

# Flood Hazard Specific Guide

Resort Municipality of Whistler  
[whistler.ca/emergencyprogram](http://whistler.ca/emergencyprogram)



# FLOOD HAZARD SPECIFIC GUIDE

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Photo credits: Jan Jansen; Fitzsimmons Creek Pedestrian Bridge; October 9, 1984.

## INTRODUCTION

### Purpose of Plan

The Flood Hazard Specific Guide (herein referred to as the Flood Plan) is a hazard-specific annex to the Resort Municipality of Whistler (RMOW) Comprehensive Emergency Management Plan. In British Columbia, as required by the BC *Emergency Program Act*, local governments are responsible for planning and responding to emergencies within their jurisdictional area, including flood emergencies.

The purpose of the Flood Plan is to describe how the RMOW will prepare for, and respond to, a flood event in the RMOW. The plan outlines response and coordination arrangements for predicted and spontaneous flood events. The intended audience for the plan is municipal staff and Council.

The objectives of the Flood Plan are:

- To provide a tool for staff to assess weather forecasts in the context of local meteorological, hydrological and pedological (soil) indicators to determine whether a flood may occur and its extent. This information will be used to determine the level of readiness required by the RMOW;
- Outlines the operational procedures for municipal staff to prepare for flooding if a flood is forecast;
- Outlines the concept of operations and operational procedures for flood response in Whistler when flooding is imminent or already occurring; and
- Provides historical flood event information, and flood plain mapping to provide context to the reader.

### Scope of Plan

The Flood Plan will be used when a concerning forecast is issued, flooding is expected, or flooding is imminent or has already occurred and response is required. The Flood Plan is designed for flood events within the RMOW.

### Plan Layout

The initial part of the plan, the [Flood Forecast Risk Rating Tool](#) on page 4, focuses on assessing local weather forecasts to determine if flooding is possible and to what extent. The following section, the [Readiness Process](#) on page 15, describes the operational preparations municipal staff may take to protect people and property once the possibility of flooding is identified. The final section, [Flood Response](#) on page 18, details the municipal flood response, once flooding is imminent or already occurring. The [Appendices](#), on page 26, includes some additional information and tools that may assist staff when predicting, preparing for, or responding to a flood event.

### Description of Flood Hazard

The RMOW Hazard, Risk and Vulnerability Analysis rates Whistler's flood risk as moderate. The RMOW has experienced several significant flood events in the past; see [Historical Flood Information](#) on page 28 for a description of past flood events. Flooding in Whistler is dependent on a variety of combined meteorological, hydrological and pedological conditions including precipitation amounts, snowpack composition and depth, soil moisture, stream flow conditions, and temperature. Historically, precipitation is the primary driver of flooding in Whistler. Generally Whistler's flooding events have occurred in the fall season and are the result of high precipitation amounts falling on unpacked snow that quickly melts and adds to river flows; these events are often referred to as "rain-on-snow." There is a decreasing risk as the snowpack develops through the season (January, February) and temperatures get colder.



Photo Credit to Whistler Museum.

Myrtle Phillip, an unknown man and two dogs in a boat paddling past Rainbow Lodge cabins through spring flood water on the grounds of Rainbow Lodge. Date of photo unknown.



Photo Credit to Whistler Museum.

This photograph shows a flooded Alta Lake, with a portion of the Rainbow Lodge property overtaken by the water. An unidentified woman stands in the water.



## FLOOD FORECAST RISK RATING TOOL

### Introduction to the Flood Forecast Risk Rating Tool

The RMOW has developed a flood forecast risk rating tool (herein referred to as the 'flood forecast tool') for staff to use to assess Whistler's flood risk in a local context when a concerning weather forecast is issued. Staff will use the flood forecast tool to assess a number of variables to determine if a weather forecast warrants monitoring, early flood preparations, or aggressive flood preparations by the RMOW.

### BACKGROUND

Some staff have a tacit/intuitive understanding, based on past flood events and individual experience, of when a weather forecast is concerning and when it is not; these staff can usually tell in advance when conditions are right for flooding. The flood forecast tool aims to capture this knowledge in a form that those with less experience can use to assess flood risk and implement an appropriate level of preparedness to protect people and property in Whistler.


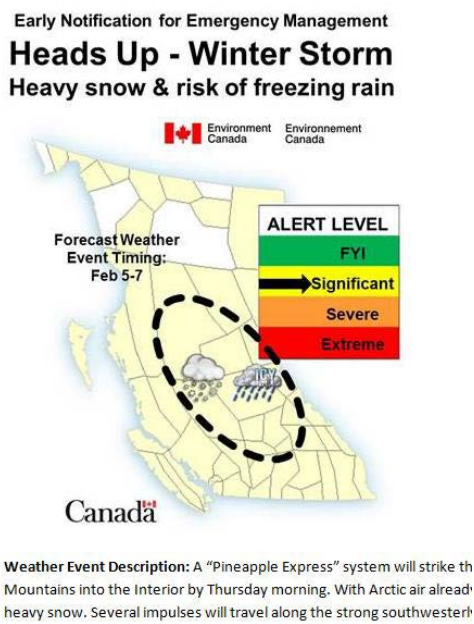


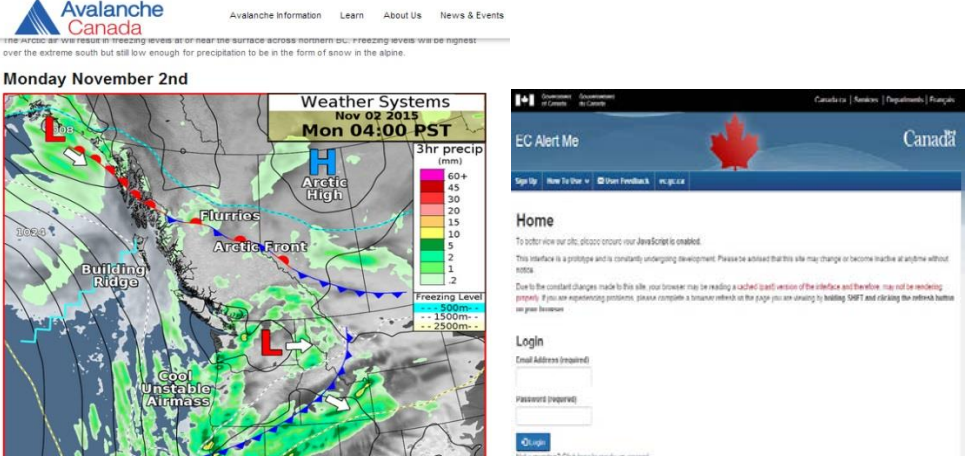
Photo by coastphoto.com; October 18, 2003

## When the Flood Forecast Risk Rating Tool Will Be Used

The flood forecast tool will be used when a concerning weather forecast is issued for Whistler. Environment Canada and the River Forecast Centre both issue formal warnings; the Potential Origin of Forecasts and Alerts chart below provides a description of both. While these warnings are important, the flood forecast tool can be used at any time staff is concerned about potential flooding, with or without a formal warning.

**Table 1 Potential Origin of Forecasts & Alerts**

FORECAST OR ALERT	DESCRIPTION
Environment Canada Weather Warnings	<ul style="list-style-type: none"> <li>Provides weather forecasting and warning services</li> <li>Seasonal forecasts</li> <li>Early Notification for Emergency Management. Issued to emergency management practitioners when a concerning forecast is developing. Usually issued 3-6 days before event.</li> </ul> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="width: 45%;">  </div> <div style="width: 45%;">  </div> </div> <ul style="list-style-type: none"> <li>Special Weather Statements - not urgent but are issued to let us know about unusual forecasts that could cause concern</li> <li>Watch - Alerts you about weather conditions that are favourable for a storm or severe weather, which could cause safety concerns</li> <li>Warning - an urgent message that severe weather is either occurring or will occur</li> <li>Environment Canada Weather Warnings publicly-available and accessed online at: <a href="http://www.weather.gc.ca/warnings/index_e.html?prov=bc">www.weather.gc.ca/warnings/index_e.html?prov=bc</a></li> <li>Issue forecasts. Publicly-available and accessed online at: <a href="http://www.weather.gc.ca/forecast/canada/index_e.html?id=BC">www.weather.gc.ca/forecast/canada/index_e.html?id=BC</a></li> <li>Environment Canada Weather blog publicly-available and accessed online at: <a href="http://www.avalanche.ca/weather">www.avalanche.ca/weather</a></li> </ul>

