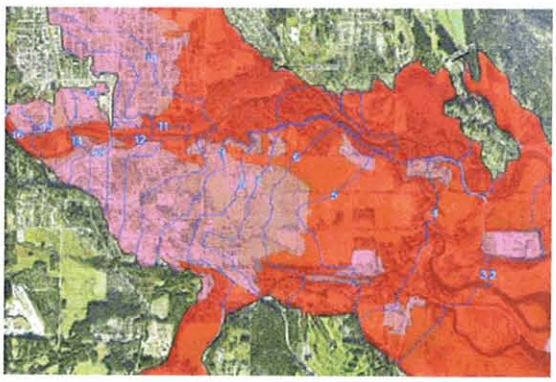
COWICHAN VALLEY REGIONAL DISTRICT




LOWER COWICHAN / KOKSILAH RIVER INTEGRATED FLOOD MANAGEMENT PLAN

FINAL REPORT

SEPTEMBER 2009

nhc northwest hydraulic consultants

Leaders in water resource technology

EXECUTIVE SUMMARY

The Cowichan Valley Regional District (CVRD), in partnership with Cowichan Tribes, the City of Duncan and the District of North Cowichan (DNC), retained Northwest Hydraulic Consultants (NHC) to update existing floodplain mapping and to develop an Integrated Flood Management Plan for the Lower Cowichan-Koksilah River floodplain, including major tributaries. Funding for this program was built by a partnership of supporting funds from the following organisations: Union of BC Municipalities Innovations Fund, Cowichan Tribes and the BC Provincial Emergency Program as well as substantial in-kind contributions from local government organisations.

Given the very broad nature of the study, NHC recommended that a phased approach be adopted so that the project goals and objectives could be refined over the course of the project. The main outputs of the project are summarized in four documents:

- Volume 1 - Scoping Report
  - Field investigations and base map development, including substantial field reviews and GIS analysis
  - Literature review of local and international flood management practices
- Volume 2 - Technical Investigations
  - Technical investigations related to hydrology, hydraulics, sedimentation and channel hazards
  - Detailed assessments of the capacity of existing flood control structures using numerical models
  - Environmental investigations including habitat and fisheries values, threats and opportunities
- Volume 3 - Integrated Flood Management Plan (this report)
  - Summary of findings from Volumes 1 and 2
  - Mapping tools for flood hazard, channel erosion and habitat value
  - Analysis of flood management best management practices
  - Project goals, guiding principles and proposed actions (priority and long-term)
- Summary Paper

COWICHAN FLOOD MANAGEMENT AREA

The headwaters of the Cowichan River/Koksilah River system are located in the rugged mountains of southern Vancouver Island. The Cowichan River has its headwaters in Cowichan Lake, and then flows in an easterly direction into Cowichan Bay. The smaller Koksilah River joins the south branch of the Cowichan River approximately 1 km upstream of Cowichan Bay. The lower slopes and floodplain of the river system contain significant areas of agricultural land as well as rural, urban and industrial development. Dikes have been built along both banks of the Cowichan River to protect the developed urban core of the City

of Duncan and the extensive agricultural and industrial zones downstream. Dikes have also been constructed on lands of the Cowichan Tribes at various times including along the Koksilah River

The Cowichan River is designated as a Heritage River and recognized for its highly valuable and productive fish habitat. The river supports seven species of salmon and trout including important stocks of chinook, coho, chum, steelhead trout, brown trout, rainbow trout and cutthroat trout. The mainstem Cowichan River supports a unique run of summer run chinook that is considered by Fisheries and Oceans Canada (FOC) to be one of the highest value stocks on Vancouver Island based on conservation concerns and rebuilding efforts. The Cowichan River also supports a highly valued wild winter run of Steelhead trout whose status is also a conservation concern with active stock rebuilding efforts undertaken by the BC Ministry of Environment (MOE).

The valley has experienced many flood events resulting from high flows in the Cowichan River and its tributaries, and from ponding in low-lying areas during heavy rain events. Large flow events in the Cowichan River were documented in 1979, 1986 and 2007. The most recent flood event of 2007 resulted in the closure of the Island Highway as well as the evacuation of 17 families living on the floodplain.

