



Federal Floodplain Mapping Framework

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Earth Sciences Sector

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Natural Resources Canada

Public Safety Canada

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Table of Contents

ACKNOWLEDGEMENTS.....	1
FEDERAL FLOODPLAIN MAPPING GUIDELINES SERIES.....	2
LIST OF ABBREVIATIONS AND ACRONYMS	2
1.0 CONTEXT AND PURPOSE.....	3
2.0 NOTE ON TERMINOLOGY.....	4
3.0 TARGET AUDIENCE.....	4
4.0 IMPORTANCE OF FLOODPLAIN MAPS.....	5
4.1 Types of Floodplain Maps.....	5
5.0 HISTORY.....	6
5.1 Early Federal/Provincial Programs	6
5.2 Flood Damage Reduction Program (FDRP)	6
5.3 National Floodplain Mapping Assessment.....	7
6.0 ROLES AND RESPONSIBILITIES	7
7.0 VISION AND PRINCIPLES.....	10
8.0 FLOODPLAIN MAPPING FRAMEWORK	11
8.1 Federal Floodplain Mapping Framework	12
8.2 Flood Hazard Identification and Priority Setting.....	12
8.3 Federal Hydrologic and Hydraulic Procedures for Floodplain Delineation.....	12
8.4 Federal Airborne LiDAR Data Acquisition Guideline.....	12
8.5 Case Studies on Climate Change in Floodplain Mapping.....	13
8.6 Federal Geomatics Guidelines for Floodplain Mapping	13
8.7 Flood Risk Assessment	13
8.8 Risk-based land-use guide: Safe use of land based on hazard risk assessment.....	13
8.9 Bibliography of Best Practices and References Related to Flood Mitigation	13
9.0 FUTURE WORK	13
10.0 GLOSSARY OF FLOODPLAIN MAPPING TERMINOLOGY.....	14
11.0 REFERENCES.....	17
ANNEX A: Integrated Flood Management Process	18

ACKNOWLEDGEMENTS

The *Federal Floodplain Mapping Guidelines Series* has been developed under the leadership of the Flood Mapping Committee, a partnership between Public Safety Canada, Natural Resources Canada, Environment and Climate Change Canada, National Research Council of Canada, Defence Research and Development Canada, and Indigenous and Northern Affairs Canada. A Technical Working Group on Flood Mapping formed in 2015 and comprised of key stakeholders from federal and provincial jurisdictions, as well as the private sector and academia, has also contributed valuable input to the development of the *Federal Floodplain Mapping Guidelines Series* documents. Provincial and territorial government representatives also provided essential feedback leading up to publication.

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FEDERAL FLOODPLAIN MAPPING GUIDELINES SERIES

The following documents are intended to inform any individual or organization involved with floodplain management in Canada:

1. **Federal Floodplain Mapping Framework (March 2017)**
2. Flood Hazard Identification and Priority Setting (*to be developed*)
3. Federal Hydrologic and Hydraulic Procedures for Floodplain Delineation (Spring 2017)
4. Federal Airborne LiDAR Data Acquisition Guideline (Spring 2017)
5. Case Studies on Climate Change in Floodplain Mapping (*to be developed*)
6. Federal Geomatics Guidelines for Floodplain Mapping (Spring 2017)
7. Flood Risk Assessment (*to be developed*)
8. Risk-based land-use guide: Safe use of land based on hazard risk assessment (2015)
9. Bibliography of Best Practices and References for Flood Mitigation (Spring 2017)

LIST OF ABBREVIATIONS AND ACRONYMS

CMHC: Canada Mortgage and Housing Corporation
CWCAA: Canada Water Conservation Assistance Act
DEM: Digital Elevation Model
DFAA: Disaster Financial Assistance Arrangements
ECCC: Environment and Climate Change Canada
FDRP: Flood Damage Reduction Program
FGP: Federal Geospatial Platform
FRFCP: Fraser River Flood Control Program
INAC: Indigenous and Northern Affairs Canada
LiDAR: Light Detection And Ranging
NDMP: National Disaster Mitigation Program
NRCan: Natural Resources Canada
PS: Public Safety Canada
PWGSC: Public Works and Government Services Canada

1.0 CONTEXT AND PURPOSE

A community achieves an elevated level of resilience when its risks are proactively managed, it is adequately prepared for known and potential disaster events and it demonstrates an ability to recover after such events have taken place. In order to become resilient, a community's mitigation planners must first understand risks and ensure their capacity to manage those risks.

Floods are the most commonly occurring natural hazard in Canada and account for the largest portion of disaster recovery costs on an annual basis. Mitigating flood risks is therefore key to increasing the resilience of affected communities. By proactively investing in flood mitigation activities, a community secures practical investments for its future growth and prosperity, reducing the risk of significant disaster recovery costs, productivity losses, economic losses, destruction of non-monetary cultural assets, environmental damage, injuries and deaths.

