BAYNES SOUND STEWARDSHIP PROGRAM

State of the Sound GIS Project
Phase 2 - Data Analysis and Interpretation

March 19, 2001 – December 7, 2001

STATE OF THE SOUND GIS PROJECT
INTERIM REPORT – Phase 2

Prepared by
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COMOX VALLEY PROJECT WATERSHED SOCIETY

Project Sponsors

BC Ministry of Community Development, Cooperatives and Volunteers
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Regional District of Comox Strathcona

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Thanks to the members of the State of the Sound Advisory Committee for your vision and commitment. For ongoing support and guidance, thank you:

Peter Crawford	City of Courtenay
Sandy Felgenhauer	North Island Laboratories
Mac Fraser	Village of Cumberland
Edda Grant	Comox Valley Economic Development Society
Bill Heath	BC Ministry of Agriculture, Food and Fisheries
March Klaver	Fisheries and Oceans Canada
Bert Kooi	Environment Canada
Roxanna Mandryk	Regional District of Comox-Strathcona, Area K
Jim McCaul	UICC Community Health Services Society
Paul Rideout	BC Ministry of Water, Land, and Air Protection
Bunny Shannon	BC Shellfish Growers Association
Cathy Slater	BC Shellfish Growers Association
ChristyWilson	Fisheries & Oceans Canada

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Executive Summary

The "State of the Sound GIS Project Interim Report – Phase 2" describes the activities and results of Phase 2 *Data Analysis and Interpretation*, the second of three linked projects that are included in the State of the Sound GIS Project. Together, the three phases lay the foundation for a long-term, ongoing State of the Sound reporting process for Baynes Sound.

Specifically, the following report:

- Identifies the problems addressed by the State of the Sound GIS Project
- Describes the overall goals of the State of the Sound GIS Project and the State of the Sound Program
- Presents the objectives and results of Phase 2 *Data Analysis and Interpretation*
- Recommends next steps to be followed in subsequent phases to achieve the goals of the State of the Sound GIS Project

The State of the Sound Program will be an ongoing, long term reporting process and community education tool that will be used to:

- Measure and report the health of Baynes Sound on a regular basis
- Plan remedial and monitoring actions
- Increase public awareness of urgent water quality and community economic issues in the area
- Help prepare individual communities to move toward local liquid waste management program planning and implementation

Phase 2 *Data Analysis and Interpretation* focused on accomplishing three main objectives. This project:

1. Compiled and analyzed marine water quality data.
2. Reviewed community stewardship programs that addressed nonpoint source pollution in Baynes Sound from 1994 – 2000
3. Developed a quality assurance program for data in the State of the Sound Program

1. Marine water quality data from different sources were compiled in a composite database, and different approaches were explored to determine the best method to present valid and meaningful information about marine water quality in Baynes Sound from 1994 – 2000. However, it was found that available marine water quality data are not sufficiently comprehensive to provide conclusive interpretation or yield valid information about marine water quality trends or hotspots. An important outcome of this result is a new awareness about the true extent of the data, and of the importance of developing meaningful and effective water quality indicators of health.

2. Significant financial and human resources were dedicated to community efforts to manage nonpoint source (NPS) pollution in Baynes Sound since 1994. In Phase 2, a study reviewed the benefits and costs of implementing these community stewardship programs. Results of this study verify the importance and effectiveness of implementing NPS pollution management actions at the regional and local level.

Community stewardship initiatives in Baynes Sound used action, information and education as an effective means of bringing diverse stakeholders together into common action through a collaborative process. Stewardship programs in the Baynes Sound region were generally successful at meeting their goals. Of seven program goals, stewardship programs in the Baynes Sound region successfully met two, partially met four, and did not meet one program goal.

Community stewardship programs in the Baynes Sound region during the period from 1994 to 2000 were delivered at an average annual cost of $129,600, or approximately $2.75 per year per person 15 years old or older.

Community approaches influenced attitudes, decisions and actions of the different parties involved in efforts to manage NPS pollution in Baynes Sound. A momentum for change has been created, and a strong stewardship ethic has developed in the Comox Valley as a direct result of the community-led approach to water quality problems in Baynes Sound.

However, the effectiveness of community efforts to address NPS pollution in the Baynes Sound region was compromised by several factors:

- The magnitude of the task
- Limited resources
- Barriers to change
- Narrow focus on one parameter of water quality (as an indicator of marine ecosystem health)

Because of the scope and nature of the problem of nonpoint source pollution, there is a need to continue efforts to build understanding about the issues. The programs reviewed in this study are only a beginning to a large and on-going water quality challenge that will continue to affect our aquatic environments and our communities.

3. At the completion of Phase 2, the Baynes Sound Quality Assurance Program Plan is presented in draft form and does not include approving signatures. It provides the foundation for the State of the Sound Program's Quality Assurance Program, and will remain in draft form until it includes all relevant guidelines as determined by Advisory Committee review and approval.

The State of the Sound Quality Assurance Program Plan (QAPP) outlines procedures to be followed to ensure that all project data gathered (in the Baynes Sound Data Program) and recorded, maintained and analyzed (in the Baynes Sound GIS) meet the program's requirements for data quality and credibility. It also describes the goals and objectives of the Baynes Sound Data Program.

The QAPP defines quality guidelines for all data included in the State of the Sound Program. Guidelines are currently developed for one indicator (water quality) and for data collection and recording protocols only. Guidelines for other indicator data will be developed as indicators are added to the program. Guidelines for data management and reporting will be developed as the State of the Sound Program evolves.

The above and other results are described fully in Section 4.3 – Methodology, Challenges, and Results.

Appended to this report are:

- "Community Approaches to Nonpoint Source Pollution in Baynes Sound – An Assessment of Stewardship Programs from 1994 – 2000"
- "State of the Sound Program Quality Assurance Program Plan"
- Project maps

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1. Introduction

Baynes Sound, located between Vancouver Island and Denman Island in the Strait of Georgia in southwestern British Columbia, is a highly productive marine ecosystem. The region is experiencing accelerated population growth, which has compromised significant areas of environmentally sensitive fish, bird, and wildlife habitats. In addition, the water quality of Baynes Sound is deteriorating as a result of non-point source pollution and the degradation of source waterways.

In 1994, Environment Canada's water quality test results indicated increased levels of fecal coliform bacterial pollution in Baynes Sound, and widespread closures of shellfish growing areas in Baynes Sound were proposed. In Baynes Sound, the growing threat to water quality is in large part due to non-point source pollution. Nonpoint source pollution is pollution that enters the aquatic environment from many different sources, rather than from one specific and easily identifiable input.

Working since 1994 in collaboration with various Baynes Sound stakeholders, Comox Valley Project Watershed Society and Comox Valley Citizen Action on Recyling and the Environment have delivered numerous water quality remediation and monitoring projects to identify and clean up nonpoint source (NPS) pollution in Baynes Sound, and to help people learn more about it.

These projects have focused on four main sources of NPS pollution: failing septic systems, agricultural run-off, stormwater drains, and boater waste. Other projects have focused on suburban wastewater runoff and chemical waste from businesses. Projects generally include monitoring activities that gather water quality data, and offer members of the community opportunities to be involved as participants and volunteers in conservation and stewardship activities.

Although Baynes Sound water quality appears to be improving as a result of these and other activities, current and historical water quality data have not been compiled in one database. There has been progress on summarising remediation activities, but no formal analysis of remediation project data or outcomes has been done. Most importantly, a comprehensive approach to Baynes Sound programming is needed to ensure that all key areas of Baynes Sound have been identified for monitoring and remediation activities. Further, although many citizens of the Comox Valley and Baynes Sound region have been directly involved in stewardship activities, many more remain unaware of the issues.

In response to these and other, related problems, Comox Valley Project Watershed Society is developing and delivering the State of the Sound Program. The State of the Sound Program builds and uses an accessible community information system for managing and reporting the ongoing state of Baynes Sound environmental health. The State of the Sound reporting process will be used to increase public awareness and help support individual communities as they move toward local waste management program planning and implementation.

2. Sponsoring Organization

The Comox Valley Project Watershed Society (Project Watershed) is a charitable nonprofit organization that was established in 1993 to "promote community stewardship of Comox Valley watersheds through information, education and action".

Community watershed stewardship is people working together and acting upon their collective sense of responsibility to take care of local land, air and water environments. Community watershed stewardship is essential to maintaining the health and integrity of our environment and our communities. It requires long-term commitment from the entire community: its organizations, its businesses, its government agencies and, especially, its citizens.

The challenge of fostering that level of commitment has been successfully met by Project Watershed. We have learned that, in order for the community to take responsibility for clean air, land and water, people of all backgrounds must be encouraged to become involved in local stewardship activities and must be given the support required to make their efforts satisfying and effective.

Project Watershed is recognized locally and internationally for our ability to provide technical expertise in the area of watershed inventory and mapping, and for our ability to involve volunteers in delivery of a diverse array of stewardship programs.

Project Watershed has piloted numerous important initiatives and is frequently lauded as a role model for community stewardship organizations throughout British Columbia and the Pacific Northwest. Our organization has been recognized with several community achievement awards.

Project Watershed has maintained its leadership role by building productive, durable partnerships with many community organizations, all levels of government, the business sector, industry leaders, resource managers, land use planners, land owners and citizens. This extensive network puts Project Watershed in a unique position to generate and nurture community collaboration, and we have been successful in fostering cooperation amongst volunteer organizations, various levels of government and the business sector. This has enabled local stewardship groups to contribute their knowledge and be part of generating effective solutions. Our efforts in bringing people together have also resulted in greater understanding of and support for grassroots initiatives throughout the region.

Project Watershed was originally established to serve the Comox Valley on Vancouver Island. However, as our capacity in technical skills/equipment and our expertise in the development of organizations and community partnerships have grown, so has Project Watershed's area of influence. Our office receives regular requests from the public for guidance on specific watershed-related concerns. We also respond to regular requests for maps, reports, databases, technical information and professional advice on community stewardship issues and initiatives from individuals, stewardship groups and government agencies, mainly in the Comox Valley, but also from across Vancouver Island, throughout BC, and other parts of Canada and the United States.

Project Watershed is in a position to maximize the effective use of resources and minimize the risk of duplication in the community. Our track record includes eight years of impeccable project management. Permanent staff members include the Baynes Sound Stewardship Program Coordinator, the Sensitive Habitats Stewardship Program Coordinator and an Office/Volunteer Coordinator. Other staff levels fluctuate between 2 and 15, according to funding and project activity. Committed to fostering collaboration within our community, Project Watershed uses a team approach and strives to model collaboration within our organization.

Project Watershed's Baynes Sound and Watershed Stewardship activities have given the citizens of the Comox Valley and Baynes Sound region access to information, education and hands-on involvement with action-based programs.

3. Project Partners

3.1 State of the Sound Program Advisory Committee

An Advisory Committee for the State of the Sound Program was convened and met regularly throughout Phase 2. Please refer to Appendix 1 - Advisory Committee Terms of Reference, for details about the purpose and function of the Advisory Committee.

Table 1 State of the Sound Program Advisory Committee Members (Phase 2)

Peter Crawford	City of Courtenay
Sandy Felgenhauer	North Island Laboratories
Mac Fraser	Village of Cumberland
Edda Grant	Comox Valley Economic Development Society
Bill Heath	BC Ministry of Agriculture, Food and Fisheries
March Klaver	Fisheries and Oceans Canada
Bert Kooi	Environment Canada
Roxanna Mandryk	Regional District of Comox-Strathcona, Area K
Jim McCaul	UICC Community Health Services Society
Paul Rideout	BC Ministry of Water, Land, and Air Protection
Bunny Shannon	BC Shellfish Growers Association
Cathy Slater	BC Shellfish Growers Association
ChristyWilson	Fisheries & Oceans Canada

3.2 Data partners

In the State of the Sound GIS Project, Phase 1 *Information Collection and Data Management*, many data partnerships were developed as data was gathered for inclusion in the Baynes Sound Geographic Information System (GIS). In Phase 2 *Data Analysis and Interpretation*, additional data partnerships were developed to gain access to necessary base maps for use in the State of the Sound GIS Project. For more information about data partnerships, please refer to Appendix 2 – Project and Data Partnerships.

3.3 Baynes Sound Round Table

The Baynes Sound Round Table (the Round Table) was formed in 1994 in response to widespread shellfish harvesting area closures in Baynes Sound. Representatives from local government, citizens groups, non-profit organizations, government agencies, the shellfish industry, and individuals have worked together through the Round Table to identify pollution sources and undertake actions to reduce non-point source pollution. The agencies working on direct remediation, public education and monitoring activities (including Project Watershed) maintained communication links with each other through the Baynes Sound Stewardship Action Group (BSSAG), a subcommittee of the Round Table.

BSSAG guided the activities of local community organizations towards the goal of improved water quality for many years until re-amalgamating with the Round Table in January 2001. Since 1994, the Round Table and BSSAG provided direction on program objectives and outcomes, as well as advice and problem solving opportunities for project staff. The Round Table continues the BSSAG tradition of annual planning sessions to define action priorities for Baynes Sound.

4. Project Description

The State of the Sound GIS Project Phase 2 - Data Analysis and Interpretation was a nine month project that started on March 19, 2001, and ended on December 7, 2001. It is the second of three projects that are included in the State of the Sound GIS Project.

Phase 2 was to have ended on September 30, 2001. However, in August 2001, the project funders approved an extension of the project completion date to November 30, 2001.

The extension was requested for the following reasons:

- From April to August 2001, the project coordinator assumed additional, unforecasted, organizational responsibilities beyond the parameters of the project, and worked on the State of the Sound GIS Project at a rate of .6 FTE, rather than the forecast rate of .8 FTE.
- Additional resources to support the completion of the benefit/cost analysis on past stewardship project results became available in September, October and November. Meeting this objective was a task that was significantly more complex than was apparent when the Phase 2 workplan and budget were developed.

The State of the Sound Program

The State of the Sound Program is a multi-phase initiative that builds a Geographic Information System (GIS), and uses it to support ongoing, long-term conservation planning and actions that help protect the health of Baynes Sound. Please refer to Section 7.2 – State of the Sound Program for more information.

State of the Sound GIS Project

Water quality, habitat and land use data shared by different agencies are organized in an ArcView Geographic Information System (GIS), and managed by Project Watershed. When implemented, this tool will be used to monitor and report on the ongoing state of Baynes Sound environmental health and water quality through the State of the Sound Program.

The State of the Sound GIS Project will:

- Construct an accessible information system (GIS) for managing and reporting Baynes Sound remediation project data and information (Phase 1)
- Analyse geographic patterns and trends of regional water quality, land use and habitat data, and remediation project results (Phase 2)
- Develop clearly defined, valid, and standardized processes and procedures to gather, record, maintain and retrieve data in both database and mapping formats (Phase 1 and Phase 2)
- Identify key environmental health indicators (Phase 3)
- Develop presentation tools and formats for reporting the health of Baynes Sound to the community (Phase 3)

The State of the Sound GIS Project has been identified by the members of the Baynes Sound Round Table and the Baynes Sound Stewardship Action Group as the most effective way to address the environmental health issues that are currently of concern in Baynes Sound. Please refer to Section 1 - Introduction and Section 4.1 - Problem Statements for more information about these issues.

4.1 Problem statements

Specifically, Phase 2 *Data Analysis and Interpretation* addressed the following problems:

- Marine water quality data collected by several organizations and ministries has not been analyzed for geographical patterns and trends.
- Significant financial and human resources have been dedicated to Baynes Sound water quality and remediation work, but benefits are not evaluated in terms of costs.
- The absence of comprehensive analysis of where Baynes Sound monitoring and remediation work has been completed means that potential critical gaps have not been identified
- Standardized data collection and recording methods and protocols may not be consistently followed throughout the various projects

4.2 Goals and Objectives

Program Goals:

The overall goals of the State of the Sound Program are to:

- measure and report the health of Baynes Sound on a regular basis
- plan remedial and monitoring actions
- increase public awareness of urgent water quality and community economic issues in the area
- help prepare individual communities to move toward local liquid waste management program planning and implementation

Project Objectives:

Phase 2 *Data Analysis and Interpretation* reviewed community stewardship programs that addressed nonpoint source pollution in Baynes Sound from 1994 - 2000, developed a quality assurance program for data used in the State of the Sound Program, and compiled and analyzed marine water quality data.

Specifically, the objectives of Phase 2 were to:

1. Involve community and other stakeholders in an Advisory Committee to guide the process
2. Conduct comprehensive geographical analyses of Baynes Sound water quality data
3. Evaluate cost/benefit ratios of remedial project accomplishments to date
4. Identify and recommend critical areas for future Baynes Sound stewardship actions
5. Develop and recommend standardized data collection and management methods and protocols
6. Establish an ongoing quality assurance plan for gathering and recording water quality data, and for the maintenance of the State of the Sound information management system
7. Continue to acquire and integrate water quality, land use, and habitat datasets and maps to the State of the Sound GIS
8. Prepare an interim report on the progress and development of the State of the Sound GIS Project

4.3 Methodology, Challenges, and Results

This section describes the efforts and achievements that are related to each project objective.

4.3.1 Objective 1 "Involve community and other stakeholders in an Advisory Committee".

An Advisory Committee for the State of the Sound Program was convened in May 2001, and met regularly throughout Phase 2. Representation was invited from local, provincial and federal government, community agencies, industry, and First Nations. Please refer to Table 1 - State of the Sound Program Advisory Committee Members for a list of members.

Advisory Committee meeting agendas included items for information and discussion as well as for review and feedback. The meetings provided the project coordinator with a check-back system to ensure that project objectives were aligned with stakeholder expectations. In addition, review of project activities and the ensuing discussions provided the project coordinator with valuable feedback from the perspective of several professional disciplines.

Please refer to Appendix 1 for the State of the Sound Advisory Committee Terms of Reference.

At the conclusion of Phase 2, the State of the Sound Advisory Committee approved several recommendations to be carried forward to Phase 3. These recommendations are described in Section 5 - Recommendations.

4.3.2 Objective 2 "Conduct a comprehensive analysis of water quality data".
In Phase 1 *Information Collection and Data Management*, several water quality databases were gathered and compiled into the Baynes Sound Geographic Information System (GIS) for analysis in Phase 2 *Data Analysis and Interpretation* for:

- Baseline water quality conditions
- Significant water quality trends
- Changes in water quality
- Causal relationships that explain changes

Because the GIS component of Phase 2 was considerably reduced from Phase 1, there were insufficient hours available to the position to employ GIS technical staff for the project. The GIS and data analysis components of Phase 2 *Data Analysis and Interpretation* were contracted to a local GIS consulting firm, EnCompass Consulting Inc.

Marine water quality data from different sources were compiled in a composite database, and different approaches were explored to determine the best method to present valid and meaningful information about marine water quality in Baynes Sound from 1994 – 2000.

Methodology

1. The entire data set accumulated by Project Watershed for the State of the Sound GIS Project was reviewed in detail to assess its usefulness for visual display and spatial analysis.
2. The project coordinator and GIS consultants reviewed the available water quality data and formats to determine the optimum approach to data analysis. Efforts were initially focused on compiling and interpreting marine water quality data, because this was the most broadly collected water quality information with the most samples available in the Baynes Sound

GIS. The data management and analysis systems developed for marine water quality data may be applied to freshwater water quality data later in the program.

3. Marine water quality datasets were reviewed to determine suitability for inclusion in a composite database for comprehensive analysis. If the data was gathered, tested and reported with compatible methods, it was included in the composite marine water quality database, or was examined separately if insufficient commonality existed.
4. Under review were the following marine water quality datasets:
    - Environment Canada marine stations, 1984 – 2000
    - Project Watershed Comox Harbour marine stations, 1995 – 2000
    - Public Health summer beach surveys, 1997 - 2000
    - Aquametrix marine stations, south Baynes Sound, 1995
5. The four datasets were examined for coverage area, redundant sites, and accurate geographic site location.
6. It was determined that there was sufficient commonality between the Environment Canada, Project Watershed and Aquametrix data for combination into one database for analysis purposes. The Public Health data was prepared and presented separately because it was tested using a different methodology.
7. Any previously identified problems with the datasets were rectified. Some sites were moved to their correct geographic location, and sites that were at the same location were renumbered, using the Environment Canada numbering system. Maps showing site location and closure locations were then prepared from these corrected georeferenced datasets.
8. The databases from the three datasets that were selected for combined analysis were exported into Microsoft Excel, rearranged into one common format, and merged. The merged dataset was exported into Microsoft Access and queried to extract discrete sets of information for analysis purposes, and exported back to Excel for analysis.
9. After analyzing the data in a number of different ways, it was decided to group the data by geographic area. These areas were digitized into the map base into 11 zones within the project area. ArcView GIS was then used to overlay the site location with the zones in order to add the zone number to the site location database. This new database was put through the Excel-Access-Excel cycle for final analysis.
10. The Public Health beach data was prepared separately. A similar cycle of Excel-Access-Excel was used to extract the relevant data and prepare a table.
11. A number of analysis methodologies were tested, including the display of average fecal coliform counts by year and by sampling zone. Rainfall within the previous 48 hours was also included in some analyses.
12. The final analysis extracted data from over 10,000 samples from nearly 200 sampling sites in Baynes Sound. Of the 10,000 samples, more than 5,000 fell within the analysis criteria (within a proscribed geographic area between 1994 and 2000).
13. Marine water quality data was interpreted by taking the geometric mean of fecal coliform samples with results over 14 MPN/100 ml from individual sampling stations. This was represented on graphs showing station results by year from 1994 to 2000.

Geomean: the geometric mean of a set of numbers.

