Integrated Flood Hazard Management Plan

River Flood Hazards & Mitigation Concepts

Council Update #7

February 16, 2016

SQUAMISH

KERR WOOD LEIDAL
consulting engineers

Arlington Group
Planning + Architecture Inc.

Agenda

- Background
- Guiding Principles
- Risk & Mitigation
- Public Engagement
- Online Survey
- Stawamus Floodplain
- Cheakamus Floodplain
- Squamish/Mamquam Floodplain
- Discussion

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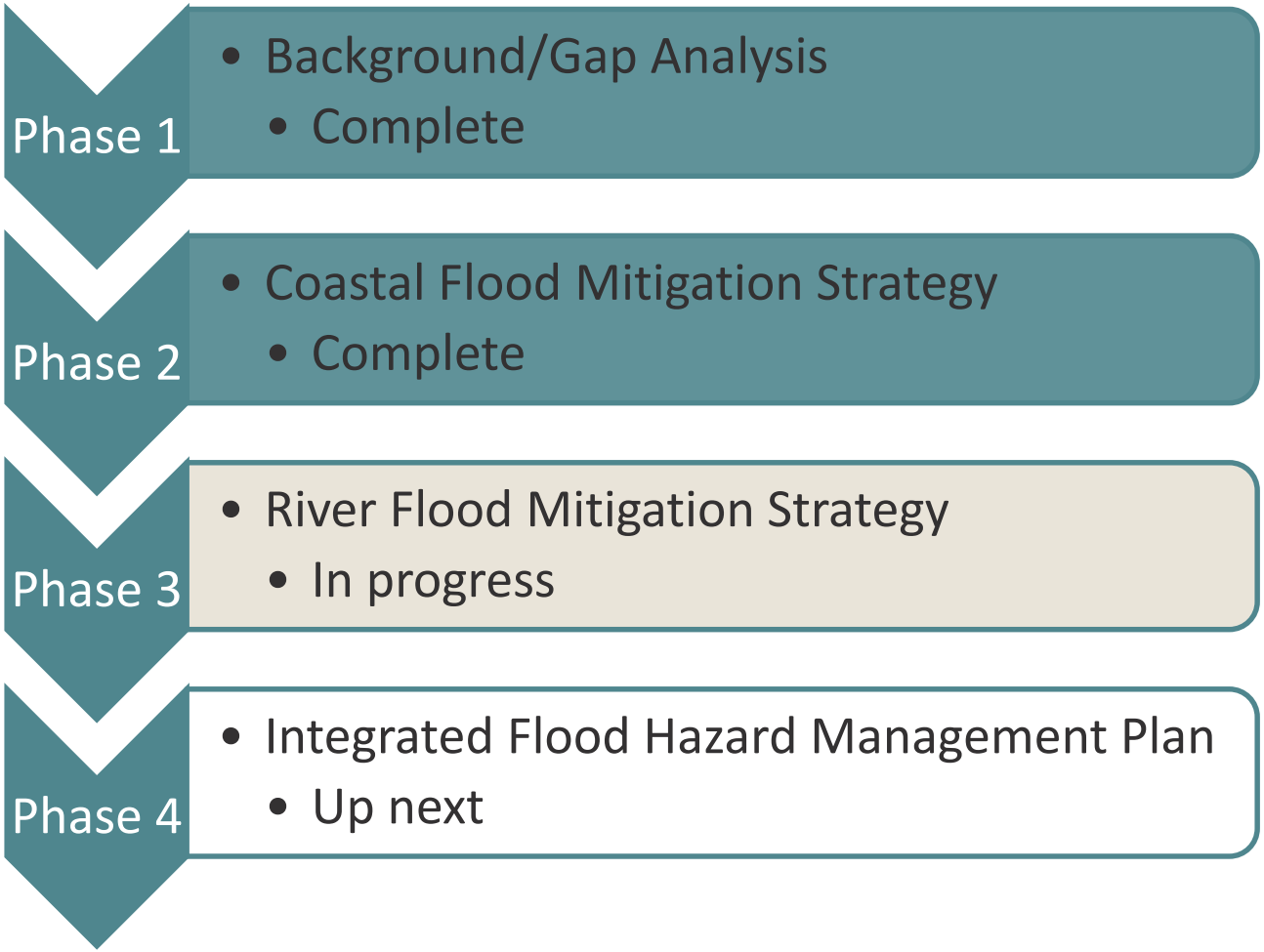
Integrated Flood Hazard Management Plan



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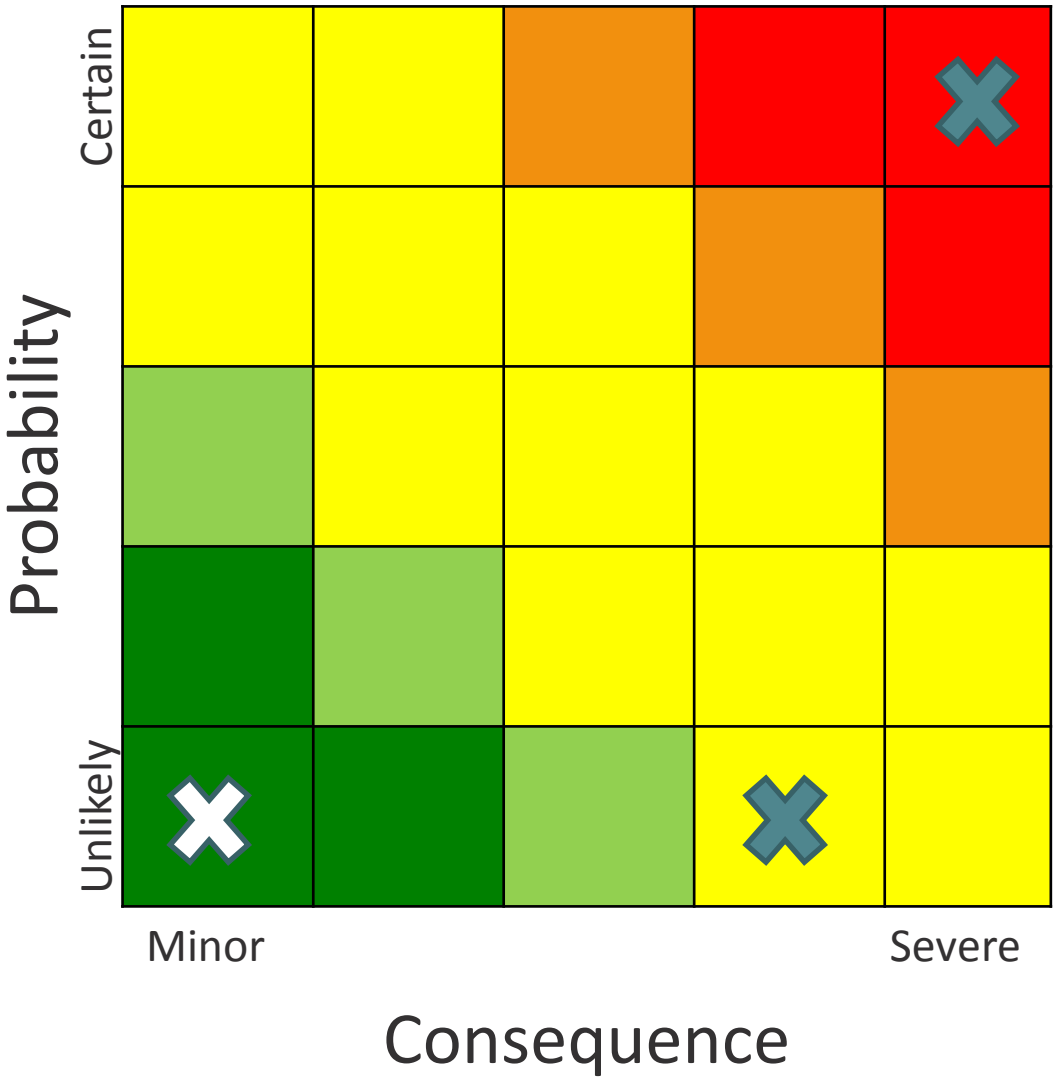
Guiding Principles

- **Reduce flood risk**
- **Identify development opportunities**
- **Make sustainable decisions**
- **Design achievable solutions**

Risk & Mitigation Strategies



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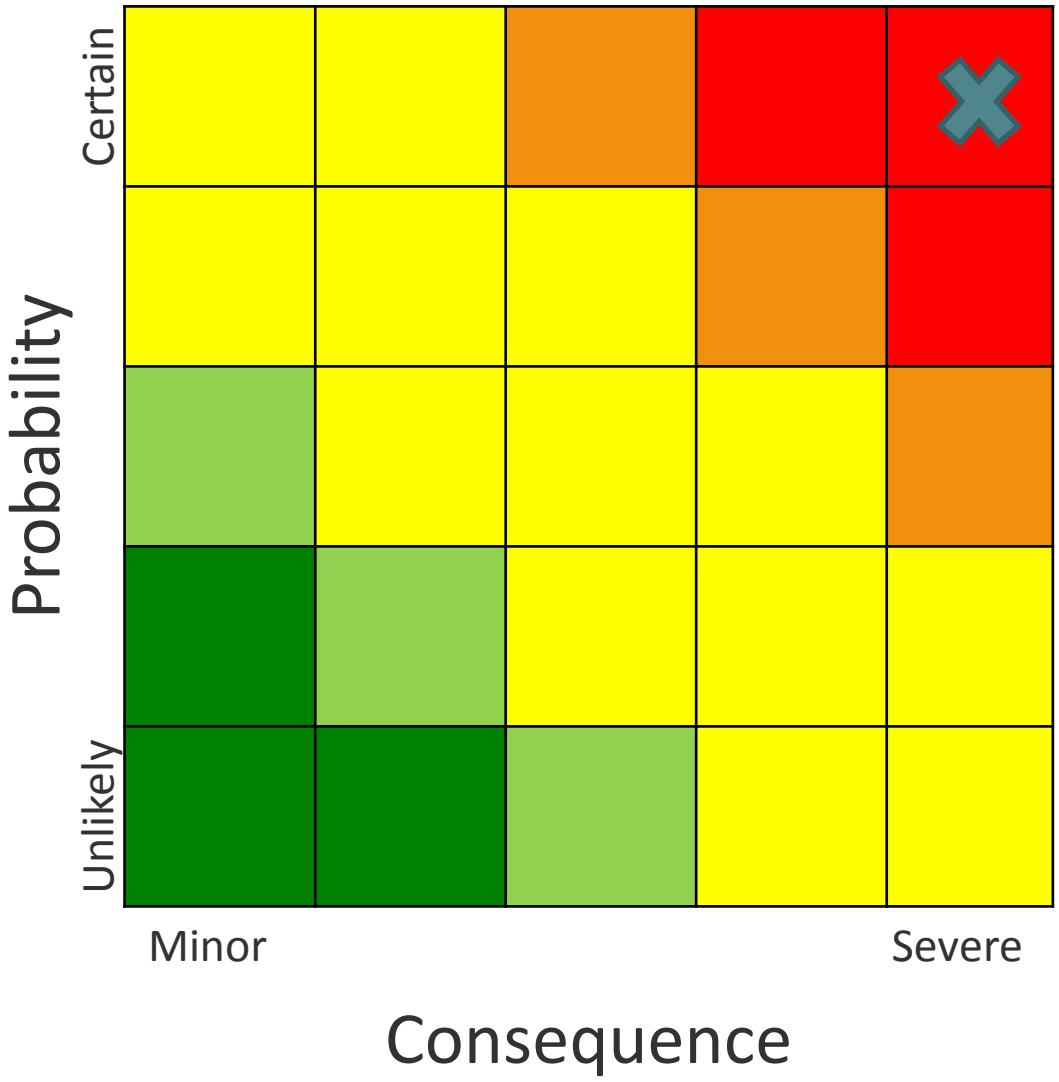
Risk & Mitigation Strategies



Community in floodplain with no protection

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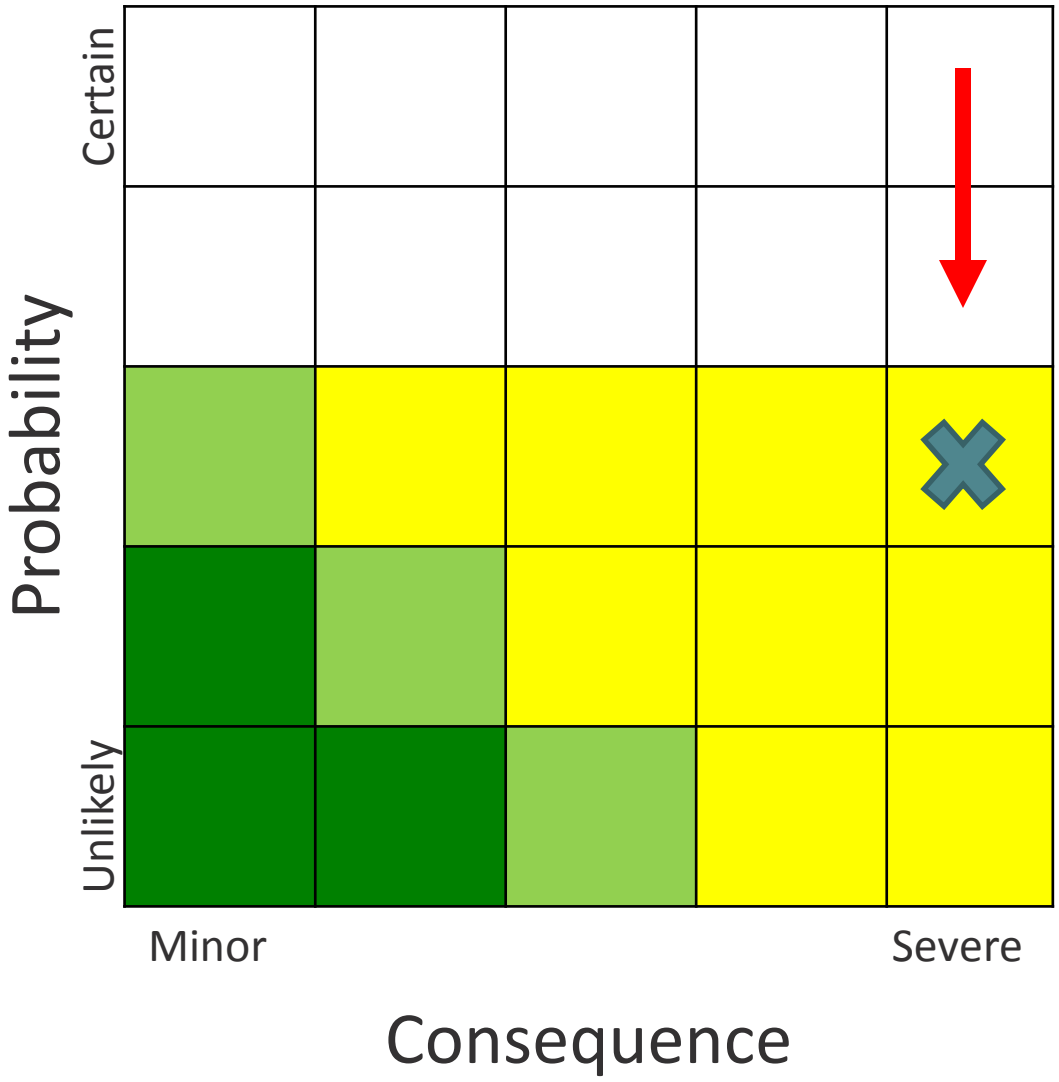
Risk & Mitigation Strategies



Protect

- Dikes

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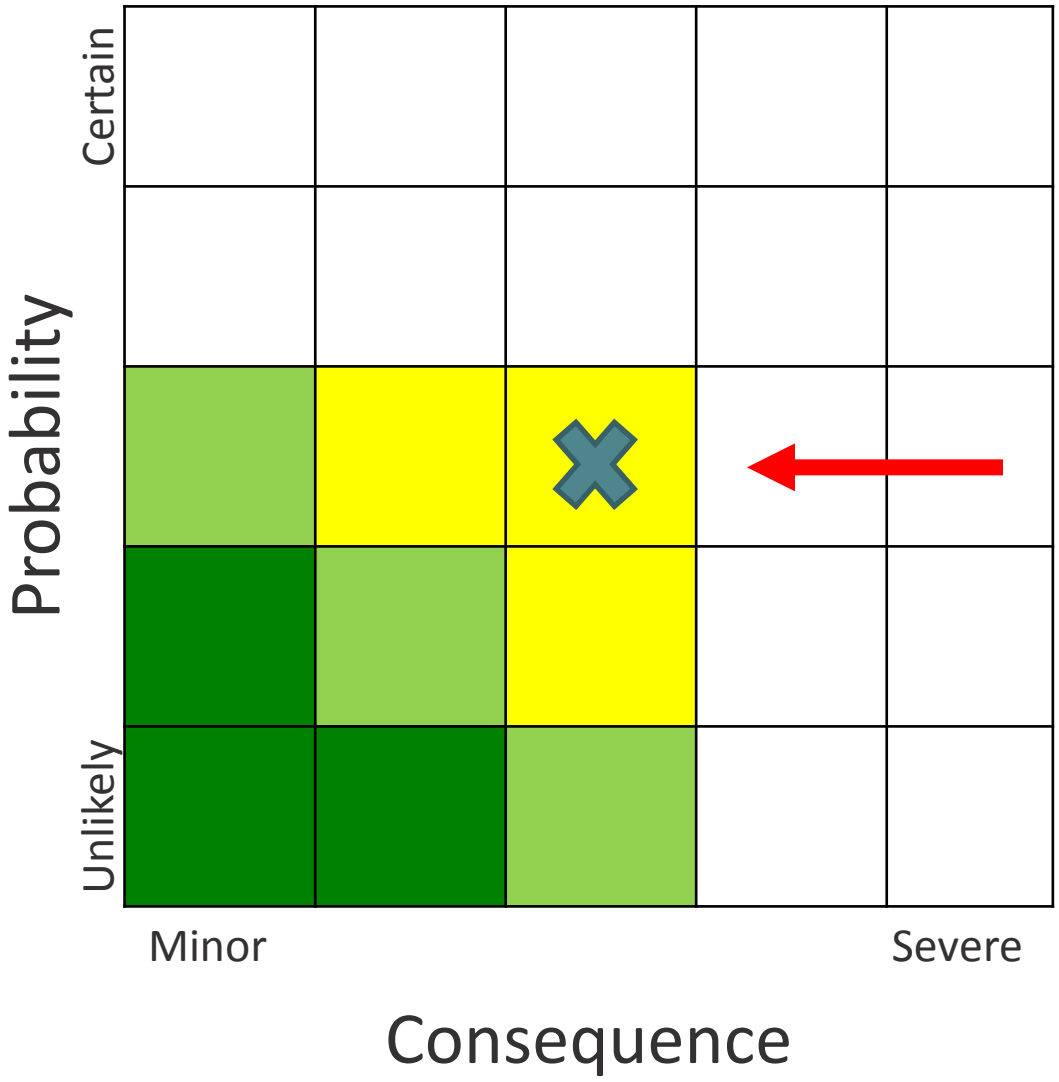
Risk & Mitigation Strategies