Floodplain mapping that accurately delineates flood hazards serves as the precondition for such mitigation activities and is therefore the first step to increasing community resilience with regard to flooding. Establishing a national approach to floodplain mapping will facilitate a common national best practice and increase the sharing and use of flood hazard information, thereby improving the foundation from which further mitigation efforts can be initiated.

The purpose of this document is to introduce the *Federal Floodplain Mapping Guidelines Series* documents and to provide a framework for how each fits into the overall floodplain mapping life cycle. Specifically, this document will provide a brief history of past and present floodplain mapping efforts in Canada, a brief summary of floodplain mapping roles and responsibilities and an overview of the contents of the suite of documents that make up the *Federal Floodplain Mapping Guidelines Series*. Together, these documents provide details on technical aspects of the following floodplain mapping-related activities:

- Hydrologic and hydraulic investigation
- Floodplain mapping
- Risk assessment
- Determining the effects of climate change on flood modelling
- LiDAR data acquisition, and
- Land use planning.

All documents in the *Federal Floodplain Mapping Guidelines Series* are intended to be evergreen and to be adapted as new technological and scientific developments emerge.

2.0 NOTE ON TERMINOLOGY

All *Federal Floodplain Mapping Guidelines Series* documents will apply the following definitions, derived from the both the Emergency Management Framework for Canada (EMFC 2016)¹ and National Disaster Mitigation Program (NDMP 2016) literature²:

Flooding: The overflow of natural drainage channels, natural shorelines and/or flood works leading to partial or complete inundation of normally dry land.

Floodplain Mapping: The delineation of flood lines and elevations on a base map. This typically takes the form of flood lines on a map that show the area that will be covered by water, or the elevation that water would reach during a specified flood event. The data shown on the maps, for more complex scenarios, may also include flow velocities, depth, other risk parameters, and vulnerabilities.

Hazard: A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Risk: The combination of the likelihood and the adverse consequences of a specified hazard being realized, including potential economic, social/cultural, environmental and human impacts.

It is recognized that provinces and territories may define these terms differently, and these definitions are not intended to be prescriptive outside the context of the *Federal Floodplain Mapping Guidelines Series* documents.

Also, it is important to note that during the Flood Damage Reduction Program (see Section 5) areas subject to designation were referred to as 'flood risk zones'. According to the terminology provided above, they would now be referred to as 'flood hazard zones'.

3.0 TARGET AUDIENCE

The documents contained in the *Federal Floodplain Mapping Guidelines Series* are to be used as a resource for floodplain mapping projects and activities undertaken across Canada. These guidelines aim to provide advice to provinces and territories, whose responsibility it is to provide technical guidance to implementing bodies, as well as individuals and organizations in Canada that need to understand and manage flood risks and their consequences to communities. They may include emergency management practitioners, flood risk managers, land-use and water resources planners, town planners, hydrologists, hydraulic engineers, geoscientists, geologists, infrastructure providers, water managers, and policy and decision makers, both within and outside of government.

Some provinces and territories may have already developed their own more specific guidelines and regulations regarding floodplain mapping and flood risk management, emergency management and land-use planning. The present guidelines are intended as a basis for further specification as defined by a province or territory.

¹ <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/mrgnc-mngmnt-frmwrk/index-eng.aspx>

² <http://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgn/ndmp/index-en.aspx>

4.0 IMPORTANCE OF FLOODPLAIN MAPS

Although there are many variations, all floodplain maps identify the boundaries of actual or potential flood events based on probability and likelihood and can be used to help identify the specific impacts of flood events on, for example, structures, people and assets. Floodplain maps serve as critical decision-making tools in flood mitigation, land use planning, emergency management and general public awareness. These maps typically provide information at large scales (1:1,000 to 1:25,000) about topography, land cover, infrastructure, flood hazards and flood risks. Floodplain maps produced under the Flood Damage Reduction Program (FDRP), which was administered from 1976 to 1997, serve to identify flood hazard areas that became “designated” under federal-provincial agreements. “Designated” flood hazard areas were subject to specified provincial/territorial flood mitigation measures with the aim of managing development in flood prone areas.

Floodplain maps offer the following advantages to communities:

- Provide a cornerstone for land use planning and land use restrictions,
- Present information on flood hazard and flood risk to stakeholders and the general public,³
- Better inform emergency management practices,
- Enable community preparedness and mitigation strategies, and
- Empower citizens and property owners with information that allows them to make informed decisions related to flood risks.

4.1 Types of Floodplain Maps

Although there is a high degree of flexibility in floodplain mapping practices, the *Federal Floodplain Mapping Guidelines Series* identifies four main types of maps that cover a wide spectrum of mapping activities. These are:

Inundation Maps: Maps that show the extent of potential floodwater coverage during flood events of different magnitudes (i.e. return periods). They are intended to aid in the management of emergency preparedness plans for communities situated within floodplains.

Flood Hazard Maps: Engineering maps that display the results of hydrologic and hydraulic investigations, including the extent of a regulatory design flood. These maps are used for regulatory planning purposes related to land use planning and flood mitigation.

