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Canada

Federal Contaminated Sites Action Plan (FCSAP)

Decision-Making Framework

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Federal Contaminated Sites Action Plan (FCSAP) Decision-Making Framework (DMF)

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Document change control

Revision Number	Date of Issue	Author(s)	Brief Description of Change
1.0	May 22, 2013	Systemscope	Document created
2.0	March 31, 2015	Systemscope	Document updated with climate change and sustainability information. References have also been updated.

Table of Contents

Decision-Making Framework (DMF)

What is the Federal Contaminated Sites Action Plan (FCSAP)?

Federal Contaminated Sites Action Plan (FCSAP) is a 15-year program that was established in 2005 with funding of $3.5 billion from the Government of Canada.

The primary objective of the FCSAP program is to reduce environmental and human health risks from known federal contaminated sites and associated federal financial liabilities. The program provides site assessment funding as well as remediation/risk management funding to custodians for FCSAP eligible sites. It also provides technical expert support staff to all custodians managing a contaminated site. As part of the program's primary objective, guidance materials such as this Decision-Making Framework (DMF) are developed to provide detailed information to all custodians managing contaminated sites, regardless of the site's FCSAP funding eligibility. For more FCSAP and other contaminated sites management guidance materials please contact the FCSAP Secretariat at Environment and Climate Change Canada (FCSAP.PASCF@ec.gc.ca) or consult the reference lists at the end of each section in this DMF.

What is the Decision-Making Framework (DMF)?

The Decision-Making Framework (DMF) for the FCSAP is a roadmap that outlines the specific activities and requirements for addressing federal contaminated sites in Canada. The DMF is based on *A Federal Approach to Contaminated Sites*, a 10-step process guiding federal custodians in all aspects of working with contaminated sites. The 10-step process was developed to provide a common approach to managing contaminated sites for which the federal government is responsible. The DMF does not replace the 10-step process; rather, it is a complementary guide to assist federal custodians in managing their contaminated sites by providing guidance on key decisions at each step of the federal approach. Custodians are encouraged to consult *A Federal Approach to Contaminated Sites* (CSMWG, 1999), as they navigate through the DMF to obtain more details at each step.

The DMF is broken into individual segments that make it easier to understand each step. It enables custodians to consider the critical decisions they have to make at each step and helps them understand how and when the expert support departments can help them in decision making. By clarifying the rules to be followed under the FCSAP, this guide also increases consistency in the decision-making process and improves the effectiveness of site assessment and remediation activities.

This updated version of the DMF now provides guidance to custodians on how to improve the sustainability of their site assessment and remediation/risk management activities, and to incorporate climate change considerations throughout their contaminated site management plan.

The sustainability measures integrated into this document are based on the FCSAP's Sustainability Strategy in which custodians are encouraged to consider sustainable options and weigh the impacts of contaminated sites management on social, financial and environmental aspects. General guidance is also provided within the document on identifying site specific climate change impacts.

All acronyms used in this document are explained in the List of Abbreviations and all references are listed in the Reference List.

How to use the DMF

To ensure consistency and ease of use, each of the 10 steps is described using the same page format:

- A general description of the step, including key decisions to be made by custodians.
- A flowchart showing the main management options available at each step, allowing users to visualize the different avenues and decision points available.
- An explanation of the services offered to the custodians by the expert support departments and FCSAP Secretariat.
- All relevant supporting documentation and tools.

Disclaimer

Although the guidance provided in the DMF is intended to meet the needs of most scenarios, professional judgment is required throughout the process.

The 10-step process

Step 1: Identify Suspect Site

Step 2: Historical Review

Step 3: Initial Testing Program

Step 4: Classify Site (optional)

Step 5: Detailed Testing Program

Step 6: Re-Classify Site

Step 7: Develop Remediation/Risk Management Strategy

Step 8: Implement Remediation/Risk Management Strategy

Step 9: Confirmatory Sampling and Final Reporting

Step 10: Long-Term Monitoring (if required)

Supporting documents and tools useful throughout the 10-step process

These are documents and tools that may be of value to a custodian throughout the 10-step process. Custodians should also refer to the IDEA secure website and the step-specific reference lists found at the end of each step in this DMF.

Legislation/Policy

- Policy on Management of Real Property (TBS, 2006)
- Reporting Standard on Real Property (TBS, 2006)

Guidance

- Guidance Document on the Management of Contaminated Sites in Canada (CCME, 1997)
- A Federal Approach to Contaminated Sites (CSMWG, 1999)
- Best Practices Advisory: Environmental Considerations in Real Property Transactions (TBS, 2002)
- Project/Program Risk Management Guidance for Federal Contaminated Sites Remediation/Risk Management (R/RM) Projects (PSPC, 2007)
- FCSAP Guidance Manual (FCSAP, 2008)
- Directive on Contingencies (TBS, 2009)
- Framework for Addressing and Managing Aquatic Sites under the Federal Contaminated Sites Action Plan (FCSAP, 2011)
- Guide to the Management of Real Property (TBS, 2011)
- Eligible Costs Guidance, ver. 5.0 (FCSAP, 2016)
- Federal Contaminated Sites Inventory (FCSI) Mini-Guide , v. 2 (TBS, 2014)
- Projects Near Water (website) (DFO, 2015)

Other

- Federal Contaminated Sites Inventory (FCSI) Input Guide (TBS, 2016)
- Waves: Fisheries and Oceans Canada Library (website) (DFO, 2014)
- Priority for Assessment Tool (PAT) (FCSAP, update in progress)

Step 1: Identify Suspect Site

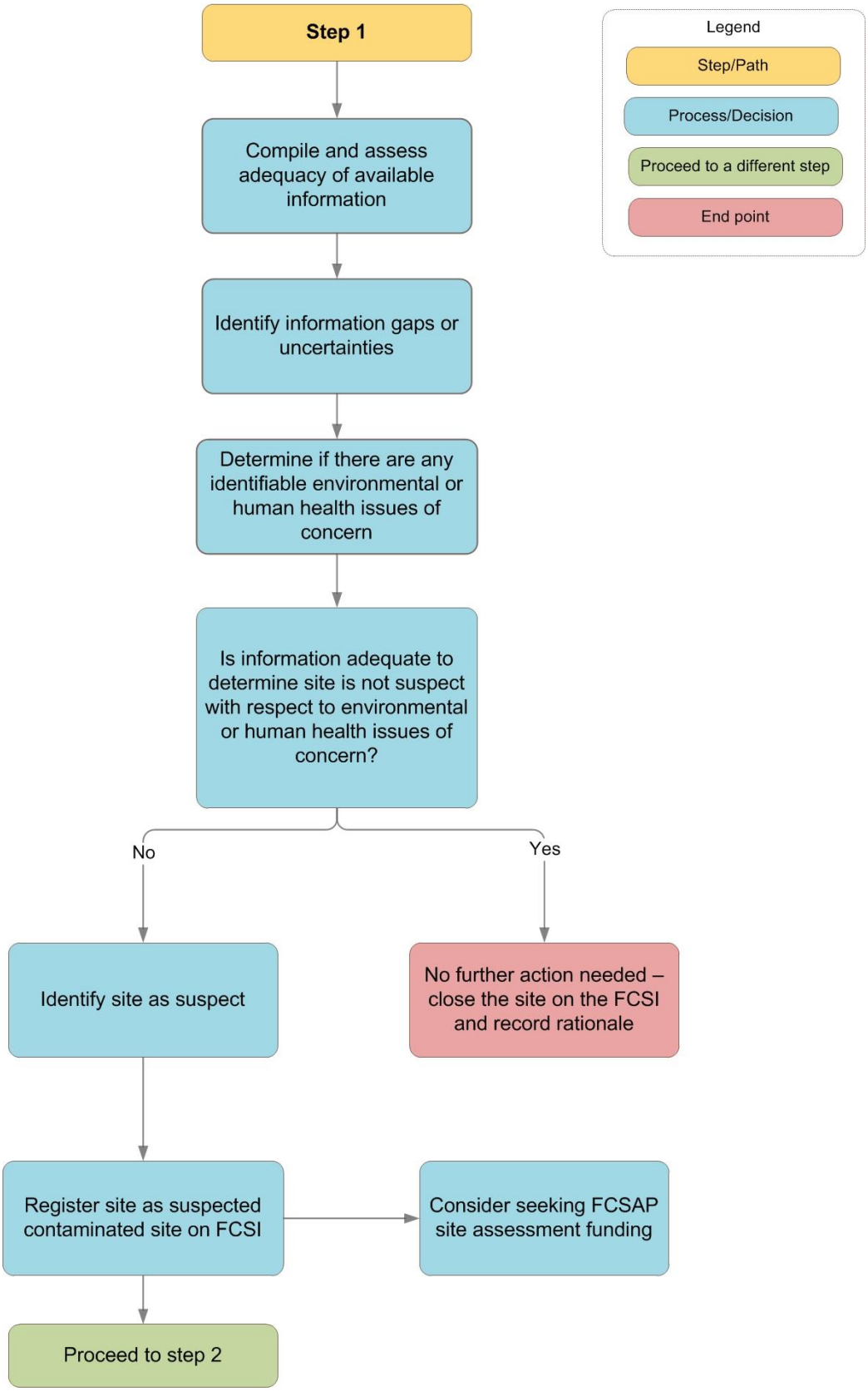
Step 1 is the identification of a potentially contaminated site, called a “suspected site,” based on past or current activities that have occurred on or near the site. This step involves compiling and reviewing past and current land uses, activities, and information about a site in order to determine whether there is a potential risk to human health and/or the environment that requires further investigation.

At this step, and throughout the 10-step process, custodians need to consider the interests of stakeholders—in other words, those interested in and affected by the site. Health Canada (HC) guidance documents for public involvement need to be reviewed at this step.

Key decision(s):

- Determine whether no further action is required or if the site should be identified as suspected and proceed to Step 2 (Historical Review).
- If a site is suspected, consider seeking FCSAP site assessment funding.
- Identify stakeholders and public involvement needs.

Step 1: Identify Suspect Site



Consider seeking Federal Contaminated Sites Action Plan (FCSAP) assessment funding

At this step, custodians can apply for FCSAP site assessment funding (the site assessment takes place from Step 1 to 6) if the site is on federal lands, or on non-federal lands for which the federal government has accepted full responsibility, and there are documented reasons for suspecting that a site is contaminated from activities that occurred prior to April 1, 1998. Custodians are required to submit assessment proposals to the FCSAP Secretariat but must demonstrate the priority of the site receiving FCSAP site assessment funding in a risk-based manner using the Priority for Assessment Tool (PAT) (FCSAP, update in progress) or an equivalent system.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Identify:
    - fish and fish habitat concerns on or near the site;
    - aquatic species listed under the *Species at Risk Act* (SARA) (2002); and
    - additional information requirements.
- Provide information on past DFO involvement at the site (studies, Fisheries Act authorizations, letters of advice, etc.).
- Provide advice on DFO regulatory responsibilities and processes.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice on known risks to the environment in the site area and impacts that may have occurred from past operations conducted at the site.
- Provide advice on ECCC regulatory responsibilities and processes.

How Health Canada (HC) expert support can assist

- Provide advice on identifying human health concerns on the site, or off-site issues related to contamination at the site based on historical activity, including the identification of additional information required to delineate contamination and adequately assess human health risks.
- Provide training and/or guidance on public involvement and advice on the implementation of an effective public involvement strategy.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice on determining if site requires further investigation and what scope of further investigation may include, such as cost and time frame estimates.

How the FCSAP Secretariat can assist

- Provide advice on the FCSAP process and eligibility for funding.

Supporting documents and tools specific to Step 1

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

Legislation

- Canada Wildlife Act (1985)
- Fisheries Act (1985)
- Migratory Birds Convention Act (1994)
- Species at Risk Act (SARA) (2002)

General Guidance

- Addressing Psychosocial Factors through Capacity Building: A Guide for Managers of Contaminated Sites (HC, 2005)
- Improving Stakeholder Relationships: Public Involvement and the Federal Contaminated Sites Action Plan (FCSAP): A Guide for Site Managers (HC, 2006)
- A Guide to Involving Aboriginal Peoples in Contaminated Site Management (HC, 2010)
- Supplemental Guidance on Developing a Contract Statement of Work for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA) (HC, 2010)
- For Human Health Risk Assessment (HHRA): Federal Contaminated Site Risk Assessment in Canada (available on request from cs-sc@hc-sc.gc.ca):
    - Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (HC, 2012)
    - Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0 (HC, 2010)
    - Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0 (HC, 2010)
    - Part V Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{CHEM}$) (HC, 2010)
    - Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment ($DQRA_{RAD}$) (HC, 2010)
    - Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites (HC, 2010)
- FCSAP Statements of Work for Ecological Risk Assessments at Federal Sites (FCSAP, 2011)
- Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011)

Other

- Species at Risk Public Registry

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- Eligible Costs Guidance, 5.0 (FCSAP, 2016)
- FCSAP Operational Guidelines (FCSAP, 2016; internal document)
- Priority for Assessment Tool (PAT) (FCSAP, update in progress)

Step 2: Historical Review

In Step 2, a suspected site identified in Step 1 undergoes a Historical Review of information, also known as a Phase I Environmental Site Assessment (ESA) and the custodial department accountable will consult with stakeholders. The four principal components of a Phase I ESA are 1) a records review; 2) a site visit; 3) interviews; and 4) an evaluation of information and reporting.

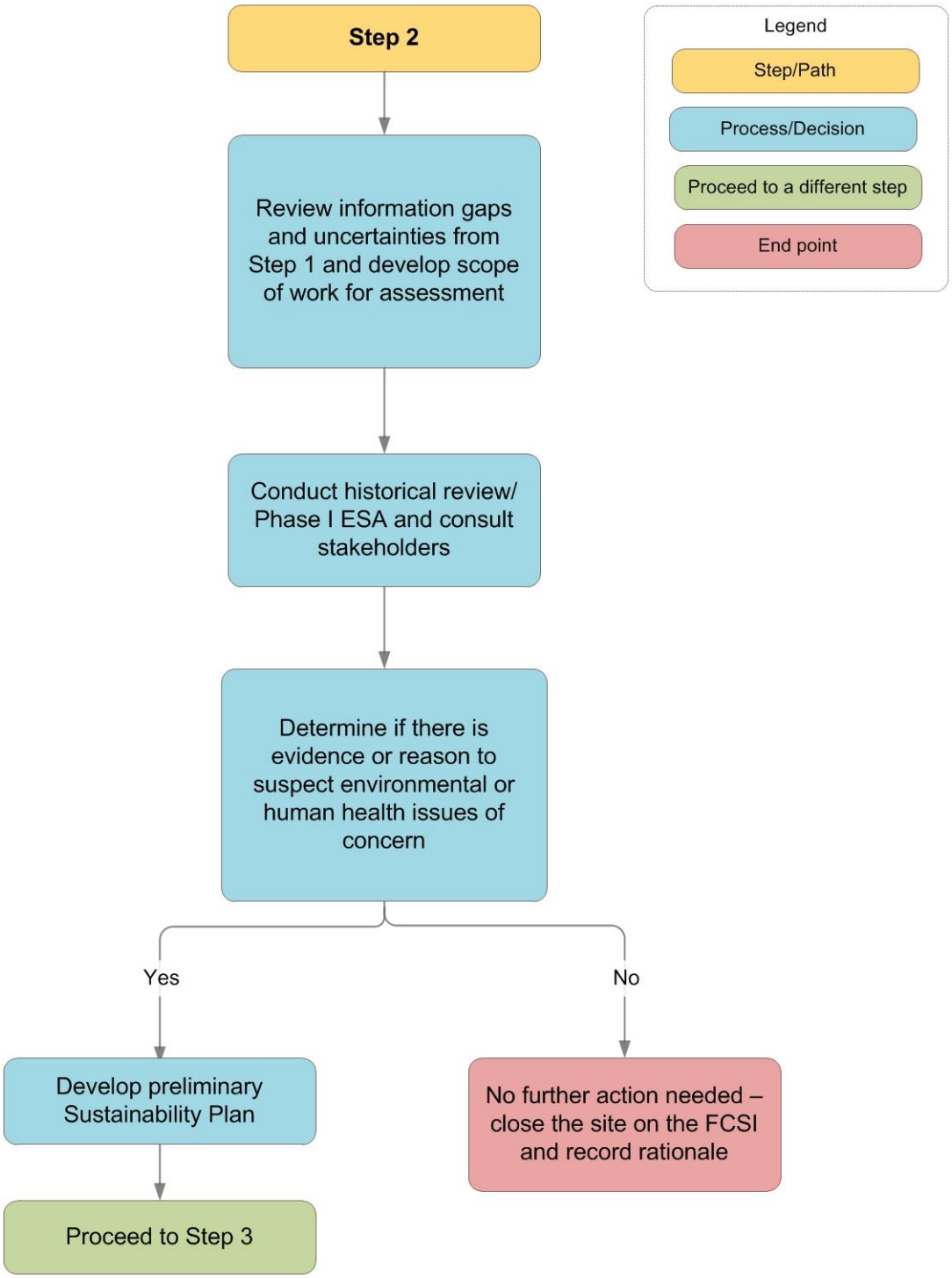
This information will provide insight into the types and locations of potential contaminants and the suspected pathways and receptors. Custodians must prioritise the sites that are being assessed (for financial capacity or prioritization of activity reasons); this can be done using the Priority for Assessment Tool (PAT) (FCSAP; update in progress) or an equivalent system. The PAT assists custodians in prioritizing assessment work by ranking sites. For FCSAP-funded site assessments, a priority assessment must be submitted to the Secretariat at some point during Step 1 to 6. Sites that are not identified as a priority for assessment should be re-evaluated periodically according to a custodian's portfolio characteristics.

