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Federal Contaminated Sites Action Plan (FCSAP)

Guidance for Assessing and Managing Aquatic Contaminated Sites in Working Harbours

Version 1.1

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DEDICATION

This document is dedicated to Mark Ernest Scott, B.E.Sc (1976-2018) for his 12 years of dedication to Fisheries and Oceans Canada (including 6 of those years involved with the Federal Contaminated Sites Program) and his significant contribution to the development and publication of this guidance document. Mark will be remembered fondly for his boisterous laugh, witty remarks and great sense of humour.

Revision Number	Date of Issue	Author(s)	Brief Description of Change
1.1	November 2021	Fisheries and Oceans Canada	• Improved alignment with FCSAP Decision-Making Framework, Version 4.0 (in press), including use of flowcharts, and updates to FCSAP Phase IV (*e.g.,* site eligibility and prioritization) • Improved alignment with updated legislation relevant to the FCSAP program, such as the *Fisheries Act* (2019) and the *Impact Assessment Act* (2019)

SUMMARY

The primary objective of this document is to provide guidance for the management of federal contaminated sites in working harbours of all sizes that are being addressed under the Federal Contaminated Sites Action Plan (FCSAP). It should be noted that not all contaminated sites in working harbours are necessarily eligible for FCSAP funding; the *FCSAP Directive on Phase IV Site and Costs Eligibility* (FCSAP 2021b) should be consulted to understand the FCSAP eligibility criteria with respect to operational sites.

This guidance document is intended to complement the FCSAP 10-step process for addressing and managing an aquatic contaminated site by providing supplementary guidance at each step of the framework to address challenges specific to working harbour sites. The main differences between this working harbour guidance document and the FCSAP aquatic contaminated sites framework are as follows:

1. The working harbour guidance advises that the Canadian Council of Ministers of the Environment (CCME) Probable Effects Level (PEL) and the CCME Residential Soil Quality Guidelines for the Protection of Human Health (SQG_{HH}) may be used as the screening criteria for the initial assessment at working harbour sites. An exception is made for highly bioaccumulative substances that are present over a large area of the site; concentrations of these chemicals are screened through comparisons to harbour ambient background conditions. New and upcoming Health Canada guidance on assessing risks due to direct contact with contaminated sediments and the aquatic biota consumption pathway should also be consulted when available.

2. General principles and an approach are established in the working harbour guidance for setting achievable remediation and risk management (R/RM) objectives given ongoing inputs into the harbour. These include a well-designed sampling program to establish harbour ambient background conditions. A recontamination evaluation is also conducted at Step 3 to identify potential limits for management actions, and/or at Step 7 once source control has been achieved to the extent possible to define appropriate limits for R/RM objectives.

Guidance on other aspects of site management, such as stakeholder and Indigenous peoples engagement, source control and site closure, is also provided.

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LIST OF ABBREVIATIONS

ASCS	Aquatic Sites Classification System (FCSAP)
CCME	Canadian Council of Ministers of the Environment
COC	Contaminant of concern
COPC	Contaminant of potential concern
CSM	Conceptual site model
CSO	Combined sewer overflow
DFO	Department of Fisheries and Oceans Canada
DLA	Detailed level assessment
DND	Department of National Defence
ERA	Ecological risk assessment
ESD	Expert support department
ESG	Environmental Sciences Group
FCSAP	Federal Contaminated Sites Action Plan
FCSI	Federal Contaminated Sites Inventory
HHRA	Human health risk assessment
HMWG	Harbour Management Working Group
ISQG	Interim sediment quality guideline
ITRC	Interstate Technology & Regulatory Council
LTM	Long-term monitoring
PEL	Probable effect level
RA	Risk assessment
R/RM	Remediation and/or risk management
SAR	Species at risk
SCR	Site Closure Report
SeQG	Sediment quality guideline
SeQO	Sediment quality objective
SLA	Screening level assessment
SQG_{HH}	Soil quality guideline for the protection of human health
US EPA	United States Environmental Protection Agency

1 INTRODUCTION

The Federal Contaminated Sites Action Plan (FCSAP) is a federal program established in 2005 with the goal of reducing environmental and human health risks from known federal contaminated sites in Canada and their associated federal financial liabilities. To achieve this objective, FCSAP provides guidance, tools and resources to federal departments, agencies and Consolidated Crown corporations (collectively referred to as "custodians") to ensure that federal contaminated sites are managed in a scientifically sound and a nationally consistent manner. The FCSAP Decision-Making Framework (DMF) is a 10-step roadmap that outlines the specific activities, requirements and key decisions to effectively address federal contaminated sites in Canada (FCSAP 2018, FCSAP in press). The DMF along with other FCSAP-related resources can be found on the FCSAP website.

1.1 Background and Purpose of this Guidance Document

A working harbour is defined as a harbour that experiences ongoing use for recreational, commercial, residential and/or industrial purposes and that may receive or may have received inputs from current or past activities and/or discharges from surrounding upland or upstream land uses. The federal government owns and manages water lots in large urban harbours as well as hundreds of sites in small harbours across Canada. Many of these working harbours are suspected or known to be impacted by historical contamination (defined in the *FCSAP Directive on Phase IV Site and Costs Eligibility;* FCSAP 2021b) as contamination that occurred at a site prior to April 1, 1998). The FCSAP aquatic contaminated sites framework (FCSAP 2021c) describes a 10-step process that generally encompasses the activities included in the management of an aquatic contaminated site. A flowchart illustrating the FCSAP aquatic contaminated sites 10-step process is shown in Figure 1-1.

While the FCSAP aquatic contaminated sites framework provides a general approach for addressing all aquatic contaminated sites, the need for supplementary guidance was identified to address the additional challenges associated with the assessment and remediation and/or risk management (R/RM) of working harbours. For example, working harbours receive physical and chemical inputs from large catchment areas and are often affected by multiple historical and ongoing sources of contamination, from both surrounding land uses and over-water uses. In the case of large working harbours there are frequently multiple property owners, stakeholders, and Indigenous peoples that must be considered and included in the process of addressing and managing a site. In addition, contaminated media in aquatic environments are generally highly mobile and can potentially migrate over long distances and across property boundaries. Finally, inputs from current harbour activities are ongoing and consequently there is a need to adopt a

practical approach for environmentally sound decision-making that balances socioeconomic considerations with environmental protection.

The primary objective of this document is to provide guidance for the management of working harbour federal contaminated sites that are being addressed under FCSAP (i.e., those sites that are eligible for FCSAP funding). It should be noted that not all contaminated sites in working harbours are necessarily eligible for FCSAP funding; the *FCSAP Directive on Phase IV Site and Costs Eligibility* (FCSAP 2021b) should be consulted to understand the FCSAP eligibility criteria with respect to operational sites.

This guidance document is intended to complement the FCSAP 10-step process for addressing and managing an aquatic contaminated site (FCSAP 2021c) and to establish general principles for addressing working harbour sites (both large and small) within the FCSAP context. To facilitate use of the guidance by custodians and environmental practitioners, the special considerations for working harbours are organized under each related step of the FCSAP 10-step process and address the key decisions associated with each step as identified in the FCSAP DMF (FCSAP 2018, FCSAP in press). The principles provide guidance on how to initiate the assessment for working harbour sites as well as when and how to make the decision to conduct detailed testing and remediate and/or risk-manage a site. Although the same general principles should be applied to all working harbour sites, it is recognized that a “one size fits all” approach is not appropriate or practicable. Each site will require a site-specific approach that considers the size and context of the water lot in relation to the harbour basin, the unique physical, chemical, and biological characteristics of a site and the need to balance stakeholder, Indigenous peoples, and public needs with technological and economic practicability.

This guidance is intended to ensure that due diligence requirements are met for FCSAP aquatic contaminated sites in accordance with the following criteria:

1. Federal sites in working harbours that pose unacceptable human and/or ecological risks to site users are carried forward for further assessment and/or the risks are communicated to affected stakeholders, and Indigenous peoples; and
2. Federal sites that may be a significant source of contaminants that pose unacceptable risk to other areas of the harbour are carried forward for further assessment.

The guidance aims to be sufficiently protective while at the same time recognizing that actions may not be justified for a small site within a large harbour where these actions would not be effective due to recontamination or inability to address risk drivers (for example, the presence of highly bioaccumulative contaminants throughout the harbour). Due diligence, however, requires that known risks are managed and communicated to site users through the posting of signs or by the use of other institutional controls. Due

diligence also requires that sites be carried forward for further assessment if they are a source of contaminants to the surrounding harbour. To support decisions on which sites to carry forward for further assessment, the guidance has identified how to use harbour ambient background concentrations early on in the assessment process (Step 3- Initial testing) to screen out sites where contaminant concentrations are reflective of general ongoing inputs, and how to use the recontamination potential to identify where remediation may not be effective and efforts should focus on risk management until better contaminant source control is achieved.

The objectives of this guidance document are to:

- establish a practical framework for environmentally sound decision-making in the management of FCSAP-eligible sites in working harbours of all sizes that takes into account ongoing uses and inputs and the current and future expected uses and needs of stakeholders, Indigenous peoples and the public;
- provide supplementary guidance within the context of the FCSAP Framework for Addressing and Managing Aquatic Contaminated Sites (FCSAP 2021c) that addresses the specific challenges associated with managing federal contaminated sites in working harbours; and
- facilitate consistency, as is practicable, across federal departments, regions and regulatory jurisdictions for addressing and managing working harbour sites.

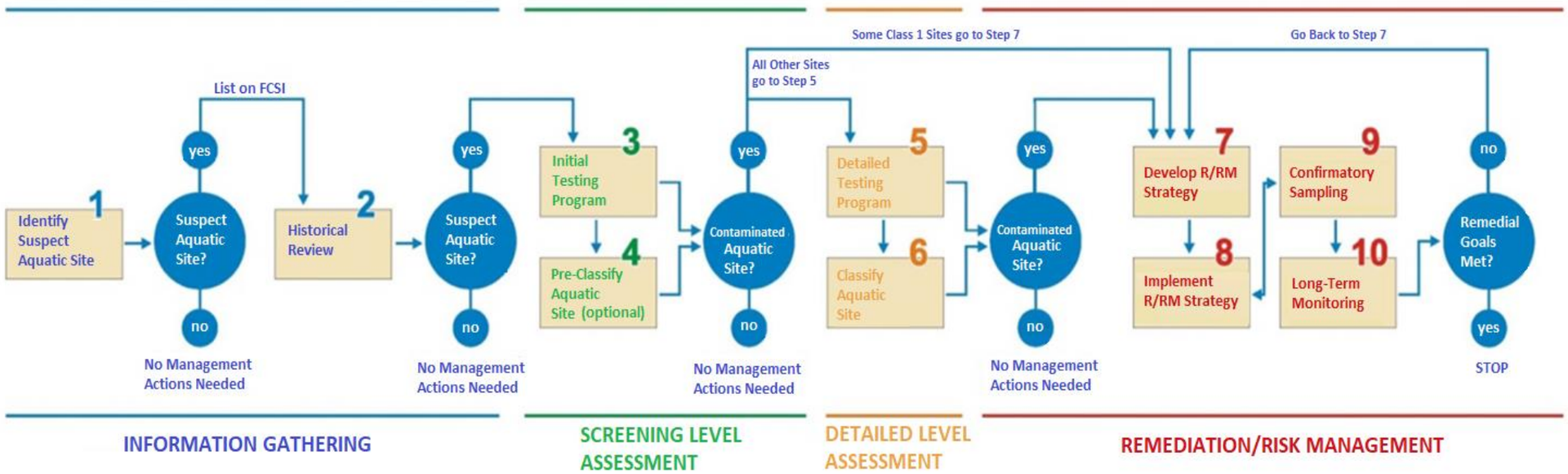

Figure 1-1: The 10 steps for addressing an aquatic contaminated site under the Federal Contaminated Sites Action Plan.

1.2 Scope of this Guidance Document

This guidance document focuses on the assessment and remediation/risk management of working harbours of any size which are federally owned in Canada. It is not intended to provide regulatory or technical guidance on working harbour contaminated sites subject to provincial or territorial jurisdictions, such as may be required for sites undergoing divestiture to non-federal parties. Canada Port Authorities operate at arm's length from the federal government and are generally outside the purview of this FCSAP guidance document. Furthermore, this document is not intended to prescribe the scale, complexity, protocols, data quality objectives or investigation, or remediation methods for meeting the needs of site-specific management. Rather, it presents a framework that can be used to promote national consistency and transparency in the consideration of issues specifically relevant to the contaminated site management decision-making process for federal working harbours. Provision is made for supplementing this guidance with regional approaches where needed (for example, in the case of site divestiture).

1.3 Intended Users

This guidance document has been developed primarily for use by custodial department project managers, expert support department (ESD) advisors and other FCSAP practitioners.

1.4 Development of the Guidance Document

This guidance document was developed in several steps. The initial phase encompassed a case study review of working harbour remediation projects (ESG 2011). This review provided insight on which contamination thresholds trigger the remediation process for different water lot uses, how remedial goals and associated sediment quality objectives (SeQOs) are developed, what protection level is provided by site-specific SeQOs, when institutional controls are integrated, what existing guidance is used, and how stakeholders and Indigenous peoples are involved throughout the assessment and remediation planning process.

The second phase was largely a collaborative process. FCSAP ESDs and custodians/managers of federal working harbour sites were invited by Fisheries and Oceans Canada (DFO) and Environment and Climate Change Canada (ECCC) to form the Harbour Management Working Group (HMWG). Group consultation with the HMWG, as well as personal interviews with DFO, Department of National Defence (DND) and Transport Canada site custodians of water lots in working harbours was undertaken to inform the development of this guidance. In consultation with the HMWG, a list of key questions that the guidance should address for the effective management of contaminated active harbour sites was compiled for each decision step in the FCSAP aquatic contaminated sites 10-step process. To gather feedback on what information

should be included as part of the guidance document, the list of questions (see Appendix A) was circulated to members of the HMWG for review and comment. A list of the members of the HMWG is provided in Appendix B.

To collect information regarding contaminated sites management in small harbours, phone interviews were completed with selected managers of water lots in small harbours across Canada. The interviewees were selected in consultation with DFO as the primary FCSAP ESD providing input to aquatic sites. More information about large working harbours was available in the literature; however, several managers of large working harbour sites were also interviewed. All interviewees were provided with the list of key questions circulated to the HMWG in advance of the interview to solicit responses based on their experience (Appendix A). The names of people interviewed for this project are presented in Appendix C.

The draft guidance and decision-making framework for working harbours were ground-truthed at a workshop with federal custodians and members of the HMWG. The workshop applied the framework to five case studies of federal contaminated sites in working harbours (two from large working harbours, one from a moderately large harbour, and two small harbour sites) to evaluate whether the approach was practical and reasonable, and identify any key challenges and potential solutions to moving through the framework. This version of the guidance incorporates outcomes from this workshop, as well as contributions from members of the HMWG and FCSAP ESDs on earlier drafts.

In addition to consultation with FCSAP practitioners, available guidance materials relevant to the management of working harbours were also reviewed. The guidance materials reviewed are referenced accordingly throughout and included in the References section at the end of this document.

2 ADDRESSING AND MANAGING WORKING HARBOUR CONTAMINATED SITES IN THE CONTEXT OF THE FCSAP AQUATIC CONTAMINATED SITES FRAMEWORK

2.1 Definition: What Is a Working Harbour?

For the purpose of this guidance document, a "working harbour" is defined as a harbour that experiences ongoing use for recreational, commercial, residential and/or industrial purposes and that may receive or may have received inputs from current or past internal activities and/or discharges from surrounding upland or upstream land uses. Working harbours encompass all sizes, from small harbours with moorage for fishing boats to large urban harbours with commercial shipping. To aid project managers in determining whether their site meets the definition of a working harbour, a list of defining characteristics for working harbour sites is presented in Box 1, with examples provided in the text below Box 1. Sites must fulfill both the criteria presented in Box 1 to be considered as a working harbour site subject to the special considerations outlined in this guidance document. All other aquatic sites should be addressed following the FCSAP 10-step process for addressing and managing an aquatic contaminated site (FCSAP 2021c).

