

Metro Vancouver – Template for Integrated Stormwater Management Planning

2022 Addendum



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Abbreviations

AMF	<i>Monitoring and Adaptive Management Framework for Stormwater</i>
B-IBI	Biotic - Index of Benthic Invertebrates
BMP	Best management practice – a technique or technology for managing stormwater runoff
EIA	Effective Impervious Area
IDF	Intensity, duration, frequency: statistical rainfall relationships built on recorded data
ILWRMP	Integrated Liquid Waste and Resource Management Plan: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities (as approved by the Minister of Environment, May 11, 2011)
ISMP	Integrated Stormwater Management Plan, sometimes referred to as Integrated Water or Rainwater Management Plan
LWMP	Liquid Waste Management Plan, which is approved by the Minister of Environment
TIA	Total Impervious Area
WHTS	Watershed Health Tracking System

Introduction

In an urbanizing region, stormwater management and land use planning are key to preserving watershed health. The aim of integrated stormwater management planning is to bring these two disciplines together to create a plan that facilitates development while protecting the environment. All Metro Vancouver municipalities are required to develop Integrated Stormwater Management Plans (ISMPs) as part of the Integrated Liquid Waste and Resource Management Plan (ILWRMP).

Stormwater management practices and planning have evolved since 2005, when the previous template came into effect (*Template for Integrated Stormwater Planning 2005, Metro Vancouver*). The 2022 Addendum provides updated information to reflect new needs and approaches, lessons learned and the current regulatory situation.

Purpose of this document

This document is intended to guide municipalities on the form and content of an ISMP. It provides the current requirements and includes an updated framework for:

- Developing a new ISMP
- Assessing an existing ISMP to determine whether it needs to be updated or replaced
- Updating an existing ISMP

The 2022 Addendum brings together core elements of the 2005 template process and clarifies a number of items, based on current understanding and tools.

How to use this document

Municipal experience with development of ISMPs since the 2000s has found that some of the proposed approaches and tools in the 2005 Template were not feasible or practical. The 2005 Template is still an important reference for existing plans but it should be used with the 2022 Addendum to develop, assess and update any plans going forward. Additional key resources are listed in Appendix A.

Overview of integrated stormwater management planning

The term ‘integrated stormwater management plan (ISMP)’ is unique to British Columbia. It was first used by the City of Kelowna in 1998 to make a clear distinction between ‘suburban watershed management’ and the Province’s existing ‘integrated watershed management’ process for natural resource management in wilderness watersheds.

While the term ISMP is used often, the intent of the process can be lost in the engineering exercise of collecting and analyzing information, and crafting solutions. Broadly speaking, integrated planning encompasses:

- a holistic approach to coordinating all planning, resources, responsibilities, in an iterative and interrelated process, which is aligned with the strategic plan in all areas;
- participation of all stakeholders and affected departments;

- examination of all economic, social, and environmental costs and benefits, in order to determine the most appropriate option and to plan a suitable course of action; and
- planning across multiple functions, levels, locations, and other natural or artificial divisions.

Plans have been developed using a wide range of titles, including integrated watershed management plans, integrated rainwater management plans, and integrated stormwater management plans.

Acknowledgements

Metro Vancouver gratefully acknowledges the participation and contribution of the following municipalities and their staff in undertaking this study, as well as the Stormwater Interagency Liaison Group for providing input and feedback.

Table 1: Stormwater Interagency Liaison Group – ISMP Technical Working Group Members

Participant	Organization
Dave Matsubara	City of North Vancouver
Simone Rousseau	City of Burnaby
Stephen Judd	City of Port Moody
Wayne Chung	City of Surrey
Trevor Hamelin	BC Ministry of Environment and Climate Change

Metro Vancouver also gratefully acknowledges the contribution of Kerr Wood Leidal Associates Ltd. who conducted a review of the use of the 2005 Template and provided valuable suggestions for the report.

Changes and Clarifications to the 2005 Template

ISMP Objectives and Watershed Health

The notion of ISMPs was introduced to protect watershed values from deforestation and interruption of natural hydrological processes. Section 2.3 of the 2005 Template states the Regional ISMP Objective:

“Strive to maintain existing *watershed health* and achieve *no net-loss* on a watershed basis.”

ISMPs are required for all Metro Vancouver member municipalities; however, the intent of this objective statement is most appropriate for predominately undeveloped watersheds where environmental values are high, and the objective does not provide good direction for extensively developed watersheds with substantially degraded environmental values.

It goes on to describe that the watershed health ***must be maintained*** throughout the development of a watershed **on an annual basis** and not just over the long term. The Template also proposed to achieve the objective **by allowing trade-offs so that environmental losses in one area are offset by gains in other areas**. It stresses that the evaluation of watershed health and trade-off options should be backed up by the **“Watershed Classification System”** or a **similar process** that is defensible, quantifiable and scientific. In the 2005 Template, the Watershed Health Tracking System (WHTS) replaced the Watershed Classification System.

Based on the review of the 2005 Template in the current context of watershed management, regulatory responsibilities, and understanding of aquatic health, a number of key clarifications from the Template can be made.

Clarifications

Watershed Health: The 2005 Template introduced the WHTS, a multi-metric graphical approach to illustrate how watershed health changes based on measurement or estimation of: benthic invertebrate indices, effective impervious area, and riparian forest integrity. The WHTS was not universally implemented in all ISMPs but used in many, and in 2014, in response to a requirement from the Ministry of Environment as a condition of the current ILWRMP, Metro Vancouver developed the **Monitoring and Adaptive Management Framework (AMF)**.

The AMF outlined a monitoring program that was generally consistent and comparable with typical ISMP baseline data collection approaches and included a suite of directly measurable biological, chemical and hydrological parameters that could be applied to similar stream types.

Based on this change, Watershed Health for ISMPs shall be described in terms of the applicable AMF parameters where:

GOOD HEALTH has a Biotic - Index of Benthic Invertebrates (B-IBI) score of 28-36, water quality parameters achieving “good” standards, and hydrological parameters with stable or positive trends.

The WHTS is still an available tool and may provide additional insight into watershed processes; however, it shall not be linked to the regional objective statement for ISMPs.

Regional ISMP Objective

With the understanding that watershed health shall be based on the applicable AMF criteria, the regional objective statement is revised as follows:

Through implementation and adaptation of ISMPs, watershed health shall be maintained as GOOD for all watersheds with GOOD Health as measured by the Monitoring and Adaptive Management Framework (AMF).

ISMPs shall adapt and implement measures to result in a positive trend for all watersheds or AMF parameters that have not yet achieved GOOD Health.

The reworded regional objective statement fulfills the notion that ISMPs support incremental and positive improvement in watershed health, where ISMPs would be living plans that are supported for generations to come.

2005 Watershed Health Tracking System

Prior to the introduction of the AMF, ISMPs included baseline measurement and tracking of a variety of indicators to monitor watershed health including, but not limited to:

- flow in the watercourse, including base flow monitoring,
- water quality (such as metals, nutrients, organics),
- TIA, EIA, and land cover changes,
- riparian forest integrity (RFI),
- benthic communities (B-IBI),
- sediment accumulation, and
- number and severity of erosion sites.

Section 2.2 of the 2005 Template provides an overview of the development and evolution of the WHTS. The WHTS was developed from research and data collection in the Metro Vancouver region. It is a tool for benchmarking health of a creek against other similar creeks in the region and identifying potential watersheds at risk. It is core to the 2005 Template but municipalities have had some challenges using it over the past 17 years. Some clarifications on its use are described below.

Ephemeral and Soft Bottom Streams

The WHTS and the calibrated relationship between B-IBI and EIA were developed for permanently flowing streams and do not apply to ephemeral and soft bottom streams. Therefore, some jurisdictions, for example those with lowland watercourses, were not able to apply the tool. Creeks where the base flows are very low or dry up in the summer may also be sufficiently

different such that benthic invertebrate communities are not comparable with permanent streams and the WHTS should not be used as it has not been calibrated for those cases.

Piped Catchments

Fully piped catchments including combined sewer areas that discharge to large water bodies such as the Burrard Inlet, the Fraser River and English Bay, are also inappropriate for the WHTS.

Some ISMPs include the WHTS and some do not. Since the publication of the AMF, some municipalities have shifted to using the AMF in place of the WHTS and other ISMP monitoring programs.

It is at the municipality's discretion to continue to use and measure the key performance indicators associated with the WHTS. They may be used for tracking and determining long-term trends in the watershed and to help interpret and supplement AMF monitoring results. In addition, ISMP baseline data and monitoring should continue to include applicable items such as sediment accumulation, and number and severity of erosion sites, to establish and understand a more holistic view of the watershed health than is provided by the AMF and the WHTS.

Effective Impervious Area (EIA)

The WHTS was built on extensive data collection regionally to relate imperviousness, B-IBI, RFI, and watershed health. EIA is a critical part of this evaluation. Given that current research supports the calculation of EIA as a useful tool to measure the effectiveness of source control implementation, it is recommended that it continue to be used to review and update ISMPs.

