Skagit River General Investigation
Preliminary Alternatives Presentation Read-Ahead, April 25, 2012
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The Skagit River General Investigation (GI) is a flood risk management study with the primary goal of reducing flood risk and increasing public safety in the Skagit River Basin (Basin). The Basin is located approximately 60 miles north of Seattle, WA. The study area encompasses the Skagit River watershed and the Skagit River floodplain from the Seattle City Lights' Ross Dam reservoir (Ross Lake) to Puget Sound, a total of approximately 150 miles. The GI is currently in the early phases of alternative formulation and the study team has recently completed development of preliminary alternatives.

The primary purpose of this meeting is to present the preliminary alternatives and to discuss natural resources issues/concerns relating to the preliminary alternatives. There will also be discussion of how the National Environmental Policy Act (NEPA) process will be implemented for the GI. Alternatives formulation is dynamic process. It is likely that the final set of alternatives will look different from the preliminary set of alternatives presented today. Agency and public input will be considered in the refinement of the preliminary alternatives into a range of alternatives that will be carried forward to a 10% level of design. Additional analysis (hydraulic, economic, environmental, and policy) will be performed on the refined range of alternatives. Agencies and public will have several opportunities to review the alternatives throughout the remainder of the study.

The study team has developed six preliminary alternatives:

Preliminary Alternative 1: No Action Alternative
Preliminary Alternative 2: Non-Structural and Dam Storage Alternative
Preliminary Alternative 3: Joe Leary Slough Bypass or Floodway
Preliminary Alternative 4: Swinomish Bypass or Floodway
Preliminary Alternative 5: Urban Areas and Critical Infrastructure Protection
Preliminary Alternative 6: System-wide Levee Setbacks

The following pages contain descriptions of each alternative including assumptions and solutions made to formulate the alternatives, and concerns and advantages identified at this time. A schematic representation of the existing hydrology used to formulate the alternatives (Figure 1) is shown below:

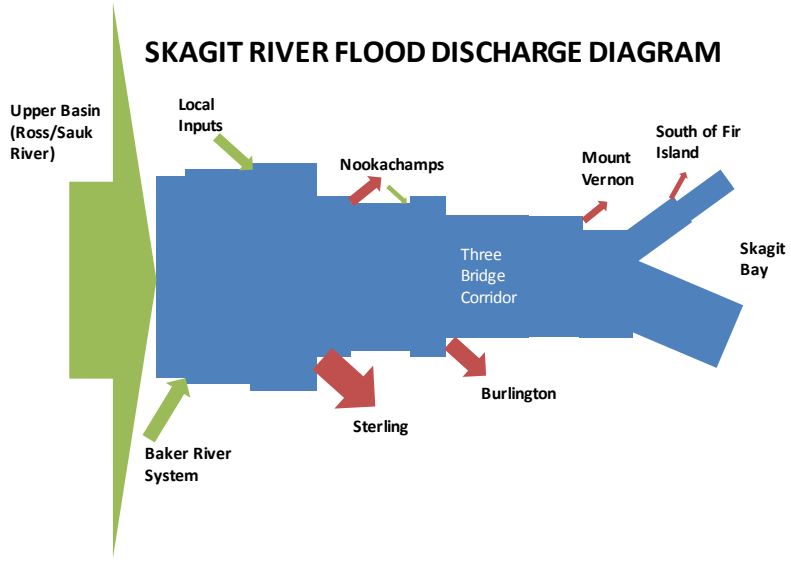

Figure 1. Skagit River Flood Discharge Diagram. This diagram is a representation of Skagit River flood inputs and outputs volumes in a greater than 50-yr flood event with existing conditions (assuming levee overtopping only). The Upper Basin (Ross reservoir and the Sauk River) contributes the majority of flood flows to the Skagit River. The Baker River system, local upstream inputs and return flows from the Nookachamps contribute a small percentage of flood flows. Flood waters exit the system at Sterling, Nookachamps, upstream of the Three Bridge Corridor into Burlington, Mount Vernon, and the left bank of the South Fork

Preliminary Alternative 1: No Action Alternative

- Per USACE planning guidance, the No Action Alternative was evaluated. In general, flooding problems in the Skagit Basin will get worse if no action is taken. The No Action Alternative does not address the study objectives to reduce flood risk and life safety risk in the Skagit River Basin. The County predicts that there will be an increase in future population and there are numerous environmental challenges to maintenance of existing levees per current regulations which further renders the No Action Alternative ineffective.