The flood management area extends along the Cowichan River from below the Catalyst water intake down to the ocean and along the Koksilah River from just below Bright Angel Park down to the ocean. Also included in the project area are Somenos Creek and Somenos Lake. In order to assess the hydrology, sedimentation processes and factors affecting channel erosion and debris hazards, the investigations have extended beyond the limits of the flood mangement area. These related studies have been conducted at a watershed scale and extend over the Cowichan River basin downstream of Cowichan Lake and portions of the Koksilah basin.

The City of Duncan, with a population of approximately 5,000 lies at the centre of the floodplain. The Cowichan Tribes has about 3,800 members, many of whom live on the floodplain. In addition to residential areas, there is urban and agricultural development in the floodplain as well as significant critical infrastructure. To date, land-use planning has not controlled the establishment of houses and other critical infrastructure from being developed on the floodplain.

PROJECT TOOLS AND RESULTS

This present study has provided technical information and a range of new management tools (GIS-based flood, erosion and habitat maps), that can be used as a road map for implementing Integrated Flood Management in the Cowichan-Koksilah basin. However, it will take various stakeholders, local organizations and participating agencies to build and implement a long-term sustainable program.

Over the course of the project, two major technical tools were developed to help in the planning process. A two-dimensional hydraulic model was developed to assess the

magnitude and extent of flood hazards in the study area. The development of this model is detailed in Volume 2 – Technical Investigations. In addition, a comprehensive GIS database that includes habitat sensitivity and flood hazard mapping was developed. Mapsheet 1 shows flood hazard areas established from the hydraulic models and erosion hazard assessments. Two hazard zones have been defined, where areas in the "floodway" are expected to experience deeper and faster flows, and therefore more hazardous conditions, during a flood event. By comparison the "flood fringe" represents the portion of the floodplain that may be subject to inundation and ponding but only contributes marginally to conveying the flood.

Extensive background studies were made using the models and mapping to assess the magnitude and extent of the flood hazards in the study area. Results of the analysis showed none of the existing dikes have adequate freeboard for a 200-year flood over their entire length. Key conclusions from the hydraulic analyses are as follows:

- None of the existing dikes have adequate freeboard for a 200-year flood over their entire length. Portions of the City of Duncan are vulnerable to flooding due to overtopping or breaching of the JUB lagoon dike, as well as from backwater flooding from Somenos Creek in the Lakes Road area. Critical infrastructure such as the JUB sewage lagoons and outfall are vulnerable to damage from flooding and bank erosion.
- Under 200-year flood conditions, large spills occur along both banks of the Koksilah River, resulting in overtopping of the Trans-Canada Highway. Deep and fast flow conditions occur on the floodplain, which could pose high erosion hazards to buildings or other structures on the floodplain.
- Flooding and bank erosion can be aggravated by log jams and sediment deposition, so that the most severe potential flood damages may not necessarily arise from the most severe hydro-meteorological events. The log debris and sediment originate in the headwaters of the watersheds, upstream of the flood management planning area.
- Flood levels and flood spills over the entire floodplain area are vulnerable to alterations in dike crest levels. Furthermore, raising roads on the floodplain can have a similar effect as raising dikes. Raising or extending a dike or road at one location may raise flood levels farther upstream. It appears many local dikes were constructed without assessing their effect on adjacent areas. Further raising or extension of dikes should not be permitted unless it can be demonstrated there will be no net water level rise at other locations.
- The Cowichan River has been artificially straightened, re-located and confined by riprap dikes, producing a canal-like appearance over much of its length. This produces high velocities and scour through narrow sections, together with localized gravel deposition and channel instability in wider sections. This type of channelized river generally requires regular maintenance and repair. Also, it adversely impacts fisheries habitat by reducing complexity.
- Currently simulated 200-year flood levels on portions of the Cowichan River, portions of Koksilah River upstream of the Trans-Canada Highway, and all of Somenos Creek and Somenos Lake are generally higher than those predicted in earlier studies. Most of the bridges in the study area appear to have inadequate

clearance under open water conditions, and are therefore susceptible to trapping logs and floating debris and potential structural failure.

