DRAFT

Lower Samish River Basin Comprehensive Flood Hazard Management Plan

PREPARED FOR

SKAGIT COUNTY
PUBLIC WORKS DEPARTMENT

PREPARED BY

CH2M HILL

June 1995

WASHINGTON STATE DEPARTMENT OF ECOLOGY

115159.A0
JMI

The Skagit County Public Works Department and CH2M HILL wish to acknowledge Skagit County Commissioners:

Robert Hart, Chairman, District 1
Harvey Wolden, District 2
Ted W. Anderson, District 3

The recommendations and proposed projects in this Comprehensive Flood Hazard Management Plan have the consensus of the diking an drainage district commissioners listed below.

	Initials/Date
Diking District 5:	
Jerry Benson	9/15/95
Jim Sullivan	
Ron Knutzen	
Drainage District 14:	
Roger Knutzen	
Fred Boonstra	
John Bouslong	
Drainage District 15:	
Leonard Lee	10-3-95
Art Voorde Poorte	
Diking District 19:	
Ron Johnson	10/9/95
David Hall	
Jerry Robbins	
Diking/Drainage District 25:	
Dick Meade	
Tom McGeHee	
John Sandell	

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Acronym List

CFHMP	Comprehensive Flood Hazard Management Plan
cfs	cubic feet per second
COE	U.S. Army Corps of Engineers
DFW	Department of Fish and Wildlife
FCAAP	Flood Control Assistance Account Program
FEMA	Federal Emergency Management Agency
FFA	Flood Frequency Analysis Model
GMA	Growth Management Act
NFIP	National Flood Insurance Program
NRCS	Natural Resource Conservation Service (formerly the Soil Conservation Service)
SCS	Soil Conservation Service (now the Natural Resource Conservation Service)
SEPA	State Environmental Policy Act
SWM	surface water management
USGS	U.S. Geological Survey
WSDOT	Washington State Department of Transportation

SECTION 1 EXECUTIVE SUMMARY

- **Project Methodologies, Public and Agency Participants, and Goals**
- **Summary of Proposed Solutions and Costs**

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This Comprehensive Flood Hazard Management Plan details the planning process, technical analysis, and improvement recommendations for managing the flood hazard in the lower Samish River basin. The primarily agricultural land in this area, which is a Federal Emergency Management Agency (FEMA) designated 100-year floodplain, historically experiences overbank flooding on an average frequency of 2 to 5 years.

PROJECT METHODOLOGIES, PARTICIPANTS, AND GOALS

This plan has been produced to comply with a state requirement that counties requesting state funding participation for flood control maintenance prepare a comprehensive flood control management plan to be adopted by the county and approved by the Washington State Department of Ecology (Ecology) in consultation with the Washington State Department of Fish and Wildlife.

An advisory committee composed of the affected diking and drainage districts was formed to guide the planning process in developing this plan. Regular meetings were held with Skagit County, the advisory committee, and the consultant to enable interactive participation in the planning process. Issues related to this planning effort were also discussed by the Samish Watershed Action Committee to provide more broadly based public participation. Plan goals and objectives were established by the Skagit County Department of Public Works, with input from the advisory committee. Recommended flood hazard management measures were then selected by a consensus vote of the committee. The primary goals of this plan include the following:

- Improve protection of public health and safety from flooding threats in the lower Samish River basin.
- Provide practical, cost-effective solutions that will result in measurable reductions in flooding frequency, duration, and frequently flooded area damages.
- Implement comprehensive floodplain management regulations to control future watershed growth impacts to flooding in the lower Samish River basin.
- Achieve diking/drainage district, County, and resource agency consensus for recommended solutions.
- Document solutions consistent with Ecology's Flood Control Assistance Account Program (FCAAP) requirements to maximize further grant funding opportunities for project and program implementation.

- Build effective political and legal strategy to result in implementation of plan solutions.

SUMMARY OF PROPOSED SOLUTIONS AND COSTS

The recommendations of the advisory committee were divided into flood hazard management measures that address problems in the specific planning area and measures that address the Samish Watershed in general. Within these two categories, proposed solutions were further divided into the following:

- Nonstructural, policy and program recommendations
- Structural, capital improvement program projects

Policy and program recommendations outlined in this plan, which will need to be evaluated for consistency with the Samish Watershed Action Plan concurrently being prepared by the Skagit County Planning Department, include:

- Floodplain development regulation
- Watershed development regulation
- Protection of existing structures
- Flood warning and monitoring program
- Flood facility maintenance program

Estimated costs for these programs total $200,000.

For the recommended capital improvement program projects, the advisory committee reviewed and ranked numerous suggested preliminary projects and finally recommended eight projects that have consensus support for funding and implementation. Table 1 briefly describes these eight projects within the planning area and gives the advisory committee ranking and total costs for each. Figure 1 shows the location of each project by the number noted on Table 1.

Table 1
Capital Improvement Projects

Capital Projects

District Commissioners' Priority Ranking	Capital Project Number	Project Description	1995 Estimated Implementation Cost
1	2	Roadside ditches and pipeline to river from Allen-West Rd East. of Thomas Rd.	$110,000
2	3	Install new floodwater return outfalls to river and upgrade existing outfalls (6 sites)	$250,000 ($42,000 ea. site)
3	4	Install roadway culverts at historic flood path crossings (12 sites)	$420,000 ($35,000 ea. site)
4	7	Improve Edison Slough capacity	$540,000
5	6	Install additional outfalls to bay in District 5 west of Samish River (4 sites)	$890,000 ($220,000 ea.)
6	1	Install pipeline to Joe Leary Slough along Allen-West Rd.	$440,000
7	9	Construct setback dikes along river corridor from river mouth to I-5. Upgrade flow capacity at four bridge crossings.	$8.8M $1.13M (Ph. 1)
8	5	Floodwater diversion to Joe Leary Slough along Farm-Market Rd. Construct pump station at mouth of Joe Leary Slough.	$400,000
		Total Capital Project Costs	**$4.18M**

SECTION 2

INTRODUCTION

- **Legal Authority and Scope**
- **Project Background**
- **Planning Proccess**
- **Description and Characteristics of Planning Area**

Section 2
RECOMMENDED FLOOD HAZARD MANAGEMENT PLAN

This section reports the recommended Comprehensive Flood Hazard Management Plan (CFHMP) that resulted from the study. The project background, planning and public involvement process, planning area characterization, goals and objectives, applicable regulatory programs, and description of the alternatives follow in subsequent chapters of this plan.

Recommended flood hazard management measures were selected by consensus vote of the plan's advisory committee, which consists of the commissioners of the five diking and drainage districts covering the study area. This committee has met seven times between February and June with representatives of Skagit County Public Works and the consultant to review flooding problems and issues and to develop and evaluate potential structural (projects) and non-structural solutions including recommended watershed and floodplain management actions.

Based on the advisory committee's input on flood hazard reduction needs, the consultant has provided guidance to the committee regarding specific project proposals and their feasibility, cost, benefit, and potential impacts. The committee has used this information to rate and establish priorities for implementing the identified capital improvement and maintenance projects and policy and program recommendations. A summary of how these recommendations meet the goals and objectives detailed in Section 4 is presented below (with no emphasis or significance placed on their order of presentation). Recommended solutions must meet the following criteria.

- Have a reasonable certainty of reducing frequent flooding hazards and their duration, thus reducing potential risks to public health and safety
- Are supported by the advisory committee and the interested public
- Are practical, cost-effective, and have realistic funding sources and plans for their implementation
- Are comprehensive in nature, addressing watershed and floodplain management issues as well as capital improvement project needs
- Identify upland development's responsibility to better control stormwater runoff (quantity and quality) to limit increased study area river impacts
- Generally maximize environmental benefit and minimize adverse impact
- Can be implemented over a reasonable period and will provide long-term benefit
- Are anticipated to be supported and approved by Skagit County and other regulatory and resource protection agencies

- Meet the requirements of WAC 173-040, with potential for additional FCAAP grant funding for projects implementation.

Specific recommendations of the advisory committee are summarized in Table 2-1.

Table 2-1
Lower Samish River Basin
Comprehensive Flood Hazard Management Plan Recommendations

Planning Area
Policy and Program: • Interim Flood Path Policy • Floodplain/Floodway Mapping • Flood Damage Protection Ordinance • Critical Areas Ordinance • Inventory Flood Prone Structure • Struct. Flood Prot. Program **Capital Improvement Projects:** • Capital Project 1—Pipline to Joe Leary Slough along Allen-West Rd • Capital Project 2—Open ditches from Allen-West Rd to Samish River, east of Thomas Rd • Capital Project 3—Upgrade return culverts • Capital Project 4—Flood path roadway culverts • Capital Project 5—Diversion to Joe Leary Slough • Capital Project 6—District 5 outfalls • Capital Project 7—Edison Slough improvements
Watershed Area
Policy and Program: • Development Standards • Drainage Ordinance • Developer Education • Flood Warning Program • Drainage Utility Funding

River Corridor
Policy and Program: • Dike Maintenance Projects • Reestablish Flow Gages • Road Crossing Structure Maintenance • Vegetative Maintenance **Capital Improvement Projects** • Capital Project 9 — Setback dikes, road crossing improvements

POLICY AND PROGRAM RECOMMENDATIONS

Recommendations presented in this section recognize the need to better manage and regulate land uses within the floodplain and watershed to limit further increases in potential severity of flooding and flood damages. Watershed recommendations extend beyond the bounds of the study planning area but affect the nature and extent of the problems within the study area and are indeed part of the comprehensive solution. Because of the existing frequency and extent of flooding within the lower Samish River basin, and the potential for more severe impacts from larger regional flooding conditions that could result in Skagit River overflows to the Samish River, control measures that help protect public health and safety are of critical importance. To meet stakeholder needs and provide an improved economic base for the farming uses predominant in the lower valley, relief from the persistent duration of flooding is needed.

The following recommendations will need to be evaluated for consistency with the final recommendations of the Watershed Action Plan (currently being prepared in draft form) by the Skagit County Planning Department in cooperation with the Washington State Department of Ecology (Ecology).

Floodplain Development Regulation

The following nonstructural policy and program recommendations are made for those areas affected by the 100-year floodplain of the Lower Samish River.

Institute Interim Policy Restricting Development/Fill in Flood Overflow Paths

Based on flood overflow paths identified in this plan and other overflow routes documented from field review, institute a temporary policy of restricting further development or permitted filling within those areas. Use County SEPA and Shoreline Management Program where possible to temporarily regulate and enforce such restrictions. Where this is not feasible for individual parcel developments, institute a temporary policy to limit filling and expand building permit inspection enforcement assuming.

Prepare Floodplain and Floodway Mapping

Prepare priority request to Federal Emergency Management Agency (FEMA) and Ecology for detailed floodplain/floodway restudy of the lower Samish River below Thomas Creek (including Samish River-only hydrologic condition). Develop topographic mapping for river floodplain, overflow paths, and sloughs. Consider options for floodway designation (equal conveyance or negotiated) to reflect overflow paths and Joe Leary/Edison Sloughs. Hold a public meeting to review results and solicit comments. Provide a letter requesting map revisions to FEMA based on the results of revised mapping.

Strengthen Flood Damage Protection Ordinance

Review County flood damage protection ordinance for update to reflect a more restrictive regulation of revised floodplain/floodway mapping. Consider a more restrictive allowable floodway elevation rise of less than current 1-foot FEMA minimum standard (e.g., zero rise and reflect in revised floodway mapping as well). Build support for adoption of revised ordinance.

Develop and Implement a Critical Areas Ordinance

Support current efforts of County planning department for development of a critical areas ordinance. Ensure that floodplains are designated as critical areas with ties to flood damage protection ordinance. This ordinance would also strengthen development restrictions in other critical areas, such as wetlands, steep slopes, and erosion hazard areas, that would benefit watershed stormwater management controls (quantity and quality).

Watershed Development Regulation

The following nonstructural policy and program recommendations are made for the entire Samish River watershed area.

Implement Restrictive Stormwater Runoff Development Standards

Promote a more restrictive detention and water quality control development standard for the Samish Watershed area based on the significance of existing flooding issues and the current Samish Bay shellfish bed closure. Consider a standard that would restrict post-development land use runoff from the 100-year design storm to a 2-year existing conditions release rate (approximate capacity of diked river channel). Also, reduce 2-year post-development runoff to 50 percent of the existing 2-year discharge condition to comply with Washington State Department of Fish and Wildlife (DFW) criteria to protect downstream habitat. Consider requirements for use of a long duration design storm (e.g., 7-day) to help compensate for development runoff volume impacts. Pursue an inter-local agreement with Whatcom County to provide similar development standards in upstream portions of the watershed.

Consider alternatives to control upland development ditch and drain practices. This may include onsite development standards for attenuation of runoff, development and enforcement of clearing impervious area limitations, and system connection charges under a drainage utility for offsite (downstream) mitigation.

Adopt a More Restrictive Drainage Ordinance

Continue process to adopt proposed (draft) drainage ordinance that meets minimum requirements of Ecology's *Stormwater Management Manual for the Puget Sound Basin* (Ecology, 1992). Consider specific needs of that ordinance to enforce more restrictive set of development standards for Samish Watershed as presented above.

Educate Development Community on Nature/Extent of Downstream Problem

Prepare a pamphlet to be distributed with development permit applications that summarizes the revised ordinance and development standards, and describes the underlying need for and benefit of Samish River improvement programs. Consider sponsoring a training seminar for development interests in use of new standards.

Protection of Existing Structures

The following nonstructural policy and program recommendations are made for structures within the floodplain.

Inventory Flood Prone Structures

Document structures with minimum floor elevations subject to flooding based on information presented in this plan and the existing Samish River floodplain mapping. Inform residents of potential flooding risk and alternative measures for protection. Also, provide information about flood warning and emergency action program.

Implement Structure Flood Protection Program

In coordination with FEMA, develop a structure flood protection program. Alternatives may include elevation of structures, ring dikes to protect low-lying structures, and possible relocation or buyout options. Consider funding support options (state, federal) for such program.

Flood Warning and Monitoring Program

The following nonstructural policy and program recommendations are made for actions throughout the watershed.

Implement Flood Warning Program

Implement flood warning program currently being developed on a county-wide basis. Consider individual needs within the Samish Watershed and required response times. Coordinate with the County's existing emergency action program.

Reestablish Samish River Flow Monitoring Gage(s)

Prepare request to the U.S. Geological Survey to reestablish a streamflow gage (or gages) on the Samish River (at Highway 99 and possibly at Friday Creek). Consider extension of flow monitoring program to include multiple crest stage gages at the various bridge sections in the lower

river to better document flood elevations. Coordinate monitoring information with the flood warning program currently being developed.

Flood Facility Maintenance Program

The following policy and program recommendations are made for small river corridor (maintenance) projects and required maintenance actions along the river corridor.

Diking and Drainage District River Corridor Maintenance Projects

Continue to assist diking and drainage districts with implementation of annual maintenance projects through the County's River Improvement Fund. Review projects to ensure that they are in compliance with the recommendations of this plan.

Road Crossing and Flood Path Drainage Structures Maintenance

Improve maintenance of channel sections at County roadway crossings of the Samish River and to drainage structures in flood overflow paths (existing and proposed). Coordinate this program with the Washington State Department of Transportation (WSDOT) for the Chuckanut Drive bridge crossing. This program would primarily consist of debris removal where obstructing flow. Develop a priority list of targeted locations to observe/maintain under flooding conditions.

River Corridor Vegetative Maintenance

Consider development of a joint program with the DFW to manage river corridor vegetative growth in areas not critical to fish and wildlife habitat that have a restrictive effect on flood flows. This may include the need for a mitigation program along river reaches where opportunities exist to enhance habitat. Establish a vegetative maintenance schedule and permit requirements.

CAPITAL IMPROVEMENT PROGRAM RECOMMENDATIONS

The advisory committee reviewed and ranked several iterations of suggested and preliminary projects and recommended eight projects that have consensus support for funding and implementation. The majority of these projects address improvements for the most frequently flooded areas by providing additional flood water return capacity to the river. A large scale recommendation included in the list proposes the construction of setback dikes from the river mouth to Highway 99.

The locations of each of the recommended projects are shown in Figure 2-1. Figures 2-2 through 2-9 provide an overview of each of the proposed projects, include specific site locations, show graphic details, and provide a summary of benefits, costs, funding, and permitting requirements.

The advisory committee set priorities for the capital projects. The ranking results, presented in Table 2-2, show the priority rankings of the capital projects developed for this plan.

Proposed Capital Project 1

Location: Allen-West Road west of Thomas Road (See Figure 2-2)

Issues: Flood water is trapped on the south side of Allen-West Road by the roadway fill. An existing 15-inch-diameter drainage pipe requires 4 to 6 weeks to drain trapped flood water to Joe Leary Slough. Flood water affects one residence and approximately 200 acres of fields.

Proposal: Replace existing 15-inch-diameter drain with 36-inch drain and multiple inlet structures fitted with trash racks. Route 36-inch drain to Joe Leary Slough and install outfall protection. Pipeline could provide approximately 30 to 40 acre-feet per day of outfall capacity.

Estimated Implementation Cost: $440,000

Proposed Capital Project 2

Location: Allen-West Road east of Thomas Road (See Figure 2-3)

Issue: Flood water is trapped on south side of Allen-West Road. No culverts currently exist under the road to allow flood water to flow naturally back to the river. Trapped water stands in fields for several weeks following a flood event prior to receding. Flooded area affects both commercial and agricultural facilities as well as several private residences.

Proposal: Construct flood water collection ditch on south side of Allen-West Road. Route collection ditch to a set of roadway culverts. Excavate a ditch through the field from the road to the river dike. Install a return culvert with flap gate through the dike.

Estimated Implementation Cost: $108,000

Table 2-2
PROPOSED CAPITAL IMPROVEMENT PROJECTS
District Commissioner's Priority Rankings

	Overflow Return						Channel/ Dike Improvements	
	Capital Project Pipeline to Joe Leary slough along Allen-West Rd	Capital Project Open ditches from Allen-West Rd to river east of Thomas Rd.	Capital Project Upgrade north and south dike return culverts	Capital Project Flood path roadway culverts	Capital Project Diversion to Joe Leary Slough	Capital Project District 5 outfalls	Capital Project Edison Slough improvements	Capital Project Setback dikes, bypass channels, road crossings
Total Project Ranking Points[a] (Initial Screening Evaluation)	**50**	**58**	**50**	**46**	**38**	**46**	**46**	**51**
Consensus (Yes or No)	Y	Y	Y	Y	Y	Y	Y	Y
June 22, 1995 Stakeholder Meeting								
All Districts Represented								
Diking District 5								
Jerry Benson	5	2	3	4	7	1	6	8
Jim Sullivan	1	3	2	6	7	5	4	8
Ron Knutzen	6	1	2	7	4	3	5	8
Sum of District 5	12	6	7	17	18	9	15	24
District 5 Priorities[b]	4	1	2	6	7	3	5	8
Drainage District 14								
Roger Knutzen (not present)								
Fred Boonstra	7	1	2	3	8	4	5	6
John Bouslog	7	1	3	2	8	4	6	5
Sum of District 14	14	2	5	5	16	8	11	11
District 14 Priorities	7	1	2	3	8	4	5	6
Drainage District 16								
Leonard Lee (not present)								
Art Voorde Poorte	7	1	4	5	8	6	2	3
Sum of District 16	7	1	4	5	8	6	2	3
District 16 Priorities[b]	7	1	4	5	8	6	2	3
Diking District 19								
Ron Johnson (not present)								
David Hall					7	4	2	8
Jerry Robbins (not present)								
Sum of District 19					7	4	2	8
District 19 Priorities[b]					7	4	2	8

Table 2-2
PROPOSED CAPITAL IMPROVEMENT PROJECTS
District Commissioner's Priority Rankings

	Overflow Return						*Channel/ Dike Improvements*	
	Capital Project Pipeline to Joe Leary slough along Allen-West Rd	Capital Project Open ditches from Allen-West Rd to river east of Thomas Rd.	Capital Project Upgrade north and south dike return culverts	Capital Project Flood path roadway culverts	Capital Project Diversion to Joe Leary Slough	Capital Project District 5 outfalls	Capital Project Edison Slough improvements	Capital Project Setback dikes, bypass channels, road crossings
Diking/Drainage District 25								
Dick Meade (not present)	5	8	6	2	1	7	3	4
Tom McGeHee	3	2	1	5	4	6	7	8
John Sandell (not present)	5	8	6	1	2	7	3	4
Sum of District 25	13	18	13	8	7	20	13	16
District 25 Priorities[b]	5	7	3	2	1	8	4	6
Sum of District Priorities[c]	23	10	11	16	24	21	16	23
Sum of District Commissioners' Priorities[c]	46	27	29	35	49	43	41	54
All Districts' Priorities[c]	6	1	2	3	8	5	4	7

[a] Largest score rates highest.

[b] Lowest total rates highest.

[c] District 19 not included due to incomplete response.

Note:

June 8, 1995, Stakeholder Meeting

Districts Represented: Dike/ Drainage District 25, Diking District 5, Drainage District 16.

Not in Attendance: Diking District 19, Drainage District 14.

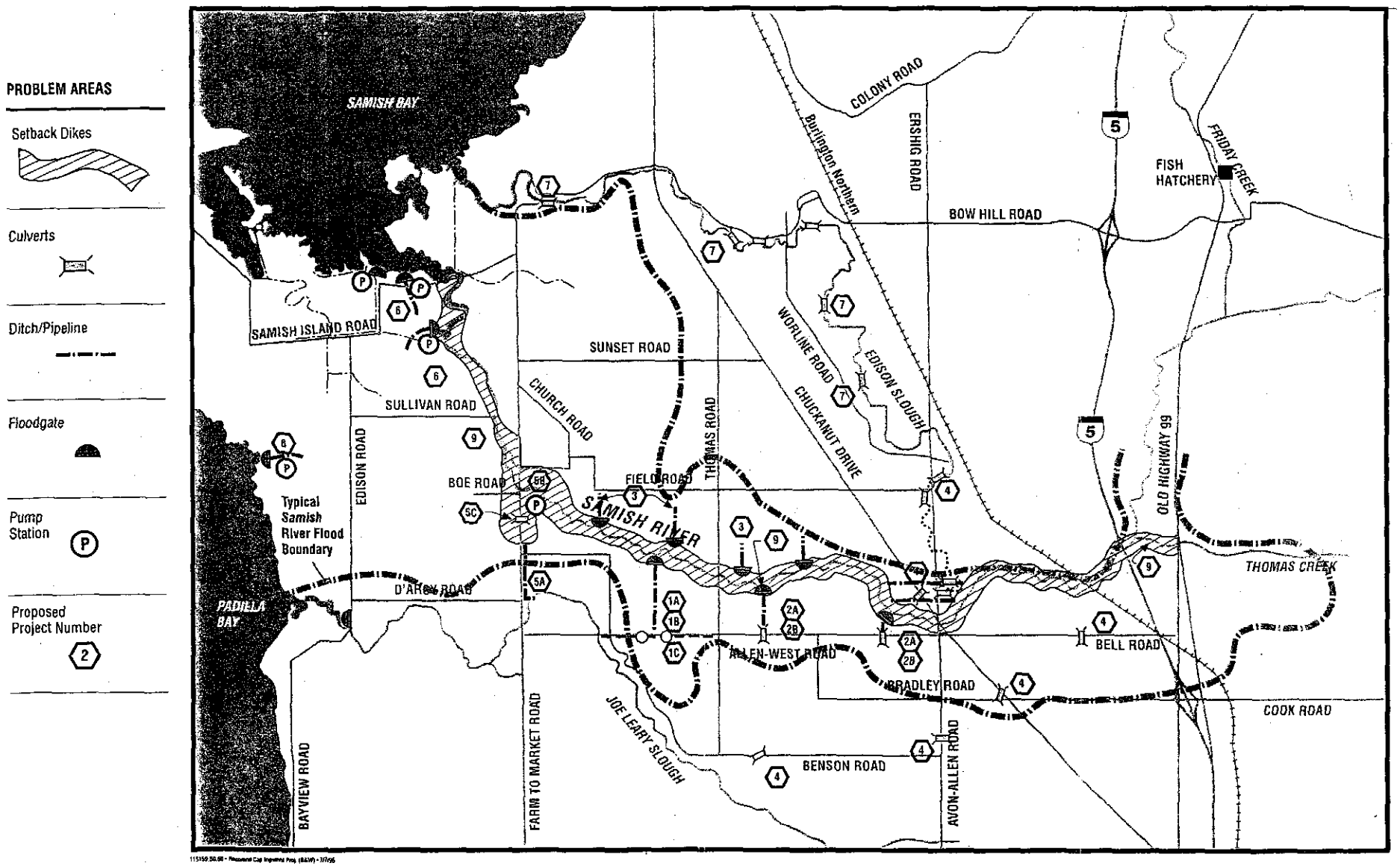
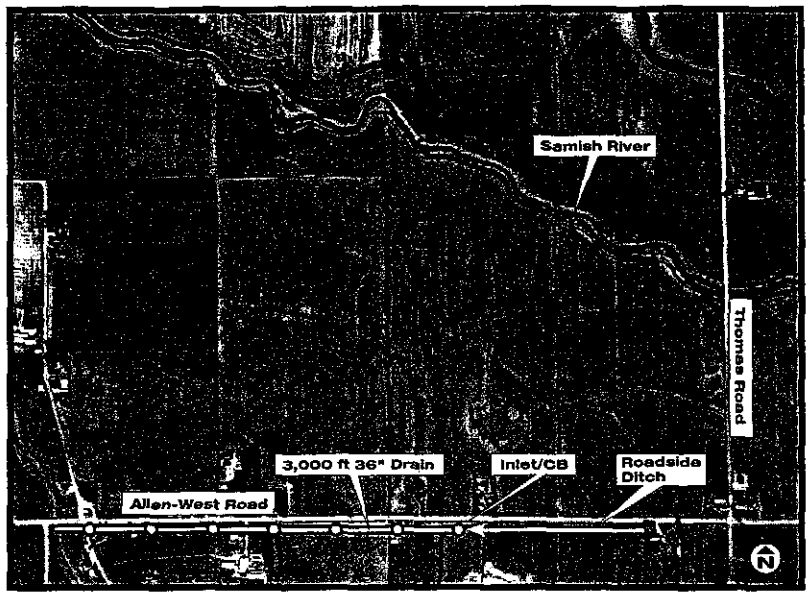
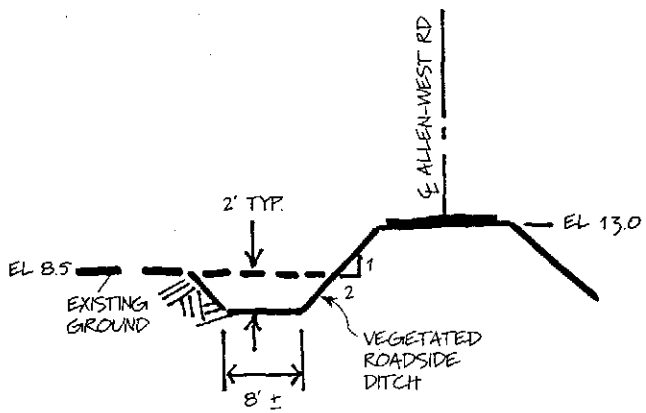


Figure 2-1
Recommended Capital Improvement Projects





ROADSIDE DITCH

PROPOSED CAPITAL PROJECT - 1
Pipeline to Joe Leary Slough along Allen-West Road

ISSUES/CONCERNS

- Blockage of natural flow paths fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods (5+ weeks)

PRELIMINARY

- Install 36-inch drainage pipe to Joe Leary Slough
- Install new catch basins and trash racks
- Provide adequate maintenance access
- Install adequate outfall protection at Joe Leary Slough

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved structure access
- Reduced field/livestock damage
- Does not raise water surface elevations on north side of Allen-West Rd

POTENTIAL

- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nation Wide Permit(s)

ESTIMATED COST

- Roadside ditch
- Pipeline to slough
- Catch basins
- Floodgate
- **Preliminary construction cost** **$ 360,000**

POTENTIAL

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds

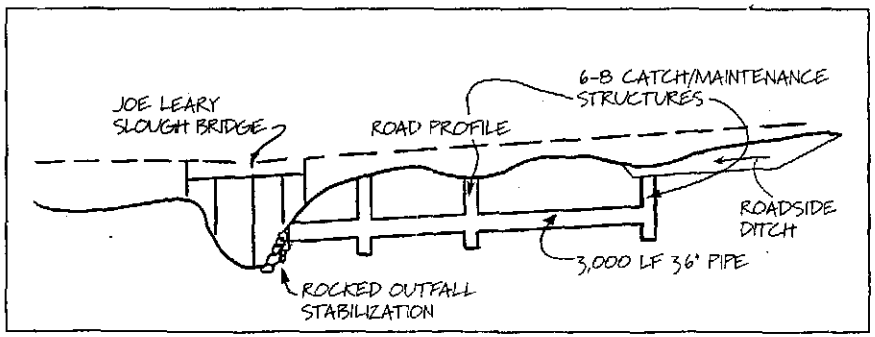
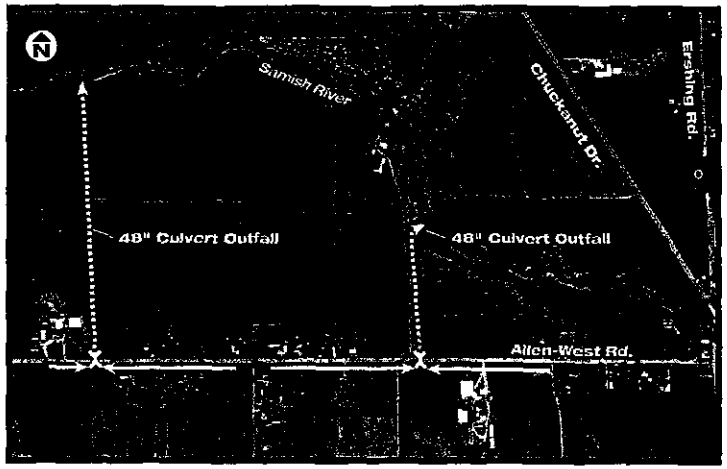
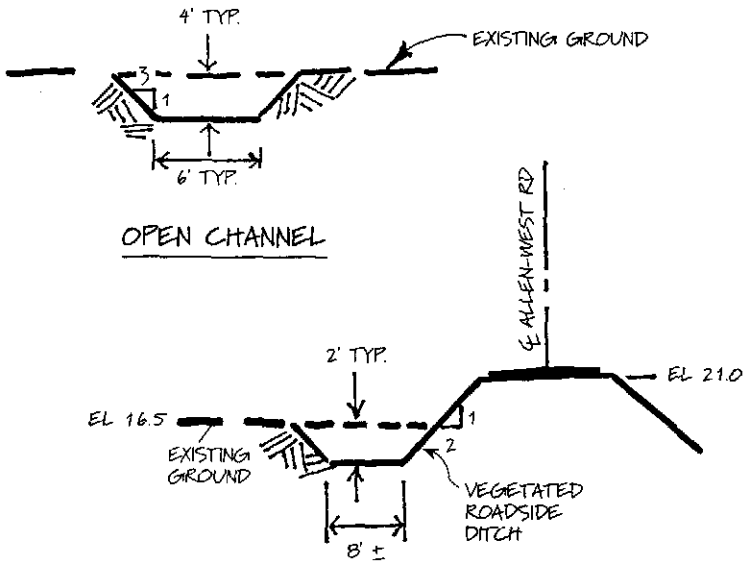


Figure 2-2
Proposed Capital Project 1





PROPOSED CAPITAL PROJECT 2
Open ditches from Allen-West Rd to River, East of Thomas Rd

ISSUES/CONCERNS

- Blockage of natural flow paths by road fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods

PRELIMINARY SOLUTIONS

- Construct collection ditch draining to set of roadway *culverts on south side of Allen-West Rd*
- Install (4) 30-inch cross culverts at two sites under Allen-West Rd
- Construct ditch to river at two locations
- Install 48 inch culvert with flap gate through dike at two

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved flood water removal time for south side of river
- *Improved structure access*
- Reduced field/livestock damage

POTENTIAL PERMITS

- County Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water *Quality Modification*
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

ESTIMATED COST

- Roadway culverts
- Ditch excavation
- Dike culvert
- Floodgate
- **Preliminary construction cost** **$85,000**

POTENTIAL FUNDING

- Drainage District Funds
- *River Improvement Matching* Funds
- County Road Improvement Funds
- FCAAP Matching Funds

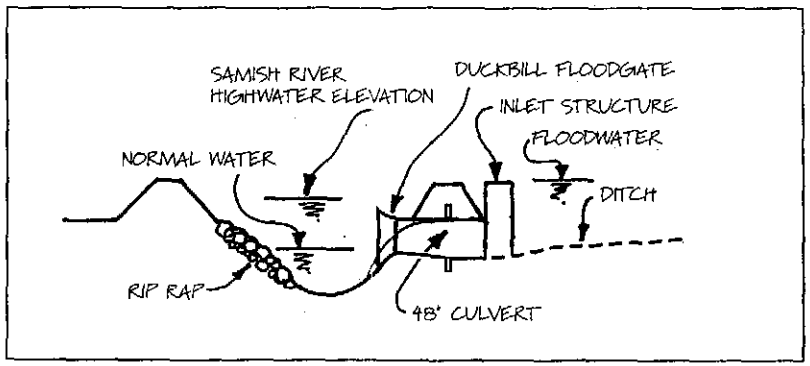
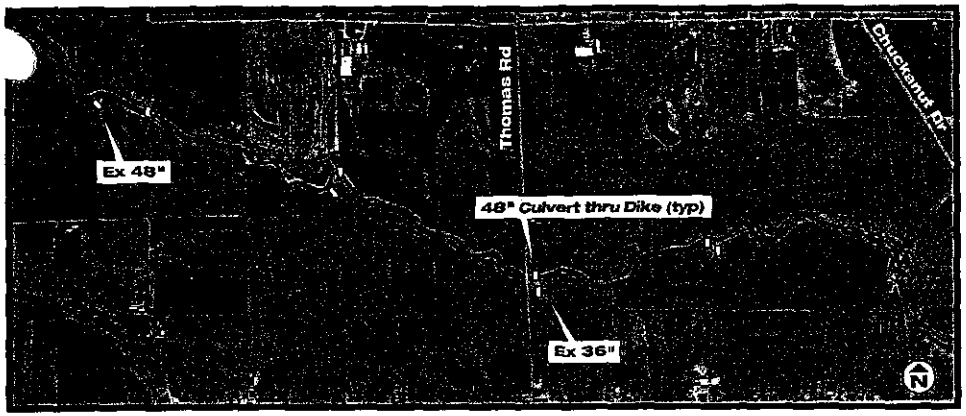


Figure 2-3
Proposed Capital Project 2



PROPOSED CAPITAL PROJECT - 3
Upgrade return culverts

ISSUES/CONCERNS

- Existing culverts plugged and undersized/ Leads to prolonged field flooding, crop damage, and livestock displacement
- Existing flood gates malfunction/Leads to backwater entering fields

PRELIMINARY SOLUTIONS

- Install new 48-inch diameter return culverts with flood gates at 6 locations
- Replace existing malfunctioning floodgates with flexible duckbill floodgates

BENEFITS

- Reduction in time of flooding
- *Reduction of "backflow" flooding problems*
- *Reduced field/livestock damage*

POTENTIAL PERMITS

- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nation Wide Permit(s)

ESTIMATED COST

- 48-inch culverts/cutoff
- Floodgates
- Rocked entrance/exit stabilization
- **Preliminary construction cost** **$ 34,000 (each site)**

102,000

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds

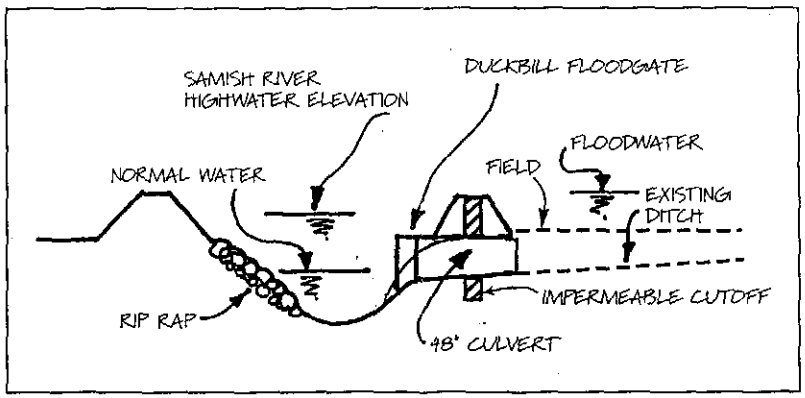
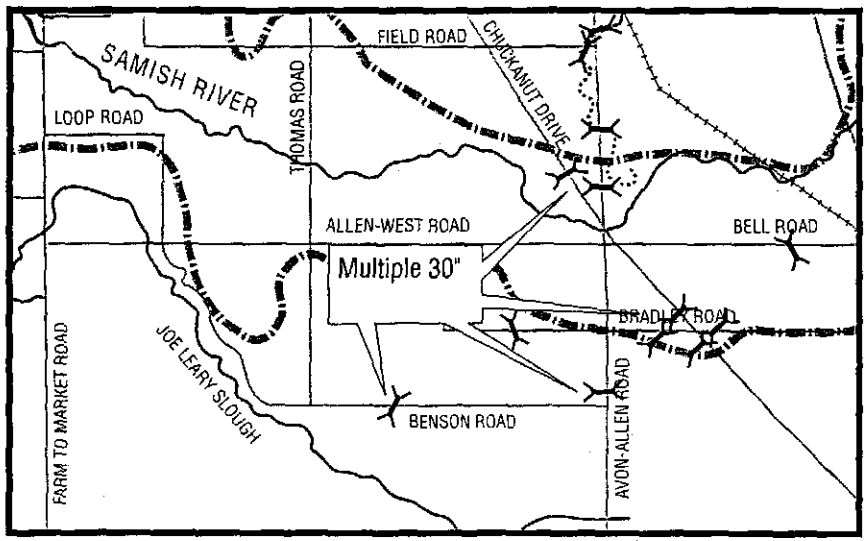


Figure 2-4
Proposed Capital Project 3



PROPOSED CAPITAL PROJECT - 4
Flood path roadway culverts

ISSUES/CONCERNS

- Existing roadways block natural floodwater paths/Raise upstream flood elevations
- Lack of cross culverts at floodwater paths/Prevents post flood drainage of upstream fields
- Water over roadways/Creates traffic hazards, impedes emergency access

POTENTIAL PERMITS

- County permits

PRELIMINARY SOLUTIONS

- Install culverts through blocking roadway fills (12 locations)

ESTIMATED COST

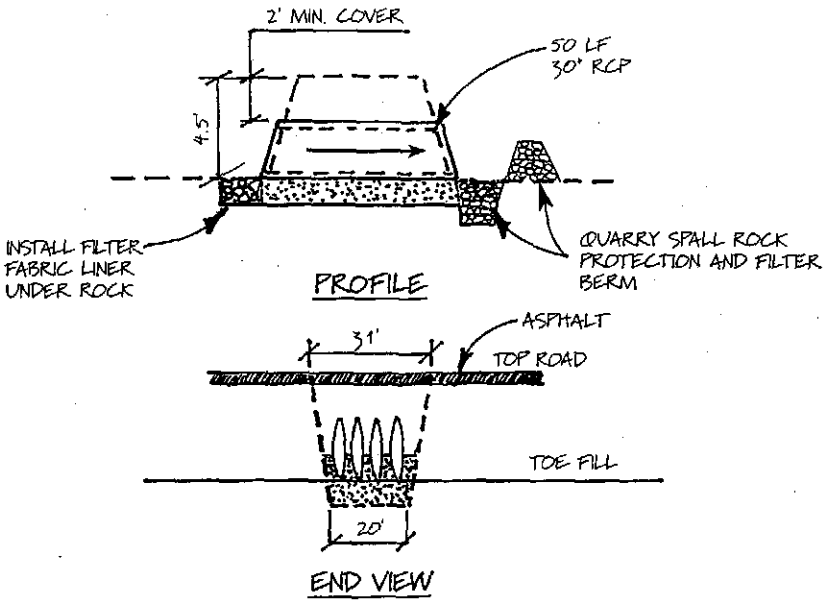
- Excavation/backfill
- Pipe installation
- *Road restoration*
- **Preliminary *construction* cost** — **$ 28,000 (each site)**

BENEFITS

- *Reduces flooding depth and duration upstream of blocking fill*
- Improves traffic and emergency access
- Provides up to 80 cfs of drainage capacity to drain flood waters.

POTENTIAL

- County road improvement funds



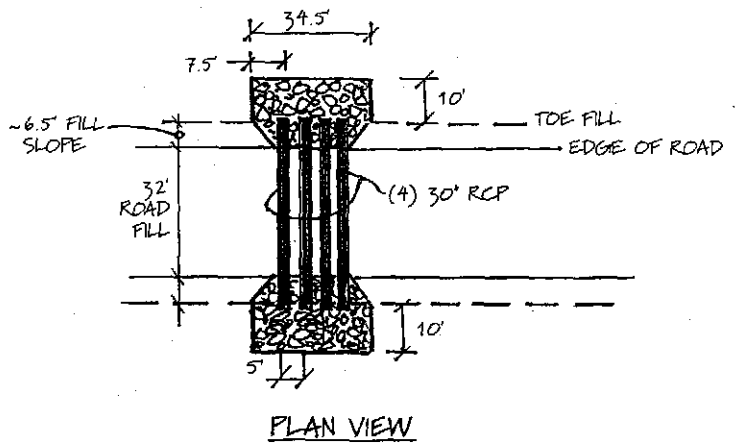
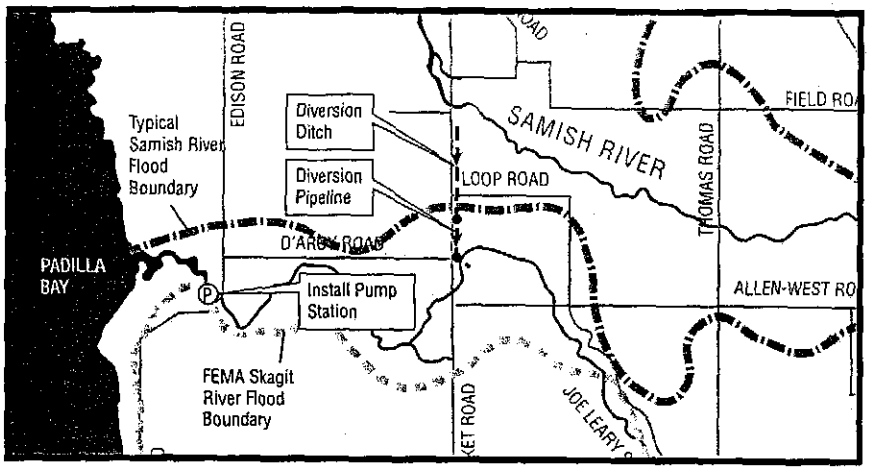
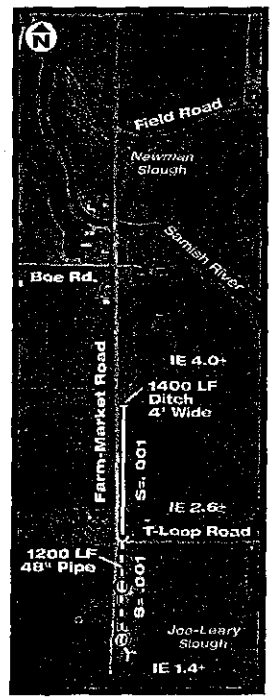
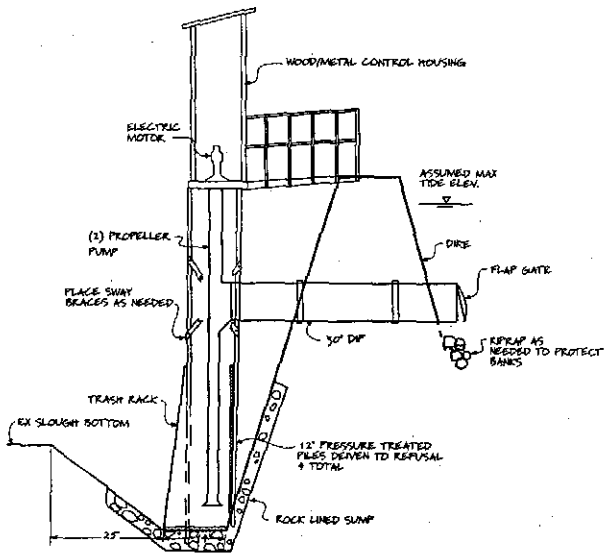


Figure 2-5
Proposed Capital Project 4







PROPOSED CAPITAL PROJECT - 5
Diversion to Joe Leary Slough

ISSUES/CONCERNS

- Limited floodwater return capacity to river/Leads to prolonged field flooding
- District 5 has limited capacity to handle floods over Farm to Market Rd/Diversion reduces flooding volumes
- Joe Leary Slough receives Samish River overflows/Slough has limited high tide capacity to discharge overflows
- Floodwater covers Farm to Market Rd/Creates traffic hazard, impedes emergency access

PRELIMINARY SOLUTIONS

- Construct flood water diversion channel/pipe on east side of Farm to Market Rd from south of bridge to Joe Leary slough
- Remove constrictions in slough downstream of Farm to Market Rd
- Install 30 to 50 cfs pump station at the outfall of Joe Leary slough

BENEFITS

- Reduction in time of flooding east of Farm to Market Rd
- Reduction of flood frequency/ depth west of Farm to Market Rd
- Improved floodwater return capacity
- Reduced field/livestock damage
- Flood and wet weather pumping capacity provided on Joe Leary Slough

POTENTIAL PERMITS

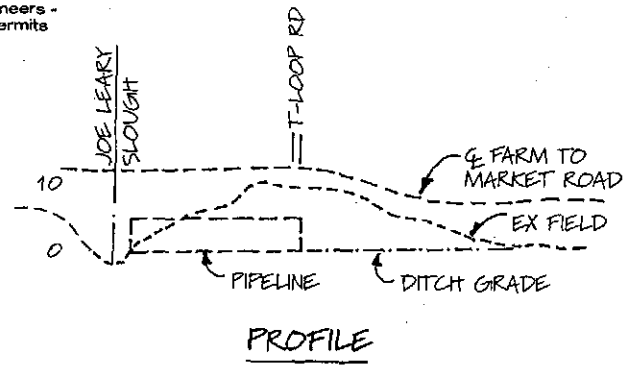
- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

ESTIMATED COST

- Diversion channel
- *Diversion pipe/gate*
- 30 cfs pump station (Joe Leary Slough)
- **Preliminary construction cost** **$320,00**

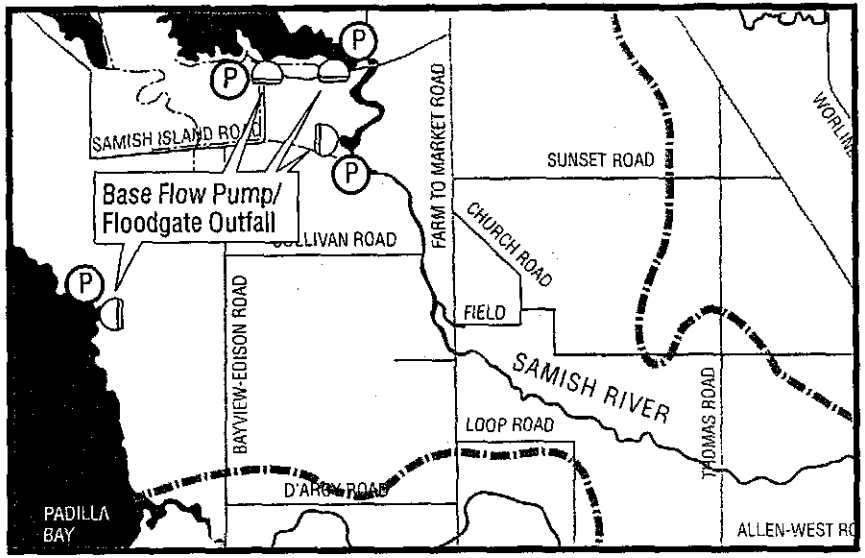
POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvement Funds
- River Improvement Matching Funds
- FCAAP Matching Funds



PROFILE

Figure 2-6
Proposed Capital Project 5



PROPOSED CAPITAL PROJECT - 6
District 5 outfalls

ISSUES/CONCERNS

- Limited existing outfall capacity/ Requires extended time (4+ weeks) to drain fields following floods
- Field elevations at or below tidal fluctation/Difficult to fully drain fields in time for Spring planting
- Extended durations of road inundations/Inhibits emergency access during and after floods

PRELIMINARY SOLUTIONS

- Install additional outfalls with multiple 48-inch pipes
- Install base flow pump at each outfall to prevent sedimentation of discharge channel and supplement high tide drainage

BENEFITS

- Reduction in time of flooding
- Improved structure access
- Reduced field/livestock damage
- Improved farm production

POTENTIAL PERMITS

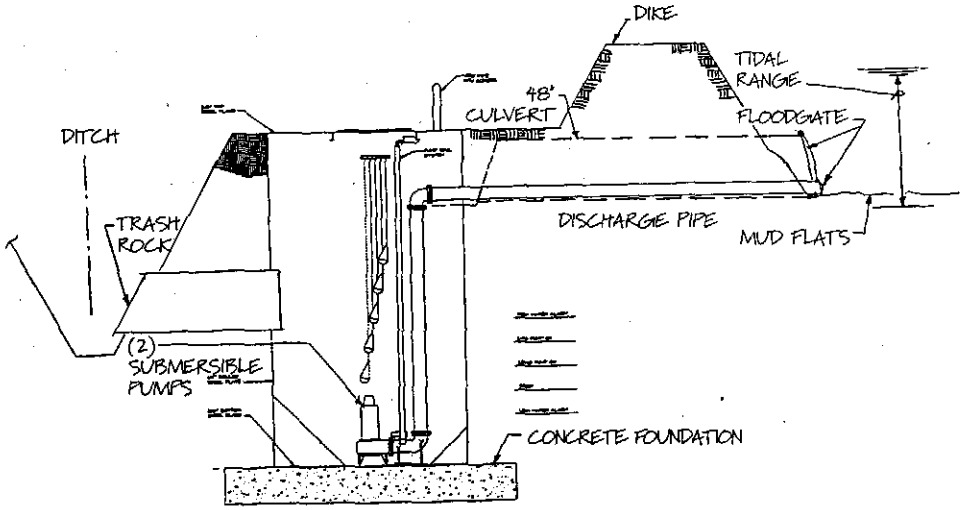
- County Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

ESTIMATED COST

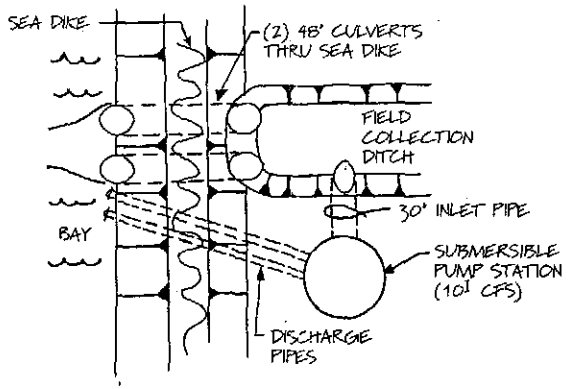
- 48-inch culverts
- Dike excavation and backfill (affected by tides)
- Channel excavation leading to new outfalls
- Pump station
- Floodgates
- **Preliminary construction cost $ 180,000 (each site)**

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds

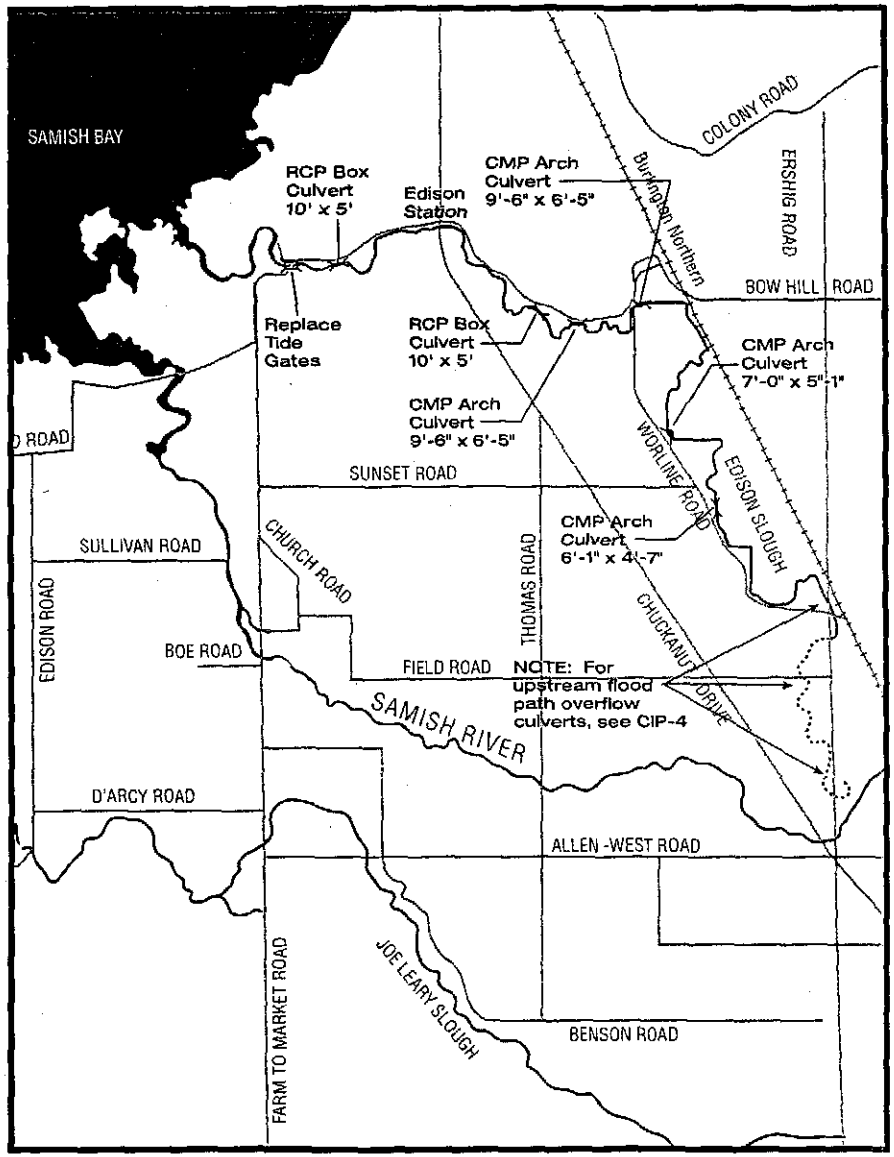


PUMP STATION ELEVATION VIEW



PLAN VIEW

Figure 2-7
Proposed Capital Project 6



PROPOSED CAPITAL PROJECT - 7
Edison Slough Improvements

ISSUES/CONCERNS

- Historic flow path has been blocked/Historic river system capacity thus diminished
- Majority of existing roadway culverts are undersized for wet weather drainage/Results in extended field flooding

PRELIMINARY SOLUTIONS

- Upgrade selected existing roadway culverts to provide consistent flow capacity through system
- Upgrade channel capacity of restrictive sections

BENEFITS

- Provides adequate local drainage capacity
- Provides additional river flood overflow capacity
- Reduces flood duration along Edison Slough
- Reduces structure flooding/ reduces crop damage

POTENTIAL PERMITS

- County Permits
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nation Wide Permit

ESTIMATED COST

- Culvert installations/ pavement repairs
- Channel improvements
- **Preliminary construction cost** **$530,000**

POTENTIAL FUNDING

- Drainage Utility Funds
- Drainage District Funds
- County Road Improvement Funds

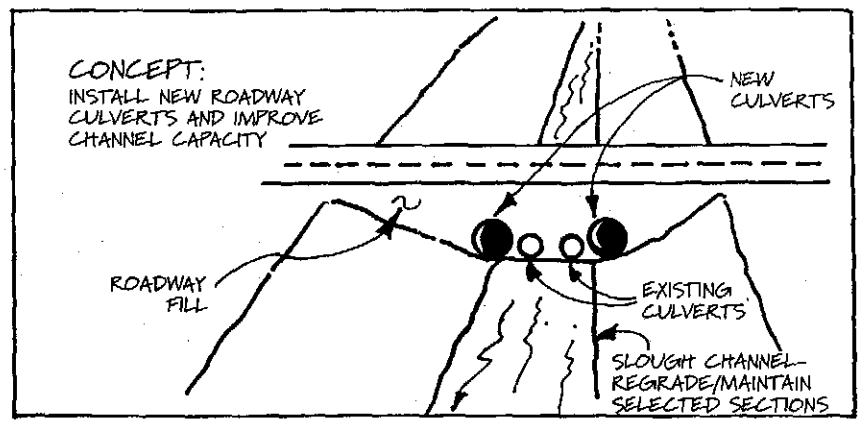
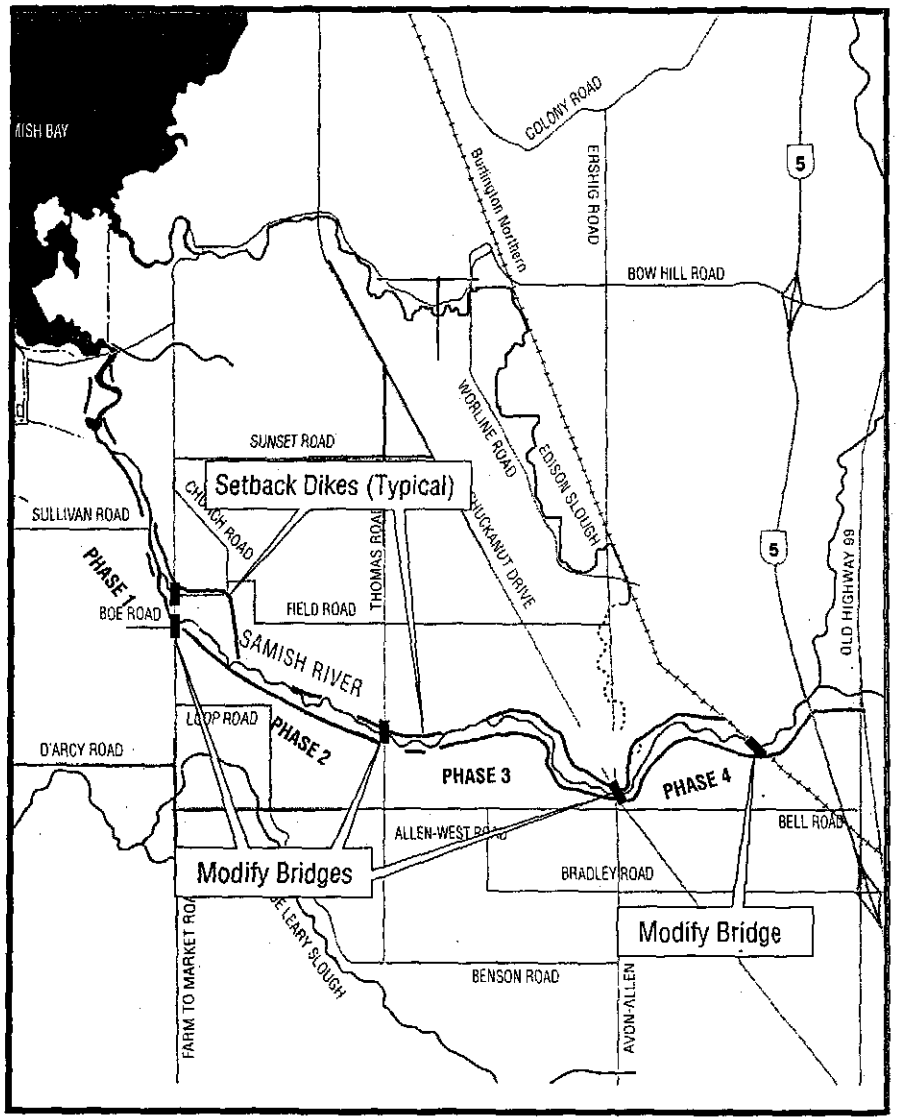


Figure 2-8
Proposed Capital Project 7



PROPOSED CAPITAL PROJECT - 9
Setback Dikes, Road Crossing Improvements

ISSUES/CONCERNS

- Existing diked river channel has *Capacity for only the 2-yr (+/-)* return event flow
- Existing bridge crossing (4 locations) impede large event river flows
- *Existing river corridor* has limited habitat value
- Dike overtopping and potential failure
- Field/road flooding and erosion
- Crop damage/livestock displacement

POTENTIAL PERMITS

- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- *Ecology* - Water Quality Certification (if Corps permit reqd.)
- Corps of Engineers - Nation wide or individual permit (if wetlands/waters of U.S. impacted)

PRELIMINARY SOLUTIONS

- Install setback dikes through a *series of four phased projects*
- *Upgrade flow capacity at Farm-*Market Rd, Thomas Rd, *Chuckanut Dr, and railroad bridge* crossings
- Revegetate selected setback areas
- *Provide increased fisheries* rearing habitat area

ESTIMATED COST

- Setback dikes
- Bridge Modifications (4 locations)
- Vegetative/habitat restoration
- **Preliminary construction cost**

Total	**$ 6,500,000**
Phase I	**$ 1,200,000**

BENEFITS

- Reduction in flood hazard
- Improved public health and safet
- Reduced field/crop damages
- Reduced farming losses *associated with flooding*
- *Improved land values*
- *Enhanced river corridor habitat fo* fish/wildlife and recreation

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching *Funds*
- County Road Improvement Funds
- FCAAP Matching Funds
- County road improvement fund *(road crossing improvements)*
- Conservation Futures Fund *(property acquistion)*
- Centennial Clean Water Fund *(water quality elements)*
- DNR ALEA grant (public access)
- State Legislative appropriations
- COE, NCRS, *USFW Grants*

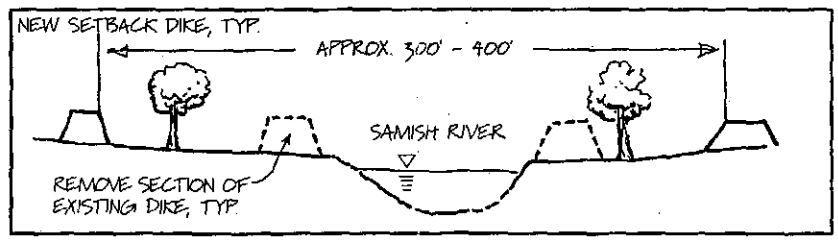


Figure 2-9
Proposed Capital Project 9

Proposed Capital Improvement Project 3

Location: River dikes between Farm to Market Road and Chuckanut Drive (See Figure 2-4)

Issue: Existing return culverts through dikes have a limited capacity for return of flood water. Most culverts are 18 inches in diameter or smaller. Most of the existing culverts are fitted with metal flap gates, several of which are in disrepair.

Proposal: Install additional 48-inch-diameter return culverts with greater capacity through the dike at several locations as shown in Figure 2-4. Install low maintenance elastomeric check valves at each of the new outfalls and on existing outfalls where the existing metal gates need replacement. Repair/replace existing return culverts as required.

Estimated Implementation Cost: $42,000 each new outfall site

Proposed Capital Project 4

Location: Along various roadways crossing historic flood channels within the floodplain area (See Figure 2-5)

Issue: Roadway fills block natural floodways in several locations across the flood plain, trapping water on the upstream side of the road fill, impeding drainage of the upstream areas, and creating artificially high flood water elevations.

Proposal: Install sets of multiple culverts under road fills blocking natural flood paths to pass flood water. Stabilize fill slopes to prevent washouts during overtopping events

Estimated Implementation Cost: $35,000 per site

Proposed Capital Project 5

Location: West side of Farm to Market Road south of Samish River (See Figure 2-6)

Issue: Insufficient capacity to drain flood water trapped on field south of river. Floodwater ponds behind dike while the river is at or near flood stage. On several occasions in recent history flood water has overtopped Farm to Market Road, flooding 2,700 acres within Diking District 5. Water depth on the south side of the road creates a hazard to traffic as well as to animals and humans.

Proposal: Install floodwater return channel/pipe along Farm to Market Road from south side of river discharging to Joe Leary Slough. Install a pump station at the outlet of slough to match the diversion system capacity. Remove constrictions in slough capacity downstream of Farm to Market Road.

Estimated Implementation Cost: $396,000

Proposed Capital Project 6

Location: Diking District 5 (See Figure 2-7)

Issue: District currently has insufficient interior drainage capacity to dispose of trapped-out-of-bank flood water. Post flood drainage time has been recorded at up to 6 weeks. Flood damage impacts the farm fields by delaying spring planting dates and results in structure flooding and livestock displacement.

Proposal: Install four additional 48-inch diameter outfalls to Samish Bay and River. Include a base flow pump at each outfall to prevent sedimentation of the discharge channels and clogging of the flood gates. Excavate collection ditches as required to route filed drainage to the new outfall locations

Estimated Implementation Cost: $150,000 each site

Proposed Capital Project 7

Location: Edison Slough from Worline Road to crossing at Edison (See Figure 2-8)

Issue: Roadway fills and field grading have constricted the historic floodway and drainage channel. Roadway culverts in several locations are of insufficient capacity to handle minor event runoff flows. Impounded water constricted segments takes several weeks to recede, creating saturated fields and leading to livestock displacement.

Proposal: Improve channel to provide even capacity throughout system. Install additional culverts at road crossings where necessary to provide capacity. Improve/ widen constricted portions of existing channel. Stabilize channel and install erosion protection where needed.

Estimated Implementation Cost: $540,000

Proposed Capital Project 9

Location: River channel from mouth to Highway 99 (setback dikes) (See Figure 2-9)

Issues: Capacity of existing channel/dikes is limited to the 2- to 5-year return flow. Samish Valley area suffers from frequent flooding damage resulting from the limited capacity of the existing channel. Existing channel has low habitat value for migrating fish.

Proposal: Construct setback dikes along river corridor. Use existing dikes where possible and construct new dikes where required to provide a 300-foot-wide (±) floodway corridor. Upgrade flow capacity at four to five bridge crossings. Excavate high flow bypass channels/dikes as required. Off- and stream corridor vegetation could be reestablished. channel habitat areas could be provided at various locations

Estimated Implementation Cost $8.8 million total project
mouth to Farm to Market Road) ($1.13 M Phase 1, river mouth to Farm to Market Road)

ESTIMATED PROGRAM COSTS

Table 2-3 presents the implementation costs for the capital projects listed above, arranged by the priority identified in Table 2-2. Project development would be based on funding availability and would be implemented following these priorities. Funding of these proposals is discussed below. It is not anticipated that funding would be available for implementation of all projects during the 6-year funding period.

The policy and program cost estimate given in Table 2-3 is the anticipated level of expenditure needed to administer the various programs. This cost could vary widely based on the level of staff effort the County commits to program development, review, enforcement, and ongoing operation. The maintenance cost presented in Table 2-4 has been based on past expenditures by the diking and drainage districts for annual maintenance and repairs of flood control facilities.

Maintenance expenditures recommended in this plan have been estimated slightly higher than the current annual expenditures to cover maintenance of newly constructed facilities.

Table 2-3
Estimated Program Costs
Capital Projects

District Commissioners' Priority Ranking	Capital Project Number	Project Description	1995 Estimated Implementation Cost
1	2	Roadside ditches and pipeline to river from Allen-West Rd east of Thomas Rd.	$110,000
2	3	Install new floodwater return outfalls to river and upgrade existing outfalls (6 sites)	$250,000 ($42,000 ea. site)
3	4	Install roadway culverts at historic flood path crossings (12 sites)	$420,000 ($35,000 ea. site)
4	7	Improve Edison Slough capacity	$540,000
5	6	Install additional outfalls to bay in District 5 west of Samish River (4 sites)	$890,000 ($220,000 ea.)
6	1	Install pipeline to Joe Leary Slough along Allen-West Rd.	$440,000
7	9	Construct setback dikes along river corridor from river mouth to I-5. Upgrade flow capacity at four bridge crossings.	$8.8M $1.13M (Phase 1)
8	5	Floodwater diversion to Joe Leary Slough along Farm-Market Rd. Construct pump station at mouth of Joe Leary Slough.	$400,000
		Total Capital Project Costs	**$4.18M**

Table 2-4
Estimated Program Costs
Policy and Programs

Floodplain Development Regulations	
Watershed Development Regulations	
Protection of Existing Structures	
Flood Warning and Monitoring Program	
Total Annual Policy and Program Costs	**$80,000**

Table 2-5 Estimated Program Cost Flood Reduction Maintenance Costs	
River Corridor Maintenance Projects	
Road Crossing and Drainage Structure Maintenance	
River Corridor Vegetative Maintenance	
Total Annual Maintenance Costs	**$120,000**

FUNDING PROGRAM

With costs identified in the previous section, attention can be turned to the sources of funds to implement the plan recommendations. Potential sources include traditional tax revenues for the County, special purpose districts, the River Improvement Fund, the County Road Fund, and state and federal grants. A more complete listing of these sources is included in Appendix A.

The majority of County tax revenues are distributed for special purposes such as schools, roads, the Port District, and the cities. Only a fraction of total property taxes are available to the County without previous designated uses. These funds are used to support the basic functions of County government and are placed in the current expense fund. The great majority of these funds go to support the criminal justice system. Because of this, there is substantial competition for the remaining funds and generally little or no money left for special needs such as drainage and flood hazard reduction. Therefore, other funding sources must be considered.

In the Samish floodplain, many of the local flooding problems are caused by roads that have been constructed without provision to pass flood flows. Projects to correct the resulting problems are proposed to be funded by the County Road Fund. The remaining projects and program elements will require other sources of funding.