Protect

- Dikes

Accommodate

- FCL

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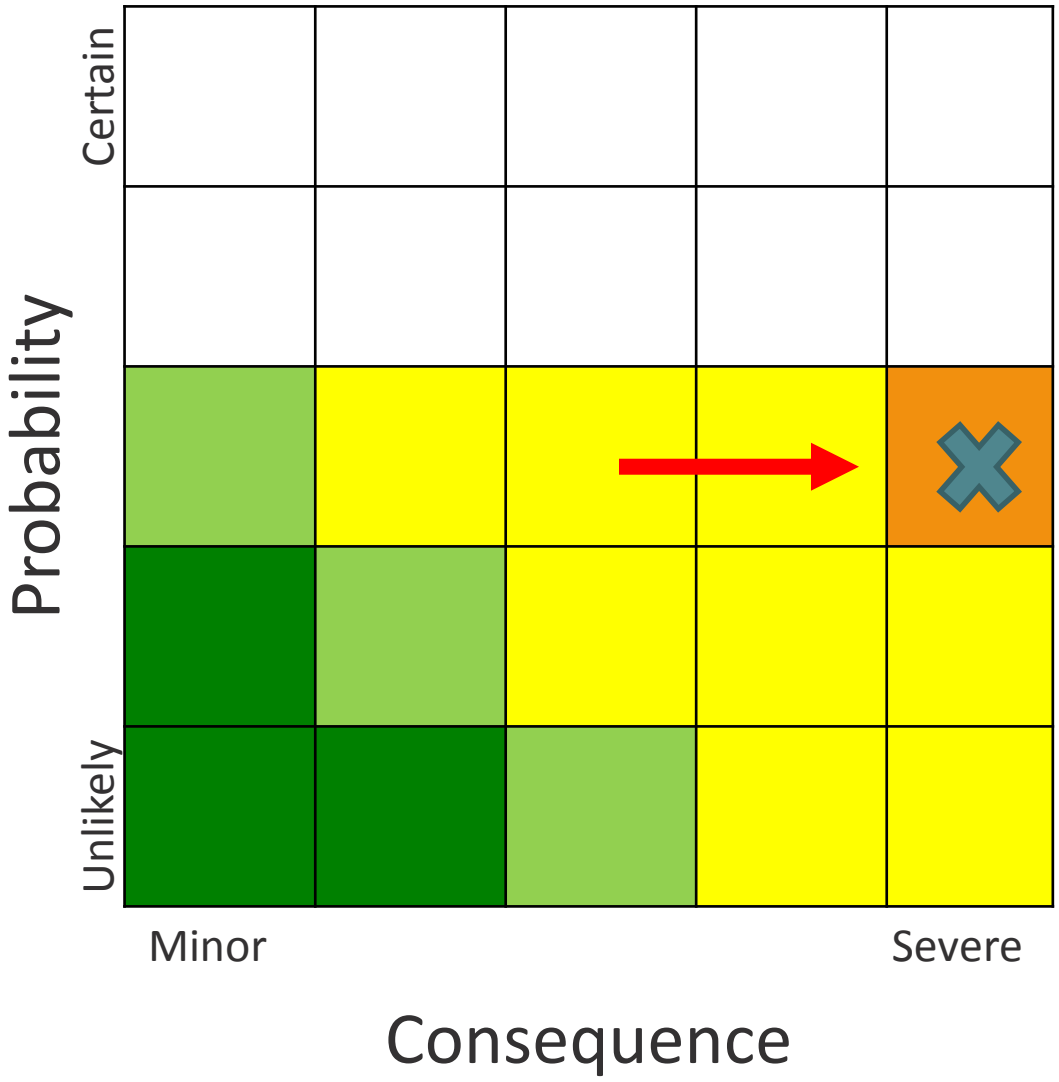
Risk & Mitigation Strategies



Protect

- Dikes

Accommodate

- FCL

Future Scenario

- Growth in floodplain

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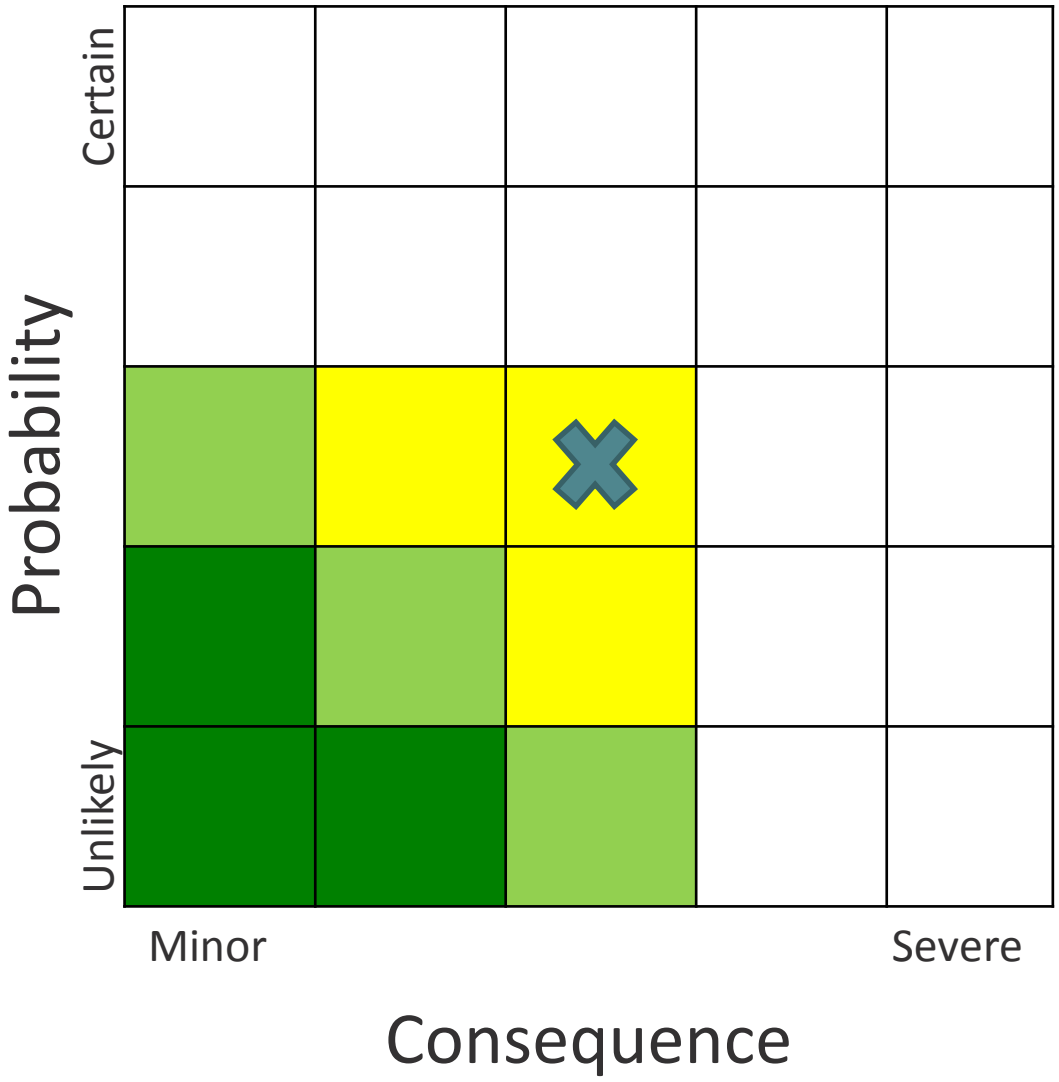
Risk & Mitigation Strategies



Protect

- Dikes

Accommodate

- FCL

Avoid

- Growth outside floodplain

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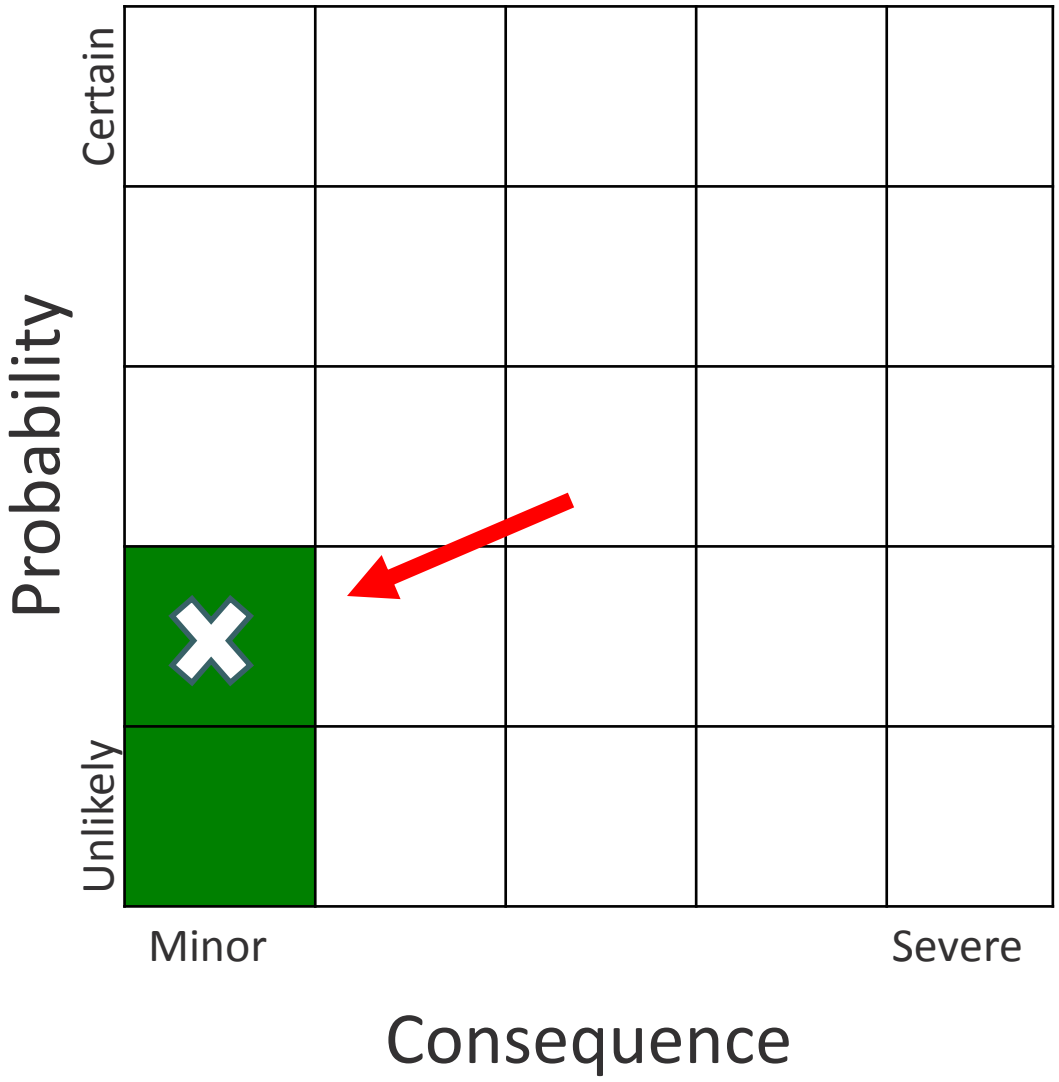
Risk & Mitigation Strategies



Protect

- Dikes

Accommodate

- FCL

Avoid

- Growth outside floodplain

Retreat

- Withdraw assets

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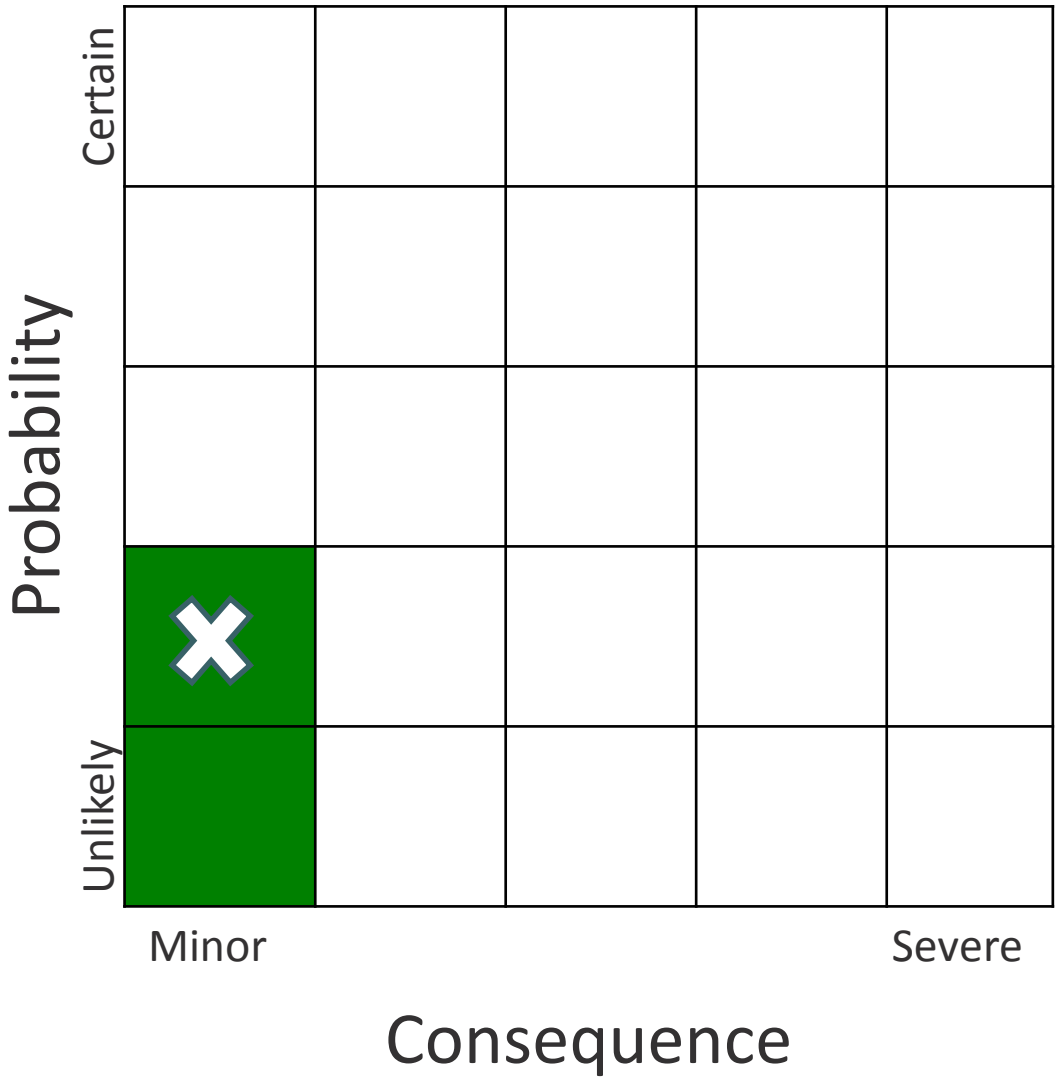

Protect

- Dikes

Accommodate

- FCL

Avoid

- Growth outside floodplain

Retreat

- Withdraw assets

Accept

- Residual Risk

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Risk Mitigation

	Reduce Probability	Reduce Consequence
Driving		

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Risk Mitigation

	Reduce Probability	Reduce Consequence
Driving	Drive speed limit Stay sober Avoid bad conditions Good tires Anti-lock breaks Traction control	

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Risk Mitigation

	Reduce Probability	Reduce Consequence
Driving	Drive speed limit Stay sober Avoid bad conditions Good tires Anti-lock breaks Traction control	Wear seatbelt Air bags Booster seats Infant Rear Facing Car Seat Crumple zones

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Flooding		

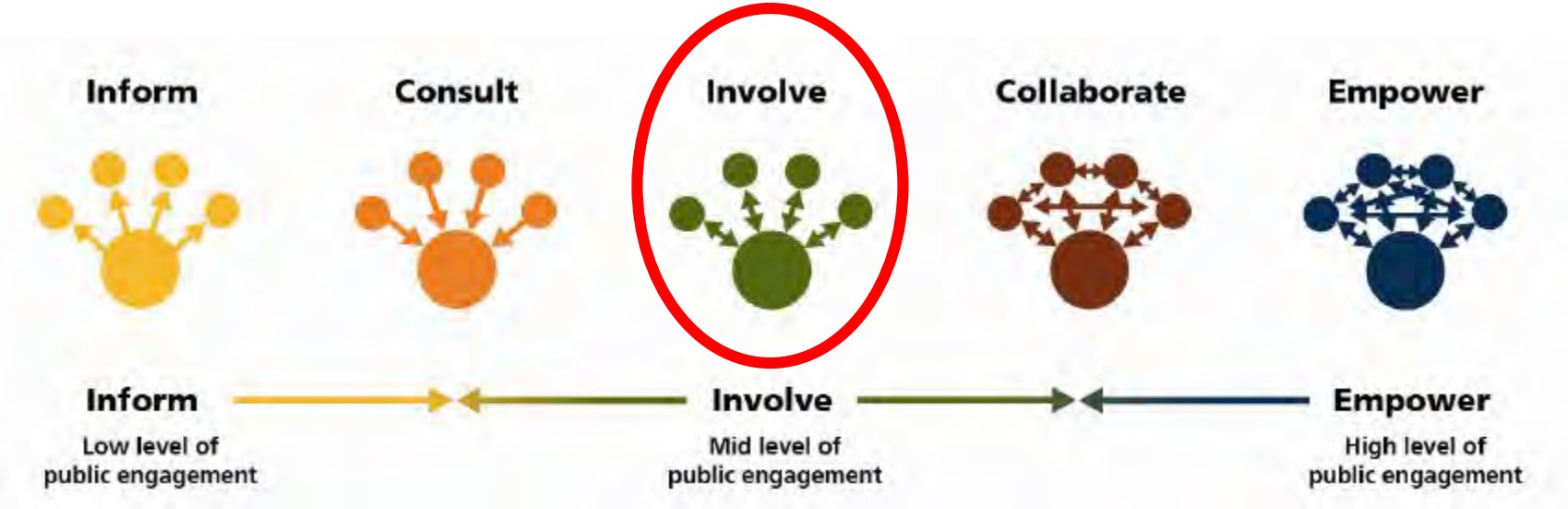
Risk Mitigation

	Reduce Probability	Reduce Consequence
Driving	Drive speed limit Stay sober Avoid bad conditions Good tires Anti-lock breaks Traction control	Wear seatbelt Air bags Booster seats Infant Rear Facing Car Seat Crumple zones
Flooding	Increase dike height Address dike deficiencies Dike Inspections Seismic assessment Toe Berm Erosion protection	