The formula for calculating geomean is:

$$GM_{\bar{y}} = \sqrt[n]{y_1 y_2 y_3 \cdots y_n}$$

Challenges

It was a significant challenge to successfully develop the means to integrate and use sparse data from several different sources with different parameters sampled at variable times, to provide meaningful information about a large area in a way that is understandable to different end users.

The large confidence intervals associated with interpretation of fecal coliform test results raise concerns about the usefulness of fecal coliform bacteria levels as an indicator of water quality conditions. Fecal coliform sampling programs in the Baynes Sound region have not been comprehensive and there are significant spatial and temporal gaps in the available data. Fecal coliform data does not lend itself well to amalgamation for the purposes of analysis because the validity of the data becomes compromised when too many variables are combined and secondary parameters become disassociated.

The major challenges in this project from a Geographic Information System (GIS) and information management perspective were identifying which data was relevant to the analysis of water quality, determining if the data was of sufficient quality and quantity to analyze, and how to prepare and present the analysis.

The challenges associated with analyzing this data were:

- its broad geographic location (nearly 200 sites)
- incomplete records (different sampling agencies recorded different parameters)
- primary data missing secondary parameters (rainfall, tide condition, salinity)
- inconsistent data entry formatting standards
- inconsistent sampling times (time of day, time of tide, month and season)

To be comprehensive, analysis of water quality data in Baynes Sound must include data about upland influences on the marine environment. Efforts to acquire data to show upland conditions were not successful during this phase. Data from the Ministry of Water, Land and Air Protection (freshwater quality, points of discharge, conservation lands), and from the Regional District of Comox-Strathcona (property parcel information in Areas B and C) did not become available during Phase 2 for inclusion in the analysis. In addition, water circulation data for Baynes Sound does not exist, yet is important information that is relevant to any comprehensive analysis of water quality in this body of water.

Results

By exploring potential data interpretation methodologies it was learned that available marine water quality data are not sufficiently comprehensive to provide conclusive interpretation or yield valid information about marine water quality trends or hotspots. Although graphs were produced by the methods described above, they are not presented in this report. There are too many temporal and spatial variables to draw meaningful conclusions or to present data that may be taken out of its proper context.

It was not possible to complete a comprehensive analysis of water quality data in Phase 2. Efforts to acquire data that show upland conditions were not successful during this phase. Even if this data had been available, there were insufficient funds in Phase 2 for the kind of in-depth analysis required for comprehensive analysis of conditions.

The Advisory Committee of the State of the Sound Program has reviewed these results and discussed the implications of the limitations of the available data. An important outcome of this

objective is a new awareness about the extent of the data, and the importance of developing meaningful and effective water quality indicators of health. The Advisory Committee recommends that project objectives for Phase 3 of the State of the Sound GIS Project include the development of water quality monitoring programs to enable comprehensive marine and fresh water quality analyses in Baynes Sound.

During the course of this project, the following maps were produced with ArcView GIS:
1. Wall map of sampling station locations, analysis zones, and sanitary shellfish closures
2. 11 x 17" map of sampling locations and sanitary shellfish closures
3. 4 – 81/2 x 11" maps showing analysis zone groups
4. 81/2 x 11" map showing beach sampling locations

Please refer to Appendix 5 to view project maps.

4.3.3 Objective 3 "Evaluate cost/benefit ratios of Baynes Sound remedial projects to date". Significant financial and human resources have been dedicated to community efforts to manage nonpoint source (NPS) pollution in Baynes Sound since 1994. This study reviewed the benefits and the costs of implementing the community stewardship programs that addressed nonpoint source pollution in the Baynes Sound region from 1994 to 2000.

Please refer to Appendix 3 - Community Approaches to Nonpoint Source Pollution in Baynes Sound to review the complete paper.

The questions addressed by this study are:
1. Did community stewardship programs meet their program goals?
2. What were the benefits of the community stewardship programs?
3. What were the costs of the community stewardship programs?
4. Were community stewardship programs an effective way to manage NPS pollution in the region?
5. Did the community stewardship programs provide good value for the public dollar?

There was a reliance on other reports and data sources for developing economic estimates. New, primary research was not undertaken to gather economic data.

Methodology

The basic concepts and approaches currently applied in environmental accounting were studied in order to establish a basis of understanding and to determine the best approach for examining the benefits and costs of Baynes Sound remedial, educational and monitoring projects.

The following methods were applied to this study in order to answer the research questions:

i) Benefit/cost analysis
ii) Geographic Information System (GIS) analysis
iii) Interviews with key individuals
iv) Literature Review (of past project proposals, reports and databases)
v) Impact Assessment

Regional stewardship goals were identified and discussed in terms of overall program implementation, results, and measures of success. Recommendations about future programs and approaches were offered as outcomes of the study.

Challenges

Undertaking a review of many different programs and projects, delivered by different agencies over a large area and several years presented significant challenges associated with summarizing a large amount of information in an accessible format, in a style that facilitates understanding. Many individuals have been involved to varying degrees over varying times in the collaborative process that has been the Baynes Sound stewardship experience. Opinions and perspectives vary widely about cause and effect of conditions and results. Drawing meaningful conclusions from a wide diversity of detail without oversimplifying, losing context or misrepresenting the subtleties of relationships and community dynamics was an additional challenge.

The results of the economic portions of the study are limited due to the limitations of the data and the methodologies that were applied in the study. It was not possible to link changes in water quality directly to specific results of stewardship action. The values and benefits that are factors in this review are largely non-economically defined and were difficult to translate to monetary values.

An important element of solving environmental problems is designing and delivering programs that are effective in changing people's behaviour. However, it is difficult to design, fund and deliver programs that are able to quantitatively measure changes in awareness, attitude and behaviour, or how those changes impact directly upon the environmental, economic or social health of a community. In this study, it was not possible to measure changes in behaviour, because most projects were not designed to include the controls that would provide measurement baselines.

Results

It is generally accepted that nonpoint source (NPS) pollution management strategies that include planning, coordination and education are most successful at preventing and mitigating the impacts of NPS pollution. Community stewardship initiatives in Baynes Sound used action, information and education as an effective means of bringing diverse stakeholders together into common action through a collaborative process.

Stewardship programs in the Baynes Sound region may be considered generally successful at meeting their goals. Of seven program goals, stewardship programs in the Baynes Sound region successfully met two, partially met four, and did not meet one program goal.

The benefits associated with community programs that addressed NPS pollution in the Baynes Sound region are:

- Action-oriented and collaborative approach to problem solving
- Increased level of awareness and stewardship ethic in the community at large
- Active stewardship involvement and leadership by individuals and groups in specific situations and locations (Ships Point, Union Bay, Craigdarroch, Marsden, Sandwick, others)
- Better decision-making from improved access to data and increased awareness
- Transferability of methodology, approach, and model to other regions and groups
- Improved water quality (Courtenay and Comox stormdrains, Comox Harbour)

Community stewardship programs in the Baynes Sound region during the period from 1994 to 2000 were delivered at an average annual cost of $129,600, or approximately $2.75 per year per person 15 years old or older.

Results of this study verify the importance and effectiveness of implementing NPS pollution management actions at the regional and local level. Community efforts to address NPS pollution in the Baynes Sound region were effective because they:

- Followed an action-based, stewardship approach
- Established trust for environmental protection initiatives
- Built capacity in communities, neighbourhoods, and individuals
- Fostered change at the community and other levels

Community approaches have influenced attitudes, decisions and actions of the different parties that have been involved in all aspects of multi-sectoral efforts to manage NPS pollution in Baynes Sound. A momentum for change has been created, and a strong stewardship ethic has developed in the Comox Valley as a direct result of the community-led approach to water quality problems in Baynes Sound.

The effectiveness of community efforts to address NPS pollution in the Baynes Sound region was compromised by several factors:

- The magnitude of the task
- Limited resources
- Barriers to change
- Narrow focus on one parameter of water quality (as an indicator of marine ecosystem health)

There are many barriers that prevent individuals from engaging in sustainable behaviour. During much of the time under review, projects were designed to bring immediate actions to location or issue-specific problems. Barriers to change were identified as they came up during the delivery of projects, and some were effectively addressed. However, had projects been designed to focus on understanding and removing barriers to change, efforts to create new behaviour would have been more successful, and change more effectively measured.

Because of the scope and nature of the problem of NPS pollution, there is a need to continue efforts to build understanding about the issues, so that individuals learn how to make choices that have a positive rather than a negative impact on the environment. The programs reviewed in this study are only a beginning to a large and on-going water quality challenge that will continue to affect our aquatic environments and our communities.

4.3.4 Objective 4

"Identify and recommend critical areas for future Baynes Sound stewardship actions".

The achievement of this objective is directly linked to the completion of a comprehensive analysis of water quality and related data. Because this analysis has not yet been completed, the identification of Baynes Sound sites for monitoring and remediation work will be addressed in Phase 3 of the State of the Sound GIS Project.

4.3.5 Objective 5

"Develop and recommend standardized data collection and recording methods and protocols".

Methodology and Results

Existing in-house and external volunteer monitoring programs were researched and reviewed to determine the most effective processes for gathering water quality data. The resulting water quality Standard Operating Procedures are incorporated into the Quality Assurance Plan as the water quality sampling methodology for the program. Additional indicator monitoring methodology will be developed in later phases, following the design established for water quality data.

4.3.6 Objective 6

"Establish an ongoing quality assurance plan for gathering and recording water quality data, and for the maintenance of the State of the Sound information management system".

The State of the Sound Quality Assurance Program Plan outlines procedures to be followed to ensure that all project data gathered (in the Baynes Sound Data Program) and recorded, maintained and analyzed (in the Baynes Sound GIS) meet the program's requirements for data quality and credibility.

Results

The Baynes Sound Quality Assurance Program Plan (QAPP) describes the goals and objectives of the Baynes Sound Data Program, which data is collected, and how the data is collected, managed, analyzed, and reported. The data (and its analyses) will be used to develop regular reports as part of the State of the Sound Program.

The draft QAPP has three sections, including:

A. Quality Assurance Program Management (overall definitions and program management systems)
B. Data Collection and Management (Standard Operating Procedures for data collection and management)
C. Evaluation (of Quality Assurance Program implementation and data quality assessment procedures)

The QAPP defines quality guidelines for all data included in the State of the Sound Program. Guidelines are currently developed for one indicator, water quality, and for data collection and recording protocols only. Guidelines for other indicator data will be developed as indicators are added to the program. Guidelines for data management and reporting will be developed as the State of the Sound Program evolves.

At the completion of Phase 2, the Baynes Sound QAPP is presented in draft form and does not include approving signatures. It provides the foundation for the State of the Sound Program's Quality Assurance Program, and will remain in draft form until it includes all relevant guidelines as determined by Advisory Committee review and approval.

Challenges

While considerable information exists and is available regarding standards and protocols for data collection, it is much more difficult to find information that is relevant to the development of data management standards. In addition to the State of the Sound GIS Project, some other agencies are engaged in the development of data management standards, including the BC Ministry of Sustainable Resource Management, currently implementing an Integrated Data Management pilot project in the Cowichan Valley on Vancouver Island. Attempts to reduce duplication by accessing the resulting data management standards from this pilot project have not been successful to date. General conceptual information may be found by reviewing data management standards currently being developed by other agencies, although the details of most are focused on data collection and mapping methodologies.

Efforts to avoid duplication by accessing information from different sources will continue during Phase 3, as the State of the Sound Quality Assurance Program Plan develops appropriate data management standards.

4.3.7 Objective 7

"Continue to acquire and integrate water quality, land-use and habitat datasets and maps for the State of the Sound GIS Project".

Results

In Phase 2, efforts were made to acquire and integrate the following data, with results as follows:

- TRIM agreement and data (WLAP) — complete
- orthophotographs agreement and data (WLAP) — complete
- Areas B and C digital data (RDCS) — not received
- Historical closure data (Environment Canada) — complete
- Fresh water quality data (WLAP) — not received
- Discharge permits (WLAP) — not received
- Aquifer data (RDCS) — received, not integrated
- Crown reserves and conservation lands (WLAP) — not received

Data exchange agreements for base map data were signed with the BC Ministry of Water, Land and Air Protection (WLAP). Access to TRIM mapsheets and orthophotographs for the project area were gained through project partnerships with the Water Protection Branch - Water Quality Section, and the Vancouver Island Wetlands Management Program, respectively.

Challenges

Data from different providers is not always available in a timely fashion within the project timelines. In Phase 2, this had an impact on the successful achievement of some project objectives. Digitized property parcel information for Areas B and C did not become available from the Regional District of Comox-Strathcona GIS department during the term of the project. Additionally, freshwater water quality data, points of discharge data, and digital information about conservation lands was not available by the end of the project from the BC Ministry of Water, Land and Air Protection.

4.3.8 Objective 8

"Compile an interim report on the progress and development of the State of the Sound Program".

This report, "State of the Sound GIS Project Interim Report, Phase 2 - Data Analysis and Interpretation", dated December 21, 2001, is the Phase 2 final project report, and is the second Interim Report on the overall State of the Sound Program.

The report includes descriptions of Phase 2 project activities and outcomes (Section 4 - Project Description). It describes the recommendations from the program Advisory Committee (Section 5 - Recommendations), and provides an outline of the proposed objectives of Phase 3 - *Report and Recommendations* that follow from those recommendations (Section 7 - Next Steps).

The report links the results of Phase 2 to the larger goals of the State of the Sound Program with a description of the comprehensive monitoring, reporting and planning process that will become the State of the Sound Program (Section 7 - Next Steps).

Appended to this report are two additional documents:

- Community Approaches to Nonpoint Source Pollution in Baynes Sound – An Assessment of Stewardship Programs from 1994 - 2000
- State of the Sound Program Quality Assurance Program Plan

5. Recommendations

Advisory Committee Recommendations from Phase 2, State of the Sound Program:

1. The State of the Sound Advisory Committee will meet as required in the interval between Phase 2 and Phase 3 *Report and Recommendations*. Approved, Dec 5, 2001.

2. Revise the State of the Sound Advisory Committee Terms of Reference as required at the beginning of Phase 3 to include Advisory Committee responsibilities specific to Phase 3. Approved, Dec 5, 2001.

3. Research and develop an indicator suite that will be monitored for information about the ongoing health of Baynes Sound. Draft, Dec 5, 2001.

4. Develop a water quality monitoring program that enables comprehensive marine and fresh water quality analyses in Baynes Sound. Draft, Dec 5, 2001.

5. Sufficient funding will be developed and allocated in Phase 3 to identify and recommend critical areas for future Baynes Sound stewardship actions. Approved, Dec 5, 2001.

6. The draft Quality Assurance Program Plan (QAPP) is accepted as the foundation of the State of the Sound Program's Quality Assurance Program. It will remain in draft form until it includes all relevant quality guidelines as determined by Advisory Committee review and approval. Approved, Dec 5, 2001.

7. Procedures and protocols are included in the QAPP as they are developed and defined. Approved, Dec.5, 2001.

8. Project objectives and funding are developed for State of the Sound Program Phase 3 - Report and Recommendations. Approved, Dec 5, 2001.

9. Efforts are continued as funds allow to obtain and integrate relevant data to the State of the Sound Program. Approved, Dec 5, 2001.

7. Next Steps

7.1 State of the Sound Program

Phase 2 *Data Analysis and Interpretation* was the second of three linked phases of the State of the Sound GIS Project, an initiative to develop and implement an information management system that will be used to support the subsequent State of the Sound Program. The State of the Sound Program will use the comprehensive system established through the State of the Sound GIS Project (Phases 1 – 3) to monitor, evaluate, and report on the state of Baynes Sound environmental health.

The State of the Sound Program will be an ongoing, long term reporting process and community education tool that will be used to:

- Measure and report the health of Baynes Sound on a regular basis
- Plan remedial and monitoring actions
- Increase public awareness of urgent water quality and community economic issues in the area
- Help prepare individual communities to move toward local liquid waste management program planning and implementation

Subject to program funding, the State of the Sound Program will be implemented in 2003, following the completion of the State of the Sound GIS Project.

7.2 Phase 3 *Report and Recommendations*

Phase 3 *Report and Recommendations* is the third and final phase of the State of the Sound GIS Project. It will address the following problems:

- There are currently few meaningful environmental indicators for evaluating and reporting the health of Baynes Sound on a long-term basis.
- The citizens of the Comox Valley have not had access to information on specific outcomes of Baynes Sound remediation work.
- Non point source pollution issues in Baynes Sound are addressed in the absence of an integrated regional liquid waste management program.
- Although many citizens of the Comox Valley and Baynes Sound region have been directly involved in stewardship activities, many more remain unaware of water quality and stewardship issues.

Project objectives for Phase 3 follow the recommendations that come from Phase 2 *Data Analysis and Interpretation*. Specifically, Phase 3 will:

1. Involve the community and stakeholders in a State of the Sound Program Advisory Committee
2. Research and identify indicators for measuring the ongoing environmental health of Baynes Sound
3. Coordinate a State of the Sound reporting process to present information about the state of Baynes Sound:
    - Design and implement community access to the Baynes Sound GIS
    - Develop presentation tools and formats for reporting the health of Baynes Sound
    - Identify individual actions that can be taken
4. Conduct a comprehensive outreach program to gather public input on all aspects of Phase 3 and the State of the Sound Program.
5. Finalize the State of the Sound Quality Assurance Program Plan.
6. Continue to acquire and integrate water quality, land-use and habitat datasets and maps to the State of the Sound GIS.
7. Conduct a comprehensive analysis of marine and fresh water quality in the Baynes Sound region.
8. Define next steps and future actions.
9. Publish a final report on the development and implementation of the State of the Sound Program.

Depending on project funding, Phase 3 *Report and Recommendations*, a twelve month project, will commence in April 2002, and end in April 2003.

Phase 3 and the State of the Sound GIS Project will be successfully completed when:

- Program recommendations are reviewed and endorsed by the community
- All agencies and organizations involved agree that they have the information they need to make decisions on future actions regarding Baynes Sound water quality and waste water management planning.

8. Resources

1. Baynes Sound Education / Action Group: monthly meeting notes and minutes
2. Baynes Sound Round Table: monthly meeting notes and minutes
3. BC Ministry of Environment, Lands and Parks, 1998: "Tackling Nonpoint Source Water Pollution in BC - An Action Plan"
4. BC Shellfish Growers Association, 1994: "Baynes Sound Environmental Assessment and Mitigation Project", BC Science Council project proposal
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6. Cardinal, Catherine, 1998 "Baynes Sound Hotspots Remediation Project Evaluation Report", Comox Valley Project Watershed Society
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8. Chamberlain, Don, 1996: "Septic System Dye Testing Project Report for the Community of Ships Point", Comox Valley Project Watershed Society
9. Comox Valley CARE, 1999: "Tribune Bay Outdoor Education Centre Constructed Wetland Project - Report to the Vancouver Foundation", Comox Valley Citizen Action on Recycling and the Environment
10. Comox Valley Project Watershed Society, 1997: "Baynes Sound Stewardship Initiative Teachers Package"
11. Crane Management Consultants, 1997: "Multiple Account Analysis of Non-Point Source Pollution in BC - Economic Losses, Environmental Impacts, Social Impacts", BC Ministry of Environment, Lands and Parks
12. Cross, Stephen F, 1996: "Water Quality in Baynes Sound - A Monitoring and Research Program to Investigate Spatial and Temporal Variability in Bacterial Contamination", BC Shellfish Growers Association
13. Drake, Richard, 1997: "Baynes Sound Hotspots Septic Systems Component Final Report", Baynes Sound Hotspots Remediation Project, Comox Valley Citizen Action on Recycling and the Environment
14. Drake, Richard, 1997: "Sound Wastewater Solutions III Biannual Report, First Bi-Annual Report Nov. 1, 1996 - Apr. 30, 1997", Comox Valley Citizen Action on Recycling and the Environment
15. Drake, Richard, 1997: "Sound Wastewater Solutions III Biannual Report, Second Bi-Annual Report May 1 - Oct. 30, 1997", Comox Valley Citizen Action on Recycling and the Environment
16. Drake, Richard, 1998: "Sound Wastewater Solutions III Biannual Report, Third Bi-Annual Report Nov. 1, 1997 - Apr. 30, 1998", Comox Valley Citizen Action on Recycling and the Environment
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21. Drake, Richard, 2000: "Sound Wastewater Solutions III Biannual Report, Final Progress Report July 1 - Dec. 31, 2000", Comox Valley Citizen Action on Recycling and the Environment
22. ESSA Technologies, 1996: "Non-Point Source Pollution in BC - An Assessment of Environmental Impacts", BC Ministry of Environment, Lands and Parks
23. Flostrand, Linnea, 1997: "Baynes Sound Hotspots Agricultural Component Report", Baynes Sound Hotspots Remediation Project, Comox Valley Project Watershed Society
24. Hart, Maureen, 2001: "Sustainable Measures", www.sustainablemeasures.com

25. Heath, Dr. William, 1998: “Summary of Water Quality Remediation Work in Baynes Sound”, Baynes Sound Round Table
26. Holdstock, J., D. Hagerty, and W. Reid, 1996: “Issues and Options Paper for Nonpoint Source Pollution Management in BC: Project Report”, BC Ministry of Environment, Lands and Parks
27. Joughin, Barbara, 2000: “Boater Pumpout and Education Project Final Report”, Comox Valley Project Watershed Society
28. Joughin, Barbara, 2001: “State of the Sound GIS Project Interim Report – Phase 1”, Comox Valley Project Watershed Society
29. Joughin, Barbara, C. Bruels, O. Pinho, 2000: “Baynes Sound Stewardship Initiatives Final Report, April 1, 1999 - May 31, 2000”, Comox Valley Project Watershed Society
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37. Pinho, Odete, 1995: “Sound Stewardship: Volunteer Water Monitoring Manual”, North Island College, Dept of Biology
38. Pinho, Odete, 1996: “Stormwater Monitoring Results”, Baynes Sound Hotspots Remediation Project, Comox Valley Project Watershed Society
39. Pinho, Odete, 1998: “Comox Valley Agricultural Program Final Report”, Down the Drain Agriculture Project, Comox Valley Project Watershed Society
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41. Rees, William E., and M. Wackernagel, 1998: “Monetary Analysis: Turning a Blind Eye on Sustainability”, Ecological Economics 29:47-52 (1999)
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44. World Commission on Environment and Development, 1987: “Our Common Future”, United Nations

Appendices

Appendix 1

State of the Sound Advisory Committee
Terms of Reference

State of the Sound Advisory Committee – Terms of Reference
November 21, 2001

Purpose and Responsibilities: The purpose of the State of the Sound Program Advisory Committee is to advise and support the State of the Sound Program. The State of the Sound Program is a long term initiative that plans and manages an on-going monitoring and reporting process on the health of Baynes Sound.