The habitat sensitivity pilot project completed as part of this study is intended to be an iterative product that will be reviewed and updated with collection of new data or integration with other mapping products. The intent of the pilot mapping tool is to provide a starting point as a tool for land and resource management that illustrates known fisheries and wildlife habitat values and conceptual habitat restoration opportunities.

Several different types of flood mapping products were produced in this study.

Updated Floodplain Maps: showing 200-year flood construction levels, flood extent, and a higher hazard "floodway" zone. The floodway classification is intended to differentiate the higher hazard (deeper and faster flood water) areas on the floodplain from the lower hazard (shallow or low velocity) "flood fringe" zone.

Flood Scenario Maps: are intended to assist in emergency response planning since they show a number of hypothetical flood spills and inundation zones during future events. The information is available in three formats - printed copies, digital GIS output and as digital output that can be displayed via the internet using Google Earth.

Habitat Sensitivity Maps: A habitat ranking system has been developed and applied to the study area using a GIS-based mapping system to support strategic planning and operational investigations related to habitat and restoration.

INTEGRATED FLOOD MANAGEMENT PLAN GOALS

Integrated Flood Management (IFM) is a relatively new concept, emerging out of broader water management policies that promote the development and management of water, land and related resources without compromising the sustainability of vital ecosystems. The defining characteristic of IFM is integration, expressed simultaneously in different forms: an appropriate mix of strategies, location of interventions, types of interventions (structural or non-structural), and a participatory and transparent approach to decision making - particularly in terms of institutional integration.

Improving integrated flood management in the region will be a challenge. Fortunately, there is a strong base of community stakeholder involvement through the Cowichan Round Table and a Water Management Plan has already been prepared. The overall strategy and goals of the plan are consistent with the aims and general direction in the new BC Living Water Smart initiative.

The overall goals of this study, as stated in the Call for Proposals, are as follows:

Goal 1

The plan should aim to reduce flood risk to all communities on the floodplain, while protecting aquatic and riparian habitat and addressing the cultural values of the rivers.

Goal 2

The plan should promote innovative methods of flood hazard management to minimise short and long-term economic, environmental and social costs and where possible, provide an increase in the environmental and social capital of the region.

In addition to these two explicit goals, the scope has also been broadened to incorporate new information and lessons-learned from other integrated flood management planning organizations.

Goal 3

The plan should be achievable and should be supported by project stakeholders and the community at large. And, tools and recommended actions should be sustainable in the long-term.

The following nine guiding principles have been followed in preparing preliminary concepts and initiatives in support of the plan and the goals outlined above.

- **Return the rivers to a more naturalised state.** The Cowichan River has been artificially straightened and confined by riprap and dikes. This type of channelized river generally requires a high degree of maintenance and repair. In the Cowichan, some of the dikes are the responsibility of local government or individuals who may not have the resources to maintain them. Channelization also adversely impacts fisheries habitat by reducing habitat complexity. Therefore, restoring the river to a more "naturalized" channel configuration that has room to convey water within a broad floodway should be a part of a long-term strategy.
- **Sustain the natural state of existing floodplain.** Remaining undeveloped floodplain areas should be sustained in a natural state. Initiatives should be compatible or be integrated with programs that protect and enhance aquatic and riparian habitat.
- **Site future development in areas with low flood hazard and low habitat sensitivity.**
- **Ensure new or upgraded flood protection structures do not adversely increase the overall flood hazard.** Based on past experience along the river, a "no-net adverse impact" flood level policy for future developments on the floodplain, including future diking and flood protection works, is needed. Constructing new dikes or extending existing ones should not increase the risk of flood damage in other vulnerable areas.
- **Mitigate impacts of high flows on mainstem.** Impacts of high flows (erosion) on mainstem should be mitigated by facilitating flow through suitable off-channel habitat.
- **Maintain channel conveyance.** Consider and maintain sites of debris jams and debris/gravel accumulation. An "adaptive" maintenance approach that incorporates habitat enhancement as part of channel maintenance is needed.
- **Create accessible and sustainable tools for flood management.** New tools developed for the project need to be designed so they can be used interactively and

dynamically for emergency management, improved land-use planning, public awareness and education.

