The Halifax Harbour Solutions Project
Provision of Sewage Treatment

PROJECT DESCRIPTION FOR CONSIDERATION UNDER THE CANADIAN ENVIRONMENTAL ASSESSMENT ACT (CEAA) COORDINATION REGULATIONS

Prepared by Halifax Regional Municipality

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HALIFAX
REGIONAL MUNICIPALITY

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1. Introduction

The current state of Halifax Harbour shows the significant effects of pollutants discharged to the harbour through untreated sanitary, storm and combined sewer outfalls. Shellfish harvesting is prohibited in the harbour, large areas of contaminated sediment exist around some forty separate outfalls, water quality is poor along the shorelines, bacterial contamination is widespread, and aesthetics are poor along the Halifax/Dartmouth waterfronts due to particulates, floatables and odour. Desired water quality objectives have been set for the various portions of the harbour, based on uses of the waters, by the Halifax Harbour Task Force (1990). A Harbour Solutions Symposium of stakeholders hosted by Halifax Regional Municipality (HRM) in 1996 endorsed these objectives. The Harbour Solutions Advisory Committee, a broadly-based stakeholder group appointed by HRM, has developed a set of recommendations to advance the project, building on the consensus results of the Halifax Harbour Solutions Symposium. A consulting group retained by HRM has used these recommendations, together with the extensive studies and data available on the harbour, to develop a Concept Plan which HRM has adopted to achieve advanced primary level treatment for all untreated discharges, which is projected to meet the desired water quality objectives.

There have been many studies of the harbour, and various plans advanced to provide for sewage treatment. Two plants have been built on the harbour over the past 20-30 years, at Mill Cove in Bedford Basin and at Eastern Passage near the harbour mouth. However, the majority of sewage continues to enter the harbour untreated. Prior to the current Concept Plan, the most recent plan was developed in the early 1990s by Halifax Harbour Cleanup Incorporated (HHCI), a Crown Corporation created under a federal-provincial cooperation agreement which provided for $200,000,000 in funding, approximately three-quarters of which was provided jointly by the federal and provincial governments. The HHCI plan called for a single primary treatment plant to be constructed on an artificial island in the harbour. Costs under this plan escalated to approximately $400,000,000 during the planning process. The plan was granted approval under a joint federal-provincial environmental assessment panel review (1993), however the funding agreement expired in 1995 and was not renewed because of the high cost estimate.

HRM has now developed a smaller-scale approach involving four advanced primary level treatment plants, which can be phased in over time, at less cost than the HHCI plan. There will be significant environmental benefits from this project. Water quality in the harbour is projected to improve to achieve desired objectives. There is significant public support for this project, and there is growing public pressure to take action on the state of the harbour. Stakeholder contributions through the Harbour Solutions Symposium and Advisory Committee have been instrumental in advancing the project. In public opinion polling conducted by HRM, 88% of respondents feel it is very important to have a new sewage treatment system for the harbour.

2. Project Description

Related Initiatives: There are several aspects of sewage management which are not part of this project, but which deserve mention as separate but related initiatives of HRM. One of the primary recommendations of the Federal-Provincial Environmental Assessment Panel for the HHCI project was for the creation of a comprehensive source control program to limit the input of toxic or noxious materials into the sewer systems. Since amalgamation, HRM has on its own initiative, undertaken a source control project, working with business to identify sources of such materials and limit their use or disposal, and to revise and expand the Sewer Use Bylaw to more effectively control inputs to the sewers. HRM expects to put forward a revised Bylaw by 2000. This initiative will improve the quality of sewage reaching the end-of-pipe, and thus augment the sewage treatment processes proposed. HRM also continues to provide and promote a Household Hazardous Waste service whereby residents may dispose of such wastes in an acceptable manner and thus prevent release to the sewer system.

One of the aspects of the present sewer system which has some impact on the proposed project is the existence of a number of combined sanitary/storm water sewers in the older parts of the system (primarily Halifax peninsula). Combined sewers increase the volume of wastewater which must be treated, and result in more frequent overflows at Combined Sewer Overflow (CSO) points. While separation of combined sewers is not at present a part of the project, HRM does have an ongoing program to separate combined sewers when financially feasible. The cost to completely separate all combined pipes is prohibitive; however, HRM has adopted the recommendation of the Solutions Advisory Committee to consider separation on a sewershed basis, when reconstruction or replacement of existing combined pipes is required, or in combination with other road work which facilitates access.

A final aspect of the present system which affects the current project is inflow/infiltration (I&I) of groundwater into sanitary and combined sewer pipes. This also has the effect of increasing the wastewater flow which must be treated. Again, while it is not part of the present proposed project, I&I reduction is a priority of HRM, and the subject of an ongoing effort. Areas of the sewer system have been studied and prioritised based on the severity of the problem, and will be addressed as financially feasible.

2.1 Purpose and Need for the Project

Given the present state of the water and sediment quality in Halifax Harbour, and the likely further deterioration if sewage inputs are left untreated, HRM has determined that there is a critical need to take action. The purpose of the project is to provide advanced primary level treatment for the untreated municipal sewer discharges to the harbour, as well as for as many of the private outfalls as can be included.

2.2 Project Location and Scope

There is a balance which must be achieved between the costs of treatment plant construction, and the costs of collection infrastructure required to convey sewage from the present discharge sites to the selected plant locations. A larger number of plants increases their capital and operating costs, but reduces the collection system cost. Fewer plants decreases their cost, but increases the cost of the collection system. The HHCI plan, with one single plant, demonstrated the extreme effect of collection costs with a single plant location. HRM has considered several multi-plant scenarios. One of the major constraints on multiple plants is the difficulty of finding suitable locations around a heavily developed, urbanized harbour. Considering the cost and siting constraints, HRM has determined that a four-plant scenario is achievable and sufficient to meet the objectives.

A Public-Private Partnership approach has been adopted by HRM, involving a combination of public and private financing, operation and ownership of system elements. HRM would finance, own and operate the new collection infrastructure, which would be designed and built by the private partner. The private partner would design/build, finance, operate, and own the new treatment plants for a defined period, after which ownership would revert to HRM based on an annual payment schedule. Project elements would be phased in over time (approximately a ten-year schedule).

Major untreated outfalls exist along both the Halifax Peninsula and Dartmouth waterfronts from Bedford Basin to the harbour mouth, with an additional untreated outfall outside the harbour mouth at Herring Cove, carrying sewer discharge from mainland south Halifax. In the four plant solution, one plant would serve Dartmouth to be located in the Dartmouth Cove area south of the Dartmouth downtown. Two plants would serve Halifax, one to be located south of the harbour narrows and a second in the south end of Halifax Peninsula in the container port area. A fourth plant would serve mainland south, to be located at Herring Cove. The accompanying maps (Figure 1) indicate the likely areas for treatment plant locations and the locations of corresponding outfalls. The outfalls must be located to avoid active shipping and anchorage areas, and to provide sufficient flow dispersion of the treated effluent. Since advanced primary treatment does not significantly remove nutrients, one of the key recommendations of the Advisory Committee was to avoid discharges into the Narrows, in order to protect Bedford Basin from ongoing nutrient enrichment. Circulation patterns in the Harbour tend to carry any Narrows discharge north into the Basin. For this reason, plant locations and outfalls have been kept to the south of the MacDonald Bridge.

The collection infrastructure would consist of a combination of limited tunnelling where necessary, along with surface trenching for collection pipes. Some pumping with force mains would be required, but gravity mains will be used whenever possible.

