Burrard Inlet Environmental Indicators Report
Public Consultation Document

February 8, 2008

Prepared for:

Burrard Inlet Environmental Action Program BIEAP

By:

Jacques Whitford AXYS Ltd.

Public Input

Public input is important to the BIEAP and its partner agencies. For further information about public consultation opportunities surrounding this document, or to order any of our publications, please contact us at:

Burrard Inlet Environmental Action Program (BIEAP)
501-5945 Kathleen Avenue,
Burnaby, BC
V5H 4J7

Tel: 604-775-5756
Fax: 604-775-5198

e-mail: mail@bieapfremp.org

Visit our website at www.bieapfremp.org

"A thriving port and urban community co-existing within a healthy environment"
BIEAP's overall vision for Burrard Inlet

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Ken Ashley, Metro Vancouver
Juergen Baumann, Vancouver Port Authority
Ken Bennett, District of North Vancouver
Darrell Desjardin (chair), Vancouver Port Authority
Robyn McLean, Environment Canada
Brent Moore, BC Ministry of Environment
Brian Naito, Fisheries and Oceans Canada

BIEAP program staff include:

Michelle Gaudry
Daria Hasselmann
Anna Mathewson

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Diane Sutherland
Les Swain
Cindy Walsh

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Peter Davidson

Caslys Consulting Ltd.
Ann Blyth

City of Port Moody
Julie Pavey

City of Vancouver
Don Brynildson
Andrew Ling
David Desrochers

Environment Canada
Greg Ambrozic
Wendy Avis
Rob Butler
John Elliott
Andrew Green
Deanna Lee
Gevan Mattu
John Pasternak
Bill Taylor
Cecilia Wong

Metro Vancouver
Nimet Alibhai
Jim Armstrong
Stan Bertold
Dianna Colnett
Terry Hoff
Derek Jennejohn
Andrew Marr
Roger Quan
Ken Reid
Shelina Sidi
John Swalby
Albert van Roodselaar

Post Consumer Pharmaceutical Stewardship Association
Ginette Vanasse

UBC Co-op Program
Heather Brekke

Vancouver Port Authority
Christine Rigby

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Mike Preston

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Executive Summary

The Burrard Inlet Environmental Action Program (BIEAP) is an inter-governmental partnership that coordinates environmental management of Burrard Inlet. In 2002, BIEAP prepared a Consolidated Environmental Management Plan (CEMP) to facilitate continued sustainability of the Inlet. Effectiveness of the CEMP can be assessed by following trends in indicators over time. These indicators will suggest whether current environmental management practices are successful in protecting Burrard Inlet or whether they should be refined.

This consultation document was prepared to provide current information about certain environmental indicators and to help guide planning for future development in the Burrard Inlet watershed. The report also describes ways in which the environment is being or can be protected by regulatory agencies, other decision-makers and the public.

Seven environmental indicators have been selected from a list of potential candidates suggested by the many monitoring programs conducted over the past two decades. These were chosen because their existing data sets and on-going monitoring programs are sufficiently robust to reliably reflect the effects of human activities on Burrard Inlet air and water quality[1], and to demonstrate the consequences of land development on ecosystem health. The selected indicators are tree canopy cover, parks and protected areas, waterbird abundance, air quality, greenhouse gas emissions, water and sediment quality (albeit only as reflected in copper and PCB levels), and recreational use and fecal coliform bacteria. For each indicator, four key questions are discussed in this document:

- What actions can governments, agencies, industries and the public take to maintain or improve the condition of this indicator? Why look at this indicator?
- How are data gathered and benchmarks established to evaluate the indicator?
- What are the results and trends?
- What actions can governments, agencies, industries and the public take to maintain or improve the condition of this indicator?

Table 1 provides a summary of the key findings and trends. Collectively, the indicators describe an ecosystem in fairly good condition, with improved sediment and air quality. However, there continue to be challenges associated with human activities:

- Tree canopy cover needed to provide a wide range of economic and ecosystem benefits is under continuous pressure from development
- The occasional accidental release of contaminants and the ongoing release of contaminants from storm water are still of concern
- Contaminant concentrations in killer whales and other animals remain a serious issue in the Strait of Georgia because of persistence of some old compounds and the emergence of new compounds and sources
- Greenhouse gas emissions continue to increase with a growing population.

The indicator data used in this report provide a baseline for comparison over time. They will help show whether the environmental management practices described in the CEMP are fulfilling BIEAP's mandate and goals to protect the ecological functioning of Burrard Inlet while encouraging sustainable development, or whether adjustments to the Plan are needed.

[1] However, their scope of coverage of environmental issues is at present not sufficient for a "State of the Environment" report.

BIEAP remains committed to translating information into action. As our understanding of the connections between a healthy environment, society and economy deepens, we learn about the many actions that individuals, communities, businesses and corporations can take to maintain the health of Burrard Inlet.

Table 1: Key Findings and Trends for Burrard Inlet Environmental Indicators

Indicator	Current Status
1. Tree Canopy Cover	The urban tree canopy provides economically valuable environmental services such as improving air quality, purifying water and helping manage stormwater. It is assessed for developable and undeveloped areas of the watershed[2] based on 2002 satellite imagery. Tree canopy cover is 42% in the developable areas (ranging from 26% in the English Bay and Inner Harbour catchments to 84% in the Indian Arm catchment) and 96% in the higher elevation undeveloped areas. The 42% value for tree cover in the developable area is high compared to many cities in Canada and the United States (25% to 40%), indicating that communities in the Inlet currently do a better than average job at protecting their urban forests. However, the 26% cover in some areas indicates the need to continue to protect urban forests through planning.
2. Parks and Protected Areas	In developable areas[2], 59% of the land is urban and suburban and 41% has some form of protection (wildlife reserve, regional or municipal park, green belt, golf course). Considering the entire watershed, 19% is urban and suburban land and 81% has some type of protection. These percentages are unlikely to change over time, as the land uses are designated, but habitat quality may decrease recreational uses increases.
3. Waterbird Abundance	Populations of four species of resident waterbirds (Double-crested Cormorant, Pelagic Cormorant, Black Oystercatcher) have been stable or increased since the mid 1990s. Glaucous-winged Gull populations have declined since 1975. Gulls are very sensitive to predation by the Bald Eagle, and their decreased abundance may reflect movement out of the Inlet as they adapt to the increasing danger posed by eagles. Results for waterbird populations indicate stable and favourable environmental conditions in the Inlet to date.
4. Air Quality	Air quality in the Burrard Inlet airshed is currently acceptable most of the time, and has improved notably over the past 20 years. Levels of “Criteria Air Contaminants” generally are below Metro Vancouver management targets. Carbon monoxide, nitrogen dioxide and sulphur dioxide levels have declined since the 1980s. Particulate matter (PM_{10}) and ozone levels have been more stable. There are not enough data yet for $PM_{2.5}$ to establish a time trend. Emissions of smog-forming pollutants have declined steadily since 1985.
5. Greenhouse Gas Emissions	Greenhouse gas emissions (carbon dioxide, methane, nitrous oxide) have increased steadily since 1990 and are projected to increase along with population growth. The rate of increase has slowed since 1990 (from 19% increase between 1990 and 1995 to 7% increase between 2000 and 2005). Emissions are projected to increase by 4% per five-year period to 2025.
6. Water and Sediment Quality (copper and PCB levels)	Copper levels in water are variable; although 20% of samples collected since 1985 exceeded the provincial water quality guideline for copper, no trend over time is apparent. Copper levels in sediment have declined since 1985, although two locations (Outer Harbour North, Inner Harbour) still exceeded Burrard Inlet sediment quality guidelines in 2005. In the 1980s, PCB levels in sediment were well above Burrard Inlet guidelines at most sites; however, levels have decreased markedly at most sites. Four of six samples collected in 2004 were below objectives but two sites (False Creek and Inner Harbour) remained above objectives. The trend of improved levels of copper and PCB in sediment over time is related to reduced discharges of these contaminants.
7. Recreational Use and Fecal Coliform Bacteria	Water quality at 15 of the 19 Burrard Inlet beaches is excellent for swimming, with no closures for elevated coliform levels over the past five years. Four beaches (Deep Cove and Cates Park in North Vancouver, Barnet Marine Park and Old Orchard Park in Port Moody) had periodic closures in 2002, 2005 and 2006, in part related to the lower amount of tidal flushing in these areas. Fecal coliforms are present at other beaches but not at, levels high enough to trigger beach closures. Shellfish harvesting has been prohibited in Burrard Inlet since the 1970's. There have been no closures for secondary contact recreation (boating, kayaking, windsurfing).

[2] The boundary for developable vs. undeveloped land is set at 320 m elevation to the west of Lynn Creek (in North Vancouver) and 200 m to the east.

PART 1 – Setting the Context

Overview of BIEAP and the Region

False Creek and surrounding area

The Burrard Inlet Environmental Action Program (BIEAP) was established in 1991 to provide a management framework to protect and improve the environmental quality of Burrard Inlet's ecosystem. BIEAP brings together the agencies responsible for setting and enforcing environmental legislation and policy with those responsible for land and water management to coordinate planning and operational decision-making to ensure a sustainable future for Burrard Inlet. BIEAP provides environmental assessments of development projects within Burrard Inlet, with partners using a consensus-based approach to finding 'made in the Inlet' environmental management solutions. Partners and communities bordering the Inlet are listed in Table 2.

Table 2: BIEAP Partners and Communities Bordering Burrard Inlet

The BIEAP Partners	Communities Bordering Burrard Inlet
BC Ministry of Environment	Village of Anmore
Environment Canada	Village of Belcarra
Fisheries and Oceans Canada	City of Burnaby
Transport Canada	City of North Vancouver
Metro Vancouver	District of North Vancouver
Vancouver Port Authority	City of Port Moody
	City of Vancouver
	District of West Vancouver

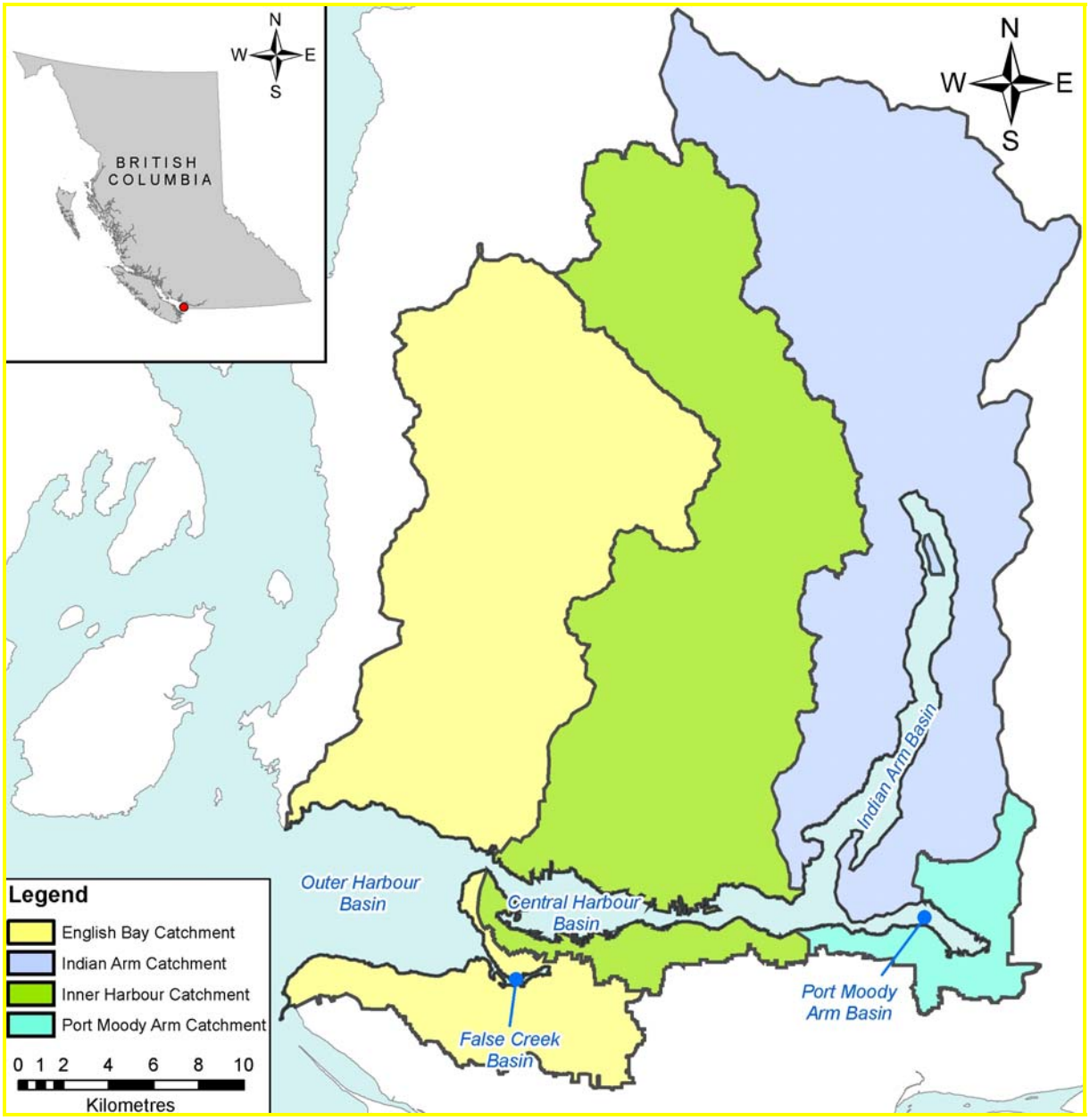
Geographically, BIEAP jurisdiction includes the marine foreshore and tidal waters east of a line between Point Atkinson and Point Grey, including False Creek, Port Moody Arm and Indian Arm. It also includes upland areas that drain into the Inlet because activities on the land influence conditions in the water. All or portions of eight municipalities bordering the Inlet form the Burrard Inlet watershed. Map 1 shows the basins (water areas) and catchments (land areas) of the Burrard Inlet watershed:

- six basins – Outer Harbour, Inner Harbour, Central Harbour, False Creek, Port Moody Arm and Indian Arm and
- four catchments – English Bay, Inner Harbour, Indian Arm and Port Moody Arm.

Burrard Inlet

Burrard Inlet is in the traditional territories of many Coast Salish peoples, including the Tsleil-Waututh, Squamish and Musqueam First Nations. Over the last 150 years, the inlet has seen much change. With European settlement, it became the active port of a burgeoning west coast timber industry and the industrial centre of the province. In recent years, the Inlet has become the centre of a highly urbanized city-region and the Port of Vancouver now serves the increasing needs of international trade.

Map 1: Basins and Catchments of the Burrard Inlet Watershed



Adapted from BIEAP

The mountains of the North Shore and the waters of Burrard Inlet give Vancouver its reputation as one of the most scenic cities in the world. Over 650,000 people live in the watershed and they, along with visitors and the remaining 1.4 million lower mainland residents, enjoy the many recreational opportunities the Inlet provides. Characterized by a temperate marine climate, the Burrard Inlet ecosystem includes rugged mountain peaks, magnificent old growth forests and fjords rich with terrestrial and aquatic life. Its forested slopes provide habitat for deer, bears, cougars and many small animals and birds and its shorelines, intertidal areas, mudflats and salt marshes support many species of marine organisms. The Pacific Flyway transects the inlet, attracting tens of thousands of migratory birds each year. An aerial view (Map 2) shows the variety of natural and developed landscapes of the watershed.

Map 2: Ortho-Image of the Burrard Inlet Watershed

Source: Metro Vancouver

Consolidated Environmental Management Plan

Environmental management of such a rich area requires balancing many priorities of the human population while ensuring clean air, water and habitat for both humans and wildlife. In addition to the effects of current and future land use, legacies from historic activities have left their imprint. These include accumulations of contaminants such as heavy metals or organic compounds (e.g., petroleum products, poly-chlorinated biphenyls [PCBs]), loss of stream and shoreline habitat, and closure of shellfish harvesting due to fecal coliform levels.

BIEAP's Consolidated Environmental Management Plan (CEMP) was approved in 2002 and provides a framework for improving the environmental quality of Burrard Inlet. The four main goals of the CEMP are to:

- Improve water quality in Burrard Inlet
- Minimize the effects of contaminated soils and sediments on human and ecological health
- Maintain and enhance productive fish and wildlife habitat and the natural biodiversity of Burrard Inlet
- Encourage human and economic development activities that enhance the environmental quality of Burrard Inlet

The Plan consolidates all the environmental management systems employed by the BIEAP partners to protect Burrard Inlet. The CEMP will help ensure that environmental values are integrated with economic and social considerations for the Inlet. It establishes a common basis for reviewing development proposals and recommends facilitation, research and information sharing to improve and enhance the Inlet's ecosystem over time. A Plan Implementation Committee was established in 2003 to help implement the CEMP and monitor its performance.

State of the Burrard Inlet Environment

One of the key commitments of the CEMP is to prepare a State of Environment report for Burrard Inlet. In 2004, BIEAP began researching potential indicators that could be used to describe the status and trends in the Inlet to policy makers, planners and the general public. Many datasets and 19 distinct indicators were evaluated for their ability to 'tell the story' of Burrard Inlet accurately (reliable dataset, ability to provide science-based statements on the state of the Inlet) and help the public understand the interconnected nature of the ecosystem. Although there are a lot of data, they did not always allow for conclusive, science-based statements to be made. BIEAP settled on seven key indicators that, taken together, help describe the complex relationship between human actions and environmental conditions in Burrard Inlet. These indicators will be monitored over time to assess performance of the CEMP and contribute information to a State of Environment report.

Indicators Used to Monitor the CEMP

The CEMP uses a risk management approach; it has identified priority ecosystem risks and issues and selected indicators to monitor the risks. Table 3 lists the indicators used, which fall into two types:

- those that quantify ecosystem assets, such as the water's ability to supply nutrients to fish and birds, and the tree canopy's ability to purify air
- those that assess the impacts of human activities on air and water.

Table 3: Burrard Inlet Environmental Indicators

Indicator Type	Indicator	Relevance
Quantifies ecosystem assets	1. Tree Canopy Cover	A measure of current levels of land development; recognizes the importance of forested land in purifying water and air, storing carbon and managing stormwater runoff
	2. Parks and Protected Areas	A measure of the amount of land protected for wildlife habitat and for recreational use
	3. Waterbird Abundance	An indicator of general ecosystem condition, as bird abundance depends on amounts of available habitat and food, and is affected by levels of contaminants in the area
Describes impacts of human activities	4. Air Quality	Related to vehicle, vessel, residential and industrial emissions; has socio-economic implications (human health, smog) and environmental implications (acid rain)
	5. Greenhouse Gas Emissions	Related to amounts of fossil fuels burned and to global climate change
	6. Water and Sediment Quality (copper and PCB levels)	Related to discharges to water from point sources (permitted outfalls) and non-point sources (stormwater, road runoff, contaminated sites, air deposition) and affects the health of aquatic organisms
	7. Recreational Use and Fecal Coliform Bacteria	Related to fecal contamination (human and animal waste) in the water; affects recreational uses such as swimming, boating and harvesting of shellfish

Because the high elevation forested mountain terrain will not be developed, indicators of land use are evaluated in terms of the lower elevation land where development has taken place or will occur. The highest elevation where development can be planned is 320 m in West Vancouver and in North Vancouver west of Lynn Creek and 200 m in areas to the east of Lynn Creek. Results are also discussed for the higher elevation areas because these areas contribute significantly to watershed functioning.

Part 2 – Links Between Human Activities and Burrard Inlet Status

Before discussing the indicators in detail, it is useful to look at the types of human activities that affect the state of Burrard Inlet, in terms of availability of wildlife habitat, introduced invasive species, and sources of contaminants and their effects on birds, fish and mammals in the Inlet. This information adds context about historic and current activities and illustrates the interconnectedness of the ecosystem.

Habitat and shoreline change over time

Stanley Park Seawalk

The 190 km of shoreline and 11,300 hectares of water and seabed of Burrard Inlet are biologically diverse ecosystems that provide habitat for many species of fish and shellfish. Changes to these habitats can have significant consequences, and can occur as a result of natural processes as well as human activities. The Burrard Environmental Review Committee (BERC), a BIEAP subcommittee of agencies with project environmental review mandates, began reviewing project proposals in Burrard Inlet in 1991. BERC objectives are to ensure that projects are designed and located to minimize or avoid significant habitat impacts and to promote habitat development.