FORECAST OR ALERT	DESCRIPTION
	
River Forecast Centre Flood Advisories and Warnings	<ul style="list-style-type: none"> <li>• Provides flood forecasting and warning services</li> <li>• Issued when necessary to provide alerts to potential flood conditions in the stream systems of the province. Updated as conditions warrant.</li> <li>• RFC Flood Warnings &amp; Advisories are publicly-available and accessed online at: <a href="http://bcRFC.env.gov.bc.ca/warnings/index.htm">http://bcRFC.env.gov.bc.ca/warnings/index.htm</a></li> <li>• High Streamflow Advisory is issued when river levels are rising or expected to rise rapidly, but that no major flooding is expected. Minor flooding in low-lying areas is possible. May be issued anywhere from three days to 18 hours in advance of an event.</li> <li>• Flood Watch is issued for specific regions (e.g. Sea to Sky Corridor) and advise that a flood is possible in those regions. They are issued 24 to 36 hours in advance of any likely flooding and updated as required. If at any time during this period there is an imminent threat of a flood occurring, the Flood Watch is upgraded to a Flood Warning.</li> <li>• Flood Warnings are issued for specific rivers when flooding is imminent or is already occurring. Predictions of flood severity (minor, moderate and major) and the estimations of rise, fall or peak at forecast locations (river gauges). Flood warning predictions are upgraded and downgraded as a flood rises, peaks and falls. Firm predictions of flooding based on: <ul style="list-style-type: none"> <li>- Actual rainfall measurements</li> <li>- Stream flow based models of catchment behaviour; and</li> <li>- Likely future rainfall</li> </ul> </li> </ul>



## How the Flood Forecast Risk Rating Tool Works

The Flood Forecast Risk Rating Tool evaluates a weather forecast in the context of factors that are historically known to increase or decrease Whistler's flood risk. Rainfall is the most important factor in creating a flood, but there are many other contributing factors including: condition of the soil (soil moisture content), snowpack, current stream flow conditions (existing water levels), temperature (freezing level) and rainfall.

The following data will need to be gathered to put into the flood forecast tool:

- How much rain is forecasted?
- What is the current streamflow in Whistler streams?
- Is there a risk of significant rain-on-snow?
- Is heavy melt from high elevations anticipated?
- Does the soil have the ability to absorb moisture?

See [Table 2 Available Information Resources to Populate Tool](#) on page 8 for information on where to gather information to populate the tool.



Photo credit to Whistler Question from Whistler Museum.

Ed and Trish Erickson and Sir Hamlet the Great Dane contemplate crossing the Whistler Creek after excessive rains took out the bridge. Year, 1995.

## AVAILABLE INFORMATION RESOURCES TO POPULATE TOOL

There are several sources of data available to populate the Flood Forecast Risk Rating Tool which are shared below. Some factors, like soil conditions, will require the user to use common sense to determine the current environment. For example, if we have had very hot, dry weather all summer with little rain it is likely the soil is hard and dry heading into the fall season.

**Table 2 Available Information Resources**

Factor	Product	Description
Precipitation Amounts & Freezing Levels	<b>Environment Canada Weather Forecast</b>	<ul style="list-style-type: none"> <li>Issue forecasts. Publicly-available and accessed online at: <a href="http://www.weather.gc.ca/forecast/canada/index_e.html?id=BC">www.weather.gc.ca/forecast/canada/index_e.html?id=BC</a></li> <li>Environment Canada Weather blog publicly-available and accessed online at: <a href="http://www.avalanche.ca/weather">www.avalanche.ca/weather</a></li> </ul>
	<b>Whistler Blackcomb Snow Forecast &amp; Freezing Levels</b>	<ul style="list-style-type: none"> <li>Whistler Blackcomb issues Whistler forecasts for 675m (village), 1480m (mid mountain just below glacier creek/chic pea), and 2284m (peak) that include a weather summary, precipitation amounts including rain and snow, and freezing levels in metres</li> <li>Publicly-available and accessed online at: <a href="http://www.snow-forecast.com/resorts/Whistler-Blackcomb/6day/mid">http://www.snow-forecast.com/resorts/Whistler-Blackcomb/6day/mid</a></li> </ul>
Current Basin Flows	<b>River Forecast Centre Current River Discharge and Water Level Information</b>	<ul style="list-style-type: none"> <li>Latest discharge and water level data for two hydrometric stations (owned by Water Survey of Canada) in Whistler Fitzsimmons Creek below Blackcomb Creek and Cheakamus River above Millar Creek</li> <li>Publicly-available and accessed online at: <a href="http://bcrcf.env.gov.bc.ca/freshet/ALL_WSC_GoogleMap.html">http://bcrcf.env.gov.bc.ca/freshet/ALL_WSC_GoogleMap.html</a></li> </ul> <p><b>*Note:</b> There is a 3 to 6 hour lag on the real-time hydrometric data for Whistler stations due to transmission requirements and quality checks of data. The compiled data on the WSC real time website goes back approximately 18 months and this data are considered "provisional" and subject to revision. Historical data available from for both stations up to 2012. That historical data set has been approved and not subject to further quality checks.</p> <ul style="list-style-type: none"> <li>7-Day Average Streamflow Map compared with historical hydrographs. Publicly-available and accessed online at: <a href="http://bcrcf.env.gov.bc.ca/lowflow/graphs/08ga072.htm">http://bcrcf.env.gov.bc.ca/lowflow/graphs/08ga072.htm</a></li> </ul>
	<b>Freshet Provincial River Outlook</b>	<ul style="list-style-type: none"> <li>Prepared weekly during freshet season</li> <li>Current discharge levels and outlook on the short-term and seasonal potential for flood conditions. Distributed via email to emergency managers, flood fighters, emergency responders</li> </ul>
	<b>Low Streamflow Bulletins and Advisories</b>	<ul style="list-style-type: none"> <li>Prepared during low-flow season and updated as conditions warrant</li> <li>Current streamflow conditions and the outlook for water supply through the low streamflow season.</li> <li>Also maintain a Drought Map which is updated when conditions warrant. Publicly-available and accessed online at: <a href="http://bcrcf.env.gov.bc.ca/lowflow/droughtmap.htm">http://bcrcf.env.gov.bc.ca/lowflow/droughtmap.htm</a></li> </ul>

Factor	Product	Description
Snowpack & Soil Conditions	<b>Snow Survey Bulletins and Commentary</b>	<ul style="list-style-type: none"> <li>• Prepared 8 times per year for the January 1, February 1, March 1, April 1, May 1, May 15, June 1, and June 15 survey periods. Distributed via email and website.</li> <li>• Reports on the snow data for each survey</li> <li>• Provides a commentary on the flood risk and water supply outlook leading into the freshet and summer season</li> <li>• Publicly-available and accessed online at: <a href="http://bcrcf.env.gov.bc.ca/bulletins/watersupply/current.htm">http://bcrcf.env.gov.bc.ca/bulletins/watersupply/current.htm</a></li> </ul>
	<b>Automated Snow Pillow Commentary</b>	<ul style="list-style-type: none"> <li>• Prepared bi-weekly during the snow season</li> <li>• Provides snow depth information based on readings from the BC Automated Snow Pillow</li> <li>• Publicly-available and accessed online at: <a href="http://bcrcf.env.gov.bc.ca/bulletins/snowpillow.htm">http://bcrcf.env.gov.bc.ca/bulletins/snowpillow.htm</a></li> </ul>

## EXPLANATION OF VARIABLES CONSIDERED IN THE FLOOD FORECAST

Below is an explanation of how each variable considered in the flood forecast tool increases or decreases Whistler's flood risk.

### Precipitation Amounts

Rainfall is the primary driver of flooding in Whistler; heavy rainfall increases Whistler's risk of flooding. When Whistler receives heavy rainfall, the ground becomes saturated and the soil can no longer store water leading to increased surface runoff. This rainwater will enter local streams and rivers much faster than it would if the ground wasn't saturated leading to higher streamflow levels and floods.

### Current Basin Streamflow

Streamflow refers to the amount of water passing through a point in the river or stream. Low streamflow before a forecasted rain event decreases flood risk; high streamflow before a forecasted rain event increases flood risk.

Streamflow is measured in cubic metres per second (m<sup>3</sup>/s or cms). The Water Survey of Canada (WSC) under the umbrella of Environment Canada has two hydrometric stations in Whistler located on Fitzsimmons Creek below Blackcomb Creek and Cheakamus River above Millar Creek. These hydrometric stations measure both streamflow and water levels. The table below provides peak flow estimates with estimated return periods for both stations.

**Table 3 Return Period Flow Analysis for Cheakamus River (08GA072) and Fitzsimmons Creek (08MG026)**

Water Survey of Canada Station No.	Water Survey of Canada Station Name	% chance of occurrence	50%	20%	10%	4%	2%	1%	0.5%
		Return Period (years)	2	5	10	25	50	100	200
			Return Period Flow (m³/sec)						
08GA072	Cheakamus River above Millar Creek								
			83.4	119.2	156.8	229.2	309.7	422.8	581.9
08MG026 Synthetic	Fitzsimmons Creek below Blackcomb Creek								
		19.6	26.8	34.0	47.6	62.2	82.1	109.4	

*Data and estimates provided by: River Forecast Centre, Water Management Branch, BC Ministry of Forests, Lands, and Natural Resource Operations.*

*DISCLAIMER FROM RIVER FORECAST CENTRE: The original data, though published by Water Survey of Canada, may not be necessarily free of error and omission. Results of flood frequency analysis can vary depending on the veracity of the input data series and interpretation of results particularly for extreme values (i.e., 100-year event) where the available data set may be short and require extrapolation over long time intervals. This information was not provided for design purposes and users should use the information with caution and at their own risk.*

### **Snow Pack**

The condition and composition of snowpack can increase or decrease flood risk in several different ways.