If there is evidence or reason to suspect environmental or human health issues of concern, then the custodian could develop a Preliminary Sustainability Plan (see Appendix A) for the site as described in the Sustainability Strategy and Implementation guidance (Appendix A). The plan should also require any consultants and contractors working on the site to consider implementing, where feasible, elements of the Preliminary Sustainability Plan (see Appendix A).

Key decision(s):

- Validate Step 1 conclusions that there is reason to suspect that the site is contaminated and that assessment should continue to Step 3 (Initial Testing program).
- Determine whether the site can be closed because no further action is required.
- Determine whether a Preliminary Sustainability Plan should be developed and, if applicable, at which steps sustainability should be integrated.

Step 2: Historical Review



How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide fish, fish habitat and fisheries background information at or near the site, if available.
- Provide information on regulatory frameworks applicable to aquatic sites.
- Review the Phase I ESA (CSA, 2001) and provide advice.
- Participate in site visit activities.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP, 2011).

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide regulatory advice concerning past operations conducted at the site.
- Provide advice on site assessment standards and best practices.
- Review the Phase I ESA, identify information gaps and provide advice on information gathering.
- Participate in site visit activities.

How Health Canada (HC) expert support can assist

- Provide advice on developing a site assessment that can be used for adequately characterizing chemicals of potential concern in site media based on historical land use, which is important for assessing risks to human health and future decision making.
- Review the Phase I ESA report and provide anticipatory technical comments related to requirements for the Step 3 Phase II ESA (CSA, 2001) to identify potential human health exposure and information gaps that may require additional assessment in order to identify whether there are human health risks.
- Participate in site visit activities.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice on the Phase I ESA, including the historical review/assessment, and determine if further work is required or no further action needs to be taken.

How the FCSAP Secretariat can assist

- Provide general FCSAP program information and support.
- Provide assistance in using the Priority for Assessment Tool (PAT) (FCSAP, update in progress) and the Eligible Cost Guidance, v. 5.0 document (FCSAP, 2016), as required.

Supporting documents and tools specific to Step 2

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

General Guidance

- Canadian Standards Association (CSA) Standards for Phase I Environmental Site Assessments (CSA, 2001)

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- Eligible Costs Guidance, 5.0 (FCSAP, 2016)
- Priority for Assessment Tool (PAT) (FCSAP, update in progress)
- Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP, 2011)

Step 3: Initial Testing Program

Step 3 involves focusing on the identified environmental issues and potential risks. An Initial Testing Program, also known as a Phase II Environmental Site Assessment (ESA) (CSA, 2004) is conducted to investigate actual site conditions, and stakeholders should be consulted. Stakeholders can provide key information about the site history and condition, end use of the site, exposure pathways, receptors, contaminants of potential concern, and safe exposure limits.

A Phase II ESA (CSA, 2004) includes six stages:

1. Planning
2. Field Investigation and Sampling
3. Sample Analysis
4. Data Interpretation and Evaluation
5. Risk Identification
6. Conceptual Site Model Development

This step will provide a preliminary assessment of the degree, nature and extent of the contamination.

In developing the scope of work and conducting a Phase II ESA (CSA, 2004), climate change effects should be considered at the ESA's Risk Identification (Stage 5) and Conceptual Site Model Development (Stage 6) stages. This involves the collection of data on climate conditions (e.g. temperature, precipitation, wind) to assist with the assessment of future predicted climate conditions.

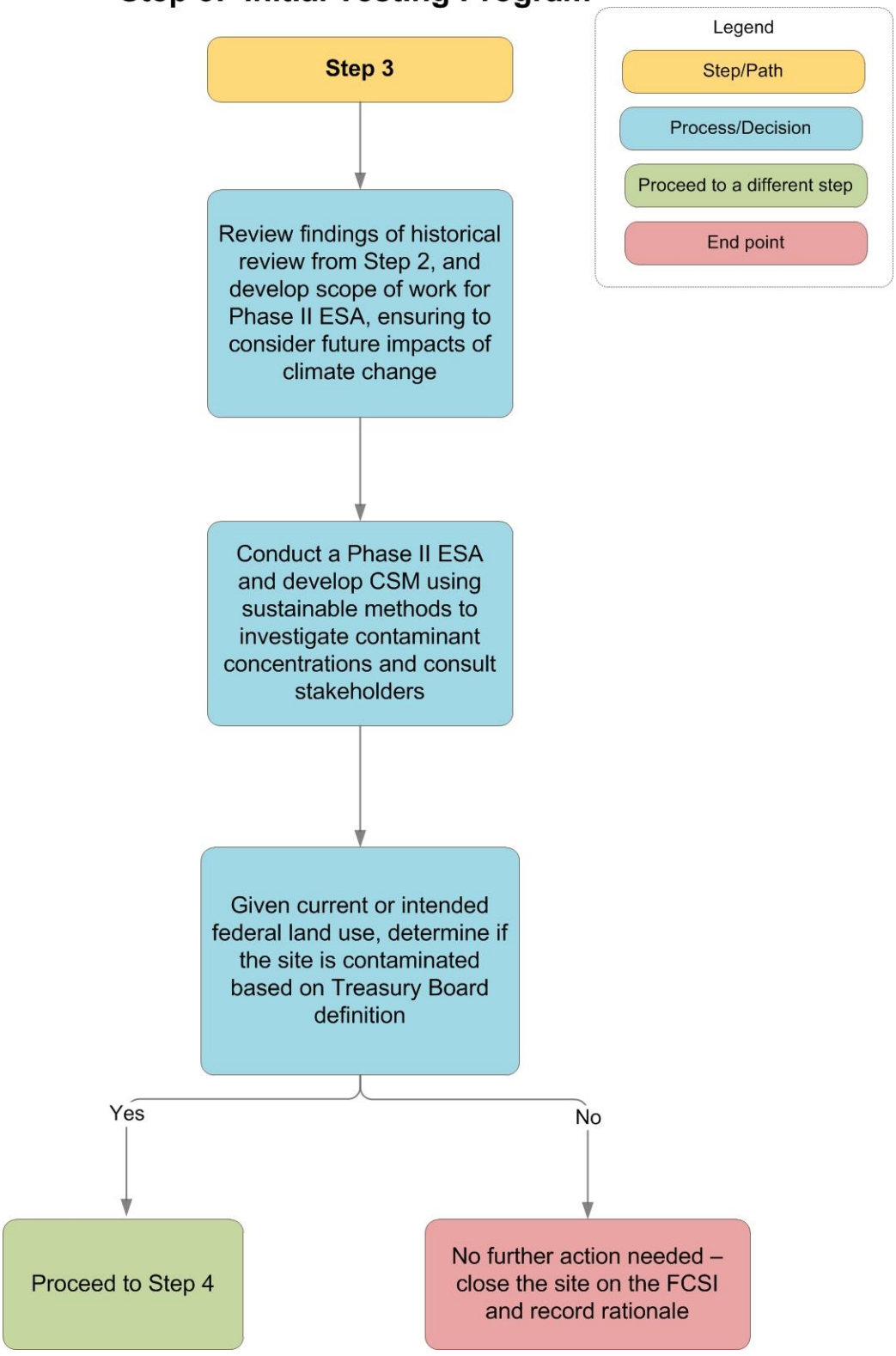
The Framework for Addressing and Managing Aquatic Sites under the FCSAP program (FCSAP, 2011) should also be consulted if aquatic ecosystems are present on the site. The Aquatic Sites Framework provides guidance on the management of aquatic sites for every step of the DMF.

ESAs should use sustainable methods that reduce energy use and waste generation, and contracting clauses encouraging the use of sustainable practices should be integrated into the procurement plan.

Key decision(s):

- Define the appropriate current or intended federal land-use scenario according to the Canadian Council of Ministers of the Environment (CCME) guidelines for land use of studied site.
- Confirm, based on the assessment results, and the current or intended land use, if the site is contaminated according to the Treasury Board of Canada (TB) definition.
- Conduct a preliminary assessment on the effects of climate change at the site and determine whether there will be any short, medium, or long-term impacts on contaminant types, concentrations, or distribution or changes in the residency media.
- Determine options for integrating sustainable practices into the site assessment including sustainable contracting clauses.
- Determine whether the site can be closed because no further action is required.
- Proceed to site classification at Step 4.

Step 3: Initial Testing Program



Identify current or intended federal use for impacted area

Before remediation or risk management (R/RM) strategies are identified and evaluated, the current or intended federal land use of a site must be agreed upon to determine the appropriate standard for remediation. Whether the site is used for industrial, commercial, agricultural or residential/parkland purposes, each will have varying degrees of human health and ecological protection. The levels of protection provided by CCME standards ensure that the remediated land has the potential to support most activities associated with the intended land use.

- **Agricultural:** growing crops, raising livestock, natural areas including National Wildlife Areas and Migratory Bird Sanctuaries*
- **Residential/Parkland:** residential or recreational activities, buffer areas between residences, campgrounds
- **Commercial:†** public access, malls, cultivated lawns, flowerbeds**, gas stations
- **Industrial:†** restricted access, production, manufacturing or construction of goods

*Natural areas consist of natural wild land (including national parks) that would apply the same standards as agricultural land for remediation purposes.

**Cultivated lawns and flowerbeds must be part of the commercial property, and not used as a public area (i.e., picnic or park areas).

†Commercial and industrial land must still be under the responsibility of the federal government.

Under the TB Secretariat Policy on Management of Real Property (TBS, 2006), remediation must be undertaken to the extent required for current or intended federal use. If a custodian plans to divest the property, he/she may remediate beyond federal standards, but the supplementary (above the current or intended federal land use) remediation will not be covered by FCSAP funds.

Treasury Board of Canada (TB) definition of a contaminated site

According to the TB definition, a contaminated site is “one at which substances occur at concentrations (1) above background (normally occurring) levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations.”

If there are no guidelines available, custodians should base their determination of a contaminated site on the background level, by looking at existing literature or undertaking additional sample analysis. Before moving to the next step, the custodian should be able to confirm whether or not the site is contaminated.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Assist with identification of fish, fish habitat and fish/fisheries information.
- Provide advice on:
    - Characterization of fish habitat or habitat mapping;
    - Confirmation of aquatic species, including species listed under the Species at Risk Act (SARA); and
    - Expectations associated with fish and fish habitat data collection.

- Document review (e.g., Phase II ESA (CSA, 2004) report, conceptual site model [CSM]) with respect to the risk(s) (including receptors, hazard and exposure) to fish and fish habitat.
- Review sampling plan to ensure that data collected will accurately represent the site and assess risks to fish and fish habitat.
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).
- Provide advice on compliance requirements under the *Fisheries Act* and other environmental requirements.

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice on and/or review of the Phase II ESA (CSA, 2004) report, with respect to ecological risks (including receptors, hazard and exposure).
- Provide advice on planning of the Phase III investigation (including providing advice on sampling plan, sampling techniques and technologies, quality assurance/quality control (QA/QC) program, and Conceptual Site Model (CSM).
- Provide advice on CCME Canadian Environmental Quality Guidelines or other applicable guidelines:
    - A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)
    - A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
    - A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995)
    - A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.
- Provide advice on the analysis of data.

How Health Canada (HC) expert support can assist

- Provide advice on and/or review of the CSM.
- Provide advice on the characterization of the site and whether there are data gaps associated with site characterization that may impact assessment of human health risks.
- Provide advice and training on sampling techniques and technologies.
- Review sampling plan to ensure that data collected will accurately represent the site and assess human health risks.
- Provide advice on QA/QC programs.
- Provide advice on Canadian Environmental Quality Guidelines or other guidelines that are applicable to screening chemicals for potential human health risks:
    - A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)
    - A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
    - A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995)

        - A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.
- Provide advice on the analysis of data from laboratories (adequate detection limits, etc.).
- Provide advice on CCME Canadian Environmental Quality Guidelines (soil, water or sediment) for the protection of human health and Canadian Drinking Water Guidelines (HC, 2014), and/or on the adoption of standards from other jurisdictions.
- Provide advice, guidance and training on the characterization and delineation of contamination at a site in ESA reports so that custodians can better risk-manage sites and obtain adequate data for use in Human Health Risk Assessment (HHRA), including:
    - Advice on and/or review of CSM with respect to human health;
    - Advice on characterization of the site;
    - Advice on the sampling and analysis plan to ensure that data collected will accurately represent the site and supply sufficient data to allow for the assessment of potential human health risks.
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice on, or develop statements of work for the completion of Phase II ESAs (CSA, 2004).
- Assist in determining whether further work is required or no further action is necessary.

How the FCSAP Secretariat can assist

- Provide assistance in using the Priority for Assessment Tool (PAT) (FCSAP, update in progress) and the Eligible Cost Guidance document, 5.0 (FCSAP, 2016) as required.

Supporting documents and tools specific to Step 3

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

Canadian Council of Ministers of the Environment (CCME) Guidance

- Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report (CCME, 1993)
- Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume II: Analytical Method Summaries (CCME, 1993)
- Subsurface Assessment Handbook for Contaminated Sites (CCME, 1994)
- Canada-Wide Standard for Petroleum Hydrocarbons in Soil (CCME, 2008)
- CCME Canadian Environmental Quality Guidelines:
    - A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)

- A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
- A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995)
- A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- Phase II ESA SOW incorporating Science-based Expert Support Input (A Federal Approach to Contaminated Sites, Appendix C, CSMWG, 1999)
- Framework for Addressing and Managing Aquatic Contaminated Sites Under the Federal Contaminated Sites Action Plan (FCSAP, 2011)
- FCSAP Guidance Document on Statements of Work for Ecological Risk Assessments (ERAs) at Federal Sites (FCSAP, 2011)
- FCSAP Ecological Risk Assessment Guidance (FCSAP, 2012)
    - Module 1: Toxicity Test Selection and Interpretation (FCSAP, 2010)
    - Module 2: Selection or Development of Site-specific Toxicity Reference Values (FCSAP, 2010)
    - Module 3: Standardization of Wildlife Receptor Characteristics (FCSAP, 2012)
    - Module 4: Causality Assessment: Determining the Causes of Impairment at Contaminated Sites: Are Observed Effects Due to Exposure to Site-Related Chemicals or Due to Other Stressors? (FCSAP, 2013)
    - Module 5: Defining Background Conditions and Using Background Concentrations (FCSAP, 2015)
- Federal Interim Groundwater Guidelines (FCSAP, 2016)
    - Federal Interim Groundwater Guidelines Update (FCSAP, 2016)
- Priority for Assessment Tool (PAT) (FCSAP, update in progress)

Other Guidance

- Canadian Standards Association (CSA) Standards for Phase II Environmental Site Assessment (CSA, 2000)
- For Human Health Risk Assessment (HHRA): Federal Contaminated Site Risk Assessment in Canada available on request from cs-sc@hc-sc.gc.ca,:
    - Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (HC, 2012)
    - Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0 (HC, 2010)
    - Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0 (HC, 2010)
    - Part V Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{CHEM}$) (HC, 2010)
    - Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment ($DQRA_{RAD}$) (HC, 2010)
    - Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites (HC, 2010)

- Supplemental Guidance on Developing a Contract Statement of Work for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA) (HC, 2010)
- Guidance and Orientation for the Selection of Technologies (GOST) (PSPC/NRC, 2012)
- Guidelines for Canadian Drinking Water Quality (HC, 2014)

Step 4: Classify Site (optional)

Step 4 is an optional step that can be used at the discretion of the custodians who wish to complete a preliminary assessment of a site's classification or if they wish to determine if enough information on the site has already been gathered to complete a robust site classification. Equally, custodians can choose to proceed directly from Step 3 to Step 5 if they need to collect more data to complete a meaningful classification (at Step 6).

In Step 4, custodians complete the Canadian Council of Ministers of the Environment's (CCME) National Classification System for Contaminated Sites Guidance Document (NCSCS) (CCME, 2008) or the Federal Contaminated Sites Action Plan (FCSAP) Aquatic Site Classification System (ASCS) worksheets (FCSAP, 2015). Custodians should refer to the Supplemental Guidance for the Scoring of Sites Using the National Classification System for Contaminated Sites (NCSCS) and Aquatic Sites Classification Systems (ASCS) under the Federal Contaminated Sites Action Plan (FCSAP, 2013). This exercise can further help the custodians identify the priority of sites for subsequent action (assessment or remediation).