Significant changes in Burrard Inlet have taken place since the start of European settlement, and have resulted in substantial declines in some habitat types (e.g., salt marsh and tidal flats). However, the BERC project review process helps ensure that further human-induced habitat changes over time are neutral or positive.

Invasive marine species

Invasive species have massive potential for ecological and economic impacts on existing species and habitat. Most invasive marine species found in Burrard Inlet were accidentally introduced through ship ballast water, pleasure boat traffic and ocean currents (e.g., Manila and varnish clams), although some (Japanese oyster) were intentionally imported to increase shellfish production.

Introduced species pose a risk to the environment by taking over habitat used by native species. Two categories of invasive marine species can be considered: those that were introduced decades ago and are now well established (making it difficult to eliminate them) and those that have been recently introduced (where a program to eliminate them may still be successful).

Currently the risks from invasive marine plants are considered relatively low; however, the status of these organisms should be reviewed periodically. The Vancouver Port Authority is reducing the risk of ongoing introduction of invasive marine species by requiring exchange of ship ballast water at mid-ocean to prevent introduction of Asian Pacific species to the west coast.

Recent introductions and threats

English cord grass (*Spartina anglica*), identified at Roberts Bank and Boundary Bay in Delta in 2003, but not yet in Burrard Inlet; this plant has an aggressive growth pattern and high potential for damage.

Salt marsh cord grass (*Spartina patens*), found at the western boundary of Maplewood Conservation Area; has spread to Port Moody Arm and possibly to other areas.

Contaminants

There are many sources of contaminants in Burrard Inlet: combined sewer overflows, wastewater treatment plant discharges and non-point sources such as stormwater runoff and atmospheric deposition, seepage from contaminated sites and spills or accidental releases of oils and other compounds. Some compounds (e.g., PCBs, PBDEs) persist in the sediment, are taken up by worms and shellfish and, because they tend to be stored in fatty tissue, become highly concentrated in predators such as whales and fish-eating birds. Contaminants can also be passed on to humans, where they can lead to disease. Figure 1 describes some pathways of contaminants in Burrard Inlet, from source to effects on organisms in the Burrard Inlet ecosystem and beyond.

Other Potential Indicators for a Burrard Inlet State of Environment Report

The Plan Implementation Committee is considering additional indicators to monitor the state of environment in Burrard Inlet. As additional information becomes available, some of the following topics may provide useful monitoring tools:

- species at risk
- mussel health
- total and effective impervious (impermeable) area
- health of benthic invertebrate communities in streams
- marine mammal abundance or levels of contaminants in tissue
- Industrial permits (numbers, discharge loadings, characteristics)
- stormwater monitoring data for streams
- water quality assessment using the Canadian Water Quality Index for a full suite of monitored parameters
- trends in air quality health index, CCME sediment quality index and new soil quality index

Including these indicators would give a wider breadth to our understanding of ecosystem health in Burrard Inlet. Additional trends would enable decision makers to assess with increased certainty the ecosystem risks of development activities and the benefits of toxin reduction efforts. Over time, these indicators would offer a robust picture of how human populations are having an impact on the local ecosystem.

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Figure 1: Examples of Contaminant Pathways in the Burrard Inlet and Strait of Georgia Ecosystems

Contaminated sites

The provincial Ministry of Environment maintains a database with reports on sites that are or may be contaminated. A contaminated site in B.C. is defined as an area of land in which the soil or underlying groundwater or sediment contains a hazardous substance in an amount or concentration that exceeds provincial environmental quality standards. The standards vary according to land use and closeness to a waterway.

Sites may be contaminated because of previous commercial or industrial activity that deposited or spilled contaminants into surrounding land. Examples include gas stations, wood treatment operations, abandoned underground oil tanks, rail and port facilities and dry-cleaning shops. Sites may contain metals (e.g., lead, arsenic, cadmium, mercury), petroleum hydrocarbons (benzene, toluene and polycyclic aromatic hydrocarbons from gasoline and other sources) and other organic compounds (polychlorinated biphenyls from electrical equipment, chlorophenols in wood preservatives).

Professional environmental site assessors conduct a formal process for investigating and cleaning up a contaminated site to an appropriate standard. Although contaminated sites may not be a visible hazard, it is important to remediate them to prevent contamination from leaching into the groundwater and further afield.

Contaminants from Combined Sewer Overflows, stormwater, wastewater treatment plants, and industrial discharges

Please see Indicator 6.

Sources of coliforms in waterways

Please see Indicator 7.

Spills in Burrard Inlet

Contaminants sometimes enter Burrard Inlet through accidental spills. Most spills are shore-based and small, although spills from vessels and unidentified sources also occur. The larger spills (e.g., release of canola oil during loading of a vessel in 1999; release of crude oil from a rupture of the Kinder Morgan oil pipeline in 2007) occur infrequently and are relatively easy to trace. Small spills can be difficult to trace and may not be recorded or cleaned up, but are a chronic source of contaminants to the inlet.

Hydrocarbons (bunker, gasoline and diesel fuel, canola oil) are the most commonly reported compounds spilled. The resulting oil sheen is highly visible and can have immediate negative effects on wildlife and plant life (e.g., oiled birds, which may die from exposure), as well as longer term effects of the contaminants. Other types of spills can be more difficult to detect.

There is a coordinated oil spill response plan for Burrard Inlet. The Port Authority and Environment Canada organize an emergency response when a spill is reported. For oil spills, Burrard Clean Operations deploys equipment to contain and remove the oil. Given the amount of industry, rail and port activity in the inner harbour, this is the area with the highest number of spills reported. Many companies have minimized spill risk by developing management plans, building containment facilities and training staff in spill response.

Burrard Inlet Ecosystem

Indicators

1. Tree Canopy Cover
2. Parks and Protected Areas
3. Waterbird Abundance
4. Air Quality
5. Greenhouse Gas Emissions
6. Water and Sediment Quality
7. Recreational Use and Fecal Coliform Bacteria

Contaminants in birds

There are many causes of fluctuations or declines in bird numbers, such as loss of overwintering or breeding habitat, increases in predation, or changes in food supply. However, many species of birds take up contaminants along with food in their diet, which can have an impact on bird health and populations.

Levels of organic contaminants have been studied in several waterbird species in British Columbia over the past 25 years, although not specifically in Burrard Inlet. These studies, many by Environment Canada scientists, have looked at relationships between industrial discharges, contaminant levels in sediment and prey organisms (fish, shellfish), and health of bird populations (Elliot *et al.* 2001, 2001a, 2005, 2007; Harris *et al.* 2003, 2005, 2007).

Levels of dioxins, furans, PCBs and organochlorine pesticides have declined in eggs of herons, cormorants and osprey over the study period, while levels of PBDEs have increased. Reported biological effects include deformities in chicks, thin egg shells and altered physiology and biochemistry.

Levels of butyltin (anti-fouling agent in marine paints) and some other metals were significantly higher in livers of surf scoters that overwinter in Vancouver harbour than in scoters from an undisturbed area on Vancouver Island, and levels increased over the winter (Harris *et al.*, 2007). The study also measured a decrease in body condition with increase in butyltin levels, suggesting a link between bird health and extent of industrialization in their winter habitat as they prepare to migrate to breeding habitat.

These trends reflect improved environmental management (e.g., changes in pulp mill bleaching processes, restrictions on use of PCBs, tributyl tin, wood preservatives, anti-sapstain compounds and several pesticides) for legacy contaminants and introduction of new contaminants of concern (e.g., PBDEs). However, results also show the persistence of many legacy compounds in the environment, decades after their use has been eliminated, and their long-range transport and deposition from the air.

Flame retardants (PBDEs) in marine mammals

Polybrominated diphenyl ethers (PBDEs) have been used as fire-retardants since the 1970s. In 2006 the Ministers of Environment and Health recommended that PBDEs be added to the List of Toxic Substances in the *Canadian Environmental Protection Act 1999*. It was concluded that PBDEs are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity.

PBDEs are present in many consumer products, including electronics, plastics, upholstery, carpets and textiles. Although PBDEs are not produced in Canada, they are imported in consumer products and for use in manufacturing. PBDEs are released to the environment when products are made or disposed of. Like polychlorinated biphenyls (PCBs), PBDEs degrade very slowly and are transported widely by winds and currents, even into pristine areas. They settle in the sediment and enter the food chain through benthic organisms, making their way up to marine mammals through fish such as salmon and herring. PBDEs are toxic to humans and other animals, are easily stored in fatty tissue and biomagnify and bioaccumulate in the food chain. Elevated levels of PBDEs have been measured in resident killer whales in the Strait of Georgia (Ross 2006).

Part 3 – The Indicators

1. **Tree Canopy Cover**

2. **Parks and Protected Areas**

3. **Waterbird Abundance**

4. **Air Quality**

5. **Greenhouse Gas Emissions**

6. **Water and Sediment Quality**

7. **Recreational Use and Fecal Coliform Bacteria**

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1. Tree Canopy Cover

Why look at tree canopy cover?

Natural vegetation, measured as tree canopy, provides many ecosystem and economic benefits. Tree canopy is particularly valuable in an urban environment, where development tends to replace natural vegetation with paved surfaces. Land use in the Burrard Inlet watershed includes urban and residential areas at lower elevations and forested mountain terrain at higher elevations.

Lions Gate Bridge and North Shore Mountains

Measuring tree canopy over time in the developable area will track how well the region balances population growth and development with ecosystem health. A decrease in tree cover could be a trigger for policy makers to increase protection of tree canopy in the approval processes for land development.

Current status: Tree canopy cover is currently 42% of the entire developable watershed, and ranges from approximately 26% in English Bay and Inner Harbour catchments to 84% in Indian Arm catchment.

Benefits of trees

Treed areas and a healthy tree canopy provide many benefits to urban, residential and undeveloped areas, such as:

- removing air pollutants
- providing shade
- providing natural rainwater management
- taking up carbon dioxide
- evapotranspiration of up to 1/3 of rainfall
- recharging groundwater and increasing summer stream flows
- providing wildlife habitat and maintaining biodiversity

When tree cover is reduced during development, these functions can be reduced. Communities replace lost natural services with infrastructure, such as stormwater conveyance and treatment systems, and pay for long-term health and economic issues related to air quality and other contaminants.

Using tree canopy an indicator

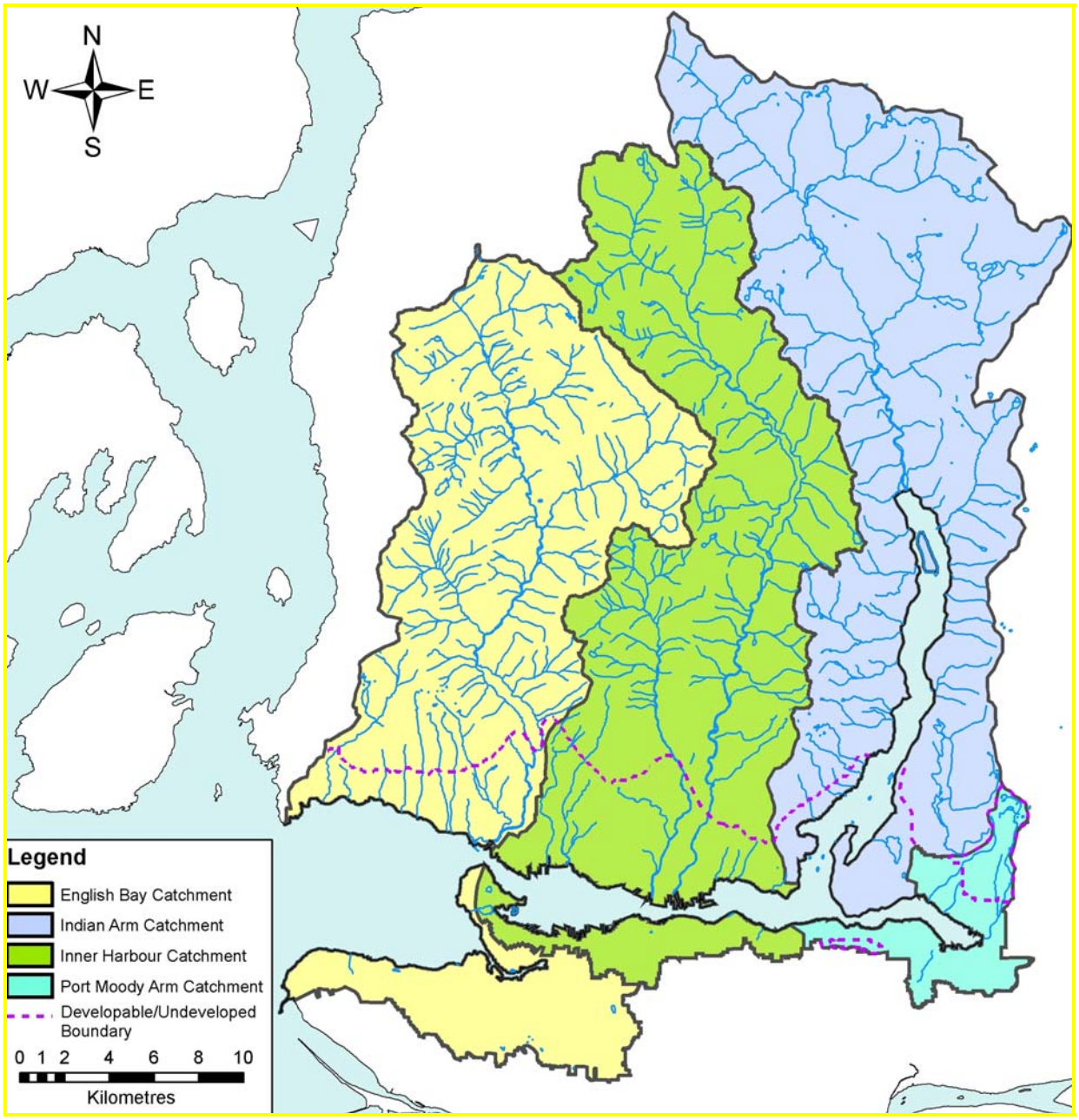
The amount of tree canopy provides an indicator of how land is used today and can be used to monitor changes in the future. To describe the indicator, the Burrard Inlet watershed has been divided into two categories (undeveloped and developable land) and four catchments (English Bay, Indian Arm, Inner Harbour and Port Moody Arm) as shown in Map 3. Undeveloped land is defined as higher elevation areas that will remain mostly forested. Developable land includes lower elevation land that contains or has the potential to become urban and residential areas.[3]

The Burrard Inlet watershed has a total area of 98,235 ha, with 76% of land in the undeveloped area and 24% in the developable area. The undeveloped area will remain forested, given the mountain terrain and political boundaries; however, development will continue in the lower elevation developable area. Monitoring tree canopy cover in the developable area keeps the focus on lands most likely to change.

The indicator was calculated by combining satellite and Geographic Information Systems (GIS) data for Burrard Inlet with a software model called CITYgreen to assess the quality and amount of forest in the Inlet. Map 2 (the aerial photograph in Section 1) provides an overview of land use in Burrard Inlet. Information on conditions such as rainfall, soil type, land use, zoning and elevation is included. The model gives a measurement of tree canopy cover over the entire inlet, and allows a breakdown of land cover type in the developable area.

[3] The boundary between developable and undeveloped land is shown in Map 3 – 320 m elevation to the west of Lynn Creek (in North Vancouver) and 200 m to the east of Lynn Creek, consistent with Official Community Plans. This line places drinking water reservoirs and protected areas within the undeveloped area.

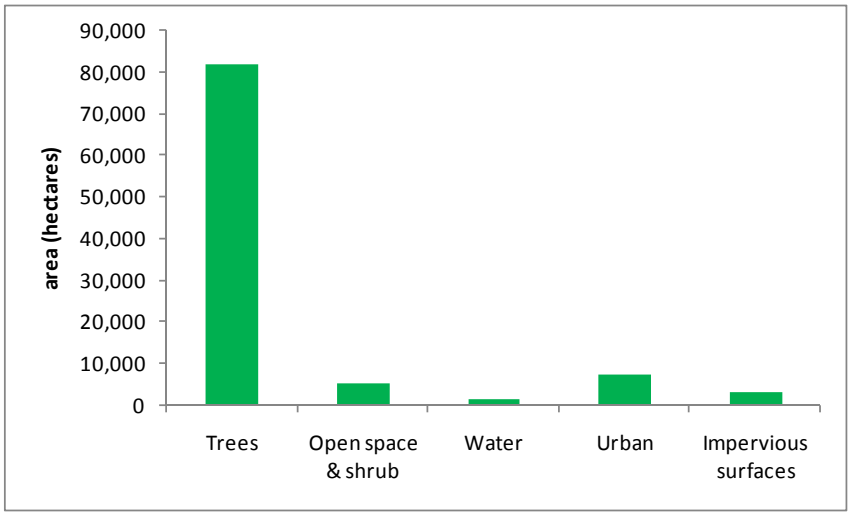
Map 3: Developable vs. Undeveloped Areas for the Burrard Inlet Catchments



Results and Trends

Charts 1-1 and 1-2 illustrate types of land cover for the Burrard Inlet watershed as a whole and for developed versus undeveloped areas within the watershed, as measured in 2002 satellite imagery. This indicator will measure tree canopy in the developable area over time to assess how well communities balance their development plans with environmental and sustainability considerations.

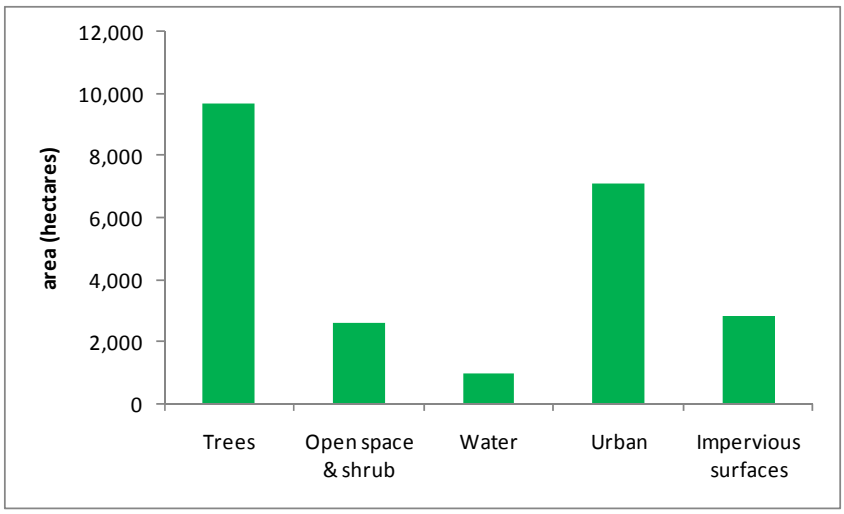
Chart 1-1: Current Land Cover across the Entire Burrard Inlet Watershed



Considering the entire watershed (Chart 1-2), tree canopy, open space and shrubs cover 88% of the land, reflecting the fact that 76% of land lies in the forested upper lands.

In the undeveloped watershed, 96% of land is covered with trees and 3% with shrubs and grassy areas. The remaining 1% consists of water and impervious cover (roads).

Chart 1-2: Current Land Cover in Developable Areas of Burrard Inlet



In the developable area (Chart 1-2), land is classified as 42% trees, 11% open space and shrubs, 4% water, 12% impervious and 31% urbanized (commercial, residential). A total of 53% of developable land is currently covered by trees, shrubs and open space.

Values for tree canopy in individual catchments are 26% in English Bay, 26% in Inner Harbour, 55% in Port Moody Arm and 84% in Indian Arm.

Tree canopy in the developable area will likely decline as the population continues to increase and land continues to be developed.

How does Burrard Inlet compare to existing targets and other localities?

Comparing tree canopy data for the Burrard Inlet watershed to other regions can be useful. However, it is important to recognize the exceptional environmental setting of Burrard Inlet and BIEAP's goals of preserving the unique biodiversity and enhancing the environmental quality of our region when setting a target. Targets for tree canopy in urban areas range from 25 to 40%, depending on population density, location and regional context. Examples from other jurisdictions include:

- the CITYGreen model, with a suggested target of 50% for suburban residential (low density), 25% for urban residential (high density) and 15% for a central business area.
- Toronto, Ontario, with a tree canopy target of 30% to 40% by 2020, and a current tree canopy of 17%
- Portland, Oregon, with 25% tree canopy cover and a goal of increasing this value.