Flood Risk Maps: Maps that contain the flood hazard or inundation delineations along with additional socio-economic values, such as potential loss or property vulnerability levels. These maps serve to identify the social, economic and environmental consequences to communities during a potential flood event.

³ For definitions of ‘risk’ and ‘hazard’ as applied in this document, see SECTION 2.0 NOTE ON TERMINOLOGY,

Flood Awareness Maps: Communication maps that serve to inform members of the public regarding the history of flooding in their communities, as well as the potential for future flooding and the risks that such flooding would pose to residential properties, businesses, cultural assets, infrastructure and human life. These poster-style maps include a range of additional content types, such as photographs, descriptive text and graphics.

It is important to recognize that, while widely used, these terms are applied differently in different jurisdictions. As such, all *Federal Floodplain Mapping Guidelines Series* documents will adhere to the descriptions provided above (which are elaborated in greater detail in the “Federal Geomatics Guidelines for Floodplain Mapping” document).

5.0 HISTORY

The past federal contribution to flood control efforts is large and warrants an historical context.

5.1 Early Federal/Provincial Programs

The first federal legislation to deal with water resource management and flooding was the Canada Water Conservation Assistance Act (CWCAA) which was instituted in 1953 and led to the construction of a number of small structural mitigation works. The last of these was completed in the early 1980s, although the CWCAA was superseded by the Canada Water Act (CWA) in 1970.

The Fraser River Flood Control Program (FRFCP) was established in 1968 by the federal and British Columbia governments to reconstruct and maintain dykes in the Lower Fraser Valley that were built following the 1948 Fraser River flood. The program ended in 1995.

Also, a series of federal-provincial agreements from the early 1950s to the 1970s resulted in the construction of a number of structural mitigation works throughout the province of Manitoba, including the Red River Floodway.

5.2 Flood Damage Reduction Program (FDRP)

A series of major flood events were the catalyst for the federal government to initiate the FDRP in 1976 under the Canada Water Act. The objectives of the FDRP were to reduce loss of life and suffering, major disruptions to regional economies and escalating disaster assistance payments. It represented a significant change in approach from an ad hoc structural response to flooding to a more comprehensive and equitable approach focusing on preventative and non-structural measures, such as floodplain mapping as a first step to inform further flood management and mitigation activities.

The FDRP was carried out under cost-shared federal-provincial-territorial agreements, negotiated by Environment and Climate Change Canada (ECCC) on behalf of the federal government. A central goal of these bi-lateral agreements was to inform decisions pertaining to developments in flood hazard areas. Other federal ministers were signatories to these agreements, including the Minister of Public Works and Government Services Canada (PWGSC) and the Ministers responsible for the Canada Mortgage and Housing Corporation (CMHC), as well as the regional economic development agencies for the affected regions of the country.

The main products of the FDRP were engineering maps and public information maps (what are referred to in the *Federal Floodplain Mapping Guidelines Series* as ‘Flood Hazard Maps’ and ‘Flood Awareness Maps’, respectively). The engineering maps were the basis for zoning regulations which are used to manage development in flood-prone areas. In total, the program designated 341 flood-risk areas covering more than 980 communities. All flood-prone areas that were legally designated within the FDRP program are still valid indefinitely. Since the end of the active mapping phase of the FDRP in 1997, provinces, territories and other levels of government have continued floodplain mapping for new areas or updated previous mapping using their own resources.

5.3 National Floodplain Mapping Assessment

In 2013, Public Safety Canada (PS) commissioned a study on the state of floodplain mapping in Canada entitled *National Floodplain Mapping Assessment – Final Report* (MMM Group, 2014). The study results identified further needs for guidelines and practices regarding floodplain mapping. This study documented:

- International floodplain mapping best practices from seven countries (United Kingdom, Australia, the United States, France, Germany, Switzerland, and New Zealand),
- National floodplain mapping practices, with a view to identifying best practices,
- The current state of floodplain mapping in Canada, including details for each province and territory,
- A proposed standard and next steps, and
- An estimate of the cost of bringing Canada up to the standard recommended in the report for 90-95% of the population.

The scope of the study addressed only riverine flooding, not urban or coastal, nor did it address climate change.

6.0 ROLES AND RESPONSIBILITIES

Table 1 - Flood management is inherently multi-faceted and involves a wide range of authorities and stakeholders, both within and outside of government. The following is a brief and informal overview of flood management roles and responsibilities, including relevant tools and resources where applicable.

Federal Government

Whereas the implementation of flood mitigation measures is mainly the responsibility of provincial/territorial/local agencies, the federal government plays an important role in ensuring a broadly consistent national approach to flood mitigation. This involves establishing national floodplain mapping requirements, as well as basic criteria for geospatial data acquisition, management and dissemination.

The federal government is committed to working with the provinces and territories on an ongoing basis through various federal-provincial-territorial forums related to Emergency Management, water resources and floodplain mapping, such as the Canadian Council on Geomatics (CCOG) and Senior Officials Responsible for Emergency Management (SOREM) to ensure Emergency Management policy/legislative coordination between all levels of government.

