SPP 2012 2015

District of West Vancouver

Shoreline Protection Plan 2012 - 2015

west vancouver

Contributors

District of West Vancouver, Municipal Hall, 750 - 17th Street, West Vancouver, BC, V7V 3T3

Brent Leigh, Deputy Chief Administrative Officer

Councillor Trish Panz

Adrian Rowland, Consultant

West Vancouver Shoreline Preservation Society, Post Office Box 91166, West Vancouver, BC, V7V 3N6

West Vancouver Streamkeepers Society, PO Box 91166, West Vancouver, BC, V7V 3N6

Balanced Environmental Services Inc., 118 Garden Avenue, North Vancouver, BC V7P 3H2

Scott Christie, President

Alexandra Barron, Project Manager

Mark Thompson, Project Manager

Integrated Planning and Consulting Services Inc., 2933 Panorama Dr., North Vancouver, BC, V7G 2A4

Ted Appleton, President

Executive Summary

During a single heavy rain event in the winter of 2007, McDonald and Lawson Creeks deposited over 600 m^3 of sand, gravel and cobble onto the shore of West Vancouver, with an estimated value of over $250,000. Prior to West Vancouver's Shoreline Protection Plan (SPP) these sediments would have been swept away by waves and tidal currents resulting in the increased erosion of the District's biggest public amenity – the Waterfront.

While the 2007 rain event was relatively unique in its order of magnitude, the process of erosion and deposition occurs 24 hours a day, seven days a week, forever. When these processes produce a stable foreshore a more balanced ecological system, with diverse plant and animal communities can flourish. At present, the West Vancouver shoreline is not stable.

The growth of West Vancouver has seen the 'urbanization' of its waterfront and watersheds resulting in the hardening of shorelines with concrete and rip rap sea walls and the channelization of watercourses. These effects have unbalanced the sediment transport system that historically fed the shoreline causing an increase in sediment losses and a decrease in deposition. The result is an accelerating process of erosion with negative impacts to the environment and infrastructure. This damage to West Vancouver's shoreline is further exacerbated by the predicted changes in climate and rise in sea levels – estimated to be as much as 1 m in the next 100 years with increasingly severe and frequent storms†. Left unchecked, these processes acting in concert will continue to cause increased capital costs to repair and maintain West Vancouver's waterfront.

The publishing of the Engineering Advisory Committee's (EAC) 'Long-Term Shoreline Planning Framework' and the formation of the West Vancouver Shoreline Preservation Society (WVSPS) in 2005 were the catalysts for a move from more than 30 years of study to action, marked by formalization of a Shoreline Protection Plan (SPP). Utilizing the EAC framework the SPP created a workable, efficient and cost-effective list of tasks to begin the process of shoreline restoration and protection. The SPP is a living document that will evolve with the shoreline, directing available funds opportunistically to maximize restoration and protection values. The SPP represents the District of West Vancouver's commitment, laid forth in its mission statement and Official Community Plan, to protect and enhance one of its greatest natural assets.

The first actions of the SPP were the creation of nine municipally funded pilot projects located between the Capilano Groyne and Navvy Jack Point. Although these projects varied in scale, cost and focus; each shared the key goals of providing improved shoreline protection from waves, reducing erosion, promoting sediment accretion, creating natural habitat and improving public amenities. Each project involved an array of coastal engineering and habitat enhancement strategies to restore sites to a more natural state and provide self sustaining 'soft' shoreline protection measures. Benefits realized include:

- reduced wave energy,
- more balanced sediment transport mechanisms,
- increased riparian, intertidal and subtidal biodiversity,
- improved creek access for salmon and spawning species,
- reestablishment of functioning surf smelt habitat ,
- increased public access through the installation of bridges and near-shore pathways,
- naturalization of the shoreline through removal of over 200 m of concrete sea wall, and,
- improved shoreline stability and high beach habitat through the accumulation of large woody debris and organic material.

The success of the pilot projects paved the way for five privately sponsored projects. Private stakeholder participation in the shoreline protection works demonstrates the potential for a more sustainable approach for the entire 30 km of West Vancouver's privately and publicly owned waterfront. Private works have resulted in more than $3 million of shoreline restoration work between Dundarave and Horseshoe Bay.

The constantly changing local and global environment requires the SPP to be a living document that is able to monitor and adapt to these changes. A process of regular (annual) evaluation of the goals, strategies and successes, and subsequent adjustment of the SPP will ensure the continued success of the shoreline protection works. In order to develop naturally sustaining systems, the SPP projects must be flexible in order to react opportunistically to available resources and take into account the long timelines associated with coastal processes. The evolution of the SPP is represented in its description of the current status of projects; it outlines new works and changes to existing projects in order to maximize shore protection and habitat benefits, including:

- tuning and adjustment of existing projects,
- new priority projects
- new long term projects
- privately funded projects.

Priority projects include the tuning and adjustment of existing pilot sites between Ambleside Pier and McDonald Creek, with the expansion of existing riparian habitat and reef structures and the creation or relocation of tombolo structures. The SPP 2012-2015 also extends shoreline protection westward to the area between Navvy Jack Point and Dundarave Pier, with strategic works planned at Marr Creek to promote sediment retention and reduce wave impacts. Larson Creek has been identified as a site in need of restoration, to improve access and habitat for fish, birds and other wildlife. The long-term projects continue to target subtidal contour realignment and habitat enhancement in order to support intertidal beach works, as well as adjustment of pier structures to restore sediment pathways along the shoreline. In addition to wave protection and habitat enhancement, the islet projects propose ocean-loop heat exchange systems to provide renewable energy and reduce green house gas emissions. Privately funded projects will continue to be based on previous shoreline successes and established whenever funding, materials and potential sites become available.

In order to afford greater public access to the SPP and its projects, information will be provided on the West Vancouver and WVSPS websites and the DWV's GIS (Geographic Information System). New communications and outreach initiatives and increased signage at the project sites will be used to share the vision of the SPP with waterfront users, to increase public awareness of the shoreline and the SPP.

This Shoreline Protection Plan 2012-2015 provides a description of the works completed to date, the challenges and their successes. It includes a description of projects for immediate consideration, potential improvements for existing projects and identifies new minor and major projects for the future. Like West Vancouver's shoreline, the SPP will forever evolve in response to changing circumstances and future issues. It is a document that describes the actions needed to create a sustainable waterfront for all that is natural, sustainable and ecologically productive.

†(Thomson, et al. 2008)

Table of Contents

Appendices

Section 1
Roadmap

1 History of the Shoreline Protection Plan (SPP)

In 2004 the District of West Vancouver commissioned the Engineering Advisory Committee (EAC) to prepare a report that recommended actions to be taken by the Municipality to reduce erosion, preserve habitat and manage maintenance and repair costs for the West Vancouver waterfront. The resulting 'Ambleside-Dundarave: Long-Term Shoreline Planning Framework' examined the current status of the waterfront, outlined key issues, suggested potential solutions, initiated the formation of the West Vancouver Shoreline Preservation Society (WVSPS) and established an action plan for future works, as shown in the timeline below.

Launched in 2006, the SPP sets forth a roadmap of long and short term projects with specific and measurable goals; it is the culmination of a lengthy process of negotiation, planning and study. The existing shoreline has undergone more than a century of development and is need of attention (Appendix A). The ultimate goal of the SPP is to recreate a naturally self-sustaining shoreline to address the impacts of development, climate change and sea level rise.
While the SPP has a study component, initially involving detailed surveying of the biophysical conditions and modelling of geo-physical processes, it is primarily a roadmap for projects to be delivered, evaluated and improved. To date, this strategy has allowed the identification of key goals, structural and ecological issues and areas for improvement, while providing the necessary flexibility for a dynamic and unpredictable environment.