For ISMPs where an EIA value was calculated for existing conditions, that EIA represents a baseline value. For ISMPs where an EIA value for existing conditions was not calculated, the ISMP update should address the gap and calculate an EIA value for the current conditions, at a minimum. If possible, it would be beneficial to also calculate a historical EIA value for the existing conditions at the time the ISMP was developed. These two values should then be compared in order to assess whether the EIA of the watershed has increased – implying loss of watershed health – or decreased – implying gain in watershed health.

New methods (since 2005) developed for calculating EIA may also be used for ISMPs, in addition to the methods described in Section 4 and Clause 3 of the 2005 Template.

Where there is no alternative, TIA may be used, but the ISMP should note this as a concern to be addressed in a future ISMP revision.

The rationale/background is as follows: WHTS requires an estimation of watershed EIA. Section 4 and Clause 3 of the 2005 Template include two methods for calculating EIA, both of which are still considered to be valid approaches as of 2019. Calculating EIA is challenging, as it requires extensive data collection and/or modelling. For several reasons, some ISMPs have not calculated an EIA value. Several ISMPs have used TIA as an approximation for EIA. While this is the best that can be done for some cases, TIA does not plot reliably on the WHTS and makes this chart a less useful tool for evaluating watershed health.

When the template was developed in 2005 there was some skepticism regarding the use of EIA as an indicator of watershed health. However, there has been significant research done on the

concept of EIA since 2005¹. There is convincing evidence in the literature that the concept of EIA is a valid one. Calculation results for EIA are now considered more reliable and more reproducible.

EIA may be the single most influential metric for determining whether mitigation approaches for development in a watershed are having the intended effect relative to the hydrology of the watershed as the metric is derived from the hydrologic behaviour of the watershed. In other words, as green infrastructure components such as rain gardens, bioretention areas, and bio-swales are implemented in a watershed, EIA will decrease relative to TIA. Measuring EIA then becomes an important metric to establish the significance of the green infrastructure implemented.

Trade-off of Gains and Losses Within a Watershed

The 2005 Template originally described:

- Maintenance of watershed health throughout the development of a watershed on an annual basis and not just over the long term; and
- Allowing trade-offs so that environmental losses in one area are offset by gains in other areas.

These two phrases were intended to help achieve the “no-net-loss” in the 2005 regional objective statement, but a rationale or methodology was not well developed further in the Template.

Maintenance of Watershed Health on an Annual Basis

The first statement regarding watershed health is interpreted as, watershed protection, and enhancement shall be implemented consistently and continuously over time (i.e. applied to all new developments), but assessed or quantified on an annual basis. Under the AMF, evaluation of Watershed Health would be evaluated at a minimum of every 5 years, and currently Municipalities report out ISMP progress to the Province in the Biennial Report. Based on this two-year and five-year reporting and assessment process, only ISMP implementation would occur on an annual basis.

Watershed Health Trade-Offs and No-Net Loss.

Possible harm to fish habitat is regulated by DFO. Jurisdictions that attempted to use the trade-off model for habitat gains and losses in the Template found that DFO requires evaluation of

¹ Alley, and Veenhuis (1983) *Effective Impervious Area in Urban Runoff Modeling*; Journal of Hydraulic Engineering.

Boyd, Bufill and Knee (1994) *Predicting pervious and impervious storm runoff from urban drainage basins*; Hydrological Sciences Journal.

Brabec, Schulte, and Richards (2002) *Impervious Surfaces and Water Quality: A Review of Current Literature and Its Implications for Watershed Planning*; Journal of Planning Literature.

Ebrahimian (2015) *Determination of Effective Impervious Area in Urban Watersheds*; PhD dissertation, University of Minnesota.

Ebrahimian, Wilson and Gulliver (2016) *Improved methods to estimate the effective impervious area in urban catchments using rainfall-runoff data*; Journal of Hydrology.

Ebrahimian, Wilson and Gulliver (2016) *Effective impervious area for runoff in urban watersheds*; Hydrological Processes.

Gulliver (2015) *Determination of Effective Impervious Area in Urban Watersheds*; Report to Minnesota Department of Transportation.

projects on a case by case basis. Trade-offs have been proposed in some watersheds but are often negotiated between the municipality and developer at the time of development.

In many ISMPs, the No-Net-Loss objective is generally achieved through recommendations for land use practices that maintain or improve EIA on redeveloping lots and by preserving riparian areas and aquatic habitat. Environmental enhancement projects are recommended where feasible. Practically speaking, the concept of trade-offs of losses and gains in habitat at the planning level has not been allowed. Municipalities typically require developers to achieve their ISMP goals on a development site basis or implement habitat enhancements in advance of losses in order to take advantage of environmental gains prior to development to maintain watershed health. The requirements for source controls or habitat enhancements are typically provided in development or servicing, and streamside protection bylaws.

Ideally the goals and criteria of the ISMP should be applied to all new development equally, and where on-site source controls are not possible an equivalent measure of source control should be applied elsewhere in the watershed.

Based on this approach, intermittent AMF monitoring and any other monitoring programs should indicate that watershed health is not being degraded by development, and that some gains are being made in the watershed relative to the key monitoring locations.

Clarification on Agency Comment, Participation and Endorsement

The interagency group included municipal departments and regulatory agencies. It has become clear in the years since the 2005 Template was released that the level of agency consultation must vary according to the needs of different municipalities and different ISMPs even within the same municipality

Agency Consultation

During development of the Template, the Department of Fisheries and Oceans Canada (DFO) and the BC Ministry of Environment (MOE) played an active role in stormwater management in the region. The regulatory environment has changed significantly since the Template was developed and the agencies no longer dedicate resources to participating in ISMPs. The implications of this change are further discussed below Sign-off Process.

As this is the case, it is no longer expected that municipalities will involve DFO and MOE in development of ISMPs. However, completed ISMPs should be made available to MOE for reference. The Ministry has the authority to review plans and require revisions based on ISMP progress and effectiveness as outlined by the AMF process.

ISMP Sign-Off Process

The 2005 Template proposed a sign-off strategy for ISMPs. In this process, the regulatory agencies would 'sign off' on the ISMP which would facilitate the approvals process by allowing the ISMP to establish trade-offs of losses and gains within each watershed. It was intended to simplify future approvals from DFO and the Province (the Ministry of Environment & Climate Change Strategy).

However, the approach to trading losses in some areas for gains in others was not acceptable in the end. The regulatory agencies determined they were not able to sign off on losses at the planning level when gains had been planned but had not been realized. DFO would not accept any losses of fish habitat, even of lesser quality habitat, to preserve or enhance other areas.

The goal for sign-off for ISMPs has evolved to be endorsement and acceptance of the plan by municipal Council. The level of involvement from councils has ranged from simply approving budgets for the ISMP studies to endorsement and funding of the ISMP implementation plan. Therefore, it is important to ensure that ISMP goals and objectives align with existing municipal visions and plans. Staff conducting ISMPs also focus on internal stakeholder consultation and strive to obtain the buy-in of the various departments and their staff who need to implement the ISMP recommendations.

Preparing Integrated Stormwater Management Plans

While more than 80 ISMPs have been developed in the Metro Vancouver region, there are still a few watersheds or parts of municipalities that do not have current plans in place. In some of these areas, there are plans under development, in others – extent of development and redevelopment is low and in lieu of plan development, monitoring is being undertaken.

For areas still requiring a plan, or considering development of a new plan, rather than revision, the 2005 Template still provides a broad number of watershed management issues, and proposes a technical scope of work to address questions related to those topics. However, all new plans must consider the Regional ISMP Objective, and should develop a scope of work to meet this objective in addition to any other objectives in the watershed.

Developing the Plan

The planning process should start with understanding the current watershed condition, the watershed needs, framed within the context of watershed health. Ideally the plan would have a singular goal, consistent with the regional objective, but may include a number of objectives and sub-objectives that address the range of watershed needs.

Based on the plan goal and objectives, a scope of scientific and engineering work would be developed to support the plan and develop information to aid in the development of policies, programs, or specific works to make progress on completing objectives and moving towards the goal.

In developing an ISMP, it has been found that an ISMP will adapt and plan to mitigate a proposed land use plan, given that ISMPs and land use planning through the development of an Official Community Plan are often happening on differing timelines. The vision and objectives of the ISMP should support the next round of land use planning, trying to address long term initiatives such as daylighting and re-establishing piped streams, or targeting density or building massing to result in riparian area gains and greater setbacks.

Section 2.4 of the 2005 Template identifies three phases of the ISMP process. The idea of phases was developed to help delineate the work and provide discrete components of the plan development. These phases were reviewed in depth in the 2011 Lessons Learned Document described in terms of Stages of work as described below:

Table 2: Breakdown of Phases and Stages of ISMP Development and Implementation

Phase (2005 Template)	Stage (2011 Lessons Learned)
Phase 1 – Watershed Screening (Municipal Wide) <ul style="list-style-type: none">• Delineate watersheds and identify needs	Stage 1 – What do you have? <ul style="list-style-type: none">• Develop inventory of information
Phase 2 – ISMP Process	Stage 2 – What do you want

<ul style="list-style-type: none"> • Planning Framework: Issues, Objectives • Develop scope of work • Collect Data and Conduct Analysis • Explore mitigative and adaptive options to achieve objectives, Implementation 	<ul style="list-style-type: none"> • Vision, Goals, Objectives with a focus on stream health and alignment with community values
	<p>Stage 3 – How do you put ISMP into Action</p> <ul style="list-style-type: none"> • Assessment, Analysis, Implementation
<p>Phase 3 – Develop Feasibility / Servicing Plans</p> <ul style="list-style-type: none"> • Provide more detailed analysis of engineering projects prior to pre-design 	<p>Stage 4 – How do you stay on Target</p> <ul style="list-style-type: none"> • Monitoring and adaptive management • Implementation plans, funding, etc.