The Advisory Committee will review and revise its purposes and responsibilities as required, in order to meet the needs of the different phases of the State of the Sound Program. During Phase 2 - Data Analysis and Interpretation, the responsibilities of the Advisory Committee are to:

1. Work collaboratively to facilitate comprehensive stakeholder representation.
2. Provide advice on the achievement of the State of the Sound Program objectives.
3. Advise the Baynes Sound Round Table about the development of Phase 3 objectives.
4. Review and evaluate program methodology and protocols that are developed and presented by program staff and subcommittees for:
   - 4.1 Data collection and management standards
   - 4.2 Development of a quality assurance plan for the Baynes Sound information management system
5. Develop recommendations for the items identified in 4.1 and 4.2. These recommendations will be presented to the community during subsequent phases of the State of the Sound Program.
6. Review and refine program objectives and process as required.

Membership:

Local government representatives:
Mac Fraser, Village of Cumberland
Peter Crawford, City of Courtenay
Roxanna Mandryk RDCS , Area K

Community and Stewardship groups:
Jim McCaul, Community Health Society
Barbara Joughin, CV Project Watershed Society
Edda Grant, CV Economic Development Society

First Nations:

Scientific research community representatives:

Industry:
Cathy Slater, BC Shellfish Growers Association
Bunny Shannon, BC Shellfish Growers Assoc.
Sandra Felgenhauer, North Island Laboratories

Senior government representatives:
Christy Wilson, Fisheries and Oceans Canada
March Klaver, Fisheries and Oceans Canada
Bill Heath, BC MAFF
Bert Kooi, Environment Canada
Paul Rideout, BC Ministry of WLAP

Administration: The State of the Sound Advisory Committee meetings will be administered by the State of the Sound Project Coordinator, including meeting arrangements, agenda development (in collaboration with the chairperson), and information distribution to members. The Advisory Committee meetings will be chaired by the membership on a rotating basis. The Project Coordinator will record the meeting minutes, and distribute to the membership prior to the next scheduled meeting.

Reporting: The State of the Sound Advisory Committee will maintain communication links with:

- The Baynes Sound Round Table
- Comox Valley Project Watershed Society

Meetings: The State of the Sound Advisory Committee will meet monthly during the course of each phase, or as requested by the Project Coordinator or any member of the Advisory Committee.

Duration: The State of the Sound Advisory Committee will meet for the above stated purposes for the duration of the State of the Sound GIS Project, Phase 2 - Data Analysis and Interpretation. The Advisory Committee Terms of Reference will be reviewed and revised as required for subsequent phases.

Appendix 2

State of the Sound Project and Data Partnerships

Appendix 2

State of the Sound Project and Data Partners:

Bird Studies Canada
BC Assessment
BC Coastal Waterbird Survey
BC Important Bird Areas Program
BC Ministry of Community Development, Cooperatives and Volunteers
BC Ministry of Agriculture, Food, and Fisheries
BC Ministry of Water, Land and Air Protection
    Water Protection Branch – Water Quality Section
    Vancouver Island Wetlands Management Program
BC Shellfish Growers Association
Canadian Wildlife Service
City of Courtenay
Comox Valley Citizen Action on Recycling and the Environment
Comox Valley Economic Development Society
Environment Canada, Shellfish Water Quality Program
Environment Canada, Georgia Basin Ecosystem Initiative
First Job in Science and Technology Program
Fisheries and Oceans Canada
Georgia Strait Alliance
Islands Trust – Denman Island
Mac's Oysters
Pacific Northwest Shellfish
Regional District of Comox-Strathcona
Town of Comox
UICC Community Health Services
Village of Cumberland

Appendix 3

Community Approaches to Nonpoint Source Pollution in Baynes Sound – An Assessment of Stewardship Programs from 1994 – 2000

COMMUNITY APPROACHES TO NON POINT SOURCE POLLUTION IN BAYNES SOUND

An Assessment of Stewardship Programs from 1994 - 2000

Prepared by
Barbara Joughin

for the

State of the Sound GIS Project
Phase 2 - Data Analysis and Interpretation

December 14, 2001

COMOX VALLEY PROJECT WATERSHED SOCIETY

Community Approaches to Nonpoint Source Pollution in Baynes Sound
An Assessment of Stewardship Programs from 1994 - 2000

Table of Contents:

1. Introduction

1a. Background

Non-point source pollution is now understood to be a major part of all pollution entering aquatic environments. The traditional approach to water quality management is to focus on controlling "end of pipe" pollution from obvious, identifiable sources. However, while the general causes of non-point source (NPS) pollution in an area can usually be easily identified, NPS pollution is caused by many accumulative acts of pollution, and it is much more difficult to identify and control specific sources, and to regulate or enforce. It is generally accepted that the key to successful management of NPS pollution is prevention through planning, coordination, and education, as well as through source control.

In Baynes Sound, recognition of the growing threat to water quality due to non-point source pollution has resulted in a variety of initiatives intended to manage both NPS pollution causes and impacts. These initiatives have been implemented by industry, government, and local community groups.

The primary NPS pollution issue in Baynes Sound has been contamination of the marine ecosystem from fecal coliform bacteria inputs. The problems and costs associated with NPS pollution have been highlighted in Baynes Sound because of the highly restrictive criteria for shellfish growing waters, and attention to date has focused on the socio-economic impacts of deteriorating water quality on the local shellfish industry. Bacterial inputs from failing rural septic systems, municipal stormdrains, agricultural runoff, and boater waste have been identified as primary human sources in this region, and have been the focus of community led education and remedial projects. Natural marine sources from birds and marine mammals also provide bacterial input to Baynes Sound marine waters.

Bacterial contamination in Baynes Sound is spatially widespread because there are inputs from upland sources along the entire shoreline, and because inputs may be dispersed tidally.

Two seasonal peaks in fecal coliform bacteria levels have been identified in Baynes Sound. One corresponds with the first fall rains that flush the accumulated landborne contaminants into the water ("fall flush"). The other peak occurs in late spring, typically during the month of May, and is known as the "spring event".

In addition to fecal coliform bacterial sources of NPS pollution, increasing human population levels and changing land uses mean other NPS issues are emerging that are cause for additional concern.

1b. Purpose of this Analysis

This study reviews the benefits and the costs of implementing community stewardship and remediation programs that addressed non-point source pollution in the Baynes Sound region from 1994 to 2000. It evaluates and discusses the effectiveness of past community-led stewardship work in Baynes Sound in terms of the overall NPS pollution management in the region.

The questions addressed by this study are:
1. Did community stewardship programs meet their program goals?
2. What were the benefits of the community stewardship programs?
3. What were the costs of the community stewardship programs?
4. Were community stewardship programs an effective way to manage NPS pollution in the region?
5. Did the community stewardship programs provide good value for the public dollar?

1c. Approach

This study is presented from a benefits perspective (value of community involvement; effectiveness of programs). There is a reliance on other reports and data sources for developing economic estimates. New, primary research was not undertaken to gather economic data.

Regional stewardship goals are identified and discussed in terms of overall program implementation, results, and measures of success. Recommendations about future programs and approaches are offered as outcomes of the study.

1d. Sustainability and Stewardship

Sustainability:
In the Brundt Report, the UN World Commission on Environment and Development defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This report first identified the interactions between economy, society and the environment. (UN Commission on Environment and Development, 1987)

Many definitions of sustainability are now used, but all identify the need for humans to:
- Live within limits
- Understand the interconnections among environment, economy, and society
- Distribute resources and opportunities equitably

Sustainability is related to the quality of life in a community - whether and how the economic, social and environmental systems that make up a community provide a healthy and productive life that is meaningful for all community residents, present and future.

Sustainability is also about understanding the connections between and achieving balance among the social, economic, and environmental parts of a community. Understanding the three parts and their links is key to understanding sustainability. When society, economy and environment are viewed as separate, unrelated parts of a community, any problems the community may be experiencing may also be viewed as isolated issues. An unintegrated approach can have a number of negative side-effects. Solutions to one problem can make another problem worse, create opposing groups, or a focus on short-term benefits without monitoring long-term results

Sustainability requires managing individual, community, national, and global accounts in ways that ensure that human economy and society continue to exist without destroying the natural environment on which they depend.

"The term 'capital' is most commonly used to refer to money and material goods. However, in the context of sustainability, communities have several different types of capital that need to be considered – natural, human, social, and built capital. Together, these types of capital are referred to as community capital. A sustainable community wisely manages all its capital – living off the interest of community capital while using and improving the social, natural and built capital in ways that allow that capital to continue to support the community in the future." (Hart, 2001)

Effective actions to improve environmental, economic, or social conditions in a sustainable community take the connections between these conditions into account.

Stewardship goals:
The stewardship goals of the programs that were implemented by the community to address NPS pollution issues in the Baynes Sound region may be generally summarized as follows:

- Raise awareness, change attitudes, and change behaviour
- Involve people in stewardship actions
- Facilitate community involvement in water management planning processes
- Improve water quality
- Reopen or upgrade shellfish growing area classifications
- Build community capacity and skills

A fundamental goal of all community stewardship programs in Baynes Sound has been to "encourage individuals to take personal responsibility to make changes in their community through voluntary, cooperative action and participation for the long term integrity of the environment". (Baynes Sound Action Plan, 1995)

One critical element of achieving sustainability is designing and delivering programs that are effective in changing people's behaviour. In the context of solving environmental problems, this often means that new behaviour must be created, rather than simply altering an existing behaviour. It is very challenging to design programs that lead individuals to engage in behaviour that collectively is sustainable. Failure is due in part to an underestimation of the difficulty of changing behaviour. (McKenzie-Mohr, 1999)

It is also very challenging to design and deliver programs that are able to quantitatively measure changes in awareness, attitude and behaviour, or how changes impact directly upon the environmental, economic or social health of a community.

1e. Assumptions and Limitations

Undertaking a review of many different programs and projects, delivered by different agencies over a large area and several years has presented significant challenges associated with summarizing a large amount of information in an accessible format in a style that facilitates understanding.

Drawing meaningful conclusions from a wide diversity of detail without oversimplifying, losing context or misrepresenting the subtleties of relationships and community dynamics is an additional challenge.

Many individuals have been involved to varying degrees over varying times in the collaborative process that has been the Baynes Sound stewardship experience. Opinions and perspectives vary widely about cause and effect of conditions and results. The personal involvement of the writer has been limited to the latter years of the study, and while every reasonable effort has been made to

collect information from as many sources as possible, some extrapolation has been necessary. Relevant sections of the study have been reviewed for objectivity by members of the State of the Sound Advisory Committee and other individuals.

The results of the economic portions of the study are limited due to the limitations of the data and the methodologies that have been applied in the study. It is difficult to link changes in water quality directly to specific results of stewardship action. It is not possible to measure changes in behaviour because projects were not designed to include the controls that would provide measurement baselines. Even when projects are designed to include control groups and pre-surveys, the surveys themselves act to alter awareness. Changes in awareness, attitude and behaviour are exceedingly difficult to measure quantitatively.

This study assumes that the natural environment is inherently valuable in its integrity, and that this integrity is worth preserving and protecting.

Finally, the various values and benefits that are factors in this review are largely non-economically defined and are difficult to translate to monetary values.

2. Values, Benefits and Costs

2a. Values

This study examines the value of one aspect of nonpoint source (NPS) pollution management efforts in Baynes Sound – community stewardship programs.

The value of community initiatives lies in their effectiveness in changing human behaviour, and in mitigating the impacts of NPS pollution on the health of Baynes Sound. However, both these values are very difficult to quantify.

One concrete way to measure the value of community stewardship programs is by adding the funders' contributions of money to support these programs. Many project funders have indicated their endorsement of the quality and effectiveness of community stewardship programs by maintaining partnerships through the development and delivery of progressive activities since 1994. In this case, the total cash contributions of the different project funders could be considered a direct measure of willingness-to-pay for efforts that address NPS pollution.

2b. Benefits of Community Stewardship Programs

The benefits associated with community programs that have addressed NPS pollution in the Baynes Sound region include:

- Action-oriented and collaborative approach to problem solving
- Increased level of awareness and stewardship ethic in the community at large
- Active stewardship involvement and leadership by individuals and groups in specific situations and locations (Ships Point, Union Bay, Craigdarroch, Marsden, Sandwick, others)
- Better decision-making from improved access to data and increased awareness
- Transferability of methodology, approach, and model to other regions and groups
- Improved water quality (Courtenay and Comox stormdrains, Comox Harbour)

2c. Costs

The costs of the community stewardship programs that addressed NPS pollution in Baynes Sound are counted as the total cash contributions to all the projects. For the purposes of this study, these total cash contributions may be considered equal to total project costs.

Total project contributions:
The following values are derived from contributions to community stewardship programs that addressed NPS pollution in the Baynes Sound region over the seven year period from 1994 to 2000. The amounts are presented in numbers rounded to the nearest hundred dollar. Please refer to Table 7 for details on project contributions.

Table 1 Community Stewardship Project Cash and In-kind Contributions:

Total Cash Contributions for community projects addressing nonpoint source pollution delivered by Project Watershed and CVCARE * from 1994 to December 31, 2000		**$907,200**
In-kind Contributions for above projects, excluding Sound Wastewater Solutions Program	389,000	
Estimated In-kind Contributions for Sound Wastewater Solutions Program **	72,000	
Estimated In-kind Contributions from Baynes Sound Round Table and Action Group ***	50,000	
Total In-kind Contributions		**$511,000**
Total Project Contributions		**$1,418,200**

The cash contributions from all funders total $907,200, and are counted as project costs.

The in-kind contributions to projects where in-kind values were tracked total $389,000. Other in-kind contributions from sources where in-kind values were not recorded are represented as a conservative estimate of donated time. In-kind goods and services were not included in this estimate. The value of this estimated in-kind time is $122,000, and the total in-kind value is $511,000.

***** Comox Valley Project Watershed Society and Comox Valley Citizen Action on Recyling and the Environment (CVCARE).

****** In-kind contributions were not tracked over the 4 years of CVCARE's Sound Wastewater Solutions Program. Community donated time has been estimated at $18,000 per year, a conservative estimate given the high number of hours that were invested by different committees and individuals in Union Bay during the course of this program. (25 people contributing 3 hrs /month x 48 months x $20/hr = $72,000)

******* In-kind contributions by members of the Baynes Sound Round Table and Action Group were not formally tracked over the years, but have been estimated at $50,000 from fall 1994 until the end of 2000. (8 people x 2 groups x 2.5 hrs/month x 60 months = $48,000, plus $2000 for meeting preparation and recording = $50,000.)

3. Approach and Methodology

3a. Approach

The study focuses on evaluating the effectiveness of past Baynes Sound stewardship and remediation work by examining the value of the benefits gained in relation to the costs of delivery. A synthesis of economic, social and environmental approaches is used in the evaluation.

Economic Approach

This approach attempts to portray the economic value of community stewardship efforts to manage nonpoint source (NPS) pollution in Baynes Sound.

Previous studies on the economic relationship between the local shellfish industry and NPS pollution were examined, and a GIS data analysis of marine water quality in Baynes Sound was undertaken in an effort to quantify improvements in water quality and any increased economic benefits to the shellfish industry. Outcomes of these two approaches have not been conclusive enough to include in an economic valuation of the benefits of community NPS pollution initiatives. Please refer to Section 3b Methodology and Results for more discussion about these results.

In this study, the community's willingness-to-pay (WTP) is used to show how actual program costs may be considered a reasonable and valid investment in the wellbeing of the environment and its ecosystems.

A community's willingness to participate in stewardship programs gives an indication of how much a community values the integrity of an ecosystem. In-kind contributions are a way to measure direct involvement in monetary terms - these contributions show how a community values a clean, healthy environment, and to a degree how it feels about sustainability issues in general. By taking action to change how NPS pollution impacts the environmental, social and economic health of their community, individuals provide concrete information about how much they would be willing to pay to ensure that positive rather than negative change occurs.

Social approach

The effectiveness of stewardship programming is examined in the context of current social goals and values, challenges and change.

The 1990s were a period of rapidly expanding public awareness about both the vulnerability and the importance of the natural environment. The "myth of progress" began to give way to a new and profoundly different belief – that we are better off than our children will be, and that we are eroding our environmental wealth and natural capital. During this time, communities of all kinds were learning about the meaning of 'downsizing', as different levels of government began to download the responsibility for many services to local communities. In addition, communities felt the pressures of increased population and development on their social, environmental, and economic systems, while experiencing the rising social costs of downturns in resource based economies.

Environmental issues in Baynes Sound, including the impacts of NPS pollution, surfaced during this time of social change and challenge. The community response to these issues has served as a tangible expression of the changing social power structure, where citizens become the experts, and leaders of meaningful processes of change. Stewardship programs in Baynes Sound have been successful largely because of the wisdom and information brought to the work by people who became involved as volunteers in projects or took the lead in community planning processes.

Some of the benefits of community stewardship work in the Baynes Sound region include changed awareness, attitude and behaviour of individuals, not only in the general public, but in business and industry, among its managers and decision makers. In addition, different levels of government are responding in new ways to the expectations of citizens who have social agendas that include community participation in planning and decision making.

Environmental approach

The environmental approach to this study includes a recognition of the inherent value of ecosystem integrity, and of the validity and importance of efforts to preserve and protect the environment from harmful human influences and behaviour.

Stewardship programs seek to provide information and opportunities for meaningful direct action to people who live, work, and play in the Baynes Sound region. These programs are valued because people who are informed about the problems and are given opportunities to become personally involved are more likely to make choices that do not harm the environment than are people who are not aware and are not personally involved.

3b. Methodology and Results

Several methods were applied to this study in order to answer the research questions:

i) Benefit/cost analysis
ii) GIS analysis
iii) Interviews with key individuals
iv) Literature Review (of past project proposals, reports and databases)
v) Impact Assessment

3b.i) Benefit / Cost Analysis:

Because it is very difficult to quantify the benefits of community stewardship programs or identify direct and measurable impacts of these programs, this study has not included a true benefit/cost analysis. Rather, an effort has been made to interpret the benefits and costs of the community stewardship programs indirectly in order to show the value of these programs in monetary terms.

This has been done in two ways.

1. The total cash contributions for all projects from 1994 until the end of 2000 were added together, then divided by seven years to yield a per year amount. This amount was then divided by the number of residents in 2000 in the region that were over 15 years old. This calculation shows the cost per person per year of community stewardship efforts to address NPS pollution in Baynes Sound. The result is an approximate rather than an exact value.

Results:

Table 2 Average Annual Cost of Community Stewardship Programs from 1994 – 2000:

Total Cash Contributions	$907,000
Divided by years between 1994 - 2000	7
Project costs per year (average)	129,600
Divided by population over 15 years of age	47,000
Project costs per person per year	**$2.75**

2. Crane Management Consultants completed a "Multiple Account Analysis of Non-Point Source Pollution in BC" in 1997. Baynes Sound was used as one of the case studies in the analysis. The study used an estimated non-use value of $5.00 as a nominal amount that local residents would be willing-to-pay on average to have the waters of Baynes Sound in a less contaminated state. This somewhat conservative value was used in that analysis for two reasons:
   - popular water-based recreation activities in Baynes Sound could still occur
   - the higher values of those most directly affected (persons who are dependent on the local shellfish industry) would be offset by the lower values of those who do not attach much value to an incremental improvement in what is probably considered by them to be fairly clean waters.

Non-use Value	what people will pay for improving or preserving resources they will never use
Option Value	the value placed on a future ability to use the environment

It may reasonably be argued that local residents would place a higher non-use value today on efforts to improve water quality in Baynes Sound than they might have in the mid 1990s, given the expanding awareness about the importance of clean water and a healthy environment. However, the $5.00 non-use value determined in the Crane report is used in this study as the basis for defining a willingness-to-pay value for both option and non-use values. The Consumer Price Index Historical Summary was used to calculate $5.00 in 1995 to a value in 2000 of $5.45.

Result:
If 47,000 local residents over the age of 15 are each willing to pay $5.45 per year to help improve water quality in Baynes Sound, this would indicate that efforts to achieve this outcome would be justified if annual average costs of these efforts were equal to or less than $256,150.