Box 1: Defining characteristics of working harbour sites

- Experiences ongoing use for recreational, commercial and/or industrial processes and activities; and
- Receives discharges from internal harbour activities and/or surrounding upland or upstream land uses, including non-point (diffuse) sources of contamination that are difficult to address.

Using the criteria in Box 1, examples of working harbours would include the following:

- A large urban harbour that receives inputs related to internal harbour activities and inputs from surrounding industries and/or municipal activities — e.g., Hamilton Harbour, Victoria Harbour, Halifax Harbour, Port of Montreal.
- A water lot in a small harbour that receives inputs related to internal harbour activities and inputs from surrounding industries, commercial developments and/or urban runoff — e.g., Brockville Harbour, Marktosis (Ahousaht Village), Red Harbour, Grande-Rivière.

However, the following sites would NOT meet the definition of a working harbour:

- An aquatic site where contamination is due to historical sources and no recreational, commercial or industrial activities are currently occurring.

- A harbour that is used for recreational fishing but does not have structures (e.g., docks) in the harbour that are actively maintained.

The guidance in the sections that follow is intended to be applicable to both large and small working harbours. The document is organized according to the stages of the FCSAP framework for addressing and managing aquatic sites (FCSAP 2021c); guidance and special considerations for decision-making at working harbour sites are discussed for each stage.

2.2 Information Gathering — Steps 1-2

The information-gathering stage of the framework for addressing and managing contaminated aquatic sites comprises Step 1 (Identify Suspect Aquatic Site) and Step 2 (Historical Review); Figure 2-1. With regards to working harbour aquatic sites, the approach taken to identify suspected aquatic sites in Steps 1 and 2 does not differ from that used for other aquatic contaminated sites; a brief overview is summarized below. Detailed guidance for the approach for these steps is provided in the FCSAP (2021c) framework for addressing and managing aquatic sites.

The objective of Step 1 is to identify suspected water lots that may have environmental and/or human health concerns. Suspect sites can be identified based on the types of past or current activities at the water lot or from adjacent properties (FCSAP 2021c), similarities to other known contaminated water lots, and/or information from site users or sport fishers (for example, visual evidence of contamination or fish deformities). Sites that may have contamination that poses potential risks to human health and/or the environment are carried on to Step 2. If the site meets the definition of a working harbour (see Section 2.1), the FCSAP working harbour guidance is used to guide the assessment and site management decisions.

Step 2 comprises a review of all the available historical and current information pertaining to the water lot (also known as Phase I Environmental Assessment). Information sources may include, for example, available reports with current and historic information on the subject property and adjacent properties, aerial photographs, and regulatory agency records, as well as a site visit and interviews with persons knowledgeable about the site. The review activities serve to identify potential contaminants and environmental concerns at the water lot, provide an overview of preliminary site characteristics, and draft an initial conceptual site model (CSM) that represents the sources of contamination, exposure pathways and potential receptors at a particular site. Based on the review, sites that may have contamination that poses potential risks to human health and/or the environment, or where more information is needed, are carried on to Step 3 (Initial Assessment). Further details on the approach and specific objectives of the historical review may be

found in FCSAP (2021c); technical guidance for developing CSMs and sampling plans is summarized in CCME (2016a).

Areas of information that are particularly important to document for working harbour sites are discussed in more detail in Section 2.2.1 (Historical Review) below.

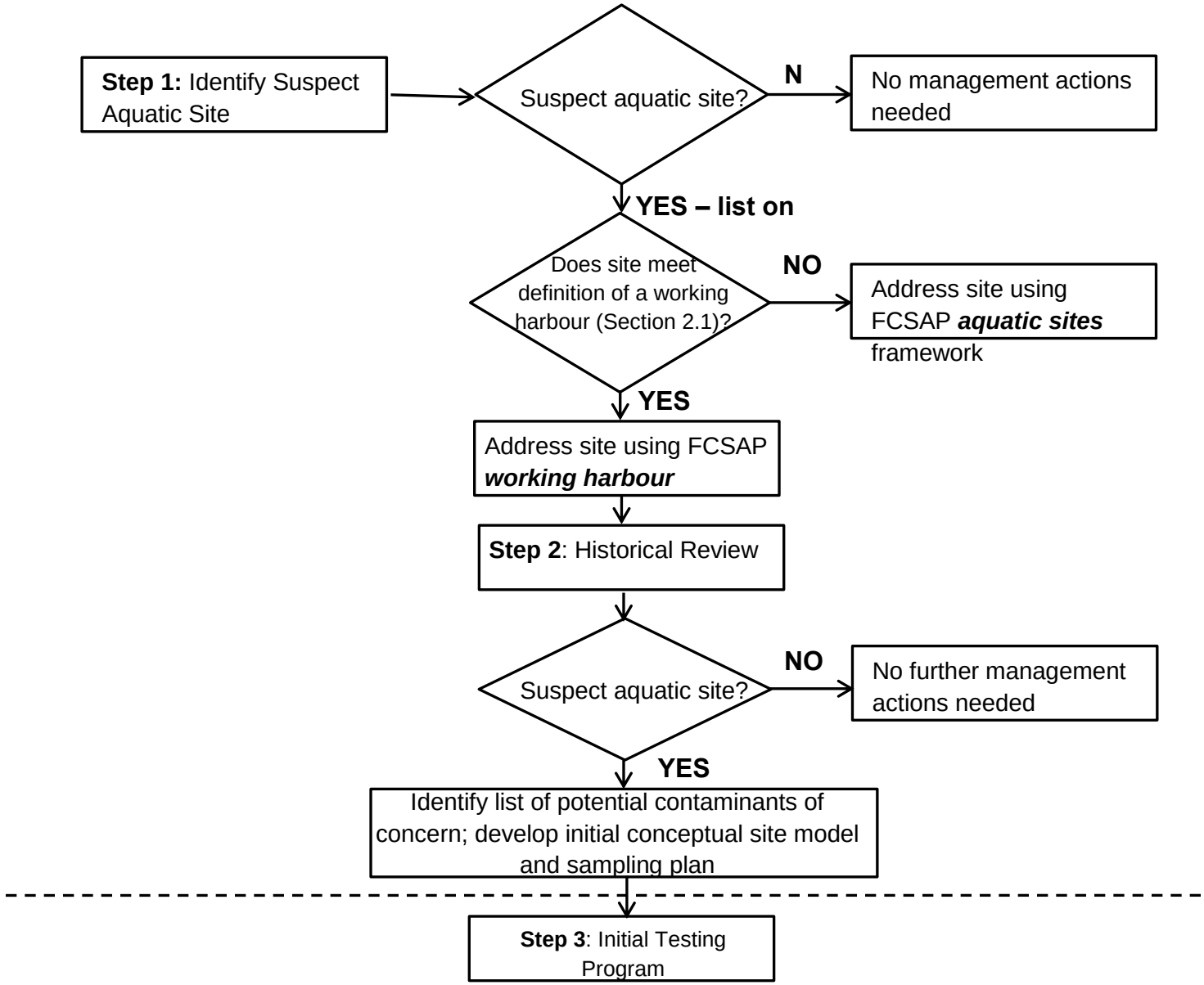

Figure 2-1: Steps 1-2 for addressing federal aquatic contaminated sites in working harbours.

2.2.1 Historical review

A thorough historical review is essential to establish a foundation of what is known about the site and to pinpoint assessment needs. The scope of the historical review and site characterization needs for working harbours will vary depending on the size and complexity of the federal water lot and the surrounding harbour. The potential site characterization needs at contaminated sediment sites listed in Table 1 below (adapted from ITRC 2014) may be used in conjunction with FCSAP (2021c) to focus historical reviews on compiling the available information important for guiding the site investigation and data interpretation. Further guidance on site characterization approaches to assess these needs is presented in Section 2.4 of the Interstate Technology & Regulatory Council (ITRC)'s Remedy Selection for Contaminated Sediments guidance (ITRC 2014).

Table 1: Summary of possible site characterization needs to support remedial option selection for contaminated sediment sites (after Table 2.2 in ITRC 2014)

Site characterization need	Data type
Land and waterway use characteristics	• Watershed characteristics and impacts • Cultural and archaeological resources • Site access • Current and anticipated waterway use • Current and anticipated land use • Confirmed presence of species at risk or associated habitat • Aquatic biota consumption advisories in effect
Physical characteristics	• Water depth and site bathymetry • In-water and shoreline infrastructure • Presence of hard bottom • Presence of debris • Hydrodynamics • Slope and slope stability • Groundwater/surface water interaction
Sediment characteristics	• Sediment stability • Sediment deposition rate • Erosion potential of bedded sediments • Sediment and pore water geochemistry • Geotechnical properties • Grain size distribution • Potential for resuspension/release • Sediment consolidation • Benthic community structure • Bioturbation potential
Contaminant characteristics	• Horizontal and vertical distribution of contamination • Contaminant type • Contaminant concentration • Exposure pathways • Presence of source material • Contaminant mobility (vertical and horizontal) • Contaminant bioavailability and toxicity • Bioaccumulation and biomagnification potential • Contaminant transformation or degradation • Source identification • Ebullition (i.e., movement of contaminants from sediments to water through gas bubble release) • Background and harbour ambient concentrations

Consultation with site custodians of working harbour sites has highlighted the site characterization needs that are particularly important to document.

a) Harbour uses

Both current and expected future use of the harbour waterways and surrounding land areas should be documented as part of the historical review. The review should include use by both human receptors (e.g., navigation, recreation, industrial use) and ecological receptors, including predominant organisms, especially any sensitive habitats and species. Important archaeological features and cultural resources should also be documented as part of the historical review for working harbours, given the long history of human use. A list of examples of harbour uses is provided in Box 2, below. While this list is not exhaustive and may not apply to every working harbour site, it may serve as a guide for historical reviews and will also inform development of protection goals for the harbour if needed at a later stage of the framework.

Box 2: Examples of harbour uses

- Commercial fisheries, shell fisheries or aquaculture
- Commercial shipping
- Ferry terminals
- Float plane use
- Industrial use of water for cooling, washing or wastewater disposal
- Use of water as a drinking water source
- Municipal wastewater discharge
- Recreational boating
- Recreational swimming and/or wading
- Use by Indigenous peoples for traditional purposes
- Human consumption of fish and shellfish through recreational or subsistence fishing
- Provision of habitat for species at risk, fish, shellfish and benthic invertebrates
- Dredging of waterways for navigation

While large working harbours have multiple uses, the uses at small harbours are generally more limited. Most small harbours are used primarily for either recreational purposes or commercial fishing or both, although some also have industrial and commercial activities such as fish processing plants, shipbuilding, and fuel storage.

Health Canada has developed supplementary guidance for assessing human health risks associated with direct contact with contaminated sediment, which includes examples of human use scenarios for the direct contact exposure pathway (Health Canada, 2017). Guidance for assessing human health risks via the consumption of country foods,

including aquatic biota, can be found in Health Canada (2010b). Further guidance on human health risk assessments can be found in Health Canada (2010a and 2021).

b) Current and historical sources of contaminants

Documenting possible historical and continuing sources of contamination to a working harbour site is an important component of the historical review. Generally, sources of contamination to the water body include the following (ITRC 2014):

i. In-water sources — elevated sediment contaminant concentrations related to current or historical discharges to the water body that act as a continuing source of contamination to downstream or adjacent areas (ITRC 2014). Examples include contaminants that have accumulated in sediments as a result of over-water activities (such as fuel spills and ship maintenance and repair) as well as sediment contamination resulting from historical industrial discharges.

ii. Land-based sources adjacent to the water body — including contaminated soil or other materials (e.g., paint) that may enter the water body through erosion and runoff, stormwater discharge, terrestrial activity or episodic erosion during flooding events. Contaminated groundwater discharging to sediment and surface water may also be a source.

iii. Watershed sources — including non-point sources such as urban and agricultural activities and atmospheric deposition.

Gathering information on storm sewer locations and discharges, including combined sewer overflows (CSOs), has been identified as being particularly useful for historical reviews of urban working harbours. For example, a case study review examining recontamination of aquatic sites following remedial activities found that urban stormwater and CSO point sources were identified as the source of recontamination at approximately 50% of the sites (Nadeau and Skaggs 2007). Available information on the frequency and volume of discharges, including CSO events, and any information on potential contaminants in the discharged material should be included as part of the historical review. The information on storm sewer locations and discharges in the historical review may be used in part to guide selection of sampling locations for the assessment program and aid in developing understanding of past and current inputs of contaminants from urban sewer systems.

Identifying potential historical sources of contamination to a large urban harbour can be time-consuming given the number of properties surrounding the harbour. A suggested approach to focus efforts is to conduct a review of aerial photographs of the harbour area at various time periods to identify the main industries and historical harbour uses. The aerial photograph review can be supplemented with other information sources (e.g.,

inventory of coal gasification plants, environmental site assessments of properties that are potentially significant land-based sources of contaminants) where necessary to provide information on past and current potential contaminant sources.

In comparison with the contaminant mixtures often found at large working harbours, where source characterization and control can be challenging, the suite of contaminants commonly found at small craft harbours is relatively well-defined. There could be commonalities among small craft harbour sites within a region that facilitate the development of a risk management framework to assess and screen for potential risks at these sites. Development of terms of references to standardize historical reviews and initial assessments can be useful to facilitate comparing and prioritizing sites for further action. This approach has been used for the assessment of contaminated sites in small craft harbours in the Pacific region (DFO 2013), for example.

c) Existing harbour infrastructure and presence of debris

Working harbours generally have significant in-water and shoreline infrastructure and often contain large amounts of debris (e.g., sunken derelict infrastructure or garbage) in bottom sediments because of the long history of harbour use. The location and anticipated future use of physical infrastructure, as well as the presence of debris and any associated potential contaminant inputs, should be documented in the site historical review, as this information needs to be considered in both assessment and R/RM planning (Step 7 of the aquatic sites framework). For example, creosote-treated infrastructure is commonly found in working harbours. The risk-based strategy developed by DFO (2013) for small craft harbours in the Pacific region stipulates that site investigators should not collect samples for polycyclic aromatic hydrocarbon analysis within 2 m of creosote-treated infrastructure on DFO water lots because the inputs would be considered part of ongoing operational activities that are associated with a beneficial use.

d) Biophysical assessment

Knowledge of sediment sources and sinks, dispersive versus non-dispersive areas and water and tidal currents is critical for developing understanding of how contaminants are likely to be transported throughout the water body. Although important for all aquatic contaminated sites, this information may be particularly significant for working harbour sites, which have multiple sources of contamination and multiple site owners. Site managers may consider contracting an authority with expertise in biophysical assessment to compile and review available information on biophysical conditions as part of the historical review. Information from these reviews is very useful in guiding selection of sampling locations for the assessment program and aiding in data interpretation and source characterization efforts and is also important in developing a feasible remediation

or risk management strategy in later steps of the framework. Further guidance on information to include in a biophysical assessment may be found in DFO (2013) and ITRC (2014).

e) Identification of Stakeholder and Indigenous peoples

Stakeholder and Indigenous peoples involvement in the process of addressing and managing aquatic contaminated sites can be important for working harbours, given the ongoing inputs from current harbour activities, discharges from upstream sources and surrounding land uses, multiple owners and high public interest in addition to the legacy of historic industrial activity. A list of potential stakeholders and Indigenous peoples should be identified during the historical review using the site-specific list of current and future anticipated harbour uses as a guide. The list may include:

- Indigenous peoples and representative organizations who use the area;
- organizations and individuals representing recreational or commercial users of the water body;
- landowners of shoreline properties;
- owners of water lots in the harbour;
- local government representatives;
- environmental regulators (provincial and federal); and
- harbour management organizations.