Risk Mitigation

	Reduce Probability	Reduce Consequence
Driving	Drive speed limit Stay sober Avoid bad conditions Good tires Anti-lock breaks Traction control	Wear seatbelt Air bags Booster seats Infant Rear Facing Car Seat Crumple zones
Flooding	Increase dike height Address dike deficiencies Dike Inspections Seismic assessment Toe Berm Erosion protection	Avoid development in high risk areas Establish FCLs Direct growth to low risk areas Preserve floodplain conveyance Develop Emergency Response Plan

Public Engagement



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Public Engagement

Month	Activities
Nov 2015	Workshops • Squamish Nation • Highly Affected Stakeholder • Residents/Stakeholders Online Survey
Dec 2015	Project Team Workshop
Feb 2016	Residents/Stakeholders Workshop Technical Working Group Meeting **Council Presentation (Today)** Public Open House
March 2016	Squamish Nation Presentation Online Survey
April 2016	Council Presentation Technical Working Group Meeting

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Online Survey

- 117 responses

- Support for mitigation strategies:
  - **Protect** (Dikes) 89%
  - **Accommodate** (FCL) 83%
  - **Avoid** (Developing High Risk) 82%
  - **Retreat** (Relocated Development) 33%

- Utilize all practical approaches 90%
- Do not rely on a single approach 92%
- Avoid/discourage intensive development in high risk areas 82%

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- Cheakamus Floodplain
- Squamish/Mamquam Floodplain
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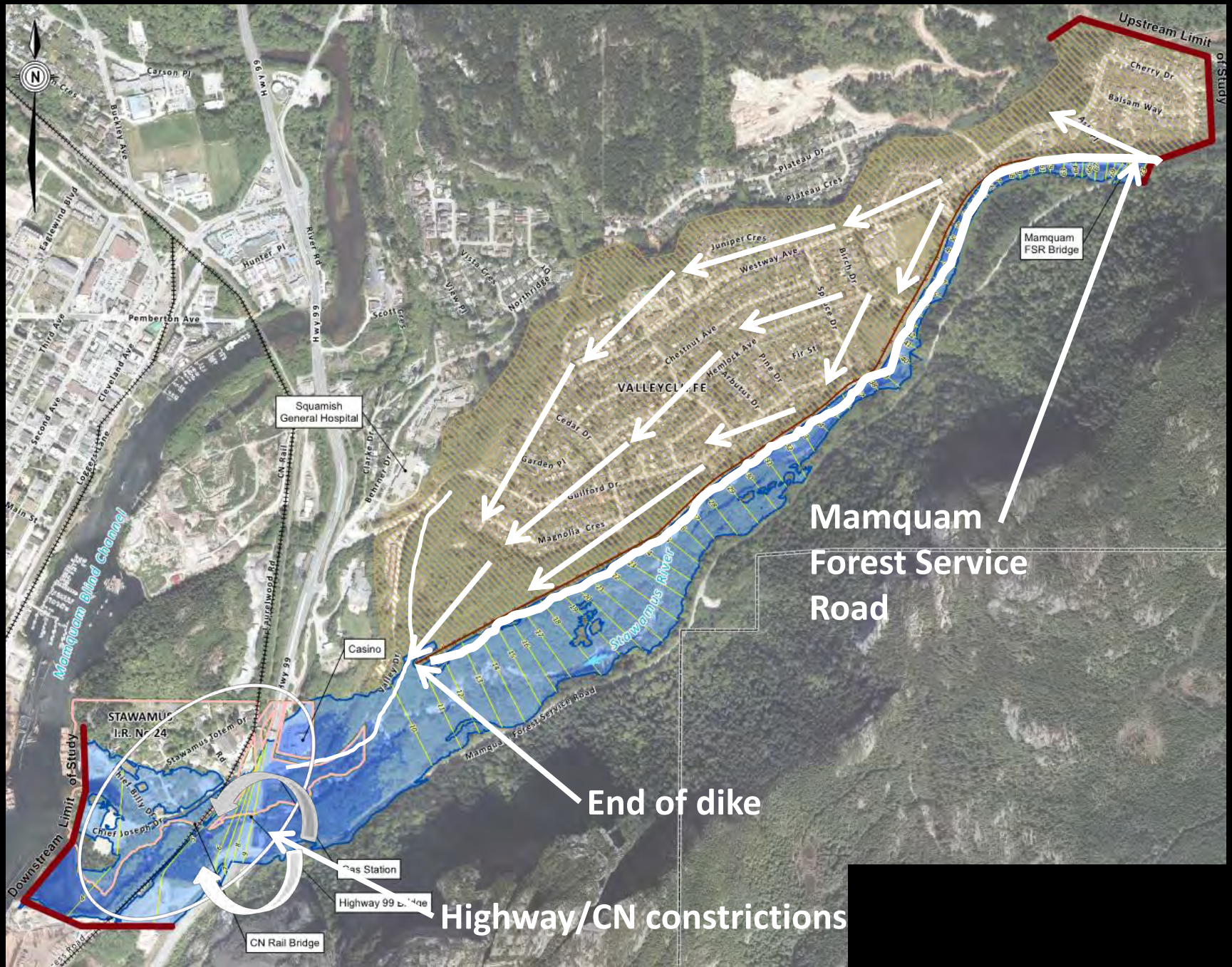
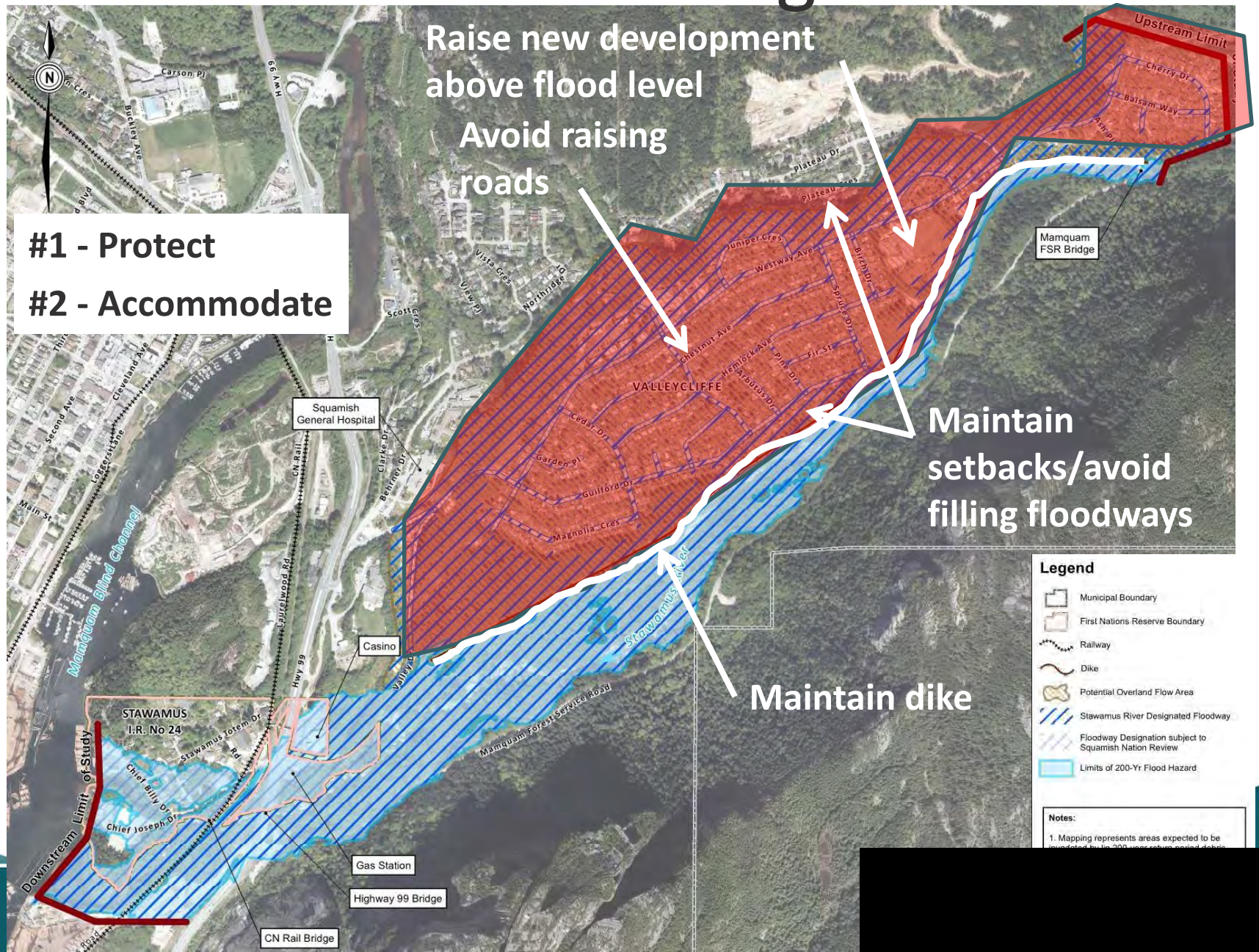
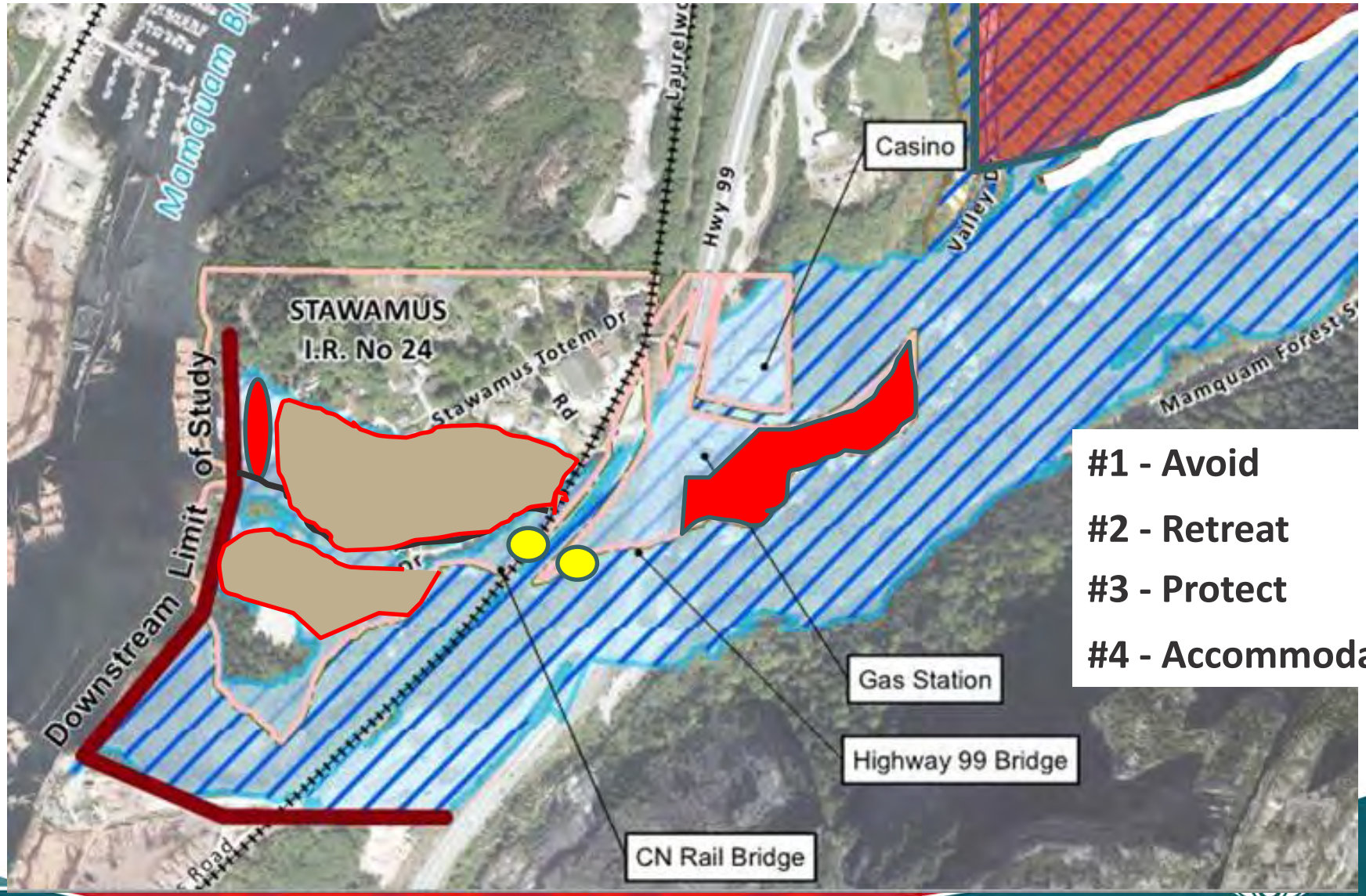
Stawamus Floodplain



Stawamus Mitigation



Stawamus Mitigation



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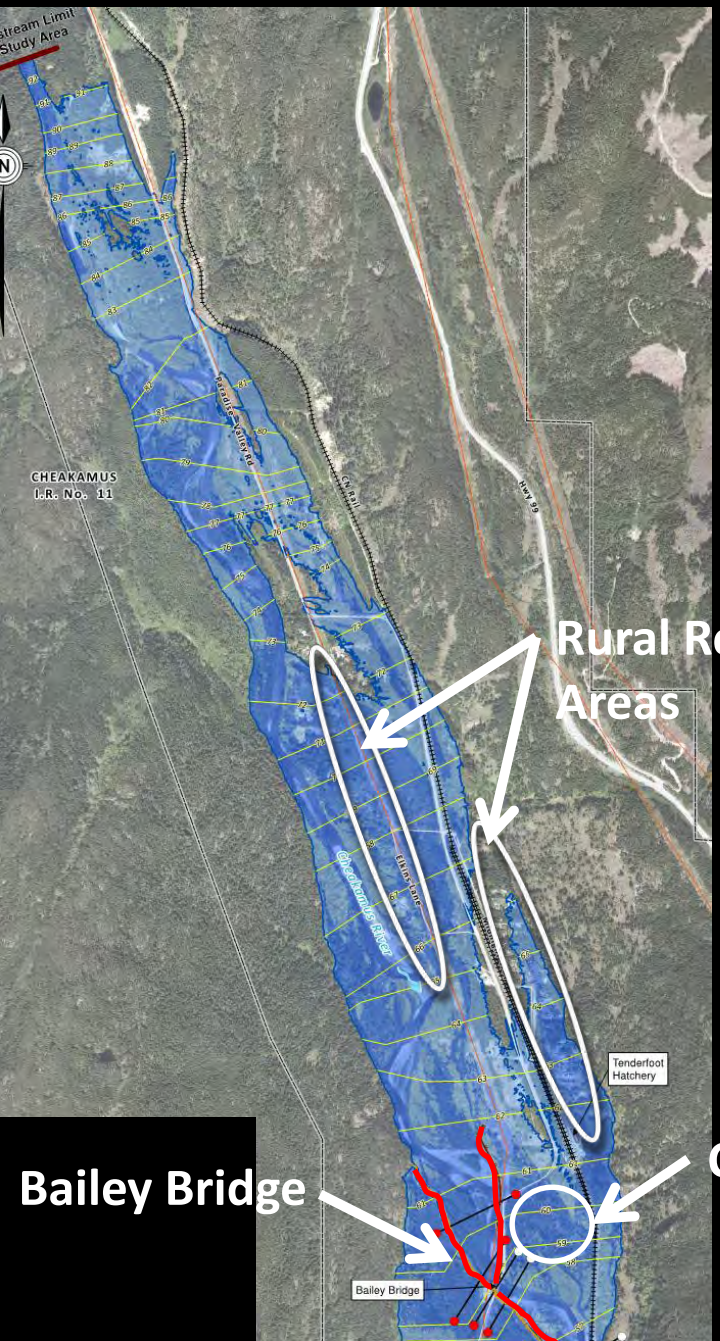
Cheakamus Floodplain