Three assumptions have been used in evaluating potential funding sources. The first is that the funding program will not rely on grants. The second assumption is that project elements must be funded locally. The third is that the program will be pay-as-you-go; it must be able to stand on its own merit. The County will pursue grant funding and apply grant funding where possible, but evaluation of the costs and benefits of proposed solutions will not rely on an assumption of grant funding. If available, grants may lower the cost of implementing the proposed program elements. Similarly, other sources such as the proposed surface water management (SWM) utility may be used in the future to supplement the program where a direct contribution to flooding or benefit from the program can be shown. At the present time, the Edison Slough project is the only project listed in this plan that is proposed to be funded in part with SWM utility fees because there was a demonstrated relationship between upland development and increased flooding in the floodplain. This project was included in a previous plan for Skagit County that was developed to support the SWM fees. Bonds or other debt financing have not

been assumed, as there are opportunities to spread the costs of implementation over multiple years and debt financing is not necessary.

The Skagit County Flood Control Zone District is inactive because of the perceived conflict with the proposed surface water management utility fee.

The assumptions noted above limit the remaining funding sources to the County's River Improvement Fund and the existing drainage and diking districts. The River Improvement Fund is limited to approximately $200,000 per year county-wide as a result of competition for other County-wide tax revenues. It will be used to fund portions of this plan implementation, but Samish River projects will be required to compete for river improvement funds with other projects throughout the County.

To assist the advisory committee in evaluating the funding options, Table 2-6 was prepared to illustrate the implications of various packages of capital plan recommendations. These will be discussed by the committee on July 11, 1995.

It is assumed that the County Road fund will pay for maintenance of facilities constructed to mitigate the impacts of the roads or to provide drainage of the roads and that the diking districts will fund maintenance of all other facilities. It is further assumed that the County's current expense fund and/or the surface water utility will fund implementation of the remaining program elements such as additional studies and plans, education, and preparation and enforcement of regulations to guide development. The results of the advisory committee's discussion of funding issues and a recommended funding plan will be incorporated in the final CFHMP.

TABLE 2.6

Alternatives for Funding Flood Hazard Management Plan Implementation Measures

Funding Source	*Primary Purpose*	*Process to form or obtain*	*Cost to obtain*	*Control*	*Revenue Potential*	*Public Acceptance*	*Adverse Impacts*
Basic County Revenues							
Current Expense	Provide general County government services	Already exists	None	County Commissioners		Good	Competes with other County service needs
Road Fund	Develop and maintain roads	Already exists	None	County Commissioners	Moderate, restricted to those services required as a result of road impacts or to provide roads.	Good	Competes with other road needs
River Improvement Fund	Provide services related to flooding or erosion along rivers	Already exists	None	County Commissioners	Minimal, competes with other County reveunes and is subject to overall tax levy lids	Generally good	Competes with other demands for County revenues
Bonding	To spread costs of capital projects that have long-term benefits over long periods of time.	Commissioners have limited authority to issue General Obligation Bonds and may issue revenue bonds without a public vote. A ballot is required for bonds that exceed basic limits.	moderate, includes interest	County Commissioners	Moderate, subject to statutory limits, ability to repay and limited to capital programs	Variable	Requires repayment in future, may limit debt available for other purposes
Real Estate Excise Tax for CIP related to development	RCW 82.46 authorizes optional real estate excise taxes to fund capital projects	Commissioner vote	minimal	County Commissioners	Moderate	Variable	Minimal, potential voter resistance
Conservation Futures for open space acquisitions	N/A						
Special Districts							
Stormwater Utility	RCW 36.89 authorizes stormwater programs including capital and maintenance programs to address problems associated with stormwater runoff such as flooding and water quality.	Vote of County Commissioners	Minimal, generally includes preparation of a plan for use of the funds and a public involvement program to assess acceptance of proposal	County Commissioners	Significant	Generally acceptable, widely implemented throughout Puget Sound region and other areas of the country.	May be perceived as another "tax" and another government bureaucracy
Flood Control Zone District	RCW 86.15 authorizes formation to address flood control or stormwater related issues.	Resolution of intent, public hearing and vote of County commissioners	Moderate, generally includes cost to prepare program proposal and conduct public inolvement program to assess public acceptance	County Commissioners	Substantial, can assess taxes or utility rates and charges	Generally favorable if need is understood	May be viewed as additional bureaucracy and as unnecessary

TABLE 2.6

Alternatives for Funding Flood Hazard Management Plan Implementation Measures

Funding Source	Primary Purpose	Process to form or obtain	Cost to obtain	Control	Revenue Potential	Public Acceptance	Adverse Impacts
Special District	RCW 85.38 authorizes formation to provide drainage and flood control services	petition, public hearing and vote of property owners affected	Moderate, includes preparation of plan for operation, assessment role, public hearing and vote	Three locally elected board	moderate, based on benefMt	High if locally supported	Narrow purpose,may conflict with broader purpose governments
Water and Sewer Services	RCW 36.94 authorizes Counties to provide water and sewer services, may provide stormwater services by amending comprehensive sewer plan	amend or prepare comprehensive sewer plan, Commissioner vote	Moderate, cost of developing or amending comprehensive sewerage plan	County Commissioners	Moderate, may use utility rates or taxes	Moderate	May be viewed as another tax and unnecessary bureaucracy
Water and Sewer Districts	RCW 56.04 authorizes formation of sewer districts. Sewer district may provide stormwater control services.	Petition, hearing, vote of affected property owners	Moderate, cost to develop plan, assessment roll, hearing, petition and vote	locally elected board	Moderate	Moderate	May compete with other agency programs or local funding needs
Lake Management District	RCW 36.61 authorizes formation to protect water quality of lakes, not applicable in Grayland	petition or resolution, public hearing and vote of property owners	Moderate, cost to develop plan, assessment roll, hearing and vote	County Commissioners	Moderate, subject to benefit of clean lake	Variable depending on perceived threat to local lake	May compete with other local funding needs
Shellfish Protection District	RCW 90.72 authorizes formation to protect shellfish areas from pollution	vote of County commissioners	Minimal	County Commissioners	High, subject to political will	Variable, dependent on perceived threat to shellfish	May be perceived as competing with other local funding needs
Utility Local Improvement District	RCW 36.94 authorizes to provide funding for capital improvements	petition or resolution, hearing and vote of affected property owners	Moderate, cost of preparing plans, cost estimates and assessment role	County commissioners following vote of property owners to establish	Moderate	Generally high because those benefitting are paying	Minimal, cannot be used to assess those causing flood problems, only those benefitting
Local Improvement District	See above	See above	See above	See above	See above	See above	See above

SECTION 3 BACKGROUND AND APPROACH

- Legal Authority
- Project Background
- Planning Process
- Stakeholder, Public, and Agency Involvement
- Overview of Technical Planning Methods
- Description and Characteristics of Planning Area

Section 3

BACKGROUND AND APPROACH

LEGAL AUTHORITY

State Authority and Requirements

Chapter 86-26 of the Revised Code of Washington (RCW) requires that counties requesting state funding participation for flood control maintenance prepare a comprehensive flood control management plan to be adopted by the county and approved by the Washington State Department of Ecology (Ecology) in consultation with the Washington State Department of Fish and Wildlife. RCW 86.26.105 states that a comprehensive flood control management plan must be completed and adopted within 3 years of the certification that it is being prepared.

Skagit County previously developed a county-wide *Comprehensive Flood Control Management Plan* (Brown and Caldwell, 1989) in response to Chapter 86.26 RCW to address the Skagit River and numerous other flooding sources within the county including the Samish River. That plan was broad-based and did not examine the lower Samish River basin in detail. The plan is in need of update to conform to current FCAAP requirements. This Comprehensive Flood Hazard Management Plan (CFHMP), which addresses the significant and frequent flooding problems that exist along the lower Samish River, is a first step in that update process. Development of this plan has been funded by FCAAP Grant Agreement No. G9500194 between Skagit County and Ecology, using a 75 percent grant funding share. Eventually, with the assistance of additional Flood Control Assistance Account Program (FCAAP) funding, a fully-updated county-wide CFHMP is targeted to be completed.

CH2M HILL has been contracted by Skagit County under Contract Agreement No. 002334, dated February 13, 1995, to develop this CFHMP for the lower Samish River basin. The CFHMP must comply with the administrative rules established for comprehensive flood control management plans in the Washington Administrative Code (WAC), Section 173-045-040. Those guidelines require the following broad elements be addressed by the plan:

1. Determine the need for flood control work, including description of the watershed and identification of types and locations of specific flooding problem areas; historical and potential flood damages; goals and objectives for planning area; applicable local regulations description and consistency with proposed instream flood control work.

2. Alternative flood control work, including description of potential instream flood control work and alternatives to instream measures.

3. Identify and consider potential impacts of instream flood control work on instream uses and resources (fish; wildlife; scenic, aesthetic, historic resources; navigation; water quality; hydrology; and existing recreation).

4. Define the specific area of coverage of the plan, including the limits of the 100-year frequency floodplain within the study reach.

5. Discuss conclusions and propose solutions based on evaluation of problems, needs, and alternative solutions; recommended corrective actions and priorities with resource impact resolution measures; and certification from the state Department of Community Development that the county is administering an acceptable comprehensive emergency operations program.

In accordance with Chapter 86.16 RCW, Floodplain Management, the state (as administered by Ecology) has full regulatory control over waters of the state for the purpose of alleviating recurring flood damage and promoting public health and safety. This includes requirements that local jurisdictions adopt floodplain management ordinances meeting minimum standards of the National Flood Insurance Program (NFIP). The administrative rules for implementing Chapter 86.16 RCW are contained in Chapter 173-158 WAC, Floodplain Management.

Flood Control Assistance Account Program

The Flood Control Assistance Account Program (FCAAP) provides matching reimbursable grants for counties' and local jurisdiction's flood hazard reduction maintenance planning and recommended project improvements.

Administered by Ecology's shoreland and coastal zone management program, FCAAP promotes a watershed approach to minimizing flood hazards. To be eligible for funding, a jurisdiction must demonstrate flood hazard management activities to the approval of Ecology in consultation with the Department of Fisheries and Wildlife. Local jurisdictions must also participate in and meet all the requirements of the NFIP and must restrict land use in the floodplain and floodway of rivers to only flood-compatible uses.

The maximum amount of funds available per county is $500,000 per biennium (beginning July 1 of odd-numbered years), subject to availability. Grants of up to 75 percent can be provided for planning work. Provided a CFHMP has been completed and adopted, or is in the process of being prepared, grants of up to 50 percent of eligible maintenance projects construction costs can be provided, subject to availability of funds. For emergency flood repair, grants of up to 80 percent can also be issued.

Sponsorship and Authority of Local Government

To maintain compliance with the FCAAP program and its flood control maintenance funding provisions, Skagit County meets the following minimum requirements of WAC 173-145-050:

1. Participates in and complies with minimum requirements of the NFIP.

2. Regulates land uses within the floodplain and floodway (where designated) to only flood-compatible uses through a Flood Damage Prevention Ordinance and a Shoreline Management Program.

These and other Skagit County regulatory programs are described in Section 5.

Skagit County has provided a 25 percent local match funding share for development of this plan. It has an established flood control emergency operations and maintenance program, including a flood warning and emergency action program under the direction of the Public

Works Department. The county actively participates in flood control maintenance projects in support of the local diking and drainage districts through an established River Improvement Fund.

The Skagit County Planing Department, in coordination with Ecology, is concurrently developing a *Samish Watershed Action Plan,* with focus on water quality improvement and habitat management throughout the watershed. A separate interagency and interest group advisory committee is developing specific policy recommendations targeted for implementation to meet that plan's goals and objectives. Limited coordination of the preliminary solutions developed in this plan and the policy guidance being developed by the watershed action plan committee has occurred; additional coordination is required prior to final plan development and adoption. The two draft plans (the Watershed Action Plan draft has not been issued yet) will need to be reviewed for consistency in policy recommendations and project implementation objectives and requirements.

This CFHMP is also an element of Skagit County's plan to meet the goals of the Growth Management Act (GMA) and associated comprehensive planning guidelines. The 1990 GMA requires county-wide planning to guide sensitive, economical, and planned development for qualifying communities. Under the GMA, all counties with a population of at least 50,000 people and a population increase of more than 10 percent in the last 10 years must adopt a comprehensive plan. Skagit County's current GMA program is described in Section 5.

The recommendations of this draft CFHMP will be assessed by county staff for compliance with the requirements of Skagit County's shoreline master program, comprehensive plan, and zoning ordinance in accordance with conditions of the FCAAP grant agreement for this plan.

Under Chapter 86.12 RCW, county governments can levy taxes, exercise eminent domain, and take action to control and prevent flood damage. The authority of counties was substantially enlarged in 1991 with the passage of ESSB 5411, which authorized counties to adopt CFHMPs "for any drainage basin that is wholly or partially within the county." It requires that the plan:

1. Designate areas that are susceptible to periodic flooding.

2. Establish a comprehensive scheme of flood control protection and improvements.

3. Establish land use regulations that preclude the location of structures, works, and improvements in critical portions of such areas subject to periodic flooding.

4. Establish restrictions on construction activities in areas subject to periodic floods.

5. Establish restrictions on land use clearing activities and development practices that exacerbate the flood problems by increasing the flow or accumulation of flood waters.

PROJECT BACKGROUND

Study Area

The required area of study for this plan, in conformance with RCW 86.26, is the 100-year floodplain of the lower Samish River, from Samish Bay upstream to its confluence with Friday Creek (at river mile 10.8). The specific study area limits for flood hazard reduction planning are shown in Figure 3-1. The entire watershed area was considered in evaluation of potential hydrologic effects of changing basin land uses.

Need for Plan

The county and affected local diking and drainage districts have long realized the need for flood hazard reduction measures in the lower Samish River basin. Significant areas of land beyond the principal channel have frequently been flooded over durations that have extended up to 8 weeks after major flooding events. Overbank flooding has historically occurred on a frequency of between 2 and 5 years. This has resulted in flooding of various structures, overtopping of numerous roadways (including Chuckanut Drive), and agricultural economic damages to crop production, dairy farming, and supporting businesses prevalent in the floodplain area. Under more extreme regional flooding conditions, more extensive flooding of the lower Samish River Valley has occurred (not documented in recent flooding history) as a result of Skagit River overflows in the lower delta area.

According to the diking and drainage districts advisory committee, the need for flood hazard reduction actions have resulted primarily from the following:

- Raising of public and private roadways within the floodplain without installing culverts to provide passage for historical flood path overflows
- Development and filling of private properties within the floodplain and overflows channels that obstruct overflows conveyance
- Raising of dikes along the edge of the river channel resulting in increased upstream flood elevations and redirection of overflows
- Watershed development with insufficient stormwater runoff controls to mitigate downstream impacts
- Reduction in allowable river channel maintenance actions based on increased regulatory controls
- The potential for redirection of a portion of Skagit River overflows down the lower Samish River valley

These problems and issues are depicted and described in more detail in Section 5.

The need clearly exists for a coordinated plan, supported by Skagit County and the affected stakeholders (dike and drainage districts, public, agencies, tribes), to guide implementation of appropriate and cost-effective solutions (both nonstructural and structural) that reflect local stakeholder priorities. The plan will only be implemented if it is supported by the stakeholders and County commissioners, and it will be supported only if there is consensus on solutions. In the past, flood protection improvements by one dike or drainage district have impacted others, with resulting difficulties in building collective agreements to implement projects benefiting all districts. This has been the focus of the advisory committee/stakeholder involvement process.

Citizens and public officials are increasingly aware of the interrelated issues of comprehensive planning, stormwater management, resource preservation, and flood damage reduction. Within this context, it is acknowledged that floods are natural events, and often it is the human activities that must be better managed to minimize watershed impacts that make flooding a more frequent and serious hazard. In the lower Samish River basin, given the frequency and extent of the existing flooding problems and future potential for additional watershed land use conversions, it is even more imperative that enhanced watershed and floodplain development standards be applied to minimize the potential for increased flooding damages. In the future, nonstructural control solution opportunities within the basin may be limited.

The State of Washington has made grant funds available to help communities and local governments comply with the state statutes calling for watershed-based flood protection activities. To qualify for these funds, a flood hazard management plan demonstrating an overall watershed understanding and management approach must be developed. This plan, coupled with the watershed action plan (currently being developed), provides the required framework and policy recommendations for implementation of effective watershed (nonstructural) protection measures.

PLANNING PROCESS

Principles of Comprehensive Flood Hazard Management

The flood hazard management planning approach considers floodplain management, which seeks to plan floodplain uses considering balances in resource protection, environmental enhancement, flood damage protection, and land use development. To be effective, it must also consider land uses, hydrology, and environmental and economic issues beyond the designated floodplain (e.g., within the watershed). In the case of the lower Samish River basin, these issues are key considerations of recommended nonstructural solutions and policies being developed jointly in this plan and the watershed action plan.

In recognition of the above goals, the process for development of this plan considered the following fundamental principles set out by the FCAAP program for comprehensive flood hazard management planning:

1. It is often more cost-effective and beneficial to accommodate a waterway's dynamic nature than to build structural improvements to contain the waterway.

2. The causes of flood damage must be identified and understood early in the planning process to be effectively addressed.

3. A watershed-based solutions approach across jurisdictional boundaries (where possible) provides the greatest opportunity for effective flood hazard management.

4. Stakeholder, public, and agency participation in the planning process and acceptance/support of plan solutions is critical to the success of the plan and its implementation.

5. The process of alternatives evaluation to meet plan goals and objectives should consider technical feasibility, benefit, cost, environmental impact, funding capabilities, and public acceptance and priorities for solutions.

6. Protection of resource management goals through preservation of natural hydrologic processes and other related approaches should be integrated with flood hazard management solutions.

7. The CFHMP process and documentation provides opportunities to improve interdepartmental coordination needed to effectively guide actions for implementing solutions.

8. A CFHMP comprehensive solutions planning approach provides a framework for addressing and proposing modification (where necessary) to other related local programs and policies (e.g., flood insurance program, stormwater, growth, shoreline management, and recreational planning).

Process for Plan Development

This CFHMP was developed in accordance with *Ecology's Comprehensive Planning for Flood Hazard Management* (Ecology, 1991). In that guidance document, the following steps outlined for successful completion of a CFHMP were accomplished in development of this plan. References to sections in this plan that discuss this development process (where applicable) are provided.

1. Establish citizen and agency participation process (Section 3).

2. Set flood hazard management short- and long-term goals and objectives (Section 4).

3. Inventory and analyze physical conditions (Section 6).

4. Determine the need for flood hazard management measures (Sections 3 and 6).

5. Identify alternative flood hazard management measures (Section 7).

6. Evaluate alternative measures (Section 7).

7. Hold public alternative evaluation workshop (Section 3).

8. Develop flood hazard management strategy (Sections 2 and 7).

9. Complete draft CFHMP and SEPA documentation (entire document). (Note to reader: Funding plan and SEPA documentation not yet complete.)

10. Submit final CFHMP to Ecology. (Note to reader: This and succeeding steps to come after draft plan agency review and comment.)

11. Hold public hearing and pass intent to adopt resolution.

12. Notify Ecology that the final plan is adopted.

Scope of Work for Plan Development

The scope of work to accomplish the above planning process was jointly established with the Skagit County Department of Public Works with input from the affected dike and drainage districts (Nos. 5, 14, 16, 19, and 25). A briefing session with the Skagit County commissioners was held prior to the Ecology grant and consultant contract execution to review the scope of services. A brief summary of the contracted scope of work tasks completed (or to be completed) is provided below.

Task 1–Public, Agency, and Stakeholder Involvement. The strategy and process for involvement of citizens, agencies, and affected stakeholders was initially established. An advisory committee composed of the affected diking and drainage districts was formed and regular meetings were held for interactive participation in the planning process (seven meetings held to date). Documentation of those meetings is provided in Appendix B. Selective agency contacts have been made to discuss potential solutions feasibility, resource benefits, and support. Additional agency coordination will occur during the draft plan review process. A public meeting for review of plan results and recommendations will be held after draft plan review.

Task 2–Flood Hazard Management Inventory, Goals and Objectives, Criteria, and Needs. The primary data gathering and review needed to develop this CFHMP was performed under this task. Specific subtasks included reviewing existing background data; interviewing local residents and diking district commissioners and performing field review; developing and documenting CFHMP goals, objectives, and evaluation criteria; documenting existing flooding problem type, location, severity, and frequency; documenting regulatory and historical floodplain limits; assessing river channel hydraulic capacities for flood flow conveyance and overflow frequency; assessing potential effects of watershed growth on flood hazards; and identifying needs and opportunities for flood hazard management measures.

Task 3–Development and Evaluation of Flood Hazard Management Alternative Solutions. Alternative flood hazard management solutions were developed and were evaluated jointly with Skagit County and the dike and drainage district advisory committee. Numerous structural projects (localized spot, capital improvement, and maintenance) and nonstructural (floodplain and watershed) management strategies were presented and screened with the advisory committee. Weighted evaluation criteria established from the committee goals and objectives were used to evaluate alternatives. Preliminary estimates of alternative projects implementation costs were also developed to establish the feasibility of alternatives. Benefits and potential impacts within the floodplain were considered for screened alternatives.

Task 4–Flood Hazard Management Program and Policy Recommendations. Based on the results of Task 3 and Skagit County and advisory committee guidance, program and policy recommendations that would provide flood hazard reduction benefit have been made for

implementation consideration. These recommendations include specific nonstructural (regulatory) and structural (project) measures that would reduce future flood event damages.

Task 5–Funding and Implementation Plan. This task will develop a funding plan and implementation measures for recommended plan components. Project priorities and anticipated scheduling within a 6-year capital improvement project period will be proposed. Funding proposals for specific project and program elements will be provided for the Skagit County commissioners' consideration and action.

Task 6–Plan Documentation. This draft plan documents the preliminary results and recommendations of the CFHMP. A final plan will be prepared, including response to a single set of agency and dike and drainage district review comments after achieving advisory committee consensus for Task 5 recommendations.

Task 7–Project Management and Coordination. Ongoing coordination with Skagit County Public Works and Planning Department staff and advisory committee members will continue through final plan completion to maintain effective communications and compatibility of solutions with local concerns.

STAKEHOLDER, PUBLIC, AND AGENCY INVOLVEMENT

Approach

The process of achieving agreement for plan solutions among the various stakeholders, each with specific interests and affected directly or indirectly by the actions of others, relied on a consensus approach. It was clear that solutions would be accepted and supported only if they emanate or are consistent with the stakeholders' ideas, are practical, and do not have major impacts on them. Clear and effective communications were critical for informed committee decisions. To achieve this, each meeting had a progressive end objective to build a committee consensus and to bring down some of the barriers to working cooperatively to achieve them.

The public process has relied to date on keeping advisory committee meetings open for public input. A formal public meeting will be scheduled after draft plan review and advisory committee consensus on recommended solutions.

Agency representation and input to solutions has occurred but on a limited basis, including interaction with Watershed Action Plan agency representatives and discussions of setback dike project with resource agencies (Department of Fish and Wildlife and U.S. Fish and Wildlife Service). It is difficult to achieve agency interaction at this conceptual level of study. This draft plan will provide the opportunity for agency review and input on recommended plan solutions.

Along a parallel path, the process has continued to build on the existing County commissioners support, not only for commitments to implement solutions, but for actions to implement improved watershed controls such as policy and ordinance revisions. A briefing session was held on June 8. Additional sessions are planned in request of County commitments to partial funding of recommended solutions.

Recommended Solutions Consensus/Implementation Strategy

A summary of the recommended strategy to achieving solutions consensus among the various stakeholders, the public, and affected agencies, and building support for their implementation is listed below. These items were integrated into the meetings and the framework of the plan.

1. Identify makeup, operating structure, and responsibilities of the advisory committee to meet stakeholder preferences; define approach to achieving agreement on plan solutions (e.g., consensus voting approach).

2. Provide a set of ground rules for meetings to allow all interested stakeholders to participate and to maintain some meeting structure to get to the end objectives.

3. Identify a targeted schedule to complete committee actions.

4. Define a practicable set of goals and objectives for CFHMP solutions; maintain focus on achieving these throughout the process; revisit and modify them as required.

5. Provide advance meeting agendas to all committee members so they can see how the process will work and come to meetings prepared with meaningful input.

6. Spend time outside of meetings with stakeholders to assure that their needs are being met and to promote support for solutions and feedback to elected officials.

7. Involve outside agency staff in meetings where appropriate to inform them of targeted solutions, gain their input and acceptance, and to educate the stakeholders on specific measures required for environmental compliance.

8. Coordinate the development of solutions with the goals, objectives, and results of the Watershed Action Plan through ongoing communications with the Skagit County Planning Department; where practical, incorporate multi-objective features such as water quality and fisheries/wildlife enhancements into solutions.

9. Identify tangible and meaningful stakeholder benefits to solutions; clarify what will not be achieved as well, so that expectations are kept in perspective.

10. Keep the County commissioners well informed of plan progress, solutions, and funding requirements to implement through staff briefings to build on existing support.

11. Keep committee members informed as to when key decisions are needed to stay on track with the project schedule.

Makeup and Role of the Project Advisory Committee

Based on CFHMP development guidance developed *in Comprehensive Management for Flood Hazard Management* (Ecology, 1991), public and agency participation is considered critical to the success of the comprehensive flood hazard management planning process. For this plan, the primary stakeholders affected by the current flood hazards and plan solutions are located within various diking and drainage districts authorized under Title 85 RCW. Those districts

that overlay the entire lower Samish River basin CFHMP planning area are as follows and are shown on Figure 3-1.

- Diking District 5
- Drainage District 14
- Drainage District 16
- Diking District 19
- Diking and Drainage District 25

These diking and drainage districts construct and maintain flood control works and provide for field drainage outside of roadway rights-of-way, including floodplain areas. Assessments are levied on residents within those districts to provide funds for such activities. Because the diking and drainage districts represent the residents in each district for flood control and drainage needs, the districts were invited to form an advisory committee for development of the CFHMP. A committee was formed consisting of the commissioners within each district. Resource agency personnel were also invited (Department of Fish and Wildlife), but declined to participate.

The committee role was advisory; however, the plan solutions were developed based on the committee members input and were adapted to meet their local concerns. Building a consensus for appropriate actions that balanced the competing objectives was the main goal of the committee. Because all members (many of which are long-term residents) represented their community and, in particular, the study area, they were also an excellent resource for providing input on flooding problems, concerns, and solution ideas.

A series of meetings were held (seven to date of draft report) to understand local flooding issues and problems; to develop, evaluate, and prioritize solutions; to build consensus for plan recommendations; and to establish an agreed-to funding plan for implementing solutions. All meetings were open to the public. The date, representatives, and results of each meeting are summarized in Appendix B. Detailed minutes for all meetings were taken by Skagit County and are available through the Public Works Department.

OVERVIEW OF TECHNICAL PLANNING METHODS

Technical planning methods used in development of this CFHMP consisted of the following:

- Watershed hydrologic evaluation
- River capacity hydraulic modeling evaluation
- Alternative solutions technical feasibility evaluation

The basic approach considered for each of these is described below.

The level of detail of analysis was commensurate with the concept level of solutions and the available data to support their technical evaluation. Since detailed topographic mapping was not available throughout the lower Samish River basin study area, estimated elevations based on information from record drawings, field reconnaissance, and supplemental surveys

conducted for this plan were made. Results of the above technical evaluations are presented in Appendix C. Further detailed evaluation of specific project recommendations will be required with design of improvements (beyond scope of this plan) based on field surveys of the projects area.

Watershed Hydrologic Evaluation

Watershed hydrologic evaluation was limited to assessment of existing condition peak flood flows (for 2- through 100-year recurrence interval events) based on available stream gage records for hydraulic model evaluation. Consideration was also given to potential watershed development runoff impacts as summarized in Section 6. No hydrologic modeling was performed.

Methods used for existing condition flood flow frequency analysis (FFFA) are those described in Section 6. Flood flow results for existing conditions are summarized in Figure 6-10. Peak flows for the full period of gage record were used for input to the hydraulic modeling analysis.

River Capacity Hydraulic Modeling Evaluation

The basis of the existing FEMA floodplain mapping of the lower Samish River (below Thomas Creek confluence) is hydraulic modeling work performed by the Corps of Engineers considering projected overflow of the Skagit River into the Samish Valley for the 100-year recurrence interval event (FEMA, 1989). Due to the projected magnitude of overflows as compared to corresponding Samish River peak flows for that event (approximately 8 times the magnitude), no specific evaluation of Samish only flood flows or floodways in that reach was completed for the FEMA FIS. For reaches upstream of the Thomas Creek confluence, detailed study mapping of the Samish River floodplain and floodway were completed by FEMA. The extent of cross-section data used in hydraulic modeling evaluations by the Corps of Engineers were limited in the lower river reach.

In the mid-1980s, the Soil Conservation Service (SCS, now NRCS) conducted a limited hydraulic evaluation of the lower Samish River between the Farm to Market Road and Chuckanut Drive crossing. This was primarily focused on capacity analysis of the existing river channel. Additional river channel cross-section data were collected for that work.

Subsequent to the above analyses, additional dike height modifications have been made both above and below Farm to Market Road. The hydraulic evaluation performed for this plan built on the collective river channel data from those prior studies and modified it to reflect recent surveys of the dikes supplemented by some additional cross-section data. Other record drawing information was used where actual field survey data were not available or sufficient.

The hydraulic analyses performed were limited to a channel rating analysis between Samish Bay and Interstate 5 to estimate the maximum capacity of the river system prior to overflow. The HEC-2 step backwater computer model was used to model hydraulic backwater effects. This model was also used for preliminary analyses to simulate the hydraulic benefits of constructing setback dikes considering the assumptions made about the expanded river corridor width. No data were available to specifically calibrate the modeling results (e.g., high

water marks) consistent with recorded flood flows). Therefore, engineering judgment was used to match modeling results closely to local resident observations of frequent flooding levels.

Primary assumptions used in the hydraulic modeling analysis are as follows:

- Steady state (fixed flow) hydraulic modeling basis
- Unobstructed flow in the river channel and at all hydraulic structures
- Manning's average channel roughness value of 0.050 (higher in off-channel areas)
- Starting tide elevation consistent with mean high water elevation (approximately elevation 4.0 NGVD)
- No overbank flows (no failure or overtopping of dikes) for range of flows considered

Results of the hydraulic modeling evaluation for existing conditions are tabulated with model input/summary output files in Appendix C. River channel freeboard depths (difference in dike elevation and computed water surface profile) are also tabulated for the conditions evaluated.

Alternative Solutions Technical Feasibility Evaluation

Limited hydraulic analyses to support the technical feasibility of alternative and recommended solutions were performed to meet the specific requirements of each project. Those analyses were typically performed by hand calculation based on assumptions pertaining to those projects.

DESCRIPTION AND CHARACTERISTICS OF PLANNING AREA

Planning Area Boundaries

The lower Samish River basin encompasses an extensive agricultural floodplain at the northern portion of the Skagit Delta. For the purposes of this plan, the planning area is generally bounded on the north by Chuckanut Drive and Samish Bay, on the east by Highway 99, on the south by Joe Leary Slough, and on the west by Padilla Bay (See Figure 2-1). These boundaries were established to coincide with the 100-year floodplain of the lower Samish River. The descriptions of the planning area characteristics in the following sections are based on information given in the *Samish Watershed Characterization Preliminary Draft Report* (Skagit County, 1994), which is part of the Watershed Action Plan.

Topography and Geology

The lowland floodplains of the lower Samish River basin are defined by a vast network of drainage ditches, levees, and coastal dikes interspersed throughout farmland. The natural lowland drainage has been significantly altered by diking, filling, and channelization of the river and streams. The whole area lies at nearly sea level. The upper watershed area, beyond

the planning area boundaries, is composed of the foothills of the Cascade Mountains, ranges in elevation from less than 100 to greater than 4,000 feet.

Surficial geological materials in the lower Samish River basin are primarily the result of deposits from Ice Age glaciers, which ended about 12,000 years ago, and alluvial river deposits. During early post-glacial time, the area of the present Skagit River Delta was a marine inlet that was subsequently filled by sediment from the Skagit River. The Samish lowlands were formed approximately 10,000 years ago by this sediment, which is composed primarily of sand, gravel, and silt.

At one time, the Skagit River likely emptied into Samish and Padilla Bays through a network of braided channels (distributaries) fanning through the lowlands. Over time, these distributaries filled in and, as a result, the Samish became a separate river system from the Skagit.

Within the past century, the surficial geologic conditions have changed as a result of the diking and dredging that has taken place in the lower Samish River basin. Wetlands and salt marshes have been filled, which has altered the natural course of streams.

Climate

As part of the Puget Sound region, the lower Samish River basin experiences a typical temperate, mid-latitude, west coast marine climate. Winters are mild, wet, and cloudy, with the highest precipitation falling from November to April; December has the highest average monthly precipitation. Annual precipitation ranges from about 30 inches in the planning area up to 70 inches in the upper Samish River watershed. Temperatures range from an average of 40 degrees F in the winter to an average of 73 degrees F in the summer. A sustained snowpack in the upper watershed area is rare, as are associated rain on snow flood events.

Soils Characterization and Mineral Resources

Detailed soil surveys of Skagit and Whatcom Counties were conducted by the Soil Conservation Service (SCS) (which has since been renamed the Natural Resource Conservation Service) in 1989 and 1992. The surveys identified over 70 soil types within the Samish watershed. Soils on the floodplains and deltas of the lower Samish River basin were characterized as very deep, poorly drained to moderately well drained, and level to nearly level. The majority of flood damage in this basin results from the inability of the soil to infiltrate standing floodwater. This results in extended inundation of farm fields and delayed planting due to saturated soil conditions.

Sand and gravel mining takes place in the glacial deposits of the Samish watershed, and there are currently active mining permits issued by the Department of Natural Resources (DNR) within the lower Samish River basin.

Hydrology

The lower Samish River basin is one of six sub-basins delineated in the *Samish Watershed Characterization Report* (Skagit County, 1994) for the purpose of identifying hydrologic units with similar characteristics within the Samish watershed. FEMA identifies virtually all of the lower Samish River basin as a 100-year floodplain. Significant flood events that occurred in

1983, 1986, and 1990 submerged large portions of the floodplain; the 1990 flood was considered a 35-year event.

According to data from a U. S. Geological Survey gaging station that was maintained on the Samish River below the Highway 99 bridge from 1943 to 1971, average daily flows were summarized as follows:

- Fall--164 cubic feet per second (cfs)
- Winter--458 cfs
- Spring--259 cfs
- Summer--62 cfs

Biological Resources

Vegetation

Vegetation within the study area is generally a function of land use, which is discussed in more detail in Section 5 of this plan. Almost 75 percent of the land in the Samish River basin is agricultural, 11 percent is forested, 12 percent is open rural or woodlots, and the remaining land is developed for residential or commercial purposes.

Wetlands

Until extensive diking, dredging, and filling began in the lower Samish River basin within the last 100 years, wetlands probably comprised a major portion of the planning area. Now wetlands comprise less than 3 percent of the total acres within this area. The environmental benefits of wetlands are numerous. They provide habitat for fish and wildlife, help maintain water quality, protect against flooding, stabilize shorelines, recharge groundwater, and maintain stream flows.

Wildlife

Species that occur within the lower Samish River basin/planning area included in the Department of Fish and Wildlife Priority Species List include the bald eagle, peregrine falcon, blue heron, black brant, osprey, sandhill crane, and common loon. Samish and Padilla Bays are part of the four-bay complex that is considered one of the largest and most important wintering habitats south of Alaska and north of Mexico for the birds noted above and many other bird species. In addition, many birds, such as the bald eagle, nest adjacent to Samish and Padilla Bays.

The estuarine and salt water portions of Samish and Padilla Bays provide habitat for river otters and harbor seals. Black-tailed deer also are common in the rural and forested areas of the planning area.

Fisheries Resources

Tidal influences in the first four miles of the Samish River create a critical adjustment zone between fresh and saltwater for fish swimming in from the ocean, but no reaches of the river has been identified as having "substantial value" for resident fish populations below Friday

Creek. As changes in existing hydrologic patterns in a watershed could directly impact fish and aquatic wildlife, this plan should take their habitats and sustainability into account.

Several species of native and non-native salmon and trout that use the Samish River and its tributaries for spawning and rearing are listed below.

- **Chinook.** Chinook salmon are probably native to the Samish River, but the present fish population is primarily from the Friday Creek fish hatchery stock. Between 1989 and 1992, the Department of Fisheries estimates found the Samish River Chinook to comprise 15 to 25 percent of the total Puget Sound Chinook run.

- **Coho.** Coho salmon using the Samish River are of mixed native and non-native stock and spawn in the wild on almost all tributaries. The Samish coho comprise between 1 and 4 percent of the total Puget Sound run.

- **Chum.** The Samish River chum salmon stock are also considered to be of mixed native and non-native stock and mostly spawn in the wild. Chum fry migrate directly to the estuary and salt marshes and then move onto the eelgrass in the bays; therefore, this species is probably more sensitive to intensive land uses within the lower Samish River basin that more directly affect their habitat.

- ***Steelhead.*** *Two runs of* steelhead use the Samish River, one wild and one planted. The wild run is considered "depressed" by the Department of Fish and Wildlife.

- **Cutthroat.** The cutthroat trout run using the Samish River is completely native and appears to be increasing in population as a result of a two-fish limit with release of fish under four inches.

Between 1989 and 1992, the average annual commercial fisheries harvest in Samish Bay totaled an approximate value of over $1 million dollars and included Chinook, coho, sockeye, sole, flounder, spiny dogfish, Manila clams, Pacific oysters, and Dungeness crab. Commercial shellfish is harvested and cultured in Samish Bay and monitored by the Washington State Department of Health.

Marine Habitat

Samish Bay provides a rich marine environment for fish, shellfish, marine invertebrates, and waterfowl. Mudflats extend from a half mile to over one mile into the bay, and remnant pockets of salt marsh are found in portions of the mudflats. Beyond the mudflats, eelgrass is the predominant vegetation. The eelgrass system supports many marine species, as well as juvenile anadromous fish and waterfowl.

Water Resources

In addition to the Samish River and Edison, Neuman, and Joe Leary Sloughs, there are approximately 63 miles of streams in the lower Samish River basin. Sixteen and a half miles of these streams are classified as major fish-bearing waters

Groundwater in the lower Samish River floodplain is susceptible to contamination from petroleum products, pesticides, nitrogen, and phosphorus because of the permeability of the soil layers and increasing human activity. Naturally occurring contaminants such as seawater, iron, manganese, and other minerals are common in the Samish floodplain (Willis, 1994) but are not considered a significant health risk by the Skagit County Health Department.

Transportation

Within the lower Samish River basin, there are 78 miles of roads. Interstate 5 and Highway 99, primary roads, total 13 miles; secondary roads, such as Chuckanut Drive and Farm to Market Road, total 21 miles; and the remaining 44 miles of roads are light duty or unimproved. Portions of many secondary and light duty roads within this area become submerged and impassable during flood events.

Recreation

The lower Samish River basin offers a variety of recreational opportunities for residents and visitors. The shores of Padilla Bay draw many local birdwatchers as well as visitors from out of state. Shellfish harvesting, duck hunting, fishing, and boating also take place in the area.

Skagit County's *Draft Comprehensive Park, Recreation, Open Space, and Trails Plan* proposes trails along the coastal dikes in the Blanchard/Edison area and the beach west of Blanchard.

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SECTION 4 GOALS AND OBJECTIVES

Section 4

GOALS AND OBJECTIVES

A set of comprehensive goals and objectives was developed jointly with the dike and drainage districts' advisory committee and Skagit County to provide an organized framework to guide the solutions planning and evaluation process for flood hazard reduction in the lower Samish River basin. These goals and objectives also provide the basis from which to assess the ultimate success of the planning process and the follow-on recommended actions for implementation of plan solutions. The goals represent the broad spectrum of desired results and improvements to address flood hazard management issues. The objectives for a particular goal are the specific "action items" that, when implemented, will successfully achieve that goal.

The following six goals and supporting objectives comprise the dike and drainage districts' advisory committee and Skagit County's guidance for development and implementation of this plan. These goals and objectives were formally adopted by the Dike and Drainage Districts Advisory Committee at the April 27, 1995, meeting (meeting No. 4).

GOAL NO. 1

Improve protection of public health and safety from flooding threats in the lower Samish River basin.

Objectives

1a. Document the approximate extent of the floodplain, historic overflow paths, flood-prone structures, and roadways for:

- Samish River only flooding
- Skagit River overflow flooding

1b. Clearly define and disseminate emergency action plan and procedures using:

- Flood warning and forecasting system
- Evacuation emergency response routes
- Temporary manpower, equipment, and supplies for flood fight

1c. Identify opportunities to improve flood protection of existing structures by:

- Ring dikes around structures
- Floodproofing and elevation of structures

1d. Provide permanent warning signs for flood-prone sections of public roadways.

1e. Maintain emergency shelters with essential supplies for displaced flood victims.

GOAL NO. 2

Provide practical, cost-effective solutions that will result in measurable reductions in flooding frequency, duration, and frequently flooded area damages.

Objectives

2a. Identify feasible river channel improvement projects that maximize the level of protection under frequent flooding conditions by:

- Selected diking and drainage district maintenance projects
- Dike height adjustments and stabilization of inadequate/overtopping sections
- Limited dike extensions not resulting in water level impacts
- Added flow capacity at restrictive roadway crossings

2b. Preserve and enhance existing overflow swales' flow capacities and control their further filling by:

- Floodway designations regulated by County floodplain ordinance
- Culverts under roadways in overflow swales

2c. Provide overflow return channels and improved gated outfall pipes to river channel, sloughs, and bay to reduce flooding duration by:

- Existing drain maintenance and improvements
- New ditches/culverts in areas of persistent flooding
- Additional gated or pumped outfalls to river channel and bay
- Overflow connections with controlled outlets to sloughs
- Improved conveyance in Joe Leary and Edison Sloughs and at outfalls

GOAL NO. 3

Implement comprehensive floodplain management regulations to control future watershed growth impacts to flooding in the lower Samish River basin.

Objectives

3a. Develop and implement floodway designations for the lower Samish River by:

- Agency coordination (FEMA and Ecology) to achieve floodway mapping
- Adequacy of existing County floodplain ordinance
- Enforcement provisions

3b. Identify frequently flooded areas; regulate further development in these areas by County code and ordinances.

3c. Define further modifications needed to surface water control element of development standards, to ordinances, and to the development review/approval/enforcement processes by:

- Control of "ditch and drain" practices
- Enhanced detention standards
- Improved erosion/sedimentation controls
- Enforcement provisions

3d. Assess expected watershed growth effects within framework of County growth management program based on:

- Increased runoff flows/volumes of targeted watershed growth
- Land surface conversion controls
- Watershed management practice controls (e.g., forest practices)

3e. Define opportunities for improved basinwide runoff regulation.

- Changes to existing lake outlet flow regulation
- Regional detention opportunities for tributary streams

GOAL NO. 4

Achieve diking/drainage district, County, and resource agency consensus for recommended solutions.

Objectives

4a. Jointly coordinate this and Watershed Action Plans' development and recommendations.

4b. Incorporate and prioritize selected diking and drainage district projects within plan.

- Modify to achieve County and permitting agency acceptance

4c. Identify and incorporate joint project opportunities within the County road improvement program (6-year CIP).

- Reduce roadway blockages
- Culvert installations within overflow channels

4d. Involve resource agencies in planning to achieve buy-in for recommended projects' permitting.

- Increased opportunities for funding support

4e. Provide water quality and fish/wildlife habitat improvement features with recommended projects (where feasible), including:

- Flood protection of dairy barns (minimize water quality impacts)
- Return channels' water quality treatment areas
- River channel and off-channel fish habitat enhancement areas
- Selective riparian planting of river channel setbacks

GOAL NO. 5

Document solutions consistent with Ecology FCAPP requirements (WAC 173-145-040) to maximize further grant funding opportunities for project and program implementation.

Objectives

5a. Develop plan document to meet requirements of Ecology FCAAP program.

- Flood history, problems, and needs
- Goals and objectives
- Alternative flood hazard reduction measures
- Potential impacts to in-stream uses and resources
- Recommended solutions
- Implementation and funding plan

5b. Provide ongoing briefings to Ecology regarding project status and proposed solution needs.

- Flood reduction maintenance and improvement projects
- Floodplain and floodway mapping needs
- Funding needs and recommended funding plan

GOAL NO. 6

Build effective political and legal strategy to result in implementation of plan solutions.

Objectives

6a. Maintain and build on County commissioners' support for program implementation.

- Periodic briefings on plan status and solution recommendations
- Field tour of recommended solutions
- Policy and ordinance needs to better regulate development runoff and manage floodplain

6b. Identify legal issues associated with routing of floodwaters back to river and bay; define County's limitations in achieving this.

6c. Recommend implementation strategy within identified implementation constraints.

The following sections document alternative and recommended project improvements and suggested revisions to current County programs and policies for floodplain and watershed management. The alternative structural solutions considered were evaluated by the dike and drainage districts' advisory committee using criteria developed from these goals and objectives. Nonstructural solution recommendations included in this plan were also measured against these goals and objectives.

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SECTION 5 POLICY AND REGULATORY ANALYSIS

- **Flood Damage Prevention Ordinance**
- **Drainage and Erosion/Sedimentation Control Ordinance**

Section 5

POLICY AND REGULATORY ANALYSIS

A critical step in managing flood hazards is to develop policies and regulations that limit or condition development of additional improvements in areas subject to flooding or that increase flood damage to other properties or resources. Under the requirements of the Growth Management Act (GMA), floodplains, along with wetlands, fish, and wildlife habitat areas, and other areas, are subject to regulation as "critical areas" where development is limited to protect the resource or avoid hazards to property owners. Policies concerning critical areas typically are set forth in the conservation element of a jurisdiction's comprehensive plan, with a critical areas ordinance placing specific limitations on development. Although there tend to be common features among other critical areas regulations of different jurisdictions, the GMA guidelines allow a wide range of variation in the ways communities choose to protect their resources.

While floodplains are considered critical areas in their own right, in practice many of the other critical areas policies and regulations also serve to limit floodplain development. For example, the area immediately adjacent to a stream channel is usually subject to setback requirements, which in some cases mandate that native vegetation be maintained in the setback area. Wetlands are often found in floodplains and are also considered critical areas.

This section briefly examines the policies and regulations of Skagit County as they relate to floodplain development. A discussion of applicable State and Federal regulations can be found in Appendix E.

Local regulations that often pertain to flood hazards include comprehensive land use plans, a zoning ordinance, flood damage prevention ordinance, Shoreline Master Program, Sensitive Area Ordinance, building code, and drainage ordinance.

FLOOD DAMAGE PREVENTION ORDINANCE

In Skagit County, the primary regulation for development in a floodplain is the Flood Damage Prevention Ordinance, Title 15, Chapter 15.20 of the County Code. Section 15.20.070 defines Areas of Special Flood Hazard as those areas identified by FEMA in the *Flood Insurance Study for the Unincorporated Areas of Skagit County, Washington* (FEMA, 1989). The ordinance requires that new construction within a floodplain be elevated one foot above the FEMA predicted 100-year flood level and/or flood proofed. Development in floodways is not permitted. In the Samish River floodplain, however, floodways have not been designated. Thus, development including fill is permitted in the Samish River floodplain.

Construction in the floodplain has the potential to subject the new development to flood hazards and to increase the flood hazard for other properties in the floodplain. Filling in the floodplain reduces the available area for storage of flood waters. The loss of storage increases the depth of flooding on remaining properties. There is no provision in the County's regulations to compensate for this impact.

In the Samish floodplain, floodways and overflow channels have not been identified by FEMA; therefore, development in these areas is subject to substantial hazards resulting from inundation and velocity damage and significantly increases hazards on other properties. Blocking flood flows in these areas divert the flows onto other properties and increases the depth of flooding.

DRAINAGE AND EROSION/SEDIMENTATION CONTROL ORDINANCE

A related ordinance is the County's Drainage and Erosion/Sedimentation Control Ordinance. This ordinance does not restrict development in the floodplain but requires that subdivisions, planned unit developments, mobile home parks, and Shoreline Substantial developments provide retention/detention facilities for stormwater originating onsite. The ordinance requires that stormwater from a 5-year return interval storm be detained onsite and released at a rate that does not exceed the rate from the site before development. Runoff from smaller and larger storms may be discharged at higher rates. There is no provision for compensation of lost floodplain storage capacity. Thus, this regulation also allows development in the floodplain that has the potential to be subjected to flood hazards and increase flooding on other properties.

Although the drainage ordinance limit increases in peak rates of stormwater discharge, it does not limit the volume of water discharged from new development. In addition, the design criteria for stormwater detention facilities results in relatively short detention times; detention ponds fillup and drainout before the peak of a flood in a river system passes. The drainage ordinance applies only to large development projects. Small projects such as short plats and individual homes are not required to provide detention. Cumulatively, these small projects have a significant affect on downstream flows. This is due to removal of the forest, increased impervious surfaces, and the common practice of constructing ditches and connecting them to the County road ditches to "dry-out" sites. The drainage ditches greatly reduce groundwater storage of stormwater and speed the flow of stormwater to streams and the river. Thus, in the Samish River system, new development in the upper watershed will increase flooding in the lower river even with enforcement of the drainage ordinance.

The County is presently considering adoption of a new drainage ordinance that would increase the standards for onsite detention of stormwater.

Development of policies that would define floodplains as critical areas in Skagit County and provide protection of critical areas is presently under way pursuant to the requirements of the GMA. Identifying locations of floodplains, floodways, wetlands, and streambanks and limiting development in these areas would greatly alleviate flood hazards.

The State Environmental Policy Act (SEPA) requires agencies to identify the impacts of new development and allows the imposition of mitigating measures for those impacts. For example, under SEPA, new development can be conditioned to include mitigating measures that go beyond the local drainage ordinance if specific downstream impacts are identified. However, this requires significant additional analysis on a case by case basis and the jurisdictions must be aware of the potential impacts. There are numerous exemptions and thresholds that allow development projects to occur without mitigating measures, but the case-by-case approach allows inconsistency. Inconsistency is a problem for both the regulators and the developers. Regulators

need consistency to ensure that impacts are addressed and to ensure fairness. Developers need consistency to be able to make informed decisions about their investments.

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SECTION 6 FLOOD DAMAGE HISTORY

- Prior Flood Control Actions and Investigations
- Historic Events
- Current and Past Problem Areas
- Future Development Runoff Impacts

Section 6

FLOOD DAMAGE HISTORY

PRIOR FLOOD CONTROL ACTIONS/INVESTIGATIONS

When the Samish Valley was originally settled in the late 1800s, flooding likely occurred frequently and subsided quickly. Historic records suggest that in its natural condition the lower Samish River had up to six distributaries flowing from the vicinity of Old Highway 99 to Samish and Padilla Bays. According to longtime residents, the river was straightened and condensed into the existing primary channel in the late 1800s or early 1900s to improve the transport of logs down the river from the upper watershed area for collection in Samish Bay and rafting to sawmills on Puget Sound. Remainders of historic channels are evident in Joe Leary and Edison Sloughs as well as in several other flood paths and undulations in the valley floor that have been reclaimed for agricultural purposes.

Diking of the river generally began in the 1940s and 1950s as better road access was provided to the valley and more intensive farming began. According to longtime residents, the first dikes along the river were built by individual farmers as a means of protecting their fields from spring runoff and allowing them the opportunity to plant the fields earlier in the season. Through a program in existence at that time, the construction of the dikes was funded by a one-third partnership between the farmer, the county, and the state. As the dikes were built individually over a term of years, there was very little coordination on dike heights or construction standards. Between 1988 and 1990, the dikes from Farm to Market Road to 3,000 feet downstream of Chuckanut Drive were rebuilt to more consistent standards. This project was funded by the diking district with assistance from the County's River Improvement Fund. No additional new dike construction has occurred since 1990.

Frequent flooding in the lower Samish River results from inadequate channel and bridge crossing hydraulic capacity as compared to watershed runoff. The dikes along the reach of river downstream of the railroad bridge have been constructed directly on the river banks, with no setbacks or overbank capacity available. Channel capacity through this section of river is approximately equivalent to the 2-year frequency flood flow. Partial filling of historic overflow channels and elevated roadway sections (without culverts) also exacerbate upstream flooding problems by raising flood elevations. Additionally, there is a lack of adequate capacity to return out-of-bank flows back to the river, which leads to extended periods of standing floodwater (weeks to months) behind the roadways and dikes. Floodway regulations have not been defined for the lower river reach.

Historically, the Samish Valley has also been a distributary for flood flows from the Skagit River. Skagit River flood flows exceeding the 25-year frequency could potentially cross into the Samish Valley and lead to extensive flooding. Skagit River 100-year overflows to the Samish Valley have been estimated at approximately ten times the estimated 100-year Samish River-only discharge rate. Flood mapping by FEMA for the 100-year Skagit River overflow shows the entire Samish Valley area as being inundated from approximately the railroad alignment to Joe Leary Slough, as shown in Figure 6-1.

Numerous investigations have been prepared for the Samish/Skagit River basins by several different agencies. To date, no large-scale projects have been implemented on the Samish River from these previous studies. In most cases, potential floodplain benefits for projects could not justify federal funding support. This has contributed to a reduction in the residents' trust in local and federal agencies responsible for management of the floodplain. This plan will include smaller scale projects that will provide benefits and can be funded and implemented, in addition to consideration of those larger scale projects. A partial list of the previous major studies is included below.

- **Army Corps of Engineers** (COE)–Studies conducted by the COE have dealt primarily with flood control issues on the Skagit River. These reports were developed in 1925, 1933, 1937, 1952, 1965, 1967, and 1979 to address different aspects of Skagit River flooding.

- **Natural Resource Conservation Service** (NRCS) (formerly Soil Conservation Service [SCS])–This agency developed two reports on the Samish River in conjunction with the U.S. Forest Service. The first was a *Watershed Investigation Report* developed in 1968. The *Samish Study Team Report* was completed in 1985 and provided an outline of flood control alternatives for the Samish River. A third report, *Preauthorization Planning Report for the Samish River Watershed*, was developed independently by the SCS in 1988. This report studied the potential for the reduction of flood damage (primarily to croplands) from erosion and sediment deposition. Flooding of communities and homes was addressed as a secondary concern. The preauthorization report found that the amortized cost of flood control facilities would be less than the annual benefit received from the facilities; thus, no flood control projects were initiated by the SCS.

- **Federal Emergency Management Agency** (FEMA)–A Flood Insurance Rate Study for Skagit County was sponsored by FEMA in 1984 and revised in 1989. These studies established flood insurance rate zones for the unincorporated portions of the County and provided information to the County for floodplain management. The floodplain/floodway of the Lower Samish River (without Skagit River overflow) was not evaluated by conventional detailed study methods.

- **Western Washington University (WWU)**–In 1986 and 1987, a WWU team conducted a study of coliform bacteria levels in Padilla Bay as well as in the Samish River and Edison Slough.

- **Skagit County Planning Department**–The Planning Department has been working with a Watershed Management Committee since 1993 to develop a Watershed Action Plan. This plan is targeted at development and implementation of project policies to reduce nonpoint pollution and improve water quality of the Samish River and its watershed. The schedule calls for finalization of the plan in the second quarter of 1995; however, the final draft may be delayed beyond that date. To date, the Watershed Management Committee has prepared and distributed a *Watershed Characterization Report* (Skagit County, 1994) and other supporting information.

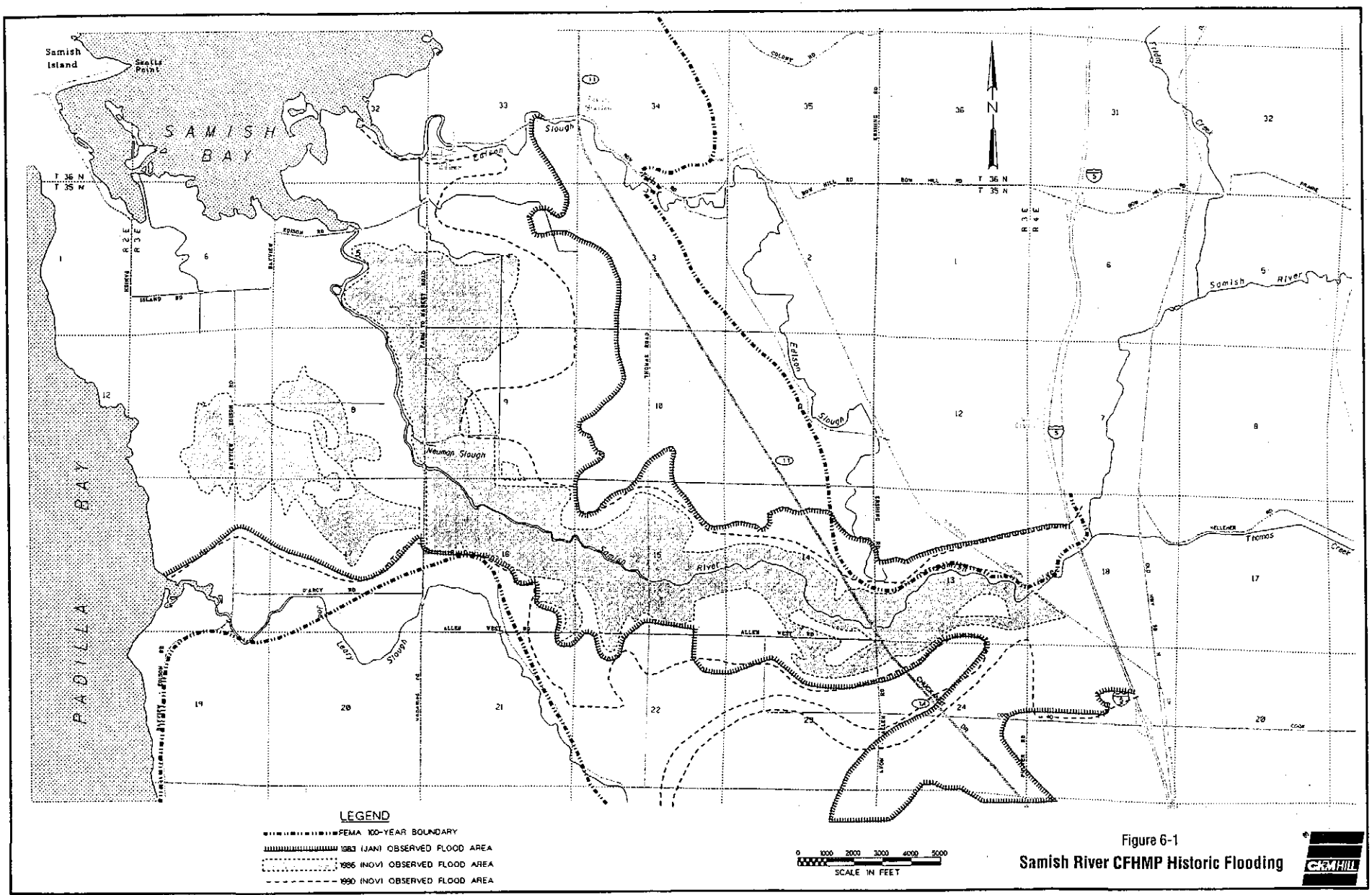

Figure 6-1
Samish River CFHMP Historic Flooding

HISTORIC EVENTS

Flooding of the Samish Valley has been an ongoing and frequent problem. Dikes along the lower river area, downstream of the railroad bridge, generally can contain less than the 2-year runoff event. Flooding of the area immediately behind the dikes is common on a yearly basis. Flooding on the river is directly related to rainfall because the watershed area is almost entirely below the typical snowpack elevation, thus negating the effect of spring snowmelt runoff.

Flows were recorded on the Samish River from July 1943 through 1983 by the U.S. Geological Survey (USGS) at a gaging station just downstream of the U.S. Highway 99 bridge near river mile 10.3. The USGS data provide information on daily mean flows at the gaging station from July 1943 through September 1971. Between 1971 and 1983 the USGS collected and recorded only peak flow data from this gage. This information provides a record of flood flows on the Samish River. When analyzed, this information defines the expected flood frequencies (annual exceedance probability) for a given flood flow based on watershed land use conditions over the period of record. Review of the information shows there were 16 events, covering 33 days, when the river flow exceeded 2,000 cubic feet per second (cfs) during the 28-year period of daily records. Additionally, during the 13 years of annual peak-flow gaging up to 1983, eight more events were recorded with peak flow above 2,000 cfs. Table 6-1 summarizes the occurrences and recorded maximum flows of flood-producing events over the period of gage record.

Table 6-1
Historic Flooding
Samish River Recorded Flows Exceeding 2,000 cfs

Date	Recorded Maximum Flow (cfs)	Date	Recorded Maximum Flow (cfs)	Date	Recorded Maximum Flow (cfs)	Date	Recorded Maximum Flow (cfs)
7-Jan-45	2,340	11-Feb-51	2,960	28-Jan-65	2,460	27-Jan-71	2,080
25-Oct-45	3,740	9-Dec-56	2,260	29-Jan-65	3,130	30-Jan-71	2,900
26-Oct-45	3,430	10-Dec-56	2,680	30-Jan-65	2,520	31-Jan-71	3,170
11-Dec-46	2,480	12-Nov-58	2,420	31-Jan-65	2,130	6-Mar-72	3,790
17-Feb-49	3,910	24-Jan-59	2,210	25-Dec-67	2,840	26-Dec-72	3,730
27-Dec-49	2,510	15-Dec-59	2,600	26-Dec-67	2,130	24-Jan-74	3,380
28-Dec-49	5,020	20-Feb-61	2,160	5-Jan-69	2,020	2-Dec-75	6,090
29-Dec-49	2,840	21-Feb-61	3,260	24-Jan-71	2,720	2-Dec-77	3,090
9-Feb-51	2,160	22-Feb-61	2,560	25-Jan-71	2,370	18-Dec-79	6,340
10-Feb-51	3,760	23-Feb-61	2,000	26-Jan-71	2,750	24-Jan-82	5,590
						10-Jan-83	8,440

Peak-runoff rates combined with runoff volumes determine the out-of-bank volumes that are produced by flooding events. The out-of-bank volume produced by an event determines the areal extent of flooding. In the *Preauthorization Planning Report for the Samish River Watershed* (1988), the SCS outlined the extent of flooding for two large events from aerial photography. Figure 6-1 includes the area of flooding from these historic events. A 1983 flood event, with peak runoff estimated at a 43-year return frequency, covered most of the valley with standing water. The 1986 event, estimated to be a 10-year return frequency, covered a somewhat smaller area of the valley.

Additionally, in November 1990, within a 2-week period, two large flood events occurred that left the valley inundated for an extended period of time. Gage readings are not available for this event as the gage has been out of service since 1983. Records from other nearby rivers show flood flow frequencies for the November 10 and 11 event in range of the 5- to 25-year recurrence flows and the November 24 and 25 event in the range of the 10- to 100-year recurrence frequency. Available aerial photographs from the 1990 event, taken after the fact, do not indicate the flooding extent (Figure 6-1) was as widespread as the 1983 event; however, longtime residents of the area recall the 1990 flooding as being the most significant and longest lasting in recent memory.

As mentioned earlier, flood flows from the Skagit River basin could cause a flooding hazard in the Samish Valley. Studies by FEMA have found that the Skagit River levee system in the vicinity of Mount Vernon and Burlington has the capacity to retain water levels for up to the 25-year return frequency flood event. Events of greater magnitude could disperse across the Skagit floodplain or cause levee overtopping and send large volumes of water to the northwest from the Mount Vernon/Burlington area into the Samish Valley. The anticipated 100-year Skagit River flood flow into the lower Samish River has been estimated at 86,000 cfs, compared to a 100-year Samish-only flow estimate of approximately 9,600 cfs. The last remembered occurrence of Skagit River overflow into the Samish Valley was in 1932 or 1933 (SCS, 1988). It is speculated that another Skagit River overflow into the Samish Valley was close to occurring during the November 24 and 25 1990, flood event; however, a Skagit River dike failed downstream of Mount Vernon on Fir Island, lowering the upstream water surface and preventing dike overtopping in the vicinity of Mount Vernon.

Figures 6-2 through 6-8 provide photo documentation of flooding on the lower Samish River after the November 1986 and November 1990 flood events. Residents report that floodwaters from the 1990 event took as long as 3 months to recede because of road fills blocking natural drainage paths and insufficient return channels to the river through the dikes east of Farm to Market Road. An approximately 3,000-acre area between Farm to Market Road and the sea dikes was inundated at depths reported up to 5 feet during the November 1990 event. Upstream overflows were partially conveyed to Joe Leary and Edison Sloughs. Large volumes of overflows were impounded behind (south of) Allen-West Road for an extended period. Damages from these events included flooding of structures and residences, root damage to berry canes, loss of cover soil, and damage to root crops.

