Feasibility Study of Proposed Water Quality, Stream Flow and Habitat Improvement Activities in the Fisher and Carpenter Creek Watershed of Skagit and Snohomish Counties, Washington

Prepared Pursuant to Washington Department of Ecology
Centennial Clean Water Fund Grant No. G0400195
"Fisher/Carpenter TMDL Implementation"

Skagit Conservation District
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Background

Fisher/Carpenter Creek is located in southwestern Skagit County and northwest Snohomish County, Washington. The watershed's several upland tributaries, manmade drainage channels, and natural slough drain an area of about 25.5 square miles. The watershed is included in the federal Clean Water Act Section 303(d) list for violating state water quality standards due to non-point source runoff pollution, in particular for ongoing violations of the fecal coliform and temperature standards. In order to address the water quality problem, the Washington Department of Ecology (WDOE) is developing Total Maximum Daily Load (TMDL) allocations for temperature and fecal coliform in the Lower Skagit Basin, including the Fisher/Carpenter Creek Watershed. In addition to its water quality problems, the watershed suffers extreme ranges of runoff flow, from very low flow in summer to occasional flooding in the wet season. The extreme range of flows impact both farming and aquatic habitat conditions in the watershed.

Responding to the desire to correct the water quality and flow problems, Skagit Conservation District (SCD) obtained a Centennial Clean Water Fund grant to complete a characterization of the watershed conditions and to prepare an engineering feasibility study of a slate of proposed projects for improving water quality, providing more consistent stream flows, and supporting fish and wildlife habitat. This document represents the feasibility study portion of the grant.

Specific Objectives

The following specific objectives were developed for correcting the problems that were identified in the *Fisher/Carpenter Creek Watershed Characterization Report* (SCD, 2006):

- Consistently comply with the Washington Water Quality Standards for temperature, dissolved oxygen and fecal coliform
- Augment summer low flow by increasing upland storage and releasing impounded water during summer
- Reduce sediment deposition and flooding at the mouths of Sandy and Johnson Creeks
- Eliminate localized flooding and fish passage barriers at high priority road culverts
- Reduce the back-water effect of Hill Ditch during high flow conditions
- Enhance the quality and extent of riparian forest vegetation
- Increase channel complexity in modified stream reaches
- Enhance the ecological functions and values of key riparian wetlands

Identification of Alternatives for Achieving the Objectives

Several potential types of projects that could help achieve the drainage, water quality, and habitat objectives were identified. These include:

- No Action
- Riparian Reforestation and Fencing
- Modification of Dam Spillways
- Creek Channel Restoration and Floodplain Reconnection
- Replacement of Culverts
- Dike Setback
- Enhancement of Riparian Wetlands
- Permanent Conservation Easements

Four policy-related alternatives were also identified:
- Drainage Tax Credits for On-site BMPs
- Small Grants for BMP Implementation
- Improved Coordination of Land Development Permitting
- Adoption and Implementation of In-stream Flow Regulations

Evaluation and Ranking of the Alternatives

Each of the alternatives was evaluated according to three basic criteria: 1) effectiveness in achieving the specific objectives, 2) potential detrimental impacts, and 3) cost. The alternatives were then ranked relative to each other in accordance with their relative "benefit" versus their cost. As future funding becomes available, SCD recommends that an advisory committee of landowners and other stakeholders in the watershed complete a second ranking of the projects based on the criteria of "public acceptance" and "likelihood of implementation." The results of the cost-benefit rankings are shown in the following table.

Summary of Rankings of Alternatives

Project Alternative	Cost per Benefit Ranking	Public Acceptance Ranking
Permanent Conservation Easements	1	(To be completed)
Modification of Dam Spillways	2	
Riparian Reforestation and Fencing	3	
Creek Restoration and Floodplain Reconnection	4	
Enhancement of Riparian Wetlands	5	
Culvert Replacements	6	
Typical Dike Setback Project	7	
Policy Alternatives		
Drainage Tax Credits for Implementing BMPs	Unranked	
Small Grants for Implementing BMPs	Unranked	
Improved Coordination of Land Development Permitting	Unranked	
Adoption and Implementation of In-Stream Flow Regulations	Unranked	

1 Introduction

1.1 Location of the Study Area

The Fisher/Carpenter Creek Watershed is located in southwest Skagit County and northwest Snohomish County, Washington. The watershed's several upland tributaries, man-made drainage channels, and natural slough drain an area of approximately 25.5 square miles, located between the communities of Mount Vernon and Stanwood, Washington.

1.2 Policy Background

Section 319 of the Federal Clean Water Act requires states to identify water bodies which, without control of non-point source pollution, cannot attain applicable water quality standards. In response to this federal mandate, the Washington Department of Ecology (WDOE) funded local initiatives to identify and rank such water bodies and to develop action plans for addressing non-point source pollution.

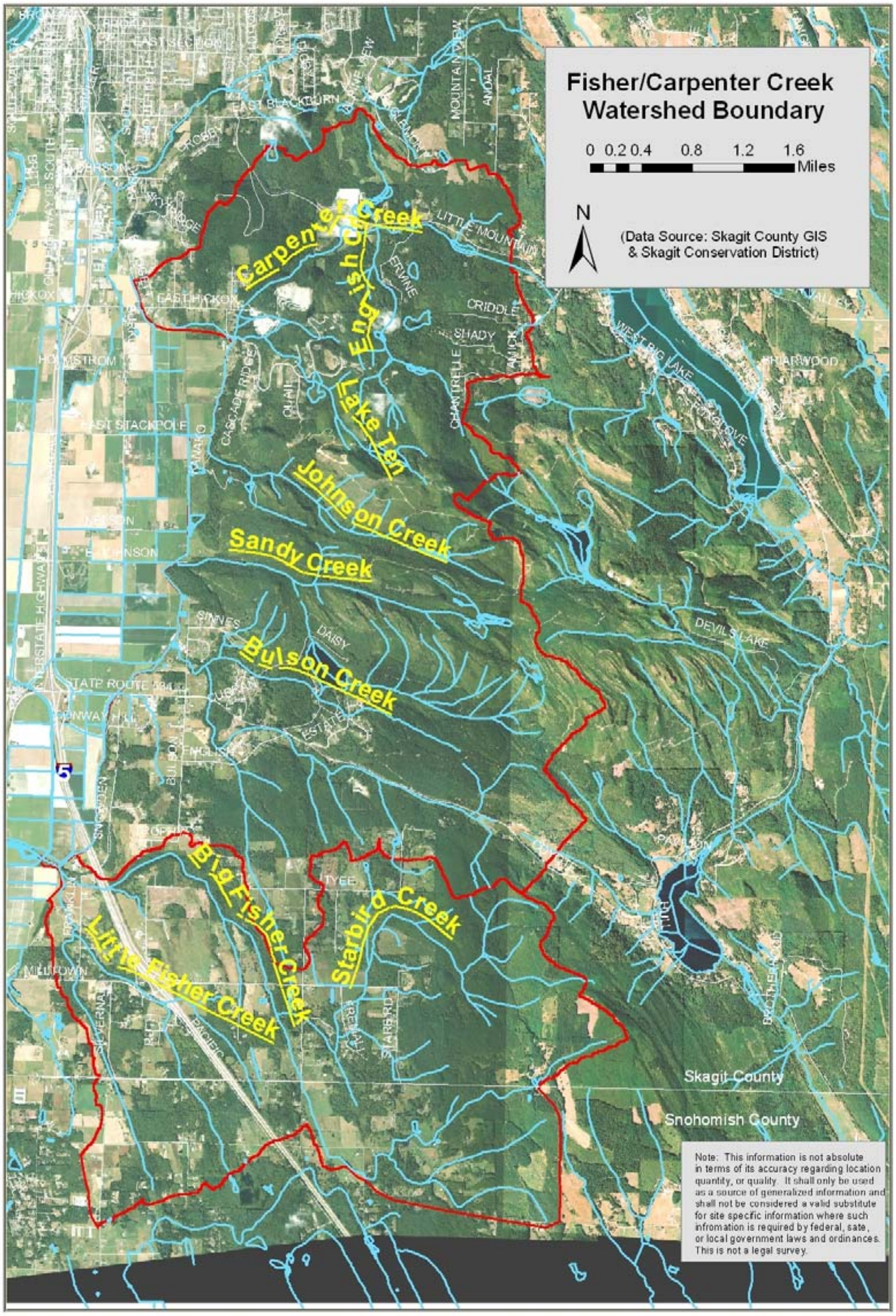
A related provision of the Federal Clean Water Act is Section 303(d), which requires states to identify water bodies for which implementation of the various point source effluent limitations will not by itself attain the relevant water quality standards. Further, states must develop plans for limiting the total point source and non-point source pollution discharges to such water bodies, in order that water quality standards can be attained. The Fisher/Carpenter Creek system is identified in WDOE's 1998 303(d) listings as a water body that, without control of non-point source pollution, cannot attain the State of Washington Water Quality Criteria for temperature and fecal coliform bacteria. (WDOE, 1998). WDOE's revised 303(d) listing includes dissolved oxygen and fecal coliform (WDOE, 2004). WDOE is presently developing "total maximum daily load" (TMDL) allocations for fecal coliform and temperature for the Lower Skagit Watershed, including the Fisher and Carpenter Creek basins. When implemented, the TMDL is expected to allow the water bodies to attain water quality standards for the particular parameter.

1.3 Purpose

In 2003, Skagit Conservation District (SCD) obtained a Centennial Clean Water Fund (CCWF) grant from WDOE to complete a suite of activities titled *Fisher/Carpenter TMDL Implementation*. The activities focus on 1) completing a detailed characterization of existing water quality, hydrology, and habitat conditions in the watershed, 2) carrying-out public education and public consultation activities to encourage community participation, and 3) completing a feasibility study of a slate of proposed projects for improving water quality, restoring some historic hydrologic function, and supporting fish and wildlife habitat.

SCD completed the report, *Fisher/Carpenter Creek Watershed Characterization,* in March, 2006 and conducted initial public education and public consultation activities in 2004-2005. This document represents the third activity of the CCWF grant, a feasibility study of a slate of proposed projects for improving water quality, restoring some degree of historic hydrologic function, and supporting fish and wildlife habitat. Based on the results of the watershed characterization and input from stakeholders during the initial public outreach activities, this feasibility study identifies and evaluates a range of proposed projects for addressing the non-point source pollution, stream flow, and habitat problems in the watershed.

Figure 1.1. Fisher/Carpenter Creek Watershed



2 Problem Description

The *Fisher/Carpenter Creek Watershed Characterization* report presents the results of studies of water quality, surface water hydrology, and natural habitat conditions, which SCD, WDOE, and other local stakeholders have conducted in the watershed since the 1990s. The most significant problems that were identified in the report are presented below. Figures 2.2 through 2.6 show the locations of the various problem areas described in this chapter.

2.1 Water Quality

2.1.1 Water Quality Standards

The Fisher/Carpenter Creek system, including its natural upland tributaries and associated man-made drainage channels, are “surface waters of the State of Washington” whose water quality is regulated by the Washington Water Quality Standards (Washington State Attorney General, 1969). The Washington Class A Freshwater Standard applies to the entire watershed. Characteristic Class A uses include water supply, stock watering, fish rearing, spawning and habitat, wildlife habitat, recreation, and commerce. Selected criteria are presented in Table 2.1.

Table 2.1 Selected Washington Class A Water Quality Criteria

Parameter	**Class A Freshwater**
Fecal coliform organisms	Not to exceed a geometric mean of 100 colonies per 100/ml; no more than 10 percent of samples may exceed 200 colonies per 100/ml
Dissolved oxygen	Shall exceed 8.0 mg/l
Temperature	Shall not exceed 18.0°C due to human activities
Turbidity	Shall not exceed 10% over natural background turbidity

Based on monitoring of these water quality parameters during the *Fisher/Carpenter Creek Watershed Characterization Study* and other studies, the following non-point source water quality problems have been identified in the watershed.[1] It should be noted that the water quality monitoring that has been conducted to date has included a relatively small number of sampling sites within the large watershed and has been conducted for a relatively short duration of time. Accordingly, the available data represent “snap shots” of likely trends in water quality problems over the entire watershed. Locations of sampling sites are shown in Figure 2.1.

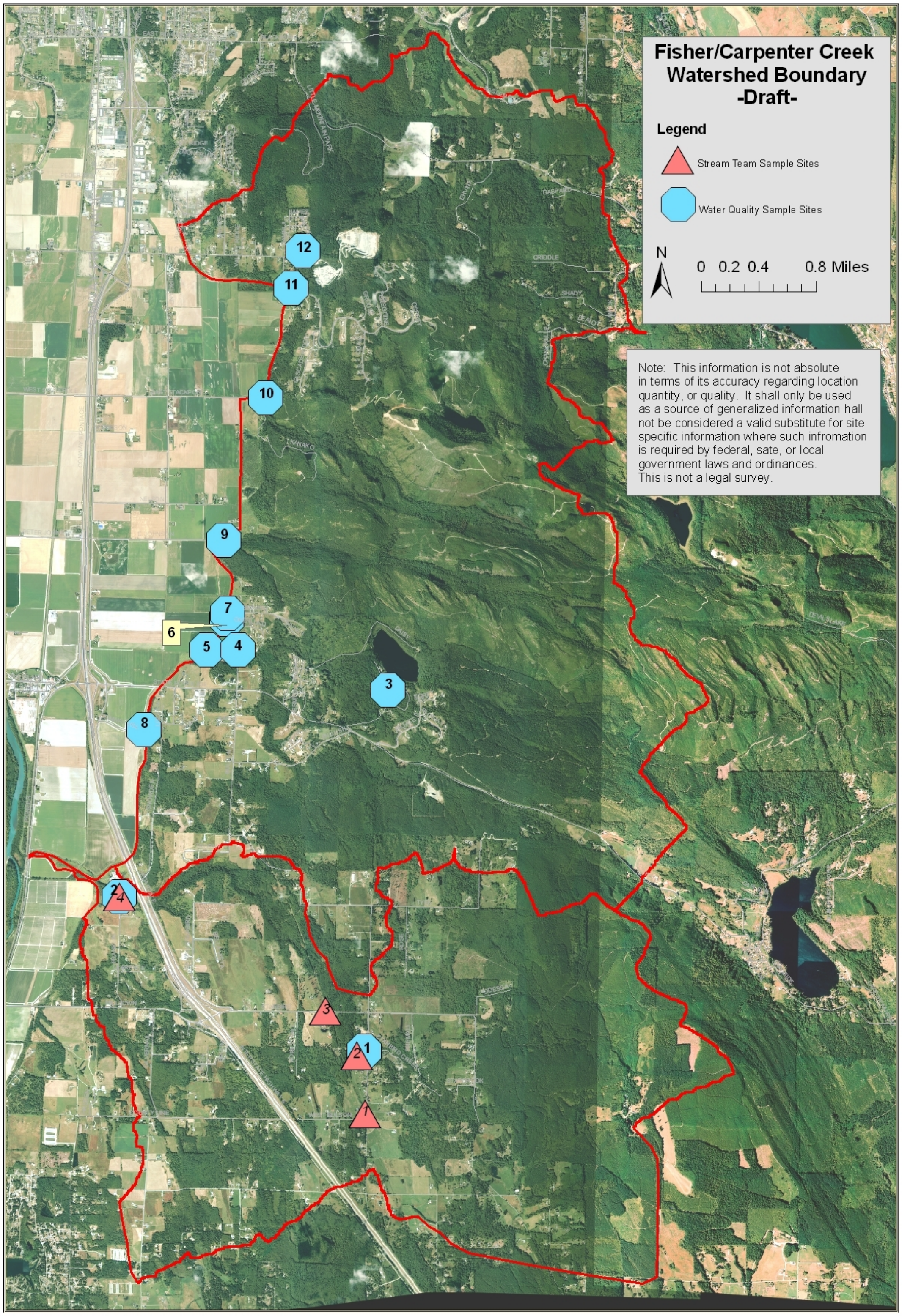
2.1.2 Water Quality Problems

<u>Fecal Coliform</u>

Fecal coliform levels exceeding the water quality standard have been detected at five sites, primarily during rainy months. Violations ranged from 200 to 1600 colonies per 100 ml. The highest levels were consistently measured at two sampling sites on Fisher Creek, one downstream of the Bulson Road crossing (Site #1) and one at the Franklin Road crossing (Site

[1] All data and conclusions in this section are referenced from Section 7 of the *Watershed Characterization Study.*

Figure 2.1 Water Quality Monitoring Sites



#2). Other sampling stations where elevated fecals have been detected, albeit at lower levels than at the Fisher Creek stations, are on Carpenter Creek (Site #12 along Stackpole Road and #6 upstream of the mouth of Bulson Creek) and at the mouths of Sandy Creek and Johnson Creek.

Likely sources of non-point source pollution in the Fisher Creek sub-basin include livestock and failing septic systems. Not only do livestock have direct access to the creek in some places, but there are several ephemeral streams located in pasture areas that run only during high winter runoff events. The sources of non-point source pollution in the Carpenter Creek sub-basin are less clear, although failing septic systems and runoff from livestock and pet areas are likely reasons. Results from samples collected downstream of the single dairy farm located along Carpenter Creek show little if any difference from upstream samples.

Dissolved Oxygen

Five of the 108 samples collected have not met the dissolved oxygen standard. All were located along Hill Ditch (Site Nos. 5 and 7), a reach characterized by complete lack of riparian shading, very flat channel gradient, and infestation of reed canary grass, where elevated fecal coliform counts have also been measured. It is surmised that the depressed dissolved oxygen levels are caused by elevated biochemical oxygen demand associated with nutrient and bacteria inputs combined with higher water temperature and very low summer flow.

Temperature

Temperature measurements conducted as part of WDOE's 2001 temperature TMDL study (WDOE, 2001) detected summer water temperatures that frequently exceeded the water quality standards at several sites in the watershed, including the mouth of Fisher Slough, Carpenter Creek at the SR 534 bridge, and Carpenter Creek along Stackpole Road. Elevated temperatures at these locations are correlated with a lack of shading along the north-south trending channel during the time of year when there is essentially no flow. SCD's 2004-2005 water quality monitoring program confirmed this trend.