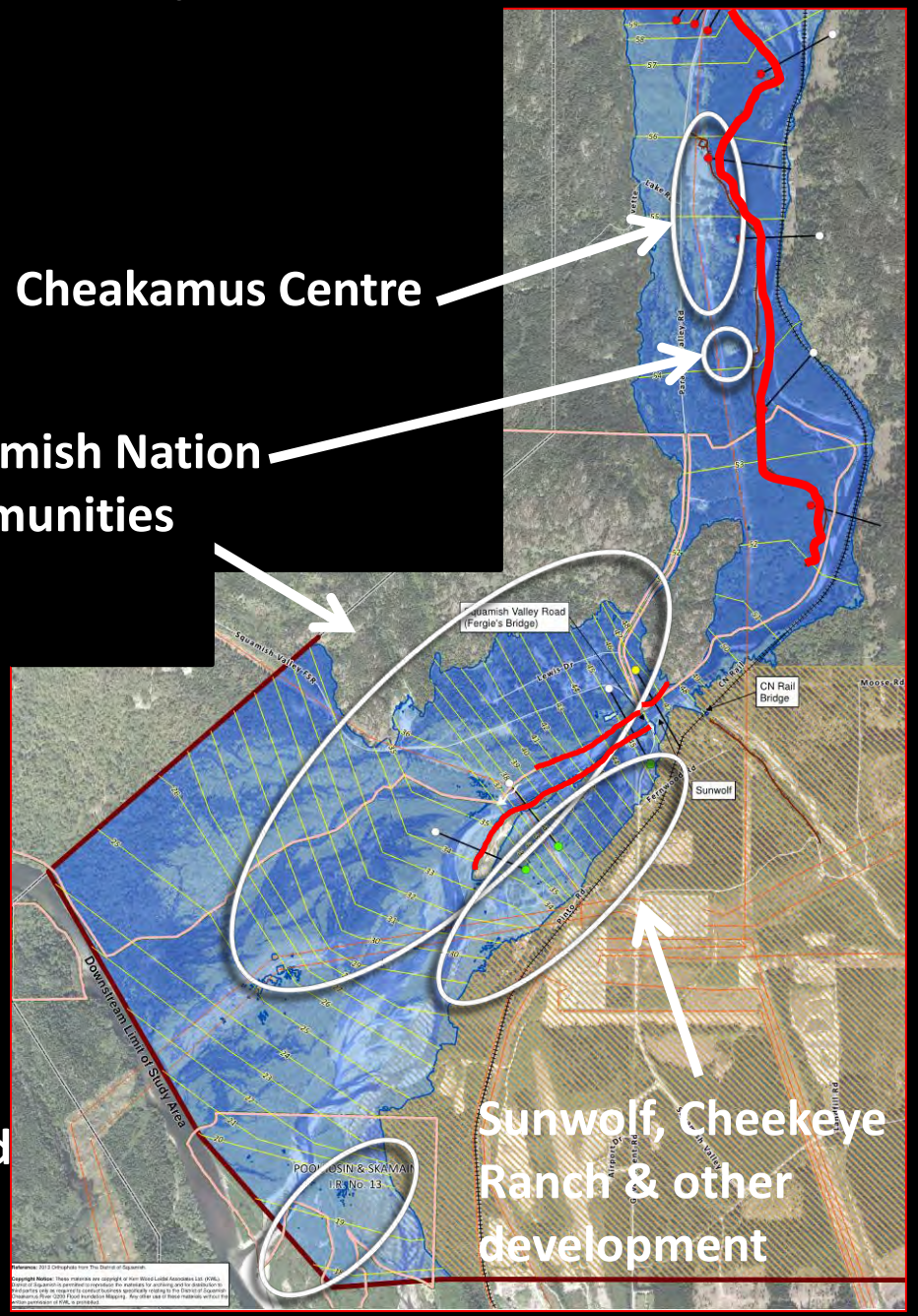
Bailey Bridge

Campground

Rural Residential Areas

Squamish Nation communities

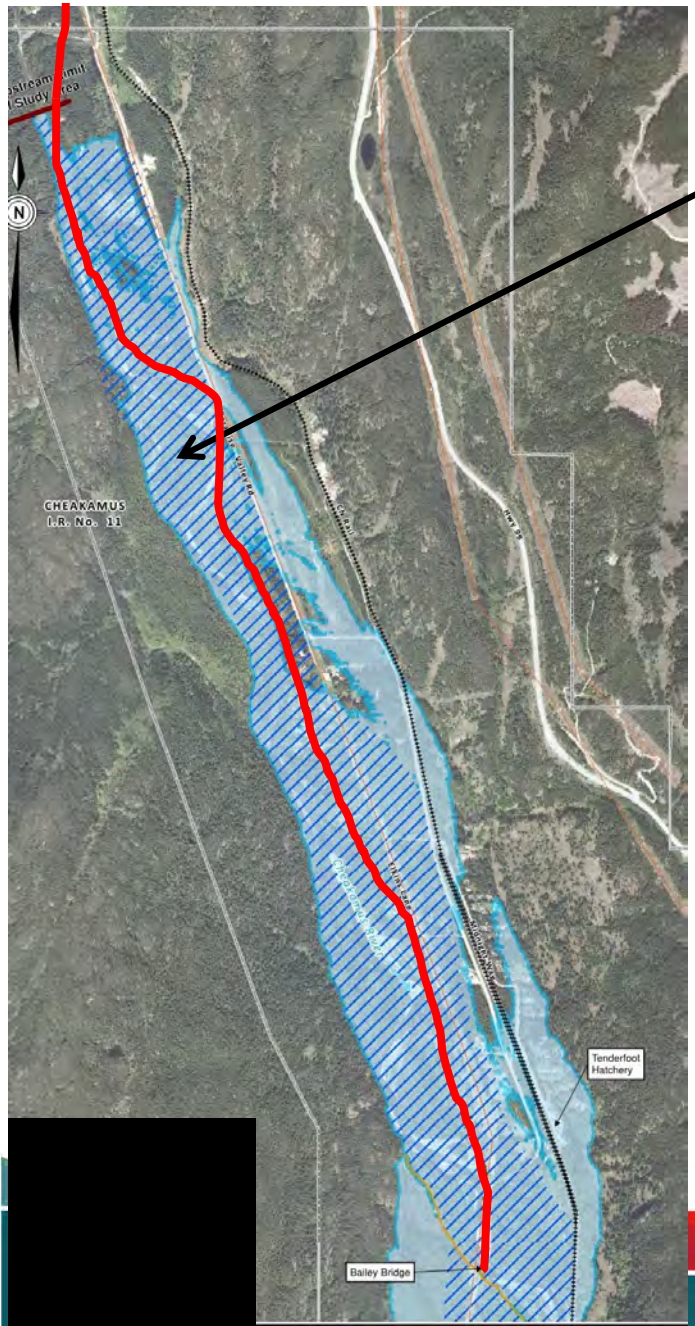
Cheakamus Centre

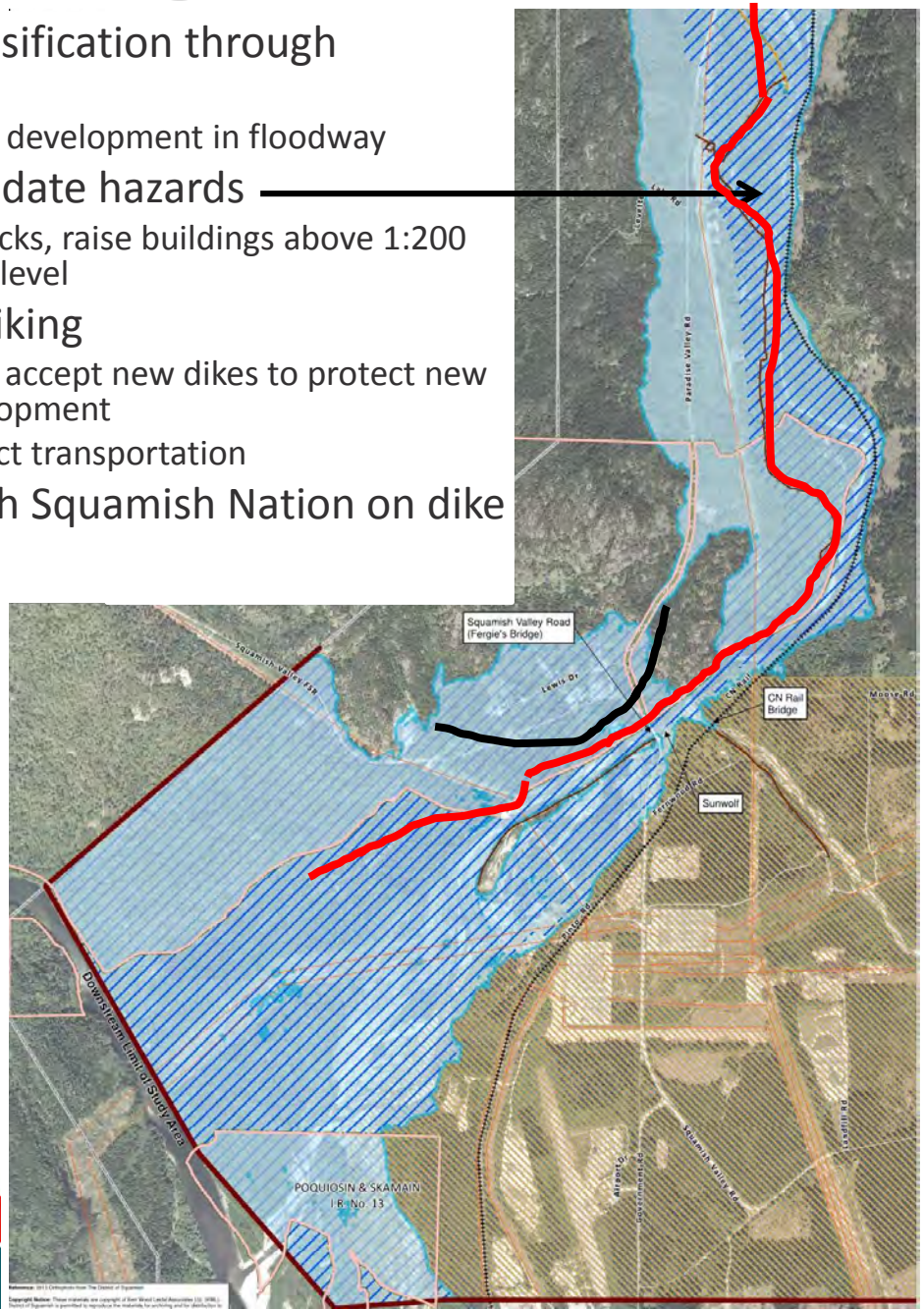


Sunwolf, Cheekeye Ranch & other development

Cheakamus Mitigation

1) Avoid densification through rezoning
   - Avoid development in floodway
2) Accommodate hazards
   - Setbacks, raise buildings above 1:200 flood level
3) No new diking
   - Don't accept new dikes to protect new development
   - Protect transportation
4) Work with Squamish Nation on dike proposal





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Squamish/Mamquam Floodplain

<u>Modeling Overview</u>

Inputs:

- 1:200 year river flows
- Topographic data
- Dike breach locations
- Year 2100 development conditions

Outputs:

- “Composite” Floodplain mapping

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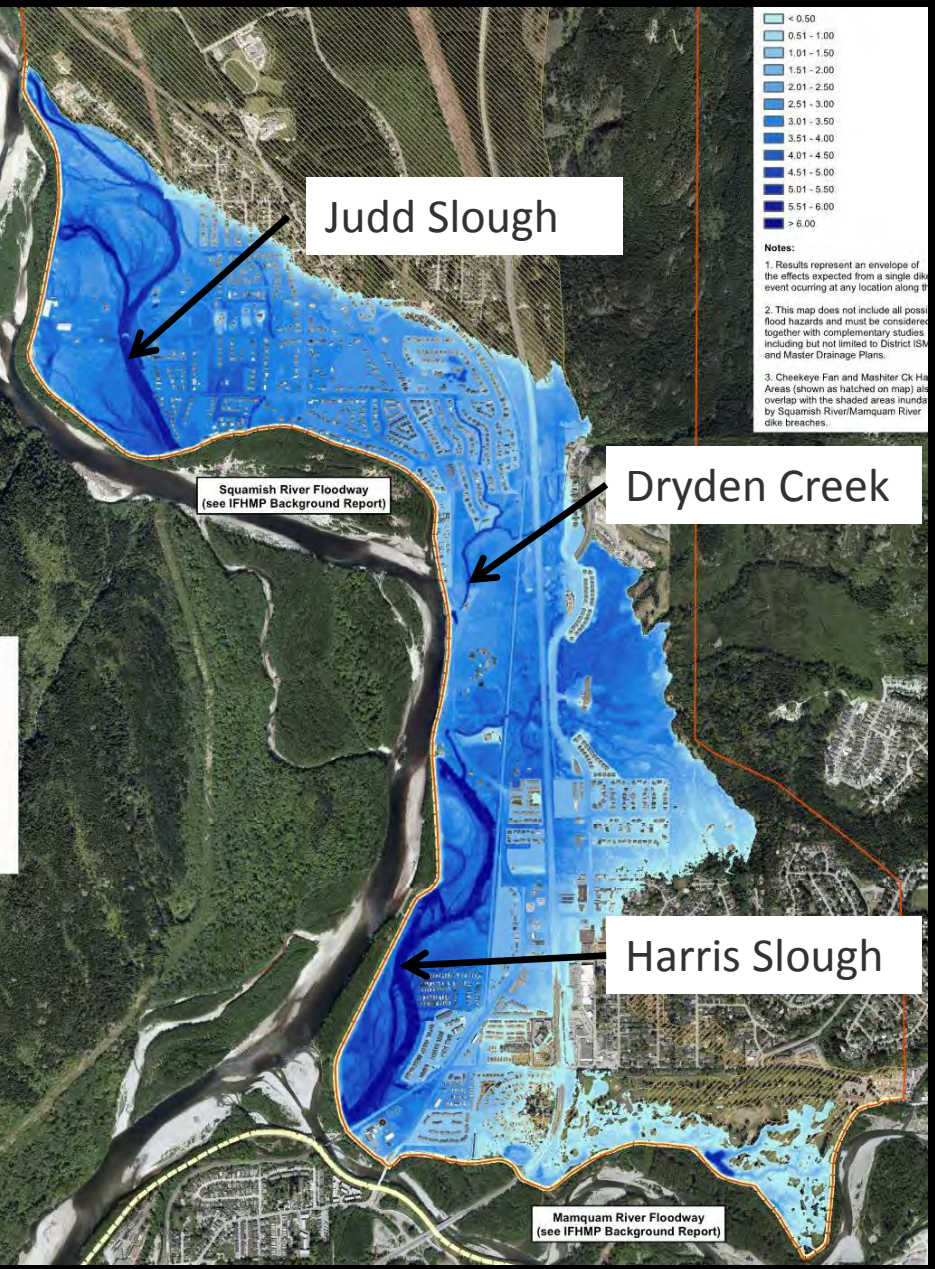
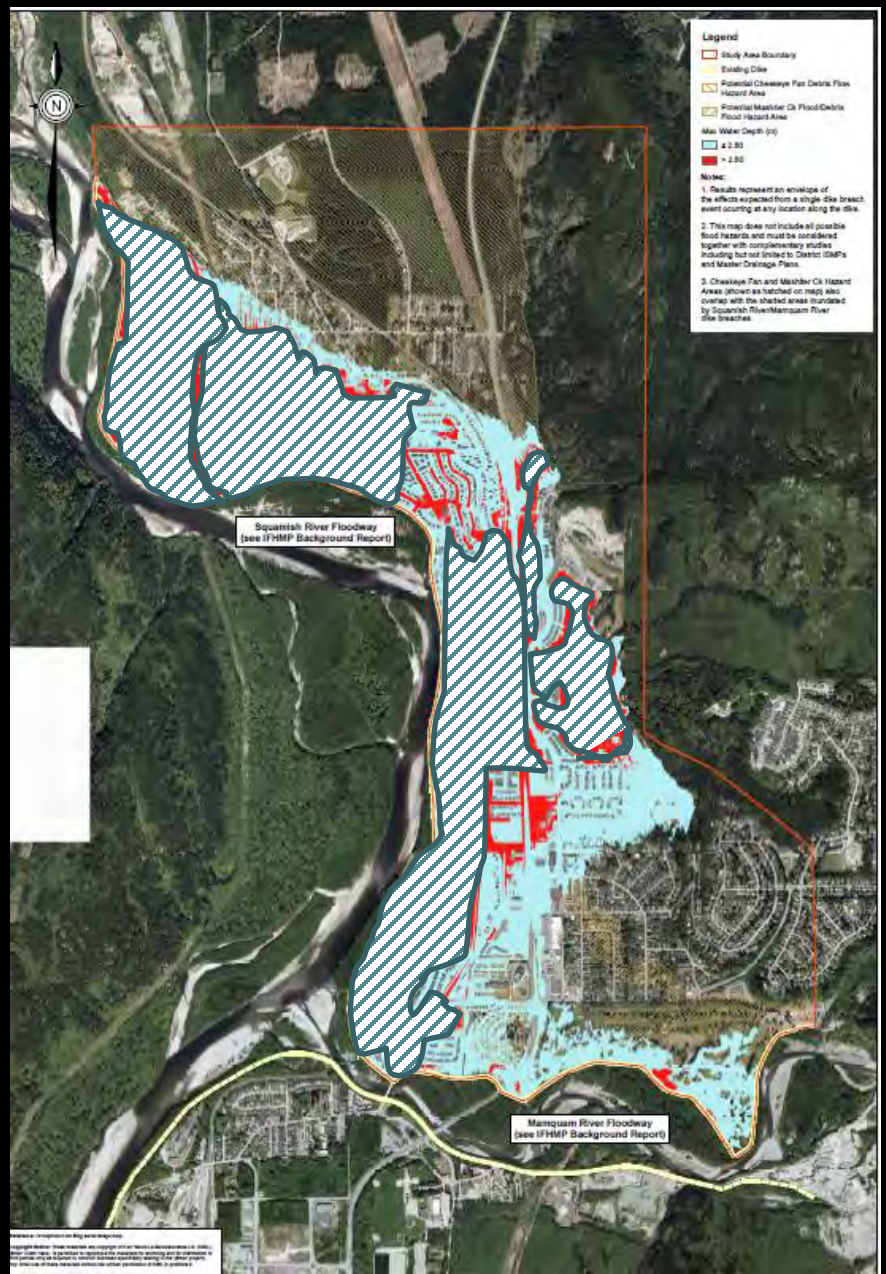
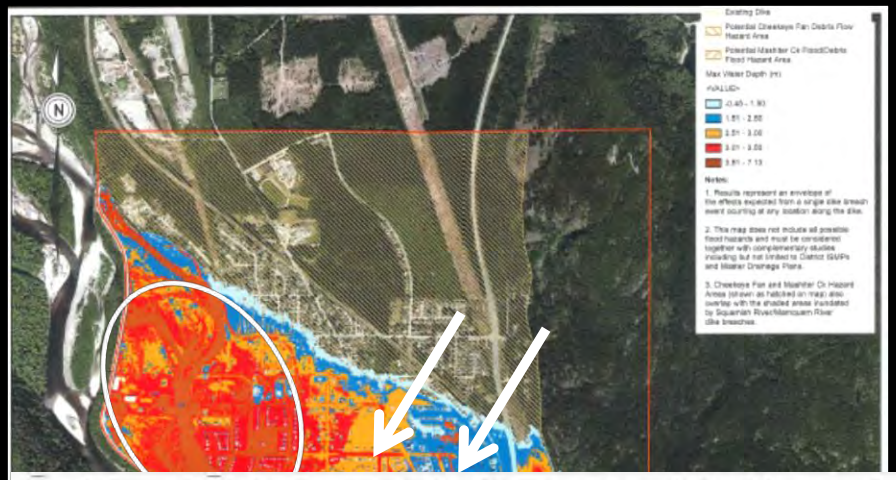
Upper Floodplain Results (Extents, Depth)