Advanced primary treatment, in which mechanical solids separation is augmented by chemical treatment to further remove solids, will be provided. Effluent will be UV disinfected prior to discharge. The proposed plant design and sites will provide for the possibility of future addition of secondary processes should this become necessary, as well as future capacity expansion if this is required. Site constraints at the likely locations will require innovative multi-level design to achieve small plant footprints. HRM has committed to working with communities which may be affected by plant locations. A WINBY (Want It In My Back Yard) approach has been adopted which seeks to provide community benefits and compatible design elements such as architecture/landscaping as well as completely enclosed systems to minimise impacts. This community process has begun for one site which has been publicly announced (Barrington-Cornwallis-Upper Water Streets area).

2.3 Project Schedule

HRM has conducted a Request for Qualifications (RFQ) process which has resulted in a short list of three proponents. A Request for Proposals (RFP) is in preparation and will be released to the short list during fall of 1999. It is anticipated that proposal submissions will be received by late winter of 2000, and a selection process concluded by spring of 2000. Negotiation of a final contract with the successful proponent should be concluded by summer of 2000, with project phases to begin following that time. HRM owns the announced Halifax North site, and is in the process of acquiring the three additional preferred sites for treatment plants, and hopes to have these processes concluded during 1999. A number of field studies on these sites and associated outfall locations have been and will be conducted during 1999, as permission for site access is obtained for those sites which HRM does not presently own.

2.4 Alternatives to the Project

Assessment processes commonly examine alternatives, both to the project, as well as within the project. In the present case, the major alternative to the project (ie. the alternative to provision of wastewater treatment) would be to continue with the *status quo*. This is generally acknowledged by regulatory agencies, the general public, as well as by HRM, to be an unsatisfactory alternative both environmentally as well as socially. Alternatives within the project would involve alternate ways of undertaking the project, which might include alternate sites, differing numbers of facilities, and alternative technologies. The Harbour Symposium and the Solutions Advisory Committee considered the issues of technology, siting and numbers of treatment plants. The present concept plan has been based upon the consensus recommendations of the stakeholders involved regarding the feasible alternatives.

The issue of specific technology to be used in the proposed plants has not yet been addressed in detail by HRM, other than the commitment to use atmospherically-controlled systems with the

necessity of stacked or multi-level design for the inner harbour facilities. Detailed facility design including the specific treatment technologies to be used will not be finalised until HRM concludes a contract with the successful proponent following the RFP process.

A different number of treatment plants is a possibility. However, HRM has concluded, based upon the consultant's Technical Report submitted to Council in 1998, that a three to five plant scenario is advantageous for financial, technical and siting reasons. The four plant scenario has been endorsed in principle by HRM Council as the most practical. Flows on the Dartmouth side of the Harbour are such that a single plant will suffice to treat the volumes, and consolidation of outfalls has already captured approximately 70% of the Dartmouth outfall volume in a single pipe. One particular siting opportunity is being explored which would avoid the downtown waterfront/Shubenacadie Canal area, which is the subject of current planning exercises for future development which may not be compatible with a treatment facility.

On the Halifax side of the harbour there are no single feasible sites between the MacDonald Bridge and Point Pleasant Park (ie. South of the Narrows) which could accommodate a single plant large enough to treat the total flow from outfalls between Duffus Street and the Halterm facility (including the Chain Rock outfall in the Northwest Arm). Thus, a two plant scenario for peninsular Halifax has been chosen. At the north end of downtown Halifax, a potential siting opportunity exists utilising HRM-owned property between the DND Dockyard and the Cogswell Street interchange. The HRM-owned parcel is of sufficient size for a facility to treat the Duffus Street outfall as well as several intervening outfalls, and possibly some portion of the outfalls along the downtown Halifax waterfront. However, it is not likely that sufficient space could be found to treat all of the peninsula outfalls in this area. It is virtually certain that an additional site will be required in the south end of Halifax. No realistic opportunities exist along the Halifax waterfront north of the old Nova Scotia Power station, as this area of prime waterfront is beginning to be developed for residential (Bishop's Landing) or other future uses. The most likely candidate area will be in the vicinity of the Halifax Ports Authority / CN-Via Rail properties. Discussions have been initiated on possible sites.

Finally, the wastewater flow from mainland South, which discharges at Herring Cove, must be treated in the Herring Cove area, as the cost of connecting this outfall to an inner harbour facility is prohibitive. Several siting opportunities may exist in the area, and HRM is currently pursuing options.

For these reasons, the current project description has focussed on the described four-plant system and the proposed siting possibilities. HRM will also entertain alternative proposals from the short-listed proponents during the RFP process. Should these or other considerations alter the plant and/or siting scenario described, HRM will update the project description and consult with all relevant regulatory agencies on any resulting implications.

2.5 Project Details

2.5.1 Sewage Collection Systems

Sewage Collection Systems are required to intercept and collect sewage from the existing system at convenient locations and deliver the sewage to the Sewage Treatment Plant (STP) locations. Some of the existing outfalls will be consolidated in this process. The normal design flow will be four times average dry weather flow (ADWF). Flows beyond this will either be stored for treatment or will outfall to the Harbour, as required to meet environmental objectives and regulations. Details of the collection systems will be appropriate for existing and future design flows, and overflows beyond the specified design flows will be handled in existing outfalls, or in improved or combined outfalls. CSOs will be equipped with screens or underflow baffles to remove floatables. The anticipated CSO at the present Chain Rock outfall site in the Northwest Arm may require some degree of additional treatment such as disinfection.

The collection systems will generally be within HRM right of way and property. The collection systems will include sections of conventional gravity collector sewers, pumping stations and force mains, and tunnel sections. The collection systems will be designed and constructed with specific entry (pick-up) points both for HRM's existing sewers and for delivery to the new collection systems of sewage flows by others (e.g. DND).

HRM's source control program will not substantially affect sewage flow quantities, but it is expected to improve sewage quality by virtue of removing some metals, oils, greases etc.

2.5.2 Sewage Treatment Plants

Locations of four provisional sites, which have been proposed for discussion and assessment, but which may be subject to change pending negotiations with landowners, are shown on Figure 1.

1) Upper Water Street / Barrington Street, Halifax (finalised, HRM owned)
2) CN / Via Rail / Halifax Port Authority, Halifax
3) Dartmouth Cove / Sandy Cove, Dartmouth (exact location to be announced)
4) Hospital Point, Herring Cove

The priorities for construction are (in order):

- Halifax Peninsula north / Duffus Street outfall
- Dartmouth / Tufts Cove, outfall to Sandy Cove area
- Herring Cove / Mainland South
- Halifax Peninsula south / Chain Rock outfall

Priorities have been determined by siting opportunities, the need to address the most serious present outfall impacts, the need to provide treatment for both sides of the harbour, and options for consolidating outfalls. Project components will be phased in over approximately 10 years. Options will be explored to advance the relocation/consolidation of the Chain Rock outfall away from the Northwest Arm should the Peninsula south plant be constructed later in the phasing. HRM Council has made a commitment to move forward on a basis affordable to the community, and to raise funds for 2/3 of the total capital costs (approximately $210,000,000 of $315,000,000). HRM is seeking the balance of funds from the federal and provincial governments. If the additional funding is not provided, the project may be scaled back appropriately.

The new treatment plants will be designed and operated to meet effluent standards on a statistically consistent basis at such flow rates as forecast in the JWEL Concept Plan (March 1998). (See Effluent and Water Quality Standards, below).

The facilities will be designed and constructed on a low maintenance budget with a life for structural elements of at least 60 years, mechanical components of 25 years and electrical/instrumentation items of at least 15 years with no major maintenance required in the first 15 years.

The minimum process requirements for the new sewage treatment plants will include:

- raw sewage pumping as required based on the hydraulic gradient, site elevation, and outfall conditions;
- screening;
- grit removal;
- chemical flocculation and settling followed by UV disinfection to produce an effluent meeting effluent standards consistently;
- biosolids handling and management. Each facility will include onsite dewatering of biosolids, with transport to offsite processing facilities. (See Biosolids Handling, below).

