 Eastlake Drive, Burnaby, BC. For Sun Life Financial, Calgary, AB. December 4, 2008

American Society of Landscape Architects, Lady Bird Johnson Wildflower Center, and Unites States Botanic Garden, The Sustainable Sites Initiative: The Case for Sustainable Landscapes. Self-published. 2009. Accessed online on January 20, 2012. http://www.sustainablesites.org/report/.

Balmori, Diana and Benoit, Gaboury. Land and Natural Development (LAND) Code, Guidelines for Sustainable Land Development. John Wiley and Sons, New Jersey. 2007. This is a useful book for some specific techniques (eg. Raingardens, bioengineering, academic case studies) in sustainable landscape development, but does not have any reference to process.

Booth, Norman. Basic Elements of Landscape Architectural Design. Elsevier Science Publishing, New York. 1983

BCLNA. British Columbia Landscape Standards. 7th Ed. 2008. BC Landscape Nursery Association, Surrey, BC.

Bureau of Land and Water Quality, Maine Department of Environmental Protection. Maine Erosion and Sediment Control BMPs. March 2003, State of Maine.

Cooper Marcus, Clare and Francis, Carolyn. People Places: Design Guidelines for Urban Open Space. 2nd Ed. John Wiley & Sons: New York. 1998.

Dee, Cathering. Form and Fabric in Landscape Architecture. Spon Press, London. 2001.

Dramstad, Wenche; Olson, James; and Forman, Richard. Landscape Ecology Principles in Landscape Architecture. Island Press, Harvard University, and American Society of Landscape Architects; Washington, D.C. 1996.

Frogger's Creek Tree Consultants Ltd. Arborist Report for Eastlake Development 8335 Eastlake Drive, Burnaby, BC. Dated May 28, 2009.

GeoPacific Consultants Ltd. Geotechnical Comments on Slope Stability: Proposed Commercial Development at 8335 Eastlake Drive, Burnaby, BC. August 03, 2012. Vancouver, BC.

Girling, Cynthia and Kellett, Ronald. Skinny Streets and Green Neighbourhoods. Island Press, Washington. 2005.

Hough, Michael. Cities and Natural Process, Towards a New Urban Vernacular. Van Nostrand Reinhold Company, New York. 1994.

Lyle, John Tillman. Design for Human Ecosystems, Landscape, Land Use, and Natural Resources. Van Nostrand Reinhold Company, New York. 1985.

Marsh, Landscape Planning, Environmental Applications. 3rd Ed. John Wiley & Sons, New York. 1998.

McHarg, Ian. Design with Nature. John Wiley & Sons, New York. 1992.

Ministry of Environment. Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia. BC, 2006.

Pottinger Gaherty Environmental Consultants Ltd. Environmental Review Committee Application for 8335 Eastlake Drive, Burnaby, BC. Dated May 16, 2012.

Pottinger Gaherty Environmental Consultants Ltd. Restoration Conceptual Design for 8335 Eastlake Drive, Burnaby, BC. Dated March 9, 2012.

Rutledge, Albert J. "Site Design Process" in Anatomy of a Park, The Essentials of Recreation Area Planning and Design. McGraw-Hill, New York. 1971.

Thompson, J. William and Sorvig, Kim. Sustainable Landscape Construction, 2nd Ed. Island Press, Washington. 2008.

Restoration Process

Abramson, Lee, Sharma, and Boyce. Slope Stabilization and Stabilization Methods. 2nd ed. John Wiley & Sons, New York. 2002.

Apostol, Dean and Sinclair, Marcia. Restoring the Pacific Northwest, The Art and Science of Ecological Restoration in Cascadia. Island Press, Washington, DC. 2006.

Biodiversity Branch, Ministry of Water, Land and Air Protection and Forest Renewal BC. Ecological Resoration Guidelines for BC. Victoria, BC.
www.env.gov.bc.ca/fia/documents/**restorationguidelines**.pdf

Clewell, Andre and Aronson, James. Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. 2nd Ed. Island Press, Washington, DC. 2013.

Nuzzo, Victoria and Howell, Evelyn. Natural Area Restoration Planning. 1990. Volume 10(4), Natural Areas Journal. Pp. 201-209.

Sauer, Leslie and Andropogon Associates. Once and Future Forest, A Guide to Forest Restoration Strategies. Island Press, Washington, DC. 1998.

Schaefer, Valentin, Rudd, Hillary, and Vala, Jamie. Urban Biodiversity: Exploring Natural Habitat and its Value in Cities. Captus Press, Concord, Ontario. 2000-2004.

Schiechtl, H.M and Stern, R. Ground Bioengineering Techniques for Slope Protection and Erosion Control. Blackwell Science. Klosterneuburg, Austria. 1992.

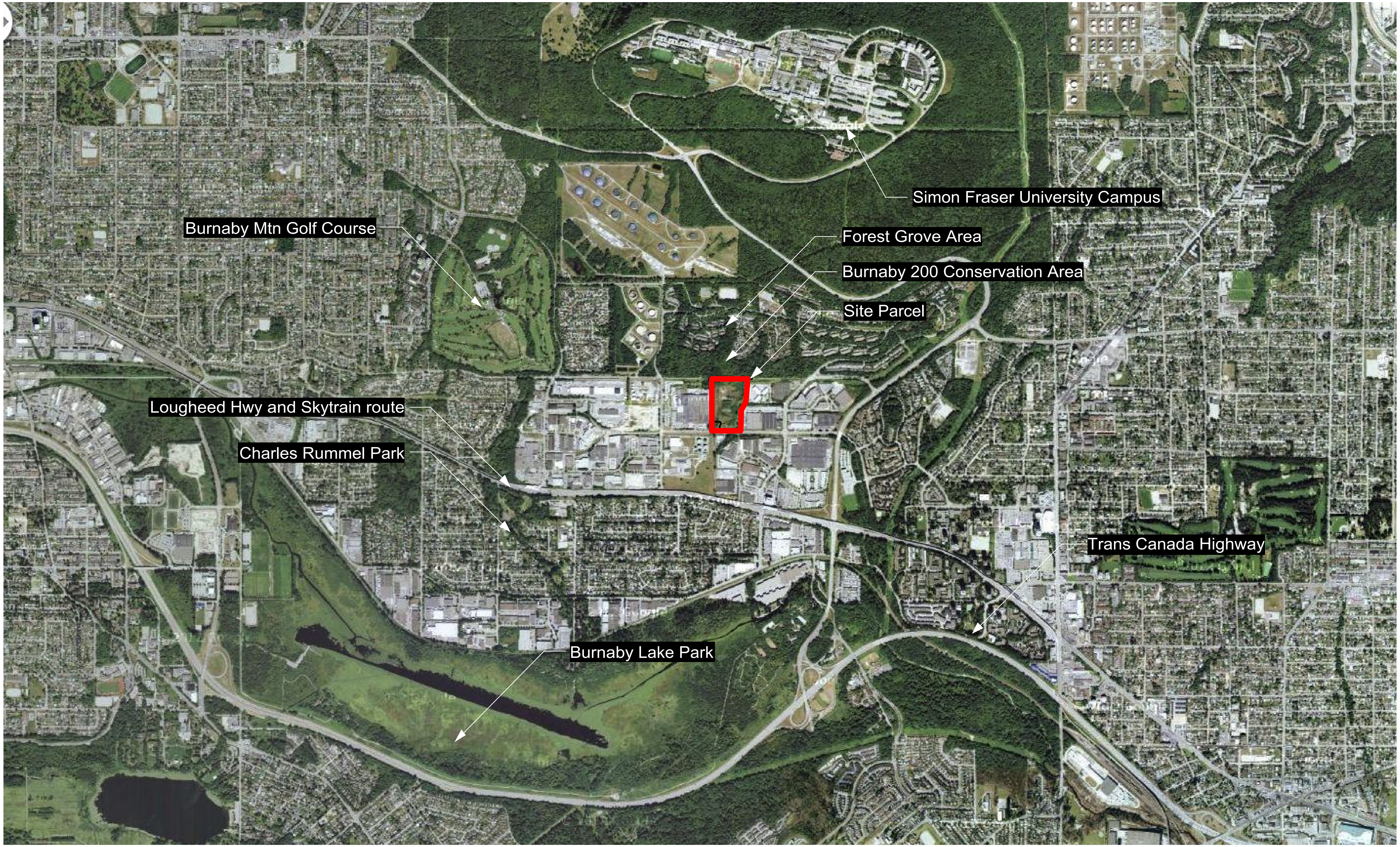
Society for Ecological Restoration International Science and Policy Working Group. 2004. The SER International Primer on Ecological Restoration Version 2. www.ser.org & Tucson: Society for Ecological Restoration International.