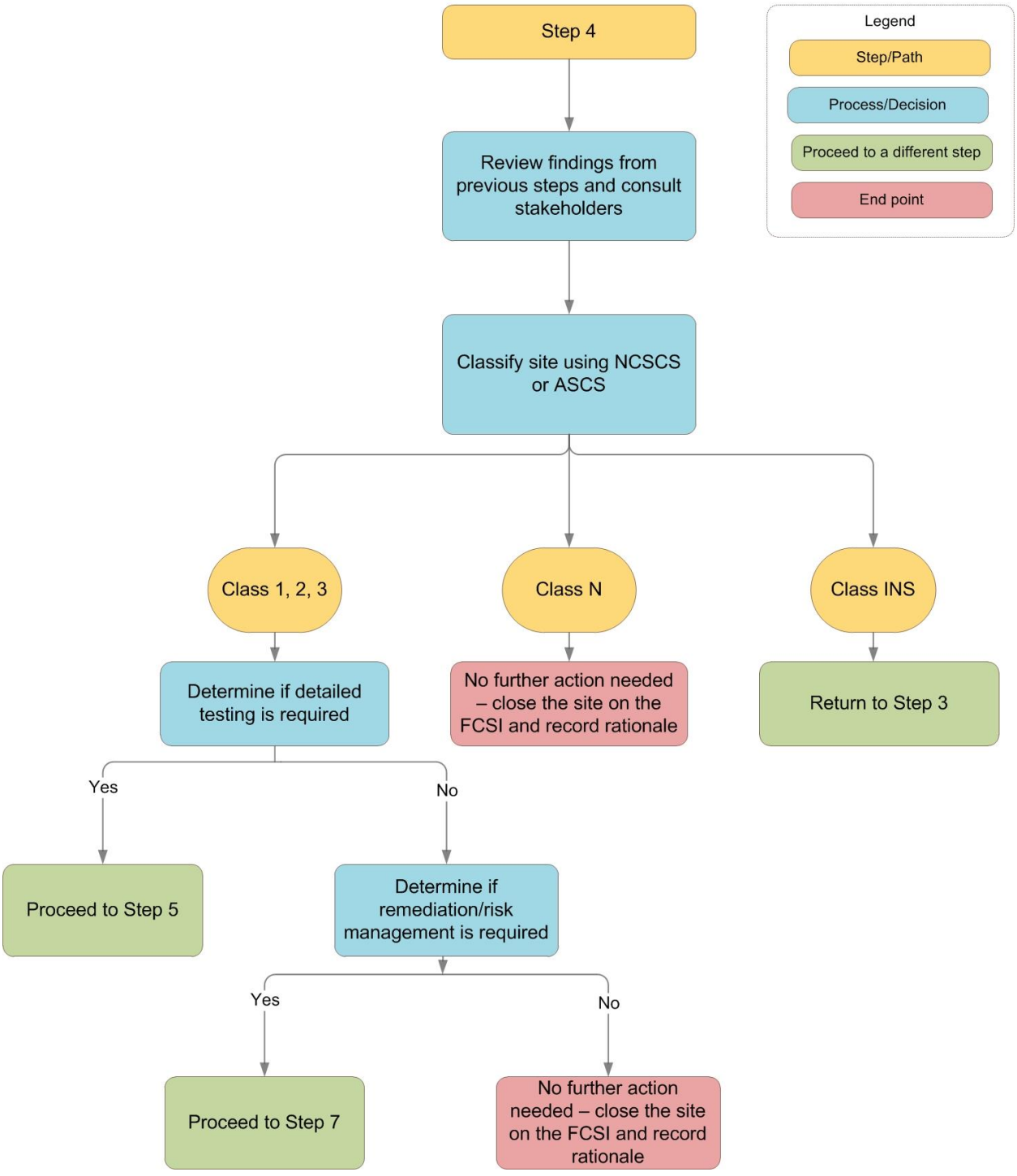
Site classifications include Class 1, 2, 3, INS (insufficient information) or N (not a priority for action), with Class 1 having the highest priority for action. For Phase II of FCSAP program (2011–2016), only Class 1 sites and ongoing Class 2 sites (with FCSAP remediation expenditures prior to April 1, 2011) are eligible for FCSAP remediation funding.

When further testing is not required and sufficient site information is available, and if the custodian wishes to have the site considered for FCSAP remediation/risk management (R/RM) funding, the site classification worksheet can be reviewed by the expert support departments and the FCSAP Secretariat to determine if the site meets the eligibility requirements for FCSAP remediation/risk management funding. However, it should be noted that classification of sites conducted at Step 4 are generally too preliminary to be reviewed for FCSAP funding eligibility. Very often it is necessary to complete Steps 5 and 6 to obtain a site eligibility review. Step 4 remains more of an internal exercise for custodians.

Key decision(s):

- Determine if the completion of a preliminary assessment of a site's classification is needed in this step.
- Determine if it is preferable to collect more information before assessing a site's classification – do not complete Step 4 and go right to Step 5 (Detailed Testing Program).
- Alternatively, determine the classification of the site at this step.
- Based on the level of priority for action and on the completeness of the classification assessment, determine if the site is eligible to request FCSAP R/RM funding and proceed to Step 7 (Develop Remediation/ Risk Management Strategy).

Step 4: Classify Site (Optional)



How Fisheries and Oceans Canada (DFO) expert support can assist

- Review and provide advice on relevant (i.e., fish and fish habitat) components of the National Classification System for Contaminated Sites (NCSCS) (CCME, 2008) or Federal Contaminated Sites Action Plan (FCSAP) Aquatic Site Classification System (ASCS) worksheets (FCSAP, 2015).
- Provide access to training and resources for the ASCS [such as the FCSAP Aquatic Sites Classification System Detailed User Guidance Manual (FCSAP, 2015)].
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice on the use and interpretation of NCSCS spreadsheet (CCME, 2008) and ASCS worksheets (FCSAP, 2014).
- Review and provide advice on ecological concerns described by the NCSCS or the ASCS.
- Provide training and guidance on the use of NCSCS or ASCS worksheets.

How Health Canada (HC) expert support can assist

- Review and provide advice on relevant (i.e., human health) components of NCSCS and ASCS classification scores and associated background information, including interpretation of NCSCS and ASCS worksheets.
- Provide advice, guidance, training and/or peer review on conducting Human Health Risk Assessments (HHRA) and interpreting their results with respect to site classification.
- Provide advice and support in ranking and prioritizing sites from a human health risk perspective.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice throughout Step 4, including on determining whether R/RM is required at a site.
- Assist in determining whether further work is required or whether no further action is necessary.

How the FCSAP Secretariat can assist

- Provide assistance in using the Priority for Assessment Tool (PAT) (FCSAP, update in progress) and the Eligible Cost Guidance, v. 5.0 document (FCASP, 2016), as required.
- Provide support to custodians on the process for submitting a site to the FCSAP Priority List for remediation funding (navigating through the Interdepartmental Data Exchange Application [IDEA], mandatory documents, reports and other eligibility concerns) if sufficient information about the condition of the site is available at this step.

Supporting documents and tools specific to Step 4

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

Canadian Council of Ministers of the Environment (CCME) Guidance

- National Classification System for Contaminated Sites (NCSCS) Guidance Document (CCME, 2008)
- National Classification System for Contaminated Sites Spreadsheet (CCME, 2008)

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- Eligible Costs Guidance, 5.0 (FCSAP, 2016)
- Supplemental Guidance for the Scoring of Sites Using the National Classification System for Contaminated Sites (NCSCS) and Aquatic Sites Classification System (ASCS) under the Federal Contaminated Sites Action Plan (FCSAP, 2013)
- Aquatic Site Classification System (ASCS) - Version 3.2 Detailed User Guidance Manual (FCSAP, 2015)
- Aquatic Site Classification System (ASCS) worksheets (FCSAP, 2015)
- Priority for Assessment Tool (PAT) (FCSAP, update in progress)

Step 5: Detailed Testing Program

If the results of the Initial Testing Program (Step 3) indicate that contaminant levels exceed guidelines or background levels and may pose a risk, a detailed testing program may be required in order to address outstanding issues.

Step 5 involves investigating site conditions, characterizing the impacted media and further delineating the areas of concern identified during Step 3. The Detailed Testing Program is accomplished by developing and completing a Phase III Environmental Site Assessment (ESA), updating and finalising the Conceptual Site Model (CSM) from the Initial Testing (Step 3), and continuing consultations with stakeholders. Sustainable site assessment methods should be implemented. Furthermore, for each of these activities, future climate change considerations should be observed.

The type and scope of the detailed assessment to be conducted at Step 5 depend on the site conditions and should aim to allow a determination if further management action is required, and aim to allow a robust classification of the site as per CCME National Classification System Detailed Evaluation Form (in Step 6).

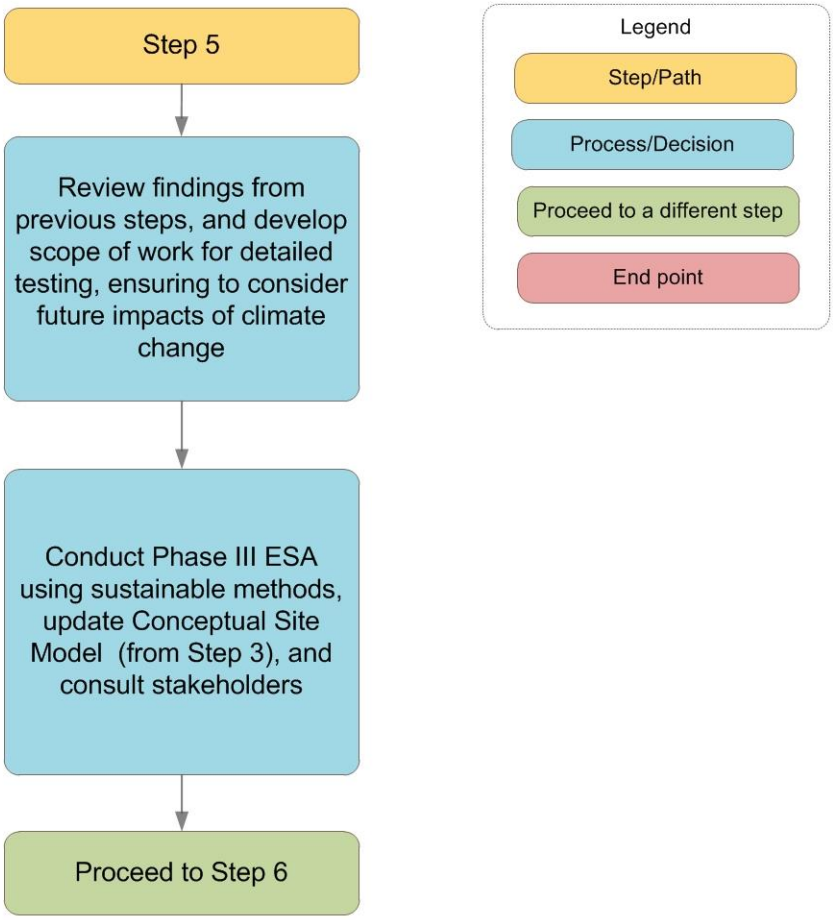
Generally, the detailed testing program will concentrate on areas identified in the initial testing program and involve a similar systematic process of sampling and analysis, evaluation, conclusions and recommendations; however, a greater number of samples are usually collected and a smaller suite of chemical substances may be analyzed as the program converges on the environmental issues and the full extent of the contamination.

Custodian who have not conducted the optional preliminarily classification of their site(s) at Step 4 may once again use the Priority for Assessment Tool (PAT) (FCSAP, update in progress) or an equivalent system to prioritise their site(s) at this step.

Key decision(s):

- Determine the need for revising existing detailed site assessment in order to ensure sufficient information has been gathered to classify site in Step 6.
- Determined the need to further substantiate the existing initial site assessment (Step 3) in order to ensure sufficient information has been gathered in Step 6.
- Conduct a more detailed assessment of the effects of climate change at the site based on the preliminary assessment in Step 3.
- Determine pathways for integrating sustainable site assessment practices into the site assessment that target reducing energy use and minimizing waste production.

Step 5: Detailed Testing Program



How Fisheries and Oceans Canada (DFO) expert support can assist

- Assist with determining level of impact to fish and fish habitat (e.g., contaminants-related impacts to fish habitat).
- Provide advice on physical processes (e.g., erosion/deposition, susceptibility to tides/currents/floods) that could affect fish and fish habitat.
- Review documents (e.g., draft site assessment) with respect to fish and fish habitat.
- Provide advice to custodians on the development of terms of reference for contracts to prevent or mitigate potential impacts to fish and fish habitat associated with testing.
- Review sampling plan to ensure that data collected will accurately represent the site and assess risks to fish and fish habitat.
- Participate in site visit activities.
- Assist with the identification of aquatic receptors and pathways to focus on during the assessment.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).
- Provide advice on compliance requirements under the *Fisheries Act* and other environmental requirements.

How Environment and Climate Change Canada (ECCC) expert support can assist

- Review environmental site assessment (ESA) reports and provide advice on treatment of data.
- Review sampling plan to ensure that data collected will accurately represent the site and assess ecological risks.
- Provide advice on sampling and analytical techniques and technologies.
- Provide advice on data requirements of an Ecological Risk Assessment (ERA) and future monitoring plans.
- Provide advice on quality assurance/quality control (QA/QC) programs.
- Provide advice on applicable environmental quality guidelines.
- Participate in site visit activities.
- Provide advice on developing a site management strategy.
- Provide advice on compliance requirements under the *Fisheries Act* and other environmental requirements.

How Health Canada (HC) expert support can assist

- Review ESA reports and CSM.
- Review sampling plan to ensure that data collected will accurately represent the site and provide input for the assessment of potential human health risks.
- Provide advice on sampling techniques and technologies.
- Provide advice on data requirements of a Human Health Risk Assessment (HHRA) and future monitoring plans.
- Provide advice on QA/QC programs.
- Provide advice on applicable environmental quality guidelines.
- Participate in site visit activities.
- Provide advice on developing a site management strategy.
- Provide advice on the treatment of data.

- Review ESA reports, and where applicable, PQRA, and provide detailed technical comments regarding the data requirements necessary to adequately characterize contamination at the site.
- Review the sampling and analysis plan to ensure that data collected will be useful in delineating contamination at the site and that the data will be adequate to support the assessment of human health risks.
- Provide advice on the development of terms of reference for contracts for HHRA.
- Provide advice on the selection and/or development of human-health-based remediation criteria and/or risk management.
- Provide advice, guidance and training on the characterization and delineation of contamination at a site so that custodians can adequately characterize their site for the purpose of risk management.
- Provide advice, guidance and training on HHRA so that custodians can obtain adequate data for use in site management with the goal of risk reduction.
- Participate in site visit activities.
- Assist with developing a CSM that includes the identification of human receptors and pathways, and that allows more targeted site investigation, which will allow for proper characterization of the contamination as it applies to human exposure.
- Provide advice on applicable human-health-based guidelines and standards and/or recommended interim values where guidelines and standards area not available (e.g., perfluorooctane sulfonate [PFOS]).

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice throughout Step 5—including on the development of a statement of work (SOW), completion of the Phase III and preliminary liabilities estimates and the use of project management tools such as preliminary project planning and the project charter.
- Provide advice to custodians in the development of terms of reference for contracts.
- Assist in determining whether further work is required or no further action is necessary.

How the FCSAP Secretariat can assist

- Provide assistance in using the Priority for Assessment Tool (FCSAP, update in progress) and the Eligible Cost Guidance, v. 5.0 document (FCSAP, 2016) as required.

Supporting documents and tools specific to Step 5

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

Canadian Council of Ministers of the Environment (CCME) Guidance

- Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report (CCME, 1993)
- Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume II: Analytical Method Summaries (CCME, 1993)
- Subsurface Assessment Handbook for Contaminated Sites (CCME, 1994)
- Canada-Wide Standard for Petroleum Hydrocarbons in Soil (CCME, 2001)

- CCME Canadian Environmental Quality Guidelines:
  - A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)
  - A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
  - A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995)
  - A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- FCSAP Ecological Risk Assessment Guidance (FCSAP, 2012)
  - Module 1: Toxicity Test Selection and Interpretation (FCSAP, 2010)
  - Module 2: Selection or Development of Site-specific Toxicity Reference Values (FCSAP, 2010)
  - Module 3: Standardization of Wildlife Receptor Characteristics (FCSAP, 2012)
  - Module 4: Causality Assessment: Determining the Causes of Impairment at Contaminated Sites: Are Observed Effects Due to Exposure to Site-Related Chemicals or Due to Other Stressors? (FCSAP, 2013)
  - Module 5: Defining Background Conditions and Using Background Concentrations (FCSAP, 2015)
- FCSAP Guidance Document on Statements of Work for Ecological Risk Assessments (ERAs) at Federal Sites (FCSAP, 2011)
- Federal Interim Groundwater Guidelines (FCSAP, 2016)
  - Federal Interim Groundwater Guidelines Update (FCSAP, 2016)
- Priority for Assessment Tool (PAT) (FCSAP, update in progress)

Other Guidance

- Canadian Standards Association (CSA) Standards for Phase II Environmental Site Assessments (CSA, 2000)
- Canada–Ontario Decision-Making Framework (DMF) for Assessment of Great Lakes Contaminated Sediment (ECCC and MOE, 2008)
- For Human Health Risk Assessment (HHRA): Federal Contaminated Site Risk Assessment in Canada:
  - Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (HC, 2012) available on request from cs-sc@hc-sc.gc.ca,
  - Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0 (HC, 2010) available on request from cs-sc@hc-sc.gc.ca,
  - Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0 (HC, 2010)
  - Part V Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{CHEM}$) (HC, 2010)
  - Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment ($DQRA_{RAD}$) (HC, 2010)
  - Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites (HC, 2010)

- Supplemental Guidance on Developing a Contract Statement of Work (SOW) for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA) (HC, 2010)
- Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{Foods}$) (HC, 2010)
- Guidelines for Canadian Drinking Water Quality (HC, 2014)

Step 6: Re-Classify Site

At this step, the site is classified for the first time, or reclassified from Step 4 if new information acquired through the Detailed Testing Program (Step 5) must be input into the classification system in order to accurately assess the priority for action of a site. A complete site classification is required in order to receive FCSAP remediation/risk management funding. Custodians should complete the Canadian Council of Ministers of the Environment (CCME) National Classification System for Contaminated Sites spreadsheets (NCSCS) (CCME, 2008) or the Federal Contaminated Sites Action Plan Aquatic Site Classification System (ASCS) worksheets (FCSAP, 2015) based on the results of the initial and detailed testing programs as detailed in the National Classification System for Contaminated Sites Guidance Document (CCME, 2008). Stakeholders can provide key information about the site history and condition, end use of the site, exposure pathways, receptors, contaminants of potential concern, and safe exposure limits.