"*The original shoreline consisted of diverse forms with cobble-sand drift-log beaches and long-shore sand and cobble transport to the terminus at the Capilano River. Included in this continuum were sections of exposed bedrock and boulders, creek estuaries that discharged to the upper foreshore, wave cut escarpments that balanced sediment supply and good access from tide-line to the water's edge for fish, birds and humans*." (EAC, 2005)

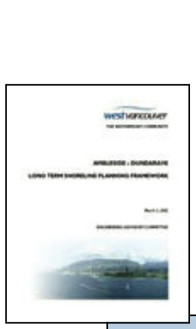
The SPP is driven by the principle that the most cost effective and environmentally sound strategy to protecting the shoreline is to recognize and re-establish the key restorative features of a natural coastline that have been altered by development. The identification of key biological and geological features of the coastline allows an effective comparison with the current conditions, and identification of areas which may be improved or enhanced with long-term and far-reaching benefits. These 'key' features of the shoreline include;

- Creeks and streams as habitat and sediment supply
- Salt marsh and riparian habitat
- Beach profile/elevations
- Reefs as natural wave defences
- Intertidal and subtidal habitat
- Sediment pathways
- Accretion and erosion processes

With sea levels expected to rise up to 60 cm by 2100, winter storms of escalating frequency and ferocity and increasingly severe El Niño events (see Appendix A, Section 4.3) protection of the West Vancouver waterfront is an issue of mounting importance. As structures age and incur more seasonal storm damage from inundation and impacts, the costs of repair will grow. The SPP provides an action plan to achieve long term sustainability and mitigate the effects of climate change and global warming, safeguarding the West Vancouver waterfront and shoreline infrastructure in a cost effective and environmentally beneficial manner.

The benefits and scope of the SPP extend beyond the physical shoreline; the coastal zone is a product of the entire watershed, which includes both the city and parkland. It is impacted by, and has the potential to significantly affect urban areas, municipal infrastructure and the upland. As such the SPP represents a piece of the puzzle that fits within the District's wider Official Community Plan. Many projects have come to fruition through cooperation and integration with the Parks, Planning, Communications and Engineering Departments. SPP community benefits over the past three years include the protection of multi-million dollar sewer infrastructure, enhancement and protection of WV Parks, creation of a mutually beneficial mechanism for private landowners to participate in shoreline restoration, improved fish access at stream and creek mouths, a better understanding of the importance of upland watercourse and ground water management, and a beneficial use for waste construction sediments normally hauled away to dumpsites.

The SPP presents a means for the District to achieve its objectives of preserving and enhancing public amenities while protecting the natural shoreline environment, from marine waters to upland parks and watersheds. As such the SPP integrates with the District's Official Community Plan, meeting policy standards for Local Economic development, Social Planning, Neighbourhood Character, Natural Environment, Parks, Recreation, Utilities, Government Connectivity and Finance.



EAC Long Term Planning Study

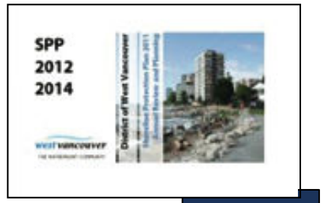
DWV Under-water shoreline study

WVSPS Shoreline Erosion General Comments

DWV Pilot Project Post-construction Habitat Assessment 2006/2007

SPP 2008

WVSPS Surf Smelt Spawning Survey Interim Report



SPP 2012

2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012

Between 1965 and 2004 29 reports were published by and for various agencies regarding the protection and enhancement of West Vancouver's shoreline infrastructure and habitat

WVSPS Established

Pilot Projects are underway Capilano & Totem Groyne, Lawson Creek and McDonald

Works at 15th St. begin

Monitoring surveys indicate increases in habitat diversity and quantity

West Van Streamkeepers record 42 salmon in Lawson Creek

First privately funded projects initiated at 27th and Horseshoe Bay

Bridge constructed at Lawson Creek with donation from Lanskail Foundation. Tuning works at Lawson Creek and McDonald

Reefs created at Ambleside Pier. Tuning intertidal habitat at Lawson Creek & Pier.

Privately funded projects completed at Ferndale & Horseshoe Bay .

Three kelp reefs created at Lawson Pier and Ambleside Pier funded by WVSPS and Coho Society.

Work at begins at 28th and Rodgers Creek site

WVSPS surf smelt spawning survey study

Subtidal reef created at Navvy Jack Point

1.1 Shoreline Preservation Techniques and Strategies

The Shoreline Protection Plan highlighted the need for 'SMART' projects (Specific, Measurable, Attainable, Realistic and Timely) that could be implemented in place of recurring shoreline repair works to create a sustainable shoreline, in a cost effective manner. The following strategies and techniques are used to implement soft shoreline protection measures, restore the historically natural condition of the beach, increase the productive capacity of the shoreline and improve public amenities.

1.1.1 Shoreline & Infrastructure Protection

- Partially buried wave trip boulders along the shoreline disrupt erosive wave energy before it reaches the upper shore and sea wall.
- Replacing sea walls with soft shoreline protection features such as boulder wave trips, reefs, berms and salt marsh reduces wave impacts and erosion.

1.1.2 Sediment Deposition

- Tombolo mounds and drift sills guide and trap sediments on the shoreline.
- Cobble and boulder berms trap sediments on the shore which would otherwise be lost.
- Elevating the shoreline improves the natural resistance of the beach to waves.

1.1.3 Creeks and Streams

- Removal of culvert pipes to 'daylight' creeks and recreation of riparian zone along banks.
- Directing creek flows laterally along the beach, reduces flow rates, limits scouring and promotes sediment retention along the upper shore.
- Creek access for fish is improved by the creation of riffle pools, staging areas, and shelter.

1.1.4 Habitat Enhancements

- Large boulders create stable substrate for colonization by algae and encrusting invertebrates, which in turn provide habitat and resources for motile species.
- Construction of subtidal reefs using large rock provides ideal substrate for colonization by kelp, creating valuable fish habitat.
- Planting high value salt marsh and riparian habitats increases biodiversity and provides an important source of nourishment for shoreline species.
- Marine and near shore plants and encrusting animals help reduce wave energy and stabilize the substrates in which they grow improving the shore's resistance to erosion

1.1.5 Public Amenities

- Constructing footpaths to improve the continuity of the Seawalk, creating and improving access to the shoreline and facilities re-connect the public with the foreshore.
- Habitat features and enhancements provide an opportunity to engage the public with the natural environment, promoting stewardship of the shoreline and watersheds.

1.1.6 Economic Benefits

- Creating habitat increases the biological productivity of the site, supporting fisheries.
- Enhanced shoreline protection will help to reduce infrastructure repair and maintenance costs.

		Protection		Sediment		Habitat			Public		Economy		
		Wave Trips	Roughening	Traps	Beach Elevation	Subtidal	Intertidal	Riparian	Amenities	Engagement	Fisheries	Infrastructure	Status
Ref.	**Pilot Projects**												
3.1	Ambleside Beach (Capilano and Totem Groyne)	•		•		•	•			•	•	•	Completed 2006
3.2	Ambleside Pier	•		•		•	•	•	•	•	•	•	Completed 2009
3.3	15th Street	•	•	•	•		•	•	•	•	•	•	Completed 2009
3.4	Lawson Pier	•	•	•		•	•	•		•	•	•	Ongoing
3.5	Lawson Creek	•	•	•	•	•	•	•	•	•	•	•	Completed 2008
3.6	18th Street	•	•	•	•	•	•	•	•	•	•	•	Completed 2010
3.7	McDonald Creek and Bypass	•	•	•		•	•	•		•	•	•	Completed 2008
3.8	Navvy Jack Point	•	•	•		•	•			•	•	•	Ongoing
	Extensions												
3.9	27th Street	•	•	•		•	•	•	•	•	•	•	Ongoing
3.10	28th Street and Rodgers Creek	•	•	•	•	•	•	•		•	•	•	Completed 2011
3.11	Ferndale Avenue	•	•	•	•	•	•		•	•	•	•	Ongoing
3.12	Nelson Avenue	•	•	•			•				•		Ongoing
3.13	Seaside Place	•	•	•	•		•	•	•	•	•	•	Completed 2011
3.14	Horseshoe Bay	•	•	•	•	•	•		•	•	•	•	Completed 2010

Table 1, The status of shoreline preservation projects conducted to date, and their areas of benefit.