Heavy rainfall can cause rapid snowmelt, increasing the volume of water entering rivers, increasing flood risk. Rapid snowmelt is more likely to occur with snow that is freshly fallen or uncompressed (light, dry, low moisture content). As a result, a freshly fallen and uncompressed snowpack increases Whistler's flood risk, particularly if the snow is from valley top to bottom. On the opposite note, snow that is compressed or packed down will not melt as quickly and as a result is less likely to lead to flooding; decreasing Whistler's flood risk.

A well-established and porous snowpack that is well established can help absorb rainfall, decreasing flood risk. A hard packed snowpack that is not porous may prevent rain water from being absorbed by the ground, increasing flood risk.

### **Freezing Level**

The freezing level can increase or decrease flood risk. The freezing level affects how much precipitation falls as rain or as snow which will influence how much rainwater enters the river – more rain increases flood risk, more snow decreases flood risk. Freezing level influences how much snowmelt runoff is expected during a heavy rainfall. A high freezing level during a period of heavy rainfall increases the amount of snowmelt runoff, increasing flood risk.

### **Soil Condition**

Soil moisture condition can increase or decrease flood risk. Soil that is already saturated due to previous rain event(s) will not absorb as much water leading to increased surface runoff. This rainwater will enter the river much faster than it would if the ground wasn't saturated leading to higher streamflow levels, increasing flood risk.



Porous soil has the ability to absorb and store rainfall, reducing the volume of water entering a river, decreasing flood risk.

Soil that has been baked by prolonged heating, is hard and cannot absorb as much water, causing rainfall to run straight into the river, increasing the flood risk river's streamflow. The same phenomenon is true for frozen ground.

## Flood Forecast Risk Rating Tool

The Roads Supervisor, or designate, will use the flood forecast tool when a concerning weather forecast is issued.

Factor	Very Low	Low	Medium	High
<b>Weather Forecast</b> How much rain is forecasted? [Forecasted temperatures within a few degrees of 0 should be considered rain] [Very high intensity rain in duration $\leq 24$ hours could also increase risk]	( $\leq 25$ mm in 24 hours)	( $\leq 50$ mm in 24 hours)	(50-90mm in 24 hours)	( $\geq 90$ mm in 24 hours)
<b>Current Basin Flows</b> What is the current flow in receiving streams? <ul style="list-style-type: none"> <li>- Lower streamflow lowers risk</li> <li>- Higher streamflow increases risk</li> </ul>				
<b>Risk of Significant Rain on Snow</b> Is rapid snowmelt from higher elevations expected? <ul style="list-style-type: none"> <li>- Freshly fallen/uncompressed snowpack increases risk</li> <li>- Well-established/compressed/packed snowpack decreases risk</li> <li>- Porous snowpack (with ability to absorb moisture decreases risk</li> <li>- Increase in temperature (freezing levels &gt; 2000 metres)</li> </ul>				
<b>Capacity of Soil to Absorb Rain</b> Does the soil have the ability to absorb rain? <ul style="list-style-type: none"> <li>- Unsaturated soil decreases flood risk</li> <li>- Saturated soil increases flood risk</li> <li>- Frozen ground increases flood risk</li> <li>- Unfrozen ground decreases flood risk</li> <li>- Recent drought conditions increase flood risk</li> </ul>				
<b>Technical Comments and Overall Ranking:</b>  <div> <p><b>Note:</b> You are required to rank the overall event</p> <p><b>TOTAL</b>            Very Low = Day to Day Operations            Low = Normal awareness and monitoring but communications to reduce worry of others            Medium = Preparedness = moderately worried            High = Aggressive preparedness = high level of concern that flooding will occur</p> </div>				

**Table 4 Potential Impacts**

	<b>Very Low</b>	<b>Low</b>	<b>Medium</b>	<b>High</b>
<b>Typical Impacts</b>	<u>No Disruption</u>	<u>Minimal Disruption</u>	<u>Significant Disruption</u>	<u>Severe Disruption</u>
	<ul style="list-style-type: none"> <li>No impact</li> </ul>	<ul style="list-style-type: none"> <li>Generally no impact</li> <li>Isolated and minor pooling of water in low-lying areas and roads</li> <li>Little or no disruption to travel although wet road surfaces could lead to difficult driving conditions</li> </ul>	<ul style="list-style-type: none"> <li>Localized flooding could affect low-lying individual properties</li> <li>Evacuation of localized low-lying properties may be necessary</li> <li>Disruption to low-lying critical infrastructure is possible</li> <li>Local disruption to travel – longer travel times</li> </ul>	<ul style="list-style-type: none"> <li>Widespread flooding affected significant numbers of properties and whole neighborhoods</li> <li>Disruption of critical infrastructure in flood areas including utilities, roads, and bridges</li> <li>Large-scale evacuation of properties and neighborhoods may be required</li> <li>Severe disruption to travel. Risk of motorists becoming stranded</li> </ul>

## READINESS PROCESS

Once the potential for flooding (level of hazard) has been identified using the Flood Forecast Tool the checklist below outlines the operational procedures for municipal staff to prepare for flooding. The information below is designed as a guide, but it not a prescriptive or exhaustive list. In some cases, not all items will be completed; in other situations additional measures may be taken.

Next-day weather forecasts (24 hours out) are fairly reliable, so preparations may being as early as 24-hours before the scheduled weather event. In severe cases, preparations may occur even earlier.

Very-Low	Assigned to:
No actions required beyond normal operational tasks (business as usual). No communication of flood risk required.	N/A

Low – Awareness & Forecast Monitoring	Assigned to:
Participate in Emergency Management British Columbia (EMBC) 'Weather Heads-Up Coordination Call' if occurring and necessary	Roads Supervisor; Emergency Program
Communicate flood risk (or lack thereof) to Manager of Transportation and Waste and General Manager of Infrastructure Services. GM will advise CAO, Senior Management Team, Communications, if he/she thinks it's necessary.	Roads Supervisor; GM of Infrastructure Services
Continue to monitor weather forecasts and re-assess flood risk using flood forecast tool as new forecasts are available or conditions/variables change (signs of ground saturation, stream flows rise, freezing level drops, etc.). Notify Manager of Transportation & Waste and GM of Infrastructure Services is threat worsens.	Roads Supervisor, or designate



<b>Medium – Flood Readiness</b>	<b>Assigned to:</b>
Participate in Emergency Management British Columbia (EMBC) 'Weather Heads-Up Coordination Call' if occurring and necessary	Roads Supervisor; Emergency Program
Communicate flood risk to Manager of Transportation and Waste and General Manager of Infrastructure Services. GM will advise CAO, Senior Management Team, Communications, if he/she thinks it's necessary.	Roads Supervisor or designate; GM of Infrastructure Services
Communicate flood risk to staff that could benefit operationally from the information: Whistler Fire Rescue Service, Utilities, Emergency Program Coordinator, Communications, Customer Service Desk, etc.	Roads Supervisor, or designate
If at any time you feel the department capacity is exceeded or additional advanced planning activities should be taken (evacuation planning, critical infrastructure protection, etc.) request the activation of the Emergency Operations Centre (EOC). The EOC will lead advanced planning activities including EOC staffing, EOC set-up, protection of critical infrastructure, public information, forecast monitoring, liaison with River Forecast Centre and other provincial ministries, and support of flood readiness efforts. The EOC must be activated once a Flood Warning is issued by the River Forecast Centre.	Roads Supervisor, Manager of Transportation & Waste, GM of Infrastructure Services
Develop a staffing plan [if necessary and if regular staffing levels will not be sufficient] so that patrols of dikes, bridges, and key areas of concern can occur during the forecasted weather event as required. When developing your staffing plan, remember that frequency of patrols may need to increase as water levels rise.	Roads Supervisor, or designate
Prior to the forecasted weather event, examine dikes to ensure they are in good condition. See <a href="#">Appendix 2 Dike Inspections &amp; Patrols During High Water Events</a> on page 28. Arrange repair if required.	Roads Supervisor, or designate
Implement measures to prevent flooding as necessary – sandbagging critical infrastructure in low-lying areas/areas of concern, ensure all flood related equipment (sand and sandbags, pumps, trucks, forklifts, front-end loaders, sandbag-filling machines, etc.) is available and ready to go.	Roads Supervisor, or designate
Ensure culverts and storm drains are free of debris. Previous heavy rainfall events may have caused urban drainage issues due to leaves and debris blocking drains.	Roads Supervisor, or designate
Ensure that the Highway 99 contractor is aware of the flooding concern and is implementing measures along Highway 99 to prevent and monitor flooding.	Roads Supervisor, or designate
Request that Central Services has fuel supplies at PWY topped up.	Roads Supervisor, or designate
Consider the need to bring in additional equipment from private contractors. If required, contact private contractors, explain the flooding threat, and put them on 'standby.'	Roads Supervisor, or designate
Set-up sand bag station for the public, if necessary.	Roads Supervisor, or designate
Request that the Communications Department issue a media release, if necessary given the hazard. See <a href="#">Appendix 4: Public Information for Residents</a> on page 34 for a detailed list of information.	Roads Supervisor, or designate; Communications Department
Continue to monitor weather forecasts and re-assess flood risk using flood forecast tool as new forecasts are available or conditions/variables change (soil becomes saturated, stream flows rise, freezing level changes).	Roads Supervisor, or designate