Turbidity

SCD's monitoring results detected elevated turbidity levels only during a flooding event in January 2005. During this event, turbidity levels at Site No. 9, at the mouth of Johnson Creek, exceeded all other stations by a factor of ten. The high turbidity at the mouth of Johnson Creek is associated with extreme aggrading of the channel by sediment inputs from historic logging in its sub-basin, a situation that requires continual dredging in order to prevent flooding.

Cattle Pasture along Upper Fisher Creek

2.2 Surface Water Hydrology

The primary surface water hydrology problem in the watershed is lack of flow during dry summer conditions. While low summer flow reflects natural climate conditions, the problem is exacerbated by various manmade development activities that either block flow from tributaries during summer or reduce that natural water retention capacity of upland soils.

In general, the hydrology of the Fisher/Carpenter Watershed is less impacted by urbanization and development than most other watersheds along the I-5 corridor in Western Washington. In particular, the watershed's relatively low proportion of impervious surface[2] makes it less subject to flashy hydrology and the associated impacts of channel erosion, excessive sediment transport, and water quality problems. Nevertheless, the watershed does have some localized areas where the hydrology has characteristics of more urbanized areas. These areas include the following.

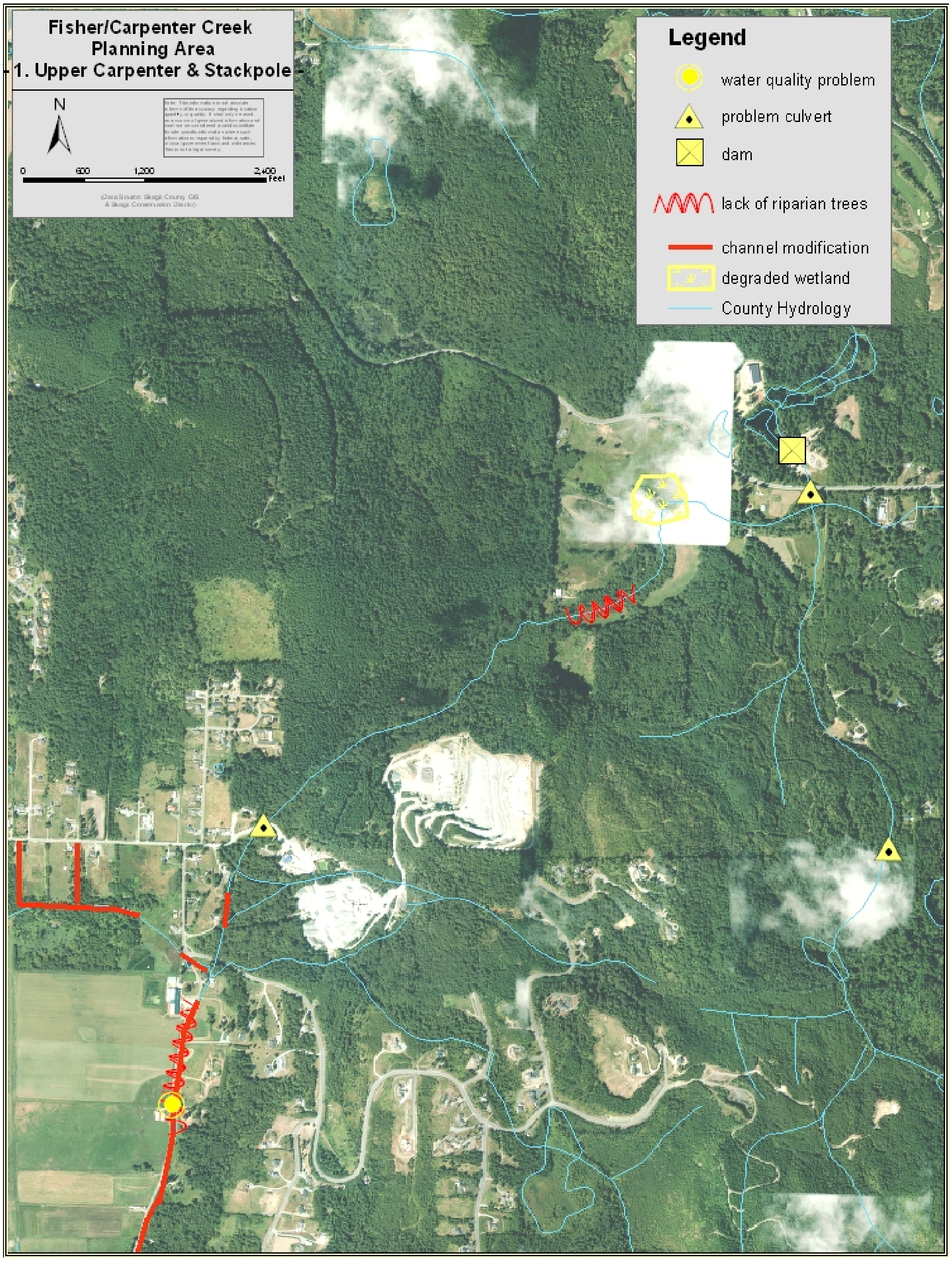
2.2.1 Stackpole Creek

The headwaters of Stackpole Creek consist entirely of roadside ditches and field ditches. Runoff from the south slopes of Little Mountain drains through a medium-density residential area north of Hickox Road, where it collects in relatively steep, rock-lined ditches alongside four residential streets. The ditches converge at one of two culverts under Hickox Road, where they run downhill through pastureland in two eroded and incised field ditches before joining Stackpole Creek. Stackpole Creek itself is ditched and straightened from historic agricultural practices.

[2] The average percent of impervious surface across the entire watershed is about 3 percent, with the highest level being in the Little Fisher Creek sub-basin (6%), which is bisected by I-5.

Runoff in the sub-basin has characteristic "flashy" hydrology with high flows immediately following storm events and no flow the rest of the time. The ditch system is shown in Figure 2.2.

Figure 2.2 Problem Areas along Upper Carpenter Creek and Stackpole Creek



2.2.2 Lake Ten Creek

Lake Ten Creek flows from the outlet of Lake Ten, on a saddle between Scott Mountain and Devils Mountain, steeply down through clear-cut mountain slopes, through the Cascade Ridge housing development, and into Carpenter Creek just upstream of the confluence with Stackpole Creek. Despite the steepness of the slopes, intact riparian buffers and natural ledge outcrops have prevented the kind of severe channel erosion problems that are sometimes associated with logging and development on steep slopes. While the outlets of some of the road crossing culverts in Cascade Ridge development are "perched," the culverts do not otherwise appear to significantly impair the natural hydrology of the sub-basin.

2.2.3 Carpenter Creek along Stackpole Road

Carpenter Creek upstream of E. Hickox Road for the most part retains its natural channel conditions, with stable pool and riffle morphology and mature riparian forests. After crossing under E. Hickox Road at the Martin Marietta quarry access road, the channel slope flattens out and channel conditions become more degraded by development activities. Severe localized bank erosion immediately downstream of the quarry access road has naturally stabilized following replacement of the former, undersized culvert with the existing 10-foot culvert.[3] Further downstream, the reach between East Hickox Road and Cascade Ridge Drive has a few places where concrete and rock fill material has been placed in the channel, both as bank armoring and as simply landfill. The presence of the fill has caused localized bank erosion downstream.

Downstream of Cascade Ridge Drive, the Carpenter Creek channel has a very low gradient and is essentially backwatered by the water level in Hill Ditch. The straightened channel is confined to a deep ditch, confined on the right bank by the Stackpole Road embankment and with no riparian buffer at all on the left bank. Several driveway bridges, ranging from 16 to 24-feet long, cross the creek in this reach, but do not appear to constrict the flow. Reed canary grass and nightshade proliferate in the low-flow, un-shaded conditions and severely clog the channel. Problem areas in Lower Carpenter Creek are shown in Figure 2.3

2.2.4 Sandy Creek along Kanako Lane

Sandy Creek formerly flowed straight west from the base of the Devils Mountain uplands through an alluvial fan to its confluence with Carpenter Creek. When the fan area was converted to agriculture land, the lowest reach of Sandy Creek was re-routed to a narrow ditch along Kanako Lane. Sediment load that was formerly deposited on the alluvial fan now accumulates at the culvert under Kanako Lane and at the confluence with Carpenter Creek/Hill Ditch[4] under the Kanako Lane Bridge. Both areas require regular dredging to prevent flooding. Riparian conditions along this lowest reach of Sandy Creek consist of the unpaved Kanako Lane on the right bank and a dense blackberry thicket on the left bank.

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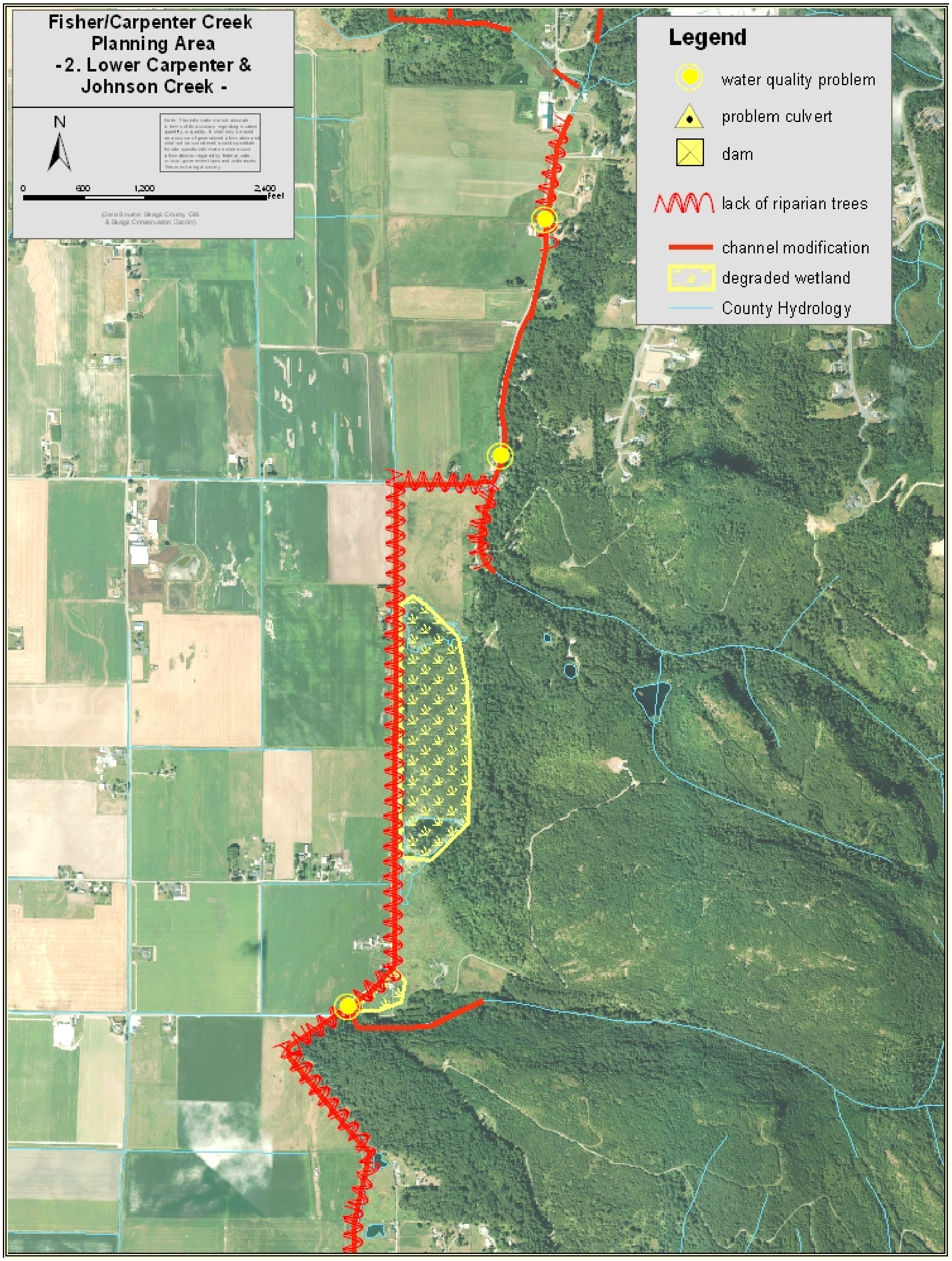
[3] The original 3-foot diameter culvert was washed away during a heavy rain event in 1990.
[4] Downstream of the Kanako Lane bridge, the Carpenter Creek channel is entirely man-made and is referred to as "Hill Ditch."

Figure 2.3 Problem Areas along Upper Hill Ditch



2.2.5 Lower Johnson Creek

Like Sandy Creek, settlers re-routed the lowest reach of Johnson Creek away from its original alluvial fan to allow more space for agricultural land use. The channel is now constrained by an unpaved road on the right bank and steep hillside slopes on the left bank. The channel in the lowest reach is severely aggraded with gravel bed load, a legacy of poor logging practices in the upper watershed. While the forest slopes have subsequently re-stabilized, channel aggradation continues to the extent that a sandbag check dam is needed to prevent regular flooding of the road, and the confluence with Hill Ditch must be dredged every few years to prevent blocking of the ditch with bed load. Problem areas along Hill Ditch, Sandy, and Johnson Creeks are shown in Figure 2.3

2.2.6 Hill Ditch

Prior to the agricultural development of the Fisher/Carpenter Watershed, Carpenter Creek meandered across the extensive wetlands of the Cedardale area, picking up the flows from Sandy, Johnson, and Bulson Creeks before flowing into the Skagit north of Conway. From the early 1900s to the 1930s, local drainage districts supervised the ditching and diking of the creek to its current configuration as the Hill Ditch. Hill Ditch runs for about five miles from the confluence with Sandy Creek, to the confluence with Fisher Creek at Fisher Slough. The slough then flows into the Skagit River through a large tidegate system. The right bank of Hill Ditch is confined by an up to eleven-foot high dike. Except for the first mile, where the creek runs straight along a section line through pasture, the left bank is confined by the base of the uplands.

The confinement of water in the diked channel, where the water surface elevation during the winter wet season can be 8 feet or higher above the surrounding ground surface, backwaters the mouths of all the creeks in the watershed, causing excessive sediment deposition and occasional flooding upstream. While Hill Ditch occasionally has overtopped its dike in extreme flood events, generally flooding is confined to a mile section of left bank floodplain located between Sandy and Johnson Creeks. The low lying pasture in this area has been more or less abandoned to shallow, open water wetland, the water level of which rises and falls depending on the level of beaver dam-building during any particular year. The very low gradient and backwatering by the tidegates and beaver dams creates a natural sediment-settling basin with essentially no flow during the summer months. In order to maintain flood flow capacity, the drainage district periodically dredges the sediment and the invasive weeds that clog the un-shaded channel.

2.2.7 Little Fisher Creek

With the exception of the East Fork of Little Fisher Creek in the vicinity of I-5, the various tributaries of Fisher Creek are generally less impacted by development than those in the Lower Carpenter Creek Watershed described above. East Fork Little Fisher emerges from extensive forested and abandoned pasture wetlands along the Snohomish/Skagit County line to a low-density residential area along Bruun Road. The channel in this area is constricted by three undersized driveway crossings with no riparian buffer. After crossing under Pacific Highway, the creek drops through an eroding channel within the I-5 right of way. This reach is impacted by runoff from I-5 and from field ditching in pastures immediately east of I-5. There is no riparian vegetation whatsoever in the interstate right of way to stabilize the eroding channel.

Further down, an undersized, 150-foot long culvert under Bonnie View Road and a perched, undersized culvert under Franklin Road have caused localized channel scour downstream. The locations of these features are shown in Figure 2.6

2.2.8 Localized Hydraulic Obstructions

Throughout the Fisher/Carpenter Creek Watershed there are a handful of major hydraulic structures that cause a localized impact on stream hydrology. While these structures do not appear to impact entire reaches, such as those described in the preceding sections, their localized impact is significant. Four standouts include the following.

Carpenter Creek Dam
An earth and rubble dam blocks Carpenter Creek just upstream of Little Mountain Road. The dam impounds the lowest pond on the Lang Pony Farm property. The dam impounds flow in Carpenter Creek for much of the year, spilling a significant flow of water over its spillway and through an eroding bypass channel only during the winter wet season.

English Road Culvert
The South Fork of Bulson Creek crosses under English Road through a 36-inch diameter culvert that is almost completely blocked with sediment at its downstream end. The inlet is backwatered during moderate and high stream flows, resulting in skewed stream flow downstream and, potentially, partial saturation conditions in the road fill prism.

Bulson Road Culverts
The main stem of Bulson Creek crosses under Bulson Road through a pair of 36-inch diameter culverts. The low point in the road at this crossing is an area of chronic flooding, caused by inadequate hydraulic capacity of the culverts.

West Fork Little Fisher Creek Dam
A private concrete dam blocks the West Fork of Little Fisher Creek just upstream of County Line Road. While the dam has a functioning concrete spillway, it impounds much of the flow in the creek during summer low flow conditions.

2.2.9 Fisher Slough

Fisher Creek flows into the Hill Ditch system at Fisher Slough, a highly manipulated, diked drainage reservoir constructed with assistance from the federal government Works Project Administration in the 1930s. The Nature Conservancy is currently conducting an in-depth feasibility study of salmon habitat restoration opportunities in Fisher Slough. In order to avoid duplication of effort, SCD has not included Fisher Slough within the scope of this Fisher/Carpenter Creek Watershed feasibility study.