Society for Ecological Restoration International. Guidelines for Developing and Managing Ecological Restoration Projects, 2nd Ed. 2005. Andre Clewell, John Rieger and John Munro. www.ser.org & Tucson: Society for Ecological Restoration International.

Tongway, David and Ludwig, John. Restoring Disturbed Landscapes, Putting Principles into Practice. Island Press, Washington, DC. 2011.

Zalite, Soil Assessment for Construction Activity on Eastlake Drive/Burnaby Mountain Urban Trail. UVic Student Paper for ER334 Soil Conservation and Restoration. November 2012.

Zalite, Kristina. Class notes from ER311 Principles and Concepts of Restoration, ER 312a Field Study in Ecological Restoration, ER312b Advanced Field Study in Ecological Restoration; ER330 Bioengineering, ER331 Urban Restoration and ER334 Soil Conservation and Restoration. University of Victoria. 2007-2012.



Scale: 1:25,000 metric

Project

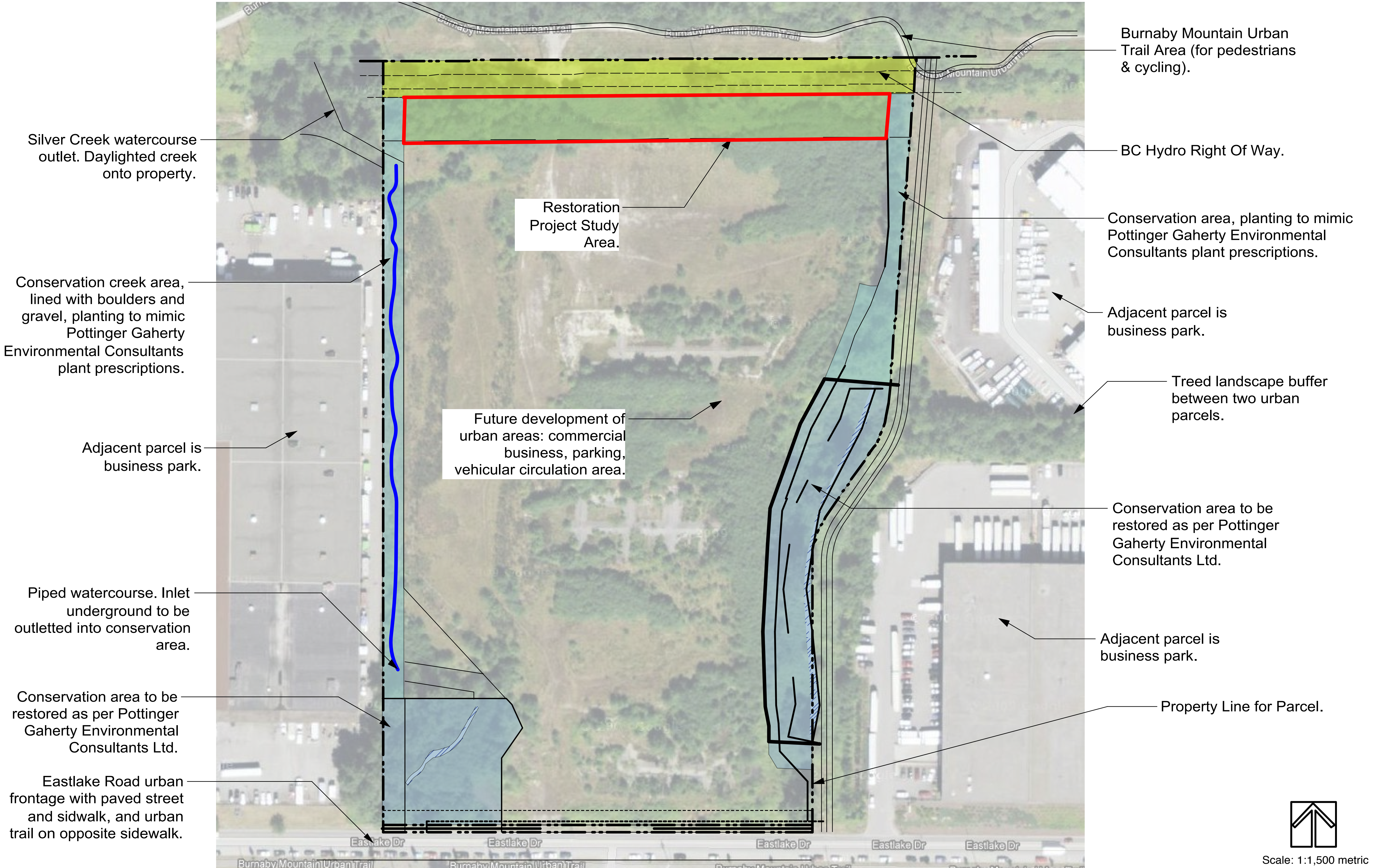
8335 Eastlake Drive
Burnaby, BC

Drawing Title

Site Context

Appendix

