TASK 4.1

SKOKOMISH RIVER
COMPREHENSIVE FLOOD CONTROL MANAGEMENT PLAN:

DRAFT PLAN

Internal Review Draft

July 1987

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WASHINGTON DEPARTMENT OF ECOLOGY
Olympia, Washington 98504-8711

xx July 1987

Dear Reader:

The attached Draft Skokomish River Comprehensive Flood Control Management Plan (CFCMP) is a model plan prepared by the Shorelands and Coastal Zone Management Program Flood Plain Management Section. The preparation of local CFCMPs was initiated by the 1984 state legislature in amendments to Chapter 86.26 RCW, State Participation in Flood Control Maintenance.

The legislation provides that state participation in funding of flood control maintenance projects shall be conditional on completion and adoption of a local "comprehensive flood control management plan" (RCW 86.26.050). The legislature further directed that a CFCMP shall:

determine the need for flood control work;

consider alternatives to instream flood control work;

identify and consider potential impacts of instream flood control work on the state's instream resources; and

identify the river's meander belt or floodway (RCW 86.26.105).

Local CFCMPs must be approved by the Department of Ecology in consultation with the state departments of Fisheries and Game (RCW 86.26.050). Ecology's regulatory guidelines for preparation of CFCMPs (WAC 173-145-040) were adopted in 1985 and amended in early 1987.

The requirement for comprehensive flood control planning is new to Washington's local governments. Therefore, this model plan has been prepared as further guidance to local governments in preparation of their own CFCMPs. This plan has been prepared in consultation with the state departments of Fisheries and Game, Mason County, and the Skokomish Indian Tribe.

The purpose of this draft Skokomish River CFCMP is to provide the public, particularly the residents of the Skokomish Valley, local government officials and staff, affected state agencies, and other interested parties, the opportunity to comment on the approaches to comprehensive flood control planning in this model plan.

This marks the beginning of the public review period for the draft Skokomish River CFCMP. We invite both your general comments on the CFCMP concept, plus your specific comments on the recommendations of the draft Skokomish River

CFCMP. To be considered in our preparation of the final Skokomish River CFCMP, written comments must be received by July xx, 1987, and should be sent to:

Skokomish River Project
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Attn: Lisa Randlette, Project Manager

Sincerely,

D. Rodney Mack, Manager
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EXECUTIVE SUMMARY

The Skokomish Valley, located in north central Mason County, is an agricultural and rural residential area which floods once or more a year during a typical winter rainy season. Other important land uses in the valley include three state fish hatcheries. The Skokomish Indian Reservation lies at the mouth of the river on Hood Canal.

Flow into the main stem Skokomish River and Skokomish Valley is principally from the South Fork Skokomish basin which drains the southeasterly portion of the Olympic National Forest. The North Fork Skokomish, which drains the southeasterly portion of Olympic National Park, was diverted out of the Skokomish basin in 1930 as part of a City of Tacoma hydroelectric project.

The Skokomish Valley has been evaluated for flood protection in the past by the US Army Corps of Engineers, the Pacific Northwest River Basins Commission, and the US Soil Conservation Service. The cost of flood protection has, and continues to exceed the benefits.

The Skokomish Valley has never experienced a major -- that is 100-year -- flood during historical times. The largest flood was a 30-year event in 1955. The annual low level flooding results from rainfall events of up to 5- to 10-year intensities which sheet flow across the valley and drain via old secondary channels. Drainage has been impeded by the filling of some old channels and meanders, as well as by the damming effect of the US 101 highway.

The frequency and severity of the annual flooding is increasing. Flood waters rise rapidly, and usually last a day or two. The problems associated with the annual flooding are:

* water damage to structures and personal property;
* soil erosion of bare, unprotected farm fields;
* damage to crops such as corn and Christmas trees;
* stranding and interrupted transportation;
* severe streambank erosion in certain locations; and
* emergency evacuation.

The cause of the increase in flooding is an aggrading -- filling -- riverbed. During the past twenty years the riverbed at the US 101 bridge has risen three feet and the flow necessary to top the riverbanks has decreased from 10- 12,000 cfs (cubic feet per second) to 8,500 cfs.

The source of the gravel and sediments filling the Skokomish River is primarily from the South Fork Skokomish basin. Slopes in the South Fork basin are steep and unstable, and soils are susceptible to erosion. Forest practices within the Shelton Cooperative Sustained Yield Unit of the Olympic National Forest are suspected but not yet confirmed as a contributing factor.

The effect of aggradation on instream fish habitat is unknown but could be detrimental.

The Skokomish River main stem flows along the north side of the Skokomish Valley. The valley floor slopes toward the south side of the valley. As riverbed aggradation continues there is an increasing likelihood that a large flood flow will cause the river to carve a new main channel south across the valley to new location along the south side. The potential damage resulting from a such an

event might include:

* destruction of fish hatcheries through undercutting of fill
* washout of US 101, a major transportation link
* destruction of structures
* loss of life

There is no immediate, affordable solution which will eliminate the chronic, annual flooding problem of the Skokomish Valley, or the catastrophic potential of the river jumping its banks and carving a new channel.

The chronic problem can be ameliorated through the following institutional measures:

* development of a better warning and evacuation system
* elevation of roadways

and the following individual measures which may require financial and/or technical assistance:

* flood proofing of structures
* agricultural practices adapted to flooding
* bank protection measures not harmful to fish habitat

The catastrophic potential should be assessed first through a detailed study of South Fork basin erosion, landsliding, and sediment transport from the South Fork to the main stem, plus streambank erosion in the Skokomish Valley. Only then can the magnitude of the problem be identified and potential solutions be evaluated for implementation.

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Chapter 1

INTRODUCTION

The Skokomish River Comprehensive Flood Control Management Plan has been developed by the Flood Plain Management Section of the Shorelands and Coastal Zone Management Program, in the Department of Ecology. This model plan is intended to serve as an example of content and level of detail for local governments which intend to prepare comprehensive flood control management plans.

NEED FOR COMPREHENSIVE FLOOD CONTROL MANAGEMENT PLANNING

State Participation in Flood Control Maintenance, Chapter 86.26 of the revised Code of Washington (RCW), is a 1984 law requiring each jurisdiction desiring state assistance for flood control maintenance to prepare a comprehensive flood control management plan (CFCMP). The purpose of comprehensive flood control management planning is to establish the need for flood control maintenance work, define structural alternatives, identify and consider potential impacts of instream flood control work on instream resources, and identify the river's floodway.

Comprehensive flood control management planning is intended to reduce flood damages and to establish, in a prioritized manner, the appropriate structural and nonstructural measures needed to reduce flood damages. The extent of the study area may include the entire watershed or, as a minimum, the one-hundred year frequency flood plain within a reach of the watershed of sufficient length to ensure that a comprehensive evaluation can be made of the flood problems for a specific reach of the watershed.

FLOOD CONTROL ASSISTANCE ACCOUNT PROGRAM

In 1984 the Washington State Legislature made significant modifications to the State Participation in Flood Control Maintenance Act (Chapter 86.26 RCW), originally enacted in 1951. The 1951 law had provided a funding mechanism to cost share with local jurisdictions in the construction of facilities for flood control maintenance. Typical projects included the installation of rock riprap on eroding streambanks or on failing existing riprap or levees. Funding was based on a legislative appropriation each biennium with the amount varying from a maximum of two million dollars per biennium, to no funding for approximately the last ten years.

The 1984 legislative amendments to the Flood Control Assistance Account Program (FCAAP; RCW 86.26.007) were based, in part, on the need to protect the investment of state and local funds allocated for the protection of public facilities or flood control structures, located on or near streambanks and coastal areas, from damage and to guide in the wise allocation of those resources. In addition, it has become widely accepted that the use of structural measures only to reduce flood damages is not adequate and that nonstructural measures such as floodproofing and land use restrictions are necessary. Flood damages have been shown to be increasing at a more rapid rate that the rate of increase in expenditures for structural measures. The implementation of the National Flood Insurance Program (NFIP) in 1968, and the associated requirement of local flood plain management ordinances as a nonstructural means of reducing flood damages, has been a major federal effort in encouraging local governments and private citizens to mitigate flood losses.

The primary elements of the current State Participation in Flood Control Maintenance law are summarized as follows:

Funding: A flood control assistance account was established with Four Million Dollars as the initial appropriation for the biennium beginning 1 July 1985. At the beginning of each succeeding biennium, the account is to be reestablished at the initial funding level.

Eligible Applicants: Counties, cities, and other local municipal corporations with flood control responsibilities such as flood control districts or diking districts, are eligible to receive state funding for flood control maintenance projects.

Eligibility Requirements: To address the concerns with previous legislation regarding the "band aid" approach to flood control maintenance, two significant eligibility requirements were established. These are flood plain management activities and comprehensive flood control management planning.

Flood Plain Management Activities: In order to receive funding for flood control maintenance projects, the Department of Ecology must approve the flood plain management activities of the county, city, or town having planning jurisdiction over the area where the particular project will be located. The Department of Ecology is also required to adopt rules concerning these flood plain management activities to ensure that they are adequate for protection of development from flood damages and to restrict land uses within the floodway to only flood-compatible uses. No state funding is provided for flood plain management activities.

Comprehensive Flood Control Management Plans: The legislation specifies that a comprehensive flood control management plan (CFCMP) must include the area where any proposed project is located and provides direction by specifying the following:

> A comprehensive flood control management plan shall determine the need for flood control work, consider alternatives to instream flood control work, identify and consider potential impacts of instream flood control work on the state's instream resources, and identify the river's meander belt or floodway. (RCW 86.26.105)

The legislation allows up to three years for completion and adoption of the plan. The county engineer must certify on specific project applications whether a plan has been completed and adopted, or is being prepared. Comprehensive plans must be prepared and adopted by the appropriate local authority and must be approved by the Department of Ecology. One of the key elements of the legislation passed in 1986 was that state funding can be provided for up to seventy-five percent of the costs of preparation of comprehensive flood control management plans.

Nonemergency Projects: The legislation specifies, in general terms, the type of maintenance work that is considered eligible work for funding. The type of work considered eligible is for "maintaining and restoring the normal and reasonably stable river and stream channel alignment and capacity ... and in restoring, maintaining, and repairing natural conditions, works and structures." In addition, state participation can include "restoration and maintenance of natural conditions, works, or structures for the protection of lands and other property from inundation or other damage by the sea or other bodies of water."

All projects must also be for public benefit as opposed to those which are strictly private interests. Projects for individual land owners are therefore not eligible unless there are adjacent facilities in jeopardy which are owned or operated by a county or other municipal corporation.

Emergency Projects: The legislation specifies that a portion of the available funding will be reserved for emergency purposes. The types of projects that are considered to be of an emergency nature are those that must be done immediately to provide protection to life and property.

Consultation With Other Agencies: The fishery resource, primarily salmon and Steelhead, is a key consideration in performing any activities within the waters of the State of Washington. The loss of fish habitat as a result of performing construction work in and adjacent to rivers has been identified as a major concern by fisheries agencies and Indian tribes.

To ensure that fishery resources are maintained, the legislature provided review authority by the state departments of Fisheries and Game for essentially all phases of the Flood Control Assistance Account Program. In addition to their existing approval authority for work done in and adjacent to waters of the state, the legislature provided that the departments of Fisheries and Game be consulted prior to Department of Ecology approval of application for specific projects, flood plain management activities, and comprehensive flood control management plans.

SKOKOMISH RIVER COMPREHENSIVE FLOOD CONTROL PLAN

The Skokomish River model plan will be the only CFCMP to be undertaken by the Shorelands and Coastal Zone Management Program of Department of Ecology for the Flood Control Assistance Account Program. All other CFCMPs will be developed by local jurisdictions. The Skokomish River watershed was chosen as an example basin for a comprehensive flood control management plan because it has a number of unresolved flood control problems.

STUDY OBJECTIVES

The Skokomish River CFCMP was funded through a Coastal Zone Management grant to the Department of Ecology from the Federal Office of Coastal Resource Management. Local jurisdictions require guidance in developing comprehensive flood control management plans, since the required format and level of detail of such a plan can be broadly interpreted.

The causes and effects of flood problems are related to the entire watershed and are most effectively addressed within the context of watershed management. A watershed study which delineated the flood control related issues and considerations was determined to be an appropriate reference document for local jurisdictions. Specifically, the objective of the study is to develop plan elements for the management of the flood plain, including measures for the mitigation of existing flood problems, and incorporating elements intended to minimize future flood problems.

A team of Department of Ecology staff was assembled which had a broad background in basin planning, hydrology, and land use planning. With limited time available to develop the study, the team contacted knowledgeable state and local specialists with expertise in flood plain management and the related resource management fields. The team identified basic flood damage problems within the watershed that required careful areawide study. These problems include health, safety, and welfare concerns due to limited access and the periodic need for evacuation; damage to agricultural crops, agricultural lands, and residential and nonresidential structures; and streambank erosion. These problems are directly related and need to be evaluated and resolved collectively.

The primary benefit of the study for Mason County is to be provided with a working document with which to develop a detailed comprehensive flood control management plan. Mason County may also choose to rely upon this CFCMP as an interim plan, in conjunction with the local flood hazard ordinance, to guide development and allocation of local funds for public facilities improvements. It is hoped that the Skokomish River CFCMP will serve as a practical interim guide for the making of decisions concerning flood plain management within the watershed.

OTHER MAJOR RELATED STUDIES

During the development of the Skokomish River CFCMP, two related planning efforts were conducted in the watershed.

Skokomish River Flood Damage Reduction Study: The US Army Corps of Engineers conducted a flood damage reduction study of the Skokomish River. During the reconnaissance phase, certain structural measures were investigated. These measures were:

1) Channel modifications in the vicinity of the Skokomish Community Church;
2) Clearing of vegetation upstream of the Highway 101 Bridge;
3) Channel modifications in various areas of the river;
4) Construction of a setback levee;
5) Increasing the Highway 101 Bridge opening;
6) Modification of the existing North Fork Skokomish Dam;
7) Excavation of a settling basin; and
8) Excavation of an overflow or bypass channel.

Flood Insurance Study for Mason County: The preliminary Flood Insurance Study for Mason County was completed the Federal Emergency Management Agency (FEMA) and made available for public review. A public workshop was held by FEMA at the Mason County Courthouse on the evening of 7 April 1987. The establishment of detailed base flood elevations for the Skokomish River Valley was particularly valuable to the hydrologic evaluation in this study. The Skokomish River CFCMP will complement the Flood Insurance Study in that detailed recommendations for implementation of a flood damage reduction strategy are partially based upon data developed for flood insurance purposes.

STAFF, COOPERATING AGENCIES, AND MASON COUNTY
Staff of the various state and federal resource agencies served as consultants and an ad-hoc technical advisory committee. Because of the general nature of the investigation, and the limited time available to develop the plan, no formal advisory committee was established.

The efforts of the Department's professional and supporting staff were supplemented with the services of specialists in selected areas, including surveying, fish biology, wildlife biology, forestry, hydrogeology, wetland and natural area identification, and flood hazard reduction.

Chapter 2

PRINCIPLES AND CONCEPTS OF THE PLAN

INTRODUCTION

Watershed planning is a term that means many things to many different interests. Typically, a single goal, such as hydropower generation, flood control, wildlife habitat preservation, or soil and water conservation is the purpose for developing watershed plans. Often, watershed plans do not go far enough in coordinating with other planning efforts within the watershed or broader regional planning efforts. Properly understanding the flood control management problems of a jurisdiction requires an examination of the principles of flood plain management and flood damage reduction. The broader setting of regional planning efforts which apply to the watershed must also be examined.

THE WATERSHED AS A PLANNING UNIT

A watershed is defined as a geographic drainage area or basin which contributes surface water runoff to a series of streams and rivers. A watershed also includes the natural and man-made features within the geographic drainage area which are interrelated and create a cumulative series of interests, including land treatment measures, soil and water management practices, and land use patterns within the watershed.

Flood plain management and flood control or storm drain facilities should be based upon a plan or system which incorporates the entire watershed. This approach allows consideration of the hydrologic characteristics of the basin. Streams and rivers must be capable of accommodating present and future anticipated runoff generated by changing conditions within the watershed. The physical problems of flooding within a watershed identify a community with mutual concerns to be protected. The watershed also serves as a geographic area for forming special districts or utilities to address flooding problems.

RELATIONSHIP OF THE WATERSHED TO THE REGION

Individual watershed plans must also consider the broader setting or context of the region. Land use and environmental problems are not exclusive to individual watersheds and have cumulative impacts upon the region. Flooding, which is experienced in the lower reaches of the Skokomish River watershed and results from upstream factors, also affects Hood Canal with accelerated sedimentation and adverse impacts to shellfish areas.

Currently, Mason County does not have any regional land use planning in effect. A shoreline management master program is in place for certain areas along Hood Canal and other water bodies. Facilities plans such as county roads and parks are limited in scope. The local flood hazard ordinance, administered through the Department of Emergency Services, is the most directly related county effort to flood control planning for the Skokomish River watershed.

The Hood Canal Coordinating Council has the potential to function as a regional development planning body. Comprehensive flood control management planning studies for all of the watersheds in the region would provide a good foundation by which to address related issues such as water quality and the affect of development patterns upon the resource base.

BASIC PRINCIPLES OF COMPREHENSIVE FLOOD CONTROL MANAGEMENT PLANNING

The purpose of developing a comprehensive flood control management plan should be to initiate public awareness and support for a program of comprehensive flood control or flood damage reduction strategies in the community. Development policies and plans for public improvements and facilities should result and be long-range, allowing for effective implementation over time.

The following principles guided the development of this study:

1. Watersheds are the appropriate planning unit for developing a comprehensive flood control management plan.

2. Flood control planning efforts should be multidisciplinary and consider related water resource and land use problems where applicable.

3. Regional planning efforts and related environmental planning studies should be considered as a part of developing comprehensive flood control management plans.

4. Preventative or nonstructural flood control measures should be conducted in conjunction with structural flood control measures.

5. Hydrologic and hydraulic evaluations must be conducted and include future capacity and maintenance as a part of any proposed structural facilities.

6. Solutions to flood-related problems should not aggravate or transport problems to downstream areas.

7. Solutions to flood-related problems should offer a variety of approaches and solutions which can be accomplished at various levels of community and government, as well as provide both short- and long-term relief.

COMPREHENSIVE FLOOD CONTROL MANAGEMENT PLANNING PROCESS

STUDY DESIGN

A study design must define the geographic area for which data will be gathered, specify the content of fact-gathering operations, outline how the information will be gathered and evaluated, and define the nature of the recommendations and the criteria used for their local adoption and implementation.

The need for, and objectives of, the Skokomish River CFCMP were established by the Shorelands and Coastal Zone Management Program of the Department of Ecology in its capacity of providing technical assistance to local governments in coastal counties. Through a grant from the Federal Office of Coastal Resource Management, the major work elements were identified. Ecology staff developed the scope and content of the proposed CFCMP and solicited comments from consulted resource agency specialists. The CFCMP design was expanded and refined during development of the plan, and as a result of communications and data contributed by various agencies.

OBJECTIVES

The formulation of objectives involves both technical and nontechnical policy determinations. The CFCMP is based upon the dual objectives of conducting a geohydrologic and land use planning evaluation of the problems which result from river flooding and developing flood damage reduction measures for the watershed. The primary information used in the investigation includes both reconnaissance information gathered through site inspections and interviews during the course of carrying out this project, plus a review of pertinent documentary information, especially geologic, hydrologic, and environmental analyses; flood frequency analyses and flood mapping; economic and financial analyses of other, prior flood control proposals; and existing land use, floodplain management, and environmental regulations.

INVENTORY

Existing data was collected and evaluated for the watershed which addressed: the characteristics of the watershed; identification of types of watershed flood problems; location and identification of specific problem areas; description of flood damage history; description of potential flood damages; description of flood control work; short-term and long-term goals and objectives for the planning area; fish resources; wildlife resources; scenic, aesthetic, and historic resources; water quality; hydrology; and existing recreation. This information is presented in Chapter 3 (general physical, biological, and socioeconomic data), Chapter 4 (geohydrologic and flooding information), Chapter 5 (flood damage characteristics and previous planning responses), and Chapter 6 (existing regulatory programs).

ANALYSIS OF INVENTORY

Information inventory and analysis was carried out in a series of "feed back loops" -- initial analyses often indicated the need for additional information in certain areas. Information analysis culminated in the identification, as specifically as possible, of problem features and geographical areas.

PLAN DEVELOPMENT AND EVALUATION OF ALTERNATIVES

Plan development was carried out by evaluating approaches used for flood control management planning in the Skokomish Valley in the past, in other areas of the state and nation, and by approaching the Skokomish Valley as an area with certain unique problems. A review of alternative flood control management measures is presented in Chapter 7.

Alternatives were developed and defined in response to specific identified problems in the Skokomish Valley and river basin. Certain alternatives which have been proposed in the past and rejected for adverse cost - benefit reasons were not included in the final articulation of alternatives. The selected alternatives are described in Chapter 8.

PLAN SELECTION AND IMPLEMENTATION

The purpose of this Skokomish River Comprehensive Flood Control Management Plan is to provide Mason County officials and citizens with general information on flood control management options as the basis for selecting specific alternatives for detailed engineering, economic, and environmental evaluation. This

CFCMP does not in and of itself provide the detailed engineering, economic, and environmental analyses.

First, Mason County officials and citizens must choose the alternatives which are socially, economically, and environmentally acceptable. Second, detailed engineering and economic plans must be completed, along with environmental review, probably including an environmental impact statement. Third, funding and technical assistance must be acquired from local, state, and federal sources. Fourth, the chosen alternatives must be implemented through construction contracts, local self help programs, and delegation of administrative responsibilities. Finally, a performance evaluation of the program should be completed to assure that what was desired was actually put in place.

Chapter 3

SKOKOMISH RIVER WATERSHED CHARACTERISTICS

INTRODUCTION

The Skokomish River basin drains approximately 240 square miles of the southeastern portion of the Olympic Peninsula (Sorlie, 1975) into southern Hood Canal, an arm of the Puget Sound system (see Figure 3.1). Most of the basin is forested, either as forest preserves in the Olympic National Park, or as managed timber forests in the Olympic National Forest or on industrial timber lands. Only in the Skokomish Valley, along the lower South Fork and the mainstem of the Skokomish River, has there been any substantial conversion to other land uses, primarily agriculture and rural residential. This chapter of the report will discuss the existing conditions in the basin, and where necessary provide an historical context for certain topics.

The primary study area for this CFCMP is the area which experiences the majority of flood damage: the 17 square mile Skokomish Valley. For the purposes of this report, the Skokomish Valley is defined as extending from the Skokomish delta on Hood Canal upstream to the narrowing of the South Fork flood plain at the Olympic National Forest boundary (South Fork River Mile (RM) 3.5). Also included is the flood plain of Vance Creek. See Figure 3.2. The secondary study area is the entire Skokomish River basin.

Comprehensive information about the Skokomish basin and the Skokomish Valley is dated, scant and widely scattered. The only comprehensive information base was assembled in the late 1960s as a part of the wider ranging Puget Sound and Adjacent Waters (PSAW) Study conducted by the Pacific Northwest River Basins Commission.

NATURAL SYSTEMS

The natural systems of the Skokomish basin -- climate, physiography, geology, water resources, and ecology -- are fundamentally the result of post-glacial conifer forest growth on steep slopes with a thin soil cover.

In this report stream names and numbers are in conformance with the Washington Department of Fisheries system (Williams, Laramie, & Ames, 1975), and river mile (RM) locations of features according to Ames & Bucknell (1981).

CLIMATE

The climate of the basin is generally typical of the Puget Sound region which is strongly influenced by the Olympic Mountains which tend to shelter the basin from the full effect of Pacific Ocean storm systems. The gap in the coast ranges system between the Willapa Hills and the Olympic Mountains south of the basin allows a limited measure of coastal storms to pass into the southern Skokomish basin and the Puget Sound basin in general (Molenaar & Cummans, 1973; Phillips, 1968; Phillips & Donaldson, 1972). Precipitation, snow cover, and evaporation, key factors in Skokomish Valley flooding, are discussed in Chapter 4.

Temperature: Temperatures vary throughout the basin due to topographic conditions. The records kept at Cushman Dam are indicative of the conditions on the plateaus adjacent to the Skokomish Valley. Typical of the Puget Sound area, the highest temperatures occur in July (mean maximum, 78.3°F; mean minimum, 47.8°F), and the lowest temperatures in January (mean maximum, 43.7°F; mean minimum, 30.5°F). The extremes recorded at Cushman Dam are 104°F and -2°F (Phillips, 1986). No temperature data is known to exist for the Skokomish Valley. Temperature has no direct effect on flooding, but does influence rainfall - snowfall patterns which do affect flooding.

Wind: No meaningful wind information is available for the study area; the closest monitoring stations within the Puget Sound basin are located in Olympia (25 miles southeast), Tacoma (35 miles east), and Seattle.

In general, however, the prevailing winds are south to southwest during the winter, and north to northwest during the summer. The strongest winds occur during the winter when intense storms move inland from the Pacific Ocean. Extreme wind velocities (at 30 feet above the surface) can be expected to exceed 55 m.p.h. once in 2 years; 80 m.p.h. once in 50 years; and 90 m.p.h. once in 100 years (Phillips, 1968). Wind patterns have no direct effect on flooding.

PHYSIOGRAPHY

The physiography or physical geography of the Skokomish basin is dominated by the northwest - southeast trending ridge and canyon systems of the two main forks of the river (North Fork and South Fork) and the major tributaries (Le Bar Creek and Vance Creek). For the most part, the minor tributaries form northeast - southwest trending secondary ridge and canyon systems. A major feature of the North Fork is Lake Cushman, a 4,000 acre, 8.4 mile long hydropower impoundment of the City of Tacoma (Ames & Bucknell, 1981; Bortleson, et al., 1976; Williams, Laramie, & Ames, 1975). The physiography of the Skokomish basin has no direct effect on flooding; however, the steep terrain is an important factor in determining the location and existence of unstable river canyon slopes which contribute to a high bed load and aggrading river bed, which directly result in an increasing frequency and severity of flooding.

Topography: With the exception of the Skokomish Valley and its adjacent plateaus, the basin is typified by steep, rugged terrain (Williams, Laramie, & Ames, 1975). The northwesterly limits of the basin run along the Olympic Mountains watershed between the Pacific Ocean and Puget Sound at elevations of 4,000 to 6,000 feet. The lower basin is characterized by steep streamside slopes and level to rolling plateaus. In the upper watershed, the valley walls are steep and the ridge tops sharp. These slopes have been deeply dissected by numerous small mountain streams. These streams discharge into the three principal tributaries which flow through deep, narrow valleys and gorges to the head of the Skokomish Valley near the confluence of the North Fork and South Fork (Cowley, 1958).

The Skokomish Valley is generally characterized as flat, though it does still exhibit the undulating topography common to the floodplains of the major Puget Sound basin lowland rivers. Additionally, side channels to the present riverbed remain from pre-settlement times. The valley, which is about 9 miles

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Figure 3.1
Skokomish River Basin
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reverse of Figure 3.1

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Figure 3.2
Skokomish Valley
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page 3-6
reverse of Figure 3.2

long, varies in width from 1/2 mile at its upper end to more than 2 miles at the river mouth on Hood Canal. The gradient of the valley is about -0.1% from the delta front upstream to about RM 5; from RM 5 upstream to the North Fork South Fork confluence, the gradient of the valley is about -0.2%.

A 1% gradient equals a 1 foot rise in 100 feet, normally considered the minimum gradient for adequate drainage of engineered structures such as roadside ditches and gutters. The gradient of the valley (and the river -- see the following paragraph) is substantially less than 1%, and thus has poor drainage characteristics causing slow drainage of flood waters.

The gradient of the river in the primary study area is erratic (FEMA, 1983). The gradient of the river is about +0.03% from the mouth (RM 0) upstream to RM 2, that is, the riverbed rises as the river itself flows downstream. Between RM 2 and RM 2.6, 5- to 10-foot high sills have been deposited, probably as a result of the interaction of tidal fluctuations and river discharge. Between RM 2.6 and 4.8 the gradient is -0.14%, with sills up to 10 feet high occurring between RM 4.8 and RM 5.5. ("Sills" in this context are abrupt rises in the riverbed topography, with lower elevations both upstream and downstream of the sill.) From RM 5.5 up to RM 8.6 just below the North Fork South Fork confluence, the gradients are: RM 5.5 to 7.2: -0.19%; RM 7.2 to 7.5: +0.27%; and RM 7.5 to 8.6: -0.33%.

Surface Drainage Patterns: The Skokomish River system is comprised of 9.0 miles of mainstem, 33.3 miles of North Fork, 27.5 miles of South Fork, and 270 miles of tributary streams. Vance Creek (11.0 miles) is the most important tributary from a fisheries viewpoint; other important tributaries are Purdy, Brown, LeBar, and McTaggert creeks (Williams, Laramie, & Ames, 1975). The drainage patterns are mapped on Figure 3.1; the river mileage (RM) locations of prominent features are listed in Table 3.1.

The Skokomish Valley is drained by a network of old meanders, creeks (Swift Creek, Hunter Creek, Weaver Creek, and Purdy Creek; see Figure 3.2), and plowed over sloughs. The sloughs, being partially filled, are clearly evident only during low intensity flooding of the valley. The old meanders have been partially filled, thus limiting their value in carrying flood flows, as well as contributing to locally chronic high water tables and flooding. These issues are discussed in greater detail in Chapter 4, Hydrology and Flooding.

Tidally Influenced Area: Cummans (1974) determined the upper limit of tidal influence to be "some point below RM 5.3" and that the "exact location of the point was not a significant factor" in his study of flood profiles of the lower Skokomish River. This is not to say that tidal influence is not an important factor in flooding of the Skokomish delta area, only that the exact location of the upper limit of tidal influence is not a significant piece of information.

The average tidal levels at the tide gage at Union at the mouth of the Skokomish River and the corresponding land-based elevations are:

	tidal elevation	1929 datum elevation
mean higher high water	11.8	4.9
mean high water	10.8	3.9
mean tide (sea) level	6.9	0.0

Table 3.1. RIVER MILE LOCATIONS OF PROMINENT RIVERINE FEATURES, SKOKOMISH BASIN, WASHINGTON. (1)

Stream Number(2)	Stream Name	Feature	River Mile
0001	Skokomish River	mouth	0.0
		SR 106 highway bridge	2.2
		Purdy Creek (16-0005)	4.1
		US 101 highway bridge;gaging station 12-0615	5.3
		powerline; former gaging station 12-0615; water quality station 16A070	6.0
		North Fork - South Fork confluence	9.0
0001	Skokomish River continues as the North Fork	confluence with South Fork	9.0
		gaging station 12-0595	10.0
		McTaggert Creek (16-0105)	13.3
		Lower Cushman Dam (Lower Lake Cushman, aka Lake Kokanee)	17.3
		Lake Cushman Dam	19.6
		Olympic National Forest boundary	24.0
		Lake Cushman inlet	28.0
		Olympic National Park boundary	28.1
		Mason-Jefferson county boundary	37.9
		headwaters	41.9
0011	South Fork	mouth = confluence with North Fork	0.0
		Vance Creek (16-0013)	0.8
		gaging station 12-0605	3.1
		Olympic National Forest boundary	3.5
		forest 2202 road bridge	6.8
		Brown Creek (16-0047)	12.8
		LeBar Creek (16-0053)	13.5
		Olympic National Park boundary	26.4
		Mason - Jefferson county boundary	27.0
		headwaters	27.5

1. Sources: Ames & Bucknell, 1981; Fleskes & O'Connor, 1980; Williams, Laramie, & Ames, 1975.
2. Stream numbers are 6-digit numbers, e.g. 12-3456, the first 2 digits indicating the basin number and the remainder representing the specific stream within the basin; Skokomish basin streams are numbered 16.0000, etc.
3. The head of tidal influence is taken as mean annual high tide at low instream flow.

* * * * * * *

Therefore, under average conditions (mean high water), direct tidal influence will extend up the Skokomish River to the location where the river bed elevation equals 3.9 feet, and under extreme conditions (mean higher high water) to the point where the river bed elevation equals 4.9 feet. Based on river bed profiles according to FEMA (1983), these locations are RM 3.7 and RM 3.8 respectively. Indirect tidal influence will occur above this location to a variable extent dependent on river flow volumes.

No information is known to exist regarding the upper limits of salt water influence in the delta. Salt water influence has no known effect on flooding in the Skokomish Valley.

GEOLOGY

Typical of most of the Puget Sound region, the lower elevations of the Skokomish basin are strongly influenced by geologically recent glacial advances and retreats. The plateaus adjacent to the Skokomish Valley which rise 400 to 600 feet above the valley floor are composed of layers (lenses) of glacial outwash sands and gravels and interglacial sediments (Molenaar & Noble, 1970). These geologic strata are well exposed in the valley's canyon walls, perhaps best under the power transmission line on the north side of the valley. In the upper portions of the basin basalt bedrock is exposed in many locations, and the canyon reaches of the North Fork and South Fork have cut down to bedrock.

Geologic Hazards: The canyon slopes edging the Skokomish Valley are classified as potentially unstable except for the right bank slopes below RM 3; for the most part this is of little or no direct consequence with respect to flood control management except where the river cuts close against a potentially unstable canyon slope (Smith & Carson, 1977). At these locations land management and land development practices could result in slope failures which partially block the river. Most slope failures occur during periods of heavy winter rainfall (Canning, 1985), a time of the year which coincides with peak river flows and flood events. There are four locations where the main stem flows close against a potentially unstable slope.

The first is along the right bank in the vicinity of RM 1 where a Class 2 slope rises from the flood plain to the plateau top. Class 2 slopes are defined as stable under normal conditions, but which may become unstable if disturbed by man's activities, by oversteepening, or by seismic shaking (Smith & Carson, 1977). Here the slopes are buffered from the river by SR 106.

The second is along the right bank between RM 2.9 and 3.7 where a Class 3 slope rises from the flood plain part of the way up the slope and is surrounded by Class 2 slopes. Class 3 slopes are defined as areas inferred to be unstable because they are underlain by weak, unstable materials with a history of landsliding (Smith & Carson, 1977). Here too, the slopes are buffered from the river by SR 106. (Slope Class is a means of categorizing land into generalized levels of stability or instability ranging from Class 1 -- most stable -- to Class 5 -- least stable.)

The third is along the left bank between RM 5.8 and 6.1 in the vicinity of a power transmission line where Class 3, 4, and 5 slopes rise to the plateau top. Class 4 slopes are defined as former landslide areas, including relatively large slumps, flows, and slides of soil, rock, and debris, which may be reactivated by excavations, slope modifications, or seismic shaking. Class 5 slopes are defined as known areas of recently active slope failures, usually within the past 50 years (Smith & Carson, 1977). Here, Sunnyside Road has been benched into the canyon slope and the river flows against the base of the canyon slope.

The fourth is along the left bank between RM 7.6 and 7.7 in the vicinity of the confluence of Stream 16-0008 where a Class 4 slope extends part way up the slope (Smith & Carson, 1977). Here the river flows against the canyon slopes.

The locations of these geologic hazard areas are delineated on oblique aerial photographs of the Skokomish Valley in Appendix B.

Geologic hazard areas are not known to be mapped for other areas of the basin, but observations of Class 5 slopes made by the authors of this report during aerial reconnaissance flights over the South Fork basin indicate that unstable slopes are common in that area also. Some of these recent slope failures in the South Fork Valley (RM 7 to RM 24) have resulted in landsliding directly into the South Fork, and are suspected of being the major contributor to the high bed load and river bed aggradation problems in the main stem. River bed aggradation is discussed in Chapter 4.

Minerals: Few mineral deposits are known from the Skokomish basin. No oil or gas exploration has occurred in the Skokomish basin (McFarland, 1983). The mid- to upper portion of the basin lies within the Olympic Peninsula limestone belt, but there has been no commercial development. The lower portion of the basin lies within a zone of sand and gravel deposits, but there has been no commercial development in the basin. No other nonmetallic minerals are known from the basin (Valentine & Huntting, 1960). Copper and manganese (and associated metallic minerals such as iron and zinc) are known from the North Fork basin, particularly from the ridges along the divide to the Hamma Hamma basin, but there has been no commercial development (Huntting, 1956). The Washington Department of Game has issued a number of HPAs (Hydraulic Project Approvals) for instream gold mining in the main stem; no information is known to be available on production. This level of minerals exploration and exploitation does not appear to have any effect on flood characteristics.

There are no known studies of the sand and gravel resource in the Skokomish basin or river system, or of sand and gravel transport. Bell (1982) reviewed sand and gravel transport and the potential effects of the then proposed South Fork hydropower dam in a theoretical context, but conducted no substantive field studies or observations. Anecdotal reports received from a number of resource agency staff indicate that the Skokomish River carries a relatively high bed load of sand and gravel. This is discussed in Chapter 4.

Soils: The soils of the Skokomish River basin are typical of the mountainous soils of the east slope of the Olympic Peninsula. These soils are characterized as having a high erosion potential that is related to slope steepness and high rainfall rates. These soils are easily disturbed by man's activities such as road building and other earth moving activities, or devegetation during clearcut logging. Soils on forest slopes are relatively shallow; soils on the plateaus are deeper. In general, the upland soils on slopes are well drained, with low to moderate water retention, and high infiltration rates. (ONF, 1986b; Rushton, 1985.)

A recent review of the cumulative effects of forest practices (Geppert, et al., 1984) concluded that:

> Forest roads and timber harvest are practices that cause the greatest disturbance to the soil. Both accelerate surface erosion and increase the frequency of debris avalanches. Increased erosion decreases water quality and degrades aquatic habitat. These forest practices also alter the hydrologic cycle affecting the timing and volume of runoff. Because of the permanency of forest roads, the persistence of associated erosion processes, and the continual nature of timber harvest, we conclude that persistent cumulative effects on erosion, water quality and quantity, and aquatic habitat and associated aquatic fauna will result. The magnitude of these cumulative effects are site specific and depend on the amount of road involved, the intensity of harvest activities, the resiliency of the individual sites, and the scheduling of activities. We also believe, as did many people interviewed, that environmental changes caused by construction, use, and maintenance of forest roads constitute the greatest contribution to these cumulative effects, especially to persistent alterations of aquatic habitat (substrate and clarity).

Forest road construction, use, and maintenance increase stream sedimentation by two processes: (1) by increasing the incidence of mass failures (e.g. land sliding and debris sliding); and (2) by erosion of the road surface, cut and fill slopes, roadside ditches, and uncompacted sidecast excess cut material, and the transport of this material to streams. In areas with steep slopes and unstable soils, landslides are the source of most road-derived sediment delivered to streams; in more stable landscapes, material eroded from road surfaces and associated areas can predominate (Duncan, et al., 1987; Megahan & Kidd, 1972)..

The South Fork basin subject to intensive logging has from 4 to over 5 miles of road per square mile (average: 4.5), a relatively high level of forest road construction.

Soil erosion indices for the Skokomish basin portion of the Shelton CYSU developed by the US Forest Service (ONF, 1986b) indicate a potential sediment yield of about 320,000 CY/D (cubic yards per decade) during the past two or three decades (Figure IV-6). Natural sediment production is estimated to be 90,000 CY/D, thus man's activities, principally forest practices, could have resulted in the generation of about 230,000 CY/D of sediment to the Skokomish River. Most of this erosion would have occurred in the South Fork basin as relatively little logging occurs in the North Fork basin. Additionally, any sediment produced in the upper North Fork basin would be deposited in Cushman Reservoir.

These US Forest Service soil erosion estimates are based on a predictive model requiring that assumptions be made. The model has not been calibrated with field measurements. Regarding sediment yield, the model assumes that within 200 feet of a stream, approximately 90% of eroded soil is delivered to the stream, and that from sites further removed from a stream, approximately 60% of eroded soil is delivered to the stream. Furthermore, the model used cannot provide actual amounts of erosion and sediment yield to a stream, only relative amounts for purposes of comparing past and alternative future land use practices. Thus the estimated natural sediment production (90,000 CY/D) and potential sediment yield (320,000 CY/D) may not be accurate, but the relative relationship -- 3.6 times as much sediment yield due to erosion caused by forest practices -- is probably accurate.

Confirmation of the US Forest Service soil erosion model estimate is suggested by a US army Corps of Engineers study of erosion and sedimentation in the Grays Harbor Estuary basin (Kehoe, 1982). Kehoe consolidated and summarized research on erosion rates in the Chehalis River basin, and found that the middle and west forks of the Satsop River and Wynoochee River basins draining the southerly portions of the Shelton CYSU had sediment discharge rates 3 to 5 times the rate from basins not subject to intensive logging. Sediment discharge from the Satsop and Wynoochee basins ranged from 1,100 to 1,500 tons/square mile/year, compared with sediment discharge rates elsewhere in the Chehalis basin of less than 100 to 300 tons/square mile/year.

The Shelton CYSU and Skokomish basin is characterized by unstable soils and steep slopes, thus land sliding and debris sliding can also be expected to contribute sediments to the river system. These materials, along with natural landslide events, all contribute to river bed aggradation.

The soils of the primary study area, the Skokomish Valley, are deep alluvial soils, many of which have relatively high agricultural Capability Class ratings and substantial limitations for development as summarized in Table 3.2 (Ness & Fowler, 1960). Alluvial soils, deposited by successive flooding of river valleys, typically have high agricultural values because of their widespread sources across the landscape. Because of their widespread sources, alluvial soils contain a variety and abundance of minerals necessary for plant growth not commonly found in soils which have developed in place from a single parent rock source. Thus the flooding of the Skokomish Valley is the source of its agricultural productivity.

The development limitations are created by a high ground water table in the alluvial soils and include: (1) sewage disposal leach field performance impaired throughout the year and prevented seasonally during high water periods; (2) soil load bearing strength for building foundations and roadways is reduced. High water tables are a natural occurrence in river valley flood plains. Extreme high water tables at the ground surface are a temporary, natural effect of flooding.

WATER RESOURCES

The water resources of the Skokomish basin are important for their contributions to groundwater recharge, fish and wildlife habitat, recreational opportunities, hydropower production, and a small amount of irrigation in the Skokomish Valley.

Groundwater: The groundwater of the Skokomish basin has not been studied in detail due a lack of need for this information.

Table 3.2. SOILS CHARACTERISTICS, SKOKOMISH VALLEY, MASON COUNTY, WASHINGTON.

Soil Code	Type Name	Capability Class	Development Limitations
Skokomish Valley above US 101			
Dg	Dungeness fine sandy loam	IIw	The Dungeness series has *severe* limitations for on-site sewage disposal and building construction due to flooding and wetness; from November through April the depth to the water table is 2 to 4 feet and less when flooding occurs.
Dh	Dungeness fsl, shallow	IIw	
Dk	Dungeness silt loam	IIw	
Pa	Pilchuck gravelly loamy sand	VIIs	The Pilchuck series has *severe* limitations for on-site sewage disposal and building construction due to flooding and wetness; from November through April the depth to the water table is 2 to 4 feet and less when flooding occurs.
Pb	Pilchuck loamy sand	VIs	
Pc	Pilchuck sand, shallow	VIIs	
Ra	Riverwash	VIII	Riverwash is considered unsuitable for any development due to its proximity to the river and frequency of flooding.
Skokomish Delta below US 101			
Dg	Dungeness fine sandy loam	IIw	See notes on Dungeness series above.
Dk	Dungeness silt loam	IIw	
Mg	Mukilteo peat	IIIw	The Mukilteo series has *severe* limitations for on-site sewage disposal and building construction due to wetness and low strength; from October through May the depth to the water table is 1.5 to 3 feet and less during flooding.
Mh	Mukilteo peat, shallow over gravel	IVw	
Pd	Puget silt loam	IIIw	The Puget and Skokomish soils have the same *severe* limitations as the Dungeness and Pilchuck soils as described above.
Sr	Skokomish silt loam	IIw	

Source: Ness & Fowler, 1960; US Soil Conservation Service Soil Interpretation Record sheets for Mason County.

* * * * *

The ground water of the Skokomish Valley was evaluated incidental to a general study of groundwater in southeast Mason County (Molenaar & Noble, 1970). At that time, dug and driven wells 9 to 22 feet deep were commonly in use. Drilled wells were generally in the range of 20 to 45 feet deep. Because these wells were used for single family domestic use and stock watering, only small capacity pumps had been installed, and the full potential of the wells had not been determined.

The water table varies seasonally, and during the winter rises to within 1.5 to four feet of the surface (see Table 3.2) and higher during periods of heavy rainfall or flooding. These data are probably conservative, that is, the winter water table is likely higher. One local resident reports that the water table under the Valley between highway US 101 and the North Fork - South Fork confluence area appears to be higher now than in the 1950s based on the current abundance of "swamp grass" -- *Juncus effusus* -- in the fields and pastures compared with the 1950s when the plant was uncommon in the Valley. *Juncus effusus*, Soft Rush, is a common indicator of wet meadows and wet pastures in the Pacific Northwest. Soft Rush can be very common in wet pastures because it resists trampling by cattle and is not palatable (Boule, et al., 1985).

Based on this evidence, it is likely that the winter water table has risen in recent decades, but there is no direct evidence. The appearance of Soft Rush could be due to a rising water table or could be due to less intensive agricultural practices. As discussed in the Land Use section of this chapter, dairying was once a widespread practice in the valley, and many former dairy farm fields now lie idle.

On the Skokomish Indian Reservation, Tribal staff and council members report an increase in ground water levels adjacent to the old river meanders in Section 14, T21N, R4W. Here, the increase in the water table is apparently solely due to the filling of the outlet of the southerly meander into the main stem (RM 4.1), thus causing a chronic, localized high water table. In low lying areas the water table is above the ground surface and has converted former farm fields to wetlands.