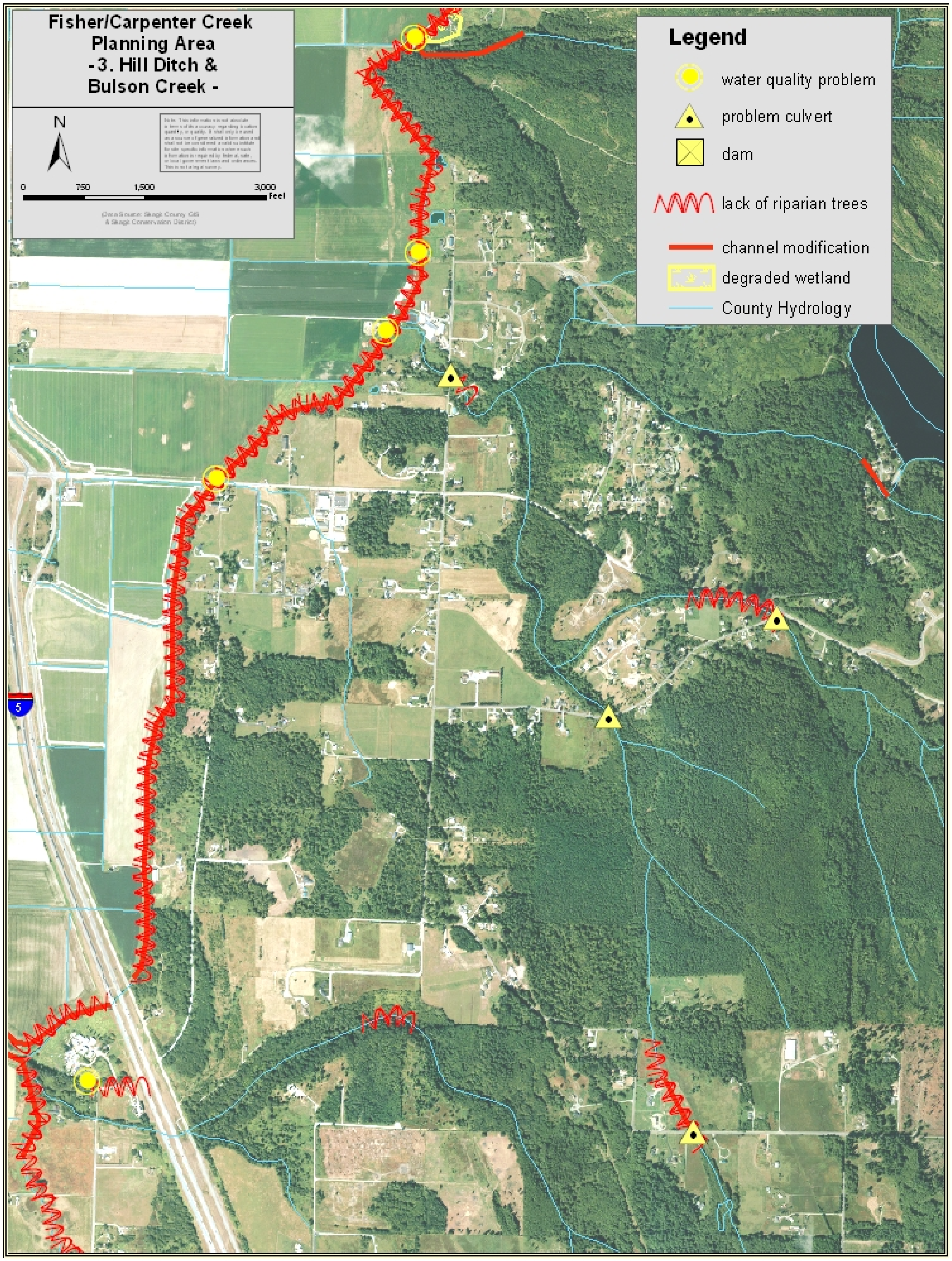
The preceding sections identify high priority problem areas where development activities have impacted the natural surface water hydrology in the watershed. It should be noted though that hydrology on the watershed scale is dynamic, responding directly and indirectly to changing land use patterns in the watershed. In some areas of Fisher and Carpenter Creeks, deeply eroded ravines that are now stabilized with mature timber are evidence of nature’s gradual recovery from the severe erosion that resulted from the initial clear-cutting of the old growth forests in the

Nineteenth Century. Likewise, the relatively intact channel conditions along many of the watershed's tributaries in rural areas may become quickly degraded in the future as these areas are converted to increasingly dense residential development.

Aggrading Channel of Lower Johnson Creek

Hill Ditch and Sediment Fan at the Mouth of Johnson Creek

Figure 2.4 Problem Areas along Bulson Creek and Lower Hill Ditch



2.3 Fish and Wildlife Habitat

Chapter 8 of the *Fisher/Carpenter Creek Watershed Characterization Study* inventories and evaluates the quality of existing habitat conditions in creeks and associated wetlands and riparian areas of the Fisher/Carpenter Creek Watershed. The most significant problems that limit the function and value of fish and wildlife habitat in the watershed are described below.

2.3.1 Water Quality and Hydrology Impairment

The water quality and hydrology problems identified in Sections 2.1 and 2.2 directly impact habitat for fish and to a lesser extent other wildlife. Excessive temperature and depleted dissolved oxygen limit the habitat potential of the main stem of Carpenter Creek for salmonids at least part of the year. Without further monitoring, it is unknown whether water quality in Fisher Creek and the tributary creeks is degraded enough to impair fish habitat. The flashy hydrology of the watershed impacts in-stream habitat both by causing excessive stream flow velocities to juvenile fish during peak runoff, as well as drying-out of some during dry late summer conditions.

2.3.2 Fish Passage Barriers

In addition to the four major hydraulic obstructions described in Section 2.2.8, there are several other in-stream structures that block fish passage into the Fisher/Carpenter Creek system. Culverts and other man-made structures that are believed to partially or fully block juvenile or adult salmonid passage during at least part of the year are listed in Table 2.2. No attempt is made during this feasibility study to prioritize the blockages by evaluating the quality of upstream habitat by “priority index” (PI), “Ecosystem Diagnostic and Treatment” (EDT) or other standard methodologies. Nevertheless, a general sense of the relative impact of each particular barrier was made by general field observations, and Table 2.2 lists the length of potential stream habitat upstream of each barrier.

Table 2.2 Potential Fish Passage Barriers

Parcel No.	Nearest Road	Structure	Length of Habitat Upstream*	Comment
English Creek				
P29743	Ervine Road	30” concrete culvert	minimal	Outlet perched 2 feet, but in a steep headwater reach
Carpenter Creek				
P29707	Little Mountain Road	Dam and spillway	1500 ft	Spillway blocks access into pond. Overflow culvert perched 4’ above eroded downstream channel
P29707	Little Mountain Road	12” CMP culvert	2000 ft	Partially squashed and buried culvert on bypass channel around pond
	E. Hickox Road	10’ CMP culvert	6000 ft	Rock sill at outlet drops 2.6 ft to pool bottom forming partial low flow barrier. Lack of gravel/rock in culvert may hinder passage at high flow

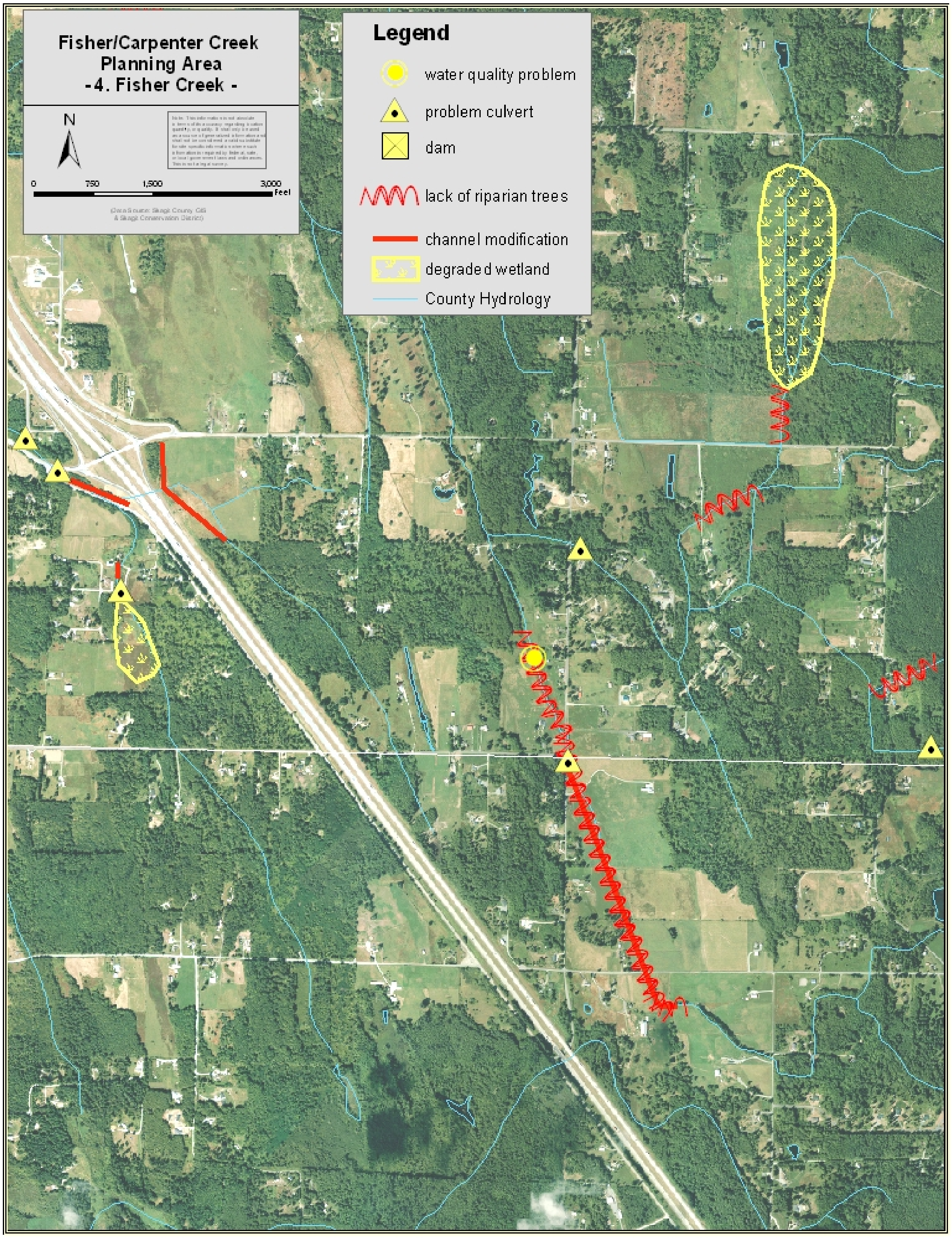
Lake Ten Creek				
P83858	Grouse Road	4' CMP culvert	Minimal	Outlet perched 1 ft., but in a steep headwater reach
Johnson Creek				
P16713	E. Johnson Road	6' CMP culvert	2000 ft?	Culvert periodically fills with gravel from creek, partially blocking flow until creek is dredged
Bulson Creek				
P17422	Bulson Road	12" concrete culvert	2000 ft?	Undersized
P17141	English Road	3' concrete culvert	5000 ft	Outlet blocked with debris, undersized
P17098	English Road	Four culverts of varying size under road	8000 ft?	All are partially blocked by sediment
P16689	Hermway Heights	Natural waterfall	N.A.	Approx. 60' high, natural fish barrier
Starbird Creek				
33204 1-009	English Grade	18" concrete culvert	minimal	Outlet buried with gravel, undersized, steep headwater upstream
P17786	Starbird Creek Lane	24" and 36" CMP culverts	14,000 ft	Left culvert perched 1 ft, right culvert perched 15 in.
Fisher Creek				
P17746	Bulson Road	5' CMP culvert	10,000 ft	Outlet partially filled with sediment, undersized
Little Fisher Creek				
P17667	Bruun Road	24" CMP culvert	6000 ft	Outlet perched 18 ", wetlands upstream
I-5 ROW	Milltown Road	5' CMP culvert, 150' long	1500 ft	Potentially a velocity barrier?
P17587	Bonnie View Road	5' CMP culvert, 150' long	1000 ft	Likely a velocity barrier due to slope
P17475	Franklin Road	3' drop over LWD jam	N.A.	Probably a natural fish barrier
P17469	Franklin Road	4' concrete culvert	3000 ft	Outlet perched 2 ft.
53241-002	County Line Road	Concrete dam	55000ft	Spillway about 3' above downstream channel
P17585	County Line Road	4' CMP culvert	500 ft (to dam)	Outlet perched 42" above channel bottom

* or length of stream to the next upstream barrier

Perched culvert, Franklin Road, Little Fisher Creek

Private Dam above County Line Road/332 St. NW, Little Fisher Creek

Figure 2.5 Problem Areas in the Fisher Creek Sub-basin



Juxtaposed against the fish passage blockages listed in Table 2.2 four engineered fishways have been installed in the last decade or so to improve fish passage conditions in the watershed. Pool and weir fishways provide upstream access into road culverts at the following locations:

- Milltown Road (West Fork Little Fisher Creek),
- Cedardale Road (main stem of Fisher Creek, just upstream of I-5),
- Starbird Road (main stem of Fisher Creek), and
- SR 534 (Middle Fork Bulson Creek).

2.3.3 Riparian Vegetation

The presence of mature riparian forests is a fundamental factor affecting the quality of fish and wildlife habitat in the Puget Sound region. Among the ecological services that riparian forests provide are shading of the water in summer, a source of woody debris recruitment and organic litter, attenuation of stormwater runoff and hyporheic flows, stabilization of stream banks from erosion, and cover for wildlife. Most of the Fisher/Carpenter Creek Watershed is forested and mature stands of forest still exist along much of the length of its creeks. The main exceptions are Carpenter Creek below Cascade Ridge Drive, Hill Ditch, where land has been converted to active agriculture, and parts of the Upper Fisher, Starbird, and Little Fisher sub-basins, where land that was cleared for agriculture has now been converted to residential development and “hobby” farms. Table 2.3 lists key large areas within the watershed where natural riparian forest conditions are absent or significantly degraded.

Table 2.3 Key Areas Lacking Riparian Forest Conditions

Parcel No.	Nearest Road	Description
Carpenter Creek		
P29715	Little Mountain Road	Cleared horse pasture with minimal fencing. Part of pasture frequently flooded by beaver pond
P16297 to P16278	Stackpole Road	Several small parcels with no trees or shrubs along left bank. Right bank of creek abuts Stackpole Road berm
Stackpole Creek		
P16256	E Hickox Road	Field ditch through unused pasture with very little riparian cover
?	E Hickox Road	Eroded field ditch through unused pasture with little riparian cover
P16257	Stackpole Road	Creek ditched through abandoned, canary grass infested pasture
P16277	Stackpole Road	Riparian area and channel infested with knotweed
Sandy Creek		
P16584	Kanako Lane	Dense hedge of blackberry bushes line the left bank for about 600’
Hill Ditch		
(Several)	(Several)	Completely devoid of riparian trees and shrubs on right (west) bank (the dike). Forest cover on left (east) bank generally intact on left bank (the hillside) from SR 534 to confluence with Fisher Slough
Bulson Creek		
P17391-	Bulson Road	Hobby farm livestock pastures. Creek partially fenced but no

17393		riparian forest buffer
P16674	Bulson Road	Abandoned pasture overgrown with canary grass and blackberry
P16740-16741	Bulson Road	Pasture used by active dairy farm
P17098	SR 532	Pasture along south bank of MF Bulson Creek with no buffer
Starbird Creek		
P17369 – P1735	Rose Road	Abandoned pasture overgrown with reed canary grass. No riparian forest vegetation on right (west) bank
P11767	Starbird Road	Abandoned pasture overgrown with canary grass. No buffer on either bank
P11794	Fremali Lane	Livestock pasture with minimal tree buffer
Fisher Creek		
33204 4-020	Brandstrom Road	Creek runs through eroding road ditch for about 100 ft. No vegetation buffer on left bank (road) side
33204 3-017 & 016	Brandstrom	Creek runs through canary grass pasture with minimal *spirea* buffer
33204 2-010	324th St. NW	Pasture with no riparian buffer. Near gas pipeline route
33204 2-002,3,& 7	44th Ave. NW	Pasture with no riparian buffer. Near gas pipeline route
P17746, P17744	Bulson Road	Active cattle pasture with no riparian buffer. Incomplete fencing does not exclude cattle from creek
P17407	Bulson Road	Large clear cut on steep right bank with only minimal to no creek buffer
P17459	Franklin Road	Minimal buffer between junk yard and right bank
Little Fisher Creek		
P17703	Starbird Road	Tributary ditched through emergent wetland pasture, no buffer
I-5 ROW	Pacific Hwy South	No riparian vegetation within highway ROW
P17661	Bruun Road	Abandoned pasture grown up in canary grass. Narrow willow and *spirea* buffer
P17469	Franklin Road	Confluence of east and west forks in active cattle pasture. No buffer or fencing, significant damage to creek by cattle
P17466	Franklin Road	Open pasture along DD3 dike. No buffer on either bank

