## **Environmental Considerations Matrix**

### **Alternative 1: Swinomish Diversion**

	Features		Benefits (+) and Impacts (-)	Possi	ble Mitigation Measures
<b>√</b>	80,000 cfs Diversion 2,000 feet wide with low flow channel (approx, 200 cfs year-round) and 500-ft riparian buffer	I.	<ul> <li>Diversion</li> <li>+ Salmon utilization potential in Diversion</li> <li>+ Increased estuary rearing habitat in Swinomish Slough</li> <li>+ Conversion of uplands to wetlands as a result of</li> </ul>	A	Maintain year round low flow in channel Allow for fish passage to river Create marsh at downstream
✓	100-year protection		Diversion construction  - Some loss of land due to berm construction	>	end of channel Create a 500-ft riparian buffer
✓	I-5 protected		<ul> <li>Potential impacts to eelgrass beds in Padilla Bay</li> </ul>		along low flow channel
✓	500-ft setback levee through Burlington		<ul> <li>Potential water quality impacts to Padilla Bay</li> <li>Increased sediment in Swinomish Channel during flood</li> </ul>		
<b>✓</b>	Riverbank excavated in 3-bridge corridor	II.	•	>	Open up historic side channels (e.g. Britts Slough,
<b>V</b>	Existing riprap and toe rock remains in place to reduce channel migration. This riprap will be planted with riparian species. The riprap will be replaced on an as needed basis to maintain protection. (Note: Corps is considering removing existing riprap and placing riprap on setback levees.)		<ul> <li>Channel locked in place with little off channel habitat</li> <li>Changes in river flows could produce significant changes in channel substrate and form</li> <li>Long-term impacts to riparian habitat and large woody debris (LWD) in channel</li> </ul>	<b>A</b>	Dry Slough, and Hearts Slough) with inlet structures for fish passage Plantings in riprap and installation of LWD structures
✓	No side channels allowed in setback areas so as to prevent river				

migration	III. Setback of Levees		
	+ Potential for additional refugia during flood	>	Plantings in riprap along river
	events	>	Plant 200 ft riparian buffer
	<ul> <li>Long-term impacts to bank vegetation, side</li> </ul>	>	Remove old riprap and place
	channel formation, and bank-side conditions		new riprap at setback levees.
	(existing bank conditions maintained – riprap		Then side channels could be
	remains)		constructed in setback areas
	<ul> <li>Loss of vegetation from over-bank excavation</li> </ul>		because levees are protected
			by riprap.
		<b>&gt;</b>	Open up historic side
			channels (e.g. Britts Slough, Dry Slough, and Hearts
			Slough) with inlet structures
			for fish passage
			Tor Tish pussage
	IV. Loss of Floodplain Habitat to Urban Conversion		
	177 Loss of Floorpain Habitat to Orban Conversion	>	Enact additional development
			restrictions
	V. Potential Loss, Temporary Impact to Habitat of		
	ESA Species (Eagle, etc)		
	• • • • • • • • • • • • • • • • • • • •		
	VI. Cultural Resources		
	<ul> <li>Potential disturbance and/or destruction of</li> </ul>	>	Evaluate for National Historic
	known or unknown sites		Register eligibility.
			Mitigation will be dependent
			upon content of discovery.

### **Alternative 2: Small Swinomish Diversion with Setbacks**

#### **Features**

- ✓ 40,000 cfs Diversion 1,000 feet wide, with low flow channel (approx. 200 cfs year-round) and 500-ft riparian buffer
- ✓ 100-year protection
- ✓ I-5 protected
- ✓ 500-ft setback levee through Burlington
- ✓ Riverbank excavated in 3-bridge corridor
- ✓ Existing riprap and toe rock remains in place to reduce channel migration. This riprap will be planted with riparian species. The riprap will be replaced on an as need basis to maintain protection. (Note: Corps is considering removing existing riprap and placing riprap on setback levees.)
- ✓ No side channels allowed in setback areas so as to prevent river migration
- ✓ Excavated riverbank at Mount Vernon
- ✓ 500-ft setback levee downstream of Mount Vernon

### **Benefits** (+) and Impacts (-)

#### I. Diversion

- + Salmon utilization potential in Diversion
- + Increased estuary rearing habitat in Swinomish Slough
- Conversion of uplands to wetlands as a result of Diversion construction
- Some loss of land due to berm construction
- Potential impacts to eelgrass beds in Padilla Bay
- Potential water quality impacts to Padilla Bay
- Increased sediment in Swinomish Channel during flood