Surface Water: The surface water resources of the Skokomish basin have been reviewed recently by the Water Resources Program, Washington Department of Ecology, in the context of the entire Water Resource Inventory Area (WRIA) Basin 16 (Rushton, 1985). WRIA 16 also includes the Hamma Hamma River, Duckabush River, Dosewallips River, and a number of small, independent drainages to the north of the Skokomish basin.

Surface water runoff volumes from the Skokomish basin are typical of the runoff rates (cubic feet second/square mile; cfs/sq mi) of other river systems draining the eastern slopes of the Olympic Peninsula (see Table 3.3), but are approximately double the typical runoff rates of river systems elsewhere in the Puget Sound basin. These higher runoff rates are attributable to the greater annual rainfall in the eastern Olympic river basins.

Average discharge volumes in the main stem as measured at the gage at RM 5.3 are highly variable. Mean minimum discharges range from approximately 160 cfs (cubic feet per second) during July through October, to 750 to 1,000 cfs during December through March. Mean monthly discharges range from approximately 300

Table 3.3. COMPARISONS OF RUNOFF FROM SELECTED PUGET SOUND RIVER BASINS.

River Basin	Mean Annual Runoff, cfs	Drainage Area, square miles	cfs/ square mile
North Olympic Peninsula Basins:			
Elwha	1510	319	4.73
Dungeness	380	203	1.87
East Olympic Peninsula Basins:			
Duckabush	470	77	6.10
Dosewallips	610	120	5.08
Hamma Hamma	560	85	6.59
Skokomish	**1245**	**240**	**5.19**
South Puget Sound:			
Deschutes	410	160	2.50
Nisqually	2070	716	2.92
Puyallup	3350	948	3.53

Source: Sorlie, 1975.

* * * * *

cfs during July through September, to approximately 2,150 during December through February. Mean maximum flows range from approximately 400 cfs during August, to 4,500 to 5,500 cfs during December and January (Richardson, 1974). Peak flows have occurred as summarized in Table 3.4. River hydrology is discussed in greater detail in Chapter 4.

On the North Fork, two impoundments constructed by Tacoma City Light, Cushman Reservoir and Lower Cushman Reservoir, provide hydropower to the City of Tacoma and its nearby service area. Cushman Dam was completed in 1926, enlarging a natural lake in the North Fork to a reservoir with a surface area of 4,000 acres and volume of 453,000 acre-feet. Lower Cushman Dam was completed in 1930 creating an impoundment covering 475 acres with a volume of 8,000 acre-feet (Bortleson et al., 1976; TCL, 1985). Virtually the entire discharge of the North Fork basin is diverted in a tunnel directly to the Tacoma City Light powerhouse on Hood Canal. The remnant flows in the North Fork contributing to main stem flow are derived from storm runoff freshets, spillage over the dam during winter high water - high runoff conditions, and diversions from the tunnel system for maintenance and debris removal purposes (Williams, et al., 1975). The direct effect on main stem flooding of the diversion of North Fork Flows was to reduce main stem flood flow volumes. The indirect effect has been a decrease in overall flow volumes leading to a decreased capacity to move bedload through the system, further contributing to river bed aggradation.

WATER QUALITY

The Skokomish River and its tributaries are classified as Class AA waters (WAC 173-201-080 [93]) for the establishment of water quality standards. Class AA water quality standards are summarized in Table 3.5.

Table 3.4. SELECTED PEAK FLOWS, MAIN STEM, SKOKOMISH RIVER.

Date	Discharge, cfs	Recurrence interval, years
3 November 1955	27,000	30 (highest recorded streamflow)
20 January 1972	18,500	4
5 March 1972	19,700	5.3

Sources: Cummans, 1974; FEMA, 1987; Molenaar & Cummans, 1973.

* * * * *

Table 3.5. CLASS AA WATER QUALITY STANDARDS, WASHINGTON. (1)

Parameter	Units	Standard
Fecal coliforms (FC)	organisms/100 ml	mean < 50/100 ml; < 10% of samples > 100/100 ml
Dissolved oxygen (DO)	milligrams/liter (parts per million)	> 9.5 mg/l
Total dissolved gas	percent of saturation	< 110 percent
Temperature	degrees Celsius	< $16^{o}C^{2}$
Hydrogen ion	pH units	pH 6.5 to 8.5
Turbidity	NTU units	< 5 NTU over background (2)
Toxics	not applicable	no effect on public health (2)
Aesthetics	not applicable	no impairment (2)

1. Source: WAC 173-201-045 (1).
2. See WAC 173-201-045 (1) for details or special conditions.

* * * * *

In October 1983, the Department of Ecology established a water quality monitoring station (number 16A070) at the USGS stream gage at RM 6.0 on the main stem. The data from that monitoring station (available through September 1986) is summarized as follows.

> Fecal coliform (FC) concentrations are generally in the range of 1/100 ml to 20/100 ml, with three extremes of 22, 29, and 53/100 ml. The FC data shows no seasonal or any other correlation. These values consistently meet the Class AA water quality standards.
>
> Dissolved oxygen (DO) concentrations are highest during the winter, approximately 12 mg/l from January through March, and lowest during the sum-

mer, usually 9.6 mg/l or greater during August and September. Only once, in August 1984, was DO below the minimum value when a concentration of 9.0 mg/l was recorded. These levels meet the Class AA water quality standards.

Total dissolved gas is not monitored on the Skokomish River. This parameter is important principally at plunge pools at the base of major dams, and thus is of little concern on the Skokomish.

Temperatures range from 9 to 11^{o}C during June through August, to 5 to 6^{o}C during December through March. These values consistently meet the Class AA water quality standards.

Hydrogen ion (pH) values range between 6.7 and 7.8 pH units with no apparent seasonal correlation or correlation with any other factor. These values consistently meet the Class AA water quality standards.

Turbidity levels are closely correlated with river flow volumes. At flow volumes of less than about 1,500 cfs, normal background turbidity is in the range of 1 to 10 mg/l suspended solids and 1 to 5 NTU turbidity units. At flow volumes of 1,500 cfs to 5,000 cfs, there appears to be a straight line relationship between flow volume and suspended solids, with suspended solids concentrations increasing from about 10 mg/l (5 to 7 NTU) at 1,500 cfs, to 50 mg/l (26 NTU) at 5,000 cfs. Above 5,000 cfs, the suspended solids loading becomes highly variable, ranging up to 260 mg/l (83 NTU) at 9,320 cfs and 360 mg/l (190 NTU) at 6,560 cfs. These data are not sufficient to determine whether these patterns represent normal background conditions for these flow volumes, or whether they represent violations of the Class AA standards due to logging practices on Olympic National Forest lands upstream.

In general, water quality in the main stem may be assumed to be in compliance with Class AA standards. Additional investigations or data evaluations would be necessary to confirm this assumption with respect to turbidity and suspended solids.

Water quality analyses performed in the Skokomish River system suggest that all water quality parameters affecting salmonids are within acceptable levels. In the lower North Fork, however, the greatly reduced flow volumes resulting from diversions by Tacoma City Light at Cushman Dam reduce the ranges of available water velocity and depths; the reduced water volumes are more subject to the warming influence of ambient air temperatures (Wampler, 1980). Spot checks of the North Fork below the Tacoma City Light diversions have shown elevated temperatures (Kendra, 1985).

ECOLOGY

The Skokomish basin lies within the greater Puget Sound basin. The Skokomish headwaters lie within the *Picea sitchensis* (Sitka Spruce) forest ecosystem, with the remainder of the basin within the Puget Sound *Tsuga heterophylla* (Western Hemlock) forest ecosystem (Franklin & Dyrness, 1973). Thus, with minor exceptions, the basin is covered by various types of conifer forests. The largest exception is the primary study area, the Skokomish Valley, which in its pre-settlement state was a riparian floodway dominated by a mix of Western

Redcedar and various broadleaf trees.

Presently, much of the South Fork basin lies within the Shelton Cooperative Sustained Yield Unit (Shelton CSYU) of the Olympic National Forest and adjacent industrial timber lands of Simpson Timber Company. The Olympic National Forest portion of the Shelton CSYU has been extensively clear-cut and roaded in recent decades, leaving the forest in early successional stages. The South Fork basin within the Shelton CSYU appears to be about 80% clearcut based on visual estimates obtained during reconnaissance flights over the area. The intensity of timber harvest in the Shelton CYSU has provoked a great measure of controversy regarding potential adverse effects on fisheries, water quality, and flooding. The Skokomish Indian Tribe initiated a lawsuit against the Olympic National Forest in 1982 which was not carried to completion because the Tribe lacked the necessary financial resources. The issue remains unresolved.

In contrast, much of the North Fork basin lies within the Olympic National Park. Here the forest is in mature and old growth successional stages. The lower North Fork basin was logged many decades ago, and is now mostly in relatively mature second growth successional stages of development.

Skokomish Valley: The Skokomish Valley has been extensively converted to agriculture through the cutting and removal of the aboriginal riparian forests. The US Government Land Office (GLO) surveyor's field notes for the subdivision of the Skokomish Valley into townships and sections during the summer of 1861 indicate a flood plain forest, swampy and impassible in places, and cut by numerous sloughs which drained the valley into the river. The witness trees to the section and quarter-section corners are indicative of a frequently inundated flood plain: Vine Maples, 4 to 8" diameter; alders, 6 to 20"; crabapples, 5 to 16"; willows, 6 to 84"; cedars 30 to 36"; maples, 18 to 36"; plus an occasional dogwood, hazel, and hardhack. The frequency with which a short lived species like Vine Maple was selected as witness trees to the section corner monuments is indicative of a valley floor with abundant, dense brush and relatively few trees.

Today, most of the valley has been converted to pasture and Christmas tree plantations. The riparian forests which remain are mostly younger, second growth stands on gravel bars, low lying areas, and less desirable soils.

Skokomish Estuary: An ecological and resource characterization of the Skokomish Estuary was developed by Canning and Shea (1979) as follows. The salt marshes at the mouths of the Skokomish River are mapped as a "major salt marsh" (Martinson, 1976) of Hood Canal. The intertidal mud flats of the Skokomish delta cover at least 1,500 acres on the east side of Annas Bay, constituting one of the largest intertidal flats on Hood Canal. Annas Bay is classified as a "major waterfowl area" and supports large beds of eelgrass (Division of Marine Land Management, 1977). The Skokomish delta is the location of the largest single Harbor Seal haul-out site in Puget Sound. The peak seal count in 1977 was 342 adults and pups, 5% of the Washington state population and 15% of the Puget Sound population (Calambokidis et al., 1978). The Annas Bay - Skokomish Estuary system has been recommended for preservation as a wetland of particular significance (Yoshinaka & Ellifret, 1974).

Historical changes in the character and extent of the Skokomish delta between

1884 and the late 1970s were studied by Bortleson, Chrzastowski, & Helgerson (1980). They noted minor changes in the shoreline near the mouths of the river where some shorelines had eroded (recession), and some had builtup (progradation), with the shifts about equal. They also noted that the delta intertidal mud flats in Annas Bay had decreased by about 0.5 sq km (0.2 sq mile).

FISHERIES
The most complete and accurate source of information on the salmon fishery resource of the Skokomish basin is still the Washington Department of Fisheries' stream catalog (Williams, Laramie, & Ames, 1975) (Whittier Johnson, WDOF, personal communication). Relatively little is known about the resident fish (e.g. non-anadromous fish) of the basin as no studies of resident fish have been carried out. The principal fisheries issues are water quality (e.g. dissolved oxygen and temperature), instream habitat (e.g. gravel quality and riffle - pool patterns), and streamside habitat (e.g. canopy coverage shading and buffers).

Anadromous Fish: Anadromous fish produced in the Skokomish River system and its tributaries support important commercial and recreational fisheries in Hood Canal, the Strait of Juan de Fuca, and the river itself. At one time the Skokomish River system produced substantially larger runs of salmon than in recent years (CH2M Hill, 1983; Findlay, 1973; Williams, et al., 1975). Cushman Dam greatly reduced anadromous fish habitat on the North Fork system by creating a barrier to historical spawning grounds and degrading habitat below the dam by diverting flows (Wampler, 1980). However, the project developer, Tacoma City Light, has partially mitigated the fish loss by construction of the George Adams Fish Hatchery on Purdy Creek (Rushton, 1985) which is operated by the Department of Fisheries. This report will concentrate on the fisheries of the primary study area, the Skokomish Valley.

Within the primary study area, the main stem, lower South Fork, and Vance Creek provide spawning and rearing habitat for Chinook, Chum, Coho, Pink, and Sockeye salmon, and Steelhead and Cutthroat Trout; this portion of the basin is particularly important to Chinook, Coho, and Chum production. A small upriver run of Spring Chinook passes through the Skokomish Valley, and matures in the deeper pools of the canyon reach of the South Fork during summer months. The major Skokomish run of Fall Chinook enters the river in September and October and spawns in the main stem, the South Fork, and occasionally in Vance Creek. All accessible tributaries contribute to Coho production. Chum Salmon spawning occurs in the main stem and the tributaries, with heaviest utilization being in Richert Springs, Vance Creek, and Swift Creek. Typical spawning populations in the early 1970s were 600 Chinook and 1,800 Chum (Williams, et al., 1975).

In recent years, the South Fork spawning populations have been about 100 Chum, 100 Coho, 500 Fall Chinook, 60 Spring Chinook, and a few hundred Winter Steelhead and some Summer Steelhead. The South Fork tributary, Vance Creek spawning populations have been about 1,100 Chum and 500 Coho. The Pink Salmon run has essentially disappeared from the South Fork apparently as a result of the large Chinook and Coho releases from George Adams Hatchery on the lower main stem. The larger Chinook and Coho juveniles are thought to feed heavily on the migrating Pink fry (Caldwell, 1984).

North Fork spawning populations have been about 3,500 Chum, 2,200 Coho, 25 Fall Chinook, and some Steelhead (Caldwell, 1984).

Mainstem spawning populations have been about 250 Chum, 500 Coho, 800 Fall Chinook, and a few hundred Winter Steelhead and some Summer Steelhead (Caldwell, 1984).

Limiting factors in the primary study area include summer low flows which limit the availability of rearing areas, and excessive winter high flows which intensify the problems associated with unstable streambed gravels (Williams, et al., 1975). Additionally, recreational misuse of the river is a localized problem where recreational vehicle (RV) operators drive in and through the river, damaging salmon eggs in the gravel. Fisheries and game enforcement agents report frequent motorized travel on the riverbed across salmon spawning redds which can compact the gravel and grind the salmon eggs within the gravel.

The locations of prime spawning gravels is not currently documented. The instability of the gravel bed of the river, the shifting pattern of the riverbed, and the riverbed aggradation produce annual changes in spawning gravel locations.

The Washington Department of Fisheries operates the George Adams Hatchery on Purdy Creek, a tributary to the mainstem. This hatchery was constructed in cooperation with the City of Tacoma to mitigate for fisheries losses caused by the construction of Cushman Dam on the North Fork (Williams, Laramie, & Ames, 1975). The production of the hatchery (see Table 3.6) is released principally into Purdy Creek, and also into other streams in Mason, Thurston, Kitsap, and Jefferson counties (Abrahamson, 1986).

Resident Fish: No substantive information is known to exist regarding resident fish (e.g. Rainbow Trout, nonmigratory Cutthroat Trout, and nongame species) anywhere in the basin. This is not an unusual situation; resident fish are not the economic resource that anadromous salmon are, thus detailed studies are rarely carried out.

The Washington Department of Game has operated the Shelton Trout Hatchery on Swift Creek at Mohrweis since 1946. A variety of freshwater species are raised at the hatchery for release throughout western Washington. A small amount of the Shelton Trout Hatchery's production is released into the Skokomish River system.

Forecast: Salmon enhancement is proposed within the Skokomish basin under the Washington Department of Fisheries' Watershed Planning Program. Under the Hood Canal Salmon Management Plan, depleted Spring Chinook stocks would be rebuilt as the first step in the development of an overall strategy for fisheries management in the Skokomish basin. Other strategies proposed include the improvement of river flows, and the restoration and protection of Spring Chinook spawning and rearing habitats (WDOF, 1987). The Point No Point Treaty Council, in conjunction with US - Canada Treaty studies, is conducting a Skokomish River Coho Indicator Stock Study. The Treaty Council also releases Chinook Salmon in the basin as a part of an enhancement program.

Table 3.6. SALMON RELEASES FROM GEORGE ADAMS HATCHERY, PURDY CREEK, SKOKOMISH BASIN, WASHINGTON, 1982 - 1986.

Year	Salmon Species			Total
	Fall Chinook	Coho	Chum	
1982	2,541,697	2,170,365	-	4,712,062
1983	3,161,200	2,260,874	16,847,700	22,269,774
1984	3,704,600	614,400	7,967,000	12,286,000
1985	4,703,400	915,900	24,772,300	30,391,600
1986	*data not yet published*			

Sources: Abrahamson, 1986; Castoldi, 1983; Hill, 1984; Kirby, 1985.

* * * * * * *

Flood control or management works could adversely affect fisheries habitat and production by impairment or destruction of spawning gravels and streamside vegetation. Questions remain regarding the effect of river aggradation and spawning gravel.

WILDLIFE

There are no recent, comprehensive studies or reports describing the wildlife of the Skokomish basin or the Skokomish Valley. This situation is typical of most areas of the state and is not indicative of low wildlife values in the area not worth monitoring.

A characterization of the Skokomish basin's wildlife and habitats was developed during the late 1960s as a part of the PSAW Study (Fish and Wildlife Technical Committee, 1970). The Skokomish basin was lumped with other east Olympic Peninsula basins and the Kitsap Peninsula basins as the "West Sound Basins," thus information specific to the Skokomish is blurred with reference to all the West Sound Basins. Information on the Skokomish basin is summarized as follows. Due to the lack of development in the area, the description is probably still accurate. Elk are found in "medium to high" population densities throughout the upper elevations of the South Fork basin and the mid elevations of the North Fork basin above Cushman Reservoir, and may be found throughout the entire basin except for the Skokomish Valley and the adjacent plateaus to the north. Deer are distributed throughout the basin, and concentrated in area between the South Fork and North Fork from the confluence area north to Cushman Reservoir. Waterfowl are distributed throughout the easterly half of the basin, and particularly in the Skokomish Valley which was identified as an important wintering area.

No wildlife population or habitat studies are known to have been conducted in the Skokomish Valley. Most native habitat has been converted to farm fields, and in recent years, to Christmas tree plantations; these agricultural land uses have relatively little wildlife habitat value. The remnant riparian forests and forested wetlands of the valley probably provide habitat for deer; small terrestrial mammals such as raccoon, chipmunks, mountain beaver*, mice, and voles; and aquatic mammals such as muskrat, beaver*, and river otter. Seasonally, the forests provide habitat for migrating and nesting song birds. The ponds and drainages of the valley provide wintering habitat for waterfowl such as mallard* and other dabbling ducks, and diving ducks such as bufflehead*. Resident species such as Great Blue Heron* can be expected to be locally common; during the late winter Bald Eagle* commonly feed along the river from perches in riverbank trees. The farm fields provide habitat for starling*, blackbirds*, and crow*. (Sightings or evidence of specific species indicated by an asterisk* in text.)

Flood control or management works could adversely affect wildlife habitat and production by impairment or destruction of streamside vegetation.

SPECIAL PLANTS, ANIMALS, AND ECOLOGICAL COMMUNITIES

Endangered, threatened, and sensitive plant and animal species and high quality native plant (ecological) communities may be found throughout the Skokomish basin. This section will address only the primary study area, the Skokomish Valley. The known occurrences of special plants, animals, and ecological communities are summarized in Table 3.7 from information provided by the Natural Heritage Data System operated by the Washington Natural Heritage Program (Department of Natural Resources) and the Nongame Wildlife Program (Department of Game). To protect these rare resources from vandalism, the exact locations are not identified.

The listing of special plants, animals, and ecological communities should not be considered complete, as it is based on fortuitous discoveries, not on a comprehensive survey of the valley.

Flood control or management works could adversely affect special species' habitat and production by impairment or destruction of streamside vegetation.

Table 3.7. KNOWN OCCURRENCES OF SPECIAL PLANTS, ANIMALS, AND COMMUNITIES, SKOKOMISH VALLEY, MASON COUNTY, WASHINGTON.

Element Name	Status	Location and notes
PLANT SPECIES		
Woodwardia fimbriata Chain-fern	Proposed State Sensitive	Known from two streamside locales: near the river's mouth and on the main stem.
ANIMAL SPECIES		
H. leucocephalus Bald Eagle	Federal & State Threatened	Breeding at two streamside locales: at the river's mouth and the confluence of the forks.
Martes pennanti Fisher	Proposed State Sensitive	Known from one location near Purdy Creek
COMMUNITY TYPES		
None yet reported within the Skokomish Valley.		

Source: Natural Heritage Data System.

* * * * *

SOCIOECONOMIC SYSTEMS

The social and economic systems of the Skokomish Valley are a subset of the larger systems operating throughout the Puget Sound region. Of predominate importance locally is the Skokomish Indian community at the mouth of the valley, and the agricultural community in the main portion of the valley. Notable outside influences are the regional economy and the programs of local, state, and federal agencies of government.

POLITICAL SUBDIVISIONS

The Skokomish basin overlies three federal reserves, the Olympic National Park, the Olympic National Forest, and the Skokomish Indian Reservation; three counties, Mason, Grays Harbor, and Jefferson; and a number of special districts.

Olympic National Park: The Olympic National Park (ONP) has jurisdiction over most of the North Fork basin above the inlet to Lake Cushman. National Park lands are managed for preservation of natural habitats and low intensity recreation. The only National Park facility and station in this portion of the park is at Staircase Campground a few miles above the inlet to Lake Cushman.

Olympic National Forest: The Olympic National Forest (ONF) has jurisdiction over most of the South Fork basin and a small portion of the North Fork Basin. National Forests are managed primarily for timber production and secondarily for other uses such as minerals, grazing, and recreation. With the exception of Brown Creek Campground and the Skokomish River Trail from Brown Creek Campground to the ONP, the South Fork basin under ONF jurisdiction is managed for intensive timber production. This portion of the basin and the National Forest has an unusually high density of logging roads.

Skokomish Indian Reservation: The Skokomish Indian Reservation covers about 7.5 square miles north of the main stem near the mouth of the river. About half the reservation lies on the flood plain, with an elevation of less than 40 feet (Molenaar & Cummans, 1973).

The Skokomish Indian Tribe has jurisdiction over tribal and individual trust lands within the Reservation boundaries. However, substantial portions of the reservation have been lost to tribal ownership through alienation of privately owned land, and condemnation for public purposes such as Tacoma City Light's powerhouse facility. Mason County can assert land use regulatory authority over alienated lands within the Reservation.

The Tribe has no formal, institutionalized land use planning or regulatory programs, including flood plain management or zoning.

County Government: The Skokomish basin lies within three counties: Mason, Grays Harbor, and Jefferson. Only minor portions of the basin lie within the latter two counties, however. Fringes of the headwaters of the South Fork basin are within Grays Harbor and Jefferson counties, and the headwater tributaries of the North Fork are within Jefferson County. These headwater areas are also wholly within the Olympic National Park and Olympic National Forest. The area of interest within the basin regarding flooding, the Skokomish Valley of the South Fork and the mainstem lies wholly within Mason County.

For purposes of this plan, therefore, the only local government involved is Mason County. Mason County's regulatory programs which affect the Skokomish Valley are principally the Shoreline Master Program (under the state Shoreline Management Act). These regulatory programs are addressed in Chapter 6.

Drainage District: No drainage district has been established in the Skokomish Valley.

Flood Control District: The Skokomish Flood Control District was established in 1976 under the authority of the Flood Control Zone Districts Act (Chapter 86.15 RCW). The district boundaries were established as the Skokomish River watershed, less those portions lying within Grays Harbor and Jefferson counties, Olympic National Park, Olympic National Forest, and the Skokomish Indian Reservation.

Flood Control Zone Districts may be established for the purpose of "undertaking, operating, or maintaining flood control projects or storm water control projects or groups of projects that are of special benefit to specified areas of the county" (RCW 86.15.020). A five member Advisory Committee composed of Skokomish Valley residents was appointed by the Mason County Commissioners in accordance with RCW 86.15.070. As a quasi municipal corporation, Flood Control Zone Districts have taxing authority; the Skokomish Flood Control District taxes property within the district at $0.50 per $1,000 assessed valuation. The District's Flood Control Plan identified three action priorities for the District Advisory Committee:

1. Develop a maintenance program that will protect and/or restore all existing flood control facilities;
2. Increase the water flow capacity of the main stream channels; and
3. To construct and maintain new dikes and barriers in locations which will reduce flood hazards;

and four specific work projects:

1. Clean channel and bank at State Highway 101 bridge (including the gravel island one-third mile up river);
2. Debris removal in selected areas, i.e. at the old Crossman place;
3. River bank stabilization, i.e. at the church; and
4. Eliminating point sources where gravel is entering the river system, i.e. the bluff below McKay Flats.

In the past, the monies raised by the District through taxation have been used to finance minor instream gravel removal, instream earthmoving, and streamside dike construction. Few of these projects have been of a substantial enough nature to resist subsequent destruction or deterioration by flood waters.

Soil and Water Conservation District: Mason County is served by a Soil and Water Conservation District which is inactive. Staff support is provided by the

Thurston County district with offices in Olympia.

POPULATION AND HOUSING

Mason County population grew at a rate of approximately 5% a year during the period 1974 - 1982 (Mason Regional Planning Council, 1982). In recent years, however, the average annual growth rate has decreased to little more than 2% as summarized in Table 3.8. During the 1980 - 1986 period, deaths (1674) exceeded natural increase (1320), thus most of the total increase (4216) is due to migration (2896).

By comparison, during the 1980 - 1986 period when Mason County population increased by 13.52%, Washington state population growth was 6.95%, and adjacent counties were experiencing the following growth: Thurston, 14.43%; Kitsap, 11.79%; 12.12%; Grays Harbor, -5.00 (OFM, 1986:29).

Mason County population growth is typically attributed to "spill over" growth from Kitsap and Thurston counties. If this were to be true, population growth would be expected to exceed employment growth. However, during the period 1980 - 1986 when Mason County population growth averaged 2.14% annually, employment growth averaged 2.19% annually despite a slump during the 1981 - 1982 recession period. This is indicative of a population growth attributable to internal growth, not external growth. In fact, it is likely that Mason County's population and employment growth is influenced by growth in the Port Orchard and Olympia areas of Kitsap and Thurston counties.

The population data, of course, includes only permanent residents. Many owners of second homes also live in the county for much of the year and place a demand on certain public services. This is particularly true of the communities and developments along Hood Canal, but is not thought to be significant in the Skokomish Valley. Many second homes are being converted to permanent residences as their owners retire and move to Mason County permanently.

For the remainder of the 20th Century, Mason County population is expected to grow at about the same rate as in the recent past (see Table 3.8). No employment projects are known to be available.

ECONOMIC SECTORS

The economy of the Skokomish basin is based on its natural resources. The principal economic sectors are timber and tourism. The timber industry relies on the public and private commercial forests. In the past, intensive timber harvest in the Shelton CSYU yielded a large number of woods and mill jobs; most of this employment was held by persons residing outside the Skokomish basin in Mason and Grays Harbor counties. The tourism and hospitality industry relies on the forest preserves of the Olympic National Park and the attraction of Hood Canal. Secondary economic sectors include shell fisheries in Hood Canal, service businesses such as food service, retail sales (e.g. convenience stores, gasoline, and fireworks), and government employment (e.g. fish hatcheries and Tribal government).

The economy of the Skokomish Valley is based on agriculture, and therefore the soil resource. Dairy farming was once the predominate business and land use in the valley. In the 1950s dairying began to decline, and by the 1980s had

Table 3.8. MASON COUNTY POPULATION (1980 - 1986) AND FORECAST (1990 - 2000).

Year	Unincorp. Areas	Shelton	Total	Average Annual Growth Rate, %	Total Employment
1980	23,555	7,629	31,184		10,180
1981	24,300	7,600	31,900		9,750
1982	24,960	7,740	32,700		9,370
1983	26,000	7,600	33,600	2.14%	10,750
1984	27,200	7,600	34,800		10,940
1985	27,250	7,550	34,800		11,300
1986	27,850	7,550	35,400		11,590
1990			38,156		
				1.99%	
1995			42,099		
				2.16%	
2000			46,840		

Source: Office of Financial Management, 1986:5, 57 (population data); US Department of Labor, Bureau of Labor Statistics (employment data).

* * * * *

vanished from the valley. In recent years Christmas tree farming has become popular here, as elsewhere in Mason County. Some dairy farms are operated for cattle production. Many farm operators have abandoned dairying, but not yet converted to another form of agriculture; their fields lie idle.

LAND USE

Most of the basin is forested, either as forest preserves in the Olympic National Park, or as managed timber forests in the Olympic National Forest or on industrial timber lands. Only in the Skokomish Valley of the South Fork and the mainstem, and to a lesser degree along the southeastern shores of Lake Cushman, are other land uses found.

Most of the South Fork basin is a part of the Shelton CSYU, a cooperative forest management agreement between the Olympic National Forest and Simpson Timber Company covering lands managed or owned by both parties. The Shelton CYSU, formed in 1946 under the Sustained Yield Forest Management Act of 1944, is the only cooperative CYSU program in the nation. The annual timber harvest from the CYSU is summarized in Table 3.9 along with projections for the next decade (ONF, 1986a, b). During the past decade timber harvest has been 40 to 70 million board foot per year higher that during the first three decades of operation of the CYSU. During the next decade (1987-96) timber harvest from the CYSU is expected to decline slightly, but will remain higher than during the first three decades of operation.

General land use in the Skokomish Valley can be characterized as rural residential and agricultural. Residences are scattered about in the valley, with a small concentration in the area of Mohrweis near the confluence of the North Fork and the South Fork.

Table 3.9. SHELTON CYSU AVERAGE ANNUAL TIMBER HARVEST.

Year		Average Annual Timber Harvest, million board feet National Forest	Simpson	Total
1947-56	allowable	-	-	100.0
	actual	54.2	46.4	100.6
1957-66	allowable	116.0	19.0	135.0
	actual	98.3	35.4	133.7
1967-76	allowable	116.0	19.0	135.0
	actual	102.4	22.2	124.6
1977-86	allowable	93.8	94.4	188.2
	actual	87.7	86.2	173.9
1987-96	allowable	46.1	118.7	164.8
	expected	1.5	152.6	154.1

Sources: ONF, 1986b:III-184; ONF, 1986a:III-9.

* * * * *

PUBLIC SERVICES AND UTILITIES
This section addresses public services and utilities within the primary study area.

Sewage Disposal: There are no sewer service facilities in the Skokomish Valley. Sewage treatment and disposal by means of individual septic systems and leaching fields. The soils of the Skokomish Valley are mostly alluvium. The water table is seasonally variable, ranging from a few feet below the surface during the summer, to at or near the surface during the winter. These conditions form severe limitations on residential development using conventional on-site sewage disposal methods. Seasonally high water tables can inundate septic tanks and saturate leach fields, and the leachate can contaminate aquifers tapped by shallow domestic wells (Foxworthy, 1975); see also Table 3.2.

Hydropower: Tacoma City Light operates two related hydropower facilities on the North Fork, Cushman Reservoir (Cushman I powerplant) and Lower Cushman Reservoir (Cushman II powerplant); see Figure 3.1 for locations. The basic characteristics of these facilities are summarized in Table 3.10. The total rated capacity of the two power plants (124,200 kW) is 18% of the total rated capacity of the entire Tacoma City Light power system. The Cushman facilities were licensed by the Federal Power Commission as single purpose hydropower facilities.

In the early 1980s Public Utilities District No. 3 of Mason County (PUD 3) conducted feasibility studies of three alternative large hydropower developments on the South Fork. A Draft Environmental Impact Statement (DEIS) was issued in February 1983. The proposal is currently dormant. The project would have

Table 3.10. CHARACTERISTICS OF CUSHMAN I AND CUSHMAN II HYDROPOWER FACILITIES, NORTH FORK SKOKOMISH RIVER.

Characteristic	Cushman I	Cushman II
Construction completion	1926	1930
Total storage, acre-feet	453,350	8,000
Usable storage, a-f	372,000	2,500
Total rated plant capacity, kilowatts	43,200	81,000
Average annual generation, kWH	127,000,000	233,000,000

Source: TCL, 1985;

* * * * *

included a 292-foot-high dam on the South Fork at RM 9.1, creating a 6-mile-long reservoir. The project would have modified flows in the lower South Fork and the main stem by augmenting low flows and reducing high flows. Floods that are an annual occurrence in the Skokomish Valley would have been reduced in size and frequency due to the proposed reservoir's minimum 25,000 acre-foot flood storage capacity. Flood flows of up to the 10-year recurrence interval could have been contained by this storage capacity. More severe flood flows could have been mitigated, but not wholly contained. Large floods (e.g. the 100-year event) could not have been contained, and the extent of the floodplain of the Skokomish Valley would not have been reduced (CH2M Hill, Inc., 1983). The reservoir would also have contained the sediments and bedload which are presently being transported from the upper South Fork into the lower South Fork and the main stem causing riverbed aggradation.

TRANSPORTATION

The transportation network in the primary study area is shown on Figure 3.2. Access to points north is provided by US 101 to Port Townsend and thence by ferry to Whidbey Island, and Port Angeles and thence by ferry to Vancouver Island. Access to points east is provided by SR 106 and SR 3 to Bremerton and thence by ferry to Seattle and highway I 5. Access to the south is provided by US 101 to Olympia and highway I 5. Limited access to the west is provided by Olympic National Forest roads.

The transportation system of the Skokomish Valley is unusual for a Pacific Northwest river valley. Historically, trails and early roadways were built along the borders of the valleys in practical acknowledgment that the valley bottoms were inundated every winter (Sedell & Luchessa, 1982:211). This practice is exemplified in the lower Skokomish Valley by the alignment of Purdy Cut-Off Road (Road 4178) and a portion of SR 106 which are constructed at the base of the slopes on the southeast side of the valley. In contrast, Skokomish Valley Road (Road 4164) and Bourgault Road West (Road 4196) were is constructed largely on public land survey lines on the valley floor, crossing many side channels of the original river system. As a result of the improper location of these roads, they are frequently flooded; this issue is discussed in Chapter 5.

Highway US 101 was constructed on fill across the Skokomish Valley to protect the roadway from frequent inundation during winter high flow periods. The highway bridges the main stem and a secondary channel approximately 1,000 feet north. Nonetheless, the highway elevation is insufficient to prevent occasional flooding of the roadway. The highway fill also acts as a dam, lessening the flooding of some downstream properties on the south side of the river, and contributing to the frequency, severity, and/or duration of flooding of some upstream properties. This effect is discussed in Chapter 5.

Highway SR 106 was also constructed on fill across the Skokomish Valley but at a lower elevation than US 101. The Bureau of Indian Affairs (BIA) is currently investigating alternatives for rebuilding and raising the elevation of SR 106 for the Skokomish Indian Tribe.

There are no local public transportation routes serving the Skokomish Valley. Mason County does not operate a public transit system.

RECREATION

Recreation in the Skokomish basin is focused on hunting and fishing, hiking and camping, and water sports. The Olympic National Park and Olympic National Forest maintain trail systems out of the USFS Brown Creek Campground on the South Fork and the road heads along Lake Cushman and the North Fork. At Lake Cushman, the state Parks and Recreation Commission maintains a campground and the City of Tacoma provides a boat launch facility.

The only established public recreation facility in the primary study area is a Washington Department of Game fishing access on the left bank of the main stem in Section 8, T21N, R4W, near RM 6.7 (Hutchison, 1976) which also provides a rough boat launch. (Rough boat launches are defined as unimproved launch areas which can be utilized by small trailered boats.) Additionally, there is an informal fishing access to the right bank of the South Fork approximately a half mile west of Mohrweis (RM 0.5) at which it is possible to launch car top carried boats.

The two state highways, US 101 and SR 106, which cross the Skokomish Valley are Designated State Scenic Highways (Hutchison, 1976).

The overall river recreation values of three segments of the Skokomish system have been evaluated under the Pacific Northwest Rivers Study of the Northwest Power Planning Council (NPPC) and Bonneville Power Administration (BPA). An upper segment of the South Fork, from the headwaters area in Olympic National Park, down to the Pine Creek confluence (RM 19.2) in Olympic National Forest is rated A (high recreation value) overall, and A for its camping and picnicking, and hiking and backpacking values, and B (above average) for its wildlife viewing values. A middle segment, from Pine Creek down to the Brown Creek confluence (RM 12.8) and US Forest Service Brown Creek Campground is rated B overall and B for its hiking and backpacking, and wildlife viewing values, and C (average) for its camping and picnicking values. A lower segment, from Brown Creek down to the river's mouth on Hood Canal is rated C overall, and B for its flatwater boating values, and C for its whitewater kayaking values (Anderson, et al., 1986).

The value of the river for boating (e.g. canoeing, kayaking, or rafting) is limited by the danger of log jams and sweepers (logs protruding over the river from the banks). Additionally, the past and continuing (illegal) practice of riprapping the river banks with automobile bodies forms an endangerment to boaters who might be swept by the river current into an automobile body and drowned.

CULTURAL RESOURCES

According to the state Office of Archaeology and Historic Preservation (Whitlam, 1987), there are no recorded cultural resource sites within the Skokomish Valley. However, it is clear that given the traditional occupation of the valley by ancestors of the present Skokomish Indian Tribe, that cultural resource sites would be likely to be abundant.

SUMMARY AND CONCLUSIONS

The following discussion summarizes pertinent findings on the characteristics of the Skokomish River basin and Skokomish Valley, and presents conclusions based on those findings that are pertinent to future development, occupation, and flood control management measures.

At four locations, the river flows close by unstable or potentially unstable canyon slopes. If not properly managed to limit or prohibit development or earthmoving in these areas, these slopes could be a source of landslide material which could block the river's flow, causing or aggravating flood conditions.

River bed aggradation appears to be both severe and the immediate cause of increased an increased rate and severity of flooding in the Skokomish Valley. The source of the gravels causing the aggradation appears to be in the upper South Fork basin within the Olympic National Forest. The South Fork basin is characterized by steep unstable slopes and erosion prone soils. Both natural landsliding and slope failures induced by forest practices may be contributing to sedimentation of the South Fork. To a lesser degree, forest road construction and operation may also be contributing sediments.

The soils of the Skokomish Valley are characterized as wet, being subject to inundation, and having high water tables. As a result, these soils have severe limitations for on-site sewage disposal and building construction, and are poorly suited for residential development.

Drainage from the Skokomish River basin (cfs/sq mi) is approximately double that of basins on the east side of Puget Sound. This is partly a natural function of the greater annual precipitation volumes on the east slope of the Olympic Mountains as compared with precipitation on the west slopes of the Cascade Range. The role of other factors such as land use practices and soil characteristics is speculative.

Water quality violations are not known to be a problem in the Skokomish River system. Water quality monitoring data show no chronic or gross violations of state water quality criteria.

Land use in the Skokomish Valley is dominated by agriculture. Formerly dairying was the predominate form of agriculture; since the 1950s dairying declined until no commercial operations remained. Currently, Christmas tree farming is the predominate form of agriculture. The state of Washington operates three fish hatcheries in the Skokomish Valley.

Chapter 4

HYDROLOGY AND FLOODING CHARACTERISTICS

INTRODUCTION

The pertinent hydrogeologic and hydrologic issues affecting flooding of the Skokomish Valley include the diversion of the North Fork directly to Hood Canal, the filling of old side channels to the river, the plowing over of valley floor drainages, accretion of the river bed, decreased bank full flow volumes, and river bank erosion. Cause and effect relationships are discussed in a speculative manner, and recommendations are made for research necessary to quantify or confirm relationships.

CLIMATE

Generalized aspects of Skokomish basin climate are discussed in Chapter 3. Addressed here in Chapter 4 are precipitation, snow cover, and evaporation.

PRECIPITATION

Mean annual precipitation onto the Skokomish basin ranges from 200 to 220 inches per year on the Olympic crest in the upper watershed, to 80 to 90 inches per year in the Skokomish Valley and 75 to 80 inches at the mouth of the river (Phillips, 1986; Molenaar & Noble, 1970). Average precipitation across the basin is about 133 inches per year. Records kept at Cushman Dam indicate an average annual precipitation of 100.25 inches, with extremes of 132.09 inches and 69.24 inches. Peak daily precipitation records of six to seven inches occur between November and February (Phillips, 1986). Given the rugged terrain and dissection of the basin landscape by river canyons, rainfall can be expected to be highly erratic between sub-basins of the Skokomish basin.

More than three-fourths of the yearly precipitation, mostly rainfall but with some snow, occurs from early October through March (Molenaar & Cummans, 1973).

SNOW COVER

During the winter, much of the precipitation in the mountainous part of the Skokomish River occurs as snow. The snow remains as snowpack until spring and early summer, when it melts and provides most of the water to the streams during the dry summer months. Winter snow storage is common to most river basins in western Washington which have headwater areas at altitudes generally above 4,000 feet above sea level (Molenaar & Cummans, 1973).

EVAPORATION

No evaporation measurements are known to have been made in or near the Skokomish basin. Based on studies conducted in Seattle (45 miles northeast) and Puyallup (45 miles east), the annual evaporation from a Class A pan is estimated to be 25 to 35 inches. Annual evaporation from lakes and reservoirs is estimated to be 20 to 25 inches. Average monthly evaporation rates range from less than an inch from November through February, to over six inches during July (Phillips, 1968).

HYDROLOGY

Stream flow is dependent on precipitation and its disposition as rainfall and/or snowmelt. This section is introduced with a generalized discussion of hydrology, followed by a discussion of Skokomish River system hydrology.

Additionally, the hydrologic characteristics of a river are closely linked to the geomorphologic characteristics -- that is, the geology and morphology, or form of the landscape. Whether a river is meandered or braided as it flows across a plain or whether it is a deeply incised canyon is a function of both the geology of the landscape, the volumes of water carried, and the volumes of sediment moved by the flowing water.

INTRODUCTION

Initially, a portion of the rain falling on the landscape is intercepted by vegetation, and in some areas by impervious surfaces. Rainfall intercepted by vegetation evaporates back to the atmosphere. Most rainfall intercepted by impervious surfaces contributes to storm runoff, although small amounts will evaporate to the atmosphere. In urban (or other built up) areas, impervious surfaces include pavement (roads, sidewalks, and parking lots), buildings, and effectively impervious surfaces such as compacted soil. In natural areas, effectively impervious surfaces include wetlands, shallow soils which become saturated early in the winter rainy season, and rock outcroppings.

Of the remaining rainfall, a portion infiltrates the ground and a portion runs off immediately as surface runoff. In the Skokomish basin, the permeability of most soils exceeds most rainfall intensities, thus there is little or no immediate surface runoff from most areas. Of that which infiltrates the ground, a portion is taken up by the plants, and through the process of transpiration, is evaporated back to the atmosphere or is embodied in the plant. The remainder moves slowly through the ground water into deeper aquifers, or through near-surface aquifers to emerge later at lower elevations as delayed runoff stream flow.

An approximate description of the disposition of rainfall on the Skokomish basin is summarized in Table 4.1 which is based on a concept for estimating rainfall disposition developed by Woolridge (1971). Different analysts will use different (and equally valid) approaches to the development of water budgets such as Table 4.1, thus the values in other studies of the Skokomish (e.g. Harr, 1982) will vary; what is important is the relative magnitude of the values.

Water draining off the landscape and through the ground water carries with it a load of suspended and dissolved solids; the drainage process is also a process of land leveling or erosion. The rates of erosion can be slow and imperceptible as in rain splash erosion, or moderate as in sheet, rill, and gully erosion, or catastrophic and dramatic as in landsliding. Once deposited in a stream, sediments are moved down stream continuously as a part a part of the suspended sediment load, or periodically as a part of the bedload which is rolled along the bottom by higher flow velocities.

River geomorphology models portray river zones as proceeding from a head waters fixed zone through braided and meandered zones to an estuarine delta (see Table 4.2), but in nature the zones are not clearly distinguishable and are usually

Table 4.1. ESTIMATED EXISTING ANNUAL RUNOFF CHARACTERISTICS, SKOKOMISH BASIN.

Event or Process	Natural Conditions: <1% effective impervious surface	Existing Conditions: Cushman Reservoir diversions
Annual precipitation	133	133
Interception by vegetation (evaporated)	3	3
Interception by impervious surfaces (contribute to runoff)	<1	<1
Infiltration into the ground	130	130
Evapotranspiration by vegetation	17	17
Total Runoff Available	113	113
Storm Runoff (surface water)	1	1
Delayed Runoff (ground water)	112	112
Cushman Diversions	0	43
Net Runoff to Main Stem	113	69

1. Based on Woolridge (1971) and others; see text.
2. All values in inches per year, as in inches of rainfall.
3. Effective impervious surface includes consideration of saturated soils under natural conditions.

* * * * *

in a mixed and repetitive order because river gradients do not uniformly decrease from headwaters to mouth. The fixed (boulder) zone is often synonymous with "V" shaped canyons, steep terrain, and high erosion rates. The braided zone is often associated with "U" shaped valleys and fixed zone tributaries. Braided river reaches are usually dynamic, shifting systems which occur where there has been a decrease in river energy due to decreased gradient or diverted flow, or to an increase in sediment supply. The meander zone is usually associated with broad lowland floodplains. Meander patterns migrate downstream as the leading edge of a meander erodes its bank while the following edge of the meander is depositional (accretional). For this reason, modern floodplain management practices often include a prohibition of any substantial construction in the meander belt, a corridor bounded by the outer extremes of meandering. Deltaic zones are usually associated with the estuarine mouths of rivers,

Table 4.2. RIVER GRADIENT, MORPHOLOGY, AND BED MATERIAL MODEL.