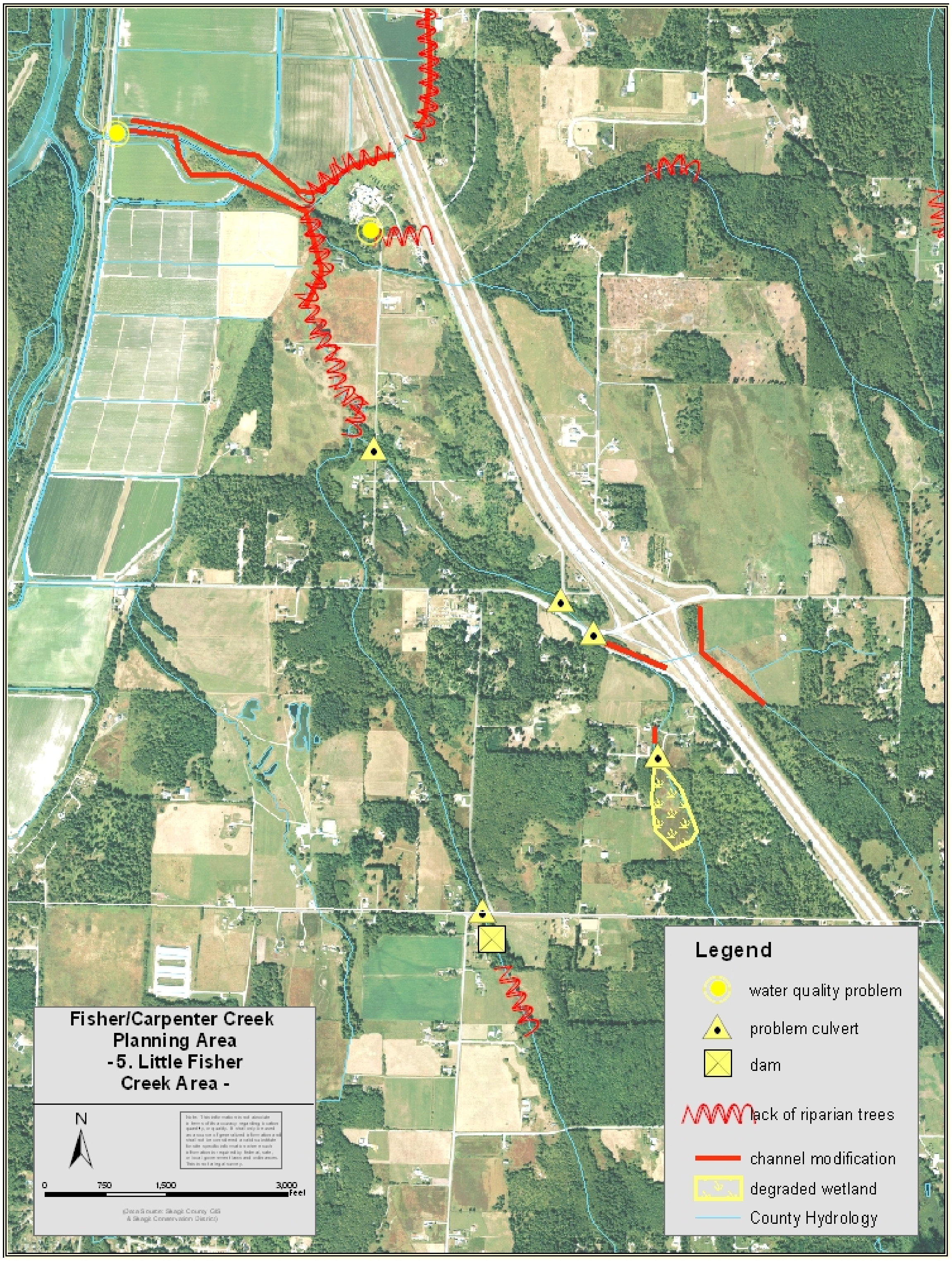
2.3.4 Bank Armoring and Channel Modifications

Ditching and armoring of stream channels removes in-stream habitat features such as bank cover, riffles, pools, and sediment deposition bars. With the obvious exception of the massive channel re-alignment and diking along the lower five miles of Hill Ditch/Carpenter Creek, degradation of in-stream habitat associated with bank armoring and other channel modifications are limited to a relatively few locations in the watershed.

Channel Ditching

Substantial ditching of stream channels occurs along Stackpole Creek, Fisher Creek in the vicinity of 324 St. NW, and the tributary of East Fork Little Fisher Creek lying southeast of the I-5/Starbird Road interchange. Likewise, the lowest reaches of Sandy Creek and Johnson Creek have been routed through ditches along roads.

Figure 2.6 Problem Areas in the Little Fisher Creek Sub-basin



<u>Bank Armoring</u>

A few sections of the right bank of Carpenter Creek between E. Hickox Road and Cascade Ridge Drive have been armored in an impromptu manner with concrete debris. At some time in the past, tires were used for bank armoring at some location on Carpenter Creek upstream of the Little Mountain Park forestlands. High creek flows have distributed these tires throughout about a half-mile of otherwise pristine creek channel in the Little Mountain Park. The left bank of the lowest reach of Fisher Creek, immediately upstream of its confluence with Fisher Slough, has been armored more deliberately with rock riprap. Attempts have been made to mitigate the habitat impacts of bank armoring on this reach by installing root wads into the bank.

2.3.5 Riparian Wetlands and Beaver Dams

Riparian wetlands support fish and wildlife habitat by attenuating peak flows, providing upstream storage that prolongs summer base flow, and providing direct habitat for birds and other animals. Agricultural development in the early 1900s resulted in the drainage of the vast wetlands that covered the Cedardale area, as well as several other riparian wetland areas in upper areas of the watershed. While the land along Hill Ditch is actively farmed, the gradual abandonment of commercial agriculture in the upper watershed has resulted in several former pasture areas reverting to emergent or scrub-shrub wetlands. Recent beaver damming activity has accelerated this trend. Three riparian wetland areas that are of particular interest related to restoring water quality, hydrology, and habitat functions in the watershed are the following.

<u>Lee Property on Upper Carpenter Creek</u>

Extensive forested and shrub wetlands cover the floodplain of the area where English Creek flows into Carpenter Creek, south of Little Mountain Road. Immediately downstream, at the point where Carpenter Creek turns south and enters the Little Mountain Park forestland, the land is used for horse pasture. Beavers frequently dam the creek in this location, flooding a large area of the pasture and making it unsuitable for horses for much of the year.

<u>Welts Property on Hill Ditch and Johnson Creek</u>

The sediment fan at the mouth of Johnson Creek frequently backwaters the flow in Hill Ditch for over a half-mile upstream. The back water effect causes Hill Ditch to spill through several gaps in the dredge spoil berm on its left bank creating a large shallow open-water wetland area. This wetland has created excellent waterfowl habitat and probably off-channel winter rearing habitat for juvenile salmonids as well. Recent beaver activity upstream of the Johnson Creek confluence has raised the water level and extended the open water area further upstream.

<u>Pilchuck Tree Farm Property</u>

An abandoned logging railroad grade on the west side of the Pilchuck Tree Farm disrupts the local hydrology patterns along the north fork of Starbird Creek, resulting in the development of a large forested wetland system in that area. In recent decades, wetland conditions have extended into former pasture areas on private lots east of Rose Road. Since these pastures are no longer actively drained, it is likely that they will eventually evolve into scrub-shrub or forested wetland.

<u>GMA Protections</u>

Much of the riparian wetlands in the watershed are already formerly protected from development under the Skagit and Snohomish Counties' critical areas ordinance processes. This trend is expected to continue, as building permits for future residential development activities require protection of wetland functions and values.

Beaver Dam on Lee Property, July 2004

Impromptu Bank Armoring, Carpenter Creek

2.4 Summary of Problems in the Watershed

Based on the discussion above, Table 2.4 summarizes the primary water quality, hydrology and habitat problems in the Fisher/Carpenter Creek Watershed.

Table 2.4 Summary of Environmental Problems in the Fisher/Carpenter Creek Watershed

Problem		Location
Water Quality		
Depressed dissolved oxygen/elevated temperature in summer		Lower Carpenter Creek and Hill Ditch
Fecal coliform violations in winter		Fisher Creek, Lower Carpenter Creek and Hill Ditch upstream of Bulson Creek
Surface Water Hydrology		
Flow impoundment during summer low flow		Upper Carpenter, W. Fork Little Fisher
Channel ditching reduces attenuation of runoff		Stackpole, E. Fork Little Fisher, Upper Fisher
Ditching and/or disconnection with floodplain causes excessive sediment deposition		Sandy, Johnson
Undersized culverts cause localized flooding		Bulson
Fish and Wildlife Habitat		
Fish passage barriers		Significant barriers listed in Table 2.2
Lack of riparian vegetation		Problem areas listed in Table 2.3
Loss of channel complexity		Lower Carpenter, Upper Fisher, E. Fork Little Fisher, Sandy, Johnson
Degradation of riparian wetland functions/values		Lower Carpenter, N. Fork Starbird, Hill Ditch

3 Objectives for Addressing the Problems

This section presents objectives for correcting the environmental problems that are identified in Section 2. The objectives are designed to be practicable within the overall context of the Fisher/Carpenter Creek Watershed.

3.1 Improve Water Quality

The ultimate objective for improving water quality in the watershed is to eliminate the violations of the Washington Class A Water Quality Standards that were identified in Section 2.1. Specifically, the following criteria will be achieved:

- During the dry season, the dissolved oxygen concentration in Hill Ditch and Carpenter Creek will consistently exceed 8.0 mg/l and the temperature will be cooler than 18°C.

- During the wet season, the levels of fecal coliform in Fisher Creek, Lower Carpenter Creek, and Hill Ditch will not exceed a geometric mean of 100 colonies per 100/ml, with no more than 10 percent of samples exceeding 200 colonies per 100/ml.

3.2 Restore Hydrologic Function

Objectives for restoring hydrologic function must address the problems of 1) artificial flow impoundment during low flow season, 2) excessive deposition of bed load at the mouth of manipulated creek channels and 3) localized flooding caused by undersized culverts. Four general objectives are identified to address these problems. While the lack of flow attenuation in ditched stream reaches does impact the natural hydrology in the watershed, ditching is generally limited to headwater areas and does not cause as great an impact as the other problems listed above.

3.2.1 Maximize Upland Storage and Release Water During Summer

Lack of flow in the watershed during summer months contributes to its poor water quality. While this problem is especially acute in Hill Ditch, the problem occurs to a greater or lesser extent in most of the watershed’s tributaries. While low flow is a natural occurrence due to lack of rainfall during the dry months, such human caused disruptions such as degradation of the natural hydrologic functions and values of riparian wetlands and artificial impoundment of upland tributaries exacerbates the problem. Accordingly, the first objective for restoring hydrologic function is to augment late summer low flows by increasing the upland storage of water during high flow periods and releasing more flow from artificial impoundments during summer low flow conditions.

3.2.2 Reconnect Creeks to their Floodplains

The lowest reaches of Sandy and Johnson Creeks in confined in narrow roadside ditches, which has disconnected them from their floodplains. This disconnection, coupled with backwatering at their confluences with Hill Ditch, causes the active bedload of these two creeks to settle out in the last few hundred feet of their channels and create concentrated sediment fans. In order to maintain flow in Hill Ditch, Skagit County DPW continually dredges these areas. The second objective is to reduce flooding and excessive deposition of bedload in these two locations by reconnecting the lowest reach of the two creeks with their historical floodplains.

3.2.3 Eliminate Flooding Caused by Undersized Road Culverts

Localized flooding occurs at several road crossings in the watershed due to the inadequate hydraulic design of road culverts. This problem is most serious at the following road crossings:

- Bulson Creek at Bulson Road
- Middle Fork Bulson Creek at English Road
- South Fork Bulson Creek at English Road
- Fisher Creek at 44th Ave. NW/Bulson Road

The third objective to restore natural hydrologic function is to eliminate the localized flooding at these locations.

3.2.4 Reduce the Backwatering Effect of Hill Ditch

The fourth objective is to reduce the water surface elevation in Hill Ditch during high-water events in order to reduce the impacts of back-watering on upstream creeks.[5]

3.3 Support Fish and Wildlife Habitat

Objectives for supporting fish and wildlife habitat must address the problems of fish passage barriers, lack of riparian vegetation, loss of channel complexity in dredged and armored stream reaches, and the degradation of the habitat functions and values of riparian wetland.

3.3.1 Correct Fish Passage Barriers

Adequate fish passage at road culverts is required by Washington law, yet there are several culverts in the watershed that do not meet WDFW fish passage guidelines (WDFW, 2003). Accordingly, the first objective for supporting fish and wildlife habitat is to correct fish passage barriers at those culverts that will result in the highest overall benefit to salmonid habitat.

3.3.2 Enhance Riparian Forest Cover

The second objective for supporting fish and wildlife habitat is to enhance the quality and area extent of riparian forest cover at locations where it is currently lacking or of poor quality. Several of these areas are listed in Table 2.3.

3.3.3 Increase Channel Complexity in Modified Stream Reaches

Objective No. 3 is to increase channel complexity in modified stream reaches by removing or mitigating man-made modifications that have impacted the natural channel complexity.

3.3.4 Enhance Functions and Values of Riparian Wetlands

Objective No. 4 is to improve the ecological functions and values of riparian wetlands in the watershed that have been degraded by recent or historic development activity. Three priority areas where riparian wetland enhancements would greatly benefit fish and wildlife habitat are listed in Section 2.3.5.

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[5] The Nature Conservancy is currently studying alternatives for restoring natural hydraulic function in Fisher Slough, including alternatives for reducing water stage during seasonal high water events.

Canary grass infestation of wetland at confluence of Johnson Creek and Hill Ditch

Channelized reach of Carpenter Creek along Stackpole Road

3.4 Summary of Objectives

The objectives identified in the preceding sections for improving water quality, restoring hydrologic function, and supporting habitat are not mutually exclusive, but instead tend to overlap and support each other. For example, enhancing the quality and extent of riparian forest vegetation not only improves fish and wildlife habitat but also reduces late summer water temperature and helps to attenuate runoff, providing more consistent in-stream flow conditions. Table 3.1 condenses the overlapping objectives from the three categories.

Table 3.1 Summary of Objectives

1. Consistently comply with the Washington Water Quality Standards for temperature, dissolved oxygen and fecal coliform
2. Augment summer low flow by increasing upland storage and releasing impounded water during summer
3. Reduce sediment deposition and flooding at the mouths of Sandy and Johnson Creeks
4. Eliminate localized flooding and fish passage barriers at high priority road culverts
5. Reduce the back-water effect of Hill Ditch during high flow conditions
6. Enhance the quality and extent of riparian forest vegetation
7. Increase channel complexity in modified stream reaches
8. Enhance the ecological functions and values of key riparian wetlands

4 Methods for Achieving the Objectives

This section describes several methods that could be implemented to try to achieve the objectives listed in Table 3.1. The methods were selected based on two basic criteria. First, it is believed that they are technically feasible and practicable in the context of the Fisher/Carpenter Creek Watershed. Second, it is believed that each method, either by itself or in combination with other methods, would be effective in achieving one or more of the objectives.

4.1 Riparian Vegetation Planting

Native trees and shrubs would be planted on stream banks that currently lack forest vegetation. Planting could be done through a formal, publicly-funded program such as the USDA Conservation Reserve Enhancement Program (CREP) or more informally according to the desire of individual landowners. Plant species would be chosen to maximize shading of the creek, filtering of runoff from developed areas, and value as wildlife habitat. The width of vegetation buffers can vary depending on requirements of a funding program or (for privately funded work) the landowner’s personal preference. To be successful, planting efforts must include several years of maintenance to assure that the individual plants survive over the long term.

4.2 Livestock Exclusion Fencing

Wire fencing can be installed along creeks, pasture wetlands, and field ditches to exclude cattle and other livestock from these areas and thus reduce the potential for manure contamination of water bodies. To be effective, the fencing should be set well back from the ordinary high water mark of creeks. Fencing projects can include construction of off-channel stock-watering systems and riparian forest planting, all of which can be funded through conservation cost share programs administered by the Skagit and Snohomish Conservation Districts.

4.3 Dairy Waste Management

The sole dairy farm in the watershed would continue to conduct waste management operations in accordance with its farm plan developed under the Washington dairy waste management regulations. The waste lagoon, dry stack storage areas, and manure application on crop ground would be operated and inspected in accordance with the dairy’s approved plan. In addition to providing technical assistance for manure management, the Skagit Conservation District would work with the dairy to address other potential sources of nutrient-laden runoff, such as at silage storage bunkers.

4.4 Septic System Replacement

Failing residential septic systems would be removed and replaced with properly operating systems that meet current county health department standards. Both Skagit and Snohomish counties have loan programs to provide financial assistance to low-income homeowners for replacing failing septic systems.

4.5 Modification of Dam Spillways

Spillways of existing water impoundment dams would be modified to release water at a wide range of flow conditions. Modifications would include such structural changes as lowering the spillway invert elevation and reconstructing the spillway to a V-notch weir or another configuration that allows for variable flows. At the same time, bypass channels associated with the dams would be improved to reduce scour erosion, provide fish passage, and other improvements.

4.6 Creek Channel Restoration and Floodplain Reconnection

To the extent feasible, modified reaches of creeks would be restored to the alignment and geomorphic condition that they had prior to manipulation for agricultural development in the early 20th Century. The restored creek channels would have a hydraulically-stable cross section that would permit bed load in the creek to be deposited on a broader floodplain than is currently the case. Where feasible, bank armoring and man-made debris would be removed. The natural banks of degraded creeks would be restored with bioengineered methods consistent with WDFW's *Integrated Streambank Protection Guidelines* (WDFW, 2003). Public funding for creek channel and floodplain restoration activities could be sought through various salmon habitat restoration funding sources.