Site classifications include Class 1, 2, 3, INS (insufficient information) or N (not a priority for action), with Class 1 having the highest priority for action. For Phase II of FCSAP (2011/12-2015/2016), only Class 1 sites and ongoing Class 2 sites (with FCSAP remediation expenditures prior to April 1, 2011) are eligible for FCSAP funding.

At this step, custodians should consider whether there is sufficient information to meet the five mandatory recognition criteria for reporting a liability as defined by the Treasury Board Secretariat of Canada and, if so, report the liability for the site using the FCSI portal. The estimate of a remediation liability includes costs directly attributable to remediation activities required to bring the site up to the current minimum standard for use prior to contamination.

A liability for remediation of contaminated sites should be recognized when, as of the financial reporting date, the following apply:

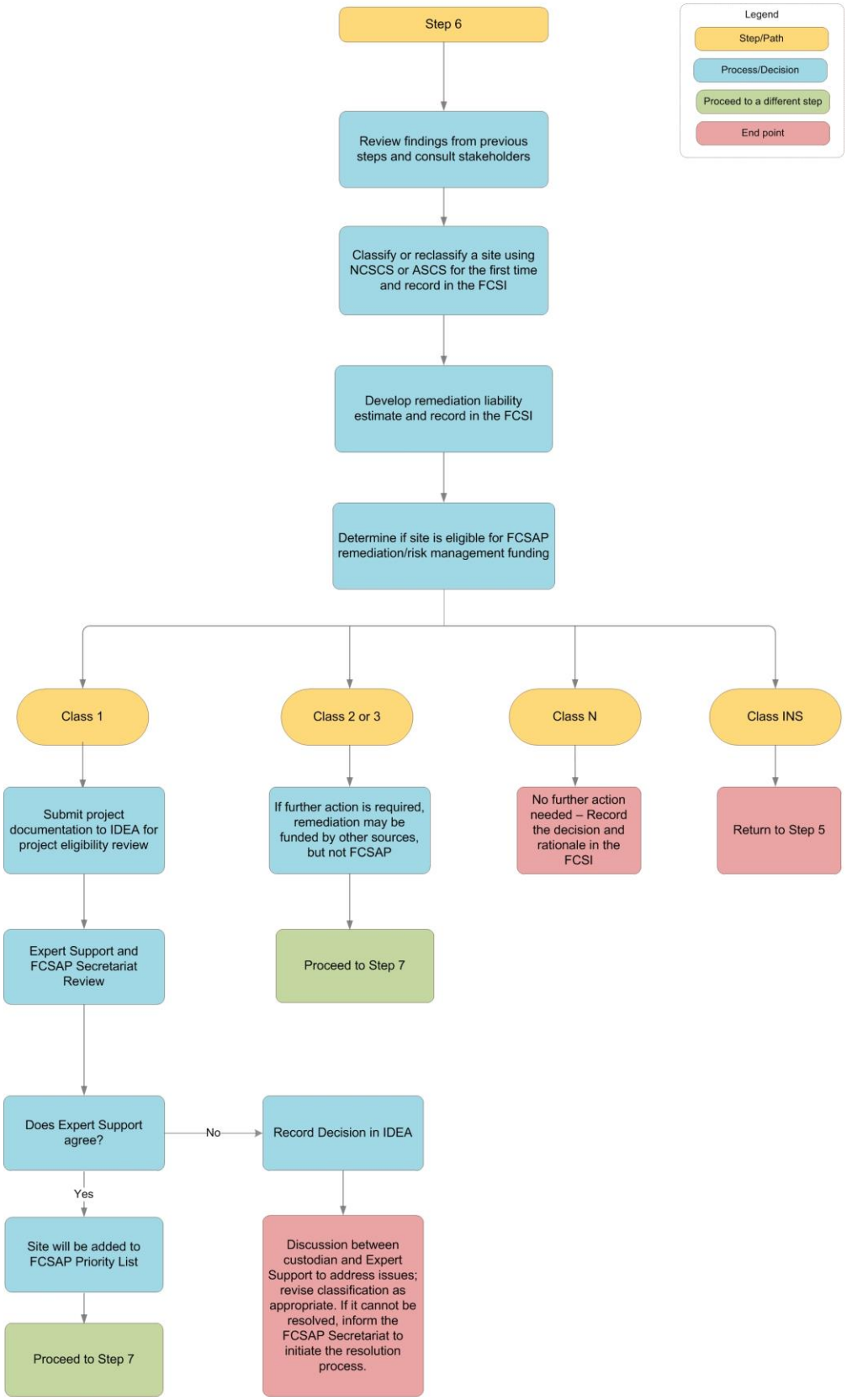
- An environmental standard exists;
- Contamination exceeds the environmental standard;
- The Government of Canada:
  - owns the land; or
  - is directly responsible; or
  - accepts responsibility (e.g., when there is little, if any, discretion to avoid the obligation);
- It is expected that future economic benefits will be given up;
- A reasonable estimate of the amount can be made.

After completion of Step 6, if the custodian wishes to have the site considered for FCSAP remediation/risk management (R/RM) funding, the classification worksheets will be reviewed by expert support departments to determine if the site meets the eligibility requirements for FCSAP R/RM funding. Only Class 1, 2 and 3 sites may eventually proceed to Step 7, although Class 1 and Class 2/3 sites require different follow up actions.

Key decision(s) for Step 6:

- Determine the new/revised site classification and if further action is required.
- If further action is required, determine if site is eligible for FCSAP R/RM funding and proceed to Step 7.

Step 6: Re-Classify Site



Treasury Board of Canada (TB) definition

According to the TB definition, a contaminated site is “one at which substances occur at concentrations (1) above background (normally occurring) levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations”.

Consider seeking FCSAP R/RM funding

For federal contaminated sites to be eligible for R/RM funding under the FCSAP Phase II (2011–2012 to 2015–2016), the following conditions must be met:

- The site must meet the TB definition of a contaminated site.
- Contamination must have occurred before April 1, 1998.
- For Phase II of the FCSAP Program (2011/12-2015/16) the site must be classified as Class 1 using an appropriate site classification system identified in the FCSAP Guidance Manual. Class 2 sites are also eligible under FCSAP if remediation expenditures were incurred prior to April 1, 2011.
- The site must have an associated financial liability reported in the Public Accounts of Canada, in accordance with current TB guidance on recording remediation liabilities for contaminated sites.
    - In those circumstances where FCSAP funding is used for remediation expenditures but no liability can be recorded, custodians should provide a justification as part of the FCSAP Secretariat’s review of priority sites.
    - An example is when a site with no opening liability for the fiscal year receives assessment and remediation funding in one field season.
- A complete and accurate site record, including annual expenditure and liability data, must be recorded in the Treasury Board of Canada Secretariat (TBS) Federal Contaminated Sites Inventory (FCSI), in compliance with Treasury Board’s Policy on Management of Real Property and the Reporting Standard on Real Property.

Custodians seeking or having obtained FCSAP funding must use the Interdepartmental Data Exchange Application (IDEA). IDEA was developed under FCSAP to facilitate the exchange of information between the program Secretariat, custodians of federal contaminated sites (departments, agencies, and consolidated Crown corporations), and the Expert Support departments (Health (HC), Environment (ECCC), Fisheries and Oceans (DFO), and Public Works (PSPC)). On IDEA, custodians submit new site funding requests and update their previously approved site submissions. Custodians who need to create user accounts should contact the FCSAP Secretariat.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Review relevant components (e.g., fish and fish habitat) of the National Contaminated Sites Classification System (NCSCS) Guidance Document (CCME, 2008) or Aquatic Sites Classification System (ASCS) classification scores and associated reports (FCSAP, 2015).
- Provide training resources (such as the FCSAP Aquatic Sites Classification System (FCSAP, 2015). Detailed User Guidance Manual) and provide advice on the submission score.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).

How Environment and Climate Change Canada (ECCC) expert support can assist

- Review the NCSCS or ASCS score and associated reports to confirm the accuracy of the classification derived by the custodian (mandatory for sites that custodians are requesting be added to the FCSAP Priority List for R/RM funding).
- Provide information on training resources.

How Health Canada (HC) expert support can assist

- Review human health components of the NCSCS and ASCS and associated reports to confirm the accuracy of the classification derived by the custodian.
- Provide advice on the use and interpretation of NCSCS and ASCS worksheets.
- Provide advice, guidance, training and/or peer review on conducting and interpreting Human Health Risk Assessment (HHRA) results as they apply to site classification.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice on the review and classification, and liaise with other expert support departments.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance, v. 5.0 document (FCSAP, 2016), and the National Contaminated Sites Classification System (NCSCS) Guidance Document (CCME, 2008) and Aquatic Sites Classification System (FCSAP, 2015) as required.
- Communicate decision to custodians on the eligibility of new sites once reviewed, and add new eligible sites to the FCSAP Priority Site List.
- Provide information on how to access and use the Interdepartmental Data Exchange Application (IDEA).

Supporting documents and tools specific to Step 6

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

Canadian Council of Ministers of the Environment (CCME) Guidance

- CCME National Classification System for Contaminated Sites (NCSCS) Guidance Document (CCME, 2008)
- National Classification System for Contaminated Sites Spreadsheet (CCME, 2008)

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- Supplemental Guidance for the Scoring of Sites Using the National Classification System for Contaminated Sites (NCSCS) and Aquatic Sites Classification Systems (ASCS) under the Federal Contaminated Sites Action Plan (FCSAP, 2013)
- Aquatic Site Classification System (ASCS) - Version 3.2 Detailed User Guidance Manual (FCSAP, 2015)

- Aquatic Site Classification System (ASCS) worksheets (FCSAP, 2015)

Other Guidance and Tools

- Checklist for Peer Review of Detailed Human Health Risk Assessment (HHRA) (HC, 2010)
- Remediation Liabilities Related to Contaminated Sites: A Supplement to the Financial Information Strategy (FIS) Manual (TBS, 2010)
- Interdepartmental Data Exchange Application (IDEA)

Step 7: Develop Remediation/Risk Management (R/RM) Strategy

A remediation/risk management (R/RM) strategy is developed once the results of the preliminary (Step 3) and detailed (Step 5) testing have indicated that risks from contamination must be addressed. For the site to be funded under the Federal Contaminated Sites Action Plan (FCSAP) for R/RM activities, the site also needs to be classified as either Class 1 or ongoing Class 2 (applicable to Phase II of the FCSAP program (2011/12 – 2015/16)) meaning high or medium priority for action, respectively.

Selection of the R/RM strategy is one of the most critical decisions in the 10-step process, since the outcome will largely determine the cost and effectiveness of the chosen approach on the reduction of risk to human health and the environment, and on the reduction of financial liability. The financial liability for the site, based on the risk and the federal government's obligation to address it, should also be calculated by the end of Step 7.

Careful consideration and evaluation of R/RM objectives, options and regulatory requirements will reduce the possibility of error and substantially increase the affordability and technical effectiveness of the proposed site management strategy. When selecting R/RM methods, consider sustainability (see Appendix A) and climate change measures. Look for opportunities to demonstrate the feasibility of incorporating sustainable remediation activities. The Preliminary Sustainability Plan (PSP) developed in Step 2 should be updated based on the site management strategy and the expected activities to occur on site during R/RM implementation and execution.

When selecting sustainable R/RM methods, consider risk management (as opposed to remediation) approaches where appropriate land-use restrictions and human health and environmental protection can be assured. Where risk management approaches are not possible, consider the use of in-situ remediation techniques and those that destroy contaminants. Use a qualitative, semi-qualitative [i.e., the Sustainable Development Tool (SDT) (PSPC, forthcoming), or quantitative (i.e., life-cycle analysis) approach to evaluate the sustainability of viable R/RM options for the site. For general activities that should be considered in the sustainability plan, see Appendix A.

At Step 7, it is recommended that custodians begin to fill in the Guidance for Site Closure Tool for Federal Contaminated Sites (SCT) (FCSAP, 2012). It enables custodians to evaluate key decisions and document important information about the R/RM activities leading to the eventual closure or long-term monitoring/management (LTM) of the site.

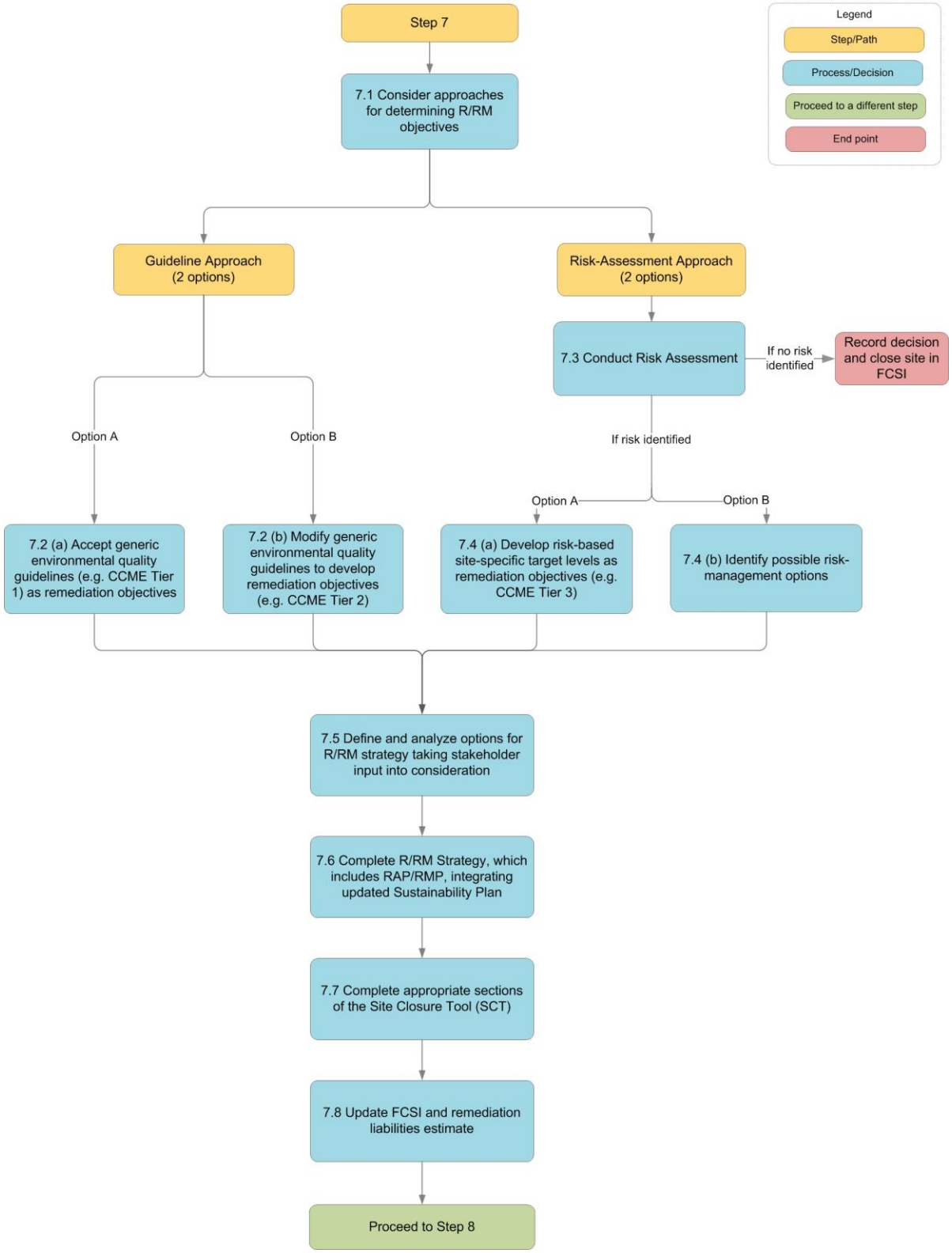
Step 7 describes two approaches, the Guideline Approach and the Risk Assessment Approach. A description of each of Step 7's sub activities follows the flow diagram.

Key decision(s):

- Determine whether a guideline approach, generic or modified, or a risk assessment approach to establish R/RM objectives will be applied.
- Establish corresponding R/RM objectives.
- Determine which R/RM options should be considered, and choose the most appropriate selection.
- Consider climate change effects that may lead to changes in the affected media and future exposure scenarios and receptors when developing the R/RM strategy.
- Consider and integrate feasible sustainability measures into the R/RM strategy.

Step 7: Develop Remediation/Risk Management (R/RM) Strategy

All activities in Step 7 should consider the future impacts of climate change on the site and should aim to use sustainable approaches.



Step 7.1: Based on the current and intended land use, consider approaches for developing a site management strategy

To develop their site management strategy, custodians will need to identify the R/RM objectives and select the best options for attaining them. These two important decisions will be made in parallel, based on the current or intended federal use of the site, which was first identified at Step 3 and Step 5 but should be reconfirmed.

R/RM objectives may be developed for a site using a **guideline approach**—where generic or modified guidelines are adopted—or using a **risk assessment approach** to derive site-specific target levels as remediation objectives. Choosing between the guidelines or risk assessment approach depends on the circumstance. For instance, if the potential site management strategies based on the guideline approach are too costly or are unacceptable for other reasons (e.g., technical feasibility or unacceptable environmental damage caused by the remedy); it may be advantageous to perform a risk assessment. A risk assessment may help custodians to better understand and focus on the main drivers of risk at the site, which can optimize R/RM actions. There are many conditions under which one or both of these approaches may be implemented. Switching between the risk assessment and guideline approach is not prohibited; an iterative analysis of the alternatives is encouraged and works to optimize the final strategy. For both approaches, custodians should take into account the effects of future climate changes on their current site conditions – including media, pathways and receptors.