Channel Character	Channel Gradient	Bed Material	Material Budget	Comments
Fixed	>25 ft/mi	Cobbles to boulders	Eroding to neutral	Usually found as a headwaters reach
Braided	5-25 ft/mi	Sand to gravel	Accretional to neutral	Usually found as a mid-elevation reach, but may occur at lower elevations
Meandered	0-5 ft/mi	Silt to sand	Usually accretional	Usually found as a lowlands reach
Deltaic	0 ft/mi	Clay to silt	Accretional	Typically an estuarine delta but may occur at lake and reservoir inlets.

Source: adapted from Proctor, et al., 1980:I, Figure 2-3.

* * * * *

but may also be found at the inlets to lakes and reservoirs where substantial sedimentation occurs. Some geohydrologists consider the deltaic zone to be a specialized form of the braided zone.

SKOKOMISH RIVER SYSTEM

The Skokomish River system is described and mapped in Chapter 3 (Physiography section; Figure 3.1). In both a flood control management context and a water resources context, it is most useful to subdivide the Skokomish basin into (1) the North Fork basin above Tacoma City Light's Cushman facilities, (2) the South Fork basin above RM 3.5, and (3) the Skokomish Valley comprised of the lower North and South Forks and the main stem.

Hydrology: The Skokomish river system is unusual if not unique in its condition of having substantial portions of its flow diverted out of the basin. Since 1930, Tacoma City Light has diverted virtually all the flow of the North Fork directly to its powerhouse on Hood Canal from its Cushman projects. Only the South Fork makes substantial contributions to flows in the main stem and the flooding problems of the Skokomish Valley. This is reflected in Table 4.1 as the difference between "natural conditions" and "existing conditions." Average annual (mean, maximum, and minimum) discharges at selected USGS Gage locations are summarized in Table 4.3 showing the relative amount of flow diverted by the Cushman project -- approximately 38% of the average annual flow. The Cushman Project diversions are diagrammed in Figure 4.1. Morrison-Maierle, Inc. (1979) estimate that the Cushman diversions have reduced flows near the mouth of the North Fork to 13% of estimated natural values.

Table 4.3. DISCHARGE STATISTICS, SKOKOMISH RIVER SYSTEM.

River Reach River Mile	Location	USGS Gage Number	Average Discharge, cfs		
			Mean	Maximum	Minimum
North Fork 29.2	Cushman Inlet	12056500	502.5	755.0	256.0
North Fork 19.6	Cushman Outlet	12057500	755.9	1019.0	137.0
North Fork 10.0	Mouth	12059500	115.2	311.0	36.6
South Fork 3.1	Mouth	12060500	732.0	1041.0	424.0
Main Stem 5.3	US 101 bridge	12061500	1194.5	1756.0	635.0

Source: Williams, et al., 1985.

* * * * *

Erosion: Erosion and sedimentation rates are not known to have been measured in the Skokomish basin. As discussed in Chapter 3, the soils of the mountainous regions of the Skokomish basin are characterized as being unstable and highly erosion prone when devegetated or disturbed. Additionally, the intensive logging of the Shelton CSYU portion of the South Fork basin has resulted in an increase in the rate of erosion from intensively logged lands by a factor of approximately 3.6 over undisturbed conditions (ONF, 1986b).

Additionally, land slides directly into the South Fork, as described in Chapter 3, are also known to have occurred.

Channel Morphology: Channel morphology changes in the primarily study area, the Skokomish Valley, are of particular importance for two reasons: (1) the streambank erosion and deposition associated with channel shifts and meander migration, and (2) the riverbed aggradation which is causing more frequent and severe flooding. Throughout geologic time, that is, the past 10- 12,000 years since the retreat of the glacier from the Skokomish Valley, the main stem has meandered across the entire valley floor. In the context of geologic time, the present location of the main stem on the north side of the valley is temporary.

During the past 120 years, gradual, cumulative shifts and migrations of the main stem and lower North and South forks can be traced from mapping and aerial photographs as shown in Figure 4.2. Figure 4.2 depicts river channel locations during the 1860s and 1870s; 60 to 70 years later in the 1930s; and 50 years later in the present. The base map of Figure 4.2 is derived from current (1986) USGS quadrangle maps of the area which in turn are based on 1979 aerial photography; the base map was partially updated to current (1987) conditions

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Figure 4.1
Diagram of Cushman Project diversions

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Figure 4.2
(11 x 17 foldout)
Skokomish Valley channel patterns

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reverse of Figure 4.2

based on field observations and aerial photography. The configuration of the river channels in the 1930s is taken from a 1935 Washington Department of Conservation and Development flood control plan map of the Skokomish Valley. The level of accuracy of this map is unknown. The configuration of the river channels in the 1860s and 1870s is derived from US Government Land Office (GLO) survey maps produced to depict the original subdivision of the area into sections and townships:

Township 21 North, Range 4 West -- 1861
Skokomish Indian Reservation -- 1871
Township 21 North, Range 5 West -- 1875

The accuracy of this mapping is known to be faulty in some locations. The channel locations of the original mapping along the line between Townships 4 and 5 do not match. The configuration in Figure 4.2 was derived by adjusting contradictions to topographic conditions. In general however, the pattern of the river depicted in Figure 4.2 for the 1860s and 1870s is representative of that time if not absolutely accurate.

During the 60 to 70 years leading up to the 1930s, the lower South Fork meanders shifted considerably with no apparent pattern. The lower North Fork changed in pattern to more pronounced meandering. The confluence of the forks migrated downstream approximately 1/4 mile. From the confluence (RM 9) down to the location of the old highway bridge (RM 6), the main stem maintained its course in a general sense, with the meanders forming more intricate patterns, including the development of secondary channels. From the old bridge down to RM 4, substantial channel changes took place: a second main channel formed south of the Section 15 meanders in a newly cut channel. The lower four miles of the river remained virtually unchanged.

During the 50 years between the 1930s and the present, the lower South Fork continued to exhibit instability and major meander migration. The confluence shifted north slightly. From the confluence (RM 9) down to the location of the old highway bridge (RM 6), the main stem meanders migrated slightly, and the secondary channels were abandoned by the river or filled by landowners. From the old bridge down to RM 4, abandonment and filling of the Section 15 meanders shifted all main stem flow to the current channel. The lower four miles of the river remained virtually unchanged.

During the past 7 or 8 years there have been no major channel shifts, although bank erosion continues to cause cumulative changes. Within the gravel bed channel of the river, however, the thread of the stream has shifted substantially, and a braided stream pattern is emerging on the main stem from RM 5.5 up to the confluence (RM 9) and on up the lower two miles of the South Fork. In addition, the riverbed has been aggrading.

Bank erosion is particularly severe and threatening at two locations. In the vicinity of the Skokomish Community Church (RM 8.1 - 8.3) the gravel bed of the river is widening and the right bank has eroding to within 50 to 70 feet of Skokomish Valley Road. Similarly, at RM 1.8 on the South Fork the gravel bed is widening and the right bank has eroded to within less than 50 feet of Skokomish Valley Road.

Local residents report that the main stem river bed is "filling" with gravel or "rising." Typical of Puget Sound lowland rivers, the main stem meanders of the Skokomish River are dynamic and shifting. Gravel bars form, migrate, and re-form annually. River bed filling, or more properly, aggrading, is caused by the deposition of sediment. Aggradation (also termed accretion in more general terms) is a dynamic process subject to seasonal and long term changes in rate, including reversals, or erosion.

Aggradation of the main stem is occurring as confirmed by an examination of the US Geological Survey (USGS) records for Gage 12061500 located at the US 101 bridge. During the 21 year period 1964 through 1985, the elevation of the thread of the stream at Gage 12061500 rose 3.2 feet; during the 20 year period 1964 through 1984 the stage (surface elevation) of a 200 cfs flow past Gage 12061500 rose 3.0 feet. These changes are computed from USGS Discharge Measurement Notes and Rating Curves respectively. The Gage 12061500 records do not, of course, confirm the same rate of aggradation through out the main stem, but do support the reports of widespread aggradation.

Aggradation of the main stem is also confirmed by the observations by the authors of this report of current conditions as compared with historical aerial photographs and maps. During the past few decades the overall pattern of the main stem between RM 9 and RM 7, and the South Fork between RM 0 and RM 3, has been shifting from a meandered pattern to a braided pattern, a condition indicative of an increase in bed load or a decrease in stream flow or both. Stream flow is not known to have decreased in the South Fork; virtually the entire flow of the North Fork was diverted directly to Hood Canal in 1930 with the completion of Tacoma City Light's Cushman projects.

The source of the gravel contributing to aggradation of the lower South Fork and main stem is from the South Fork basin upstream of the Skokomish Valley, not from within the Valley. In particular, the recent, active landslides into the South Fork noted in the Geologic Hazards section (Chapter 3) are thought to be a principal source along with general landscape erosion from intensively logged portions of the Shelton CYSU (see also Appendix A). There are no known, active, major gravel sources in the Skokomish Valley, either along the lower South Fork or the main stem.

River bed aggradation is progressively aggravating flooding of the Skokomish Valley. As the river bed fills with gravel the channel capacity is reduced resulting in more frequent overbank flood flows and eroding riverbanks.

FLOODING

The Skokomish River floods several times a year, principally during the period November through March. The highest recorded peak flow occurred on 3 November 1955 with a peak flow of 27,000 cfs, probably as measured at the US 101 bridge. The estimated return period for a flow of this volume is 30 years (FEMA, 1983:10). The much discussed "100 year flood" (Table 4.4) has not occurred in the Skokomish Valley during recorded history.

The North Fork is estimated to contribute approximately 10% of the flood flows in the Skokomish Valley. For example, during the December 26th flood of 1980, main stem flows of 21,500 cfs had their source principally from the South Fork (14,800 cfs) with the North Fork flows relatively minor (2,220 cfs) (CH2M Hill, Inc., 1983). (The balance of the main stem flow at the US 101 bridge was contributed by Vance, Hunter, and Swift creeks which enter the main stem below the South Fork.)

Table 4.4. PREDICTED PEAK DISCHARGES, SKOKOMISH RIVER SYSTEM.

USGS Gage Number, Location	Peak Discharge (cfs) Based on Log-Pearson III Analysis (Exceedence Probability/Recurrence Interval, years) 0.99/1	0.50/2	0.20/5	0.10/10	0.04/25	0.01/100
12056500 Cushman Inlet	2,168	4,041	9,666	12,522	16,745	24,430
12057500 Cushman Outlet	1,638	8,056	11,162	12,668	14,083	15,483
12059500 No. Fork Mouth	486	2,185	3,671	4,791	6,340	8,893
12060500 So. Fork Mouth	4,376	11,685	15,767	18,235	21,118	25,002
12061500 US 101 Bridge	6,619	15,579	20,027	22,574	25,430	29,094

Source: Williams, et al., 1985.

* * * * *

Peak flows (discharges) at selected gaging stations in the basin as estimated by the US Geological Survey (Williams, et al., 1985) are summarized in Table 4.4 for 1-, 2-, 5-, 10-, 25-, and 100-year recurrence intervals. Peak flow predictions are based on statistical models which vary slightly, thus other reports on the Skokomish system provide different, usually higher estimates of peak flows (e.g. Cummans, 1973; Flood Control Technical Committee, 1970; FEMA, 1987). This model predicts a flow at the US 101 bridge which is less than the combined outputs of the North and South forks. This is not an error; the difference is contained in floodwater storage and flow on the Skokomish Valley.

PRE-SETTLEMENT CHARACTERISTICS

Prior to settlement by Caucasians, the Skokomish Valley was drained by numerous sloughs and ancient meanders of the main stem of the Skokomish River. Based on a review of the US Government Land Office land survey field notes for the subdivision of the area into Townships and Sections in 1861, the Skokomish Valley was densely covered by willows, Douglas Spiraea, Vine Maple, Salmonberry, and other shrubs associated with wet or periodically flooded soils. The forest trees were a mix of primarily willow, Red Alder, Black Cottonwood, and Western Redcedar, also indicative of wet or seasonally flooded conditions. Lesser numbers of Western Hemlock and Douglas-fir were found on higher ground. The survey work was conducted during September 1861, thus the surveyor noted few portions of the valley as inundated or swampy at the time.

Historically, the lowland reaches of the larger Pacific Northwest rivers were characterized by multiple channels, numerous sloughs and old side channels, and an abundance of snags and log jams in the channels. Stream flow through the multiple channels was sluggish, and during the winter rainfall and spring snowmelt seasons, the river's flow regularly over topped the channel banks and spread across the entire floodplain for days or weeks at a time, if not the season. Soon after settlement by Caucasians, a program of river snagging was begun by agriculturalists, and later institutionalized by the US Army Corps of Engineers, to hasten the drainage of peak flows and drain the floodplain land for agriculture (Sedell & Froggatt, 1984; Sedell & Luchessa, 1982).

There is ample evidence that the Skokomish main stem was typical of Pacific Northwest lowland rivers. In 1861, the surveyor subdividing Township 21 North, Range 4 West, surveying north between sections 15 and 16, arriving at the right bank of the Skokomish River, recorded in his notes: ". . . at this point there is a large raft of timber in the river from one bank of [the] river to the other, upon which I chain [measure] across." There were probably other log jams in the river at that time, and even today the Skokomish main stem contains log jams periodically, though not ones a person can walk across.

Additionally, the Skokomish Valley also exhibited the typical characteristics of intricate drainage by numerous sloughs (but not multiple channels); the US Government Lands Office 1861 survey maps of Township 21 North Range 4 West and 5 West show a flood plain drained by up to six old channels and sloughs across the valley bottom. Although many of these drainages have been filled or plowed over by agricultural activities through the decades, even today the Skokomish Valley shows many drainages and swales which are the remnants of ancient sloughs and meanders of the main stem of the Skokomish River (FEMA, 1987).

CURRENT FLOODING CHARACTERISTICS

Cummans (1973) described flood distribution and characteristics of the Skokomish Valley as follows:

> Three principal streams -- the North and South Forks Skokomish River and Vance Creek -- join to form the main stem Skokomish River which flows for 9 miles (14.5 km) in the lower valley. Vance Creek, with a drainage area of 24.8 sq mi (square miles) or 64.2 sq km (square kilometers) and the South Fork Skokomish, with a drainage of 104 sq mi (269 sq km) are unregulated. The North Fork (118 sq mi or 257 sq km) is regulated, and at Cushman Dam No. 2 [Lower Cushman Reservoir] (drainage area 99.2 sq mi or 257 sq km) the entire flow normally is diverted to a power plant on Hood Canal. Infrequent spills and releases down the North Fork and natural runoff from about 19 sq mi (49.2 sq km) below the dam constitute the source of stream flow from this tributary. Potential floodflows from the area upstream from the dam are significantly reduced or excluded by the regulation and diversion.
>
> Overbank flooding was observed during this study [1970 - 1972] in the main stem Skokomish River. Flooding appears to occur first at points downstream from US Highway 101. At a river discharge of 4,650 cfs (cubic feet per second) or 132 cms (cubic meters per second) at profile station 9 [US 101 bridge], shallow overbank flow was observed to be spreading in the NE1/4 Section 15, the northerly 3/4 of Section 14, the S1/2 Section 11, the NW1/4 Section 12, and the SW1/4 Section 1, T21N, R4W. Discharges in the lower reach of the river exceed 4,650 cfs (132 cms) several times each winter and therefore parts of

the valley flood plain downstream from US Highway 101 are submerged frequently. From records of flow obtained since 1943 at the US Highway 101 gage, some degree of flooding is estimated to occur in this reach on a yearly average of 1 day in November, 3 days in December, 3 days in January, 2 days in February, and 1 day in March. During the flood of January 20, 1972 (discharge of 18,500 cfs (524 cms) and stage of 26.3 ft (feet) or 8.02 m (meters), water was observed at a depth of 8 ft (2.44 m) in some low spots in the E1/2 of Section 14.

Upstream from US Highway 101 the channel presently appears to contain flows of approximately 8,900 cfs (252 cms) at a 24.4 ft (7.44 m) elevation at profile station 9 [US 101 bridge]. At flows greater than this, overbank flooding occurs in the E1/2 Section 18, T21N, R4W, with water overflowing south across the county road. The south riverbank also is topped in Sections 17 and 8, and, at higher flows, in Sections 9 and 16. Specific information was not obtained regarding flooding along the entire county road in N1/2 Section 16 and N line Section 17. Flows greater than 8,900 cfs (253 cms) have occurred at least once each year since 1943, and as many as six times during one year. In only two water years since 1943 (1946 and 1962) was overbank flooding upstream from US Highway 101 considered insignificant at the times of peak annual flows.

Cummans' description is still essentially valid, however, overbank flows in the vicinity of the US 101 bridge are known to occur at lower flows in recent years. Cummans observed that overbank flows began to occur at about 8,900 cfs during his 1970 - 71 study period. Current US Geological Survey rating curves for the gage at the US 101 bridge indicate that overbank flow now occurs at 8,500 cfs. That flooding occurs at lower flows at the US 101 bridge than in the past is confounded by the fact that flooding now appears to occur upstream of the US 101 bridge before it occurs at the bridge. Additionally, Cummans' 1973 observation that overbank flows immediately upstream of the US 101 bridge begin occurring at flows of about 8,900 cfs appear to be in contradiction with US Geological Survey rating curves for Gage 12061500 at the US 101 bridge for the same period which indicated overbank flow occurring at about 10,500 cfs.

An overbank flow of 8,500 cfs has a recurrence interval of about 1.2 years based on the recurrence intervals and associated peak discharges listed in Table 4.4; this translates into an 80% probability of an overbank flow each year. In fact, overbank flows often occur more than once a year.

Annual flooding of the Valley between the forks and the US 101 bridge currently exhibits the following characteristics (see Figure 4.3) based on the following information provided by Wes Johnson, a Valley resident and member of the Skokomish Flood Zone District Advisory Committee.

The Mohrweis area (see Figure 4.3) is protected from low level annual flooding by a dike along the right bank of Swift Creek which extends from Skokomish Valley Road downstream to the main stem, and then runs along the right bank of the main stem to about the Section 18 - 17 line (T21N, R4W). This dike appears to be well constructed, properly compacted, and is covered by moderately dense vegetation which protects the dike against erosion. At the end of this dike, approximately RM 8.4, flood waters flow south onto the flood plain and west behind the dike, then move south across the Skokomish Valley Road to Hunter Creek on the south side of the Valley.

A short, low, marginally effective dike has been erected along the north side of Skokomish Valley Road at the Skokomish Community Church. The dike appears to be mostly loose fill with no adequate vegetation to resist erosion. Overbank flow occurs at each end of this dike (RM 8.3 and 8.1), and the flood waters flow southeast across the Valley into an old, plowed over creek channel, and then east into Hunter Creek. Christmas tree plantations in this area are clean cropped, that is, no ground cover is maintained, and sheet and gully erosion readily occurs during flooding.

Flood waters are also known to escape the river at about RM 7.5 in Section 8, T21N, R4W, and flow south and southeast past the fire hall and grange hall, across Skokomish Valley Road, where there is a merger of all the flood flows across the Valley.

East of the Section 17 - 16 line (T21N, R4W) flood water flows across the Valley becomes complex. Over bank flows in Hunter Creek continue east towards the main stem. From the NE1/4, NE1/4, Section 17, flood waters flow east across Skokomish Valley Road south of the section corner to sections 8, 9, 16, and 17; some of this flow may run northerly and return to the main stem at about RM 6.7; some the flow probably runs southerly and merges with Hunter Creek overbank flow.

In Section 16, flood waters flow east over the fields north of Skokomish Valley Road, and south over the road at specific locations, and then into Weaver Creek.

Flood water movements in Section 15 are thought to follow the pattern mapped, but there is uncertainty about the return of flood waters to the river. North of Skokomish Valley Road, flood water flows east and northeast over the old highway, and is though to reenter the main stem at about RM 5.7. This, however, is unconfirmed, and drainage swales evident on aerial photographs suggest that east of the Section 16 - 15 line, flood waters may move southeast towards Weaver Creek. Flood waters which flow southeasterly over the east - west segment of Skokomish Valley Road continue southeast across the north - south segment of the road, apparently merging with Weaver Creek over bank flows north of Bourgault Road. It is thought that some of the Weaver Creek overbank flow verges northeast and reenters the main stem at about RM 5.5, but this too is unconfirmed.

Below US 101, information sources other than Mr. Johnson indicate that flood waters enter the old slough and meander system north of the main stem in Section 15, T21N, R4W, and flow under US 101 0.2 mile north of the main stem. When US Geological Survey staff read the gage at the US 101 bridge coincident with overbank flow, measurements of water depth and velocity are taken in the main stem and the overflow channels north and south (Weaver Creek) of the main stem. In recent years, however, the inlet to and outlet from the old slough and meander system north of the main stem has been filled, impeding the movement of flood waters. The filling of the meander system outlet at about RM 4.1 has apparently resulted chronic high ground water conditions in NE1/4, Section 14 as reported by Skokomish Tribal members, and, of course, the flood waters which enter the slough and meander system are unable to readily escape.

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Figure 4.3
(11x17 foldout)
Skokomish Valley low level flooding patterns

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reverse of Figure 4.3

Highway 101 and Skokomish Valley Road (former US 101) are built on fill where they cross the Valley in Section 15, and these road fills act as low dams, backing up flood waters. At times of severe flooding, both roads are inundated. Skokomish Valley Road fill causes the impoundment of low level flood waters in S1/2, SE1/4, Section 16, T21N, R4W. US 101 fill causes the impoundment of low level flood waters in NW1/4, SW1/4, Section 15, T21N, R4W.

Flooding on the Skokomish Indian Reservation is described by Molenaar and Cummans (1973) as follows:

> Flooding or reservation lands by the Skokomish River is common and usually occurs during periods of heavy rainfall in winter. Floodflows are characterized by rapid increases in flows within a few hours, followed by decreases to small flows with 2 or 3 days. Several floodflows occur each year, often in close succession. Such flows have been recorded on the North Fork since 1913, on the South Fork since 1932, and on the Skokomish River main stem since 1943. However, Cushman Dam No. 1 has partially regulated floodflows on the North Fork since 1926, and since then the large streamflows in the lower valley are almost entirely from the South Fork basin.
>
> At streamflows of about 2.1 million gpm [4,680 cfs] past the gaging station [US 101 bridge], the water begins to overflow the channel and flood adjacent lowland. Discharges of at least this much occur several times a year, generally during December through March.
>
> At least some parts of the reservation are covered by floodwaters approximately 10 days each winter, averaging 1 day each in November and March, 2 days in February, and 3 days in December and January. The longest periods of flooding were 13 days in December 1966 and 18 days in January 1953. Flooding has occurred as early as October and as late as May.

Flooding on the Skokomish Indian Reservation is more frequent and more severe than on the Skokomish Valley above the US 101 bridge.

SUMMARY AND CONCLUSIONS

The Skokomish Valley floods frequently because the Skokomish basin receives an unusually high level of precipitation. While it may seem simplistic to make this kind of statement, it is important to remember that high rain fall intensities concentrated during the winter months is the basic cause of the flooding.

We conclude that the local residents' contention that the Skokomish Valley floods more frequently and more severely in recent years, as compared with past decades, is accurate. Our reconnaissance review of USGS Gage 12061500 (US 101 bridge) data confirm that overbank flows occur at lower discharges, and therefore will tend to occur more frequently.

The reason for the increased frequency and severity of flooding could be due to (1) an increase in the volume and frequency of peak flows, (2) a reduced carrying capacity of the riverbed, or (3) a combination of (1) and (2). Local residents, at different times, have attributed recent flooding problems to both possible causes. The Skokomish Indian Tribe initiated litigation against the Olympic National Forest contending that forest practices had increased peak flows in the Skokomish main stem. The case was never brought to court. Other Skokomish Valley residents report that the river has been filling and shifting its channel in recent years.

Harr (1982), a US Forest Service research hydrologist, investigated the relationship between forest practices and Skokomish River peak flows in preparation for the lawsuit brought by the Skokomish Indian Tribe. Harr found no evidence that forest management practices, including roadbuilding, in the South Fork basin have increased the size of peak flows in the South Fork. These findings are consistent with actual research in other watersheds (e.g. Harris, 1973).

We conclude that the principal, if not the sole cause of increased flooding, is an aggrading riverbed in the main stem and lower South Fork (see also Appendix A). Our reconnaissance review of USGS Gage 12061500 (US 101 bridge) data confirm that aggradation is occurring, and at a rate of approximately three feet during the past 20 years at that location. Additionally, the widening of the gravel bed of the river in general, and the bank erosion at RM 1.8 on the South Fork and RM 8.1 - 8.3 on the main stem are also indicative of an aggrading riverbed.

We conclude from field reconnaissance that there is no sediment source in the Skokomish Valley sufficient to account for the degree of aggradation which has occurred, nor is the North Fork a sediment contributor due to the reduced flows in that tributary. Therefore, the source of the aggrading sediments must lie in the South Fork basin above the Skokomish Valley -- that is, from within the Olympic National Forest (see also Appendix A).

Olympic National Forest erosion modeling (ONF, 1986b) indicates an increase in the rate of erosion from the Skokomish basin due to forest practices by a factor of 3.6 above natural rates. A US Army Corps of Engineers evaluation of erosion and sedimentation in an adjacent basin of the Olympic National Forest (Kehoe, 1982) arrived at similar conclusions. This suggests that a major portion of the aggrading sediments could have their source on logged lands and roads of the Olympic National Forest.

The South Fork basin is characterized by steep, potentially unstable slopes (Chapter 3). We have observed recent landslides directly into the South Fork during aerial reconnaissance flights. This suggests that a major portion of the aggrading sediments could also have their source in landsliding and other forms of slope failure. The extent to which these slope failures are natural events or are induced by clearcut logging and/or forest road construction is not known, and must be researched before a conclusive answer is possible.

We also conclude that diversion of the North Fork to Hood Canal has had mixed effects. The diversion of all but 10 to 13% of the North Fork flow directly to Hood Canal had a beneficial effect on flooding by decreasing main stem peak flows. Conversely, the diminished flows in the main stem aggravate aggradation by removing a streamflow energy source necessary to move sediments through the main stem to Hood Canal. Further research is necessary to quantify this conclusion.

We conclude that a secondary effect of riverbed aggradation will be continued severe bank erosion. River channels evolve to carry a 1.5- to 2-year flow. In an aggrading situation the river will maintain its carrying capacity by increasing its width as compensation for reduced depth.

We also conclude that the partial filling of the old meander system in the north half of Section 15 (T21N, R4W) impedes the drainage of Skokomish Valley flood waters, and contributes to or causes chronic high ground water conditions in a portion of the Skokomish Indian Reservation.

Finally, we conclude that the potential for a substantial shift in alignment of the main stem should be considered. The north side of the Skokomish Valley, where the main stem presently flows, is higher than the south side of the valley as illustrated by the flood water drainage patterns in Figure 4.3. The largest flood during historical times was a 30-year event in 1955, presumably prior to the accelerated aggradation presently occurring. In the event of a 100-year flow -- and there is a 1% chance of that every year -- it is possible, if not likely, that a major shift of the main stem to the south side of the valley would occur. Most likely this would begin as head cutting on the bed or banks of Hunter or Weaver Creek or as gully erosion and subsequent headcutting in a clean cropped Christmas tree plantation. Head cutting is a process of progressive, severe gully erosion, with the head of the gully eroding, or cutting, upstream; when a head cut erodes through a river bank, a new channel is formed. The consequences of a major channel shift, are, of course, not predictable

Short term measures to provide immediate protection from flooding, to mitigate the effects of flooding, or to provide streambank protection are available and are discussed in Chapters 7 and 8.

However, no immediate measures undertaken can be effective in the long term unless the broader problem of aggradation is addressed soon (see also Appendix A). While it is clear that the key problem is aggradation, and the that the source of the sediments lies in the South Fork basin within the Shelton CYSU, a full understanding of the magnitude of the problem will require some quantification of the sediment load moving into the Skokomish Valley from the South Fork basin.

Chapter 5

HISTORIC FLOOD DAMAGES AND PLANNING

INTRODUCTION

Development in the Skokomish Valley since Caucasian settlement has always included efforts to contain and open the channels of the Skokomish River and its tributaries. Residents have individually and collectively worked to keep the river clear of debris and to stabilize the stream banks where there has been erosion. Sediment has been periodically removed from river bars. Overflow channels have been filled and side channels have been blocked off. Small drainages on the valley floor have been plowed over. With limited resources and community initiative, a consistent effort has been made by residents to manage the adverse affects of the Skokomish River on agricultural land.

Information on floodproofing of residential and nonresidential structures has not been effectively recorded to date. In many cases, Mason County building permit and assessor records do not reflect floodproofing or flood damage repair work. Some residential structures have been raised to reduce flood damages. Until the recent completion of the Mason County detailed flood insurance study by the Federal Emergency Management Agency (FEMA), no adequate information was available to establish a base elevation for floodproofing. Nonresidential structures, primarily agricultural structures, have experienced repeated flooding and were typically not been constructed with floodproofing measures such as orientation of flood flows in mind.

Early flood control activities were described in the Puget Sound and Adjacent Waters (PSAW) Study (Flood Control Technical Committee, 1970) as follows:

> Bank Protection and Stabilization. Improvements by local interests, aided by the Public Works Administration and the Works Progress Administration, have been directed largely toward the prevention of bank erosion. Bank protective works constructed prior to 1936 along the right bank of the Skokomish River at various points consisted of training levees and and revetments. In 1936 and 1937, the Works Progress Administration placed four log-floated shear cables, totaling 7,900 feet in length, across the bends where most of the erosion was taking place, and cleared the old channel bed along the northern bank opposite the cables. The purpose of the cables was to catch debris and divert the stream into the cleared channel. In 1940, local interests extended and strengthened one shear cable and improved the lower portion of Vance Creek channel. The shear cables have provided some small local benefits, but have not accomplished their primary purpose.
>
> Levees. A landowner has diked a large portion of the island between the two channels at the mouth of the river and some land west of Nalley's Slough. This land was formerly subject to frequent inundation by high tides and high riverflows.
>
> Upstream Storage. Tacoma City Light has constructed two dams on the North Fork of the Skokomish River and operates two hydroelectric plants that have a combined maximum head of 735 feet. Cushman Dam No. 1 is approximately 9 miles above the mouth of the North Fork. The reservoir,

Lake Cushman, is 9.6 miles long, covers 4,200 acres, and has a usable storage capacity of 360,00 acre-feet. Cushman Dam No. 2 is a reregulating project approximately 6 miles above the mouth of the North Fork with a reservoir 2 miles ling. The reservoir has a storage capacity of 8,000 acre-feet. A tunnel 17 feet in diameter and 2.5 miles long leads to the powerhouse on Hood Canal near Potlatch. The Federal Power Commission license for these reservoirs does not provide for formal flood control storage; however, Tacoma City Light has held the level of Lake Cushman about 10 feet below the spillway elevation during the flood season to provide some flood storage. This voluntary action has reduced the magnitude of floodflows in the Skokomish Valley.

In 1931, Tacoma City Light obtained a preliminary permit from the Federal Power Commission for a proposed power project on the South Fork. Application for a license was filed on 7 September 1954. The city proposed to increase the power output of Cushman Projects 1 and 2 by diverting water from the South Fork reservoir through a tunnel to Lake Cushman. This proposed project would have a total storage capacity of 225,000 acre-feet. Application was filed on 8 July 1963 by the city of Tacoma to withdraw its application for license. Permission was granted by the Federal Power Commission on 27 August 1963.

HISTORIC FLOOD CONTROL MEASURES

Information on historic instream and bank measures based on discussions with Skokomish Valley residents and available records on state flood control cost sharing projects, Hydraulic Project Approval (HPA) permits dating back to 1980, and state Flood Control Zone Permits is summarized in this section. Unfortunately, Soil Conservation Service (SCS) and Mason County Soil and Water Conservation District records, the most detailed information on historic activities, have been destroyed without any summaries kept of the information.

STATE FLOOD CONTROL PARTICIPATION:

From 1949 through 1973, Mason County and the State of Washington participated in the cost of ten flood control work projects throughout the Skokomish Valley, with the state contributing close to 50% of the expenses. The majority of the projects were sediment removal from river bars and debris removal for the purpose of maintaining the channel capacity and reducing bank erosion. Records do not indicate the exact location or volumes of material removed from the Skokomish River or Vance Creek. Flood control cost share work is summarized in Table B1, Appendix B.

The first major rock revetment project was constructed on Vance Creek in 1950 and included sediment removal and the placement of a groin. An extensive dike, which extends along the left bank of Vance Creek for almost a mile and which has alleviated the regular historic flooding, appears to have been constructed in 1953. Another major project during 1953 included changing the alignment of the Skokomish River and diking portions of the valley adjacent to the main stem of the Skokomish River. It is not known why the dike was not continuous when constructed, but the remaining undiked sections were never connected. Either the Vance Creek dike or preexisting portions of the Skokomish River dike were also repaired in 1953.

Sediment removal on bars of the Skokomish River and Vance Creek occurred in 1954, possibly in the vicinity of the previous year's diking projects. According to valley residents, efforts were usually concentrated on the river bank opposite the eroding bank. Work done to stabilize the actual eroding bank may not have been conducted or included as a part of the cost share projects.

The last cost share project through the state's flood control participation program was a rock revetment placed on the Skokomish River in June of 1973. This project may have been maintenance on the previously constructed dikes along the main stem of the river.

STATE FLOOD CONTROL ZONE PERMITS:
Records dating from 1956 show a significant number of private projects were initiated on not only the Skokomish River and Vance Creek, but also on smaller tributaries such as Swift Creek, Purdy Creek, Hunter Creek, Weaver Creek, and unnamed tributaries or historic side channels on the northerly side of the Skokomish River. Information is not available on project costs to determine the scale of activity. Flood control zone permits are summarized in Table B3, Appendix B.

The majority of the projects involved bank revetment or riprap placement. Road and bridge maintenance and dike construction increased, while sediment removal from river bars and debris removal continued. It is assumed that the Soil Conservation Service or the local conservation district provided technical assistance to most of these streambank protection projects on an advisory basis. Design and construction standards were not established as part of the state flood control zone permit program, therefore there were no consistent requirements to be enforced by the state. Project planning and design was therefore primarily the result of private initiative and any technical assistance provided by SCS and/or the conservation district.

HYDRAULIC PROJECT APPROVAL RECORDS:
Flood control related projects approved by the state departments of Fisheries and Games through their Hydraulic Project Approval (HPA) permit program are summarized in Table B4, Appendix B.

Bank Revetment and Riprap Projects: The South Fork of the Skokomish River has been the area of concentration for most bank revetment and riprap projects. Almost half of all recent Hydraulic Project Approvals (HPAs) issued for private bank stabilization on the Skokomish River have been for the area just upstream of the confluence with the North Fork. Cabled tree or log revetments were often used in preference to boulder riprap which is not locally available.

The main stem of the Skokomish River and various Skokomish Valley creeks have received a well distributed attention in the area downstream from the North Fork confluence to west side of State Route 101, with most of the projects being constructed by the Mason County (3), the Skokomish Valley Flood Control Zone District (1), the state Department of Transportation (1), and the state Game Department (1). Those bank stabilization projects constructed by Mason County and the Skokomish Valley Flood Control Zone District were placed on private land with the owners permission. Three projects were privately constructed within a two mile reach east or downstream of the Skokomish Community Church.

Roads and Bridges: A bridge was constructed over Hunter Creek in 1956 by Mason County. It is not known what had been in place previously, but it can be assumed that the bridge was constructed in a way to better avoid potential flood damage and sheet flooding which would limit access during high flows. There are no historic records of work done on county roads within the Skokomish Valley to assess historic flood damages or flood-related maintenance. No road plan or construction effort has been made to elevate the roadway above the elevation of annual flooding. As noted in Chapter 3, the construction of Skokomish Valley Road and Bourgault Road West on public land survey lines on the valley floor, crossing the many side channels of the original river system, exposes these primary transportation and evacuation routes to flooding on an annual basis.

Vance Creek was reportedly diverted by a major landslide during the early 1950s, necessitating construction of a new bridge at the present location. The Swift Creek bridge is known locally as the old Vance Creek bridge.

Other road work consisted of revetment placed along Purdy Creek Road in 1962 by Mason County. The US 101 bridge and culvert over Hunter Creek was replaced by the then Washington Department of Highways in 1969. State Route 106 required riprap revetment along main stem RM 1 in 1975, due to channel change and erosion. In 1983, the state Department of Transportation replaced a bridge over an unnamed side channel on the northerly side of the Skokomish main stem. Local residents and historic records indicate that the side channel was previously the main stem channel. The capacity of this channel has been reduced over time by filling for residential purposes. Also in 1983, Mason County received a Hydraulic Project Approval to replace a culvert with a bridge over Weaver Creek. During the same year, a private bridge was constructed over Weaver Creek. The Vance Creek Bridge, located in the upper valley, was repaired and, in 1986-1987 due to channel erosion, was replaced with a significantly floodproofed new bridge. During 1986, the state Department of Transportation repaired the bridge over Purdy Creek and began replacement of the State Route 106 bridge. Although the SR 106 bridge was not damaged by flooding, it will be elevated to accommodate flooding.

Substantial maintenance has been carried out over the years on all roads, and particularly water crossings, within the Skokomish River floodplain. As flooding continues to increase in rate and severity due river bed aggradation, the need for road and bridge maintenance and replacement will become more regular and extensive.

Sediment and Debris Removal: Debris and gravel removal projects have been carried out by private individuals and by the Washington Department of Fisheries in Vance Creek, Weaver Creek, Hunter Creek, Purdy Creek, and the South Fork and main stem of the Skokomish River.

DAMAGE COST ESTIMATES

Information on damage cost estimates is scant, and based on numerous information sources. What is known of flood damage costs from the best available sources is summarized in Table 5.1

Table 5.1. ESTIMATED FLOOD DAMAGES, SKOKOMISH VALLEY.

Event	Year	Dollars	Notes
Cushman Dam constructed 1926	1926	13,400	A flood control evaluation report on the Skokomish Valley issued by the US Army Corps of Engineers (Dunn, 1942) estimated average annual flood damages of $13,400 from 1926 through 1941, except as noted.
	1927	13,400	
	1928	13,400	
	1929	13,400	
	1930	13,400	
	1931	13,400	
	1932	13,400	
major flood	1933	56,600	
	1934	13,400	
	1935	13,400	
	1936	13,400	
	1937	13,400	
	1938	13,400	
	1939	13,400	
	1940	13,400	
	1941	13,400	
3 Nov flood	1955	125,000(5)	
30 Apr flood	1959	71,000(5)	
20 Nov flood	1959	56,000(5)	
15 Jan flood	1961	114,000(5)	
	1962	1,218	
major flood	1964	31,486	
20 January flood	1972	no data	
5 March flood	1972	no data	
	1974	20,652(2)	
		69,350(4)	
	1975	6,924(2)	
	1986	110,000(2)	

Sources:
1. Dunn, 1942.
2. Washington State Department of Emergency Services; flood damage reports filed by Mason County with the State of Washington.
3. Mason County Department of Emergency Services flood damage records.
4. Soil Conservation Service,Olympia; flood damage records.
5. Flood Control Technical Committee, 1970.

* * * * *

CHRONIC PROBLEMS AND PROBLEM AREAS

The following identification of chronic problem areas is based on the reports of Skokomish Valley residents. Naturally, the list will be incomplete, as we were unable to interview all shoreline property owners in the Valley.

Agricultural soil erosion is a problem for operators of Christmas tree plantations who have chosen to use clean cropping methods, that is, to not maintain a ground cover of grass. Plantations with a ground cover show no signs of soil loss. Clean cropped plantations show signs of both sheet and gully erosion. Operators of clean cropped plantations assert that clean cropping is necessary to achieve rapid growth of Christmas trees for an adequate return on investment.

Roadways covered by flood waters impede or prevent travel by Valley residents. Persons who live in low lying areas often move their vehicles to higher ground when they receive adequate advance warning of flooding.

Structures, both residential and agricultural, are subject to water damage. The level of damage occasionally includes structural damage. In addition, the contents of the structures, such as home furnishings, appliances, and farm machinery, may also be damaged. Few Valley residents have elevated their homes to a level adequate to protect against substantial flooding.

Agricultural fencing may be damaged by debris carried by flood waters, and fields may be littered by stranded debris.

Sewage disposal throughout the Valley is by on-site drain fields. Under normal conditions a high water table makes drain fields marginally effective. When the Valley is flooded, sewage disposal drain fields are nonfunctional during the flood and for days to weeks thereafter.

The following identification of chronic problem areas is based on reconnaissance field investigations conducted for this report, and on the reports of Skokomish Valley residents. Naturally, the list will be incomplete, as we were unable to interview all shoreline property owners in the Valley.

The South Fork and main stem from South Fork RM 3 downstream to about main stem RM 5.5 is aggrading. The secondary effects of aggradation is generalized streambank erosion which is notably severe in certain locations. These locations of severe bank erosion are identified in the following paragraphs.

At South Fork RM 1.8, bank erosion has cut to within 50 feet of Skokomish Valley Road, and threatens to undermine the roadway within a few years.

An eroding right bank between RM 8.1 and 8.3 in the vicinity of Skokomish Community Church has cut to within 50 to 70 feet of Skokomish Valley Road.

An eroding left bank at RM 3.5 affects Skokomish tribal trust land. The cause of the erosion may due to the normal meandering process, or may be aggravated by streambank protection projects carried out upstream over the years.

PRIOR FLOOD CONTROL INVESTIGATIONS AND PLANS

Three prior investigations of flooding and potential flood control measures have been carried out on the Skokomish River: (1) in the early 1940s by the US Army Corps of Engineers (Dunn, 1942), (2) in the late 1950s and early 1960s by the US Soil Conservation Service (Cowley, 1958; SCS file correspondence), and (3) in the late 1960s as a part of the Puget Sound and Adjacent Waters (PSAW) Study carried out by the Pacific Northwest River Basins Commission (Flood Control Technical Committee, 1970).

These investigations all use the basic benefit:cost analysis premise: the average annual equivalent benefits from a project must exceed the average annual equivalent costs of the project. That is, the benefits divided by the costs must exceed 1.0 to be a viable project.

None of these studies appear to have addressed the secondary costs of implementation, that is, the costs of damage to the anadromous fishery as a result of instream or streamside construction effects on fish habitat.

US ARMY CORPS OF ENGINEERS, 1942

In response to chronic and catastrophic flooding of the Skokomish Valley agricultural lands during the 1920s and 1930s, the Corps of Engineers initiated a study and issued their report to Congress in 1942. A summary of their findings follows.

The average annual flood damages, not including land erosion, had been about \$13,400/year during the 16 year period since construction of Cushman Dam in 1926. Since 1931, erosion of approximately 37 acres of farmland at several locations along the south bank of the channel had occurred, at the rate of about 3.4 acres a year. This loss was largely of developed farmland, thus the value of land lost annually was computed to be \$600. The total annual combined cost was \$14,000/year.

During this pre-World War II period, the agricultural economy of the Valley was based on dairy farming on the larger ownerships, and on gardening, "truck farming," and subsistence farming on the smaller holdings. Protection of the developed farmland from flooding would have permitted more intensive cultivation and the growing of higher value crops, but it was judged that the distance from a major market would limit the acreage that would be intensively cultivated.

Additionally, if flooding were prevented, the remaining undeveloped land could be cleared and developed agriculturally (at a cost of about \$90/acre) and thereby potentially attaining the same value (\$168/acre) as the other agricultural land in the valley. The potential value (\$168/acre) less the base value (\$61/acre) and the cost of development (\$90/acre) would leave a residual \$17/acre in increased value attributable to flood control, or a total of \$38,964.

Three protective measures were evaluated: levees, channel improvements, and upstream storage. Protection by levees would have required the construction of over 14 miles of levees, protected from erosion on the riverside by heavy riprap. The construction cost estimate was \$225,000. Annual maintenance, amortization, and interest charges on such a project would have amounted to about 10 percent of the construction cost, or 22,500 annually, which is 160 percent of the yearly benefits ($14,000 in average annual flood damage costs).

Because of the vast amount of gravel moved by the river in flood stages, an improved channel could not be maintained in the middle and upper reaches of the valley, except at excessive cost. No actual costs were computed.

Likewise, the cost of a flood control storage reservoir exceeded the expected benefits. No actual costs were computed.

Bank erosion, which caused an average annual cost of $600 in lost land could have been prevented by revetment or riprap. The estimated cost of either a brush mat revetment or rock riprap would have been $65,000. The annual cost of such a project based on a 25 year life, would have been $4,300, which exceeds the annual benefits by 360 percent.

As a result of these findings, the Corps of Engineers recommended to Congress that no flood control project be approved for the Skokomish River.

US SOIL CONSERVATION SERVICE, 1964

Periodic reconnaissance studies by US Soil Conservation (SCS) staff (principally Cowley, 1958) and internal SCS reports on flooding in the Skokomish Valley culminated in an internal memorandum and summary benefit:cost study in 1964 (memorandum, J. A. Paulson to L. F. Kehne, 3 September 1964).