Figure 6-2

Looking Southwest at Thomas Road Bridge and Samish River

November 1990

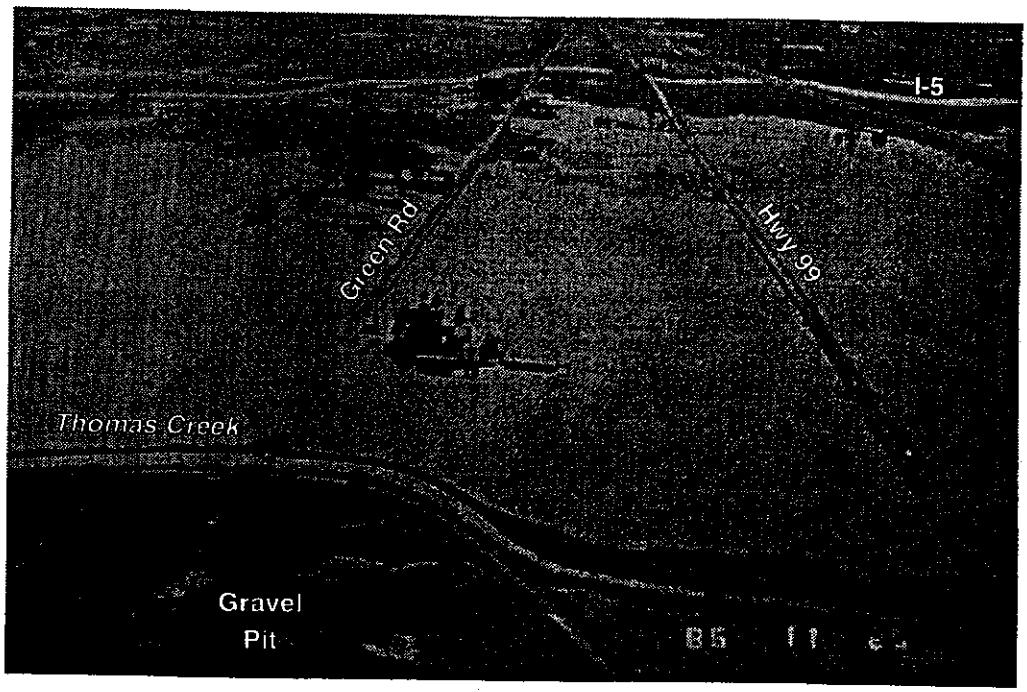

Figure 6-3

Looking South at Vicinity of Highway 99 and Thomas Creek

November 1986

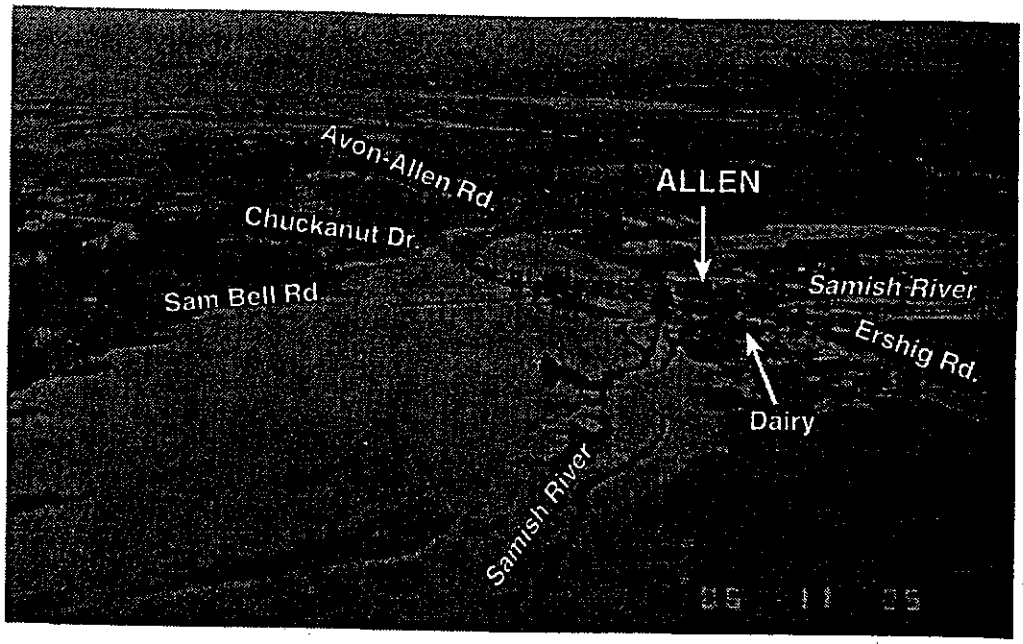

Figure 6-4
Looking Southwest at Community of Allen
November 1986

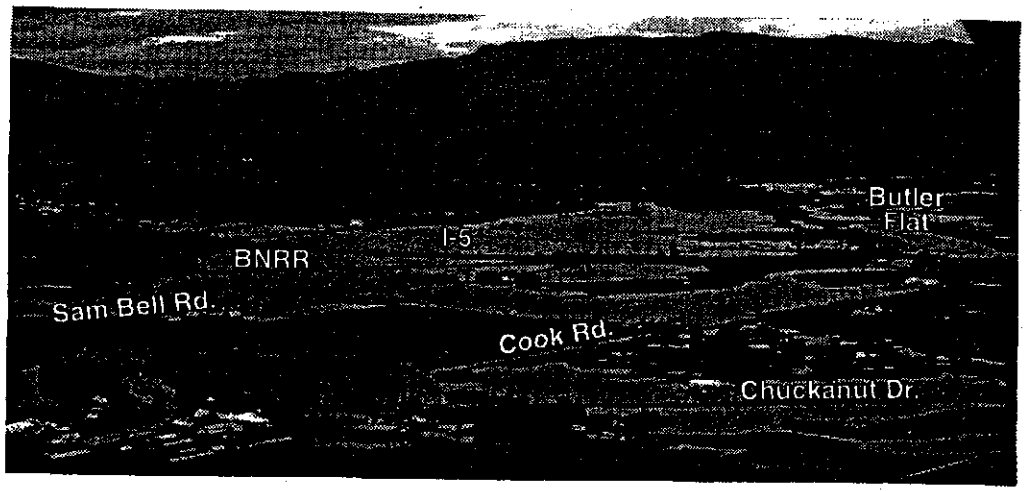

Figure 6-5
Looking Northeast at Vicinity of I-5 and Sam Bell Road
November 1990

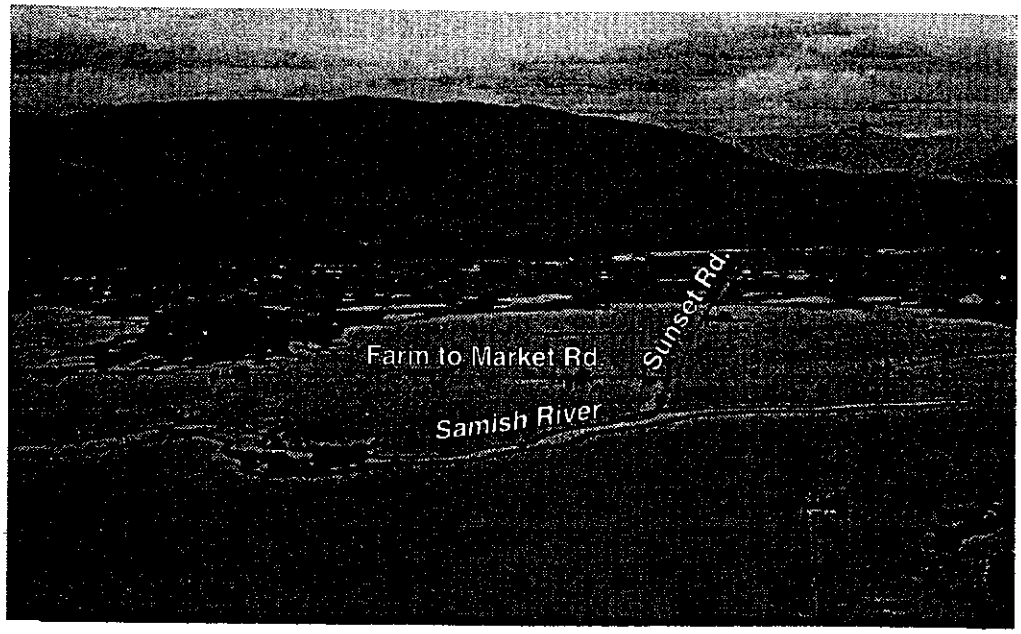

Figure 6-6

Looking East at Vicinity of Sunset Road and Market Road

November 1990

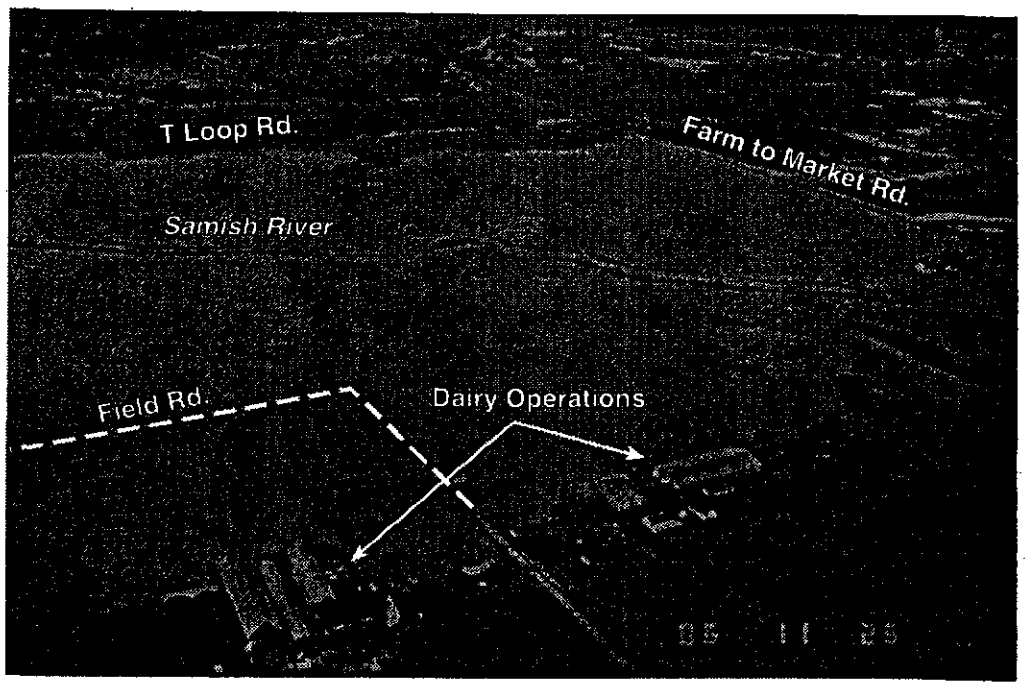

Figure 6-7

Looking South at Samish River Upstream of Farm to Market Road

November 1986

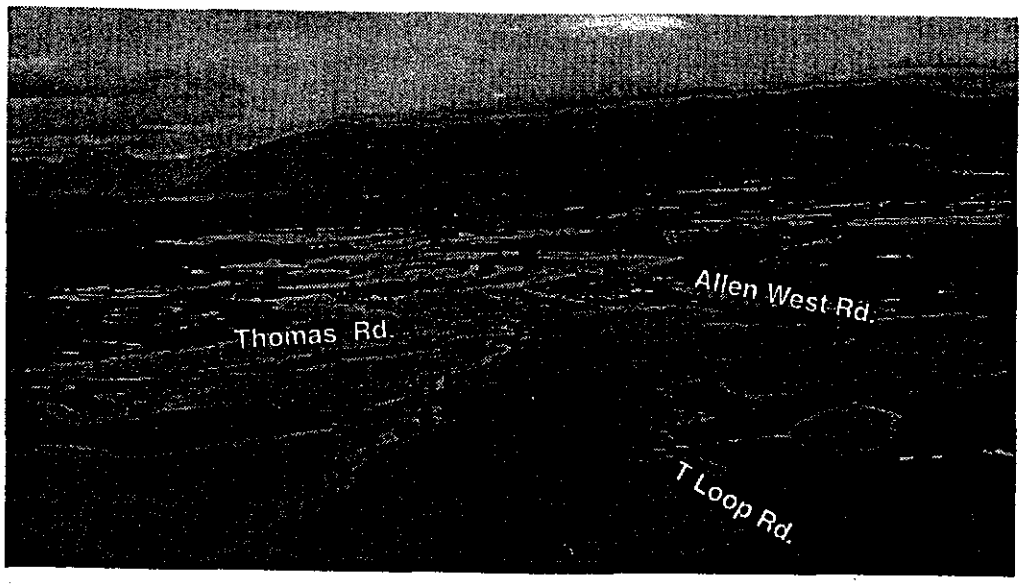

Figure 6-8

Looking East (Upstream) at Samish River Floodplain in Vicinity of Thomas Road

November 1990

CURRENT AND PAST PROBLEM AREAS

Flooding in the Samish Valley is relatively widespread. Particular problem areas are located just behind the dikes on both sides of the river between Farm to Market Road and Chuckanut Drive; the community of Allen, which is located in an overflow path; and the south side of Allen-West Road, which traps floodwaters that lead to extensive periods of flooding. Several of the diking and drainage (D/D) districts have provided input on flooding problem areas in the Samish floodplain area. Figure 6-9, which identifies problem areas, was developed based on comments from the D/D districts, information in the 1988 SCS report, and input solicited at the stakeholder meetings held for this project. Many of problem areas are associated with standing water either behind roadway fills or overtopping roadways, thus impeding traffic and creating a public safety hazard.

The number of structures located within the floodplain was tabulated using the flood boundary estimates for the 1983 Samish River flood area and typical Skagit River 100-year flood events. Overlays of these two flood boundaries were placed onto a recent aerial photo of the planning area, and the number of potentially affected structures within the boundaries was then projected. Because of local variations in topography, not all of the structures within the flood boundaries would be touched by floodwater; however, properties associated with such structures could still be damaged by floodwater. An estimate of the number of potentially affected residential structures and farm buildings is presented in Table 6-2.

Table 6-2
Structures Within Flood Boundaries

Area	Groups of Buildings	
	Farming	Residential
Samish River 1983 Observed Flood Area	32	80
Skagit River FEMA 100-Year Flood Boundary	67	138

FUTURE DEVELOPMENT RUNOFF IMPACTS

Prior to European settlement, most of the Samish Watershed was heavily forested, with the exception of fresh water and estuarine systems and some open wet meadows. Most of the watershed was logged between 1890 and 1940 and since then has been converted to agricultural and developed land uses or replanted for future logging. Estimated population growth within the Samish Watershed boundary is expected to grow by 4,600, or approximately 43 percent, from 1993 to 2014 (Skagit County, 1994). With the increase of population comes an increase in impervious area from buildings, roads, and lawns. Because impervious surface decreases the amount of precipitation that can percolate into the soil for storage and slow release and because impervious surface decreases the time of concentration, peak flows in the river could occur more often and be of greater magnitude as development increases. Runoff volume would also increase.

The current land use and cover are shown in Table 6-3. If the land were developed to meet build-out to current zoning regulations, the basin would lose approximately 28 percent of its current forested land and 13 percent of its current agricultural land. Although rural/low density residential land would increase by only 5 percent, medium- to high-density residential land would increase more than fivefold from 1,513 acres to 8,417 acres (an increase of 556 percent). Higher density residential land creates a significant increase in impervious land surface, including the need for more roads. Without proper control measures in place, problems associated with increased runoff flows and volume could result.

Table 6-3
Samish Watershed Land Cover/Land Use[a]

Land Cover/Type	1990 Land Use Acres (percent of total)	Current Zoning[b] Acres (percent of total)	Difference Acres (percent loss/gain from current)
Forest 0 - 10 years	9,138 (10.1)		
Forest 10 - 30 years	5,134 (5.7)		
Forest 30+ years	34,650 (38.4)		
Total Forest	**48,922 (54.2)**	**35,312 (39.1)**	**13,610 (-27.8)**
Agricultural	**20,022 (22.2)**	**17,370 (19.2)**	**2,652 (-13)**
Rural / Woodlot	12,882 (14.3)		
Rural/ open	4,484 (5.0)		
Residential Low Density	647 (0.7)		
Total Rural/Low Density	**18,013 (19.9)**	**22,620 (25)**	**4,607 (+20.4)**
Residential Medium Density	676 (0.7)	5,343 (5.9)	
Residential High Density	837 (0.9)	3,074 (3.4)	
Total Med + High Density	**1,513 (1.7)**	**8,417 (9.3)**	**6,904 (+556)**
Golf Course[c]	198 (0.2)	198 (0.2)	0 (0)
Interstate 5 Highway[c]	326 (0.4)	326 (0.4)	0 (0)
Freshwater lakes/ponds	987 (1.2)	798 (1.2)	0 (0)
Gravel Pit	354 (0.4)		
Rural Forestry Reserve		1,248 (1.4)	
Agricultural Reserve		2,562 (2.8)	
Other	3	1,825 (2)[d]	
TOTAL	**90,338 (100)**	**90,338 (100)**	

[a]Numbers are rounded from *Watershed Characterization Draft Report* (Skagit County, 1994).
[b]Most land use designations are expected to vary little with regard to growth management planning; therefore, change identified in column 4 is using a worst case scenario, such as that the land was developed to the maximum amount allowed by current zoning regulations.
[c]No change assumed.
[d]Zoning includes less than 2 percent public use and a very small amount commercial.

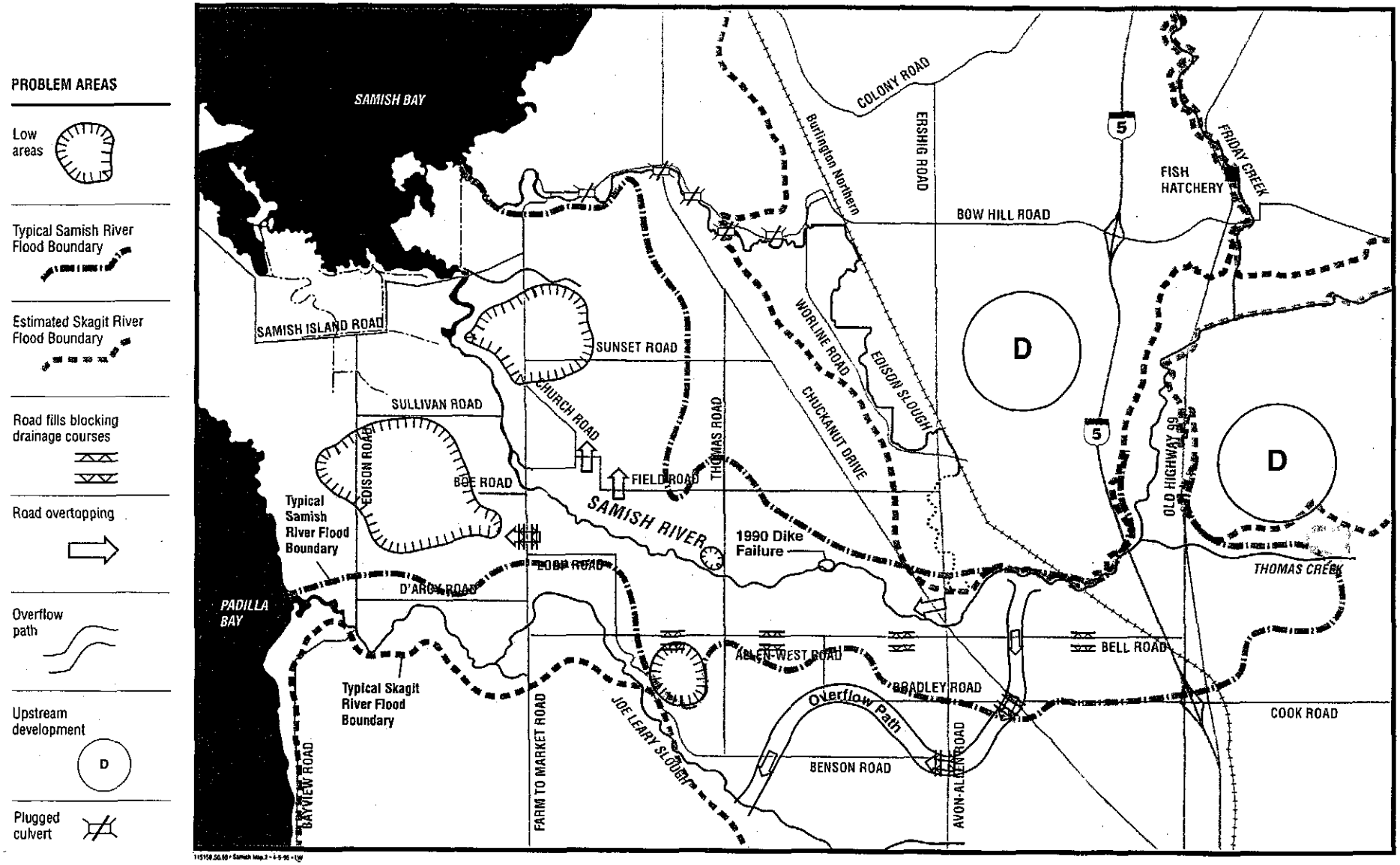

Figure 6-9
Problem Areas

Peak flow data for the Samish River from 1944 through 1983 were used in a Flood Frequency Analysis Model (FFA) developed by the U.S. Army Corps of Engineers to estimate the lower Samish River peak recurrence interval flows for various periods of record. Figure 6-10 shows the results of the FFA model and quantifies the recurrence intervals based on peak flows for 39 years of available data. The four data intervals analyzed are shown in Table 6-4.

Table 6-4
FFA Data Interval Characteristics

Time Interval	Number of Years	Total Average Annual Rainfall at Sedro Woolley (inches) (from available data)
1944 - 1983	39	47.14
1944 - 1958	14	47.43
1957 - 1971	14	48.45
1970 - 1983	13	45.54

The whole period of record (39 years) was analyzed to establish the average recurrence interval flows for cumulative watershed land cover conditions throughout the period. The data were then divided into three equal intervals to show if a trend in peak flows exists by time period. As shown in Figure 6-10, the 1957-1971 period has the lowest discharge compared to the other three data sets, while the 1970-1983 period shows the greatest discharge. There is no obvious chronological trend with these data because discharge for the 1957-1971 data fell below both the 1970-1983 and 1944-1958 periods. Without more specific watershed event precipitation data and information on land use characteristics, such as forest cover and impervious land area for each time period, it is difficult to draw conclusions from these results. In addition, because much of the land use changes prior to 1984 were primarily a result of logging and agricultural practices, streamflow data from 1984 to present would better assess the impacts of increased urbanization on streamflows in this basin.

An analysis of a basin of similar size and climatic characteristics that has undergone suburban development in the last 35 years provides an indication of potential impacts of suburban development on streamflow. A recent study of the Issaquah Creek basin (King County, 1991), which is of similar size and hydrologic character as the lower Samish River basin, quantifies the increase in runoff as resulting from the change in land cover/usage from forested land to current land use characteristics. Land-use cover is defined primarily by three major elements: forest, grass (pasture and residential clearing), and impervious surface. As forested land was replaced by grass and impervious surface, to its 1989 condition, Issaquah Creek experienced a 7 percent increase in its 2- through 100-year average peak flow. Future land-use conditions in the Issaquah Creek basin were derived from existing zoning and comprehensive land use plans for King County and the City of Issaquah. If the highest foreseeable level of development occurs, resulting in the highest potential runoff, results of the model show an increase in streamflow by 30 percent from forested to future land-use conditions if inadequate runoff control measures are taken. Figure 6-11 shows results of this study.

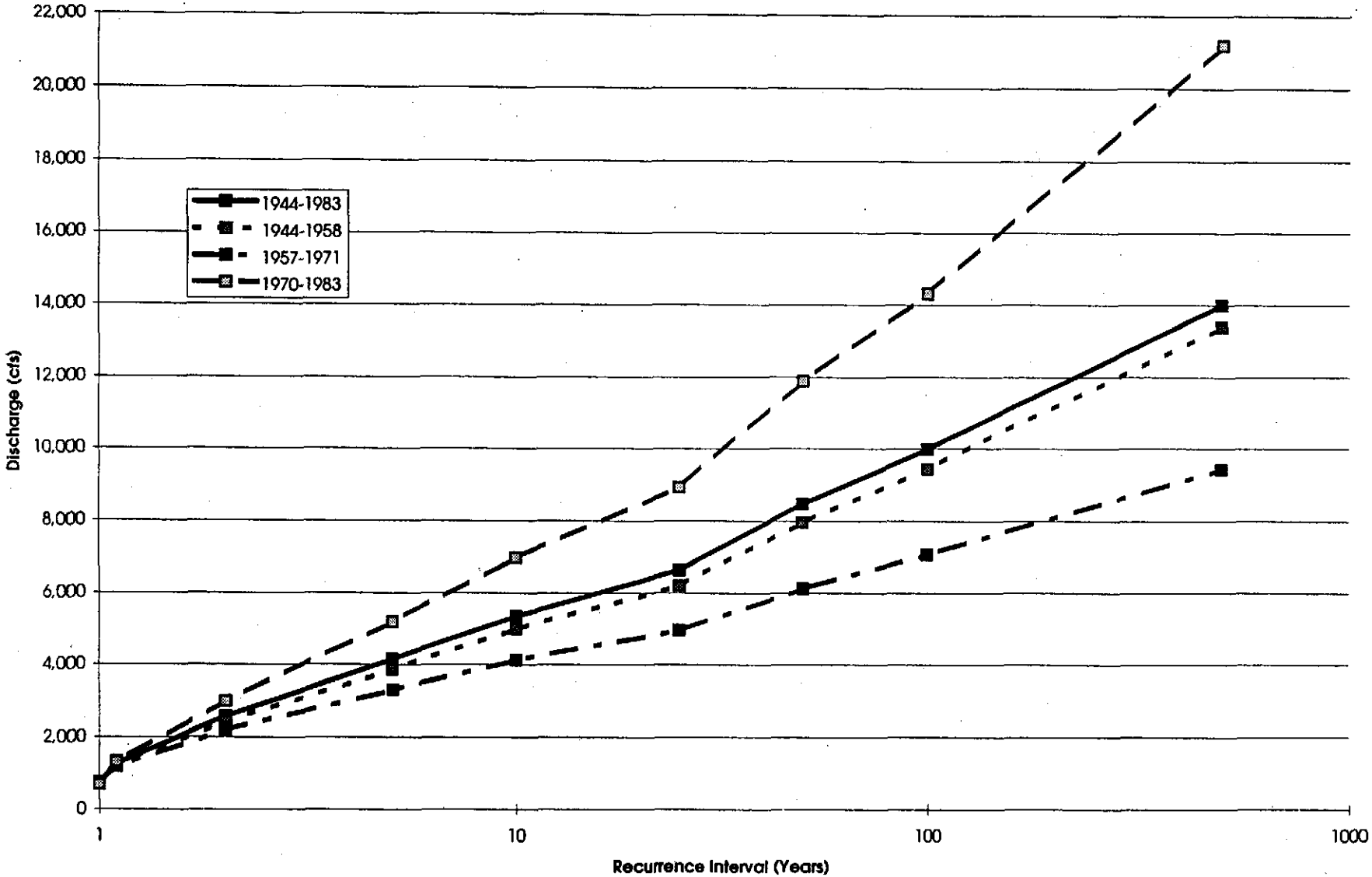

Figure 6-10

Event Recurrence Interval for Samish River Peak Flows 1944-1983

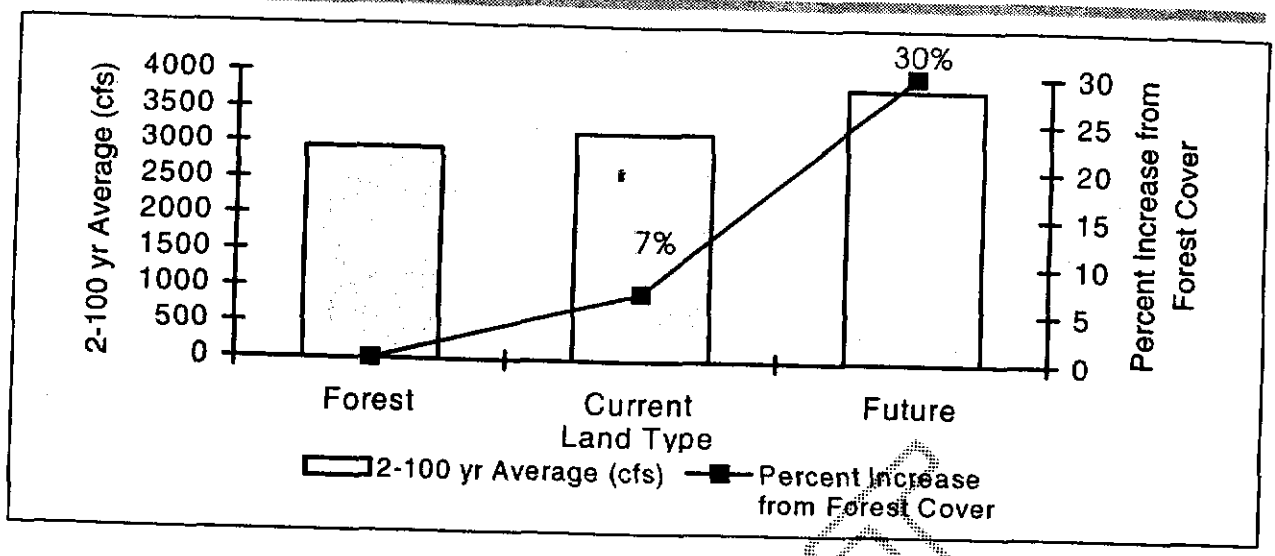

Figure 6-11
Issaquah Creek Changes in Flow Frequency

Based on the Issaquah Creek flow frequency analysis, it appears that further development within the Samish River watershed, without runoff control, would lead to higher flood flow rates and volumes. If no additional river capacity or runoff controls are provided, the frequency and severity of field and structure flooding will likely increase. Runoff control and zoning regulations and/or setback levees along the river channel could reduce these impacts.

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SECTION 7

ALTERNATIVE FLOOD HAZARD MANAGEMENT MEASURES

- Structural Projects
- Non-Structural Projects
- Environmental Impacts

- Implementation and Duration Benefits
- Conformance with Goals and Objectives

Section 7

ALTERNATIVE FLOOD HAZARD MANAGEMENT MEASURES

This section presents alternative projects that have been developed to address flood hazard management in the lower Samish River basin. A three-phase process was used to develop the alternatives. First, historical documents outlining previous flood control studies were reviewed. Documents included *the Preauthorization Planning Report for the Samish River Watershed* (SCS, 1988) report, which discussed projects to maintain and improve agricultural productivity, and several project outlines submitted by the various diking/drainage districts to address recurring problems. Interviews were then conducted with affected property owners and district commissioners to establish the scope of the problems and possible solutions that would address their concerns. Finally, the generation of this plan included the consolidation of all the previously proposed alternative projects and their further refinement into comprehensive and specific capital improvement project proposals. These alternative projects have been developed through a combination of efforts by the consultant, Skagit County staff, and input from the stakeholder committee. Alternative projects are categorized as structural or nonstructural.

STRUCTURAL PROJECTS

Structural projects for this plan refer to projects that enhance the flow of water through the river corridor or the return of floodwater to the river channel. Two phases of structural alternative projects were developed addressing different levels of detail. The first phase included compilation and review of all localized "spot" projects suggested for the Samish River floodplain downstream of I-5. This list included projects suggested by the SCS, the diking and drainage districts, and the consultant. These spot projects were then developed into preliminary capital improvement project (capital project) proposals to address floodplain management. Two stakeholder meetings were held to review the merits of the initially compiled list of spot projects and rank them based on a predetermined evaluation matrix. At these meetings, the stakeholders gave recommendations to accept, reject, or modify the various spot project proposals. These projects are further discussed and presented in Tables 7-1 and 7-2.

The second phase of alternative project development resulted from the stakeholder committee recommendations. The consultant modified and further developed the original spot project proposals to address the concerns of the stakeholders as well as key issues within the basin. A preliminary set of capital project proposals, which would provide more comprehensive solutions to the problems within the basin, was developed from the spot projects. These preliminary capital project proposals were developed to a level of detail so that initial concepts on their location, size, and cost of implementation could be provided. Locations of and outlines for these projects are documented later in this section.

Table 7-1
Localized Spot Project Descriptions

Project No.	Type	Location	Description/Comment
SCS 1988 Recommendations			
S-1	Channel	District 5, west bank of river	Reinforce and raise dikes in four low areas ***(completed by Dike 5)***
S-2	Channel	District 25, Farm to Market Road to Chuckanut Dr	Modify height and/or slope on 10,000 feet of existing dikes on north and south sides of river ***(completed by Dike 25, 1986 - 1990)***
S-4a	Overflow	Edison pump station	Install additional pump to raise station capacity ***(completed by Drainage Dist 16)***
S-4b	Overflow	West end of Sunset Rd	Install large-capacity return flow pump station and associated ditches to drain vicinity of Sunset and Farm to Market Roads
S-5	Overflow	West of RR bridge	Construct farm-over dike to direct floodwater from south floodplain back to the river through a vegetated waterway
S-6	Channel	South bank between RR bridge and Chuckanut Dr	Construct 5,000 feet of new dike and floodway on south side of river
Drainage/Diking District Proposed Projects			
D-1	Overflow	Allen-West Road	Install four 24"-30" culverts under the road to return trapped floodwater from the south side of Allen-West Road back to river
D-2	Overflow	South bank between Farm to Market Rd and Chuckanut Dr	Excavate four floodwater return channels to the river; install 36" to 48" culvert with flood gates under the dike at each discharge

Table 7-1
Localized Spot Project Descriptions

Project No.	Type	Location	Description/Comment
D-3	Overflow	Farm to Market Rd south of Samish River bridge	Lower roadway or install culverts to equalize floodwater surface elevation across Farm to Market Rd on south side of river
D-4	Overflow	North dike between Farm to Market Rd and Chuckanut Dr	Repair/replace/upgrade return culverts and flood gates
D-5	Overflow	Allen-West Road east of Joe Leary Slough	Enlarge 3,000 feet of existing 15-inch diameter on south side of road draining to Joe Leary Slough
D-6	Overflow	Various locations in District 5	Install additional outfalls to Samish Bay and River; include a base flow pump at each outfall to prevent sedimentation of discharge channels and clogging of flood gates
D-8	Overflow	South side of river, upstream of Farm to Market Rd	Install floodwater return pump station on south bank immediately upstream of Farm to Market Rd; construct approximately 1,000 ft of collection ditch at toe of dike
Consultant's Preliminary Solutions			
C-1	Overflow	Farm to Market Road between Joe Leary Slough and Samish River	Construct diversion channel from proposed culverts under Farm to Market Road to Joe Leary Slough to drain floodwater held behind road; improve slough to handle additional flow including possible installation of automated gates at the intake on Farm to Market Road and additional flood gates or pumps at the discharge to the bay
C-2	Channel	Chuckanut Dr bridge	Install an 8- to 9-ft-diameter culvert on north side of bridge abutment in conjunction with downstream channel improvements

Table 7-1
Localized Spot Project Descriptions

Project No.	Type	Location	Description/Comment
C-4	Overflow	Sea dike–District 5	Install several new flood gates through the sea dike to allow faster discharge of floodwater held behind existing dike system ***(previously proposed by District 5)***
C-5	Overflow	Downstream of Farm to Market Rd	Construct a diversion dike on the west side of Farm to Market Rd to capture overflows from south side of river; route diversion waters to a setback dike and floodway along the south side of the river from Farm to Market Rd to Samish Bay
C-6	Overflow	Various flood paths	Install culverts under road fills blocking natural flood paths to reduce ponding depths and durations and road overtoppings by floodwaters.
C-7	Channel	Edison Slough	Improve channel capacity to provide even capacity throughout system; install additional culverts at road crossings where necessary to provide capacity; improve constricted portions of existing channel
C-10	Channel	River channel, from mouth to I-5	Construct setback dikes along river corridor; use existing dikes where possible to provide 300 ft (+/-) wide floodway corridor; upgrade flow capacity at four to five bridge crossings; excavate high flow bypass channels/ dikes as required

Localized Spot Projects

Based on information from the 1988 SCS report, input from the drainage and diking districts, and recommendations from the consultant, several spot projects were developed to address flood prevention and, more specifically, floodwater return systems. These suggested projects both highlight specific problem areas and suggest possible solutions to address specific sites. Generally, the spot projects presented in this section have been developed to address these specific problem sites and thus have not been developed in terms of comprehensive solutions. Figure 7-1 identifies the location, and Table 7-1 provides a description of the proposed spot projects. Graphical summaries of each of these projects, as presented to the stakeholders, are included in Appendix F.

In a group forum, the stakeholders reviewed these projects and ranked them in terms of benefit and practicality. Table 7-2 gives a summary of the spot project rankings as developed at the stakeholder meetings. Review of these projects at the stakeholder meetings was generally limited to a consensus rating of each project based on subjective analysis of the net benefits versus the anticipated costs and construction feasibility. The committee members identified which projects from the initial list would provide a tangible benefit and should be further evaluated by the consultant. Several projects were also identified that did not appear to have significant benefits or would be impracticable to construct and were thus dropped from further consideration.

The ratings developed during these meetings were used to identify projects deemed worthy of further consideration in terms of a capital project proposal recommendation. Projects in bold type in Table 7-2 were recommended for further development by the stakeholder committee at a project review meeting.

Table 7-2
Localized Spot Project Rankings

Project	Rating	Project	Rating
Project S-4b (Sunset Rd Pump Station)	1	**Project C-1 (Joe Leary Slough diversion and improvements)**	**2**
Project S-5 (Farm-over dike)	1	**Project C-5 (Diversion/setback dike)**	**2**
Project D-1 (Culverts under Allen-West Rd)	**3**	**Project C-6 (Flood path road culverts)**	**3**
Project D-2 (Overflow return culverts)	**3**	Project S-6 (Construct new dikes east of Chuckanut Dr)	2
Project D-3 (Lower Farm-Market Rd)	2	**Project C-2 (Improve Chuckanut Dr bridge capacity)**	**3**
Project D-4 (Upgrade N side return culverts/flaps)	**2**	**Project C-7 (Improve Edison Slough)**	**3**
Project D-5 (Tile to Joe Leary Slough)	**3**	**Project C-10 (Setback dikes)**	**2**
Project D-6 (Additional outlets to bay)	**3**		

Note: Projects in **bold type** recommended for development as preliminary capital projects.

Capital Improvement Projects

Based on the stakeholders' recommendations, the highlighted projects in Table 7-2 have been developed into more comprehensive capital project proposals to address problem areas in the floodplain. Several of the projects have been modified to better address the issues of concern, and some have been combined to provide a more integrated solution for certain sites. Figure 7-2 identifies the project locations, and Table 7-3 describes the preliminary capital projects developed as a result of these recommendations.

Each of the proposed capital projects has been developed to a preliminary level so as to establish its benefits and implementation feasibility. Summary graphic sheets for each of the projects identified in Table 7-3 are included in Appendix F. Each graphic sheet identifies the issues and concerns being addressed, outlines and depicts a preliminary solution, identifies the benefits and potential permits and funding sources, and provides a preliminary opinion of implementation costs for the project.

An evaluation and ranking matrix, presented in Table 7-4, was also developed for the proposed capital projects in order to help define which projects should be refined and submitted as a recommended capital project proposal. The alternative projects are grouped into two categories: overflow return and channel/dike improvements. A rating of Low, Medium, or High was assigned to each category of criteria. These ratings were translated into a total project ranking by evaluating the results from each category. Table F-1 in Appendix F presents the more detailed number ranking system from which the rankings in Table 7-4 were derived.

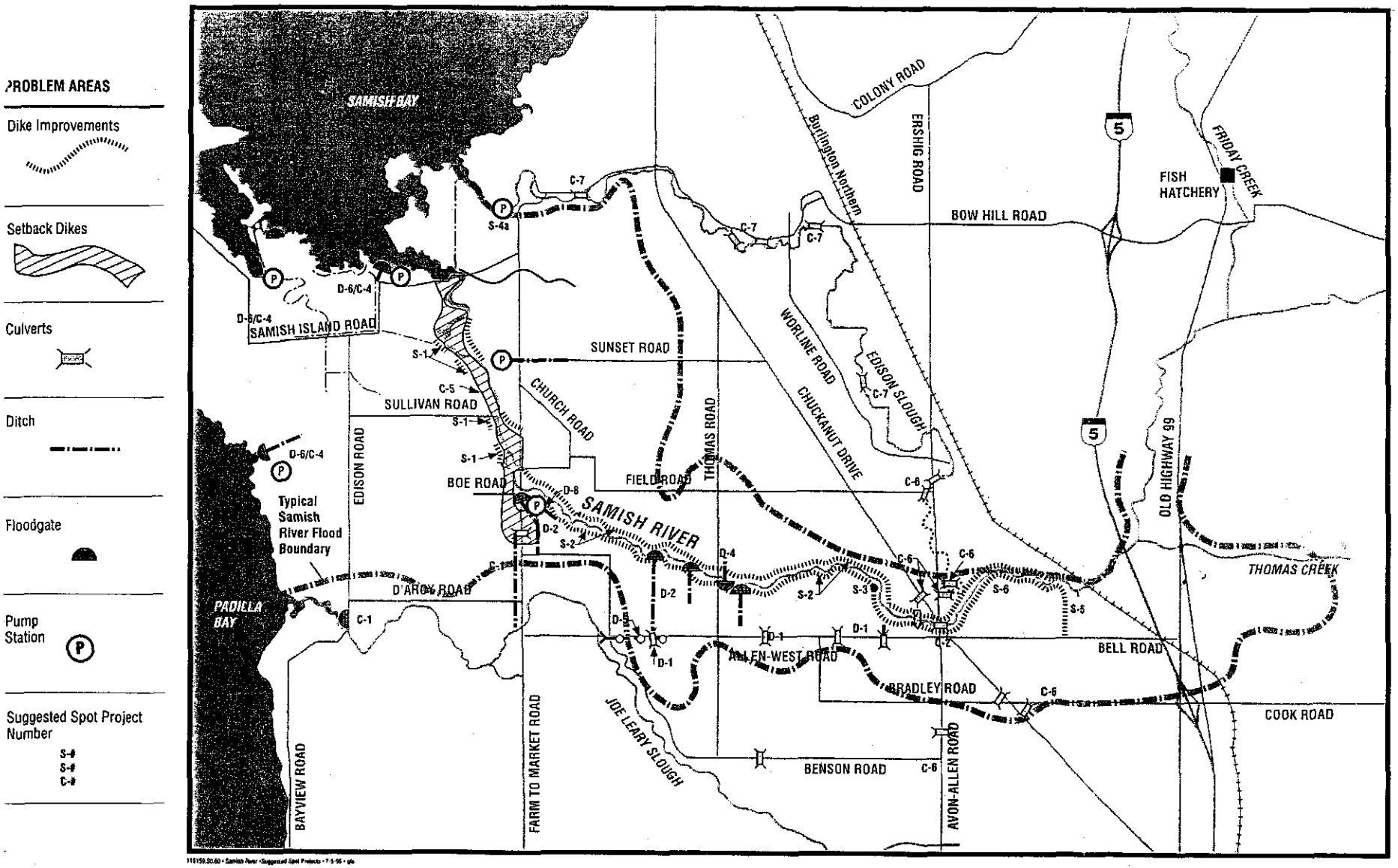
It is also noted in Table 7-4 whether there is consensus for each project among the stakeholders. As this planning process has endeavored to develop a cooperative atmosphere for floodplain management, group consensus has emerged as one of the most important rating categories to establish which capital projects should be considered for further development in the recommended plan.

NONSTRUCTURAL PROJECTS

Nonstructural projects outlined in this plan refer to projects that maintain existing facilities or protect them from further damage from floodwater. Two types of nonstructural projects are presented below. Maintenance projects primarily address dike maintenance while the proposed management actions address regulatory controls and protection of agricultural and residential structures.

Maintenance Projects

The drainage and diking districts have responsibility for maintaining the flood control structures within the lower Samish floodplain area. The districts develop annual plans for specific maintenance needs and are responsible for implementation of these measures. Funding comes from two primary sources, including the annual revenue income to the districts based on fees levied against property owners within the districts and river improvement funds administered by the County, which provides a one-to-one match to the levied revenues.



7-7

Figure 7-1
Suggested Spot Projects

Table 7-3
Preliminary Capital Improvement Project Descriptions

Project No.	Type	Location/Description/Estimated Cost	Issue/Proposal
Capital Project-1 Alternative A (Projects D-1 and D-2 modified)	Overflow	Allen-West Rd west of Thomas Rd (cross culverts with ditch to river) Implementation (typical for all) **Estimated Cost: $200,000**	**Issue**: Floodwater is trapped by Allen-West Rd. ***Proposal***: Construct floodwater collection ditch on south side of Allen-West Rd. Route ditch to a set of roadway culverts. Excavate a ditch through the field from the road to the river dike. Install a return culvert with flap gate through the dike.
Capital Project-1 Alternative B (Projects D-1 and D-2 modified)	Overflow	As above (cross culverts with closed pipe to river) **Estimated Cost: $850,000**	**Issue**: As noted above. **Proposal**: Construct collection ditch and roadway culverts as above. Install a closed and buried pipeline from the roadway to the river with a gated discharge. Include a gated discharge box to allow field drainage into river outfall at low river stages.
Capital Project-1 Alternative C (Project D-5)	Overflow	As above (enlarge drain to Joe Leary slough) **Estimated Cost: $770,000**	**Issue**: As noted above. **Proposal**: Route floodwater trapped on south side of Allen-West Rd to Joe Leary Slough. Replace existing 15-inch-diameter drain with 30-inch drain and multiple inlet structures fitted with trash racks.
Capital Project-2 Alternative A (Projects D-1 and D-2 modified)	Overflow	Allen-West Rd east of Thomas Rd. (cross culverts with ditch to river) **Estimated Cost: $310,000**	**Issue**: Floodwater is trapped by Allen-West Rd. **Proposal**: Construct floodwater collection ditch on south side of Allen-West Rd. Route ditch to a set of roadway culverts. Excavate a ditch through the field from the road to the river dike. Install a return culvert with flap gate through the dike.

Table 7-3
Preliminary Capital Improvement Project Descriptions

Project No.	Type	Location/Description/Estimated Cost	Issue/Proposal
Capital Project-2 Alternative B (Projects D-1 and D-2 modified)	Overflow	As above (cross culverts with closed pipe to river) **Estimated Cost: $990,000**	**Issue**: As noted above. **Proposal**: Construct collection ditch and roadway culverts as above. Install a closed and buried pipeline from the roadway to the river with a gated discharge. Include a gated discharge box to allow field drainage into river outfall at low river stages.
Capital Project-3 (Project D-4)	Overflow	North dike, Farm to Market Rd to Chuckanut Dr (upgrade return culverts and flood gates) **Estimated Cost: $270,000**	**Issue**: Existing return culverts through dike have insufficient capacity. **Proposal**: Install additional return culverts with gated discharge through dike. Repair/replace existing return culverts as required.
Capital Project-4 (Project C-6)	Overflow	Various flood paths **Estimated Cost: $370,000**	**Issue**: Roadway fills block natural floodways. **Proposal**: Install culverts under road fills blocking natural floodways to pass floodwater flows. Stabilize fill slopes to prevent washouts during overtopping events.
Capital Project-5 Alternative A (Project C-1 modified)	Overflow	Farm to Market Rd south of river (overflow return pipe to Joe Leary Slough) **Estimated Cost: $490,000**	**Issue**: Insufficient capacity to drain floodwater trapped on field south of river. **Proposal**: Install floodwater return channel/pipe along Farm to Market Rd from south side of river discharging to Joe Leary Slough. Install a pump station at the outlet of slough to match the diversion system capacity. Remove constrictions in slough capacity downstream of Farm to Market Rd.
Capital Project-5 Alternative B (Project D-8)	Overflow	As above (overflow return pump to river) **Estimated Cost: $200,000**	**Issue**: As noted Above. **Proposal**: Install a floodwater return pump station (5,000 to 10,000 gpm) discharging to the river, on the south river bank upstream of Farm to Market Rd.

Table 7-3 Preliminary Capital Improvement Project Descriptions			
Project No.	**Type**	**Location/Description/Estimated Cost**	**Issue/Proposal**
			Pump would provide additional drainage capacity during high river/tide conditions, reducing the length of field flooding.
Capital Project-5 Alternative C (Projects C-5 and D-3 combined)	Overflow	As above (overflow return channel to river) **Estimated Cost: $1,010,000**	**Issue**: As noted above. Additional concern with flood-water overtopping road embankment, washing out road, and flooding an additional 2,700 acres to west. **Proposal**: Install a diversion dike/channel west of Farm to Market Rd to route floodwater back to river channel. Lower roadway and/or install culverts under roadway fill section. This alternative requires construction of Capital Project-Phase 1 (setback dikes) prior to implementation.
Capital Project-6 (Project D-6)	Overflow	Various locations in District 5 (District 5 outfalls) **Estimated Cost: $980,000**	**Issue**: Insufficient interior drainage capacity. **Proposal**: Install additional outfalls to Samish Bay and River. Include a base flow pump at each outfall to prevent sedimentation of discharge channels and clogging of flood gates.
Capital Project-7 (Project C-7)	Channel	Edison Slough (improve capacity) (Proposal previously developed by Skagit County) **Estimated Cost: $540,000**	**Issue**: Roadway fills and field grading have blocked/constricted the historic floodway. **Proposal**: Improve channel to provide even capacity throughout system. Install additional culverts at road crossings where necessary to provide capacity. Improve/widen constricted portions of existing channel.
Capital Project-8 (Project C-2 modified)	Channel	Chuckanut Dr bridge (enhance channel capacity) **Estimated Cost: $950,000**	**Issue**: Bridge and downstream river section are constrictions in river capacity. **Proposal**: Extend dikes from Chuckanut Dr 3,000 ft west to existing dikes. Construct bypass channel/dikes

Table 7-3
Preliminary Capital Improvement Project Descriptions

Project No.	Type	Location/Description/Estimated Cost	Issue/Proposal
			through fields north of Chuckanut bridge.
Capital Project-9 (Project C-10)	Channel	River channel, from mouth to I-5 (setback dikes) **Estimated Cost: ~~$9~~ 140,000**	**Issue**: Capacity of existing channel/dikes is limited to the 2- to 5-year return event flow. **Proposal**: Construct setback dikes along river corridor. Use existing dikes where possible and provide 300-ft (+/-) wide floodway corridor. Upgrade flow capacity at four to five bridge crossings. Excavate high flow bypass channels/dikes as required.

Table 7-4
Proposed Capital Improvement Projects Alternative Evaluation Criteria

Ranking Criteria Categories	Overflow Return											Channel/Dike Improvements		
	CIP-1 Alternative A (Projects D-1 & D-2 modified) Open ditches from Allen-West Rd to River west of Thomas Rd.	CIP-1 Alternative B (Projects D-1 & D-2 modified) Pipeline from Allen-West Rd to River west of Thomas Rd.	CIP-1 Alternative C (Project D-5) Pipeline to Leary slough along Allen-West Rd	CIP-2 Alternative A (Projects D-1 & D-2 modified) Open ditches from Allen-West Rd to River east of Thomas Rd.	CIP-2 Alternative B (Projects D-1 & D-2 modified) Pipeline from Allen-West Rd to River east of Thomas Rd.	CIP-3 (Project D-4) upgrade northside return culverts	CIP-4 (Project C-6) Flood path roadway culverts	CIP-5 Alternative A (Project C-1 modified) Diversion to Joe Leary slough	CIP-5 Alternative B (Project D-8) Pump station at Farm-Market Rd.	CIP-5 Alternative C (Project C-5 & D-3 combined) Diversion dikes/channel west of Farm-Market Rd.	CIP-6 (Project D-6) District 5 outfalls	CIP-7 (Project C-7) Edison Slough improvements	CIP-8 (Project C-2 modified) Chuckanut Dr. bypass channel	CIP-9 (Project C-10) Setback Dikes, Bypass Channels, Road Crossings
Public Safety and Health Protection	High	High	High	High	High	Medium	High	Medium	Low	High	Medium	High	High	High
Improved Flood Warning														
Improved Emergency Access														
Reduced Road/ Structure Flooding														
Flood Hazard Reduction Benefit	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	High	Medium	Medium	High	High
Flooding Frequency/ Duration														
Flood-Prone Area Reduction														
Frequent Flood Damage Reduction														
Environmental/Socioeconomic Benefit	High	High	Medium	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High	High
Water Quality Protection														
Fish/Wildlife Enhancement														
Farm Preservation														
Implementation Feasibility	High	Medium	Medium	High	Medium	High	Medium	Low	High	Low	Medium	Medium	Low	Low
Facility Requirements														
Landowner Acceptance														
Funding Potential														
Permit/Legal Issues														
Project's Compatibility (with)	High	High	High	High	High	High	Medium	Medium	High	Medium	High	Medium	Medium	Medium
D/D District Plans														
County Programs/Ordinances														
State Regulations														
Total Project Ranking	High	High	Med	High	High	High	Med	Low	Low	Medium	Medium	Medium	Medium	Medium
*Estimated Implementation Cost	$ 200,000	$ 850,000	$ 770,000	$ 310,000	$ 990,000	$ 270,000	$ 370,000	$ 490,000	$ 200,000	$ 1,010,000	$ 980,000	$ 540,000	$ 950,000	$ 9,140,000
Group Consensus (Yes or No)	No	No	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes

*Costs for Design, Construction, Administration.

June 8, 1995, Stakeholder Meeting

Districts Represented: Dike/Drainage District 25, Diking District 5, Drainage District 16

Not in Attendance: Diking District 19, Drainage District 14

Typical maintenance projects include tasks such as repairing areas of river bank sloughing, dike stabilization, dike grading and topping, and vegetative management. Table 7-5 outlines several maintenance projects put forth by the districts for the 1995 construction season. These projects outline the typical yearly need for maintenance of the existing dikes along the Samish River corridor. While the location and type of projects may change on a yearly basis, the level of need presented below is typical for annual maintenance of the dikes. Appendix F includes summary sheets for each of these projects.

Table 7-5
Annual Maintenance Projects

Project Number	Type	Location	Description/Comment
S-3	Channel	River channel downstream of Allen-West Road	Remove point bars in several locations down to effective discharge water line
D-7	Channel	River dike at various locations in District 25	Repair bank erosion at several locations on south side dikes between Farm to Market Rd and Chuckanut Dr. Reshape bank and place riprap to repair erosion. Reestablish vegetation to prevent future erosion.
D-9	Channel	Western dikes downstream of Sullivan Rd	Repair and upgrade dikes on west side of river downstream of Sullivan Rd. Fill areas of settlement, and raise/upgrade old dikes to newly established grades.
C-8	Channel	North dike in Section 14 South dike in Section 16	Spot repair at two locations where existing dike is failing. Reshape bank, and install riprap and vegetative reinforcement.

Floodplain Management Actions

In addition to structural projects to aid in containment and return of floodwaters and maintenance projects to protect the investment in the current facilities, several additional floodplain management actions have also been identified. These actions focus on preventing damage to the floodplain and existing structures by modifying construction standards, developing new regulations, and implementing other management activities to reduce the threat of flood hazards. A list of these flood management alternatives is presented in Table 7-6.

Skagit County currently has very few regulations to control the type and location of land development within the Samish River floodplain. Part of the focus of this plan is to identify potential changes to the existing county zoning regulations in order to provide better control of development within the floodplain. An example of the result of inadequate zoning protection and floodplain management standards is the recent construction of two homes near the lower Samish River. An application by a developer for construction of two homes in the floodplain area adjacent to a historic flood path was challenged by the County. Ultimately, the construction of the houses was allowed to proceed because the current zoning regulations did not preclude home construction and the County has no floodway designations within the

Samish River basin. Shortly after construction of the houses, the river topped its banks and flooded the newly constructed homes. As a result, these homes are currently being elevated to prevent future damage.

Table 7-6
Floodplain Management Alternatives

Project Number	Type	Location	Description
C-3	Regulatory	Various overflow channels	Designate floodways and overflow channels. Develop regulations that allow no additional development in these areas.
C-9	Flood-proofing	Various frequently flooded facilities (approximately 16 locations)	Install ring dikes to protect commercial and farm facilities from inundation by floodwaters. (Approximately 16 building clusters affected)
C-11	Flood-proofing	Various locations	Elevate affected residential/commercial structures above base flood elevation. (Approximately 80 structures within the floodplain could be affected.)
C-12	Management	Lake Samish	Re-regulate Lake Samish to reduce flow out of lake and retain more water during storm events. Reconstruct outlet structure. Increase winter fluctuation in lake surface elevation.
C-13	Regulatory	Watershed	Develop and implement enhanced development runoff standards within the basin.
C-14	Mapping	Watershed	Complete detailed floodplain and floodway mapping. Develop detailed river model to establish 100-yr Samish River floodway and floodplain boundaries.

Nonstructural Project Rankings

In order to evaluate and rank the nonstructural projects, a rating matrix presented in Table 7-7 has been developed to give each project a comparative score and help guide development of these measures. Table F-2 in Appendix F presents the more detailed number ranking system from which the rankings in Table 7-7 were derived. To provide a consistent ranking method, the rating used here is the same format as used for the capital project projects presented in Table 7-4. Projects that received the highest rankings include dike leveling projects and ring dikes, and those with the lowest ranking include removing point bars and regulation of Lake Samish, which will do relatively little to reduce flood hazards. The regulatory actions are expected to have high benefits; however, anticipated resistance from landowners and developers led to attenuated overall rankings.

Table 7-7
Proposed Nonstructrual Alternative Project Evaluation Criteria

Ranking Criteria Categories	Proposed Drainage Improvement Project Alternatives Ranking									
	Maintenance Projects					Watershed Protection/ Floodplain Management				
	Project C-6 (flood path road culverts)	Project S-3 (remove point bars)	Project D-7 (repair bank erosion in Dist 25)	Project D-9 (upgrade west dikes D/S of Sullivan Rd)	Project C-8 (Spot repair in Sec. 14 and 16)	Project C-3 (floodway designations)	Project C-9 (ring dikes)	Project C-11 (elevate structures)	Project C-12 (Lake Samish reregulation)	Project C-13 (enhanced development runoff standards)
Public Safety and Health Protection	High	Low	Medium	Medium	Medium	Low	Low	Low	Low	Low
Improved Flood Warning										
Improved Emergency Access										
Reduced Road/Structure Flooding										
Flood Hazard Reduction Benefit	Medium	Low	Medium	Medium	Medium	Medium	High	High	Low	Medium
Flooding Frequency/Duration										
Flood-Prone Area Reduction										
Frequent Flood Damage Reduction										
Environmental/Socioeconomic Benefit	High	Low	Medium	Medium	Medium	Medium	High	Low	Medium	High
Water Quality Protection										
Fish/Wildlife Enhancement										
Farm Preservation										
Implementation Feasibility	High	High	High	High	High	Medium	Medium	Medium	Low	Medium
Facility Requirements										
Landowner Acceptance										
Funding Potential										
Permitting/Legal Issues										
Project's Compatibility with	High	Medium	Medium	High	Medium	High	Medium	Medium	Medium	High
Diking/Drainage District Plans										
County Programs/Ordinances										
State Regulations										
Total Project Ranking	**High**	**Low**	**Medium**	**High**	**High**	**Medium**	**High**	**Low**	**Low**	**Medium**
Group Consensus (Yes or No)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

ENVIRONMENTAL IMPACTS

Environmental impacts associated with the projects considered in this section would be as variable and diverse as the situations being addressed. The majority of the projects being considered in this plan propose construction of facilities primarily within farm fields and under existing county roads. Both of these types of sites are currently highly disturbed from their natural conditions; thus, additional impacts to natural systems would likely be very limited as long as reasonable construction precautions are implemented.

Generally, construction of new outfalls to the river, sloughs, and Samish and Padilla Bays and construction of setback levees adjacent to the river have the highest potential for impact to the natural environment. These issues must be addressed for each project through the environmental permitting process administered by the County, Ecology, and the Corps of Engineers and described in Section 3 and Appendix D of this plan. These permits could include:

- Grading permit (County)
- SEPA checklist (County)
- Shoreline substantial development permit (County)
- Hydraulic permit application (Department of Fish and Wildlife)
- Temporary water quality modification (Ecology)
- Water quality certification (Ecology)
- Section 10 approval (Army Corps of Engineers)
- Section 404 approval (Army Corps of Engineers)
- DNR easement (Department of Natural Resources)

Table 7-4 rates the anticipated environmental impacts from each of the preliminary capital project. High-ranking projects include those which prevent floodwaters from being contaminated by farm and dairy wastes and projects that propose habitat enhancement or restoration. Several projects also provide socioeconomic benefits by reducing crop losses resulting from flood events, thus preserving the farming community and maintaining profitability.

Nonstructural projects with low rankings in Table 7-7 provide no identifiable environmental benefits; however, this does not imply that these projects would create a negative environmental impact. Projects with high rankings include ring dikes around dairy facilities, which would reduce the volume of dairy waste contact with floodwaters. Projects with low rankings, such as elevating structures, would reduce losses to individuals but otherwise do not provide a general environmental improvement.

IMPLEMENTATION AND DURATION OF BENEFITS

The majority of the projects identified in the preliminary capital project list could be developed and implemented during a single construction season. These types of projects include roadway culverts, dike culverts, pumping stations, and return channels/pipes. Projects that might take longer to implement include those that require installation of structures at multiple locations and large projects such as setback levee construction, which may require several seasons to construct.

The other major obstacle to development and construction of projects is implementation costs that exceed available funding. As identified in Section 2, Recommended Flood Hazard Management Plan, the available funding support for the construction of flood control facilities is sufficient for only annual maintenance plus construction of two to three capital projects over a 6-year financing period.

The duration of benefits will vary with the type of facility constructed. Return channels and levees, if adequately maintained, could have an indefinite life span. Where pipelines are used for floodwater return, a 20- to 30-year benefit span could be expected for metal pipes while concrete pipes typically have a benefit span of 50 years or greater. Life expectancies of pumping stations vary with the element. Pumps are highly maintenance-intensive and could require replacement at 8- to 10-year intervals; ductile iron piping systems would have a life expectancy of greater than 50 years while the structure itself, if constructed of wood, may have a life of 20 to 40 years, depending on quality of finish materials.

CONFORMANCE WITH GOALS AND OBJECTIVES

The comprehensive goals and objectives outlined in Section 3 of this plan served as a basis from which to develop and evaluate the alternative projects outlined in this section. The objectives of Goal No. 2 (provide practical solutions to provide measurable reductions in flooding frequency and durations) guided the consultant in selecting the type and scope of alternative projects developed for this plan.

The ranking criteria categories presented in Tables 7-4 and 7-7 generally reflect the intent of the goals and objectives developed for this plan. The total ranking developed for each project reflects how well that project conformed with the stated goals and objectives. While most of the capital projects outlined in Table 7-4 provide equivalent levels of flood hazard reduction, those projects with the greater implementation feasibility generally rated highest in the overall ranking scores.

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SECTION 8 REFERENCES

Section 8
REFERENCES

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Soil Conservation Service. *Preauthorization Planning Report for the Samish River Watershed.* 1988.

Washington State Department of Ecology. *Comprehensive Planning for Flood Hazard Management.* August 1991.

Washington State Department of Ecology. *Stormwater Management Manual for the Puget Sound Basin.* February 1992.

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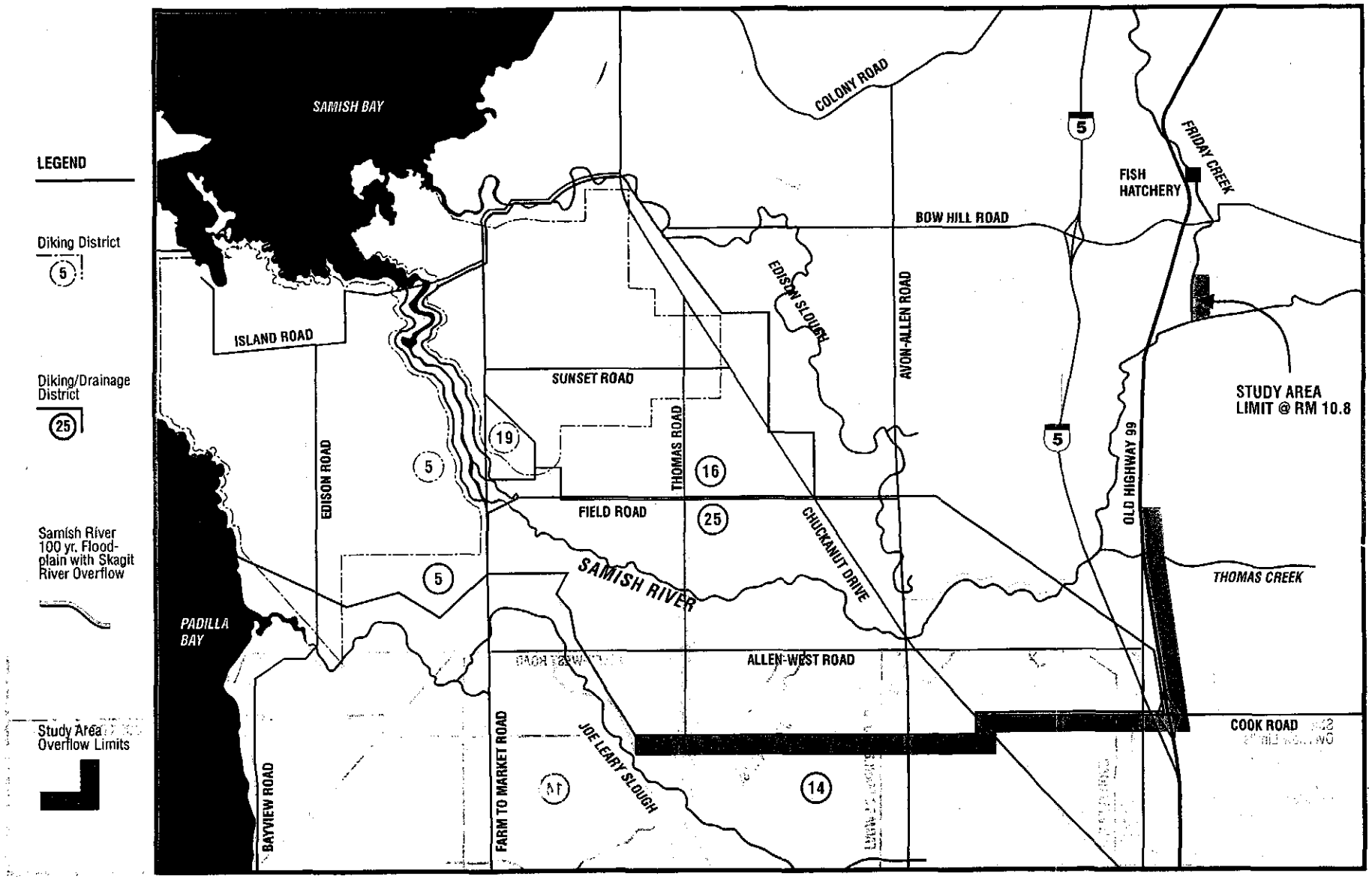

Figure 3-1
Study Area Lower Samish River Basin
Comprehensive Flood Hazard Management Plan

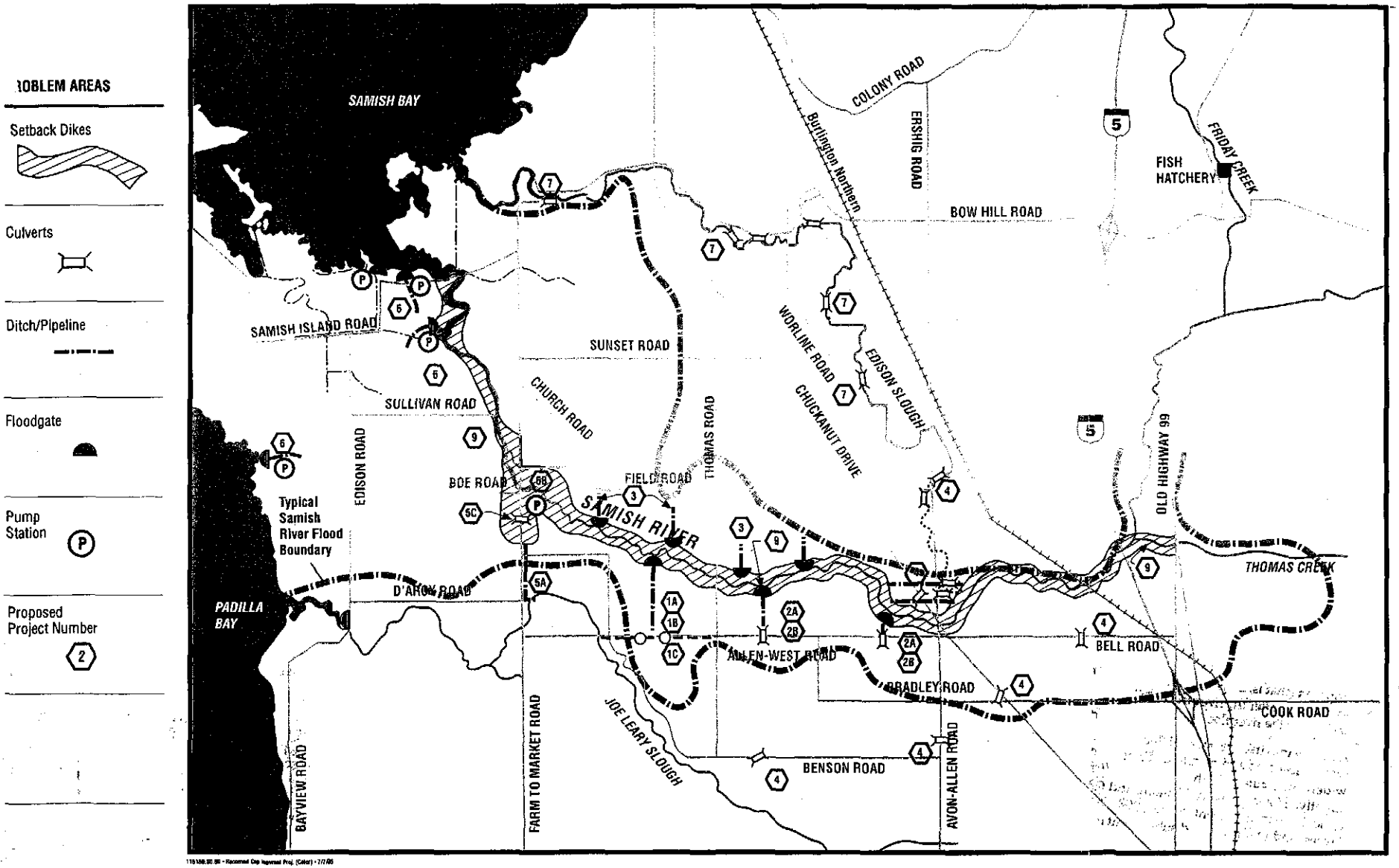

Figure 1
Recommended Capital Improvement Projects

DRAINAGE DISTRICT 19

Comments:

DRAINAGE DISTRICT 14

Comments:

DRAINAGE DISTRICT 6

Comments:

Appendix A

ESTIMATED IMPLEMENTATION COSTS

Project Name: Lower Samish River
Flood Hazard Management Plan

Task Description: Conceptual Plan Cost Estimate

Project Number: NPW 40238.A0.30

CH2MHILL

Creation Date: 6/7/95 By S. Wasson
Last Edited Date: 7/5/95 By S. Wasson

CIP-1, Alternative A (Open ditches from Allen-West Rd to River west of Thomas Rd.)

Item	Quantity	Units	Unit Cost	Total Cost	Comment
Culverts, 30" diameter x 50 LF, 4 ea.	200	LF	$ 85	$ 17,000	
Drainage Channel, Open Grass-Lined 4' bott. 3:1 side slopes, 4' deep	8300	CY	$ 5	$ 41,500	
Concrete Discharge Structures (Headwall) Concrete (Reinf)	25	CY	$ 600	$ 15,000	
Discharge Pipe, 48" diameter x 100'	100	LF	$ 147	$ 14,700	
48" Flap Gate (Tide Check Valve)	1	EA	$ 10,300	$ 10,300	
Gravel Aprons (1.5' thick)	275	CY	$ 30	$ 8,250	
Total Improvement Costs				$ 106,750	
Land Acquisition Costs	2.5	AC	$ 3,000	$ 7,500	

CIP-1, Alternative B (Pipeline from Allen-West Rd to River west of Thomas Rd.)

Item	Quantity	Units	Unit Cost	Total Cost	Comment
Culverts, 30" diameter x 50 LF, 4 ea.	200	LF	$ 85	$ 17,000	
Concrete Junction Structures Concrete (Reinf)	35	CY	$ 600	$ 21,000	
Grating and misc metals	1	LS	$ 2,100	$ 2,100	
Discharge Pipe, 48" diameter CPE/CMP	3500	LF	$ 115	$ 402,500	
48" Flap Gate (Tide Check Valve)	1	EA	$ 13,000	$ 13,000	
Concrete Discharge Structures Concrete (Reinf)	30	CY	$ 600	$ 18,000	
Grating and misc metals	1	LS	$ 1,800	$ 1,800	
Gravel Aprons (1' thick)	95	CY	$ 30	$ 2,850	
Total Improvement Costs				$ 478,250	
Land Acquisition Costs	1	AC	$ 3,000	$ 3,000	

CIP-1, Alternative C (Pipeline to Joe Leary slough along Allen-West Rd)

Item	Quantity	Units	Unit Cost	Total Cost	Comment
72 inch CB Type 2, 8 ft deep	7	EA	$ 4,000	$ 28,000	
Discharge Pipe, 36" diameter, 3000 LF	3000	LF, of pipe	$ 50	$ 150,000	From price list
Trench Excav	5100	CY	$ 2	$ 10,200	
Backfill, compacted native material	2700	CY	$ 5	$ 13,500	
Bedding	1800	CY	$ 25	$ 45,000	
36" Flap Gate (Tide Check Valve)	1	EA	$ 6,700	$ 6,700	Quote
Gravel Aprons (1.5' thick)	60	CY, of gravel	$ 30	$ 1,800	
Total Improvement Costs				$ 255,200	
Land Acquisition Costs	1.1	AC	$ 3,000	$ 3,300	

CIP-2, Alternative A (Open ditches from Allen-West Rd to River east of Thomas Rd.)