The treatment plants located on the Halifax Peninsula and in Dartmouth will require innovative design in order to minimize land requirements. Designs will be used which have been proven and successfully applied in other locations, treating municipal sewage at similar flow rates. Such designs may involve inclined plate settling, stacked sedimentation tanks, reactor clarifiers with micro-sand addition, or other alternatives, in order to reduce the land area requirement of the plants (maximum 1.5 - 2 hectares, depending on number of plants and site limitations). Similarly, buildings will be designed to efficiently utilize land area and as well to provide for future expansions and possible upgrades to secondary treatment. (See below).

The STP's will be designed to be aesthetically attractive and to blend the facilities into the surrounding area and land uses. At the treatment plant site near Herring Cove, a compact type plant or alternatively, a "conventional" advanced primary type plant may be used depending on suitability of the identified site(s).

2.5.3 Capacity Expansion and Treatment Upgrade

Land requirements for treatment plant sites include:

- area for advanced primary treatment for flows to be encountered in first 7 to12 (±) years of plant operation (utilising compact design).
- area for expansion of advanced primary treatments facilities for increased flows for 50 (±) year period (utilising compact design).
- area for compact-type secondary treatment for 50 (±) year flows to upgrade level of treatment if required in future.
- buffer area around the plants appropriate to the design and surrounding land uses, to be determined in consultation with Nova Scotia Department of Environment (NSDOE).

2.5.4 Outfall Design and Construction

Each STP will have a marine outfall constructed in an acceptable manner and terminating at an acceptable location in the Harbour. Outfalls will be designed hydraulically to meet present and future design flows. Diffuser design will be dependant on receiving water assimilative capacity as determined in consultation with NSDOE, and may require extension or alteration over time as flows increase. Outfalls will meet all the requirements of regulatory agencies, including but not limited to Canadian Coast Guard pursuant to the Navigable Waters Protection Act (NWPA), Department of Fisheries and Oceans (DFO), Environment Canada and the Halifax Port Authority. Outfalls will be designed to achieve an initial dilution of 50-1 or greater.

Outfalls will be located to conform to the containment principle (Halifax Harbour Task Force, 1990). Locations will be in areas of deeper water to allow for adequate diffusion and dispersion, to achieve the water quality objectives as defined by the Halifax Harbour Task Force and the Solutions Advisory Committee, and adopted by HRM. The location of the Herring Cove outfall necessarily lies outside the inner harbour due to the nature of the collection system. Concept outfall locations were defined based on preliminary oceanographic review, and are shown in Figure 1 (A - D).

Where outfalls have to be routed under existing or planned future marine/wharf structures, they will be constructed as tunnels, with suitable downshafts and upshafts as required. All outfalls will be lined, and sized so that maintenance inspections can be conducted. Placement of outfalls and diffusers may require dredging, with disposal of dredging spoils. Efforts will be made to avoid areas of contaminated sediment for any dredging operations, to minimise the impacts of both the dredging operations as well as disposal of the spoils. If ocean disposal is chosen, then an Ocean Disposal permit will be required. Final determination of the need for dredging will be made during the pre-design phase.

2.5.5 Biosolids Handling and Management

At each treatment plant site, screenings, grit and biosolids will be produced. Plant design will include process equipment for collection, conveying, compaction, storage, mixing, pumping, thickening and dewatering as required, as well as any chemical feed system and chemical storage required. Biosolids from the treatment process will be stabilized and disposed of for beneficial use (such as compost or land spreading) or other environmentally acceptable means. Facilities for this purpose will be defined by HRM in conjunction with its private partner during the Request for Proposals phase.

2.5.6 Effluent and Water Quality Standards

Since treated sewage is disposed of to waterbodies, it is necessary to control the characteristics of the discharges in order to meet and maintain water quality objectives. Specific criteria for assessing the polluting effects of treated sewage effluent in Halifax Harbour will be developed and delineated through permit requirements. As such, effluent standards may vary for various treatment facilities.

One of the key objectives of previous studies and advisory processes has been to establish environmental quality guidelines which address the multi-use nature of the Harbour and the goal of sustaining the environmental integrity of biota, water and sediments. The *Halifax Harbour Task Force (HHTF) Final Report* (August, 1990) proposed Environmental Quality Guidelines based upon water quality objectives derived from a literature review of criteria and reported levels of contaminants. They presented long-term water and sediment quality objectives.

Working with these Environmental Quality Guidelines and a classification scheme for groups of water uses requiring different minimum levels of environmental quality, the Task Force prioritized sections of the Harbour. These classifications depended on the importance of each region of the Harbour to primary user groups and the assimilative capacity of the receiving waters. Recently, the *Halifax Harbour Solutions Advisory Committee Final Report to Council* (1998) recommended one substantive change in this classification scheme, upgrading the Northwest Arm to at least an 'SB' (HHTF, 1990) classification.

In general, given the current Harbour treatment Concept Plan and the minimum requirement for advanced primary level treatment of sewage, it is expected that the water quality guidelines for harbour regions can be met with prudent design and siting of outfalls. Further, localized environmental impacts in the area of the effluent plumes must meet the standards required by environmental approvals and permits.

NSDOE has indicated that the HHTF objectives are generally acceptable. A receiving water assimilative capacity study will be conducted as required by the NSDOE permitting process, based upon known information on circulation patterns from harbour modelling studies conducted by the Halifax Harbour Task Force. NSDOE will specify effluent quality limits based on the results of the receiving water assimilative capacity studies.

Studies have been conducted during 1999 to verify and update the existing information on wastewater characteristics, including both volume and quality, for selected major harbour outfalls.

2.5.7 Air Emissions/Odour/Noise

The treatment plants will be designed, constructed and operated as atmospherically controlled systems to prevent the potential occurrence of objectionable odour in the community beyond the property limits of the treatment plant site during routine operations. Highly effective odour control systems will be used for all process areas of each plant, as well as any new CSOs or pumping stations. Enclosed plant design will also serve to minimise noise beyond the site boundary.

3. Existing Environment and Impacts

3.1 Existing Environment

The intent of the environmental assessment process is to document the valued ecosystem and socioeconomic components at risk, to define the nature of a proposed project, to examine alternatives both to and within the project design, to predict likely direct and cumulative impacts, to define reasonable mitigations and monitoring requirements, and determine the residual impacts following mitigation. The existing environment has been extensively documented in previous studies. HRM has undertaken to update information for the proposed outfall locations as required.

The intent of this project is essentially mitigative in nature. The impacts of the present situation, in which the majority of wastewater enters Halifax Harbour untreated, are well documented. The proposed project seeks to alleviate these impacts through provision of wastewater treatment. It is possible that ambient conditions at the proposed outfall locations will be impacted, and this may require further study. However, the overall condition of the harbour will significantly improve.

HHCI described the existing environment in it's Environmental Assessment Report (1992) and 24 associated Component Studies. HHCI obtained conditional approval for its' project in 1993 following a full environmental assessment and public hearings under a joint federal-provincial panel review. The resulting information base is considered to be still largely relevant for purposes of the present project. The expected environmental impacts of the HHCI project were well documented, and appropriate mitigations described. Study of the present project should therefore focus on the differences between the present project and the HHCI proposal, and the likely differences in environmental impacts which might reasonably be expected. The following material in Sections 3.1 and 3.2 on the existing environment is taken from the published HHCI Environmental Assessment Report, Volume 1 (HHCI, 1992) and the Marine Biological Environment Component Study (1991), which also provides the sources for much of this information.