The Cowley (1958) report identified estimated annual flood damages in the Skokomish Valley to total $69,316 based on the following breakdown: annual damage to 52 farms, $45,616; annual damage to County roads, bridges, etc., $15,000; annual damage to logging industry, $7,200; annual damage to public utility district, $1,500. The identified watershed flood problems included: (1) streambank erosion; (2) sand and gravel deposition on pastures; (3) flood water damage to residences, farm buildings, machinery, and stored feed; (4) damage to transportation and public utility structures; (5) the cost to timber companies in transportation delays; and (6) excessive deposition on oyster beds on the Skokomish delta.

The proposed solutions included channel excavation, streambank diking and riprapping, bridge alterations, and installation of drainage floodgates. The estimated cost was nearly $3 million. Amortized over 100 years at 3-1/8 percent, and including operation and maintenance expenses, the total average annual equivalent cost was $117,575. Balanced against an estimated average annual benefit of $85,000, the benefit:cost ratio of 0.72 was below 1.0, thus the project could not qualify for funding.

PUGET SOUND AND ADJACENT WATERS (PSAW) STUDY, 1970

The PSAW Flood Control Technical Committee (1970) found flooding of the Skokomish Valley to be frequent, but because the land was used almost exclusively for pasture, the resulting average annual damages were estimated to be $27,000 at 1966 prices. Voluntary operation of Cushman Reservoir by the City of Tacoma for partial flood control on the North Fork had reduced the frequency and severity of overbank flooding in the main stem.

Three alternative flood control measures were evaluated, a storage reservoir on the South Fork, levees along the main stem and north and south forks up to river mile 10, and streambank protection. As summarized in Table 5.2, none of the alternatives had a favorable benefit:cost ratio.

Table 5.2. FLOOD CONTROL ALTERNATIVES, PSAW STUDY, 1970.

Flood Control Alternative	Estimated Development Cost, 1968 $	Estimated Annual Cost, $	Estimated Annual Benefit 1966 $
South Fork Storage Reservoir	22,500,000	1,100,000	25,000
Levees, RM 0.0 to 10.0	900,000	100,000	25,000
Bank protection	300,000	17,000	1,200

Source: Flood Control Technical Committee, 1970.

* * * * *

The Flood Control Technical Committee recommended implementation of flood plain zoning and management measures for the entire flood plain to limit future development and to minimize future flood damages.

SUMMARY

Flood control works in the Skokomish Valley have been concentrated on gravel and debris removal from the river and its tributaries to maintain flows, streambank riprapping and revetment placement for bank protection, and bridge and culvert construction. This work has been carried out by individuals using private funding, and by Mason County under cost share programs with the state of Washington. No significant amount of floodproofing of residences or agricultural buildings has been done. Little is known regarding the economic impact of annual flooding.

Three prior investigations of flooding and potential flood control measures have been carried out on the Skokomish River: the first in the early 1940s by the US Army Corps of Engineers, the second in the late 1950s and early 1960s by the US Soil Conservation Service, and the third in the late 1960s as a part of the Puget Sound and Adjacent Waters (PSAW) Study carried out by the Pacific Northwest River Basins Commission.

These investigations all use the basic benefit:cost analysis premise: the average annual equivalent benefits from a project must exceed the average annual equivalent costs of the project. That is, the benefits divided by the costs must exceed 1.0 to be a viable project. In each instance, the cost of effective flood protection exceeded the benefits to be derived.

However, these investigations all focused on structural solutions to flood protection for the valley. None addressed nonstructural solutions such as floodproofing individual structures, or emergency warning and evacuation systems.

Chapter 6

SKOKOMISH BASIN REGULATORY PROGRAMS

INTRODUCTION

Various regulatory programs affect both the need for flood protection measures, as well as the manner in which structural approaches to flood protection may be carried out. Unrestricted development of a flood plain will increase the potential damage resulting from flooding, and thus the need for flood protection measures; properly conceived and implemented land use regulations can temper excessive public and private development investment in flood plains, and thus the need to expend public funds for flood protection and disaster relief. Structural flood protection, like any other construction or development, must comply with the criteria of laws regulating instream and shoreline construction.

LAND USE AND SHORELINE REGULATION

Local land use and shoreline regulations which can affect development in flood hazard areas, and which can also affect flood control measures, include building codes, zoning ordinances, comprehensive plans, shoreline master programs, and flood control regulations. Each local jurisdiction will approach land and shoreline use regulation in their own way, to meet their own needs. Mason County's approach is outlined below.

MASON COUNTY BUILDING CODE

Building codes may be used to alert home builders and home owners to the hazards of occupying floodplains, or in conjunction with a zoning ordinance may be used as a check point to assure that required flood proofing of new construction occurs.

Mason County has adopted the Uniform Building Code (UBC) which contains no special regulations regarding construction in flood plains. The County Building Department does use the soil load bearing strength provisions of the UBC to regulate proposed development in wetlands, bogs, peatlands, etc.

MASON COUNTY ZONING AND COMPREHENSIVE PLAN

Zoning and comprehensive plans may be used to specially regulate development, particularly residential development, in hazardous areas such as flood plains or landslide zones. The special regulation may take the form of development density limitations, or of outright prohibition of certain forms of development in certain areas. The identification of special hazard areas may be done by establishing and mapping special zones, or may be through overlay zoning over the basic zoning map.

Mason County has no county zoning ordinance.

The County Comprehensive Plan now in effect was adopted in 1973. This Plan contains broad goals for Mason County land use and generalized policies to guide decisions in attaining those goals. The Plan contains no specific guidelines or land use density recommendations as the map accompanying the draft plan was not adopted. Updated county-wide comprehensive plans were developed in 1979 and again in 1982. Neither updated plan was officially adopted by the County Commissioners. Presently, Mason County proposes developing an updated comprehensive plan using the subarea planning process. There is no completion schedule for the proposed subarea planning.

The comprehensive plan proposed in 1982 identified the Skokomish Valley as Natural Hazard Area due to flooding, and the adjacent canyon slopes as a Natural Hazard Area due to unstable slopes. The comprehensive plan would have discouraged residential and commercial development in floodplains, and would have encouraged land uses "such as agriculture, recreation, or very low density residential to protect the public health, safety and welfare."

The special goals and policies recommended for the Olympic/Skokomish (Hoodsport) Subarea include forestry, agriculture, aquaculture, tourism and recreation, and overall policies, but nothing regarding land use in the Skokomish Valley.

MASON COUNTY SHORELINE MASTER PROGRAM

The Mason County Shoreline Master Program (MCSMP) was first approved by the Department of Ecology on 6 August 1975. The most recent amendment was approved on 16 October 1984.

Local shoreline master programs (SMPs) are mandated by the state Shoreline Management Act (SMA; Chapter 90.58 RCW) which has as its central intent:

> . . . to insure the development of these shorelines in a manner which, while allowing for limited reduction of rights of the public in navigable waters, will promote and enhance the public interest. This policy contemplates protecting against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life, while protecting generally public rights of navigation . . .

Thus, the broad purposes of the SMA is to manage public and private development in the shoreline zone, while protecting the public's interest in public resources such as water, fish and wildlife, and the habitat that supports those species. The SMA is implemented by local government under the oversight of the state Department of Ecology. The SMA applies to waters of the state: all marine waters, all streams with an average annual flow of 20 cfs or greater, and all lakes with a surface area of 20 acres or greater. The SMA is a state law which is implemented at the local government level.

The SMA requires a permit for "substantial development" in shorelines of the state. With certain exceptions, substantial development is anything with a value of $2,500 or more (RCW 90.58. 140). "Shorelines" includes all waters of the state, plus adjacent lands within 200 feet of the ordinary high water line, all associated wetlands, and, in counties so designating, the 100-year flood plain (RCW 90.58.030). The Mason County SMP defines shorelines as the 200 foot zone, plus associated wetlands which includes "marshes, bogs, swamps, floodways, river deltas, and flood plains associated with the streams, lakes, and tidal waters which are subject to the provisions of the Act and this ordinance" (MCSMP 7.08.250). Essentially the entire Skokomish Valley is a 100 year flood plain, thus a substantial development permit is necessary for any regulated construction in the valley.

Mason County will propose amendments to the SMP which will in part redefine associated wetlands as the "floodway plus a 200 foot setback zone," rather than the current "flood plains" definition. Adoption by Mason County and approval by the Department of Ecology is anticipated in late 1987.

Special provisions of the SMA apply to Shorelines of Statewide Significance (SSS; RCW 90.58.020) which are defined for streams west of the Cascade Range crest as having a mean annual flow of 1,000 cfs or greater (RCW 90.58.030 [2] [e] [v]). Regarding development on Shorelines of Statewide Significance, the Act states:

> The legislature declares that the interest of all the people shall be paramount in the management of shorelines of state-wide significance. The department [of ecology], in adopting guidelines for shorelines of state-wide significance, and local government, in developing master programs for shorelines of state-wide significance, shall give preference to uses in the following order of preference which:
>
> (1) Recognize and protect the state-wide interest over local interest;
> (2) Preserve the natural character of the shoreline;
> (3) Result in long over short term benefit;
> (4) Protect the resources and ecology of the shoreline;
> (5) Increase public access to publicly owned areas of the shorelines;
> (6) Increase recreational opportunities for the public in the shoreline;
> (7) Provide for any other element as defined in RCW 90.58.100 deemed appropriate or necessary.

The Skokomish River is a Shoreline of Statewide Significance downstream of the confluence of the North Fork and the South Fork (WAC 173-18-270 [26]). The Mason County SMP contains no special provisions regarding SSS (Chapter 7.24.010), thus the general provisions of the SMA provide primary guidance. However, the Mason County SMP also states that in recognition "that all shoreline areas of Mason County are of equal importance to Mason County residents and the state as a whole; all shorelines designated in this ordinance shall be considered as being of state-wide significance, whether or not they are so designated in the Act" (MCSMP 7.04.032).

Because federal government reservations are generally exempt from the SMA, the SMA does not apply to the shorelines of the Skokomish River within the Skokomish Indian Reservation. This exception applies only to the left bank of the river which lies within the reservation and forms its southerly and easterly boundary.

The Mason County SMP identifies four shoreline environment designations -- Natural, Conservancy, Rural, and Urban -- in accordance with the SMA regulatory guidelines for development of local SMPs (WAC 173-16-040). Shoreline environments are mapped and defined to address relative needs for shoreline management. The Mason County SMP designates the main stem of the Skokomish as a Rural Shoreline Environment; the North Fork, South Fork, and Vance Creek within the primary study area are designated as Conservancy Shoreline Environment.

The principal development activities in the Skokomish Valley which are regulated by the Mason County SMP include:

7.16.010 Agriculture, pesticides, and fertilizers;
7.16.080 Residential development; and
7.16.180 Shoreline protection.

Agricultural and residential regulations are summarized in Table 6.1; shoreline protection regulations are described in detail below.

Agricultural practices, as a practical matter, cannot be effectively regulated through the local SMP. No permits are necessary to carry out agricultural practices, thus the SMP provisions for agricultural practices are advisory. Feedlots however, being a form of land development, can be regulated under an SMP. There are no feedlots in the Skokomish Valley, though some valley farmers keep dairy or beef cattle.

Residential development (but not the construction of individual homes) requires a Shorelines Substantial Development Permit. The Mason County SMP regulates only residential setbacks from the shoreline, and not residential densities or types. New home construction in the Valley is infrequent, and no residential developments (e.g. subdivisions) have been proposed since the SMA was enacted.

Flood control and streambank protection measures, to the extent they are regulated by the Mason County SMP, come under the provisions of Chapter 7.16.180, Shoreline Protection, which states:

A. Urban Environment
   1. Shoreline protection measures which might result in channelization should be closely evaluated prior to construction.

   2. Riprapping and other bank stabilization measures shall be designed, located, and constructed with intent to preserve natural character of the area.

   3. The use of automobile bodies for shoreline protection shall be prohibited.

B. Rural Environment
   1. All Urban Environment use regulations shall apply in this environment.

C. Conservancy Environment
   1. All Urban Environment use regulations shall apply in this environment.

   2. Construction designed to protect the shoreline should be permitted only when such construction is necessary for the protection of life and property.

   3. Bank stabilization by the planting of vegetation shall be permitted.

D. Natural Environment

1. All Conservancy Environment use regulations shall apply in this environment.

2. Shoreline protection measures shall be compatible with the Natural Environment.

By policy, the Mason County Department of General Services considers diking requiring 500 CY (cubic yards) of fill material to be valued at $2,500.00, thus diking projects requiring 499 CY of fill material (or less) are categorically exempt from requirements for a Shoreline Substantial Development Permit.

Table 6.1. AGRICULTURAL AND RESIDENTIAL SHORELINE REGULATIONS.

Activity	Rural Environment	Conservancy Environment
Agriculture		
Tillage patterns	Tillage which permits large quantities of soil and sediments to enter waterways is prohibited.	
Feedlots and stockyards	Prohibited in floodways.	Prohibited throughout the Conservancy Environment
Buffers	A buffer of permanent vegetation is required between tilled areas and waterways to retard surface runoff.	
Residential		
Setbacks	Fifteen feet from ordinary high water with no exceptions allowable.	
Cluster development	Discouraged.	Discouraged.
General	None.	Greater emphasis on protection of biophysical limitations and aesthetics.

Source: Mason County Shoreline Master Program, 7.16.010 and 7.16.080.

* * * * *

The Mason County SMP is administered by:
Mason County Department of General Services
Mason County Courthouse Annex 1
Shelton, Washington 98584

State oversight of Shorelines Substantial Development Permits is administered by:
Management Section
Shorelands & Coastal Zone Management Program
Washington Department of Ecology
Olympia, Washington 98504

RESOURCE MANAGEMENT

Resource management regulations are intended and designed to protect public resources such as water, fish, and wildlife, while allowing reasonable exercise of private property rights. Because structural flood protection measures are usually carried out within the stream or nearby in the shoreline zone, they have the potential to damage public resources.

HYDRAULIC PROJECT APPROVAL

The Hydraulic Project Approval (HPA) is issued by the state department of Fisheries or Game under the authority of the Washington Hydraulic Code (RCW 75.20.100) which requires the departments to regulate activities within the marine and fresh waters of the state. The Department of Fisheries exercises jurisdiction over marine waters. The two agencies share jurisdiction over fresh waters, though one agency will assume lead status over a specific fresh water body. The Department of Fisheries exercises jurisdiction over the Skokomish River. Regulation is implemented in accordance with the Hydraulic Code Rules (Chapter 220-110 WAC).

Therefore, any shore protection works, such as dikes constructed waterward of the line of ordinary high water, or instream work such as gravel removal, conducted in the Skokomish Valley require an HPA.

The primary function of the Hydraulic Code is to protect the state's fisheries resources, including spawning and rearing habitat. Thus the rules for gravel removal (WAC 220-110-140) limit the removal to gravel two feet above the current water level, prohibit the leaving of potholes, and require a maximum gradient on the excavated surface of two percent. The rules for bank protection work (WAC 220-110-050) limit such construction to stream banks actually damaged.

An HPA is required for both new construction and repair of old or damaged bank protection works. An approved HPA will ordinarily carry strict limitations on the time of year during which construction activities may be carried out. This is necessary to protect certain fish populations during critical phases of their life cycle.

HPAs for the Skokomish River are administered by:

Habitat Management Section
Washington Department of Fisheries
3939 Cleveland Avenue
Tumwater, Washington 98504

DEPARTMENT OF THE ARMY PERMIT

The US Army Corps of Engineers (Corps) is required to regulate discharges of dredged and fill material into waters of the United States and associated wetlands under Section 404 of the Clean Water Act. This regulatory charge includes shore protection structures and any associated earthmoving and landfilling. The Corps is also required to regulate any construction within navigable waters under Section 10 of the Rivers and Harbors Act of 1899. The Corps has developed a consolidated permit application and review program for their responsibility under both laws, known as the Department of the Army Permit.

Therefore, any shore protection structures constructed waterward of the line of ordinary high water (or within an associated wetland) will require a Department of the Army Permit.

Certain minor shore protection projects may come under the Corps' nationwide permit program, for which no formal permit application is required. However, notification of the Corps is required for certification of exemption from full permit application and processing requirements. Minor shore protection works eligible for the nationwide permit program are still required to meet certain minimal design and construction specifications. An exemption to the requirement for a full permit application and processing under the nationwide permit program may be obtained if the proposed shore protection work complies with the following criteria (33 CFR 330.5 [a] [13]):

1. the proposed shore protection work is less than 500 feet in length;

2. the project is necessary for erosion prevention;

3. the filling within waters of the United Stated is limited to less than one cubic yard per running foot of shore protection;

4. no material is placed in excess of the need for shore protection;

5. no material is placed in a wetland;

6. no material is placed so as to impair surface water flow into or out of a wetland;

7. only clean fill free of waster metal products, organic materials, unsightly debris, etc., is used; and

8. the proposal is for a single, complete project.

The Department of the Army Permit program is administered by:

Regulatory Functions Branch
Seattle District
US Army Corps of Engineers
P. O. Box C-3755
Seattle, Washington 98124

WATER QUALITY CERTIFICATION

The Washington Department of Ecology administers the state Water Pollution Control Act Chapter 90.48 RCW) in accordance with the Water Quality Standards for Waters of the State of Washington (Chapter 173-201 WAC).

Stream bank protection and instream gravel removal has the potential to create temporary instream turbidity (sedimentation) in excess of state water quality standards during the construction period. The Water Quality Standards provide for short term modifications of the standards "when necessary to accommodate essential activities, respond to emergencies, or to otherwise protect the public interest" (WAC 173-201-035 [8] [e]).

Stream bank protection and instream gravel removal projects require a Water

Quality Certification including a short term modification of pertinent water quality standards. Each such certification is reviewed and issued on an individual basis as an administrative order, and includes specific limitations on how and when construction activities may be carried out. For projects which also require a Department of the Army Permit, application for a Water Quality Certification should be made to:

Environmental Quality Section
Southwest Regional Office
Washington Department of Ecology
7272 Cleanwater Lane
Olympia, Washington 98504

For projects not requiring a Department of the Army Permit, application for a Water Quality Certification should be made to:

Environmental Review Section
Washington Department of Ecology
Olympia, Washington 98504

FLOOD CONTROL AND FLOODPLAIN MANAGEMENT

There are a number of programs which relate to flood control or flood plain management. Some are intended to regulate certain activities (e.g. land use) to limit the effects of flooding. Others are nonregulatory programs intended to coordinate and finance public flood control measures.

NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program is described in detail in a publication available from the Shorelands and Coastal Zone Management Program of the Washington Department of Ecology (*Floodplain management handbook for local administrators*; Floodplain Management Section, 1986). The following is a summary of the program.

The National Flood Insurance Program (NFIP) was established in 1968 to make flood insurance available for residential and nonresidential structures. Prior to 1968 flood insurance was not available at costs affordable to most home owners or small businesses. The NFIP has two central purposes. First, by making flood insurance available, Congress felt that it could alleviate the financial burden and general economic distress resulting from both chronic and disastrous flooding, and which affects individuals, local economies, and the nation as a whole.

Second, Congress also had the goal reducing the fiscal drain on the national Treasury of having to provide flood disaster relief and remedial flood control works for persons who have chosen to live in or otherwise occupy flood plains. Accordingly, Congress linked the availability of low cost flood insurance to the local implementation of land use management and construction practices designed to limit future development in flood plains and thus future flood damages. Thus as past unsound land use patterns and construction practices cease and are replaced with patterns and practices in conformance with the criteria of the NFIP for insurance eligibility, the drain on the national Treasury for flood disaster relief and flood control work will lessen.

The basis of operation of the NFIP is an agreement between a city or county government, a community in NFIP terminology, and the Federal Emergency Management Agency (FEMA), the federal agency which administers the program. When FEMA identifies a community as being "flood prone" and the community chooses to participate in the program by adopting and enforcing flood plain management measures, the community, in exchange, becomes eligible to have flood insurance coverage made available. The community must adopt and enforce flood plain management regulations in accordance with the minimum criteria of FEMA. The community may also adopt more stringent regulations if it desires.

Under the "Emergency Phase" of the program, minimal insurance coverage is made available in limited amounts at low-cost, subsidized rates. Increased amounts of flood insurance coverage become available at actuarial (unsubsidized) rates when the community converts to the "Regular Phase" of the program. Conversion to the Regular Phase occurs following completion of a detailed Flood Insurance Study by FEMA, and adoption of additional flood plain land use and construction practices regulations by the community. The actual flood insurance policy is written by any licensed agent or broker at the choice on the property owner.

Participation in the NFIP by local communities is voluntary, but most communities have chosen to participate to gain the benefits of low cost flood insurance for local residents, taxpayers, and small businesses.

Mason County is presently in the Emergency Phase of the program. FEMA has recently completed its detailed study which is still in review and is described in the following section.

FEMA FLOODWAY MAPPING, 1987

The Federal Emergency Management Agency (FEMA), under the National Flood Insurance Program (NFIP) issued Floodway (Flood Boundary and Floodway) Maps and FIRM (Flood Insurance Rate Maps) maps for Mason County in 1983. Subsequently, FEMA restudied Mason County, and reissued draft Floodway and FIRM maps in 1987 during the preparation of this draft Skokomish River CFCMP.

This mapping indicates that essentially the entire Skokomish Valley lies within the 100-year floodplain of the Skokomish River.

Flood plain management and flood insurance programs use certain terms to describe specific portions of the flood plain which have specific meanings. A typical stream cross-section and illustration of those terms is depicted in Figure 6.1.

The "stream channel" is the part of the stream way which carries the normal low flows as discussed in the Introduction to this Chapter.

The "100-year flood plain" is that part of the stream way which historically has carried flood flows of a specific magnitude, and provided temporary flood water storage. At lower elevations in western Washington it typically has a forest of Red Alders, Black Cottonwoods, Oregon Ash, willows, or other deciduous trees, in comparison to the conifer-forested uplands. The term "100-year flood" was unfortunately a misleading choice of terminology, as it implies a regular cycle of high intensity storms. Actually, the term 100-year flood means one chance in 100 of a specific flood volume each year, or a one

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Figure 6.1 Flood Plain Schematic Cross Section

percent chance of occurrence. Similarly, the 50-year flood has a two percent chance of occurrence each year. It is possible, though highly improbable, to have a 100-year flood two years in a row, or even twice in a year.

The "floodway fringe" and "floodway" are terms identifying portions of the flood plain where encroachment is allowed and disallowed.

It is important to remember that the FEMA program is a flood insurance program, not a flood plain regulatory program. However, for a community to remain qualified for enrollment in the flood insurance program, certain criteria must be met through local government flood plain regulation.

FEMA requirements allow filling and development of the floodway fringe, and most local governments adopt the FEMA requirements without change since they are a minimum requirement. Filling and development in the floodway fringe eliminates a portion of the flood water storage capacity of the flood plain, causing a rise in flood water elevation. The FEMA program is designed to account for this: the dashed river surface line A-B in Figure 6.1 represents the surface elevation of the 100-year flood under "natural" conditions; the solid line C-D represents the surface elevation of the 100-year flood under full development encroachment of the floodway fringe. The width of the floodway fringe is fixed by FEMA to allow a maximum one foot rise (surcharge) in the surface elevation of the 100-year flood.

FLOOD CONTROL ZONE ACT

The Flood Control Zone Act was first enacted by the state legislature in 1935 for the "alleviation of recurring flood damages to public and private property, to the public health and safety, and to the development of the natural resources of the state . . ." (RCW 86.16.010). The Act originally specified state regulatory authority over designated flood control zones, including the authority to regulate construction and planning within flood plains and floodways (RCW 86.16.020, 025).

In June 1987, the Legislature enacted substantial changes to the Act (ESB 5556), shifting basic regulatory authority from the state to local government, eliminating the designated flood control zones, and extending authority of the act to the entire state, not just the designated flood control zones. The state retained oversight authority over the actions of local governments in implementing the new Act. The Department of Ecology provides technical assistance to local governments, and must approve locally prepared floodplain management programs.

Floodplain management programs must be consistent with the regulatory requirements of the National Flood Insurance Program whether or not the local community is enrolled in the NFIP or not. Local floodplain management programs must include a prohibition of construction or reconstruction of residential structures with designated floodways. The Act directs the Department of Ecology to "assume regulatory authority for floodplain management activities in the event of failure by the local government to comply with the requirements of" the Act.

At this time (July 1987), Ecology has not yet promulgated new rules for the implementation of the revised Act.

MASON COUNTY FLOODPLAIN REGULATIONS
Mason County has not yet adopted any floodplain management regulations. The matter is presently under consideration. If Mason County is to continue to participate in the National Flood Insurance Program, a floodplain management ordinance acceptable to FEMA must be adopted.

COORDINATION

There are no institutionalized programs for comprehensive coordination of land use and flood control regulations or permit processing at either the state or local government level. Informal coordination occurs between the state departments of Ecology and Fisheries regarding comprehensive flood control management planning.

Four permits are potentially necessary to carry out a structural flood control work. A federal Department of the Army Permit, a consolidation of the Section 10, Rivers and Harbors Act, and Section 404, Clean Water Act permits, is necessary for work carried out in navigable waters, waters of the United States, and adjacent wetlands. A state hydraulic project approval (HPA) is necessary from the state departments of Fisheries and/or Game for work in or near fish bearing waters. A local Shoreline Substantial Development Permit, under the state Shoreline Management Act, is necessary for work in and within the wetlands adjacent to streams with an average annual flow of 20 cfs or greater. A Flood Control Zone Permit under the Flood Control Zone Act is necessary for new construction in the floodway, as well as any flood control work or maintenance of existing flood control structures.

The state's ECPA (Environmental Coordination Procedures Act) process is voluntarily available to permit applicants through the Department of Ecology's Environmental Review Program for coordination of state permits, but this does not include coordination of federal permits. Coordination is considered necessary to avoid contradictory conditions of permit approval by different agencies with different regulatory mandates.

Interagency Stream Corridor Management Guidelines were promulgated in 1985 as an interagency memorandum of understanding (MOU) between the Washington departments of Game, Fisheries, and Ecology, the Washington Conservation Commission, and the US Soil Conservation Service. The Guidelines establish a procedure for interagency cooperation and coordination in the planning, designing, and implementing of structural and nonstructural works and activities within stream corridors, including permit review. The MOU established an ongoing Stream Corridor Committee to carry out the intents of the MOU. The contact persons under the MOU for the Skokomish River basin are:

Department of Game:
Regional Habitat Biologist
Region 6
905 East Heron
Aberdeen, WA 98520

Department of Fisheries:
Regional Habitat Manager
Habitat Management Section
Washington Department of Fisheries
3939 Cleveland Avenue
Tumwater, Washington 98504

Department of Ecology:
Flood Control and Water Quality:
Southwest Regional Office
Washington Department of Ecology
7272 Cleanwater Lane
Olympia, Washington 98504

Shoreline Management:
Management Section
Shorelands and Coastal Zone Management Program
Washington Department of Ecology
Olympia, WA 98504

Mason County Soil Conservation District:
Inactive; contact:
District Conservationist
Thurston County Soil Conservation District
816 East 5th Street
Olympia, WA 98501

US Soil Conservation Service:
Olympia Field Office
816 East 5th Street
Olympia, WA 98501

SUMMARY

Various regulatory programs affect both the need for flood protection measures, as well as the manner in which structural approaches to flood protection may be carried out.

Building codes may be used to alert home builders and home owners to the hazards of occupying floodplains, or in conjunction with a zoning ordinance may be used as a check point to assure that required flood proofing of new construction occurs. The Mason County Building Code contains no special regulations regarding construction in flood plains.

Zoning and comprehensive plans may be used to specially regulate development, particularly residential development, in hazardous areas such as flood plains or landslide zones. The County Comprehensive Plan in effect was adopted in 1973. This Plan contains broad goals for Mason County land use and generalized policies to guide decisions in attaining those goals. The Plan contains no specific guidelines or land use density recommendations.

Local shoreline master programs (SMPs) are mandated by the state Shoreline Management Act (SMA; Chapter 90.58 RCW). Residential development (but not the construction of individual homes) requires a Shorelines Substantial Development Permit. The Mason County SMP regulates only residential setbacks from the shoreline, and not residential densities or types. New home construction in the Valley is infrequent, and no residential developments (e.g. subdivisions) have been proposed since the SMA was enacted. The Mason County SMP regulations of shore protection are mostly advisory.

The National Flood Insurance Program (NFIP) is a federal program instituted in 1968 to make flood insurance available to home owners and small business persons. Participation in the NFIP by local communities is voluntary, but most communities have chosen to participate to gain the benefits of low cost flood insurance for local residents, taxpayers, and small businesses. Mason County is presently in the Emergency Phase of the program.

The Flood Control Zone Act was first enacted by the state legislature in 1935. In June 1987, the Legislature enacted substantial changes to the Act (ESB 5556), shifting basic regulatory authority from the state to local government, extending authority of the act to the entire state, not just the former designated flood control zones. The state retained oversight authority over the actions of local governments in implementing the new Act. The Department of Ecology must approve locally prepared floodplain management programs. Floodplain management programs must be consistent with the regulatory requirements of the National Flood Insurance Program whether or not the local community is enrolled in the NFIP or not. Local floodplain management programs must include a prohibition of construction or reconstruction of residential structures with designated floodways. The Act directs the Department of Ecology to "assume regulatory authority for floodplain management activities in the event of failure by the local government to comply with the requirements of" the Act. At this time (July 1987), Ecology has not yet promulgated new rules for the implementation of the revised Act.

Mason County has not yet adopted any floodplain management regulations. The matter is presently under consideration. If Mason County is to continue to participate in the National Flood Insurance Program, a flood hazard ordinance acceptable to FEMA must be adopted.

The Skokomish Flood Control District was established in 1976 under the authority of the Flood Control Zone Districts Act (Chapter 86.15 RCW). As a quasi municipal corporation, Flood Control Zone Districts have taxing authority; the Skokomish Flood Control District taxes property within the district at $0.50 per $1,000 assessed valuation.

There are no institutionalized programs for comprehensive coordination of land use and flood control regulations or permit processing at either the state or local government level. Four permits are potentially necessary to carry out a structural flood control work: a federal Department of the Army Permit; a state hydraulic project approval (HPA); a local Shoreline Substantial Development Permit; and a Flood Control Zone Permit.

Chapter 7

ALTERNATIVE FLOOD CONTROL MANAGEMENT MEASURES

INTRODUCTION

Nationally, the general history of flood damage reduction has been one of a steadily increasing awareness of the adverse secondary effects of earlier attempts at localized flood control. In the past, the principal means of flood control involved structural solutions such as diking or channelization. In comparison with other rivers in the state, there has been relatively little construction of structural flood control facilities along the Skokomish River.

The size of a stream or river bed, its width and depth, is created by the waters it carries. Streams "size themselves" to carry the water from the largest flow volume normally occurring every year or two. Flows larger than those typically occurring every year or two top the stream banks and flow downstream in the flood plain. Thus the historical function of the stream bed is to carry ordinary, low volume stream flows and the function of the flood plain has been to carry larger flows and provide temporary storage of flood waters (Dunne & Leopold, 1978). Occupancy of flood plains and their conversion to agricultural and other land uses has created conflicts between man's desires for use of the land and the land's historical methods of passing flood waters.

Nationwide, the earliest attempts at flood control were direct efforts to pass the flood waters by as quickly as possible. Typically this was accomplished through stream channelization which enlarged, straightened, and sometimes paved the stream channel and/or stream banks. This caused degradation or elimination of fish and wildlife habitat values in the vicinity of the channelized reach, and a resultant decrease or loss of fish production. The flood water was passed downstream, sometimes increasing the flood hazard for downstream land owners. There has been no substantive stream channelization of the Skokomish River, and what has occurred has mostly been incidental to other actions such as highway or bridge construction.

Another widespread approach to flood control has been the construction of dikes and levees along the stream bank. This protected the lands behind the dike, but usually resulted in a loss of the flood storage reservoir value of the flood plain, further resulting in an increased downstream flood hazard. An emerging practice is to locate dikes back from the river bank, balancing the protection of uplands values with the preservation of the flood plain's storage reservoir values, while minimizing adverse impacts on downstream land owners. Most of the dike and levee construction on the Skokomish has been small scale, privately constructed facilities, poorly capable of resisting major flooding.

Flood storage reservoirs are constructed as an alternative or supplement to stream channelization and diking. Some reservoirs are multipurpose in that they are designed to provide for flood control, hydropower production, and irrigation water storage. The reservoirs on the North Fork are single purpose hydropower production facilities with little capacity for flood control under current licensing conditions. However, because the Cushman projects divert most of the North Fork flows to Hood Canal, they inadvertently do provide some flood flow mitigation.

Structural solutions to flood control, such as the above, are costly. In recent years, benefit cost analyses have often shown it to be more cost effective for the public to purchase the development rights to lands at risk from flooding, than to purchase structural solutions to flood control for those private properties.

Flood insurance programs, while not reducing flooding or providing structural flood protection measures, do mitigate the effects of flooding for persons who have chosen to occupy flood plains and to purchase flood insurance. The National Flood Insurance Program (NFIP) is administered by the Federal Emergency Management Agency (FEMA). The regulatory permit programs are administered by local government, and are based on their own flood regulation ordinances. These local ordinances must comply with the minimum requirements of the NFIP regulations in order for the community to remain eligible. Any person in the community may buy flood insurance from any insurance agent regardless of where the buildings are located only if the community remains eligible and enrolled in the program. Mason County is currently enrolled in the emergency phase of the program, and will need to adopt a local ordinance in order to convert to the regular phase of the program.

This chapter considers stream corridor management and flood control management measures which have been conducted in the Skokomish Valley as a response to historical and current damages as described in Chapter 5, Historic Flood Damages and Planning.

Potential nonstructural and structural measures, successfully practiced elsewhere and applicable to property in the Skokomish Valley are discussed. Although the upper half of the Skokomish River watershed is within the Olympic National Forest and therefore exempt from state and local regulations, private lands within the National Forest are not. It is appropriate to consider certain flood control management measures for those upstream lands as well.

The summary of this chapter addresses additional information or studies which will be needed prior to effective implementation of flood control management measures.

Various measures are recommended for consideration by the Skokomish Valley residents, Mason County, and the Skokomish Indian Tribe, as well as the Washington State through its various agencies. Technical assistance from the Federal Emergency Management Agency and the US Army Corps of Engineers can provide a major contribution in implementing some floodproofing strategies. Also, a combination of flood control management measures will be more effective than any singular approach in reducing flood damages, especially if applied throughout the watershed.

NONSTRUCTURAL MEASURES

Nonstructural measures consist of flood control alternatives which typically affect one or two structures at a time or limit the location and type of development occurring in floodprone areas. Human actions and behavior are the primary focus of nonstructural measures in reducing flood damages. Susceptibility to flood damage and disruption, as well as the impact of flooding on individuals and the community, is reduced with effective implementation of nonstructural measures.

INTRODUCTION

Susceptibility to flood damage and disruption can be reduced with nonstructural measures. Uneconomic, undesirable, or unwise uses of the floodplain are modified or eliminated. These measures include:

(1) Development policies
  - Location of sewers and utilities
  - Permanent evacuation
  - Renewal and redevelopment
  - Open space

(2) Flood warning and forecasting
  - Evacuation plan
  - Flood watch
  - Flood warning system

(3) Disaster plans
  - Flood fighting, life saving
  - Emergency shelter
  - Medical and health

(4) Flood proofing
  - Modify buildings
  - Landfill
  - Elevate structures

(5) Land regulation
  - Zoning
  - Building codes
  - Subdivision regulation
  - Disclosure

Recovery from flooding and flood damages can be improved with nonstructural measures which assist individuals and communities in their preparatory, survival, and recovery responses to floods. These measures include:

(1) Flood insurance maps

(2) Flood emergency operations
  - Flood fighting
  - Emergency health care and shelter

(3) Financial assistance for recovery
  - Low interest loans
  - Federal reconstruction assistance
  - Grants and disaster aid

(4) Tax adjustments

Structural measures are intended to modify flooding by artificially diverting or retaining flood waters. These measures include:

(1) Flood diversions
(2) Channel alterations
(3) Dikes, levees, and floodwalls
(4) Dams and reservoirs
(5) Land treatment

Floodplain management measures which have the potential of being alleviating flood damages of the Skokomish Valley are discussed below.

FLOOD DAMAGE REDUCTION

(1) Development policies
- Location of sewers and utilities
- Permanent evacuation
- Renewal and redevelopment
- Open space

(2) Flood warning and forecasting
- Evacuation plan
- Flood watch
- Flood warning system

(3) Disaster plans
- Flood fighting, life saving
- Emergency shelter
- Medical and health

(4) Flood proofing
- Modify buildings
- Landfill
- Elevate structures

(5) Land regulation
- Zoning
- Building codes
- Subdivision regulation
- Disclosure

DEVELOPMENT POLICIES

Evaluate siting of critical facilities and transportation: Relocate flood warning and response communication center from Fire Hall to an area safely out of the floodway and possibly out of the floodplain.

Evaluate current road alignment and elevation. Alternative emergency escape routes should be identified and established.

FLOOD WARNING AND FORECASTING

Evacuation or flood preparedness plans: Flood preparedness plans are a necessary part of an effective flood warning system. Emergency actions in the case of flooding should be established in advance to enable residents and the various response services to best use the limited response time. These activities can include establishing a communication and operation center for response teams, notifying responsible officials and volunteers, evacuation routes, and arranging temporary shelter. Residents can take a series of actions which will limit or reduce damage to property.

Residents: Each resident within the flood prone area of the Skokomish Valley should have a list of early actions to be taken in anticipation of flood situations. Regular practice drills would assist in effectively responding in case of an emergency or short notice. The following list of precautions is taken from the *Flood Emergency and Residential Repair Handbook* (FEMA, 1986):

* Investigate the feasibility of purchasing flood insurance.
* Identify items to be evacuated with you.
* Prepare a checklist of emergency supplies and equipment for combatting flood waters such as rope, plastic bags, sand bags, sump pump, buckets.
* List items to be relocated to a safer place in the order of their priority.
* Identify vulnerable areas where sandbags should be placed.
* Provide a circuit breaker or fuse chart with a list of those circuits to be disconnected in a flood emergency.
* List locations and emergency turnoff instructions for main gas, water, fuel tank, and sewer lines.
* Tie up a boat where it is readily available but not subject to damage.
* Write instructions for installing temporary shoring, bracing, or shear wall supports.
* Provide instructions for opening and closing doors and windows at various flood levels. Describe location of stored closure panels.
* Know destination and route to your evacuation point.
* List telephone number of a person to be notified that you are evacuating and later that you have arrived safely. This provides knowledge that your home does not have to be checked for emergency evacuees and also the signal to notify authorities if you are unable to reach your destination.

Local flood warning systems: To date, there has been no formal flood warning system available to the residents of the Skokomish Valley. Warning systems forecast the intensity and timing of floods to provide the community adequate time to take pre-planned actions which protect life and property and preventative measures to minimize damage throughout the flood event.

Fire District No. 9 has the primary responsibility for notifying and evacuating residents in flood situations. Currently, the district does not have a formal system for flood alerts or a flood preparedness plan.

Flood preparedness plans should be practiced and coordinated with all responsible agencies and municipalities. A system should be developed whereby the Fire District receives flood warnings and relays the information quickly to affected persons. The Fire Hall is presently located in the Skokomish River floodway. Headquarters for such a communication center should be located in an area which is safe from flooding.

Mason County's emergency response plan is general and does not prescribe an evacuation plan or other specific flood fighting measures.

The City of Tacoma and residents of the community have been discussing the need to install a warning system in the event of a dam failure at their Lake Cushman facility and the most effective method for notifying residents. Currently, the preferred local option appears to be the installation of weather radios in each residence with an automated gage hookup to the Seattle and Olympia Weather Bureau offices so that information regarding dam failure may be immediately relayed. There is discussion of a brochure being printed and mailed to each resident showing evacuation routes and giving general emergency response information as well as Fire District 9 receiving on-going support.

Flood forecasting: Flood forecasting will always be limited in the Skokomish Valley due to the fact that the river watershed is comparatively small and doesn't allow for measurable lead time between the rainfall occurrence and flooding in the valley. The high volumes of rainfall experienced within the watershed and resulting rapid rise of water levels also limit the time to take protective actions.

Flood alert: The National Weather Service has a communication system for relaying weather watch information to local communities. The information is general in terms of amount or duration of storm events. The Mason County Sheriff Department Dispatch receives the National Weather Service information. Mason County Emergency Services is then contacted by phone, determines which Fire Districts or other entities should receive the weather information, and relays information by phone or radio transmitter. When necessary, the Mason County Sheriff Department will make direct contact. A 'tone' is transmitted by radio dispatch to fire district volunteers that a flood watch or alert is in affect. There are a limited number of receivers available to residents in the Skokomish Valley (Conversation with Merle McNeil, Mason County Emergency Services - April 3, 1987).

The existing stream gage system consists of stream gages owned and operated by the Tacoma City Light on the North Fork of the Skokomish River above Lake Cushman and on Lake Cushman Dam, Deer Meadow Creek, and on McTaggert Creek above Gibbons Creek. The United States Geological Service (USGS) maintains the following manual gages:

Purdy Creek - westerly side of State Route 101
Skokomish River - at US 101 bridge, RM 5.3
Skokomish River, North Fork - just above river mile 10
Skokomish River, South Fork - just above river mile 3

The information from the stream gages is not coordinated with local flood warning efforts at this time. A volunteer gage reading program could be established with a flood preparedness plan which informs residents of specific flood levels so that they may take pre-planned action. Such actions would be based on a knowledge of the elevation of their structures and a series of appropriate preventative measures for each stage of a flood event.

DISASTER PLANS

Flood fighting/evacuation/emergency shelter: Fire District No. 9 is the primary rescue and evacuation service. The Fire District station is located in the floodway of the Skokomish River and is floodprone. Access to the station can be cut off to regular vehicles during a flood event. The district maintains a 6 x 6 vehicle for evacuating residents in flood events. The community has an informal network of mutual assistance and a long-term familiarity with which portions of the Skokomish Valley are more flood prone. On a volunteer basis, assistance is provided to those residents needing to be evacuated. Currently, there is no flood preparedness plan in place for the fire district or individuals in the flood prone areas.

There is no system of flood response for minimizing flood damages to property. An audit of each structure in the floodplain should be developed which establishes a list and priority for protective actions. This information should be kept on file with the fire district, as well as easily accessible to the residents.

The county sheriff's department provides 24-hour response and serves as a first point of contact and assistance in relaying for flood warnings. Assistance in early evacuation is also provided.

Medical Service:

Emergency Shelter:

FLOOD PROOFING
Elevating Structures
Construction Standards for new and reconstructed structures

STRUCTURE RELOCATION
Identify structures within the floodway which should receive priority consideration for relocation. Establish a loan or cost-share program

LAND REGULATION
As discussed in Chapter 6, the primary land use regulation affecting the Skokomish Valley is the state law prohibiting construction of new residences within a designated floodway. The majority of the Skokomish Valley is within such a floodway, as recently determined by a flood insurance study for Mason County.

Zoning: Mason County has no zoning in place to regulate siting of development.

Dedication of Land to Open Space:

Local Flood Hazard Ordinance: Mason County does not currently have a flood hazard ordinance in effect.

DISCLOSURE
Disclosure that property is within a floodprone area becomes even more important with the residential development prohibition discussed above.

PUBLIC INFORMATION PROGRAMS
Any effort to reduce flood damages is only as effective as the effort to inform the public about the extent of potential flood hazard and measures in place to reduce or prevent the flood-related threats.

FLOOD RECOVERY
(1) Flood insurance maps
(2) Flood emergency operations
    Flood fighting

Emergency health care and shelter
(3) Financial assistance for recovery
Low interest loans
Federal reconstruction assistance
Grants and disaster aid
(4) Tax adjustments

FLOOD INSURANCE
Mason County is presently in the emergency phase of the National Flood Insurance Program. The Federal Emergency Management Agency completed a preliminary flood insurance study in February, 1987 and Mason County is preparing to adopt the study. A Local Flood Hazard ordinance must also be adopted and administered by Mason County to continue eligibility in the National Flood Insurance Program.

A detailed study was conducted for 6.3 miles of the Skokomish River, extending from the State Highway 106 bridge to the confluence of the North Fork Skokomish River. The area appears to have been selected due to its known severe flood hazard, as identified at a meeting attended by representatives of the study contractor, FEMA, and Mason County in May 1980 (FEMA, 1983). Flood elevations for 10, 50, 100, and 500 year recurrence intervals were calculated. A floodway was also calculated and mapped which included almost the entire floodplain for the area studied. Upon adoption of the maps by Mason County, the Skokomish River floodway will become a 'regulatory floodway,' where development or encroachment (filling, etc.) which would cause any increase in the base flood elevation must be prohibited (Washington Department of Ecology, 1986).

Approximate studies were conducted for 1.5 miles of the North Fork Skokomish River, 1.9 miles of the South Fork Skokomish River, and 2.9 miles of Vance Creek (Appendix A)

FLOOD EMERGENCY OPERATIONS

Public Works Department: (restoring access)

PUD No. 3: Electrical power restoration and residential safety checks.

FINANCIAL ASSISTANCE FOR RECOVERY
According to Terry Simmonds of the Department of Community Development's Emergency Management Program, over the years Mason County has received Federal Disaster Assistance Grants for a number of floods, as shown in Table 7.1. The Federal Highway Administration has provided indirect assistance totalling $170,769.00. To date, no flood hazard mitigation study has been conducted for Mason County.

Table 7.1. FEDERAL DISASTER ASSISTANCE GRANTS, MASON COUNTY.