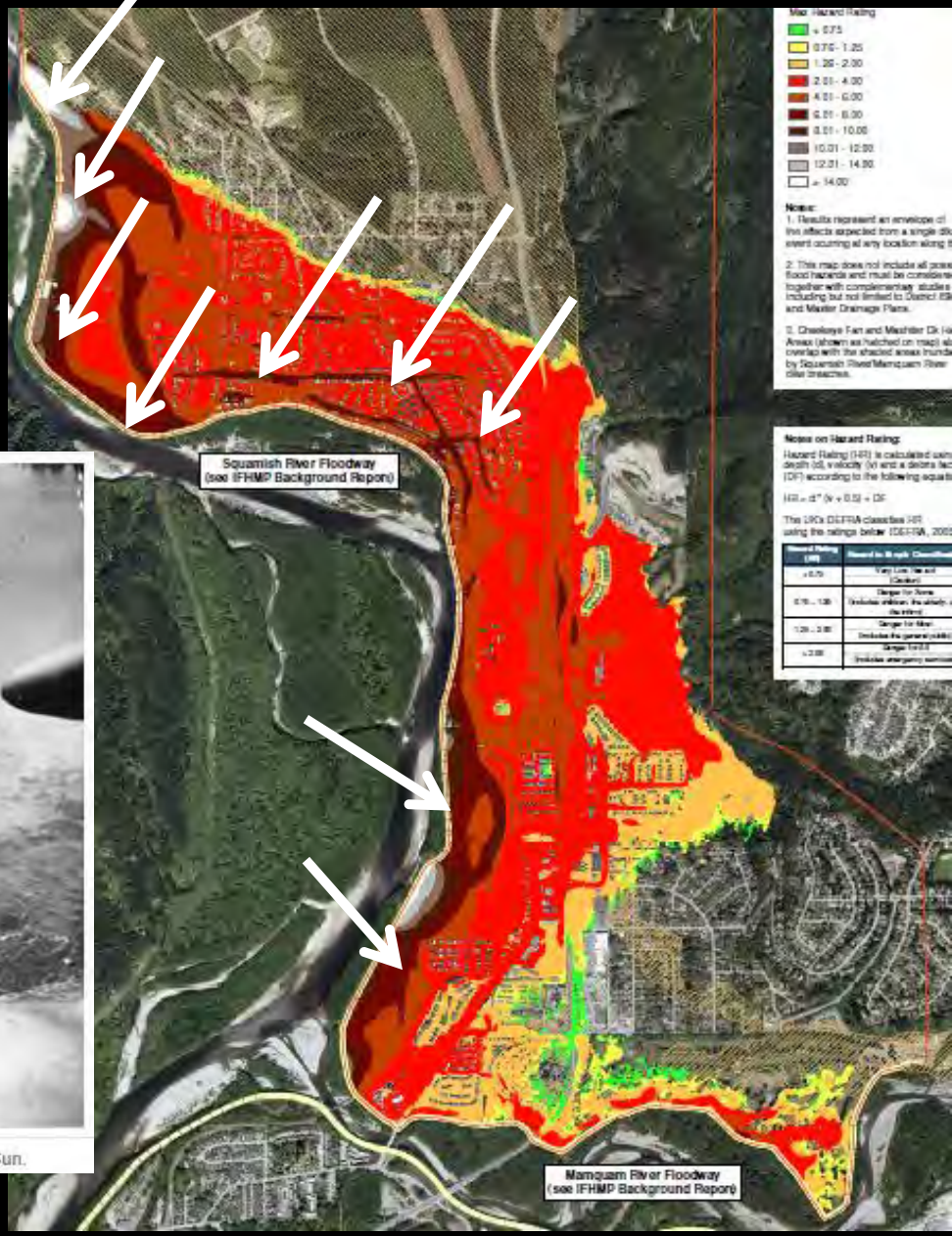




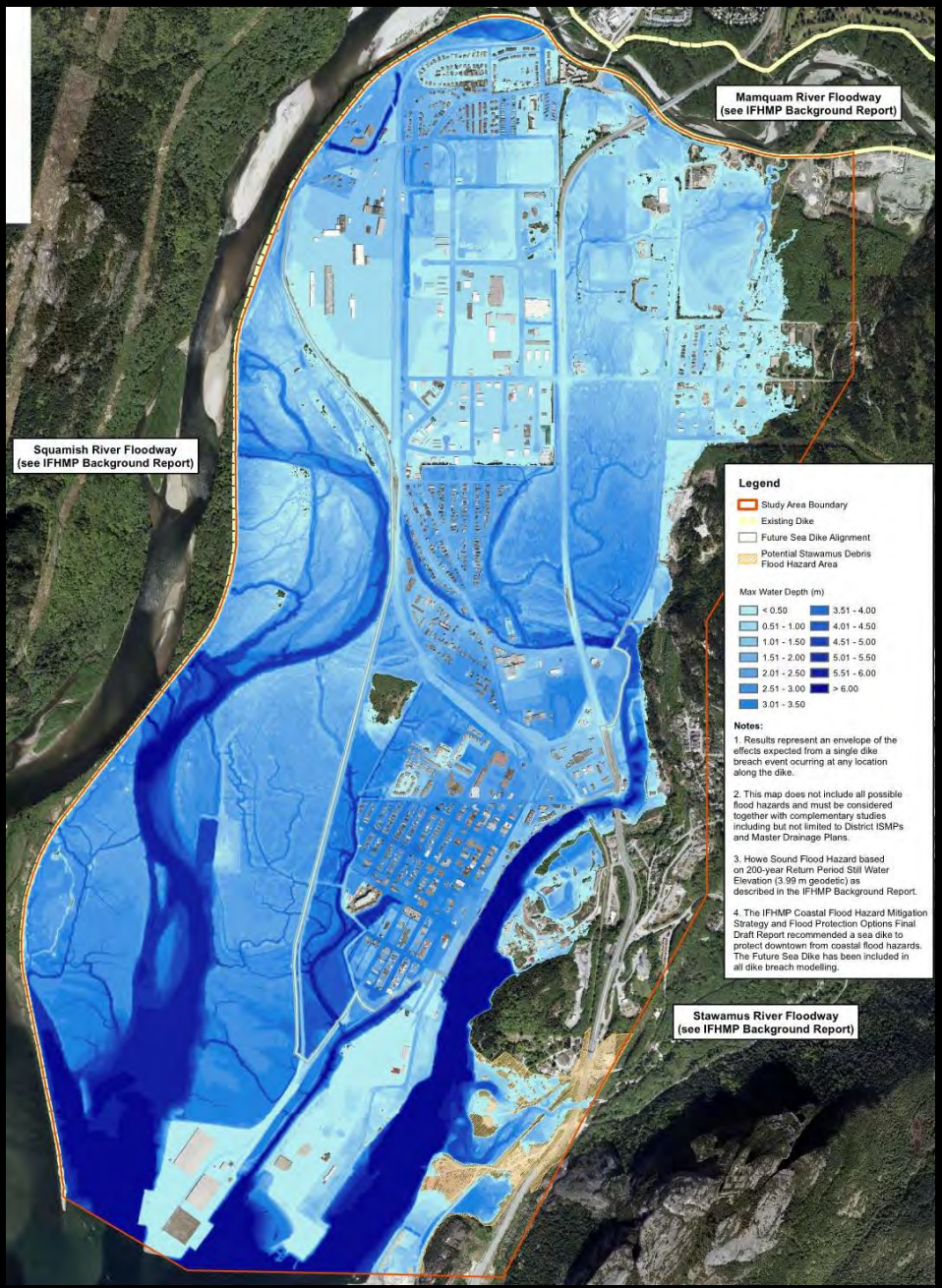
Upper Floodplain Results (Depth, Hazard Rating)

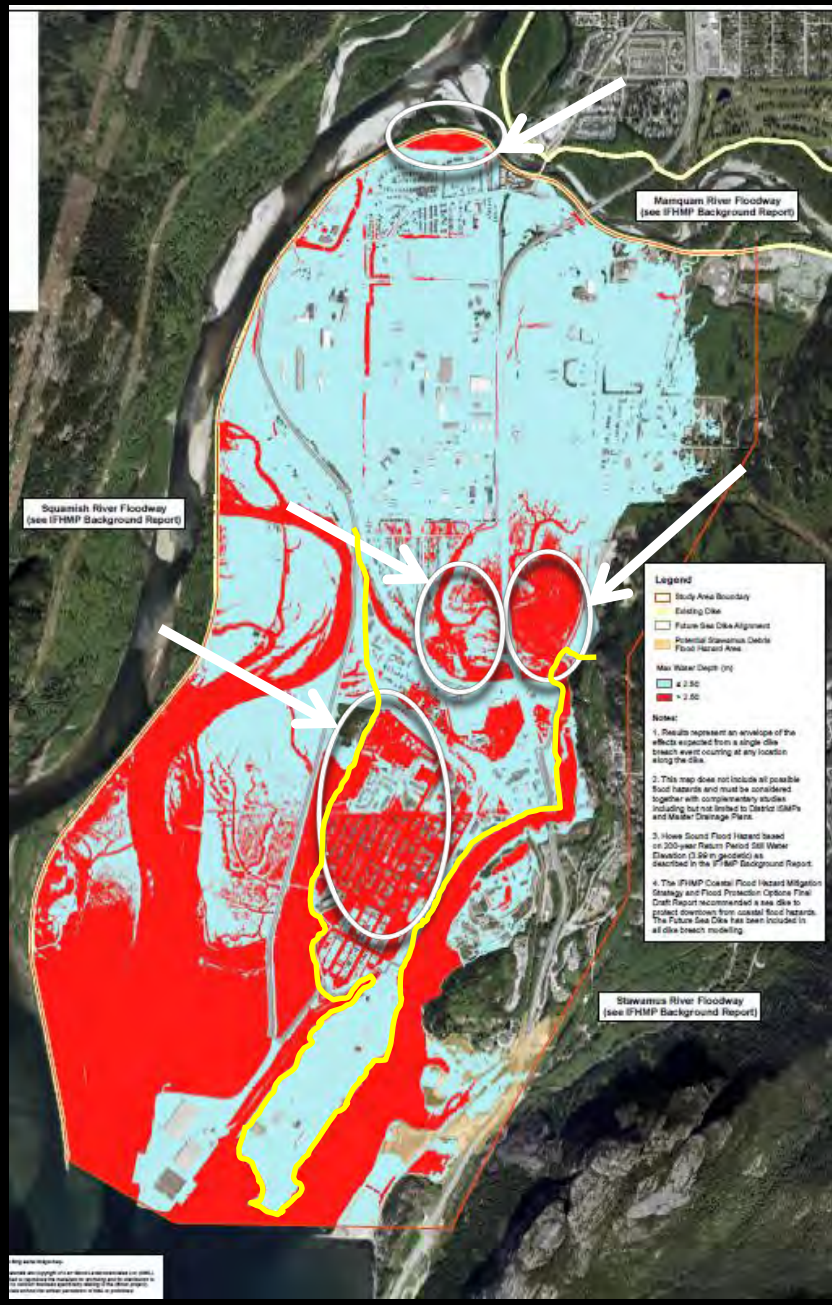


June 3, 1948: The Fraser River flood at Hatzic Lake where the dike broke. Photo: Dave Buchan/Vancouver Sun.



Lower Floodplain Results (Extents, Depth)





Social/Environmental Consequences

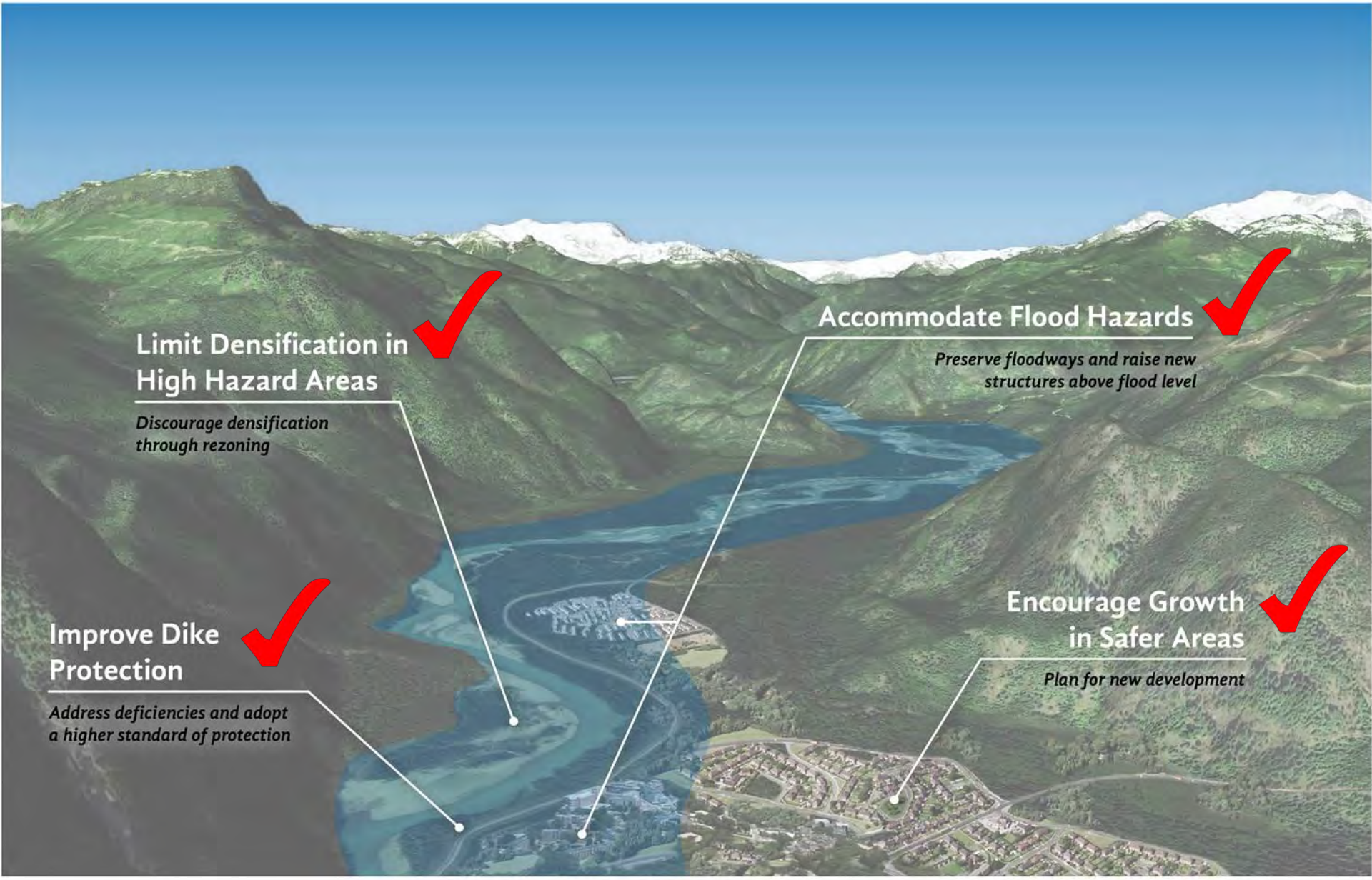
- Community Impacts
  - Social
    - Public safety
    - People displaced
    - Emergency response
    - Core services impacted
    - Infrastructure damage
    - Employment disruption
  - Environmental

Economic Consequences

- Upper Floodplain:
  - $190 million (mostly residential)
  - 7,000 displaced
- Lower Floodplain:
  - $257 million (half residential)
  - 3,400 displaced
- Building damage and inventory only → lower bound estimate

High River, AB 2013

Squamish / Mamquam Mitigation



Improve Protection

- Correct all known deficiencies (ongoing)
  - Dike too low → Raise dike to 1:200yr
  - Lack of land tenure → Acquire SROWs
  - No access → Ensure adequate access
  - Oversteepened slopes → Flatten slopes
  - Too narrow → Widen
  - Poor quality/missing erosion protection → Fix
  - Etc, etc, etc

Challenge Areas: Judd Slough/Eagle Viewing Area

Reduced probability= Reduced Risk

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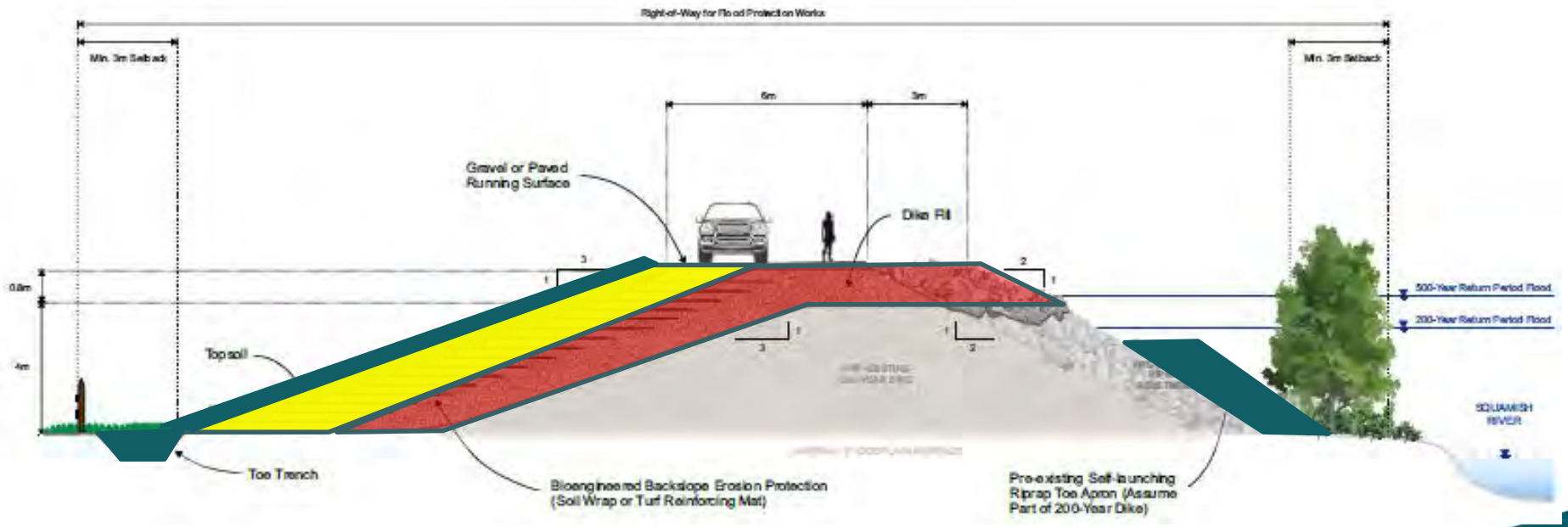
Squamish River Super Dike