The value of efforts to manage NPS pollution undertaken by industry and government must be considered as part of the amount of the community's willingness-to-pay (WTP). This study does not include a review or evaluation of other sectoral approaches to managing NPS pollution. However, given the importance of community-led public education and involvement programs to the successful management of NPS pollution, a distribution of the community's WTP as follows may be considered reasonable:

Table 3 Allocation of Willingness-To-Pay Value

35%	**$1.90**	Government initiatives	• Monitoring and enforcement of regulations • Investment in infrastructure and repairs
35%	**$1.90**	Community initiatives	• Education programs • Remediation
30%	**$1.65**	Industry initiatives	• In-kind contributions to community programs • On-site water quality control • Infrastructure improvements • Water quality monitoring programs (shellfish industry)

The results of industry-led water quality monitoring programs are used by industry to manage their harvests, and to manage growing area classification. When shellfish growers provide access to the water quality data that they have gathered, this information may be used to help identify pollution hotspots and potential sources. However, shellfish growers have little incentive to provide public access to information about water quality when that use could result in negative effects on their

business. Although shellfish industry investments in water quality monitoring are high, they represent a contribution to managing the industry more than a contribution to identifying or reducing the impacts of NPS pollution in Baynes Sound.

Annual average community stewardship project costs were found to be $129,600, which has been further defined as $2.75 per person (over 15 years of age) per year. This amount is 15% higher than the $1.90 allocated in Table 3, and represents 50% of the total willingness-to-pay value of $5.45, rather than 35%.

3b.ii) GIS Analysis:

Marine water quality data from different sources were compiled in a composite database, and several different methods were explored in an effort to interpret the data for trends and hotspots. For the purposes of this study, the results were to be used to determine if water quality had improved in Baynes Sound in areas that were specifically associated with community stewardship actions.

Results:

It was learned during the course of exploring different possible methodologies that available marine water quality data are not sufficiently comprehensive to provide conclusive interpretation or to present valid information about marine water quality trends or hotspots. There are too many temporal and spatial variables to draw meaningful conclusions.

The Advisory Committee of the State of the Sound Program has reviewed these results and is recommending the development of water quality monitoring programs that enable comprehensive marine and fresh water quality analyses in Baynes Sound.

3b.iii) Interviews with key individuals:

Interviews with industry, government and community representatives were conducted to gather qualitative information on the effectiveness of community stewardship programs in the Baynes Sound region between 1994 and 2000. Nine people were interviewed – 2 community representatives, 4 people from different levels of government, 2 shellfish growers, and 1 water quality professional. All interviewees but one have been participants in the Baynes Sound stewardship process for most of the 7 years of the study, and 5 were involved from the beginning.

Results:

Interviewees were asked four questions in an informal interview. Notes were taken and compiled by question. The general responses are summarized below.

1. What worked?

The Baynes Sound Round Table brought people together, increased awareness, established productive working relationships, provided endorsement to community groups, and created synergy and collaboration.

> Comox Valley community organizations were key to creating action and motivating and involving citizens. The community stewardship work was innovative, transferable to other communities, of consistently high quality, and legitimized the effectiveness of community involvement efforts.

Public involvement has been a key component of our success, with citizens taking a proactive approach to solving specific community problems.

> The proactive, positive approach to managing NPS pollution in the Baynes Sound region is another key component of success. The partners that have been working together over the years

have created a climate of understanding, cooperation and problem solving that has resulted in many positive benefits.

Recognition of the work in Baynes Sound locally, regionally and beyond has been a result of community stewardship work in the area. Other regions are watching how the Baynes Sound experience is evolving, and beginning similar processes. Those involved in Baynes Sound initiatives are mentoring the process in several other areas.

The focus on education in stewardship programs has been very effective at improving both public awareness and political will.

Specific areas of project focus that were highly effective include stormdrain monitoring projects in northern Baynes Sound, the series of projects at Ships Point, and Union Bay's community led liquid waste management planning process.

2. What hasn't worked?

There is ongoing NPS pollution – failing septic systems, shellfish closures and other problems.

All participants identified the lack of local government involvement as a major barrier to success. Some defined it as a lack of meaningful endorsement (ie funding), others as a lack of vision and leadership. There is a general perception that local government sees programs that address NPS pollution as "offloading" rather than understanding that local governments are an essential part of the solution.

Ongoing lack of resources for projects addressing NPS pollution result in program discontinuity, inconclusive datasets, and project personnel burn-out.

Public apathy is one result of frustration with bureaucratic systems. When people are apathetic, little effort is invested in changing political will, which results in little change in the bureaucratic systems that create the frustration and public apathy in the first place. Incomplete public buy-in means tax dollars are not committed to efforts to address NPS pollution.

There is an absence of effective legislation and enforcement.

For the most part, project methodology has not included controls that would indicate more definitively any changes in attitude, awareness and behaviour that occurred as a direct result of the projects.

3. What remains to be done (gaps)?

Local government involvement is the key place to become innovative, change the vision and inspire the leadership. Put together a plan to engage local politicians.

The local shellfish industry has not been as involved as they could be. Whether there are concerns within the industry about monitoring methodology and interpretation or not, there are real issues about NPS pollution that need industry engagement.

Public involvement – personal responsibility is still lacking. "Manage people, not the environment."

First Nations have not chosen to be involved, and are missed at the table.

Other gaps: Delayed no-discharge regulations for Baynes Sound
Sustainability practices implemented in the community
Manure storage and management

4. Have we been effective?

Interview participants believe that water quality has been improved through stormdrain work, that less shellfish growing areas are closed and more areas are being upgraded. However, water quality improvement is hard to measure, and it may take years before efforts to reduce NPS pollution show success.

Community involvement in the process has been stimulating and encouraging to those participating.

Awareness and attitude changes are very difficult to measure directly, but there is general agreement that awareness about the impact of human activities on the environment has increased as a result of the work.

Participants identified specific changes in behaviour, including municipal responses to stormdrain problem identification, and Environment Canada's changes in the way they operate. Several participants expressed the belief that community involvement has influenced regulator approach, decisions, and actions.

3b.iv) Literature Review:

Since 1994, different communities, groups and individuals have been active participants in efforts to manage NPS pollution in the region. During this time, many stewardship projects have been developed and delivered to address fecal coliform and other non-point source pollution issues in Baynes Sound.

Reports, evaluations, and financial summaries from these projects were gathered and reviewed for details about goals and objectives, results and recommendations, and financial information. The objectives, outcomes, and recommendations of these projects and programs were compiled into an MS Excel spreadsheet for review and evaluation of project results.

In addition, total expenditures and revenues were calculated for all projects, and are shown in Table 7 – Total Project Contributions, on page 22.

Other studies and reports were used as reference materials in the preparation of this study. All resource materials that were used in the preparation of this study are identified in Section 6 - Resources.

Results:

Please refer to Section 4 - Conclusions for a discussion of project results, and Section 7 - Project Inventory for tables showing project goals, objectives, and results.

3b.v) Impact Assessment:

In the mid 1990s, the Water Quality Branch of the BC Ministry of Environment, Lands and Parks (MELP) contracted several studies of nonpoint source (NPS) pollution in BC in their efforts to develop a nonpoint source pollution management plan for BC. One study defined the nature and extent of NPS pollution (Norecol Dames and Moore, 1996), while KPMG reviewed the issues and options for NPS pollution management. (Holdstock, J., D. Hagerty, and W. Reid, 1996)

The NDM study concluded that because region-specific issues and impacts are the result of differing human and industrial practices across the province, control measures should be implemented either regionally or locally in order to address NPS priorities.

KPMG reported that, in 1995, regulatory and non-regulatory approaches as a whole were less than adequate in meeting most of the factors that stakeholders consider necessary for effective NPS pollution management in BC. KPMG identified the need for integrated watershed planning to effectively begin controlling the problem and to focus efforts to the unique requirements of individual ecosystems. A vision was developed for BC's NPS pollution management initiative, and 20 critical success factors (CSFs) were developed to support this vision. These critical success factors describe the outcomes a successful NPS management strategy should accomplish, and became the measurement tool for use in assessing nonpoint source pollution management strategies. The 20 critical success factors were divided into seven areas:

- Legislation and enforcement
- **Problem identification and prioritization**
- **Appropriateness**
- **Education, communication, training and reporting**
- **Institutional framework**
- Achievement of intended results
- **Operational effectiveness**

This study uses eight critical success factors from five of these areas (indicated in bold) to measure the effectiveness of community stewardship programs to address NPS pollution in Baynes Sound.

Results:

Table 4 Assessment of Effectiveness of Community NPS Pollution Management Efforts

Assessment Rating: ● meets CSF ◉ partially meets CSF

Critical Success Factors (CFS) from KPMG 1996		**Comments:**
Institutional framework		
5. Ensure that key agencies have adequate physical, financial, and human resources.	◉ ◉ ◉	– Fiscal restraints mean sufficient resources are not always available for program development and delivery. – Projects are short-term and program continuity is difficult to provide in project-based funding environments. – Community stewardship programs have provided substantial volunteer human resources.
Problem identification and Prioritization		
7. Ensure that there is an effective monitoring system in place.	● ◉	– Stormdrain monitoring in north Baynes Sound identified problems – Gaps in current water quality data have been identified, planning is underway to develop a comprehensive water quality monitoring program (incomplete).
8. Set and monitor key indicators that track the effectiveness of NPS pollution management activities	◉	– State of the Sound Program develops key indicators for direct measurement of aquatic ecosystem health (incomplete).
Operational effectiveness		
12. Support creative solutions by participants	● ●	– Projects provide best management practices information to business and government. – Community-led LWMP processes underway in several locations in Baynes Sound., supported by community stewardship programs.
Education, communication, training & reporting		
15 Encourage public and stakeholder education, training, involvement and support.	●	– Coordinated development and delivery of public education and involvement programs raise awareness and help change attitude and behaviour.
16 Periodically report to the general public and other key stakeholders on the effectiveness of activities designed to address NPS water quality problems	● ◉ ◉	– Ongoing stakeholder meetings provide opportunities for stakeholder reporting. – Public reporting occurs regularly through media and educational releases. More could be done. – State of the Sound Program designed to provide regular reports on the health of Baynes Sound (incomplete).
Appropriateness		
17 Promote integrated watershed management	◉ ◉	– Baynes Sound Round Table and State of the Sound Program bring together concerned stakeholders and groups. – Community stewardship programs have encouraged and supported citizen involvement with integrated planning at a watershed level.
19. Take a preventative/ pollution prevention approach to reducing NPS pollution	◉	– Community stewardship programs in the region encourage individuals to develop ways to reduce their impact on the environment.

4. Conclusions

The questions addressed by this study are:

- 4a. Did community stewardship programs meet their program goals?
- 4b. What were the benefits of the community stewardship programs?
- 4c. What were the costs of the community stewardship programs?
- 4d. Were community stewardship programs an effective way to manage NPS pollution?
- 4e. Did the community stewardship programs provide good value for the public dollar?

This study used different methods to review the benefits, the costs and the effectiveness of community stewardship and remediation programs that addressed non-point source (NPS) pollution in the Baynes Sound region from 1995 to 2000.

The answers to these questions draw upon the results of these methods to offer conclusions about the benefits, costs and effectiveness of community efforts to manage NPS pollution in the study area and time.

4a. Did community stewardship programs meet their program goals? YES

The stewardship goals of the programs that were implemented by the community to address NPS pollution issues in the Baynes Sound region are summarized as follows, with brief accompanying commentary about their achievement:

Table 5 Achievement of Project Goals

Goal:	Met goal?	Comments:
Raise awareness, change attitudes, and change behaviour	PARTIAL	Changes in awareness, attitude and behaviour have occurred; much more remains to be done; not possible to measure directly.
Involve people in stewardship actions	PARTIAL	All projects involved people in direct stewardship action; many more people remain uninvolved.
Facilitate community involvement in water management planning processes	YES	Community involvement has been the key component to efforts to address NPS pollution in the region.
Improve water quality	PARTIAL	Stormdrain repairs resulted in improved water quality in stormdrain systems; some improvement in Comox Harbour; not possible to conclusively measure water quality trends with current water quality datasets.
Reopen or upgrade shellfish growing area classifications	NO	Not possible to prove direct causal links between community stewardship programs and upgraded shellfish growing area classifications.
Build community capacity and skills	YES	Community involvement projects have been key to building community capacity and skills.
Encourage individuals to take personal responsibility for the long term integrity of the environment	PARTIAL	Projects encouraged people to take responsibility for personal choice and action, and while many people have responded; many more need to be reached.

Stewardship programs in the Baynes Sound region may be considered generally successful at meeting their goals. The goals that were defined in some projects as goals were actually objectives. Projects commonly included objectives that were not possible to measure. In most projects, the defined goals must be understood to be very long term in their nature and beyond reasonable

expectation of achievement within individual project timelines. Project efforts to reach these goals may be considered "a work in progress".

4b. What were the benefits of the community stewardship programs?

The benefits associated with community programs that have addressed NPS pollution in the Baynes Sound region are:

- Action-oriented and collaborative approach to problem solving
- Increased level of awareness and stewardship ethic in the community at large
- Active stewardship involvement and leadership by individuals and groups in specific situations and locations (Ships Point, Union Bay, Craigdarroch, Marsden, Sandwick, others)
- Better decision-making from improved access to data and increased awareness
- Transferability of methodology, approach, and model to other regions and groups
- Improved water quality (Courtenay and Comox stormdrains, Comox Harbour)

4c. What were the costs of community stewardship programs from 1994 - 2000? $907,000

Community stewardship programs between 1994 and 2000 received a total cash contribution of $907,000. This is an average of $129,600 per year, or $2.75 per year per person over 15 years of age.

4d. Were community stewardship programs an effective way to manage NPS pollution? YES

A better way of phrasing this question might be to ask, "ARE community stewardship programs an effective way to manage NPS pollution?"

The answer is a resounding "YES". The key to successful management of NPS pollution is prevention through planning, coordination, and education. Any implementation of these basic strategies is an investment toward changing the awareness, attitude and ultimately the behaviour of individuals.

Results of this study verify the importance and effectiveness of implementing NPS pollution management actions at the regional and local level. Community efforts to address NPS pollution in the Baynes Sound region were effective for several reasons:

- Action-based Approach:

The Baynes Sound Round Table was formed in direct response to an environmental problem by individuals with a commitment to action. Community environmental organizations that became involved in the process to manage NPS pollution brought a stewardship approach to actions to address that problem. Community organizations continue to help maintain the focus on specific stewardship action through the design and delivery of remediation, monitoring, and education programs in the Baynes Sound region.

- Collaboration:

Community approaches to addressing the issues helped define the collaborative process that has been followed by the Baynes Sound Round Table, the Baynes Sound Stewardship Action Group, the Union Bay Liquid Wastewater Management Plan (LWMP) Committee, and other groups. Community approaches have influenced attitudes, decisions and actions of the different parties who

have been involved in all aspects of multi-sectoral efforts to manage NPS pollution in Baynes Sound. The success of these efforts is a result of all parties focusing on a shared vision, on a stewardship ethic, and on action.

The cooperative approach of active agencies and organizations is reducing duplication, maximizing the effectiveness of everyone's efforts and increasing the collective commitment to achieving goals.

Productive, professional working relationships amongst community groups, industry experts, government agencies, and committed volunteers have developed through the collaborative process of the Baynes Sound Round Table and different Advisory Committees.

- Trust:

The cooperative approach modeled by the community agencies who have been delivering projects has helped develop a higher level of trust for environmental protection initiatives within different sectors of the community at large, and has created a precedent of commercial and environmental interests working together on local issues. Developing a sense of cooperation and environmental stewardship with farmers, business people, boaters, and rural landholders has created an immeasurable, yet invaluable effect in this community.

- Building Capacity:

Community programs have helped build healthy networks, capacity, and skills in communities, neighbourhoods, and individuals, and effective action is occurring in ways that will have direct positive impacts on the environment. Rural areas are starting to take a proactive approach to their sewage issues, and have been supported in this by community organizations who have been active.

- Fostering Change:

Initiatives to promote behaviour change are most effective when they are carried out at the community level, and involve direct contact with people. Community efforts to reduce NPS pollution inputs have directly involved different sectors of the community in actions that were specifically meaningful to each sector. Barriers to involvement and commitment were identified and reduced in some projects. This has been an extremely effective and successful strategy.

A momentum for change has been created. Comox Valley residents continue to contact program staff from Project Watershed and CVCARE for information about the issues and to volunteer. People generally want to do the right thing, once they know what that means in terms of their personal ability to choose and to respond.

> "To energize and focus the reservoir of goodwill it is necessary to assure that citizens are informed. One of the appeals of information strategies is their ability to achieve results when more traditional approaches prove inadequate. Appropriately designed information strategies may result in significant pollution control, even in the absence of traditional monitoring and enforcement". (Tietenberg, 2001)

A strong stewardship ethic has developed in the Comox Valley as a direct result of the community-led approach to water quality problems in Baynes Sound.

The effectiveness of community efforts to address NPS pollution in the Baynes Sound region has been compromised by several factors.

- The magnitude of the task:

While there has been good success with involving many people with meaningful actions, many more remain uninfluenced and unaffected.

- Narrow Focus:

Projects focused mainly on the effects of elevated fecal coliform bacteria levels in the marine ecosystem of the Baynes Sound region, as measured primarily by its impact on the local shellfish industry. However, many other kinds of NPS pollution have negative effects upon aquatic ecosystems. Although the very real threat to the local economy provided an immediate and legitimate reason for action, the long term implications of unmanaged NPS, in the wider context of increasing development without integrated planning and management, have received less attention.

- Limited Resources:

There were limits to how much could be accomplished when money, time and human resources were limited.

- Barriers to Change:

There are many different barriers that prevent individuals from engaging in sustainable behaviour. During much of the time under review, projects were designed to bring immediate actions to location or issue-specific problems. Barriers to change were identified as they came up during the delivery of projects, and some were effectively addressed. However, had projects been designed to focus on understanding and removing barriers to change, efforts to create new behaviour would have been more successful, and change more effectively measured.

4e. Did the community stewardship programs provide good value for the public dollar? YES

During the years between 1994 and 2000, there was an increasingly strategic approach brought to the development and delivery of community stewardship projects. There was a noticeable evolution of project definition, as goals and objectives became more clearly stated, measured, and reported. This was particularly noticeable in the review of project final reports.

As data and information collection and storage have become more standardized, there has been a corresponding acceptance of the legitimacy of the data and information by government and academic stakeholders. There is an ongoing need for careful and thorough record keeping and reporting.

Project results met and usually exceeded project objectives. Please refer to Table 9, page 25, for details about the objectives and results for each project.

A project-based funding environment means that continuity is jeopardized when project personnel become unemployed after project completion. This results in inefficiencies when new project staff must become familiar with the complexities of the issues, the partnerships, and how the project fits into the overall picture. This factor also creates staff burnout and turnover when individuals attempt to maintain continuity by developing ongoing programming without being paid to do so.

Community stewardship programs provide excellent human resources per dollar spent due to the high rate of volunteerism associated with the projects. Many more hours were contributed than were paid for.

Project coordinators and program managers have exercised a high degree of flexibility, creativity and innovation as they have addressed a complex issue with limited resources. The nature of the work that has been accomplished is considered by program funders to be innovative, replicable, and consistently performed. The collaborative approach that has been taken to programming has led to credibility of the partners and the process. A high level of professionalism is exercised by the individuals who have led this work, and acceptance of this expertise has resulted in widespread recognition of the legitimacy and importance of community involvement in processes of this kind.

All community stewardship projects during the period of this study were finished on time and within budget.

5. Next steps

Continuing urbanization of the Baynes Sound region will result in further increases in the sources of contaminants to Baynes Sound, and a continuing decline in water quality.

Our fundamental challenge is to effectively foster sustainable behaviour in our communities and in our institutions. Community initiatives to address environmental issues in the Baynes Sound region must be very strategic and focused in order to maximize the use of our very limited resources and create real and measurable change in individual choices and behaviour.

To accomplish this:

- ✓ Ensure that the programs that are implemented have a high likelihood of actually changing behaviour:
  - Articulate more clearly the specific desired change in behaviour
  - Deliver programs that remove barriers and enhance benefits for different sectors of the population

    ie. Identify barriers and benefits of sustainable behaviour
    Design a strategy that utilizes behaviour change tools
    Pilot the strategy with a small segment of a community
    Implement the strategy across the community
    Evaluate the impact of the program
- ✓ Develop measurement methods that quantify the value of community programs.
- ✓ Develop an integrated plan for encouraging sustainable principles in the local community, including strategies for involving both local governments and local citizens.
- ✓ Develop water quality monitoring programs that enable comprehensive marine and fresh water quality analyses in Baynes Sound.
  - Define appropriate parameters
  - Develop methodology and approach
- ✓ Identify future stewardship project focus.

