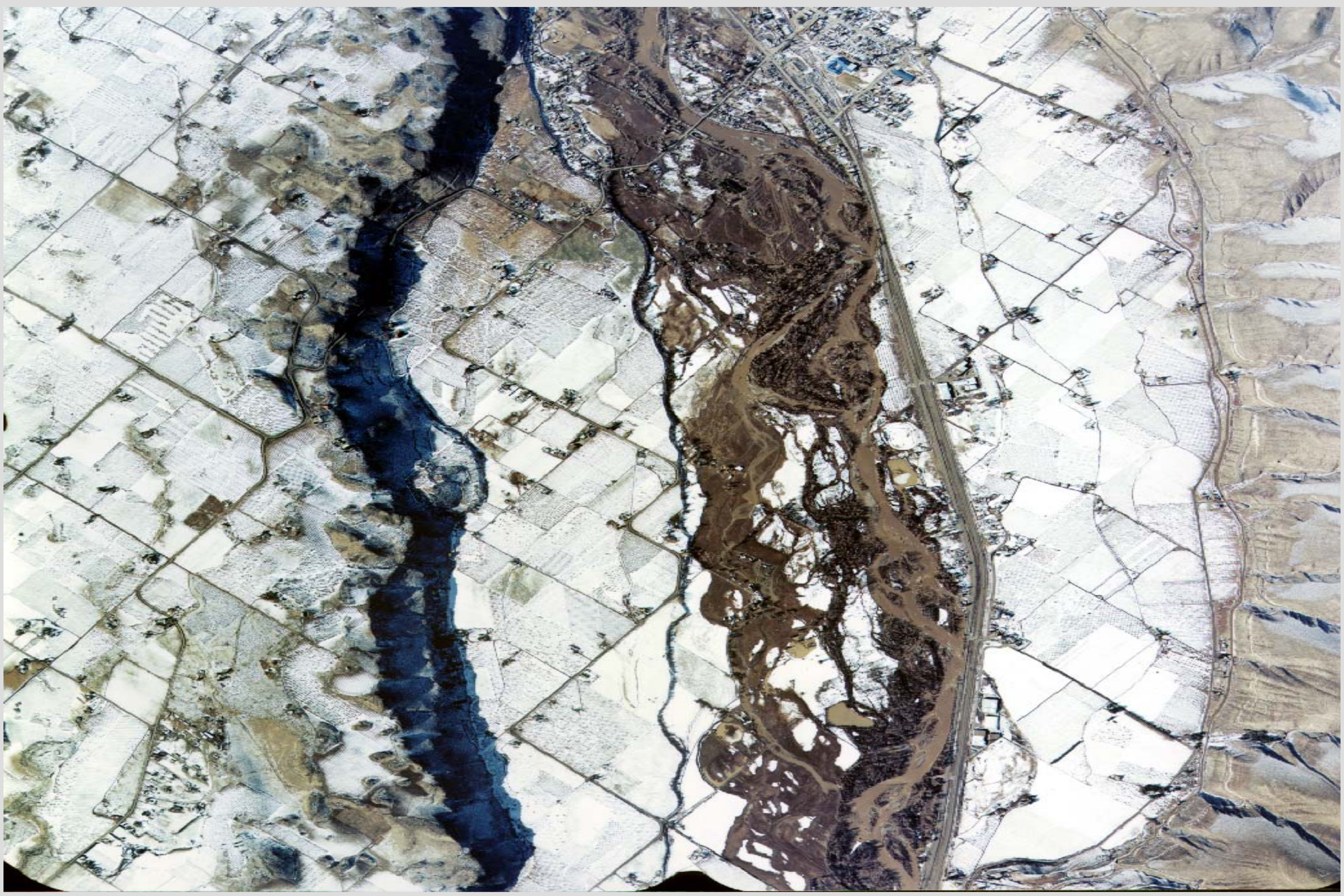
NACHES RIVER
COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Yakima County

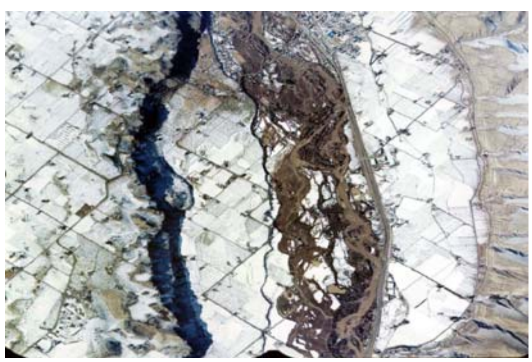


Tetra Tech/KCM

October 2003

UPDATED FEBRUARY 2005

Naches River Comprehensive Flood Hazard Management Plan



Tetra Tech/KCM

October 2003

Updated
February 2005

NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN
(River Mile 3.7 To River Mile 17.5)

October 2003

Updated February 2005

Adopted by the Yakima Board of County Commissioners

August 22, 2006

Resolution No. 461-2006

Adopted by the Naches Town Council

September 11, 2006

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This document was prepared by Tetra Tech/KCM, Inc. (KCM) under the direction of David Carlton, P.E., for Yakima County Department of Public Works. John Knutson, P.E., Manager of County Surface Water Management Division (SMD), served as the project manager for Yakima County.

Several others assisted in the development of this report. Issue development and alternative selection was performed with assistance from Advisory Committee members listed below. Yakima County GIS Department provided shape files for Tetra Tech/KCM to use in creating base maps. Erika Lacey, of FEMA, provide GIS flood data and maps describing flood damage resulting from the February 9, 1996 flood. Walker and Associates and Washington Department of Transportation provide aerial photographs. Historical photographs were provided by Yakima Herald-Republic and Yakima County.

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ADDENDUM SHEET

Final Naches River CFHMP
August 2006

◊ Added “Acknowledgements” page

◊ Updated Table 2-14 statistics for County Zoning map

◊ Added zoning map & statistics for Town of Naches

◊ Updated 1996 inundation map, Figure 4-1

◊ Updated Naches Wonderland subdivision information

Naches River Comprehensive Flood Hazard Management Plan
TABLE OF CONTENTS

Appendices

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

No. *Title* *Page No.*

LIST OF ABBREVIATIONS

BA—Biological Assessment

BE—Biological Evaluation

BFE—Base Flood Elevation

BMP—Best Management Practice

CAO—Critical Areas Ordinance

CFHMP—Comprehensive Flood Hazard Management Plan

cfs—Cubic feet per second

CIP—Capital Improvement Program

CMZ—Channel Migration Zone

Corps—U.S. Army Corps of Engineers

CRS—Community Rating System

DDT—dichloro diphenyl trichloroethane

DNR—Washington State Department of Natural Resources

DNS—Determination of Non-significance

DSC—Development Services Center

EIS—Environmental Impact Statement

Ecology—Washington State Department of Ecology

EOC—Emergency Operations Center

EMI—Emergency Management Institute

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

ESSB—Engrossed Senate Substitute Bill

FCAAP—Flood Control Assistance Account Program

FCZD—Flood Control Zone District

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FHBM—Flood Hazard Boundary Map

FIA-Federal Insurance Agency

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

FOZ—Flood Overlay Zone

FRP—Flood Response Plan

FWS—U.S. Fish and Wildlife Service

GIS—Geographical Information System

GMA—Growth Management Act

GO—General obligation (bond)

GA—General Agricultural

GR—General Rural

HPA—Hydraulic Project Approval

LWD—Large woody debris

MDNS—Mitigated Determination of Nonsignificance

MOA—Memorandum of Agreement

NAWQA—National Water Quality Assessment

NEPA—National Environmental Policy Act

NFIP—National Flood Insurance Program

NPDES—National Pollutant Discharge Elimination System

NMFS—National Marine Fisheries Service (name was recently changed to NOAA Fisheries)

NRCS—Natural Resources Conservation Service

NTU— Nephelometric Turbidity Unit

NWI—National Wetland Inventory

NWS—National Weather Service

OCD—Washington State Office of Community Development

OHWM—Ordinary High Water Mark

YPHD—Yakima Public Health Department

R-1—One Family Residential

RCW—Revised Code of Washington

R/ELDP—Remote Extremely Limited Development Potential

RM—River Mile

RMZ—Riparian Management Zone

ROW—Right-of-way

RR—Rural Residential

RT—Rural Transitional

SCS—U.S. Department of Agriculture Soil Conservation Service

SEPA—State Environmental Policy Act

SFHA—Special Flood Hazard Area

SMA—Shoreline Master Act

SMD—Surface Water Management Division of Yakima County Public Services Department

SMP—Shoreline Master Plan/Program

SR—State Route

TCWRA—Tri-County Water Resource Agency

TMDL—Total maximum daily load

TSS—Total suspended solids

UGA—Urban Growth Area

UGB—Urban Growth Boundary

USBR—U.S. Bureau of Reclamation

USC—U.S. Code

USDA—U.S. Department of Agriculture

USFWS—U.S. Fish and Wildlife Service

USGS—U.S. Geological Survey

VR—Valley Rural

WAC—Washington Administrative Code

WDFW—Washington State Department of Fish and Wildlife

WMZ—Wetland Management Zone

WRIA—Water resource inventory area

WSDOT—Washington State Department of Transportation

YHR—Yakima Herald-Republic

EXECUTIVE SUMMARY

This Comprehensive Flood Hazard Management Plan (CFHMP) was prepared for Yakima County to address flood hazard management issues related to the Naches River. The study area for this plan includes the floodplain of the Naches River from its confluence with the Tieton River (RM 17.6) to the Twin Bridges near the City of Yakima (RM 3.7). Although agriculture makes up 41 percent of the current land use in the study area, there are also residential and commercial developments in the floodplain that have been subject to repeated flood damage. Several reaches in the study area have exhibited rapid channel migration, resulting in loss of property and significant changes to the river's floodplain over relatively short periods of time. The primary goal of the CFHMP was to identify and evaluate flooding problems in the study area and to develop cost-effective alternatives for the mitigation of these problems. This effort resulted in a comprehensive plan that can be used by the County as a guide for flood hazard management in the Naches River area.

This CFHMP fulfills one of the main requirements for the County to become eligible for funding from the State of Washington under the Flood Control Assistance Account Program (FCAAP). State funds from this program can be used for emergency and non-emergency activities that reduce property loss and threats to human health caused by flooding. In addition, this plan is recognized by the Federal Emergency Management Agency (FEMA) and the Washington State Emergency Management Division as a mitigation plan to be used to direct post-disaster mitigation measures.

APPROACH

A successful CFHMP requires a solid foundation in science and engineering and support from the local community and regulators. Public and agency involvement was accomplished through an advisory committee, interviews and written correspondence with County staff, local residents and agencies, and newspaper articles. The advisory committee was an integral participant and decision-maker throughout the planning process. A series of eleven meetings were held during which the committee helped in establishing plan goals and objectives, identifying flood problems, and evaluating alternative solutions to flood problems. The advisory committee was comprised of a diverse group of interested community members and representatives from local and state government agencies, enabling all interested primary stakeholders to present their ideas and viewpoints and come to agreement on final plan recommendations. Consensus by the group on the plan's outcome will help ensure the future successful implementation of recommendations proposed in the CFHMP. A prioritization of recommended activities will be developed based on input from the committee. Mailings were sent out before each meeting to give members time to review information and pertinent documents prior to discussion. Specific goals and objectives of the plan are summarized in Table ES-1.

TABLE ES-1. GOALS AND OBJECTIVES FOR NACHES RIVER CFHMP	
Goal	Objectives
1. Enhance our understanding of the Naches River system	1.1 Obtain accurate mapping of the geomorphic floodplain, including the extent of the floodplain, historical channels, previous inundation areas and flood elevations. 1.2 Evaluate the effect of reservoir management in the upper watershed on sediment transport, flooding, geomorphology, etc. in the study area. 1.3 Identify areas where property loss caused by channel migration or avulsions is probable. 1.4 Identify high flood hazard areas. 1.5 Identify hazards associated with debris and ice jams. 1.6 Catalog man-made conveyance systems that captured and conveyed floodwater during previous floods, causing flood problems for locations potentially outside the FEMA floodplain.
2. Protect the natural functioning of the river system	2.1 Where development has encroached into the floodplain, encourage flood protection measures that are compatible with the natural functioning of the river system. 2.2 Where bank erosion or side-slope stability is a problem and a bank section must be stabilized, use bank stabilization techniques that also enhance fish and wildlife habitat. 2.3 Identify significant accumulations of in-stream debris and determine whether they have a positive influence on the river system (e.g., by providing fish and wildlife habitat) or a negative influence (e.g., by endangering floodplain residents). 2.4 Encourage preservation or enhancement of existing flood storage areas. 2.5 Minimize the amount of in-stream maintenance work. 2.6 Provide solutions to protect irrigation diversions from the erosive force of channel migration.
3. Increase public awareness and understanding of flooding issues	3.1 Enhance public education. 3.2 Enhance assistance programs. 3.3 Enhance public participation. 3.4 Enhance public trust. 3.5 Promote floodplain preservation programs such as the County's Open Space Taxation Program. Provide examples of potential cost savings, program details, and contacts to local residents who could benefit from the program.

TABLE ES-1 (continued) GOALS AND OBJECTIVES FOR NACHES RIVER CFHMP	
Goal	Objectives
4. Address problems in a systematic and defensible manner	4.1 Implement a comprehensive flood hazard management program. 4.2 Review the CFHMP periodically to determine its effectiveness and whether revisions are needed. 4.3 Provide a stable funding source for implementing the CFHMP and for specific projects. 4.4 Foster cooperative relationships. 4.5 Foster a proactive rather than reactive approach to flood issues. 4.6 Use current and best available science.
5. Ensure that land use plans and regulations protect the floodplain functions	5.1 Evaluate the adequacy of County enforcement of land use regulations. 5.2 Evaluate the adequacy of County land use plans. (Also being evaluated in the update of the critical areas ordinance (CAO)) 5.3 Evaluate the County's development regulations to determine whether they protect floodplain functions. (Also being evaluated in the CAO update) 5.4 Use best available flood hazard data for regulation of land development and permitting. 5.5 Review recently approved development in the study area. 5.6 Evaluate other development requirements that may impact flood hazard management. Topics addressed by this review should include: • Septic system siting • Design requirements that may be unsuitable for floodplain locations (e.g., maintaining an area cleared of vegetation for drainfields) • Drinking water well siting and head protection requirements • Fire codes • Hazardous material storage. 5.7 Communicate with private developers to convey the results of interim CFHMP analyses affecting proposed development parcels. 5.8 Review development proposals to ensure consistency with flood hazard management alternatives that are likely to be developed in the CFHMP.

TABLE ES-1 (continued). GOALS AND OBJECTIVES FOR NACHES RIVER CFHMP	
Goal	Objectives
6. Promote public safety	6.1 Evaluate the potential flood hazard to the City of Yakima Water Treatment Facility and recommend solutions if needed. 6.2 Identify facilities that have been flooded previously or are likely to be flooded, and the frequency and severity of the impact: • Buildings • Irrigation systems • Recreational facilities 6.3 Evaluate the need for enhancements to the County's emergency management program related to flooding. Specific items include: • Access to safe drinking water • Saturated septic systems that may pose a health risk, especially to shallow wells • Traffic control during floods • Access to flood protection materials such as sandbags • Evacuation routes based on flood stage • Current and accurate flood prediction by the National Weather Service • Accessibility of temporary housing • Early warning system. 6.4 Evaluate the flood hazards to, and associated with, county and state infrastructure (roads, bridges). Issues include: • The proximity of the river to roads and U.S. Highway 12, endangering the roads and reducing floodplain storage • Hydraulic capacity of bridges • Damage to structures from debris/ice jams. 6.5 Levees and dikes • Evaluate functionality versus environmental impact • Perform proper maintenance
7. Promote actions that are consistent with fish and wildlife needs	7.1 Identify and protect critical habitat areas within the study area. 7.2 Incorporate fish and wildlife enhancement elements into all recommended flood hazard reduction projects.

FLOOD ISSUES

Flooding issues were identified by examining historical flooding patterns, reviewing previous studies, and collecting information from advisory committee members and County staff. Each flooding issue was discussed at advisory committee meetings to define the problem, evaluate related issues, and determine a range of solutions. Specific flood hazard management options were then developed to address each flood issue. The following issues were identified:

- **Scientific/Engineering Information Gaps**
  - A. Inadequate mapping (geomorphic floodplain) and FEMA floodplain maps (accuracy of flood elevations and extents).
  - B. Better understanding of Naches River geomorphology and reservoir impacts
- **Public Education**
  - C. Public perception and lack of confidence in FEMA's flood insurance program and emergency relief operations following the 1996 flood
  - D. Lack of public understanding of river system behavior and flood hazards
  - E. Public health and safety
  - F. Advertising the County's Open Space Taxation Program, conservation easements, etc.
  - G. Understanding the County's roles in emergency management
  - H. Lack of knowledge of the physical and ecological functions of the floodplain.
  - I. Technical assistance currently unavailable
- **Emergency Management**
  - J. Lack in accuracy of flood predictions (timing, magnitude)
  - K. Better access to flood fighting materials
  - L. Emergency access (escape routes, traffic congestion)
  - M. The responsibilities of the Flood Control Zone District (FCZD) during a flood
- **Facilities and Existing Structures**
  - N. Damage to existing structures and facilities; includes buildings, roads, bridges, levees, and diversion structures
  - O. Proximity of Highway 12 to Naches River
- **Regulatory**
  - P. More restrictive and inclusive requirements in the County's Flood Hazard Ordinance and development code (emphasis on development and septic tank design and siting)
  - Q. Enforcement of development regulations and land use codes in the Special Flood Hazard Area (SFHA)
  - R. Streamlining of the federal and state permitting process
- **Bank Erosion/Channel Migration**
  - S. Loss of property due to bank erosion and channel migration
- **Site Specific Flood Issues**
  - T. Rambler's Park; Simplification of the river channel
  - U. Inadequate protection of the City of Yakima water treatment facility
  - V. Naches Wonderland
  - W. Hillslope instability near Rose's Café.

ALTERNATIVE ANALYSIS

Potential flood hazard management solutions were developed to address all the flooding problems identified in this study. The alternatives are grouped in the following categories:

- Flood hazard reduction for new and existing structures
- Open space preservation/habitat preservation and enhancement
- Public facilities
- Emergency management
- Mapping/data collection
- Public education, outreach, and public safety
- Implementation funding.

The alternatives that best met the goals and objectives of the CFHMP and received support from the advisory committee were selected for recommendation.

SUMMARY OF RECOMMENDED ACTIONS

The recommendations selected for implementation are summarized in Table ES-2. They represent an action plan that the County can use for planning and implementing floodplain management activities and capital improvement projects. The Surface Water Management Division/Flood Control Zone District (SMD/FCZD) will lead the effort to implement the Naches River CFHMP by providing guidance and direction in the following ways:

- Administering the implementation of the CFHMP by working with the agencies and parties responsible for implementing the recommended projects and programs
- Updating the CFHMP as projects are completed and keeping the plan consistent with current conditions

The plan should be updated periodically to account for actions that have been completed, changes in local conditions and changes in local priorities. Priorities for each activity were defined based on input from the advisory committee and County staff. Several of the proposed capital improvements will need further study and analysis to assess their overall impacts and effectiveness. Estimated costs, implementing agency and issues addressed are summarized in Chapter 10-Summary of Recommended Actions.

TABLE ES-2.
RECOMMENDED GENERAL ACTIONS FOR THE NACHES RIVER STUDY

Flood Hazard Reduction for New Development and Existing Structures

1. Prohibit surface mining within this reach to reduce impacts on channel migration and habitat and the need for levees.

   SMD/FCZD will provide support as needed.

2. Prohibit the creation of new lots entirely within the floodplain and require new partial lots to have at least a 5,000-square-foot building envelope outside the floodplain.

   Implement for the study reach during the revision or update of the Critical Areas Ordinance, with support provided by SMD/FCZD as needed.

Revise ordinances:

3. Establish a freeboard of 1 to 3 feet above the base flood elevation to which the lowest floor of residential buildings must be elevated.
4. Increase to 1 to 3 feet above the base flood elevation the elevation to which the lowest floor of nonresidential buildings must be elevated.
5. Require compensatory storage for all fill in the floodplain or fill beyond a set volume to prevent increases in downstream flood peaks. Single-family homes (not subdivisions) would be exempt.
6. Require new structures on all existing floodplain lots to be placed at the safest location on the property, with consideration of the feasibility of meeting other requirements such as siting of septic systems.
7. Adopt specific channel migration/avulsion regulations that prevent the construction or substantial reconstruction (as defined by the Flood Hazard Ordinance) of any residential, commercial, or industrial structures in channel migration hazard zones.
8. Implement deep/fast-flowing water regulations to further define the floodway (see also Data Collection/Mapping – remapping project to include mapping regions of deep/fast-flowing water). Regulate the same as the regulatory floodway.

9. Properly store hazardous/toxic materials in the floodplain to keep them safe from floodwaters.

   Implement by providing safe materials storage information during permitting processes. Also send information to existing properties within the study area.

10. Naches Wonderland—Use the Naches River model and the results of the Channel Migration Study to identify the nature of and likelihood of severe flood damage or erosion hazard. Identify appropriate measures to protect or move permanent structures if needed. (other subdivision constraints may impact this recommendation)
11. Acquire or relocate floodprone structures or land uses with equitable compensation when money is available and owner is willing.

    This project will be implemented through the Non-regulatory Natural Resource Protection Program, in policies currently being developed by the Yakima County Planning Division.

12. Implement a limited cost-share program to floodproof or elevate residential structures. This action is to be used only in extreme cases, as determined by the SMD/FCZD.
13. Ensure that future comprehensive plan revisions and policies are compatible with CFHMP goals and policies.

    Implementation support to be provided by SMD/FCZD as needed. Reach-specific policies, goals, and standards shall be created in the comprehensive plan by reference to the CFHMP.

TABLE ES-2 (continued).
RECOMMENDED GENERAL ACTIONS FOR THE NACHES RIVER STUDY

Ramblers Park Recommended Actions

14. Implement a buyout program to relocate some residents and businesses.

    This effort should be coordinated by SMD/FCZD with the Yakima County Non-Regulatory Natural Resource Protection program in conjunction with the Yakima County Planning Division.
15. Seek ways to relocate residences or businesses using partial grant funds and cooperative projects with owners, such as is being done in the current project by SMD/FCZD and the Yakima County Planning Division to relocate Auto Recycling facilities from the high hazard floodplains, using Ecology Centennial Grant funds.
16. Seek ways to relocate residences and businesses during County or State transportation projects.
17. Continue to study Ramblers Park. If certain facilities are relocated, the existing levee should be removed and a setback levee constructed closer to Highway 12/Powerhouse Road.
18. McCormick Levee—Continue to stabilize the eroding portion of the McCormick levee using techniques that enhance fish and wildlife habitat conditions. Repair and enhancement project was completed, but additional measures may be required. Generate funds from residents and businesses protected by the levee by developing a sub-zone.
19. Bioengineered bank stabilization devices (engineered logjams, replanting of trees and other riparian vegetation, cabled root wads, etc.) are preferred where relocation is not an option.

    Implement through the local permitting process (including GMA, SMA, and NFIP related reviews/permits) and during environmental review (SEPA). This recommendation also applies to County and City projects.
20. Use conventional bank stabilization devices (spur dikes, barbs, trench fill revetment, approach dikes at bridges, etc.) in conjunction with habitat mitigation as a last resort for protecting existing structures that cannot be relocated.

    Implement through the local permitting process (including GMA, SMA, and NFIP related reviews/permits) and during environmental review (SEPA). This recommendation also applies to County and City projects.

Open Space Preservation/Habitat Preservation and Enhancement

21. Continue to operate and promote the Open Space Tax Program
22. During permit review, continue to look for ways to coordinate current and ongoing restoration and mitigation projects in the study area to maximize benefits.
23. Consider keeping undeveloped County-owned parcels in flood hazard areas as permanent open space by attaching deed restrictions, using conservation easements, etc.

    Consultation with all County divisions/departments that own properties in flood hazard areas shall be done during the implementation of this policy. This policy shall not override an imminent planned use of a property unless fair compensation to the owner is made.
24. Use regulatory and non-regulatory tools to promote preserving and increasing open space areas in the floodplain.

    These tools include the Non-Regulatory Natural Resource Protection Program, the Open Space Tax Program, policies currently being developed by the Yakima County Planning Division, and the Channel Migration Zone regulations.
25. Pursue open space preservation (increasing the amount of open space in the floodplain through purchase, conservation easements, etc. versus permanently maintaining existing open space parcels)

TABLE ES-2 (continued).
RECOMMENDED GENERAL ACTIONS FOR THE NACHES RIVER STUDY

Public Facilities

26. Craig Road Flooding—Reconstruct the South Naches Irrigation District (SNID) headgate and levee to eliminate imminent flood hazard.

    SMD/FCZD is currently providing assistance as part of the technical advisory team for SNID's Comprehensive Irrigation District Management Plan. Other assistance is possible, such as agency coordination, funding, and design review at SMD/FCZD discretion.

27. Add a new section for the siting of critical facilities. Prohibit construction in the floodplain, and require critical facilities to be elevated at least 2 feet above the base flood elevation. Require these facilities to be accessible during a flood.

    The addition of new critical facilities in the floodplain is not expected to be a significant issue in the future.

28. Relocate Lewis Road, in conjunction with the South Naches Road upgrade project, to an alignment that does not result in damage to the road during flood events or when inundated.

    Road may be elevated above the BFE if it is set back far enough from the river. Channel migration issues are a factor and should be carefully considered in siting this facility. Alignment and design criteria assistance to be provided by SMD/FCZD. This project is in the design phase.

29. Continue to discuss options to protect Highway 12 and increase floodplain storage with WSDOT.

30. Evaluate the potential for relocating levees away from the river or removing them to reduce flood hazards.

    Implement with cooperation from WSDOT, City of Yakima and others as time and opportunities allow. Implementation of a specific levee setback or removal project may require partnerships and external funding assistance.

31. Design and construct roads such that they are flood resistant where needed. These include erosion resistant shoulders or dips in the roadway.

    This is currently being applied in the design and construction of new roads and roadway improvements.

32. Encourage the modification of headgate structures to make them less susceptible to damage from flood debris and ice jams, including conversion of smaller canals to piped/pressurized systems or by combining diversions.

33. Work with WSDOT to identify potential sites where minor work on Highway 12 will result in the safe reconnection of floodplain area or side channels.

    Cooperate with WSDOT as time and opportunities allow. A specific floodplain reconnection project may require partnerships with WDFW, WSDOT, and SMD/FCZD and others to obtain funding.

34. Use a Naches River hydraulic model to analyze measures at the City of Yakima Water Treatment Plant to increase the facility's level of protection.

    Specifically, evaluate the construction of a setback levee or removal of the existing levees located on the opposite side of the plant to reduce the potential for erosion of the Treatment Plant levee and Highway 12.

    Conduct analysis as part of modeling used to revise FIRMs. Implementation of a setback project will require partnerships with the City of Yakima, SMD/FCZD, property owners, and others to obtain funding.

TABLE ES-2 (continued).
RECOMMENDED GENERAL ACTIONS FOR THE NACHES RIVER STUDY

35. When new bridges are constructed, or bridges are rebuilt or replaced, the bridge should span the floodway as much as possible. This prevents the new bridge from creating additional flooding.

    Implement through applicable permitting programs (GMA, SMA, NFIP).

Emergency Management

Recommendations related to Emergency Response currently being considered in the development of a Flood Emergency Response Plan:

36. Create, publicize, and implement an action plan for use in the Emergency Operations Center during a flood event.
37. Emphasize what the County's roles are in providing flood response, including sandbagging, evacuation notices, etc.
38. Document flood warning and emergency response activities to gain more credits in CRS program, when the program is joined.
39. Establish evacuation procedures and routes considering flooded roads (fire departments).
40. Ensure provisions have been made for warning and self-evacuation for all occupied structures during a flood if they do not have dry land access.
41. Coordinate training classes and materials for emergency personnel, police, fire and public works on their responsibilities during a flood.
42. Promote EMI training courses for emergency personnel.
43. Promote police patrols at emergency access routes during flood events.
44. Publish maps showing evacuation routes and gage height at which roads are flooded/closed (see also evacuation recommendations under Emergency Management).
45. Increase public awareness on post-flood drinking water well safety, well testing, and health risks associated with flooded septic systems. Make clear the locations of public water supplies temporarily available to residents after a flood.

Recommendations related to improving access to flood- fighting materials:

46. Provide access to flood-fighting materials including sand, sandbags, etc. at fire stations.
47. Improve access to flood-fighting materials by organizing and advertising locations for pick-up and stocking materials before flood season.

    Implement in SMD/FCZD sandbag machine/equipment purchasing/siting project currently underway.

Mapping/Data Collection

48. Update existing FEMA floodplain maps and facilitate future updates as needed. Include regions of fast/deep flowing water. Create a hydraulic model of the river to predict flood heights and areas of inundation based on the USBR gage reading at Naches (project currently underway in the Naches Channel Migration Study). Coordinate with new FEMA mapping initiative.

    Implement as next phase of the Naches River CFHMP project (project currently underway).

49. Map channel migration hazard zones. Currently underway through the Naches Channel Migration Study.

    Implement as part of current Naches River CFHMP project. Table 10-1 has further details for incorporating study results into the CAO update process.

50. Monitor hill slope instability near Rose's Cafe to determine the overall rate of movement of the instability and provide warning of imminent failure.

TABLE ES-2 (continued).
RECOMMENDED GENERAL ACTIONS FOR THE NACHES RIVER STUDY

51. Continue to collect new channel information and data over time, using LIDAR and/or other techniques. Periodically review channel migration hazard and FEMA floodplain maps to determine the need to update the maps. Incorporate new technology as it becomes available. Seek partnerships with others.

52. Encourage an update to the NWS flood-forecasting model for the Naches River, if not already updated.

53. Research studies of basins similar to the Naches Basin on how altered flow regimes have affected sediment transport, flooding, geomorphology, etc.

    Implement as time and opportunity allow. Consider partnerships with others with similar interests, such as USBR, WDFW, Yakama Nation, Central Washington University.

54. Continue to support and cooperate with the USBR on projects relating to the Naches River, including the current sediment transport study on the Tieton River, which will determine the impact of the Tieton River reservoir on sediment transport, flooding, and geomorphology in the Naches River.

55. Use mapping activities to gain CRS credits, if the CRS program is joined.

    SMD/FCZD will coordinate with the Yakima County Planning Division and Building and Fire Safety Division.

Public Education, Outreach, and Public Safety

56. Develop a SMD/FCZD library for documents, maps, research reports, periodicals, photos, etc. Include flood protection information in the SMD/FCZD library.

Recommendations related to public outreach:

- 57. Provide flood preparedness, outreach and education programs that emphasize what owners can do to be prepared to minimize damage to their property.
- 58. Implement outreach projects to inform the public about the Open Space Tax Program and the floodplain's physical and ecological functions.
- 59. Incorporate public education projects that provide information to the public about post-disaster flood relief.
- 60. Use public education projects to gain CRS credits, when the program is joined.

Recommendations related to publishing maps for public use:

- 61. Include channel migration hazard maps and information in the flood protection library and other county information sources.
- 62. Continue to make flood inundation maps available to the public. Have maps at the planning division, development services center, public libraries and on the web.

Recommendations related to technical assistance:

- 63. Continue to provide informal floodplain information to the public as a free public service.
- 64. Provide technical assistance on desired techniques for bank stabilization and flood protection, and the permitting process (trained staff, brochures on acceptable techniques, field assistance, funding sources). Include information on acceptable bioengineering techniques for bank stabilization and native vegetation that will enhance and stabilize the riparian zones.

65. Develop and provide information on any available voluntary relocation opportunities to floodplain residents through the planning department, permit services division, and SMD/FCZD library.

TABLE ES-2 (continued). RECOMMENDED GENERAL ACTIONS FOR THE NACHES RIVER STUDY
66. Send out notifications to floodplain properties. This should include periodic reminders of flood season, their location in the floodplain, information about relevant County policies, and where they can receive additional information should they want more.
Implementation Funding
67. Ensure future funds exist to implement the Naches River CFHMP by making the Flood Control Zone District a permanent funding mechanism. Update: permanent funding was established for the FCZD in May 2004.

CHAPTER 1.
INTRODUCTION

The Naches River and the Yakima River watersheds are valuable resources for Yakima County residents. The importance of these water resources was described as follows in the *Yakima Valley Visioning Reports* (Citizens of the Greater Yakima Area 1992; Citizens of the Lower Yakima Valley 1992):

> The air we breath and water we drink are of their greatest value in their purest form, and the open lands and Yakima River corridor which exist in their natural state are essential resources.
>
> Uses are managed in a manner that is institutionally and environmentally acceptable to meet the ever increasing demand for this resource. The community appreciates the special bond between itself and water.
>
> Water flows into and out of this community, thus linking a whole region to our collective activity.
>
> The importance of water to this community provides the central focus of care and concern with all of the community's diverse activity.

These statements reflect County residents' concern for the Yakima River watershed and emphasize the need to plan for its future use and protection. The Naches River Comprehensive Flood Hazard Management Plan (CFHMP) enlarges on a previous planning effort for the Upper Yakima River CFHMP, completed in 1998. Developed by the County and its consulting firm, Tetra Tech/KCM, Inc., with input from the public and all affected public agencies, this CFHMP presents a balanced approach to flood damage protection, resource protection, environmental enhancement, and land development.

BACKGROUND

Yakima County, east of the Cascade Mountains in Central Washington and encompassing approximately 4,400 square miles, is the state's second largest county in land area. It is bordered by Kittitas, Klickitat, Skamania, Lewis, Pierce, and Benton Counties. This CFHMP focuses on the floodplain of the Naches River from its confluence with the Tieton River to Twin Bridges in Yakima (see Figure 1-1). This study area includes significant urban and farmland areas, and therefore has great potential for flood damage.

Flooding Issues in Study Area

Flooding in the study area normally occurs in winter or spring. Spring floods occur when warm weather and rainstorms accelerate snowmelt and runoff. Winter floods, which are more frequent and of larger magnitude, occur when rainfall on accumulated snow and warm winds produce large volumes of runoff from snowmelt and rain. The largest recent flood in the study area peaked on February 9, 1996, with damage amounting to several million dollars in the study area and over $17.7 million in Yakima County as a whole (Lacey, E., 1 March 1996, personal communication). Numerous other historical flood events resulted in significant damage, as documented in this report. A review of historical flood events identified recurring flood issues.

Principles of Flood Hazard Management

The terms *flood hazard management*, *flood control*, *floodplain management*, and *stormwater management* are commonly used to describe ways to minimize or prevent flood damages:

- Flood control usually entails structural techniques for separating people and property from damaging floodwaters. Nonstructural techniques, such as land use regulations and growth management, have typically been excluded from flood control.
- Floodplain management involves resource protection, environmental enhancement, flood damage protection, and regulation of land use within the floodplain.
- Stormwater management focuses on the quality, quantity, and controlled conveyance of surface runoff from urban areas during precipitation events.
- Flood hazard management encompasses flood control and floodplain management techniques, including structural and nonstructural measures affecting the river, the floodplain, and the watershed beyond.

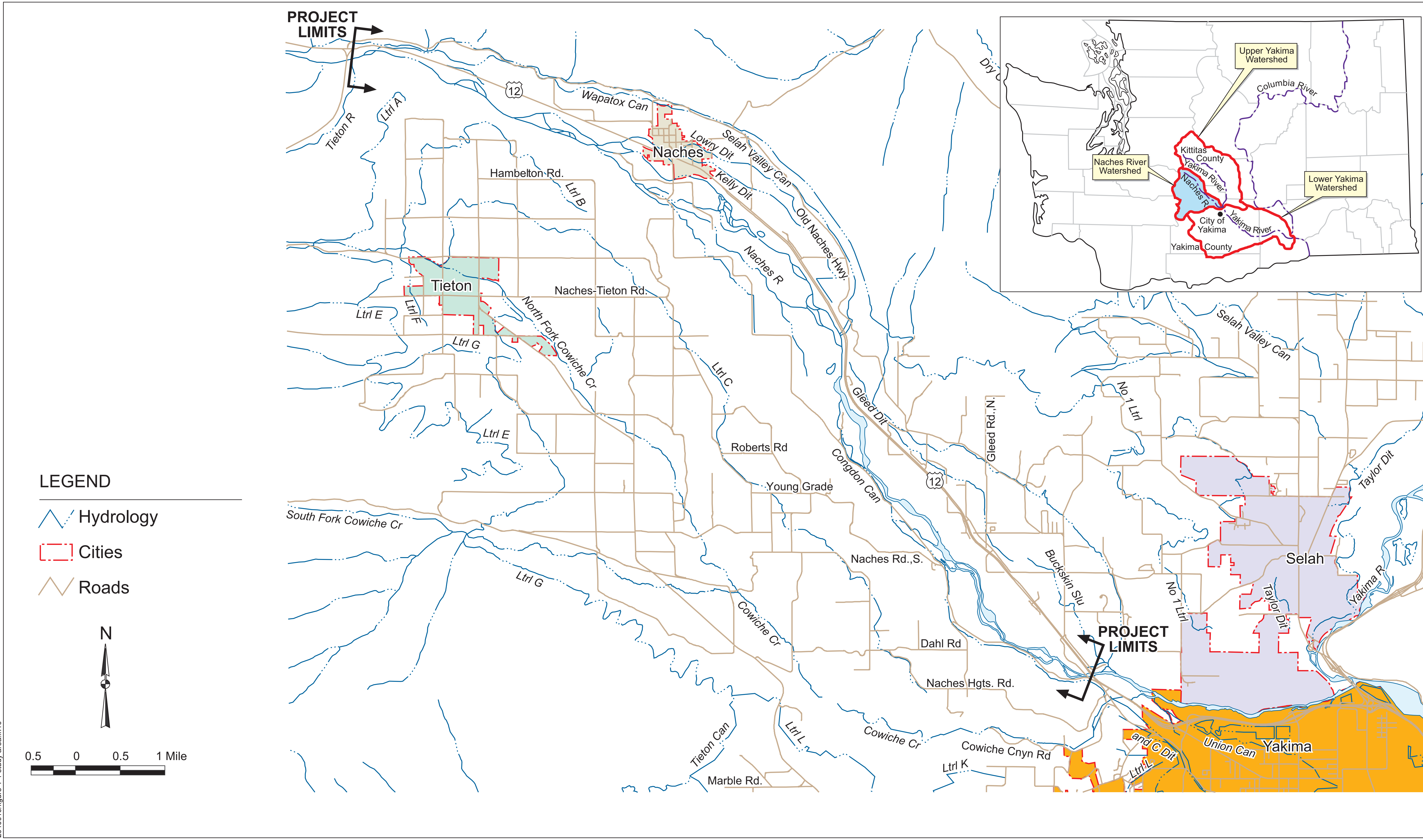
Flood hazard management, to be successful, must take into account the entire river system. Any activity in a river or its watershed can change the nature of the river's flooding. Human intervention can exacerbate or reduce the extent of flooding and its effects on human health, property, and the environment. These effects must be fully understood before any flood control actions are taken.

Authority and Scope for Naches River CFHMP

On December 7, 1999, Yakima County contracted with Tetra Tech/KCM, Inc., to assist in the development of a CFHMP for the Naches River in the vicinity of Naches, Washington. The final CFHMP report is scheduled to be approved by the Washington State Department of Ecology (Ecology) and adopted by Yakima County in 2003.

The material developed in Phase I, including the first six chapters of this report, was combined with additional study findings, analysis of flood mitigation alternatives, and recommendations to make up the final CFHMP. Phase I of the CFHMP study established a citizen and agency participation process, initiated the plan's public policy framework, and provided the technical information necessary to make informed decisions during subsequent evaluation of flood hazard reduction alternatives.

Funding for the Naches River CFHMP was provided under an agreement between Ecology and Yakima County, with Ecology contributing 75 percent of the project costs through the state's Flood Control Assistance Account Program (FCAAP) and Yakima County contributing the remainder from County funds. Completion of the CFHMP makes the County eligible for state funds for emergency and non-emergency activities that reduce property loss and threats to human health from flooding.



Tetra Tech/
KCM, Inc.
1917 First Avenue
Seattle, Washington 98101

Yakima County
NACHES RIVER CHANNEL MIGRATION STUDY

Figure 1-1.
NACHES RIVER STUDY AREA

PLAN DEVELOPMENT PROCESS

Figure 1-2 outlines the CFHMP process. The planning process conforms with Revised Code of Washington (RCW) Chapter 86.26: *State Participation in Flood Control Maintenance*, and with Washington Administrative Code (WAC) Chapter 173-145: *Administration of the Flood Control Assistance Account Program*. Phase I of the CFHMP study addressed the first five steps of the planning process:

- Establish a citizen and agency participation process.
- Set goals and objectives for flood hazard management.
- Develop an inventory and analysis of physical conditions.
- Determine the need for flood hazard management measures.
- Review existing regulations that impact flood hazard management.

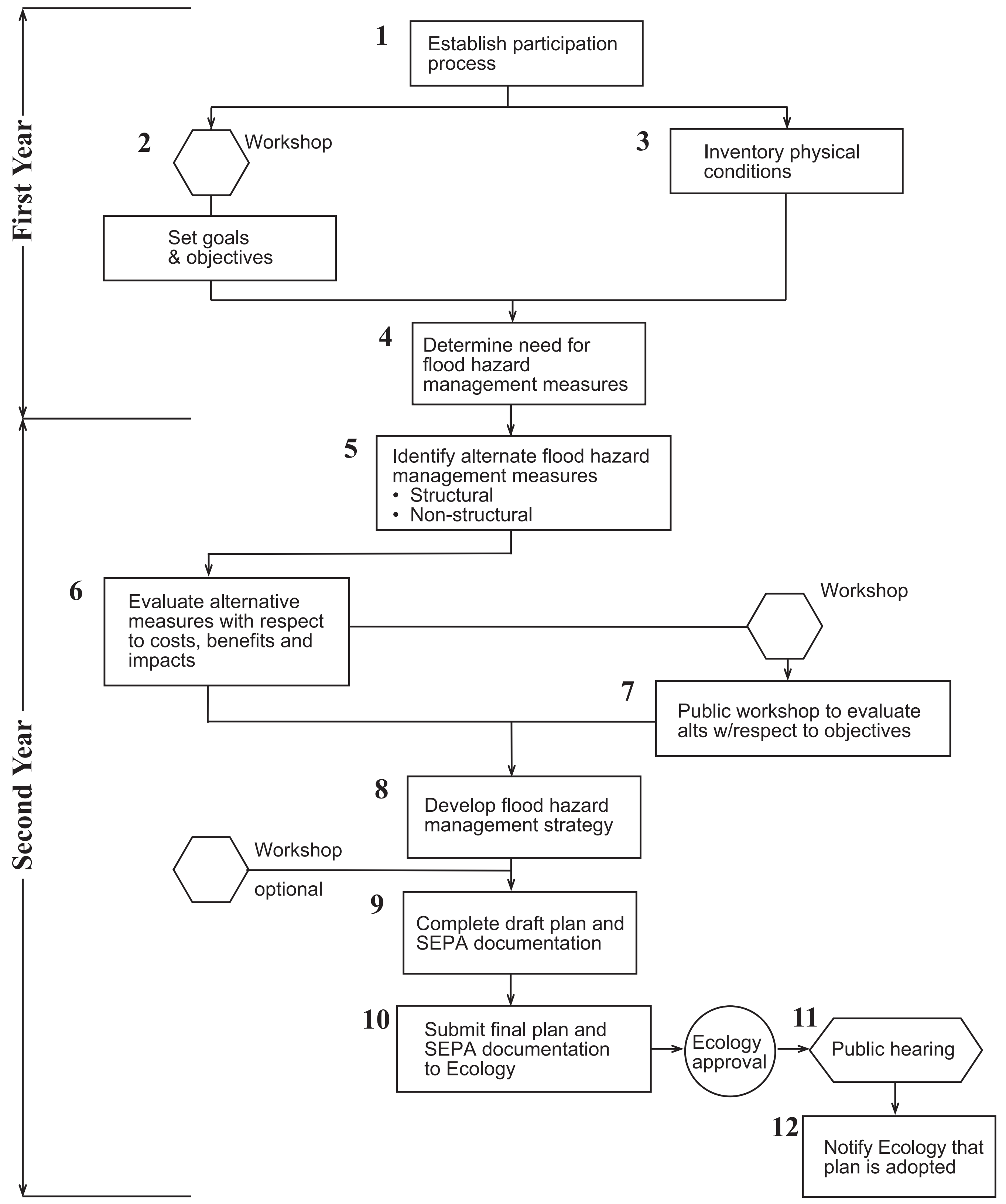
Phase II of the CFHMP study concentrated on the remaining planning steps:

- Identify alternative flood hazard management measures.
- Evaluate alternative measures.
- Hold advisory committee meetings for evaluation of alternatives.
- Develop a flood hazard management strategy.
- Complete the draft CFHMP and submit to Ecology.
- Submit the final CFHMP to Ecology.
- Hold a public hearing and adopt the CFHMP.
- Notify Ecology the final plan is adopted.

Involving the Public and Affected Agencies

Public and inter-agency involvement is critical to the success of a CFHMP for the following reasons (Ecology 1991):

- Proposed measures will affect local property owners, and their support will be needed to take action.
- WAC 173-145-070 calls for review of all FCAAP projects by state agencies including the Washington Department of Fish and Wildlife (WDFW) and the Washington Department of Natural Resources (DNR), as well as by affected Native American tribes and other public entities; all of these parties should be involved in formulating the plan.
- Since watersheds typically cross jurisdictional lines, representatives from neighboring local governments should be involved in the process.
- As the plan must be adopted by the local government, it is important to build support among the local constituency.



Source: Ecology 1991

2040016/figure 1-2 Process.fh10

Tetra Tech/ KCM, Inc. 1917 First Avenue Seattle, Washington 98101	Yakima County NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN	Figure 1-2. CFHMP PLANNING PROCESS

- The planning process offers an opportunity to educate the public on the issues, opportunities, and public responsibilities of flood hazard management.

Public and agency involvement was achieved by forming an advisory committee whose members—representatives of public and private organizations and agency representatives—assisted in establishing plan goals and objectives, identifying flood problems, and evaluating alternative solutions to flood problems. Invitations to sit on the advisory committee were sent to all potentially interested community members and representatives from local and state government agencies, enabling all interested primary stakeholders to participate and present their ideas and viewpoints.

Table 1-1 lists the active members who participated on the citizen advisory committee. Other interested parties invited who chose not to actively participate, listed in Table 1-2, were kept informed of meeting dates and the plan's progress with regular mailings and e-mails. Meeting dates and topics discussed are presented in Table 1-3. Mailings were sent out before each meeting to give members time to review information and pertinent documents prior to discussion. Additional agency representatives were contacted as needed throughout the plan preparation, and contact was maintained with Ecology to ensure compliance with FCAAP requirements. Consensus by the group on the plan's recommendations will help ensure successful implementation of the Naches River CFHMP.

Defining Goals and Objectives

Defining goals and objectives provided a framework for preparing the CFHMP. Goals reflect a broad expression of a community's desires in preparing the plan; objectives target specific results that fulfill the intent of the goals. Table 1-4 lists the goals and objectives.

Collecting Data

Background information for the CFHMP was compiled from sources including the County, state and federal agencies, and advisory committee members. Data collected to define the study area's physical, social, and historical characteristics included the following:

- Land use and topographic information from County geographic information system (GIS) maps
- Information describing the physical setting, including climate, soil, vegetation, hydrology, water quality, fisheries, and wildlife
- Population data
- The findings of past flood-related studies performed by the U.S. Army Corps of Engineers and the Federal Emergency Management Agency (FEMA)
- County Comprehensive Plan and supporting data
- Applicable county, state, and federal regulations
- Records of historical flood control activities, including permanent records and newspaper accounts.

TABLE 1-1.
NACHES RIVER CFHMP ADVISORY COMMITTEE

Committee Member	Affiliation
Bob Rosen	Citizen
Ralph Berthon	Citizen
Dave Burdick	Washington State Department of Ecology
Chuck Steele	Washington State Department of Ecology
Jerry Franklin	Washington State Department of Ecology
Cynthia Carlstad	Tetra Tech/KCM, Inc.
Dave Carlton	Tetra Tech/KCM, Inc.
Joel Freudenthal	Yakima County SMD, Fish and Wildlife Biologist
Monty Kieser	US Army Corps of Engineers – Flood Manager
Anne Knapp	Yakima County Planning Division
John Knutson	Yakima County SMD, Surface Water Manager
Gary Lukehart	Citizen, Lower Naches Business Representative
Khalid Marcus	Yakima County SMD, Senior Engineer
Jim Park	Washington State Department of Transportation, Flood Manager
Dean Patterson	Yakima County Planning Division
Richard Visser	Washington State Department of Fish and Wildlife
Rick Swanson	Citizen
Ron Stiles	Citizen, Naches Area Contractor
Scott Nicolai	Yakama Nation Fisheries
Dianna Woods	Yakima County SMD, Program Analyst

TABLE 1-2.
NON-ACTIVE PARTICIPANTS

Committee Member	Affiliation
Jeff Ranger	Town of Naches Representative—Town Administrator
Nick Gayeski	Environmental Representative—Washington Trout
Al Brown	Greenway Foundation Representative
Stephen Young	Citizen
Tracey Yerxa	Bureau of Reclamation “Enhancement Program”

Other sources of data were existing local, state, and federal regulations pertaining to flood hazard management, historical documents, newspaper articles, and interviews with local officials and citizens. The advisory committee continually provided valuable information throughout the data-collection phase of CFHMP development.

TABLE 1-3.
SUMMARY OF ADVISORY COMMITTEE MEETINGS

Meeting Date	Topic
February 27, 2001	Overview of CFHMP planning process and review of flooding issues
March 27, 2001	Vision statement, goals and objectives, Existing Conditions report review
April 24, 2001	Finalize CFHMP goals and objectives
June 26, 2001	Refine CFHMP goals and objectives and discuss remaining actions
September 11, 2001	Refine identified flooding issues, discuss land use in floodplain and review land use and regulatory flood hazard reduction strategies
November 13, 2001	Review common alternative structural and non-structural solutions
January 29, 2002	Review geomorphic analysis progress and begin making recommendations
February 26, 2002	Continue with recommendations for identified issues
April 23, 2002	Continue with recommendations for identified issues (emergency management and "facilities and existing structures" were discussed)
August 6, 2002	Continue with recommendations for identified issues
January 16, 2003	Draft CFHMP review and discussion of channel migration study

TABLE 1-4.
GOALS AND OBJECTIVES FOR NACHES RIVER CFHMP

Goal	Objectives
1. Enhance our understanding of the Naches River system	1.1 Obtain accurate mapping of the geomorphic floodplain, including the extent of the floodplain, historical channels, previous inundation areas and flood elevations. 1.2 Evaluate the effect of reservoir management in the upper watershed on sediment transport, flooding, geomorphology, etc. in the study area. 1.3 Identify areas where property loss caused by channel migration or avulsions is probable. 1.4 Identify high flood hazard areas. 1.5 Identify hazards associated with debris and ice jams. 1.6 Catalog man-made conveyance systems that captured and conveyed floodwater during previous floods, causing flood problems for locations potentially outside the FEMA floodplain.
2. Protect the natural functioning of the river system	2.1 Where development has encroached into the floodplain, encourage flood protection measures that are compatible with the natural functioning of the river system. 2.2 Where bank erosion or side-slope stability is a problem and a bank section must be stabilized, use bank stabilization techniques that also enhance fish and wildlife habitat.

TABLE 1-4 (continued).
GOALS AND OBJECTIVES FOR NACHES RIVER CFHMP

Goal	Objectives
2. Protect the natural functioning of the river system (continued)	2.3 Identify significant accumulations of in-stream debris and determine whether they have a positive influence on the river system (e.g., by providing fish and wildlife habitat) or a negative influence (e.g., by endangering floodplain residents). 2.4 Encourage preservation or enhancement of existing flood storage areas. 2.5 Minimize the amount of in-stream maintenance work. 2.6 Provide solutions to protect irrigation diversions from the erosive force of channel migration.
3. Increase public awareness and understanding of flooding issues	3.1 Enhance public education. 3.2 Enhance assistance programs. 3.3 Enhance public participation. 3.4 Enhance public trust. 3.5 Promote floodplain preservation programs such as the County's Open Space Taxation Program. Provide examples of potential cost savings, program details, and contacts to local residents who could benefit from the program.
4. Address problems in a systematic and defensible manner	4.1 Implement a comprehensive flood hazard management program. 4.2 Review the CFHMP periodically to determine its effectiveness and whether revisions are needed. 4.3 Provide a stable funding source for implementing the CFHMP and for specific projects. 4.4 Foster cooperative relationships. 4.5 Foster a proactive rather than reactive approach to flood issues. 4.6 Use current and best available science.
5. Ensure that land use plans and regulations protect the floodplain functions	5.1 Evaluate the adequacy of County enforcement of land use regulations. 5.2 Evaluate the adequacy of County land use plans. (Also being evaluated in the update of the critical areas ordinance (CAO)) 5.3 Evaluate the County's development regulations to determine whether they protect floodplain functions. (Also being evaluated in the CAO update) 5.4 Use best available flood hazard data for regulation of land development and permitting. 5.5 Review recently approved development in the study area. 5.6 Evaluate other development requirements that may impact flood hazard management. Topics addressed by this review should include: • Septic system siting • Design requirements that may be unsuitable for floodplain locations (e.g., maintaining an area cleared of vegetation for drainfields)

TABLE 1-4 (continued).
GOALS AND OBJECTIVES FOR NACHES RIVER CFHMP

Goal	Objectives
5. Ensure that land use plans and regulations protect the floodplain functions (continued)	• Drinking water well siting and head protection requirements • Fire codes • Hazardous material storage. 5.7 Communicate with private developers to convey the results of interim CFHMP analyses affecting proposed development parcels. 5.8 Review development proposals to ensure consistency with flood hazard management alternatives that are likely to be developed in the CFHMP.
6. Promote public safety	6.1 Evaluate the potential flood hazard to the City of Yakima Water Treatment Facility and recommend solutions if needed. 6.2 Identify facilities that have been flooded previously or are likely to be flooded, and the frequency and severity of the impact: • Buildings • Irrigation systems • Recreational facilities 6.3 Evaluate the need for enhancements to the County's emergency management program related to flooding. Specific items include: • Access to safe drinking water • Saturated septic systems that may pose a health risk, especially to shallow wells • Traffic control during floods • Access to flood protection materials such as sandbags • Evacuation routes based on flood stage • Current and accurate flood prediction by the National Weather Service • Accessibility of temporary housing • Early warning system. 6.4 Evaluate the flood hazards to, and associated with, county and state infrastructure (roads, bridges). Issues include: • The proximity of the river to roads and U.S. Highway 12, endangering the roads and reducing floodplain storage • Hydraulic capacity of bridges • Damage to structures from debris/ice jams. 6.5 Levees and dikes • Evaluate functionality versus environmental impact • Perform proper maintenance
7. Promote actions that are consistent with fish and wildlife needs	7.1 Identify and protect critical habitat areas within the study area. 7.2 Incorporate fish and wildlife enhancement elements into all recommended flood hazard reduction projects.

RELATED STUDIES AND SOURCES OF INFORMATION

Recent revisions to the County comprehensive plan (Plan 2015), the Yakima County Flood Insurance Study, and ongoing projects including updates to the Critical Areas Ordinance, the Non-Regulatory project, and the Mineral Resources Task Force work directly affect CFHMP development. A short description of each and its relationship to the CFHMP is given below.

Plan 2015

Adopted in 1997, with significant revisions in February 2000, Plan 2015 is mandated under the state's Growth Management Act (GMA). Plan 2015 balances growth and development needs with environmental objectives and guides growth in the unincorporated areas of the Upper and Lower Yakima Valley. The CFHMP and GMA planning process have common goals to prevent flood damage through appropriate land use measures and to provide guidance for future surface water capital improvement projects. The following elements of the GMA process facilitate CFHMP development (Ecology 1991):

- Population forecasts and development projections to predict increased stormwater runoff and flooding problems
- Floodplain information, such as the identification of critical areas
- Definition of urban growth boundaries which, if properly located, can minimize the need for flood control structures
- Integration of flood hazard management measures into a capital improvement program to adequately service new growth.

Yakima County Flood Insurance Study

The Yakima County FIS was revised in 1998 (original study dated 1985) to address the contention that floodplain boundaries were inaccurate because the original study did not properly take into account hydraulic conditions such as the geometry of the river channel and levees along the reach through the City of Yakima. This location is out of the study area for this Flood Plan, so the earlier 1985 conditions and conclusions were not revised in the 1998 FIS.

Mineral Resources Task Force

Yakima County is currently reviewing its Mineral Resources Land zoning designation to ensure that there are adequate and available sources of mineral resources to meet demand over the next 50 years. The majority of the County's mineral resources are construction aggregates, which include sand, gravel and rock. It is expected that further investigation of aggregate mineral resources in the County will provide additional guidance regarding mining policies. Specific tasks related to the CFHMP that will be undertaken include the following:

- Develop criteria for assessing the suitability of specific sites in the inventory based on existing goals and policies.
- Identify specific areas necessary to meet 50 year demands (including a review of all the existing designated sites).

- Develop protection policies/regulations for designated but non-zoned sites.
- Review temporary mining policies.
- Develop and participate in a public outreach process.
- Review the setbacks and operational standards of the mining zone.

Critical Areas Ordinance

Yakima County is currently updating its Critical Areas Ordinance, which regulates development and building practices in frequently flooded areas, wetlands, geologically hazardous areas, aquifer recharge areas, and fish and wildlife habitat areas. The goal of the revisions is the creation of a well-balanced set of regulations that uses scientific knowledge to preserve and protect critical areas and is fair and reasonable to private property owners. Areas the review will focus on that pertain to this CFHMP include the following:

- Reviewing best available science to develop policies and regulations that protect critical areas
- Special consideration of Endangered Species Act requirements for conservation and protection of anadromous fisheries
- Conducting inventories of critical areas and preparing an atlas
- Developing and adopting regulations and policies to protect critical areas.

Non-Regulatory Natural Resources Protection Program

Yakima County is in the process of developing a Non-Regulatory Natural Resources Protection Program to aid the protection of critical areas and natural resource lands within the county. A non-regulatory incentive based program can provide an array of land use options that are economically and socially beneficial to the private landowner, the goals and mandates of the regulatory agencies and to the public. A broad range of possible tools is being considered, including: changes in zoning and/or taxation, easements and purchases. To accomplish this, the Planning Division with assistance from the Surface Water Management Division (both in Public Services Department) is investigating various options that will then be presented to the Board of County Commissioners.

FLOOD CONTROL ASSISTANCE ACCOUNT PROGRAM (FCAAP)

The Washington State program to assist local jurisdictions with comprehensive planning and flood control maintenance is described in *State Participation in Flood Control Maintenance* (RCW 86.26), originally enacted in 1951 and amended in 1994. Funds for flood control maintenance projects and preparation of this CFHMP have been provided to Yakima County through FCAAP. Administrative and procedural information concerning FCAAP and RCW 86.26 can be found in *Administration of the Flood Control Assistance Account Program* (WAC 173-145).

Funding

Distribution of FCAAP grant money depends on the amount appropriated by the state legislature each biennium and is based on eligibility of the applicant and the proposed project. Proposals are reviewed by several state agencies to ensure that appropriate resource issues and regulations are adequately addressed.

Legislative appropriations for the Flood Control Assistance Account, made each biennium, have varied from no funding (during the years 1975 through 1985) to the previous biennium's appropriation (2001-2003) of $2 million, to the recent biennium's appropriation of $954,000 (2003-2005). Restrictions include the following:

- Grants are limited to 50 percent of the total cost for non-emergency projects.
- The non-emergency FCAAP contribution is limited to $500,000 per county.
- Emergency funds of up to $150,000 per county per biennium are available on a first-come-first-served basis; the state will fund up to 80 percent of the cost of emergency projects.
- Unused emergency funds ($500,000 total emergency fund) can be disbursed on a discretionary basis by Ecology.
- The state can fund 75 percent of the cost of preparing a CFHMP.

Requirements for CFHMPs

To obtain funds for flood control maintenance through FCAAP, jurisdictions must prepare a CFHMP that, as discussed in RCW 86.26.105, accomplishes the following:

- Identifies the river's meander belt or floodway
- Establishes the need for flood control work
- Considers alternatives to in-stream flood control work
- Identifies and considers potential impacts of in-stream flood control work on the state's in-stream resources.

The CFHMP must also identify and rank appropriate structural and nonstructural measures to reduce flood damage. The study area may include the entire watershed or, at a minimum, the 100-year floodplain along a reach of the watershed. The reach must be of sufficient length that a comprehensive evaluation can be made of its flood problems. The completed CFHMP provides the technical foundation for future nonstructural and structural flood hazard management measures.

State law requires that a CFHMP describe the area where any proposed project is located and the types and locations of existing flood problems. A complete description of the information that a CFHMP must include is contained in WAC 173-145-040. Among the required information is certification from the Washington State Office of Community Development that the local emergency management organization is administering an acceptable comprehensive emergency operations plan. The law allows up to three years for local authorities to complete and adopt a CFHMP. Applications for project funding under

FCAAP require the county engineer to certify that a CFHMP plan has been completed and adopted or is in preparation. Ecology must approve the final CFHMP, and the municipality must subsequently adopt the plan.

Applicant Eligibility

Counties, cities, and other entities with flood control responsibilities, such as flood control districts and diking districts, are eligible to receive state funding for flood control maintenance projects. Eligible entities must file a flood control budget with Ecology by February 15 each year.

To receive funding for flood control maintenance projects, the county, city, or town having planning jurisdiction over the project area must have its floodplain management activities approved by Ecology. The requirements include the following:

- Participation in the National Flood Insurance Program (NFIP)
- Certification of the local emergency response plan by the State Department of Emergency Management
- Restriction of land uses to flood-compatible uses within a river's meander belt or floodway.

Adoption of a Shoreline Master Program (SMP) is also sometimes required. Yakima County meets all of these requirements, including having adopted an SMP.

Maintenance Project Eligibility

Evaluation of proposed FCAAP projects is based on cost-benefit relationships, local priority of projects, severity of local flood hazard management problems, and information in the CFHMP. Maintenance projects must reflect a comprehensive approach to flood hazard management planning and must meet specific guidelines with respect to project goals. Typical structural measures funded through FCAAP include installation of riprap on eroding stream banks, repair of riprap embankments, and the construction and maintenance of levees.

FCAAP legislation describes in general terms the type of maintenance work eligible for funding, including "maintaining and restoring the normal and reasonably stable river and stream channel alignment and capacity" and "restoring, maintaining, and repairing natural conditions, works and structures." State participation can also 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" (RCW 86.26.090).

Funding for enhancement of flood control facilities was authorized by Engrossed Senate Substitute Bill (ESSB) 5411, enacted in July 1991. This expands FCAAP project eligibility to include purchase of floodprone property or land to be used for flood storage, but only if these measures are identified in the applicable CFHMP (Ecology 1991).

Permits such as the Hydraulic Project Approval (HPA), Shoreline Substantial Development, and Conditional Use must be obtained before the project is funded by Ecology. All projects must be planned and designed in accordance with applicable SMPs and CFHMPs, and must benefit the public, as opposed to strictly private interests.

Emergency Projects

A portion of the available FCAAP funding is reserved by law for emergency use. Projects considered emergencies are those that must be done immediately to protect life and property from “unusual, unforeseeable, and emergent flood conditions” (WAC 173-145-100). Release of emergency funds is contingent on an emergency declaration by the appropriate authority. Depending on the emergency measure, a shoreline permit or HPA may be required.

Required Consultation with Other Agencies

A variety of state and federal agencies are involved in key river issues such as fishery resources, wildlife habitat, and public use. The presence of fishery resources, primarily salmon and steelhead, is a key consideration in performing any flood hazard management activities in and around the waters of the State of Washington. The potential loss of fish habitat resulting from construction in and next to rivers has been a major concern of fisheries agencies, sports fishermen, and Native American groups.

To ensure that fishery resources are maintained, the WDFW has review authority for most phases of FCAAP. Ecology is required to consult with WDFW before approving any CFHMP. Applicants for FCAAP project funds must review their proposals with WDFW, DNR, and affected Native American tribes.

Construction work to be performed in or adjacent to navigable waters of the United States, including wetlands, must be approved by the U.S. Army Corps of Engineers. In addition, any projects that may impact an endangered or threatened species are subject to review by the U.S. Fish and Wildlife Service (USFWS). The Corps’ permit process ensures that all other federal, state, and local regulatory agencies with jurisdiction over the project, including the National Oceanic and Atmospheric Administration’s Fisheries Service (NOAA Fisheries) and the USFWS, are properly notified and approve the project. The Corps will not approve a project that has been rejected by another permitting agency.

CHAPTER 2.
STUDY AREA CHARACTERISTICS

The CFHMP study area is the segment of the Naches River beginning at the Twin Bridges on U.S. Highway 12 just east of the City of Yakima and extending upstream to the confluence with the Tieton River (Figure 1-1). This reach is approximately 15 miles in length and lies entirely within Yakima County.

GENERAL DESCRIPTION

Naches River

The Naches River is a major tributary of the Yakima River (Figure 2-1). Originating in the Cascade Mountains east of Mount Rainier, the Naches River is formed by the confluence of the Little Naches River and the American River. From this point, the river flows southeast for approximately 30 miles before it emerges from the mountains. Here the Naches is joined by another major tributary, the Tieton River, near the junction of State Highway 410 and U.S. Highway 12, at River Mile (RM) 17.5. The river continues to flow southeast through a broad valley, past the Town of Naches and toward the City of Yakima. Just upstream of the City of Yakima, the Naches River cuts through a narrow gap in the highlands making up Naches and Selah Heights, and flows along the northern edge of the City of Yakima before joining the Yakima River near Interstate 82. The drainage basin covers an area of approximately 1,105 square miles, including portions of Kittitas County in the headwater region.

The Naches River has many tributaries, the largest being the Tieton River. Other major tributaries are the American River, Bumping River, Rattlesnake Creek, Little Naches, and Cowiche Creek. Characteristics of these tributaries are listed in Table 2-1.

Study Area

The study area for this CFHMP is defined as the 100-year floodplain along a 14-mile reach of the Naches River west of the City of Yakima. According to current FEMA floodplain maps, the 100-year floodplain along this reach covers 2,526 acres. The Naches River in this reach flows through a wide alluvial valley bounded by highlands on both sides. The surrounding land is primarily farmland and undeveloped land. Because of the river's history of channel migration through this reach, much of the land directly adjacent to the river is not developed or actively cultivated. No major tributaries enter the Naches River in the study area. Table 2-2 lists the characteristics of the Naches River in the study area.

The Town of Naches is the only incorporated jurisdiction in the study area. With a portion of its southern city limits bordering the river, the Town of Naches is directly affected by Naches River flooding. Gleed is an unincorporated area near the downstream end of the study area with some suburban residential, a few services, and a golf course (Sun Tides).

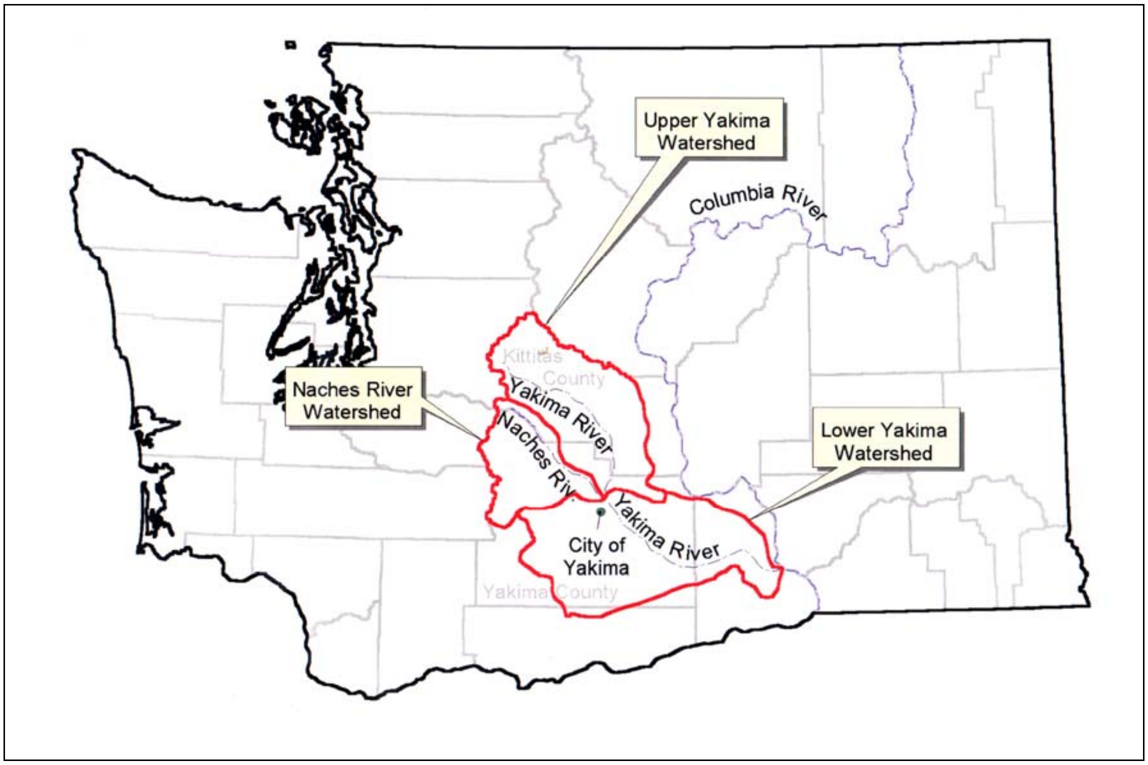


Figure 2-1. Vicinity Map

TABLE 2-1.
CHARACTERISTICS OF THE NACHES RIVER AND MAJOR TRIBUTARIES

River or Tributary Name	Confluence (River Mile)	Drainage Area (square miles)	Percent Area of the Naches River Basin	Stream Length (miles)	Average Gradient (feet/ mile)
Little Naches River	—	149	14	—	—
American River	44.6	80	7	21	60
Bumping River[a]	—	115	10	—	—
Rattlesnake Creek	27.8	134	12	24	135
Tieton River[a]	17.5	296	27	18	109
Mid-Naches[b]	—	166	15	—	—
Cowiche Creek[c]	2.7	165	15	9	15
Naches River	—	1,105	100	20	27

a Flows in the Tieton River are controlled by Tieton Dam (creating Rimrock Lake); flows in the Bumping River are controlled by Bumping Lake Dam.

b Includes Rock and Nile Creeks, and some Naches River upstream of study area.

c Cowiche Creek drainage includes Naches River within the study area.

Source: "Hydrologic Unit Boundaries Oregon, Washington, California", OR BLM - USFS

TABLE 2-2.
PHYSICAL CHARACTERISTICS OF NACHES RIVER STUDY AREA

River Channel	
Extent (river miles)	3.7 – 17.4
Length (miles)	13.7
Average Gradient (feet/mile)	30.8
Floodway	
Average Width (feet)	1,011
Average Velocity (feet/second)	7.4
100-year Floodplain	
Area (acres)[a]	2,526
Average Width (feet)	1,685

a. Floodplain area is based on the mapped FEMA 100-year floodplain boundaries.

Source: FEMA 1994/Yakima County GIS

Although development is sparse throughout the study area, a number of physical structures function as hard boundaries and potential constraints for the river. These consist of four bridges over the Naches River, numerous levee segments, several diversion structures (irrigation and power) and associated canals, and a highway (Highway 12) that parallels the river throughout the study area.

PHYSICAL CHARACTERISTICS

Climate

The climate in the Naches River Basin varies from desert conditions in the southern lowlands to moist alpine conditions in the mountain headwater region. The study area is entirely within the low elevation semi-arid portion of the watershed. This area, like the surrounding Yakima Valley region, is shielded by the Rocky Mountains to the east and north from winter cold-air masses moving southward from Canada, and shielded by the Cascade Mountains from moist Pacific Ocean marine air moving eastward. This produces relatively mild winters, and warm and dry summers. Mean monthly precipitation is shown in Figure 2-2.

Within the Naches River basin, climate data are collected at the Town of Naches and at Bumping Lake and Rimrock Lake. These data illustrate the variation of weather patterns between the downstream and upstream portions of the watershed.

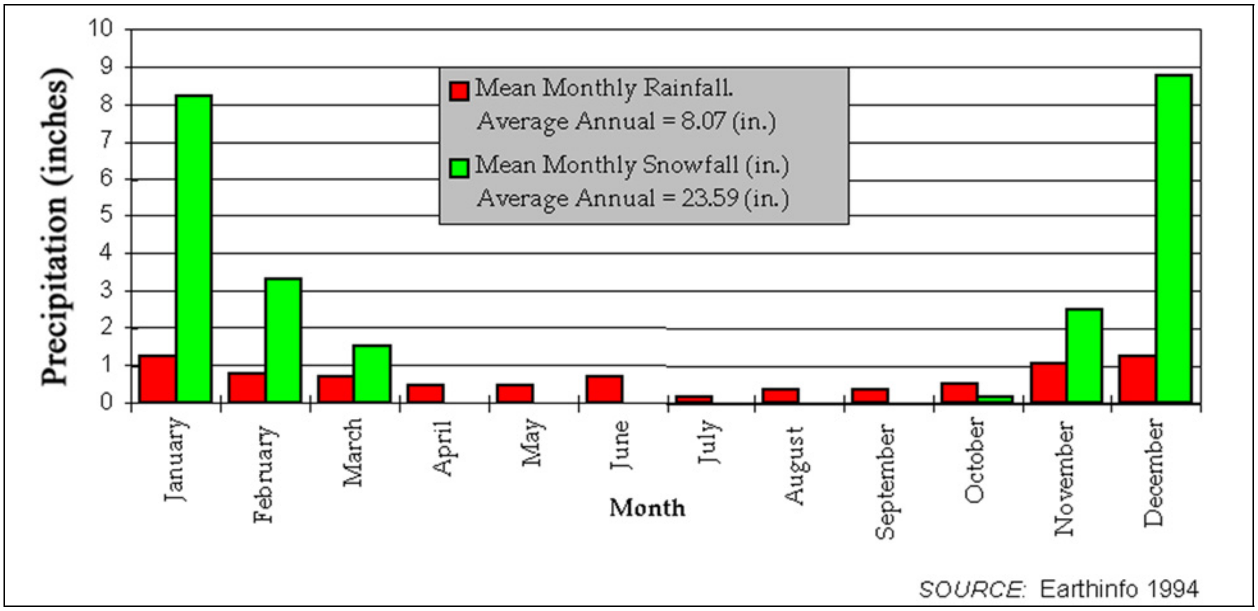


Figure 2-2. Mean Monthly Precipitation in Nearby Yakima

Geology

Dunne (1976) describes the geology in the region and the study area as follows:

> During the Pliocene epoch (2-12 million years ago) an ancestral Yakima River flowed from the Cascade Mountains across flat-lying basalt lava which had originated from great fissures in the earth's surface during the Miocene epoch (12-26 million years ago). In the vicinity of Yakima, mountain-building forces began to fold the lava into a series of parallel ridges and downwarps. As the lava beds were pushed up the river cut down through the ridges in a series of narrow gaps. Down-cutting kept pace with uplift.
>
> At the same time, large andesitic volcanoes in the mountains to the west were undergoing explosive eruptions and vast quantities of ash and volcanic agglomerates were fed into the Yakima Basin and carried downstream by the river. The sediments were deposited as thick layers in the downwarps between the rising basalt ridges. Erosion of the gaps also contributed coarse basaltic gravel to the accumulating deposits. These sediments are now called the Ellensburg formation and in the Moxee Valley are as much as 1,500 feet deep.
>
> During the Pleistocene epoch (2 million to 10,000 years ago) the activity described above continued and glaciers advanced from the high Cascades down the Yakima Valley as far as Cle Elum. The Yakima River was swollen many times with glacial meltwater and large quantities of coarse gravelly sediment from the Naches and Upper Yakima basins. This Pleistocene sediment now covers the surface of the Moxee Valley in the vicinity of

> Yakima and consists of gravel derived from the basalt ridges together with a minor amount of granitic rocks from the Cascades.
>
> Since the retreat of the Cascade glaciers, the river has cut down about 10 feet into its Pleistocene sediments leaving a terrace of sand and gravel covered by windblown silt along both sides of the valley. This terrace now defines a natural corridor within which the floodwaters are confined.… [The floodplain] is intricately laced with active and abandoned river channels which reflect the vigor with which the river has been migrating across its floodplain during the last few thousand years.

The Naches River flows through a broad valley between two of these uplifted and folded basalt ridges. In the Naches River valley, a layer of alluvium overlies the sedimentary Ellensburg formation of volcanic agglomerates and ash. The alluvium consists of poorly sorted sand and gravel deposited by glaciers and streams, of Quaternary to Recent Age. Beneath the Ellensburg formation are three basalt layers, the Saddle Hills, Wanapum, and Grande Ronde formations.

Figure 2-3 shows the identified geologically hazardous areas in the study area- landslide hazard areas, and steep slopes. Geologically hazardous areas are lands that, because of their susceptibility to erosion, sliding, earthquake, or other geological events, pose public health and safety concerns for the siting of commercial, residential, or industrial development (WAC 365-195). These areas require protection under the GMA, and are discussed in further detail in Chapter 6.

Alluvial fans are zones of sediment deposit near the mouths of streams that can experience debris flows and catastrophic flooding. Landslide hazard areas are potentially subject to landslides due to a combination of geologic, topographic, and hydrologic factors and can be found along the steep walls of the Naches' tributary creeks.

Geomorphology

The sections of the Naches River above and below the confluence with the Tieton River exhibit markedly different geomorphology. Upstream from the confluence, the river is confined to a narrow valley. Below the confluence, the river flows through a wide alluvial valley along the entire length of the study reach. The gradient of the river decreases below the confluence, with the average gradient being 42 feet per mile above the confluence and 30.8 feet per mile below the confluence (through the study reach).

The channel pattern through the study area is characterized by a meander-braided transition pattern. This channel pattern is characterized by Chorley et. al (1984) as having a large sediment load with a significant fraction of sand, gravel and cobbles. Channel width is variable and the channel is relatively wide and shallow with a (relatively) steep gradient. The following are common definitions used to describe river migration patterns.

- Point Bar—Gravel bar sediments that accumulate on the inside (concave side) of a meander bend.
- Lateral Migration—Gradual shifting of the main river channel toward the outside (convex side) of a meander bend.

- Avulsion—Abrupt switching of the river to a new location
- Chute Cutoff—Type of avulsion where the new channel is through a point bar (often reoccupying an old channel).
- Neck Cutoff—Type of avulsion where the new channel cuts across the outside of two meander bends that have converged (also called meander cut-off).
- Channel Migration Zone—The corridor within which the river can be expected to migrate within a specified period (usually 50 to 200 years).

Chute cutoffs, thalweg and meander shifts, and bank erosion are characteristic of the meander-braided transition pattern. The development of bars and islands may modify flow alignments and change the location of bank erosion. Recent studies also suggest that aggradation has occurred through this reach. This stretch of the Naches River has historically experienced very active channel migration.

Avulsions, the most unpredictable and destructive (to property) type of channel migration, are common on the Naches River. Avulsions typically occur during a flood when the river reoccupies an old channel or erodes a barrier to gain access to a new path. A major avulsion occurred on the Naches River just upstream from Ramblers Park during the 1996 flood. Another important avulsion occurred near Kershaw Road during the same flood.

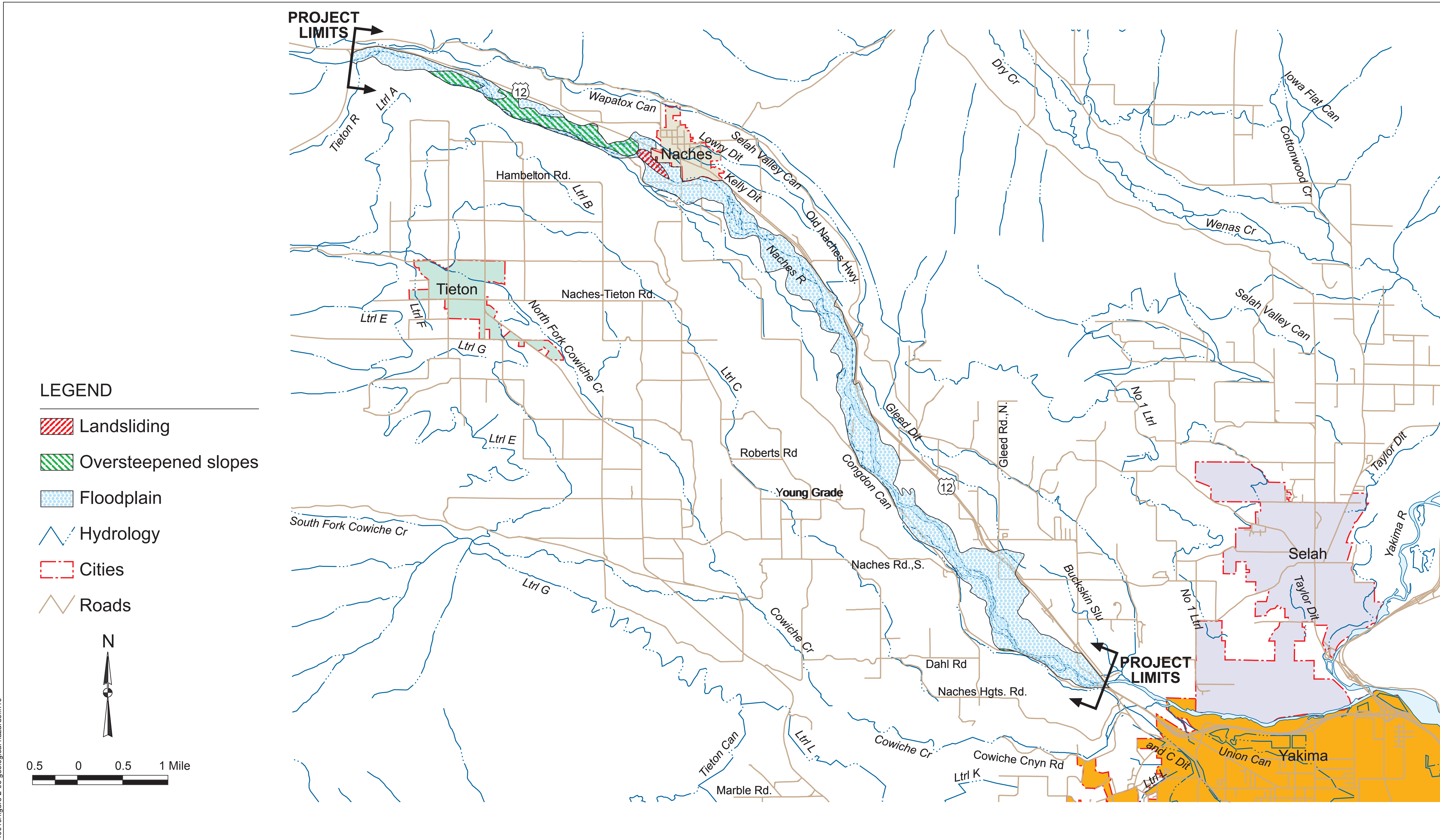
A recent study conducted by Eitemiller et al. (in press) for the U.S. Bureau of Reclamation focused on anthropogenic alteration on select alluvial floodplains in the Yakima River basin, including the Naches River segment. The study focused on mapping the emergence of cultural features, including roads and levees, that have altered the structure and function of the riverine ecosystems. Results from this study suggest a major reduction in riverine habitat that was once inundated by small, frequent flood events.

Soils

Most of the soils in or near the floodplain developed from transported materials. Water-transported soil deposits are present on the lower slopes of the ridges and on the benchlands, stream terraces, alluvial fans, lowlands, and stream bottoms. U.S. Soil Conservation Service (SCS) soil maps delineate these areas as *map units* according to the predominant soil types. General map units typically include one or more major soil type and some minor soil types. Detailed map units represent areas dominated by one or more major soil of a specific classification. Soil types mapped in the Naches River floodplain are shown in Table 2-3 and Figure 2-4.

Along the floodplain, the primary soil types are Weirman sandy loam, fine sandy loam, and gravelly fine sand loam. Weirman loam is characterized by stratified layers and beds of permeable gravel and sand at shallow depths. It contains minimal organic matter, and drainage through the soil is medium to very rapid. It is best suited for general farm crops.

Isolated patches of Logy silt loam also occur throughout the study area. The Logy series soils are deep, well drained floodplain soils. Areas where this soil type is found may be prone to flooding between January and April. Soil properties are described in the SCS Soil Survey (SCS 1985).



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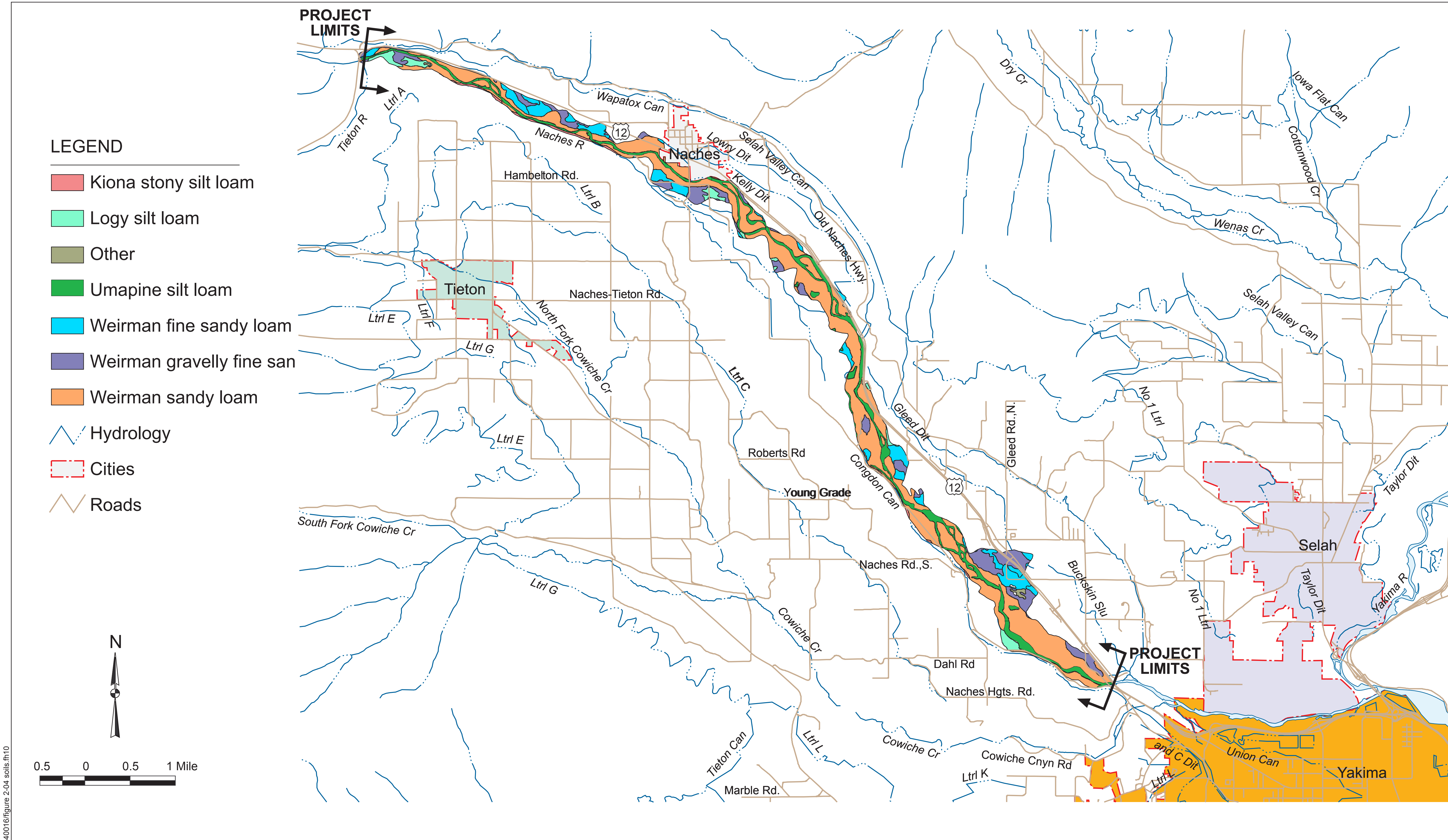
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 2-3.
GEOLOGICALLY HAZARDOUS AREAS



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NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 2-4.
FLOODPLAIN SOILS

TABLE 2-3.
SOIL TYPES WITHIN THE NACHES RIVER FLOODPLAIN

Soil Type	Area of Coverage (acres)	Percent of Floodplain
Weirman Sandy Loam	1425.3	56.4%
Umapine Silt Loam	351.2	13.9%
Weirman Fine Sandy Loam	280.4	11.1%
Weirman Gravelly Fine Sandy Loam	335.7	13.3%
Logy Silt Loam	84.1	3.3%
Kiona Stony Silt	37.4	1.5%
Other	11.8	0.5%
Total	**2,526**	**100.0%**

*Other category includes soil types which make up less than 1% of the floodplain area, including Ashue Loam, Clemen Very Fine Sandy Loam, Esquatzel Silt Loam, Ritzville Silt Loam, Starbuck-Rock Outcrop Complex, Torriorthents, and Yakima Silt Loam.