- **Promote basin-wide planning initiatives.** Basin-wide planning is important, particularly since most of the flood water, sediment and debris originates upstream of jurisdictional boundaries in the basin headwaters.
- **Monitor and maintain flood management program.** Monitoring and maintenance are essential components of a flood management program. This should not just apply to dikes or bank protection works, but the channel as a whole. This is particularly important when considering the unknown future implications of climate change that may affect hazard levels in the region.

RECOMMENDED ACTIONS

A portfolio of planning and structural (engineering) measures was developed as part of the flood plan. Key structural projects are shown in Figures 8.1 and 8.2. Twenty specific projects that promote the guiding principles (above) and include habitat enhancement as a project component are also outlined in this report and include:

- Dike upgrades or new dike construction (two priority projects are described below)
- Channel maintenance and improvement programs
- Gravel removal and maintenance programs
- Log jam removal and modification programs
- Selective vegetation removal
- Set-back dike construction
- Upstream sediment and debris control
- Road modifications
- Bridge replacements
- Recommended compensation projects

The existing flood protection around critical infrastructure and higher density populated areas in Duncan should be upgraded as soon as possible. In particular, the existing dikes around the JUB sewage lagoon should be raised and provided with erosion protection and tied in to the Cowichan (City of Duncan) Dike. A design review of the lagoons should be carried out as part of this work.

The Koksilah Village Dike is vulnerable to overtopping and erosion and local residences are exposed to a higher flood risk than most other locations on the floodplain. Given the deep and fast flow conditions after a dike breach, floodproofing the residences is not a practical option. Discussions should be held with residents on options for dike strengthening and raising versus re-settlement.

Land use planning instruments including the use of floodproofing and a two-zone flood map are described in this report. These are in addition to further policy instruments including public education, flood warning mechanisms and emergency response planning.

Finally, consideration was given on ways to promote integrated flood management in the region and assisting in its implementation. Forming a Basin Council (modelled on the Fraser Basin Council) would be one option for promoting integrated, basin-wide sustainable water management. The Council would still require existing authorities for implementing major projects. Forming a Basin Water Board (modelled after the Okanagan Board) would provide powers for raising funds and implementing programs directly. The two organizations are not incompatible.

CONCLUSIONS

The results of this study are intended to assist the communities with developing strategies and plans to address mutual flood hazards over the next decade. The measures include both structural flood control and non-structural flood mitigation initiatives in addition to providing resources for future planning. The aim is to help provide a "road map" leading to more flood-resistant communities and a more natural, ecologically productive and sustainable river system. This approach requires that floodwaters and floodways be seen as a resource and opportunity rather than simply a management issue, and that habitat enhancement is carried out as part of the flood protection work, rather than simply trying to mitigate environmental impacts from new flood infrastructure. Ultimately, the stakeholders, local governments and Cowichan Tribes will need to frame their own goals and objectives in order to implement the final plan.

