

Disclaimer:
 This document has been prepared by Northwest Hydraulic Consultants Ltd. for the benefit of Cowichan Valley Regional District for specific application to the Chemainus River Flood Mapping Program. The information and data contained herein represent Northwest Hydraulic Consultants Ltd. best professional judgment in light of the knowledge and information available to Northwest Hydraulic Consultants Ltd. at the time of preparation, and was prepared in accordance with generally accepted geoscience practices. Despite these efforts, actual geomorphic hazards their extents may vary from those shown; Northwest Hydraulic Consultants Ltd. and Cowichan Valley Regional District, including officers and employees, do not assume any liability for such variations, or for use of the maps or data for uses other than that intended.

General Notes:


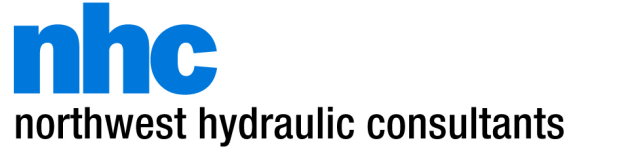
1. Please Refer to the Disclaimer.
2. The geomorphic hazard map was prepared under the Cowichan Valley Regional District's "Chemainus River Flood Mapping Program" by Northwest Hydraulic Consultants Ltd (NHC) in 2021-2022. This study's final report, Chemainus River Flood Mapping Program Part 1 – Floodplain Mapping, should be consulted prior to use of the geomorphic hazard maps.
3. The map delineates areas that are susceptible to channel and shoreline migration hazards. Seven types of geomorphic hazards are identified:
 - 3.1. Modern Valley Bottom (MVB): Area where channel migration has likely occurred in the past several thousand years and is susceptible to occurring under the present-day hydroclimate regime.
 - 3.2. Historical Channel Migration Zone (HMZ): Area that the channel occupied in the historical record, based on available imagery and survey data. This area is also susceptible to erosion and avulsion hazards.
 - 3.3. Channel Erosion Hazard Zone (EHZ): Area susceptible to bank erosion by stream flow over a 60-year planning horizon. This area is also susceptible to avulsion hazards.
 - 3.4. Avulsion Hazard Zone (AHZ): Area that is susceptible to avulsion. This area may also be susceptible to estuary distributary channel hazards in tidally influenced areas. The AHZ is classified into two categories:
 - 3.4.1. First-order avulsion: sudden and major shift to a new part of the floodplain
 - 3.4.2. Second-order avulsion: sudden reoccupation of an old channel on the floodplain. Second-order avulsion zones may also be subject to first-order avulsions.
 - 3.5. Potential Geotechnical Hazard (Unrated): Area with steep slopes within the channel erosion hazard zone, which may become geotechnically unstable due to inundation or erosion of the toe of the slope. A geotechnical assessment is required to determine an appropriate geotechnical setback for land that may potentially be subject to any potential geotechnical hazards. Only steep slopes within 10 m of the erosion hazard zone boundary were flagged as potential geotechnical hazards. Additional steep slope hazards not flagged may exist outside areas identified as potential geotechnical hazard.
 - 3.6. Estuary Distributary Channel Hazard Zone (DHZ): Relatively lower gradient area influenced by tidal processes and susceptible to the formation of distributary channels. This area is also susceptible to channel erosion and avulsion hazards.
 - 3.7. Coastal Erosion Hazard Zone (CHZ): Landward extent of area likely to be susceptible to erosion from tidal currents and waves generated during coastal storms, with 1 m sea level rise. This area is also susceptible to channel erosion, avulsion, and estuary distributary channel hazards.

Data Sources:


1. Geomorphic hazard zones were developed in part using floodplain topography information based on Lidar flown by GeoBC between October 14, 2018 – October 1, 2019 and Chemainus River and immediate overbank topography information based on Lidar acquired by the Cowichan Watershed Board on March 27, 2021. Data was provided to NHC by the CVRD.
2. Geomorphic hazard zones were developed in part using river channel bathymetry on Chemainus River and Bonsall Creek, surveyed by NHC on various dates from May 2021 to June 2021. Offshore bathymetry in Stuart Channel was supplied by Canadian Hydrographic Service (CHS) Non-Navigational 10 m Gridded Bathymetric Data (NONNA-10).
3. Municipal boundaries and cadastral information were provided by the CVRD and GeoBC. High-resolution orthoimagery flown in June 2019 was provided by the CVRD and displayed on the maps where it exists. 2020 orthoimagery from Esri is displayed where the high-resolution data does not exist.