1.2 Key Successes

Appendices A and B review the pilot projects in more detail. It must be recognized that the shoreline enhancement features are not expected to have immediate effect. The coastal processes being addressed and their effects can occur over periods from weeks to decades, and as such the shoreline protection process includes long term monitoring in order to identify changes on a seasonal, annual and longer term basis so that shoreline protection successes can be optimized.

Site	Measure of Success
All projects	❖ Replacement of over 200 m vertical sea wall with soft shoreline protection.
Ambleside Pier to Navvy Jack	❖ Half of vertical sea wall replaced with soft shoreline protection features. ❖ More than 1/3 of the beach has increased in profile from the natural accumulation of sediments, with a net volume increase of 4,500 $m^{3.}$ ❖ Replacement of over 6,000 m^2 low productivity intertidal habitats with high productivity habitat. ❖ Construction of 1500 m^2 stable subtidal habitat for kelp and fishes. ❖ Creation of 3000 m^2 stable intertidal habitat for algae and invertebrates with an associated population increase of 30,000,000 barnacles. ❖ Establishment of over 1000 m^2 riparian fringe and salt marsh habitat.
Ambleside Pier	❖ Bull kelp and lingcod observed on subtidal reef enhancement in 2010.
15th Street	❖ Removal of broken concrete culverts from beach. ❖ Creation of a pedestrian trail and beach access
Lawson Pier	❖ Improved sediment transport across site by opening pier structure resulting in the formation of a sandy beach to east of pier. ❖ Bull kelp and fishes observed on the subtidal reef enhancement.
Lawson Creek	❖ Creation of viable surf smelt spawning habitat through natural sediment deposition, eggs found in 2010. ❖ Increased population of spawning salmon. ❖ Construction of naturalized footpath and bridge.
18th Street	❖ Replacement of more than 50 m of vertical sea wall with soft shoreline features and riparian fringe habitat.
McDonald Creek and Bypass	❖ Pilot project features resulted in the retention of more than 600m^3 of sediments from the creek in a single 2007 rainfall event. ❖ Increase in number of spawning salmon.
Navvy Jack	❖ Enhancement features displayed 95% coverage by mussels and barnacles
27th Street	❖ Replacement of sea wall with soft shoreline protection and riparian habitat. ❖ Creation of new fresh water creek and riparian habitat. ❖ Creation of subtidal bull kelp reef.
28th Street and Rodgers Creek	❖ Replacement of sea wall with soft shoreline protection and riparian habitat. ❖ Creation of staging pool for migrating salmon and improvement of creek flow.
Ferndale	❖ Deposition of fine sediments along upper shore. ❖ Complete coverage of intertidal habitat structures by algae and invertebrates.
Seaside Place	❖ Creation of salt marsh and riparian habitat
Horseshoe Bay	❖ Establishment of subtidal kelp reef colonized by bull kelp and ling cod. ❖ Elevation of shoreline resulting in retention of fine sediments.

Table 2, Key measures of success across the SPP projects.

1.2.1 Shoreline Protection and Sediment Transport

The total length of vertical sea wall between Ambleside Pier and Navvy Jack Point has been halved (5321-D14.1-14.2, Appendix C). Across the entirety of the West Vancouver shoreline more than 200 m of vertical sea wall has been replaced with 'soft' shoreline protection. There are six areas in which there has been a net volume increase (shown as area A to F on 5321-D-14.2) accounting for over 1/3 of the beach and a total net volume increase of more than 4,500 m^3. During a single heavy rainfall event in 2007, McDonald Creek produced more than 600 m^3 of sediment which was retained on the upper shore as a result of pilot project structures.

1.2.2 Habitat Enhancements

In total the SPP projects have seen the creation of over 4,500 m^2 of stable substrate along the shoreline. Of this, more than 1,500m^2 has created high value subtidal habitat for kelp. Post construction surveys of the reefs at Ambleside Pier, Lawson Pier and 27th-28th Street identified 27 different species including bull kelp, which was abundant on each reef, and lingcod. For a full list of species and their abundance see Table 6 in Section 2.5.

Project Site	Intertidal 0m - 3.8m Chart Datum (barnacles, rockweed, mussels)	Subtidal Below 0m Chart Datum (kelp, broad-leaf algae, chitons)	Total New Stable Substrate
Ambleside Beach	200 m^2	60 m^2	260 m^2
Ambleside Pier	200 m^2	70 m^2	270 m^2
15th Street	130 m^2	-	130 m^2
Lawson Pier	280 m^2	50 m^2	330 m^2
Lawson Creek	350 m^2	10 m^2	360 m^2
18th Street	320 m^2	-	320 m^2
McDonald Creek	590 m^2	100 m^2	690 m^2
Navvy Jack Point	150 m^2	20 m^2	170 m^2
27th Street	160 m^2	750 m^2	910 m^2
Ferndale Avenue	220 m^2	-	220 m^2
26th /Rodgers Creek	80 m^2	-	80 m^2
Seaside Place	300 m^2	-	300 m^2
Nelson Avenue	20 m^2	-	20 m^2
Horseshoe Bay	30 m^2	530 m^2	560 m^2
	3030 m^2	1590 m^2	4620 m^2

Table 3, Approximate area of new stable intertidal and subtidal substrate created across all sites.

Approximately 3,000 m^2 of stable intertidal habitat was created across the pilot projects (see Table 3), with an associated population increase of over 30,000,000 barnacles. The larvae of barnacles are a valuable food source for juvenile herring and salmonids. A comparison of conditions between Ambleside Pier and McDonald Creek noted the replacement of almost 7,000 m^2 of low productivity intertidal habitat with high productivity habitat. The pilot projects have also created 1,000 m^2 of high value salt marsh and riparian habitat.

The 2010 surf smelt spawning survey found smelt eggs along a 120 m^2 patch of fine substrates at Lawson Creek which had accumulated as a result of the pilot projects (WVSPS, 2010). The survey noted increased beach elevation and kelp coverage, as key factors in the creation of habitat for surf smelt. Habitat improvements have also included creek enhancements, most notably the restoration of Lawson Creek mouth and creation of a new stream habitat at 27th Street. According to data from the West Vancouver Streamkeepers Association (WVSK) shown in Table 4, in the years following the restoration of Lawson Creek, the numbers of spawning salmon have been notably higher.

		2006 (Pre-SPP)	2007	2008	2009	2010
Lawson Creek	Chum	3	4	18	4	0
	Coho	0	47	1	4	12
	Total	3	51	19	8	12
McDonald Creek	Chum	0	0	2	0	0
	Coho	0	14	0	1	1
	Total	0	14	2	1	1

Table 4, Spawning salmon counts, by species, for Lawson and McDonald Creeks (reproduced from West Vancouver Streamkeepers Society, 2010).

1.2.3 Public Access and Amenities

A new trail between 15th Street and 18th Street creates safer pedestrian access across the site and allow the public greater contact with natural habitat features while protecting them from disturbance. Riparian habitat improves the aesthetic value for Seawalk visitors and creates drainage to protect the Seawalk, parkland and public spaces from flooding and inundation by storm waves. Art installations and signage promote awareness of fish habitat and the importance of riparian plants. Kayak access points and work to improve water access for recreational boat users improves public amenities across the waterfront.