Table 2 provides a good illustration of two alternative approaches to characterize the steps and key actions in developing ISMPs. The two approaches show some similarity in grouping of tasks, but are intentionally different and provide alternative approaches.

Level of Effort for ISMP Preparation

A minimum level of effort for ISMPs was articulated in the 2005 Template. This helped some local governments address ISMPs for predominately lowland systems, heavily urbanized, or small municipalities that were in need of universal policies to achieve goals.

The minimum level of effort is:

- Adopt a Bylaw for Stormwater Source Controls for New and Re-Developing Parcels.
- Adopt a Bylaw for alternate Instrument to protect Riparian Areas (e.g. Riparian Areas Regulation or Streams Protection Regulation).
- Adopt a Sediment and Erosion Control Bylaw, and Point and Non-Point Source Water Quality (Pollution Control) Bylaw.

The minimum effort, when the Template was revised, was centred around having bylaws, protections, etc. in place. A much higher level of effort is outlined in the 2002 template in a series of clauses and was originally conceived to be required of all plans; however, the 2005 Template does not specify discrete clauses under the “minimum level of effort”.

Practice has shown that development of ISMPs has varied significantly across different municipalities and watersheds and typical minimum work has been:

- For upland watersheds draining to flowing creeks, some of the 2005 Template clauses are necessary, and the remainder are still generally relevant. The necessary clauses have typically related to understanding of biological, water quality, and hydrological parameters in the watershed, and inclusion of other clauses would depend on watershed needs and desired

complexity of the plan. The clauses do include a “minimum level of effort” area for additional guidance.

- For lowland areas, low-gradient watercourses, areas draining only to large water bodies such as the ocean or the Fraser River, and areas served only by combined sewer systems, the ISMP must define the goals of the ISMP within the context of protecting watershed health values of the receiving waters or watercourses. These areas are excepted from using the Template as the basis for the ISMP. It is up to the municipality to make the determination when this is the case, and to establish the framework for these non-standard ISMPs.

Municipalities can group similar watersheds for an ISMP, whether they are upland watersheds or other types of watersheds falling into category 2, above. Therefore, it is acceptable for a municipality to pursue a municipality-wide ISMP if all watersheds in the municipality fall into category 2.

Since development of the Monitoring and Adaptive Management Framework (AMF) in 2014, all monitoring activities associated with the protocol are mandatory for ISMPs.

Adaptive Management Framework

Metro Vancouver published the *Monitoring and Adaptive Management Framework for Stormwater (AMF)* in 2014. The framework provides a “weight of evidence approach” for monitoring and adaptive management of watershed health for three types of systems in Metro Vancouver: low gradient streams, high gradient streams, and piped systems. It provides guidelines for flow, water quality, and benthic invertebrates monitoring for each system type. It also provides some tools for reporting on implementation and effectiveness of ISMPs. Municipalities can adopt the AMF to satisfy Condition 7 of the Minister of Environment’s Letter of Acceptance (2011) of the Integrated Liquid Waste and Resource Management (ILWRMP). All new ISMPs should include baseline data collection and monitoring recommendations in accordance with the AMF.

Note that the methodology prescribed in the AMF for measuring B-IBI is different than the approach included in Section 4 of the 2005 Template (Recommended Watershed Health Tracking System). However, based on previous work comparing benthic invertebrate monitoring approaches (e.g., Page and Sylvester, 2006), the methods are expected to be similar enough to yield comparable results.

The AMF allows for alternative monitoring approaches and use of modified or alternate indicators where these can be justified. This option may be appropriate for lower gradient systems (e.g., City of Richmond), and combined sewer systems (e.g., Vancouver, New Westminster, Burnaby). A formal request process to the Ministry of Environment is required for alternative approaches.

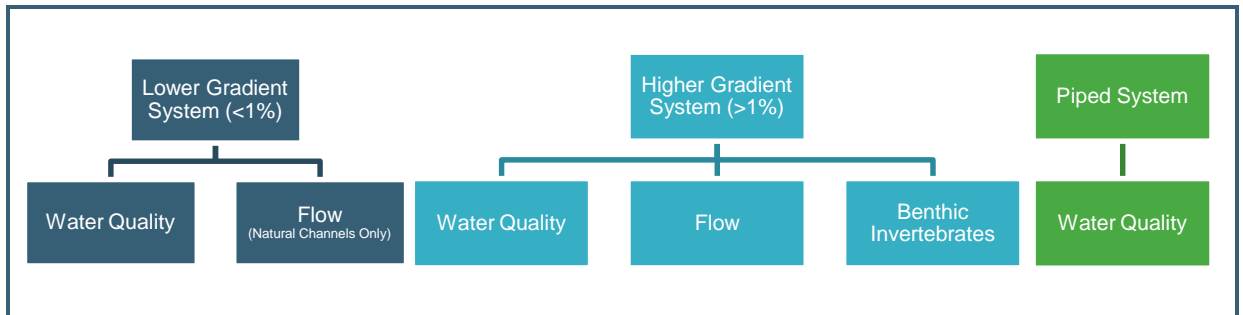


Figure 1: Standard AMF Monitoring Approach for Different System Types

As part of the Biennial and Interim reporting for the ILWRMP, regular reporting on AMF monitoring progress and results will be made available to the Ministry of the Environment.

Detailed Scope of Work and Clauses

The 2002 and 2005 Template includes 35 “clauses” to help define a scope of work around watershed issues and values. The clauses also include an Objective, Significance, List of Tasks, and Deliverables, to help aid in developing a scope of work.

The table below summarizes the Clauses and provides a comment on relevance regarding the minimum required level of effort as shown in green shading and the strongly recommended steps as shown in yellow shading.

Table 3: Summary of Clauses

Clause	Description	Relevance
1	Establish Framework	<ul style="list-style-type: none"> Important step of any plan to review issues, goals and objectives Recommend that Goals and Objectives are clearly articulated
2	Mapping/Information Gathering	<ul style="list-style-type: none"> This step is largely already done for local governments with mature GIS systems
3	Hydrometric Data and EIA Calculation	Required Task <ul style="list-style-type: none"> Collection of hydrometric data is needed to support AMF metric Hydrometric data also is important to support hydraulic models, and can support EIA estimates, which are no longer mandatory for an ISMP.
4	Drainage System Inventory	<ul style="list-style-type: none"> Usually included in GIS data Opportunity for updated condition evaluation and GIS updates
5	Hydrogeology/Geotechnical Assessment	<ul style="list-style-type: none"> Should be reviewed on a site specific basis as to issues ISMP will likely not replace detailed groundwater studies, geotechnical hazard assessments or otherwise

Clause	Description	Relevance
6	Land Use Information	<ul style="list-style-type: none"> • Effort dependant on land use planning status
7	Agricultural Lands	<ul style="list-style-type: none"> • May be relevant to some areas (i.e. ALR)
8	Recreational Amenities	<ul style="list-style-type: none"> • Should be considered optional, or based on community values
9	Aquatic Species and Habitat	<ul style="list-style-type: none"> • Should be considered optional, but provides additional value regarding stream health
10	Riparian Corridor Assessment	<ul style="list-style-type: none"> • Should be considered optional, but provides additional value regarding stream health
11	Terrestrial Species and Habitat Assessment	<ul style="list-style-type: none"> • Should be considered optional, but provides additional value regarding stream health
12	Benthic Community Sampling	Required Task Generally required for most systems for Watershed Health
13	Water and Sediment Quality Analysis	Required Task <ul style="list-style-type: none"> • Required for Watershed Health determination
14	Baseplan mapping	<ul style="list-style-type: none"> • Optional
15	Existing Stormwater Program Review	Required Task <ul style="list-style-type: none"> • review current bylaws and regulatory tools for stormwater source controls, ESC, and pollution
16	Hydrological Analysis	<ul style="list-style-type: none"> • Optional – appropriate for hydraulic modelling, capacity analysis, and evaluation of source controls
17	Hydraulic Analysis	<ul style="list-style-type: none"> • Optional – appropriate for hydraulic modelling, capacity analysis, and evaluation of source controls
18	Channel Erosion	<ul style="list-style-type: none"> • Optional – can be an indicator of hydrological conditions.
19	Agricultural Assessment	<ul style="list-style-type: none"> • May be relevant to some areas (i.e. ALR)
20	Natural Hazard Assessment	<ul style="list-style-type: none"> • Optional - may be relevant to some areas, but need not be integrated in the ISMP
21	Land Use Sensitivity Analysis	<ul style="list-style-type: none"> • Optional – can be applied if appropriate hydrological models are prepared
22	Recreation and Public Access Analysis	<ul style="list-style-type: none"> • Optional – based on specific issues and community values
23	Environmental Parameters	<ul style="list-style-type: none"> • Optional – EIA, RFI and WHTS evaluation
24	Ecological Health Parameters	<ul style="list-style-type: none"> • Optional – B-IBI, EIA, RFI and WHTS evaluation
25	Flood/Erosion Management Alternatives	<ul style="list-style-type: none"> • Optional – based on specific issues and community values
26	Land Use Alternatives	<ul style="list-style-type: none"> • Optional – based on specific issues and opportunities