Surface Water Hydrology

Reservoir Management

The surface water hydrologic regime in the study area is controlled, in large part, by the U.S. Bureau of Reclamation management of reservoirs in the upper Naches and upper main stem Yakima River watershed. These six reservoirs are managed as a group to provide irrigation water to farms in the Naches and Yakima River valleys.

During the early 1900s, the Bureau of Reclamation began extensive development of an irrigation water supply system in the Yakima Basin (see Figure 2-5). Six storage reservoirs (listed in Table 2-4), three of which are in the Naches River drainage basin, 14 diversion dams, approximately 2,000 miles of irrigation canals, numerous pump stations, and three hydroelectric plants have been constructed to service approximately 500,000 acres in the basin. About 60 percent of total water use in the basin is attributed to agriculture.

Operation of the three Naches River reservoirs, Bumping Lake, Rimrock Lake, and Clear Lake, has altered the natural hydrologic regime of the Naches River system. The goal for these reservoirs is to capture runoff during the winter and release the stored water during the summer to supply irrigation water to farmers in the Naches and lower Yakima portions of the watershed. This operation results in lower-than-natural flows during the winter and higher-than-natural flows during the summer.

Release of water from the Naches system reservoirs is coordinated with release of stored water from the main stem Yakima reservoirs under the following scenario known locally as “flip-flop”: Water is released primarily from the main stem Yakima reservoirs and Bumping Lake (on the American River branch of the Naches) until around the first of September each year. At that time the main stem Yakima reservoirs and Bumping Lake stop releasing water, and the bulk of irrigation demands are met through water releases from Rimrock Lake. This arrangement results in artificially high flows in the American River branch of the Naches during the early summer (and correspondingly artificially low flows in the Tieton branch during this period). Then in September, flows are artificially high in the Tieton branch of the Naches when water is released from Rimrock Lake.

TABLE 2-4.
RESERVOIRS IN THE YAKIMA RIVER BASIN

Reservoir Name	River	Year of Completion	Drainage Area (sq. mi.)	Active Storage[a] (acre-feet)
Bumping Lake[b]	Bumping River	1910	69.3	33,700
Cle Elum Lake	Cle Elum River	1933	203.0	436,900
Clear Lake[b]	North Fork Tieton River	1914	60.0	5,300
Kachess Lake	Kachess River	1912	63.6	239,000
Keechelus Lake	Yakima River	1917	54.7	157,800
Rimrock Lake[b]	Tieton River	1925	187.0	198,000

a. Capacity assigned to flood control function.
b. Reservoir is located within the Naches River basin.

Source: FEMA 1994.

The Clear Lake, Rimrock Lake, and Bumping Lake reservoirs in the upper basin, although designed and constructed primarily for the purpose of irrigation, have been operated for flood control when deemed appropriate by the operators and when the reservoirs have the capacity to store water. However, the reservoirs have a limited utility for reducing flood peaks because of their limited storage capability and their location high in the watershed. The area draining into these reservoirs makes up only 27 percent of the total basin area for the Naches River. The Bumping Lake and Clear Lake reservoirs have very limited amounts of flood storage capacity—33,700 acre-feet and 5,300 acre-feet respectively. Rimrock Lake reservoir has 198,000 acre-feet of available flood storage capacity. Flood storage capacity is seasonally variable.

Stream Flow Data

The U.S. Bureau of Reclamation (USBR) currently collects river flow data on the Naches River. Two USBR gauging stations on the Naches River are within the study area. One is 0.6 miles upstream from the confluence of the Yakima River, and the other is approximately 0.75 miles below the confluence with the Tieton River. These stations are described in Table 2-5. Table 2-6 summarizes daily average flows at each station.

Naches River flow comes from snowmelt and rainfall on the eastern slopes of the Cascade Mountains. Average flows are highest during April, May, and June (see Figure 2-6) as a result of spring snowmelt runoff. However, peak flood flows typically occur during the winter. Winter flood flows are associated with warm temperatures and rainfall on melting snow pack, and typically follow precipitation periods that have saturated or frozen soils, producing greater rates of runoff.

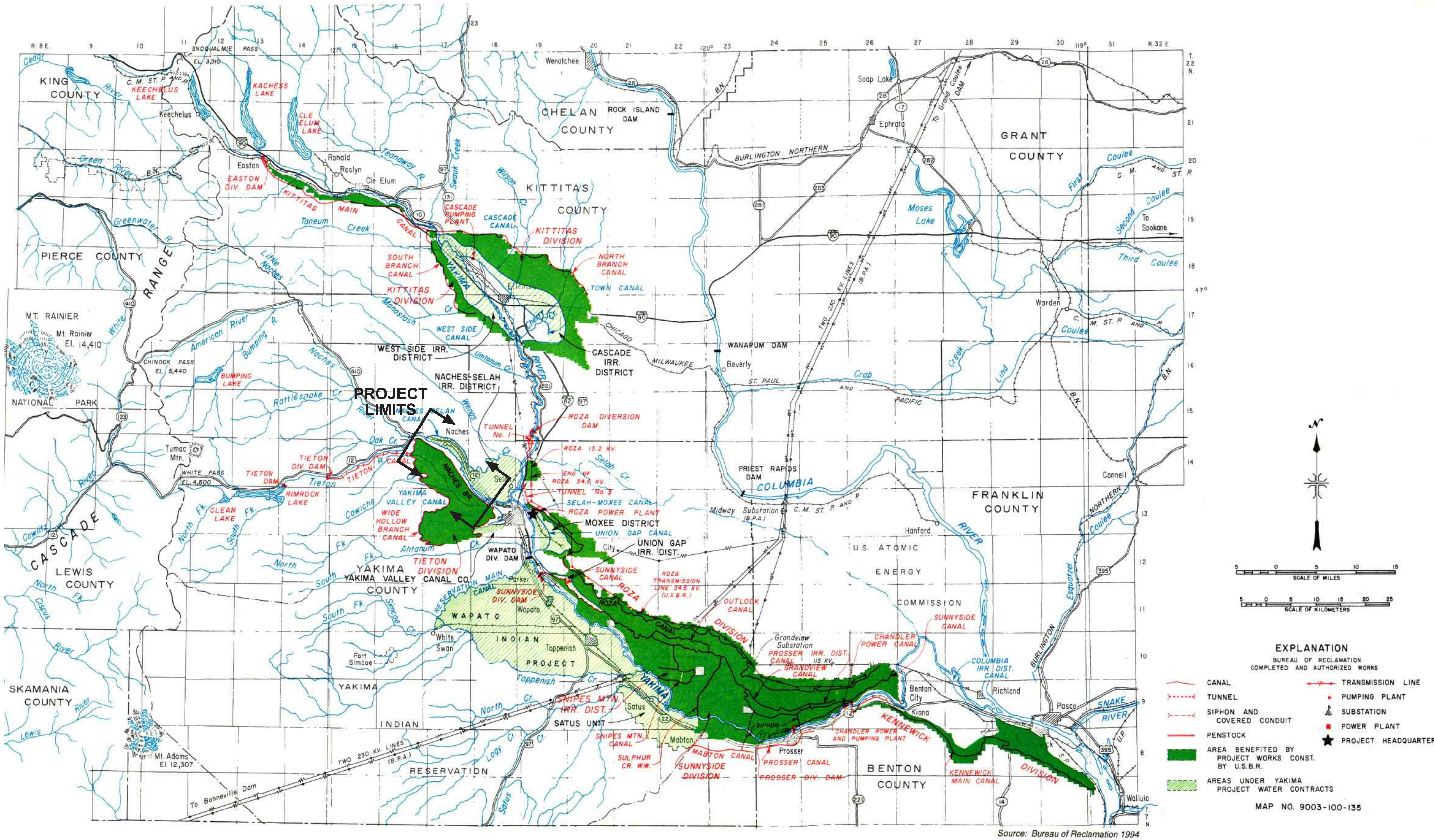

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Figure 2-5.
BUREAU OF RECLAMATION
YAKIMA RIVER PROJECT

TABLE 2-5.
USBR FLOW GAUGING STATIONS IN THE STUDY AREA

Station	Naches near North Yakima[a]	Naches River near Naches[b]
Station ID	NRYW	NACW
Agency	USBR	USBR
Drainage Area (sq. mi.)	1,106	941
Location	0.6 miles upstream from the confluence of the Naches and Yakima Rivers	0.75 miles downstream of the confluence of the Tieton River near the Town of Naches
Period of Record	1899 to 1915, 1987 to present	August-October 1905, October 1908 to present
Maximum daily flow/Date	28,000 cfs/November 24, 1909	32,200 cfs/December 22, 1933
Minimum daily flow/Date	30 cfs/August 24, 1906	not available

a. This station was maintained by the USGS prior to 1990.
b. This station was maintained by the USGS prior to 1979. Prior to September 9, 1936 the gage was located at a site 0.6 miles upstream.

Source: USBR 2000.

TABLE 2-6.
SUMMARY OF DAILY AVERAGE FLOWS

	Naches near North Yakima		Naches River below Tieton River	
Month	Daily Avg. Flow (cfs)	Percent of Avg. Annual Flow	Daily Avg. Flow (cfs)	Percent of Avg. Annual Flow
January	999	6	700	5
February	1,419	8	1,016	7
March	1,529	9	1,211	9
April	2,232	13	1,789	13
May	3,019	17	2,761	20
June	2,550	15	2,308	17
July	996	6	825	6
August	532	3	346	2
September	1,623	9	1,257	9
October	803	5	502	4
November	791	5	541	4
December	900	5	627	5
Annual	**17,393**	**100%**	**13,883**	**100%**

Source: USBR Pacific Northwest Region, Hydromet System Data Access, 2003

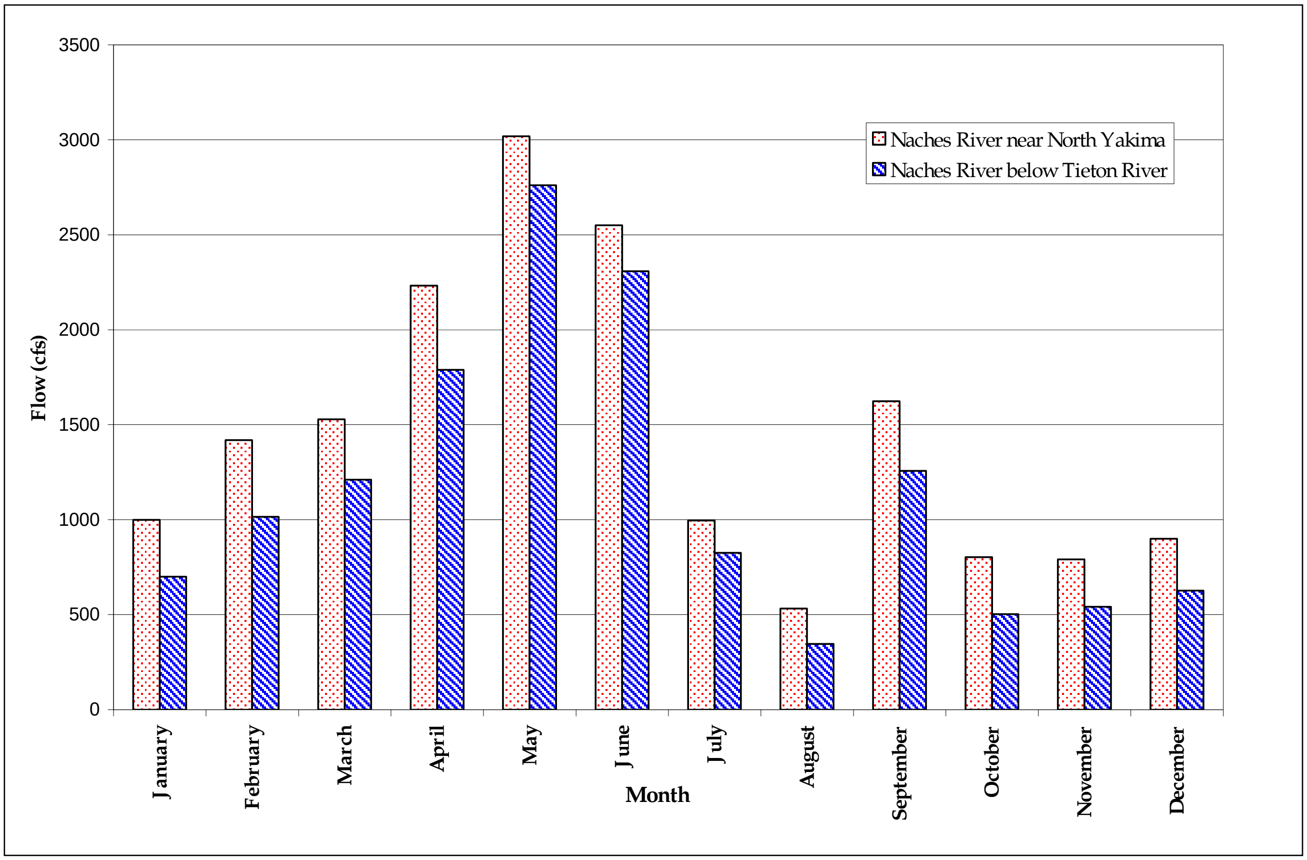

Figure 2-6. Summary of Daily Average Flow

Data from these two stream-flow stations represent the inflow and outflow of the study area quite well. The upper station (Naches River below Tieton River) is near the upper end of the study area. The downstream station (Naches River near Yakima) is approximately five miles downstream from the lower end of the study area. Only one major tributary, Cowiche Creek, enters the Naches River between the gauging station and the study area's lower boundary.

A comparison of average daily flows for the two stream-flow stations (Table 2-7) suggests that a number of factors influence stream flow throughout the year. From June through September, average daily stream flow at the upstream end of the study area has ranged from 91 to 177 percent of stream flow just downstream from the study area. This indicates that the river is losing substantial water through this reach during the summer irrigation season. Stream flow loss may be to irrigation, the Wapatox Canal, the City of Yakima Water Treatment Facility, or groundwater infiltration through the stream channel.

Conversely, during the rest of the year, the upstream flow gauging site experienced average daily flows that were 35 to 87 percent of flows at the downstream station. This indicates that the river is gaining water through the study reach during the October through April period. This additional stream flow is probably coming from local tributary stream inflow and groundwater discharge to the river.

TABLE 2-7[a].
RELATIONSHIP OF NACHES RIVER STUDY AREA INFLOW AND OUTFLOW

	Daily Average Flow (cfs)		
Month	Naches Near North Yakima (Outflow)	Naches Below Tieton River (Inflow)	Inflow to Outflow Ratio (%)
January	999	700	70
February	1,419	1,016	72
March	1,529	1,211	79
April	2,232	1,789	80
May	3,019	2,761	91
June	2,550	2,308	91
July	996	825	83
August	532	346	65
September	1,623	1,257	77
October	803	502	63
November	791	541	68
December	900	627	70

[a]Average streamflow values between January 1, 1984 and January 1, 2003, reflecting current reservoir release practices.

Wetlands

Wetlands, as defined in RCW 36.070A.030, are areas inundated or saturated by surface water or groundwater at a frequency and duration to support vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. They also include wetlands artificially created as mitigation for conversion of natural wetlands to other uses. Wetlands do not include artificial wetland areas that have been unintentionally created from irrigation, drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, or landscape amenities.

Wetlands are important to flood hazard management because they serve natural retention and detention functions. They store water above and below the ground surface, reducing the volume and velocity of floodwaters downstream and thus decreasing downstream erosion. Wetlands also improve water quality and provide habitat for a wide range of plants and animals. Maintaining wetlands, particularly those located in floodplains, is one of the most cost-effective ways to reduce the adverse effects of flooding and erosion and to support healthy ecosystems. A GIS analysis of wetland coverage, as mapped by the National Wetland Inventory, in the 100-year floodplain was conducted to identify the distribution of wetlands in the study area. The distribution of wetlands is shown in Figure 2-7 and summarized in Table 2-8. The U.S. Department of Fish and Wildlife (USFWS) welcomes more detailed, ground-truthed information to improve their wetland inventory maps.

Wetlands that can be found in the 100-year floodplain are *riverine* and *palustrine*. Generally, a riverine system includes all wetlands and deep water habitats within a channel of continuously moving water. A palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all wetlands in tidal areas where salinity is below 0.5 percent.

TABLE 2-8.
WETLAND DISTRIBUTION WITHIN THE 100-YEAR FLOODPLAIN

Wetland Type	Area (acres)	Percent of Total
Palustrine Wetlands	1059	54%
Riverine Wetlands	903	46%
Total	**1,962**	**100%**
Percentage of 100-Year Floodplain That Is Wetland	—	77.7%

Source: National Wetlands Inventory, 1984

Fisheries and Wildlife

Fish and wildlife presence in the Naches River watershed has been described in numerous recent documents, and is the subject of much interest for many. Fish and wildlife issues have recently focused on the health of several fish species that inhabit the Naches, Yakima, and greater Columbia River systems.

Fisheries

The Naches River supports spring chinook, coho, steelhead, rainbow trout and bull trout, as well as a number of other salmonid and non-salmonid species (WDFW, 1998). Based on data from radio-tagged adults (Hockersmith et al. 1995) steelhead spawn throughout the Naches and all of its tributaries except the Tieton and American Rivers. Spring chinook spawn in the Naches largely above Rattlesnake Creek, in the Bumping River, the Little Naches River, Rattlesnake Creek and the American River. Coho are in the process of being reintroduced to the basin and currently spawn primarily in the Naches below and just above the confluence with Cowiche Creek, with a handful spawning in the vicinity of the Town of Naches. The spawning distribution of rainbow trout is unknown but is probably similar to that of steelhead, including the exclusion of the American River. The reach from the mouth to the Rattlesnake Creek confluence is the historical summer chinook spawning area.

Endangered Species Act Issues

Three fish species with an Endangered Species Act connection are known to use the Naches River. Bull trout were listed as threatened in the Columbia River watershed by the USFWS in June 1997. Steelhead were listed as a threatened species in the mid-Columbia River watershed by the National Marine Fisheries Service (NMFS) in March 1999. Spring chinook salmon have not been formally listed as threatened or endangered but are a species of interest for which listing was considered in March 1998. Both steelhead and spring chinook are anadromous fish; bull trout are resident fish.

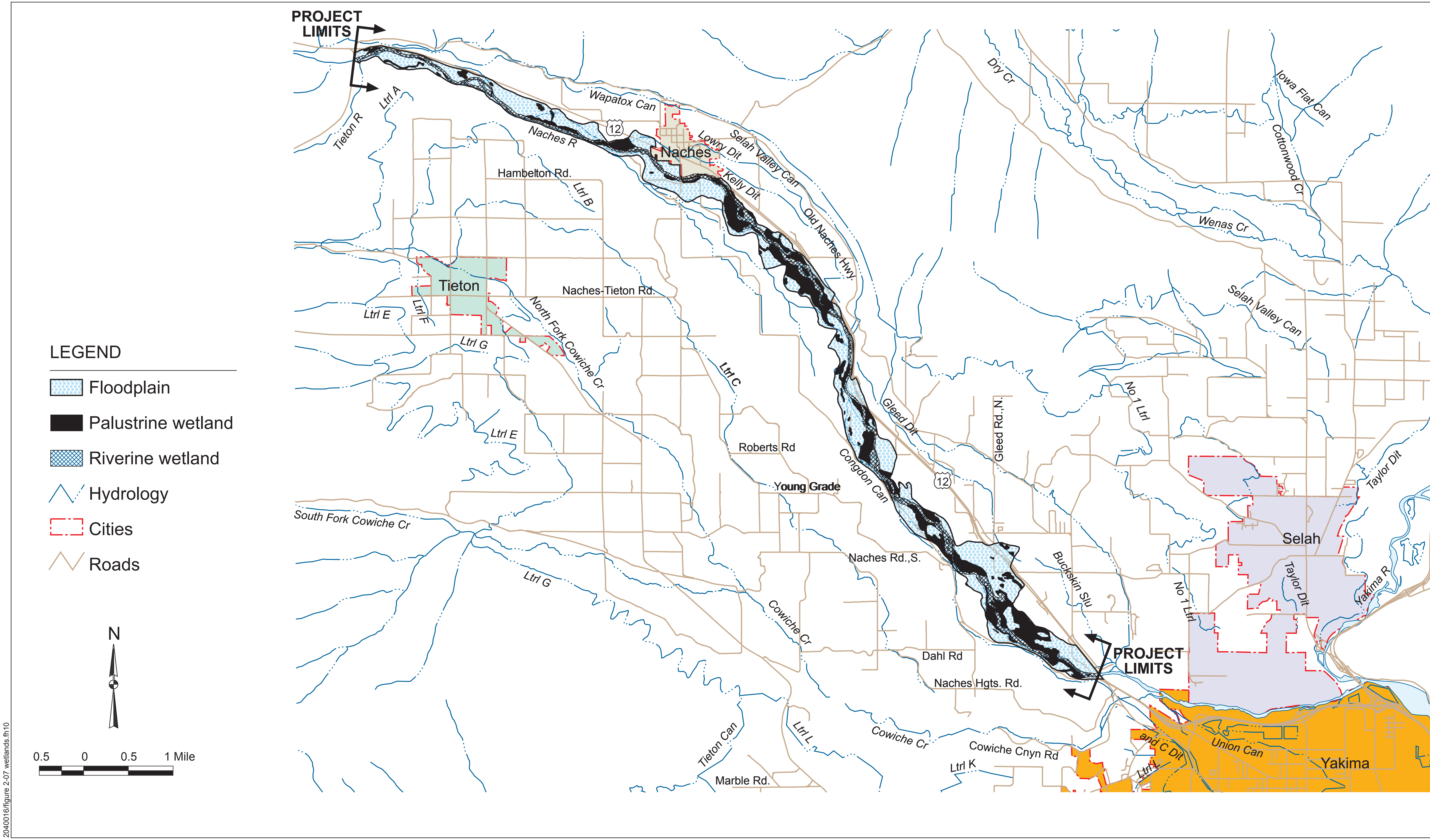

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Figure 2-7.
NWI WETLAND CLASSIFICATION FOR THE NACHES RIVER

Analysis of the limiting factors affecting each of these species has been performed in the past and is currently being updated. According to the Salmon and Steelhead Stock Inventory (Northwest Power Planning Council et al., 1992), limiting factors for each species can be summarized as follows:

- **Spring Chinook**—Peak winter and spring flows and spawning gravel quality; human influences on these include logging, irrigation withdrawals, irrigation return flows, grazing, loss of in-stream large woody debris, bank trampling, bank protection and channel alterations.
- **Summer Steelhead**—Inadequately screened irrigation diversions, large irrigation withdrawals, low in-stream flows, degraded riparian and in-stream habitat from urbanization and livestock grazing, and high water temperatures.
- **Bull Trout**—Dams with inadequate fish passage facilities, inadequate screening on diversions, low-water conditions in tributary streams, streamside development that reduces cover and increases water temperature and sediment load, and timber harvest, which can increase water temperatures and sediment load. (Department of Fish and Wildlife, 1998).

The Naches River through the study area is important for each of these species. The Naches River main stem is one of the most important spawning reaches in the Yakima River Watershed. Gravels are relatively clean and spawning habitat is generally good, with the exception of a lack of off-channel rearing habitat. The major problems within this reach include excessive summer water temperatures, low flows for a portion of the summer, confinement of the channel by roads and levees, and uncertainty about the adequacy of screening on all diversions. Low flows and flow changes are a concern for optimal rearing and adult fish passage between the diversion at Wapatox Dam and the power plant outfall.

Fish inventories of the three species described above have indicated their use of most of the Naches watershed. Steelhead and spring chinook are believed to use the entire main stem reach for migration and spawning. The upper 27 miles of the Naches River (above the study reach) is one of the best spawning reaches in the Yakima River basin. In addition to steelhead and spring chinook, this reach reportedly has potential for spawning and rearing coho. The study area reach has excellent potential for chinook spawning and rearing, and fair to good potential for coho and steelhead spawning and rearing. A deficiency of riparian cover has been noted for this lower reach, however.

Bull trout are found in the Naches River system, but are associated with the tributary streams. They are not reported to use the main stem much, however it would be accessible to them. The USFWS watershed analysis has positively identified them within Nile and Orr Creeks, which are upstream of the study area.

The study reach of the Naches is considered by many to be deficient in large woody debris (LWD). While the river system as a whole meets the East Side (Washington) Regional Standard, regional fisheries biologists have expressed concern about the low amount currently present and the lack of available LWD upstream (Nicolai, 2001). USFWS surveys of LWD also indicate LWD densities in the main stem Naches are significantly lower than Wenatchee National Forest Plan standards (USFWS, 1995).

The Tri-County Water Resource Agency completed a habitat assessment for the Yakima River watershed in 2001. The study included the Naches River watershed and summarized habitat conditions using 25 factors describing the categories of water quantity/water quality, physical/geomorphic factors, and ecological interactions. The results of this assessment for the study reach are shown in Table 2-9. The major issues are the need for more off-channel habitat, the quantity of LWD, low flows and associated elevated temperatures during July and August, and the uncertainties of the impact of the flip-flop reservoir management system on fish populations. The recognition that this segment is very important for fish spawning underscores the need to preserve and enhance existing good habitat and restore degraded habitat within this reach.

Water Quality

In Washington State, the Department of Ecology (under authority of state law and direction of the federal Clean Water Act) is responsible for determining appropriate water quality standards and classifying water bodies. These surface water quality standards are intended to protect the beneficial uses of waters of the state, such as swimming, fishing, aquatic life habitat, and agricultural and domestic water supplies. The water quality standards establish water quality goals for lakes, rivers, and marine waters.

The Naches River through the study area is designated a Class A water under Ecology's stream classification. The following water quality criteria apply to Class A water bodies (WAC 173-201-045(2)):

- Water quality shall meet or exceed the requirements for all or substantially all uses.
- Fecal coliform organisms shall not exceed a geometric mean value of 100 organisms/100 mL, with not more than 10 percent of samples exceeding 200 organisms/100 mL.
- Dissolved oxygen shall exceed 8 mg/L.
- Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
- Temperature shall not exceed 21.0°C due to human activities. When natural conditions exceed 21.0ºC, no temperature increase will be allowed that will raise the receiving water temperature by greater than 0.3ºC; nor shall such temperature increases, at any time, exceed $t = 34/(T+9)$. ("t" represents the change across the dilution zone, and "T" represents the highest existing temperature in the water classification outside of any dilution zone.)
- Turbidity shall not exceed 5 NTU (nephelometric turbidity units) over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

TABLE 2-9.
SUMMARY OF HABITAT ASSESSMENT FOR STUDY AREA

Low Flow and Dehydration	Flows considered deficient for spring chinook between July and September in the reach between the Wapatox Dam and the power plant outfall.
Peak Flow/Scour/ Turbulence	Not a concern related to fish habitat.
Flow Fluctuations	Rapid flow fluctuations have been documented. Even small fluctuations can initiate channel width changes, particularly where multiple channels exist. Flip-flop operations force fish to relocate when flows are rapidly increased in September. This can increase vulnerability to predation.
Dissolved Oxygen	No known problems.
Suspended Sediment	Some concern about to sediment-related problems in the upper watershed
Temperature	Elevated water temperature is a concern below the Wapatox Canal intake.
Nutrients	No known problems.
Channel Width, Depth, Gradient	Channel width reduced in upper watershed.
Channel Stability	Not completely understood. Channel width reduction in upper watershed is indication that channel is not stable. Head cutting has also occurred near some diversions.
Channelization/ Dredging	No known problems.
Channel Complexity	Braided channels with adequate complexity exist through much of this reach. Deficiency of LWD is a concern.
Levees, Dredging and Filling	Some levees in study area reach. Highways that parallel river are considered more significant to river confinement than levees. Levee management policy to limit tree growth on levee is detrimental to riparian cover.
Barriers	No known problems.
Diversions/Screens	Adequacy of screening on diversions is unknown at this time.
Streambed Gravel/ Recruitment	Clean gravel is abundant; no known problems in study area.
Pools and Riffles	No known problems.
Groundwater Contributions	No known problems related to habitat. Good surface/ groundwater interaction.
Competition	Competition from hatchery fish is not considered a concern.
Food Web	No known issues.
Predation	No known problems; some concern over lack of juvenile fish hiding places.
Disease and Stress	No known problems.
Riparian Shade/ Streambank Cover	More off-stream channels with cover needed. Streambank shade is deficient in much of study area.
Large Woody Debris	LWD is deficient, even though excellent spawning habitat does exist.
Side Channels/ Wetlands	Off-channel rearing needs are an important limiting factor.

Source: Watershed Assessment Yakima River Basin, 2001

- Toxic, radioactive, or deleterious material concentrations shall be below those of public health significance, or those that may cause acute or chronic toxic conditions for the aquatic biota or that may adversely affect any water use.
- Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.

In general Class A is considered excellent water quality. Stream segments above the study area on the Upper Naches, American, and Bumping River are classified AA, or "exceptional."

Recent water quality studies in the Yakima River watershed have focused on sediment load and its DDT and metal association. Through some of this work, the Naches River has been identified as carrying a high total suspended solids (TSS) load (94 tons/day) during the spring runoff (March to July) relative to July through October (27 tons/day). The high TSS load was hypothesized to be caused by logging activities, sediment releases from the reservoirs (Joy and Patterson, 1997), and/or the influence of the reservoir flip-flop flow regime (Northwest Power Planning Council, 2001).

Under Section 303 of the federal the Clean Water Act, every two years Ecology must identify its polluted water bodies and submit a list of these water bodies to the U.S. Environmental Protection Agency (EPA). Ecology uses monitoring data to identify locations where water quality standards are being violated. From this data, Ecology makes a determination about the severity and potential causes of water quality violations and prepares the 303(d) list. The 303(d) list identifies the locations of impaired water bodies, the water quality standards that each water body fails to meet, and the amount by which it fails to meet the standard. The most recent 303(d) list was prepared in 1998; the next list will be submitted to EPA in 2002 (Ecology changed when a list would be due for this time period).

Within the Naches River watershed a number of river and stream segments were included on the 1998 303(d) list (see Table 2-10). The stream segment that includes the study area was listed for temperature, silver, and pH. These listings were based on sampling at sites near the Town of Naches and near the confluence with the Yakima River. The majority of the 303(d) listings for the Naches watershed are temperature-related water quality excursions. The recommended action for most of these listings was a Total Maximum Daily Load (TMDL) study.

Total Maximum Daily Load

Section 303(d) of the federal Clean Water Act requires states and the EPA to prioritize and establish TMDLs for all waters that fail to meet state water quality standards. TMDLs are used to control the discharge of pollutants to surface waters and maintain water quality. TMDL studies include five main components:

- Identification of the type, amounts, and sources of water pollution in a particular water body or segment

- Determination of the capacity of the water body to assimilate pollution and still remain healthy
- Allocation of how much pollution each source may discharge
- A strategy to attain the allocations
- A monitoring plan to assess effectiveness.

TABLE 2-10.
1998 303(D) LISTINGS IN NACHES WATERSHED

Water Body	Parameter	Action Recommended
Study Area Listings		
Naches River	pH	TMDL
	Silver	TMDL
	Temperature	TMDL
Other Naches Watershed Listings		
American River	Temperature	TMDL
Bear Creek	Temperature	TMDL
Blowout Creek	Temperature	TMDL
Bumping River	Temperature	TMDL
Cowiche Creek	Temperature	TMDL
	In-Stream Flow	Other Control
	Fecal Coliform	TMDL
Cowiche Creek, South Fork	Temperature	TMDL
	Fecal Coliform	TMDL
Cowiche Creek, North Fork	Temperature	TMDL
	Fecal Coliform	TMDL
Crow Creek	Temperature	TMDL
Gold Creek	Temperature	TMDL
Little Naches River	Temperature	TMDL
Little Rattlesnake Creek	Temperature	TMDL
Mathew Creek	Temperature	TMDL
Myron Lake	Ammonia-N	TMDL
Nile Creek, North Fork	Temperature	TMDL
Rattlesnake Creek	Temperature	TMDL
Reynolds Creek	Temperature	TMDL
Tieton River, South Fork	Temperature	TMDL

TMDLs specify the amount of pollutants that can be discharged to a receiving stream without impairing beneficial uses. Strategies may include setting permit limits and recommending best management practices (BMPs) such as fencing, planting trees, and ensuring buffers next to streams. TMDLs are implemented through conditions set in discharge permits and non-point source management plans. These control actions are developed through a public involvement process, and progress under a TMDL is monitored to test the effectiveness of the control actions in meeting water quality standards.

Ecology recommended development of TMDLs to address most of the water quality concerns in the Naches watershed in the most recent 303(d) listing. At this time however, the agency has not prioritized the Naches for TMDL studies, so it is uncertain when these issues will be addressed. Ecology's draft Fiscal Year 2002 TMDL Priority List does call for additional sampling for silver on the Naches River to verify previous sample results and determine whether a TMDL is necessary for this constituent. The agency will also continue to monitor the watershed with the goal of refining knowledge about other water quality conditions in the basin.

National Water Quality Assessment for the Yakima River Basin

The National Water-Quality Assessment (NAWQA) Program is a study undertaken by the USGS to describe the status and trends in the quality of the nation's groundwater and surface-water resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources. The NAWQA Program began with several pilot projects in 1987; the Yakima basin was one of these pilot study watersheds.

The USGS completed the pilot program NAWQA study in the Yakima basin in 1991. This study consisted of intensive data collection and analysis of water, sediment and aquatic biota. The study included sample sites within the Naches River watershed as listed in Table 2-11. The USGS has published results from the pilot program in several topical publications since 1991.

As a follow-up to the pilot study the USGS conducted additional sampling beginning in 1999, and planned through summer 2001. The follow-up study calls for three to five years of intensive data collection and analysis followed by five to six years of less intensive monitoring and analysis. Results of both studies have revealed a significant DDT contamination problem in Yakima River sediments, likely caused by the large sediment load draining into the river from irrigation return flows and tributary streams. These results have been a major impetus in the current TMDLs in the main stem Yakima River. None of this work has focused on the Naches River, but some sampling has been done on the Naches River as part of the NAWQA project.

TABLE 2-11.
NAWQA SAMPLE SITES IN NACHES WATERSHED, 1987-1990

	Streambed Sediment	Suspended Sediment	Aquatic Biota Tissue	Filtered Water	Unfiltered Water
Naches River near North Yakima	X	X	X	X	X
Tieton River at mouth near Naches					X
Rattlesnake Creek above North Fork Rattlesnake Creek near Nile	X		X	X	
Rattlesnake Creek above North Fork Rattlesnake Creek near Nile	X		X		
Naches River at Cottonwood Campground near Cliffdell				X	
American River near Nile				X	
American River at Hells Crossing near Nile	X		X		
Bumping River at Soda Springs Walkway near Nile				X	
Little Naches River at mouth near Cliffdell				X	

SOCIOECONOMIC CHARACTERISTICS

The Town of Naches, a small farming community, began to grow in 1908 when local valley farmers, with the help of the Bureau of Reclamation, built the first irrigation system. The irrigation system allowed local farmers to produce various kinds of crops, primarily fruits. The Naches Valley is known for its variety of apples, pears, peaches and cherries. Fruit packaging plants and lumber companies provide the economic backbone of the community. While most of the available land in the Naches Valley is used exclusively for fruit orchards, the low-lying areas adjacent to the river have provided room for growth and development of the Town of Naches.

Along with the large area of farmland, the Town of Naches has a number of recreational sites where members of the small community and surrounding areas can enjoy hiking, fishing, scenic driving, skiing, snowmobiling and horseback riding. The Naches River also provides the community with many recreational sources.

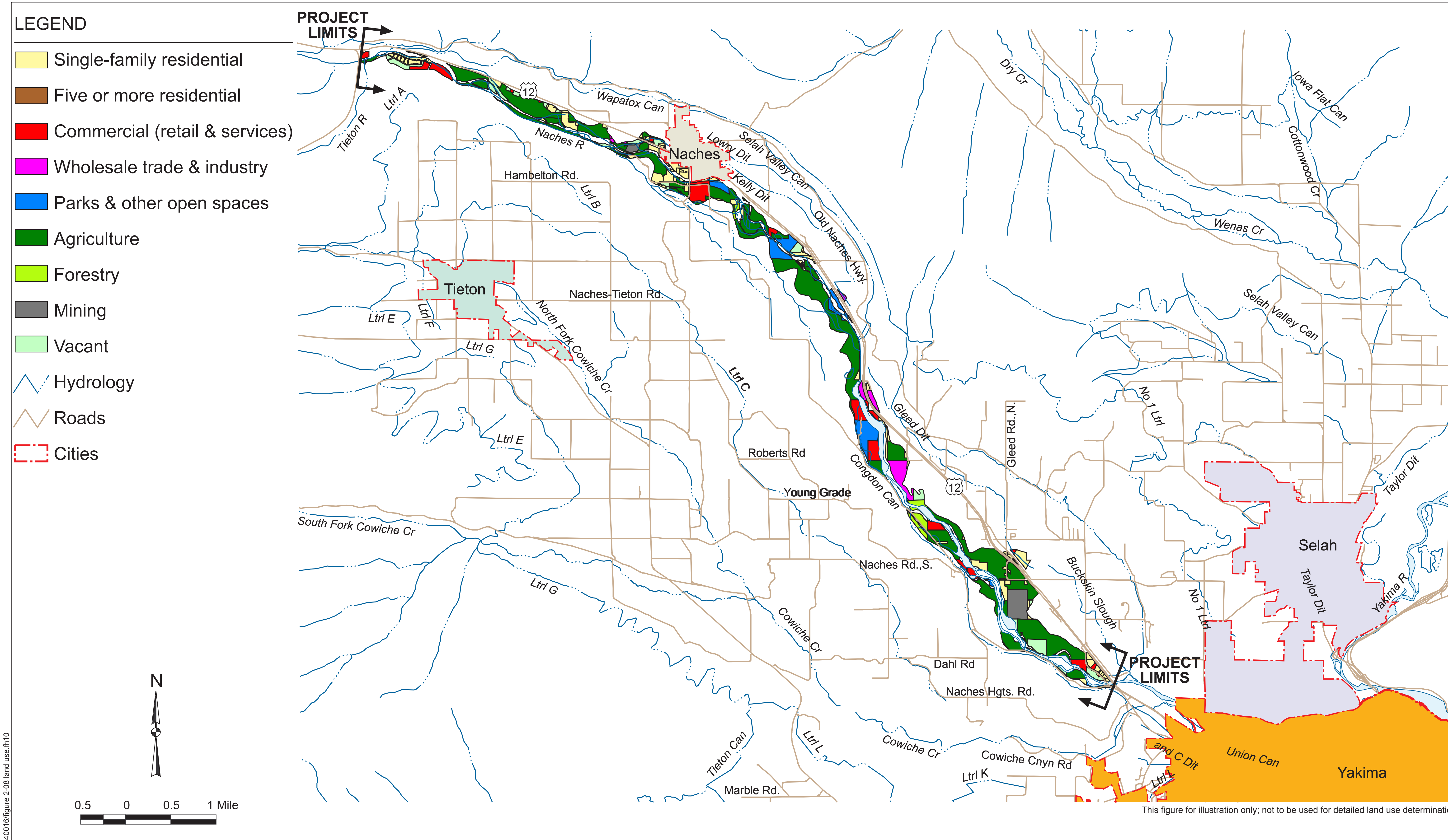
Land Use

The majority of the Naches River floodplain in the study area is sparsely developed. A GIS analysis was conducted to determine the distribution of land use (Figure 2-8) and zoning in flood-prone areas (the FEMA 100-year floodplain). The GIS land use data is from the county assessor's office and the planning division. Table 2-12 and Figure 2-9 display the results of the land use analysis. Agriculture, the predominant land use, comprises 56.7 percent of the land by area. Parks, open spaces, and vacant lands comprise an addition 15.1 percent. Other land uses in the study area include residential development (8.5 percent), primarily single-family dwellings, commercial/retail/industrial (12.4 percent), with a small percentage used for mining and timber. Residential, commercial, and industrial development can be found in the vicinity of the Town of Naches, near the Naches Wonderland RV Park, and also between Eschbach Park and Rambler's Park.

TABLE 2-12.
LAND USE DISTRIBUTION IN THE 100-YR FLOODPLAIN[a]

	Area		Parcels	
Land Use Category	Amount (acres)	Percent of Total	Number	Percent of Total
Commercial (Retail and Services)	182.5	9.1	34	5.8
Agriculture	1140.3	56.7	141	23.9
Mining	62.9	3.1	3	0.5
Single Family Residential	169.7	8.4	131	22.2
Five or More Residential	1.9	0.1	3	0.5
Wholesale Trade and Industry	66.9	3.3	12	2.0
Vacant	162.8	8.1	233	39.4
Forestry	71.9	3.6	7	1.2
Parks and Open Spaces	140.4	7.0	14	2.4
Other[b]	11.3	0.6	13	2.2
Total	**2010.5**	**100.0**	**591**	**100.0**

Source: Yakima County GIS, 2000. Area included in analysis does not include the river corridors, waterways, lakes or roadway easements, therefore total area is less than the total floodplain area of 2,526 acres.
a. The 100-year floodplain refers to the 100-year floodplain as mapped by FEMA.
b. Other category includes 13 parcels at the north end of Naches Wonderland that are shown on the zoning and parcel shapefiles, but were not included on the land use shapefile.



Tetra Tech/
KCM, Inc.
1917 First Avenue
Seattle, Washington 98101

Yakima County
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 2-8.
LAND USE

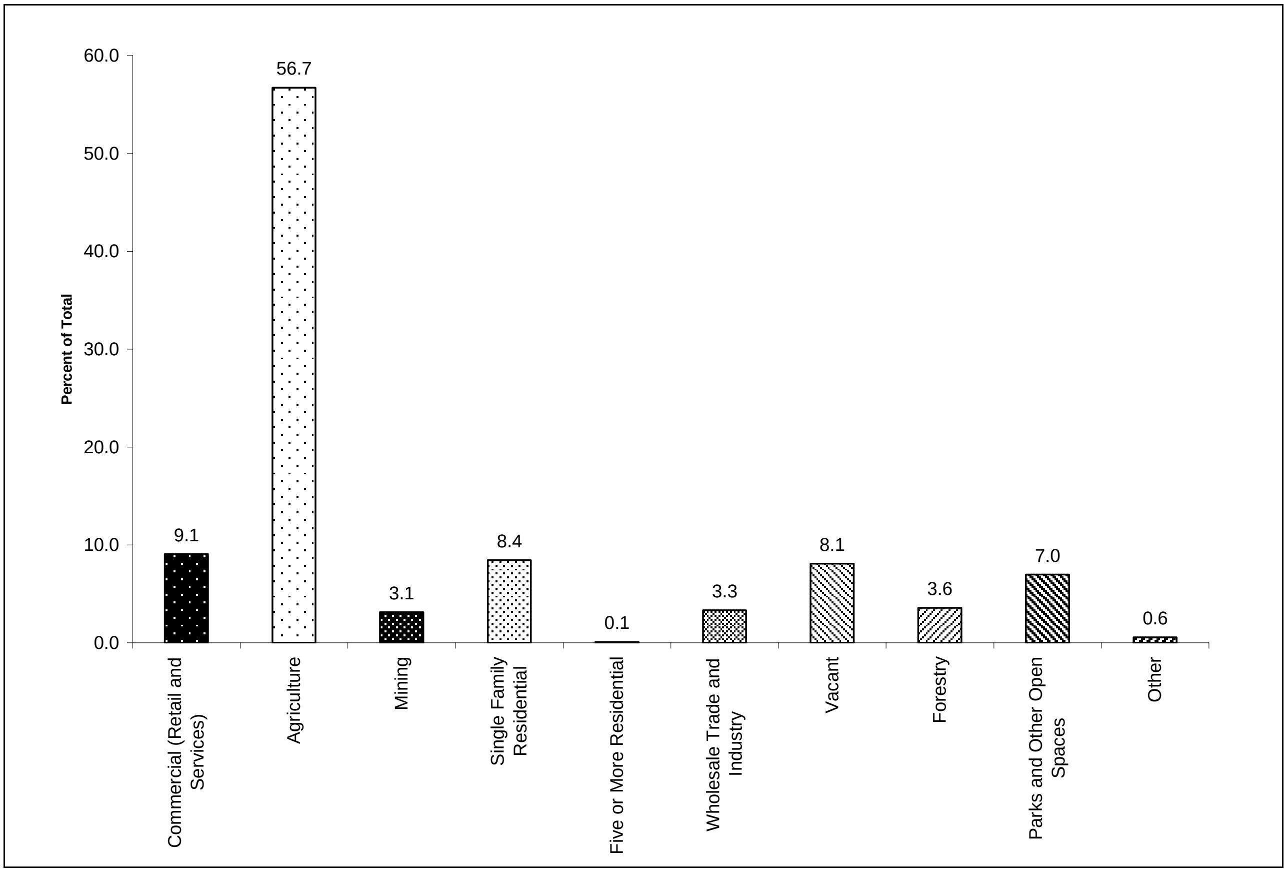


Figure 2-9. Land Use Distribution in the Floodplain

Parcel Size in the Floodplain

Parcels in the combined 100-year/Febuary 1996 event floodplain range from 141 acres to less than 1 acre (Table 2-13).

TABLE 2-13.
PARCEL SIZE DISTRIBUTION IN THE 100-YEAR FLOODPLAIN

Parcel Size (acres)	100-Year Floodplain Number	Percent of Total	Area[a] (acres)	Percent of Total	Parks and Open Space Number	Percent of Total	Area[a] (acres)	Percent of Total
0-1.99	365	61.8	188.2	5.1	2	14.3	1.7	1.1
2-4.99	77	13.0	250.8	6.9	5	35.7	16.5	10.5
5-9.99	57	9.6	439.9	12.0	3	21.4	26.1	16.6
10-49.99	79	13.4	1631.6	44.6	3	21.4	54.8	34.7
50-99.99	8	1.4	508.3	13.9	1	7.1	58.7	37.2
100+	5	0.8	641.4	17.5	0	0.0	0.0	0.0
Total	**591**	**100.0**	**3660.2**	**100.0**	**14**	**100.0**	**157.9**	**100.0**

a. Area shown includes the entire parcel area, not just the area located in the floodplain.

Of 591 parcels in the floodplain, 61.8 percent are smaller than 2 acres and 84 percent are smaller than 10 acres. However, 76 percent of floodplain acreage is in parcels larger than 10 acres. Large parcels are generally located in agricultural areas and parks and open spaces. Parcel sizes are smaller near the Naches Wonderland RV park, the Town of Naches and in the lower reach near Rambler's Park.

Current Zoning in the Floodplain

Much of the study area floodplain in the unincorporated county has been identified Remote/Extremely Limited Development Potential (75.0 % by land area), which limits development to 1 unit/40 acres. Agriculture has been identified in the middle reach southeast of the Town of Naches. The only areas currently zoned for residential use (single-family) are in and around the Town of Naches.

Current Yakima County zoning is shown in Figure 2-10. Zoning classifications are described in Table 2-14 and discussed below. Zoning for the Town of Naches is shown in Figure 2-11.

TABLE 2-14.
COUNTY ZONING DISTRIBUTION IN THE 100-YEAR FLOODPLAIN[a]

Zoning Classification[a]	Average Lot Size	Area	
		Area (acres)	Percent of Total
Agriculture (AG)	40 acres	173	6.9
Remote/Extremely Limited Development Potential (R/ELDP)	40 acres	1,879	75.0
Rural Transitional (RT)	2.0 acres (clustered) 2.5 acres (non-clustered)	8	0.3
One-Family Residential (R-1)	7,200 sq. ft. (clustered) 2.5 acres (non-clustered)	41	1.6
Valley Rural (VR)	5-10 acres (non-clustered) 3 acres (clustered)	353	14.0
Rural Settlement		13	0.5
Highway/Tourist Commercial		49	1.9
Industrial		6	0.2
Total		2,522	100

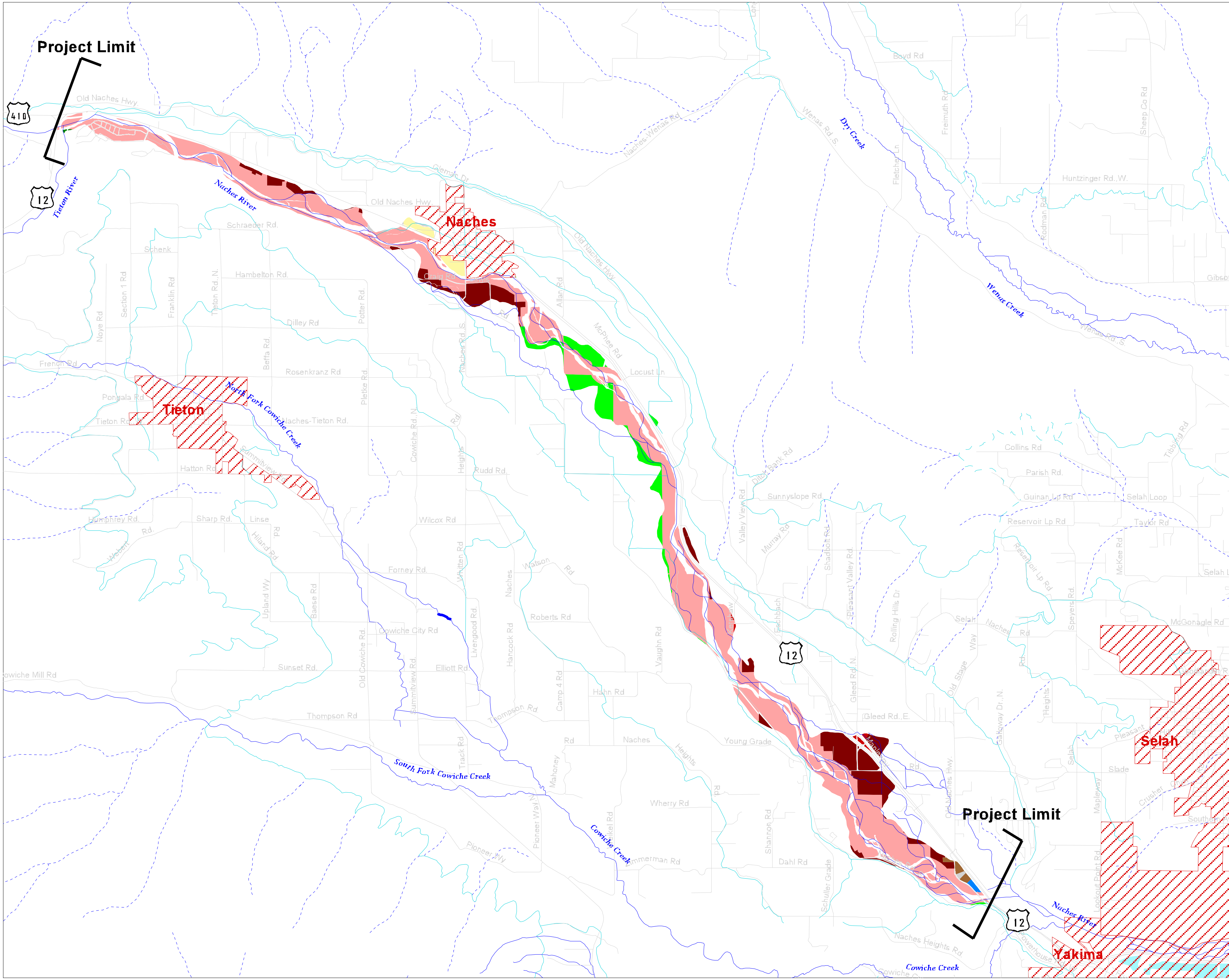
a. Zoning classification for parcels within the FEMA 100-year floodplain.

YAKIMA COUNTY

GEOGRAPHIC INFORMATION SERVICES

Figure 2-10. Zoning

Yakima County
Naches River Comprehensive Flood
Hazard Management Plan



All Roads

Streams

Perennial Stream

Intermittent Stream

Lake or Pond

Canal or Ditch

Aquaduct

Siphon

Cities

County Zoning

Forest Watershed

Agriculture

Remote/Extremely Limited

Valley Rural

Rural Transitional

Rural Settlement

Highway Commercial

Single-Family Residential

Industrial

Light Industrial

0 0.5 1 1.5 2

1"= 1.0 miles

Yakima County GIS

Plot date: Nov 5,

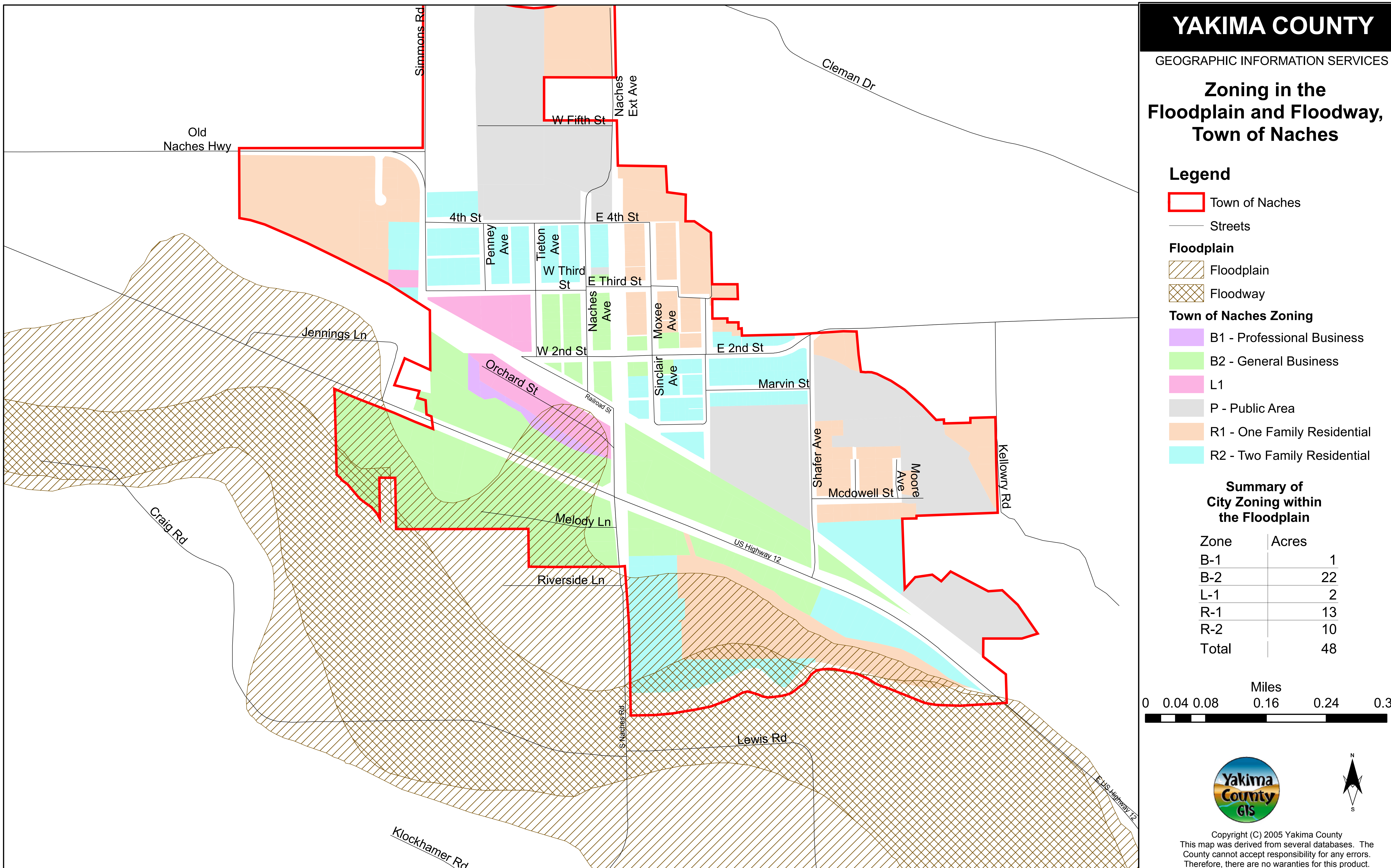

YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Zoning in the Floodplain and Floodway, Town of Naches
Legend
Town of Naches
Streets
Floodplain
Floodplain
Floodway
Town of Naches Zoning
B1 - Professional Business
B2 - General Business
L1
P - Public Area
R1 - One Family Residential
R2 - Two Family Residential
Summary of City Zoning within the Floodplain
Zone | Acres
B-1 | 1
B-2 | 22
L-1 | 2
R-1 | 13
R-2 | 10
Total | 48
Miles
0 0.04 0.08 0.16 0.24 0.32
N
S
Yakima County GIS
Copyright (C) 2005 Yakima County
This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Simmons Rd
Naches Ext Ave
W Fifth St
Cleman Dr
Old Naches Hwy
4th St
E 4th St
Penney Ave
Tieton Ave
W Third St
E Third St
Naches Ave
Moxee Ave
Jennings Ln
W 2nd St
E 2nd St
Orchard St
Railroad St
Sinclair Ave
Marvin St
Shafer Ave
Moore Ave
Mcdowell St
Kellowry Rd
Craig Rd
Melody Ln
US Highway 12
Riverside Ln
S Naches Rd
Lewis Rd
E US Highway 12
Klockhamer Rd

Figure 2-11

The Agriculture (AG) zoning designation is intended to preserve and maintain lands for the continued practice of agriculture, and to permit only uses that are compatible with agriculture. The minimum lot size for this zone is 40 acres. Clustering may be permitted on existing lots where it is in conformance with permitted Type I uses and is approved through a short subdivision exemption review process (Yakima County Code 15.21.045).

The Remote/Extremely Limited Development Potential (R/ELDP) zoning designation restricts development density in environmentally sensitive areas (shorelines and critical areas), protected scenic areas, and remote regions outside of expected fire suppression service areas and where costs are high to maintain and extend roads and services. The minimum lot size is 40 acres.

The One-Family Residential (R-1) zoning designation is restricted to urban growth areas and provides for lower urban density land development where urban government services are available or can be provided without excessive public cost, or where on-site sewer or water systems are available in the interim. The minimum lot size is 7,200 square feet, or 2.5 acres in cases where public water and sewer are unavailable and clustering is not an option. In the latter option, half or 2 acres of the parent lot, whichever is greater, must be maintained as open space.

The Rural Transitional (RT) zoning designation serves as a transitional area between urban growth areas surrounding cities and towns and lower density zoning districts and the agriculture zoning district. The RT zoning designation encourages infill and redevelopment in currently developed areas that are nearing suburban levels of development and that already have public infrastructure and services. The intent of the RT zoning designation is to decrease pressure on existing agriculture areas and less populated rural areas where infrastructure and public services are more difficult and expensive to provide. The average lot size for the RT zone is 2.5 acres, however for lots 6 acres and larger, a clustering alternative is available that reduces the required average lot size to 2 acres. The minimum lot size for the clustering option is 1/3 acre. The required lot sizes may vary depending on the date the property was last subdivided.

The Valley Rural (VR) zoning designation is generally located around urban growth boundaries or around the RT zoning district where it exists. The intent of the VR district is to protect the rural character of existing low-density areas where public infrastructure and services are limited. Uses found in the VR zone include rangelands, large and small-scale commercial agriculture, hobby farms, and low-density residential development. The VR zone protects the rural character of these areas by requiring large lot sizes and encouraging clustered development. The average lot size requirement varies depending on the lot's location with respect to public facilities and public access (paved roads). The minimum lot size for the clustering alternative is 1 acre.

CHAPTER 3.
PREVIOUS STUDIES

Many studies related to flood issues in the Naches River study area have been conducted over the last 40 years. This chapter describes several of the most significant studies. Four previous studies focused directly on flood issues. Three recent or ongoing studies are more global in focus, but contain relevant information and have potential impacts on overall management of the Naches River and greater Yakima River watershed.

LOWER NACHES RIVER CHANNEL MIGRATION STUDY, 2003

The lower Naches River in the CFHMP study area has had a long history of active channel migration. Local residents have witnessed dramatic channel changes over short periods of time and during major flood events; even more extensive channel migration is evident from ancient channels recognizable on aerial photographs and Lidar images.

Yakima County elected to conduct a channel migration study of the study reach to identify and better understand the flood hazards associated with channel migration along the Naches River and to develop a more effective means of protecting public and private property from the risks associated with future channel migration along this reach. Channel migration hazard areas have historically not been shown on FEMA flood insurance rate maps, which only show areas subject to inundation. Yakima County uses these maps to regulate development in flood hazard areas along the Naches River. The risk to land and structures from channel migration can be much more severe than from inundation, as a sudden channel shift can sweep away a structure or hundreds of feet of riverbank. The Channel Migration Analysis Report is included in Appendix A.

Channel migration has created chronic or occasional problems at numerous locations in the study area. Specific problem areas that were identified include the following:

- In the Lewis Road area, meander migration pressure is occurring on the south (right) bank just downstream from the South Naches Road bridge along Lewis Road. A low levee exists at this location to protect residents along Lewis Road. In 1996 the river breached the levee at this location, and flowed in a southeasterly direction across Lewis Road.
- The Ramblers Park / Powerhouse Road area, like the Lewis Road area, has had a long history of flooding and channel migration. At this location, the river has a complex, multi-channel form with large, shifting bars. During the February 1996 flood, a section of the Ramblers Park levee washed out, and floodwaters poured through Ramblers Park. Although the levee was repaired after the flood, a major avulsion also occurred during the flood, which relocated a quarter-mile length of river channel to a more southerly channel against the South Naches Road.
- The City of Yakima Water Treatment Facility was constructed on a relatively vulnerable feature called a point bar. The channel upstream from the filtration plant flows in a southerly direction and is constrained on its east side by Highway 12. The channel swerves to the west to bend around the treatment facility, which is protected by a heavily fortified levee. High

erosive pressure is exerted by the river at this point where the channel swerves to the west.

- There is a potential avulsion site downstream from the Lewis Road area and north of Running Springs Road. Although human impact would be minimal and the avulsion site is in an undeveloped area, the channel shift could pose a future threat to a few homes and some farmland in the vicinity of Running Springs Road. On the positive side, this avulsion would alleviate some erosive pressure on the Highway 12 embankment along about a half mile stretch of road.
- The current location of the channel near Kershaw Road presents a channel migration risk to homes and farmland. The current configuration of the channel places most of the north-south segment of Kershaw Road on the outside of a meander bend, creating bank erosion associated with meander shift/enlargement.
- The Eschbach Park region is immediately downstream from the City of Yakima Water Treatment Facility. During the 1940s and before, the main channel flowed through Eschbach Park. Today the channel bends back to the west below the treatment facility, once again placing Highway 12 on the outside (erosive side) of a meander bend. The old channels through the Eschbach Park area were active during the 1996 flood, and probably carry water during most floods. Although this area does not pose any immediate risk associated with channel migration, it is possible that the river could switch back to one of the old channels at some point. For this reason, it is desirable for this area to remain in a natural state.
- The County is pursuing construction of a spur dike in the region around Long Road to protect an irrigation diversion and levee where the main channel has historically switched between three or four different channels.

The study will have several outcomes, foremost of which are the following:

- Channel Migration Zone maps for the study reach showing "severe," "moderate," "mitigated" and "potential" channel migration hazard areas.
- Field maps (large scale aerial photographs) showing locations of significant features such as abandoned back-channels that could be potential avulsion locations.
- A Channel Migration Analysis Report, which will address the following aspects of Naches River channel migration history:
  - The history of channel pattern adjustments and the rate of meander-bend migration and cutoff before and since reservoir construction and damming
  - The contemporary depth of incision below the floodplain, and changes in hydraulic geometry in response to a 30-year discharge regime (cross-section study)

- The relation between peak runoff and channel-pattern adjustments resulting in streambank erosion (and subsequent channel changes, including avulsions)
- Whether changes since the construction of dams are very different from those before
- The utility of a database created for the project in predicting the where and when of channel changes, and recommendations for using available data for such predictions.

Additional pertinent information and data that will be either collected or produced during this study include the following:

- Resurveyed cross-sections of the lower Naches River (updating those previously surveyed by the Corps of Engineers in 1972 for the Naches River Floodplain Information report)
- Creation of a LIDAR-based Digital Elevation Model (DEM) and three-dimensional comparative surface models of the lower Naches River from Lidar points, digital imagery and cross-sectional data that will be useable on the County GIS, with sufficient information content to support County hydrological modeling
- GIS coverages of channel change for nine time periods (1901, 1927, 1947, 1972, 1977, 1984, 1992, 1999, and 2000)

UPPER YAKIMA RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN, 1998

Yakima County began the process of flood hazard planning under the State's FCAAP program with the Upper Yakima River Comprehensive Flood Hazard Management Plan. This plan addressed flood issues on the reach of the Yakima River stretching from Yakima Canyon to Union Gap and the Naches River from the Twin Bridges to its mouth. The current planning effort for the Naches is the second step in the County's plan to carry out comprehensive flood hazard planning for all of its watersheds. Although the two plans will address flood issues in different portions of the watershed, they will share many flood hazard management principles and policies, as well as some County-wide flood hazard management recommendations.

The Upper Yakima River CFHMP was adopted by the County Commissioners in 1998. The plan's purpose was to gain an understanding of flood hazard management alternatives so that appropriate and informed management proposals and decisions could be made. This study also aided in the development of a flood hazard management program to address the identified flood issues.

The CFHMP summarizes the river's flood history, existing flood conditions, flood control facilities, and previous studies of the study area. It includes an evaluation of alternative solutions to the flooding problems. Alternatives were evaluated based on the following:

- Ease of implementation
- Cost effectiveness

- Potential for success
- Environmental considerations
- Applicable policies and regulations.

Recommended alternatives were selected by an advisory committee consisting of state and local government officials, landowners and other interested parties. The CFHMP discusses existing local state and federal funding sources and outlines future program funding options.

Recommended alternatives included planning and land use changes, modifications of county and municipal regulations, and increased public education as well as improvements to existing flood control structures and roads. Some of these alternatives are local in nature, involving improvements to levees and repair of eroded riverbanks and changes to zoning in specific areas. These alternatives will have little effect on the flooding situation in the Naches River above the Twin Bridges.

However, many of the alternatives involve changes to county policies, programs and regulations that will have a significant impact on flooding throughout the county. In general, the CFHMP recommends non-structural measures as opposed to structural measures as the most cost-effective way to manage flood damage. Since the plan's adoption, zoning changes have been made to reduce development density in frequently flooded areas and a Floodplain Overlay District was added to the Yakima Urban Areas zoning code. Adoption of a county-wide Floodplain Overlay District would bring consistency to future land use and zoning regulations. For existing structures in the floodplain, the CFHMP recommends that the County, with help from the federal government, develop programs to dispense information and funding to floodproof these structures.

YAKIMA COUNTY FLOOD INSURANCE STUDY, 1998

The 1998 revision of the Yakima County Flood Insurance Study (FIS) is the most recent FEMA analysis of flood levels and predicted inundation areas in unincorporated Yakima County. The 1998 FIS focused only on the Yakima River and did not reanalyze the floodplain boundaries of the Naches River. This document modifies the original FIS, published in 1985 by FEMA, to address the contention that floodplain boundaries were inaccurate because the original study did not properly take into account hydraulic conditions such as the geometry of the river channel and levees along the reach through the City of Yakima.

While hydraulic model results associated with these revisions determined backwater effects in the Yakima River due to levees, the backwater effects these may have on water surface elevations in the Naches River were not addressed. It is unlikely that any backwater effect would extend upstream into the current CFHMP study area, which is 3.5 miles upstream of the confluence with the Yakima River. FEMA did not publish new FIRMs or revise flood elevations and inundation areas for the Naches River. The FIS data for the study area of this CFHMP dates from the original 1985 FEMA study.

Flood risk data developed in the FIS are used by the National Flood Insurance Program (NFIP) to determine flood insurance ratings. The NFIP, a federal program established in

1968 and administered by FEMA, allows property owners to purchase federally backed flood insurance. In return for insurance protection, participating communities are required to implement floodplain management measures to reduce flood risks in new developments. Yakima County entered the NFIP on April 11, 1974 and converted to the Regular Program on June 5, 1985. The City of Naches entered the NFIP on April 29, 1975 and converted to the Regular Program on January 9, 1983. Table 3-1 lists the current numbers of policy holders, premiums, claims and other pertinent information.

TABLE 3-1.
NATIONAL FLOOD INSURANCE PROGRAM PARTICIPANTS IN YAKIMA COUNTY

	No. of Policies	Annual Premiums Paid	Coverage	Total Claims Since Date of Entry	Dollars Paid Since Date of Entry	Repetitive Loss Structures
Yakima County	568	$272,571	$69,284,300	168	$783,031	17
City of Naches	13	$5,288	$1,332,700	4	$27,325	0
Total	**659**	**$315,065**	**$71,909,100**	**171**	**$807,639**	**17**

Source: FEMA 2003

Hydrologic analyses were carried out by the Corps to establish the peak discharge-frequency relationships for floods of 10-, 50-, 100-, and 500-year recurrence intervals. Flood flow estimates on the Naches River were based on statistical analysis of flow records at two USBR gauging stations. Table 3-2 shows the results of this analysis for these two gauging stations.

TABLE 3-2.
NATIONAL FLOOD INSURANCE STUDY FLOOD DISCHARGES

Stream Location	Drainage Area (square miles)	10-Year (cfs)	50-Year (cfs)	100-Year (cfs)	500-Year (cfs)
Naches River near Naches	941	12,500	20,000	27,000	47,500
Naches River at Mouth	1,125	12,600	20,300	27,100	49,400

Source: FEMA 1998. USBR gauging stations chosen for stream locations.

Flood Insurance Rate Maps, Floodway Maps, and Flood Boundary Maps

FEMA uses the results of the FIS to prepare Flood Insurance Rate Maps (FIRMs) identifying special flood hazard area (areas subject to inundation by the 100-year flood). The FIRMs show different types of flood hazard areas, or zones, based on the location of the 100-year floodplain and the type of analysis used to predict water surface elevations. Flood hazard zones are used to determine insurance rates. FEMA delineated the following zones within the study area:

- Zone A—Areas subject to inundation by the 100-year flood where base (100-year) flood elevations and flood hazard factors were not determined. Mandatory flood insurance purchase requirements apply in this zone.
- Zones AE and A1, A4, A7, A8, and A9—Areas subject to inundation by the 100-year flood determined by the FIS using detailed methods; base flood elevations shown. Mandatory flood insurance purchase requirements apply.
- Zone B, C, and X—Areas with moderate or minimal flood hazard from the principal source of flooding in the area. These areas may experience flooding from severe storm events or inadequate local drainage. Flood insurance is available but not required in these zones. Zone X is used on new and revised maps in place of Zones B and C.

In addition to the zones described above, the FIRM shows the floodway, as determined by FEMA. The floodway usually includes the main channel of the stream and the land along its sides that must be reserved in an unobstructed condition in order to convey the 100-year flood without increasing flood levels by more than 1 foot (less if specified in local ordinances). FEMA requires communities to designate the floodway to avoid significantly increasing upstream flood elevations. To maintain insurance coverage, communities must prohibit development within the designated floodway that would cause any increase in the 100-year flood elevation.

NACHES RIVER FLOODPLAIN INFORMATION, 1972

The Naches River Floodplain Information report was prepared to assess the Naches River's flood potential and flood hazards and to guide revisions to the Comprehensive Land Use Plan. The study area of the report is the Naches River valley from the Highway 12 bridges to the confluence with the Tieton River. The report estimates flood flows for two flood events and identifies floodprone areas by mapping flood elevations on aerial photographs. The report does not provide solutions to flood problems on the Naches River but discusses factors that increase flood depths and damage.

The report briefly documents the history of flooding in the vicinity of the City of Naches and includes photographs of the 1933 flood. Flood flows were estimated for the Intermediate Regional Flood (100-year recurrence interval event) and Standard Project Flood (approximately 40 to 60 percent of the probable maximum flood). Flows for these two events at the USGS gage at Naches were estimated at 33,500 cubic feet per second (cfs) and 83,000 cfs, respectively. This estimate of the 100-year event is 6,500 cfs higher than what was estimated for the FEMA FIS (27,000 cfs) which came after this study. It is unknown how the hydrology was revised between the Floodplain Information Report and FEMA's Flood Insurance Study.

The report identified debris jams collecting on bridges and other natural obstructions as a factor that may impede flood flows and increase flood heights. The report includes the under-clearance elevations of the three bridges over the Naches River in the study area. During the Standard Project Flood, two of these bridges would be overtopped and would act as significant obstructions. However the flood elevations published in the report assumes that flows would not be obstructed.

Flood modeling was also used to estimate flood flow velocities, maximum rates of rise and flood duration. Flood profiles were not included in the report, although floodplain maps showing the limits of inundation for the Standard Project Flood and the Intermediate Regional Flood were published. These maps can be used to identify areas of flooding for flood events greater than the 100-year event.

YAKIMA AND NACHES RIVERS FLOODPLAIN INFORMATION, 1970

This report was prepared at the request of the Washington State Department of Water Resources and focuses on the flood situation along the Yakima River and Naches River below the current CFHMP study area. The goal of this report was to assist local residents and public officials in identifying flood hazard areas along the rivers. Although the study area for the *Floodplain Information Report* does not overlap with the current planning study, the report does contain some information relevant to the Naches River CFHMP. It provides elevation data for the Twin Bridges and the Northern Pacific Railway Bridge (Table 3-3), and notes that these bridges obstruct the passage of the Standard Project Flood. In addition, some approach fills for bridges, irrigation canals, diversion structures and sandbars tend to form flood flow obstructions through this reach. Ditches and canals with raised banks tend to confine and impound the flood overflows.

TABLE 3-3.
ELEVATIONS AT U.S. HIGHWAY 12 TWIN BRIDGES[a]

		Elevation (feet)				Underclearance (feet)	
Mile Above Mouth	Bridge	Stream Bed	Average Deck Elevation	Intermediate Regional Flood Crest	Standard Project Flood Crest	Elevation	Relative to Intermediate Regional Flood[b]
3.6	Northern Pacific Railway	1,157.5	1,181.0	1,171.3	1,180.0	1,176.0	4.3
3.7	U.S. Highway 12, Westbound	1,159.0	1,181.0	1,172.4	1,180.0	1,176.8	4.4
3.72	U.S. Highway 12, Eastbound	1,159.6	1,182.0	1,173.0	1,180.0	1,177.0	4.0

a. Table modified from U.S. Army Corps, 1970
b. Intermediate regional flood of 33,500 cfs near the City of Naches computed in this study. This flow was later revised down to 27,000 cfs based on the 1984 FEMA FIS. Intermediate Regional Flood is also known as the 100-year flood.

Other information included in the study includes maps, flood profiles, and river cross-sections indicating the extent of past and probable future flooding within its study area. It also discusses flooding history and includes photographs of the 1933 and 1948 floods.

Flood flows on the Naches River were estimated to be 33,500 cfs for the Intermediate Regional Flood (100-year recurrence interval event) and 83,000 cfs for the Standard Project Flood at the gaging station near the City of Naches. The study reported that flows above

5,720 cfs at the gage near Naches resulted in flooding between the mouth of the Tieton River and the mouth of the Naches River.

This report was the first study to propose 100-year floodplain boundaries for portions of the Yakima River and the Naches River up to the U.S. Highway 12 twin bridges, but it did not address the upstream study area.

CHAPTER 4.
FLOOD HISTORY CHARACTERISTICS

Flooding is a common event on the Naches River. Since 1909, the river has overtopped its banks approximately 60 times. Although flooding is an intrinsic part of the river's natural processes, it can also be destructive and poses a hazard to those living in the floodplain. Most flood events on the river have been relatively minor and caused little if any damage. High-magnitude floods, such as the February 1996 flood, occur very infrequently but can be much more damaging and disruptive. This chapter reviews historical information on previous flood events, including flood magnitudes, damage reports, and anecdotal reports, and focuses on key physical factors that affect flooding on the Naches River.

FACTORS AFFECTING FLOODING

The extent and severity of flood damage in the Naches River valley is determined by such characteristics as time of year, flood magnitude and duration, sediment transport and deposition, the presence of development in the floodway, and natural obstructions. Seasonal conditions and physical factors that play an important role in flooding on the Naches River are described below and summarized in Table 4-1.

Seasonal Conditions

Flooding on the Naches River typically occurs during the winter and spring. The largest flood on record for the Naches River Basin was a winter rain-on-snow event that occurred in December 1933. The high flows resulted in tremendous damage throughout the Naches valley.

Damaging spring floods include the May 1948 flood and the June 1956 flood. Spring floods usually occur as a result of unusually warm weather and rainstorms, triggering an excessive amount of snowmelt in the higher elevations. Spring floods are normally moderate in magnitude but can last up to four weeks. The river can rise from normal flow to extreme flood peaks within a week and may remain above flood stage for more than two weeks. These floods tend to have the greatest impact on crops and farmlands, which may already have begun their growth season.

Winter floods occur more frequently and are typically caused by warm Chinook winds, heavy rain and rapid snowmelt. Frozen ground creates an impervious surface that causes runoff to accumulate faster. Historically, winter floods have been larger in magnitude, such as the December 1933 and February 1996 events. Winter floods typically last less than a week, so the total volume of runoff is not as high as that of spring floods.

Late fall and early winter floods can have detrimental impacts on salmon, resident fish and aquatic organisms. Spawning salmon lay their eggs in September and October in gravel nests called "redds." Flooding during late fall and early winter can destroy the redds.

TABLE 4-1. PHYSICAL CHARACTERISTICS OF NACHES RIVER FLOODS	
Season	• Flooding commonly occurs during the winter and spring • Winter floods are more common than spring floods • The season can have a significant impact on damage sustained by crops and farmland • Frozen ground in winter acts like an impervious surface and increases runoff
Snow	• Rapid snowmelt during winter floods increases runoff volumes
Warm Chinook Winds and Heavy Rain	• Many winter flood events have occurred in the aftermath of warm Chinook winds, heavy rain and increased snowmelt
Magnitude	• Defined as the peak river flow and crest elevation during a flood • Highly dependent on weather and runoff conditions • Flood magnitude becomes progressively larger in the downstream direction
Duration	• Total length of time the river experiences flooding • Directly related to runoff volume and groundwater levels
Sediment Transport/Deposition	• Higher flow depth increases the river's power to transport sediment and debris • High flows can result in rapid channel migration and an increased potential for channel avulsions
Channel Obstructions	• Can be natural (trees and brush) or man-made (bridges and diversion dams) • Debris can accumulate at bridge piers, further constricting the flow area • Obstructions increase flood elevations upstream and flow velocities immediately downstream
Dikes and Levees	• Provide protection for properties up to the design elevation of the structure • Increase flood elevations upstream and through the diked section • Increase flow depth, velocity and stream power through diked sections and downstream, which can increase sediment transport and channel migration in unprotected areas downstream • If overtopped, can trap floodwater in the floodplain

Flood Magnitude and Duration

The magnitude and duration of a flood are highly dependent on weather and runoff conditions. If the total amount of runoff is significant, high flood flows will result, affecting more land and causing a greater amount of damage. In the December 1933 flood, the estimated peak discharge was 32,200 cfs at the USGS gauge near Naches. The flood affected many properties in the study area.

The potential impact of a flood increases in the downstream direction as flow volume increases. In some instances, floodplain storage may aid in reducing the magnitude of a flood as it travels downstream. However, if the floodplain storage has reached a maximum because of long flood duration or due to development in the floodplain, the flood magnitude is not reduced and greater downstream flooding occurs.

The Naches River can remain at critical stage for more the 30 days, rising 11 to 16 feet. Near the City of Naches, it usually takes at least a day for overbank flooding to occur. Most significant floods on the Naches River have remained above flood stage for five to seven days. There have been cases in which the river crested above flood stage more than once within a two-week period. In 1977, the river crested at 20.06 feet one week in December and a week and a half later crested at 16.4 feet. For the two floods combined, the river remained above flood stage for a long period of time, causing significantly more damage than a single flood would have.

Flow Depth and Velocity

Water velocity during a flood depends largely on the size and shape of the channel cross-sections, conditions of the river and the slope of the river bed. Flood velocities above the City of Naches can reach 12 to 15 feet per second (FEMA FIS 1998). Deep water flowing at this rate can cause severe erosion and transport large objects and debris. In the lower reaches, flow velocities can reach 9 to 13 feet per second. Floodwaters in the overbanks near the town of Naches can reach average velocities of 3 to 5 feet per second.

Deep, fast moving water in the floodplain poses a safety risk to buildings, people and livestock. Even shallow, fast moving water flowing across a roadway can wash a car off the road, and as little as 6 inches of moving water can knock people off their feet (FEMA Floods and Flash Floods Fact Sheet, 2003). Downed utility lines along roads and submerged utility equipment in buildings poses a fire hazard and the threat of electrocution. Wood framed building walls can be severely damaged by the hydrostatic pressure exerted by water depths exceeding 3 feet. Foundations for residential construction, especially basement walls, can be susceptible to cracking and failure from hydrostatic pressures exerted by the surrounding saturated soil. Pressures against outer building walls is increased when the water is in motion. In addition to the pressures exerted solely by water, buildings can also be severely damaged by debris impact.

Sediment Transport and Deposition

Sediment deposition and transport in a river channel are the primary mechanisms affecting channel movement in the river valley. River geomorphology and deposition patterns control the river's ability to contain floodwaters. Large quantities of sediment can be transported over short periods of time during a flood. Sediment deposition occurs where the river becomes wider or flatter than upstream reaches, reducing the energy of its flow and its ability to carry sediment downstream. Constrictions caused by significant sediment deposition can reduce the river channel's capacity for high flows and promote channel migration upstream of the constriction.

Sediment enters the Naches River from the erosion of surrounding mountains, glacial sediment deposits in the Naches Basin and erosion of the river banks. A significant amount of fine sediment is carried in suspension by the river; coarser sediments are transported downstream by rolling and bouncing along the channel bed. Deposition increases in areas where channel slope is low or flow area is wide, and transport increases in steeper or narrower reaches. During floods, overbank flow carries fine-grained sediments and clays, depositing them across the floodplain as the water recedes.

Most of the sediment transport that occurs in the Naches River system occurs during more frequent high flow events. Dominant discharge flows (flows that have the most significance in channel shaping and alignment changes over time) are those that occur with higher frequency and with enough flow to move sediment. Although flood flows have the capacity to move large amounts of sediments, they occur infrequently, whereas the dominant discharge flow in river systems has generally been correlated to flows occurring with a frequency of between 1 and 2 years (Knighton, 1998).

Sediment transport in the Naches River basin is also impacted by upstream dams on Rimrock Lake and Bumping Lake and by diversion structures in the river downstream. Gravel and sediments that would normally supply the Naches River are trapped in the reservoirs. A reduction in sediment supply can increase downcutting in the river system. Increased erosional processes may also lead to increased sinuosity and the rate of channel migration. Diversion structures affect sediment transport by decreasing stream gradient upstream as aggradation occurs behind the structures.

Obstructions

Natural and man-made obstructions can partially block flood flows, slowing velocities and creating increased flood heights. Natural obstructions can include trees and woody debris, brush and ice. Manmade constrictions such as diversion dams, levees and bridges, can also exacerbate flooding. Trees and other debris may be carried downstream and collect on bridges and other obstacles, resulting in higher flood heights upstream. As the flow increases, masses of debris can break apart, allowing a surge of water and debris to rush downstream until another obstacle is encountered. The impact of the debris on irrigation structures and bridge piers can cause these structures to fail if the impact or weight of debris exceeds their structural capacity. Irrigation structures and bridge piers are susceptible to impact damage. Obstructions also result in rivers overtopping their banks, unpredictable areas of flooding, destruction or damage to culverts, and an increased velocity of flow immediately downstream. Table 4-2 lists bridges and irrigation intakes that cross the Naches River in the study area.

FLOOD HISTORY AND DAMAGE

Information on past floods was obtained from previous flood studies, newspaper articles, FEMA disaster survey reports, and flow records kept by the USGS and USBR. The Yakima County Public Services Department and the Yakima Herald-Republic newspaper provided photographs of historical floods. Table 4-3 lists the 10 most significant floods on record for the Naches River. The first and second largest on record occurred in December 1933 and February 1996, respectively. Appendix B lists all events that exceeded flood stage.

TABLE 4-2.
BRIDGES AND IRRIGATION DIVERSIONS
ACROSS THE NACHES RIVER IN THE STUDY AREA

Mile above Mouth	Bridge	Bridge Low Chord Elevation (feet)	Predicted FEMA 100-Year Flood Elevation (feet)[a]
3.6	Northern Pacific Railway	1,176.0	N/A
3.7	U.S. Highway 12, Westbound	1,176.8	N/A
3.72	U.S. Highway 12, Eastbound	1,177.0	N/A
3.75	Powerhouse Rd.	1,177.8	1,174.6
12.9	Naches Bridge (near Town of Naches)	1,460.72	1,456.7
16.63	Private Bridge (near USGS gauging station)	1,569.8	N/A
17.13	Wapatox Diversion Structure	—	—

a. FEMA computed a 100-year flood peak discharge of 27,000 cfs near the City of Naches in the FIS for Yakima County.
Source: U.S. Army Corps of Engineers

TABLE 4-3.
LARGEST HISTORIC FLOOD EVENTS ON THE NACHES RIVER

Date of Crest	Flow (cfs)	Stage[a]	Comments
22-Dec-1933	32,200	22.4	Prompted construction of federal levee system.
9-Feb-1996	20,924	22.36	Largest flood since construction of levees. Natural (unregulated) flow estimated to be 28,128 cfs.
24-Nov-1909	19,400	19.7	Little information available.
2-Dec-1977	18,000	20.1	Two flood peaks within 1-1/2 weeks. Water filtration plant shut down because of turbidity.
30-Dec-1917	16,800	18.9	Little information available.
1-Dec-1995	16,434	19.02	Two private bridges destroyed in Nile area. Rattlesnake Creek bridge approach destroyed.
13-Dec-1921	14,500	18.3	Little information available.
4-Dec-1975	14,100	18.4	Highway 12 threatened by channel shifting.
1-Jun-1956	13,300	17.9	No information.
17-Jun-1974	12,800	18.0	City of Yakima's drinking water main damaged.

a. Stage recorded at USBR Gage #1249400, Naches River near Naches.