- Long term: Adopt higher level of protection
  - Implement: Opportunistic/planning
- Higher, wider, stronger than provincial standard



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“Super Dike” Benefit-Cost Analysis

- Cost for “super dike” upgrades: ±$40M
- B-C analysis results:

Design Life	Effective Discount Rate				
(years)	-1%	0%	1%	2%	3%
50	2.34	1.79	1.41	1.13	0.92
75	4.04	2.69	1.89	1.39	1.07
100	6.21	3.59	2.26	1.55	1.13
200	23.18	7.17	3.10	1.76	1.19

- Stakeholder consultation indicates support

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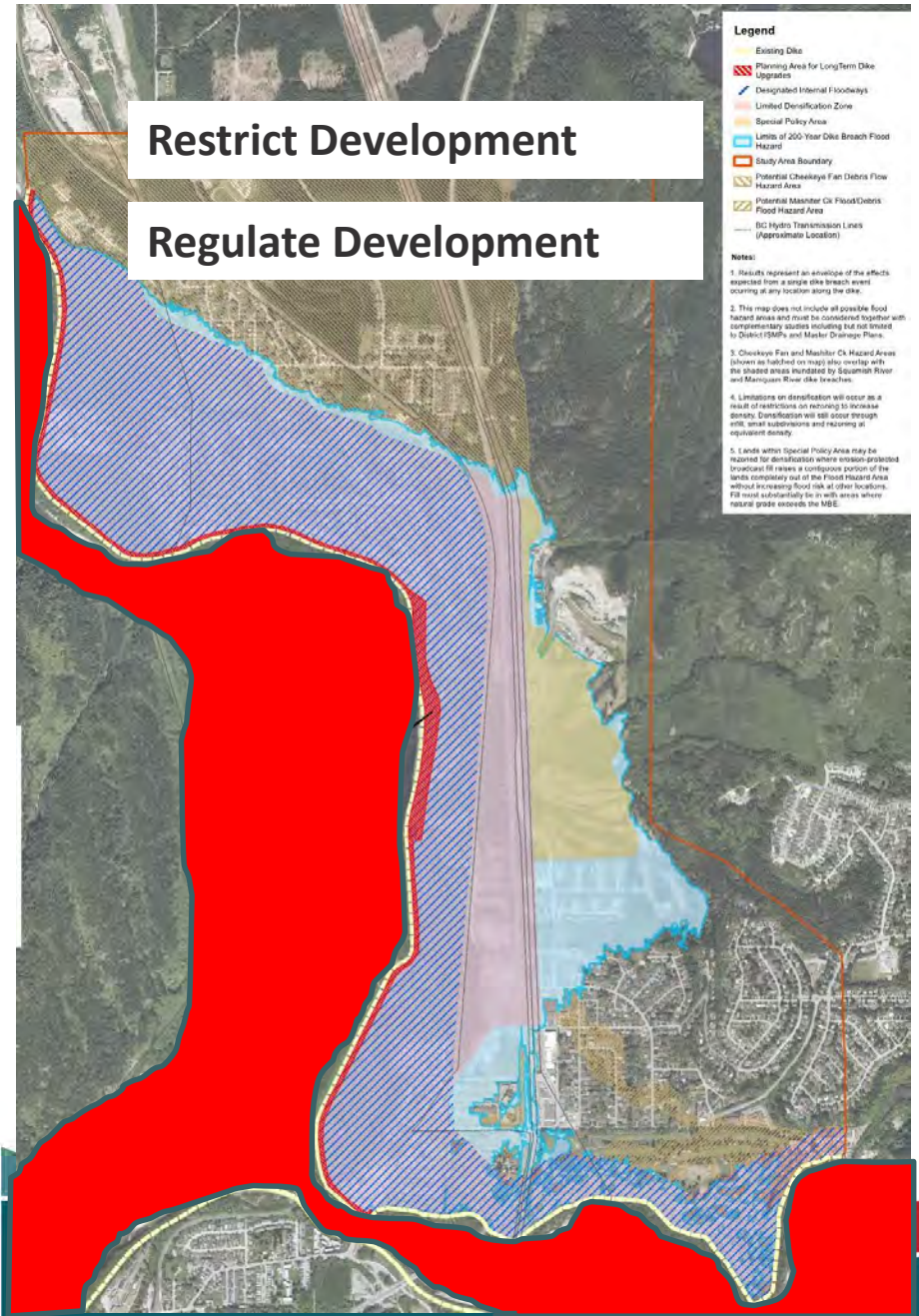
Accommodate Flood Hazards

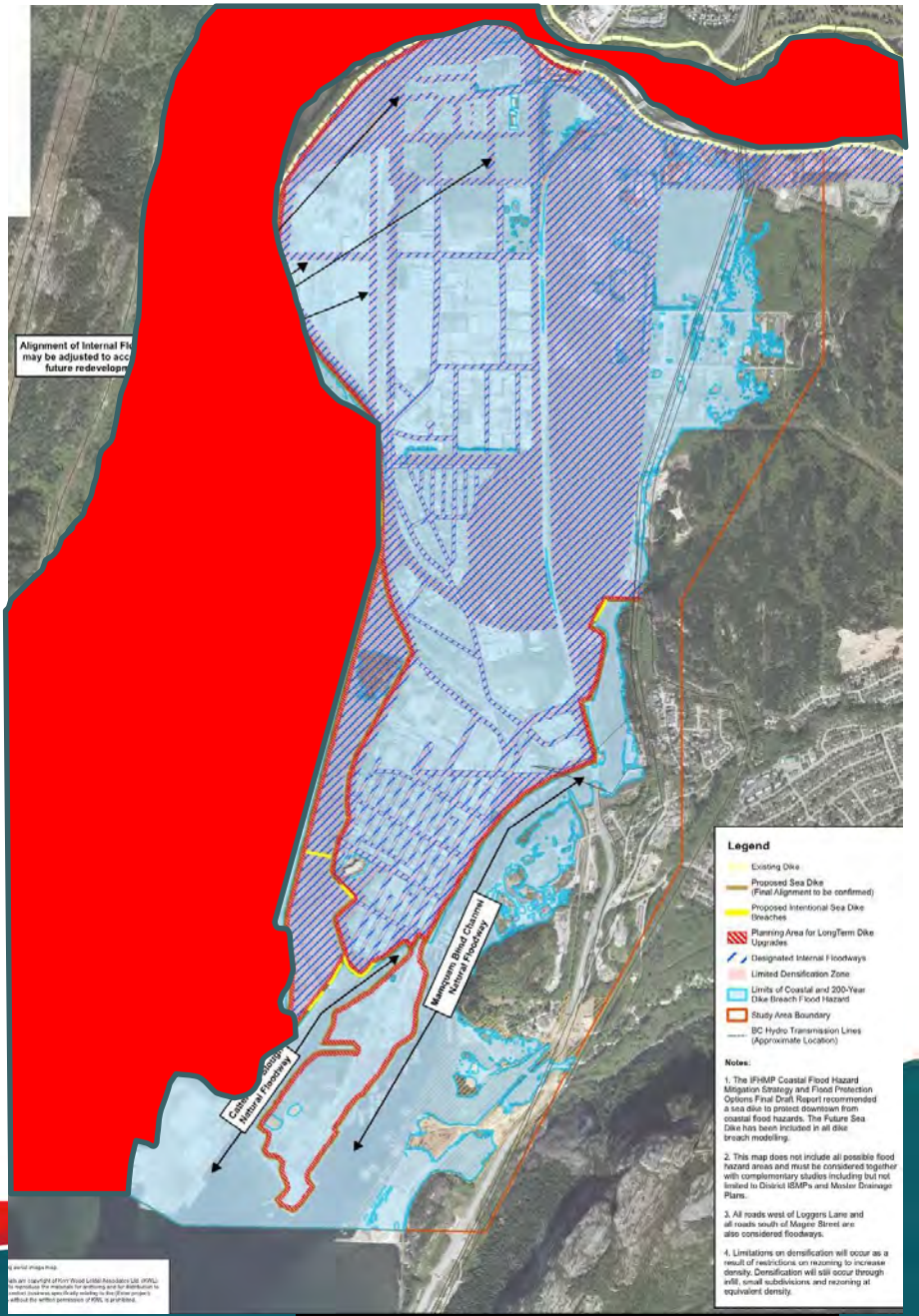
- Implement new Flood Construction Levels (FCL)
  - Process for granting variances in hardship
- Establish building requirements
- Establish/preserve floodways

Establish/Preserve Floodways

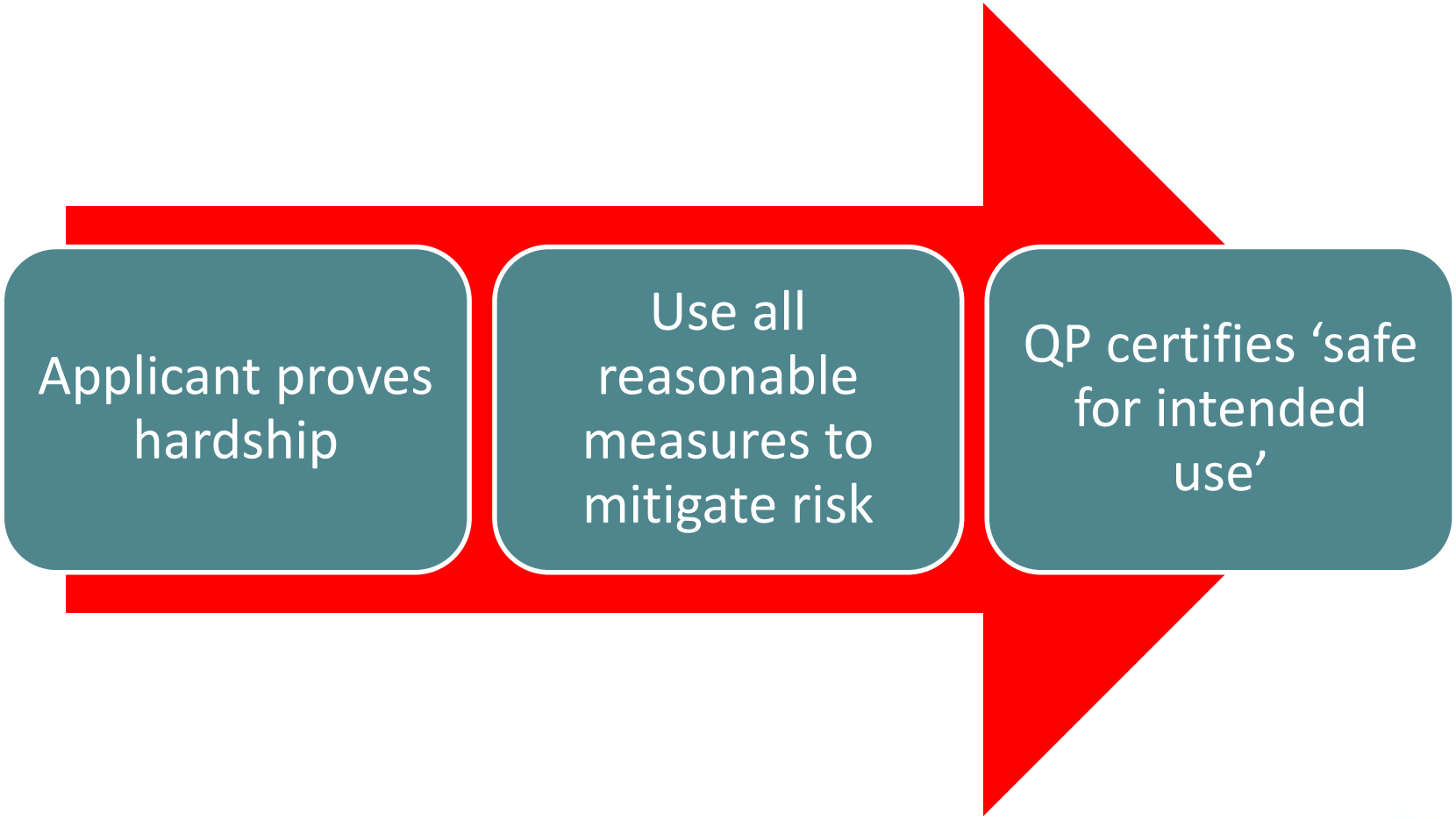
Restrict Development

Regulate Development





Variance Process



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FCL Exemption for Downtown Area

- Continue exemption for ground-level businesses
- All other variance requirements apply
- Mitigation measures
  - Diking upgrades
  - Emergency response
  - Flood insurance

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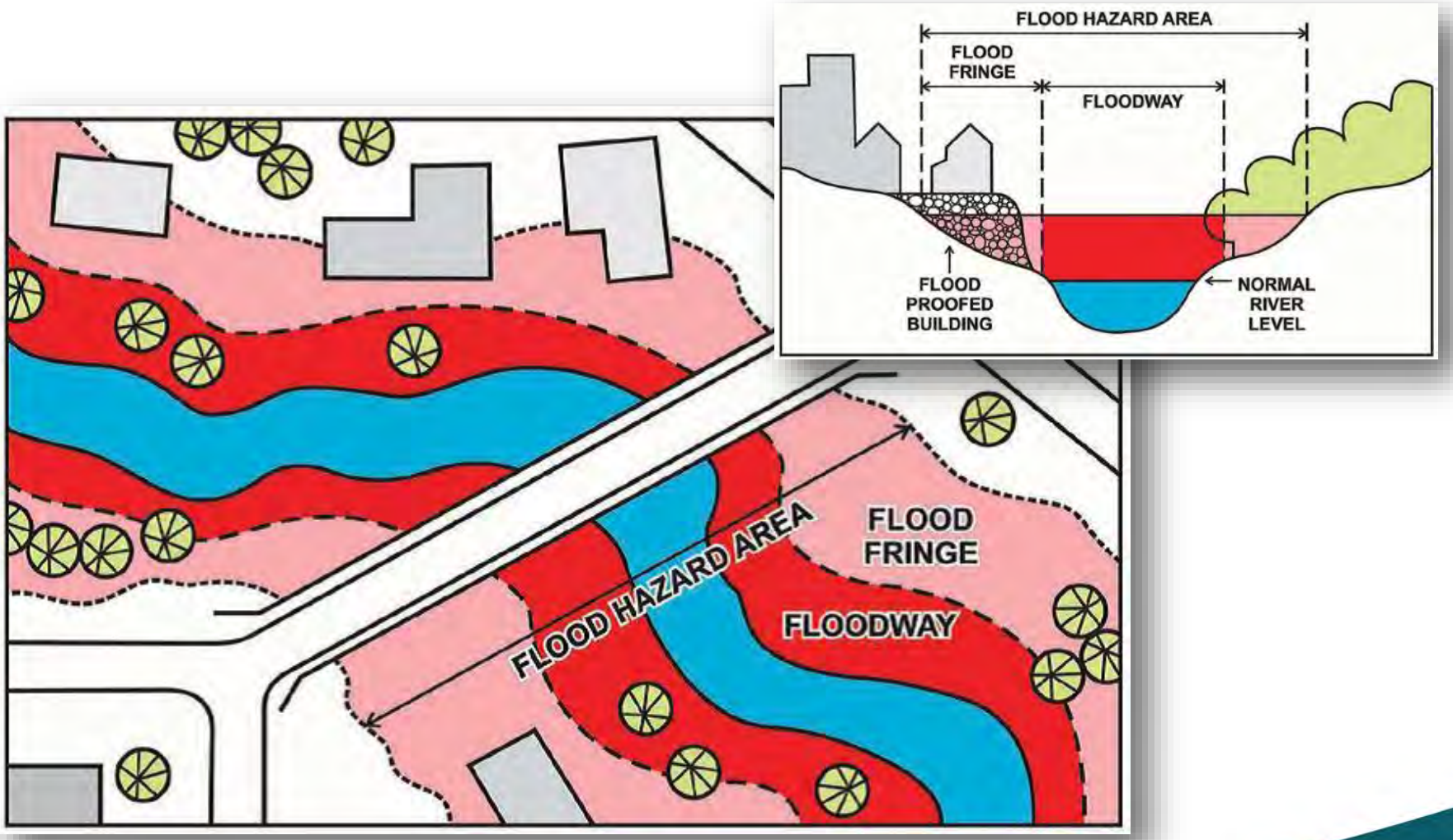
Calgary, 2013


Calgary, 2013
CALGARY STAMPEDE


Canmore, 2013


High River, 2013

Floodways



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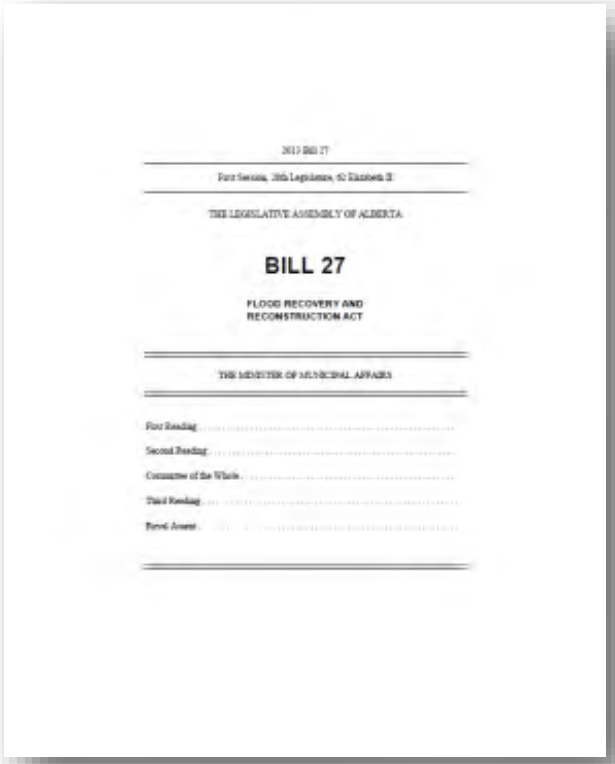
Bill 27 and Floodway Development Regulations



2013 Bill 27

First Session, 28th Legislature, 62 Elizabeth II

THE LEGISLATIVE ASSEMBLY OF ALBERTA

BILL 27

FLOOD RECOVERY AND RECONSTRUCTION ACT

THE MINISTER OF MUNICIPAL AFFAIRS

First Reading .....

Second Reading .....

Committee of the Whole .....

Third Reading .....

Royal Assent .....