Tree cover in Burrard Inlet watershed is higher than for many other cities, with 42% canopy in the developable area and 11% shrubs and open space. This benchmark reflects the forested mountain slopes on the Inlet's north shore, and should be protected as population growth continues. The lower tree canopy cover of 26% in developable areas of English Bay and Inner Harbour catchments indicates the loss of trees that tend to accompany urban growth.

Economic benefits of tree cover

Trees provide natural stormwater management, air purifying and climate control functions, assets that help municipalities balance their infrastructure costs. The CITYgreen model can generate information about the monetary value of ecosystem services provided by the tree canopy (Caslys 2006), as has been done by Metro Vancouver for its regional biodiversity assessment (AXYS 2006). Although assigning economic value to ecosystem services can divert attention from the non-monetary benefits, it does provide powerful information to decision-makers who manage infrastructure budgets.

Based on the CITYgreen model, maintaining the current level of tree canopy in the 13,800 ha of developable area in Burrard Inlet will provide many economic savings, including:

- $44M per year in tax dollars that would otherwise be spent on stormwater infrastructure over the next twenty years (based on a comparison of the current condition vs. 0% tree canopy and $3,200 per hectare per year)
- $6M per year for pollution removal (air pollutants such as nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particulate matter; water pollutants such as nitrogen, phosphorus, suspended solids, metals, organic matter)
- $1.2M for carbon storage and sequestration (carbon credits for preservation of existing trees equal to 89 tons per hectare)
- additional savings in health care costs related to improved air quality.

Further information about the current status of air quality, greenhouse gas emissions and water quality, and related issues in the Burrard Inlet watershed is provided in Indicators 4, 5 and 6, respectively.

What can we do to maintain or improve tree canopy cover?

Changing our thinking to value trees as a public utility will be helpful during municipal budgeting and planning processes. Other options include:

- establishing a tree canopy goal as part of municipal development and maintenance projects
- creating a formal process for measuring tree cover and recording data in the region's GIS system
- adopting policies, regulations and incentives to increase and protect the green infrastructure and to promote natural infiltration of rainwater
- supporting installation of green roofs by providing incentives, development guidelines and education
- planting an appropriate mix of trees and other vegetation, along with adequate soil depths, in residential gardens

For more information…

- CITYgreen model: www.americanforests.org/resources/urbanforests/analysis.php
- Green Roofs: www.greenroofs.org/, www.toronto.ca/greenroofs/index.htm, www.inhabit.com/2006/08/01/chicago-green-roof-program/
- Tree Canopy Policy: www.fundersnetwork.org/usr_doc/Urban_Forests_FINAL.pdf

2. Parks and Protected Areas

Why look at parks and protected areas?

The parks and protected areas indicator helps describe the overall health status of the Burrard Inlet ecosystem. These areas include provincial, regional and municipal parks, protected drinking water watersheds and areas such as the Lower Seymour Conservation Reserve. The parks and protected areas in Burrard Inlet are managed to conserve fish and wildlife habitat, and to preserve natural and built environments for public use.

Capilano Reservoir, Capilano River Regional Park

Parks allow a range of recreational activities, including medium and high impact activities such as field sports, mountain biking and skiing, as well as lower impact hiking activities. Balanced land use programming is important to ensure recreational activities do not have a negative effect on habitat.

Current status: For the watershed as a whole, 66% of the land has some measure of protection, and a further 15% is in high elevation areas outside of the Metro Vancouver classification system, leaving 19% designated as residential and urban areas. Most of the protected land is in the undeveloped portion of the watershed (only 3% is residential or urban). The amount of protected land in the developable area is 41% and varies for individual catchments.

Using parks and protected areas as an indicator

Parks and protected areas fall into three management classes, defined by Metro Vancouver, and Rockfish Conservation Areas, defined by Fisheries and Oceans Canada. These categories are described in Table 2-1, along with examples for each category.

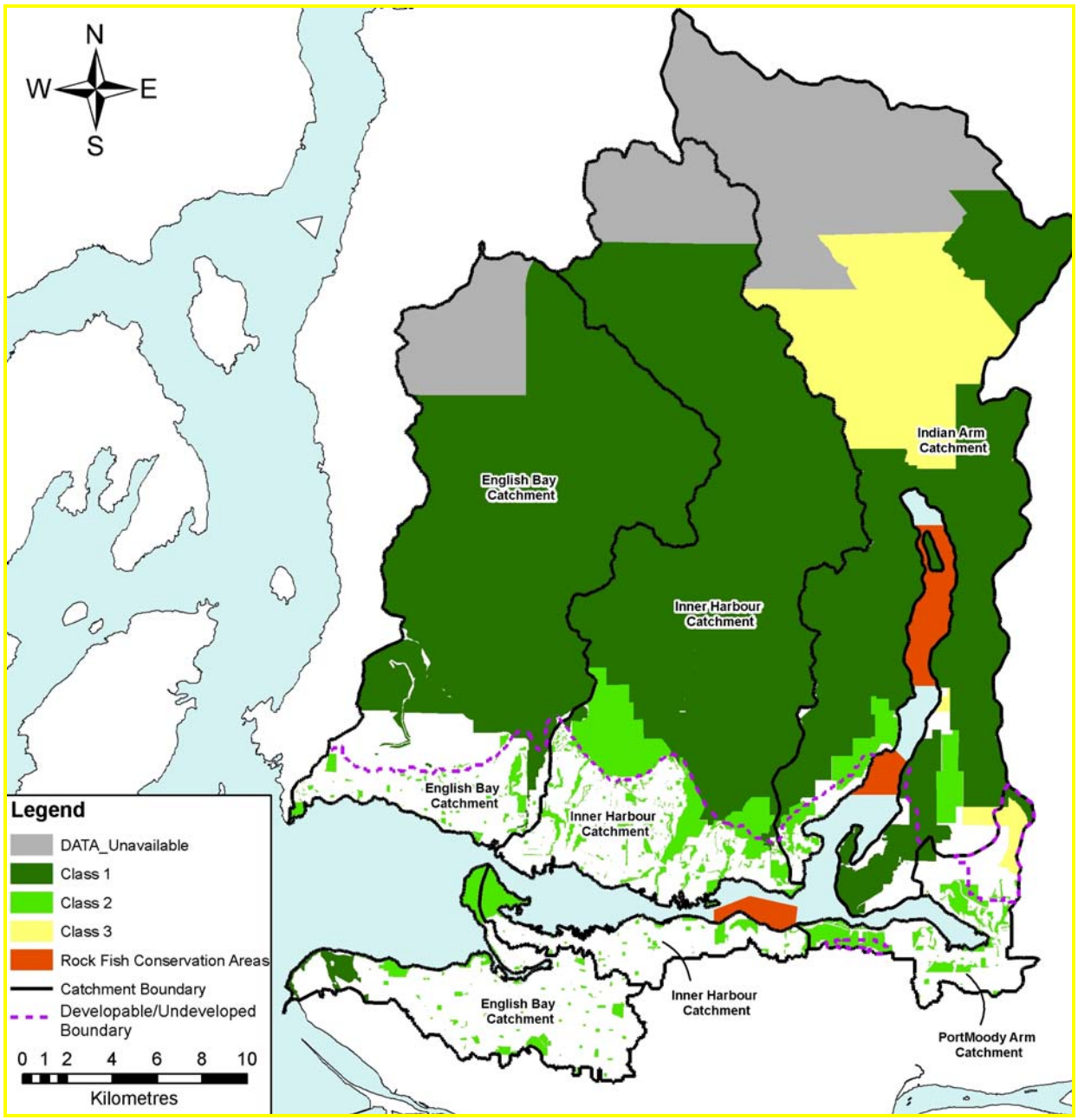
The indicator was developed by calculating the proportion of land in each management class for the four main catchments in Burrard Inlet for both developable and undeveloped areas (Map 4). The developable area (below the 320 m elevation to the west of Lynn Creek in North Vancouver, and 200 m to the east of Lynn Creek) includes suburban, urban and some protected areas. The undeveloped area at the higher elevations includes land in Classes 1 through 3 and small amounts of land used for park facilities and forestry.

Protected areas conserve or manage habitat required for:

- endangered, threatened, sensitive or vulnerable species
- a critical life-cycle phase of a species, e.g., spawning, rearing, nesting, or winter feeding
- migration routes or other movement corridors
- areas of very high productivity or species richness
- recreational uses

Black Bear

Map 4: Location of Management Area Classes and RCAs in the Burrard Inlet



Modified from ESSA (2007)

Table 2-1: Management Area Classes

Class	Description	Examples	
1 Lands with the highest degree of protection	Protected watersheds Provincial wildlife management areas, parks, and ecological reserves Existing and pending federal wildlife preserves Crown lands secured for environmental management Metro Vancouver regional parks	Thwaytes Landing Regional Reserve Indian Arm Provincial Park Mount Seymour Provincial Park Belcarra Regional Park Capilano River Regional Park Lower Seymour Conservation Reserve Pacific Spirit Regional Park	
2 Lands that are protected due to their park or land use designation	Areas more heavily affected by human disturbance than Class 1 May not have long-term protection Specific port recreation designated areas Municipal parks, reserves Nature reserves Conservation areas Greenbelts Golf courses	**Vancouver:** Stanley Park Devonian Harbour Park Coal Harbour Park C.R.A.B. Park New Brighton Park **Burnaby:** Montrose Park Barnet Marine Park	**Port Moody:** Rocky Point Park Inlet Park Old Orchard Park Shoreline Park Tidal Park **North Vancouver:** Maplewood Conservation Area Cates Park
3 Forest reserve areas	Areas where urban expansion is unlikely to occur Urban forest, provincial forest Timber supply areas Crown land	Upper Indian Arm catchment Upper Port Moody Arm catchment UBC research forest	
4 Rockfish Conservation Areas (RCAs)	Areas designed to alleviate further declines in rockfish population in Coastal BC (inshore rockfish are protected from mortality associated with recreational and commercial fisheries.	Berry Point Twin Islands Crocker Island	

Results and Trends

The amount of land in various management classes is listed in Table 2-2.

Table 2-2: Amount of Protected and Park Land in Burrard Inlet Watershed (total area and % of land in each management class)

Management Class	Total Watershed		Developable Area		Undeveloped Area	
Total area	983 km^2	–	273 km^2	–	710 km^2	–
Class 1	515 km^2	52%	62 km^2	23%	453 km^2	64%
Class 2	57 km^2	6%	39 km^2	14%	18 km^2	3%
Class 3	76 km^2	8%	10 km^2	4%	65 km^2	9%
Unclassified (beyond Metro Vancouver boundary)	149 km^2	15%	1 km^2	0%	149 km^2	21%
No Class (urban and suburban)	186 km^2	19%	161 km^2	59%	25 km^2	3%

Catchment area (km^2): English Bay = 308, Inner Harbour = 311, Indian Arm = 329, Port Moody Arm = 35

Considering the entire watershed, 66% of the land has park or protected status (total of Classes 1 through 3). A further 15% of the land lies in remote areas of the watershed (unclassified land outside of Metro Vancouver boundaries).

Considering only the developable areas, 51% of the land has park or protected status. The amount varies among the catchment areas, as shown in Table 2-3. The total for Classes 1 through 3 is 27% for Port Moody Arm, 32% for English Bay, 36% for Inner Harbour catchment and 78% for Indian Arm.

Table 2-3: Proportion of Land in Management Classes for Each Burrard Inlet Catchment

Management Class	English Bay	Inner Harbour	Indian Arm	Port Moody Arm
Class 1	23%	18%	42%	2%
Class 2	9%	18%	15%	25%
Class 3	0%	0%	21%	0%
Unclassified (outside Metro Vancouver)	0%	0%	1%	0%
No class (residential and urban areas)	68%	65%	22%	73%

In the undeveloped areas, 76% of the land is in Classes 1 through 3 and 21% is in remote areas beyond the Metro Vancouver boundary. With a high proportion of protected land and mountain terrain that restricts extensive development, the undeveloped area is likely to remain in its current state.

These data provide a baseline for monitoring changes in amounts of parks and protected areas as development pressures increase. It does not assess the quality of habitat preserved, or the amount of wildlife inhabiting the protected area. Although there is no dedicated habitat quality monitoring program for the watershed, it can be assumed that land in Class 1 provides the most benefits for wildlife because these forests are largely intact, with restrictions to human use and development, and topographic limitations to human access. These limitations protect natural ecosystems, and the benefits of Class 1 protected areas can be seen in the outcomes of other indicators, such as tree canopy, air quality and water quality.

What more can we do to maintain protected areas?

Government policy, public awareness and certification programs for park management all play a role in enhancing the natural environment and preserving parks and protected areas.

- Governments can designate land use within the management classes, ensuring that highly valued recreational opportunities do not have a detrimental impact on the surrounding sensitive ecosystems
- Limiting intensive recreational activities such as mountain biking and ATVs to designated areas will help ensure the quality of protected land is maintained
- Pesticide use in parks, golf courses and residential areas can be limited or eliminated to protect the natural environment and human health. This can be encouraged through by-laws, parks management plans, demonstration gardens, or the Audubon Sanctuary Protection Program (an international education and certification initiative that helps golf courses preserve the environment)
- Park users are encouraged to explore protected areas respectfully and enjoy the recreational opportunities. This means treading lightly with activities that do not damage the forest, being mindful of wildlife and leaving no waste.

For more information…

- http://www.audubonintl.org/programs/acss/golf.htm
- http://www.env.gov.bc.ca/bcparks/legacy.html
- http://www.pac.dfo-mpo.gc.ca/recfish/Restricted_Areas/RCAs/booklet/RCA_booklet_2007.pdf

3. Waterbird Abundance[4]

Why look at waterbird abundance?

Great Blue Heron

Waterbirds are an indicator of Burrard Inlet health due to their sensitivity to pollutants, human disturbance and dependence on a rich, functioning ecosystem. Their abundance reflects the cumulative influences of human activities, as well as other ecosystem processes, such as predation from other species. Waterbirds require sufficient habitat for nesting, clean air and water, and ample food resources, including fish, shellfish, and invertebrates. Their position in the food web makes them vulnerable to bioaccumulation of toxic compounds from the environment. Human activities can remove valuable habitat or release contaminants into the environment, which can have a negative impact on bird populations.

Current status: Abundance of four resident waterbirds (Black Oystercatchers, Double-crested Cormorants, Pelagic Cormorants and Great Blue Herons) has remained stable or increased over time. Numbers of Glaucous-winged Gulls have decreased over time. Linking bird declines to any one cause is challenging. For example, one hypothesis for the decline of Glaucous-winged Gulls in the inlet is that they have moved to other breeding sites to gain safety from predation by increasing populations of Bald Eagles.

Black Oystercatcher

Black Oystercatchers are a lesser known resident species in Burrard Inlet. They live along the Pacific coast from Baja through to the Aleutian Islands. They eat mussels, limpets, and other marine invertebrates, using their long, thin orange bills to pry their prey from hard surfaces. These birds mate for life, nesting along rocky shorelines just above the high tide line. Both parents alternate incubating the eggs and feeding chicks until they leave the nest only a few days after hatching.

Using waterbird abundance as an indicator

This indicator tracks abundance of five species that are year-round residents of Burrard Inlet: Double-crested Cormorants, Pelagic Cormorants, Black Oystercatchers, Glaucous-winged Gulls and Great Blue Herons. Although many other species use Burrard Inlet during winter, breeding or migration periods, changes in abundance of year-round residents are more likely to reflect local changes than are birds that spend much of the year elsewhere.

Two sources of data were used to examine Burrard Inlet bird populations: Audubon Society Christmas Bird Counts (1975 to 2006) and Bird Studies Canada Coastal Waterbird Surveys (1999 to 2004).

Volunteer birdwatchers conduct these surveys. The Christmas Bird Count is a one-day count conducted within a 24 km diameter circle, mid December through mid January. Coastal Waterbird Surveys are conducted on the second Sunday of the month from September through April. Survey results are viewed with some caution, due to the nature of data collection and because the more frequent Coastal Waterbird Surveys have only occurred since 1999.

Monitoring bird populations provides an early warning system for changes in health of the Burrard Inlet ecosystem. If there

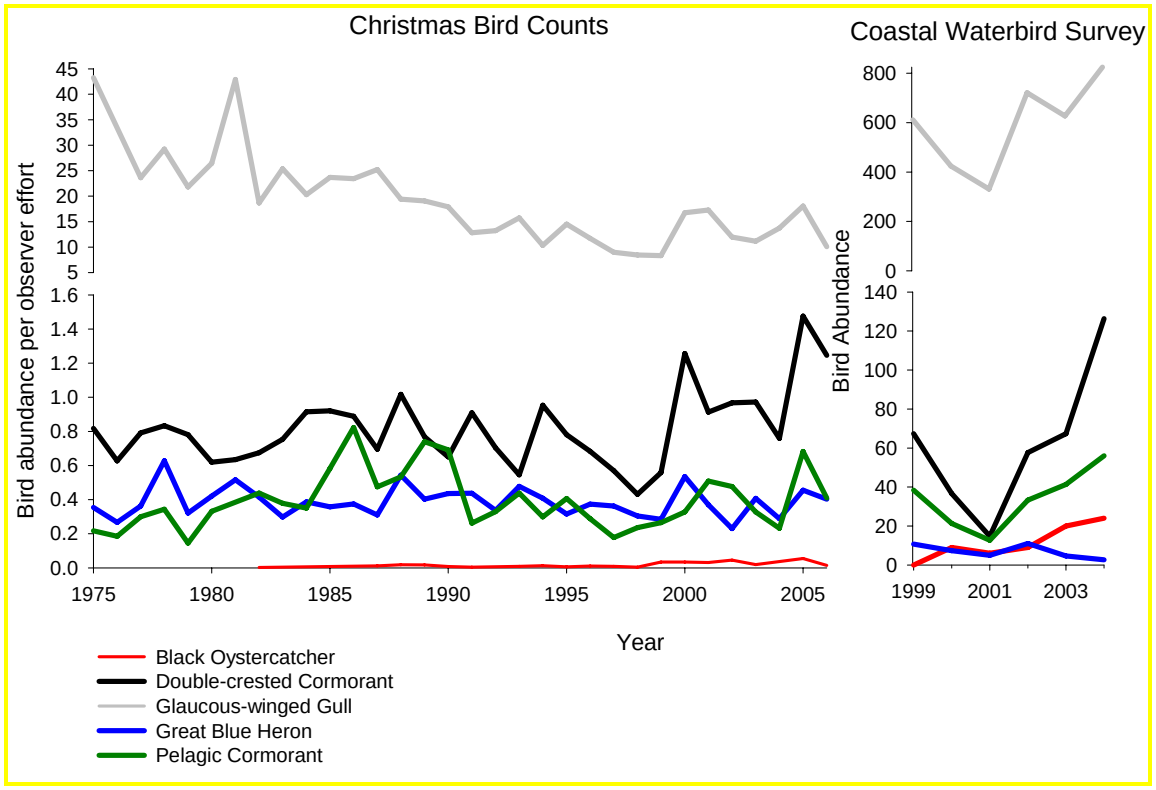
[4] Photo credits: Heron: Kiyoshi Takahashi, all others: Tom Middleton

are changes in the abundance of these species over time, researchers can use a science-based approach to determine the underlying cause. By comparing trends here to other areas in the Georgia Basin or to global trends, researchers can determine if local, regional or global factors are affecting the populations. Levels of organic contaminants such as dioxins, furans, polychlorinated biphenyls and polybrominated diphenyl ethers have been studied in eggs of several species of birds in British Columbia (herons, osprey, pelagic and double crested cormorants, bald eagles and petrels). Some of these studies, discussed in Part 2, show linkages between contaminant levels in sediment, fish tissue (prey items) and bird eggs, and with improved environmental management practices, although effects at the population level are not always evident.

Results and Trends

Chart 3-1 shows the considerable variation in bird abundance from year to year and the importance of looking for longer term trends and links to contaminants and habitat availability.

Chart 3-1: Waterbird Abundance in Burrard Inlet Since 1975



SOURCE: Bird Studies Canada; Audubon Christmas Bird Count Data

Glaucous-winged Gull populations in Burrard Inlet have decreased significantly since 1975. Abundance elsewhere in the Georgia Basin remains stable (Badzinski *et al.* 2005). Gulls are very sensitive to predation by the Bald Eagle, and their decreased abundance may reflect movement of gulls out of the Inlet as they adapt to the increasing danger posed by eagles.