Flood data was recorded at USBR Gaging Station #1249400, *Naches River near Naches*. The USGS maintained the station, located at RM 16.8, just upstream from the Town of Naches, from August to October 1905 and from October 1908 to 1979. The USBR has maintained the station from 1979 to the present. Prior to September 9, 1936, the station was 0.6 miles upstream from its current location. A staff gage was used at that site until December 7, 1916, when a water stage recorder was installed.

Recent flood events are described below to assess potential risks and identify areas sustaining repeated flood damage. The major floods of 1933 and 1948 are also described briefly to compare past and present flooding conditions and assess the range of potential hydrologic conditions that create flooding.

Recent Significant Flood Events

May 1997 Flood

The May 1997 flood was a relatively minor flood caused by warm weather and heavy rain, which produced heavy snowmelt. The Naches River was the only river in the County to crest above flood stage, at 18.1 feet (flood stage is 17.0 feet, measured at Naches). The Yakima River and small tributaries crested either slightly at or below flood stage. Only minor damage was suffered along the Naches River.

From a sediment transport standpoint, the May 1997 event and the months surrounding it were significant. Significant aggradation and channel changes occurred during this period due to the extended period of higher than average flows (Freudenthal, J., 2003 personal communication).

February 1996 Flood

The February 1996 flood is the second largest Naches River flood on record. This flood was a typical winter event. Unseasonably warm weather and heavy rainfall on a significant snowpack produced flood flows from snowmelt and rainfall runoff. Precipitation for the month of February was at a high; two-thirds of the way through the month Yakima County was at 209 percent of the average precipitation (Yakima Herald Republic 2/22/96). Flooding conditions were aggravated by small ice jams on the Yakima and Naches Rivers. Flow crested on the Naches River at Naches at 20,924 cfs and reached a stage of 22.4 feet. This slightly exceeded the flow FEMA predicts for a 50-year event at this location. The Bureau of Reclamation estimated that the natural, unregulated peak flow for this event would have been approximately 28,000 cfs.

Ramblers Park, located just outside of Gleed along Highway 12, and portions of Highways 12 and 410 were hit the hardest by the floodwaters (see Tables 4-4 and 4-5). Residents in Ramblers Park were engulfed by floodwaters for the second time in three months (see November/December 1995 Flood). Approximately 10 families in Ramblers Park were forced to evacuate their homes and businesses located there were shut down for more than a month.

Poor Boy's Auto Wrecking, located in Ramblers Park, sustained major flood damage. The Naches floodwaters overtook the company's inventory of cars and parts, wiped out much of its fencing and knocked a storage facility off its foundation (Yakima Herald Republic 8/4/96). The owners estimated that their business lost $50,000 in damage and another $20,000 in revenue. Weber's Auto Parts, across from Poor Boy's Auto Wrecking, estimated its damage at between $40,000 and $50,000 and its lost revenue at $20,000.

TABLE 4-4.
SUMMARY OF DOCUMENTED FLOOD DAMAGE FOR NACHES RIVER, FEBRUARY 1996

Location and Impacts	Information Source
Study Area	
• Ramblers Park (levee failure – see County Levees) – 10 families (30 to 40 people) were evacuated. – Four businesses were closed. – Poor Boy's Auto Wrecking sustained heavy damage and lost revenue during flood. – Weber's Auto Parts sustained significant damage and lost revenue during flood. Business was closed down for one month. Received an SBA loan and bought flood insurance.	Yakima Herald Republic (2-24-96)
• South Naches Channel Company – Headgates and diversion dam on canal damaged 1 mile southwest of Naches.	FEMA Damage Survey Report for Yakima County
• South Kershaw Drive – Two farms impacted. – Damage included lost irrigation lines, fencing, and approximately 50 pine trees. – The flood damaged a boat dock and undermined a retaining wall. – Landscaping and driveways were washed out. – One basement was flooded and a private well was found to be contaminated. – Properties sustained flood damage in both 1995 and 1996.	Yakima County
County Roads and Bridges	
• Lewis Road (mile post 0.05 south of Naches)—Damage to shoulders, crushed surfacing and subgrade. • West Powerhouse Road (MP 2.2 at Ramblers Park)—Damage to shoulders, pavement, and subgrade. Culverts and riprap washed out. • Craig Road (south of Naches)—Damage to shoulders, crushed surfacing and subgrade.	FEMA Damage Survey Report Data Sheet for Roadway System Repairs in Lower Naches River Basin
County Levees	
• Ramblers Park levee failed, flooding low-lying areas for 14 days until the Corps made emergency repairs and reinforced the levee in two places. The Corps trucked in 3,000 cubic yards of fill material to repair the damage.	Yakima Herald Republic (2-11- 97)
State Highways	
• Highway 12—Damage to shoulders and pavement; Highway 12 bridge near Highway 410 junction ("the Y") washed out; Washington State Department of Transportation constructed a temporary bridge; access to White Pass was cut off. • Highway 410—One section of highway was washed out. Damage to shoulders and pavement.	Yakima Herald Republic

TABLE 4-5.
DOCUMENTED MONETARY FLOOD DAMAGE IN NACHES RIVER STUDY AREA
FEBRUARY 1996 FLOOD EVENT

Damage Type	Total Damage	Information Source
YAKIMA COUNTY (NACHES RIVER)		
County Roads	$111,507	FEMA Damage Survey Reports
Debris Removal[a]	31,953	
Emergency Management (Protective Measures)[a]	12,836	
Yakima County Fire District #12 (Security Patrols)[a]	12,069	
Subtotal	**$102,358**	
U.S. ARMY CORPS OF ENGINEERS		
Ramblers Park Levee ($30,000 flood-fighting, $130,000 levee rehabilitation)	**$160,000**	Corps of Engineers
WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)		
Repairs to sections of Highway 12 between the SR 410 and I-82 Junctions (includes replacement of the Naches River Bridge)	**$3,701,091**	WSDOT
TOWN OF NACHES		
Public Facilities	**$0**	Town of Naches
PRIVATE LOSSES (REPORTED)		
Poor Boy Auto Wrecking (approximately $20,000 lost revenue)	$70,000	Yakima County
Weber's Auto Wrecking (approximately $20,000 lost revenue)	70,000	
Kershaw Road – two properties	35,100	
South Naches Channel Company	20,147	
Small Business Administration Loans	N/A	
Individual & Family Grants	N/A	
Housing Grants	N/A	
Subtotal	**$195,247**	
Total	**$4,158,696**	

a. County-wide damage estimates. Damage to County facilities does not include administrative costs.

Officials estimated that at least 55 businesses employing 240 people were affected in Yakima County, totaling over $2.3 million in damage. At the White Pass ski area, sales were down 65 percent due to road closures and extreme weather conditions. Submerged portions of Highway 12 and 410 were impassable.

The flood washed out the Highway 12 bridge over the Naches River just above “the Y” junction with Highway 410. This bridge was a major east-west link across the Cascade

Mountains. The bridge collapse and an additional washout 4 miles east of the White Pass summit cut off the primary access routes for White Pass area residents. Washington State Department of Transportation (WSDOT) crews replaced the bridge with a temporary bridge two weeks after the flood.

The high flows and debris loads caused significant channel erosion and scour, eroding embankments, widening the stream channel and washing out vegetation and trees in the flood's path. The main Naches River channel shifted in location in several places, most notably just upstream from Ramblers Park, where a major avulsion put the force of the main channel adjacent to the Ramblers Park levees.

Approximately $112,000 was spent to repair the roadway system in the Naches River drainage area (DSR 458806 submitted by Yakima County). The Corps of Engineers spent $160,000 on flood-fighting efforts and repairs to the Ramblers Park levee. Nearly $1.5 million of flood damage was sustained by forest roads, trails, and recreation facilities in the Naches Ranger District.

Other areas of Yakima County and the state were similarly hard hit during this flood. Yakima County was declared a federal disaster area. As of May 23, 1996, FEMA had received over 1,780 applications for disaster assistance from Yakima County residents. Requests for public and private assistance totaled $11 million countywide. Information is lacking as to how much of this can be attributed to damage in the Naches River basin.

Figures 4-1 through 4-3 and Photos 4-1 through 4-7 show aerial and ground photographs of the 1996 flood. FEMA's 100-year and 500-year floodplain limits are included on the figures for comparison to the extent of the 1996 flooding. The February 1996 inundation limits extend outside the 100-year floodplain boundaries in several areas between the City of Naches and Ramblers Park. About 540 acres outside the 100-year floodplain was flooded. Most of this area extended from Naches to 2.8 miles downstream. Within this 2.8-mile area, the flooding also extended outside the predicted 500-year limits.

A key explanation for these differences is the occurrence of channel migration within this reach. Ice jams were not a problem during this flood event, nor have significant changes been made to bridges, levees, or other structures in the floodplain. Yakima County recently completed a study to quantify channel migration characteristics in the Naches River basin. Results of the study will be incorporated into the CAO during the update process.

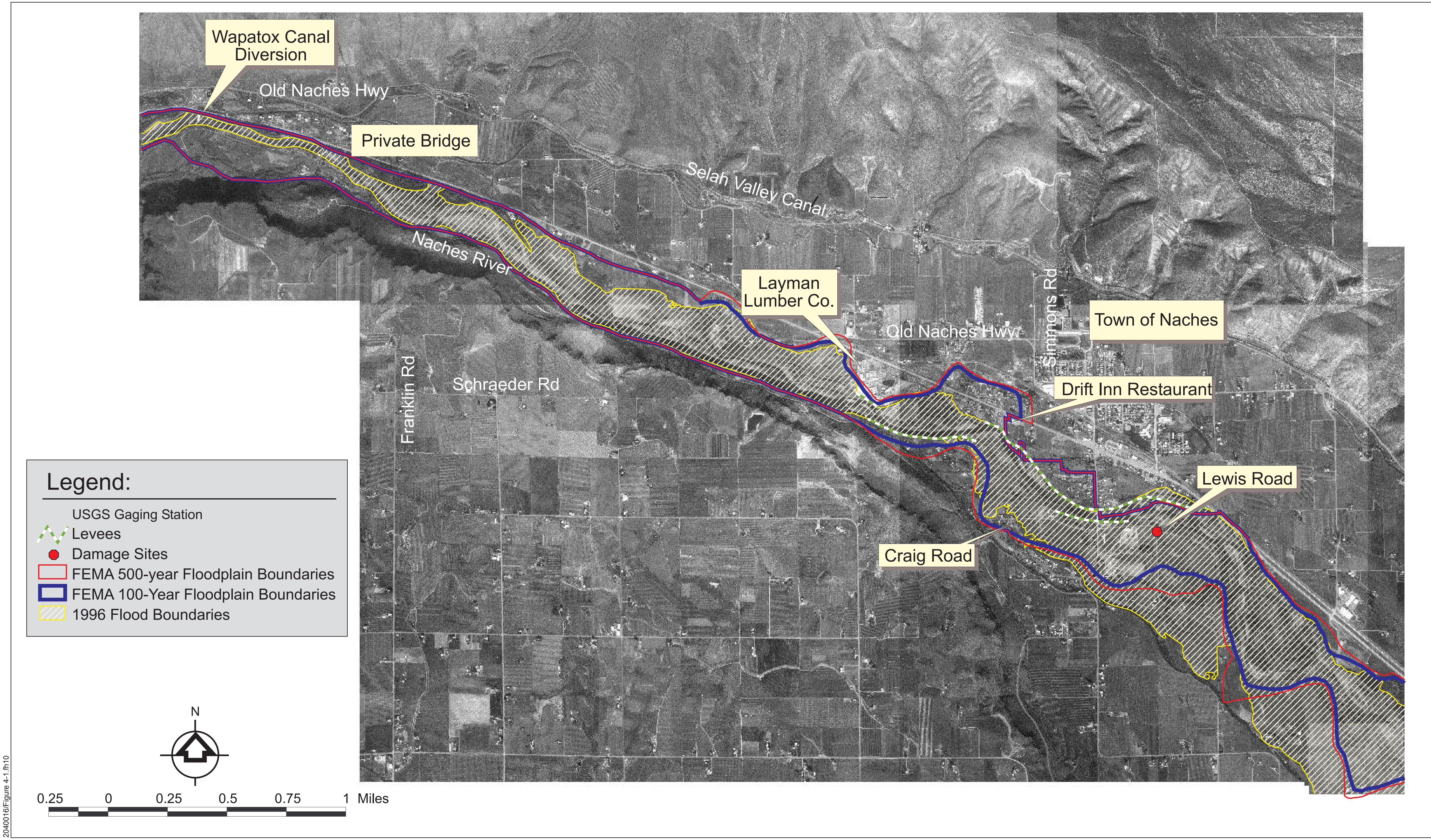
November/December 1995 Flood

A weather pattern called a "Pineapple Express" brought record high temperatures of up to 66ºF to the Naches and Yakima valleys in late November and early December 1995. Heavy mountain rains combined with heavy snowmelt from the warm temperatures and sent rivers rising in the Naches and Yakima valleys. The Naches River crested at 18.7 feet. Although a presidential disaster declaration was made for Yakima County, actual damage in the study area was minimal.

Flood damage in the study area was localized in Ramblers Park and in the outskirts of Gleed. Flooding also resulted in the closure of four County roads. Yakima Health District officials issued an advisory for private well owners to watch for signs of contamination.

Photo 4-1. Dump trucks and excavators finish emergency repairs to the breached Ramblers Park levee following the February 1996 flood. (Yakima-Herald Republic, February 24, 1996)

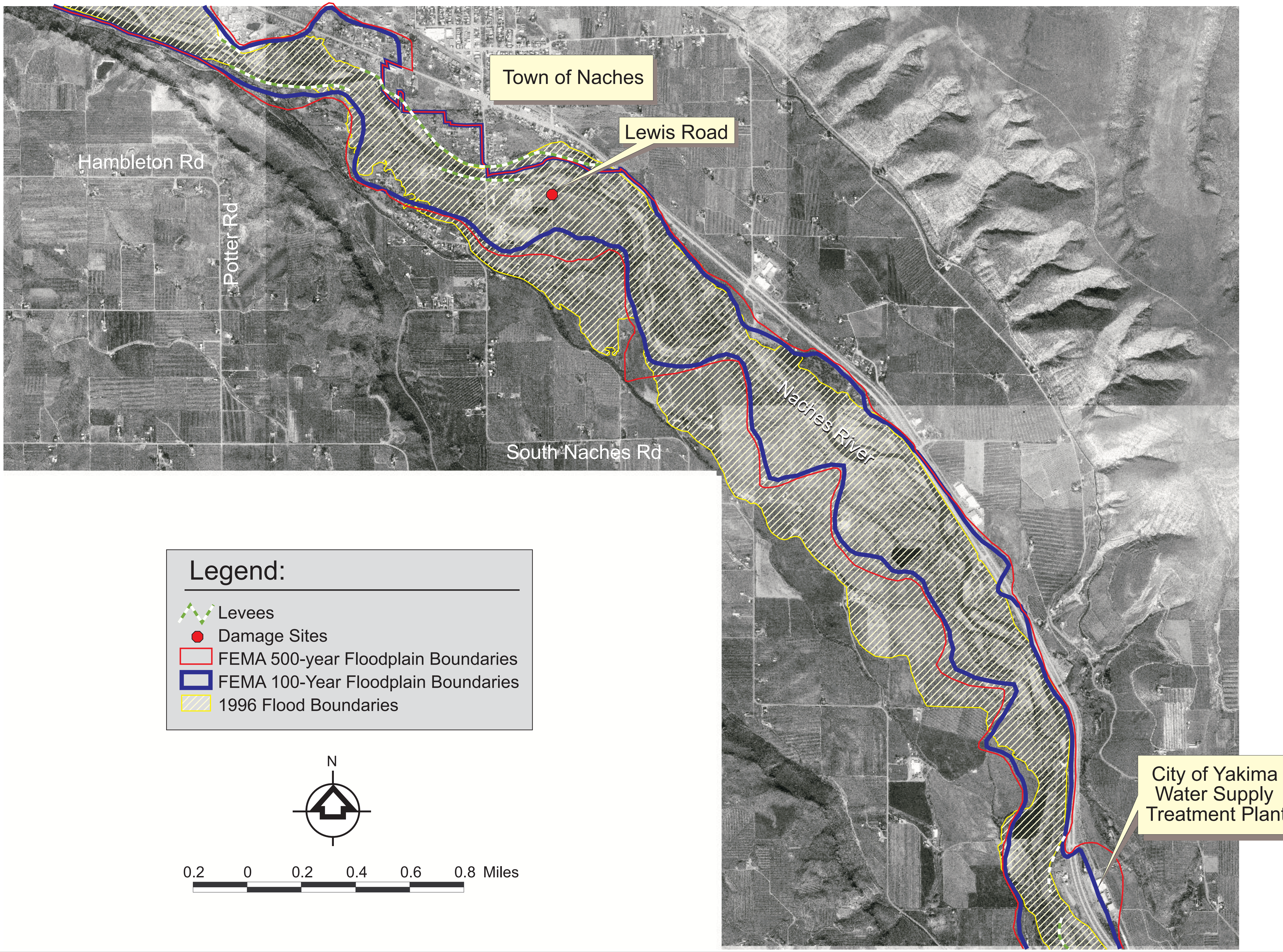
Photo 4-2. Roy and Diane Beaman and Jerry Weber, Ramblers Park business owners, stand atop the recently repaired Ramblers Park levee. The Corps of Engineers made emergency repairs to close a breached section of the levee carved out by the Naches River. (Yakima-Herald Republic, February 1996)



Tetra Tech/
KCM, Inc.
1917 First Avenue
Seattle, Washington 98101

Yakima County
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 4-1.
1996 FLOODPLAIN BOUNDARIES (WEST PANEL)



2040016/Figure 4-2.fh10

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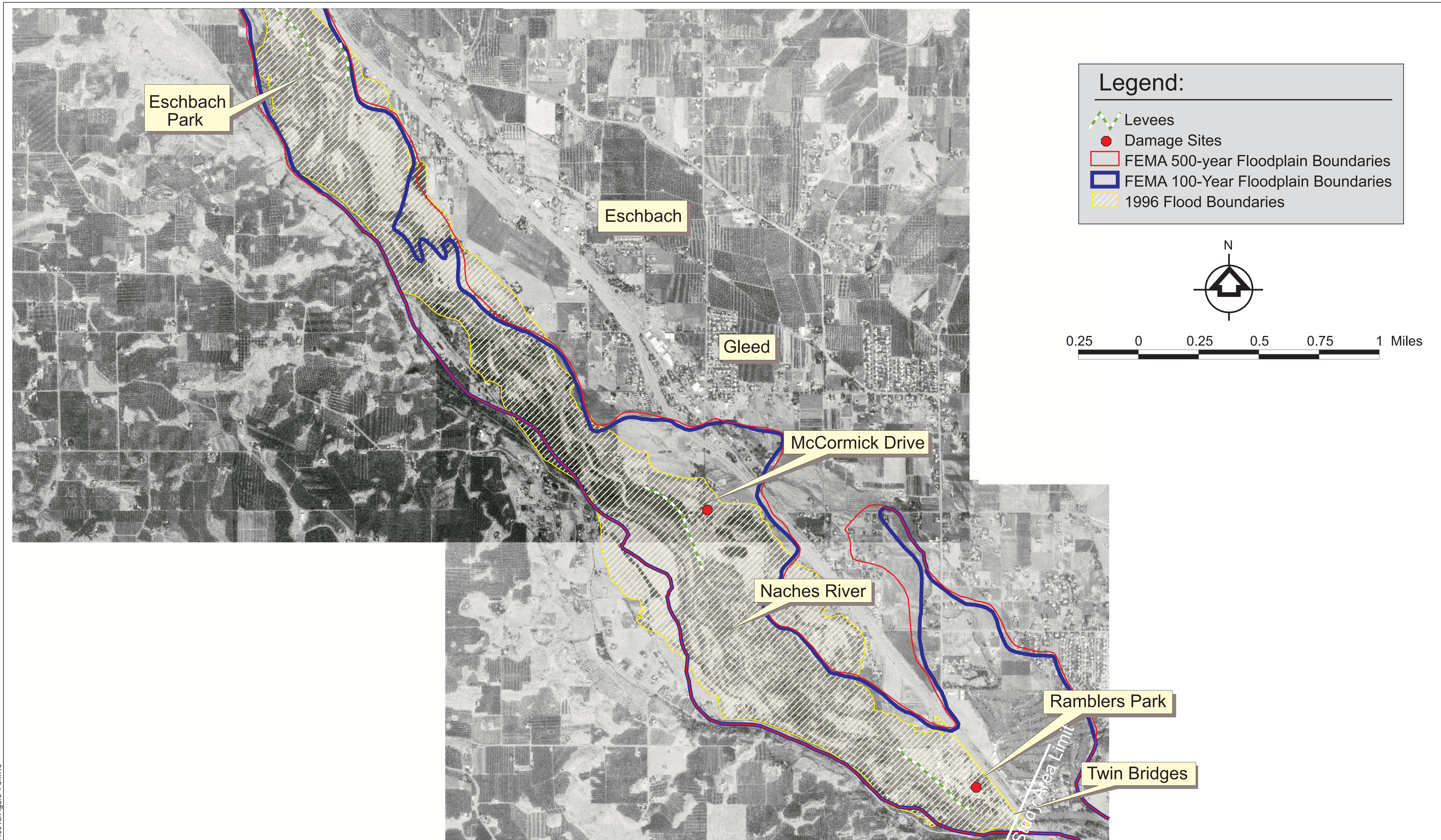
Yakima County
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 4-2.
1996 FLOODPLAIN BOUNDARIES (CENTER PANEL)



2040016/Figure 4-3.fh10

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Yakima County
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 4-3.
1996 FLOODPLAIN BOUNDARIES (EAST PANEL)

Photo 4-3. Lewis Road flood damage near the Town of Naches (Yakima County, March 22, 1996).

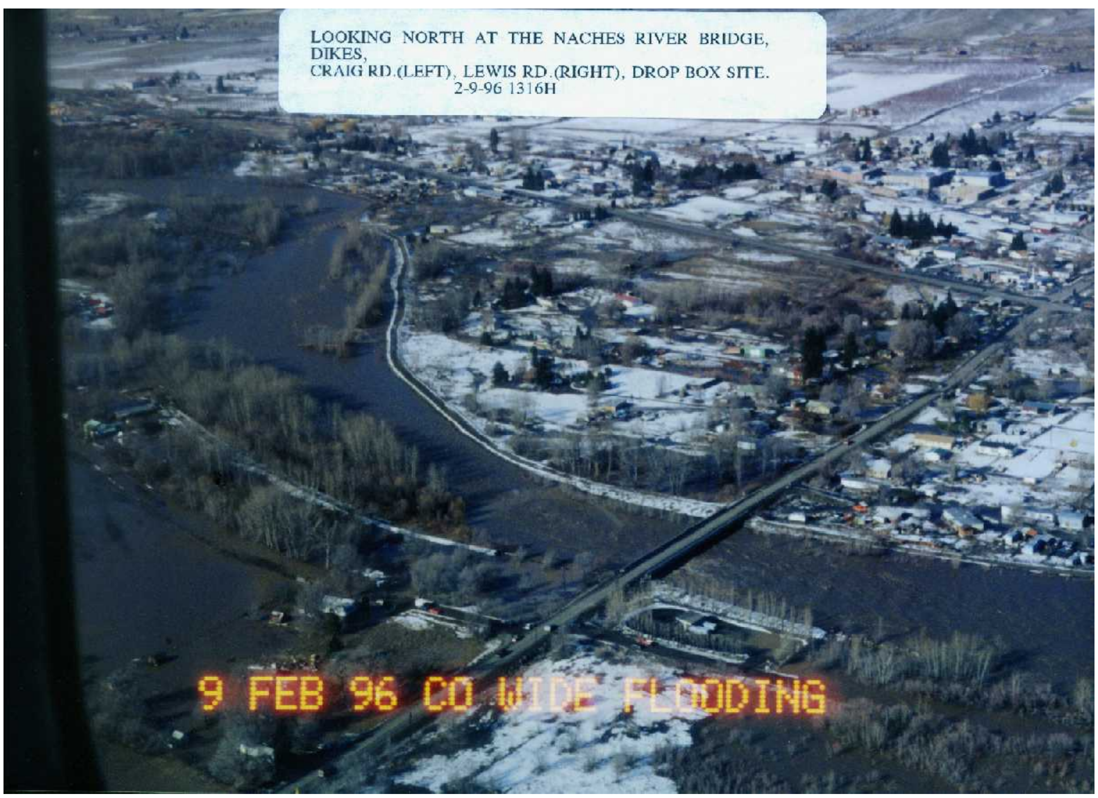


Photo 4-4. Craig and Lewis Roads at the Naches River Bridge leading into Naches (Yakima County, February 9, 1996).

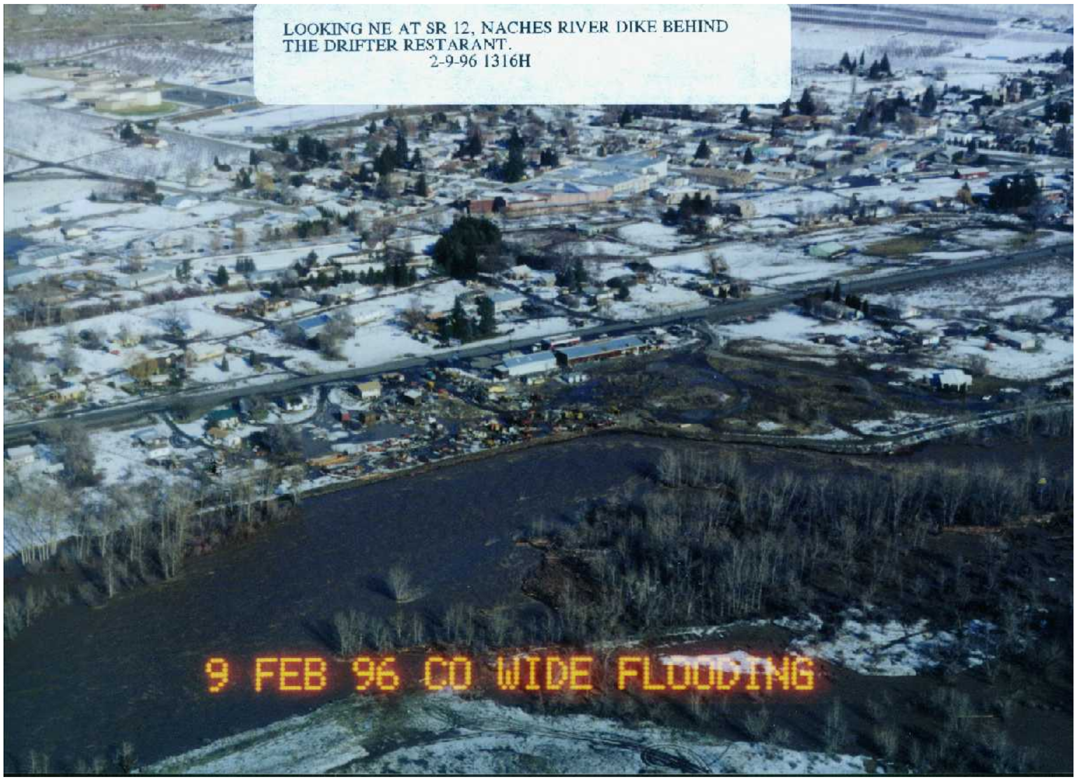


Photo 4-5. Floodwater breached the Naches River Dike near the Drift Inn Restaurant in Naches (Yakima County, February 9, 1996).

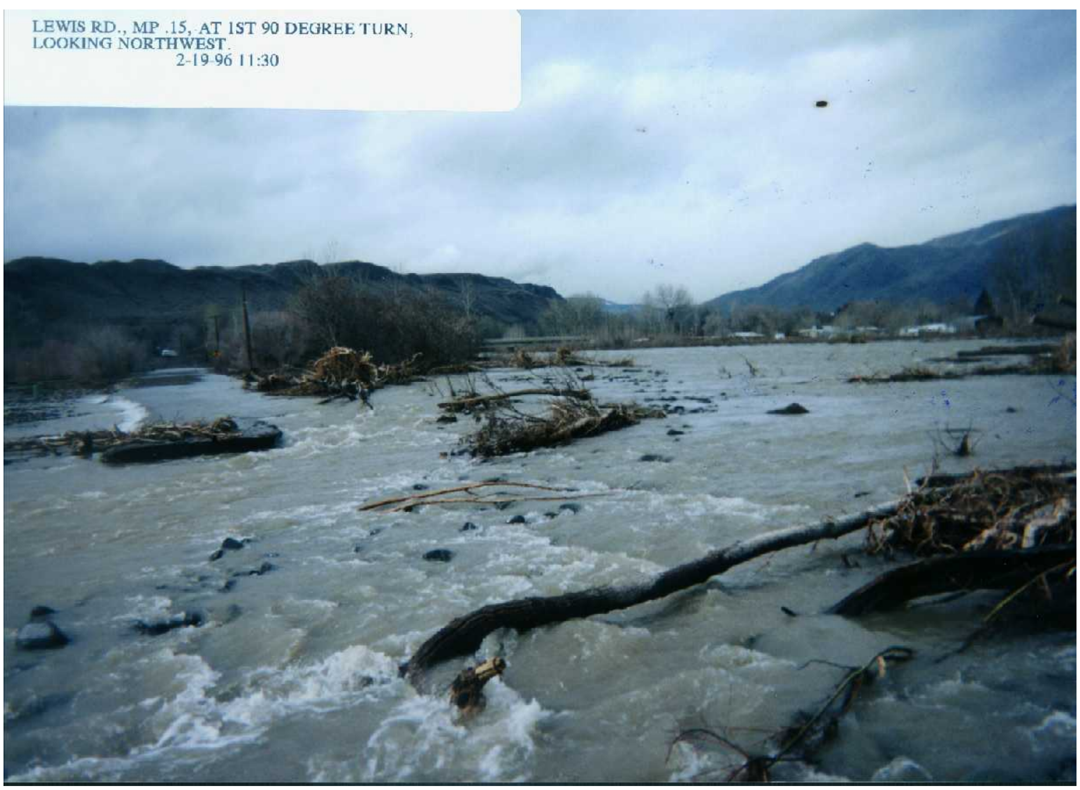


Photo 4-6. The Naches River inundated and washed out several sections of Lewis Road east of the Naches River Bridge (visible in background). (Yakima County, February 19, 1996).

Photo 4-7. Flooded farm buildings and pastures approximately 1.5 miles upstream of Eschbach Park. (Yakima County, February 9, 1996).

November 1990 Flood

The November 1990 flood was the sixth largest flood on record for the Yakima River but only the 16th largest flood on the Naches River. The peak flow of the Naches River at Naches reached 8,888 cfs and the peak flow at Parker dam on the Yakima River reached 35,600 cfs. The flood event was short, with river levels dropping just 5 hours after reaching their crest. Unusually warm weather and record-breaking rainfall, producing an excessive amount of snowmelt runoff, was the cause of this typical winter flood.

The flood resulted in the closure of several County and City roads due to debris and water over the roadway. This included Lewis Road (off South Naches Road), which sustained damage.

January and February 1985 Ice Jams

In mid-January of 1985, an ice jam formed on the Naches River about 8.5 miles west of Naches. The ice jam was the result of an unusual warming trend in the higher elevations of the Cascades. The 5-foot-high ice jam extended from bank to bank and ranged in length from 300 yards to a half-mile. New ice piled up against the existing jam, blocking the river and forcing water over the banks of the stream. The rising water caused the evacuation of five families and minor flooding of three homes. The flooding occurred after the rising water behind the jam caused a crack to form in the ice, sending ice chunks and water downstream. A concerned resident told the Yakima Herald, “We haven’t had flooding like this since 1977. It was so hard when it hit I thought it was going to take the motel and everything out." (Yakima Herald, January 17, 1985)

After the break up of the ice jam, another one quickly formed in the Naches and stayed firm until late February. On February 23, 1985, the National Weather Service cautioned residents along the Naches River to be on the alert for the breakup of the ice. Temperatures were expected to hit the mid-50s and there was concern that runoff from higher elevations could cause flooding and the break up of the jam. On February 26, an eyewitness reported that a channel ranging from 10 feet to 30 feet wide had formed in the melting 200-yard-long ice jam. The jam eventually broke up causing only minor flooding and damage. A small portion of a road in Naches Heights collapsed as a result of floodwater and a few other roads were temporarily closed without damage.

This event is an example of flooding hazards not associated with high stream flow in the river. Damage from ice jams tends to be localized, but can severely damage structures such as bridges as the partially melted ice jam is carried downstream.

Historic Flood Events

May 1948 Flood

The May 1948 flood is the fourth largest flood on record for the Yakima River Basin. It is one of the few significant spring floods. This flood was the result of a winter with above-average snow pack followed by unseasonably warm weather. Warm temperatures and rain produced excessive high-elevation snowmelt and unusually high volumes of runoff. On May 27 and 28, over 3 inches of rain fell in the Cascades Mountains, and temperatures reached the high 80s. The Naches River near Naches crested at a stage of 17.7 feet, equating to a flow of 12,600 cfs.

Brief newspaper accounts reported region-wide damage. According to a May edition of the Yakima Herald Republic, it was the worst flood citizens had seen in 13 years. The Naches River levee near its mouth experienced serious erosion and the Elks Golf Course was inundated from both the Naches and Yakima Rivers. Most of the significant damage was outside the study area and was mainly the result of flooding on the Yakima River.

December 1933 Flood

The December 1933 flood was the largest flood on record for the Naches River. A combination of warm, moist Chinook winds, unusually heavy rain, and high volumes of snowmelt sent runoff cascading out of the mountains. Flooding was widespread and affected the entire Yakima River basin. Precipitation in the watershed was at least 500 percent above normal. Flow in the Naches River, measured near Naches, crested at 32,200 cfs and reached a stage of 22.4 feet. The flood was estimated to be equivalent to a 200-year flood.

The 1933 flood caused damage estimated at over $1 million in Yakima County. Newspapers reported widespread flooding near Naches when the river flow reached 12,500 cfs and water rushed over the Naches Bridge, which was eventually washed out. One of the worst hit areas was Ramblers Park. A newspaper article reported, "The water rose nine inches in

Ramblers Park Wednesday and late in the day was up to the level of the floors in the cabin after the tenants (since) had moved out." (Yakima County Herald, 1933)

HISTORIC FLOOD IMPROVEMENT PROJECTS

The vast damage caused by the December 1933 flood in the Yakima and Naches valleys provided the incentive to construct an extensive federal levee system, which included levees along both the Naches and Yakima Rivers. Currently, there are levees along both banks of the Naches River at the City of Naches and on the left bank at Ramblers Park, and embankment stabilization along highway and railroad embankments along the river.

Yakima County levee maintenance records document river improvement projects along the Yakima and Naches Rivers from 1965 to 2001. The records describe project type, location, and eligibility for various funding sources. Some of the projects listed were never completed.

Table 4-6 summarizes the number of river improvement projects by location. Only about half of the levee maintenance records document project costs; therefore, cumulative expenditures for maintenance and repairs are not presented. Projects have included post-flood repairs and regular maintenance, such as riprap replacement and vegetation control. Numerous projects occurred in 1978 as a result of the December 1977 flood. Repairs to the Ramblers Park levee following the February 1996 flood cost $130,000. River improvement projects in the study area have consisted primarily of reconstructing damaged sections of levees, riprap replacement, debris removal and other routine maintenance tasks. Repetitive expenditures along the Naches River have been concentrated near the town of Naches at four levees, the Gleed area near McCormick Road, three levees upstream of Eschbach Park, and the Ramblers Park levee.

TABLE 4-6.
SUMMARY OF HISTORIC RIVER IMPROVEMENT PROJECTS (1965-2001)

Location	Number of Projects	Project Descriptions
Eschbach Park	9	Riprap, dike repair
Gleed/McCormick Road	7	Riprap, dike repair
Naches	10	Riprap, dike repair
Ramblers Park	6	Riprap, dike reconstruction
Other	4	Flood-fighting, vegetation management
Total	**36**	

CHAPTER 5.
FLOOD CONTROL FACILITIES AND PROGRAMS

In response to heavy damage incurred during the 1933 flood, the U.S. Secretary of War authorized the Yakima River flood control works project, which included the installation of nine earthen levees and associated drainage structures in the Naches River study area. The project was authorized June 28, 1938 and the Corps of Engineers completed construction on March 26, 1948. The levees, shown in Figure 5-1, were constructed between Ramblers Park and the junction of Highways 12 and 410. The levees have since been maintained and upgraded by Yakima County, except for one levee maintained by the City of Yakima that protects the City of Yakima Water Treatment Plant. This chapter describes flood control facilities in the study area and programs that affect flood control.

FACILITIES INVENTORY

Flood control works in the study area were inventoried by type and location; information was compiled from past studies, Corps and County inspection reports, Corps inventory records and drawings, and interviews with County and Corps staff. The inventory focused on facilities maintained by the County. Other pertinent facilities were inventoried if information was available. The location and condition of the facilities was provided by the County. Appendix C contains a data sheet for each structure, including the following information:

- Facility name and location
- Type of structure
- Managing agency
- Physical characteristics (dimensions, construction material, internal drainage system, elevations)
- Level of protection, freeboard, and internal drainage structures for levee facilities
- Agency responsible for maintenance, schedule of maintenance, and previous maintenance performed
- Inspection deficiencies, if applicable.

The nine levees constructed by the Corps are listed in Table 5-1. Approximately 21,250 feet of levees were constructed. All but one levee is adequate to contain a 5-year flood event with 1 foot of freeboard. Two are adequate to contain the 10-year flood with 3 feet of freeboard. Drainage structures were built to convey surface runoff and irrigation water through the levees. Most of the drainage structures have floodgates to keep floodwater from backing up into the drainage channel.

TABLE 5-1.
INVENTORIED LEVEES IN NACHES RIVER STUDY AREA

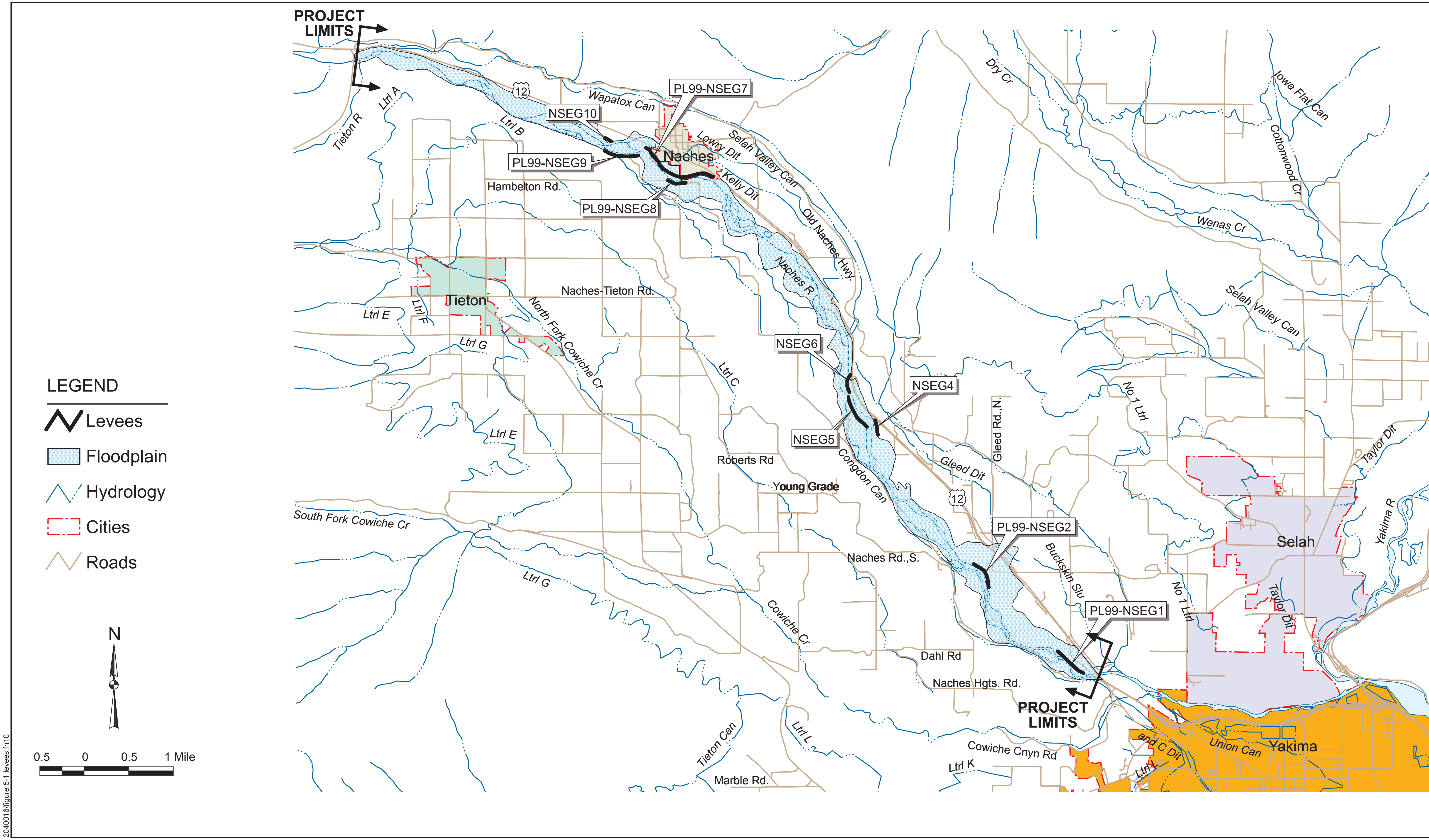
Identification[a]	Managing Agency	Source of Elevation Data	Level of Protection[b]	Remarks
PL 84-99 Eligible Levees				
PL99-NSEG1	Yakima County	Corps; needs to be verified	10 (3)	Rambler Park/Weber Auto Wrecking levee
PL99-NSEG2	Yakima County	Corps; needs to be verified	5 (1)	McCormick levee
PL99-NSEG6	City of Yakima	Corps; needs to be verified	5 (1)	City of Yakima water treatment plant levee
PL99-NSEG7	Yakima County	Corps; needs to be verified	5 (1)	South Naches Road
PL99-NSEG8	Yakima County	Corps	5 (1)	South Naches Road
PL99-NSEG9	Yakima County	Corps; needs to be verified	5 (1)	Near Craig Road
Ineligible Levees				
NSEG4	Yakima County	Corps; needs to be verified	10 (3)	Near Kershaw Road
NSEG5	Yakima County	Corps; needs to be verified	5 (1)	Near Eschbach Park
NSEG10	Yakima County	Corps; needs to be verified	N/A	Near Craig Road

a. NSEG = Naches River Segment
b. Level of protection is noted by flood event and freeboard as designated by the Corps. For example, 100 (3) refers to a level of protection equal to the 100-year flood event with 3 feet of freeboard.

Public Law 84-99 Levees

Public Law 84-99 authorizes the use of an emergency fund to prepare for emergency response to natural disaster, carry out flood-fighting and rescue operations, or repair or restore any flood control work threatened, damaged, or destroyed by flood. Disaster assistance is administered by the Secretary of the Army and implemented by the Corps. A determination of eligibility follows detailed policies and procedures outlined in *Natural Disaster Procedures* (ER 500-1-1, Corps 1991). Eligibility requirements for PL 84-99 certification are typically less stringent than the requirements for federally authorized flood control works. Currently, federally authorized levees must have a 100-year level of protection with 3 feet of freeboard above the 100-year flood elevation. Any completed, locally operated and maintained flood control work can be eligible for PL 84-99 funding except the following:

- Those constructed, modified, or repaired with financial assistance from other federal agencies
- Those constructed, operated, and maintained by the Corps or other federal agencies
- Corps or other federal agency projects uncompleted or under construction
- Those not meeting design and maintenance standards.



Tetra Tech/ KCM, Inc.
1917 First Avenue
Seattle, Washington 98101

Yakima County
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 5-1.
LEVEES IN THE CFHMP STUDY AREA

Six of the Naches River levees are PL 84-99-eligible (see Table 5-1), and have been listed by the Corps as meeting all certification requirements. These structures are listed as *active* with the Corps, and are therefore eligible for funding for emergency repairs and reconstruction due to floods.

Other Flood Control Works

Other flood control works include levees inspected for PL 84-99 certification that did not meet the minimum eligibility requirements. There are three of these levees in the study area that are still maintained by Yakima County.

OPERATION AND MAINTENANCE

The Corps inspects PL 84-99-eligible levees annually for the following:

- Vegetation growth
- Bank erosion
- Caving of levee slopes
- Seepage, saturation areas or boils
- Accumulation of sediment and debris
- Road condition
- Encroachments by culverts or drainage channels
- Proper operation and condition of closure structures and materials
- Proper operation and condition of drainage and irrigation structures.

The Corps follows the 1955 *Operations and Maintenance Manual* developed for federal facilities (Corps 1955) with a few modifications. A draft Memorandum of Agreement (MOA) between the Corps, Ecology, and WDFW guides the County on vegetation and habitat management for flood control structures. In addition, the County performs levee maintenance under a modified SEPA Mitigated Determination of Nonsignificance that incorporates the MOA and additional conditions.

SPECIAL DISTRICTS

Yakima County has a variety of special districts, including a flood control zone district and diking, irrigation, and drainage districts. The flood control zone district is responsible for floodplain management operations in all floodprone areas of the County. These operations include levee maintenance and repair, improving floodplain information systems (better flood maps), public education, implementation of flood plans, flood-fighting exercises and access to flood-fighting equipment, review of floodplain development proposals, acquisition of grant monies, NFIP coordination, and interactions with other agencies such as the Corps of Engineers and the Yakama Nation. The flood control zone district is operated by the Surface Water Management Division of Yakima County Public Services.

Other special districts that provide a public benefit but have no direct connection to County government include diking, irrigation, and drainage districts. Diking districts construct and maintain dikes and levees; irrigation districts provide and maintain irrigation facilities; and drainage districts provide drainage facilities for agricultural areas. These are municipal corporations that have no direct connection to County government other than project approval by the county engineer and possible engineering support. Most are controlled by locally elected governing bodies and serve constituents within their district boundaries. Funding is derived from assessments on properties that benefit from constructed improvements.

Drainage Districts 28 and 43 are the only known drainage districts in the study area. The districts own and maintain underground drains for the purpose of dewatering fields. Irrigation districts in the study area include the Naches-Selah Irrigation District and the South Naches Channel Company.

OTHER FLOOD-RELATED PROGRAMS

In the past year, activity concerning the management of the Yakima River Basin has increased. Programs are being developed to address threats to water supply, water quality, fisheries and wildlife resources, and the basin's ecosystem. Current programs have brought together concerned citizens with a mix of interests to address these issues. Local coalitions have been formed and conservation programs are underway. Each of these programs affects conditions in the Yakima River Basin, and therefore flooding conditions.

Tri-County Watershed Planning Study

The Tri-County Watershed Plan is the product of locally led watershed planning efforts and is administered by the Tri-County Water Resource Agency (TCWRA). TCWRA has responded to state-mandated watershed planning by producing this study, which calls for an assessment of surface and groundwater resources within the Yakima River Basin. The goal of the plan is to identify the current allocation of water resources, estimate current usage, assess the adequacy of water supply for future needs, assess the status of water quality, and address fishery habitat issues. The focus of the plan will be on three Water Resource Inventory Areas (WRIAs); the Naches River basin (WRIA 38), the Lower Yakima River basin (WRIA 37), and the Upper Yakima Basin (WRIA 39).

Yakima River Basin Water Enhancement Project

The Yakima River Basin Water Enhancement Project grew out of a feasibility study authorized by Congress in 1979 to address water resource needs in the Yakima River Basin. This project was developed by the Secretary of the Interior with the State of Washington, the Yakama Indian Nation, Yakima River Basin irrigators, and other interested parties. The Yakima River Basin Water Enhancement Project (YRBWEP) was authorized in 1984 to protect, mitigate, and enhance fish and wildlife and to improve the reliability of the water supply for irrigation through water conservation and management and other appropriate means. Specifically, the program calls for development of structural and nonstructural improvements to existing irrigation systems and their operation and management in order to reduce the amount of water that needs to be diverted to maintain full crop production. This will reduce the demand on the total water supply available.

Phase I of the program focused on reducing anadromous fish mortality at diversion dams and canals by replacing outdated fish ladders and inadequate fish screens. Phase II was authorized in 1994 with the passing of Title XII of Public Law 108. Phase II will implement water conservation measures that will increase the efficiency of water delivery and use in the Yakima River basin. Funding for Phase II is provided by the Yakima River Basin Water Conservation Program. The Bureau of Reclamation operates and manages the program. A project manager from the Eastern Regional office directs the effort.

The primary project element of Phase II is a basin conservation program to be completed in four phases within two and a half years from the date of enactment. The phases are as follows:

- Development of water conservation plan options
- Investigation of the feasibility of specific water conservation measures
- Implementation of conservation measures
- Monitoring and evaluation.

Current efforts include the acquisition and restoration of floodplain properties with water rights and valuable habitat. Habitat condition/value assessment is largely based on natural floodplain functions, including hyporheic zone function. The importance of floodplain/river connectivity and hyporheic zone functions to salmonid health was demonstrated by Stanford et al. in a study of the impacts of anthropogenic features on several floodplains in the Yakima River basin, including reaches on the Naches River. Many papers stemming from this research have been published and have added to the knowledge of the impacts of levees, roadways and other anthropogenic features on floodplain connectivity and fisheries habitat.

The project also includes Toppenish Creek corridor enhancement, a Yakama Indian irrigation demonstration project, modifications and improvements to Lake Cle Elum, a Taneum Creek enhancement study, Kachess Dam modifications, modifications to the Chandler pumping plant and power plant operations at Prosser Dam, and a comprehensive basin operating plan. Implementation of Phase II is pending completion of funding prerequisites.

The Reaches Project

A recent study (also known as the Reaches Study, October 4, 2002) by Stanford et al from the Flathead lake Biological Station (FLBS) at the University of Montana with assistance from Central Washington University focused on the impacts of dams, levees, roadway embankments and other anthropogenic features on floodplain connectivity and fisheries habitat in the lower Naches River basin and on the main stem of the Yakima River. The Reaches Study documents current floodplain-channel connectivity, the role of groundwater-surface water interactions (the hyporheic zone) in sustaining side channel habitats, the influence of flow regime on these side channel ecosystems, and provides reasonable approaches to mitigation where needed. The YRBWEP will use this study to develop sound approaches for fisheries habitat mitigation.

CHAPTER 6.
REGULATORY OVERVIEW

Regulations that support the recommendations proposed by a CFHMP are a critical component of effective flood hazard management. These recommendations may include engineered projects as well as regulatory programs affecting land use, critical areas management, shorelines, floodplains, and resource management. The need for engineered projects to prevent or mitigate flood hazards can often be eliminated if complementary and forward-looking regulatory programs are initiated before extensive development occurs. A general public understanding of existing regulations can help prevent the waste of time and money on projects that will never be permitted.

This chapter provides an overview of existing federal, state, and local regulatory and permitting requirements that relate to flood hazard management, surface water management, water quality, and wetlands protection. A detailed discussion of each regulation is provided in Appendix D.

SUMMARY OF EXISTING REGULATIONS

Many laws that address flood hazard management directly or indirectly have been enacted at the federal, state, and local levels. These laws are summarized in Table 6-1 and presented in greater detail in Table 6-2. Most federal laws are implemented at the state and local levels. For example, the federal Clean Water Act regulates stormwater discharge, but the EPA has delegated the responsibility of administering the program in Washington to the state. The National Flood Insurance Program, which offers affordable flood insurance to private property owners, is a national program administered by FEMA, but requires cities and counties to adopt floodplain regulations.

With the exception of the National Flood Insurance Program and the Endangered Species Act, the laws most relevant to flood hazard management originate at the state level. Most of these begin with state legislation that enables local governments to adopt regulations promoting public health, safety, and general welfare. Environmental laws that affect flood hazard management through habitat, shoreline, and other critical-area protection measures also exist at the state level, but enforcement is increasingly becoming the responsibility of local governments. State growth management requirements contain additional recommendations regarding land use and development near wetlands and in frequently flooded areas, with regulatory implementation largely in the hands of local jurisdictions.

TABLE 6-1.
SURFACE WATER MANAGEMENT REGULATIONS/POLICIES IN YAKIMA COUNTY

Category	Federal	State	Yakima County
Land Use Policies and Regulations	• National Flood Insurance Act/Flood Disaster Protection Act. • Executive Order 11988 (Floodplains)	• Floodplain Management Program • Shoreline Management Act	• Flood Hazard Ordinance (currently part of the County's Critical Areas Ordinance) • Critical Areas Ordinance • Zoning and Subdivisions Ordinance • Shoreline Master Program (currently part of the County's Critical Areas Ordinance)
Facilities and Building Standards	—	• Hydraulic Code (HPA)	• Flood Hazard Ordinance.
Planning and Policy	—	• Growth Management Act (GMA) • Flood Control by Counties	• Plan 2015 and SEPA/GMA Integration. • Critical Areas Ordinance
Facilities	—	• Hydraulic Code (HPA)	• Zoning Ordinance
Water Quality	• Clean Water Act, Sections 401 and 402.	• Water Pollution Control Act (Water Quality Certification or Modification) • State program for National Pollutant Discharge Elimination System (NPDES) (when implemented for cities with less than 100,000 population).	—
Stream Corridors	• Clean Water Act, Section 404 • River and Harbor Act	• Shoreline Management Act • Hydraulic Code (HPA)	• Shoreline Master Program • Critical Areas Ordinance
Wetlands	• Clean Water Act, Section 404 (dredge & fill) • Executive Order 11990 • River and Harbor Act	• Shoreline Management Act • Executive Order 90-04	• Critical Areas Ordinance • Shoreline Master Program
Fisheries and Wildlife Habitat	—	• Hydraulic Code	—
General Environmental	• National Environmental Policy Act	• State Environmental Policy Act (SEPA)	• SEPA Ordinance • Comprehensive Plan and SEPA/GMA Integration.

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
FEDERAL					
Clean Water Act, Section 401	State agencies empowered by EPA (i.e., Ecology)	Ensures that federally permitted activities comply with the Clean Water Act, state water quality laws, discharge limitations, and other state regulations	Waters of the U.S.	Water Quality Certification or Modification	Structural measures affecting surface water will require Water Quality Certification or Modification
Clean Water Act, Section 402	State agencies empowered by EPA (i.e., Ecology)	Establishes permit application requirements for stormwater discharges under National Pollution Discharge Elimination System Program (NPDES)	All stormwater discharge associated with industrial activity and from municipal storm sewer systems	Stormwater Discharge Permits	NPDES stormwater permit is required for jurisdictions with over 100,000 population; will be required of smaller jurisdictions in 2003
Clean Water Act, Section 404	COE	Regulates the discharge of dredged or fill material in rivers, streams, and wetlands	Waters of the U.S., including wetlands	Individual or Nationwide Permits	Dredging or filling in wetlands or the Yakima River will require permit
National Flood Insurance Act	FEMA	Offers affordable flood insurance to communities that adopt approved floodplain management regulations	Floodplains of the U.S.	Flood Insurance Study and approval letter from FEMA	Participation in NFIP requires minimum floodplain management regulations
Flood Disaster Protection Act	FEMA	Provides incentive to communities to join the NFIP by increasing amounts of flood insurance available and providing penalties for communities and individuals that do not join the NFIP and are subsequently flooded	Floodplains of the U.S.	Approval by FEMA	Requires purchase of flood insurance for funding by federally backed lending institutions for purchase of property in floodplains
National Environmental Policy Act	Varies (usually the federal agency issuing the permit)	Requires full disclosure of potential impacts associated with proposed actions and mitigative measures	All federal actions	Environmental Assessment and EIS	Regulates actions that may result in significant adverse environmental impacts
River and Harbor Act, Section 10	COE	Preserves the navigability of the nation's waterways	U.S. navigable waters.	Section 10 permit	Regulates activities within the Ordinary High Water Mark (OHWM) on navigable waters.

TABLE 6-2 (continued).
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Name	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
FEDERAL (continued)					
Executive Order 11988	Federal Agencies	Protects floodplain from development by federal agencies	Federal projects	None	Enhances existing floodplain management regulations.
Endangered Species Act	Federal Agencies	Protection of fish and wildlife habitat and evaluation of species health	Nationwide	Approval	Regulates activities in endangered species habitat such as Naches River and tributaries
Executive Order 11990	Federal Agencies	Protects wetlands and evaluates impacts of proposed actions on wetlands	Federal projects, federally funded activities, or other activities licensed or regulated by federal agencies	None	Enhances existing wetland protection regulations
STATE					
SEPA	Varies (usually the local agency issuing the permit); circulation to state and federal agencies for review	Requires full disclosure of the likely significant adverse impacts associated with a proposed action and identification of mitigative measures	All proposed actions that require permits	Environmental Checklist or EIS	Requires environmental review of any project with potential adverse environmental impacts
Shoreline Management Act	Ecology; local jurisdictions when state approved	Manages uses of the shorelines of the state for protection of public interests and natural environment	All shorelines of the state (including all marine waters, lakes > 20 acres reservoirs, streams and rivers >20 cfs mean annual flow, and associated wetlands)	State or state-approved local shoreline permit	Applies to activities within the Yakima and Naches Rivers, adjacent lands within 200 ft. of the floodway or within the 100-year floodplain, (whichever is less) and all associated wetlands
Senate Bill 5411 (ESSB 5411); Flood Control by Counties (RCW 86.12)	Counties	RCW 86.12 gives county governments the power to levy taxes, exercise eminent domain and take action to control and prevent flood damage. ESSB 5411 provides a greatly expanded role for counties in formulating and adopting drainage basin plans to address flooding and land use regulations	All drainage basins located wholly or partially within the County	Comprehensive Flood Hazard Management Plan	Allows for development of CFHMPs

TABLE 6-2 (continued).
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Name	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
STATE (continued)					
Floodplain Management Program (RCW 86.16)	Ecology	Reduces flood damages and protects human health and safety. Department oversees local implementation of floodplain regulations required for participation in the NFIP.	All floodplains within the state	State approval of floodplain management programs and regulations	Provides eligibility for national flood insurance and for state matching funds to construct flood control facilities
State Participation in Flood Control Maintenance	Ecology	Assists local jurisdictions in comprehensive planning and flood control maintenance efforts	All flood hazard management activities of local jurisdictions as approved by Ecology	FCAAP grant application, approved CFHMP for maintenance grants	FCAAP funds available for preparation of CFHMPs, flood control maintenance projects, and emergency flood control projects
Water Pollution Control Act	Ecology	Empowers the state to develop, maintain, and administer the federal statutes and programs required by the federal Clean Water Act	All receiving waters of the state	Water Quality Certification/ Modification	Regulates activities that violate state water quality standards per the Clean Water Act
Hydraulic Code	WFDW	Protects fish, fish habitat, and wildlife habitat from damage by construction and other activities	All marine and fresh waters of the state and drainage corridors	Hydraulic Project Approval (HPA)	HPA is required for all activities within the OHWM of streams and along natural drainage corridors
GMA (RCW 36.70A)	CTED	Requires comprehensive plans to include surface water considerations and facilities (quantity and quality)	Selected high-growth counties (including Yakima County) and their cities.	Comprehensive Plan	Requires adoption of development regulations and comprehensive plans
		Requires designation and regulation of critical areas, including wetlands and frequently flooded areas.	All Washington counties and cities.	Critical areas and resource lands designation.	Requires adoption of critical areas and resource lands ordinances regulating development in designated areas.
Executive Order 90-04, Protection of Wetlands/ Model Wetlands Protection Ordinance	Ecology	Provides guidance to local governments to achieve no net loss of wetland functions and values	State wetlands buffers	None	Provides voluntary technical assistance to the local jurisdiction to regulate activities that affect wetlands

TABLE 6-2 (continued).
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Name	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
YAKIMA COUNTY					
Plan 2015 Comprehensive Plan	Yakima County Planning Division	Guides orderly future growth and development of county land use, circulation, and other elements of interest to the community	Yakima County unincorporated areas	None	Promotes preservation of natural drainage corridors, cost-effective measures to control flooding, and limits floodway developments
Zoning Ordinance (Title 15, County Code)	Yakima County Planning Division	Implements the growth management policies of the Comprehensive Plan by prescribing use and density requirements for land development	Yakima County unincorporated areas	Building permit Conditional use permit	Newly revised Zoning Ordinance (2/2000) provides County R/ELDP zoning district which includes areas of special flood hazard.
Shoreline Master Program	Yakima County Planning Division	Restricts development along shorelines	Shorelines of the State within Yakima County unincorporated areas	County approval	Flood control facilities along Yakima and Naches Rivers must comply with shoreline management regulations
Flood Hazard Ordinance (County Ordinance 3-1985)	Yakima County Building and Fire Safety Division	Restricts development and requires special standards for development in Areas of Special Flood Hazard identified in Flood Insurance Study. Flood Hazard Ordinance is contained within Critical Areas Ordinance (described below)	Yakima County areas identified in Flood Insurance Rate Maps	Flood hazard permit, County approval	Restricts inappropriate land use in flood hazard areas Prohibits channel alterations that increase flood hazard in other areas
SEPA Implementation (Title 16, County Code)	Yakima County Planning Division	Enacts provisions of SEPA at local level	Yakima County unincorporated areas	Environmental Checklist, EIS	SEPA review may be required for significant flood control projects (includes projects within the OHWM)
Open Space Tax Program	Yakima County Planning Division and Yakima County Assessor	Preserves open space (including floodplains) through land use reclassification and property tax reductions.	Yakima County unincorporated areas.	Tax Program Application. Planning Commission and County Commission approval .	Defines floodplains as high-priority open space resources and encourages protection through property tax reduction.
Critical Areas Ordinance (County Ordinance 8-1995)	Yakima County Planning Division	Enacts provisions of GMA for preserving critical areas at local level. Revisions will provide framework for integrating Shoreline Master Program and Flood Hazard Ordinance.	Designated critical areas within unincorporated Yakima County.	Critical Area development authorization	Includes provisions of Flood Hazard Ordinance if development lies in Special Flood Hazard areas identified on flood maps.

TABLE 6-2 (continued).
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Name	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
YAKIMA COUNTY (continued)					
Yakima Urban Area Zoning Ordinance (County Title 15A , City Title 15)	Yakima County City of Yakima	Implements the growth management policies of the Comprehensive Plan by prescribing use and density requirements for land development	Yakima Urban area	Building permits Class 1, 2, 3 zoning review	Floodplain Overlay district for flood hazard areas

KEY FEDERAL REGULATIONS

National Flood Insurance Program

The NFIP establishes floodways and 100-year flood boundaries for local communities and provides federally-subsidized flood insurance to all property owners if the community adopts a local flood hazard ordinance. Yakima County participates in this federal program and has adopted flood hazard regulations. The County's NFIP program is described below in the discussion of County regulations. The basis for the NFIP floodplain classifications and boundaries is the FEMA Flood Insurance Study (FIS) discussed in Chapter 3.

Endangered Species Act

Since the listing of steelhead, bull trout and several species of salmon as endangered or threatened under the federal Endangered Species Act (ESA), all projects that may directly or indirectly impact these fish or their habitat are subject to environmental review by the USFWS or NOAA Fisheries. The USFWS oversees freshwater fish and terrestrial species, including bull trout, and NOAA Fisheries oversees marine and anadromous species, including salmon. These agencies review projects to determine the extent of the impacts and the proper mitigation and conservation measures to be implemented to eliminate or limit these impacts. The ESA applies to all projects that meet any of the following criteria:

- Projects requiring a permit from a federal agency, such as the Corps of Engineers
- Projects on federal lands
- Federally funded projects
- Projects that may cause either direct injury to the listed species, alteration of habitat, or significant disturbance of the habitat.

The first three types of projects listed above are covered under Section 7 of the ESA, which requires agency consultation. The last category is covered under Section 9, which defines prohibited acts. Under both categories, applicants must show either that the project would have negligible impact on any listed species or that the project includes mitigation or conservation measures to sufficiently negate any potential impacts.

Initially, a local agency works with the applicant and the federal authority (USFWS or NOAA Fisheries) to determine which species reside in the project area and the probable extent of the impact. The applicant submits a brief assessment—a Biological Evaluation (BE)—to the local and federal agencies describing the scope of the project, the listed species determined to reside in the project area, and the probable project impacts on the species or its habitat.

If the impacts are determined to be negligible, then the federal agency issues a letter or notification of "no effect," and the project may proceed without additional permitting from USFWS or NOAA Fisheries. If potential significant impacts on the listed species or its habitat are identified, the applicant must hire a biologist to complete a Biological Assessment (BA). In a BA, the biologist conducts a field investigation, collects pertinent biological information, and interviews local specialists to assess potential impacts on the listed species and its habitat. The BA is submitted to the federal agency, along with a request for a "formal consultation," and is used as the technical reference whereby the federal agency determines the project's level of impact. The agency issues one of two "biological opinions:"

- No Jeopardy/No Adverse Modification—The project can proceed without additional permitting from USFWS or NOAA Fisheries.
- Jeopardy/Adverse Modification—The applicant can implement reasonable and prudent alternatives approved by the agency and proceed with the project or seek an exemption from the opinion. Otherwise, the project must be abandoned. The USFWS or NOAA Fisheries may also issue an "incidental take permit," which allows limited take of a species as long as the activity is otherwise legal ("take" consists of a number of potential impacts on the species as defined in the ESA).

In Washington State, most projects must undergo local environmental review as part of the permit process. If, upon reviewing a State Environmental Policy Act (SEPA) checklist the responsible official determines the project will result in significant environmental deterioration, an environmental impact statement (EIS) is required. A BA would provide supporting documentation for the EIS.

Any projects in the Naches River study area entailing excavation activities and work within the river's channel or adjacent wetlands would require a Corps of Engineers 404 permit. Since this is a federal permit, the project would fall under the requirements of ESA Section 7, and because the Naches River is utilized by several ESA-listed fish species, a BA would likely be required.

KEY STATE REGULATIONS

Floodplain Management Program

Washington State's Floodplain Management Program (RCW 86.16) requires that local floodprone jurisdictions adopt a flood damage prevention ordinance based on federal standards contained in the NFIP. State regulations go beyond federal standards, though, in prohibiting new or substantially improved residential construction in designated floodways. Yakima County's flood damage prevention ordinance is described below in the discussion of County regulations.

The state Floodplain Management Program also provides technical and financial assistance to local communities. The lower Naches River CFHMP is partially funded by the State Floodplain Management Program through the FCAAP (Flood Control Assistance Account Program).

Hydraulic Code

The Washington State Hydraulic Code (RCW 75.20.100-140) regulates activities affecting the state's salt and fresh waters. The purpose of the Hydraulic Code is to reserve fish and wildlife habitat in and around the waters of the state. The Washington State Department of Fish and Wildlife administers the Hydraulic Code.

Any work that falls within the definition of a hydraulic project requires a Hydraulic Project Approval (HPA) from the WDFW. Hydraulic projects are defined as work that will use, divert, obstruct, or change the natural flow or bed of any waters of the state. Most structural flood hazard reduction projects require an HPA.

The WDFW is currently conducting the HPA Program Review and ESA Compliance Project. The current anticipated date for project implementation is January 1, 2003. The WDFW, USFWS, and NOAA Fisheries have signed a Memorandum of Agreement to develop an ESA compliance agreement for HPAs issued by the WDFW. The Memorandum of Agreement also outlines procedures and criteria for issuance of HPAs to minimize risk of endangered species take.

Other State Programs Implemented at the County Level

The following state laws relevant to flood hazard management are implemented at the County level:

- Shoreline Management Act
- Growth Management Act
- State Environmental Policy Act (SEPA).

State involvement in these programs is limited to oversight and technical assistance. The County regulations and programs implementing these state laws are described below.

KEY COUNTY REGULATIONS

Yakima County Critical Areas Ordinance (CAO)

The Critical Areas Ordinance (CAO), Chapter 16 of the Yakima County Code, establishes development regulations for designated critical areas within Yakima County. This includes special flood hazard areas, wetlands, geologically hazardous areas, aquifer recharge areas, and fish and wildlife habitat areas. The CAO satisfies requirements of the state Growth Management Act. Table 6-3 lists the number of parcels in the study area containing critical areas. County has merged the Flood Hazard Ordinance into the CAO.

Yakima County is currently updating the CAO to incorporate the use of Best Available Science and revisions to the permitting process for the preservation and protection of anadromous fisheries habitats. Included will be revisions to existing development regulations and policies, conducting an inventory and creating revised maps of critical areas. The updated CAO will also include Channel Migration Zones (CMZs) for major rivers in the county.

TABLE 6-3.
PARCELS CONTAINING CRITICAL AREAS IN THE STUDY AREA

Classification	Number of Parcels	Value	Total Area (acres)
Priority Species and Habitat Areas	5	$190,400	9
Wetlands	275	$13,325,350	1962
Geologic Hazards	107	$7,241,100	278
FEMA 100-Year Floodplain	591	$28,055,100	2011
1996 Inundation	351	$21,279,650	1800
Parcels outside FEMA 100-year floodplain that were flooded in 1996	136	$5,706,150	563
Parcels inside FEMA 100-year floodplain that were not flooded in 1996	517	$25,032,400	765

Note:
Table information based on a GIS overlay analysis of Yakima County GIS data. Property values include the assessed land value and property improvements (buildings, etc.) Priority species and habitat areas, wetlands, and geologic hazards parcels include only those parcels in the FEMA 100-year floodplain in the study area. The total area is the area of the parcel contained within the floodplain.

Yakima County Flood Hazard Ordinance

The NFIP requires local governments to adopt and implement a flood hazard ordinance such as Yakima County's for participation in the NFIP. This ordinance sets minimum standards and regulations for development in flood hazard areas. The standards and requirements in the County's Flood Hazard Ordinance apply to floodplain areas delineated in the FEMA Flood Insurance Study and its accompanying maps, which the ordinance adopts above reference, including any amendments made by FEMA.

The Yakima County Flood Hazard Ordinance is included in Sections 16A.05.20 through 16A.05.71 of the CAO. Its provisions apply to all development projects in special flood hazard areas, including substantial development projects and "floodprone projects." Floodprone projects are small projects for which the County assesses the impact they may have on floodplain function even though they are not considered substantial development. The following general standards (16A.05.28.010) apply to all special flood hazard areas.

(a) Anchoring and Construction Techniques.

(1) All new construction and substantial improvements shall be:

(A) Anchored to prevent flotation, collapse or lateral movement of the structure; and

(B) Constructed using materials and utility equipment resistant to flood damage; and

(C) Constructed using methods and practices that minimize flood damage; and

(D) Electrical, heating, ventilation, plumbing, and air-conditioning equipment and other service facilities shall be designed and/or otherwise elevated or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

(2) All manufactured homes must likewise be anchored to prevent flotation, collapse or lateral movement, and shall be installed using methods and practices that minimize flood damage. Anchoring methods may include, but are not limited to, use of over-the-top or frame ties to ground anchors (Reference FEMA's *Manufactured Home Installation in Flood Hazard Areas* guidebook for additional techniques). Anchoring shall meet the specifications set forth below for structures located within 100 feet of a floodway or the ordinary high water mark if no floodway has been established.

(3) All new construction and any improvements or additions to existing floodproofed structures that would extend beyond the existing floodproofing located within 100 feet of the floodway or 100 feet of the ordinary high water mark if no floodway has been established, shall be elevated to a height equal to or greater than the base flood, using zero-rise methods such as piers, posts, columns, or other methodology, unless it can be demonstrated that non-zero-rise construction methods will not impede the movement of floodwater or displace a significant volume of water. The size and spacing of any support devices used to achieve elevation shall be designed to penetrate bearing soil, and be sufficiently anchored, as specified above in subsection (1)(a) of this section.

(4) Except where otherwise authorized, all new construction and substantial improvements to existing structures shall require certification by a registered professional engineer, architect or surveyor that the design and construction standards are in accordance with adopted floodproofing techniques.

(b) Utilities.

(1) All new and replacement water supply systems and sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems and discharge from the systems into floodwaters; and on-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

(c) Subdivision Proposals. Subdivision proposals shall:

(1) Be consistent with the need to minimize flood damage;

(2) Have roadways, public utilities and other facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage;

(3) Have adequate drainage provided to reduce exposure to flood damage; and

(4) Include base flood elevation data.

(d) Watercourse Alterations. The flood-carrying capacity within altered or relocated portions of any watercourse shall be maintained. Prior to the approval of any alteration or relocation of a watercourse in riverine situations, the department shall notify adjacent communities, the Department of Ecology and FEMA of the proposed development.

The Flood Hazard Ordinance includes the following additional specific requirements (16A.05.28.020), which apply in all special flood hazard areas where base flood elevation data has been provided (FIS or FIRMs):

(1) Residential Construction.

(A) New construction and substantial improvement of any residential structure shall have the lowest floor, including basement, elevated at a minimum to or above the base flood elevation.

(B) Fully enclosed areas below the lowest floor subject to flooding are prohibited, or shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or must meet or exceed the following minimum criteria:

(i) A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided.

(ii) The bottom of all openings shall be no higher than one foot above grade.

(iii) Openings may be equipped with screens, louvers, or other coverings or devices, provided that they permit the automatic entry and exit of floodwaters.

(C) Residential construction within one hundred feet of a floodway or the ordinary high water mark, if no floodway has been established, shall also meet the requirements of Section 16A.05.28.010(a)(3).

(2) Nonresidential Construction. New construction and substantial improvement of any commercial, industrial or other nonresidential structure, and any addition to an existing floodproofed structure that would extend beyond the existing floodproofing, shall either have the lowest floor, including basement, elevated a minimum of one foot above the base flood elevation; or, together with attendant utility and sanitary facilities, shall:

(A) Be floodproofed so that below an elevation one foot above base flood level the structure is watertight, with walls substantially impermeable to the passage of water; and

(B) Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy;

(C) Be certified by a registered professional engineer or architect that the design and method of construction are in accordance with accepted standards of practice for meeting provisions of this subsection, based on their development and/or review of the structural design, specifications and plans. Such certifications shall be provided to the building official;

(D) Nonresidential structures that are elevated, not floodproofed, must meet the same standards for space below the lowest floor as described in Section 16A.05.28.020(1)(B) above;

(E) Meet the special standards for structures set forth in Section 16A.05.28.010(a)(3) above if within one hundred feet of a floodway or within one hundred feet of the ordinary high water mark and no floodway has been established;

(F) Applicants floodproofing nonresidential buildings shall be notified that flood insurance premiums will be based on rates that are one foot below the floodproofed level (e.g., a building constructed to the base flood level will be rated as one foot below the level).

(3) Agricultural Construction. New construction and substantial improvement of any agricultural structure shall either have the lowest floor, including basement, elevated at a minimum to or above the base flood elevation; or meet the floodproofing requirements of subsection (2) of this section. Agricultural construction or other accessory structures that constitute a minimal investment and comply with the floodway encroachment standards may be exempt from the floodproofing and elevation requirements of subsection (2) above when such structures, together with attendant utility sanitary facilities:

(A) Have a low potential for structural flood damage;

(B) Are designed and oriented to allow the free passage of floodwaters through the structure in a manner affording minimum flood damage; and

(C) Ensure that all electrical and mechanical equipment subject to floodwater damage and permanently affixed to the structure be elevated a minimum of one foot above the base flood elevation or higher, or floodproofed;

(D) Are constructed and placed on the building site so as to offer the minimum resistance to the flow of floodwaters; and

(E)Will not be used for human habitation.

(4) Manufactured Homes.

(A) Manufactured homes shall be anchored in accordance with Section 16A.05.28.010(a)(2), shall have the lowest floor elevated to or above the base flood elevation, and shall be securely anchored to an adequately anchored foundation system in accordance with Section 16A.05.28.010(a)(2).

Permitted and prohibited uses in flood-fringe and floodway areas are given in Chapter 16A.05.32 and Chapter 16A.05.36, respectively.

Shoreline Master Program

Yakima County's Shoreline Master Program (SMP) implements requirements of Washington State's Shoreline Management Act at the local level. The current revisions to the CAO will merge the SMP into the CAO to streamline the permitting process. Yakima County's SMP is in accordance with the state SMP. However, the state is still in the process of revising its guidelines for SMPs by local governments. The state plans to introduce the new guidelines for public comment in the near future. A mediation agreement was also made between the state and a coalition of local governments and business groups on guideline revisions and on extending the local agency adoption period and providing financial assistance to local governments.

Within the shoreline jurisdiction defined by the SMP, developers who propose substantial development (total cost equal to or greater than $5,000 or that materially interferes with public use of the shoreline or water) must obtain a substantial development permit evaluated by Ecology and the County. The County defines shoreline jurisdictions as follows (Yakima County 1981):

- Where the floodway has been established by a flood hazard study prepared by FEMA's Federal Insurance Administration, shorelines jurisdiction shall be the floodway plus 200 feet, measured on a horizontal plane, or the 100-year floodplain, whichever is less.
- Where the 100-year floodplain has been identified by a flood hazard study prepared by the Corps but no floodway has been identified, shorelines jurisdiction shall be the 100-year floodplain boundary or 200 feet, measured in a horizontal plane, from the ordinary high water mark, whichever is greater.
- Where there are no detailed floodplain or floodway studies from either the Federal Insurance Administration or the Corps, shorelines jurisdiction shall be 200 feet, measured on a horizontal plane, from the ordinary high water mark.
- Under no circumstances shall shorelines jurisdiction be less than 200 feet, measured on a horizontal plane, from the ordinary high water mark.
- All wetlands within the 100-year floodplain are included.

Yakima County Zoning Ordinance and Code

Yakima County's zoning ordinance and code implements land use recommendations from the comprehensive plan for areas within the unincorporated County. The Yakima County Critical Areas Ordinance and Zoning Ordinance are complementary. The CAO states that the regulation that is most restrictive shall apply to potential development. Existing County zoning outside the Yakima urban area does not include a Floodplain Overlay District that would reinforce requirements of the flood hazard ordinance.

The County's Zoning Ordinance recently underwent a comprehensive revision (adopted in February 2000). As part of this revision, the County created and designated a new category called "Remote/Extremely Limited Development Potential (R/ELDP) zoning. This new category may be useful for regulating land use in flood hazard areas.

Yakima County Open Space Tax Program

The Open Space Tax Program provides an opportunity for qualifying landowners to reduce their property taxes through classification of portions of their land as open space. The Yakima County Open Space Tax Program defines floodplains as a high-priority open space resource. The Tax Program reclassifies land as open space through the approval of the Planning Commission and County Commissioner. Once reclassified, assessed value of the property usually falls, resulting in reduced property taxes to the landowner. The Non-Regulatory Program may recommend revisions to the Open Space Tax Program.

Plan 2015 (Policy Plan)

In part to comply with the state Growth Management Act, the County has developed Plan 2015, adopted in 1997, to address growth and development issues for the next 20 years. The Plan documents the features, characteristics and statistics that describe Yakima County and serves as a guide for future activities in the County. It lays out the vision of what local residents and business people would like Yakima County to become.

The relationship of Plan 2015 to flood hazard management is primarily through its Natural Resource element. This element addresses the need to protect the region's hydrologic resources as well as provide for reliable water supply to areas where development is to be allowed and encouraged.

KEY CITY OF NACHES REGULATIONS

City of Naches regulations that pertain to flooding include the following:

- Flood Damage Prevention Ordinance—This ordinance is required of communities by FEMA to participate in NFIP. The ordinance sets minimum standards and a development review process for flood hazard areas.
- Zoning Code—Designates allowable land uses throughout the city. The region adjacent to the Naches River is designated "General Business" west of Naches Road South and single and multi-family residential east of Naches Road South.

- Wetlands/Critical Areas Regulations—Designates the extreme southwest and extreme southeast corners of the city limits, where they intersect the Naches River, as wetlands. It adopts the Flood Damage Prevention Ordinance as development regulations for these wetlands.
- Comprehensive Plan (Natural Systems element)—Describes the natural physical and biological environment in terms of opportunities and limitations for growth and development. This element identifies the area's resource lands and critical areas and explains how they will be protected. The Natural Systems element addresses a number of GMA requirements related to natural systems, including the following: identification, protection, and conservation of resource lands, fish and wildlife habitat, and critical areas, protection of groundwater; and review of drainage, flooding, and stormwater, and guidance for corrective action. Goals and policies of the Natural Systems element include conscientious floodplain and stormwater management, enforcing local and federal regulations, public education, and encouraging development in areas free from environmental constraints and problems.

PERMITTING REQUIREMENTS

Many regulatory programs include permit requirements. A flood-related project may require one or more permits and/or approvals, depending on its nature and location. Most in-stream, shoreline, floodplain, and river engineering projects require up to eight permits or approvals. The most common requirements for structural flood hazard reduction projects are HPA, a Corps Section 404 permit, ESA review, a Shoreline Substantial Development permit, Critical Areas review, and SEPA review. A WSDOT right-of-way permit is required for work in any state highway right-of-way. Table 6-4 summarizes project permit requirements by project location and type of work.

Many permit requirements depend on the project location in relation to the river, shoreline jurisdiction, and floodplain boundary. In-stream and shoreline work has the most intense permitting requirements and receives the most detailed review by regulatory agencies.

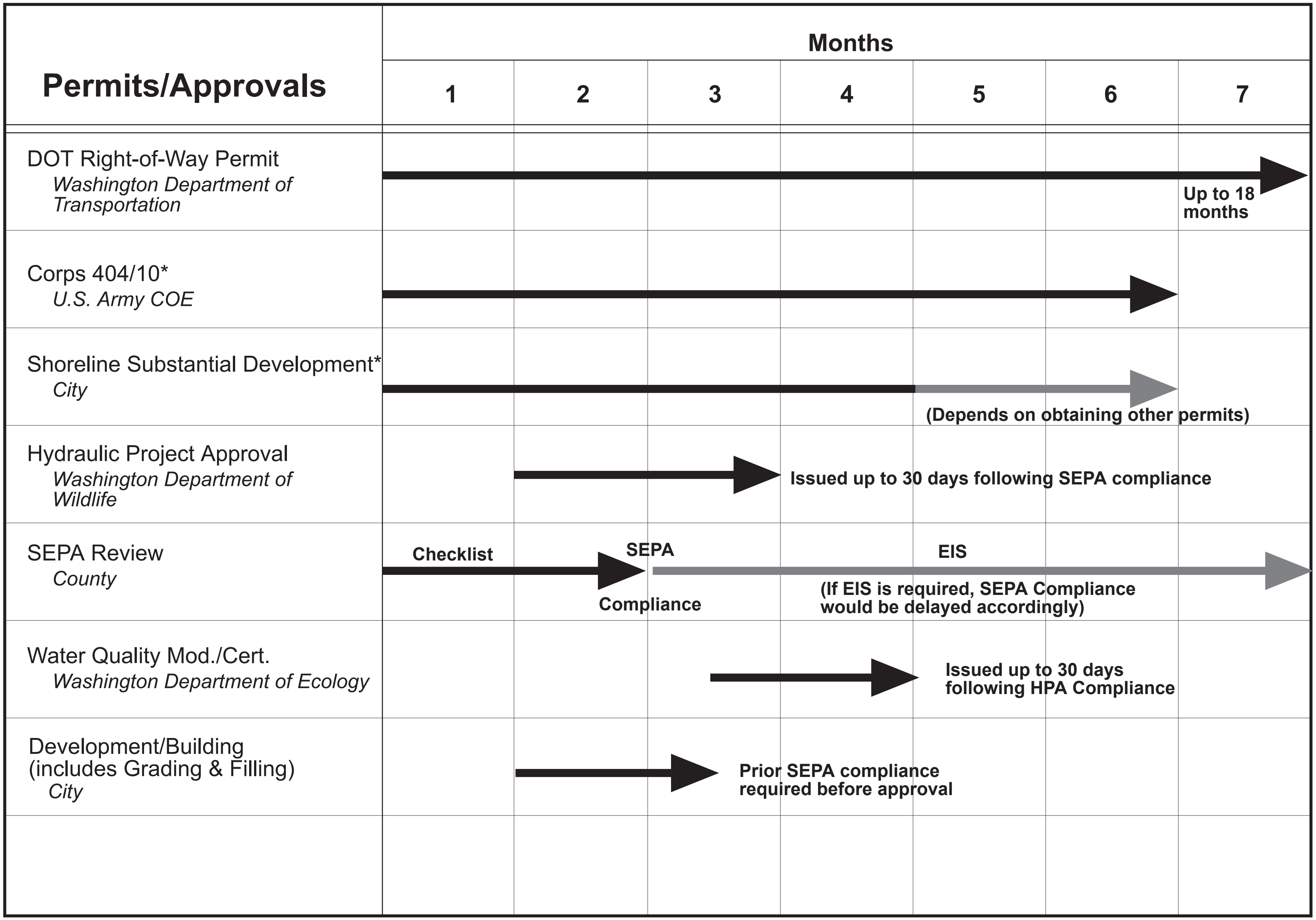
Sequencing of permit acquisition and regulatory review is also a consideration when developing flood hazard reduction projects. The timeline for obtaining permits/approvals varies greatly, and some permits can only be issued after others have been acquired. Figure 6-1 illustrates permit timing relationships. The WSDOT right-of-way permit process, required whenever work is proposed within a state right-of-way, is listed first because it can have the longest processing time. The Corps and Shorelines permit processes require procurement of most other required permits and approvals before issuance. An HPA can only be issued after SEPA review has been completed. SEPA compliance may be accomplished by simply preparing and circulating an environmental checklist for comment, but if an EIS is found to be necessary, preparation of the EIS can substantially delay the project. The grading and filling permit requires SEPA compliance prior to issuance. Individual processing times may require up to two months for these permits.

TABLE 6-4.
PERMIT REQUIREMENTS FOR FLOOD CONTROL WORK

Permit	Permitting Agency	Project Location: In-Stream Work	Project Location: Shoreline Work	Type of Work: Floodplain Work	Type of Work: Outside Floodplain	Type of Work: Structural Flood Control
ROW Permit (for work in state right-of-way)	WSDOT		X		X	X
Corps 404/10	Corps	X	X	X		X
Shoreline Substantial Development	County	X	X	X		X
Hydraulic Project Approval (HPA)	WDFW	X	X	X		X
SEPA Review	County	X	X	X	X	X
Corps 401 (Water Quality Certification)	Ecology	X	X	X		X
Endangered Species Act Consultation	Corps	X	X	X	X	X
Standard Development	County	X	X	X	X	X

SEPA/GMA Integration

Yakima County has developed an integrated SEPA/GMA strategy for its comprehensive plan to reduce overlapping permitting requirements on new development projects. Potential adverse effects of development are defined as either *system impact* (affecting a system of facilities, services or the natural environment) or *project impact* (affecting a specific development project). A mitigation model is used to determine mitigation measures that may be required. The model is subject to further development and expansion. Selected systems prioritized for inclusion in the model at the system level of environmental review include water supply, sewage disposal, roads, wetlands, habitat, floodplains, and geologic hazards. It is unclear at this time how the mitigation model will alter the permitting process for flood-related projects. However, some standardized mitigation has been preliminarily identified for floodplain protection, including other mitigation payments, land dedication/protection, on-site stormwater retention, transfer of development rights, and greenway program (or similar structure).



*These are "umbrella" permit processes that require procurement of other permits before they can be issued.

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Tetra Tech/ KCM, Inc. 1917 First Avenue Seattle, Washington 98101	Yakima County NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN	Figure 6-1. TYPICAL PERMIT TIMING REQUIREMENTS

CHAPTER 7.
FLOOD PROBLEM AREAS

PROBLEM IDENTIFICATION

Flooding issues and concerns were identified by examining historical flooding patterns along the Naches River, reviewing previous studies, and collecting information from Advisory Committee members and County staff. Each flooding issue was discussed further at Advisory Committee meetings to define and prioritize each problem, evaluate related issues, and determine a range of solutions. A comprehensive list was developed of flooding problems and issues that the County would like to see addressed. These issues fall under the following categories:

- Scientific/engineering information gaps
- Public education
- Emergency management
- Facilities and existing structures
- Regulatory
- Bank erosion/channel migration
- Site-specific flood issues.