Federal Geospatial Platform (FGP) and Open Maps

The FGP is an initiative of the Federal Committee on Geomatics and Earth Observations (FCGEO), a committee of senior executives from 21 departments and agencies that are producers and/or consumers of geospatial data, or have an interest in activities, requirements and infrastructure related to geomatics.

This platform serves as an internal collaborative online environment where the Federal Government’s most relevant geospatial data can be retrieved and viewed on maps to support evidence-based decision-making and foster innovation.

Whereas the FGP is an internal site, available to all members of the federal government, Open Maps⁴ is a public resource available through the Open Government portal.

Public Safety Canada (PS)	PS is the primary federal Agency responsible for disaster mitigation in Canada. As such, the PS portfolio contains a variety of initiatives related to emergency management.
	<p>National Emergency Management System (NEMS)</p> <p>NEMS is a PS-led holistic online emergency management environment through which emergency management partners will coordinate efforts and improve decision-making across the four pillars of emergency management: prevention and mitigation, preparedness, response and recovery.</p> <p>Public Safety will leverage NEMS to promote the <i>Federal Floodplain Mapping Guidelines Series</i> as a tool for use in future floodplain mapping activities.</p>
	<p>Disaster Financial Assistance Arrangements (DFAA)</p> <p>In the event of a large-scale natural disaster, the Government of Canada provides financial assistance to provincial and territorial governments through the DFAA, administered by PS.</p> <p>Through the DFAA, assistance is paid to the province or territory when eligible expenditures exceed an established initial threshold (based on provincial or territorial population). A request for reimbursement under the DFAA is processed immediately following receipt of the required documentation of provincial/territorial expenditures and a review by federal auditors.</p>
Natural Resources Canada (NRCan)	NRCan, through its Canada Centre for Mapping and Earth Observation (CCMEO), has actively contributed to the development of these guidelines by providing leadership, advice, expertise, and technical resources in the area of floodplain mapping and stakeholder engagement. NRCan’s involvement follows from its pre-existing expertise regarding geomatics and natural hazards
Environment and Climate Change Canada (ECCC)	ECCC is the federal agency responsible for the collection, interpretation and dissemination of standardized water quantity data in Canada. These data contribute toward hydrotechnical engineering analyses. In addition, ECCC carries out a foundational research program to understand the climate system and the science of climate change that can contribute to established best practices for considering climate change in the development of floodplain mapping.

⁴ <http://open.canada.ca/en/open-maps>

<p>Indigenous and Northern Affairs Canada (INAC)</p>	<p>Through a number of initiatives, INAC provides funding for local indigenous communities to engage in various activities related to flood management, such as flood forecasting and water level monitoring, as well as the implementation of floodplain mapping and flood mitigation measures.</p>
<p>Defence Research and Development Canada (DRDC)</p>	<p>Defence Research and Development Canada's (DRDC) ongoing contribution to floodplain mapping occurs through the Canadian Safety and Security Program (CSSP). CSSP is led by DRDC's Centre for Security Science (DRDC CSS) in partnership with Public Safety Canada. The CSSP's mandate includes objectives to strengthen Canada's ability to anticipate, prevent, mitigate, prepare for, respond to, and recover from natural disasters.</p>
<p>Provincial/Territorial</p>	
<p>Whereas the federal government plays an important role in ensuring that flood management across Canada is approached in a broadly consistent manner, provincial and territorial governments are ultimately responsible for overseeing flood mitigation efforts within their jurisdictions. Although each province and territory manages flood risks separately, with the involvement of different departments and ministries, these efforts invariably involve working with local municipalities or other water agencies to identify flood mitigation needs, establish priorities and implement initiatives, such as preparing and maintaining floodplain mapping. In many cases responsibility for such activities is delegated primarily to the municipality or water agency.</p> <p>Depending on the jurisdiction, the following areas related to flood management can fall under the jurisdiction of provincial or territorial agencies:</p> <ul style="list-style-type: none"> • Water management, • Emergency management and continuity of service, • Land use planning/zoning regulation, • Funding and implementation of watershed scale mitigation measures, • Disaster recovery funding program administration, • Insurance industry regulation, and • Public outreach. <p>Coordination between the provincial/territorial and federal governments will occur through annual meetings of Ministers Responsible for Emergency Management, as well as regular meetings at Deputy Minister and senior official levels, such as Senior Officials Responsible for Emergency Management (SOREM).</p>	
<p>Community/Municipal</p>	
<p>It is at the municipal level that identification of flood risks and implementation of flood mitigation measures ultimately takes place and local governments, working in conjunction with provincial/territorial authorities, therefore play a central role in flood risk management.</p> <p>Municipal roles can include:</p> <ul style="list-style-type: none"> • Water management, • Emergency management and continuity of service, • Land use planning/zoning regulation, • Critical infrastructure design and utility operation, 	

- Public services, and
- Ownership/operation/insurance of public assets

Further, community outreach is a critical element of flood risk management and offers the following benefits to those involved in flood management:

- Allows flood authorities to draw on community knowledge of past flood events,
- Enables the sharing of flood risk information with the community, and
- Aids in establishing community support for flood-related initiatives.