6. Resources

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7. Project Inventory

Please refer to the following tables for details about stewardship projects in Baynes Sound from 1994 – 2000:

Table 6 Projects, Dates, and Lead Organizations

Date	Project	Agency
1994	Shellfish Closure-shellfish growing leases closed due to bacterial contamination.	
1994 July	MAFFassists with creation of BSnd Round Table.	MLA MLord, BCSGA, Minister,MAFF Zirnhelt
1994 Sept	first meeting of the Baynes Sound Round Table.	
1994 Oct	Workshop for Stakeholders	BCSGA
1994 Nov	Baynes Sound Educational Subcommittee established.	
1994 Dec	BSnd Env Assessment&Mitigation Project	NIC, BCSGA, Project Watershed
1995	**"Sound Stewardship"**	BSRT Educ Sub-Cttee, CVCARE, GSA, PW
1995 Feb	Sound Stewardship - Baynes Sound Forum	BSRT Education Sub-Cttee
1995 March -	BSnd Cmty WQ Sampling Program	PW, NIC students, vltrs, TAP
1995 June	Volunteer Monitoring Training	EC
1995 Sept	Ships Point	CVCARE
	Agricultural Project	DFO, REF, Project Watershed
1995 Mar - Dec	Baynes Sound Action Plan	GSA, EC, Project Watershed
	Alternate Wastewater Treatment Workshops	CVCARE
1996	**"Hotspots"** 1996 - 98	Project Watershed. CVCARE
1996 April-Mar97	Baynes Sound Hot Spots - Storm drain monitoring	Project Watershed
1996 Mar-Mar97	Baynes Sound Hot Spots - Septic System Component	CVCARE
1997 Apr - Oct	Baynes Sound Hot Spots - Agricultural Component	Project Watershed
1996	Comox Harbour Marine Monitoring Program	Project Watershed
1996 March 2	BSnd Forum - Celebration, Solutions and Action	Sound Stewardship
1997	BSRT Educational Committee revised and renamed the Baynes Sound Stewardship Action Group	
1997	Ship's Point Dye Testing Project	Ship's Point volunteers, Project Watershed
1997 April	BSSI Teachers Package	Project Watershed
1997 Nov96-Apr97	**Sound Wastewater Solutions III** - 1. Baseline Survey Design and Delivery	
1997 May1-Oct30	2. Baseline Data Analysis & Community Study	CVCARE
1998 Nov97-Apr98	3.Study Communities Project Design&Action Plan	
	Union Bay LWMP	
1998 May1-Oct 31	4.Implement Cmty Actions&Midpoint Evaluation	CVCARE
	Union Bay LWMP	CVCARE
1998 Apr98-Jun99	Tribune Bay Constructed Wetland Project - Ph 1	CVCARE
1998	**"Down the Drain"** 1998 - 1999	Project Watershed, CVCARE
1998 March - Oct	Down the Drain Agricultural Project	Project Watershed
1999 Jan1 - Jun30	**Sound Wastewater Solutions III**	CVCARE
	5.1 Communication/Education/Dissemination	CVCARE
	5.2 Union Bay	CVCARE
1999 Jul-Oct00	5.3 Tribune Bay Constructed Wetland Project	CVCARE
1999 July-Dec 2000 Jan-June	**Sound Wastewater Solutions III**	
	6. Communication, Union Bay Project, Tribune Bay	CVCARE
1999 April - Oct	Down the Drain Biofiltration Wetland-Ships Point	Project Watershed
1999 April - Oct	Down the Drain Septic Education	CVCARE
1999 Feb - Nov	Down the Drain Survey & Education of Businesses	Project Watershed
1999 May	Baynes Sound Restoration Actions Mapping Project	Project Watershed
1999	sewer/stormdrain crossconnection repairs 1997-99	City of Courtenay, Town of Comox
2000 Jan-Jun30	**Sound Wastewater Solutions III**	
	7. Communication, Union Bay Project, Tribune Bay	CVCARE
2000	Septic Solutions	CVCARE
2000 Sept99-Mar00	Pumpout and Boater Education 1999 - 2000	PW, Deep Bay Hrbr Auth, CV Hrbr Authority.
2000	Comox Harbour Marine Monitoring 1999 - 2000	Project Watershed
2000 Sept99-Mar00	Stormdrain Remonitoring Project 1999 - 2000	Project Watershed
2000 May	Hazardous Waste Drop off Day	CVCARE, RDCS
2000 July-Dec 31	**State of the Sound** GIS Project - Phase 1	Project Watershed

Table 7 Total Project Contributions

Date	Project	Total Project Costs	Cash Contributions	In-kind Contributions
1995	**"Sound Stewardship"**	121698	71246	50,452
1995 Feb	Sound Stewardship - Baynes Sound Forum			
1995 March -	Sound Stewardship - BSnd Cmty WQuality Sampling Program			
1995 June	Volunteer Monitoring Training			
1995 Sept	Ships Point			
1995	Agricultural Project			
1995 Mar - Dec	Baynes Sound Action Plan			
1995	Alternate Wastewater Treatment Workshops			
1996	Comox Harbour Marine Monitoring Program			
1996 March 2	Baynes Sound Forum - Celebration, Solutions and Action			
1996 April - Mar 97	**Baynes Sound Hot Spots** - Storm drain monitoring	192191	67064	125127
1996, Mar96-Mar97	Baynes Sound Hot Spots - Septic System Component	49677	30477	19200
1997 Apr - Oct	Baynes Sound Hot Spots - Agricultural Component	57172	36649	20523
1997 April	BSSI Teachers Package			
1996	Ship's Point Dye Testing Project	15000	7000	8000
1997 Nov/96-Apr/97	**Sound Wastewater Solutions III**	36475	36475	
	1. Baseline Survey Design and Delivery			
1997 May 1-Oct 30	**Sound Wastewater Solutions III**			
	2. Baseline Data Analysis & Community Study	74,684	74,684	
1998 Nov97-Apr98	**Sound Wastewater Solutions III**			
	3. Study Communities Project Design and Action Plan	29,405	28135	1270
1998 May 1-Oct 31	**Sound Wastewater Solutions III**			
	4. Implement Community Actions and Midpoint Evaluation	42,736	42736	
1998 Apr98-Jun99	Tribune Bay Constructed Wetland Project - Phase 1	41,094	21500	19594
1998	**"Down the Drain"** 1998 - 1999	234,020	151328	82692
1998 March - Oct	Down the Drain Agricultural Project			
1999 April - Oct	Down the Drain Biofiltration Wetland Pilot Project - Ships Point			
1999 April - Oct	Down the Drain Septic Education			
1999 Feb-Nov00	Down the Drain Survey and Education of Businesses			
1999 Jan1-Jun30	**Sound Wastewater Solutions III**	153,865	153865	
	5. Communication, Union Bay Pilot Project, Tribune Bay Project			
	5.1 Communication/Education/Dissemination			
	5.2 Union Bay Pilot Project			
1999 July-Oct00	5.3 Tribune Bay Constructed Wetland Project			
1999 July1 - Dec31	**Sound Wastewater Solutions III**			
2000 Jan - June 30	6 & 7. Communic, Union Bay Pilot Project, Tribune Bay Project	36,527	36527	
2000 May	Hazardous Waste Drop off Day			
1999 May	Baynes Sound Restoration Actions Mapping Project	5,900	5900	
2000	Septic Solutions	20030	15080	4950
2000 Sept99-Mar00	Pumpout and Boater Education 1999 - 2000	85,333	73663	11670
2000	Comox Harbour Marine Monitoring 1999 - 2000	3540	2800	740
2000 Sept99-Mar00	Stormdrain Remonitoring Project 1999 - 2000	19776	7160	12616
2000 July 7-Dec 31	**State of the Sound** GIS Project - Phase 1	77076	44891	32185
		1296199	907180	389019

Table 8 Project Goals

Project	**Goals**
Baynes Sound Round Table	Bring together industry, government and other stakeholders to identify and find solutions to the pollution problem in Baynes Sound.
	1. Improve fresh and marine water quality in the Baynes Sound area
Workshop for Stakeholders	plan next steps to address Baynes Sound pollution and growing area closures
BSnd Educ. Subcommittee	1. Endorse the goals of the Round Table by changing individual and community awareness
	2. Oversee and manage the Sound Stewardship programs
BSnd Env Assessment and Mitigation Project	1. Identify, assess and mitigate water quality impacts presently affecting Baynes Sound.
"Sound Stewardship"	1. Encourage individuals to take personal responsibility to make changes in their community through voluntary, cooperative action and participation for the long-term integrity of the environment. (BS Action Plan, 1995)
Sound Stewardship - BSnd Cmty WQ Sampling Program	support water quality testing services.
Volunteer Monitoring Training	a) present basic skills required to identify potential pollution sources
Ships Point	a) work with Ships Point community to improve care and maintenance of septic systems.
Baynes Sound Action Plan	Develop a comprehensive stewardship program for Baynes Sound
"Hotspots" 1996 - 98	1. Reduce fecal coliform counts in Baynes Sound
	2. Strengthen the ability of volunteer and non profit community groups to take action on remediation of pollution sources
	3. Increase the number of people practicing environmentally friendly behaviour to prevent increased pollution to Baynes Sound
Baynes Sound Hot Spots - Storm drain monitoring	Reduce the fecal coliform component of untreated stormwater run-off flows into BSnd
Baynes Sound Hot Spots - Septic System Component	a) protect wildlife habitat, human and environmental health and shellfish beds by mitigating the affects of farm activities on watersheds in and around the Comox Valley that drain into BSnd
Baynes Sound Hot Spots - Agricultural Component	Improve water quality from farm animal impacts and protect streamsides
Comox Harbour Marine Monitoring Program	1. Identify shellfish contamination sources in northern Baynes Sound
	2. Upgrade classification of closed or restricted shellfish harvesting areas
	3. Prevent further shellfish harvesting closures in Comox Harbour
Baynes Sound Forum	Celebrate a year of pollution prevention in Baynes Sound - Celebration, Solutions and Action
BSRT Educational Committee revised and renamed the Baynes Sound Stewardship Action Group	
Ship's Point Dye Testing Project	Initiate remedial actions among landowners who previously had no means of confirming contributors to local water quality problem
BSSI Teachers Package	Promote Sound Stewardship among the students of School District 71
"Sound Wastewater Solutions III"	1. Research the most effective methods of delivering health education on septic systems and their maintenance, and encourage community stewardship of water resources
1 & 2. Baseline Survey Design and Delivery	2. Develop a model for community participation in identification and remediation of septic systems, which can be used in other communities
3. Study Communities Project Design and Action Plan	3. Provide relevant, quality data that will encourage the BC Ministry of Health to evaluate and approve alternative wastewater treatment systems
4. Implement Cmty Actions and Midpoint Evaluation	4. Develop educational campaign to inform and motivate Comox Valley citizen participation in LWM planning
Union Bay LWMP	1. Use an inclusive community-based planning process that will produce a solution to the current wastewater pollution in Union Bay
	2. Develop a knowledge base, build capacity and skills in the community which can bring about actions for change and new knowledge which can be used in other communities
	3. Encourage community stewardship of water resources
Tribune Bay Wetland Proj P1	1. Demonstrate and research innovative wastewater treatment systems
	2. Build, evaluate and construct a constructed wetland to treat the septic effluent from a 4 bdrm single family residence.

Project	Goals
"Down the Drain" 1998 - 1999	1. Expand education and remediation efforts to include a broader cross section of the population in having a long term effect on protecting local water quality.
	2. Implement projects on a watershed scale, engender sustainable community stewardship efforts, and accelerate the recovery of the health of Baynes Sound.
Down the Drain Agri. Project	a) provide landowners with information on best farm management practices
	b) undertake restoration projects with farmers wishing to protect habitat or improve water quality
"Sound Wastewater Solutions III" - 5, 6, & 7. Communication, Union Bay, Tribune Bay Project	1. Study factors influencing the delivery of health education related to septic systems and their maintenance
	2. Encourage community stewardship of water resources
	3. Develop a knowledge base, build capacity and skills in the community which can bring about actions for social change and new knowledge which can be used in other communities.
	4. Provide relevant, quality data that will encourage the Ministry of Health to evaluate and approve alternative wastewater treatment systems.
Down the Drain Biofiltration Wetland Pilot Project - Ships Point	1. Develop long term, comprehensive watershed stewardship plans to accelerate the recovery of water quality and protect Baynes Sound from further pollution.
	2. Prepare individual communities to move towards local planning and action to address water quality issues on a comprehensive scale.
Down the Drain Septic Education	1. Increase public awareness about the importance of septic system maintenance
	2. Provide assistance to homeowners for septic system inspections, pumpouts or repairs to reduce contamination of groundwater and run-off
Down the Drain Survey and Education of Businesses	Promote citizen stewardship of the waters of Baynes Sound
Baynes Sound Restoration Actions Mapping Project	a) compile Baynes Sound remediation data
	b) produce a map showing Baynes Sound remediation actions from 1995 - 1999
Septic Solutions	1. Strengthen community partnerships and increase capacity in the community to solve their own problems
	2. Further establish the link between environmental and human health
	3. Expand the septic education program to area in the Comox Valley still impacted by failing septic systems
	4. Increase awareness in school children of water pollution issues surrounding the use of septic systems
	5. Address the lack of information available to realtors with regards to issues involving on-site sewage treatment
Pumpout and Boater Education 1999 - 2000	a) develop and implement boater pumpout facilities in Deep Bay and Comox Harbour
	b) develop a stewardship ethic for the protection of the aquatic environment through a boater education program
Comox Harbour Marine Monitoring 1999 - 2000	1. Help determine the cumulative effectiveness of Baynes Sound remediation work
	2. Identify additional remediation action
Stormdrain Remonitoring Project 1999 - 2000	Evaluate the progress resulting from municipal efforts to improve water quality
Hazardous Waste Dropoff Day	a) organize a one day drop off event for hazardous waste
State of the Sound GIS Project - Phase 1	Establish a comprehensive and standardized process to monitor and report on the ongoing health of Baynes Sound

Table 9 Project Objectives and Results (page following)

Project	Objectives	Results
"Sound Stewardship"		a) produced 7 Cable 10 shows on Sound Stewardship Initiatives
		b) attended 7 public events; recruited volunteers
		c) raised funds for Baynes Sound Stewardship Initiative projects
Sound Stewardship - Baynes Sound Forum	a) share information on recent shellfish closures	a) Ideas for Sound Stewardship forum attended by 120 people.
	b) describe the work done to date, including formation of the Baynes Sound Round Table	b) 39 volunteers join Sound Stewardship Initiative.
	c) launch the Baynes Sound Stewardship Initiative	c) logo contest, announcement of funding, Stewardship Coord hired.
	d) recruit volunteers and supporters	
Sound Stewardship - Baynes Sound Community Water Quality Sampling Program	a) determine primary sources of bacteriological pollution.	a) primary sources of bacteriological pollution determined to be storm sewers, failing on-site sptic systems and agricultural practises.
	b) develop sampling design for community sampling component	b) 65 volunteers trained to monitor water quality in North BSnd; volunteers donate 346 hours to marine shoreline, storm sewer and freshwater monitoring.
		c) 30 monitoring volunteers trained at Union Bay by Envt Canada
		d) volunteer monitoring of Mansfield Drive stormdrains result in 3 sewer cross connections repaired by City of Courtenay
		e) "Volunteer's Handbook for Water Quality Sampling" produced; Baynes Sound Stewardship pamphlet printed.
Volunteer Monitoring Training	a) present basic skills required to identify potential pollution sources	a) more than 30 volunteer water quality monitors trained at Union Bay by EC staff
Ships Point	a) work with Ships Point community to improve care and maintenance of septic systems.	a) 180 households rreceived information on proper septic system care and maintenance. 50 residents signed up for septic inspections by trained neighbours.
		b) 9 residents trained in proper septic care and maintenance.
		c) Workshop for Sound Solutions Ph 2 at Ships Point attended by 65 people.
Agricultural Project		a) focused on fencing and revegetation work at the mouth of Portugese Creek, where 12 cattle access sites were reduced to 2.
Baynes Sound Action Plan	a) describe a functioning action-oriented framework that is addressing marine water quality issues in the Comox Valley	"The Sound Stewardship Initiative - An Action Plan for Baynes Sound" produced by S. Morin and D. Chamberlain
	b) faciilitate a common understanding among participants of the Baynes Sound Stewardship Initiative about what results their stewardship actions will produce	
	c) provide an insightful document for other BC communityies that have an interst in developing a similar marine water quality stewardship framework	
"Hotspots" 1996 - 98	a) train the public and provide skills and knowledge that prevent pollution	"Community Based Remediation Projects - The Comox Valley Experience" published as a summary of the experiences of Baynes Sound citizens in addressing nonpoint source pollution in the Comox Valley.
	b) report and publicize results to demonstrate measurable gains and provide motivation	
	c) contact landowners	

Project	Objectives	Results
Baynes Sound Hot Spots - Storm drain monitoring	a) train volunteers to monitor storm drain discharges monthly over 6 months	a) 40 volunteers sampled 60 sites and collected 381 fecal coliform samples in 1996
	b) recommend corrective measures to repair storm/sewer cross connections to local governing bodies based on quanitified data	b) City of Courtenay repaired 63 sewage/ stormdrain cross connection, Town of Comox corrected 7. Cities purchased smoke testing equipment.
Baynes Sound Hot Spots - Septic System Component	a) protect wildlife habitat, human and environmental health and shellfish beds by mitigating the affects of farm activities on watersheds in and around the Comox Valley that drain into Baynes Sound	a) 1000 information kits distributed by 33 volunteers
		b) 6 septic Socials" were held in Mission Hill, Point Holmes, Royston, Kilmarnock, Union Bay, and Hornby Island
		c) 113 participants received training in septic system awareness and management
		d) 65 site inspections were performed in the Baynes Sound region; passing = 17%, evidence of limitations = 42%, pre-failing = 23%, absolute failure = 18%
		e) project databases recorded 222 participant survey responses and other info
		f) 2000 doorhangers were distributed to residences between Point Holmes and Rosewall Creek
		g) Septic model developed for use as an educational tool at public presentations
		h) 17 articles in 2 local newspapers
Baynes Sound Hot Spots - Agricultural Component	a) protect wildlife habitat, human and environmental health and shellfish beds by mitigating the affects of farm activities on watersheds in and around the Comox Valley that drain into Baynes Sound	a) 7 staff and vlrs canvased 132 rural properties in 10 watersheds
	b) improve water quality from farm animal impacts	b) 116 rural properties were ground truthed in conjuction with WIP
	c) protect streamsides	c) 6500 feet of fencing installed on 6 farms to restrict livestock access to surface watercourses
	d) provide remediation support to residents willing to make changes to their properties to reduce potential water pollution	d) 2312 native plants planted on streamsides on 11 farms, >1000 conifer seedlings planted
	e) collect information on farm practices that could pollute waterways	e) 6 horse stables received manure covers, 3 horse stables accessed manure collection service
		f) 2 farms changed stream cattle crossings, one existing crossing received gravel
		g) 23 community presentations and displays
		h) 10 media releases published in 3 local newspapers and 1 newsletter
		I) 146 volunteers contributed 1213 hours fencing, planting, canvasing, administration, Advisory
Comox Harbour Marine Monitoring Program	a) provide a continuous source of wq sample results to develop a scientific baseline of Cmx Hrbr water quality	please refer to 2000 Comox Harbour Marine Monitoring Program below for complete results
	b) analyse water samples from marine and freshwater inputs to aid in the identification of sources of contamination	6 marine stations in Comox Harbour monitored every 2 weeks from May 95 to Nov 96.
	c) increase public awareness of water quality issues in the Comox Valley	

Project	Objectives	Results
Baynes Sound Forum - Celebration, Solutions and Action	a) thank volunteers	a) approximately 80 participants attend
	b) offer educational workshops	b) launch "Hotspots" program
	c) generate community interest in involvement	c) 23 new volunteers
Ship's Point Dye Testing Project	a) trained volunteers confidentially test and identify potentially malfunctioning septic systems	a) 6 septic systems were tested and 2 were found to be failing
	b) provide options for solutions to landowners whose systems are found to be failing	b) detailed reports delivered to landowners whose systems were tested including site map with recommendations for maint & repair
	c) investigate known upland contamination sites	c) highway ditching and drainage systems will be redesigned to help control groundwater flows
BSSI Teachers Package		BSSI School District 71 Teachers' Package distributed to all interested schools
		b) Education Coordinator visited classrooms presenting the package
		b) students from Lake Trail Junior presented "The Murky Water Caper" to elementary students in SD 71
		c) Teacher Resource Kits provided for teacher sign out for classroom use
Sound Wastewater Solutions III	a) determine whether the community involvement process is effective, utilizing an initial baseline assessment survey	a) 182 surveys returned from 656 distributed in Mud Bay, Ships Point, Fanny Bay, Union Bay, Royston
1. Baseline Survey Design and Delivery	b) develop a knowledge base, build capacity and skills in the cmty which can bring about actions for social change, using a cmty-driven participatory action research process using feedback loops within the cmty	b) survey development and distribution process led by focus groups of stakeholders.
	c) provide relevant, quality data that will encourage the BC Ministry of Health to evaluate and approve alternative wastewater treatment systems	c) project partnership developed between CVCARE and GHOSTS
	d) develop educational campaign to inform and motivate Comox Valley citizen participation in LWM planning	d) 5 presentations, 10 community meetings, 1 public event.
Sound Wastewater Solutions III		e) local referendum postponed 4 months to allow cmty process to devp
2. Baseline Data Analysis & Community Study	a) analyse and feedback baseline survey data	a) survey data analysed by the IHPR, results used to direct project, and returned to community in a condensed newletter format to respondants and at LWMP meetings
(Step II **-** Utilizing Experienced Communities)	b) evaluate lessons of experienced communities	b) 2 meetings in experienced communities with 3 members from Kye Bay and 6 members from Ships Point gathered information about what had and had not worked in these communities
(Step III - Mobilizing in Study Cmtys)	c) introduce project to study communities	c) 11 public events, 7 presentations, 11 LWMP meetings, 35 office visits and calls
	d) encourage participation and long term commitment	d) 19 new volunteers, formation of community planning group to work with project staff
	e) raise community awareness	e) 16 newspaper articles, use of septic model & display increased prfl
	f) learn about study communities and their issues	f) provided public input process to LWMP, 168 people attented 4 LWMP public meetings, 49 participants in 'pollution solution' contest at 3 of these meetings, LWMP referendum defeated by public distrust of govt
		g) community gaining a voice through public meetings, experience of community individuals given relevance and audience