<b>High – Aggressive Flood Readiness</b>	<b>Assigned to:</b>
Participate in Emergency Management British Columbia (EMBC) 'Weather Heads-Up Coordination Call' if occurring and necessary	Roads Supervisor; Emergency Program
Communicate flood risk to Manager of Transportation and Waste and General Manager of Infrastructure Services. GM will advise CAO, Senior Management Team, Communications, Human Resources, and others as required.	Roads Supervisor or designate; GM of Infrastructure Services
Communicate flood risk to staff that could benefit operationally from the information: Whistler Fire Rescue Service, Utilities, Emergency Program Coordinator, Communications, Customer Service Desk, etc.	Roads Supervisor, or designate.
Request the activation of the Emergency Operations Centre (EOC) for the purpose of advanced planning activities including EOC staffing, EOC set-up, protection of critical infrastructure, public information, forecast monitoring, liaison with River Forecast Centre and other provincial ministries, notifying external agencies (EMBC, SD#48, Whistler Transit, Whistler Health Care Centre, BCAS, Whistler Blackcomb, etc.) and support of flood readiness efforts. The EOC must be activated once a Flood Warning is issued by the River Forecast Centre; RMOW is eligible for a task number from Emergency Management BC once a formal Flood Warning is issued.	GM of Infrastructure Services
Develop a staffing plan [if necessary and if regular staffing levels will not be sufficient] so that patrols of dikes, bridges, and key areas of concern can occur during the forecasted weather event as required. When developing your staffing plan, remember that frequency of patrols may need to increase as water levels rise.	Roads Supervisor, or designate
Prior to the forecasted weather event, examine dikes to ensure they are in good condition. See <a href="#">Appendix 2 Dike Inspections &amp; Patrols During High Water Events</a> on page 28. Arrange repair if required.	Roads Supervisor, or designate
Implement measures to prevent flooding as necessary – sandbagging critical infrastructure in low-lying areas/areas of concern, ensure all flood related equipment (sand and sandbags, pumps, trucks, forklifts, front-end loaders, sandbag-filling machines, etc.) is available and ready to go.	Roads Supervisor, or designate
Ensure culverts and storm drains are free of debris. Previous heavy rainfall events at this time of year have created urban drainage issues due to leaves and debris blocking drains.	Roads Supervisor, or designate
Ensure that the Highway 99 contractor is aware of the flooding concern and is implementing measures along Highway 99 to prevent and monitor flooding.	Roads Supervisor, or designate
Request that Central Services has fuel supplies at PWY topped up.	Roads Supervisor, or designate
Consider the need to bring in additional equipment from private contractors. If required, contact private contractors, explain the flooding threat, and put them on 'standby.'	Roads Supervisor, or designate
Set-up sand bag station for the public.	Roads Supervisor, or designate
Request that the EOC or Communications Department issue a media release. See <a href="#">Appendix 4: Public Information for Residents</a> on page 34 for a detailed list of information.	Roads Supervisor, or designate; Communications Department

Continue to monitor weather forecasts and re-assess flood risk using Flood Forecast Risk Rating Tool as new forecasts are available or conditions/variables change (soil becomes saturated, stream flows rise, freezing level changes).	Roads Supervisor
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Potential Emergency Operations Centre Activities for Flood Readiness	
Establish and staff the Emergency Operations Centre. See <a href="#">Annex 1 Emergency Operations Centre Activation Guide</a> and <a href="#">Annex 2 EOC Quick Action Checklists and Forms</a> .	
If the River Forecast Centre has issued a 'Flood Warning' call the <b>Provincial Emergency Coordination Centre</b> at <b>1-800-663-3456</b> and confirm a Task Number.	
If necessary, establish a Public Information Call Centre to handle public inquiries and provide flood readiness information.	
Issue a media release to inform the public about the possibility of flooding, that a sandbag station is available, and to call the Roads Department at 604-966-8675 (office-hours) or 604-935-8320 (after-hours or weekends) if flooding is occurring on their property. Include statement to advise the public that the RMOW is monitoring the situation closely and roads crews are actively engaged in the field and monitoring areas of concern. Request that the public stay away from rivers, streams, etc. Remind residents to ensure their driveway culvert is clear and free from mud, debris, and rocks.	
Alert the ESS Director to the potential for flooding by phone at <b>604-966-4845</b> . Direct the ESS Director to ready ESS Reception Centres for use.	
Develop a staffing plan for the Emergency Operations Centre for future operational periods, as necessary.	
Provide assistance to site/Roads Department as requested.	
Using flood plain mapping, forecasting and other information to determine the potential threat area. Consider protection of critical infrastructure in the identified threat area.	
Continue to monitor the situation. Determine 'trigger points' for public information, Evacuation Alert and Order as required.	
Notify external agencies - EMBC, SD#48, Whistler Transit, Whistler Health Care Centre, BCAS, SAR, Whistler Blackcomb, etc.	

## FLOOD RESPONSE

### Concept of Operations

#### **BRITISH COLUMBIA EMERGENCY MANAGEMENT SYSTEM**

The RMOW has adopted the British Columbia Emergency Management System (BCEMS) as a comprehensive management system that ensures a coordinated and organized response to emergencies. Endorsed and utilized by the Provincial Government, BCEMS provides the framework for a standardized emergency response for all levels of government in British Columbia. BCEMS is an emergency management system founded on the principles of the Incident Command System (ICS) and includes common language, span of control, management by objectives, and scalability.

The BCEMS operational goals are as follows:

- Provide for the safety and health for all responders
- Save lives
- Reduce suffering
- Protect public health
- Protect government infrastructure
- Protect property
- Protect the environment
- Reduce economic and social losses

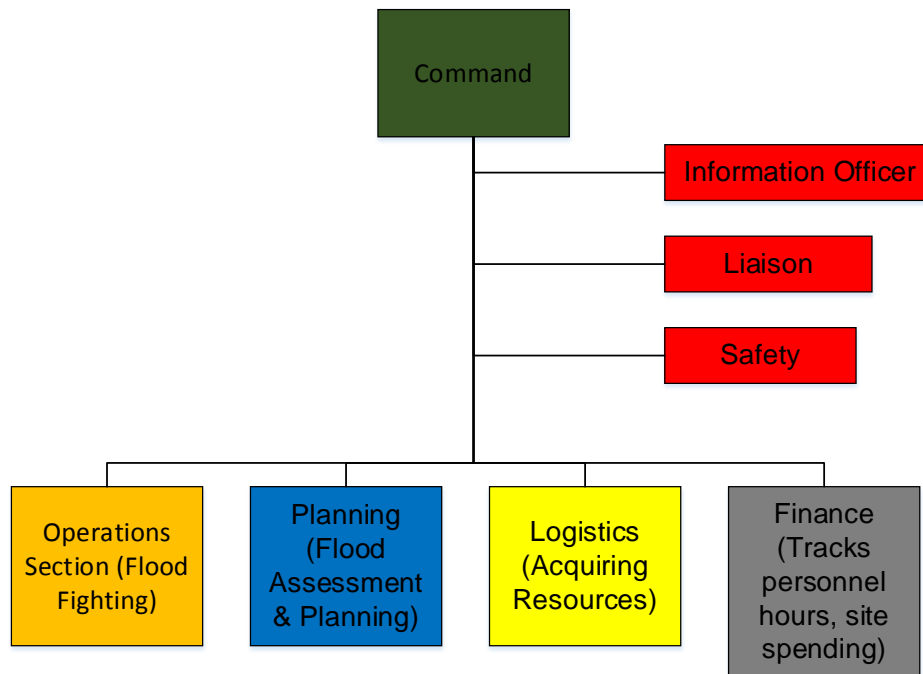
BCEMS identifies four operational levels:

1. Site level
2. Site support (Emergency Operations Centre)
3. Provincial regional coordination (Provincial Regional Emergency Operations Centre - Surrey)
4. Provincial central coordination (Provincial Emergency Coordination Centre - Victoria)

#### **ICS Structure**

ICS allows for the timely coordination of resources and staff resources during a flood and promotes communication among responders and agencies. ICS ensures a consistent, coordinated and organized response to emergency events. The principles of the system are applied at the site and site support level (Emergency Operations Centre). The ICS structure is comprised of five functional sections: Command, Operations, Planning, Logistics, and Finance. For flood response at the site, these functional sections are supported by units with specific responsibilities. For information on ICS structure in the [Emergency Operations Centre](#), see [Annex 2 EOC Quick Action Checklists and Forms](#).