1.2.4 Economic Benefits

Six projects west of Dundarave were privately funded contributing more than $3 million to the restoration of the West Vancouver shoreline.

Topographic monitoring has revealed a single heavy rainfall can contribute $100,000 of fine sediments which are now retained on the shoreline. The projects conducted between McDonald Creek and Ambleside Pier have resulted in the deposition of more than $750,000 of fine sediments to date.

Wave protection from the enhancement can also bear considerable economic benefit by reducing storm and debris impacts to the sea wall and upper shore. The 2001 storms resulted in more than $540,000 worth of repairs with a program of work that spanned two years.

Although it is hard to quantify economic benefits of the improvements to fish habitat; greater coverage of barnacles and kelp, the presence of surf smelt spawn and increased numbers of salmon indicate that the West Vancouver shoreline restoration works have had a positive impact on the productive capacity of the shore that will result in benefits to fish and in turn the recreational and commercial fisheries.

1.3 Shoreline Protection Plan 2012

The SPP 2012 is built on the successes of previous works and while it identifies a wide range of project types, size, and cost along sections of the West Vancouver coastline it intends to focus attention on the shoreline between Navvy Jack Point and Dundarave. This section of the public shoreline includes a significant section of West Vancouver's biggest public amenity, the Seawalk that continues to sustain overtopping wave and debris damage during winter storms. This damage and associated costs of repair will increase along with climate change and sea level rise if not addressed.

The SPP 2012 focus on public shoreline projects is driven by the reality that shoreline restoration fronting private residents must be "opportunistic" rather than planned. While true, many of the projects completed and planned for the public shoreline can be applied to areas fronting private properties as timing and events permit.

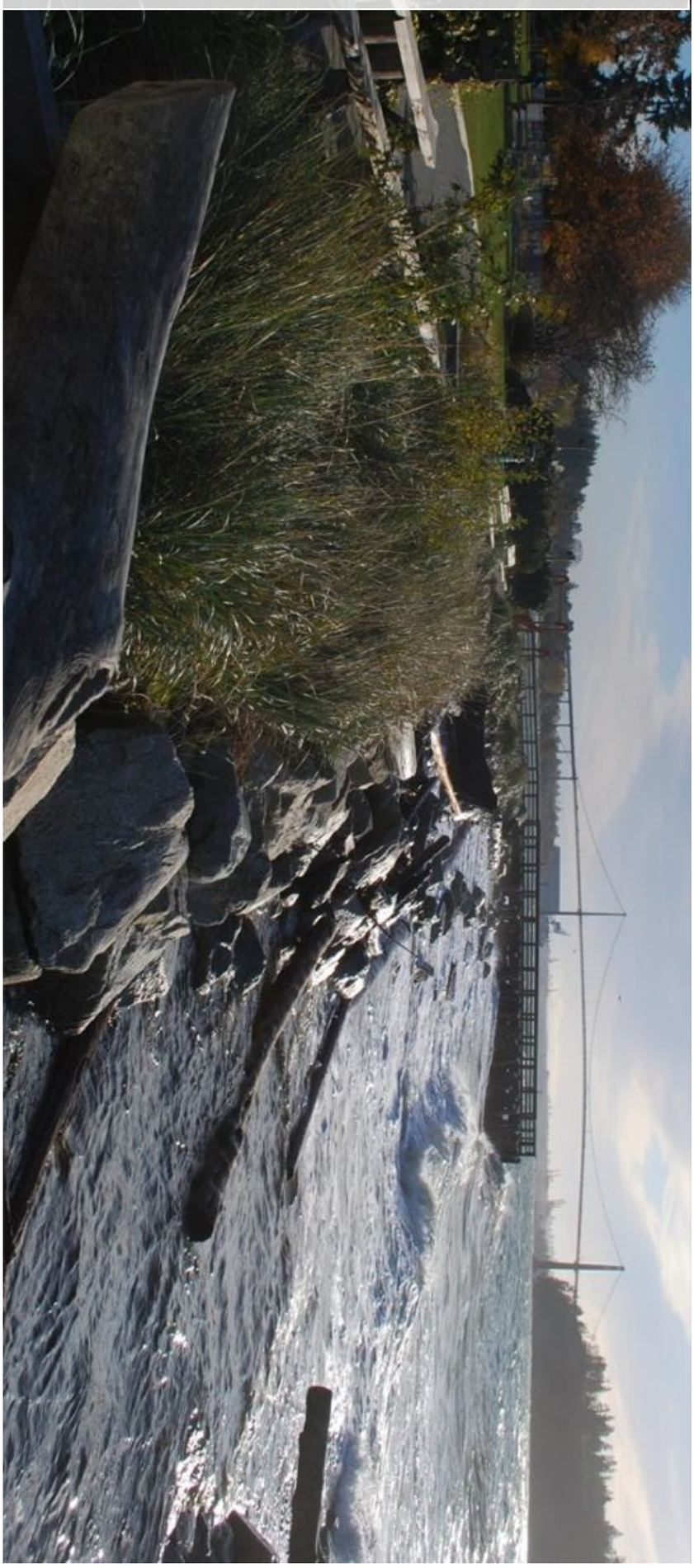
An overview of proposed projects for 2012, estimated costs and duration of construction work is provided in Table 5. These projects are described in more detail in Section 2 with additional long term projects. This report presents potential projects that have been identified at this time, however given the rapid development of new projects over the past three years it is recommended that the SPP be reassessed on an annual basis to ensure that all opportunities are identified, planned, recorded and managed for maximum success and value.

#	Location / Project	Est. Cost	Start Date (by phase)	Est. Length
1	Marr Creek Intertidal Reef Construction	$30,000	Biophysical Survey: March 12 Construction: 4 June 2012 or 18 June 2012	5 days
2	Lawson Park Riparian Enhancement	$25,000	ASAP - during construction of Arts building	5 days
3	Navvy Jack Shoreline Enhancement	$25,000	Biophysical Survey: 9 April 2012 Construction: 2 July 2012	5 days
4	Public Communication & Outreach	$10,000	Immediately/ when required	-
5	Lawson Creek to McDonald Riparian Enhancement and Tuning	$25,000	Biophysical Survey: 7 May 2012 Construction: 16 July 2012	5 days
6	McDonald Creek Intertidal Reef Extension	$20,000	Biophysical Survey: 21 May 2012 Construction: 10 September 2012	2-3 days
7	Lawson Park and Ambleside Shoreline Enhancement	$10,000	Biophysical Survey: 18 June 2012 Construction: 23 September 2012	2 days
8	Larson Stream Enhancement	$20,000	Biophysical Survey: 26 March 2012 Construction: June 18, 2012 or Aug 2012	2-3 days
9	Project Management and Agency Interaction	$25,000	Immediately/ when required	-
10	Shoreline Surveying inputs to DWV GIS	$20,000	Immediately/ when required	-

Table 5, Proposed Projects for 2012; costs, start dates and estimated duration of physical works.

Section 2

Future Projects



2 Future of the SPP

2.1 Priority Projects 2012

Ten items have been prioritized for action in 2012 including practical projects between Marr Creek and Ambleside Pier. The projects proposed are intended to build on previous successes and continue the work of the pilot projects. Particular attention is also paid to Marr Creek as a critical source of sediment input to the shoreline and one of the few remaining stretches of the public waterfront with a hard-faced concrete seawall, and also Navvy Jack as a key point for controlling longshore drift and sediment erosion. In addition to the practical projects outlined below the SPP 2012 action plan includes a focus on communications and outreach (see Section 2.4) and Agency Liaison (see Sections 2.5-2.7).