Individuals

It is critically important that individuals be aware of flood risks and the steps necessary to address them, both in terms of preparation and response. It is therefore essential that such information be made available to them by municipal authorities, particularly through the use of Flood Awareness Maps and other public outreach tools.

Private Sector

Many private businesses are involved in flood mitigation efforts and/or are affected by the severe impacts of flooding. While it is essential that all private businesses be aware of flood risks and how to mitigate them, some businesses have greater responsibilities than others in terms of managing the impacts of flooding. In particular, it is essential that industries involved in land development adhere to land use regulations and policies, as well as ensure that their work is conducted in a manner that does not create or aggravate flood risks.

Insurers

The recent development of a private residential flood insurance market in Canada marks the emergence of a new and invaluable resource for individual property owners to manage flood risk. With the growth of this market, the insurance industry will come to play an increasingly important role in rebuilding efforts following major flood events. Further, coordination of flood-related data and knowledge between federal-provincial-territorial governments and the insurance industry will serve to advance all parties' interests.

7.0 VISION AND PRINCIPLES

A vision for Canadian flood guidance has been developed in order to enhance community resilience with regard to flood mitigation. It consists of the following elements:

- The development of a comprehensive understanding of hazard exposure in order to inform mitigation and preventative measures aimed at increasing the resilience of Canadian communities.
- The development of common principles and guidelines for floodplain mapping in order to address flood-specific knowledge requirements necessary to inform the management of Canada's most expensive and frequent hazard.
- The establishment of an inclusive process to provide consistent and usable body of information to support flood risk analysis and modelling.
- The establishment of consistent flood hazard information collection and mapping practices across Canada.

The following principles pertain to all documents in the *Federal Floodplain Mapping Guidelines Series*.

Key Principles	
Local	National guidelines will take regional considerations and priorities into account.
Accessible	Data, information and knowledge products related to topographic features, hydrologic and hydraulics characteristics, and the population and infrastructure at risk will be as accurate and accessible to relevant practitioners as possible.
Collaborative	Community engagement and collaboration between stakeholders are key to the development and implementation of effective guidelines.
Interoperable	Floodplain maps and risk data should be maintained in digital form so that they are sharable and interoperable with those related to other natural disasters (e.g. storm surges, wild fires, landslides, earthquakes, etc.).
Adaptable	Floodplain mapping will be adapted to suit changing conditions, including factoring climate change data, information and knowledge into the development of risk assessment tools and flood design events.
Evergreen	The <i>Federal Floodplain Mapping Guidelines Series</i> will evolve and be updated as new information, technologies and practices emerge.
Voluntary	Given that flood management is a provincial/territorial responsibility, adoption and use of the <i>Federal Floodplain Mapping Guidelines Series</i> is voluntary. Provinces and territories are encouraged to take into account any federal guidelines and consider whether these guidelines are appropriate to the provincial/territorial circumstances.

8.0 FLOODPLAIN MAPPING FRAMEWORK

The Floodplain Mapping Framework consists of all the components of the flood mitigation process, from flood hazard identification to the implementation of flood mitigation efforts. The following flow chart illustrates the relationship between these different components and links each of them to the relevant *Federal Floodplain Mapping Guidelines Series* document. For more references detailing the floodplain mapping process, please see Annex A.

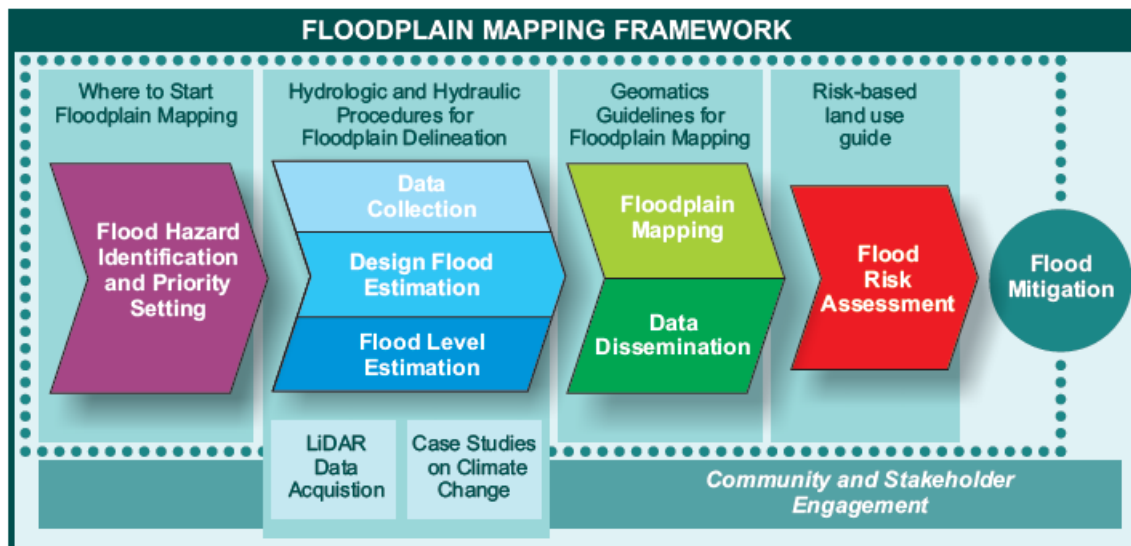


Figure 1: Floodplain Mapping Framework

In addition, the *Federal Floodplain Mapping Guidelines Series* also includes a Bibliography that contains references and best practices related to flood mitigation.