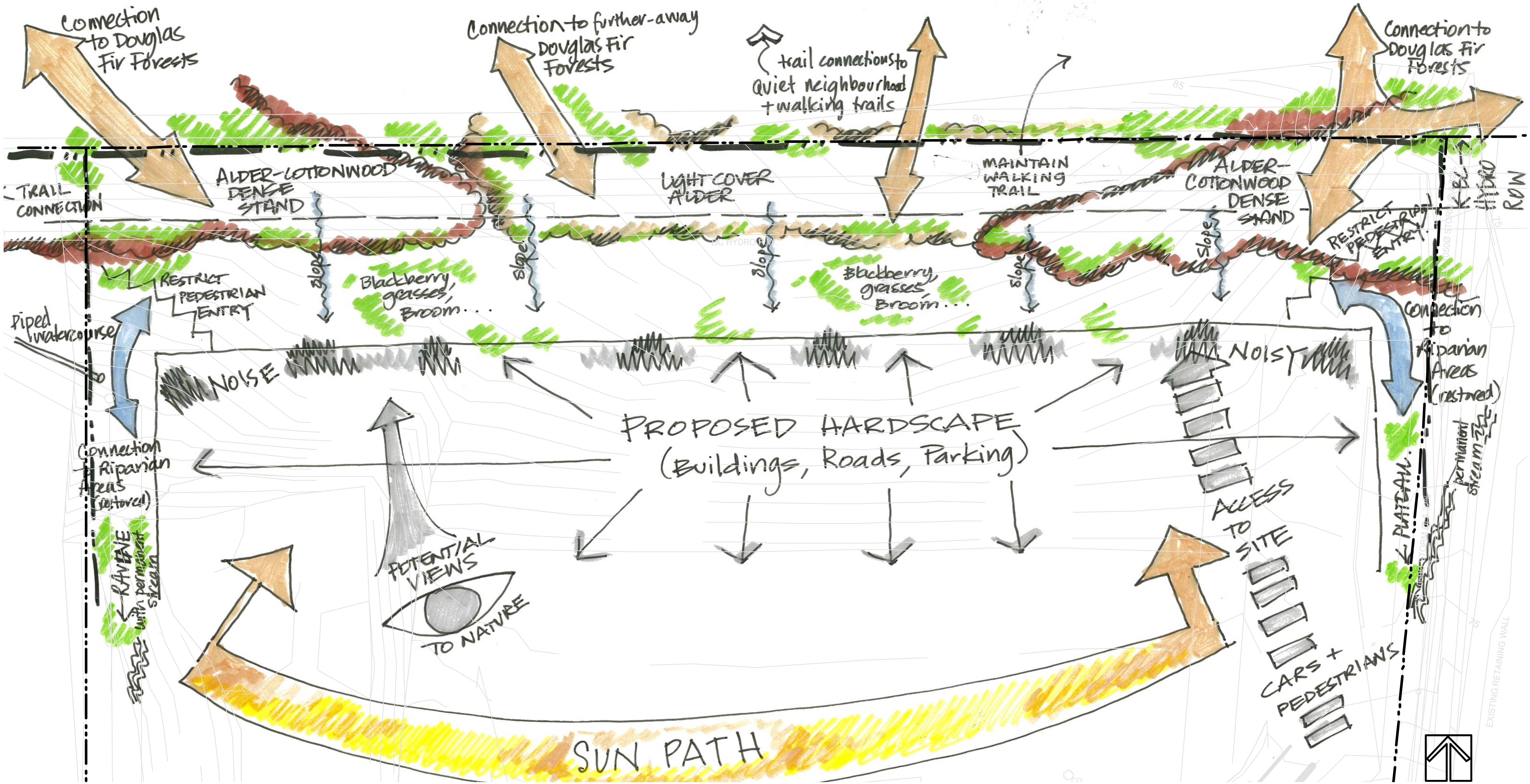
A



Project
8335 Eastlake Drive
Burnaby, BC

Drawing Title
Study Area Boundaries and Adjacent Features

Appendix
B



Scale: 1:600 metric

Project	Drawing Title	Appendix
8335 Eastlake Drive Burnaby, BC	Study Area Inventory & Analysis	C

Burnaby Mountain Trail System. Looking westward toward the uphill side of the study site

Burnaby Mountain Trail System north of study site.

Burnaby Mountain Trail System. Looking eastward toward the uphill side of the study site.

Adjacent lands uses. Parking lot for light industrial/commercial development on west side of site.

Study site. Vegetation at top of hill on site, adjacent to BC Hydro ROW.

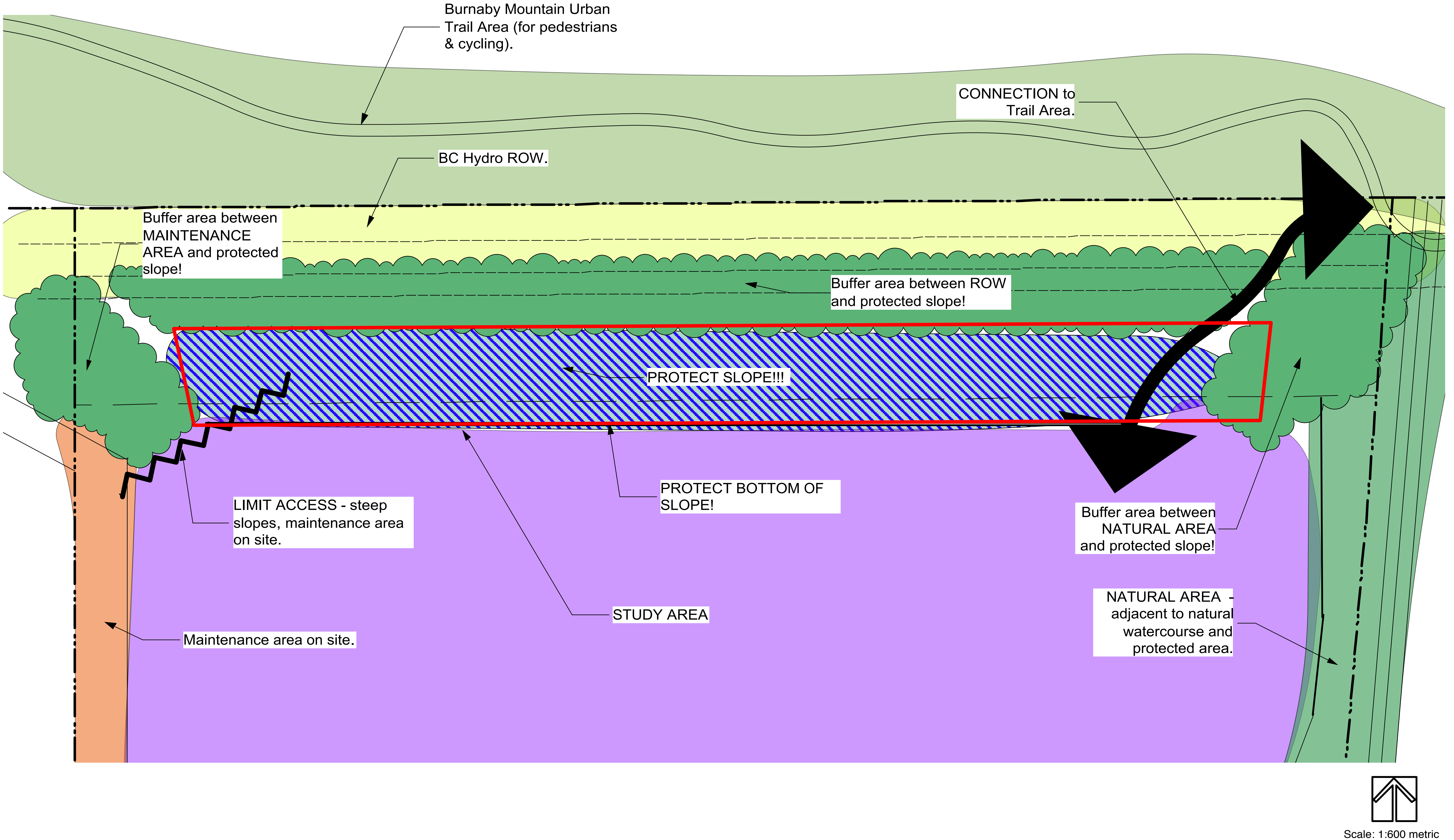
Study site. Vegetation at tmiddle of hill on site.

Study site. Vegetation at tmiddle and bottom of hill on site. Adjacent land use - light industrial/commercial building on west side of site.

Study site. Vegetation at tmiddle and bottom of hill on site. Adjacent land use - light industrial/commercial building on west side of site.