2.1.1 Marr Creek Intertidal Reef

Marr Creek is a source of significant sediment input to the West Vancouver shoreline. To date no enhancement structures have been employed to promote the retention and distribution of these sediments. The vertical lock-block sea wall is prone to over-topping and experiences significant wave impacts during storms. Large boulders will be used to construct wave defences, trap sediments and create intertidal habitat along the shore adjacent to the Marr Creek culvert. Crescent shaped reefs will be positioned in the lower intertidal zone to create wave trips and disrupt energy on the lower shore while trapping and stabilizing fine sediments at the base of the sea wall. The boulders will provide stable habitat along the intertidal zone for various algae, invertebrates and fishes as well as stabilizing fine sediments for eelgrass bed enhancement.

2.1.2 Lawson Park Riparian Enhancement

The shoreline and creek mouth at Lawson Park have undergone extensive enhancement work with great success. Reshaping the pathway will permit the expansion of the riparian habitat along the upper shore and replace the existing angular rock along the upper beach with round river rock which has been reclaimed from nearby construction work. The project will provide better protection for the upper shore and John Lawson Park from flooding or overtopping by waves, or debris impact. In addition the project will improve public access across the site and to the shoreline, improved aesthetic value of the upper shore for visitors to the site, and enhanced biodiversity.

2.1.3 Navvy Jack Point Shoreline Enhancement

The proposed works at Navvy Jack Point continue works performed in 2011 with the strategic placement of boulders to consolidate the existing boulders along the shallow subtidal and intertidal zone. The steep drop-off at Navvy Jack Point contributes to erosion and loss of sediments across the entire shore, as sediments carried from the west by longshore drift are intercepted at the point by easterly shearing currents and carried to deeper water where they are lost. The focus of these proposed works is to create a more stable toe at Navvy Jack Point to guide and trap near-shore sediments, thereby rebuilding the shoreline, while at the same time creating valuable stable habitat at a range of depths. The intention is to create habitat and shoreline enhancement features that will increase biodiversity and enhance existing habitat features while recreating a more natural shoreline that protects and maintains the upland.

2.1.4 Lawson Creek to McDonald Enhancement

The projects at 15th Street, Lawson Pier, Lawson Creek, 18th Street, and McDonald Creek and Bypass (see Sections 5.3 to 5.7 in Appendix A) involved the construction of tombolos and wave trips that were initially positioned along the upper and mid shore to rebuild the upper shore. To provide maximum benefit, as sediments continue to collect on the upper shore the tombolos will need to be moved closer to the low water line and, where appropriate, new tombolos will be constructed. Reusing the existing tombolos will mitigate temporal impacts as these boulders are already colonized by a variety of species and act as seed stock, and reduce project transportation and material costs by reusing onsite materials. Tombolos along the mid and lower shore will not only trap more nearshore sediments and expand the beach profile, but also increase wave protection for the Seawalk and waterfront. In addition to the relocation and construction of tombolos, expansion of the existing riparian habitat bench along the shoreline will provide additional wave protection and drainage, preventing flooding and overtopping of the Seawalk while increasing biodiversity across the site and improving the aesthetic value of the site for the public.

2.1.5 McDonald Creek Intertidal Reef Extension

The existing intertidal reef on the west side of the McDonald Creek culvert was installed to direct creek flow along the beach to prevent scouring, promote sediment retention on the upper shore, provide wave protection and create stable intertidal habitat for algae, marine life and seabirds. The reef has also served to stabilize the beach to the west by trapping sediments carried by longshore drift, resulting in sediments collecting to form a pocket beach next to the culvert. Extension of this reef structure would further stabilize this area and allow the accumulated sediments to expand, softening the upper shoreline, while providing additional intertidal habitat.

2.1.6 Lawson Park and Ambleside Shoreline Enhancement

A step formation of tombolos was positioned in front of John Lawson Park as part of the pilot projects in an effort to trap sediments along the mid and upper shore, widening and roughening the beach; which was achieved with great success. Extending the sequence of tombolos along the shoreline towards Ambleside would benefit sections of shoreline that still experience high levels of erosion. The creation of additional tombolos would provide increased wave protection along the mid and lower shore, preventing waves from reaching the sea walls while continuing the successful sediment retention strategy to help rebuild a narrow section of shoreline. In addition, extension of the spur at the foot of Ambleside Pier would provide extra stabilization for fine sediments along the upper shore and create additional stable, subtidal habitat for kelp, marine life and seabirds.

2.1.7 Larson Stream Enhancement

As with all creeks along the West Vancouver watershed Larson Creek is important habitat for salmon which use the creek as spawning habitat, and for other freshwater fish, amphibians and birds. The creek mouth opens onto the beach at Larson Park and is often choked with large woody debris which creates a barrier for migrating fish. Opening and enhancing the creek mouth, using logs, rocks and sediments to create meanders, shade and riffle pools provides ideal habitat for migrating fish, aquatic life and birds. While the initial survey date is flexible, construction works need to be planned for spring or if necessary August in accordance with Fisheries and Oceans Canada (DFO) recommendations.

2.1.8 Ferndale Berm Expansion - Privately Funded

The elevated mid-shore berm was constructed at Ferndale to trap and stabilize fine sediments on the heavily eroded upper shore. Construction of Phase 1 began in 2008 with a mid-shore berm elevating the upper shore fronting 4140 and 4270 Evergreen Avenue, and placement of wave trips along the mid and upper shore. Photographic documentation of the site has shown considerable aggregation of fine sediments along the upper shore since construction. The next phase of the Ferndale project has been initiated by neighbouring property owners and will see the existing berm extended to the east as shown in 5321-D-11.1 (Appendix B). The phased approach allows the berm to be constructed in concert with funding, weather conditions, time limitations, and availability of materials and labour. For a full description of the Ferndale project see Section 5.11 in Appendix A and the drawings and photographs in Appendices B and C.

2.2 Long Term Projects

These projects encompass larger areas, with far reaching effects and goals. The scale of the project and costs mirror the scale of the long term benefits. These projects primarily address the underlying problem of the narrowing shoreline by restoring the natural beach profile using techniques that would create significant habitat enhancements and provide much greater protection of the waterfront infrastructure.

2.2.1 Lawson and Dundarave Pier Adjustment

The piers at Lawson Park and Dundarave were both designed over 100 years ago. The pier structures have contributed to shoreline erosion by interrupting sediment transport along the shore. In the previous shoreline preservation works at Lawson Pier, piles were removed to improve sediment transport along the upper shore by allowing more sediment to leak through the structure (see Section 5.4 in Appendix A, 5321-D-5.1 in Appendix B). It is recommended that this process is repeated to open both structures allowing the transport of sediments from west to east across the site. As Dundarave Pier has a more solid structure this may involve the creation of a bridge structure. A short term solution at Dundarave could involve manually moving sediment from the over full beach on the west.

2.2.2 **Navvy Jack Point to Dundarave Pier**

Shallow, sloped tombolo humps will be positioned along the lower intertidal zone to create stable habitat for rockweed, barnacles, mussels and other intertidal biota; stabilize near-shore sediments and trap fine sediments on the mid and upper shore, and to provide wave protection for the sea wall. Two drift sills will be constructed to create additional lower intertidal and subtidal habitat for key species such as kelp, while providing enhanced protection from storms, waves and rising sea levels.

2.2.3 **Subtidal Contour Alignment**

Raising the subtidal elevations with reefs and drift sills will achieve three key goals; it will create habitat and improve the productive capacity of the site, improve wave protection and stabilize sediments along the shoreline.
Subtidal reefs and drift sills will provide habitat for kelp, allowing the patches of kelp which already exist to expand into kelp forests spanning the shoreline. Kelp forests are important habitat for many marine species including salmon, rock cod, and sea otters, and also provide considerable shoreline protection as the complex of kelp fronds disrupts wave energy off-shore. Purposefully placed drift sills will also serve to moderate the process of longshore drift so that sediments are trapped on the upper shore and erosion is reduced. Widening the beach profile will assist this process, reducing wave action on the upper shore by slowing waves as they travel inshore, ensuring that fewer reach the sea wall.