Clause	Description	Relevance
27	Stormwater Management Alternatives	Required Task <ul style="list-style-type: none"> • Ensure bylaws allow for appropriate source control level
28	Water Quality Alternatives	Required Task <ul style="list-style-type: none"> • Ensure appropriate bylaws in place for point-source and non-point source pollution
29	Evaluate Alternatives	<ul style="list-style-type: none"> • Recommended to evaluate any proposed measures against goal and objectives
30	Stormwater Program	Required Task <ul style="list-style-type: none"> • Develop a program to implement bylaws
31	Integrated Stormwater Management Plan	<ul style="list-style-type: none"> • Should be developed to meet local government needs
32	Implementation Strategy	<ul style="list-style-type: none"> • Optional
33	Integrate with Other Municipal Plans	Required Task <ul style="list-style-type: none"> • Review and ensure policy alignment between overarching and other policies and plans
34	Adaptive Management	Required Task <ul style="list-style-type: none"> • Develop monitoring plan for AMF
35	Report	<ul style="list-style-type: none"> • Should be developed to meet local government needs • No endorsement required

Based on the review of experience and for consideration of updates or revisions to ISMPs, it may not be helpful to follow the concept of the Phases or Clauses as laid out in the Template, but rather address the issues of the watershed/plan. Important steps to consider:

- Early AMF data collection even prior to issuing any RFPs
- Careful review of watershed issues, including AMF data to define or refine the goals, and objectives
- Many of the clauses can be completed prior to an ISMP being initiated and may be applied on a municipality-wide basis to reduce total effort, including: data collection, bylaw and policy review, and financial options analysis. For example, Clauses 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15 may be implemented municipality-wide, and the resulting policies and programs may be referenced or used in individual ISMPs.
- Under the clauses that are applicable to a given ISMP, not all the necessary work needs to be completed at the same time as the ISMP report. Clauses can be completed as part of other studies and monitoring programs, either before or after the ISMP report is completed. However, when relevant studies are completed, the results should be incorporated into the ISMP or into the next iteration of the ISMP. For example: Natural Hazard Assessments (Clause 20), if applicable, are often performed separately from the ISMP, but the results should be incorporated into the ISMP or ISMP revision when they are available.

- Some of the minimum effort clauses are satisfied through initiatives that are undertaken separately by other departments and without reference to ISMPs. For example, Ecological Networks and Green Infrastructure Network Plans address the requirements of the Terrestrial Species and Habitat Assessment (clause 11). The ISMP can simply refer to the findings of these studies or incorporate the findings into the ISMP as input for development of the ISMP recommendations.
- The minimum level of effort for a clause may be zero if the municipality has considered the clause and determined that it does not apply for that ISMP. A municipality may also determine that a clause does not apply to all watersheds, and therefore to all ISMPs within the municipality. The onus is on the municipality to show that the clause is not applicable within each ISMP within the municipality.
- Careful and clear definition of projects
- Only advance priority projects to feasibility level.

Functional/Feasibility Plans: Project Prioritization and Pre-design

The intent of Phase 3 from the 2005 Template is to ensure recommendations undergo feasibility assessment and options evaluation prior to detailed design.

The experience from the last fifteen years is that not all ISMPs included the development of projects at the feasibility level, and that developing extensive feasibility work at the time of the ISMP for a 10 to 20-year planning horizon did not always provide sufficient detail to understand all of the implementation issues, or appropriately adjust for rising construction costs. It is to the benefit of the municipal staff to develop or use a process that best fits with their current programs and processes to evaluate and move forward individual projects recommended in ISMPs.

While this remains a valid process that municipalities may use if desired, it is not necessary that ISMPs develop functional/feasibility plans.

In the event that feasibility or preliminary design of works be considered at the time of ISMP development, the following should be considered:

- Specific projects recommended in an ISMP should have been referred to other municipal departments (i.e. planning, parks, environment, operations) and in addition to being technically feasible, as the consequence is that the Plan actions cannot be implemented.
- Plans are intended to be updated on a 12-year horizon and development of project detail for more projects than what is financially feasible may not be beneficial. Detailing of only high priority projects may be a better approach for the future, while only identifying possible benefits of other projects.

ISMP Review

The intent of the ISMP review process is to look at the overall watershed goals of each ISMP and examine the specific objectives of each plan to understand the overall progress and effectiveness of the plan. At a regional level, the minimum objectives for an ISMP developed under the 2005 Template were to develop and implement tools to address:

- Stormwater source controls for new and re-developing parcels.
- Riparian areas protection (e.g. Riparian Areas Regulation or Streams Protection Regulation).
- Sediment and erosion control standards, and point and non-point source water quality requirements.

The following checklist provides an approach to identifying when a review of an existing ISMP may be necessary:

Table 4: ISMP Review Checklist

Triggers for an ISMP Review		Yes	No	ISMP Action
Review ISMP Cycle	Has it been 12 years or more since the ISMP was completed/reviewed?	<input type="checkbox"/>	<input type="checkbox"/>	If yes, proceed to ISMP Review
If it has been less than 12 years since the ISMP was completed/reviewed:				
Review of AMF	Is Monitoring and Adaptive Management Framework (AMF) indicating that ISMP revisions are needed?	<input type="checkbox"/>	<input type="checkbox"/>	If yes, proceed to ISMP Review
Existing Issues	Are there significant management issues (e.g. flooding, pollution, water quality)?	<input type="checkbox"/>	<input type="checkbox"/>	
Review of Policy Changes	Are there new policies or a new OCP that might influence development?	<input type="checkbox"/>	<input type="checkbox"/>	
	Are there municipal needs for a new plan?	<input type="checkbox"/>	<input type="checkbox"/>	
	Is there a change in the LWMP?	<input type="checkbox"/>	<input type="checkbox"/>	
	Is the current ISMP failing to meeting municipal/provincial goals and policies?	<input type="checkbox"/>	<input type="checkbox"/>	
Review of Development Progress	Has there been extensive development within the watershed?	<input type="checkbox"/>	<input type="checkbox"/>	

The ISMP review should provide a synopsis of the plans objectives including all proposed plan elements, and any observed outcomes. This review would provide an opportunity to bring together all of the watershed actions and view them from the context of the plan. Given that staff may have changed, and

will change throughout the implementation of the plan, these review documents will be good resources for future generations of watershed managers.

Roles and Responsibilities

The role of the Regional Engineers Advisory Committee –Liquid Waste Sub-Committee (REAC – LWSC) is to facilitate the regional reporting of ISMP progress as part of the Liquid Waste Management Plan’s Biennial Reporting. The responsibility for the development, review and update of ISMPs resides with the municipality.

Typically, the engineering departments led the development of the ISMPs and would be responsible for completing the review and updated of the ISMP. Although, municipalities have engaged consultants to develop the majority of the original ISMPs, consultants are not required to complete the review and update of ISMPs. The use of engineering consultants may be beneficial to meet capacity or specialist knowledge needs.

While a single municipal department will likely lead the ISMP update, implementation of ISMPs involves the efforts of multiple departments. Each municipality will need to develop a process for informing other departments of the ISMP update process and including them in any adaptations to the original ISMPs.

ISMP Review Level of Effort

The intent of the review process is not to redo or re-create the ISMP, but is limited in scope to only assess changes that have occurred in the watershed, review the existing document, and then inform the municipality if an ISMP update is necessary.

The actual level of effort required will vary depending on such factors as:

- The extent to- which monitoring and tracking of indicators have been systematized by the municipality;
- The extent of gap filling and updates needed for that ISMP based on the more recent guidance documents; and
- The changes in watershed health that have occurred since the original ISMP was developed and the extent of adaptive management required to address any negative trends.

Municipalities can reduce the level of effort required for an individual ISMP review by setting up ongoing systems to accomplish some tasks on a municipality-wide basis. These could include:

- Collecting monitoring data for all watersheds on a regular cycle to develop a standard approach for the work;
- Setting up databases to store monitoring data and track indicators, making sure the data is separable by watershed; and
- Setting up recurring tasks to review and evaluate the data collected as part of the Biennial reporting in advance of the ISMP review and update process.

ISMP Review

The following is a checklist of tasks to help guide the review of an ISMP. However, since all plans are unique, each review should carefully consider the components of the plan.