Year	Type of Disaster	Location	Amount of Grant	
1962	Flooding	County	$1,218.00	
1964	Flooding	Hood Canal School District #404	$1,500.00	
		Mason County PUD #1	$16,562.00	
		Mason County PUD #3	$13,424.59	
		Subtotal	$31,486.59	
1965	Earthquake	Mason County School District #309	$562.00	
1974	Flooding	County	$20,652.15	
1975	Flooding	County	$6,924.00	
			Total	$60,842.74

Source: Simmonds, Terry, 1987.

* * * * *

STRUCTURAL MEASURES

(1) Flood diversions
(2) Channel alterations
(3) Dikes, levees, and floodwalls
(4) Dams and reservoirs
(5) Land treatment

STREAMBANK STABILIZATION

Historically, the primary flood control management measures taken in the Skokomish Valley have concentrated on streambank protection measures aimed at reducing erosion from channel changes.

STORAGE OF FLOOD WATERS

Lake Cushman Dam: The construction of the upper and lower Cushman Dams has effectively reduced the flow of water from the North Fork of the Skokomish River which had historically contributed over one-half of the winter stream flow.

Wetlands:

DIKES AND LEVEES

Diversion Dikes and Levees:

Setback Levees and the Floodway:

Mason County Proposal:

INSTREAM WORK
Channel Modification:

Gravel Removal:
(refer to Corps recon. study evaluating feasibility of setback levee)

Mason County Proposal:
(refer to Corps recon. study evaluating feasibility of setback levee)

FLOOD DIVERSION
Bypass Systems:

Existing and Historic Side Channels: Records show that the Skokomish Valley floor had an extensive network of side channels which carried flood waters during peak flows. These side channels have been filled and blocked off through the process of converting land for agricultural and residential use.

SUMMARY AND CONCLUSIONS

Both structural and non structural flood control and management measures are available to Mason County for improving conditions in the Skokomish Valley. To date, measures taken by local residents and County officials have focused on structural measures.

Nonstructural measures consist of flood control alternatives which typically affect one or two structures at a time or limit the location and type of development occurring in floodprone areas. Nonstructural measures also include administrative or institutional programs such as flood warning and evacuation systems. Nonstructural approaches can also include administrative procedures to conserve natural wetlands for flood water storage reservoir use.

Future detailed flood control and management planning for the Skokomish Valley should include a strong measure of nonstructural alternatives which provide more cost effective flood protection than certain structural measures. Principal issues which should be addressed include: and technical assistance to local residents in self help measures including floodproofing of structures; emergency warning and evacuation alternatives; land management alternatives and compliance with state and federal law.

Structural measures typically include construction projects and facilities such as streambank protection, dikes, gravel and debris removal, bridges and culverts, and flood water storage reservoirs. Past analyses of intensive approaches to structural solutions have proven not to be cost effective (Chapter 5).

Skokomish Valley has a special problem in that public roads in the Valley are constructed to finish elevations below annual flood heights (Chapter 3).

The Skokomish Valley has another special problem in that the lower South Fork and upper main stem are rapidly aggrading (Chapters 3 and 4). The long term importance of this is that any structural remedies undertaken will have a short lived value -- probably no more than five years.

It is generally accepted that the incidental flood water storage function of Cushman Reservoir has helped to reduce the intensity of flooding in the Skokomish Valley by diverting most of the North Fork flows. However, the Cushman Project was licensed as a single purpose hydroelectric facility.

A major component of future detailed planning for flood control and management should include a comprehensive and integrated structural program including at least the following elements: short term bank protection measures to alleviate existing hazardous conditions; elevating certain low-lying roads such as the Skokomish Valley Road and Bourgault Road West to maintain the public road system in anticipation of future increased flooding; revising the operations of the Cushman Project to include permanent procedures for flood flow mitigation and early warning of flood season discharges; a detailed sediment transport study should be conducted to establish the volume of material within the stream system, locate the source of material, and determine the feasibility and most appropriate locations for removing the material from the stream system. Given that it is difficult-to-impossible to accurately measure bedload movement, it will probably be necessary to construct a sediment retention facility without any knowledge of the volumes of sediment which can be anticipated, and determine those volumes based on the filling rate of the retention facility.

REFERENCES CITED AND CONSULTED

Abrahamson, Pam. 1986. *A detailed listing of the liberations of salmon into the open waters of the state of Washington during 1985. Progress Report No. 243.* Washington Department of Fisheries, Olympia.

AIA Research Corporation. 1981. *Design guidelines for flood damage reduction. FEMA - 15.* Federal Emergency Management Agency, Washington, D. C.

ASFM - see Association of State Floodplain Managers.

Association of State Floodplain Managers. 1985. *Reducing losses in high risk flood hazard areas: A guidebook for local officials.* Federal Emergency Management Agency Publication FEMA 116 (February 1987).

Ames, James J. and Patrick Bucknell. 1981. *Puget Sound river mile index.* Washington Department of Fisheries, Olympia.

Anderson, Jim, et al. 1986. *River recreation in Washington: An initial inventory and assessment.* National Park Service, Seattle, Washington.

Bell, Milo C. 1982. *South Fork Skokomish River hydroelectric project: Technical Report No. 7, Gravel and sediment transport.* School of Fisheries, University of Washington, Seattle.

Bortleson, G. C., M. J. Chrzastowski, and A. K. Helgerson. 1980. *Historical changes of shoreline and wetland at eleven major deltas in the Puget Sound region, Washington. Hydrologic Investigations Atlas HA-617.* USDI Geological Survey.

Bortleson, G. C., N. P. Dion, J. B. McConnell, and L. M. Nelson. 1976. *Reconnaissance data on lakes in Washington: Volume 3, Kitsap, Mason, and Pierce counties. Water Supply Bulletin 43, Volume 3.* Washington Department of Ecology, Olympia.

Bortleson, G. C. and B. L. Foxworthy. 1973. *Relative susceptibility of lakes to water-quality degradation in the southern Hood Canal area, Washington. Miscellaneous Geological Investigations Map I-853-B.* USDI Geological Survey.

Burch, G. J., R. K. Bath, I. D. Moore, and E. M. O'Loughlin. 1987. Comparative hydrological behavior of forested and cleared catchments in southeastern Australia. *Journal of Hydrology* 90: 19-42.

Burroughs, Jr., Edward R. and Byron R. Thomas. 1977. *Declining root strength in Douglas-fir after felling as a factor in slope stability. Research Paper INT-190.* USDA Forest Service Intermountain Forest and Range Experiment Station.

Calambokidis, J., et al. 1978. *Chlorinated hydrocarbon concentrations and the ecology and behavior of Harbor Seals in Washington state waters.* The Evergreen State College, Olympia, Washington

Caldwell, Brad. 1984. *Skokomish River - Minimum Stream Flows.* Memorandum to Gordon Zillges, Department of Fisheries, Habitat Management Division.

Canning, Douglas J. 1985. *Shoreline bluff and slope stability: Technical management options. Shorelands Technical Advisory Paper No. 2.* Shorelands & CZM Program, Washington Department of Ecology.

Canning, Douglas J. and G. Bradford Shea. 1979. *Evaluation of the proposed Northern Tier oil pipeline through Mason County, Washington.* (Final report to Mason Regional Planning Council) Northwest Environmental Consultants, Inc. Seattle, Washington.

Carson, R. J., Mackey Smith, and B. L. Foxworthy. 1973. *Geologic conditions related to waste-disposal planning in the southern Hood Canal area, Washington. Miscellaneous Geological Investigations Map I-853-D.* USDI Geological Survey.

Castoldi, Pam. 1983. *A detailed listing of the liberations of salmon into the open waters of the state of Washington during 1982. Progress Report No. 185.* Washington Department of Fisheries, Olympia.

CH2M Hill, Inc. 1983. *South Fork Skokomish Hydroelectric Project: Draft environmental impact statement.* Public Utilities District #3 of Mason County, Shelton, Washington.

Cowley, Earl W. 1958. *Report of field examination Skokomish River watershed, Mason County, Washington.* US Soil Conservation Service, Spokane, Washington.

Cummans, J. E. 1974. *Flood profiles and inundated areas along the Skokomish River, Washington. Water Resources Investigations No. 62-73.* USDI Geological Survey, Tacoma, Washington.

Division of Marine Land Management. 1977. *Washington marine atlas, Volume 2: South inland waters.* Washington Department of Natural Resources, Olympia.

Drainage and Land Stabilization Technical Committee. 1970. *Comprehensive study of water and related land resources, Puget Sound and adjacent waters: Appendix XIV, Watershed management.* Pacific Northwest River Basins Commission.

Duncan, S. H., R. E. Bilby, J. W. Ward, and J. T. Heffner. 1987. Transport of road-surface sediment through ephemeral stream channels. *Water Resources Bulletin* 23(1):113-119.

Dunn, B. C. 1942. *Report and survey of Skokomish River, Mason County, Washington.* (Presented to the House of Representatives, 76th Congress, 1st Session, March 23, 1942.) Board of Engineers for Rivers and Harbors, US Army Corps of Engineers, Washington D.C.

Fajen, Otto and James L. Robinson. 1985. *Stream corridor management: A proposed response to streambank erosion.* USDA Soil Conservation Service and Missouri Department of Conservation.

Federal Emergency Management Agency. 1987. *Flood insurance study: Mason County, Washington unincorporated areas.* (Community number 530115) Federal Emergency Management Agency.

FEMA - see Federal Emergency Management Agency.

Fiksdal, Alan J. and Matthew J. Brunengo. 1981. *Forest slope stability project, Phase II, Volume 1. WDOE 81-14.* Washington Department of Ecology, Olympia.

Findlay, John D. 1973. *Map showing spawning areas of anadromous fish in southern Hood Canal, Washington. Miscellaneous Geological Investigations Map I-853-A.* USDI Geological Survey.

Fish and Wildlife Technical Committee. 1970. *Comprehensive study of water and related land resources, Puget Sound and adjacent waters, Appendix XI: Fish and wildlife.* Pacific Northwest River Basins Commission.

Fleskes, Carol and Marty O'Connor. 1980. *Skokomish-Dosewallips Basin WRIA 16: Office Report No. 74.* Water Resources Management Division, Washington Department of Ecology, Olympia.

Flood Control Technical Committee. 1970. *Comprehensive study of water and related land resources, Puget Sound and adjacent waters: Appendix XII, Flood control.* Pacific Northwest River Basins Commission.

Floodplain Management Section. 1986. *Floodplain management handbook for local administrators.* Shorelands and Coastal Zone Management Program, Washington Department of Ecology, Olympia.

Franklin, Jerry F. and C. T. Dyrness. 1973. *Natural vegetation of Oregon and Washington. General Technical Report PNW-8.* USDA Forest Service.

Geppert, Rollin R., Charles W. Lorenz, and Arthur G. Larson. 1984. *Cumulative effects of forest practices on the environment: A state of the knowledge.* Washington Forest Practices Board, Olympia.

Harr, R. Dennis. 1982. Prefiled testimony prepared for US Forest Service General Counsel, Portland, Oregon, for potential litigation in Skokomish Indian Tribe v Forest Supervisor, Olympic National Forest.

Harris, D. D. 1973. Hydrologic changes after clear-cut logging in a small Oregon coastal watershed. *Jour. Research U. S. Geol. Survey* 1(4): 487-491.

Hill, Pamela M. 1983. *A detailed listing of the liberations of salmon into the open waters of the state of Washington during 1983. Progress Report No. 210.* Washington Department of Fisheries, Olympia.

Hogan, Dwain F. 1987. Letter to Edward Binder, Skokomish Indian Tribe, dated 12 March 1987. US Army Corps of Engineers, Seattle, Washington

Hood Canal Coordinating Council. 1986. *Hood Canal Regional Planning Policy.* Hood Canal Coordinating Council, Silverdale, Washington.

Huntting, Marshall T. 1956. *Inventory of Washington minerals: Part 2, Metallic minerals. Bulletin 37.* Division of Mines and Geology, Washington Department of Conservation and Development, Olympia.

Hutchison, R. P. 1973. *Public recreation resources and facilities in the southern Hood Canal area, Washington. Miscellaneous Geological Investigations Map I-853-G.* USDI Geological Survey.

James, Karen. 1980. *The Skokomish River North Fork: An ethnographic and historical study.* Skokomish Consulting Services, Skokomish Indian Tribe, Shelton, Washington

James, Karen and Victor Martino. 1980. *Water resources of the Skokomish Indian Tribe.* Skokomish Consulting Services, Skokomish Indian Tribe, Shelton, Washington

Johnson, William K. 1978. *Physical and economic feasibility of nonstructural flood plain management measures.* US Army Corps of Engineers

Kehoe, David M. 1982. *Sources of sediment to Grays Harbor Estuary.* US Army Corps of Engineers, Seattle District.

Kendra, Will. 1985. *North Fork Skokomish River streamflow and water quality survey.* Washington State Department of Ecology Memorandum from Will Kendra to Greg Sorlie, dated July 24, 1985.

Keown, Malcolm P. 1983. *Streambank protection guidelines for landowners and local governments.* Waterways Experiment Station, US Army Corps of Engineers, Vicksburg, Mississippi.

Kirby, Loree L. 1985. *A detailed listing of the liberations of salmon into the open waters of the state of Washington during 1984. Progress Report No. 231.* Washington Department of Fisheries, Olympia.

Klingeman, Peter C., Scott M. Kehe, and Yaw A. Owusu. 1984. *Streambank erosion protection and channel scour manipulation using rockfill dikes and gabions. WRRI-98.* Water Resources Research Institute, Oregon State University, Corvallis.

Land Usage and Development Technical Committee. 1970. *Comprehensive study of water and related land resources, Puget Sound and adjacent waters: Appendix V, Water-related land resources.* Pacific Northwest River Basins Commission.

Latourell Associates, The. 1974. *Comprehensive Plan: Skokomish Indian Reservation.* Skokomish Indian Tribe, Shelton, Washington.

Martinson, R. K. 1973. *Salt-water fishery resources and shoreline development in the southern Hood Canal area, Washington. Miscellaneous Geological Investigations Map I-853-E.* USDI Geological Survey.

Mason Regional Planning Council. 1982. *Mason County Comprehensive Plan.* Mason Regional Planning Council, Shelton, Washington.

McFarland, Carl R. 1983. *Oil and gas exploration in Washington, 1900 - 1982. Information Circular 75.* Division of Geology and Earth Resources, Washington Department of Natural Resources, Olympia. (Including addendum dated 29 January 1986.)

Megahan, W. F. and W. J. Kidd. 1972. *Effects of logging roads on sediment production rates in the Idaho batholith. Research Paper INT-123.* USDA Forest Service.

Milhous, R. T. 1982. Effect of sediment transport and flow regulation on the ecology of gravel-bed rivers. pp 819-842 in: R. D. Hey, J. C. Bathhurst, and C. R. Thorne. *Gravel-bed rivers.* J. Wiley, New York.

Molenaar, Dee and J. E. Cummans. 1973. *Water resources of the Skokomish Indian Reservation, Washington.* US Geological Survey, Tacoma, Washington.

Molenaar, Dee and John B. Noble. 1970. *Geology and related ground-water occurrence, southeastern Mason County, Washington. Water Supply Bulletin No. 29.* Washington Department of Water Resources, Olympia.

Morrison-Maierle, Inc. 1979. *Skokomish River hydropower and natural flow evaluation.* (Final report to Skokomish Consulting Services, Shelton Washington.) Morrison-Maierle Inc., Helena, Montana.

Navigation Technical Committee. 1970. *Comprehensive study of water and related land resources, Puget Sound and adjacent waters: Appendix VII, Navigation.* Pacific Northwest River Basins Commission.

Ness, A. O. and R. H. Fowler. 1960. *Soil survey of Mason County, Washington.* USDA Soil Conservation Service.

Newkirk, Ray. 1983. *Skokomish-Dosewallips Basin WRIA 16, Technical Document Supplement (Natural Flow Study). Office Report No. 74-A.* Water Resources Management Division, Washington Department of Ecology.

Office of Financial Management. 1986. *1986 Population Trends for Washington State.* Office of Financial Management, Olympia, Washington.

OFM - see Office of Financial Management.

Olson, Forrest W. 1983. *Flow-related effects of the proposed South Fork Skokomish River hydroelectric project on salmon and Steelhead.* CH2M Hill, Inc., Bellevue, Washington.

Olympic National Forest. 1978. *Canal land management plan: Final environmental impact statement.* Olympic National Forest, Olympia, Washington.

Olympic National Forest. 1986a. *Proposed land and resource management plan: Draft plan.* Olympic National Forest, Olympia, Washington.

Olympic National Forest. 1986b. *Proposed land and resource management plan: Draft environmental impact statement.* Olympic National Forest, Olympia, Washington.

ONF - see Olympic National Forest.

Phillips, Earl L. 1968. *Washington climate for these counties: King, Kitsap, Mason, and Pierce. Publication E.M. 2734.* Cooperative Extension Service, College of Agriculture, Washington State University, Pullman.

Phillips, Earl L. and Wallace R. Donaldson. 1972. *Washington climate for these counties: Clallam, Grays Harbor, Jefferson, Pacific, and Wahkiakum. Publication EM 3708.* Cooperative Extension Service, College of Agriculture, Washington State University, Pullman.

Proctor, C. M, et al. 1980. *An ecological characterization of the Pacific Northwest coastal region. 5 Vol. FWS/OBS-79/11 - 79/15.* US Fish and Wildlife Service, Biological Services Program.

Recreational Technical Committee. 1970. *Comprehensive study of water and related land resources, Puget Sound and adjacent waters: Appendix X, Recreation.* Pacific Northwest River Basins Commission.

Richardson, Donald. 1973. *Streamflow in the southern Hood Canal area, Washington, as related to land-use planning. Miscellaneous Geological Investigations Map I-853-C.* USDI Geological Survey.

Rushton, Clifford D. 1985. *Instream Resources Protection Program: Skokomish - Dosewallips Water Resource Inventory Area.* Washington Department of Ecology, Olympia.

Saunders, Robert S. 1981. *Land Use Ordinance: Skokomish Indian Tribe.* South Puget Intertribal Planning Agency.

SCS - see Skokomish Consulting Services.

SPIPA - see South Puget Intertribal Planning Agency.

Sedell, James R. and Wayne S. Duval. 1985. *Influence of forest and rangeland management on anadromous fish habitat in western North America. General Technical Report PNW-186.* USDA Forest Service Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Sedell, James R., Fred H. Everest, and Frederick J. Swanson. 1982. Fish habitat and streamside management: Past and present. pp 244-255 in: *Proceedings of the Society of American Foresters, Annual Meeting (September 27-30, 1981).* Society of American Foresters, Bethesda, Maryland.

Sedell, James R. and Judith L. Froggatt. 1984. Importance of streamside forests to large rivers: The isolation of the Willamette River, Oregon, U.S.A., from its floodplain by snagging and streamside forest removal. *Verh. Internat. Verein. Limnol.* 22:1828-1834.

Sedell, James R. and Karen J. Luchessa. 1982. Using the historical record as an aid to salmonid habitat enhancement. pp 210-223 in: Neil B. Armantrout, Ed. *Proceedings of a Symposium on Acquisition and Utilization of Aquatic Habitat Inventory Information, 28-30 October 1981, Portland, Oregon.* Western Division, American Fisheries Society, Bethesda, Maryland.

Smith, Mackey, and R. J. Carson. 1973. *Relative slope stability of the southern Hood Canal area, Washington. Miscellaneous Geological Investigations Map I-853-F.* USDI Geological Survey.

Sorlie, Greg. 1975. *Background information for water resources management planning in the western and southern Puget Sound basins. WRIS Technical Bulletin No. 18.* Washington Department of Ecology, Olympia.

South Puget Intertribal Planning Agency & Skokomish Consulting Services. 1979. *Overall Economic Development Plan: Skokomish Indian Tribe.* Skokomish Indian Tribe, Shelton, Washington.

Strickland, Richard (ed.). 1986. *Wetland functions, rehabilitation, and creation in the Pacific Northwest: The state of our understanding. Proceedings of a conference held April 30 - May 2, 1986, Fort Worden State Park, Port Townsend, Washington.* Washington Department of Ecology publication number 86-14.

Swanston, Douglas N. 1978. Effect of geology on soil mass movement activity in the Pacific Northwest. pp 89-115 in: *Forest Soils and Land Use: Proc. Fifth North Amer. For. Soils Conf., Colo. State Univ. Aug. 1978.* USDA Forest Service.

Tacoma City Light. 1985. *Tacoma power system information.* City of Tacoma, Department of Public Utilities, Light Division.

TCL - see Tacoma City Light.

Troendle, C. A. and R. M. King. 1987. The effect of partial and clearcutting on streamflow at Deadhorse Creek, Colorado. *Journal of Hydrology* 90: 145-157.

Valentine, Grant M. and Marshall T. Huntting. 1960. *Inventory of Washington minerals: Part 1, Nonmetallic minerals. Bulletin 37.* Division of Mines and Geology, Washington Department of Conservation, Olympia.

Wampler, Phillip L. 1980. *Instream flow requirements of the lower North Fork, South Fork and mainstem Skokomish River.* Fisheries Assistance Office, US Fish and Wildlife Service, Olympia, Washington.

Washington Department of Fisheries. 1957. *Research relating to fisheries problems that will arise in conjunction with current and projected hydroelectric developments in the Skokomish River.* Washington Department of Fisheries, Olympia.

Washington Department of Fisheries. 1987. *Watershed planning: Proposed enhancement report.* Washington Department of Fisheries, Olympia.

WDOF - see Washington Department of Fisheries.

Whitlam, Robert G. 1987. State Archaeologist, Washington Office of Archaeology and Historical Preservation, Olympia. Letter to Douglas J. Canning, Washington Department of Ecology.

Williams, R. Walter, Richard M. Laramie, and James J. Ames. 1975. *A catalog of Washington streams and salmon utilization: Volume 1, Puget Sound region.* Washington Department of Fisheries, Olympia.

Williams, J. R., H. E. Pearson, and J. D. Wilson. 1985. *Streamflow statistics and drainage-basin characteristics for the Puget Sound region, Washington: Volume 1, Western and southern Puget Sound. Open File Report 84-144-A.* US Geological Survey, Tacoma, Washington.

Woolridge, David D. 1971. *Revised objectives for design of urban stormwater systems in the Puget Sound region. Completion report for US Department of the Interior OWRR Project B-035-WASH, Annual Allotment Agreement Number 14-31-0001-3140.* College of Forest Resources, University of Washington, Seattle.

Yoshinaka, M. S., and N. J. Ellifret. 1974. *Hood Canal: Priorities for tomorrow.* US Fish and Wildlife Service, Portland, Oregon.

SKOKOMISH RIVER
COMPREHENSIVE FLOOD CONTROL MANAGEMENT PLAN

APPENDIX A
SKOKOMISH RIVER INVESTIGATION

June 1987

Dr. Donald R. Reichmuth

Geomax, P.C.
Professional Engineers and Surveyors
622 South 6th Avenue
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INTRODUCTION

In April 1987, the Floodplain Management Section, Shorelands and Coastal Zone Management Section, Washington Department of Ecology contracted with Dr. Donald R. Reichmuth, a specialist in river and streambank erosion control and management. Dr. Reichmuth conducted an aerial reconnaissance of the Skokomish Valley and central South Fork basin on May 20th, as well as inspections of the two streambank erosion hazard areas -- the vicinity of Skokomish Valley Community Church, and the vicinity of River Mile (RM) 1.8 on the South Fork.

Dr. Reichmuth's report to Ecology is reproduced in its entirety in this appendix.

Geomax
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June 25, 1987

TO: Lisa Randlette, Washington Dept. of Ecology

FROM: Dr. Donald R. Reichmuth

RE: Skokomish River Investigation

This report is based on my examination of photos and reports provided by the Department of Ecology, a one-day field investigation which included both an aerial observation of most of the drainage and a ground investigation of some of the lower river. Additionally, discussions were held with local landowners, county officials and personnel from the affected State agencies. These field investigations were carried out on May 20, 1987.

The Skokomish River system consists of two primary tributaries, each approximately thirty miles long, and a lower main stem which is approximately ten miles long that has its mouth in the Hood Canal. The lower portions of the river are affected by tide, and, consequently, have a very flat gradient. On the other hand, the upper drainages have many very steep side tributaries which feed into the main forks. The north fork is totally controlled by Lake Cushman, and most of the water is diverted out of the reservoir directly into Hood Canal for power generation. This loss of water in the north fork does limit the sediment carrying capacity of the main stem because of loss of water. With Lake Cushman totally trapping sediment from the upper drainage, the north fork contributes very little material to the main stem.

The upper south fork is characterized by moderate gradient, and extremely steep side drainages entering the stream. The lower five miles of the south fork are largely on bedrock, and here the stream has been incised and flows in a rather steep, narrow gorge. Below the gorge, the south fork has a quite flat gradient, and the areas here and below the junction of the north fork on the main stem are flowing in a rather wide valley with fairly low gradients.

It is apparent that this lower area, from about five miles upstream from the mouth to the area where the south fork enters the gorge, is receiving large quantities of sediment, which is destabilizing the streams. It was observed in this area that large gravel bars are building, and, consequently, the stream is forced to erode into banks where finer or more erodible material is present. This has produced considerable bank erosion, and has diminished the channel capacity sufficiently so that floods are occurring into areas and at frequencies that have not been experienced earlier.

The aerial observation of the upper south fork drainage revealed that large quantities of sediment are being released from the heavily logged areas that cover large portions of the basin. Examples of this logging and erosion are typified by photos A and B which accompany this report. These photos are typical of the logging activity in most of the upper south fork.

Photo A illustrates the general characteristic of most of the upper basin. As seen in this photograph, there are numerous clear cuts of varying age, and many log haul roads cutting the hillsides. The river channel is braided and unstable, and large quantities of gravel and logging debris or trees are seen in the floodplain.

Photo B shows a more detailed picture of one side drainage. The gravel moving down this drainage is clearly seen in the photograph. The tree buffer which separates the logging area from the river bottom has not been able to filter out and trap the gravel from the upper areas. Many of the logs seen on the floodplain undoubtedly are derived from the stream being forced into the wooded banks by the gravel depositions occurring in the main channel. These gravels are flushed down the stream and passed through the steeper gorge areas without causing significant deposition or bank erosion, because this section is confined by bedrock. However, once the river leaves this gorge, large quantities of gravel are immediately deposited. This is shown very clearly in the left side of Photo C. Here it is noted that gravel has been deposited far away from the channel and that the bare depositional area is very large, as compared with the gorge areas seen on the right side of the photograph.

From this point downstream to near the Indian reservation border, which is some five miles upstream from the mouth, the river is characterized by a braided, unstable set of channels, and numerous unvegetated gravel bars. These bars are clearly filling the channel, which greatly reduces the flood carrying capacity of the river. Consequently, much of the water in flood stage will go out into the farm areas. Photo D is typical of the conditions which occur in this zone. Because the gradient is so flat, only the finer materials can be carried down to the mouth near the Hood Canal. In these areas, one sees only deposition of finer materials.

Because the upper drainages are contributing so much material and show no signs of reaching stability, it is expected that this downstream migration of large quantities of gravel will continue until something is done to control the material nearer its source. This will require either limiting future logging, or carefully controlling the areas where logging occurs, so that sediment releases are minimized. Additionally, control structures should be placed in the upper drainage to trap as much gravel as possible, before it reaches the canyon area. If these measures are not taken, it is virtually impossible to protect the lower agricultural areas from extreme bank instability, because the gravels will, of necessity, deposit within the farm area, causing the stream to be diverted into the banks or fields during flood stage. Until the upper area is controlled, there is really very little that can be done to protect the lower agricultural areas from bank erosion and flooding.

It is possible to locally protect structures such as highways, and perhaps some of the key building areas, by installing structures in the lower area. At best, these will be temporary measures, which do not address the prime cause but only deal with the localized effects of the gravel depositions.

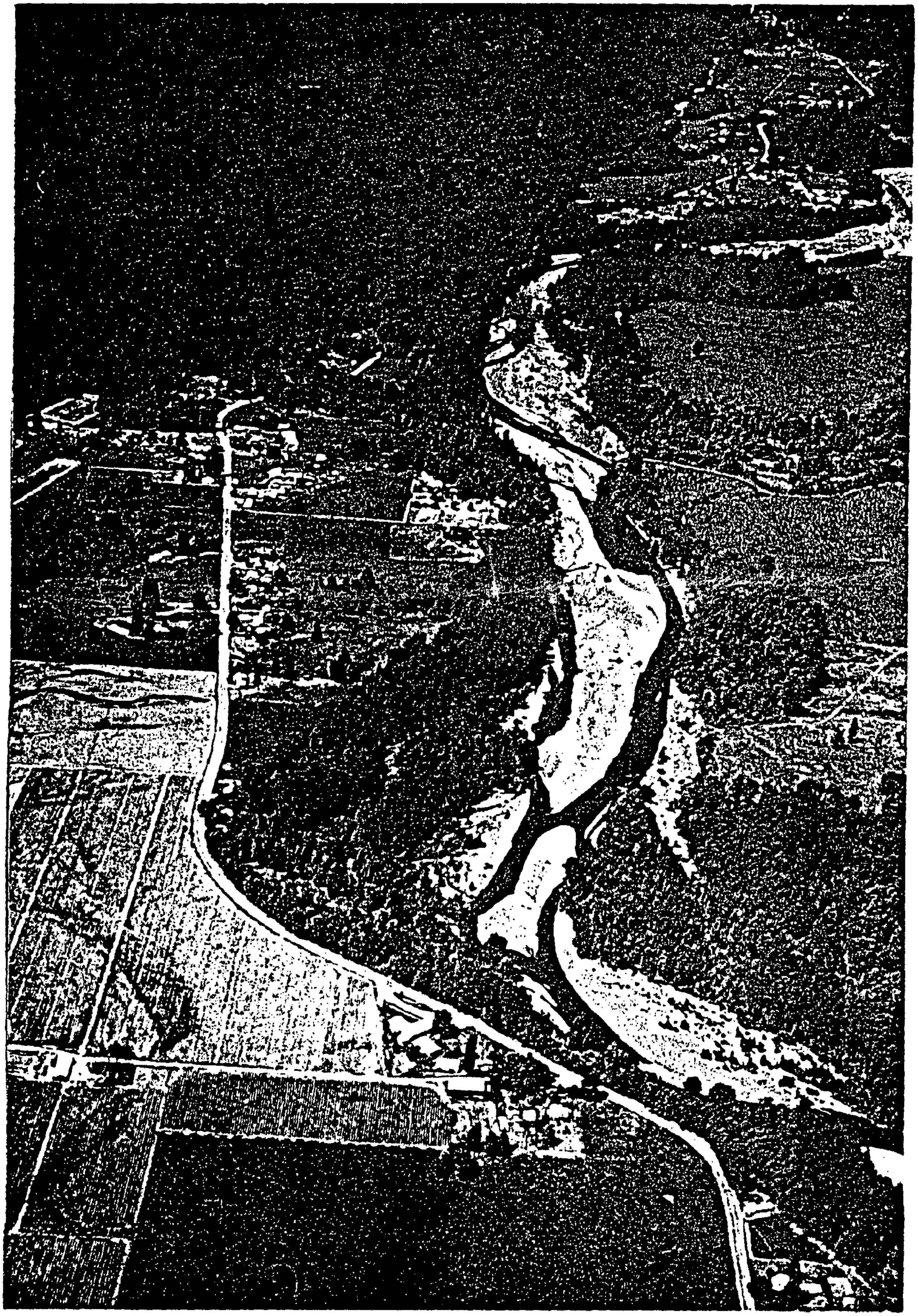
It should be clear from the above discussion that a solution to the erosion and increased flooding problems occurring in the lower agricultural area requires more than a localized "band-aid" approach to the problem. It is therefore recommended that an integrated, drainage-wide program be established, which simultaneously considers the upper drainage affected by logging with the middle agricultural area and the lower tidal area. If such a program is not established, it is my feeling that there will be continuous conflict between the logging and agricultural interests in the lower areas. It is equally clear that if work is only attempted in the agricultural area, the money will be largely wasted, because these efforts are only dealing with symptoms and not the root cause of the instability which has been observed on the river.

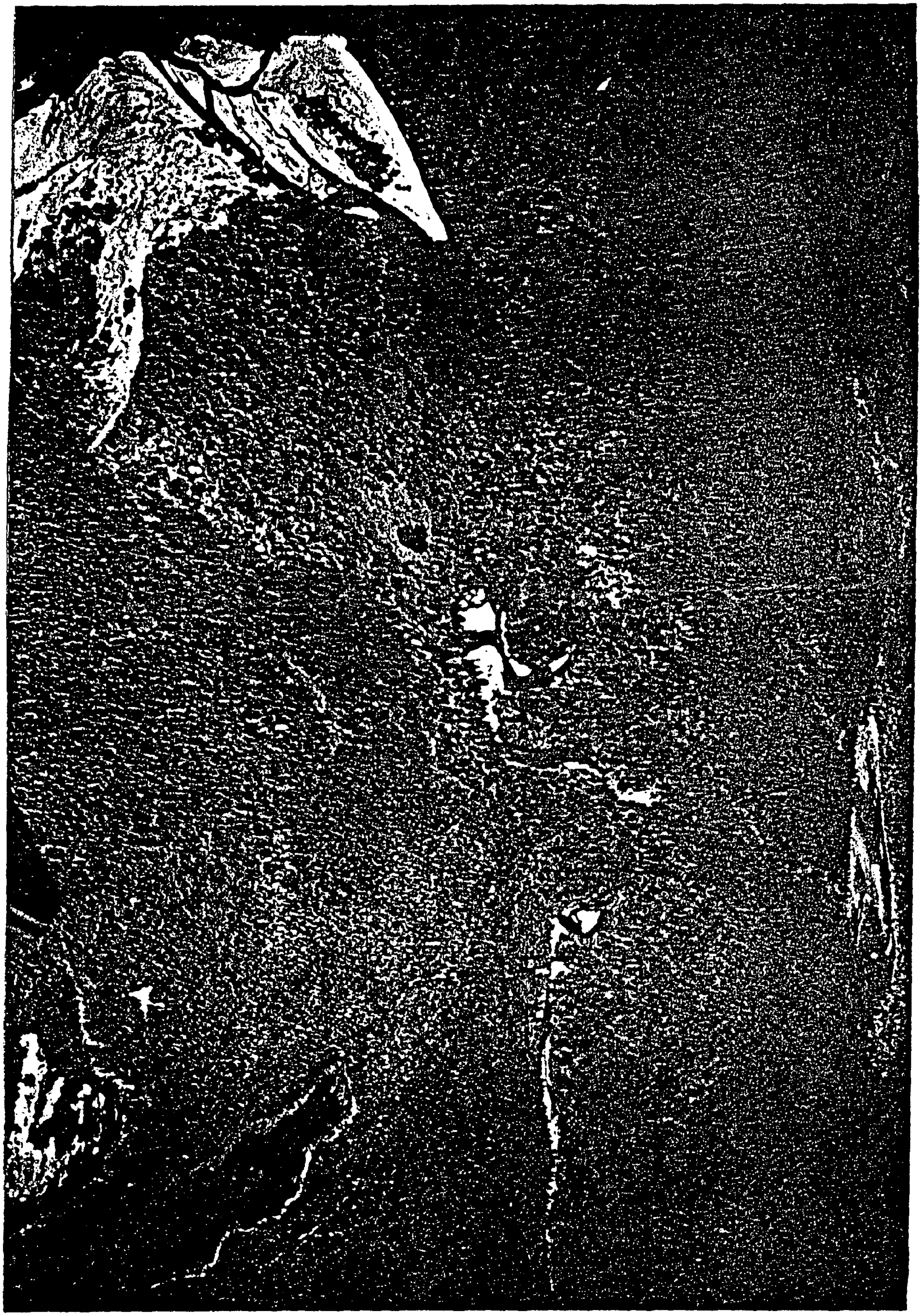
GEOMAX, P.C.

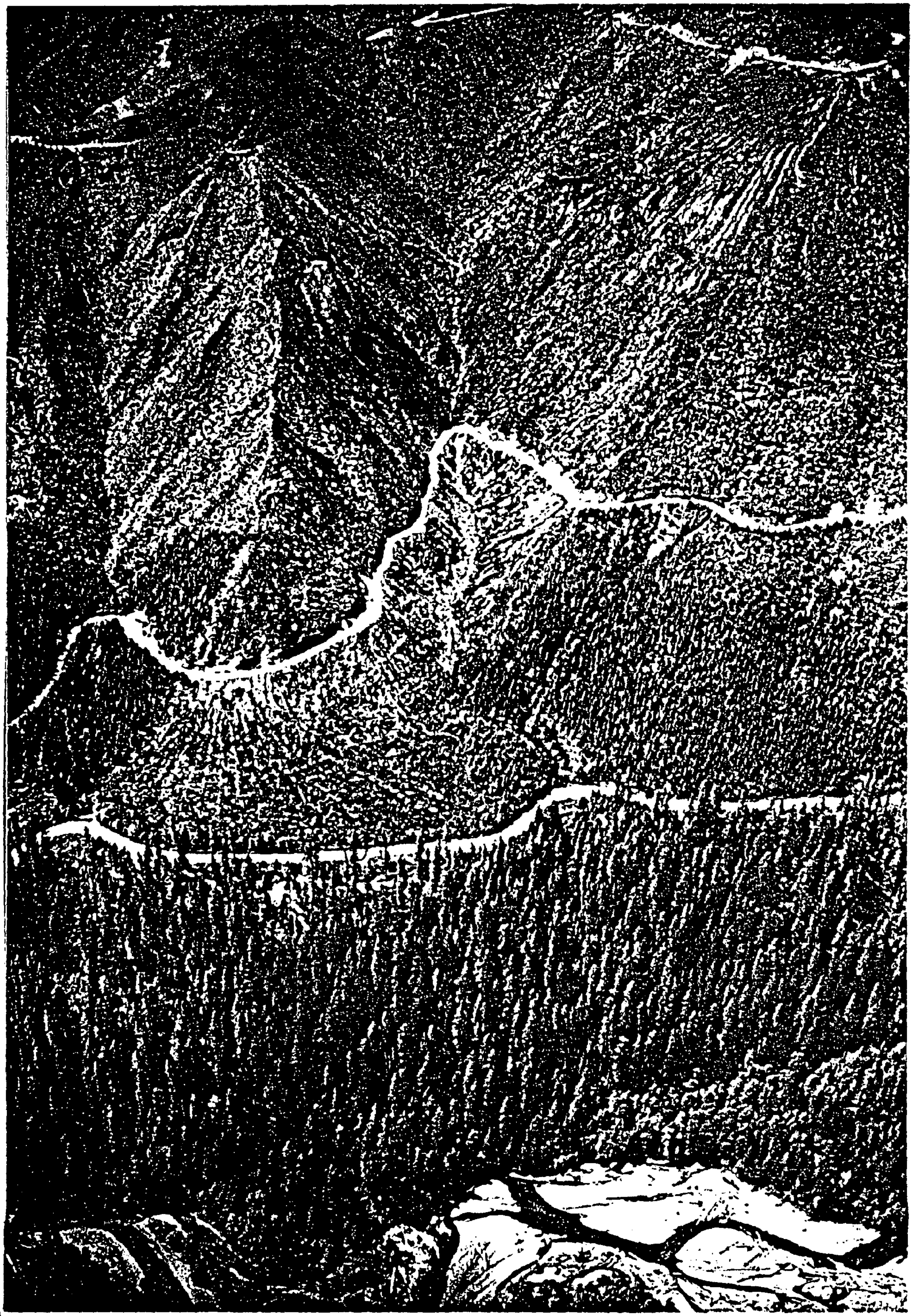
By Donald R Reichmuth

Dr. Donald R. Reichmuth, PE/LS
President

DRR:mdl
Enclosures







SKOKOMISH RIVER
COMPREHENSIVE FLOOD CONTROL MANAGEMENT PLAN

APPENDIX B
HISTORIC FLOOD CONTROL WORK

INTRODUCTION

This appendix summarizes known flood control work and other works affecting flooding and stream flow undertaken in the Skokomish Valley during the past forty years. The information assembled in this appendix is not exhaustive; it is based on available information on state cost sharing projects, flood control work permits, and Hydraulic Project Approval (HPA) records. Numerous flood control works have been constructed without benefit of either a state cost sharing or a permit.

Flood control works constructed under state cost sharing programs are summarized in Table B1.

Flood control works permitted under the Flood Control Zone Permit system are summarized in Table B3.

Instream and streambank work permitted under the Hydraulic Project Approval program is summarized in Table B4.

Table B1. FLOOD CONTROL COST SHARE WORK, SKOKOMISH RIVER VALLEY, 1950 - 1973.

Stream Section(s); Township, Range	Work Period	Nature of Work	Project Cost, $ Total	 State Share
Skokomish 7,8,9,16,17,18; 21N, 4W	8-9, 1949	CA	1,650	825
Vance Creek 12,13; 21N, 4W	6-9, 1950	CA, RA, SG	12,551	6,275
Skokomish W12; 21N, 4W	8-9, 1951	CB	700	280
Skokomish W12; 21N, 4W	7-9, 1951	CA	1,075	430
Skokomish NW18; 21N, 4W	1-3, 1953	CB	566	226
Skokomish 7,8,9,18; 21N, 4W 12,13; 21N, 5W	9-10, 1953	CB	8,080	3,232
Skokomish 7; 21N, 4W	9, 1953	CB	3,000	1,200
Skokomish 7,8,9,16,17,18; 21N, 4W Vance Creek 11,12,13; 21N, 4W	8-9, 1953	CC, DB, DC1	12,736	5,094
Skokomish & Vance Creek 12,13; 21N, 4W	12, 1954	CA	1,456	582
Skokomish	6, 1973	RA	3,570	860
TOTAL			45,384	19,004

Notes:
1. All projects completed as State Flood Control Participation work under Chapter 86.26 RCW with Mason County as the participating agency.
2. See Table B2 for a key to the Nature of Work codes.

* * * * *

Table B2. NATURE OF WORK CODES (Table B1).

Code	Nature of Work
C	Channel Modification
CA	Bar Removal or Dredging
CB	Debris Removal, Jam Removal
CC	Change or Realignment
CD	Stabilization
D	Dike
DA	Restored
DB	Repaired
DC	Improved
DC1	New
DC1a	Widened
DC1b	Heightened
DC1c	Lengthened
DC2	Relocated
DE	Reinforced
GM	General Maintenance
OD	Outlet Ditch
DRD	Drainage Ditch
BM	Borrow Material
R	Revetment (Riprap)
RA	Rock
RAa	Reinforcing
RB	Brush
RC	Tied Trees
RD	Piling or Timber Cribbing
SD	Drainage Structures
SDA	Culvert
SDB	Tide Gate
SG	Groin

Table B3. FLOOD CONTROL PERMITS, SKOKOMISH FLOOD CONTROL ZONE 16. Page 1.

Permit Year	Stream Section(s); Township, Range	Applicant	Description of Work
101 1956	Hunter Creek 16; 21N; 4W	Mason County	Hunter Creek Bridge.
102 1962	Skokomish River	Mason County	Revetment; construction of Purdy Cutoff Road.
103 1962	Skokomish River	Mason County	Restoration & revetment on road near & along Vance Creek.
105 1964	South Fork S1/2, SE1/4, 12; 21N; 5W	Herbert Baze	Rock riprap revetment
106 1965	Hunter Creek W1/2, 17; E1/2, 18; 21N; 4W	Arvid Johnson	Channel modification; debris removal.
107 1965	Hunter Creek N1/2, 17; 21N; 4W	Haldane Johnson	Channel modification; debris removal.
108 1965	South Fork 12; 21N; 5W	Theodore Richert	Debris removal; gravel bar removal.
110 1965	Skokomish River SE1/4, 8; 21N; 4W	Hunter Brothers	Cabled log revetment.
111 1965	Skokomish River SW1/4, 9; 21N; 4W	Martin Smith	Revetment.
112 1966	North Fork 7; 21N; 4W	Ted Richert	Diking; riprap.
113 1966	South Fork 12; 21N; 5W	C. D. Gravett	Cabled tree revetment.
114 1966	not identified SE1/4, 12; 21N; 4W	Hunter Brothers	Dike; cabled tree revetment.
115 1966	Skokomish River NW1/4, 13; 21N; 4W	Hunter Brothers	Dike.
116 1967	Vance Creek SW1/4, 11; 21N; 5W	C. L. Barnett	Revetment; channel realignment.
117 1967	Vance Creek SE1/4, 12; 21N; 5W	Charles Linder	Riprap; wing dike.
118 1967	Vance Creek SE1/4, 12; 21N; 5W	Hayes Davis	Dike reconstruction.

Table B3. FLOOD CONTROL PERMITS, SKOKOMISH FLOOD CONTROL ZONE 16. Page 2.