2.2.4 **Future Islets**

The islet projects would provide shoreline protection, waterfront enhancement and the potential for a cutting edge energy conservation project. Three potential sites have been identified; the foot of 22nd Street at Navvy Jack, just off shore of Ambleside Pier and off shore of Lawson Pier. In addition to habitat enhancement and wave protection, these projects are designed to contain an ocean loop heat exchange facility providing a low grade, renewable energy source for heating and cooling residential, commercial and civic properties in the vicinity.

- ***Infrastructure Protection***.
  The construction of an islet at any of the three sites would provide wave protection for the shoreline and waterfront developments by disrupting wave energy off-shore, and by intercepting the oblique waves and currents of longshore drift as they travel east. The size of the islet(s) may range from a subtidal reef to a small landmass depending on available funds and materials; the larger the islet, the greater the protection.

- ***Sediment Deposition***.
  The islets are designed to function in the same manner as a tombolo, interrupting longshore drift to trap and stabilize near-shore sediments, gradually building and widening the beach. There is flexibility in the design of the islet; however, the efficacy of the islet as a sediment trap will be dependent on its size, the bigger the islet the bigger the benefit.

- ***Habitat Enhancements***.
  The construction of an islet on the subtidal foreshore would provide stable habitat for kelp, algae, and invertebrates, creating valuable fish habitat. The islet will serve to increase the total area of productive, shallow-water shoreline for forage fish. Depending on the height above high water, the feature also has the potential to create intertidal and riparian habitat.

- ***Public Amenities***.
  The structure is designed to house an ocean-loop heat exchange system, providing low-grade energy heating and cooling for residential, civic and commercial properties in the locale. These facilities will be a significant step in the DWVs targets of 33% reduction in greenhouse gases (GHG) by 2020 and 80% reduction by 2050. Furthermore, depending on the size, location and layout, the islets provide opportunities for the creation of public space.

- ***Economic Benefits***.
  There are three main economic benefits; firstly, the islet will create improved protection for the waterfront infrastructure reducing maintenance and repair costs, secondly the ocean-loop system will provide a renewable energy source reducing the costs of heating and cooling buildings able to access the system, and finally the increase in productive subtidal and shallow coastal habitat will help support healthy fisheries.

The importance of the project in terms of reducing GHG emissions and its potential as a prototype which could be replicated throughout the Province also creates potential funding initiatives and opportunities from third party groups and Federal/Provincial agencies.

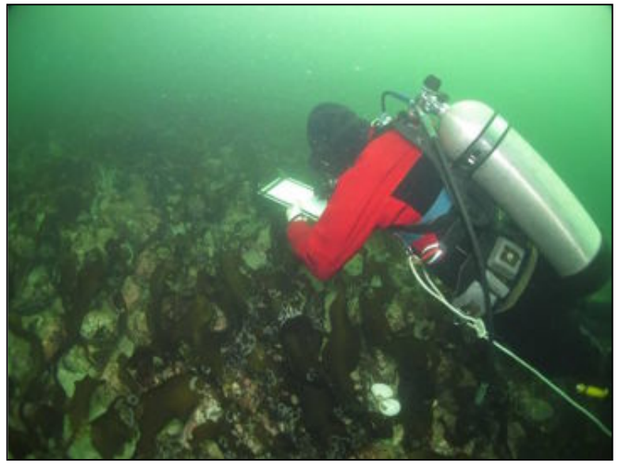
2.3 Public Engagement, Communications, and Stakeholder Participation

In addition to planning and managing the physical construction of the pilot projects, the SPP 2008 also identified the need for communication and engagement with the public and stakeholders, throughout the entire process ensuring that the public are in possession of all the facts and details. The establishment of the West Vancouver Shoreline Preservation Society (WVSPS) and the development of their website provided an important point of contact and source of information for the public and local media regarding the shoreline enhancement works. In addition to this the DWV has run information campaigns via its website and through the council members. Community participation in the SPP has also been encouraged through the installation of art projects, and the use of community volunteers and school students in the surf smelt spawning study. Volunteers, stakeholders and Non-Profit Organizations can greatly leverage the work of municipal staff and play an important role in facilitating and driving an extensive communications network that would be beneficial for the community, the District and the shoreline.

The SPP 2012-2015 provides the opportunity to examine the existing outreach and stakeholder participation strategies, and develop new approaches to communication and engagement. One of the major developments in the communication strategy is the incorporation of the SPP into the DWV GIS (Geographical Information System) http://westmap2.westvancouver.ca/westmap_basic/. Project profiles (see Appendix E) will be linked to their location on the interactive map, providing detailed information and photographs of the project features. The WVSPS and Ambleside Now websites also provide a platform for communication to the general public and media; with the ability to link to resources, images and other websites allowing the reader to access as much or as little information as they require. Communicating with technology provides open access to the general public regardless of their age, location, mobility, language and sensory impairments.

In addition to communicating via websites and the internet, direct communication *in-situ* through signage, art installations and other forms of communication are vital to immediately address questions and concerns and promote an interest of the various enhancement features that are directly accessible to the public in that space. On-site signage should encourage active engagement and interaction with the environment and the projects, directing public attention to features, species, and observable successes. Interpretation at the site has the capacity to promote a sense of stewardship over the shoreline and waterfront, promoting environmental responsibility among beach and Seawalk users.

2.4 Shoreline Surveying & Monitoring



As the process of shoreline restoration is necessarily slow and the techniques employed may require occasional tuning, ongoing monitoring is a requirement to ensure the success of future works and existing works in the long term. Biophysical surveys of the sites have quantified changes in substrate and biota (see Table 6), identifying the most successful strategies and optimizing future projects to ensure maximum benefit for key species.

The level of monitoring, techniques employed, and consequently the detail of the data and costs vary according to constraints and requirements.

The existing surveys of the shoreline between Ambleside Pier and McDonald Creek have used topographic, GPS and photographic surveying to perform a rapid assessment of intertidal habitat zones and elevation across the site, and quadrat and transect surveys to obtain a more detailed description of biophysical features. The survey technique provides a repeatable system which permits analysis of general conditions over extended time periods and comparison with a baseline (calculated using historical survey data and photographs) to show overall changes.

The pilot projects also presented an opportunity to third party organizations to collect and share data and for community participation projects. The West Vancouver Streamkeepers Society (WVSS) closely monitors the annual salmon run in the creeks of West Vancouver. The West Vancouver Shoreline Preservation Society (WVSPS) Surf Smelt Spawning Habitat Project has provided a measure of success for the sediment transportation features at Lawson Creek. The WVSPS surveys have revealed significant changes in the available habitat at Lawson Creek (see Appendix C). These surveys have the potential to be expanded to other indicator species such as herring, lingcod, shorebirds and plant species, to provide a quantifiable measure of success of other habitat features.