Table 5: ISMP Review Tasks

Suggested ISMP Review Tasks		Review Synopsis
Minimum Requirements	Check that the ISMP satisfies the minimum requirements described in the 2005 Template.	Summary of progress
Implementation	Synopsis of previous work: what's happened, recommendations, barriers to progress, opportunities for improvement, and etc.	Summary of progress
	Review progress of ISMP Implementation.	Summary of progress
	Are there recommendations or projects that are no longer relevant?	Analysis of Current Requirements
	Carry forward revised recommendations into the ISMP update.	Analysis of Current Requirements
Watershed Health Indicators	Establish current Health of Watershed as prescribed in the AMF.	Analysis of Regional Objective
Key Issues	Review key objectives in the original ISMP and assess if there are issues unresolved or require further considerations.	Summary of progress
New Considerations	<p>Source control requirements:</p> <ol style="list-style-type: none"> 1. Are there on-lot source control requirements in the plan? 2. Do the requirements meet or exceed the On-Site Source Control Baseline Requirements? 3. Are health indicators positive under current source control policy? 	Review ISMP with respect to the Baseline requirements and update the plan as needed
	<p>Climate Change:</p> <ol style="list-style-type: none"> 1. Does the ISMP have objectives around conveyance of peak flows in the storm sewer system? 2. Is it necessary to update the plan for increased or decreased seasonal precipitation and temperature? 3. Do source control requirements need be updated to reflect climate change predictions? 	Review ISMP with respect to the current climate change resources and update the plan as needed

Each of the suggested review tasks in Table 5 are described in the following sections.

Minimum Requirements

As a first step in the review process, the minimum requirements for an ISMP (based on the 2005 Template) should be confirmed. The minimum requirements generally include the objective of establishing policy or other administrative tools as described earlier in Section 3. The review should consider both if the need for policy were recommended, and if policy or other tools have been implemented. In the event that there is no objective, nor a policy in place, the ISMP should be updated to reflect that need.

The ISMP can also be read together with the recommended “mandatory” clauses from Section 3, to confirm that these elements have been included. It should be noted that these Clauses support the development of the broader policy and collecting baseline watershed health indicators.

Table 6.1: Summary of Process for Assessment of Existing ISMP

Requirements	Indicators/Considerations
Check for Minimum Content for Existing Template	
Meet Requirements of the 2010 ILWRMP	
Develop and implement ISMPs at the watershed scale (3.4.7)	<ul style="list-style-type: none"> Completed ISMP at the watershed scale Completed ISMPs on a municipality-wide scale - State Justification.
Integrate land use and rainwater management (3.4.7)	<ul style="list-style-type: none"> ISMPs reviewed land use and land use change in the watershed. ISMPs include recommendations/targets for land development practices.
Update municipal bylaws to require on-site rainwater management sufficient to meet criteria established in municipal integrated stormwater plans or baseline region-wide criteria (1.1.20)	<ul style="list-style-type: none"> Using the MV Baseline, conduct self-evaluation and determine if bylaws meet Baseline requirements.
Update municipal utility standards and neighbourhood design guidelines (1.1.21)	<ul style="list-style-type: none"> As recommended in ISMP
Prohibit construction of new combined sewer (1.2.1) & Replace combined sewer with sanitary and storm (1.2.3)	<ul style="list-style-type: none"> ID relevant plans, bylaws, and policies Report % progress in sewer separation
Meet Condition 7 of the 2011 MOE Approval Letter	

Requirements	Indicators/Considerations
Performance measures “watershed and stream health indicators as set out in the ISMP...”	<ul style="list-style-type: none"> Tracking KPIs using AMF or other appropriate method Tracking KPIs via a municipality-wide program Tracking implementation of recommendations in ISMP

Implementation

The second step is to identify which of the recommendations from the existing ISMP have been implemented and to what extent. The review should include:

- Policy and bylaw updates;
- Development mitigation being implemented as required;
- Capital infrastructure upgrades completed or in process; and
- Environmental enhancement projects completed or in process.

Table 6.2: Summary of Process for Assessment of Existing ISMP

Requirements	Indicators/Considerations
Review Monitoring Data and Assess ISMP Progress	
Implementation Indicators	
<ul style="list-style-type: none"> % capital projects implemented Policy updates On-Site Source Controls Operation and maintenance practices 	<ul style="list-style-type: none"> Has ISMP recommendations been implemented? To expected extent for timeline? Are there specific barriers to implementation?
Integration with Future Municipal Plans, Goals, Objectives	
<ul style="list-style-type: none"> Periodically review municipal objectives and evaluate the impact on ISMPs Review whether referenced municipal documents that contribute to the ISMP have changed, e.g., OCP update Recommend changes to future updates of planning documents, standards, and bylaws 	<ul style="list-style-type: none"> Update references and data as needed for ISMP update

Not all projects and upgrades should be expected to be completed within the interval up to the ISMP review occurring. Rather, the assessment should determine whether the progress of implementation is consistent with the expected timeline laid out in the ISMP.

The review of progress on implementation should also identify barriers that have prevented or impeded progress on implementation of ISMP recommendations as well as any recommendations that are no longer required or have been achieved through alternative measures.

Watershed Health Indicators

The third step in the review process is to confirm the effectiveness of the ISMP in achieving good watershed health or a positive trend towards good watershed health in accordance with the AMF criteria as well as addressing any provincial or federal site-specific criteria established by the ISMP. The net result of the plan should indicate that watershed health is being maintained as good or improved through incremental implementation of the practices set out in the plan.

To ensure that the current ISMP is effective and on track to achieving the watershed health goals, a 12-year review cycle is required as part of the approved Metro Vancouver 2002 Liquid Waste Management Plan. Additional AMF monitoring is required every five years establishing two sets of monitoring data for comparison to the original baseline values established in the development of the ISMP within this 12-year review cycle. If two data sets are not available, the ISMP review and update will require additional monitoring prior to being complete.

Trend Assessment

For all AMF metrics and site specific ISMP KPIs the key to using these indicators to assess watershed health and the changes in watershed health is to calculate and identify trends. For every indicator, the assessment is:

- Is there a trend identifiable in the data?
- Is the trend good or bad relative to the baseline state?
- Does this fit with what we know about what happened in the watershed?

When three or more data points or a longer time series of data (e.g., flow data) has been collected, it may be possible to undertake a trend analysis. Trend analysis is the formal statistical process of determining whether there is an underlying pattern or signal in time series data. Because monitoring data often contains a lot of “noise”, a signal or trend not be immediately apparent, and a trend analysis is needed to determine whether there is a statistically significant trend relative to the variability within the data.

If the trend can be assumed to be linear, trend analysis can be undertaken within a formal regression analysis. If the trends have other shapes than linear, trend testing can be done by non-parametric methods, such as a Mann-Kendall test. Obtaining appropriate statistical expertise is recommended.

Ideally, any trend analyses would be updated every time new monitoring data is collected.

AMF Indicators

Under the AMF approach for data assessment and reporting, there are protocols for monitoring, sampling, calculating, and reporting on specific key indicators for ISMPs. In particular, the AMF details:

- Flow and water quality indicators to be used for assessment of watershed health.
- Indicators are divided into Priority and Secondary categories, with Priority indicators being the central focus of the AMF monitoring framework.

- Water quality sampling to calculate an average of 5 samples in 30 days for each of the dry and wet season.
- Comparison of measurements to AMF assessment levels to determine if the indicators are “Good”, “Satisfactory”, or “Need Attention”

AMF assessment levels are based on federal and provincial water quality guideline values and results are reported out on an annual basis to BC Ministry of Environment through the Greater Vancouver Sewerage & Drainage District’s annual environmental management and quality control reports for wastewater.

The AMF datasets in Table 4-1 should indicate possible trends or variability in biotic, water chemistry, or hydrological parameters, which would inform any possible revisions or updates to the plan.

Site Specific Performance Indicators

If the ISMP identified site specific land uses or concerns in the watershed which require additional monitoring of Key Performance Indicators (KPIs) the following procedure is recommended:

- Identify what water uses are to be protected in a watershed (e.g., freshwater aquatic life, wildlife, livestock, irrigation, recreation);
- Identify most sensitive water use, typically (but not always) protection of aquatic life;
- Identify relevant federal and provincial guidelines;
- Assess measured values relative to guideline values; and
- Report on the magnitude and frequency of exceedances of the guidelines within the data.

The ISMP typically includes a list of Performance Indicators or Key Performance Indicators (KPIs), in addition to AMF indicators, recommended for tracking on a recurring schedule after the ISMP is complete. An example list of KPIs for an ISMP is shown in Table 7, along with the baseline data for those KPIs and the future trends that are anticipated.