Glaucous-winged Gull

Double-crested Cormorant

Pelagic Cormorant and **Double-crested Cormorant** populations have increased in Burrard Inlet and in the Georgia Basin in recent years (1999 – 2004). A study by Chatwin *et al.* (2002) showed that numbers of Pelagic Cormorants nesting in the Georgia Basin have declined by almost 50% between 1987 and 2000. Despite possible earlier declines elsewhere, these birds, which feed by diving for fish, appear to be thriving in Burrard Inlet. Many cormorants vacated former nesting cliffs in favour of bridges in Burrard Inlet.

Pelagic Cormorant

Great Blue Heron numbers have been stable in Burrard Inlet over much of the past 30 years, and their numbers have been increasing significantly in the Georgia Basin as a whole (Badzinski *et al.* 2005).

Black Oystercatcher populations increased significantly in Burrard Inlet between 1999 and 2004, while their numbers have increased slightly in other areas of the Georgia Basin over the same time period. This suggests Burrard Inlet provides especially good living space for this disturbance-sensitive species.

What can we do to maintain bird populations in Burrard Inlet?

Protecting bird habitat is essential to their continued health. Local, provincial and federal governments provide frameworks for maintaining habitat:

- The Burrard Environmental Review Committee (BERC), comprised of regulatory agencies, reviews applications for development that may affect shoreline and other habitat.
- Governments and industry have programs in place to reduce the amounts of contaminants entering the marine environment through stormwater and combined sewer-stormwater outfalls, permitted industrial discharges and accidental releases. These continue to be refined.
- The Maplewood Conservation Area, in North Vancouver east of the Seymour River, was established in 1992 with agreement from the Vancouver Port Authority, Environment Canada, Fisheries and Oceans Canada and District of North Vancouver. This conservation area and wildlife sanctuary provides valuable mudflat, saltmarsh and upland habitat for many species. The Wild Bird Trust operates the wildlife sanctuary and provides educational opportunities for the public.

Residents and visitors can support these efforts by learning about how individual actions affect the health of Burrard Inlet and by reducing discharges from their properties and local streets into storm drains (see Indicator 6).

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4. Air Quality

Why look at air quality?

Air quality and air emissions have direct and indirect effects on the environment, regional economy and human health. Improved air quality increases the socio-economic well-being of Canadians, reducing illness and associated health care costs and improving productivity of industry while decreasing health care costs.

Current Status: Air quality in the Burrard Inlet airshed has improved notably over the past 20 years and is currently acceptable most of the time, although it may occasionally be of concern for vulnerable members of the population.

Vancouver skyline

Effects of poor air quality on humans

Short- and long-term exposure to air pollutants is harmful to human health, depending on how much and how long people are exposed. Asthma, bronchitis and exacerbation of pre-existing conditions such as diabetes and heart problems have been clearly linked with air pollution. In Canada, thousands of premature deaths per year, as well as increased rates of medical treatment and hospitalization are associated with poor air quality. Pregnant women, children and the elderly are especially at risk.

The increased health care costs and missed time from work or school affect the economy. Other socio-economic costs include lost tourism dollars associated with degraded visibility related to smog, and environmental damage related to acid rain, which may affect water and soil chemistry, and abundance and condition of vegetation.

Air quality as an indicator

Air quality in the Burrard Inlet area can be assessed by measuring the quality of the ambient air and by assessing the amounts of contaminants emitted into the air from local sources. This indicator looks at both ambient air quality and emissions, as information about emissions is useful in determining causes of declining or improving air quality and developing approaches for reducing emissions. Emissions come from both human (e.g., burning of fossil fuels in transportation and heating of buildings, emissions from industries) and natural (e.g., dust from wind erosion, ash from forest fires) activities. In addition, air contaminants transported from outside the Burrard Inlet area can affect local air quality.

Several air pollutants are defined as Criteria Air Contaminants (CACs, see sidebar on the following page) as they affect human health and contribute to smog, acid rain and reduced visibility. For example, particulate matter (PM10 and PM2.5) is of particular concern for health and visibility effects, whereas SOx and NOx contribute to acid rain and visibility degradation, as well as to the subsequent formation of particulate matter in the atmosphere.

Air quality information was provided by Metro Vancouver, which manages the Lower Fraser Valley Air Quality Monitoring Network. CAC levels are recorded continuously and reported as hourly or longer averages. There are nine monitoring stations located within the Burrard Inlet area, five of which were used for this indicator. These stations (Kitsilano in Vancouver, Kensington Park in Burnaby, Second Narrows and Mahon Park in North Vancouver and Rocky Point Park in Port Moody) were selected because they provide the most complete time series for CACs and best represent ambient conditions in the area. For each station, data were calculated over three time periods (annual average, annual maximum 24-hour and annual maximum 1-hour) to reflect short-term and long-term conditions. Data are generally available for the period from 1981 to 2006, although there is some variation in terms of when stations began operation and when particulate monitoring data

became available. Results were compared to Metro Vancouver objectives for CACs and to federal Canada-Wide Standards for ozone and fine particulate matter (PM2.5). Data can also be presented as an air quality index, which uses a scale of 0 (good) to >100 (very poor), derived from the individual pollutant driving the index, or the recently developed Air Quality Health Index based on multiple pollutants.

Criteria Air Contaminants (CACs)

CACs are contaminants that affect human health and contribute to air pollution problems such as smog, acid rain and reduced visibility.

CO – carbon monoxide
NOx – nitrogen oxides
SOx – sulphur oxides
VOCs – volatile organic compounds
O_3 – ground-level ozone
PM10 – particulate matter (< 10 micron size)
PM2.5 – fine particulate matter (< 2.5 micron)
NH_3 – ammonia

Emissions data for all sources were drawn from the 2005 Metro Vancouver Emissions Inventory, considering contributions from the Lower Fraser Valley airshed, which includes Metro Vancouver, the southeast portion of the Fraser Valley Regional District and Whatcom County in the State of Washington. The emissions inventory also includes forecasts of 2005 emissions to the year 2030, based on projected population growth, economic trends and other available data, and backcasts to 1990, to allow equitable comparison of emission trends. Results for all these sources are presented as total annual emissions of individual pollutants and collectively as smog forming pollutants or SFPs, the sum of NOx, PM2.5, SOx, VOCs, and NH_3.

Results and Trends

Ambient Air Quality

For the five stations assessed for the Burrard Inlet area, concentrations of CO, NOx, O_3, PM10, PM2.5 and SOx have been below the Metro Vancouver and federal management objectives and standards all or nearly all the time since at least the early 1990s. This indicates that air quality in the Burrard Inlet area is good most of the time and fair or poor for brief periods. In general, the levels of NOx and SOx monitored in the Burrard Inlet area are higher than other areas in the Lower Fraser Valley.

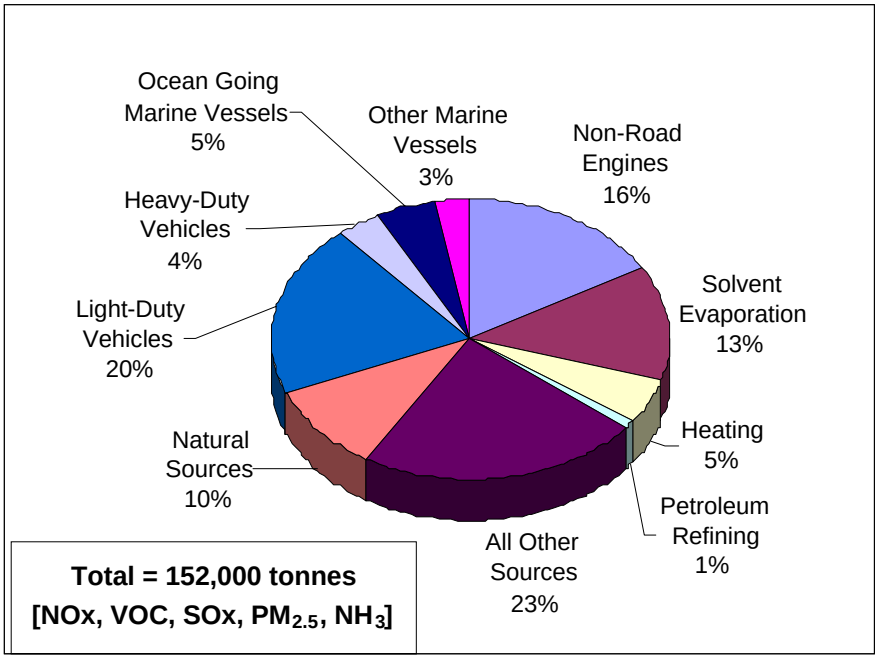
Regionally, levels of CO, NOx and SOx have decreased since 1981, while levels of ozone and PM10 appear to have remained stable or increased. Since the early 1990s, ozone levels have generally met the Metro Vancouver objective and the numerical target within the Canada-Wide Standard (4^{th} highest annually, averaged over 3 years), but have been between the federal acceptable and desirable objectives (annual maximum 1-hour level). Ozone levels are influenced by global as well as local sources, so some variability may be related to an increase in background levels. PM2.5 is included in the PM10 data, but has been measured separately since 2003, and there is not enough data to identify a trend at this time (GVRD and FVRD 2005a, GVRD and FVRD 2005b and GVRD and FVRD 2006).

Air Emissions

Emissions of SFPs for 2005, broken down by source sector, are shown in Charts 4-1 and 4-2. Emissions from some sources are expected to increase, while emissions from others are expected to decrease. Due to increasing demand for international trade there is a potential for port-related emissions, including those from ocean going vessels (OGVs), to increase over time. However, the industry is working to reduce those emissions wherever possible. Results of Metro Vancouver's emissions inventory and trend analysis will be available in 2008 from their website at www.metrovancouver.org.

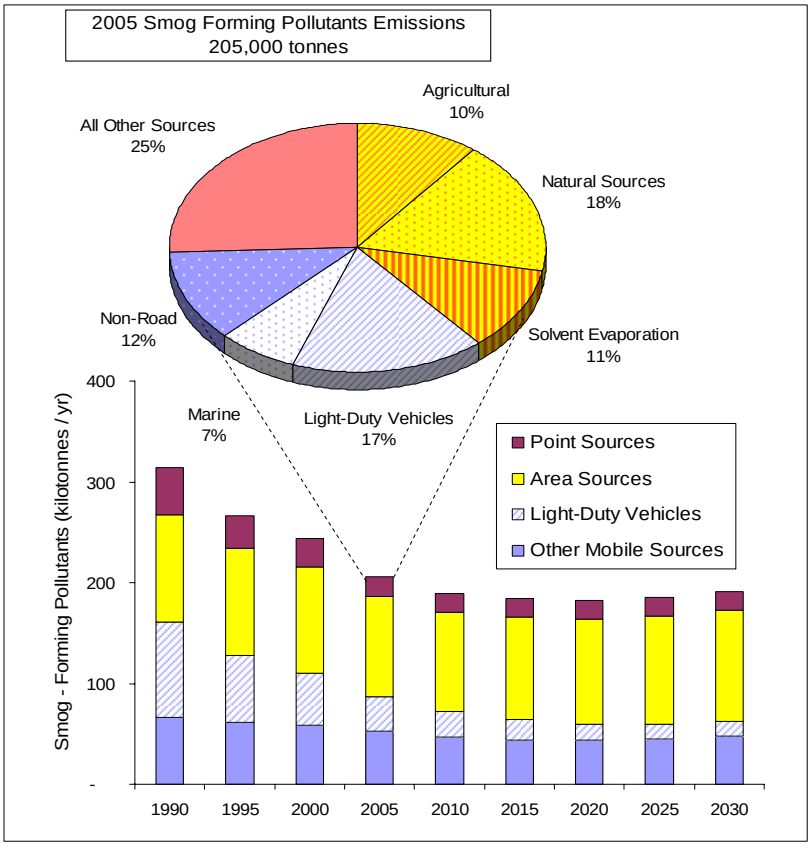
On the whole, there are fewer emissions of SFP's now than a generation ago. For example, Canada's Sulphur in Diesel Fuel Regulations and various engine emissions standards apply to rail, marine, onroad and offroad engines, and have reduced emissions from these sources.

Chart 4-1: Smog Forming Pollutants in the Canadian Portion of the Lower Fraser Valley, 2005



SOURCE: Metro Vancouver, 2008

Chart 4-2: Total Smog Forming Pollutants (SFPs) in the Lower Fraser Valley (Canadian and United States Sources)



Land sources of air contaminants

- *Point sources* – large industrial facilities or utilities operating under an air discharge permit
- *Area sources* – light industrial, residential, commercial and institutional sources not normally operating under an air discharge permit
- *Mobile sources* – passenger cars, trucks, buses, motorcycles, aircraft, railways, construction
- lawn and garden equipment

Marine sources of air contaminants

- ocean-going vessels
- harbour vessels
- ferries
- fishing vessels
- recreational vessels
- tank venting

What can we do to improve air quality?

To preserve good air quality we must manage the effects of a growing population and international trade on health, the environment and the economy. Industry, governments, regulatory agencies and other stakeholders are responding with programs to reduce emissions and improve air quality. Because motor vehicles are the largest source of air emissions, several programs have been developed that target reductions in vehicle emissions. The reduction of marine vessel emissions is also important for the Burrard Inlet area. For example, the International Maritime Organization is considering stricter international regulations to reduce NOx, SOx and PM emissions from ships.

Quality of our air depends on emissions, meteorology and chemistry. Emissions are a function of technology, fuel quality, operational efficiency and the number and magnitude of sources. In many cases, reducing SFP emissions can also reduce greenhouse gas (GHG) emissions. Although the issue is complex, there are some clear and intelligent choices to be made by both industry and members of the public. These include cleaner fuels, more efficient technologies, more efficient operations and changes in behaviour.

Local and regional initiatives such as airshed planning, anti-idling and air quality by-laws, open burning restrictions, HOV lanes and transit upgrades are having a positive effect on air emissions. In 2007, Metro Vancouver initiated a study for the Burrard Inlet area to assess air quality issues at a more localized scale. The study will integrate emission inventory, air quality monitoring and modeling data to characterize emission sources and air quality impacts in Burrard Inlet. Federal and provincial initiatives also contribute to air emission reductions.

The Vancouver Fraser Port Authority (VFPA) is working to reduce emissions of CACs and GHGs by developing a data baseline, improving operational efficiency, making technological innovations and supporting regulatory change as a part of their Air Action Program. Examples of emission reduction initiatives by the VFPA, terminal operators and other industries include:

- Differentiated Harbour Dues to encourage and recognize vessels that reduce emissions
- use of alternative fuels including biodiesel, hydrogen and lower sulphur diesel
- idle reduction programs and technologies
- container truck license system that phases out older, dirtier trucks and includes, idling and education requirements
- truck reservations, extended gate hours and rail co-production
- collaborative efforts to reduce emissions such as the Northwest Ports Clean Air Strategy
- green buildings
- employee programs to increase awareness and facilitate sustainable commuting

For more information…

- http://www.ec.gc.ca/cleanair-airpur/Home-WS8C3F7D55-1_En.htm
- http://www.portvancouver.com/the_port/air_quality/
- http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/air_quality_e.html
- http://www.env.gov.bc.ca/air/airquality/index.html and/or http://www.metrovancouver.org

5. Greenhouse Gas Emissions

Why measure greenhouse gas emissions?

Traffic on Highway 1

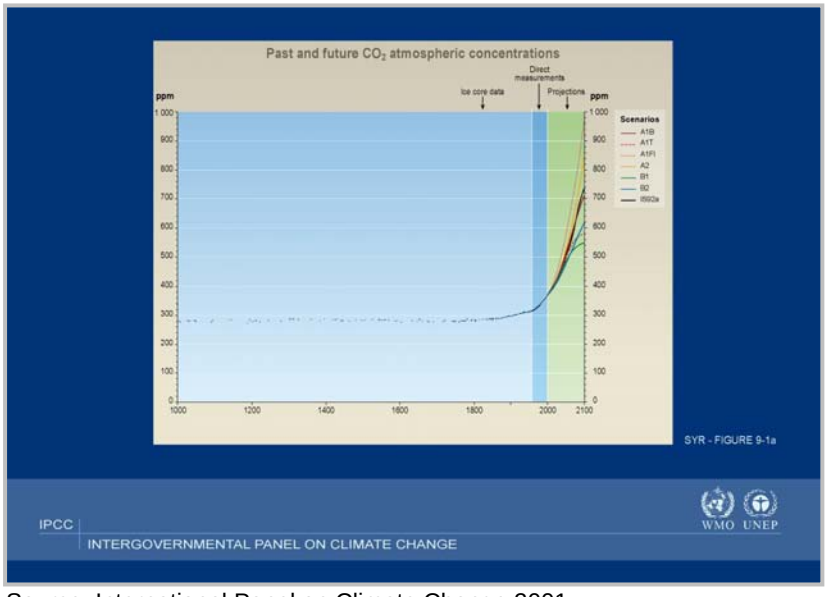
Greenhouse gas (GHG) emissions change the composition of the earth's atmosphere and contribute to global climate change. In simple terms, GHGs prevent infrared heat from escaping into the atmosphere and reflect this heat back onto the surface of the planet, altering the Earth's energy budget. The natural process of heat leaving the atmosphere has been altered through human activities, which are increasing GHG emissions, primarily through burning of fossil fuels. Increased GHG emissions have also been linked to changes in air temperature and moisture, ecosystem-level processes, desertification and sea-level rise.

Current status: GHG emissions in Burrard Inlet have increased steadily since 1990 and are projected to increase along with population growth.

Greenhouse gases as an indicator

GHGs occur naturally in the atmosphere and are also released as a result of human activities. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and water vapour (H_2O). Figure 5-1 shows the increase in CO_2 levels in the atmosphere since the late 1800s, and the dramatic increase over the past 40 years. Although climate change is a global issue, reducing local emissions will help reduce global impacts. It is important to note that our climate will continue to change even if large local and global reductions are made. Preparing for climactic changes by adapting our region for inevitable change will enhance the resiliency of the Burrard Inlet over time.

Figure 5-1: Past and Future CO_2 Levels in the Atmosphere



Source: International Panel on Climate Change 2001

Human sources of CO_2, CH_4 and N_2O include activities such as burning of fossil fuels, deforestation for agriculture and urban development, and increased use of nitrogen-containing fertilizers (Table 5-1). Natural sources include decomposing natural materials and methane from animals.

Did you know…

A vehicle releases 2.3 kg of CO_2 per litre of gasoline or 2.7 kg of CO_2 per litre of diesel fuel.

Even low emission vehicles can emit N_2O in the exhaust.

Table 5-1: Common Sources and Contributors of GHGs

GHGs and their sources (EC, 2007)	Contributors to GHG
CO_2 is emitted during fossil-fuel combustion and industrial processes such as cement production; deforestation removes important carbon sinks	*Point Sources* – large industrial facilities or utilities operating under an air discharge permit
CH_4 is emitted during livestock cultivation, biomass burning, natural gas delivery, landfill use and coal mining	*Area Sources* – light industrial, residential, commercial and institutional sources not normally operating under an air discharge permit
N_2O is emitted as a result of use of nitrogenous fertilizers and combustion of fossil fuels and wood	*Mobile Sources* – passenger cars, trucks, buses, motorcycles, aircraft, marine vessels, railways, construction and lawn and garden equipment

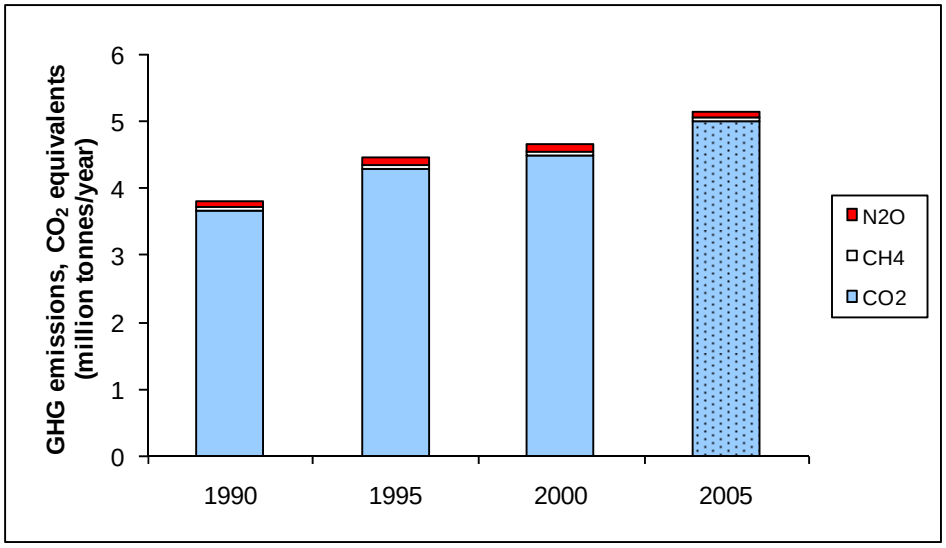
Emission inventory data for the Burrard Inlet were obtained from the Metro Vancouver Air Quality Policy and Management division (GVRD and FVRD 2003a; 2003b). These reports include a variety of air emissions data, including GHGs. The amount of GHGs emitted in each municipality (or portion within in the Burrard Inlet watershed) was determined using the 2000 database and estimated for point, area and mobile sources. Estimates for 1985 to 1995 were backcast using historic data and estimates for 2005 were forecast using population growth rates. These estimates are based on data available at the time of study, and provide a rough estimate of GHG measurements. Accurate data for ocean going vessels are not available at this time, but will be calculated for future reports.