#### **II. Stronger Dikes**

- Complicates future restoration options through levee
- Channel locked in place with little off channel habitat
- Changes in river flows could produce significant changes in channel substrate and form
- Long term impacts to riparian habitat and LWD in channel

### **Possible Mitigation Measures**

- Maintain year round low flow in channel
- ➤ Allow for fish passage to river
- Create marsh at downstream end of channel
- > Create a 500-ft riparian buffer along low flow channel

- Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage
- Plantings in riprap and installation of LWD structures

III. Setback of Levees		
<ul> <li>H. Setback of Levees</li> <li>Potential for additional refugia during flood events</li> <li>Long-term impacts to bank vegetation, side channel formation, and bank-side conditions (existing bank conditions maintained – riprap remains)</li> <li>Loss of vegetation from over-bank excavation</li> </ul>	AAA	Plantings in riprap along river Plant 200-ft riparian buffer Remove old riprap and place new riprap at setback levees. Then side channels could be constructed in setback areas because levees are protected by riprap. Open up historic side channels (e.g. Britts Slough, Dry Slough and Hearts Slough) with inlet structures for fish passage
V. Loss of Floodplain Habitat to Urban Conversion	>	Enact additional development restrictions
VI. Potential Loss, Temporary Impact to Habitat of ESA Species (Eagle, etc)  VII. Cultural Resources  — Potential disturbance and/or destruction of known or unknown sites	>	Evaluate for National Historic Register eligibility. Mitigation will be dependent upon content of discovery.

# **Alternative 3: Setback Levees with Selected Overtopping**

	Features		Benefits (+) and Impacts (-)	Possi	ble Mitigation Measures
✓ ✓ ✓	Over-topping levees down stream at River Bend and downstream of Mount Vernon  500-ft setback levee through Burlington  Riverbank excavated in 3-bridge corridor  I-5 protected	I.	<ul> <li>Stronger Dikes</li> <li>Complicates future restoration options through levee</li> <li>Channel locked in place with little off channel habitat</li> <li>Changes in river flows could produce significant changes in channel substrate and form</li> <li>Long term impacts to riparian habitat and LWD in channel</li> </ul>	A	Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage Plantings in riprap and installation of LWD structures
✓	Excavated riverbank at Mount Vernon. Levee segments to protect Burlington and Mount Vernon. 100- year protection.  Rest of floodplain protected to 25- year event  Existing riprap and toe rock remains in place to reduce channel migration. (Note: Corps is considering removing existing riprap and placing riprap on		<ul> <li>Setback of Levees</li> <li>Potential for additional refugia during flood events</li> <li>Long-term impacts to bank vegetation, side channel formation, and bank-side conditions (existing bank conditions maintained – riprap remains)</li> <li>Loss of vegetation from over-bank excavation</li> </ul>	A A A	Plantings in riprap along river Remove old riprap and place new riprap at setback levees. Then side channels could be constructed in setback areas because levees are protected by riprap. Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage
	setback levees.)	III.	<ul> <li>Ring Dikes - Cities</li> <li>Wetland impacts due to levee construction</li> </ul>	>	Wetland mitigation most likely in diversion

<ul> <li>IV. Over Topping Levees         <ul> <li>Possible increase or decrease in fish stranding after flood event (still needs to be evaluated)</li> <li>Assumption is that all fish going over overtopping sections are lost. Should be evaluated in concurrence with other dike options.</li> <li>Water quality impacts from overland flooding</li> </ul> </li> <li>V. Potential Loss, Temporary Impact to Habitat of ESA Species</li> </ul>	<ul> <li>Create instream habitat for refugia</li> <li>Improve mainstem habitat</li> </ul>
VI. Cultural Resources  - Potential disturbance and/or destruction of known or unknown sites	<ul> <li>Evaluate for National Historic Register eligibility.</li> <li>Mitigation will be dependent upon content of discovery.</li> </ul>