Only those ICS positions required for safe and effective response need to be activated. In a small emergency, one person often handles all of the functions, at least for a limited time. The same is true even in a larger flood at the initial stage of activation and mobilization. As the response expands to meet the requirements of the emergency, a person is assigned to each component section, and then that person gains additional personnel who are assigned individual functional responsibilities as their section become more active.

#### **Command**

- Responsible for management of the incident either as single or unified command
- Sets objectives and priorities, has overall responsibility of flood event
- Command Section is comprised of the Information Officer, Liaison Officer, and Safety Officer

#### **Operations (Flood Fighting)**

- Assists in the formulation of objectives and priorities
- Conducts tactical operations in support of objectives and priorities
- Determine the response services and field crews required to fulfill operations' objectives
- Directs all resources at the site

#### **Planning (Flood Assessment & Planning)**

- Develops the incident action plan to accomplish the objectives
- Gathers and evaluates information required for the event
- Obtains technical specialists as required which could include geotechnical, hydrological, dam safety, dike safety, river processes, habitat, hazardous materials or other types as required by the flood event

#### **Logistics (Support Coordination)**

- Provides support to meet incident needs, provides resources (medical, food, equipment staging, supporting facilities, communication devices) and all other services needed to support the incident
- Responsible for the provision of heavy equipment, trucks, boats, sandbags, materials, etc.

#### **Finance / Administration**

- Tracks hours and time for those responding on site.
- Collects invoices

## Response Process

Below is information to guide the RMOW's response to a flood, once flooding is imminent or already occurring.

### Lead Agency

- Infrastructure Services; Roads Department (Reports to Manager of Transportation & Waste Management)

### Support Agencies

- Whistler Fire Rescue Service
- Search & Rescue
- RCMP
- BC Ambulance
- Emergency Social Services
- Whistler Transit Ltd.
- RCMP Victim Services
- Whistler Community Services Society (Recovery)
- Emergency Management BC
- River Forecast Centre - Ministry of Forests, Lands, and Natural Resource Operations
- Ministry of Environment (environmental contamination as a result of flooding)
- Vancouver Coastal Health (protection of drinking water/boil water advisories)

### Site Response

#### Single Agency Response

- First-in responding agency (roads, fire, police, or ambulance) will establish command. The most senior person or person with the highest jurisdictional authority assumes role of Incident Commander.
- Determines the scale of the emergency.
- If the first-in agency is able to complete the response within their resource capabilities and within their jurisdiction, the incident remains a single agency response.

#### Multi-Agency or Multi-Jurisdictional Response

- First-in responding agency (roads, fire, police, or ambulance) will establish command. The most senior person or person with the highest jurisdictional authority assumes role of Incident Commander.
- Determines the scale of the emergency.
- If the first-in responding agency determines that other agency resources are required and not already deployed, a multi-agency/multi-jurisdictional response is initiated.
- Each agency will make every effort to identify a liaison person who will be the primary link between their own agency and the Incident Commander. Ideally the Agency Liaison will remain at the incident command post. *Agencies that are unable to provide an Agency Liaison who can remain at the incident command post must establish a method of direct communications with the Incident Commander.*
- Agencies will make every effort to communicate their resources, current and future planned tasks, potential resource needs and other information as required and as available. It is preferable that this communication is reported face to face between the Agency Liaison and Incident Commander.
- This information will be utilized to establish a multi-agency incident action plan (note: an incident action plan is a legal requirement for some agencies).

### Responsibilities of the Incident Commander or Unified Command

- Establish a visible Incident Command Post (ICP). Announce location of Incident Command Post to all responders.
- Evaluate the situation.
- Notify Manager of Transportation & Waste and GM or Infrastructure Services and provide briefing.
- Request activation of the Emergency Operations Centre.

- Establish the first operational period.
- Prioritize response activities (develop Incident Action Plan).
- Identify the flood risk areas.
- Develop an effective Incident Command Organization. Activate needed elements of ICS. Assign Command Staff (Information Officer, Safety Officer, Liaison Officer), Sections Chiefs and other site personnel to sections. Ensure all personnel are reporting to one supervisor and that each supervisor has no more than seven subordinates.
- Provide a briefing to Command Staff and Section Chiefs (number of dwellings effected, scope, etc.). Communicate priorities (incident action plan) and assign appropriate tasks to each Section Chief. (Sandbagging, traffic management, clearing debris at bridges, etc.).
- Identify equipment and resources needed. Deploy flood equipment as necessary.
- Request the disconnection or discontinuance of any service that may constitute a public hazard.
- Provide regular updates to the EOC and request additional resources.
- Ensure safety of on-scene personnel. Communicate any obvious safety concerns.
- Document all mutual aid requests, purchases made, staff hours and contractors used during response to assist in reimbursement under task from Province.
- Transfer of command will occur when a more senior/higher jurisdictional authority arrives at the established incident command post.

The chart below lists the functions that may be required on-site and the ICS section responsible and agency most likely responsible for staffing the section. If the function is not assigned to a section, it is the responsibility of the Incident Commander to fulfill.

Function	ICS Section	Agencies that can provide
Technical Rescues (Rope, ice, marine, swift water, confined space, first medical responder)	Operations	Whistler Fire Rescue Service
Missing people, searches, body recovery (via the Coroner)	Operations	RCMP, Search & Rescue, Whistler Fire Recue Service may assist
Evacuate the affected areas	Operations & EOC	RCMP & EOC
Provide pre-hospital care and transportation of inured people; medical oversight to response	Operations	BC EHS
Protection of vulnerable areas using sandbags and or transporting and setting up generators and submersible pumps	Operations	Whistler Fire Rescue Service, convergent volunteers, private property owners
Clearing debris at bridges	Operations	RMOW Roads Department, private contractors
Secure the affected areas & manage traffic	Operations	RCMP, Private Security Companies
Utility protection & shutoff	Operations	RMOW Utilities department and private utility companies
Environmental contamination as a result of flood	Operations	Ministry of Environment, EOC
Implement actions to protect water and sewer systems and identify threats to drinking water	Operations	Utilities staff
Debris Removal	Operations	Whistler Fire Rescue Service, RMOW Public Works
Transportation of evacuees or responders	Operations and Logistics	Whistler Transit, EOC
Sourcing of resources	Logistics	Central Services or EOC
Staging of resources	Logistics	Roads Crew or WFRS staff (WFRS have lots of experience with staging)
Collecting information and arranging for technical expertise	Logistics or EOC	EOC
Prepare strategies for flood fighting	Planning	Roads Crew, EOC
Prepare Incident Action Plans for upcoming operational periods	Planning	Roads Crew
Helicopter observation, Helicopter External Transportation (H.E.T S.).	Operations	Search and Rescue (Can be requested by Police, Fire Ambulance, and the Coroner; cannot self-deploy.



## Emergency Operations Centre Response

The general responsibilities of the Emergency Operations Centre (EOC) is listed in detail the [Emergency Operations Centre, see Annex 2 EOC Quick Action Checklists and Forms](#).

### TRIGGERS FOR EMERGENCY OPERATIONS CENTRE ACTIVATION

The EOC will be activated at direction of the Chief Administrative Officer (COA) or designate; the CAO can activate the EOC at any time they deem it necessary. Specific trigger points that will prompt the activation of the EOC for potential or actual flooding include:

- Flood Warning is issued by the River Forecast Centre (CAO may want to activate EOC at Flood Watch stage)
- Site requires support or requests EOC activation
- Risk to public safety
- Waters in rivers or creeks are rising rapidly or breach their banks
- There is concern about the integrity of the debris barrier
- Damage to public or private property is occurring, is imminent, or has a very high probability of occurring
- Significant road closures occur
- Significant or extended power outages occur

Below are some potential activities the EOC should consider when flooding is imminent or has already occurred.