4.7 Culvert Replacement

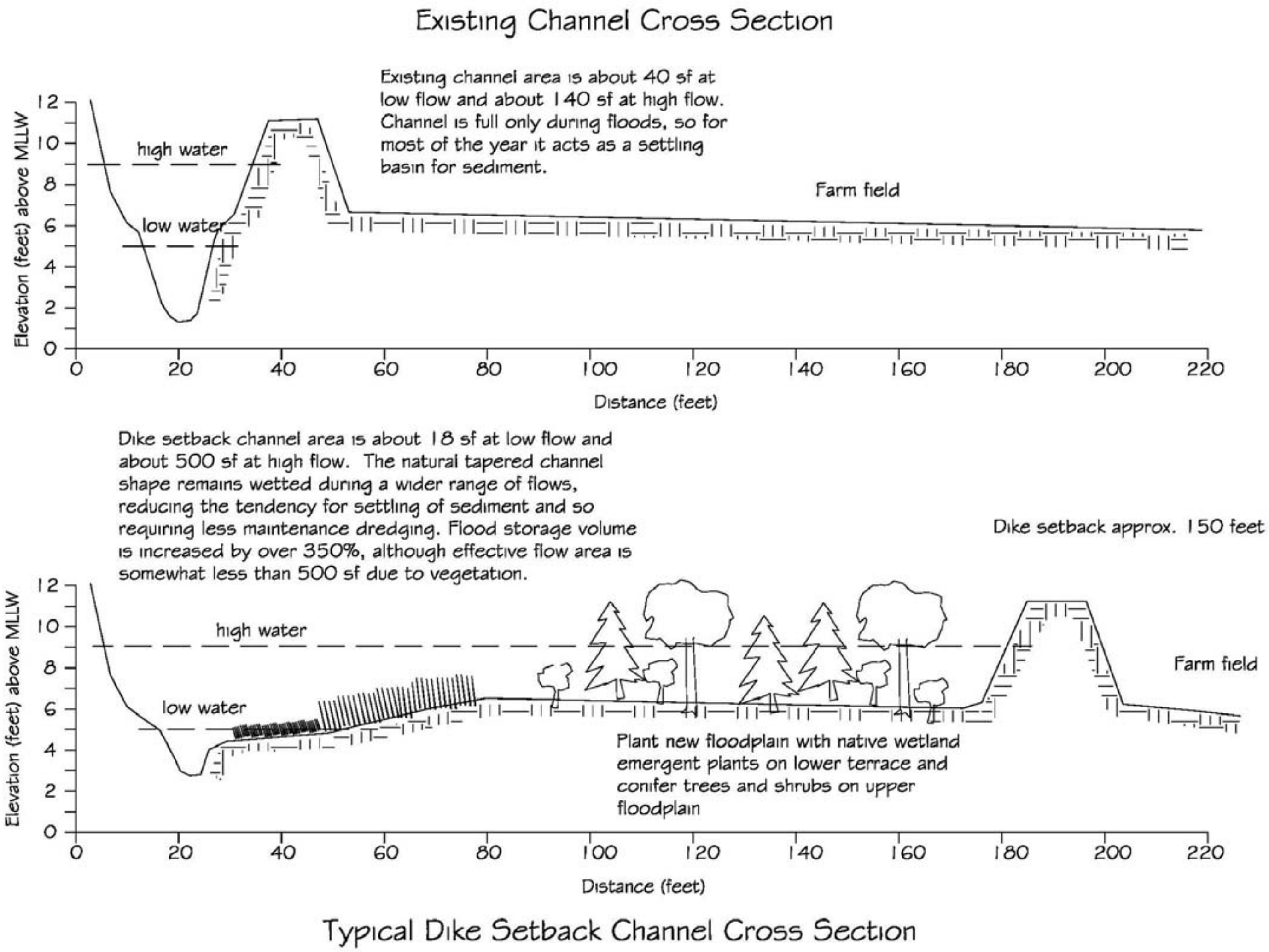
Road crossing culverts that frequently flood and/or block fish passage to high priority upstream fish habitat would be replaced with new culverts that are designed in accordance with WDFW's *Design of Road Culverts for Fish Passage* guidelines (WDFW, 2003).

4.8 Dike Setback

A portion of the existing dikes along Lower Hill Ditch, Lower Fisher Creek, and/or Fisher Slough would be set back and the intervening land would be allowed to be flooded during high stream flow events, thus providing significantly more flood storage and reducing the upstream backwatering effect of Hill Ditch. Depending on the availability of land, the dikes could be set back 100 feet or more from the existing locations. The resulting widened channel cross section would include a relatively narrow and deep low flow channel and a gradually-sloping floodplain along the edges. In this way, water would flow in the central channel even during summer low flow conditions, thus reducing the tendency for sediment to settle out of the water column and accumulate in the channel bottom. Water would cover the higher terrace only during high flow/peak runoff conditions. This design minimizes the need for continuous maintenance dredging of the channel.

With proper grading and elevation control, native wetland and forest plant communities would become established on the floodplain terrace, thus providing shading and wetland habitat value between the dikes. Figure 4.1 illustrates the dike setback/widened channel design.

Figure 4.1 Typical Widened Channel Cross Section



4.9 Flood Control Structures at Fisher Slough

In conjunction with setting back dikes on Lower Carpenter Creek and Fisher Slough, the existing tide gates at the mouth of Fisher Slough would be modified to better regulate flood flows. Additional flood regulation could be provided by installing a pump station at this location. A detailed evaluation of the effect of modifying the existing flood control structures at the mouth of the slough is planned as part of The Nature Conservancy's forthcoming Fisher Slough Restoration Project.

4.10 Enhancement of Riparian Wetlands

Riparian wetland enhancement involves improving the water storage and habitat values of wetlands located adjacent to creeks and ditches. Enhancement activities could include planting native wetland shrub and tree species in degraded pasture wetlands and restoring original hydrology by removing man-made drainage ditches and other artificial water control structures. While wetland protection regulations generally prohibit the manipulation of wetlands to function as stormwater detention ponds, they do allow the modification of ground topography and other site features to increase the storage of naturally-occurring runoff and groundwater seepage, as well as other *bona fide* enhancement of wetland functions and values, when appropriate.

4.11 Acquisition and Protection of Conservation Land

Existing forests and wetlands in the upland part of the watershed would be preserved in their present state. While land use regulations established under the Washington Forest Practices Act, the Washington Growth Management Act, and the Federal Clean Water Act require a limited degree of protection to forests and wetlands in the watershed, other land use controls such as the sale of conservation easements that limit development rights on parcels containing these natural features provide a stronger degree of protection.

4.12 Policy Methods

Drainage Tax Credits for On-site BMPs

Local legislators would be urged to revise the county drainage utility tax structure to provide a tax credit or other form of financial incentive for property owners in the Fisher/Carpenter Creek Watershed (as well as elsewhere in Skagit County) who implement best management practices (BMPs) related to reducing peak flows and improving the quality of stormwater runoff from their property.

Small Grants Program for BMP Implementation

Skagit County and Snohomish County government would be urged to provide a source of funding to provide relatively small grants to landowners or resource management agencies to implement BMPs on individual properties for the purpose of reducing peak runoff flows and improving the quality of stormwater runoff. The small grant program could be administered directly by the county government, or by local non-government agencies such as the two county conservation districts.

Improved Coordination of Land Development Permitting

The Skagit County Planning and Permit Office would be encouraged to improve the quality and comprehensiveness of permit review for development activities in the Fisher/Carpenter Creek Watershed by actively engaging technical input from not only Skagit County government agencies but also Dike District 3, the Skagit Conservation District, WDFW, and other interested stakeholders that have technical expertise in drainage, water quality, habitat, and related issues in the watershed. For development projects in the Upper Fisher and Little Fisher sub-basins, Snohomish County and Skagit County planning and permitting offices would be encouraged to work collaboratively to coordinate the review of development-related impacts.

Technical input should be sought prior to issuing a public notice of the intent to issue Determination of Non-Significance in order to give stakeholders ample opportunity to provide meaningful technical input. To the extent feasible and allowable by regulations, the technical review of drainage development plans should encourage the identification of mitigation opportunities on a coordinated, watershed-wide scale.

Adoption and Implementation of In-stream Flow Regulations

As part of its wider mandate to establish in-stream flow regulations in Water Resource Inventory Area (WRIA) 3, the Washington Department of Ecology would promulgate and implement in-stream flow management regulations for the Fisher/Carpenter Creek Watershed. Regulations should include limiting the number of new well installations to a quantity that will not jeopardize sustainable minimum summer flow levels in the creeks, metering of well withdrawals and, if necessary, interruption of withdrawals to ensure minimum in-stream flow levels. Future development would potentially be required to provide water-management infrastructure, such as community or public water supplies and wastewater treatment facilities, if necessary for preserving in-stream flows.

5 Identification of Project Alternatives

The following section describes several potential projects that could be implemented to help achieve the drainage, water quality, and habitat improvement objectives in the Fisher/Carpenter Creek Watershed. Each project consists of a unique combination of the methods identified in Section 4. The project sites are located throughout the watershed in order to disperse their benefits widely. Appendix 1 describes each of the projects. Project side locations are shown in the following figures:

- Figure 5.1 Upper Carpenter Creek area
- Figure 5.2 Lower Carpenter /Upper Hill Ditch area
- Figure 5.3 Bulson Creek and Hill Ditch Area
- Figure 5.4 Fisher Creek area
- Figure 5.5 Little Fisher Creek area

The suite of potential projects described in this section is by no means intended to be exclusive, nor is it assumed that they all will be feasible to implement. The project locations and designs were identified because of amenable existing site conditions, they are located on large and less intensively developed land parcels, or had other attributes that were favorable. These attributes are presented and evaluated in detail in Section 6.

5.1 No Action

The No Action alternative, in which no projects are implemented, is included as basis of reference for comparing the benefits and costs of other alternatives. Under the No Action alternative, water quality, flooding, and habitat conditions would remain the same or gradually degrade as the upland area is developed further. The costs associated with continued dredging of sediment from the slough, flooding of agricultural land, and loss of fish and wildlife habitat would gradually increase over time.

5.2 Riparian Vegetation and Livestock Fencing

Native trees that provide dense shade, such as fir, cedar, or maple, would be planted along creek banks at locations where shade is now lacking or of poor quality, including the parcels listed in Table 5.1. Riparian forest cover is most beneficial on the west or south side of creeks to shade afternoon sun. At parcels where livestock is currently pastured, wire fencing would be installed along the creek bank to keep stock out of the creek. Off-creek livestock watering facilities consisting of galvanized or plastic storage tanks filled through a pump (fed either from the creek or a well) would be installed. The tank would be placed on a gravel pad to minimize mud during wet weather.

Figure 5.1. Proposed Alternatives in the Upper Carpenter Creek Area

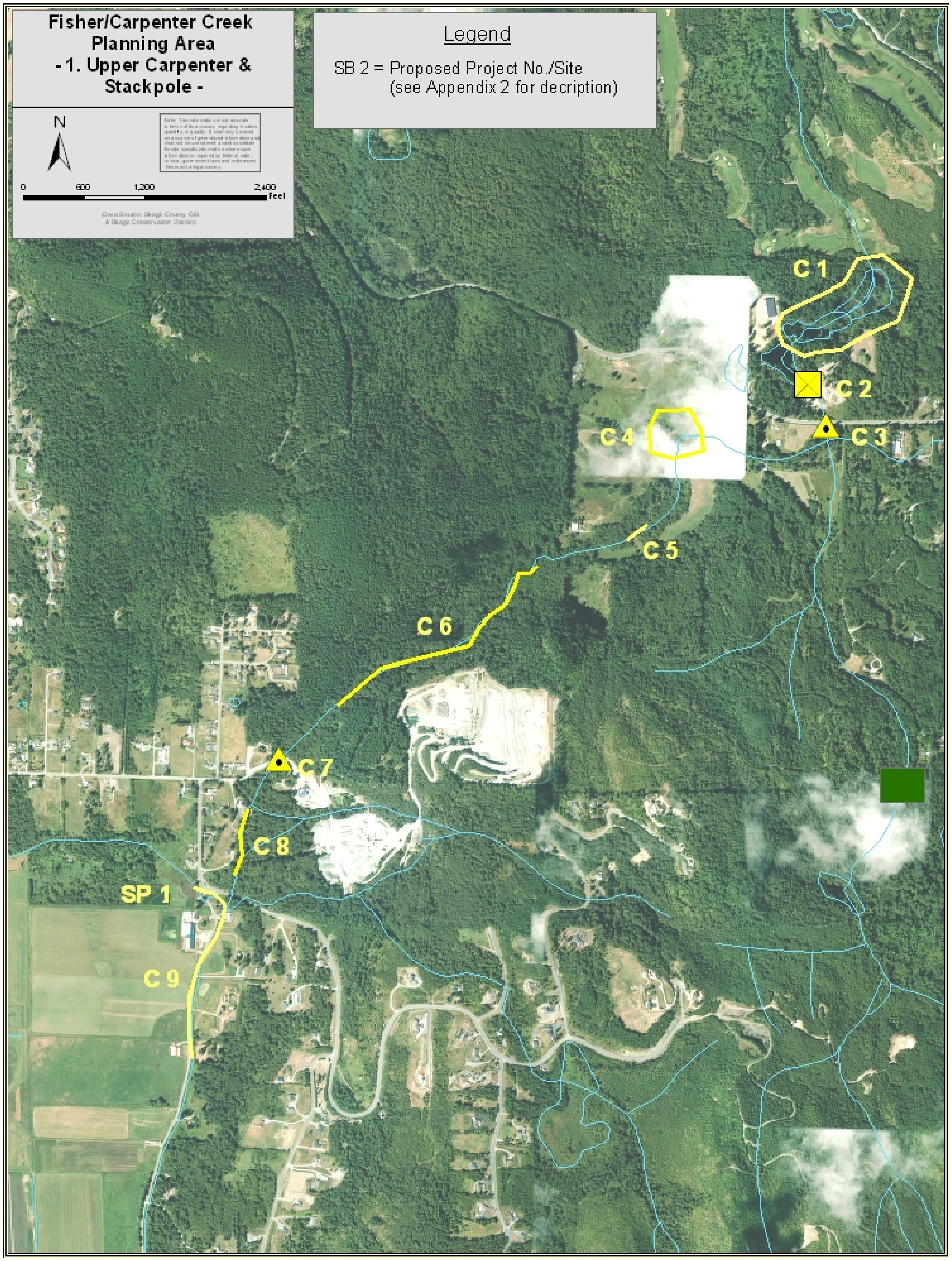


Table 5.1 Potential Sites for Riparian Vegetation and Fencing

Creek	Project. No.	Parcel No.	Action
Carpenter Creek	C 5	P29715	Discontinue stock watering area. Fencing and planting (200 ft). Install tank with nose pump.
	C 9	P16297 – P16278	Plant conifers on creek left bank in residential yards along Stackpole Rd. (approx. 1,600 ft)
Stackpole Creek	SP 1	P16277	Clear blackberry and knotweed and plant conifers on both sides of creek in residential yard (200 feet).
Hill Ditch (Sandy Creek to Johnson Creek)	H 1	P16585	Plant conifer buffer on about 2000 feet of left bank (right bank is the dike). Plant narrow row of conifers west of dike, allowing access for dike maintenance.
Hill Ditch (Johnson Creek to SR 534)	H 3	P16713 – P16746	Plant narrow row of conifers on west side of dike, allowing access for dike maintenance. (6,400 feet)
Bulson Creek	B 1	P16683, P16741	Plant conifer buffer on left bank floodplain (400 feet)
Middle Fork Bulson Creek	BMF 2	P17098	Plant conifer buffer on left bank (600 feet). Install livestock fencing and watering station.
South Fork Bulson Creek	BSF 1	P17390 – P17393	Plant conifer buffer on both banks. Install livestock fencing and stock water tank /nose pump. (1200 feet)
Starbird Creek	SB 2	P17842	Install conifer buffer between driveway and creek (200’)
	SB 3	P17788, P17794	Plant conifer buffer on left bank, install livestock fencing (800 feet)
Fisher Creek	F 1	330204 3 016 & 017	Enhance existing narrow buffer with conifer plantings (1000 feet)
	F 2	330204 2-002,3,7&10	Plant shrub buffer to extent allowable within gas pipeline ROW (2600 feet)
	F 4	P17744 – P17747	Plant conifer buffer and install livestock fencing on both banks (800 feet). Install stock watering tanks and nose pumps.
	F 5	P17407	Enhance existing right bank buffer adjacent to clear cut steep slope (800 feet)
	F 6	P17459, P17461	Enhance existing narrow buffer on both banks (600 feet)
Little Fisher Creek	LF01	P17466 – P17469	Plant conifer buffer and install livestock fencing on both banks (1,600 feet). Install nose pumps and stock watering tanks.
West Fork Little Fisher	LFWF01	320405 1-005	Plant conifer buffer on left bank (400 feet)
East Fork Little Fisher	LFEF02	P17660	Install narrow shrub or tree buffer in residential yards (600 feet)
	LFEF03	Pacific Hwy ROW	Install narrow conifer buffer on road shoulder/left bank (400 feet). Include stabilization of head cut erosion.

Legend: C 5 = the 5^{th} project identified on Carpenter Creek, beginning numbering from upstream. SP = Stackpole Creek, H = Hill Ditch, S = Sandy Creek, J = Johnson Creek, B = Bulson Creek, BMF = Middle Fork Bulson Creek, BSF = South Fork Bulson Creek, F = Fisher Creek, SB = Starbird Creek, LF = Little Fisher Creek, LFWF = West Fork Little Fisher, LFEF = East Fork Little Fisher Creek.