Scale: 1:600 metric

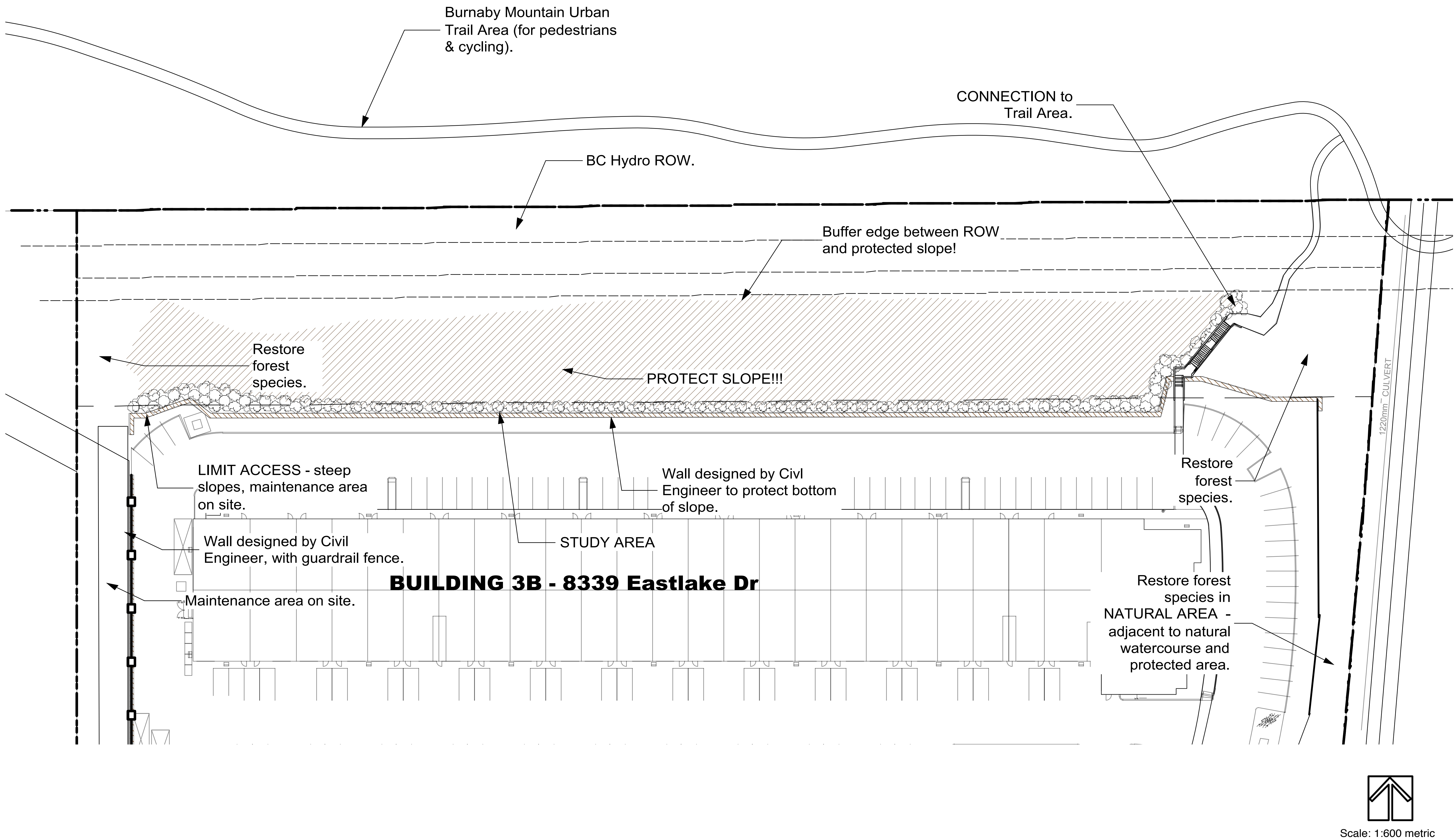
Project	Drawing Title	Appendix
8335 Eastlake Drive Burnaby, BC	**Study Area Photographs**	**D**



Project
8335 Eastlake Drive
Burnaby, BC

Drawing Title
Functional Diagram

Appendix
E



Project
8335 Eastlake Drive
Burnaby, BC

Drawing Title
Conceptual Plan

Appendix
F

HYDROMULCHED SLOPE:

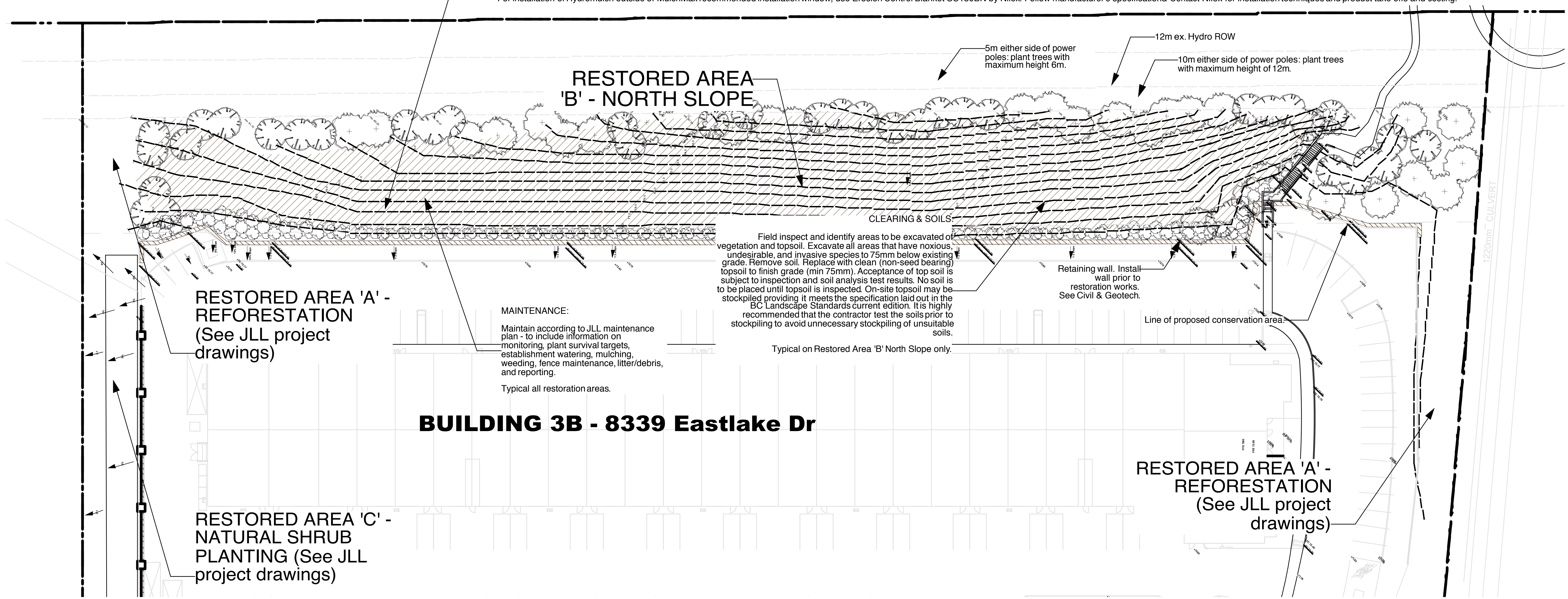
For installation of Hydromulch between March and June, or August and October, install MulchMax HydroMulch with tackifier agent by Nilex. Follow manufacturer's specifications.
Ensure full coverage application rate of 5000kg/ha. This product will provide erosion protection for approximately 1 year.
Ensure that the soil is suitable for supporting vegetation growth. If not, amend soil as needed. If topsoil is added, the layer is be limited to 1" thickness. If a 4"-6" layer of topsoil is added it could compound the erosion problem that you are trying to control.
Follow MulchMax installation guides for best practices including maintenance and watering schedules.
Quality assurance is to be high priority when mulch is being applied. Ensuring that the application rates are met is critical to ensure correct performance. Contact Nilex if a sample calculation for field measurements is required.
Install Sediment Stop at the top of the slope and in the middle of the slope in an effort to slow sheet flows and control run-off from above the slope. Follow Nilex installation guidelines and product specifications.