- FINAL DECISION: The No Action Alternative will not achieve the study objectives and will not be brought forward for further consideration as the recommended plan; however, the No-Action Alternative will be used in evaluation of the range of alternatives during analysis under the National Environmental Protection Act (NEPA).

Preliminary Alternative 2: Non-Structural and Dam Storage Alternative

This alternative does not involve construction of significant new infrastructure or structural modifications of existing infrastructure in the Skagit River Basin.

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - Federal Energy Regulatory Commission (FERC) license Article 107 Flood Storage
    - (a) referencing 74,000 acre feet of flood storage in the Upper Baker River reservoir,
    - (b) referencing 29,000 acre feet of flood storage in the Lower Baker River reservoir, and
    - (c) referencing imminent flood operations; and Article 106 referencing modification of flow implementation plans (Aquatics Table 2).

  It is assumed that during a flood event peak, discharge from the dams will be 0 cfs.

- Debris management for river bridges
- A combination of the following non-structural components will be implemented throughout the basin with focus on the areas of Nookachamps, Sterling, Cockreham Island, Hamilton, Cape Horn, and Concrete.
    - Education and outreach
    - Evacuation routes
    - Installation of additional gauges
    - Flood warning systems
    - Real estate acquisition
    - Relocation of structures
    - Elevation of structures
    - Flood proofing buildings

Preliminary Alternative 3: Joe Leary Slough Bypass or Floodway

The defining piece of this alternative is the Joe Leary Slough Bypass or Floodway. The Joe Leary Slough Bypass or Floodway would allow for removal of flood waters from the Skagit River system upstream of the Three Bridge Corridor either through a defined channel (bypass) or sheet flow (floodway). This alternative does not include structural modification to river bridges or setback levees in the Three Bridge Corridor.

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - Federal Energy Regulatory Commission (FERC) license Article 107 Flood Storage
    - (a) referencing 74,000 acre feet of flood storage in the Upper Baker River reservoir,
    - (b) referencing 29,000 acre feet of flood storage in the Lower Baker River reservoir, and
    - (c) referencing imminent flood operations; and Article 106 referencing modification of flow implementation plans (Aquatics Table 2).

  It is assumed that during a flood event peak, discharge from the dams will be 0 cfs.

- Joe Leary Slough Bypass or Floodway
- Sterling Levee
- Levees to protect Sedro-Woolley, Burlington and La Conner from induced flooding
- Completion of the Mount Vernon Floodwall
- Debris management for river bridges
- A combination of the following non-structural components will be implemented throughout the basin with focus on the Nookachamps, Sterling, Cockreham Island, Hamilton, Cape Horn, and Concrete areas: education and outreach, evacuation routes, installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings.

The following assumptions and solutions were made to formulate this alternative:

Assumption	Solution
Increased flood storage upstream at Upper and Lower Baker reservoirs can potentially reduce flood damages in the Basin	Optimized operations of Upper and Lower Baker Dam per the Federal Energy Regulatory Commission (FERC) license.
Removal of flood waters from the Skagit River system can potentially reduce flood damages in the Basin.	During a flood event, flood waters would be diverted out of the Skagit River system to Padilla Bay through a Joe Leary Slough Bypass/Floodway. Solution assumes that flood volumes continuing through the river system downstream of the bypass can be contained by the existing levee system.
During a large flood event, flooding will occur in	Non-structural measures would be considered.

the Sterling and Nookachamps areas	
Diversion of floodwaters into the Joe Leary Slough Bypass may induce flooding in Burlington, Sedro-Woolley and La Conner.	Levees would be constructed to protect these communities from induced flooding.
Flooding or spill may occur in downtown Mount Vernon	The Mount Vernon floodwall would be completed.

Concerns Indentified as of April 2012:

- Routing of floodwaters through the Joe Leary Bypass or Floodway may adversely impact salinity levels in Padilla Bay.
- Routing of floodwaters through the Joe Leary Bypass or Floodway may adversely impact eelgrass beds in Padilla Bay.
- Routing of floodwaters through the Joe Leary Bypass or Floodway may require additional infrastructure for drainage of farmland along the Bypass.
- The Joe Leary Bypass or Floodway crosses through miles of farmland. Runoff entering the bypass may contain high levels of agricultural runoff resulting in adverse water quality impacts to Padilla Bay.
- The Joe Leary Bypass or Floodway may remove agricultural farmland out of production.
- Construction of the Joe Leary Bypass/floodway may require modifications to Interstate 5 and Burlington Northern Santa Fe railroad, local roadways, and utilities.
- The Joe Leary Bypass or Floodway may involve significant real estate acquisition and costs.