3.1.1 Marine Physical Environment

Halifax Harbour is an estuary in the sense that it is a semi-enclosed saline body of water whose properties and circulation are influenced by freshwater runoff from land and ocean tides and swells. The freshwater, being less dense, flows outward on the surface of the harbour waters. At the same time, more dense, saline water from the Atlantic Ocean flows inwards along the bottom. Mixing takes place as the two water masses meet, resulting in a salinity variation between the surface and the bottom of the harbour waters. Wind can act either to reinforce or weaken the estuarine circulation pattern of the harbour waters, depending on its direction and strength. Other factors, such as tides and currents that vary over periods of hours to weeks, contribute to the circulation and mixing and, at times, are so strong that the estuarine circulation process is altered or even reversed.

The sediments on the sea floor of Halifax Harbour provide a record of the geological and natural history of the formation of the harbour and its use as a depository of wastes since the beginning of significant urban development in 1749. In addition, these sediments have been modified by disturbances such as dredging, construction of docking facilities and water discharge and intake pipes, infilling, mining of sand and gravel, dumping, and dragging anchors as well as the impacts related to significant soil erosion as the result of land clearance and development. These disturbances have interacted with natural processes of sedimentation and sediment transport to produce the present characteristics of the harbour sediments.

Assuming an average annual sedimentation rate for the harbour of about 0.5-0.8 cm, the top 45-75 cm of sediments represents sedimentation since 1900. However, there are areas of the harbour associated with large sewage outfalls with much deeper layers of recent depostions, reflecting significant suspended solids and organic detritus imports via sewage.

The most extensive area of coarse sediment north of McNabs Island occurs in the Narrows. The sediment in that area is mostly cobble and boulders, reflecting the strong bottom currents which scour or limit deposition of fine-grained silts and clays. Limited deposition of fine-grained silts and clays does occur in these areas, but only as a thin layer, in patches, or between large cobble. Other areas of the harbour devoid of fine-grained sediments include the entrance to Bedford Bay, Ives Knoll, the shallow coastal areas to a depth of 10 m, many bedrock shoals in the outer harbour, and large expanses of the outer harbour southeast of McNabs Island. Wave action may account for the absence of sediments in the outer harbour and in the shallow coastal areas. In the inner harbour, north of McNabs Island, many small east-west trending ridges of coarse sediment protrude through the muddy seabed.

Three large mud patches dominate the inner harbour south of the hard gravel seabed of the Narrows. These mud patches extend seaward to the Maugher Beach area of McNabs Island. Mud also dominates the seabed of Northwest Arm and Eastern Passage, generally corresponding with weak flows that occur in those areas.

No direct measurement of sediment transport in Halifax Harbour has been conducted, but certain features can be used to deduce transport patterns. Based on an analysis of sediment grain size in various sedimentary areas, sediment transport appears to be landward in the outer harbour with up-estuary transport occurring into Northwest Arm and on both sides of McNabs Island.

The distribution of geochemical anomalies in harbour sediments in many cases suggests that material from sewage existing outfalls disperses and settles in a northerly direction along the shores of the harbour. Anomalies of mercury occurring in marine sediments suggest that material discharged from the Duffus Street and Tufts Cove areas is transported through the Narrows and deposited on the southeast side of Bedford Basin. In a similar fashion, the sewage discharging at Pier A in the south

end of Halifax Peninsula can be traced up the harbour to an area north of Georges Island.

The inferences for sediment distribution from this circulation pattern would be a general tendency for the finer sedimentary particles on the bottom to move toward the head of the harbour—that is, toward Bedford Basin. Moreover, sewage particles, which enter the harbour waters in the surface layer, will initially be carried southward towards the outer harbour. However, as these particles sink, they would be caught up in the deeper inflow currents and will move back up the harbour. As a result, sewage-derived sediments might be expected to be confined largely to the inner harbour, the Narrows, and Bedford Basin, and the locations of the major sewage outfalls.

In the harbour, currents can change rapidly, with the most familiar variation due to the tidal flows. Wind also can bring rapid and dramatic changes to the circulation by causing surface water to cross the harbour or by stirring up the bottom sediments through wave action. Tidal height ranges in the harbour are moderate, with a maximum of about 2.0 m. The residual circulation of the harbour is significantly modified by strong tidal currents during spring tides and occasionally by meteorological events.

Calculations based on salinity distribution plus actual current measurements show that the strongest average currents occur in the Narrows, ranging 1.7–6.1 cm/s, with the highest values observed along the bottom. In the outer harbour, average currents are strong, with a general flow to the southwest. Evidence from measuring the variation of salinity with depth show that moderate winds can push the surface freshwater to one side or the other of the harbour, depending on their direction.

3.1.2 Marine Chemical Environment

The current water quality in the harbour can be classified under the USEPA criteria as "SC" which is acceptable for boating and other secondary recreational activities, fish and wildlife habitat, industrial cooling, and has good aesthetic value. The latter criteria is sometimes not met in the inner harbour as the result of oil slicks and flotsam and jetsam. Present concentration of faecal coliform and chemical contaminants are higher than those permitted under the "SB" classification, suitable for primary contact recreation and shellfish harvesting following depuration (i.e., restricted shellfish area). Dissolved oxygen levels are greater than the maximum limit for "SA" criteria, indicating that the harbour water is well oxygenated. Total suspended solids concentrations in the harbour were low compared to measurements from Bedford Bay or Pictou Harbour and nutrient concentrations are not excessive.

On a more localized scale, significant deterioration of water quality associated with depleted dissolved oxygen levels, high faecal coliform counts, and accelerated algal growth have been noted within 50–200 m of virtually all the major outfalls.

Most metals are presumed to originate from anthropogenic sources except for elevated concentrations of manganese and iron in some localities that are likely the result of natural processes such as erosion and weathering of adjacent land masses with high mineral concentrations. Despite elevated organic matter in the sediments of Northwest Arm, the dissolved and particulate metal concentrations in the water column are relatively low.

Concentration and distributions of trace metal contaminants in Halifax Harbour sediments are well characterized, but few data are available for trace organic contaminants such as PCB or PAH. Broad areas of sediment in the inner harbour, Northwest Arm, and Bedford Basin can be classified as "contaminated" in that they exceed guidelines recommended for ocean disposal of dredged sediments as set by Environment Canada with respect to the concentration of copper, zinc, lead, and mercury. It is noteworthy that concentrations of lead and PAH exceed "high" concentrations for U.S. harbours and, therefore, could have critical implications for biological impacts. Values for copper and PCB are essentially equal to the "high" values.

Most of these sediments are organic rich with only limited oxygen penetration into the upper 2–5 cm of sediments. As a result, most of the metals such as zinc, lead, and mercury are probably present as highly insoluble metal sulphides.

A rather striking characteristic of the sediments in Halifax Harbour is the extreme spatial variability in metal concentrations throughout the harbour.

Areas of major contamination can be identified by high concentrations of organic matter and metals. Many of these areas are associated with major sewer outfalls (e.g., Duffus Street and Pier A) or with suspected industrial contamination (e.g., the shipyards). Zones of contamination that are smaller than those associated with major outfalls, but may still exceed suggested guidelines, are typically associated with various non-point sources (e.g., run-off from shoreline parking lots) and shoreline disposal (e.g., leaching from Seaview Point).

3.1.3 Marine Biological Environment

The marine communities represented in the harbour range from microbes to whales. With few exceptions, the general taxonomic composition of the various communities is similar to non-industrialized marine bays within the region. The exceptions are those associated with the marine benthic and microbial communities within the harbour. The faunal composition if the marine benthic community is dominated by polychaetes (marine worms). In terms of the microbial community, the harbour experiences high counts of faecal coliform bacteria near outfalls, a common occurrence for waters receiving untreated sewage. It is likely that they are also the habitat areas for lobster in the harbour.