Harbour authorities overseeing management of small harbours are typically volunteer organizations. Water lots and harbours with government-owned infrastructure (e.g., wharf, shed, or ferry terminal) are usually managed at the federal level in concert with harbour authorities. Larger urban harbours are generally managed by municipalities, while large economically significant ports such as those of Montréal, Halifax and Vancouver are managed by port authorities. The differences in management structure affect approaches taken for stakeholder engagement and source control.

It is also recommended that FCSAP ESDs be engaged early (i.e., in Step 3) to review initial assessment sampling plans and conceptual site models (CSMs). Guidance on stakeholder engagement at FCSAP sites is provided in “Improving Stakeholder Relationships: Public Involvement and the Federal Contaminated Sites Action Plan — A Guide for Site Managers” (Health Canada 2006). Additionally, FCSAP is developing guidance for custodians on engagement with impacted Indigenous peoples (FCSAP, in press).

f) Overall approach

Regarding project management, departmental portfolio managers with multiple working harbour aquatic sites that are similar may consider developing terms of reference for historical reviews that can be applied to all sites in a portfolio. This provides a standardized approach that ensures that all of the important information is captured within the scope of the site historical review, and this also facilitates inter-site comparisons to aid in grouping and prioritizing sites for further action. This approach has been applied, for example, to managing small craft harbour sites in the Pacific region (DFO 2013).

The final step of the historical review is to develop a CSM for the site and a sampling and analysis plan (SAP) for assessment if needed. Further guidance on historical reviews and developing CSMs and SAPs for aquatic contaminated sites may be found in FCSAP (2012), CCME (2016a), and FCSAP (2021c).

2.3 Screening Level Assessment (SLA) — Steps 3–4

The initial assessment and classification of an aquatic site occurs in Step 3 (Initial Testing Program) and Step 4 (Pre-Classify Aquatic Site) of the framework for addressing and managing contaminated aquatic sites (Figures 2-2 and 2-3).

For sites where a potential environmental and/or human health concern or the need for more information was identified in Step 2 (Historical Review), initial testing is carried out in Step 3 to determine the presence or absence of suspected contaminants and to characterize physical conditions. An initial testing program (also known as a Phase II Environmental Assessment) consists of several stages as follows:

- **Planning:** development of a sampling plan based on the results of the historical review. The sampling plan should be tailored in a way that would collect the information needed to adequately answer the questions on the decision-making flowcharts in Figures 2-2 and 2-3. This includes collecting samples to assess chemical concentrations in sediments of the water lot (using the list of Contaminants of Potential Concern (COPCs) identified in the historical review as a guide), as well as information on source characterization (see Section 2.3.3) and recontamination potential (Section 2.3.7). In most cases samples will also need to be collected to evaluate harbour ambient background (see Section 2.3.5). Further technical guidance for developing sampling and analysis plans may be found in CCME (2016 a,d).
- **Field investigation and sampling:** conducting sampling activities following established sampling protocols and quality assurance/quality control (QA/QC) programs (e.g., CCME 2016c).

- **Sample analysis:** analyzing samples for COPC concentrations using accredited laboratory methods (see CCME 2016d).
- **Data interpretation and evaluation:** this includes ensuring that QA/QC benchmarks for the sampling program and data analysis have been met, as well as comparing the results to the questions outlined in the decision-making framework presented in Figures 2-2 and 2-3. The data is evaluated for each individual COPC so that the list of COPCs requiring further assessment can be refined. Further guidance in data interpretation can be found in Sections 2.3.3 to 2.3.7.
- **Refinement of the Conceptual Site Model:** data collected in the initial assessment is used to update the CSM with regards to the nature and location of contaminants, migration pathways, and receptors.

Based on the data interpretation and evaluation for the initial assessment, decisions are made regarding the need for further assessment at the site. At sites where measured chemical concentrations are below guidelines and/or below harbour ambient background concentrations, the site may be closed under FCSAP (see Section 2.3.4 to Section 2.3.6). At sites where chemical concentrations exceed harbour ambient background, but the recontamination potential is evaluated as likely (see Section 2.3.7), the management focus should be on ensuring that due diligence has been completed for the site. Other sites where chemical concentrations exceed harbour ambient background typically proceed to site pre-classification or classification (Step 4; Section 2.3.8 or Step 6; Section 2.4) and further assessment.

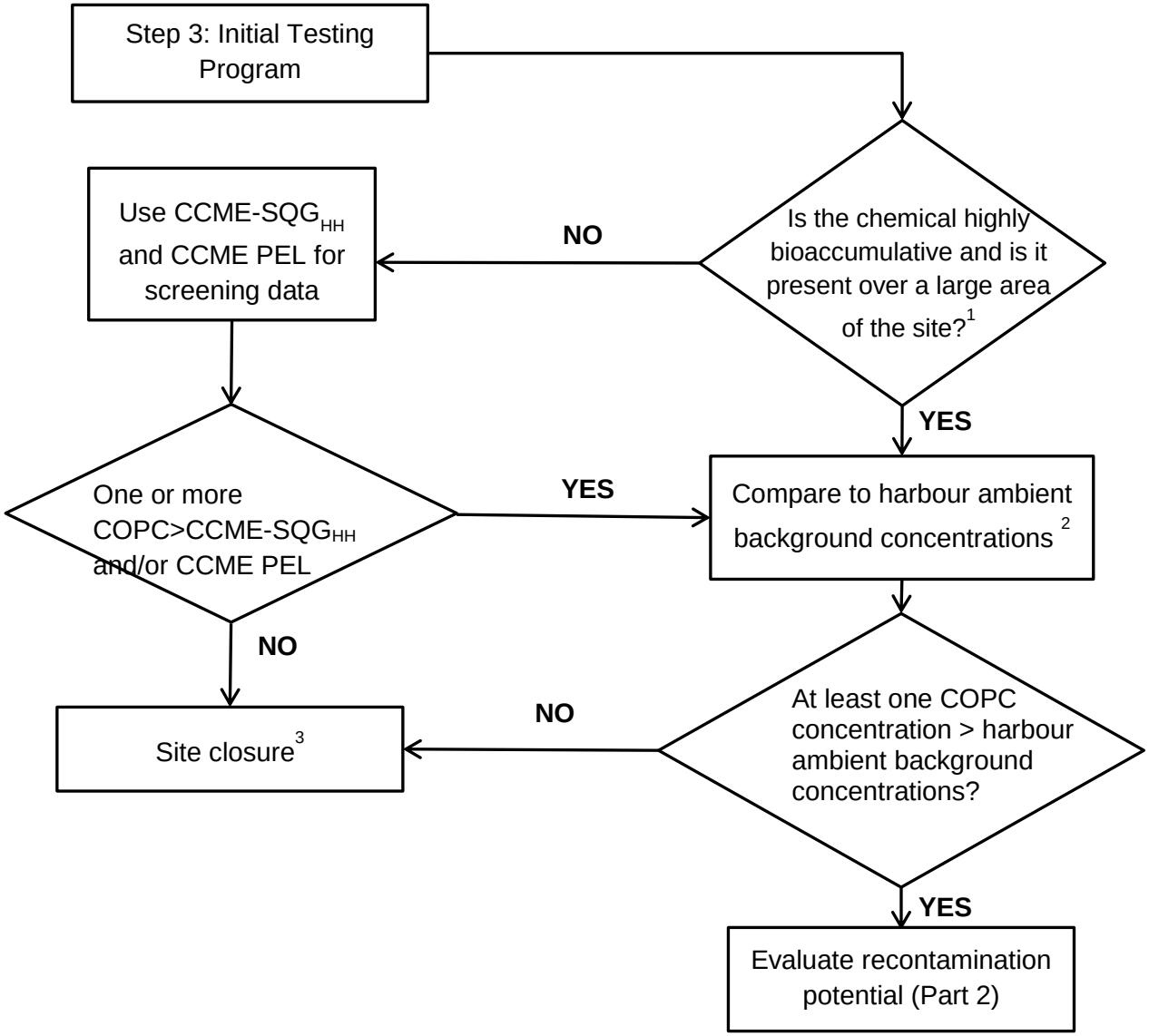

Figure 2-2: Steps 3-4 for addressing federal aquatic contaminated sites in working harbours. Part 1: Initial screening.

1. See section 2.3.4 for more details; a list of highly bioaccumulative chemicals is provided in Box 3.
2. See section 2.3.5 for more details
3. If bioaccumulative chemicals are present in the area, there is potential for risk to humans consuming aquatic biota. Existing restrictions on harvesting and fish consumption advisories should be communicated to site users if necessary as part of due diligence.

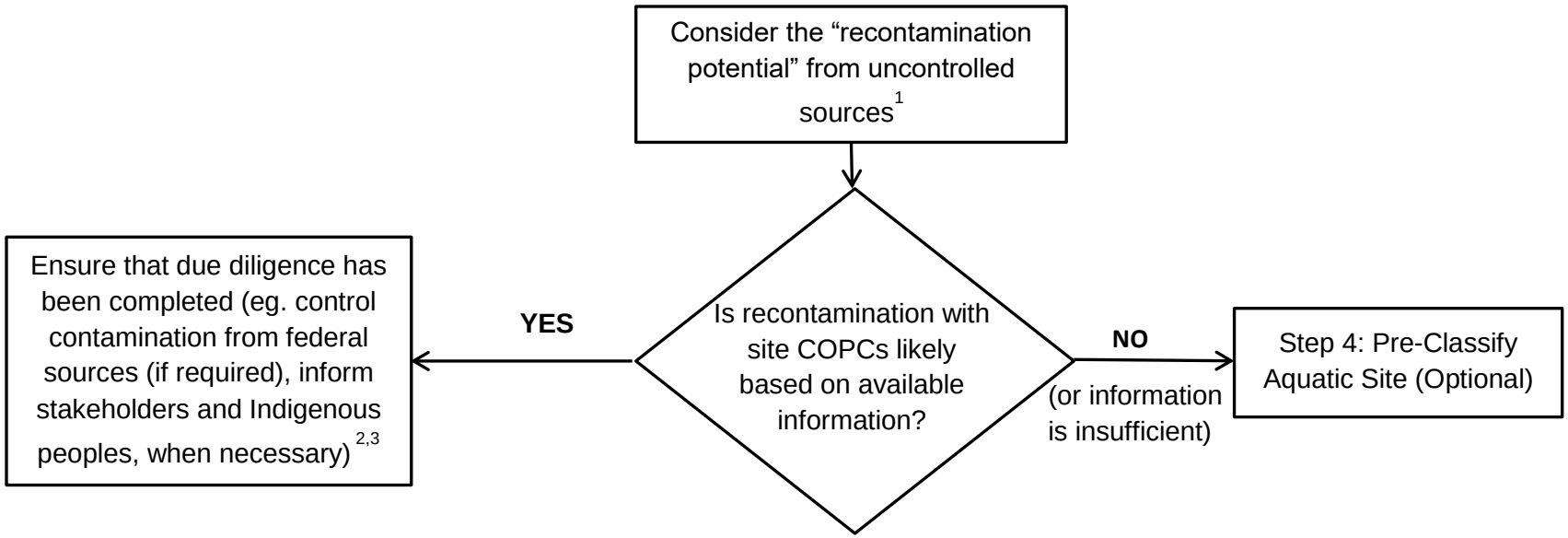

Figure 2-3: Steps 3-4 for addressing federal aquatic contaminated sites in working harbours. Part 2: Evaluation of recontamination potential.

1. Consider point sources (ex. plume of municipal outflows or adjacent contaminated structure or site) as sources and pathways for recontamination, both inside and outside site boundaries. Potential for contaminated sediments to migrate onto the site should also be considered. See sections 2.3.3 and 2.3.7 for more details.
2. If bioaccumulative chemicals are present, there is potential for risk to humans consuming aquatic biota. Existing restrictions on harvesting and fish consumption advisories should be communicated to site users if necessary as part of due diligence.
3. No active remedial actions would be advisable at this time, but risk management (e.g., monitor site, control contamination from federal sources (if required), inform stakeholders and Indigenous peoples) should be considered if necessary. Consider contacting the ESDs for advice on due diligence and moving the site forward through the 10 Step process.

2.3.1 Stakeholder and Indigenous peoples engagement

The importance of early stakeholder engagement and an effective engagement strategy for working harbour projects was emphasized by site managers consulted during the preparation of this guidance and was also identified in a case study review (ESG 2011). It is particularly important for sites with multiple users and high public interest. Benefits of stakeholder engagement include increased stakeholder trust and understanding of the decision-making process for a site, avoidance of conflicts by addressing key stakeholder concerns early in the process, and management of expectations regarding the outcomes and timelines of potential remediation and risk management actions (e.g., a working harbour site will not be returned to a pristine condition).

The relative proportion of federal ownership in the working harbour and the scope of the study are important in determining the appropriate degree of stakeholder engagement for a project which may be initiated as early as Step 3. For example, if most of the water lot area in the harbour is federally owned, it is advantageous for federal custodians to engage other stakeholders and facilitate a group approach to harbour management early on in the assessment process. In contrast, federal custodians of small water lots where most of the area is owned by a third party might contact other stakeholders to discuss potential contamination if warranted, but would not be expected to lead a stakeholder engagement strategy.

Many harbours are located within the traditional territory of Indigenous peoples, and it is important to include them in early engagement as appropriate. Early engagement is important, so that information is received on how people use the harbour, including for harvesting activities, and so that concerns can be incorporated into protection goals for the harbour.

The timing and degree of involvement of different stakeholder groups in the decision-making process is expected to vary based on the size of the water lot and the scope of the study. Stakeholder engagement is left to the discretion of site managers. Some examples of stakeholder and Indigenous peoples engagement at various steps of the FCSAP framework include:

- Contacting property owners to request permission to sample on adjacent properties if needed (Step 3, Step 5)
- Treasury Board policy states that a reasonable amount of effort must be made to recover remedial costs for contamination from responsible parties. If source characterization studies indicate that there are significant uncontrolled sources to the water lot, site custodians should consider contacting responsible parties at Step 5 to discuss the findings and bring the issue to their attention as part of due diligence (Step 5, Step 7). Consultation with federal legal services should also

be considered if there are ongoing sources from third parties that could be contaminating federal property.

- If assessment results indicate that there is significant contamination on a water lot that may have potential human health effects, custodians should consider engaging with harbour users to receive information on how people use the harbour for incorporation into risk assessment exposure scenarios (Step 5, Step 7). Human receptors present at aquatic sites/harbours may include sport and subsistence fishers, workers, and receptors of all ages from the general public and Indigenous peoples communities that may use the harbour or consume aquatic food that has been impacted by chemicals at the site. Development of a culturally appropriate risk communication strategy would also be important in this situation.

Guidance on developing a stakeholder and community engagement strategy for FCSAP sites may be found in Health Canada (2006) Guide for Site Managers. A case study of stakeholder engagement at a small harbour site is also discussed in the Health Canada document. Additionally, FCSAP is developing guidance for custodians on engagement with impacted Indigenous peoples (FCSAP, in press).