Step 7.2a: Guideline Approach Option A

Accept generic environmental quality guidelines as remediation objectives

Published guidelines such as the CCME Canadian Environmental Quality Guidelines are selected as the remediation objectives. These are conservative, generic numeric concentrations of residual contamination that are considered to be acceptable for a wide range of site conditions and receptors under defined land uses.

Step 7.2b: Guideline Approach Option B

Modify generic environmental quality guidelines to develop remediation objectives

When site conditions, land use, receptors or exposure pathways differ slightly from those set out for the generic guidelines—and when adjustment of certain parameters in equations or pathway exposure assumptions is deemed acceptable based on jurisdictional approval and guidance—it is possible to apply limited modification of generic guidelines.

Step 7.3: Risk Assessment Approach

Conduct risk assessment

When the environmental quality guideline approaches cannot be implemented, or if site conditions are unique or particularly sensitive and would limit the effectiveness of generic criteria, a risk assessment approach may be used to determine if the existing contamination/site conditions represent a risk. If generic environmental quality guidelines for the contaminant of concern do not exist in Canada or other jurisdictions, if costs of remediating to guideline levels

are too high, if the site is particularly large and complex, if the environmental impacts of using available remediation techniques are unacceptable, or if little information is known about the contaminants of concern, risk assessment may be warranted.

Depending on the site and receptors present, both a human health and an ecological risk assessment will likely be necessary. Guidance for these assessments is published by the FCSAP program, the Canadian Council of Ministers of the Environment (CCME), Health Canada (HC) and Environment and Climate Change Canada (ECCC). A risk assessment at Step 7 typically requires substantially more effort and detail than simpler risk assessments that may have been completed previously.

A risk assessment can identify R/RM Site Specific Target Levels, but can also reveal that no unacceptable risk exists at this site. When this is the case then no other, no further action is required and the site should be closed in the Federal Contaminated Sites Inventory (FCSI) (Treasury Board Secretariat). No further action should also be recorded in the Site Closure Tool (mandatory for FCSAP-funded sites) (FCSAP, 2012) and the recommended Tool for Risk Assessment Validation (TRAV) (found in the Site Closure Tool). If risks are identified, they can either be managed through remediation to site-specific target levels or by risk management of the contamination in such a way that no risk exists, essentially blocking exposure pathways between the contamination and the receptors of concern.

Step 7.4a: Risk-Assessment Approach Option A

Develop risk-based site-specific target levels as remediation objectives

Site-specific target levels (SSTLs) are established using risk assessment. SSTLs are concentrations at or below which no risk exists for this particular site. Remediation should aim to attain those levels.

Step 7.4b: Risk-Assessment Approach Option B

Identify possible risk management options

Options for risk management typically involve engineering or institutional controls that a) interrupt the exposure pathways (e.g., installing fencing, filtering drinking water, removing children's sandboxes, importing clean soil for raised garden beds); b) remove receptors (e.g., not allowing deep-rooted trees on site); or c) change the form of the contaminant to make it less accessible (e.g., liming soil to reduce metal mobilization, encapsulating metals in cement).

Step 7.5: Define and analyze options for site management strategy, taking stakeholders' input into consideration

A site management strategy may include one or a combination of R/RM options to address a variety of site conditions. For example, it may be decided that remediation methods are appropriate for some areas of the site or impacted media, but that other site conditions are more appropriately addressed by engineering and/or institutional controls to prevent potential exposure by receptors. In this context, it is necessary to consider various options and to assess their relative advantages and disadvantages. See Appendix B for further guidance on how to assess available options. Custodians should consider future effects of climate change and apply sustainability principles when selecting R/RM methods, and look for opportunities to

demonstrate the feasibility of incorporating sustainable remediation methods.

Step 7.6: Select site management strategy and develop remediation action plan/risk management plan (RAP/RMP)

Once the preferred R/RM techniques are determined, a strategy is developed that may rely on a combination of R/RM approaches. One of the main components of the strategy is the Remedial Action Plan (RAP) and/or Risk Management Plan (RMP), depending on the chosen route. Each plan should contain some key details about the site, including the following:

- A summary of all data from previous investigations, including identifying contaminants of concern, affected media and quantity of materials to be treated;
- A summary of the R/RM techniques that were evaluated and how the preferred strategy was chosen;
- A detailed plan for the R/RM processes to be used, as well as an implementation plan and control measures to minimize further risk;
- Updated Preliminary Sustainability Plan (PSP);
- A description of remedial verification and long-term monitoring (LTM) plans.

Step 7.7: Complete appropriate sections of the Site Closure Tool (SCT), including the Tool for Risk Assessment Validation (TRAV)

The Site Closure Tool (SCT) (FCSAP, 2012) is meant to provide custodians with consistent evaluation criteria for determining when it is appropriate to close sites remediated using FCSAP funding. It also provides a template for determining which critical information about site remediation decisions should be documented and summarized in a closure report. The TRAV is embedded within the SCT and acts as a quality assurance tool describing the expectations of ECCC, Fisheries and Oceans Canada (DFO), and HC with respect to the proper procedure for conducting risk assessments. The TRAV is not a mandatory tool, but is strongly recommended by the FCSAP Secretariat. Custodians will begin to fill out the sections of the SCT related to R/RM planning and the quality of site assessment data during Step 7. This will ensure that any deficiencies are identified early enough in the R/RM process that they can be corrected, rather than doing so at the end of the site work.

Step 7.8: Update Federal Contaminated Sites Inventory (FCSI)

The FCSI should be updated to include liability estimates, if the Treasury Board of Canada Secretariat (TBS) liability recognition criteria are met. At this step, custodians should have sufficient information about the site to meet the five mandatory recognition criteria for reporting a liability as defined by the Treasury Board Secretariat of Canada and report the liability for the site using the Federal Contaminated Sites Inventory (FCSI) portal (TBS, 2016). The estimate of a remediation liability includes costs directly attributable to remediation activities required to bring the site up to the current minimum standard for use prior to contamination. See Step 6 for more details.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide input and advice on risk management options (including remediation and mitigation measures).

- Review and provide advice on the following points to ensure that activities on site are compliant with DFO's regulatory requirements and mandate to protect fish and fish habitat that support fisheries:
    - draft RAP or RMP;
    - remedial strategy to ensure coherence with broader DFO initiatives;
    - *Species at Risk* Act (SARA) recovery strategies, action plans and management plans to ensure compliance with the SARA-listed aquatic species or particular harvested aquatic species;
    - draft Environmental Assessment (EA) and supporting documentation;
    - draft Ecological Risk Assessment (ERA);
    - plans for physical works and undertakings;
    - mitigation, monitoring and contingency plans.
- Participate in site visit activities (if specific issues arose).
- Identify appropriate contacts within DFO.
- Provide support to the public engagement process.
- Provide advice to custodians on the development of terms of reference for contracts to prevent or mitigate potential impacts to fish and fish habitat that would be associated with testing or R/RM programs.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).
- Provide advice on compliance requirements under the *Fisheries Act* and other environmental requirements.

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice on and/or review of ERAs, remediation objectives, risk-based site-specific target levels, RAPS or RMPs.
- Provide advice on the accuracy of model assumptions made during the ERA and the Risk Management Strategy (RMS).
- Provide advice so custodians may ensure that R/RM activities on site are compliant with regulatory requirements including the *Fisheries Act* and other environmental requirements.
- Provide advice on the development and comparison of R/RM options.
- Provide advice to custodians in the development of terms of reference for contracts.
- Provide advice on mitigation activities and sustainable strategies to reduce impacts from remediation.
- Assist on the EA for remediation activities (e.g., excavation) where required under the Canadian Environmental Assessment Act, 2012 (CEAA 2012) (Note: sending the EA to the FCSAP expert support department does not replace the formal EA process).
- Participate in site visit activities.

How Health Canada (HC) expert support can assist

- Provide advice, guidance, training and review on developing site-specific human health remediation objectives (risk-based remediation standards).
- For the Human Health Risk Assessment (HHRA), HC can review the statement of work, provide a technical review of the draft and final report, and provide advice on standard or more complicated aspects of HHRA (including, but not limited to, how to incorporate bioavailability of substances in soil to reduce remediation costs, how to address short-term exposure in a fiscally responsible manner, and how to ensure protection of human health).

- Provide advice on and/or review of HHRA and RAPS or RMPs as they pertain to human health.
- Provide advice on human health impacts associated with remedial options and on mitigating human health impacts on a technology- and site-specific basis.
- Participate in site visit activities.
- Provide advice on mitigation options to reduce human health exposure as they relate to site contamination and/or remediation options.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Assist throughout Step 7 including the evaluation of remedial options, which may include the use of project management and database tools; innovative procurement; and awareness of innovative, green, sustainable remediation approaches.
- Assist in project planning, including developing scope of work, work breakdown structure, schedule development, cost estimating and budgeting, quality planning, communications planning, risk identification and response, and procurement planning.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance, v. 5.0 document (FCSAP, 2016) as required.

Supporting documents and tools specific to Step 7

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

Canadian Council of Ministers of the Environment (CCME) Guidance

- CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report (CCME, 1993)
- CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume II: Analytical Method Summaries (CCME, 1993)
- Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada (CCME, 1996)
- Canada-Wide Standard for Petroleum Hydrocarbons Spreadsheet Model (CCME, 2008-2009)
- Canadian Environmental Quality Guidelines
    - A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)
    - A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995)
    - A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
    - A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)
- CCME Canadian Environmental Quality Guidelines (Website)

Federal Contaminated Sites Action Plan (FCSAP) Guidance

- FCSAP Guidance Document on Statements of Work for Ecological Risk Assessments (ERAs) at Federal Sites (FCSAP, 2011)
- FCSAP Ecological Risk Assessment (ERA) Guidance (FCSAP, 2012)
  - Module 1: Toxicity Test Selection and Interpretation (FCSAP, 2010)
  - Module 2: Selection or Development of Site-specific Toxicity Reference Values (FCSAP, 2010)
  - Module 3: Standardization of Wildlife Receptor Characteristics (FCSAP, 2012)
  - Module 4: Causality Assessment: Determining the Causes of Impairment at Contaminated Sites: Are Observed Effects Due to Exposure to Site-Related Chemicals or Due to Other Stressors? (FCSAP, 2013)
  - Module 5: Defining Background Conditions and Using Background Concentrations (FCSAP, 2015)
- Federal Interim Groundwater Guidelines (FCSAP, 2016)
  - Federal Interim Groundwater Guidelines Update (FCSAP, 2016)
- Guidance for Site Closure Tool at Federal Contaminated Sites (SCT), including Tools for Risk Assessment Validation (TRAV) (FCSAP, 2012)
- Federal Guidance for Estimating Remediation Liabilities at Federal Contaminated Sites (FCSAP, 2015)

Other Guidance and Tools

- Accounting Standard 3.1 – Treasury Board – Capital Assets (TBS, 2001)
- Accounting Standard 3.6 - Treasury Board– Contingencies (TBS, 2006)
- Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils (FCSAP, 2006, Editorial Update 2013)
- Directive on Contingencies (TBS, 2009)
- Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{Foods}$) (HC, 2010)
- Supplemental Guidance on Developing a Contract Statement of Work for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA) (HC, 2010)
- Fisheries and Oceans Canada (DFO) Pathways of Effects (website) (DFO, 2011)
- Guidance and Orientation for the Selection of Technologies (GOST) (PSPC/NRC, 2012)
- Guidelines for Canadian Drinking Water Quality (HC, 2014)
- For Human Health Risk Assessment (HHRA): Federal Contaminated Site Risk Assessment in Canada:
  - Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (HC, 2012) available on request from cs-sc@hc-sc.gc.ca,
  - Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0 (HC, 2010)
  - Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0 (HC, 2010)
  - Part V Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{CHEM}$) (HC, 2010)
  - Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment ($DQRA_{RAD}$) (HC, 2010)
  - Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites (HC, 2010)
- FCSAP Sediment Remediation Conceptual Cost Estimation Tool (PSPC, 2013)
- FCSAP Long Term Monitoring (LTM) Planning Guidance (FCSAP, 2013)
- Remediation Liabilities Related to Contaminated Sites: A Supplement to the Financial Information Strategy (FIS) Manual (TBS, 2010)

- Sustainable Remediation Forum (SuRF) Canada (Website)

Legislation

- Canadian Environmental Assessment Act (CEAA, 2012)
- Canadian Environmental Protection Act (CEPA, 1999)

Step 8: Implement Remediation/Risk Management (R/RM) Strategy

Step 8, which is based on the analysis and planning outcomes from Step 7, involves implementing the Remediation/ Risk Management Strategy (which includes the Remedial Action Plan (RAP) and Remediation Management Plan (RMP) to reduce the risk from contaminants at the site to acceptable levels. Other responsibilities include:

- Meeting requirements under the Canadian Environmental Assessment Act (CEAA 2012);
- Obtaining all permits and approvals required to undertake any work at the site;
- Developing sustainable contracting clauses;
- Selecting the contractor;
- Conducting operations, maintenance and monitoring during implementation of the remediation during the RAP/RMP; and
- Verifying the efficacy of the RAP/RMP.

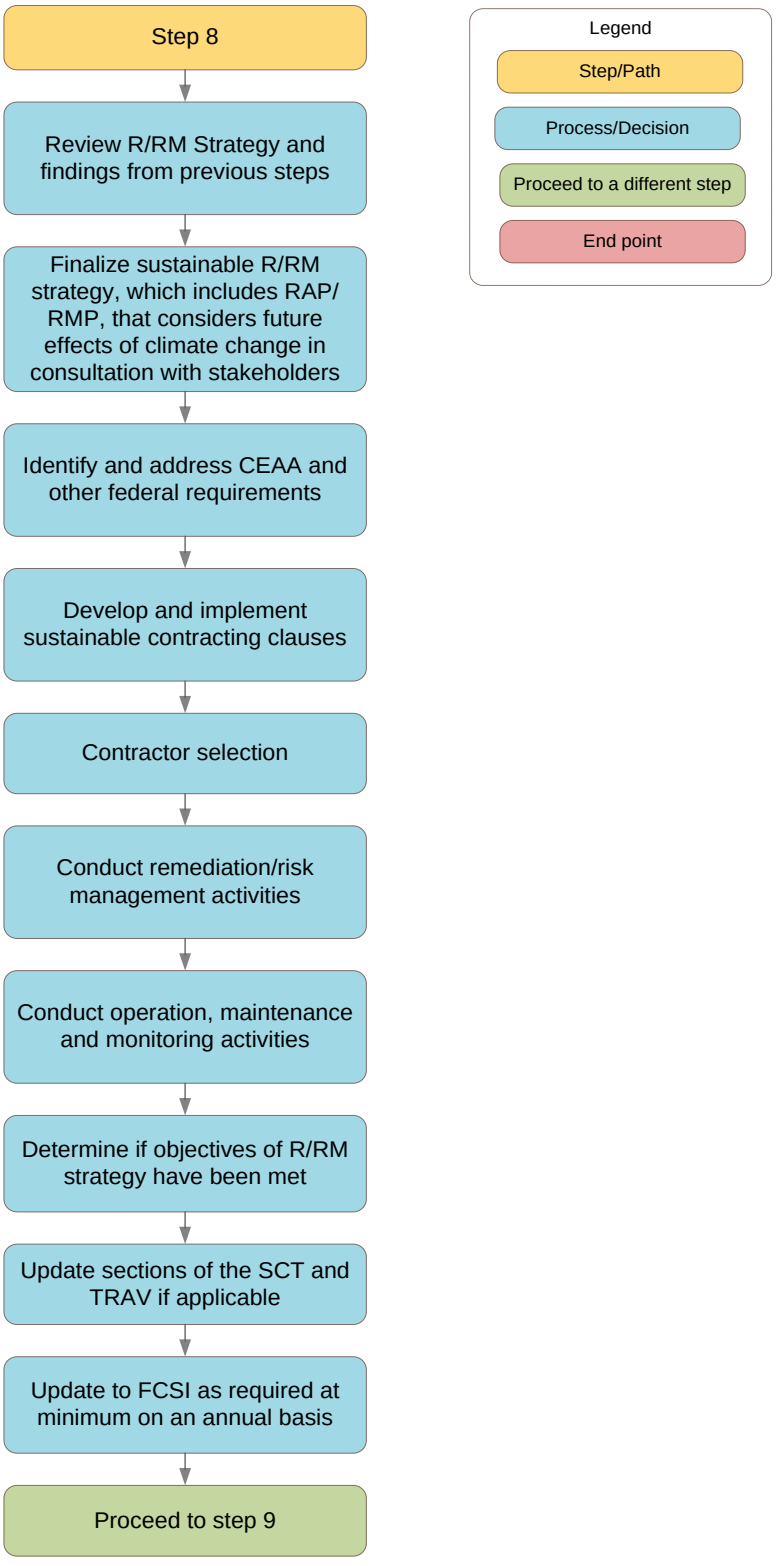
This step should include strict documentation control and adherence to the remediation/risk management (R/RM) objectives, as any unanticipated occurrences will require modification of the RAP and potential re-evaluation of the technologies applied. Stakeholders should be consulted as appropriate. Effects of climate change should be taken into consideration, and sustainable R/RMs should be included at all stages of the RAP/RMP. If it is determined that the remediation objectives will not be met, a full review of the R/RM Strategy and RAP/RMP for the site is required. It may be necessary to revisit earlier steps to determine what supplemental work is required or to determine if the site management strategy needs to be refined.

Key decision(s):

- Categorize site strategy based on approach and determine whether short, medium, or long-term plans will be affected by climate change by reviewing the assessment conducted in Step 7.
- Develop integrate sustainable contracting clauses.
- Determine if the performance expectations of the R/RM strategy have been met.