Cod (*Gadus morhua*), herring (*Clupea harrengus*), haddock (*Melanogrammus aegelfinus*), and mackerel (*Scomber scombrus*) are all fished in the harbour. Commercial catches occur in the middle and outer harbour, around and to the seaward of McNabs Island. Pollock (*Pollachius virens*) and flatfish are taken by recreational fishermen. There is a winter fishery for grey sole or witch flounder (*Glyptocephalus cynoglossus*) in deep channels (50-100 m) off Portugese Cove and Pennant Point. There are small runs of gaspereau and salmon in the Sackville River. Many of these species are migratory. There is a trend towards inshore distribution of cod in spring and summer, and offshore distribution in winter.

Eleven marine mammals have been recorded in Halifax Harbour and approaches, including several rare whales and porpoises. The whale species most frequently observed is the fin whale, which has been designated as a vulnerable species. Humpback whales, another vulnerable species, have occasionally been sighted near the mouth of the harbour as they migrate south to breeding areas in the fall and early winter. Minke whales have been seen in the harbour in August. Common dolphins (*Delphinus delphis*), white-sided dolphins (*Lagenorhynchus acutus*), and harbour porpoise (*Phocoena phocoena*) commonly visit the harbour in summer and fall. In summer, schools of dolphin entering the harbour can number in the hundreds. Harbour seals (*Halichoerus grypus*) are commonly sighted as far up as Bedford Basin, especially in winter; up to 75 seals at once have been sighted on the shoal off Point Pleasant. Seals move out of the harbour in May to June for the pupping season. There are no breeding mammals in the harbour.

3.2 Existing Fisheries (as of 1992)

Lobster: Roughly 15 full-time fishermen deploy up to 600 lobster traps in the inner harbour and earn up to $10,000 per person annually. Another 12 full-time fishermen set up to 2,000 traps from Purcells Cove to Herring Cove and make $10,000–$15,000 per person from fishing lobster; eight or nine fishermen earn about $10,000 each lobster fishing from Halibut Bay to Sambro Head; and 40 fishermen set traps in the shallow waters in the harbour approaches, making about $20,000 per person annually. The annual lobster catch in Halifax Harbour is estimated to be between 225 and 400 metric tonnes, or less than 1% of Nova Scotia landings in 1987.

The lobster season in Halifax Harbour extends from the last Monday in November to the end of May. Fishing activities, however, are sometimes limited during February and March due to poor weather conditions. The area within the harbour is fished by fishermen from adjacent communities, primarily Herring Cove, Eastern Passage, Purcells Cove, and Halifax. The lobster fishery is governed in part by unwritten rules concerning who may fish in particular areas.

The dominant lobster fishing ground in Halifax Harbour is centred around Thrumcap Shoal near the south end of McNabs Island. Other productive fishing grounds include the area from Devils Island to Hartlen Point, the south end of Lawlor Island, and along the southern and western shores of

McNabs Island towards Ives Point. Nearshore areas between Purcells Cove and Chebucto Head are also fished, usually by fishermen from Purcells Cove, Herring Cove, and Portuguese Cove. Approximately 75% of the lobster caught by fishermen from Halifax Harbour are caught inside a line between Devils Island and Chebucto Head. The lobster fishery produces more than 65% of the income for these fishermen.

Other Commercial Species: Commercial fishing takes place throughout the harbour, although the inner harbour is limited to commercial hand lining for cod, haddock, and occasionally, mackerel. The same species, plus herring and grey sole, are fished with nets in the outer harbour.

Pelagic species (mackerel and herring) are fished primarily in the fall and early spring using gillnets. Market conditions and catch rates determine the intensity of fishing effort for these species. Even when market prices are low, fishermen will catch these species to use as bait for trawls, handlines, and lobster traps. Nets, and occasionally traps, for herring and mackerel are set at a variety of locations around the outer harbour, in particular close to shore between Herring Cove and Chebucto Head, and towards the mouth of Halifax Harbour between Devil's Island and Chebucto Head.

Groundfish species (cod, haddock, halibut, and pollock) are fished predominantly during the spring, summer, and early fall using gillnets, baited trawls, and handlines. Groundfish are fished primarily towards the mouth of the harbour beyond the edge of Thrumcap Shoal, out 2.5 km to Head Rock Shoal and Portuguese Shoal. Areas in the harbour, including the main channel between McNabs Island and the west side of the harbour, are also fished, usually with handlines. Cod and haddock are the principal species sought in the inner harbour. This fishing takes place sporadically with catches reaching 90 kg/day.

Herring Cove and Area: The present discharge of sewage into Halifax Harbour appears to have a localized effect on the fisheries, particularly in the immediate vicinity of major outfalls (e.g., Watleys Cove). Gear set near these outfalls is readily fouled by sludge and other sewage debris, making the areas unfishable. Most concerns about sewage impacts on the fishery in Herring Cove focussed on gear fouling.

3.3 Environmental Impacts

The major difference between the present project and the HHCI plan is that this project will consist of four treatment plants rather than one single plant (HHCI had also considered a separate Herring Cove facility), with four corresponding outfalls rather than one. There will be no construction of artificial islands associated with the present project, and therefore any impacts expected from such activity for the HHCI project will not occur. The four outfalls will be treated to an advanced primary

level rather than simple primary (which was HHCI's original concept), resulting in a significantly higher quality effluent than would have been the case for HHCI. However, there will be four outfall locations rather than one. HRM will conduct receiving water assimilative capacity studies as outlined in the Nova Scotia Standards and Guidelines Manual for Sanitary Sewage (1993), to establish the impacts on receiving waters in the areas of the four proposed outfalls. In addition, HRM will also conduct baseline environmental quality monitoring beginning this year, to establish existing water quality and sediment quality conditions in the areas of the four proposed outfalls. UV disinfection will be used rather than chlorine, avoiding the impacts of chlorine (or the cost of processes for recovering chlorine prior to discharge). The treatment plants will be located closer to other land uses under this project plan than was the case for HHCI. HRM has committed to working with affected communities to define and implement benefits which can be provided through the project, as well as to utilise current state of the art technology in enclosed systems to minimise odour and noise impacts.

Onshore construction impacts should be essentially similar to those for any construction project, and can be adequately addressed through existing regulatory mechanisms. Marine impacts from construction of the outfall diffusers will be similar in nature to those projected for the HHCI diffuser. Individual diffusers will be smaller under the present project, but four will be constructed, one of which will be located outside of the inner harbour near Herring Cove. Outfall pipes under the present plan may be tunnelled or trenched, depending on individual circumstances. Onshore operational impacts will be similar to those for other treatment facilities of similar design. The potential sites (possibly excepting Herring Cove) will be within approximately 100 meters of residential land use, which would be similar to the present situation at the existing Mill Cove treatment plant in Bedford. While the Mill Cove plant is not entirely enclosed, the proposed plants would involve completely enclosed process systems with odour control.

An analysis of the major project differences between the HRM Harbour Solutions project and the HHCI project is provided in Appendix A.

4. Federal Permits and CEAA Triggers

4.1 Federal Permits

The following permits may be required for the proposed project:

Fisheries Act authorisation (Impacts on fish habitat)	DFO	Fisheries Act ss.35(2)

Navigable Waters Protection Act permit (Construction of outfalls)	Coast Guard	NWPA ss.5(1)(a)
Ocean Disposal permit (Disposal of dredging spoils)	Environment Canada	CEPA

Approvals processes will be initiated as soon as possible, once sufficient design information is available. HRM may initiate these processes, with responsibility for final approvals taken over by the private-sector partner at an appropriate stage.

Provincial permits for construction and operation of sewage treatment plants will also be required. The provincial Minister of Environment has determined that no provincial environmental assessment will be required.