Table 7: Example ISMP Key Performance Indicators and Expected Trends

Performance Indicator	Method of Analysis	Baseline	Expected Change
TIA (% of Watershed Area)	GIS Analysis of Aerial Photos and Assessment Data	% TIA	Increase (expected due to development)
EIA (% of Mainstem Watershed Area)	Mainstem Modelling Using Spring/Summer Flow Monitoring Data	% EIA	Same; decrease after 2012 when source controls are implemented
RFI (% of Riparian Area)	GIS Analysis of Aerial Photos	% RFI	Same or Increase
Fish Populations	Density, Species Composition	No data	Increase in density and diversity of species

Performance Indicator	Method of Analysis	Baseline	Expected Change
Fish Passage Barriers	City/Streamkeepers Records	# Full Barriers # Partial Barriers # Natural Barriers	Progressive removal of non-natural barriers
Sediment quality	Metals in Sediment	See Guidelines	Same or Decrease
No. of Erosion Sites	Field Assessment and Designation as Low, Medium, or High Priority	# High Priority Sites	Same or Decrease
Q_{avg} , Q_{5-yr} (m^3/s)	Flow Monitoring (Continuous Station)	To Be Determined With Longer Record	Same or Lower
Minimum Pipe Capacity (return period)	SWMM Model results – 10 yr Design Standard	< Design Std. for # pipes	Same or Decrease
Major Overland Flow Routes Capacity (return period)	Analysis and Field Reconnaissance Results	Existing Level of Service for Flood Routes	Adequate Capacity
Lineal km of Roadside Ditches/Swales/Rain Gardens (km)	GIS Data Analysis	___ km	Increase
Length of Creek Channels (not including culverts/ bridges)	GIS Data Analysis	___ km	Same or Greater

The values of the indicators should be compared to the baseline data and the differences evaluated. As shown in Table 7, the goal for the trend will be higher or lower depending on what the indicator is measuring. A table similar to Table 7 should be created to review the changes in KPIs for the watershed.

Key Issues

The fourth step in the review process is to evaluate the status of the key Issues identified in the ISMP compared with the implementation of the recommendations and watershed health indicators. Key issues that were not resolved as a result of the implementation of the ISMP recommendations should be reviewed for additional information regarding the identified key issues including:

- Details in the assessment process that may have resulted in one or more key issues being determined to be non-critical at the time of the study; or
- Identification of further study needed to resolve an identified key issue.

If after additional review the key issue is not resolved, it will need to be included into the ISMP update as discussed in Section 5 below.

New Considerations

Finally, as the ISMP review process is a 12-year cycle there is opportunity for new legislation, research, techniques and technology to be developed that may expand and improve upon the initial scope of the existing ISMP.

Metro Vancouver has developed a number of new tools and standards developed for urban watershed planning and management since 2005 and as part of the review, it is important to consider the relevance of existing plans.

ISMP Update and Implementation

ISMP Update Work Scoping

Following a review of an ISMP, it may be clear that an update, revision, and addendum to an ISMP is required to adapt the plan to current understanding of watershed health, development policy, or any other factor. An update to the ISMP is not intended to re-do the work in the original ISMP development, but use the results of monitoring and progress on implementation together with any regional or broader experience to add or revise current plan objectives to help meet the regional objective of “Good Watershed Health”.

Part of an ISMP update could include adding specific objectives, measures, or work items to meet new resources or considerations in watershed management as discussed previously.

Table 8 outlines some of these items, which are described in more detail in the following section.

Table 8: Considerations to Updating the ISMP

Developing Scope and Integrating New Resources		Yes	No	ISMP Action
Municipal Needs and Priorities	Are there pressing issues in the watershed?	<input type="checkbox"/>	<input type="checkbox"/>	
	Are there regulatory changes to adapt to and incorporate?	<input type="checkbox"/>	<input type="checkbox"/>	
	Has there been fundamental changes that affect priorities?	<input type="checkbox"/>	<input type="checkbox"/>	
AMF	Determine whether to implement watershed-wide or in watershed-groups.	<input type="checkbox"/>	<input type="checkbox"/>	
	In addition to AMF, are there other metrics required for tracking specific watershed issues?	<input type="checkbox"/>	<input type="checkbox"/>	
Other Key Performance Indicators	Review all key performance indicators (KPI) established in the ISMP that are not captured under the AMF, determine which indicators should be updated for an indication on trends and progress.			
Climate Change	Assess impacts of climate change in the watershed.	<input type="checkbox"/>	<input type="checkbox"/>	
	Determine the role of the ISMP in addressing the impacts of climate change.	<input type="checkbox"/>	<input type="checkbox"/>	
	Include recommendation for mitigation or reference recommendations in other plans and programs.	<input type="checkbox"/>	<input type="checkbox"/>	
	Assess impacts of sea level rise.	<input type="checkbox"/>	<input type="checkbox"/>	
	Are there new drainage standards for dealing with climate change?	<input type="checkbox"/>	<input type="checkbox"/>	

Developing Scope and Integrating New Resources		Yes	No	ISMP Action
Region-wide Baseline for On-site Stormwater Management	Include minimum regional standard or better for stormwater management on single family residential lots.	<input type="checkbox"/>	<input type="checkbox"/>	

Updated ISMP Goals and Objectives

Any ISMP update, revision or addendum, should at a minimum update the framework of goals and objectives to include the overall regional objective for watershed health.

Based on the updated regional objective, existing ISMP objectives may need revision, and some new objectives may be added to the plan. Creating a clear framework of goals and objectives will better support ISMP actions and implementation.

Integrating New Considerations in the ISMP

Fill Identified Gaps

The review of the existing ISMP may have identified gaps in the existing ISMP that should be filled during the ISMP update process. These gaps may include:

- Items needed to meet minimum requirements for the ISMP; and
- Items needed to address key issues that were not resolved in the existing ISMP.

For items that are needed to meet the minimum requirements, the basic need is that the items be considered to determine whether they apply to the given watershed. The clauses from the checklist that need to be addressed should be, at a minimum, listed in the ISMP update and annotated as to whether they are applicable and if they are applicable, how they either have been addressed by municipal efforts since the existing ISMP was developed, or how they will be addressed in the ISMP update. For clauses which are noted to be not applicable, no further action is required.

For any documented key issues for the watershed that were not addressed in the existing ISMP, the ISMP update should include scope to review and address those issues with recommendations or other resolutions.

Adaptive Management Practices

One of the key goals of the ISMP update process is to provide adaptive management for maintaining watershed health. This means that the ISMP should be updated in response to what the monitoring results indicate about changes in watershed health since the completion of the existing ISMP.

The adaptive management process involves:

1. Reviewing the monitoring and tracking data and identifying indicators where the data shows a trend in the wrong direction, i.e., indicates worsening impacts or watershed health.

2. Determining and evaluating the factors (such as development) and actions (such as detention or other mitigation) that have already been implemented in the watershed that may have contributed to or partially mitigated the observed impacts.
3. Developing approaches to change the outcome for the betterment of watershed health in the future. This could be by influencing what is thought to be causing the impact (such as loss of riparian forest area due to clearing), or by mitigating the impacts that have occurred (such as replanting in riparian areas), or both for the greatest overall improvement for the future. These approaches should be incorporated into the updated ISMP as new or revised recommendations.

The AMF includes a chapter on Adaptive Management (see Chapter 9 of that report), which discusses adaptive management practices that can be used to respond to adverse indications in the AMF monitoring results. Table 8 in the AMF provides a list of results for different indicators that should trigger adaptive management, and lists examples of adaptive management practices that may be used to respond. This table provides a great starting point for adaptive management for the ISMP. However, note that this table has Step 2 (above) as an implied but not explicit element and that there must be an investigative step to link possible causes to the adverse trends in indicators before using Table 8 to select adaptive management practices.

New Study Area Issues and Concerns

New issues and concerns for the ISMP may need to be added to the ISMP if there are, for example:

- Changes in the land use in the watershed relative to the land use planning information used for the existing ISMP;
- New issues such as flooding, pollution or creek erosion that are new or worsening;
- Climate change information or assessment approaches have changed; or
- Updates or changes to municipal initiatives that impact the ISMP, such as sustainability guidelines or a new official community plan.

If there are new municipal initiatives rather than issues and concerns, these may provide new goals or objectives for the ISMP that may not have been considered when the existing ISMP was developed.

Once new issues and concerns have been identified, they must be studied to assess causes and identify possible solutions, similar to the work done to develop the recommendations in the existing ISMP. Then recommendations should be developed and incorporated into the ISMP update to address these new issues and concerns.

The 2005 Template does not specifically include clauses to conduct condition assessments, life expectancy analysis, replacement timelines and failure risks, or other analysis that can assist in establishing the timing of future capital replacement programs and proper asset management and valuation. Over time, the value of these analyses will become more important as the region's stormwater infrastructure ages and the timing of capital replacement decisions carry larger risks, and this work may be incorporated or referenced in future ISMP updates.

There is also an emerging area of asset management called "Natural Asset Accounting" where many of the green infrastructure and natural water related components may eventually be

accounted for and linked to the asset management of a stormwater utility. Therefore, future ISMP updates may incorporate or reference natural asset management aspects in addition to traditional infrastructure.

Increased Consideration of Water Quality and Ecosystem Impacts

One aspect to be further addressed in the update of ISMPs is the water quality and ecosystem impacts from stormwater. Primary contaminants in urban stormwater are pathogens, nutrients, sediments, and heavy metals. Research in Canada and the US has found that polluted stormwater runoff is a leading pollution threat to aquatic species and ecosystems. For example, research in Washington State has found polluted stormwater can cause direct impacts to salmon, a keystone species in the Pacific Northwest. These impacts range from physiological and behavioural impacts in juvenile fish to pre-mature death in adult Coho salmon returning to their natal creeks, before they are able to spawn. Polluted stormwater also contributes to the closures of shellfish beds and swimming beaches.