Step 8: Implement Remediation/Risk Management (R/RM) Strategy

All activities in Step 8 should consider the future impacts of climate change on the site and should aim to use sustainable approaches.



How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide advice during implementation of the R/RM strategies related to:
  - mitigation measures and compliance requirements under the *Fisheries Act*;
  - effectiveness and compliance monitoring;
  - unforeseen issues; and
  - revisions to the sampling and monitoring plans, if required.
- Provide support to the public engagement process.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice related to the implementation of R/RM strategies (specific to potential environmental)
- Provide advice on compliance requirements under the *Fisheries Act* and other ecological requirements.
- Provide advice on revising the design, implementation and objectives for the long-term management plan including a long-term monitoring plan (to be developed and implemented in Step 10).
- Provide advice on the preparation of the site closure report and assist with the Site Closure Tool (SCT) (FCSAP, 2012) including the Tool for Risk Assessment Validation (TRAV) an optional component of the SCT.

How Health Canada (HC) expert support can assist

- Provide advice related to the implementation of R/RM strategies (specific to potential human health impacts).
- Provide advice and support in the determination of the site's significant environmental effects as defined under the Canadian Environmental Assessment Act, 2012 (CEAA 2012).
- Provide advice and support on risk communication to stakeholders (including the general public).
- Provide advice on the accuracy of model and other assumptions made during the Human Health Risk Assessment (HHRA) and the RM Strategy.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Provide advice on, among other things, finalizing the RAP/RMP, developing tender specifications, selecting contractors, providing oversight of remedial activities, and completing the SCT. Ensure that the monitoring and control of the site, such as the status, scope, schedule, communication, risk control and lessons learned, are complete.

How the FCSAP Secretariat can assist

- Provide support to custodian as they complete the SCT/TRAV and assesse effectiveness of R/RM strategy.

Supporting documents and tools specific to Step 8

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

Legislation

- *Canada Wildlife Act(1985)*
- *Fisheries Act (1985)*
- *Canadian Environmental Assessment Act (CEAA) 1992*, *CEAA* 2012
- *Migratory Birds Convention Act (1994)*
- *Canadian Environmental Protection Act (CEPA), 1999*
- *Species at Risk Act* (SARA) (2002)

General Guidance

- Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils (FCSAP, 2006, Editorial Update 2013)
- Project/Program Risk Management Guidance for Federal Contaminated Sites Remediation/Risk Management (R/RM) Projects Guidance and Orientation for the Selection of Technologies (GOST) (PSPC/NRC, 2012)
- Site Closure Tool (SCT) and Tool for Risk Assessment Validation (TRAV) (FCSAP, 2012)
- Remediation Checklist (internal, Health Canada)
- Contaminated Site Remediation Projects Roadmap (Website) (PSPC)

Other

- Fisheries and Oceans Canada (DFO) Pathways of Effects (DFO, 2011)
- Sustainable Remediation Forum (SuRF) Canada (Website)

Step 9: Confirmatory Sampling and Final Reporting

Step 9 involves confirming the achievement of remediation/risk management (R/RM) objectives following the implementation of the R/RM Strategy (which includes the Remedial Action Plan (RAP) and Remediation Management Plan (RMP)).

Confirmatory sampling is completed to demonstrate that the contamination has been removed or stabilized effectively and that the clean-up R/RM objectives have been attained.

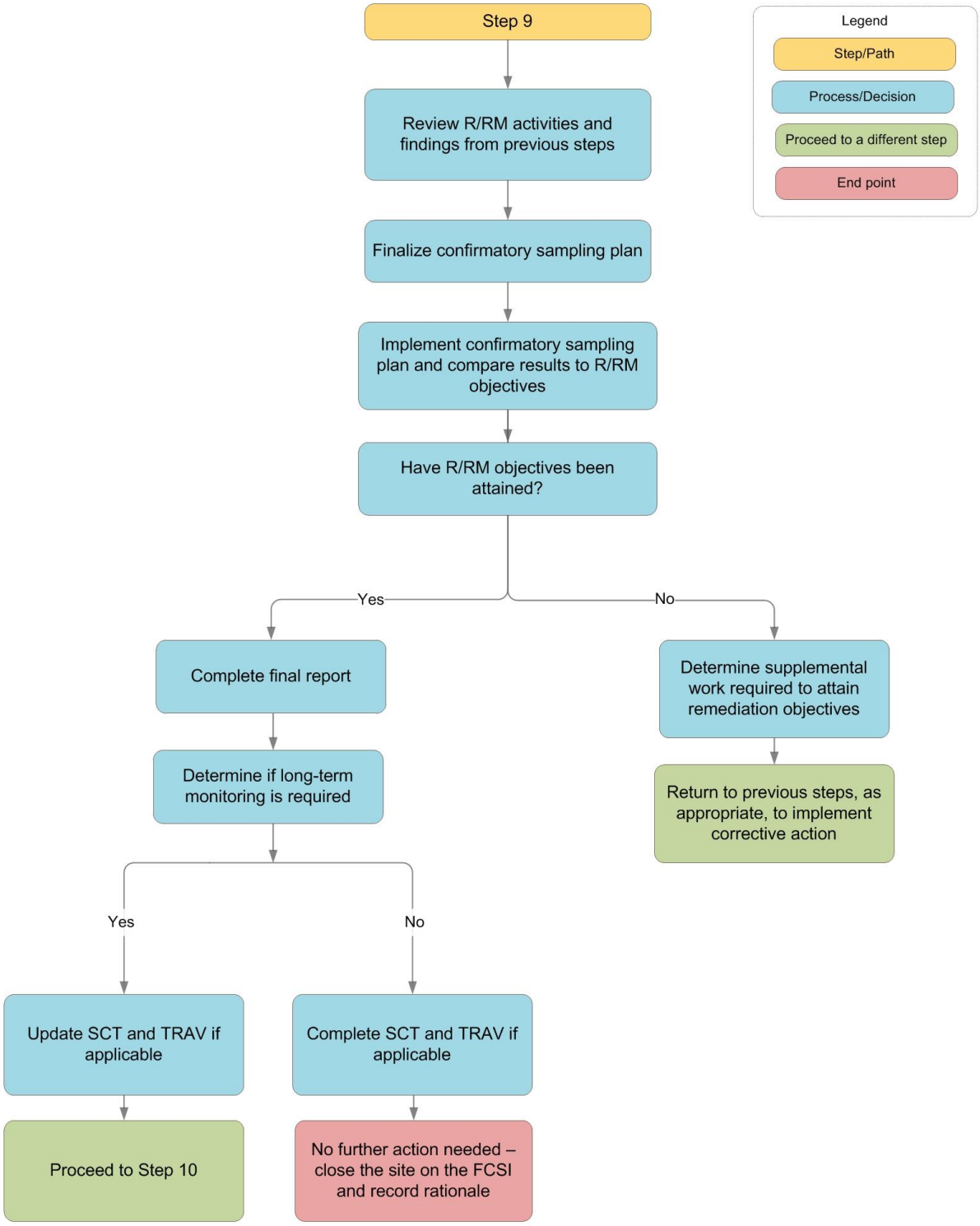
The site conditions as well as activities carried out during site decommissioning and clean-up, including drawings, records, and monitoring data will be documented in a report. At this step it is important to explain how climate change effects may have impacted the progress of the R/RM activities and whether potential climate change effects are expected to have significant future impacts with respect to the site's R/RM strategies and/or long-term monitoring (LTM) strategy.

Closure reporting using the Site Closure Tool (SCT) (FCSAP, 2012) to document the reduction of risk to acceptable levels will be completed and submitted to the Federal Contaminated Sites Action Plan (FCSAP) Secretariat (mandatory for FCSAP-funded sites), if it is determined that no further action is required, and to profile the use of sustainable approaches at the site. For sites that require additional R/RM activities or LTM, this information would also be recorded in the site closure report in preparation for closure in the future.

Key decision(s):

- Evaluate the success of the site management strategy implementation.
- Determine whether the site can be closed or whether additional work (e.g., continued R/RM or LTM) is required.
- Document climate change assessment and analysis, especially where expected climate change effects would encourage use of LTM.
- When required, begin planning sustainable LTM techniques that minimize energy usage and waste production.

Step 9: Confirmatory Sampling and Final Reporting



How Fisheries and Oceans Canada (DFO) expert support can assist

- Review and provide advice on the results of the confirmatory sampling.
- Advise on the effectiveness of monitoring in protecting fish and fish habitat.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP (FCSAP, 2011).
- Provide advice on the design and expectations associated with the LTM plan.

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice on the design, implementation and results of confirmatory sampling.
- Provide advice on the preparation of the site closure report and assist with the Site Closure Tool (SCT) including the Tool for Risk Assessment Validation (TRAV) (2012), an optional component of the SCT.

How Health Canada (HC) expert support can assist

- Provide advice on the design and implementation of confirmatory sampling.
- Provide advice on the preparation of closure reporting and on the reporting of risk reduction.
- Provide advice on ongoing site work and long-term management.
- Provide assistance with interpreting LTM results and reports as they relate to human health.

How Public Services and Procurement Canada (PSPC) expert support can assist

- Can assist in confirming whether the R/RM objectives were met, including the completion of the sampling plan.
- Assist in confirming that no further action is necessary and in documenting completion through the SCT.

How the FCSAP Secretariat can assist

- Offer support by providing clarification on the application of the Eligible Cost Guidance, v. 5.0 (FCSAP, 2016) document as required, and assist in reporting on the Federal Contaminated Sites Inventory (FCSI).

Supporting documents and tools specific to Step 9

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

Canadian Council of Ministers of the Environment (CCME) Guidance

- CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report (CCME, 1993)
- CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume II: Analytical Method Summaries (CCME, 1993)
- CCME Canadian Environmental Quality Guidelines
    - A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)

- A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
- A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995)
- A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)

Other Guidance

- Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils (FCSAP, 2006, Editorial Update 2013)
- Federal Interim Groundwater Guidelines, (FCSAP, 2016)
    - Federal Interim Groundwater Guidelines Update (FCSAP, 2016)
- Guidelines for Canadian Drinking Water Quality (HC, 2014)
- Site Closure Tool (SCT), including the Tool for Risk Assessment Validation (TRAV) (FCSAP, 2012)
- FCSAP Long Term Monitoring Planning Guidance (FCSAP, 2013)

Step 10: Long Term Monitoring (LTM) (if required)

The objective of Step 10 is to implement a long-term monitoring (LTM) strategy at sites where the remediation/risk management (R/RM) objectives have been met but where conditions are such that the site could not be closed. For example, a risk management site would likely require long term monitoring. Long-term monitoring (LTM) may not be required at all sites. According to the 10-step Approach, LTM is meant to confirm that the nature and extent of the remediation activities have been carried out as per the site management goals, and that the objectives of the remediation or risk management strategy **continue** to be met over time to protect human health and the environment. Sustainable methods for site monitoring and contracting should be implemented as part of the LTM. Climate change effects should be considered during the development and assessment of the monitoring program in order to take potential changes in site conditions and exposure pathways into account. Stakeholders should be consulted as appropriate.

LTM objectives must be achieved and verified before a site can be closed, indicating that no further action is required. However, at some sites, perpetual monitoring may be required.

Once the LTM Strategy has been completed satisfactorily and the site can be closed, a closure tool should be completed, or updated. For FCSAP funded sites (R/RM activities) the Site Closure Tool (SCT) (FCSAP, 2012) must be completed and submitted to the FCSAP Secretariat.

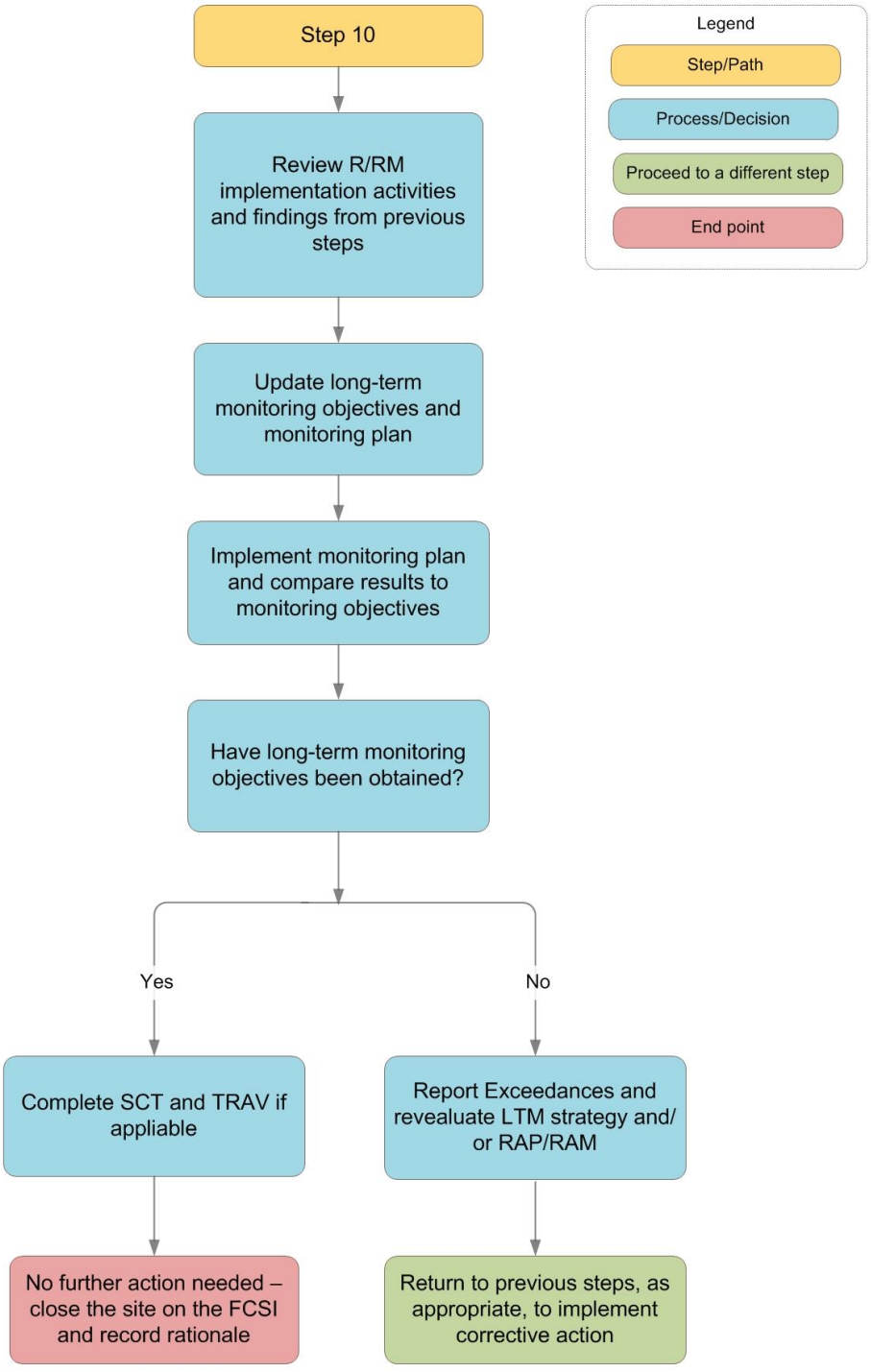
If LTM objectives have not been met (e.g. monitoring results indicate exceedance of objectives), the exceedances should be reported to the appropriate level of management and custodians should re-evaluate the LTM Strategy and/or the Remedial Action Plan (RAP)/Risk Management Plan (RMP) (see Step 7).

Key decision(s):

- Decide whether the LTM plan, developed in Step 7, is still applicable.
    - Is the remedy functioning as intended by the R/RM plan?
    - Are the exposure assumptions, toxicity data, cleanup levels, and Remediation Action Plan/Risk Management Plan objectives used during Step 7 still valid?
    - Has any other information come to light that could call into question the protectiveness of the remedy?
- Decide when LTM is no longer required.
- Consider climate change effects during LTM planning, including possible permafrost loss or increases and decreases in infiltration rates, and
- Plan and implement sustainable LTM techniques, where feasible, that minimize energy usage and waste production.

Step 10: Long-Term Monitoring (if required)

All activities in Step 10 should consider the future impacts of climate change on the site and should aim to use sustainable approaches.



How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide advice during the design and development of a LTM program (e.g., selecting monitoring targets/endpoints and monitoring plans).
- Provide support for public engagement activities (e.g., help with the interpretation and communication of results).
- Assist with interpreting LTM results and reports.
- Provide advice on adaptive management and possible modifications to the monitoring plan.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP, 2011).
- Provide assistance with interpreting LTM results and reports.

How Environment and Climate Change Canada (ECCC) expert support can assist

- Provide advice during the design and development of a LTM plan.
- Provide advice on establishing procedures for identifying decision criteria prior to LTM data collection.
- Provide assistance with interpreting LTM results and reports.
- Provide advice on the need to continue monitoring.

How Health Canada (HC) expert support can assist

- Provide advice on the need for LTM and on the design of the monitoring plans, including the need for risk communication with stakeholders and those affected, for the duration of the monitoring program (if necessary).

How Public Services and Procurement Canada (PSPC) expert support can assist

- Assist with the update of the LTM plan and with continual monitoring and the Site Closure Tool (SCT) (FCSAP, 2012) when applicable.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance document, v. 5.0 (FCSAP, 2016) as required.