Figure 5.2 Proposed Project Alternatives in the Lower Carpenter /Upper Hill Ditch area

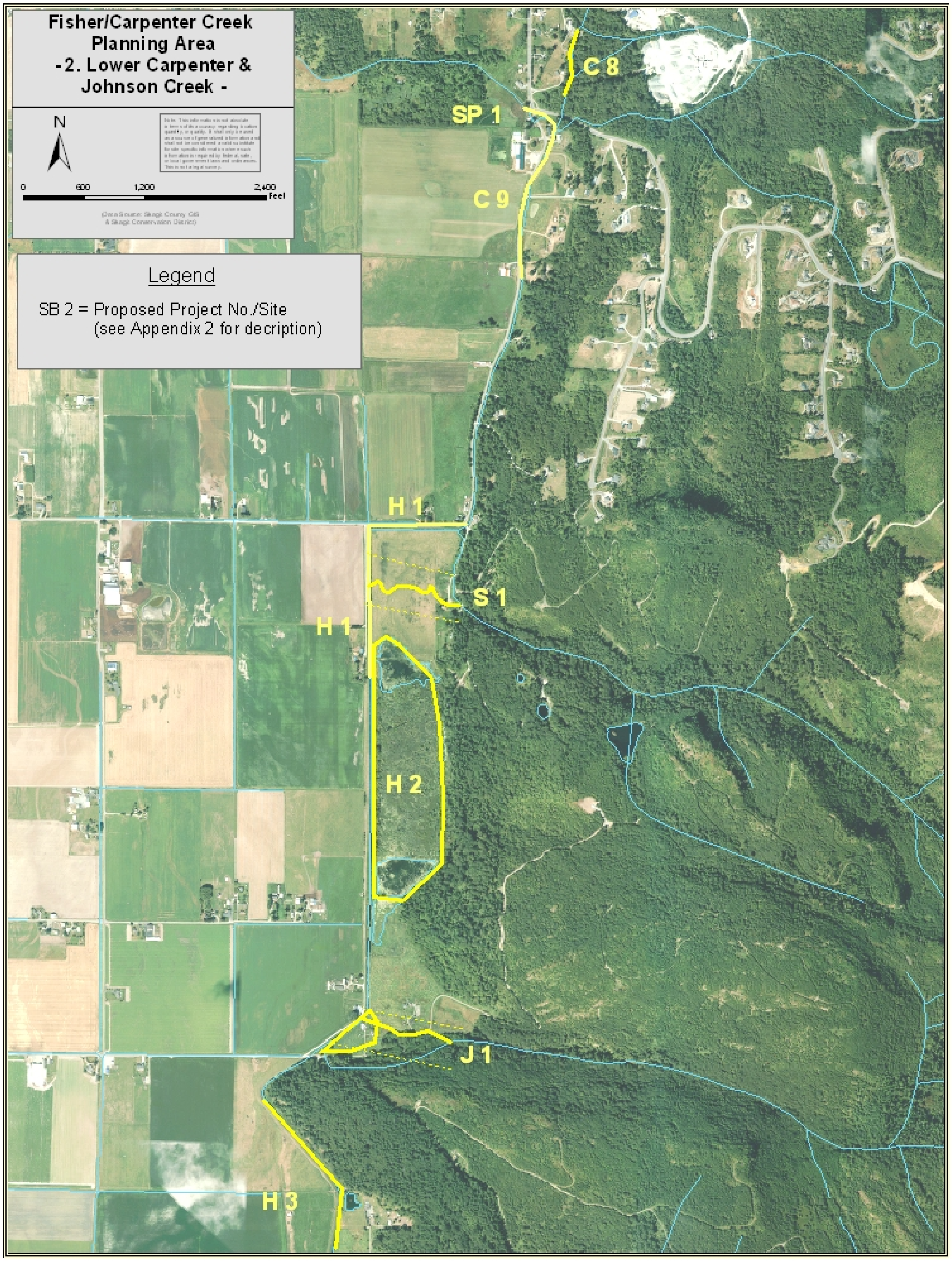
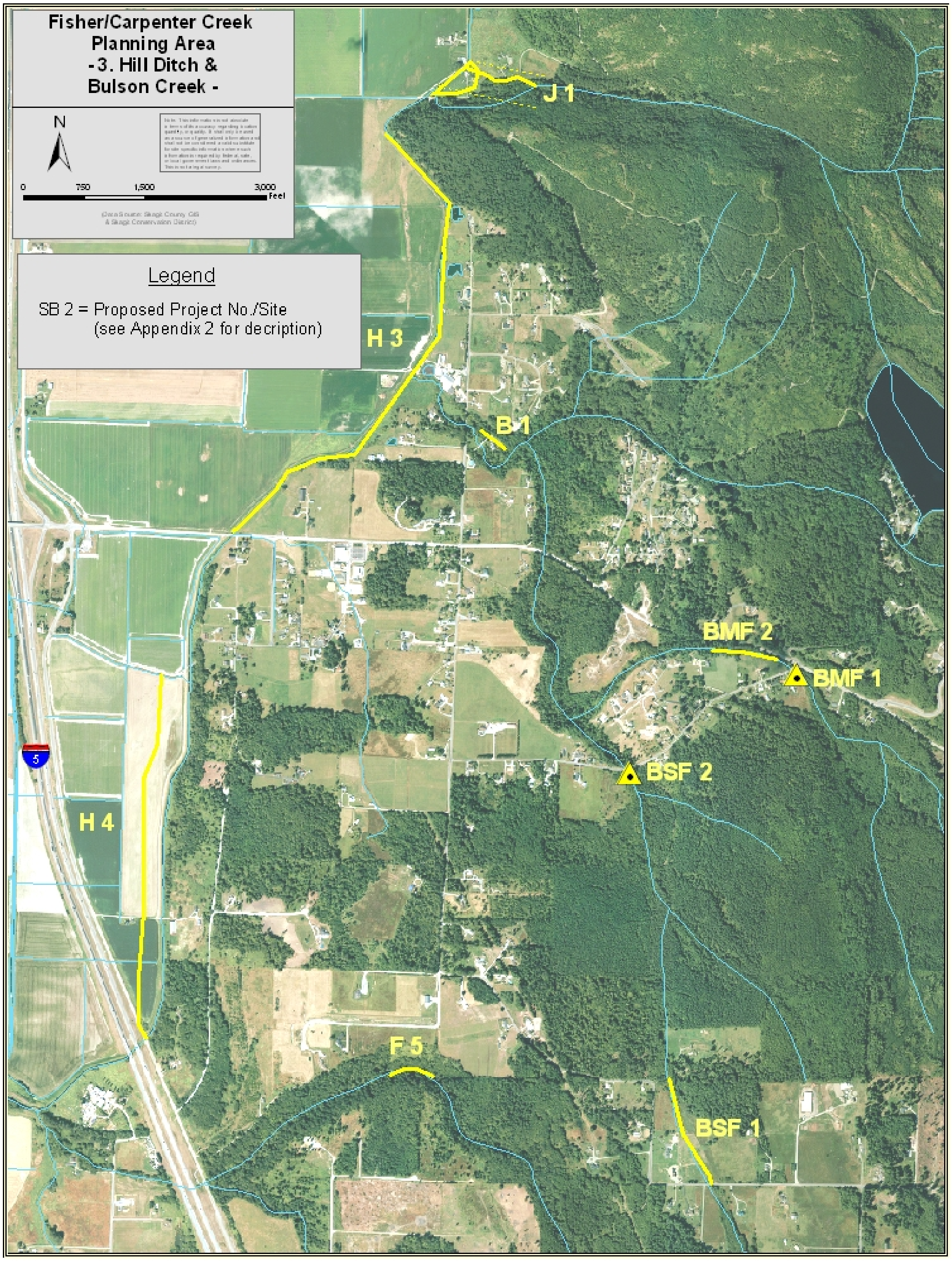


Figure 5.3 Proposed Project Alternatives in the Bulson Creek/Lower Hill Ditch Area



5.3 Modification of Dam Spillways

The dams on the Lang property (Upper Carpenter Creek) and O'Malley property (West Fork Little Fisher Creek) would be modified to allow greater in-stream flow during summer low flow conditions. Modifications at the Lang dam (Project No. C 2) would include lowering the outlet elevation and routing the flow into the existing bypass channel. The eroded bypass channel would be stabilized and widened with bioengineered design elements to allow it to function more or less like a natural creek at both summer low and winter high flow conditions. The channel restoration design would include provisions for fish passage. The existing, deteriorated dam outlet structure would be removed and the dam would be stabilized with additional fill material. Correction of the fish passage barrier at the dam would only be done if the undersized 18" culvert located under Little Mountain Road about 500 feet downstream of the dam were also replaced to meet WDFW fish passage design guidelines (Project No. C 3).

Potential modifications at the O'Malley dam (Project No. LFWF 2) could range from removal of the dam to installing some form of fishway past the dam to simply installing a new low-flow outlet at a lower elevation than the current spillway. The quantity of potential good quality salmon habitat upstream of the site would have to be determined before deciding whether to install a fish way. Correction of the fish passage barrier at the dam would only be done if the perched 48" culvert located under County Line Road about 200 feet downstream of the dam were also replaced to meet WDFW fish passage design guidelines (Project No. LFWF 3).

5.4 Creek Channel Restoration and Floodplain Reconnection

The two top priority sites in the watershed for creek channel restoration and floodplain reconnection are the lowest reaches of Sandy Creek (Parcel No. P16585) (Project No. S 1) and Johnson Creek (Parcels No. P16598 and P16572) (Project No. J 1). Permanent control of the original alluvial fans/floodplains would be obtained through the purchase of drainage easements, conservation easements, fee simple acquisition, or some other mechanism. At Johnson Creek, acquisition and demolition of some farm buildings would likely be necessary and a new bridge would be constructed to provide a road crossing over the relocated creek.

At both locations, a hydraulically-stable channel would be excavated at about the same location as the historic channel location. The channel would be designed to allow the creek to spill onto its floodplain and deposit bedload there, rather than depositing it in Hill Ditch, as is currently the case. Channel restoration would involve installing fish habitat features, such as large woody debris, as well as replanting the riparian area with appropriate native shrub and tree species. Public funding for these two projects would be sought from various flood control and salmon habitat restoration public funding sources.

Lower priority channel restoration projects include removing the unnecessary concrete bank armoring and fill from the right bank of Carpenter Creek on Parcel No. P100882 (Project No. C 8). Rock bank armoring would also be removed from the left bank of the lowest reach of Fisher Creek (Parcel No. P17518) if feasible within the context of The Nature Conservancy's Fisher Slough habitat restoration design. The natural creek bank at these locations would be restored with bioengineered methods consistent with WDFW's *Integrated Streambank Protection*

Guidelines (WDFW, 2003). Another simple channel restoration project would involve removing the old tires that litter the channel of Upper Carpenter Creek within Little Mountain Park (Project No. C 6). Stabilizing the headcut erosion in the channel of East Fork Little Fisher Creek just upstream of the long culvert under I-5 could be included in riparian reforestation project LFEF 4 by installing a few small rock grade control weirs.

5.5 Culvert Replacement

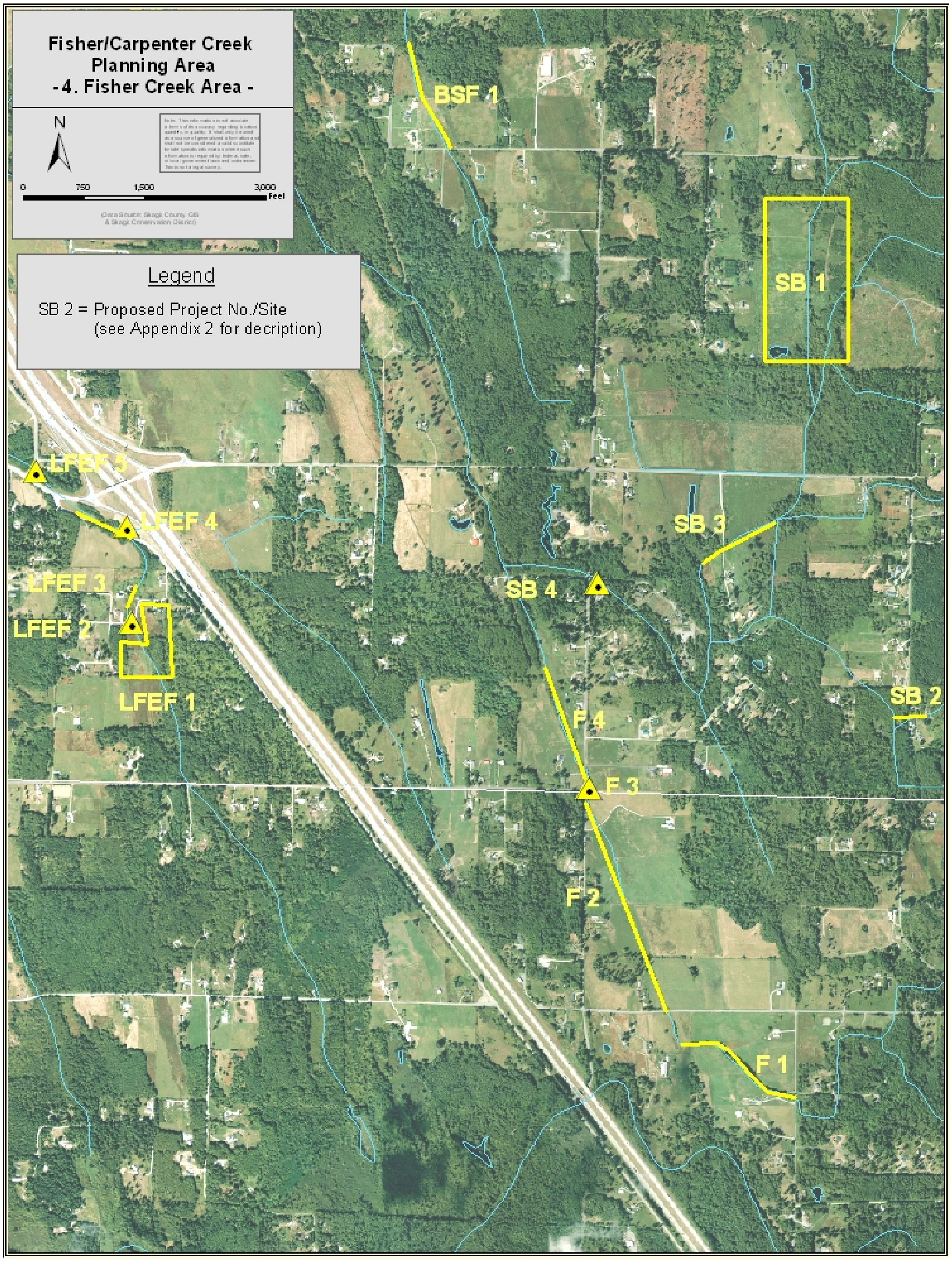
Road crossing culverts that frequently flood and/or block fish passage to high priority upstream fish habitat would be replaced with new culverts that are designed in accordance with WDFW's *Design of Road Culverts for Fish Passage* guidelines (WDFW, 2003). Skagit Conservation District has identified the culverts listed in Table 5.2 as priority candidates for replacement.

Table 5.3 High Priority Culvert Replacement Projects

Creek	Project. No.	Parcel No.	Action
Carpenter Creek	C 3	P29707	Replace 18" culvert under Little Mountain Road with approx. 7' diameter culvert
	C 7	P6288	Place stable, natural gravel/cobble substrate in bottom of existing 10' diameter culvert. Add additional rock sills at outlet consistent with fish passage design criteria.
Middle Fork Bulson Creek	BMF 1	P17068	Replace four undersized culverts under English Road with properly sized culvert meeting fish passage criteria. Raise road grade to intersection with SR 534.
South Fork Bulson Creek	BSF2	P17141	Replace 36" culvert under English Road with approx. 8' diam. culvert meeting fish passage criteria.
Starbird Creek	SB 4	P17786	Replace two undersized and perched culverts under Starbird Creek Lane with an approx. 10'-wide pipe arch or box culvert
Fisher Creek	F 3	P17746	Replace 5' diam. culvert and 2 overflow culverts with approx. 12' x 6' concrete box culvert.
West Fork Little Fisher Creek	LFWF 3	P17585	Replace perched, corroded 4' diam. culvert under County Line Road with approx. 8' diam. culvert meeting WDFW fish passage criteria.
East Fork Little Fisher Creek	LFEF 2	P17667	Replace perched, 24" culvert under Bruun Road with approx. 6' diam. culvert meeting fish passage criteria.
	LFEF 5	P17584, P17603	Evaluate existing 150' long, 5' diam. culvert under Bonnie View Road for fish passage conditions. Retrofit with baffles and/or outlet weirs if necessary.
	LFEF 6	P17469	Replace perched 4' diam. culvert under Franklin Road with approx. 10' pipe arch or box culvert meeting WDFW guidelines. Provide fish passage past natural LWD jam just upstream of Franklin Road if necessary.

SCD has not included replacement of the two 36-inch Bulson Creek culverts under Bulson Road as a high priority project. SCD believes that the primary cause of flooding at this site has more to do with backwatering of the creek by Hill Ditch than with the design of the culverts themselves. Likewise, while the culverts do not meet WDFW fish passage guidelines, they apparently do not cause a significant barrier to salmon migration.

Figure 5.4 Proposed Project Alternatives in the Fisher Creek Area



5.6 Dike Setback and Modification of Flood Control Structures

The Nature Conservancy's ongoing Fisher Slough restoration study will reportedly evaluate dike setbacks along Hill Ditch and Fisher Slough and modifications of the Fisher Slough tidegates as alternatives for improving drainage and salmon habitat in the lowest reach of the watershed. For the purposes of evaluating one such project within the context of the other alternatives identified in SCD's current study, Project No. H 4, a typical generic dike setback is proposed. Project H 4 includes setting the Hill Ditch dike from Conway Hill Road to I-5 back 150 feet. The channel and floodplain inside the dike would be re-graded and planted as described in Section 4.8.

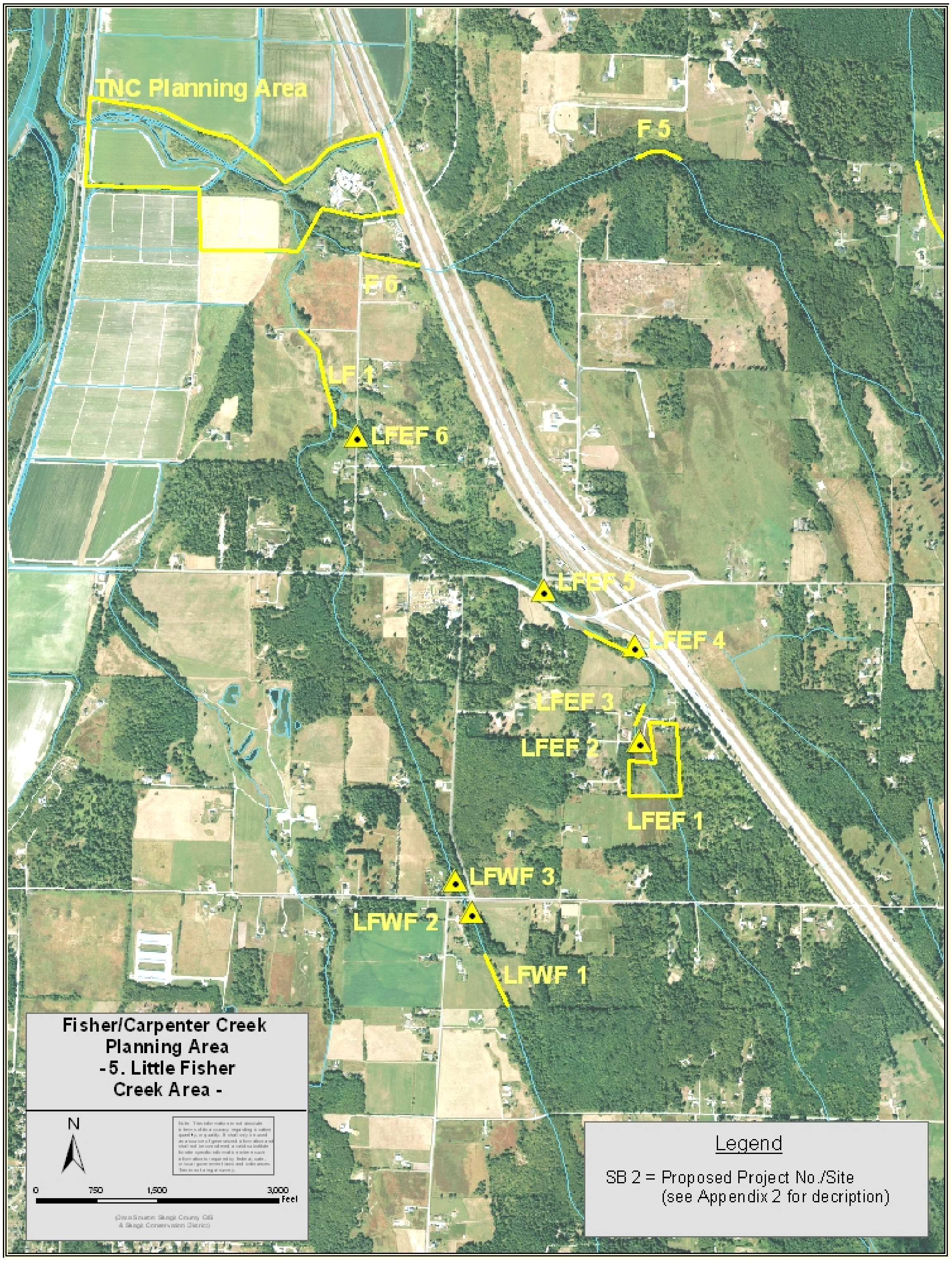
5.7 Wetland Enhancement Projects

Potential high priority riparian wetland enhancement projects could be implemented at the locations described in Table 5.3. Permanent control of these wetland sites would be secured through the purchase of drainage easements, conservation easements, fee simple acquisition, or some other mechanism. Enhancement activities could include planting native wetland shrub and tree species in degraded pasture wetlands and restoring original hydrology by removing man-made drainage ditches and other artificial water control structures.