SEED SELECTION:

40%/52% Creeping Red Fescue
35%/18% Turf-type Perennial Ryegrass
25%/30% Hard Fescue
Suggested Seeding Rate: 350kg/ha

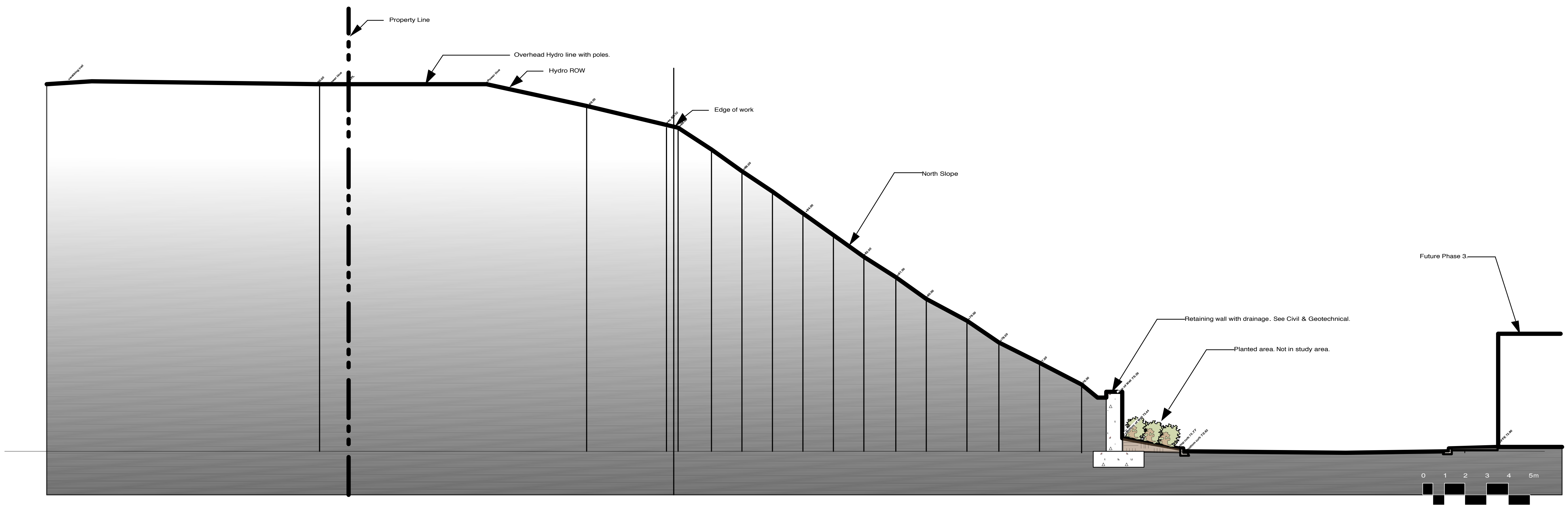
(The first percentage shown per species is the % by Seed Weight. This is the basis on how the mixture is blended. The second percentage per species is the % by Seed Count). Ensure minimum percentages of seed for invasive species out-competition (Creeping Red Fescue) and deep/fibrous root systems (Hard Fescue) and quick germination (Turf-type Perennial Ryegrass).

For installation of Hydromulch outside of MulchMax recommended installation window, use Erosion Control Blanket SC150BN by Nilex. Follow manufacturer's specifications. Contact Nilex for installation techniques and product take offs and costing.



Scale: 1:600 metric

Project	Drawing Title	Appendix
8335 Eastlake Drive **Burnaby, BC**	**Initial Construction Drawing - Layout**	**G**



Scale: 1:200 metric

Project	Drawing Title	Appendix
8335 Eastlake Drive Burnaby, BC	**Initial Construction Drawing - Details**	**H**

July 30, 2013

EASTLAKE Landscape Establishment Maintenance of Restoration Areas A, B, and C

Responsibilities:

The developer/ strata corporation:

1. Maintain the Restoration Areas A, B, and C for a period of 3 years once the City has accepted the planting material.
2. Build and maintain a 3-rail delineator fence in perpetuity.
3. Continue maintenance of the landscapes in the building areas in perpetuity.

The City of Burnaby:

1. Maintain the Restoration Areas A, B, and C after the 5-year establishment maintenance period is completed and signed off by the City.

Goal:

The goal of the maintenance plan is to allow the plants to survive and achieve their natural size and form while limiting competition from invasive species. A survival rate of 80% for shrubs and 100% for trees is the target during the 3-year maintenance period.

Overview: This site is a new commercial/industrial development within a ring of landscape areas, situated on a steep slope on the south side of Burnaby Mountain. The northern edge of the site is connected to parklands with pedestrian trails. The landscape areas on the north, east and west side are to be restored to a natural state. The landscape areas on the east and west side have watercourses of varying significance. The landscape areas have been separated into the following landscape units: Restored Area 'A', Restored Area 'B', Restored Area 'C', Future Covenant Area and Existing Covenant Area. This maintenance plan covers three restored areas (A, B, and C). Please see reports by Pottinger Gaherty Environmental Consultants Ltd for prescription of the Existing and Future Covenant Areas. Please see BC Landscape Standards current edition for landscape areas in the building area (that is, shrub beds, tree beds, and lawn areas).

The three restored areas are planted to provide biodiversity, local habitat, slope stabilization and erosion control. The largest threats to the achievement of these goals are insufficient water during the dry season, and out-competition by invasive species. This maintenance schedule lays out a plan that will address these issues. Due to the proximity of a creek, pesticides and fertilizers are prohibited. The design of the site is intended to be very low maintenance. The plants are densely planted to increase cover, to decrease the risk of invasion by weeds, and to shade the soil and thereby decrease evaporation from the soil. Likewise, dense planting and quick establishment of root zones are to increase stabilization of slopes. The maintenance schedule described below will help the maintenance goals be achieved.

1. General Maintenance Procedure

Maintenance contractors and managers are to be familiar with the landscape establishment maintenance and maintenance specifications in the current edition of the BC Landscape Standards.

Maintenance levels are to be BC Landscape Standard Maintenance Level 4 Open space/ Play during the first year of establishment. After one year of establishment, maintenance levels are to be Level 5 Background and Natural Areas. All procedures are to meet the BC Landscape Standards current edition and to follow the prescriptions outlined in this maintenance plan.

2. Monitoring

Monitoring will be key to achieving the goal of this maintenance period. Monitoring is to begin upon acceptance of the installation by the Landscape Architect (Jonathan Losee). For the first year, monitoring is to take place monthly, and to increase in the dry-month watering periods to every 2 weeks. From the second year, monitoring can take place every 6 months. The maintenance inspection form (included at end of this report) is to be used for the monthly monitoring. Monitoring is to assess the following items:

- Soil moisture
- Mulch
- Weeds and invasive species
- Fencing
- Litter
- Plant health

3. Establishment Watering

Establishment watering allows the plants to develop a deep and healthy root system. The goal is to water deeply to thoroughly saturate the root zone, and then to allow the soil to dry out to below 50% moisture before watering again. This will promote a deep root system. Depending on when the plants are installed, after 2 summers, the plants should no longer need supplemental watering. Refer to the BC Landscape Standard, 7th Edition, Section 13.3.2 for information on establishment watering, and Table 14-11, for the practical chart for determining soil moisture. Note that adequate rain can make watering unnecessary, so evaluation of soil moisture is useful for determining if watering is necessary.

Watering to be done on all landscaped areas using a water truck, and ensuring the water penetrates to the full depth of the root zone (as per BC Landscape Standard section 13.3.2). Test holes shall be dug after watering to ensure that the water has saturated the root zone.

Year 1

Month	Watering Frequency/ month	Notes
May	0-1	Only if exceedingly dry
June	0-2	Every 15 days, only if dry
July	1-3	Every 10 days, only if dry
August	1-3	Every 10 days, only if dry
September	0-2	Every 15 days, only if dry
October	0-1	Only if exceedingly dry

Year 2-5

Month	Watering Frequency/ month	Notes
May	0	
June	0-1	Only if exceedingly dry
July	0-2	Every 20 days, only if dry
August	0-2	Every 20 days, only if dry
September	0-1	Once, only if dry
October	0	

4. MULCHING

Restoration areas ‘A’ and ‘C’ are mulched with a layer (2-3”) of non-cedar wood chips. Top-dress the mulch annually in May to maintain this thickness. If significant invasive species removal is necessary, mulch may need to be topped up during the growing season to prevent re-invasion into exposed soil.

5. WEEDING

Invasive plants can quickly overtake a site and threaten the establishment of trees and shrubs. For a description of weed and invasive plant control, see BC Landscape Standard section 14.3.7. Monitor the site monthly and remove weed and invasive species as per BC Landscape Standard Maintenance Level 4 Open space/play. See Table 14-12 in the BC Landscape Standards. After the establishment maintenance period, the maintenance level can be reduced to Level 5 Background and Natural Areas. Note that the cottonwood and alder seedlings can be left to grow and not removed, except for above the BC Hydro ROW and Restored Area ‘C’, where no trees shall be permitted to grow.