4.2 CEAA Triggers

In addition to the permits above, the following additional CEAA triggers may apply:

Federal lands	possibly DFO, DND and Halifax Port Authority
Federal funds	ACOA (possible funding agency - a funding request to the federal government is in progress)

5. Ongoing and Proposed Studies

The following studies have been initiated by HRM to provide data which will aid in assessing the likely impacts of the project:

Migratory and Nesting Bird Survey: The proposed Herring Cove site has potential for migratory and nesting bird habitat, which must be assessed through field survey. Status: Complete.

Wastewater Characterisation Study: Intended to update information collected by HHCI on the flow volumes and characteristics of wastewater entering the harbour through the sewer system. Status: Complete.

Geotechnical Surveys - Onshore and Marine: In order to assess the suitability of the proposed STP and associated outfall locations, geotechnical surveys of the onshore sites and the marine outfall routes/diffuser sites will be undertaken. The studies of the 4 sites will involve assessment of existing information as well as onsite borehole drilling. Status: Ongoing.

Environmental Site Assessment: Existing site conditions must be assessed, once suitability has been

established. Phase I Environmental Site Assessments will be conducted in accordance with CSA Z768-94. Status: Ongoing.

Marine Benthic Habitat: Evaluation of marine benthic habitat will be made along the proposed outfall pipe routes, and within a 200 meter radius of the proposed diffuser locations. Status: Complete.

Sediment Quality Survey: Evaluation of sediment chemistry at the proposed diffuser locations and potential depositional areas. Status: Completed, in conjunction with marine benthic habitat survey.

Archaeology and Heritage Resources Survey: A Phase I survey combining review of available information with field assessment of potential for both onshore and marine sites. Status: Ongoing.

Oceanographic Modelling and Assimilative Capacity Study: Existing modelling of the harbour will be reviewed and used to predict expected water quality at the diffuser sites based upon wastewater characteristics, treatment levels, diffusion and dispersion characteristics. Assimilative capacity of receiving waters at the sites will be assessed to ensure that regulatory requirements and water quality objectives will be met. Status: Ongoing.

Fisheries Impact Assessment: A survey to confirm and update information on the likely impacts on fishing activity and current license holders, particularly in the Herring Cove area. Status: Complete.

Required field work for most of the studies outlined was conducted during the 1999 field season, with follow-up analysis to be concluded during 1999.

Public Consultation: Public consultation and information efforts are ongoing, and will focus during 1999 on those communities in close proximity to the proposed STP sites.

6. References

HRM / Jacques Whitford Environment Ltd., 1998. Halifax Harbour Solutions Concept Plan.

Halifax Harbour Solutions Advisory Committee, 1998. Final Report to HRM Council.

Halifax Harbour Cleanup Inc. (HHCI), 1992. Environmental Assessment Report, Volume 1. Project Description and Existing Conditions.

Halifax Harbour Cleanup Inc. (HHCI), 1991. Environmental Assessment Report, Marine Biological Environment Component Study.

Halifax Harbour Task Force, 1990. Final Report.

Nova Scotia Standards and Guidelines Manual for the Collection, Treatment and Disposal of Sanitary Sewage, 1992; updated 1993.

7. Project Contact

Questions or requests for further information should be directed to:

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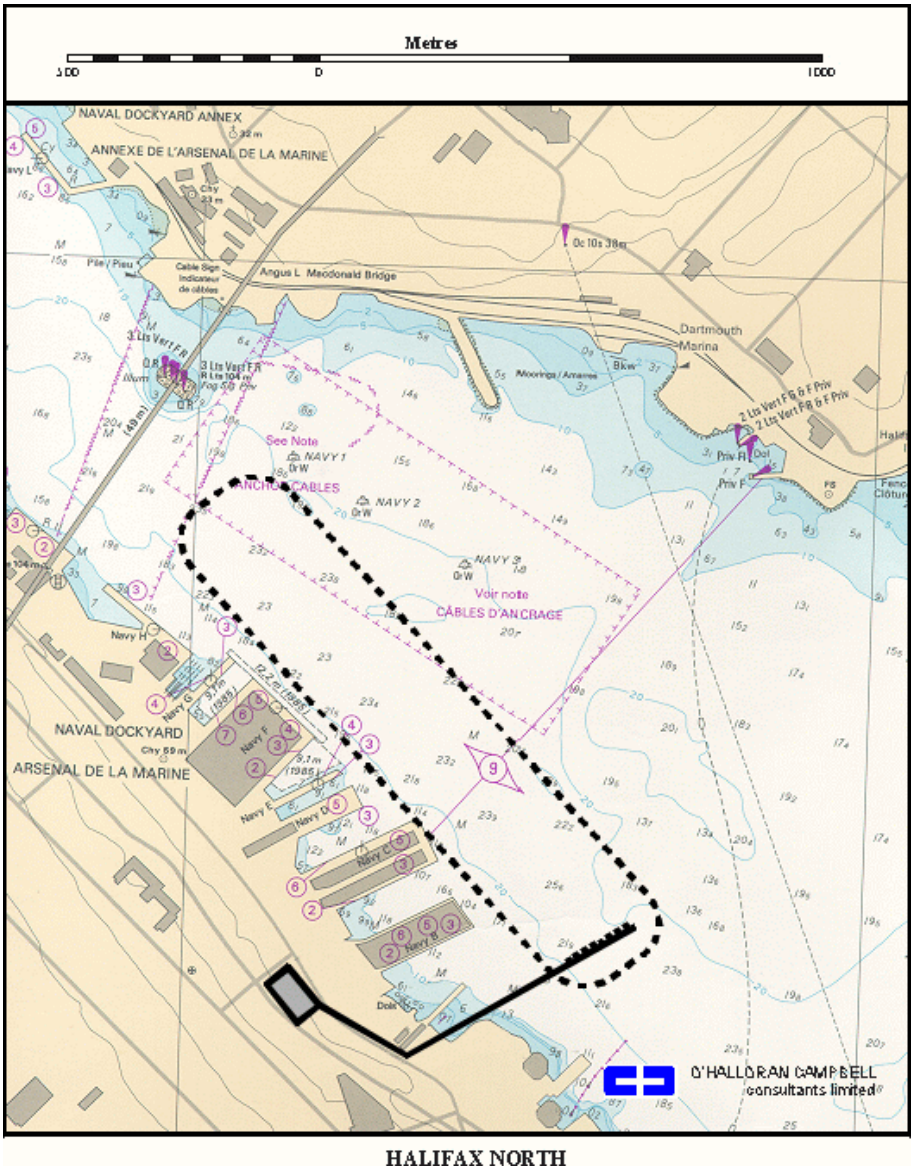
8. Figures and Appendices