Item	Quantity	Units	Unit Cost	Total Cost	Comment
Roadside Ditch, 24" deep, 3:1 side slopes	1200	CY	$ 4	$ 4,800	
Roadway Culverts					
Excavation, roadfill for pipe installation	233	CY	$ 2	$ 466	
Bedding, pipe	76	CY	$ 25	$ 1,900	
Backfill, compacted native material	157	CY	$ 5	$ 785	
Quarry Spalls, outlet protection	58	CY	$ 30	$ 1,740	
Asphalt, road restoration	146	SY	$ 22	$ 3,212	
Culverts, 30" diameter x 50 LF, 4 ea.	200	LF	$ 60	$ 12,000	
Drainage Channel, Open Grass-Lined 4' bott. 3:1 side slopes, 4' deep	2880	CY	$ 4	$ 11,520	
Discharge Pipe, 48" diameter x 100' (CPE)	100	LF	$ 60	$ 6,000	
Trench Excav	200	CY	$ 2	$ 400	
Backfill, compacted native material	140	CY	$ 5	$ 700	
Bedding	60	CY	$ 25	$ 1,500	
48" Flap Gate (Tide Check Valve)	1	EA	$ 13,000	$ 13,000	Quote from Red Valve
Gravel Aprons (2' thick) (inlet&outlet)	80	CY	$ 30	$ 2,400	
Total Improvement Costs				$ 60,423	
Land Acquisition Costs	1.2	AC	$ 3,000	$ 3,600	

Project Name:	**Lower Samish River Flood Hazard Management Plan**
Task Description:	**Conceptual Plan Cost Estimate**
Project Number:	**NPW 40238.A0.30**

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CIP-2, Alternative B (Pipeline from Allen-West Rd to River east of Thomas Rd.) Item	Quantity	Units	Unit Cost	Total Cost	Comment
Roadside Ditch, 24" deep, 3:1 side slopes	2300	CY	$ 5	$ 11,500	
Culverts, 30" diameter x 50 LF, 4 ea.	400	LF	$ 85	$ 34,000	
Concrete Junction Structures					
Concrete (Reinf)	70	CY	$ 600	$ 42,000	
Grating and misc metals	1	LS	$ 4,200	$ 4,200	
Discharge Pipe, 48" diameter x 100'	3500	LF	$ 115	$ 402,500	
48" Flap Gate (Tide Check Valve)	1	EA	$ 10,300	$ 10,300	
Concrete Discharge Structures					
Concrete (Reinf)	60	CY	$ 600	$ 36,000	
Grating and misc metals	1	LS	$ 3,600	$ 3,600	
Gravel Aprons (1.5' thick)	275	CY	$ 30	$ 8,250	
Total Improvement Costs				**$ 552,350**	
Land Acquisition Costs	1	AC	$ 3,000	$ 3,000	

CIP-3 (upgrade northside return culverts) Item	Quantity	Units	Unit Cost	Total Cost	Comment
Discharge Pipe, 48" diameter x 100' (CPE)	100	LF	$ 60	$ 6,000	
Trench Excav	200	CY	$ 2	$ 400	
Backfill, compacted native material	140	CY	$ 5	$ 700	
Bedding	60	CY	$ 25	$ 1,500	
48" Flap Gate (Tide Check Valve)	1	EA	$ 13,000	$ 13,000	Quote from Red Valve
Gravel Aprons (2' thick) (inlet&outlet)	80	CY	$ 30	$ 2,400	
Total Each Site				**$ 24,000**	
Six Sites Total				x 6	
Total Improvement Costs				**$ 144,000**	
Land Acquisition Costs	0	AC	$ 3,000	$ -	

CIP-4 (Flood path roadway culverts) Item	Quantity	Units	Unit Cost	Total Cost	Comment
Culverts, 30" diameter x 50 LF, 4 ea.	200	LF	$ 60	$ 12,000	
Excavation, roadfill for pipe installation	233	CY	$ 2	$ 466	
Bedding, pipe	76	CY	$ 25	$ 1,900	
Backfill, compacted native material	157	CY	$ 5	$ 785	
Quarry Spalls, outlet protection	58	CY	$ 30	$ 1,740	
Asphalt, road restoration	146	SY	$ 22	$ 3,212	
Total Improvement Costs				**$ 20,103**	
(for 12 sites) Total				**$ 241,236**	
Land Acquisition Costs	0	AC	$ 3,000	$ -	

CIP-5, Alternative A (Diversion to Joe Leary slough) Item	Quantity	Units	Unit Cost	Total Cost	Comment
Ditch Excavation, 4 ft wide, 1400 ft long	3250	CY	$ 4	$ 13,000	
48 inch pipeline, 1,100 LF, CPE	1100	LF	$ 51	$ 56,100	
Trench Excav	2550	CY	$ 2	$ 5,100	
Backfill, compacted native material	1900	CY	$ 5	$ 9,500	
Bedding	600	CY	$ 25	$ 15,000	
Quarry Spalls, inlet/outlet protection	80	CY	$ 30	$ 2,400	
Catch basins, 72 inch	2	EA	$ 4,000	$ 8,000	
Pump Station, 30 cfs w/ 2 pumps					
Pumps and motors installed	2	EA	$ 29,000	$ 58,000	(from Auburn project)
Discharge pipe, (2) 24" x 60 LF DIP	120	LF	$ 100	$ 12,000	
Wood Piles, 12" x 30 ft	4	EA	$ 3,000	$ 12,000	allowance
Concrete sump	30	CY	$ 600	$ 18,000	allowance
Pump house, wood	1	LS	$ 8,000	$ 8,000	allowance
Electrical/Controls	1	LS	$ 10,000	$ 10,000	allowance
Total Improvement Costs				**$ 227,100**	
Land Acquisition Costs	1.1	AC	$ 3,000	$ 3,300	

Project Name:	**Lower Samish River Flood Hazard Management Plan**
Task Description:	**Conceptual Plan Cost Estimate**
Project Number:	**NPW 40238.A0.30**

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CIP-5, Alternative B	**(Pump station at Farm-Market Rd.)**					
Item	**Quantity**	**Units**	**Unit Cost**	**Total Cost**		**Comment**
Collection Ditch, 3 ft dp x 3 ft wide x 2000 ft	2000	CY	$ 5	$ 10,000		
Package pump station	1	LS	$ 80,000	$ 80,000		(Quote)
(2) submersible pumps 2500 gpm ea			$ -	$ -		
12 ft dia steel station 12 ft deep			$ -	$ -		
twin discharge pipes to river with check valves			$ -	$ -		
Installation at 25%	1	EA	$ 20,000	$ 20,000		
Riprap, outlet protection	30	CY	$ 30	$ 900		
Total Improvement Costs				**$ 110,900**		
Land Acquisition Costs	1.2	AC	$ 3,000	**$ 3,600**		

CIP-5, Alternative C	**(Diversion dikes/channel west of Farm-Market Rd.)**				
Item	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Comment**
Containment Dike Embankments (5500 lf)	33000	CY	$ 5	$ 165,000	
FTM Rd. and S. Dike Culverts (4-60" dia or Equiv.)	600	LF	$ 210	$ 126,000	
Lowered Roadway Sections (FTM Rd. & Local Access)	1500	LF	$ 100	$ 150,000	
Lowered Dike Section	300	LF	$ 70	$ 21,000	
Sluice Gates	4	EA	$ 15,000	$ 60,000	
Total Improvement Costs				**$ 522,000**	
Land Acquisition Costs	25	AC	$ 3,000	**$ 75,000**	

CIP-6	**(District 5 outfalls)**				
Item	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Comment**
Collection Ditch, 3 ft dp x 3 ft wide x 750 ft	750	CY	$ 4	$ 3,000	
48 inch outfall, twin RCP	200	LF	$ 60	$ 12,000	
Trench Excav	390	CY	$ 2	$ 780	
Backfill, compacted native material	275	CY	$ 5	$ 1,375	
Bedding	113	CY	$ 25	$ 2,825	
Quarry Spalls, inlet/outlet protection	80	CY	$ 30	$ 2,400	
48" Flap Gate (Tide Check Valve)	2	EA	$ 13,000	$ 26,000	
Package pump station	1	LS	$ 80,000	$ 80,000	(Quote)
(2) submersible pumps 2500 gpm ea			$ -	$ -	
12 ft dia steel station 12 ft deep			$ -	$ -	
twin discharge pipes with check valves			$ -	$ -	
Installation at 25%	1	EA	$ 20,000	$ 20,000	
Total Improvement Costs				**$ 128,380**	
(for four sites) Total				**$ 513,520**	
Land Acquisition Costs	1.5	AC	$ 3,000	**$ 4,500**	

CIP-7	**(Edison Slough Improvements)**				
Item	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Comment**
Culverts, installationand pavement repairs				$ 382,000	Previously prepared by
Outfall, improvements				$ 152,000	Montgomery Watson -
Total Improvement Costs					
(includes contingencies)				**$ 534,000**	detailed costs not included here
Land Acquisition Costs	-	AC	$ 3,000	$ -	

Project Name:	**Lower Samish River Flood Hazard Management Plan**
Task Description:	**Conceptual Plan Cost Estimate**
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CIP-8 Item	(Chuckanut Dr. bypass channel/culverts) Quantity	Units	Unit Cost	Total Cost	Comment
Bypass Channel Excavation	55000	CY	$ 2	$ 110,000	
Dike Embankments	30000	CY	$ 5	$ 150,000	
Roadway Culverts (3 @ 72" dia)	500	LF	$ 150	$ 75,000	
Lowered Roadway Secton	100	LF	$ 100	$ 10,000	
Overflow Control Structure/CIP	150	CY	$ 600	$ 90,000	
Sluice Gates (3 @ 72" dia)	3	EA	$ 15,000	$ 45,000	
Slope Protection	30	CY	$ 200	$ 6,000	
Total Improvement Costs				**$ 486,000**	
Land Acquisition Costs	10	AC	$ 3,000	**$ 30,000**	

CIP-9 Item	(Setback dikes, road crossings, habitat restoration) Quantity	Units	Unit Cost	Total Cost	Comment
Setback Dikes (6' Avg. Ht. x 66,000 ft (6 cy/LF)	400000	CY	$ 5	$ 2,000,000	
Roadway Bridge Improvements (Assume 8,000 sq. ft. decl @200' span x 40' width)	32000	SF	$ 50	$ 1,600,000	
				$ -	
Vegetation/Habitat Restoration	25	AC	$ 40,000	$ 1,000,000	
Total Improvement Costs				**$ 4,600,000**	
Land Acquisition Costs	300	AC	$ 3,000	**$ 900,000**	

Phased Breakdown		% of Total (Imprv. & Land)	Phase Total
Phase 1	Bayview-Edison to FTM Rd. (No Bridges)	15%	$ 825,000
Phase 2	FTM to Thomas Rd (1 Bridge)	25%	$ 1,375,000
Phase 3	Thomas Rd. to Chuckanut Dr. (1 Bridge)	25%	$ 1,375,000
Phase 4	Chuckanut Dr. to I-5 (2 Bridges)	35%	$ 1,925,000
	Total	100%	$ 5,500,000

Project Name:	**Lower Samish River Flood Hazard Management Plan**
Task Description:	***Conceptual Plan Cost Estimate***
Project Number:	**NPW 40238.A0.30**

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Project Summary	**Total Cost**
CIP-1 Projects	
CIP-1, Alternative A	$ 106,750
Undefined (8%)	$ 8,540
Contingency (25%)	$ 26,688
General Conditions (8%)	$ 8,540
Sub-Total	$ 150,518
Sales Tax (7.6%)	$ 11,439
Engineering/Administration (15%)	$ 22,578
Sub-Total	$ 184,534
Land Acquisition ($3000/acre)	$ 7,500
Total	$ 192,034
CIP-1, Alternative B	$ 478,250
Undefined (8%)	$ 38,260
Contingency (25%)	$ 119,563
General Conditions (8%)	$ 38,260
Sub-Total	$ 674,333
Sales Tax (7.6%)	$ 51,249
Engineering/Administration (15%)	$ 101,150
Sub-Total	$ 826,732
Land Acquisition ($3000/acre)	$ 3,000
Total	$ 829,732
CIP-1, Alternative C	$ 255,200
Undefined (8%)	$ 20,416
Contingency (25%)	$ 63,800
General Conditions (8%)	$ 20,416
Sub-Total	$ 359,832
Sales Tax (7.6%)	$ 27,347
Engineering/Administration (15%)	$ 53,975
Sub-Total	$ 441,154
Land Acquisition ($3000/acre)	$ 3,300
Total	$ 444,454
CIP-2 Projects	
CIP-2, Alternative A	$ 60,423
Undefined (8%)	$ 4,834
Contingency (25%)	$ 15,106
General Conditions (8%)	$ 4,834
Sub-Total	$ 85,196
Sales Tax (7.6%)	$ 6,475
Engineering/Administration (15%)	$ 12,779
Sub-Total	$ 104,451
Land Acquisition ($3000/acre)	$ 3,600
Total	$ 108,051
CIP-2, Alternative B	$ 552,350
Undefined (8%)	$ 44,188
Contingency (25%)	$ 138,088
General Conditions (8%)	$ 44,188
Sub-Total	$ 778,814
Sales Tax (7.6%)	$ 59,190
Engineering/Administration (15%)	$ 116,822
Sub-Total	$ 954,825
Land Acquisition ($3000/acre)	$ 3,000
Total	$ 957,825

Project Name:	**Lower Samish River Flood Hazard Management Plan**
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CIP-3 Projects

CIP-3		
Undefined (8%)	$	144,000
Contingency (25%)	$	11,520
General Conditions (8%)	$	36,000
Sub-Total	$	11,520
Sales Tax (7.6%)	$	**203,040**
Engineering/Administration (15%)	$	15,431
Sub-Total	$	30,456
Land Acquisition ($3000/acre)	$	**248,927**
Total	$	-
	$	**248,927**

CIP-4 Projects

CIP-4 (for 12 sites)		
Undefined (8%)	$	241,236
Contingency (25%)	$	19,299
General Conditions (8%)	$	60,309
Sub-Total	$	19,299
Sales Tax (7.6%)	$	**340,143**
Engineering/Administration (15%)	$	25,851
Sub-Total	$	51,021
Land Acquisition ($3000/acre)	$	**417,015**
Total	$	-
	$	***417,015***

CIP-5 Projects

CIP-5, Alternative A		
Undefined (8%)	$	227,100
Contingency (25%)	$	18,168
General Conditions (8%)	$	56,775
Sub-Total	$	18,168
Sales Tax (7.6%)	$	**320,211**
Engineering/Administration (15%)	$	24,336
Sub-Total	$	48,032
Land Acquisition ($3000/acre)	$	**392,579**
Total	$	3,300
	$	**395,879**

CIP-5, Alternative B		
Undefined (8%)	$	110,900
Contingency (25%)	$	8,872
General Conditions (8%)	$	27,725
Sub-Total	$	8,872
Sales Tax (7.6%)	$	**156,369**
Engineering/Administration (15%)	$	11,884
Sub-Total	$	23,455
Land Acquisition ($3000/acre)	$	**191,708**
Total	$	3,600
	$	**195,308**

CIP-5, Alternative C		
Undefined (8%)	$	522,000
Contingency (25%)	$	41,760
General Conditions (8%)	$	130,500
Sub-Total	$	41,760
Sales Tax (7.6%)	$	**736,020**
Engineering/Administration (15%)	$	55,938
Sub-Total	$	110,403
Land Acquisition ($3000/acre)	$	**902,361**
Total	$	75,000
	$	**977,361**

Project Name: Lower Samish River
Flood Hazard Management Plan
Task Description: Conceptual Plan Cost Estimate
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CIP-6 Projects

CIP-6 (for 4 sites)	
Undefined (8%)	$ 513,520
Contingency (25%)	$ 41,082
General Conditions (8%)	$ 128,380
Sub-Total	$ 41,082
Sales Tax (7.6%)	$ 724,063
Engineering/Administration (15%)	$ 55,029
Sub-Total	$ 108,609
Land Acquisition ($3000/acre)	$ 887,701
Total	$ 4,500
	$ 892,201

CIP-7 Projects

CIP-7	
Undefined (8%)	$ 534,000
Contingency (25%)	-
General Conditions (8%)	-
Sub-Total	-
Sales Tax (7.6%)	-
Engineering/Administration (15%)	-
Sub-Total	-
Land Acquisition ($3000/acre)	-
Total	$ -
	$ 534,000

CIP-8 Projects

CIP-8

Undefined (8%)	$ 486,000
Contingency (25%)	$ 38,880
General Conditions (8%)	$ 121,500
Sub-Total	$ 38,880
Sales Tax (7.6%)	$ 685,260
Engineering/Administration (15%)	$ 52,080
Sub-Total	$ 102,789
Land Acquisition ($3000/acre)	$ 840,129
Total	$ 30,000
	$ 870,129

CIP-9 Projects

CIP-9	
Undefined (8%)	$ 4,600,000
Contingency (25%)	$ 368,000
General Conditions (8%)	$ 1,150,000
Sub-Total	$ 368,000
Sales Tax (7.6%)	$ 6,486,000
Engineering/Administration (15%)	$ 492,936
Sub-Total	$ 972,900
Land Acquisition ($3000/acre)	$ 7,951,836
Total	$ 900,000
	$ 8,851,836

Appendix B

ADVISORY COMMITTEE MEETING NOTES

Meeting No. 1

Date: February 23, 1995

Districts Represented: 5, 14, 16, 19, 25

Results Summary:

1. Defined background, needs, and expectations of plan

    - Why plan is being done, schedule, and how funded
    - Relationship with Skagit River and current legal issues
    - Plan solutions will not solve flooding problem, will reduce frequency/duration
    - Priority for getting improvements built following plan completion
    - Need for comprehensive solutions approach including watershed controls

2. Defined expectations and needs from stakeholders/districts

    - Need for coordinated plan and solutions
    - Need to collectively support solutions to gain County Commissioners commitment and support
    - Preferences to structure advisory committee; expectations of committee
    - Sharing of local knowledge base about river and problems/needs

3. Documented initial concerns, flooding issues/problems, and solution ideas

    - Flooding history, severity, duration, and flood flow paths
    - Issues with redirection of water in floodplain (eg, county roads impound)
    - Issues with dike effects, levels of flooding protection, and system restrictions
    - Issues of watershed development, need for improved ordinances and enforcement to control
    - Need for upstream detention and flow regulation
    - Need for new outfalls to river (through river dikes) and to bay (through sea dikes); potential for adding pumps

4. Discussed Watershed Action Plan (WAP) activities and status

    - Plan focus on water quality control and related resource protection issues
    - Policy recommendations being made (advisory only)
    - Public education on water quality improvement is important part
    - Watershed stormwater management control is key element
    - Draft plan scheduled for June/July '95

Meeting No. 2

Date: March 23, 1995

Districts Represented: 5, 14, 16, 19, 25

Results Summary:

1. Organized advisory committee and establish operating ground rules

    - Decided that all 5 district to be represented (1-3 reps. each)
    - Distributed and completed committee ground rules checklist
    - Chairperson - Dave Brookings
    - Voting - Consensus approach, 1 vote/district (all reps. can input)
    - Meetings - 2 to 3 week increments typical; day, then night
    - Outside agency representation - Invite DFW and WSDOT to later meetings
    - Public input - all meetings open to public; separate public meeting for input after solutions developed by districts

2. Documented additional flooding issues/concerns

    - Educate upstream property owners on flood issues in lower valley; can't handle additional water
    - Development impacts to river; need for upland development controls
    - Tidal influence issues and ability to convey water to river and bay

3. Summarized flooding problems/preliminary solutions feedback

    - Field reconnaissance results and meetings with stakeholders
    - Overflow paths and roadway/other obstruction locations
    - Verified limits of historical flooding
    - Reviewed district solutions ideas (pump outlets, control Thomas Creek)
    - Summarized prior SCS (NRCS) study solution ideas, D/D district ideas, consultant ideas (distributed table and map summary)

4. Developed goals/objectives for solutions development (draft based on input and send out for review with meeting notes)

    - Improve public health and safety
    - Cost-effective solutions with flood reduction benefit
    - Flood warning system
    - Plan districts can work with (consensus to implement)
    - Effective political and legal strategy to implement

- Get additional funding to implement (comply with Ecology FCAAP standards)
- Improved drainage ordinance, define floodways, upstream detention
- Remove/lower roadway obstructions

Meeting No. 3

Date: April 6, 1995

Districts Represented: 5, 14, 16, 19, 25

Results Summary:

1. Recap of goals/objectives - not ready to adopt - next meeting; received various information from district commissioners

2. Presented preliminary solution concept - setback dikes above river outlet

   - Limited setback dikes from FTM Road to BE Road; tie to existing dikes where possible; multiple benefits (flood capacity, habitat, access); potential for multiple grant funding sources
   - Culverts under FTM Road with overtopping section (maybe BE Road also)
   - Diked return flow channel downstream FTM Road (south side); Neuman Slough to return flow (north side)
   - Issues of land acquisition and potential project costs
   - Committee agreement that worthwhile to pursue evaluation

3. Presented preliminary solution concept - District 5 outfalls

   - Enlarged gravity outlets (48" assumed) through sea dike with flap gates; multiple (up to 4) locations
   - Need for smaller pump station also to keep outlet channel clean (by experience)
   - Potential constructability issues (tide protection, dewatering)

4. Presented preliminary solution concept - return channel/pipe for flooding problem, south side of Allen-West Road at T. McGehee residence

   - Culvert(s) under Allen-West Road, ditch across field to river, culvert through dike with flap gate
   - Benefit for each 48" culvert - capacity approximately 50 cfs (100 acre-feet/day) - reduce flooding duration by 1-2 weeks for large flood
   - Concern by committee of transfer of flooding problem to north side of road

5. Presented alternatives evaluation worksheet with proposed criteria - review for comment by next meeting

Meeting No. 4

Date: April 27, 1995

Districts Represented: 5, 16, 19, 25

Results Summary

1. Goals and objectives approved as drafted from committee input

2. Objective to screen alternative projects presented; updated alternative evaluation table provided and reviewed for comments and weighting factors

   - Agreement on rating criteria except comment to consider farming environment factor under environmental category
   - All factors given equal weight except flood reduction benefit - highest weight
   - For rating, agreed to focus on Samish basin perspective versus district or individual

3. Presented overflow return category projects and rated by criteria

   - Projects S4B, S5 - prior SCS proposed projects - Sunset pump station (S4B, not needed), farm over dike upstream of Chuckanut (S5, limited benefit), concerns with erosion of farm fields - both eliminated

   - Projects D1 through D-6 - dike and drainage district proposed projects - Return channels or pipes to river (D1, D2) or Joe Leary Slough (D5) from south side of Allen-West Road (issues with displacement of overflows, needs pipeline); lower FTM Road and partially capture with project C1 or C5 (generally not a positive response); return culverts through north river dike (consider enlarged outlet at Neuman Slough as option); new gravity/pump outfalls in District 5 (D6) to bay to reduce duration overflows impoundment (potential issues with shellfish beds, construction requirements)

   - Project C5 - consultant proposed project - river setback dikes below FTM Road with overflow return channel on south side (aerial photo layout provided); most significant (multi-purpose) benefit of all projects; many concerns by committee - feasibility (cost), land acquisition issues, overflow return channel

   - Project C1 - consultant proposed project - channel, control gate, pipeline to Joe Leary Slough; return of river overflows when capacity exists in slough; possible pump station addition at slough outlet (District 14 need); potential technical feasibility, legal and land owner issues

- Project C6 - consultant proposed project - flood path overflow culverts (favorable response)

- Additional projects requested by committee - Pump station at D. Meade residence (east side FTM Road south of river); Edison slough improvements to handle north overflows

4. Reviewed (provided handout) potential local, state, federal agencies grant funding sources (local match typically required)

Meeting No. 5

Date: May 18, 1995

Districts Represented: 14, 16, 25

Results Summary:

1. Continued with projects review and screening - river corridor and maintenance projects

   - Project D8 - new overflow return project - pump station with collection ditch at southeast corner of river and FTM Road - medium rating

   - Projects S3, D7, D9, C8 - river corridor maintenance - point bar scalping (S3); river bank toe repair/reinforcement (D7); District 5 dike upgrade (D9); repair deficient dike section upstream Thomas Road (C-8) - all rated high; discussed options for less-intensive instream work

   - Project C2, C7 - Chuckanut Drive bridge improvements (C2) - large diameter bore/jack culvert addition (issues with downstream channel capacity) - rated high; Edison Slough capacity improvements (C7) - follow recommendations from drainage improvements study - rated high

   - Project C-10 - Setback dike concept to entire river corridor with structure capacity upgrades (similar to project C5 extended) - feasibility not previously demonstrated, would provide maximum benefit to flood hazard reduction - rated as medium

2. Described and evaluated nonstructural program improvement alternatives

   - Project C3 - floodway designations on Samish River with split floodway along overflow paths to and including Joe Leary/Edison Sloughs - not previously mapped by FEMA, needed for enhanced floodplain development regulation - rated high

   - Project C9 - Ring dikes, elevating/flood proofing structures - ring flood-prone dairy barns with low dikes for water quality protection, provide internal drainage; provide ring dikes or elevate flood prone structures or relocate; some grant funding or low-interest loans may be possible for both - rated as medium

3. Reviewed other nonstructural improvements alternative measures

- Re-regulate Lake Samish outlet for better use of storage (not feasible, little benefit because of location at north end of watershed) - rated high (but likely infeasible)

- Enhanced development controls in watershed - Possible to do a better job of controlling peak runoff, increased volume could still be a problem (with limited outflow to bay). Reviewed results of hydrologic assessment for range of land use conditions (from periods of gage record) - no clear trends resulted in comparison to precipitation. Based on modeling analysis of similar basin by King County SWM (Issaquah Creek Basin), projected increase in peak runoff on order of 20 to 50 percent may be possible if inadequately controlled - Need for enhanced development detention standard and updated ordinance to enforce rated as high

Meeting No. 6

Date: June 8, 1995

Districts Represented: 5, 16, 25

Results Summary:

1. Road Department staff reviewed proposed '95 County road oiling program projects in Lower Samish Basin for districts OK

    - Generally acceptable, except overflow areas on Field (don't do) and Ershing Roads (survey first, then bring back to grade)
    - District commissioners want culverts incorporated

2. Reviewed proposed capital improvement projects (CIPs) based on elements previously reviewed, some with alternatives - took a districts consensus poll regarding CIPs to be included in plan

    - Graphics package handout with updated alternatives evaluation table provided
    - Preliminary estimates of implementation costs were presented - concern expressed by committee with cost levels (too high) - explained basis
    - Summarized comparative level of cost and benefit for each alternative
    - All projects except CIP 8 (Chuckanut Drive high flow bypass channel) received favorable consensus vote; for alternatives, 1C, 2A, and 5C were the preferred option (see attached rating sheet)
    - Summarized preliminary estimate of total improvements program costs (4 to 6 million without CIP-9 (9 million for all phases)
    - Maintenance projects could be set up under an annual budget allocation utilizing matching funds from the river improvement fund (similar to existing program)

3. Discussed scheduled briefing on plan status with County Commissioners on June 14 - Need to demonstrate consensus between districts for projects to have chance at County funding support.

Meeting No. 7

Date: June 22, 1995

Districts Represented: 5, 14, 16, 19, 25

Results Summary:

1. Objective of meeting to prioritize CIP projects and get feedback on funding approach and levels that may be able to be supported at local level

   - Updated CIP project graphic sheets distributed for projects with consensus support
   - Project priority rating table distributed for each district commissioners input.

2. Consensus CIP projects (8) briefly reviewed with modification requested from June 8 meeting (Projects 1C, 2A, 3, 4, 7)

   - Included revised preliminary estimates of projects construction costs
   - Responed to questions about feasibility, benefits, costs, potential impacts for each project
   - Presented letter from District 14 regarding their concerns with diversion of overflows to Joe Leary Slough - indicated District would require mitigation for flow impacts if projects accepted
   - Requested each commissioner to rank projects in order of their priorities; tabulated results (see attached table)
   - Discussed concerns with low rank of CIP-9 (setback levees, Phase 1) - County would at minimum like to see included in plan as policy guideline to follow for incremental improvements to dike system

3. Funding Program Options and Local Share Needs

   - Discussed existing maintenance improvements program funding (river improvement fund, road fund, D/D district funds)
   - Potential to added component of drainage utility funding for selected projects (rate structure currently being evaluated by county commissioner-appointed committee) - need to get utility rate structure approved first
   - Reviewed existing levy rates being assessed in each district and resulting revenues
   - Noted preliminary funding evaluation assumptions about grant funding contribution (none except for CIP-9)
   - Presented preliminary allocation of local funding needs for four alternatives levels of capital improvement projects implementation
   - Input on districts estimated percentage of maintenance/projects expenditures

Appendix C

HYDRAULIC MODELING AND HYDROLOGIC ANALYSIS

SAMISH4.FFA

EVENT RECURRENCE INTERVAL FOR SAMISH RIVER
PEAK FLOWS 1944 THROUGH 1983

TT	Station	SAMISH RIVER NR BURLINGTON, WASH.			Id	12-2015.00	
TT	State	WA	Drainage Area	87.8	Hydrolog Unit	17110002	
TT	County	057	Contribute Area	0.0	Years	1944-1983	
TT	Latitude	48:32:46	Gage Datum	45.00	Continuous	Yes /No	
TT	Longitude	122:20:13	Base Flow	1100.0	Ann/Part Cnt	40 /111	
GS	2015	.441					
QR	201512031943	998					
QR	201601071945	2820					
QR	201710251945	4310					
QR	201812111946	2750					
QR	201910191947	1210					
QR	202002171949	4990					
QR	202112281949	5830					
QR	202202101951	4030					
QR	202301311951	1210					
QR	202401311953	2150					
QR	202512091953	2330					
QR	202602081955	2420					
QR	202711031955	2000					
QR	202812091956	3670					
QR	202901161958	1490					
QR	203011121958	2670					
QR	203112151959	2690					
QR	203202211961	3770					
QR	203301071962	1220					
QR	203411191962	1590					
QR	203511261963	1540					
QR	203601291965	3740					
QR	203701081966	1280					
QR	203802041967	2200					

SAMISH5.FFA

EVENT RECURRENCE INTERVAL FOR SAMISH RIVER
PEAK FLOWS 1944 THROUGH 1958

TT	Station	SAMISH RIVER NR BURLINGTON, WASH.			Id	12-2015.00	
TT	State	WA	Drainage Area	87.8	Hydrolog Unit	17110002	
TT	County	057	Contribute Area	0.0	Years	1944-1958	
TT	Latitude	48:32:46	Gage Datum	45.00	Continuous	Yes /No	
TT	Longitude	122:20:13	Base Flow	1100.0	Ann/Part Cnt	40 /111	
GS	2015	.441					
QR	201512031943	998					
QR	201601071945	2820					
QR	201710251945	4310					
QR	201812111946	2750					
QR	201910191947	1210					
QR	202002171949	4990					
QR	202112281949	5830					
QR	202202101951	4030					
QR	202301311951	1210					
QR	202401311953	2150					
QR	202512091953	2330					
QR	202602081955	2420					
QR	202711031955	2000					
QR	202812091956	3670					
QR	202901161958	1490					
ED							

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QR  203912251967     3300
QR  204001041069     2590
QR  204101191970      891
QR  204201301971     3980
QR  204303061972     3790
QR  204412261972     3730
QR  204501241974     3380
QR  204601171975     1940
QR  204712021975     6090
QR  204801181977     1650
QR  204912021977     3090
QR  205011031978     1340
QR  205112181979     6340
QR  205212261980     1490
QR  205301241982     5590
QR  205401101983     8440
ED
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SAMISH4.FFA

EVENT RECURRENCE INTERVAL FOR SAMISH RIVER
PEAK FLOWS 1944 THROUGH 1983

TT	Station	SAMISH RIVER NR BURLINGTON, WASH.			Id	12-2015.00
TT	State	WA	Drainage Area	87.8		Hydrolog Unit 17110
002						
TT	County	057	Contribute Area	0.0		Years 1944-
1983						
TT	Latitude	48:32:46	Gage Datum	45.00		Continuous Yes /
No						
TT	Longitude	122:20:13	Base Flow	1100.0		Ann/Part Cnt 40 /
111						

GS	2015	.441
QR	201512031943	998
QR	201601071945	2820
QR	201710251945	4310
QR	201812111946	2750
QR	201910191947	1210
QR	202002171949	4990
QR	202112281949	5830
QR	202202101951	4030
QR	202301311951	1210
QR	202401311953	2150
QR	202512091953	2330
QR	202602081955	2420
QR	202711031955	2000
QR	202812091956	3670
QR	202901161958	1490
QR	203011121958	2670
QR	203112151959	2690
QR	203202211961	3770
QR	203301071962	1220
QR	203411191962	1590

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QR  203511261963     1540
QR  203601291965     3740
QR  203701081966     1280
QR  203802041967     2200
QR  203912251967     3300
QR  204001041069     2590
QR  204101191970      891
QR  204201301971     3980
QR  204303061972     3790
QR  204412261972     3730
QR  204501241974     3380
QR  204601171975     1940
QR  204712021975     6090
QR  204801181977     1650
QR  204912021977     3090
QR  205011031978     1340
QR  205112181979     6340
QR  205212261980     1490
QR  205301241982     5590
QR  205401101983     8440
ED
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SAMISH6.FFA

EVENT RECURRENCE INTERVAL FOR SAMISH RIVER
PEAK FLOWS 1957 THROUGH 1971

TT	Station	SAMISH RIVER NR BURLINGTON, WASH.			Id	12-2015.00	
TT	State	WA	Drainage Area	87.8	Hydrolog Unit	17110002	
TT	County	057	Contribute Area	0.0	Years	1957-1971	
TT	Latitude	48:32:46	Gage Datum	45.00	Continuous	Yes /No	
TT	Longitude	122:20:13	Base Flow	1100.0	Ann/Part Cnt	40 /111	
GS	2015	.441					
QR	202812091956	3670					
QR	202901161958	1490					
QR	203011121958	2670					
QR	203112151959	2690					
QR	203202211961	3770					
QR	203301071962	1220					
QR	203411191962	1590					
QR	203511261963	1540					
QR	203601291965	3740					
QR	203701081966	1280					
QR	203802041967	2200					
QR	203912251967	3300					
QR	204001041069	2590					
QR	204101191970	891					
QR	204201301971	3980					
ED							

SAMISH7.FFA

EVENT RECURRENCE INTERVAL FOR SAMISH RIVER
PEAK FLOWS 1970 THROUGH 1983

TT	Station	SAMISH RIVER NR BURLINGTON, WASH.			Id	12-2015.00	
TT	State	WA	Drainage Area	87.8	Hydrolog Unit	17110002	
TT	County	057	Contribute Area	0.0	Years	1970-1983	
TT	Latitude	48:32:46	Gage Datum	45.00	Continuous	Yes /No	
TT	Longitude	122:20:13	Base Flow	1100.0	Ann/Part Cnt	40 /111	
GS	2015	.441					
QR	204001041069	2590					
QR	204101191970	891					
QR	204201301971	3980					
QR	204303061972	3790					
QR	204412261972	3730					
QR	204501241974	3380					
QR	204601171975	1940					
QR	204712021975	6090					
QR	204801181977	1650					
QR	204912021977	3090					
QR	205011031978	1340					
QR	205112181979	6340					
QR	205212261980	1490					
QR	205301241982	5590					
QR	205401101983	8440					
ED							

HEC 2 INPUT FOR
EXISTING CONDITIONS

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T1       SAMISH RIVER WATERSHED(SAMISHE.HEC) JUNE 26, 1995
T2       EDISON ROAD TO INTERSTATE 5
T3       MHHW EL 4.0 MSL DATUM - EXISTING CHANNEL CONDITIONS
J1   -10       2       0       0       0       0       0       0       4       0
J2     1       0      -1       0       0       0      -1       0       0       0
J3    38      23      42      24      14       1       4      21      22
J5   -10     -10
NC 0.050   0.050   0.050      .1      .3       0       0       0       0       0
QT     5    2000    2500    3000    3500    4000
*        ESTIMATED SECTION BELOW EDISON ROAD W/ DIKE @ EL 9.0
X1    .1      25    5049    5320       0       0       0
X3    10                                                     100     100
GR   9.0       0     9.0    5049       6    5050     3.0    5060     1.0    5070
GR   0.3    5078     0.1  5079.1     0.2    5090    -2.0    5110    -3.6  5121.1
GR  -2.0    5135    -3.6    5159    -3.6  5161.1    -4.1    5170    -5.7    5190
GR  -6.8  5201.1    -7.8    5210    -6.0    5225    -3.8    5230    -1.3  5241.1
GR   0.5    5250     9.0    5320     9.0    5400     9.0    5700     9.0    7500
*        EDISON ROAD BRIDGE - TOP OF RD=12',LOW CHORD=11'(NOT CODED)
X1     1      49    5079    5269      50      50      50
X3    10                                                     100     100
GR   3.6       0     3.6    1000     3.6    2000     3.6    3600       8    4279
GR    12    5010    12.3    5049       6    5050     3.0    5060     1.0    5070
GR   0.3    5078      11  5078.1      11    5079      .1  5079.1      .2    5090
GR  -2.0    5110    -3.6    5119    10.8  5119.1    10.8    5121    -3.6  5121.1
GR  -2.0    5135    -3.6    5159    10.8  5159.1    10.8    5161    -3.6  5161.1
GR  -4.1    5170    -5.7    5190    -6.7    5199    10.8  5199.1    10.8    5201
GR  -6.8  5201.1    -7.8    5210    -6.0    5225    -3.8    5230    -2.0    5237
GR  -1.5    5239    10.8  5239.1    10.8    5241    -1.3  5241.1     0.5    5250
GR   1.4    5257     6.6    5269    10.8  5269.1    10.8    5271    12.4  5271.1
GR  12.0    5320     8.0    5400    4.10    5700    4.10    7500
X1     2      49    5079    5269      30      30      30      30
X3    10                                                     100     100
GR   3.6       0     3.6    1000     3.6    2000     3.6    3600       8    4279
GR    12    5010    12.3    5049       6    5050     3.0    5060     1.0    5070
GR   0.3    5078      11  5078.1      11    5079      .1  5079.1      .2    5090
GR  -2.0    5110    -3.6    5119    10.8  5119.1    10.8    5121    -3.6  5121.1
GR  -2.0    5135    -3.6    5159    10.8  5159.1    10.8    5161    -3.6  5161.1
GR  -4.1    5170    -5.5    5190    -6.5    5199    10.8  5199.1    10.8    5201
GR  -6.5  5201.1    -7.5    5210    -6.0    5225    -3.8    5230    -2.0    5237
GR  -1.5    5239    10.8  5239.1    10.8    5241    -1.3  5241.1     0.5    5250
GR   1.4    5257     6.6    5269    10.8  5269.1    10.8    5271    12.4  5271.1
GR  12.0    5320     8.0    5400    4.10    5700    4.10    7500
*        SEC 88+61.5 - BY LEONARD, BOUDINOT & SKODJE INC MAY 1995
X1 88615      23      12     247    1000    1000    1000
X3    10                                                     100     100
GR   7.5       0     7.5      12     4.5    17.5     2.8    25.0     0.3    29.0
GR  -1.3    34.5    -1.2    72.0    -2.7    96.0    -3.1    99.0    -4.3   124.0
GR  -4.4     144    -2.0     151     3.5     179     3.5   193.5     1.9     202
GR   1.7     218     2.8   228.5     4.3   236.5     6.6   241.5     8.8     247
GR   8.8     262     2.0     277     2.0     600
X1  7950      10     535     672    1590    1590    1590
X3    10                                                     100     100
GR   1.0       0     1.0     500     9.0     520     9.0     535    -7.0     570
GR  -7.0     640     9.0     672     9.0     687     1.0     707     1.0    1000
NC 0.100
X1  7400      12     515     600     600     600     600
X3    10                                                     100     100
GR     1       0       1      84     9.2     100     9.2     115       1     130
GR     1     515    -6.7     525    -6.7     575     9.2     600     9.2     615
GR     1     630       1    1100
NC 0.050
X1  7200      10     535     655     200     200     200
X3    10                                                     100     100
GR   1.0       0     1.0     500     9.0     520     9.0     535    -6.5     570
GR  -6.5     623     9.0     655     9.0     670     1.0     690     1.0    1000
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X1   5900      10      500      600     1290     1290     1290
X3     10                                                  100      100
GR      1       0        1      469      9.0      485      9.0      500     -6.2      525
GR   -6.2     575      9.0      600      9.0      615        1      631        1     1100
X1    100      24     2857     2999     1197     1197     1197
X3     10                                                  100      100
GR    4.3       0      4.4        5      4.5       19      5.6      118      5.0      140
GR    4.5     160      4.0      180      4.0      337      4.0     2837      8.3     2844
GR    7.9    2857      0.6     2878     -5.8     2905     -4.5     2917     -3.2     2930
GR   -2.3    2954      2.4     2965     -0.6     2973      0.9     2980      9.1     2993
GR    9.3    2999      8.4     3008      6.0     3013      6.0     4373
X1   2653      12      460      640     2100     2100     2100
X3     10                                                  100      100
GR      3       0        3      430      9.5      445      9.5      460        3      475
GR      3     525     -4.6      550     -4.6      590      9.7      640      9.7      655

GR      3     670        3     1100
*          EXISTING EAST SIDE RIVER CONTAINMENT DIKE IN PLACE
X1   1115      21        7      149     1585     1585     1585
X3     10                                                  100      100
GR    9.4       0      9.1        7      3.9       14      2.5       19      1.5       20
GR   -2.3      27     -2.6       49     -1.8       54     -1.3       63     -0.5       74
GR   -0.3      84      4.1      100      3.7      112      3.9    121.5      4.3    133.5
GR    5.6     139      9.7      149     10.3      156      4.0      170      4.0      450
GR   10.0     465
X1     10      46     3000     3161     1080     1080     1080        0        0        0

X3     10       0        0        0        0        0        0      100      100

GR   11.5     200      8.6      400      6.6      600      5.6      800        4     1000

GR    3.4    1200      2.5     1400      2.1     1600      2.3     1800      3.9     2000

GR    2.9    2200      8.1     2400        8     2600      8.4     2800     11.8     3000

GR   11.7    3003     10.1     3013      9.3     3023      4.5     3033      1.2     3043

GR   -0.9    3053     -3.1     3063       -3     3073     -1.7     3083     -2.5     3093

GR   -2.2    3103     -0.2     3113      0.8     3123        5     3133      6.4     3140
GR   10.9    3153     13.5     3161     10.4     3165      8.3     3200      9.4     3400
GR    6.8    3600      6.5     3800      6.5     3837        5     3843      0.9     3852
GR   -0.2    3858     -1.4     3866     -0.2     3875      3.8     3881      7.5     3894
GR      7    4000
*          FARM TO MARKET ROAD BRIDGE (NOT CODED)
X1     11      65     3003     3165       50       50       50        0        0        0
X3     10       0        0        0        0        0        0      100      100
GR   12.6     200     10.7      400      9.4      600      9.1      800      9.2     1000
GR    9.8    1200       10     1400     10.2     1600       10     1800     10.2     2000
GR   10.1    2200      9.6     2400      9.1     2600      9.6     2800     13.7     3003
GR     13  3003.1       13  3003.2       10     3018      9.8     3038     11.5  3038.1
GR   11.5    3040      8.8  3040.1        1     3053     -2.0     3060     -3.0     3062
GR   -3.2    3063     -2.2     3073     -2.2     3082     11.5  3082.1     11.5     3084
GR   -2.2  3084.1     -2.2     3093     -2.5     3104     11.5  3104.1     11.5     3106
GR   -2.5  3106.1     -2.8     3113     -1.5     3123     -0.8     3126     11.5  3126.1
GR   11.5    3128     -0.4  3128.1        0     3130        6     3139      8.2     3148
GR   11.5  3148.1     11.5     3150        9  3150.1       13     3161     13.2     3165
GR   13.5  3165.1     14.6  3165.2     14.2     3200     11.8     3400     10.7     3600
GR   10.6    3800      7.4     3837        5     3843      0.9     3852     -0.2     3858
GR   -1.4    3866     -0.2     3875      3.8     3881      7.5     3894     10.6     4000
X1     12      45     3023     3153       50       50       50        0        0        0
X3     10       0        0        0        0        0        0      100      100
GR   10.3     200      8.2      400      7.1      600      5.9      800      5.6     1000
GR    5.8    1200      4.1     1400      5.3     1600      6.2     1800      6.5     2000
GR    5.9    2200      4.9     2400      4.5     2600      3.6     2800        9     3000
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GR	9	3003	9	3013	9.3	3023	4.5	3033	1.2	3043
GR	-0.9	3053	-3.1	3063	-3	3073	-1.7	3083	-2.5	3093
GR	-2.2	3103	-0.2	3113	0.8	3123	5	3133	6.4	3143
GR	10.9	3153	9.5	3161	5.3	3200	6.3	3400	7.2	3600
GR	7.4	3800	7.4	3837	5	3843	0.9	3852	-0.2	3858
GR	-1.4	3866	-0.2	3875	3.8	3881	7.4	3894	7.5	4000
X1	1019	15	528	643	875	875	875			
X3	10							100	100	
GR	6.1	0	4.2	490	10.8	513	9.4	528	4.5	541
GR	-0.2	547	-2.0	550	-2.7	560	-2.5	565	0	598
GR	4.0	610	11.19	643	11.0	658	5.53	669	5.5	1150
X1	2303	19	551	666	1215	1215	1215			
X3	10							100	100	
GR	5.1	0	5.1	500	5.1	506	4.60	524	10.30	536
GR	10.59	551	5.8	561	5.5	564	0.6	567	-1.8	579
GR	-0.7	622	3.2	636	4.0	642	6.0	645	7.7	655
GR	12.03	666	11.78	681	5.67	694	6.5	1170		
X1	2583	17	526	641	560	560	560			
X3	10							100	100	
GR	5.2	0	3.8	495	11.39	511	10.92	526	6.3	544
GR	4.8	566	2.5	568	-1.8	586	-3.8	605	-2.0	613
GR	2.2	618	5.7	626	7.0	634	11.69	641	12.17	656
GR	5.2	670	6.4	1150						
X1	20	46	4120	4210	770	770	770	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	12.5	264	12.3	400	12.7	600	13.7	800	14.4	1000
GR	14.7	1200	14.1	1400	13.9	1600	13.5	1800	13.4	2000
GR	13.1	2200	12.2	2400	11.4	2600	8.4	2800	7.6	3000
GR	6.9	3200	6.4	3400	5.8	3600	5.8	3800	5.0	4091
GR	11.94	4105	11.72	4120	7.5	4130	6.1	4139	3.4	4145
GR	0.9	4148	-3	4150	-3	4180	0.6	4183	7.4	4192
GR	9.1	4197	11.32	4210	10.98	4225	5.5	4236	6.2	4300
GR	6.4	4400	6.1	4600	5.3	4800	5.4	5000	5	5200
GR	4.8	5400	8.8	5500	8.4	5600	8.8	5800	9.7	6000
GR	10.4	6200								
X1	4070	16	531	621	706	706	706			
X3	10							100	100	
GR	6.7	0	4.9	500	4.9	501	12.16	516	11.38	531
GR	7.3	540	0.7	544	-2.5	559	-2.3	575	0.7	586
GR	6.4	590	8.5	610	12.36	621	12.62	636	6.5	649
GR	6.8	1130								
X1	4316	16	541	651	245	245	245			
X3	10							100	100	
GR	7.0	0	4.90	512	11.78	526	11.72	541	0.5	548
GR	-1.7	552	0	558	-1.0	564	-1.7	590	10.2	610
GR	6.8	620	6.8	635	12.11	651	12.24	666	6.80	677
GR	6.8	1120								
X1	4937	15	536	626	588	588	588			
X3	10							100	100	
GR	8.6	0	7.14	512	11.25	521	11.16	536	6.3	544
GR	-0.8	550	-0.2	561	-0.6	575	0.2	593	7.8	596
GR	9.0	610	11.70	626	11.34	641	5.0	654	5.5	1160
X1	5168	17	532	627	270	270	270			
X3	10							100	100	
GR	7.7	0	7.7	500	7.15	508	11.56	517	11.11	532
GR	8.2	539	4.3	545	0.5	547	-1.0	559	0	572
GR	-0.5	585	8.5	600	8.3	614	12.18	627	11.97	642
GR	5.5	655	6.3	1130						
X1	30	42	3183	3279	1375	1375	1375	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	12.4	1	9	27	4.2	281	5.8	471	5.1	681
GR	4.7	891	5.5	1099	6.3	1303	9.6	1503	9.1	1702
GR	8.2	1911	8.5	2120	7.6	2309	6.6	2509	6	2703
GR	7	2898	7.2	3099	7.4	3157	12.71	3165	12.12	3183

GR	9.1	3194	0.6	3206	-0.6	3213	-0.2	3239	0.5	3248
GR	3.1	3261	11.8	3273	11.95	3279	12.07	3285	6.8	3294
GR	4.4	3347	8.2	3595	10.3	3796	11	3995	11.2	4194
GR	11.2	4385	10.1	4573	10.1	4773	9.9	4962	8.1	5159
GR	8.9	5292	11.8	5312						
X1	7596	13	528	608	1000	1000	1000			
X3	10							100	100	
GR	8.1	0	7.5	503	12.42	513	12.17	528	8.7	547
GR	1.4	556	-0.9	561	-1.5	582	0.5	590	8.5	600
GR	11.72	608	11.85	623	7.4	632				
X1	8216	14	542	617	612	612	612			
X3	10							100	100	
GR	9.0	0	9.0	500	9.2	511	9.2	518	12.7	542
GR	4.8	559	1.5	560	-.05	564	1.5	601	10.0	611
GR	12.64	617	12.43	632	8.01	643	8.6	1140		
X1	8746	15	525	635	495	495	495			
X3	10							100	100	
GR	9.8	0	9.8	500	8.6	502	12.76	510	12.08	525
GR	9.5	535	2.0	544	-.02	559	2.1	580	8.8	591
GR	9.9	618	14	635	14.0	650	9.41	660	10.2	1150
X1	40	35	1745	1835	1052	1052	1052	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	11.8	200	10.7	400	9.9	600	8	800	7.7	1000
GR	7.9	1200	8.8	1400	9.2	1600	9.9	1726	14.3	1736
GR	14.2	1745	1.8	1766	0	1768	-0.3	1801	1.7	1806
GR	4.7	1810	11.1	1829	14.2	1835	14.2	1845	10.2	1854
GR	9.9	2000	9.7	2200	12.1	2800	9.3	3020	9.9	3200
GR	9	3400	9.6	3600	10	3800	9.5	4000	8.7	4200
GR	8.7	4400	9.5	4600	9.5	4800	10.6	5000	11	5200
*		THOMAS ROAD BRIDGE (NOT CODED)								
X1	41	40	1748	1840	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	13.3	200	12.5	400	10.9	600	11.4	800	11.3	1000
GR	11.4	1200	12.2	1400	15.3	1600	18.5	1748	12.5	1750
GR	8.3	1765	4.8	1771	2.1	1775	1.1	1784	0.4	1794
GR	0.4	1797	0.9	1806	1.6	1812	2	1816	5.5	1820
GR	8.7	1824	11.3	1837	18.5	1840	14.9	2000	11.9	2200
GR	11.5	2400	12.4	2600	12.5	2800	11.2	3000	11.6	3200
GR	11.7	3400	11.5	3600	11.2	3800	10.7	4000	10.7	4200
GR	10.6	4400	11.4	4600	11.7	4800	12.4	5000	12.3	5200
X1	42	37	1745	1835	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	12.7	200	10.7	400	10.7	600	9.1	800	9.5	1000
GR	9.2	1200	9.4	1400	10.4	1600	9.9	1726	14.3	1736
GR	14.2	1745	1.8	1766	0	1768	-0.3	1801	1.7	1806
GR	4.7	1810	11.1	1829	14.2	1835	14.2	1845	10.2	1854
GR	9.4	2000	9.6	2200	9.9	2400	12.4	2600	8.9	2800
GR	8.8	3000	9.2	3200	8	3400	9.2	3600	9	3800
GR	8.7	4000	8.1	4200	8.1	4400	10.1	4600	9.5	4800
GR	9.5	5000	10.8	5200						
X1	50	44	2276	2380	2800	2800	2800	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	16.9	1	14.5	30	13.3	200	12.6	400	13.6	600
GR	13.4	800	13.6	1000	13.4	1200	12.9	1400	11.6	1600
GR	11.6	1800	11	2000	11.6	2200	12	2250	13.3	2262
GR	13.7	2276	7.5	2285	2.8	2292	0	2300	0.4	2305
GR	2.8	2335	7.8	2340	10.7	2350	12.1	2360	12.5	2370
GR	16.5	2380	11.6	2398	11.1	2593	10	2791	12.7	2986
GR	14	3175	15.2	3367	14.6	3557	15.7	3753	14.4	3940
GR	13.4	4012	14.9	4132	14.8	4326	15.2	4529	13.2	4730
GR	13.1	4922	13.1	5113	12.4	5291	15.6	5315		
X1	500	24	2559	2657	688	688	688			
X3	10							100	100	
GR	20.7	0.0	20.5	10	20.0	<15	18.6	24	16.0	1600
GR	16.0	2056	17.1	2559	15.4	2569	9.5	2580	4.7	2585

GR	1.7	2592	0.7	2602	2.1	2605	3.3	2611	3.6	2619
GR	4.7	2620	12.6	2635	16.6	2654	17.2	2657	16.0	2670
GR	16.0	3500	18.2	5398	19.1	5402	20.0	5429		
X1	60	33	2247	2352	1970	1970	1970	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	20.2	1	15.6	50	15.3	200	16.1	400	16.2	600
GR	16.2	800	18.7	1000	18.4	1200	17.9	1400	18.9	1600
GR	19.9	1800	19.9	2000	19.7	2200	19.3	2247	15.1	2261
GR	5.2	2288	3.2	2293	4	2299	4	2307	4.6	2318
GR	5.3	2323	6.5	2327	13.6	2339	18.8	2352	19.4	2400
GR	18.6	2493	19.5	2600	19.6	2800	19.8	3000	17.6	3200
GR	17.1	3400	17.8	3600	19.1	3800				
X1	61	33	2247	2352	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	20.2	1	17.8	50	17	200	17.3	400	17.4	600
GR	18.6	800	19.4	1000	18.5	1200	17.8	1400	19.5	1600
GR	19.9	1800	19.9	2000	19.7	2200	19.3	2247	15.1	2261
GR	5.2	2288	3.2	2293	4	2299	4	2307	4.6	2318
GR	5.3	2323	6.5	2327	13.6	2339	18.8	2352	19.4	2400
GR	18.6	2493	19.5	2600	19.4	2800	20.2	3000	17.6	3200
GR	16.6	3400	16.9	3600	19.1	3800				
X1	62	31	2247	2352	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	20.2	1	15.3	50	16.9	200	17.3	600	19.2	800
GR	19.7	1000	16.4	1200	15	1400	15.7	1600	19.9	1800
GR	19.9	2000	19.7	2200	19.3	2247	15.1	2261	5.2	2288
GR	3.2	2293	4	2299	4	2307	4.6	2318	5.3	2323
GR	6.5	2327	13.6	2339	18.8	2352	19.4	2400	19.5	2600
GR	14.2	2800	12.5	3000	14.7	3200	14	3400	15.5	3600
GR	19.1	3800								
X1	70	35	3721	3794	3655	3655	3655	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	26.3	2000	25.7	2100	23.8	2200	23.5	2300	20.4	2400
GR	21.5	2490	22.9	2600	20.6	2700	20.9	2800	21.4	3000
GR	22.8	3600	23.7	3700	20.2	3721	14.8	3726	9.8	3733
GR	9.1	3737	7.5	3745	7.7	3756	7	3763	7.1	3772
GR	9.1	3781	14.6	3790	17.8	3794	20.8	3800	20.7	4000
GR	19.7	4200	20.5	4400	20	4600	19.3	4800	18.2	5000
GR	17.7	5200	18	5400	18.7	5600	20	5800	20.4	6000
*	CHUCKANUT ROAD BRIDGE (CODED AS SPECIAL BRIDGE)									
NC				.3	.5					
X1	71	39	3721	3794	40	40	40	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	26.3	2000	25.7	2100	24.7	2200	23.7	2300	22.8	2400
GR	22.5	2490	22.9	2600	22.9	2700	23.1	2800	22.6	3000
GR	22.5	3200	23.1	3400	25.1	3600	27.2	3700	20.2	3721
GR	14.8	3726	9.8	3733	9.1	3737	7.5	3745	7.7	3756
GR	7	3763	7.1	3772	9.1	3781	14.6	3790	17.8	3794
GR	20.8	3800	25.1	3814	27.2	3826	24	4000	21	4200
GR	20.6	4400	20.4	4600	20.3	4800	20.2	5000	20.3	5200
GR	20.5	5400	20.7	5600	20.8	5800	20.9	6000		
SB	1.05	1.6	2.6	20	40	0	813	1	8.5	7.5
X1	640	18	38	107.5	10	10	10			
X2			1	25	27					
X3	10							27	27	
BT	18	0	27	27	10	26.8	26.8	18	26.6	26.6
BT	30	27	19	38	27	15.6	40	27	17	50
BT	27	22	60	27	24	70	27	25	80	27

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BT  24.5    90    27    23    97    27    20.5  107.5   27    15.5
BT   110    27    17   120    27    22     125    24    24     142
BT    27    27   160  26.8  26.8
GR    27     0  26.8    10  26.6    18    19.0    30  15.6      38
GR  14.5    40   9.0    50   8.0    60     7.5    70   7.5      80
GR   8.0    90   8.5    97  15.5 107.5      17   110    22     120
GR    24   125    27   142  26.8   160
X1   641                    20    20      20
X2                                          1
X1   711    39  3721  3794    10    10      10
X3    10                                          100   100
GR  26.3  2000  25.7  2100  24.7  2200    23.7  2300  22.8  2400
GR  22.5  2490  22.9  2600  22.9  2700    23.1  2800  22.6  3000
GR  22.5  3200  23.1  3400  25.1  3600    27.2  3700  20.2  3721
GR  14.8  3726   9.8  3733   9.1  3737     7.5  3745   7.7  3756
GR     7  3763   7.1  3772   9.1  3781    14.6  3790  17.8  3794
GR  20.8  3800  25.1  3814  27.2  3826      24  4000    21  4200
GR  20.6  4400  20.4  4600  20.3  4800    20.2  5000  20.3  5200
GR  20.5  5400  20.7  5600  20.8  5800    20.9  6000
NC                    .1    .3
X1    72    36  3721  3794    40    40      40     0     0     0

X3    10     0     0     0     0     0       0   100   100

GR  26.3  2000  25.7  2100  22.6  2300    22.1  2400  20.4  2490

GR    20  2600  22.1  2700  21.6  2800    22.1  3000  22.6  3400

GR  21.8  3600    22  3700  20.2  3721    14.8  3726   9.8  3733

GR   9.1  3737   7.5  3745   7.7  3756       7  3763   7.1  3772
GR   9.1  3781  14.6  3790  17.8  3794    20.8  3800    23  3900

GR  23.3  4000    20  4200  20.6  4400    20.2  4600  20.3  4800

GR  18.1  5000  16.9  5200  17.2  5400    18.2  5600  20.3  5800

GR  21.7  6000
X1   690    18  2038  2149  4200  4200    4200
X3    10                                          100   100
GR  27.5   0.0  27.1     5  22.2  2028    22.3  2038  17.5  2091
GR  11.9  2092  11.0  2096  10.2  2105     7.9  2119   8.5  2127
GR  11.0  2130  17.1  2136  17.9  2141    22.7  2149  22.6  3766
GR  23.1  3829  30.2  3845  31.0  3849
*       300' DOWNSTREAM FROM RAILROAD CROSSING
X1   780    19  2053  2161  2930  2930    2930
X3    10                                          100   100
GR  26.9   0.0  26.6    10  25.7    17    23.5  2053  20.4  2099
GR  15.6  2109  14.5  2117  13.4  2126    11.8  2130  10.0  2140
GR  11.1  2144  13.5  2149  14.5  2150    23.2  2161  23.5  2188
GR  23.3  2284  23.0  2306  31.3  2326    31.8  2331
X1   790    18   508   566   250   250     250
X3    10                                          100   100
GR  33.5   0.0  33.5   380  33.5   441    32.9   491  24.5   500
GR  22.8   508  18.4   513  16.1   518    15.3   528  10.3   550
GR  15.3   557  22.0   566  23.0   572    32.0   578  33.2   625
GR  33.2   673  34.2   803  35.0  1000
*       RAILROAD BRIDGE - TOP RAIL=35.37, LOW CHORD= 31.40
X1   800    11     0    68    50    50      50
X3    10                                           35    35
GR  35.4     0    26   0.1  21.5    15    17.5    17    16    20
GR    14    34    13    54  12.5    60    17.0    62  20.0  67.9
GR  35.4  68.0
X1   801                      20    20      20
*       500 FEET DOWNSTREAM OF INTERSTATE 5
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X1    820      17     3938     4042      500      500      500
X3     10                                                  100      100
GR   28.0     0.0     31.0     1160     31.0     3200     35.0     3205     37.0     3217
GR   37.0    3316     35.0     3330     30.0     3341     29.0     3365     28.7     3913
GR   27.4    3938     18.1     3949     17.0     3998     18.0     4027     25.0     4042
GR   27.1    4067     50.0     4090
X1    850      33     2254     2312     1550     1550     1550
X3     10                                                  100      100
GR   59.0     0.0     34.0       60     34.0       85     32.2      100     32.2      210
GR   34.0     220     34.0      245     32.0      255     32.2      350     34.0      375
GR   34.0     400     31.4      407     31.1      604     30.7      644     31.6      740
GR   31.1    1446     30.4     1560     30.5     2120     32.6     2238     23.3     2254
GR   19.2    2264     17.7     2274     19.2     2279     16.3     2291     16.2     2295
GR   19.2    2301     23.4     2312     28.6     2314     34.5     2326     37.4     2342
GR   41.4    2383     42.0     2400     77.0     2450
X1    920      22     1463     1567     3200     3200     3200
X3     10                                                  100      100
GR   60.0     0.0     50.0       50     50.0       75     34.0      550     34.0      590
GR   38.0     605     38.0      635     34.0      650     34.0     1463     27.5     1475
GR   26.6    1522     23.1     1523     22.1     1533     18.2     1544     21.1     1554
GR   23.1    1567     31.2     1589     29.2     1647     35.0     1664     35.5     1700
GR   40.0    2800     60.0     2850
X1    966      22     1110     1215     2000     2000     2000
X3     10                                                  100      100
GR   55.0     0.0     50.0      200     45.0      400     40.5      600     40.0      650
GR   41.0     700     40.5      800     41.0      900     40.5     1000     40.0     1100
GR   35.5    1110     26.4     1120     25.5     1125     26.7     1140     28.4     1151
GR   29.8    1162     31.8     1185     37.1     1215     40.0     1230     41.0     1700
GR   41.3    2110     50.0     2200
X1   1030      20     1584     1715     1800     1800     1800
X3     10                                                  100      100
GR  100.0     0.0     52.0      100     51.8     1140     54.0     1160     54.0     1200
GR   51.5    1255     51.1     1360     49.0     1450     48.5     1584     35.5     1602
GR   33.4    1610     34.0     1621     35.5     1645     35.7     1657     39.6     1669
GR   43.1    1715     44.6     1730     44.6     2835     55.2     2875     80.0     2920
X1   1040      24       74      140     2000     2000     2000
X3     10                                                  100      100
GR   53.6       0     53.6      1.0     45.5       35     42.2       42     41.6       62
GR   40.6      74     36.2       84     32.7       92     32.7      100     34.3      108
GR   35.6     120     36.1      128     42.5      140     41.8      160     41.3      180
GR   40.0     200     42.8      220     43.0      240     44.1      260     43.6      300
GR   44.1     340     45.1      360     46.4      370     53.0      386
EJ
T1       SECOND PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=2500 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        3        0        0        0        0        0        0      4.0        0
J2     2        0       -1        0        0        0       -1        0        0
T1       THIRD PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=3000 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        4        0        0        0        0        0        0      4.0        0
J2     2        0       -1        0        0        0       -1        0        0
T1       FOURTH PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=3500 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        5        0        0        0        0        0        0      4.0        0
J2     2        0       -1        0        0        0       -1        0        0
T1       FIFTH PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=4000 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        6        0        0        0        0        0        0      4.0        0
J2    15        0       -1        0        0        0       -1        0        0
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HEC 2 INPUT FOR
MODIFIED DIKE CONDITIONS

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T1       SAMISH RIVER WATERSHED(SAMISHF.HEC) JULY 5, 1995
T2       EDISON ROAD TO INTERSTATE 5
T3       MHHW EL 4.0 MSL DATUM - MODIFIED CHANNEL CONDITIONS
J1    -10        2        0        0        0        0        0        0        4        0
J2      1        0       -1        0        0        0       -1        0        0        0
J3     38       23       42       24       14        1        4       21       22
J5    -10      -10
NC 0.050    0.050    0.050       .1       .3        0        0        0        0        0
QT      5     2000     2500     3000     3500     4000
*        ESTIMATED SECTION BELOW EDISON ROAD W/ DIKE @ EL 9.0
X1     .1       25     5049     5320        0        0        0
X3     10                                                      100      100
GR    9.0        0      9.0     5049        6     5050      3.0     5060      1.0     5070
GR    0.3     5078      0.1   5079.1      0.2     5090     -2.0     5110     -3.6   5121.1
GR   -2.0     5135     -3.6     5159     -3.6   5161.1     -4.1     5170     -5.7     5190
GR   -6.8   5201.1     -7.8     5210     -6.0     5225     -3.8     5230     -1.3   5241.1
GR    0.5     5250      9.0     5320      9.0     5400      9.0     5700      9.0     7500
*        EDISON ROAD BRIDGE - TOP OF RD=12',LOW CHORD=11'(NOT CODED)
X1       1       49     5079     5269       50       50       50
X3      10                                                      100      100
GR    3.6        0      3.6     1000      3.6     2000      3.6     3600        8     4279
GR     12     5010     12.3     5049        6     5050      3.0     5060      1.0     5070
GR    0.3     5078       11   5078.1       11     5079       .1   5079.1       .2     5090
GR   -2.0     5110     -3.6     5119     10.8   5119.1     10.8     5121     -3.6   5121.1
GR   -2.0     5135     -3.6     5159     10.8   5159.1     10.8     5161     -3.6   5161.1
GR   -4.1     5170     -5.7     5190     -6.7     5199     10.8   5199.1     10.8     5201
GR   -6.8   5201.1     -7.8     5210     -6.0     5225     -3.8     5230     -2.0     5237
GR   -1.5     5239     10.8   5239.1     10.8     5241     -1.3   5241.1      0.5     5250
GR    1.4     5257      6.6     5269     10.8   5269.1     10.8     5271     12.4   5271.1
GR   12.0     5320      8.0     5400     4.10     5700     4.10     7500
X1       2       49     5079     5269       30       30       30       30
X3      10                                                      100      100
GR    3.6        0      3.6     1000      3.6     2000      3.6     3600        8     4279
GR     12     5010     12.3     5049        6     5050      3.0     5060      1.0     5070
GR    0.3     5078       11   5078.1       11     5079       .1   5079.1       .2     5090
GR   -2.0     5110     -3.6     5119     10.8   5119.1     10.8     5121     -3.6   5121.1
GR   -2.0     5135     -3.6     5159     10.8   5159.1     10.8     5161     -3.6   5161.1
GR   -4.1     5170     -5.5     5190     -6.5     5199     10.8   5199.1     10.8     5201
GR   -6.5   5201.1     -7.5     5210     -6.0     5225     -3.8     5230     -2.0     5237
GR   -1.5     5239     10.8   5239.1     10.8     5241     -1.3   5241.1      0.5     5250
GR    1.4     5257      6.6     5269     10.8   5269.1     10.8     5271     12.4   5271.1
GR   12.0     5320      8.0     5400     4.10     5700     4.10     7500
*        SEC 88+61.5 - BY LEONARD, BOUDINOT & SKODJE INC MAY 1995
*        SECTION MODIFIED - EAST DIKE MOVED 200' EAST
X1 88615       23       12      447     1000     1000     1000
X3      10                                                      100      100
GR    7.5        0      7.5       12      4.5     17.5      2.8     25.0      0.3     29.0
GR   -1.3     34.5     -1.2     72.0     -2.7     96.0     -3.1     99.0     -4.3     124.0
GR   -4.4      144     -2.0      151      3.5      179      3.5    193.5      1.9      202
GR    1.7      218      2.8    228.5      4.3    236.5      2.0    441.5      8.8      447
GR    8.8      462      2.0      477      2.0      600
*        APPROXIMATE SECTION ESTIMATED FROM AERIAL PHOTO
*        SECTION MODIFIED - EAST DIKE MOVED 200' EAST
X1   7950       12      535      872     1590     1590     1590
X3      10                                                      100      100
GR    1.0        0      1.0      500      9.0      520      9.0      535     -7.0      570
GR   -7.0      640      1.0      672      1.0      857      9.0      872      9.0      887
GR    1.0      907      1.0     1000
*        APPROXIMATE SECTION ESTIMATED FROM AERIAL PHOTO
*        SECTION MODIFIED - EAST DIKE MOVED 300' EAST
NC 0.100
X1   7400       14      515      900      600      600      600
X3      10                                                      100      100
GR      1        0        1       84      9.2      100      9.2      115        1      130
GR      1      515     -6.7      525     -6.7      575        1      600        1      884
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GR   9.2     900     9.2     915       1     930       1    1100
*       APPROXIMATE SECTION ESTIMATED FROM AERIAL PHOTO
*       SECTION MODIFIED - EAST DIKE MOVED 300' EAST
NC 0.050
X1  7200      12     535     955     200     200     200
X3    10                                                  100     100
GR   1.0       0     1.0     500     9.0     520     9.0   535    -6.5     570
GR  -6.5     623       1     655       1     939     9.0   955     9.0     970
GR   1.0     990     1.0    1000
*       SECTION MODIFIED - WEST DIKE MOVED 200' WEST
X1  5900      12     300     600    1290    1290    1290
X3    10                                                  100     100
GR     1       0       1     269     9.0     285     9.0   300       1     316
GR     1     515    -6.2     525    -6.2     575     9.0   600     9.0     615