Supporting documents and tools

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

Guidance

- Site Closure Tool (SCT), including the Tool for Risk Assessment Validation (TRAV) (FCSAP, 2012)
- FCSAP Long Term Monitoring (LTM) Planning Guidance (FCSAP, 2013)

Appendix A: Incorporating Sustainability in Contaminated Sites Management

Please refer to <Link on Webportal for Sustainability Appendix>

Appendix B: Site Management Options Assessment

This appendix discusses methods for assessing the relative advantages and disadvantages of a variety of remediation or risk management (R/RM) options.

Part 1 – The Theory

Role of cost/benefit analysis

Cost/benefit analysis is a commonly accepted approach for determining the feasibility of various alternatives being considered to address a particular problem or project requirement. In the context of contaminated sites, this can be used as a basis to determine the optimum approach where a variety of alternatives exist to address site conditions, representing a range of effectiveness, implementability and cost considerations.

In order to conduct the cost/benefit analysis, it is typically necessary to determine the alternatives for consideration, identify the evaluation criteria to be applied, and then conduct the comparative evaluation using an appropriate method. This is discussed in more detail below.

Development of an alternatives array

The formulation of a range of alternatives can be illustrated in an array that identifies the technical options available for addressing the site conditions (identified prior to Step 7). This may include both remediation and risk management techniques, and a combination depending on the site-specific circumstances and the environmental media that need to be addressed.

For illustration purposes, an example alternatives array is included in Table 1. As shown in the table, a total of nine alternatives are included. Each alternative includes specific actions related to individual site-specific areas or units (e.g., equipment/storage vessels, waste disposal areas, impacted soil areas, impacted groundwater areas). The scope of the alternatives progress sequentially from “do nothing,” to limited action (waste material removal, access restrictions, monitoring), then containment, and finally to active remediation through treatment. The potential application of both risk management and remediation methods is an integral part of the array, and a variety of other combinations may be available beyond what is shown in this example. In carrying out the comparative assessment, it may ultimately be decided that the optimum alternative is a refinement of the alternatives initially included in the array. The evaluation process should provide flexibility for this type of decision making.

It is noted that Alternative 1 (no action) may appear inherently unacceptable at the outset. However, its inclusion in the array may be useful for representing a baseline condition to identify the consequences of “do nothing” and for assisting with the justification for selecting one of the other alternatives.

Table 1
Example Alternatives Array
Cost/benefit analysis for remediation/risk management alternatives for federal contaminated sites

Area/Unit	1	2	3	4	5	6	7	8	9
Drums/tanks/ piping	No action	Remove	Remove	Remove	Remove	Remove	Remove	Remove	Remove
Waste disposal pit	No action	Restrict access	Cap	Cap	Excavate/dispose	Excavate/dispose	Excavate/dispose	Excavate/dispose	Excavate/dispose
Soil impacted above industrial use guidelines	No action	Restrict access	Cap	Cap	Cap	Cap	Excavate/dispose/treat	Excavate/dispose/treat	Excavate/dispose/treat
Soil impacted above unrestricted use guidelines	No action	Restrict access	Restrict access	Restrict access	Restrict access	Restrict access	Restrict access	Cap	Excavate/dispose/treat
Groundwater at source area	No action	Monitor	Monitor	Treat-ment	Treat-ment	Treat-ment	Treat-ment	Treat-ment	Treat-ment
Groundwater plume	No action	Monitor	Monitor	MNA*	MNA	Treat-ment/ MNA	Treat-ment/ MNA	Treat-ment/ MNA	Treat-ment/ MNA

**MNA: monitored natural attenuation*

Potential evaluation criteria

In most situations, the comparative evaluation of alternatives relies on the use of criteria against which each alternative can be assessed relative to other alternatives. These criteria may be either qualitative or quantitative, and will generally consider factors relating to overall protection, effectiveness, implementability, cost, stakeholder considerations and regulatory compliance. A list of potential evaluation criteria is included in Table 2. As shown in the table, various criteria may be applicable under each category, and are further classified according to the type of criteria (threshold, balancing and acceptance).

Table 2
Potential Evaluation Metrics
Cost/benefit analysis for remediation/risk management alternatives for federal contaminated sites

CATEGORY/EVALUATION METRICS	METRIC TYPE		
Overall protection	**Threshold**	**Balancing**	**Acceptance**
Protection of human health	**X**		
Protection of the environment	**X**		
Effectiveness	**Threshold**	**Balancing**	**Acceptance**

CATEGORY/EVALUATION METRICS	METRIC TYPE		
Short-term effectiveness		X	
Long-term effectiveness and permanence		X	
Reduction of toxicity, mobility, volume		X	
Implementability	**Threshold**	**Balancing**	**Acceptance**
Use of proven technology		X	
Use of innovative technology		X	
Use of sustainable construction/remediation methods		X	
Permits and approvals required		X	
Time required for implementation		X	
Impacts and risks to the environment		X	
Impacts and risks to the public and workers		X	
Cost	**Threshold**	**Balancing**	**Acceptance**
Construction cost		X	
Operation and maintenance cost		X	
Decommissioning cost		X	
Present worth cost		X	
Stakeholder considerations	**Threshold**	**Balancing**	**Acceptance**
Federal government/custodian acceptance			X
Provincial government acceptance			X
Local government acceptance			X
Community/public acceptance			X
Regulatory compliance	**Threshold**	**Balancing**	**Acceptance**
Compliance with regulatory requirements – federal	X		
Compliance with regulatory requirements – provincial	X		
Compliance with regulatory requirements – local	X		
Other	**Threshold**	**Balancing**	**Acceptance**
Sustainable development		X	
Future development potential		X	
Long-term liability		X	
Impact on land value		X	
Impacts on future operations		X	
Compatibility with federal government policies			X

CATEGORY/EVALUATION METRICS	METRIC TYPE		
Socio-economic impacts		X	

Threshold criteria include minimum requirements that need to be met in order for the alternative to be considered for selection. Typically, this relates to protection of human health and the environment, and regulatory compliance. Alternatives that satisfy these threshold criteria will be suitable for passing an initial screening and then short-listed for more detailed consideration.

Balancing (or modifying) criteria are those which are used to compare the relative merits of the various alternatives and associated trade-offs. For example, Alternative A might be expected to achieve a permanent solution and unrestricted future site use, whereas other alternatives may achieve an acceptable cleanup level for commercial or industrial site use at a much lower cost.

Acceptance criteria are those that relate to meeting the expectations of various stakeholder groups, including various levels of government and the local community. Acceptance considerations may ultimately be used to make a final selection from a list of several otherwise suitable alternatives, or as a basis for refinement of a preferred alternative.

An alternative that is preferable based on balancing criteria considerations may not ultimately be selected for implementation if it is not acceptable to stakeholders. In some cases (e.g., large/complicated sites), stakeholder input will probably have already been considered in developing the list of alternatives.

The list shown in Table 2 represents potential criteria for consideration. The selection of relevant criteria may be affected by site-specific factors, and it may be decided that some should be deleted, or others added, as necessary and appropriate.

Options for comparative evaluation of alternatives

A variety of methods are available for conducting a comparative evaluation of alternatives in order to identify the most suitable alternative (and hence site management strategy) for implementation. This includes the following examples described herein: ad hoc methods, checklist methods, economic methods, pairwise comparison methods and matrix methods.

Ad hoc methods compare alternatives in narrative terms without using any explicitly stated methods to order the preferences, based on professional judgment. Typically, the use of ad hoc methods, as the name implies, does not necessarily follow an explicit set of evaluation criteria. This approach can be applied to situations in which the scope of the problem is narrow and well defined, and the rationale for selection of the proposed alternative can be readily communicated. However, in more complex situations this method is subject to potential problems such as assuring that each alternative is evaluated in a consistent manner.

Checklist methods compare and evaluate alternatives against a specified set of criteria with no compensatory rules or tradeoffs. Typically, this involves posing a series of questions related to the individual criteria that require a yes or no response, such as:

- Is the alternative protective of human health and the environment?
- Is the alternative effective in the long term?

- Does the alternative use proven methods or technology?
- Is the estimated cost below a defined threshold?

This approach may be useful for identifying dominant alternatives for screening purposes. For example, if Alternative A is better than Alternative B in at least one respect and no worse than Alternative B in any other respect, Alternative A may be considered dominant.

Economic methods use economic procedures and principles to translate non-commensurable units into monetary units. This methodology relies largely on determining an individual's willingness-to-pay (the amount that individuals affected by the project would be willing to pay for the defined benefits), and the availability of market prices that relate to the benefits. By their nature, many of the benefits associated with environmental improvements cannot be readily determined based on market prices; however, this type of method may have application in situations where the property is being considered for sale and/or redevelopment. In this case, it may be possible to directly relate the cost of implementing an alternative to the beneficial value of land improvement.

Pairwise comparison methods use the sequential comparison of alternatives in pairs as a basis for subsequent ordering of preferences. In its simplest form, the procedure develops a measure of how frequently one alternative is superior to another based on the various evaluation criteria. This is improved using **fuzzy set procedures**, which is based on subjective interpolation, and is used to identify inefficient alternatives (those that are dominated by other alternatives). In this case, each alternative is numerically ranked for each evaluation criteria. Initially, two alternatives are compared to determine dominance, i.e., which of the two alternatives has the greater number of occasions of dominance. The dominant alternative is then compared to the next alternative, and so on, until one dominant alternative is identified. The method can be based on either a non-parametric or parametric ranking; however, in both cases, the assignment of the ranking values may be subjective. Also, the relative importance of each criterion is not reflected in the procedure unless the criteria are ranked into groups.

Matrix methods use a matrix for the summary, comparison and evaluation of criteria and alternatives, based on professional judgment (as an extension of ad hoc methods). In this case, weight factors are applied to each evaluation criterion to reflect its overall importance, and ranking factors are applied to each alternative (for each criterion). These are multiplied and summed to develop an overall score. In this manner, alternatives that score well can be considered to be superior to other alternatives. This method relies on subjective assignment of the weight and ranking factors, and therefore would need to be supported by the assessor's justification for assigning the factors. It is an improvement over ad hoc methods in that all evaluation criteria need to be considered for each alternative, and it is amenable to sensitivity analysis by examining the effects of changes in the factors. Both the pairwise comparison and the matrix methods are transparent in the identification of the preferred alternative and hence potentially very useful in public consultation.

Expert support tools that may assist the custodian in completing the preceding evaluation include the **Guidance and Orientation for the Selection of Technologies (GOST)** and the **Sustainable Development Tool (SDT)**. GOST is a technology database that contains individual fact sheets on a host of treatment technologies/approaches. The user is prompted for a series of inputs regarding contaminant and site data (e.g., hydro-geologic conditions), which results in the identification of a number of technically feasible R/RM options. Custodians could consider the use of GOST as early as Step 5 and during Step 7 of the 10-step federal process, primarily to identify potential candidate technologies/approaches for management of their sites.

A secondary benefit of GOST is that it provides assistance to the custodian in confirming the necessary data to be collected during the environmental site assessment (ESA), via the required inputs to the model, to support this evaluation.

Once the custodian has identified a suite of potential technologies/approaches using GOST, a secondary evaluation can be conducted using SDT to evaluate and compare up to five separate treatment options from the perspective of the three pillars of sustainability: economic, social and environmental. Custodians can choose from a suite of parameters for all three elements—and further, use weightings for each parameter—to reflect their specific site situation. The output from the model is both graphical and numerical, such that it serves as a communication as well as an analytical tool. This approach allows for stakeholder engagement and incorporation of multi-stakeholder requirements. The intent is that custodians will select the most balanced alternative with the cost in mind; SDT will help them to incorporate sustainability aspects into their evaluation process when identifying the preferred alternative.

Part 2 – Example Alternatives Assessment

An example of alternatives assessment using the pairwise comparison and matrix methods based on a contaminated site scenario is presented below.

Use of evaluation metrics to select the preferred remediation/risk management (R/RM) alternative

Table 2 includes the potential evaluation metrics within various categories that can be used as part of the process for identifying the preferred R/RM alternative. Although Table 2 lists a number of evaluation metrics associated with each category, not all evaluation metrics will be employed in an actual evaluation. In practice, it is only necessary to employ the evaluation metrics that are relevant to discriminating between the R/RM alternatives. Hence, only a subset of the potential evaluation metrics will be employed in any particular evaluation.

As apparent from the list of potential evaluation metrics, individual metrics are not measured using the same units, and hence they are not additive. As a result, they cannot be combined in a simple manner. Instead, a means of combining the value of an alternative must be made relative to the various evaluation metrics, to determine which of the alternatives is preferred.

An additional dimension of the evaluation criteria must also be acknowledged; if an alternative does not attain a threshold (e.g., with respect to human health and the environment), that alternative is not acceptable and is not considered beyond the first level of analysis.

Example problem definition

The following example demonstrates how the methodology is applied. Please note that this problem situation has been kept fairly simple in order to focus on the methodology rather than on precise complexities that may arise in practice. Furthermore, the exact details of the preferred strategy are not supplied but are assumed to be consistent with good practice, specifically for a remote site.

Consider the following situation:

A waste disposal pit and an underlying groundwater plume have been identified at a site. The alternatives for the remediation of the disposal pit were identified as capping the pit, or excavation and disposal of the waste.

For the underlying groundwater plume, the alternatives that will be considered are monitored natural attenuation (MNA) and groundwater treatment with MNA combined (treatment/MNA). The duration of these options will vary, since treatment will promote a more rapid reduction in contaminant concentrations. The status quo ("do nothing") option associated with the groundwater plume should also be considered, as there may be no need to undertake action, and it will provide a baseline for comparison of this scenario.

The individual alternatives, as classified into vertical sets of options, are illustrated in Table 3. Other options may be available, for example cap and treatment/MNA, but are not included in this example in order to maintain simplicity.

Table 3
List of Alternatives

Area/Unit	***EXC****	***1***	***2***	***3***
Waste disposal pit	No action	Cap	Excavate/dispose	Excavate/dispose
Groundwater plume	No action	MNA	MNA	Treatment/MNA

**EXC: excluded as a viable alternative as it does not attain the necessary threshold levels.*
**MNA: monitored natural attenuation*

These alternatives include elements related to both risk management (i.e., cap and MNA) and remediation (i.e., excavate/dispose and groundwater treatment/MNA). We are now interested in selecting the preferred alternative, where the preferences between the options regarding long-term effectiveness may be different, for example, than cost considerations.

To proceed to the next step, each of the alternatives needs to be considered with respect to each of the evaluation criteria within the categories. This step is accomplished in the following sub-tables, as follows:

(i) The alternative is judged to be unacceptable or excluded in terms of threshold levels and, hence, is no longer considered.
(ii) Table 4(a) summarizes the attributes of each of the alternatives relevant to effectiveness. It should be noted that the only relevant effectiveness evaluation criteria are the long-term effectiveness and the reduction of toxicity, mobility or volume.

Table 4(a)
Description of attributes of alternatives related to effectiveness criteria

Alternative	*Long-term effectiveness*	*Reduction of toxicity, mobility or volume*
1. Capping and MNA	Capping not necessarily effective in the long term, and attenuation of groundwater contamination will occur but will take some time.	There will be no reduction of toxicity, mobility or volume of chemicals within the waste disposal pit contents, and reduction of groundwater contamination will occur over time.
2. Excavation/disposal and MNA	This represents a permanent solution for in situ wastes, and attenuation of groundwater contamination will occur but will take some time.	This will reduce/eliminate the waste disposal pit contents, and will result in attenuation of the groundwater contamination over time.
3. Excavation/disposal and treatment/MNA	This represents a permanent solution for in situ wastes, and will result in attenuation of groundwater contamination more rapidly than MNA alone.	This will reduce the toxicity of waste pit contents, and will result in attenuation of groundwater contamination more rapidly than MNA alone.

**MNA: monitored natural attenuation*

(iii) Table 4(b) summarizes the attributes of each of the alternatives relevant to "implementability." All of the alternatives involve the application of proven technologies, none are innovative, all involve the necessity to obtain permits, etc. This means that the discriminating factor between the alternatives is the time required for implementation (e.g., MNA requires a lengthy period for site remediation whereas capping is implemented relatively quickly). Impacts and risks to the environment during implementation must also be a consideration (i.e., consider the risks associated with the transport and disposal of the excavated material).

Table 4(b)
Description of attributes of alternatives related to implementability criteria

Alternative	*Time required for implementation*	*Impacts and risks to environment*
1. Capping and MNA	Rapid to construct cap. MNA will take time to be totally effective.	Technology of capping is understood, and risks to environment by MNA are small, although the possible ongoing source of contamination must be considered.
2. Excavation/disposal and MNA	Excavation/disposal relatively rapid. MNA will take time to be totally effective.	May be issues in relation to contaminant release during excavation as well as at the disposal site. MNA risks are small.

Alternative	*Time required for implementation*	*Impacts and risks to environment*
3. Excavation/disposal and treatment/MNA	Excavation/disposal relatively rapid. Treatment/MNA will be more rapid than MNA alone.	May be issues in relation to contaminant release during excavation. Treatment/MNA risks are small and less than MNA alone.

(iv) Table 4(c) describes the attributes of the various alternatives in terms of costs. In this application, the costs are determined in terms of present worth (or net present value) and therefore show the combination effect of construction costs, operation and maintenance costs, and discount rate.

Table 4(c)
Description of attributes of alternatives related to cost criteria

Alternative	*Magnitudes of costs of each alternative*
1. Capping and MNA	2 million + 1 million = 3 million
2. Excavation/disposal and MNA	10 million + 1 million = 11 million
3. Excavation/disposal and treatment/MNA	10 million + 2 million + 0.5 million = 12.5 million

(v) Table 4(d) describes the attributes for different alternatives in terms of the "Other" category. This may be a relevant consideration in selecting between the alternatives in that there is long-term liability for ensuring that MNA functions as intended, as opposed to, for example, the excavation and destruction of the wastes. For MNA, there is some degree of long-term liability associated with the site. Also, the potential impacts on future site operations may be a consideration.