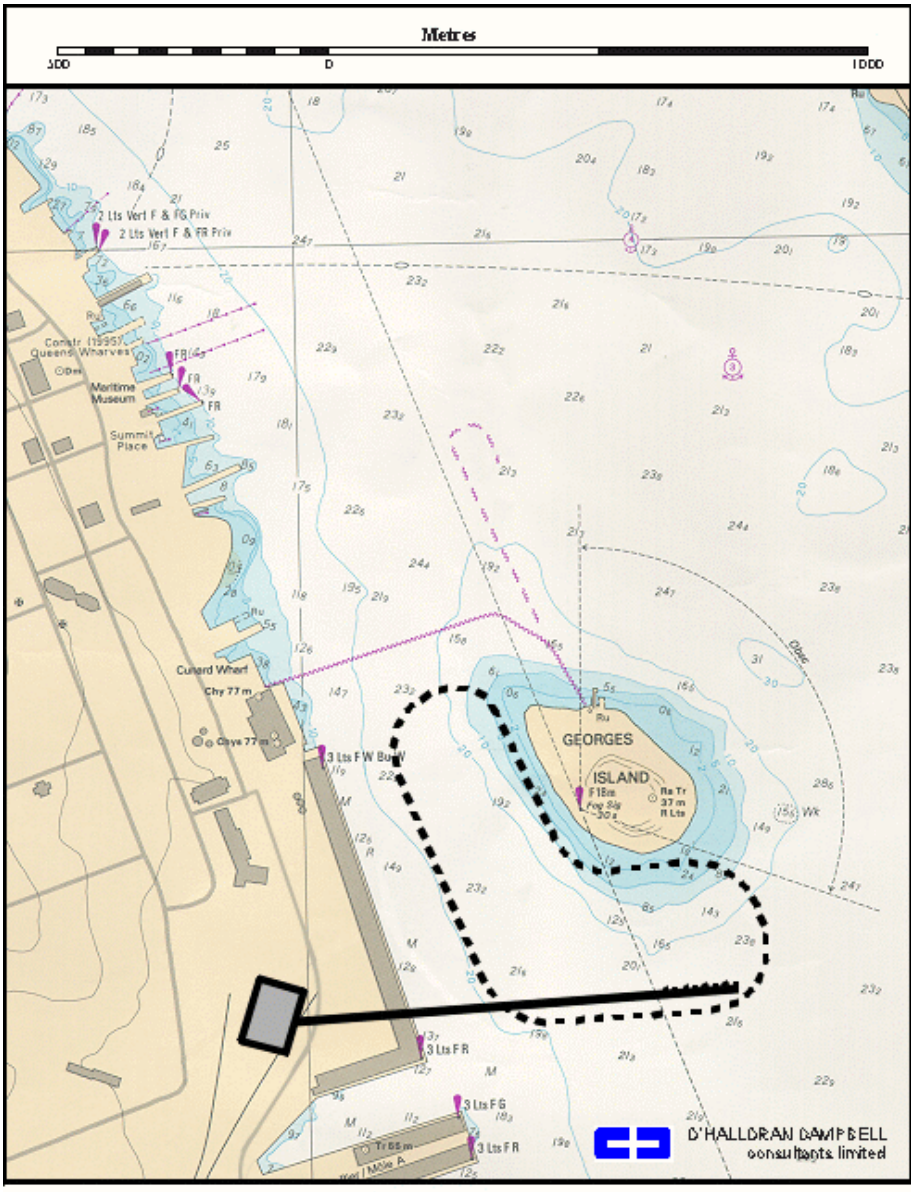
Figure 1. Proposed Sewage Treatment Plant and Outfall Locations.
Dotted outlines show possible outfall areas as defined in the Concept Plan, solid lines indicate outfall suggested locations.