While most ISMPs to date have included water quality sampling and evaluation of water quality parameters for the creeks within the study watersheds, they have not often considered the link between water quality and protecting the downstream water uses in creeks or in the major receiving waterbodies such as Burrard Inlet, the Fraser River, and Boundary Bay. Yet ongoing monitoring of these areas continue to suggest impacts and these impacts continue to reduce opportunities for some water uses including First Nations traditional harvesting and cultural practices. All of this suggests further attention to water quality impacts in ISMPs is warranted.

While it is not recommended that ISMPs should attempt to quantify impacts to particular species or receiving waterbodies, it is recommended that the link between stormwater management in ISMP watersheds and water quality and ecosystem impacts in downstream water bodies be recognized and potentially used to prioritize actions. Furthermore, the fact that these links exist and are important to regional watershed and waterway health can provide additional support for proposed water quality mitigation and improvement in the upland watersheds. Green infrastructure should be emphasized in the update process as a preferred mitigation approach because of its potential to both reduce flows and improve stormwater runoff quality.

Consideration of Climate Change Impacts

Since the release of the original ISMP template document, a great deal more work has been done in order to provide a better understanding of the forecasted effects of climate change on the Metro Vancouver area. Regional climate change projections predict warmer temperatures, a decrease in snowpack, longer dry spells in summer months, more precipitation in fall, winter and spring, and more intense extreme events.

How these predicted changes will affect local watersheds, and potential mitigation and adaptation measures are what should be included in any new ISMP or ISMP update. Impacts to consider could include, but are not limited to:

- An increase in precipitation may mean periods of flooding, damage to property, and risks to human health.

- An increase in extreme rainfall events may affect slope stability and increase erosion of stream banks leading to water quality and ecosystem impacts and public safety issues.
- Higher temperatures and prolonged dry spells will affect watershed ecosystems, riparian area vegetation and water quality.
- The decrease in snowpack and summer precipitation will have an impact on groundwater levels and stream baseflows.

All regions will experience climate change, however the impacts and to what degree could be unique to each watershed. Incorporating climate change into new ISMPs or ISMP updates will build resiliency into the plans to provide a holistic approach to managing climate change impacts.

Update Monitoring and Adaptive Management Process

The ISMP monitoring approach should be updated to incorporate any gaps from the existing monitoring program. The monitoring approach should also be synchronized with the monitoring for other ISMPs within the municipality and with any municipality-wide monitoring and tracking efforts. This will have the effect of streamlining the monitoring process across all ISMPs within a municipality and reducing the total effort required for ISMP monitoring.

The resulting monitoring program for the ISMP update should include the following elements:

- Incorporate the AMF process and indicators if they are not already part of the ISMP.
- Retain and use the Watershed Health Tracking System (WHTS) from the 2005 Template, where applicable or if desired.
- Ensure any other ISMP-specific indicators from the existing ISMP or the ISMP update are being tracked.
- Ensure there is a process to track future implementation of ISMP recommendations.
- Incorporate any municipality-wide monitoring and tracking programs in the ISMP update so that in future it is clear that the monitoring is being done as part of a program that is not limited to the specific ISMP.
- To the extent that it is practical, synchronize the ISMP monitoring program with other ISMP monitoring to simplify the work of municipal staff with regard to the monitoring work. This could mean establishing a cycle of monitoring for different ISMPs in sequential years, or simply revising the monitoring approaches so that all ISMPs within a municipality have the same monitoring approach.
- Outline steps for periodically reviewing data and evaluating whether adaptive management practices are required on a time scale that is synchronized with the monitoring cycle, rather than the ISMP update cycle. While the ISMP will be reviewed and updated on the 12-year cycle, review of monitoring data for adaptive management should occur on a 5-year or more frequent cycle corresponding to the ISMP's monitoring cycle.

Updating the Reporting

The ISMP update process can revise the reporting format and/or approach for an ISMP. A municipality may wish to create a single reporting structure for all their ISMPs to improve consistency and usability of the ISMP documentation.

Update ISMP Recommendations

The recommendations from the existing ISMP should be reviewed and updated.

First the recommendations should be reviewed and assessed as to whether they are still valid or relevant. If some of the recommendations have been completed, for example, if bylaw and policy updates have been completed and the new policies are in place and being used, then those recommendations are obsolete and should be deleted from the ISMP recommendations in the update. However, some recommendations may have been partially implemented, for example, if policy updates have been made, but the new policies are not being followed. If that is the case, the recommendations should be revised to update them to the current conditions. In this example, the recommendations would be revised to focus on implementing or enforcing the updated policies.

After the existing ISMP recommendations have been reviewed and, if needed, updated, then new recommendations should be added. New recommendations would result from the work discussed in this and previous sections of this document and may include recommendations to address:

- Identified gaps in the existing ISMP, e.g. climate change;
- Overcoming barriers to implementation;
- Adaptive management to correct observed adverse trends in the monitoring data;
- New issues and concerns identified since the completion of the existing ISMP; and
- New goals and objectives linked to new municipal initiatives.

Internal Stakeholder Consultation

Once the review process has been completed and there is a new set of ISMP recommendations for the municipality to move forward with, the next step is to undertake internal stakeholder consultation to review the process and plan implementation of the recommendations with staff from all departments that would be affected and involved.

A workshop format is recommended to incorporate views and approaches from all relevant departments on how implementation should be pursued. The workshop would be used to review:

- the ISMP update process;
- the progress to date on the ISMP;
- new issues and concerns;
- new goals and objectives;
- updated ISMP recommendations; and

- further implementation needed.

This internal consultation will help smooth the way for staff from multiple departments to work together to implement the updated ISMP recommendations.

Some of the larger municipalities may face the prospect of having multiple ISMP updates happening concurrently or overlapping. In order to streamline the internal consultation process, there may be a benefit to having only a single ISMP update workshop each year, with review and discussion of multiple ISMPs if more than one have been completed in the past year.

Consistency with Existing ISMP

While the reporting structure for an ISMP can be changed and updated, the process should preserve the key elements of the existing ISMP reporting and the ISMP update should follow up and build upon the reporting from the existing ISMP. Therefore, while the format and layout of the reporting may change, the essential content of an existing ISMP should be brought forward in the update and added to, rather than being completely replaced. This will help to provide continuity over time through ISMP updates such that the narrative is preserved to show the work done to study the watershed and provide for improvement of the watershed's health.

While ISMPs will continue to be reviewed and updated on a 12-year cycle, monitoring and adaptive management are on a 5-year cycle. Reporting for both those time scales should be considered when reviewing and updating the ISMP reporting. In addition, the current process of biennial reporting to the province is expected to remain unchanged for the foreseeable future.

Options for Reporting

The ISMP reporting to date has primarily focussed on report-style documentation of the study of the watershed and the process of developing recommendations. While this approach provides excellent documentation of the work, it has proved challenging for municipal staff to then use the ISMP reports as input to processes such as capital plans and land use planning. Therefore, municipalities may wish to consider new ways to approach reporting for ISMPs.

Possible new ways of reporting for ISMPs to improve on technical reports as the main reporting method could include:

- Summarizing recommendations in tables, formatted as “To-Do” lists for the municipal staff and divided up by responsible department.
- Summarizing monitoring results in charts and graphics to quickly convey information to a reader.
- Reporting of monitoring results and metrics can be done on a municipality-wide scale to simplify the process of finding results and metrics as there would be a single place to look regardless of the watershed.
- Utilizing location-based mapping of monitoring results and trends in KPIs to link these parameters to the locations in the watershed where they are measured and assessed. This approach would assist staff with comparing between watersheds as well, because monitoring and metrics for all ISMP watersheds could be part of the same system or database.

- Utilizing location-based mapping of recommendations as much as possible to display proposed project and upgrade locations for individual ISMPs or for multiple ISMPs. As above, using similar systems for ISMPs or a single system for the whole municipality will improve usability for the staff.
- Integration of mapping for ISMP monitoring and recommendations with a municipality's Geographic Information System (GIS) may also be possible, which allows municipal staff to identify opportunities to combine the implementation of ISMP recommendations with other municipal or development-related projects.
- Reporting can be internal to the municipality using an internal filing system, however, municipalities may wish to make reporting on ISMP monitoring, metrics, and recommendations public. The advantage of providing results to the public is that it should reduce the need for staff to respond to inquiries about ISMPs, and provides the public insight on all of the work that is ongoing for monitoring and implementing ISMPs.

In addition to the ISMP reports, ISMP Summary Sheets can be created by summarizing the entire ISMP into one single "summary sheet" that can be used by developers to more effectively find information relevant to them within the ISMPs. Refer to City of Surrey's ISMP Summary Sheets for an example of this approach.

Appendix A – Key Resources

ISMP Lessons Learned

Integrated Stormwater Management Plans - Lessons Learned to 2011 (2012) provides additional tools primarily for Phase 1 of the ISMP process (Watershed Screening). It can help municipalities “get started” and determine relevant issues in their watersheds. The *ISMP Lessons Learned* is intended to provide further guidance and support for municipalities that are about to embark on the ISMP process in addition to the guidance provided in the 2005 ISMP Template.

For ISMPs that were developed prior to the release of the Lessons Learned document, the review and update process should check through the Lessons Learned and assess whether this guidance should change the approach and structure of the ISMP for the update.