GR     1     631       1    1100
*       SECTION MODIFIED - WEST DIKE MOVED 200' WEST
X1   100      26    2657    2999    1197    1197    1197
X3    10                                                  100     100
GR   4.3       0     4.4       5     4.5      19     5.6   118     5.0     140
GR   4.5     160     4.0     180     4.0     337     4.0  2637     8.3    2644
GR   7.9    2657     4.0    2665     3.0    2870     0.6  2878    -5.8    2905
GR  -4.5    2917    -3.2    2930    -2.3    2954     2.4  2965    -0.6    2973
GR   0.9    2980     9.1    2993     9.3    2999     8.4  3008     6.0    3013
GR   6.0    4373
*       SECTION MODIFIED - WEST DIKE MOVED 200' WEST
X1  2653      13     260     640    2100    2100    2100
X3    10                                                  100     100
GR     3       0       3     230     9.5     245     9.5   260       3     285

GR     3     475       3     525    -4.6     550    -4.6   590     9.7     640
GR   9.7     655       3     670       3    1100
*       EAST SIDE RIVER CONTAINMENT DIKE REMOVED
X1  1115      21       7     149    1585    1585    1585
X3    10                                                  100       6
GR   9.4       0     9.1       7     3.9      14     2.5    19     1.5      20
GR  -2.3      27    -2.6      49    -1.8      54    -1.3    63    -0.5      74
GR  -0.3      84     4.1     100     3.7     112     3.9 121.5     4.3   133.5
GR   5.6     139     6.0     149     6.0     156     4.0   170     4.0     450
GR  10.0     465
X1    10      46    3000    3161    1080    1080    1080     0       0       0

X3    10       0       0       0       0       0       0   100       8

GR  11.5     200     8.6     400     6.6     600     5.6   800       4    1000

GR   3.4    1200     2.5    1400     2.1    1600     2.3  1800     3.9    2000

GR   2.9    2200     8.1    2400       8    2600     8.4  2800    11.8    3000

GR  11.7    3003    10.1    3013     9.3    3023     4.5  3033     1.2    3043

GR  -0.9    3053    -3.1    3063      -3    3073    -1.7  3083    -2.5    3093

GR  -2.2    3103    -0.2    3113     0.8    3123       5  3133     6.4    3140
GR   8.0    3153     8.0    3161     8.0    3165     8.3  3200     9.4    3400
GR   6.8    3600     6.5    3800     6.5    3837       5  3843     0.9    3852
GR  -0.2    3858    -1.4    3866    -0.2    3875     3.8  3881     7.5    3894
GR     7    4000
*       FARM TO MARKET ROAD BRIDGE (NOT CODED)
X1    11      65    3003    3165      50      50      50     0       0       0
X3    10       0       0       0       0       0       0   100     100
GR  12.6     200    10.7     400     9.4     600     9.1   800     9.2    1000
GR   9.8    1200      10    1400    10.2    1600      10  1800    10.2    2000
GR  10.1    2200     9.6    2400     9.1    2600     9.6  2800    13.7    3003
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GR    13   3003.1      13   3003.2      10      3018     9.8      3038    11.5    3038.1
GR  11.5     3040     8.8   3040.1       1      3053    -2.0      3060    -3.0      3062
GR  -3.2     3063    -2.2     3073    -2.2      3082    11.5    3082.1    11.5      3084
GR  -2.2   3084.1    -2.2     3093    -2.5      3104    11.5    3104.1    11.5      3106
GR  -2.5   3106.1    -2.8     3113    -1.5      3123    -0.8      3126    11.5    3126.1
GR  11.5     3128    -0.4   3128.1       0      3130       6      3139     8.2      3148
GR  11.5   3148.1    11.5     3150       9    3150.1      13      3161    13.2      3165
GR  13.5   3165.1    14.6   3165.2    14.2      3200    11.8      3400    10.7      3600
GR  10.6     3800     7.4     3837       5      3843     0.9      3852    -0.2      3858
GR  -1.4     3866    -0.2     3875     3.8      3881     7.5      3894    10.6      4000
X1    12       45     3023     3153      50        50      50         0       0         0
X3    10        0        0        0       0         0       0       100     100
GR  10.3      200     8.2      400     7.1       600     5.9       800     5.6      1000
GR   5.8     1200     4.1     1400     5.3      1600     6.2      1800     6.5      2000
GR   5.9     2200     4.9     2400     4.5      2600     3.6      2800       9      3000
GR     9     3003       9     3013     9.3      3023     4.5      3033     1.2      3043
GR  -0.9     3053    -3.1     3063      -3      3073    -1.7      3083    -2.5      3093
GR  -2.2     3103    -0.2     3113     0.8      3123       5      3133     6.4      3143
GR  10.9     3153     9.5     3161     5.3      3200     6.3      3400     7.2      3600
GR   7.4     3800     7.4     3837       5      3843     0.9      3852    -0.2      3858
GR  -1.4     3866    -0.2     3875     3.8      3881     7.4      3894     7.5      4000
X1  1019       15      528      643     875       875     875
X3    10                                                      100     100
GR   6.1        0     4.2      490    10.8       513     9.4       528     4.5       541
GR  -0.2      547    -2.0      550    -2.7       560    -2.5       565       0       598
GR   4.0      610   11.19      643    11.0       658    5.53       669     5.5      1150
X1  2303       18      551      666    1215      1215    1215
X3    10                                                      100     100
GR   5.1        0     5.1      500     5.1       506    4.60       524   10.30       536
GR 10.59      551     5.8      561     5.5       564     0.6       567    -1.8       579    -
0.7      622
GR   3.2      636     4.0      642     6.0       645     7.7       655   12.03       666
GR 11.78      681    5.67      694     6.5      1170
X1  2583       17      526      641     560       560     560
X3    10                                                      100     100
GR   5.2        0     3.8      495   11.39       511   10.92       526     6.3       544
GR   4.8      566     2.5      568    -1.8       586    -3.8       605    -2.0       613
GR   2.2      618     5.7      626     7.0       634   11.69       641   12.17       656
GR   5.2      670     6.4     1150
X1    20       46    4120     4210     770       770     770         0       0         0
X3    10        0       0        0       0         0       0       100     100
GR  12.5      264    12.3      400    12.7       600    13.7       800    14.4      1000
GR  14.7     1200    14.1     1400    13.9      1600    13.5      1800    13.4      2000
GR  13.1     2200    12.2     2400    11.4      2600     8.4      2800     7.6      3000
GR   6.9     3200     6.4     3400     5.8      3600     5.8      3800     5.0      4091
GR 11.94     4105   11.72     4120     7.5      4130     6.1      4139     3.4      4145
GR   0.9     4148      -3     4150      -3      4180     0.6      4183     7.4      4192
GR   9.1     4197   11.32     4210   10.98      4225     5.5      4236     6.2      4300
GR   6.4     4400     6.1     4600     5.3      4800     5.4      5000       5      5200
GR   4.8     5400     8.8     5500     8.4      5600     8.8      5800     9.7      6000
GR  10.4     6200
X1  4070       16      531      621     706       706     706
X3    10                                                      100     100
GR   6.7        0     4.9      500     4.9       501   12.16       516   11.38       531
GR   7.3      540     0.7      544    -2.5       559    -2.3       575     0.7       586
GR   6.4      590     8.5      610   12.36       621   12.62       636     6.5       649
GR   6.8     1130
X1  4316       16      541      651     245       245     245
X3    10                                                      100     100
GR   7.0        0    4.90      512   11.78       526   11.72       541     0.5       548
GR  -1.7      552       0      558    -1.0       564    -1.7       590    10.2       610
GR   6.8      620     6.8      635   12.11       651   12.24       666    6.80       677
GR   6.8     1120
X1  4937       15      536      626     588       588     588
X3    10                                                      100     100
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GR	8.6	0	7.14	512	11.25	521	11.16	536	6.3	544
GR	-0.8	550	-0.2	561	-0.6	575	0.2	593	7.8	596
GR	9.0	610	11.70	626	11.34	641	5.0	654	5.5	1160
X1	5168	17	532	627	270	270	270			
X3	10							100	100	
GR	7.7	0	7.7	500	7.15	508	11.56	517	11.11	532
GR	8.2	539	4.3	545	0.5	547	-1.0	559	0	572
GR	-0.5	585	8.5	600	8.3	614	12.18	627	11.97	642
GR	5.5	655	6.3	1130						
X1	30	42	3183	3279	1375	1375	1375	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	12.4	1	9	27	4.2	281	5.8	471	5.1	681
GR	4.7	891	5.5	1099	6.3	1303	9.6	1503	9.1	1702
GR	8.2	1911	8.5	2120	7.6	2309	6.6	2509	6	2703
GR	7	2898	7.2	3099	7.4	3157	12.71	3165	12.12	3183
GR	9.1	3194	0.6	3206	-0.6	3213	-0.2	3239	0.5	3248
GR	3.1	3261	11.8	3273	11.95	3279	12.07	3285	6.8	3294
GR	4.4	3347	8.2	3595	10.3	3796	11	3995	11.2	4194
GR	11.2	4385	10.1	4573	10.1	4773	9.9	4962	8.1	5159
GR	8.9	5292	11.8	5312						
X1	7596	13	528	608	1000	1000	1000			
X3	10							100	100	
GR	8.1	0	7.5	503	12.42	513	12.17	528	8.7	547
GR	1.4	556	-0.9	561	-1.5	582	0.5	590	8.5	600
GR	11.72	608	11.85	623	7.4	632				
X1	8216	14	542	617	612	612	612			
X3	10							100	100	
GR	9.0	0	9.0	500	9.2	511	9.2	518	12.7	542
GR	4.8	559	1.5	560	-.05	564	1.5	601	10.0	611
GR	12.64	617	12.43	632	8.01	643	8.6	1140		
X1	8746	15	525	635	495	495	495			
X3	10							100	100	
GR	9.8	0	9.8	500	8.6	502	12.76	510	12.08	525
GR	9.5	535	2.0	544	-.02	559	2.1	580	8.8	591
GR	9.9	618	14	635	14.0	650	9.41	660	10.2	1150
X1	40	35	1745	1835	1052	1052	1052	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	11.8	200	10.7	400	9.9	600	8	800	7.7	1000
GR	7.9	1200	8.8	1400	9.2	1600	9.9	1726	14.3	1736
GR	14.2	1745	1.8	1766	0	1768	-0.3	1801	1.7	1806
GR	4.7	1810	11.1	1829	14.2	1835	14.2	1845	10.2	1854
GR	9.9	2000	9.7	2200	12.1	2800	9.3	3020	9.9	3200
GR	9	3400	9.6	3600	10	3800	9.5	4000	8.7	4200
GR	8.7	4400	9.5	4600	9.5	4800	10.6	5000	11	5200
*	THOMAS ROAD BRIDGE (NOT CODED)									
X1	41	40	1748	1840	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	13.3	200	12.5	400	10.9	600	11.4	800	11.3	1000
GR	11.4	1200	12.2	1400	15.3	1600	18.5	1748	12.5	1750
GR	8.3	1765	4.8	1771	2.1	1775	1.1	1784	0.4	1794
GR	0.4	1797	0.9	1806	1.6	1812	2	1816	5.5	1820
GR	8.7	1824	11.3	1837	18.5	1840	14.9	2000	11.9	2200
GR	11.5	2400	12.4	2600	12.5	2800	11.2	3000	11.6	3200
GR	11.7	3400	11.5	3600	11.2	3800	10.7	4000	10.7	4200
GR	10.6	4400	11.4	4600	11.7	4800	12.4	5000	12.3	5200
X1	42	37	1745	1835	50	50	50	0	0	0
X3	10							100	100	
GR	12.7	200	10.7	400	10.7	600	9.1	800	9.5	1000
GR	9.2	1200	9.4	1400	10.4	1600	9.9	1726	14.3	1736
GR	14.2	1745	1.8	1766	0	1768	-0.3	1801	1.7	1806
GR	4.7	1810	11.1	1829	14.2	1835	14.2	1845	10.2	1854
GR	9.4	2000	9.6	2200	9.9	2400	12.4	2600	8.9	2800
GR	8.8	3000	9.2	3200	8	3400	9.2	3600	9	3800
GR	8.7	4000	8.1	4200	8.1	4400	10.1	4600	9.5	4800

GR	9.5	5000	10.8	5200						
X1	50	44	2276	2380	2800	2800	2800	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	16.9	1	14.5	30	13.3	200	12.6	400	13.6	600
GR	13.4	800	13.6	1000	13.4	1200	12.9	1400	11.6	1600
GR	11.6	1800	11	2000	11.6	2200	12	2250	13.3	2262
GR	13.7	2276	7.5	2285	2.8	2292	0	2300	0.4	2305
GR	2.8	2335	7.8	2340	10.7	2350	12.1	2360	12.5	2370
GR	16.5	2380	11.6	2398	11.1	2593	10	2791	12.7	2986
GR	14	3175	15.2	3367	14.6	3557	15.7	3753	14.4	3940
GR	13.4	4012	14.9	4132	14.8	4326	15.2	4529	13.2	4730
GR	13.1	4922	13.1	5113	12.4	5291	15.6	5315		
X1	500	24	2559	2657	688	688	688			
X3	10							100	100	
GR	20.7	0.0	20.5	10	20.0	15	18.6	24	16.0	1600
GR	16.0	2056	17.1	2559	15.4	2569	9.5	2580	4.7	2585
GR	1.7	2592	0.7	2602	2.1	2605	3.3	2611	3.6	2619
GR	4.7	2620	12.6	2635	16.6	2654	17.2	2657	16.0	2670
GR	16.0	3500	18.2	5398	19.1	5402	20.0	5429		
X1	60	33	2247	2352	1970	1970	1970	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	20.2	1	15.6	50	15.3	200	16.1	400	16.2	600
GR	16.2	800	18.7	1000	18.4	1200	17.9	1400	18.9	1600
GR	19.9	1800	19.9	2000	19.7	2200	19.3	2247	15.1	2261
GR	5.2	2288	3.2	2293	4	2299	4	2307	4.6	2318
GR	5.3	2323	6.5	2327	13.6	2339	18.8	2352	19.4	2400
GR	18.6	2493	19.5	2600	19.6	2800	19.8	3000	17.6	3200
GR	17.1	3400	17.8	3600	19.1	3800				
X1	61	33	2247	2352	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	20.2	1	17.8	50	17	200	17.3	400	17.4	600
GR	18.6	800	19.4	1000	18.5	1200	17.8	1400	19.5	1600
GR	19.9	1800	19.9	2000	19.7	2200	19.3	2247	15.1	2261
GR	5.2	2288	3.2	2293	4	2299	4	2307	4.6	2318
GR	5.3	2323	6.5	2327	13.6	2339	18.8	2352	19.4	2400
GR	18.6	2493	19.5	2600	19.4	2800	20.2	3000	17.6	3200
GR	16.6	3400	16.9	3600	19.1	3800				
X1	62	31	2247	2352	50	50	50	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	20.2	1	15.3	50	16.9	200	17.3	600	19.2	800
GR	19.7	1000	16.4	1200	15	1400	15.7	1600	19.9	1800
GR	19.9	2000	19.7	2200	19.3	2247	15.1	2261	5.2	2288
GR	3.2	2293	4	2299	4	2307	4.6	2318	5.3	2323
GR	6.5	2327	13.6	2339	18.8	2352	19.4	2400	19.5	2600
GR	14.2	2800	12.5	3000	14.7	3200	14	3400	15.5	3600
GR	19.1	3800								
X1	70	35	3721	3794	3655	3655	3655	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	26.3	2000	25.7	2100	23.8	2200	23.5	2300	20.4	2400
GR	21.5	2490	22.9	2600	20.6	2700	20.9	2800	21.4	3000
GR	22.8	3600	23.7	3700	20.2	3721	14.8	3726	9.8	3733
GR	9.1	3737	7.5	3745	7.7	3756	7	3763	7.1	3772
GR	9.1	3781	14.6	3790	17.8	3794	20.8	3800	20.7	4000
GR	19.7	4200	20.5	4400	20	4600	19.3	4800	18.2	5000
GR	17.7	5200	18	5400	18.7	5600	20	5800	20.4	6000
*	CHUCKANUT ROAD BRIDGE (CODED AS SPECIAL BRIDGE)									
NC				.3	.5					
X1	71	39	3721	3794	40	40	40	0	0	0
X3	10	0	0	0	0	0	0	100	100	
GR	26.3	2000	25.7	2100	24.7	2200	23.7	2300	22.8	2400
GR	22.5	2490	22.9	2600	22.9	2700	23.1	2800	22.6	3000
GR	22.5	3200	23.1	3400	25.1	3600	27.2	3700	20.2	3721
GR	14.8	3726	9.8	3733	9.1	3737	7.5	3745	7.7	3756

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GR     7   3763   7.1   3772   9.1   3781   14.6   3790   17.8   3794
GR  20.8   3800  25.1   3814  27.2   3826     24   4000     21   4200
GR  20.6   4400  20.4   4600  20.3   4800   20.2   5000   20.3   5200
GR  20.5   5400  20.7   5600  20.8   5800   20.9   6000
SB  1.05    1.6   2.6     20    40      0    813      1    8.5    7.5
X1   640     18    38  107.5    10     10     10
X2                  1     25    27
X3    10                                          27     27
BT    18      0    27     27    10   26.8   26.8     18   26.6   26.6
BT    30     27    19     38    27   15.6     40     27     17     50
BT    27     22    60     27    24     70     27     25     80     27
BT  24.5     90    27     23    97     27   20.5  107.5     27   15.5
BT   110     27    17    120    27     22    125     24     24    142
BT    27     27   160   26.8  26.8
GR    27      0  26.8     10  26.6     18   19.0     30   15.6     38
GR  14.5     40   9.0     50   8.0     60    7.5     70    7.5     80
GR   8.0     90   8.5     97  15.5  107.5     17    110     22    120
GR    24    125    27    142  26.8    160
X1   641                      20     20     20
X2                                          1
X3    10                                          27     27
X1   711     39   3721   3794    10     10     10
X3    10                                          27     27
GR  26.3   2000  25.7   2100  24.7   2200   23.7   2300   22.8   2400
GR  22.5   2490  22.9   2600  22.9   2700   23.1   2800   22.6   3000
GR  22.5   3200  23.1   3400  25.1   3600   27.2   3700   20.2   3721
GR  14.8   3726   9.8   3733   9.1   3737    7.5   3745    7.7   3756
GR     7   3763   7.1   3772   9.1   3781   14.6   3790   17.8   3794
GR  20.8   3800  25.1   3814  27.2   3826     24   4000     21   4200
GR  20.6   4400  20.4   4600  20.3   4800   20.2   5000   20.3   5200
GR  20.5   5400  20.7   5600  20.8   5800   20.9   6000
NC                      .1    .3
X1    72     36   3721   3794    40     40     40      0      0      0
X3    10      0      0      0     0      0      0    100    100
GR  26.3   2000  25.7   2100  22.6   2300   22.1   2400   20.4   2490
GR    20   2600  22.1   2700  21.6   2800   22.1   3000   22.6   3400
GR  21.8   3600    22   3700  20.2   3721   14.8   3726    9.8   3733
GR   9.1   3737   7.5   3745   7.7   3756      7   3763    7.1   3772
GR   9.1   3781  14.6   3790  17.8   3794   20.8   3800     23   3900
GR  23.3   4000    20   4200  20.6   4400   20.2   4600   20.3   4800
GR  18.1   5000  16.9   5200  17.2   5400   18.2   5600   20.3   5800
GR  21.7   6000
X1   690     18   2038   2149   4200   4200   4200
X3    10                                          100    100
GR  27.5    0.0  27.1      5   22.2   2028   22.3   2038   17.5   2091
GR  11.9   2092  11.0   2096  10.2   2105    7.9   2119    8.5   2127
GR  11.0   2130  17.1   2136  17.9   2141   22.7   2149   22.6   3766
GR  23.1   3829  30.2   3845  31.0   3849
*        300' DONSTREAM FROM RAILROAD CROSSING
X1   780     19   2053   2161   2930   2930   2930
X3    10                                          100    100
GR  26.9    0.0  26.6     10   25.7     17   23.5   2053   20.4   2099
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GR  15.6    2109    14.5    2117    13.4    2126    11.8    2130    10.0    2140
GR  11.1    2144    13.5    2149    14.5    2150    23.2    2161    23.5    2188
GR  23.3    2284    23.0    2306    31.3    2326    31.8    2331
X1   790      18     508     566     250     250     250
X3    10                                                    100     100
GR  33.5     0.0    33.5     380    33.5     441    32.9     491    24.5     500
GR  22.8     508    18.4     513    16.1     518    15.3     528    10.3     550
GR  15.3     557    22.0     566    23.0     572    32.0     578    33.2     625
GR  33.2     673    34.2     803    35.0    1000
*       RAILROAD BRIDGE - TOP RAIL=35.37, LOW CHORD=31.40
X1   800      11       0      68      50      50      50
X3    10                                                    100     100
GR  35.4       0      26     0.1    21.5      15    17.5      17      16      20
GR    14      34      13      54    12.5      60    17.0      62    20.0    67.9
GR  35.4    68.0
X1   801                              20      20      20
X3    10                                                    100     100
*         500 FEET DOWNSTREAM OF INTERSTATE 5
X1   820      17    3938    4042     500     500     500
X3    10                                                    100     100
GR  28.0     0.0    31.0    1160    31.0    3200    35.0    3205    37.0    3217
GR  37.0    3316    35.0    3330    30.0    3341    29.0    3365    28.7    3913
GR  27.4    3938    18.1    3949    17.0    3998    18.0    4027    25.0    4042
GR  27.1    4067    50.0    4090
X1   850      33    2254    2312    1550    1550    1550
X3    10                                                    100     100
GR  59.0     0.0    34.0      60    34.0      85    32.2     100    32.2     210
GR  34.0     220    34.0     245    32.0     255    32.2     350    34.0     375
GR  34.0     400    31.4     407    31.1     604    30.7     644    31.6     740
GR  31.1    1446    30.4    1560    30.5    2120    32.6    2238    23.3    2254
GR  19.2    2264    17.7    2274    19.2    2279    16.3    2291    16.2    2295
GR  19.2    2301    23.4    2312    28.6    2314    34.5    2326    37.4    2342
GR  41.4    2383    42.0    2400    77.0    2450
X1   920      22    1463    1567    3200    3200    3200
X3    10                                                    100     100
GR  60.0     0.0    50.0      50    50.0      75    34.0     550    34.0     590
GR  38.0     605    38.0     635    34.0     650    34.0    1463    27.5    1475
GR  26.6    1522    23.1    1523    22.1    1533    18.2    1544    21.1    1554
GR  23.1    1567    31.2    1589    29.2    1647    35.0    1664    35.5    1700
GR  40.0    2800    60.0    2850
X1   966      22    1110    1215    2000    2000    2000
X3    10                                                    100     100
GR  55.0     0.0    50.0     200    45.0     400    40.5     600    40.0     650
GR  41.0     700    40.5     800    41.0     900    40.5    1000    40.0    1100
GR  35.5    1110    26.4    1120    25.5    1125    26.7    1140    28.4    1151
GR  29.8    1162    31.8    1185    37.1    1215    40.0    1230    41.0    1700
GR  41.3    2110    50.0    2200
X1  1030      20    1584    1715    1800    1800    1800
X3    10                                                    100     100
GR 100.0     0.0    52.0     100    51.8    1140    54.0    1160    54.0    1200
GR  51.5    1255    51.1    1360    49.0    1450    48.5    1584    35.5    1602
GR  33.4    1610    34.0    1621    35.5    1645    35.7    1657    39.6    1669
GR  43.1    1715    44.6    1730    44.6    2835    55.2    2875    80.0    2920
X1  1040      24      74     140    2000    2000    2000
X3    10                                                    100     100
GR  53.6       0    53.6     1.0    45.5      35    42.2      42    41.6      62
GR  40.6      74    36.2      84    32.7      92    32.7     100    34.3     108
GR  35.6     120    36.1     128    42.5     140    41.8     160    41.3     180
GR  40.0     200    42.8     220    43.0     240    44.1     260    43.6     300
GR  44.1     340    45.1     360    46.4     370    53.0     386
EJ
T1      SECOND PROFILE
T2      EDISON ROAD TO INTERSTATE 5
T3      Q=2500 CFS  EXISTING CHANNEL CONDITIONS
J1   -10       3       0       0       0       0       0       0     4.0       0
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J2     2        0       -1        0        0        0       -1        0        0
T1       THIRD PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=3000 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        4        0        0        0        0        0        0      4.0        0
J2     2        0       -1        0        0        0       -1        0        0
T1       FOURTH PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=3500 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        5        0        0        0        0        0        0      4.0        0
J2     2        0       -1        0        0        0       -1        0        0
T1       FIFTH PROFILE
T2       EDISON ROAD TO INTERSTATE 5
T3       Q=4000 CFS  EXISTING CHANNEL CONDITIONS
J1   -10        6        0        0        0        0        0        0      4.0        0
J2    15        0       -1        0        0        0       -1        0        0


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HEC 2 OUTPUT SUMMARY TABLE
EXISTING AND MODIFIED CONDITIONS

Table A-1

LOWER SAMISH CFHMP

RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
			HEC2	TOP WIDTH	HEC2	TOP WIDTH		
	MINIMUM		CALCULATED	BETWEEN	CALCULATED	BETWEEN	TOP OF EXISTING	
CROSS	CHANNEL	STREAM	WATER	TOP OF	WATER	TOP OF	DIKE ELEVATIONS	
SECTION	ELEV	FLOW	SURFACE	BANKS	SURFACE	BANKS	LEFT	RIGHT
NUMBER	(FT)	(CFS)	ELEV (FT)	(FT)	ELEV (FT)	(FT)	(FT)	(FT)
ESTIMATED SECTION BELOW BAYVIEW-EDISON ROAD W/ 9.0 DIKES ALONG SHORE								
0.1	-7.8	2000	4.0	222	4.0	222	9.0	9.0
0.1	-7.8	2500	4.0	222	4.0	222	9.0	9.0
0.1	-7.8	3000	4.0	222	4.0	222	9.0	9.0
0.1	-7.8	3500	4.0	222	4.0	222	9.0	9.0
0.1	-7.8	4000	4.0	222	4.0	222	9.0	9.0
BAYVIEW-EDISON ROAD BRIDGE WITH ESTIMATED ROAD PROFILE								
1	-7.8	2000	4.0	176	4.0	176	11.0	12.4
1	-7.8	2500	4.0	176	4.0	176	11.0	12.4
1	-7.8	3000	4.0	176	4.0	176	11.0	12.4
1	-7.8	3500	4.0	176	4.0	176	11.0	12.4
1	-7.8	4000	4.0	176	4.0	176	11.0	12.4
2	-7.5	2000	4.1	190	4.1	190	12.3	12.4
2	-7.5	2500	4.1	190	4.1	190	12.3	12.4
2	-7.5	3000	4.1	190	4.1	190	12.3	12.4
2	-7.5	3500	4.2	190	4.2	190	12.3	12.4
2	-7.5	4000	4.2	190	4.2	190	12.3	12.4
NEW SECTION SURVEYED BY L.B.& S. MAY 1995								
88615	-4.4	2000	4.0	215	4.0	397	7.5	8.8
88615	-4.4	2500	4.0	215	4.0	398	7.5	8.8
88615	-4.4	3000	4.0	215	4.1	400	7.5	8.8
88615	-4.4	3500	4.0	215	4.1	402	7.5	8.8
88615	-4.4	4000	4.0	216	4.1	405	7.5	8.8
7950	-7	2000	4.6	118	4.5	319	9.0	9.0
7950	-7	2500	4.8	120	4.7	319	9.0	9.0
7950	-7	3000	5.1	121	4.9	320	9.0	9.0
7950	-7	3500	5.5	122	5.2	321	9.0	9.0
7950	-7	4000	5.8	124	5.4	322	9.0	9.0
7400	-6.7	2000	4.7	78	4.6	376	9.2	9.2
7400	-6.7	2500	5.0	78	4.8	376	9.2	9.2
7400	-6.7	3000	5.4	79	5.1	377	9.2	9.2
7400	-6.7	3500	5.8	80	5.3	377	9.2	9.2
7400	-6.7	4000	6.2	80	5.6	378	9.2	9.2
7200	-6.5	2000	4.8	102	4.6	401	9.0	9.0
7200	-6.5	2500	5.2	104	4.9	402	9.0	9.0
7200	-6.5	3000	5.6	105	5.1	403	9.0	9.0
7200	-6.5	3500	6.0	107	5.4	405	9.0	9.0
7200	-6.5	4000	6.5	109	5.7	406	9.0	9.0

Table A-1
LOWER SAMISH CFHMP
RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
CROSS SECTION NUMBER	MINIMUM CHANNEL ELEV (FT)	STREAM FLOW (CFS)	HEC2 CALCULATED WATER SURFACE ELEV (FT)	TOP WIDTH BETWEEN TOP OF BANKS (FT)	HEC2 CALCULATED WATER SURFACE ELEV (FT)	TOP WIDTH BETWEEN TOP OF BANKS (FT)	TOP OF EXISTING DIKE ELEVATIONS LEFT (FT)	RIGHT (FT)
5900	-6.2	2000	5.3	88	4.8	285	9.0	9.0
5900	-6.2	2500	5.9	90	5.1	286	9.0	9.0
5900	-6.2	3000	6.4	92	5.5	287	9.0	9.0
5900	-6.2	3500	7.0	93	5.8	288	9.0	9.0
5900	-6.2	4000	7.6	95	6.1	289	9.0	9.0
100	-5.8	2000	5.8	125	5.2	324	7.9	9.3
100	-5.8	2500	6.5	128	5.6	326	7.9	9.3
100	-5.8	3000	7.2	131	6.0	327	7.9	9.3
100	-5.8	3500	7.9	134	6.4	329	7.9	9.3
100	-5.8	4000	8.6	135	6.8	330	7.9	9.3
2653	-4.6	2000	6.7	163	6.1	354	9.5	9.7
2653	-4.6	2500	7.5	168	6.6	358	9.5	9.7
2653	-4.6	3000	8.3	172	7.0	361	9.5	9.7
2653	-4.6	3500	9.0	176	7.5	364	9.5	9.7
2653	-4.6	4000	9.7	180	7.9	367	9.5	9.7
NEW SECTION SURVEYED BY L.B.& S. MAY 1995								
1115	-2.6	2000	7.4	134	6.6	446	9.1	10.3
1115	-2.6	2500	8.2	137	7.1	448	9.1	10.3
1115	-2.6	3000	9.0	140	7.6	450	9.1	10.3
1115	-2.6	3500	9.8	142	8.0	452	9.1	10.3
1115	-2.6	4000	10.5	142	8.4	453	9.1	10.3
10	-3.1	2000	7.9	118	7.0	117	11.8	13.5
10	-3.1	2500	8.8	123	7.6	123	11.8	13.5
10	-3.1	3000	9.7	131	8.0	632	11.8	13.5
10	-3.1	3500	10.5	141	8.4	724	11.8	13.5
10	-3.1	4000	11.2	147	8.9	833	11.8	13.5
FARM TO MARKET ROAD BRIDGE								
11	-3.2	2000	7.9	99	7.0	94	13.7	14.6
11	-3.2	2500	8.8	102	7.6	98	13.7	14.6
11	-3.2	3000	9.7	104	7.9	100	13.7	14.6
11	-3.2	3500	10.5	129	8.3	101	13.7	14.6
11	-3.2	4000	11.2	134	8.7	102	13.7	14.6
12	-3.1	2000	8.0	121	7.1	117	9.3	10.9
12	-3.1	2500	8.9	125	7.7	119	9.3	10.9
12	-3.1	3000	9.8	127	8.1	121	9.3	10.9
12	-3.1	3500	10.5	129	8.5	123	9.3	10.9
12	-3.1	4000	11.3	130	8.9	125	9.3	10.9

Table A-1

LOWER SAMISH CFHMP

RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
	MINIMUM		HEC2 CALCULATED	TOP WIDTH BETWEEN	HEC2 CALCULATED	TOP WIDTH BETWEEN	TOP OF EXISTING	
CROSS SECTION	CHANNEL ELEV	STREAM FLOW	WATER SURFACE	TOP OF BANKS	WATER SURFACE	TOP OF BANKS	DIKE ELEVATIONS LEFT	RIGHT
NUMBER	(FT)	(CFS)	ELEV (FT)	(FT)	ELEV (FT)	(FT)	(FT)	(FT)
1019	-2.7	2000	8.4	100	7.7	94	10.8	11.2
1019	-2.7	2500	9.4	106	8.4	100	10.8	11.2
1019	-2.7	3000	10.2	111	8.9	103	10.8	11.2
1019	-2.7	3500	11.1	114	9.5	107	10.8	11.2
1019	-2.7	4000	11.8	115	10.0	110	10.8	11.2
2303	-1.8	2000	9.2	105	8.9	103	10.6	12.0
2303	-1.8	2500	10.2	110	9.7	107	10.6	12.0
2303	-1.8	3000	11.1	113	10.4	111	10.6	12.0
2303	-1.8	3500	12.0	115	11.1	113	10.6	12.0
2303	-1.8	4000	12.7	115	11.7	114	10.6	12.0
2583	-3.8	2000	9.5	106	9.3	105	11.4	12.2
2583	-3.8	2500	10.6	112	10.2	110	11.4	12.2
2583	-3.8	3000	11.5	115	11.0	114	11.4	12.2
2583	-3.8	3500	12.3	115	11.7	115	11.4	12.2
2583	-3.8	4000	13.1	115	12.3	115	11.4	12.2
20	-3	2000	10.1	79	9.9	77	11.9	11.3
20	-3	2500	11.2	88	10.9	85	11.9	11.3
20	-3	3000	12.1	90	11.7	90	11.9	11.3
20	-3	3500	12.9	90	12.4	90	11.9	11.3
20	-3	4000	13.7	90	13.1	90	11.9	11.3
4070	-2.5	2000	10.7	84	10.6	83	12.2	12.6
4070	-2.5	2500	11.9	89	11.6	88	12.2	12.6
4070	-2.5	3000	12.8	90	12.5	90	12.2	12.6
4070	-2.5	3500	13.6	90	13.3	90	12.2	12.6
4070	-2.5	4000	14.4	90	14.0	90	12.2	12.6
4316	-1.7	2000	10.9	106	10.8	105	11.8	12.2
4316	-1.7	2500	12.1	110	11.9	109	11.8	12.2
4316	-1.7	3000	13.0	110	12.8	110	11.8	12.2
4316	-1.7	3500	13.9	110	13.6	110	11.8	12.2
4316	-1.7	4000	14.7	110	14.3	110	11.8	12.2
4937	-0.8	2000	11.3	88	11.2	87	11.3	11.7
4937	-0.8	2500	12.5	90	12.3	90	11.3	11.7
4937	-0.8	3000	13.4	90	13.2	90	11.3	11.7
4937	-0.8	3500	14.3	90	14.0	90	11.3	11.7
4937	-0.8	4000	15.0	90	14.7	90	11.3	11.7

Table A-1

LOWER SAMISH CFHMP

RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
			HEC2	TOP WIDTH	HEC2	TOP WIDTH		
	MINIMUM		CALCULATED	BETWEEN	CALCULATED	BETWEEN	TOP OF EXISTING	
CROSS	CHANNEL	STREAM	WATER	TOP OF	WATER	TOP OF	DIKE ELEVATIONS	
SECTION	ELEV	FLOW	SURFACE	BANKS	SURFACE	BANKS	LEFT	RIGHT
NUMBER	(FT)	(CFS)	ELEV (FT)	(FT)	ELEV (FT)	(FT)	(FT)	(FT)
5168	-1	2000	11.5	93	11.4	93	11.6	12.2
5168	-1	2500	12.7	95	12.5	95	11.6	12.2
5168	-1	3000	13.6	95	13.4	95	11.6	12.2
5168	-1	3500	14.5	95	14.2	95	11.6	12.2
5168	-1	4000	15.3	95	15.0	95	11.6	12.2
30	-0.6	2000	12.3	96	12.2	96	12.7	12.1
30	-0.6	2500	13.5	96	13.4	96	12.7	12.1
30	-0.6	3000	14.5	96	14.3	96	12.7	12.1
30	-0.6	3500	15.3	96	15.1	96	12.7	12.1
30	-0.6	4000	16.2	96	15.9	96	12.7	12.1
7596	-1.5	2000	12.8	80	12.7	80	12.4	11.9
7596	-1.5	2500	13.9	80	13.8	80	12.4	11.9
7596	-1.5	3000	14.9	80	14.8	80	12.4	11.9
7596	-1.5	3500	15.8	80	15.7	80	12.4	11.9
7596	-1.5	4000	16.7	80	16.5	80	12.4	11.9
8216	-0.05	2000	13.2	75	13.1	75	12.7	12.6
8216	-0.05	2500	14.3	75	14.2	75	12.7	12.6
8216	-0.05	3000	15.3	75	15.2	75	12.7	12.6
8216	-0.05	3500	16.3	75	16.1	75	12.7	12.6
8216	-0.05	4000	17.1	75	16.9	75	12.7	12.6
8746	-0.02	2000	13.5	108	13.4	108	12.8	14.0
8746	-0.02	2500	14.7	110	14.6	110	12.8	14.0
8746	-0.02	3000	15.7	110	15.6	110	12.8	14.0
8746	-0.02	3500	16.6	110	16.5	110	12.8	14.0
8746	-0.02	4000	17.5	110	17.3	110	12.8	14.0
40	-0.3	2000	14.0	89	13.9	89	14.3	14.2
40	-0.3	2500	15.2	90	15.1	90	14.3	14.2
40	-0.3	3000	16.2	90	16.1	90	14.3	14.2
40	-0.3	3500	17.1	90	17.0	90	14.3	14.2
40	-0.3	4000	18.0	90	17.9	90	14.3	14.2
THOMAS ROAD BRIDGE								
41	0.4	2000	14.0	89	13.9	89	18.5	18.5
41	0.4	2500	15.2	90	15.1	89	18.5	18.5
41	0.4	3000	16.2	90	16.1	90	18.5	18.5
41	0.4	3500	17.2	91	17.0	91	18.5	18.5
41	0.4	4000	18.0	92	17.9	92	18.5	18.5

Table A-1
LOWER SAMISH CFHMP
RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
CROSS SECTION NUMBER	MINIMUM CHANNEL ELEV (FT)	STREAM FLOW (CFS)	HEC2 CALCULATED WATER SURFACE ELEV (FT)	TOP WIDTH BETWEEN TOP OF BANKS (FT)	HEC2 CALCULATED WATER SURFACE ELEV (FT)	TOP WIDTH BETWEEN TOP OF BANKS (FT)	TOP OF EXISTING DIKE ELEVATIONS LEFT (FT)	RIGHT (FT)
42	-0.3	2000	14.0	89	14.0	89	14.3	14.2
42	-0.3	2500	15.2	90	15.1	90	14.3	14.2
42	-0.3	3000	16.2	90	16.2	90	14.3	14.2
42	-0.3	3500	17.2	90	17.1	90	14.3	14.2
42	-0.3	4000	18.1	90	17.9	90	14.3	14.2
50	0	2000	15.0	100	15.0	100	13.7	16.5
50	0	2500	16.3	103	16.2	103	13.7	16.5
50	0	3000	17.3	104	17.3	104	13.7	16.5
50	0	3500	18.3	104	18.2	104	13.7	16.5
50	0	4000	19.2	104	19.1	104	13.7	16.5
500	0.7	2000	15.3	79	15.3	79	17.1	17.2
500	0.7	2500	16.6	92	16.5	91	17.1	17.2
500	0.7	3000	17.7	98	17.6	98	17.1	17.2
500	0.7	3500	18.6	98	18.6	98	17.1	17.2
500	0.7	4000	19.6	98	19.5	98	17.1	17.2
60	3.2	2000	16.6	90	16.6	90	19.7	19.4
60	3.2	2500	18.0	98	17.9	98	19.7	19.4
60	3.2	3000	19.1	104	19.0	104	19.7	19.4
60	3.2	3500	20.0	105	20.0	105	19.7	19.4
60	3.2	4000	20.9	105	20.9	105	19.7	19.4
61	3.2	2000	16.6	91	16.6	91	19.7	19.4
61	3.2	2500	18.0	99	18.0	98	19.7	19.4
61	3.2	3000	19.1	104	19.1	104	19.7	19.4
61	3.2	3500	20.1	105	20.0	105	19.7	19.4
61	3.2	4000	20.9	105	20.9	105	19.7	19.4
62	3.2	2000	16.7	91	16.6	91	19.7	19.4
62	3.2	2500	18.0	99	18.0	99	19.7	19.4
62	3.2	3000	19.1	104	19.1	104	19.7	19.4
62	3.2	3500	20.1	105	20.0	105	19.7	19.4
62	3.2	4000	21.0	105	20.9	105	19.7	19.4
70	7	2000	18.7	72	18.7	72	23.7	20.8
70	7	2500	20.1	73	20.1	73	23.7	20.8
70	7	3000	21.3	73	21.3	73	23.7	20.8
70	7	3500	22.3	73	22.2	73	23.7	20.8
70	7	4000	23.2	73	23.1	73	23.7	20.8

Table A-1
LOWER SAMISH CFHMP
RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
	MINIMUM		HEC2 CALCULATED	TOP WIDTH BETWEEN	HEC2 CALCULATED	TOP WIDTH BETWEEN	TOP OF EXISTING	
CROSS	CHANNEL	STREAM	WATER	TOP OF	WATER	TOP OF	DIKE ELEVATIONS	
SECTION	ELEV	FLOW	SURFACE	BANKS	SURFACE	BANKS	LEFT	RIGHT
NUMBER	(FT)	(CFS)	ELEV (FT)	(FT)	ELEV (FT)	(FT)	(FT)	(FT)
CHUCKANUT ROAD BRIDGE								
71	7	2000	18.8	72	18.8	72	27.2	20.8
71	7	2500	20.1	73	20.1	73	27.2	20.8
71	7	3000	21.3	73	21.3	73	27.2	20.8
71	7	3500	22.3	73	22.3	73	27.2	20.8
71	7	4000	23.2	73	23.2	73	27.2	20.8
640	7.5	2000	18.8	70	18.8	70	27.0	26.8
640	7.5	2500	20.1	70	20.1	70	27.0	26.8
640	7.5	3000	21.3	70	21.3	70	27.0	26.8
640	7.5	3500	22.3	70	22.2	70	27.0	26.8
640	7.5	4000	23.2	70	23.1	70	27.0	
641	7.5	2000	18.8	83	18.8	70	27.0	26.8
641	7.5	2500	20.2	88	20.2	70	27.0	26.8
641	7.5	3000	21.3	92	21.3	70	27.0	26.8
641	7.5	3500	22.3	96	22.3	70	27.0	26.8
641	7.5	4000	23.2	100	23.2	70	27.0	26.8
711	7	2000	18.8	72	18.8	72	27.2	27.2
711	7	2500	20.2	73	20.2	73	27.2	27.2
711	7	3000	21.4	73	21.4	73	27.2	27.2
711	7	3500	22.4	73	22.4	73	27.2	27.2
711	7	4000	23.3	73	23.3	73	27.2	27.2
72	7	2000	18.8	72	18.8	72	22.6	23.3
72	7	2500	20.2	73	20.2	73	22.6	23.3
72	7	3000	21.4	73	21.4	73	22.6	23.3
72	7	3500	22.4	73	22.4	73	22.6	23.3
72	7	4000	23.3	73	23.3	73	22.6	23.3
690	7.9	2000	22.0	107	22.0	107	27.5	22.7
690	7.9	2500	23.3	111	23.3	111	27.5	22.7
690	7.9	3000	24.3	111	24.3	111	27.5	22.7
690	7.9	3500	25.3	111	25.3	111	27.5	22.7
690	7.9	4000	26.3	111	26.2	111	27.5	22.7
300' DOWNSTREAM FROM RAILROAD CROSSING								
780	10	2000	24.5	108	24.5	108	26.9	31.8
780	10	2500	25.5	108	25.5	108	26.9	31.8
780	10	3000	26.5	108	26.5	108	26.9	31.8
780	10	3500	27.4	108	27.4	108	26.9	31.8
780	10	4000	28.2	108	28.2	108	26.9	31.8

Table A-1

LOWER SAMISH CFHMP

RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE EDISON ROAD TO INTERSTATE-5			EXISTING CHANNEL CONDITIONS		MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT			
	MINIMUM		HEC2 CALCULATED	TOP WIDTH BETWEEN	HEC2 CALCULATED	TOP WIDTH BETWEEN	TOP OF EXISTING DIKE ELEVATIONS	
CROSS SECTION NUMBER	CHANNEL ELEV (FT)	STREAM FLOW (CFS)	WATER SURFACE ELEV (FT)	TOP OF BANKS (FT)	WATER SURFACE ELEV (FT)	TOP OF BANKS (FT)	LEFT (FT)	RIGHT (FT)
790	10.3	2000	24.6	58	24.6	58	33.5	33.2
790	10.3	2500	25.6	58	25.6	58	33.5	33.2
790	10.3	3000	26.6	58	26.6	58	33.5	33.2
790	10.3	3500	27.4	58	27.4	58	33.5	33.2
790	10.3	4000	28.3	58	28.3	58	33.5	33.2
RAILROAD BRIDGE - TOP RAIL = 35.37, LOW CHORD =31.40								
800	12.5	2000	24.7	63	24.7	63	35.4	35.4
800	12.5	2500	25.7	67	25.7	67	35.4	35.4
800	12.5	3000	26.6	68	26.6	68	35.4	35.4
800	12.5	3500	27.5	68	27.5	68	35.4	35.4
800	12.5	4000	28.4	68	28.4	68	35.4	35.4
801	12.5	2000	24.7	63	24.7	63	35.4	35.4
801	12.5	2500	25.7	67	25.7	67	35.4	35.4
801	12.5	3000	26.7	68	26.7	68	35.4	35.4
801	12.5	3500	27.6	68	27.6	68	35.4	35.4
801	12.5	4000	28.4	68	28.4	68	35.4	35.4
500' DOWNSTREAM OF INTERSTATE-5								
820	17	2000	25.2	101	25.2	101	37.0	37.0
820	17	2500	26.3	103	26.3	103	37.0	37.0
820	17	3000	27.3	104	27.3	104	37.0	37.0
820	17	3500	28.3	104	28.2	104	37.0	37.0
820	17	4000	29.1	104	29.1	104	37.0	37.0
850	16.2	2000	26.8	58	26.8	58	34.0	42.0
850	16.2	2500	27.9	58	27.8	58	34.0	42.0
850	16.2	3000	28.8	58	28.8	58	34.0	42.0
850	16.2	3500	29.7	58	29.7	58	34.0	42.0
850	16.2	4000	30.5	58	30.5	58	34.0	42.0
920	18.2	2000	31.0	98	31.0	98	38.0	35.5
920	18.2	2500	32.0	100	32.0	100	38.0	35.5
920	18.2	3000	33.0	102	33.0	102	38.0	35.5
920	18.2	3500	33.9	104	33.9	104	38.0	35.5
920	18.2	4000	34.7	104	34.7	104	38.0	35.5
966	25.5	2000	34.2	87	34.2	87	41.0	41.0
966	25.5	2500	35.1	93	35.1	93	41.0	41.0
966	25.5	3000	35.9	98	35.9	98	41.0	41.0
966	25.5	3500	36.7	103	36.7	103	41.0	41.0
966	25.5	4000	37.5	105	37.5	105	41.0	41.0

Table A-1
LOWER SAMISH CFHMP
RIVER CAPACITY HYDRAULIC EVALUATION

HEC2 SUMMARY TABLE
EDISON ROAD TO
INTERSTATE-5

CROSS SECTION NUMBER	MINIMUM CHANNEL ELEV (FT)	STREAM FLOW (CFS)	EXISTING CHANNEL CONDITIONS HEC2 CALCULATED WATER SURFACE ELEV (FT)	EXISTING CHANNEL CONDITIONS TOP WIDTH BETWEEN TOP OF BANKS (FT)	MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT HEC2 CALCULATED WATER SURFACE ELEV (FT)	MODIFIED CHANNEL WITH PHASE 1 CIP-9 SETBACK DIKE PROJECT TOP WIDTH BETWEEN TOP OF BANKS (FT)	TOP OF EXISTING DIKE ELEVATIONS LEFT (FT)	TOP OF EXISTING DIKE ELEVATIONS RIGHT (FT)
1030	33.4	2000	40.8	90	40.8	90	54.0	44.6
1030	33.4	2500	41.6	101	41.6	101	54.0	44.6
1030	33.4	3000	42.2	111	42.2	111	54.0	44.6
1030	33.4	3500	42.8	120	42.8	120	54.0	44.6
1030	33.4	4000	43.3	124	43.3	124	54.0	44.6
1040	32.7	2000	44.3	66	44.3	66	53.6	53.0
1040	32.7	2500	45.3	66	45.3	66	53.6	53.0
1040	32.7	3000	46.2	66	46.2	66	53.6	53.0
1040	32.7	3500	46.9	66	46.9	66	53.6	53.0
1040	32.7	4000	47.6	66	47.6	66	53.6	53

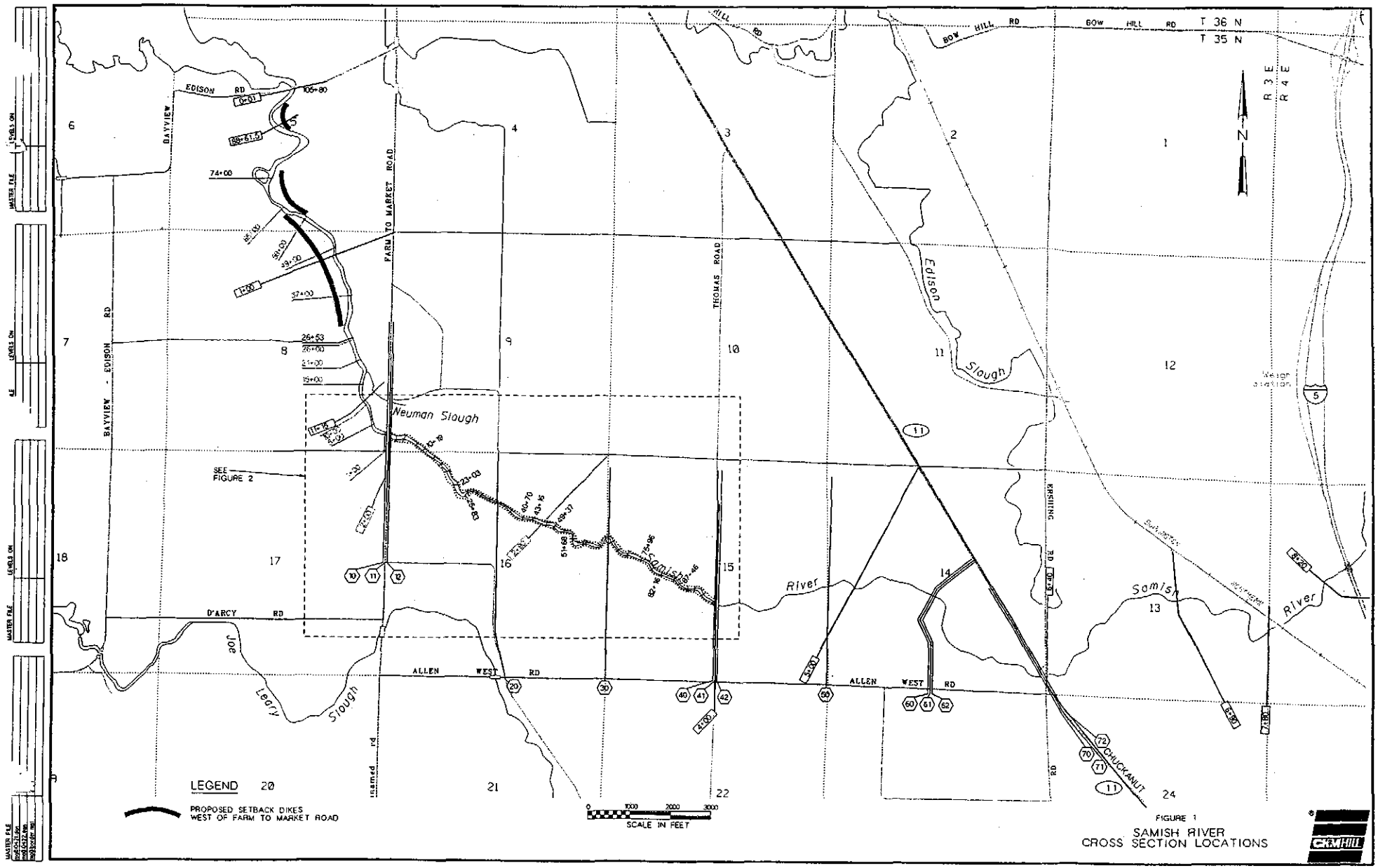


FIGURE 1
SAMISH RIVER
CROSS SECTION LOCATIONS

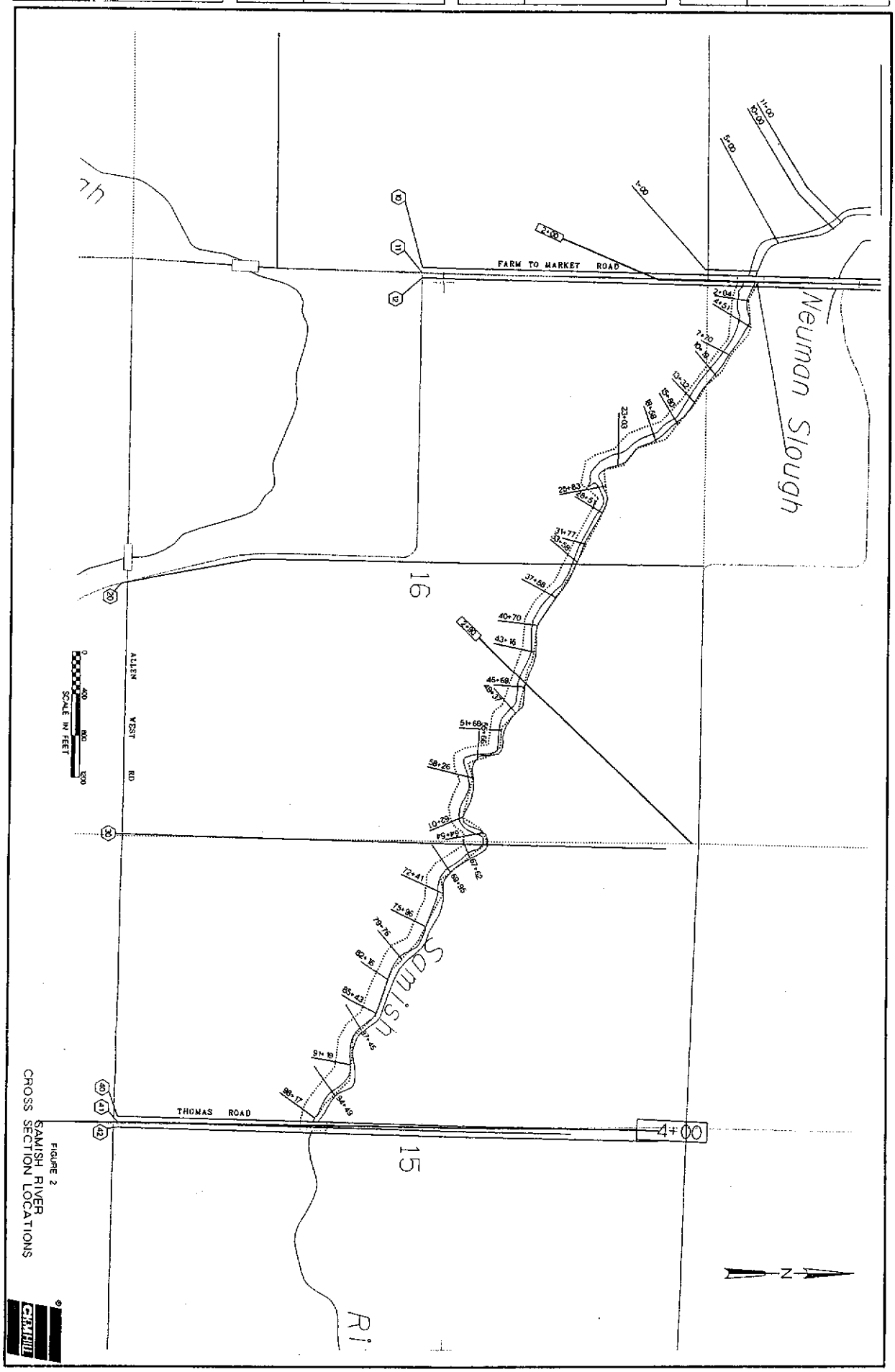
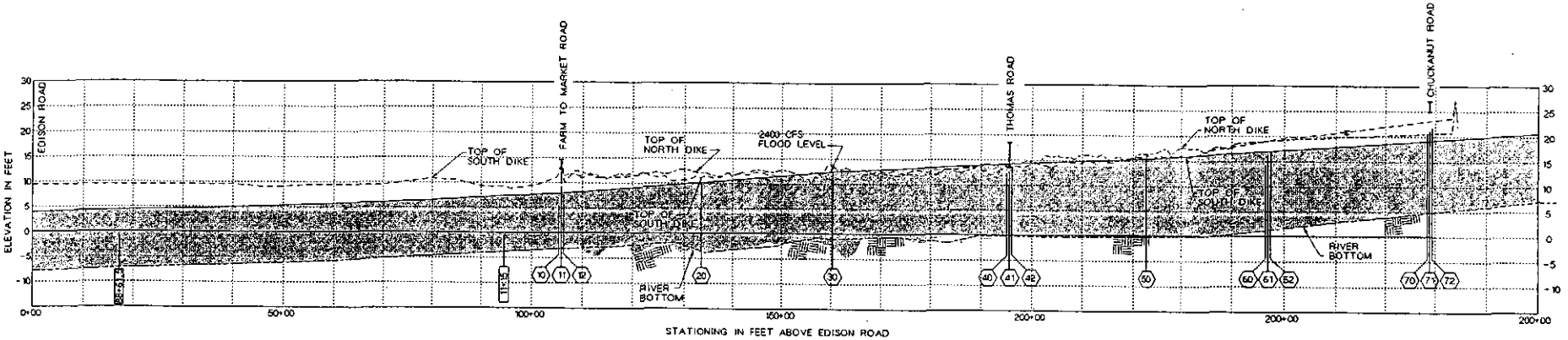


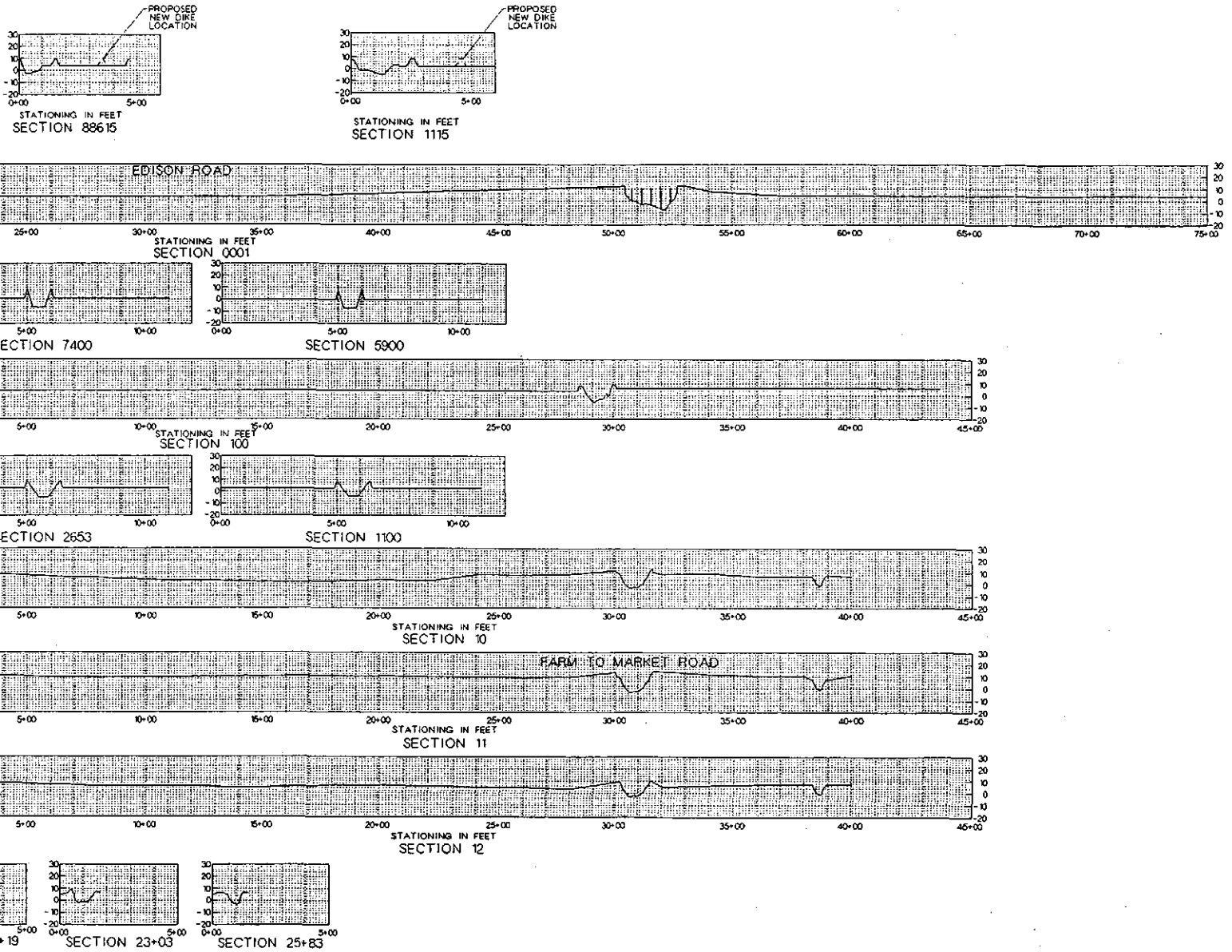
FIGURE 2
SAMISH RIVER
CROSS SECTION LOCATIONS

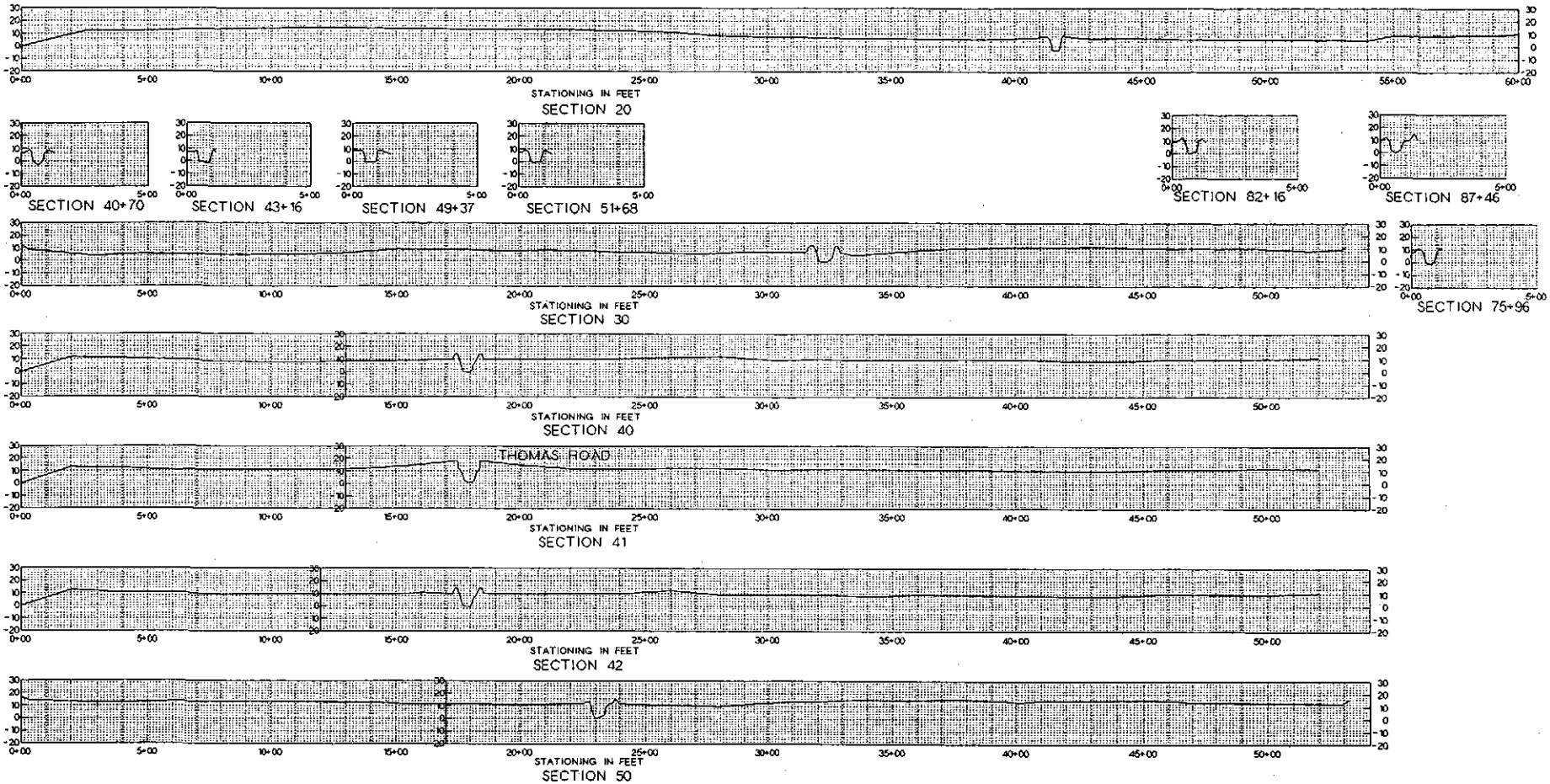


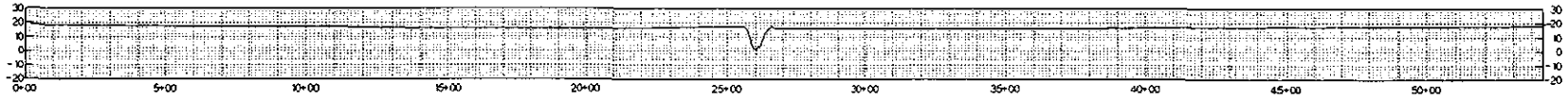
SAMISH RIVER PROFILE

FIGURE 3

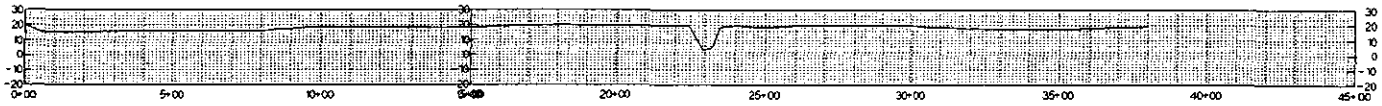
SAMISH RIVER PROFILE


PROPOSED NEW DIKE LOCATION
STATIONING IN FEET
SECTION 88615
PROPOSED NEW DIKE LOCATION
STATIONING IN FEET
SECTION 1115
EDISON ROAD
STATIONING IN FEET
SECTION 0001
SECTION 7400
SECTION 5900
STATIONING IN FEET
SECTION 100
SECTION 2653
SECTION 1100
STATIONING IN FEET
SECTION 10
FARM TO MARKET ROAD
STATIONING IN FEET
SECTION 11
STATIONING IN FEET
SECTION 12
SECTION 10+19
SECTION 23+03
SECTION 25+83


STATIONING IN FEET
SECTION 20
SECTION 40+70
SECTION 43+16
SECTION 49+37
SECTION 51+68
SECTION 82+16
SECTION 87+46
STATIONING IN FEET
SECTION 30
SECTION 75+96
STATIONING IN FEET
SECTION 40
THOMAS ROAD
STATIONING IN FEET
SECTION 41
STATIONING IN FEET
SECTION 42
STATIONING IN FEET
SECTION 50



SECTION 500



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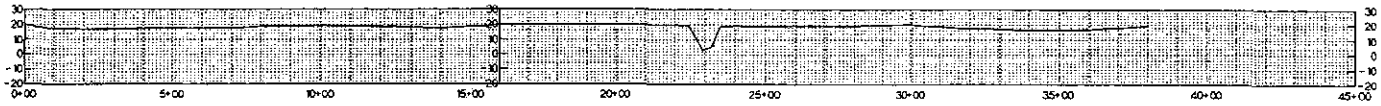

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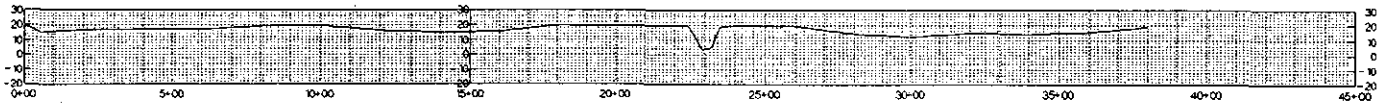

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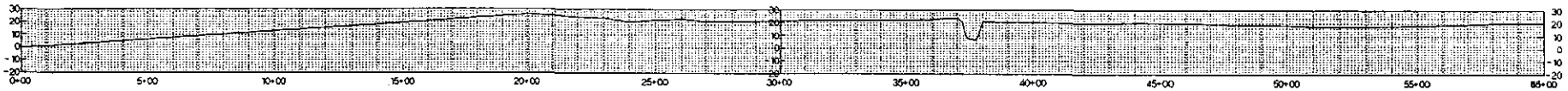

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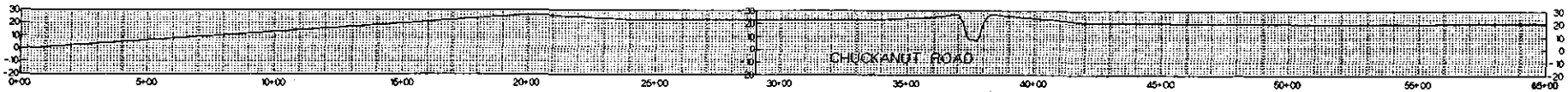

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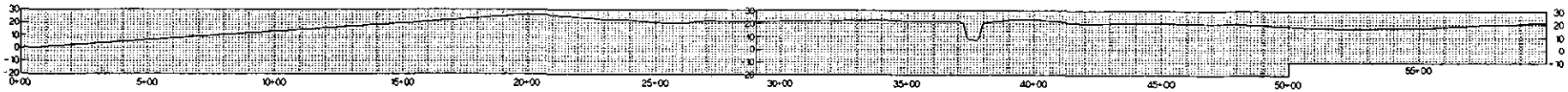


SECTION 72

Appendix D

SEPA CHECKLIST

Appendix D
SEPA CHECKLIST

The SEPA checklist is currently being prepared by Skagit County and will be included in the Final Comprehensive Flood Hazard Management Plan.