8.1 Federal Floodplain Mapping Framework

This document sets out the context, stakeholders, vision, principles and framework for floodplain mapping.

8.2 Flood Hazard Identification and Priority Setting

This document has yet to be developed. It will outline methods for determining where to conduct floodplain mapping and how to prioritize floodplain mapping projects.

8.3 Federal Hydrologic and Hydraulic Procedures for Floodplain Delineation

This document covers the Data Collection, Design Flood Estimation, Flood Level Estimation and Climate Change components of the floodplain mapping process. It explains how to conduct hydrologic and hydraulic investigations in order to determine flood magnitudes and water surface elevations in specific environmental circumstances. It also includes information on how to incorporate climate change considerations into these analyses, which is intended to be supplemented by the document "Case Studies on Climate Change in Floodplain Mapping".

8.4 Federal Airborne LiDAR Data Acquisition Guideline

This document is under development. Whereas basic information pertaining to the acquisition and management of LiDAR data is contained in "Federal Geomatics Guidelines for Floodplain Mapping", further guidance will be provided in this document, which will be intended for a broader audience, reflecting LiDAR's applicability to a variety of geomatics-related fields beyond floodplain mapping.

8.5 Case Studies on Climate Change in Floodplain Mapping

This collection of documents, which has yet to be developed, will survey projects from across Canada where climate change has been incorporated into the floodplain mapping process. It will provide examples for practitioners to draw on and learn from others' experiences and will complement the climate change-related information and resources included in the "Federal Hydrologic and Hydraulic Procedures for Floodplain Delineation" document.

8.6 Federal Geomatics Guidelines for Floodplain Mapping

This document covers the Floodplain Mapping and Dissemination components of the Floodplain Mapping Framework. It contains information on the different types of floodplain maps and outlines methods for acquiring, managing and disseminating these maps and associated geospatial data.

8.7 Flood Risk Assessment

This document has yet to be developed. Once flood hazards have been identified, this document provides guidance in determining associated risks to life, assets and property.

8.8 Risk-based land-use guide: Safe use of land based on hazard risk assessment

This is a pre-existing document, produced by Natural Resources Canada in 2015, which provides guidance to communities in using risk-based methodologies for the purpose of land-use planning.

8.9 Bibliography of Best Practices and References Related to Flood Mitigation

This document contains lists of Canadian and international references and case studies pertaining to hydrology and hydraulics, climate change, risk assessment and floodplain mapping.

9.0 FUTURE WORK

As outlined above, there are a number of planned *Federal Floodplain Mapping Guidelines Series* documents scheduled for publication. These documents will provide further guidance to those involved in floodplain mapping in Canada. Information regarding expected publication dates will be announced as it becomes available.

10.0 GLOSSARY OF FLOODPLAIN MAPPING TERMINOLOGY

The following glossary is intended as a consolidated reference for all of the *Federal Floodplain Mapping Guidelines Series* documents.

Base Map: A map of a community that depicts cultural features (e.g. roads, railroads, bridges, dams, culverts, drainage features, and corporate limits).

Catchment: Also known as drainage area, drainage basin or watershed. It is the area of land draining to a particular location and includes the upstream drainage area of the main waterway as well as any tributary streams.

Cross-section: A survey string of channel and floodplain elevations that is taken perpendicular to the main flow direction in a river.

Coastal Flooding: Coastal flooding can be defined as flooding associated with a defined shoreline along an ocean. This can be due to a combination of high tides, storm surges, waves, rising sea levels and riverine flooding.

Design Flood: A flood elevation or peak flow used for planning, infrastructure design or floodplain management investigations. It is typically defined by its probability of occurrence or estimated using a selected design storm.

Designated Flood Risk Area: Areas that were delineated under the Flood Damage Reduction Program (FDRP) as being prone to flooding by a regulatory flood event and formally recognized by federal and provincial governments.

Digital Elevation Model (DEM): A file with terrain elevations recorded for the intersection of a fine-grained grid and organized by quadrangle as the digital equivalent of the elevation data on a topographic base map.

Digital Terrain Model (DTM): A land surface represented in digital form by an elevation grid or lists of three-dimensional coordinates.

Drainage Area: See **Catchment**.