Figure 7-1 shows the locations of site-specific flooding problems. The general problems identified are listed in Table 7-1.

SCIENTIFIC/ENGINEERING INFORMATION GAPS

Information and mapping needs for the study area include the following:

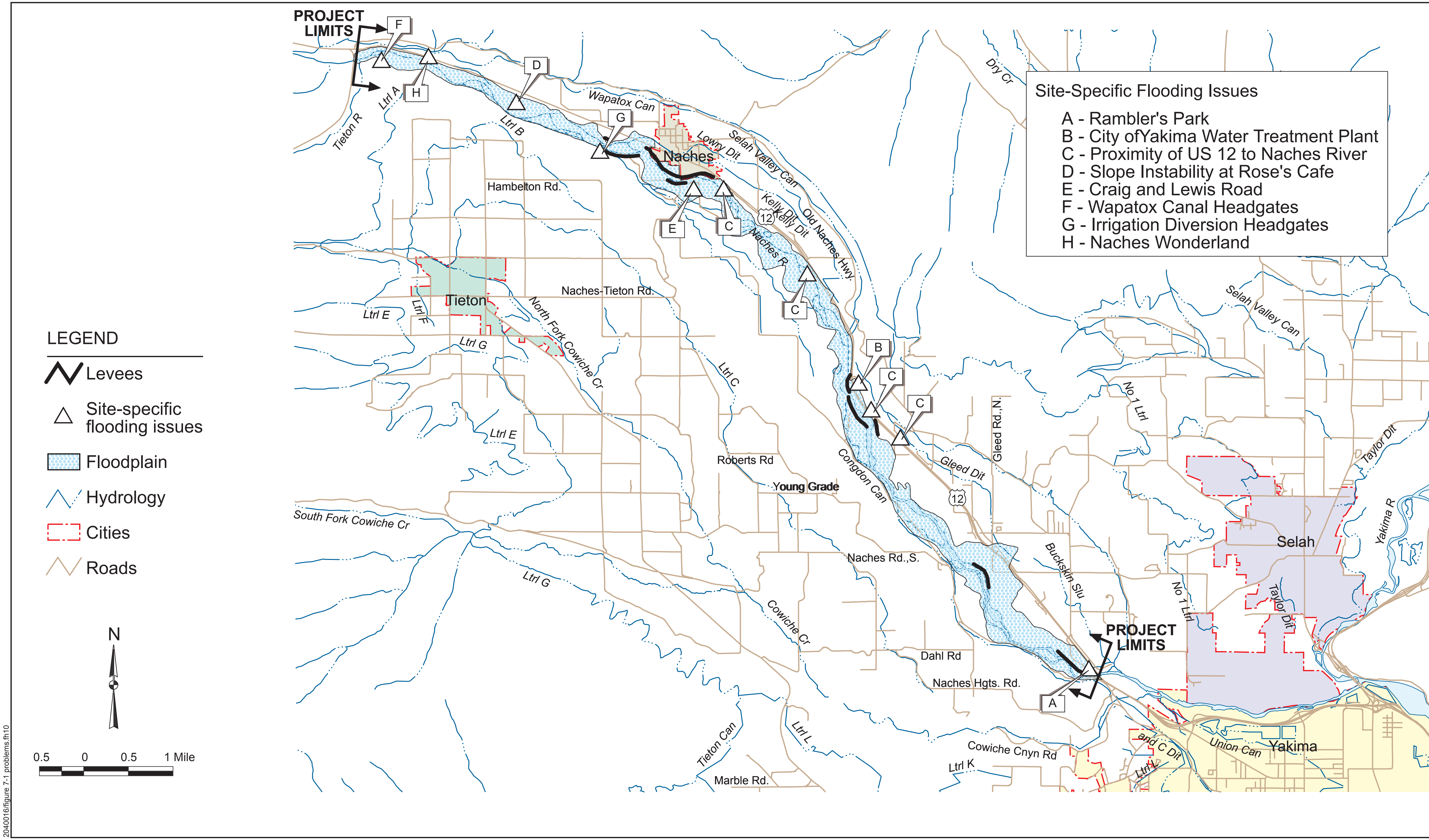
- Accurate floodplain maps and identification of channel migration hazard areas
- Better understanding of Naches River geomorphology and reservoir impacts.

The FEMA flood insurance maps for the Naches River, based on the 1985 Yakima County Flood Insurance Study, are the most current representation of the floodplain, flood hazard zones, and flood elevations. Relatively rapid channel migration in the study area has changed the river alignment and floodplain boundaries in places since the maps were prepared. Reasonably accurate floodplain mapping is a necessary technical tool for effective flood hazard management. Channel migration hazard areas in the study area were identified and mapped as part of the Lower Naches River Channel Migration Study to identify existing structures and facilities that will need protection and to curtail future development where necessary. The Channel Migration Analysis Report is included as Appendix A.

TABLE 7-1.
IDENTIFIED FLOODING ISSUES

Flooding Issue
Scientific/Engineering Information Gaps
A. Accurate floodplain maps and identification of channel migration hazard areas
B. Better understanding of Naches River geomorphology and reservoir impacts
Public Education
C. Public perception and lack of confidence in FEMA's flood insurance program and emergency relief operations following the 1996 flood
D. Lack of public understanding of river system behavior and flood hazards
E. Public health and safety
F. Advertising the County's Open Space Taxation Program, Conservation Easements, etc.
G. Understanding the County's roles in emergency management
H. Lack of knowledge of the physical and ecological functions of the floodplain
I. Technical assistance currently unavailable
Emergency Management
J. Lack of accuracy of flood predictions (timing, magnitude)
K. Better access to flood-fighting materials
L. Emergency access (escape routes, traffic congestion)
M. The responsibilities of the FCZD during a flood
Facilities and Existing Structures
N. Damage to existing structures and facilities; this includes buildings, roads, bridges, levees, and diversion structures
O. Proximity of Highway 12 to Naches River
Regulatory
P. More restrictive and inclusive requirements in the County's Flood Hazard Ordinance and development code (emphasis on development and septic tank design and siting)
Q. Enforcement of development regulations and land use codes in the Special Flood Hazard Area (SFHA)
R. Streamlining of the federal and state permitting process
Bank Erosion/Channel Migration
S. Loss of property due to bank erosion and channel migration
Site Specific Flood Issues
T. Ramblers Park; Simplification of the river channel
U. Inadequate protection of City of Yakima water treatment facility
V. Naches Wonderland
W. Hillslope instability near Rose's Café

Numerous studies exist on the topic of reservoir impacts on river systems. Reservoirs impact stream flows, hydrologic cycles, and sediment transport. Ecologically, reservoirs can have significant impacts on aquatic organisms and fish by altering stream-flow



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Yakima County
NACHES RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

Figure 7-1.
SITE SPECIFIC FLOODING PROBLEMS

temperature, turbidity, and nutrient cycling. It is unclear how the operation of the Bumping Lake, Clear Lake, or Rimrock Lake reservoirs has impacted these parameters on the Naches River. Quantifying these impacts would be vastly helpful in understanding changing geomorphic conditions and future habitat needs, and for identifying potential measures to mitigate detrimental reservoir impacts.

PUBLIC EDUCATION

Issues that were identified relating to public education include the following:

- Public perception and lack of confidence in FEMA's flood insurance program and emergency relief operations following the 1996 flood
- Lack of public understanding of river system behavior and flood hazards
- Public health and safety
- Advertising the County's Open Space Taxation Program, conservation easements, etc.
- Understanding the County's roles in emergency management
- Lack of knowledge of the physical and ecological functions of the floodplain
- Technical assistance currently unavailable

Public Perception of Disaster Assistance Provided through FEMA

The cost of federal flood insurance and public lack of awareness of the federal flood insurance program can deter homeowners from purchasing flood insurance. The lack of public knowledge about flood hazards may result in lack of appreciation of the magnitude of the flooding risks to property owners, thereby limiting property owner involvement in the flood insurance program or proper floodproofing of property.

Members of the Advisory Committee said that emergency relief centers did not provide adequate assistance during the February 1996 flood. Others were discouraged as people without flood insurance applied for disaster relief funds and received money. In addition some uninsured owners received funds before those who had purchased flood insurance.

Current FEMA disaster relief policies and state-wide NFIP statistics help to elaborate on these concerns:

- The assistance available to the majority of uninsured property owners is a long-term, low-interest Small Business Administration loan.
- Only those who do not qualify for these loans (low-income property owners who cannot pay the loans back) are eligible for an Individual and Family Assistance grant.
- In the 1995-1996 floods, there were over 2,200 flood insurance claims in the State of Washington. The average claim payment was over $24,600. At the same time, the average Emergency Housing grant was $2,500, and the average Individual and Family Assistance grant was $2,600; thus, flood insurance claims paid out almost 10 times the amount of disaster grants.

- The claims process for flood insurance follows insurance industry standards, and all flood insurance claims are required to be settled and the insured paid within 60 days from the date that a Proof of Loss is submitted by the insured.
- It is possible for an uninsured disaster victim to receive grant or loan funds faster depending on the insurance claim, but many claims (if uncomplicated) can be settled faster than 60 days.

Since passage of the Flood Disaster Protection Act of 1973, there has been a prohibition on disaster aid for those who do not carry flood insurance. However, in the past this policy has been applied sporadically. The National Flood Insurance Reform Act of 1994 strengthened the policy with the following requirements:

- Section 582 of the act requires individuals who received disaster assistance after February 7, 1998 to purchase flood insurance coverage.
- If flood insurance is not purchased and maintained, future disaster assistance would be denied.
- The requirement to maintain flood insurance coverage stays with the structure that received the disaster assistance.

Since there have been no Presidential-declared flood disasters in Yakima County since the February 1996 storm, citizens have not yet seen the effect of this policy change. Hence, leading up to that flood event, there was a valid public perception that some property owners were repeatedly receiving disaster aid without being required to purchase flood insurance. The current policy will significantly reduce the number of post-flood disaster grants. Educating the public on how the NFIP works and these post-disaster policies would help to increase public confidence in the NFIP.

Floodplain Functions and Behavior, Flood Hazards, and Public Health and Safety

Other public education programs can inform the public about the risks associated with floods and the actual level of safety provided by the Naches River levees and the upper basin reservoirs. Providing the public with facts about flood hazards will help residents make informed decisions about purchasing flood insurance and taking appropriate steps to floodproof their properties and protect their belongings. Floodplain property owners should also be knowledgeable about pubic health and safety issues such as evacuation procedures, moving livestock to safe locations, electrical and fire hazards, post-flood well testing and preventing cross-contamination from septic systems.

Public perception about the role of rivers and other natural resources influences the types of flood hazard management measures the public prefers for preventing flood damage. Although floods can be damaging, they are also a natural function of the river. Trying to physically contain or control flooding alters the natural processes of the river, which can have detrimental impacts on aquatic organisms and riparian wildlife. The public should be aware of how structural controls can impact the environment and their communities. In addition, any project impacting ESA-listed species of anadromous salmon and steelhead will be much more difficult to implement with current regulations and the increased focus by tribes and environmental groups on fisheries protection.

Open Space Taxation Program and Conservation Easements

Opportunities exist for property owners to benefit from leaving floodplain property undeveloped, such as the County's Open Space Taxation program and conservation easements. By advertising the potential benefits of these programs, the County could emphasize the preservation of open space in the floodplain and give property owners a way to benefit from conservation.

Technical Assistance

The County is exploring ways to streamline its permitting process and provide more technical assistance to the public. The County currently provides permitting assistance through the Planning Division, Building and Fire Safety Division, and free informal floodplain map determinations. Additional technical assistance could be provided on appropriate measures to improve flood protection and reduce flood hazards. Lack of coordination of projects in the floodplain, including floodproofing and environmental mitigation projects, has reduced the projects' effectiveness.

Providing technical assistance can help guide citizens through the process for rebuilding or floodproofing their homes, post-flood well testing, proper design and siting of septic systems, and preventing cross-contamination from septic systems. Integrating and coordinating designs for environmental mitigation projects located in the same area would improve their overall effectiveness.

EMERGENCY MANAGEMENT

Emergency management issues that were raised include the following:

- Lack in accuracy of flood predictions (timing, magnitude)
- Better access to flood-fighting materials
- Emergency access (escape routes, traffic congestion)
- The responsibilities of the FCZD during a flood.

Flood warnings and predictions are made by the National Weather Service (NWS). The NWS uses weather conditions, snow pack data, reservoir storage information, and river gage data to predict the severity of flooding conditions throughout the Naches and Yakima River basins. Many of these components are highly variable. Flood predictions tend to be more reliable at the downstream end of river basins, where the NWS and the USBR can generally correlate actual upstream flood depths to probable downstream flood depths. The study area however, is a relatively short distance from the mountains and it is difficult to make timely and accurate flood predictions for an area relatively close to the source of flooding.

Not all flood hazard areas in the study area have reliable emergency access routes. Timing is essential for residents who could be stranded on their flooded properties without an open access route. Emergency access is also important for emergency vehicles and search and rescue teams. Increased traffic congestion from distracted drivers and sightseers has also created problems for emergency vehicles.

All emergency management and FCZD personnel should know their specific roles during flood events to increase the efficiency and response time of emergency personnel, emergency operations, and post-flood activities.

FACILITIES AND EXISTING STRUCTURES

The costs of repeated damage to public and private facilities and buildings are long-term out-of-pocket expenses that are avoidable through cost-effective protection measures. Existing facilities that would benefit from such measures are residential and commercial buildings, bank levees, County roads and bridges, Highway 12, and headgate structures and canals owned by private irrigation districts.

REGULATORY

Regulatory changes that could prevent future flood damage and minimize future development in flood hazard areas include the following:

- More restrictive and inclusive requirements in the County's Flood Hazard Ordinance and development code (emphasis on development and septic tank design and siting)
- Enforcement of development regulations and land use codes in the Special Flood Hazard Area (SFHA)
- Streamlining of the federal and state permitting process

The County's current Flood Hazard Ordinance meets current minimum flood regulation requirements to be accepted by the NFIP. New residential properties are required to elevate the first floor of the house at or above the base flood elevation (BFE). Commercial structures can either elevate the building at or above the BFE or use floodproofing to meet this criteria. County ordinances and zoning codes have not been effective at preventing new development within SFHAs. This is partly due to lack of enforcement of existing land use codes and partly to a lack of coordination in the permitting process. Since the adoption of new ESA regulations, the permitting process has become even more cumbersome and confusing for developers and local government alike. Streamlining the permitting process will be one of the goals of the Development Services Center. The Center provides early assistance during the permitting process, before the permit application submission, to answer questions and aid applicants in interpreting code. The current CAO update addresses issues that have led to confusion during the permitting process. Also included in the update will be revisions to development regulations and policies. The goal of updating the CAO will be to incorporate current techniques and requirements for protecting critical areas in a way that is both reasonable and fair to private property owners. The County should use the current CAO update process as an opportunity to incorporate regulatory changes recommended in this CFHMP.

The County's current development codes do not always promote practices that are compatible with flood hazard areas. One example of this is the siting and design criteria for septic tanks. The current design standards require that all deciduous vegetation be cleared, which may promote bank erosion and destabilization. Another issue that has been raised is that of leaking septic tanks contaminating private drinking water wells. When possible, septic tanks should be sited above the BFE to prevent cross-contamination.

BANK EROSION/CHANNEL MIGRATION

Channel migration in the study area is a function of the river's geomorphic characteristics. Non-point or point source sediment loading, the operation of upstream reservoirs, and water diversions can alter the river's rate of sediment transport and deposition, with resulting effects on channel migration and bank erosion. It is unclear to what extent these factors may be affecting the system, or if the character of channel migration on the Naches River has changed significantly in recent decades. The Lower Naches River Channel Migration Study assessed historical channel migration patterns (Appendix A). The study also mapped channel migration hazard zones. As part of the county CAO update, CMZs will be mapped for major streams in the county. More detailed CMZ studies such as the one listed above will be integrated into the CAO as they become available. Mapping channel migration hazard areas will likely have adverse impacts on property values in these areas. Another aspect of this issue is the loss of property to bank erosion and equitable compensation for these losses.

SITE-SPECIFIC FLOOD ISSUES

Ramblers Park Development, Simplification of the River Channel / CMZ

The Ramblers Park area has sustained repeated flood damage, most recently in 1995 and 1996, but also historically, such as during the 1933 flood when it was one of the hardest hit areas. During the February 1996 event, flooding destroyed sections of the north end of the levee and caused serious damage to commercial structures and residences as it flowed through the development. The Ramblers Park levee, which has a 10-year level of protection, is inadequate to provide long-term protection for the community. It is likely that the levee will continue to be overtopped and damaged by flood events in the future.

Analysis of aerial photos over the last 80 years shows that the braided reach upstream of Ramblers Park is an active zone of channel migration. A significant avulsion occurred just upstream of Ramblers Park during the 1996 flood. The flood created a chute cut-off across the existing point bar. The direction of flow was shifted to the south, and the river presently flows perpendicular to the Ramblers Park levee.

Level of Flood Protection at the City of Yakima Water Treatment Facility

The Yakima River Water Treatment Facility northwest of Gleed is protected from flooding by a levee maintained by the City of Yakima. According to County records, the bank levee has a 5-year flood event level of protection. However, this level of protection is based on the Corps' 3-foot freeboard standard, which requires levees to be constructed to an elevation 3 feet above the estimated 100-year flood elevation. Since the levee was constructed to the estimated height of the 100-year flood elevation, it doesn't meet this requirement. However the levee withstood the flood event in February 1996.

The 3-foot freeboard requirement is used as a conservative design factor to provide for the uncertainty inherent in predicting the 100-year flood level and the inherent uncertainty of flood events (debris and ice jams, etc). Increasing flood protection at this facility would decrease the likelihood of flooding that would occur for flood events exceeding the 100-year event.

Naches Wonderland

Naches Wonderland is an RV park that borders the south bank of the Naches River immediately downstream of the Tieton River confluence. A private bridge provides access to the park from Highway 12 to the north. This area was indicated as being very susceptible to flooding impacts due to its proximity to the river. Further study and analysis is needed to identify the severity of the problem here. Yakima County is currently doing a restudy of the FEMA flood maps for the lower Naches River. This floodplain model could be used to assess alternatives for Naches Wonderland.

Hillslope Instability Near Rose's Café

Continued failure of the hillslope on the opposite bank from Rose's Café may have a significant impact on the future course and direction of the river in this area. The instability, shown in Photo 7-1, consists of a large lateral instability that can be seen in the photos as a sloughing ridge running parallel to the hillside. Several smaller slides are associated with this instability. Residents have noted recent changes in the general shape of the slide, which may indicate further movement below the surface. No notable slides or sloughing have occurred recently at the site. The instability is currently well vegetated, however it is unknown how long this vegetation has been established. There is little information to document the rate of movement of this slope failure other than that provided by residents.

Continued failure of the slope may be a slow, gradual process, although there is also the possibility of catastrophic slope failure. A likely trigger for a catastrophic failure would be if the slope were to become heavily saturated. The size and volume of the slope failure is significant and would cause the river to redirect its course toward the left bank if this material were to block its path. Such a shift may not be permanent, in some cases slide material can be cleared out over time by sediment transport. The ability of the river to do this depends on hydrologic conditions, the shape and density of the material to be moved, and the river's sediment transport capacity.

Photo 7-1. Hillslope Instability Behind Rose's Café (Yakima County, November 2001)

CHAPTER 8.
ALTERNATIVE ANALYSIS APPROACH

Options for addressing flooding concerns include engineered projects, public information programs, planning measures, and environmental protection and enhancement measures. Comprehensive flood hazard management emphasizes selecting a mix of approaches to minimize flooding impacts. This chapter outlines the general types of alternatives commonly used in floodplain management and presents the process that was used to evaluate and select alternatives for implementation.

GENERAL CATEGORIES OF SOLUTIONS

Flood hazard management measures are commonly classified as structural or nonstructural. *Structural measures* involve physical activities in or near the stream, such as excavation, placement of bank protection materials, and other engineering and construction activities. *Nonstructural measures* include stormwater and land use regulations, flood preparedness programs, public awareness programs, floodproofing, and maintenance programs. The federal government encourages the use of cost-effective, long-term nonstructural alternatives. Tables 8-1 and 8-2 summarize typical nonstructural and structural solutions, respectively.

ALTERNATIVE ANALYSIS AND SELECTION

Potential flood hazard management solutions were developed for each issue identified in this study. The potential solutions include construction projects, new policy decisions, land use modifications, additional development standards, and options for retrofitting existing structures. Several criteria, based on the plan's goals and objectives, were considered in selecting the alternatives. The alternatives that were found to best meet the selection criteria and that received support from the Advisory Committee were recommended.

Selection Criteria

Evaluating flood hazard management alternatives requires an understanding of existing floodplain use, a clear community vision of future floodplain use, and a review of current floodplain management practices, both within the community and across the nation. The alternatives evaluated for this project were analyzed based on the following selection criteria:

- Ease of implementation
- Cost-effectiveness (benefits vs. costs)
- Potential for success
- Flexibility and robustness
- Environmental impacts
- Applicable policies and regulations.

TABLE 8-1.
TYPICAL NONSTRUCTURAL FLOOD HAZARD MANAGEMENT SOLUTIONS

Measure	Description	Typical Activities
Public Information	Public information activities to advise people of the risks associated with flood hazards and about flood insurance and ways to reduce flood damage	• Map determinations/technical assistance • Public outreach projects • A flood protection library • Flood preparedness programs • Hazard disclosure • Elevation certificates
Regulation and Mapping	Regulatory and mapping measures to provide protection for existing structures and new development through land use regulation and the collection of accurate floodplain information	• Higher regulatory standards • Low-density zoning • Open-space preservation • Ordinance consistency • Interagency agreements • Accurate floodplain and floodway mapping, and migration hazard mapping
Planning, Evaluation & Data Collection	Activities to develop accurate floodplain information and flood data, analyze alternative feasibility, and increase the understanding of the river's flood characteristics	• Flood data maintenance (GIS, databases) • Floodplain audits • Flood gage installation/improvements • Engineering studies
Flood Damage Reduction	Measures addressing flood damage to existing structures (buildings, roads, bridges, levees, etc.)	• Acquiring or relocating floodprone structures • Wet or dry floodproofing • Developing repetitive loss plans
Flood Preparedness	Actions to minimize the effects of flooding on people, property, and the contents of buildings	• Individual action plans • Comprehensive planning • Flood warning systems • Flood facility maintenance programs

TABLE 8-2.
TYPICAL STRUCTURAL FLOOD HAZARD MANAGEMENT SOLUTIONS

Measure	Description	Typical Activities
Alignment Control	Measures designed to accommodate discharge along a course that allows the channel to develop without eroding adjacent property	• Barbs (spur dikes) • Flow realignment • Vane dikes • Cutoff channels
Bank Protection	Measures designed to produce a stable, durable streambank that can withstand floodwaters up to the predicted 100-year flood	• Reestablishing riparian vegetation (bioengineering) • Constructing approach dikes • Installing gabions • Constructing windrow revetments • Reducing bank slope • Constructing standard trench fill revetment (riprap)
Conveyance Capacity	Increasing channel bed slope or cross-sectional area or decreasing channel roughness in order to increase the amount of flow that a stream can carry before water spills over the bank; increasing off-channel storage or floodplain storage	• Constructing overflow/secondary channels • Removing vegetation and debris • Widening or deepening the channel • Controlling growth of vegetation in the channel • Gravel bar scalping • Increasing floodplain storage by removing levees or moving roads • Replacing multi-span bridges with single span bridges (no interior piers) • Installing culverts through embankments to minimize obstructions to flow.
Floodplain Protection	Measures that reduce flood hazards for property, structures, and occupants in the 100-year floodplain; protection from inundation, floating debris, sediments, and the force of water flowing in the floodplain	• Constructing setback levees • Constructing low dikes (floodplain levees) • Constructing ring levees • Constructing cutoff levees • Elevating roads • Redesigning and replacing bridges • Constructing/expanding storage reservoirs • Changing the configuration/alignment of headgate structures at diversions
Streambed Controls	Measures to prevent streambed degradation and upstream headcutting and control bed slope, bed elevation, and water surface elevation by dissipating stream energy that would otherwise alter the characteristics of the streambed	• Constructing stabilizers • Constructing drop structures

Ease of implementation is measured by the level of effort and capital cost associated with a proposed action.

Cost-effectiveness compares planning-level cost estimates to potential public benefits. Cost estimates were developed based on standard labor costs, and markups for contingencies and engineering fees where applicable.

Potential for success measures the feasibility of the solution. Potential for success was determined by conducting a reconnaissance-level engineering analysis, in which options were investigated without detailed work on any specific design. Such an analysis assesses whether the flooding issue is specifically addressed, considers the public benefit derived, reviews the existing regulatory environment, and considers funding options, environmental impact, and community values.

The *flexibility and robustness* of an alternative represent how well it will stand the test of time, including foreseeable changes in the physical and socioeconomic environment. Due to the possible far-reaching effects of flood events, solving flooding problems often requires the implementation of a variety of structural and/or nonstructural measures. An appropriate set of solutions may include both short- and long-term alternatives to increase the measures' flexibility and robustness.

Flood hazard management measures that involve structural modification of the floodplain produce unavoidable *environmental impact* through changes forced on natural processes. Nonstructural solutions, such as changes in development regulations and roadway design standards, may also have environmental impacts. The impact on fisheries and wildlife; on scenic, aesthetic, and historic resources; on water quality; and on hydrology were considered in evaluating alternatives. A table of effects associated with various flood hazard management alternatives (Table 8-3) is listed at the end of this chapter. Upon completion of the CFHMP, environmental assessment documentation will be prepared (a SEPA checklist).

Applicable policies and regulations were also considered in the alternatives analysis and selection. Alternatives were evaluated for consistency with the goals and objectives developed in this CFHMP, policies currently being developed in the local comprehensive plan update process, and applicable federal and state regulations. Only alternatives consistent with existing regulations and policies were selected for recommendation.

TABLE 8-3.
PROBLEM ADDRESSED AND ENVIRONMENTAL IMPACT ASSOCIATED WITH FLOOD HAZARD MANAGEMENT MEASURES

	Problem Solved[a]							Impact[b]					
Alternative	Channel Migration	Bank Erosion	Conveyance Capacity	Property Protection	Streambed Degradation/ Aggregation	Public Knowledge	Long-term Flood Control Expenditures	Fisheries	Wildlife	Scenic/ Aesthetic/ Historic	Water Quality	Hydrology	Recreation
Nonstructural													
Public Information Program	0	0	0	+	0	+	+	+	0	0	+	+	0
Regulatory Measures	+	0	+	+	0	0	+	+	+	+	+	+	+
Flood Damage Reduction for Existing Structures	0	0	0	+	0	0	+	+	+	+	+	+	+
Flood Preparedness/ Emergency Management	0	0	0	+	0	+	–	0	0	0	0	0	0
Alignment Control													
Barbs (Spur Dikes)	+	+	–	+	–	0	–	+	0	0	+	0	0
Flow Realignment	+	+	–	+	–	0	–	–	–	–	–	–	–
Vane Dikes	+	+	–	+	–	0	–	–	–	–	+	–	0
Cutoff channels	+	+	–	+	–	0	–	–	–	–	–	–	–
Bank Protection													
Bioengineering	+	+	0	+	0	0	+	+	+	+	+	0	0
Cabling Trees	+	+	–	+	0	0	0	+	+	+	+	0	0
Approach Dikes	+	+	–	+	0	0	–	–	–	–	–	–	0
Gabions	+	+	–	+	0	0	–	–	–	–	0	0	0
Fencing	+	+	–	+	0	0	–	+	0	0	+	0	0
Windrow Revetment	+	+	–	+	0	0	–	0	0	0	+	0	0
Reducing Bank Slope	+	+	+	0	0	0	0	0	0	0	0	0	0
Standard Riprap	+	+	–	+	0	0	–	–	–	–	+	0	0
Conveyance Capacity													
Gravel Bar Scalping	0	+	+	+	+	0	–	–	–	0	–	0	0
Overflow Channels	+	+	+	+	0	0	–	+	0 to +	0	0	0	0
Vegetation & Debris Removal	0	–	0	0	– or +	0	–	–	–	–	–	0	– to 0
Channel Widening or Deepening	+	+	+	+	+	0	–	–	–	0	– to 0	0	– to 0
Floodplain Protection													
Setback Levees	+	0	–	+	0	0	–	+	+	+	+	0	+
Low Dikes (Floodplain Levees)	+	0	–	+	–	0	–	–	–	– to 0	–	–	–
Ring Levees	+	–	–	+	–	0	–	0	0	– to 0	–	0	0
Cutoff Levees	+	–	–	+	0	0	–	–	–	– to 0	0	0	0
Storage Reservoirs	+	+	0	+	0	0	–	–	–	– to 0	– to 0	+	0 to +
Floodproofing of Structures	0	0	0	+	0	0	+	0	0	0	0	0	0
Streambed Control													
Stabilizers	+	+	–	0	+	0	–	–	–	–	+	0	0
Drop Structures	+	+	–	0	+	0	–	–	–	–	+	0	0

a. + = problem solved; 0 = problem not addressed; – = problem aggravated
b. + = positive impact; 0 = no impact; – = negative impact

CHAPTER 9.
ANALYSIS OF FLOOD MITIGATION ALTERNATIVES

This chapter presents an evaluation of all structural and nonstructural alternatives that were identified as potential ways to reduce flooding impacts. Input from Advisory Committee members and County staff was used to select recommended alternatives. These alternatives are prioritized in Chapter 10 using input from the Advisory Committee and the County, in addition to the selection criteria described in Chapter 8. Recommended alternatives are incorporated into a long-term action plan for flood hazard management in the Naches River study area.

The potential alternatives were categorized by type of solution in the following categories:

- Flood Hazard Reduction for New Development and Existing Structures
- Open Space Preservation/Habitat Preservation and Enhancement
- Flood Hazard Reduction for Public Facilities
- Mapping/Data Collection
- Emergency Management
- Public Education, Outreach, and Public Safety
- Measures Addressing Site-Specific Flooding Problems.

The first six categories cover general solutions that can be applied throughout the study area or in some cases County-wide. Measures addressing site-specific flooding problems are capital improvements and projects that address conditions at a specific geographic location. The sections below describe the potential alternatives analyzed in each category and identify those selected for recommendation by the Advisory Committee. The goals addressed by each alternative are referenced by number, corresponding to Table 1-4.

Various alternatives will need to be assessed further through the use of a hydraulic model. The County will soon undertake to revise FEMA's hydraulic model for the lower Naches River following the completion of this CFHMP. This modeling effort will have many benefits, including the ability to analyze many of the proposed structural flood hazard reduction projects recommended in this CFHMP. The revised model is referred to in many sections of this chapter. For consistency the proposed modeling effort will be referred to as the revised hydraulic river model for the lower Naches River.

FLOOD HAZARD REDUCTION FOR NEW DEVELOPMENT AND EXISTING STRUCTURES

Table 9-1 lists alternatives that can be used throughout the study area to prevent damage to buildings, roads, bridges, levees, and diversion structures that are at risk of flood damage. The alternatives address the following issues (see Table 7-1 for letter codes of Identified Flooding Issues, additional issues are referred to in other sections of chapter 9):

E. Public health and safety.

N. Damage to existing structures and facilities; this includes buildings, roads, bridges, levees, and diversion structures

Q. Enforcement of development regulations and land use codes in SFHAs

R. Streamlining of the federal and state permitting process

S. Loss of property due to bank erosion and channel migration

TABLE 9-1.
FLOOD HAZARD REDUCTION ALTERNATIVES FOR NEW DEVELOPMENT AND EXISTING STRUCTURES

Description	Selected for Recommendation	Goals Addressed[a]
Policy Alternatives		
Bioengineered bank stabilization devices (engineered log jams, replanting of trees and other riparian vegetation, cabled root wads, etc.) are preferred where relocation is not an option.	Yes	2, 6, 7
Use conventional bank stabilization devices (for example, spur dikes, barbs, trench fill revetment, approach dikes at bridges, etc.) in conjunction with habitat mitigation as a last resort for protecting existing structures that cannot be relocated.	Yes	6,7
Flood Hazard Reduction Alternatives		
Prohibit surface mining within this reach to reduce impacts on migration and habitat and the need for levees.	Yes	2, 6, 7
Revise the Flood Hazard Ordinance. Alternatives include the following:		
Establish a freeboard of 2 feet above the base flood elevation to which the lowest floor of residential buildings must be elevated.	Yes	6
Increase the elevation to 2 feet above the base flood elevation to which the lowest floor of nonresidential buildings must be elevated	Yes	6
Require compensatory storage for all fill in the floodplain or fill beyond a set volume to prevent increases in downstream flood peaks. Single family homes (not subdivisions) would be exempt.	Yes	2, 5, 6
Require new structures on all existing floodplain lots to be placed at the safest location on the property, with consideration for the feasibility of meeting other requirements such as siting of septic systems.	Yes	2, 4, 6, 7
Adopt specific channel migration/avulsion regulations that prevent the construction or substantial reconstruction (as defined by the Flood Hazard Ordinance) of any residential, commercial, or industrial structures in channel migration hazard zones.	Yes	1, 4, 5, 6
Implement deep/fast-flowing water regulations to further define the floodway. See also (Data Collection/Mapping – remapping project to include mapping regions of deep/fast-flowing water). Regulate the same as the regulatory floodway.	Yes	5, 6

a. Goals are described in Chapter 1

TABLE 9-1 (continued).
FLOOD HAZARD REDUCTION ALTERNATIVES FOR NEW DEVELOPMENT AND EXISTING STRUCTURES

Description	Selected for Recommendation	Goals Addressed[a]
Flood Hazard Reduction Alternatives (continued)		
Properly store hazardous/toxic materials in the floodplain to keep them safe from floodwaters.	Yes	6
Implement by providing safe materials storage information during permitting processes. Also send information to existing properties within the study area.		
Remove floodproofing as an option, leaving elevation as the required method.	No	6
Prohibit the creation of new lots entirely within the floodplain and require new partial lots to have at least a 5,000-square-foot building envelope outside the floodplain.	Yes	2, 5, 6
Implement for the study reach during the revision or update of the Comprehensive Plan, with support provided by SMD/FCZD as needed.		
Low-density zoning to reduce the number of new structures	No	2, 5, 6
Require minimum 100-foot setbacks from the existing river channel to maintain as a native growth protection area (no clearing).	No	2, 6, 7
Consider adopting the Naches River CFHMP as a comprehensive plan element.	No	2, 4, 5
Higher design standards for private roads and drainage structures	No	6
Prohibit in-stream maintenance practices that increase sedimentation and channel migration.	No	2, 5, 6, 7
Rambler's Park	Yes	2, 3, 6, 7
Implement a buy-out program to relocate some residents and businesses. Listed cost is the low and high end assessed values for properties in Rambler's Park. Cost includes assessed land value and improvements (buildings). The average property value is $159,100.		
This effort should be coordinated by SMD/FCZD with the Yakima County Non-Regulatory Natural Resource Protection program in conjunction with the Yakima County Planning Division.		
Seek ways to relocate residences or businesses using partial grant funds and cooperative projects with owners, such as is being done in the current project by SMD/FCZD and the Yakima County Planning Division to relocate Auto Recycling facilities from the high hazard flood plains, using Ecology centennial grant funds.		
Seek ways to relocate residences and businesses during County or State transportation projects.		
Continue to study Rambler's Park. If certain facilities are relocated the existing levee should be removed and a set-back levee constructed closer to SR12/Powerhouse Road.		

a. Goals are described in Chapter 1

TABLE 9-1 (continued).
FLOOD HAZARD REDUCTION ALTERNATIVES FOR NEW DEVELOPMENT AND EXISTING STRUCTURES

Description	Selected for Recommendation	Goals Addressed[a]
Flood Hazard Reduction Alternatives (continued)		
McCormick Levee - Continue to stabilize the eroding portion of the McCormick levee using techniques that enhance fish and wildlife habitat conditions. Generate funds from residents and businesses protected by the levee by developing a sub-zone.	Yes	6
Naches Wonderland – Create a revised hydraulic model for the Naches River and use the results of the Channel Migration Study to identify the nature of and likelihood of severe flood damage or erosion hazard. Identify appropriate measures to protect or move permanent structures if needed.	Yes	4, 5, 6
Acquire or relocate floodprone structures or land uses with equitable compensation when money is available and owner is willing.	Yes	2, 5, 6, 7
This project will be implemented through the Non-regulatory Natural Resource Protection Program, in policies currently being developed by the Yakima County Planning Division.		
Implement a limited cost-share program to floodproof or elevate residential structures. This action is to be used only in extreme cases, as determined by the SMD/FCZD.	Yes	6
Create a cost-share program to floodproof commercial structures	No	6
Increase riparian vegetation	No	2, 7
Ensure that future comprehensive plan revisions and policies are compatible with CFHMP goals and policies.	Yes	4, 5

a. Goals are described in Chapter 1

Policy Alternatives

The first two policy actions in Table 9-1 define the preferred approaches to protecting existing at-risk structures. Preferably, the structures should be relocated or purchased and demolished. Where this is not an option, such as at the City of Yakima Treatment Plant, the use of bioengineered bank stabilization devices is preferable to conventional bank stabilization devices. Bioengineered devices have fewer impacts on aquatic habitat and can be easier to permit than the use of conventional bank stabilization devices. In some situations, bioengineered devices are not feasible and may not have the required durability. Where conventional bank stabilization methods are used, their impacts on the river and the riparian zone should be minimized with habitat mitigation measures.

A policy to preserve floodplains can also provide development options for floodplain property owners. An example is to allow a higher density of development in the portion of a property outside the 100-year floodplain through transfer of development rights or cluster lot development from the portion of the property inside the floodplain. Site-specific conditions such as underlying zoning designations may limit the number of residential units that can be built. Such factors as parcel shapes, access requirements, and percentage of land outside the floodplain also determine the type and density of development that is feasible for individual parcels. In general however, this policy would provide a strong incentive for floodplain landowners to participate in preserving open space in the floodplain.

The last policy measure listed formally associates the goals and policies of the Naches River CFHMP with those of the County's Comprehensive Plan. Compatibility with the County Comprehensive Plan and this CFHMP will ensure that future land use and regulatory changes are consistent with the County's floodplain management policies and objectives.

Regulatory Actions

Many of the recommended actions in this CFHMP relate to regulating how and where new structures are constructed in Special Flood Hazard Areas (SFHAs). Once these regulatory changes are adopted, the County will need to coordinate with officials from the City of Naches to adopt compatible regulatory changes. Floodplain management in the study area can also be impacted by water use agreements and enhancements to irrigation works that affect the dams and irrigation districts in the Naches River basin. Plans underway that specifically apply are the Yakima River Basin Water Enhancement Project and the Tri-Country Watershed Plan. The County should continue to be involved in these projects to ensure that their outcomes are consistent with this CFHMP's goals and objectives.

Zoning alternatives were discussed in detail. The action preferred by the committee, prohibiting the creation of new lots in the floodplain and regulating building location on partial floodplain lots, would retain the current building density in the floodplain and eliminate the potential creation of new flooding problems that construction of new floodplain structures may bring. This alternative simplifies the achievement of the goal to minimize the impacts of future development by prohibiting new development instead of increasing regulatory oversight, which can lead to a more complex and demanding permit review process.

The impacts of new development on surrounding properties can include changing the depth of flooding through loss of on-site flood storage or changing the direction of flow, which can shift the flooding to new locations. The Advisory Committee recommended enhancing the current permit review by emphasizing the need to review a project's impacts on neighboring properties, specifically impacts relating to loss of storage or conveyance capacity and impacts on neighboring habitat features.

Yakima County's Flood Hazard Ordinance was written into the Critical Areas Ordinance (CAO). The potential revisions discussed included higher construction standards for new construction and substantial improvements, measures to preserve and enhance floodplain function, new standards for RVs in SFHAs, regulations addressing channel migration and fast/deep flowing water, and regulations addressing the siting and design of critical facilities. The current round of revisions to the CAO gives the County an opportunity to introduce recommended regulatory measures from this plan in a timely manner.

Higher regulatory requirements in the Flood Hazard Ordinance would serve as a means of protecting existing structures from the negative impacts of development and other activities that reduce floodplain storage or alter how the floodplain functions. These would also ensure that new developments and substantial improvements are built to withstand major flood events or are built out of harm's way. Higher design standards will also make SFHAs less favorable for future development, although some options such as prohibiting new development in certain areas would eliminate future developments altogether. Lowering the substantial improvement threshold to less than 50 percent would mean that most significant improvements or repairs to existing structures would be required to meet flood damage reduction codes.

Deep/fast flowing water regulations and compensatory storage requirements are relatively new regulatory tools that have been applied effectively in Washington. Deep/fast flowing water regulations regulate areas of high flood depth or velocity potential as if they were in the floodway. Washington jurisdictions that have implemented deep/fast flowing water regulations include Pierce County and the City of North Bend. Figure 9-1 shows the diagram that Pierce County's *Stormwater Management and Site Development Manual* uses to designate these areas. Compensatory storage regulations require that any significant filling activities be offset by an equal volume of storage. The compensatory storage must function in the same manner as the pre-developed site: the direction of flood flows entering and leaving the site must remain the same; and an equal volume per depth of flooding must be contained by the post-developed site as the pre-developed site.

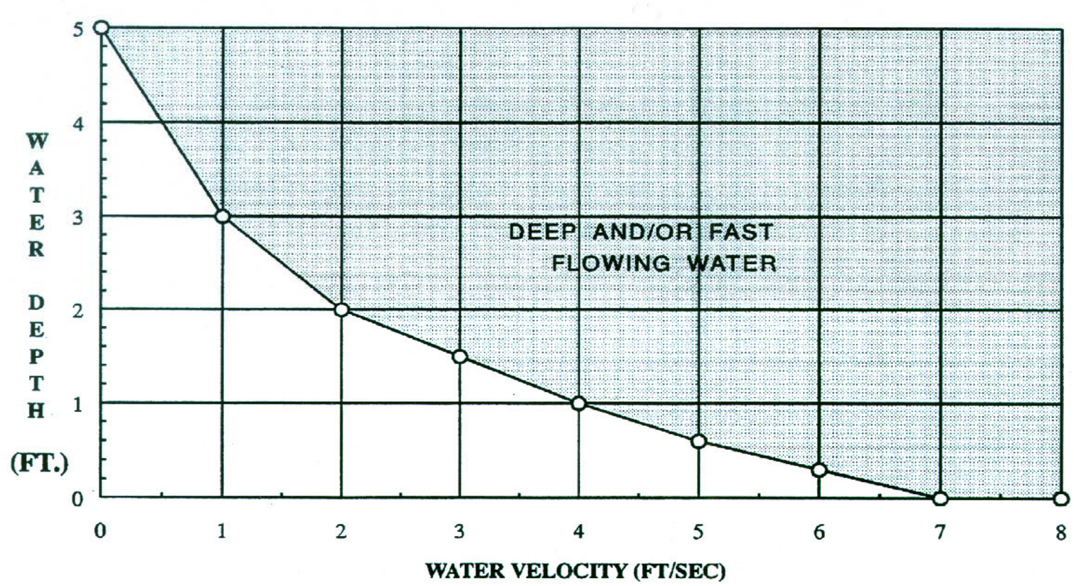

Figure 9-1. Graph used by Pierce County to define conditions where deep/fast flowing water regulations apply (Pierce County Stormwater Management and Site Development Manual).

Yakima County is currently mapping channel migration hazard/avulsion zones for all major river and stream reaches. Once these areas have been mapped, requirements for development within them will be incorporated into the CAO. The Lower Naches River

Channel Migration Zone (CMZ) Study assessed historical channel migration patterns. The study also mapped channel migration hazard zones and was recently completed as part of this flood plan (Appendix A). The study is somewhat more detailed than the broader CMZ delineations for major rivers, and it will also be incorporated into the CAO. Some practices in the floodplain, such as gravel mining practices, can increase the variability of channel migration. Gravel mining operations in the Naches River floodplain are located upstream of the City of Naches and on a parcel south of McCormick Road (see Figure 2-8). To prevent any adverse impacts from these operations, the Advisory Committee recommended that gravel mining be prohibited in the study area.

Health and safety issues could also be addressed by implementing measures to protect critical facilities, improve emergency access, and reduce the risk of contamination from hazardous materials.

To ensure the safety and continued operation of critical facilities and on-site sewer construction during flood events, the County should include a section on siting and design criteria for on-site sewerage systems and critical facilities in the flood damage reduction standards. A commonly used design criterion used by many jurisdictions is to require that critical facilities be located outside the floodplain to the extent possible. Where this is not practical, the facility is required to be raised a minimum of 3 feet above the BFE or protected by a levee with 3 feet of freeboard or at the 500-year flood elevation, whichever is higher. Access routes to the facility are required to be elevated at or above the BFE.

Actions to Protect Existing Structures and Enhance Emergency Access

Approximately 52 percent of parcels in the regulated floodplain are comprised of single family residential (25 percent) or agricultural land use (27 percent). An additional 13 percent are commercial and 4 percent are industrial or wholesale trade. The composition of the floodplain is primarily agricultural in the upper reaches, commercial, agricultural and undeveloped in the middle reach, and residential and open space in the lower reach. Higher densities of single family residential lots are located in the vicinity of the City of Naches and in and around Ramblers Park.

The Advisory Committee considered the following methods of protecting existing buildings which are further described in the following sections:

- Acquire or relocate flood-prone structures (equitable compensation)
- Dry or wet floodproofing of commercial structures
- Elevating existing residential structures
- Increase riparian vegetation
- Elevating access roads and providing adequate cross-drainage

Costs for buy-outs, relocating and retrofitting methods vary widely depending on the situation. However, funding for a buy-out or retrofitting program could be facilitated by applying for grant funding through federal or state sponsored flood hazard reduction programs. Costs for elevating structures in Western Washington can be in excess of $40,000. If a structure has been substantially damaged or has suffered repeated damage, the owner may be eligible for funding through the NFIP's Increased Cost of Compliance program if they carry flood insurance. If eligible the property owner can receive up to $30,000 (effective May 1, 2003) towards retrofitting the building.

County sponsored projects should focus on bringing existing buildings into compliance with the Flood Damage Prevention Ordinance. The right retrofitting method can have the added benefit of reducing the property owner's flood insurance policy rate. Although the Flood Damage Prevention Ordinance only applies to new or substantially improved buildings, many retrofitting projects end up being substantial improvements in order to raise the lowest floor of the building above the BFE and adequately protect the building from flooding. Several considerations should be made when selecting an appropriate retrofitting method. These include the following:

- What actions are needed to bring the building into compliance with the County's Flood Damage Prevention Ordinance?
- What actions would significantly reduce the property owner's flood insurance rate? (Flood insurance rates are based on the lowest floor regardless of whether or not the building is floodproofed, or whether the building is protected by a levee or floodwall)
- The type of building construction (masonry versus frame construction, basement, crawlspace, or slab-on-grade) and footprint area (residential versus large commercial building)
- Is the method technically and economically feasible? (Buy-out versus elevating or floodproofing the building)
- Are the property owners eligible for Increased Cost of Compliance (ICC) funds, which are available with NFIP flood insurance policies? Also if the structure was substantially damaged a substantial part of the cost could be covered by their flood insurance policy?

For Special Flood Hazard Areas (areas within the regulated 100-year floodplain) the County's Flood Damage Prevention Ordinance requires the lowest floor of a new or substantially improved residential structure, including basement, to be located at or above the BFE. Fully enclosed basements below the BFE are prohibited. Non-residential structures on the other hand must either have the lowest floor, including basement, placed one foot or more above the BFE, or be watertight and structurally able to withstand expected hydrostatic pressure to one-foot above the BFE. The watertight provision means that only non-residential structures may be dry-floodproofed. Levees or floodwalls may also be used where the structure would not adversely affect the direction, magnitude or depth of flooding of adjacent properties.

Acquiring Property or Relocating Structures

This option has been used successfully in Yakima County at repetitive loss sites. This option is also being discussed as a potential project for the County's Non-Regulatory Program. It is also used in places where flooding conditions are severe, such as areas where flood velocities or flood elevations are very high, where there is very little warning time before a flood, or where there is a high potential for debris damage.

In some cases, acquisition can be beneficial to all parties, especially when the cost is shared with the property owner and the local government with assistance from federal grants. The property owner can use the money from the acquisition to buy another property in a safer location if they wish, and the vacant lot can be used for habitat restoration, park or open space, pasture or agriculture. The existing structures are purchased, torn down and disposed of and the site restored. Demolition of structures normally includes purchase of the property for use by the public, but not always.

Relocating buildings out of the floodplain involves jacking the structure up, placing it on a wheeled vehicle, moving it to a new location, and placing it on a new foundation. Large buildings need to be moved in pieces. Buildings can be moved onto higher ground on the same property, to a nearby lot that could be purchased, or other land that is located outside the floodplain. Buy-out parcels or cleared land from relocation projects funded by federal dollars are required to be converted to open space.

Key advantages of these alternatives are as follows:

- They eliminate the risk to the current residents and the building's contents.
- They eliminate the need for flood insurance for that building.
- They increase floodplain storage and open space; land can be used for habitat restoration, converted into a county park or public recreational space.

Potential disadvantages of these alternatives are as follows:

- Relocation and acquisition are often less acceptable to affected property owners than other methods.
- Implementing these methods is costly and difficult to finance on a large scale.
- For relocating, an available site outside the floodplain must be located and purchased.
- There may be additional costs if the relocated house must be brought up to current building and plumbing codes.

Elevating Structures

Elevating an existing structure requires raising the structure until the lowest floor is above the BFE. It is usually recommended that structures be raised at least 1 foot above the BFE as a factor of safety. Elevating can be accomplished by elevating the entire house on a higher foundation. The crawlspace must be fitted with openings to allow water to flow under the building and equalize hydrostatic pressure on the foundation. If elevation is used to bring a substantially improved structure into compliance with local Code, the lowest floor of the building, including basement, must be elevated at or above the BFE. If elevation is used to bring a substantially improved non-residential structure into compliance, the lowest floor, including basement, must be raised to 1 foot or more above the BFE. Methods of elevating vary based on the type of foundation.

Key advantages of this alternative are as follows:

- Elevation allows a substantially improved building to be brought into compliance with the County's flood damage prevention ordinance.
- The risk of damage to the structure and its contents is greatly reduced.
- Elevation eliminates the need to move vulnerable contents during flooding.
- Elevation often reduces flood insurance premiums.
- If the property owner has flood insurance, they can be eligible for ICC funding (up to $30,000 towards retrofitting the building).

Potential disadvantages of this alternative are as follows:

- Elevation costs, although typically less expensive than relocating and acquiring properties, often exceed 50 percent of the value of the building.
- The appearance and ease of access to the building may be adversely affected.
- The house will still need to be evacuated during a flood.
- This method is not appropriate in areas with high-velocity flows, fast moving debris, ice-jams, or erosion.
- Additional costs may be involved if the building needs to be brought into compliance with local building or plumbing codes.
- Potential wind and earthquake loads must be considered.

Wet Floodproofing

Wet-floodproofing is relatively inexpensive and could be used to retrofit existing buildings that have not been substantially damaged. Wet floodproofing allows water to flow through the building's foundation, and requires that all construction and finishing materials below the floodproofing elevation be made resistant to flood damage. For substantially improved buildings, wet-floodproofing alone can only be applied in cases where a lower floor (such as a walk-out-on-grade basement) can be converted into non-living space with permanent openings for flood passage. The foundation walls must be adequate to support the building as well. County code will also not allow a fully enclosed basement. For a substantially improved structure the basement could be filled in and any utilities relocated to the floors above. The above-grade foundation could then be modified with the required openings to allow floodwater to flow through the crawlspace.

Key advantages of this alternative are as follows:

- Less costly than most other types of retrofitting
- Does not usually affect the appearance of the structure
- Internal and external hydrostatic pressures of the floodwater are allowed to equalize, which puts less stress on the walls of the structure.

Potential disadvantages of this alternative are as follows:

- Has a limited application and should only be used on existing structures
- Does not remove the need for evacuation and the hazard to personal safety
- Not applicable to slab-on-grade structures.

Dry Floodproofing

Dry floodproofing entails making a structure watertight below the desired flood protection level (1 foot above the 100-year flood elevation for non-residential structures). For new and substantially improved buildings, County code limits its use to non-residential structures only. FEMA does not recommend its use for any residential structure, which typically do not have foundations capable of withstanding high hydrostatic pressures. Dry floodproofing methods include sealing walls with waterproof coatings, impermeable membranes, or supplemental layers of masonry or concrete, installing backwater valves to prevent backflow of sewer lines and drains, and equipping doors, windows, and other openings with permanent or removable shields.

Key advantages of this alternative are as follows:

- The risk of damage to the structure and its contents is greatly reduced for floods less than the design event.
- Less costly than many other types of retrofitting, especially for large commercial buildings that can not be elevated without considerable expense.

Potential disadvantages of this alternative are as follows:

- The structure must be able to withstand hydrostatic pressures (method usually can not be applied to frame building construction).
- Dry floodproofing does not minimize the potential for damage from high-velocity flood flows, debris, and wave action.
- Does not remove the need for evacuation and the hazard to personal safety.
- Flood insurance premiums are not reduced.
- For new or substantially improved structures, dry floodproofing can only be used on non-residential structures.
- Generally not an accepted or effective method of floodproofing residential structures.

Ramblers Park

Several combinations of measures were evaluated to reduce flooding on properties in Ramblers Park and east of Highway 12. The committee recommended leaving the levee as is and pursuing other efforts to reduce the flood hazard, such as property acquisition, relocation, or floodproofing where appropriate. The County should continue to pursue efforts to relocate or buy out businesses and homes in the Ramblers Park area using any available means. Funding for property acquisition can become available through road or bridge reconstruction projects in the area as well as through grant funding. Where federal funds are involved, buy-out properties are required to be maintained as open space, thus increasing floodplain storage. Table 9-2 describes the primary advantages and disadvantages of the Ramblers Park alternatives.

TABLE 9-2.
DAMAGE REDUCTION ALTERNATIVES EVALUATED FOR RAMBLER'S PARK

Project Description	Advantages	Disadvantages
Alternative #1—Floodproof the existing buildings		
• Floodproof existing buildings (dry/wet floodproofing, elevate, floodwalls or ring levees) • Leave levee as is	• Reduces flood damage • Less expensive than other options • Corps permit not needed	• Potential for damage not completely eliminated • Area will still need to be evacuated during floods • In some areas of fast flowing or deep water, floodproofing may be ineffective • Does nothing to reduce the depth or duration of flooding • Does not increase floodplain storage or improve fish habitat
Alternative #2 – Buyout program		
• Implement a voluntary buyout program to relocate residents and businesses out of the areas of worst flooding • Floodproof and/or elevate remaining structures • Continue buyout program as funding become available	• Would eliminate repetitive flood damage to structures in areas of worst flooding • Relocated property owners would no longer need flood insurance, and floodproofed property owners would pay lower flood insurance premiums • Floodproofing would significantly reduce the risk of flood damage • Corps permit not needed • Increases floodplain storage by adding open space	• Potential for damage not completely eliminated for properties that are left • Remaining residents and businesses will still need to be evacuated during floods • In some areas of fast flowing or deep water, floodproofing may be ineffective • Does nothing to reduce the depth or duration of flooding • Does not increase floodplain storage or improve fish habitat • Relocating may be cost-prohibitive

TABLE 9-2 (continued).
DAMAGE REDUCTION ALTERNATIVES EVALUATED FOR RAMBLER'S PARK

Project Description	Advantages	Disadvantages
Additional Options		
• Reconstruct and raise the Ramblers Park levee • Levee would be raised and lengthened to meet federal standards (100-year level of flood protection with 3 feet of freeboard). • Significantly reduces risk of flood damage • If levee is raised to federal standards, flood insurance would no longer be required	• Repeated damage to Ramblers Park levee from overtopping and scour will be significantly diminished • Ramblers Park would still flood if the flood exceeds the levee's level of protection • Corps permit required	• May be cost-prohibitive • Does not increase floodplain storage or improve fish habitat
• Associated costs include the cost of construction, permitting, and ongoing maintenance and repairs • If a buyout program is successful and Ramblers Park is converted to open space, remove the Ramblers Park levee	• Area would not need to be evacuated during all but the most severe floods (>100-year) • Would help reduce flood potential of properties northwest of the golf course • Would create more floodplain storage and improve fish habitat at this natural bottle-neck • Would eliminate the cost of repairing repetitive flood damage to the levee • Makes sense if there were no property owners left to protect	• Raising the levee height may increase flood elevations upstream and increase flow velocity and erosion downstream and through the levee reach • Corps permit required, although more likely to be permitted since it would enhance fish habitat • May increase the risk of flood damage to Highway 12 and properties east of highway
• Elevate Powerhouse Road 1 foot above BFE to allow emergency access into and out of Ramblers Park	• Keeps one emergency access route open at all times	• May be cost-prohibitive depending on height road must be raised
• Raise Highway 12 to create a setback levee that would protect properties northwest of the golf course (100-year level of protection) • Could also be used in conjunction with removing the Ramblers Park levee	• Significantly reduces the risk of flood damage to properties northwest of the golf course	• Does not reduce flood risk for mobile homes along river south of the golf course • Costs may outweigh the benefits

Naches Wonderland

This area has a high potential for flood damage due to its proximity to the river. The RV park borders the south bank of the Naches River and extends to the confluence of the Tieton River. A private bridge provides access to the park from Highway 12. Further study and analysis is needed to identify the severity of the problem here, as little is known about past flood damages. The revised hydraulic river model for the lower Naches River and the results of the Channel Migration Study may be used in this analysis. (Note: other subdivision constraints may impact this recommendation)

OPEN SPACE PRESERVATION/HABITAT PRESERVATION AND ENHANCEMENT

Measures to preserve open spaces in the floodplain are proactive because they help to maintain the size and function of the natural floodplain and provide protection for critical habitat areas. The County's Open Space Taxation Program gives tax breaks to property owners who maintain a portion of their undeveloped land as open space. This program and other alternatives open to land owners, such as conservation easements, should be advertised. Conservation easement and placing deed restrictions on County-owned parcels are ways to preserve open space in perpetuity.

The Non-Regulatory Program, a current County project, will also look at ways to enhance open-space preservation in the floodplain. Upon completion, the County, cities and other agencies can utilize the framework to evaluate individual sites for easements, acquisition, etc on the basis of multiple objectives, including flood hazard reduction. Possible funding sources for the Non-regulatory Program include SMD/FCZD grants, loans, and donations which may be sought by any interested entity or partnership.

The open space preservation/habitat preservation alternatives listed in Table 9-3 address the following issues (see Table 7-1 for letter codes of Identified Flooding Issues, additional issues are addressed in other sections of chapter 9):

E. Public health and safety

F. Advertising the County's Open Space Taxation Program, Conservation Easements, etc.

N. Damage to existing structures and facilities; this includes buildings, roads, bridges, levees, and diversion structures

S. Loss of property due to bank erosion and channel migration

FLOOD HAZARD REDUCTION FOR PUBLIC FACILITIES

Floodprone County facilities include roads, culverts, and levees. In addition to structural retrofits to the facilities themselves, alignment and streambed controls can be applied where it is feasible and more cost-effective. Typical alignment and streambed controls are listed in Chapter 8. Appendix G of the Yakima River CFHMP can be used as an alternate resource on these techniques. Recommended policies that pertain to the use of bio-engineered and conventional bank stabilization and alignment controls are included in the *Flood Hazard Reduction for New and Existing Structures* section of this chapter.

The flood hazard reduction alternatives described in this section and listed in Table 9-4 address the following issues (see Table 7-1 for letter codes of Identified Flooding Issues, additional issues are referred to in other sections of chapter 9):

N. Damage to existing structures and facilities; this includes buildings, roads, bridges, levees, and diversion structures

O. The proximity of Highway 12 to the Naches River:
  - The proximity of Highway 12 to the Naches River endangers the highway and reduces floodplain storage.
  - The potential for overtopping at Ramblers Park and near Locust Lane, 1 mile south of the City of Naches.

TABLE 9-3.
OPEN SPACE/HABITAT PRESERVATION AND ENHANCEMENT ALTERNATIVES

Description	Selected for Recommendation	Goals Addressed[a]
Open Space Policies		
Consider keeping undeveloped County-owned parcels as permanent open space by attaching deed restrictions, using conservation easements, etc.	Yes	2, 4, 5, 6, 7
Consultation with all county divisions/departments that own properties in flood hazard areas shall be done during the implementation of this policy. This policy shall not override an imminent planned use of a property unless fair compensation to the owner is made.		
Use regulatory and non-regulatory tools to promote preserving and increasing open space areas in the floodplain.	Yes	2, 5, 6, 7
These tools include the Non-regulatory Natural Resource Protection Program, the Open Space Taxation Program, policies currently being developed by the Yakima County Planning Division, and the Channel Migration Zone regulations.		
Open Space Preservation		
Continue to operate and promote the Open Space Taxation Program.	Yes	2, 3, 5, 6, 7
During permit review, continue to look for ways to coordinate current and ongoing restoration and mitigation projects in the study area to maximize benefits.	Yes	2, 4, 7
Create a Naches River Greenway to preserve and increase open space and enhance recreational opportunities.	No	2, 3, 5, 6, 7
Pursue open space preservation (increasing the amount of open space in the floodplain through purchase, conservation easements, etc. versus permanently maintaining existing open space parcels)	Yes	2, 6, 7

a. Goals are described in Chapter 1

TABLE 9-4.
FLOOD HAZARD REDUCTION ALTERNATIVES FOR PUBLIC FACILITIES

Description	Selected for Recommendation	Goals Addressed[a]
Flood Hazard Reduction Policy for Public Facilities		
When new bridges are constructed, or bridges are rebuilt or replaced, the bridge should span the floodway as much as possible. This prevents the new bridge from creating additional flooding.	Yes	2, 6, 7
Implement through applicable permitting programs (GMA, SMA, NFIP).		
Flood Hazard Reduction for Public Facilities		
Craig Road flooding:	Yes	4, 6
Reconstruct the South Naches Irrigation District headgate and levee to eliminate imminent flood hazard.		
SMD/FCZD may provide implementation assistance such as agency coordination, funding, and design review at its discretion.		
Add a new section for the siting of critical facilities. Prohibit construction in the floodplain, and require critical facilities to be elevated at least 2 feet above the base flood elevation. Require these facilities to be elevated at least 2 feet above the base flood elevation. Require these facilities to be accessible during a flood.	Yes	2,5,6
The addition of new critical facilities in the floodplain is not expected to be a significant issue in the future.		
Lewis Road flooding:	Yes	6
Relocate Lewis Road, in conjunction with the South Naches Road upgrade project, to an alignment that does not result in damage to the road during flood events or when inundated.		
Road may be elevated above the BFE if it is set back far enough from the river. Channel migration issues are a factor and should be carefully considered in siting this facility. Alignment and design criteria assistance is being provided by SMD/FCZD.		
Continue to discuss options to protect US 12 and increase floodplain storage with WSDOT.	Yes	2, 6
Evaluate the potential for relocating levees away from the river or removing them to reduce flood hazards.	Yes	2, 6, 7
Implement with cooperation from WSDOT, City of Yakima and others and time and opportunities allow. Implementation of a specific levee set-back or removal project may require partnerships and external funding assistance.		

a. Goals are described in Chapter 1

TABLE 9-4 (continued).
FLOOD HAZARD REDUCTION ALTERNATIVES FOR PUBLIC FACILITIES

Description	Selected for Recommendation	Goals Addressed[a]
Design and construct roads such that they are flood resistant where needed. These include erosion resistant shoulders or dips in the roadway.	Yes	2,6
This is currently being applied in the design and construction of new roads and roadway improvements.		
Encourage the modification of headgate structures to make them less susceptible to damage from flood debris and ice jams, including conversion of smaller canals to piped/pressurized systems or by combining diversions.	Yes	4, 6
Work with WSDOT to identify potential sites where minor work on US 12 will result in the safe reconnection of floodplain area or side channels.	Yes	7
Cooperate with WSDOT as time and opportunities allow. A specific floodplain reconnection project may require partnerships with WDFW, WSDOT, and SMD/FCZD and others to obtain funding.		
Use the revised hydraulic river model for the lower Naches River to analyze measures at the City of Yakima Water Treatment Plant to increase the facility's level of protection:	Yes	6
Construction of a set-back levee and/or removal of the existing levees located on the opposite side of the plant, to reduce the potential for erosion of the Treatment Plant levee and US 12.		
Conduct analysis as part of modeling used to revise FIRMs. Implementation of a set-back project will require partnerships of the City of Yakima, SMD/FCZD, property owners, and others to obtain funding.		
Bring existing levees up to federal standard (100-year flood with 3-foot freeboard)	No	6
Install culverts through embankments/roads to minimize obstructions to flow and overflows	No	6
Other alternatives discussed as options to suggest to WSDOT:		
Relocate section of Highway 12 near Locust Lane to the east outside the 100-year floodplain. Ensure that the Highway 12 embankment is protected from erosion and other flood impacts. Elevate Highway 12 1 foot above the 100-year flood elevations and provide adequate cross-drainage. This would ensure emergency access.	County not responsible for implementation, suggest to WSDOT as optional actions	2, 6

a. Goals are described in Chapter 1

Levees

Raising, relocating and removing existing levees were discussed as potential alternatives to protect critical access routes and existing structures during floods. In most all cases that were discussed, including the Ramblers Park Levee and the City of Yakima Water Treatment Plant levee, raising levees to meet federal standards is cost-prohibitive. Relocating levees to a setback position where space is available or removing a levee altogether may be more feasible as a way of increasing floodplain capacity and lowering flood elevations. Relocating and removal was selected as a recommendation that should be analyzed further. This analysis would involve identifying potential sites for setback or removal based on land use and buildings in the immediate vicinity, a cost-benefit analysis, and hydraulic modeling of alternatives. The revised hydraulic river modeling effort for the lower Naches River could be used in addition to the results of the Channel Migration Study to assess these alternatives. The Channel Migration Study was completed in 2004 and the restudy is expected to be completed and submitted to FEMA in summer of 2005.

Roads

Alternatives discussed to protect roads from repeated flood damage included strengthening roadbeds and shoulders with erosion resistant material, raising roads to provide emergency access where needed, and installing adequate cross-drainage. Other nonstructural measures have been identified in this plan to identify which roads are flooded during which flood events and to plan evacuation procedures and emergency access routes accordingly. Where needed to improve emergency access to populated or critical areas, roads can be structurally modified. Specific roads identified in this plan where repeated flood damage is a problem include Craig and Lewis Roads in the floodplain on the south side of the river near the City of Naches, and Highway 12, whose proximity to the Naches River in multiple reaches of the study area increases its susceptibility to channel migration. Lewis and Long Roads were identified as facilities that could be affected by channel migration or avulsion.

Specific recommendations for Lewis and Craig Roads include evaluating alternatives for providing emergency access to areas served by these roads. This may include looking at different routes or low-level elevation or by modeling selected discharges and return periods. The County is pursuing construction of a spur dike in the vicinity of Long Road to protect an irrigation diversion and levee where the main channel has historically switched between three or four different channels.

Highway 12 is a major highway in the County and damage to it would severely impact transportation in the area. The highway follows the north side of the river and is very close to the eastern city limits of the City of Naches. Channel migration could impinge on Highway 12 at this location and at the City of Yakima Water Treatment Plant further downstream.

Once the revised hydraulic river model for the lower Naches River is completed in 2005, the model could be used for locating and optimizing culvert locations if needed to improve drainage and increase floodplain storage by directing water to old flood channels in the floodplain. The vulnerability of Highway 12 to erosion due to channel migration was recently analyzed in the lower Naches River Channel Migration Study. This is especially true where the Naches River runs alongside the highway; the spatial distribution of flow and velocity from the hydraulic river model would help identify potential erosion at these places. The model could be used to determine locations of overtopping on Highway 12 for various flood magnitudes and select appropriate measures to protect these areas.

Some citizens have indicated a desire to have existing cross-culverts under Highway 12 (in the vicinity of the Wapatox Canal intake structure) gated to prevent backflow during high-flow events in the river. The feasibility of this as a solution requires an assessment of each structure with regard to flows from the river and tributary to the culvert, shoreline and critical areas regulations, and the potential hazard to buildings in the surrounding area. The County can analyze these culverts by using existing information and the hydraulic river model, however some additional survey work may be required to identify culvert invert elevations and the existing condition of these structures.

A cost-effective measure for some roads may be to protect susceptible shoulders with appropriately sized riprap or other erosion-resistant material. Road beds can be reinforced using large diameter ballast or other erosion-resistant material. Culverts could be installed under high roadway embankments or bridge approaches to increase conveyance across these structures and reduce flood elevations upstream. The culverts would have to be big enough to pass the high flows present during flood conditions. Culverts can easily become blocked with debris, especially during a flood, significantly reducing their effectiveness.

Elevating roads to near, at or above the 100-year flood elevation is a good option where the road would only need to be raised a few feet and would not obstruct flood flows. Driveways and intercepting roads would need to be raised to meet the new roadway grade. A high roadway embankment will act like a dam, raising flood elevations for properties upstream. The expense of raising roads more than a few feet would have to be weighed against the advantages.

City of Yakima Water Treatment Facility

Current standard design for protection of critical facilities calls for 3 feet of freeboard above the 100-year flood elevation to protect against the uncertainty inherent in predicting 100-year flood elevations and against flood events greater than the 100-year event. The City of Yakima's water treatment facility, although designed for the estimated 100-year flood elevation, has a limited amount of freeboard. Yakima County flood control works inventory records list the levee as having a 5-year level of protection with 1 foot of freeboard.

Alternatives to address this issue were discussed by the Advisory Committee, City of Yakima officials and County staff. The Advisory Committee recommended that the City ensure that the facility is operable during the 100-year event. Based on past performance, the City believes the levee provides adequate protection again the 100-year flood event. The treatment facility has withstood several large flood events, most notably the February 1996 flood, which was estimated to have an approximately 52-year recurrence interval. County staff offered to further analyze potential solutions to increase the treatment facility's level of protection. The County's offer is the final recommendation for this problem area. The County would use the revised hydraulic river model for the lower Naches River. Alternatives discussed that could be analyzed include the following:

- Construction of a setback levee or removal of the existing levees located on the opposite side of the plant.
- Diversion and storage of floodwater in an existing pond located on the opposite side of the treatment plant.

Measures to Protect Diversion Structures

Flood debris and ice have caused repeated damage to diversion structures. During the February 1996 flood, floodwater washed out irrigation ditches and canals and spread to areas outside the floodplain through these conveyance networks. Alternatives were discussed that irrigation districts could implement to protect their diversion structures and canals. As these are private entities, the County could encourage irrigation districts to modify headgate structures to make them more flood resistant. The County could recommend that this issue be addressed during the development of emergency contingency plans for each irrigation district (see the *Emergency Management* section below).

EMERGENCY MANAGEMENT

Many things can be done to minimize damage when a flood occurs. Through coordination, preparation, and proper warning, emergency management can provide an effective flood-fighting system. The alternatives described in Table 9-5 address the following issues (see Table 7-1 for letter codes of Identified Flooding Issues, additional issues are referred to in other sections of chapter 9):

C. Public health and safety

D. Public perception and lack of confidence in FEMA's flood insurance program and emergency relief operations following the 1996 flood

E. Lack of accuracy of flood predictions (timing, magnitude)

F. The need for better access to flood-fighting materials

G. Emergency access (escape routes, traffic congestion)

H. Understanding the roles and responsibilities of the County's emergency management program

I. The need to clarify the responsibilities of the Flood Control Zone District FCZD during a flood.

TABLE 9-5.
EMERGENCY MANAGEMENT ALTERNATIVES

Description	Selected for Recommendation	Goals Addressed[a]
General		
Recommendations related to Emergency Response currently being considered in the development of a Flood Emergency Response Plan:	Yes	4,6
Create, publicize, and implement an action plan for use in the Emergency Operations Center during a flood event.		
Emphasize what the County's roles are in providing flood response, including sandbagging, evacuation notices, etc.		
Document flood warning and emergency response activities to gain more credits in CRS program, when the program is joined.		
Establish evacuation procedures and routes considering flooded roads (fire departments).		
Ensure provisions have been made for warning and self-evacuation for all occupied structures during a flood if they do not have dry land access.		
Coordinate training classes and materials for emergency personnel, police, fire and public works on their responsibilities during a flood.		
Promote EMI training courses for emergency personnel.		
Promote police patrols at emergency access routes during flood events.		
Publish maps showing evacuation routes and gage height at which roads are flooded/closed. (See also evacuation recommendations under Emergency Management)		
Increase public awareness on post-flood drinking water well safety, well testing, and health risks associated with flooded septic systems. Make clear the locations of public water supplies temporarily available to residents after a flood.		
Recommendations related to improving access to flood fighting materials:		
Provide access to flood fighting materials including sand, sandbags, etc. at fire stations.	Yes	6
Improve access to flood fighting materials by organizing and advertising locations for pick-up and stocking materials before flood season.	Yes	3, 4, 6
Implement in SMD/FCZD sand bag machine/equipment purchasing/siting project currently underway.		
Work with irrigation and drainage districts to come up with effective flood emergency contingency plans.	No	4,6
Organize an informal communication network of residents.	No	4, 6

a. Goals are described in Chapter 1

One way the County can address these issues is to create a Flood Response Plan (FRP) that would document the goals, objectives, and policies for emergency response in the County. The FRP will document current flood warning and emergency response activities as well as proposed activities, such as additional personnel training, the need for police patrols at emergency access routes, improving access to flood-fighting materials, and coordinating an effort with local irrigation and drainage districts to create flood emergency contingency plans to reduce flood hazards associated with diversion structures and canals. It will also create an action plan for use in the Emergency Operations Center. The FCZD initiated this planning effort and the plan is nearing completion.

Courses in emergency management, flood response and recovery, and other flood disaster related courses are available through the state Emergency Management office at Camp Murray and through FEMA's Emergency Management Institute in Emmitsburg, Maryland. Tuition, course materials, housing, and travel expense are provided at no expense for local government employees and members of active emergency management organizations. Some free training materials are also available through FEMA to augment in-house training exercises.

Some structures can become completely cut-off from the nearest emergency access route during floods. Ensuring that the occupants of these structures have adequate warning and have a plan for self-evacuation can be facilitated by documenting the County's evacuation procedures and educating residents using public outreach activities.

MAPPING/DATA COLLECTION

It is important to understand how sediment transport, flooding, channel migration, and other geomorphic processes shape the Naches River floodplain. The more information that is available on these issues, the easier it will be to define flood hazard and channel migration areas, making it easier to minimize impacts on surrounding residents and structures. The alternatives described in Table 9-6 address the following issues (see Table 7-1 for letter codes of Identified Flooding Issues, additional issues are referred to in other sections of chapter 9):

A. Accurate floodplain maps and identification of channel migration hazard areas

B. Better understanding of Naches River geomorphology and reservoir impacts.

Mapping Activities

Incorporating channel migration hazard zones will be the most significant element of revising the currently mapped flood hazard areas. In addition, the Naches River is eligible for FEMA's current Map Modernization Program, which will cost-share with local governments to revise FIRMs. In-kind contributions such as the County's floodplain models, GIS data, LIDAR, and channel migration hazard mapping can be used toward the County's share of the cost. The mapping activities described below can also be used to gain additional credits through the CRS program, toward reductions in flood insurance premiums for policy holders Countywide.

TABLE 9-6.
MAPPING/DATA COLLECTION ALTERNATIVES

Description	Selected for Recommendation	Goals Addressed[a]
Mapping/Data Collection Policy		
Use mapping activities to gain CRS credits, if the CRS program is joined.	Yes	3,4
SMD/FCZD will coordinate with the Yakima County Planning and Building and Fire Safety Divisions.		
Mapping/Data Collection Alternatives		
Update existing FEMA Floodplain Maps and facilitate, and perform periodic updates as needed. Include regions of fast/deep flowing water. Create a hydraulic model of the river to predict flood heights and areas of inundation based on the BOR gage reading at Naches. (Project currently underway) Coordinated with new FEMA mapping initiative.	In-progress	1, 2, 6
Implementing as next phase of the Naches River CFHMP project.		
Map channel migration hazard zones. Recently completed through the Naches Channel Migration Study.	Completed	1, 2, 6
Implemented as part of current Naches River CFHMP project.		
Monitor hill slope instability near Rose's Cafe to determine the overall rate of movement of the instability and provide warning of imminent failure.	Yes	2, 6, 7
Continue to collect new channel information and data over time, using LIDAR and/or other techniques. Periodically review channel migration hazard and FEMA floodplain maps to determine the need to update the maps. Incorporate new technology as it becomes available. Seek partnerships with others.	Yes	1, 4
Cost estimate includes periodic mapping assessment.		
Encourage an update to the NWS flood forecasting model for the Naches River, if not already updated.	Yes	4, 6
Research studies of basins similar to the Naches Basin on how altered flow regimes have affected sediment transport, flooding, geomorphology, etc.	Yes	1, 4
Implement as time and opportunity allow. Consider partnerships with others with similar interests, such as USBR, WDFW, Yakima Nation, Central Washington University.		
Continue to support and cooperate with the USBR on projects relating to the Naches River including the current sediment transport study on the Tieton River which will determine the impact of the Tieton River reservoir on sediment transport, flooding, and geomorphology in the Naches River.	Yes	1, 4
Ask USBR to recalibrate its gage at Naches if needed.	No	1, 6

a. Goals are described in Chapter 1

Map Channel Migration Hazard Zones

The County's Channel Migration Hazard Study was recently completed and identifies migration hazard zones. The County will create a channel migration hazard ordinance to be integrated into the Critical Areas Ordinance. Migration hazard mapping was based on analysis of field data, geological information and historical aerial photography. This study should be updated periodically as needed to accommodate future geomorphic changes.

Update Existing FEMA Floodplain Maps

The County could do the following to improve Naches River floodplain mapping:

- Compile high-water elevations from the February 9, 1996, flood. The Corps of Engineers surveyed high-water elevations throughout the floodplain (Weber, J., 19 June 1996, personal communication), and the results should be used to verify the hydraulic model used to define regulatory floodplain boundaries.
- Obtain accurate topographic data throughout the floodplain, especially in areas of suspected inaccuracy, including the right bank between the City of Naches and the City of Yakima Water Supply Treatment Plant, the left bank southwest of Eschbach, and the left bank southeast of McCormick Drive. This has been done.
- Submit certification forms and supporting data to FEMA for a complete FIRM map Restudy following FEMA guidelines (FEMA 1990). Restudy is underway with map submission to FEMA expected in summer 2005.
- Request that FEMA produce maps based on future-conditions hydrology, to reflect logging activities and watershed development. This may be a component in the restudy listed above.
- Request that FEMA produce a digital floodplain map that combines all jurisdictions and reflects recent data. County is currently coordinating county-wide digital map creation with Ecology and FEMA under the Map Modernization program.
- Enforce the County's CAO based on best available data, such as data obtained from recent floods. Base development, floodproofing, and elevation building standards on high water observed during the February 1996 flood or the FIRM BFE, whichever is higher.
- Integrate areas of rapid channel migration into County flood hazard maps and limit development in these areas as it is limited in floodways.
- Review channel migration hazard and FEMA floodplain maps to determine the need to update following all major flood events. Incorporate new technology as it becomes available.

Publish Maps Showing Evacuation Routes and Gage Heights at Which Roads are Flooded/Closed

Flood inundation maps are maps that show the extent of flooding for different magnitudes of flood events, such as the 5-, 10-, 50-, and 100-year flood events. These maps are useful for identifying emergency access routes that are likely to remain open during minor to severe flood events. Flood inundation maps could be made available on-line, at local libraries in the flood protection section (see Public Education Alternatives), or through DSC.

Data Collection Activities

These measures relate to improving the current state of knowledge about channel migration and contributing factors, sediment transport, flooding and the impacts of development in floodplain areas.

Channel Migration and Sediment Transport

The degree to which the upper basin reservoirs impact flooding and channel migration in the study area and the potential impact of changing the reservoir release policies remain uncertain. The results of academic studies on reservoir impacts are available through research journals and local universities (Central Washington University, University of Washington, Washington State University). In addition, the USBR is currently conducting a sediment transport study on the Tieton River to determine the Tieton Dam's impacts on sediment transport downstream. The USBR's Interim Operating Report, which recommended the study, includes a recommendation to begin a gravel-reintroduction project downstream of the dam if the study finds that a sediment transport problem exists. The County should assist and cooperate with the USBR's study as needed to help address downstream impacts of the Tieton Dam on the river system. The County should review the success of other gravel reintroduction projects as a way to assess the merit of this type of operation and maintain awareness of potential consequences if the USBR determines such an action is needed.

Continue Collecting Flood and Floodplain Information

The County should, where feasible, integrate technological advances in floodplain modeling and continue to collect data and update GIS coverages that reflect current floodplain conditions (e.g., mapped flood zones, channel migration hazard zones) and other coverages related to floodplain management (e.g., locations of reported flood damage, flood control structures, parcel and zoning information). The County should also work with the NWS to ensure that the current flood forecasting model is based on current basin conditions so that reliable predictions are made. Historical flood information coupled with a review of land use changes and levels of development over time can be used to monitor cumulative impacts of subdivisions and other developments in the floodplain.

Inundation mapping is a useful tool for hazard disclosure, public education, and emergency response planning. The revised hydraulic river model for the lower Naches River could be used to predict flood heights and publish inundation maps for public use and for emergency response planning.

Hillslope Instability Near Rose's Café

Alternatives listed in Table 9-7 associated with this hillslope instability address the following issues:

- Large hillslope is slowly sloughing off toward the river below on the opposite bank from Rose's Café.
- Rate of movement and potential for disturbance is unknown.
- Slope failure may cause river to shift towards café.

The County is considering the feasibility of installing devices to monitor the hillslope instability near Rose's Café. One of these devices, an inclinometer, is a probe that can be lowered into a borehole crossing the shear zone of the hillslope. The inclinometer would detect any sliding and record readings with a continuous data logger. The system can be set up with an alarm to warn of significant sliding before catastrophic failure occurs. Different hillslope failure scenarios could be modeled using the floodplain model and LIDAR data to map and analyze hydrologic/hydraulic impacts on the river system and nearby properties.

PUBLIC EDUCATION, OUTREACH, AND PUBLIC SAFETY

Public information activities are used to inform people of the risks associated with flood hazards and about flood insurance and ways to reduce flood damage. Measures that were discussed to increase public awareness included implementing a public outreach program, establishing a flood protection library, and increasing technical support and public services. The alternatives described in Table 9-7 address the following issues (see Table 7-1 for letter codes of Identified Flooding Issues, additional issues are referred to in other sections of chapter 9):

C. Public perception and lack of confidence in FEMA's flood insurance program and emergency relief operations following the 1996 flood

D. Lack of public understanding of river system behavior and flood hazards

E. Public health and safety

F. Advertising the County's open space taxation program, conservation easements, etc.

G. Understanding of the County's roles in emergency management

H. Lack of knowledge of the physical and ecological functions of the floodplain

I. Technical assistance currently unavailable.

Public Outreach and Flood Preparedness Program

There are several avenues that public outreach and flood preparedness programs can use to meet their goals, including the following:

- Convey information using advertising tools such as commercials on the radio, newsletters, annual fliers included with utility bills, or a prominent information display at the public library;

TABLE 9-7.
PUBLIC EDUCATION ALTERNATIVES

Description	Selected for Recommendation	Goals Addressed[a]
Develop a SMD/FCZD library for documents, maps, research reports, periodicals, photos, etc. Include flood protection information in the SMD/FCZD library.	Yes	3, 6
Recommendations related to public outreach:		
Provide flood preparedness, outreach and education programs that emphasize what owners can do to be prepared to minimize damage to their property.	Yes	3, 6
Implement outreach projects to inform the public about the open space taxation program and the floodplain's physical and ecological functions.	Yes	3
Incorporate public education projects that provide information to the public about post disaster flood relief.	Yes	3
Use public education projects to gain CRS credits, when the program is joined.	Yes	3, 4
Recommendations related to publishing maps for public use:		
Include channel migration hazard maps and information in the flood protection library and other county information sources.	Yes	3, 6
Continue to make flood inundation maps available to the public. Have maps at the Planning Division, public libraries and on the web.	Yes	3, 6
Recommendations related to technical assistance:		
Continue to provide informal floodplain information to the public as a free public service.	Yes	3, 6
Provide technical assistance on desired techniques for bank stabilization and flood protection, and the permitting process (trained staff, brochures on acceptable techniques, field assistance, funding sources). Include information on acceptable bioengineering techniques for bank stabilization and native vegetation that will enhance and stabilize the riparian zones.	Yes	2, 3, 6, 7
Develop and provide information on any available voluntary relocation opportunities to floodplain residents through the Planning Division, permit services division, and SMD/FCZD library.	Yes	2, 3, 6
Send out notifications to floodplain properties. This should include periodic reminders of flood season, their location in the floodplain, about relevant county policies, and where they can receive additional information should they want more.	Yes	3, 6
Increase public awareness on post-flood drinking water well safety, well testing, and health risks associated with flooded septic systems. Make clear the locations of public water supplies temporarily available to residents after a flood. (See Also Flood Response Plan Alternatives in Emergency Management section)	Yes	3, 6

a. Goals are described in Chapter 1

- Use Yakima County's GIS Department to map and identify the owners of all properties within the floodplain and send out notifications. Notifications would describe the property's floodplain status and would include information on flood hazards and flood preparedness, flood insurance and ways that owners can protect their property;
- Add flood data coverages (using GIS on-line mapping tools) and flood hazard information to the County web site as it becomes available. Flood data can include historical areas of flood damage, the regulated floodplain boundaries and channel migration hazard zones, inundation maps, and maps relating road closures to flood stage;
- Participate in community events such as fairs by hosting a booth to hand out pamphlets and answer questions.

Additional information that could be conveyed through public outreach and a flood preparedness program including the following:

- The fact that most homeowner's insurance policies do not cover flood damage;
- Natural and beneficial functions of the river's floodplain;
- Information on appropriate siting, design and retrofitting methods for on-site septic systems;
- The importance of limiting unnecessary access to emergency routes during floods (reduce the number of gawkers);
- Information on the NFIP and disaster relief, including benefits received by insured property owners over those without flood insurance. Important information includes the following:
  - In the 1995-1996 floods, flood insurance claims paid out almost 10 times the amount of disaster grants;
  - Flood insurance claims are required to be settled within 60 days, though most cases are closed in less time;
  - In order to receive a Replacement Cost claim adjustment on a flood insurance policy, the insured needs to take out an amount of at least 80 percent of the replacement cost value of a residential structure;
  - Options are available to reduce annual premiums by choosing a higher deductible;
  - Most uninsured property owners are not eligible for IFG disaster grants, but only for the SBA disaster loan, which must be repaid;
  - A new FEMA policy requires individuals who received disaster assistance, in the form of an SBA loan or IFG grant, after February 7, 1998 to purchase flood insurance coverage, otherwise future disaster assistance will be denied;
  - This requirement to maintain flood insurance coverage stays with the structure that received the disaster assistance.

Key advantages of these alternatives are as follows:

- Many of these activities would be easy to implement in a short period of time;
- Activities would be relatively inexpensive;
- These actions would increase awareness of flood hazard potential among floodplain residents;
- Public understanding of how disaster relief is allocated and the benefits of owning flood insurance would improve the public's perception of the NFIP and could increase the number of residents who buy flood insurance;
- Notifying residents of their floodplain status would help decrease the number of "don't know" disclosure statements to potential buyers (see explanation below);
- Using GIS information already in the County's possession would save taxpayers the fees commonly associated with professional floodplain determination services;
- Activities can be used to gain CRS credits.