EMERGENCY OPERATIONS CENTRE ACTIVITIES FOR FLOOD RESPONSE	
Activity	Assigned to:
Gather as much information as possible from the Incident Commander (IC) including the location of flooding, potential threat area, structures affected, etc.	EOC Director or Operations Chief
If not already activated, activate and staff the RMOW Emergency Operations Centre. See <a href="#">Annex 1 Emergency Operations Centre Activation Guide</a> and <a href="#">Annex 2 EOC Quick Action Checklists and Forms</a> . Once activated, the EOC will lead the coordination of resources requested from the site and other local agencies involved in response.	EOC Director
Notify the <b>Provincial Emergency Coordination Centre</b> at <b>1-800-663-3456</b> , if not already notified. Confirm a Task Number.	EOC Director
Support for site, including personnel and equipment.	EOC
Assess potential impacts and duration of the flood. Consider the following when assessing potential impacts: <ul style="list-style-type: none"><li>• public and private property damage</li><li>• evacuations</li><li>• road closures and emergency detours</li><li>• bridge washouts</li><li>• canceling public events</li><li>• staffing of the municipality's critical services</li><li>• damage to critical infrastructure</li><li>• continued operation of identified critical infrastructure</li><li>• impacts on vulnerable populations</li><li>• inspection of damaged buildings, roads, bridges</li><li>• addressing the management of toxic debris/waste</li></ul>	EOC Director, Planning Chief

Note: While efforts will be made to assist residents in the protection of their property during a flood emergency, the protection of critical municipal infrastructure must be the first priority to ensure continuity of municipal services to the community.	
If not already occurring, request that EOC organize a Coordination Call with subject matter experts to assist the RMOW (River Forecast Centre, Environment Canada, MOTI, BC Hydro, etc.). These usually occur twice daily during response.	Liaison Officer
If Provincial Powers are required, recommend a Declaration of Local Emergency to Council and oversee the process.	EOC Director
If there a potential or confirmed need for evacuation see <a href="#">Annex 4 Evacuation Plan</a> .	EOC Staff
If necessary, establish a Public Information Call Centre to handle public inquiries and provide flood information.	Logistics, Information Officer, EOC Director, IT Branch
Issue a media release sharing flood warning or watch information or confirmation that rivers have breached or property damage has occurred. Ensure residents and stakeholders are kept informed of the developments and the impacts of the flood. Ensure they know how to report flooding. Advise the public of protective actions that may be required in the event of damage or concerns related to the sewer systems and/or drinking water sources. Provide regular media updates, as needed.	Information Officer
Develop a staffing plan for the Emergency Operations Centre for future operational periods, as necessary.	Logistics
Notify external agencies - EMBC, SD#48, Whistler Transit, Whistler Health Care Centre, BCAS, Whistler Blackcomb, etc.	Liaison Officer
Coordinate subject matter experts as required including flood specialists, forecasters, etc.	Liaison Officer
Continue to monitor weather forecasts and provide updates to site. Monitor River Forecast Centre advisories, warnings, and watches.	Planning, Operations
In the event the flood results in the release of untreated or partially treated sewage into lakes and rivers, implement internal procedures and notify the Ministry of Environment.	Liaison Officer
Coordinate damage assessments with Engineering, Utilities, Health Unit, etc. when the river has receded to a point where personnel can safely navigate the area	Planning
Flooding may impact the ability to treat and/or supply water meeting drinking water quality standards, as a result supply shortages and water quality advisories may be experienced. In addition, stormwater and/or sewer system breaches and backups result in environmental and public health hazards.	Public Works Branch

**Note:** Overland flooding may be declared eligible for coverage under the provincial Disaster Financial Assistance (DFA). If the flood event is identified as a DFA event by Emergency Management BC (EMBC), individuals, local governments, businesses and not-for-profit organizations AND flood insurance was not reasonable and readily available for purchase, the individuals can then apply for financial assistance to assist with eligible restoration and repair costs.

## Provincial Regional Emergency Operations Centre (Emergency Management BC)

### **The PREOC/EMBC will support Whistler's flood response by:**

- Activating the Provincial Regional Emergency Operations Centre (PREOC) to provide resource support and coordination with Provincial ministries
- Assigning a Provincial task number so the RMOW can recoup eligible response and recovery costs – will issue task number at the Flood Warning Stage
- River Forecast Centre (MFLNRO) subject matter experts to forecast and analyze river behavior. The RFC monitors, analyzes and models the stream flow conditions around the province by using a variety of scientific knowledge, methodologies, techniques and models with data input of snow surveys, weather and stream flow from BC Ministry of Environment, Environment Canada and other sources, and provides Current River Discharge and Water Level Information.
- Coordinate high-level briefings with provincial ministries and technical experts on a regular basis (typically through daily or twice daily conference calls with the PREOC and local authorities) to provide update to date information, weather and river forecasts and a synopsis of response activities. Agencies included may be: MOTI, River Forecast Centre, BC Hydro, Telus, Environment Canada, Vancouver Coastal Health, SLRD, District of Squamish, Village of Pemberton, and others as required.
- Access to geographical information systems and floodplain mapping; Aviation resources for reconnaissance, surveying and advanced planning;
- Rip rap provided and managed by Ministry of Transportation and Infrastructure (MoTI) primarily for the protection of provincial infrastructure;
- Gabion baskets for distribution to local authorities when appropriate; Sandbags for distribution to local authorities;
- Operational and available sandbag filling machines;
- Skilled heavy equipment operators and specialized heavy equipment; and
- Field crews to assist with sandbagging when local authorities and their residents are overwhelmed.
- Assistance with Declaration of Local Emergency

### **What the PREOC/EMBC will ask the RMOW EOC for:**

- Resource Requests and Expenditure Authorization Forms
- Situation Reports – one per operational period. Will want an initial situation summary within one to two hours of EOC activation (can be informal over phone or email if resources are stretched). After first operational period will want a daily situation report within a timeframe determined by the PREOC.
- Situation Reports should include operational updates with the following information:
  - Confirm top 3 priorities
  - Changes since last situation report or overnight
  - Critical resource needs
  - Location of Reception Centres, Group Lodging, Housing Locations
- Daily Cost Estimates. This contributes to the Disaster Financial Assistance determination by the Province. Activate the Finance Section early.
- If a State of Local Emergency is declared PREOC will need a copy
- Copies of any Evacuation Alerts or Orders

## APPENDIX

### Appendix 1 Helpful Sources of Information

#### WATER STEWARDSHIP (MOE)

##### Provincial Floodplain Maps

- Delineates the area that can be expected to flood, on average, once every 200 years. A 200-year flood can occur at any time in any given year; the indicated flood level may be exceeded; and portions of the floodplain can flood more frequently
- Show the location of the normal channel of a water course, surrounding features or developments, ground elevation contours, flood levels and floodplain limits (the elevation and horizontal extent of the high water marks of a 200-year flood)
- Within the floodplain, flood level isograms show the water elevation during a 200-year flood. (The maps may also include the 20-year flood level, which is used in applying Health Act requirements for septic tanks.) A flood level isogram is a line which spans the floodplain, plotting the location at which the floodwater is expected to reach the indicated elevation. The elevation of floodwater between each isogram can be interpolated.
- Publicly-available and accessed online at:
  - Millar Creek from Cheakamus River confluence to Nita Lake Floodplain Map 1993:  
[http://www.env.gov.bc.ca/wsd/data\\_searches/fpm/reports/bc-floodplain-maps/WhistlerArea\\_Nita\\_AlphaLk\\_GreenR\\_Millar\\_Alta/2-89-16-1.pdf](http://www.env.gov.bc.ca/wsd/data_searches/fpm/reports/bc-floodplain-maps/WhistlerArea_Nita_AlphaLk_GreenR_Millar_Alta/2-89-16-1.pdf)
  - Alta Lake Floodplain Map 1993:  
[http://www.env.gov.bc.ca/wsd/data\\_searches/fpm/reports/bc-floodplain-maps/WhistlerArea\\_Nita\\_AlphaLk\\_GreenR\\_Millar\\_Alta/2-89-16-2.pdf](http://www.env.gov.bc.ca/wsd/data_searches/fpm/reports/bc-floodplain-maps/WhistlerArea_Nita_AlphaLk_GreenR_Millar_Alta/2-89-16-2.pdf)
  - Alta Creek from Green Lake Floodplain Map 1993:  
[http://www.env.gov.bc.ca/wsd/data\\_searches/fpm/reports/bc-floodplain-maps/WhistlerArea\\_Nita\\_AlphaLk\\_GreenR\\_Millar\\_Alta/2-89-16-3.pdf](http://www.env.gov.bc.ca/wsd/data_searches/fpm/reports/bc-floodplain-maps/WhistlerArea_Nita_AlphaLk_GreenR_Millar_Alta/2-89-16-3.pdf)
  - Green River near the outlet of Green Lake Floodplain Map 1993  
[http://www.env.gov.bc.ca/wsd/data\\_searches/fpm/reports/bc-floodplain-maps/WhistlerArea\\_Nita\\_AlphaLk\\_GreenR\\_Millar\\_Alta/2-89-16-4.pdf](http://www.env.gov.bc.ca/wsd/data_searches/fpm/reports/bc-floodplain-maps/WhistlerArea_Nita_AlphaLk_GreenR_Millar_Alta/2-89-16-4.pdf)

**\*Note:** 1994 is still the most recent complete set of data available to the RMOW. Updated mapping for Fitz Creek should be available by early 2016, and the other critical areas in Whistler are scheduled for later in 2016.