Common Name	Scientific Name	Abundance*		
		Ambleside	Lawson	27th
Barnacles				
Acorn	*Balanus glandula*	Abundant	Abundant	Common
Brown Alga				
Seersucker	*Costaria costata*	Common	Common	Sparse
Sugar Wrack Kelp	*Laminaria saccharina*	Abundant	Rare	Sparse
Rockweed	*Fucus gardineri*	Common	-	-
Bull Kelp	*Nereocystis luetkeana*	Abundant	Common	Abundant
Crabs				
Red Rock	*Cancer productus*	Sparse	Sparse	Sparse
Fish				
Tide-pool Sculpin	*Oligocoitus maculosus*	Sparse	-	-
Black-Eyed Goby	*Coryphopterus nicholsi*	Few	-	Rare
Lingcod		Rare	-	-
Perch	*Rhacochius vacca*	-	Rare	-
Green Alga				
Sea Lettuce	*Ulva fenestrata*	Abundant	Abundant	Abundant
Jellies				
Moon	*Aurelia aurita*	Common	-	-
Red Alga				
Arches Red Seaweed	*Fryeella gardneri*	-	Abundant	Common
Bladed	*Unidentified Species***	Abundant	Abundant	Abundant
Mermaid Glove	*Dictyota binghamiae*	-	Few	-
Network Red	*Polyneura latissima*	-	Rare	-
Rainbow	*Mazzaella sp.*	Rare	-	Rare
Turkish Washcloth	*Mastocarpus papillatus*	-	-	Common
Thin Dulse	*Plamaria mollis*	-	-	Abundant
Purple Laver	*Porphyra sp.*	-	-	Sparse
Red Filamentous	*Polysiphonia sp.*	Few	Few	Few
Sea Anemone				
Buried Green	*Arthopleura artemisia*	Common	-	-
Sea Cucumbers				
California	*Parastichopus californicus*	Sparse	Sparse	Sparse
Sea Stars				
Ochre	*Pisaster ochraceus*	Abundant	Abundant	Abundant
Mottled	*Evasterias troschelii*	Sparse	Sparse	Sparse
Sunflower	*Pycnopodia helianthoides*	Abundant	Abundant	Abundant
Leather	*Dermasterias imbricata*	Sparse	-	-

Abundance Category	*Algae & Attached Organisms* (% Coverage)	*Mobile Organisms* (Counts per Site)	*Bivalves* (Counts per m^2)
Rare	<5%	1	<1
Sparse	5-25%	2-4	1
Few	26-50%	5-10	2-3
Common	51-75%	11-30	4-9
Abundant	>75%	>30	>10

Table 6, Observed species on subtidal reef enhancements, October 21st 2010.

2.5 Scheduling

Experience from the pilot projects has shown that projects should be started/ completed during low tide events between March and November in order that they mitigate impacts during construction and are in place before exposure to extreme winter wave and storm conditions. Early exposure to significant natural forces and events permits 'tuning' of the structures so that they achieve maximum benefits from the very start. By timing the various phases of the pilot studies in this way the maximum benefit can be achieved, over the shortest period of time with minimum effort. Managing the pilot projects as 'annual phases' enables knowledge and experience gained throughout the year to be immediately applied. This degree of flexibility is preferable and necessary in such a dynamic environment.

It must be recognized, however, that flexibility must also be included at the planning phase; the pilot projects were conducted so as to take full advantage of the availability of materials and access to labour and equipment to minimize cost. For certain projects and enhancement features it may also be necessary to time construction phases so that they coincide with low tides, fish sensitive periods or more favourable weather.

2.6 Agency Liaison

The shoreline enhancement works can require approval and permits from DFO, Environment Canada and Transport Canada. It is important that a range of projects of varying size are prepared and planned sufficiently in advance, including the acquisition of relevant authorizations and permits, so that they can be implemented efficiently and take full advantage of suitable windows and available materials and equipment. Similarly the notification and agency liaison process must be initiated in advance, wherever possible.

It is a goal of the SPP to continue to strengthen and streamline linkages between Municipal needs and Provincial/Federal reviewing agencies' requirements so that project review and permitting becomes an enabling process for shoreline protection. Investment in these professional relationships is necessary to streamline the SPP and ensure its long term success. It is intended that the SPP document can be presented to agencies as a long term plan for pre-approval where possible to reduce red tape and maximize efficiency, and benefit to the shoreline.

2.7 Budget Planning

The pilot projects are planned to minimize costs maximize benefit while staying within the $100,000 annual budget. While the major projects demand greater financial commitment they provide greater benefit and value per dollar spent by virtue of their size.

The construction strategy for the initial pilot projects was designed to take advantage of available materials and equipment to reduce project costs. Similarly, the plans for tuning the existing pilot projects are designed so that the existing structures are simply dismantled and relocated within the same site. By reclaiming the materials in this manner the costs are limited to logistics and equipment, with significantly reduced outlay for materials. In the early pilot projects rock from the Squamish Highway development and various excavation projects in the district were used as a cost-effective source of native materials. A large amount of rock has recently been reclaimed from the British Properties for future works and it is likely that there will be construction projects planned throughout the Lower Mainland that may offer a cost effective source of suitable materials. These opportunities should be actively sought out by municipal staff from existing District works, associated consultants and contractors. Establishment of a short term storage site at the foot of 24th will greatly assist this cost-cutting activity.

The initial pilot projects were planned with sufficient flexibility so designs could be adapted according to the availability of materials without altering the structural or environmental integrity of the projects. The new phase pilot projects will be approached with this same flexibility, and with new knowledge and techniques acquired during the SPP 2008, to improve further construction and financial efficiencies.

To take advantage of available funding and materials a range of projects of varying size must be planned, approved or authorized and 'ready to go' at any given time. The participation of the regulatory agencies (DFO, Environment Canada, Transport Canada, and DWV Strategic Planning) in the SPP is essential in order to continue to deal with the 'on demand' economic realities of economically sensitive shoreline protection work.

2.8 Conclusions

The Shoreline Protection Plan 2012-2015 identifies a number of new projects and extensions of existing projects which will build on the successes of the SPP so far and increase the effectiveness of West Vancouver's Shoreline Protection Program. New projects are primarily proposed for the area between Navvy Jack Point and Dundarave. The outflow of Marr Creek is a potential source of sediments and there are key habitat features such as eelgrass, which would benefit from protection and enhancement. Because of its geographic and topographical position, Navvy Jack Point is a site of considerable importance in terms of sediment transport across the shoreline, for this reason it will be a significant focal point for future works with the overarching goal of creating a stable toe at this area. All of the proposed structures, whether providing wave protection or sediment transport are strategically positioned to provide maximum habitat opportunities for algae, invertebrates and fish. Similarly, additional new pilot projects include the restoration of Larson Creek mouth to improve access and habitat for fish.

The existing pilot projects between Ambleside and McDonald will require tuning and further development to optimize the benefits that have already been accrued. The tombolos and drift sills constructed along the mid and upper intertidal zones were designed to improve the upper beach and riparian zones, these structures can now be moved to a lower elevation where they will trap fine sediments to thicken the mid shore while maintaining the gains realized in upper shore areas. Reusing structures in this manner reduces cost and environmental impacts. Additional structures should be created along the lower and mid shorelines where necessary, in particular along the shoreline fronting Lawson Park. Biophysical surveying of the sites will guide these works.

Riparian and salt marsh habitats should be extended and re-planted to increase the biodiversity and aesthetic value to Seawalk users. This work can be continued along the full length of shoreline but particular attention should be paid to Lawson Creek, with the reworking of the Seawalk trail to extend the riparian habitat and create a more aesthetically pleasing and accessible amenity.

The new major projects proposed represent large-scale efforts and major initiatives; the scale and estimated cost of these projects reflects the scale of the predicted benefits. The major projects include contour realignment and subtidal elevation at the key areas of Lawson Pier and Navvy Jack Point to Dundarave; providing more effective wave protection, decreasing erosion, trapping near-shore sediments and creating significant subtidal habitat for kelp beds. The pier structures at Dundarave and Lawson Creek are also recommended for tuning allow beach materials to leak across the site, restoring natural sediment pathways and reducing the effects of erosion.

The construction of offshore islets at 22nd Street, Ambleside Pier and/or Lawson Pier will create a large stable toe at strategic points along the shoreline with maximum beneficial effect on sediment transportation. The islets also have the potential to create scalable high value habitat features and public amenities. Most notably, they provide a site for the creation of an ocean-loop heat exchange system. This initiative will help the Municipality reach its emissions targets for 2020, cementing the reputation of the Municipality as a 'Green Leader'. The innovative nature of the future islets project as an energy conservation project, and the potential as a design model for 'cookie cutter' projects throughout BC's coastal communities may create opportunities for third party and provincial funding.