There are few disadvantages to implementing outreach and flood preparedness programs. Implementing an outreach program is an inexpensive and effective way of increasing public awareness of flood hazards and increasing local response to flood emergencies. These programs can also help gain public support for future floodplain management programs and capital improvements.

The success of this program will depend on the public's perceptions and attitudes toward the severity and likelihood of flooding in their neighborhoods. Many people may still think the cost of flood insurance outweighs the potential for damage. It should be stressed that purchasing flood insurance is the only mechanism that floodplain property owners can use to receive the replacement costs of their losses, and that the average payout of $2,500 for disaster assistance (IFG grants) is far less than what is paid out to insured property owners. Flood insurance covers losses up to $250,000 for single-family residences and more for other structures, whereas IFG grants are capped at $13,000.

Establishing a Flood Protection Resource Section in Local Libraries

The County could establish an area in public libraries where information on flood protection can be found. A clearly labeled location provides a reliable source for the public. The section should include FEMA maps and documents, channel migration hazard zone maps, city and county ordinances, and pamphlets that give recommendations for flood protection and preparedness. This would also be an opportunity to advertise programs such as the Open Space Taxation Program and conservation easements.

Identifying Ways to Improve Hazard Disclosure

RCW 64.06.020 requires sellers of real property in Washington to disclose to buyers if a property is within a designated floodplain or flood hazard zone (Items 7(d) and 7(e) of the real property transfer disclosure statement). Disclosure is based on the seller's actual knowledge of the property at the time the disclosure form is completed. Response options for floodplain disclosure include "yes," "no," and "don't know." No further explanation or documentation is required. However, the seller is advised to obtain and pay for the services of a qualified specialist to determine the floodplain status of the property.

The County could achieve flood hazard reduction benefits by participating in a program for public disclosure of floodplain status. Actions to implement such a program could include the following:

- Require that a hazard disclosure statement be attached to the deed of sale for all sales of residential and commercial property in the floodplain.
- Use the DSC effort to streamline permit review coordination among County departments to ensure that project reviews are triggered (which are a form of hazard disclosure) for new projects or use changes within the floodplain.
- Perform standard public notification to all floodplain property owners and residents, and include information about floodplain status, the NFIP, and RCW 64.06.020 in a mailing to all floodplain residents. Refer property owners to qualified floodplain determination specialists, or establish a program to provide such services using the County's GIS.
- Publish flood inundation maps. Potential homebuyers who recognize from inundation maps that the property they plan to buy is frequently inundated may be deterred from the purchase. Inundation maps can also be used to educate existing property owners. The maps can show depths of flooding for various flood events (5-, 10-, 50-, and 100-year events) as well as flood extent.

Many benefits may be accrued from encouraging and supporting floodplain disclosure. If the County participates in determining floodplain status for floodplain residents, citizens will become more aware of the magnitude of the flood threat and associated risks, will be more active in reducing flood risks, and could receive lower flood insurance rates. Currently, zoning regulations in the Yakima Urban Area implicitly support property disclosure by triggering project reviews for new projects or use changes within the established flood overlay zone. New developments outside the existing flood overlay zone, or floodplain property transfers, may take place without proper disclosure of floodplain status.

The opportunity exists to increase floodplain disclosure by using the County's GIS to publish notifications of floodplain occupancy to each affected property owner. These notifications could be accompanied by information on the NFIP. This action would reduce the incidence of "don't know" disclosure statements, increase flood insurance coverage in the County, and possibly decrease flood insurance rates. Using GIS information already in the possession of the County would save taxpayers the fees commonly associated with professional floodplain determination services. The effectiveness of this mechanism is limited by the accuracy of the NFIP maps, emphasizing the need to keep these maps up to date and accurate.

Technical Assistance Activities

The County currently provides map determinations as a free public service, which is a valuable resource for potential buyers and existing landowners. To expand on this public outreach, the County could also assist property owners with technical questions on the NFIP, appropriate floodproofing and flood damage reduction measures, state and local ordinances related to floodplain management, and acceptable methods (standard and bioengineered) for stabilizing embankments. Providing technical assistance to property owners and developers will help reduce confusion over interpretation of development regulations and land use codes. The Yakima Health Department could also provide technical assistance on proper methods of retrofitting drinking water wells to protect them from contamination, as well as proper procedures for post-flood well testing.

The County could train existing staff to answer technical questions and interpret FIRM maps using FEMA publications as training materials. Free classes for County employees are available through the state Emergency Management office at Camp Murray and through FEMA's Emergency Management Institute in Emmitsburg, Maryland.

IMPLEMENTATION FUNDING

An adequate and on-going source of funding is critical to the successful implementation of the Naches River CFHMP Action Plan. Most of these projects in whole or in part will be funded by the Flood Control Zone District. On May 4, 2004 a permanent funding mechanism was established. This was critical step in plan implementation since many of the actions recommended are on-going projects that will need a long-term source of funding to be successful. Previous to the establishment of this funding mechanism the following recommendation was made to address the issue of long-term funding:

- Ensure future funds exist to implement the Naches River CFHMP by making the Flood Control Zone District a permanent funding mechanism. Update: permanent funding was established for the district in May 2004.

CHAPTER 10.
SUMMARY OF RECOMMENDED ACTIONS

This chapter presents an action plan for flood hazard management on the Lower Naches River that was developed in cooperation with the Citizen Advisory Committee and County officials. The recommended actions present a consistent and comprehensive approach that reflects the committee's vision for flood hazard management on the lower Naches River. The action plan is proactive, reducing future flood impacts through compatible land use, consistent regulation, efforts to better understand floodplain functions and factors influencing channel migration, and protective measures for citizens living in flood hazard areas and existing public facilities. The actions recommended are categorized as follows:

- Flood hazard reduction for new and existing structures
- Open space preservation/habitat preservation and enhancement
- Public facilities
- Emergency management
- Mapping/data collection
- Public education, outreach, and public safety
- Implementation funding.

The action plan is outlined in Table 10-1. Related projects are listed as one group; in some cases these related projects have only one cost associated with them since they would be implemented at the same time as one overall project. Examples of this are the recommended revisions to the Flood Hazard Ordinance or the recommendations relating to public outreach, which would likely be developed and implemented at the same time.

Many of the recommendations give specific guidance on how projects can be implemented (e.g., the Ramblers Park alternatives) or identify specific project components to ensure that specific flooding problems are effectively addressed. Others are more general to give the responsible agency flexibility in implementing the recommendation. Examples of this type of recommendation are the open space preservation/habitat preservation and enhancement policy recommendations, and programmatic and regulatory actions listed under Flood Hazard Reduction for New and Existing Structures. In some cases, the CAC could not reach agreement on how certain actions would be implemented but felt strongly that the recommendation should continue to be pursued. In these cases the recommendation is written as "consider" or "continue to consider." Detailed discussion of the recommendations and the approach used to formulate them is provided in Chapters 8 and 9.

Estimated costs for each recommendation were developed by the consultant after they were organized into related projects and non-related projects. Cost estimates assume a County cost of $70,000 for one full time employee (FTE), which includes overhead and material expenses. Property values for capital improvement projects were referenced from the County Assessor's Database through the Yakima County GIS. The property value reflects the assessed value of the land and improvements (buildings) and any additional costs where applicable, such as forest or agricultural resources on the property, which would increase the property's sale value.

The Surface Water Management Division/Flood Control Zone District (SMD/FCZD) will lead the effort to implement the Naches River CFHMP by providing guidance and direction in the following ways:

- Administering the implementation of the CFHMP by working with the agencies and parties responsible for implementing the recommended projects and programs
- Updating the CFHMP as projects are completed and keeping the plan consistent with current conditions

This CFHMP should be updated periodically to account for actions that have been completed and changes in local conditions that affect how the plan or specific projects are implemented. Several of the recommendations will need further study and analysis to assess their overall impacts and effectiveness. This includes the City of Yakima Water Treatment Facility river reach, where the FCZD recommended additional study, and the Ramblers Park alternative, which will require further analysis in the form of hydraulic modeling to assess the overall impact of various actions on flooding. These subsequent analyses may be done concurrently with the current hydraulic modeling effort for the lower Naches River.

TABLE 10-1.
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Flood Hazard Reduction for New Development and Existing Structures (Issues[b] N, Q R, S, E)			
1. Prohibit surface mining within this reach to reduce impacts on channel migration and habitat and the need for levees. SMD/FCZD will provide support as needed.	H	$21,000	Yakima County Planning Division
2. Prohibit the creation of new lots entirely within the floodplain and require new partial lots to have at least a 5,000-square-foot building envelope outside the floodplain. Implement for the study reach during the revision or update of the Critical Areas Ordinance, with support provided by SMD/FCZD as needed.	H	$14,000	Yakima County Planning Division
Revise ordinances:		$126,000	Permit process – Agency with applicable review process oversight (GMA, SMA, NFIP, SEPA). Mailings – SMD/FCZD
3. Establish a freeboard of 1 to 3 feet above the base flood elevation to which the lowest floor of residential buildings must be elevated.	H		
4. Increase to 1 to 3 feet above the base flood elevation the elevation to which the lowest floor of nonresidential buildings must be elevated	H		
5. Require compensatory storage for all fill in the floodplain or fill beyond a set volume to prevent increases in downstream flood peaks. Single-family homes (not subdivisions) would be exempt.	H		
6. Require new structures on all existing floodplain lots to be placed at the safest location on the property, with consideration of the feasibility of meeting other requirements such as siting of septic systems.	H		
7. Adopt specific channel migration/avulsion regulations that prevent the construction or substantial reconstruction (as defined by the Flood Hazard Ordinance) of any residential, commercial, or industrial structures in channel migration hazard zones.	H		

a. Priority Codes: H = high; M = medium; L = low; C = currently being done or developed; P = policy recommendation (no priority or cost assigned to policy recommendations)
b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Flood Hazard Reduction for New Development and Existing Structures (Issues[b] N, Q R, S, E) (cont'd)			
Revise Ordinances (continued):			
8. Implement deep/fast-flowing water regulations to further define the floodway (see also Data Collection/Mapping – remapping project to include mapping regions of deep/fast-flowing water). Regulate the same as the regulatory floodway.	H		
9. Properly store hazardous/toxic materials in the floodplain to keep them safe from floodwaters. Implement by providing safe materials storage information during permitting processes. Also send information to existing properties within the study area.	H		
10. Naches Wonderland—Use the revised hydraulic river model for the lower Naches River and the results of the Channel Migration Study to identify the nature of and likelihood of severe flood damage or erosion hazard. Identify appropriate measures to protect or move permanent structures if needed. The estimated cost applies to the study only. The cost of any actions or projects resulting from the study would be determined at that time with the possibility of funding coming from the application of a FCZD sub-zone. (other subdivision constraints may impact this recommendation)	H	$5,000	SMD/FCZD
11. Acquire or relocate floodprone structures or land uses with equitable compensation when money is available and owner is willing. This project will be implemented through the Non-regulatory Natural Resource Protection Program, in policies currently being developed by the Yakima County Planning Division.	M	$900,000	Yakima County Planning Division, SMD/FCZD
12. Implement a limited cost-share program to floodproof or elevate residential structures. This action is to be used only in extreme cases, as determined by the SMD/FCZD.	M	$3,500	SMD/FCZD

a. Priority Codes: H = high; M = medium; L = low; C = currently being done or developed; P = policy recommendation (no priority or cost assigned to policy recommendations)
b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Flood Hazard Reduction for New Development and Existing Structures (Issues[b] N, Q R, S, E) (cont'd)			
13. Ensure that future comprehensive plan revisions and policies are compatible with CFHMP goals and policies. Examples could include transfer of development rights or cluster lot development to decrease floodplain development. Implementation support to be provided by SMD/FCZD as needed. Reach-specific policies, goals, and standards shall be created in the comprehensive plan by reference to the CFHMP.	M	$3,500	Yakima County Planning Division, Yakima County Building and Fire Safety Division
Ramblers Park Recommended Actions	H		
14. Implement a buyout program to relocate some residents and businesses. Listed cost is the low- and high-end assessed values for properties in Ramblers Park. Cost includes assessed land value and improvements (buildings). The average property value is $159,100. This effort should be coordinated by SMD/FCZD with the Yakima County Non-Regulatory Natural Resource Protection program in conjunction with the Yakima County Planning Division.		Property values range from $43,000 to $473,000	SMD/FCZD in conjunction with others
15. Seek ways to relocate residences or businesses using partial grant funds and cooperative projects with owners, such as is being done in the current project by SMD/FCZD and the Yakima County Planning Division to relocate Auto Recycling facilities from the high hazard floodplains, using Ecology Centennial Grant funds.			
16. Seek ways to relocate residences and businesses during County or State transportation projects.			
17. Continue to study Ramblers Park. If certain facilities are relocated, the existing levee should be removed and a setback levee constructed closer to Highway 12/Powerhouse Road.			

a. Priority Codes: H = high; M = medium; L = low; C = currently being done or developed; P = policy recommendation (no priority or cost assigned to policy recommendations)
b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Flood Hazard Reduction for New Development and Existing Structures (Issues[b] N, Q R, S, E) (cont'd)			
18. McCormick Levee—Continue to stabilize the eroding portion of the McCormick levee using techniques that enhance fish and wildlife habitat conditions. Repair and enhancement project was completed, but additional measures may be required. Generate funds from residents and businesses protected by the levee by developing a sub-zone.	C	\$125,000-\$200,000	SMD/FCZD
19. Bioengineered bank stabilization devices (engineered logjams, replanting of trees and other riparian vegetation, cabled root wads, etc.) are preferred where relocation is not an option. Implement through the local permitting process (including GMA, SMA, and NFIP related reviews/permits) and during environmental review (SEPA). This recommendation also applies to County and city projects.	P		Implemented by the agency with oversight over the applicable review process. Proposed techniques to be reviewed by SMD/FCZD for technical concerns
20. Use conventional bank stabilization devices (spur dikes, barbs, trench fill revetment, approach dikes at bridges, etc.) in conjunction with habitat mitigation as a last resort for protecting existing structures that cannot be relocated. Implement through the local permitting process (including GMA, SMA, and NFIP related reviews/permits) and during environmental review (SEPA). This recommendation also applies to County and city projects.	P		Implemented by the agency with oversight over the applicable review process. Proposed techniques to be reviewed by SMD/FCZD for technical concerns
Open Space Preservation/Habitat Preservation and Enhancement (Issues[b] E, F, N, S)			
21. Continue to operate and promote the Open Space Tax Program	H	Inclusion of numerous floodplain parcels may cause a minor reduction in revenue	Yakima County Planning Division

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b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Open Space Preservation/Habitat Preservation and Enhancement (Issues[b] E, F, N, S) (cont'd)			
22. During permit review, continue to look for ways to coordinate current and ongoing restoration and mitigation projects in the study area to maximize benefits.	C	—	Agency with oversight over the applicable review process (GMA, SMA, NFIP, SEPA)
23. Consider keeping undeveloped County-owned parcels in flood hazard areas as permanent open space by attaching deed restrictions, using conservation easements, etc. Cost associated with implementing this policy (review of this issue by County officials) was estimated to be $5,000. Consultation with all County divisions/departments that own properties in flood hazard areas shall be done during the implementation of this policy. This policy shall not override an imminent planned use of a property unless fair compensation to the owner is made.	P	—	Yakima County Planning Division, SMD/FCZD
24. Use regulatory and non-regulatory tools to promote preserving and increasing open space areas in the floodplain. These tools include the Non-Regulatory Natural Resource Protection Program, the Open Space Tax Program, policies currently being developed by the Yakima County Planning Division, and the Channel Migration Zone regulations.	P	—	Yakima County Planning Division, SMD/FCZD
25. Pursue open space preservation (increasing amount of floodplain open space through purchase, conservation easements, etc. versus permanently maintaining existing open space parcels)	P	—	Yakima County Planning Division, SMD/FCZD
Public Facilities (Issues[b] N, O, U)			
26. Craig Road Flooding—Reconstruct the South Naches Irrigation District (SNID) headgate and levee to eliminate imminent flood hazard. SMD/FCZD is currently a member of the technical advisory team for SNID's irrigation district management plan. Other assistance is possible.	C		South Naches Irrigation District

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b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Public Facilities (Issues[b] N, O, U) (continued)			
27. Add a new section for the siting of critical facilities. Prohibit construction in the floodplain, and require critical facilities to be elevated at least 2 feet above the base flood elevation. Require these facilities to be accessible during a flood. The addition of new critical facilities in the floodplain is not expected to be a significant issue in the future, therefore this action was given a low priority.	L	$14,000	Yakima County Planning Division, Yakima County Building and Fire Safety Division
28. Relocate Lewis Road, in conjunction with the South Naches Road upgrade project, to an alignment that does not result in damage to the road during flood events or when inundated. Road may be elevated above the BFE if it is set back far enough from the river. Channel migration issues are a factor and should be carefully considered in siting this facility. Alignment and design criteria assistance to be provided by SMD/FCZD. Project is in design phase.	C	$200,000 funded by SMD/FCZD to County Road Fund	Yakima County Public Services, Transportation/ Engineering/ Right of Way Divisions
29. Continue to discuss options to protect Highway 12 and increase floodplain storage with WSDOT.	C	—	SMD/FCZD
30. Evaluate the potential for relocating levees away from the river or removing them to reduce flood hazards. Implement with cooperation from WSDOT, City of Yakima and others as time and opportunities allow. Implementation of a specific levee setback or removal project may require partnerships and external funding assistance.	M	$28,000	SMD/FCZD
31. Design and construct roads such that they are flood resistant where needed. These include erosion resistant shoulders or dips in the roadway. This is currently being applied in the design and construction of new roads and roadway improvements.	C	—	Yakima County Building and Fire Safety Division, SMD/FCZD

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b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Public Facilities (Issues[b] N, O, U) (continued)			
32. Encourage the modification of headgate structures to make them less susceptible to damage from flood debris and ice jams, including conversion of smaller canals to piped/pressurized systems or by combining diversions.	C	$2,000	SMD/FCZD
33. Work with WSDOT to identify potential sites where minor work on Highway 12 will result in the safe reconnection of floodplain area or side channels. Cooperate with WSDOT as time and opportunities allow. A specific floodplain reconnection project may require partnerships with WDFW, WSDOT, and SMD/FCZD and others to obtain funding.	L	$2,000	WSDOT
34. Use the revised hydraulic river model for the lower Naches River to analyze measures at the City of Yakima Water Treatment Plant to increase the facility's level of protection. Specifically, evaluate the construction of a setback levee or removal of the existing levees located on the opposite side of the plant to reduce the potential for erosion of the Treatment Plant levee and Highway 12. Conduct analysis as part of modeling used to revise FIRMs. Implementation of a setback project will require partnerships with the City of Yakima, SMD/FCZD, property owners, and others to obtain funding.	L	$13,000	SMD/FCZD
35. When new bridges are constructed, or bridges are rebuilt or replaced, the bridge should span the floodway as much as possible. This prevents the new bridge from creating additional flooding. Implement through applicable permitting programs (GMA, SMA, NFIP).	P		For County projects, the policy will be implemented by the Public Services Department Implement by department/agency that has oversight of related permits.

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b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Emergency Management (Issues[b] J, K, L, M)			
Recommendations related to Emergency Response currently being considered in the development of a Flood Emergency Response Plan: 36. Create, publicize, and implement an action plan for use in the Emergency Operations Center during a flood event. 37. Emphasize what the County's roles are in providing flood response, including sandbagging, evacuation notices, etc. 38. Document flood warning and emergency response activities to gain more credits in CRS program, when the program is joined. 39. Establish evacuation procedures and routes considering flooded roads (fire departments). 40. Ensure provisions have been made for warning and self-evacuation for all occupied structures during a flood if they do not have dry land access. 41. Coordinate training classes and materials for emergency personnel, police, fire and public services on their responsibilities during a flood. 42. Promote EMI training courses for emergency personnel. 43. Promote police patrols at emergency access routes during flood events. 44. Publish maps showing evacuation routes and gage height at which roads are flooded/closed (see also evacuation recommendations under Emergency Management). 45. Increase public awareness on post-flood drinking water well safety, well testing, and health risks associated with flooded septic systems. Make clear the locations of public water supplies temporarily available to residents after a flood.	C	Funds already allocated for Flood Emergency Response Plan	Yakima Valley Office of Emergency Management, SMD/FCZD, in cooperation with other agencies

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b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority [a]	Cost Estimate	Implementing Agency
Emergency Management (Issues[b] J, K, L, M) (continued)			
Recommendations related to improving access to flood-fighting materials: 46. Provide access to flood-fighting materials including sand, sandbags, etc. at fire stations. 47. Improve access to flood-fighting materials by organizing and advertising locations for pick-up and stocking materials before flood season. Implement in SMD/FCZD sandbag machine/equipment purchasing/siting project currently underway.	C	Funds already allocated	SMD/FCZD
Mapping/Data Collection (Issues[b] A, B, W)			
48. Update existing FEMA floodplain maps and facilitate future updates as needed. Include regions of fast/deep flowing water. Create a hydraulic model of the river to predict flood heights and areas of inundation based on the USBR gage reading at Naches. Coordinate with new FEMA mapping initiative. Implement as next phase of the Naches River CFHMP project (project currently underway).	C	$250,000	SMD/FCZD
49. Map channel migration hazard zones. Recently completed through the Naches Channel Migration Study. Implement as part of current Naches River CFHMP project. See #7 and 24 above for incorporation into CAO.	C	$50,000	SMD/FCZD
50. Monitor hill slope instability near Rose's Cafe to determine the overall rate of movement of the instability and provide warning of imminent failure.	M	$8,500	SMD/FCZD
51. Continue to collect new channel information and data over time, using LIDAR and/or other techniques. Periodically review channel migration hazard and FEMA floodplain maps to determine the need to update the maps. Incorporate new technology as it becomes available. Seek partnerships with others. Cost estimate includes periodic mapping assessment.	M	Up to $25,000 every 2-5 years	SMD/FCZD

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b. Issues are defined in Table 7-1

TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Mapping/Data Collection (Issues[b] A, B, W) (continued)			
52. Encourage an update to the NWS flood-forecasting model for the Naches River, if not already updated.	M	$2,000	SMD/FCZD
53. Research studies of basins similar to the Naches Basin on how altered flow regimes have affected sediment transport, flooding, geomorphology, etc. Implement as time and opportunity allow. Consider partnerships with others with similar interests, such as USBR, WDFW, Yakama Nation, Central Washington University.	M	$7,000	SMD/FCZD
54. Continue to support and cooperate with the USBR on projects relating to the Naches River, including the current sediment transport study on the Tieton River, which will determine the impact of the Tieton River reservoir on sediment transport, flooding, and geomorphology in the Naches River.	—	—	SMD/FCZD
55. Use mapping activities to gain CRS credits, if the CRS program is joined. SMD/FCZD will coordinate with the Yakima County Planning Division and Building and Fire Safety Division.	P		SMD/FCZD
Public Education, Outreach, and Public Safety (Issues[b] C, D, E, F, G, H, I)			
56. Develop a SMD/FCZD library for documents, maps, research reports, periodicals, photos, etc. Include flood protection information in the SMD/FCZD library.	H	$25,000	SMD/FCZD
Recommendations related to public outreach:		$21,000	
57. Provide flood preparedness, outreach and education programs that emphasize what owners can do to be prepared to minimize damage to their property.	H		SMD/FCZD, Yakima County Planning Division, Building and Fire Safety Division, Yakima Valley Office of Emergency Management

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TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Public Education, Outreach, and Public Safety (Issues[b] C, D, E, F, G, H, I) (continued)			
Recommendations related to public outreach (cont'd):			
58. Implement outreach projects to inform the public about the Open Space Tax Program and the floodplain's physical and ecological functions.	M		SMD/FCZD, Yakima County Planning Division, Building and Fire Safety Division
59. Incorporate public education projects that provide information to the public about post-disaster flood relief.	M		SMD/FCZD
60. Use public education projects to gain CRS credits, when the program is joined.	M		SMD/FCZD
Recommendations related to publishing maps for public use:		$8,500	
61. Include channel migration hazard maps and information in the flood protection library and other county information sources.	H		SMD/FCZD
62. Continue to make flood inundation maps available to the public. Have maps at the Planning Division, public libraries and on the web.	M		SMD/FCZD
Recommendations related to technical assistance:		$14,000	
63. Continue to provide informal floodplain information to the public as a free public service.	H	No new costs	SMD/FCZD, Planning Division, Building and Fire Safety Division

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TABLE 10-1 (continued).
NACHES RIVER CFHMP ACTION PLAN

Recommendation	Priority[a]	Cost Estimate	Implementing Agency
Public Education, Outreach, and Public Safety (Issues[b] C, D, E, F, G, H, I) (continued)			
Recommendations related to technical assistance (cont'd):			
64. Provide technical assistance on desired techniques for bank stabilization and flood protection, and the permitting process (trained staff, brochures on acceptable techniques, field assistance, funding sources). Include information on acceptable bioengineering techniques for bank stabilization and native vegetation that will enhance and stabilize the riparian zones.	M		SMD/FCZD with coordination with the Yakima County Planning Division, Building and Fire Safety Division, and WDFW
65. Develop and provide information on any available voluntary relocation opportunities to floodplain residents through the Planning Division, Building and Fire Safety Division, and SMD/FCZD library.	M	$5,000	Permit review: Yakima County Planning Division, Building and Fire Safety Division Library and walk-in customers: SMD/FCZD
66. Send out notifications to floodplain properties. This should include periodic reminders of flood season, their location in the floodplain, information about relevant County policies, and where they can receive additional information should they want more.	M	$1,000/year	SMD/FCZD
Implementation Funding			
67. Ensure future funds exist to implement the Naches River CFHMP by making the Flood Control Zone District a permanent funding mechanism. Update: permanent funding was established for the FCZD in May 2004.	C	$10,000	SMD/FCZD Yakima County Planning Division

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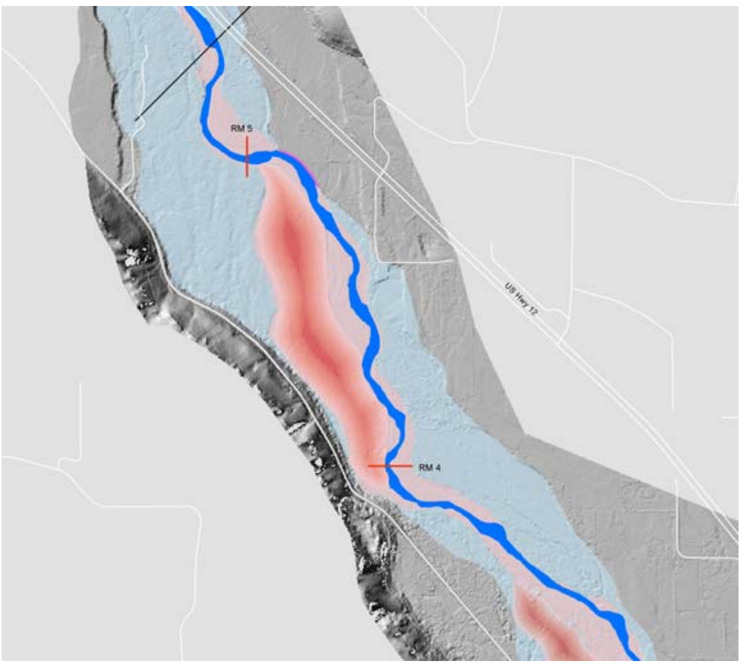
NACHES RIVER CHANNEL MIGRATION STUDY

Draft Report



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Yakima County

Tetra Tech/KCM

October 2003

NACHES RIVER CHANNEL MIGRATION STUDY

June 2004

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Naches River Channel Migration Study
TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

CHAPTER 1.
INTRODUCTION

This study reports the results of a channel migration zone (CMZ) study on the lower Naches River, from the twin Highway 12 bridges over the Naches River near Gleed upstream to the Highway 12 bridge over the Naches River ("the Y") near the junction of Highways 410 and 12 above the Town of Naches (see Figure 1-1). This reach of the lower Naches River is approximately 15 miles long and lies entirely within Yakima County. It has a long history of active channel migration. Local residents have witnessed dramatic channel changes; even more extensive channel migration is evident from ancient channels recognizable on aerial photographs and LIDAR images.

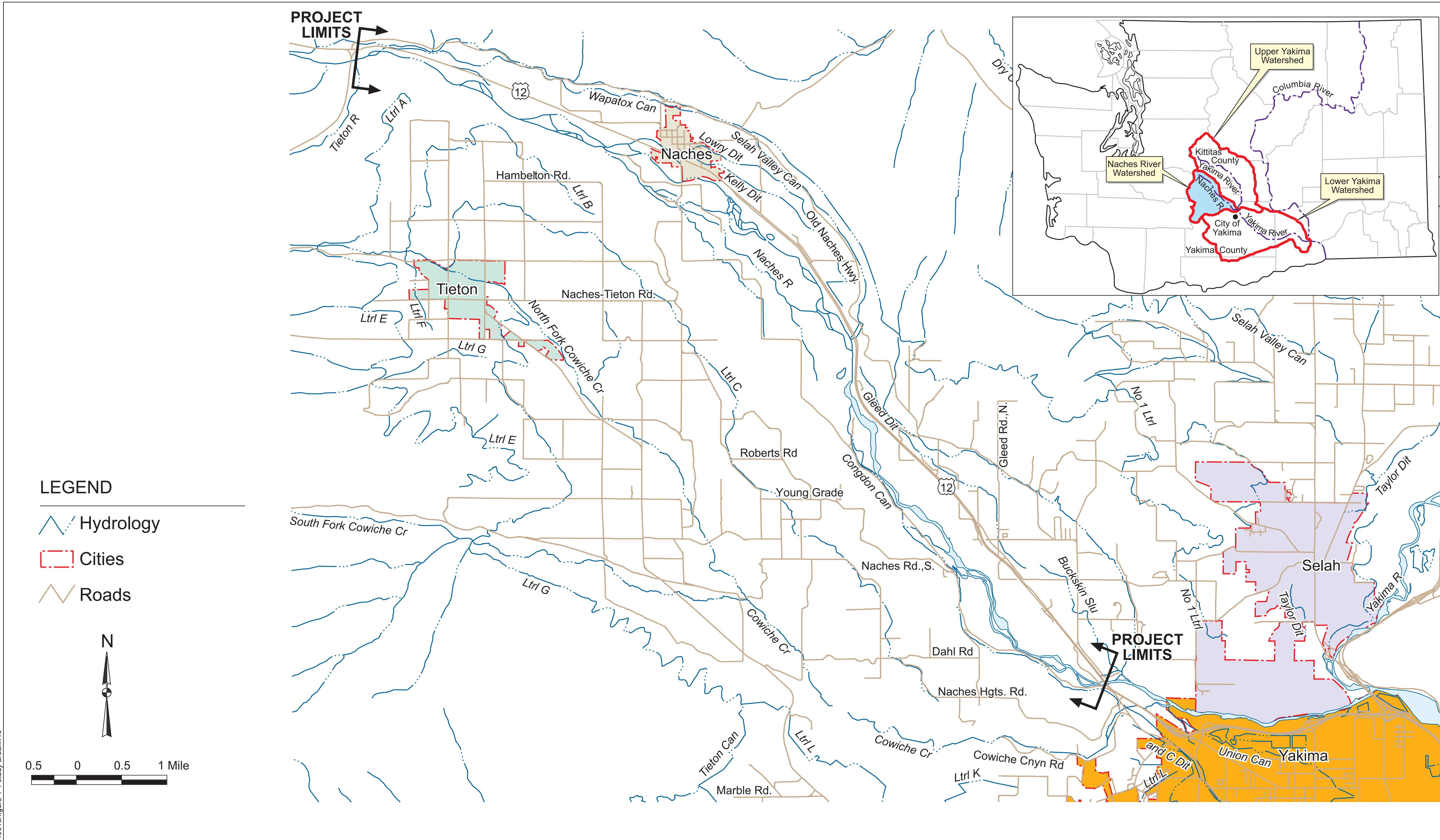
Yakima County elected to conduct a channel migration study to identify and better understand the flood hazards associated with channel migration along the Naches River and to develop a more effective means of protecting public and private property from the risks associated with future channel migration. The primary products of this study are the Channel Migration Hazard Zone maps, which will be used as a tool for regulating land use and future development in CMZs along the lower Naches River corridor. The maps identify high and medium channel migration hazard zones and potential avulsion hazards associated with channel migration.

HISTORICAL CONTEXT AND NEED FOR CMZ DELINEATION

Federal Emergency Management Agency (FEMA) flood insurance rate maps (FIRMs) are used by most communities to identify flood hazard areas, but these maps historically have not shown CMZ hazard areas. In the past, FIRMs were the only available tool for local governments such as Yakima County to determine where development can be allowed along rivers such as the Naches. Although the maps show flood hazard areas subject to inundation, they are based on fixed-bed hydraulics, which neglects channel movement. The maps do not characterize areas of the channel that have suffered or are likely to suffer erosion problems. In most situations channel migrations rates are relatively slow, and FIRMs remain useful for many years.

In the Naches River system, where some areas exhibit high rates of channel movement, channel migration presents a hazard different from flooding. The risk to land, structures and people from channel migration can be much more severe than from inundation alone, as a sudden channel shift may sweep a structure or hundreds of feet of riverbank away in one event. Channel migration is a continuous process. Typically, annual high flows and frequent small-magnitude flood events contribute more to long-term channel migration than less frequent severe flood events. Over time, the spatial extent of the river channel and its floodplain can change significantly and impact new areas.

The traditional approach to managing channel migration, locally and worldwide, has been to replace erodible river banks with hard surfaces such as riprap. Within the Naches study area, several discontinuous sections of levee were constructed to attempt to control the path of the river. Levees owned by Yakima County or the City of Yakima are actively maintained and create segments where channel movement is confined to a narrow corridor. Other



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Yakima County
NACHES RIVER CHANNEL MIGRATION STUDY

Figure 1-1.
NACHES RIVER STUDY AREA

structures identified in the field as likely abandoned dikes or private flood control levees can affect migration rates but to an uncertain degree, since most do not appear to be actively maintained. Other engineered structures that impede channel migration also exist in the study area; these include Highway 12 and its roadway embankment, the Highway 12 twin bridges, the Powerhouse Road bridge, the South Naches Road bridge south of the Town of Naches, the Wapatox diversion dam, and the City of Yakima water filtration plant and associated intake structures. These channel control structures create an ongoing maintenance requirement to ensure that they remain stable and secure. Though they provide protection for critical facilities and vulnerable developed areas, they can also deflect a bank erosion problem to another location in the river system.

These manmade structures have had limited success in preventing the Naches River from migrating into areas that damage public and private property. Two locations along the study reach that experience recurring and severe flood damage are the Ramblers Park and Lewis Road areas. The flood problems in both areas are related to channel migration.

REGULATORY CONTEXT

Federal and state regulations that relate to the management of channel migration hazard areas include the National Flood Insurance Program, the Endangered Species Act, the Shoreline Management Act and the Floodplain Management Program.

Floodplain Management

The National Flood Insurance Program (NFIP) and the state Floodplain Management Program support local communities in identifying channel migration hazards and incorporating CMZ hazards into their floodplain management programs. The state's Flood Control Assistance Account Program (FCAAP), through the Floodplain Management Program, provides financial assistance to communities that adopt Comprehensive Flood Hazard Management Plans (CFHMP). In a CFHMP, local agencies are required to lay out a plan for meeting all the requirement of the NFIP and the state program, and provide measures for effectively managing flood hazards in floodplains and meander belts. Delineating a CMZ using contemporary methods incorporates the meander belt and hazards related to it and identifies potential avulsion hazards and erosion hazards.

Shoreline Management

The state's Shoreline Management Act requires local agencies to regulate "shorelines of state-wide significance" (the Naches River falls into this category), by preparing a Shoreline Master Plan (SMP). The SMP regulates development and future land uses in the shoreline area and must provide management strategies for CMZs. The state Department of Ecology is preparing a guidance document to assist local agencies in delineating CMZs and managing shorelines; the document will be included in Washington Administrative Code (WAC) Chapter 173-26. The state's work on the guidance document was monitored during the course of this project to ensure that the outcomes of the study will be compatible with the new state guidelines.

Endangered Species Act

Limit 12 of the 4(d) rule of the Endangered Species Act (ESA) requires the delineation of CMZs (where they apply) for proposed development in areas of municipal, residential, commercial, and industrial (MRCI) development and redevelopment, to identify potential habitat impacts. For the listed anadromous fish in the Naches River (salmon and steelhead), the ESA is administered by National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries). The agency evaluates whether MRCI development ordinances or plans adequately conserve listed fish under their jurisdiction. There are twelve evaluation considerations, including impacts on riparian buffer zones, which are measured from the edge of the CMZ. Also considered are how the MRCI ordinances or plans protect the CMZ and avoid bank hardening. These guidelines require the CMZ to be delineated.

OVERVIEW OF METHODS AND APPROACH

The methods and approach used to delineating CMZs for the lower Naches River incorporate contemporary and state-of-the-art techniques. Geomorphologists typically use historical and contemporary field information to delineate the CMZ. They often use aerial photographs and historical maps to map out the historical migration zone (HMZ), including rates of lateral channel movement. Detailed field work and further analysis of aerial photographs and hydrologic records enable geomorphologists to assess factors that affect the rate of channel migration, including bank erodibility, system hydrology, woody debris loading, vertical channel movement, and sediment supply. This data enables an evaluation of relative rates of channel movement, erosion hazard areas (EHAs), and avulsion hazard zones (AHZs). The information produced from these two study phases (historical and field) enables delineation of the CMZ, itself a product of the HMZ, EHA, and AHZ.

CHAPTER 2.
METHODOLOGY

Historical records (primarily aerial photos and maps) and field survey data were used to assess the magnitude and rate of historical channel migration. The field survey included a survey of cross-sections and an inventory of pertinent geomorphic features and man-made structures, such as levees, diversion dams, and related intake structures. Field reconnaissance was used to confirm or refine draft CMZ delineations and to collect additional information needed to assign risk categories to locations within the CMZ. This chapter describes the methods used to analyze the historical information and field data; Appendix A provides a glossary of terms.

ANALYSIS OF HISTORICAL RECORDS

Image Processing

The first step in this study was to identify historical Naches River channel positions in the study area. Aerial photos and maps were used to determine the historical channel positions at 9 points in time (dates listed in Table 2-1). These photos and maps were geo-rectified and mosaiced, then relevant channel features were digitized.

TABLE 2-1.
ROOT MEAN SQUARE ERRORS FOR RECTIFIED AERIAL PHOTOGRAPHS

	Root Mean Square Error (meters)	
Date	X	Y
1927	5.6	5.75
1947	6.3	7.0
1956-9	3.9	4.2
1972	4.4	3.8
1984-85	3.8	4.0
1992	3.7	3.5
1996	4.0	3.6
1998	2.8	3.1
2000[a]	0.0	0.0

a. The 2000 photograph is the one used as the ground control point source, therefore the RMSE is zero.

Image processing, digitizing, overlay and analysis of these features was accomplished with the aid of geospatial software programs including ERDAS Imagine and ArcGIS. The maps and photographs, initially in analog format, were scanned, scaled and then rectified using a color infrared (CIR) digital imagery base map created in 2000. In rectifying each image, standard image processing guidelines using ground control points (GCPs) were followed (ERDAS 1999). Each image was visually checked for errors using independent GCPs, road centerlines and junctions digitized from the 2000 CIR data, and co-registration with the 2000 CIR base map. Co-registration is the process by which the digital maps were brought in to the same coordinate system, so that an X-Y coordinate on one map aligns with the same X-Y coordinate on the others (for example, a road junction on the 1947 image would align with the same road junction from the 2000 CIR and all other images). Afterward individual images were mosaiced to create a seamless image of the study reach for each time period.

Each mosaic was evaluated for accuracy using a standard error assessment technique, root mean square error (RMSE), which indicates the level of (global) error in the X and Y directions. Table 2-1 lists the RMSEs calculated for the mosaic from each time period. Considerable attention was paid to the river corridor area of the images to ensure that resampling of the images during the rectification process was most effective in that area. Because of this, the error in the region of the river channel is less than the mean global error estimate for the whole image in most cases.

The highest errors, 6.3 meters (X) and 7.0 meters (Y), are for the 1947 data. The source of error was the mosaicing of the original aerial photographs, which was done prior to acquisition for this study; some significant localized error problems were produced by the subjective nature in which the mosaic was created. Despite this uncertainty, the errors in the data are low enough that the dataset is still a reliable source for this CMZ task.

Digitizing the Active Channel and Significant Features

Channel position maps were constructed for each time period by displaying the image on-screen and digitizing the *active channel*, that is the area of the channel where sparse or unvegetated gravels indicate frequent inundation by flows. The channel centerline, primary and secondary low-flow channels at the time of image capture, and unvegetated gravel bars were also digitized. Other significant features that were digitized include the following:

- Relict channels visible on older photos and LIDAR images that show ancient channel positions
- Road and railway embankments that may function as obstacles to channel migration
- Concrete bridge abutments and irrigation diversion headworks that may fix the channel position in one location and that can deflect the river's erosive energy to a nearby location
- Bedrock outcrops and valley sides that may deter channel migration
- Existing, historical and likely snag sites for large woody debris (LWD) and other debris
- Beaver dam sites and activity
- Unstable banks
- Sediment-storage and sediment-transport dominated reaches.

Studies have shown that digitizing errors produce a relatively small error margin (Gurnell, Downward et al. 1994). In a study by Gurnell and Downward, in which a sample channel boundary was digitized 50 times using 1:10,000 maps and aerial photographs, a digitizing error margin of ±2 meters was determined. This information, in addition to the errors resulting from the co-registration of channel maps produced for this study, leads to the conclusion that differences in channel boundary positions in excess of 7.5 meters are likely to result from a component of channel movement rather than errors in data handling. In practice, the error is probably much less, and the most significant uncertainty will be a function of the difficulty in determining the boundary of the subjective *active channel* (described below). This is apparent even on the high-resolution 2-meter CIR 2000 data, where shadows cast by riparian vegetation conceal the edge of the channel on the imagery.

The focus of image processing and digitizing was to produce lines representing channel changes over successive years (i.e., channel planform) in a common map projection so that all the data can be readily compared quantitatively with an acceptable degree of reliability. Error sources were identified to assess the degree of reliability of the comparative mapping. The primary reliability problems arose from the use of older data sets—the 1927 data (in which the map was mosaiced by manually pasting together separate photographs) and the 1901 map. The errors due to the manual pasting of the 1927 photo are embedded in the digital version. The key uncertainties associated with using the 1901 map are the following:

- The 1901 map likely does not show the actual channel boundary but rather the centerline of the channel at the time of survey
- The map's scale is an order of magnitude smaller than all the other data used in this study

In addition, reliable rectification of this map was made difficult by a shortage of features present in both the 1901 and 2000 datasets. To overcome this, a crude rectification was carried out initially, followed by further refinement by subsequent re-rectification as features became recognizable as being present for both time periods. Subsequent draping of the rectified image over a contemporary 10-meter digital elevation model, shown in Figure 2-1, indicated that floodplain contours, as well as most key features such as roads, align remarkably well. Given these issues, the 1901 data was used primarily as a base map to discuss changes in channel migration on the Naches River in the post-dam era and was not used for quantitative comparison.

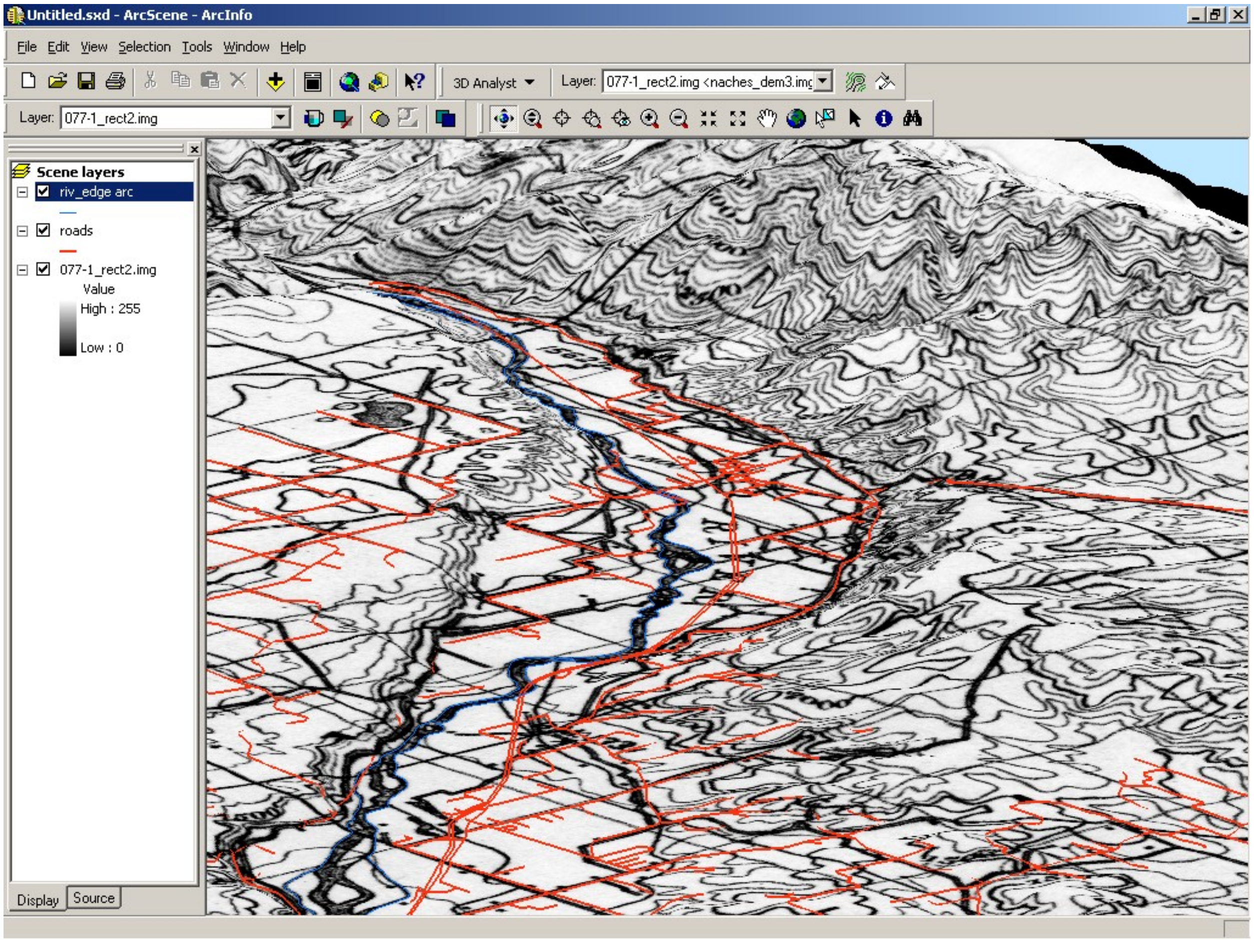

Figure 2-1. 1901 Map Draped onto a 10 meter Digital Elevation Model

CONSTRUCTION OF A DIGITAL ELEVATION MODEL

A digital elevation model (DEM) was created for the study area from a dense LIDAR-point data set created in 2000. This model provides elevation (Z) data with an absolute accuracy of 15 cm, and a relative accuracy of 10 cm. Absolute accuracy of the X-Y data was assessed to be within 0.5 meters. A bare-earth model was created from the LIDAR raw point data using an adaptive vegetation filtering technique adapted from Raber, (Jensen et al. 2002). This data was then interpolated using extra points in certain areas and a heightened channel center break-line to enforce hydrologic integrity.

LIDAR does not penetrate water, therefore in the low flow channel the LIDAR data shows the water surface instead of the channel bottom. These data points were filled in by incorporating the surveyed cross-sections of the low flow channel into the surface interpolation process.

A number of tests were conducted to ensure the reliability of the surface as a surface boundary for hydraulic modeling, for cutting channel and floodplain cross-sections, and for estimating gravel bar volumes. Methods and results are discussed in Aggett (in Press). The resulting DEM provides a reliable tool for the following:

- Determining the hydraulic geometry of the floodplain and active channel (excluding the low-flow wetted areas where the LIDAR data reflects the water surface rather then the river bottom)
- Assessing relative elevations of primary, secondary, and abandoned channels in order to evaluate avulsion hazards
- Estimating the volumes of stored sediment in gravel bars

The DEM also allows for the creation of shaded relief images to facilitate identification of historical channel migration patterns and allows "virtual" visits to the field to check field observations. The LIDAR DEM is used throughout this report as a base map for figures and for the draft CMZ maps It will be used in combination with surveyed cross-sections for subsequent hydraulic modeling work on the Naches River.

FIELD SURVEY

Approximately 50 cross-sections originally surveyed by the U.S. Army Corps of Engineers in 1972 were resurveyed for this study. The original surveyed cross-sections were used for development of the FEMA Flood Insurance Study upon which the Yakima County Flood Insurance Rate Maps are based (Corps of Engineers, 1972). A laser total-station survey was used to collect more than 50 dense cross-sections at important sections of the river, and additional cross-sections of the entire floodplain to validate sections cut from the DEM. The dense total-station survey data did not prove useful for that comparison however. A significant effort was made to try to match the two data sets for comparison, but the coarseness of the Corps cross-section data made creating a useful and meaningful comparison nearly impossible. Although there appears to be a correlation between data sets near the center the cross-sections, the tails of the cross-sections for most of the comparisons do not match well. This could be because the Corps data is very generalized at the ends of the cross-sections and additional points were added through interpolation rather than through survey. Other differences between the data sets that made meaningful comparison difficult include the following:

- The two data sets have different start and end points, making it difficult to decide at which point one data set starts within the other.
- Corps data was collected in opposite directions along the transect (e.g., north to south vs. south to north) making direct comparisons more difficult.
- Transect length (the distance the data covers) was different between the two data sets.
- Different data collection interval were used for the two data sets. Corps data was collected at a coarse resolution and was sporadic. LIDAR-DEM based data is continuous, and has a fine resolution (3- to 6-foot consistent intervals). Floodplain features are therefore not as clearly defined on the Corps cross-sections as they are on the LIDAR-DEM based cross-sections.

In order to create a better comparison between the cross-sections, the resolution of the GZT data was reduced to create a cross-section with points that would plot at the same stations as the Corps data points. This was accomplished by selecting a common starting point where both cross-sections match up and then plotting the GZT data points at the stations matching the Corps data points. This common starting point was selected as a best guess based on a prominent feature common to both cross-sections. Some error in both the X and Y directions was introduced by doing this.

Although the new cross-sections could not be matched satisfactorily with the Corps 1972 sections, they provide a much denser, more detailed topographic slice to use as a benchmark for the future. These surveyed in-channel cross sections provided topography for the submerged low-flow channel. The new cross-sections were GPS-benchmarked for future resurvey.

In addition to the cross-section surveys, the field work included recording observations on geologic materials, river bank height and composition, levee and revetment locations, vegetation types and age, presence of eroding banks, abandoned channels and other potential avulsion sites, depositional zones, and descriptions of river and floodplain morphology. Locations of significance identified by the analysis of historical air photos were observed during field visits to identify and document the locations of actively eroding river banks, observe and document the flow alignment, and determine the accessibility of abandoned channels for potential avulsions. Sediment sampling of surficial bed material using pebble counts (Wolman, 1954) was conducted along 14 cross-sections.

CHANNEL CHANGE INDICES

The flexibility of the image processing package and GIS-based channel change data allowed the development of a number of indices for channel change. The concepts of geomorphic thresholds and geomorphic sensitivity are fundamental to the work of identifying channel migration zones. Attempting to locate these thresholds for mapping requires not just an accurate record of the historical behavior of the system, but a reliable means to assess whether a particular stimulus has repeatedly produced the same response. In this study several indices, described below, were used to assess these thresholds.

The 1901 map data was not used for developing indices because of uncertainties with the active channel boundary digitized from photographic records. General Land Office data and other turn of the century data is likely to show an inferred channel extent at "mean high water elevation," which is "found at the margin of the area occupied by the water for the greater portion of each average year" (Bureau of Land Management 1973, pp. 93-97), rather than the actual active channel boundary. For discussion purposes, the original mapped data is presented draped over a 10-meter DEM, with photograph-derived channel change data draped over the map.

Channel migration is essentially a vector property, with channels moving both laterally and downstream through processes such as bank erosion, avulsion, bend migration and extension (Hooke 1997). Lateral shift of the channel is a commonly used index of change, and provides quantitative information to help interpret the historical behavior of a river.

To quantify planform features, 200 transects were digitized approximately perpendicular to the 2000 primary low-flow channel centerline, at irregular increments with a mean spacing of 285 feet (see Figure 2-2). The transects were digitized manually using the full set of historical vectors as a guide to ensure that individual transects crossed all of the multi-temporal channel boundaries as close to 90 degrees as possible. These transects were used to measure the width of the floodplain, the width of active channel for each time period, and the width of the primary low flow channel for the 2000 data. The primary low flow channel is based on the widest wetted channel, as field-checked and mapped with GPS during field survey. This approach allows for systematic temporal and spatial analysis of channel movement within a floodplain without the bias introduced by taking measurements at specific channel geometric features such as channel bends or straight reaches.

Changes in channel width and in the ratio of channel width to floodplain width were analyzed together with map information and hydrologic records of major floods.

Channel Width

Downstream and temporal changes in the width of the channel were investigated. An increase in channel width can be associated with a flood or change in the controlling variables of water and sediment, while reductions in width can be associated with vegetation-driven stabilization or channel reinforcement projects.

Ratio of Channel Width to Floodplain Width

The changing stability of the reach downstream and over time was investigated using the "transect ratio" for the period between 1927 and 2000. The transect ratio is the ratio of the channel width to the width of the floodplain occupied by the channel. The total width of floodplain occupied by the channel was calculated for each transect by overlaying the planform data and identifying the lateral extent of channel occupancy. The larger the ratio, the greater the area of floodplain used by the channel. The greater the variation in ratios over time, the less stable the channel has been over the study period.

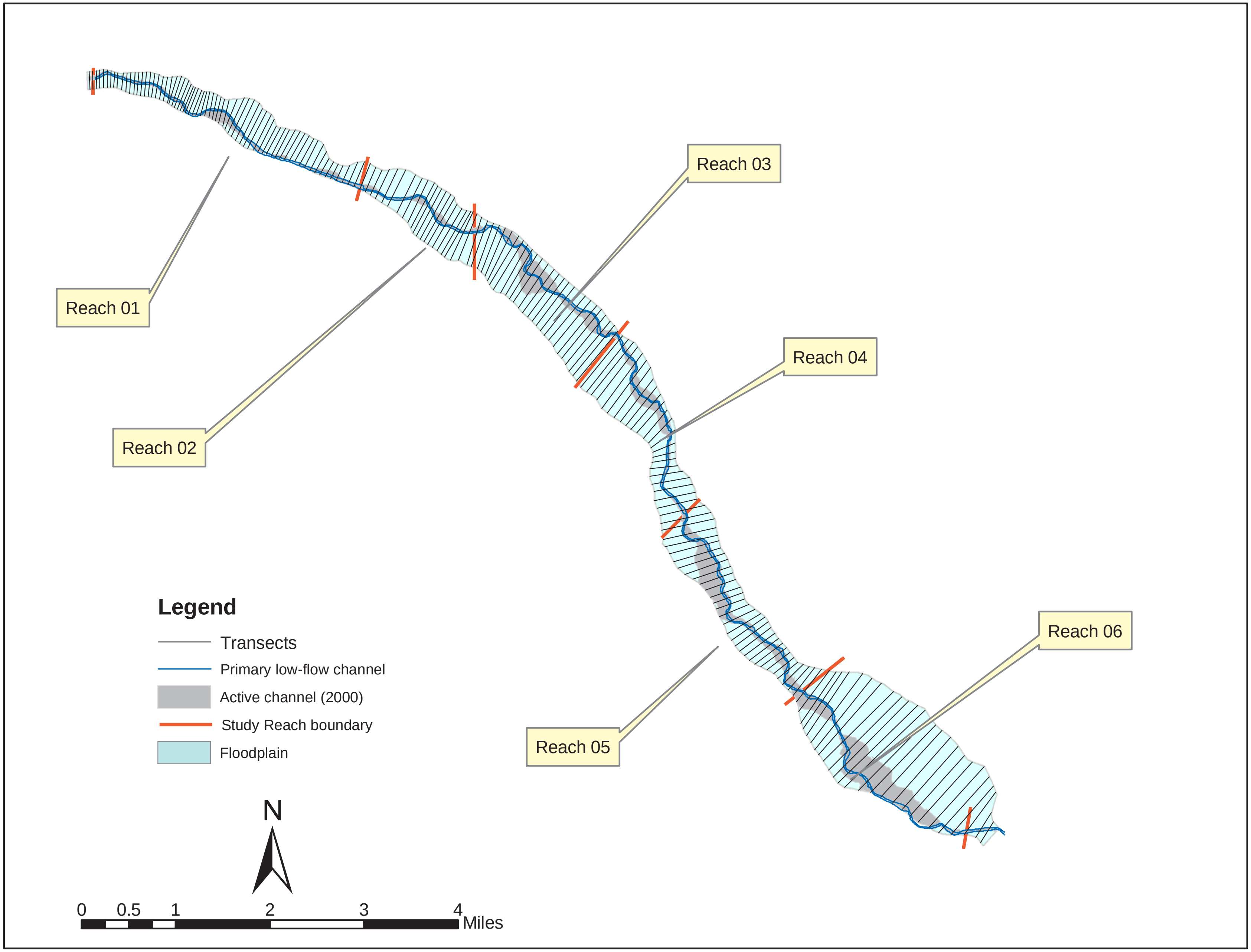

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Figure 2-2.
STUDY AREA AND SHOWING LOCATIONS OF FLOODPLAIN SWATHS (TRANSECTS)

CHAPTER 3.
STUDY AREA CHARACTERISTICS

In the study area for the CMZ analysis, the Naches River flows through a 14-mile-wide alluvial valley bounded by highlands on both sides. Because of the river's history of channel migration through the study area, much of the land directly adjacent to the river is not developed or actively cultivated. Land use is primarily agriculture and undeveloped land with the exception of the Town of Naches, near the northwestern end of the study area. With a portion of its southern city limits bordering the river, the Town of Naches is directly affected by the river's erosional and deposition patterns as well as by flooding. The community of Gleed is an unincorporated area near the downstream end of the study area where some suburban residences, a few services, and a golf course (Sun Tides) are clustered. The 100-year floodplain in the study area, according to the current FEMA floodplain maps, encompasses 2,892 acres.

Although development is sparse throughout the study area, a number of physical structures are present that function as hard boundaries and potential constraints for the river. These structures consist of four bridges over the Naches River, numerous levee segments, several diversion structures for irrigation and power with associated canals, and a federal highway (U.S. 12) that parallels the river throughout the study area.

The Naches River is a major tributary of the Yakima River (see Figure 3-1). Originating in the Cascade Mountains east of Mount Rainier, the Naches River is formed by the confluence of the Little Naches River and the American River. From this point, the river flows southeast for approximately 30 miles before it emerges from the mountains. Here the Naches is joined by another major tributary, the Tieton River, near the junction of State Highway 410 and U.S. Highway 12 (at Mile 15). The river continues to flow southeast through a broad valley, past the Town of Naches and toward the City of Yakima. Other major tributaries include Rattlesnake Creek at RM 27.8 (above the study area), Buckskin Slough, and Cowiche Creek at RM 2.7 (below the study area). Just upstream from the City of Yakima, the Naches River cuts through a narrow gap in the highlands making up Naches and Selah Heights, and flows along the northern edge of the City of Yakima before joining the Yakima River near Interstate 82. The drainage basin covers a total area of 1,120 square miles, including portions of Kittitas County in the headwater region. Characteristics of the Naches River tributaries and the Naches River in the study area are listed in Tables 3-1 and 3-2.

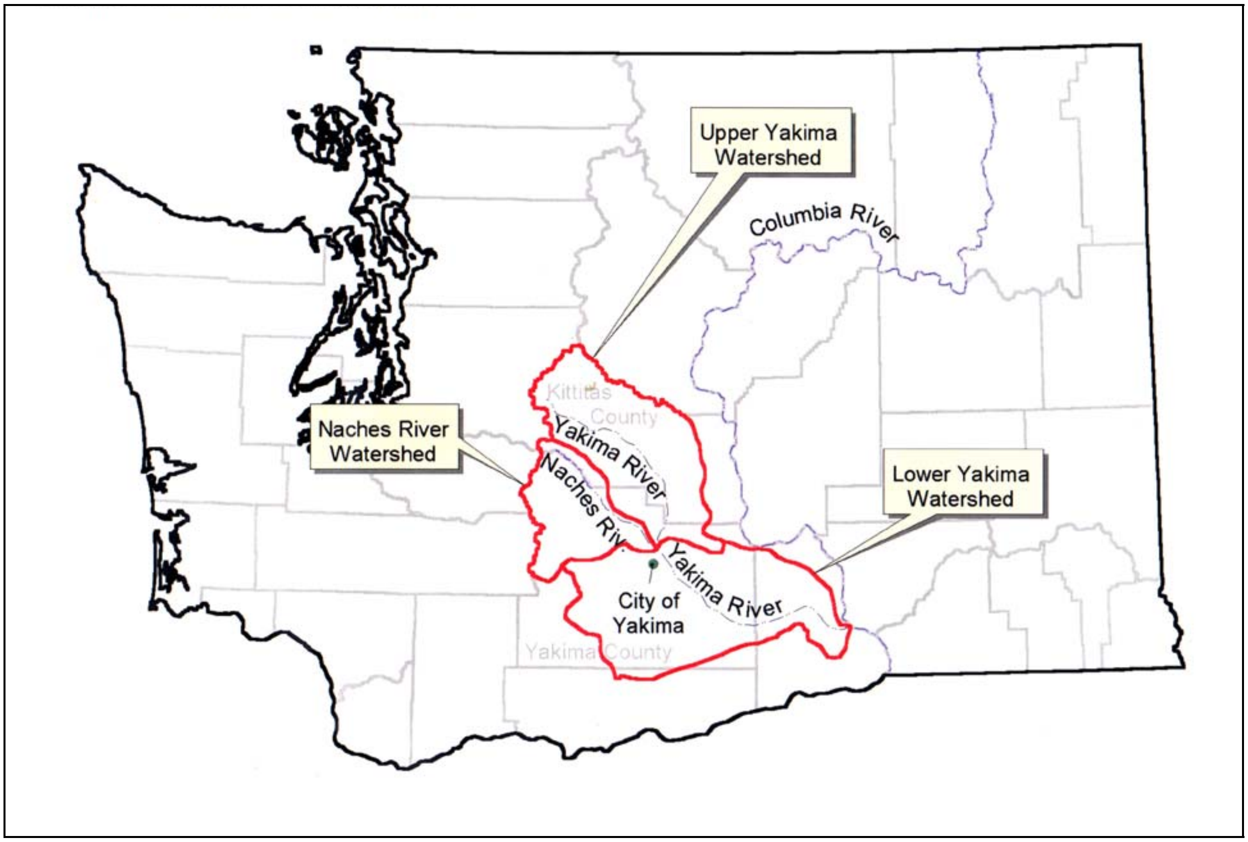

Figure 3-1. Project Vicinity

TABLE 3-1.
CHARACTERISTICS OF THE NACHES RIVER AND MAJOR TRIBUTARIES

River or Tributary Name	Confluence (River Mile)	Drainage Area (square miles)	Percent Area of the Naches River Basin	Length (miles)	Average Gradient (feet/mile)
Tieton River[a]	13.8	296	26	18	109
American River[a]	40.9	342	31	21	60
Rattlesnake Creek	24.1	610	54	24	135
Upper Naches River[b]	13.8	643	57	44	49
Naches River	—	1,120	100	20	27

a Flows in the Tieton River are controlled by the Rimrock Lake Reservoir; flows in the Bumping River portion of the American River are controlled by the Bumping Lake Reservoir.
b Upper Naches begins upstream of the Tieton River.

Sources: Yakima County GIS, U.S. Geological Survey 7.5-minute Quadrangles

TABLE 3-2.
PHYSICAL CHARACTERISTICS

River Channel	
Length (miles)	13.7
Average Gradient (feet/mile)	30.8
Floodway	
Average Width (feet)	1,011
Average Velocity (feet/second)	7.4
100-Year Floodplain	
Area (acres)[a]	2,892
Average Width (feet)	1,685

a. Floodplain area is based on Yakima County's GIS system, which is being updated to reflect recent revisions to the 100-year floodplain.
Source: FEMA 1994

REACH SUBDIVISIONS

For the CMZ study, the study area was divided into six reaches, with Reach 1 at the upstream end of the study area and Reach 6 at the downstream end (Figure 3-2). Boundaries between reaches were defined at breakpoints in slope of the longitudinal channel profile, at notable changes in channel planform or other channel characteristics, or where the reach lengths created are manageable in scale for analysis.

River gradient, floodplain width, and active and primary channel widths were plotted for each reach (see Figures 3-3 through 3-5). Average gradients and widths are listed by reach in Table 3-3; data is provided in Appendix B. Generally, and as should be expected, channel width and floodplain width increase in the downstream direction. The average channel gradient between reaches remains fairly constant around 0.6 percent. Figures 3-6 through 3-8 show transect ratios (the ratio of active channel width to floodplain width) for 1984-2000, 1927-1972, and 1927-2000.

TABLE 3-3.
CHARACTERISTICS OF THE NACHES RIVER REACHES

Reach Number	Channel Gradient (feet/foot)	Active Channel Width (feet)	Primary Channel Width (feet)	Floodplain Width (feet)
1	0.006	240	109	1490
2	0.0057	275	98	2613
3	0.0068	661	107	3158
4	0.0053	405	100	2562
5	0.0053	655	126	2156
6	0.0056	893	115	4685

ANTHROPOGENIC INFLUENCES

Anthropogenic influences include all manmade structures and activities in the Naches River basin that can influence channel migration. The key human influences in the Naches River basin are the upper basin reservoirs; levees; irrigation structures such as diversion dams, intake structures, and canals; and roads and bridges.

Reservoir Management

The surface water hydrologic regime in the study area is controlled, in large part, by the U.S. Bureau of Reclamation (USBR) management of reservoirs in the upper Naches River and upper main stem Yakima River watersheds. During the early 1900s, the Bureau of Reclamation began extensive development of an irrigation water supply system in the Yakima Basin. Six storage reservoirs (listed in Table 3-4), three of which are in the Naches River drainage basin, 14 diversion dams, approximately 2,000 miles of irrigation canals, numerous pump stations, and three hydroelectric plants have been constructed to service approximately 500,000 acres in the basin. From USBR data, about 60 percent of total water use in the Yakima River basin is attributed to agriculture.

TABLE 3-4.
RESERVOIRS IN THE YAKIMA RIVER BASIN

Reservoir Name	River	Year of Completion	Drainage Area (sq. mi.)	Active Storage[a] (acre-feet)
Bumping Lake[b]	Bumping River	1910	69.3	33,700
Cle Elum Lake	Cle Elum River	1933	203.0	436,900
Clear Lake[b]	North Fork Tieton River	1914	60.0	5,300
Kachess Lake	Kachess River	1912	63.6	239,000
Keechelus Lake	Yakima River	1917	54.7	157,800
Rimrock Lake[b]	Tieton River	1925	187.0	198,000

a. Capacity assigned to flood control function.
b. Reservoir is located within the Naches River basin.

Source: FEMA 1994.

Operation of the three Naches River reservoirs, Bumping Lake, Rimrock Lake, and Clear Lake (Figure 3-9), has altered the natural hydrologic regime of the Naches River system. The goal for these reservoirs is to capture runoff during the winter and release the stored water during the summer to supply irrigation water to farmers in the Naches and lower Yakima portions of the watershed. This operation results in lower-than-natural flows during the winter and higher-than-natural flows during the summer.

Release of water from the Naches system reservoirs is coordinated with release of stored water from the main stem Yakima reservoirs under the following scenario known locally as "flip-flop": Water is released primarily from the main stem Yakima reservoirs and Bumping Lake (on the American River branch of the Naches) until around the first of September each year. At that time the main stem Yakima reservoirs and Bumping Lake stop releasing

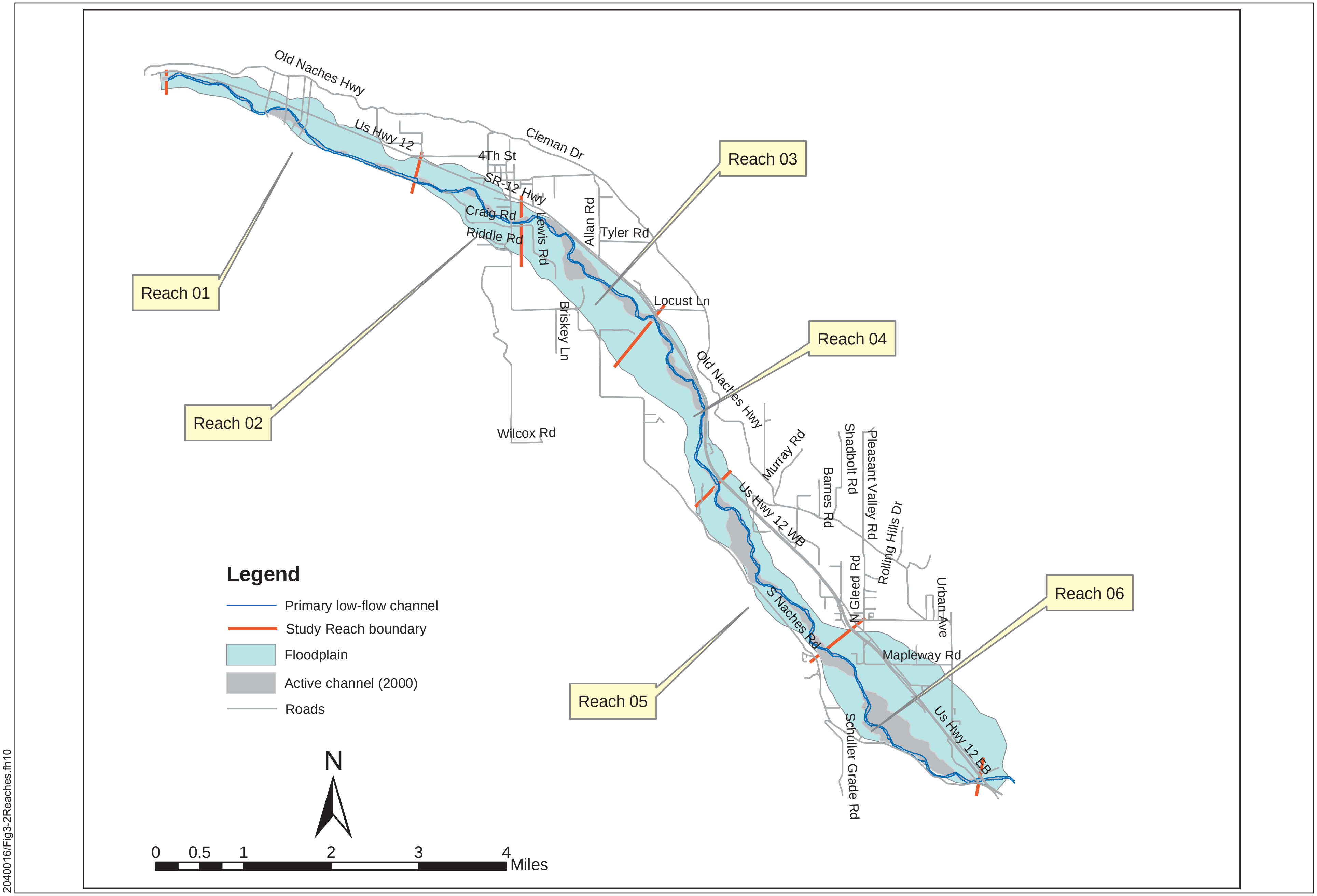

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Figure 3-2.
STUDY AREA AND STUDY REACH BOUNDARIES

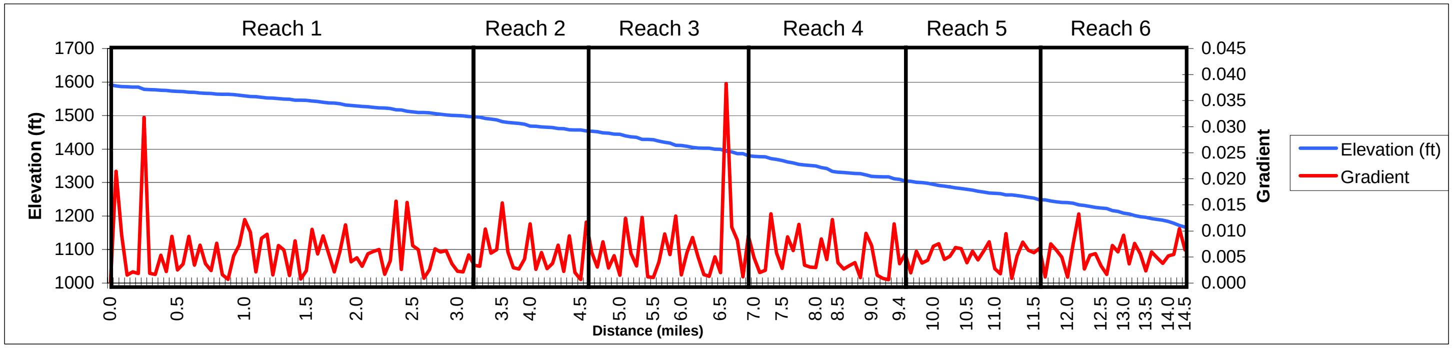


Figure 3-3. Stream Profile and Gradient by Transect

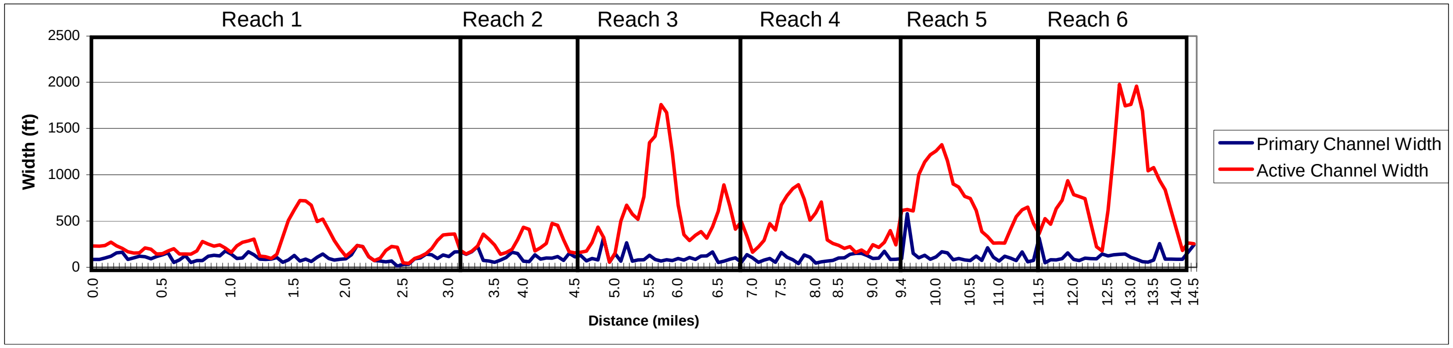


Figure 3-4. Active and Primary Channel Widths

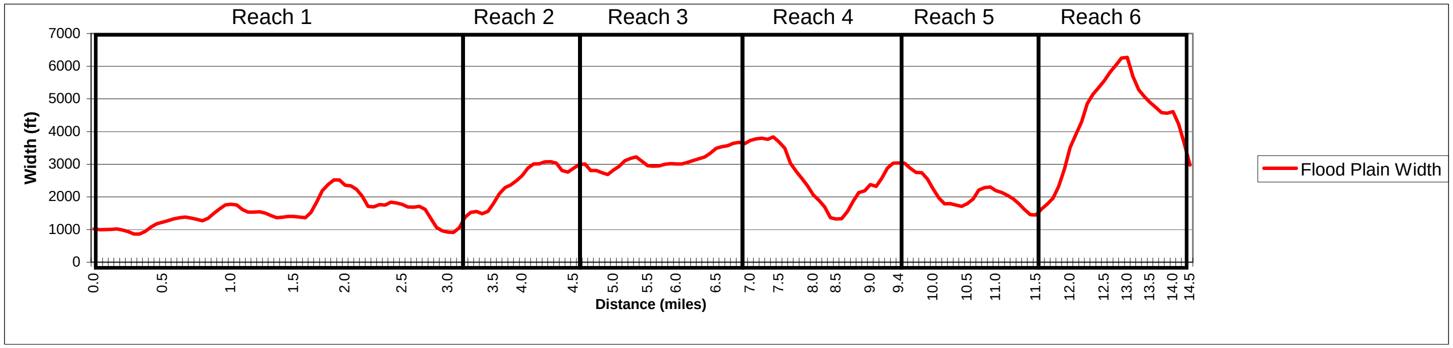


Figure 3-5. Flood Plain Width

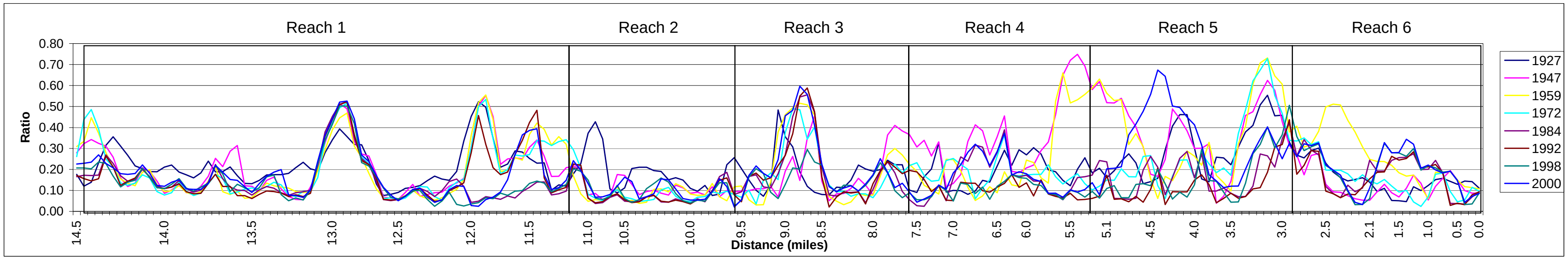


Figure 3-6. Ratio of Active Channel to Floodplain Width (1927 - 2000)

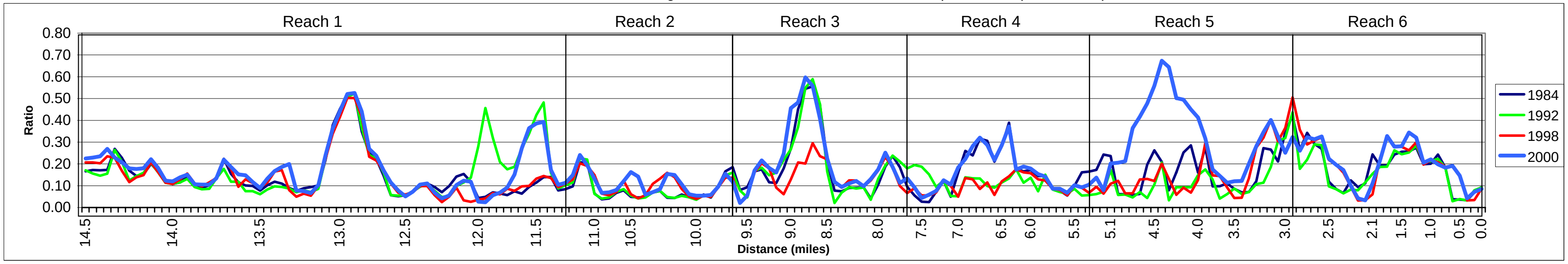


Figure 3-7. Ratio of Active Channel to Floodplain Width (1984 - 2000)

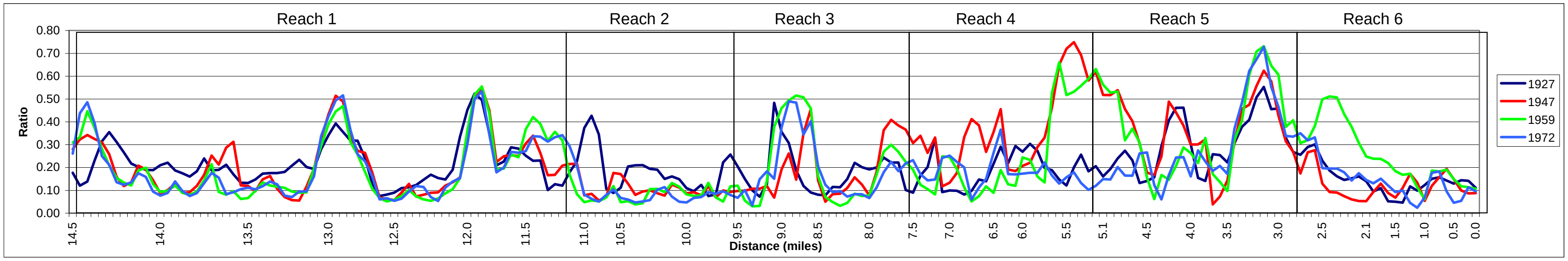
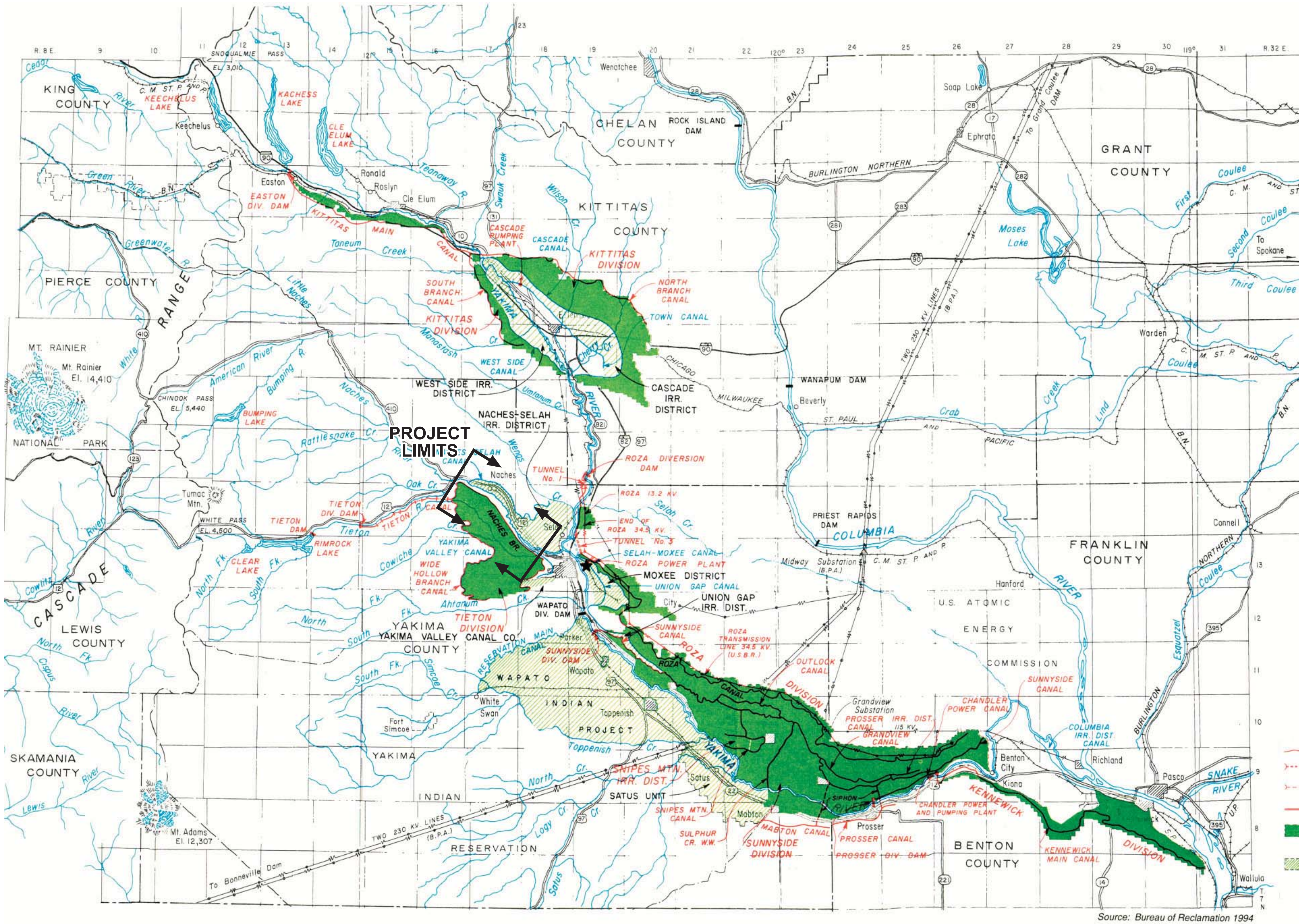


Figure 3-8. Ratio of Active Channel to Floodplain Width (1927 - 1972)



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Tetra Tech/ KCM, Inc. 1917 First Avenue Seattle, Washington 98101	Yakima County NACHES RIVER CHANNEL MIGRATION STUDY	Figure 3-9. BUREAU OF RECLAMATION YAKIMA RIVER PROJECT

water, and the bulk of irrigation demands are met through water releases from Rimrock Lake. This arrangement results in artificially high flows in the American River branch of the Naches during the early summer (and correspondingly artificially low flows in the Tieton branch during this period). Then in September, flows are artificially high in the Tieton branch of the Naches when water is released from Rimrock Lake.

The Clear Lake, Rimrock Lake, and Bumping Lake reservoirs in the upper basin, although designed and constructed primarily for the purpose of irrigation, have been operated for flood control when deemed appropriate by the operators and when the reservoirs have the capacity to store water. However, the reservoirs have a limited utility for reducing flood peaks because of their limited storage capability and their location high in the watershed. The area draining into these reservoirs makes up only 23 percent of the total basin area for the Naches River. The Bumping Lake and Clear Lake reservoirs have very limited amounts of flood storage capacity—33,700 acre-feet and 5,300 acre-feet respectively. The Rimrock Lake reservoir has 198,000 acre-feet of available flood storage capacity. Flood storage capacity is also seasonally variable.

Flood Control Facilities

In response to heavy damage incurred during the 1933 flood, the U.S. Secretary of War authorized the Yakima River flood control works project, which included the installation of nine earthen levees and associated drainage structures in the Naches River study area, listed in Table 3-5. The levees were constructed to provide embankment armoring in key areas, such as near the Town of Naches and at the City of Yakima Water Treatment Facility. As the levees are discontinuous, their effectiveness is limited by the ability of the river to damage or circumnavigate the structures and by ongoing maintenance needs. However, as long as critical facilities and developed areas exist along the river, in the long-term perspective, these facilities will always be actively maintained and steps taken to ensure that the river remains confined where necessary.

The federal levee project was authorized June 28, 1938 and the Corps of Engineers completed construction on March 26, 1948. The levees, shown in Figure 3-10, were constructed between Ramblers Park and the junction of Highways 12 and 410. The levees have since been maintained and upgraded by Yakima County, except for one levee maintained by the City of Yakima that protects the City of Yakima Water Treatment Plant. Approximately 21,250 feet of levees were constructed. Drainage structures were built to convey surface runoff and irrigation water through the levees. Most of the drainage structures have floodgates to keep floodwater from backing up into the drainage channels.