Table 4(d)
Description of attributes of alternatives related to other evaluation criteria

Alternative	*Magnitudes of long-term liability*	*Impacts on future operations*
1. Capping and MNA	***Liability*** exists since capping does not destroy the contaminants, and the time for MNA to be effective is potentially long.	***Operations:*** Capping will limit certain land-use activities on site.
2. Excavation/disposal and MNA	Reduced long-term liability since the remediation removes the contaminants, although time for MNA to be effective may still be prolonged.	Excavation/disposal will allow future land uses depending on residual contaminant concentrations.
3. Excavation/disposal and treatment/MNA	Minimum long-term liability since the remediation removes the contaminants and time for treatment/MNA is shorter.	Excavation/disposal will allow future land uses depending on residual contaminant Concentrations.

The set of Tables 4(a) through 4(d) summarizes how the alternatives are measured with respect

to each of the evaluation criteria. The next stage is to identify which of the alternatives is/are the preferred alternative(s). This will be accomplished using the two separate procedures designed for this identification, namely (i) the pairwise comparison method and (ii) matrix weighting procedures.

Identification of preferred alternative

Using the pairwise comparison method

Table 5
Comparison of Alternatives 1 and 2

Category/Evaluation Criteria	*Preferred Alternative*	*Rationale*
Effectiveness		
Long-term effectiveness	2	Alternative 2 is more effective since it removes the waste material.
Reduction of toxicity, mobility or volume	2	Alternative 2 is more effective since it removes the waste material.
Implementability		
Time required for implementation	1	Alternative 1 requires less time for implementation and avoids potential
Impacts and risks to the environment	1	Alternative 1 requires less time for implementation and avoids potential
Costs	1	Alternative 1 involves lower cost.
Other		
Long-term liability	2	Alternative 2 reduces long-term liability associated with leaving the waste in place.
Impacts on future operations	2	Alternative 2 reduces long-term liability associated with leaving the waste in place.

Alternative 2 has four evaluation criteria in which it is preferred to Alternative 1, and there are three criteria in which Alternative 1 is preferred to Alternative 2. In this situation, Alternative 2 moves on to be compared with Alternative 3. It is noted that this comparison suggests that there is little difference between Alternatives 1 and 2.

In a more complete assessment of impacts, other considerations such as off-site impacts like transportation of excavated material and liability/risk associated with disposal might also be evaluated with regard to each alternative. Please note this type of evaluation does not give weight to the evaluation criteria; it only allows a preference for one alternative method or another. A weighted matrix example is explained later in this appendix.

Table 6
Comparison of Alternatives 2 and 3

Category/Evaluation Criteria	*Preferred Alternative*	*Rationale*
Effectiveness		
Long-term effectiveness	3	Alternative 3 is more effective since it reduces the contaminant mass through treatment.
Reduction of toxicity, mobility, or volume	3	Alternative 3 is more effective since it reduces the contaminant mass through treatment.
Implementability		
Time required for implementation	3	Alternative 3 requires less time to reach acceptable contaminant levels because
Impacts and risks to the environment	3	Alternative 3 requires less time to reach acceptable contaminant levels because
Costs	2	Alternative 2 involves lower cost.
Other		
Long-term liability	3	Alternative 3 shortens the time that groundwater contamination persists.
Impacts on future operations	No Difference	--

In this comparison, Alternative 3 is preferred to Alternative 2 with regard to five evaluation criteria, whereas Alternative 2 is preferred to Alternative 3 in only one criterion. This indicates that Alternative 3 is the preferred alternative remediation option.

Based on the above, it could be concluded that Alternative 3 is the preferred alternative, if all evaluation criteria were considered to have equal weight (or importance), as is the case with this method. Weightings are applied in the matrix method discussed below.

Using Matrix Weighting Procedures

Two sets of weighting factors are required:

- The factor weights for the evaluation criteria within each category, where the sum of the factor weights equals one. For example, within the effectiveness category there are two evaluation criteria (long-term effectiveness and reduction of toxicity, mobility or volume), each of which is assigned a factor weight.
- The priority group weights, to reflect the relative importance of each category and assign values such that the sum of the priority group weights equals one. In this case, each of the four categories (effectiveness, implementability, cost, other) is assigned a priority group weight.

The selection of the weighting factors needs to consider the viewpoints of the interested parties, recognizing that different stakeholders may be more sensitive to specific evaluation criteria than others. However, the procedure does allow sensitivity testing to determine differences in the analysis resulting from changes in the weight factors.

Ranking of one alternative relative to another

In the example matrix, each of the alternatives is ranked relative to the others using non-parametric means, such that the best of the three alternatives associated with each of the evaluation criteria receives a 3, the second-best gets a 2, and the third-best gets a 1. In the event of a tie, the average of the two is assigned to both.

Simple matrix weighting calculations are summarized in the table below, which shows that Alternative 3 is the preferred alternative of the three (i.e., has the highest score).

Table 7
Scoring calculation for alternatives using matrix weighting procedure

Category/Evaluation Criteria	*Factor Weight*	*Ranking Score Alternative (1, 2, 3)*			*Weighted Factor*			*Priority Group Weight*	*Weighted Factor Alternative (1, 2, 3)*		
Effectiveness											
Long-term effectiveness	0.7	1	2	3	0.7	1.4	2.1				
Reduction in toxicity	0.3	1	2	3	0.3	0.6	0.9				
				Total Weighted Factor	1	2	3	x 0.2	0.2	0.4	0.6
Implementability											
Time required	0.5	3	1	2	1.5	0.5	1				
Impacts of risks	0.5	1	2	3	0.5	1	1.5				
				Total Weighted Factor	2	1.5	2.5	x 0.3	0.6	0.45	0.75
Cost											
Present worth	1	3	2	1	3	2	1				
				Total Weighted Factor	3	2	1	x 0.3	0.9	0.6	0.3
Other											
Long-term liability	0.7	1	2	3	0.7	1.4	2.1				
Impacts on future operation	0.3	1	3	2	0.3	0.9	0.6				
				Total Weighted Factor	1	2.3	2.7	x 0.2	0.2	0.46	0.54
							Final Alternative Score		1.9	1.91	2.19

**Note: red numbers refer to Alternative 1; blue numbers refer to Alternative 2; and purple number refers to Alternative 3.*

Ranking of each alternative on a scale of one to ten

Another option is to rank the values on a scale from one to ten using parametric means. This allows the assessor to determine, for example, the magnitude of the differences between the alternatives for individual evaluation criteria.

Additional considerations

The example problem was kept very simple to allow the primary focus to be on the selection procedure for the preferred alternative. However, it should be clear that the process may be considerably more complex in a real situation. Examples of the challenges that could arise

include the following:

- There may be more than one evaluation criteria necessary to discriminate between the preferred alternatives in a particular application. For example, there could be both long- and short-term differences in the effectiveness of different alternatives. In this situation, and if both long- and short-term ramifications are better for Alternative A in comparison with B, the approach is relatively simple in that both could be combined into a single metric by which the alternatives can be compared. The challenge will be where Alternative A is better than B with respect to short-term effectiveness, and B is better than A with respect to long-term effectiveness. In this situation, it may be necessary to employ the preferred alternative within an individual category first, and then proceed to the next level of assessment.

- The procedures are readily transparent and are apparent to reviewers. Hence, discussion on the assignments can be focused on points of controversy, should they exist.

The procedures are straightforward to apply and test the sensitivity of the selection by allowing different methods to arrive at the same conclusion.

There is merit in completing evaluations using one or more procedures, for example pairwise comparison or matrix weighting comparisons; if the results are the same, it demonstrates that the findings are robust.

List of Abbreviations

Abbreviation	Definition
ASCS	Aquatic Site Classification System
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
CEPA	*Canadian Environmental Protection Act, 1999*
CSA	Canadian Standards Association
CSM	Conceptual Site Model
DFO	Fisheries and Oceans Canada
DMF	Decision-Making Framework
DQRA	Detailed Quantitative Risk Assessment
ECCC	Environment and Climate Change Canada
EA	Environmental Assessment
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
FCSAP	Federal Contaminated Sites Action Plan
FCSI	Federal Contaminated Sites Inventory
GOST	Guidance and Orientation for the Selection of Technologies
HC	Health Canada
HHRA	Human Health Risk Assessment
IDEA	Interdepartmental Data Exchange Application
INS	Insufficient information
LTM	Long-term monitoring
MNA	Monitored natural attenuation
NCSCS	National Classification System for Contaminated Sites
PAT	Priority Assessment Tool

Abbreviation	Definition
PQRA	Preliminary Quantitative Risk Assessment
PSPC	Public Services and Procurement Canada
QA/QC	Quality assurance/quality control
R/RM	Remediation/risk management
RAP	Remedial Action Plan
RMP	Risk Management Plan
RMS	Risk Management Strategy
SARA	*Species at Risk Act*
SCT	Site Closure Tool
SDT	Sustainable Development Tool
SOW	Statement of Work
SSTL	Site-specific target levels
TB	Treasury Board of Canada
TBS	Treasury Board of Canada Secretariat
TRAV	Tool for Risk Assessment Validation

Reference List

Canadian Council of Ministers of the Environment

Document:	Also mentioned in:
Introduction	
Guidance Document on the Management of Contaminated Sites in Canada (CCME, 1997)	
Step 3	
Canadian Environmental Quality Guidelines • A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007) • A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006) • A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1995) • A Protocol For The Derivation Of Groundwater Quality Guidelines For Use At Contaminated Sites (CCME, 2015)	Step 5, Step 7, Step 9
Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report (CCME, 1993)	Step 5, Step 7, Step 9
Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume II: Analytical Method Summaries (CCME, 1993)	Step 5, Step 7, Step 9
Subsurface Assessment Handbook for Contaminated Sites (CCME, 1994)	Step 5
Canada-Wide Standard for Petroleum Hydrocarbons in Soil (CCME, 2008)	Step 5. Step 7
Step 4	
National Classification System for Contaminated Sites Guidance Document (NCSCS) (CCME, 2008)	Step 6
National Classification System for Contaminated Sites Spreadsheet (CCME, 2008)	Step 6
Step 7	
CCME Canadian Environmental Quality Guidelines (website) {*http://www.ccme.ca/en/testscript/cqge-sub.html*}	
Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada (CCME, 1996)	
Canada-Wide Standard for Petroleum Hydrocarbons Spreadsheet Model (CCME, 2008-2009)	

Canadian Standards Association

Document:	Also mentioned in:
Step 2	
Canadian Standards Association (CSA) Standards for Phase I Environmental Site Assessments (CSA, 2001)	

Canadian Standards Association (CSA) Standards for Phase II Environmental Site Assessment (CSA, 2004)	Step 3, Step 5

Contaminated Sites Management Working Group

Document:	Also mentioned in:
Introduction	
A Federal Approach to Contaminated Sites (Contaminated Sites Management Working Group, 1999)	
Phase II ESA SOW incorporating Science-based Expert Support Input (A Federal Approach to Contaminated Sites, Appendix C, CSMWG, 1999)	

Environment and Climate Change Canada & the Ontario Ministry of the Environment

Document:	Also mentioned in:
Step 5	
Canada–Ontario Decision-Making Framework (DMF) for Assessment of Great Lakes Contaminated Sediment (ECCC and MOE, 2008)	

Federal Contaminated Sites Action Plan

Document:	Also mentioned in:
Introduction	
FCSAP Guidance Manual (FCSAP, 2010)	
Framework for Addressing and Managing Aquatic Sites under the Federal Contaminated Sites Action Plan (FCSAP, 2011)	Step 1, Step 2, Step 3, Step 4, Step 5, Step 6, Step 7, Step 8, Step 9, Step 10
Eligible Costs Guidance, ver. 5.0 (FCSAP, 2016)	Step 1, Step 2, Step 3, Step 4, Step 5, Step 6, Step 7, Step 9, Step 10
Priority for Assessment Tool (PAT) (FCSAP; update in progress)	Step 1, Step 2, Step 3, Step 4, Step 5, Step 7, Step 8, Step 9
Step 1	
FCSAP Guidance Document on Statements of Work for Ecological Risk Assessments (ERAs) at Federal Sites (FCSAP, 2011)	Step 3, Step 5, Step 7
FCSAP Operational Guidelines (FCSAP 2016, internal document)	
Step 3	
FCSAP Ecological Risk Assessment Guidance (FCSAP, 2012) • Module 1: Toxicity Test Selection and Interpretation (FCSAP, 2010) • Module 2: Selection or Development of Site-specific Toxicity Reference Values (FCSAP, 2010) • Module 3: Standardization of Wildlife Receptor Characteristics	Step 5, Step 7

(FCSAP, 2012) • Module 4: Causality Assessment: Determining the Causes of Impairment at Contaminated Sites: Are Observed Effects Due to Exposure to Site-Related Chemicals or Due to Other Stressors? (FCSAP, 2013) • Module 5: Defining Background Conditions and Using Background Concentrations (FCSAP, 2015)	
Federal Interim Groundwater Guidelines (FCSAP, 2016) • Federal Interim Groundwater Guidelines Update (FCSAP, 2016)	Step 5, Step 7, Step 9
Statements of Work for Ecological Risk Assessments (ERAs) at Federal Sites (FCSAP, 2011)	Step 7
Step 4	
Aquatic Site Classification System (ASCS) worksheets (FCSAP, 2015)	Step 5, Step 6
Supplemental Guidance for the Scoring of Sites Using the National Classification System for Contaminated Sites (NCSCS) and Aquatic Sites Classification Systems (ASCS) under the Federal Contaminated Sites Action Plan (FCSAP, 2013)	Step 6
Aquatic Site Classification System (ASCS) - Version 3.2 Detailed User Guidance Manual (FCSAP, 2015)	Step 6
Step 6	
Interdepartmental Data Exchange Application (IDEA) (FCSAP)	
Step 7	
Guidance for Site Closure Tool for Federal Contaminated Sites (SCT) (FCSAP, 2012) • Including Tool for Risk Assessment Validation (TRAV)	Step 8, Step 9, Step 10
Federal Guidance for Estimating Remediation Liabilities at Federal Contaminated Sites (FCSAP, 2015)	
Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils (FCSAP, 2006, Editorial Update 2013)	Step 8, Step 9, Step 10
FCSAP Long Term Monitoring (LTM) Planning Guidance (FCSAP, 2013)	Step 9, Step 10

Fisheries & Oceans Canada

Document:	Also mentioned in:
Introduction	
Projects Near Water (website) (DFO, 2015)	
Waves: Fisheries and Oceans Canada (DFO) Library (website) (DFO, 2014)	
Step 7	
Fisheries & Oceans Canada (DFO) Pathways of Effects (website) (DFO, 2011)	Step 8

Health Canada

Document:	Also mentioned in:
Step 1	
Addressing Psychosocial Factors through Capacity Building: A Guide for Managers of Contaminated Sites (HC, 2005)	
Improving Stakeholder Relationships: Public Involvement and the Federal Contaminated Sites Action Plan (FCSAP): A Guide for Site Managers (HC, 2006)	
A Guide to Involving Aboriginal Peoples in Contaminated Site Management (HC, 2010)	
Supplemental Guidance on Developing a Contract Statement of Work for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA) (HC, 2010)	Step 3, Step 5, Step 7
For Human Health Risk Assessment (HHRA): Federal Contaminated Site Risk Assessment in Canada (available on request from cs-sc@hc-sc.gc.ca): • Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (HC, 2012) • Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0 (HC, 2010) • Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0 (HC, 2010) • Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM) (HC, 2010) • Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment (DQRARAD) (HC, 2010) • Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites (HC, 2010)	Step 3, Step 5, Step 7
Step 3	
Guidelines for Canadian Drinking Water Quality (HC, 2014)	Step 5, Step 7, Step 9
Step 5	
Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAFoods) (HC, 2010)	
Step 6	
Supplemental Guidance: Checklist for Peer Review of Detailed Human Health Risk Assessment (HHRA) (HC, 2010)	
Step 8	
Remediation Checklist (internal, Health Canada)	

Legislation

Document:	Also mentioned in:
Step 1	
Species at Risk Act (SARA) (2002) • Species at Risk Public Registry	Step 7, Step 8
Fisheries Act (1985)	Step 3, Step 5, Step 7, Step 8
Canada Wildlife Act (1985)	Step 8
Migratory Birds Convention Act (1994)	Step 8

Step 7	
Canadian Environmental Assessment Act (CEAA, 1992 & 2012)	Step 8
Canadian Environmental Protection Act (1999)	Step 8

Public Works Government Services Canada/National Research Council

Document:	Also mentioned in:
Step 3	
Guidance and Orientation for the Selection of Technologies (GOST) (PSPC/NRC, 2012)	Step 7, Step 8

Public Services and Procurement Canada

Document:	Also mentioned in:
Introduction	
Project/Program Risk Management Guidance for Federal Contaminated Sites Remediation/Risk Management (R/RM) Projects (PWGSC, 2007)	Step 8
Step 7	
FCSAP Remediation Conceptual Cost Estimation Tool (PSPC, 2013)	
Sustainable Development Tool [SDT] (PSPC, forthcoming)	

Treasury Board Secretariat

Document:	Also mentioned in:
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Accounting Standard 3.6 – Treasury Board – Contingencies (TBS, 2006)	

Websites

Title:	Also mentioned in:
Sustainable Remediation Forum (SuRF) Canada = http://www.sustainableremediation.org/	Step 8

www.ec.gc.ca

Additional information can be obtained at:

Environment and Climate Change Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca