BRITISH COLUMBIA
REAL ESTATE
ASSOCIATION

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# BC Floodplain Map Inventory Report

**Prepared by**

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## Executive summary

Most floodplain maps in BC are out of date, putting communities and citizens at risk. The British Columbia Real Estate Association (BCREA) has made this assertion since 2012, and this report is the latest study to reinforce that conclusion.

Floodplain maps can support municipal decision making by demonstrating the risks to both existing and proposed developments and infrastructure and, in the process, help foster resilient community growth and emergency planning. To be effective, however, floodplain maps must be updated regularly to account for many factors, including changes in development, the environment and climate.

This report delivers on BCREA's primary objective, which was to present an inventory of floodplain maps in British Columbia updated outside the BC Floodplain Mapping Program, which ended in 2004. It also describes how floodplain maps are used, the public availability of maps, availability of supporting data, and challenges and opportunities that communities have experienced in attempting to prepare/update floodplain maps. Data were obtained through a survey of and interviews with local governments and First Nations bands in BC. This report helps to identify gaps in floodplain mapping and highlights the need for up-to-date floodplain information in BC.

Seventy-two local governments and First Nations responded to a survey commissioned by BCREA, and 25 of those respondents participated in telephone interviews. While the small sample makes it difficult to generalize, the findings are worth noting:

- Only 21% of the 72 communities that responded have access to floodplain maps updated within the past ten years and nearly 31% reported they have no access to floodplain maps at all, which means decisions about growth, development and emergency response are based on unreliable information.

- More than half of interviewees indicated floodplain maps are a low priority for their organizations; most of those that rank it high have experienced recent flood events.

- Communities and First Nations report a variety of barriers to updating floodplain maps, though they can generally be categorized into technical, financial and political obstacles.

- While many respondents have access to data that can be used for flood management and/or risk assessment, data formats and resolutions vary widely and responses may indicate a lack of awareness of existing publicly-available resources.

- Some respondents believe proactively designating floodplains increases a community's liability; others believe designating floodplains reduces liability.

These results suggest that better information about floodplain maps, guidelines for their development and the standardization of data, and stronger funding mechanisms will all improve the state of floodplain mapping in BC. Better floodplain maps will make communities, First Nations and the entire province more resilient.


### *Acknowledgements*

BCREA thanks all involved in making this study happen.

Catherine Parsons, at the time a master's student at Simon Fraser University, carried out the bulk of the work for this study.

The framework for the research was established by Steve Conrad, a Ph.D. candidate at Simon Fraser University and Pacific Institute for Climate Solutions research fellow, while he worked under contract with BCREA. Steve's work was made possible by a grant provided by the Real Estate Foundation of British Columbia.

The Fraser Basin Council (FBC) provided some data that appears in Appendix B, which was gathered as part of the Lower Mainland Flood Management Strategy—a significant, collaborative initiative coordinated by FBC, which involves a long list of local governments and stakeholders, including the provincial government. The objective is to better protect communities along the lower Fraser River and coast—from Hope to Richmond and from Squamish to White Rock.

Nathan Vadeboncoeur, principal with Vadeboncoeur Consulting, completed the review and helped to polish the report.

Finally, members of BCREA's Floodplain Maps Working Group helped shape this project over the course of several months as part of their work in assisting BCREA implement its Floodplain Maps Action Plan (available at www.bcrea.bc.ca/government-relations/flood-protection). The Working Group consists of:

- Jeff Fisher – Vice President & Senior Policy Advisor, Urban Development Institute
- Deborah Harford – Executive Director, Adaptation to Climate Change Team, Simon Fraser University
- Robert Laing – Chief Executive Officer, BCREA
- Steve Litke – Senior Manager, Fraser Basin Council
- Tamsin Lyle – Principal & Flood Management Specialist, Ebbwater Consulting
- Monica Mannerstrom – Principal, Northwest Hydraulic Consultants Ltd.
- Norma Miller – Manager of Government Relations, BCREA
- Damian Stathonikos – Director of Communications and Public Affairs, BCREA
- Aaron Sutherland – Manager, Government Relations, Insurance Bureau of Canada
- Anna Warwick Sears – Executive Director, Okanagan Basin Water Board

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# 1. Introduction

Planning and preparing for floods is becoming increasingly important as flooding continues to threaten communities and the Canadian climate becomes more variable. Municipal governments are on the front lines of flood risk management because of their powers to control land use and, in British Columbia, to designate floodplains. If municipalities are better informed about flood risks, they can better use their policy toolkit[1] to reduce the impact of flooding. This involves improving access to up-to-date, publicly-available information on flood frequency, extent, depth and impacts. One way to illustrate this information is through the development of a floodplain map.[2] Floodplain maps can support municipal decision making by demonstrating the risks to both existing and proposed developments and infrastructure and, in the process, help foster resilient community growth.

This report provides an inventory of updated floodplain maps in BC. It also characterizes the way maps are used, the public availability of maps, the availability of data supporting existing floodplain maps, and the challenges and opportunities that local governments have experienced in preparing and/or updating floodplain maps. It is hoped that this project will contribute to the conversation about floodplain management in BC and raise awareness about the availability, advantages and need for further floodplain mapping in the province.

The BC government commenced a Floodplain Mapping Program in 1974 to direct and/or limit development in floodplains.[3] The program was improved in 1984 when the federal government signed on to contribute to the development of floodplain maps in BC under the Canada/British Columbia Agreement Respecting Floodplain Mapping. This program identified approximately 90 provincially-designated river floodplains. In 2003-2004, the responsibility for flood management was devolved to municipalities through the *Flood Hazard Statutes Amendment Act*,[4] and the BC Floodplain Mapping Program was cancelled.

Local governments in BC now face the significant challenge of designating floodplains, producing floodplain maps and keeping them current. Many municipalities in BC have not updated their floodplain maps—the large majority of floodplain maps in BC are at least 20 years old. These out-dated maps present a barrier to flood hazard mitigation across the province. The scale of this problem is unknown because there is no up-to-date inventory of the floodplain mapping projects undertaken by local governments since the cancellation of the BC Floodplain Mapping Program.

The British Columbia Real Estate Association (BCREA) has, in response to this challenge, commissioned an analysis of the state of floodplain maps in BC. This research, reported here, will provide a clearer picture of the state of, and need for, updated floodplain mapping. It is hoped that this research will raise awareness of the existence and purpose of floodplain maps among local governments and First Nations and contribute to greater flood resilience in BC.

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[1] See BC *Environmental Management Act*, *Local Government Act*, *Land Title Act*, and *Community Charter* (www.env.gov.bc.ca/wsd/public_safety/flood/fhm-2012/landuse_prov_legs.html), as well as the BC Climate Action Toolkit (www.toolkit.bc.ca).

[2] For more information about floodplain maps, please refer to the BCREA *Floodplain Mapping Backgrounder* (www.bcrea.bc.ca/docs/government-relations/2014-FM-backgrounder.pdf).

[3] Province of British Columbia, 2015.

[4] Lyle & McLean, 2008.

# 2. Methodology

A survey was administered to 170 local governments and 199 First Nations Band offices in BC over a one-month period from April 13 to May 11, 2015. The aim of this survey was to collect information about the status, use and availability of floodplain maps, and the availability of supporting data. Follow-up interviews were conducted throughout May with selected communities to obtain more detailed information about factors motivating floodplain mapping efforts in BC. These data formed the basis for this analysis (described below), and were combined with data collected by the Fraser Basin Council for their Lower Mainland Flood Management Strategy to form an inventory of the flood planning data available throughout BC (Appendix B). The resulting research report was sent for external review upon completion of a final draft, and then updated based on reviewer feedback.

## *2.1 BCREA Floodplain Mapping Survey*

All local governments and First Nations in BC were sent a survey questionnaire.[5] Contact information for local governments and First Nations bands was obtained from BC CivicInfo or from previous communications. This survey followed the Tailored Design Method,[6] which is as follows:

- An introduction email with the questionnaire attached was sent to all local governments and First Nations in BC.
- One week later, a reminder email with the attached questionnaire was sent to community representatives that had not yet responded.
- Two weeks later, a second reminder email with the attached questionnaire was sent to community representatives who had still not responded.
- Three weeks later, a third and final reminder email with the attached questionnaire was sent to the remaining local governments and First Nation representatives that had not yet responded.

Information letters and surveys were sent by post to First Nations bands whose electronic contact information was not available from BC CivicInfo. Reminder letters were mailed two weeks later.

Survey questions were designed to obtain information about the availability and age of floodplain maps, the level of public access to these maps, flood-related data and studies and flood-related infrastructure (see Appendix C for Survey Questionnaire).

Seventy-two communities responded to the survey.

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[5] With the exception of those that had already provided floodplain mapping information to the Fraser Basin Council as part of the Lower Mainland Flood Management Strategy. That initiative is linked to this research and therefore it was not necessary to collect this information twice. For a list of local governments that were not sent a survey, please see Appendix D. In addition, the email or mailing address for one First Nation band could not be located and therefore was not sent a survey.

[6] Dillman, 2007.

## 2.2 Follow-Up Interviews

Fifty survey respondents indicated an interest in participating in follow-up interviews. This list of potential interviewees was narrowed to 26 responding communities that were invited to participate in interviews if they satisfied at least one of the following criteria:

- The responding community has undertaken a floodplain mapping project since the cancellation of the BC Floodplain Mapping Program.
- The responding community attempted or is planning to undertake a floodplain mapping project.
- The responding community described encountering barriers to updating their floodplain maps.
- A subject matter expert recommended the responding community, or a specific member of their government, for an interview.
- A local government or First Nation recommended the responding community, or a specific member of their government, for an interview.

A final pool of interview candidates was determined following a review of their geographic location and form of government (i.e., regional, municipal, First Nations) to ensure broad representation across the province and among orders of government. Since only five First Nations bands expressed interest in being interviewed, a small proportion when compared to the number of local and regional government respondents, all were selected for interviews.

Interviews followed a semi-structured approach (see Appendix E for the interview schedule). Questions were designed to obtain information about an organization's involvement in floodplain mapping and the collection of relevant data, the use of floodplain maps, management of community risk and vulnerabilities, and the challenges and opportunities local governments and First Nations encountered during floodplain mapping projects. These questions asked for both specific answers and also allowed respondents the freedom to describe additional information they felt would contribute important context.

## 2.3 Analysis

Descriptive statistics were calculated for quantitative (numerical) survey data. Frequency distributions were then produced for the following variables; access to floodplain maps, access to flood-relevant data, and access to other forms of flood mapping/risk identification data. Qualitative (text or verbal) responses were coded based on their fit within the above-defined categories, and also into both pre-defined thematic clusters and those that emerged during a review of survey and interview data. Pre-defined categories included known sources of funding (i.e., different levels of government, community partners and internal). Emergent categories were determined by content analysis. This involved assigning a label to each coded response, reviewing the results of this process and identifying overarching themes. Responses were then reviewed again and sorted into appropriate themes and sub-themes (e.g., different forms of flood data that were publicly available were all clustered under the same theme "publicly available," and then further sorted into sub-themes such as "published online" or "available for a fee").

### 2.4 Limitations

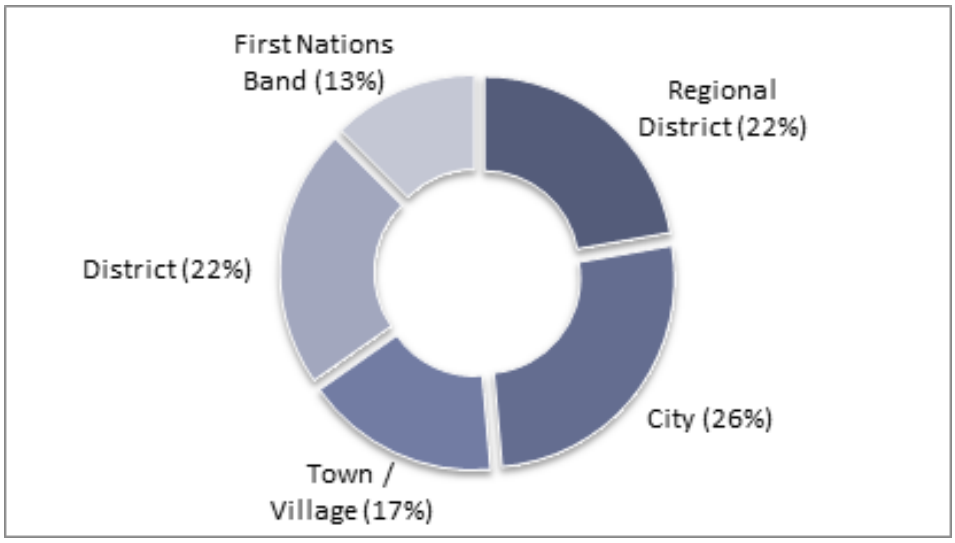
The low survey response rate limits the generalizability (external validity) of the study findings. Differing levels of survey completeness and the potential for human error inherent in asking one individual to represent the available knowledge of an entire organization also limit the consistency of results across respondents (internal reliability). Due to fiscal and time limitations, the number of follow-up interviews conducted was limited to 25. However, as far as the authors are aware, the data presented herein represents the best available sample of the factors contributing to the development of floodplain maps among local governments and First Nations in BC.

## 3. Results and Discussion

### 3.1 Study Participation

Seventy-two of 369 surveys were returned, providing a response rate of 19.5%. There was relatively balanced representation between different forms of government (Figure 1). Follow-up interviews were conducted with a regionally-balanced sample of a subset of 25 of the 72 study participants (Table 1).

Figure 1: Survey Respondents by Form of Government




N=72

Table 1: Follow-Up Interview Participants

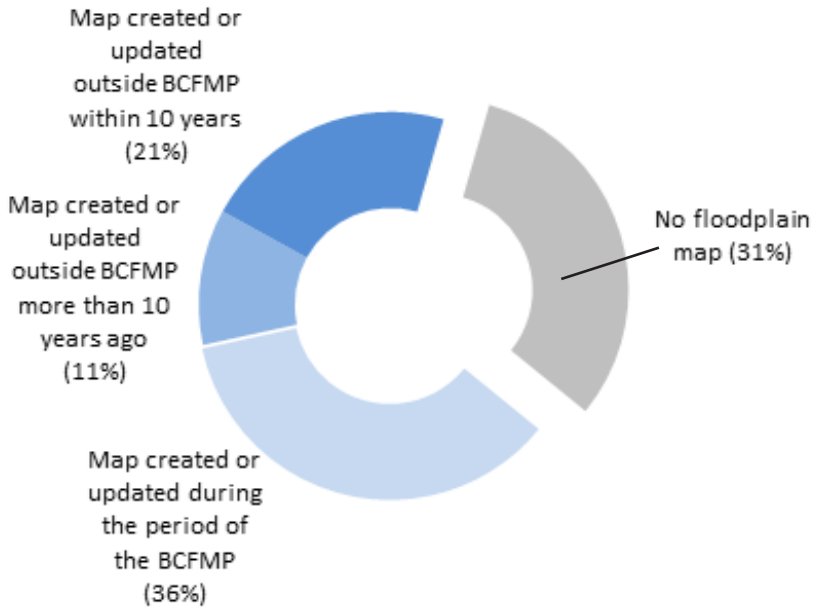
| Region | Organization | N |
|---|---|---|
| Northern BC | Regional Districts | 3 |
| | Villages / Towns | 1 |
| | Districts | 1 |
| | Cities | 1 |
| Vancouver Island | Regional Districts | 0 |
| | Villages / Towns | 0 |
| | Districts | 1 |
| | Cities | 1 |
| Lower Mainland and Sea to Sky | Regional Districts | 2 |
| | Villages / Towns | 0 |
| | Districts | 1 |
| | Cities | 2 |
| Central Okanagan | Regional Districts | 2 |
| | Villages / Towns | 0 |
| | Districts | 1 |
| | Cities | 1 |
| Kootenays | Regional Districts | 1 |
| | Villages / Towns | 1 |
| | Districts | 0 |
| | Cities | 1 |
| Province-Wide | First Nations | 5 |
| TOTAL | All | 25 |

## *3.2 State of Floodplain Mapping in BC*

Survey respondents from 49 communities (72%) indicated that they have access to a 200-year floodplain map or other type of floodplain map that covers their jurisdiction (Figure 2). Roughly half these maps (N=24) were updated outside of the BC Floodplain Mapping Program.[7] Overall, 21% (N=15) of communities have floodplain maps that were updated within the last ten years, and 31% (N=22) did not report access to any form of floodplain map.

[7] BC Floodplain Mapping Program maps are available at www.env.gov.bc.ca/wsd/data_searches/fpm.

Figure 2: Floodplain Maps: Source and Age



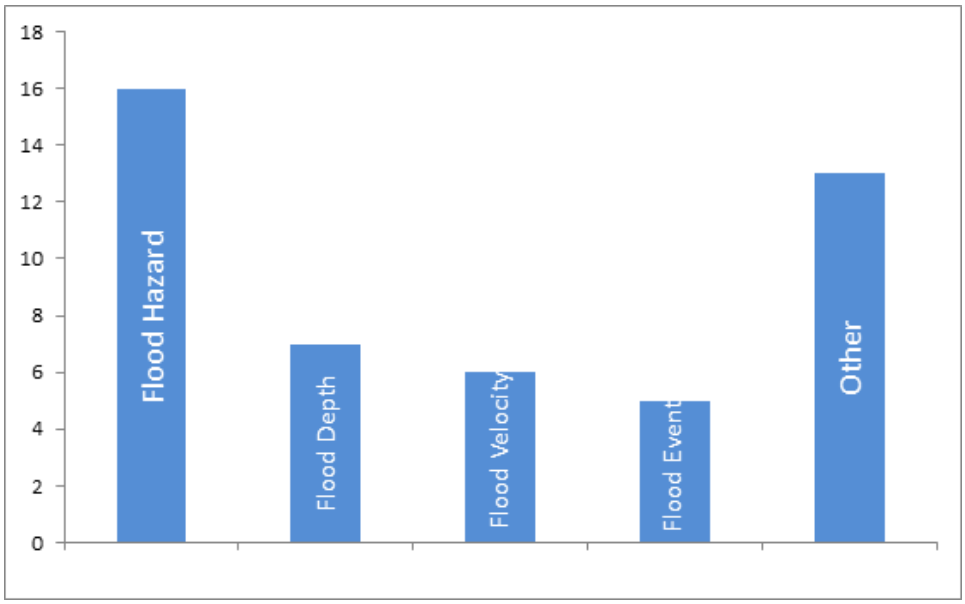

N=71

It is important to note that the respondents representing the 31% of communities that reported no access to a floodplain map may not be aware of the maps available to them online from the provincial government. This does not suggest that the community administration, as a whole, is unaware of the available floodplain maps, but rather that key individuals within these organizations are themselves unaware. This suggests that there is a need for increasing the awareness of the availability of floodplain maps.

In addition to 200-year floodplain maps, 39% (N=28) of local governments and First Nations bands noted that they have access to various other types of flood maps (Figure 3). The most common type of alternative map respondents mentioned was a flood hazard map.

It is worthwhile to note that many flood-related maps produced by non-government organizations and the private sector exist but were not included in this study. For example, BC Hydro has produced approximately 150 inundation/breach of dam scenario maps that have been provided to appropriate local governments and First Nations for emergency planning. A survey of non-governmental organizations and the private sector was beyond the scope of this study, and the results are therefore dependent on the degree to which respondents reported knowledge of these maps.

Figure 3: Alternate (Not 200-Year) Floodplain Maps Reported by Local/Regional Governments and First Nations Bands




N=47 studies reported by 28 communities. Entries represent all responses to survey Question 9: *Which other [not 200-year] flood maps does your organization have access to, if any?*

## *3.3 Updating Floodplain Maps*

Relatively few (21%, N=15) of the communities surveyed have access to a floodplain map that was updated within the past ten years, since the cancellation of the BC Floodplain Mapping Program. Of these, 7 community representatives mentioned both the motivation and funding sources that contributed to the development of these recent maps.[8] These results are summarized in Table 2.

[8] BCREA has previously examined funding resources available to local governments for floodplain mapping projects in this study: *Floodplain Mapping Funding Guidebook for BC Local Governments* (updated June 2015), prepared by BCREA, Ebbwater Consulting and Sustainability Solutions Group (www.bcrea.bc.ca/docs/government-relations/floodplainmapguidebook.pdf).

Table 2: Catalysts and Funding Sources for Updated Floodplain Maps

| | Funding Source | | | | |
|---|---|---|---|---|---|
| **Project Leading to / Motivation for Update of Floodplain Map** | **Internal** | **Province** | **Federal** | **Academic Research Funding** | **TOTAL** |
| Flood management study or plan | | 1 | 1 | | 2 |
| Regional climate change adaptation plan | | | 1 | | 1 |
| Floodplain Mapping Project | 1 | | | | 1 |
| Making sure a development or project was above fluctuating water levels | 2 | | | | 2 |
| Existing engagement with university researchers | | | | 1 | 1 |
| **TOTAL** | 3 | 1 | 2 | 1 | 7 |

N=7 (communities)

It is important to note that many of the remaining 8 communities with maps updated during the past ten years, whose responses are not described in Table 2, did provide a response to at least one of the two questions examined here (project catalyst or funding source). This information, including details about the type of map, data used to produce maps, and the availability of updated maps is available in Appendix A.

## *3.4 Flood-Related Studies*

Local and regional governments and First Nations bands in BC have completed various flood-related studies (Table 3). Most types of studies have been updated, on average, within the last five years. However, hydraulic and hydrographic studies are the most out of date, and most common.

Table 3: Date of Local Government and First Nation Flood-Related Studies

| Type of Study | Date of Completion (Range) | Average Date of Completion | # Ongoing | N |
|---|---|---|---|---|
| Needs/Gap Assessment | 2007-2016 | 2013 | 1 | 8 |
| Infrastructure Survey | 2007-2015 | 2013 | 2 | 12 |
| Weather or Climate | 2011-2016 | 2013 | 1 | 7 |
| Flow | 2009-2016 | 2013 | 3 | 10 |
| Topographic | 1982-2015 | 2010 | 1 | 14 |
| Land Use | 1995-2016 | 2010 | 2 | 11 |
| Hydraulic | 1999-2016 | 2008 | 1 | 14 |
| Hydrologic | 1992-2016 | 2004 | 1 | 14 |
| Other | 1994-2015 | 2009 | 2 | 16 |

N = the number of communities with access to each form of data

These flood-related studies were used to update planning tools (such as infrastructure, land use surveys and needs/gap assessments) or to update geospatial data (topographic, hydrologic).

Most of the geospatial data communities reported as available to them is relatively current (average studies were completed within the last five years), with the exception of bathymetric data (Table 4).

Table 4: Average Age of Geospatial Data

| Type of Geospatial Data | Date Range Collected | Average Date of All Data | N |
|---|---|---|---|
| Hydrographic | 2011-2015 | 2013 | 8 |
| LiDAR | 2006-2015 | 2012 | 25 |
| Orthophoto | 2000-2015 | 2010 | 49 |
| Bathymetric | 1980-2015 | 2002 | 9 |
| Other | 1985-2015 | 2007 | 14 |

N = the number of communities with access to each form of data

Orthophoto is by far the most common type of geospatial data available to the communities that participated in this study, followed by LiDAR. LiDAR is typically much higher resolution than orthophoto and is the most useful for creating floodplain maps. Hydrographic and bathymetric data are also important for floodplain mapping, as they are used in calculations of the potential for overland flooding as a result of changes to the flow rates (and water levels) of watercourses and also of the impact of waves on shorelines.

The relatively low proportion of communities with access to any form of geospatial data suggests that many governments lack the capacity to update their floodplain maps. For example, 25 of 72 communities reported access to LiDAR data. Therefore, the 47 communities that did not report access to LiDAR data are likely unable to produce detailed maps of potential flood extents (the only exception to this is if they have access to LiDAR, but the respondent was unaware).

It is important to note that, as with floodplain maps, the respondents participating in this study may not be aware of the full suite of geospatial data available to them. For example, only 49 of 72 communities (68%) reported access to orthophoto data, even though orthoimages are available for the entire province from Natural Resource Canada's GeoGratis[9] program. Therefore, the capacity to update floodplain maps may be higher than reported. However, if this is true, the current capacity for updating floodplain maps is likely still quite limited. For example, a recent inventory of the geospatial data available to local governments in coastal BC found that LiDAR data are only available for 59.5% (50/84) of communities.[10]

## 3.5 Data Sharing Capabilities

Survey respondents reported a broad range of data sharing capabilities and preferences. The most frequently reported was data sharing agreements by request and on websites. Table 5 provides a summary of data sharing options reported by study respondents.

Table 5: Summary of Data Sharing Capabilities for Local/Regional Governments and First Nations

| Data Availability | Available Via | # of Organizations | Total |
|---|---|---|---|
| Publicly Available | Published online | 18 | 35 |
| | Method not specified | 9 | |
| | By request | 6 | |
| | By request for a fee | 2 | |
| Available to Institutions | Data sharing agreement | 33 | 35 |
| | Digital data license agreement | 2 | |
| Limited Access | From third party | 10 | 20 |
| | Could be made available | 6 | |
| | Not shareable | 4 | |

NB: It is possible, but uncommon, to enter into data sharing agreements with private individuals

## 3.6 Managing Community Risk and Vulnerability

Many respondents reported that their organizations engaged in a variety of approaches to flood risk mitigation. These included planning, engineering, emergency management and research (Table 6). Of these, planning was the most common, followed by engineering and emergency response. The amount of research was very limited in contrast to these. This is expected, given that research is not a common mandate of local governments, regional districts or First Nations Bands. However, the finding (reported in the previous section) that respondents may not be aware of the suite of information available to them that could assist in flood planning suggests that research support (or at least a data inventory) is needed if local governments, regional districts and First Nations are to improve their capacity to update floodplain maps on their own.

[9] The GeoGratis data can be accessed at: www.geogratis.gc.ca. These data are available as shapefiles (.shp) and can be viewed and analyzed using the free, open-source, GIS program QuantumGIS (see: www.qgis.org) or through a commercial product such as ArcGIS.

[10] Vadeboncoeur, 2015.

Table 6: Approaches to Flood Risk Mitigation and Risk Management Planning

| Department / Activity | Strategy | # of Communities | Total |
|---|---|---|---|
| Planning | Using zoning bylaw and floodplain/flood management/flood protection bylaws to restrict development<br>• via specifying flood construction levels (9 of 11) | 11 | 26 |
| | Requiring development permit area process for hazard lands of site specific floodplain exemption | 7 | |
| | Incorporating mapping and policies into official community plans | 5 | |
| | Integrating climate change projections into planning | 3 | |
| Engineering | Maintaining dykes and drainage infrastructure | 11 | 20 |
| | Requiring building permits to ensure safe development | 5 | |
| | Using a flood protection strategy | 3 | |
| | Managing water levels | 1 | |
| Emergency Response | Having an emergency response system or emergency management plan | 17 | 17 |
| Research | Conducting hazard risk studies and other studies | 2 | 4 |
| | Tracking river elevations and flood threats throughout winter/spring | 1 | |
| | Engaging in community education and awareness of hazard areas | 1 | |

## *3.7 Floodplain Mapping Priorities and Needs*

The 25 interviewees were asked how their organizations prioritize floodplain mapping relative to other projects. Thirteen interviewees (52%) felt that floodplain mapping projects are given low to zero priority by their organizations. Reasons for this varied and included: limited capacity (including budget limitations), political positions on spending taxpayers' money, low awareness of flood issues including lack of awareness of floodplain maps, other priorities taking precedence, a perceived lack of need for updated floodplain maps, and the opinion that floodplain mapping is not the responsibility of local/regional governments/First Nations.

Six interviewees (24%) reported that their organizations give floodplain mapping projects a high priority. The most common reason for this is that flooding had recently occurred and floodplain maps are either unavailable or do not accurately reflect land use. New recommendations for accounting for climate change impacts, especially in coastal areas, also contributed to prioritizing floodplain mapping.

Four interviewees (16%) responded that their organizations place a medium and/or increasing priority on floodplain mapping. Reasons for this include an increased awareness of the importance of floodplain mapping and funding challenges.

Eighteen interview respondents (72%) identified a need for more and more recent data, updated information about flood protection infrastructure performance, guidance for the incorporation of climate models into flood data, and site-specific mapping.

## *3.8 Perspectives on Liability for Maintaining a Floodplain Map*

There is some confusion among local governments in British Columbia regarding the effect of designating (or not designating) floodplains. Evidence from across Canada[11] suggests that liability may arise from negligence and/or nuisance claims as a result of failures to identify and prepare for potential flooding. However, the perception of liability among respondents differed widely.

Six interviewees (24%) believe that updating a floodplain map can increase their organization's liability because it implies that they are taking responsibility for determining where development and growth is or is not safe. In direct contrast, three (12%) interviewees responded that designating a floodplain reduces their liability because they have taken steps to identify where it is safe to develop. A further nine (36%) believe there is no liability associated with maintaining floodplain maps, while three (12%) were unsure, citing a lack of information regarding how local governments should approach floodplain mapping.

## *3.9 How Floodplain Maps Are Used*

Representatives from the communities interviewed used floodplain maps in a variety of ways. Most often, floodplain maps were referenced as part of broad land-use planning activities. However, several specific actions were also implemented as a result of a community's access to a floodplain map (Table 7). These actions affected both land use planning and building construction.

[11] Class action lawsuits in Stratford and Thunder Bay, Ontario after mass flooding events resulted in claims for property damage amounting to hundreds of millions of dollars. The lawsuit in Stratford was eventually settled for $7.7 million (www.lfpress.com/news/london/2010/03/23/13335481.html).

Table 7: Use of Floodplain Maps

| Floodplain Maps Used for: | | # of Communities | Total |
|---|---|---|---|
| Planning | General reference, as needed | 8 | 21 |
| | Part of official community plan | 6 | |
| | Emergency planning | 4 | |
| | Included in hazard, vulnerability and risk assessment | 1 | |
| | Zoning / identifying development permit areas | 2 | |
| Action | Determining flood construction levels | 4 | 7 |
| | Building permitting | 2 | |
| | Floodplain bylaw | 1 | |
| Other | Do not use | 12 | 12 |

## *3.10 Addressing Challenges to Floodplain Mapping*

Interview participants identified several challenges to floodplain mapping activities (Table 8).

Table 8: Challenges to Floodplain Mapping

| Challenge | N | Context |
|---|---|---|
| Lack of funding | 15 | Small tax base |
| Jurisdictional challenges | 13 | Lack of commitment from higher levels of government, lack of control over activity in other areas |
| Lack of expertise | 8 | Lack of climate change and floodplain mapping expertise, unaware of resources available to assist with mapping |
| Lack of political buy-in | 5 | Politicians feel they cannot justify the expenditure on floodplain mapping |
| Lack of standardization | 3 | Different types of data |
| Inability to engage stakeholders | 3 | |
| Lack of data | 2 | |
| Perceived liability of updating floodplain map | 2 | |

N = the number of mentions. Some communities reported multiple challenges

Interviewees had several suggestions for addressing the challenges associated with floodplain mapping. The most common suggestion was developing a regional approach to updating floodplain maps (28%).

Waterways often transect multiple political jurisdictions. As a result, communities sharing a floodplain can be as vulnerable as the least prepared among them. For example, if neighbouring communities sharing a common floodplain have different dike standards, a breach of the weakest dike can impact both communities. One barrier to coordinated regional approaches to floodplain mapping is a lack of coordinated approaches to data collection. There is at present no standardized approach to data collection, modelling and floodplain mapping, making it difficult to coordinate vulnerability assessments among communities with different data resolutions.

Other suggestions for addressing barriers include: increased funding from the province, given the limited budgets of local/regional governments and First Nations Bands (16%); and the provincial government is best able to serve as a regulating/authoritative body for floodplain mapping, and could set standards for data collection and processing (20%).

## 4. Conclusions

There is a strong need for updated floodplain mapping in British Columbia. Only 21% of the 72 communities surveyed have access to a floodplain map updated within the past 10 years.

Floodplain maps are a low priority among a small majority of the communities interviewed (52%). Perhaps unfortunately, it appears that experiencing a flood event is an important reason behind the decision of communities to give floodplain maps a higher priority.

There are several barriers to updating floodplain maps. Many communities lack access to the geospatial data needed to update their own maps and, for those that have the required data, a lack of capacity (financial and technical) and a suite of jurisdictional (transboundary) issues present barriers to their doing so.

There is a need for greater clarity regarding the data available for, and legal liability associated with, floodplain maps. Nearly one-third (31%) of communities reported that they have no access to a floodplain map at all. In some cases, a map may in fact exist (as a product of the BC Floodplain Mapping Program); however, these maps are out of date. Many communities also indicated that they do not have access to some of the data required for floodplain mapping, when these data are freely available online. There is also confusion regarding the legal liability associated with designating floodplains, with some community representatives holding opposite opinions (i.e., floodplain mapping creates liability vs. floodplain mapping reduces liability).

BCREA set out to accomplish two objectives with this research: to create an inventory of floodplain maps in British Columbia, and to raise awareness of the existence and purpose of floodplain maps among local, regional and First Nations governments. This project has developed a snapshot of the state of floodplain maps in BC, and presented a detailed discussion of the types of maps and data, their uses and the challenges to updating them. These results suggest that better information about floodplain maps, guidelines for their development and the standardization of data, and stronger funding mechanisms will all improve the state of floodplain mapping in BC.

## 5. References


Lyle, T. and McLean, D. (2008). "British Columbia's Flood Management Policy Window - Can We Take Advantage?" In *4th International Symposium on Flood Defence: Managing Flood Risk, Reliability and Vulnerability* (pp. 102–1 to 102–8). Toronto, ON: Institute for Catastrophic Loss Reduction.

Dillman, D.A. (2007). *Mail and Internet Survey—The Tailored Design Method* (2nd edition, *2007 Update with New Internet, Visual, and Mixed-Mode Guide*), New York: John Wiley & Sons, Inc.

Fraser Basin Council & Arlington Group (2008). Review of Flood Hazard Management Land Use in BC. Fraser Basin Council, Vancouver. Retrieved from www.fraserbasin.bc.ca/_Library/Water/report_land_use and_flood_review_2008.pdf.

Province of British Columbia. (2015). Water Stewardship. Retrieved from www.env.gov.bc.ca/wsd/data_ searches/fpm.

Vadeboncoeur, N. (2015). British Columbia Coastal Geodata and Flood Planning Inventory. Fraser Basin Council, Vancouver, BC.

# Appendix A: Inventory of floodplain maps created or updated by local governments and First Nations outside the BC Floodplain Mapping Program[12]

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Campbell River (City) | | 2007 | Unknown | | | |
| Coquitlam (City) | Mapping developed by consultant. | 2014 | Coquitlam and Fraser Rivers Floodplain Mapping (Draft) 2014 | Internal project | City's LiDAR data was used to produce the floodplain maps. 1D-2D coupled MIKE Flood model used for the Coquitlam River. Existing studies used for the Fraser River, "Fraser River Hydraulic Model Update" by Province in 2008 and "Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios — Final Report" by Province in 2014. | Will be released to the public after the report is finalized and received by Council. |

[12] In addition to this list, BCREA is aware of mapping projects undertaken by the City of Vancouver, City of Surrey, Maple Ridge, District of North Vancouver, City of North Vancouver and City of Prince George. These projects are briefly described in the *Floodplain Mapping Funding Guidebook for BC Local Governments* (updated June 2015), prepared by BCREA, Ebbwater Consulting and Sustainability Solutions Group (www.bcrea.bc.ca/docs/government-relations/floodplainmapguidebook.pdf). As part of this study, the District of Squamish indicated that it expects to complete mapping projects in 2016, but that is not included in this list.

The maps created under the BC Floodplain Mapping Program are available online at www.env.gov.bc.ca/wsd/data_searches/fpm/reports/index.html.

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Courtenay (City) | Has floodplain mapping for up to the 1:200 year storm event with climate change impacts to the year 2200. The Courtenay River is subject to tidal back flooding from the ocean as well as tributary flooding in heavy rain/snow situations. | 2013 | Staff undertook an Integrated Flood Management Study in 2012/2013 as part of an EMBC grant after 2 significant flood events in the years prior | EMBC (Emergency Management BC 2/3 grant) | LiDAR data, orthophoto, 2 & 3D MIKE Model. | Will be enshrined in the Floodplain Bylaw once Council adopts the final report that developed the data (May 4, 2015 Council Meeting). Bylaws available online at www.courtenay.ca/EN/main/city-hall/bylaws.html. |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Cowichan Valley Regional District | Has developed updated floodplain mapping and analysis for the Lower Cowichan and Koksilah floodplain (to BC specifications and reviewed by the province) area, as well as the eastern coastal zone of the region which identifies the current flood zone, as well as the projected increase 1m due to climate change. | 2015 | • Community concern<br>• Development of regional climate adaption program and<br>• For Lake Cowichan, the development of a drought and water security plan and proposed infrastructure | • Funding from First Nations and gas tax innovation funds, internal project | • High resolution LiDAR data. For the riverine-based analysis, a cross-linked model using MIKE 11, MIKE 21 and HEC RAS was used to develop the ISMP and resultant maps.<br>• For the Coast area, high-resolution side cast LiDAR was collected and forecasted projections were made using GIS based on the provincial rational analysis methodology. | Available to the public on the CVRD ftp site (www.cvrd.bc.ca/index.aspx?nid=224) or by request. The coastal zone mapping has been provided to partners municipalities and interested stakeholders. |
| Elkford (District) | Provincial Flood Hazard Mapping | 2004 | Through subdivision and dike repair, have had some area-specific updates. | Some disaster assistance funding and internal project. | Flood models and anecdotal information | Not publicly available. |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Fernie (City) | BC Environment May 1979 | In process for Elk River floodplain map. Fairy Creek Coal Creek new maps in 2014 by consul-tant. | Engaged consultant to prepare Coal Creek floodplain map in October 2014. | Gas Tax | Consultant did a geomorphic and hydraulic assessment of Coal Creek | Floodplain Management Bylaw will be prepared when new floodplain map is done. |
| Fraser Valley Regional District | 1:200 year Fraser River floodplain with flood elevations; 1:200 year Chilliwack River flood and 1:100 year Chilliwack river erosion; various alluvial fans | Fraser River floodplain map was updated in 2006 | | Internal project | | |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Gibsons (Town) | 1:100 year, and assessment impact sea level rise | 1991 for flood map, 2012 for sea level rise | Partnership with UBC to explore cost of sea level rise by assessing land and infrastructure at risk. | Research funding through UBC and others (C-Change program) | Elevation of land, value of land and infrastructure, sea level rise scenarios, resulting in maps and tables. | Through OCP, Development Permit Area #1, Geotechnical Hazards (www.gibsons.ca/ocp). |
| Kamloops (City) | Extent and Depth<br>20 & 200 year | 2005 | Unknown; initiated an update to the floodplain boundaries, the results of which were accepted by the province as the new official floodplains for the City. | Internal project | 1D HEC – RAS Model DEM, river cross sections, historical river flows | Available as part of the Floodplain Bylaw and on the City's online interactive mapping. Available for free download from the City's open data download website (www.kamloops.ca/maps/maps.shtml#.VgxKR_lVhBe). |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Kelowna (City) | | 2011 | The latest update to the mapping resulted from some proposed design changes at the Kelowna International Airport (KIA), which required detailed survey and hydraulic analysis to fine tune the Flood Construction Level (FCL). | City of Kelowna funded program and KIA funded update. | Hydraulic model assessment of Mill Creek and its floodplain to estimate design flood water levels. Hydraulic model developed based on existing information and a field inventory of significant hydraulic structures. The model was calibrated by comparison of results to recorded flood events on Mill Creek.<br><br>Hydrodynamic approach used to develop final flood level estimates. | Applied via Bylaw. The stream setbacks and FCL are to be met at time of application for development or building permits. Available on the City's website as a "regulatory" layer, along with zoning, Development Permit Areas and others. |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Kent (District) | 200-year floodplain map for the majority of the District's floodplain area. | 2007 | A Fraser Valley Floodplain Mapping Project Advisory Committee was established and, ultimately, a grant funded mapping project took place in Harrison Hot Springs and the District of Kent | BC Ministry of Environment | Maps were developed using the hydrodynamic model MIKE FLOOD which couples with the two dimensional hydrodynamic MIKE 21 model. High resolution topographic data of the floodplain area using LIDAR for data capture provided the detail required for tow dimensional modelling | The mapping can be reviewed by the public at the District office. |
| Kimberley (City) | Map of 200-year floodplain limits for specific section of Kimberley Creek. | 2012 | | | | |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| North Cowichan (Municipality) | South End of North Cowichan: provincial mapping updated with more recent flood modelling data. Current mapping needs minor updating and production of larger-scale floodplain maps required.<br><br>Other areas of the municipality: still using provincial floodplain maps. | 2009 | New flood levels in bylaw, but it is not official. Because of flooding. | Not sure | | Available in Zoning Bylaw No. 2950 (www.northcowichan.ca/Documents/Cache/Zoning%20Bylaw.pdf). |

| Jurisdiction | Type of Map | Year | Project Leading to Map/Update | Funder | Data Used | Accessibility |
|---|---|---|---|---|---|---|
| Sidney (Town) | Capital Regional District prepared maps for the entire region (which includes Sidney) showing potential sea level rise and flood hazard area. The Town of Sidney did not prepare or commission the work, but received the draft maps from the CRD. | 2014 | Proposed amendments to the Provincial FHALUMG led the CRD to prepare a map showing possible implications for the region. Contact CRD for details of project. | Contact CRD for information | | Not publicly available from Sidney. |

# Appendix B: Inventory of topographic data available to local governments and First Nations[1]

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **LiDAR** | Abbotsford (City) | Matsqui Prairie and Sumas Prairie | 0.5 m contours; bare-earth digital elevation model (among other formats) | – |
| | Alberni Clayoquot (Regional District) | Somass Estuary | – | Unknown |
| | Anmore (Village) | Partially covered by Port Moody | – | – |
| | Belcarra (Village) | Partially covered by Port Moody | – | – |
| | Campbell River (City) | 4-5 sq km along the coast of Campbell River from Rockland Rd to downtown | – | Data sharing agreement |
| | Central Coast (Regional District) | Bella Coola Valley | – | Not shareable |
| | Central Kootenay (Regional District) | Regional District infrastructure areas | – | Could discuss data sharing agreement |
| | Chilliwack (City) | Estimated floodplain within municipal boundary | 0.5 m contours; bare-earth digital elevation model (among other formats) | – |
| | Coldstream (District) | City of Vernon, District of Coldstream | ECW images, DWG | www.rdno.ca |

[1] Compiled from the results of the survey and interviews conducted as a part of this study, and data provided by the Fraser Basin Council, which coordinates the Lower Mainland Flood Management Strategy.

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **LiDAR** | Coquitlam (City) | City-wide and Fraser River | LiDAR LAS files (full coverage); LiDAR point files (partial coverage) | Upon request and fee to package data |
| | Courtenay (City) | Most of city | – | Data sharing agreement |
| | Cowichan Valley (Regional District) | ¾ of region, including both coasts, developed areas and river corridor | – | www.cvrd.bc.ca/index.aspx?nid=224 |
| | Delta (District) | n/a | Contours, 0.5 m | – |
| | Fernie (City) | City extent | LAS, TIFF/peg (DEM) | Data sharing agreement |
| | Fort St. John (City) | Charlie Lake to Airport to Northern Lights College to south of Peace River | – | Not shareable |
| | Fraser Valley (Regional District) | Chilliwack River Valley (portion) | – | Data sharing agreement |
| | Fraser Valley (Regional District) | Fraser River floodplain | – | Contact Fraser Basin Council for more information |
| | Fraser Valley (Regional District) | Estimated floodplain on Nicomen Island | 0.5 m contours; bare-earth digital elevation model (among other formats) | – |
| | Greater Vancouver Electoral Area A | Barnston Island | 1 m LiDAR | – |
| | Harrison Hot Springs (Village) | – | 10 m LiDAR (also covered by District of Kent contours) | – |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **LiDAR** | Hope (District) | Estimated floodplain within district boundary | 0.5 m contours; bare-earth digital elevation model (among other formats) | – |
| | Kamloops (City) | Whole city | – | www.kamloops.ca/maps/maps.shtml |
| | Kelowna (City) | Mission Creek Floodplain | – | Underway; to be made available upon request |
| | Kent (District) | District of Kent | Kent contours (mixed resolution); 10 m LiDAR; 10 m LiDAR, SHP, DWG | Data sharing agreement; purchase |
| | Kitimat-Stikine (Regional District) | Dease Lake and Lakelse Lake (Thornhill) | – | – |
| | Langley (City) | – | 1 m contours and spot heights | – |
| | Langley (Township) | – | 1 m contours; irregular points | – |
| | Lions Bay (Village) | – | LiDAR BE LAS files; 1 m contours | – |
| | Maple Ridge (City) | Data from Pitt Meadows covers Maple Ridge | – | – |
| | Mission (District) | Estimated floodplain within district boundary | 0.5 m contours; bare-earth digital elevation model (among other formats) | – |
| | New Westminster (City) | – | LiDAR DEM, 5 m grid; 1 m LiDAR | – |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **LiDAR** | North Cowichan (Regional Municipality) | All but western-most side of municipality | – | – |
| | North Vancouver (City) | – | BE LiDAR | – |
| | North Vancouver (District) | – | FF LiDAR | – |
| | Pitt Meadows (City) | Pitt Meadows and most of Port Coquitlam | 5 m DEM and a TIN based on TRIM II data | – |
| | Port Coquitlam (City) | Pitt Meadows data covers most of Port Coquitlam (Coquitlam covers most of remaining gap) | – | – |
| | Port Moody (City) | Main parts of Belcarra and Anmore | DEM | – |
| | Radium Hot Springs (Village) | Village + 100 m | – | Not shareable |
| | Richmond (City) | – | DEM points (30 - 50 m spacing) and breaklines (CGVD28 Ht2) | – |
| | Salmon Arm (City) | City | XYX, LAS | Data sharing agreement; for purchase |
| | Sidney (Town) | Municipal boundary + 1 km north, 1.7 km east and 1.7 km south | | Inside municipal boundary: available upon request from Town of Sidney, outside of boundary available upon request from District of North Saanich |
| | Squamish (District) | – | DEM in GCS, vertical units feet | Data sharing agreement, with consent from consultant |
| | Stz'uminus First Nation | Indian Reserve 12 and 13 | – | – |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **LiDAR** | Surrey (City) | – | LiDAR-based DEM at 2 m, 5 m and 10 m grid resolution | – |
| | Sunshine Coast (Regional District) | Developed areas of Electoral Areas B,D,E,F | – | Data sharing agreement |
| | Toquaht Nation | Partial coverage | – | – |
| | Vancouver (City) | – | BE LiDAR 0.5 m grids | – |
| | West Vancouver (District) | District of West Vancouver | 1 m contours, DEM points and breaklines | – |
| | White Rock (City) | – | 1 m contours | – |
| | Tsawwassen First Nation | Tsawwassen First Nation lands | – | – |
| **Orthophoto** | 100 Mile House (District) | Municipality | – | – |
| | Alberni Clayoquot (Regional District) | Entire regional district | – | Not shareable |
| | Campbell River (City) | 10 cm within the urban containment boundary and 30 cm outside of the urban containment boundary to the extent of the City of Campbell River boundary | – | Data sharing agreement; www.campbellriver.ca/city-services/maps |
| | Castlegar (City) | City-wide | – | www.castlegar.ca/gismapping.php |
| | Central Coast (Regional District) | Central Coast (provided by BC Government) | – | – |
| | Central Kootenay (Regional District) | Most of the populated corridors of the regional district | – | www.rdck.ca/EN/main/services/mapping-gis.html |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Orthophoto** | Central Okanagan (Regional District) | Regional District of Central Okanagan | – | www.regionaldistrict.com/your-services/mapping-gis.aspx |
| | Comox Valley (Regional District) | Regional District extent | TIFF | Available from consultant |
| | Coquitlam (City) | City-wide | – | Available upon request and fee to package data |
| | Courtenay (City) | City limits and fringe | – | Data sharing agreement |
| | Cowichan Valley (Regional District) | Cowichan Valley Regional District | – | www.cvrd.bc.ca/index.aspx?nid=224 |
| | Cumberland (Village) | – | – | Data sharing agreement with Comox Valley Regional District |
| | Fernie (City) | City extent | TIFF/peg | Data sharing agreement |
| | Fort St. John (City) | Charlie Lake to Airport to Northern Lights College to south of Peace River | – | Data sharing agreement |
| | Fraser Valley (Regional District) | Fraser Valley Regional District Electoral Areas (portion) | – | Data sharing agreement |
| | Golden (Town) | Entire town | – | Data sharing agreement |
| | Grand Forks (City) | – | TIFF | May be available upon request, in electronic form |
| | Highlands (District) | – | – | http://viewer.crdatlas.ca/public#/Home |
| | Kamloops (City) | Entire city | – | www.kamloops.ca/maps/maps.shtml |
| | Kelowna (City) | Parts of city (pre-2000); entire city (post-2000) | – | Available upon request in electronic form |
| | Kent (District) | District of Kent | SID | Publicly available for viewing; through data sharing agreement and data purchase |
| | Kitimat-Stikine (Regional District) | North Terrace; Dease Lake; Lakelse Lake (Thornhill) | – | Webmap request |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Orthophoto** | Lake Country (District) | District of Lake Country area | GIS mapping layer | GIS mapping is provided through agreement with Regional District of Central Okanagan |
| | Lantzville (District) | Area within whole municipality | ESRI Shapefile | Possible data sharing agreement with Regional District of Nanaimo |
| | Maple Ridge (City) | City boundary | TIFF | Data sharing agreement |
| | McLeod Lake Indian Band | Treaty lands | Hard copy | Data sharing agreement |
| | Merritt (City) | Entire city | – | Data sharing agreement |
| | North Cowichan (Municipality) | All but western-most side of municipality | – | – |
| | Northern Rockies (Regional Municipality) | – | 30 cm aerial photos | Data sharing agreement |
| | North Vancouver (District) | – | Ortho on GEOWeb | http://geoweb.dnv.org |
| | Oak Bay (District) | Updated through the Capital Regional District every two years | – | Data sharing agreement |
| | Okanagan-Similkameen (Regional District) | Much of the urban areas | geoTIFF | Possibly shareable |
| | Powell River (Regional District) | – | – | ICIS Online through imap |
| | Radium Hot Springs (Village) | Village + 100 m | – | Not shared |
| | Revelstoke (City) | City and buffer area beyond | – | Digital Data License Agreement |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Orthophoto** | Salmon Arm (City) | Salmon Arm | MRSID, ECW, TIFF | Data sharing agreement for purchase; www.salmonarm.ca/FormCenter/Online-Mapping-2/City-of-Salmon-Arm-Site-Disclaimer-33 |
| | Sidney (Town) | Municipal boundary | – | Available upon request in electronic form |
| | Squamish (District) | All of district boundary extents | – | www.squamish.ca/discover-squamish/maps-and-data |
| | Squamish-Lillooet (Regional District) | Electoral Area D, C | – | – |
| | Summerland (District) | District boundary | – | Possibility to share depending on circumstance; www.summerland.ca/planning-building/gis-mapping |
| | Sunshine Coast (Regional District) | Developed areas of Electoral Areas B,D,E,F | – | Data sharing agreement |
| | Surrey (City) | – | Contractor has ortho | – |
| | Thompson Nicola (Regional District) | – | BING, ESRI (from province) | Licensed; www.tnrd.ca/content/interactive-maps |
| | Tk'emlups te Secwepemc | Indian Reserve 1 | – | Public |
| | Tofino (District) | District of Tofino | – | Data sharing agreement; some public access: www.tofino.ca/content/maps |
| | Toquaht Nation | Full coverage of treaty settlement lands | – | Shareable upon request |
| | Tsawwassen First Nation | Tsawwassen First Nation lands | – | – |
| | Tumbler Ridge (District) | Town site area and approximately 2 km beyond | TIFF | Possibly shareable |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Orthophoto** | Vancouver (City) | – | Contractor has ortho | – |
| | Vanderhoof (District) | Entire municipality | – | Possibly shareable |
| | Vernon (City) | Entire city | ECW | www.vernon.ca/map |
| | West Kelowna (District) | District of West Kelowna | – | www.districtofwestkelowna.ca/888/Open-Data---Orthophotos |
| | White Rock (City) | – | Ortho TIFF | – |
| **Bathymetric** | Campbell River (City) | John Hart Reservoir; provided by BC Hydro | – | – |
| | Central Okanagan (Regional District) | Partial coverage of Okanagan Lake as part of the Okanagan Lake Floodplain Mapping; provided by BC Government | Hard copy | – |
| | Cowichan Valley (Regional District) | Lake Cowichan | – | www.cvrd.bc.ca/index.aspx?nid=224 |
| | Fernie (City) | Coal Creek | Raster | Data sharing agreement |
| | Kamloops (City) | Entire city in 2005; partial survey (key crossings) in 2015 | – | www.kamloops.ca/maps/maps.shtml |
| | Kelowna (City) | Okanagan Lake Limnology | – | Electronic |
| | Maple Ridge (City) | North and South Alouette | – | Data sharing agreement |
| | Sidney (Town) | Offshore, extending beyond 100 m of town boundary | – | Available upon request in electronic format |
| | Squamish (District) | Coastal areas | – | Possibly available through consultant |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Hydrographic** | Central Okanagan (Regional District) | Okanagan Basin | – | Available from the Okanagan Basin Water Board www.obwb.ca/projects |
| | Cowichan Valley (Regional District) | Cowichan Bay and satellite channel | – | Department of Fisheries and Oceans license |
| | Cumberland (Village) | Streams | SHP | Data sharing agreement |
| | Golden (Town) | Kicking Horse | – | Unknown |
| | Kelowna (City) | Okanagan Lake – Lambly (Bear) Creek to Peachland; review and identification of the limnological threats to water security for the City of Kelowna | – | Available upon request in electronic form |
| | Maple Ridge (City) | North and South Alouette | – | Data sharing agreement |
| | Squamish (District) | All rivers | – | www.squamish.ca/assets/IFHMP/20150224-FINAL%20DRAFT_BackgroundReport%20-%20web.pdf |
| | Tumbler Ridge (District) | Town site and approximately 2 km beyond | DWG, SHP | Possibly shareable |
| **Other** | 100 Mile House (District) | Digital terrain model: municipality | – | – |
| | Alberni-Clayoquot (Regional District) | – | TRIM | – |
| | Burns Lake (Village) | Burns Lake shoreline; Rio Tinto Alcan Emergency Preparedness Mapping | – | – |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Other** | Central Okanagan (Regional District) | Contours: RD of Central Okanagan, District of Lake Country, District of Peachland, West Bank First Nations | – | www.regionaldistrict.com/your-services/mapping-gis.aspx |
| | Central Okanagan (Regional District) | Sensitive Habitat Inventory and Mapping (identifies top of bank – GPS): Regional District of Central Okanagan and member municipalities – covers most streams on private property | – | Data sharing agreement or Community Mapping Network: www.cmnbc.ca |
| | Comox Valley (Regional District) | Contours:<br>• 5 k – shoreline 0 to 20 m at 5 m intervals,<br>• 2 k – various 5 k map sheets | Contours, scanned and georeferenced | Data sharing agreement |
| | Cumberland (Village) | Contours: Village of Cumberland (data is scanned from maps done in 1981 at a 1:5000 scale) | 2 m contour dataset | Data sharing agreement |
| | Kelowna (City) | Kelowna Shore Zone Fisheries and Wildlife Habitat Assessment | – | Available upon request in electronic form |
| | Revelstoke (City) | City and buffer area | Digital elevation model | Digital Data License Agreement |
| | Sts'ailes First Nation | Community | GIS | – |
| | Stz'uminus First Nation | Stz'uminus First Nation Lands | 20 m contours | – |

| Topographic Data Type | Local Government | Coverage of Data | Format(s) | Data-Sharing Capabilities |
|---|---|---|---|---|
| **Other** | Thompson Nicola (Regional District) | – | TRIM | Licensed; www.tnrd.ca/content/interactivemaps |
| | Vernon (City) | – | Digital elevation model, breaklines, contours, GIS, DWG | www.vernon.ca/map/data_catalogue.html |
| | West Kelowna (District) | – | Digital elevation model | www.districtofwestkelowna.ca/471/Open-Data---GIS-Downloads |

# Appendix C: Survey

## BC Floodplain Maps Inventory Questionnaire

Thank you for taking time to complete this questionnaire in support of developing an updated inventory of floodplain maps in British Columbia. The British Columbia Real Estate Association is reaching out to communities to gain a better understanding of the availability and use of floodplain maps in British Columbia. At the conclusion of this work, we will prepare a summary report noting any updates to the floodplain maps developed under the BC Floodplain Program.[13]

Please complete the following questionnaire to the best of your ability, or pass it along to individuals more suited to the task.

Organization:

Your Name:

Your Position:

Your Contact Phone and Email:

1. Does your organization currently have access to a 200-year floodplain map or other floodplain maps covering your local government's jurisdiction?

   ❑ Yes; please specify the type of floodplain map:

   ❑ No; move on to question 9.

2. In what year was the floodplain map last updated?

3. Was this map last updated under the BC Floodplain Mapping Program?

   ❑ Yes

   ❑ No; move on to question 9.

4. Briefly describe the project that led to the latest update of the floodplain map.

[13] Information on the BC Floodplain Mapping program is available at www.env.gov.bc.ca/wsd/data_searches/fpm.

5. What funding sources were utilized to update the floodplain map (e.g., the NRCAN Climate Adaptation program, internal project)?

6. If known, what data were used to update the floodplain map (e.g., 1D , 2D flood models, empirical methods, anecdotal information, etc.)?

7. Describe any ongoing program for maintaining or updating floodplain maps in your organization (e.g., how often you revisit the floodplain map based on changing data, land use, climate or other conditions).

8. Describe if and how the updated floodplain map is publicly available.

9. Which other flood maps does your organization have access to, if any? (select all that apply)

   - ❑ Flood depth map
   - ❑ Flood velocity/propagation map
   - ❑ Flood event map
   - ❑ Flood hazard map
   - ❑ Other, please describe

10. Please describe any flood-related studies undertaken in support of determining the spatial extent of a floodplain.

| **Type** | **Describe study, cost and funding source** | **Date undertaken** (month and year) |
|---|---|---|
| Topographical study | | |
| Infrastructure survey (size of bridges and culverts, etc.) | | |
| Land use study | | |
| Weather or climate study | | |
| Flow studies (e.g., data collection) | | |
| Hydrologic study (a study to establish the amount of flow) | | |

| **Type** | **Describe study, cost and funding source** | **Date undertaken** (month and year) |
|---|---|---|
| Hydraulic study (a study to establish where water might go) | | |
| Needs assessment or gap assessment | | |
| Other | | |

## Data

The following questions will help provide a better understanding of any data and tools that might be available to support regional floodplain mapping. BCREA is particularly interested in spatial data regarding the potential extent and depth of flooding, as well as critical infrastructure, buildings and other assets that may be vulnerable to flood impacts. Please list and describe to the best of your ability any data available to your organization in this regard.

11. Please describe any detailed hydrological and/or hydraulic models your organization has and when the model was last updated.

12. Please identify the details of the topographic data to which your organization has access.

| **Type** | **Date of data** (month and year) | **Area of coverage** (description, available formats) | **Describe capabilities you may have to share the data** (licensing, publicly available, through data-sharing agreement) |
|---|---|---|---|
| LiDAR | | | |
| Orthophoto | | | |
| Bathymetric | | | |
| Hydrographic | | | |
| Other | | | |

13. Are there any publicly available reports that use the data described in question 12?

    ❑ Yes; please list references for the reports, and/or provide links:

    ❑ No

14. Please list any mapped data or other data your organization may have regarding the location and characteristics of flood protection and/or drainage infrastructure such as dykes, erosion protection, watercourses, drainage networks, pump stations, flood gates, etc.

| **Type of infrastructure** | **Describe and include date of data** (month and year) | **Describe capabilities you may have to share the data** (licensing, publicly available, through data-sharing agreement) |
|---|---|---|
| Flood protection infrastructure | | |
| Drainage infrastructure | | |

## Additional Comments and Further Dialogue

BCREA is interested in learning as much as possible about your organization's floodplain mapping efforts. Is there anyone else you recommend we contact?

Would you be agreeable to being interviewed at a later date to further explore your responses?

- ❑ Yes
- ❑ No

If you have any suggestions or additional comments regarding this questionnaire or floodplain mapping efforts in your organization, please provide them.

Note to readers:

Question 3 of the survey contained an error that directed some respondents to skip several early questions. This initially resulted in missing data, which were recovered by contacting respondents by phone and obtaining their responses that way, or via a follow-up email. This error did not affect the quality of the final dataset.

# Appendix D: Local and regional governments not sent an invitation to participate in survey (already participating in Lower Mainland Flood Management Strategy)

City of Abbotsford

Village of Belcarra

City of Burnaby

City of Chilliwack

District of Hope

Township of Langley

Village of Lions Bay

District of Mission

City of New Westminster

City of North Vancouver

District of North Vancouver

City of Pitt Meadows

City of Port Coquitlam

City of Port Moody

City of Richmond

City of Surrey

City of Vancouver

Metro Vancouver

District of West Vancouver

City of White Rock

The following local governments are involved in the Lower Mainland Flood Management Strategy, and were also invited to participate in BCREA's floodplain maps inventory project:

Corporation of Delta

Fraser Valley Regional District

District of Kent

District of Maple Ridge

District of Squamish

# Appendix E: Follow-up interview protocol

This interview protocol provides a guide for a structured interview with an organization that has previously returned a floodplain mapping questionnaire. Depending on responses from their questionnaire, certain questions are to be omitted.

PART 1: HISTORICAL FLOODPLAIN MAPPING EFFORTS AND ATTITUDES

> "The majority of flood mapping in Canada was developed during the era of the Federal Damage Reduction Program (1975 to mid-nineties) and the subsequent provincial-federal agreements on flood mapping, which provided 50/50 cost-sharing between the Federal and Provincial governments. The Federal-BC agreement was called the BC Floodplain mapping Program."

1. Were you aware of this program before this interview, and how you could retrieve maps from the BC Floodplain Mapping database?

   *If not aware, provide information as to how they can view maps at www.env.gov.bc.ca/wsd/data_searches/fpm/reports/index.html, skip to question 3*

2. Describe your organization's involvement with BC Floodplain mapping program.

3. Describe your organization's overall flood protection activities.

   *Take special care to note activities that support floodplain mapping projects (such as flood extent management, data activities, climate change activities, etc.).*

4. What priority is given to floodplain mapping in your organization?

5. Describe your perspective on local government's liability for maintaining a floodplain map.

   *Skip to question 7 if preliminary survey indicates the organization does not have access to a floodplain map.*

6. How does your organization use a floodplain map?

7. Are there any floodplain mapping activities that you feel are important, but are not being addressed by your organization?

8. Describe and discuss how your organization manages community risk and vulnerabilities.

   *If the organization has access to or awareness of existing floodplain maps and has not undertaken a floodplain map update project, ask…*

   a. How relevant do you think existing floodplain maps are in representing current land use conditions and climate change? If not relevant, what tools are?

PART 2: DISCUSSION OF FLOODPLAIN MAPPING UPDATES

This section is used to discuss and detail any floodplain mapping activities that were indicated on the floodplain mapping questionnaire or in discussion.

*If the previously described floodplain mapping project, either in the discussion or questionnaire response, is insufficient, ask question  otherwise skip to question 9.*

9. Can you further describe the floodplain mapping project your organization undertook or is undertaking?

10. What are the greatest challenges your organization has had in undertaking a floodplain mapping project?

    *Prompts, if needed*:

    - Describe any barriers (e.g., financial, organizational, data) that have hampered your efforts in completing your floodplain mapping efforts.

    - Considering your organization's structural arrangements, can you describe any issues with undertaking floodplain mapping activities (e.g., does your organization lack a planning department)?