Results and Trends

Quantities of GHG emissions in the Burrard Inlet watershed are increasing over time, with steady increase in CO_2 and low, relatively constant CH_4 and N_2O emissions (Chart 5-1). The rate of increase has slowed since 1990 (from 19% increase between 1990 and 1995 to 7% increase between 2000 and 2005), and is projected to be 4% per five-year period to 2025. The increase in GHG emissions is related to increased local use of fossil fuel associated with increased motor vehicle traffic, urban and commercial development and marine traffic. These activities will continue to increase with increased population growth and associated development in Burrard Inlet and as the Vancouver port responds to increasing levels of international trade.

Targets for reduction of GHG emissions are being discussed at various levels of government. The Kyoto Protocol is an international protocol signed by Canada and many other nations as a commitment to reduce GHGs to 6% below 1990 emissions by 2008 to 2012. The trend shown in Chart 5-1 indicates the importance of setting realistic goals for reduction in GHG emissions.

Chart 5-1: Total Annual Emissions of GHGs Within the Burrard Inlet Airshed (marine and land sources, including vehicles)



SOURCE: ESSA (2006)

NOTES: Emissions of CH_4 and N_2O are calculated as CO_2 equivalents. CH_4 has 21 times more global warming potential than CO_2 while N_2O has 310 times more global warming potential

Data from 2005 (dotted bar) represent a forecast based on 2000 data.

What can we do to reduce GHG emissions?

Government and industry-sponsored programs to reduce GHG emissions are important locally, nationally and globally. In many cases, a reduction in GHG emissions is linked with improvements in air quality (see Indicator 4). Integrated public transit infrastructure and smart urban design will reduce congestion and link people to workplaces and other destinations. Energy-wise community planning and the adoption of efficient building practices will improve energy efficiency and conservation.

Examples of local programs to cap and reduce emissions in the Burrard Inlet watershed include:

- municipal anti-idling by-laws, energy and GHG emissions planning, community planning
- all Burrard Inlet municipalities are participants in the Federation of Canadian Municipalities' Partners for Climate Protection program, which aims to reduce GHG emissions
- City of North Vancouver initiatives (community energy and greenhouse gas emissions planning, a Local Action Plan, establishing corporate and community reduction targets)
- City of Port Moody initiatives (corporate energy and GHG emissions planning and establishment of corporate and community reduction targets)
- Metro Vancouver improvements to public transit and land use planning
- support for alternative fuels and energy technologies, energy efficiency and conservation initiatives, green buildings
- Vancouver Port Authority's Integrated Air Emissions Reduction Program, with development of a data baseline, improving operational efficiency, technological innovation and supporting regulatory change
- education and awareness programs

Individuals can do their part by taking positive actions to save energy and reduce emissions of GHGs:

- improve energy efficiency at home (space heating, appliances, household management)
- reduce fuel use for transportation (plan trips efficiently, use alternative transportation) and vacations

Provincial and national programs include:

- the Partners for Climate Protection (PCP) Program, a national initiative founded by the Federation of Canadian Municipalities and the International Committee on Local Environmental Issues. The goal of the PCP Program is to support municipal governments in their efforts to reduce greenhouse gas emissions, which addresses the larger issues of the greenhouse effect, global climate change, and its implications to the world's inhabitants.
- an announcement in 2007 by the Province of British Columbia to challenge municipalities to be carbon neutral by 2012, which was signed by 62 municipalities in September 2007.

International cooperation for GHG reduction is essential. Climate change is a global and local issue; our global climate is affected by local actions, and the effects of global climate change are evident in local regions. This year, the International Panel on Climate Change concluded that anthropogenic activities are directly linked to climate change.

Industry and governments are becoming involved in carbon trading partnerships and global reforestation and many international initiatives have begun to address the political challenges of reducing global GHG emission levels. The Kyoto Protocol has raised awareness and set strong targets for nations to pursue, although not all countries, including Canada, will meet their targets. While local pollution reduction programs and mitigation/adaptation strategies play a role in rebalancing the energy budget, international cooperation, such as the post-Kyoto framework currently being developed, is necessary to ensure all nations are contributing to reducing GHG production.

6. Water and Sediment Quality

Why look at water and sediment quality?

Water and sediment quality reflect the state of the aquatic environment and the effects of activities on land, water and air. Good quality water is linked to the health of all living organisms, including humans.

Contaminants such as metals, nutrients, pesticides, hydrocarbons and chlorinated organic compounds enter Burrard Inlet from many sources, including combined sewer overflows, wastewater treatment plant discharges and non-point sources such as stormwater runoff and atmospheric deposition.

Intertidal area, north shore of Burrard Inlet

These contaminants can be dissolved, attach to particles that float on the water surface and/or settle in sediment on the ocean floor. Contaminants that settle on the sediment can either become covered over time by further sedimentation, resuspended in the water column, or move into the food chain as they are consumed by bottom feeders.

Current status: Levels of copper and polychlorinated biphenyls (PCBs) in sediment have declined since 1985, although levels remain above provincial sediment quality objectives to protect marine life (100 mg/kg copper, 0.03 mg/kg PCBs) in areas such as the Inner Harbour and False Creek. Copper levels in water are above guidelines (0.003 mg/L) in 20% of samples collected over the past 20 years, but there are no clear trends over time or space.

Copper in the environment

Copper occurs naturally in water, and is also introduced through many human activities. The most common sources of copper for Burrard Inlet are wastewater treatment plant effluents, combined sewer overflows, stormwater runoff and industrial discharges.

Copper is an essential element for many plants and animals, but in high concentrations it is toxic for humans and aquatic organisms, including crustaceans, cyprinids, salmonids, worms and algae. Young fish are particularly sensitive, as elevated copper levels can interfere with ion transport (affecting gill activity) and can reduce the ability of coho salmon smolts to adapt to seawater.

Water and sediment quality as an indicator

There has been considerable monitoring of metals and organic compounds in water and sediment of Burrard Inlet over the past 35 years by Metro Vancouver, Environment Canada and the BC Ministry of Environment (Goyette and Boyd 1989; Boyd *et al.* 1998; Paine 2004; McPherson *et al.* 2005, 2005a, 2006; Ministry of Environment 2007). Results are compared to provincial guidelines for protection of marine life. BIEAP selected copper and PCBs as indicators of water and sediment quality because they have been identified as persistent concerns over the years. Levels of some other contaminants also exceed guidelines occasionally. Other assessment approaches, such as the Canadian Water Quality Index, may be considered in the future.

Historic monitoring programs have differed in terms of sampling locations, frequency and parameters measured, making it a challenge to develop an accurate monitoring baseline. However, Metro Vancouver has developed an ambient monitoring program to consistently monitor sediment and water quality at seven locations across the Inlet (Nautilus 2006). Data for this BIEAP indicator have been summarized to be consistent with the Metro Vancouver sampling design, to help address these historic differences. Provincial objectives for Burrard Inlet (Nijman and Swain 1990) were used. The sediment objective for PCB is being reviewed and may be lowered to provide greater protection for organisms at higher trophic levels.

Results and Trends

Copper and PCB levels are the selected indicators; however, many other contaminants also enter Burrard Inlet, where they may have a negative effect on marine life. Water and sediment are also monitored for pH (acidity or alkalinity), dissolved oxygen, suspended solids, turbidity, other metals (arsenic, cadmium, chromium, lead, mercury, nickel and zinc) bacteria (total coliforms, enterococci), chlorine-produced oxidants, cyanide, ammonia, hydrogen sulphide, phenol, chlorophenol, styrene, tributyl tin, 1,2-dichloroethane and polycyclic aromatic hydrocarbons (PAHs).

Copper concentrations in water

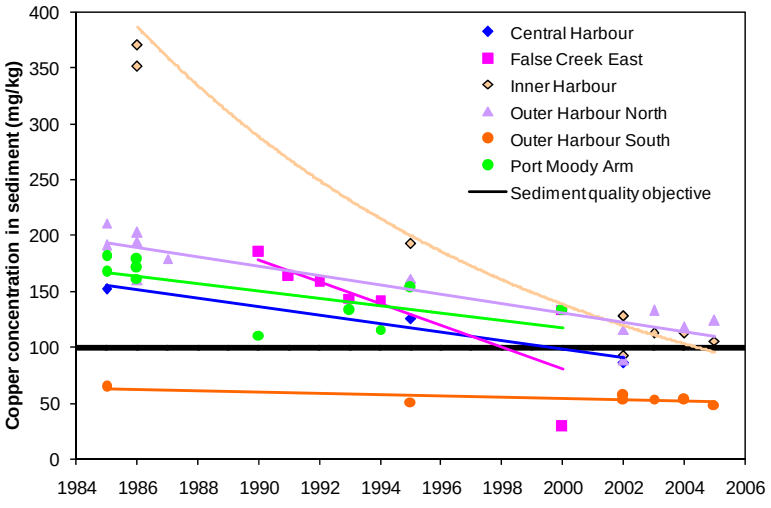
Between 1985 and 2005, 86 samples were collected from several sites in Burrard Inlet. Copper levels ranged from 0.0001 mg/L to 0.012 mg/L, with 17 samples (20%) exceeding the water quality guideline maximum of 0.003 mg/L. Data were examined for change over time, but no statistically significant trends were apparent. Samples from the Central Harbour had the lowest number of exceedances. These results highlight the difficulties associated with sampling water, which can easily miss transient events. In such cases, copper levels in sediment can provide more reliable indications of changes over time.

Copper in the surface microlayer

The surface microlalyer, the 50 to 100 micron thin boundary between water and air is ecologically important. This is the area where complex transport processes occur between the ocean and atmosphere and where larval forms of many fish and invertebrates live. The surface microlayer has been shown to contain contaminants at levels many times higher than in the water column, which may have an impact on marine life stages that inhabit this layer.

In 2000, the Ministry of Environment collected surface microlayer samples at six locations in Burrard Inlet (Moore and Freyman 2001). Copper levels exceeded water quality guidelines, and were 3 to 30 times higher than in the underlying water. Levels were greatest in the Inner Harbour and Port Moody Arm. This suggests contamination in areas immediately surrounding point sources, or in embayed areas adjacent to developed lands, which can supply atmospheric deposition and runoff. Based on this limited sampling, it is not expected that significant microlayer contamination extends over large areas of Georgia Strait; however, further monitoring is required to characterize the environmental significance of microlayer contamination.

Chart 6-1: Copper Concentrations in Burrard Inlet Sediment (1985 to 2005)



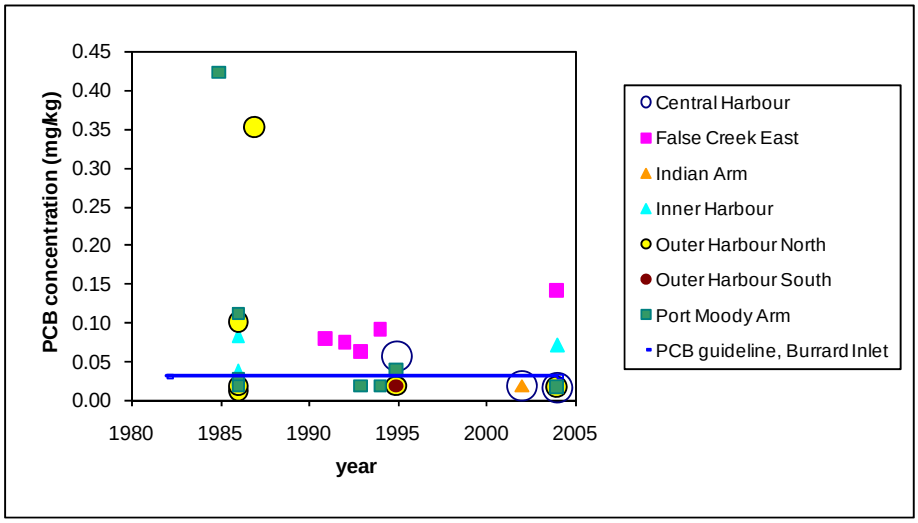
Copper concentrations in sediment have decreased consistently between 1989 and 2005 as shown in Chart 6-1, although levels still exceed guidelines (108 mg/kg, probable effects level) at the Outer Harbour North and Inner Harbour locations. Levels higher than this guideline put sediment-dwelling organisms at risk for toxic effects. Historically, levels were highest within the Inner Harbour and lowest in Outer Harbour South. The amount of copper in surface sediments is decreasing, in part due to decreased levels from permitted effluents, combined sewer overflows and industrial sources and in part because Metro Vancouver has added buffering to the drinking water (less acidic drinking water results in less leaching of copper from older household pipes).

PCB concentrations in sediment

Historically, PCBs were used as coolants and lubricants in transformers, capacitors and other electrical equipment. Production and import to Canada stopped in 1977. However, this stable substance entered the air, water and soil, and can still be released from hazardous waste sites, improper disposal of equipment containing PCBs and incinerators. PCBs persist for a very long time. They adhere to particles and settle in the bottom sediments. Small organisms and fish that feed on organic particles and sediments also take up the PCBs. Larger organisms consume the smaller ones. The resulting biomagnification of PCBs along the food chain can result in extremely high levels and toxicity in larger marine mammals such as seals and whales. Effects on mammals include disruption of endocrine, reproductive and immune systems and presence of physical deformities. Although concentrations in sediment are relatively low compared to copper, PCBs are more toxic than copper, as a result of their direct effects on organisms and their biomagnification.

Between 1985 and 2004, 30 sediment samples were collected from locations in Burrard Inlet. Results are shown in Chart 6-2. PCB levels exceeded the Burrard Inlet sediment quality objective (0.03 mg/kg) in 50% of the samples, and decreased over time at most locations. Not all sites were sampled in each year, making temporal trends difficult to assess. Maximum values of up to 0.42 mg/kg were reported in 1985 and 1986, but most values have been below 0.15 mg/kg. In 2004, PCB levels remained above guidelines in two of the six samples collected (False Creek East and the Inner Harbour). The proposed lowering of PCB sediment objectives (to protect marine mammals) could result in a re-evaluation of this indicator.

Chart 6-2: PCB Concentration in Burrard Inlet Sediment (1985 to 2004)



What can be done to protect water and sediment quality?

Government agencies, alone and through BIEAP, conduct several initiatives to protect Burrard Inlet:

- monitoring of ambient water and sediment quality and point-source discharges
- Integrated Stormwater Management Planning for all watersheds in Metro Vancouver, to be completed by 2012. This will help identify contaminant sources, stormwater treatment options and Best Management Practices to reduce levels of contaminants
- the Metro Vancouver program to separate combined sanitary and stormwater sewers (CSOs), which should result in improved water quality in Burrard Inlet over time (water pipes are a common source of copper, and CSOs discharge a variety of contaminants untreated into Burrard Inlet)
- Metro Vancouver plans to upgrade the Lions Gate plant to secondary treatment; the original timeline of 2030 is being reviewed at the request of the regulatory agencies. Because

wastewater treatment plants cannot remove 100% of the copper, the Lions Gate Wastewater Treatment Plant is an ongoing source of copper to Burrard Inlet

- ongoing identification and remediation of contaminated sites, which will help reduce amounts of contaminants that enter Burrard Inlet
- ongoing improvements in spill containment and treatment technology

Residents can play an important role in reducing non-point sources of contaminants to roadways, the storm drain system, local streams and Burrard Inlet:

- by ensuring they properly use or eliminate use of moss and algae killing products (pesticides, treated roof shingles), which may contain copper
- by avoiding release of common household contaminants (runoff from roads and gardens, draining of hot tubs and pools, improper disposal of household products)

Links with other water and sediment quality issues

Separation of Combined Sewer Overflows (CSOs)

Areas of Vancouver and Burnaby are served by a CSO system. CSOs discharge a combination of stormwater and domestic waste to the wastewater treatment plant under dry and low rainfall conditions. However, they discharge waste untreated to Burrard Inlet when the sewer capacity is exceeded during heavy rainstorms. Metro Vancouver is committed to reducing CSO discharges into Burrard Inlet. At present, a comprehensive automatic sampling program is underway to assess the volume of overflows and determine concentrations and loading of pollutants in order to prioritize CSO separation activities.

Surfactant Reduction Program

Surfactants are used to make detergents and other personal care products more effective cleaners. However, they have been shown to be a cause of fish mortalities in some of the regularly scheduled effluent toxicity tests at the Lions Gate Wastewater Treatment Plant. High levels of surfactants can impair gill function of fish, resulting in mortalities.

To reduce toxicity of the wastewater, Metro Vancouver developed a Surfactant Reduction Program to inform and educate Lower Mainland residents about using less detergent. With the soft tap water in the Lower Mainland, much less detergent is needed than in areas of hard water (the amounts listed on the packages). Reducing the amount of detergent used will save residents money, prolong appliance and clothing lifetime, and reduce the negative environmental effects of surfactants in Burrard Inlet.

For more information:
www.gvrd.bc.ca/sewerage/residential_sources.htm

Pharmaceutical Return Program

Pharmaceuticals, personal care products and cleansers enter the wastewater stream when people shower, take medication or clean their house. Many of these compounds are not removed at the wastewater treatment plant, so are discharged to the environment. Specialized chemical analysis has indicated the presence of over one hundred organic compounds, and their degradation products, in receiving waters across North America (Kolpin et al. 2002). It is difficult to measure the effects of low levels of so many compounds on marine organisms; however, disruption of reproductive systems of fish and other organisms has been well documented (United States Geological Survey 2007).

Providing alternatives for disposal of leftover medications so people do not dispose of them in the garbage or the toilet is one way to address this situation. BC Ministry of Environment developed the Environmental Protection Division Medications Return Program, and has tracked amounts of medications returned to pharmacies since 1998. Amounts returned have increased annually, which may be attributable to increased general awareness, increased pharmaceutical use among the population, and/or increased awareness of the return program resulting from targeted awareness raising campaigns.

For more information:
www.env.gov.bc.ca/epd/epdpa/ips/meds/index.html

7. Recreational Water Quality, Fecal Coliforms

Why look at fecal coliform bacteria?

Fecal coliform bacteria are one indicator of water quality, as they reflect the presence of human or animal waste in a waterway. Fecal coliforms live in the lower intestines of warm-blooded animals and are excreted in feces. These bacteria are used as an indicator for the potential presence of pathogenic organisms associated with fecal material that may cause gastrointestinal illnesses.

The presence of fecal coliforms affects recreational uses (swimming, boating) and harvesting of shellfish in Burrard Inlet by raising the risks of exposure to disease in humans using the water.

English Bay, mouth of Capilano River

Current Status: Primary contact recreation (swimming) is excellent at 15 of the 19 beaches in Burrard Inlet, with no closures over the past five years. There have been occasional closures at beaches in the eastern part of the Inlet, where tidal flushing is lower than in other areas. Shellfish harvesting has been prohibited in Burrard Inlet for several decades. There have been no closures of secondary contact recreation (boating, kayaking, windsurfing) in Burrard Inlet.