1. A - Halifax North



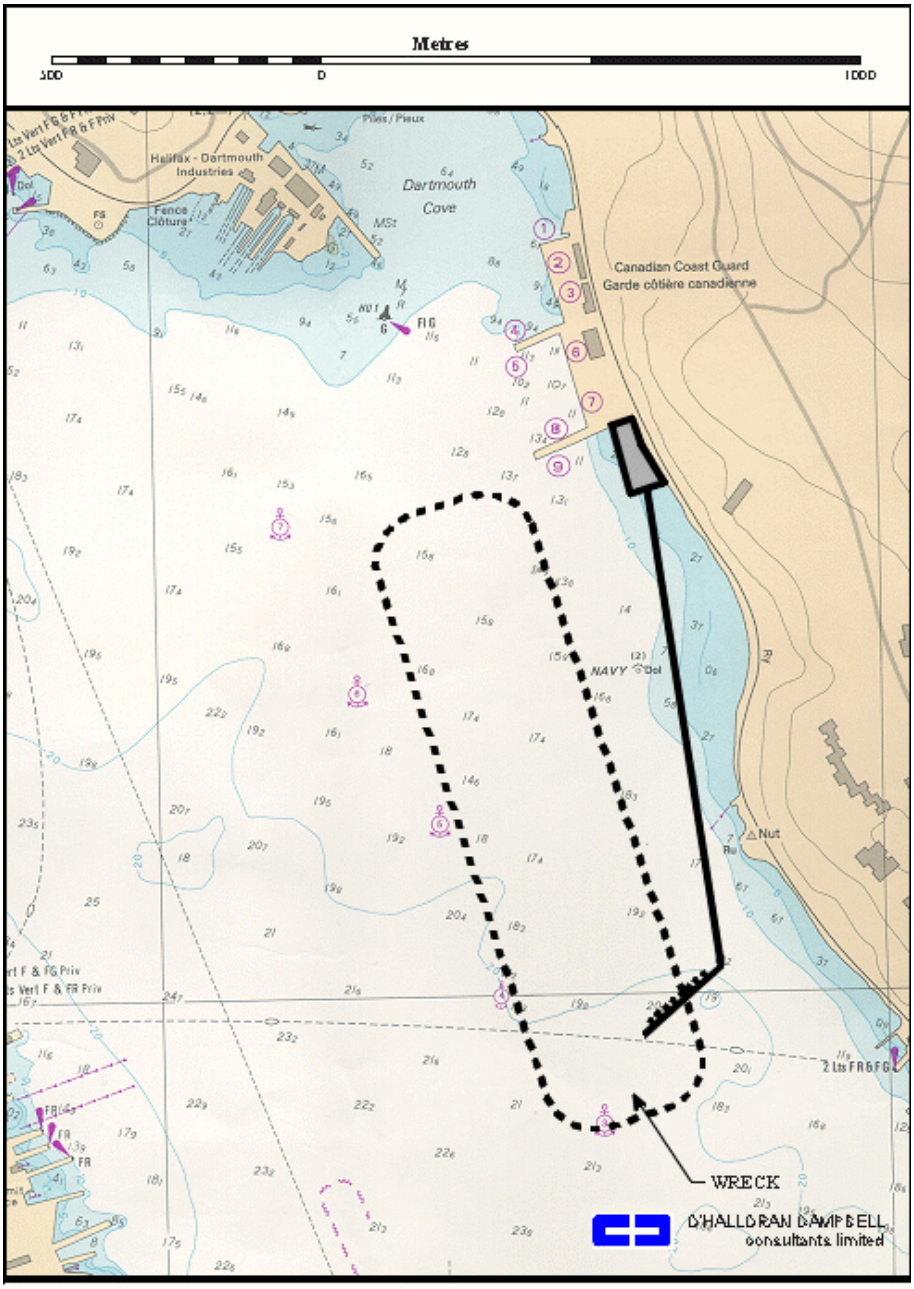
HALIFAX NORTH

1. B - Halifax South



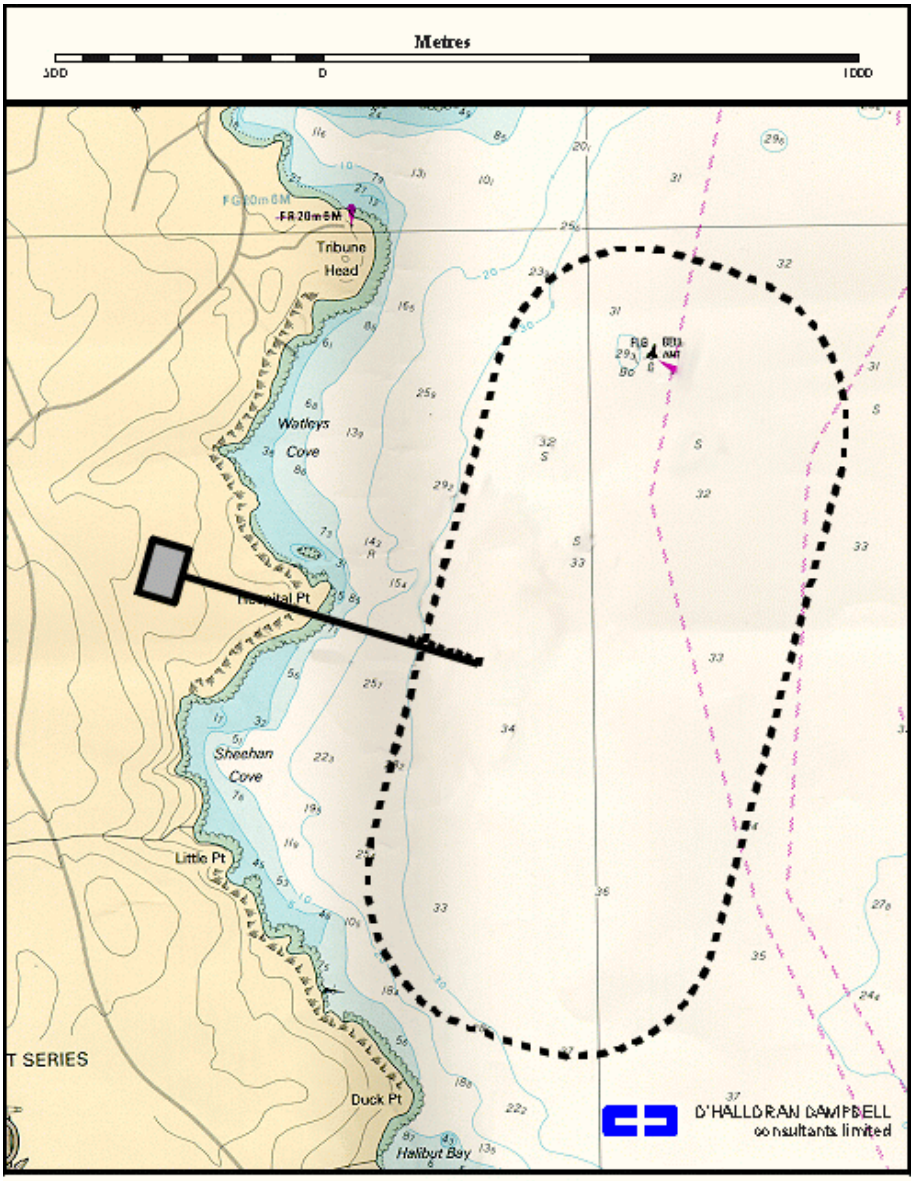
HALIFAX SOUTH

1.C - Dartmouth



DARTMOUTH

1. D - Herring Cove



HERRING COVE

Appendix A. Differences between the Halifax Harbour Cleanup Inc. and Halifax Harbour Solutions Projects

Overview of Key Differences Between Halifax Harbour Sewage Treatment Projects			
Element	**HHCI Project**	**Halifax Harbour Solutions Project**	**Comments**
	Collection System		
Design Capacity	• Normal design flow was 3.8 x Average Dry Weather Flow (ADWF) • Collection system was 25 km long of which 75% was tunnelled. System included interceptor sewers, tunnels, pumping stations, and CSOs to intercept wastewater from 39 existing outfalls • Included 1 major pumping station at the single STP and 4 secondary pumping stations • 2 large “mine head” shafts for tunnels	• Normal design flow will be 4 x ADWF, 75% of total annual flow will be captured and conveyed to treatment facility • Collector system will be approximately 17 km with approximately 22 % tunneled • Includes 10 major pumping stations (includes 1 at each STP) and 6 secondary pumping stations to collect wastewater from isolated areas to major collector system	• Includes approximately 8 km less collection system length, with 53% less tunneling • Current project involves 11 more pumping stations (9 major, 2 minor) • More surface disturbance associated with trenching, but less associated with minehead shafts

Overview of Key Differences Between Halifax Harbour Sewage Treatment Projects			
Element	**HHCI Project**	**Halifax Harbour Solutions Project**	**Comments**
CSOs	• Preliminary treatment to remove floatables and 25 % suspended solids (vortex concentrators) at 14 sites; treatment by sedimentation within consolidation tunnels proposed at Lr. Water Street and Dartmouth Cove • Disinfection was provided at the 2 Northwest Arm CSOs • 75% of the raw sewage and stormwater discharged into the Harbour from existing outfalls was to be intercepted and conveyed to the treatment plant	• CSOs (approximately 15-20) will be equipped with screens or underflow baffles to remove floatables, and disinfected, if required, to meet water quality objectives	• CSO disinfection (e.g. NW Arm) is unresolved (EA/Public issues) • More CSOs under current project with possible land use and water quality implications • Storage at STPs or in tunnels?

Overview of Key Differences Between Halifax Harbour Sewage Treatment Projects			
Element	**HHCI Project**	**Halifax Harbour Solutions Project**	**Comments**
	Sewage Treatment Plant		
Location and size	• Single large regional STP on an artificial island ("Ives Island") approximately 9.5 ha at Ives Cove, 30 m off north end of McNabs Island • One smaller plant in Herring Cove area to service Mainland South	• 4 STPs including 1 in Dartmouth (South side of Dartmouth Cove on Coast Guard Property), 2 in Halifax Peninsula (Railyards area and Cogswell Street Interchange on city property) and 1 in Mainland South	• Larger number of plants = smaller size of STPs except for Mainland South • STPs closer to developed areas potentially affecting land use and raising host community concerns • Less likely to affect an area perceived as parkland (i.e., McNabs Island) • Phasing of project could reduce construction-related impacts
Facility design/Expansion capability	• The STP/OFS was completely enclosed. Space included for doubling initial primary treatment capacity. Upgrading to secondary treatment would require island expansion • Extensive buffers from developed land uses • Odour and noise control • Aesthetics considered in architecture and landscape	• Plants will be "compact" advanced primary type plant in Halifax and Dartmouth. A compact or conventional advanced primary plant will be used for Mainland South depending on site • STPs will be totally enclosed process systems to provide noise and odour control • Buildings shall be designed to provide for future expansion and possible upgrade to secondary treatment of all facilities • STPs shall be designed to be attractive and blend into surrounding area	• Less buffering from developed areas in Halifax Peninsula and Dartmouth • Commitment to work with adjacent communities to make the facilities acceptable and provide benefits

Overview of Key Differences Between Halifax Harbour Sewage Treatment Projects			
Element	**HHCI Project**	**Halifax Harbour Solutions Project**	**Comments**
Treatment level / Disinfection method	• Primary treatment for large STP • Chlorine disinfection for effluent	• Advanced primary treatment for all STPs • UV disinfection	• Advanced primary improves level of treatment • UV disinfection reduces concern with residual chlorine
Outfall design and location	• Tunneled outfall, west-southwest of Ives Point, with a three section diffuser • Outfall for Mainland South STP included diffuser in vicinity of Watley's Cove	• Each STP to have a marine outfall complete with diffusers which may require extension or alteration over time as flows increase • Diffusers located offshore generally in vicinity of STP in areas of sufficient depth and circulation and avoiding navigation concerns.	• Increasing the number of outfalls will result in increased number of affected areas, but with less concentrated impacts on water quality • Except possibly for Mainland South outfall, all other outfalls are located in areas previously unevaluated by EA • Specific areas require oceanographic, geotechnical, habitat and archaeological evaluation
Sludge Management			
Biosolids (sludge) management	• Oil-from-Sludge (OFS) process • Ash to be disposed of in approved manner	• Onsite sludge dewatering and stabilization • Attaining pH >12 would result in product that could be used for land application, site rehabilitation, or composting on a year round basis	• Current process requires more offsite disposal capacity (ash vs. compost) • Different types of air emissions generated (OFS vs. composting)