6. FENCE MAINTENANCE

Monitor fence every 3 months to ensure that no boards are loose, fabric (if present) is tight and nails and screws are securely installed. Repair as necessary.

7. LITTER/ DEBRIS

Woody debris such as fallen branches and twigs can be left in the planting areas. Remove litter and other debris monthly.

8. REPORTING

A report is to be completed at the end of each year and these reports are to be submitted to the following individuals. The maintenance inspection form included in this report can be submitted as the report.

Lise Townsend
Ecosystem Planner
City of Burnaby
Planning and Building Department
4949 Canada Way
Burnaby, B.C.

V5G 1M2
lise.townsend@burnaby.ca

Mr. Brad Jones
Development Manager
Adera Group
Suite 2200-1055 Dunsmuir Street
Four Bentall Centre
PO Box 49214
Vancouver BC
V7X 1K8
bradj@adera.com
604-684-8277

Jonathan Losee
Principal
Jonathan Losee Ltd
Suite 102-1661 West 2nd Ave
Vancouver, BC
V6J 1H3
jon@jonathanlosee.com
604-669-1003

Prior to hand-over at the end of the 3-year maintenance period, a detailed assessment is to be conducted and a report submitted to the City.

Report submitted by.
Jonathan Losee Ltd.

Cc: Lise Townsend – City of Burnaby
Brad Jones – Adera Developments

SITE MAINTENANCE INSPECTION FORM – FOR NATURAL AREAS AT EASTLAKE PROJECT

Site: Eastlake
Address: 8335 Eastlake Drive
Municipality: Burnaby, BC
Client: Adera Development

Maintained by (company name):
Inspected by:
Date of Inspection:
Weather:

CATEGORY	GOOD	NEEDS ATTENTION	COMMENTS/LOCATION
TREES			
• General Appearance			
• Water/Moisture			
• Mulch Levels			
• Weed control			
• Plant litter control			
• Plant Health			
SHRUBS & GROUNDCOVER			
• General Appearance			
• Water/Moisture			
• Mulch Levels			
• Weed control			
• Plant litter control			
• Plant Health			
HILLSIDE- SLOPE			
• General Appearance			
• Water/Moisture			
• Surface conditions			
• Weed control			
• Litter control			
• Plant Health			

HYDROMULCHED SLOPE:

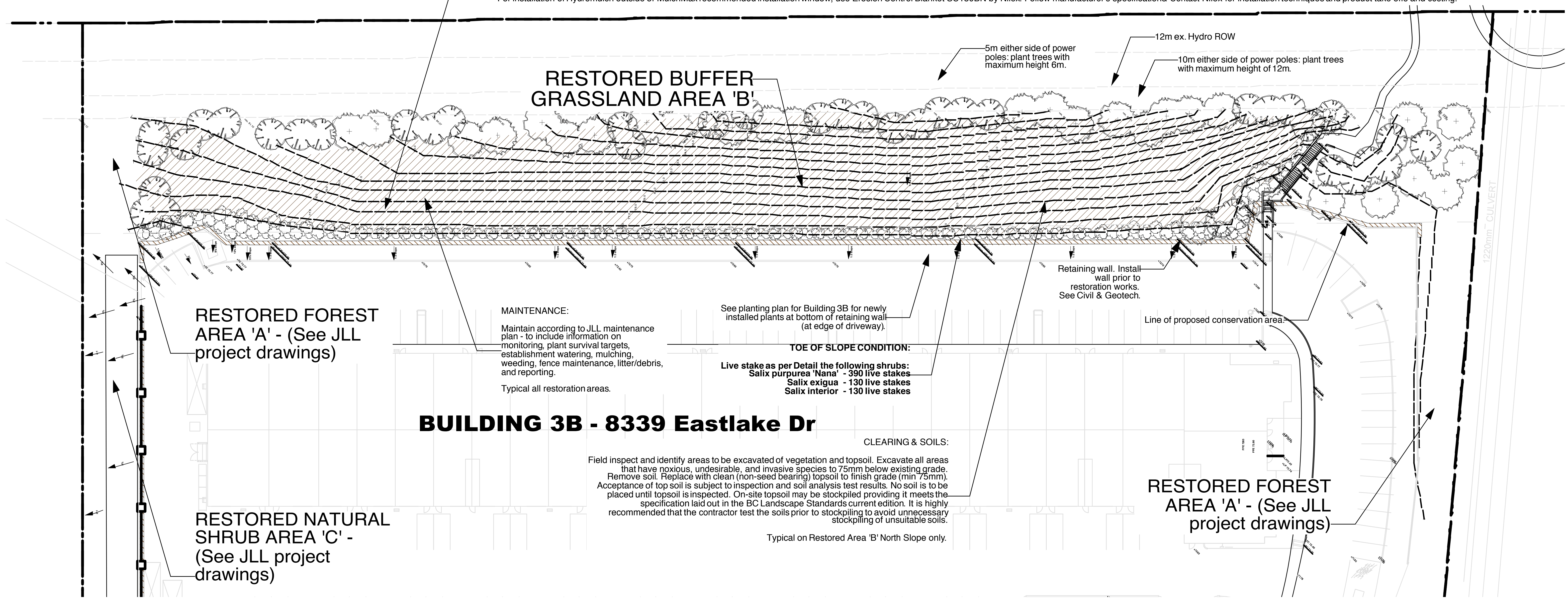
For installation of Hydromulch between March and June, or August and October, install MulchMax HydroMulch with tackifier agent by Nilex. Follow manufacturer's specifications.
Ensure full coverage application rate of 5000kg/ha. This product will provide erosion protection for approximately 1 year.
Ensure that the soil is suitable for supporting vegetation growth. If not, amend soil as needed. If topsoil is added, the layer is be limited to 1" thickness. If a 4"-6" layer of topsoil is added it could compound the erosion problem that you are trying to control.
Follow MulchMax installation guides for best practices including maintenance and watering schedules.
Quality assurance is to be high priority when mulch is being applied. Ensuring that the application rates are met is critical to ensure correct performance. Contact Nilex if a sample calculation for field measurements is required.
Install Sediment Stop at the top of the slope and in the middle of the slope in an effort to slow sheet flows and control run-off from above the slope. Follow Nilex installation guidelines and product specifications.

SEED SELECTION:

40%/52% Creeping Red Fescue
35%/18% Turf-type Perennial Ryegrass
25%/30% Hard Fescue
Suggested Seeding Rate: 350kg/ha