Project	Objectives	Results
Sound Wastewater Solutions III	a) ascertain which actions will best address the community issues	a) 15 person focus group examined water quality issues and directed CARE to initiate a community owned action project
3. Study Communities Project Design and Action Plan	b) determine logistics required for implementation of actions	b) community planning group of 14 members met 7 times to plan focus group meeting, review ideas and develop action plans for communications, Union Bay Project, Hornby Island Project, and Mapping.
(Step IV - Study Cmtys Project Design)	c) implement actions	c) conference planning subcommittee of 4 members met 7 times to organize Sound Solutions II Conference
(Step V - Study Cmtys Action Plan & Implementation)		d) 4 issues of Sewage News developed and distributed
		e) volunteer outreach interviewed 9 volunteers about their motivation and recruited 15 volunteers for project activities
		f) Water Works Day celebrated volunteers and Earth Day with 60 volunteers and 3 organizations, provided learning workshops and networking opportunities, and updated CVCARE's volunteer database.
		g) Hornby Island Wetland Project funded and underway
		h) Union Bay LWM planning process initiated
Union Bay LWMP	Develop a liquid waste plan for Union Bay	a) 13 committee meetings held; 56 participants attended a public meeting March 23/98
		b) models community led "process for change"
		c) documentation of Union Bay planning process
Sound Wastewater Solutions III	a) implement action plans	a) implemented 7 actions, including Sound Solutions Conference (May 1998 - 25 presenters to 60 participants), Union Bay Pilot Project, Tribune Bay Wetland Project, 2 issues of "Sewage News", 4 Septic Socials, 4 public events with display and septic model, survey and GIS mapping of Union Bay septic system conditions
4. Implement Cmty Actions & Midpoint Evaluation	b) re-survey study communities to determine changes in the baseline variables	b) survey deferred to project conclusion in 2000 and to include a larger "State of Baynes Sound" assessment
	c) evaluate project to determine the impact and effectiveness of the approach, and whether the approach should be modified	c) project evaluation of 12 actions showed that 1. knowledge, attitude and behaviour have been affected by these actions; 2. motivated participation in planning process; 3. promoted community stewardship; 4. facilitated exploration of alternatives to conventional septic systems.
Union Bay LWMP		a) a standing committee of UBID formed to develop LWM options through a bottom-up, consensus-based process
		b) Union Bay process recorded, reviewed, and analysed
		c) Sound Solutions Conference presented LWM information to 60 participants, gathered ideas, helped develop community capacity, and created a vision for integrating Union Bay wastewater management and community values with community economic development opportunities
		d) preparation of a Stage 1 Report for MELP submitted to RDCS and MELP
		e) Round Table approach enabled decision-making equality at at least 24 weekly Standing Committee and other meetings
		f) a closed and exclusive approach became more open to include RDCS representatives and officials; politicians changed from being adversarial to cooperative.
		g) LWMP meetings translated information into action

Project	Objectives	Results
Tribune Bay Constructed Wetland Project - Phase 1	a) construct, research, evaluate and demonstrate a constructed wetland at the Hornby Is. Outdoor Educ Centre	a) construction of an 800 sq ft filtering wetland planted with 4 different wetland species
	b) provide the Ministry of Health with well-researched local data to enable them to evaluate and approve alternative systems	b) >50 volunteers contribute hundreds of hours
	c) provide an educ opportunity for 1-2000 students every yr	c) installation of interpretive signage for self-directed tours
		d) 48 water quality samples tested for fecals, BOD, TSS, NH4, NO3, PO4, DO, pH, conductivity
"Down the Drain" 1998 - 1999		
Down the Drain Agricultural Project	a) provide landowners with information on best farm management practices	a) reached approximately 20% of commercial and hobby farms in the Comox Valley region within a 7 month period; provided 98 farms with educational materials; distributed 1000 program brochures at 34 businesses; printed 23 articles in local media, 2 radio shows; 6 public displays; 15 presentations
	b) undertake restoration projects with farmers wishing to protect habitat or improve water quality	b) installed 5800 meters of streamside fencing on 17 farms; planted 6000 trees and shrubs on 23 farms covering 2300 meters of riparian area; constructed 3 farm bridges, I coho rearing pond, 1 large scale manure containment; 15 free manure covers distributed
Sound Wastewater Solutions III		c) 88 community volunteers contributed 852 hours
5. Communication, Union Bay Pilot Project, Tribune Bay Project	a) Enhance public awareness of septic system issues (functioning, maintenance and remediation) within the Courtenay/Comox region over a four year period by 50% as measured in a repeated survey	
	b) Increase public knowledge of septic system issues (functioning, maintenance and remediation) within the Courtenay/Comox region over a four year period by 50% as measured in a repeated survey	
	c) Enable community members to change their behaviours regarding septic system issues (functioning, maintenance and remediation) as measured by specific actions to address problem areas (eg. systme pumpouts, system repairs, change in the way systems are used, requests for monitoring, etc)	
5.1 Communication / Education / Dissemination	a) Sewage News will be a primary source of providing specific information to the broad community	a) distributed 1500 copies of Sewage News Issue #5
	b) Septic Socials will provide hands-on knowledge through onsite training programs, at the houses of volunteers	b) 46 people attended 3 Septic Socials in Union Bay, Fanny Bay, and Deep Bay; 65 kits distributed.
	c) Two community surveys will occur, the first within 6 months.	c) 188 people responded to a survey evaluating the first 5 issues of Sewage News at 1 large public event and 3 Septic Socials
5.2 Union Bay	a) Describe and analyse the community mobilization process and decision-making as it pertains to environmental health planning.	a) 2nd Union Bay Process Report published in conjunction with the IHPR
		b) Stage 1 report approved by MELP
		c) LWMP committee maintained round table approach and community based process
		d) increased government interest in innovative technologies and community processes
		e) increased community capacity through continued project ownership of LWMP process
		f) project vision and timeline clarified by LWMP committee
		g) 100+ people attend Union Bay community meeting
5.3 Tribune Bay Constructed Wetland Project	a) measure water quality through monitoring a wide range of constituents to assess the treatment of wastewater in an alternative sewage treatment system	a) BC Ministry of Health will permit testing of 3 more constructed wetlands to provide sufficient data for systems approval

Project	Objectives	Results
Sound Wastewater Solutions III		
6. Communication, Union Bay Pilot Project, Tribune Bay Project	a) Enhance public awareness of septic system issues (functioning, maintenance and remediation) within the Courtenay/Comox region over a four year period by 50% as measured in a repeated survey	a) distributed 200 information kits; 6 Septic Socials; 32 septic system inspections; 3 school presentations; 4 conference presentations; produced a legacy issue of Sewage News; produced 2 new display boards
Communication	b) Increase public knowledge of septic system issues (functioning, maintenance and remediation) within the Courtenay/Comox region over a four year period by 50% as measured in a repeated survey	b) interviewed 15 Union Bay stakeholders; surveyed 440 people at 8 public events to evaluate the effectiveness of Sewage News as a communication tool.
	c) Enable community members to change their behaviours regarding septic system issues (functioning, maintenance and remediation) as measured by specific actions to address problem areas (eg. systme pumpouts, system repairs, change in the way systems are used, requests for monitoring, etc)	c) participate in Baynes Sound Business Survey; identify research sites for greywater treatment systems
Union Bay Pilot Project		d) Union Bay is creating an innovative and unique approach to LWMP that provides a template for other communities and jurisdictions
		e) Union Bay approach has resulted in higher levels of community involvement in decision-making and has forged new relationships between the community and formal decision makers
Tribune Bay Constructed Wetland Project		f) evaluation of first year of sampling concluded that the system needs more time to stabilize before definitive data is available
		g) project development underway to construct, research and evaluate 3 greywater systems
"Down the Drain" Biofiltration Wetland Pilot Project - Ships Point	a) research, construct and monitor the effectiveness of a Biofiltration Wetland to clean runoff using biological processes in the community of Ships Point.	a) constructed 4 retention ponds, planted 170 native plants, monitored water quality
	b) complete education and promotion component, including media, 3 community events, 2 school workshops, site signage	b) educ campaign included 4 community events,2 in collaboration w Septic Socials reached >100 ppl directly, neighbourhood canvassing to 30 individuals in 8 households, 2 school tours, 3 articles in 2 local news.
		c) 13 community volunteers donated 210 hours
		d) Community Health Services Soc donated free wq testing for the future
Down the Drain Septic Education		a) distributed 200 information kits; 5 "Septic Socials" with 80 participants; 9 articles in local media; 5 displays, 3 presentations at elementary schools.
		b) 32 systems inspected; 25 systems pumped out; 9 systems repaired.
		c) 18 professionals donated 146 hrs; 38 other volunteers donated 300 hrs.
Down the Drain Survey and Education of Businesses	a) bring awareness of water quality issues to the business community and public	a) conducted 115 surveys; 89 follow up telephone interviews; distributed 162 brochures, 122 info kits, 56 customized best mgt practices pkgs; published 6 newspaper articles, 3 Business Environmental Leadership profiles
	b) provide opportunities for local businesses to make a positive contribution to the improvement of water quality	b) 10 businesses participated in advertising special; 1 business awarded Chamber of Commerce Environmental Award; 30 stormdrains marked at businesses; 9 project displays, >6 project presentations
	c) collect information on the kinds of wstes being generated	c) 9 volunteer surveyors donated 135 hrs, other vltrs donated 130 hrs
	d) explore the need for additional commercial hazardous waste collection or treatment processes to reduce wastewater contaminants from entering Baynes Sound	d) Focus group of 18 resource people and business owners clarified key issues arising out of business survey data and generated solution and project ideas.

Project	Objectives	Results
Baynes Sound Restoration Actions Mapping Project	a) compile Baynes Sound remediation data	a) BSnd remediation action information from 1995-99 compiled in a dbase
	b) produce a map showing Baynes Sound remediation actions from 1995 - 1999	b) ArcView 1:50k map showing 56 remediation actions produced
Sound Wastewater Solutions III	a) Enhance public awareness of septic system issues (functioning, maintenance and remediation) within the Courtenay/Comox region over a four year period by 50% as measured in a repeated survey	a) 11 community presentations; 2 conference presentations; 2 Septic Seminars with guest speakers in Union Bay
7. Communication, Union Bay Pilot Project, Tribune Bay Project	b) Increase public knowledge of septic system issues (functioning, maintenance and remediation) within the Courtenay/Comox region over a four year period by 50% as measured in a repeated survey	b) SWS results spread to communities of Arden, Sandwick and Kye Bay; SWS staff contracted by RDCS to consult with these groups about failing septic system issues
Communication	c) Enable community members to change their behaviours regarding septic system issues (functioning, maintenance and remediation) as measured by specific actions to address problem areas (eg. systme pumpouts, system repairs, change in the way systems are used, requests for monitoring, etc)	
Union Bay Pilot Project		a) "Ownership" workshop helps Union Bay committee to define level and form of cmty involvement & responsibility in the mgt of the project
Tribune Bay Constructed Wetland Project		b) 200 Union Bay participants chose options for community sewage treatment systems at a 'casino' night
		c) Union Bay incorporated water conservation planning into their LWMP
Septic Solutions	a) design a "Neighbourhood Cleanup" program	a) 6 Septic Socials held; 28 septic systems inspected; 2 public events attended; information kits distributed
	b) make 5 presentations to grade 4/5 classes in rural schools	b) 4 rural elementary schools host presentations
	c) develop an education module in conjunction with the Tribune Bay Outdoor Education Centre	c) developed an education model of wastewater in conjunction with the Tribune Bay Outdoor Education Centre
	d) develop and deliver realtor presentations	
	e) deliver ongoing promotional campaign, distribute 500 information kits, attend 2 public events	
Pumpout and Boater Education 1999 - 2000	a) develop and implement boater pumpout facilities in Deep Bay and Comox Harbour	a) boater pumpouts installed at Deep Bay and Comox Harbour, and a washroom/shower facility constructed at Deep Bay Harbour
	b) develop a stewardship ethic for the protection of the aquatic environment through a boater education program	b) 80 respondants to a regional boater survey on clean boating awareness and practice
		c) 28 water quality test results from Comox Harbour, 40 from Deep Bay
		d) community involvement: 528 volunteer hours from 27 individuals, 7 regional recreational groups, 14 marine and other businesses
		e) promotion: presentations to 6 recreational boating groups; 2027 surveys and pamphlets distributed; 10 articles in 4 local newspapers; 7 articles in 5 boater newsletters; 1 article in Pacific Yachting magazine
Comox Harbour Marine Monitoring 1999 - 2000	a) provide comparative data from 2 consecutive winter seasons	a) in total in a 48 month period from 1995 to 2000, 445 samples were tested for fecal coliform levels from 6 marine stations sampled biweekly.
	b) add corroborative marine water quality test results from Comox Harbour to concurrent monitoring data from stormdrains in Courtenay, Comox, and Royston	b) a general decrease in fecal counts is evident for most sites except NBS025

Project	Objectives	Results
Stormdrain Remonitoring Project 1999 - 2000	a) gather wq samples for comparison and evaluation of water quality trends in municipal stormdrains since 1996	a) 24 volunteers monitored 44 stormdrains and collected 256 samples in total from Sept 99 to March 00.
		b) study results show general improvement in urban stormwater quality in Courtenay and Comox and an increase in fecal coliform levels at sites sampled in Royston
Hazardous Waste Drop off Day	a) organize a one day drop off event for hazardous waste	a) hundreds of people bring way too much hazardous waste for 40 trained volunteers to handle
		b) promoted public use of the local paint drop-off centre
		c) RDCS committed resources for more hazardous waste drop-off events
State of the Sound GIS Project - Phase 1	a) summarize remediation work done to date	a) remedial projects have been included in the Baynes Sound GIS project
	b) develop a GIS for Baynes Sound remediation results and water quality data	b) a GIS was constructed for Baynes Sound Baynes Sound remediation project results, marine and fresh water quality data, and regional habitat and land-use values
	c) create maps that show the location of water quality issues and remediation work	c) water quality sampling sites are mapped and linked with water quality databases. Remedial actions have been represented in composite format from 1995 - 2000
	d) complete an interim report on progress of project and remediation status	d) completion of report describing State of the Sound activities and results. The Baynes Sound Methodology Manual describes technical process followed in the development of the Baynes Sound GIS

Appendix 4

State of the Sound Program Quality Assurance Program Plan

DRAFT

State of the Sound Program
Quality Assurance Program Plan

November 30, 2001

Project Partners

Comox Valley Project Watershed Society
Environment Canada
BC Ministry of Agriculture, Food and Fisheries
Fisheries and Oceans Canada
BC Ministry of Water, Land, and Air Protection
Upper Island Central Coast Community Health Services Society
BC Shellfish Grower's Association
North Island Laboratories
Village of Cumberland
City of Courtenay
Regional District of Comox-Strathcona
Comox Valley Economic Development Society

Approved by:

DRAFT
Barbara Joughin
Comox Valley Project Watershed Society

Date: _____

DRAFT
Bert Kooi
Shellfish Water Quality Program
Environment Canada

Date: _____

DRAFT
Bill Heath
Sustainable Economic Development Branch
BC Ministry of Agriculture, Food, and Fisheries

Date: _____

DRAFT
Jim McCaul
Regional Manager, Health Protection
UICC Community Health Services Society

Date: _____

Distribution List

The following individuals and organizations will receive a copy of the final State of the Sound Quality Assurance Program Plan and all subsequent revisions.

Project Watershed
Baynes Sound Round Table
North Island Laboratory
Environment Canada
Fisheries and Oceans Canada
BC Ministry of Agriculture, Food and Fisheries

Introduction

The State of the Sound Quality Assurance Program Plan (QAPP) outlines procedures to be followed to ensure that all project data gathered (in the Baynes Sound Data Program) and recorded, maintained and analyzed (in the Baynes Sound GIS) meet the program's requirements for data quality and credibility.

The Quality Assurance Program defines quality guidelines for all data included in the State of the Sound Program. Guidelines are currently developed for one indicator, water quality, and for data collection and recording protocols only. Guidelines for other indicator data will be developed as indicators are added to the program. Guidelines for data management and reporting will be developed as the SOS program evolves.

At the completion of Phase 2, the Baynes Sound QAPP is presented in draft form and does not include approving signatures.

State of the Sound Program
Quality Assurance Program Plan

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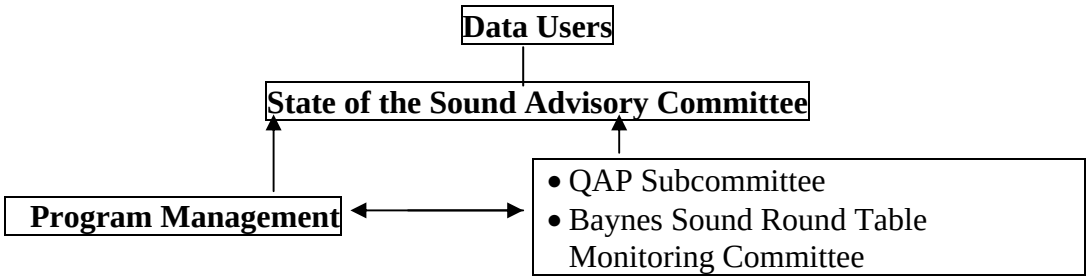
A Project Management

1. Program Organization



Personnel and organizations involved in the Quality Assurance Program include:

Program Manager:

Barbara Joughin, Comox Valley Project Watershed Society

Roles and Responsibilities:

- Develop a standard operating procedure to screen new data inputs with respect to quality assurance prior to inclusion into the SOS database.
- Co-ordinate and collaborate with the QA Subcommittee in the development and evaluation of this procedure and its application.
- Develop a process that ensures education and training of existing and future data providers in the implementation of this standardised data collection procedure and appropriate QA/QC processes to assure inclusion of information into the SOS program.

Quality Assurance Program Subcommittee:

Sandra Felgenhauer, North Island Laboratories
Bill Heath, BC MAFF
Bert Kooi, Environment Canada
Paul Rideout, BC Ministry of WLAP

Roles and Responsibilities:

- Provide technical support and assistance to the Program Manager throughout the development, implementation, education, training and review stages of the QAP.

Baynes Sound Round Table Monitoring committee:

Bill Heath, BC Ministry of Fisheries
Dave Cherry, Environmental Health Officer
Paul Rideout, BC Ministry of Land, Water and Air Protection

Roles and Responsibilities:

- Facilitate the implementation of QA/QC program through the education and training of existing and future data collection groups.

Advisory Committee:

Peter Crawford	City of Courtenay
Sandra Felgenhauer	North Island Laboratories
Mac Fraser	Village of Cumberland
Edda Grant	Comox Valley Economic Development Society
Bill Heath	BC Ministry of Agriculture, Food and Fisheries
March Klaver	Fisheries and Oceans Canada
Bert Kooi	Environment Canada
Roxanna Mandryk	Regional District of Comox-Strathcona, Area K
Jim McCaul	Community Health Society
Paul Rideout	BC Ministry of Water, Land, and Air Protection
Bunny Shannon	BC Shellfish Growers Association
Cathy Slater	BC Shellfish Growers Association
ChristyWilson	Fisheries & Oceans Canada

Roles and Responsibilities:

- The State of the Sound Advisory Committee is the project team that provides feedback and guidance to the process. Please refer to Appendix 4 – State of the Sound Advisory Committee Terms of Reference for a description of roles and responsibilities.

Data users:

City of Courtenay
Town of Comox
Village of Cumberland
Comox Valley Economic Development Society
Regional District of Comox-Strathcona
BC Ministry of Agriculture, Food and Fisheries
BC Ministry of Water, Land, and Air Protection
Fisheries and Oceans Canada
Environment Canada
Community Health Society
Shellfish growers
Community members
Stewardship volunteers

Please refer to Section 3 – Quality Assurance Program Plan Purpose for more detailed information about data users.

2. Background and Problem Identification

Background:
Baynes Sound is located between Vancouver Island and Denman Island in the Strait of Georgia in southwestern British Columbia, and is a highly productive marine ecosystem. The region is experiencing accelerated population growth, which has compromised significant areas of environmentally sensitive fish, bird, and wildlife habitats. In addition, the water quality of Baynes Sound is deteriorating as a result of non-point source pollution and the degradation of source waterways.

In 1995, Environment Canada's water quality test results indicated increased levels of fecal coliform bacterial pollution in Baynes Sound, and widespread closures of shellfish growing areas in Baynes Sound were proposed. Since December 1996, Baynes Sound has been under a Conditional Management Plan, with shellfish growing area classification dependent upon ongoing water quality survey results.

Comox Valley Project Watershed Society's mission is to promote community stewardship of Comox Valley watersheds through education, information and action. Working since 1995 in collaboration with various Baynes Sound stakeholders, Project Watershed has delivered numerous water quality remediation and monitoring projects to identify and clean up non-point source pollution in Baynes Sound. These projects have focused on four main sources of non point source pollution: failing septic systems, agricultural run-off, stormwater drains, and boater waste. Other projects have focused on suburban wastewater runoff and chemical waste from businesses. Projects generally include monitoring activities that gather water quality data, and offer members of the community opportunities to be involved as participants and volunteers in conservation and stewardship activities.

Problem Statements:
- Standardized data collection and recording methods and protocols may not be consistently followed throughout various Baynes Sound monitoring programs
- Marine water quality data collected by several organizations has not been compiled or analyzed for geographical patterns and trends.
- There are currently insufficient environmental indicators for evaluating and reporting the health of Baynes Sound on a long-term basis.
- Although many citizens of the Comox Valley and Baynes Sound region have been directly involved in stewardship activities, many more remain unaware of water quality and stewardship issues.

In response to these and other, related problems , Project Watershed is developing and delivering the State of the Sound Program. The State of the Sound Program builds and uses an accessible community information system for managing and reporting Baynes Sound remediation project data and information, and monitors and reports on the ongoing state of Baynes Sound environmental health and water quality. The State of the Sound reporting process will be used to increase public awareness and help support individual communities as they move toward local waste management program planning and implementation.