Permit Year	Stream Section(s); Township, Range	Applicant	Description of Work
119 1968	Hunter Creek SW1/4, NE1/4, 18; 21N; 4W	Wash. Dept. Game	Construct fish rearing ponds.
320 1969	Vance Creek NE1/4, SW1/4, 15; 21N; 4W	Wash. Dept. Highways	Bridge and culvert placement.
564 1970	Skokomish River E1/2, 12; 21N; 5W	Ted Richert	Dike reconstruction.
854 1971	Skokomish River NE1/4, 16; 21N; 4W	Emil Griebel	Construct cabin.
945 1971	Skokomish River NW1/4, 17; 21N; 4W	Mason County	Rock riprap.
1267 1971	Skokomish River NW1/4, 13; 21N; 4W	Hunter Brothers	Extend existing dike.
1323 1973	Skokomish River S1/2, 9; 21N; 4W	Wash. Dept. Game	Construct public fishing access.
1471 1975	not identified NW1/4, NW1/4, 7; 21N; 4W	Wash. Dept. Highways	Riprap revetment.
1478 1976	Hunter Creek SE1/4, NW1/4, 18, 21N; 4W	Wash. Dept. Game	Construct earthfill steelhead rearing pond.
1487 1976	not identified NE1/4, NE1/4, 18; 21N; 4W	Ted Richert	Debris removal.
1529 1976	Skokomish River N1/2, 16; 21N; 4W	Glenn Breedlove	Riprap.
1624 1977	Purdy Creek SW1/4, SW1/4, 15; 21N; 4W	Wash. Dept. Fisheries	Construct drainage ditch, rearing pond, and road.
1635 1977	unnamed Purdy Ck. tributary SE1/4, SE1/4, 16; 21N; 4W	Clinton Taylor	Construct residence.
1747 1978	Weaver Creek E1/2, 16; 21N; 4W	Wash. Dept. Fisheries	Construct salmon rearing facilities.
1773 1979	Skokomish River SW1/4, 15; 21N; 4W	Wash. Dept. Fisheries	Structural fill.
1799 1979	South Fork: 12; 21N; 5W 18; 21N; 4W	Skok. Flood Control Dist.	Debris removal.

Table B3. FLOOD CONTROL PERMITS, SKOKOMISH FLOOD CONTROL ZONE 16. Page 3.

Permit Year	Stream Section(s); Township, Range	Applicant	Description of Work
2032 1981	South Fork NW1/4, 12; 21N; 5W	Vince McNally	Log revetment.
2124 1982	Skokomish River E1/2, 15; 21N; 4W	Wash. Dept. Fisheries	Structural fill maintenance.
2181 1983	unnamed side channel N1/2, 15; 21N; 4W	Wash. Dept. Transportation	Replace bridge.
2187 1984	Purdy Creek SW1/4, 15; 21N; 4W	Wash. Dept. Fisheries	Construct salmon incubation ponds and wells.
2286 1986	Purdy Creek SW1/4, 15; 21N; 4W	Wash. Dept. Transportation	Repair bridge.

Source: Washington Department of Ecology files.

Table B4. FLOOD CONTROL RELATED HYDRAULIC PROJECT APPROVAL (HPA) PERMITS, SKOKOMISH RIVER VALLEY. Page 1

Year	Stream Section(s); Township, Range	Applicant	Description of Work
1981	Skokomish River 15; 21N; 4W.	W. Bourgault	Debris removal; bank protection.
1981	Vance Creek 12; 21N; 5W.	W. Bresee	Debris removal.
1981	Vance Creek 12; 21N; 5W.	P. Carney	Bank protection.
1981	Skokomish River 12; 21N; 5W.	James Cox	Bank protection.
1981	Skokomish River 17; 21N; 4W.	Mason County	Bank protection.
1981	Weaver Creek 15; 21N; 4W.	Mason Construction	Debris removal.
1981	South Fork Skokomish 12; 21N; 5W.	Y. McNally	Debris removal.
1981	Skokomish River 15; 21N; 4W.	Skok. Flood Cont. Dist.	Bank protection.
1982	Weaver Creek 15; 21N; 4W.	W. Bourgault	Debris removal.
1982	Vance Creek 11; 21N; 5W.	P. Carney	Bank protection.
1982	North Fork 7; 21N; 4W.	Wash. Dept. Fisheries	Debris removal.
1982	Hunter Creek 17; 21N; 4W.	H. Johnson	Debris removal.
1983	Purdy Creek 14; 21N; 4W.	Wash. Dept. Fisheries	Debris removal.
1983	Weaver Creek 14; 21N; 4W.	Wash. Dept. Fisheries	Debris removal.
1983	Skokomish River 17; 21N; 4W.	H. Johnson	Gravel removal.
1983	Hunter Creek 18; 21N; 4W.	W. Johnson	Debris removal.

Table B4. FLOOD CONTROL RELATED HYDRAULIC PROJECT APPROVAL (HPA) PERMITS, SKOKOMISH RIVER VALLEY. Page 2

Year	Stream Section(s); Township, Range	Applicant	Description of Work
1983	Weaver Creek 15; 21N; 4W	Mason County Public Works	Bridge/culvert removal.
1983	South Fork Skokomish 12; 21N; 5W.	Ted Richert	Bank protection.
1983	Skokomish River 7; 21N; 4W.	Ted Richert	Bank protection.
1983	Weaver Creek 15; 21N; 4W.	Tozier Bros.	Bridge construction.
1984	Skokomish River 15; 21N; 4W	Wash. Dept. Transportation	Bridge replacement.
1984	Weaver Creek 16; 21N; 4W	Wash. Dept. Fisheries	Debris removal.
1984	Purdy Creek 14; 21N; 4W.	Wash. Dept. Fisheries	Debris removal.
1984	Weaver Creek 15; 21N; 4W	Mason County Public Works	Bridge/culvert removal.
1984	Weaver Creek 18; 21N; 4W.	Tozier Bros.	Bridge construction.
1985	Vance Creek 11; 21N; 5W.	Mason County	Bridge maintenance.
1985-86	Hunter Creek 18; 31N; 4W.	Wash. Dept. Game	Bank protection.
1985-88	Purdy & Weaver creeks 14; 21N; 4W.	Wash. Dept.	Debris removal.
1986	Skokomish River 12; 21N; 4W	Wash. Dept. Transportation	Bridge/culvert removal
1986	Swift Creek 18; 21N; 4W	Mason County Public Works	Shoreline maintenance.
1986-87	Vance Creek 11; 21N; 5W.	Mason County Public Works	Bridge construction.
1987	Purdy Creek 15; 21N; 4W.	Wash. Dept.	Bridge construction.

TASK 4.1

Chapter 8

RECOMMENDED FLOOD CONTROL MANAGEMENT PLAN

INTRODUCTION

This study has addressed the problems associated with flooding on the Skokomish River and its tributaries. The study has also discussed some flood control measures used in other communities for reducing flood damages. This chapter recommends alternatives to be further refined and implemented by Mason County in a comprehensive flood control management plan. A management strategy which accounts for all affected land use interests must be developed, from assisting individuals with floodproofing their homes, to making the public roads safer during flood events, to addressing the long term problems of an aggrading and severely floodprone area.

Some difficult questions must be asked within Mason County, and answered. How much in the way of financial and technical resources can Mason County afford to commit to maintaining the Skokomish River in its present channel and what can be done if there is not adequate funding available?

What can Mason County do to maintain the channel capacity of the Skokomish River or risk the increasing frequency and severity of flooding in the Skokomish Valley?

What responsibility does Mason County have in alleviating the potential flood threat and at what point will Mason County have to decide that it cannot guarantee the residents of the Skokomish Valley a safe home and a continued agricultural livelihood?

What is the worst case scenario for flooding in the Skokomish Valley and how will Mason County avoid it?

Local residents and Mason County must choose from immediate and short-term alternatives to address current flood damage problems. The alternatives presented in this chapter as recommendations address:

1. Continuing existing practices
2. Developing and implementing emergency preparedness plans
3. Floodproofing structures
4. Providing for storage of floodwaters
5. Watershed management to limit excessive sedimentation or flooding
6. Artificial or supplemental channel maintenance
7. Diking floodprone areas
8. Bank stabilization
9. Constructing instream diversions in critical areas

The alternatives described and evaluated are not necessarily mutually exclusive. Some alternatives, or aspects of alternatives could be combined. The purpose of describing these alternatives is to outline the array of options available.

Long-term recommendations are also made for the study of aggradation and gravel source. Failure to implement the long-term recommendation will compromise the long term effectiveness of immediate and short term measures.

FLOOD CONTROL MANAGEMENT ALTERNATIVES

ALTERNATIVE 1: CONTINUE EXISTING PRACTICES

Description: No major additional actions would be taken to reduce flood damages in the Skokomish Valley through nonstructural or structural measures. No new residential structures would be constructed within the regulatory floodway, as a requirement of Chapter 86.16 RCW Flood Control Zone Act. Development within the 100-year floodplain would continue to be unregulated since there is no zoning in effect. Floodproofing of proposed structures would be required through the Mason County Flood Hazard Ordinance, which must be adopted for the county to enter the regular phase of the National Flood Insurance Program and continue eligibility for flood insurance. No new channel modifications, dikes, or diversion structures would be built for erosion control or flood reduction purposes. The primary responsibility for flood evacuation would continue to be carried out in an ad-hoc manner by Fire District No. 9.

Effects: The Skokomish River and tributaries would remain partially contained in flood conditions by existing dikes. The river would continue to aggrade and annual flood damages would increase with the increased intensity of flooding.

Private property: Individual floodproofing would reduce some flood damages. Future development in the floodplain would not be restricted to flood compatible uses, although residential development in the floodway would be prohibited. Debris would continue to require removal from fields and roads.

Public property: Debris would continue to require removal from roads. Roads would increasingly be impassable during flood events.

Public safety: Residents of the Skokomish Valley would continue to be exposed to life, health and safety threats, and social disruption. Evacuation would be difficult during flooding.

Agriculture: Soil erosion and crop damage would continue.

Fish and wildlife resources: Existing habitat conditions would continue to be affected by the aggrading river. Riparian habitat would continue to be lost to a widening of the braiding channel.

Recreation: The widening and braiding of the Skokomish River would continue and may increase the difficulty of recreational navigation in summer months.

Sedimentation and aggradation: Existing trends would continue.

Hydrology: Existing trends would continue. The frequency and severity of annual flooding would continue to increase.

Implementation: As Mason County enters the regular phase of the National Flood Insurance Program, new structures within the floodplain will be required to floodproofed. Emergency response assistance will be provided without the benefit of detailed flood preparedness plans. Homeowners will continue to floodproof structures without technical assistance or adequate information on flood heights.

Annual management: The federal government will continue to provide insurance premiums subsidy. Mason County will maintain roads, right-of-ways, riprap, and existing dikes, and provide emergency response assistance. Individuals will maintain their floodproofed structures and repair flood damages without technical assistance on minimizing after flood damages and pay flood insurance premiums.

ALTERNATIVE 2: EMERGENCY PREPAREDNESS

Description: A community's ability to effectively respond during flood events depends upon the emergency preparedness measures that are in place. Both individual and institutional provisions must be made prior to an actual flood event for necessary actions to reduce flood damages and assure public safety.

Individual property owner action plans would consist of provisions for:

1. Auxiliary power
2. Evacuation plan by storm stage and degree of floodprone tendency by area
3. Flood preparedness plan for individual homes. This information would be on file with the Fire District and Sheriff's Department and regular drills would be conducted.
4. The current county emergency preparedness plan would add detailed response measures, such as:
   - A. Preventative evacuation of persons with health or mobility considerations.
   - B. Notice of power shut off or reconnection.
   - C. Post flood inspection process prior to residence reentry.

An automated flood warning system eventually could be developed to provide additional response time for the early implementation of the individual and community emergency preparedness plans. The system would have a receiving station for flood information, such as the County Sheriff's Department. Specific flood warning information could be made available to floodprone residents through an automated message system which would either dial resident's phones and transmit a message or provide a phone number for residents to call for information on flood stage and forecast.

Effects: A certain amount of flood damage can be prevented with an adequate and coordinated response plan and enough time for implementation.

Private property: Flood damages would be reduced, depending on the amount of response time available to implement flood response measures.

Public property: Flood damages would be reduced, depending on the amount of response time available to implement flood response measures.

Public safety: Public safety would be increased.

Agriculture: Soil erosion and crop damage may be reduced if management practices are altered. Agricultural structures would be better protected.

Fish and wildlife resources: No change.

Recreation: No change.

Sedimentation and aggradation: No change.

Hydrology: No change.

Implementation:
Federal - USGS technical assistance in developing or reviewing plans for an automated flood warning system. National Weather Service participation in evaluating and distributing information from an automated flood warning system.

Mason County - Develop flood preparedness plan and make necessary organization and structural changes as needed to effectively implement plan in a flood event. Establish a local flood response center outside of the floodplain at a location other than Fire District No. 9 station. Conduct flood audits on all structures within the floodprone area of the Skokomish Valley.

Individual - Develop an individual flood response plan and implement all recommended measures from a flood audit.

Annual Management:
Federal - Possible National Weather Service participation in an automated flood warning system maintenance.

Mason County - Regular review and practice of flood preparedness plans would be necessary.

Individual - Regular review of individual flood preparedness plans.

ALTERNATIVE 3: FLOOD PROOFING OF STRUCTURES

Description: Many residential and agricultural or nonresidential structures would be floodproofed to reduce flood damages through a combined public and private effort. Floodproofing measures would include:
Elevating electrical and stored materials, elevating structures on fill or a raised foundation, retrofitting closures, and constructing berms around floodprone structures. Relocating structures out of floodprone areas in some instances may be the safest and most effective approach.

To protect public transportation access during flooding, roads could be elevated. Provision for flood water movement would be necessary to avoid a diking affect. A road improvement program, extending over a period of years, would prioritize the most frequently flooded road areas.

Nonresidential structures would be modified so that all openings below the base flood elevation can be made water tight or wet floodproofed. Flood insurance would continue to be available and the rates would be reduced after floodproofing.

Residents would need technical and financial assistance. Public assistance would be made available through Mason County and other participating agencies such as the Army Corps of Engineers and the Federal Emergency Management Agency (FEMA).

1. Develop a plan to make financing available through grants or loans and technical assistance for structural measures. This could be administered through the county building department.

2. Surveys and benchmarks established with Army Corps of Engineers and FEMA assistance.
3. Individualized plans for floodproofing structures developed with assistance from a consultant specializing in flood reduction management.
4. Financial assistance provided to individuals.
5. Individual floodproofing measures conducted.
6. Public floodproofing measures conducted.

Effects: Flood damages and related flood hazards would be reduced significantly.

Private property: Structural damages would be reduced. Skokomish Valley residents would be better informed about flood damage reduction. The river would continue to aggrade and annual flood damages would increase with the increased intensity of flooding. Debris would continue to require removal from fields. Future development in the floodplain would not be restricted to flood compatible uses only. The cost of future development would initially be higher if flood proofed.

Private Property: Flood damage to structures would be significantly reduced.

Public Property: Road access would be improved during flooding.

Public Safety: Life, health and safety threats, and social disruption to residents would be reduced.

Agriculture: No change.

Fish and wildlife resources: Existing habitat conditions would continue to be affected by the aggrading river. Riparian habitat would not be altered by instream flood control measures.

Recreation: The widening and braiding of the Skokomish River would continue and may increase the difficulty of recreational navigation in summer months.

Sedimentation and aggradation: No change.

Hydrology: Existing trends would continue. The floodplain would continue to dissipate flood water without restriction.

Implementation:

Federal - Establish base flood elevations for structures, provide technical assistance in elevating and wet floodproofing of structures, as available under the Corps of Engineers Flood Plain Management Services (FPMS) Program.

Mason County - Provide technical through the building department. Financial assistance, such as a revolving loan fund, could be established for financing individual floodproofing measures. Road access and emergency response would be improved by measures such as elevating the roadway and locating the flood response facility outside of the floodprone area of the Skokomish Valley.

Individual - Finance individual flood proofing measures with outside technical assistance.

Annual management:
Federal - None.
Mason County - Administration of technical and financial assistance, maintenance of roads and right-of-ways, and provide emergency response.
Individual - Reduced insurance premiums and repairs of non-floodproofed items.

ALTERNATIVE 4: STORAGE OF FLOOD WATERS

Description: Historically, wetlands constituted much of the land within the Skokomish Valley floodplain. The flood storage function of wetlands is becoming increasingly appreciated as engineered stormwater detention facilities are designed and constructed at great expense. Where remnant wetlands can be retained or restored to serve the natural function of flood water storage, this approach should be implemented prior to the development of more expensive and higher maintenance flood storage options of man-made structures. A detailed wetland inventory should be conducted of the Skokomish River watershed. The inventory would establish current and historic wetland sites, evaluate current and historic storage capacities, and determine potential areas for increasing storage capacity through wetland enhancement.

1) Retention structures of varying capacities would be constructed in the South Fork Skokomish River drainage basin and Vance Creek drainage basin. Peak flows of flood water would be retained over a greater time period and would reduce the amount of flooding experienced in the lower Skokomish Valley. Low stream flow would be enhanced somewhat. In the early 1980's, a proposal was made to establish a hydropower facility on the South Fork, which would have incidentally provided some moderation of peak flood flows.

2) Lake Cushman - Lake Cushman provides storage and diversion of approximately half of the water within the Skokomish basin. Some additional flood storage capacity may be available, according to preliminary Corps of Engineers review, although it is not anticipated to provide much relief during peak flood flows.

Effects: Peak flood flows would be reduced, although floods would have a longer duration.

Private property: Flood damages would be less severe.

Public property: Flood damages would be less severe.

Public safety: Evacuation would be more feasible.

Agriculture: Flood damages would be less severe.

Fish and wildlife resources: Summer stream flows would be increased somewhat which may improve fish habitat. Some spawning and wildlife habitat areas would be lost to water impoundment. To the extent that existing wetlands are conserved for flood water storage, fish and wildlife habitat could be maintained.

Recreation: Pond or lake-oriented opportunities may be increased. Stream-oriented opportunities would be reduced by retention areas.

Sedimentation and aggradation: To the extent that instream detention structures are used, sedimentation of suspended and bed load materials would reduce aggradation of the lower South Fork and upper main stem.

Hydrology: Peak flood flows would be reduced and water surface levels would be lower while the duration of peak flows would be increased. The degree of inconvenience would be less, but the duration longer.

Implementation: Depends on the scale and type of the proposed storage facility. Wetland acquisition and maintenance could be a multi-agency project.

Annual management: Depends on the scale and type of the proposed storage facility.

ALTERNATIVE 5: WATERSHED MANAGEMENT

Description: Land use practices within the Skokomish watershed would be evaluated to determine which activities may be accelerating surface water runoff and contributing to increased peak flows and sediment transport materials. Measures to reduce the impacts of land use activities in the watershed would include;

1. Erosion control and remedial action throughout the watershed.
2. Vegetation management and revegetation throughout the watershed.
3. Upland sediment traps in ephemeral channels to slow water velocity over bare soils and prevent soil migration.
4. Headcut control measures such as reducing slopes and seeding.
5. Identify sediment feeder areas such as bluffs and control if possible.
6. Retention and settling ponds.

We also recommend early adoption of the TFW agreements by the Olympic National Forest, particularly with respect to closure of roads.

Effects: Long term slowing of the rate of river sedimentation and aggradation. Channel braiding and debris build up would be reduced. Rate of increased overbank flooding would be slowed.

Private property: Threat of continuously more frequent and severe flooding would be reduced.

Public property: Threat of continuously more frequent and severe flooding would be reduced.

Public safety: Private property: Threat of continuously more frequent and severe flooding would be reduced.

Agriculture: Private property: Threat of continuously more frequent and severe flooding would be reduced.

Fish and wildlife resources: Fish and wildlife resources would be improved to the extent that they are currently adversely affected by channel braiding and reduced channel capacity.

Recreation: No change.

Sedimentation and aggradation: Long term slowing of the rate of river sedimentation and aggradation.

Hydrology: Peak flood flows might be reduced somewhat.

Implementation: An extensive and cooperative effort by private and public property owners would be required to evaluate all lands within the watershed and implement measures to reduce erosion and surface water runoff. Technical assistance regarding erosion control, vegetation management, sediment traps, and headcut control measures could be provided by the Soil Conservation Service.

Annual management: Ongoing management by all property owners would be supplemented by a long-term monitoring program to evaluate the effectiveness of watershed management practices.

ALTERNATIVE 6: CHANNEL CAPACITY

Description: A perceived purpose of channel capacity maintenance has been to reduce the amount of overbank flooding experienced in the main stem Skokomish Valley. Channel capacity maintenance works include: restoration of lost capacity in old meanders and side channels; removal of impediments such as unused pilings; and gravel and debris removal.

Evidence shows that only minor or limited reductions of flood height can be achieved through debris and gravel removal. The effect of channel restoration is variable, and must be evaluated on a case by case basis. Since the Skokomish Valley experiences overbank flooding on an annual basis, the containment of major flooding through channel maintenance would require a channel capacity which is environmentally impractical to establish, let alone prohibitively expensive to maintain.

A secondary, but possibly more achievable, purpose for conducting channel maintenance is to reduce the amount of river braiding and bank erosion occurring in areas where river sediment materials accumulate. The potential of the main stem Skokomish River to significantly change its course across the Skokomish Valley makes channel maintenance a particularly challenging matter for Mason County.

The reduced North Fork flows -- approximately half of the entire basin's flow -- has potentially reduced the amount of sediment transported through the river system and therefore may have increased the need for artificial or supplemental channel clearing to maintain channel capacity. The reestablishment of minimum flows on the North Fork may increase the channel capacity somewhat and therefore lessen the amount of material considered for removal from the river.

Channel maintenance would incorporate considerations such as removing sediment and fill from blocked old meanders. An old meander system of the main stem Skokomish River, flowing west of US 101 and north of the main channel (N 1/2, Section 15, T21N, R4W), historically carried more volume but has been blocked at both the inlet and the outlet. Additional channel capacity can be regained by evaluating and restoring old meander systems.

Abandoned pilings in the lower reach of the Skokomish River main stem should be removed to prevent the accumulation of log jams and resulting channels shifts.

The entire reach of the Skokomish River and its tributaries should be evaluated to determine the most efficient locations for removing sediment from the system. Where possible, sediment traps should be located at sites between the initial source and the deposit area rather than merely at the point of deposition.

Effects: Bank erosion and river braiding may be reduced. The threat of a major channel change may be reduced or delayed. Some minor reduction of flood heights may be accomplished for frequent floods.

Private property: Bank protection measures may become less necessary if bank erosion and river braiding are reduced.

Public property: Roads and bridges may be less threatened.

Public safety: The chance of road or bridge washouts may be reduced, assuring that evacuation during flooding would be feasible. Flood height would not be notably affected.

Agriculture: Where bank erosion is threatening crops, these areas may experience a reduced rate of land loss.

Fish and wildlife resources: If conducted properly, fish and wildlife resources would not be adversely affected. Increased channel capacity may enhance fish habitat. If the channel maintenance program included back channel removal of materials, impacts would be limited. Drop structures in some instances may enhance fish habitat.

Recreation: No change.

Sedimentation and aggradation: Sedimentation and aggradation would be to some extent regulated or maintained at a lower rate.

Hydrology: The river channel may be more stable with sediments removed.

Implementation: Effective artificial channel maintenance requires that either the current or an historic channel capacity throughout the river be established. The rate of sediment movement and volumes of sediment material being contributed to the rapidly aggrading river channel must be calculated to determine the degree of channel maintenance needed. A maintenance program should be developed for the entire length of river experiencing altered channel capacity. This would include estimates of material to be removed at various cross-sections and a regular schedule for removing the material at specific sites. Long-term monitoring of the bedload amount and channel capacity would be a part of the channel maintenance program.

Annual management: Mason County would have to commit significant financial resources to a regular channel maintenance program. The large volumes of sediment materials to be removed from the Skokomish River floodplains would probably require a large commercial use on the scale proposed by Hamma Hamma Sand and Gravel for a location on Hood Canal.

Individual efforts could effectively supplement a river-wide channel maintenance program.

ALTERNATIVE 7: DIKING

Description: Diking can effectively reduce the amount of flood waters experienced, depending on the structures height and frequency of flood protection provided. The current diking in the Skokomish Valley provides flood relief to an undetermined flood frequency. Along the Vance Creek it has been reported that no flooding has been experienced since the dike running along the bank was constructed. It should be established just how much flood water can be accommodated before overtopping or breaching occurs. Even more severe flooding can occur when that level of dike protection is exceeded. Also, no regular dike maintenance or inspection has been conducted. Mason County should acquire this information so that any preventative maintenance or dike improvements can be made.

The existing diking in the lower Skokomish Valley is incomplete and allows annual flood flows to cut around the end of one reach of dike. There is a possibility that the partial diking is diverting and focusing the flood flows into a more narrow area and causing more severe erosion at the end(s) of the diked area. Rather than shallow sheet flows over a broader area, the velocity and volume of the flood flows through the undiked area may be creating more of an overall threat of catastrophic channel change.

These concerns related to the existing dikes should be addressed be any proposals for additional diking are considered. The appropriate alignment for any diking within the lower Skokomish Valley should take into account the level of flood protection sought, necessary internal drainage systems needed for diked area, upstream and downstream impacts of diking, the necessary ongoing maintenance of such structures, possible improvements that may be needed as the river continues to aggrade, comparison of diking to other floodproofing measures. It may be more appropriate to floodproof structures or construct localized berms or dikes around compounds of structures, with the provision of internal pumping of surface waters.

Effects: An effective diking system could provide substantial relief from low-frequency to high-frequency flooding and reduce flood damages.

Private property: Structural damage from flooding could be minimized.

Public property: Road and bridge access could be improved during flood events.

Public Safety: Evacuation during flood events would not be necessary.

Agriculture: Soil loss and crop damage would be reduced.

Fish and wildlife resources: More intense instream flood flows could adversely affect fish and wildlife resources.

Recreation: River access would be affected

Sedimentation and aggradation: The effects of diking are not readily predictable, and would vary depended on the extent and design of the diking; effects could be beneficial or adverse.

Hydrology: The effects of diking are not readily predictable, and would vary depending on the setback of the dikes from the main channel.

Implementation: An evaluation and design of the appropriate dike alignment and an environmental impact statement would be required.

Annual management: Construction and maintenance of dikes would be a very resource intensive flood control measure but will result in a substantial reduction of flooding to the south side of the Skokomish Valley. The tendency to divert erosion downstream would be increased.

ALTERNATIVE 8: BANK STABILIZATION

Description: The term, bank stabilization, encompasses a wide range of measures intended to prevent soil losses from slopes and streambanks. Slope regrading and bank hardening with rock revetment, concrete lined channels, and intensive vegetation planting with or without revetments are some of the more commonly constructed bank stabilization projects. On the Skokomish River where the streambed has been braiding or widening significantly, a streambank maintenance program needs to be practiced for the entire length of the river and, ideally, the tributaries. This would be coordinated through Mason County, with easements or acquisition of land to assure continued access and maintenance. Channel maintenance and sediment removal need to be practiced for bank stabilization to be effective long term.

Instream approaches to reduce bank erosion such as sediment traps or drop structures should be evaluated and, where appropriate, constructed.

Historically, measures such as rock and timber revetments have been placed on eroding banks, as well as trees being cabled downstream into the river to deflect current. Vegetation has been planted to stabilize and protect threatened slopes. In many instances these measures have been effective in slowing or eliminating soil loss. Diversion dikes and river bar scalping have also been practiced on the Skokomish River and Vance Creek. Maintenance of most of the bank stabilization efforts has been by local land owners, individually and collectively as resources were available.

Effects: Reduce soils and land lost due to river braiding. Reduce threat of major channel change.

Private property: Reduce loss of land.

Public property: Reduce loss of land and threat to roads.

Public safety: Reduce possibility of road washouts.

Agriculture: Reduce soil and land loss.

Fish and wildlife resources: May reduce streambank cover through bank hardening, or enhance habitat if biotechnical measures are adopted.

Recreation: No change.

Sedimentation and aggradation: Reduce sedimentation from bank erosion, a minor source of aggradation.

Hydrology: Bank hardening may divert velocities to downstream locations.

Implementation: Mason County would determine and obtain the needed easements to effectively maintain streambanks through whatever site-specific measures of stabilization are chosen throughout the system. In most cases, cooperative efforts can be established with property owners. In some instances, relocation of residences may be necessary.

Annual management: Maintenance of streambanks will be a very resource intensive flood control measure but will result in a comprehensive approach to bank erosion. The tendency to divert erosion downstream will be reduced. Continued individual efforts will assure that problems areas are identified quickly and maintained regularly.

ALTERNATIVE 9: INSTREAM DIVERSIONS IN CRITICAL AREAS

Description: Spur jetties or deflectors can divert flows in critical areas, such as the proposed design by Wolf Bauer for Mason County. Instream drop structures are another method for diverting flows to secondary channels. These measures and their instream impacts must be evaluated in relation to the value of the area of concern. These structures would be considered in conjunction with channel maintenance and streambank stabilization efforts.

Effects: A localized diversion of flows would protect critical, intended sites such as roads. The erosion would possibly be diverted downstream to another location. A major benefit would be experienced, to the extent that a diversion structure would assist in reducing the likelihood of a major channel shift.

Private property: Significant protection may be provided to private property, especially where a major channel shift if prevented.

Public property: Significant protection may be provided to roads and bridges, especially where a major channel shift is prevented.

Public safety: The benefit of reducing the threat of a road washout or major channel shift is a primary consideration in stream diversion measures.

Agriculture: A major channel shift could have a substantial impact on agricultural lands.

Fish and wildlife resources: Little or none.

Recreation: Structures may reduce access to river.

Sedimentation and aggradation: Location of deposited materials would be altered. Bank erosion would be reduced somewhat with proper design; improper jetty design can have adverse bank erosion effects due to back scour.

Hydrology: Diversion structures generally have no effect on flow volumes, but do locally redirect stream flows to alleviate bank erosion.

Implementation: Mason County would have detailed project plans developed and would address environmental issues, as raised for previous proposals, through the services of a consultant. These issues include an evaluation or modeling of the project's effectiveness in accomplishing the channel stabilization; an analysis of effects upon downstream lands and fish and wildlife habitat; and proposed mitigation measures.

Annual management: A regular maintenance program would be required, including the possibility of extensive, ongoing repairs or additional structural measures to hold the channel in a specific location.

LONG-TERM RECOMMENDATION

The foregoing planning alternatives all address emergency and/or short term needs and issues. Without long term planning designed to address the problem of river bed aggradation, none of the immediate or short term measures can had any substantial value. Following is a summary outline of the components of a long term approach to addressing aggradation and flooding in the Skokomish Valley.

1) Evaluate South Fork Skokomish River basin erosion rates from:
    general landscape
    unvegetated area
    roadways
    debris slides, slope failure

This information can be derived from available data, photos, etc. to establish an average estimated input to the river system.

2) Locate and map slope failures on and near the South Fork and tributaries and evaluate input rates to the river system.

3) Evaluate general bank erosion and estimate contribution to sediment load.

4) Measure suspended solids transport in the South Fork at USGS gage 12-0605 at South Fork RM 3.1 for one water year and correlate measurement with runoff, rain or snow pack.

5) Evaluate bedload transport into main stem by means of available data -- aerial photos -- and if possible, topographic measurement.

6) Estimate sediment loading of main stem under natural and existing conditions and project the future effects of that rate on the river bed geomorphology under existing conditions and modified land use practices.

7) Develop and evaluate alternatives for handling the sediment load, including but not limited to:
    no action
    land use practices in the South Fork basin
    sedimentation trap(s) in the South Fork basin
    channel management in the Skokomish Valley

The study should be carried out by an independent consultant with the assistance of:

1) Ecology - floodplain management
   - water resources program
2) Fisheries - habitat management
3) Natural Resources - Forest practices, TFW agreement
4) Corps of Engineers - flood management
5) FEMA - flood management
6) Fish & Wildlife Service - fisheries
7) Skokomish Tribe - fisheries, flood management
8) US Forest Service - forest management
9) USGS - hydrology

It is important to remember that it is difficult if not impossible to measure bedload transport. Thus the most practical procedure may be to construct one or more "temporary" sediment traps and monitor the rate of filling over a few years as a means of estimating bedload transport. Based on this experience, a "permanent" solution may then be designed.

SUMMARY AND CONCLUSION

A multi-agency task force should be established to assist Mason County in establishing and implementing a work program of flood control management measures. The problems and issues that are being experienced in the Skokomish Valley are not so unique and isolated that they remain only a local problem. Emergency response agencies and resource agencies alike share in the concerns that the people of Mason County have about flooding on the Skokomish River. It is hoped that the discussion in this study will further the ongoing dialogue between those entities with technical expertise and those in need of assistance.

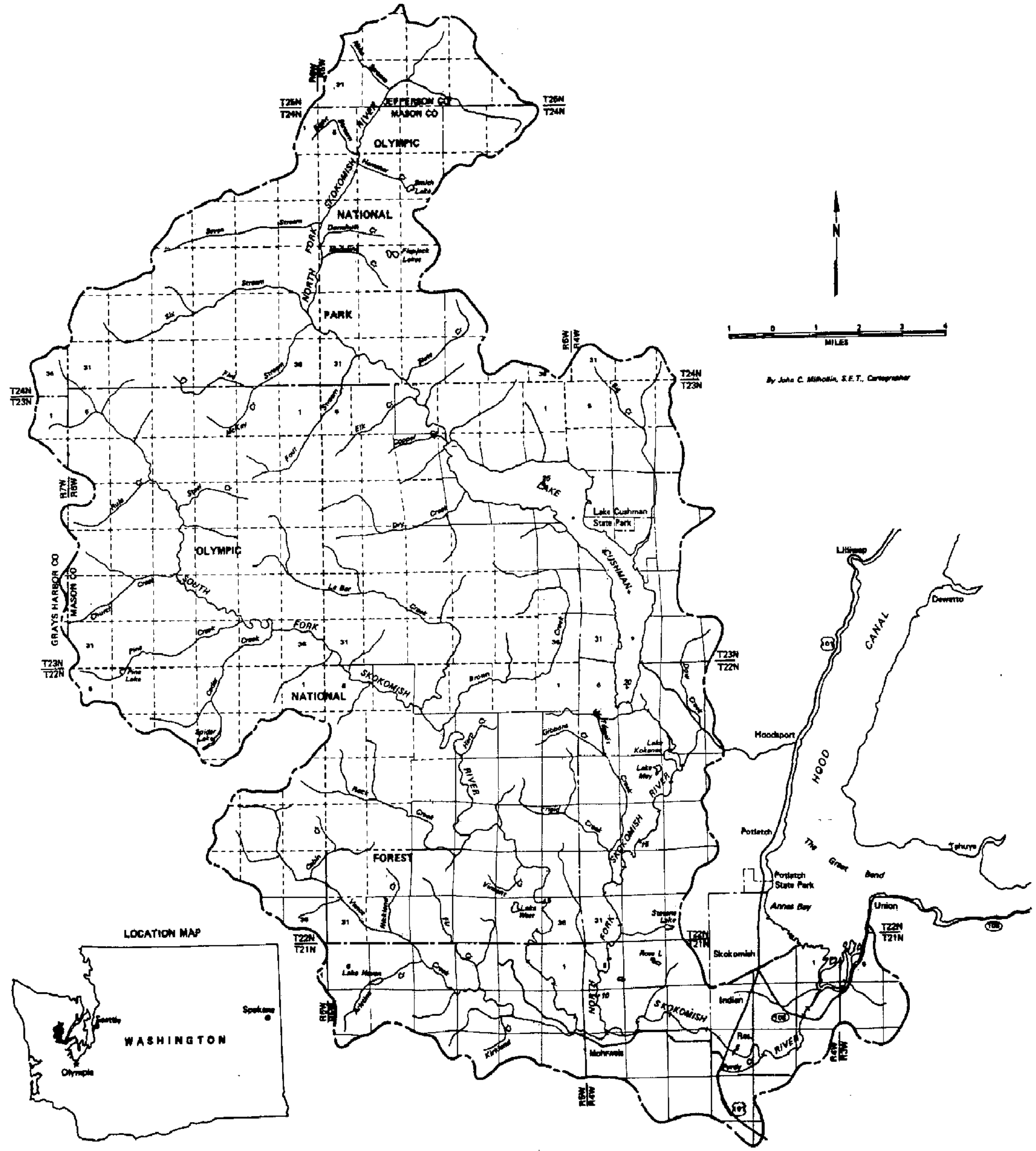


Figure 3.1
SKOKOMISH RIVER WATERSHED MAP

BASE DATA:

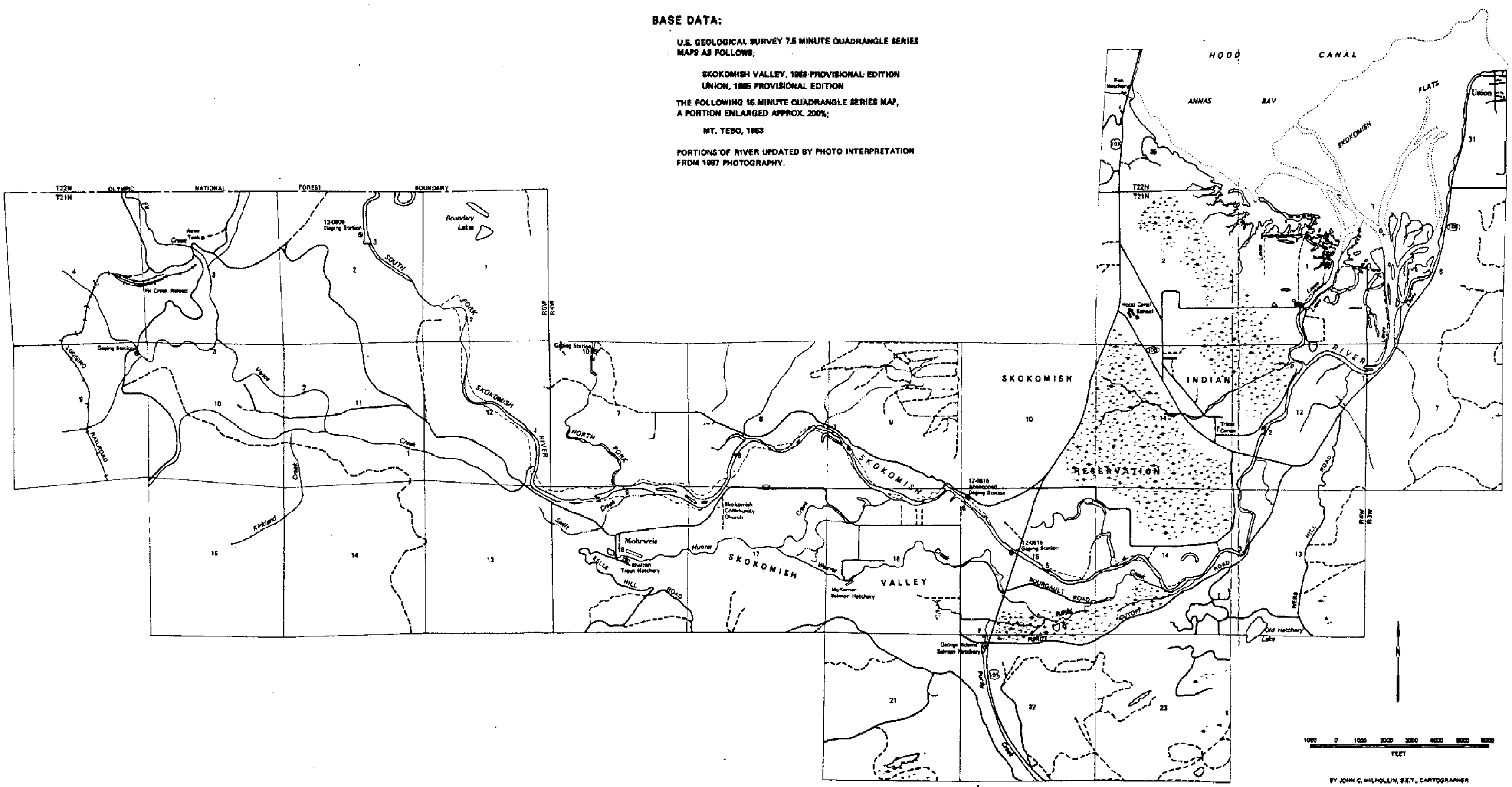
U.S. GEOLOGICAL SURVEY 7.5 MINUTE QUADRANGLE SERIES MAPS AS FOLLOWS;

SKOKOMISH VALLEY, 1968 PROVISIONAL EDITION
UNION, 1985 PROVISIONAL EDITION

THE FOLLOWING 15 MINUTE QUADRANGLE SERIES MAP, A PORTION ENLARGED APPROX. 200%;

MT. TEBO, 1953

PORTIONS OF RIVER UPDATED BY PHOTO INTERPRETATION FROM 1987 PHOTOGRAPHY.



BY JOHN C. MILHOLLIN, S.E.T., CARTOGRAPHER

Figure 3.2
SKOKOMISH VALLEY

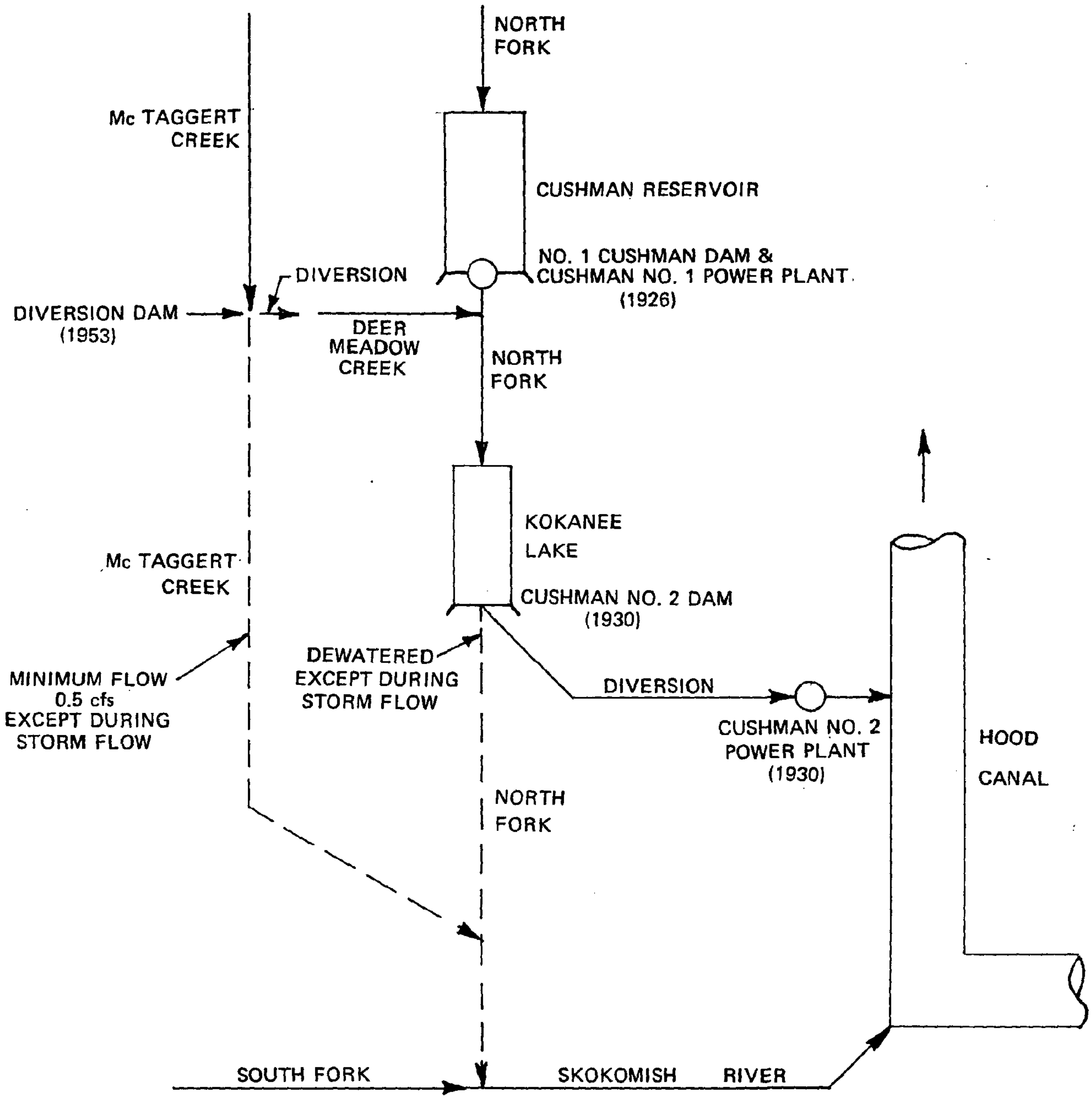


Figure 4.1

DIAGRAM OF CUSHMAN PROJECT DIVERSIONS.