Advantages Identified as of April 2012:

- The Joe Leary Bypass follows the path of the natural hydraulic condition under existing conditions at the Three Bridge Corridor.
- Construction of the Joe Leary Bypass may eliminate the need to modify the Three Bridge Corridor to increase conveyance of floodwaters through the Skagit River system.

Preliminary Alternative 4: Swinomish Bypass or Floodway

The defining piece of this alternative is the Swinomish Bypass or Floodway. The Swinomish Bypass or Floodway would allow for removal of flood waters from the Skagit River system downstream of the Three Bridge Corridor either through a defined channel (bypass) or sheet flow (floodway).

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - Federal Energy Regulatory Commission (FERC) license Article 107 Flood Storage
    - (a) referencing 74,000 acre feet of flood storage in the Upper Baker River reservoir,
    - (b) referencing 29,000 acre feet of flood storage in the Lower Baker River reservoir, and
    - (c) referencing imminent flood operations; and Article 106 referencing modification of flow implementation plans (Aquatics Table 2).

  It is assumed that during a flood event peak, discharge from the dams will be 0 cfs.

- Swinomish Bypass or Floodway
- Structural modifications to the Burlington Northern Santa Fe railroad bridge and setback levees in the Three Bridge Corridor, and potential modification to the Division Street Bridge if needed.
- Setback of existing right bank levees from Sterling to the Swinomish Bypass
- Sterling Levee
- Levees to protect Sedro-Woolley and La Conner from induced flooding
- Completion of the Mount Vernon Floodwall
- Debris management for river bridges
- A combination of the following non-structural components will be implemented throughout the basin with focus on the Nookachamps, Sterling, Cockreham Island, Hamilton, Cape Horn, and Concrete areas: education and outreach, evacuation routes, installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings.

The following assumptions and solutions were made to formulate this alternative:

Assumption	Solution
Increased flood storage upstream can potentially reduce flood damages in the Basin	Optimized operations of Upper and Lower Baker Dam per the Federal Energy Regulatory Commission (FERC) license.
Removal of flood waters from the Skagit River system can potentially reduce flood damages in the Basin.	1) During a flood event, flood waters can be diverted out of the Skagit River system to the Swinomish Channel through the Swinomish Channel Bypass or Floodway 2) Solution assumes that flood volumes continuing through the river system downstream of the bypass can be contained by the existing levee system.

Effectiveness of the Swinomish Bypass or Floodway is dependent on increased conveyance of flood waters through the system upstream of the bypass, i.e. the Three Bridge Corridor.	1) Structural modifications to the BNSF railroad bridge and setback levees in the Three Bridge Corridor may increase conveyance of flood waters. 2) Existing right bank levees from Sterling to the Swinomish Bypass or Floodway would be set back.
During a large flood event, flooding will occur in the Nookachamps area.	This area would be addressed with non-structural measures
Construction of Sterling levee may induce flooding in Sedro-Woolley	Levee would be constructed to protect Sedro-Woolley
Diversion of floodwaters into the Swinomish bypass may induce flooding in La Conner.	Levee would be constructed to protect La Conner.
Flooding or spill may still occur in downtown Mount Vernon	The Mount Vernon floodwall would be completed.

Concerns Identified as of April 2012:

- The Swinomish Bypass or Floodway may introduce sediment contamination into the Swinomish Channel. The presence of contaminated sediments in the Swinomish Channel may interfere with disposal options for maintenance dredging material because contaminated material cannot be disposed at open water disposal sites.
- Increased volume of flood waters into Swinomish Channel may adversely affect sedimentation patterns in the Channel.
- Routing of floodwaters through the Swinomish Bypass or Floodway may adversely impact salinity levels in the Swinomish Channel.
- The Swinomish Bypass would require a large number of modifications to existing utilities, pipelines, and roads.
- The Swinomish Bypass or Floodway may remove agricultural farmland out of production.
- The Swinomish Bypass or Floodway may involve significant real estate acquisition and costs.
- Routing of floodwaters through the Swinomish Bypass may require additional infrastructure for drainage of farmland along the Bypass.