2.3.2 Defining protection goals for a working harbour

Given the complexities of working harbour sites with respect to human and ecological exposure scenarios, harbour protection goals should be determined using a site-specific approach. A starting point for defining protection goals for a working harbour is to identify a list of current or future beneficial uses that the water body may provide (i.e., the designated roles that the harbour fulfills, such as commercial fishing or shipping, safe drinking water sources or recreational boat use), including spatial information such as the location of recreational beaches or critical habitat for species at risk (SAR). The key objective of this review is to document human and ecological use of the site, and to use this information when designing the initial assessment program to inform sampling site selection if needed (for example, assessing sediment contamination in the intertidal zone of a site if children are known to play there). Although the list of harbour uses identified in Box 2 above, under Step 2, is not exhaustive and will not apply to every site, it may be used as a guide to facilitate identification of beneficial uses for a particular working harbour site.

The results of the initial assessments conducted at Step 3 may identify beneficial uses that are being impacted by the sediment contamination. If needed, site-specific protection goals would be defined in more detail during Steps 5 and 7, when the human health and ecological risk assessment is completed. Further technical guidance concerning the development of exposure scenarios, receptor selection, CSMs and sampling plans to

support risk assessments may be found in the CCME (2016a) guidance for environmental site characterization in support of environmental and human health risk assessment, as well as guidance for HHRAs (Health Canada 2010a, b; 2017; 2021) and for ecological risk assessments (ERAs) (FCSAP 2012). Early stakeholder and Indigenous peoples involvement in discussions regarding potential options for protection goals and a cost-benefit analysis may be helpful in facilitating decisions about what is reasonable and feasible to protect, as an urban harbour will not be returned to a pristine condition because of ongoing use. Approaches for developing R/RM objectives for working harbours that are realistic given ongoing inputs to the harbour are discussed in more detail in Section 2.5, below.

2.3.3 Source characterization

Identifying the sources of contaminants to a water body is extremely important for working harbour sites to inform control measures and establish the relative contribution between on-site and off-site sources. In addition, FCSAP funds are intended to address historical contamination (i.e., contamination from activities that occurred before April 1, 1998), and so delineating ongoing sources from historical activities is key, although it may be challenging to achieve. Source characterization is initiated in the historical review (Step 2) and refined throughout the assessment process. The following approach is suggested for the characterization of contaminant sources to the water lot(s) during the assessment phase (Steps 2 to 5):

- Contact jurisdictional authorities and/or property owners at Step 2 to obtain copies of any available existing environmental assessment and environmental site assessment reports.
- Conduct a well-designed harbour ambient background sampling program (see Section 2.3.5 below) and use the results of biophysical assessments (for example, sediment sources and sinks) to inform interpretation of potential sources (Step 3, Step 5).
- Conduct sampling at known point sources such as sewage outfalls and industry discharge locations that are entering the water lot directly or are located close by (Step 3, Step 5).
- If there is an adjoining federally owned terrestrial property, sample along the edge of the property (e.g., install monitoring wells in areas most likely to be contaminated) to evaluate whether contaminants are entering from upland sources (Step 5).
- Obtain permission to sample on adjacent water lots if biophysical conditions would facilitate redistribution of sediments from adjacent properties onto the federal water

lot. Use a gradient approach to establish sediment contaminant concentrations in surrounding water lots that may be a source to the site (Step 3, Step 5).

- The level of effort for this sampling will be site specific and will depend on the size of the water lot, the complexity of the harbour, and the number of potential sources. It should include enough samples to identify quantitatively whether the federal property is a significant source of contaminants to the surrounding harbour, or if sediment concentrations are similar or lower than surrounding water lots.

Given dynamic conditions in aquatic environments, it is challenging to delineate federal liability from other liability at large working harbour sites. A suggested approach is to complete a desk-top historical review to identify potential historical and ongoing sources and associated contaminants, combined with assessment sampling (onsite and offsite) to delineate sources as above. When available, good temporal data from regional monitoring programs, such as determining whether a contaminant plume is growing, receding or stable or identifying how fish tissue contaminant concentrations have changed over time, is also useful, particularly for larger sites. Sediment coring studies in depositional areas can also aid in determining whether there have been changes in contaminant deposition over time.

Overall, the level of effort for source characterization sampling programs should be practical, given the costs and uncertainties associated with collecting and interpreting environmental data. In many cases, the balance between historical and ongoing sources of contamination can be determined by apportioning impacts in a relative manner (e.g., the bulk of PCB and lead contamination at this site is from historical sources and therefore merits R/RM action, given risks posed by the contaminants). Detailed technical guidance for developing sampling approaches and determining the level of effort for sediment characterization programs is provided in CCME (2016a). At a minimum, source characterization programs should identify the primary COPCs in the harbour and approximate locations of maximum concentrations, as well as define contaminant concentrations in adjacent areas to the water lot that may be a source to the water lot of concern. Factors influencing the level of effort for sampling programs include (after CCME 2016a):

- Study objectives
- Information available from historical review
- Numbers and types of known potential sources
- Size of the study area
- Types of contaminants

- Physicochemical sediment characteristics
- Accessibility and budget

Sources of ongoing contamination should be controlled to the extent possible before remedial actions are taken; this is discussed further in Section 2.5, below. Where control of an ongoing source is not possible, the recontamination potential for the water lot should be evaluated and taken into account in decision-making at both the assessment stage and the remediation/risk management stage (see Section 2.3.7 and 2.5.2). Action should be undertaken to review and address federal on-site active sources of contamination at this stage through, for example, implementing best management practices to control current inputs and offsite transport.

Further technical guidance for designing and conducting source characterization sampling programs may be found in US EPA (2005), ITRC (2014), and CCME (2016a).

2.3.4 Screening guidelines for working harbour sites

The first step in evaluating the data collected in the initial assessment program involves comparing measured chemical concentrations in sediment samples from the site to appropriate screening criteria (e.g., sediment quality guidelines). The screening comparison serves to identify the subset of chemicals at the site that are present in concentrations above screening criteria for potential human health and ecological effects. The framework in Figure 2-2 outlines the screening process and associated decision-making for determining when a site should undergo further assessment.

Working harbour sites may receive ongoing inputs from harbour activities and upstream land uses and therefore require an assessment approach that balances the need to be protective of human and ecological health with recognition that these sites will continue to experience ongoing inputs. To address this issue, the available screening criteria were reviewed as part of the working harbour guidance development and recommendations were made regarding which criteria to apply for screening sediment contaminant concentrations. These recommendations have been developed to screen contaminant concentrations at sites remaining under federal jurisdiction and may not be appropriate in cases where sites are undergoing divestiture, where additional provincial or legal requirements may apply.

Site managers should be aware that the available sediment screening guidelines are based on risk to benthic invertebrate communities; there are currently no CCME sediment screening guidelines for human health effects. Health Canada has developed supplemental guidance for assessing human health risks due to direct contact with contaminated sediments (Health Canada 2017). This guidance recommends the use of CCME Soil Quality Guidelines for Human Health (SQG_{HH}), residential/urban parkland

land use, for screening sediment contaminant concentrations of non-bioaccumulating chemicals for potential human health effects due to direct contact with sediments. In some cases, the soil quality guidelines may not be sufficiently protective of human health for the direct contact pathway for sediments; for example, where people visit the site regularly and participate in high-contact activities (e.g., shoreline play, wading) or when sediments are fine-grained. Comparing sediment concentrations to harbour ambient background concentrations of chemicals (see Section 2.3.5) may be used as an alternative screening approach in these situations. The Health Canada (2017) supplemental guidance may be consulted for more details on the recommended screening approach, particularly for sites undergoing risk assessment in Step 5.

At sites where humans consume aquatic biota, the CCME SQG_{HH} are not appropriate for screening sediment contaminant concentrations for potential human health risks. COPC screening for the food ingestion pathway should generally focus on chemicals with the potential to bioaccumulate or biomagnify. Health Canada is currently developing guidance to assess human health risks due to aquatic biota consumption at aquatic contaminated sites and this guidance should be consulted when it becomes available. In the interim, the working harbour guidance addresses screening of highly bioaccumulative chemicals in sediment through comparison to harbour ambient background concentrations (see Section 2.3.5).

The CCME sediment quality guidelines (SeQGs) adopted by the federal government were developed using a two-tiered approach. The CCME Interim Sediment Quality Guidelines (ISQGs) include a set of contaminant concentrations that were derived on the basis of the threshold effect level. This value represents the concentration below which adverse biological effects are rarely expected. The CCME guidelines also specify a probable effect level (PEL), which defines the level above which adverse effects in biota are expected to occur frequently. It should be noted that the SeQGs were derived using conservative assumptions; exceedances of these guidelines at a particular site indicate a need for further assessment but are not necessarily indicative of ecological effects.

The framework for addressing and managing aquatic contaminated sites currently recommends using the CCME ISQGs as the primary screening criteria for evaluating contaminant concentrations in sediment measured during the initial assessment phase (Step 3). This approach is protective but, as stated above, is conservative, and exceedance of the CCME ISQG(s) does not always correlate well with actual ecological effects on aquatic receptors. The need for a practical alternative regarding screening criteria for working harbour sites was identified by the HMWG and managers of working harbours.

The outcomes of consultations with the HMWG and other federal contaminated sediment experts determined that the CCME PELs, which are less conservative than the CCME

ISQGs, may be used as the screening criteria for working harbour sites during the initial assessment phase. This decision is also consistent with the DFO national procedure for assessing aquatic sites, which has adopted the CCME PEL as the main environmental standard for initial assessment. Appropriate and recent guidelines from other jurisdictions may be used when a CCME SeQG is not available for a particular COPC (see Section 2.3.1 of the FCSAP aquatic contaminated sites framework (FCSAP 2021c)).

An exception is made for substances that are highly bioaccumulative (see Box 3). The criteria used to define highly bioaccumulative contaminants are consistent with those defined under the Canadian Environmental Protection Act (CEPA) "Persistence and Bioaccumulation Regulations" (CEPA, 1999)[1]. Bioaccumulative substances are chemical compounds that can build up in biological tissue over time to concentrations higher than those present in the surrounding environment (USGS 2015a); persistent and highly bioaccumulative substances often biomagnify (i.e., tissue concentrations of chemicals in organisms at one trophic level exceed tissue concentrations in organisms at the next lower trophic level; USGS 2015b). Even at relatively low concentrations in the aquatic environment, biomagnifying substances may pose risk to upper-trophic-level receptors including humans because of their tendency to build up to high concentrations in organisms and also because of the persistence of many of these substances. For this reason, highly bioaccumulative substances in sediments are retained as COPCs regardless of concentration at working harbour sites during the initial guideline screening phase if they are present at detectable concentrations over a large area of the site. This is consistent with the approach taken for these substances under the COA approach and the FCSAP aquatic sites framework (EC and OMOE, 2008; FCSAP 2021c).

The list of highly bioaccumulative substances provided in Box 3 is intended to provide practitioners with examples of chemicals found in aquatic environments and is not exhaustive; further additions to this list are anticipated as new information emerges on the persistence and bioaccumulation of existing chemicals. For example, the United Nations Environment Program (UNEP) on the Stockholm Convention of Persistent Organic Pollutants (POPs) reviews organic chemicals using similar benchmarks as the CEPA (1999) criteria. A list of POPs identified under the Stockholm Convention (to which

[1] A substance is bioaccumulative:

(a) when its bioaccumulation factor is equal to or greater than 5 000;
(b) if its bioaccumulation factor cannot be determined in accordance with a method referred to in section 5, when its bioconcentration factor is equal to or greater than 5 000; and
(c) if neither its bioaccumulation factor nor its bioconcentration factor can be determined in accordance with a method referred to in section 5, when the logarithm of its octanol-water partition coefficient is equal to or greater than 5

Canada is a party), as well as their properties and use, can be found in UNEP (2019). Some substances which do not meet the CEPA (1999) criteria may still biomagnify; therefore, if a literature review indicates that a substance biomagnifies, it should be treated as highly bioaccumulative regardless of whether or not it meets the CEPA (1999) criteria. The Contaminated Sites Division of Health Canada may also be contacted for more guidance on identifying potentially highly bioaccumulative chemicals when selecting COPCs for inclusion in a human health risk assessment.

Although PAHs may bioaccumulate, they do not biomagnify and are not considered to be highly bioaccumulative under this guidance. Consequently, concentrations of PAH compounds should be screened by comparison to the available CCME PEL guidelines and ambient background concentrations.

Box 3: Examples of highly bioaccumulative substances

- Pesticides
  - aldrin/dieldrin
  - chlordane
  - DDT, DDD, DDE
  - endrin
  - heptachlor
  - isodrin
  - mirex
  - toxaphene
- hexachlorobenzene
- methylmercury
- polychlorinated biphenyls (PCBs)
- dioxins and furans
- perfluorooctoane sulfonic acid (PFOS)
- polybrominated diphenyl ethers (PBDEs)
- organotin compounds such as tributyltin (TBT) and triphenyltin (TPT)

A summary of the overall decision point for guideline screening undertaken in Step 3 is provided in Box 4. The concentration of each chemical is assessed according to the first two decision points of the decision-making framework presented in Figure 2-2. For small water lots, the entire site is considered; large water lots are generally subdivided into areas of concern based on characteristics such as past use and sediment characteristics (see CCME 2016a). If there are no highly bioaccumulative substances present over a

large area of the site/area of concern (for example, detectable concentrations at few or no locations), AND all the sediment COPC concentrations are below the CCME SQG_{HH}, CCME PEL or other applicable guidelines, than no further action is required. All other sites proceed to comparison with harbour ambient background concentrations (Section 2.3.5).

Box 4: Overall decision point for comparisons to screening criteria using the CCME SQG_{HH} (residential land use) and CCME PEL for working harbour sites.

Comparison	Decision
All sediment COPCs < CCME SQG_{HH} (residential land use) and CCME PEL, **and** no highly bioaccumulative substances present over a large area of the site	No further action is required.
One or more sediment COPCs > CCME SQG_{HH} (residential land use) and CCME PEL, **and/or** one or more highly bioaccumulative substances present over a large area of the site	Potential risk; further assessment required. See Section 2.3.5.

2.3.5 Defining ambient background condition for working harbour sites

The definitions for “background” and “reference” conditions used in this guidance are similar to those used in the FCSAP Ecological Risk Assessment Guidance, Module 5: Defining Background Conditions and Using Background Concentrations (FCSAP 2019) with slight modification. They are as follows:

- ***Natural background*** refers to conditions that are representative of naturally occurring concentrations in the environment primarily reflecting local geological variations and not influenced by human activity. They are sometimes referred to as “regional background” or “natural geochemical” conditions (ITRC 2014). For example, sediment concentrations of inorganic elements such as arsenic may exceed guidelines in a region because of weathering of local bedrock that naturally contains high arsenic concentrations.

- ***Harbour ambient background*** conditions are representative of concentrations in the environment that reflect regional anthropogenic (not site-related) sources of contaminants. They account for situations where local conditions surrounding a site are not pristine as a result of non-point sources of contaminants. They are sometimes referred to as “urban background” or “ambient background” conditions (ITRC 2014; FCSAP 2019). In this document, “harbour ambient background” is used to describe sediment contaminant concentrations in the harbour that are reflective of inputs from non-point sources and urban runoff (i.e., ongoing inputs of contaminants that cannot easily be addressed), but not due to point sources such as contaminated upland properties.

The third decision point in the FCSAP framework for managing aquatic contaminated sites involves comparison of measured concentrations of site sediment contaminants to ambient background conditions (see Figure 2-2). The intent of this comparison is to investigate whether concentrations of highly bioaccumulative contaminants and/or chemicals that exceed the SQG_{HH} and SeQGs at the site are also elevated in the surrounding harbour area. Comparison of contaminant concentrations to pristine natural background conditions is not appropriate for working harbour sites, which almost always receive ongoing input from non-point sources such as urban runoff. Initial assessment sampling should include the collection of sediment samples to characterize local harbour ambient background conditions unless 1) these have already been defined by previous environmental studies using methodology and QA/QC appropriate for Phase II investigations; 2) initial assessment data indicate that concentrations of chemicals of interest are either below established regional background concentrations and/or generic environmental quality guidelines; or 3) if ambient background concentrations near the site would most likely be less than the site concentrations (for example, a small harbour in a remote area with few other harbour sources).