3. Quality Assurance Program Purpose

The State of the Sound Quality Assurance Program Plan (QAPP) defines standardized processes and procedures to gather, record, manage and retrieve data within the Baynes Sound Geographical Information System (GIS) and the State of the Sound Program. It outlines procedures to be followed to ensure that all project data gathered in the Baynes Sound Data Program, and all data that is recorded, maintained and analyzed in the Baynes Sound GIS, meet the program's requirements for quality and credibility.

The QAPP describes the goals and objectives of the Baynes Sound Data Program, which data is collected, and how it is collected, managed, analyzed, and reported. This data is used to develop regular reports as part of the State of the Sound Program.

Project data in the Baynes Sound Data Program are used to:

- Identify trends
- Define problems
- Set priorities for action
- Evaluate effectiveness of remediation work
- Provide volunteer opportunities
- Identify information gaps
- Promote an integrated management plan for the Baynes Sound area

Data users:

The following list is not intended to be final and other users will be included as they are identified.

Government:

Who: BC Ministry of Agriculture, Food and Fisheries
BC Ministry of Water, Land, and Air Protection
Fisheries and Oceans Canada
Environment Canada
Ministry of Health
Comox First Nations

How: Water quality trends; analysis of causal relationships, resource management, identification of faulty septic fields, protection of drinking water supplies and integrated management of aquatic ecosystems

Local government:

Who: City of Courtenay
Town of Comox
Village of Cumberland
Comox Valley Economic Development Society
Regional District of Comox-Strathcona

How: Water quality trends; planning (OCP, streamside protection measures, protection of drinking water supplies)

Shellfish Industry:

Who: BC Shellfish Growers Association
Individual growers

How: Trends, causal relationships, communication with upland users, protection of shellfish harvest areas, removal of Conditional Management Plan.

Community:

Who: Groups:

- Community Health Society
- Comox Valley CARE
- Union Bay Liquid Waste Management Committee

Stewardship volunteers
Monitoring volunteers
Public
Local businesses
Local schools

How: Access to data and reports for proposals, project development and implementation
Liquid Waste Management Planning
Implementation of Best Management Practices, promotion of 3 Rs, protection of ground and surface waters, increased understanding, awareness and participation.

4. Project Data Description

In the State of the Sound Program, different data are gathered, compiled, interpreted, and reported on an ongoing basis in order to measure the state of the environmental health of Baynes Sound. These data sets help provide information about the indicators that are chosen to represent the health of the Baynes Sound region and its inhabitants. Initially, measures will indicate environmental health, and may be expanded in time to include economic and social indicators.

Data that support indicators of health are received from individual data providers as regular updates according to individual data agreements and arrangements, and are incorporated to the Baynes Sound GIS for review, interpretation, and reporting.

Biophysical data are gathered for use with different indicators by agency field crews and by community volunteers, following the protocols and methodologies that are described in this document.

Indicators:
The indicators in current use, and those that are suggested for possible future development include:

i. Water Quality	(current)
ii. Eelgrass	(possible)
iii. Shoreline Biodiversity	(possible)
iv. Bird Populations	(possible)
v. Protected Areas	(possible)
vi. Others	may be determined in Phase 3 with community consultation

The list is neither conclusive nor finalized at the time of this edition (November 2001).

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i. Water Quality:
Fecal coliform bacteria levels from marine and freshwater environments are the primary water quality condition currently monitored in the State of the Sound Program. Other parameters of water quality will eventually be incorporated into the program, and will be identified as they are included.

Marine:
The local shellfish industry uses the Canadian Shellfish Sanitation Program standards for sampling bacterial contamination (including fecal coliform bacteria levels). Fecal coliform data from Environment Canada, Community Health, and volunteer monitoring programs are compiled into a composite marine database for interpretation of temporal and spatial trends.

Secondary data that accompany marine fecal coliform counts include rainfall, salinity, and tidal conditions. The secondary data must be included in all interpretations of fecal coliform data. Fecal coliform testing can provide variable results (ie. two samples taken within minutes at the same site can provide different test results). Secondary data help isolate possible causes for variations.

Freshwater:
The provincial guidelines developed by the BC Ministry of Environment, Lands and Parks (now Ministry of Water, Land and Air Protection) for variables that are important in the surface waters of British Columbia are used as ambient water quality objectives in the Baynes Sound Data Program. The process for establishing water quality objectives is more fully outlined in “Principles for Preparing Water Quality Objectives in British Columbia”. Copies are available from the Water Quality Section of Water Management Branch, BC Ministry of Water, Land and Air Protection.

Water quality monitoring:
Individual water quality monitoring projects are designed to gather specific information. Each project describes the sampling program that is required to meet its monitoring objectives, and defines sample parameters, the optimal timeline, a sampling schedule, and evaluation criteria.

Water quality monitoring projects in the State of the Sound Program are generally either trend or impact assessment style monitoring programs, or a combination of these two, and are designed to satisfy the following criteria, within the limits of available resources. Compliance monitoring programs are not used in the State of the Sound Program at this time.

1. Trend monitoring
    - Used to detect changes over time that may result from a potential long-term problem, measurements are made at regular time intervals to determine if long-term trends are occurring for an identified variable.
    - Minimize variability through time by remaining consistent in terms of frequency, location, time of day samples are collected, and the collection and analytical techniques that are used
    - Extend over as long a period as possible to ensure that true trends are detected

2. Impact assessment monitoring
    - Measure the effects on water quality of a particular project or event
    - Include test and control sites, initiate prior to project start-up, continue while the project is operational, and extend for a defined post-project time period.
    - Determine pre-operation baseline to provide data for post-operation data comparison for better estimates of the limits of normal variation
    - When baseline information is not collected, use a reference site as the next best option
    - Methodology is better suited for freshwater than marine applications

ii.	Eelgrass	(to be developed)
iii.	Shoreline Biodiversity	(to be developed)
iv.	Bird Populations	(to be developed)
v.	Protected Areas	(to be developed)

5. Data Quality Objectives for Measurement Data

The following data quality objectives have been defined for each indicator of health, in order to ensure that State of the Sound program data and its interpretation and analysis are accurate, meaningful, and useful.

i. Water Quality:
Water quality monitoring programs obtain representative samples in order to provide a true measure of the conditions of the aquatic environment (water, sediment and/or biota).

"Representative" means that the sample resembles the population of all possible samples.

"Comparability" is achieved by using the standards described in this document for collection, analysis and reporting of all data. Training requirements for water quality sampling crews are defined in Section 6 – Training Requirements.

"Completeness" is the amount of valid data that is obtained compared to the amount of data planned. Each water quality monitoring project will design the optimal number of samples to be collected. It is expected that at least 80% of the sampling program will be completed in any given project, due to such factors as volunteer absenteeism and unsafe weather conditions.

Precision, Accuracy and Measurement Range

On-Site Analysis:

Table 1 Precision, Accuracy and Measurement Range

Parameter	**Precision**	Accuracy	Measurement Range
Temperature	TBA	+/- 1 degree C	-30*C to 50*C
Dissolved Oxygen	TBA	+/- 0.2 mg/L +/- 1 mg/L	0.2 – 4 mg/L low range test 1 – 20 mg/L high range test
Conductivity	TBA	+/-0.2 micromhos	0.0001 – 1 micromhos
PH	TBA	+/-0.1 pH	5.5 – 8.5 pH
Turbidity	TBA	+/- 5 JTU	5 – 200 Jackson Turbidity Units

Precision: Measure of the degree of agreement among replicate analyses of a sample, usually expressed as the standard deviation (if the same sample is measured for a specific parameter 100 times, the number of times one will achieve the same result).

Accuracy: is a combination of bias and precision of an analytical procedure, which reflects the closeness of a measured value with a true (actual) value. Routine and regular calibration of instruments using appropriate standards is essential for assuring stated accuracy.

Bias: consistent deviation of measured values from the true value by systematic errors in a procedure.

Laboratory Analysis:
Data quality criteria for laboratory analysis of project samples are defined by the testing laboratory's Standard Operating Procedures (SOPs). This includes data quality testing criteria for fecal coliform bacteria levels, oil and greases, and other parameters specific to individual projects.

The water quality information provided through the State of the Sound Program is not intended to duplicate or replace regulatory processes.

Fecal Coliform Sampling

Marine and freshwater fecal coliform testing employ different testing methods that yield different units – most probable number (MPN) and membrane filtration (MF). Test results must be analysed using the same methodology. Fecal coliform levels must be examined in the context of secondary parameters for proper interpretation. Samples are collected and delivered to testing laboratories as described in Section 9 – Monitoring Methods Requirements . Only samples collected by Environment Canada-trained personnel or the equivalent will be included in data analyses.

Marine Fecal Coliform Sampling:

Fecal coliform bacteria levels are currently sampled and tested as a primary water quality condition, even though an indication of the presence of fecal coliform bacteria does not always correlate with the incidence of disease. Fecal coliform testing is being replaced in some situations by more specific indicators. These include Escherichia coli and E. enterococci, which are good indicators of the potential risk for gastrointestinal disease, and Pseudomonas aeruginosa, which correlates well with ear and skin infections. Although the appended fecal coliform criteria are the only ones that currently apply, others may be included in the future if other organisms are sampled (Appendix 1 – Data Quality Objectives for Measurement Data, Water Parameter Specifications). For more information, please refer to "Water Quality Criteria for Microbiological Indicators", P. D. Warrington, March 8, 1988. (http://wlapwww.gov.bc.ca/wat/wq/BCGuidelines/microbiology.html)

Marine sites have been established by Environment Canada (EC) to cover a range of foreshore environments. Other sample sites are located according to EC sampling stations locations whenever possible. Sampling is done at the time of the high ebb tide to ensure a similar mixing of the water column.

Freshwater Fecal Coliform Sampling:

Freshwater ambient quality conditions are evaluated through the comparison of available historical data in order to identify changes at one particular site or watershed over a specific time period. The appended freshwater data collection standards are based on optimal limits for aquatic life (Appendix 1, Data Quality Objectives for Measurement Data – Water Parameter Specifications). A particular site may indicate significant variations over time that are within the standards and still may be considered cause for concern. A baseline for each site or watershed will help define individual standards as required. Fecal coliform bacteria levels are the primary water quality condition, however, other parameters may be considered primary conditions as defined by individual project objectives.

Freshwater sites include stormdrain outfalls, creeks and ditches, chosen to capture the highest concentration of pollutants in that system prior to dispersal into the marine environment. In order to identify a pollution source, samples are taken from several sites along the system.

Chemical Sampling

Aquatic systems may be contaminated by substances such as metals, pesticides and chlorinated organic chemicals. Monitoring temperature, conductivity, turbidity, pH, dissolved oxygen, nitrates, detergents, phosphates, and greases and oils help determine possible pollution causes. These tests are usually secondary conditions in freshwater ambient water quality sampling, but may become primary conditions in specific projects.

The Baynes Sound Data Program uses standards for these parameters that have been developed by the Water Quality Branch of the BC Ministry of Water Land and Air Protection. The standards may be viewed at www.elp.gov.bc.ca/wat/wq/wqhome.html#5.

General descriptions of water quality parameters that are collected and analysed through volunteer monitoring programs are described below, with details included in Appendix 1 Data Quality Objectives for Measurement Data – Water Parameter Specifications.

Water Temperature guidelines are designed to protect aquatic life in fresh, estuarine and coastal marine waters from excessive temperature fluctuations that are influenced by anthropogenic activities during sensitive periods. Ambient temperatures are factored into the guidelines so that they adhere closely to the natural temperature regime to which sensitive organisms have adapted through evolutionary processes. The guidelines for streams and rivers are based on temperature tolerance data for salmonids. Salmonids are cold-water dependent and prefer a narrow range of water temperatures during critical periods to meet their life history requirements. Temperature also changes the sensitivities of some aquatic organisms to specific contaminants.

Dissolved Oxygen levels in BC's surface waters are usually high, close to saturation levels, and often greater than 10 mg/L. The amount of oxygen in marine water is naturally about 20% less than in freshwater. Diurnal oxygen fluctuations typically result in sub-optimal conditions for at least brief periods, therefore the timing of measurements is very important. Daily cycles usually are sinusoidal with a maximum concentration reached late in the day and a minimum concentration in early morning. For normal ambient monitoring, five measurements taken evenly spaced within 30 days is a minimum frequency.

Conductivity standards have not been established. Monitoring results will be evaluated on historical site data.

pH - Marine Water
The need for water quality criteria for pH in marine waters has not been defined by other jurisdictions. Based on the narrow pH tolerance of marine molluscs, and the importance of marine molluscs in British Columbia, the pH criterion for marine waters is 7.0 to 8.7.

pH - Fresh Water
The British Columbia pH criteria to protect aquatic life takes into account the wide variability of the natural pH found in the freshwaters of British Columbia and the most sensitive aquatic organisms. pH also changes the sensitivities of some aquatic organisms to specific contaminants.

Turbidity
Guidelines are designed to protect aquatic life in fresh, estuarine and coastal marine waters from excessive suspended sediments originating from anthropogenic sources. As the biotic, physical and chemical conditions describing aquatic ecosystems are diverse, the recommended guidelines are compared to natural background levels. To determine if guidelines are exceeded, for short-term (acute) exposures, hourly samples taken over a 24-hour period are preferred to demonstrate the continuity of an event. For long-term (chronic) exposures, daily samples taken over a 30-day period are preferred. The statistical reliability of the data is increased with increased frequency of monitoring.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

6. Training Requirements/Certification

i. Water Quality:
Fecal coliform samples included in the State of the Sound Program for the purpose of interpretation and reporting are gathered by personnel who have received Environment Canada training, or its equivalent.

Annual training sessions are provided in conjunction with Environment Canada and the BC Ministry of Agriculture, Food and Fisheries. These sessions are provided at no charge for people involved in monitoring fecal coliform levels, and are arranged as needed.

Volunteers are trained to sample other water quality conditions, including temperature, conductivity, turbidity, pH, dissolved oxygen, nitrate, detergents, phosphorus and greases and oils, by an instructor who has received training through a Streamkeeper or equivalent college level environmental assessment course. Volunteers are also encouraged to attend Streamkeeper courses.

Volunteer training for all aspects of water quality sampling includes classroom lectures, demonstration of the specific tests, hands-on practice of sampling techniques, and distribution of personal copies of a field manual. To assess volunteer performance, volunteers are required to simultaneously test the same sample water and a test parameter standard with the kits they will use in the field.

Field manuals incorporate information from this document that is specifically relevant to individual projects. Field manuals include: basic information about the project, how to contact the project coordinator, safety reminders, and information about each data parameter, including protocols for sample collection, storage, and delivery.

Volunteers are supervised by the trainer during initial sample collection sessions. This practice also confirms the exact location of the sampling site. A mid-project supervision session occurs to evaluate volunteer field collection techniques. Supervised outings occur at a minimum of every 6 months. Supervision sessions include replicate samples taken by the trainer to confirm volunteer performance.

Training includes the provision of information on the appropriate circumstances for both proceeding with and waiving data collection. Volunteer safety is the primary concern. Procedures to reschedule a sampling outing are described during each training session. Each volunteer is provided with a list of other volunteers with similar training who can act as substitutes in the event that the volunteer cannot fulfill a scheduled sampling outing.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

7. Documentation and Records

i. Water Quality

Field data collection sheets are refined for each project to ensure the inclusion of the required water quality parameters. Samples of previously used collection sheets are appended. Please see Appendix 6.

Data collection sheets are completed by the sampling team, on site, at the time sampling occurs. All data collection sheets must include the following:

- Site identification number
- Date and time of sample collection
- Chain of custody - the name of crew responsible for each aspect of the outing (ie. equipment pickup and check, sample collector, data recorder, delivery of samples to the lab, equipment clean-up and return)
- Instruments used for field measurements
- Space to indicate deviation from standard procedures
- Space to indicate quality control measures taken, field instrument calibration (date, time, by whom, standards used, and expiry date of standards) field blanks, replicates etc.
- Shoreline observations (relating to possible source of fecal contamination).

Sample crew members must ensure that all data sheets are filled in correctly and completely. The results are reviewed and evaluated for "reasonableness" by the sampling crew before leaving the field, and if necessary, measurements are repeated.

Data sheets are initially stored in marked binders at the laboratory where the samples are delivered for testing. Project coordination staff collect the sheets weekly, and review for discrepancies and missing data. The sampling crew members are contacted to provide any missing information. All information from data collection sheets are entered into the appropriate database. A second person (not the person who originally entered the data) randomly selects a minumum of 10% of the data sheets to verify accurate data entry to the database. Databases are periodically backed up, and hard copies are made of the data.

Data sheets and the corresponding database printouts are stored at the Comox Valley Project Watershed Society office for five years following the completion of the specific project.

Copies of all reports are maintained in Project Watershed's library.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
vi. Bird Populations (to be developed)
vii. Protected Areas (to be developed)

B. Data Collection and Management

8. Monitoring Process Design

i. Water Quality

The design of a monitoring process is related directly to the objectives of the monitoring project. Monitoring parameters are chosen to provide the desired information. Most projects include a combination of tests done on site by the sample crew, and samples taken for laboratory analysis. Please refer to Section 3 – Quality Assurance Program Plan Purpose for information about data use, and to Section 4 – Program Data Description for more information about monitoring program styles.

Water quality sampling is done in teams of two or more people. This policy helps provide risk management as well as mutual supervision of proper procedures. When a crew member is unable to attend a scheduled sampling outing, she or he will:

1. Attempt to find a replacement from the list of similarly trained volunteers given them at their training
2. Notify the project coordinator of the change, asking for assistance if a replacement has not been arranged.

Sample Stations
Established Environment Canada marine sampling stations are used whenever possible. Maps showing Environment Canada and other sample station locations, with descriptions of visual and GPS reference points (where available) are attached in Appendix 2 Marine Water Quality Sampling Station Locations.

When access to a sampling site requires crossing private property, prior to the commencement of the monitoring program, the project coordinator will obtain the written permission of the landholder, and will notify the landholder in writing when sampling events are scheduled to occur.

Risk Management
Water quality monitoring programs emphasize the safety of sampling crew members and the environment over the importance of obtaining the sample. Crews are encouraged to remain aware of the surrounding environment and conditions at all times, and to follow basic commonsense safety rules.

The project coordinator will develop a monitoring safety plan that includes:

- Completion of a medical form by each sampling crew member that includes emergency contacts, insurance information, and relevant health information such as allergies, diabetes, epilepsy, etc.
- Insurance coverage for volunteers
- Training session on safety precautions
- Provision of a safety check list to all crew members

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

9. Monitoring Methods Requirements

This section describes monitoring methods, including information on what parameters are sampled and how samples are taken. Analytical methods requirements are also described for on-site measurements performed by sampling crews. Laboratory analytical methods are described in the Quality Assurance Program Plan of the facility testing the samples.

i. Water Quality

In the Baynes Sound Data Program, sampling protocols used for fresh water are those set out in the Resources Inventory Committee publication "Ambient Fresh Water and Effluent Sampling Manual". Marine sample protocols follow those set out in the Resources Inventory Committee publication "Standard Methods for Sampling Resources and Habitats in Coastal Subtidal Regions of British Columbia: Part 2 - Review of Sampling with Preliminary Recommendations", available for viewing at www.for.gov.bc.ca/RIC/o_docs/Coastal/subtidal/index.htm. Additional protocols are derived from the manufacturer's operational manuals of the test kits. Fecal coliform sampling procedures are set out in the Environment Canada training pamphlet. Please see Appendix 3 Environment Canada Volunteer Monitoring Training Pamphlet.

The significant difference between fresh water and marine water sampling is the attention to the depth of the sample taken in the marine water column. Baynes Sound water quality projects evaluate surface marine water only, using the same procedures as for fresh water.

Fecal Coliform Bacteria Levels

Fecal coliform bacteria samples are gathered by sampling crew members and analysed at an Environment Canada approved laboratory, North Island Laboratories (NIL). Sample crews require a transport cooler, ice pack and sample containers. Twice the volume of ice is used to refrigerate samples collected during the summer season, and one volume of ice for samples collected during the winter season. Grab sample containers are either sterilized plastic bottles with lids closed, or sealed 'Whirlpack' plastic bags.

Procedure:

1. Label the container with the site number, date and time of sample collection.
2. If bottle, remove the lid without touching the inner surface of the bottle or the lid. If using a bag, tear off the seal and open the bag by the tabs at the centre. Do not touch the inner surfaces of the bag.
3. Grasp bottle well below the neck and in one continuous motion plunge it 6 inches beneath the surface and slowly force it through the water until it is full. This motion creates a current over the mouth of the bottle such that water entering the bottle has not come in contact with a hand.
4. If a bag, hold the bag open by the tabs at the centre and proceed to fill in the same manner as for a bottle.
5. If water depth is insufficient to completely submerge the container, hold the container in the stream of the water at a depth not to disturb sediment, and allow the water to flow into the container.
6. Recap the bottle or seal the plastic bag and place in the cooler with sufficient ice.
7. Proceed to the lab as soon as possible. If a delay is necessary, keep samples refrigerated at temperatures between 5 – 10 degrees C. Fresh water samples must be processed by the laboratory within 24 hours and marine water samples within 6 hours.

Temperature

Temperatures are recorded on-site by the sampling crew members. Water temperature is measured with an armored alcohol-filled thermometer at the sampling site. Air temperature can be measured with the same thermometer used for reading water temperature. Measure air temperature first as a wet thermometer will give an erroneous air temperature reading.

Air Temperature Procedure:

1. Place the armored thermometer so it is not touching other objects and is not in direct sunlight. Allow the thermometer to equilibrate with the surrounding air temperature for three to five minutes.
2. Take the reading. Notice if there is a calibration correction written on the case of the thermometer. Adjust your reading to incorporate the correction. Record resulting temperature on the data sheet.