Advantages Identified as of April 2012:

- Removal of floodwaters from the Skagit system through the Swinomish Bypass/Floodway may eliminate the need to set back levees downstream of Mount Vernon.

Preliminary Alternative 5: Urban Areas and Critical Infrastructure Protection

This alternative focuses on providing flood risk reduction for urban areas, such as the cities of Sedro-Woolley, Burlington, and Mount Vernon, and critical infrastructure, such as waste water treatment plants and hospitals, in the Skagit River Basin. This alternative prioritizes flood risk reduction for areas with the potential for high economic and infrastructure damages during a large flood event. This alternative does not include structural modification to river bridges or setback levees in the Three Bridge Corridor.

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - Federal Energy Regulatory Commission (FERC) license Article 107 Flood Storage
    - (a) referencing 74,000 acre feet of flood storage in the Upper Baker River reservoir,
    - (b) referencing 29,000 acre feet of flood storage in the Lower Baker River reservoir, and
    - (c) referencing imminent flood operations; and Article 106 referencing modification of flow implementation plans (Aquatics Table 2).

  It is assumed that during a flood event peak, discharge from the dams will be 0 cfs.

- Levees/ring dikes around Burlington, Mount Vernon and La Conner
- Ring dikes around critical infrastructure such as the Sedro-Woolley Waste Water Treatment Plant, the United General Hospital, and also the Anacortes Water Treatment Plant if needed.
- Completion of the Mount Vernon Floodwall
- Debris management for river bridges
- A combination of the following non-structural components will be implemented throughout the basin with focus on the Nookachamps, Sterling, Cockreham Island, Hamilton, Cape Horn, and Concrete areas: education and outreach, evacuation routes, installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings.

The following assumptions and solutions were made to formulate this alternative:

Assumption	Solution
Increased flood storage upstream can potentially reduce flood damages in the Basin.	Optimized operations of Upper and Lower Baker Dam per the Federal Energy Regulatory Commission (FERC) license.
During a large flood event, the greatest flood damages will occur in Burlington, Sedro-Woolley, Mount Vernon, and La Conner.	Levees/ring dikes would be constructed to protect these urban areas.
Critical infrastructure outside of the urban areas protected by levees may still be subject to flooding.	Ring dikes would be constructed around critical infrastructure such as the Sedro-Woolley Waste Water Treatment Plant, the United General Hospital, and also the Anacortes Water Treatment Plant if needed.
Flooding or spill may still occur in downtown	The Mount Vernon floodwall would be completed.

Mount Vernon.	
Flooding may occur in areas outside the urban areas.	Non-structural measures would be considered.

Concerns Identified as of April 2012:

- This alternative may induce flooding on agricultural lands.
- Would require evacuation routes and procedures out of areas enclosed by levees to provide an additional level of safety for residents.

Preliminary Alternative 6: System-wide Levee Setbacks

This alternative increases conveyance of floodwaters though the river system and contains floodwaters within the river system by setting back the entire levee system, modifying river bridge structures, and constructing a West Mount Vernon Bypass.

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - Federal Energy Regulatory Commission (FERC) license Article 107 Flood Storage
    - (a) referencing 74,000 acre feet of flood storage in the Upper Baker River reservoir,
    - (b) referencing 29,000 acre feet of flood storage in the Lower Baker River reservoir, and
    - (c) referencing imminent flood operations; and Article 106 referencing modification of flow implementation plans (Aquatics Table 2).

  It is assumed that during a flood event peak, discharge from the dams will be 0 cfs.

- Set back the entire Skagit River levee system
- Structural modifications to the Burlington Northern Santa Fe railroad bridge and setback levees in the Three Bridge Corridor, and potential modification to the Division Street Bridge if needed.
- Completion of the Mount Vernon Floodwall
- West Mount Vernon Bypass
- Fir Island Bypass
- Sterling levee
- Levees to protect Sedro-Woolley as needed to reduce flood risk from induced flooding caused by the Sterling levee.
- Completion of the Mount Vernon Floodwall
- Debris management for river bridges
- A combination of the following non-structural components will be implemented throughout the basin with focus on the West Mount Vernon, Nookachamps, Sterling, Cockreham Island, Hamilton, Cape Horn, and Concrete areas: education and outreach, evacuation routes, installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings.