Detailed technical guidance on selecting appropriate reference locations for aquatic contaminated sites, sampling design considerations and the importance of matching physical and chemical characteristics of reference locations with the contaminated site is contained in Module 5 of the FCSAP Ecological Risk Assessment Guidance (FCSAP 2019), as well as in CCME (2016a). A summary of the main points as they apply to defining appropriate ambient background for working harbour sites is provided below.

Sampling site selection should be informed in part by the biophysical assessment carried out as part of the historical review (e.g., sediment sources and sinks, prevailing water currents). For example, where the contaminated site represents a well-defined point source into surface water with a constant flow (e.g., streams or rivers), harbour ambient background samples should be collected from upstream locations in areas that receive urban run-off, but are not influenced by point sources of contamination. In larger lakes or

marine environments where the shoreline is typically a high energy environment (i.e., with significant wave action or strong currents), harbour ambient background locations may be selected using a gradient-based sampling method. For smaller lakes and wetlands, where the contaminated site may comprise the entire aquatic habitat, harbour ambient background locations may include upstream aquatic habitats in the same system or similar, nearby aquatic systems with similar non-point inputs.

Contaminant fate and transport in aquatic systems is dependent in part on the physical and chemical characteristics of the water and sediment. To ensure comparability with conditions at the contaminated site, harbour ambient background sampling locations should have similar geographical characteristics (e.g., location, size/area), hydrological characteristics (e.g., flow dynamics, currents, tidal conditions), water depths and water clarity (CCME 2016a). The physical and chemical characteristics of the surface water and sediment at the harbour ambient background locations should also be comparable to those at the contaminated site with respect to pH, total organic carbon (TOC), dissolved oxygen content (DOC), particle size distribution and total suspended solids (TSS). Finally, if the harbour ambient background locations are to be used as part of an ERA in later stages of the aquatic sites framework, the ecological characteristics of the aquatic habitat and the surrounding terrestrial environment must also match those of the contaminated site. Although finding an exact match between characteristics at working harbour site and ambient background locations can be challenging, a practical approach should be taken to find the best available match given conditions in the harbour.

The scope of the harbour ambient background sampling program should depend on the size and the complexity of the working harbour site with respect to ongoing uses and sources of contaminants. The FCSAP ERA background sampling guidance recommends sampling at least four independent locations with two to three random samples collected at each location, for a minimum of 10 background samples in total (FCSAP 2019). Experience from DFO small harbour sites has indicated that carrying out a well-defined background sampling program is very useful for interpreting the site investigation results. Given that initial assessment sampling programs are often limited in scope, “harbour ambient background” can be a moving target that is refined as one proceeds through the site assessment process.

An example of the overall decision point for harbour ambient background condition comparisons is provided in Box 5. When screening against harbour ambient background, those chemicals that are significantly greater in site-impacted sediments compared with harbour ambient background should be carried forward as COPCs for the site. Further assessment of the site may be required to assess whether these COPCs are acting as a source to other areas of the harbour, and to evaluate potential environmental and human health risks associated with the contamination (see Section 2.4, below). In cases where

the site will definitely require risk assessment, other chemical concentrations that are elevated above guidelines but not specifically related to the site in question, may still be retained by the risk assessor as a COPC in the risk assessment to provide a thorough evaluation of risks associated with the site. If concentrations of all of the COPCs for the water lot are not statistically different than harbour ambient background, then no further assessment or remediation is required and the site may be closed (see Section 2.3.6).

Further technical guidance for designing a background sampling program and for statistical approaches to reference site comparisons may be found in CCME (2016a), FCSAP (2019), and EC and OMOE (2008), as well as guidance from Health Canada on evaluating human health risks from sediment contamination through direct contact (HC 2017) and consumption exposure (HC 2010b) pathways.

Box 5: Overall decision point for comparisons to harbour ambient background conditions for working harbour sites

Comparison	Decision
[Concentrations of all sediment COPCs **and** bioaccumulative substances present] < harbour ambient background and not significantly different* from harbour ambient background	No further action required.
[Concentrations of one or more sediment COPCs > CCME SQG_{HH} , CCME PEL, **and/or** one or more bioaccumulative substances present] are significantly* > harbour ambient background	Potential risk; further assessment required.

*statistical significance

2.3.6 Closure of working harbour sites not requiring further action

One possible outcome of the initial assessment screening criteria and harbour ambient background comparisons for working harbour sites is a decision of “no further action required” (see Boxes 4 and 5). In this case, the suspect aquatic contaminated site may be closed under departmental procedures provided that the following items are completed:

- There may be a need to communicate potential harbour-wide risks to site users as part of due diligence. For example, if there are harvesting restrictions (e.g., fish consumption advisories) in place for the harbour and people are known to consume aquatic biota from the federal site, the restrictions should be communicated to site users.
- A quality assurance/quality control check of the initial assessment sampling program should be completed by the site custodian to ensure that the sampling program was robust enough to adequately characterize site contamination in abiotic media (e.g., sediments, water). The revised FCSAP Site Closure Report (SCR) template (FCSAP in press) provides useful checklists that could be used for this purpose. Alternatively, the CCME (2016b) checklists for Phase II environmental site assessments can also be used to verify the quality of the sampling program.
- A brief written rationale for closing the site that documents the reasons for closure should be prepared. The revised FCSAP Site Closure Report (SCR) template (FCSAP in press) may be used for this purpose, or, alternatively, FCSAP-approved departmental site closure documentation processes may be followed. Procedures should be put in place to trigger a review of the site data should the working harbour be decommissioned/divested in the future.

2.3.7 Evaluation of recontamination potential

Assessing recontamination potential from surrounding sources of contamination is important for guiding decisions on the management of contaminated water lots in working harbours. This is especially true for small water lots surrounded by non-federally owned property, where there may be limited capacity to alter risk with remedial actions. To account for this situation, assessment of recontamination potential has been added as a final screening step in the initial assessment of aquatic contaminated sites in working harbours (Figure 2-3).

A suggested approach for evaluating the recontamination potential to the water lot is outlined in Section 2.3.3 (Source characterization). The decision point on Figure 2-3 (“Is recontamination with site COPCs likely based on available information?”) is evaluated based on the results of the source characterization study. The evaluation examines each COPC identified through the comparisons with screening criteria and harbour ambient background. For each COPC, recontamination would be considered likely if one or more of the following conditions are met:

1. Sediment concentrations of site COPCs in the vicinity of the sewer outfall or surrounding water lots are significantly higher than those on the federal water lot

AND biophysical conditions are such that sediments from these areas have a high potential to be redistributed onto the federal water lot.

2. Surface soil COPC concentrations of the adjoining terrestrial property are significantly higher than those in sediments of the water lot and there is reason to believe that there is physical soil erosion onto the water lot.
3. Groundwater COPC concentrations for shoreline wells are much higher than water concentrations in the water lot and there is reason to believe that groundwater is discharging into the water lot.

The evidence for recontamination should be examined individually for each COPC, as there will likely be differences in distribution and recontamination potential amongst the potential COPCs. For example, it is possible that recontamination with inorganic elements could be considered likely for a particular water lot due to elevated concentrations in the sediments of surrounding water lots, while PCB concentrations in the federal water lot sediments are particularly elevated and represent a potential source of unacceptable risk to surrounding areas. In this case, remedial action to address the hotspot of PCB contamination may be justified despite potential recontamination with inorganic contaminants, and the site should continue on for further assessment.

Evaluation of the decision point on whether recontamination of the site is likely should also consider the ownership of the contaminant sources and the potential for implementation of future source control measures (see Section 2.5.1). Sources of COPCs that are under federal ownership and that present unacceptable human health and ecological risks to the harbour should be addressed as part of due diligence for a site. This includes coordination with other federal departments to address contaminated sediments or other media if the adjacent properties or water lots with sources are federally owned. For non-federally owned sources, if source control measures such as encouraging adjacent property owners to follow environmental regulations or stakeholder and Indigenous peoples engagement are likely to be effective, then the site could also proceed to further assessment.

However, when recontamination with site COPCs is evaluated as being likely to occur and there is very limited potential for source control, this needs to be taken into account early on in decision-making for the site. FCSAP will not provide remediation funding for a site if recontamination with uncontrolled sources is likely. Consequently, for small water lots or areas in large water lots where recontamination with COPCs is likely (according to the above criteria) and there is little confidence that the sources can be addressed, the management focus should be on ensuring that due diligence has been completed for the area (see Section 1.1) as active remedial measures will not be effective. Examples of activities to address due diligence include controlling on-site contaminant sources and informing stakeholders and Indigenous peoples and site users of potential risks if

necessary, and using institutional controls that address the specific needs of the site such as harvesting advisories. Federal custodians should consider contacting FCSAP ESDs for advice on due diligence and the suggested approach for moving the site through the 10-step process.

2.3.8 Site pre-classification — Step 4

The FCSAP Aquatic Sites Classification System (ASCS) (FCSAP 2021a) allows for adjustment of the default screening criteria (CCME ISQGs) used in the worksheets as long as a written rationale is provided. On the "Contaminant Characteristics" worksheet of the ASCS, the following modifications may be used to score a working harbour site:

- For chemicals that are highly bioaccumulative and present in detectable concentrations over a large area of the site, the screening criteria columns (user-defined criterion and CCME ISQG) should be left blank. The harbour ambient background concentration (see Section 2.3.5) should be entered into the "Background/reference concentration" column for screening.

- For all other chemicals and at sites where highly bioaccumulative contaminants are only detected at a few sampling locations, the CCME PEL should be entered as the "user-defined criterion" and the harbour ambient background concentration should be entered into the "Background/reference concentration" column for screening. For sites where humans could be exposed to sediments through the direct contact pathway, the residential /urban parkland SQG_{HH} (soil ingestion and/or direct contact pathways) should also be considered, and the lower of the two guidelines (CCME PEL or SQG_{HH}) used for screening. Where CCME PEL are not available for a chemical, appropriate and recent guidelines from other jurisdictions should be used instead. Further details on screening guideline selection are found in Section 2.3.4 as well as FCSAP (2021c) and HC (2017).

- A rationale justifying why the selected criteria are appropriate for the site should be provided in the "Contaminant Characteristics" worksheet and may also be discussed with FCSAP ESDs.

2.4 Detailed Level Assessment — Steps 5–6

The Detailed Level Assessment (DLA) encompasses Step 5 (Detailed Testing Program) and Step 6 (Classify Aquatic Site) of the FCSAP 10-step process (Figure 2-4). As outlined in the FCSAP framework for managing aquatic contaminated sites, detailed testing is carried out to delineate and further characterize the aquatic site contamination and measured/observed or suspected biological effects. Typically, sites that are assessed as INS (Insufficient Information) in Step 4 require further testing, as do high-priority Class 1 sites that will be subject to management actions but for which more information is needed to develop a specific management plan. Depending on the scope of the initial assessment, more information may be needed to refine the definition of the harbour ambient background condition, provide further biophysical assessment, and characterize contaminant sources to the water lot. The second objective of the DLA is to assess if there are biological effects from site contamination in the context of a human health and ecological risk assessment (HHERA). This typically involves establishment of site protection goals and definition of the scope of the risk assessment within a problem formulation stage, followed by assessment of exposure and effects to characterize risks to human and/or ecological receptors. Further details are provided in the following section.

The results of the DLA will be used to address key information gaps and uncertainties, to refine the CSM, to provide information necessary to update the site classification, and to provide information necessary to develop an R/RM plan if required.

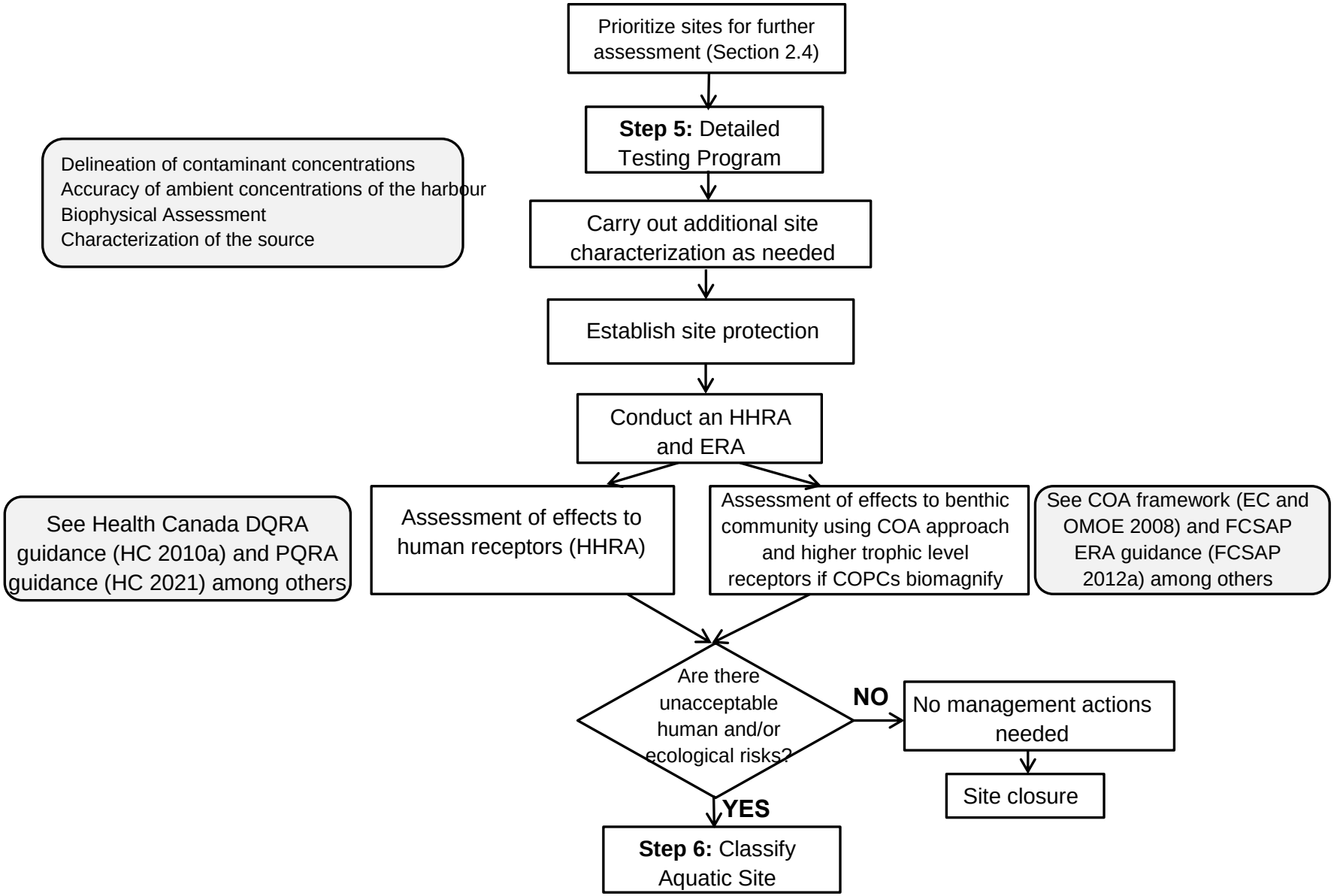

Figure 2-4: Steps 5-6 for addressing federal aquatic contaminated sites in working harbours.