In addition to the maintained levees, numerous private levee or dike structures that have been constructed in the floodplain were observed and mapped during field reconnaissance. The construction date, maintenance history, and level of protection provided by these structures are unknown, which means that their impact on the rates of channel migration is uncertain. Where identified, they are shown on the channel migration maps in Chapter 4.

TABLE 3-5.
INVENTORIED LEVEES IN NACHES RIVER STUDY AREA

Identification	Managing Agency	Source of Elevation Data	Level of Protection[a]	Remarks
PL99-NSEG1	Yakima County	Corps; needs to be verified	10 (3)	Ramblers Park/Weber Auto Wrecking levee
PL99-NSEG2	Yakima County	Corps; needs to be verified	5 (1)	McCormick levee
PL99-NSEG6	City of Yakima	Corps; needs to be verified	5 (1)	City of Yakima water treatment plant levee
PL99-NSEG7	Yakima County	Corps; needs to be verified	5 (1)	South Naches Road
PL99-NSEG8	Yakima County	Corps	5 (1)	South Naches Road
PL99-NSEG9	Yakima County	Corps; needs to be verified	5 (1)	Near Craig Road
NSEG4	Yakima County	Corps; needs to be verified	10 (3)	Near Kershaw Road
NSEG5	Yakima County	Corps; needs to be verified	5 (1)	Near Eschbauch Park
NSEG10	Yakima County	Corps; needs to be verified	N/A	Near Craig Road

a. Level of protection is noted by flood event and freeboard as designated by the Corps. For example, 100 (3) refers to a level of protection equal to the 100-year flood event with 3 feet of freeboard.

Other Manmade Structures

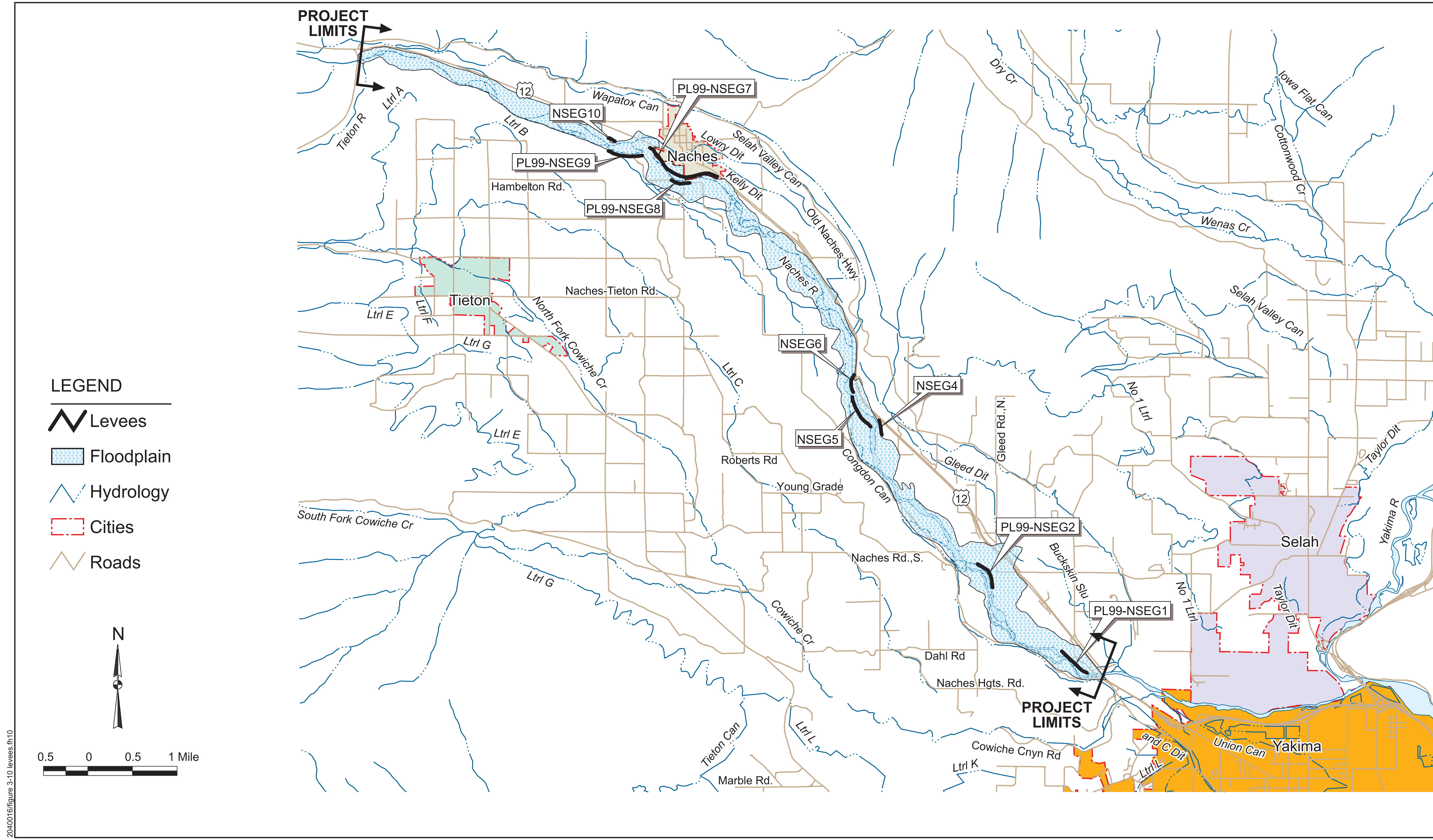
Table 3-6 lists bridges and intake structures that are present in the study area. Highway 12 parallels the river along its north bank throughout most of the study area. Near the Town of Naches and the City of Yakima Water Treatment Plant the highway could be threatened by channel migration due to its proximity to the river.

HYDROLOGY AND FLOODING

Channel migration is influenced by a river's hydrologic regime, sediment load, and flood characteristics. The surface water hydrologic regime in the study area is controlled, in large part, by the USBR management of reservoirs in the upper Naches and upper main stem Yakima River watershed.

Stream-Flow Records

The USBR collects Naches River flow data. Two USBR gauging stations on the Naches River were used to characterize flows in the study area. One is 0.6 miles upstream from the confluence with the Yakima River; the other is 0.8 miles below the confluence with the Tieton River. Taken together, data from these two stations provide rough inflow and outflow data for the study area.



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NACHES RIVER CHANNEL MIGRATION STUDY

Figure 3-10.
LEVEES IN THE STUDY AREA

TABLE 3-6.
BRIDGES ACROSS THE NACHES RIVER AND IRRIGATION DIVERSIONS IN THE STUDY AREA

Mile above Mouth	Bridge	Bridge Low Chord Elevation (feet)	Predicted FEMA 100-Year Flood Elevation (feet)[a]
0	U.S. Highway 12, Westbound	1,176.8	N/A
0.02	U.S. Highway 12, Eastbound	1,177.0	N/A
0.05	Powerhouse Rd.	1,177.8	1,174.6
9.2	Naches Bridge (near Town of Naches)	1,460.72	1,456.7
12.93	Private Bridge (near U.S. Geological Survey gauging station)	1,569.8	N/A
13.43	Wapatox Diversion Structure	—	—

a. FEMA computed a 100-year flood peak discharge of 27,000 cubic feet per second (cfs) near the Town of Naches in the Flood Insurance Study for Yakima County.
Source: U.S. Army Corps of Engineers

Naches River flow comes from snowmelt and rainfall on the eastern slopes of the Cascade Mountains. Average flows are highest during April, May, and June (see Table 3-7 and Figure 3-11) as a result of spring snowmelt runoff. However, peak flood flows typically occur during the winter. Winter flood flows are associated with warm temperatures and rainfall on melting snow pack, and typically follow precipitation periods that have saturated or frozen soils, producing greater rates of runoff.

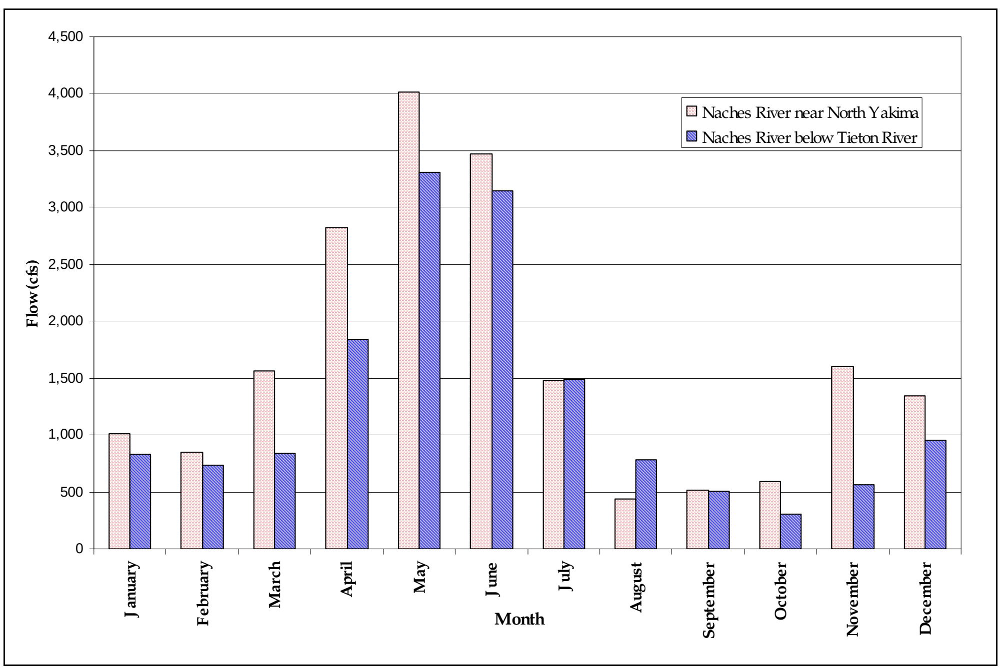


Figure 3-11. Summary of Daily Average Flow for Period of Record

TABLE 3-7.
SUMMARY OF DAILY AVERAGE FLOW FOR PERIOD OF RECORD

	Naches near North Yakima		Naches River below Tieton River	
Month	Daily Average Flow (cfs)	Percent of Average Annual Flow	Daily Average Flow (cfs)	Percent of Average Annual Flow
January	999	6%	700	5%
February	1,419	8%	1,016	7%
March	1,529	9%	1,211	9%
April	2,232	13%	1,789	13%
May	3,019	17%	2,761	20%
June	2,550	15%	2,308	17%
July	996	6%	825	6%
August	532	3%	346	2%
September	1,623	9%	1,257	9%
October	803	5%	502	4%
November	791	5%	541	4%
December	900	5%	627	5%
Annual	17,393	100%	13,883	100%

Source: USBR Pacific Northwest Region, Hydromet System Data Access, 2003.

Sediment Transport and Deposition

Sediment deposition and transport in a river channel are primary mechanisms affecting channel movement in the river valley. River geomorphology and deposition patterns control the river's ability to contain floodwaters. Large quantities of sediment can be transported over short periods of time during a flood. Sediment deposition occurs where the river becomes wider or flatter than upstream reaches, reducing the energy of its flow and its ability to carry sediment downstream. Constrictions caused by significant sediment deposition can reduce the river channel's capacity for high flows and promote channel migration upstream of the constriction.

Sediment enters the Naches River from the erosion of surrounding mountains, glacial sediment deposits in the Naches Basin and erosion of the river banks. A significant amount of fine sediment is carried in suspension by the river; coarser sediments are transported downstream by rolling and bouncing along the channel bed. Deposition increases in areas where channel slope is low or flow area is wide, and transport increases in steeper or narrower reaches. During floods, overbank flow carries fine-grained sediments and clays, depositing them across the floodplain as the water recedes.

Flooding

Deep, fast-flowing floodwater can promote rapid and dramatic channel migration. Flooding is a relatively common event on the Naches River. Since 1909, the river has overtopped its banks approximately 60 times. The majority of these flood events caused minimal, if any, damage. The first and second largest floods on record for the Naches River occurred in December 1933 and February 1996, respectively. Table 3-8 lists the 10 most significant floods on record for the river. High magnitude floods, such as the February 1996 flood and December 1933 flood, which caused extensive damage, occur infrequently but are much more disruptive to human activities.

Flooding on the Naches River typically occurs during the winter and spring. Winter floods occur more frequently and are typically caused by warm Chinook winds, heavy rain and rapid snowmelt. Frozen ground creates an impervious surface that causes runoff to accumulate faster. Historically, winter floods have been larger than spring floods. Winter floods typically last less than a week, so the total volume of runoff is not as high as that of spring floods. Spring floods usually occur as a result of unusually warm weather and rainstorms, triggering an excessive amount of snowmelt in the higher elevations. Spring floods are normally moderate in magnitude but can last up to four weeks. The river can rise from normal flow to extreme flood peaks within a week and may remain above flood stage for more than two weeks.

Sediment transport and deposition during flood events in the Naches River corridor is dependent on water velocity, flow depth, and the size of the material in the channel and in the floodplain. Flood velocities above the Town of Naches can reach 12 to 15 feet per second (FEMA 1998). Deep water flowing at this rate can cause severe erosion and transport large objects and debris. In the lower reaches, flow velocities can reach 9 to 13 feet per second. Floodwaters in the overbanks near the town of Naches can reach average velocities of 3 to 5 feet per second.

Natural obstructions such as log jams, woody debris, and ice, can partially block flood flows, causing the river to overflow into a different channel. Manmade constrictions such as diversion dams, levees and bridges, can collect trees and other debris being swept downstream. The overflow channel may be a relict, formerly abandoned channel, or simply a low or weak spot in the river bank or gravel bar that erodes during a flood event. This process can result in channel changes that persist after floodwaters have receded. This type of channel migration is termed an *avulsion*. The role of channel obstructions in causing historical avulsions on the Naches River has not been documented, and therefore is not well understood.

Avulsions do occur with regularity on the Naches River and, due to their unpredictable nature, are one of the most destructive (to property) types of channel migration. A major avulsion occurred on the Naches River just upstream from Ramblers Park during the 1996 flood. The main channel for the river at normal flows is now south of where it was prior to the flood.

TABLE 3-8.
LARGEST HISTORIC FLOOD EVENTS ON THE NACHES RIVER

Date of Crest	Flow (cfs)	Stage[a]	Comments
22-Dec-1933	32,200	22.4	Prompted construction of federal levee system.
9-Feb-1996	20,924	22.36	Largest flood since construction of levees. Natural (unregulated) flow estimated to be 28,128 cfs.
24-Nov-1909	19,400	19.7	Little information available.
2-Dec-1977	18,000	20.1	Two flood peaks within 1-1/2 weeks. Water filtration plant shut down because of turbidity.
30-Dec-1917	16,800	18.9	Little information available.
1-Dec-1995	16,434	19.02	Two private bridges destroyed in Nile area. Rattlesnake Creek bridge approach destroyed.
13-Dec-1921	14,500	18.3	Little information available.
4-Dec-1975	14,100	18.4	Highway 12 threatened by channel shifting.
1-Jun-1956	13,300	17.9	No information.
17-Jun-1974	12,800	18.0	City of Yakima's drinking water main damaged.

a. Stage recorded at USBR Gage #1249400, Naches River near Naches.

GEOLOGY AND SEDIMENT CHARACTERISTICS

Dunne (1976) describes the geology in the region and the study area as follows:

> During the Pliocene epoch (2-12 million years ago) an ancestral Yakima River flowed from the Cascade Mountains across flat-lying basalt lava which had originated from great fissures in the earth's surface during the Miocene epoch (12-26 million years ago). In the vicinity of Yakima, mountain-building forces began to fold the lava into a series of parallel ridges and downwarps. As the lava beds were pushed up the river cut down through the ridges in a series of narrow gaps. Down-cutting kept pace with uplift.
>
> At the same time, large andesitic volcanoes in the mountains to the west were undergoing explosive eruptions and vast quantities of ash and volcanic agglomerates were fed into the Yakima Basin and carried downstream by the river. The sediments were deposited as thick layers in the downwarps between the rising basalt ridges. Erosion of the gaps also contributed coarse basaltic gravel to the accumulating deposits. These sediments are now called the Ellensburg formation and in the Moxee Valley are as much as 1,500 feet deep.
>
> During the Pleistocene epoch (2 million to 10,000 years ago) the activity described above continued and glaciers advanced from the high Cascades down the Yakima Valley as far as Cle Elum. The Yakima River was swollen many times with glacial meltwater and large quantities of coarse gravelly sediment from the Naches and Upper Yakima basins. This Pleistocene

> sediment now covers the surface of the Moxee Valley in the vicinity of Yakima and consists of gravel derived from the basalt ridges together with a minor amount of granitic rocks from the Cascades.
>
> Since the retreat of the Cascade glaciers, the river has cut down about 10 feet into its Pleistocene sediments leaving a terrace of sand and gravel covered by windblown silt along both sides of the valley. This terrace now defines a natural corridor within which the floodwaters are confined…. [The floodplain] is intricately laced with active and abandoned river channels which reflect the vigor with which the river has been migrating across its floodplain during the last few thousand years.

The Naches River flows through a broad valley between two of these uplifted and folded basalt ridges. In the Naches River Valley a layer of alluvium overlies the sedimentary Ellensburg formation of volcanic agglomerates and ash. The alluvium consists of poorly sorted sand and gravel deposited by glaciers and streams, and is of Quaternary to Recent Age. Beneath the Ellensburg formation are three basalt layers: the Saddle Hills, Wanapum, and Grande Ronde formations.

The Naches River channel pattern through the study area is characterized by a meander-braided transition pattern. This channel pattern is characterized by Chorley et. al (1984) as having a large sediment load with a significant fraction of sand, gravel and cobbles. Chute cutoffs, thalweg and meander shifts, and bank erosion are characteristic of this channel pattern, and of this reach of the Naches River. The development of bars and islands may modify flow alignments and change the location of bank erosion. Aggradation in some areas has also occurred through this reach.

Sediment Sampling

A quantitative analysis of channel substrate particle size was conducted, using pebble counts (Wolman, 1954) to determine bed material particle-size distribution along 14 cross-sections. Given the limited sampling, transects were selected to afford a spacing between samples that provides an overview of the whole study reach, covering both pool and riffle sections of the river. The primary channel (2000 data), its shoreline and bank-full mark defined the extent of the sample transects along the cross-section lines.

The pebble counts were conducted by taking bed material measurements at close intervals along each transect. Each count began at the bank-full elevation on the left bank of the transect and proceeded to the bank-full elevation on the right bank. Where transects could not be waded near the thalweg (Reaches 5 and 6) samples were taken from the bars on each side, and as close to the thalweg as safety allowed. Measurements were made across the intermediate axis of each stone.

The size distribution of particles (listed in Table 3-9) was determined and expressed in percentage by number of particles (a count of at least 180 particles was achieved for all transects). No subsurface samples were included in this survey, due to the large caliber of the subsurface sediment. The pebble counts indicated that the surficial bed material could be classified as coarse gravel to large cobble.

TABLE 3-9.
SEDIMENT SIZE DISTRIBUTION FOR SEDIMENT SAMPLING AT SELECTED TRANSECTS

Cross-Section Number	Reach Number	Surface Diameter (mm)		
		16%	50%[a]	84%
13.26	1	32	120	271
12.14	1	32	103	292
11.07	1	29	144	288
9.93	2	38	145	276
9.2	2	25	139	198
8.34	3	35	172	203
7.51	3	27	97	188
6.43	4	34	121	211
5.68	4	30	102	212
4.51	5	36	141	176
3.65	5	41	150	204
2.69	5	33	118	195
1.49	6	25	84	187
1.18	6	15	67	125

a. Median diameter is the size for which 50 percent of sediment particles are smaller.

As the Naches River descends from Reach 1, the mean gradient gradually decreases and the floodplain steadily widens, then narrows considerably in Reach 4 and 5, finally gaining its widest extent in Reach 6. In general a downstream fining of sediment could be expected; this is a function of gradual reduction in sediment transport capacity as gradients lessen and peak flows are distributed across a wider plain. While this general trend exists for the sediment particle-size data, there are some anomalies in Reach 4 and 5, likely caused by channel constriction and entrenchment causing locally transport-dominated sub-reaches.

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
19	0.18	0.28	0.31	0.26	0.17	0.17	0.21	0.23	76560	14.50	
20	0.12	0.32	0.33	0.44	0.17	0.16	0.21	0.23	76406	14.47	
21	0.14	0.34	0.45	0.49	0.17	0.15	0.20	0.23	76199	14.43	
22	0.23	0.32	0.37	0.39	0.17	0.16	0.23	0.27	76002	14.39	
23	0.31	0.31	0.28	0.25	0.27	0.26	0.23	0.23	75769	14.35	
24	0.36	0.26	0.21	0.21	0.23	0.21	0.17	0.21	75550	14.31	Wapatox dam head
25	0.31	0.16	0.15	0.14	0.17	0.12	0.12	0.18	75323	14.27	
26	0.27	0.12	0.13	0.12	0.14	0.14	0.14	0.18	75107	14.22	
27	0.22	0.14	0.12	0.13	0.15	0.16	0.15	0.18	74923	14.19	
28	0.20	0.21	0.19	0.17	0.20	0.20	0.21	0.22	74641	14.14	bar and side low-flow channel
29	0.19	0.19	0.20	0.16	0.17	0.16	0.16	0.18	74411	14.09	
30	0.19	0.14	0.13	0.09	0.12	0.11	0.11	0.12	74188	14.05	riffle off tail of bar
31	0.21	0.09	0.09	0.08	0.11	0.11	0.11	0.12	73950	14.01	
32	0.22	0.10	0.10	0.09	0.12	0.12	0.13	0.14	73757	13.97	
33	0.19	0.13	0.12	0.14	0.15	0.13	0.16	0.15	73533	13.93	bar with low flow side channel
34	0.17	0.09	0.09	0.10	0.11	0.09	0.11	0.11	73327	13.89	bar with low flow side channel
35	0.16	0.09	0.08	0.08	0.09	0.08	0.10	0.10	73093	13.84	
36	0.18	0.12	0.09	0.09	0.10	0.09	0.11	0.11	72877	13.80	
37	0.24	0.17	0.14	0.13	0.14	0.13	0.13	0.13	72629	13.76	37 is fraction upstream from trailer park bridge
38	0.19	0.25	0.21	0.18	0.22	0.18	0.22	0.22	72340	13.70	riffle downstream from bridge
39	0.19	0.21	0.09	0.16	0.16	0.12	0.18	0.19	72029	13.64	riffle over bar
40	0.21	0.29	0.08	0.08	0.12	0.12	0.10	0.15	71748	13.59	
41	0.17	0.31	0.10	0.09	0.10	0.07	0.13	0.15	71614	13.56	
42	0.13	0.12	0.06	0.11	0.10	0.07	0.11	0.12	71409	13.52	
43	0.13	0.12	0.07	0.11	0.08	0.06	0.09	0.09	71220	13.49	
44	0.15	0.10	0.10	0.10	0.10	0.08	0.11	0.13	71015	13.45	riffle clear on CIR photo
45	0.17	0.15	0.14	0.12	0.12	0.10	0.16	0.17	70828	13.41	
46	0.18	0.16	0.12	0.14	0.11	0.09	0.17	0.19	70607	13.37	riffle
47	0.18	0.11	0.12	0.13	0.09	0.09	0.08	0.20	70393	13.33	riffle
48	0.18	0.07	0.11	0.08	0.08	0.07	0.05	0.08	70200	13.30	
49	0.21	0.06	0.09	0.07	0.09	0.08	0.06	0.07	69992	13.26	
50	0.23	0.06	0.09	0.09	0.09	0.07	0.05	0.07	69772	13.21	riffle visible on CIR
51	0.20	0.12	0.09	0.10	0.10	0.09	0.10	0.10	69493	13.16	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSE CT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
52	0.19	0.19	0.20	0.16	0.22	0.22	0.22	0.24	69158	13.10	riffle
53	0.28	0.33	0.29	0.34	0.38	0.36	0.34	0.36	68886	13.05	
54	0.34	0.43	0.39	0.42	0.45	0.44	0.42	0.44	68675	13.01	
55	0.39	0.51	0.45	0.49	0.51	0.51	0.50	0.52	68471	12.97	
56	0.36	0.49	0.47	0.52	0.52	0.52	0.50	0.53	68238	12.92	
57	0.32	0.33	0.31	0.36	0.35	0.37	0.42	0.44	67983	12.88	riffle
58	0.32	0.27	0.26	0.26	0.25	0.24	0.23	0.27	67647	12.81	
59	0.24	0.26	0.18	0.23	0.22	0.22	0.22	0.24	67322	12.75	
60	0.13	0.18	0.11	0.16	0.14	0.16	0.17	0.17	67024	12.69	riffle
61	0.08	0.07	0.07	0.06	0.06	0.06	0.11	0.11	66692	12.63	riffle
62	0.08	0.06	0.05	0.07	0.05	0.05	0.07	0.08	66327	12.56	
63	0.09	0.06	0.06	0.05	0.06	0.06	0.06	0.05	66036	12.51	
64	0.11	0.09	0.08	0.06	0.07	0.07	0.07	0.07	65755	12.45	
65	0.11	0.13	0.10	0.09	0.10	0.10	0.10	0.10	65434	12.39	
66	0.12	0.07	0.07	0.12	0.11	0.11	0.10	0.11	65155	12.34	riffle (mid channel bar)
67	0.15	0.08	0.06	0.12	0.09	0.08	0.06	0.07	64905	12.29	
68	0.17	0.09	0.05	0.07	0.07	0.05	0.02	0.04	64668	12.25	
69	0.15	0.09	0.06	0.05	0.10	0.05	0.05	0.05	64387	12.19	
70	0.15	0.12	0.09	0.11	0.14	0.10	0.09	0.10	64152	12.15	lateral bar
71	0.19	0.14	0.11	0.14	0.15	0.11	0.03	0.12	63883	12.10	
72	0.33	0.16	0.15	0.15	0.12	0.14	0.03	0.12	63643	12.05	riffle
73	0.45	0.31	0.36	0.30	0.04	0.28	0.03	0.03	63365	12.00	
74	0.52	0.50	0.52	0.50	0.05	0.46	0.04	0.02	63067	11.94	
75	0.50	0.55	0.55	0.53	0.07	0.32	0.07	0.06	62742	11.88	
76	0.35	0.45	0.44	0.35	0.06	0.21	0.06	0.07	62428	11.82	
77	0.21	0.22	0.19	0.18	0.06	0.18	0.09	0.09	62094	11.76	
78	0.23	0.25	0.20	0.20	0.07	0.19	0.08	0.15	61774	11.70	
79	0.29	0.25	0.26	0.27	0.06	0.27	0.10	0.27	61469	11.64	
80	0.28	0.25	0.24	0.26	0.09	0.34	0.10	0.36	61145	11.58	
81	0.25	0.31	0.37	0.27	0.11	0.42	0.13	0.39	60837	11.52	
82	0.23	0.34	0.42	0.34	0.14	0.48	0.14	0.39	60512	11.46	
83	0.23	0.26	0.39	0.34	0.14	0.16	0.13	0.17	60161	11.39	
84	0.10	0.17	0.32	0.31	0.08	0.09	0.09	0.10	59810	11.33	
85	0.13	0.17	0.36	0.33	0.08	0.10	0.11	0.11	59469	11.26	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
86	0.12	0.21	0.32	0.34	0.10	0.11	0.13	0.15	59121	11.20	END of REACH 01 ~ and start of large mid-channel bar
87	0.18	0.22	0.17	0.29	0.21	0.23	0.20	0.24	58773	11.13	
88	0.23	0.22	0.08	0.21	0.21	0.22	0.19	0.19	58412	11.06	
89	0.37	0.08	0.05	0.08	0.06	0.06	0.15	0.13	58074	11.00	
90	0.43	0.09	0.06	0.06	0.04	0.04	0.06	0.07	57655	10.92	
91	0.34	0.06	0.05	0.05	0.04	0.05	0.06	0.07	57245	10.84	
92	0.11	0.07	0.07	0.08	0.07	0.07	0.07	0.08	56569	10.71	
93	0.09	0.18	0.12	0.10	0.08	0.08	0.12	0.12	56044	10.61	
94	0.11	0.17	0.05	0.07	0.05	0.05	0.06	0.16	55559	10.52	riffle
95	0.20	0.13	0.05	0.06	0.05	0.04	0.04	0.14	55217	10.46	
96	0.21	0.08	0.04	0.05	0.05	0.05	0.06	0.06	54893	10.40	
98	0.21	0.09	0.04	0.05	0.07	0.07	0.11	0.07	54604	10.34	
99	0.19	0.10	0.11	0.06	0.08	0.08	0.13	0.08	54256	10.28	
100	0.19	0.09	0.11	0.10	0.05	0.05	0.16	0.15	53912	10.21	riffle
101	0.15	0.08	0.09	0.11	0.04	0.04	0.14	0.15	53643	10.16	
102	0.16	0.12	0.13	0.07	0.06	0.05	0.09	0.11	53321	10.10	
103	0.15	0.11	0.12	0.05	0.05	0.05	0.05	0.06	52977	10.03	
104	0.11	0.09	0.08	0.05	0.04	0.04	0.04	0.05	52672	9.98	
106	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.05	52448	9.93	
107	0.12	0.08	0.08	0.07	0.05	0.05	0.05	0.06	52209	9.89	
108	0.08	0.12	0.13	0.09	0.10	0.10	0.09	0.10	51881	9.83	
109	0.08	0.07	0.07	0.09	0.17	0.15	0.14	0.16	51464	9.75	END of STUDY REACH 2 ~ riff
110	0.22	0.10	0.05	0.10	0.19	0.16	0.14	0.12	51051	9.67	
111	0.26	0.09	0.12	0.08	0.08	0.08	0.02	0.02	50516	9.57	bar - bend in channel - riffle
112	0.20	0.10	0.12	0.07	0.09	0.05	0.05	0.05	50181	9.50	
113	0.15	0.10	0.06	0.10	0.17	0.17	0.16	0.17	49794	9.43	riffle alongside bar
114	0.10	0.11	0.03	0.03	0.17	0.18	0.20	0.22	49302	9.34	
115	0.07	0.11	0.03	0.15	0.12	0.15	0.18	0.18	48902	9.26	
116	0.13	0.12	0.14	0.18	0.11	0.16	0.09	0.16	48403	9.17	riffle - very steep here
117	0.48	0.07	0.38	0.15	0.18	0.22	0.06	0.25	48065	9.10	
118	0.36	0.19	0.46	0.38	0.27	0.27	0.13	0.46	47691	9.03	
119	0.31	0.26	0.49	0.49	0.45	0.37	0.21	0.48	46523	8.81	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
120	0.19	0.15	0.52	0.48	0.54	0.55	0.20	0.60	46172	8.74	
121	0.12	0.35	0.51	0.34	0.56	0.59	0.30	0.56	45713	8.66	riffle
122	0.09	0.46	0.46	0.40	0.47	0.48	0.24	0.41	45208	8.56	riffle
123	0.08	0.14	0.16	0.21	0.21	0.16	0.22	0.22	44821	8.49	
124	0.08	0.05	0.07	0.12	0.08	0.02	0.12	0.12	44443	8.42	
125	0.12	0.08	0.05	0.09	0.07	0.07	0.09	0.09	44089	8.35	riffle
126	0.11	0.09	0.03	0.10	0.09	0.09	0.12	0.11	43705	8.28	riffle
127	0.15	0.11	0.04	0.07	0.09	0.09	0.12	0.12	43334	8.21	
128	0.22	0.16	0.09	0.08	0.09	0.09	0.10	0.10	42944	8.13	
129	0.20	0.13	0.08	0.08	0.04	0.04	0.12	0.13	42527	8.05	
130	0.19	0.08	0.08	0.07	0.10	0.13	0.17	0.17	42025	7.96	
131	0.20	0.18	0.17	0.11	0.19	0.19	0.23	0.25	41884	7.93	riffle
132	0.24	0.36	0.27	0.18	0.24	0.24	0.18	0.19	41707	7.90	
133	0.22	0.41	0.30	0.23	0.18	0.21	0.10	0.11	41061	7.78	mid channel bar
134	0.22	0.38	0.27	0.18	0.10	0.18	0.07	0.13	40729	7.71	
135	0.10	0.37	0.22	0.22	0.06	0.20	0.09	0.09	40077	7.59	END of study REACH 3
136	0.09	0.31	0.19	0.23	0.03	0.19	0.06	0.04	39689	7.52	
137	0.17	0.34	0.12	0.17	0.02	0.15	0.06	0.06	39246	7.43	
138	0.20	0.26	0.11	0.14	0.07	0.09	0.07	0.08	38879	7.36	
139	0.33	0.33	0.08	0.15	0.12	0.12	0.12	0.13	38518	7.30	
140	0.09	0.12	0.25	0.24	0.05	0.05	0.10	0.10	38069	7.21	
141	0.10	0.13	0.25	0.25	0.16	0.05	0.05	0.18	36927	6.99	
142	0.10	0.18	0.19	0.22	0.26	0.14	0.13	0.22	36441	6.90	
143	0.08	0.33	0.11	0.20	0.24	0.13	0.13	0.28	35959	6.81	
144	0.10	0.41	0.05	0.06	0.32	0.13	0.09	0.32	35559	6.73	
145	0.15	0.38	0.07	0.11	0.31	0.10	0.12	0.29	35123	6.65	
146	0.14	0.27	0.12	0.15	0.21	0.09	0.06	0.22	34601	6.55	
147	0.22	0.36	0.09	0.26	0.28	0.11	0.12	0.29	34165	6.47	
148	0.29	0.46	0.19	0.37	0.39	0.13	0.14	0.37	33574	6.36	
149	0.22	0.19	0.13	0.17	0.18	0.17	0.18	0.17	32997	6.25	
150	0.29	0.18	0.12	0.17	0.17	0.11	0.16	0.19	32232	6.10	debris jam/bar/outatke
151	0.27	0.21	0.24	0.17	0.17	0.14	0.16	0.18	31792	6.02	
152	0.30	0.22	0.23	0.18	0.14	0.07	0.13	0.15	31455	5.96	
153	0.27	0.29	0.16	0.18	0.14	0.15	0.12	0.14	31064	5.88	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
154	0.20	0.33	0.14	0.22	0.09	0.08	0.08	0.09	30654	5.81	
155	0.19	0.46	0.53	0.17	0.08	0.07	0.08	0.09	30178	5.72	next to treatment plant
156	0.15	0.65	0.66	0.13	0.06	0.06	0.06	0.07	29749	5.63	
157	0.12	0.72	0.52	0.16	0.10	0.09	0.10	0.10	29125	5.52	
158	0.20	0.75	0.53	0.18	0.16	0.06	0.09	0.09	28656	5.43	
159	0.26	0.69	0.56	0.13	0.17	0.06	0.07	0.10	28184	5.34	End of REACH 4
160	0.18	0.58	0.59	0.10	0.17	0.06	0.10	0.14	27711	5.25	lateral bar
161	0.21	0.62	0.63	0.12	0.24	0.07	0.06	0.08	27235	5.16	riffle
162	0.16	0.52	0.56	0.15	0.24	0.17	0.11	0.20	26694	5.06	
163	0.19	0.52	0.53	0.15	0.06	0.06	0.12	0.21	25887	4.90	
164	0.24	0.54	0.53	0.20	0.06	0.06	0.07	0.21	25211	4.77	
165	0.27	0.46	0.32	0.17	0.06	0.05	0.07	0.36	24785	4.69	
166	0.23	0.40	0.37	0.16	0.06	0.07	0.13	0.42	24394	4.62	
167	0.13	0.31	0.31	0.26	0.20	0.04	0.13	0.48	23984	4.54	start large lateral bar (right)
168	0.14	0.18	0.16	0.27	0.26	0.10	0.12	0.56	23531	4.46	large lateral bar
169	0.16	0.17	0.06	0.12	0.21	0.21	0.20	0.67	23148	4.38	large lateral bar
170	0.29	0.25	0.17	0.06	0.08	0.03	0.13	0.64	22728	4.30	end bar - riffle
171	0.41	0.49	0.15	0.17	0.16	0.09	0.06	0.50	22222	4.21	
172	0.46	0.44	0.21	0.24	0.25	0.09	0.09	0.50	21855	4.14	
173	0.46	0.38	0.29	0.25	0.29	0.09	0.07	0.45	21491	4.07	riffle - lateral bar left
174	0.30	0.30	0.26	0.16	0.16	0.15	0.13	0.41	20900	3.96	
175	0.15	0.30	0.22	0.28	0.27	0.17	0.30	0.32	20441	3.87	start of another large bar complex (left) with side channels
176	0.14	0.32	0.33	0.23	0.10	0.13	0.15	0.17	19726	3.74	
177	0.26	0.04	0.17	0.19	0.10	0.04	0.14	0.15	19348	3.66	channel merges from left, but splits right - long mid-channel bar
178	0.26	0.07	0.14	0.21	0.11	0.06	0.09	0.11	18994	3.60	
179	0.22	0.14	0.10	0.17	0.09	0.09	0.04	0.12	18633	3.53	
180	0.31	0.31	0.32	0.37	0.07	0.06	0.05	0.12	18240	3.45	
181	0.38	0.46	0.41	0.48	0.07	0.07	0.13	0.20	17839	3.38	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
182	0.41	0.48	0.61	0.62	0.12	0.11	0.27	0.28	17485	3.31	4.5 transect long mid-channel bar - primary channel left
183	0.51	0.56	0.71	0.67	0.27	0.11	0.32	0.35	17117	3.24	
184	0.55	0.62	0.73	0.73	0.27	0.19	0.40	0.40	16786	3.18	
185	0.46	0.58	0.65	0.55	0.21	0.31	0.30	0.33	16402	3.11	
186	0.46	0.43	0.61	0.47	0.35	0.32	0.37	0.25	15972	3.03	
187	0.33	0.31	0.38	0.34	0.42	0.44	0.51	0.32	15238	2.89	
188	0.27	0.27	0.41	0.34	0.26	0.18	0.36	0.26	14808	2.80	
189	0.26	0.17	0.31	0.35	0.34	0.22	0.29	0.32	14394	2.73	END STUDY REACH 5
190	0.29	0.27	0.32	0.32	0.29	0.29	0.31	0.31	14017	2.65	
191	0.30	0.28	0.38	0.33	0.27	0.29	0.32	0.33	13594	2.57	
192	0.23	0.13	0.50	0.20	0.12	0.10	0.22	0.22	13141	2.49	
193	0.19	0.09	0.51	0.20	0.08	0.08	0.20	0.20	12875	2.44	
194	0.16	0.09	0.51	0.20	0.07	0.07	0.16	0.17	12528	2.37	
195	0.15	0.07	0.43	0.18	0.12	0.08	0.10	0.10	11927	2.26	
196	0.15	0.06	0.38	0.14	0.09	0.08	0.03	0.04	11307	2.14	
197	0.16	0.05	0.31	0.17	0.11	0.12	0.03	0.03	10848	2.05	
198	0.14	0.05	0.25	0.15	0.24	0.15	0.06	0.11	10244	1.94	
199	0.10	0.09	0.24	0.13	0.19	0.19	0.22	0.21	9644	1.83	
200	0.11	0.13	0.24	0.15	0.19	0.19	0.32	0.33	8713	1.65	
201	0.05	0.09	0.22	0.12	0.24	0.26	0.28	0.28	8260	1.56	
202	0.05	0.07	0.18	0.09	0.26	0.24	0.28	0.28	7726	1.46	
203	0.05	0.11	0.17	0.10	0.26	0.25	0.26	0.34	7073	1.34	
204	0.12	0.17	0.17	0.05	0.27	0.28	0.30	0.32	6479	1.23	
205	0.10	0.13	0.11	0.02	0.20	0.21	0.20	0.21	5859	1.11	
206	0.12	0.05	0.06	0.07	0.20	0.21	0.22	0.22	5127	0.97	
207	0.15	0.12	0.19	0.18	0.24	0.22	0.21	0.20	4491	0.85	
208	0.16	0.16	0.18	0.18	0.18	0.18	0.19	0.18	3890	0.74	
209	0.14	0.19	0.19	0.10	0.04	0.03	0.19	0.19	3280	0.62	
210	0.13	0.15	0.15	0.05	0.04	0.04	0.15	0.15	2548	0.48	
211	0.14	0.10	0.12	0.05	0.03	0.03	0.03	0.04	1528	0.29	
212	0.14	0.09	0.11	0.11	0.07	0.08	0.03	0.07	964	0.18	
213	0.11	0.09	0.11	0.10	0.09	0.09	0.09	0.09	147	0.03	END Reach 6 ~ end study area

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSE CT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
214	0.48	0.11	0.12	0.12	0.13	0.11	0.11	0.11	-627	-0.12	
215	0.72	0.12	0.21	0.37	0.14	0.11	0.13	0.15	-1110	-0.21	

CHAPTER 4.
DESCRIPTION OF CHANNEL MIGRATION IN THE STUDY AREA

This chapter describes the contemporary and historical channel migration characteristics of the study area by river reach (see Figure 3-2). The Naches River has actively migrated throughout historical and geologic time. Evidence of abandoned channels are visible on air photos and maps. Relict channels that pre-date European settlement are visible on LIDAR images across the entire geomorphic floodplain. Although the Naches River has migrated via gradual channel shifting, abrupt channel changes through avulsions have been very common. Most of the major channel changes have been caused by avulsions, with the subsequent shifting of the river's erosive energy to new sections of stream bank downstream from the avulsion.

Channel migration has created major disturbance to humans at two locations in the study area: in Reach 3 just downstream from the South Naches Road bridge south of the town of Naches; and at the downstream end of the study area in the vicinity of Powerhouse Road. Chronic or occasional problems have resulted from channel migration at numerous other locations.

Much of the floodplain subject to active channel migration has remained largely undeveloped because sustained channel migration has made the land difficult to develop. Leaving this land undeveloped provides an effective buffer and allows the channel to move without causing difficulties for people. It also helps mitigate for locations where the river is laterally constrained. Allowing channel migration upstream or downstream of a location that is constrained to protect infrastructure (such as Highway 12) can reduce the power the stream may possess to damage reinforced stream banks during higher flows.

At several places in the study area, an avulsion into a former channel would drastically change the position of the channel, relocating the erosive energy of the main channel close to active farmland and numerous homes. The assessment of avulsion hazard zones (AHZ) used the LIDAR DEM and field observation to determine zones where avulsions are likely, to predict new channel patterns, and to delineate hazard areas resulting from avulsion processes.

The historical analysis performed for this study found that the active channel was wider (more active) in most locations in 1927, 1947 and 1959 than in subsequent years reviewed. This likely is due to a more dynamic transport regime, including greater flood activity, between 1927 and 1959, to the widespread reinforcement of the channel after 1959, or to a combination of these and other factors, including the response of the river to damming in 1914. Reductions in channel and active width may be associated with vegetation driven stabilization, but for the most part are a function of bank reinforcement. Relative channel indices and their significance by reach are also discussed in the following sections. Figures 4-1 through 4-3 show the mapped active channels for 1947, 1959, 1972, 1984, 1992, 1998, and 2000. These active channels and time periods were selected to illustrate historical channel movement in the various study reaches.

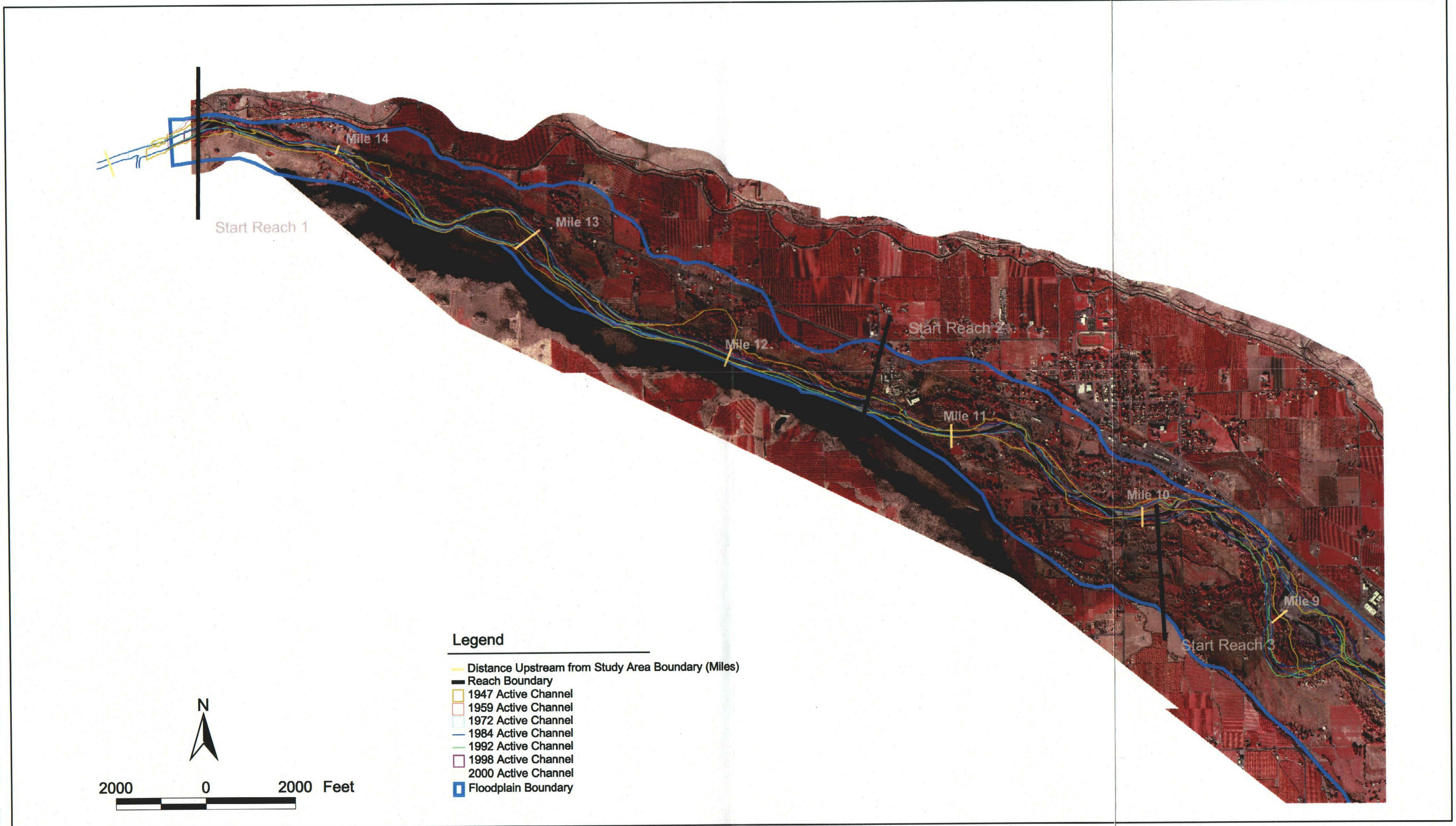
REACH 1

Reach 1, shown in Figure 4-4, begins just below the confluence with the Tieton River, which flows from Rimrock Reservoir. The river flows through a well entrenched channel upstream from this confluence, under the highway bridge crossing the Naches, and then past the confluence for some 2,000 feet before meeting the Wapatox power canal dam and intake, shown in Photo 4-1 and Figure 4-5.

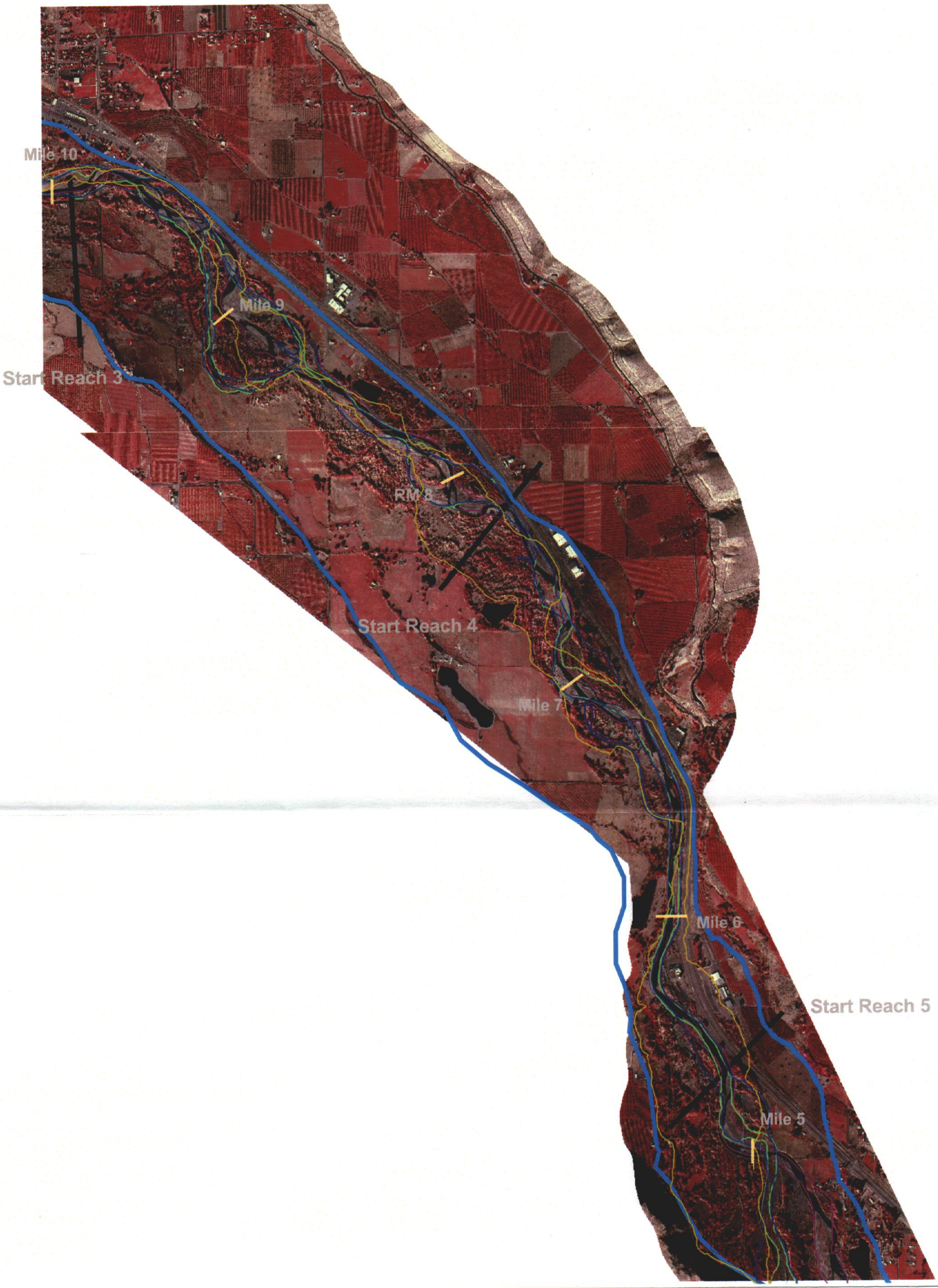
Photo 4-1. Wapatox Diversion Dam and Intake Structure

The Naches River has not migrated a great distance in Reach 1, as this section of river is more incised than the other reaches. The upper part may be partially constrained by bedrock, as the valley is narrower where the river approaches the confluence with the Tieton River. The river banks are steep and thus prone to undercutting in places, and consist predominantly of loose cobbles and boulders with supporting sand-size particles in many places below the Wapatox diversion dam. For the first quarter-mile into the study area, the river is narrow and runs fast down a steep section as it passes the confluence with the Tieton River (see gradient plot, Figure 3-3) until it hits the Wapatox Dam.

The Wapatox Dam consists of a concrete diversion dam and intake structure, representing a hard control within the channel. At the intake structure the river is hard against Highway 12 and is deflected east/southeast where it runs straight and narrow, along a



Tetra Tech/ KCM, Inc. 1917 First Avenue Seattle, Washington 98101 GeoEngineers	Yakima County NACHES RIVER CHANNEL MIGRATION STUDY	Figure 4-1 REACHES 1 AND 2 HISTORICAL ACTIVE CHANNELS



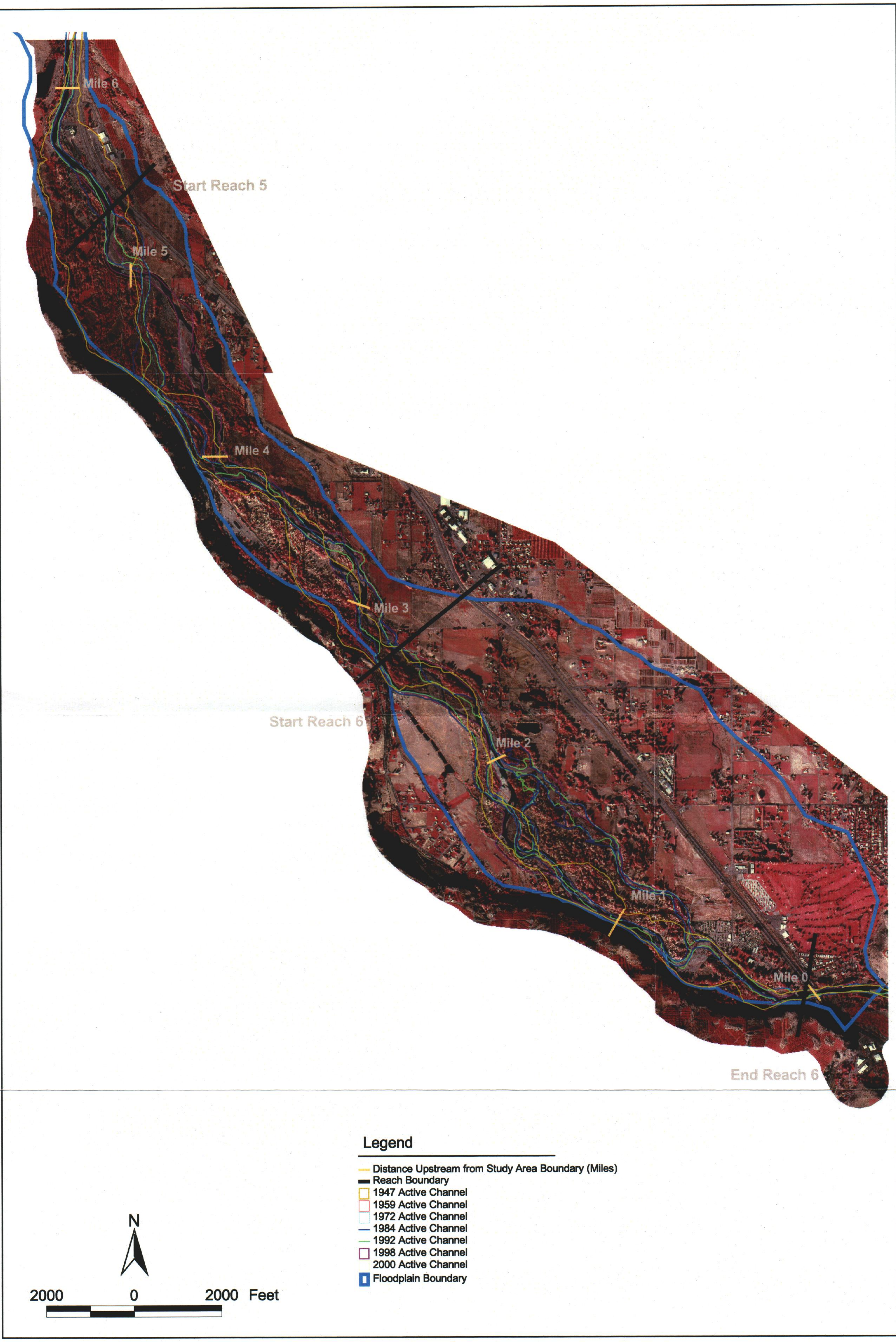
Legend

- Distance Upstream from Study Area Boundary (Miles)
- 1947 Active Channel
- 1959 Active Channel
- 1972 Active Channel
- 1984 Active Channel
- 1992 Active Channel
- 1998 Active Channel
- 2000 Active Channel
- Floodplain Boundary
- Reach Boundary

N

2000 0 2000 Feet

Tetra Tech/ KCM, Inc. 1917 First Avenue Seattle, Washington 98101 GeoZenTec	Yakima County NACHES RIVER CHANNEL MIGRATION STUDY	Figure 4-2 REACHES 3 AND 4 HISTORICAL ACTIVE CHANNELS



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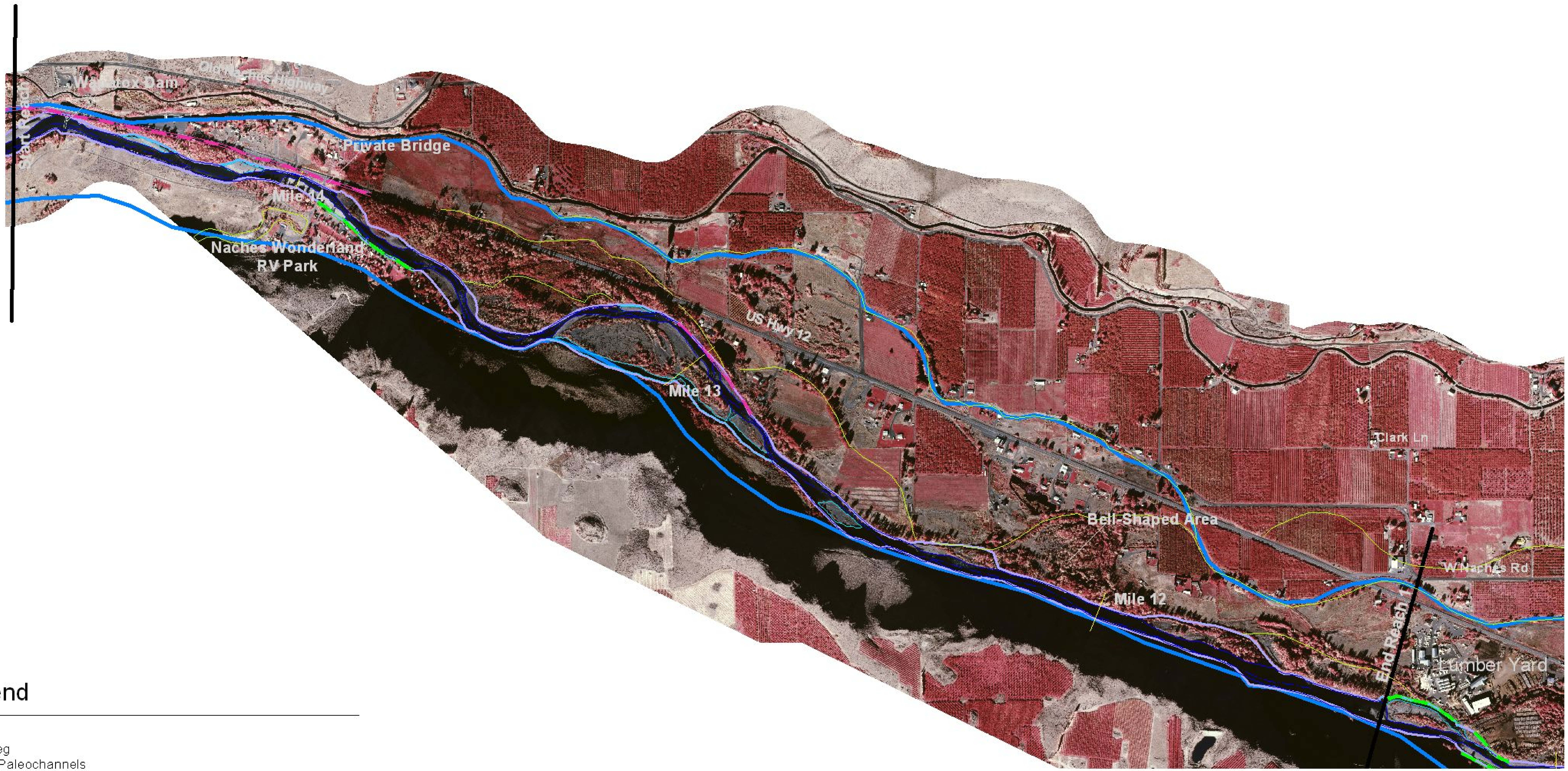
GeoZenTec

Yakima County
NACHES RIVER
CHANNEL MIGRATION STUDY

Figure 4-3
REACHES 5 AND 6
HISTORICAL ACTIVE CHANNELS



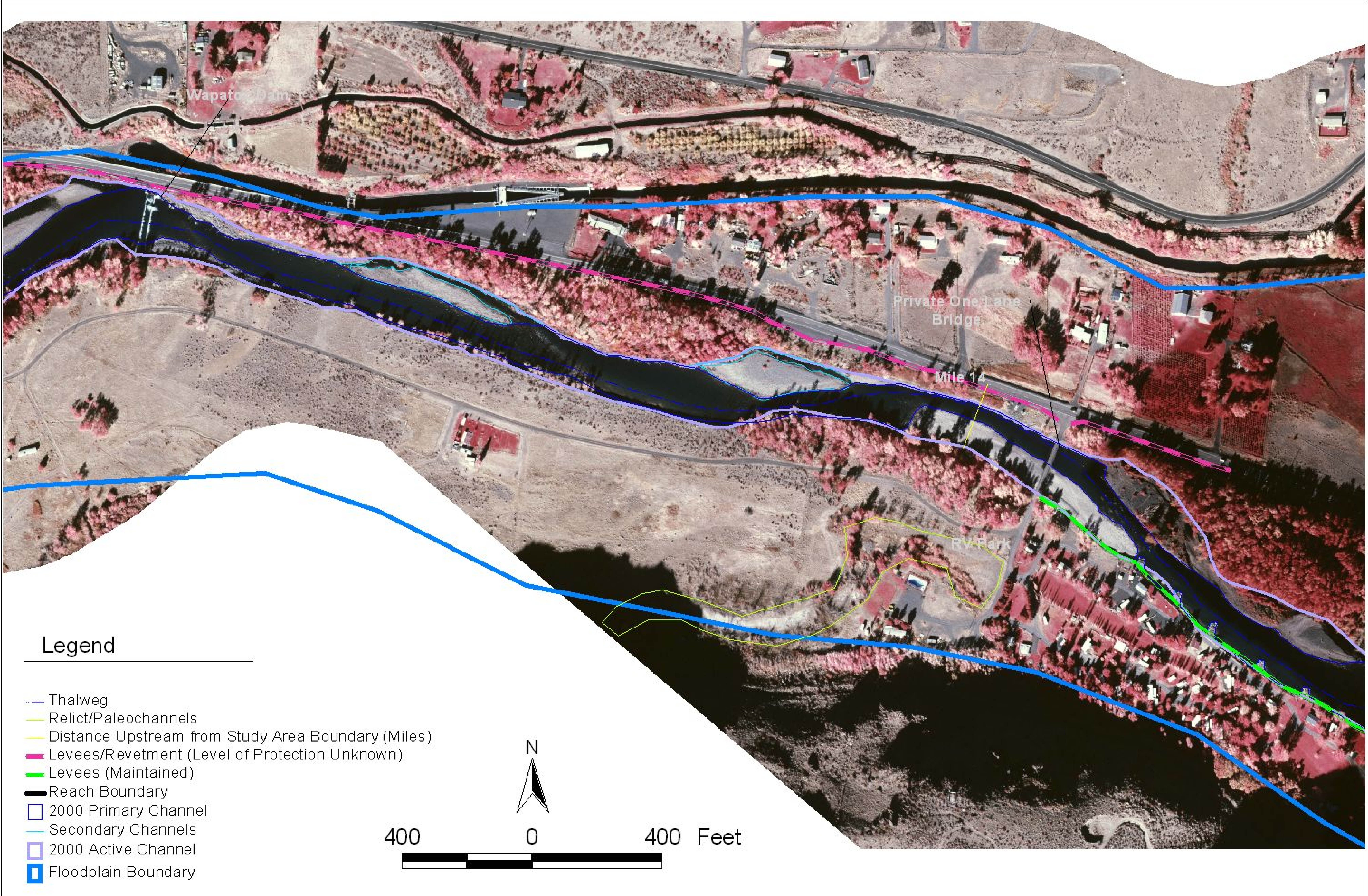
Legend

- Thalweg
- Relict/Paleochannels
- Levees/Revetment (unknown level of protection)
- Distance Upstream from Study Area Boundary (Miles)
- Levees (maintained)
- Reach Boundary
- 2000 Primary Channel
- 2000 Islands and Secondary Channels
- 2000 Active Channel
- Floodplain Boundary (FEMA)

N

1200 0 1200 2400 Feet

Tetra Tech/ KCM, Inc. 1917 First Avenue Seattle, Washington 98101 GeoEngineers	Yakima County NACHES RIVER CHANNEL MIGRATION STUDY	Figure 4-4 REACH 1 OVERVIEW



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Yakima County
NACHES RIVER
CHANNEL MIGRATION STUDY

Figure 4-5
WAPATOX DAM AND
NACHES WONDERLAND
RV PARK

relatively low gradient for approximately 0.36 miles. Transect ratios indicate that the river has been stable through this segment, although the 1927 data indicates that the active channel was likely wider through this reach up until construction of the diversion dam, and for at least 10 years following dam construction. This can also be seen by comparing the 1947 aerial photo with later photos. The change likely results from the dam cutting off the upstream sediment supply. The potential mobilization of this stored sediment should be considered if the Wapatox Dam should be retired (this has been proposed to increase in-stream flows for salmonid protection, but it is not a certainty).

Upstream and downstream from the dam, the north side of the river is heavily riprapped to protect the power canal and infrastructure and Highway 12. On the south side, the river is flanked by a 600-foot-wide floodplain that reaches the valley wall. The mainly unvegetated, unconsolidated banks on this side of the river are up to 12 feet high in places and are highly erodible, providing a considerable quantity of sand-cobble-sized sediment for transport; however, these banks have not historically been an area of active erosion. There are few buildings on this floodplain segment until about a half-mile downstream from the Wapatox Dam. Here a one-lane private bridge (near Mile 14.0) crosses from Highway 12 to allow access to the Naches Wonderland RV Park, on the south side of the river. The bridge is low and has the potential to snag large debris in a flood, which could create a subsequent hazard for the trailer park (Photo 4-2).

Photo 4-2. Private Bridge to Naches Wonderland RV Park, Downstream of Wapatox Canal

Channel stability in this section of Reach 1 influences potential CMZ impacts on the Naches Wonderland RV Park, which has more than 60 structures. The floodplain begins to widen here, and transect ratios indicate that the channel has been more active in this location. The key hazard appears to be the potential for the river to cut into the south bank above the bridge, with subsequent undermining of the bridge and rerouting of the channel through the RV park. However, the current configuration of the channel doesn't appear to favor this scenario. A more likely hazard is a bridge washout and subsequent stranding of park inhabitants during a large flood. Fortunately, use of the park during winter appears to be minimal, and it would take an extreme flood event to exceed bank-full flows upstream.

Below the bridge, the RV park and associated buildings are protected by riprap on the south, and by a large, densely vegetated lateral bar to the north that clearly dissipates considerable energy during high flows, judging by the debris snagged in the dense vegetation that covers it (Figure 4-4). The bar is dissected by old flow channels and scour pools that contain water. It also appears to have some wetland value. The peak in the 1947 transect ratio data at Mile 13.7 indicates that the upstream area of this bar was actively scoured at that time.

Rounding the lateral bar, the river is deflected toward the road by a small bluff on the valley wall, and immediately splits into two low-flow channels flowing around a large mid-channel bar (at approximately Mile 13.25) some 2,600 feet long and 550 feet wide at its widest point. The northern channel gets within 180 feet of Highway 12 before turning back toward the southern valley wall, flowing past riprap that protects some farm buildings and a small lake (Mile 13.0), and rejoining the southern channel, which is directly beside the valley wall. Although the river appears to be fairly well entrenched along this straight reach, with large banks constraining it on the north side (Photo 4-3), the LIDAR-based DEM and 1947 historical data clearly indicate that the river has regularly broken out of this linear channel. Transect ratios are high here (0.4 to 0.5) because the active channel is wide and the floodplain narrow. If the raised Highway 12 is counted as the floodplain boundary, then the active channel nearly covers the entire floodplain for several hundred feet here. Figure 3-4 shows, however, that the active channel is considerably wider than the primary channel in many places.

The transect ratios indicate that the river's behavior has been remarkably consistent at this location over the study period, both in terms of its occupation of the readily available floodplain, and in the location of the large mid-channel bar, which has consistently acted as a major sediment storage point. It is apparent from the 1901 channel change and LIDAR data that the channel used to sweep farther north toward and across Highway 12. The river has traditionally expended considerable energy here, which is why extensive riprap now protects property and the storage pond between Highway 12 and the river. Debris blockage of the southern channel could create problems if water is redirected fully into the northern arm. Landslides from the canyon flanks are also a possibility, although unlikely under contemporary conditions.

Photo 4-3. Entrenched, straight reach section downstream of River Mile 13

Transect ratios fall back down at Mile 12.5 as the active channel narrows considerably (Figure 4-1), this offsetting the fact that the floodplain narrows here too, remaining less than 2000 feet wide until the river flows into Reach 2 (Figure 3-5). Ratios remain low until mile 11.95 where years 1927, ’47, ’59, ’72 and ’92 climb similarly to around 0.5, while years 1984 and ’98 remain low, as does 2000, although this climbs within 0.4 miles. This trend is explained by the river exploiting a small area of a larger section of floodplain that has clearly been highly active in the past 250 years or so, but is now only active in a small area. This area appears as a vegetated bell-shape (approximately Mile 12.2) on the CIR image, flanked by farmland that has not been disturbed recently. The transect ratio data indicates that on or before the dates 1927, ’47, ’59, ’72 and ’92 the river was utilizing this bell-shape area (i.e. this has been classified as part of the ‘active channel’ for these periods).

Understanding the river’s tendency to occupy this area is important for at least three reasons:

- There are farms and homes immediately north of the area – one owner perceives flooding problems in this area due to the tendency of beaver to dam paleochannels that create the curve of the “bell.”
- The area facilitates some energy dissipation in higher flows, and should not be altered if possible.

- Water movement into this area during large floods could, if sustained, begin to follow drainage ditches and lines of old flow on the floodplain (evident from LIDAR data and noted in the field) down to the timber yard just over a half-mile downstream.

REACH 2

Study Reach 2, shown in Figure 4-6, begins in the vicinity of a lumber yard. Transect ratios are low here and do not change significantly until the beginning of Reach 3. The exception to this is the 1927 data, which indicates that the active channel at that time occupied at least part of the land now taken by the lumber yard. At the beginning of Reach 2 a small mid-channel bar briefly splits the low flow channel, the channel to the north of the bar scouring deeply as it is deflected by riprap protecting the lumber yard, and the channel to the south keeping against the valley wall. As the channels merge on the downstream end of this vegetated bar, the river moves away east from the valley wall, and becomes tightly constrained on both sides by riprap protecting the lumber yard, Craig Road, and numerous properties on the south bank.

Mobilization of timber at the lumber yard during a flood is a serious hazard to people and property in this area. The river is highly dynamic in the reach just upstream of and past the lumber yard, yet it is constricted by the canyon wall on the north and by heavy bank protection on the lumber yard side. The river flows very fast through here in moderate to high flows (see gradient plot, Figure 3-3). Potential CMZ problems downstream from here (in the Craig Road area) may be substantially mitigated by moving the lumber yard and allowing the river to access the floodplain in this area. This would have the added benefit of moving potentially hazardous lumber away from the channel.

Near Mile 10.75, riprap protecting a junk yard and Highway 12 deflects the river 80 degrees to the south, where it flows some 0.6 miles to the South Naches Road Bridge. The north bank is heavily riprapped all through this section to the bridge. The floodplain begins to open out downstream of the bridge. Almost all transect ratios remain under 0.2 for the rest of the reach, indicating again that the river has behaved fairly consistently for the study period, maintaining a narrow active channel despite flowing through a broader floodplain with little bedrock control once the channel turns east and away from the canyon wall. This is mainly due to heavy bank reinforcement that protects the junk yard and, just downstream, the buildings of South Naches. The exception to the low ratios is again the 1927 data, which shows a transect ratio of 0.4 just inside Reach 2. The active channel in 1927 occupied considerably more area of the floodplain than subsequent photographic surveys indicate. This greater active channel area trended to the south, covering the still largely unoccupied floodplain north of Craig Road (as did the 1901 channel, which probably flowed much closer to the line of Craig Road than the contemporary channel).

Upstream from the South Naches Road bridge, the south (right) bank is the outside of a wide meander bend. Contrary to a typical migration pattern, the active river channel has moved a bit north at this location since 1947. The current alignment places the brunt of the meander migration pressure on the south (right) bank just downstream from the bridge along Lewis Road. Once under the South Naches Road Bridge, the river flows some 0.2 miles to the end of Reach 2, constrained by riprap protecting Lewis Road on the south

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side and the Town of Naches on the north. In 1996 the river breached the levee at this location, and flowed in southeast across Lewis Road.

REACH 3

Reach 3 begins just downstream of the South Naches Road Bridge in the vicinity of Lewis Road (Figure 4-7). Reach 3 is characterized by a large spike in transect ratio value at Mile 8.8 (in the area of Lewis Road), a rapid steepening of channel gradient at Mile 7.8, and generally a considerable widening of the active channel. The floodplain continues its widening trend throughout the reach. The spike in transect ratio is in response to a half-mile-long section of the river (between Mile 8.5 and Mile 9.0) where the river has consistently made widespread use of the floodplain; this is an area of particular concern for avulsion hazard, and a likely location for future channel migration. The most prominent spikes include recent years, 1992, 1998 and 2000, in areas still left sparsely vegetated following large floods in 1995 and 1996.

While Reach 2 contains many hard structures and control points, tends to be more incised, and has a slightly steeper gradient, Reach 3 flows across a lower gradient floodplain that is for the most part unconstrained. In response, the floodplain is much wider and the river has made full use of it. Rapid energy loss occurs downstream of the Naches River bridge even under moderate flows, which has resulted in a large deposition point. A large vegetated bar has formed downstream of the bridge, which is essentially a dumping ground for sediment and debris as the river opens out onto the floodplain. This bar has two major paleochannels 6 to 8 feet higher than the contemporary low flow channel. Avulsions have clearly been prevalent here, and field survey indicated that in a large flood there is potential for the river to again divert and take a short cut across this feature. It is likely that LWD has been a major contributing factor to avulsions that have occurred in this area.

At Mile 9.8, about a half-mile downstream of the South Naches Road bridge, the highway is impinged by the outside of a major meander bend. This meander has persisted since at least 1947, but has changed in shape significantly, shifting the threat to Highway 12 along an approximately half-mile stretch of road. Although the north bank of the river is heavily riprapped in several segments of this reach (to protect Highway 12), there is a half-mile-wide plain available to the south, much of which was completely inundated during the 1996 flood, including part of Lewis Road. It is apparent from the aerial photography, LIDAR and infra-red photography that the main channel has shifted dramatically through this area, by avulsing into relict channels at different points in time.

An often used relict channel is shown in Figure 4-8 and is noted as an avulsion site on Figure 4-7. The relict channel runs south for a half-mile, cuts a high bank in the floodplain, turns east for 0.2 miles, then joins the contemporary low flow channel. This area was investigated in the field and it was found that the L-shaped channel has been recently active, and was holding water in November 2002. The channel has apparently been occupied by the main channel intermittently since before 1947. The most recent period was around 1984, bringing the main channel closer to the end of Lewis and Fortune Roads. This was apparently a short-lived phenomenon, because by 1992 the main channel was back closer to where it is now through this stretch. Besides the main L-shaped meander, several similarly shaped meander scars are visible on aerial photos of this area, suggesting that the river has shifted location through here many times. Currently, an avulsion here would result in approximately a mile of the channel moving to a new position. The impacts on humans in the immediate vicinity would be minimal however, because the probable new channel location would cut through an intact riparian area. Such an avulsion could, however, pose a threat to a few homes, a large farm with more than 15 buildings at the end of Fortune Road (where the banks of the channel have been recently attacked), and a storage pond in the vicinity of Running Springs Road. This type of avulsion would alleviate some erosive pressure on the opposite (Highway 12) embankment along about a half-mile stretch of road, but might result in the river attacking Highway 12 more directly just above the drinking water filtration plant.

Downstream of the L-shaped avulsion site, the river straightens in the vicinity of a small lake that was once a borrow pit, shown in Figure 4-9. The low flow channel is straight along the lake because the pit has been protected with a line of riprap for approximately 1,600 feet. Digital flood extent lines taken from 1996 aerial photo data indicate that the full width of the floodplain was inundated in the 1996 flood over the entire downstream half of Reach 3. The rapid steepening of the channel occurs in a very large gravel area (observed during low flow conditions) that, judging by field work and CIR image analysis, has undergone large and rapid channel changes even under normal high flow (not flood) conditions. About 1,000 feet downstream from this steep riffle, flow in the primary channel is still accelerating as it dog legs east/northeast of Running Springs Road and hits the riprap guarding Highway 12 on the boundary with Reach 4. This area provides room for the flooding Naches River to spread out and expend energy before becoming constrained by riprapped banks again just downstream. From Mile 9.0, transect ratios indicate that recently the active channel has been largely constrained by massive riprap and other armoring to protect Highway 12 as it turns south, the water treatment plant, and many farmland locations on the opposite bank.

The cause of the Lewis Road situation is not clear, given the multiple factors that play a role in channel migration here. The placement of the Lewis Road levee, Highway 12 road embankment, and South Naches Road bridge play a role in the migration dynamics by fixing the channel in one location, which increases the energy available to the river downstream for migration. For example, the Highway 12 embankment is impeding the channel from migrating to the northeast and probably magnifying the erosive energy of the river in the vicinity of the L-shaped meander. If the Lewis Road levee were not present, the river might continue southward, eventually taking a new route toward the southeast similar to the swath inundated during the 1996 flood. The role of the South Naches Road bridge is unclear, but it must be considered a potential factor because the river channel is fixed in location by the presence of the bridge.

REACH 4

This reach, shown in Figure 4-10, is primarily characterized by a complex and highly active floodplain that extends laterally from the valley wall to the west and the raised platform of Highway 12 to the east. This zone ranges between 1,000 and 2,000 feet wide. For the entire length of Reach 4 (2.3 river miles) the low flow channel centerline does not stray more than 850 feet from Highway 12, and for the most part it is hard up against riprap.

At the start of the reach the river is close to the highway, then it rounds a large partly vegetated lateral bar (850 feet wide at its widest point) before returning to the road

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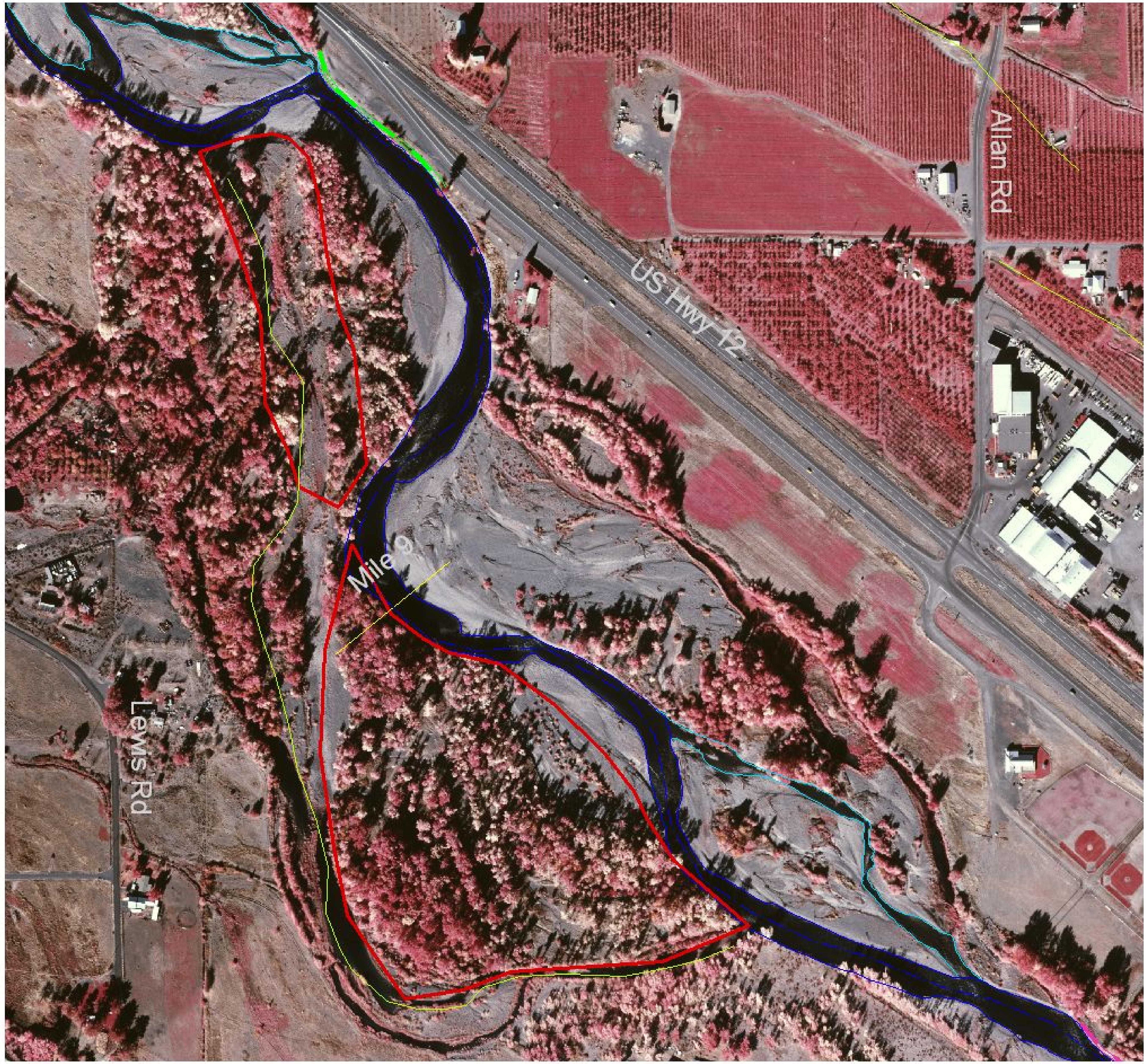
Figure 4-7

REACH 3 OVERVIEW

N

500 0 500 Feet



Legend

- Thalweg
- Relict/Paleochannels
- Distance Upstream from Study Area Boundary (Miles)
- Identified Avulsion Hazards
- 2000 Primary Channel
- 2000 Islands and Secondary Channels
- Levees (Maintained)
- Levees/Revetment (Level of Protection Unknown)

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Figure 4-8
LEWIS ROAD AVULSION SITE

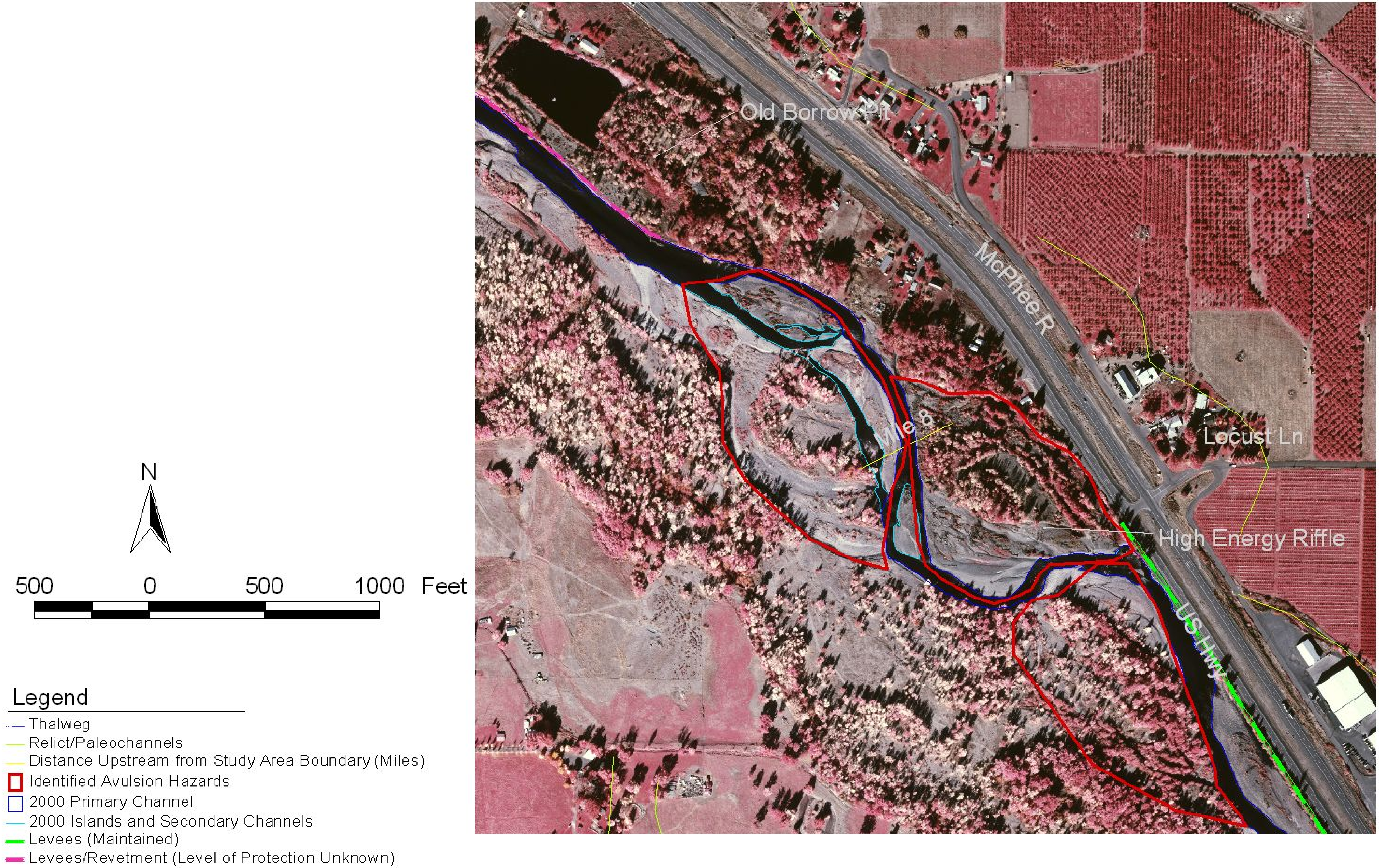

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Figure 4-9
AVULSION HAZARD NORTH OF RUNNING SPRINGS ROAD

Legend

- Relict/Paleochannels
- Distance Upstream from Study Area Boundary (Miles)
- Levees/Revetment (level of protection unknown)
- Levees (maintained)
- Reach Boundary
- 2000 Primary Channel
- 2000 Islands and Secondary Channels
- 2000 Active Channel
- Floodplain Boundary (FEMA)

N

1200 0 1200 Feet

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0.4 miles downstream. The river then flows against a 1,000-foot-long concrete canal that controls a steady flow of water that is released back into the Naches River from the Power Project (the water having been extracted upstream at the Wapatox Dam). For the next 0.65 miles, the river again follows the road until it flows around a large lateral bar on which is sited the Naches River Water Treatment Plant. Prior to reaching the treatment plant, the river flows over a complicated mid channel bar assemblage and past a concrete water intake that frequently facilitates snags of large debris. Photo 4-4 shows this problem in a moderately high flow, with debris accumulating at the start of the water intake (lower left) as well as on the mid-channel bars. Also visible is riprap on the opposite side of the bank. Even in moderate flows the river, which has become entrenched as a result of constraints on both sides from the water intake structure down past the treatment plant, reaches very high velocities through this reach. From the intake to the treatment plant, the river has a relatively steep gradient of 0.0062 ft/ft.