Use and Limitations of Geomorphic Hazard Maps:

1. Geomorphic hazard maps are an administrative tool that depict the potential extent of geomorphic hazards for a given planning horizon. However, a Qualified Professional must be consulted for a site-specific analysis of geomorphic hazards.
2. In the context of this mapping, geomorphic hazards refer specifically to hazards associated with channel avulsion, lateral channel instabilities and shoreline erosion. The geomorphic hazard limits have not been established on the ground by legal survey. The accuracy of the geomorphic hazard boundaries is limited by the Lidar base mapping and orthophotography.
3. The geomorphic hazard maps do not represent flood levels or extents. Details on flooding, including Flood Construction Levels, can be found in the Flood Maps prepared in the same study (NHC, 2022).
4. The maps depict the geomorphic hazard potential at the time that the surveys, field investigations and desktop-based assessment was carried out. Future changes to the river channels, floodplain, and future climate change or sea level rise will render the maps obsolete. The information on the maps should be reviewed after 5 years have elapsed since publication or after any extreme flood occurrence, or if the physical conditions of the watershed or floodplain substantially change.
5. Geotechnical hazards were not analyzed as a part of this study. Areas with steep slopes within the erosion hazard zone have been flagged, but these areas have not undergone a geotechnical assessment. Areas with steep slopes may exist outside the erosion hazard zone and such areas have not been flagged. A geotechnical assessment is required to identify and evaluate potential geotechnical hazards.
6. The geomorphic hazard analysis performed was limited only to the Chemainus River reach located within the map study extents. The geomorphic hazard zones delineated on this map do not include the geomorphic hazard potential from channel processes on Bonsall Creek, Whitehouse Creek, or other tributaries to the Chemainus River.
7. The hazard maps do not include other hazards, such as those associated with stormwater, fire, seismic, geotechnical, wildlife, etc. The maps do not account for other, uncertain future changes that could alter the landscape and may alter the geomorphic hazard potential, nor do they account for sediment sources, terrain assessment, or assessment of the potential or frequency of slope instabilities, debris flow, debris flood, potential for channel jamming and outburst flooding, or hyper-concentrated flow. Additional, undetected geomorphic hazards may exist on the Chemainus River upstream of the map extent; Northwest Hydraulic Consultants Ltd. (NHC) and the Cowichan Valley Regional District do not assume any liability for such variations.

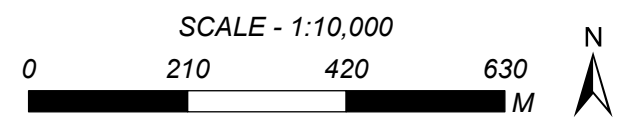
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	MODERN VALLEY BOTTOM
	HISTORICAL MIGRATION ZONE
	CHANNEL EROSION HAZARD ZONE
	FIRST ORDER AVULSION HAZARD ZONE
	SECOND ORDER AVULSION HAZARD ZONE
	POTENTIAL GEOTECHNICAL HAZARD FLAG
	ESTUARY DISTRIBUTARY CHANNEL HAZARD ZONE
	COASTAL HAZARD ZONE
	FLOW DIRECTION
	EXTENT OF STUDY
	FIRST NATION ADMINISTRATIVE BOUNDARY
	CVRD ELECTORAL AREA BOUNDARY
	MINOR ROAD
	MAJOR ROAD
	RAIL
	PARCEL BOUNDARY
	DETECTED RELIC CHANNEL PATHS
	CREEKS

REFER TO GENERAL NOTES AND LIMITATIONS ON MAP

SCALE - 1:10,000



Coordinate System: NAD 1983 CSRS UTM Zone 10N
 Units: Metres; Vertical Datum: CGVD2013

Geomorphologist WPH, IBK, RAM	GIS IBK, RAM	Reviewer WPH
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**CHEMAINUS RIVER
 INTEGRATED FLOOD
 MANAGEMENT PROGRAM
 GEOMORPHIC HAZARD MAP
 SHEET 1 OF 1**