A DLA is almost always required for large working harbour sites. Situations where a DLA would not be required include the following:

- At sites where detectable concentrations of chemicals do not exceed the CCME PEL and appropriate criteria for the protection of human health and are not statistically different from harbour ambient background concentrations. These sites are expected to be closed at Step 3 or pre-classified as a low priority for action at Step 4 (see Sections 2.3.4 to 2.3.8).
- At sites that have operational dredging or where hot spots will be dredged under operational maintenance.
- At small sites with extremely high concentrations of one or a small number of contaminants and documented evidence of human health and/or ecological effects, such that there is no doubt that the site is impacted and needs an R/RM solution.

A particular challenge for managers of small harbours and small water lots is to identify a scientifically defensible and economical approach to determining which sites require detailed assessment, so that sites chosen for DLA are those most likely to exhibit human health and ecological risks necessitating remedial or risk management actions. Experience from site custodians managing large portfolios of aquatic contaminated sites has allowed identification of a number of factors that are important in prioritizing sites for further assessment under Step 5. A list of these is provided in Box 6. Furthermore, within a region there could be commonalities in COPCs, aquatic receptors, and site characteristics among small harbour sites that facilitate the development of a class-based risk management framework to assess and screen for potential risks at these sites. This type of approach has been considered to prioritize DFO small harbour sites for further assessment in the Pacific region (DFO 2013) and Atlantic region. Where available and appropriate, these regional initiatives may also be employed by site custodians to screen and prioritize sites for DLA.

Box 6: Factors that may help prioritize sites for further assessment

- Site classification from the ASCS (e.g., Class 1, Class 2, Class 3)
- Scope of initial site assessment
- Contaminant type and concentrations found
- Size and complexity of the site
- Stakeholder and Indigenous peoples concerns
- Suspected off-site migration of contamination
- Sensitivity and quality of aquatic habitat
- Presence of species at risk
- Human use of the harbour
- Significance of upland sources of contamination

Risk assessment is an iterative process, and it is possible that a more or less detailed HHRA could be completed for a site at different stages of site assessment, depending on site investigation data. Although it is recommended that a detailed quantitative risk assessment (DQRA) be used to estimate human health risk at most sites, the level of detail of the HHRA should be defined on a site-specific basis. Health Canada has developed guidance for assessing human health risks due to direct contact with sediments (HC 2017). Health Canada's guidance on completing DQRAs (HC 2010a) and supplemental guidance on country food consumption (HC 2010b) can be consulted when assessing risks associated with the fish and aquatic biota consumption pathway. The Contaminated Sites Division of Health Canada may also be contacted for more guidance on the subject.

The FCSAP framework for aquatic sites has adopted the Canada-Ontario (COA) decision-making framework for assessment of Great Lakes contaminated sediment (EC and OMOE 2008) to guide the DLA for aquatic contaminated sites. The COA framework uses a weight-of-evidence approach to assess potential biological risks based on biomagnification of contaminants, sediment toxicity testing and benthic community assessments (where site conditions are appropriate). Decision criteria to evaluate potential biological risks for these three lines of evidence are found in Table 1 of the COA framework (EC and OMOE 2008) and in Table 2 of the FCSAP aquatic sites framework (FCSAP 2021c). Assessment of contaminant concentrations in deeper sediments is also completed if there is reason to believe that these deeper sediments could become exposed as a result of natural or human-related factors. The COA framework has been incorporated into the FCSAP ERA guidance (FCSAP 2012) as an approach to evaluate potential risks to the benthic community. If COPCs at the site biomagnify, evaluation of potential risks to higher trophic level receptors is also important, especially for receptors anticipated to have a high degree of exposure to contaminated sediments at the site.

Screening of contaminant concentrations in aquatic food tissue may also be completed if the contaminants are highly bioaccumulative and humans and/or ecological receptors consume aquatic biota at the site. Further technical guidance for completing ERAs for aquatic contaminated sites can be found in FCSAP (2012).

A key component of FCSAP ERAs for aquatic contaminated sites is the evaluation of multiple lines of evidence using a weight-of-evidence approach to characterize overall ecological risk and associated uncertainty at a site (FCSAP 2012). The weight-of-evidence approach integrates the results from each line of evidence used for the ERA (e.g., sediment toxicity testing, benthic community assessment, food chain modelling) and evaluates the degree of concurrence or divergence in the outcomes. Each line of evidence for the ERA is evaluated according to the magnitude of response, causality for the observed effects, ecological relevance, and uncertainty associated with the measurement endpoint. Use of this approach enables risk assessors and site managers to identify which ecological receptor groups are at potential risk, and whether there is good confidence that the observed effects are due to site contamination such that a remedial or risk management solution may be needed.

Several outcomes are possible for the HHRA and the ERA. One possibility is that the site-related COPCs do not pose unacceptable human and environmental risks. In this case, no management actions are needed and the site may be closed under FCSAP. Other possibilities are that potential risks are identified, but further work is needed to refine uncertainties or to identify causation for the potential risks. In this situation, the site would proceed to more detailed risk assessment under Step 7 of the framework.

A key challenge for working harbour sites is defining the level of effort required for the detailed testing program. While the level of effort will be site-specific and depend largely on the size and complexity of the site, it may be guided by looking at general information gathered for similar working harbours. Technical guidance for determining the level of effort required for sampling programs is contained in CCME (2016a) and also in Section 2.4 of the ITRC (2014) guidance document on contaminated sediment remediation, which summarizes the types and amounts of characterization data needed to support remedy selection at an aquatic contaminated site. This information may be reviewed in the context of the CSM for a particular site to determine site characterization needs. In practice, managers of large working harbours have indicated that stakeholder and Indigenous peoples' needs and project management considerations, such as the need to reduce uncertainties with R/RM cost estimates, also influence the level of effort needed for site characterization.

Once the detailed testing program is complete, the site is classified in Step 6 using the FCSAP ASCS. Site custodians should score the site in the ASCS using the suggested approach outlined in Section 2.3.8.

2.5 Remediation/Risk Management (Strategy) — Steps 7–8

The Remediation/Risk Management (Strategy) phase of the FCSAP aquatic contaminated sites framework comprises Step 7 (Develop Remediation/Risk Management Strategy) and Step 8 (Implement Remediation/Risk Management Strategy). Risk management involves developing and implementing a strategy of control of risk and may include institutional controls that decrease the probability, intensity, frequency or duration of the exposure to contamination (CSMWG 1999). Remediation deals with the removal or destruction or containment of pollution or contaminants from media. A framework for Step 7 at working harbour sites is presented in Figures 2-5 and 2-6.

Risk assessment can be conducted in an iterative process such that at Step 7 a more detailed evaluation may be undertaken to refine uncertainties and assess causation for potential risks (see Section 2.5.3.d). If there are no unacceptable risks due to site contaminants of concern (COCs) following the more detailed assessment, the site may be closed at this time (Figure 2-5; see Section 2.3.6). For other sites where unacceptable risks have been identified that warrant an R/RM solution, the risk assessment will likely have identified the COCs and exposure pathways that are the main determinants of overall risk. Source control (Section 2.5.1) measures can then be implemented to address significant uncontrolled sources of these COCs if necessary. A recontamination evaluation (see Section 2.5.2) is then carried out to quantify contribution of COCs from ongoing sources that cannot be addressed (e.g., urban runoff, contaminated groundwater).

The information from the risk assessment and the recontamination evaluation is used in part to derive R/RM objectives for the site as needed (see Section 2.5.3). R/RM objectives are compared with the results from the recontamination evaluation to ensure that the R/RM objectives are not lower than the recontamination potential for the site (see Section 2.5.2). The zones for R/RM are then identified, and an R/RM options analysis is carried out as part of R/RM plan development (Figure 2-6). Evaluation of potential improvements to environmental quality from the R/RM plan (see Section 2.5.4), as well as a cost benefit analysis, are important to ensure that R/RM activities will be both cost-effective and result in significant risk reduction for the site. There is also the option to proceed with the ‘hybrid approach’, which the DMF, Version 4.0 (FCSAP in press) describes as a combined R/RM approach that uses both generic environmental quality guidelines and site-specific quantitative objectives.

Guidance for developing a R/RM strategy for working harbour sites is outlined in more detail in the next sections.

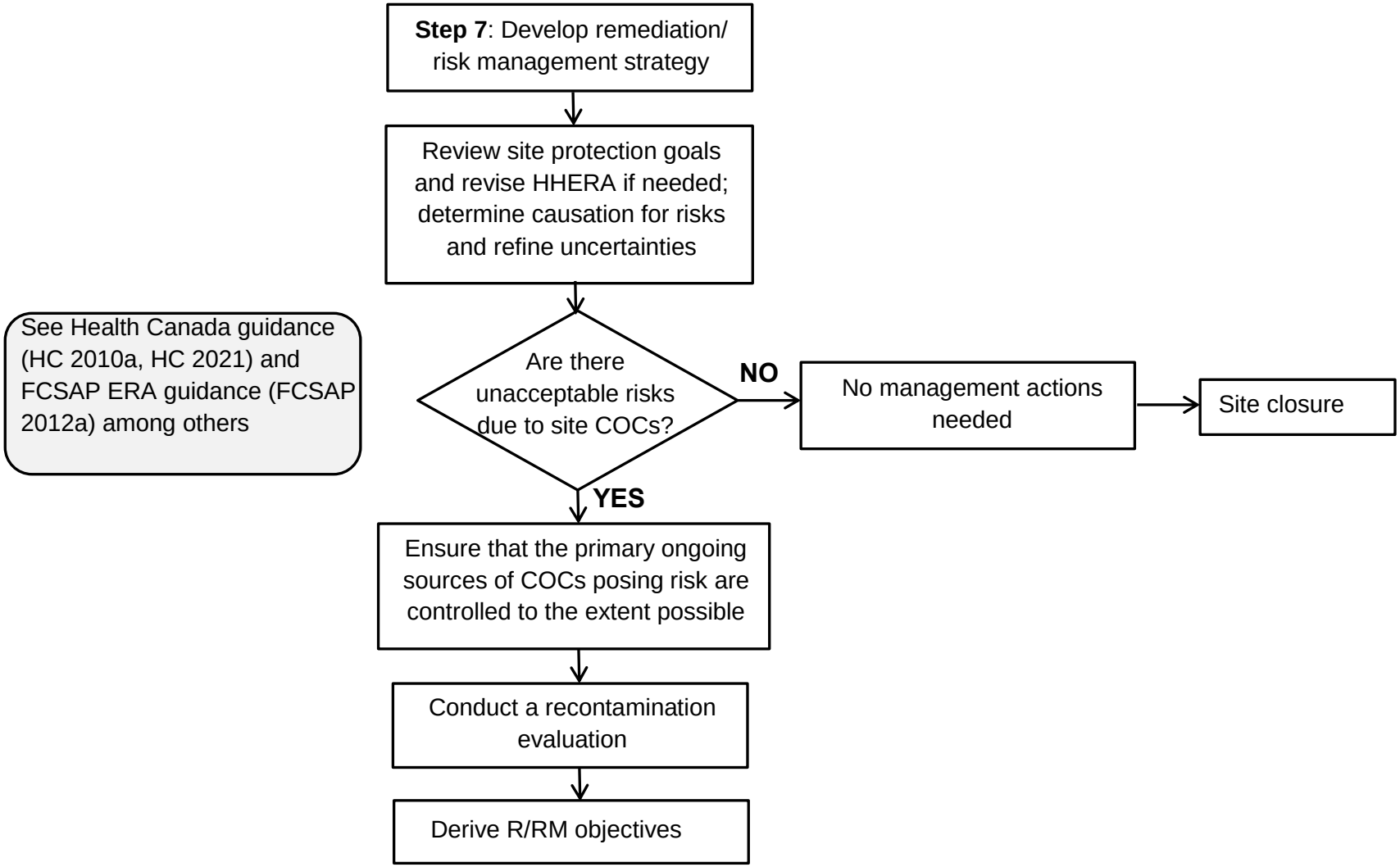

Figure 2-5: Step 7 for addressing federal aquatic contaminated sites in working harbours. Part 1: Risk assessment and source control.

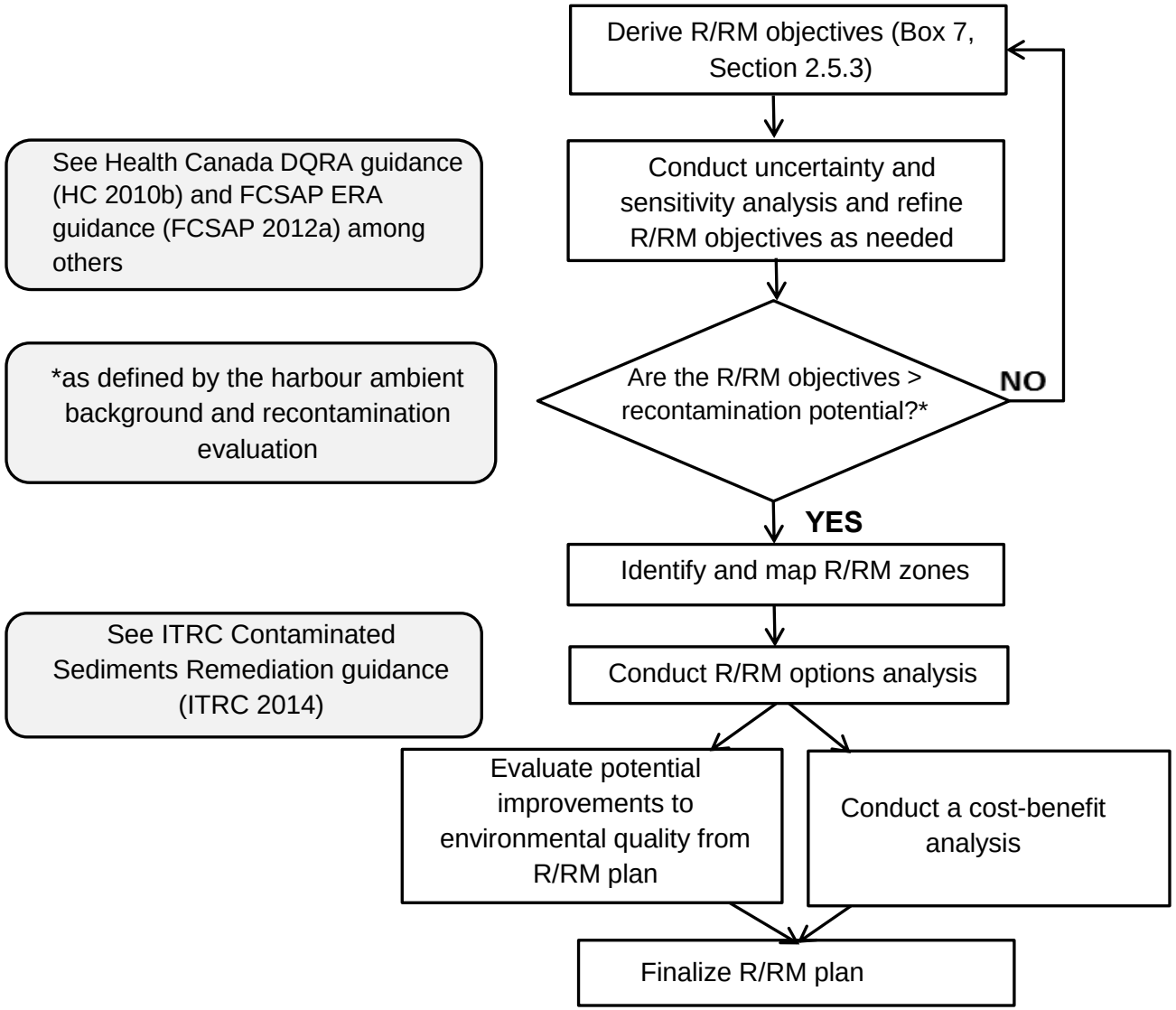

Figure 2-6: Step 7 for addressing federal aquatic contaminated sites in working harbours. Part 2: Derivation of remedial and/or risk management objectives and development of a remedial action/risk management plan.