Flood Awareness Map: Communication maps that serve to inform members of the public regarding the history of flooding in their communities, as well as the potential for future flooding and the risks that such flooding would pose to residential properties, businesses, cultural assets, infrastructure and human life. These poster-style maps include a range of additional content types, such as photographs, descriptive text and graphics.

Flood Fringe Areas: The part of the flood hazard where flood depths, flow velocities, or wave energies are relatively low and critical flow paths and flood storage areas are maintained, therefore permitting development, provided that such development is compatible with flood hazard and appropriate building measures and provides an adequate level of flood protection. This is the remaining area affected by flooding after critical flow conveyance paths and flood storage areas have been defined for a particular event.

Flood Hazard Management: The operation of a program of corrective and preventative measures for reducing flood damage, including, but not limited to, development plans, emergency preparedness plans, flood-control works, and land use regulations.

Flood Hazard Map: A description of the threat of a flood at a given location, based on the flood's anticipated magnitude (e.g. its depth, horizontal extent, and flow velocity) and its probability of occurrence. It contains the extent of the regulatory flood hazard, potentially including two zones: floodway and flood fringe areas. This type of map is used for regulatory planning purposes. Hazard maps are sometimes referred to as floodplain maps.

Flood Inundation Map: Maps that show the extent of potential floodwater coverage during flood events of different magnitudes (i.e. return periods). They are intended to aid in the management of emergency preparedness plans for communities situated within floodplains.

Flood Mitigation: A sustained action taken to reduce or eliminate long-term risk to people and property from flood hazards and their effects. Mitigation distinguishes actions that have a long-term impact from those that are more closely associated with preparedness for, immediate response to, and short-term recovery from specific events.

Floodplain Map: See **Flood Hazard Map**.

Flood Protection: Any combination of structural and non-structural additions, changes, or adjustments to structures, which reduce or eliminate risk of flood damage to real estate or improved real property, water and sanitation facilities, or structures with their contents.

Flood Risk Map: Maps that contain the flood hazard or inundation delineations along with additional socio-economic values, such as potential loss or property vulnerability levels. These maps serve to identify the social, economic and environmental consequences to communities during a potential flood event.

Flood Risk: Flood risk is a combination of the likelihood of occurrence of a flood event (**Flood Hazard**) and the social or economic consequences of that event when it occurs (the exposure to the flood hazard).

Floodway: The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge a design flood without cumulatively increasing the water surface elevation more than a designated height. It is typically the portion of a floodplain where flood depths are greatest and flow velocities are highest.

Flow: The rate of flow of water measured in volume per unit time – for example, cubic metres per second (m^3/s). Flow is different from the speed or velocity of flow, which is a measure of how fast the water is moving – for example, metres per second (m/s).

Freeboard: The height added to a flood elevation to account for the many unknown factors, such as climate change, and uncertainties in estimates that could lead to the underestimation of predicted water surface elevations. Incorporating freeboard in floodplain mapping may be one approach to account for uncertainty when a quantitative approach to assessing the flood impact, such as future climate change conditions, is not feasible.

Hydraulic Analysis: An engineering analysis of flow scenarios carried out to provide estimates of the water surface elevations and behaviour for selected recurrence intervals.

Hydraulics: The study of the dynamics of movement of a given amount of water in a watershed.

Hydrologic Analysis: An engineering analysis of a flooding source carried out to establish peak flood discharges and their frequencies of occurrence.

Hydrology: Scientific study of the movement, distribution, and quality of water as it relates to the land.

Infiltration: The penetration of water through the ground surface into the sub-surface soil.

Lake Flooding: Lake flooding can be defined as flooding associated with a defined shoreline along a lake. This can be due to a combination of high water levels, waves, storm surges and riverine flooding.

Light Detection and Ranging (LiDAR): A remote sensing technology which uses lasers to collect accurate continuous elevation data.

Peak Flow: The maximum flow occurring during a flood event measured at a given point in the river system (see **Flow**).

Probability of Occurrence: An estimate of the likelihood of an event occurring in any given year. For instance, a 1:100 year return period flood has a predicted 1% chance of occurring each year.

Recurrence Interval: See Probability of Occurrence.

Regulatory Flood: The defined flood event used to delineate areas prone to flooding. The minimum regulatory flood criteria standard is the 100-year return period flood which is the peak or flood flow with one chance in one hundred of occurring in any given year, although some provinces and territories implement more stringent standards.

Return Period: See Probability of Occurrence.

Riverine Flooding: Riverine flooding can be defined as excess of stream flow in a watercourse such that land outside the normal banks is submerged or inundated. This can be a result of either extreme rainfall or snowmelt runoff events, or physical conditions associated with a watercourse. These physical conditions could be ice jams, undersized watercourse crossings or encroachments into the flood hazard zone.

Runoff: The amount of precipitation or water deriving from snowmelt that drains into the surface drainage network to become streamflow; also known as rainfall excess.

Stage: Equivalent to water level measured with reference to a specified geodatic datum.

Still water level: The elevation of the water if all gravity waves are at rest. This is the elevation that is measured in the field in a stilling well.