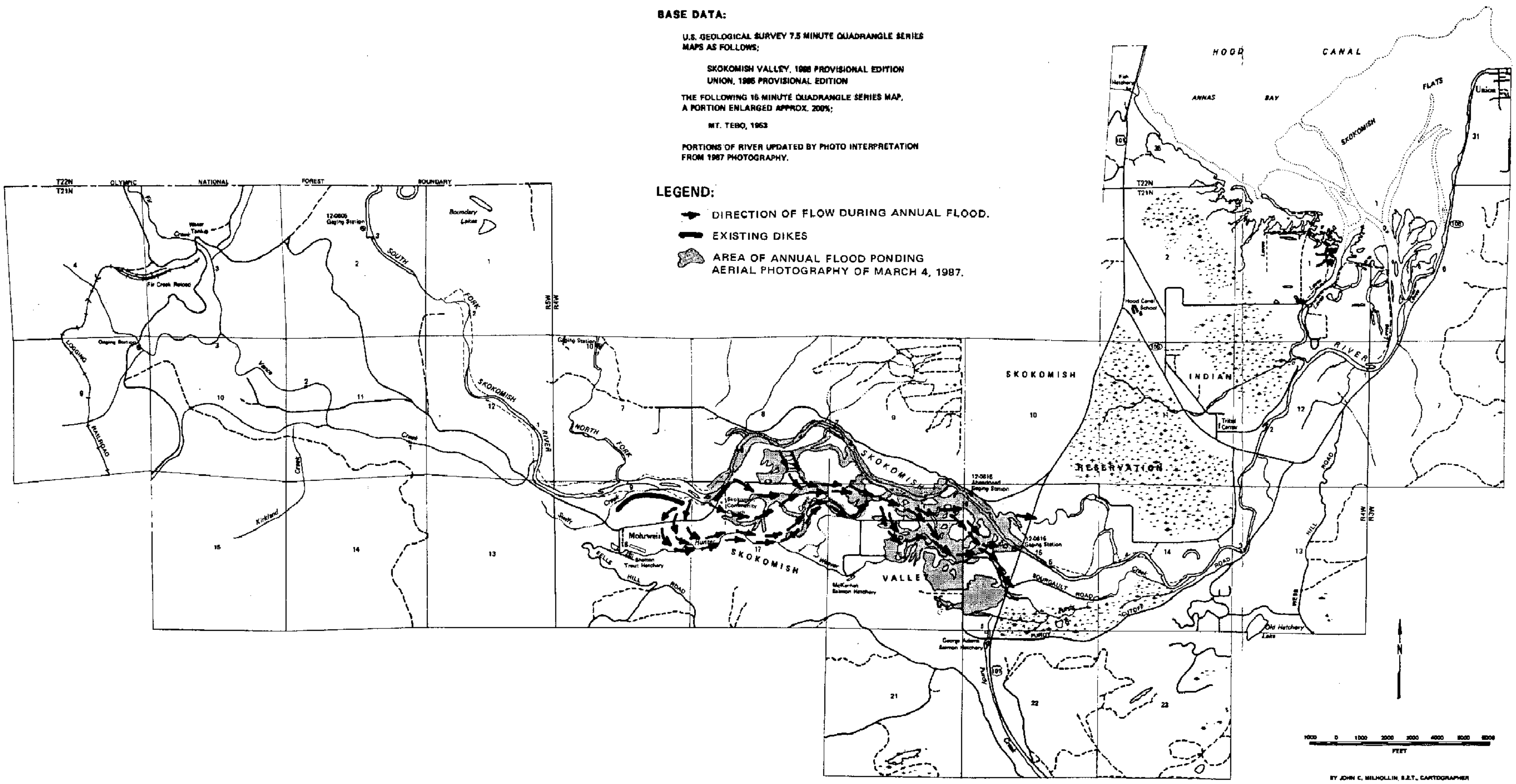
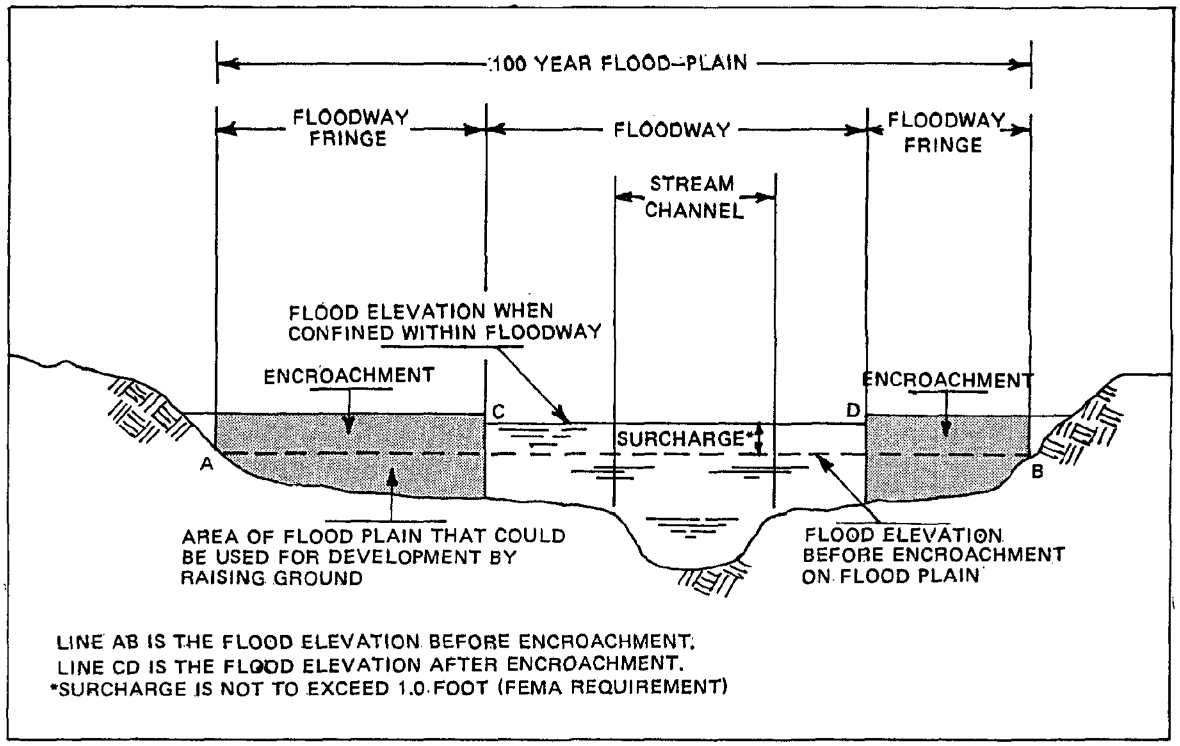


Figure 4.3

SKOKOMISH VALLEY LOW LEVEL FLOODING PATTERNS



THE CONCEPT OF THE FLOODWAY

THE "FLOODWAY" IS AN ENGINEERING CONCEPT WHICH HAS BEEN INCORPORATED INTO THE NFIP FLOODPLAIN MANAGEMENT CRITERIA. FLOODWAYS ARE DEFINED AS THE AREAS OF LAND IMMEDIATELY ADJACENT TO A STREAM OR RIVER CHANNEL WHICH IN TIMES OF FLOODING ACTUALLY BECOME THE ENLARGED STREAM OF RIVER CHANNEL AND CARRY THE FLOODWATERS WITH THE HIGHEST VELOCITY. FLOODWAYS ARE CALCULATED BY FEMA FOR THE 100 YEAR BASE FLOOD FOR MAJOR RIVERS AND STREAMS AS PART OF THE FLOOD INSURANCE STUDY UNDERTAKEN FOR A COMMUNITY. FLOODWAYS ARE SHOWN ON THE COMMUNITY'S FLOODWAY AND FLOOD HAZARD BOUNDARY MAP PREPARED BY FEMA, AND DATA ON THEIR WIDTH, CROSS-SECTIONAL AREA AND FLOOD-WATER VELOCITY ARE GIVEN IN THE FLOOD INSURANCE STUDY. WHEN FLOODWAY DELINEATIONS AND DATA HAVE BEEN FURNISHED BY FEMA, THE COMMUNITY IS REQUIRED TO ADOPT A "REGULATORY FLOODWAY" AND BEGIN ENFORCING THE "NO-ENCROACHMENT" REQUIREMENT THROUGH ITS ZONING ORDINANCE.

Figure 6.1

FLOOD PLAIN SCHEMATIC CROSS SECTION.

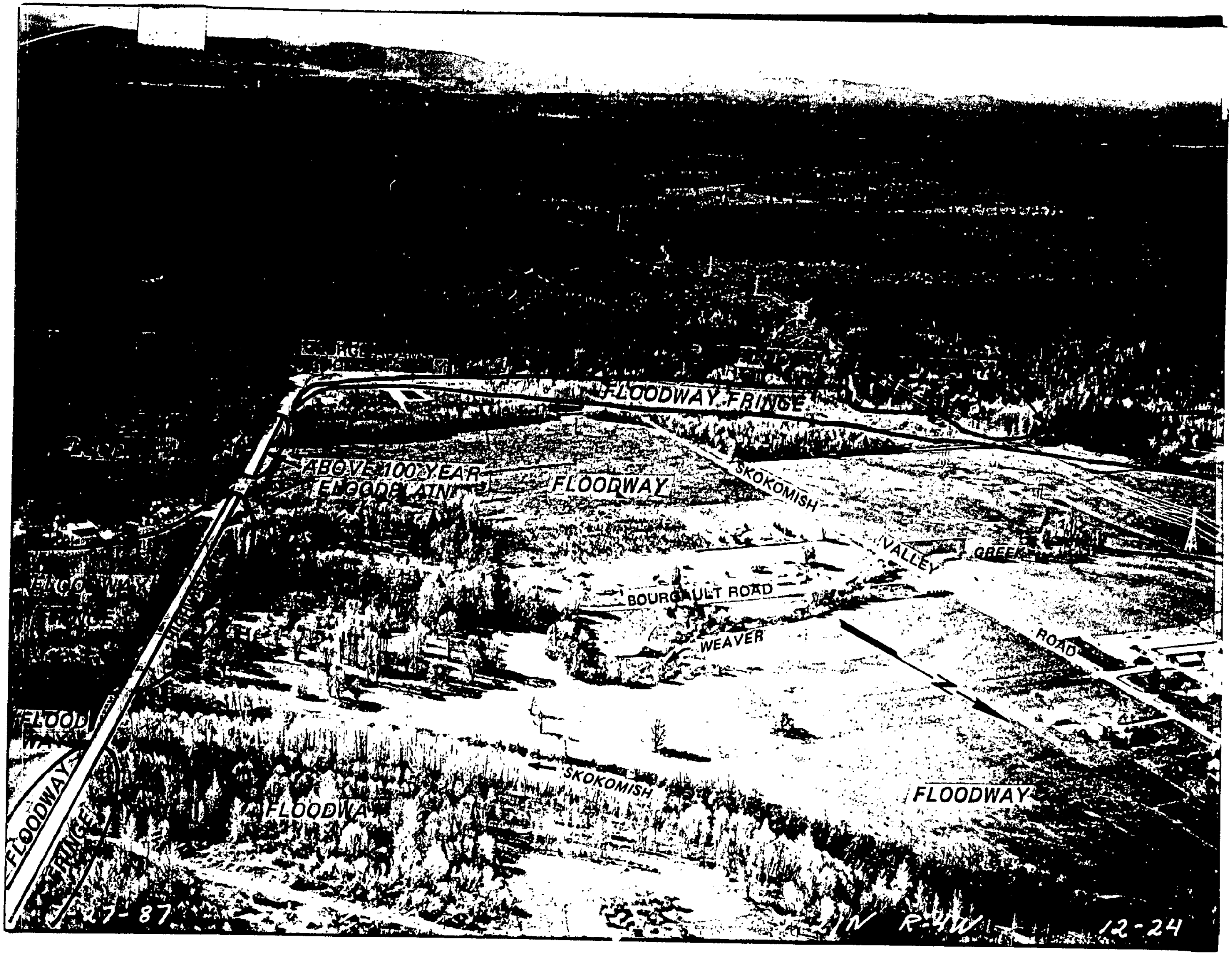


Figure [illegible]. FLOODWAY AND FLOODWAY FRINGE.

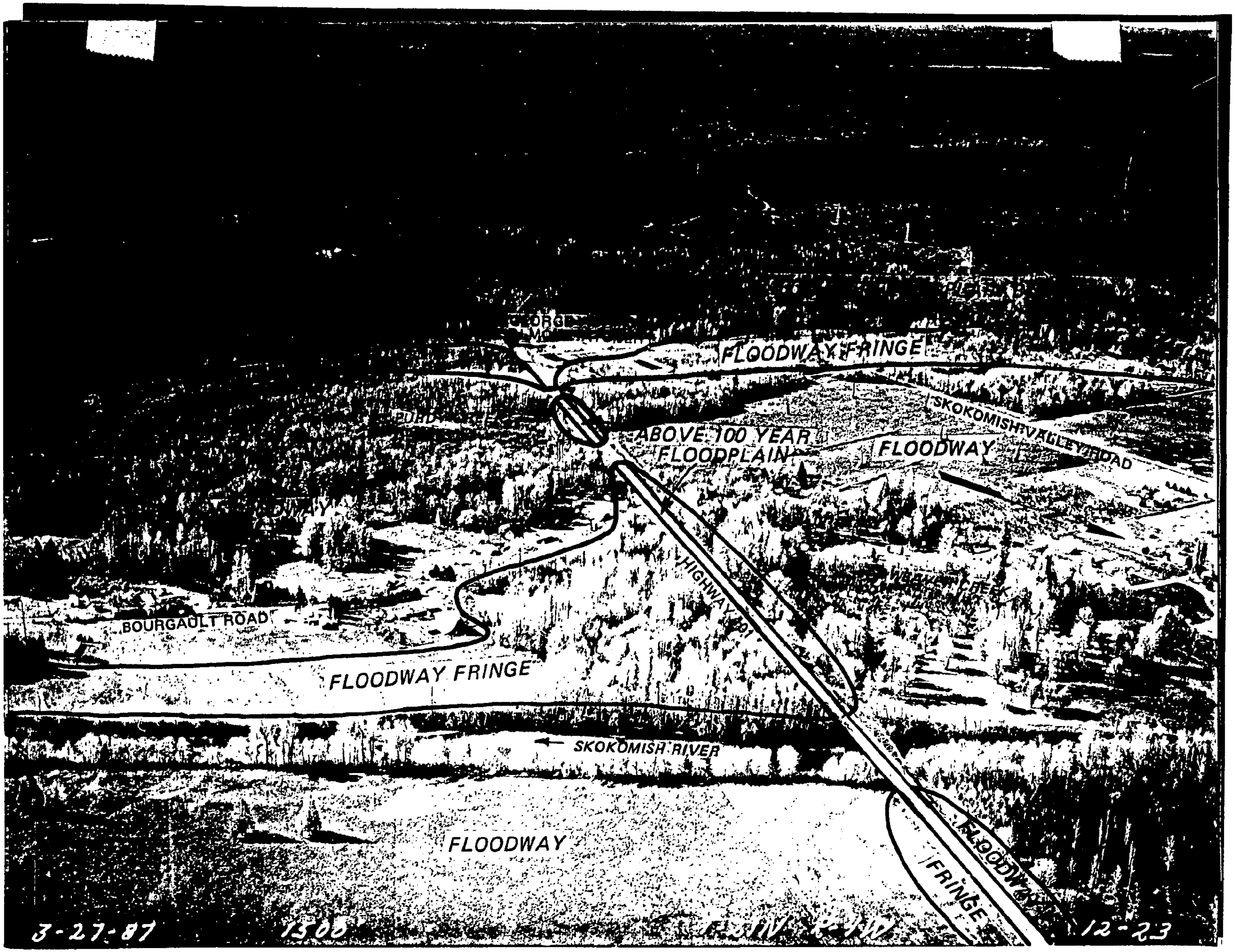


Figure 2A. FLOODWAY AND FLOODWAY FRINGE.

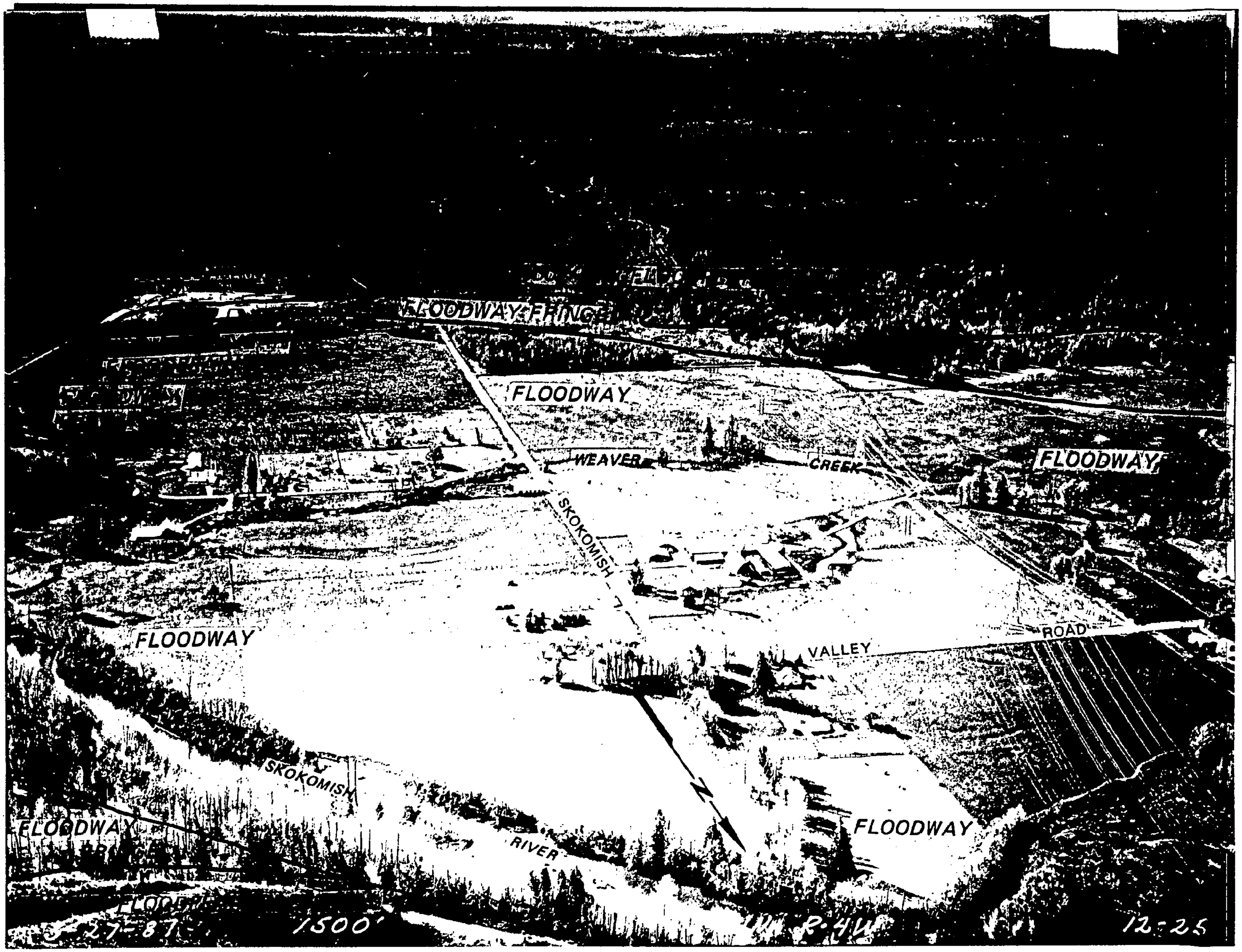


Figure 3A. FLOODWAY AND FLOODWAY FRINGE

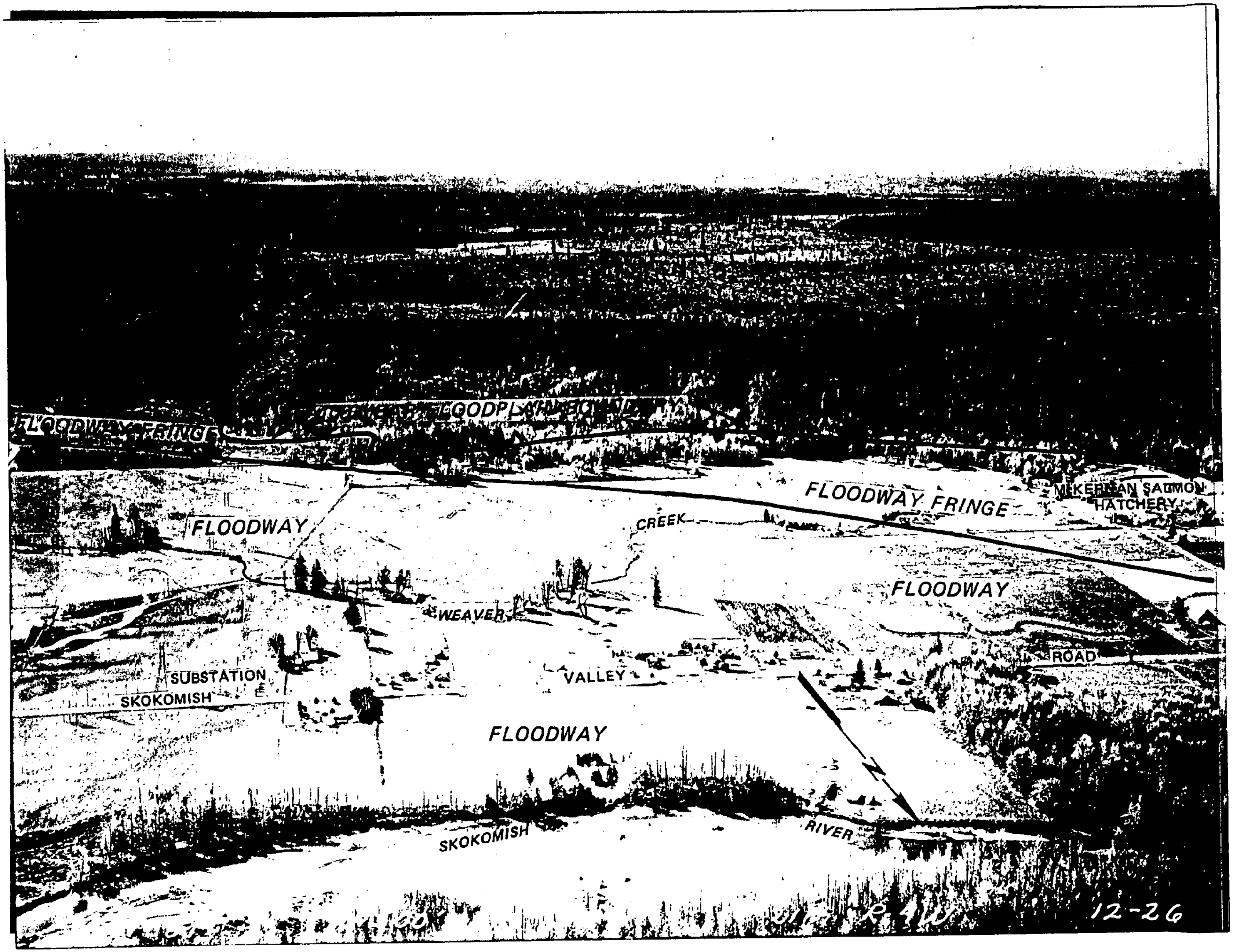


Figure 4A. FLOODWAY AND FLOODWAY FRINGE.

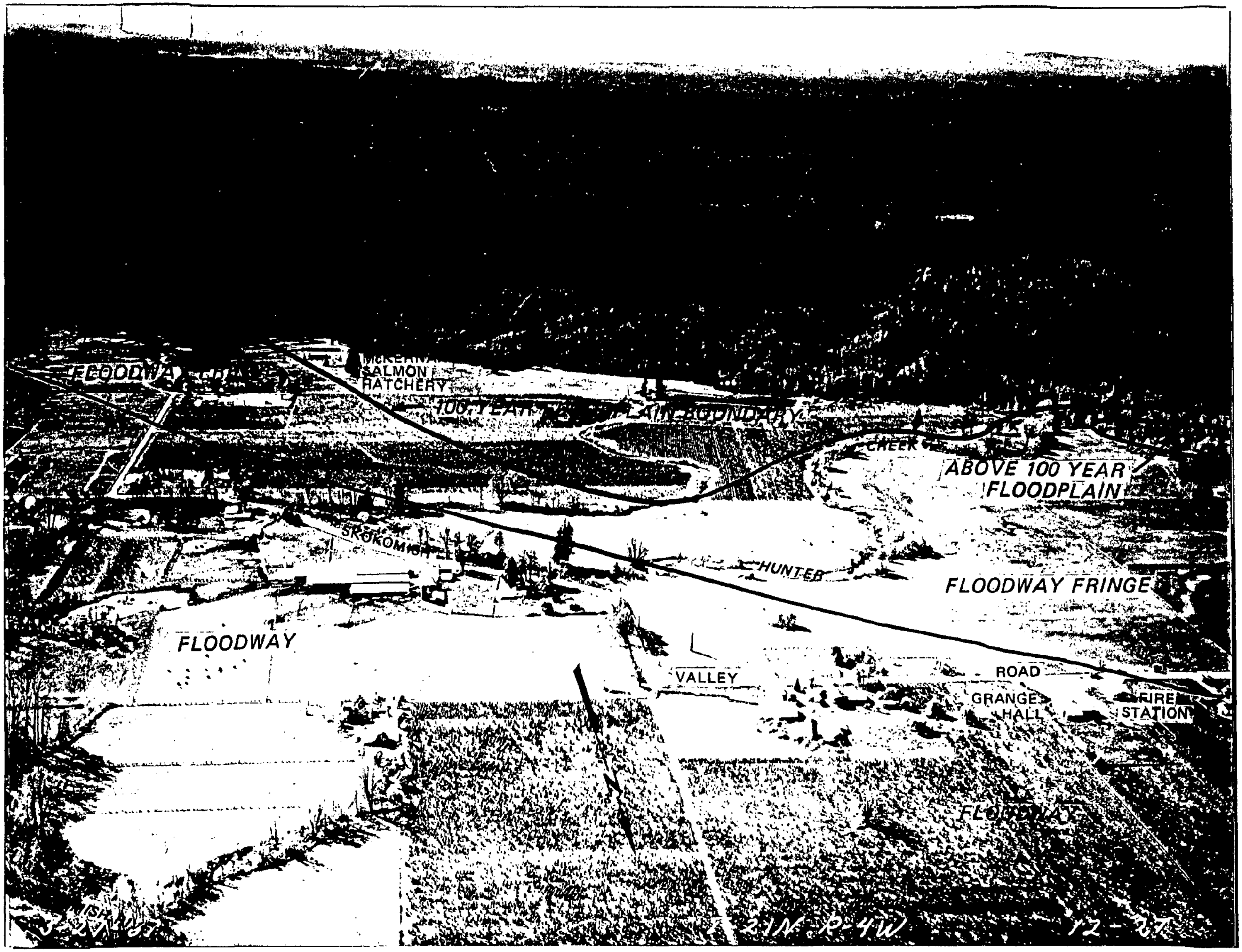
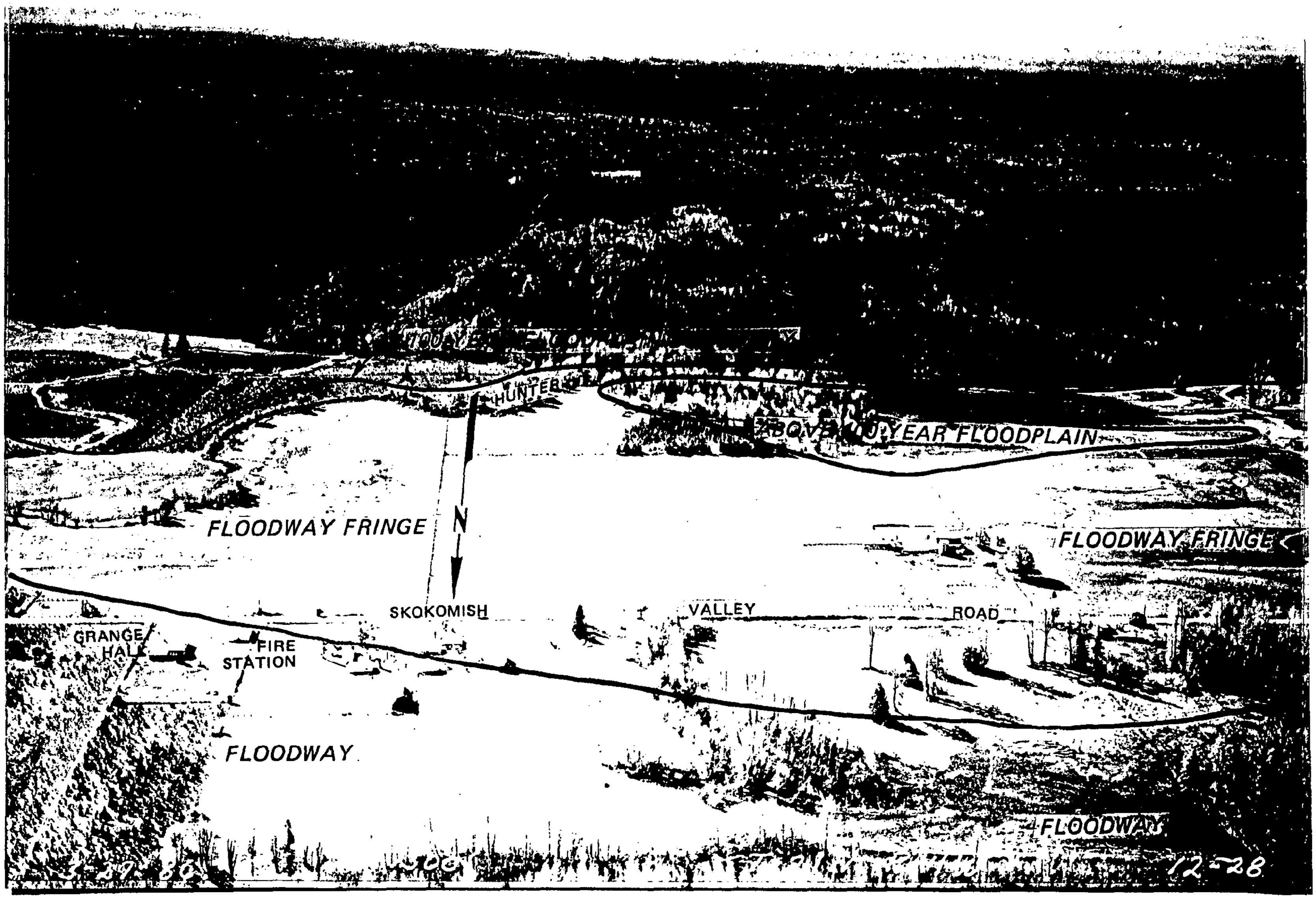


Figure 5A FLOODWAY AND FLOODWAY FRINGE



Fi[redacted]6A. [redacted]OOD[redacted]Y A[redacted]FLO[redacted]WAY[redacted]ING

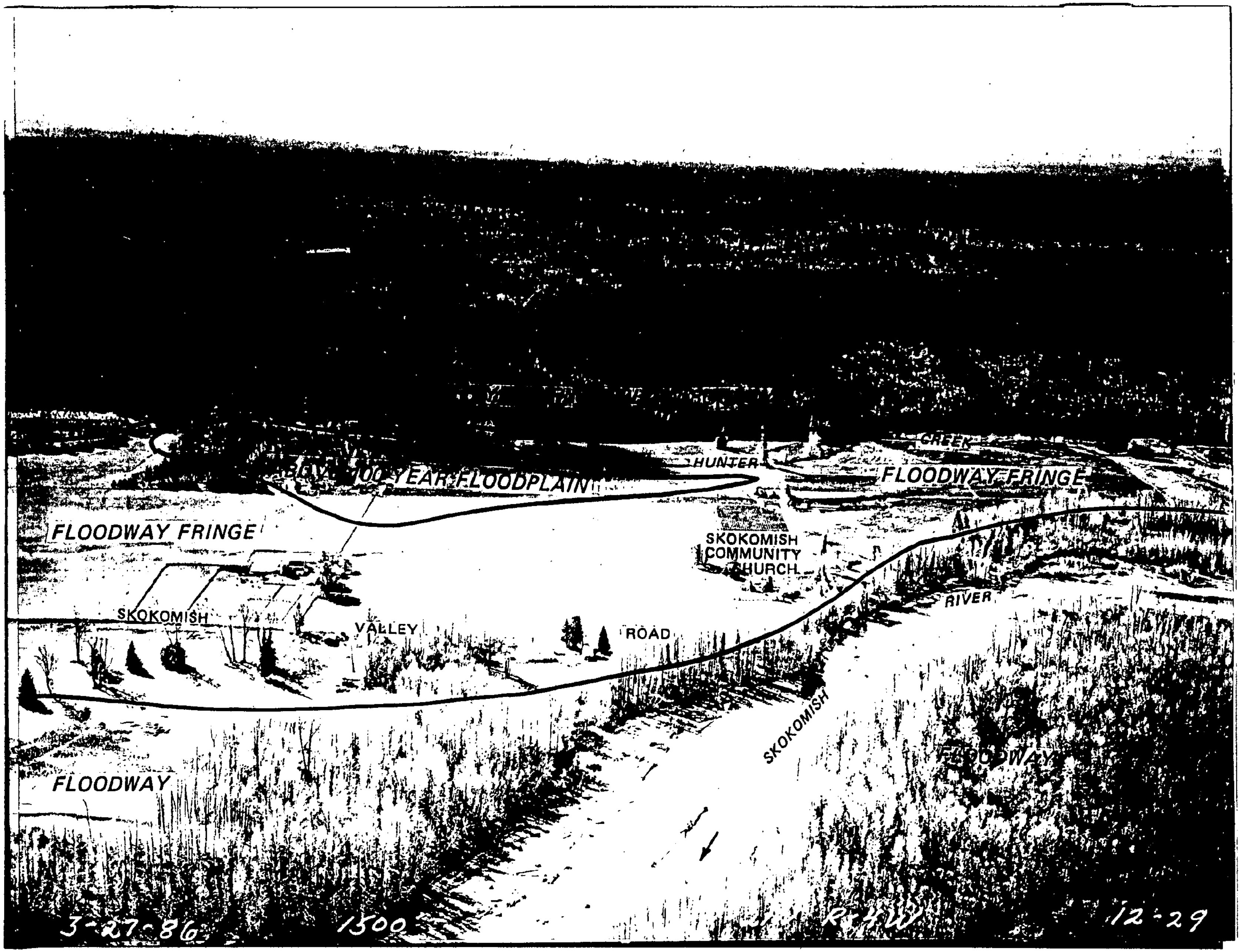


Figure 7A. FLOODWAY AND FLOODWAY FRINGE.

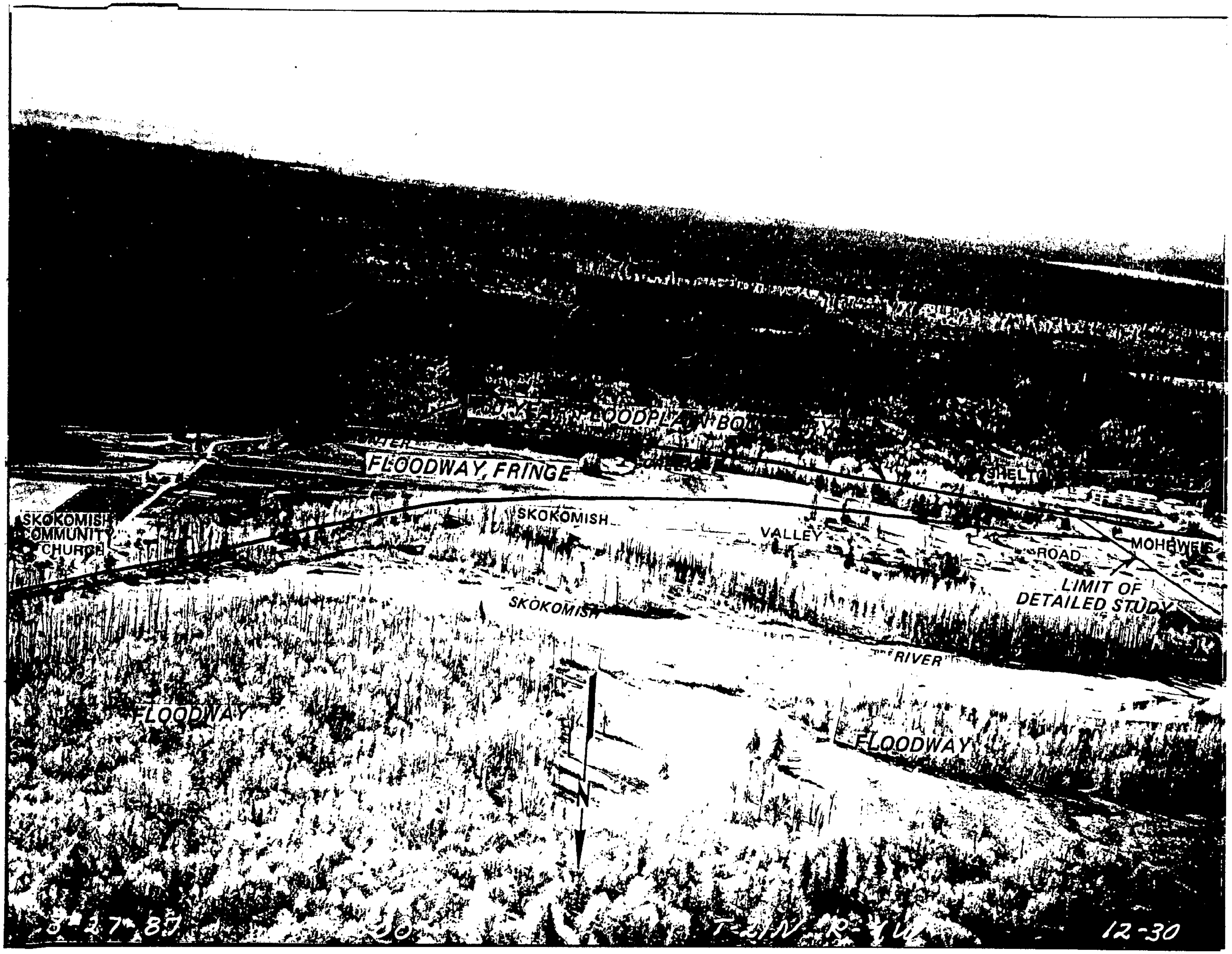


Figure 8A. FLOODWAY AND FLOODWAY FRINGE.

Figure 9A. FLOODWAY AND FLOODWAY FRINGE.

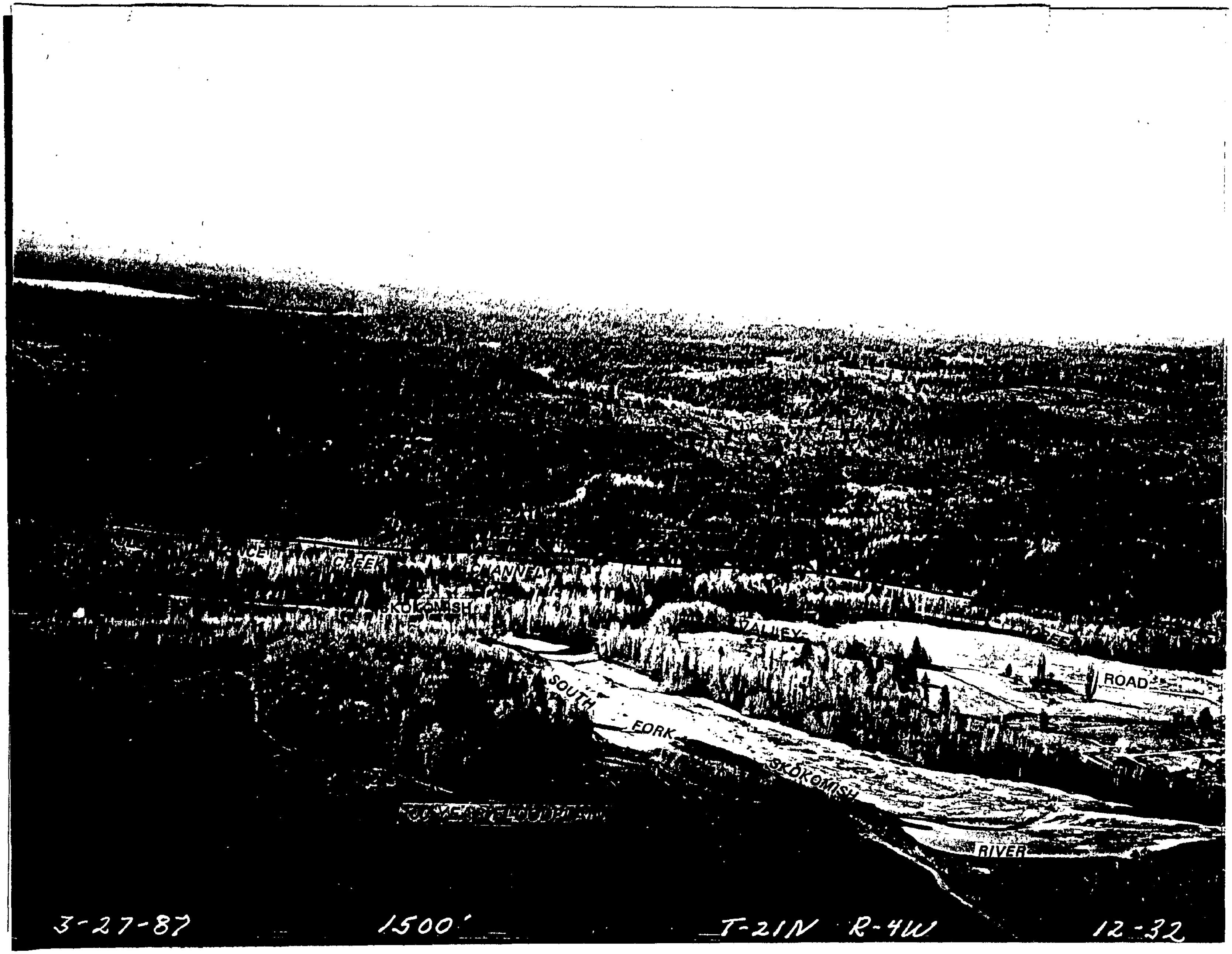


Figure 10A. FLOODWAY AND FLOODWAY FRINGE.

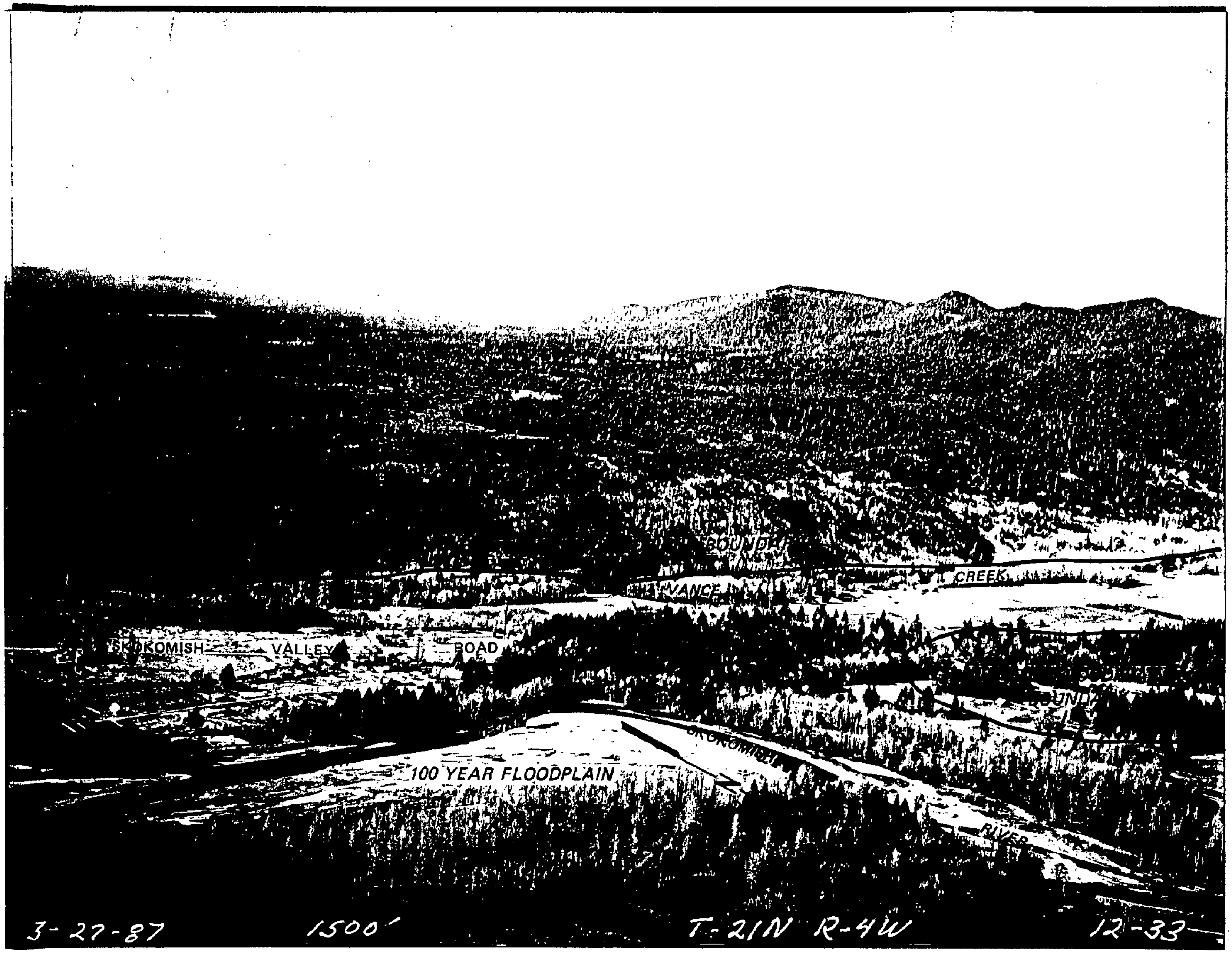


Figure 11A. FLOODWAY AND FLOODWAY FRINGE.