There is potential for many more projects along the west of Dundarave Pier, however as this stretch of shoreline is fronted by privately owned properties this work can only be done as opportunities become available. Although these projects cannot be included into the SPP due to their opportunistic and unpredictable nature, they will benefit from the SPP as they can be designed and planned according to the previous successes of the pilot projects and the knowledge and strategies outlined in the present document.

Communications and outreach play an important role in the future of the SPP. The West Vancouver shoreline is a much-loved public amenity however the opportunities for public engagement and stakeholder participation have not been fully seized. The creation of temporary, permanent and interactive signage would create a valuable opportunity to inform the public of West Vancouver's commitment to sustainability and preservation of natural habitats and public amenities.

Monitoring of the existing sites should be continued indefinitely, and expanded to new projects as soon as possible. The scheduling of the projects proposed in the SPP 2012-2015 is dependent on the availability of materials, equipment and funding. The existing pilot projects were planned with flexibility so that they could be initiated opportunistically to minimize environmental and financial impacts. This proven strategy forms the 'back bone' of the SPP 2011 with the proposed projects being designed with varying budgets and material requirements. SPP 2008 demonstrated that Municipal, Provincial and Federal reviews can be an enabling process for shoreline protection and enhancement. The SPP 2011 seeks to strengthen and improve these regulatory processes in order ensure the District of West Vancouver is able to maximize shoreline protection and enhancement of its waterfront.

Glossary

Accretion	The deposition of **sediments** by natural forces, as in the addition of sand to a beach by ocean currents or rivers.
Algae	A large and diverse group of aquatic plants which contain chlorophyll but lack flowers, roots, true stems or leaves, e.g., seaweeds
Amphibian	A group of cold-blooded invertebrate animals which includes frogs and toads.
Backshore	The area of shoreline between the high water mark and the **riparian** zone, which is usually exposed but may be affected by storms and very high water events.
Beach Nourishment	The addition of imported **sediments**, usually sand, to the upper shore of an eroded beach.
Berm	A raised, armoured platform created along the shoreline to increase the beach profile and provide wave defences.
Biodiversity	The number of different species contained within a habitat or **ecosystem**.
Biological Productivity	The amount of organic matter accumulated or produced by an **ecosystem** in a set period of time; the amount of **biota** an ecosystem can accommodate and support.
Biophysical	The application of physics and physical processes to biological phenomena; **Biophysical monitoring** - the assessment of the biological and physical features of the coastline
Biota	The animal and plant life of a particular habitat or region.
Coastal Processes	Collective term covering the action of natural forces on the shoreline and nearshore seabed, for example waves, currents, **erosion** and **accretion**.
Drift Sill	Low impact **groyne** which does not protrude above the natural storm beach profile, may also be a natural formation such as bedrock.
Erosion	The removal of sediments or materials from a beach by natural forces such as waves and currents.
Fish Habitat	Areas which provide space or resources for fishes; may include spawning substrates, **riparian** habitats which contribute insect food and the **intertidal** zone which is periodically available.
Foreshore	The area of shoreline between the high water mark and low water mark.
Geophysical	The study of the structure, composition, and dynamic changes of the physical environment.
GIS (Geographic Information System)	Integrated system of hardware, software and GPS data for electronic geographical mapping.
Groyne	A stone breakwater which runs along the beach, perpendicular to the shoreline, to prevent **erosion**.
Intertidal	See **Foreshore**. The area of shoreline between the high water mark and low water mark, which is covered during high tide (water) events, and uncovered during low tide (water) events.
Invertebrate	An animal lacking a backbone, sometimes with an external shell.
Longshore Drift	The movement of **sediments** along a coast by waves that approach at an oblique angle to the shore and then recede directly away from it.
Motile	(of an animal) Capable of motion.
Naturalization	To be brought into conformity with the natural environment.
Nearshore	The area of shoreline between the backshore and the **offshore** zone.
Offshore	Moving away from the shoreline; the area beyond the **nearshore** or surf zone characterized by deeper waters, away from land.
Organic Material	Seaweed, driftwood, plant material and debris carried by waves to the shoreline
Overtopping	Breaching of a sea wall by water.
Quadrat Survey	A survey technique using a sampling plot (usually $1m^2$) to count **biota**, which can be extrapolated to provide a population estimate.
Riparian (Fringe)	The vegetated zone along the banks of watercourses and shorelines, riparian zones are important to the ecology of aquatic and marine environments.
Riprap	Loose broken stone or angular rock used to create shoreline defences and breakwaters.
Roughening (Shoreline)	The process of replacing uniformly low-profile shorelines, and hard-faced sea walls with more natural, irregular shoreline using features such as **wave trips**, **salt marsh**, **berms** and **drift sills**.
Salt Marsh	A **riparian** habitat; coastal grassland along the upper shore which is regularly inundated with sea water.
Sea Wall	A defensive structure along the upper shore to protect waterfront property.
Sediment	Beach **substrates** of varying grades from fine sand and mud to cobble and boulders.
Sediment Transport	The movement of **sediment** by waves and currents includes processes such as longshore drift.
Substrate	The surface on which an organism lives.
Subtidal	The area of shoreline below the low water mark, which is always covered by water.
Tombolo	A group or mound of rocks which serve to trap **sediment** and creates a sand bar or strip of sediment connecting it to the upper beach.
Topography (Topographic)	The detailed surface features of a place.
Transect Survey	A survey technique that involves sampling (counting) **biota** observed along a pre-established line or area, which can then be extrapolated to a population estimate.
Watershed	The area of land that drains into a river, creak or stream; includes the **riparian** zone.
Wave Trip	A large partially buried rock, or group of rocks, strategically placed to diffuse wave energy. Wave trips are usually constructed along the lower shore, or in front of shoreline structures.

References

B.C. Ministry of Environment. 2007. Environmental Trends in British Columbia: 2007. State of Environment Reporting. Victoria, B.C. www.env.gov.bc.ca/soe/et07/

B.C. Ministry of Environment. 2006. Alive and Inseparable: British Columbia's coastal environment. State of Environment Reporting. Victoria, B.C.

Bornhold, B. D. 2008. Projected sea level changes for British Columbia in the 21st Century. B.C. Ministry of Environment.

de Graaf, R. C. and Liao, W-L. 2010. West Vancouver Shoreline Preservation Society Surf Smelt Spawning Habitat Project: Interim report - December 2010. BC Shore Spawners Alliance / Emerald Sea Research & Consulting.

Engineering Advisory Committee. 2005. Ambleside - Dundarave Long Term Shoreline Planning Framework. District of West Vancouver. http://westvanshoreline.ca/2005EACReporttext.pdf

Foreshore Technologies Inc. 2008. Shoreline Preservation Plan 2008-2011: District of West Vancouver shoreline preservation plan, British Columbia, December 14, 2007. http://westvanshoreline.ca/F20071214WVSPPReport.pdf

Hardy, E. 2003. West Vancouver Watershed Profiles. The Pacific Streamkeepers Federation. http://www.pskf.ca/ecology/watershed/index.html#westvan

Heap, N. 2007. Hot Properties: How global warming could transform B.C's real estate sector. David Suzuki Foundation.

Jenkins, S. 2011. Foreshore Protection Strategy Update, January 28 2011. District of West Vancouver Council Report.

Thomson, R. E., Bornhold, B. D. and Mazzotti, S. 2008. An Examination of the Factors Affecting Relative and Absolute Sea Level in Coastal British Columbia. Can. Tech. Rep. Hydrogr. Ocean Sci. 260. 49p.

West Vancouver Shoreline Preservation Society. 2006. West Vancouver Shoreline Erosion General Comments. WVSPS.

West Vancouver Streamkeepers Society. 2010. West Vancouver Creeks Spawner Surveys 2010. http://www.westvancouverstreamkeepers.ca/dox/2010_SpawnerSurvey.pdf