The *ISMP Lessons Learned* provides guidance on how to implement Phase 1 and how to get the ISMP process started. It offers tools to help municipalities determine which Template Clauses are acceptable to their subject watersheds and what level of effort is required for each. Specifically, in addition to the direction from the 2005 Template, the 2011 Lessons Learned:

- Further breaks down the ISMP process into groups of tasks for the municipality, including:
 - Understanding the context
 - Developing the Terms of Reference
 - Providing for inter-departmental engagement and support
 - Re-working the ISMP process into four consecutive stages
- Discusses creating an ISMP with the intent that it will be a living document to be used and updated.
- Includes checklists for nine different elements of the ISMP process.

The checklists and further information can be found in the *ISMP Lessons Learned to 2011* Report.

Stormwater Source Control Design Guidelines 2012 Update

The Stormwater Source Control Design Guidelines 2012 Update (SSCDG 2012) provides updated information for design of stormwater source controls in the Metro Vancouver region. SSCDG 2012 discusses typical stormwater criteria used in the region and provides design tools for two categories of criteria (i.e., mm of capture / % average annual rainfall). It can be referenced by municipalities in Engineering Design Guidelines, Subdivision Development Bylaws, and other relevant stormwater policies/bylaws. It can replace old references to the GVRD Best Management Practices (BMP) Handbook.

For ISMPs developed prior to 2012, the SSCDG 2012 may need to be referenced in the review and updated process for setting the design criteria and design of source controls for mitigation development and/or re-development.

Monitoring and Adaptive Management Framework

The Monitoring and Adaptive Management Framework for Stormwater (AMF, 2014) provides an approach for monitoring stormwater using a “weight of evidence performance measurement approach” and provides a framework for reporting on implementation and effectiveness of ISMPs. It is a tool that municipalities can adopt to satisfy Condition 7 of the Minister of Environment’s approval of Metro Vancouver’s 2011 Integrated Liquid Waste Resource Management Plan (ILWRMP).

The AMF provides a minimum standard framework for monitoring, reporting, and assessing trends in various watershed health metrics. For ISMPs developed prior to the release of AMF in 2014, the review and update process should incorporate the AMF framework into the ISMP’s monitoring and adaptive management approach. Some municipalities have instituted AMF monitoring programs on a municipality-wide basis, such that individual ISMPs do not need to have individual recommendations in accordance with the AMF, but may reference the municipality-wide AMF program.

It should be noted that some ISMPs may need additional metrics beyond the minimum standards in the AMF to more accurately reflect specific priority issues in the watershed and unique changes that may be occurring over time. The goal of the monitoring and adaptive management process is to be able to answer: Is this working? Are the objectives of what we’re trying to accomplish in this watershed being achieved? ISMP monitoring should include such additional metrics as necessary to be able to answer these questions.

Regional Climate Change Projections

In 2016 Metro Vancouver released the report *Climate Projections for Metro Vancouver*, which provides regional-scale predictions for climate change based on the work of the Pacific Climate Impacts Consortium (PCIC). Regional climate change projections can be used as a starting point for scoping potential impacts of climate change in a municipality such as increase in rainfall volume and/or intensity, increase in temperature, changes in seasonal climate patterns, etc.

ISMPs have gradually begun to include consideration of climate change impacts to the watershed in various ways. However, until this report was released, there was no available guidance specific to the Metro Vancouver region on which the ISMP could base an approach to climate change considerations and impacts. The ISMP review and update process should consider the effects and impacts of climate change on the hydrology and ecology of the watershed, in accordance with the guidance in this report.

While this is the most recent information available at the time this Addendum was written, it is expected that there will be further an ongoing work to quantify and assess the effects of climate change on the region. In 2018, Metro Vancouver expects to have climate-change-adjusted intensity-duration-frequency (IDF) curves for the region published, and further work will no doubt be completed over time. The ISMP review and update process should consider and incorporate the latest information on climate change that is available at the time of the review. One of the new significant tasks in an ISMP review will now be to identify how to mitigate the impacts of climate change. For example, will it mean a reduction in level-of-service, new green infrastructure

components such as new source control measures, capacity upgrades to existing conveyance systems, or other methods?

Region-Wide Baseline for On-Site Stormwater Management

The Region-Wide Baseline for On-Site Stormwater Management (2017) outlines the minimum acceptable on-site stormwater practices for single-family residential lots in Metro Vancouver. It includes guidelines for implementation of the Baseline by municipalities, cost implications, and typical design drawings for BMPs. It is a tool to assist municipalities to fulfill their commitment to ILWRMP Actions 1.1.20 and 1.1.21.

The Region-Wide Baseline provides a minimum standard template for municipalities to use for requirements for stormwater management on single family residential lots. This minimum standard is intended to be used both for new development and/or re-development of existing zoning. As such, ISMPs developed prior to 2017 should incorporate the recommendations of this document when the ISMP is revised and updated as a minimum standard for mitigation of development and re-development of single family residential lots.

Appendix B – Checklists

Triggers for an ISMP Review		Yes	No	ISMP Action
Review ISMP Cycle	Has it been 12 years or more since the ISMP was completed/reviewed?	<input type="checkbox"/>	<input type="checkbox"/>	If yes, proceed to ISMP Review
If it has been less than 12 years since the ISMP was completed/reviewed:				
Review of AMF	Is Monitoring and Adaptive Management Framework (AMF) indicating that ISMP revisions are needed?	<input type="checkbox"/>	<input type="checkbox"/>	If yes, proceed to ISMP Review
Existing Issues	Are there significant management issues (e.g. flooding, pollution, water quality)?	<input type="checkbox"/>	<input type="checkbox"/>	
Review of Policy Changes	Are there new policies or a new OCP that might influence development?	<input type="checkbox"/>	<input type="checkbox"/>	
	Are there municipal needs for a new plan?	<input type="checkbox"/>	<input type="checkbox"/>	
	Is there a change in the Liquid Waste Management Plan (LWMP)?	<input type="checkbox"/>	<input type="checkbox"/>	
Review of Development Progress	Is the current ISMP failing to meeting municipal/provincial goals and policies?	<input type="checkbox"/>	<input type="checkbox"/>	
	Has there been extensive development within the watershed?	<input type="checkbox"/>	<input type="checkbox"/>	

Suggested ISMP Review Tasks		Review Synopsis
Minimum Requirements	Check that the ISMP satisfies the minimum requirements described in the 2005 Template.	Summary of progress
Implementation	Synopsis of previous work: what's happened, recommendations, barriers to progress, opportunities for improvement, and etc.	Summary of progress
	Review progress of ISMP Implementation.	Summary of progress
	Are there recommendations or projects that are no longer relevant?	Analysis of Current Requirements
	Carry forward revised recommendations into the ISMP update.	Analysis of Current Requirements
Watershed Health Indicators	Establish current Health of Watershed as prescribed in the AMF	Analysis of Regional Objective
Key Issues	Review key objectives in the original ISMP and assess if there are issues unresolved or require further considerations.	Summary of progress
New Considerations	<p>Source control requirements:</p> <ol style="list-style-type: none"> 4. Are there on-lot source control requirements in the plan? 5. Do the requirements meet or exceed the On-Site Source Control Baseline Requirements? 6. Are health indicators positive under current source control policy? 	Review ISMP with respect to the Baseline requirements and update the plan as needed
	<p>Climate Change:</p> <ol style="list-style-type: none"> 4. Does the ISMP have objectives around conveyance of peak flows in the storm sewer system? 5. Is it necessary to update the plan for increased or decreased seasonal precipitation and temperature? 6. Do source control requirements need be updated to reflect climate change predictions? 	Review ISMP with respect to the current climate change resources and update the plan as needed

Developing Scope and Integrating New Resources		Yes	No	ISMP Action
Municipal Needs and Priorities	Are there pressing issues in the watershed?	<input type="checkbox"/>	<input type="checkbox"/>	
	Are there regulatory changes to adapt to and incorporate?	<input type="checkbox"/>	<input type="checkbox"/>	
	Has there been fundamental changes that affect priorities?	<input type="checkbox"/>	<input type="checkbox"/>	
AMF	Determine whether to implement watershed-wide or in watershed-groups.	<input type="checkbox"/>	<input type="checkbox"/>	
	In addition to AMF, are there other metrics required for tracking specific watershed issues?	<input type="checkbox"/>	<input type="checkbox"/>	
Other Key Performance Indicators	Review all key performance indicators (KPI) established in the ISMP that are not captured under the AMF, determine which indicators should be updated for an indication on trends and progress.			
Climate Change	Assess impacts of climate change in the watershed	<input type="checkbox"/>	<input type="checkbox"/>	
	Determine the role of the ISMP in addressing the impacts of climate change.	<input type="checkbox"/>	<input type="checkbox"/>	
	Include recommendation for mitigation or reference recommendations in other plans and programs.	<input type="checkbox"/>	<input type="checkbox"/>	
	Assess impacts of sea level rise.	<input type="checkbox"/>	<input type="checkbox"/>	
	Are there new drainage standards for dealing with climate change?	<input type="checkbox"/>	<input type="checkbox"/>	
Region-wide Baseline for On-site Stormwater Management	Include minimum regional standard or better for stormwater management on single family residential lots.	<input type="checkbox"/>	<input type="checkbox"/>	