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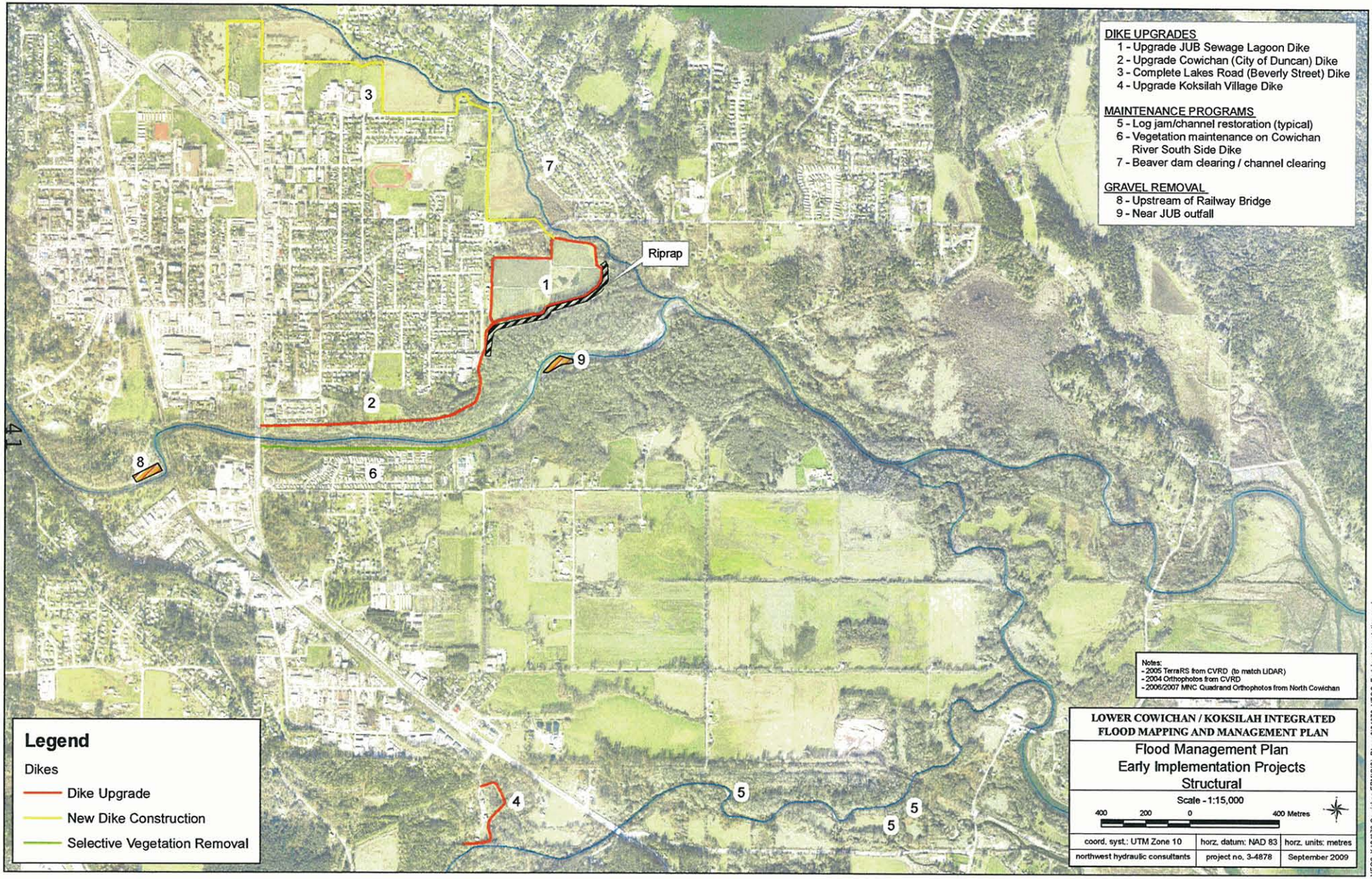
DIKE UPGRADES
1 - Upgrade JUB Sewage Lagoon Dike
2 - Upgrade Cowichan (City of Duncan) Dike
3 - Complete Lakes Road (Beverly Street) Dike
4 - Upgrade Koksilah Village Dike
MAINTENANCE PROGRAMS
5 - Log jam/channel restoration (typical)
6 - Vegetation maintenance on Cowichan River South Side Dike
7 - Beaver dam clearing / channel clearing
GRAVEL REMOVAL
8 - Upstream of Railway Bridge
9 - Near JUB outfall
Riprap
Legend
Dikes
Dike Upgrade
New Dike Construction
Selective Vegetation Removal
Notes:
- 2005 TerraRS from CVRD (to match LiDAR)
- 2004 Orthophotos from CVRD
- 2006/2007 MNC Quadrand Orthophotos from North Cowichan
LOWER COWICHAN / KOKSILAH INTEGRATED FLOOD MAPPING AND MANAGEMENT PLAN
Flood Management Plan
Early Implementation Projects
Structural
Scale - 1:15,000
400 200 0 400 Metres
coord. syst.: UTM Zone 10
horz. datum: NAD 83
horz. units: metres
northwest hydraulic consultants
project no. 3-4878
September 2009
\\FOC_X:\3-4878 Cowichan FPM\GIS_Phase3\3-4878_VFOC_Early\Implementation.mxd