The following assumptions and solutions were made to formulate this alternative:

Assumption	Solution
Increased flood storage upstream can potentially reduce flood damages in the Basin.	Optimized operations of Upper and Lower Baker Dam per the Federal Energy Regulatory Commission (FERC) license.
Increased conveyance of flood waters through the Skagit River system can potentially reduce flood damages in the Basin.	Set back the entire Skagit River levee system. This would involve construction of right bank levee set backs beginning from a Sterling levee to the south of Mount Vernon, construction of a Riverbend levee, and setback of levees on both sides of the

	river from south of Mount Vernon along both forks of the Skagit River (Fir Island) to Skagit Bay. Structural modifications to the BNSF railroad bridge. Construction of the West Mount Vernon Bypass. Construction of the Fir Island Bypass.
Construction of Sterling levee may induce flooding in Sedro-Woolley.	Construction of levee to protect Sedro-Woolley.
During a large flood event, flooding will occur in the Sterling, Nookachamps and West Mount Vernon.	These areas would be addressed with non-structural measures.
Critical infrastructure not protected by new levees is subject to flooding.	Ring dikes would be constructed around critical infrastructure such as the Sedro-Woolley Waste Water Treatment Plant, the United General Hospital, and the Anacortes Waste Water Treatment Plant.
Flooding or spill may occur in downtown Mount Vernon	The Mount Vernon flood wall would be completed.

Concerns:

- West Mount Vernon Bypass may involve relocation of numerous homes and businesses and may impact the West Mount Vernon urban growth area.
- Levee setback may require large number of modifications to existing utilities and roads.
- Levee setbacks may remove agricultural farmland out of production.
- Levee setbacks may involve significant real estate acquisition and costs.

Advantages:

- Setting back of levees would increase the width of the riparian corridor and provide potential environmental benefit.
- Maximizes the flood capacity of the existing channel.

Skagit River General Investigation
Preliminary Alternative 2
Non-Structural & Dam Storage

Hamilton
Cockreham Island
Lyman
Sedro-Woolley
United General Hospital
Sedro-Woolley WWTP
Sterling
Burlington WWTP
Burlington
Nookachamps
Clear Lake
Three Bridge Corridor
Anacortes Water Treatment Plant
Mount Vernon WWTP
Skagit Regional Airport
Laconner

Upper Skagit Basin

1:192,000
1"~ 3 miles

Upper Baker Dam
Lower Baker Dam
Cape Horn
Concrete
Lake Shannon
Goat Mountain
Welker Peak
Jackman

Legend

City Extents

Population
- 0 - 1200
- 1201 - 7500
- 7501 - 22100

Points of Interest

- Hospital
- Water Treatment Plant
- Waste Water Treatment Plant
- Existing Levee

Measures

- Dam Operational Modifications
- Nonstructural

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NAD83 UTM10N
ESRI US & Canada City Areas
CENWS FCW Levees
National Geographic Basemap

0 2 Miles

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Skagit River General Investigation
Preliminary Alternative 3
Joe Leary Slough Bypass/Floodway

JLS Bypass Floodway

Three Bridge Corridor

United General Hospital

Sedro-Woolley WWTP

Burlington WWTP

Anacortes Water Treatment Plant

Mount Vernon WWTP

Sedro-Woolley

Sterling

Nookachamps

Burlington

Clear Lake

Cockreham Island

Hamilton

Lyman

Laconner

Skagit Regional Airport

Eaglemont Golf Course

Upper Skagit Basin

1:192,000
1" ~ 3 miles

Upper Baker Dam

Lower Baker Dam

Cape Horn

Concrete

Goat Mountain

Lake Shannon

Lake Cavanaugh

Legend

City Extents

Population
- 0 - 1200
- 1201 - 7500
- 7501 - 22100

Points of Interest
- Hospital
- Water Treatment Plant
- Waste Water Treatment Plant
- Existing Levee

Measures
- Dam Operational Modifications
- New levee
- New Levee (Induced Flooding)
- Mount Vernon Floodwall
- Bypass channel
- Bypass overland flow
- Nonstructural

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ESRI US & Canada City Areas
CENWS FCW Levees
National Geographic Basemap

0 2 Miles

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Skagit River General Investigation
Preliminary Alternative 4
Swinomish Bypass/Floodway