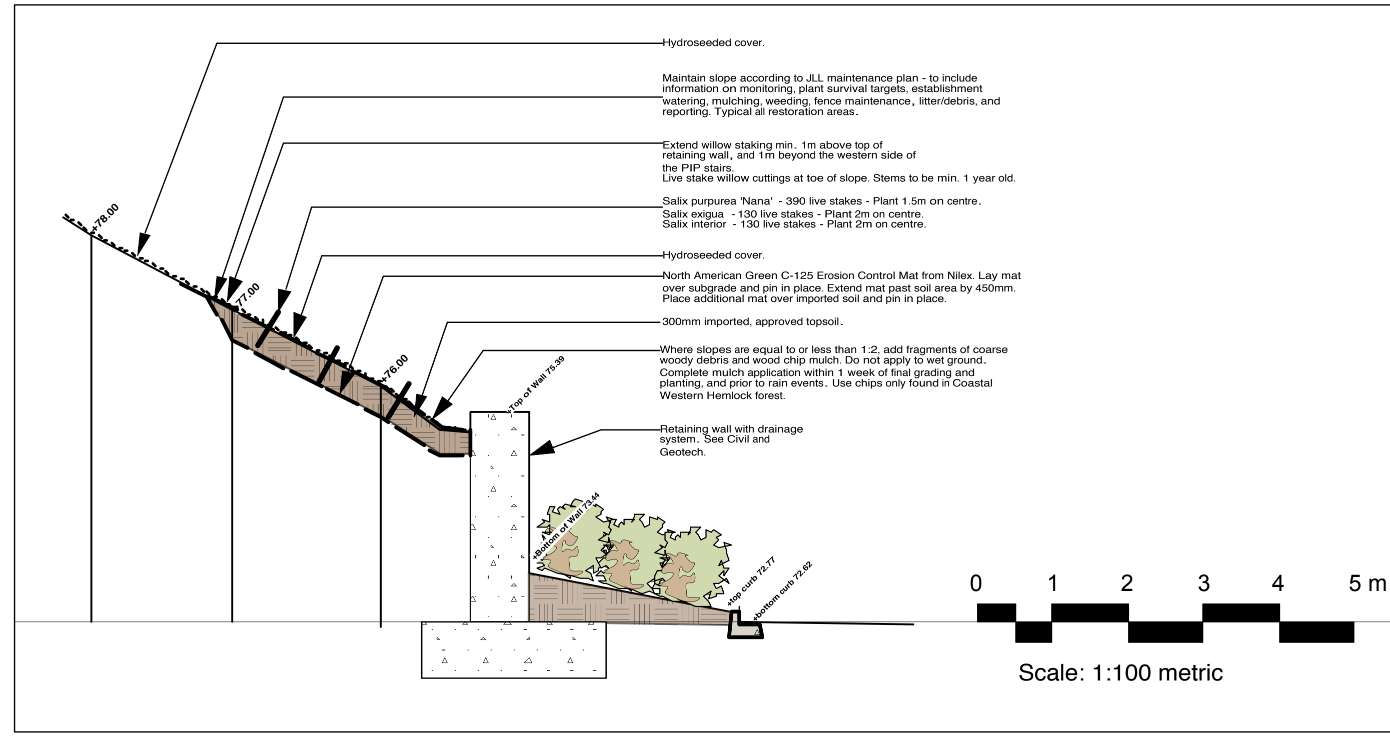
(The first percentage shown per species is the % by Seed Weight. This is the basis on how the mixture is blended. The second percentage per species is the % by Seed Count). Ensure minimum percentages of seed for invasive species out-competition (Creeping Red Fescue) and deep/fibrous root systems (Hard Fescue) and quick germination (Turf-type Perennial Ryegrass).

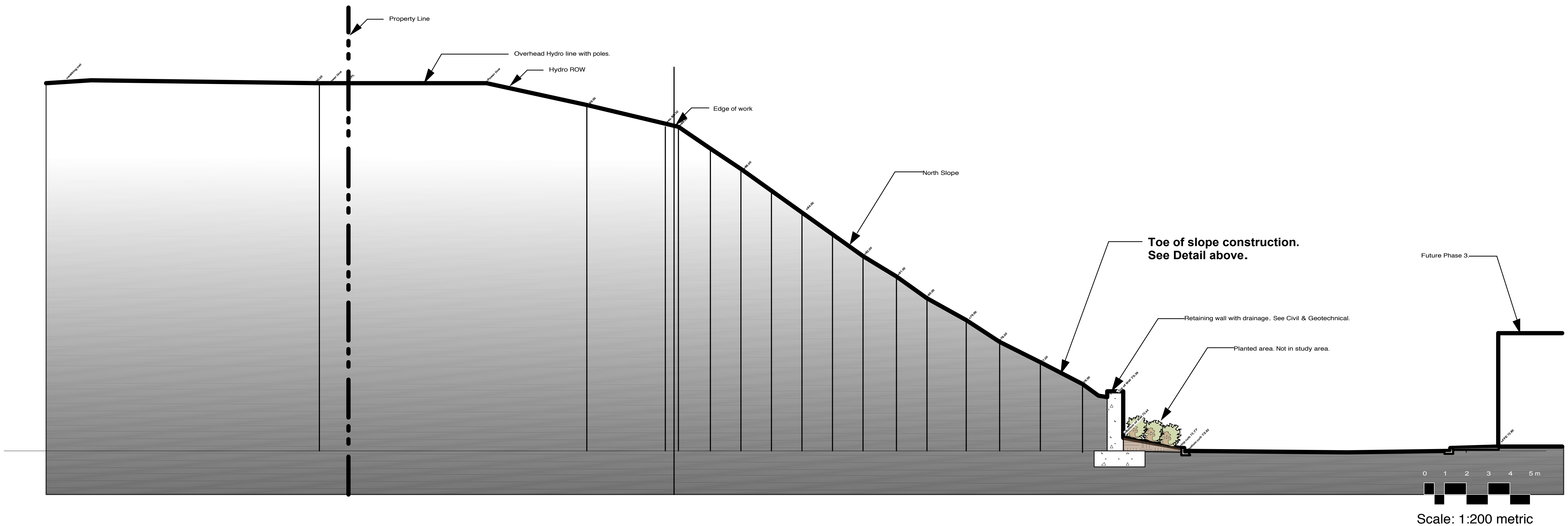
For installation of Hydromulch outside of MulchMax recommended installation window, use Erosion Control Blanket SC150BN by Nilex. Follow manufacturer's specifications. Contact Nilex for installation techniques and product take offs and costing.



Scale: 1:600 metric

Project	Drawing Title	Appendix
8335 Eastlake Drive Burnaby, BC	**Amended Construction Drawing - Layout**	**J**





Project	Drawing Title	Appendix
8335 Eastlake Drive **Burnaby, BC**	**Amended Construction Drawing -Details**	**K**

Jonathan Losee Ltd. LANDSCAPE ARCHITECTURE

Suite 102
1661 West 2nd Avenue
Vancouver BC
V6J 1H3

t 604.669.1003
f 604.669.0402

jon@jonathanlosee.com
www.jonathanlosee.com

March 06, 2015

EASTLAKE Landscape Establishment Maintenance of Restoration Areas A, B, and C

Responsibilities:

The developer/ strata corporation:

1. Maintain the Restoration Areas A, B, and C for a period of 5 years once the City has accepted the planting material.
2. Build and maintain a 3-rail delineator fence in perpetuity.
3. Continue maintenance of the landscapes in the building areas in perpetuity.

The City of Burnaby:

1. Maintain the Restoration Areas A, B, and C after the 5-year establishment maintenance period is completed and signed off by the City.

Goal:

The goal of the maintenance plan is to allow the plants to survive and achieve their natural size and form while limiting competition from invasive species. A survival rate of 80% for shrubs and 100% for trees is the target during the 5-year maintenance period.

The long-term goal for Area 'B' Grassland is a gradual and natural advancement toward a Coastal Western Hemlock forest ecosystem, starting with grassland ecology and achieving good soil development, vegetative development, declining erosion, and evidence of feedback loops.

Overview: This site is a new commercial/industrial development within a ring of landscape areas, situated on a steep slope on the south side of Burnaby Mountain. The northern edge of the site is connected to parklands with pedestrian trails. The landscape areas on the north, east and west side are to be restored to a natural state. The landscape areas on the east and west side have watercourses of varying significance. The landscape areas have been separated into the following landscape units: Restored Area 'A', Restored Area 'B', Restored Area 'C', Future Covenant Area and Existing Covenant Area. This maintenance plan covers three restored areas (A, B, and C). Please see reports by Pottinger Gaherty Environmental Consultants Ltd for prescription of the Existing and Future Covenant Areas. Please see BC Landscape Standards current edition for landscape areas in the building area (that is, shrub beds, tree beds, and lawn areas).