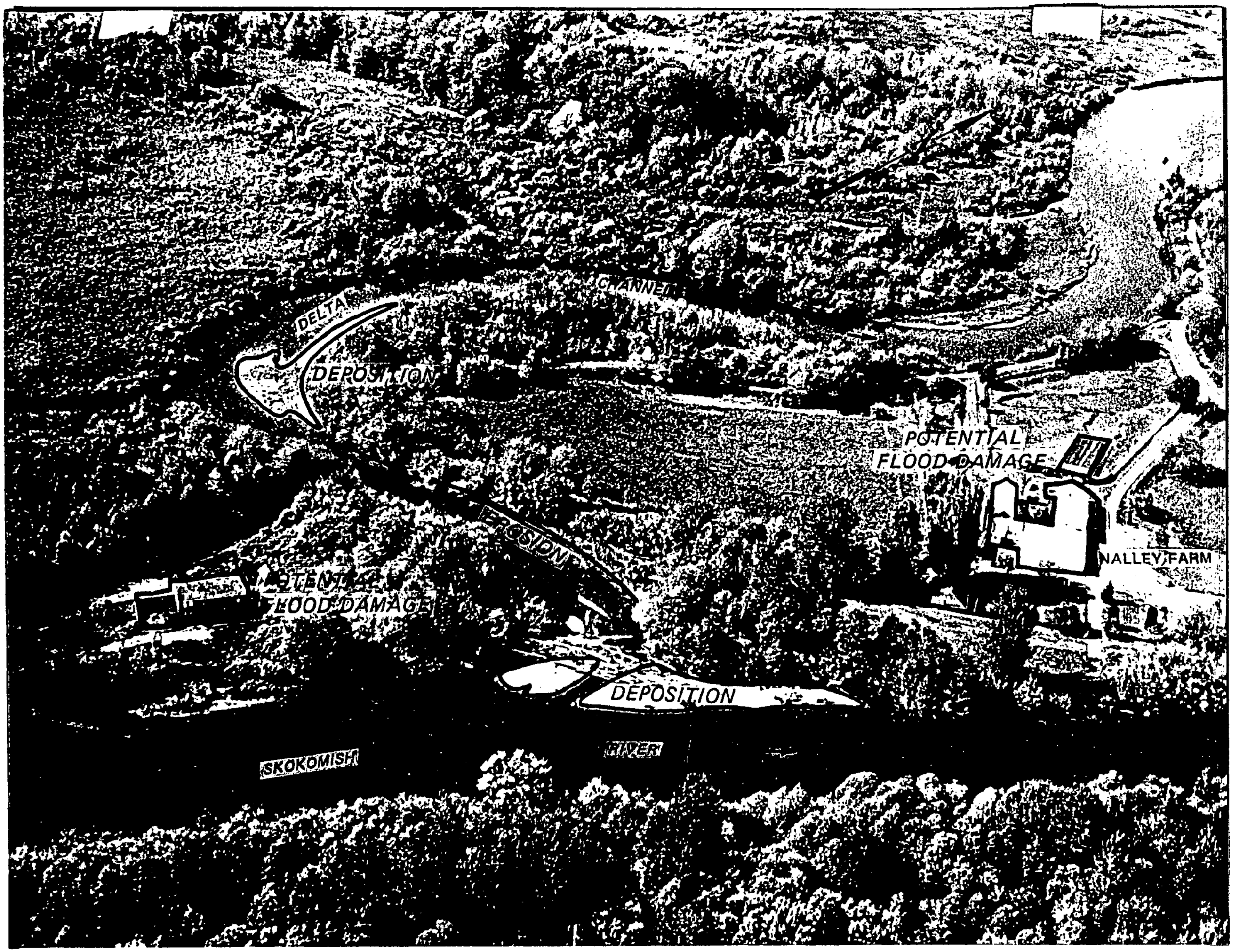


Figure 1B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC. 12, T21N–R4W, RM 1.2–1.4.

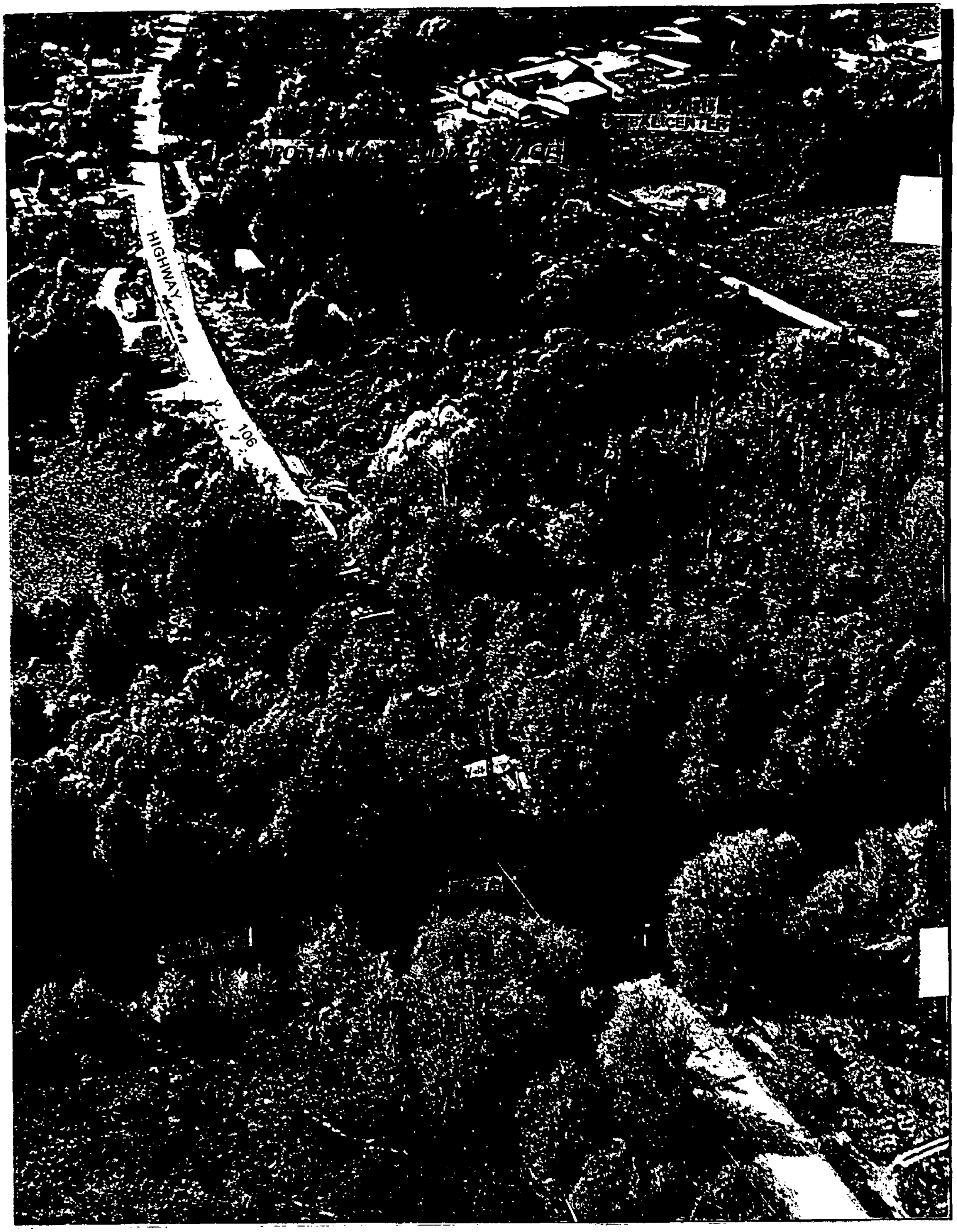


Figure 2B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC. 12, T21N–R4W, VICINITY OF SR 106, RM 2.2.

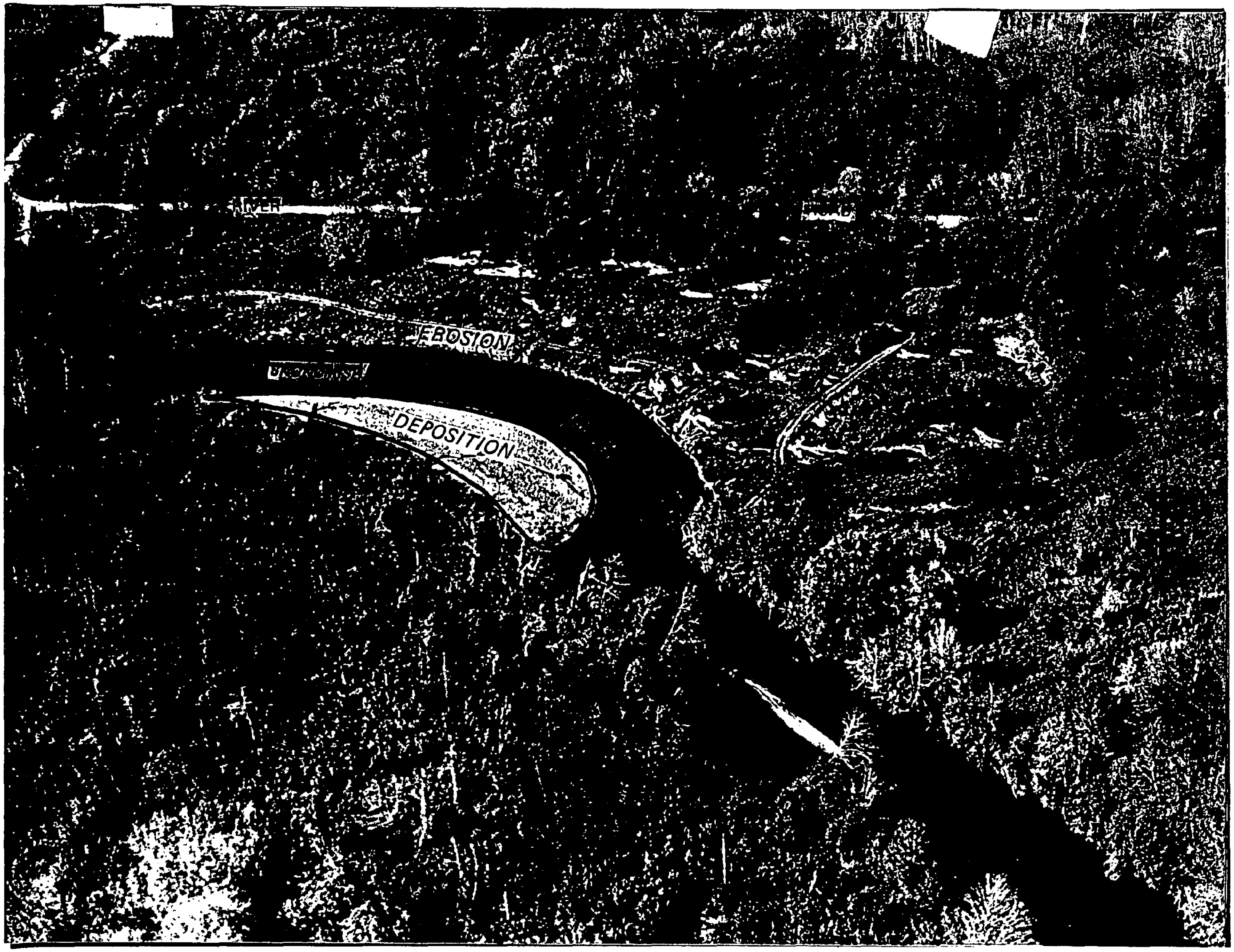


Figure 3B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC. 14, T21N–R4W, RM 3.6–3.8.

Figure 4B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 12&13, T21N–R4W, RM 2.4–2.7.

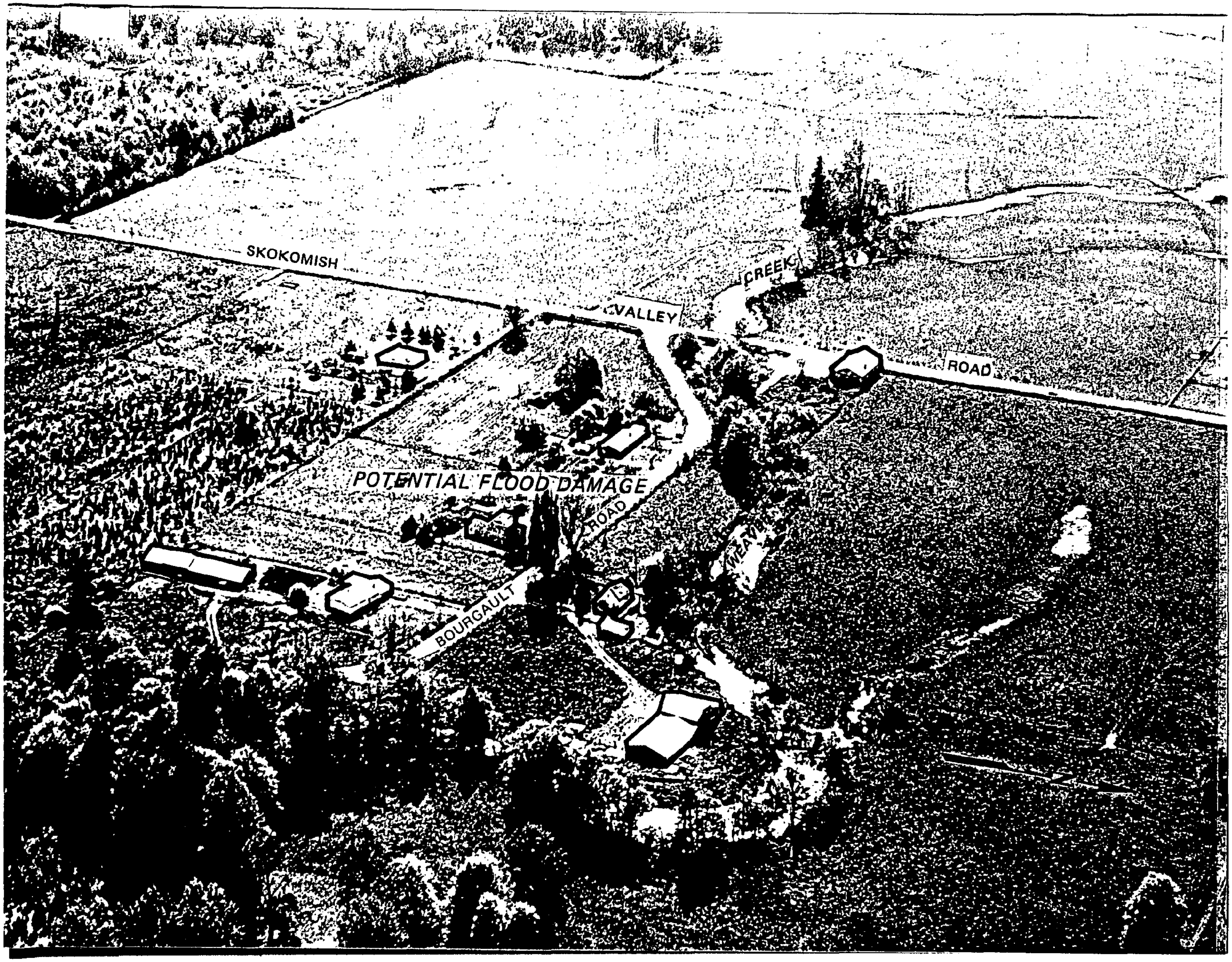


Figure 5B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 15&16, T21N–R4W, WEAVER CREEK AT SKOKOMISH VALLEY ROAD.

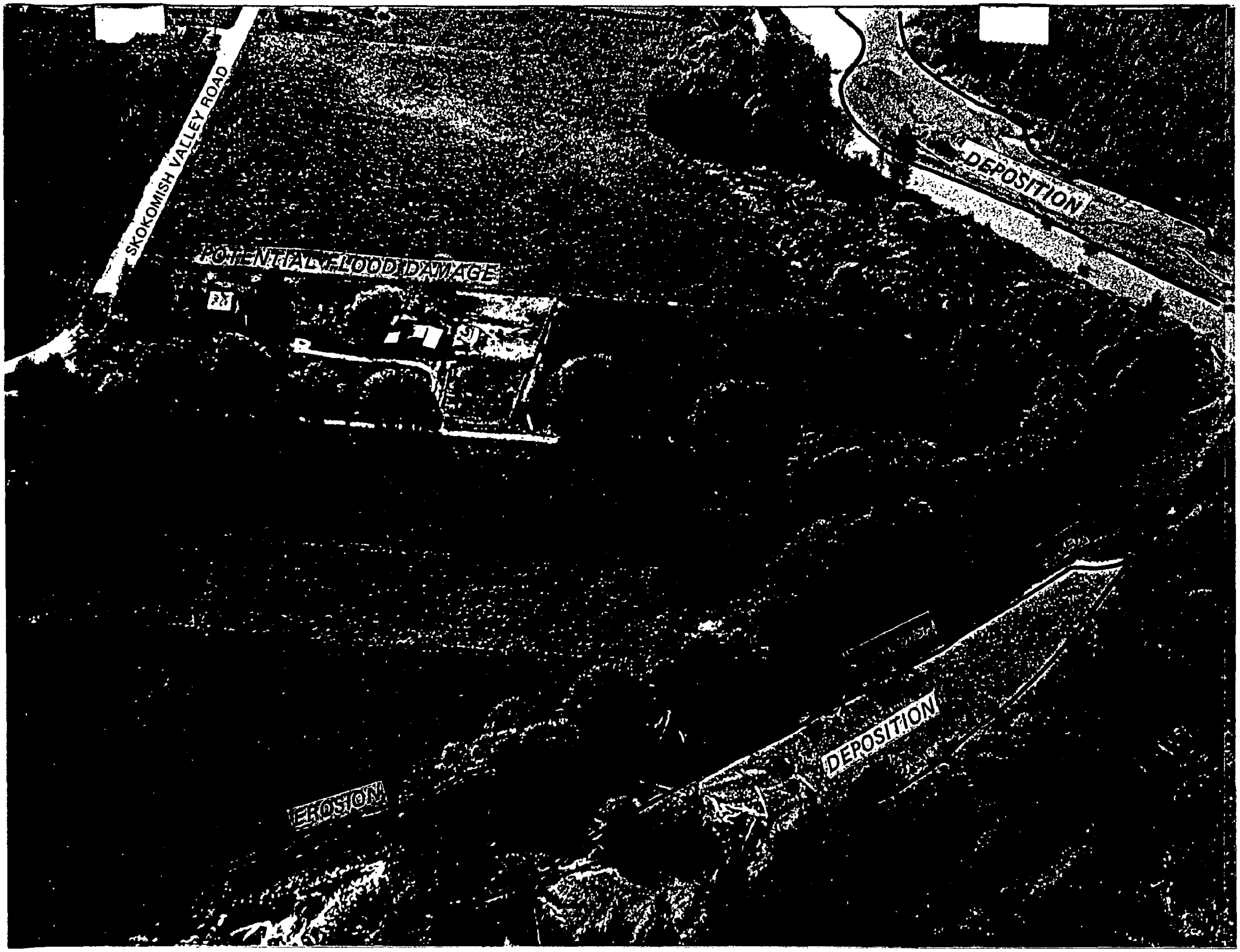


Figure 6B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 15&16, T21N–R4W, RM 5.7–6.1.

Figure 7B.   EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 15, T21N–R4W, RM 5.4–5.5.

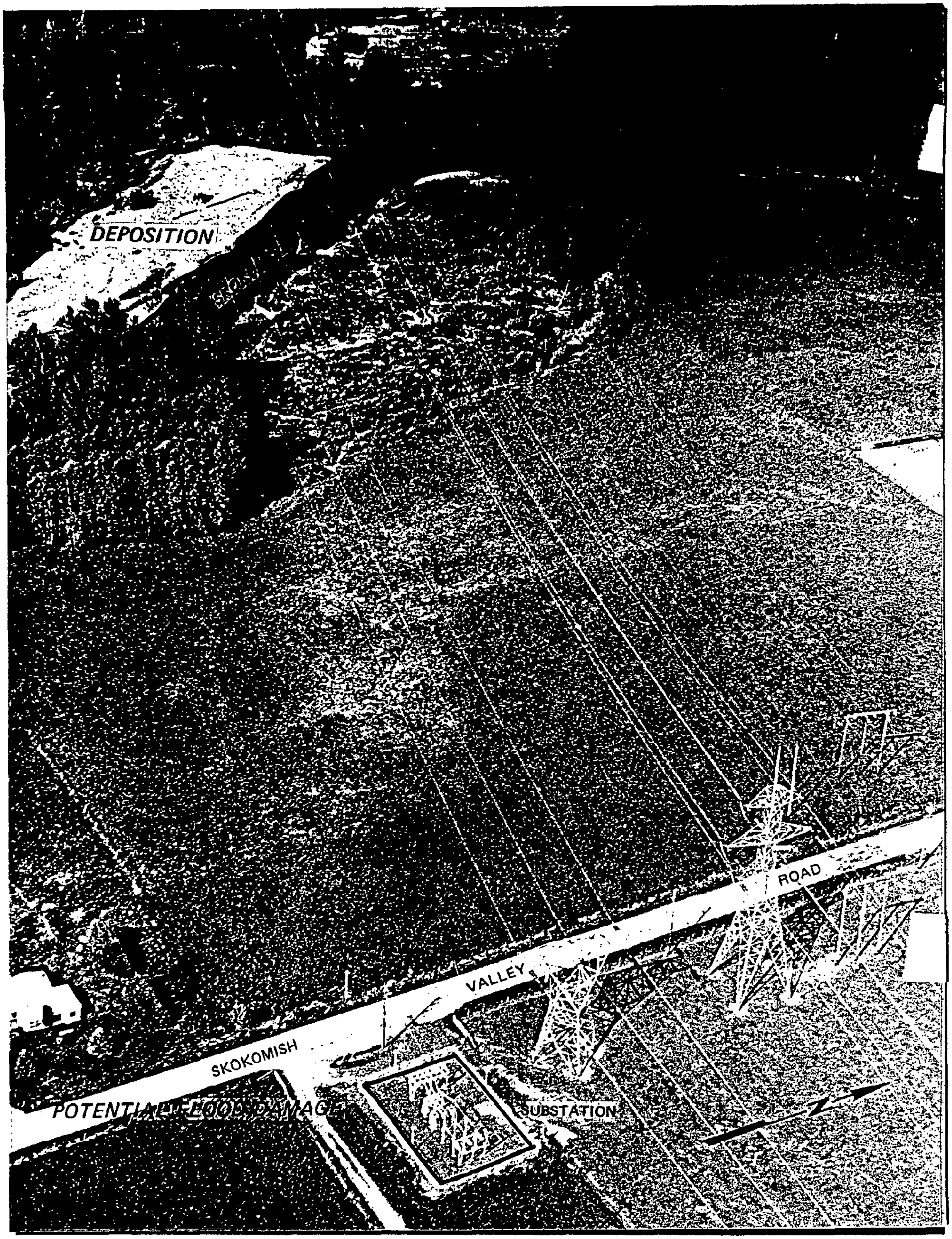


Figure 8B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 16, T21N–R4W, POWER LINE CROSSING AT RM 5.9.

Figure 9B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 9, T21N–R4W, RM 6.7–6.9.

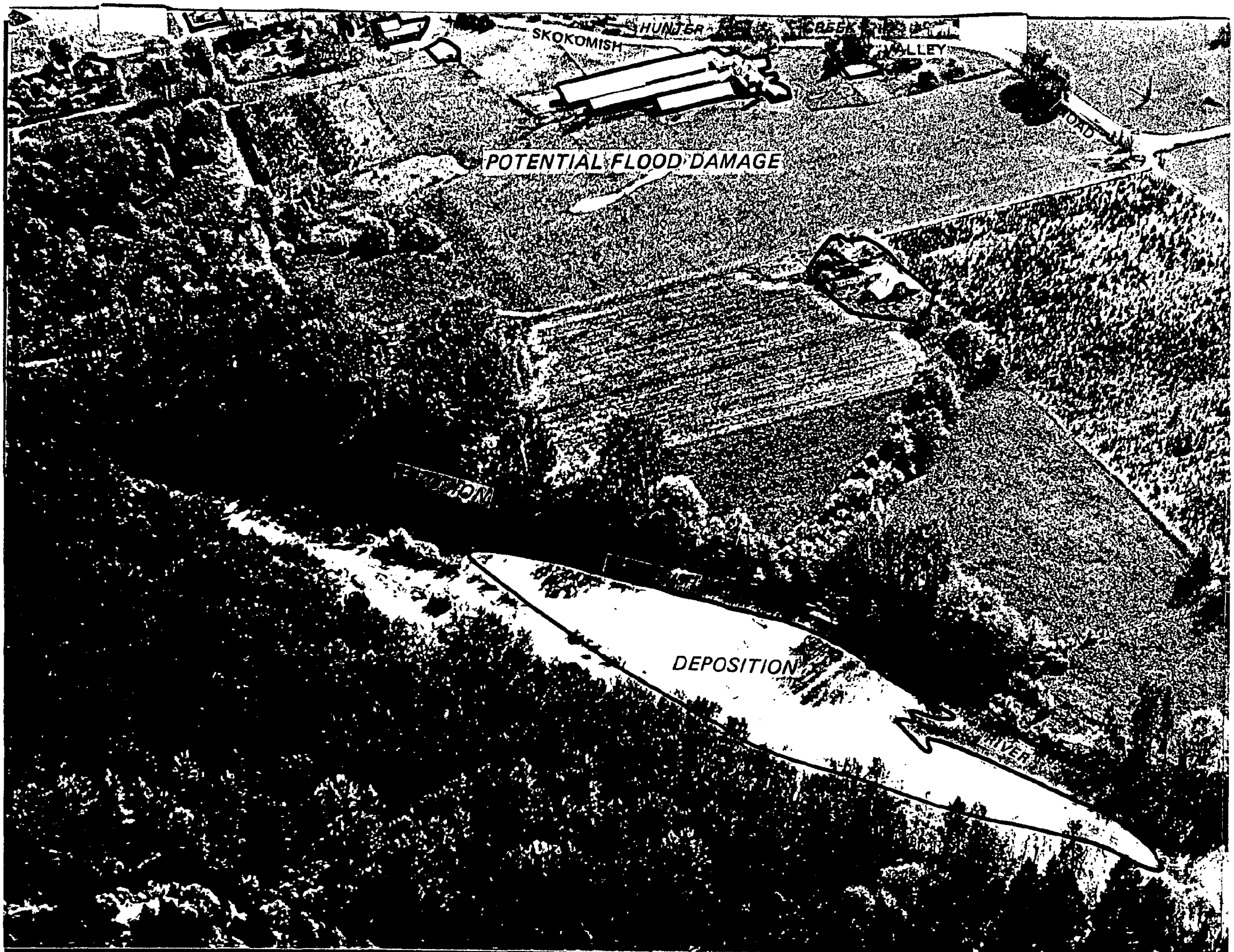


Figure 10B EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE SEC 9, T21N, R4W, RM 6.5–6.7

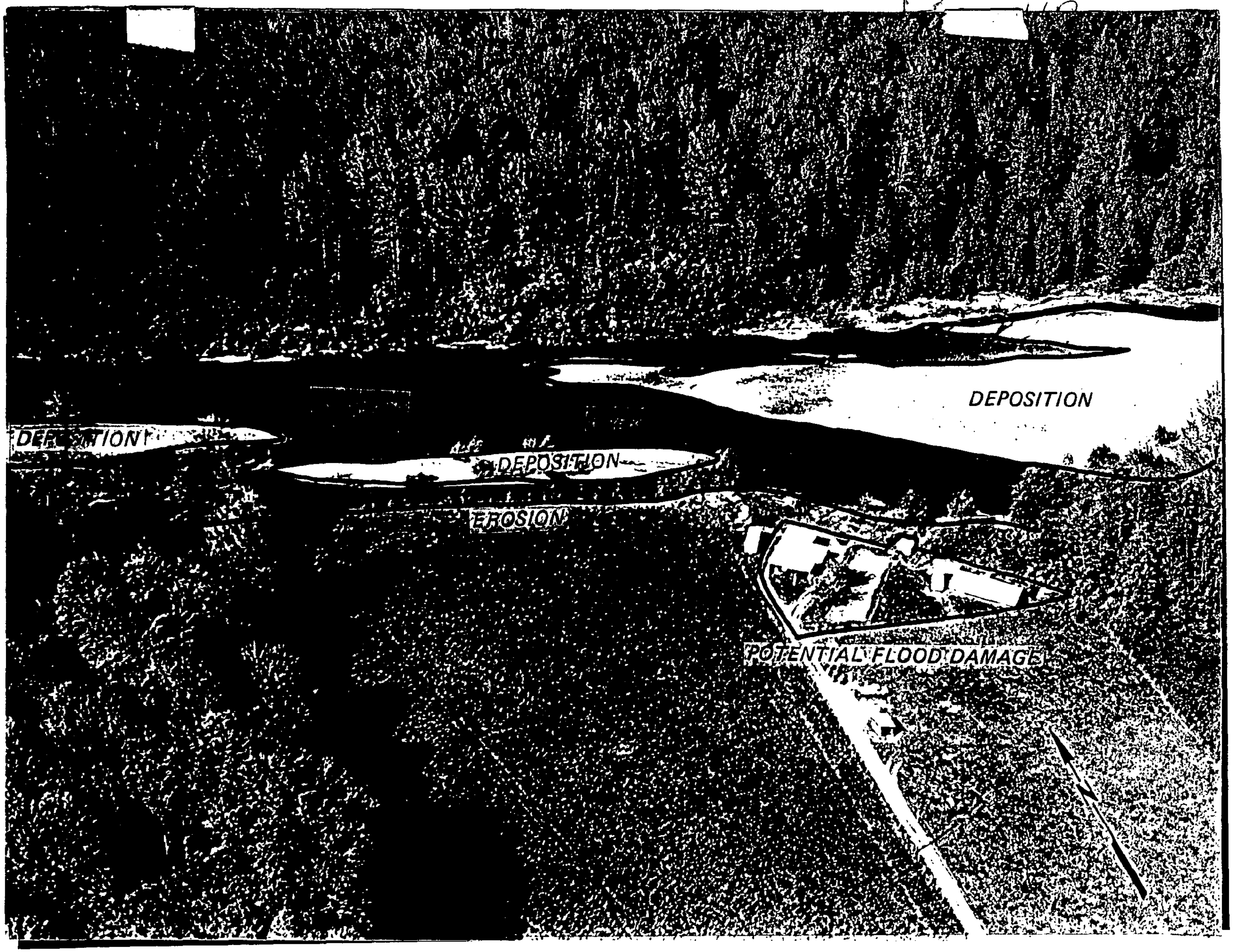


Figure 11B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 16, Y T21—R4W, RM 6.2—6.5

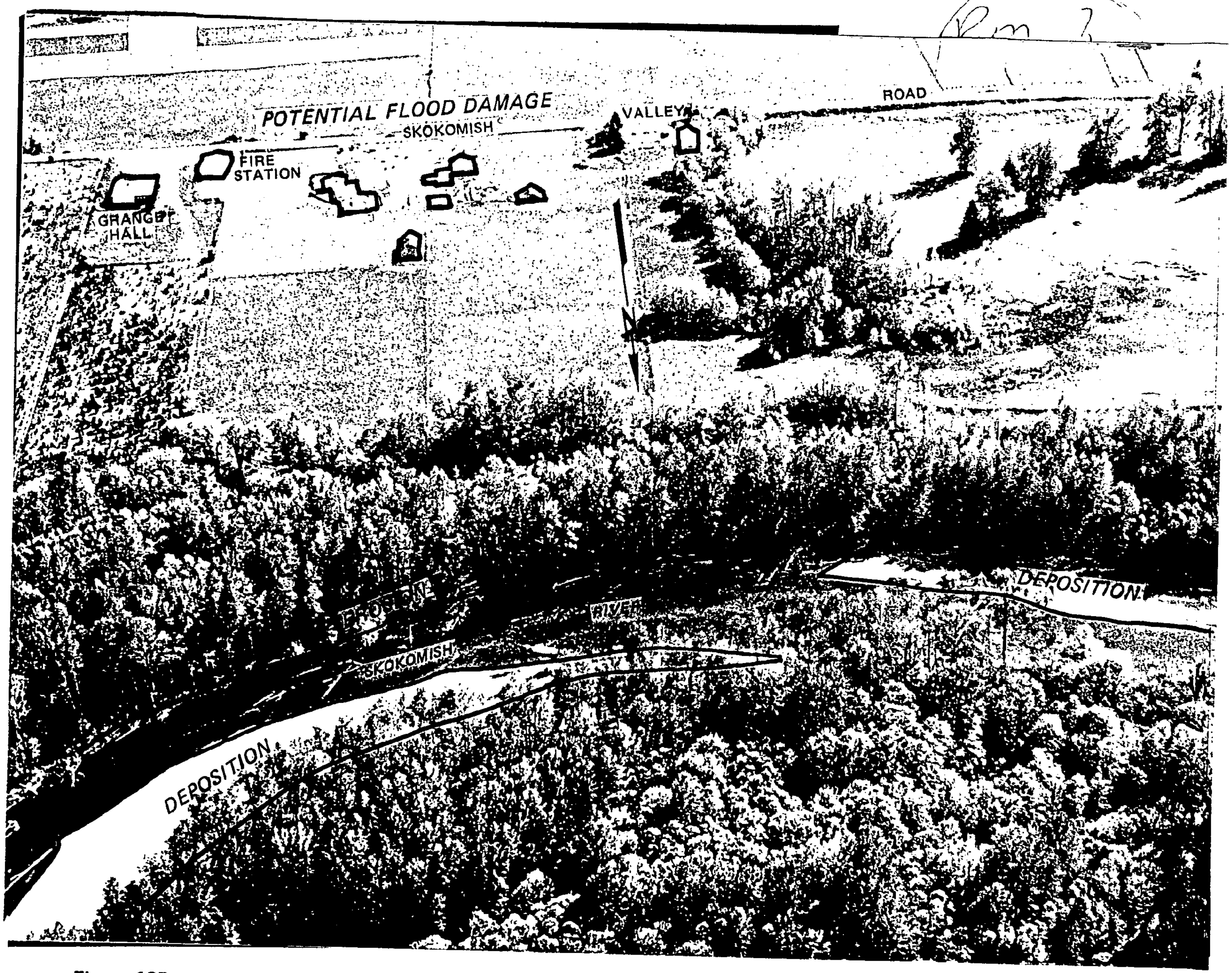


Figure 12B EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE SEC 8, T21N, R4W, R[illegible] RM 7.2–7.4

Figure 13B EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC8, SEC 8, T21N–R4W, RM 7.9–8.1.

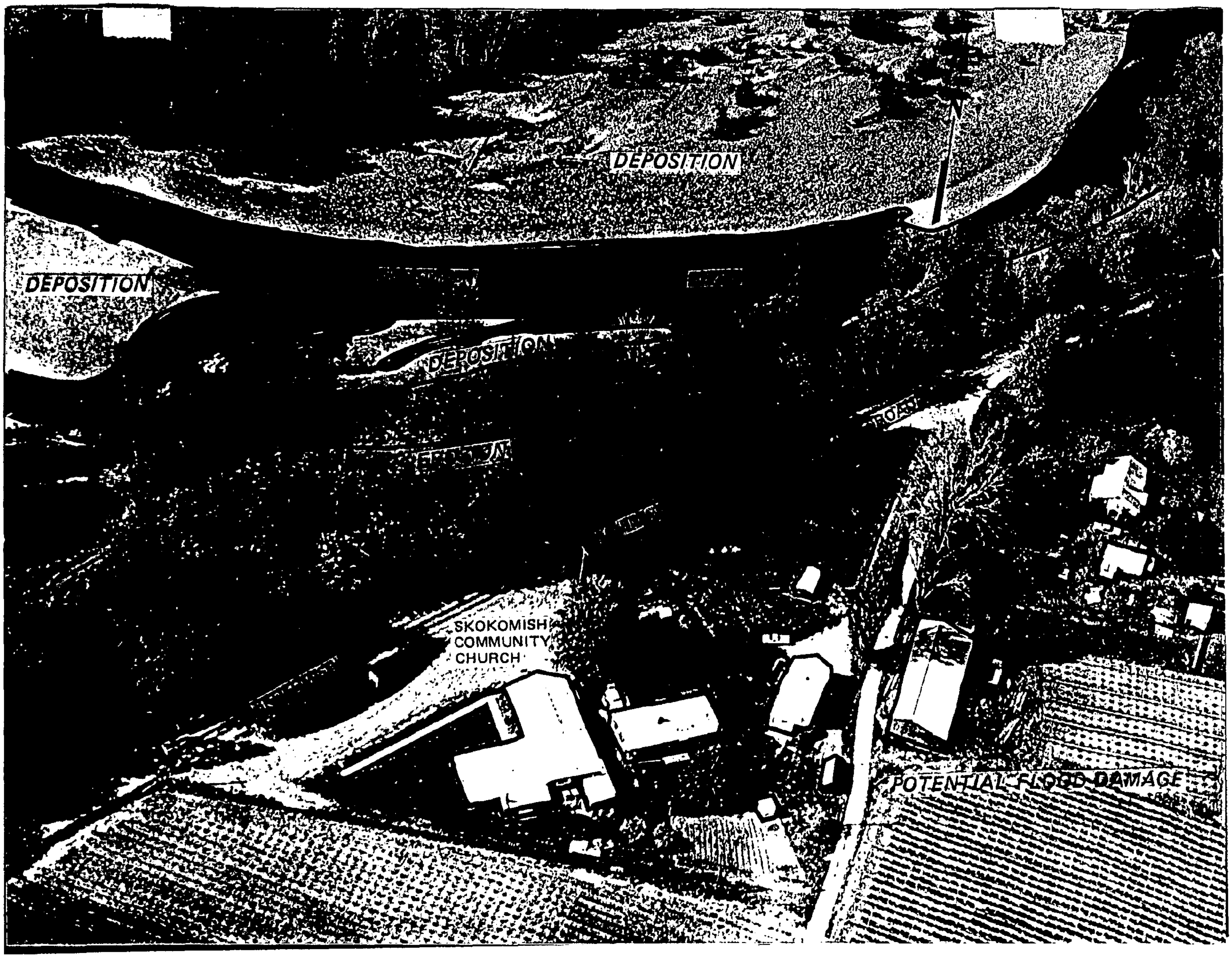


Figure 14B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 17, T21N, R4W, RM 8.2.

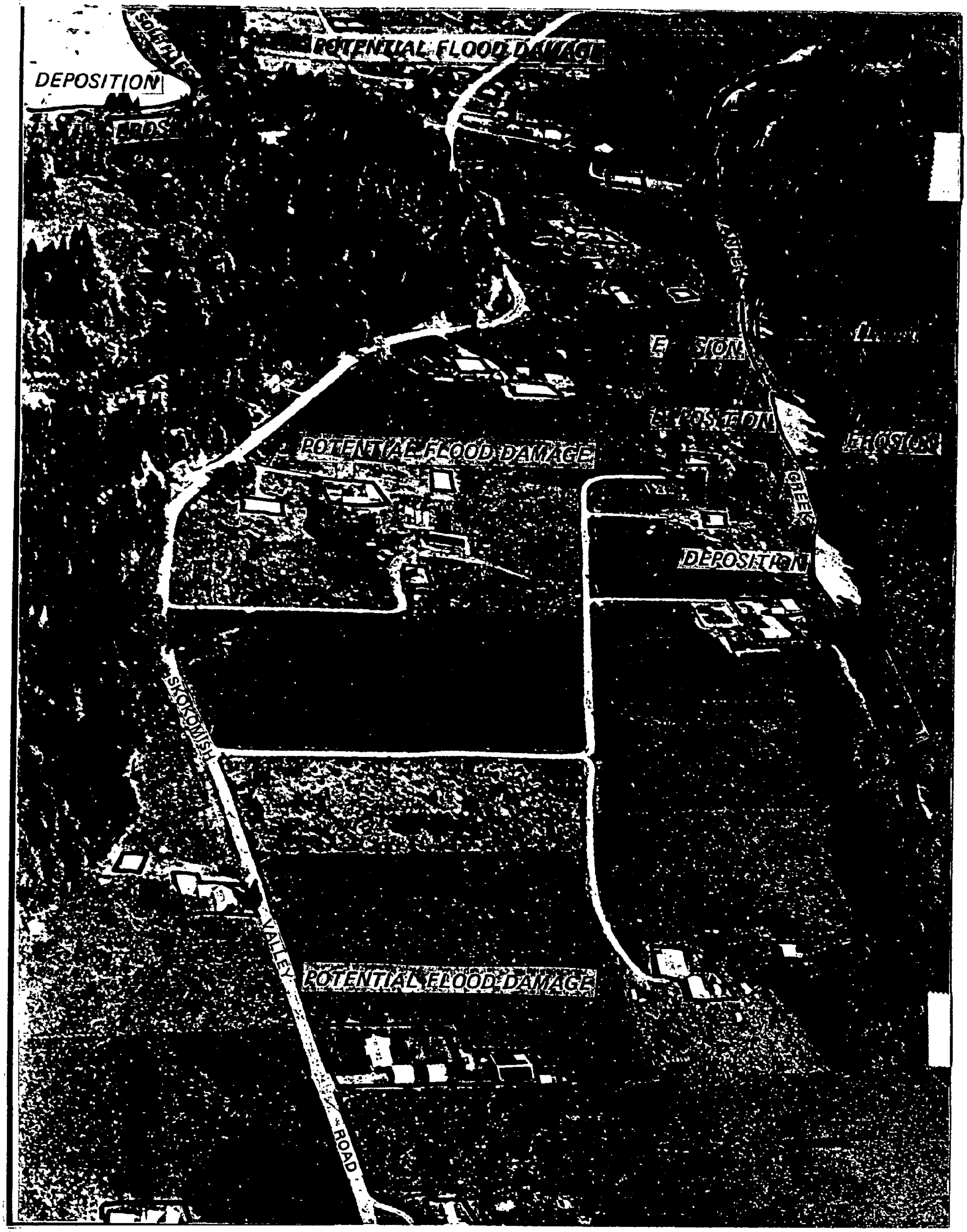


Figure 15B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 11&12, T21N–R5W, LOWER VANCE CREEK.

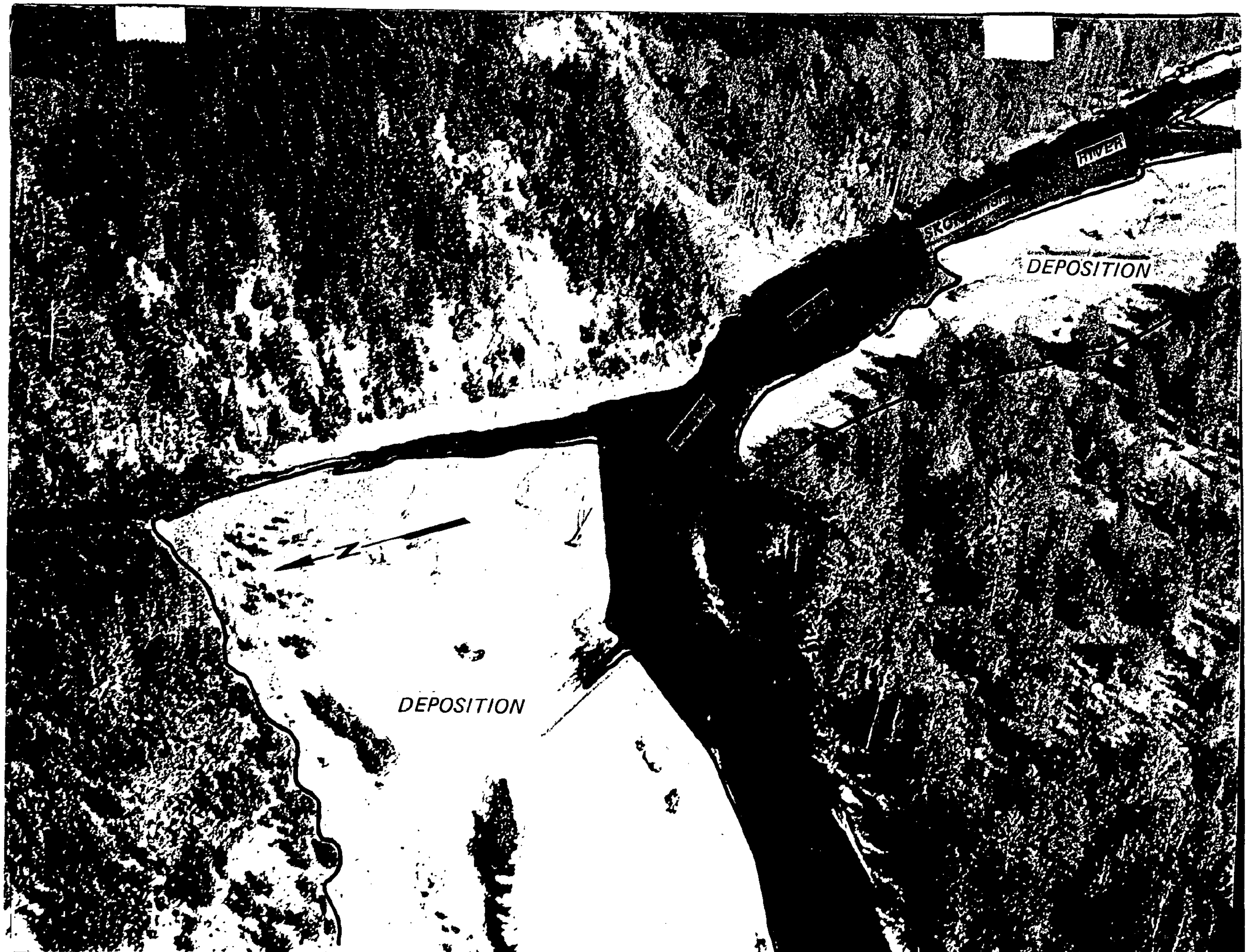


Figure 16B. EROSION, DEPOSITION AND POTENTIAL FLOOD DAMAGE, SEC 1, T21N–R5W, RM 2.4, SOUTH FORK