##### Whistler Dike Inventory Map

- Show the flood protection infrastructure regulated under the Dike Maintenance Act
- Maps contain information on dike infrastructure, pump stations, floodboxes, riprap, relief wells; known areas of hazard concerns, boil locations, low dikes; major road & street network showing access points onto dikes; other infrastructure relevant to safe operation of the dikes, such as major pipeline crossings, hydro lines, railway lines, etc
- Publicly-available and accessed online at:
  - Whistler North Dike Inventory Map:  
[http://www.env.gov.bc.ca/wsd/public\\_safety/flood/maps/whistler\\_n\\_37.pdf](http://www.env.gov.bc.ca/wsd/public_safety/flood/maps/whistler_n_37.pdf)
  - Whistler South Dike Inventory Map:  
[http://www.env.gov.bc.ca/wsd/public\\_safety/flood/maps/whistler\\_s\\_38.pdf](http://www.env.gov.bc.ca/wsd/public_safety/flood/maps/whistler_s_38.pdf)

## Appendix 2 Dike Inspections & Patrols During High Water Events

The RMOW is responsible for carrying out additional inspections or patrols during high water events on Fitzsimmons Creek and all other drainage to monitor the performance of the flood control works and take corrective action as required.

During high water events, water levels at bridges and other points where measurements are feasible should be monitored regularly and the readings recorded for long-term reference. Patrol frequency of the training berms should increase as the water levels approach critical conditions, and must be continuous while the level is within 1.0 metre of the berm crest.

The patrol crews are to observe and report to the Roads Supervisor any occurrences that could signal a weakening of the works, including but not limited to the following:

- Damage to the training berm slope;
- Some seepage through and at the landside toe of the training berm is to be expected at high flood levels. This seepage is considered to be normal provided flows are not excessive or concentrated in the form of piping<sup>2</sup> or boils<sup>3</sup>;
- Sloughing and/or erosion of the training berm slopes (gullying); Settlement of the training berm crest and slopes (depressions); Areas of low freeboard;
- Desiccation cracking<sup>4</sup>, transverse cracking<sup>5</sup>, or longitudinal cracking<sup>6</sup> of the training berm crest or slopes;
- Erosion of the riverbank adjacent to the training berm;
- Sloughing and/or erosion of bank protection works. Critical areas must be closely inspected during and after high water events;
- Debris accumulation at floodboxes, flapgates and trashracks;
- Stream blockage or shifts in flow direction due to log and debris jams, especially near bridge or other constrictions;
- Seepage along cables or pipes that transverse the training berm fill.<sup>1</sup>

### SPECIAL INSPECTION CONSIDERATIONS

- The BC Rail Floodway and the 400m area north to overflow culverts should be inspected for erosion damage. The four 1800 mm diameter metal culverts should be inspected for debris blockage and possible damage in the vicinity of the culvert entrances and exits.

### INSPECTIONS FORMS AND REPORTS

The Flood Protection Works Management Checklist and the Flood Protection Inspection Report need to be completed annually. In the event of high water, a Dyke Patrol Log must be completed.

Cases of severe damage to flood protection works during high water conditions must be recorded with photographs. Also, records must be kept of training berm inspection logs, gauge readings and high water marks.

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<sup>2</sup> Piping results where fill is transported by the seepage flow; this can be identified either as suspended silts (murky water) or visible grain particles. This process enlarges or progresses toward the river at an increasing rate. Eventually an open path is created and the berm is breached. The piping process is sometimes indicated by boils.

<sup>3</sup> Boils are small upwellings which can appear at considerable distances from the inside toe of the berm and which are caused by excess seepage. Close attention must be paid to seepage, as the safety of the training berm can be threatened by an increase or concentration of seepage flows.

<sup>4</sup> Desiccation cracking: forms in random, honeycomb patterns and is serious only when deep.

<sup>5</sup> Transverse cracking: forms perpendicular to the training berm alignment and can easily create a seepage path.

<sup>6</sup> Longitudinal cracking: forms parallel to the training berm alignment and may indicate the start of a slide or slump. May result for toe erosion, differential settlement or saturation.

Annual inspection report must be sent to the Deputy Inspector of Dykes.

Records kept by the Dyking Authority are important to insure complete information available for future operation, maintenance and repairs.

- Records should be kept of all inspections.
- Patrol logs and records, gauge readings, high water ark profile surveys and other performance data should be retained.
- All cases of damage should be recorded with location, nature of damage, repairs affected, dates, time and photographs.
- Performance monitoring records should be maintained.
- Drawings and plans of the works should be kept available together with revisions, additions, etc.



## Appendix 3 Historical Flood Information

**Table 5 Historical Flood Event Estimated Return Period for Annual Max Daily Flows (m<sup>3</sup>/s)**

Station No.	Station Name	Whistler's Flood Event Estimated Return Period (m <sup>3</sup> /s)				
		09-Oct-84	11-Nov-90	30-Aug-91	18-Oct-03	10-Dec-14
08GA072	Cheakamus River above Millar Creek	256	113	260	199	103 <sup>^</sup>
Approximate Return Period in Years		32	4	34	18	3
08MG026	Fitzsimmons Creek below Blackcomb Creek	No Data	No Data	No Data	30 E	2
08MG026 Synthetic*	Fitzsimmons Creek below Blackcomb Creek	46.9	20.8	47.7	36.5	2.6 <sup>^</sup>
Approximate Return Period in Years		24	2	25	12	<1
<p>*data from 08MG026 synthetic dataset  E Water Survey of Canada estimate  <sup>^</sup>provisional WSC data</p> <p>Data and estimates provided by: River Forecast Centre, Water Management Branch, BC Ministry of Forests, Lands, and Natural Resource Operations.</p> <p>DISCLAIMER: The original data, though published by Water Survey of Canada, may not be necessarily free of error and omission. Results of flood frequency analysis can vary depending on the veracity of the input data series and interpretation of results particularly for extreme values (i.e., 100-year event) where the available data set may be short and require extrapolation over long time intervals. This information was not provided for design purposes and users should use the information with caution and at their own risk.</p>						

**Table 6 Historical Flood Event Estimated Return Period for Annual Peak Flows (m<sup>3</sup>/s)**

Water Survey of Canada Station No.	Water Survey of Canada Station Name	Whistler's Flood Event Estimated Return Period for Annual Peak Flows (m <sup>3</sup> /s)				
		09-Oct-84	11-Nov-90	30-Aug-91	18-Oct-03	10-Dec-14
08GA072	Cheakamus River above Millar Creek	269	145	331	219	128 <sup>^</sup>
Approximate Return Period in Years		36	8	58	22	6
08MG026	Fitzsimmons Creek below Blackcomb Creek	No Data	No Data	No Data	30 E	2
08MG026 Synthetic*	Fitzsimmons Creek below Blackcomb Creek	64.9	28.8	66.0	50.5	3.6
Approximate Return Period in Years		56	6	58	30	<1
<p>*data from 08MG026 synthetic dataset  E Water Survey of Canada estimate  <sup>^</sup>provisional WSC data</p> <p>Data and estimates provided by: River Forecast Centre, Water Management Branch, BC Ministry of Forests, Lands, and Natural Resource Operations.</p> <p>DISCLAIMER: The original data, though published by Water Survey of Canada, may not be necessarily free of error and omission. Results of flood frequency analysis can vary depending on the veracity of the input data series and interpretation of results particularly for extreme values (i.e., 100-year event) where the available data set may be short and require extrapolation over long time intervals. This information was not provided for design purposes and users should use the information with caution and at their own risk.</p>						