2.5.1 Source control

An important prerequisite to remedial planning is to ensure that ongoing sources of contamination are controlled to the extent possible to achieve acceptable protection levels before taking remedial action involving physical works (FCSAP 2021c). A key component of any R/RM strategy for working harbours is therefore characterizing and addressing ongoing and historical sources of contamination to the harbour and the water lot (i.e., source control) and determining the extent that they can be controlled given ownership, technical and economic feasibility, use of appropriate best management practices and compliance with current regulatory guidelines. Challenges inherent in the identification and control of sources of contamination are outlined in ITRC (2014). ITRC (2014) includes detailed guidance on source control for contaminated sediment sites that is applicable to working harbours. The main points are summarized below.

As outlined in Section 2.2.1, sources of contaminants to a water body can be classified as in-water sources, land-based sources adjacent to the water body and watershed sources, including urban activities. In general, guidance suggests that in-water sources, including hot spots of contaminated sediment, be considered for early remedial action (US EPA 2005; ITRC 2014). Land-based sources adjacent to an area of sediment contamination should be adequately controlled prior to or in combination with the in-water sediment remediation. Watershed sources contributing to harbour ambient background on a regional level are difficult to control but must be taken into account when setting R/RM goals (see Section 2.5.3, below). Source control efforts should focus on ongoing sources of contamination that have the capability to cause recontamination of an R/RM area.

The list of COCs for the site is formulated during the initial and detailed assessments (Step 3 and 5). Risk assessment can also be initiated at these steps. A detailed risk assessment can be completed based on similar work from earlier steps or revised in Step 7 (see Figure 2-5). The detailed risk assessment includes realistic exposure scenarios to refine major uncertainties in risk outcomes that may have been identified in an earlier iteration of the risk assessment, assesses causation for the identified risks, and evaluates the need for potential action (HC 2010a; FCSAP 2012, 2013b). Once the COCs that are the dominant contributing factors to overall risk are known, the list of ongoing sources of contamination in a working harbour can be reviewed to identify the subset that are primary sources of COCs driving risk at the site. In this way, source control efforts can be focused where they will be most effective in reducing risk.

Large working harbours are typically affected by multiple sources of contamination, and consequently, source identification, evaluation and control is complex and requires coordination with multiple agencies and owners. For small federal water lots in working harbours, the ability to control sources is much more limited and may primarily involve

addressing federal on-site sources, including hotspots of contaminated sediment on the water lot that are acting as an in-water source of contaminants to other areas of the harbour (see Section 2.3.7). To facilitate the management of their aquatic sites, federal custodians may need to engage and/or work with property owners, other levels of government (provincial, territorial and local), Indigenous peoples and community groups to coordinate efforts around source control. Some of these efforts could include:

- implementing short-term institutional controls (e.g., consumption advisories) if needed while source control is pursued;
- reviewing and addressing federal on-site sources as early as possible;
- undertaking hot spot removal or containment in the short term if there are known unacceptable risks to human and/or ecological receptors and if the bulk of contamination is due to historical activities that are no longer occurring;
- encouraging property owners to follow environmental regulations and use best management practices to control current inputs;
- encouraging municipal efforts to address stormwater and CSO inputs, including public education;
- facilitating or participating in a stakeholder group with other property owners to coordinate remedial and risk management efforts to address source issues;
- consultation with federal legal services should also be considered if there are ongoing sources from third parties that could be contaminating federal property.

Further suggestions may be found in ITRC (2014). Ultimately, a harbour basin–wide strategy would be most effective in coordinating efforts from all property owners and users of a harbour to support the long-term effectiveness of R/RM actions aimed at addressing risks to the aquatic environment. However, it is recognized that this is not currently within the FCSAP mandate. As outlined in section 2.3.1, Treasury Board policy states that a reasonable amount of effort must be made to recover remedial costs from responsible parties. If source characterization studies indicate that there are significant uncontrolled sources to the water lot, site custodians should consider contacting responsible parties to discuss the findings and bring the issue to their attention as part of due diligence. Following these efforts, sources of ongoing contamination that are not under federal control are taken into account when setting remedial objectives by a recontamination evaluation, which is described in more detail in section 2.5.2 below.

2.5.2 Evaluating the potential for recontamination following remedial activities

Once sources have been adequately characterized and addressed to the extent possible, a recontamination evaluation should be carried out for the working harbour site as part of remedial plan development. This recontamination evaluation is particularly important for

working harbours, given their complexity and the inherent challenges of source control. For example, a case study review examining recontamination of aquatic sites following remedial activities found that recontamination is most likely to occur as a result of uncontrolled sources (particularly urban stormwater and CSOs) and/or incomplete remediation in the adjacent/upstream portions of the water body (Nadeau and Skaggs 2007). The results emphasize the need for an effective source control strategy and coordination of remedial efforts with other property owners.

Remediation should not be completed if there are significant ongoing point sources of contamination that need to be addressed. However, as discussed above, non-point sources of contamination, such as urban runoff, are difficult to address and contribute to ambient contaminant concentrations in the harbour sediments (i.e., harbour ambient background). The recontamination evaluation seeks in part to quantify these ongoing inputs so that they can be taken into account when designing realistic and achievable remedial goals. The overall objectives of the recontamination evaluation are as follows:

- Ensure that effective control of point sources of contamination has been achieved to the extent possible.
- Quantify ongoing inputs so that realistic remedial objectives may be determined (remediation cleanup objectives should not be lower than harbour ambient background concentrations and recontamination potential).
- Evaluate the CSM assumptions concerning the transport and fate of contaminants in the water body.
- Provide information on limiting factors for remedial strategies that may guide remedy selection. For example, recontamination of sediments from ongoing harbour non-point sources may limit the effectiveness of monitored natural recovery (MNR) in achieving remedial objectives within a reasonable timeframe and needs to be taken into account during R/RM planning.
- Evaluate long-term effectiveness of the proposed R/RM strategy.

Recontamination potential can be evaluated by completing an effective sampling program to characterize harbour ambient background conditions (see Section 2.3.5) and monitoring to quantify current inputs. Depending on the contaminant source, monitoring may be conducted by the federal custodian or be carried out in cooperation with the appropriate authority, such as stormwater monitoring for a municipality. Source characterization activities, including delineation of historical contamination compared with ongoing inputs, should already have been completed for the site by this stage. This information and the CSM should be reviewed to identify key assumptions regarding contaminant fate and transport and to determine appropriate sampling and monitoring locations.

It is particularly important to ensure that biophysical conditions governing contaminant fate and transport at the site are well understood. These include considerations such as the location of areas of burial and dispersion, the sediment regime, sources of disturbance (e.g., propeller wash, bioturbation, tidal action, mechanical dredging) and the extent of mixing in the sediments. A list of factors that may be useful to consider in evaluating potential recontamination is provided in Table 1, under the physical, sediment and contaminant characteristic categories.

Once the current inputs are quantified and the assumptions regarding contaminant fate and transport are evaluated, modelling can be used to assess what this may mean for future sediment and/or surface water contamination. The suggested timeframe is 10 to 20 years but may be longer, based on the COCs and the possible time period for ecosystem recovery. An evaluation of the uncertainties associated with the modelling should be completed.

Designing an effective recontamination evaluation strategy at a large working harbour site will probably require input from professionals with expertise in monitoring and modelling as well as a good understanding of ongoing harbour sources and the biophysical conditions that govern contaminant fate and transport at the site. For small water lots in working harbours, a recontamination evaluation strategy may primarily involve examination of surficial sediment contamination in adjacent water lots that, given biophysical conditions, has high potential to be resuspended and deposited on the federal water lot (see Section 2.3.7). Contaminant input from storm sewer outlets or industrial discharges that may directly affect the water lot should also be considered.

Detailed technical guidance for assessing recontamination potential and modelling contaminant fate and transport may be found in US EPA (2005) and ITRC (2014).

2.5.3 Approach to deriving R/RM objectives that are realistic given ongoing inputs to the harbour

One of the key concerns for working harbour sites is determining an approach to deriving remedial and risk management objectives that are protective yet realistic and achievable given ongoing inputs to the harbour. In essence, this guidance seeks to answer the question “How clean should a working harbour site be following remediation or during the risk management period?” Given the complexities and varying characteristics of working harbour sites, R/RM objectives must be derived on a site-specific basis but should never be more stringent than the recontamination potential that is outside federal control. A risk-based approach that takes into account the current and expected future uses for the harbour is recommended. Many factors should be taken into consideration when developing the R/RM objectives to help determine whether remediation is justified in a working harbour and what level of action is appropriate. Detailed technical guidance on

site characterization needed to support the development of R/RM objectives and key components to consider during the development of remedial action alternatives is found in ITRC (2014). A cost-benefit analysis should also be incorporated into decision-making, as it is often not feasible or cost-effective to remediate to risk-based criteria.

A case study review of working harbour remediation projects examined the process used to define remedial goals and SeQOs for harbours and urban sites (ESG 2011). The review found that initial drivers that prompted remediation were generally based on beneficial use impairments such as degradation to fish and wildlife populations, restrictions on fish/shellfish consumption, human health issues and/or restrictions on harbour uses such as navigational dredging. Sediment contamination exceeding relevant guidelines/criteria was not the initial trigger for remediation. Remedial SeQOs were usually developed using a risk-based or background-based approach using the results of a site-specific human health and ecological risk assessment to upper-trophic-level receptors for bioaccumulative substances and benthic communities for non-bioaccumulative substances.

Several guiding principles for setting realistic and protective R/RM objectives for federal working harbour sites have been established in this guidance. These are summarized in Box 7, and each is discussed in more detail in the text below Box 7. A framework for deriving R/RM objectives and developing a remedial action/risk management plan is contained in Figure 2-6. The guiding principles and framework are applicable to all working harbour sites remaining under federal control, but sites undergoing divestiture to non-federal parties may have alternate requirements for R/RM objectives and R/RM action.

Box 7: Guiding principles for setting R/RM objectives for working harbour sites

a. Ongoing sources of contamination should be addressed to the extent possible before developing R/RM objectives (see Section 2.5.1).

b. Involve stakeholders and Indigenous peoples early in the process of setting R/RM objectives.

c. Work towards removing institutional controls (e.g., consumption advisories) where possible, but recognize that this may not always be feasible.

d. Risk-based R/RM objectives should be based on a risk assessment that is as realistic as possible in terms of exposure scenarios and with the uncertainties defined.

e. The causality and mechanisms for observed ecological and human health effects should be established with a low to moderate degree of uncertainty based on professional judgement.

f. For species at risk, focus on protecting critical and important habitat and documented resident species within the harbour. Consult existing recovery strategies for individual species at risk as well as teams developing recovery strategies for other species.

g. Remedial SeQOs should not be below the screening criteria used in the initial assessment (see Section 2.3.4).

h. SeQOs should not be below harbour ambient background or the recontamination potential for the working harbour site as defined through the harbour ambient background sampling program and recontamination evaluation.

i. Uncertainty in the investigation, modelling and risk assessment outcomes should be acknowledged and considered in decision-making.

a) Ongoing sources

Control of ongoing sources of contamination to the extent possible is an important prerequisite to the development of R/RM objectives (see Section 2.5.1).

b) Stakeholder and Indigenous peoples involvement

While left to the discretion of site custodians, early involvement of stakeholders and Indigenous peoples in the process to set remedial objectives may be important, so that stakeholder and Indigenous peoples concerns may be taken into

account. This engagement also provides an opportunity to gather information about the use of the harbour for risk assessment purposes, and it provides the opportunity to manage expectations, as a working harbour will not be returned to a pristine condition. If risk-based objectives are not feasible, stakeholder and Indigenous peoples consensus on what level of risk is acceptable (e.g., potential effects for 20% of a piscivorous bird population versus no effects) can be critical. Establishing good relationships and transparency early on in the process is very beneficial in terms of coming to a decision on an R/RM strategy that is acceptable to all.

c) Institutional controls

Institutional controls such as consumption advisories are commonly applied in working harbours because local or regional contamination has affected fish and wildlife populations. A long-term goal for all harbours should be removal of consumption advisories, but this may not always be feasible in the short term. Project managers should evaluate the reasons for the consumption advisories, considering especially whether the elevated contamination levels in biota are due to site contamination or reflect regional geological or harbour ambient background concentrations. The difficulty of enforcing institutional controls should also be taken into account during remedial planning.

d) Risk assessment needs

HHRAs may be conducted to varying levels of detail and complexity, depending on the goals for the HHRA, the extent of available data, and the results or outcomes of the initial steps. In some cases, a preliminary assessment may be followed by a more detailed evaluation as part of an iterative process. More and more, on federal sites, HHRAs are site-specific in nature. A detailed quantitative HHRA or detailed ERA is more appropriate for the derivation of remedial objectives in large working harbours, as conservatism is reduced. However, for small water lots or small harbour sites, a detailed HHRA or ERA may not be feasible or justified given the size and lower complexity of the site.

Risk assessments can also be designed to examine causality for the observed effects, an important prerequisite to remedial planning. Detailed technical guidance for performing risk assessments, including considerations for receptor selection, study design and developing site-specific remediation standards, is contained in HC (2010a,b; 2021) and FCSAP (2012, 2013b). Supplementary guidance for addressing risks due to direct contact with contaminated sediment has also been published (HC, 2017).

e) Causality

It is particularly important to carry out a causation assessment at sites such as working harbours that have multiple owners, multiple contaminants, confounding

factors such as mechanical disturbance, and significant harbour ambient contamination (FCSAP 2012). There must be good confidence that the primary contaminants and mechanisms responsible for the observed ecological effects are known before developing site-specific remedial objectives. Module 4 of the FCSAP ERA guidance provides detailed technical guidance on assessing causality for ERAs (FCSAP 2013b).

f) Species at risk

Risk to resident species at risk and/or the presence of critical or important habitat should be assessed if these are known to be present within the harbour (FCSAP 2012). Site-specific biological surveys are often needed and, if this is the case, these should be carried out under the risk assessment activities to aid in defining ecological protection goals. The existing recovery strategies for individual SARs and the task teams developing recovery strategies for other species should be consulted. Further technical guidance for assessing risk to SARs may be found in the FCSAP ERA guidance (FCSAP 2012).

g) Lower limits for R/RM SeQOs: screening guidelines

The R/RM SeQOs should not be set below the screening guideline used in the initial assessment (e.g., CCME SQG_{HH} or CCME PEL). Identification of areas requiring further site investigation and potential remedial activities may have been based in part on the use of the screening guidelines. Using a more stringent guideline is not appropriate at this step of the framework as it will almost certainly not be achievable.

h) Lower limits for R/RM SeQOs: harbour ambient background concentration and recontamination potential

Lower limits for the R/RM SeQOs can also be set by examining the harbour ambient contaminant concentrations defined through the harbour ambient background sampling program and the recontamination evaluation. These represent the baseline sediment contamination that is due to ongoing non-point sources within the watershed including urban runoff, and it will not be feasible or practical to remediate to below this level.

i) Acknowledging uncertainty

Uncertainty is inherent in environmental investigations and in risk assessment. Key uncertainties in the assumptions used to develop the R/RM SeQOs should be identified and refined by additional data collection and/or better modeling if possible. A sensitivity analysis can be used to examine the influence of uncertainty in the investigation, modelling and risk assessment assumptions on the derivation of R/RM SeQOs. Further guidance for these is contained in FCSAP (2012). For example, biota monitoring to examine contaminant bioavailability may be important

for sites where human health and/or ecological risks are due to biomagnification of contaminants through food webs, to test assumptions concerning links between site contamination and biota uptake.

j) Cost-benefit analysis

Although a risk-based approach is recommended for deriving R/RM SeQOs, achieving the risk-based targets is sometimes not feasible or would be prohibitively expensive. A cost-benefit approach should be used to examine the relative reduction in risk associated with various R/RM SeQOs with the corresponding remedial costs to achieve a practical balance between the two. The R/RM SeQOs should also be associated with improved outcomes to beneficial uses (see examples of harbour uses in Box 2) so that costs can be weighed against tangible benefits to the harbour system. Examples of using cost-benefit analyses to evaluate remedial action alternatives are provided in ITRC (2014).