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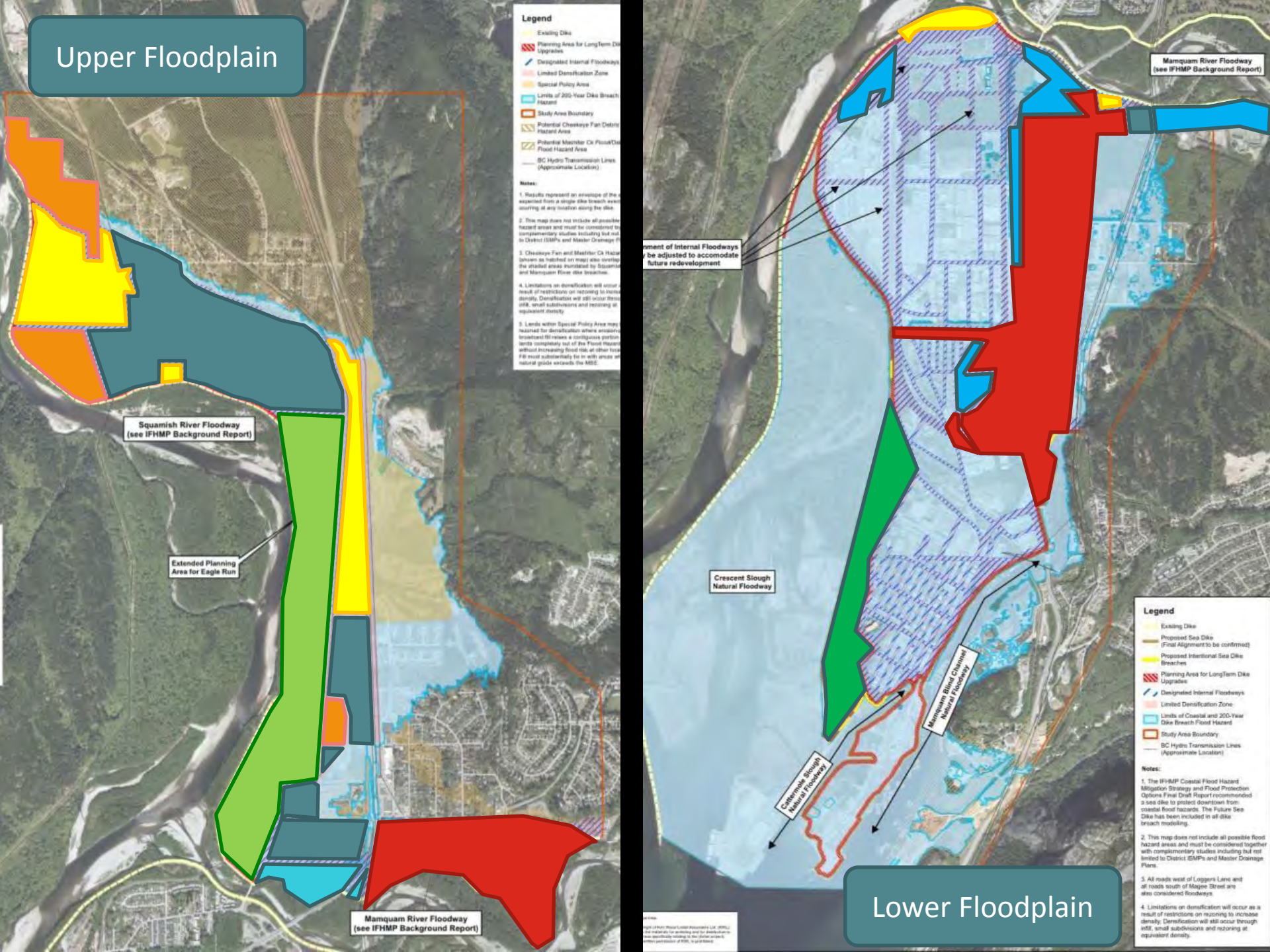
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Legend
Existing Dike
Designated Internal Floodways
Limited Densification Zone
Special Policy Area
Study Area Boundary
BC Hydro Transmission Lines (Approximate Location)
Notes:
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Extended Planning Area for Eagle Run
Mamquam River Floodway (see IFHMP Background Report)
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Crescent Slough Natural Floodway
Mamquam Blind Channel Natural Floodway
Cattermole Slough Natural Floodway
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Proposed Sea Dike (Final Alignment to be confirmed)
Proposed Intentional Sea Dike Breaches
Planning Area for LongTerm Dike Upgrades
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Limits of Coastal and 200-Year Dike Breach Flood Hazard
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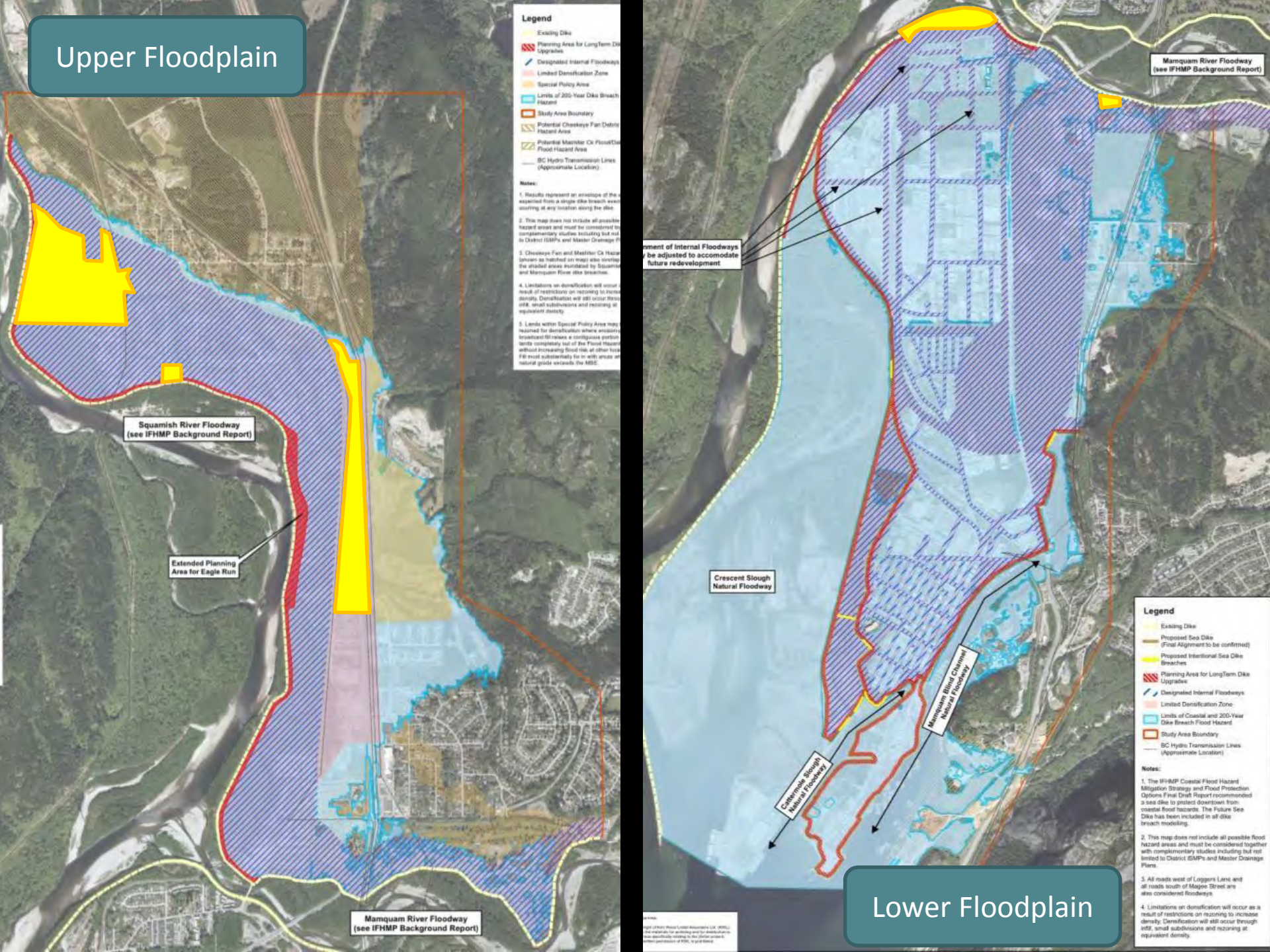
2. This map does not include all possible flood hazard areas and must be considered together with complementary studies including but not limited to District ISMPs and Master Drainage Plans.
3. All roads west of Loggers Lane and all roads south of Magee Street are also considered floodways.
4. Limitations on densification will occur as a result of restrictions on rezoning to increase density. Densification will still occur through infill, small subdivisions and rezoning at equivalent density.
Lower Floodplain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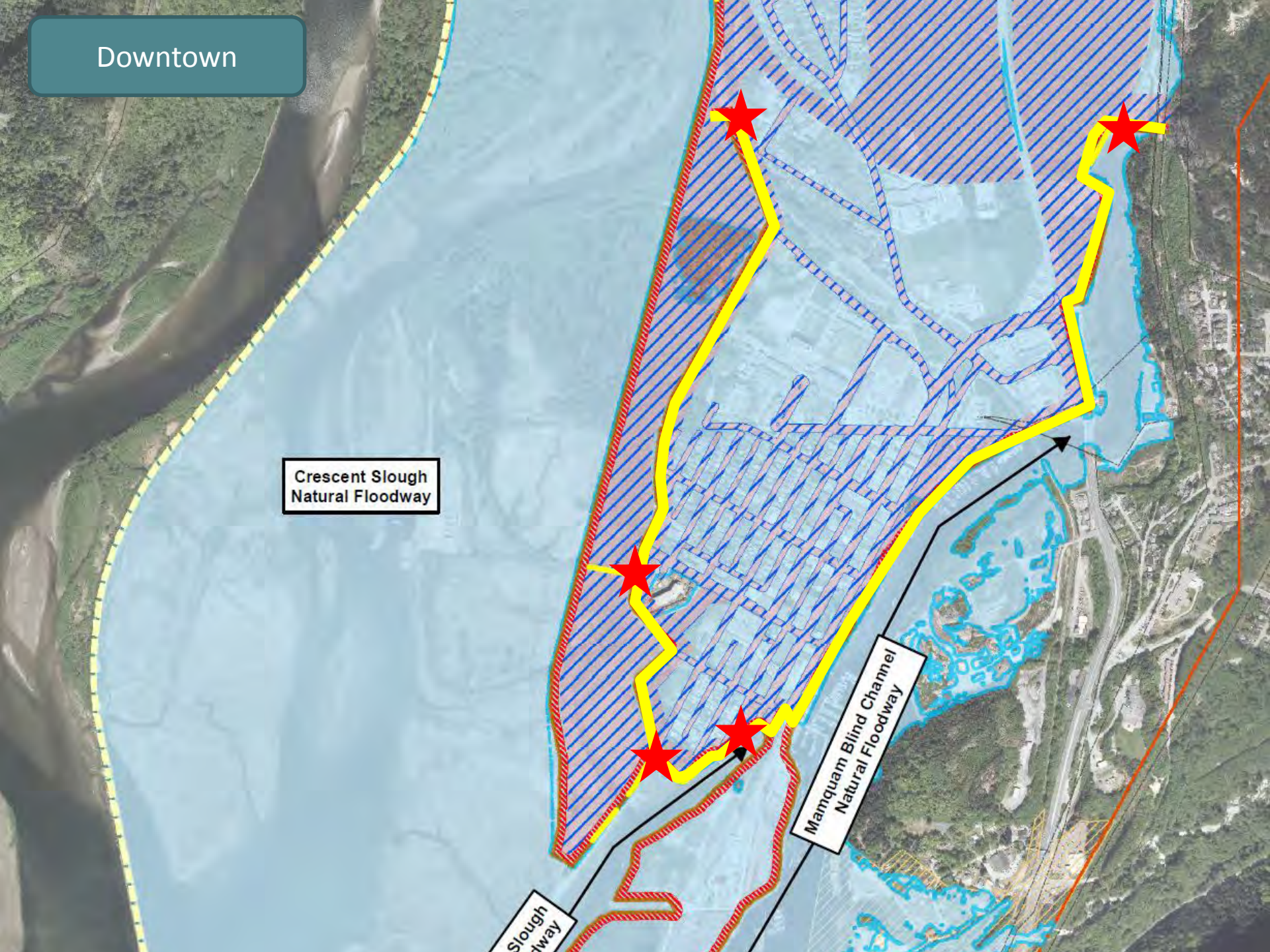
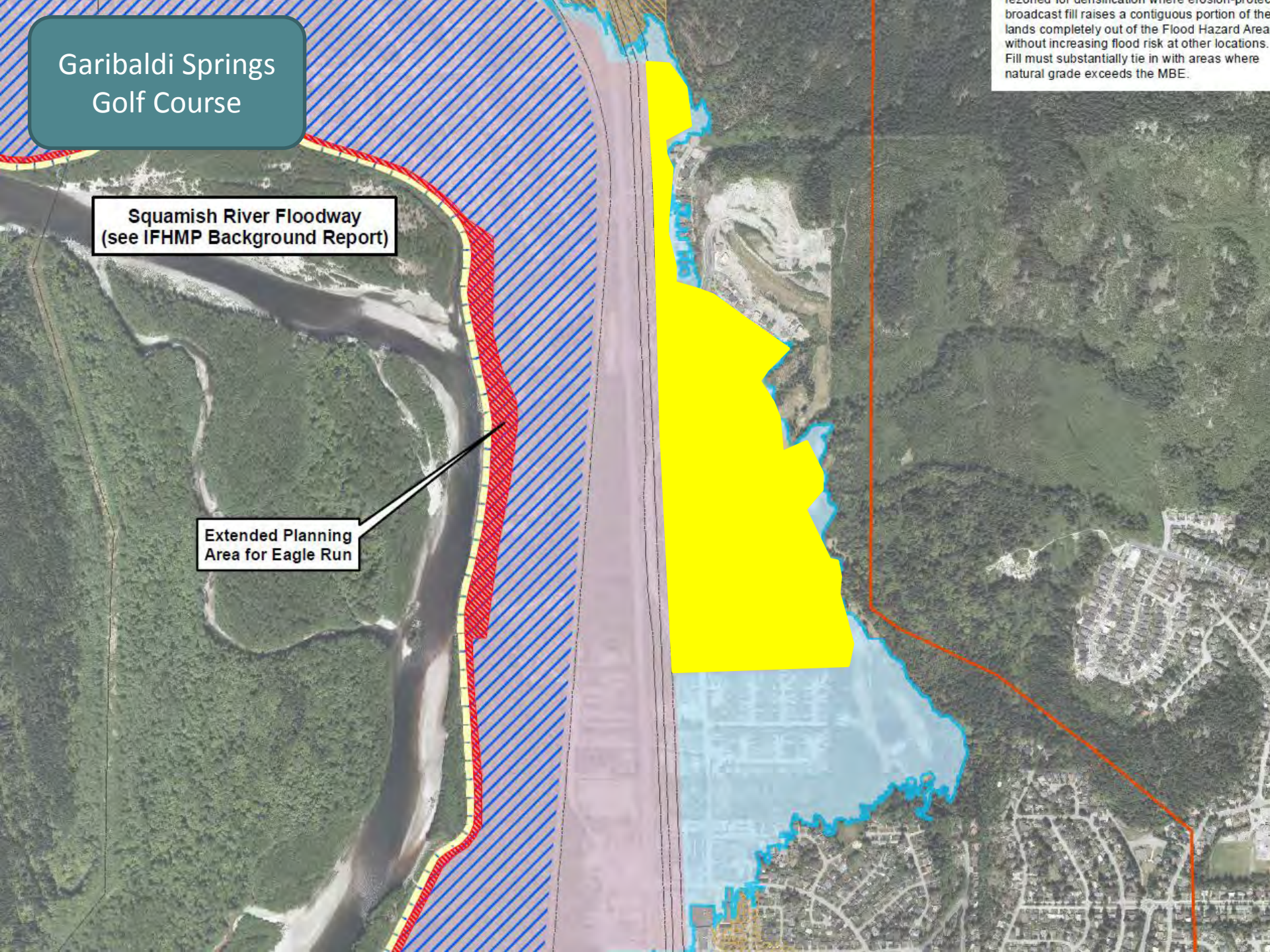
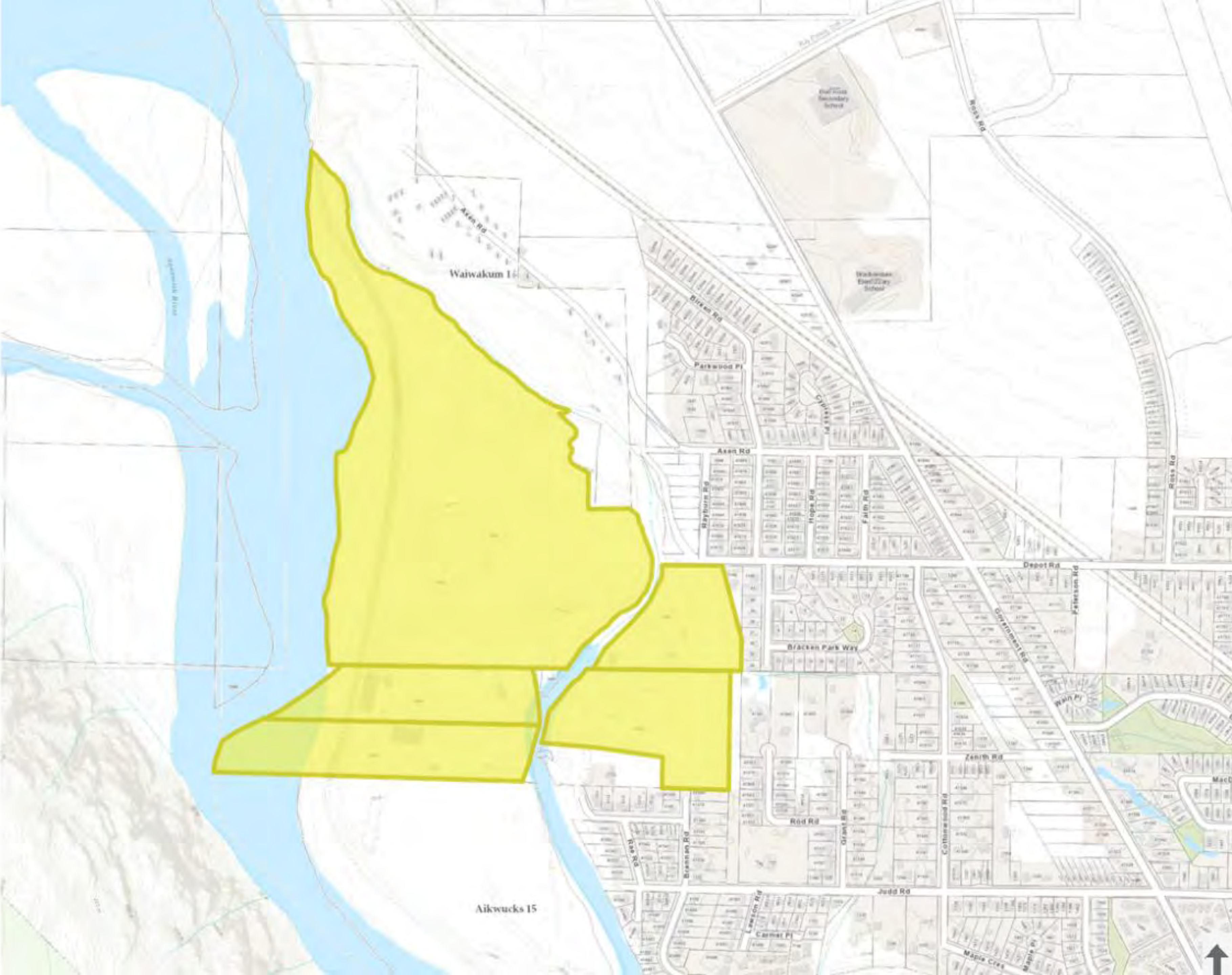
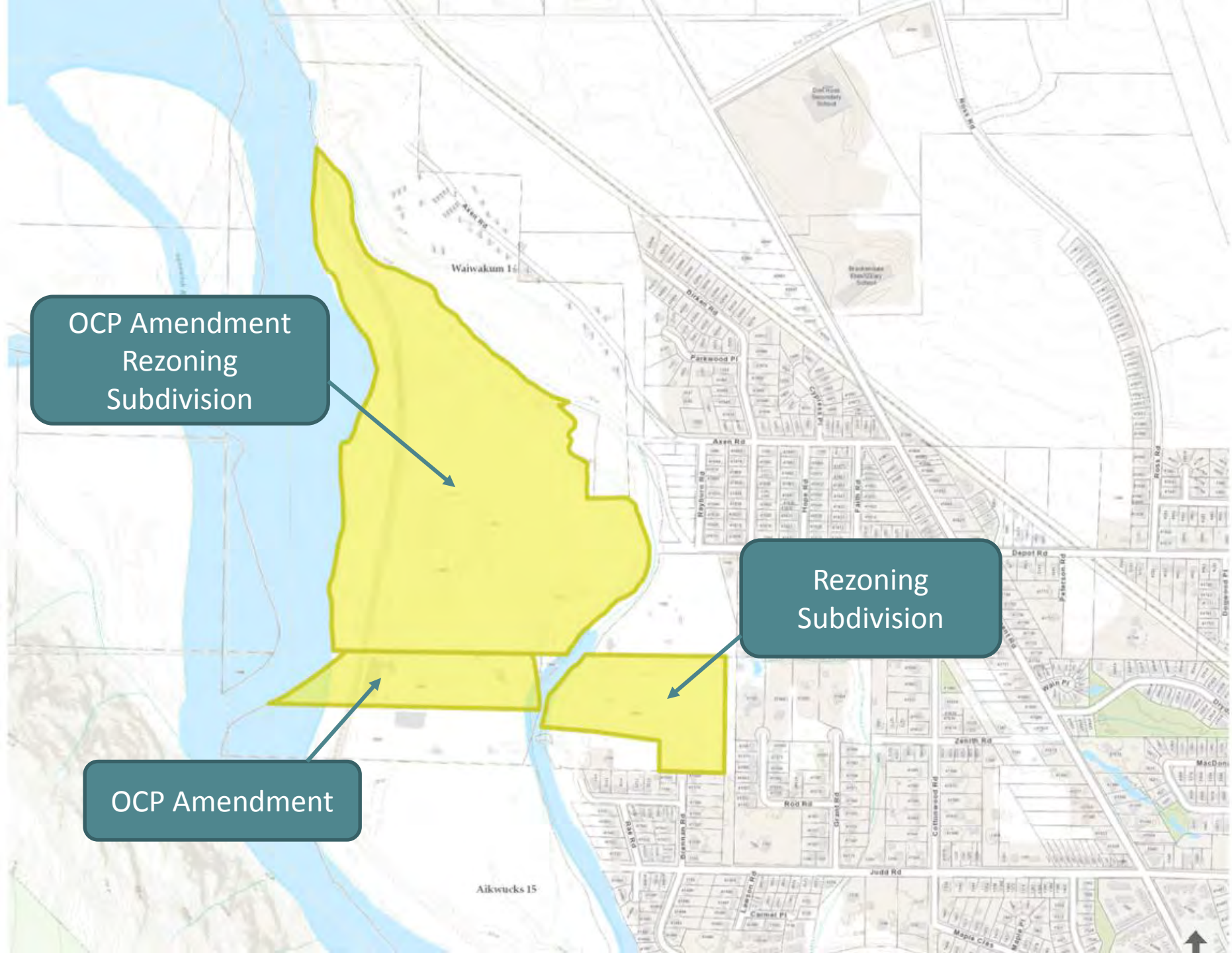
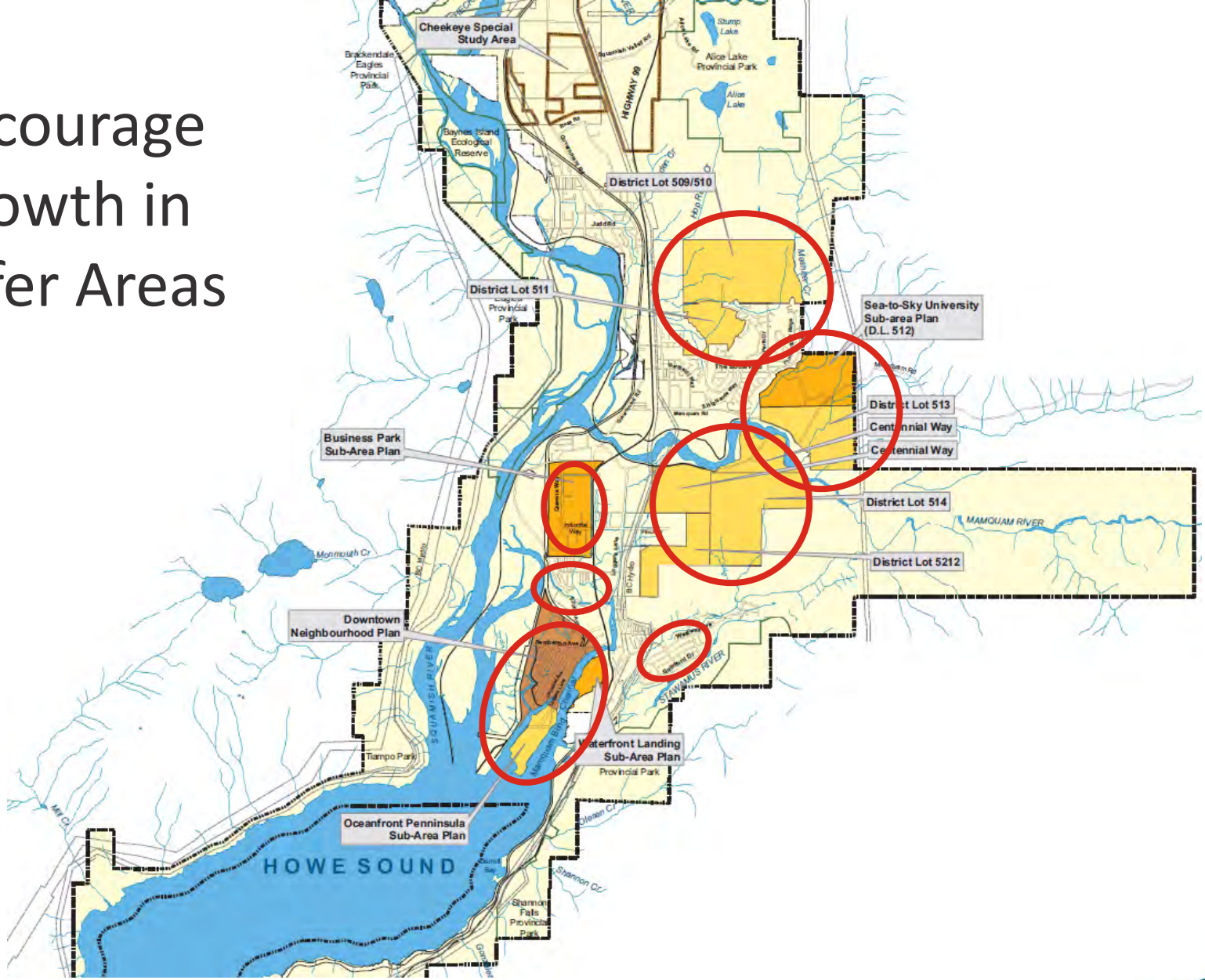