Common sources of coliforms in waterways

- fecal waste from pets, mammals and birds
- agricultural and garden runoff when manure is used or stored
- combined storm sewer overflows
- leaks in the sewage collection system
- ineffective disinfection of wastewater treatment plant effluent
- improperly maintained septic tanks
- release of raw sewage from boat holding tanks (many marinas provide pumping facilities)

Fecal coliforms as an indicator

Recreational use

Metro Vancouver monitors swimming beaches weekly from May through September for numbers of fecal coliforms. Samples are taken less frequently during the rest of the year. The entire list of monitored beaches is provided in Table 7-1. This report focuses on several well-used beaches: Ambleside, Third Beach, Locarno Beach, Wreck Beach Acadia, Old Orchard Park, Belcarra Park and Cates Park.

Coliform numbers are compared with provincial water quality criteria for primary contact recreational use and other uses. When levels exceed the criteria, the relevant health authority (Vancouver Coastal Health or Fraser Health) closes the beach to protect human health and requires the beach owner (e.g., a municipality) to post clear warning signs without delay at the affected beach. The signage is left in place until coliform levels are below the guideline. The number of days that beaches are closed for swimming and other recreation uses is an indicator of water quality and associated fecal coliform contamination.

The provincial criteria for bacteria in water are:

- for swimming (primary contact), fecal coliforms less than or equal to 200 bacteria per 100 mL, *E. coli* less than or equal to 77 per 100 mL and enterococci less than or equal to 20 per 100 mL (all as geometric means from weekly sampling over a five-week period).
- for boating (secondary contact) and crustacean harvesting, *E. coli* less than or equal to 385 per 100 mL and enterococci less than or equal to 100 per 100 mL (all as medians); there are no criteria for fecal coliforms.

Table 7-1: Burrard Inlet Beach Locations

Area	Location	Beach closures since 2002
Outer Harbour	Dundarave	No
	Ambleside	No
	Third Beach	No
	Second Beach	No
	English Bay Beach	No
	Sunset Beach	No
	Kitsilano Beach	No
	Jericho Beach	No
	Locarno Beach	No
	Point Grey Beach (Spanish Banks)	No
	Wreck Beach – Foreshore East	No
	Wreck Beach – Acadia	No
	Wreck Beach – Trail 4	No
Inner Harbour	Brockton Point	2002
Central Harbour	Barnet Marine Park	2005, 2006
Indian Arm	Cates Park	2005
	Deep Cove	2002, 2005, 2006
	Bedwell Bay Belcarra – Picnic Area	No
	Sasamat Lake – White Pine Beach	No
Port Moody Arm	Old Orchard Park	2006
False Creek	No beaches	Not applicable

Shellfish harvesting

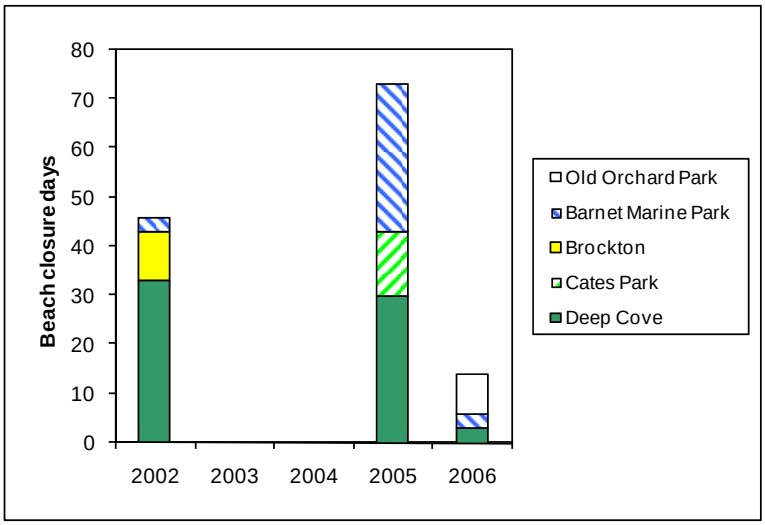
Clams, oysters and mussels are filter feeders, and take up bacteria and contaminants, along with nutrients from the water. As a result, humans could become ill from eating contaminated shellfish and there are stringent coliform guidelines for harvesting shellfish (14 bacteria per 100 mL, median). First Nations, recreational and commercial harvesting of shellfish was an important activity in Burrard Inlet in the past. However, the Inlet was closed to shellfish harvesting after Environment Canada conducted coliform and water quality surveys in the 1970s. Currently the Inlet is unclassified and, therefore, closed to harvest. This has affected First Nations and recreational users of this resource. Shellfish also play an important ecosystem function: they are food for many other species; their filter feeding improves water clarity; and they remove organic matter from the water that would otherwise lead to low oxygen levels.

Results and Trends

Beach closures

Results are presented for 2002 to 2006, the most recent five-year monitoring period. Primary contact recreational water quality throughout Burrard Inlet was excellent in 2003 and 2004, with no beach closures to protect swimmers from potential contact with disease-causing bacteria. There were several closures in 2002, 2005 and 2006, but at only a few beaches (Chart 7-1). The total number of beach-closure days ranged from 0 (2003 and 2004) to 73 days (2005). Overall, the percentage of time each year that Burrard Inlet beaches were deemed acceptable for swimming ranged from 98% to 100% during the bathing season.

Chart 7-1: Number of Days Burrard Inlet Beaches were Closed for Swimming (2002 to 2006)

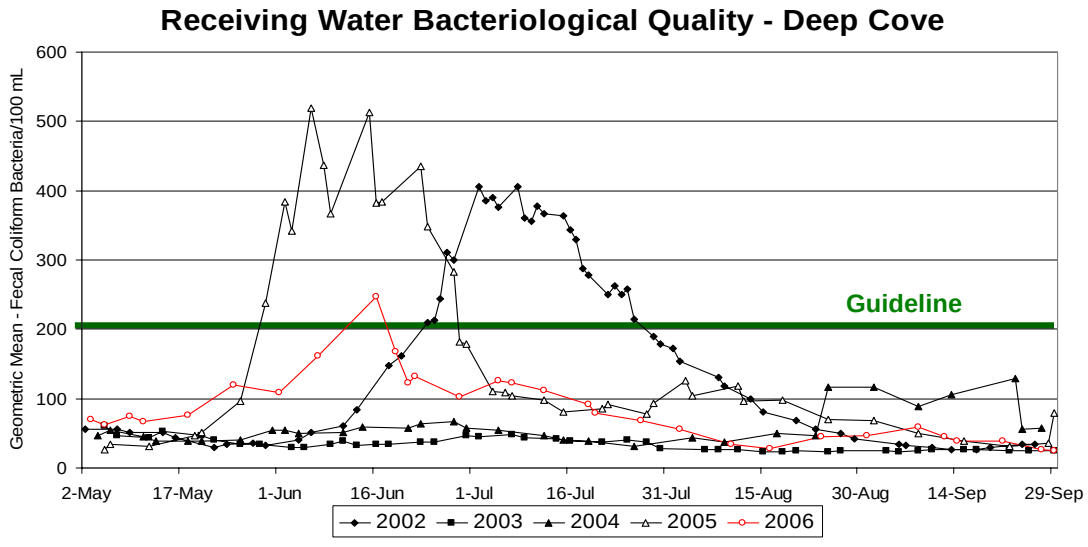


When they occur, beach closures typically last one to seven days; however, areas such as Deep Cove and Barnet Marine Park have been closed for up to 33 days in some years. When closures occur, Metro Vancouver staff take extra water samples and work with the local government to try to determine the cause. Potential causes such as pleasure craft, rainfall, sanitary sewer cross-connections, aging infrastructure, poorly maintained septic fields, waste from pets and geese and tidal flushing rates are considered possible sources, but it is often difficult to identify a specific cause. Beaches with persistent problems tend to be in areas that receive poor tidal flushing.

Fecal coliform data

The fecal coliform data used to determine beach closure status are useful in showing underlying trends. The data can be used to identify areas and times when the beaches remain open, but where there may be concerns about upward trends in fecal contamination. The following figures summarize fecal coliform data (30-day geometric mean) for two affected beaches (Deep Cove in North Vancouver and Old Orchard Park in Port Moody Arm) and one unaffected beach (Sunset Beach in Vancouver), expanding on information provided in Chart 7-1.

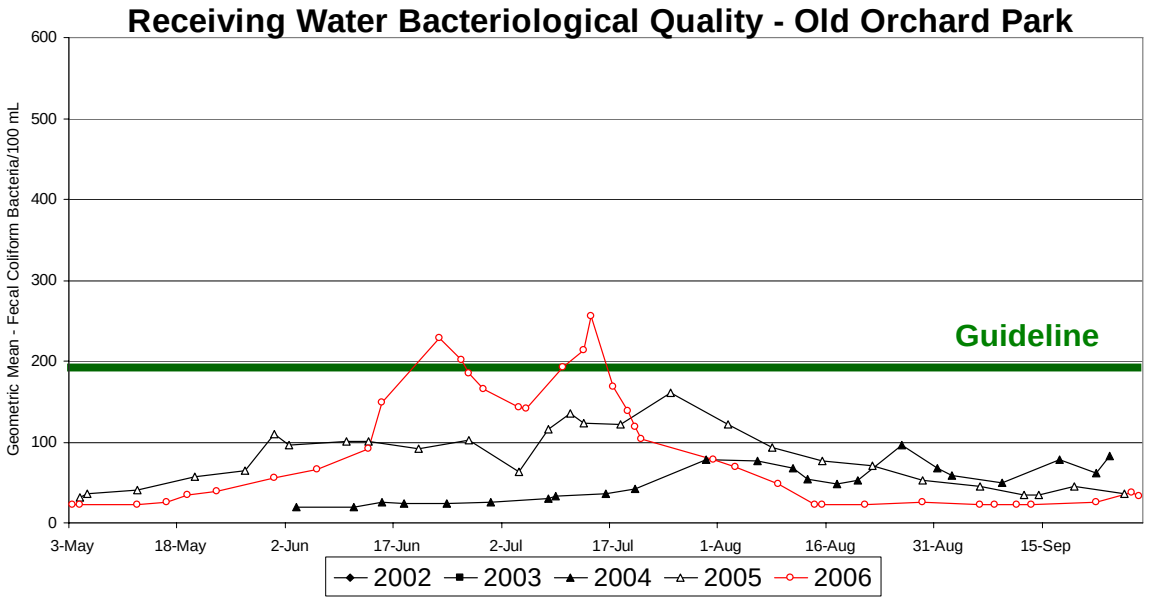
Chart 7-2: Fecal Coliform Data for Deep Cove (2002 to 2006)



Deep Cove (Chart 7-2) had closures in 2002 (33 days in June), 2005 (30 days in July) and 2006 (3 days in June), and no closures in 2003 or 2004.

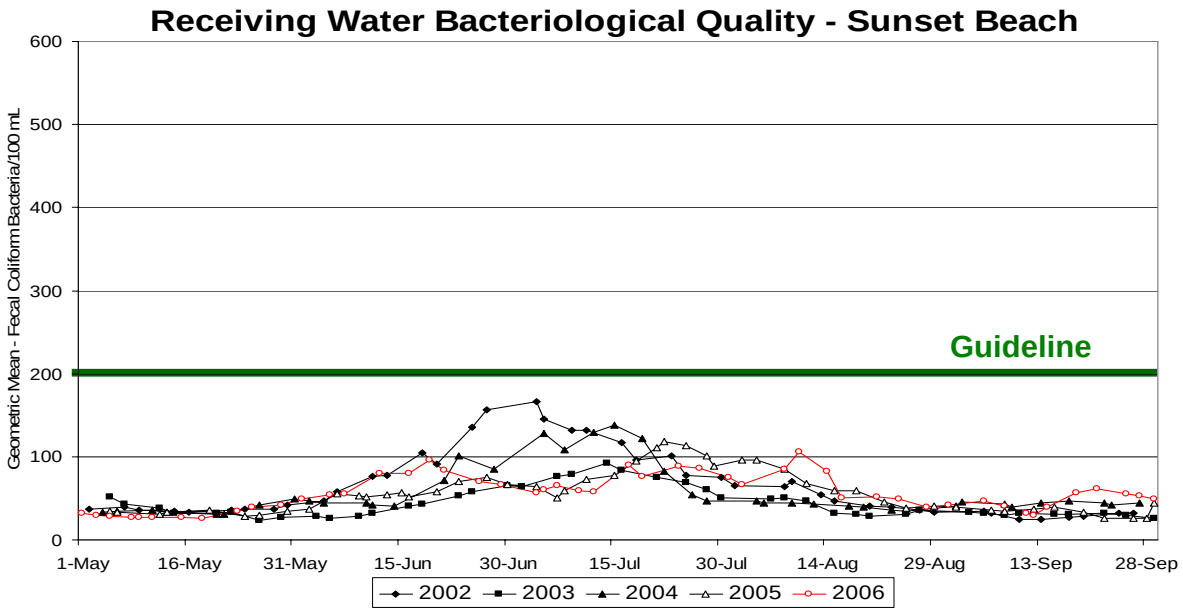
Old Orchard Park (Chart 7-3) has been monitored since 2004. There were two closures of four days each in 2006. Levels have been elevated at various times in 2004 and 2006, but did not exceed the guideline.

Chart 7-3: Fecal Coliform Data for Old Orchard Park (2002 to 2006)



Sunset Beach (Chart 7-4), in the West End of Vancouver, has had no beach closures between 2002 and 2006, although levels have been elevated in mid-summer in several years.

Chart 7-4: Fecal Coliform Data for Sunset Beach (2002 to 2006)



What can we do to protect recreational use of the Inlet?

Liquid wastes, including stormwater, untreated sanitary waste and wastewater treatment plant effluent, contain fecal bacteria, along with many other contaminants, which can accumulate in Burrard Inlet and have a negative effect on marine life.

All levels of government take the issue of fecal contamination seriously:

- when persistent elevated coliform counts are reported, potential causes are investigated
- municipalities work to identify potential cross-connections between the sanitary and storm sewers
- Metro Vancouver plans to separate the combined sanitary-storm sewers and to upgrade the Lions Gate Wastewater Treatment Plant, as described in Indicator 6.
- Municipalities and Metro Vancouver have long-term budgets for replacement of aging infrastructure. Aging storm and sanitary sewer pipes become leaky, so that water enters (infiltrates) the pipes and wastewater exits (exfiltrates) into surrounding land and water. The same processes occur on a small scale for individual property owners.

Metro Vancouver suggests the following ways of safe pet waste disposal:

- Flush it into the municipal wastewater system
- Compost it in a separate location and use it for flower beds
- Burry it with a carbon source (wood chips or ash) away from food
- Bag it and place it in a park bin

www.gvrd.bc.ca/recycling-and-garbage/dog-waste.htm

Enterococci monitoring protocols

Many agencies (BC Ministry of Environment, US Environmental Protection Agency, World Health Organization) recommend the use of Enterococci, rather than fecal coliforms as a human health indicator in marine waters. Enterococci offer several advantages over fecal coliforms in the marine environment:

- their numbers are more strongly correlated to incidents of gastrointestinal symptoms
- they are more resistant to sewage treatment, including chlorination
- they survive longer in water and sediment

The revised primary contact guidelines for Enterococci are 35/100 mL (logarithmic mean of at least 5 samples) and 70/100L (maximum for one sample), with a minimum of one sample per week recommended. Secondary contact recreational guidelines for Enterococci have been proposed for False Creek by the Ministry of Environment.

Residents can help reduce the potential for fecal contamination by in several ways:

- collecting their dog waste and disposing of it as suggested by municipal authorities
- maintaining septic fields properly (e.g., in rural areas of Indian Arm)
- taking care not to leave waste when spreading manure on garden areas
- reporting breaks in the sewage lines to your municipality (identifiable by odour and sight)

Boaters should use holding tanks and pump out sewage at marinas rather than emptying tanks into the sea. Although older boats often lack holding tanks, the number of such boats is decreasing over time.

PART 4 – References

AXYS Environmental Consulting Ltd. 2006.Assessment of Regional Biodiversity and Development of a Spatial Framework for Biodiversity Conservation in the Greater Vancouver Region. Prepared for the Greater Vancouver Regional District, Burnaby, BC. 137 pp.

Badzinski, S.S., R.J. Cannings, T.S. & J. Komaromi. 2005. British Columbia Coastal Waterbird Survey: An Evaluation of Survey Power and Species Trends after Five Years of Monitoring.

BC Ministry of Environment. 2007. Water Quality Data. wlapwww.gov.bc.ca/sry/p2/eq/wat_qual_data/index.html#burrard

Boyd, J., J. Baumann, K. Hutton, S. Bertold and B. Moore. 1998. Sediment quality in Burrard Inlet using various chemical and biological benchmarks. November 1998. Prepared for Burrard Inlet Environmental Action Program by BIEAP Environmental Quality Objectives and Monitoring Action Team. 87 pp. + appendices.

Brekke, H. 2006. Review of upland issues in Burrard Inlet: a background report to assist in developing indicators for Burrard Inlet. Prepared for Vancouver Port Authority, BIEAP Plan Implementation Committee.

Burrard Inlet Environmental Action Plan. 2002. Consolidated Environmental Management Plan for Burrard Inlet.

Burrard Inlet Environmental Action Plan. 2006. Consolidated Environmental Management Plan for Burrard Inlet. Plan Implementation Tracking Report 2006.

Caslys Consulting Ltd. 2006. BIEAP CITYgreen Analysis Results, Summary Report. Prepared for the Burrard Inlet Environmental Action Program, Burnaby, BC. 24 pp.

Chamber of Shipping. 2007. Emissions data for vessels using the Port of Vancouver. www.chamber-of-shipping.com

Chatwin, T.A., M.H. Mather, T.D. Giesbrecht. 2002. Changes in Pelagic and Double-crested Cormorant nesting populations in the Strait of Georgia, British Columbia. Northwestern Naturalist 83:109-117.

Elliott, J.E., M.L. Harris, L.K. Wilson, P.E. Whitehead, R.J. Norstrom. 2001. Monitoring temporal and spatial trends in polychlorinated dibenzo-p-dioxin (PCDDs) and dibenzofurans (PCDFs) in eggs of Great Blue Heron (*Ardea herodias*) on the coast of British Columbia, Canada, 1983-1998, Ambio 30: 416-428.

Elliott, J.E., Wilson, L.K., Henny, C.J., Trudeau, S.F., Leighton, F.A., Kennedy, S.W., Cheng, K.M. 2001a. Assessment of biological effects of chlorinated hydrocarbons in osprey chicks: Environmental Toxicology and Chemistry 20: 866-879.

Elliott, J.E., Wilson, L.K., and Wakeford, B. 2005. Polybrominated diphenyl ether trends in eggs of marine and freshwater birds from British Columbia, Canada, 1979-2002. Environmental science & technology 39: 5584-5591. 2005.

Elliott, J.E., M.L. Harris, L.K. Wilson, B.D. Smith, S.P. Batchelor and J. Maguire. 2007. Butyltins, trace metals and morphological variables in surf scoter (*Melanitta perspicillata*) wintering on the south coast of British Columbia, Canada. Environmental Pollution 149: 14 -124

Environment Canada. 2007. Information on greenhouse gas sources and sinks. http://www.ec.gc.ca/pdb/ghg/about/gases_e.cfm

ESSA 2007. Burrard Inlet Indicators Development – Indicator Data Collection and Analysis. Prepared by ESSA Technologies Ltd. for the Burrard Inlet Environmental Action Program, Burnaby, B.C.

Government of Canada. 2006. Polybrominated Diphenyl Ethers Regulations. http://canadagazette.gc.ca/partI/2006/20061216/html/regle3-e.html

Goyette, D. and J. Boyd. 1989. Distribution and Environmental Impact of Selected Benthic Contaminants in Vancouver Harbour, British Columbia, 1985 to 1987. Environment Canada, Conservation and Protection, Environmental Protection, Pacific and Yukon Region.

Greater Vancouver Regional District (GVRD) and Fraser Valley Regional District (FVRD). 2003b. 2000 Emission Inventory for the Canadian Portion of the Lower Fraser Valley Airshed: Detailed Listing of Results and Methodology.

Greater Vancouver Regional District (GVRD) and Fraser Valley Regional District (FVRD). 2005a. Lower Fraser Valley Ambient Air Quality Report 2004.

Greater Vancouver Regional District (GVRD) and Fraser Valley Regional District (FVRD). 2005b. Lower Fraser Valley Air Quality Monitoring Network: Ambient Air Quality Monitoring Report Technical Appendix Air Quality Data 2004.