Appendix E

REGULATORY PROGRAMS

Appendix E
Regulatory Programs

Introduction

Federal, state, and local regulatory programs directly affect flood hazard management. For the purpose of sorting out the numerous jurisdictions that have a role in flood hazard management, the many regulations are grouped here into four major types:

1. Land Use Management
2. Resource Management
3. Environmental Protection
4. Flood Hazard Management

There will be a brief discussion concerning their individual rationale, the regulatory mechanisms that drive them, and how the jurisdictions are responsible. Each regulation will be discussed in greater detail, exploring the individual tools available and how they relate to a Comprehensive Flood Hazard Management Plan (CFHMP).

Land Use Management

The purpose of land use management is to provide guidance for growth and development and the associated physical improvements that coincide with it. Both the State of Washington and federal agencies require counties to adopt specific regulations concerning land use issues and as such, many of the county regulations are very similar. Within most cities/counties, development regulations will include a comprehensive plan, zoning ordinance, building code, subdivision ordinance, shoreline master program and possibly a flood plain management ordinance. Those land use management regulations that affect flood hazard management plans are discussed briefly below.

Comprehensive Plan

The purpose of a city/county comprehensive plan is to give long range direction and guidance for systematic growth and development. The plan should emphasize immediate local concerns that can include land use, transportation, utilities, water resources, open space, environmentally sensitive areas, drainage, and others. Typically, these plans are non-regulatory, lacking the enforcement mechanisms to ensure compliance. Their purpose is to provide goals, objectives, and policy statements that are met through various ordinances set by the jurisdiction.

The State of Washington Growth Management Act (GMA) of 1990 is an integral part of the comprehensive planning process. The intention of the GMA is to manage growth in the State's fastest growing counties through the adoption of local comprehensive land use plans and development regulations. Even in counties with smaller populations and growth rates, such as Grays Harbor, portions of the GMA have been adopted. Although comprehensive planning is a common tool used by many local governments, the legislature found that too often growth occurred in an uncoordinated and unplanned manner, lacking common goals that expressed the public's interest in conservation and wise use of lands. The citizenry of the State saw the effects of undirected growth as a threat to their quality of life. Growth without direction was seen as posing a threat to not only the environment, but to the sustainability of economic development across the state. The GMA attempts to bring consistency and coordination to long-range planning by reforming the decision-making processes that have been often unpredictable and disjointed.

The planning goals of the GMA focus on economic land use issues such as urban growth, transportation, housing and economic development, as well as resource/environmental issues dealing with open space, conservation, and cultural resources. The resource/environmental planning goals specifically address critical areas (including: wetlands, critical recharge areas affecting aquifers used for potable water, fish and wildlife habitat, frequently flooded areas, and geologically hazardous areas), requiring affected counties to adopt development regulations that preclude land uses or development deemed

incompatible with those critical areas. The protection given these critical areas is intended to cross over jurisdictional boundaries in a coordinated manner.

It is at the comprehensive plan level, whether defined by the GMA or through a local effort, that communities are able to set a direction for regulations. For example, some comprehensive plans identify special flood hazard areas and include a set of guidelines to direct growth within those areas. These areas are typically designated by the United States Department of Housing and Urban Development using maps developed by the Federal Emergency Management Agency (FEMA). Using the FEMA maps to designate special flood hazard areas in a comprehensive plan is one of several necessary steps.

Zoning Ordinance

The purpose of a zoning ordinance is to implement the growth management policies of the Comprehensive Plan. Typically, the zoning code assigns use and density requirements that guide land use in either a city or county. The major tools are a zoning map that identifies specific land use zones accompanied by a zoning code book that defines each zone and provides specific regulations. Zoning codes have the ability to grant variance and conditional uses as well as to enforce the code.

Land use zones are determined by environmental constraints and infrastructure. The availability of water, sewer, fire protection and transportation sets limits to construction densities. Environmental constraints include: geology, soils, slopes, drainage, earthquake potential, avalanche danger, flooding, as well as wildlife protection for fisheries and endangered species.

Development diminishes the ability of soils to absorb precipitation and recharge groundwater. This removal of pervious soil increases the loads on drainage systems and elevates the frequency and extend of flooding. Similarly, development constructed on fill intended to withstand a 100-year storm reduces the flood plain's capacity to carry the increased flow by displacing volume. Employing zoning regulations is a useful tool in flood hazard

management. Zoning sets the density and standards of development and has the ability to direct growth in such a way as to minimize the impact on flood plains.

Building Code

Building codes are meant to regulate the safety and quality of a structure. The Uniform Building Code (UBC) is often used to set those standards. Of particular interest to low lying areas prone to flooding, the UBC regulates excavation and filling on private property. The building code is intended to be used in conjunction with other regulations such as the zoning ordinance.

When used with flood hazard management planning, the building code ensures proper flood proofing of new construction in flood hazard areas. The UBC grading regulations are implemented through local zoning codes.

Subdivision Ordinance

A Subdivision Ordinance prescribes procedures and conditions for dividing land into smaller parcels. The definition of a subdivision may vary among jurisdictions but is usually determined by some specified amount of parcels, usually five or more. Typically, subdivisions must conform to zoning regulations in effect at the time of the proposed subdivision.

Subdivision ordinances typically contain drainage plans and drainage system standards. These plans set out criteria for the collection, storage, and discharge of runoff from subdivisions. Because they are tied to zoning, subdivision are often limited by environmental constraints including flood hazards.

Washington State Shoreline Management Act

The purpose of the Washington State Shoreline Management Act (SMA) is to protect the public's interests in preserving natural resources such as water, fish, and wildlife and their habitat by regulating public and private development in shoreline areas. Although the administrative framework includes both state and local jurisdictions, the Department of

Ecology (Ecology) is the agency mandated to oversee the development of local Shoreline Master Programs and their subsequent implementation. The legal basis for SMA regulatory documents is through the Washington Administrative Code (Chapter 173-14, 16, 17, 18, 19, 20, and 22).

The Shoreline Management Act and local shoreline master programs are extremely useful in flood hazard management planning. The SMA requires local governments to define their shoreline jurisdictions along rivers in one of two ways:

1. The area 200 feet from the ordinary high water mark (OHWM) or floodway, whichever is greater, plus all wetlands in the 100-year flood plain associated with them; or

2. All or any portion of the 100-year flood plain as long as it includes all of those areas falling within the area described in option 1 above.

The SMA requires permits for any "substantial development" within the 200-foot shoreline jurisdiction. A substantial development is defined as any development where the total cost of fair market value is equal to or exceeds $2,500, or any development which materially interferes with the normal public use of the water or shorelines of the state; except as specifically exempted pursuant to RCW 90.58.030(3)(e) and WAC 173-14-040. Permits can be issued through the local Shoreline Master Programs and are reviewed by Ecology.

Proposed developments that do not include wetland areas and are not within 200 feet of the floodway do not require a shoreline permit. These developments, however, may still be required to attain local flood permits and go through a State Environmental Policy Act (SEPA) review process.

Sometimes a diked floodway is used as the boundary from which the 200-foot shoreline jurisdiction is measured. In order to qualify under FEMA requirements, the dike must extend at least as high as the 100-year flood elevation plus 3 feet.

Another important element of the SMA and local Shoreline Master Programs is shorelines of statewide significance. Designated by the SMA, Chapter 173-16 WAC, these shorelines have a set of prioritized policies that first and foremost "recognize and protect the state-wide interest over local interest" and secondly, "preserve the natural character of the shoreline." The consequences of these policies is a strong shoreline management policy that provides another layer of protection to particularly unique shorelines within Washington.

The SMA recognizes Washington's shorelines as an important public natural resource which should be protected from degradation. The SMA authorizes local jurisdictions to develop local Shoreline Master Programs that reflect a community's goals and values in keeping with the SMA. The local regulations are used as an overlay to zoning and as such can guide future development within the flood plain and its watersheds.

Shoreline Master Program

The Shoreline Master Program (SMP), developed at the local, city, or county level, is mandated by the state's SMA for the purpose of protecting the public's shoreline resources. Local governments develop SMPs, guided by the Department of Ecology, the SMA, and the WAC's pertaining to it as briefly discussed above.

As a regulatory tool, the SMP provides local government a strong means by which to manage the effects of development on shorelines, including flood plains. All streams with a mean annual flow of 20 cubic feet per second (cfs) or more, and associated wetlands, are included within the shoreline management jurisdiction. Development can be regulated around these streams, reducing urban runoff and reducing densities. Wetlands can be retained to perform one of their major functions, absorbing excess water, thereby reducing storm surge effects downstream.

The SMP is an excellent tool to be used in consort with a flood hazard management plan because it directs land use and activities along shorelines, sets design criteria to ensure

best management practices, and provides the enforcement mechanism that will be backed by Ecology.

Resource Management

The purpose of resource management is to preserve and protect the nation's natural resources from degradation. Resource management emphasizes sustainability of natural resources while recognizing the economic realities of industries using these resources. To this end, resource conservation and best management practices of productive forest and agricultural lands, and habitats associated with fisheries is the direction resource management regulations has taken. Various state and federal agencies are involved in resource management. All cities/counties must comply with these state and federal regulations depending on the type of project. Resource management regulations affecting flood hazard management include the Washington State Hydraulic Code (Hydraulic Code), Sections 404 and 401 of the Federal Clean Water Act, Section 10 of the Rivers and Harbor Act, and other local ordinances developed to reflect the needs of the particular community.

Hydraulic Code

The purpose of the Washington State Hydraulic Code, RCW 75.20.100-103, is to preserve fish and wildlife habitat by regulating activities within the state's salt and fresh waters. Any construction that will use, divert, obstruct, or change the natural flow or bedding of any of Washington's waters within high water areas, including many wetlands, will require a Hydraulic Project approval (HPA) permit. Such activities include, but are not limited to, streambank protection, dredging, culvert installation, pile driving, construction of bridges, piers and docks, pond construction, log jam or debris removal, mineral prospecting and extraction, and alteration or realignment. Within the code, specific technical provision for hydraulic projects are provided by the administrating agency, the Department of Fish and Wildlife. An application may be denied when the administering agency determines that the project will be directly or indirectly harmful to fish life and acceptable mitigation cannot be assured.

The Hydraulic Code provides city and county jurisdictions with a tool to ensure that no harm to fish and wildlife habitat will occur during the construction of any structural or bioengineering modifications of shorelines. The provision given to assist in the design and construction of shoreline modification structures can also be useful to evaluate proposed projects.

Section 404—Clean Water Act

Section 404 of the Clean Water Act is one of three federal laws that empowered the Army Corps of Engineers to maintain the biological integrity of the nation's waters. Section 404 requires a COE permit for any project that alters or degrades the waters of the United States, ranging from the open water disposal of dredge or fill material to the filling of nearshore areas. This includes adjacent wetlands and tributaries to navigable waters, and any degradation or destruction that could affect interstate or foreign commerce. Guidelines for permit approval have been developed by the Environmental Protection Agency (EPA). There are two types of permits issued: an individual permit and a general, or nationwide, permit. The following details each.

1. Individual Permit—This permit is generally issued for a single proposed activity, unless it falls under a blanket authorization for a general permit or if the project involves an especially valuable ecological area such as a wetland. The determination is based on whether the benefits of the project outweigh the predicted environmental impacts. Known as a public interest review, the evaluation process involves an optional meeting with the COE and other resource agencies prior to the submission of a permit application. Public notice and review are required, and a public hearing is held if required. The COE decides on whether to prepare an Environmental Assessment and Finding of No Significance, or to prepare a National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS). The District engineer can then either approve or reject the permit application.

2. General Permit—The General Permit, also called the Nationwide Permit 26, provides blanket authorization on a nationwide, state or regional level for actions which have minimal adverse impacts on the environment. Such actions would include, but are not limited to, bank stabilization projects, navigation markers, utility line structures, minor road crossings and bridges and boat docks. Also included are minor dredge and fills involving less than 10 cubic yards, or fills involving 1 to 10 acres of isolated wetland or adjacent wetlands located above the headwaters of a stream with an average annual flow of less than 5 cfs. The process involves notification of the EPA and other permitting agencies for a review of the potential environmental impacts. The COE will then either accept or reject the permit; whereupon the applicant may appeal the decision.

Section 401—Clean Water Act

Section 401 is closely tied to Section 404 with the difference being that it is a certification process issued through the Washington Department of Ecology. Whenever there is an activity requiring a federal permit, the applicant must obtain certification as a prerequisite. The state essentially certifies the materials discharged into a water body, ensuring compliance with discharge limitations, water quality standards and any other applicable conditions of state law (Chapter 173-201 WAC). This certification and those conditions become part of the federal permit.

As Section 401 applies to flood hazard management measures, the application often requires what is called a 'modification.' Typical structural flood control measures such as stream bank protection and instream gravel removal have the potential to temporarily create excess instream turbidity during the construction phase. This will require a Temporary Modification of Water Quality Criteria from Ecology before a water quality certification will be issued.

Structural shoreline modification or bioengineering techniques have the potential to affect water quality due to the proximity of construction to the shoreline. Section 401 certifica-

tions are an important part of the permitting process required through Section 404 of the Clean Water Act, and in fact takes precedence over it.

The certification process begins with notification to Ecology at the time a Section 404 permit is filed with the COE. The Environmental Review Section (ERS) prepares a state comment letter based on the responses from the various state agencies, along with the 401 certification or denial. All State 401 certifications are exempt from the State Environmental Policy Act (SEPA).

Section 10—Rivers and Harbors Act

Enacted in 1989 to preserve the navigability of the nation's waterways, Section 10 prohibits the unauthorized obstruction or alteration of those navigable waters without a permit from the COE. The provisions apply to all structures or activities associated with a structure located "in, over, or affecting" navigable waters below the mean high water mark of tidal waters or ordinary high water mark of fresh waters.

This law pertains to navigable waters that are presently, were historically, or have a reasonable potential to be navigable, and all waters subject to the ebb and flow of the tide up to mean higher high tide or ordinary high water mark. The permit process includes consideration of navigational waters, flood control, fish and wildlife management and environmental impacts. Section 10 review often occurs simultaneously with the Section 404 permitting process and includes compliance with the National Environmental Policy Act (NEPA).

Environmental Management

Environmental management concerns the natural resources of our state, including fish and wildlife and their habitats, along with recreational resources. Landmark legislation at the federal and state levels have provided a strong foundation for management of our environment. These laws are not strictly preservation or conservation oriented, but rather

attempt to link our natural resources (i.e., air, water, public access and wildlife) to provide rigorous examination of proposed projects to minimize adverse environmental impacts.

These regulations consist of the national Environmental Policy Act, State Environmental Policy Act, Shoreline Management Act and its Shoreline Master Programs, several Executive Orders for Wetland and Floodplain Protection, and other local ordinances developed to reflect the needs of the particular community.

National Environmental Policy Act

With the passing of the National Environmental Policy Act (NEPA) (42 USC 4321 et. seq.) a process was initiated requiring federal agencies to consider the environmental impacts of both development projects sponsored by the agency and those privately sponsored projects that require agency permits and approval. Concerned with project impacts, the NEPA process stresses full disclosure of environmental impacts along with technical and economic considerations of a development project, prior to an agency decision.

The Council of Environmental Quality (CEQ) provides the guidance to implement NEPA; however, most federal agencies have adopted their own regulations for implementation. The CEQ Regulation (40 CFR 1500-1508) emphasizes the consideration of alternatives, including ways to mitigate harmful environmental effects through reducing or avoiding impact. The NEPA process generally occurs concurrently with Section 404.

To determine whether a proposal would produce significant adverse impacts, an environmental assessment (EA) must be performed. Typically the permit applicant provides much of the information and analysis used to prepare the EA. If it is determined that an EIS is not required, a "Finding of No Significant Impact" document is prepared, explaining why an EIS is not needed.

Any major federal action that would have significant adverse environmental impacts is required by NEPA to prepare an environmental impact statement (EIS). The EIS must thoroughly evaluate any negative environmental impacts caused from the proposed action and its alternatives. Privately sponsored projects may also be required to perform an EIS

if any federal monies are a part of the project or if anyone recommends to the permitting federal agency that an EIS be performed. Such a recommendation should be based on evidence that indicates a proposed action would result in significant adverse environmental impacts.

Generally, all structural and bioengineering flood control projects are federally funded, as such, they must comply with NEPA requirements. Even when grants are appropriate for operations and maintenance, those funds trigger the NEPA process and must comply with the rules. Private projects are also subject to preparing an EIS when, during review by state or federal agencies, the project is seen as potentially detrimental to the environment.

Washington State Environmental Policy Act

The Washington State Environmental Policy Act (SEPA) was passed by the legislature in 1969 for the purpose of providing a process to analyze the environmental impacts of development. SEPA is not a permit but rather a process of information gathering for the purpose of helping agency decisionmakers and the general public understand how a project would affect the environment. SEPA requires a full disclosure of likely significant adverse environmental impacts of a proposed action and a mitigation plan for identified impacts to either the natural or built environment. Many agency decisions can only be made after the SEPA process has been completed. This process may include: Hydraulic Project Approval, Shoreline Substantial Development permit, and many other local permits (clearing and grading, utility, street use, etc.).

There are a variety of actions that are "categorically exempt" from the SEPA process. For example, size is used as the criteria to differentiate between an exempt or nonexempt action. Exempted projects include most single-family homes, commercial buildings under 4,000 square feet, parking lots for 20 cars or less, and any landfill or excavation of 100 cubic yards or less. SEPA rules allow cities and counties to set their own size criteria based on a specific range for five categories of exemptions. The criteria cannot be more restrictive than those of SEPA unless the action affects an environmentally sensitive area.

One of the first steps in the SEPA process is the analysis of alternatives. Funds are available through FCAAP to assist in the EIS process and can actually be extended up to the time of implementation.

Executive Order 11990 and Executive Order 90-40

Enacted in 1977, the Federal Executive Order 11990 (Protection of Wetlands) protects wetlands to the extent possible from short- and long-term adverse impacts associated with the destruction or modification of wetlands. It is intended to prevent direct or indirect support of new construction in wetlands wherever there is a practicable alternative. As well as structural impacts, "new construction" includes draining, dredging, channelizing, filling, diking, impounding and related activities. This legislation mandates that all agencies performing wetland-related regulation utilize their full legal power to protect the beneficial uses of wetlands.

In 1990, the State Executive Order 90-40 (Protection of Wetlands) was enacted. The sections of this act relative to flood hazard reduction planning mandate that all state agencies rigorously enforce their existing authorities to protect wetland functions and values. To the extent permissible, mitigation for all agency actions affecting wetlands is required under SEPA authority.

Executive Order 11988

Federal Executive Order 11988, passed in 1977, furthers floodplain management legislation such as the Flood Disaster Protection Act and the National Flood Insurance Act. It mandates that short- and long-term adverse impacts associated with the occupancy and modification of floodplains be avoided to the extent possible. Likewise, when practicable, direct or indirect support of floodplain development shall be guided as follows:

- Activities Involving or Using Federal Lands: Each federal agency shall provide leadership and take action to reduce the risk of flood loss and hazards.

- Activities in a Floodplain: Each federal agency shall plan for, evaluate alternatives for and provide budget requests for issues of flood hazard and floodplain management.

- Public Review: Each federal agency shall provide the opportunity for early public review of any plans or proposals for actions in floodplains.

Flood Hazard Management

This section is concerned with policies and programs relating directly to issues surrounding flood hazard management and the protection of life and property. A primary regulatory tool is the National Flood Insurance Program (NFIP) which provides low cost insurance to communities that have adopted approved flood plain management regulations.

National Flood Insurance Program

The U.S. Congress initiated the National Flood Insurance Program (NFIP) in 1968 for the purpose of relieving the national Treasury and local jurisdictions from the burden of disaster relief. This program is administered by the Federal Insurance Administration (FIA) which is part of the Federal Emergency Management Agency (FEMA). The thrust of the program is to make affordable flood insurance available to communities. To qualify, the community must adopt approved flood plain management regulations. In 1973, Congress expanded the NFIP to require that funding for structures related to government programs within the 100-year flood plain be permitted only if the structure is covered under a flood insurance policy and the community participates in the NFIP.

The NFIP administers two separate programs, the emergency program and the regular program. Each has their own process within FIA and each provides for the community differently.

- Emergency Program—The process begins with the identification by FIA of flood prone communities. Notification comes in the form of a Flood Hazard Boundary Map (FHBM) which is a preliminary delineation of flood hazard areas. Along with the FHBM, the community receives an application from the FIA for the purpose of attaining limited amounts of flood insurance. Based on the FHBM, the community is required to adopt minimum flood plain management regulations. They are also encouraged to use any additional information available to establish flood elevations.

- Regular Program—The regular program provides communities full flood insurance once that community adopts a local flood plain management ordinance approved by FEMA. The ordinance is based on a detailed technical flood insurance study involving hydrologic and hydraulic analyses culminating in the Flood Insurance Rate Map (FIRM), and a report. Data on floodway width, cross sectional area and flood water velocity are provided at various points along the water course. The purpose is to determine the flood risk and thereby the insurance rates for areas adjacent to the river. The floodway map defines the areas along the river channel where encroachment is not allowed.

The floodplain management ordinance is a local ordinance which is intended to satisfy the FEMA requirement for participating in the NFIP. Washington State requirements for floodplain management ordinances are contained in Chapter 86.16 RCW. Typically, floodplain management ordinances contain the floodway designation, special flood hazard areas identified by the FIA and specific development regulations intended to minimize losses due to flooding. Specific regulations concern building codes for onsite disposal systems, the use of flood-resistant materials, the flood-proof design of onsite disposal systems, and special designs for RV parks. Other specific regulations involve land use, such as limiting subdivision for residential or commercial use and permitting agricultural, recreational and business uses in the floodplain. Variances and conditional use permits are often allowed for hardship situations which demonstrate need, or actions that will not in-

crease flood levels or result in the habitable portion or a structure being below the base flood elevation. Variances should maintain the minimum requirements of FEMA to continue participation in the NFIP.

State Flood Plain Management

Chapter 86.16 RCW—Flood Plain Management forms the core of the state's regulatory program. WAC 173-158 are the rules developed by Ecology to administer the provisions of Chapter 86.16 RCW. The State's regulatory program has adopted the NFIP minimum standards as the State minimum standards for floodplain management. Washington exceeds the minimum federal standards in one area—Chapter 86.16 RCW—which has a provision prohibiting new or substantially improved residential development in any designated floodway. Other provisions of the State's program include the availability of technical assistance to localities in determining floodplain boundaries and the ability to assist localities in the development of additional standards that exceed the minimum federal requirements.

County Flood Plain Management Ordinance

Text to be added later (if applicable)

County Stormwater Management Ordinance

Text to be added later (if applicable)

Appendix F

ALTERNATIVE MEASURES DEVELOPMENT

Table F-1
PROPOSED CAPITAL IMPROVEMENT PROJECTS

Ranking Criteria Categories	Weighting Factor (1 through 5)	Alternative Projects Point Score (1 through 3)													
		Overflow Return											Channel/ Dike Improvements		
		CIP-1 Alternative A (Projects D-1 & D-2 modified) Open ditches from Allen-West Rd to River west of Thomas Rd.	CIP-1 Alternative B (Projects D-1 & D-2 modified) Pipeline from Allen-West Rd to River west of Thomas Rd.	CIP-1 Alternative C (Project D-5) Pipeline to Leary slough along Allen-West Rd	CIP-2 Alternative A (Projects D-1 & D-2 modified) Open ditches from Allen-West Rd to River west of Thomas Rd.	CIP-2 Alternative B (Projects D-1 & D-2 modified) Pipeline from Allen-West Rd to River east of Thomas Rd.	CIP-3 (Project D-4) Upgrade northside return culverts	CIP-4 (Project C-6) Flood path roadway culverts	CIP-5 Alternative A (Project C-1 modified) Diversion to Joe Leary slough	CIP-5 Alternative B (Project D-8) Pump station at Farm-Market Rd.	CIP-5 Alternative C (Project C-9 & D-3 combined) Diversion dikes/channel west of Farm-Market Rd.	CIP-5 (Project D-9) District 5 outfalls	CIP-7 (Project C-7) Edison Slough Improvements	CIP-8 (Project C-2 modified) Chuckanut Dr. bypass channel	CIP-9 (Project C-10) Setback Dikes, Bypass Channels, Road Crossings
Public Safety and Health Protection	4	3	3	3	3	3	2	3	2	1	3	2	3	3	3
Improved Flood Warning															
Improved Emergency Access															
Reduced Road/ Structure Flooding															
Total Category Points															
Category Points X Weighting Factor		12	12	12	12	12	8	12	8	4	12	8	12	12	12
Flood Hazard Reduction Benefit	5	2	2	2	2	2	2	2	2	1	3	2	2	3	3
Flooding Frequency/ Duration															
Flood Prone Area Reduction															
Frequent Flood Damage Reduction															
Total Category Points															
Category Points X Weighting Factor		10	10	10	10	10	10	10	10	5	15	10	10	15	15
Environmental/Socio-Economic Benefit	4	3	3	2	3	3	2	2	2	2	2	2	2	3	3
Water Quality Protection															
Fish/ Wildlife Enhancement															
Farm Preservation															
Total Category Points															
Category Points X Weighting Factor		12	12	8	12	12	8	8	8	8	8	8	8	12	12
Implementation Feasibility	4	3	2	2	3	2	3	2	1	3	1	2	2	1	1
Facility Requirements															
Land Owner Acceptance															
Funding Potential															
Permit/Legal Issues															
Total Category Points															
Category Points X Weighting Factor		12	8	8	12	8	12	8	4	12	4	8	8	4	4
Project's Compatibility (with)	4	3	3	3	3	3	3	2	2	3	2	3	2	2	2
D/D district Plans															
County Programs/ Ordinances															
State Regulations															
Total Category Points															
Category Points X Weighting Factor		12	12	12	12	12	12	8	8	12	8	12	8	8	8
Total Project Ranking Points		58	54	50	58	54	50	46	38	41	47	46	46	51	51
*** Estimated Implementation Cost**		$ 200,000	$ 850,000	$ 770,000	$ 310,000	$ 990,000	$ 270,000	$ 370,000	$ 490,000	$ 200,000	$ 1,010,000	$ 980,000	$ 540,000	$ 950,000	$ 9,140,000
Consensus (Yes or No)		N	N	Y	Y	N	Y	Y	Y	N	N	Y	Y	N	Y

* = Costs for Design, Construction, Administration

June 8, 1995 Stakeholder Meeting

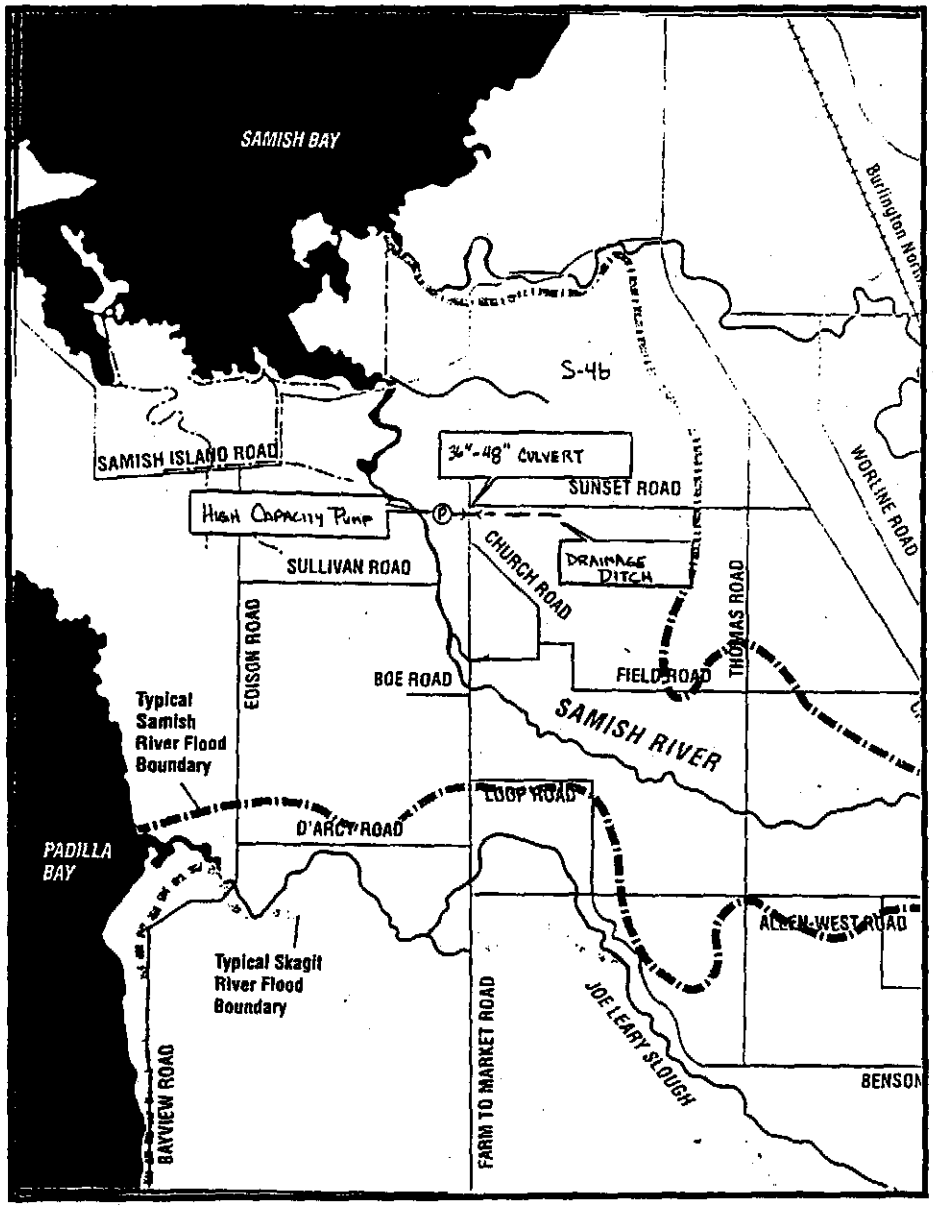
Districts Represented: Dike/ Drainage District 25, Diking District 5, Drainge District 16

Not in Attendance: Diking District 19, Drainage District 14

Table F-2
Non-Structural Projects Evaluation Matrix

Ranking Criteria Categories	Weighting Factor (1 thru 5)	Maintenance Projects					Watershed Protection/ Floodplain Management				
		Project C-6 (flood path road culverts)	Project S-3 (remove point bars)	Project D-7 (repair bank erosion in Dist 25)	Project D-9 (upgrade west dikes D/S of Sullivan Rd)	Project C-8 (Spot repair in Sec 14)	Project C-3 (floodway designations)	Project C-9 (ring dikes)	Project C-11 (elevate structures)	Project C-12 (lake Samish reregulation)	Project C-13 (enhanced development runoff standards)
Public Safety and Health Protection											
Improved Flood Warning	4	3	1	2	2	2	1	1	1	1	1
Improved Emergency Access											
Reduced Road/ Structure Flooding											
Total Category Points											
Category Points X Weighting Factor		12	4	8	8	8	4	4	4	4	4
Flood Hazard Reduction Benefit											
Flooding Frequency/ Duration	5	2	1	2	2	2	2	3	3	1	2
Flood Prone Area Reduction											
Frequent Flood Damage Reduction											
Total Category Points											
Category Points X Weighting Factor		10	5	10	10	10	10	15	15	5	10
Environmental/Socio-Economic Benefit											
Water Quality Protection	4	3	1	2	2	2	2	3	1	2	3
Fish/ Wildlife Enhancement											
Farm Preservation											
Total Category Points											
Category Points X Weighting Factor		12	4	8	8	8	8	12	4	8	12
Implementation Feasibility											
Facility Requirements	4	3	3	3	3	3	2	2	2	1	2
Land Owner Acceptance											
Funding Potential											
Permit/Legal Issues											
Total Category Points											
Category Points X Weighting Factor		12	12	12	12	12	8	8	8	4	8
Project's Compatibility (with)											
D/D district Plans	4	3	2	2	3	2	3	2	2	2	3
County Programs/ Ordinances											
State Regulations											
Total Category Points											
Category Points X Weighting Factor		12	8	8	12	8	12	8	8	8	12
Total Project Ranking Points		58	33	46	50	46	42	47	39	29	46
Consensus (Yes or No)		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

PRELIMINARY LOCALIZED SPOT PROJECTS



Samish River
Flood Hazard Management Plan

PROPOSED PROJECT S-4b (Sunset Road Pump Station)

ISSUES

- Field Drainage
- Property Access

CONCERNS

- Flooded Fields
- Access to building
- Crop damage

PRELIMINARY SOLUTIONS

- Extend drainage ditch on Sunset Road west to river dike
- Construct large capacity pump station with return to river

BENEFITS

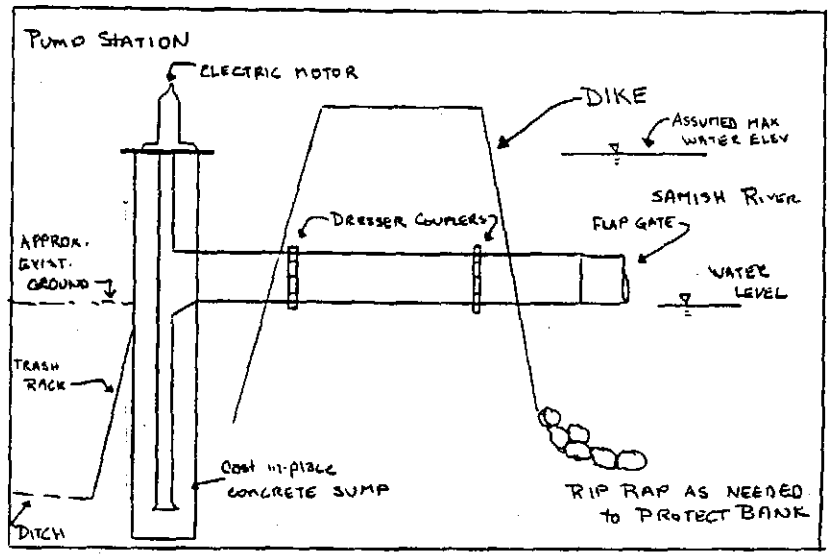
- Allows installation of flooding alarm system
- Reduces length of flooding
- Field drainage and minor overflow return

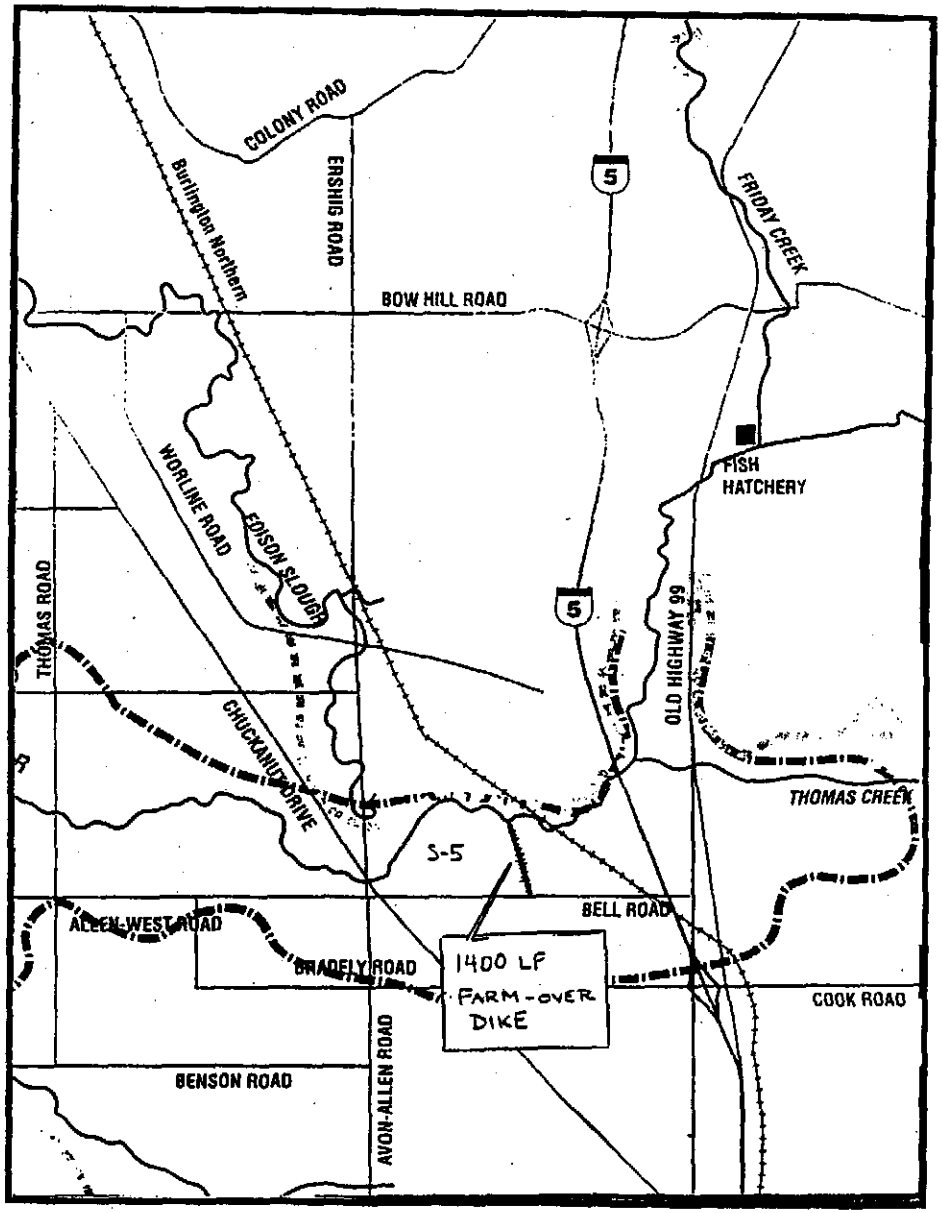
COST ITEMS

- High capacity pump station with outfall to river
- 36" to 48" roadway culvert
- 1200 LF ditch
- (2) 24" outfall pipes
- Trash rack and tide gates

POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvements Funds (culvert crossings)
- FCAAP Matching Funds
- River Improvement Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT S-5 (Farm-Over Dike)

ISSUES

- Flood water return

CONCERNS

- Field flooding
- Field erosion
- Crop damages
- Control of flood flows upstream of BNRR

PRELIMINARY SOLUTIONS

- Install farm-over dike to route overflows back to river

BENEFITS

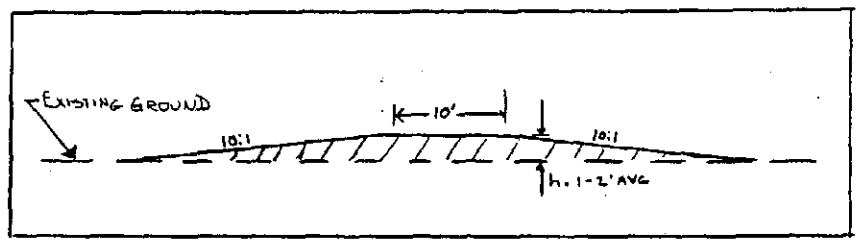
- Return of floodwater to river channel
- Reduces Field erosion

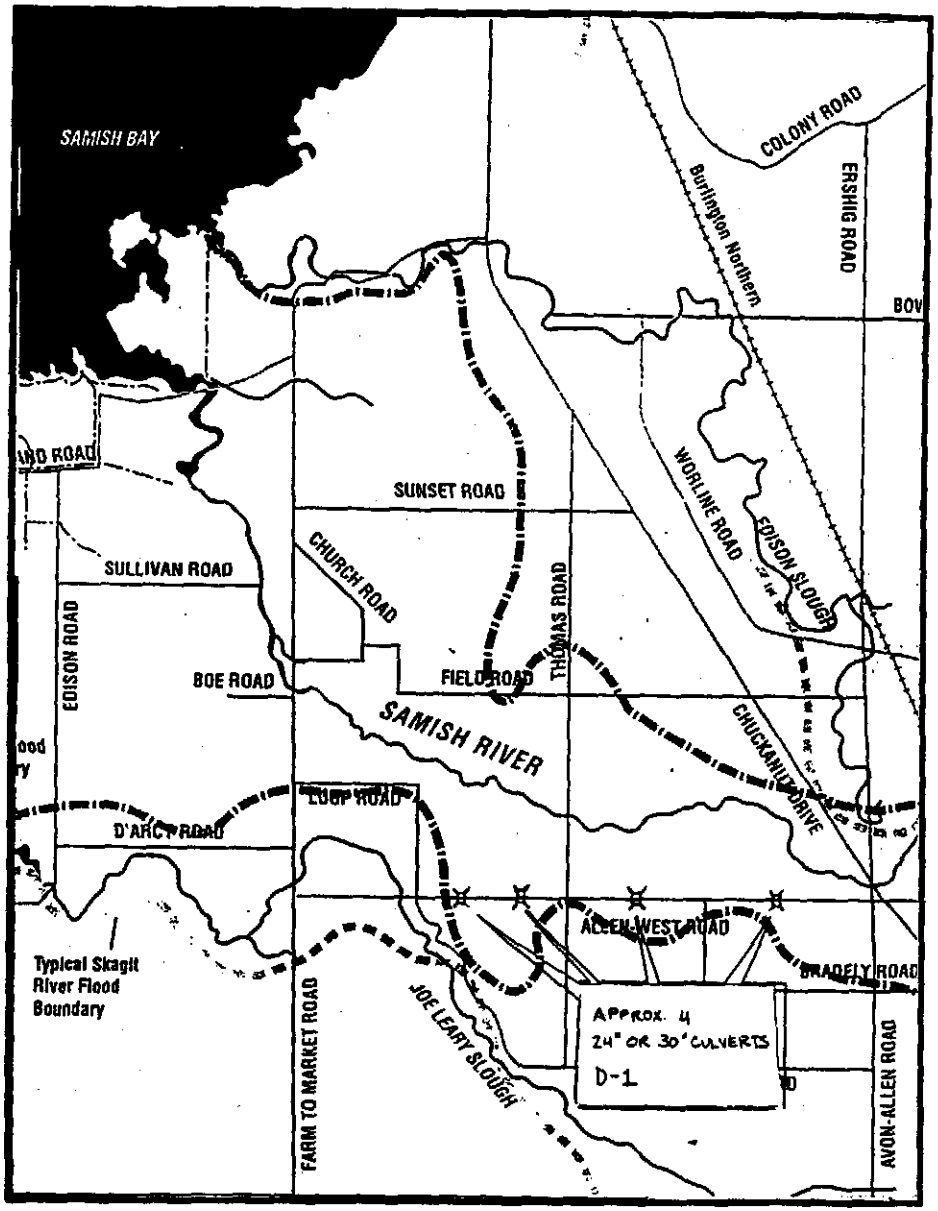
COST ITEMS

- 1400 LF low dike
- Rock chute outlet
- Rip rap protection

POTENTIAL FUNDING

- Drainage/Diking District Funds
- River Improvement Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT D - 1 (Culverts under Allen-West Road)

ISSUES

- Blockage of natural flow paths
- No cross culverts
- Prolonged field flooding

CONCERNS

- Structure flooding
- Structure access
- Crop/ livestock damage
- Work stoppages

PRELIMINARY SOLUTIONS

- Install multiple cross culverts under road at approx. 4 locations
- Place near existing drainage paths
- Coordinate with property lines
- Phase after return channel construction (Proj D-2)

BENEFITS

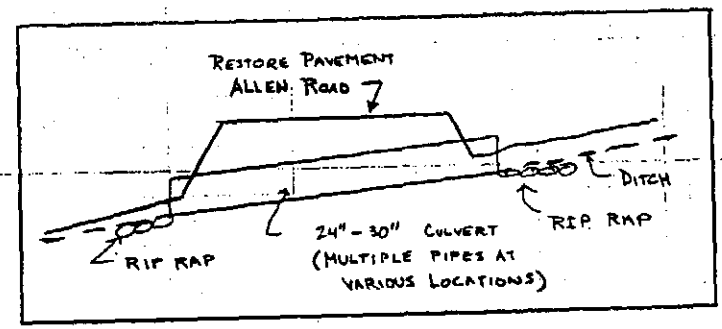
- Reduction in time of flooding
- Improved structure access
- Reduced field/ livestock damage

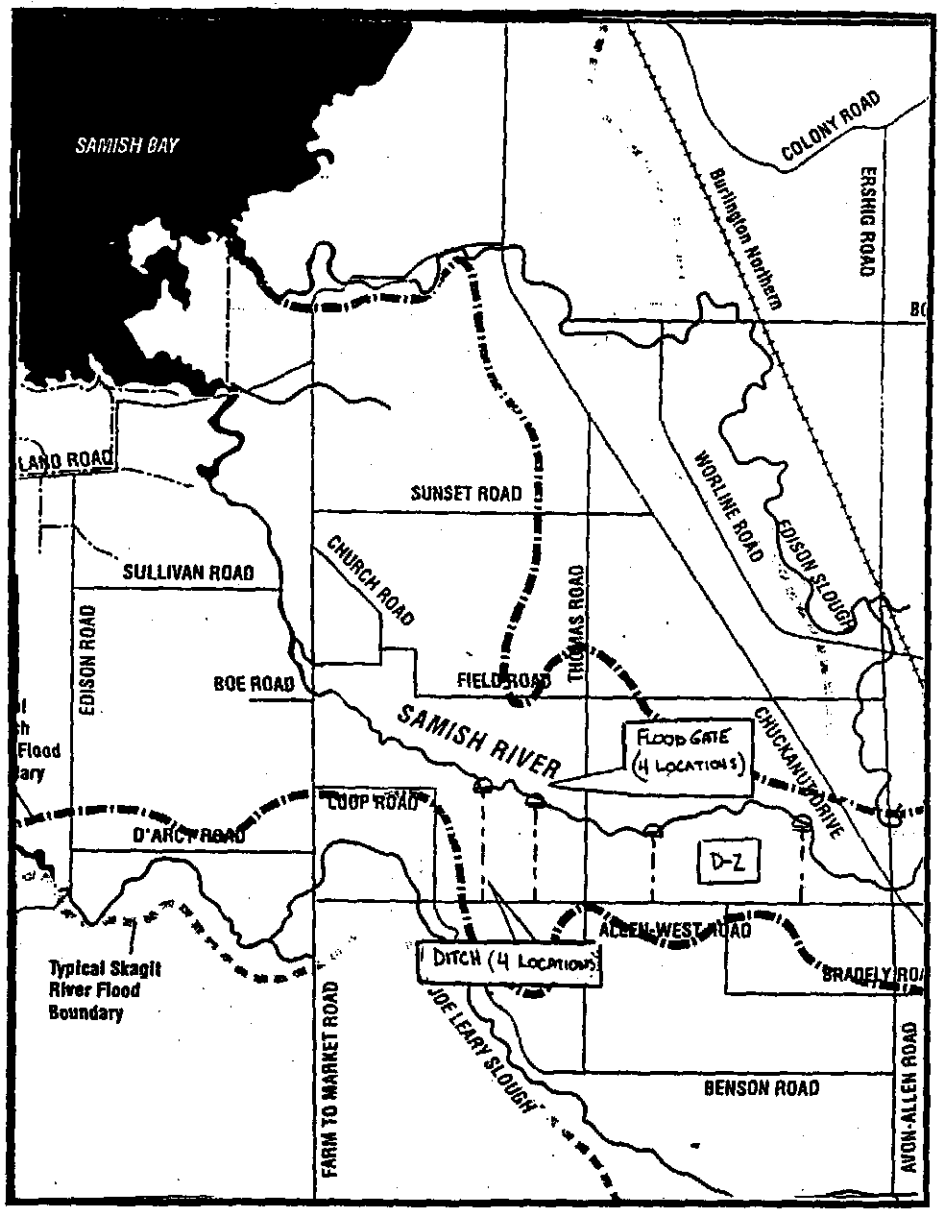
COST ITEMS

- Approx. 550 LF 24-30" culvert
- Trench excavation
- Asph pavement restoration
- Rocked entrance/ exit stabilization

POTENTIAL FUNDING

- County Road Improvement Funds
- Drainage District Funds
- River Improvement Funds





Samish River
Flood Hazard Management Plan
PROPOSED PROJECT D- 2 (Return channels to river)

ISSUES

- Lack of overbank/ drainage return channels through fields
- Insufficient return culverts through existing dikes
- Prolonged field flooding

CONCERNS

- Structure flooding/ access
- Crop damage/ livestock displacement
- Field erosion
- Emergency Access

PRELIMINARY SOLUTIONS

- Install at approx. 4 locations
- Excavate broad drainage ditch to return flood/ drainage water
- Route ditches to (36"-48") return culverts with flood gate through dike
- Coordinate with property lines
- Associate with return channel construction (Proj D-2)

BENEFITS

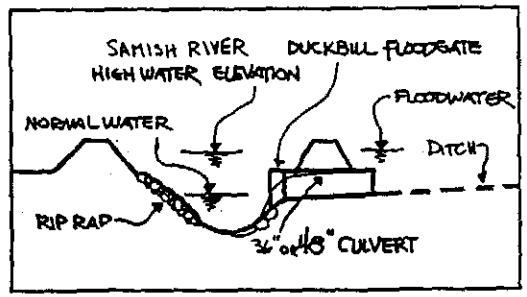
- Reduction in time of flooding
- Improved structure access
- Reduced field/ livestock damage

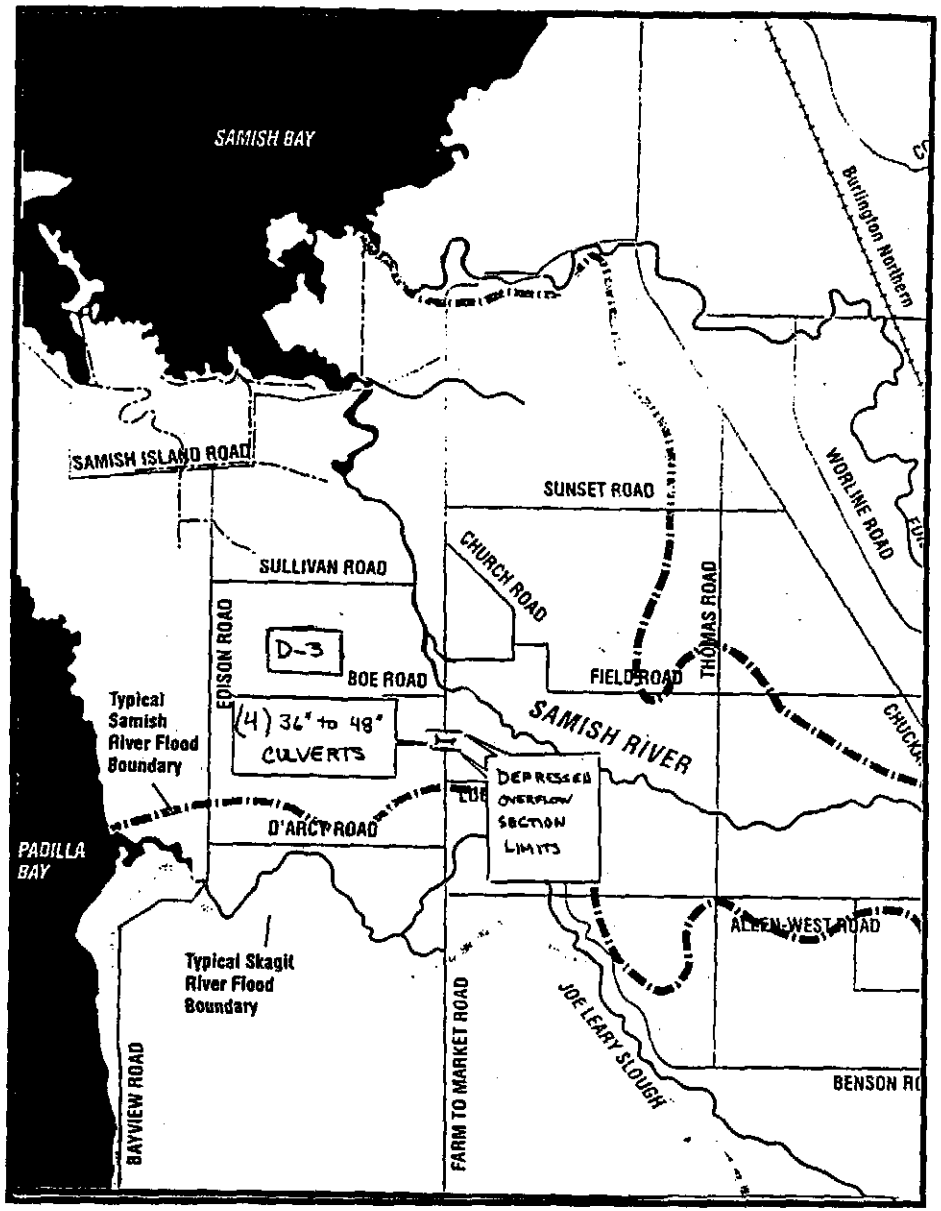
COST ITEMS

- Approx. 2000 to 3000 LF ditch excavation at each location
- Approx. 60 LF culvert excavation /installation at each location
- Flood gates
- Rocked entrance/ exit stabilization
- Easement acquisition

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT D - 3 (Lower grade elev. of Farm to Market Road)

ISSUES

- Artificial dike created by Farm to Market Road
- Blockage of natural flow paths
- No cross culverts

CONCERNS

- Increased flood water elevation east of Farm to Market Road
- Structure flooding/ access
- Crop damage/ livestock displacement
- Work stoppages
- Water quality impact of dairy flooding
- If solution implemented will increase flood damage in District 5

PRELIMINARY SOLUTIONS

- Install multiple cross culverts under road, or lower elevation of roadway at south approach to Samish River bridge

BENEFITS

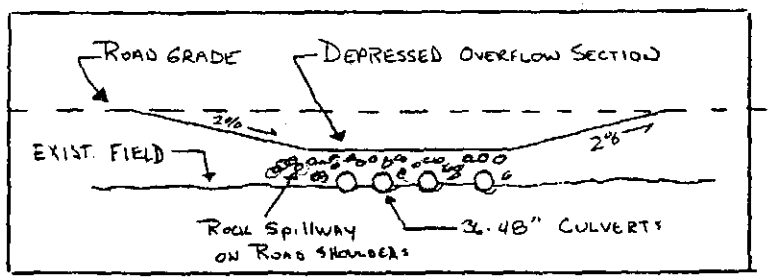
- Lowers peak flood water surface east of Farm to Market Road
- Reduction in time of flooding east of Farm to Market Road
- Reduction in frequency of floodwaters overtopping Field Road, impacting dairy, and flooding District 16
- Improved structure access
- Reduced field/ livestock damage

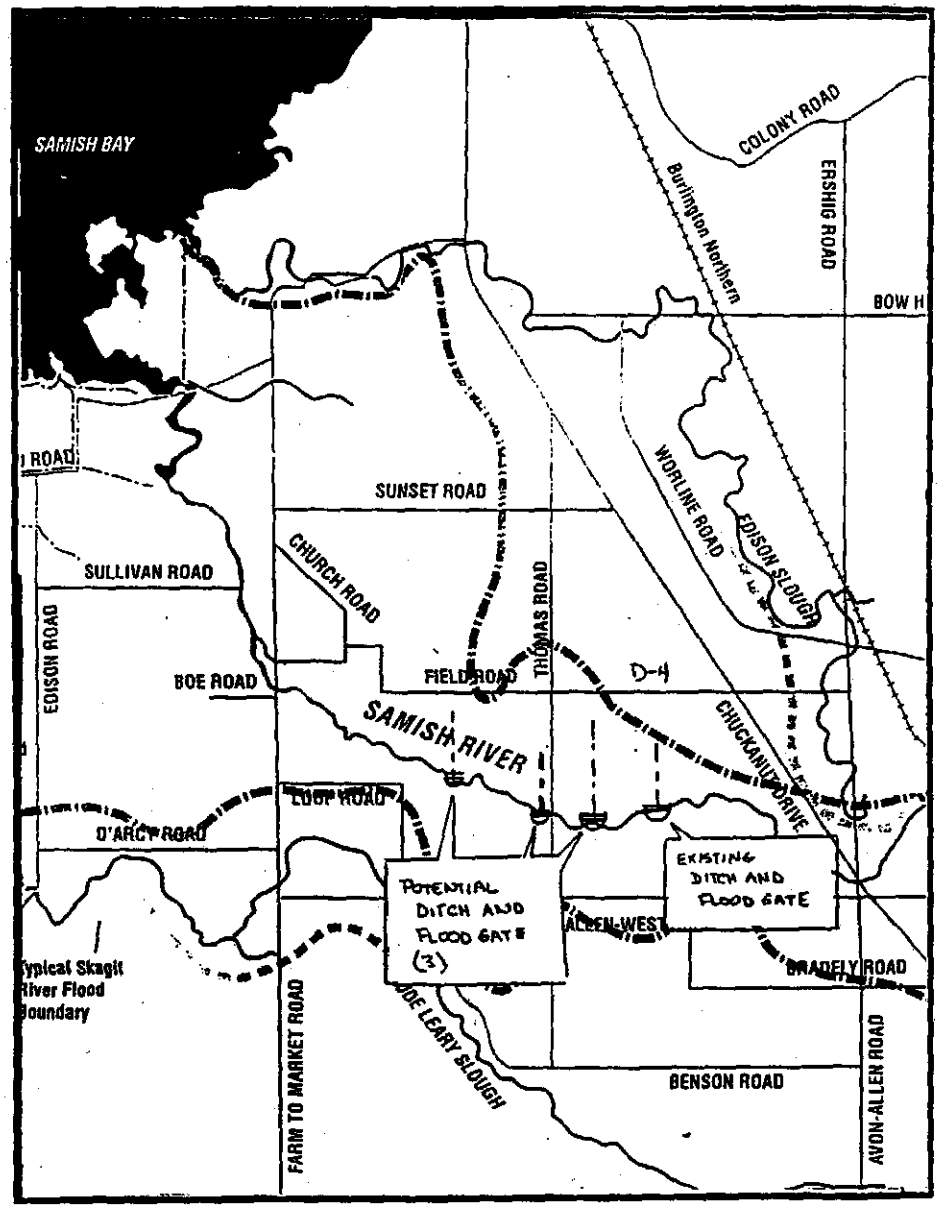
COST ITEMS

- Re-grade approx. 300 LF of roadway
- Install (4) 36" to 48" culverts
- Asph pavement restoration
- Install rocked spillway sections on road shoulders

POTENTIAL FUNDING

- County Road Improvement Funds
- Drainage District Funds
- River Improvement Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT D - 4 (Repair/ replace/ upgrade return culverts)

ISSUES

- Insufficient drainage return
- Existing plugged/ undersized culverts
- Malfunctioning flood gates

CONCERNS

- Structure flooding/ access
- Crop damage/ livestock displacement
- Prolonged field flooding due to inadequate sizing

PRELIMINARY SOLUTIONS

- Document existing floodwater return system
- Identify return culverts to be replaced
- Establish locations for additional return culverts
- Replace existing malfunctioning floodgates with flexible duckbill floodgates

BENEFITS

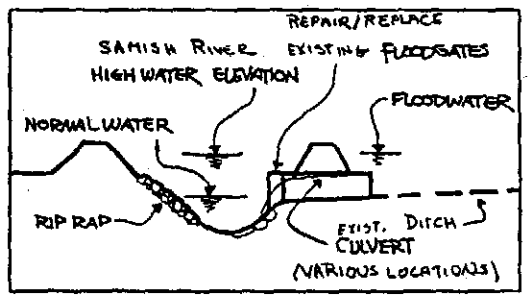
- Reduction in time of flooding
- Reduction of "backflow" flooding problems
- Reduced field/ livestock damage

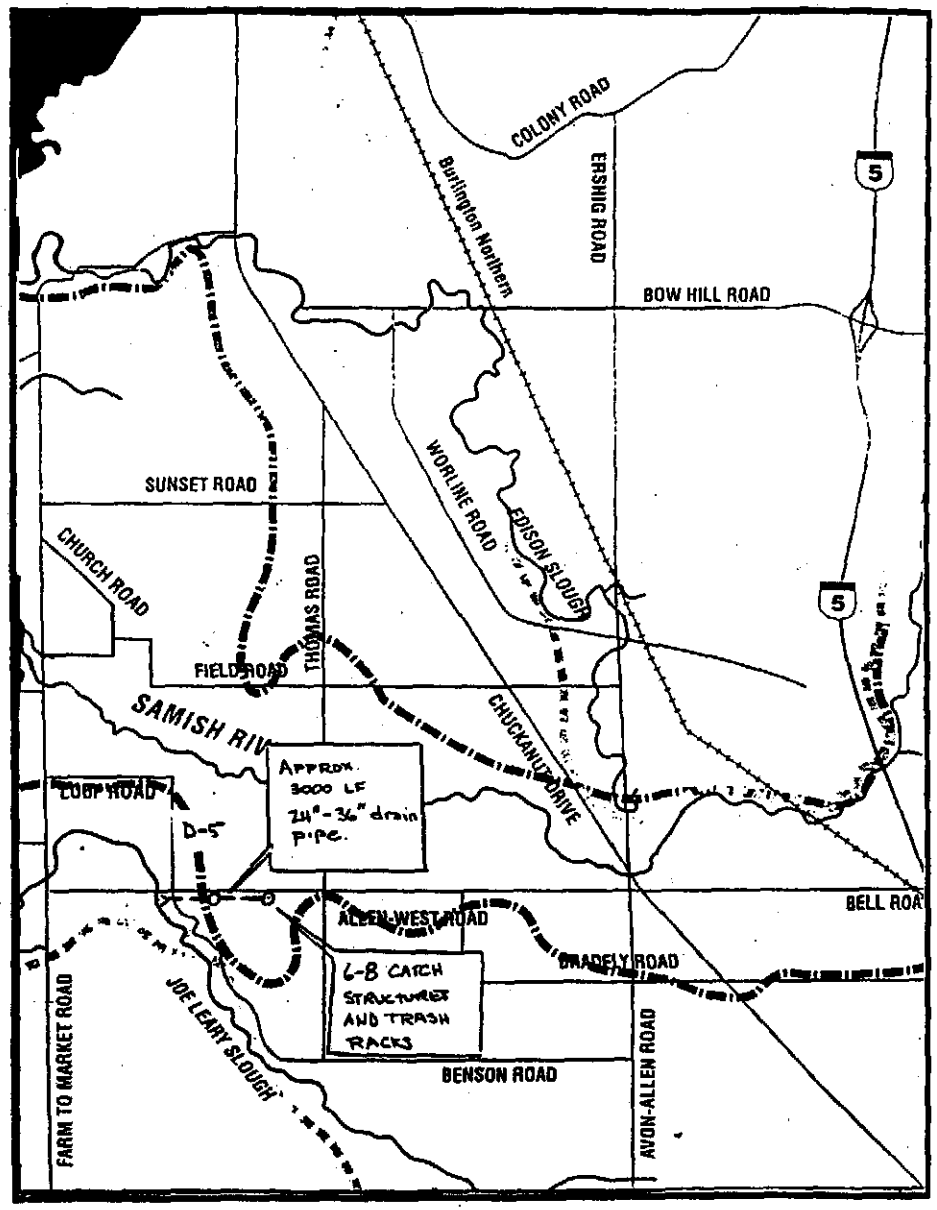
COST ITEMS

- Approx. 60 LF culvert excavation /installation at each location
- Flood gates
- Rocked entrance/ exit stabilization

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT D - 5 (Upgrade 3000 LF of 15" drain to Joe Leary slough)

ISSUES

- Existing drain undersized for floodwater return
- Existing drain hard to maintain
- Existing drain approx. 50 year old, approaching design life

CONCERNS

- Long flood water drainage time due to limited capacity of existing 15" drain
- Flooding problems exacerbated due to frequent clogging
- Installation of project could impact Joe Leary slough

PRELIMINARY SOLUTIONS

- Enlarge approx. 3000 LF of drainage pipe
- Install new catch structures and trash racks
- Provide adequate maintenance access
- Install adequate outfall protection at Joe Leary slough

BENEFITS

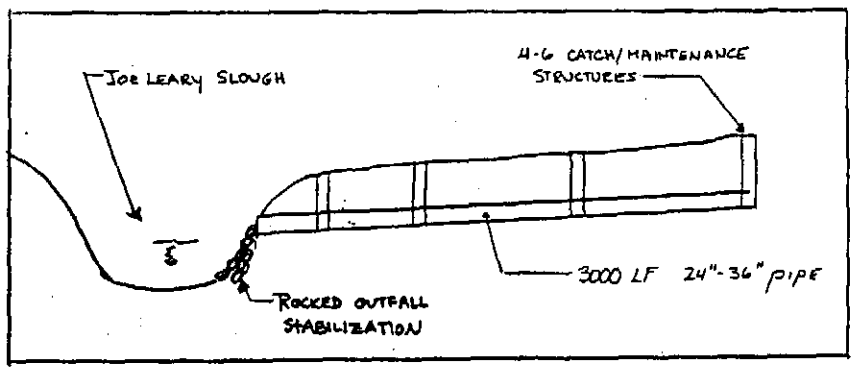
- Reduction in time of flooding
- Improved maintenance access
- Reduced field/ livestock damage

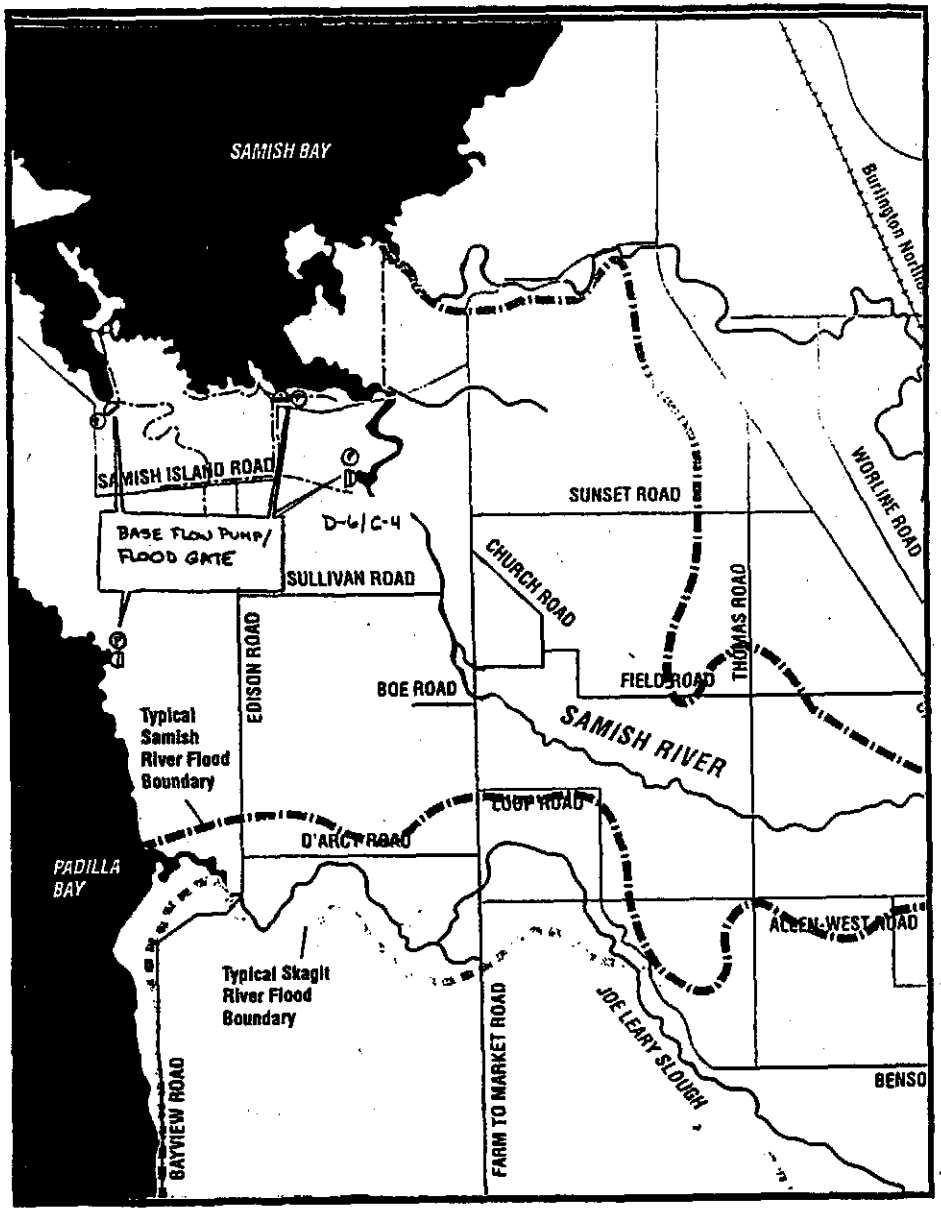
COST ITEMS

- Approx. 3000 LF trench excavation
- Removal of existing 15" drain
- Approx. 3000 LF of 24"-36" drain pipe
- 6 to 8 catch/ maintenance structures
- Rocked outfall stabilization

POTENTIAL FUNDING

- County Road Improvement Funds
- Drainage District Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT D - 6/ C - 4 (District 5 outfalls)

ISSUES

- Limited outfall capacity
- Long time to drain floodwaters

CONCERNS

- Structure flooding/ access
- Emergency access during floods
- Crop damage/ livestock displacement
- Field depletion

PRELIMINARY SOLUTIONS

- Install additional outfalls to Samish Bay
- Install base flow pump at each outfall to prevent sedimentation of discharge channel

BENEFITS

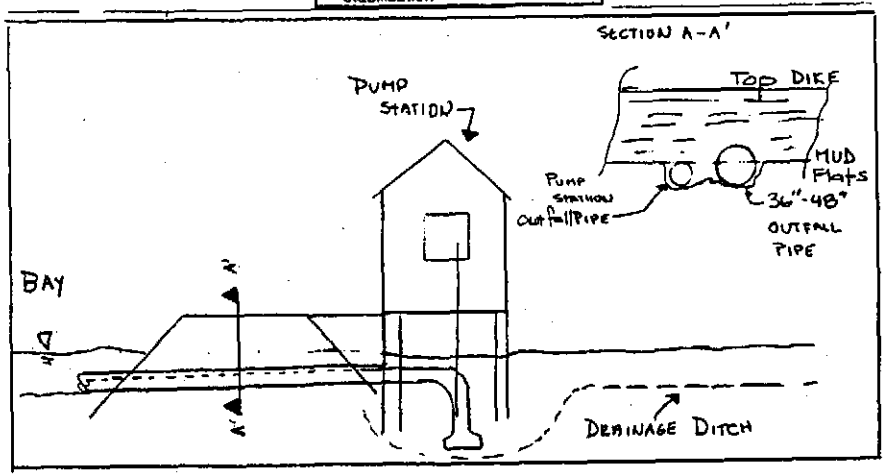
- Reduction in time of flooding
- Improved structure access
- Reduced field/ livestock damage

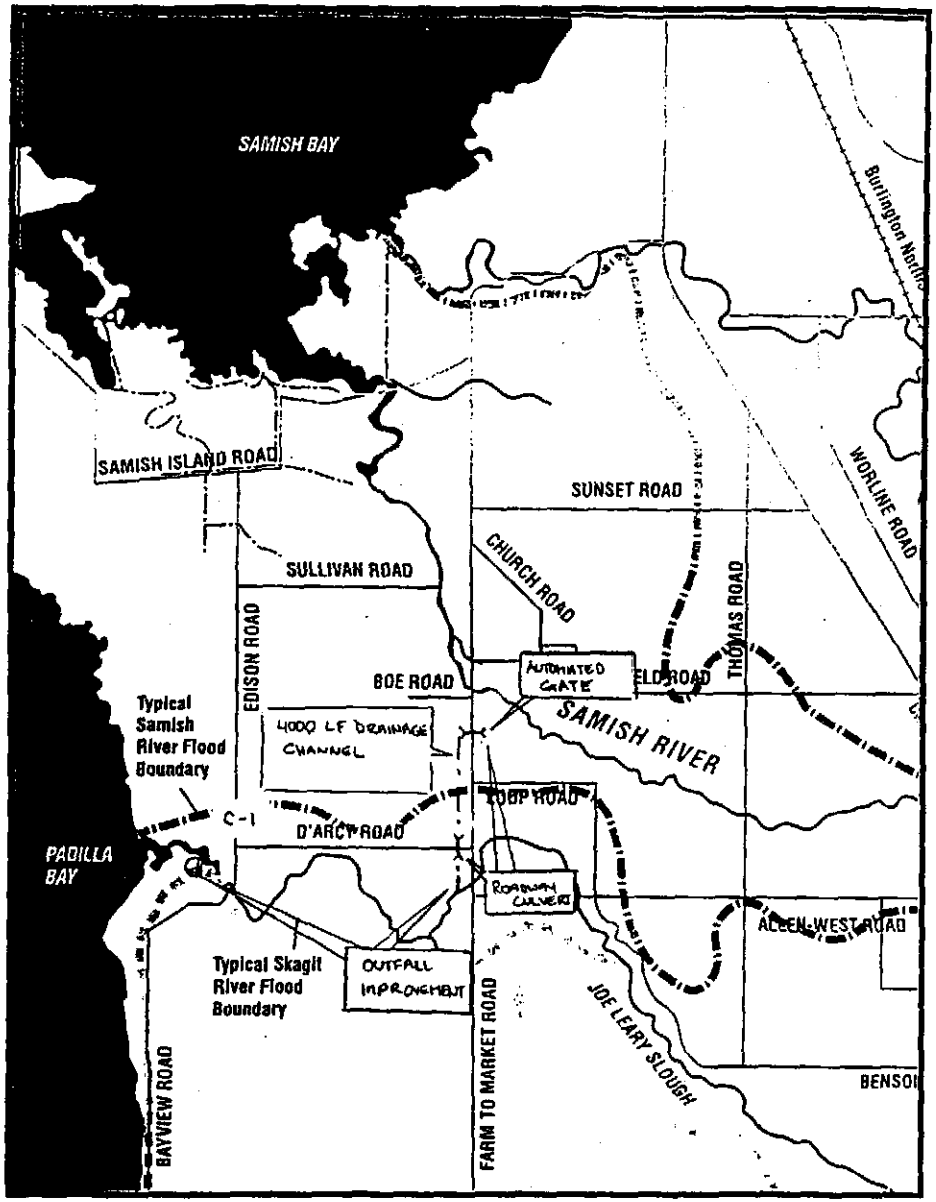
COST ITEMS

- Multiple 36" to 48" outfall pipes at 3 to 4 locations
- Sea-dike excavation and replacement (affected by tides)
- Drainage channel excavation leading to new outfalls
- Base flow pump station at each site
- Rocked entrance/ exit stabilization

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT C - 1 (Diversion channel to Joe Leary slough)

ISSUES

- Limited floodwater return capacity to river during high flows/ high tides
- District 5 has limited capacity to handle flood flows over Farm to Market Rd.