Figure 8.1

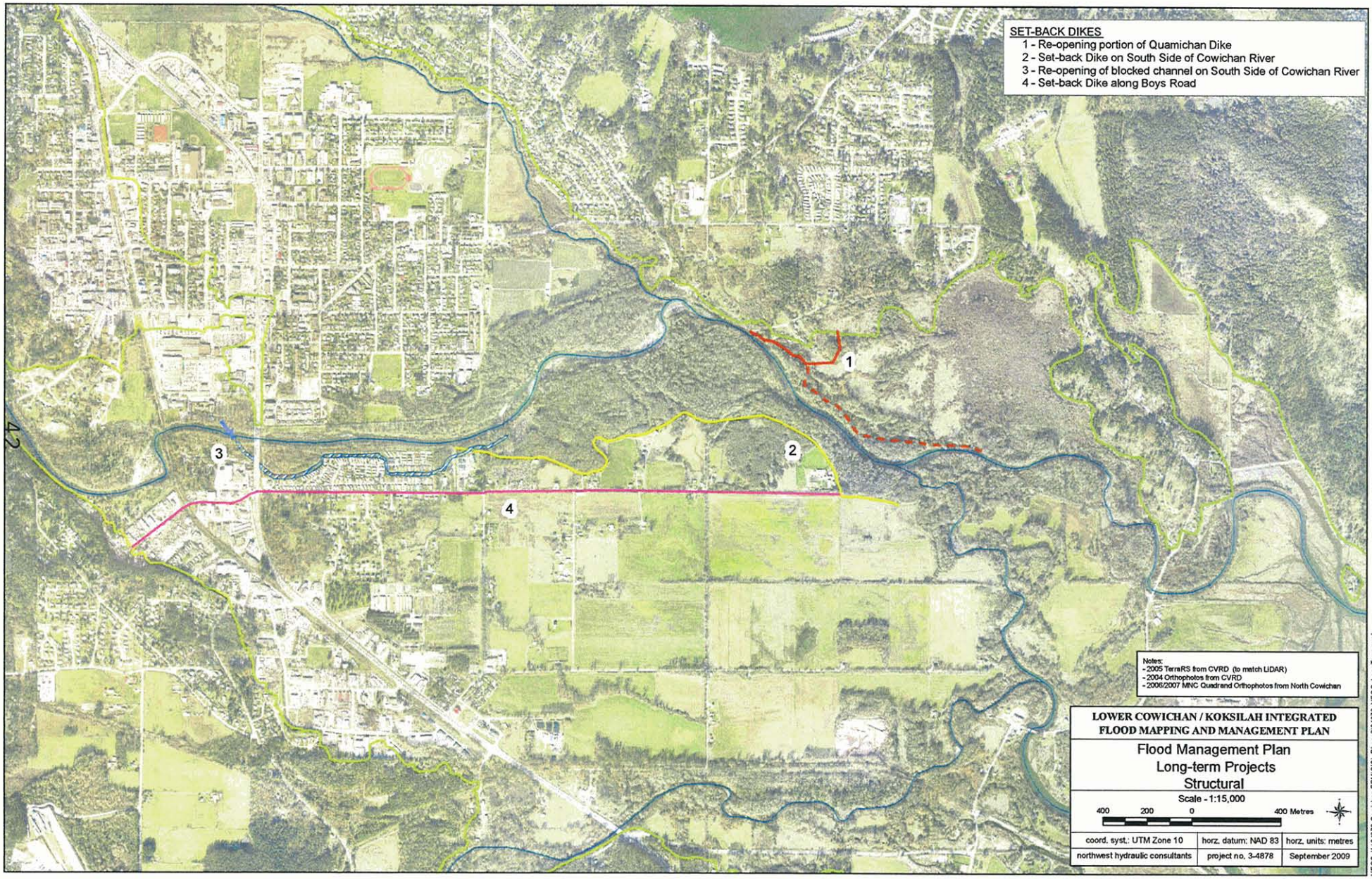
SET-BACK DIKES
1 - Re-opening portion of Quamichan Dike
2 - Set-back Dike on South Side of Cowichan River
3 - Re-opening of blocked channel on South Side of Cowichan River
4 - Set-back Dike along Boys Road
1
2
3
4
Notes:
- 2005 TerraRS from CVRD (to match LiDAR)
- 2004 Orthophotos from CVRD
- 2006/2007 MNC Quadrand Orthophotos from North Cowichan