Greater Vancouver Regional District (GVRD) and Fraser Valley Regional District (FVRD). 2006. Lower Fraser Valley Ambient Air Quality Report 2005. Available at: www.gvrd.bc.ca/air/pdfs/ AmbientAirQualityReport2005.pdf

Harris, M. L.; Wilson, L. K.; Norstrom, R. J.; Elliott, J. E. 2003. Egg Concentrations of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans in Double-Crested (*Phalacrocorax auritus*) and Pelagic (*P. pelagicus*) Cormorants from the Strait of Georgia, Canada, 1973-1998. Environ. Sci. Technol. 37: 822-831.

Harris, M. L.; Wilson, L. K.; Elliott, J. E. 2005. An Assessment of PCBs and OC Pesticides in Eggs of Double-crested (*Phalacrocorax auritus*) and Pelagic (*P. pelagicus*) Cormorants from the West Coast of Canada, 1970 to 2002Ecotoxicology 14: 607-625.

Harris, M.L., L.K. Wilson, S.F. Trudeau and J.E. Elliott. 2007. Vitamin A and contaminant concentrations in surf scoters (*Melanitta perspicillata*) wintering on the Pacific coast of British Columbia, Canada. Science of the Total Environment (in press)

International Panel on Climate Change (IPCC). 2001. Past and future CO_2 atmospheric concentrations. http://www.ipcc.ch/present/graphics/2001syr/large/02.21.jpg

Kiehl and Trenberth, 1997: Earth's Annual Global Mean Energy Budget, Bull. Am. Met. Soc. 78, 197-208. http://www.grida.no/climate/ipcc_tar/wg1/041.htm

Kolpin, D.W., E.T. Furlong, M.T. Meyer, E.M. Thurman, S.D. Zaugg, L.B. Barber and H.T. Buxton. 2002. Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000. Environmental Science & Technology 36: 1202-1211.

Levelton Engineering Ltd (Levelton). 2002. Marine vessel air emissions in the lower Fraser Valley for the year 2000. Prepared for Greater Vancouver Regional District, Policy and Planning Department, Burnaby, BC and Environment Canada, Pacific and Yukon Region, North Vancouver, B.C. Prepared by Levelton Engineering Ltd., Richmond, BC.

Levelton Engineering Ltd (Levelton). 2003. Backcast and forecast of year 2000 Lower Fraser Valley Marine Vessel Emissions. Prepared for Greater Vancouver Regional District, Policy and Planning Department, Burnaby, B.C. and Environment Canada, Pacific and Yukon Region, North Vancouver, B.C. Prepared by Levelton Engineering Ltd., Richmond, BC.

McPherson, C.A., P.M. Chapman, M.K. Lee, M.L. Fanning, J. Olson and F. Chen. 2005a. Lions Gate Outfall, 2003 Sediment Effects Survey. Final Draft Report. Prepared for the Greater Vancouver Regional District (GVRD), Burnaby, BC by EVS Environment Consultants, North Vancouver, BC. 100 pp. + appendices.

McPherson, C.A., P.M. Chapman, S.J. McKinnon, M.L. Fanning, B.J. Burd, J. Olson, F. Chen and G. Brooks. 2005. Lions Gate Outfall, 2004 Sediment Effects Survey. Final Draft Report. Prepared for the Greater Vancouver Regional District (GVRD), Burnaby, BC by EVS Environment Consultants Ltd., North Vancouver, BC. 210 pp. + appendices.

McPherson, C.A., P.M. Chapman, S.J. McKinnon, M.L. Fanning, B.J. Burd, J. Olson, F. Chen and G. Brooks. 2006. Lions Gate Outfall, 2005 Sediment Effects Survey. Draft Report. Prepared for the Greater Vancouver Regional District (GVRD), Burnaby, BC by EVS Environment Consultants Ltd., North Vancouver, BC. 212 pp. + appendices.

Metro Vancouver. 2008. 2005 Lower Fraser Valley Air Emissions Inventory and Forecast and Backcast

Moore, B., and E. Freyman. 2001. A preliminary survey of surface microlayer contaminants in Burrard Inlet, Vancouver, B.C., Canada. Puget Sound Research 2001.

Nautilus Environmental. 2006. Ambient Monitoring Program for Burrard Inlet. Final Report submitted to Greater Vancouver Regional District, Burnaby, BC.

Nelitz, M., C Murray and K Pawley. 2006. Developing Environmental Indicators for a State of Environment Report of Burrard Inlet. Final Report. Prepared for: Burrard Inlet Environmental Action Program, Burnaby BC by ESSA Technologies Ltd, Vancouver, BC

Nijman, B. and L.G. Swain. 1990. Coquitlam-Pitt River Area: Burrard Inlet Water Quality Assessment and Objectives. Water Management Branch, Ministry of Environment. Victoria, BC.

Paine, M.D. 2004. Environmental Significance of Sediment Quality and Tissue Residue Monitoring Data for the GVRD Iona and Lions Gate Outfall Study Areas. Draft Report. Prepared for Greater Vancouver Regional District (GVRD), Burnaby, B.C. by Paine, Ledge and Associates (PLA), North Vancouver, BC. 31 pp. + tables and figures. December 2003. [Appendix B, Cautions, Warnings and Triggers document]

Ross, P. 2006. Fireproof killer whales (*Orcinus orca*): flame-retardant chemicals and the conservation imperative in the charismatic icon of British Columbia, Canada. Can. J. Fish. Aquat. Sci. 63: 224-234

US Environmental Protection Agency. 2007. Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel. http://www.epa.gov/otaq/climate/420f05001.htm

United States Geological Survey 2007. Endocrine disruption. http://toxics.usgs.gov/regional/emc/endocrine_disruption.html

PART 5 – Glossary

Ambient air pollution – outdoor air pollution within a region

Airshed – geographical area associated with a given air supply and air supply in a given region

Anthropogenic – effects, processes, objects, or materials derived from human activities, as opposed to those occurring in natural environments without human influences

Atmospheric deposition – refers to the movement of pollutants from the air to the land or water surface through rain and snow, falling particles, and absorption from the gas phase to the water.

Basin – a region drained by a single river system, i.e., Fraser Basin

BERC – the Burrard Environmental Review Committee, a coordinated project review body that operates under BIEAP

BIEAP – Burrard Inlet Environmental Action Program (BIEAP), an inter-governmental partnership established to coordinate the environmental management of Burrard Inlet

Benthic organism – the organisms living on or very near, the bottom of the ocean, sea, river, or lake; an important food source for fish

Biodiversity – the variation of life forms within a given ecosystem, region or the entire planet; often used as a measure of the health of biological systems.

Biomagnification – the increase in concentration of a substance, such as the pesticide DDT, from one link in a food chain to another

Bioaccumulation – uptake of a toxic substance by an organism at a rate greater than its loss (excretion or metabolisms)

Buffering – the ability to moderate the effect of addition of acidic or alkaline substances

Catchment – an area of land where water from rain or snow melt drains downhill into a body of water; also includes the streams and rivers that convey the water (watershed)

Carbon sink – the natural ability of trees, other plants and the soil to soak up carbon dioxide and temporarily store the carbon in wood, roots, leaves and the soil

CITYgreen – software used to calculate the environmental and economic benefits of tree cover in a region

Coliform – bacteria abundant in the feces of warm-blooded animals, and also in water, soil and on vegetation; Eschericia coli and fecal coliform bacteria are commonly used as indicators of fecal (sanitary waste) contamination in water and their presence may indicate the presence of pathogenic organisms of fecal origin

CSO – combined sewer overflow, a system where sanitary and stormwater waste flow in the same pipe to the wastewater treatment plant; during heavy rainfall, increased flows can result in discharge of untreated sewage and stormwater through an overflow pipe into a river or the marine environment

CACs – Criteria Air Contaminants (ground-level ozone, carbon monoxide, nitrogen oxides, sulphur oxides, volatile organic compounds, particulate matter (<10 micron size), fine particulate matter (<2.5 micron size), ammonia

Ecosystem – a natural unit consisting of all plants, animals and micro-organisms in an area functioning together with all the non-living physical factors of the environment

Ecosystem asset – resources and processes supplied by the natural environment that benefit humankind

Evapotranspiration – the movement of water vapour from the land to the air through evaporation and plant transpiration

Food chain – A succession of organisms in a community that moves food energy from one organism to another as each consumes a lower member and in turn is preyed upon

Foreshore – the part of a shore between high water and low water; includes the backshore exposed at maximum ebb spring tides

FREMP – Fraser River Estuary Management Program (FREMP), inter-governmental partnership established to coordinate management of the Fraser River estuary

GHG – Greenhouse Gases; emissions that cause the greenhouse effect

Exfiltrate – loss of wastewater from a sanitary system as the result of seepage into the surrounding soil

Habitat – the place or environment where a plant or animal naturally or normally lives and grows, which provides food, water, shelter and space

IMO – International Maritime Organization, a United Nations agency responsible for improving marine safety and preventing pollution from ships

Impermeable – a surface that does not allow water to pass through, e.g., pavement, concrete

Infiltrate – the downward movement of water through soil; also the movement of water into a wastewater pipe

Intertidal – the zone of influence from the tide; a component of the foreshore, includes the part of a shore between the high tide mark and the low tide mark

Mobile source pollution – a source of pollution that is not fixed in space, such as the exhaust from a car, or boat

Non-point source – a source of pollution that is not concentrated in one specific area, such as stormwater collected from a neighbourhood

OGV – Ocean going vessel, a size classification of ships

PBDE – Polybrominated diphenyl ethers; PBDEs are flame retardants that have been used in a wide array of household products, including fabrics, furniture, and electronics

PCB – Polychlorinated biphenyl; PCBs are persistent organic pollutants that were manufactured as cooling and insulating fluids for industrial transformers and capacitors, and electronic components. PCB production was banned in the 1970s due to the high toxicity.

PCP – Partners for Climate Protection; program run by the Federation of Canadian Municipalities for municipalities to measure and reduce carbon emissions

Pathogen – a biological agent that causes disease or illness to its host

Permeable – capable of passing water or other materials through

PM_{10} – Particulate Matter of 10 micrometre diameter or less. Larger particles are generally filtered in the nose and throat and do not cause problems, though small particulate matter can settle in the bronchi and lungs and cause health problems, including asthma, lung cancer, cardiovascular issues, and premature death.

$PM_{2.5}$ – particulate matter of less than 2.5 micrometres in diameter. See **PM_{10}** for a description of associated health effects.

Point source – a source of pollution that comes from a localized area, such as a smoke stack or an industrial discharge pipe

Sanitary sewers – sewers that carry sanitary (human) liquid waste

Secondary treatment – a level of sewage treatment that is designed to substantially degrade the biological content of the sewage derived from human waste, food waste, soaps and detergent

Short sea shipping – the movement of freight along coasts and inland waterways

SFP – Smog Forming Pollutants

Sub-Basin – a smaller division of a catchment or basin

Substrate – sediment, sand, gravel, cobble, boulder or bedrock in the bottom of a water body

Subtidal – below the low tide line; submerged virtually continuously

Surfactant – wetting agent that lowers the surface tension of a liquid, allowing easier spreading

Tree canopy – area taken up by canopy of a tree; can be a measure of the area under leafy cover in a region, to quantify green space

Toxicity – degree to which a compound produces illness or damage to an exposed organism

Turbidity – cloudiness or haziness of a fluid caused by individual suspended solids that are generally invisible to the eye

Waterbird – all birds that live in or around water; includes seabirds, waterfowl, shorebirds, etc.

Watershed – region of land whose water drains into a particular watercourse

ADDENDUM

On April 8 & 9, 2008, BIEAP hosted three public consultation workshops to introduce the *Burrard Inlet Environmental Indicators Report* and solicit feedback from the public.

PART A – Public Feedback

Attendees were asked to fill out questionnaires to determine their level of satisfaction with the report and workshops and were given the opportunity to provide comments and recommendations for future reporting. The following is a summary of the received feedback.

1. **Has this report helped you understand the status of the Burrard Inlet ecosystem?**

   Strongly Agree (1)

   Agree (6)

   Disagree (1)

   Strongly Disagree (2)

   General Comments:

   - Good overview, however several relevant indicators are missing.
   - A lot of information has been overlooked, the summaries are too general.
   - The current list of indicators seems to be measuring what is measurable, not necessarily what is important. The report is about Burrard Inlet – a body of water that provides habitat, or should, to a vast range of marine creatures - yet there is no indicator discussing the health of benthic or marine communities. The inlet has a long and rich history of fishing – from early Aboriginal settlements through to the role of the cannon at Stanley Park calling in the fleets to salmon derbies even into the present. Yet this compelling and interesting history of the role of the Inlet and the people residing in surrounding communities is completely missing except for a short paragraph on shellfish harvesting.
   - Appreciating BIEAP's desire to work with indicators which have a historical context, there is room for creating new indicators that recognize public or scientific concerns and new technologies available for monitoring. The canopy/forest coverage indicator is an excellent example of such an indicator. A similar indicator would measure the percentage of the developed and undeveloped portions of the coastal zone of the Inlet – this can be derived from the forestry cover work and corroborated through examination of municipal plans in the developed areas of the Inlet. This is definitely a concern into the future and the related comments can discuss the mix of urban development, industrial and port facilities, recreational and undeveloped portions that surround the Inlet.

- To compare forest coverage in the study area with coverage in any other urban area is not a fair comparison since the study area is only a portion of the Metro Vancouver region. It is likely the percentage of forest canopy will drop as one includes the south of the Fraser communities.

2. Do the selected indicators adequately capture trends over time?

Agree (5)

Disagree (2)

Strongly Disagree (3)

General Comments:

- The trend lines are interesting.
- Fish monitoring data should be included (even if it is coarse data).
- Information on chemicals and hydrocarbons should be included (ie. the status of the 2007 Burnaby oil spill).
- The indicators are too rigid and do not allow for the required flexibility.

3. The seven indicators discussed in this report were selected because their monitoring programs are reliable, consistent and on-going and their existing datasets reflect the effects of human activities on Burrard Inlet. New indicators may be considered for future reports as other monitoring programs are established.

What are important environmental issues for your community? Are there other indicators that meet the selection criteria listed above that have been missed?

- Fish populations and trends
- Abundance and diversity of marine invertebrates
- Water temperature, oxygen content and associated fish stress
- Industrial permits, pollution and dumping
- Combined Sewer Overflows
- Oil spills
- Storm water management
- Loss of natural shorelines
- Water quality in the streams that feed Burrard Inlet, including phosphates, nitrates and silt
- Invasive marine species
- Wildlife abundance
- Fecal coliforms in Bedwell Bay
- Park/beach cleanliness and safety
- Housing/building developments
- Industrial Air Pollution Monitoring on the North Shore Harbour

General Comments:

- I am concerned about the chemicals and hydrocarbons in the sand in Port Moody beaches such as Orchard Park. My children play there and I would like to know how safe it is. Fecal count monitoring is good, but chemicals, heavy metals and

hydrocarbons should also be monitored at beaches with the same frequency in order to ensure public safety.

- I am mostly concerned with contaminant levels in higher trophic level organisms in the inlet. While it is good that BIEAP is considering including an indicator of tissue contaminant levels in marine mammals, I wonder how feasible this is (financially and ethically). It is my hope that contaminant modeling will be used as a management tool more frequently in the future.
- The report is too shallow, and paints a pretty rosy picture.

4. How can BIEAP best communicate environmental information on Burrard Inlet?

General Comments:

- Provide a website that is vibrant and has cumulative and changing data.
- Provide short concise communiqués about the state of the Inlet and list the threats, positive trends and what governments, businesses and individuals can do to improve the health of the inlet.
- BIEAP should consider providing educational resources for teachers.
- Be clearer on who BIEAP is, what you want from the public, what will happen to their comments and who will see them
- Be truthful with the information and do not gloss over the facts.
- Provide all references that are in the report and any other key data details on the BIEAP website.
- A report like this is a good start, but BIEAP should be given resources to conduct their own monitoring (rather than relying on others) and be able to generate a report like this on a yearly basis – not every 5 years.

5. How would you like to keep informed in the future?

Email (6)
Website (6)
Workshops (1)

6. How did you hear about this workshop?

- Emails
- Website
- Word of mouth (2)
- City staff on North Vancouver Parks & Environment & Advisory Committee
- North Shore Streamkeepers
- Port Moody City Council
- Community advisor with Fisheries and Oceans Canada
- UBC SEC mailing list
- MP
- Article in Burnaby Now

7. Additional Comments

BIEAP

- BIEAP should develop a funding strategy so that it is not subject to the whims of agency funding.

- There may be funding opportunities through national defense (terrorist chemical releases that could impact human health). Models needed to analyze those types of situations may be very similar to those needed to model contaminant dispersal in Burrard Inlet.
- It is concerning that BIEAP relies so heavily on datasets available from other agencies.
- It is important to re-engage the public. Politicians must also be made aware of environmental conditions.
- BIEAP should consider increased emphasis in schools and with children to support a sustainable, long-term approach.
- A research component of BIEAP does not exist and should be initiated. Post-graduate studies relating to answering some of the questions about the Burrard Inlet ecosystem should be encouraged at our local universities. Some examples of projects that could be carried out are:
    - Why has there been a fall in size and distribution of kelp beds? Kelp is the forest of the marine world and supports a very complex and biodiverse ecosystem.
    - Surf smelt and sand lance are important components of the food chain. Their spawning locations should be identified and protected.
    - The causes of elevated coliform counts should be positively identified & understood. By doing this, preventive action could be taken rather than the present method of reactive response.
    - There should be a better understanding of the effects of sewage discharge on marine ecosystems of Burrard Inlet.
    - There should be further research on the effects of ballast water efflux on the marine ecosystem of the Inlet.

Workshop

- It would have been valuable to have a round table of introductions for resource staff and attendees.
- The full group discussion we had was important to all; it should have been a planned part of the evening.
- The report should be made printer friendly if documents are not readily available for participants.
- The consultation was ambiguous with no clear goal for the public. If one does not have a strong environmental background it would be difficult to sufficiently answer these questions.

Report

- The report should look at targets for the indicators rather than trends.
- This report needs to incorporate recommendations for change in order to improve the health of the inlet (although I understand this may be more relevant for the CEMP).
- An important communications piece that is missing is a 1-2 page summary document of the indicators conveying the trend in the eight indicators, not a report card.
- BIEAP should be more explicit in its communications and presentation about its geographical jurisdiction. A map delineating the area defined as the Burrard Inlet basin as well as a short list of the communities incorporated into the analysis would be very helpful in marking the territory described in the indicators.

- It would be useful to link the CEMP Tracking Reports to the Environmental Indicators Report.
- A technical addendum to the report should be provided to list the monitoring programs carried out by BIEAP partner agencies.
- The BIEAP presentation on the report, and the indicator storyboards, should be presented to BI municipalities/city council.
- The state of the environment report should deal with the problems in the inlet. It should not only deal with the chosen seven indicators. What about the residual effects from the Kinder Morgan oil spill?

Indicators

I. Tree Canopy Cover

- Information on the diversity of tree species would be useful in assessing the risk of forest fires in the area.

III. Bird Abundance

- The bird species used as indicators are all seabirds and the trend appears to be an increase in population for most. However some recent information indicates that songbird populations are decreasing around the inlet.

IV. Air Quality

V. Greenhouse Gas Emissions

- Greenhouse gases are more of a global issue than a harbour issue.

VI. Water and Sediment Quality

- With so few water samples and with the Barnett Marine Park being closed for months after the 2007 Burnaby Oil Spill, BIEAP's assessment of water quality is much too positive.
- This report gives no sense of what is going on in terms of pollutant contributions to the inlet. The public is unaware because permits have discharge information that is not released to the public.

VII. Fecal Coliforms

- Research and the resulting understanding of the Burrard Inlet ecosystem should facilitate the monitoring and beach closure process. Closures are being carried out in a climate of ignorance.

General Comments and Recommendations

- First Nations traditional/oral history is presently not included and should be. With the oral history of species that once populated the waters of Burrard Inlet and Indian Arm we can gain a better understanding of ecosystem changes.
- Transport mechanisms for contaminants need to be considered.
- The changing rainfall regime, which has been characterized by periods of more intense rainfall, may be causing increased sediment load and turbidity in streams. This may be causing increased siltation and turbidity thus impacting the marine ecosystem of Burrard Inlet (e.g. substrate for

kelp attachment such as bedrock & cobbles may be buried by sediment deposition and could explain the loss of kelp in certain areas of the Inlet).