# **Alternative 4: Setback Levees with Overtopping**

	Features		Benefits (+) and Impacts (-)	<b>Possible Mitigation Measures</b>	
<b>✓</b>	Over-topping levees downstream at River Bend and downstream of Mount Vernon	I.	<ul> <li>Stronger Dikes</li> <li>Complicates future restoration options through levee</li> <li>Channel locked in place with little off channel</li> </ul>	>	Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts
✓	Transportation corridor is NOT protected		<ul> <li>Chainler locked in place with fittle off chainler habitat</li> <li>Changes in river flows could produce significant changes in channel substrate and</li> </ul>	>	Slough) with inlet structures for fish passage Plantings in riprap and
<b>✓</b>	500-ft setback levee through Burlington		form  - Long-term impacts to riparian habitat and LWD in channel		installation of LWD structures
<b>√</b>	Riverbank excavated in 3-bridge corridor	II.	Setback of Levees		
<b>√</b>	Excavated riverbank at Mount Vernon. Levee segments to protect Burlington and Mount Vernon. 100- year protection		<ul> <li>Potential for additional refugia during flood events</li> <li>Long-term impacts to bank vegetation, side channel formation, and bank-side conditions (existing bank conditions maintained – riprap remains)</li> </ul>	<b>&gt;</b>	Plantings in riprap along river Remove old riprap and place new riprap at setback levees. Then side channels could be constructed in setback areas because levees are protected
✓	Ring dikes to protect Burlington and Mount Vernon. 100-year protection		Loss of vegetation from over-bank excavation	>	by riprap. Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts
✓	Rural floodplain protected to 25-year event				Slough) with inlet structures for fish passage
✓	Existing riprap and toe rock remains in place to reduce channel migration. (Note: Corps is considering removing existing	Ш	<ul> <li>Ring Dikes - Cities</li> <li>Wetland impacts due to levee construction</li> </ul>	>	Wetland mitigation most likely in diversion

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riprap and placing riprap on	IV. Overtopping Levees		
setback levees.)	? Possible increase or decrease in fish stranding	>	Create instream habitat for
	after flood event.		refugia
	<ul> <li>Assumption is that all fish going over</li> </ul>	>	Improve mainstem habitat
	overtopping sections are lost. Should be		improve mainstein naoitat
	11 0		
	evaluated in concurrence with other dike		
	options.		
	<ul> <li>Water quality impacts from overland flooding</li> </ul>		
	V. Potential Loss, Temporary Impact to Habitat of		
	ESA Species (Eagle, etc)		
	ESA Species (Eagle, etc)		
	VI. Cultural Resources		
	<ul> <li>Potential disturbance and/or destruction of</li> </ul>	>	Evaluate for National Historic
	known or unknown sites		Register eligibility.
			Mitigation will be dependent
			upon content of discovery.
			apon content of discovery.

## **Alternative 5: Setback Levees**

Features	Benefits (+) and Impacts (-)	Possible Mitigation Measures	
✓ 100-year event contained within the setback levees	<ul> <li>Setback of Levees</li> <li>+ Potential for additional refugia during flood events</li> </ul>	<ul> <li>Plantings in riprap along river</li> <li>Remove old riprap and place</li> </ul>	
✓ In 3-bridge corridor, set back levee 500 feet including bank excavation	<ul> <li>Long-term impacts to bank vegetation, side channel formation, and bank-side conditions (existing bank conditions maintained – riprap</li> </ul>	new riprap at setback levees.  Then side channels could be constructed in setback areas	
✓ In West Mount Vernon; set back levee additional 500 feet behind Ball Street	remains)  - Loss of vegetation from over-bank excavation	because levees are protected by riprap.  Plant 200-ft riparian buffer Open up historic side	
✓ Downstream of Mount Vernon, set back levees combined total of 1,000 feet, no bank excavation. Taper back to normal at bridges on both North and South Forks.		channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage	
✓ Existing riprap and toe rock remains in place to reduce channel migration. (Note: Corps is	II. Loss of Floodplain Habitat to Urban Conversion	Enact additional development restrictions	
considering removing existing riprap and placing riprap on setback levees.)	III. Potential Loss, Temporary Impact to Habitat of ESA Species (Eagle, etc)		
	<ul> <li>IV. Cultural Resources</li> <li>Potential disturbance and/or destruction of known or unknown sites</li> </ul>	<ul> <li>Evaluate for National Historic Register eligibility.</li> <li>Mitigation will be dependent upon content of discovery.</li> </ul>	