Water Temperature Procedure:

1. Place the armored thermometer in its case in a moving area of the water flow. Anchor the string with a rock or to a branch if necessary. If water depth will allow, suspend at least 4 inches below the surface. Wait until it reaches a stable temperature reading (3-5 minutes).
2. If possible, read the temperature with the thermometer bulb beneath the water surface. Otherwise, quickly remove the thermometer and read the temperature immediately.
3. Notice if there is a calibration correction written on the case of the thermometer. Adjust your reading to incorporate the correction. Record resulting temperature on the data sheet.
4. Rinse the thermometer and casing with distilled water. Dry thoroughly when doing closing maintenance.

Dissolved Oxygen (DO)

Dissolved oxygen samples are measured on-site by sampling crew members. Measuring DO require particular care, since any contact between the sample and the air will modify the results.
Dissolved Oxygen measurements are taken with a Hach Dissolved Oxygen kit Model Number OX-2P, which is a drop count titration/modified Winkler procedure.

Procedure:

1. Rinse the round bottle with the glass stopper with distilled water. Fill this bottle with the water sample by allowing the water to overflow the bottle, flushing 3 volumes of water through the bottle before considering the sample collected. Insert the stopper avoiding any trapped air.
2. Using the clippers open one Dissolved Oxygen 1 package and one Dissolved Oxygen 2 package and add both to the bottle. Insert the stopper with a quick thrust so that all air bubbles are expelled. If air bubbles become trapped in the bottle in the next steps, the sample should be discarded and test repeated. Grip the bottle and stopper firmly: shake vigorously. A precipitate may form causing the sample to take on a brownish orange colour. A small amount of powdered reagent may remain stuck to the bottom of the bottle. This will not affect the test results.
3. Allow the sample to stand for 5 minutes, shake the bottle again at the half way time; the precipitate will settle.
4. Use the clippers to open one Dissolved Oxygen 3 package and add it to the bottle. Carefully restopper the bottle to exclude air bubbles and shake to mix. If oxygen is present, the precipitate will dissolve and a yellow colour will develop.
5. Completely fill the round skinny measuring tube with the prepared sample water and pour into the square mixing bottle.
6. The measure is determined by the drops of Sodium Thiosulfate Standard Solution it takes to change the sample to colorless. Count each drop. Swirl the mixing bottle between each drop.
7. Each drop of sodium Thiosulfate Standard Solution used is equal to 1 mg/L of dissolved oxygen. Record on the data sheet.
8. Empty all remaining sample waters into the waste water bottle. Rinse all 3 test containers with distilled water; add to the waste water bottle. Dry containers when doing closing maintenance.

Conductivity

Conductivity is measured on-site by sample crew members with Myron l Company Nalcometer Model MLN and Model DML conductivity meters. The conductivity meter may not function properly if the temperature of the water is too cold. Note any difficulties with obtaining a reading on the data sheet.

Procedure:

1. Rinse the well of the conductivity meter with distilled water.
2. Take a sample of the water with a separate container. Pour enough water into the well of the conductivity meter until the top electrode is submerged. Press the button on the conductivity meter to activate the current and read the results on the dial. Adjust the power gauge until results are easily readable. Record on the data sheet. Pour the sample water back into the stream.
3. Repeat step 2 for a total of 3 readings. Take the average of the three readings and record on the data sheet.
4. Rinse the well with distilled water. Dry when doing closing maintenance.

pH

pH is measured on-site by sampling crew members, using the Hach mid range test kit Model 17F (color disc method). Perform measurements immediately after gathering water sample to avoid rapid changes that occur as a result of gas diffusion, biological activity, and chemical reactions.

Procedure:

1. Rinse both tubes with distilled water. Fill both tubes with water to be tested to the 5 ml mark, the lowest ring on the tube.
2. Place one tube in the furthest outside hole in the color comparator.
3. Add eight drops of Bromthymol Blue Indicator Solution to the other tube. Swirl to mix. Insert in the closest to center hole in the color comparator.
4. Hole the comparator against a white background or up to the light and rotate the dial until the color matches between the two tubes. Read the scale at the indicator window choosing the reading that is closest to the indicator and record on the data sheet.
5. Return the unaltered sample to the stream and pour the mixed sample into the waste water bottle. Rinse both tubes with the distilled water, dumping into the waste water bottle. Dry when doing closing maintenance.

Turbidity

Turbidity is measured on-site by sampling crew members with a LaMotte kit Model TTM Code 7519.

Procedure:

1. Rinse one tube with distilled water. Fill the tube to the 50ml line with the sample water. Look down the tube. If the black dot on the bottom is not visible, pour out sufficient amount of the water sample so that the tube is filled to the 25ml line.
2. Fill the second tube with the distilled water to an equal volume as the sample water tube.
3. Place the two tubes side by side and note the difference in clarity of the black dot. If the black dot is equally clear in both tubes, the turbidity is zero. Record zero on the data sheet.
4. Shake the Standard Turbidity Reagent vigorously. Measure 0.5ml in the eye dropper. Add to the tube holding the distilled water. Stir both tubes with the mixing rod to equally distribute turbid particles. Check the visibility of the black dot.
5. Repeat step 4 until the visibility of the black dot is the same in the distilled water as the sample water. Count the number of additions of Standard Turbidity Reagent. Use the chart in the kit to determine the Jackson Turbidity Units of the sample. Record on the data sheet.
6. Pour the mixers into the waste water bottle and rinse both tubes with distilled water. Dry when doing closing maintenance.

Samples collected for laboratory analysis

Sterilized containers are provided by the testing laboratory. Use an amber glass bottle for oils and grease samples, and a plastic bottle for phosphorous samples.

Procedure:

1 Write the site identification information on the container.
2 Open the bottle without touching inside surfaces of the bottle or lid.
3 Rinse sample bottle and lid 3x with sample water: Fill ½ full, swirl and empty downstream/behind you, repeat twice more before taking final sample. Submerge into a flowing part of the watercourse so the water flows directly into the bottle until completely full. Avoid capturing plants and debris if possible; avoid agitating the bottom sediments. Recap tightly.
4 Place into cooler. Deliver to laboratory as soon as possible.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

10. Sample Handling and Custody Requirements

All data sheets include a chain-of-custody section to be filled out for each sampling site with the names of the sampling crew responsible for each step. All samples taken for laboratory analysis are labeled with the site number, date and time of collection prior to collecting the sample.

11. Quality Control Requirements

i. Water Quality:
Three methods of quality control (QC) for both marine and freshwater samples are used: field blanks, split samples and replicate samples. These methods are applied to at least 10% of the samples taken for each parameter, and result in a corresponding budgetary consideration. Quality control samples do not add to the total data collected within a monitoring project, but are specific measures of the project systems.

Note:
- Field blanks require extra sampling containers and distilled or de-ionized water.
- Split samples require a large collecting container that both samples are taken from. Clean the sampling equipment between each split sample.
- Replicate samples for lab analysis require extra sampling containers.

Blind samples are created when each water sample is labeled with a code that describes on the data sheet which sample is for QC and which is for water quality testing.

Table 2 Parameters And Applicable Quality Control Samples

Parameter	**QC sample**	**Who analyses**	**Additional Comments**
Fecal coliform	Field blank	Lab	Done as blind sample
Fecal coliform	Replicate sample	Lab	Done as blind sample
Temperature	Replicate sample	Sampling crew	
Dissolved Oxygen	Replicate sample	Sampling crew	
Conductivity	Split sample	Sampling crew	
Conductivity	Replicate sample	Sampling crew	Standard protocol
PH	Split samples	Sampling crew	
PH	Replicate samples	Sampling crew	
Turbidity	Split samples	Sampling crew	
Turbidity	Replicate samples	Sampling crew	
Other lab samples	Field blank	Lab	Blind sample
Other lab samples	Replicate samples	Lab	Blind sample

All laboratory testing will be done in an Environment Canada approved facility. North Island Laboratories in Courtenay BC, maintains an extensive quality control program, and the plan is available at the lab for inspection.

Variations of measurements done by sampling crews as quality control samples exceeding 10% accuracy flags the data, and the sampling crew members are evaluated and retrained.

Variations of measurements done by the testing laboratory as quality control samples exceeding 10% accuracy flags the data, and the lab is notified and requested to report on possible causes of the variations, and measures taken to rectify.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

12. Instrument and Equipment Maintenance

This section describes routine inspection and preventative maintenance of field equipment. Please refer to testing laboratory Quality Assurance Program Plans for details on laboratory equipment maintenance.

Routine and regular calibration of instruments using appropriate standards is essential for assuring stated accuracy.

i. Water Quality
All kits are inspected for completeness, reagent date, cleanliness and working order prior to and following each sampling period, or per manufacturer's recommendations by the Streamkeeper coordinator at Project Watershed. The kits assigned to specific projects are inspected by the project coordinator at the beginning of the project and after (approximately) every 20 site visits. Replacement parts, new thermometers and new reagents are available throughout the duration of monitoring projects from the Streamkeeper coordinator.

Sampling crew members are instructed to immediately advise the program coordinator of any equipment damage or loss.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

13. Instrument Calibration and Frequency

i. Water Quality:
All kits are calibrated prior to and following each sampling period, or per manufacturer's recommendations by the Streamkeeper coordinator.

Thermometer Accuracy
Thermometer are checked against a National Institute of Standards and Technology (NIST) certified thermometer prior to and following each sampling period. This service is provided by North Island Laboratories in Courtenay. The adjustment to the thermometer is written on the top portion of the armored case with a waterproof marker. If the variation is more than +/- 0.5 degrees C the thermometer must not be used.

Dissolved Oxygen (DO)
DO meters are calibrated using Winkler titrations periodically, depending on use (approximately every 20 tests). To calibrate DO titration kits, use a standard solution of potassium bi-iodate to check the accuracy of the titrant. The amount of titrant required to make the blank sample colorless should equal the amount of potassium bi-iodate added to the sample, ± 0.1 ml. Conductivity meters are calibrated at least once a year. A log book for each meter, identified by its serial number, is kept by the Streamkeeper coordinator.

pH
pH kits are checked annually with a buffer solution for each of an acid, neutral and alkalie reading. Sampling crew training sessions include using a buffer solution for neutral as additional checks on the accuracy of the kit. The buffer solution is dated upon receipt. A distinct color change of the solution is another indication of the need to replace the chemical.

Turbidity
Turbidity reagents are checked for manufacturer dates when received. The date of manufacture is determined by decoding the lot number, in which the first two digits indicate the week the reagent was made and the third digit indicates the year the reagent was made. Thus, lot number 221654 was manufactured during the 22nd week of 2001. Any reagents over two years old are replaced.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

14. Inspection/Acceptance Requirements for Supplies

i. Water Quality
Kit parts and replacement chemicals are ordered from kit manufacturers. Different companies and models are not interchangable. All supplies are inspected by the Streamkeeper coordinator for chips, breaks and incompatible chemicals, which are returned to the supplier.

ii. Eelgrass (to be developed)
iii. Shoreline Biodiversity (to be developed)
iv. Bird Populations (to be developed)
v. Protected Areas (to be developed)

15. Data Acquisition Requirements (to be developed)
(Identify data used that is received from external data providers
Identify Limits on use of this data due to uncertainty about quality)

16. Data Management (to be developed)
(Describe:
Data path from collection to storage and use
Accuracy and completeness checks
Error management
Forms and checklists

Identify computer hardware / software used for data management)

C. Evaluation

17. Reports (to be developed)

(Identify frequency, content, distribution of reports that detail QAPP audits and problems and resolutions.)

18. Data Review, Validation, and Verification Requirements

All data is reviewed by the Project Manager and the Quality Assurance Subcommittee to determine if the data meet QAPP objectives. Decisions to reject or quantify the data are made by the Project Manager.

19. Validation and Verification Methods (to be developed)

(Describe procedures used to validate and verify data. this can include comparing computer entries to field data sheets, looking for data gaps, analyzing quality control data such as chain of custody information, spikes, and equipment calibrations, checking calculations, examining raw data for nonsensical readings, reviewing graphs, tables and charts.

Include a description of how errors if detected will be corrected, and how results will be conveyed to data users.)

20. Reconciliation with Data Quality Objectives (to be developed)

(Describe the process for determining whether the data meet project objectives. This includes calculating and comparing the project's actual data quality indicators to those specified at the start of the project, and describing what will be done if they are not the same. Actions might include discarding data, setting limits on the use of the data, revising project's data quality objectives.)

Appendices

Appendix 4.1

Data Quality Objectives for Measurement Data – Water Parameter Specifications

Fecal Coliform

(From "Water Quality Criteria for Microbiological Indicators", P. D. Warrington, March 8, 1988.)
http://wlapwww.gov.bc.ca/wat/wq/BCGuidelines/microbiology.html

Water Use	Escherichia coli	Enterococci	Pseudomonas aeruginosa	Fecal coliforms
Aquatic Life	less than or equal to 43MPN/100 mL 90th percentile	less than or equal to 11MPN/100 mL 90th percentile	None applicable	less than or equal to 43MPN/100 mL 90th percentile
Shellfish harvesting	less than or equal to 14MPN/100 mL median	less than or equal to 4MPN/100 mL median	None applicable	less than or equal to 14MPN/100 mL median

Medians and geometric means are calculated from at least 5 samples in a 30-day period. Ten samples are required for 90th percentiles. These recreation and shell harvesting criteria are applicable to fresh and marine waters, except the E. coli criteria, which apply only to fresh water.

Temperature (From "Water Quality Guidelines for Temperature" 2001)

Marine and Estuarine:
Insufficient data are available to set specific limits for marine and estuarine conditions.

- + or - 1 degree Celsius change from the natural condition
- the natural temperature cycle characteristic of the site should not be altered in amplitude or frequency by human activities. The maximum rate of any human-induced temperature change should not exceed 0.5 degrees Celsius per hour.

Freshwater Aquatic Life: (streams with unknown fish distribution)

- The mean weekly maximum temperature (MWMT) is defined as the average of the warmest daily maximum temperatures for seven consecutive days.
  MWMT = 18 degrees Celcius
  (maximum daily temperature = 19 degrees Celcius)
  Hourly rate of change not to exceed 1 degree Celcius
  maximum incubation temperature = 12 degrees Celcius (in the spring and fall)

Dissolved Oxygen (From "Ambient Water Quality for Dissolved Oxygen' 1997)

Life Stages	All Life Stages other than buried Embryo/Alevin	Buried Embryo/Alevin Life Stages	Buried Embryo/Alevin Life Stages
Dissolved Oxygen -concentration-	Water Column mg/L O2	Water Column mg/L O2	Interstitial Water mg/L O2
Instantaneous minimum	5	9	6
30-day mean	8	11	8

For the buried embryo/alevin life stages these are in-stream concentrations from spawning to the point of yolk sac absorption or 30 days post-hatch for fish; the water column concentrations recommended to achieve interstitial dissolved oxygen values when the latter are unavailable. Interstitial oxygen measurements would supersede water column measurements in comparing to criteria.

The instantaneous minimum level is to be maintained at all times.

pH (From "Ambient Water Quality for pH" 1991)

Acidic conditions are commonly found in the high precipitation areas on the west coast of British Columbia. Waters in these areas are typically acidic, and in boggy areas water can have a pH as low as 5. These areas may have a fauna and flora that are at the low end of their pH range.

To protect the aquatic communities from further acidification and possible elimination of species from the system:

For freshwater with less than 6.5 pH:

- No statistically significant decrease from background or upstream values

For pH from 6.5 to 9.0:

- Unrestricted change permitted within this range.

To create a baseline for comparison, the average is calculated from at least 5 evenly spaced samples taken in a period of 30 days.

Turbidity (From "Ambient Water Quality Guidelines (Criteria) For Turbidity, Suspended And Benthic Sediments' 1998

Distinct water quality guidelines are required during clear flow and turbid flow periods. The terms clear flow period and turbid flow period are used to describe the portion of the hydrograph when suspended sediment concentrations are low (i.e., less than 25 mg/L or less than 8 NTU) and relatively elevated (i.e., greater than or equal to 25 mg/L or greater than or equal to 8 NTU), respectively.

Clear Flow Periods

Induced turbidity should not exceed background levels by more than 8 NTU during any 24-hour period (hourly sampling preferred). For sediment inputs that last between 24 hours and 30 days (daily sampling preferred) the mean turbidity should not exceed background by more than 2 NTU.

Turbid Flow Periods

Induced turbidity should not exceed background levels by more than 8 NTU at any time when background turbidity is between 8 and 80 NTU. When background exceeds 80 NTU, turbidity should not be increased by more than 10% of the measured background level at any one time.

Appendix 4.2

Marine Water Quality Sampling Station Locations

(please refer to Project Maps, Appendix 5)

Appendix 4.3

Environment Canada Volunteer Monitoring Training Pamphlet

Appendix 4.4

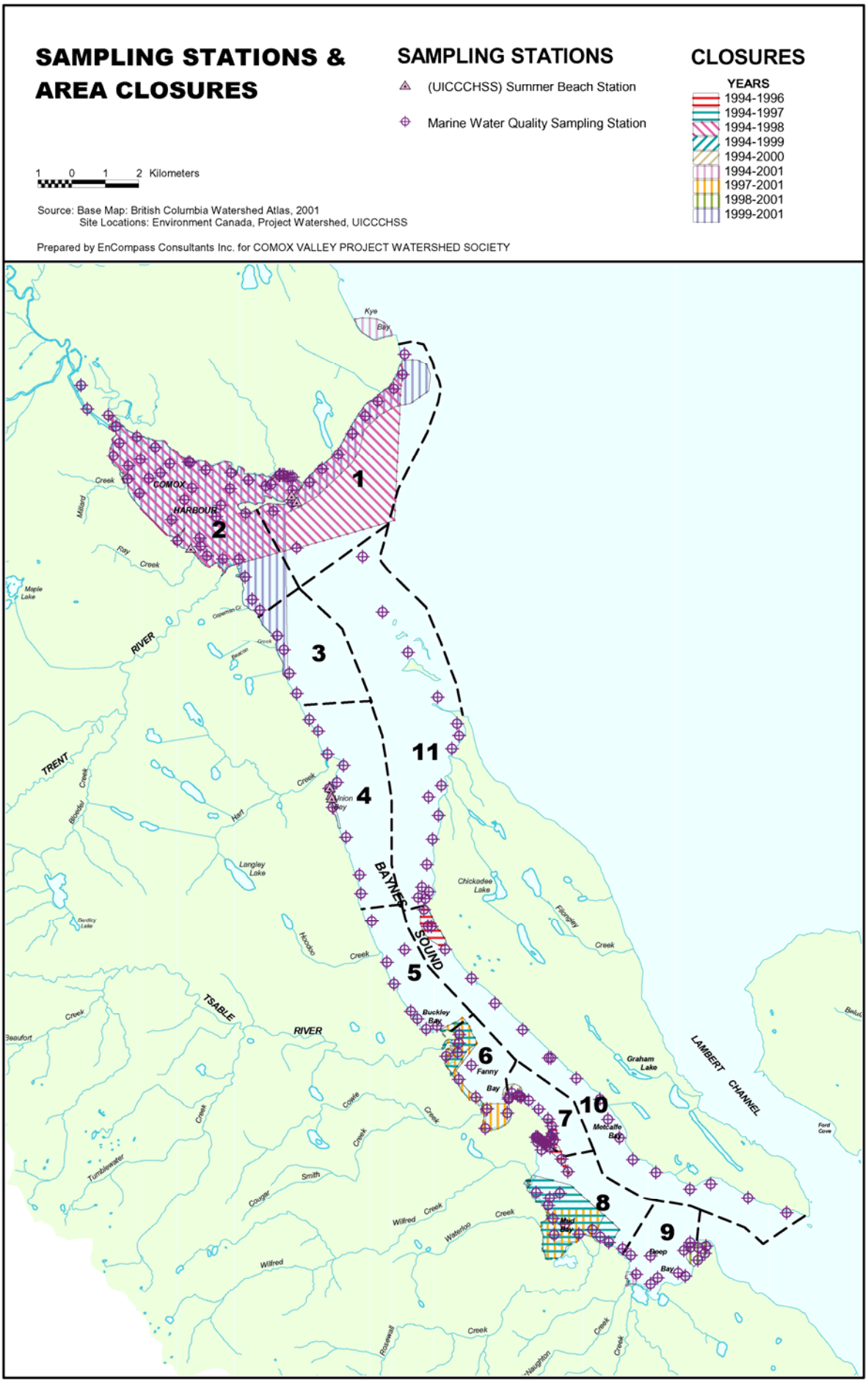
State of the Sound Advisory Committee Terms of Reference, Phase 2

Appendix 4.5

Field Data Collection Sheet Samples

Appendix 5

Project Maps


SAMPLING STATIONS & AREA CLOSURES
SAMPLING STATIONS
(UICCCHSS) Summer Beach Station
Marine Water Quality Sampling Station
CLOSURES
YEARS
1994-1996
1994-1997
1994-1998
1994-1999
1994-2000
1994-2001
1997-2001
1998-2001
1999-2001
1 0 1 2 Kilometers
Source: Base Map: British Columbia Watershed Atlas, 2001
Site Locations: Environment Canada, Project Watershed, UICCCHSS
Prepared by EnCompass Consultants Inc. for COMOX VALLEY PROJECT WATERSHED SOCIETY
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2
3
4
5
6
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9
10
11
COMOX
HARBOUR
BAYNES
SOUND
LAMBERT
CHANNEL
TRENT
RIVER
TSABLE
RIVER
Kye
Bay
Union
Bay
Buckley
Bay
Fanny
Bay
Mud
Bay
Deep
Bay
Graham
Lake
Chickadee
Lake
Langley
Lake
Maple
Lake
Buckley
Lake
Metcalfe
Bay

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Comox Valley Project Watershed Society
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