Storm Surge: The increases in coastal water levels above predicted astronomical tide level (i.e. tidal anomaly) resulting from a range of location-dependent factors including low atmospheric pressure, wind and wave set-up and astronomical tidal waves, together with any other factors that increase tidal water levels.

Velocity of Floodwater: The speed at which flood waters are moving, typically measured in metres per second (m/s).

Watershed: See Catchment.

Water level: The mean elevation of the water when averaged over a period of time long enough (about one minute) to eliminate oscillations caused by surface gravity waves which have periods in the order of a few seconds. In essence, water level is the sum of still water level and gravity waves.

11.0 REFERENCES

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ANNEX A: Integrated Flood Management Process

Below is a graphic outlining the process involved in flood risk mitigation and management. This graphic includes more detail than **Figure 1: Floodplain Mapping Framework**, contained in Section 8 of this document. This graphic was adapted from a diagram provided by Dave Murray, P.Eng., ASCT, CPESC, Principal, Water Resources Engineer at Kerr Wood Leidal Consulting Engineers.

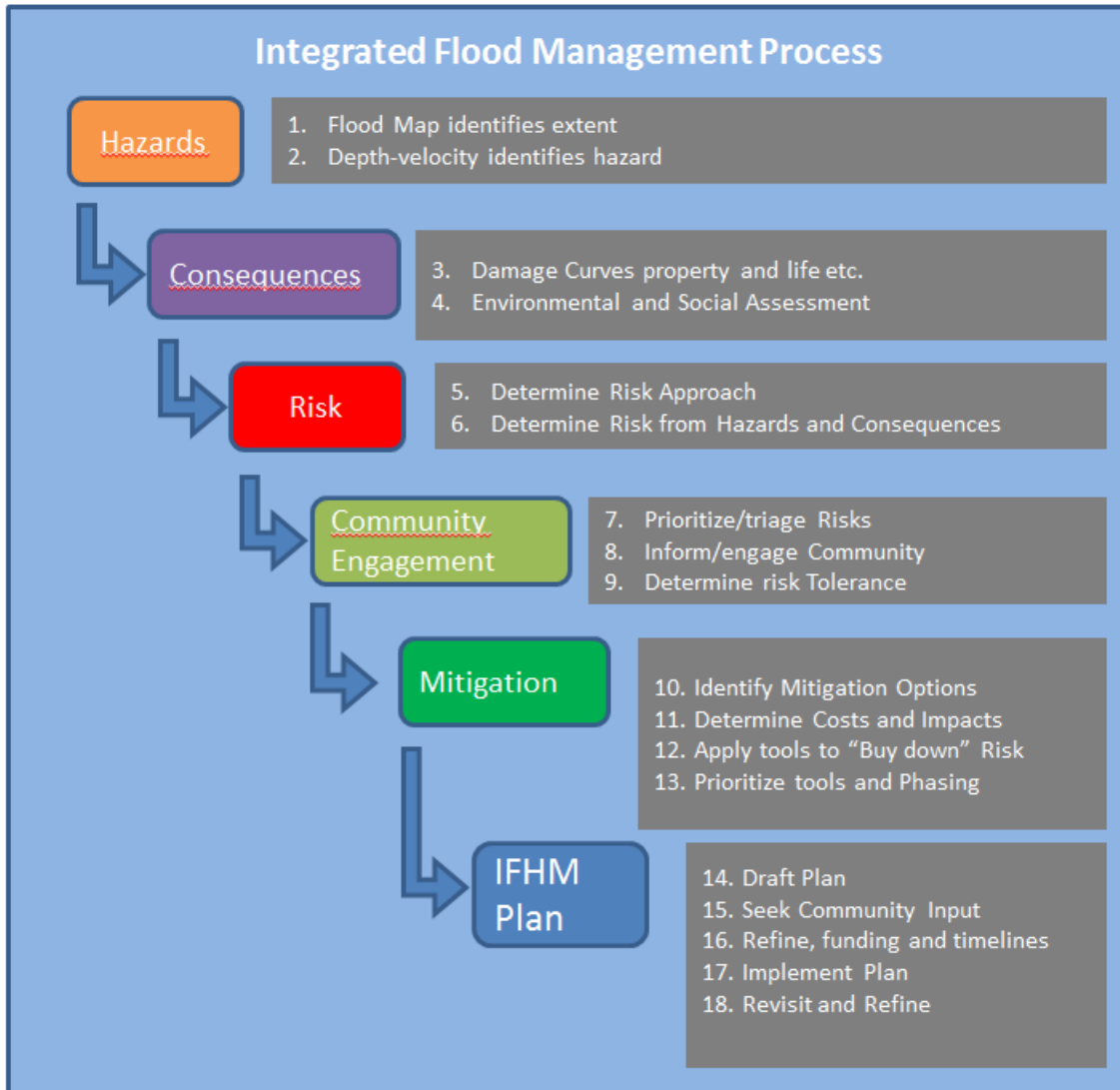


Figure 1: Integrated Flood Management Process