Table 5.4 High Priority Wetland Enhancement Projects

Creek	Project. No.	Parcel No.	Action
Carpenter Creek	C 4	P29715	Obtain a conservation easement or some other protection on portion of this site along Little Mountain Road that is routinely flooded. Install livestock fencing and plant a buffer of native wetland shrubs and trees along wetland boundary. Install "beaver deceivers" in the downstream beaver dams to regulate water depth behind the dams so that the remainder of the parcel can continue to be used as horse pasture.
Hill Ditch	H 2	P16591, P16576	Obtain conservation easements or some other permanent protection mechanism on the lowland portion of these parcels between Sandy and Johnson Creek. Install livestock fencing and plant a buffer of native wetland shrubs and trees along the wetland boundaries and along the dredge spoil berm on the left bank of Hill Ditch.
Starbird Creek	SB 1	P17369, P112974, P17382, P17384, P17385, P101063, PP17779, P17781, P17761, P17762.	Obtain conservation easements or some other permanent conservation protection from willing landowners of several parcels in the Starbird Creek headwater area north of Starbird Road. Eradicate reed canary grass and plant native trees and shrubs adapted to wetland conditions at suitable locations. Check the creek crossing structure(s) under the abandoned RR grade to ensure that it complies with WDFW fish passage criteria.

Figure 5.5 Proposed Project Alternatives in the Little Fisher Creek Area



5.8 Acquisition and Protection of Conservation Land

Skagit Conservation District believes that purchasing a conservation easement or some other permanent protection measure on the properties listed in Table 5.4 would provide significant long-term environmental protection to the Fisher/Carpenter Watershed. These sites are located in areas where development pressure is likely to impair their existing high quality environmental functions and values in the relatively near future.

Table 5.5 Priority Sites for Conservation Protection

Creek	Project. No.	Parcel No.	Action
Carpenter Creek	C 1	P29695 P29707	Obtain a conservation easement or some other protection on land surrounding the beaver ponds and upper reaches of Carpenter Creek on the Lang property.
East Fork Little Fisher Creek	LFEF 1	P17667, P17661	Obtain conservation easement on the abandoned pasture area bordering East Fork of Little Fisher Creek immediately upstream of the subdivision on Bruun Road.
Little Fisher Creek	LF 1	P17468, P17469	In conjunction with riparian planting and fencing activities in Project No. LF 01, obtain conservation easement on the pastureland surrounding the confluence of the east and west forks of Little Fisher Creek.

5.9 Policy Methods

County and state legislators, regulatory agencies, and special purpose districts would be urged to work cooperatively to develop and implement the policy methods described in Section 4.12.

Project C 7 would include installing rock inlet weirs and placing a gravel bed in this new culvert so that it complies with WDFW fish passage guidelines.

6 Evaluation of the Project Alternatives

This section evaluates each of the project types identified in Section 5 according to relevant evaluation criteria. The projects are then ranked relative to each other in accordance to their fit with the various criteria.

6.1 Evaluation Criteria

Three general criteria are used for evaluating the project types:

- Effectiveness in Achieving the Objectives;
- Potential Detrimental Impacts; and
- Cost.

Each of these is explained below.

6.1.1 Effectiveness in Achieving the Objectives

In Chapter 3, specific objectives were developed for addressing the flooding, water quality, and habitat problems in the Fisher/Carpenter Creek Watershed. While the objectives are not mutually exclusive, for convenience they can be grouped into three general goals for the watershed, as follows.

1. Improve Water Quality
   - Consistently comply with the temperature, dissolved oxygen and fecal coliform water quality criteria

2. Restore Hydrologic Functions
   - Reduce flooding and sediment deposition at road culverts and the mouths of Sandy and Johnson Creeks
   - Reduce backwatering of Hill Ditch during high flows
   - Increase summer base flow

3. Support Fish and Wildlife Habitat.
   - Improve the quality and extent of riparian forest vegetation
   - Enhance the ecological functions and values of key riparian wetlands
   - Improve in-stream fish habitat by removing passage barriers and increasing channel complexity in modified stream reaches.

For the purposes of this feasibility study, “effectiveness” in achieving the objectives is evaluated in a qualitative manner for each alternative. Because of the large number of potential projects and the lack of data about the varied environmental factors associated with each, it is impractical at the conceptual level of planning taken in this study to attempt a quantitative analysis. Nevertheless, because each alternative is evaluated in relation to the others in a consistent manner, this qualitative evaluation approach is believed to provide a useful basis for comparing the relative advantages and disadvantages of the various alternatives.

6.1.2 Potential Detrimental Impacts

Detrimental impacts that may potentially be associated with implementing the various project alternatives include “short-term” and “long-term” impacts. Short-term impacts include those caused during construction and implementation of the project, such as traffic interruption and temporary increases in sediment runoff from disturbed soil. Long-term impacts include conversion of existing land uses to other uses, extinguishing land development rights, and interruption in existing drainage patterns.

6.1.3 Cost

The overall cost of implementing the various project alternatives identified in Chapter 5 includes such components as the cost of planning and permitting, property acquisition, construction, and long-term monitoring and maintenance.

6.2 Evaluation of Project Alternatives

The three general evaluation criteria are applied to each of the categories of project alternatives as follows. A summary of the evaluations of the project alternatives is shown in Table 6.1

6.2.1 No Action

Effectiveness in Achieving the Objectives
No improvement would be made towards improving water quality, restoring hydrologic function, and supporting fish and wildlife habitat. Due to inevitable development of upland areas of the watershed, particularly in areas located south of SR 534, it can be expected that the existing problems would gradually get worse over time.

Potential Detrimental Impacts
Not applicable

Cost
Due to the increase in peak runoff that is associated with increased development, the costs associated with more frequent channel dredging due to increased sediment loads would increase over time. Quantification of such future costs is beyond the scope of this feasibility study. Similarly, quantification of the value of lost beneficial uses due to increased peak runoff, decreased summer base flow, and non-compliance with the water quality criteria, while undoubtedly substantial, is beyond the scope of this study.

6.2.2 Riparian Vegetation and Livestock Fencing

Effectiveness in Achieving the Objectives
Nineteen potential riparian reforestation and fencing projects are identified in Table 5.1. Implementation of all the projects would result in effective shading of about 22,6200 lineal feet of primarily north-south oriented reaches of creeks and Hill Ditch. When grown to maturity, the shading would likely result in a major improvement in summer temperature and dissolved oxygen water quality conditions. Installation of the proposed 8,680 feet of fencing to exclude livestock from the water courses would probably also result in improved fecal coliform conditions. As the trees and shrub buffers mature, they would likely have a minor effect in attenuating peak runoff flows and summer low base flows. They also would improve wildlife habitat along the creeks and Hill Ditch and, over the long-term, likely improve fish habitat conditions in the creeks due to eventual recruitment of large woody debris.

Potential Detrimental Impacts

Reforestation at seven of the proposed sites would result in the conversion of 10.5 acres of alpaca, cattle, and horse pasture. At each site off-stream stock-watering stations would be installed to compensate for the loss of livestock access to the creeks. Reforestation of a 30-foot buffer along 3,800 feet of Hill Ditch (Project No. H 3) would convert about 4.4 acres of productive cropland to forest. The reforestation plan for three of the sites adjacent to the gas pipeline along Upper Fisher Creek would have to be designed to be compatible with pipeline right-of-way maintenance requirements. Reforestation of several of the potential sites on residential properties adjacent to Carpenter Creek and East Fork Little Fisher Creek would likely improve the aesthetic appearance of these properties.

Cost

Table 6.2 summarizes the costs for implementing the nineteen proposed riparian reforestation projects. Detailed cost estimates for each project are included in Appendix 1. The estimated present worth of 10-year costs for this alternative is $442,000. The 10-year cost for each individual project is shown below.

Project No.	Length of Creek (ft)	Acres	Cost		Project No.	Length of Creek (ft)	Acres	Cost
C 5	200	0.1	$6,700		F 1	1,000	1.4	$17,800
C 9	1,600	1.1	$15,000		F 2	2,600	2.4	$28,100
SP 1	200	0.2	$4,400		F 4	1000	0.9	$33,300
H 1	2,000	4.6	$54,800		F 5	800	1.8	$20,600
H 3	6,400	1.4	$78,400		F 6	600	0.8	$12,400
B 1	400	0.3	$8,800		LF 1	1,600	2.2	$56,000
BMF 2	600	0.4	$14,000		LFWF 1	400	0.6	$10,200
BSF 1	1,200	1.7	$35,000		LFEF 3	600	0.4	$7,100
SB 2	200	0.1	$4,300		LFEF 4	400	0.3	$6,200*
SB 3	800	0.6	$16,600		*includes costs of stabilizing channel erosion at the site			

6.2.3 Modification of Dam Spillways

Effectiveness in Achieving the Objectives

Modification of the spillways at the private dams on the Lang and O'Malley properties would result in a modest improvement in summer low-flow conditions in Carpenter and Little Fisher Creeks, respectively. Increased summer flows of cool, aerated water would also be expected to modestly improve late summer dissolved oxygen and temperature conditions in these two creeks. Provision of fish passage past these two structures (as required by Washington law) would have a moderate improvement in the fish habitat of Upper Carpenter Creek (Lang dam) by opening access to migratory fish to the extensive, high quality beaver pond/winter rearing habitat upstream on the Lang property. The amount of high quality habitat upstream of the O'Malley dam on West Fork Little Fisher Creek appears to be less extensive than on Upper Carpenter Creek, so the habitat benefit of modifying the O'Malley dam would be less.

Potential Detrimental Impacts

Spillway modifications would result in lowering of the water level in the two private impoundments during late summer low flow conditions. The spillway invert elevations would be designed to permanently impound a minimum level of water to retain the aesthetic value of these ponds. Neither pond is believed to be currently used for water supply.

Cost
Table 6.2 summarizes the costs for implementing the two proposed spillway modification projects. Detailed cost estimates for each project are included in Appendix 1. The estimated present worth of 10-year costs for this alternative is $166,400, divided between the Lang dam ($77,600) and the O'Malley dam ($88,800)

6.2.4 Creek Channel Restoration and Floodplain Reconnection Projects

Effectiveness in Achieving the Objectives
Reconnection of the lowest reach of Sandy Creek and Johnson Creek to their original floodplains would have a major benefit in restoring hydrologic function in those sub-basins. Following channel restoration, sediment bedload, which presently deposits in Hill Ditch at the mouths of these creeks and which must be dredged every few years, would deposit on the restored alluvial fans before reaching Hill Ditch. Correcting the sedimentation problem at Johnson Creek in particular would result in less backwatering and flooding of Hill Ditch upstream.

Restoration of the lowest reaches of Sandy and Johnson Creeks would result in significant improvements to local fish and wildlife habitat conditions as well. Installation of large woody debris habitat structures would increase channel complexity. Livestock fencing and reforestation of the historic alluvial fan areas would provide the kinds of benefits provided by the riparian reforestation projects listed above.

The two smaller-scale channel restoration projects proposed for Carpenter Creek (removing concrete bank armoring and tires) would not provide significant improvement in the water quality and hydrology objectives, but would have a modest improvement in local fish habitat conditions on Carpenter Creek.

Potential Detrimental Impacts
Construction of the Sandy Creek project alternative would convert about 2.8 acres of cattle pasture to forest and stream channel. Construction of the Johnson Creek project alternative would convert about 3.4 acres of unused, canary grass-infested land to forested wetland habitat. Depending on the final design of the Johnson Creek project, one or more existing farm buildings may have to be removed. Except for the tire removal project, the construction of the other three proposed projects would result in a significant temporary increase in sedimentation in Carpenter Creek and Hill Ditch. Runoff would be mitigated as part of the project TESC plans.

Cost
Table 6.2 summarizes the costs for implementing the four proposed creek channel restoration projects. Detailed cost estimates for each project are included in Appendix 1. The estimated present worth of 10-year costs for this alternative is $400,000, broken out as follows:

Sandy Creek Project:	$155,500	Carpenter Creek concrete removal:	$37,800
Johnson Creek Project:	$196,700	Carpenter Creek tire removal:	$10,000

6.2.5 Culvert Replacement Projects

Effectiveness in Achieving the Objectives

Replacement of culverts at the ten proposed project sites generally would not be expected to significantly improve water quality in the watershed, except for reducing erosion turbidity at a few of the locations. Replacing the culverts at Middle Fork Bulson Creek at English Road (No. BMF 1), South Fork Bulson Creek at English Road (No. BSF 2), and especially Fisher Creek at Bulson Road (F 3) would have a moderate improvement in restoring natural hydrology by eliminating chronic flooding at these locations.

The main benefit of the ten culvert projects would be to achieve the fish and wildlife habitat objectives of removing fish passage barriers. The projects would improve and/or allow access to additional eleven or so miles of upstream habitat. While a systematic rating of the fish habitat quality upstream of these ten culverts was not conducted as part of this study, field observations suggest that the projects that would have the highest fish habitat benefit are:

- No. C 7 (Carpenter Creek at Little Mountain Road)
- No. BSF 2 (South Fork Bulson Creek at English Road)
- No. SB 4 (Starbird Creek at Starbird Creek Lane)
- No. F 3 (Fisher Creek at Bulson Road)
- No. LFEF 5 (East Fork Little Fisher Creek at Bonnie View Road) and
- No. LFEF 6 (East Fork Little Fisher Creek at Franklin Road).

Potential Detrimental Impacts

Construction of most of these projects would cause major temporary interferences in local traffic patterns, requiring the temporary road closures at several locations. At sites where no practical temporary traffic detours are available (such as at No. C 3, No. SB 4, and No. LFEF 6), it will be necessary to either construct the work phases, keeping half the road open at a time, or to negotiate temporary easements for traffic through adjacent private property. Construction would also cause a significant temporary increase in sedimentation in the creeks. Runoff would be mitigated as part of each project's TESC plan. No long-term detrimental impacts are anticipated for these projects.

Cost

Table 6.2 summarizes the costs associated with completing all ten of the proposed culvert replacement projects. A detailed cost estimate is included in Appendix 1. The estimated present worth of 10-year costs for all the projects in this alternative is $1,101,000, as broken down in the following table. Note that the cost of replacing the South Fork Bulson Creek culvert under English Road represents over one third of the total cost, due to the high cost of jacking a replacement culvert beneath the deep road fill.

Project No.	Upstream Habitat	Cost		Project No.	Upstream Habitat	Cost
C 3	2,000 ft*	$66,100		F 3	10,000 ft	$103,300
C 7	7,000 ft	$19,200		LFWF 3	3,000 ft*	$152,800
BMF 1	8,000 ft	$99,600		LFEF 2	6,000 ft	$42,700
BSF 2	3,000 ft	$391,700		LFEF 5	2,500 ft	$66,100
SB 4	14,000 ft	$64,900		LFEF 6	3,000 ft	$94,700

*Access assumes that fish passage is provided at the private dams located immediately upstream (see Section 6.2.3).

6.2.6 Typical Dike Setback Project

Effectiveness in Achieving the Objectives

Setting 3,800 linear feet of Hill Ditch dike back 150 feet, as proposed in the generic dike setback alternative, would provide about 105 additional acre-feet of flood storage, which would significantly reduce flood stage and the backwatering effect of Hill Ditch. Re-grading the existing channel of Hill Ditch from a trapezoidal cross section to a more natural shape that includes a narrow, summer low flow channel combined with a sloping terrace floodplain for high flows would likely improve summer water quality by concentrating summer low flow. Planting of the new floodplain with wetland emergent plants (nearest the channel) and a wide buffer of conifer trees (on the outer, slightly higher floodplain) would have a major improvement in water quality by providing nearly three quarters of a mile of high quality shading on this exposed, north-south oriented water body. The wetland and forest plants would also create about 8.7 acres of high quality habitat for birds and wildlife.

Potential Detrimental Impacts

The generic dike setback proposed in this study would convert about 13.1 acres of productive farmland to conservation and flood control use. Construction of the project would cause a large but temporary increase in sediment runoff to Hill Ditch and Fisher Slough. Runoff would be mitigated as part of the project's TESC plan.