United General Hospital

Sedro-Woolley WWTP

Sterling

Burlington WWTP

Burlington

Nookachamps

Three Bridge Corridor

BNSF Bridge

Anacortes Water Treatment Plant

Swinomish Bypass

Floodway

Division St Bridge

Mount Vernon WWTP

Mount Vernon

Sedro-Woolley

Cockreham Island

Hamilton

Lyman

Clear Lake

Big Lake

Laconner

Skagit Regional Airport

Legend

City Extents

Population

- 0 - 1200
- 1201 - 7500
- 7501 - 22100

Points of Interest

- Hospital
- Water Treatment Plant
- Waste Water Treatment Plant
- Existing Levee

Measures

- Dam Operational Modifications
- Bridge Mods
- Setback levee
- New levee
- New Levee (Induced Flooding)
- Mount Vernon Floodwall
- Bypass channel
- Bypass overland flow
- Nonstructural

Upper Skagit Basin

1:192,000
1"~ 3 miles

Upper Baker Dam

Lower Baker Dam

Cape Horn

Concrete

1:96,000, 1"=1.5 miles
NAD83 UTM10N
ESRI US & Canada City Areas
CENWS FCW Levees
National Geographic Basemap

0 2 Miles

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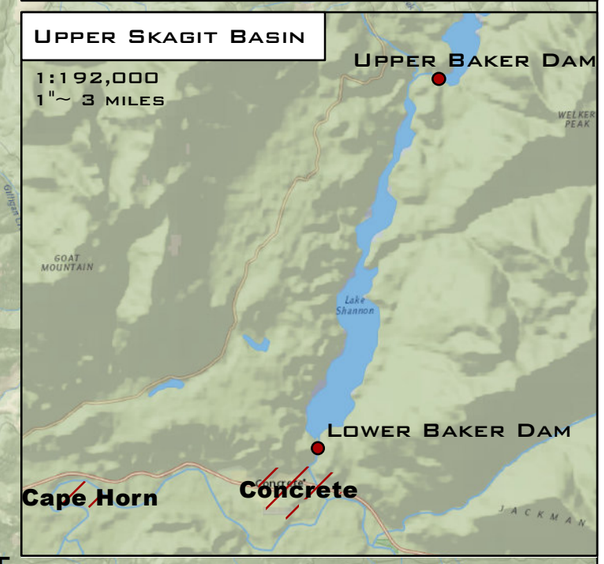
Skagit River General Investigation
Preliminary Alternative 5
Urban Area Protection

Cockreham Island
Hamilton
Lyman
Sedro-Woolley
United General Hospital
Sedrow-Woolley WWTP
Sterling
Burlington WWTP
Burlington
Nookachamps
Clear Lake
Three Bridge Corridor
Anacortes Water Treatment Plant
Mount Vernon WWTP
Mount Vernon
Laconner
Skagit Regional Airport

Upper Skagit Basin



Legend

City Extents

Population
- 0 - 1200
- 1201 - 7500
- 7501 - 22100

Points of Interest
- Hospital
- Water Treatment Plant
- Waste Water Treatment Plant
- Existing Levee

Measures
- Dam Operational Modifications
- Setback levee
- New levee
- Levee modification
- Mount Vernon Floodwall

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CENWS FCW Levees
National Geographic Basemap

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Skagit River General Investigation
Preliminary Alternative 6
System-wide Levee Setbacks

United General Hospital

Sedrow-Woolley WWTP

Sedro-Woolley

Sterling

Burlington WWTP

Burlington

Nookachamps

Three Bridge Corridor

BNSF Bridge

Anacortes Water Treatment Plant

River Bend

W Mt Vernon Bypass

Division St Bridge

Mount Vernon WWTP

Fir Island Bypass

Cockreham Island

Hamilton

Lyman

Laconner

Clear Lake

Big Lake

Skagit Regional Airport

Legend

City Extents

Population

- 0 - 1200
- 1201 - 7500
- 7501 - 22100

Points of Interest

- Hospital
- Water Treatment Plant
- Waste Water Treatment Plant
- Existing Levee

Measures

- Dam Operational Modifications
- Bridge Mods
- Setback levee
- New levee
- New Levee (Induced Flooding)
- Mount Vernon Floodwall
- Bypass channel
- Nonstructural

Upper Skagit Basin

1:192,000
1"~ 3 miles

Upper Baker Dam

Lower Baker Dam

Cape Horn

Concrete

Lake Shannon

Lake Cavanaugh

1:96,000, 1"=1.5 miles
NAD83 UTM10N
ESRI US & Canada City Areas
CENWS FCW Levees
National Geographic Basemap

0 2 Miles

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