- By-catch from beam trawl shrimping boats should be examined for documented historical species.
- Although there is some reference to invasive species, not much follow-up action is contemplated. In spring plankton samples in the Inlet an invasive tunicate is the dominant planktonic form in numbers and biomass. These tunicates are recently (last 4 years) establishing themselves in the harbour and are out competing the traditional mussel/barnacle community. This same tunicate is spreading and endangering the shellfish industry. A similar species, where it exists, has decimated the scallops on the east coast. Yet there are no specific examples of recent invasives in the inlet in the report.
- Another potentially serious issue is the extremely rapid increase in ephermeral filamentous green algal mats (Family Chlorophycea). These mats are one of the most visible symptoms of eutrophication. There is concern that the decomposing algal biomass is starting to cause a serious nuisance problem for recreational use of the harbour/marina. This algae is often cast high on the shore, rip rap, and pilings causing an unsightly rotting mass. It also impacts boat cooling water intakes.
- I would like to see how the harbour managers will monitor newer pollutants and forms of degradation in the environment. PCB use is all but extinguished and not as much of a concern, nor are the metallic ions. Nitrogen, phosphorus and potassium runoff from fertilizers and detergents is developing into an enrichment concern in the inlet and the streams that feed it.
- The report does not refer to the historic beds of eelgrass in the harbour. Does BIEAP have a position on the importance and role that it plays in the harbour, especially Port Moody, Maplewood Flats and Bedwell Bay? The Pacific Wildlife Foundation and the Reed Point Marine Education Centre are involved in restoring and replanting these beds. The plantings are being monitored and sampled for increases in productivity and habitat creation for a variety of fish, bird and invertebrate species.

PART B – Questions and Answers

The following is a record of questions posed by the public through the questionnaire and consultation workshop discussions with BIEAP's response provided below.

1. **What is the purpose of the indicators report?**

The BIEAP Consolidated Environmental Management Plan (CEMP) identifies actions for partners to take to improve the health of Burrard Inlet, including the development of a State of Environment Report (SOE). The Burrard Inlet Environmental Indicators Report is a first step towards this commitment, and serves as a baseline assessment of ecosystem health in the inlet. The BIEAP partners intend to develop an SOE report in the future based on the collection of trends and analysis from the indicator assessment. The Environmental Indicators Report also measures what BIEAP and partner agencies are doing to address issues and commitments identified in the CEMP.

2. **What is the target audience for the report?**

The general public is the main target audience for the report; although the status and trends of the indicators does influence policy within the partner agencies to some extent.

3. **What is the timeframe for completing the indicators report?**

Feedback and comments received from the Public Consultation Workshops will be collected until April 30th, 2008. A summary of the feedback the BIEAP PIC receives will be included as an addendum to the report. The report will be finalized by the end of 2008, and the objective is to revisit the indicators every 5 years to establish trends over time.

4. **Does BIEAP report on partner programs and progress towards goals of the CEMP?**

Yes. The annual CEMP Tracking Report provides partner agency project and program status and progress reports against the goals of the CEMP. The annual tracking report is a monitoring and progress reporting tool that is shared amongst agencies and is posted on the BIEAP website.

5. **Has BIEAP considered partnering with universities to leverage research and resource needs?**

Yes. Metro Vancouver, one of the BIEAP partner agencies engages graduate programs to assist with ambient water quality monitoring programs that relate to Burrard Inlet. The Metro Vancouver Environmental Monitoring Committee also engages representatives from UBC and SFU.

6. **Why is industry not more clearly reflected in the document?**

Human impacts on Burrard Inlet are captured more generally in the indicators report, and this includes the industrial component. For example, Port Metro Vancouver –

one of the major industries in Burrard Inlet - was involved in the development of the report, and provided data sets to support the assessment of several of the indicators described in the report.

7. **Why were fish data sets (i.e. extinctions) not used in the same manner as the waterbird surveys?**

Waterbird sampling through the Coastal Waterbird Survey and Christmas Bird Count are consistent sampling programs that have provided a robust data set upon which to interpret waterbird abundance trends in Burrard Inlet. In contrast, sampling programs for abundance of resident fish or fish that spend a majority of their life in Burrard Inlet have been inconsistent (i.e. lack of programs that separate annual variations vs. long term trends), and therefore, do not provide a measurable indication of the health of the inlet.

8. **Were sea level rise and climate change issues considered in the report?**

Climate change is addressed by many of the BIEAP partner agencies. However, there is not a lot of data specific to Burrard Inlet that can be used to interpret present and/or future impacts of climate change to the inlet. The BIEAP PIC is currently conducting an assessment of shoreline change over time, and this research may establish an important baseline for future studies on climate change impacts at the local level.

9. **Why were the "possible future indicators" described in the workshop presentation not included in the report?**

Additional indicators considered by the BIEAP PIC are listed on page 9 of the report. These topic areas may be used as indicators in future reports as additional information becomes available.

10. **When will BIEAP consider new indicators (i.e. invasive species)?**

The indicators chosen for the report were based on a series of selection criteria. These criteria include consistent data sets that show risks to the health of the Burrard Inlet ecosystem through ongoing monitoring programs. New indicators will be considered if the required data becomes available. In addition, BIEAP partner agencies manage other programs such as invasive species management, and sediment and water quality programs. These program areas are tracked and progress reports are released annually through the BIEAP CEMP Tracking Report.

11. **How will the feedback from community and local stewardship groups be integrated into future iterations of the report?**

The public consultation process on the report is the first step in engaging community and stewardship groups. The feedback that we receive will directly inform the next iteration of the indicators report.

12. **I was shocked to hear of the funding cutbacks. Are the funds moving to another monitoring program?**

In 2003, BIEAP-FREMP was downsized to fit the requirements of some of the partners. At the onset of the year, the programs shifted from facilitating a number of different activities to defining our two key roles: policy planning and coordination, and coordinated project review.

Our 'Back-to-Basics' approach was put to the test over the following year and evaluated in January 2004 by the Management Committee. Their recommendation to the Steering Committee strongly stated that core functions were being effectively managed and that the BIEAP and FREMP programs should continue in their new format. This recommendation was supported by the entire partnership, with financial contributions being secured for the upcoming year. The Management Committee also continues to explore new partnership opportunities for the programs' operational support and specific plan implementation projects.

13. Does BIEAP encourage specific kinds of data collection by these agencies or will BIEAP collect data?

BIEAP suggests program directions to its partner agencies through the Management Committee. It typically undertakes direct data collection works only when specific projects are undertaken by more than one partner and BIEAP is nominated to coordinate the activities

14. The current presentation is lacking an integrative piece – how are these indicators linked to each other and how do they collectively provide a baseline assessment of the state of the Burrard Inlet?

At this time, there is not sufficient available information to permit the derivation of a state of the environment baseline. The report does not attempt to do this; that is why BIEAP hopes to add indicators in the future. Nevertheless, the report does provide baselines for the currently addressed indicators, to permit some trends indications in future reports.

15. Why is this report directed at the public and what the public can do to reduce pollution rather than at industry? There should be more of a focus on industry's contributions to poor air and water quality and what they can do to reduce their footprint.

The report is directed at anyone and everyone who can use the provided information to effect positive change. Identifying specific problems and solutions is beyond the scope of the report, but is a CEMP mandate. The CEMP reflects the partners' commitments to address environmental issues such as those identified in the question.

16. How does BIEAP incorporate community knowledge (ie. stream health/insect population data from local streamkeeper groups)?

The examples are not amongst the indicators chosen for this report. Nevertheless, community knowledge is incorporated for any indicators where it is appropriate and available (e.g. Christmas bird count data).

17. In 1991, BIEAP had many volunteers involved in various studies and shoreline cleanups. What happened to all of the collected data?

The data were not applicable to any of the selected indicators.

18. **The report is too general; it should include more local and specific situations. What actions are planned as a result of this report?**

Local and specific situations are not within the scope of the report. The report will be used to measure future progress in the selected indicators.

19. **The harbour contains numerous specific items of contemporary concern. Perhaps it is because of their recent nature there are no "existing data sets and on-going monitoring programs that are sufficiently robust." If existing data was to be the measure of study topics, a whole host of emerging biodiversity, sustainability and change studies could not be considered. Will this study only discuss past data sets or will it suggest the collection of new data sets?**

Gap analysis is an ongoing priority for the CEMP Implementation Committee. The current report was useful in highlighting areas where additional effort would be desirable and will be taken into consideration by the BIEAP partners when planning new programs.

20. **Are bird populations really a good indicator of good water quality? Isn't it possible that poor water quality, due to an increase in nutrients, could actually correspond to an increase in food and therefore more birds?**

The issue is complex and not amenable to generalities. The report did not seek identify causal relationships.

21. **Is it possible that the decrease in gull population is due to closure of open landfills?**

The issue is complex and not amenable to generalities. The report did not seek identify causal relationships.

22. **Is the breakdown of air emission source sectors presented in the report available somewhere?**

Yes, from Metro Vancouver and Environment Canada.

23. **If GHGs are a harbour issue why does the report not mention that the potentially largest point source of carbon dioxide - Burrard Thermal Generating Station is on the shores of the inlet using the waters of the harbour for cooling?**

The intent of the report was to discuss the selected indicators and why they are problematic. It was never intended that all contributing sources be listed in this report.

24. **Why doesn't the report summarize industry discharge permits?**

This information does not support any of the selected indicators.

25. Is any testing being done on endocrine disruptors and pharmaceuticals from the Lion's Gate Wastewater Treatment Plant?

Metro Vancouver has measured pharmaceuticals in Wastewater using Trent University. Results were similar across Metro Vancouver WWTPs and overall, results were similar to other WWTPs in Canada. Most of the results in the literature focus on individual or two or three constituents at a time, and effects often occur at higher concentrations than those observed in wastewater. Simon Fraser University used the yeast estrogen screen bioassay (basically measuring activity relative to 17 beta-estradiol) as a surrogate rather than measuring these constituents individually. Some confirmatory chemistry was done in relation to results from the bioassay.

26. Can information be provided about the success or status of the ballast water exchange program?

The then Vancouver Port Authority monitored compliance with its ballast water standing order before responsibility was assigned to Transport Canada by regulation a couple of years ago. The order required vessels arriving from ports outside of a designated local area to conduct mid-ocean ballast exchanges. The port knew the compliance rate with a high degree of confidence. However, there is no practical way to determine whether the program was actually successful in preventing the introduction of non-indigenous species. There are many reasons for this, including:

- Introductions can occur by many pathways, including ballast tank sediments that are not easily exchanged and as fouling on ships' hulls and propellers.
- While there are known to be many non-indigenous species present in Burrard Inlet, it is not known how many, if any, are recent arrivals. An invasive species may exist for years as a small pocket population until a combination of circumstances creates an environment favourable for the population to grow exponentially.

Nevertheless, the available evidence is sufficiently strong that in the absence of an effective ballast water treatment method, mid-ocean ballast exchange is an effective management tool. This is why so many jurisdictions are now requiring it.

27. What is the role of the Port? Do port activities contribute to ongoing environmental conditions?

Port Metro Vancouver is a BIEAP partner. Port-related activities such as shipping do affect environmental quality in Burrard Inlet. Port Metro Vancouver engages in active management of environmental issues, both directly and through agency partnerships such as BIEAP.

28. Why was waste discharge permitting data not included in the report? Tracking programs on waste discharges (i.e. permits, NPRI) should be presented in the report in addition to beach closure data to better illustrate water quality in BI.

BIEAP does not maintain detailed data on industrial permits, NPRI, and beach closures. Metro Vancouver provides summaries of information to BIEAP for general reporting purposes. If detailed data is required, requests can be made directly to Metro Vancouver. Information is also available on Environment Canada's National

Pollutant Release Inventory website:
http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm

29. Is the source of sediment copper due to the acidic nature of the region's drinking water and leaching of nutrients from the copper piping in plumbing systems?

It appears likely that there are a number of sources for the copper in Burrard Inlet sediments, including copper piping. Others could include ship and boat maintenance activities and vessel antifouling coatings, ore concentrate handling, and natural sources. Suspected human sources are the subject of ongoing management efforts.

30. At what depth are sediments samples taken? Are sediment samples taken in the intertidal zone and/or deeper areas of the inlet?

This is an example of why data robustness is important in indicator selection. There have been a great many sediment sampling programs in Burrard Inlet in the last couple of decades. The ones used for this report are those that repeated similar sampling and analysis techniques, stations, timing and other parameters over a period of time. These did not include those programs that included intertidal samples, but did include samples at a number of depths within the Inlet.

31. Is there a plan to move PCB contaminated sediments or will they be left in place?

There are no identified sediment parcels in Burrard Inlet that are particularly heavily contaminated with PCBs, and no plans for the remediation of such parcels.

32. What will happen when the backwash water from the new drinking water filtration plant is discharged to Burrard Inlet?

The discharge from the Drinking Water Filtration Plant will be subject to a comprehensive treatment and environmental monitoring program which was developed by consultants, and will be administered by Metro Vancouver.

33. Will it contain sediments and untreated pathogens such as bacteria that will be pushed by tidal action towards the beaches?

Potential for pathogens:
The presence of Contaminants of Potential Concern (COPCs), including pathogens in the backwash water, was not identified during the summary of effluent quality by Golder Associates and is not likely to present any identifiable health concerns based on the calculated dilution of the discharge (i.e. greater than 280:1 at edge of IDZ). The composition of the effluent from the backwash cycle will contain Total Suspended Solids <45mg/L; Iron or Aluminium < 3mg/L total or <0.05 mg/l dissolved; Cationic polymer <6 mg/L. The 96h LC50 has been calculated at ≥ 100%.

With the historical tidal current (3m/s) at the outfall, the potential for any TSS to be carried onto the nearby shoreline is negligible.

Sediment and pathogens removed in the filtration plant will be managed as part of the solid residuals and will not be discharged to the inlet. The water discharged from

the Drinking Water Filtration Plant will be treated and will meet all requirements for safety and environmental protection.

34. What is the source of fecal contamination at beaches?

There are a number of suspect sources including pleasure crafts, storm drainage contamination (run-off from residential and park areas contaminated with pet feces), and pet and/or bird droppings (primarily from geese) on or close to the beaches. Sanitary pump stations are now available for the pleasure craft pump-out and it is an offence under the Canada Shipping Act to discharge sewage from boats to Burrard Inlet.

35. What sort of human intervention can we do to prevent fecal contamination of beaches?

Enforce the prohibition of dogs on beaches, continue with regular pick up of goose droppings on beaches and discouraging geese from loitering on beaches. Municipal staff should vacuum up goose and dog feces from large waterfront park areas (Port Moody uses the leaf sweeper, which does a good job).

36. How do you plan to continue with fish studies that were done previously? (i.e. flat fish all died from cancerous lesions so they can't be studied anymore, but the contaminants that killed them are still present). What about looking at fish extinctions?

The "flat fish" did not all die from cancerous lesions. It is true that some studies that were carried out in the Inlet since the 1980's did find English sole with precancerous lesions that were attributed to the presence of polycyclic aromatic hydrocarbons (PAHs) in the sediments. Metro Vancouver has included English sole in its ambient monitoring program. The "fish extinctions" issue was addressed in the response to question 7.

37. In the past, English Bay shrimp trawls frequently picked up rare specimens. They caught fish such as sharpchin rockfish. Do they still exist in the harbour?

It is not known if Sharpchin Rockfish are still present in Burrard Inlet. However, several Rockfish Conservation Areas have been established to protect rockfish stocks in the Inlet.

38. Sailfin sculpins were common in trawls dating back as far as 1891. What is their present status? Spiny lumpsuckers, which were frequently found in trawls and beach seines along with 5 or 6 species of snailfish (1946) are not there now. What does this say about sustainability in the harbour? In a hundred short years we may have extirpated untold species of fish.

BIEAP member agencies, in particular, Fisheries and Oceans Canada is not aware of any fish species extirpated in Burrard Inlet.

39. Is BIEAP aware that in the Burrard Inlet Eastern portion, there is a location where the world's largest Giant Pink Stars (Pisaster

brevispiinus) exist? They are also possibly the largest echinoderms in existence. This is of great biological significance. Very large old individuals usually indicate stable environmental conditions and few pollution events. Could something be learned from this unique bed of sea stars? There is a long history of using aquatic invertebrates as indicators of water quality in streams and lakes. Why not in the harbour?

BIEAP and its partners are aware of these giants. The suggestion will be considered at future PIC meetings.

40. **What is being done in the harbour with respect to the use of creosote treated timbers and pilings? I believe that Puget Sound has banned their use. Some jurisdictions have a creosote pile removal and recovery program in effect. Others are encasing the creosoted piling to allow growth and specifically herring spawn on them. Is this a concern to be included in the Report?**

This is not an aspect covered by the report. However, BERC is satisfied that creosoted pilings can be used in Burrard Inlet if guidelines are adhered to. The guideline document proponents are usually referred to is: Guidelines to Protect Fish and Fish Habitat from Treated Wood Used in Aquatic Environments in the Pacific Region (Hutton, K.E. and S.C. Samis. 2000. Can. Tech. Rep. Fish. Aquat. Sci. 2314: vi + 34 p).

41. **Are you aware that there are private housing developments extending geothermal pipes into Burrard Inlet? Has anyone considered the environmental impacts?**

BIEAP is aware of the presence of a number of geothermal heating and cooling projects in Burrard Inlet, both industrial and residential. The known projects were reviewed by the Burrard Environmental Review Committee, which concluded that the environmental effects were mitigable or not significant in the specific project circumstances.

42. **Are there any plans to install sanitation barges at the north end of Indian Arm and Bedwell Bay? These are popular areas for boaters with no pump out facilities provided. The closest pump out facility is at the Deep Cove Marina and boaters have to burn fossil fuels to get there.**

BIEAP is not aware of any such plans.

43. **Has there been any consideration to providing biodegradable doggie bags around the inlet?**

BIEAP is not aware of any such plans.

44. **Has there been any consideration to installing composting toilets in areas where kayakers and campers frequent?**

Metro Vancouver operates two areas on Burrard Inlet that have potential for kayakers and campers: Pacific Spirit Park and Belcarra Regional Park. Metro studied

composting toilets a few years ago, and concluded that they would not be suitable for a number of reasons:

- Composting toilets require regular maintenance and 'input' to operate properly, and many of the sites are unsupervised and/or not used by the public for much of the season
- The isolated areas where many of the toilets might potentially be located are particularly vulnerable to vandalism
- Composting toilets require a power source which is not available in most sites in the parks. Experience has shown that passive solar panels for power in isolated areas are particularly susceptible to theft and vandalism.

The toilets in the main developed areas of the parks use traditional septic systems. Other areas use conventional pit toilets, and in at least one case a propane toilet is used. Regardless of the toilet systems used, Metro Vancouver maintains them properly so that there is no discharge to any waterway.

45. Are there any plans to treat storm water runoff?

Under the Liquid Waste Management Plan, the Stormwater Interagency Liaison Group (SILG) was created to facilitate municipal stormwater management activities, and to research sustainable stormwater management practices. Members include: Metro Vancouver, Fisheries and Oceans Canada, Environment Canada, Ministry of Environment and municipal government agencies.

Several initiatives to manage stormwater are currently being undertaken by local government agencies in the BIEAP area:

A number of new rain gardens have been constructed throughout the City of North Vancouver to improve stormwater quality. Also, planted bioswales and detention areas at field and lane perimeters adjacent to Kinsmen Field have been installed to prevent rock dust from the field from entering Mission Creek. Reconstruction of Wagg Pond to increase its storm water improvement functions is almost complete with the final stage involving additional excavation to create greater holding capacity along with the installation of wetland vegetation, a viewing platform along the shore, and interpretive signage. Water quality and benthic invertebrates will be monitored post-installation and compared with pre-installation metrics.

The City of Vancouver (CoV) continues with the combined sewer main and building separation program with the goal to eliminate all combined sewer overflows by 2050. CoV and Metro Vancouver are jointly proceeding with the "Greening" of the English Bay Interceptor. Currently, construction plans are being finalized to redirect three sewage pumping stations from the English Bay Interceptor to the Eighth Avenue Interceptor which will reduce combined sewer overflows into Burrard Inlet. This project involves tunneling four blocks from 4th Avenue to 8th Avenue.

The District of North Vancouver has installed and maintains 17 large oil and grit separators on its storm drainage system. As a result, several incidents of significant oil contamination were prevented from entering the Inlet and a source was identified and abated.

The District of West Vancouver has also installed new wetlands at Ambleside Park, along with an oil and grit separator.