Cost

Table 6.2 summarizes the costs associated with completing the generic dike setback project alternative. A detailed cost estimate is included in Appendix 1. The estimated present worth of 10-year costs for this alternative is $2,087,000.

6.2.7 Wetland Enhancement Projects

Effectiveness in Achieving the Objectives

Planting conifer buffers and installing livestock fencing around the three large wetlands identified in Section 5 (Project Nos. C 4, H 2, and SB 1) would result in a moderate improvement in water quality by excluding livestock from these shallow open water areas and partially shading them in the summer. Because the wetlands already provide significant benefit and attenuating peak runoff and low summer stream flows, no significant additional benefit to restoring hydrologic conditions would be expected. Nevertheless, protecting the wetlands with conservation easements and regulating the water surface elevation of the existing beaver dams using "beaver deceivers" would help the people who own these wetlands to manage them properly for conservation purposes. Enhancement of high quality scrub-shrub and forested wetland habitat conditions at these sites would have a major benefit to fish and wildlife habitat.

Potential Detrimental Impacts

Permanently protecting nearly 80 acres of existing wetland would formally preclude their conversion to more economically-productive uses. Because these sites are already protected from development by Skagit County's critical areas ordinance, the potential for developing them for more economically productive use is limited. Sod stripping and "de-leveling" to eliminate reed canary grass at Site No. SB 1 would likely result in a temporary increase in sediment runoff to nearby Starbird Creek. Runoff would be mitigated as part of the project TESC plans.

<u>Cost</u>
Table 6.2 summarizes the costs associated with implementing the three proposed wetland enhancement projects. Detailed cost estimates for each project are included in Appendix 1. The estimated present worth of 10-year costs for this alternative is $445,000, divided as follows:

Project No. C 4	1.8 ac.	$46,600
Project No. H 2	41.3 ac.	$179,500
Project No. SB 1	36.7 ac.	$218,500

6.2.8 Permanent Conservation Easements

<u>Effectiveness in Achieving the Objectives</u>
The purchase of development and logging rights on site Nos. C 1 and LFEF 1 would result in a potential major benefit to water quality, flooding/hydrology, and habitat conditions in the headwaters of Carpenter Creek and East Fork Little Fisher Creek, respectively, by preserving the existing valuable forest and wetland functions that they presently provide. Purchase of development rights, combined with the fencing and reforesting of the creek banks at Site No. LF 1, would likewise have potential major benefit to water quality and habitat at this key site at the confluence of the forks of Little Fisher Creek.

<u>Potential Detrimental Impacts</u>
Purchase of permanent conservation easements would prevent the conversion of these parcels to other potentially lucrative future uses such as logging or residential development.

<u>Cost</u>
Table 6.2 summarizes the costs associated with purchasing conservation easement on these sites. A detailed cost estimate is included in Appendix 1. The estimated present worth of 10-year costs is $182,000, divided as follows:

Project No. C 1	11.0 ac.	$74,200
Project No. LFWF 1	6.9 ac.	$52,700
Project No. SB 1	6.9ac.	$55,500.

Recently planted CREP riparian forest buffer along Hill Ditch north of SR 534. Project H 3 would complete similar reforestation efforts along the west side of Hill Ditch.

Table 6.1. Comparison of Evaluations of Alternatives

Project Type or Name	Description	No. Pro-jects	Estimated 10-year Cost	Acreage Impact-ed	Benefits			Detriments
					Water Quality	Flooding/ Hydrology	Habitat Conditions	
1. Riparian Reforestation	Plant native trees and shrubs along creek banks at sites where shade is lacking or poor. Buffer widths vary according to site conditions. Install fencing and off-stream stock watering stations at sites where livestock currently drink out of the creek.	19	$442,000	24.3	Major improvement in summer DO and temp. when trees are mature. Moderate reduction in fecal coliform over entire watershed	Minor improvement in attenuating peak runoff flows and summer base flows.	Moderate improvement in wildlife habitat along some creeks and especially Hill Ditch. Long term improvement in fish habitat by providing source of LWD recruitment.	Conversion of 10. 5 acres of livestock pasture and 4.4 acres of crop land.
2. Modification of Spillways	Modify the spillways at the Lang and O'Malley private dams to spill more water during summer low flow and provide fish passage.	2	$166,000	N.A.	Minor improvement in summer D.O. and temp. by slightly increasing base flow.	Minor improvement in prolonging summer base flows	Moderate increase in salmonid rearing habitat, especially upstream of Lang dam.	Aesthetic impact associated with lowering the summer water level in the two impoundments.
3. Creek Channel Restoration and Floodplain Reconnection	Reconnect Lower Sandy Creek and Johnson Creek to their original alluvial fans. Remove concrete debris and tires from Carpenter Creek.	4	$400,000	6.4	Indirect improvement in turbidity by eliminating need to dredge Hill Ditch at the mouths of Sandy and Johnson Creeks.	Major improvement in correcting the back-watering problems associated with excessive sediment deposition in Hill Ditch.	Major improvement in fish habitat at Sandy and Johnson creeks by restoring natural channel conditions. Minor improvement in Carpenter Creek by removing debris and adding LWD.	Conversion of 6.2 acres of pasture and vacant land. Temporary increase in sediment runoff in creek during construction
4. Culvert Replacement	Replace or retrofit undersized culverts at ten sites to meet proper fish passage and hydraulic standards.	10	$1,101,000	N.A.	Minor improvement in reducing turbidity from channel erosion at some of the sites.	Moderate improve-ment in local hydrology by eliminating upstream back-watering and downstream channel scour.	Major improvement in fish habitat by allowing access to11.1 miles of upstream habitat. Habitat quality varies with each site.	Temporary disruption of traffic and increase in sediment runoff during construction.
5. Typical Dike Setback Project	Set about 3,800 feet of dike back 150 feet. Re-grade Hill Ditch cross section to include low flow channel and terraced floodplain. Plant floodplain with wetland plants and conifer buffer.	1	$2,087,000	13.1	Major improvement in summer DO and temp. when trees are mature. Minor reduction in turbidity and coliform by bio-filtration of high flows.	Major improvement in flood management by adding 105 ac-ft of storage. Natural channel floodplain cross section reduces need for maintenance	Major improvement in fish and wildlife habitat by restoring natural channel conditions and about 13 acres of riparian forest habitat.	Conversion of 13.1 acres of productive farmland. Temporary increase in sediment runoff during construction.

						dredging.		
6. Enhancement of Riparian Wetlands	Plant conifer buffers and install livestock fencing around three large wetlands. Manage beaver flooding. Remove canary grass and replace with native shrubs.	3	$445,000	79.8.	Moderate improvement in in-stream temp. and fecals by shading and fencing.	Will protect but not add additional flood and base flow attenuation value to the existing wetlands functions	Moderate benefit to wildlife by enhancing high quality scrub-shrub and forested wetland habitat	Stripping of canary grass and "de-leveling" causes temporary increase in sedimentation
7. Permanent Conservation Easement	Purchase permanent conservation easements on three forest and wetland properties.	3	$182,000	24.8	Potential major benefit by preserving valuable forest and wetland functions along creek	Potential major benefit by preserving valuable forest and wetland functions along creek	Potential major benefit by preserving valuable forest and wetland functions along creek	Prevent conversion of site to more lucrative future uses.

Table 6.2. Summary of Project Cost Estimates

Project Type or Name	No. of Projects	Project Design & Management	Property Acquisition	Construction & Implementation	10-year Maintenance & Monitoring	Total Present Worth	Add 15% Contin-gency*
Riparian Reforestation and Fencing Projects	19	$46,300	$42,750	$162,482	$132,427	$873,958	$441,552
Modification of Dam Spillways	2	$40,500	$0	$91,877	$12,354	$144,731	$166,441
Stream Channel Restoration and Floodplain Reconnection	4	$75,300	$35,500	$230,043	$31,350	$347,792	$399,961
Culvert Replacement Projects	10	$217,800	$14,750	$718,067	$5,328	$957,368	$1,100,973
Typical Dike Setback Project	1	$32,400	$106,700	$1,616,531	$59,071	$1,814,702	$2,086,907
Riparian Wetland Enhancement Projects	3	$29,000	$207,400	$65,145	$85,131	$386,676	$444,677
Conservation Easements	3	$13,500	$67,700	$0	$38,300	$158,200	$181,930

6.3 Policy Methods

The three general evaluation criteria are applied to each of the policy method alternatives as follows.

6.3.1 Drainage Tax Credits for On-site BMPs

Effectiveness in Achieving the Objectives

The effectiveness of this alternative depends upon the quantity and quality of best management practices (BMPs) that are implemented by individual landowners. It is assumed that the value of the tax credit would be correlated to how effective the landowner's activities are in reducing upland runoff.

Potential Detrimental Impacts

Potentially this alternative could divert significant tax revenues from the county drainage utility; however, if the program is effective, it would also lower the drainage utility's operating costs.

Cost

An economic evaluation of this alternative is beyond the scope of this feasibility study.

6.3.2 Small Grants for BMP Implementation

Effectiveness in Achieving the Objectives

The effectiveness of this alternative depends entirely upon the quantity and quality of BMPs that are implemented by landowners. It is assumed that the awarding of grants would be dependant on the likely effectiveness of the individual applicant's proposed projects.

Potential Detrimental Impacts

No detrimental impacts are anticipated from this alternative.

Cost

An economic evaluation of this alternative is beyond the scope of this feasibility study.

6.3.3 Improved Coordination of Land Development Permitting

Effectiveness in Achieving the Objectives

The effectiveness of this alternative depends upon the quantity and quality of input that various stakeholders (e.g. drainage district, conservation district, WDFW, et al.) provide during the land development permitting at individual sites. Likewise, Skagit County government must have the political will to require and enforce mitigation activities that may be identified during the review process. It will be particularly important to coordinate stakeholder review in evaluating the impacts of individual development projects on off-site receiving waters, such as downstream creeks; an issue that tends not to receive sufficient technical evaluation during the current development review process.

Potential Detrimental Impacts

The main detrimental impact associated with this alternative is the potential to increase the cost of site development activities.

Cost

An economic evaluation of this alternative is beyond the scope of this feasibility study.

6.3.4 Adoption and Implementation of In-Stream Flow Regulations

Effectiveness in Achieving the Objectives

The effectiveness of this alternative depends upon how effectively any in-stream flow regulations that may be enacted are actually enforced. The protection of minimum in-stream flows would have a major benefit in improving summer low-flow temperature and dissolved oxygen in the watershed's creeks. Likewise, protection of in-stream flows would have a major benefit to fish habitat.

Potential Detrimental Impacts

Were this alternative to be implemented, it would likely result in the eventual development of community and/or public water supplies and wastewater treatment facilities in the more densely populated parts of the watershed. Until the necessary infrastructure is developed, enforcement of in stream flow requirements might limit the quantity of residential and commercial development in the watershed. An analysis of the economic impact of this alternative is beyond the scope of this feasibility study.

Cost

An economic evaluation of this alternative is beyond the scope of this feasibility study.

East Fork Little Fisher Creek Just Above Confluence with the West Fork.
Project LF 1 would protect and plant trees along the banks of this reach.

7 Public Review and Ranking of Alternatives

In this chapter, each of the project alternatives is ranked relative to the entire suite of proposed alternatives. The ranking is based on the evaluations in Chapter 6.

7.1 Ranking Procedures

Alternatives were ranked in accordance with their relative "benefit" compared to each other, that is, their effectiveness in achieving the various objectives identified in Chapter 3. For each project, arbitrary benefit units ranging from "0" (no benefit) to "5" (highest benefit) were assigned to each category of objective (i.e. water quality, flooding/hydrology, and habitat conditions). Assignment of "benefit units" was based on the evaluation of each individual alternative in Chapter 6. Even though the assignment of benefit units was done somewhat subjectively, it is believed to accurately reflect the relative difference in overall "effectiveness" among each type of project alternative.

Following a tabulation of the overall "benefit scores," a "cost per unit benefit" was calculated for each alternative. The cost per unit benefit is simply the quotient of the estimated 10-year cost divided by the overall benefit score. For example, if the estimate cost of an alternative is $200,000 and the overall benefit score is 8, the cost per unit benefit value is ($200,000 / 8) = $25,000. An alternative that included two or more individual project sites, for example, the "Riparian Reforestation Projects" alternative, which included nineteen potential riparian reforestation sites, was considered to be one single alternative for the purpose of cost-benefit ranking. Finally, the alternatives were ranked according to their cost per benefit value, with the least expensive values being ranked highest.

The proposed policy alternatives were not ranked because of uncertainties associated with estimating the cost of adopting and implementing them.

Based on SCD's experience with similar projects in other Skagit County watersheds, it is important to obtain input from local residents and other stakeholders in the watershed into the overall ranking process. Consultation with local stakeholders helps to define which of the projects have the best chance of being implemented and which are perceived to be most valuable to the local community. Accordingly, as future funding becomes available, SCD recommends that an advisory committee of landowners and other stakeholders in the watershed be convened to conduct a second ranking of the projects. The basic ranking criteria for the advisory committee would be "public acceptance" and "likelihood of implementation."

7.2 Results of Ranking

Table 7.1 shows the results of the cost versus benefit rankings for the alternatives. Based on the ranking process, the three permanent conservation easement alternatives have the lowest cost to benefit ratio ($30,300) and the typical dike setback alternative has the highest ratio ($139,100). Figure 7.1 graphs the cost versus benefit ratios of all seven alternatives. The graph shows that there is not a great difference in the cost-benefit ratios of the top five-ranked alternatives, but that the ratio jumps substantially for the last two ranked alternatives. This trend reflects the high construction costs associated with culvert replacement and dike setback projects. In particular, even though the environmental benefit of the dike setback alternative is much higher than each of the other alternatives, its construction cost is two to ten times more expensive than the others. A summary of the results of the rankings is shown in Table 7.2.

Figure 7.1 Comparison of Project Cost versus Benefit

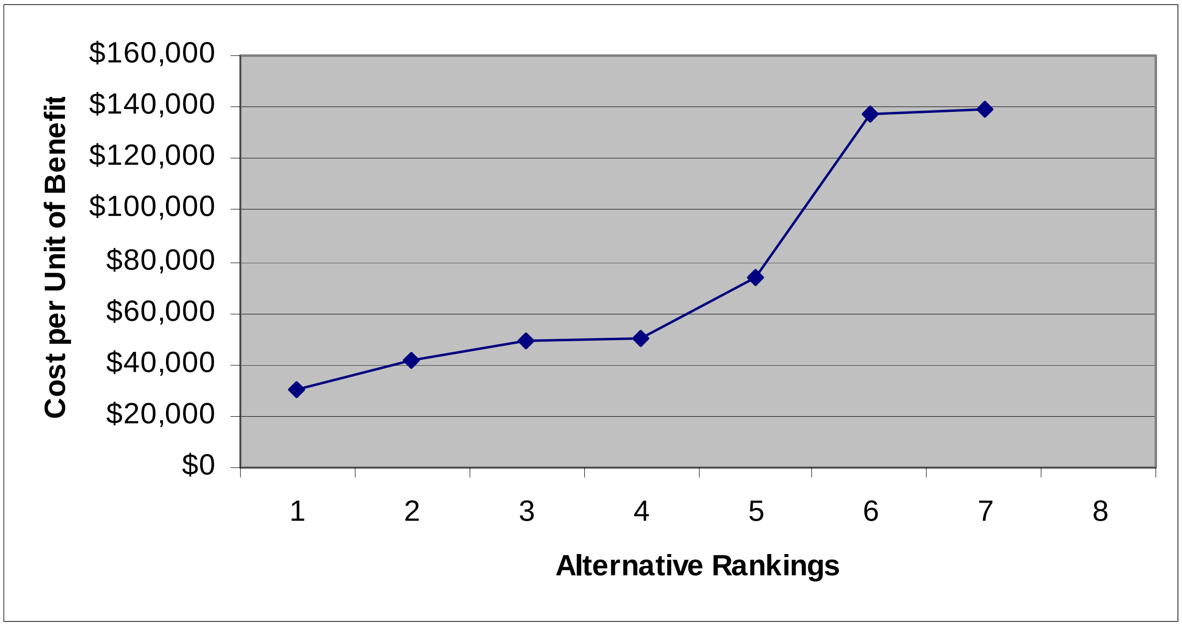


Table 7.1. Comparison of Project Cost versus Benefit

Project Name or Type	No. Pro-jects	Estimated 10-year Cost	Benefit Scoring* Water Quality	Flooding/ Hydrology	Habitat Conditions	Overall Score	Cost per Unit of Benefit*	Relative Ranking
1. Riparian Reforestation and Fencing Projects	19	$442,000	4	1	4	9	$49,100	3
2. Modification of Spillways	2	$166,000	1	1	2	4	$41,500	2
3. Creek Restoration & Floodplain Reconnection	4	$400,000	1	4	3	8	$50,000	4
4. Culvert Replacements	10	$1,101,000	1	3	4	8	$137,600	6
5. Typical Dike Setback Project	1	$2,087,000	5	5	5	15	$139,100	7
6. Enhancement of Riparian Wetlands	3	$445,000	2	1	3	6	$74,200	5
7. Permanent Conservation Easements	3	$182,000	2	2	2	6	$30,300	1

Notes
1. Benefit scoring units are arbitrarily assigned from "0" (no benefit) to "5" (highest benefit) to reflect the relative qualitative and quantitative differences between the various projects.
2. Cost per unit benefit is calculated as the overall cost per project type divided by the benefit score.

Table 7.2. Summary of Rankings of Alternatives

Project Alternative	Cost per Benefit Ranking	Public Acceptance Ranking
Permanent Conservation Easements	1	(To be completed)
Modification of Dam Spillways	2	"
Riparian Reforestation and Fencing	3	"
Creek Restoration & Floodplain Reconnection	4	"
Enhancement of Riparian Wetlands	5	"
Culvert Replacements	6	"
Typical Dike Setback Project	7	"
Policy Alternatives		
Drainage Tax Credits for Implementing BMPs	Unranked	"
Small Grants for Implementing BMPs	Unranked	"
Improved Coordination of Land Development Permitting	Unranked	"
Adoption and Implementation of In-Stream Flow Regulations	Unranked	"

8 References

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