  Joe Leary slough was a historic Samish River distributary

CONCERNS

- Prolonged floodwater return time
- Structure flooding/ access on south side of river east and west of Farm to Market Rd.
- Emergency access during floods
- Crop damage/ livestock displacement
- Impact of proposed project on flooding along Joe Leary slough

PRELIMINARY SOLUTIONS

- Construct flood water diversion channel on west side of Farm to Market Rd. from south of bridge to Joe Leary slough
- Remove constrictions in slough downstream of Farm to Market Rd.
- Improve outfall capacity of slough to bay as required
- Install automated gates at intake to diversion channel as required to prevent additional flooding of slough
- Coordinate with Project D-3 (Lowering of Farm to Market Rd)

BENEFITS

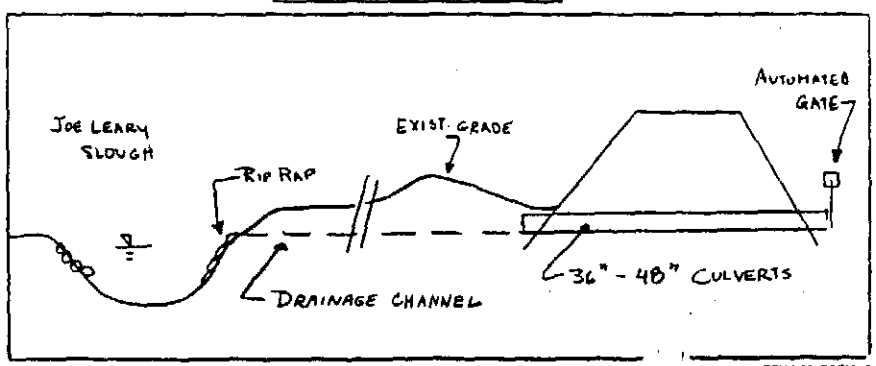
- Reduction in time of flooding east of Farm to Market Rd. (when coordinated with project D-3)
- Reduction of flood frequency/ depth west of farm to market Rd.
- Improved floodwater return capacity
- Reduced field/ livestock damage

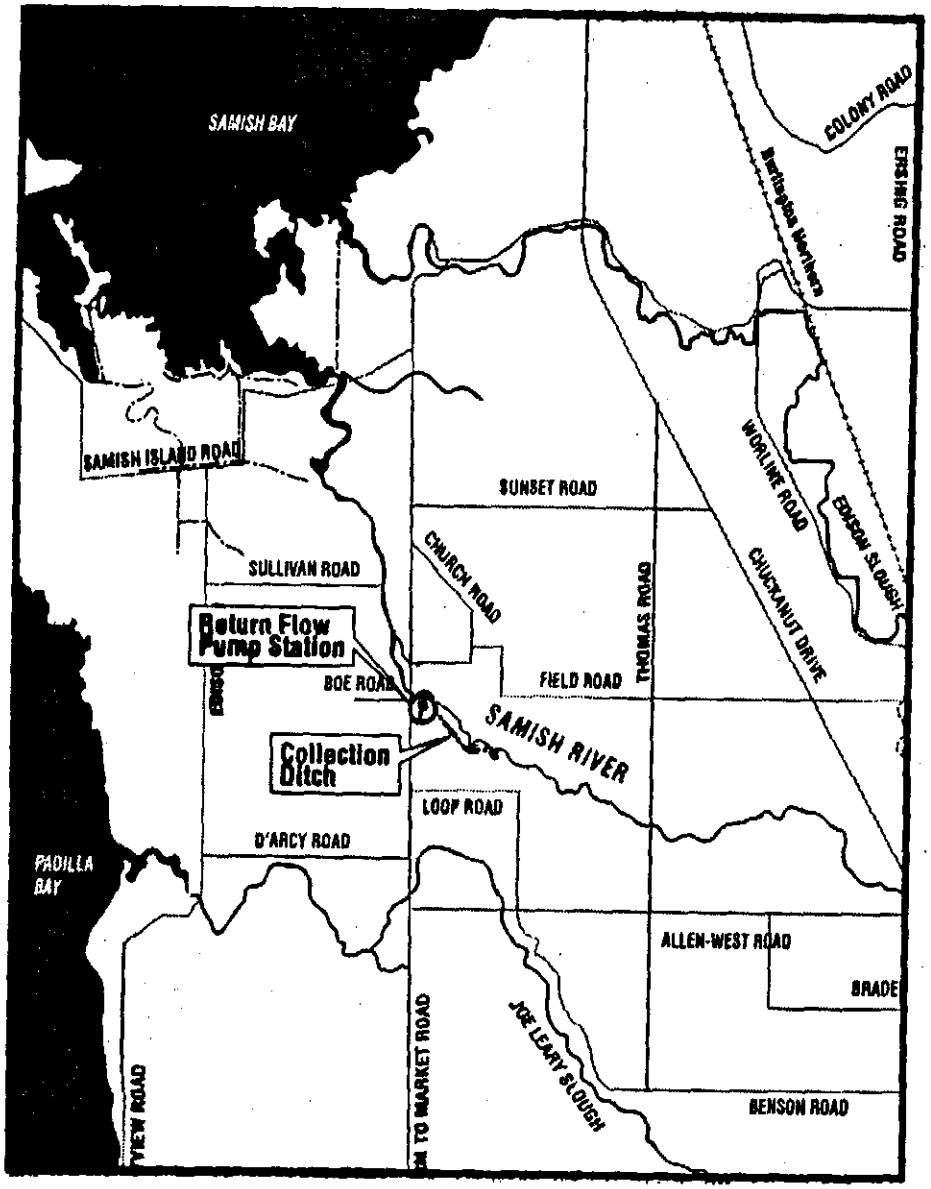
COST ITEMS

- Approx 4000 LF drainage channel excavation
- Roadway cross culverts at 2 locations and associated roadway replacement
- Removal of flow constrictions in slough
- Automated gates at intake
- Outfall improvement to Joe Leary as required (additional/ enlarged pipes, and/or pump)

POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvement Funds
- River Improvement Matching Funds





Samish River Flood Hazard Management Plan

PROPOSED PROJECT D-8 (Flood water return pump station at Farm-Market Rd.

ISSUES

- Fields on south side of river U/S of Farm-Market Rd. are slow to drain after a flood
- Existing return culverts do not fully drain while the river remains at an elevated stage

CONCERNS

- Extended field flooding
- Crop damage/livestock displacement

PRELIMINARY SOLUTIONS

- Install flood water return pump on south side of river east of Farm-Market Rd.
- Construct 1000 LF drainage ditch along south side of river at toe of existing dike to direct flood water to pump station

BENEFITS

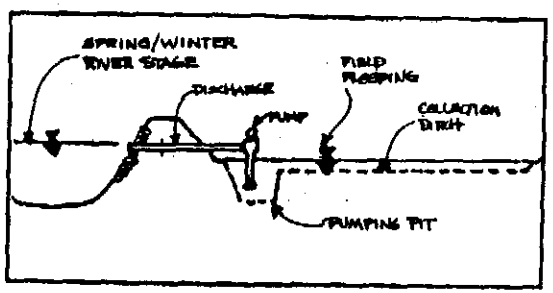
- Reduction in time of flooding for approximately 118 ac of fields

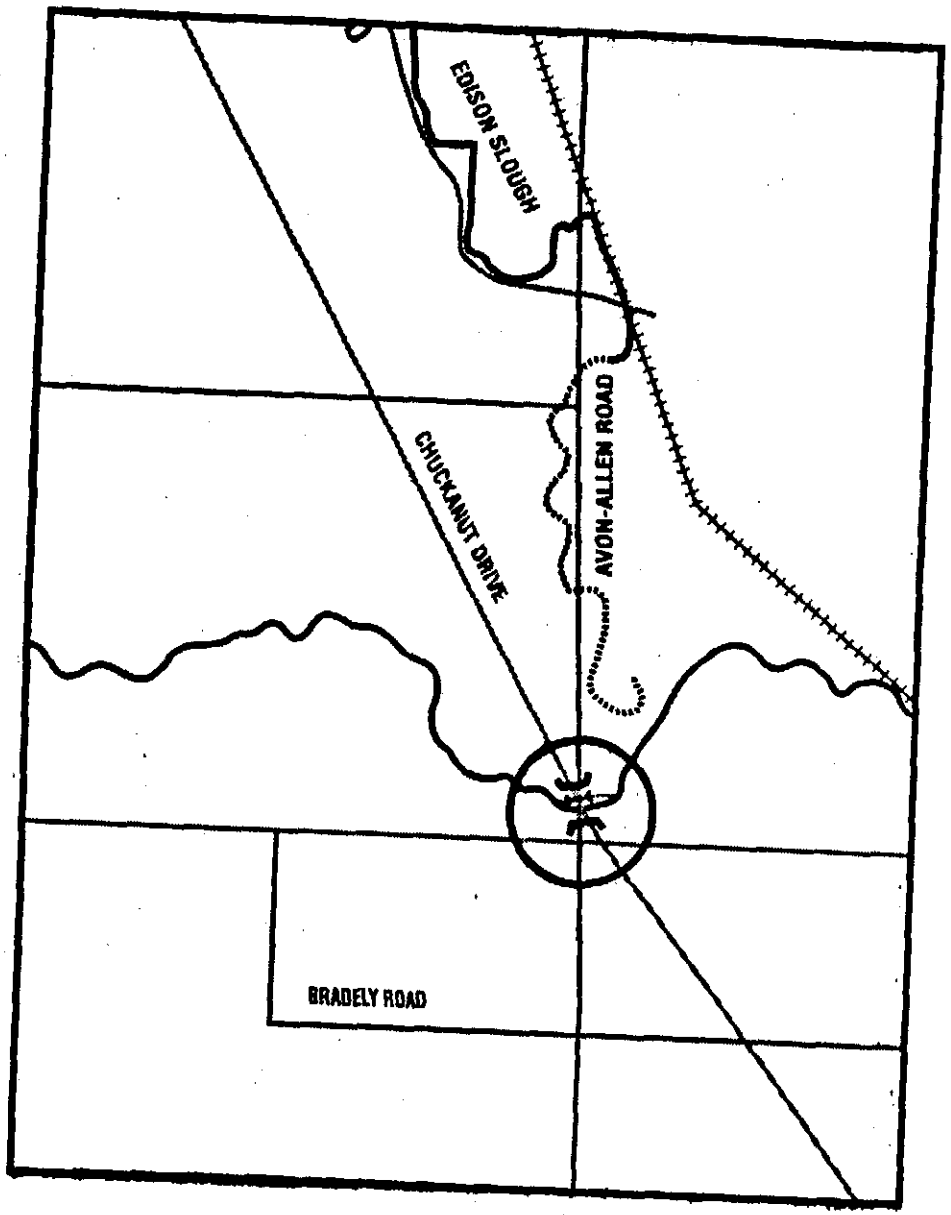
COST ITEMS

- Pump system
- Discharge piping with flap gate
- Dike stabilization at discharge
- Pump station structure
- Ditch excavation

PRELIMINARY FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds





Samish River Flood Hazard Management Plan

PROPOSED PROJECT C-2 (Chuckanut Dr. bridge improvements)

ISSUES

- Bridge structure restricts river channel area
- Downstream channel may have greater capacity than bridge section

CONCERNS

- Bridge restriction leads to increased upstream water surface elevation and flooding
- Field flooding/erosion
- Crop damage/livestock displacement
- Structure/roadway flooding

PRELIMINARY SOLUTIONS

- Expand bridge crossing capacity
- Install 8 to 9 foot diameter culvert under north abutment, or
- Expand existing bridge section capacity
- Channel excavation for supplemental capacity

BENEFITS

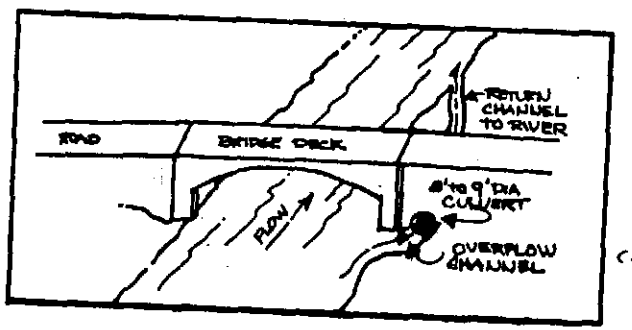
- Reduced water surface elevation upstream of Chuckanut Dr.
- Enhanced river channel capacity
- Reduction in flooding frequency
- Reduced pollution associated with frequent Dairy flooding

COST ITEMS

- Bridge reconstruction
- 100-300 feet pipe jacking excavation
- Supplemental channel excavation
- Environmental restoration

POTENTIAL FUNDING

- WSDOT Maintenance Funds?
- FCAAP Matching Funds
- River Improvement Matching Funds
- Centennial Clean Water Fund



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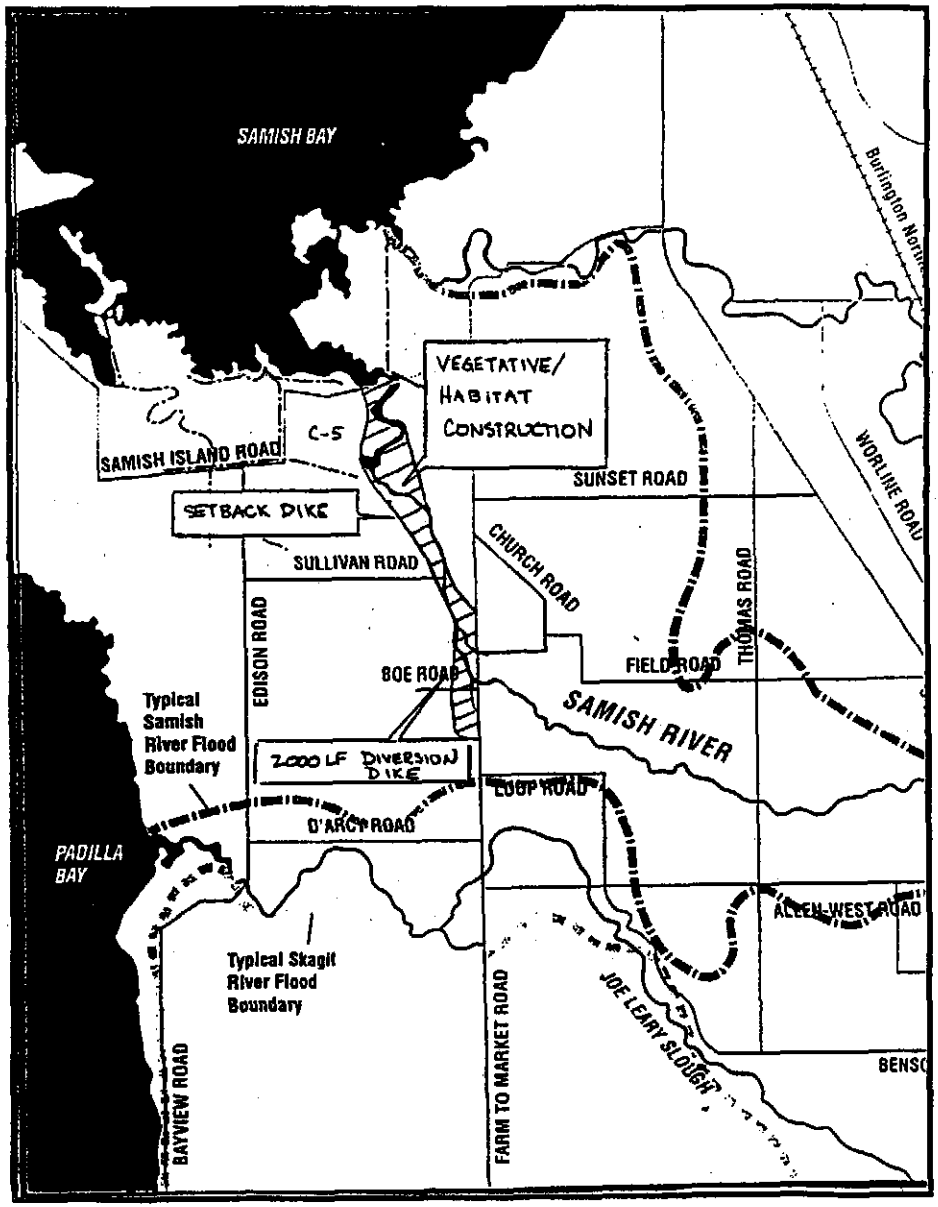


Samish River
Flood Hazard Management Plan

PROPOSED PROJECT C - 5 (Diversion/ setback dikes west of Farm to Market Rd.)

ISSUES

- Elevated water surface profile of river due to location of existing dikes
- No existing return channels to river on south side west of Farm to market Rd.

CONCERNS

- Structure flooding/ access
- Emergency access during floods
- Crop damage/ livestock displacement
- Field depletion

PRELIMINARY SOLUTIONS

- Construct diversion dike on west side of Farm to Market Rd. to route flood waters back to river
- Construct setback dikes and floodway along river from Farm to Market Rd. to mouth
- Improve discharge capacity at Edison bridge.

BENEFITS

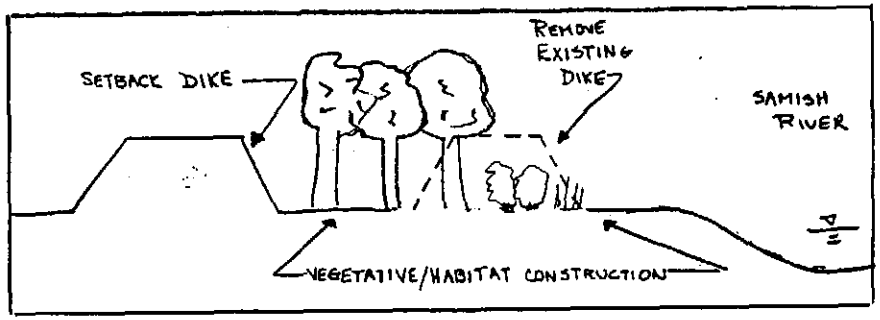
- Reduces water surface profile west of Farm to Market Rd.
- Improves river capacity east of Farm to Market Rd.
- Reduction in flooding depths along south side of river
- Improved structure/emergency access
- Reduced field/ livestock damage
- Habitat enhancement

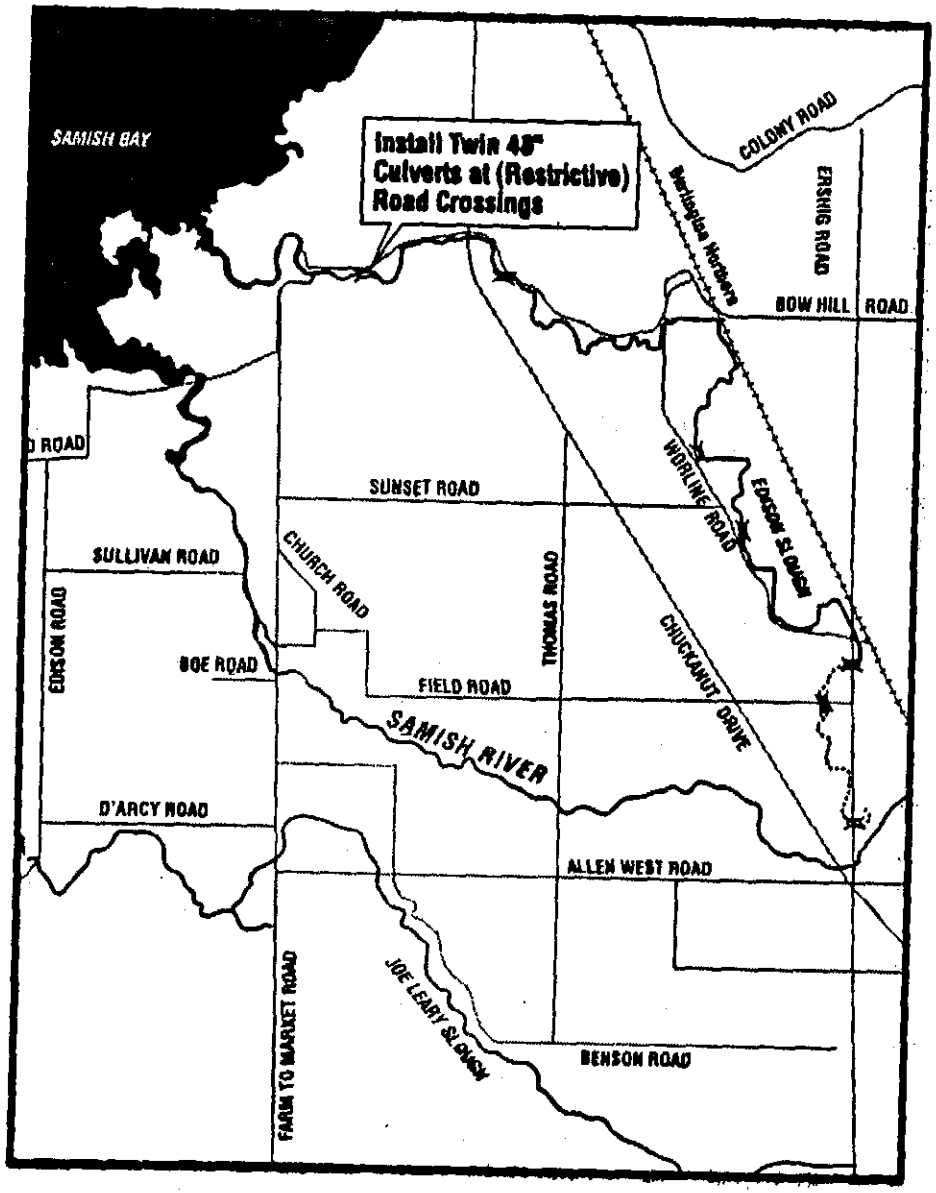
COST ITEMS

- 2000 LF diversion dike
- Approx 1.5 mi. dike removal and setback dike construction
- Regrade approx 500 to 600 LF of roadway at two locations
- Install energy dissipation at two locations
- Vegetative/Habitat construction
- Land acquisition

POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvement Funds
- FCAAP Matching Funds
- River Improvement Matching Funds
- Conservation Futures Matching Funds
- DNR ALEA Grant
- Centennial Clean Water Fund Match (WQ components)





Samish River Flood Hazard Management Plan

PROPOSED PROJECT C-7 (Edison Slough Improvements)

ISSUES

- Historic distributary has been blocked by road fills and grading of farm fields
- Majority of existing roadway culverts are undersized or plugged
- Slough channel has been realigned and capacity diminished in multiple locations

CONCERNS

- Historic flow path has been blocked thus diminishing the historic river system capacity
- Field flooding/ erosion and extended after event time to drain
- Crop damage/ livestock displacement

PRELIMINARY SOLUTIONS

- Upgrade selected existing roadway culverts to provide even flow capacity through system
- Install new culverts under roadway fills blocking the natural flood path west of Ershig Rd.
- Improve channel capacity at select locations where the cross section has been restricted

BENEFITS

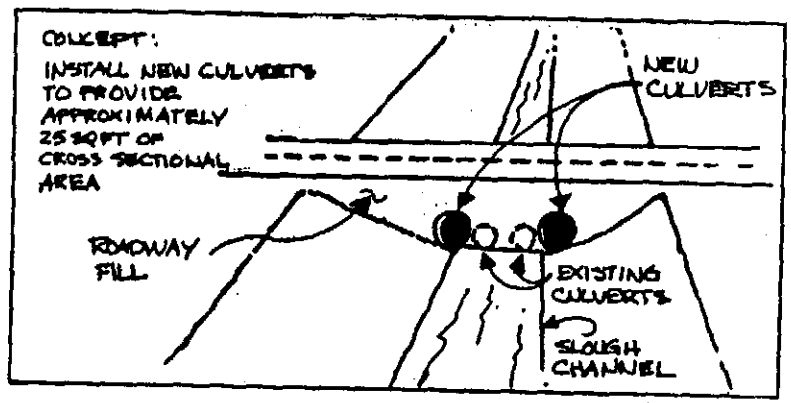
- Provides additional river flood capacity
- Reduction in flood duration along Edison Slough
- Improved field conditions/ reduced crop damage
- Reestablishes historic flood channel

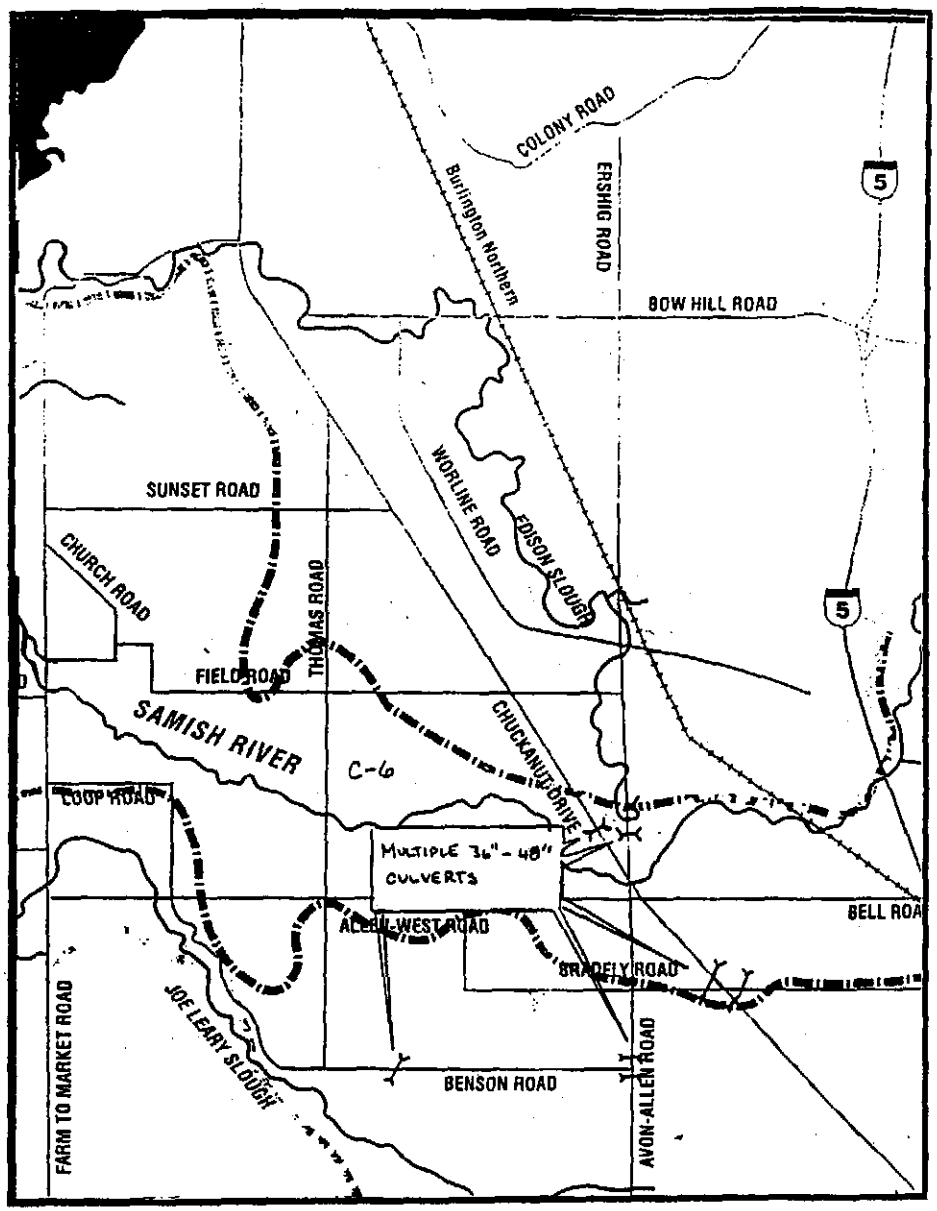
COST ITEMS

- Culvert installation and pavement repairs
- Slough/channel excavation in constricted sections
- Field regrading to

POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvement Funds
- River Improvement Funds
- PCAAP Matching Funds





Samish River
Flood Hazard Management Plan

PROPOSED PROJECT C - 6 (Roadway culverts)

ISSUES

- Existing roadways blocking natural floodwater paths

CONCERNS

- Artificially high floodwater depths upstream of obstructing roadway fills
- Danger to traffic form flooded roadways
- Emergency access during floods

PRELIMINARY SOLUTIONS

- Install culverts through blocking roadway fills

BENEFITS

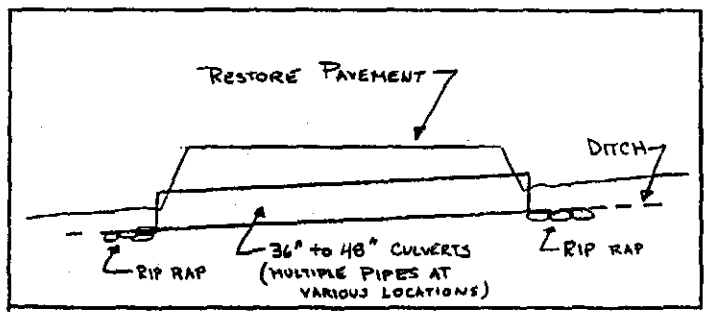
- Reduces flooding depth and duration upstream of blocking fill
- Improves traffic and emergency access

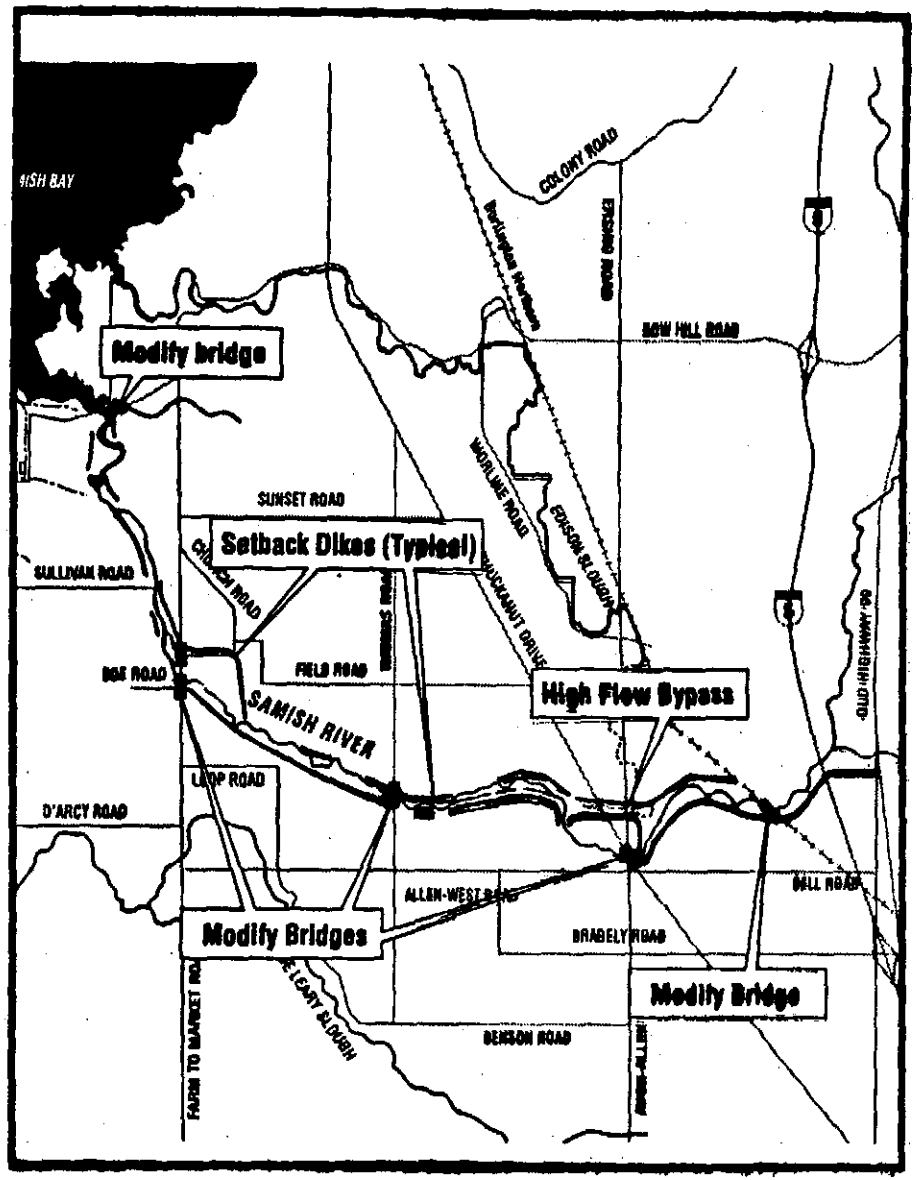
COST ITEMS

- Pavement removal/ roadbed excavation
- Bed and install multiple 36" to 48" culverts at each location
- Backfill to grade, install new roadway base
- Pavement restoration

POTENTIAL FUNDING

- County Road Improvement Funds
- River Improvement Matching Funds





Samish River Flood Hazard Management Plan

PROPOSED PROJECT 6-10 (Setback Dikes, Bypass Channels, Road Crossings)

ISSUES

- Existing diked river channel has capacity for only the 8-yr (+/-) return event flow
- Existing bridge crossings (4-6 locations) impede large event river flows
- Existing river corridor has limited habitat value

CONCERNS

- Dike overtopping and potential failure
- Field/road flooding and erosion
- Crop damage/livestock displacement
- Public health and safety
- Improve river corridor fish/wildlife habitat

PRELIMINARY SOLUTIONS

- Install setback dikes through a series of four phased projects
- Excavate high flow bypass channels/dikes are required
- Upgrade flow capacity at Farm-Market, Thomas, Chuckanut, and railroad bridge crossings

BENEFITS

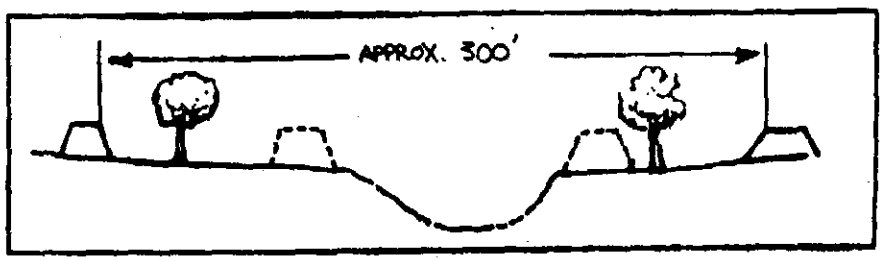
- Reduction in flood hazard improved public health and safety
- Reduced field/crop damages
- Reduced farming losses associated with flooding improved land values
- Enhanced river corridor habitat for fish/wildlife and recreation

COST ITEMS

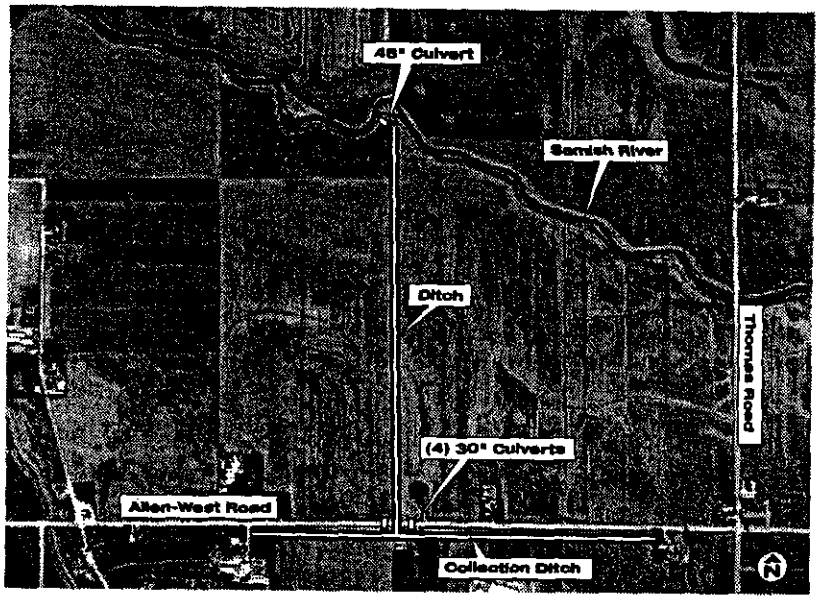
- Approx 12 mi of dike construction
- 4 to 6 bridge modifications/ new bridges
- 250 to 500 acres of property acquisition
- Vegetative and habitat restoration

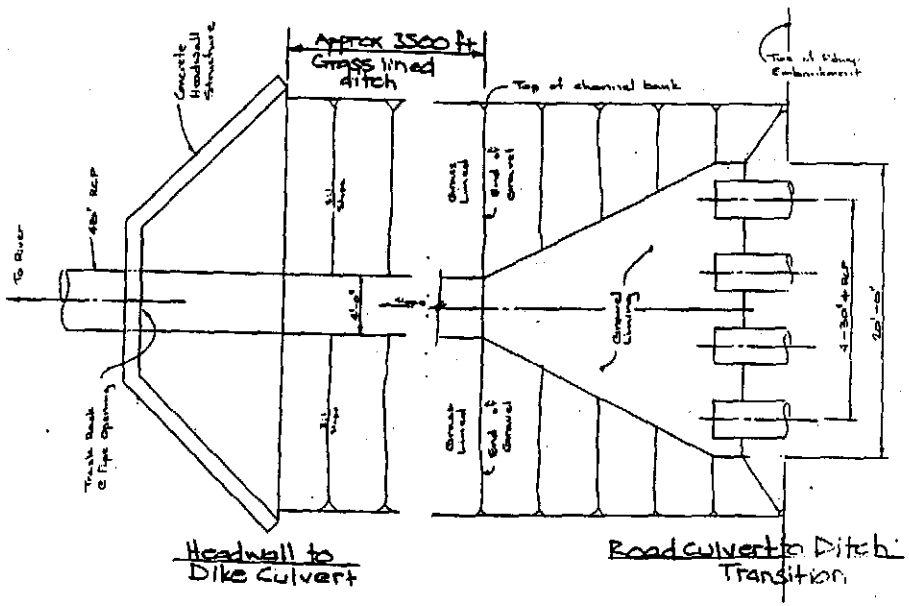
POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds
- County Road Improve Fund (road crossing improvements)
- Conservation Futures Fund (property acquisition)
- Centennial Clean Water Fund (water quality elements)
- DNR ALEA grant (public access)
- Legislative appropriations
- Federal Agency support



PRELIMINARY CAPITAL IMPROVEMENT PROJECTS





Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 1 ALT. A
(Open ditches from Allen-West Rd to River, West of Thomas Rd)

ISSUES/CONCERNS

- Blockage of natural flow paths fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods (5+ weeks)

PRELIMINARY SOLUTIONS

- Construct collection ditch draining to set of roadway culverts on south side of Allen-West Rd
- Install (4) 30 inch cross culverts at single site under Allen-West Rd
- Construct ditch to river
- Install 48 inch culvert with flap gate through dike

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved flood water removal time for south side of river
- Improved structure access
- Reduced field/livestock damage

POTENTIAL PERMITS

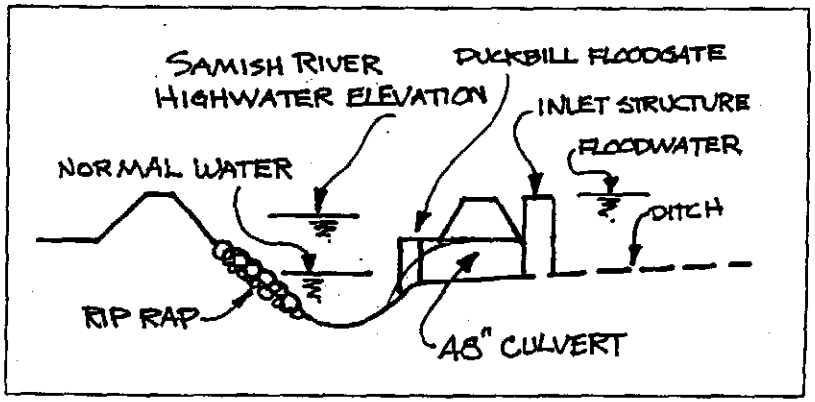
- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engr - Nation Wide Permit(s)

ESTIMATED COST

- Roadway culverts
- Ditch excavation
- Dike culvert
- Land/easement acquisition
- **Total cost (preliminary)** **$ 200,000**

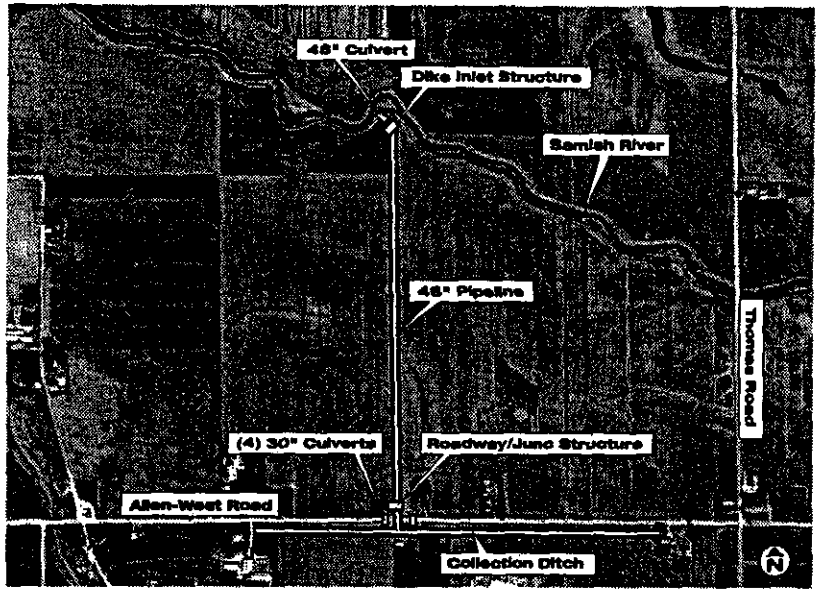
POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds



Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 1 ALT. B
(Pipeline from Allen-West Rd to River, West of Thomas Rd)



ISSUES/CONCERNS

- Blockage of natural flow paths fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods (5+ weeks)

PRELIMINARY SOLUTIONS

- Construct collection ditch draining to set of roadway culverts on south side of Allen-West Rd
- Install (4) 30 inch cross culverts at single site under Allen-West Rd
- Construct 48 inch pipeline to river
- Install 48 inch culvert with flap gate through dike

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved flood water removal time for south side of river
- Improved structure access
- Reduced field/livestock damage
- Does not raise water surface elevations on north side of Allen-West Rd

POTENTIAL PERMITS

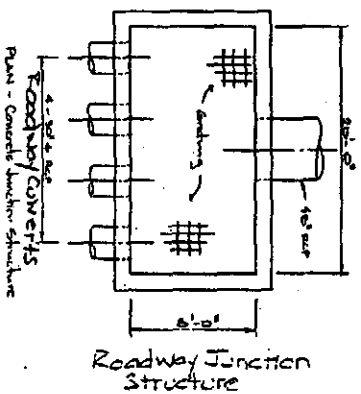
- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engr - Nation Wide Permit(s)

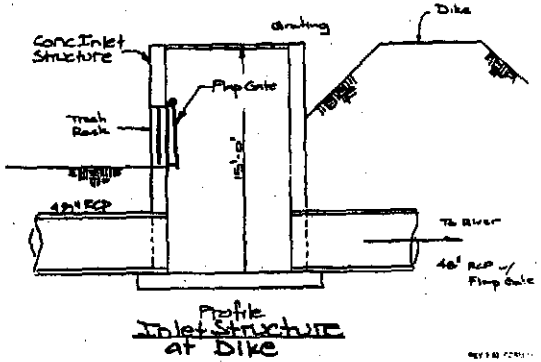
ESTIMATED COST

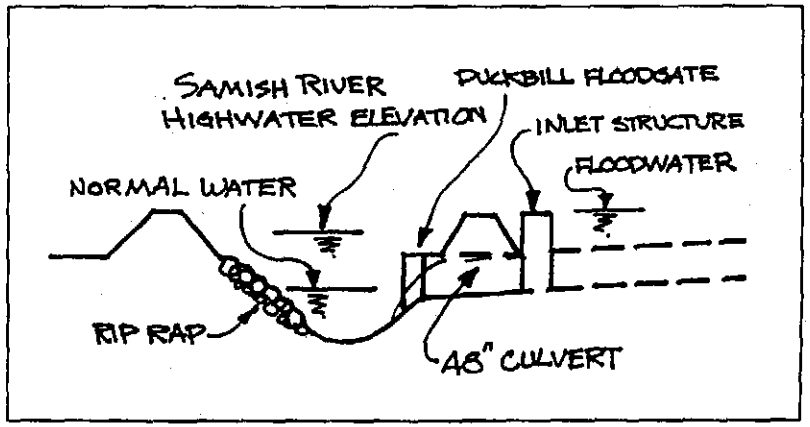
- Roadway culverts
- Ditch excavation
- Pipeline to river
- Dike culvert
- Land/easement acquisition
- **Total cost (preliminary)** **$ 850,000**

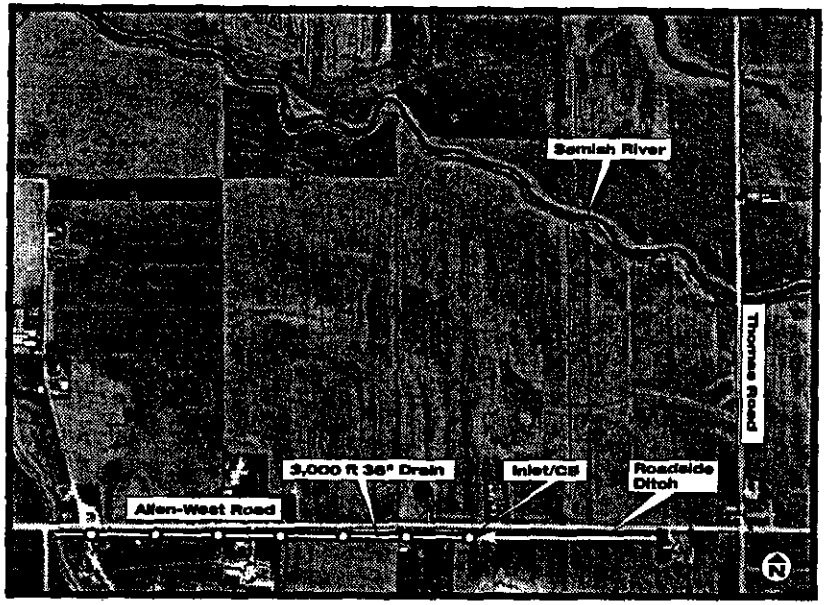
POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds









Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 1 ALT. C
(Pipeline to Joe Leary Slough along Allen-West

ISSUES/CONCERNS

- Blockage of natural flow paths fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods (5+ weeks)

PRELIMINARY

- Install 36-inch drainage pipe to Joe Leary Slough
- Install new catch basins and trash racks
- Provide adequate maintenance access
- Install adequate outfall protection at Joe Leary Slough

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved structure access
- Reduced field/livestock damage
- Does not raise water surface elevations on north side of Allen-West Rd

POTENTIAL

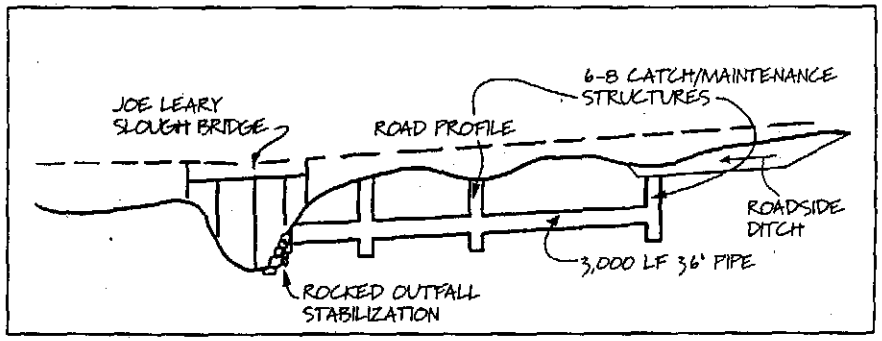
- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nation Wide Permit(s)

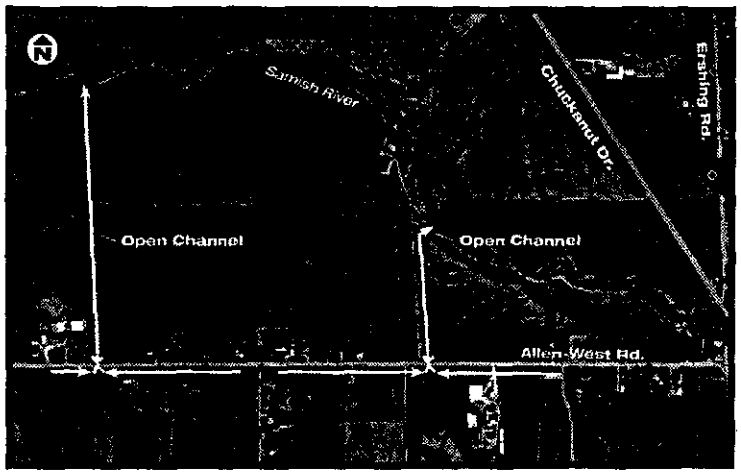
ESTIMATED COST

- Roadside ditch
- Pipeline to slough
- Catch basins
- Floodgate
- **Preliminary construction cost** **$ 360,000**

POTENTIAL

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds





Samish River Flood Hazard Management Plan

PRELIMINARY CIP PROJECT 2 ALT. A (Open ditches from Allen-West Rd to River, East of Thomas Rd)

ISSUES/CONCERNS

- Blockage of natural flow paths by road fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods

PRELIMINARY SOLUTIONS

- Construct collection ditch draining to set of roadway culverts on south side of Allen-West Rd
- Install (4) 30-inch cross culverts at two sites under Allen-West Rd
- Construct ditch to river at two locations
- Install 48 inch culvert with flap gate through dike at two

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved flood water removal time for south side of river
- Improved structure access
- Reduced field/livestock damage

POTENTIAL PERMITS

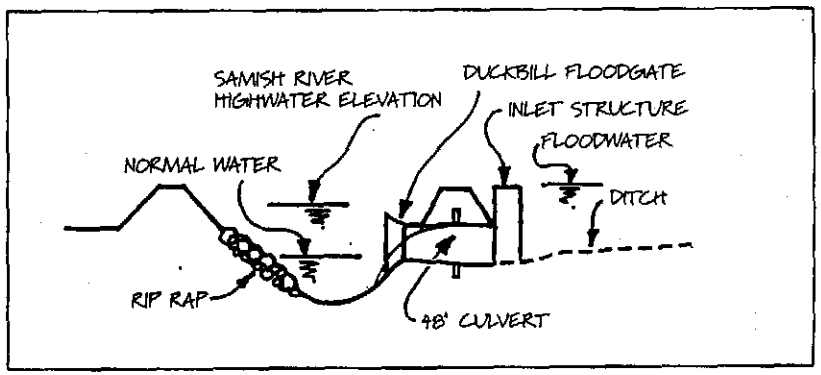
- County Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

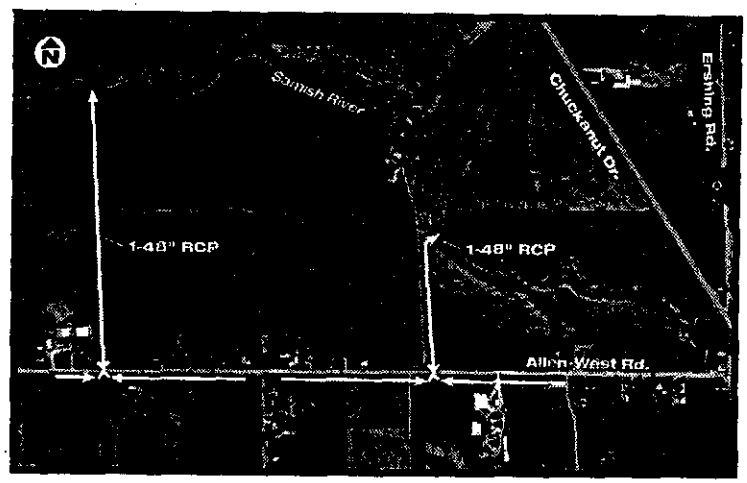
ESTIMATED COST

- Roadway culverts
- Ditch excavation
- Dike culvert
- Floodgate
- **Preliminary construction cost** **$85,000**

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds





Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT 2 ALT. B
(Pipeline from Allen-West Rd to River, East of Thomas Rd)

ISSUES/CONCERNS

- Blockage of natural flow paths fill/Leads to field and structure flooding
- No roadway culverts/Leads to extended time to drain fields following floods (5 weeks)

PRELIMINARY SOLUTIONS

- Construct collection ditch draining to set of roadway culverts on south side of Allen-West Rd
- Install (4) 30-inch cross culverts at two sites under Allen-West Rd
- Construct 48" pipeline to river at two locations
- Install 48 inch culvert with flap

BENEFITS

- Reduction in time of flooding south of Allen-West Rd
- Improved flood water removal time for south side of river
- Improved structure access
- Reduced field/livestock damage
- Does not raise water surface elevations on north side of Allen-West Rd

POTENTIAL PERMITS

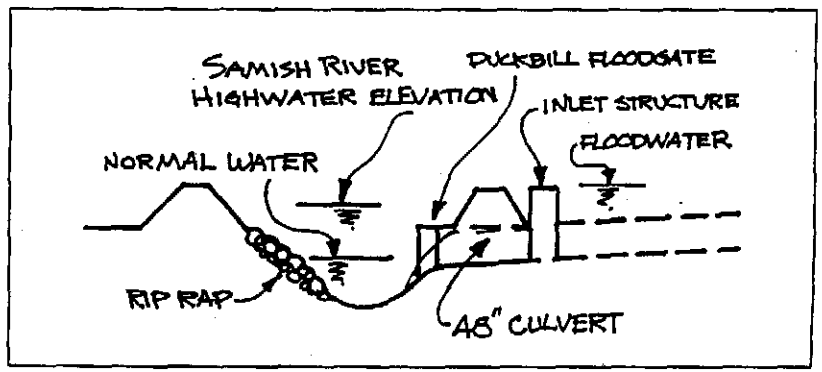
- County Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

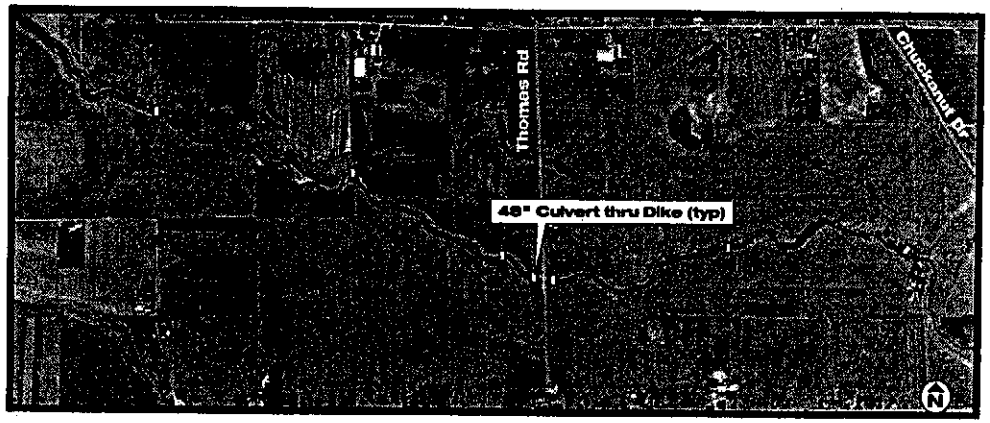
ESTIMATED COST

- Roadway culverts
- Ditch excavation
- Pipeline to river
- Dike culvert
- Land/easement acquisition
- **Total cost (preliminary)** **$990,000**

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds





Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 3
(Upgrade return culverts)

ISSUES/CONCERNS

- Existing culverts plugged and undersized/ Leads to prolonged field flooding, crop damage, and livestock displacement
- Existing flood gates malfunction/Leads to backwater entering fields

PRELIMINARY SOLUTIONS

- Install new 48-inch diameter return culverts with flood gates at 6 locations
- Replace existing malfunctioning floodgates with flexible duckbill floodgates

BENEFITS

- Reduction in time of flooding
- Reduction of "backflow" flooding problems
- Reduced field/livestock damage

POTENTIAL PERMITS

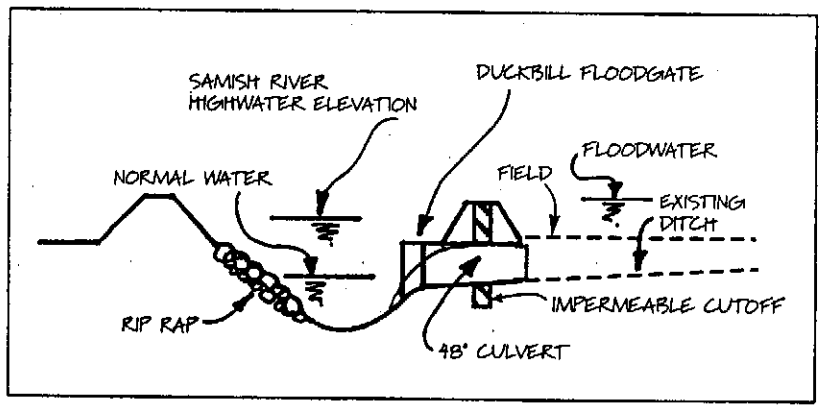
- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nation Wide Permit(s)

ESTIMATED COST

- 48-inch culverts/cutoff
- Floodgates
- Rocked entrance/exit stabilization
- **Preliminary construction cost** **$ 34,000 (each site)**

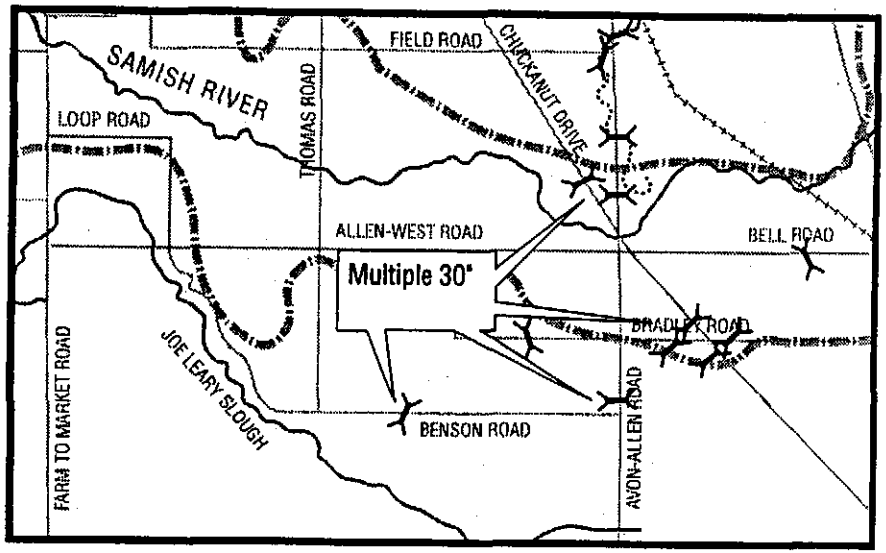
POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds



Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 4 (Flood path roadway culverts)



ISSUES/CONCERNS

- Existing roadways block natural floodwater paths/Raise upstream flood elevations
- Lack of cross culverts at floodwater paths/Prevents post flood drainage of upstream fields
- Water over roadways/Creates traffic hazards, impedes emergency access

POTENTIAL PERMITS

- County permits

PRELIMINARY SOLUTIONS

- Install culverts through blocking roadway fills (12 locations)

ESTIMATED COST

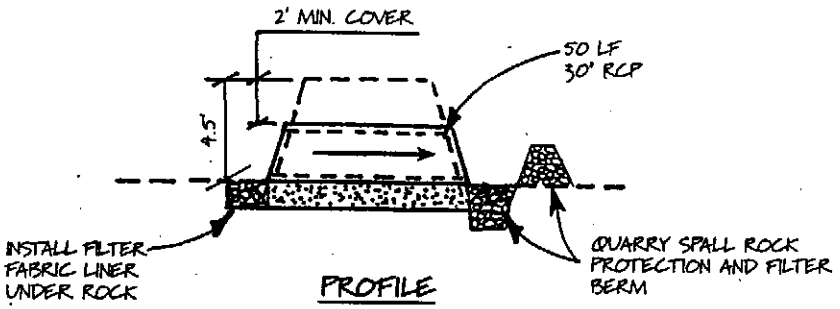
- Excavation/backfill
- Pipe installation
- Road restoration
- **Preliminary construction cost** **$ 28,000 (each site)**

BENEFITS

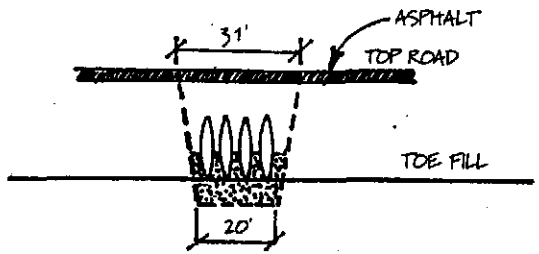
- Reduces flooding depth and duration upstream of blocking fill
- Improves traffic and emergency access
- Provides up to 80 cfs of drainage capacity to drain flood waters.