Downtown
Crescent Slough
Natural Floodway
Mamquam Blind Channel
Natural Floodway


Garibaldi Springs
Golf Course
Squamish River Floodway
(see IFHMP Background Report)
Extended Planning
Area for Eagle Run
rezoned for densification where erosion-protected
broadcast fill raises a contiguous portion of the
lands completely out of the Flood Hazard Area
without increasing flood risk at other locations.
Fill must substantially tie in with areas where
natural grade exceeds the MBE.


Waiwakum 1
Asen Rd
Birken Rd
Parkwood Pl
Ross Rd
Wayburn Rd
Hope Rd
Faith Rd
Depot Rd
Paterson Rd
Government Rd
Bracken Park Way
Wain Pl
Zenith Rd
Rod Rd
Grant Rd
Cottonwood Rd
Brennan Rd
Rae Rd
Judd Rd
Lawson Rd
Carmel Pl
Maple Cres
Aikwucks 15

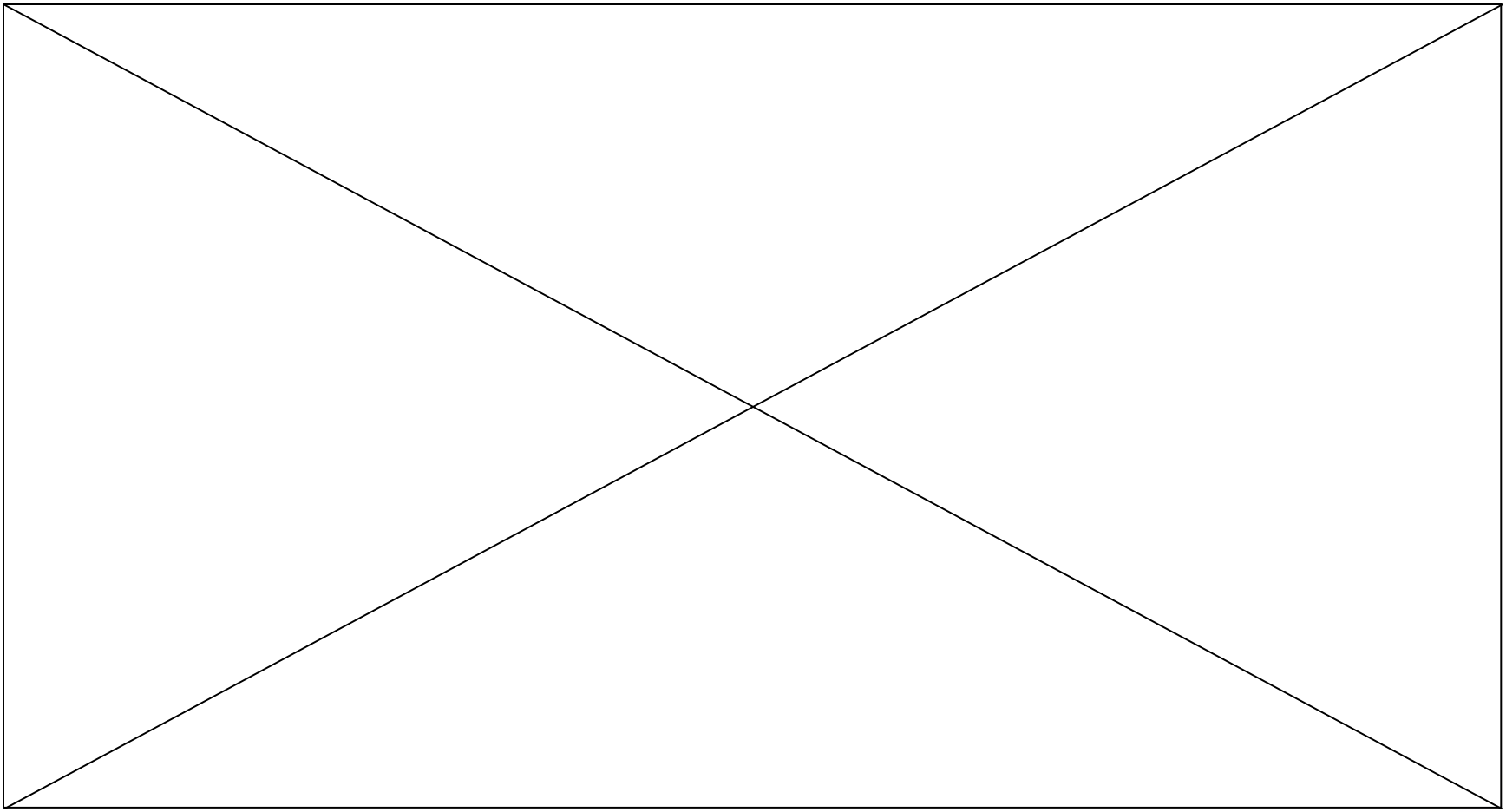

OCP Amendment
Rezoning
Subdivision
Rezoning
Subdivision
OCP Amendment
Waiwakum 14
Aikwucks 15
Axen Rd
Depot Rd
Judd Rd
Rod Rd
Zenith Rd
Parkwood Pl
Ross Rd

Encourage Growth in Safer Areas



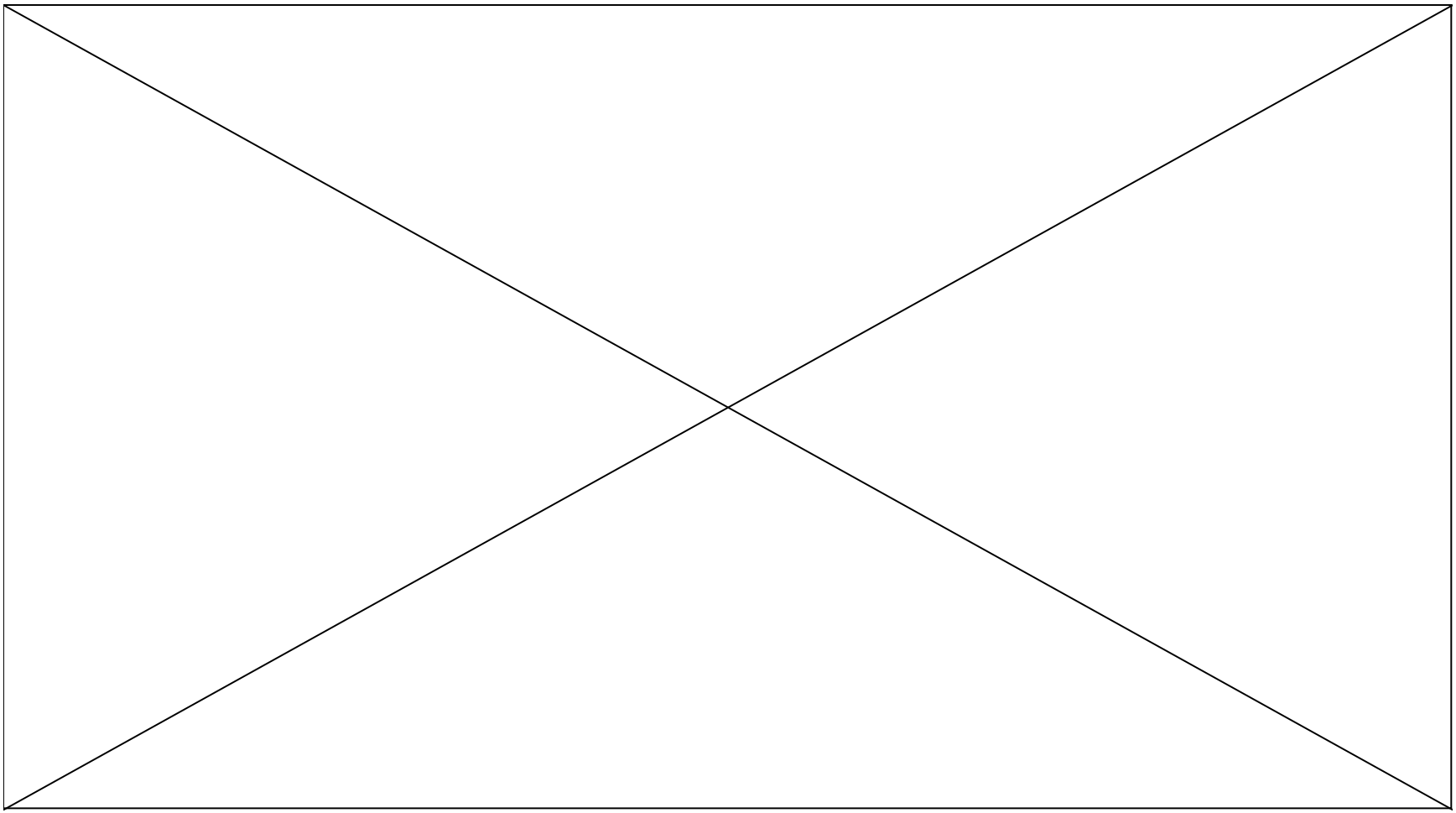
SQUAMISH

Joso, Japan 2015



SQUAMISH

Squamish 2003



SQUAMISH

IFHMP Next Steps

Now

Aug 2016

- Complete engagement process
- Finalize plan
- Council endorsement of mitigation plan
- Prepare final IFHMP
  - Draft floodplain bylaw
  - Further consultation
- Finalize IFHMP, 1st Reading draft bylaw
- Incorporate into OCP

SQUAMISH

Guiding Principles

- Reduce flood risk
- Identify development opportunities
- Make sustainable decisions
- Design achievable solutions

SQUAMISH

Questions/Discussion

SQUAMISH