Photo 4-4. Debris Snag During High Flow at Concrete Intake Upstream of the City of Yakima Water Treatment Plant

The transect ratio data for lower Reach 4 shows that the channel is presently tightly constrained but that prior to 1960 it migrated widely in this area. Despite some uncertainty in the 1901 vector data, it is reliable enough to say that the river meandered across the area that Highway 12 was built on (this is backed up by geomorphic evidence). However, not even the 1901 data show the channel far west of this constricted zone, even though there was probably little protection on the side of the river before the treatment plant was built (the channel at that time probably did meander 400 to 700 feet west opposite the treatment plant). The wider migration zones available to the contemporary river in the Reach 3 are clearly critical in terms of reducing flow velocities in flood conditions, and hence reducing the potential damage to Highway 12 and the treatment plant.

The treatment plant is in a vulnerable location, having been built on a feature called a point bar. As the river approaches the treatment plant, it swerves slightly to the west to bend around the site. There is significant erosive pressure focused on the river bank at the point where the channel swerves to the west. This area is heavily fortified with riprap and a protective levee on the Treatment Plant side that was built strong and high enough to protect the filtration plant from being flooded during the 1996 flood event.

Key management issues for consideration in this reach relate to potential damming or breaching of the channel at the intake and potential damage to the treatment plant. This threat could be substantially mitigated by allowing the river access to the floodplain on the west bank at this location, although dike removal here would leave a handful of properties and an irrigation reservoir exposed to damage. Historical data from 1927 indicates that this area of the floodplain was active prior to levee construction. Because of the configuration of the channel, location of the filtration plant, and constraint of the channel by Highway 12, this river bank will continue to need periodic fortification.

REACH 5

Immediately downstream from the water treatment plant lies the Eschbach Park region, shown in Figure 4-11. During the 1940s and before, the main channel flowed through Eschbach Park. Today the channel bends to the west below the filtration plant, once again placing Highway 12 on the outside (erosive side) of a meander bend. The old channels through the Eschbach Park area were active during the 1996 flood, and probably carry water during most floods. Although this area does not pose any immediate risk associated with channel migration, it is possible that the river could switch back to one of the old channels at some point. For this reason, it is desirable for this area to remain in a natural state.

The current location of the channel is causing channel migration pressure on homes and farmland served by Kershaw Road. The configuration of the channel places most of the north-south segment of Kershaw Road on the outside of a meander bend (Figure 4-12), creating bank erosion associated with meander shift/enlargement.

Key trends in Reach 5 are a substantial drop in gradient, a wide active channel relative to the primary channel, and a narrow floodplain compared to Reach 6. Although the channel migration history of this reach is difficult to interpret, the juxtaposition of stable and unstable reaches suggests the operation of site controls over time, which was noted in the field. For example in places there are piles of riprap considerable distances from the contemporary channel that have become vegetated over. Mapping and dating of these structures would enable a clearer interpretation of what has controlled channel migration.

This is a highly active area that has historically served as a buffer to downstream areas during flood conditions. The spike in the 2000 data (Figure 3-8) is a function of two large

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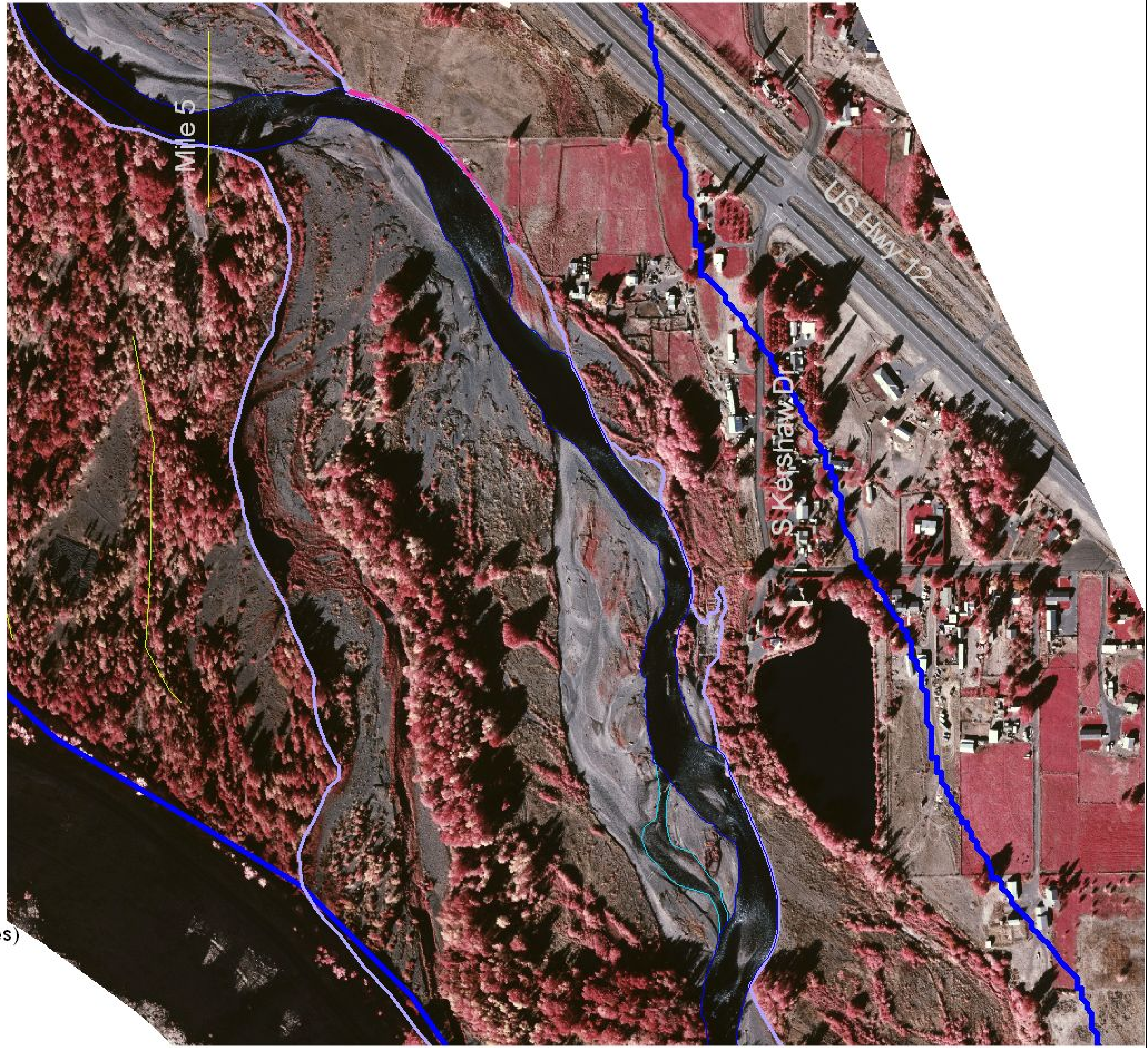
Figure 4-11
REACH 5 OVERVIEW



N

500 0 500 Feet

Legend

- Thalweg
- Relict/Paleochannels
- Distance Upstream from Study Area Boundary (Miles)
- Levees/Revetment (Level of Protection Unknown)
- Levees (Maintained)
- 2000 Primary Channel
- 2000 Islands and Secondary Channels
- 2000 Active Channel
- Floodplain Boundary (FEMA)

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Figure 4-12
CHANNEL CONFIGURATION
NEAR SOUTH KERSHAW ROAD

floods in the past eight years (1995 and 1996) from which some areas have not yet fully re-vegetated. The 1927 and 1947 data indicate that the Eschbach Park/S. Kershaw Drive area has historically been subjected to widespread high-energy events. Shortly downstream of this section, the transect ratios all drop briefly at a minor pinch-point, and then increase again to reflect the widening of the active channel east of the South Naches Road and west of McLaughlin Road. However, the decreasing ratios are primarily a function of difficulties interpreting the active channel in this area on the older photographs as discussed in Chapter 2, difficulties acknowledged widely in the literature (e.g., (Hooke 1980; Winterbottom and Gilvear 1997; Gurnell and Montgomery 1998; Winterbottom and Gilvear 2000). It seems likely from geomorphic evidence that this reach has been active in all floods throughout the study period, undergoing rapid re-vegetation afterward, which is important in dissipating the energy of subsequent events.

REACH 6

The floodplain in Reach 6 opens out to 6,000 feet, but the active channel has made relatively little use of this over the past 100 years (although the widest active channel in the study area is in this reach, between Mile 12.7 and Mile 13.4). This is primarily a function of lateral control for property and infrastructure protection. Just inside Reach 6, transect ratios drop rapidly as the active channel passes through a pinch point even as the floodplain widens. This pinch point is geomorphically controlled by a low terrace to the south and by extensive bank reinforcement protecting property and McCormick Road to the north (shown in Figure 4-13). A large avulsion site exists between McCormick Road and a large junk yard at Ramblers Park, shown in Figure 4-14. The region around Long Road and McCormick Road is a region where the river has historically switched among three or four different channels. The current channel position places the outside (erosive side) of a meander bend against the levee built to protect properties along these roads (Figure 4-13) and an irrigation diversion. Erosion and bank undercutting at this site have prompted Yakima County to pursue construction of a spur dike to protect the irrigation diversion and levee. An avulsion at this site would relocate an approximately 2-mile length of channel and increase the hazard to several homes and farms off Mitchell Road. Such an avulsion also would increase the threat to the junkyard off Powerhouse Road that was severely damaged during the 1996 flood.

The Ramblers Park/Powerhouse Road area, shown in Figure 4-13, like the Lewis Road area, has a long history of flooding and channel migration. This is a point in the river system where the complex, multi-channel form of the Naches River, with large, shifting bars, funnels down to a single channel, becoming more constricted as it approaches the bedrock gap at the downstream end of the study area. During the 1996 flood, a section of the levee washed out, and floodwaters poured through Ramblers Park. The levee was repaired after the flood, so the left bank is again fortified. Also during the 1996 flood, a major avulsion occurred, relocating a quarter-mile of river channel to a channel farther south against the South Naches Road (Figure 4-13). Since 2001, when these infrared photographs were created, the channel has migrated 80 feet to the south. This channel location persists today.

Transect ratios upstream of the Ramblers Park area diverge chaotically, indicating that the river has made wide use of this area of the floodplain over time. This is important, as it indicates that the river uses this wide area during flood events to dissipate energy (through channel changes and avulsions) that would otherwise be concentrated on the Ramblers

Park area. For example, the 1959 transect ratio spike is a response to an active area scoured by a large flood in 1956 (data used to produce the 1959 active channel information extends over the period 1956-59).

All transect ratios drop systematically in response to the pinch point at the end of the study area, geomorphically controlled on the south by the bedrock canyon sidewall, to the north by riprap protecting the bridges and the junkyard, and to the east by a diversion dam (Figure 4-13). The final transect ratios indicate that the active channel is constrained more here than anywhere in the study area, at a location with a relatively high gradient, highlighting the need to maintain and possibly increase the availability of floodplain for energy dissipation upstream from this location.

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Figure 4-13

REACH 6 OVERVIEW

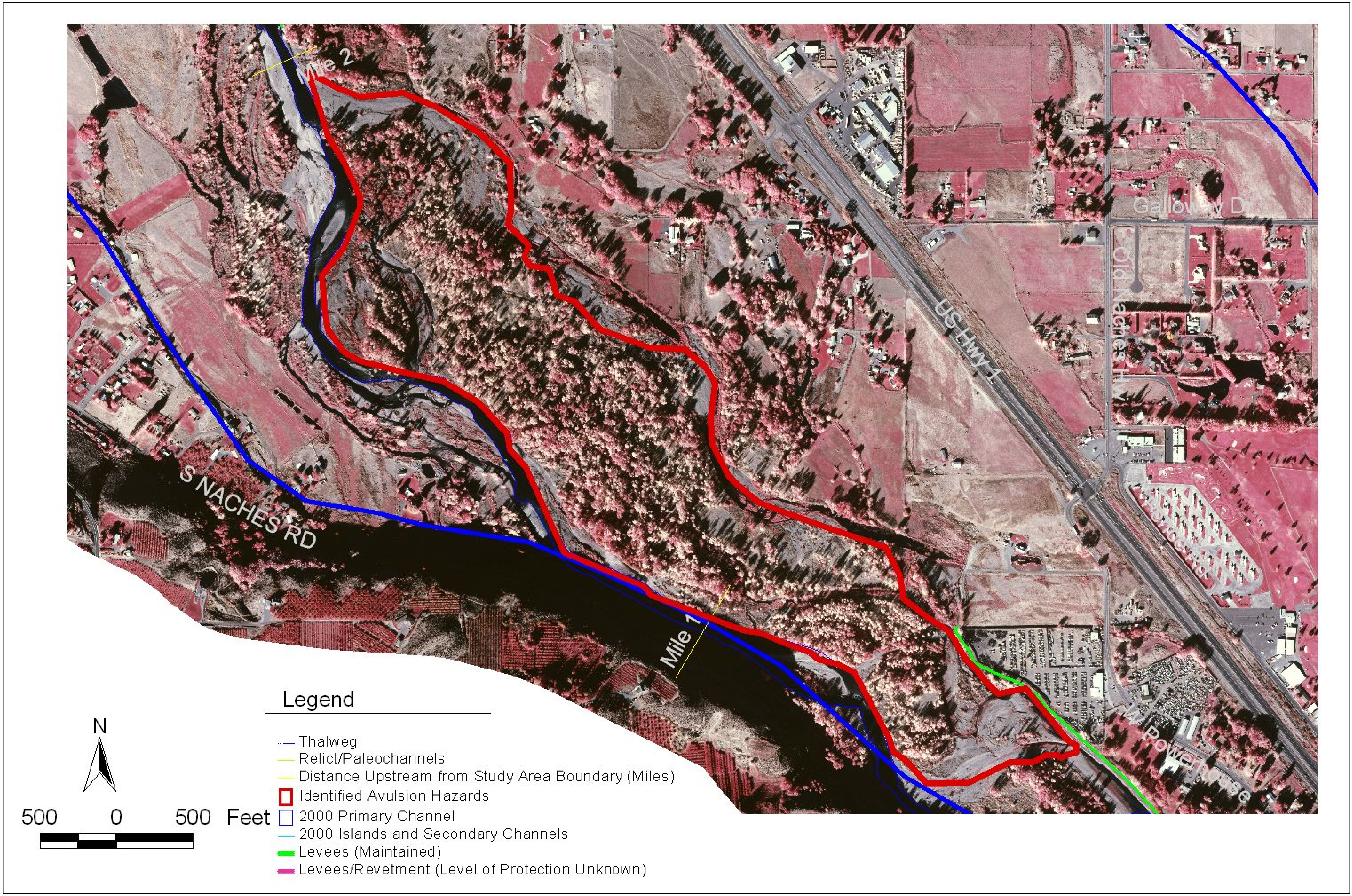

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Figure 4-14
AVULSION SITES IN THE
VICINITY OF RAMBLERS PARK

CHAPTER 5.
DELINEATED CHANNEL MIGRATION HAZARD ZONES

This chapter presents the delineated channel migration hazard zones as well as the methods used to determine them. Much of the theory and methods came from previous studies that have set a precedent, input from the Department of Ecology, academic research, and contemporary approaches to hazard management. The maps were developed as a tool to be used in planning future development in the study area as it pertains to land use, transportation, and utilities.

APPROACH

During the course of this study Ecology was separately developing guidelines for delineating migration zones. To ensure that the results of this study were compatible, we followed Ecology's guidelines and have incorporated methodologies and strategies for delineating and regulating CMZs from those guidelines. The approach to delineating the CMZ described in this section is based on input on the subject from numerous sources, including Ecology.

The CMZ is the area in which all channel processes are likely to occur over time, illustrated in Figure 5-1. To define that area, this study analyzed historical aerial photographs, surface models derived from LIDAR data, infrared photographs and other sources such as cartographic maps to identify the spatial extent of all channel processes. These channel processes typically include historical migratory patterns, potential avulsion areas, and erosion hazard areas.

Manmade features such as levees and roads can limit channel migration to a narrower area than what would naturally occur. Migration areas disconnected by such features are at low risk for channel migration as long as the structures are actively maintained and there is not a clear indication that the feature could be circumvented at any point. The Rambler's Park levee and the junk yard levee in the Town of Naches are examples which illustrate this point. Both levees are currently maintained by the County and it can be assumed that they will continue to be maintained indefinitely against erosion. However, whereas the CMZ is confined by the junk yard levee, the CMZ extends beyond the Rambler's Park levee since there is a clear potential that the Rambler's Park levee could be circumvented at its north end. The river in the vicinity of the junk yard levee is much more confined than the Rambler's Park area, and it is not likely that the river could go behind the levee at its upstream end. In recent decades, according to the historical comparison of indices and aerial photograph comparisons, this river has also been less active in this location.

Some manmade features in the floodplain are not maintained by the County, and are either privately owned, abandoned roadbeds or levees unknown origin which may or may not be actively maintained. Some of these features are end dumped material placed by land owners to protect their property. Some of these were identified in the field and have been termed "soft" features; County-owned, routinely maintained structures have been termed "hard" features. Hard features provide a reliable defense against channel migration, whereas the level of protection provided by soft features is not easily gaged.

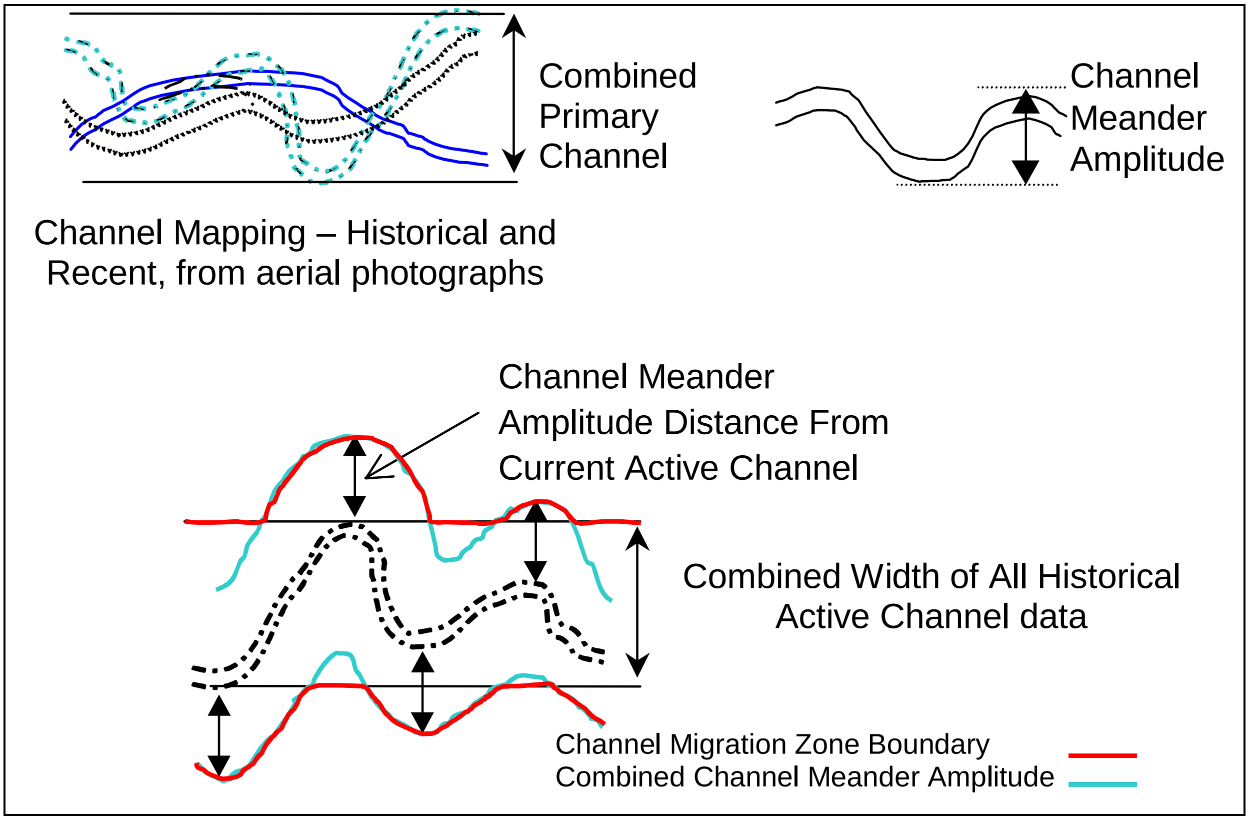


Figure 5-1. Conceptual Drawing of Method Used to Delineate the CMZ

For regulatory purposes, the regulated CMZ includes areas where channel migration has historically been known to occur over the period of record analyzed in this study, but does not include areas that lie behind maintained flood control facilities that are designed to last indefinitely or provide the foundation for a major road. This concept is illustrated by the following two equations:

CMZ = HMZ + AHZ + EHA – DMA

EHA = ES + GS

Where:

HMZ= historical migration zone
AHZ = avulsion hazard zone
EHA = erosion hazard areas (component neglected since none identified in study area)
DMA= disconnected migration areas
ES = erosion setback
GS = geotechnical setback

The HMZ is the collective area the channel occupied over the course of the historical record. The AHZ was defined in this study as an area inside or outside the HMZ that is at significant risk of avulsion over time. The DMA is the portion of the CMZ where manmade structures such as levees and roads eliminate the risk of channel migration. This does not include levees and roads that are not actively maintained or have a history of failure such as the Rambler's Park levee. Another form of failure that was considered in assigning DMA's was the ability for the river to migrate around the upstream end of a structure. The Rambler's Park levee is also one example of where the river could potentially migrate around the levee to the north and through the residential/commercial area.

The EHA is the area not included in the HMZ that is at risk of bank erosion from stream flow or mass wasting over time. The EHA has two components, the erosion setback (ES) and the geotechnical setback (GS). The ES is the area at risk of future bank erosion by stream flow not included in the HMZ or AHZ. The GS projects from the ES at a side slope angle that forms a stable bank configuration in order to account for mass wasting processes and to ensure the protection of infrastructure and development. There are no known EHAs of significance in the study area for this project, nor were any identified during field research. Therefore the EHA component was neglected.

One large hillslope instability does exist near Rosa's Café on the south bank of the river. Although not a component of a typical CMZ equation, the hillslope instability could impact channel migration by continuing to place sloughed material at the toe of the slope or by placing a large amount of material in the river through catastrophic embankment failure. Likely impacts include channel diversion, flooding, and ponding behind a temporary dam. This instability is currently being monitored by the County.

METHODS

Initially the CMZ maps were to be developed by projecting historical erosion rates into the future, using rates calculated for study reaches. However due to the prevalence of channel avulsions and levees and bank hardening in many of the study reaches, using this approach was not appropriate in all areas. Avulsions can produce a sudden change in stream location at any given time, and there is not a good measure for how soft features may delay channel migration. For areas where there is inherent unpredictability which needed to be accounted for, other more suitable methods were used. This included relying more heavily on interpretation of the historical evidence, current conditions and the nature of anthropogenic influences, in the form of measurable indices, comparisons of digitized features, field notes, terrain modeling, reviews of previous studies, and discussions with County staff and other knowledgeable people. Key steps used to delineate the CMZ maps were as follows:

1. The study area was divided into six reaches. A general understanding of the river was developed by reviewing reports, maps, and aerial photos.
2. Detailed maps of each year were prepared for each reach using image processing software and GIS. Key features from the aerial photos were digitized (converted into digital information for use in GIS mapping). These features included elements such as the following:
   - Active channel boundaries, bars, islands and water surface areas, logjams, side and back channels, and the channel thalweg (path of the deepest flow)
   - Boundaries of the valley flat area, including the floodplain and lowest level terrace adjacent to the channel and geologically resistant features including terraces (raised or relict floodplain), and hillslopes (high relief or mountainous areas)

- – Evidence of human interference with the river and streams including Highway 12 and other roads, bridges, dams, and levees (where not mapped, it is assumed that these structures are protected by loose rock or riprap where river erosion could threaten them.)

3. Channel characteristic indices were calculated, such as average channel width for each reach, and ratio of active channel width to floodplain width for each year.

4. Maps were prepared showing changes in the active channel boundary. Vectors identifying the prevailing direction of erosion were calculated and average erosion rates (where applicable). Due to insufficient dating of the widespread bank armoring and associated uncertainty regarding unchecked migration rates, this migration data, while very useful for CMZ delineation, was determined to be of variable accuracy. In order to use this information most sensibly, 2 zones of relative annual migration rates (high, medium) were determined for sub-reaches. The channel migration zone (CMZ) was then digitized.

5. The final map was prepared by combining the information for each date of mapping using GIS, delineating the maximum amplitude of all primary and active channels. This maximum boundary forms the greatest distance of the CMZ from the contemporary primary channel. The severity of hazard was then classified based on observed or historical erosion and relative migration rates. Areas that have no historical erosion were not assigned a hazard zone, while areas that could be in a hazard area based on the historical record or that lie within the contemporary active channel were assigned higher hazards. The highest hazard level was assigned to areas that have been prone to significant historical erosion, are within the amplitude wave of the contemporary active channel, and have been or are likely to be subject to significant avulsion hazard.

   Avulsions hazards were mapped based on the presence of features which define a high risk avulsion site. Due to the highly active nature of the Naches river and the presence of many relict channels there were numerous sites where, under the right circumstances, an avulsion could potentially occur. Not all of these sites were mapped, otherwise the map would be nearly filled with "possible" avulsion sites. It is important to note the distinction between situations where the river breaks free of the channel during floods, but returns to its original channel following the flood, and situations where the river actually switches to a new channel. In the context of this study, the former is considered a flood hazard; the latter an avulsion hazard. The features which identified a high risk avulsion site included a combinations of the following:

   - – The potential for sediment and debris deposition,
   - – The presence of a frequently inundated secondary or relict channel
   - – Potential for the river to create a permanent cut-off channel (following the path of least resistance once the primary channel is blocked by sediment and debris)

   – Historical record of channel activity
   – History of avulsions in that area
   – Floodplain scouring denoting high erosion potential during floods

6. The final mapping task was to use vector data describing hard and soft manmade structures to determine where a normally active and migrating channel would be constrained indefinitely, depending on adequate maintenance of the existing structure.

CHANNEL MIGRATION ZONE MAPS

In addition to the foldout map included in an envelope in Appendix C, the CMZs for each of the six reaches have been enlarged and are presented as separate foldout figures, Figures 5-2 through 5-7, with the hill-shaded LIDAR image and major roadways as backgrounds. This provides a level of relief that brings into view relict channels, raised terraces, and hillslopes. High and medium CMZ hazard areas, avulsion hazard areas, reach boundaries, and riprap are color-coded on the maps. Boundaries between high and medium CMZ hazard areas and avulsion hazard areas were purposely left indistinct to reflect the level of uncertainty inherent in predicting actual migration rates, especially where the rate of erosion near soft structures cannot be readily determined. Riprap and hardened bank segments are drawn spatially as they were identified in the field.

The following discussions describes the CMZ delineations reach by reach.

Reach 1

Reach 1 is relatively confined compared to other reaches. Over the period of record studied, the river has not migrated a great deal, as illustrated by the historical active channels shown in Figure 4-1. The high hazard zone is limited to a narrow band adjacent to the river and follows the edges of natural terraces. The banks are relatively steep and consist of large loose cobbles and boulders. The delineated migration zones, which include the combined historical active channel width in addition to the calculated channel meander amplitude distance, are no wider than 500 feet from the beginning of Reach 1 until just below the Naches Wonderland bridge, where the zones widen to about 1000 feet. Anthropogenic influences in this vicinity include the Wapatox diversion dam, the Naches Wonderland bridge, and heavy rip rap placed on the north side of the river. The diversion dam and bridge are control points in this segment of the Naches. The high hazard zone reflects these controls.

Between Miles 14 and 13 the migration zones slowly widen to approximately 1,000 feet. Downstream of the bridge the south edge of the river is confined by maintained riprap for approximately 1,300 feet. At approximately Mile 13.4, the river swings northeast after following the valley wall to the south, coming to within 180 feet of Highway 12 before turning south again. Wetlands are present in the low lying area to the north, which continue on the north side of Highway 12. Debris collected in these wetlands and scouring indicate that the river inundated these wetlands during the 1996 flood. The wetlands up to Highway 12 are included in the medium hazard zone. Areas beyond Highway 12 were not included, as Highway 12 creates a continuous, actively maintained barrier to northward channel migration. The potential for avulsion through the low-lying wetland area is not significant as the river is still relatively entrenched within 4-6 foot banks that consist of coarse material. The high migration zone follows natural terraces to the north and south, narrowing as the valley narrows near Mile 13.

At Mile 13.4, the channel splits, with the northern channel acting as the primary channel. Greater migration pressure could potentially occur along the outer bend of the primary channel if the southern channel were to be completely blocked with sediment. Historically this has not been the case (see Figure 4-1). The active channel utilizes much of its floodplain and during high flows the river is able to expend a significant amount of energy on the mid-channel bar.

At Mile 13, a private levee protects several farm buildings and a small lake. A small channel on the north side of the levee feeds into the lake. It could be possible for the river to jump the channel above the private levee, flow down through a side channel to the pond, paralleling the levee, or even possibly cut farther north across Highway 12. This however, is not highly likely, due again to the wide active channel through the meander and the river's use of the low-lying gravel bar to expend energy.

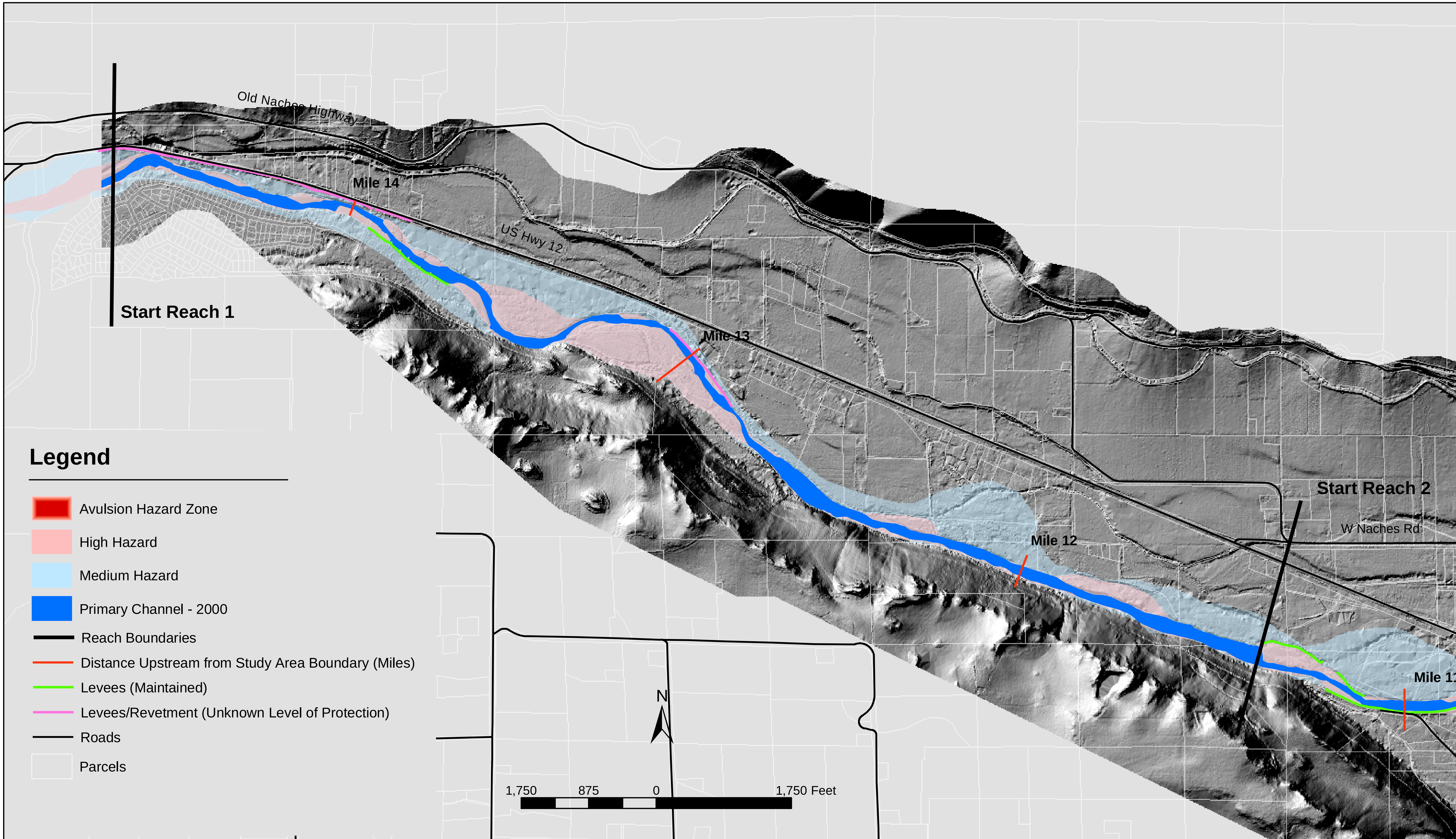
Along the southerly curve of the meander, downstream of Mile 13, the river is entrenched and the banks are comprised of coarse erosion resistant material (Photo 4-3). The migration hazards in this entrenched corridor are very narrow, until widening out at the vegetated bell shaped area at Mile 12.2.

The bell-shaped area appears to have been part of the active channel in both the 1927 and 1947 aerial photographs. A side channel along the northern edge of the bell-curve can still be seen on the LIDAR, though this area is currently inactive and has not been disturbed recently. It is possible that during a large flood, water could follow these paleo-channels toward the timber yard half a mile downstream, however it is unlikely that this area poses a high avulsion hazard since the river is still entrenched along the southern valley wall. The streambanks along the north side of the channel are 8 to 10 feet high.

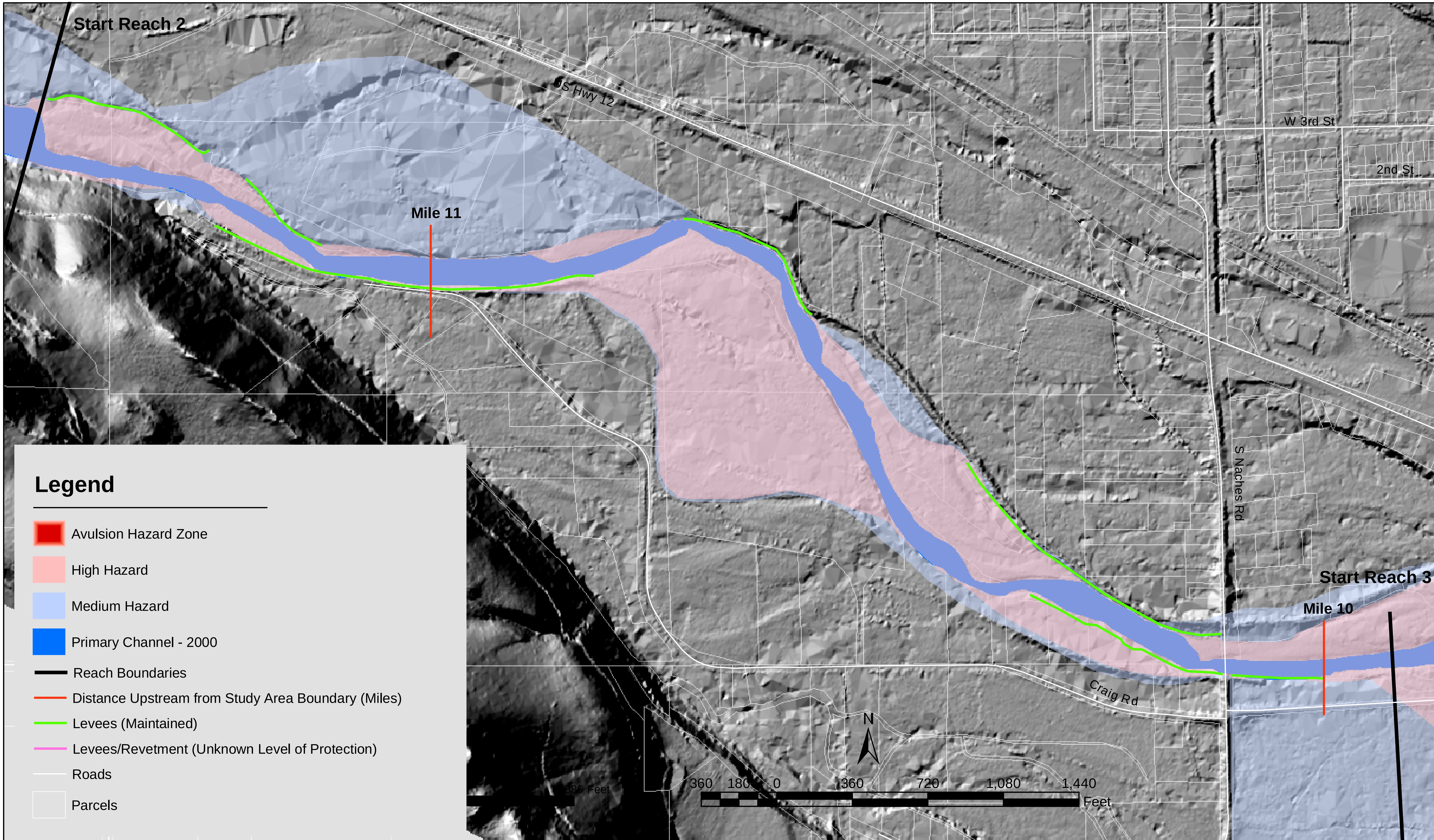
Reach 2

Reach 2 begins at the South Naches Irrigation diversion. The channel is confined by high banks and several discontinuous maintained levees on both sides of the channel throughout much of this reach. The river flows very fast during medium to high flows through this confined section, building energy which it expends in unconfined reaches downstream. The location of the active channel in Reach 2 has been relatively consistent over the historical record (Figure 4-1). The transect ratios are also relatively low, reflecting that the river here has not made wide use of the floodplain, though during major flood events such as the 1996 flood, the river does expand to cover much of the floodplain. Though the placement of the lumber yard in the floodplain poses a potential threat to downstream properties during a severe flood event, it is not likely that an avulsion here could occur since the banks are built up and armored by levees. There is also no history of these levees being breached. The stream gradient is relatively steep through this section.

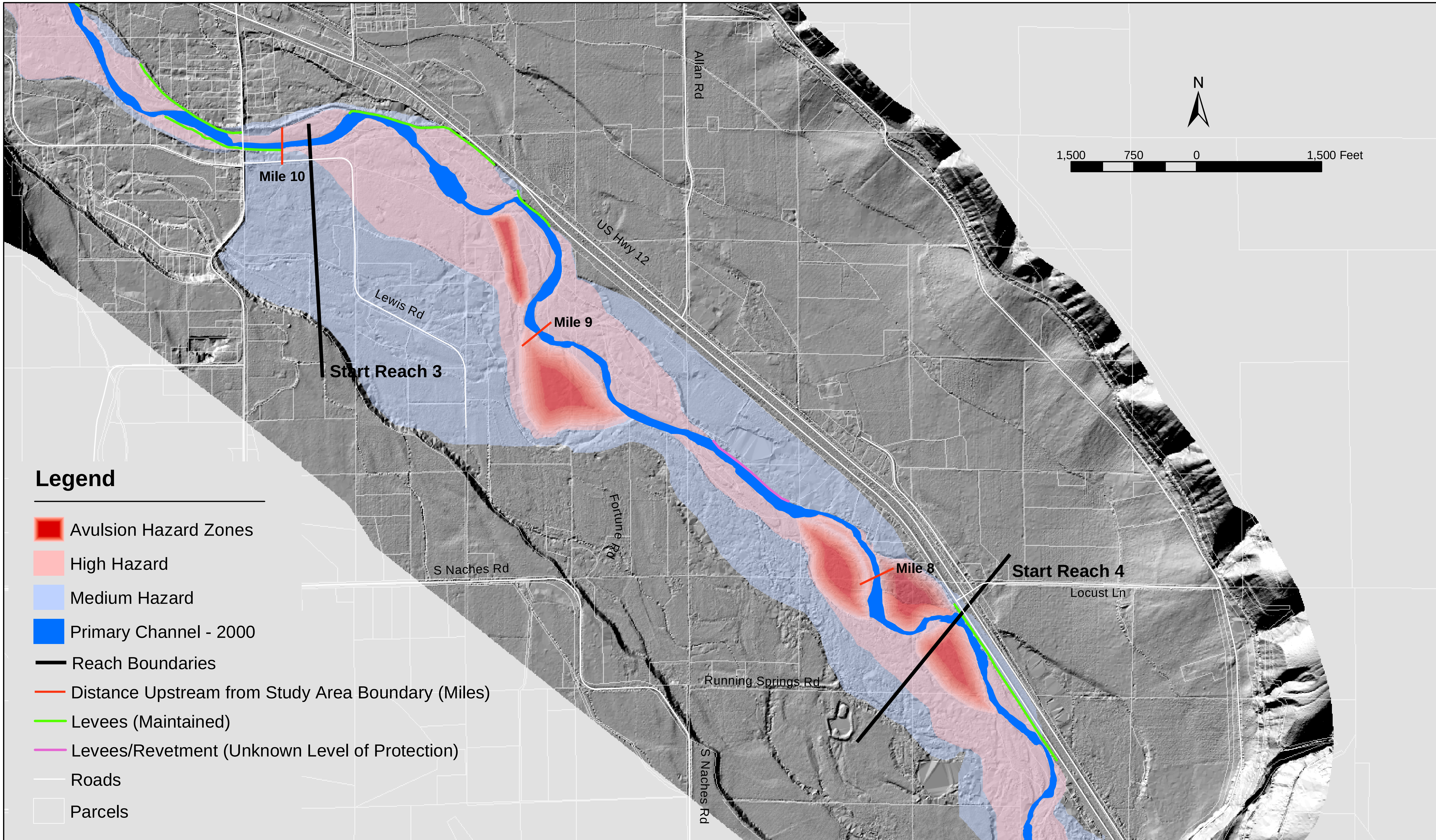
Approximately 800 feet downstream from Mile 11 a levee bordering the south bank ends. At this location a side channel cuts to the southeast following the boundary of previous active channels (see Figure 4-1, the 1947 active channel). This area has been designated a high



Tetra Tech/ KCM,Inc. 1917 First Avenue Seattle, Washington 98101	GeoEngineers	Yakima County NACHES RIVER CHANNEL MIGRATION STUDY	Figure 5-2. CHANNEL MIGRATION HAZARD ZONES REACH 1



Tetra Tech/ KCM,Inc. 1917 First Avenue Seattle, Washington 98101 GeoZenTec	Yakima County NACHES RIVER CHANNEL MIGRATION STUDY	Figure 5-3. CHANNEL MIGRATION HAZARD ZONES REACH 2



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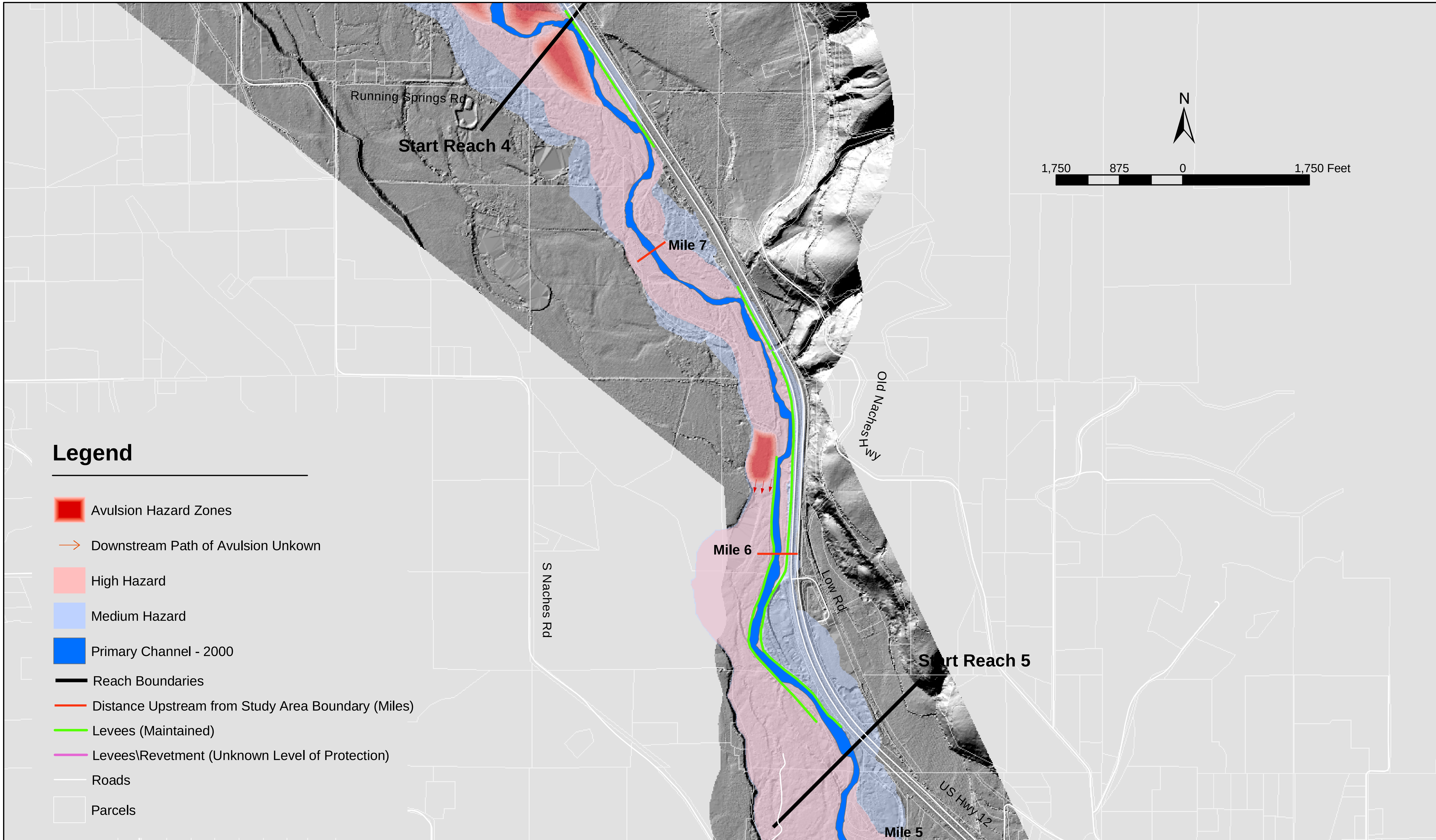
Yakima County
NACHES RIVER
CHANNEL MIGRATION STUDY

Figure 5-4.
CHANNEL MIGRATION HAZARD ZONES
REACH 3



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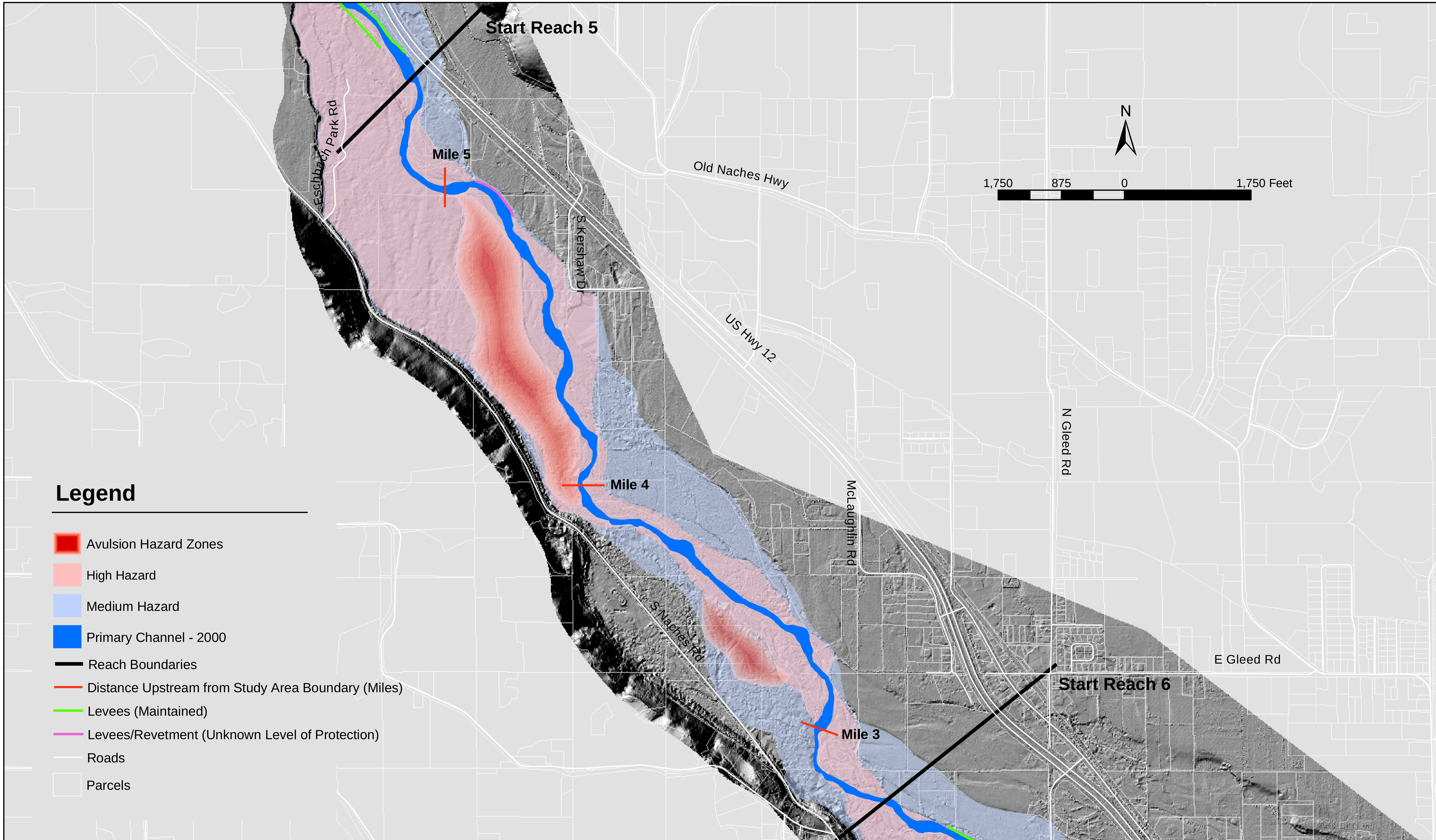
GeoZenTec

Yakima County
NACHES RIVER
CHANNEL MIGRATION STUDY

Figure 5-5.
CHANNEL MIGRATION HAZARD ZONES
REACH 4



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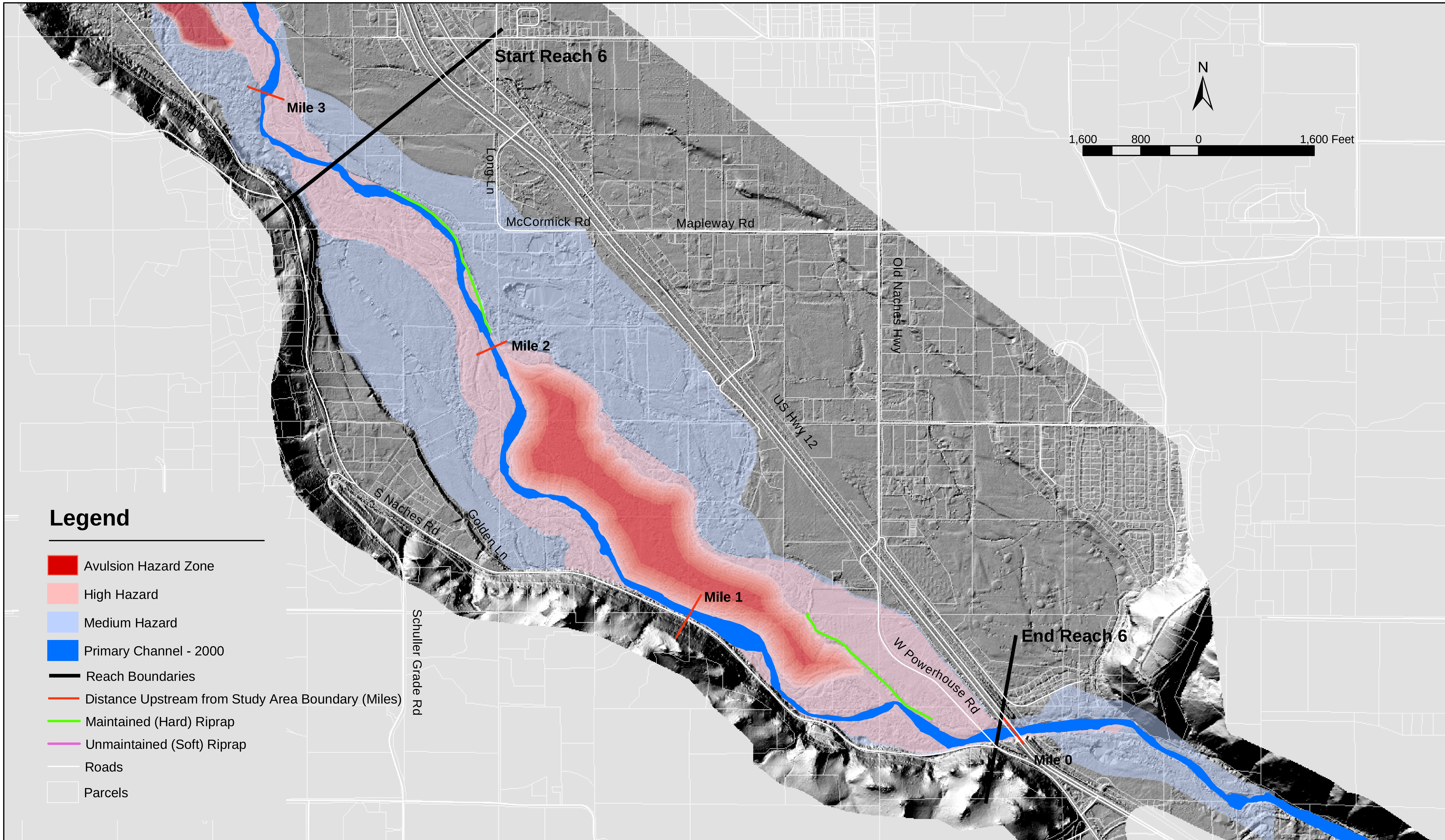
NACHES RIVER
CHANNEL MIGRATION STUDY

Figure 5-6.
CHANNEL MIGRATION HAZARD ZONES
REACH 5



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Yakima County
NACHES RIVER
CHANNEL MIGRATION STUDY

Figure 5-7.
CHANNEL MIGRATION HAZARD ZONES
REACH 6

hazard zone, since the banks here are not high and there are notable areas along the terrace to the south and southeast (at the southern edge of the high hazard zone) that are actively eroding during high flows.

The South Naches Road bridge is protected by high approach levees on either bank. The area behind the south dike has been designated a high hazard area. A small side channel extends behind this dike. The river could potentially circumvent the west end of the levee. This area is included in the high hazard designation, but not classified as an avulsion hazard because of the likelihood that human intervention in this area will continue to prevent the river from a permanent channel change.

Reach 3

After passing through the South Naches bridge the floodplain widens considerably. This allows the river to expend a great deal of energy before reaching the confined reach downstream near the Water Treatment Plant. The levee protecting the south bank downstream of the bridge ends at Mile 10. The river impinges on Highway 12 approximately half a mile downstream of the bridge. The highway is protected by two County-maintained levees. The river has remained in this location since 1947, though the shape of the meander bend has changed over time. The high migration hazard zone abuts the highway through this section, but does not go further north of the levee since the levee is maintained and there has been no history of the levee being breached.

A large high hazard zone is delineated in the Lewis Road area where there are no barriers to prevent the river from utilizing the half mile floodplain to the south. This area is marked by relict channels and scour and is typically inundated with fast moving water during large flood events, such as the 1996 flood which washed out Lewis Road. Due to the historic activity in this region, the medium hazard zone extends to the edge of the floodplain on the south side.

Several avulsion sites are delineated in this reach, near Mile 8 and 9. Potential avulsion sites were delineated along existing secondary channels which could become active if sediment and debris cut-off the primary channel. These avulsion sites are described in more detail in Chapter 4.

Near River Mile 8, the high hazard area widens to the south, encompassing a springbrook which provides a line a weakness, evidenced by the gradient and by the 1996 flood photographs, which the river could potentially utilize. The springbrook extends into Reach 4.

Reach 4

Anthropogenic influences play a key role in the behavior of the river in Reach 4. A series of maintained levees confines the river in the vicinity of the treatment plant to a 150 to 240 foot wide corridor. Unleveed conditions are illustrated by the 1947 active channel boundaries and the 1947 and 1959 transect ratios, which show that the river at that time utilized a much wider portion of the available floodplain.

At the start of Reach 4 a high hazard zone follows a large springbrook which starts near River Mile 8 in Reach 3 and extends into Reach 4. Further downstream, the avulsion site midway between Mile 6 and 7 is located at the confluence of the primary channel with a secondary channel. The bank at that location is approximately 6 feet high and is not protected or naturally armored. Aggradation or debris blockage in the primary channel against Highway 12 could result in more flow routing into the secondary channel which would place pressure on this bank. If the river were to avulse here, the river would circumvent the maintained levee and would most likely create a new path between the levee and the valley wall. It is likely the river would utilize the area of the large irrigation pond downstream, however it is not certain which path the avulsion may take since there are any number of potential routes through relict channels and swales that the avulsion could take. In 1947, the active channel downstream of this point followed the terrace on the west side of the river and utilized what is now Eschbach Park. The large width of the high migration hazard zone throughout this area illustrates this risk.

Removing the levees on the west side of the river at the treatment plant would be beneficial in alleviating the erosive pressure on the levees protecting the treatment plant (described in Chapter 4). Although development on the west bank is minimal, this action would expose a handful of agricultural use properties, the irrigation pond, and may impact Eschbach Park.

Reach 5

Reach 5 starts in the vicinity of Eschbach Park which is delineated in the high migration zone due to the history of channel migration through this region described above and in Chapter 4. Downstream of Mile 5, the river swings back to the east adjacent to properties adjacent to S Kershaw Drive. Before the 1996 flood the river flowed south into the west bank terrace. The river avulsed during the flood, which placed the river at its present position. Although the road itself is elevated, there is significant migration pressure on the properties adjacent to the road (designated in the high migration zone). There is also a high potential for the river to avulse back to its prior position utilizing the secondary channel or another relict channel on the gravel bar (shaded as an avulsion hazard area).

The channel narrows near Mile 4 where the river meets the valley terrace and curves eastward again. There are two large spikes in the transect data between Mile 3 and 4.2 due to the narrowing of the floodplain and an increase in the width of the active channel. This region has been highly active throughout the historical record. The lack of lateral controls such as levees allows the river access to the entire floodplain and through this the river is able to dissipate a considerable amount of energy during high flows. The avulsion shown between Mile 3 and 4 follows the path of a secondary channel.

Reach 6

Reach 6 is one of the most dynamic reaches in the study area. Though the floodplain opens out to 6,000 feet, the active channel is confined by levees and, in the lower reach, by the valley wall to the south and the Rambler's Park levee. The reach ends at a bottleneck created by the valley wall to the south, four bridges and a diversion dam. Whereas the upper reaches of the study area that were more incised are dominated by sediment transport regimes, Reach 6 is a deposition zone with a wider floodplain and characteristically smaller sediment sizes. Median grain size diameter measured at two cross-sections in Reach 6 were 84 mm and 67 mm, versus all other study reaches which had median grain size diameters 97 mm and greater. As the primary channel aggrades, the river eventually seeks a new path, either through avulsion or migration, two processes which are both active in shaping the river through this reach. During high flows, the bottleneck at the end of the reach increases sediment deposition upstream by increasing the water surface elevation and reducing flow velocity.

The widest active channel in the study area occurs upstream of Rambler's Park where the river splits off into a north channel south of McCormick Road and a south channel that flows toward and meets the valley wall. Historically the river has taken three or four different paths across the gravel bars between these channels and could easily reestablish itself across one of these during the next flood event. This hazard is classified as the large avulsion hazard zone downstream of Mile 2.

Below Mile 1 the high hazard zone extends across the maintained levee and up to Highway 12, reflecting the path taken by the river during previous flood events which have breached the Rambler's Park levee or circumvented the north end of the levee to flow through the park. The recent activity in the Rambler's Park area is further illustrated by the movement of the channel that has occurred since the active channel was mapped in 2000. Since that time, the channel has migrated 80 feet to the south.

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APPENDIX A.
GLOSSARY OF TERMS

DEFINITION OF TERMS RELATED TO CHANNEL MIGRATION STUDY	
100-Year Flood or Base Flood	Flood that has a 1-percent probability of being equaled or exceeded in any given year.
Active Channel	The area of the channel where sparse or unvegetated gravels indicate that the area is frequently submerged
Aggradation	A process in which the rate of sediment deposition exceeds that of erosion and creates a persistent, long-term rise in the elevation of a streambed.
Aquifer	Rock or rock formations (often sand, gravel, sandstone, or limestone) that contain or carry groundwater and act as water reservoirs.
Assessment	The collection, integration, examination, and evaluation of information and values.
Avulsion	Abrupt switching of the river to a new location
Bankfull Discharge	Sometimes referred to as the effective flow or ordinary high water flow. It is the channel-forming flow. It is an empirical fact that, for most streams, the bankfull discharge is the flow that has a recurrence interval of approximately 1.5 years in the annual flood series. Most bankfull discharges have a recurrence range between 1.3 and 1.8. In some areas it could be lower or higher than this range. It is the flow that transports the most sediment for the least amount of energy.
Base Flood	Flood event that has a 1-percent probability of being equaled or exceeded in any given year. Also know as the 100-year flood.
Base Flood Elevation (BFE)	Elevation of the Base Flood (100-year flood). This elevation is the basis of the insurance and floodplain management requirements of the National Flood Insurance Program.
Bed Material	The material of which a streambed is composed.
Channel Confinement	Lateral constriction of a stream channel.
Co-registration	The process by which digital maps are brought in to the same coordinate system, so that an x,y coordinate on one map aligns with the same x,y coordinate on the others (for example, a road junction match up with the same road junction on every orthographic image from every time period).
Channel Migration Zone	The corridor within which the river can be expected to migrate within a specified period (usually 50 to 200 years).
Chute Cutoff	Type of avulsion where the new channel is through a point bar (often reoccupying an old channel).
Digitize	Process of creating a digital replica of a map or image.
Federal Emergency Management Agency (FEMA)	Independent agency crated in 1978 to provide a single point of accountability for all Federal activities related to disaster mitigation and emergency preparedness, response and recovery. FEMA

	administers the NFIP.
Federal Insurance Administration (FIA)	Component of FEMA directly responsible for administering the flood insurance aspects of the NFIP.
Fill	Materials such as soil, gravel, or stone which is dumped in an area and to increase the ground elevation. Fill is usually placed in layers and each layer compacted (see "Compaction").
Flood	Under the NFIP, a partial or complete inundation of normally dry land areas from 1) the overland flow of a lake, river, stream, ditch, etc.; 2) the unusual and rapid accumulation or runoff of surface waters; and 3) mudflows or the sudden collapse of shoreline land.
Flood Control	Physically controlling a river or stream by structural means such as dikes and levees, which separate people and property from damaging floodwater.
Flood Depth	Height of flood waters above the surface of the ground at a given point.
Flood Duration	Amount of time between the initial rise of flood, including freeboard, waters and their recession.
Flood Elevation	Height of flood waters above an elevation datum plane.
Flood Frequency	Probability expressed as a percentage, that a flood of a given size would be equaled or exceeded in any given year. The flood that has a1-percent probability (1 in 100) of being equaled or exceeded in any given year is often referred to as the 100-year flood. Similarly, the floods that have a 2-percent probability (1 in 50) and a 0.2-percent probability (1 in 50) and a 0.2-percent (1 in 500) of being equaled or exceeded in any year are referred to as the 50-year flood and the 500-year flood, respectively.
Flood hazard management	A comprehensive approach to flood control issues that encompasses both flood control management and floodplain management and utilizes both structural and nonstructural methods of reducing flood hazards. Flood hazard management is not limited to areas within the floodplain, but can extend to the entire watershed. Stormwater management is also included since the control of the quantity and quality (sediment load) of stormwater runoff into streams and rivers can have significant impacts on stream and river flooding.
Floodplain	The land area along the sides of a river that becomes inundated with water during a flood. Floodplains are often defined by the level of intensity of the flood. The 100-year floodplain, for example, is the area likely to be inundated once, on average, every 100 years, based on statistics derived from past flooding.
Floodplain management	Management of areas within the floodplain, which includes resource protection, environmental enhancement, flood damage protection, and land use regulations.
Floodprone Area	Generally includes the active floodplain and the low terrace. The elevation of the floodprone is qualitatively defined as 2 times the max. bankfull depth.
Floodway	Portion of the regulatory floodplain that must be kept free of development so that flood elevations will not increase beyond a set limit

	– a maximum of 1 foot under the National Flood Insurance Program (NFIP). The floodway usually consists of the stream channel and land along its sides.
Flood Velocity	Speed at which water moves during a flood. Velocities usually vary across the floodplain. They are usually greatest near the channel and lowest near the edges of the floodplain.
Freeboard	Additional amount of height incorporated into the FPE to account for uncertainties in the determination of flood elevations.
Geographic Information System (GIS)	An information processing technology to input, store, manipulate, analyze, and display data; a system of computer maps with corresponding site-specific information that can be combined electronically to provide reports and maps
Geologic and Geomorphic Processes	The actions or events that shape and control the distribution of materials, their states, and their morphology, within the interior and on the surface of the earth.
Geomorphology	The geologic study of the shape and evolution of the earth's landforms.
Glacial Till	Mixed rock of clay, sand, gravel, and boulders transported and deposited by glaciers.
Gradient (of stream)	Degree of inclination of a stream channel parallel to stream flow; it may be represented as a ratio, fraction, percentage, or angle.
Ground Control Point (GPC)	A spatial reference point (common feature such as a roadway intersection) used in rectifying digital images.
Hazard Mitigation	Action taken to reduce or eliminate long-term risk to people and property from hazards such as floods, earthquakes, and fires.
Headcut	A stream segment that is actively incising and shows an evident, abrupt change in bed elevation and/or the bank-height ratio. The upstream end of the headcut is the "nick-point" which could be a permanent structure such as bedrock or a culvert, or could be temporary, as an embedded logjam.
Incised Channel	A stream channel in which the bed has dropped and as a result, the stream is disconnected from its floodplain.
Indices	For the purposes of this study, indices are parameters used to characterize changes in channel and floodplain geometry at fixed spatial locations along the longitudinal axis of the river.
Landscape	All the natural features such as grasslands, hills, forest, and water, which distinguish one part of the earth's surface from another part; usually that portion of land which the eye can comprehend in a single view, including all its natural characteristics.
Lateral Migration	Gradual shifting of the main river channel toward the outside (convex side) of a meander bend.
Levee	Flood barrier constructed of compacted soil
Low Flow Channel	The low flow channel was based on the widest wetted channel when the 2000CIR data was taken. The low flow channel was field-checked and mapped with GPS during field survey during the summer.
Meander Pattern	A series of sinuous curves or loops in the course of a stream that are

	produced as a stream sw3ings from side to side in flowing across its floodplain.
Neck Cutoff	Type of avulsion where the new channel cuts across the outside of two meander bends that have converged (also called meander cut-off).
Paleochannel	Relict channels that at one time was the primary active river channel.
Point Bar	Gravel bar sediments that accumulate on the inside (concave side) of a meander bend.
Rates of rise and fall	How rapidly the elevation of the water rises and falls during a flood.
Reach	River sections selected to subdivide the study area into smaller lengths. Reach boundaries were placed at breakpoints in slope of the longitudinal channel profile, notable changes in channel planform or other channel characteristics, and where the reach lengths created would be manageable in scale so as to facilitate description and viewing of features in each study area reach.
Rectification	The process of correcting for errors (of scale, etc) in digital images.
Regulatory floodplain	Flood hazard area within which a community regulates development, including new construction, the repair of substantially damaged buildings, and substantial improvements to existing buildings. In communities participating in the NFIP, the regulatory floodplain must include at least the area inundated by the base flood, also referred to as the Special Flood hazard Area (SFHA). See "Floodplain."
Riparian Area	Area with distinctive soil and vegetation between a stream or other body of water and the adjacent upland; includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.
Riparian Vegetation	Vegetation adapted to moist growing conditions found along waterways and shorelines.
Riprap	Pieces of rock added to the surface of a fill slope, such as the side of a levee, to prevent erosion.
Scour	Process by which floodwaters remove soil around objects that obstructs flow, such as the foundation wall of a house.
Sinuosity	The ratio of stream channel length (measured in the thalweg) to the down-valley distance, or is also the ratio of the valley slope to the channel slope. When measured accurately from aerial photos, channel sinuosity may also be used to estimate channel slope (valley slope/sinuosity). Sometimes sinuosity is referred to as the meanderness of a stream.
Special Flood Hazard Area (SFHA)	Portion of the floodplain subject to inundation by the base flood, designated Zone A, AE, A1 – A30, AH, AO, V, VE, V1 – V30, or M on a FIRM.
Geomorphology (fluvial or riverine)	The study of the riparian landscape and its affects on stream flow patterns. The landscape tends toward a dynamic equilibrium state where stream flow patterns are affected by the landscapes (or streambeds) ability to erode or resist erosion.
Watershed	The region draining into a river, river system, or body of water.

Watershed/drainage basin	The area within which all surface water – whether from rainfall, snow melt, springs, or other sources – flows to a single water body or watercourse. The boundary of a watershed is defined by natural topography.
Wetland	In general, an area soaked by surface or groundwater frequently enough to support vegetation that requires saturated soil conditions for growth and reproduction. Federal agencies define wetlands as possessing three essential characteristics: 1.) hydrophytic vegetation, 2.) hydric soils, and 3.) wetland hydrology. These three features must all be met before an area is identified as a wetland.

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
19	0.18	0.28	0.31	0.26	0.17	0.17	0.21	0.23	76560	14.50	
20	0.12	0.32	0.33	0.44	0.17	0.16	0.21	0.23	76406	14.47	
21	0.14	0.34	0.45	0.49	0.17	0.15	0.20	0.23	76199	14.43	
22	0.23	0.32	0.37	0.39	0.17	0.16	0.23	0.27	76002	14.39	
23	0.31	0.31	0.28	0.25	0.27	0.26	0.23	0.23	75769	14.35	
24	0.36	0.26	0.21	0.21	0.23	0.21	0.17	0.21	75550	14.31	Wapatox dam head
25	0.31	0.16	0.15	0.14	0.17	0.12	0.12	0.18	75323	14.27	
26	0.27	0.12	0.13	0.12	0.14	0.14	0.14	0.18	75107	14.22	
27	0.22	0.14	0.12	0.13	0.15	0.16	0.15	0.18	74923	14.19	
28	0.20	0.21	0.19	0.17	0.20	0.20	0.21	0.22	74641	14.14	bar and side low-flow channel
29	0.19	0.19	0.20	0.16	0.17	0.16	0.16	0.18	74411	14.09	
30	0.19	0.14	0.13	0.09	0.12	0.11	0.11	0.12	74188	14.05	riffle off tail of bar
31	0.21	0.09	0.09	0.08	0.11	0.11	0.11	0.12	73950	14.01	
32	0.22	0.10	0.10	0.09	0.12	0.12	0.13	0.14	73757	13.97	
33	0.19	0.13	0.12	0.14	0.15	0.13	0.16	0.15	73533	13.93	bar with low flow side channel
34	0.17	0.09	0.09	0.10	0.11	0.09	0.11	0.11	73327	13.89	bar with low flow side channel
35	0.16	0.09	0.08	0.08	0.09	0.08	0.10	0.10	73093	13.84	
36	0.18	0.12	0.09	0.09	0.10	0.09	0.11	0.11	72877	13.80	
37	0.24	0.17	0.14	0.13	0.14	0.13	0.13	0.13	72629	13.76	37 is fraction upstream from trailer park bridge
38	0.19	0.25	0.21	0.18	0.22	0.18	0.22	0.22	72340	13.70	riffle downstream from bridge
39	0.19	0.21	0.09	0.16	0.16	0.12	0.18	0.19	72029	13.64	riffle over bar
40	0.21	0.29	0.08	0.08	0.12	0.12	0.10	0.15	71748	13.59	
41	0.17	0.31	0.10	0.09	0.10	0.07	0.13	0.15	71614	13.56	
42	0.13	0.12	0.06	0.11	0.10	0.07	0.11	0.12	71409	13.52	
43	0.13	0.12	0.07	0.11	0.08	0.06	0.09	0.09	71220	13.49	
44	0.15	0.10	0.10	0.10	0.10	0.08	0.11	0.13	71015	13.45	riffle clear on CIR photo
45	0.17	0.15	0.14	0.12	0.12	0.10	0.16	0.17	70828	13.41	
46	0.18	0.16	0.12	0.14	0.11	0.09	0.17	0.19	70607	13.37	riffle
47	0.18	0.11	0.12	0.13	0.09	0.09	0.08	0.20	70393	13.33	riffle
48	0.18	0.07	0.11	0.08	0.08	0.07	0.05	0.08	70200	13.30	
49	0.21	0.06	0.09	0.07	0.09	0.08	0.06	0.07	69992	13.26	
50	0.23	0.06	0.09	0.09	0.09	0.07	0.05	0.07	69772	13.21	riffle visible on CIR
51	0.20	0.12	0.09	0.10	0.10	0.09	0.10	0.10	69493	13.16	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
52	0.19	0.19	0.20	0.16	0.22	0.22	0.22	0.24	69158	13.10	riffle
53	0.28	0.33	0.29	0.34	0.38	0.36	0.34	0.36	68886	13.05	
54	0.34	0.43	0.39	0.42	0.45	0.44	0.42	0.44	68675	13.01	
55	0.39	0.51	0.45	0.49	0.51	0.51	0.50	0.52	68471	12.97	
56	0.36	0.49	0.47	0.52	0.52	0.52	0.50	0.53	68238	12.92	
57	0.32	0.33	0.31	0.36	0.35	0.37	0.42	0.44	67983	12.88	riffle
58	0.32	0.27	0.26	0.26	0.25	0.24	0.23	0.27	67647	12.81	
59	0.24	0.26	0.18	0.23	0.22	0.22	0.22	0.24	67322	12.75	
60	0.13	0.18	0.11	0.16	0.14	0.16	0.17	0.17	67024	12.69	riffle
61	0.08	0.07	0.07	0.06	0.06	0.06	0.11	0.11	66692	12.63	riffle
62	0.08	0.06	0.05	0.07	0.05	0.05	0.07	0.08	66327	12.56	
63	0.09	0.06	0.06	0.05	0.06	0.06	0.06	0.05	66036	12.51	
64	0.11	0.09	0.08	0.06	0.07	0.07	0.07	0.07	65755	12.45	
65	0.11	0.13	0.10	0.09	0.10	0.10	0.10	0.10	65434	12.39	
66	0.12	0.07	0.07	0.12	0.11	0.11	0.10	0.11	65155	12.34	riffle (mid channel bar)
67	0.15	0.08	0.06	0.12	0.09	0.08	0.06	0.07	64905	12.29	
68	0.17	0.09	0.05	0.07	0.07	0.05	0.02	0.04	64668	12.25	
69	0.15	0.09	0.06	0.05	0.10	0.05	0.05	0.05	64387	12.19	
70	0.15	0.12	0.09	0.11	0.14	0.10	0.09	0.10	64152	12.15	lateral bar
71	0.19	0.14	0.11	0.14	0.15	0.11	0.03	0.12	63883	12.10	
72	0.33	0.16	0.15	0.15	0.12	0.14	0.03	0.12	63643	12.05	riffle
73	0.45	0.31	0.36	0.30	0.04	0.28	0.03	0.03	63365	12.00	
74	0.52	0.50	0.52	0.50	0.05	0.46	0.04	0.02	63067	11.94	
75	0.50	0.55	0.55	0.53	0.07	0.32	0.07	0.06	62742	11.88	
76	0.35	0.45	0.44	0.35	0.06	0.21	0.06	0.07	62428	11.82	
77	0.21	0.22	0.19	0.18	0.06	0.18	0.09	0.09	62094	11.76	
78	0.23	0.25	0.20	0.20	0.07	0.19	0.08	0.15	61774	11.70	
79	0.29	0.25	0.26	0.27	0.06	0.27	0.10	0.27	61469	11.64	
80	0.28	0.25	0.24	0.26	0.09	0.34	0.10	0.36	61145	11.58	
81	0.25	0.31	0.37	0.27	0.11	0.42	0.13	0.39	60837	11.52	
82	0.23	0.34	0.42	0.34	0.14	0.48	0.14	0.39	60512	11.46	
83	0.23	0.26	0.39	0.34	0.14	0.16	0.13	0.17	60161	11.39	
84	0.10	0.17	0.32	0.31	0.08	0.09	0.09	0.10	59810	11.33	
85	0.13	0.17	0.36	0.33	0.08	0.10	0.11	0.11	59469	11.26	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
86	0.12	0.21	0.32	0.34	0.10	0.11	0.13	0.15	59121	11.20	END of REACH 01 ~ and start of large mid-channel bar
87	0.18	0.22	0.17	0.29	0.21	0.23	0.20	0.24	58773	11.13	
88	0.23	0.22	0.08	0.21	0.21	0.22	0.19	0.19	58412	11.06	
89	0.37	0.08	0.05	0.08	0.06	0.06	0.15	0.13	58074	11.00	
90	0.43	0.09	0.06	0.06	0.04	0.04	0.06	0.07	57655	10.92	
91	0.34	0.06	0.05	0.05	0.04	0.05	0.06	0.07	57245	10.84	
92	0.11	0.07	0.07	0.08	0.07	0.07	0.07	0.08	56569	10.71	
93	0.09	0.18	0.12	0.10	0.08	0.08	0.12	0.12	56044	10.61	
94	0.11	0.17	0.05	0.07	0.05	0.05	0.06	0.16	55559	10.52	riffle
95	0.20	0.13	0.05	0.06	0.05	0.04	0.04	0.14	55217	10.46	
96	0.21	0.08	0.04	0.05	0.05	0.05	0.06	0.06	54893	10.40	
98	0.21	0.09	0.04	0.05	0.07	0.07	0.11	0.07	54604	10.34	
99	0.19	0.10	0.11	0.06	0.08	0.08	0.13	0.08	54256	10.28	
100	0.19	0.09	0.11	0.10	0.05	0.05	0.16	0.15	53912	10.21	riffle
101	0.15	0.08	0.09	0.11	0.04	0.04	0.14	0.15	53643	10.16	
102	0.16	0.12	0.13	0.07	0.06	0.05	0.09	0.11	53321	10.10	
103	0.15	0.11	0.12	0.05	0.05	0.05	0.05	0.06	52977	10.03	
104	0.11	0.09	0.08	0.05	0.04	0.04	0.04	0.05	52672	9.98	
106	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.05	52448	9.93	
107	0.12	0.08	0.08	0.07	0.05	0.05	0.05	0.06	52209	9.89	
108	0.08	0.12	0.13	0.09	0.10	0.10	0.09	0.10	51881	9.83	
109	0.08	0.07	0.07	0.09	0.17	0.15	0.14	0.16	51464	9.75	END of STUDY REACH 2 ~ riff
110	0.22	0.10	0.05	0.10	0.19	0.16	0.14	0.12	51051	9.67	
111	0.26	0.09	0.12	0.08	0.08	0.08	0.02	0.02	50516	9.57	bar - bend in channel - riffle
112	0.20	0.10	0.12	0.07	0.09	0.05	0.05	0.05	50181	9.50	
113	0.15	0.10	0.06	0.10	0.17	0.17	0.16	0.17	49794	9.43	riffle alongside bar
114	0.10	0.11	0.03	0.03	0.17	0.18	0.20	0.22	49302	9.34	
115	0.07	0.11	0.03	0.15	0.12	0.15	0.18	0.18	48902	9.26	
116	0.13	0.12	0.14	0.18	0.11	0.16	0.09	0.16	48403	9.17	riffle - very steep here
117	0.48	0.07	0.38	0.15	0.18	0.22	0.06	0.25	48065	9.10	
118	0.36	0.19	0.46	0.38	0.27	0.27	0.13	0.46	47691	9.03	
119	0.31	0.26	0.49	0.49	0.45	0.37	0.21	0.48	46523	8.81	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
120	0.19	0.15	0.52	0.48	0.54	0.55	0.20	0.60	46172	8.74	
121	0.12	0.35	0.51	0.34	0.56	0.59	0.30	0.56	45713	8.66	riffle
122	0.09	0.46	0.46	0.40	0.47	0.48	0.24	0.41	45208	8.56	riffle
123	0.08	0.14	0.16	0.21	0.21	0.16	0.22	0.22	44821	8.49	
124	0.08	0.05	0.07	0.12	0.08	0.02	0.12	0.12	44443	8.42	
125	0.12	0.08	0.05	0.09	0.07	0.07	0.09	0.09	44089	8.35	riffle
126	0.11	0.09	0.03	0.10	0.09	0.09	0.12	0.11	43705	8.28	riffle
127	0.15	0.11	0.04	0.07	0.09	0.09	0.12	0.12	43334	8.21	
128	0.22	0.16	0.09	0.08	0.09	0.09	0.10	0.10	42944	8.13	
129	0.20	0.13	0.08	0.08	0.04	0.04	0.12	0.13	42527	8.05	
130	0.19	0.08	0.08	0.07	0.10	0.13	0.17	0.17	42025	7.96	
131	0.20	0.18	0.17	0.11	0.19	0.19	0.23	0.25	41884	7.93	riffle
132	0.24	0.36	0.27	0.18	0.24	0.24	0.18	0.19	41707	7.90	
133	0.22	0.41	0.30	0.23	0.18	0.21	0.10	0.11	41061	7.78	mid channel bar
134	0.22	0.38	0.27	0.18	0.10	0.18	0.07	0.13	40729	7.71	
135	0.10	0.37	0.22	0.22	0.06	0.20	0.09	0.09	40077	7.59	END of study REACH 3
136	0.09	0.31	0.19	0.23	0.03	0.19	0.06	0.04	39689	7.52	
137	0.17	0.34	0.12	0.17	0.02	0.15	0.06	0.06	39246	7.43	
138	0.20	0.26	0.11	0.14	0.07	0.09	0.07	0.08	38879	7.36	
139	0.33	0.33	0.08	0.15	0.12	0.12	0.12	0.13	38518	7.30	
140	0.09	0.12	0.25	0.24	0.05	0.05	0.10	0.10	38069	7.21	
141	0.10	0.13	0.25	0.25	0.16	0.05	0.05	0.18	36927	6.99	
142	0.10	0.18	0.19	0.22	0.26	0.14	0.13	0.22	36441	6.90	
143	0.08	0.33	0.11	0.20	0.24	0.13	0.13	0.28	35959	6.81	
144	0.10	0.41	0.05	0.06	0.32	0.13	0.09	0.32	35559	6.73	
145	0.15	0.38	0.07	0.11	0.31	0.10	0.12	0.29	35123	6.65	
146	0.14	0.27	0.12	0.15	0.21	0.09	0.06	0.22	34601	6.55	
147	0.22	0.36	0.09	0.26	0.28	0.11	0.12	0.29	34165	6.47	
148	0.29	0.46	0.19	0.37	0.39	0.13	0.14	0.37	33574	6.36	
149	0.22	0.19	0.13	0.17	0.18	0.17	0.18	0.17	32997	6.25	
150	0.29	0.18	0.12	0.17	0.17	0.11	0.16	0.19	32232	6.10	debris jam/bar/outatke
151	0.27	0.21	0.24	0.17	0.17	0.14	0.16	0.18	31792	6.02	
152	0.30	0.22	0.23	0.18	0.14	0.07	0.13	0.15	31455	5.96	
153	0.27	0.29	0.16	0.18	0.14	0.15	0.12	0.14	31064	5.88	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
154	0.20	0.33	0.14	0.22	0.09	0.08	0.08	0.09	30654	5.81	
155	0.19	0.46	0.53	0.17	0.08	0.07	0.08	0.09	30178	5.72	next to treatment plant
156	0.15	0.65	0.66	0.13	0.06	0.06	0.06	0.07	29749	5.63	
157	0.12	0.72	0.52	0.16	0.10	0.09	0.10	0.10	29125	5.52	
158	0.20	0.75	0.53	0.18	0.16	0.06	0.09	0.09	28656	5.43	
159	0.26	0.69	0.56	0.13	0.17	0.06	0.07	0.10	28184	5.34	End of REACH 4
160	0.18	0.58	0.59	0.10	0.17	0.06	0.10	0.14	27711	5.25	lateral bar
161	0.21	0.62	0.63	0.12	0.24	0.07	0.06	0.08	27235	5.16	riffle
162	0.16	0.52	0.56	0.15	0.24	0.17	0.11	0.20	26694	5.06	
163	0.19	0.52	0.53	0.15	0.06	0.06	0.12	0.21	25887	4.90	
164	0.24	0.54	0.53	0.20	0.06	0.06	0.07	0.21	25211	4.77	
165	0.27	0.46	0.32	0.17	0.06	0.05	0.07	0.36	24785	4.69	
166	0.23	0.40	0.37	0.16	0.06	0.07	0.13	0.42	24394	4.62	
167	0.13	0.31	0.31	0.26	0.20	0.04	0.13	0.48	23984	4.54	start large lateral bar (right)
168	0.14	0.18	0.16	0.27	0.26	0.10	0.12	0.56	23531	4.46	large lateral bar
169	0.16	0.17	0.06	0.12	0.21	0.21	0.20	0.67	23148	4.38	large lateral bar
170	0.29	0.25	0.17	0.06	0.08	0.03	0.13	0.64	22728	4.30	end bar - riffle
171	0.41	0.49	0.15	0.17	0.16	0.09	0.06	0.50	22222	4.21	
172	0.46	0.44	0.21	0.24	0.25	0.09	0.09	0.50	21855	4.14	
173	0.46	0.38	0.29	0.25	0.29	0.09	0.07	0.45	21491	4.07	riffle - lateral bar left
174	0.30	0.30	0.26	0.16	0.16	0.15	0.13	0.41	20900	3.96	
175	0.15	0.30	0.22	0.28	0.27	0.17	0.30	0.32	20441	3.87	start of another large bar complex (left) with side channels
176	0.14	0.32	0.33	0.23	0.10	0.13	0.15	0.17	19726	3.74	
177	0.26	0.04	0.17	0.19	0.10	0.04	0.14	0.15	19348	3.66	channel merges from left, but splits right - long mid-channel bar
178	0.26	0.07	0.14	0.21	0.11	0.06	0.09	0.11	18994	3.60	
179	0.22	0.14	0.10	0.17	0.09	0.09	0.04	0.12	18633	3.53	
180	0.31	0.31	0.32	0.37	0.07	0.06	0.05	0.12	18240	3.45	
181	0.38	0.46	0.41	0.48	0.07	0.07	0.13	0.20	17839	3.38	

TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSECT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
182	0.41	0.48	0.61	0.62	0.12	0.11	0.27	0.28	17485	3.31	4.5 transect long mid-channel bar - primary channel left
183	0.51	0.56	0.71	0.67	0.27	0.11	0.32	0.35	17117	3.24	
184	0.55	0.62	0.73	0.73	0.27	0.19	0.40	0.40	16786	3.18	
185	0.46	0.58	0.65	0.55	0.21	0.31	0.30	0.33	16402	3.11	
186	0.46	0.43	0.61	0.47	0.35	0.32	0.37	0.25	15972	3.03	
187	0.33	0.31	0.38	0.34	0.42	0.44	0.51	0.32	15238	2.89	
188	0.27	0.27	0.41	0.34	0.26	0.18	0.36	0.26	14808	2.80	
189	0.26	0.17	0.31	0.35	0.34	0.22	0.29	0.32	14394	2.73	END STUDY REACH 5
190	0.29	0.27	0.32	0.32	0.29	0.29	0.31	0.31	14017	2.65	
191	0.30	0.28	0.38	0.33	0.27	0.29	0.32	0.33	13594	2.57	
192	0.23	0.13	0.50	0.20	0.12	0.10	0.22	0.22	13141	2.49	
193	0.19	0.09	0.51	0.20	0.08	0.08	0.20	0.20	12875	2.44	
194	0.16	0.09	0.51	0.20	0.07	0.07	0.16	0.17	12528	2.37	
195	0.15	0.07	0.43	0.18	0.12	0.08	0.10	0.10	11927	2.26	
196	0.15	0.06	0.38	0.14	0.09	0.08	0.03	0.04	11307	2.14	
197	0.16	0.05	0.31	0.17	0.11	0.12	0.03	0.03	10848	2.05	
198	0.14	0.05	0.25	0.15	0.24	0.15	0.06	0.11	10244	1.94	
199	0.10	0.09	0.24	0.13	0.19	0.19	0.22	0.21	9644	1.83	
200	0.11	0.13	0.24	0.15	0.19	0.19	0.32	0.33	8713	1.65	
201	0.05	0.09	0.22	0.12	0.24	0.26	0.28	0.28	8260	1.56	
202	0.05	0.07	0.18	0.09	0.26	0.24	0.28	0.28	7726	1.46	
203	0.05	0.11	0.17	0.10	0.26	0.25	0.26	0.34	7073	1.34	
204	0.12	0.17	0.17	0.05	0.27	0.28	0.30	0.32	6479	1.23	
205	0.10	0.13	0.11	0.02	0.20	0.21	0.20	0.21	5859	1.11	
206	0.12	0.05	0.06	0.07	0.20	0.21	0.22	0.22	5127	0.97	
207	0.15	0.12	0.19	0.18	0.24	0.22	0.21	0.20	4491	0.85	
208	0.16	0.16	0.18	0.18	0.18	0.18	0.19	0.18	3890	0.74	
209	0.14	0.19	0.19	0.10	0.04	0.03	0.19	0.19	3280	0.62	
210	0.13	0.15	0.15	0.05	0.04	0.04	0.15	0.15	2548	0.48	
211	0.14	0.10	0.12	0.05	0.03	0.03	0.03	0.04	1528	0.29	
212	0.14	0.09	0.11	0.11	0.07	0.08	0.03	0.07	964	0.18	
213	0.11	0.09	0.11	0.10	0.09	0.09	0.09	0.09	147	0.03	END Reach 6 ~ end study area

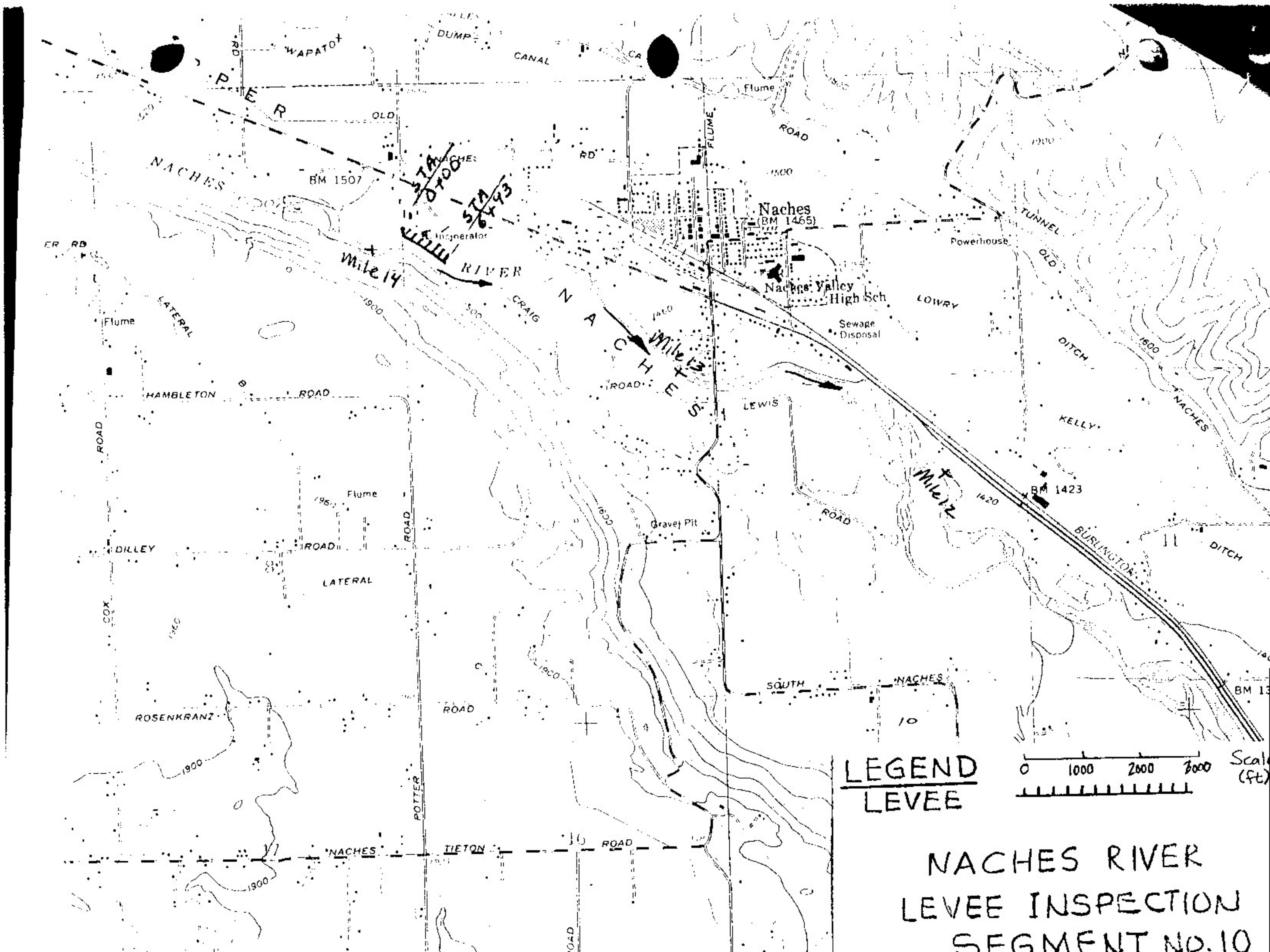
TABLE B-3. FLOODPLAIN WIDTH TO ACTIVE CHANNEL WIDTH TRANSECT RATIOS

UNIQUE TRANSE CT ID	1927	1947	1959	1972	1984	1992	1998	2000	Distance Upstream (in feet)	Distance Upstream (in miles)	Comment
214	0.48	0.11	0.12	0.12	0.13	0.11	0.11	0.11	-627	-0.12	
215	0.72	0.12	0.21	0.37	0.14	0.11	0.13	0.15	-1110	-0.21	

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME:	
REF. ID:	NSEG10
RIVER:	Naches
BANK:	Left
CLASS:	County
COE ID.:	Segment 10
TYPE:	Levee
MANAGING AGENCY:	Yakima County Public Works
OWNERSHIP:	
LOCATION DESC:	Near Craig Road
TWNS:	14
RNG:	17
SEC:	4
MP:	0.0
US/RM:	14.12
DS/RM:	14.00
LENGTH:	693
HEIGHT:	3-5
WIDTH:	10-12
RWSLOPE:	2-5h:1v
LWSLOPE:	1.5h:1v
BANK PROT.:	RW riprap throughout
LOP:	
FREEBOARD:	
BFELEV:	
CRELEV:	
MATERIAL:	Silty sandy gravel with cobbles
ACRES PROT:	176
INTERN. DRAINAGE:	None provided through the embankment, although a irrigation ditch drains landward of the levee
DRAWINGS:	
SURVEY DATA:	Not available - verify with COE
MAINT. SCHEDULE:	None
LAST INSPECTED:	5/5/88
BY?:	Ed Zapel, COE
DEFICIENCY:	Clear brush and trees Annual maintenance
MAINT:	1978 - 515 LF rehabilitated in 1978 by COE
COMMENTS:	This levee segment met minimum PL-99 criteria during initial inspection.
ACCESS:	


NACHES RIVER
LEVEE INSPECTION
SEGMENT NO.10
LEGEND
LEVEE
Scale (ft)
0 1000 2000 3000
STA 0+00
STA 6+93
Mile 14
Mile 13
Mile 12
NACHES RIVER
Naches
(BM 1465)
Naches Valley High Sch
Sewage Disposal
Powerhouse
Incinerator
Gravel Pit
BM 1507
BM 1423
BURLINGTON
TUNNEL
OLD
DITCH
KELLY
LOWRY
CRAIG
LEWIS
ROAD
SOUTH NACHES
NACHES TIETON ROAD
POTTER
HAMBLETON ROAD
DILLEY ROAD
LATERAL
ROSENKRANZ
COX
Flume
WAPATO
DUMP
CANAL

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME: Weber Auto Wrecking Dike

REF. ID: PL99-NSEG1

RIVER: Naches

BANK: Left

CLASS: PL-99

COE ID.: Segment 1

TYPE: Levee

MANAGING AGENCY: Yakima County Public Works

OWNERSHIP:

LOCATION DESC: Ramler bridge area

TWNS: 13

RNG: 18

SEC: 9

MP: 4.0

US/RM: 4.30

DS/RM: 3.85

LENGTH: 2,336

HEIGHT: 3-7

WIDTH: 10-15

RWSLOPE: 2-5h:1v

LWSLOPE: 2-5h:1v

BANK PROT.: RW riprap

LOP: 10

FREEBOARD: 3

BFELEV:

CRELEV:

MATERIAL: Clean to slightly silty sands & gravels

ACRES PROT: 84

INTERN. DRAINAGE: None provided

DRAWINGS:

SURVEY DATA: Not available - verify with COE

MAINT. SCHEDULE: Annual

LAST INSPECTED: 5/1/94

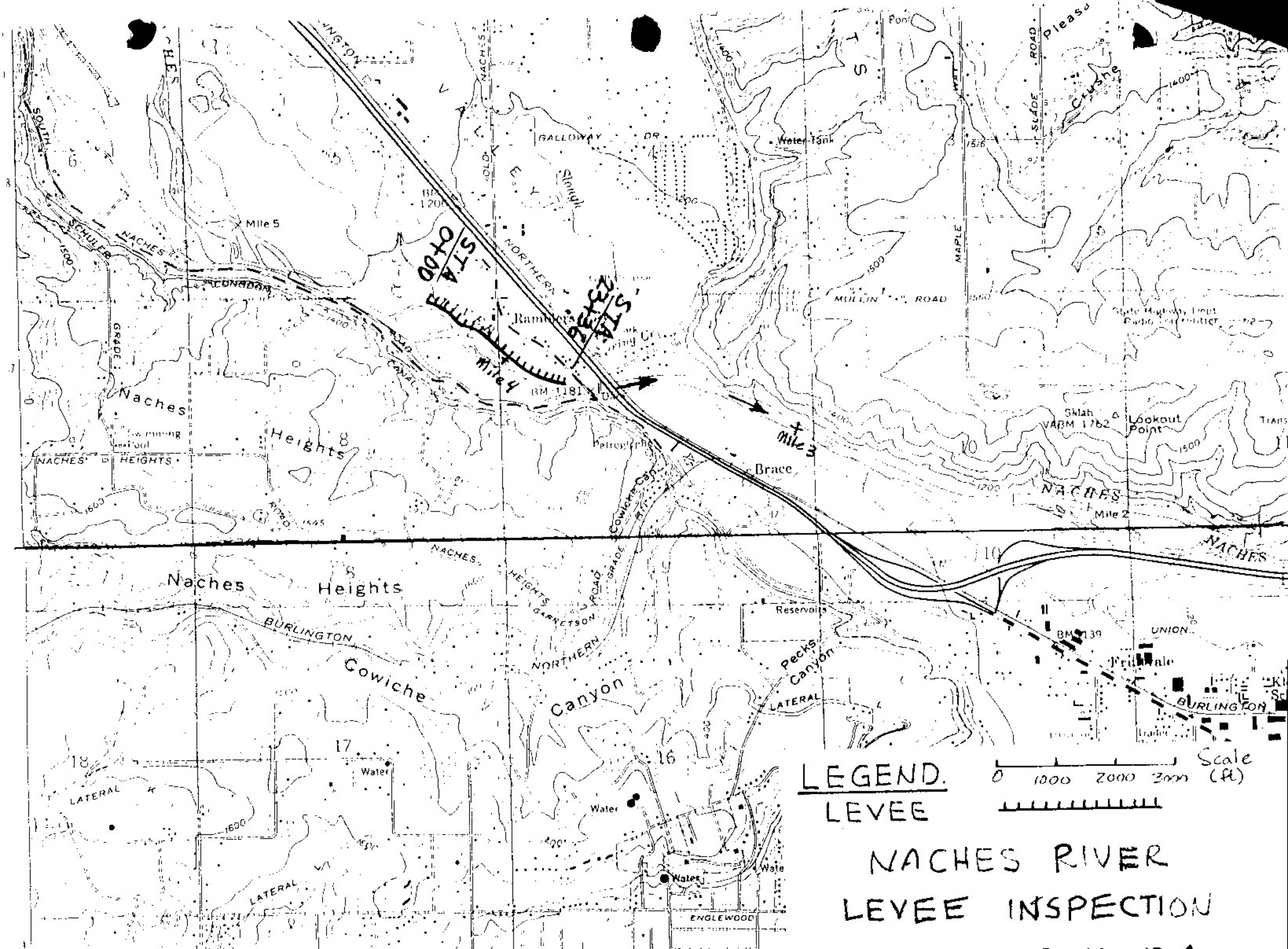
BY?: Yak. Cnty.

DEFICIENCY: Remove trees at north end of dike

MAINT:
1972 - 300 LF riprapped by COE
1974 - 200 LF rock replacement by COE
1976 - 250 LF riprapped by COE
1977 - 175 LF reconstructed

COMMENTS: This levee met minimum PL- 99 criteria following initial inpection in 1988.

ACCESS: Powerhouse Road near Weber Auto Wrecking



LEGEND.
LEVEE
Scale (ft)
0 1000 2000 3000
NACHES RIVER
LEVEE INSPECTION
STA 0+00
STA 23+36
Mile 3
Mile 4
Mile 5
Mile 2
NACHES
NORTHERN
BURLINGTON
Naches Heights
Cowiche Canyon
Pecks Canyon
Reservoirs
Water Tank
Water
MAPLE
MULLIN ROAD
GALLOWAY DR
SCHULER
CONDON
CANAL
SOUTH
Brace
Sklah
VABM 1762
Lookout Point
BM 1181
BM 1139
UNION
LATERAL
ENGLEWOOD
GARRETSON
Slough
Swimming Pool
Pleasant

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME: McCormick Dike

REF. ID: PL99-NSEG2

RIVER: Naches

BANK: Left

CLASS: PL-99

COE ID.: Segment 2

TYPE: Levee

MANAGING AGENCY: Yakima County Public Works

OWNERSHIP:

LOCATION DESC: South of Gleed

TWNS: 14

RNG: 18

SEC: 31

MP: 6.0

US/RM: 6.05

DS/RM: 5.60

LENGTH: 2,378

HEIGHT: 3-7

WIDTH: 10-12

RWSLOPE: 2-5h:1v

LWSLOPE: 2-5h:1v

BANK PROT.: RW riprap

LOP: 5

FREEBOARD: 1

BFELEV:

CRELEV:

MATERIAL: Clean to slightly silty sandy gravel with cobbles

ACRES PROT: 492

INTERN. DRAINAGE: None provide

DRAWINGS:

SURVEY DATA: Not available - verify with COE

MAINT. SCHEDULE: Annual

LAST INSPECTED: 5/1/94

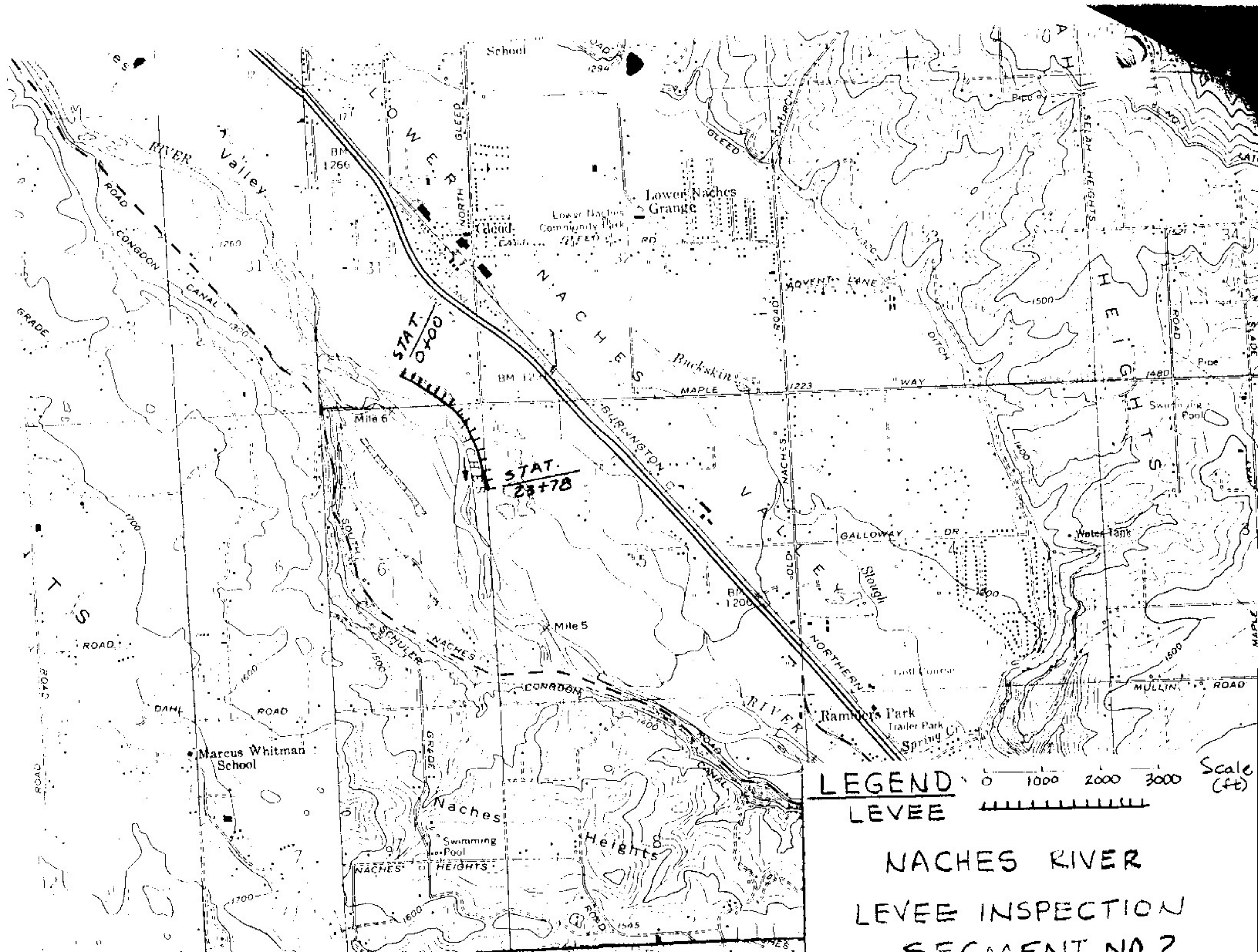
BY?: County

DEFICIENCY: None noted

MAINT: 1973 - 900 LF repaired
1974 - 650 LF reconstructed & rock protection
1978 - 280 LF rehabilitated

COMMENTS: This levee segment did not meet minimum PL-99 criteria during initial inpection due to lack of flood gate on irrigation intake culvert and excessive vegetation. Currently, the levee has PL-99 certification.

ACCESS: At the intersection of N. Gleed Road and Maple Way



STAT. 0+00
STAT. 23+78
LOWER NACHES VALLEY
HEIGHTS
Lower Naches Grange
School
Mile 6
Mile 5
Marcus Whitman School
Ramblers Park
Naches Heights
Slough
Buckskin
BURLINGTON
NORTHERN
RIVER
CONGDON
CANAL
MAPLE
WAY
GALLOWAY DR
MULLIN ROAD
Water Tank
Swimming Pool
LEGEND
LEVEE
0 1000 2000 3000 Scale (ft)
NACHES RIVER
LEVEE INSPECTION
SEGMENT NO 2

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME:

REF. ID: PL99-NSEG6

RIVER: Naches

BANK:

CLASS: PL-99

COE ID.: Segment 6

TYPE: Levee

MANAGING AGENCY: City of Yakima

OWNERSHIP:

LOCATION DESC:

TWNS:

RNG:

SEC:

MP:

US/RM:

DS/RM:

LENGTH:

HEIGHT:

WIDTH:

RWSLOPE:

LWSLOPE:

BANK PROT.:

LOP:

FREEBOARD:

BFELEV:

CRELEV:

MATERIAL:

ACRES PROT: 0

INTERN. DRAINAGE:

DRAWINGS:

SURVEY DATA:

MAINT. SCHEDULE:

LAST INSPECTED:

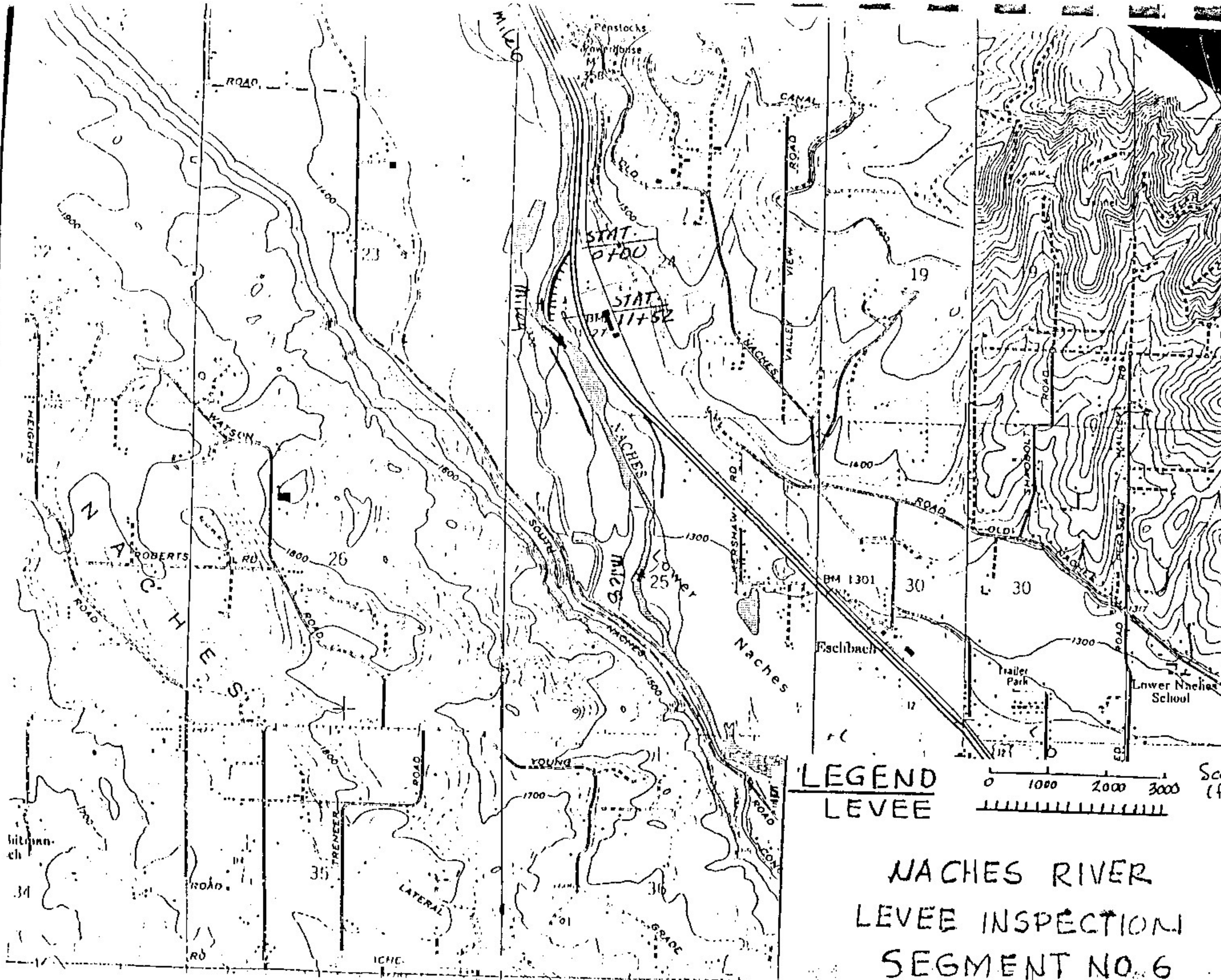
BY?:

DEFICIENCY:

MAINT:

COMMENTS: Limited information available on this facility.

ACCESS:



NACHES RIVER
LEVEE INSPECTION
SEGMENT NO. 6

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME: Naches Dike
REF. ID: PL99-NSEG7

RIVER: Naches
BANK: Left
CLASS: PL-99

COE ID.: Segment 7
TYPE: Levee

MANAGING AGENCY: Yakima County Public Works
OWNERSHIP:

LOCATION DESC: Adjacent to South Naches Road bridge

TWNS: 14
RNG: 17
SEC: 3

MP: 13.0
US/RM: 13.55
DS/RM: 12.45

LENGTH: 5,885
HEIGHT: 3-10
WIDTH: 12-17

RWSLOPE: 2-5h:1v
LWSLOPE: 2-5h:1v
BANK PROT.: 93% or RW slope riprapped

LOP: 5
FREEBOARD: 1
BFELEV:
CRELEV:

MATERIAL: Clean to slightly silty sandy gravel with cobbles
ACRES PROT: 102

INTERN. DRAINAGE: One 48" ungated culvert at station 59+00

One 24" ungated culvert at station 59+50

DRAWINGS:

SURVEY DATA: Not available - verify with COE

MAINT. SCHEDULE: Annual
LAST INSPECTED: 5/1/94
BY?: Yak. Cnty.

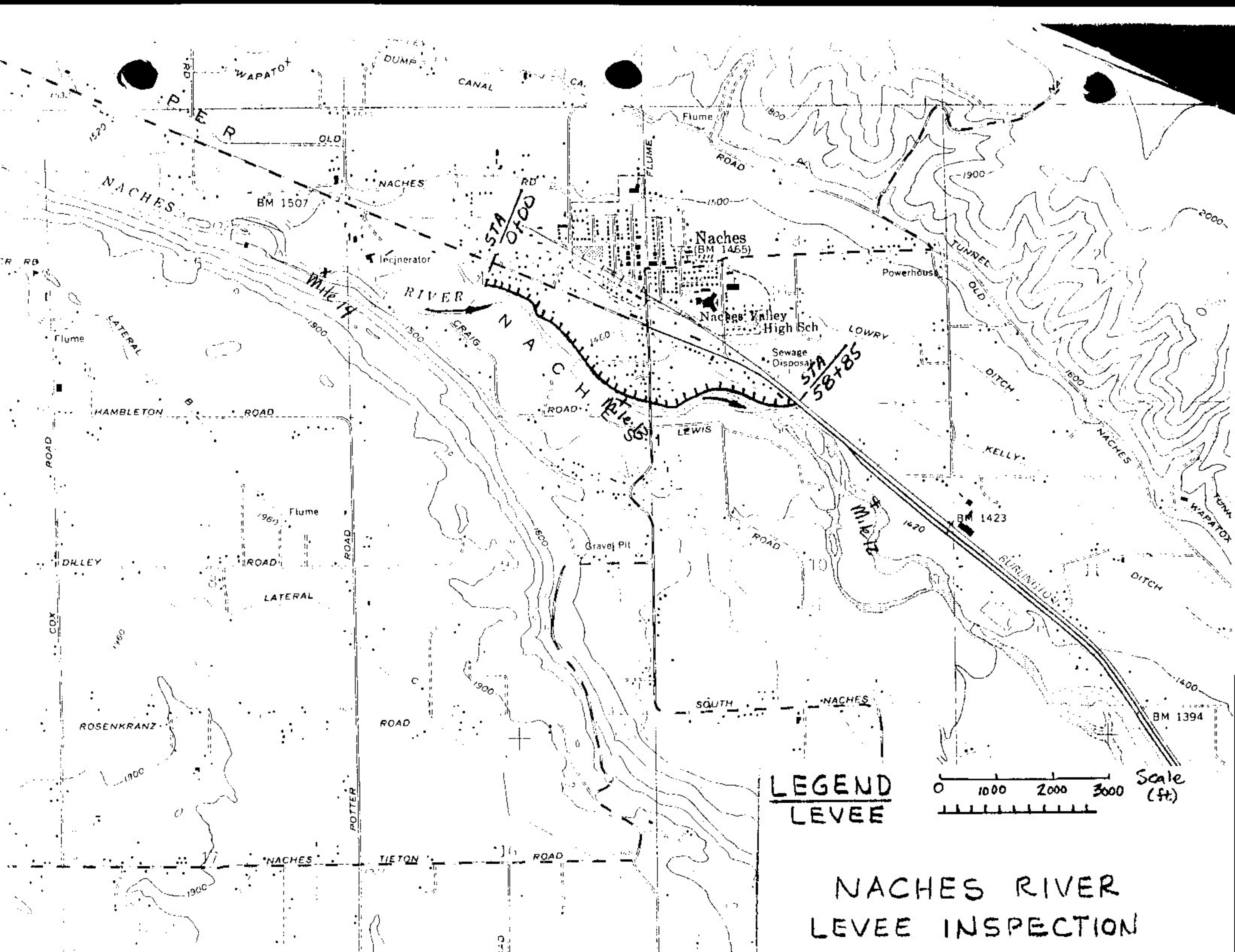
DEFICIENCY: Minor brushing needed from MP 13 east

MAINT: 1976 - 350 LF riprapped, 2360 LF reconstructed by COE

1981 - 1000 LF restored

COMMENTS: This levee segment met minimum PL-99 criteria during intial inpection and is currently listed as a COE PL-99 levee.

ACCESS: South Naches Road



NACHES RIVER
LEVEE INSPECTION

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME: Naches Dike
REF. ID: PL99-NSEG8

RIVER: Naches
BANK: Right
CLASS: PL-99

COE ID.: Segment 8
TYPE: Levee

MANAGING AGENCY: Yakima County Public Works
OWNERSHIP:

LOCATION DESC: Adjacent to South Naches Road bridge

TWNS: 14
RNG: 17
SEC: 9

MP: 13.0
US/RM: 13.13
DS/RM: 12.83

LENGTH: 1,688
HEIGHT: 3-6
WIDTH: 8-15

RWSLOPE: 2-5h:1v
LWSLOPE: 2-5h:1v
BANK PROT.: 70% RW slope riprapped

LOP: 5
FREEBOARD: 1
BFELEV:
CRELEV:

MATERIAL: Clean gravels and cobbles
ACRES PROT: 0

INTERN. DRAINAGE: None provided
DRAWINGS:

SURVEY DATA: Not available - verify with COE

MAINT. SCHEDULE: Annual
LAST INSPECTED: 5/1/94
BY?: Yak. Cnty.

DEFICIENCY: Minor brushing needed

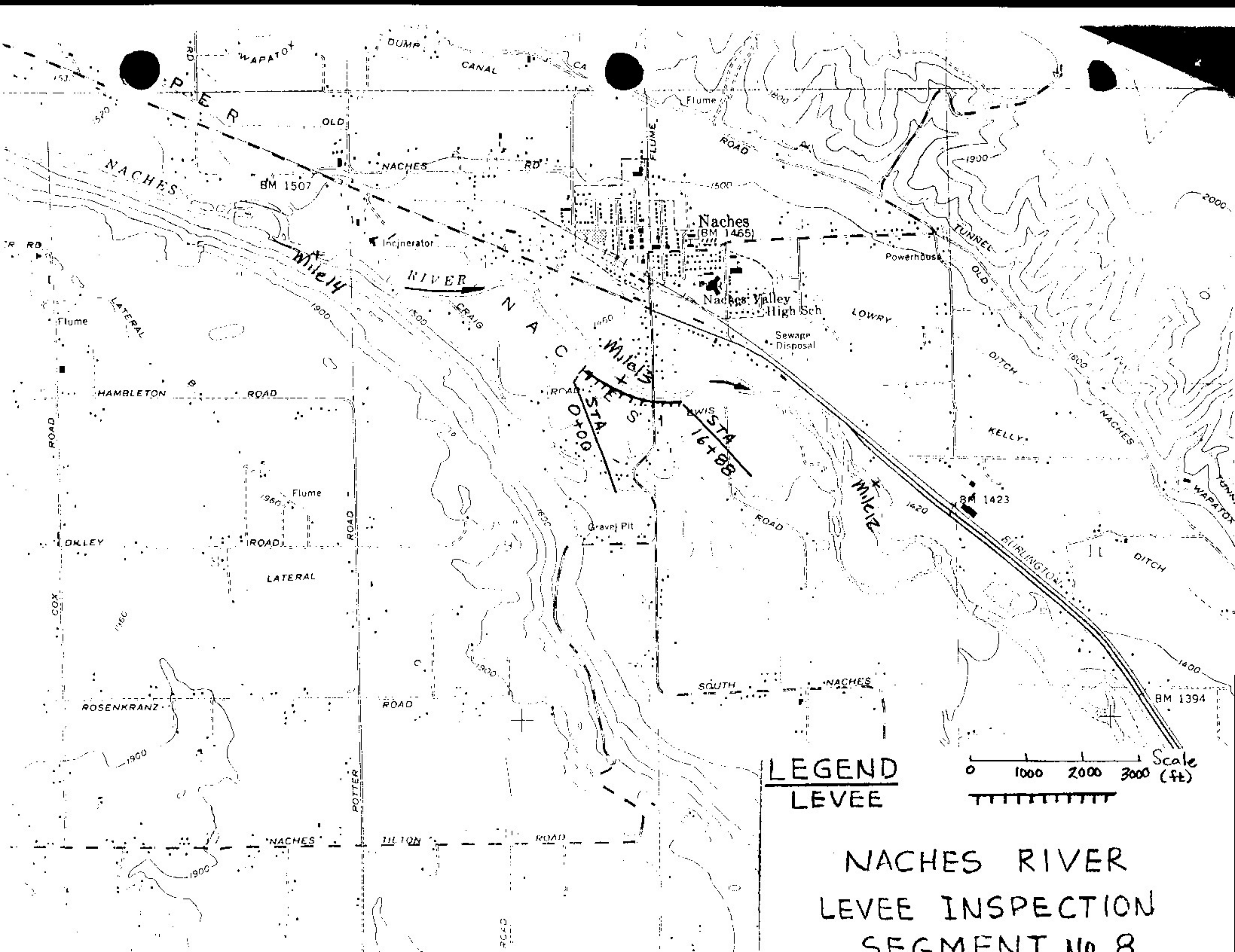
Fences and gates along top should be removed

Access through guard rails along bridge

MAINT: 1978 - 1400 LF rehabilitated

COMMENTS: This levee segment met PL-99 minimum criteria during the initial inpection and is currently list as a COE PL-99 levee.

ACCESS: South Naches Road

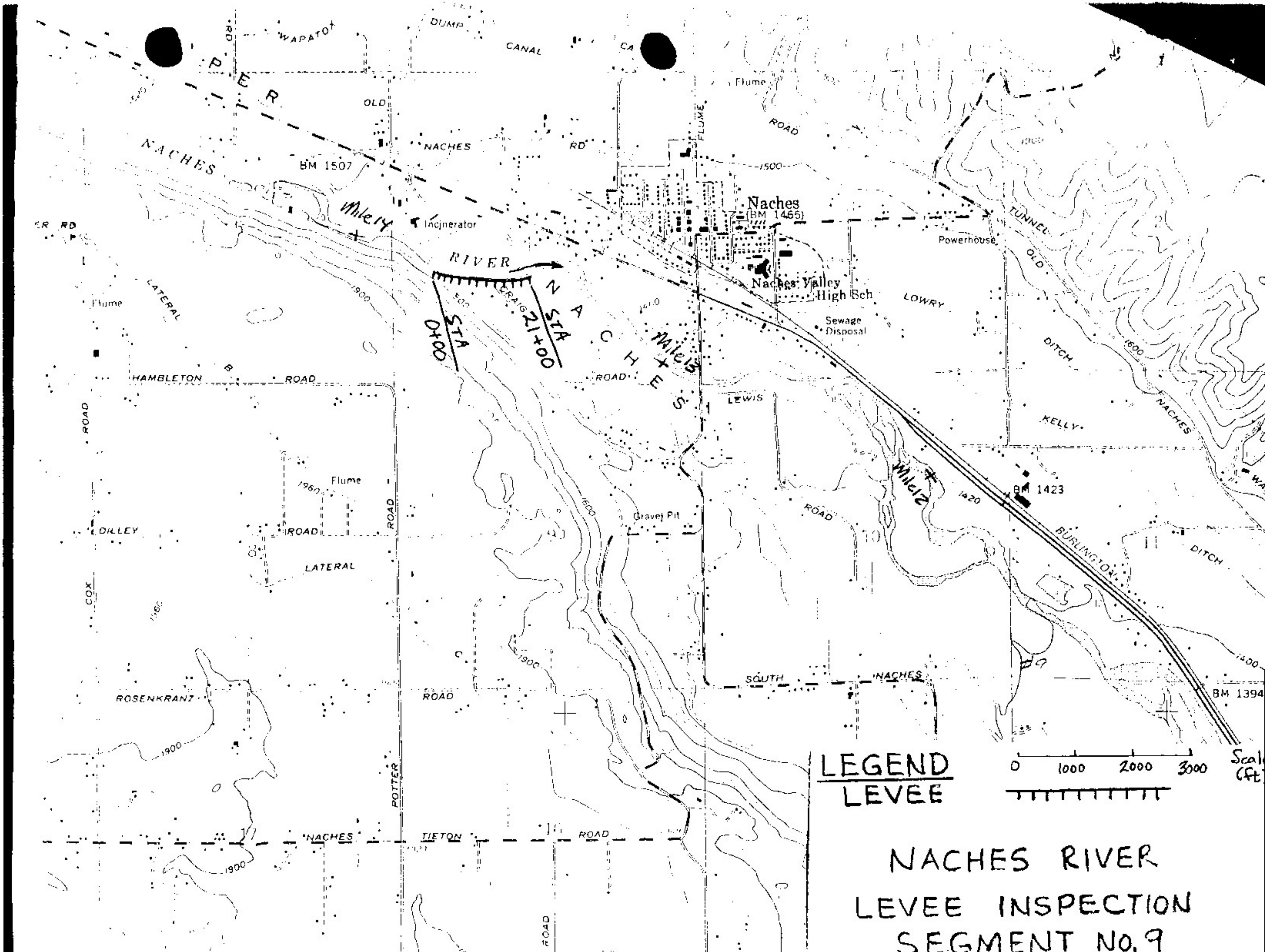


NACHES RIVER
LEVEE INSPECTION
SEGMENT No 8
LEGEND
LEVEE
Scale (ft)
0
1000
2000
3000
STA 0+00
STA 16+88
Mile 12
Mile 13
Mile 14
Naches
(BM 1465)
Naches Valley High Sch
Sewage Disposal
Powerhouse
Incinerator
Gravel Pit
Flume
BM 1507
BM 1423
BM 1394
NACHES RIVER
BURLINGTON
TUNNEL
OLD NACHES DITCH
KELLY DITCH
LOWRY
WAPATOX
DUMP
CANAL
OLD NACHES RD
ROAD
CRAIG
LEWIS
SOUTH NACHES ROAD
HAMBLETON ROAD
OKLEY ROAD
LATERAL
ROSENKRANZ ROAD
POTTER ROAD
NACHES TILTON ROAD
COX

YAKIMA COUNTY DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL WORKS INVENTORY

FACILITY NAME:	Naches Dike South Side
REF. ID:	PL99-NSEG9
RIVER:	Naches
BANK:	Right
CLASS:	PL-99
COE ID.:	Segment 9
TYPE:	Levee
MANAGING AGENCY:	Yakima County Public Works
OWNERSHIP:	
LOCATION DESC:	Near Craig Road
TWNS:	14
RNG:	17
SEC:	4
MP:	14.0
US/RM:	14.10
DS/RM:	13.70
LENGTH:	2,100
HEIGHT:	3-5
WIDTH:	12-20
RWSLOPE:	2-5h:1v
LWSLOPE:	2-5h:1v
BANK PROT.:	iprap provided throughout
LOP:	5
FREEBOARD:	1
BFELEV:	
CRELEV:	
MATERIAL:	Sandy gravel with cobbles and quarry spalls
ACRES PROT:	223
INTERN. DRAINAGE:	None provide through the embankment, although the irrigation ditch drains to landward of the levee
DRAWINGS:	
SURVEY DATA:	Not available - verify with COE
MAINT. SCHEDULE:	Annual
LAST INSPECTED:	5/1/94
BY?:	Yak. Cnty.
DEFICIENCY:	None noted
MAINT:	1965 - 1850 LF riprap protection and irrigation canal protection 1974 - 200 LF riprapped, 1000 LF rehabilitated
COMMENTS:	The levee segment met PL-99 minimum criteria during initial inpection and is currently a COE PL-99 levee.
ACCESS:	From Craig Road



LEGEND

LEVEE

NACHES RIVER

LEVEE INSPECTION

SEGMENT No. 9

APPENDIX D.
FEDERAL, STATE, AND LOCAL REGULATIONS AND POLICIES

This appendix provides an overview of the existing federal, state, and local regulations that directly or indirectly affect flood hazard management in Yakima County.

FEDERAL REGULATIONS

Clean Water Act

The Clean Water Act of 1977 and the Water Quality Act of 1987 (amendments to the Federal Water Pollution Control Act) provide the backbone for national water quality policy and action. The goal is to eliminate pollutant discharges into "waters of the U.S." Sections 401, 402, and 404 of the Clean Water Act (33 USC 1251 et seq., as amended by Public Law 92-500) are pertinent to surface water management in Yakima County.

Section 401 - Water Quality Certification

Section 401 (40 CFR 121) ensures activities requiring a federal permit (such as COE Section 404 permit for filling of a wetland) comply with the Clean Water Act, state water quality laws, and other appropriate state regulations (e.g., the Hydraulic Code, Water Pollution Act). Section 401 is implemented through a certification process. In the State of Washington, the Department of Ecology (Ecology) implements Section 401 requirements [WAC 173-225; RCW 90.48; WAC 173-201-035(8)(e)]. Ecology is the final authority on approval, denial, or development of special conditions for certification.

A Water Quality Certification ensures that federal permitted activities comply with water quality standards and discharge limitations for waters of the State of Washington (Chapter 173-201 WAC). The Certification is similar to a permit and is a prerequisite requirement for obtaining a COE permit, an FERC license, or other federal permit. Usually, the federal permitting agency notifies Ecology of applications for federal permits. Issuance of a Certification is exempt from SEPA requirements.

Application to Yakima County

Most in-stream construction activities, including flood hazard management projects such as riprap revetment and gravel bar scalping, will unavoidably violate state water quality standards (particularly the turbidity standard) on a short-term basis. Such projects will require a Temporary Modification of Water Quality Standards, an order issued by Ecology to control water quality impact by short-term activities essential to the public interest. The order may be required before Ecology issues a Water Quality Certification and must comply with SEPA requirements (see below).

Section 402 - National Pollution Discharge Elimination System

The Water Quality Act of 1987 amended Section 402 with a new subsection regulating stormwater discharges. The amendment requires a phased approach to control pollutants mobilized and transported by stormwater runoff. Although pollutants entering storm and surface water systems have historically been considered nonpoint in nature, they are now regulated as point sources under Section 402(p) and subject to the permitting process of the Clean Water Act's National Pollutant Discharge Elimination System (NPDES).

On November 6, 1990, the EPA established permit requirements for stormwater discharges associated with industrial activity and municipal storm sewer systems (MS4) serving 100,000 population or more (40 CFR Parts 122, 123, and 124). Permitting authority in Washington State was granted to Ecology by EPA. On December 8, 1999, the EPA published its Final Rule applying to smaller MS4s serving less than 100,000 population, called collectively Phase II MS4s. EPA issued Phase II MS4 guidance, on recommended Best Management Practices (BMPs), and model permits for Phase II MS4s and small construction sites, in October 2000. EPA will issue further guidance on measurable goals in October 2001. Ecology will issue modifications to the State NPDES program no later than December 2001. The EPA has set a deadline of December 8, 2002 for issuance of a general permit for Phase II MS4s, and operators of Phase II MS4s must apply for permit coverage by March 10, 2003.

Application to Yakima County

Yakima County, and the cities of Yakima and Selah are classified as Stormwater Phase II communities according to Dept. of Ecology and EPA determination -pursuant to NPDES regulations. Therefore, Yakima County and the cities of Yakima and Selah are subject to NPDES stormwater requirements for Phase II MS4s. The specific permit requirements to be established by the EPA under Phase II are still under development, but under the December 2, 1999 Final Rule the following six program elements will be required: public education, community participation, illicit detection/elimination, construction sites, post-construction (permanent) controls, and operation and maintenance. Controls for these programs may include a variety of structural or nonstructural measures. The model permit guidance for smaller urban areas reflect the experience EPA has gained from permitting larger cities and counties.

Section 404 - Dredge and Fill Requirements

Section 404 of the Clean Water Act (USC 1394) regulates the discharge of dredged or fill material into waters of the United States, including wetlands. The COE administers a permitting program under the provisions of Section 404.

Under the law, discharge of dredged or fill material to wetlands may require a nationwide permit or an individual permit. A nationwide permit is required for smaller projects and authorizes specific categories of work such as minor road crossing fills, replacement, repair, and rehabilitation, and mooring buoys. The review process generally takes less than 20 days. Nationwide Permit 26 covers wetland fills. This permit regulates filling that will cause the loss or substantial adverse modification of less than one acre of isolated waters or waters with an average annual flow of less than 5 cubic feet per second at the headwaters.

This includes isolated wetlands and wetlands adjacent to and above the headwaters of tributary water bodies. Wetland fills of 1 to 10 also require environmental impact review by the COE, EPA, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Ecology. Individual permits are required for wetland proposals involving any of the following:

- Fill of less than 10 acres that is not authorized under Nationwide Permit 26
- Fill of more than 10 acres
- Fill of any wetland area adjacent to a stream and below the headwaters. Fill of any area in tidal waters and their adjacent wetlands.

The individual permit review process includes an analysis by the COE of whether the project's benefits outweigh predicted environmental impact. Completion of an Environmental Impact Statement may be necessary for some projects. In addition, there is a 30-day period during which the proposal is available for review by federal, state, and local agencies, Native American groups, interest groups, and the general public.

Proposed wetland activities may be subject to other laws in addition to or in association with a Section 404 permit. For example, in the State of Washington, Ecology has the right to place conditions on or request denial of a Section 404 permit if a proposed project does not comply with state water quality laws. The COE cannot issue a Section 404 permit if the state has denied water quality certification. Furthermore, if any local agency permit is denied, the COE will deny the 404 permit.

Consultation under Section 7 or Section 10 of the Endangered Species Act is a required review process for actions which may result in "take" or harm to an endangered species, and takes place within the framework of a federal agency decision or action. In the case of the U.S. Army Corps of Engineers 404 or other permit, endangered species coordination is effected with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS). Biological assessment and other analyses and coordination may be required to support an evaluation of no "take" in connection with a permit decision.

National Flood Insurance Act / Flood Disaster Protection Act

In 1968, the U.S. Congress initiated the National Flood Insurance Program (NFIP) (Chapter 44 CFR) under the National Flood Insurance Act to relieve the burden of disaster relief on the national treasury and state and local tax bases. The NFIP is administered by the Federal Insurance Administration (FIA), which is part of the Federal Emergency Management Agency (FEMA). The NFIP makes available affordable flood insurance to communities that adopt approved floodplain management regulations. Communities that do not participate in the NFIP do not qualify for certain flood disaster relief.

Congress added several provisions to the NFIP under the Flood Disaster Protection Act of 1973 in order to strengthen the program. The 1973 act provided additional incentives to communities to join the NFIP by substantially increasing the amount of flood insurance coverage available and providing penalties for communities and individuals that choose not to join the NFIP and are subsequently flooded. Specific new requirements include the following:

- Any acquisition or construction undertaken in identified special flood hazard areas requires purchase of federal flood insurance if available.
- Acquisition of properties in the floodplain to be secured under mortgages from a federally related lender require purchase of federal flood insurance if available.
- Communities identified by FEMA as flood-prone have one year from the time of designation to enroll in the NFIP; otherwise disaster-assistance funds and federal financial assistance for acquisition or construction of property in flood hazard areas will be denied.

The NFIP consists of an emergency program and a regular program. The emergency program is initiated when FIA notifies a community that it has been identified as a flood-prone area. Notification is provided in the form of a Flood Hazard Boundary Map (FHBM). The FHBM is a preliminary delineation of the flood hazard areas and shows no elevations. After receiving the FHBM, a community becomes a participant by completing an application to the FIA. Upon acceptance of the application, limited amounts of flood insurance are made available to the community. The community is required to adopt minimum floodplain management regulations based on the FHBM and is encouraged to use any additional information available to establish flood elevations.

A community enters the regular NFIP program upon adoption of an ordinance approved by FEMA. A detailed flood insurance study that involves hydrologic and hydraulic analyses is normally performed and is referenced in the ordinance as the basis for the regulatory program. The products of the study are the Flood Insurance Rate Map (FIRM) and the Flood Insurance Study. The Flood Insurance Study provides data on the width of the floodway and floodplain, the cross-sectional area, and the floodwater velocity at given points in the stream. The FIRM delineates areas adjacent to rivers that are subjected to flood risks and an insurance rate is determined for each area. New FIRMs also delineate flood insurance rate zones, limits of the 100-year floodway and floodplain, and, frequently, the limits to the 500-year floodplain. FIRMs and the associated insurance studies are available from the regional branch of FEMA.

The 100-year flood determines the geographic jurisdiction of NFIP-related programs. The 100-year flood is frequently called the “base flood” and is defined as the discharge that has a one percent chance of occurring or being exceeded in a given year. The 100-year floodplain is the area that would become inundated by water during the 100-year flood.

The floodway is an engineering concept incorporated into the NFIP floodplain management criteria. A floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to convey the base flood without cumulatively increasing the water surface elevation more than a certain amount (one foot for NFIP). 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.

Since 1990, communities that have adopted programs or regulations to reduce flood-related damages have been eligible to receive reduced insurance rates under the Community Rating System (CRS). Communities must apply to FEMA to be certified for a rate reduction before policy holders within the community can receive a rate reduction. There are 21 different activities, divided into four groups that count towards the credit. The groups are public information, mapping and regulations, flood damage reduction, and flood preparedness.

Application to Yakima County

Yakima County and the City of Naches are currently members of the NFIP. Table F-1 displays dates of entry into the NFIP. FIRMs for Yakima County were updated in 1998 for several locations along the Yakima River, but the revised portions are outside of this study area. Naches and the County have adopted Flood Damage Prevention Ordinances (see below) as required by NFIP. Therefore, federally subsidized flood insurance is available to local residents. To continue coverage, the communities must maintain participation in the NFIP and maintain minimum floodplain management regulations. FEMA requires a certification letter for any revisions to a FIRM. Certification activities include stream channel modifications, installation of culverts, and bridge construction. Yakima County may become eligible for CRS credits and a reduction in insurance rates after adoption and implementation of this plan.

TABLE F-1.
YAKIMA COUNTY INVOLVEMENT IN THE NATIONAL FLOOD INSURANCE PROGRAM

Community	Community Number	Date of Entry into NFIP	Date of Current FIRM
Yakima County	530217	June 5, 1985	March 1998
Naches	530223	January 19, 1983	January 1983

Endangered Species Act (Federal)

Since the listing of steelhead and several species of salmon as endangered or threatened under the federal Endangered Species Act (ESA), all projects that may directly or indirectly impact these fish or their habitat are subject to environmental review by the U.S. Department of Fish and Wildlife (USFWS) or the National Marine Fisheries Service (NMFS). The USFWS oversees terrestrial and freshwater fish species, including bull trout, and the NMFS oversees marine and anadromous species, including salmon. These agencies review projects to determine the extent of the impacts and the proper mitigation and conservation measures to be implemented to eliminate or limit these impacts. The ESA applies to all projects that meet any of the following criteria:

- Projects requiring a permit from a federal agency, such as the Corps of Engineers
- Projects on federal lands
- Federally funded projects
- Projects that may cause either direct injury to the listed species, alteration of habitat, or significant disturbance to the habitat.

The first three types of projects listed above are covered under Section 7 of the ESA, which requires agency consultation. The last category is covered under Section 9, which defines prohibited acts. Under both categories, applicants must show either that the project would have negligible impact on any listed species or that the project includes mitigation or conservation measures to sufficiently negate any potential impacts.

Initially, a local agency works with the applicant and the federal authority (USFWS or NMFS) to determine which species reside in the project area and the probable extent of the impact. The applicant submits a brief assessment—a Biological Evaluation (BE)—to the local and federal agencies describing the scope of the project, the listed species determined to reside in the project area, and the probable project impacts on the species or its habitat.

If the impacts are determined to be negligible, then the federal agency issues a letter or notification of “no effect,” and the project may proceed without additional permitting from USFWS or NMFS. If potential significant impacts on the listed species or its habitat are identified, the applicant must hire a biologist to complete a Biological Assessment (BA). In a BA, the biologist conducts a field investigation, collects pertinent biological information, and interviews local specialists to assess potential impacts on the listed species and its habitat. The BA is submitted to the federal agency, along with a request for a “formal consultation,” and is used as the technical reference whereby the federal agency determines the project’s level of impact. The agency issues one of two “biological opinions”:

- No Jeopardy/No Adverse Modification—The project can proceed without additional permitting from USFWS or NMFS.
- Jeopardy/Adverse Modification—The applicant can implement reasonable and prudent alternatives approved by the agency and proceed with the project or seek an exemption from the opinion. Otherwise, the project must be abandoned. The USFWS or NMFS may also issue an “incidental take permit,” which allows limited take of a species as long as the activity is otherwise legal (“take” consists of a number of potential impacts on the species as defined in the ESA).

In Washington State, most projects must undergo local environmental review as part of the permit process. If on reviewing a State Environmental Policy Act (SEPA) checklist the responsible official determines the project will result in significant environmental deterioration, an environmental impact statement (EIS) is required. A BA would provide supporting documentation for the EIS.

Application to Yakima County

Any projects on the Naches River entailing excavation, dredging or work within the river’s channel or adjacent wetlands would require a Corps of Engineers 404 permit. Since this is a federal permit, the project would fall under the requirements of ESA Section 7, and a BA would likely be required.

River and Harbor Act, Section 10

The River and Harbor Act was enacted in 1899 to preserve the navigability of the nation’s waterways. Section 10 (33 USC 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. The provisions apply to all structures or work below the mean high water mark of navigable tidal waters and the ordinary high water mark of navigable fresh waters. Actions in wetlands within these limits are subject to Section 10 provisions.

Provisions of Section 10 are implemented by the COE through a permit process that includes consideration of navigation, flood control, fish and wildlife management, and environmental impact. Compliance with NEPA (National Environmental Policy Act) is required. Section 10 reviews often occur simultaneously with Section 404 permit processing.

Application to Yakima County

The Naches River is not a navigable waterway. Therefore, activities in the river channel and wetlands within the Ordinary High Water Mark (OHWM) are generally not regulated through Section 10, although regulations set by Section 404 still apply.

Executive Order 11990 (Wetlands)

In 1977, Executive Order 11990 directed federal agencies to avoid the unnecessary alteration or destruction of wetlands. The order requires federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands affected by any federal project or project that receives federal funding. Federal agencies must also address impact on wetlands and mitigate any unavoidable impact. The order establishes wetland protection as the official policy of all federal agencies.

Application to Yakima County

While the order does not regulate wetlands per se, it does establish wetland protection as the official policy of all federal agencies. Many policies and regulations in the State of Washington reflect this policy as described below.

STATE REGULATIONS

Water Pollution Control Act

The Water Pollution Control Act (RCW 90.48) empowers the state to develop, maintain, and administer the statutes and programs required by the Clean Water Act. The policies set forth in the federal act are reflected in the State Water Quality Standards (WAC 73-201).

Application to Yakima County

The Water Pollution Control Act empowers Ecology to bring punitive actions for the illegal discharge of pollutants, including fines, prosecution, and incarceration. It also authorizes assistance to local jurisdictions for construction of water quality control projects.

State Environmental Policy Act

The Washington State Environmental Policy Act (SEPA) (Chapter 43.21C RCW) was passed to ensure that environmental values are considered in decisions by state and local government officials. Washington, as other states, has used NEPA as a model for the state process (SEPA). SEPA policies and goals apply to actions at all levels of government except the judiciary and state Legislature. The most recent implementing rules (WAC 197-11) were adopted by Ecology in 1990.

RCW 43.21C lists SEPA's four primary purposes as follows:

- To encourage productive and enjoyable harmony between people and their environment.
- To prevent or eliminate damage to the environment and biosphere.
- To stimulate the health and welfare of people.
- To enrich the understanding of ecological systems and natural resources important to the state and the nation.

The SEPA process starts with a permit application to an agency or an agency proposal for official action. Potential environmental impact is evaluated by the lead agency (agency with lowest level of permitting authority) and distributed to other affected agencies for comment. If the potential environmental impact is significant, an EIS is required. If the environmental impact can be mitigated, a Mitigated Determination of Nonsignificance (MDNS) is issued. If the potential environmental impact is insignificant, a Determination of Non-significance (DNS) is issued after completion of the EIS, MDNS, or DNS agencies may act upon the permit application or other approvals required for the project.

A variety of proposed actions are categorically exempt from the SEPA process. Most categorical exemptions use size criteria to differentiate between exempt and non-exempt actions. Exempted projects include most single-family homes, commercial buildings under 4,000 square feet, parking lots for 20 cars or less, and landfills or excavations of 100 cubic yards or less. Under SEPA provisions, cities and counties are allowed to set their own size criteria within a specified range for five categories of exemptions. Criteria cannot be more restrictive than those of SEPA unless the location of a proposed action is an environmentally sensitive area.

Application to Yakima County

Yakima County acts as the lead local agency in the SEPA process. SEPA requires an environmental assessment for floodplain management projects. The effect on flooding must be considered during the environmental review. The consistency of a proposal with existing plans and policies (e.g., local critical areas/shoreline master programs, comprehensive plans, zoning codes) may also be evaluated. Completion of the SEPA process is necessary before agency decisions may be made on the Hydraulic Project Approval, Shoreline Substantial Development permit and other local and state permits.

Washington State Shoreline Management Act

The purpose of the Washington State Shoreline Management Act (SMA) (RCW 90.58) is to protect public resources such as water, fish and wildlife, and supporting habitat by regulating public and private development in shoreline areas. SMA defines shoreline designations; provides guidance to Ecology and local jurisdictions for developing procedures, rules, and plans for shoreline activities; establishes timelines for the development of local shoreline management plans; and identifies activities generally exempt from shoreline permits.

New guidelines and legislation adopted in July 2003 provide details on how local governments can achieve the level of protection required by the SMA through development or revision of a Shorline Master Program (SMP). The revised shoreline guidelines apply only to new development or re-development, not to existing homes, businesses or farming practices, nor to shoreline projects that have already been approved under existing city or county shoreline master programs.

Shorelines of the State that are governed by the SMA include the following:

- All water areas of the state, including reservoirs, and their associated wetlands, together with the lands underlying them, except 1) shorelines of statewide significance; 2) shorelines on segments of streams upstream of a point where the mean annual flow is 20 cubic feet per second or less and the wetlands associated with such upstream segments; and 3) shorelines on lakes less than 20 acres in size and wetlands associated with such small lakes; and,
- Shorelines of Statewide Significance which include the rivers (downstream of where mean annual flow is 200 cubic feet per second or greater for Eastern Washington), adjacent lands within 200 feet of the ordinary high water mark, areas within the floodway, contiguous floodplain areas landward 200 feet from the floodway, and all associated marshes, bogs, and swamps.

The SMA defines wetlands as “those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all marshes, bogs, swamps, and river deltas associated with the streams, lakes, and tidal waters which are subject to the [Shoreline Management Act].”

The SMA requires permits for substantial development within the Shorelines of the State. Substantial development is defined as any development for which the total cost, or fair market value, exceeds $5,000, or any development that materially interferes with normal public use of the water or Shorelines of the State. Exceptions include normal maintenance or repair of existing structures, construction of residential bulkheads, emergency construction, construction of barns or similar agricultural structure on wetlands, construction or modification of navigational aids, construction of a single-family residence on a wetland, construction of docks for pleasure boats, irrigation systems, and pre-existing agricultural drainage and diking systems.

A conditional use permit can be issued to allow greater flexibility, consistent with the policies of RCW 90.58.020. By authorizing conditional use, the appropriate local government agency may attach special conditions to prevent undesirable effects of the proposed use. A variance can be granted for relief from bulk, dimensional, or performance standards set forth in the Shoreline Master Program where extraordinary or unique circumstances affect the property such that unnecessary hardships are imposed on the applicant.

The SMA provides the following criteria (in order of preference) to Ecology and local jurisdictions when developing master programs for Shorelines of Statewide Significance (RCW 90.58.020):

1. Recognize and protect state-wide interest over local interest.
2. Preserve the natural character of the shoreline.
3. Consider long-term 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 other considerations when appropriate, including economic development, circulation, housing, a range of land uses adjacent to shorelines, historic, cultural, and scientific considerations, and other considerations found to be appropriate or necessary.

Any permitted uses that are allowed based on the above criteria must minimize damage to the ecology and environment of the shoreline area and minimize any interference with the public's use of the water.

Application to Yakima County

Pursuant to the SMA, Yakima County adopted a shoreline master program (Title 23) on September 5, 1974. SMA gives primary authority over shoreline development to local governments following review from the State. The Yakima County Shoreline Master Program is discussed further in the local regulatory mechanisms section below. The SMP for Yakima County is part of, and will be updated with the Critical Areas Ordinance update (additional information about this ordinance on page D-23).

State Statutes Addressing Flood Hazard Management

The three principal state statutes that address flood hazard management activities are titled: Flood Control by Counties (RCW 86.12), Floodplain Management (RCW 86.16), and State Participation in Flood Control Maintenance (RCW 86.26) (Ecology 1991). Portions of these statutes were amended in 1991 by Engrossed Substitute Senate Bill 5411 (SB 5411) to strengthen and coordinate flood hazard management activities statewide.

Flood Control by Counties/Senate Bill 5411

RCW 86.12, originally enacted in 1907, authorizes counties to levy taxes and exercise eminent domain to control and prevent flood damage. RCW 86.12 was substantially enlarged in 1991 by SB 5411, which added three new sections. SB 5411 developed a "coordinated and comprehensive state policy to address problems of flooding and minimize flood damage..." The bill greatly expands counties' roles in the formulation and adoption of CFHMPs. Specifically, "the county legislative authority of any county may adopt a comprehensive flood control management plan for any drainage basin that is located wholly or partially within the county..." Plan elements are mandated. While counties are given responsibility for basin plan development, plans are to be developed through a participatory process involving cities, towns, or special districts within the basin.

Floodplain Management Program

Washington State's Floodplain Management Program (RCW 86.16) integrates local and state regulatory programs in a comprehensive effort to reduce flood damages and protect human health and safety. The state program requires local flood-prone jurisdictions to adopt a flood damage prevention ordinance based upon federal standards contained in the NFIP.

State Participation in Flood Control Maintenance

Through the Flood Control Assistance Account Program (FCAAP), local governments are eligible for matching state funds to repair or restore existing flood control facilities, to maintain or improve channel capacity, and to develop comprehensive flood control management plans such as this document. An optional element of this program provides local governments a means to develop wetland management strategies in flood-prone areas.

Application to Yakima County

Yakima County's Flood Hazard Ordinance is consistent with the requirements of the NFIP, as well as the state Floodplain Management Program. Therefore, Yakima County is eligible for national flood insurance and matching state funds to improve or construct flood control facilities and to develop flood control management plans. This CFHMP is funded by this program.

Water Pollution Control Act

The Water Pollution Control Act (Chapter 90.48 RCW) empowers the state to develop, maintain, and administer the federal statutes and programs required by the Clean Water Act. The policies set forth in the federal act are reflected in the State Water Quality Standards (WAC 173-201). Ecology can bring punitive actions against water quality violators including fines, prosecution, and incarceration as outlined in the act

Application to Yakima County

In the absence of water quality control measures and other best management practices, increased development can result in violation of water quality standards for the Naches River. Activities within the County that may result in violations of state water quality standards can be controlled or halted through the provisions of this act. Two water quality assessment programs have recently been conducted, National Water Quality Assessment (NAWQA) Program by U.S. Geological Survey (USGS) and a Total Maximum Daily Load (TMDL) study by Department of Ecology.

Washington State Hydraulic Code

The Washington State Hydraulic Code (RCW 75.20.100-140) regulates activities affecting the state's salt and fresh waters. The purpose of the Hydraulic Code is to preserve fish and wildlife habitat in and around the waters of the state. The Hydraulic Code is administered by the Washington State Department of Fish and Wildlife.

Any work that falls within the definition of a hydraulic project requires a Hydraulic Project Approval (HPA) from the Department of Fish and Wildlife. Hydraulic projects are defined as work that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state. Application consists of a form submitted to the Department of Fish and Wildlife accompanied by project plans and specifications. Each of the following constitutes application for an HPA:

- A completed hydraulic project approval application submitted to the Department of Fish and the Department of Wildlife
- A completed forest practice application submitted to the Department of Natural Resources if the project is part of a forest practice as defined in WAC 222-16-010(19)
- A Section 10 or 40l public notice circulated by the COE or U.S. Coast Guard.

Verbal approval for emergency work may be granted immediately upon request to repair existing structures, move obstructions, restore banks, or protect other property that is subject to immediate danger by weather, flow, or other natural conditions. Verbal approval may also be granted immediately for driving across a stream during an emergency. "Emergency" is defined as an immediate threat to life or public or private property, or an immediate threat of serious environmental degradation arising from weather, stream flow conditions or other natural conditions.

The Hydraulic Code specifies technical provisions for hydraulic projects (WAC 220-110-050 through 220-110-220). Technical provisions do not automatically apply to each HPA, the applications are reviewed individually. Activities having provisions that are applicable to this plan include the following:

- Bank protection
- Bridge, pier, and piling construction
- Bridge construction—stringer type
- Channel change—temporary and permanent
- Channel realignment
- Temporary bypass culvert or flume
- Dredging
- Gravel removal
- Log and log jam removal
- Logging
- Pond construction
- Water diversions.

A hydraulic project application may be denied when the Department of Fish and Wildlife rules it is directly or indirectly harmful to fish and adequate mitigation cannot be assured by conditioning or modifying the proposal. The code states that protection of fish life is the only grounds for denying or conditioning an application.

The Department of Fish and Wildlife (WDFW) is currently conducting the HPA Program Review and ESA Compliance Project. The timeline for project implementation has been extended from July 1, 2001 to January 1, 2003. There is a Memorandum of Agreement (September 1999) among the U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NFMS), and WDFW, to develop an ESA compliance agreement for Hydraulic Project Approvals (HPAs) issued by WDFW. The Memorandum of Agreement also outlines procedures and criteria for issuance of HPAs, to minimize risk of take.

Application to Yakima County

The County will be required to obtain an HPA for most structural flood control activities including stream bank protection; construction of bridges, piers, and docks; culvert installation; gravel removal; channel realignments; placement of outfalls; debris removal; and pipeline crossings. HPAs are required for activities in natural drainage corridors as well as in flowing stream corridors.

Growth Management Act

In April 1990, the Washington Legislature passed the Growth Management Act (RCW 36.70A). Amended by the Legislature in 1991 and 1993, the Act takes significant steps toward managing growth in the state's fastest growing counties. The Act defines 13 goals to guide development of comprehensive plans and regulations in counties and cities that are required to or choose to plan under this act. The goals include the following:

- Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development.
- Encourage the retention of open space and development of recreational opportunities; conserve fish and wildlife habitat; increase access to natural resource lands and water; and develop parks.
- Maintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries. Encourage the conservation of productive forests and productive agricultural lands, and discourage incompatible uses.
- Protect the environment and enhance the state's high quality of life, including air and water quality and the availability of water.

The Growth Management Act (GMA) is administered by the Washington State Office of Community Development (OCD). According to Section 4.0 of the GMA, the following counties and their cities were required to develop and adopt comprehensive plans by July 1, 1995:

- Counties with a population of 50,000 or more that have experienced a population increase of at least 10 percent in the last 10 years, and cities within such counties.
- Counties, regardless of population, that have experienced a population increase of more than 20 percent in the last 10 years, and cities within such counties.

After May 16, 1995, any county with a population of 50,000 or more, and the cities within the county, that increases in population by more than 17% over 10 years, and any county (and the cities within the county) regardless of its population that increases in population by more than 20% in 10 years is required to adopt a comprehensive plan.

Local governments are required to classify and designate “resource lands of long-term commercial significance” and “critical areas.” Resource lands of long-term commercial significance include agricultural, forest, and mineral resource lands. Critical areas include wetlands, fish and wildlife habitat areas, aquifer recharge areas, frequently flooded areas, and geological hazardous areas.

Comprehensive plans must include the following:

- A description of objectives, principles, and standards used to develop the plan.
- A land use element designating the proposed general distribution, general location and extent of uses of lands. The land use element should also provide for the protection of the quality and quantity of groundwater used for public water supplies, review drainage, flooding, and stormwater runoff patterns, and provide guidance for corrective actions to mitigate or cleanse discharges that pollute waters of the state.
- A housing element recognizing the vitality and character of established residential neighborhoods.
- A capital facilities plan consisting of an inventory of publicly owned facilities, a forecast of future needs, proposed locations and capacities of expanded or new capital facilities, and a six-year financing plan.
- A utilities element consisting of the general location and capacity of all existing and proposed utilities, including electric lines, telecommunication lines, and natural gas lines.
- A transportation element that implements and is consistent with the land use element.
- A rural element (counties only) permitting land uses compatible with the rural character of such lands that provide for a variety of rural densities.

Optional elements of the plan include economic development, conservation, solar energy, and recreation.

The GMA also requires the designation of areas for which urban growth shall be encouraged and areas where growth can occur only if it is not urban in nature. Furthermore, each urban growth area is required to include greenbelt and open space areas. Open space corridors between and within urban growth areas must include lands designated for recreation, wildlife habitat, trails, and connection of critical areas.

The GMA establishes reporting requirements for counties and cities required to develop comprehensive plans. Designations of resource lands of long-term commercial significance and critical areas were required by March 1, 1992. The development of comprehensive plans or modification of existing plans was to have begun by March 1, 1992. County-wide planning policies, which are used to provide the framework for comprehensive plans, were to be developed by July 1, 1993. Extensions enacted by the 1993 Legislature postponed both the comprehensive plan and implementation regulations deadlines from 1994 to 1995.

OCD has established a program of technical and financial assistance and incentives to encourage the creation of comprehensive plans and development regulations throughout the state. The act encourages jurisdictions to require, by ordinance, that new growth and development pay a proportionate share of the cost of new facilities needed to serve it.

The GMA requires the adoption of regulations and procedures for the development of short plats and subdivisions, regional transportation plans, forest practices and water rights issues. The GMA also encourages economic prosperity and balanced economic growth by building to local capacity in rural areas and encouraging urban-rural links.

House Bill 1025 amended the GMA and established requirements that county-wide planning policies be adopted as a framework for county and city comprehensive plans. These policies, to be adopted by the county in cooperation with its cities, were required by July 1, 1992. The following features were to be included:

- Urban Growth Areas (areas targeted for higher density development)
- Policies for promotion of contiguous and orderly development and provision of urban services to such development
- Policies for siting public capital facilities of a county-wide or state-wide nature
- Policies for county-wide transportation facilities and strategies
- Policies that consider the need for affordable housing, such as housing for all economic segments of the population and parameters for its distribution
- Policies for joint county and city planning within urban growth areas
- Policies for county-wide economic development and employment
- An analysis of fiscal impact.

Application to Yakima County

Yakima County has developed and adopted *Plan 2015,* a GMA comprehensive plan. Yakima County meets both criteria specified in RCW 36.70A.040: at least 50,000 residents and a population increase of more than 10 percent over the previous 10 years (1980 - 1990). Yakima County was awarded an OCD grant to integrate redundant parts of the SEPA and GMA processes. A description of this integration is given in *Plan 2015, Chapter III: Environmental Analysis Element.* The approach adopted by the County has been to define potential adverse impact of new development as either *system impact* or *project impact* according to Washington laws applied to determination of impact fees (RCW 82.02).

A *system impact* affects a system of facilities, services or the natural environment. An off-site impact is generally a system impact. The level of impact is determined and quantified at the time of comprehensive plan development, based on the population forecasts and preferred land use advocated by the Comprehensive Plan. A *project impact* affects a specific development project rather than a natural or service system. An on-site impact is generally a project impact. Potential adverse impact is determined on a case-by-case basis at the time of permit approval, similar to the existing SEPA process.

In the case of system impact, including stormwater, a mitigation model will be employed that converts information about the type, size and location of proposed developments into a mitigation obligation expressed in standardized units. Once determined, the developer may fulfill the obligation by providing equivalent facilities in any system service category according to a "Cafeteria Plan" administered by the Yakima County Planning Division. Several potential mitigations for the *floodplain protection* system include mitigation payments, land dedication/protection, on-site stormwater detention, transfer of development rights, and greenway program or similar program.

The Flood Hazard Management Plan will be an important addition to the critical areas inventory and to the comprehensive planning process addressing future land use, transportation, environmentally sensitive areas, and capital improvements.

Executive Order 90-04, Protection of Wetlands

Washington Executive Order 90-04 directs all state agencies to "rigorously enforce their existing authorities to ensure wetlands protection" and includes the following stipulations:

- Ecology shall exercise its authority under the Shoreline Management Act and the Clean Water Act to condition, deny, or appeal permits to assure wetlands protection.
- Ecology shall develop a model wetlands protection element for local governments to consider when amending shoreline master programs under the Shoreline Management Act.
- The Departments of Wildlife and Fisheries shall fully implement the authority granted under the Hydraulic Code to condition or deny permits to protect fish life assuring wetlands protection.

The order also directs the Department of Natural Resources, the Forest Practices Board, the Department of Agriculture, the Office of Community Development, and other state agencies to review and amend their rules and regulations to better protect wetlands. Ecology is directed to assist these agencies in the review of their rules. Development of statewide policies, standards for wetlands rating systems and inventories, mitigation, buffers, restoration, and enhancement is the prime responsibility of Ecology. The executive order also creates an interagency Wetlands Review Board and requires wetlands education and outreach activities.

In response to Executive Order 90-04, Ecology developed a Model Wetlands Protection Ordinance in September 1990. The model ordinance is a voluntary technical assistance recommendation. Ordinance standards and policies are based on existing local ordinances that protect wetlands and on the expertise of Ecology staff and other professional experts. Local governments may use the model ordinance to achieve the goal of "no net loss of wetlands" within their jurisdiction. Ecology has no authority to require that local governments adopt the ordinance or any of its policies or standards.

In addition, Ecology has established a Wetland Protection Grant Program to assist local jurisdictions in implementing wetland protection regulations. Local jurisdictions that choose to adopt the model ordinance under the grant program can modify the ordinance based on public comment and site-specific needs of the community and its environmental setting. Local programs funded by the grant are expected to reflect the intent of the model ordinance to achieve a goal of no net loss of wetland functions and values.

Application to Yakima County

Because Executive Order 90-04 requests that all actions of local governments in the state be consistent with its intent and goals, the County can gain additional support from the state in the regulation of activities in its wetlands. Wetlands provisions in existing state regulations, such as the Hydraulic Code and the Shoreline Management Act, are also strengthened as a result of this order.

Water Resources Program - Surface and Groundwater Codes

The water resources program is administered by Ecology in accordance to Chapter 90.03, 90.45, and 90.54 RCW. The goal of the program is to ensure that waters of the state are properly allocated for the greatest benefit of people of the state and to regulate uses according to established water rights. Ecology manages surface and groundwater planning, water rights adjudication, and water well technology.

Application to Yakima County

The water resources program would apply to Yakima County if flood hazard management practices divert water from the Naches River or channel re-routing affects other water-users.

Forest Practices Act

The Forest Practices Act (RCW 76.09) regulates forest practices on state and private lands. Responsibility for administering the act lies with the Forest Practices Board and the Department of Natural Resources (DNR). Rules and regulations are enumerated in Title 222 of the WAC. Notification or application must be sent to DNR before the start of any forest practices except those with no direct potential for damaging a public resource.

Forest practices are divided into four classes, depending on their potential for *impact* on the environment. Under the classification system, an operation with no direct potential for damaging a public resource, such as removal of less than 5,000 board feet of timber for personal use in a 12-month period, would be rated Class I. Potentially significant operations such as forest practices in areas designated as critical habitat of threatened or endangered species would be rated Class IV Special.

The following rules apply to forestry activities in riparian and wetland areas (Chapter 22 WAC):

> Riparian Management Zones (RMZs) are to be established adjacent to Type 1, 2, or 3 streams as defined in WAC 222-16-030. They extend anywhere from 25 to 100 feet from the stream, depending on the type and average width of the stream. Specific

requirements relating to the minimum number of trees that must be left within the RMZ, the ratio of conifer to deciduous trees, and the minimum size of standing trees are listed for each water type and average stream width.

Wetland Management Zones (WMZs) are to be established for non-forested wetlands (defined as wetlands that have, of if the trees were mature would have, a crown closure of less than 30 percent). Specific widths of the WMZ (as measured horizontally from the wetland edge or the point where the non-forested wetland becomes a forested wetland) are specified depending on type and size of the non-forested wetland. A total of 75 trees that have a diameter at breast height (dbh) of greater than 6 inches must be left after harvest in each acre with the WMZ. The regulations also contain suggestions for the number and types of trees that should be left in forested wetlands.

The WAC also contains regulations pertaining to road construction and maintenance, reforestation, and the use of forest chemicals.

The DNR is assessing Watershed Administrative Units (drainage basins of 10,000 to 50,000 acres) to determine the impact of forest practice on fish, water, and capital improvements of the state (WAC 222-22). WAC 222-22-010 describes the project as follows:

> The long-term objective ...is to protect and restore [public resources] and productive capacity of fish habitat adversely affected by forest practices while maintaining a viable forest products industry... through prescriptions designed to protect and allow the recovery of fish, water, and capital improvements of the state or its political subdivisions, through enforcement against non-compliance of the forest practices rules in Title 222 WAC, and through voluntary mitigation measures.

The forest practices rules and regulations will receive continuing review through annual evaluations, development of resource management plans to achieve the purpose and policies of the Forest Practices Act, and adoptive management. Adoptive management involves modification of the regulations when baseline data, monitoring, evaluation, or the use of interdisciplinary teams show modifications will better meet the purpose and policies of the act.

Application to Yakima County

Forest Practices rules affect flood hazard management insofar as they help ensure that watersheds such as the Naches and Yakima River's are managed responsibly to limit their contribution to increased flooding.

COUNTY REGULATORY MECHANISMS

Planning Documents

The Yakima County Commissioners have adopted various comprehensive planning documents affecting floodplain management. These non-regulatory documents are used as policy guidelines for making future land use decisions in the County. They are implemented through County zoning, shoreline, and floodplain codes. Those that affect floodplain management are discussed below.

Yakima County Comprehensive Plan

The 1977 Yakima County Comprehensive Plan addresses flood hazard potential in its section on the natural environment. The following policy directives are designed to guide floodplain development:

- Prohibit the construction of buildings in the floodway of any river or stream and discourage structural development in the floodplain; any essential floodplain development shall be floodproofed.
- Maintain sufficient open space for the storage of floodwaters.
- Ensure that proposed subdivisions and large site developments include provisions to protect the natural drainage system, or provide supplemental drainage facilities.
- Encourage the expansion of water storage capacities where feasible.

The 1977 Comprehensive Plan establishes a *Shoreline-Wetland Areas* land use category, the criteria for which include “all areas covered by flood management programs or mapped as floodplains or floodway.”

The 1981 Yakima Urban Land Use Plan and 1981 Yakima Rural Land Use Plan apply the recommendations of the County’s Comprehensive Plan within the Yakima urban area.

2015 Comprehensive Plan (Plan 2015)

Plan 2015 was adopted in 1997 to address growth and development issues for the next twenty years. The “2002 Update” of the plan is currently underway. This document is both a resource, documenting the features, characteristics and statistics that describe Yakima County, and a planning guide for future activities in Yakima County. Policies that apply to floodplain management in unincorporated areas of the County are included in the Natural Resources Element. This element addresses the need to protect the region’s hydrologic resources as well as provide for reliable water supply to areas where development is to be allowed and encouraged.

Open Space Tax Program

Yakima County recognizes the importance of incentive programs that give property tax concessions for conserving open space. Many property owners are eligible to apply for an open space tax classification that reduces their property tax obligation.

Yakima County Zoning Ordinance

The Yakima County Zoning Ordinance is adopted as Title 15 of the Yakima County Code. This ordinance was most recently amended in February 2000. A primary purpose of the Zoning Ordinance is to further the goals and policies of the comprehensive plan for the physical development of the County. The County has 16 zoning districts, including an overlay district and a reserved district. The zoning ordinance describes uses, density requirements, setbacks, lot clustering, height regulations, lot coverage, and development standards for each zoning district. Much of the area within the Naches River floodplain outside of the urban area is zoned Remote/Extremely Limited, along with Agriculture, and other rural zoning; however, within and near urban areas, there are residential and other more intensive zones.

Yakima County Flood Hazard Ordinance

Yakima County's Flood Hazard ordinance (County Ordinance 3-1985) is required by the FEMA for participation in the NFIP. Yakima County's Flood Hazard Ordinance is contained within the Critical Areas Ordinance. Therefore the CAO permit review process triggers a flood check if the project is located in a flood hazard area. The Ordinance regulates development in areas of special flood hazard. Development is defined as any manmade change to real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations. Special flood hazard areas are areas subject to a one percent or greater chance of flooding in any given year as shown in FEMA flood hazard maps. The ordinance emphasizes standards for construction of residential and nonresidential structures. Standards for flood hazard protection in special flood hazard areas include the following:

- Anchoring requirements for new developments, substantial improvements, and manufactured homes
- Requirements of flood-resistant construction materials and utility equipment and the use of construction methods that minimize flood damage
- Design and location requirements for water and sewage disposal systems that minimize adverse impact due to flooding
- The requirement that subdivision proposals include designs to minimize flood damage
- Review of building permits to ensure proposed construction is reasonably safe from flooding.

The provisions for flood hazard protection in designated floodways are considerably more stringent than those for areas between the floodway and the edge of the floodplain. The placement, construction, reconstruction, or substantial improvement of any structure is prohibited in the floodway, as are a range of other encroachments associated with development. However, exceptions to this requirement can be made if the encroachment does not result any increase in flood levels during the base flood, unless a residential structure is involved, in which case no exceptions are allowed. If this requirement is satisfied, the general and special standards for special flood hazard areas must still be met for construction and substantial improvements within floodways.

Yakima County SEPA Ordinance

SEPA is implemented at the local level through Yakima County's Planning Division. Policies and procedures are specified in Title 16 of the County Code. Title 16 largely incorporates the State's rules for ensuring potential environmental impact is considered when making decisions such as the issuance of permits. The SEPA process is as follows:

- A permit application is submitted to a County agency or an agency proposes an activity, plan, ordinance, or regulation.

- Yakima County determines whether the proposal is exempt from the SEPA regulation. If so, no further action relating to SEPA is required.
- If the project is not exempt, an environmental checklist is completed. The checklist solicits additional information to be used in determining potential impact on earth, air, water, plants, animals, energy and natural resource, environmental health, land and shoreline use, housing, aesthetics, light and glare, recreation, historical and cultural preservation, transportation, public services, and utilities.
- The environmental checklist is reviewed to determine whether the project is likely to have significant environmental impact. If not, a determination of non-significance (DNS) is issued and no further action is required.
- If is determined that the project will have significant adverse environmental impact but mitigation measures could reduce or eliminate the impact, a mitigated DNS may be issued. The mitigated DNS documents the mitigation measures that must be implemented with the project.
- If it is not possible to issue a DNS or mitigated DNS, an environmental impact statement must be prepared.

Yakima County Shoreline Management

Yakima County regulates shoreline uses and development through its Shoreline Master Program (SMP). The SMP is implemented under requirements of the Washington State Shoreline Management Act, which gives local governments authority to regulate shoreline development and activities. The definition of “shoreline” includes lands extending landward for 200 feet in all directions as measured on the horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways and all marshes, bogs, swamps, and river deltas associated with the streams and lakes which are subject to the provisions of the Shoreline Management Act.

County shorelines are divided into four designations: Natural, Conservancy, Rural, and Urban. The most stringent regulations are associated with natural shoreline areas and the least stringent regulations are associated with urban shoreline areas.

Land use activities regulated under the SMP include the following: agriculture, aquaculture, archeological, natural and historic sites, commercial, dredging, forest management, historic sites, industrial activities, landfill, mining, recreation, residential, roads and railways, shoreline protection activities, signs, solid waste disposal, and utilities. Polices and regulations are defined for each activity.

The SMP regulates shoreline use and development through the following permit requirements:

- **Shoreline substantial development permit** -- Required for development that costs $5,000 or more or that materially interferes with the normal public use of the water or shorelines of the state.

- **Shoreline conditional use permit** -- Applies to uses or developments listed in the regulations as being permitted only conditionally. This permit is designed to recognize and allow for special circumstances or a type or style of land use that is consistent with the goals and policies of the SMP, yet are not provided for under the program.
- **Shoreline variance** -- An adjustment of the SMP's standard regulations for a particular site.

Yakima County Critical Areas Ordinance

The Yakima County Critical Areas Ordinance (CAO) was adopted in 1995 to comply with the Washington State Growth Management Act. The purpose of the CAO is to identify and manage environmentally critical areas and ecosystems in accordance with Yakima County's Comprehensive Plan. The critical areas governed include flood hazard areas, wetlands, geologically hazardous areas, aquifer recharge areas, and fish and wildlife habitat areas areas. Yakima County is currently updating the CAO to incorporate the use of Best Available Science and revisions to the permitting process that are concurrent with ESA requirements for the preservation and protection of anadromous fisheries habitats. Included will be revisions to existing development regulations and policies, conducting an inventory and creating revised maps of critical areas.

The ordinance includes regulation of stream corridors, defining them to include the 100-year floodway and floodplain, the main and all secondary channels of the stream, any vegetated shallows, any additional flood-prone areas determined by professional geologists or engineers, and jurisdictional wetlands in upland environments. Locations of Type I and Type II stream descriptions are contained in the CAO. The Planning Division has mapped these locations in addition to other regulated stream corridors (Types III, IV, and V).

Permit applications begin with a pre-application conference with the Planning Division to discuss the project feasibility and regulatory restrictions. Upon submittal of a project proposal, the Division makes an initial determination as to whether the project affects or impairs a designated critical area and the level of project review required. If the project affects a critical area, additional guidance may be provided through a technical assistance conference with representatives of agencies and organizations with expertise, interest, or jurisdiction in the project.

A critical area development authorization application must be filed with the Planning Division for projects in identified critical areas. Information required for the application is listed in the ordinance. Following evaluation of the project, the Planning Division may grant a critical area development authorization, grant a conditional authorization, return the application for needed revisions that would eliminate or reduce critical area impact, or deny the application.

Other Local Regulatory Mechanisms

The City of Naches has ordinances similar to those administered by the County, including, a flood damage prevention ordinance, zoning code, and critical areas ordinance.