POTENTIAL

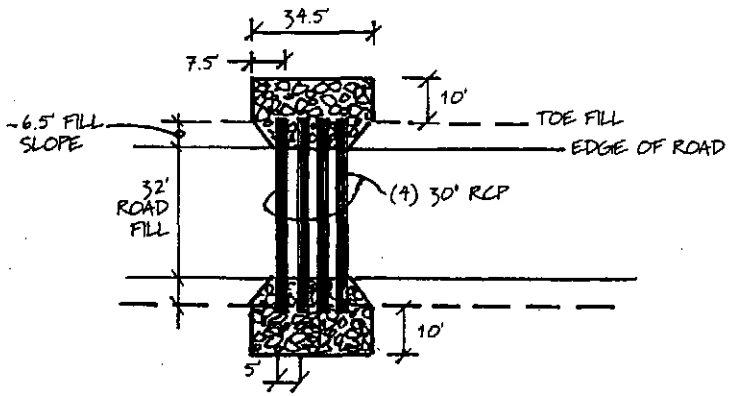
- County road improvement funds



PROFILE



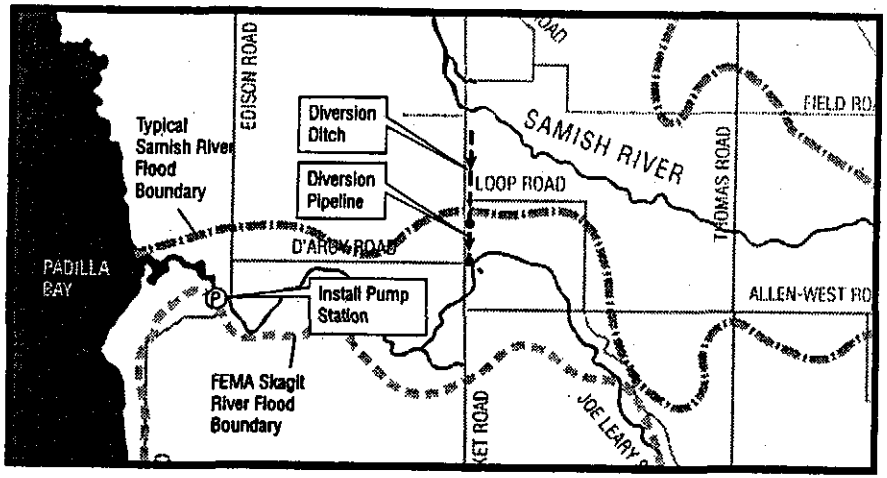
END VIEW

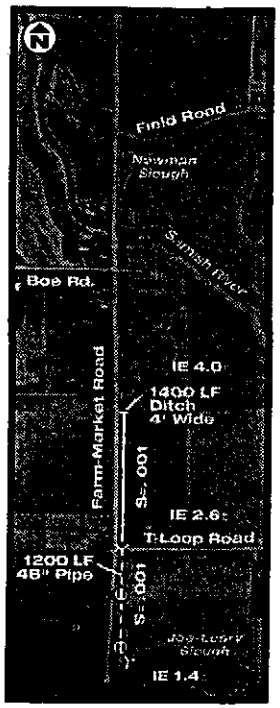


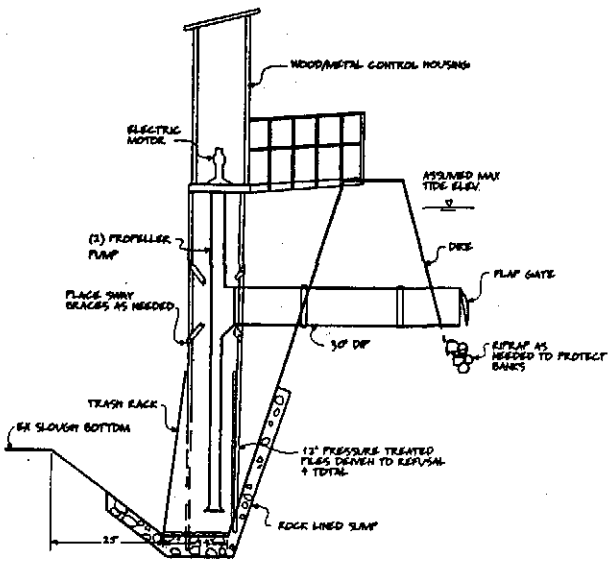
PLAN VIEW

Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 5 ALT. A
(Diversion to Joe Leary Slough)







ISSUES/CONCERNS

- Limited floodwater return capacity to river/Leads to prolonged field flooding
- District 5 has limited capacity to handle floods over Farm to Market Rd/Diversion reduces flooding volumes
- Joe Leary Slough receives Samish River overflows/Slough has limited high tide capacity to discharge overflows
- Floodwater covers Farm to Market Rd/Creates traffic hazard, impedes emergency access

PRELIMINARY SOLUTIONS

- Construct flood water diversion channel/pipe on east side of Farm to Market Rd from south of bridge to Joe Leary slough
- Remove constrictions in slough downstream of Farm to Market Rd
- Install 30 to 50 cfs pump station at the outfall of Joe Leary slough

BENEFITS

- Reduction in time of flooding east of Farm to Market Rd
- Reduction of flood frequency/ depth west of Farm to Market Rd
- Improved floodwater return capacity
- Reduced field/livestock damage
- Flood and wet weather pumping capacity provided on Joe Leary Slough

POTENTIAL PERMITS

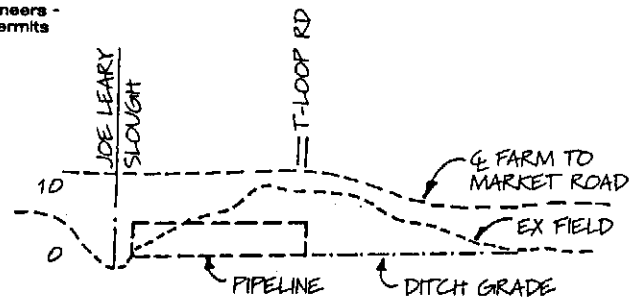
- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

ESTIMATED COST

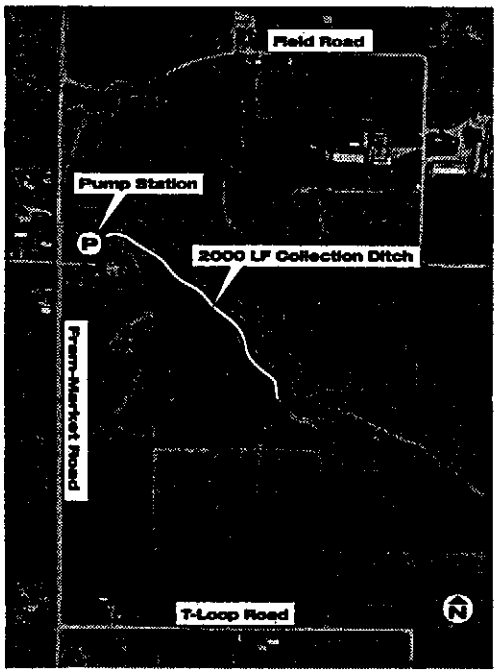
- Diversion channel
- Diversion pipe/gate
- 30 cfs pump station (Joe Leary Slough)
- **Preliminary construction cost** **$320,00**

POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvement Funds
- River Improvement Matching Funds
- FCAAP Matching Funds



PROFILE



Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 5 ALT. B
(Pump Station at Farm-Market Rd.)

ISSUES/CONCERNS

- Fields on south side of river are slow to drain after a flood/Leads to extended field flooding and structure inundation
- Existing return culverts do not fully drain while the river remains high in spring/Delays field preparation and crop planting

PRELIMINARY SOLUTIONS

- Install flood water return pump on south side of river east of Farm-Market Rd
- Construct drainage ditch along south side of river at toe of existing dike to direct flood/drainage water to pump station side

BENEFITS

- Reduction in time of flooding for approximately 115 ac of fields
- 5,000 gpm pump could remove up to 20 ac ft of water per day

POTENTIAL PERMITS

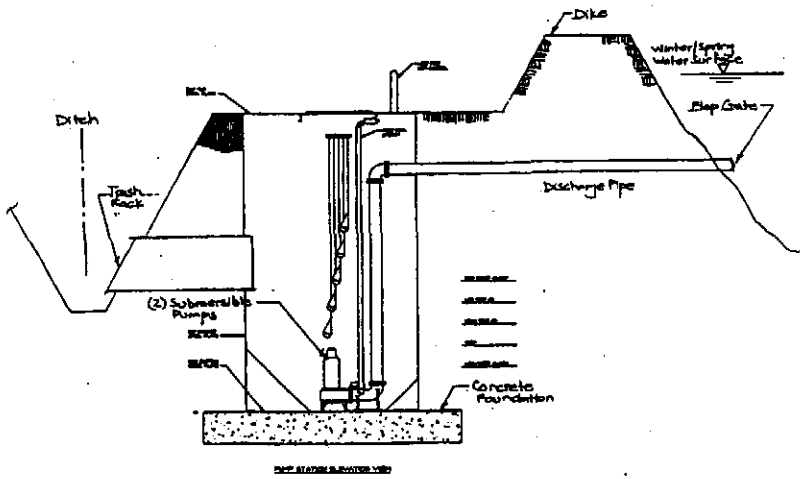
- County Permits
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

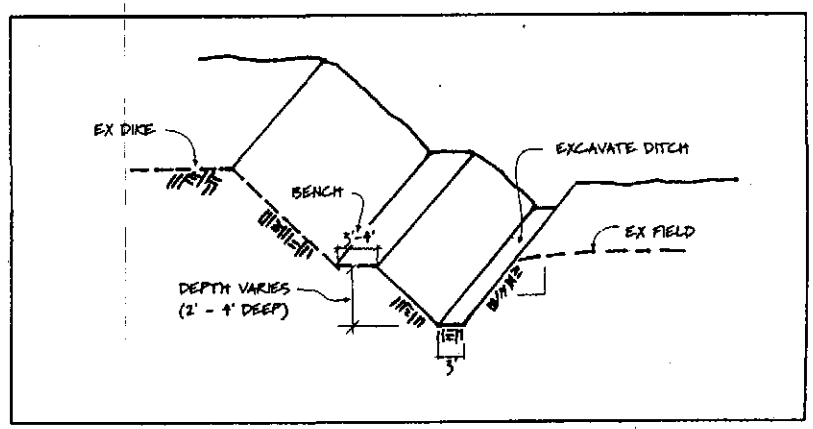
ESTIMATED COST

- Pump system
- Discharge piping
- Ditch excavation
- Land/easement acquisition
- **Total cost (preliminary) $ 200,000**

POTENTIAL FUNDING

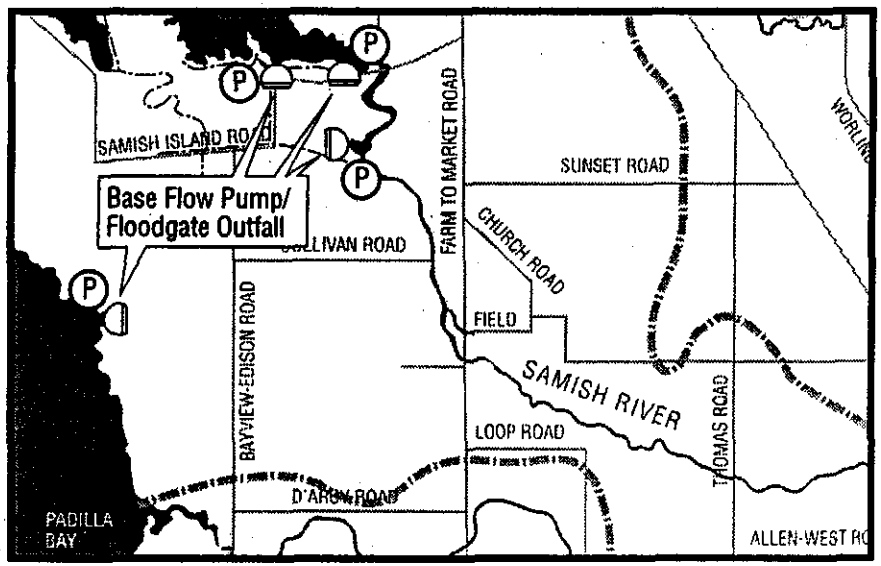
- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds





Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 6 (District 5 outfalls)



ISSUES/CONCERNS

- Limited existing outfall capacity/ Requires extended time (4+ weeks) to drain fields following floods
- Field elevations at or below tidal fluctation/Difficult to fully drain fields in time for Spring planting
- Extended durations of road inundations/Inhibits emergency access during and after floods

PRELIMINARY SOLUTIONS

- Install additional outfalls with multiple 48-inch pipes
- Install base flow pump at each outfall to prevent sedimentation of discharge channel and supplement high tide drainage

BENEFITS

- Reduction in time of flooding
- Improved structure access
- Reduced field/livestock damage
- Improved farm production

POTENTIAL PERMITS

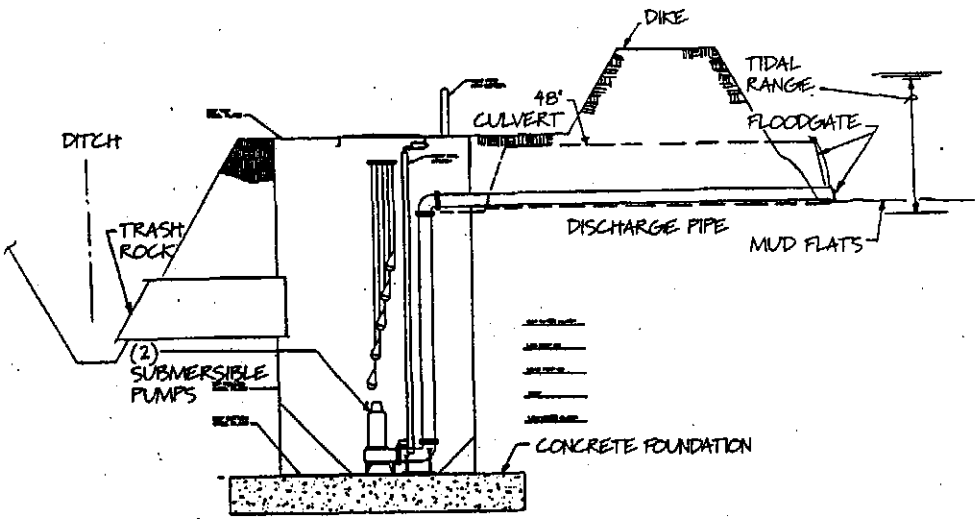
- County Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nationwide Permits

ESTIMATED COST

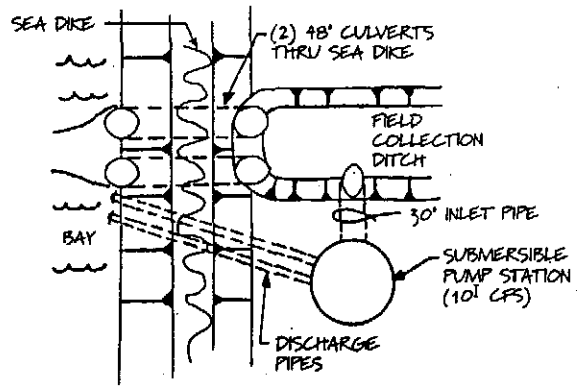
- 48-inch culverts
- Dike excavation and backfill (affected by tides)
- Channel excavation leading to new outfalls
- Pump station
- Floodgates
- **Preliminary construction cost** **$ 180,000 (each site)**

POTENTIAL FUNDING

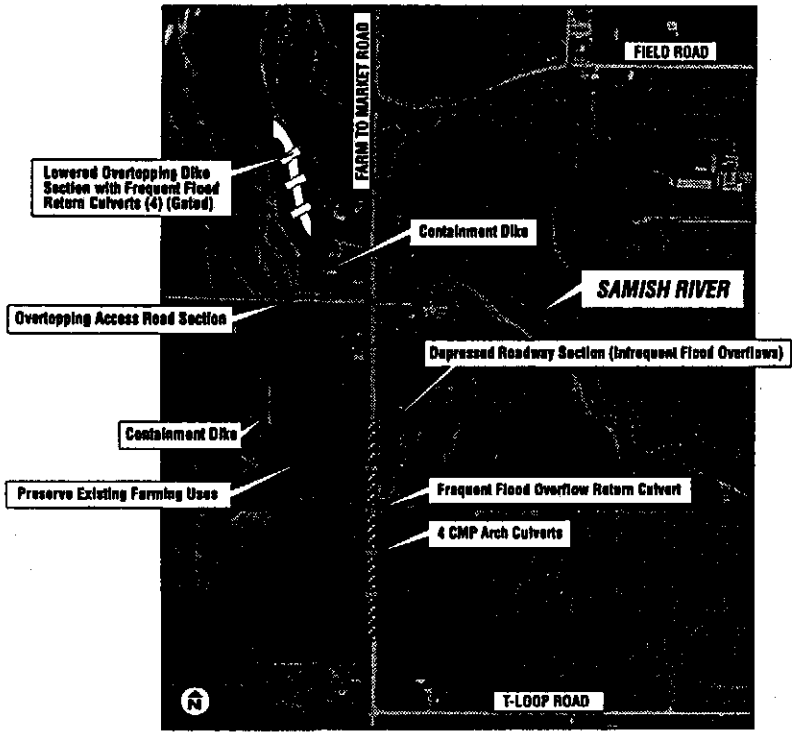
- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds

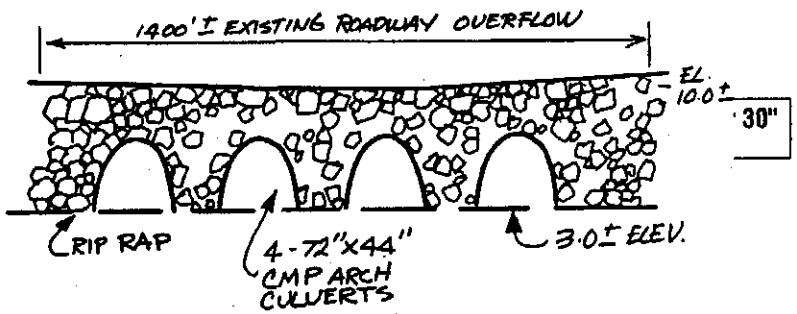


PUMP STATION ELEVATION VIEW



PLAN VIEW





ELEVATION

FARM TO MARKET RD OVERFLOW/IMPROVEMENTS

Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 5 ALT. C
(Diversion dikes/channel west of Farm-Market Rd)

ISSUES/CONCERNS

- River overflows impounded behind dikes and Farm to Market Rd on south side of channel (Dike District 25)
- Large flood overtopping of Farm to Market Rd floods substantial areas to west (Dike District 5)
- Structure flooding/emergency access
- Flooding duration/ Crop damage/ Livestock displacement

POTENTIAL PERMITS

- County Shoreline Permits
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification (If Corps Permit is required)
- Corps of Engineers - Nationwide Permits (If wetland/waters of the U.S. are impacted)

PRELIMINARY SOLUTIONS

- Implement with CIP 9 (Phase 1), setback dikes
- Construct diversion (containment) dikes on west side of Farm to Market Rd to route flood waters back to river
- Install multiple culvert (4 assumes under Farm to Market Rd and south river dikes (w/gates)
- Lower roadway, build overtopping dike sections to capture/efficiently return large flood overflows

ESTIMATED COST

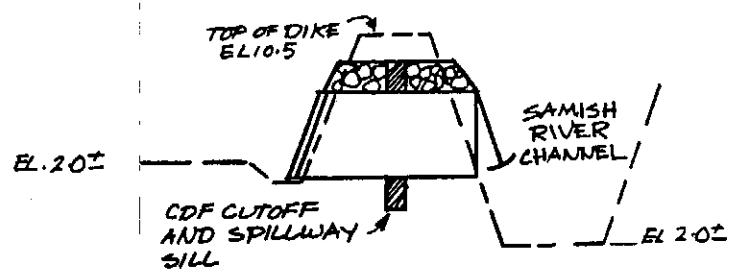
- Containment dikes
- Roadway crossing culverts/gates
- Lowered rowadway/ dike improvement
- Land/easement acquisition
- **Total Cost $ 1,010,000 (preliminary)**

BENEFITS

- Reduces flooding (extra duration) west of Farm to Market Rd and on south side of river
- Improves river capacity east of Farm to Market Rd
- Reduced farming/livestock damages

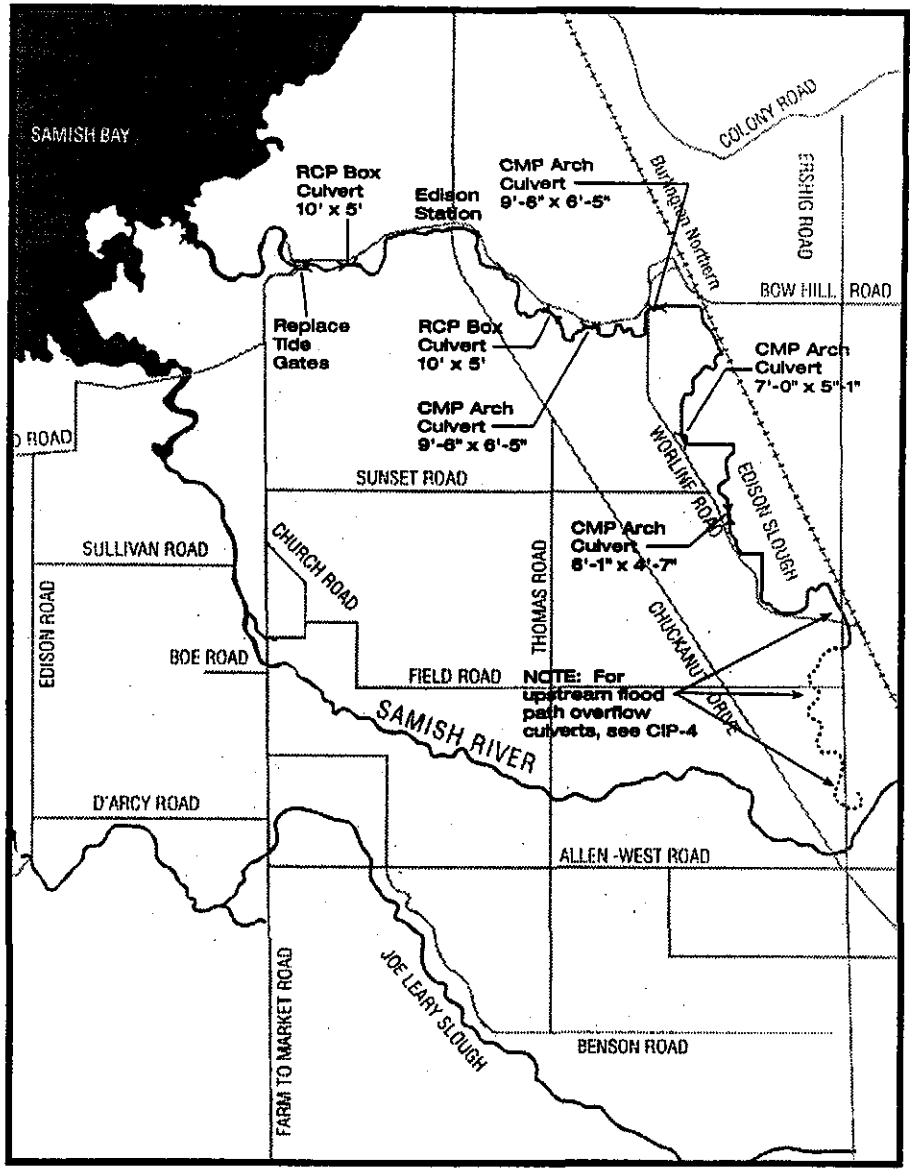
POTENTIAL FUNDING

- Drainage District Funds
- County Road Improvement Funds
- River Improvement Matching Funds
- FCAAP Matching Funds



SECTION

SOUTH DIKE RETURN CULVERTS/ OVERTOPPING IMPROVEMENTS



Samish River Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 7 (Edison Slough

ISSUES/CONCERNS

- Historic flow path has been blocked/Historic river system capacity thus diminished
- Majority of existing roadway culverts are undersized for wet weather drainage/Results in extended field flooding

PRELIMINARY SOLUTIONS

- Upgrade selected existing roadway culverts to provide consistent flow capacity through system
- Upgrade channel capacity of restrictive sections

BENEFITS

- Provides adequate local drainage capacity
- Provides additional river flood overflow capacity
- Reduces flood duration along Edison Slough
- Reduces structure flooding/ reduces crop damage

POTENTIAL PERMITS

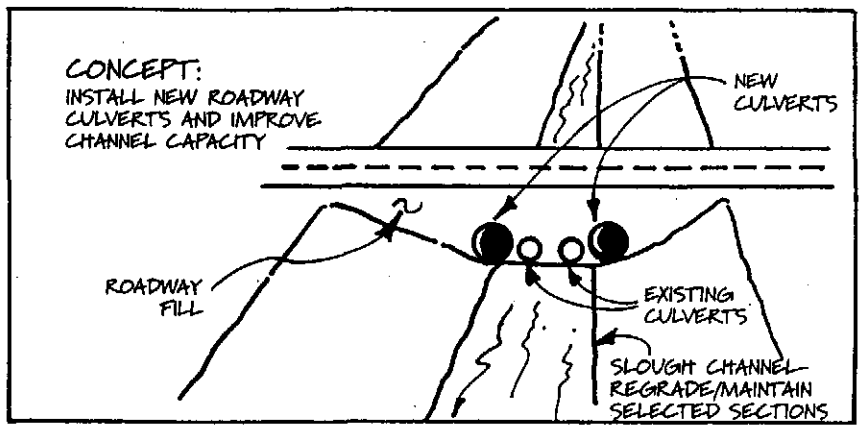
- County Permits
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification
- Corps of Engineers - Nation Wide Permit

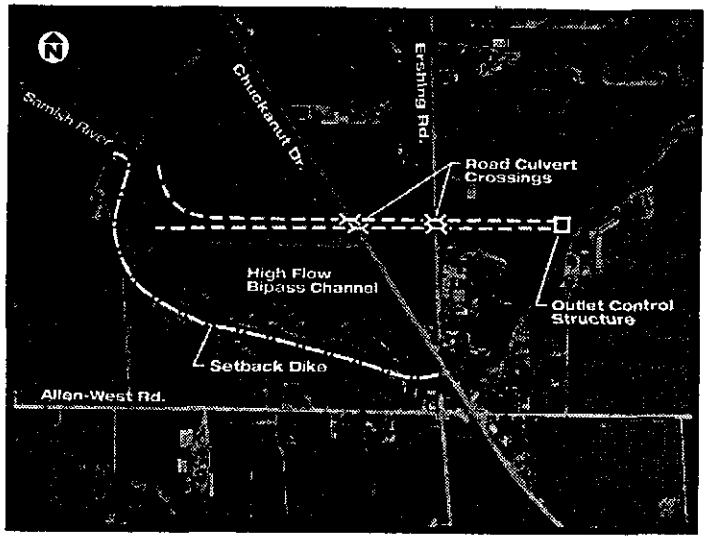
ESTIMATED COST

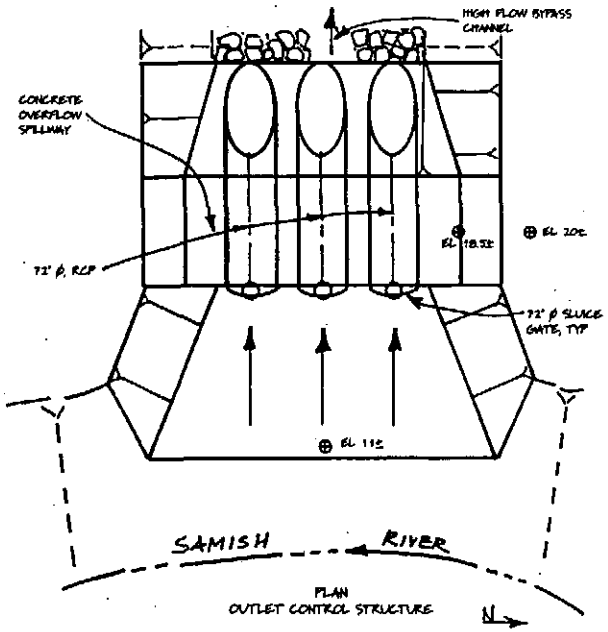
- Culvert installations/ pavement repairs
- Channel improvements
- **Preliminary construction cost** **$630,000**

POTENTIAL FUNDING

- Drainage Utility Funds
- Drainage District Funds
- County Road Improvement Funds







Samish River
Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 8
(Chuckanut Drive bridge improvements)

ISSUES/CONCERNS

- Bridge/channel restriction leads to increased upstream water surface elevation and flooding
- Field flooding/erosion
- Crop damage/livestock displacement
- Structure/roadway flooding

PRELIMINARY SOLUTIONS

- Expand bridge section, or
- Install 8 to 9 foot diameter culvert under north abutment, or
- High flow bypass channel (to north) with culvert crossing of Ershing Rd and Chuckanut Dr

BENEFITS

- Reduces water surface elevation upstream of Chuckanut Dr
- Enhances bridge capacity by 400-600 cfs (20 to 30%)
- Reduces flooding frequency
- Reduces pollution associated with frequent Dairy flooding
- Provides additional (off-channel) fisheries rearing habitat

POTENTIAL PERMITS

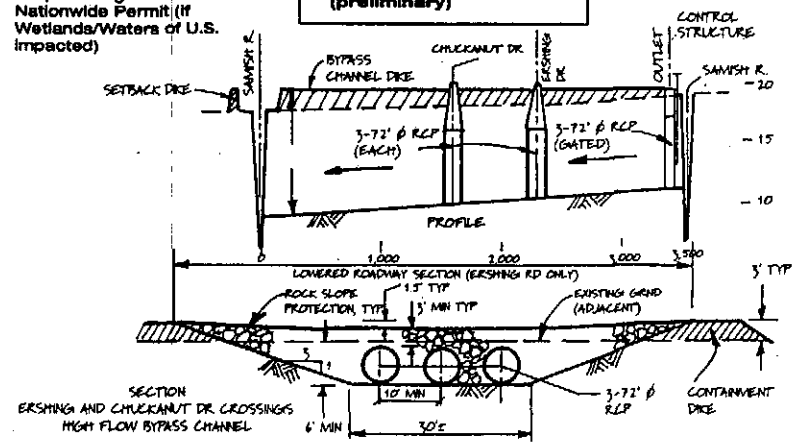
- County Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification (if Corps permit required)
- Corps of Engineers - Nationwide Permit (if Wetlands/Waters of U.S. impacted)

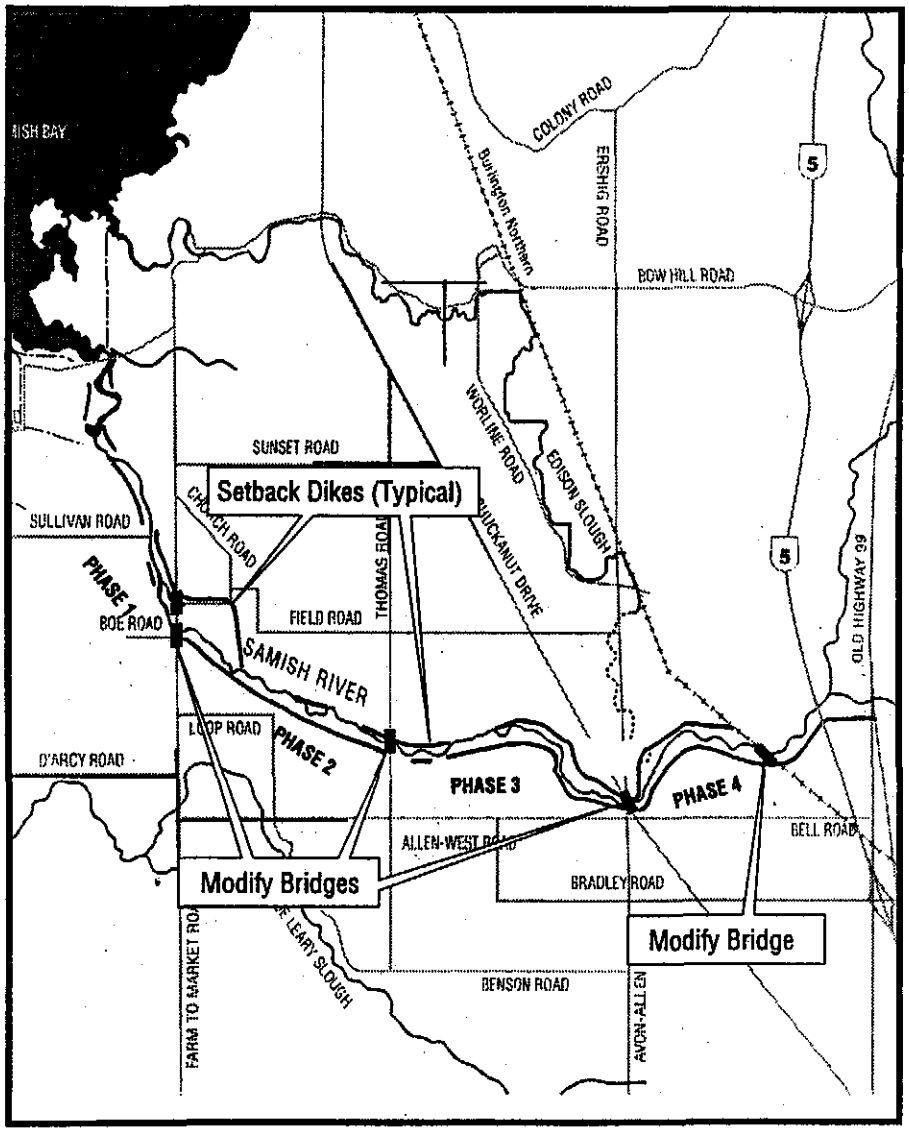
ESTIMATED COST

- Bypass channel
- Roadway crossing culverts
- Outlet control structure
- Dike improvements
- Land/easement acquisition
- **Total cost (preliminary)** **$950,000**

POTENTIAL FUNDING

- WSDOT Funding
- FCAAP Matching Funds
- River Improvement Matching Funds
- Centennial Clean Water Fund
- Public Works Trust Fund Loan





Samish River Flood Hazard Management Plan

PRELIMINARY CIP PROJECT - 9
(Setback Dikes, Road Crossing Improvements)

ISSUES/CONCERNS

- Existing diked river channel has Capacity for only the 2-yr (+/-) return event flow
- Existing bridge crossing (4 locations) impede large event river flows
- Existing river corridor has limited habitat value
- Dike overtopping and potential failure
- Field/road flooding and erosion
- Crop damage/livestock displacement

POTENTIAL PERMITS

- County - Shoreline Permit
- Fish and Wildlife - HPA
- Ecology - Temporary Water Quality Modification
- Ecology - Water Quality Certification (if Corps permit reqd.)

  Corps of Engineers - Nation wide or individual permit (if wetlands/waters of U.S. impacted)

PRELIMINARY SOLUTIONS

- Install setback dikes through a series of four phased projects
- Upgrade flow capacity at Farm-Market Rd, Thomas Rd, Chuckanut Dr, and railroad bridge crossings
- Revegetate selected setback areas
- Provide increased fisheries rearing habitat area

ESTIMATED COST

- Setback dikes
- Bridge Modifications (4 locations)
- Vegetative/habitat restoration
- **Preliminary construction cost**

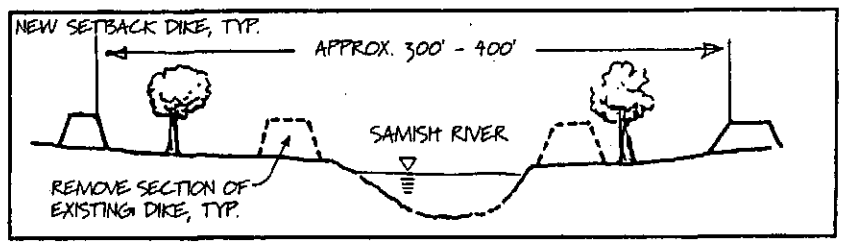
Total	**$ 6,500,000**
Phase I	**$ 1,200,000**

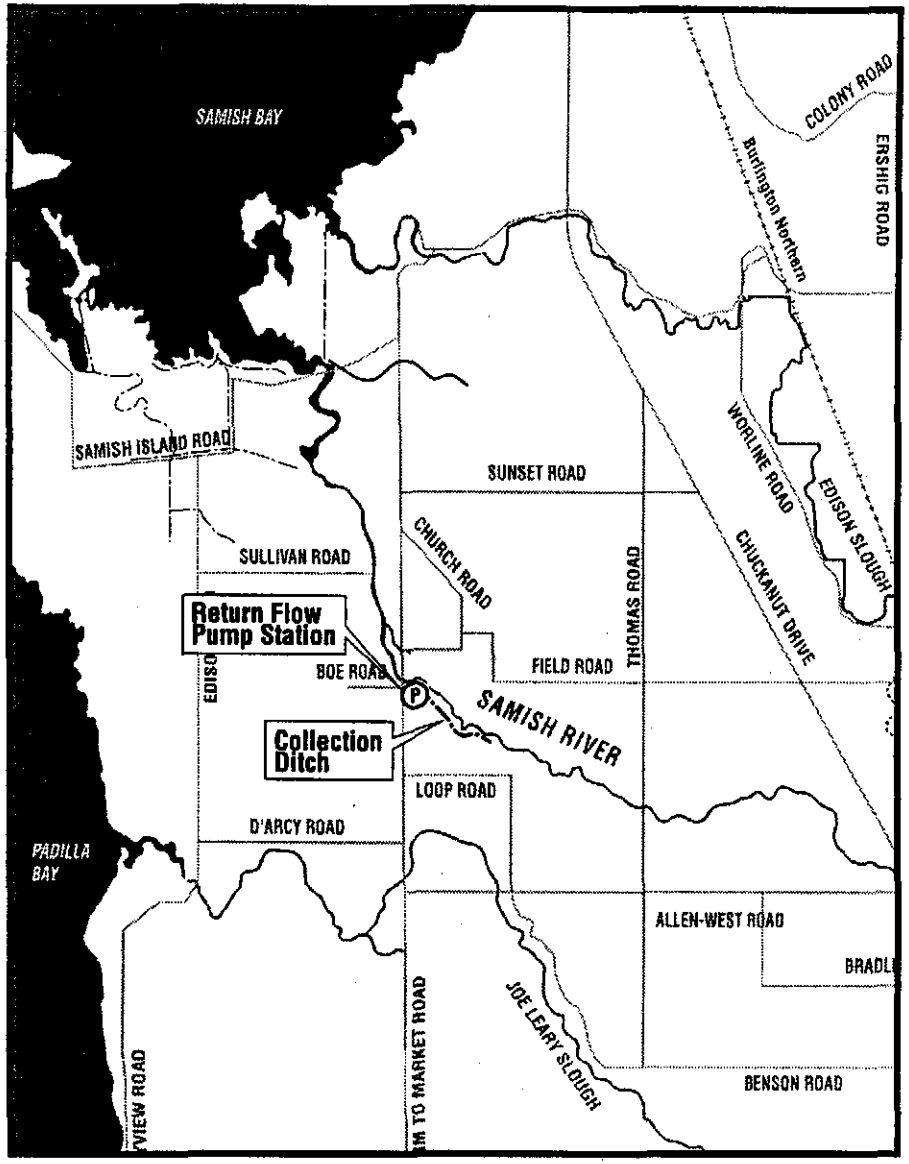
BENEFITS

- Reduction in flood hazard
- Improved public health and safety
- Reduced field/crop damages
- Reduced farming losses associated with flooding
- Improved land values
- Enhanced river corridor habitat for fish/wildlife and recreation

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- County Road Improvement Funds
- FCAAP Matching Funds
- County road improvement fund (road crossing improvements)
- Conservation Futures Fund (property acquistion)
- Centennial Clean Water Fund (water quality elements)
- DNR ALEA grant (public access)
- State Legislative appropriations
- COE, NCRS, USFW Grants





Samish River Flood Hazard Management Plan

PRELIMINARY PROJECT D-8 (Flood water return pump station at Farm-Market Rd.

ISSUES

- Fields on south side of river U/S of Farm-Market Rd. are slow to drain after a flood
- Existing return culverts do not fully drain while the river remains at an elevated stage

CONCERNS

- Extended field flooding
- Crop damage/livestock displacement

PRELIMINARY SOLUTIONS

- Install flood water return pump on south side of river east of Farm-Market Rd.
- Construct 1000 LF drainage ditch along south side of river at toe of existing dike to direct flood water to pump station

BENEFITS

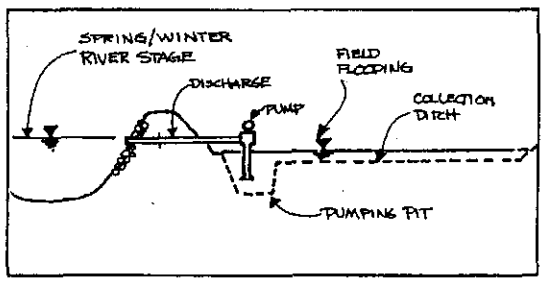
- Reduction in time of flooding for approximately 115 ac of fields

COST ITEMS

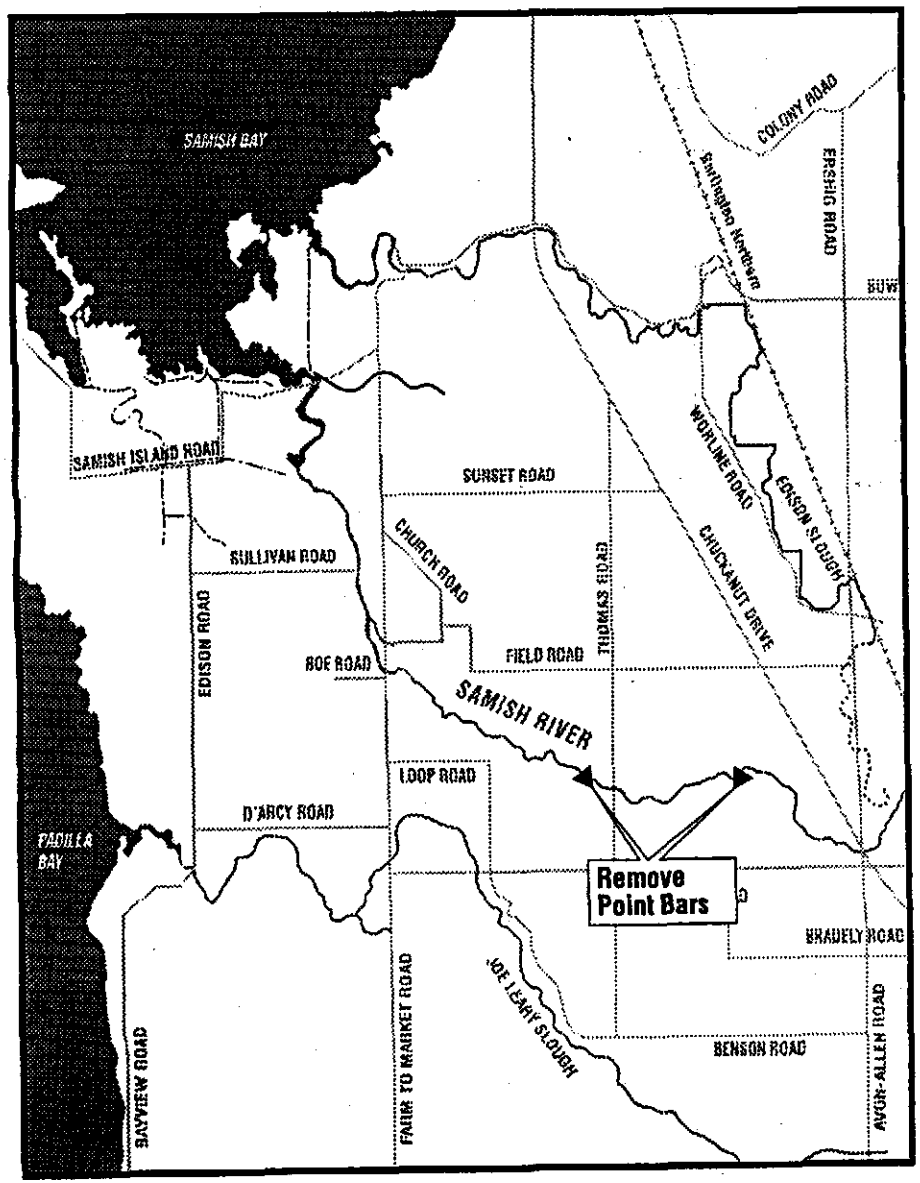
- Pump system
- Discharge piping with flap gate
- Dike stabilization at discharge
- Pump station structure
- Ditch excavation

PRELIMINARY FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds



ANNUAL MAINTENANCE ALTERNATIVES



Samish River Flood Hazard Management Plan

PROPOSED PROJECT S-3 (Remove point bar)

ISSUES

- Accumulated gravel deposition reduces channel capacity
- Enhanced potential for dike erosion

CONCERNS

- Dike failure
- Field flooding/erosion
- Crop damage/livestock displacement

PRELIMINARY SOLUTIONS

- Remove point bar to effective discharge water level at two locations
- Repair any associated dike erosion

BENEFITS

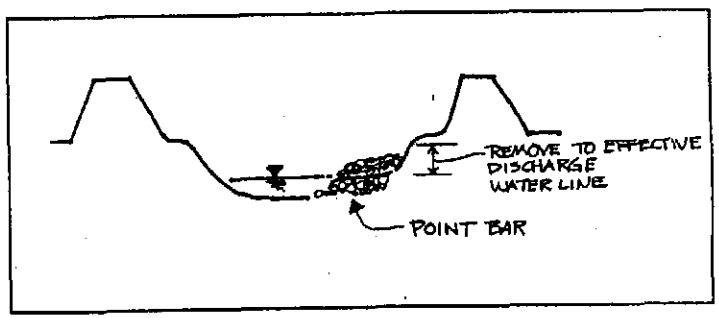
- Reduction in flooding potential
- Improved dike stability

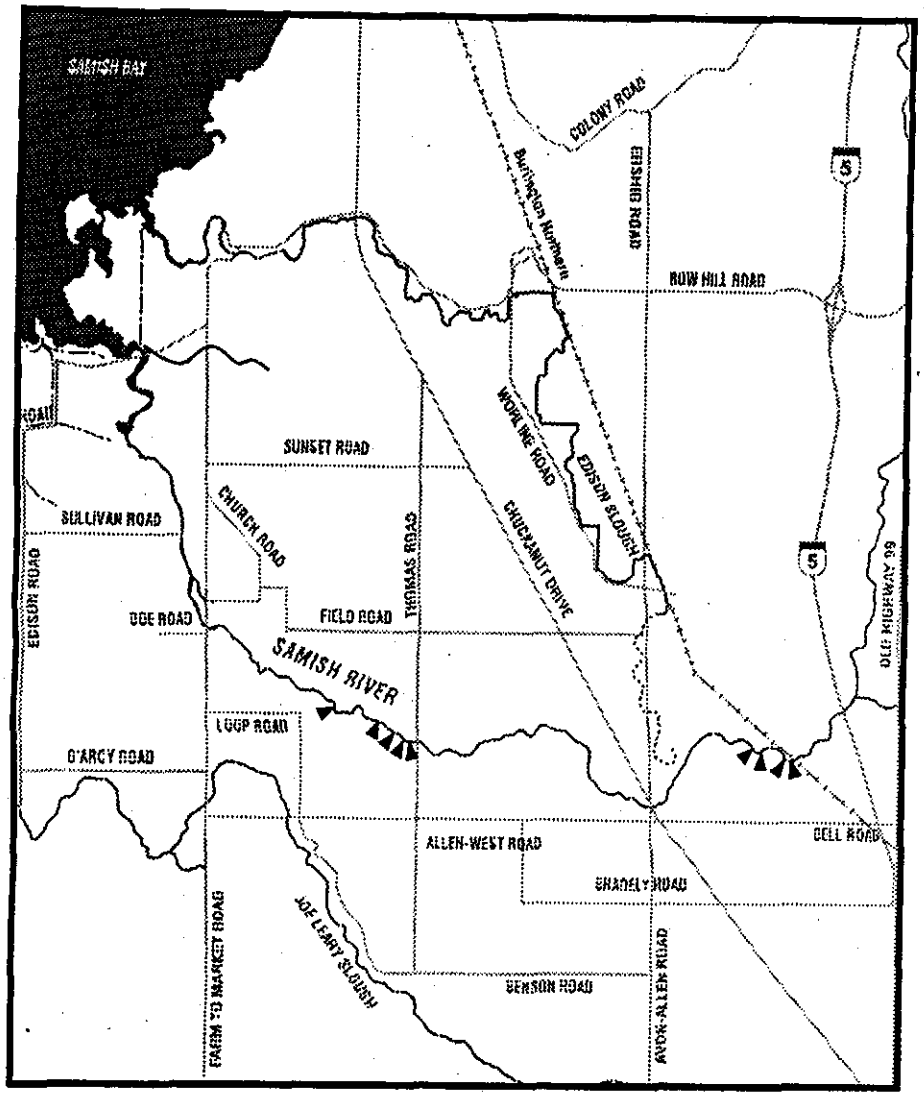
COST ITEMS

- Gravel excavation
- Hauling and dumping costs
- Dike repair/improvements
- Environmental restoration

POTENTIAL FUNDING

- Drainage District Funds





Samish River Flood Hazard Management Plan

PROPOSED PROJECT D-7 (Erosion Repairs Dist. 25)

ISSUES

- Dikes have become eroded in several locations due to river action in several locations

CONCERNS

- Dike failure from erosion
- Field flooding/erosion
- Crop damage/livestock displacement

PRELIMINARY SOLUTIONS

- Place rip rap at several locations along dikes to stabilize banks

BENEFIT

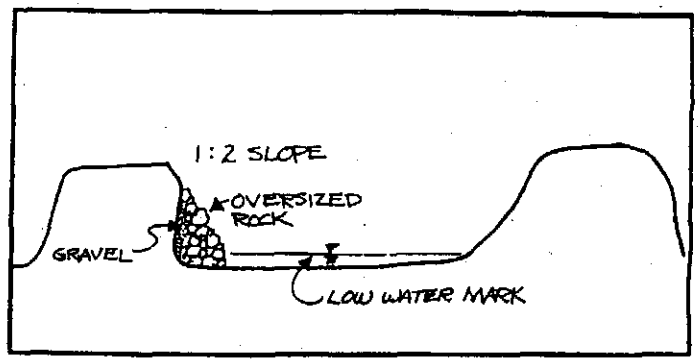
- Reduction in flooding potential
- Improved dike stability

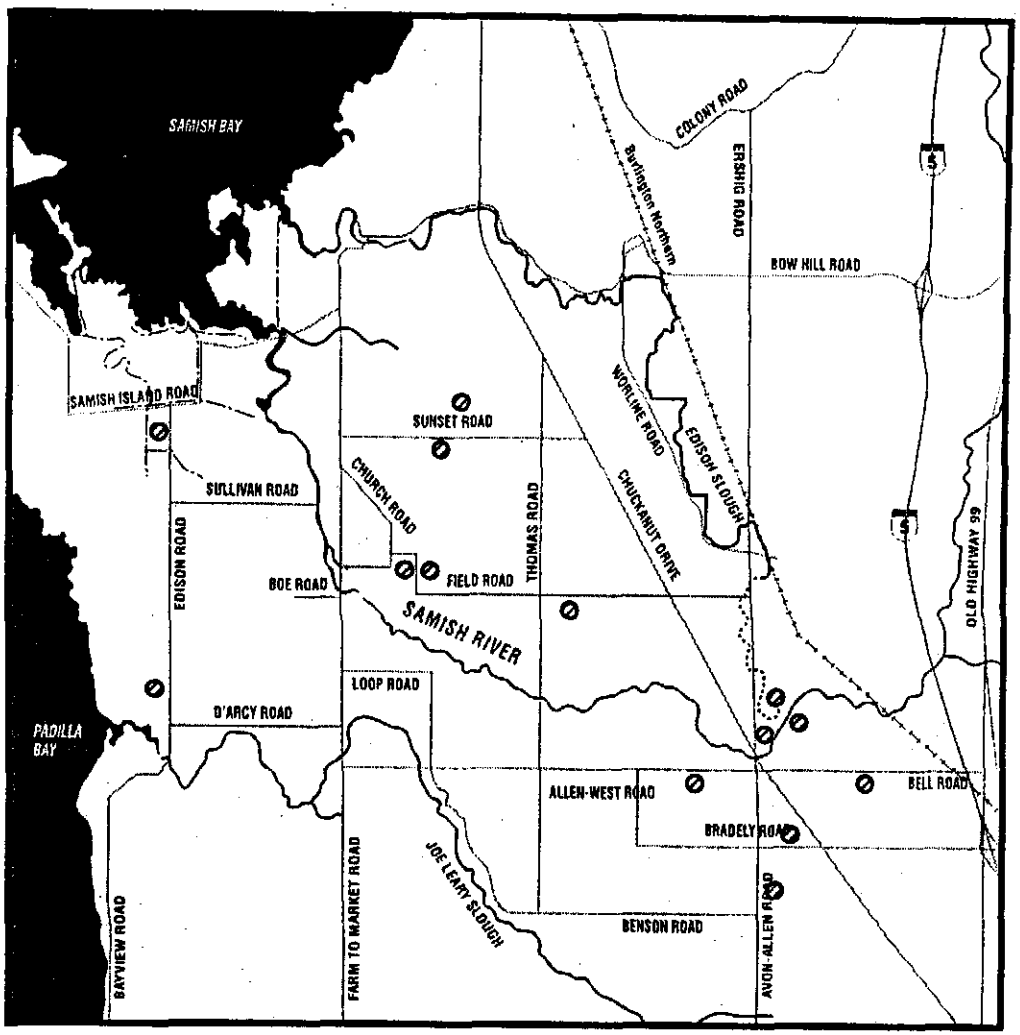
COST ITEMS

- Bank reshaping
- Imported rock placement
- Dike regrading
- Vegetative restoration

PRELIMINARY FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds





Samish River Flood Hazard Management Plan

PROPOSED PROJECT C-9 (Ring dikes around structures)

ISSUES

- Commercial/farming facilities partially inundated by flood waters
- Dairy waste flushed into river by floodwaters

CONCERNS

- Loss of stock and payroll, and damage to equipment at commercial facilities
- Herd displacement/cessation of milking activities at dairy facilities
- Coliform contamination threat to humans and shellfish beds from dairy waste

PRELIMINARY SOLUTIONS

- Identify commercial/farm structures subject to historic inundation due to river flooding through field interviews and surveys
- Establish locations where ring dikes could reasonably be constructed to protect the subject facilities
- Install ring dikes to enclose and protect the identified locations from floodwaters

BENEFITS

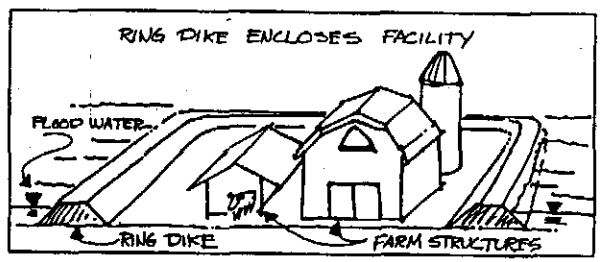
- Reduction in flooding potential of individual facilities
- Reduced contamination of flood waters by dairy/farm waste

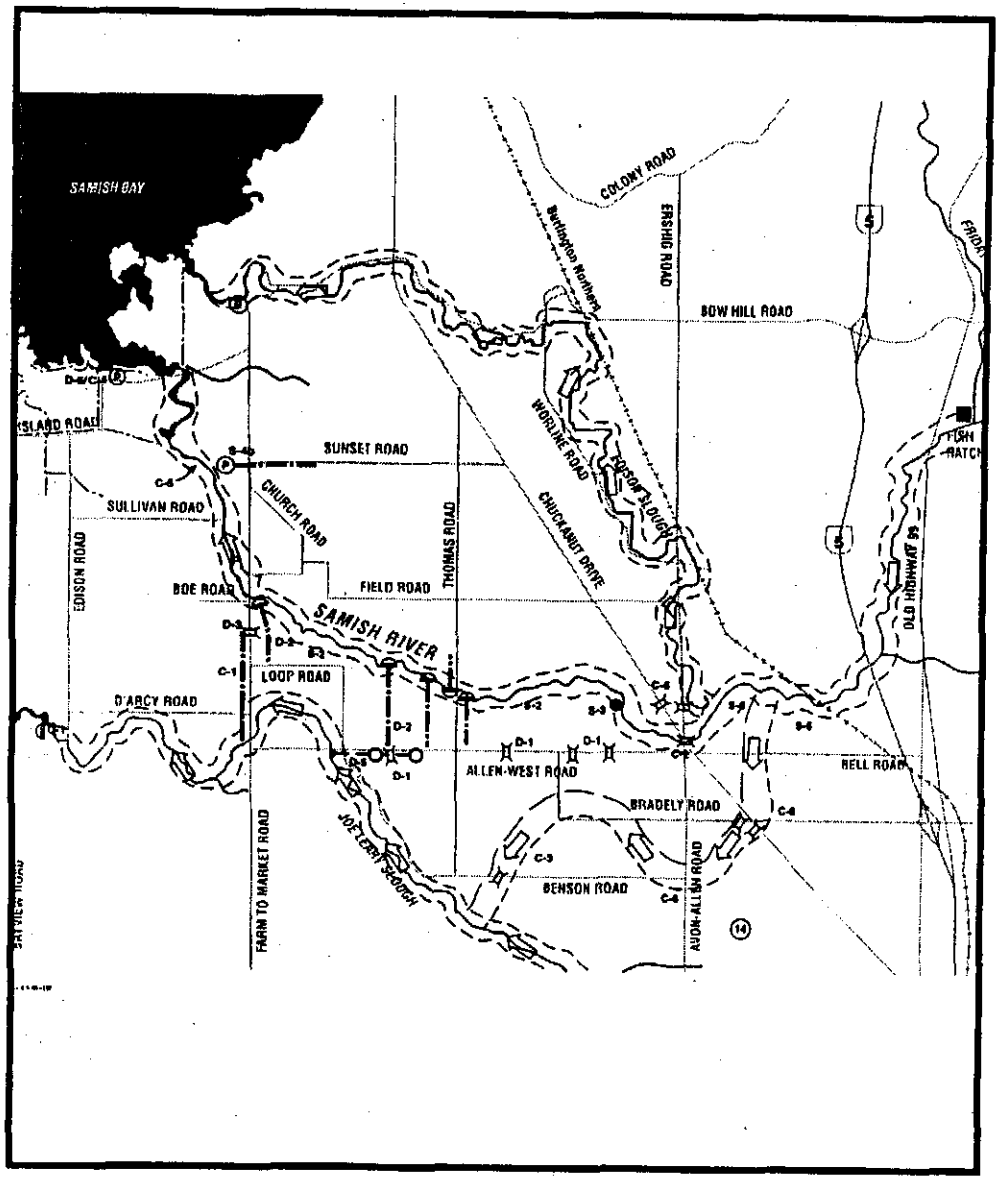
COST ITEMS

- Field reconnaissance/survey
- Clear and Grub proposed ring dike location
- Import, place and compact dike fill material
- Reestablish ingress roads over new dike as necessary
- Provide internal drainage for rain water and dike overtopping floodwaters

POTENTIAL FUNDING

- Drainage District Funds
- Benefited property owner participation
- River Improvement Matching Funds
- FCAAP Matching Funds
- Centennial Clean Water Fund (for WQ improvements)
- FEMA 1362 Property Purchase/Relocation Fund





Samish River Flood Hazard Management Plan

PROPOSED PROJECT C-3 (Dike Floodway Designations)

ISSUES

- Development and structures encroaching on historic flood channels
- Roadway fills and field grading have blocked historic flood channels

CONCERNS

- Reduction in river system capacity
- Structure flooding within flood channels
- Flooding caused by encroaching fills

PRELIMINARY SOLUTIONS

- Designate floodways along historic channels
- Limit development within floodway

BENEFITS

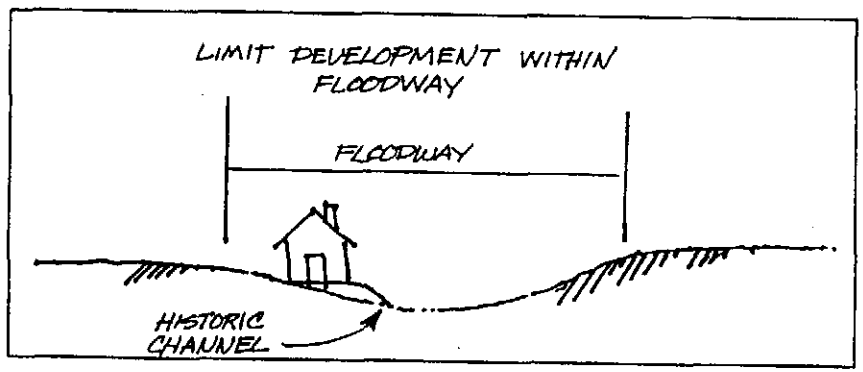
- Reduction in flooding impacts along floodways
- Improved floodway capacity
- Minor reduction in river corridor flooding.

COST ITEMS

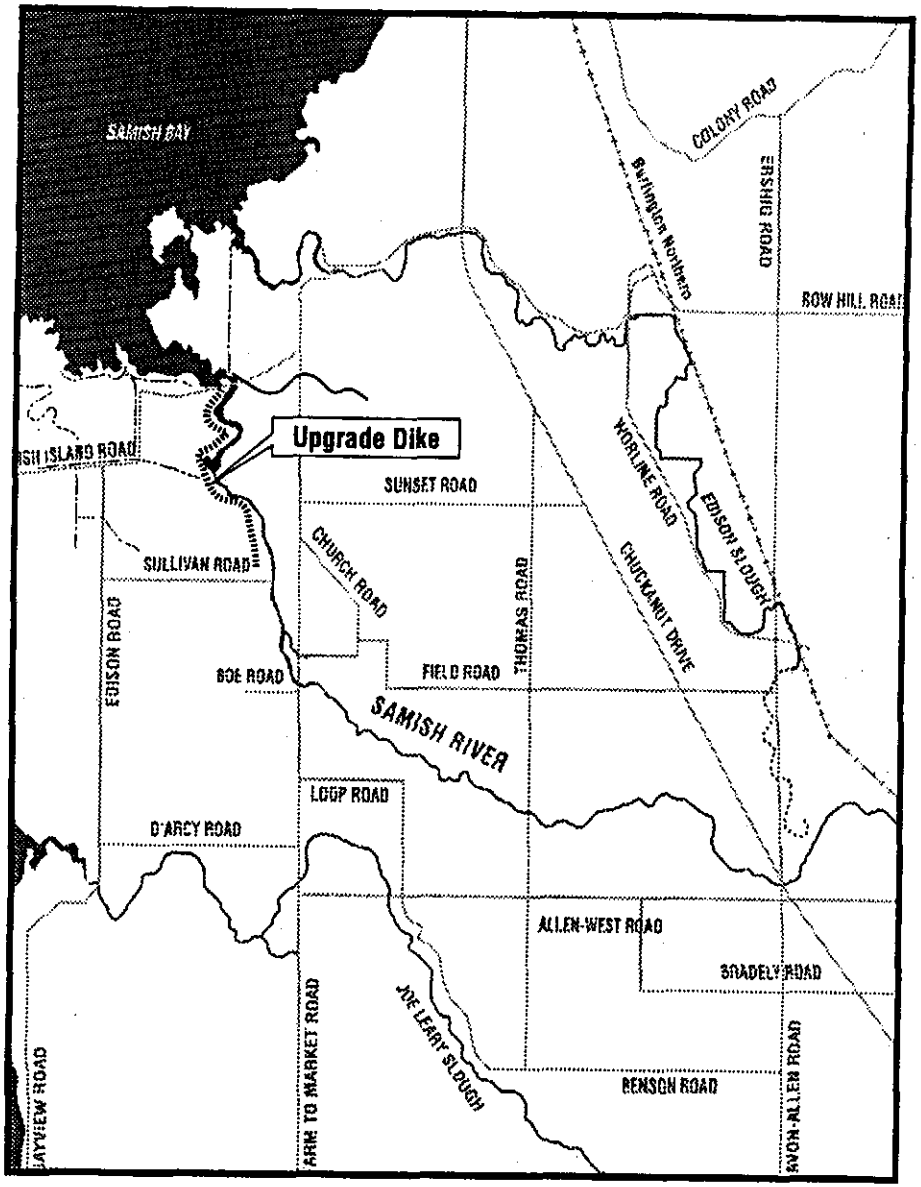
- Staff time for ordinance development, review and approval
- Reduction in allowed use of privately held lands

POTENTIAL FUNDING

- Drainage Utility Funds (if implemented)
- County General Fund



FLOODPLAIN MANAGEMENT ALTERNATIVES



Samish River Flood Hazard Management Plan

PROPOSED PROJECT D-9 (Wester dike improvement D/S of Sullivan Road)

ISSUES

- Portions of existing dike constructed at insufficient elevation
- Crown of dike has settled in several locations
- Minimal dike width in localized areas

CONCERNS

- Dike overtopping, leading dike damage or failure
- Long duration flooding behind sea dikes
- Minimal dike width in localized Crop damage/livestock displacement
- Erosion of farm fields
- Dike embankment sloughing

PRELIMINARY SOLUTIONS

- Top and regrade dike to consistent grade throughout section
- Fill and compact dike at settled locations
- Improvement dike embankment stability

BENEFITS

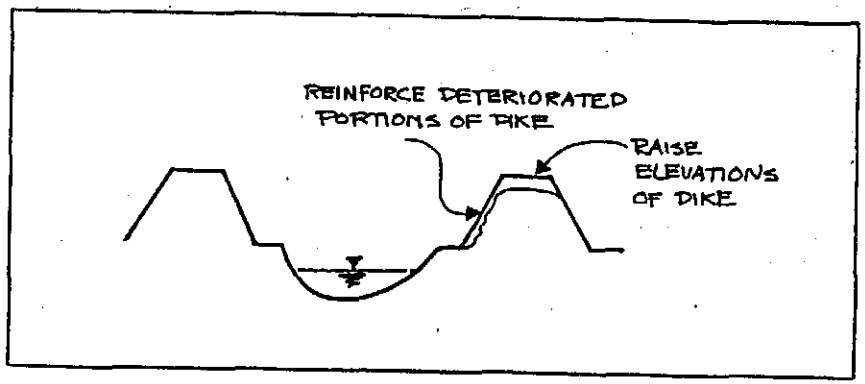
- Reduction in flooding potential
- Improved dike stability
- Enhanced farming economics

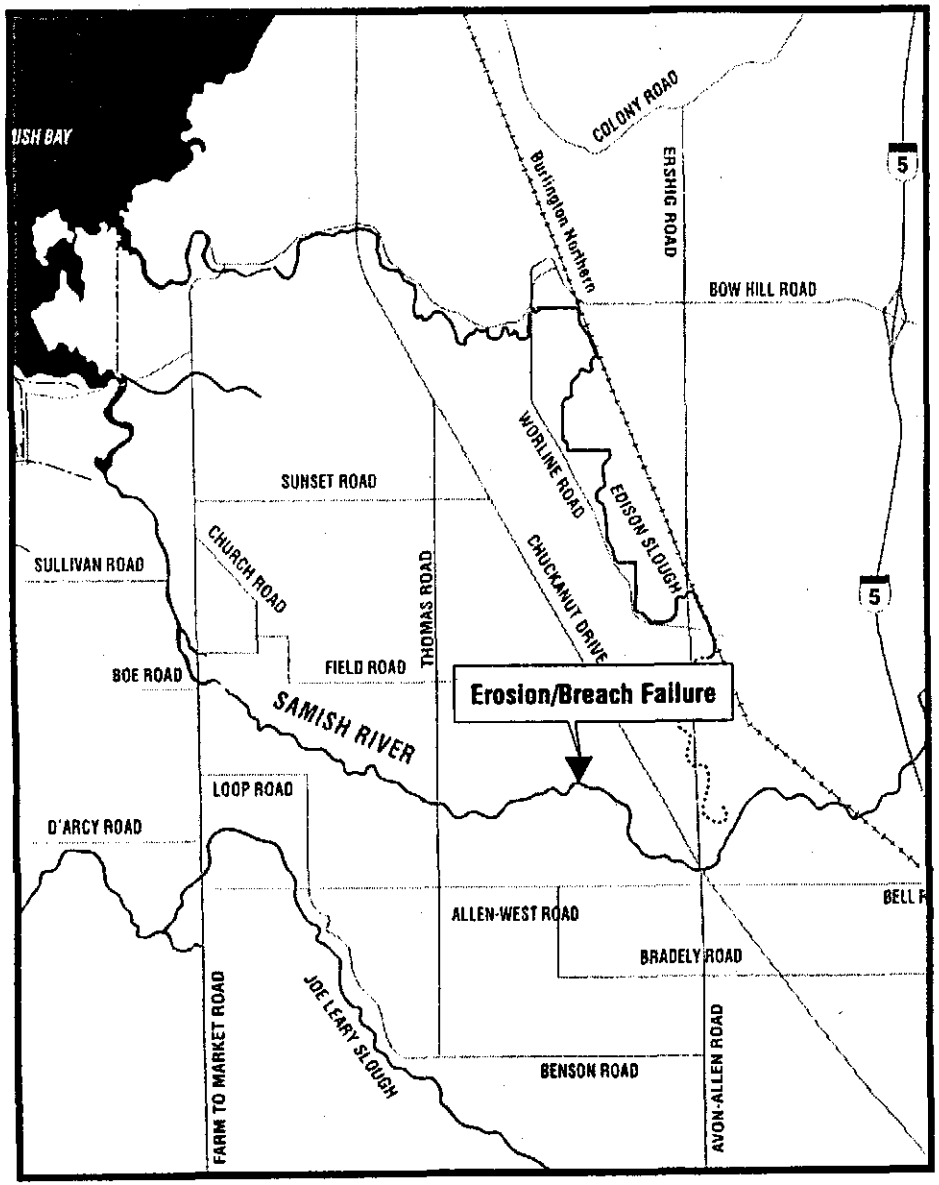
COST ITEMS

- Install compacted fill/raise dike
- Top and Regrade approximately 3,000 ft of existing dike
- Place riprap on dike face at deteriorated locations

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds
- FCAAP Matching Funds





Samish River Flood Hazard Management Plan

PROPOSED PROJECT C-8 (Dike Replacement/Repair Dist. 25)

ISSUES

- Existing dike on north side of river severely eroded

CONCERNS

- High potential for dike failure during flood events
- Field flooding/erosion
- Crop damage/livestock displacement

PRELIMINARY SOLUTIONS

- Reshape river bank
- Install rip rap rock bank protection
- Regrade top of levee

BENEFITS

- Reduction in flooding potential
- Improved dike stability

COST ITEMS

- Bank reshaping
- Imported rock replacement
- Dike regrading
- Vegetative restoration

POTENTIAL FUNDING

- Drainage District Funds
- River Improvement Matching Funds