The three restored areas are planted to provide biodiversity, local habitat, slope stabilization and erosion control. The largest threats to the achievement of these goals are insufficient water during the dry season, erosion activities on slopes, loss of soil fertility, and out-competition by invasive species. This maintenance schedule lays out a plan that will address these issues. Due to the proximity of a creek, pesticides and fertilizers are prohibited. The design of the site is intended to be very low maintenance. The plants are densely planted to increase cover, to decrease the risk of invasion by weeds, and to shade the soil and thereby decrease evaporation from the soil. Likewise, dense planting and quick establishment of root zones are to increase stabilization of slopes. The maintenance schedule described below will help the maintenance goals be achieved.

1. GENERAL MAINTENANCE PROCEDURE

Maintenance contractors and managers are to be familiar with the landscape establishment maintenance and maintenance specifications in the current edition of the BC Landscape Standards.

Maintenance levels are to be BC Landscape Standard Maintenance Level 4 Open space/ Play during the first year of establishment. After one year of establishment, maintenance levels are to be Level 5 Background and Natural Areas. All procedures are to meet the BC Landscape Standards current edition and to follow the prescriptions outlined in this maintenance plan.

2. MONITORING

Monitoring will be key to achieving the goal of this maintenance period. Monitoring is to begin upon acceptance of the installation by the Landscape Architect (Jonathan Losee). For the first year, monitoring is to take place monthly, and to increase in the dry-month watering periods to every 2 weeks. From the second year, monitoring can take place every 6 months. The maintenance inspection form (included at end of this report) is to be used for the monthly monitoring. Monitoring is to assess the following items:

- Soil moisture, fertility, stability
- Mulch
- Weeds and invasive species
- Fencing
- Litter
- Plant health

3. ESTABLISHMENT WATERING

Establishment watering allows the plants to develop a deep and healthy root system. The goal is to water deeply to thoroughly saturate the root zone, and then to allow the soil to dry out to below 50% moisture before watering again. This will promote a deep root system. Depending on when the plants are installed, after 2 summers, the plants should no longer need supplemental watering. Refer to the BC Landscape Standard, 7th Edition, Section 13.3.2 for information on establishment watering, and BC Landscape Standard Table 14-11, for the practical chart for determining soil moisture. Note that adequate rain can make watering unnecessary, so evaluation of soil moisture is useful for determining if watering is necessary.

Watering to be done on all landscaped areas using a water truck, and ensuring the water penetrates to the full depth of the root zone (as per BC Landscape Standard section 13.3.2). Test holes shall be dug after watering to ensure that the water has saturated the root zone.

Watering on steep slopes where there is seed is to be done uniformly in such a manner to avoid washing out seed or soil.

Year 1

Month	Watering Frequency/ month	Notes
May	0-1	Only if exceedingly dry
June	0-2	Every 15 days, only if dry
July	1-3	Every 10 days, only if dry
August	1-3	Every 10 days, only if dry
September	0-2	Every 15 days, only if dry
October	0-1	Only if exceedingly dry

Year 2-5

Month	Watering Frequency/ month	Notes
May	0	
June	0-1	Only if exceedingly dry
July	0-2	Every 20 days, only if dry
August	0-2	Every 20 days, only if dry
September	0-1	Once, only if dry
October	0	

4. MULCHING

Restoration areas 'A' and 'C' are mulched with a layer (2-3") of non-cedar wood chips. Top-dress the mulch annually in May to maintain this thickness. There are to be no patches without shrubs, trees, or mulch (ie. exposed soils). If significant invasive species removal is necessary, mulch may need to be topped up during the growing season to prevent re-invasion into exposed soil.

5. WEEDING

Invasive plants can quickly overtake a site and threaten the establishment of trees and shrubs. For a description of weed and invasive plant control, see BC Landscape Standard section 14.3.7.

For the first year establishment period, monitor the site monthly. Remove minimum 80% of weedy patches. Weedy patches are patches that are 12" (300mm) wide or more. Vegetation debris is to be removed from the site at each site visit and taken to a facility that can dispose of it appropriately.

After the establishment period, monitor the site bi-annually. Remove weedy patches when they threaten the natural area landscape. Vegetation debris is to be removed from the site at each site visit and taken to a facility that can dispose of it appropriately.

Note that cottonwood and alder seedlings should be left to grow and not removed, except for above the BC Hydro ROW and Restored Area 'C', where no trees shall be permitted to grow. Refer to the drawings to determine the location of ROW and Restored Area 'C'.

On the slopes of Area 'B', less aggressive weeds are to not be removed if they are controlling overland flows and protecting the slope's surface from erosion.

6. FENCE MAINTENANCE

Monitor fence every 3 months to ensure that no boards are loose, fabric (if present) is tight and nails and screws are securely installed. Repair as necessary.

7. LITTER/ DEBRIS

Woody debris such as fallen branches and twigs can be left in the planting areas. Remove litter and other debris monthly.

8. PLANT HEALTH

Replanting: Plant survival is to be minimum 80% for shrubs and 100% for trees. Inspect for plant survival annually in the late summer/fall. If plants are dead or dying, they are to be replaced in the fall of the year. This is the optimum time for planting to ensure plant survival.

Reseeding: Monitor for seed germination, grassland coverage, and patchy areas. If coverage on seeded areas is less than 90%, reseed with the same seed mix and seeding methods outlined in the installation documents. Do not use machinery on sloped area. Grasses are considered established when they are mature enough to control soil erosion.

Soil health: Provide an annual soil analysis report for each of the restoration areas. Check for total nitrogen, soil organic carbon, carbon to nitrogen ratio, and the ratio of microbial biomass carbon to organic carbon.

9. REPORTING

A report is to be completed at the end of each year and these reports are to be submitted to the following individuals. The maintenance inspection form included in this report can be submitted as the report.

Lise Townsend
Ecosystem Planner
City of Burnaby
Planning and Building Department
4949 Canada Way
Burnaby, B.C.
V5G 1M2
lise.townsend@burnaby.ca

Mr. Brad Jones
Development Manager
Adera Group
Suite 2200-1055 Dunsmuir Street
Four Bentall Centre
PO Box 49214
Vancouver BC
V7X 1K8
bradj@adera.com
604-684-8277

Jonathan Losee Ltd. LANDSCAPE ARCHITECTURE

Jonathan Losee
Principal
Jonathan Losee Ltd
Suite 102-1661 West 2nd Ave
Vancouver, BC
V6J 1H3
jon@jonathanlosee.com
604-669-1003

Prior to hand-over at the end of the 5-year maintenance period, a detailed assessment is to be conducted and a report submitted to the City.

Report submitted by.
Jonathan Losee Ltd.

Cc: Lise Townsend – City of Burnaby
Brad Jones – Adera Developments

SITE MAINTENANCE INSPECTION FORM – FOR NATURAL AREAS AT EASTLAKE PROJECT

Site: Eastlake
Address: 8335 Eastlake Drive
Municipality: Burnaby, BC
Client: Adera Development

Maintained by (company name):
Inspected by:
Date of Inspection:
Weather:

CATEGORY	GOOD	NEEDS ATTENTION	COMMENTS/LOCATION
TREES			
• General Appearance			
• Water/Moisture			
• Plant Survival (target 100%)			
• Mulch Levels (target 90% coverage)			
• Weed control (target 10% max. coverage)			
• Plant litter control (target 10% coverage)			
• Plant Health			
SHRUBS & GROUNDCOVER			
• General Appearance			
• Water/Moisture			
• Plant Survival (target 90%)			
• Mulch Levels (target 90% coverage)			
• Weed control (target 10% max. coverage)			
• Plant litter control (target 10% coverage)			
• Plant Health			
HILLSIDE- SLOPE			
• General Appearance			
• Soil infiltration rate (moisture)			
• Surface conditions – rills and gullies no greater than 12”			
• Surface conditions – no sediments from dislodged soil particles at toe of slope			
• Plant coverage (target 90%)			
• Weed control (target max. 10%)			
• Organic materials present			
• Plant growth, persistence, and patches			

Once a year, supply a soil analysis report for each of the restoration areas. Check for total nitrogen, soil organic carbon, carbon to nitrogen ratio, and the ratio of microbial biomass carbon to organic carbon.