2.5.4 Evaluating improvements to environmental quality and associated valued ecosystem components/beneficial uses from the suggested R/RM plan

Predicting and assessing improvements to environmental quality that would result from a proposed R/RM plan can be challenging for working harbours because of the elevated harbour ambient concentrations of contaminants. Several recommendations for an approach to evaluating improvements to environmental quality are as follows:

- Ensure that a causality assessment has been carried out for the working harbour to identify the primary contaminants and mechanisms driving the risk to receptors at the site. This may include examining the CSM critically for assumptions about linkages between historical contamination and ecological/human health risks and for ways in which the R/RM plan works to address these. These assumptions can be tested through monitoring and modelling, as in the recontamination evaluation described in Section 2.5.2. Further guidance for causality assessments is provided in the FCSAP ERA guidance, Module 4 (FCSAP 2013b).

- Link expected remedial and/or risk management outcomes to improvements in the ability to achieve the beneficial uses for a particular harbour (see Box 2 for a suggested list of harbour uses).

- Evaluate the uncertainty associated with the ability to achieve the remedial goals for each proposed remedial option.

- Design a long-term monitoring (LTM) plan to monitor remedy effectiveness and ecosystem recovery. The LTM plan should monitor ecosystem components that are related directly to the remedial goals to ensure that the goals are achieved. Adaptive management should be used to alter the remedial action strategy if

needed, based on the LTM outcomes. Further guidance for designing LTM plans may be found in FCSAP (2013a).

2.6 Confirmatory Sampling and LTM— Steps 9–10

The final phase of the FCSAP aquatic contaminated sites framework comprises Step 9 (Confirmatory Sampling) and Step 10 (Long-term Monitoring); (Figure 2-7). The goals of this phase are to document the success of the R/RM strategy and implement additional actions if needed, and the process is very similar for working harbour sites as for other contaminated sites. In Step 9, the results from confirmatory sampling are compared with the short-term R/RM objectives (Figure 2-7). If the R/RM objectives are not met, then further implementation of the R/RM strategy occurs. When all of the R/RM objectives have been met, the site either is closed or proceeds to long-term monitoring if needed (see FCSAP 2013a for guidance). For sites undergoing long-term monitoring in Step 10, site closure can occur when all of the R/RM goals of the LTM are met (see Section 2.6.2). Given the dynamic nature of working harbours, periodic monitoring to confirm that the assumptions of the remedial action/risk management plan remain valid and assess recontamination will likely be needed. Further guidance on evaluating the effectiveness of the site management strategy when recontamination occurs, as well as determining how and when to close a working harbour site within the FCSAP context, is provided in the following section.

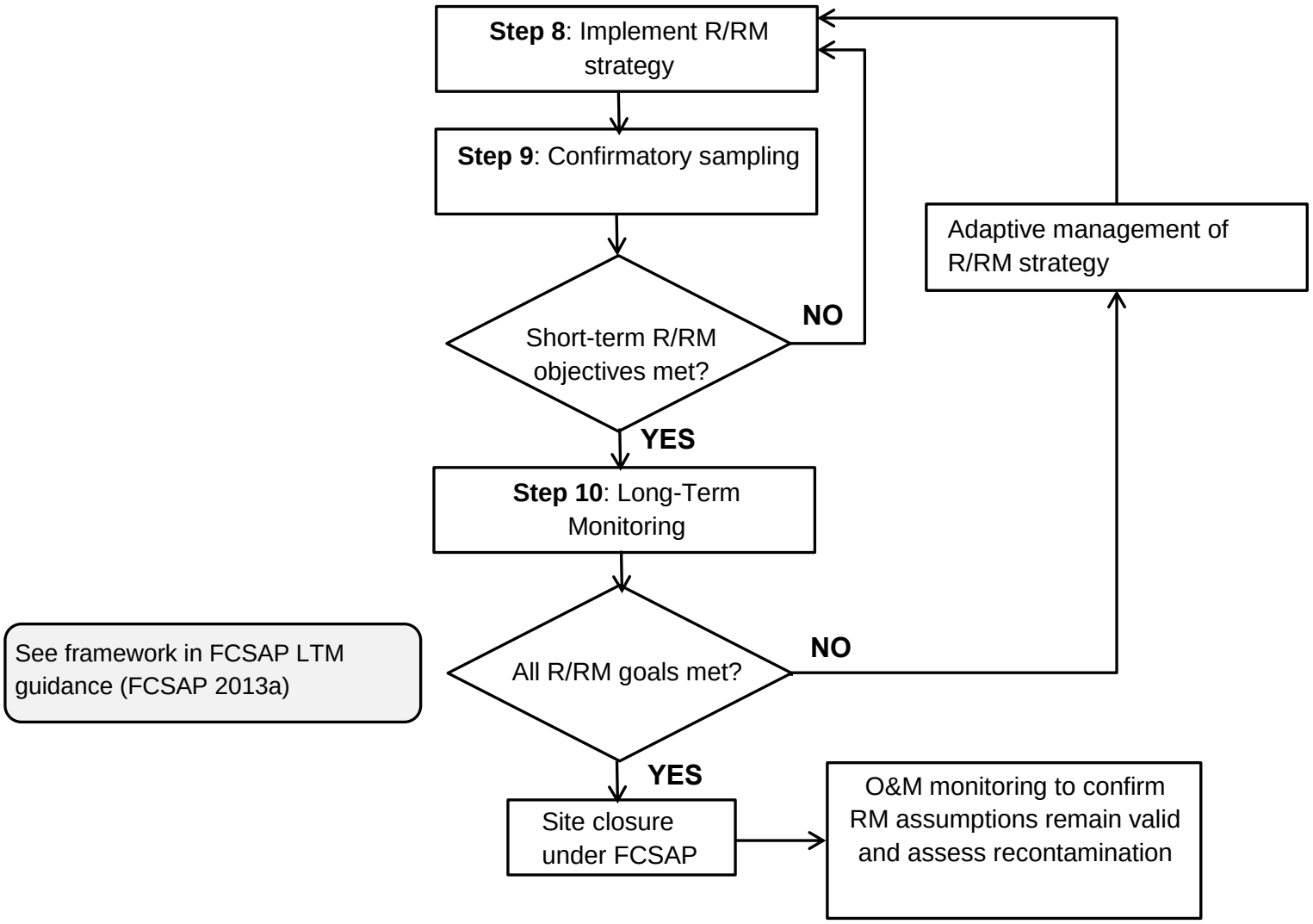

Figure 2-7: Steps 8-10 for addressing federal aquatic contaminated sites in working harbours.

2.6.1 Evaluating the effectiveness of the R/RM strategy when recontamination occurs

Given the ongoing sources present in a working harbour site, some recontamination of the remediated area is inevitable. A LTM plan for assessing recontamination should be developed and clearly defined in Step 7. The plan should include what to assess, “action” levels and strategies, and a plan for corrective R/RM actions if needed. Results of the monitoring program to evaluate contaminant concentrations following R/RM actions can be compared to the modelling outcomes from a recontamination evaluation, as recommended under Step 7 (see Section 2.5.2). Recontamination should be considered acceptable only if it is at levels similar to current harbour ambient contaminant concentrations in the harbour and/or the R/RM objectives.

As described above in Section 2.5.4, the effectiveness of the R/RM strategy should be linked to improved beneficial uses that can be quantified (e.g., decrease in fish tissue concentrations to levels where local anglers may consume fish). A list of potential uses for working harbours is shown in Box 2.

2.6.2 Closing a working harbour site

Working harbour sites are subject to the same LTM and site closure process as other FCSAP sites. However, some monitoring will probably be required for working harbour sites as long as they are active, particularly for large sites that support multiple activities. Common post-remediation LTM funded under FCSAP includes monitoring to ensure the effectiveness of remedial and risk management strategies prior to site closure. This includes monitoring to confirm the achievement of remedial goals related to ecosystem recovery, such as decreases in fish tissue contaminant concentrations, as well as performance monitoring to ensure that the risk management and/or remedial strategy is successful. Costs for LTM need to be identified at Step 7 and taken into account as part of the remedial decisions. Further technical guidance to support the development of LTM plans for FCSAP sites to facilitate site closure is contained in FCSAP (2013a).

Particularly for large sites, following site closure, a working harbour site may require additional monitoring to confirm that the assumptions of the remedial action/risk management plan remain valid. This may include operational and maintenance monitoring to ensure that ongoing federal activities are not continuing to contribute contaminants to the water lot and that recontamination is not occurring at unacceptable levels (see Section 2.6.1 above). Recommendations for ongoing monitoring to ensure compliance with environmental standards may also be made to the managing harbour authority.

The current Treasury Board definition of a “closed” site is one for which no future action is required and no further liability exists. Site closure is not listed as a discrete step in the

FCSAP aquatic contaminated sites framework, but it corresponds to the final decision point on the achievement of remedial goals — that is, the point at which the contaminated site no longer poses unacceptable human health and ecological risks and the site conditions used to assess risk are anticipated to continue for the foreseeable future, so no further management action is required.

Consistent with the decision framework presented in FCSAP (2013a), a working harbour site may be closed under one or more of the following circumstances:

- All contaminated materials on the site have been removed or treated so that no COCs at concentrations above the R/RM criteria remain on the site, and a recontamination evaluation shows that contamination levels are consistent with harbour ambient background concentrations and/or the R/RM SeQOs.
- Contaminated materials have been left in place on the site using a risk management approach, and the assumptions of the risk assessment and management plan have been tested and are anticipated to remain valid into the foreseeable future.
- All of the exit criteria in the LTM plan have been attained.
- The site undergoes divestiture to a non-federal party and there are no post-divestiture monitoring requirements for the federal government. An exception is when a site is divested with an indemnity agreement outlining federal responsibilities to remediate under defined conditions. If the probability of those defined conditions occurring is high or is undeterminable, then there is still liability associated with the site and the site should be kept open.

The revised site closure report template (FCSAP in press) should be completed, with input from FCSAP ES as needed, to document the rationale for site closure.

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APPENDIX A: LIST OF QUESTIONS IDENTIFIED FOR CONSULTATION ON DEVELOPING CONTENT FOR THE FCSAP WORKING HARBOUR GUIDANCE DOCUMENT

Step 1: Identify Suspect Aquatic Sites

- How should working harbours be defined?

Step 2: Historical Review

- What items should be included in a historical review for working harbour aquatic contaminated sites?

Step 3: Initial Testing Program

- What screening criteria should be used for the initial assessment and to decide whether detailed testing is warranted or the site is not contaminated?
    - If the ISQG is considered too sensitive, what is a more appropriate and realistic criterion/guideline and what justification is needed to use it as a screening benchmark? (For example, significant ongoing impacts in the watershed or proximity to an urban environment and low ecological value would be appropriate justification for using a less stringent criterion/guideline.)
    - If an appropriate guideline does not exist, what is an appropriate reference background condition? How should background/baseline conditions be defined for working harbour sites?
- How should the protection goals be defined for a working harbour site (e.g., human fish/shellfish consumption, protection of species at risk, human recreational swimming and wading)? What protection goals are practical and feasible, given ongoing uses?
- If a site is confirmed to be contaminated, how should adjacent contaminated non-federal property be considered?
- When and how should non-federal property owners and other stakeholders, including the public, become engaged in the assessment and remediation/risk management decision-making process?

Step 4: Classify Site

- Should the FCSAP ASCS be modified for working harbour sites? (For example, it could be modified to allow the criterion used in Step 3 of the framework to be applied to classify the site if it is different from the ISQG.)

Step 5: Detailed Testing Program

- As source characterization and control is very important for effective harbour basin management, what level of effort should custodians be investing to characterize contaminant sources to the harbour that are not a federal responsibility?
- Are there cases where a risk assessment for working harbours may NOT be required? (For example, a risk assessment may not be required if no beneficial use impairments can be identified despite the presence of detectable concentrations of contaminants or if the site will be dredged.)

Step 6: Re-Classify Site

- See Step 4.

Step 7: Develop Remediation/Risk Management Strategy

- How should ongoing source issues (e.g., outfalls) and/or historic contamination from adjacent properties be addressed? Under what conditions should there be agreement from other non-federal parties, including parties from external jurisdictions, to participate before any R/RM action occurs on a federal site?
- What approach should be used to derive R/RM objectives that are realistic given ongoing inputs to the harbour? (That is, how clean should it be after remediation?)
- How should the potential for recontamination following remediation be evaluated in a working harbour context?
- How should improvements to the environmental quality and associated valued ecosystem components/beneficial uses resulting from the selected R/RM approach be evaluated?
- Under what conditions should hot spot remediation be eligible for funding? (For example, should it be eligible when the bulk of the contamination is due to historical sources that are no longer active or when it is not possible to identify point sources of contamination but contamination is elevated above the PEL?)

Step 8: Implement Remediation/Risk Management Strategy

- No questions identified, as this would be the same as for all FCSAP projects.

Step 9: Confirmatory Sampling and Final Reporting

- How should the effectiveness of the site management strategy be evaluated when some recontamination of the remediated area is probably inevitable because of ongoing harbour activities? (That is, how much recontamination is acceptable?)

- When can a working harbour site be closed, or is some long-term monitoring always required because of ongoing use?

Step 10: Long-Term Monitoring (if required)

- See Step 9.

APPENDIX B: MEMBERS OF THE HARBOUR MANAGEMENT WORKING GROUP

Members:	Department/ Organization
Anglesey, Jeremy	ECCC
Beresford, James	DFO
Bird, Emily	DFO
Bodman, Michael	DND
Chiang, Eric	DFO
Cloutier, Matthew	DFO
Cormier, Mario	ECCC
Dean, Stuart	DFO
Fortin, Marie-Claude	ECCC
Graham, Matt	ECCC
Laing, Tamsin	ESG/RMC
Laroche, Daniel	DFO
Longpré, Darcy	HC
Melanson, Terry	DFO
Moseley, Scott	DFO
Mroz, Rita	ECCC
Paquin, Viviane	ESG/RMC
Pott, Ute	ECCC
Roushorne, Meghan	HC
Scott, Mark	DFO
Setiawan, Genevieve	ECCC
Shankie, Erin	PSCP
Smith, Murray	DFO
Thibodeau,Suzie	ECCC
Watson, Gary	TC
White, Louise	HC
Willis, Jody	DFO
Yakobowski, Sarah	DFO

APPENDIX C: INDIVIDUALS INTERVIEWED FOR INPUT REGARDING GUIDANCE NEEDS TO BE ADDRESSED IN THE FCSAP WORKING HARBOUR GUIDANCE DOCUMENT

Name	Department	Working harbour type
Randi Hay	DFO Ontario	Small
Jean Pineault, Daniel Laroche	DFO Québec	Small
Glenn Marshall	DFO Newfoundland and Labrador	Small
Tasha Andrews	DFO Maritimes and Gulf	Small
Mark Sandeman	DFO Central and Arctic Region	Small and large
Scott Moseley	DFO Pacific	Small
Stephen Corbett	Transport Canada	Large
Michael Bodman	DND	Large
Heather Osborne	Transport Canada	Large

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