LOWER COWICHAN / KOKSILAH INTEGRATED FLOOD MAPPING AND MANAGEMENT PLAN
Flood Management Plan
Long-term Projects
Structural
Scale - 1:15,000
400 200 0 400 Metres
coord. syst.: UTM Zone 10
horz. datum: NAD 83
horz. units: metres
northwest hydraulic consultants
project no. 3-4878
September 2009
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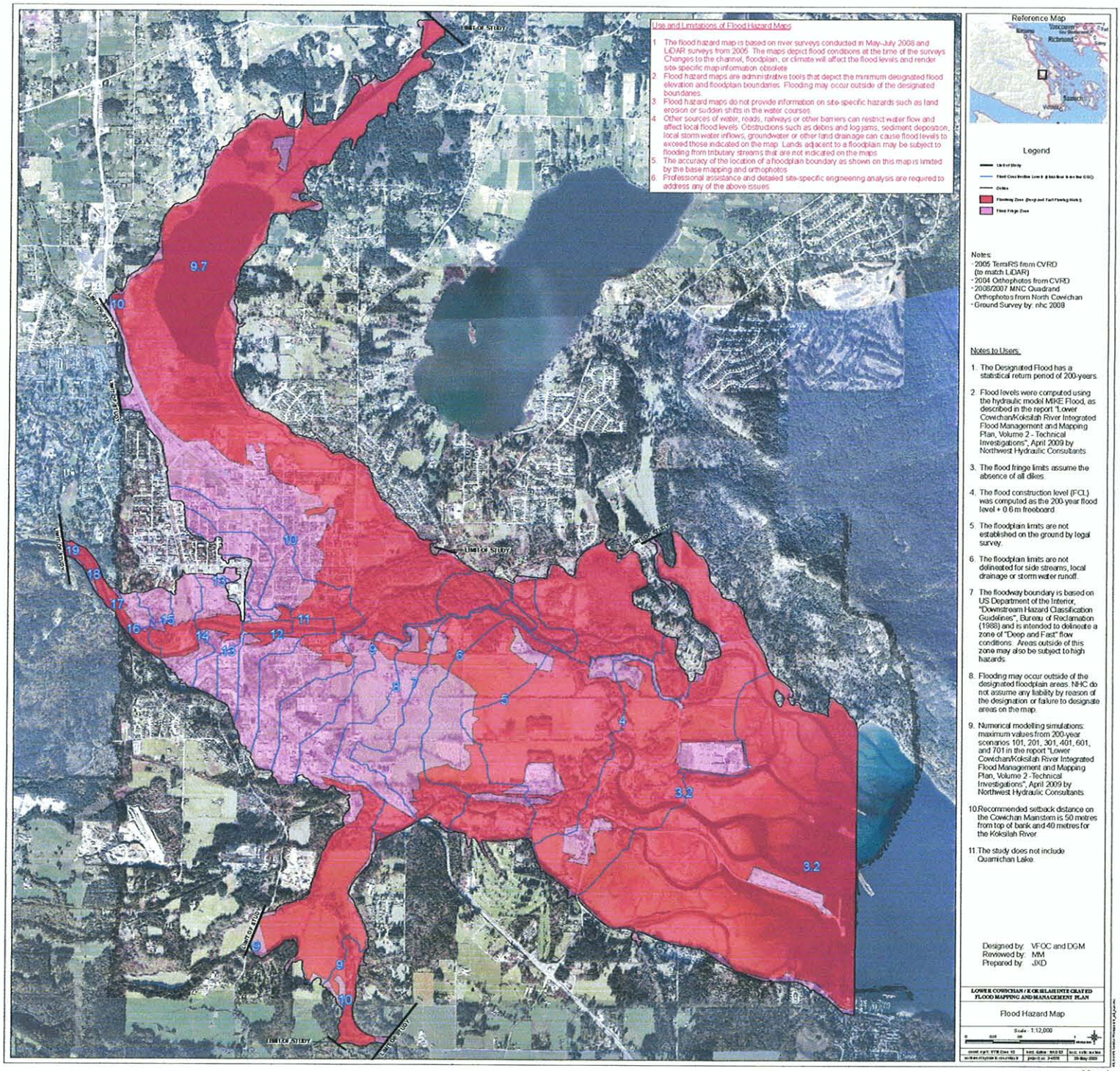
Figure 8.2