**Table 7 Expanded Description of Whistler's Flood History**

<b>EVENT</b>	<b>DATE</b>	<b>DESCRIPTION</b>
<b>Flood, Crabapple Drive</b>	December 8-10, 2014	194.5mm of rain in 3 days (30.5mm, 89.6mm, 74.4mm) lead to overland flooding in the Whistler Cay/Tapley's Farm area. On the afternoon of December 10, Crabapple Creek exceeded its bank near the Whistler Gold Course - water from the creek entered the basement of 2 residences. A family of four and two tenants living in the suite were evacuated.
<b>Fitzsimmons Slip</b>	November 2004 - January 2005	Sometime between November 2004 and January 2005, a large mass of earth sitting about 2 km above Whistler slipped almost 1 meter. The slip generally moves a few centimeters each year but occasionally accelerates and moves several meters. Following this event, Whistler constructed a debris barrier to mitigate the debris hazard from future slips.
<b>Rain on Snow Event</b>	October 18, 2003	During a 5-day period from October 16 <sup>th</sup> to 20 <sup>th</sup> , Whistler received over 220mm of rain. The unusually heavy rain produced record rain-on-snow peak flows. Floodwaters destroyed the Rutherford Creek Bridge, linking Whistler and Pemberton on Highway 99, resulting in the deaths of 5 people. In addition, floodwaters along the Cheakamus River near Cheakamus Canyon took out 200m of pavement from Highway 99. Whistler was cut-off both to the north and south.
<b>Flood, Fitzsimmons Creek</b>	August 29-30, 1991	Whistler Valley received 150mm of rain in 5 days, with 76.2mm of rain (return period of 20 years) on August 30 <sup>th</sup> . Consequently, the Fitzsimmons Creek basin contributed runoff generating high flows with significant debris. As a result, there was significant damage to bridges, a water intake structure, and utility crossing and deposited 128 000 m <sup>3</sup> of bed load in the lower reaches of Fitzsimmons Creek. (Sigma Engineering Ltd., 1991). High water level at Alta Lake was 639.4m; Green Lake 634.9m. Residents at Alta Lake stated that 1990/1991 were the highest water levels observed in 52 years.
<b>Rain on Snow Event</b>	November 9 -12, 1990	Over a 4 day period Whistler received approximately 200mm of rain. The storm was a high-intensity, long-duration rain-on-snow event and exceeded the 25-year records at Whistler. Flooding was reported in several low-lying areas of Whistler. High water level at Alta Lake was 639.25m; Green Lake 634.74m. Residents at Alta Lake stated that 1990/1991 were the highest water levels observed in 52 years. Residents at Green Lake stated that 1990/1991 were the highest water levels observed since 1956.
<b>Thanksgiving Day Flood</b>	October 9, 1984	Whistler received 127mm of rain in 3 days causing major flooding in Whistler. Flood damage in Whistler included: Severe erosion of the Cheakamus River approximately 250 meters above the municipal sewage treatment facility, resulting in migration of the Cheakamus River channel and loss of about 1 hectare of land. Large logjams completely blocked the Cheakamus River in its canyon section downstream of the treatment facility. In addition, debris flows in Fitzsimmons Creek washed-out two footbridges and minor accumulations of logs and debris were scattered over the reach from the Blackcomb Way Bridge to the Nancy Green Drive Bridge. Creek overflows were reported to have entered the day parking area. Damage was estimated at \$100 000.

EVENT	DATE	DESCRIPTION
<b>Rain on Snow Event</b>	December 23-27, 1980	Between December 25 <sup>th</sup> and 27 <sup>th</sup> , Whistler experienced heavy precipitation and unusually high seasonal temperatures. The freezing level rose to approximately 2000 meters. Snowmelt combined with more than 100 mm of rain triggered debris flows in many torrents, such as Nineteen-Mile, Twenty-one mile and Fitzsimmons Creek. Some damage was done to roads and bridges in the valley. (Eisbacher 1983).



Photo Credit to Whistler Question from Whistler Museum.  
 Above, an excavator removes rocks and gravel carried down  
 Fitzsimmons Creek during 1991 Labor Day Weekend Flood.

## **RMOW's BYLAW HISTORY RE: FLOODING**

### **Zoning Bylaw No. 9 September 24, 1976**

- 2.6.0 (1) Notwithstanding any other provisions of this Bylaw, no building shall be constructed:
- within fifty feet (50') of the natural boundary of the lake;
  - within one hundred feet (100') of the natural boundary of Green River, Fitzsimmons Creek, Cheakamus River, Alta Creek and River of Golden Dreams;
  - within fifty feet (50') of the natural boundary of any other watercourse not mentioned in the preceding clause; or
  - with the underside of the floor system of habitable areas less than 2 feet above the 200 year flood level where this level can be determined, or if not, less than 10 feet above the natural boundary of Fitzsimmons Creek, Green River, and Cheakamus River; and
  - less than five feet above the natural boundary of any other lake or watercourse.
- provided that with the approval of the Deputy Minister of Water Resource Service these requirements may be reduced.
  - (2) No encroachment of the floodways as defined above in (1) (d) shall be permitted for the various watercourses and lake by landfill or other means.

### **Zoning Bylaw No. 380**

Bylaw No. 380 (September 1984) lists flood control requirements that were current as of June 1992.

### **Ministry of Environment Adopted Flood Levels**

Ministry of Environment adopted flood levels for administration purposes in 1984 of 640m for Alta Lake, and 635.5m for Green Lake.

Ministry of Environment updated flood levels for administration purposes in 1992 to 640.5m for Alta Lake, and 636 m for Green Lake.



Photo Credit to Whistler Question from Whistler Museum  
Rechannelization work and extensive rip-rapping upstream from the Culliton Creek Bridge began September 23, 1991. The \$450,000 repair job became necessary when flood waters forced closure of the span, 40 km south of Whistler.

## Appendix 4: Public Information for Residents

Public information may be issued to residents. Sample information below:

PUBLIC INFORMATION	
Message Type	Essential Message Content
<b>General Information about Whistler's Flood Hazard</b>	<ul style="list-style-type: none"> <li>The Emergency Program webpage on <a href="http://whistler.ca">whistler.ca</a> has information about Whistler's top hazards, one of these is flooding.</li> <li>Link: <a href="http://whistler.ca/flood">whistler.ca/flood</a></li> </ul>
<b>Flood Preparedness Information (when a concerning forecast is issued)</b>	<ul style="list-style-type: none"> <li>RMOW is monitoring the situation closely and roads crews are actively engaged in the field and monitoring areas of concern.</li> <li>Residents should be prepared for power outages and flooding in low-lying areas. Clean leaves from catch basins and eaves to prevent flooding.</li> <li>Information on how you can prepare for flooding and protect your property from flooding can be found on <a href="http://whistler.ca/flood">whistler.ca/flood</a></li> </ul>
<b>Flooding is Expected</b>	<p>RMOW will issue information if a flood warning or watch is issued by the River Forecast Centre. A sample public information release is below:</p> <p>A flood warning/watch is in effect for Whistler. Residents should monitor <a href="http://whistler.ca">whistler.ca</a> for updates or tune to local radio station 102.1 Mountain FM for information on affected areas, safe driving routes, and instructions on what to do if emergency responders ask you to leave your home.</p> <p>How to Prepare for Flooding:</p> <p><b>If flooding occurs, refer to the following points to help protect your family and property:</b></p> <ul style="list-style-type: none"> <li>If you are in immediate danger, phone 9-1-1.</li> <li>If your basement is flooding rapidly, call 9-1-1. Do not enter the basement or crawlspace. Do not flush toilets or turn on taps because this will cause more flooding.</li> <li>If you smell gas in your home, leave immediately. On the way out, leave the doors open to air out your home. Do not touch any electrical appliances or switches because they can spark and ignite natural gas. Once you are out of your home, phone FortisBC's 24-hour Emergency Line at 1-800-663-9911 or 911.</li> <li>If the streets are flooded, don't go on them. Flood water can hide hazards such as open manholes. It only takes 15 centimetres (six inches) or less of rushing water to pull down an average adult and less than 2.5 centimetres (one inch) to drown.</li> <li><b>Report Flooding. If rainwater on the street is creating a hazard or flooding call the municipality Roads Department at 604-966-8675. After hours or on weekends please call the after-hours emergency line at [call Roads Supervisor to confirm after-hours number issuing media release – number changes depending on time of year].</b></li> </ul>



PUBLIC INFORMATION	
Message Type	Essential Message Content
<b>Sand-bag Station is set-up</b>	<p>RMOW may set-up a self-serve sandbag station for residents. A sample public information release is below:</p> <p><b>Sand and sandbags available for Whistler residents concerned about potential flooding</b></p> <p>Another intense rain event is impacting Whistler today and tomorrow, with intermittent rain forecast to continue into Sunday.</p> <p>While it's not possible to predict exactly how much precipitation to expect over the next few days, the Resort Municipality of Whistler is taking preventative measures to prepare in the event that flooding occurs.</p> <p><b>Self-serve sandbag station available at Public Works Yard</b></p> <p>The RMOW has set up a self-serve sandbag station for residents outside the gates of the Public Works Yard (8001 Highway 99). Effective immediately, the self-serve sandbag station is accessible 24 hours per day and will remain open until the risk of flooding subsides. Bags, sand and shovels are being provided free-of-charge to residents.</p> <p>Please continue to check Whistler.ca for updates.</p> <p>Report Flooding. If rainwater on the street is creating a hazard or flooding call the municipality Roads Department at 604-966-8675. After hours or on weekends please call the after-hours emergency line at [call Roads Supervisor to confirm after-hours number issuing media release – number changes depending on time of year].</p>
<b>Sample Owner/Tenant Information Meeting</b>	<p style="text-align: center;"><b><i>Insert Address</i></b></p> <p style="text-align: center;"><b><i>Owner/Tenant Information Meeting</i></b></p> <p><b>Time:</b> 1 p.m. to 2 p.m.</p> <p><b>Date:</b> Thursday, May 8, 2008</p> <p><b>Location:</b> 2<sup>nd</sup> Floor, 147 East 14<sup>th</sup> Street, North Vancouver</p> <p><b>Parking:</b> Paid parking in either the Safeway Parking lot or at Lion's Gate Hospital, or street parking.</p> <p><b>Please bring I.D. with you as this meeting is for tenants only.</b></p>