## **Alternative 6: Samish Diversion**

Features	Benefits (+) and Impacts (-)	<b>Possible Mitigation Measures</b>	
<ul> <li>✓ 80,000 cfs Diversion 1,500 feet wide to Samish Bay</li> <li>✓ For the Skagit River, existing riprap and toe rock remains in place to reduce channel migration</li> </ul>	<ul> <li>Diversion         <ul> <li>Enhancement of riparian corridor along the Samish River</li> <li>Increased estuary rearing habitat in Samish Bay</li> <li>Potential impacts to eelgrass beds in Samish Bay</li> <li>Conversion of uplands to wetlands as a result of Diversion construction</li> <li>Some loss of land due to berm construction</li> <li>Potential water quality impacts to Samish Bay</li> <li>Increased sediment in Samish Bay during flood</li> </ul> </li> </ul>	Samish River	
	<ul> <li>II. Stronger Dikes         <ul> <li>Complicates future restoration options through levee</li> <li>Channel locked in place with little off channel habitat</li> <li>Changes in river flows could produce significant changes in channel substrate and form</li> <li>Long-term impacts to riparian habitat and LWD in channel</li> </ul> </li> </ul>	<ul> <li>Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage</li> <li>Plantings in riprap and installation of LWD structures</li> </ul>	
	<ul><li>III. Loss of floodplain habitat to urban conversion</li><li>IV. Potential loss, temporary impact to habitat of ESA species (Eagle, etc)</li></ul>	Enact additional development restrictions	
	<ul> <li>V. Cultural Resources         <ul> <li>Potential disturbance and/or destruction of known or unknown sites</li> </ul> </li> </ul>	<ul> <li>Evaluate for National Historic Register eligibility.</li> <li>Mitigation will be dependent upon content of discovery.</li> </ul>	

# **Alternative 7: Upper Swinomish Diversion**

Features	Benefits (+) and Impacts (-)	Possible Mitigation Measures
<ul> <li>✓ 80,000 cfs Diversion 2,000 feet wide</li> <li>✓ 100-year protection</li> <li>✓ 500-ft setback levee through Burlington</li> <li>✓ Riverbank excavated in 3-bridge corridor</li> <li>✓ Existing riprap and toe rock</li> </ul>	<ul> <li>I. Diversion         <ul> <li>Salmon utilization potential in Diversion</li> <li>Increased estuary rearing habitat in Swinomish Slough</li> <li>Conversion of uplands to wetlands as a result of Diversion construction</li> <li>Some loss of land due to berm construction</li> <li>Potential impacts to eelgrass beds in Padilla Bay</li> <li>Potential water quality impacts to Padilla Bay</li> <li>Increased sediment in Swinomish Channel during flood</li> </ul> </li> </ul>	<ul> <li>Maintain year round low flow in channel</li> <li>Allow for fish passage to river</li> <li>Create marsh at downstream end of channel</li> <li>Create a 500-ft riparian buffer along low flow channel</li> </ul>
remains in place to reduce channel migration. (Note: Corps is considering removing existing riprap and placing riprap on setback levees.)	<ul> <li>II. Stronger Dikes         <ul> <li>Complicates future restoration options through levee</li> <li>Channel locked in place with little off channel habitat</li> <li>Changes in river flows could produce significant changes in channel substrate and form</li> <li>Long-term impacts to riparian habitat and LWD in channel</li> </ul> </li> </ul>	<ul> <li>Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage</li> <li>Plantings in riprap and installation of LWD structures</li> </ul>

	. Setback of Levees		
	<ul> <li>Potential for additional refugia during flood events</li> <li>Long-term impacts to bank vegetation, side channel formation, and bank-side conditions (existing bank conditions maintained – riprap remains)</li> <li>Loss of vegetation from over-bank excavation</li> </ul>	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Plantings in riprap along river Remove old riprap and place new riprap at setback levees. Then side channels could be constructed in setback areas because levees are protected by riprap. Plant 200-ft riparian buffer Open up historic side channels (e.g. Britts Slough, Dry Slough, and Hearts Slough) with inlet structures for fish passage
IV	. Loss of Floodplain Habitat to Urban Conversion	>	Enact additional development restrictions
	Potential Loss, Temporary Impact to Habitat of ESA Species (Eagle, etc)  Cultural Resources  Potential disturbance and/or destruction of known or unknown sites	>	Evaluate for National Historic Register eligibility. Mitigation will be dependent upon content of discovery.