Use and Limitations of Flood Hazard Maps
1. The flood hazard map is based on river surveys conducted in May-July 2008 and LiDAR surveys from 2005. The maps depict flood conditions at the time of the surveys. Changes to the channel, floodplain, or climate will affect the flood levels and render site-specific map information obsolete.
2. Flood hazard maps are administrative tools that depict the minimum designated flood elevation and floodplain boundaries. Flooding may occur outside of the designated boundaries.
3. Flood hazard maps do not provide information on site-specific hazards such as land erosion or sudden shifts in the water courses.
4. Other sources of water, roads, railways or other barriers can restrict water flow and affect local flood levels. Obstructions such as debris and log jams, sediment deposition, local storm water inflows, groundwater or other land drainage can cause flood levels to exceed those indicated on the map. Lands adjacent to a floodplain may be subject to flooding from tributary streams that are not indicated on the maps.
5. The accuracy of the location of a floodplain boundary as shown on this map is limited by the base mapping and orthophotos.
6. Professional assistance and detailed site-specific engineering analysis are required to address any of the above issues.
Reference Map
Legend
Notes:
- 2005 TerraRS from CVRD (to match LiDAR)
- 2004 Orthophotos from CVRD
- 2008/2007 MNC Quadrand Orthophotos from North Cowichan
- Ground Survey by: nhc 2008
Notes to Users:
1. The Designated Flood has a statistical return period of 200-years.
2. Flood levels were computed using the hydraulic model MIKE Flood, as described in the report "Lower Cowichan/Koksilah River Integrated Flood Management and Mapping Plan, Volume 2 - Technical Investigations", April 2009 by Northwest Hydraulic Consultants.
3. The flood fringe limits assume the absence of all dikes.
4. The flood construction level (FCL) was computed as the 200-year flood level + 0.6 m freeboard.
5. The floodplain limits are not established on the ground by legal survey.
6. The floodplain limits are not delineated for side streams, local drainage or storm water runoff.
7. The floodway boundary is based on US Department of the Interior, "Downstream Hazard Classification Guidelines", Bureau of Reclamation (1988) and is intended to delineate a zone of "Deep and Fast" flow conditions. Areas outside of this zone may also be subject to high hazards.
8. Flooding may occur outside of the designated floodplain areas. NHC do not assume any liability by reason of the designation or failure to designate areas on the map.
9. Numerical modelling simulations: maximum values from 200-year scenarios 101, 201, 301, 401, 601, and 701 in the report "Lower Cowichan/Koksilah River Integrated Flood Management and Mapping Plan, Volume 2 -Technical Investigations", April 2009 by Northwest Hydraulic Consultants.
10. Recommended setback distance on the Cowichan Mainstem is 50 metres from top of bank and 40 metres for the Koksilah River.
11. The study does not include Quamichan Lake.
Designed by: VFOC and DGM
Reviewed by: MM
Prepared by: JXD
LOWER COWICHAN / KOKSILAH INTEGRATED FLOOD MAPPING AND MANAGEMENT PLAN
Flood Hazard Map
Limit of Study
9.7
3.2

Map 1